

Exam Procedures:

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

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

- Your Student PID Number (excluding “A”)
- Your last name and first name
- Course ID in “subject” **this is BMB 514 Exam #1**
- Date**09/13/13**
- Exam form in “period”**this is form A**
- By signing this coversheet for this exam, the student certifies that he/she has adhered to the policies of academic honesty in the performance of this exam.

Signature

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.
- Make sure your exam has **32** questions.
- 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.
- A simple calculator is supplied for your use during this exam. Cell phones must be off (not on vibrate) and stored with your bags/backpacks/other materials.
- 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.
- We will not answer questions of clarification. However, if you think there is an error on your exam, summon an exam proctor.
- When you finish, place all exam materials (except the tear sheet) into the manila envelope. When you leave the exam room, please turn in your envelope to the proctors. Once you exit the auditorium, please leave the area. 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.
- We will close the exam promptly at **9:10 a.m.** At the announcement of the examination end time, the examination and scantron and images (if provided as part of the examination) must immediately be placed into the manila envelope provided.

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

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					logs				

E.g. $\log 3.5 = 0.54$

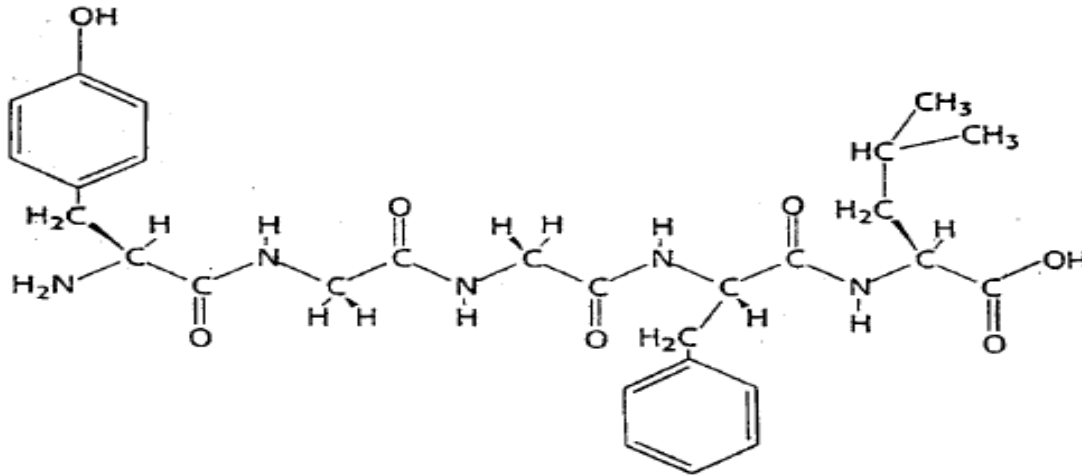
Reminder: How to form logs of multiples

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

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

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

Questions 1 -3 refer to the structure shown below.



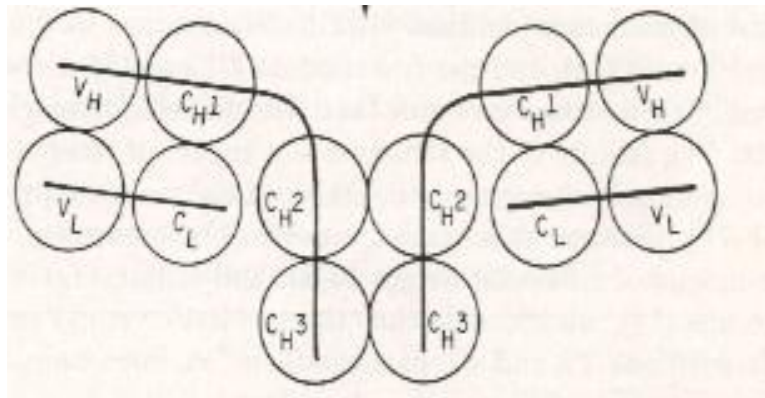
- 1) Which of the following best describes the molecule shown by the above structure?
 - A) a carbohydrate
 - B) a disulfide
 - C) a nucleotide
 - D) a peptide
 - E) a vitamin
- 2) Considering **ONLY** the **SIDE CHAINS** of the amino acids in this molecule, how many can participate in hydrogen bonding with water?
 - A) 1
 - B) 3
 - C) 5
 - D) 7
 - E) 9
- 3) This molecule can serve as an effective buffer over the pH range 9.5-10.5. The buffering power over this pH range is due to which amino acid?
 - A) amino acid #1
 - B) amino acid #2
 - C) amino acid #3
 - D) amino acid #4
 - E) amino acid #5

