BIOLOGY

GENERAL OBJECTIVES

The aim of the Unified Tertiary Matriculation Examination (UTME) syllabus in Biology is to prepare the candidates for the Board's examination. It is designed to test their achievement of the course objectives, which are to:

1. demonstrate sufficient knowledge of the concepts of the diversity, interdependence and unity of life;
2. account for continuity of life through reorganization, inheritance and evolution;
3. apply biological principles and concepts to everyday life, especially to matters affecting living things, individual, society, the environment, community health and the economy.

DETAILED SYLLABUS
A: VARIETY OF ORGANISMS

TOPICS/CONTENTS/NOTES	OBJECTIVES
1. Living organisms: a. Characteristics b. Cell structure and functions of cell components c. Level of organization i. Cell e.g. *euglena and paramecium*, ii. Tissue, e.g. epithelial tissues and hydra iii. Organ, e.g. onion bulb iv. Systems, e.g. reproductive, digestive and excretory v. Organisms e.g. *Chlamydomonas*	Candidates should be able to: i. differentiate between the characteristics of living and non-living things. ii. identify the structures of plants and animal cells. iii. analyse the functions of the components of plants and animal cells. iv. compare and contrast the structure of plant and animal cells. v. trace the levels of organization among organisms in their logical sequence in relation to the five levels of organization of living organisms.
2. Evolution among the following: a. Monera (prokaryotes), e.g. bacteria and blue green algae. b. Protista (protozoans and protophyta), e.g. *Amoeba*, *Euglena* and *Paramecium* c. Fungi, e.g. *mushroom* and *Rhizopus*. d. Plantae (plants) i. Thallophyta (e.g. *Spirogyra*) ii. Bryophyta (mosses and liveworts) e.g. iii. *Brachmenium* and *Merchantia*. iv. Pteridophyta (ferns) e.g. *Dryopteris*. v. Spermatophyta (Gymnospermae and vi. Angiospermae) - Gymnosperms e.g. Cycads and conifers - Angiosperms (monocots, e.g. maize; dicots, e.g. water leaf) e. Animalia (animals) i. Invertebrates - coelenterate (e.g. *Hydra*) - Platyhelminthes (flatworms) e.g. *Taenia* - Nematoda (roundworms) - Annelida (e.g. earthworm) - Arthropoda e.g. mosquito, cockroach, housefly, bee, butterfly - Mollusca (e.g. snails)	Candidates should be able to: i. analyse external features and characteristics of the listed organisms: ii. apply the knowledge from (i) above to demonstrate increase in structural complexity . iii. trace the stages in the life histories of the listed organisms. iv. apply the knowledge of the life histories to demonstrate gradual transition from life in water to life on land. v. trace the evolution of the listed plants. i. trace the advancement of the invertebrate animals. ii. determine the economic importance of the insects studied. iii. asses their values to the environment.

ii. Multicellular animals (vertebrates) - pisces (cartilaginous and bony fish) - Amphibia (e.g. toads and frogs) - Reptilia (e.g. lizards, snakes and turtles) - Aves (birds) - Mammalia (mammals)	i. trace the advancement of multi-cellular animals. ii. determine their economic importance.
3.a Structural/functional and behavioural adaptations of organisms. **b.** adaptive colouration and its functions c. Behavioural adaptations in social animals d. Structural adaptations in organisms.	Candidates should be able to: i. describe how the various structures, functions and behaviour adapt these organisms to their environment, and way of life ii. Categorize countershading in fish, toads, snakes and warning colouration in mushrooms. iii. Differentiate various castes in social insects like termites and their functions in their colony hive. iv. Account for basking in lizards, territorial behavour of other animals under unfavourable conditions (hibernation and aestivation). Candidates should be able to account for adaptation in organisms with respect to the following: i. Obtaining food (beaks and legs of birds, mouthparts of insects, especially mosquito, butterfly and moth.) ii. Protection and defence (stick insects, praying mantis and toad). iii. Securing mates (redhead male and female Agama lizards, display of feathers by birds). iv. Regulating body temperature (skin, feathers and hairs) v. Conserving water (spines in plants and scales in mammals).

B: FORM AND FUNCTIONS

TOPICS/CONTENTS/NOTES	OBJECTIVES
1. Internal structure of a flowering plant i. Root ii. Stem iii. Leaf b. Internal structure of a mammal	Candidates should be able to: i. identify the transverse sections of these organs. a. relate the structure of these organs to their functions. b. identify supporting tissues in plants (collenchyma) sclerenchyma, xylem and phloem fibres) c. describe the distribution of supporting tissues in roots, stem and leaf Candidates should be able to: i. examine the arrangement of the mammalian internal organs. ii. describe the appearance and position of the digestive, reproductive and excretory organs.
2. Nutrition	Candidates should be able to:

a. Modes of nutrition i. Autotrophic ii. Heterotrophic	i. compare the photosynthetic and chemosynthetic modes of nutrition; ii. provide examples from both flowering and non- flowering plants. iii. compare autotrophic and heterotrophic modes of nutrition.
b. Types of Nutrition	Candidates should be able to: differentiate the following examples: - holozoic (sheep and man) - Parasitic (*roundworm*, *tapeworm* and *Loranthus*) - saprophytic (*Rhizopus* and *mushroom*) - carnivorous plants (sundew and bladderwort) - determine their nutritional value.
c. Plant nutrition i. Photosynthesis	Candidates should be able to: i. differentiate the light and dark reactions, and state conditions necessary for photosynthesis. ii. determine the necessity of light, carbon (IV) oxide and chlorophyll in photosynthesis. iii. detect the presence of starch in a leaf as an evidence of photosynthesis.
ii. Mineral requirements (macro and micro-nutrients)	Candidates should be able to: i. identify macro-and micro-elements required by plants. ii. recognise the deficiency symptoms of nitrogen, phosphorous and potassium.
d. Animal nutrition i. Classes of food substances; carbohydrates, proteins, fats and oils, vitamins, mineral salts and water	Candidates should be able to: i. indicate the sources of the various classes of food; ii. relate the importance and deficiency e.g. scurvy, rickets, kwashiorkor etc. of each class; iii. determine the importance of a balanced diet.
ii. Food tests (e.g. starch, reducing sugar, protein, oil, fat etc.	Candidates should be able to detect the presence of the listed food items from the result of a given experiment.
iii. The mammalian tooth (structures, types and functions)	Candidates should be able to: i. describe the structure of a typical mammalian tooth; ii. differentiate the types of mammalian tooth and relate their structures to their functions. iii. compare the dental formulae of man, sheep, and dog.
iv. Mammalian alimentary canal	Candidates should be able to: i. relate the structure of the various components of the alimentary canal and its accessory organs (liver, pancreas, and gall bladder)to their functions.

v. Nutrition process (ingestion, digestion, absorption, and assimilation of digested food.	Candidates should be able to: i. identify the general characteristics of digestive enzymes; ii. associate enzymes with digestion of carbohydrates, proteins and fats; iii. determine the end products of these classes of food.
3. Transport a. Need for transportation	Candidates should be able to: i. determine the relationship between increase in size and complexity and the need for the development of a transport system in plants and animals.
b. Materials for transportation. Excretory products, gases, manufactured food, digested food, nutrient, water and hormones)	Candidates should be able to: i. determine the sources of materials and the forms in which they are transported.
c. Channels for transportation i. Mammalian circulatory system (heart, arteries, veins, and capillaries)	Candidates should be able to: i. describe the general circulatory system; ii. compare specific functions of the hepatic portal vein, the pulmonary vein and artery, aorta, the renal artery and vein
ii Plant vascular system (phloem and xylem)	Candidates should be able to: i. identify the organs of the plant vascular system. ii. understand the specific functions of the phloem and xylem.
d. Media and processes of mechanism for transportation.	Candidates should be able to: i. identify media of transportation (e.g. cytoplasm, cell sap, body fluid, blood and lymph); ii. know the composition and functions of blood and lymph; iii. describe diffusion, osmosis, plasmolysis and turgidity as mechanism of transportation in organisms. iv. compare the various mechanisms of open circulatory systems, in animal transpiration pull, root pressure and active transport as mechanism of transportation in plants.
4. Respiration	Candidates should be able to: i. examine the significance of respiration; ii. describe a simplified outline of the chemical process involved in glycolysis and krebs cycle with reference to the role ATP iii deduce from an experimental set up, gaseous exchange and products, exchange and production of heat energy during respiration.
a. Respiratory organs and surfaces	Candidates should be able to: i. describe the following respiratory organs and surfaces with organisms in which they occur;

b. The mechanism of gaseous exchange in: i. Plants ii. Mammals c. Aerobic respiration d. Anaerobic respiration	body surface, gill, trachea, lungs, stomata and lenticel. Candidates should be able to: i. describe the mechanism for the opening and closing of the stomata; ii. determine respiratory movements in these animals. Candidates should be able to: iii. examine the role of oxygen in the liberation of energy for the activities of the living organisms; iv. deduce the effect of insufficient supply of oxygen to the muscles.
5. Excretion a. Types of excretory structures: contractile vacuole, flamecell, nephridium, Malpighian tubule, kidney, stoma and lenticel. b. Excretory mechanisms: i. Kidneys ii. lungs ii. skin c. Excretory products of plants	Candidates should be able to: i. define the meaning and state the significance of excretion; ii. relate the characteristics of each structure with functions. Candidates should be able to: i. relate the structure of the kidneys to the excretory and osmo-regulatory functions. ii. identify the functions and excretory products of the lungs and the skin. Candidates should be able to: i. deduce the economic importance of the excretory products of plants, e.g carbon (IV) oxide, oxygen, tannins, resins, gums, mucilage, alkaloids etc.
6. Support and movement a. Tropic, tactic, nastic and sleep movements in plants b. supporting tissues in animals c. Types and functions of the skeleton i. Exoskeleton ii. Endoskeleton iii. Functions of the skeleton in animals	Candidates should be able to: i. determine the need for support and movement in organisms; ii. identify supporting tissues in plants (collenchyma, sclerenchyma, xylem and phloem fibres); iii. describe the distribution of supporting tissues in roots, stem, and leaf. Candidates should be able to: i. relate the response of plants to the stimuli of light, water, gravity and touch; ii. identify the regions of growth in roots and shoots and the roles of auxins in tropism. Candidates should be able to: i. relate the location of chitin, cartilage and bone to their supporting function.

