COVENANT UNIVERSITY

ALPHA SEMESTER TUTORIAL KIT
(VOL. 2)

PROGRAMME: BIOCHEMISTRY

200 LEVEL

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LIST OF COURSES

BCH211: Biomolecules I
BCH212: Introduction to Physical Biochemistry

*Not included

BCH 211: BIOMOLECULES I (TUTORIAL QUESTIONS)

1. Mention two functions each of major biomolecules.
2. Mention the major biomolecules, their monomers and the bonds that hold the monomers together to form polymers.
3. Mention the major functional groups of an amino acid.
4. Mention the ways by which aminoacids can be classified.
5. Mention five physical properties of an amino acid.
6. Draw the structure of the following peptides a) Thr-Phe-Met b)serylarginylglycylphenylalanine c) IMQDK d)ELVIS
7. Classify amino acids based on nutritional requirement and metabolic fate.
8. Mention the levels of protein structure and the bonds that stabilize these structures
9. Mention the biological functions of proteins
10. (a) Consider the peptide V-F-D-K-G-F-V-E-R. How many fragments will result from its treatment with (i)Trypsin (ii) Chymotrypsin? Draw the resulting peptides and name them.

    (b) Describe the steps involved in determining the primary structure of an amino acid.

11. Differentiate between standard and non-standard amino acids.
12. Mention all the types of RNAs you know.
13. Draw the structures of purine and pyrimidine rings and label them according to the international system of numbering.
14. Distinguish between nucleosides and nucleotides.
15. Draw the structure of 2′-deoxy-guanosine-5′-monophosphate.
16. Summarize the chemical differences between RNA and DNA.
17. Give a brief account of Chargaff's rule in relation to the structure of DNA.
18. By indicating the appropriate structures where applicable, explain briefly the various applications of synthetic nucleotide analogs.
19. Explain the following models of enzyme action

    I. Lock and key model
    II. Induced fit model

20. Draw the structure of the coenzymes derives from the following vitamins and state their biochemical functions.

I. Thiamin
II. Riboflavin
III. Pyridoxine

ANSWERS

1. Carbohydrates: Living things use carbohydrates as their main source of energy. Carbohydrates may also play a structural role e.g. Cellulose and lignin play structural role in plants.

   Proteins: Proteins are responsible for many enzymatic functions in the cell and play an important structural role (cell membrane).

   Lipids: Lipids are used to store energy and are an important part of the cell membrane.

   Nucleic Acids: Nucleic acids store and transmit hereditary or genetic information. There are two kinds of nucleic acids: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). Nucleotides are responsible for more than just composing DNA and RNA. ATP which is a nucleotide is also the energy currency of the cell.

3. Amino group and carboxylic acid group

5. Colourless , Crystalline, May be sweet(Glycine, Alanine, Valine), tasteless(Leucine) or bitter(Arginine, Isoleucine). **Aspartame- An artificial sweetener contains Aspartic acid and Phenyl alanine,** Soluble in water, acids, alkalis but insoluble in organic solvents, High melting point(More than 200^0c).

7. **Essential amino acids:** These amino acids cannot be synthesized in the body and have to be present essentially in the diet. Examples-**Valine, Isoleucine, Leucine, Lysine, Methionine, Threonine, Tryptophan and Phenylalanine.**

   Semi-essential amino acids: These amino acids can be synthesized in the body but the rate of synthesis is lesser than the requirement (e.g. during growth, repair or pregnancy) Examples-**Arginine and Histidine.**

   Non-essential amino acids: These amino acids are synthesized in the body, thus their absence in the diet does not adversely affect the growth. Examples: **Glycine, Alanine, and the other remaining amino acids**.

9. **Enzymatic Functions** –Enzymes are catalysts that accelerate the rates of biological reactions and they are specific.

Regulation- Proteins that control regulation are known as regulatory proteins. E.g. include hormones, DNA-binding proteins (gene regulatory proteins) and cell receptors.

Storage – Storage proteins serve as reservoirs of amino acids and other nutrients. Ca and Fe attached to storage proteins.

Transport- Transport proteins carry substances from one place to another.Hemoglobin transports oxygen from lungs to the tissues, Albumin transports fatty acid from adipose tissues to various organs. Others are Mgb, transferrins, etc

Support – Structural proteins provide strength and protection to cells and tissues. E.g. keratin, fibrin, collagen, etc

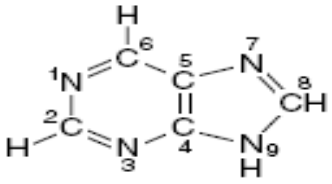
Motion – Movement is accomplished by contractile and motile proteins e.g. actin and myosin, cytoskeletal fibers.

Defense – These are protective or exploitative proteins e.g. immunoglobulins or antibodies. Others are blood clotting proteins like thrombin and fibrinogen.

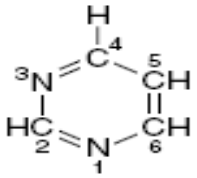
11. Standard amino acids are the 20 amino acids used as building blocks for the synthesis of protein molecules. While non-standard amino acids consist of amino acid residues that have been chemically modified after they have been incorporated into a polypeptide or amino acids that occur in living organisms but not found in proteins.

12. messenger RNA, transfer RNA, ribosomal RNA

13.



Purine



Pyrimidine

14. Nucleosides contain nitrogenous bases and sugars while the nucleotides contain nitrogenous bases, sugars and phosphate group.