4) A 60-year-old man is brought to his physician from an institution for severe mental deficiency. The physician reviews his family history and finds he has an older sister in the same institution. Their parents are deceased but reportedly had normal intelligence and no chronic diseases. The man sits in an odd position as though he was sewing. This prompted the experienced physician to obtain a ferric chloride test on the man's urine. The ferric chloride test turns color with aromatic compounds, including certain amino acids and a green color confirms the physician's suspicion. Which of the following amino acids was most likely detected in the man's urine?

- A) glutamine
- B) glycine
- C) methionine
- D) phenylalanine
- E) serine

5) The structure of an immunoglobulin G (antibody) molecule is shown schematically below. The black solid line depicts an individual polypeptide and so there are four polypeptides in the quaternary structure of this molecule. Each of the spheres represents a stretch of about 100 amino acids folded independently of the rest of the polypeptide (i.e. the other spheres) and performs a specific function in the molecule. Therefore, each sphere was given its own individual name (V_H , C_H1 , C_H2 , etc.). Without knowing additional details, you can predict that there must be TWELVE _____ in this molecule.

- A) α -helices
- B) domains
- C) protomers
- D) subunits
- E) β -barrels



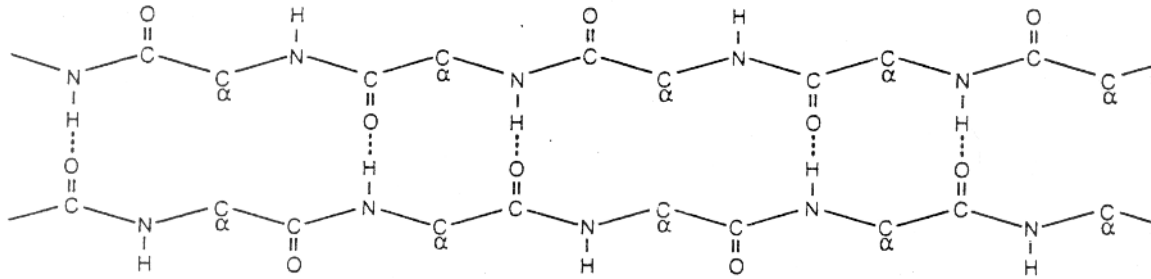
6) Some patients with erythrocytosis (excess red blood cells) have a mutation that converts a lysine to alanine at residue 82 in the β -subunit of hemoglobin. This particular lysine normally protrudes into the central cavity of deoxyhemoglobin, where it participates in binding 2,3-diphosphoglycerate (DPG). Which of the following effects would you predict this mutation (Lys82Ala) will have on the affinity of hemoglobin for DPG and for O_2 , respectively, in patients with erythrocytosis? (Below, the terms "increase" and "decrease" are relative to normal (without mutation))

affinity for DPG

affinity for O_2

- | | |
|---|----------|
| A) increase | decrease |
| B) increase | increase |
| C) decrease | increase |
| D) decrease | decrease |
| E) no effect on either binding function | |

7)



The above diagram illustrates one type of secondary structure within a polypeptide. Which of the following best describes where you would find this secondary structure?

- A) a disulfide-bonded polypeptide
- B) a transmembrane α -helix
- C) ionic bonds between two polypeptides
- D) an anti-parallel β -structure in a β -barrel
- E) the side chains of a polypeptide

Questions 8-10 refer to the diagram below. You may find it helpful to identify the chemical names of the various components labeled M, N, P, Q, etc. before proceeding.

