CHEMISTRY

HIV/AIDS

A GENERIC INTEGRATION COURSE
MODULE FOR UNIVERSITIES IN AFRICA

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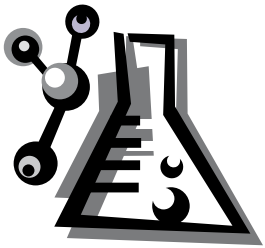

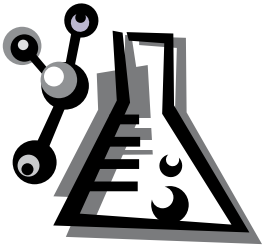

PREAMBLE

The AIDS pandemic is one of the most disastrous health and development events in our world today. Between 5 and 6 deaths occur every minute, one of them being a child below 15 years. There are 500 new HIV infections every hour. HIV and AIDS have left a sea of orphans without parents in its wake. Since it was first diagnosed in 1981, the pandemic has spread at a rate never thought possible.

The AIDS pandemic continues to ravage populations across the world, and most particularly 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 impact of the scourge will only be felt in 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. This being the case, the mandate of service to society demands the engagement of every university with HIV/AIDS.

Every university should recognize that HIV and AIDS are vital university issues that demand a coordinated university response. A society with AIDS needs special of help that only a university can give. Universities have a special responsibility for the development of human resources and are crucial agents of change and providers of leadership directions in society. Thus, they should be at the forefront in developing a deeper understanding of HIV and AIDS.

In an effort to prepare students to address HIV and AIDS at personal and professional levels, universities must be involved in a proactive and sustainable manner in mitigation of the pandemic through 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 life, to address AIDS issues in their professions as managers, policy makers, leaders, politicians or community workers and to bring AIDS into the open within their societies.

In recognition of the above, United Nations Educational, Scientific and Cultural Organization (UNESCO) and the African Women in Science and Engineering (AWSE) organized training workshops in Ghana, Rwanda, Botswana and Kenya for lecturers in tertiary institutions on integration of HIV and AIDS in the teaching of Engineering, Physical and Biological Sciences. This generic module has been developed from the existing modules in selected areas of chemistry. The content of the current teaching units remains the same but there is HIV and AIDS education and HIV related examples. The duration of the teaching unit is as stipulated in the requirements of each individual institution. The focus of the unit remains the same. It is anticipated that in the course of the unit contact hours the student will not only learn the basic tenets of chemistry as prescribed but will also be impacted with some HIV and AIDS knowledge that could influence, the perception, behavioral change, demystification and contribute in the fight against HIV and AIDS in the universities and communities at large.

This integrated teaching module is an output of the in-country training workshops for lecturers on "Higher Education Science and Curricular Reforms: African Universities responding to HIV and AIDS, held in Kumasi (Ghana), Kigali (Rwanda), Gaborone (Botswana) and Nairobi (Kenya). The module contains input from participants from public and private institutions of Higher education and is based on their curricula in the teaching of chemistry.

ACKNOWLEDGMENT

This generic integration module has benefited from the inputs of participants at the UNESCO/AWSE in-country Training Workshops for Universities in Ghana (6-8 December, 2006), Rwanda (28 - 30 March 2007), Botswana (17 - 19 April 2007) and Kenya (08 - 10 May 2007), on Mainstreaming of HIV/AIDS into Engineering, Biological and Physical Sciences. Further technical inputs came from Professors Mabel Imbuga and Caroline Lang'at Thoruwa of AWSE and Alice A. Ochanda of UNESCO.

The training workshops were facilitated by **Prof. Zipporah W. Ng'ang'a of Jomo Kenyatta University of Agriculture & Technology, Department of Medical Laboratory Sciences.** Professor Ng'ang'a also compiled information from all the training sessions to come up with this intergration module.

Profound gratitude and further acknowledgement is expressed to UNAIDS who made the production of these modules a reality through their Unified Budget Work plan (UBW) funds.

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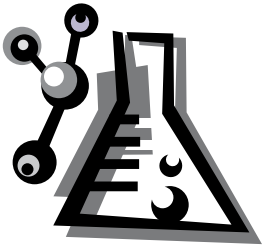


GENERAL CHEMISTRY

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

Matter, state of matter, heterogeneous and homogeneous mixtures, pure substance, compound, Elements, Physical properties. Physical changes, chemical changes. Law of conservation of mass, law of definite proportions. Law of multiple proportions. Daltons atomic theory, Avogadros hypothesis. Relative atomic and molecular mass. Mole, molar mass and molarity. The periodic table. Electronegativity, Thermochemistry. The chemical bond. Covalent bond. The chemical reaction. Rate law. Rate influencing factors. Activity series. Acids and bases. Buffer solutions.

