

Faculty of Science



Principles of Biochemistry BIC1B01/BIC01B1
SSA Examination

DATE

SESSION 08h30 – 11h30

EKSAMINAR

Dr. G. Koorsen

MODERATOR

Dr I. Mwaba

TIME

3 HOURS

MARKS

80

Please read the following instructions carefully:

- Answer all the questions in the examination book provided.
- The use of calculator is allowed.

Question 1 (8)

Consider the following Table and answer the questions that follow:

Acid	HA	A ⁻	K _a
Pyruvic acid	CH ₃ C(=O)COOH	CH ₃ C(=O)COO ⁻	3.16 × 10 ⁻³
Formic acid	HCOOH	HCOO ⁻	1.78 × 10 ⁻⁴
Lactic acid	CH ₃ CHOHCOOH	CH ₃ CHOHCOO ⁻	1.38 × 10 ⁻⁴
Benzoic acid	C ₆ H ₅ COOH	C ₆ H ₅ COO ⁻	6.46 × 10 ⁻⁵
Acetic acid	CH ₃ COOH	CH ₃ COO ⁻	1.76 × 10 ⁻⁵
Ammonium ion	NH ₄ ⁺	NH ₃	5.6 × 10 ⁻¹⁰
Oxalic acid (1)	HOOC—COOH	HOOC—COO ⁻	5.9 × 10 ⁻²
Oxalic acid (2)	HOOC—COO ⁻	⁻ COO—COO ⁻	6.4 × 10 ⁻⁵
Malonic acid (1)	HOOC—CH ₂ —COOH	HOOC—CH ₂ —COO ⁻	1.49 × 10 ⁻³
Malonic acid (2)	HOOC—CH ₂ —COO ⁻	⁻ COO—CH ₂ —COO ⁻	2.03 × 10 ⁻⁶
Malic acid (1)	HOOC—CH ₂ —CHOH—COOH	HOOC—CH ₂ —CHOH—COO ⁻	3.98 × 10 ⁻⁴
Malic acid (2)	HOOC—CH ₂ —CHOH—COO ⁻	⁻ COO—CH ₂ —CHOH—COO ⁻	5.5 × 10 ⁻⁶
Succinic acid (1)	HOOC—CH ₂ —CH ₂ —COOH	HOOC—CH ₂ —CH ₂ —COO ⁻	6.17 × 10 ⁻⁵
Succinic acid (2)	HOOC—CH ₂ —CH ₂ —COO ⁻	⁻ COO—CH ₂ —CH ₂ —COO ⁻	2.3 × 10 ⁻⁶
Carbonic acid (1)	H ₂ CO ₃	HCO ₃ ⁻	4.3 × 10 ⁻⁷
Carbonic acid (2)	HCO ₃ ⁻	CO ₃ ²⁻	5.6 × 10 ⁻¹¹
Citric acid (1)	HOOC—CH ₂ —C(OH)(COOH)OCH ₂ —COOH	HOOC—CH ₂ —C(OH)(COOH)—CH ₂ —COO ⁻	1.78 × 10 ⁻⁵
Citric acid (2)	HOOC—CH ₂ —C(OH)(COOH)OCH ₂ —COO ⁻	⁻ COO—CH ₂ —C(OH)(COOH)—CH ₂ —COO ⁻	
Citric acid (3)	⁻ COO—CH ₂ —C(OH)(COOH)OCH ₂ —COO ⁻	⁻ COO—CH ₂ —C(OH)(COO ⁻)—CH ₂ —COO ⁻	3.9 × 10 ⁻⁶
Phosphoric acid (1)	H ₃ PO ₄	H ₂ PO ₄ ⁻	7.25 × 10 ⁻⁸
Phosphoric acid (2)	H ₂ PO ₄ ⁻	HPO ₄ ²⁻	6.31 × 10 ⁻⁸
Phosphoric acid (3)	HPO ₄ ²⁻	PO ₄ ³⁻	3.98 × 10 ⁻¹³

1.1. In a solution of formic acid, what would be the ration of **HCOOH : HCOO⁻** at pH 6? (4)

1.2. Draw a titration curve for the titration of acetic acid with NaOH. Label the axes clearly and indicate the value of the pKa of acetic acid on the graph. (4)