Diagram X

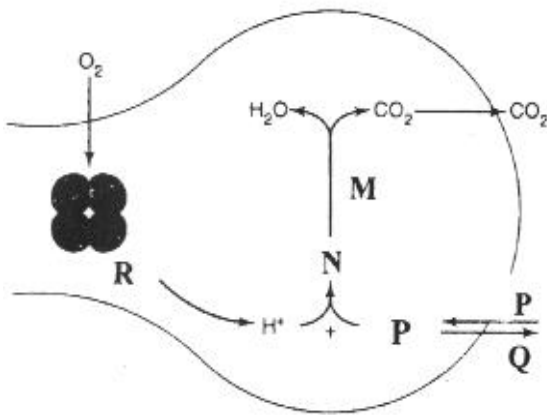
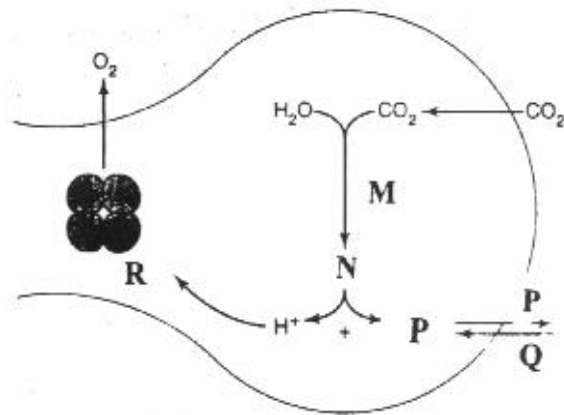


Diagram Y



8) Which of the following best represents the locations (tissue/organ) of the various biochemical events depicted in Diagrams X and Y?

Diagram X

Diagram Y

- | | | |
|----|-------|-------|
| A) | toe | brain |
| B) | toe | lung |
| C) | brain | lung |
| D) | brain | toe |
| E) | lung | toe |

9) In both Diagram X and Diagram Y, one of the letters (M, N, P, Q, R) denotes an enzyme. This enzyme is labeled as:

- A) M
- B) N
- C) P
- D) Q
- E) R

10) In the "chloride shift," the Cl^- anion is exchanged for the component labeled as:

- A) M
- B) N
- C) P
- D) Q
- E) R

11) In a patient with severe chronic obstructive pulmonary disease (COPD), COPD "flares" are common and result in an inability to ventilate and the accumulation of carbon dioxide in the body. This leads to a primary respiratory acidosis. Of the following mechanisms, which is the most important for the management of the acid-base status?

- A) $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$
- B) $\text{H}^+ + \text{NH}_3 \rightleftharpoons \text{NH}_4^+$
- C) R-COOH (β -COOH group of Aspartic Acid) $\rightleftharpoons \text{H}^+ + \text{R-COO}^-$ (β -COO⁻ group of Aspartate)
- D) $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$
- E) $\text{H}_3\text{PO}_4 \rightleftharpoons \text{H}^+ + \text{H}_2\text{PO}_4^-$

Questions 12 and 13 refer to the case below.

A 45-year-old man was rushed to the emergency room from a local restaurant after having "choked" while eating. On physical examination (temperature, 37.2° C; pulse, 125; blood pressure, 170/110), there was marked cyanosis and very labored respiration. Lab measurements yielded the following results:

	<u>Patient Data</u>	<u>Normal Range</u>
pCO ₂ (mm Hg)	90	35 - 45
[HCO ₃ ⁻] (mM)	27	22 - 26
[Na ⁺] (mEq/L)	143	136 - 145
[K ⁺] (mEq/L)	4.8	3.5 - 5.0
[Cl ⁻] (mEq/L)	104	95 - 105

The solubility coefficient for CO₂ at 37° C is 0.03 mM/mmHg; the pK_a value for the carbonic acid-bicarbonate buffer system is 6.1.

12) Choose the value below that most closely matches the patient's blood pH.

- A) 7.5
- B) 7.4
- C) 7.3
- D) 7.2
- E) 7.1

13) Characterize the acid-base disturbance and physiologic compensation, if any.

