

# KCSE BIOLOGY SYLLABUS

## **GENERAL OBJECTIVES**

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

1. Communicate biological information in a precise, clear and logical manner
2. Develop an understanding of interrelationships between plants and animals and between humans and their environment
3. Apply the knowledge gained to improve and maintain the health of the individual, family and the community
4. Relate and apply relevant biological knowledge and understanding to social and economic situations in rural and urban settings
5. Observe and identify features of familiar and unfamiliar organisms, record the observation and make deductions about the functions of parts of organisms
6. Develop positive attitudes and interest towards biology and the relevant practical skills
7. Demonstrate resourcefulness, relevant technical skills and scientific thinking necessary for economic development
8. Design and carry out experiments and projects that will enable them understand biological concepts
9. Create awareness of the value of cooperation in solving problems acquire a firm foundation of relevant knowledge, skills and attitudes for further education and for training in related scientific fields.

## **FORM ONE SYLLABUS**

### **1.0.0 INTRODUCTION**

#### **1.1.0 Specific Objectives**

1.2.1 Definition of biology

1.2.2 Branches of biology

1.2.3 Importance of biology

1.2.4 Characteristics of living organisms

1.2.5 Comparison between plants and animals

#### **1.3.0 Practical Activities**

1.3.1 Collecting, observing and recording external features of plants and animals

## **2.0.0 CLASSIFICATION (12 LESSONS)**

### **2.1.0 Specific Objectives**

2.2.1 Review the use of magnifying lens

2.2.2 External features of plants and animals

2.2.3 Necessity and significance of classification

2.2.4 Major units of classification: (naming)

- Kingdoms
  - Monera
  - Protoctista
  - Fungi
  - Plantae
  - Animalia (At least one example of each)

2.2.5 Discussion on Binomial nomenclature

### **2.3.0 Practical activities**

2.3.1 Use of collecting nets, cutting instruments and hand lens. Collection and detailed observation of:

- Small animals e.g. insects
- Plants - rhizoids, root systems (taproot, fibrous and adventitious), stems and leaves

## **3.0.0 THE CELL (20 LESSONS)**

### **3.1.0 Specific Objectives**

3.2.1 Definition of the cell

3.2.2 Structure and functions of parts of a light microscope

3.2.3 Use and care of the light microscope

3.2.4 Cell structure and functions as seen under a light microscope and electron microscope

3.2.5 Preparation of temporary slides of plant cells

3.2.6 Estimation of cell size

3.2.7 Cell specialization, tissues, organs and organ systems

3.3.1 Observe, identify, draw and state the functions of parts of the light microscope

3.3.2 Prepare and observe temporary slides of plant cells

3.3.3 Observe permanent slides of animal cells

3.3.4 Comparison between plant and animal cells

3.3.5 Observe, estimate size and calculate magnification of plant cells

#### **4.0.0 CELL PHYSIOLOGY (20 LESSONS)**

##### **4.1.0 Specific Objectives**

4.2.1 Meaning of cell physiology

4.2.2 Structure and properties of cell membrane (Theories of membrane structure not required)

4.2.3 Physiological processes - diffusion, osmosis and active transport

4.2.4 Factors affecting diffusion, osmosis and active transport

4.2.5 Role of diffusion, osmosis and active transport in living organisms

4.2.6 Water relations in plant and animal cells: turgor, plasmolysis, wilting and haemolysis

##### **4.3.0 Practical Activities**

4.3.1 Diffusion as demonstrated with Potassium permanganate or potassium iodide/flower dyes/coloured plant extracts/smoke

4.3.2 Experiments with visking tubing and living tissues: fresh arrow roots/cassava/sweet potatoes/leaf petioles/irish potatoes/carrots

4.3.3 Plasmolysis can be demonstrated by using any of the following: spirogyra, epidermal cells of onion or raw egg that has been put in dilute hydrochloric acid overnight.

