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**AWSE**  
African Women  
in Science and Engineering

# BIOLOGICAL SCIENCES & HIV and AIDS

Integration Module  
(Kenya)





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# BIOLOGICAL SCIENCES & HIV/AIDS

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## INTEGRATION MODULE (Kenya)

### Project Implementation Team:-

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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, behavioral change, demystification 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 at the Kenya Institute of Education in Nairobi, Kenya. The module contains input from participants from the 11 public and private universities in Kenya and is based on their curricula in the teaching of biology.

## ACKNOWLEDGMENT

This integrated course module has benefited from the input of the participants from the following public and private Institutions of Higher Education: public and private institutions of Higher education in Kenya: Kenyatta University (KU), Jomo Kenyatta University of Agriculture and Technology (JKUAT), University of Nairobi (UoN), Maseno University (MU), Masinde Muliro University of Science and Technology (MMUST), Egerton University, Catholic University of East Africa (CUEA), Africa Nazarene University, United States International University (USIU), Daystar and Kenya Methodist University (KEMU) and is based on their curricula in the teaching of biology.

The training workshop was facilitated by **Prof. Zipporah W. Ng'ang'a** from 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.

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## SZL 101 INVERTEBRATE ZOOLOGY

Introduction: origin and diversity of animals classification, kingdoms of living organisms, the species, embryonic features used in animal classification, the rise of zoology, where animals are found, animals of the past and their distribution through geological times.

### Entry points for HIV integration

- *Origin and evolution of retro viruses with reference to HIV. The theories of origin and history of HIV*
- *Sub-types and viral strains in relation to geographical regions*
- *Phylogeny and viral strains/types. Implications of HIV subtypes on progression to AIDS, HIV prevalence across the world, therapy and prospects for vaccination. The relationship between multiple sexual partners and mixed infection with different sub-types.*

*The scope of zoology.* The Invertebrata: a survey of invertebrate groups emphasizing their habits, structural features, functional anatomy, and evolutionary relationships using Eastern African examples. Kingdom Protista, Subkingdom Protozoa, Phyla Sarcomastigophora, Labyrinthomorpha, Apicomplexa, Microspora, Ascetospora, Myxozoa and Ciliophora. Origin of Metazoa. Kingdom Animalia: Subkingdom Phagocytellozoa Phylum Placozoa; Subkingdom Parazoa Phylum Porifera; Subkingdom Metazoa: phylum Mesozoa. The Radiata: Cnidaria and Ctenophora. The Bilateria: the Acoelomata: Platyhelminthes, Nemertea and Gnathostomulida. The Pseudocoelomata: Nematoda and minor pseudocoelomates. The Coelomata: Annelida, Mollusca, Arthropoda, Echinodermata, the unsegmented coelomates, and other minor coelomates. Differences between the Protostomata and Deuterostomata phyla. Invertebrate phylogeny.

### **Entry points for HIV integration**

- *The HIV structure. The relationship between structure and HIV replication. The role of viral enzymes in replication and as targets of drug action.*
- *Why viruses are not living things.*

## **SZL 303: BIOSTATISTICS**

Introduction to quantitative treatment of biological data: nature of biological variation; basic descriptive statistics.

### **Entry points for HIV integration**

- *Use of medical statistics for quantitative analysis and practical use of HIV related data. Data on uptake of VCT, MTCT, ARV therapy, condom use, TB screening and treatment. STD treatment, mortality due to HIV related complications among schools, universities, industry etc. this creates the realia of HIV and AIDS.*

Types of distribution, probability and tests of significance, differences between means, association of two variables, parametric and non-parametric tests and variation under different conditions.

