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**AWSE**

African Women  
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# BIOLOGICAL SCIENCES & HIV and AIDS

Integrated Course  
Module (Ghana)



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# BIOLOGICAL SCIENCES & HIV and AIDS

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## Integrated Course Module (Ghana)

### **Project Implementation Team**

Dr. Alice Ochanda	- UNESCO
Prof. Mabel Imbuga	- AWSE
Prof. Caroline Lang'at-Thoruwa	- AWSE

## Preamble

The pandemic of HIV and 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 and 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 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 mainstreaming and integration of HIV and 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 Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. The module contains input from participants from the 5 public universities in Ghana 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 Institutions of Higher Education: Kwame Nkrumah University of Science and Technology, University of Ghana, University of Cape Coast, Kumasi Polytechnic, Garden City University College, University of Education in Winneba and the Christian Service University College.

The training workshop was facilitated by **Dr. Zipporah W. Ng'ang'a** from Kenyatta University, Kenya. Technical and editorial inputs were 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.

# **B: 101 Diversity of Living Organisms**

## **Course Description**

Origins of the universe, earth and life forms. Principles and significance of protistan and Animal kingdoms. An evolutionary and taxonomic review of the main phyla of these two Kingdoms. Brief overview of membranes, cells, resistance to diseases, homeostasis, thermoregulation, respiration, nervous system, skeletal system, excretion and osmoregulation, circulatory system, micro and macro-evolution.

## **Topic 1: Origins of the universe, earth and life forms**

By the end of this topic learners should be able to:

- Describe the origin of the universe, earth and life forms.  
*The theories of the origin of HIV should be used to describe origin of life forms. The history of HIV: the past, present and the future.*

## **Topic 2: Principles and significance of protistan and Animal kingdoms**

By the end of this topic the learners should be able to:

- Describe the principle of classification and importance of protistans and Animal Kingdom.  
*The basis of classification of viruses and significance of viruses as etiological agents of diseases, as vectors, as plasmids etc....*

## **Topic 3: A taxonomic and evolutionary review of the main phyla in the two kingdoms**

By the end of the topic, the learner should be able to:

- Classify and describe the evolutionary trend of organisms in the 2 Kingdoms.  
*Classification of viruses: basis of genetic material, presence or absence of coats, shape of the envelop etc. The classical example of HIV. Phylogenetic tree to describe evolution of HIV. The different strains and substrains of HIV. The implications of strain diversity*

*on transmission, disease progression, resistance to ARV therapy, prospects for vaccination.*

*The role of multiple infections (multiple sexual partners, correct and consistent use of condoms).*

#### **Topic 4: Brief overview of membranes, cells, resistance to diseases, homeostasis, thermoregulation, respiration, reproduction, nervous system, skeletal system, excretion, circulatory system.**

By the end of this topic learners should be able to:

- Describe cells and membranes

*Viruses are exclusively intracellular. How do they penetrate membranes? HIV transmission and life cycle.*

*Cells: Different cell types including blood cells.*

*Relationship of cells and HIV. Who is the target for HIV? What are the characteristics of the target cells? Presence of CD4 receptors. Polymorphisms in CD4 receptors that explain resistance to infection. The difference between Africans and Caucasians.*

Resistance to disease - Innate (Natural) and acquired immunity. The role of cells in resistance to disease (immune cells, CD4).

*The consequences of HIV infection on resistance to disease (disease progression in HIV infection, immunosuppression and opportunistic diseases (AIDS): HIV pathogenesis.*

Cellular processes - homeostasis, thermoregulation, respiration, reproduction, nervous system, circulation- How does HIV affect body processes?

*General tiredness, weight loss, fever, HIV dementia, confusion, memory loss, breathlessness, fainting, irregular menstrual flow in women, anemia etc (signs and symptoms that typify AIDS (WHO classification).*

- Take Away Assignment: Write an essay on the economic importance of viruses, bacteria and fungi in the face of HIV/ AIDS.
- Seminars.

# B 203: Cell and Tissue Organization

## Course Description

Ultrastructure of prokaryotic and eukaryotic cell organelles, nucleus, cell membrane, plasma membrane, mitochondria, golgi bodies, ribosomes, lysosomes and peroxisomes. Cytoplasmic organelles, biochemistry of some specialized cells; red blood cells, nerve cells, muscle cells, renal tubular cells. Extracellular fluids, blood and lymph, their composition and relationship to the cells.