	<u>Primary Problem</u>	<u>Compensation</u>
A)	Metabolic acidosis	Respiratory compensation
B)	Metabolic alkalosis	No compensation
C)	Respiratory alkalosis	Metabolic compensation
D)	Respiratory acidosis	Metabolic compensation
E)	Metabolic acidosis	No compensation

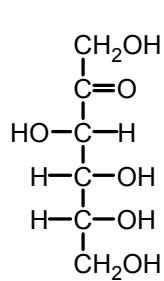
Questions 14 and 15 refer to the lab results shown below. For each question, match the clinical description with the lab result that seems most appropriate.

	<u>pH</u>	<u>pCO₂</u> <u>(mm Hg)</u>	<u>[HCO₃⁻]</u> <u>(mM)</u>
normal range	7.35-7.45	35-45	22-26
A)	7.22	69	26
B)	7.26	26	11
C)	7.33	68	34
D)	7.40	40	24
E)	7.50	29	22

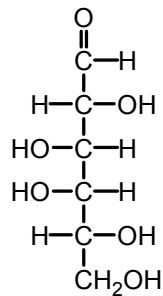
14) A 26-year-old medical student suffers an acute anxiety attack and hyperventilates. The respiratory rate is 26 breaths/min (normal 12-18). Because the condition is acute, there has not been enough time for compensation.

15) A 57-year-old female smoker suffering from chronic obstructive pulmonary disease (COPD). There is inflammation and damage to the mucous membrane of the airway bronchi, resulting in poor gas exchange and shortness of breath. Because the condition is chronic, there has been opportunity for compensation.

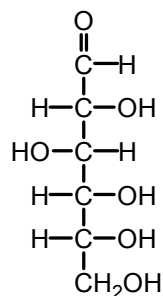
16)



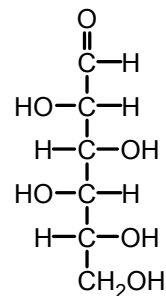
Molecule 1



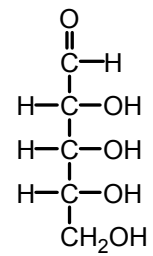
Molecule 2



Molecule 3



Molecule 4

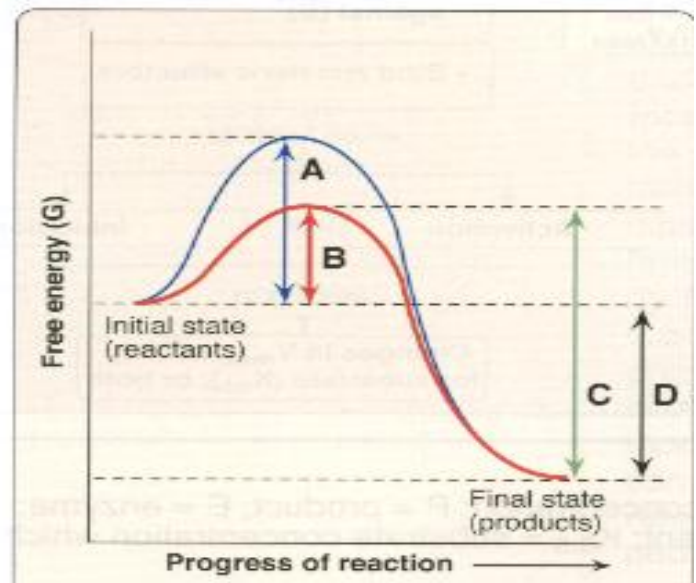


Molecule 5

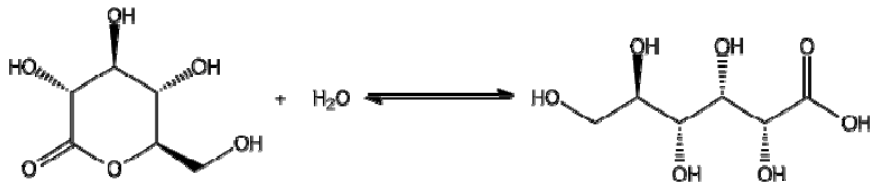
In the above figure, which two molecules are epimers?