### **Entry points for HIV integration**

- *Variations in infection, prevalence rates across sex, age gender, geographical areas, race. A comparison between prevalence in developing and developed countries. Reasons for the higher rates among Africans and among women compared to men. Intervention measures to reduce the high rates. Tests of significance between rates of infection among circumcised and uncircumcised males. The role of circumcision in mitigating the spread of HIV.*
- *Efficacy of data on condom / ARV usage*
- *Bio-geographical survey*

## Experimental design

### Entry points for HIV integration

- *Use of experimental design in HIV related research such as vaccine testing, factors influencing VCT uptake among the youth, condom use, factors influencing behavior, factors hindering behavior change, factors hindering PMTCT, ARV use etc....*
- *Methods of data collection. Use of different tools in collection of HIV related data i.e. Questionnaires, desk reviews, FGD's, key informant interviews etc....*
- *Epidemiological surveillance. Survey to determine HIV prevalence and the factors influencing prevalence.*
- *Error reduction techniques in relation to HIV/ AIDS data.*
- *Statistical / prediction models for projecting future trends, response to ARV therapy using single therapy as well as combined therapy. The effect of dosage on outcome i.e. CD4 count and viral load.*

## SZL 404: HISTORY AND PHILOSOPHY OF BIOLOGY

*History: the growth of biological thought from the ancient Greeks to the present day. From Alcmaeon and the Hippocratic school to Aristotle. Aristotle's biology and his scientific method. Theophrastus to Crateuas and Galen. The eclipse of ancient science in the West. Transmission of Greek science by the Christian Syrians to the Arabs.*

### Entry points for HIV integration

- *Theories and origin of HIV.*
- *Nature and biology of HIV (The biology of HIV: structure, characteristics, replication, adaptations ).*
- *HIV virus- HIV 1 and HIV 2. The different subtypes of HIV. Distribution worldwide. Implications of HIV variability in treatment and prospects of a vaccine.*
- *Discovery of the HIV virus. A line history of HIV from 1981 to present and the future.*



## Islamic biology and medicine from the 9th to the 12th centuries.

### Entry points for HIV integration

- *Various religious perspectives towards HIV – The relationship between religion and AIDS. The role of religion in mitigating the spread and reduction of stigma and discrimination through education, care and support, lobbying and advocacy. The role of religion in emotional care of HIV infected. African traditional religion and AIDS. The role of polygamy, Female Genital Mutilation in the spread of HIV. The conflict between HIV mitigation measures religious perspectives.*
- *Ethical implications (homosexuality, wife inheritance and role of cultural practices in preventing or promoting HIV transmission) Ethical implications of mandatory testing, denial of care, drugs, employment and all forms of discrimination. Ethical implications in use of humans for testing of drug efficacy and vaccine trials.*
- *Moral implications (shame, guilt, stigma) of HIV infection.*

Re-transmission to the West and the rise of Western science in the 12th and 13th centuries. The Western Universities. Leonardo and Vesalius to Borelli and Harvey. The classical microscopists. The early taxonomists to Linnaeus.

The overthrow of spontaneous generation theory: Redi, Spallanzani and Pasteur; modern ideas on the origin of life. Organic evolution: Buffon, Lamarck to Darwin and Wallace; modern controversies.

Mendel and modern genetics and research. The new synthesis. Watson and Crick and molecular biology. Philosophy: the presuppositions of science.

The nature of scientific law and the meaning of scientific explanation. The hypothetico-deductive method.

## Entry points for HIV integration

- Legal and human rights issues in HIV infection (mandatory testing, breach of confidentiality, stigma, abuse, discrimination and denial of care, retrenchment, dismissal, denial of insurance, denial of hospital admission and drugs, abandonment, violence etc ). The rights of HIV infected persons. The HIV / AIDS Act

Scientific proof: verificationism and falsificationism. Reductionism in science. The unity and diversity of scientific methods. Role of concepts and their refinement in biological explanation.

## Entry points

- *Impact of HIV on national development. The impact of HIV on demography, households, agriculture, education, industry, culture, health. The relationship between HIV and poverty*
- *Discordant couples. Genetic resistance to HIV*
- *Gender disparity and HIV/AIDS. Gender differences between men and women in education, economic empowerment, information and implications in HIV transmission . Intervention measures in reduction of HIV prevalence among women.*

## SZL 410: POPULATION ECOLOGY

### Growth and regulation of populations

#### Entry points for HIV integration

- *Diseases as regulators of populations e.g. Impact of HIV on human populations, demography, life expectancy*
- *Age and gender dimensions in HIV and implications on population dynamics*

### **Intra specific and inter specific interactions:**

- *Polygamy and its role in HIV transmission*

Evolution of ecological strategies. Community ecology, delimitation of communities locally geographically, energy flow and its regulation.