## Topic 1: Ultrastructure of prokaryotic and eukaryotic cells and cellular organelles

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

- Describe the ultrastructure of cell and cellular organelles.
- Describe the detailed structure and function of cellular organelles.

*Use the example of the detailed structure of HIV to represent prokaryotes*

The cell membrane - The lipid protein bilayer arrangement and the functions of cell membranes.

*The membrane as a site of HIV attachment, receptors on surfaces of specialized cells (CD 4 receptors on blood cells), glycoproteins on the surface of envelopes of prokaryotes (Example of HIV). CCXR4 and CCRR5 receptors and their polymorphisms that explain resistance and susceptibility to HIV infection.*

The nucleus- structure, nucleopores, Site of cellular control.

*Effect of integration of viral DNA with host cell DNA in the nucleus of a cell (A case of CD 4 cells)*

Mitochondria- structure and function. Sites of respiration.

*(Effect of HIV infection on Energy production)*

The cytoplasm - a site for metabolic reactions.



## Topic 2: Biochemistry and functions of some specialized cells

By the end of this topic the learners should be able to:

- Describe the biochemistry and function of red blood cells, white blood cells, nerve cells, muscle cells and renal tubular cells.

*The effect of HIV on hemoglobin content, oxygen transport (fainting, anemia), white blood cells (immunosuppression), nerve cells (paralysis in advanced stages of HIV infection) and kidney function (HIV pathogenesis).*

## Topic 3: Extracellular fluids

By the end of this topic, the learner should be able to:

- Distinguish blood and lymph.
- Describe the composition and functions of blood and lymph.

*The role of blood in defense (Acquired immunity)*

*Role of blood in transmission of pathogens (HIV transmission, sexual contact, blood contact, MTCT). Blood cells as targets of attack by pathogens (CD 4 cells). Consequences of destruction of CD4 cells by HIV (opportunistic infections), lymphadenopathy (Enlarged lymph nodes as a minor sign of HIV infection).*

*Activity: A hemogram to show composition of blood Immune status monitoring- CD 4 count determination*

- Seminars.
- Signs and symptoms that typify AIDS.
- Take Away Assignment: Write an essay on the composition and role of blood elements.

# **B 204: Survey of the Plant Kingdom**

## **Course Description**

Classification of the kingdom. General characteristics and life cycle of major plant groups, bacteria, algae, fungi, lichens, bryophytes, pteridophytes, gymnosperms, angiosperms. Economic importance of the major groups.

Topics where HIV/AIDS can be integrated in the teaching of this module.

## **Topic 1: Classification of the kingdom**

By the end of this topic the learner should be able to:

- Understand classes of plants important as food, fuel, sources of alternative medicines.

*The role of food plants, their distribution in relation to HIV management should be emphasized.*

## **Topic 2: Bacteria, algae, fungi, lichens, angiosperms and gymnosperms**

By the end of this topic learners should be able to:

- Understand the role of algae as a source of gel for HIV diagnosis.
- Economic importance of bacteria as agents of disease in HIV infection.
- Economic importance of fungi as source of drugs and as agents of disease.

*The classification of fungi, bacteria with reference to microorganisms important in opportunistic infections in HIV disease should be emphasized.*

# B 204: Cytogenetics and Molecular Biology

## Course Description

Physical basis of heredity, mitosis and meiosis. Variation in chromosome structure, number and morphology. Nature of genetic material in microorganisms, replication, recombination, transformation and transduction. Gene regulation and suppression. Cytogenetic maps and sequence of genetic markers. Causes, types and consequences of mutations.

## Topics Where HIV/AIDS can be integrated in teaching of this module:

### Topic 1: Mitosis and meiosis

By the end of this topic the learner should be able to:

- Understand the role of HIV in interfering with meiosis and mitosis in target cells.

*Modes of HIV transmission and effects of the virus on target cell's mitosis and meiosis.*

### Topic 2: Nature of genetic material in microorganisms

By the end of this topic, the learner should be able to:

- Understand the nature of genetic material in viruses.