#### **5.0.0 NUTRITION IN PLANTS AND ANIMALS (59 LESSONS)**

##### **5.1.0 Specific Objectives**

5.2.1 Meaning, importance and types of nutrition

5.2.2 Nutrition in plants (autotrophism)

- Definition of photosynthesis and its importance in nature
- Adaptations of leaf to photosynthesis
- Structure and function of chloroplast
- Process of photosynthesis - light and dark stages (omit details of electron transport system and chemical details of carbon dioxide fixation)
- Factors influencing photosynthesis
  - light intensity
  - carbon dioxide concentration
  - water
  - temperature

5.2.3 Chemical compounds which constitute living organisms

- Chemical composition and functions of carbohydrates, proteins and lipids (omit details of chemical structure of these compounds and mineral salts in plant nutrition).

- Properties and functions of enzymes (omit lock and key hypothesis)

#### 5.2.4 Nutrition in Animals (heterotrophism)

- Meaning and types of heterotrophism
- Modes of feeding in animals
- Dentition of a named carnivorous, herbivorous and omnivorous mammal
- Adaptation of the three types of dentition to feeding
- Internal structure of mammalian teeth
- Common dental diseases, their causes and treatment

#### 5.2.5 Digestive system and digestion in a mammal (human)

- Digestive system, regions, glands and organs associated with digestion
- Ingestion, digestion, absorption, assimilation and egestion

#### 5.2.6 Importance of vitamins, mineral salts, roughage and water in human nutrition

#### 5.2.7 Factors determining energy requirements in humans

### 5.3.0 Practical activities

#### 5.3.1 Carry out experiments on factors affecting photosynthesis

#### 5.3.2 Observe stomata distribution

#### 5.3.3 Carry out food test experiments

#### 5.3.4 Carry out experiments on factors affecting enzymatic activities

#### 5.3.5 Investigate presence of enzymes in living tissues (plants and animals)

#### 5.3.6 Observe, identify, draw and label different types of mammalian teeth

#### 5.3.7 Carry out dissection of a small mammal to observe digestive system and associated organs (demonstration)

## FORM TWO SYLLABUS

### 6.0.0 TRANSPORT IN PLANTS AND ANIMALS (20 LESSONS)

#### 6.1.0 Specific Objectives

#### 6.2.1 Meaning and importance of transport systems

#### 6.2.2 Absorption of Water and Mineral Salts

- Internal structure of root and root hairs
- Absorption of water
- Active uptake of mineral salts

#### 6.2.3 Transpiration

- Definition of transpiration
- Review of the structure of the leaf
- Structure and function of xylem
- Factors affecting transpiration
- Forces involved in water movement in plants
  - Transpiration pull
  - Cohesion and adhesion
  - Capillarity
  - Root pressure

#### 6.2.4 Translocation

- Structure and function of phloem
- Materials translocated (omit mechanisms of translocation)

#### 6.2.5 Comparison between open and closed circulatory system

#### 6.2.6 Mammalian Circulatory System

- Structure and function of the heart, arteries, veins, and capillaries
- Diseases and defects of the circulatory system (Thrombosis, Varicose veins, Arterio-sclerosis) and how to control them.

#### 6.2.7 The Structure and Functions of Blood

- Composition of blood
- Functions of blood plasma
- The structure and functions of red blood cells and white blood
- Mechanism of blood clotting and its importance

#### 6.2.8 Blood groups (ABO system and the Rhesus factor)

#### 6.2.9 Immune responses

- Natural and artificial immunity
- Allergic reactions
- Importance of vaccinations against diseases (Tuberculosis, Poliomyelitis, Measles, Diphtheria, Whooping cough)