- *Geographical variations in HIV prevalence, locally and worldwide. Africa as the epicenter of the HIV pandemic. Reasons for HIV prevalence in Africa compared to the rest of the world. Energy loss in humans due to HIV infection.*

Determinants of community structures and diversity

### **Entry points for HIV integration**

- *Cultural practices e.g. polygamy, wife cleansing, wife inheritance, female genital mutilation, moranism etc. The effects of cultural practices on HIV transmission. The impact of HIV on cultural values and customs.*
- *The conflict between HIV mitigation measures and culture*

Topics will be given a mathematical treatment whenever appropriate.

- *Modeling of population dynamics*
- *Survival analysis*

## **SBT 103: BOTANICAL TECHNIQUES**

An introduction to the scientific method, basic methods and instrumentation in biology, emphasizing fundamental laboratory procedures. Techniques to be studied include light and electron microscopy, spectrophotometry, gel electrophoresis

### **Entry point for HIV integration**

- *Diagnosis of HIV using Southern blot and ELISA. Introduction to HIV testing*

Chromatography, sectioning and staining. Laboratory specimen: collection, classification, nomenclature, storage, preservation and processing.

- *Blood sample collection methods, risk of infected blood as a source of HIV. The role of sharp objects in transmission (Intravenous drug users, health care providers , female genital mutilation ).*

Records and inventory. Laboratory reagents, preparation and storage.  
Safety

- *HIV as a biohazard. Safety in handling and storage of HIV infected material. Rules and regulations of working with biohazards and disposal methods with reference to HIV.*

### **Teaching Methodologies**

- Lectures, tutorials, class presentations, practicals, assignments, resource persons.

### **Proposed Assignment**

- *Establish the diagnostic techniques used in clinics, hospitals and VCT centers for HIV diagnosis.*

## **SBT 200: PLANT ECOLOGY**

A study of the ecosystems will be done. The abiotic environment; minimums, tolerances and the medium; isolation, precipitation, and climate; soils, nutrients, and other factors will be looked into. Species interactions.

### **Entry point for HIV integration**

- *Parasitism –The relationship between HIV and the human host*

### **Biotic environment**

- *The relationship between HIV and the biotic environment. HIV is exclusively intracellular. Modes of HIV transmission through contact with the biotic environment (fluids of infected persons). Methods through which HIV is not transmitted. Relationship between HIV*

*and the abiotic environment. HIV is not transmitted through sharing of clothing, utensils, seats etc....*

Energy flow in ecosystems: energy fixation by autotrophs; energy flow beyond the producers will be examined. Biogeochemical cycles and ecosystems: gaseous and sedimentary nutrient be examined, so will be community ecology (habitat locations of plants with bioactive molecules), its structure, function; stability and change. the nature of human ecology, the human population.

- *Impact of HIV on energy flow in the ecosystem. HIV infected loses lots of energy in fever.*

Impact of pollutants on human health and other living systems. Risk assessment of chemicals in the environment will be examined together with global approach to solution of environmental problems.

- *The role of air, water pollutants on health in HIV infected persons. Opportunistic infections in HIV disease (TB, typhoid, cholera, meningitis etc).*

Techniques used in terrestrial and aquatic environments to gather ecological data and quantitative data analysis using computers will be examined.

- *Analysis of impact of HIV on land use, crop yields (agriculture) and implications for food security and income.*

### **Herbal Medicines**

- *Herbal remedies in HIV disease. The relationship between herbal and modern medicine.*

### **Teaching Methodologies**

- Lectures, tutorials, class presentation, field trips, assignments, resource person (herbalists).

### **Proposed Assignment**

- *Field trip to list plants of medicinal and nutritional value*

## **SBT 310: PLANT BIOCHEMISTRY AND PHYSIOLOGY**

The course examines the basic principles of plant physiology including cell structure and function together with hereditary and environmental influences on plant behavior. Respiration.