*Reference to the genetic material of HIV can be emphasized (the biology of HIV, structure and role of components in attachment, integration and replication).*

### Topic 3: Replication, recombination, transformation

Replication of micro organisms.

*Replication of HIV can be included here. The replication stages used as targets of ARV therapy. ARV use in HIV management.*

## **Topic 4: Cytogenetic maps**

By the end of this topic, learners should be able to:

- Understand cytogenetic changes following HIV infection.

*The T cell as target of attack by HIV:*

*Cell surface changes following ARV therapy*

*The role of markers that are genetically determined on cells on susceptibility to HIV infection.*

*Cytogenetic changes at different stages of HIV disease (disease progression) to explain disease progression and response to ARV therapy.*

## **Topic 5: Mutations**

### **Causes, types and consequences of mutations**

By the end of this topic learners should be able to:

- Understand HIV variability.

*Reference should be made to the rapid mutation of HIV.*

*The existence of multiple strains of HIV and the implications of the variability on transmission, disease progression, drug resistance, vaccine production. Behavior change to avoid multiple infections by avoiding multiple sexual partners can be discussed here.*

*The role of mutations in cancer development with reference to common cancers in HIV disease.*

# B 306: Nutritional Biochemistry

## Course Description

Basic requirements for human nutrition: proteins, carbohydrates, lipids, minerals and Vitamins. Starvation. FAO indicator in surveying food quality essential amino acids. Protein requirements during growth and recovery. Protein Energy malnutrition. Recommended dietary allowances. The role of vitamins and minerals in diets. Importance of vegetables, legumes, cereals and fruits. Assessment of nutritional status. Vegetarian diets.

## Topic 1: Basic Requirements for Human Nutrition

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

- Understand human nutrition and FAO indicators in surveying food quality.

This topic should define nutrition, balanced diet, under nutrition and malnutrition. The role of the following: Proteins, Carbohydrates, Lipids, Minerals and Vitamins in the diet

Nutritional Deficiency and related diseases i.e. Protein Energy Malnutrition (PEM).

*The importance to adopt healthy eating habits and the special nutritional needs of PLWA (i.e. HIV affects food intake, absorption and leads to wasting, HIV affects weight, PLWA have increased requirements for minerals and vitamins) should be emphasized in this topic (nutrition is therapeutic). The role of nutrition in management of HIV to supplement ARV use.*

*Activity: Quality assessment of selected locally available foods*

## Topic 2: Essential Amino Acids

Objective: By the end of this topic the student should be able to:

- Distinguish essential and non essential amino acids.
- Understand protein requirements in growth and recovery.

*The topic should discuss the importance of special amino acids in diet of PLWA i.e glutathione, lysine, alanine, arginine. Important sources of protein for children for growth with emphasis on protein needs and sources for OVC and PLWA for recovery from opportunistic infections.*

*The consequences of Protein Energy Malnutrition (PEM)*

## Topic 3: The Role of Vitamins and Minerals

By the end of this topic learners should be able to:

- Understand the role of vitamins and minerals in the diet of HIV infected persons

Vitamins and Minerals are protective foods. They are important for healthy lining of the skin, lungs and gut. They also help in recovery from infection.

*Important vitamins in the diet and particularly in HIV disease (Vitamin A, B complex, C, K etc. Important minerals: Iron, selenium, calcium, magnesium, Zinc etc. Dietary sources of vitamins and minerals. Recommended dietary allowances:*

- Nutritional deficiency and associated metabolic disorders.
- The role of supplements and dangers of over dosage.

## Topic 4: Importance of Vegetables, Legumes, Cereals and Fruits

By the end of this unit the learners should be able to:

- Understand the role of vegetables, legumes, cereals and fruits in the diet.

*What is in foods? Emphasis should be on traditional fruits and vegetables as sources of vitamins and minerals. The importance of whole grains as a source of nutrients, Handling of vegetables, preparation and storage.*

*Activity: Collect traditional fruits and vegetables commonly used by your local community. Use biochemical techniques to determine their nutritional value.*

## **Topic 5: Assessment of Nutritional Status**

By the end of this topic, learners should be able to:

- Determine nutritional status by use of biochemical assessment versus use of anthropometric measurements.
- Understand WHO Indicators of wasting, stunting particularly among children.
- Consequences of malnutrition (a common feature in HIV) with emphasis on PEM (Protein Energy Malnutrition) among children and PLWA.

