UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF BIOTECHNOLOGY AND FOOD TECHNOLOGY

DIPLOMA IN BIOTECHNOLOGY

MODULE BIC12B1/BIC21B1

Biochemistry 2

CAMPUS **DFC**

NOVEMBER MAIN EXAMINATION 2019

DATE: 21/11/2019 **SESSION: 16:30 – 18:30**

ASSESSOR(S): **DR K KONDIAH**

INTERNAL MODERATOR **MR. L. ALAGIOZOGLOU**

DURATION: 2 HOURS **MARKS: 75**

NUMBER OF PAGES: 9

INSTRUCTIONS TO INVIGILATORS:

1. **CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT).**
2. **THIS QUESTION PAPER MUST BE RETURNED WITH SCRIPT.**
3. **QUESTION 1 TO BE ANSWERED IN THE MCQ SECTION OF ANSWER SCRIPT.**

INSTRUCTIONS TO STUDENTS:

1. **ANSWER ALL THE QUESTIONS SHOWING ALL CALCULATIONS WHERE NECESSARY.**
2. **RETURN EXAMINATION PAPER WITH SCRIPT.**
3. **ANSWER QUESTION 1 IN MCQ SECTION OF THE ANSWER SCRIPT.**
4. **ANSWER QUESTIONS 2-4 IN THE MAIN SECTION OF ANSWER SCRIPT.**
5. **STANDARD GENETIC CODE, CHART OF AMINO ACIDS AND pKa VALUES FOR AMINO ACIDS ARE PROVIDED AT THE BACK OF THE ASSESSMENT.**
6. **IT IS IN YOUR BEST INTEREST TO WRITE CLEARLY AND LEGIBLY**
7. **GOOD LUCK!**

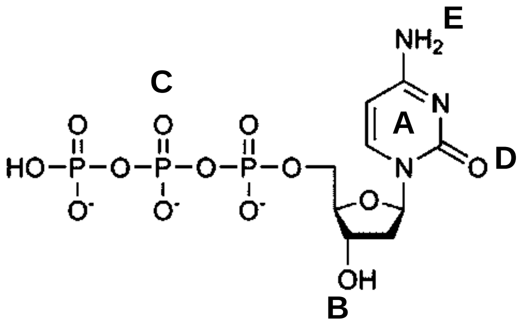
Question 1: **[25x1 = 25 marks]**

Answer the multiple choice questions by clearly selecting the best option.

1.1. A single H_2O molecule binds to ____ other H_2O molecules in the lattice structure of ice
   a) 7
   b) 5
   c) 4
   d) 3
   e) 2

1.2. How much of a 0.55 M solution of NaOH is required to make 15 mL of a 0.2 M solution of NaOH?
   a) 41.25 mL
   b) 41.25 µL
   c) 41.25 L
   d) 5.45 µL
   e) 5.45 mL

Study the biomolecule below and answer questions 1.3 and 1.4.



1.3. This is an example of a
   a) Nucleic acid
   b) Deoxyribonucleotide
   c) Ribonucleotide
   d) Deoxyribonucleoside
   e) Ribonucleoside

1.4. What is the name of structure A?
   a) Thymine
   b) Cytosine
   c) Uracil
   d) Adenine
   e) Guanine

1.5. Molecules that carry charged groups of opposite polarity are known as
   a) Racemic
   b) Hydropathic
   c) Enantiomers
   d) Chiral
   e) Zwitterions

1.6. Which amino acid does not belong in the group?
   a) G
   b) E
   c) R
   d) D
   e) K

1.7. Which of the following statements best reflects the properties of enzymes?
a) Enzymes lower the activation energy of a reaction to speed it up.
b) Enzymes can change an endothermic reaction to an exothermic one.
c) Enzymes alter the equilibrium constant of a reaction.
d) Enzymes are non-specific and can bind any molecule.
e) Enzymes are globular molecules made of polysaccharides.

1.8. If the pH of physiological saline is 7.4, what is the concentration of H^+?
a) 4×10^{-8}
b) 4×10^{8}
c) 2.5×10^{7}
d) 2×10^{-9}
e) 2×10^{9}

Use the following sequence to answer questions 1.9 and 1.10.