❖ *HIV relies on host cell's energy*

Biological oxidation; respiratory metabolism; photophysiology; and photochemistry will be looked into. Biochemistry that is role of ATP and NADPH, chloroplast as unit of photosynthesis; factors influencing photosynthesis; photorespiration: characteristics and biochemistry of CAM, C3 and C4 plants will be examined. The course will also look into mineral nutrition –essential and beneficial elements, solutions and sols as nutrient sources; elemental analysis of plant tissues; nutritional disorders; chemical fertilizers in crop production; foliar nutrition. Biosynthesis: primary and secondary metabolites

### **Entry points for HIV integration**

- *The role of primary and secondary metabolites in management of HIV. The role of vitamins and minerals. Important plant sources.*

The physiological and biochemical actions of plant growth substances and genetics of plant will be studied. Physiology of seeds – development, germination, dormancy.

- *The latency of CD4 cells in the asymptomatic period*

### **Teaching Methodologies**

- Lectures, tutorials and practical sessions.

### **Proposed Assignment**

- *Write an essay on secondary plant metabolites used to boost immunodeficiency in HIV-AIDS (Use electronic and bibliographic literature).*

## **SBT 420: BIOTECHNOLOGY**

Plant cell, tissue and organ structure, and their application methods of creating recombinant DNA molecules, isolation and cloning of genes.

- *Isolation and cloning of HIV genes for PCR*

Genetic engineering of plants, viral vectors,, haploids, protoplasts, hybrids and fusion. Mutagenesis, molecular and somatic hybridization. Genetic engineering, fermentation and down stream processing.

- *Genetic engineering of plants for high yields, disease resistant and fast growth to ensure income and food security for infected and affected by HIV Biosensors, formation and recovery of biologicals. Applications to agriculture, medicine, industry, health care and food processing with reference to Kenyan situation.*
- *The role of biosensors in monitoring pathology of HIV and drug action on selected organs*

## **SBT 415: FERMENTATION**

History and types of fermentation processes. Conditions for better fermentation processes. Recovery of fermentation products. Study of modern fermentation processes. Use of technology in fermentation.

### **Entry point for HIV integration**

- *The role of fermentation products i.e. alcohol in HIV transmission. Clouded judgement leading to casual sex, alcohol results in immunosuppression, alcohol accelerates the downward spiral to poverty, alcohol and malnutrition, intravenous drug use.*

## **SBC 101: THE CELL AND ITS EXTERNAL ENVIRONMENT**

Ultrastructure of prokaryotic and eukaryotic cell organelles: nucleus, cell wall, plasma membrane, cytoplasmic inclusions and intracellular attachments. Extracellular fluids, blood and lymph, their composition and relationship to the cell. Biochemistry of specialized cells- renal tubular cells, red blood cells, nerve cells and muscle cells.

### **Entry points for HIV integration**

- *prokaryotes – the example of HIV*
- *The role of cellular organelles in the HIV life cycle (the plasma membrane, cytoplasm and nucleus).*
- *Biochemistry of some specialized cells- WBC.*
- *WBC's are immune cells which contain CD4 receptors. The HIV virus attaches to the CD4 receptors to gain entry to the human cell.*
- *The role of extra cellular fluid in HIV transmission. The composition of extracellular fluids with reference to cells containing CD4. T lymphocytes, langerhans cells, dendritic cells and macrophages. Consequences of destruction of CD4 cells by HIV. Immunosuppression leads to AIDS.*
- *Effects of HIV on muscle and nerve cells (wasting, paralysis).*
- *Exercise in positive living with HIV.*
- *Effects of antiretroviral drugs on renal tubular cells.*

## **SBC 308: INTRODUCTION TO BIOTECHNOLOGY**

Production of new generation of certain vaccines against pathogenic bacteria: Salmonella, Diphtheria, Chlamydia, Bordetella.