Question 2 (6)

Draw the structure of the amino acid histidine and label all the functional groups. (6)

Question 3 (12)

3.1. Answer the following question regarding the disease *phenylketonuria (PKU)*:

3.1.1. What enzyme is deficient in PKU? (1)

3.1.2. What *amino acid* accumulates in the cells of PKU individuals? (1)

3.1.3. What *metabolite* accumulates in the cells of PKU individuals? (1)

3.1.4. What is the effect of this accumulation on the health of PKU individuals? (1)

3.2.1. Give the dissociation reaction for the amino acid histidine. (6)
 $\text{pKa}(\alpha\text{-COOH}) = 1.82$; $\text{pKa}(\alpha\text{-NH}_3^+) = 9.17$; $\text{pKa}(\text{R}) = 6.04$

3.2.2. What is the pI of histidine? (2)

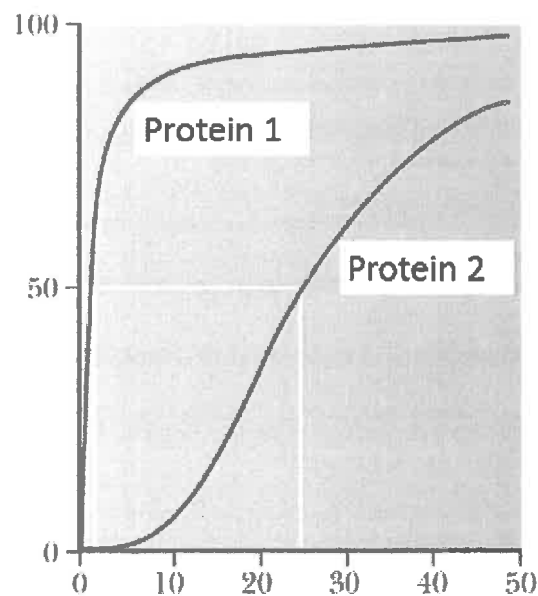
Question 4 (6)

What are the two different types of beta sheets that can be formed by proteins? What are the differences between them? (6)

Question 5 (11)

5.1. Describe the difference in composition between the three forms of haemoglobin. (9)

5.2. The following diagram shows the binding curves of two oxygen binding proteins. Consider the curves carefully and answer the question that follow:



5.2.1. What do the x- and y-axes of the graph represent? (2)

Question 6 (18)

6.1. What is the difference between a nucleoside and a nucleotide? (2)

6.2. Give the complementary DNA strand to the following reference strand: (2)

5'-ATGTGTC-3'

6.3. Draw the structures of the following nucleotides:

6.3.1. deoxyadenosine-5'-phosphate (3)

6.3.2. deoxycytidine-5'-phosphate (3)

6.4. Compare A-DNA and B-DNA with respect to:

6.4.1. The handedness of the helix (left-handed or right-handed) (2)

6.4.2. The number of base pairs per turn of the helix (2)

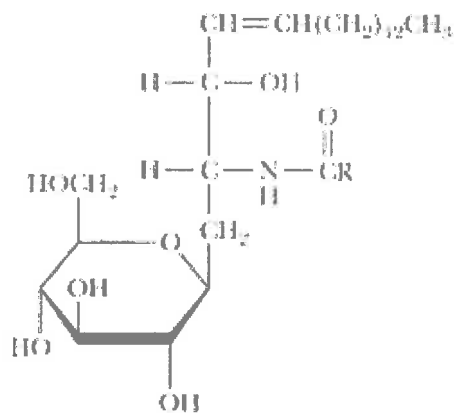
6.4.3. The angle between the base-pairs and the helix axis (2)

6.5. What is the difference between a Class I and a Class II topoisomerase? (2)

Question 7 (4)

7.1. Draw the general ring structure of a steroid and number all the rings and carbon atoms. (3)

7.2. Identify the following lipid: (1)



Question 8 (6)

8.1. Draw the structures of the following monosaccharides:

8.1.1. α -D-glucopyranose (3)

8.1.2. α -D-fructofuranose (3)

Question 9 (9)

9.1. Compare amylose and amylopectin with respect to their:

9.1.1. Composition (3)

9.1.2. Structure (2)

9.1.3. Degradation (4)

TOTAL [80]