### 6.3.0 Practical Activities

#### 6.3.1 Observe permanent slides of sections of stems and roots

#### 6.3.2 Carry out experiments to compare transpiration on lower and upper leaf surfaces

#### 6.3.3 Observe wall charts/models

#### 6.3.4 Analyse data on transpiration rate under different environmental conditions in Plants

#### 6.3.5 Dissect a small mammal and observe its transport system (demonstration)

#### 6.3.6 Make a longitudinal section of the mammalian heart to display the chambers and associated blood vessels

6.3.7 Record pulse rate at the wrist before and after vigorous activities and analyse the results

6.3.8 Demonstrate the unidirectional flow of blood in the cutaneous veins of the fore arm

## **7.0.0 GASEOUS EXCHANGE (36 LESSONS)**

### **7.1.0 Specific Objectives**

7.2.1 Gaseous exchange in living organisms (necessity)

7.2.2 Gaseous Exchange in Plants

- Mechanisms of opening and closing of stomata
- The process of gaseous exchange in root, stem and leaves of both aquatic (floating) and terrestrial plants

7.2.3 Gaseous Exchange in Animals

- Types and Characteristics of Respiratory Surfaces - cell membrane, gills, buccal cavity, skin and lungs
- Mechanism of gaseous exchange in
  - Protozoa – amoeba
  - Insect – grasshopper
  - Fish – bonyfish
  - Amphibia – frog
  - Mammal - human

7.2.4 Factors affecting rate of breathing in humans

7.2.5 Respiratory diseases: Asthma, Bronchitis, Pulmonary tuberculosis, Pneumonia and whooping cough

### **7.3.0 Practical Activities**

7.3.1 Observe permanent slides of cross- sections of aerial and aquatic leaves and stems

7.3.2 Examine the distribution of spiracles on grasshopper or locust

7.3.3 Examine the gills of a bony fish

7.3.4 Dissect a small mammal and identify the structures of the respiratory system (demonstration) Construct and use models to demonstrate breathing mechanisms in a mammal (human) Demonstrate the effect of exercise on the rate of breathing

## **8.0.0 RESPIRATION (18 LESSONS)**

### **8.1.0 Specific Objectives**

8.2.1 Meaning and significance of respiration

8.2.1 Tissue respiration

- Mitochondrion - structure and function
- Aerobic respiration (Details of kreb's cycle not required)
- Anaerobic respiration in plants and animals, the products and by-products
- Application of anaerobic respiration in industry and at home
- Compare the energy output of aerobic and anaerobic respiration

### **8.3.0 Practical Activities**

#### **8.3.1 Carry out experiments to Investigate**

- The gas produced when food is burnt
- The gas produced during fermentation<sup>4</sup>
- Heat production by germinating seeds

## **9.0.0 EXCRETION AND HOMEOSTASIS (42 LESSONS)**

### **9.1.0 Specific Objectives**

#### **9.2.1 Excretion in Plants**

- Methods of excretion in plants
- Useful and harmful excretory products of plants and their economic importance e.g. caffeine in tea and coffee, quinine, tannins, colchicines, cocaine, rubber, gum, papain (from pawpaw) and products of cannabis sativa (bhang) and khat (miraa)

#### **9.2.2 Excretion and homeostasis in Animals**

- Distinction between excretion, homeostasis and egestion
- Excretion in a named uni-cellular organism (protozoa)
- Structure and functions of skin and kidney
- Neuro-endocrine system and homeostasis
  - Water balance (blood osmotic pressure)
  - Blood sugar level (control)
  - Temperature regulation (mention the role of hypothalamus)

