MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL AND BIOLOGICAL SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2018/2019 ACADEMIC YEAR

SECOND YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

ACH 313 – CHEMISTRY OF PROTEINS AND CARBOHYDRATES

DURATION: 2 HOURS

DATE: 26/4/2019

TIME: 9-11 A.M.

Instructions to candidates:

1. Answer question One and Any Other Two questions.
2. Amino acids chart is provided.
3. Mobile phones are not allowed in the examination room.
4. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) Define the following terms: (5 marks)

i. Zwitterions

ii. Isoelectric point

iii. Peptide bond

iv. Essential amino acid

v. Enantiomers

b) Identify (with examples) any five functions of protein in living organisms. (5 marks)

c) Using suitable examples distinguish between the following:

i. $\propto$-Amino acid and β-amino acid (3 marks)

ii. D and L sugars (3 marks)

iii. Epimers (3 marks)

iv. Anomers (3 marks)

d) Amino acids are amphoteric. Explain the statement using any amino acid of your choice. (4 marks)

e) (i) What sequence of bases on one strand of DNA is complementary to the sequence 5'-GGCTAATCCGT-3'? (2 marks)

(ii) The DNA of a sea fish was found to contain 14% adenine. What percentage of the other three types of bases would be expected in the sea fish? Explain. (2 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) Arginine, glutamic acid and tryptophan have pI values of 10.79, 3.22, and 5.89 respectively. Explain how electrophoresis might be used to separate the three amino acids. (5 marks)

b) Leucine is an essential amino acid with the systematic name 2-amino-4-methylpentanoic acid. Its $p\text{ka}_1$=2.36 and $p\text{ka}_2$=9.60.

i. Draw the condensed structure for leucine and label all chirality centers with an asterisk. (2 marks)

ii. Draw a Fischer projection of L-leucine and label the chirality center as R or S. (2 marks)

iii. Draw the structure of the predominant form of leucine at:

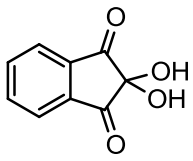
I. PH=10.00

II. PH=1.50

c) Ninhydrin is an important reagent in the laboratory.

i. Using a chemical equation, explain the use of ninhydrin in amino acid chemistry. (3 marks)

ii. Describe how ninhydrin might be useful in a criminal case involving kidnapping. (2 marks)

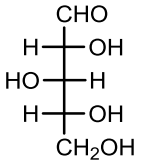


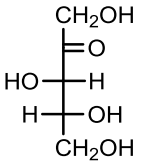
Ninhydrin

d) Using chemical equations, suggest how alanine might be synthesized from a carboxylic acid and using any other necessary reagents. (4 marks)

QUESTION THREE (20 MARKS)

a) Using the structures of monosaccharides below to answer the following questions:

I 

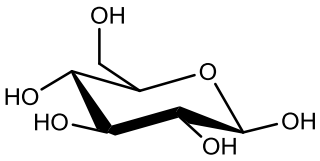
II 

i. Classify each of the sugars above. (2 marks)

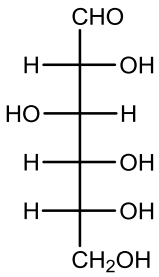
ii. Assign R and S configuration to each chirality center in the sugars. (3 marks)

iii. Give the IUPAC names of the sugars. (2 marks)

b) Draw the structure(s) of the products you would expect to obtain from reaction of β-D-glucose with each of the following reagents. Name the type of reaction in each case.



beta-D-Glucose



D-Glucose

i. CH_3I, Ag_2O (1.5 marks)

ii. Warm dilute HNO_3 (1.5 marks)

iii. $(CH_3CO)_2O$, Pyridine (1.5 marks)

iv. $NaBH_4$ in H_2O (1.5 marks)

v. CH_2OH, HCl (2 marks)

vi. Br_2, H_2O (2 marks)

c) Although tryptophan contains a heterocyclic amine, it is considered a neutral amino acid. Explain why the indole nitrogen of tryptophan is more weakly basic than one of the imidazole nitrogen of histidine. (3 marks)

QUESTION FOUR (20 MARKS)

a) The amino acid cysteine undergoes a reversible dimerization reaction when subjected to a suitable oxidizing agent.

   i. Write the equation for the dimerization reaction. (2 marks)

   ii. Explain how this cysteine chemistry is applicable in a beauty industry. (2 marks)

b) Suggest how you would use reductive amination to synthesize an amino acid of your choice using α-keto acid and any other necessary reagents. (4 marks)

c) Draw and label any two DNA nucleosides. (3 marks)

d) (i) Draw the structure of the polymer used in solid phase synthesis of peptides. (2 marks)

   (ii) Suggest how you would synthesize the dipeptide Val-Phe by the solid-phase synthesis method. (4 marks)

   (iii) Draw the full structure of the peptide ELVIS. (3 marks)