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AWSE
African Women
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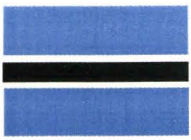
CHEMISTRY
&
HIV and AIDS

Integration Module
(Botswana)



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HIV/AIDS

INTEGRATION MODULE (Botswana)

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Preamble

The pandemic of HIV/AIDS is a public health emergency of unparalleled magnitude and particularly so in resource strained countries especially those in sub-Saharan Africa. Despite efforts to curb the spread of the pandemic, there are reports of increased prevalence rates and deaths due to HIV in the last 2 decades. It is estimated that the real impacts of the scourge will not be felt until 2050.

Universities have not been spared by the scourge. The disease has the potential to impair institutional functioning. The long lead time between initial HIV infection and development of AIDS has major implications for universities. The mandate of service to society demands the engagement of every university with HIV/AIDS.

Universities have a special responsibility for the development of human resources and are crucial agents of change and providers of leadership direction in society. Thus, they should be at the forefront in developing a deeper understanding of HIV/AIDS.

In an effort to prepare students to address HIV/AIDS at personal and professional levels, universities must be involved in a proactive and sustainable manner in mitigation of the pandemic through mainstreaming and integration of HIV/AIDS in the teaching curriculum of every university faculty. This will ensure development of AIDS educated and AIDS competent graduates who will be adequately qualified to carry AIDS concerns into their subsequent lives, to address AIDS issues in their professions as managers, policy makers, leaders, politicians, community workers etc..., and to bring AIDS into the open within their societies.

This sample module has been developed from the existing modules in selected areas of biological sciences. The content of the current teaching units remains the same but there is HIV and AIDS education and HIV related examples. Each teaching unit should be covered in 35 hours as before. The focus of the unit remains the same. It is anticipated that in the course of 35 contact hours the student will not

only learn the basic tenets of biology as prescribed but will also be impacted with some HIV and AIDS knowledge that could influence, the perception, behaviour, and contribute in the fight against HIV and AIDS in the universities and the communities at large.

This teaching module is an output of the in country training workshop on "Higher Education Science and Curricular Reforms: African Universities responding to HIV and AIDS in Gaborone, Botswana. The module contains input from lecturers from the University of Botswana and other tertiary institutions; and is based on their curricula in the teaching of chemistry.

ACKNOWLEDGMENT

This integrated course module has benefited from the input of the participants from the University of Botswana , Colleges of Education, Institute of Health Sciences and Botswana College of Agriculture and other Tertiary Institutions and is based on their curricula in the teaching of chemistry.

The training workshop was facilitated by **Prof. Zipporah W. Ng'ang'a,** of Jomo Kenyatta University of Agriculture and Technology, Kenya. Technical and editorial input was also received from Professors Mabel Imbuga and Caroline Lang'at Thoruwa of African Women in Science and Engineering (AWSE), and Alice A.Ochanda of UNESCO Nairobi Office.

Profound gratitude and further acknowledgement is expressed to UNAIDS who made this work possible through the UBW funds.

AWSE also appreciates secretarial services offered by Mrs. Monica Gammimba.

DESIGN AND LAYOUT BY DESIGNER PRINT

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CHE 101: GENERAL CHEMISTRY 1

Aims and learning objectives

Students will be introduced to the fundamental concepts and principles of chemistry with emphasis on the structure of matter. The course aims to help students develop their problem solving skills and to appreciate the quantitative aspects of Chemistry. The connection between the principles of chemistry and the familiar examples of every day life will be established during the study of each topic.

Course Synopsis

Composition of matter, elements, nomenclature of compounds, measurements and units, the mole, reaction, stoichiometry, precipitation reactions, acid base and redox reactions, limiting reagents, chemical bonding, chemical equilibrium, calculations involving equilibrium constant, rates of reactions, half life of reactions, temperatures and rate, activation energy

Entry points for HIV integration

- *Chemical bonding in HIV. The binding of gp120 and the CD 4 receptors of target cells.*
- *The binding of antigen and antibody in HIV involves weak forces and may result in precipitation reactions*
- *Irreversible reactions analogous to HIV infection*
- *Healthy individual + Infected Individual □ HIV infected (Irreversible)*
- *The rates of reactions are analogous to disease progression in HIV infection. The higher the viral load, the higher the risk of MTCT, HIV infection and progression to AIDS*

Assessment: Continuous assessment (50%) final examination (50%)

Recommended Text book

L. Jones and P. Atkins: Chemistry, molecules, matter and change 4th Edition, 2000

CHE 242: PHYSICAL CHEMISTRY

Aims and Learning Objectives

To provide the students with the understanding of the basic principles of thermodynamics and kinetics. Students should be able to apply these to a wide range of chemical and physico chemical situations.