Entry points for HIV integration

- Explain Abstinence from point of view of pure substances, homogenous mixtures, relate this to one partner sexual relationships.
- Heterogenous mixtures in relation to mixed sex and multiple infections and implications in HIV transmission and HIV disease.
- Opportunity to introduce control of HIV such as use of condoms to avoid heterogenous mixtures.
- Introduce HIV screening as a measure of determining purity i.e. Absence of HIV.
- The HIV infection is analogous to a chemical change, it is irreversible.
- Multiple sexual partners and mixed infections and progression from HIV to AIDS may be related to multiple proportions.

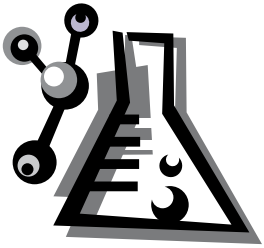
- Chemical bonding in HIV. The binding of gp120 and the CD 4 receptors of target cells.

- The binding of antigen and antibody in HIV involves weak forces and may result in precipitation reactions. The forces governing interactions during HIV testing (ELISA) are weak Van der Waals interactions.

- Irreversible reactions analogous to HIV infection. The forces governing interactions during HIV testing (ELISA) are weak Van der Waals interactions.

- 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.



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

Thermodynamic: 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. Gaseous state: kinetic theory of gases; general equation of state; units of variables, properties of molecules and gas laws; velocities of molecules and kinetic energy; specific heats, Cp and Cv for monatomic gases; behaviour of real gases; determination of molar masses. Gas-liquid equilibrium; liquids

and their solutions containing non-volatile solutes; modes of expressing concentrations; colligative properties and Raoult's laws; solutions of gases in liquids; Henry's law; solutions of two volatile (ideal) liquids. Chemical equilibrium; equilibrium constant; equilibria in gas phase, Kc and Kp interrelationship; ionic equilibria and solubility product principle; aqueous solutions of weak acids, weak bases and their salts; dissociation constant, hydrogen ion. Characteristics of atomic particles. Natural radioactivity. Artificial radioactivity. Half life of a radioisotope. Law of radioactive decay. Binding energy. Nuclear fusion. Electrochemistry. Thermochemistry. Chromatography: paper and thin layer chromatography, ion exchange chromatography.

Chemical kinetics: Reaction rate. Dependence of reaction rate on concentration. The temperature dependence of reaction. Catalysis.

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.

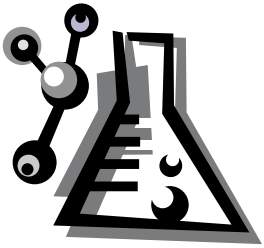
- Factors that decelerate the rate of HIV progression to AIDS i.e. Antiretroviral drugs, Vitamin A supplementation, elective caesarean section, healthy eating habits.

- *Catalysis:* bioorganic enzymes that facilitate replication of the HIV. Catalysts are analogous to factors that enhance progression of HIV to AIDS such as malnutrition, multiple sexual partners, drug and substance abuse, pregnancy, steroid therapy etc.

- ARV acts as inhibitors of HIV replication. The role of ARV as targets of drug action by inhibiting the HIV life cycle. The role of ARV's in Post Exposure Prophylaxis (PEP) following accidental contact with HIV infected fluids (rape, occupational hazards).

- 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.

- The irreversibility and complete destruction of infected host cells by HIV. The transmission equation is irreversible. Once infected you remain infected for life.

- Weak acids and bases analogous to different strains of HIV. Some are more virulent than others.

- Chromatographic techniques in HIV diagnosis.

- Protective mechanisms of HIV with emphasis of cellular immune responses which could be measured in a recall proliferative responses by use of radionucleids like tritium.

- Comparison between radioactive decay with decline of CD 4 cells following HIV infection.

- The analogy between nuclear fusion and the fusion of HIV and the target cell should be used to describe the target cell of HIV and the role of Anti Retro Virals in blocking fusion.

- Compare half life of radioisotopes and the half life of the T cell. The role of radioisotopes in HIV diagnosis, effects of ARV's and HIV pathogenesis.