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

17) For this question, use the graph below which shows the changes in free energy when a reactant is converted to a product in the presence and absence of an enzyme. Select the letter that best represents the free energy of activation of the **catalyzed reverse** reaction?



- 18) Below is a reaction in the oxidative phase of the pentose phosphate pathway catalyzed by the enzyme gluconolactonase. This enzyme would be classified as what type?



- A) Transferase
- B) Hydrolase
- C) Lyase
- D) Oxidoreductase
- E) Isomerase

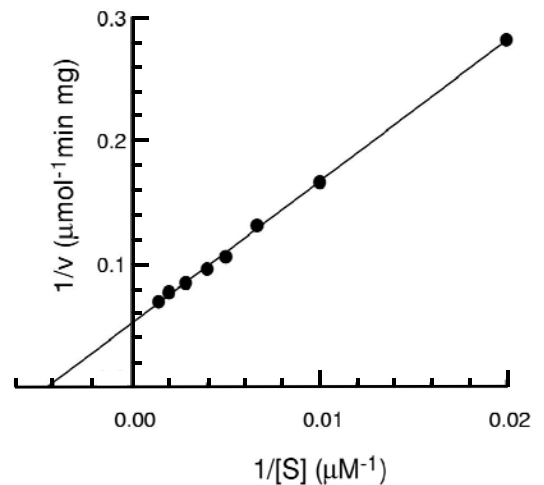
The graph on the right represents the data obtained from an experiment where various concentrations of Coenzyme A were hydrolyzed by a known amount of enzyme (1 mg).

Use this graph to answer the next two questions.

Given: $v = V_{max} * ([S]/([S] + K_m))$

- 19) When this enzyme was incubated with 585 μM substrate, what was the rate of catalysis?

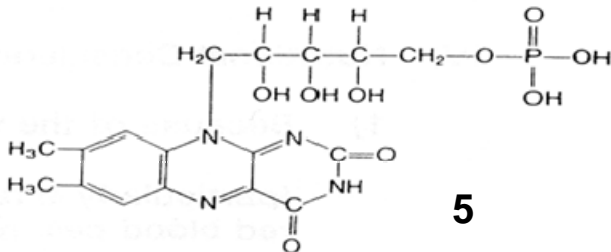
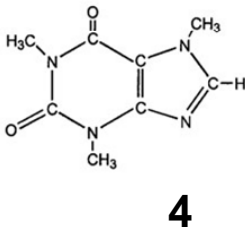
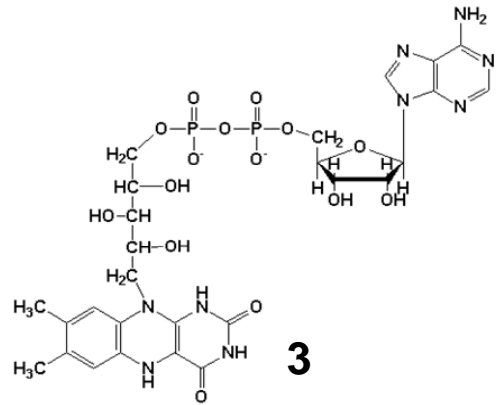
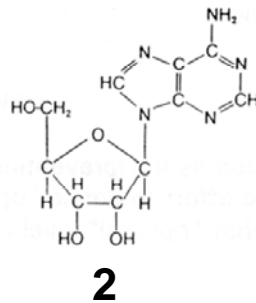
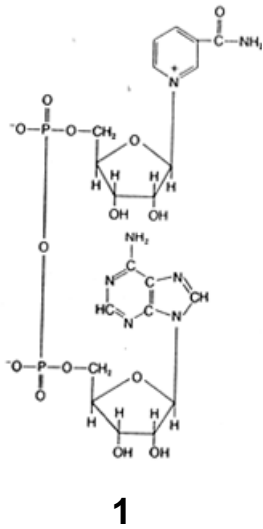
- A) 0.35 $\mu\text{mol} / \text{min}$
- B) 1.9 $\mu\text{mol} / \text{min}$
- C) 5.0 $\mu\text{mol} / \text{min}$
- D) 14 $\mu\text{mol} / \text{min}$
- E) 20 $\mu\text{mol} / \text{min}$



- 20) If this enzyme were treated with a non-competitive inhibitor, how would you expect the graph to change?