17. Give a brief account of Chargaff's rule in relation to the structure of DNA.
i) The base composition of DNA generally varies from one species to another.
ii) DNA specimens isolated from different tissues of the same species have the same base composition.

iii) The base composition of DNA in a given species does not change with an organism's age, nutritional state, or changing environment.

iv) In all cellular DNAs, regardless of the species, the number of adenosine residues is equal to the number of thymidine residues (that is, A T), and the number of guanosine residues is equal to the number of cytidine residues (G C). From these relationships it follows that the sum of the purine residues equals the sum of the pyrimidine residues; that is, A + G = T + C.

BCH 212: Introduction to Physical Biochemistry (Tutorial Questions)

Part 1

1. Discuss the structure, physical and chemical properties of water.
2. Describe the nature and significance of the following and give examples
   - hydrogen bonding ii. Hydrophilic iii. hydrophobic interactions.
3. Discuss extensively on the following
   - solvent
   - solutions
   - Extensive properties
   - Intensive properties
4. Explain osmotic pressure as it relates to water
5. Write on the following a) isotonic b) hypertonic c) hypotonic solutions
   Write a brief note on and give examples
   a) Homogenous and heterogeneous materials
   b) Homogenous mixtures and pure substances
6. Explain chemical equilibrium
7. Write extensively on chemical kinetics
8. Write on Donnan equilibrium
9. Write a note on artificial and biological membranes
10. Write on the applications of membrane on biochemical techniques such as
    a) High Performance Liquid
    b) Chromatography
    c) Electrophoresis
    d) Spectrometry

Answers

- Any property of matter that can be measured can be classified as extensive or intensive.

Extensive properties depend on the amount of substance present; intensive properties do not

- Solutions of osmolarity equal to that of a cell's cytosol are said to be isotonic relative to that celi. Surrounded by an isotonic solution, a cell neither gains nor loses water.
- In a hypertonic solution, one with higher osmolarity than that of the cytosol, the cell shrinks as water moves out.

- In a hypotonic solution, one with a lower osmolarity than the cytosol, the cell swells as water enters. In their natural environments, cells generally contain higher concentrations of biomolecules and ions than their surroundings, so osmotic pressure tends to drive water into cells.
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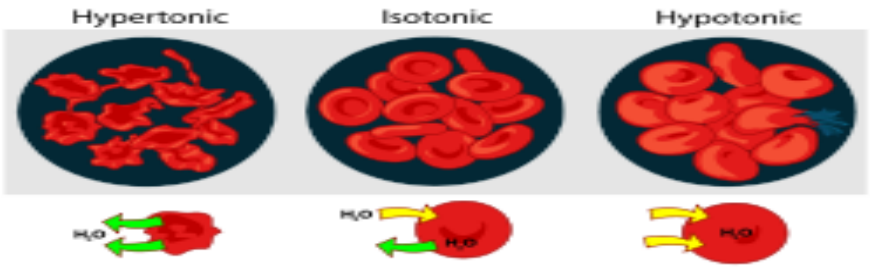

Part 2

1. Write short notes on the following:
    a. Ionization of water
    b. Acids and Bases
    c. pH scale
2. Elaborately discuss the effect of pH on cellular activities.
3. Explain how phosphate buffer as a major biological buffer maintains the pH of the blood.
4. Solve the following calculations:
    a. Calculate the $[H^+]$, $[OH^-]$ pH and pOH of a 0.001M solution of HNO_3. Calculate the number of of H^+ and OH^- ions per liter in solutions if **1 g-ion/liter = 6.023 X 10^{23} ions/liter.**
    b. What is the pH of a solution of 0.1M acetic acid if K_a is 1.76 x 10^{-5}M.
    c. Calculate the hydronium concentration and the pH of a 0.5M solution of HF. (K_a = 7.2 x 10^{-4}M).
    d. What pH do you get when you add 0.02M NaOH to 0.1M acetic acid if the pKa of acetic acid is 4.76?
5. Solve the following:

a. Calculate the pH, pOH and $[H^+]$ when $[OH^-] = 10^{-5}$M.
b. Calculate the pH of a solution of 0.1M acetic acid and 0.2M acetate ion given that pKa of acetic acid is 4.76.
c. Calculate the pKa of lactic acid when the concentration of free lactic acid is 0.01M , lactate ion is 0.087M and pH is 4.8.
d. Calculate the ratio of acetate ion and acetic acid in a buffer system of pH 5.3 given that pKa of acetic acid is 4.76.

6. Solve the following:
   a. Calculate the $[H^+]$, $[OH^-]$ and pOH of an aqueous solution of pH 3.5.
   b. Determine the pOH of a solution in which the $[OH^-] = 3.33 \times 10^{-3}$M.
   c. Calculate the $[H^+]$, $[OH^-]$ pH and pOH of a 0.001M solution of HCL.
   d. Caluclate the $[H^+]$, $[OH^-]$ and the number of H^+ and OH^- ions per liter in solutions having a pH value of 2.73. **(1 g-ion/liter = 6.023 X 10^{23}ions/liter).**
   e. What is the concentration of HNO_3 in a solution that has a pH of 3.4?
7. Solve the following:
   a. If lemon juice has $[H_3O^+]$ of 5×10^{-3}M, what is the $[OH^-]$ of the solution?
   b. The $[OH^-]$ of an ammonia solution is 2.0×10^{-2}M. What is the $[H_3O^+]$ of the solution?
   c. The hydronium ion concentration of an acidic solution is 3.0×10^{-5}M. What is the $[OH^-]$?
   d. What is the hydronium ion concentration if the hydroxide concentration is 2.5×10^{-3}M?
8. Discuss the laws of thermodynamics and their relevance in cellular processes.
9. Outline the energy cycle and describe the types of energy transactions in living cells.
10. Describe the various types of electrochemical and redox reactions which take place in living cells.