THEORY OF SPECTROSCOPIC METHODS

Course Description

The electromagnetic spectrum. Relationship between energy, frequency and wavelength. Absorption and emission of electromagnetic radiation: electric dipole and magnetic dipole transition moments. General introduction to spectroscopy, rotational, infrared and Raman spectroscopy; Electronic spectra of atoms and molecules. Instrumentation and procedures for: molecular absorption/emission techniques; UV visible, infra red phosphorescence, fluorescence. Atomic absorption/emission spectroscopy, mass spectroscopy and X- ray spectroscopy.

Aims and Objectives

Students will be introduced to the spectroscopic methods of analysis.

Intended learning outcomes

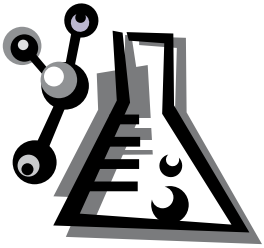
At the end of the course, students should be able to:

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.

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 PLWAs.
- Speciation chemistry of drugs example of ARVs 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

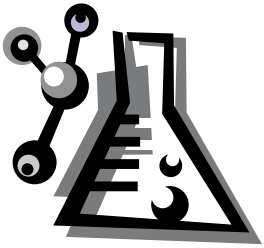
ATOMIC STRUCTURE AND CHEMICAL BONDING

Course Description

Radiation: properties and applications; the theory of atomic spectroscopy – Planck, Einstein, Bohr and de Broglie theories; the line spectrum of hydrogen. The classical wave equation, the wave function concept, Heisenberg's uncertainty principle and the photoelectric effect, introduction to the Schrödinger equation; Quantum numbers, orbital types, shapes and energies. The electronic configuration of atoms and ions; Pauli Exclusion Principle and Hunds rule. The Aufbau principle: filling of s, p d and f orbitals. Trends in atomic properties: the periodic table; ionization energies, effective nuclear charge, electronic affinities, atomic and ionic radii. Ionic and covalent bonding: bond length, bond energy, and bond polarity as indicators of reactivity and The Born-Haber cycle and Born Lande equation. The molecular orbital theory, the valence bond and valence shell electron pair repulsion models as applied to shapes of simple molecules and ions. Hybridization of atomic orbitals.

Entry points for HIV integration

- *Periodic table:* Mention on the micronutrients of metals and non metals.
- Nutritive value of Mg, Ca, Fe, Zn, Se & I2 in management of HIV and foods rich in them.
- *Chemical reactions, van- der Waals bond, hydrogen bonds:* The type of bonding between the HIV molecule and the cell can be said to be either van-der Waal forces. These are weak bonds which are holding the molecules together. (Antigen and antibodies in HIV infection. The forces responsible for ag/ab interactions are weak chemical bonds.
- *Lattice energy:* A HIV/AIDS patients needs a lot of energy.
- HIV infection is analogous to a chemical change. It is irreversible. The nature of co-receptors on the CD4 determines the susceptibility to HIV. Africans compared to other races.



CHEMISTRY OF THE MAIN BLOCK ELEMENTS

Course Description

General trends of physical and chemical properties of Groups I – VIII along the periods and down the groups; Chemical intuition for inorganic chemistry connecting chemical composition, structure and bonding with reactivity; the chemistry, properties and uses of selected inorganic compounds including boranes, silicones, silicates, sulphates, nitrates, phosphates. Chemistry of some compounds of Noble gases; Ozone and freons in the atmosphere; Role of inorganic chemistry in biology and the environment.

Entry points for HIV integration

- Role of inorganic elements as micronutrients. Mention the role of Ca, Mg, Se and Fe in management of HIV disease.

- Importance of inorganic elements as antioxidants in HIV infection. Selenium as immune booster through its antioxidant properties. Most reactions in patients results in production of free radicals (ozone reactions) that are oncogenic predisposing to cancer. Populations in areas where soils are rich in selenium have low HIV prevalence (West Africans).

- Introduce opportunistic infections in HIV disease.

INTRODUCTION TO CHEMICAL KINETICS AND ELECTROCHEMISTRY

Course Description

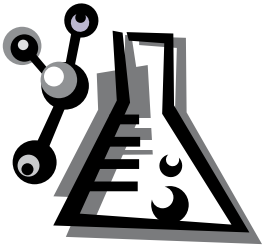
Reaction rate processes and rate laws; order and molecularity of a reaction; explanation of zero, first, second, third and pseudo order reactions; determination of an order of a reaction; differential and integral rate equations; effect of temperature on reaction rate; energy of activation; Arrhenius equation.