- A) The y-intercept would move up (away from the origin)
- B) The x-intercept would move left (away from the origin)
- C) The y-intercept would move down (toward the origin)
- D) The x-intercept would move right (toward the origin)

Questions 21 and 22 refer to the structures shown below



21) Which of the molecules, as drawn above, could accept two hydrogens?

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

22) A 57 yr old male patient is seen who complains of dry, itchy, scaly skin patches and diarrhea of increasing frequency. The patient also complains of bouts of confusion. The patient admits to having "a few" beers a day and an occasional drink of "something stronger". You suspect a deficiency in which of the molecules depicted above?

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

23) Enzymes form a complex with their substrates in the process of conversion to product. What feature of this complex would facilitate catalysis?

- A) Stabilize the transition state by lowering the ΔG of the reaction
- B) Hold substrates close together, effectively increasing their concentration
- C) Increase the energy of activation by inducing bond stress or strain
- D) Bind substrates in a stable, low energy conformation

24) Human alcohol dehydrogenase is capable of oxidizing several substrates; the kinetic parameters for these substrates are given in the table below. Which is the most preferred substrate according to these values? Assume a constant enzyme amount of 1 mg when these experimental values were obtained.

Answer Choice	Substrate	Km (μM)	Vmax ($\mu\text{mol min}^{-1}$)
A	Hexanol	39	16
B	Butanol	31	30
C	Ethylene Glycol	14	11
D	Methanol	11	26
E	Propanol	15	28

25) The reaction Fructose 6-P + ATP \rightleftharpoons ADP + Fructose 1,6-bisP is catalyzed by the glycolytic enzyme phosphofructokinase 1. In muscle tissue, it is a homotetramer (contains 4 identical subunits). Adenosine monophosphate (AMP) can bind at a site distant from the site of catalysis on any of the four subunits and induce a conformational change that favors a relaxed and more active state of the whole tetramer. How would the role of the molecule, AMP, be classified in this reaction?

- A) Positive homotropic effector
- B) Negative homotropic effector
- C) Positive heterotropic effector
- D) Negative heterotropic effector

26) A 67 year old male patient is new to your practice at a retirement home in southern Florida as he and his wife recently moved here from Alberta Canada. He has not been to a doctor in several years, considers himself healthy, and is only here to appease his wife. He is 5 feet 11 inches tall and weighs 223 pounds. When you ask about his diet and exercise, he tells you he has had the same general routine for many years and has always “been in a good place” whenever he was checked out. You inform your patient that he is _____ I _____, and this is most likely due to a _____ II _____.

$$\text{BMI} = \frac{((\text{weight in pounds}) * 704)}{(\text{height in inches})^2}$$

	<u>BMI Value</u>
underweight:	below 18.5
normal:	18.5-24.9
overweight:	25-29.9
obese:	30 & above

- | | I | II |
|----|------------|-------------------------------------|
| A) | overweight | increased BMR due to warmer climate |
| B) | obese | decreased BMR due to age |
| C) | obese | increased BMR due to age |
| D) | overweight | decreased BMR due to age |
| E) | obese | decreased BMR due to warmer climate |