*Activity: Nutritional status assessment of orphaned and vulnerable children in orphanages in the local community.  
Calculate the Z- scores and classify the children on the basis of their nutritional status.*

This topic should prepare learners to carry out nutritional surveys.

## **Topic 6: Technical aspects in formulating a balanced diet**

By the end of this topic the learner should be able to:

- Plan a balanced diet

*Activity: Formulate a one week menu for a Person Living With Aids*

# **B 306: Biostatistics**

## **Course Description**

This course applies statistical methods to biological information. It deals with sampling techniques, data presentation, analysis, and interpretation. Types of distribution (example normal, binomial, Poisson) are also discussed. Analytical procedures including T-tests, Chi-square, F-Ration, correlation and regression will be used to analyze biological data. Students will be taken through some basic experimental designs (e. g. CRD, RCD, Factorial design).

- Use of HIV / AIDS data and prevalence in teaching the various aspects of statistics, epidemiology.
- Seminars.
- Assignment: Using UNAIDS (2005) HIV data in Africa, determine using suitable statistical tools the relationships between gender, age, region and HIV prevalence.
- Describe the experimental design that would be appropriate in collection of data on HIV testing within your province.

## **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 40 % and University examinations which shall contribute 60%.
- The pass mark is 40%.
- Only a student that is registered with the faculty/department shall be allowed to do 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 Participants

## Kenya

**UNESCO - DUCC-AA Jilvat Programme Officer**

*Mrs. Alice Ochanda*

**AWSE - Jomo Kenyatta University**

*Prof. Mabel Imbuga*

**AWSE/ Kenyatta University**

*Prof. Caroline Lang'at-Thoruwa*

**Kenyatta University**

*Dr. Zipporah Ng'ang'a*

**University Of Johannesburg**

*Prof. Debra Meyer*

## Ghana

**University Of Cape Coast**

*Prof. Sam Yeboah*

*Dr. Alfred Owusu*

*Mr. David K. Esumang*

*Dr. B.A. Mensah*

*Rev. Prof. D.K. Dodoo*

*Prof. S.B. Kendie*

*Mr. David K. Dzontoh*

*University of education Winneba*

*Mrs. Josephine Osei-Agyekum*

**University of Ghana**

*Dr. K. Tano-Debrah*

*Dr. June de Graft Hanson*

*Dr. Ebenezer Owusu*

*Mr. George A. Annor*

**Garden City University College**

*Mr. Eric F. Oteng-Abayie*

**Kumasi Polytechnic**

*Mrs. Beatrice Ennison*

**Christian Service University College**

*Mrs. Christine Adjei*

*Rev. E. Atami*

**Kwame Nkrumah University of Science And Technology**

*Mr. Samuel Aggrey-Smith*

*Mr. Eric K.T. Addison*

*Prof. Aba Bentil Andam*

*Mrs. Nana Yaa Koomson*

*Dr. F.A. Yeboah*

*Prof. Peter Donkor*

*Dr. A.B.C. Dadson*

*Mrs. Juliana Serwa Andoh*

*Prof. I.K. Dontwi*

*Dr. Angela Amedo*

*Dr. S.C.K. Tay*

*Dr. Eric Forkuo*

*Dr. S. Osafo-Acquah*

*Rev. Dr. G.O. Lartey*

*Dr. Peggy Oti-Boateng*

*Mr. David K. Takyi*

*Mr. Thomas Tindan*

*Mr. Abdul Rashid Mensah*

*Mr. Deatanyah Philip*

*Miss. Mary Adjeiwah*

*Miss. Adelaide Dansah Appiah*

*Dr. Theophilus B*



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United Nations Avenue, ICRAF House  
P.O. Box 30677-00100  
Nairobi, Kenya  
Tel. 254-20- 7224750 or 7224000 Ext. 4750  
Fax. 254-20- 7224001  
E-mail: [awse@cgiar.org](mailto:awse@cgiar.org)