#### **9.2.3 Common kidney diseases, their symptoms and possible methods of prevention and control**

#### **9.2.4 The role of the skin in thermoregulation, salt and water balance.**

#### **9.2.5 Major functions of the liver and their contributions to homeostasis**

#### **9.2.6 Common diseases of the liver, their symptoms and possible methods of prevention/control**

### **9.3.0 Practical Activities**

#### **9.3.1 Examine and draw the mammalian kidney**

#### **9.3.2 Make vertical sections of the kidney to identify cortex and medulla**

#### **9.3.3 Observe permanent slides of mammalian skin**

#### **9.3.4 Investigate effect of catalase enzyme on hydrogen peroxide**

## FORM THREE SYLLABUS

### 10.0.0 CLASSIFICATION II (35 LESSONS)

#### 10.1.0 Specific Objectives

10.2.1 Review of binomial nomenclature

10.2.2 General principles of classification

10.2.3 General characteristics of kingdoms

- Monera
- Protocista
- Fungi
- Plantae
- Animalia

10.2.4 Main characteristics of major divisions of plantae

- Bryophyta
- Pteridophyta
- Spermatophyta (cover only up to class level)

10.2.5 Main Characteristics of the Phyla Arthropoda and Chordata (cover up to classes as shown)

- Arthropoda
  - Diplopoda
  - Chilopoda
  - Insecta
  - Crustacean
  - Arachnida
- Chordata
  - Pisces
  - Amphibian
  - Reptilian
  - Aves
  - Mammalia

10.2.6 Construction and use of simple dichotomous keys based on observable features of plants and animals

#### 10.3.0 Practical activities

10.3.1 Examine live/preserved specimen or photographs of representatives of major divisions of plantae and phyla arthropoda and chordata

10.3.2 Construct simple dichotomous keys using leaves/parts of common plants/arthropods/common chordates in the local environment

10.3.3 Use dichotomous keys to identify organisms



## **11.0.0 ECOLOGY (55 LESSONS)**

### **11.1.0 Specific Objectives**

#### **11.2.1 Concepts of Ecology**

- Ecology
- Habitat
- Niche
- Population
- Community Ecosystem
- Biomass
- Carrying capacity

#### **11.2.2 Factors in an ecosystem**

- Abiotic factors (environmental factors) - light, temperature, atmospheric pressure, salinity, humidity, pH and wind
- Biotic factors
- Inter-relationships – competition, predation, saprophytism, parasitism and symbiosis
- Nitrogen cycle

#### **11.2.3 Energy flow in an ecosystem. Food chains, food webs, decomposers, pyramid of numbers and pyramid of biomass**

#### **11.2.4 Population estimation methods**

- Quadrat method
- Line transect
- Belt transect
- Capture – recapture method

#### **11.2.5 Adaptations of plants to various habitats**

- Xerophytes
- Mesophytes (common terrestrial plants)
- Hydrophytes - Nymphaea, Salvinia, spp
- Halophytes — mangrove

#### **11.2.6 Effect of pollution on human beings and other organisms Causes, effects and control of pollutants in air, water and soil**

#### **11.2.7 Human diseases**

- Bacterial diseases - Cholera and Typhoid
- Protozoa - Malaria and Amoebic dysentery (Amoebiasis)
- Ascaris lumbricoides and Schistosoma
  - Mode of transmission
  - Effects of the parasites on the hosts
  - Adaptive characteristics of the parasites
  - Control/prevention of diseases associated with the parasites

### **11.3.0 Practical activities**

11.3.1 Collect, record, analyse and interpret data from ecological studies (examples of food chains should be used to join up to make food webs. Calculate ratios of consumers to producers from data provided)

11.3.2 Examine specimens of hydrophytes, mesophytes and xerophytes, and identify the features that adapt them to their habitats

11.3.3 Examine roots of legumes taken from fertile and poor soils to compare the number of root nodules

11.3.4 Estimate populations using sampling methods (for quadrat and line/belt transect, measure pl-1, temperature, wind direction and humidity)

## **12.0.0 REPRODUCTION IN PLANTS AND ANIMALS**

### **12.1.0 Specific Objectives**

12.2.1 Concept of reproduction

- Importance of reproduction

12.2.2 Chromosomes, mitosis and meiosis (mention gamete formation)

12.2.3 Asexual reproduction

- Binary fission in amoeba
- Spore formation/reproduction in mucor/Rhizopus
- Budding in yeast

