LANDMARK UNIVERSITY, OMU-ARAN

COURSE COMPACT

COLLEGE: SCIENCE AND ENGINEERING
DEPARTMENT: BIOLOGICAL SCIENCES
PROGRAMME: BIOCHEMISTRY
COURSE COMPACT for: INTRODUCTION TO PHYSICAL BIOCHEMISTRY

Course

Course code:	BCH 212
Course title:	Introduction to Physical Biochemistry
Credit unit:	3
Course status:	Compulsory

Lecturers' Data

Name of the lecturers:	Prof. O. Ademuyiwa Dr. O.M. Oluba (Ph.D)
Department:	Biological Sciences
College:	Science and Engineering
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Consultation Hours: Mon – Wed (1- 2PM)

INTRODUCTION TO THE COURSE

Course Description:

The course introduces students to water, taking special note of its hydrogen bonding, which makes it unique even in its physical properties; its hydrophobic interaction and its ability to serve as a solvent. It also examines solution and osmotic pressure, acids and bases and how the pH and pK values affect cellular activities. It further enlightens on buffers, Donnan equilibrium, Chemical Kinetics, Chemical equilibrium, applied thermodynamics, electrochemical cells and redox reactions.

Course Justification:

Enzymes are biological catalysts that are involved in speeding up the rate of almost all biochemical reactions in life, without these reactions taking place in living organisms will progress very slowly.it is therefore important to study the properties and functions of these enzymes in other to understand how they regulate metabolic reactions.

Course objectives

At the end of this course, students should be able to:

i. Enumerate the unique properties of water and giving reasons in each case why water exhibit such properties.
ii. Highlight the importance of water in biologic systems
iii. Define buffer and state their constituents
iv. Carry out thermodynamic calculations
v. Identify redox reactions in the biologic system
vi. Solve calculations involving electrochemical cells.

Course Content:

Water: Physical properties and hydrogen bonding; water as a solvent, hydrophobic interactions. Solutions, osmotic pressure. Acids and Bases; pH and pK values and their effects on cellular activities. Buffers, Donnan cells and redox reactions.

Course Expectations:

Attendance and full participation in class is expected from all students. Students are to attend practical sections with their lab notes and lab coats.

Method of Grading- An example below

S/N	Grading	Score (%)
1.	CA1	7
2.	CA2	15
3.	CA3	8
4.	Final Examination	70
	Total	**100**

Course Delivery Strategies – Illustration below

Course delivery will be by face-to-face method, participatory method and Lecture method. Assignments will be given out to students periodically as individual and in groups.

Course Duration:

Three hours per week for 15 weeks (45 hours)

LECTURE CONTENT

Module 1

Week 1: Water: Physical properties and hydrogen bonding

Objectives

At the end of the topic, students should be able to:

i. Explain what makes water unique in its properties
ii. Enumerate the physical and chemical properties of water

Description

First hour

The unusual properties of water, Structure of water

Second hour

Hydrogen bonding

Study Questions

1. Enumerate the physical and chemical properties of water
2. What is hydrogen bondin?

Reading List

1. Koolman, J. and Roehm, K.H. Colour Atlas of Biochemistry. 2nd edition, revised and enlarged. Pp 26-29.
2. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
3. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 2: Water as a solvent

Objectives:

At the end of this topic, students should be able to:

1. Describe the molecular interactions of water
2. Explain the solvent properties of water such as hydrophobic interactions.

Description

First hour:

Molecular interactions of water

Second hour

Solvent properties of water including hydrophobic interactions

Study Questions:

Enumerate the solvent properties of water.

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 3: Solutions and osmotic pressure

Objectives:

At the end of this topic, students should be able to:

1. Describe the various types of solutions
2. Define osmosis

Description

First hour

Type of solution

Second hour

Practical: Investigate osmotic pressure exerted by 10 ml of 0.9% w/v solution of sodium chloride across a semi-permeable membrane. Results would be observed after 24 hours.

