UNIVERSITY OF JOHANNESBURG

Faculty of Science

Principles of Biochemistry BIC1B01/BIC01B1

Examination

November 2015

EKSAMINAR **Dr. G. Koorsen**

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MODERATOR **Dr. J. James**

TIME **3 HOURS** **MARKS** **100**

Please read the following instructions carefully:

- Answer Section A on the Answer Sheet provided.
- Answer Section B in the Exam Books provided.
- The use of calculator is allowed.

SECTION A **[20]**

Multiple choice questions: Choose the best answer and mark your choice with a 'X' onthe ANSWER SHEET provided.

1. Carbon dioxide is non-polar because:

   a. The molecule is linear
   b. The molecule does not contain covalent bonds
   c. The molecule does not dissolve in water
   d. a and c
   e. All of the above

2. Which of the following classes of compounds is hydrophilic?

   a. Salt
   b. Cholesterol
   c. Phosphate esters
   d. a and c
   e. All of the above

3. True hydrogen bonds can ONLY form between hydrogen and this element:

   a. S
   b. H
   c. C
   d. O
   e. All of the above

4. Synthetic buffers that are unlikely to interfere with biological reactions include:

   a. Tris
   b. Hepes
   c. Phosphate
   d. a and b
   e. All of the above

5. If the pH of 1 liter of a 1.0M carbonate buffer is 7.0, what is the actual number of moles of H_2CO_3 and HCO_3^-? (pKa = 6.37)

	mol H_2CO_3	**mol HCO_3^-**
a.	0.86	0.14
b.	0.81	0.19
c.	0.76	0.2
d.	0.19	0.81
e.	0.14	0.86

6. Which amino acid has a beta hydroxyl group?
   a. Glutamic acid
   b. Histidine
   c. Isoleucine
   d. Serine
   e. Tyrosine

7. Evidence that the peptide bond displays resonance includes all of these reasons, **except**:
   a. It is planar
   b. It is shorter than a normal N-C single bond
   c. The alpha carbons attached to the peptide bond are always in a *cis* configuration
   d. It has double bond character
   e. a and b

8. The carboxyl group is attached to this carbon of the amino acid lysine:
   a. α
   b. β
   c. χ
   d. δ
   e. ε

9. Which amino acid contains an imidazole ring?
    a. Histidine
    b. Tryptophan
    c. Phenylalanine
    d. Proline
    e. Tyrosine

10. The pKa of a weak acid is:

    The choices are:

    1. Its dissociation constant
    2. The pH at which the concentration of acid and conjugate base are equal.
    3. Found at the midpoint of the titration curve.

    The answer is:

    a. 1
    b. 2
    c. 3
    d. Both 2 and 3
    e. All of these are correct

11. The buffer system in blood is:
    a. Phosphate buffer
    b. Tris
    c. Acetate buffer
    d. Oxalic acid buffer
    e. None of the above

12. Which amino acid is neither L- or D- configuration?
    a. Ala
    b. Asp
    c. Gly
    d. Pro
    e. Trp

13. A single water molecule can form a maximum of this number of hydrogen bonds:

    a. 1
    b. 2
    c. 3
    d. 4
    e. 5

14. Which of the following compounds are most likely to form a micelle?

    a. Acetic acid
    b. Glycerol
    c. Glucose
    d. Sodium phosphate
    e. Sodium palmitate

For Questions 15 to 20, decide if the statements are True or False. If True, mark A on the answer sheet provided and if False, mark B.

15. Any amphiphilic substance will form a micelle when it is dissolved in water.
16. Methionine is a highly hydrophobic amino acid.
17. The secondary structure of a protein can be completely described by all the combinations of backbone phi and psi angles.
18. The tertiary structure of a protein refers to the 3D structure of only the amino acid component of a protein.
19. A protein with more than one polypeptide chain has quaternary structure.
20. Vasopressin is a protein hormone.

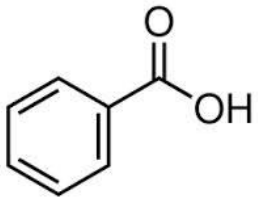
SECTION B **[80]**

Answer all Questions in the Exam books provided.

QUESTION1 **[30]**

1.1. Why is water essential for life? (2)

1.2. Benzoic acid is a weak acid (pKa = 4.2) that is used in the treatment of fungal skin infection.



Benzoic acid

Write down a dissociation reaction for benzoic acid and identify the acid and conjugate base. (2)

1.3. Describe how you would prepare 500 mL of a 0.2 M phosphate buffer (pKa = 7.2) at pH 7.2 from K_2HPO_4 and KH_2PO_4. (6)

$M_r(KH_2PO_4)$ =174.2 g/mol; $M_r(K_2HPO_4)$ = 136.1 g/mol

1.4. Draw the structures of the following amino acids:

1.4.1. Tryptophan (3)

1.4.2. Histidine (3)

1.4.3. Arginine (3)

1.5. Write down a dissociation reaction for the amino acid aspartic acid. Your equation must be in the form:

X ⇔ y ⇔ z ⇔ etc.

pKa=… **pKa=…** **pKa=…** (6)

You may use the following information in your answer:

Amino acid	**pKa (COOH)**	**pKa (NH_3^+)**	**pKa (R)**
D	1.7	8.4	3.8
R	1.4	9.2	11.6
A	1.6	8.8	-

Now answer the following questions:

1.5.1. What is the net charge of glutamic acid at pH 1, 7 and 12? (3)

1.5.2. What is the pI of arginine? (2)

QUESTION 2 **[10]**

2.1. Give the principle of ion exchange chromatography (4)

2.2. Define electrophoretic mobilty (2)

2.3. What is the name of an enzyme used to break ester bonds for the release of fatty acids (FA). (2)

2.4. What is the name of a technique used to determine the sedimentation coefficients of rRNA. (2)

QUESTION 3

[20]

Draw the structures of the following:

3.1. Sphingosine (4)

3.2. Draw a ceramide containing a 20: 2 $\Delta^{9\,(trans),12\,(cis)}$ fatty acid . (4)

3.3. All nucleotides found in RNA and name them (4)

3.4. A steroid skeletal structure containing

- a double bond between C6 and C7
- a hydroxyl group at C14
- a methyl group at C1 and C13 (8)

QUESTION 4 **[20]**

4.1. Give three properties of B-DNA form. (3)

4.2. Define topology. (2)

4.3. Define epigenetics. (2)

4.4. What is a nucleoside? (1)

4.5. What is the function of the following during protein synthesis? (8)

a. rRNA
b. tRNA
c. mRNA
d. miRNA/siRNA

4.6. What is the difference between chitin and cellulose? (4)

TOTAL [100]