12.2.4 Sexual reproduction in plants

- Structure and functions of parts of named insect and wind pollinated flowers
- Pollination and agents of pollination
- Features and mechanisms that hinder self-pollination and self-fertilization
- The process of fertilization
- Fruit and seed formation and dispersal

12.2.5 Sexual reproduction in animals

- External fertilization in amphibians
- Structure of the reproductive system of a named mammal (human) functions
- Functions of the parts of reproductive system
- Fertilization, implantation and the role of placenta
- Gestation period
- Role of hormones in reproduction in humans (secondary sexual characteristics, menstrual cycle)

### 12.2.6 Sexually transmitted infections (S.T.Is)

- Gonorrhoea
- Herpes simplex
- Syphilis, Trichomoniasis, Hepatitis, Candidiasis
- HIV/AIDS (Acquired Immune Deficiency Syndrome) - emphasize preventive measures especially change of behaviour

### 12.2.7 Advantages and disadvantages of asexual and sexual reproduction

### 12.3.0 Practical Activities

12.3. Examine stages of mitosis using squashed young onion tip/charts/electron micrographs

12.3.2 Examine stages of meiosis using anthers of a flower

12.3.3 Grow bread mould and examine using a hand lens

12.3.4 Examine spores in son of a fern

12.3.5 Examine various types of insect and wind pollinated flowers and relate structure to function

12.3.6 Collect, classify and dissect fruits and seeds and relate their structure to mode of dispersal

12.3.7 Dissect a small mammal to show organs associated with reproduction (demonstration)

## 13.0.0 GROWTH AND DEVELOPMENT (20 Lessons)

### 13.1.0 Specific Objectives

13.2. 1 Concepts of growth and development

13.2.2 Growth and development in plants

- Dormancy and ways of breaking it
- Conditions necessary for germination
- Epigeal and hypogeal germination
- Measurement of one aspect of growth in a named seedling e.g. region of growth
- Primary and secondary growth
- Role of growth hormones in plants
- Apical dominance

13.2.3 Growth and development in animals

- Complete and incomplete metamorphosis in insects
- Role of growth hormones in insects

### 13.3.0 Practical activities

13.3. Examine, draw and differentiate seeds

13.3.2 Determine the region of growth in shoots and roots

13.3.3 Investigate hypogeal and epigeal germination

13.3.4 Carry out experiments to demonstrate apical dominance

13.3.5 Observe stages of complete and incomplete metamorphosis in insects

13.4.0 Project work:

- Measure either length of internodes/ breadth of leaves/height/dry weight of seedlings over a known period of time, analyse and present the data obtained in form of graphs, charts or histograms

## **FORM FOUR SYLLABUS**

### **14.0.0 GENETICS (34 LESSONS)**

#### **14.1.0 Specific Objectives**

14.2.1 Concepts of genetics

- Variation within plant and animal species
- Review of chromosomes
- Brief mention of genes and DNA (without details of the molecular structure of genes and DNA)

14.2.2 First law of heredity

- Mendel's experiments - monohybrid inheritance (3:1 ratio)
- Complete and incomplete dominance, backcross/testcross
- Inheritance of ABO blood groups and Rh factor

14.2.3 Sex determination in humans

14.2.4 Linkage

- Sex linked genes, sex linked characteristics e.g. Colour blindness, Haemophilia, Hairy ears and Nose

14.2.5 Mutations

- Types of mutations
- Causes and consequences of chromosomal mutations
- Gene mutations(only cover the following examples of genetic disorders: Albinism, Sickle cell Anaemia, Haemophilia, Colour blindness)

14.2.6 Practical applications of genetics

- Blood transfusion
- Plant and animal breeding using artificial selection

- Genetic counselling
- Genetic engineering

### **14.3.0 Practical Activities**

14.3.1 Measure and record heights of class members and plot the data on graphs

14.3.2 Demonstrate chromosome behaviour in mitosis and meiosis by using clay / plasticine / insulated coloured wires/coloured thread