Study Questions

1. Write short notes on the following:
   i. Isotonic solution
   ii. Hypotonic solution
   iii. Hypertonic solution

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Module 2

Week 4: Acids and bases

Objectives:

At the end of this topic, students should be able to:

i. Define acid and base
ii. Understand the underlining principles of titration reactions

Description

First hour:

Definition of acids and bases. Dissociation constant of water, pK_w

Second hour

Practical: Titration reactions

Study Questions:

1. Write short notes on the following:
   i. Conjugate bases and conjugate acid
   ii. Strong acid and weak acid

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 5: pH and pK values and their effects on cellular activities

Objectives

At the end of this topic, students should be able to:

i. Define pH and pK
ii. Ascertain the pK of a strong acid
iii. Derive the Henderson-Hasselbach's equation

Description

First hour:

Definition of pH and pK, calculations of pHs of solutions

Second hour:

The Henderson-Hasselbach's equation

Study Question:

1. State the Henderson-Hasselbach's equation

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 6 and 7: Buffers

Objectives

At the end of this topic, students should be able to:

i. Have an understanding of the concept of buffers
ii. Understand the place of buffers in biologic systems/industries
iii. Prepare buffers

Description

First hour:

Definition and constituents of buffers, pH indicators, applications of buffers in pharmaceutical and food industries

Second hour:

Practical: Preparation of 0.2 M phosphate buffer pH 7.4 from sodium dihydrogen phosphate and sodium hydroxide solutions

Study Question:

What is the range of pH over which a buffer performs optimally?

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Module 3

Week 8: Donnan equilibrium

Objective

At the end of the topic, the students should be able to:

i. Explain Donnan equilibrium

Description

First hour:

Donnan equilibrium

Second hour:

Donnan equilibrium

Study Question:

Explain the Donnan equilibrium

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 9: Chemical Kinetics

Objectives

At the end of this topic, the students should have an understanding of:

i. Reaction rates and theories guiding them, half-life of the reactions

ii. Order of reactions and rate constant

Description

First hour:

Rates of chemical reactions, the theories of reactions and factors affecting rate of chemical reactions

Second hour:

Order of reaction, determination of rate constant

Study Questions:

State the rate law as it relates to:

i. First order reactions
ii. Second order reactions

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 10: Chemical Equilibrium

Objectives

At the end of this topic, the students should be able to:

i. Understand the concept of chemical equilibrium
ii. Understand that the equilibrium constant, Keq of a reaction is a measure of the extent of the reaction and the relative stabilities of the reactants and products
iii. Understand that chemical reactions in a cell operates at steady states
iv. Be able to carry out some calculations related to free energy changes

Description

First hour:

Equilibrium constant, standard free energy changes

Second hour:

Coupled reactions

Study Question:

Highlight the first and second order rate laws

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 11 and 12: Applied Thermodynamics

Objectives

At the end of this topic, the students should be able to:

i. State the first, second and third laws of thermodynamics
ii. Understand the concept of free energy as a hypothetical but useful device
iii. Understand the physical significance of thermodynamic properties

Description

First hour:

Concept of enthalpy and entropy, first and second laws of thermodynamics

Second hour:

Third law of thermodynamics, free energy change, physical significance of thermodynamic properties

Study Questions:

1. State the laws of thermodynamics
2. Define the following:
   i. Enthalpy
   ii. Entropy
   iii. Free energy change

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 13: Electrochemical Cells

Objectives

At the end of this topic, the students should be able to:

i. State the laws of thermodynamics
ii. Understand the concept of free energy as a hypothetical but useful device
iii. Understand the physical significance of thermodynamic properties
iv. Carry out calculations on electrolytic cells

Description

First hour:

Definition and types of electrochemical cells

Second hour:

Half cells, standard electrode potentials and their calculations

Study Question

i. Calculations on electrode potential

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 14: Redox Reactions

Objectives

At the end of this topic, the students should be able to:

i. Understand that oxidation-reduction reactions are half reactions
ii. Understand that energy release usually accompanies electron flow from reductant to oxidant

Description

First hour:

Definition of terms associated with redox reactions, concept of electrode potential

Second hour:

The electron transport chains as an important set of redox reactions in biologic system

Study Questions:

1. Describe the electron transport chain

Reading List:

1. Nelson, D.L. and Cox, M.M. (2004). Lehninger Principles of Biochemistry. 4th edition. Worth Publishers, New York
2. Garrett Reginald H and Grisham Charles M. (2007). Biochemistry. Updated Third Edition. Brooks/Cole. ISBN 0-495-11912-1

Week 15: Revision