Electrolysis: electrical units; electrolytic conductance; molar conductance; experimental determination of conductance; conductance of solutions of strong and weak electrolytes; ionic conductance at infinite dilution. Applications of conductance measurements - conductometric titrations and solubility of sparingly soluble salt. Transference numbers and the methods of their determinations.

Electrochemical cells: electromotive force (emf) of cells, the hydrogen electrode, the emf series and its uses, Nernst equation, concentration cells, the standard cell, the principle of measurement of the emf of a cell. Applications (electrolysis of NaCl, electroplating).

Entry points for HIV integration

- HIV concentration in body fluids (Viral load) influences the efficiency of fluids in HIV transmission.
- Factors increasing the risk of HIV infection: multiple sexual partners, cultural practices, poverty, drug and substance abuse influencing progression from HIV to full-blown AIDS as analogy.
- Applications of electromotive force in HIV testing. Benefits of HIV testing.



COORDINATION CHEMISTRY

Course Description

General properties of transition elements: electronic configuration, variable oxidation states, catalysis, coloured compounds and complexes. Transition metal complexes: Ligands, nomenclature, coordination number, effective atomic number (EAN) or 18-electron rule, stereochemistry, isomerism, Chelate and chelate effect. Bonding of coordination complexes: Valence bond theory, Crystal field theory: crystal field splitting of different geometries, electronic configuration of complexes and states arising, high and low spin complexes, crystal field stabilization energy, spectrochemical series, Orgel and Tanabe- Sugano diagrams. Ligand field theory: interelectronic parameters, Nephelauxetic effect. Molecular Orbital theory: complexes with and without π orbitals. Steric effects: tetragonal distortion, square planar and the Jahn Teller effect. Electronic Spectra: d-d transitions, charge transfer, selection rules, colours of different complexes. Effect of d orbital splitting: ionic radii and thermodynamic factors. Magnetic properties of transition metal complexes. Some application and uses of selected examples of useful coordination compounds.

Entry points for HIV integration

- Multi-dentate and chelating properties of protein (e.g. in HIV).
- The charge transfer in chromophores (i.e. presence of S, P, N, O etc in proteins).
- Haemoglobin as a metallo-protein complex: role in uptake and distribution of oxygen in human body.
- The role of iron in HIV disease management. Important sources.

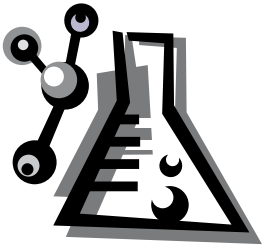
SURFACE AND COLLOID CHEMISTRY

Course Description

Adsorption: determination, characteristics and classification. Contributions of Langmuir, Brunauer-Emmett-Teller. Applications - chromatographic methods. Heterogeneous catalysis. Liquid surface. Solutes and surface tension. Action of surface active agents.
Colloid state. Soils - preparation and properties. Gels. Emulsions. Natural and synthetic macromolecules - principles involved in their molar mass determinations. Applications.

Entry points for HIV integration

- The more the HIV particles adsorbed on the cell the more the destruction of the CD4 cells.
- HIV only binds on CD4 selectively; colloidal nature of protein separation in electrophoresis.
- Chromatographic techniques in separation of HIV proteins. The role of HIV proteins in HIV replication.



THE CHEMISTRY OF TRANSITION ELEMENTS

Course Description

Discussion of common features: Properties; colour, radii, shapes of d & f orbitals, magnetism, oxidation states and trends in ionization potential of first, second, third d-block and f block elements. Elemental sources; binary compounds, chemistry of lower and higher oxidation states, shapes of stable compounds, and reaction mechanisms of the first, second and third series of d and f-block elements. Introduction to lanthanides and actinides. Industrial uses and biological role of some transition elements.

Entry points for HIV integration

- Importance of foods containing Fe and Zn to PLWHA.
- Important sources of Fe and Zn.
- Chemical determination of foods for Fe and Zn.
- Magnetism analogous to attraction of opposite sexes. Healthy relationships to be introduced.
- Oxidation states analogous to excited youth.