### **Entry points for HIV integration**

- *Opportunistic infections in HIV disease. Positive living with HIV. The role of vaccination against typhoid, whooping cough and TB in people living with HIV.*



Mechanisms of virus transformation. Virus association with human tumors, virus prevention and control by vaccination. Development of DNA vaccines. Importance of retroviruses in activating oncogenes associated with cancer

- *The HIV virus transformation, replication and variability. Common cancers in HIV disease – Kaposi sarcoma, cervical cancer. HIV prevention and protection. The ABC of HIV prevention and protection. The prospects of development of a DNA vaccine against HIV. The current vaccine trials. The constraints in development of HIV vaccine. HIV as an example of a retrovirus.*

### **Application of modern biology techniques in food production.**

- *The role of tissue culture techniques in production of fast growing, fast yielding, drought and disease resistant crop varieties for food security and income generation among infected and affected by HIV.*

### **Genetic engineering in animal husbandry**

- *The role of modern biology in animal production for hybrids that are fast growing, high yielding and disease resistant*

### **Production of monoclonal antibodies. Ethical considerations in regard to DNA manipulation**

- *The role of MABs in HIV diagnosis, as therapeutic agents and as candidates for vaccine.*
- *Ethical implications in use of DNA vaccines and testing in humans. Handling and disposal of HIV DNA in laboratories.*

## **SBC 311: PHARMACOGNOSY AND PHARMACOLOGY**

Geographical distribution, habitat, collection, curing, drying, cultivation, storage of medicinal plants. Natural products in medicine either as crude drugs or in pure form. Active constituents from the drugs. Distribution, biosynthesis, extraction, isolation from crude drugs

### **Entry points for HIV integration**

- *Medicinal plants in HIV management, distribution, active components. The role of herbalists.*

### **Principles of drug action, absorption, distribution, biotransformation, and elimination of drugs.**

- *Anti Retro Viral drugs- types, mode of action, side effects, barriers hindering use and methods of overcoming them. Antibiotics and fungicides used in management of opportunistic infections associated with HIV disease.*

### **Laboratory methods of studying drug actions using animals and isolated organs**

- *Methods of studying ARV action using animal models and specific effects of ARVs on the liver, kidneys and brain. The use of biosensors in monitoring the side effects associated with ARVs.*

## **SBC 413: COMPUTER APPLICATIONS IN BIOSCIENCES**

Computer simulation techniques to design molecular models. Application of computer simulation techniques in pharmaceutical industry.

### **Entry points for HIV integration**

- *Computer simulation in predicting the effects of different doses of either mono or combined ARV therapies on viral load and CD 4 counts.*
- *Computer simulation models predicting the pattern of transformation of HIV with time and the phylogenetic relationships between the different strains and the circulating clades within a population.*

## **Design of synthetic genes coding for specific proteins**

- *Design of synthetic genes for the gag, pol and env genes of HIV. The role of these genes in HIV diversity and prospects of vaccine production.*

Computer software for selecting primers, reagents and equipment for genetic engineering.

- *Selection of HIV primers for use in molecular characterization particularly bDNA PCR in paediatric diagnosis. The role of PCR in confirmatory HIV testing. Approaches to vaccine production.*

Computer programming languages and fundamental techniques of using such languages in problem solving. Use of the computer in solving a series of scientific problems. Electronic mail and internet.

- *The use of computers in obtaining and sharing information on HIV (Internet browsing, E mail).*
- *Computer programs in design and analysis of HIV related data with practical examples. The use of SPSS, SAS, Epi Info in data analysis.*
- *Computer networking analogous to sex networks. Viruses that affect and corrupt computers can be compared with HIV in the human body. The severity of computer viruses can be compared with the different strains of HIV.*

## **ALL FINALISTS**

- *Certified exit seminar – information on HIV-AIDS (for all universities)*
- *Presentation of latest HIV-AIDS data*
- *Knowledge Assessment for purposes of Evaluation of Impact.*

## **Course Evaluation**

- A teaching unit is equivalent to 35 lecture hours.
- All courses are examined at the end of the semester in which they are taken.
- Examination consists of Continuous Assessment Tests which

shall contribute 30 % and University examinations which shall contribute 70%.

- The pass mark is 40%.
- Only a student that is registered with the faculty / department shall be allowed to sit examinations.
- Failure to do a CAT shall lead to fail in the unit.
- Each student must attend at least 2/3 of the lectures for a unit in a semester, to be allowed to sit for the examination.

## List of Participant

### University of Nairobi

1. Mr. Vasant Dharmadhikary
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