14.3.3 Carry out investigations on finger prints and tongue rolling

## **15.0.0 EVOLUTION (19 LESSONS)**

### **15.1.0 Specific Objectives**

15.2.1 Meaning of evolution

15.2.2 The origin of life

- Special creation
- Chemical evolution (Brief explanation required)

15.2.3 Evidences for organic evolution

- Fossil records - brief mention of human evolution
- Geographical distribution - continental drift
- Comparative embryology
- Comparative anatomy (Convergent and divergent evolution based on homology and analogy)
- Cell biology - occurrence of cell organelles and blood pigments

15.2.4 Mechanisms of evolution

- Lamarcks theory (Brief mention)
- Evolution by natural selection
- Natural selection in action e.g. peppered moth (industrial melanism)Resistance to drugs, pesticides and antibiotics

### **15.3.0 Practical activities**

15.3.1 Compare vertebrate limbs

15.3.2 Compare wings of birds and insects

15.2.3 Education tour to an archaeological site/local museum

## **16.0.0 RECEPTION, RESPONSE AND COORDINATION IN PLANTS AND ANIMALS (43 LESSONS)**

### **16.1.0 Specific Objectives**

16.2.1 Meaning of stimulus, response and irritability

16.2.2 Reception, response and coordination in plants

- Response to a variety of external stimuli
- Tropisms and tactic movements and their survival values
- Production of auxins and their effects on plant growth

16.2.3 Reception, responses and coordination in animals

- Components of the nervous system in a mammal
- Structure and functions of the neurons
- Functions of major parts of human brain
- Simple and conditioned reflex actions

16.2.4 The role of hormones in coordination in a mammal

- Effects of over secretion and under secretion of adrenaline and thyroxine in humans
- Functional differences and similarities between endocrine and nervous systems

16.2.5 Effects of drug abuse on the human health

16.2.6 Structure and functions of parts of the mammalian eye (human)

- Accommodation, image formation and interpretations
- Common eye defects and their corrections

16.2.7 Structure and functions of parts of the mammalian ear (human)

- Hearing (omit details of cochlea)
- Balance and posture (mention only parts involved)

### **16.3.8 Practical activities**

16.3.1 Carry out experiments to investigate tactic responses e.g. chemotaxis - use any of the following organisms: worker termites/fly maggots/earth worms/honey bee/grasshoppers/woodlice

16.3.2 Carry out experiments on tropisms and etiolation

16.3.3 Determine the distance of blind spot

16.3.4 Carry out knee jerk experiment

## **17.0.0 SUPPORT AND MOVEMENT IN PLANTS AND ANIMALS (39 Lessons)**

### **17.1.0 Specific Objectives**

#### **17.2.1 Plants**

- Necessity for support and movement in plants
- Review of tissue distribution in monocotyledonous and dicotyledonous plants (Histological details of tissues are not required)

#### **17.2.2 Animals**

- Necessity for support and movement in animals
- Types and functions of the skeleton
  - Exoskeleton in arthropods
  - Endoskeleton in vertebrate

#### **17.2.3 Locomotion in a finned fish**

17.2.4 Identification of the bones of axial and appendicular skeletons (names of individual bones of coccyx not required)

17.2.5 Types and functions of movable joints (ball and socket, hinge joint)

17.2.6 Structure, function and location of cardiac, smooth and skeletal muscles (Details of fine structure not required)

- Role of muscles in the arm in humans

### **17.3.0 Practical activities**

17.3. 1 Observe permanent slides of transverse sections of the stems of herbacious and woody plants

17.3.2 Observe wilting in young herbacious plants

17.3.3 Examine the exoskeleton in arthropods

I 7.3.-I Observe and identify external features of a finned fish

17.3.5 Examine and draw different types of bones in mammals