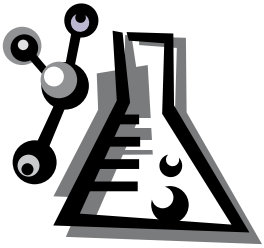
ADVANCED ORGANOMETALLIC AND SOLID STATE CHEMISTRY

Aims and Learning Objectives

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

Course Synopsis

General survey of organometallic compounds: ionic, sigma bonded and non-classically bonded compounds. Synthetic methods, structures and chemical reactions of non-transition metals, organo compounds of lithium, sodium, potassium, magnesium, mercury, boron, aluminium, silicon, germanium, tin, lead, phosphorus, arsenic, antimony, bismuth compounds. Organometallic compounds of transition elements with lewis bases: phosphine, halides, hydride, oxygen, nitrogenase. Organometallic compounds of alkyls, aryls, carbines, cyclopentadiene and carbonyls. Introduction to reaction mechanisms/kinetics of catalysis of selected organometallic complexes. Industrial application and uses of some organometallic complexes. 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

- Application of organometallic compounds as catalysts in drug synthesis (e.g. ARVs/ART).
- Solid state behaviour of ARVs.

- Application of organometallic chemistry in synthesis of ARVs.
- Characterization using modern methods (spectroscopic and X-ray diffraction).
- Properties of ARV drugs in solution and solid states.
- Organometallic lattices for rapid HIV testing.
- Zeigler-Natta catalysis in polymerisation alkenes for making polythene (condoms).
- Introduce HIV prevention and protection. Correct and consistent use of condoms. Disposal of condoms.

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 behavior 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

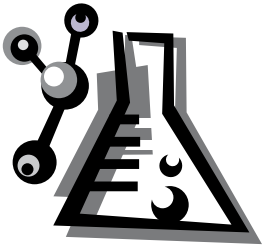
Entry points for HIV integration

- *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.
- The role of nutrition in management of HIV.

SAMPLE HANDLING AND BIOCHEMICAL ANALYSIS

Aims and Learning Objectives

Students will be introduced to various methods of sample preparation and bioanalysis

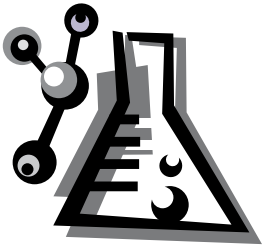
Intended Learning Outcomes

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.

INTRODUCTION TO CLASSICAL ANALYSIS AND SEPARATION TECHNIQUES

Course Description

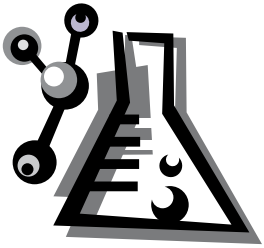
Introduction to nature and scope of Analytical chemistry, Collection and treatment of analytical data, Types of errors and error analyses, Mean, Standard deviation, Variance, Student t-test, Confidence limits, Gravimetric and Titrimetric analysis.

Separation Techniques including non chromatographic techniques such as Liquid-liquid extractions, Distillation, Crystallization, Chromatographic Techniques such as planar and column chromatography which comprise of paper chromatography, Thin layer chromatography, ion exchange, Liquid –liquid and Gas-liquid chromatography. Gel electrophoresis.

Practical: Methodology of analytical chemistry with particular reference to Industrial and Environmental problems. Include practical in Gravimetric analyses, trimetric analysis, non chromatographic and chromatographic analyses

Entry points for HIV integration

- Collection of HIV/AIDS related data.
- Detailed disease description which include the following information; Clinical symptoms, host range including various age groups with emphasis of most vulnerable groups, etiology and etiological factors including routes and modes of transmission, incubation periods with emphasis of long latency stages of infection.
- Diagnostic methods- with emphasis of rapid diagnostic procedures, Treatments and prognoses with emphasis on role of ARVS and nutrition in management of HIV and AIDS.
- HIV and AIDS epidemiology with emphasis of different kind of data



related to HIV and AIDS for example mortality data, prevalence data, incidence data, morbidity data, infection rates, Percentage responses to ARV treatments, Viral loads and CD4 profiles.

- Separation of different immunoglobulin isotypes with reference to antibodies against HIV.

Practical: Use column chromatography to separate components of blood

- Use of acrylamide gel in separation of HIV proteins according to molecular size in SDS PAGE.

- Western blotting as a confirmatory test for HIV.

Practical: Use of PAGE to separate the components of HIV.