Intended learning Outcomes

The student should be able to:

1. understand energy conservation in closed, open and reacting systems
2. Apply the three laws of thermodynamics to chemical and physical processes
3. calculate changes in enthalpy, entropy, Gibbs free energy, the equilibrium constants of chemical reactions
4. Determine the rate of a chemical reaction and understand the significance of rate, first and second order, rate determining step and mechanism
5. Know how the concentration of reactants change with time for zero, first and second order reactions, as well as first order opposing, consecutive and reversible reactions so that the relevant rate constants can be calculated

Course Synopsis:

Thermodynamics, heat, work and energy. First law of thermodynamics, enthalpy change, the second law, entropy, spontaneity of processes, the Helmholtz and Gibbs energies, the Third law, chemical potential of pure substances, equilibrium between pure phases, rates of

chemical reactions, experimental techniques in chemical kinetics, integrated rate laws, temperature dependence of reactions, theory of reaction rates, reaction mechanisms, unimolecular reactions

Entry points for HIV integration

- *Risk factors in HIV infection: multiple sexual partners, drug and substance abuse, cultural practices, gender, poverty, malnutrition, pregnancy are analogous to rate limiting factors of reactions.*
- *Factors that decelerate the rate of HIV progression to AIDS, i.e. Antiretroviral drugs, Vit A supplementation, elective caesarean section, healthy eating habits*
- *The role of HIV enzymes as catalysts in HIV replication (reverse transcriptase, integrase and protease)*
- *Antiretroviral drugs as inhibitors of enzyme action. Types, mode of action. The specificity of ARV drugs*
- *Multiple infections from multiple sexual partners are analogous to second and third order reactions*
- *HIV affects the entropy of the body by disrupting body processes (respiration, digestion, reproduction and thermoregulation) by causing generalized immunosuppression. The higher the viral load, the higher the degree of entropy.*
- *The presence of opportunistic infections affects equilibrium of individuals and countries. Impact of HIV on the individual, households, community, culture, demography, economy, agriculture, health, education, industry etc. The impact of HIV on the infected and the affected.*

Recommended Textbook: Physical Chemistry, P. W. Atkins, 7th Ed. 2001

CHE 312: ANALYTICAL SPECTROSCOPY

Aims and Objectives

Students will be introduced to the spectroscopic methods of analysis

Intended learning outcomes

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

1. Demonstrate understanding of the various spectroscopic methods
2. Understand the limitations and advantages of the spectroscopic techniques
3. Aware of the applications of these techniques in industry and medicine

Course Synopsis

Instrumentation and procedures for: molecular absorption/emission techniques; UV visible, infra red phosphorescence, fluorescence. Atomic absorption,/ emission spectroscopy, mass spectroscopy and X ray spectroscopy

Entry points for HIV integration

- *The use of spectroscopic methods in HIV testing. The example of direct and indirect Enzyme Linked Immunosorbent Assays (ELISA). The basis of HIV testing, benefits for positive and negative persons and the barriers that hinder testing. The role of HIV testing in mitigating the spread of HIV*
- *The use of Indirect Immunofluorescent Assay (IFA) as a confirmatory test for HIV*
- *The use of fluorescence to determine drug action on selected organs. The role, mode of action, side effects and barriers hindering ARV usage among PLWA's*

- *Speciation chemistry of drugs example of ARV's and drugs used in management of opportunistic infections,*
- *X ray crystallography in analysis of the composition of drugs and screening of opportunistic infections*

Teaching Methods

Lectures, discussion groups

Practicals

Take away assignment

Assessment: Continuous assessment (50%) and final examination (50%)

Recommended textbook: Principles & practice of analysis, Fifield & Kealey, Fundamentals of Analytical Chemistry 7th Edition- Skoog, West & Holler

CHE 432: SECONDARY METABOLITES AND BIOMOLECULES

Aims and learning objectives

Students will be able to know the applications of chemical concepts and principles into the realm of biologically important and naturally occurring compounds..