3'-AATGCTTAAGGTCAAGGC-5'

1.9. Which restriction enzyme will cut this sequence?
a) *Sma*I (CCC*GGG)
b) *Hind*III (A*AGCTT)
c) *Pst*I (CTGCA*G)
d) *Bam*HI (G*GATTC)
e) *Eco*RI (G*AATTC)

1.10. After electrophoresis, ______ DNA fragments will be visible on the gel.
a) 1
b) 2
c) 3
d) 4
e) 5

1.11. Which of the following is responsible for the ABO blood groups?
a) Glycolipid
b) Polysaccharide
c) Peptide
d) Palmitic acid
e) Peptidoglycan

1.12. Which of the following is NOT a characteristic of lipids?
a) They can form polymers
b) They are hydrophobic
c) They are soluble in methanol
d) They are sources of energy
e) They are composed of fatty acids

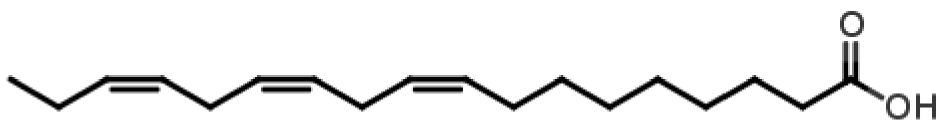
1.13. Codons are found in
a) mRNA
b) rRNA
c) tRNA
d) 5'-3' DNA
e) 3'-5' DNA

1.14. A bond formed between glycine and tyrosine is a
a) Phosphodiester bond
b) Hydrogen bond
c) Peptide bond
d) Glycosidic bond
e) Van der Waal's force

1.15. A buffer is a
   a) solution consisting of a strong acid and a strong base that resists large changes in pH.
   b) solution consisting of a strong acid and a strong base that resists small changes in pH.
   c) solution consisting of a weak acid and its conjugate base that resists large changes in pH.
   d) solution consisting of a weak acid and its conjugate base that resists small changes in pH.
   e) neutral solution.

1.16. Semi conservative DNA replication results in progeny where
   a) One strand is from the parent and one strand is from the daughter
   b) Both strands are from the parent
   c) Both strands are from the daughter
   d) One strand is from DNA and one strand is from RNA
   e) One strand is the original template and one strand is mutated

Study the biomolecule below and answer questions 1.17 and 1.18.



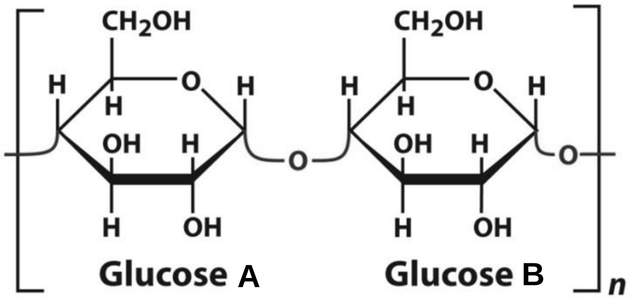
1.17. The biomolecule is
   a) Saturated
   b) Monounsaturated
   c) Polyunsaturated
   d) Hydrophilic
   e) A beta-sheet

1.18. The systematic name for the biomolecule is
   a) 18:3 n-3
   b) 18:3 n-9
   c) 16:3 n-9
   d) 16:3 n-3
   e) 17:3 n-3

1.19. Glutathione is a ___________ that helps inactivate oxidative compounds capable of causing cellular damage.
   a) Glycoprotein
   b) Lipid
   c) Nucleic acid
   d) Tripeptide
   e) Enzyme

1.20. The helices in collagen form a ___________ coil; the helices in keratin form a _________coil.
   a) Left-handed; left-handed
   b) Right-handed; left-handed
   c) Right-handed; right-handed
   d) Left-handed; right-handed
   e) Random; structured

Study the polysaccharide provided below and answer questions 1.21 to 1.23.