WATER POLLUTION AND WASTE WATER TREATMENT

Course Description

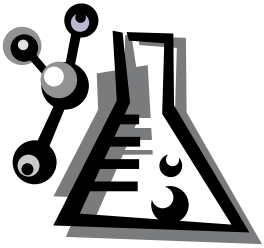
Physical properties of water, polarity and geometry of water molecule. Characteristics of waste water. Biological microorganisms: bacteria, fungi and protozoa.

Natural water, Indicators of water quality. Drinking water quality parameters, microbiological, inorganic substance content, organic substances, radioactive substance content. Treatment of natural water. Destruction of microorganisms if their presence exceeds a certain limit.

Entry points for HIV integration

- The purity of water is analogous to a HIV free body. Contaminated water is analogous to a body infected by HIV.
- Discuss waste water as a source of Giardia, Salmonella, Shigella and, Entamoeba. Discuss opportunistic infections and the increased risk for typhoid, giardiasis, amoebic dysentery and shigellosis with chronic diarrhea and dehydration.
- Discuss the importance of safe drinking water in HIV infected persons. Water harvesting and storage.
- Water as a habitat for fish and the importance of fish protein in the diet of PLWA's.
- The relationship between fishing and the increased vulnerability of HIV due to the fishing culture. The need for behavior change. Fish as a source of income to reduce poverty among PLWA's.
- The importance of water in breeding of mosquitoes. The relationship between malaria and HIV infection.

Practical: Use appropriate chemical analysis to determine the water quality within your institution.



ATOMIC STRUCTURE, CHEMICAL BONDING AND CHEMICAL KINETICS

Course Description

Particles and waves, waves and the wave equation: Energy levels, electron configuration and the periodic table. Ionic, covalent, hydrogen and metallic bonds. Reaction kinetics. Methods of determining rates and orders of chemical reactions. Reaction mechanisms. Dependence of reaction rates on temperature. Parallel, consecutive and reversible reactions. Mechanisms of enzyme catalyzed reactions. Theories of reaction rates.

Entry points for HIV integration

- Example of various forces bonds involved in antigen antibody interaction with respect to HIV derived antigen and antibodies. Emphasis should be made on various diagnostic techniques involving antigen and antibody reaction which are governed by various forces and bonds as taught in chemistry.

- The valency of different antibodies. Binding properties of antibodies in relation to their valency.

- HIV disease progression by detection of antibodies against HIV using chemical reactions.

- HIV testing. Enzyme linked immunosorbent assay (ELISA) should be demonstrated as applicable for preliminary antibody detection in HIV testing. Competitive and non competitive ELISA as used in HIV testing.

    - Take Away Assignments
    - Seminars and Workshops

INSTRUMENTAL METHODS

Course Description

Spectrometric methods: ultra violet, visible- absorption and emission processes, infrared, nuclear, magnetic resonance, flame photometry and electrothermal atomic absorption. Fluorimetry. Immunoassay techniques and radioisotopes in analytical chemistry. Thermal analytical techniques. Chromatographic techniques.

Entry points for HIV integration

- Use of fluorimetry in determining CD4 counts in serum (FACS) Role of CD4 cells in defence and consequences of T cell destruction can be emphasized here.

- Use of fluorochrome labelling techniques in monitoring HIV disease Role Fluorescence conjugated antibody for monitory CD4 counts.

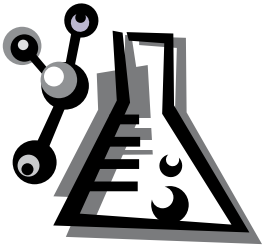
- Response to chemotherapy by measuring CD4 counts by using FACs, use of Immunofluorescence assay (IFA) as confirmatory tests for HIV diagnosis.

- Emphasis on etiology, pathogenesis, involvement of cellular and humoral arms of the immune system.

- Measurement of cellular responses due to HIV using radioisotopes, ie lymphocyte proliferation assays, chromium release assay.

- Measurement of humoral responses using immunoassay techniques like ELISA, radioimmunossay (RIA).Use of radioisotopes in determining effects of ARVs.

    - Take Away Assignments
    - Seminars



Course Evaluation

- The time for the teaching unit is as described in the curriculum for each university.
- All courses are examined at the end of the semester in which they are taken.
- Examination consists of Continuous Assessment Tests and University examinations. The marks allocation and pass mark is as per the regulations governing courses in the respective universities.

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