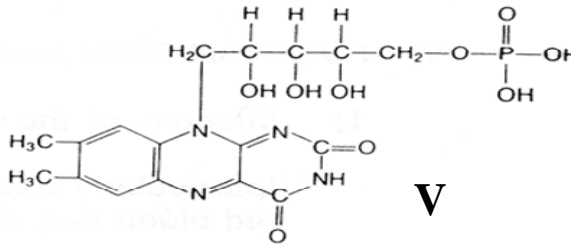
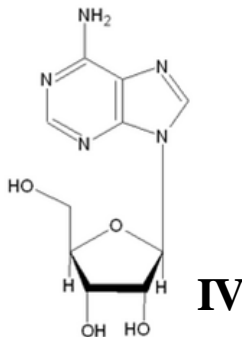
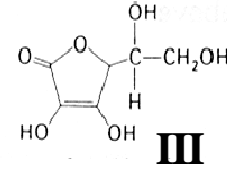
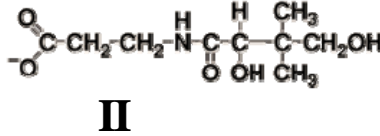
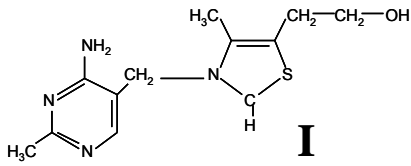
27) What central molecule of metabolism contains a high energy bond and is involved in the catabolism of proteins, carbohydrates, and fats as well as anabolism of many other biological molecules as a carbon source?

- A) ATP
- B) Glucose
- C) Acetyl CoA
- D) Carbon dioxide
- E) ADP

28) The metabolic process that includes thermogenesis, muscle contractions, and ion transport is characterized by which of the following statements?

- A) it is a constructive process
- B) it is an oxidative process
- C) it is extracellular in location
- D) it primarily produces energy
- E) it is predominantly unregulated

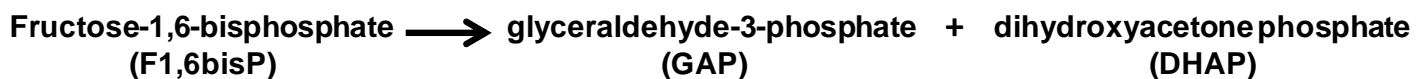
29) While on a medical mission to Nepal, you venture into the refugee camps and see several Bhutanese refugees who complain of joint pain, have multiple bruises and poor dental hygiene. These people have been completely dependent on provided food aid for some time. You determine that they are deficient in which of the following?



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

Questions 30 and 31 refer to the reaction catalyzed by adolase described below

30) The glycolytic enzyme, aldolase, catalyzes the reaction below with a $\Delta G^{\circ} = 5.6$ kcal/mol.
Given: $\Delta G' = \Delta G^{\circ} + 1.4 \log ([\text{Products}]/[\text{Reactants}])$



What is the equilibrium constant for this reaction?

- A) 10^{-4}
- B) 10^{-3}
- C) 10^{-2}
- D) 10^{-1}
- E) 1

31) Given the cellular concentrations $[\text{F1,6bisP}] = 10$ mM, $[\text{GAP}] = 1$ mM, $[\text{DHAP}] = 1$ mM, how would this reaction proceed?

- A) It would go in reverse (right to left as written above)
- B) It would go forward (left to right as written above)
- C) It would not proceed (at equilibrium)
- D) It would go in reverse, but very slowly

- 32) Which of the following is accurate concerning why ATP is an effective energy carrier for the cell?
- A) ATP is stable and requires enzymes to hydrolyze its phosphoanhydride bonds
 - B) ATP contains 3 identical high energy phosphoanhydride bonds.
 - C) ATP is only used for chemical work
 - D) The phosphoanhydride bonds of ATP are the highest energy bonds formed in the body
 - E) Adenine is the only nucleobase that can participate in an energy carrying molecule

END OF EXAMINATION - Tear off this sheet and save to check your answers.

- You may write in your answer to each question on this sheet. DO NOT make any other marks on this sheet. If there are any extraneous marks on this page it will be confiscated.
- Only the answer on the scantron is the official answer. **WE CANNOT USE THE ANSWERS ON THIS TEAR OFF SHEET TO DETERMINE YOUR GRADE.**

Please remember to:

- Write in the **letter of your form** in the area titled "Period" on the exam scantron.
- Return your examination** in the envelope provided to a proctor **before leaving the exam room.**

BMB 514 SS 2013 Exam #1

FORM: A

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