1.21. The glucose is represented as a
   a) Chair conformation
   b) Linear conformation
   c) Furanose ring
   d) Helix ring
   e) Pyranose ring

1.22. What is the anomeric form of Glucose A?
   a) α
   b) β
   c) D
   d) L
   e) N

1.23. Which of the following is the correct systematic name for the disaccharide shown above?
   a) β-D-glucopyranosyl-(1→4)-β-D-glucopyranoside
   b) α-D-glucofuranosyl-(1→4)-α-D-glucofuranoside
   c) α-D-glucopyranosyl-(1→4)-α-D-glucopyranoside
   d) α-D-glucopyranosyl-(1→4)-β-D-glucopyranoside
   e) β-D-glucopyranosyl-(1→4)-α-D-glucopyranoside

1.24. Sucrose is a non-reducing sugar because
   a) The anomeric carbon on fructose is not involved in a glycosidic bond.
   b) The anomeric carbon on glucose is not involved in a glycosidic bond.
   c) The anomeric carbons on both glucose and fructose are not involved in a glycosidic bond.
   d) The anomeric carbons on both glucose and fructose are involved in a glycosidic bond.
   e) C6 on both glucose and fructose are involved in a glycosidic bond.

1.25. The complementarity between enzyme and substrate is known as ______ model.
   a) Pins and needles
   b) Soap and water
   c) Shoes and socks
   d) Needle and thread
   e) Lock and key

Question 2: **[12 marks]**

Study the DNA sequence below and answer the questions that follow.

3'- AGG CTG TTT TGC AAA TCT -5'

2.1. Write out the sequence of the complimentary DNA strand indicating direction. (1)

2.2. Write out the sequence of the mRNA strand indicating direction. (1)

2.3. What is the G+C content of this DNA molecule? Show your calculations. (2)

2.4. List two differences between DNA and RNA. (2)

2.5. Translate the mRNA sequence using the one letter amino acid abbreviated form clearly indicating termini. (2)

2.6. Group the amino acids in question 2.5 above by polarity. (3)

2.7. How many of these amino acids have ionisable side chains? (1)

Question 3: **[22 marks]**

3.1. A buffer solution was made by dissolving 75 g C_2H_5COOH (propionic acid) in 600 mL of 0.5 M C_2H_5COONa. To this buffer is added 0.025 moles of NaOH. Assume the change in volume when the NaOH is added is negligible. The Ka of C_2H_5COOH is 1.30 x 10^{-5}. Calculate the pH of the buffer after the addition of the NaOH. M_r Na = 23, C = 12, O = 16, H = 1. Show all calculations to obtain full marks. (7)

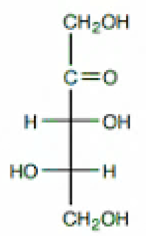
3.2. Draw a clear ionisation pattern from acid to base for tyrosine and cysteine indicating the pH for each ionisation. (11)

3.3. Calculate the pI for both tyrosine and cysteine. Show all your calculations. (2)

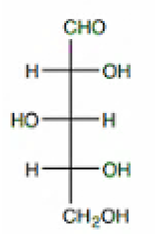
3.4. Comment on the charge of both tyrosine and cysteine if they were placed in the buffer solution from question 3.1. (2)

Question 4: **[16 marks]**

4.1. Study the molecules below and answer the questions that follow.



A



B

4.1.1. Classify molecules A and B according to the Fischer convention. (2)

4.1.2. Classify molecules A and B according to their ring structure should they cyclise. (2)

4.2. Draw a table comparing cellulose and chitin. (8)

4.3. Write brief notes on cholesterol in animals and its role in the cell membrane. (4)

STANDARD GENETIC CODE

2nd base

1st base	U		C		A		G		3rd bsae
U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
C	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
A	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine (Start)	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
G	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

TABLE OF pKa VALUES FOR AMINO ACIDS

Amino Acid	pKa Value		
Name	Alpha Carboxy	+Alpha Amino	Side Chain
Glycine	2.34	9.60	
Alanine	2.34	9.69	
Valine	2.32	9.62	
Leucine	2.36	9.60	
Isoleucine	2.36	9.68	
Methionine	2.28	9.21	
Phenylalanine	1.83	9.13	
Tryptophan	2.38	9.39	
Proline	1.99	10.60	
Serine	2.21	9.15	
Threonine	2.63	9.10	
Cysteine	1.71	10.78	8.33
Tyrosine	2.2	9.11	10.07
Asparagine	2.02	8.84	
Glutamine	2.17	9.13	
Aspartic Acid	2.09	9.82	3.86
Glutamic Acid	2.19	9.67	4.25
Lysine	2.18	8.95	10.79
Arginine	2.17	9.04	12.48
Histidine	1.82	9.17	6.04

AMINO ACIDS