Intended learning outcomes

Describe the differences between DNA and RNA

Describe the biosynthesis of DNA and RNA

Learn the behaviour of viruses on DNA and RNA Management of viruses

Course Synopsis

Carbohydrates, structure, nomenclature, stereochemistry and reactions of monosaccharides and disaccharides. Structure and properties of polysaccharides. Amino acids and proteins structure. Chemistry of purines and pyrimidines. Nucleosides, nucleotides and nucleic acids. Mechanisms of co enzymes. Examples of secondary metabolites from the acetate, mevalonate and shikimic acid pathways

Entry points for HIV integration

- *DNA and RNA of viruses. Introduction to HIV as an RNA virus*
- *Biosynthesis of RNA the role of reverse transcriptase in HIV replication. RT as a target for chemotherapeutic attack. ARV drugs, mode of action, limitations in use*
- *Viruses as aetiological agents of disease. The example of HIV. Mode of transmission, disease progression, signs and symptoms that typify AIDS*
- *Management of viruses: prevention/ protection. The ABC of HIV prevention and protection.*
- *The role of therapeutic agents (ARVs) and vaccines in management.*

Recommended text book: Organic Chemistry by Marc Loudon, 4th Edition, Benjamin/Cummings Publishing Company

CHE 412: SAMPLE HANDLING AND BIOCHEMICAL ANALYSIS

Aims and Learning Objectives

Students will be introduced to various methods of sample preparation and bio-analysis

Intended Learning Outcomes:

At the end of the course students should

1. Know the various sample preparation methods for analytes in various matrices. These include sample clean up procedures, using solvent extractions, membrane based extraction, solid phase as applied to air, water and solid samples.
2. Know how enzymes are applied and used as analytical tools
3. Know the properties of enzymes And how they behave under different environments
4. Know what enzyme immobilization is and how it is used in analytical systems
5. Be able to describe how the HIV / AIDS antibodies are tested for using the ELISA or other immunoassay techniques

Course Outline:

Sampling, sampling strategies, sample preparation. Sample clean up techniques; solid phase extraction, solid phase micro-extraction, dialysis, solvent extraction, supported liquid membrane, Enzymatic analysis methods, application of immobilized enzymes, competitive immunoassays, proteinomics and genomics. Properties of antibodies. Polymer structure elucidation of carbohydrate polymers, precipitation assays.

Entry points for HIV integration

- *Solvent extraction of RNA from viruses for HIV characterization. HIV the aetiological agent for AIDS*
- *Enzymatic analysis methods. The role of enzyme based assays for HIV diagnosis*
- *Immunoassays in determination of immune effectors (antibodies).*
- *Handling of blood as a sample. The role of blood and other fluids in transmission of HIV. Methods of contacting infected blood (blood transfusion, sharing of sharp objects, intravenous drug users, cultural practices, accidental contact among researchers, health care givers, TBA's etc)*

- *The role of radioimmunoassay in determining IgG levels in HIV infected*
- *Properties and functions of antibodies. Antibodies as therapeutic agents in HIV infection, Monoclonal antibodies as diagnostic agents*

Teaching Methodology

Lectures

Practical: Assays of immune serum to determine the nature of antibodies, levels

Take away assignments

Recommended text books:

1. Statistics and chemometrics for Analytical 4th Ed Chemistry by JN Miller & JC Miller- Prentice Hall
2. Instrumental analysis in the Biological Sciences Gorden & Macrae Blackie Academics & professional
3. Environmental Sampling and Analysis. A practical guide by LH Keith= Lewis publishers

CHE 422: ADVANCED ORGANOMETALLIC AND SOLID STATE CHEMISTRY

Aims and Learning Objectives

Students will be introduced to solid state chemistry and explore the applications of organometallic chemistry

Intended learning Outcomes

The students should be able to:
Describe reactions of main group organometallics with various substrates and possible mechanisms involved
Apply organometallics to synthesize other compounds, especially organic compounds
Describe the nature of metal- metal bonds in simple clusters

Course Synopsis

Main group organometallics and application in synthesis and industry: structure and chemistry. Organometallic chemistry in synthesis, stereochemically non-rigid molecules; metal clusters and metal-metal bonds. Solid state chemistry, space lattices, ionic structures, defects in solids, metallic bonding.

Entry points for HIV integration

- *Solid state behaviour of ARVS*
- *Application of organometallic chemistry in synthesis of ARV's*
- *Characterization using modern methods (spectroscopic and X ray diffraction*
- *Properties of ARV drugs in solution and solid states*
- *Organometallic lattices for rapid HIV testing*

Assessment: Continuous assessment (40 %) and final examination (60%)

Recommended Text book

1. Inorganic chemistry- Principles and applications by IS Buttler and JF Harrod
2. Supplementary: Advanced Inorganic Chemistry by F. A. Cotton.

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