	ii. relate the structure and the general layout of the mammalian skeleton to their supportive, locomotive and respiratory function. iii. differentiate types of joints using appropriate examples. Candidates should be able to: i. apply the protective, supportive, locomotive and respiratory functions of the skeleton to the well being of the animal.
7. Reproduction a. A sexual reproduction i. Fission as in *Paramecium* ii. Budding as in yeast iii. Natural vegetative propagation iv. Artificial vegetative propagation. b. sexual reproduction in flowering plants i. Floral parts and their functions ii. Pollination and fertilization iii. products of sexual reproduction c. Reproduction in mammals i. structures and functions of the male and female reproductive organs ii. Fertilization and development. (Fusion of gametes)	Candidates should be able to: i. differentiate between asexual and sexual reproduction ii. apply natural vegetative propagation in crop production and multiplication. iii. apply grafting, budding and layering in agricultural practices. Candidates should be able to: i. relate parts of flower to their functions and reproductive process. ii. deduce the advantages of cross pollination. iii. deduce the different types of placentation that develop into simple, aggregate, multiple and succulent fruits. Candidates should be able to: i. differentiate between male and female reproductive organs ii. relate their structure and function to the production of offspring. Candidates should be able to: i. describe the fusion of gametes as a process of fertilization. ii. relate the effects of the mother's health, nutrition and indiscriminate use of drugs on the developmental stages of the embryo up to birth. iii. modern methods of regulating reproduction on e.g. invitro fertilization and birth control
8. Growth a. meaning of growth b. Germination of seeds and condition necessary for germination of seeds.	Candidates should be able to: i. apply the knowledge of the conditions necessary for germination on plants growth. ii. differentiate between epigeal and hypogeal germination.
9. Co-ordination and control a. Nervous coordination: i. the components, structure and functions of the central nervous system; ii. The components and functions of the peripheral nervous systems; iii. Mechanism of transmission of impulses; iv. Reflex action b. The sense organs	Candidates should be able to: i. apply the knowledge of the structure and function of the central nervous system in the coordination of body functions in organisms. ii. illustrate reflex actions such as blinking of the eyes, knee jerk etc. iii. differentiate between reflex and voluntary actions as well as conditioned reflexes such as salivation, riding a bicycle and swimming.

i. skin (tactile) ii. nose (olfactory) iii. tongue (taste) iv. eye (sight) v. ear (auditory)	Candidates should be able to: i. associate the listed sense organs with their functions. ii. apply the knowledge of the structure and functions of these sense organs in detecting and correcting their defects.
c. Hormonal control i. animal hormonal system - Pituitary - thyroid - parathyroid - adrenal gland - pancreas - gonads	Candidates should be able to: i. locate the listed endocrine glands in animals. ii. relate the hormone produced by each of these glands to their functions.
ii. Plant hormones (phytohormones)	Candidates should be able to: i. examine the effects of various phytohormones (e.g. auxins, gibberellin, cytokinin, and ethylene) on growth, tropism, flowering, fruit ripening and leaf abscission.
d. Homeostasis i. Body temperature regulation ii. Salt and water regulation	Candidates should be able to: i. relate the function of hormones to regulating the levels of materials inside the body.

C: ECOLOGY

TOPICS/CONTENTS/NOTES	OBJECTIVES
1. Factors affecting the distribution of Organisms i. Abiotic ii. Biotic	Candidates should be able to: i. deduce the effects of temperature; rainfall, relative humidity, wind speed and direction, altitude, salinity, turbidity, pH and edaphic (soil) conditions on the distribution of organisms. ii. use appropriate equipment (e.g. secchi disc, thermometer, rain gauge etc) to measure abiotic factors. Candidates should be able to: i. describe how the activities of plants/animals (particularly human) affect the distribution of organisms.
2. Symbiotic interactions of plants and animals (a) Energy flow in the ecosystem: food chains, food webs and trophic levels	Candidates should be able to: i. determine appropriate examples of symbiosis, parasitism, saprophytism, commensalism, mutualism, amensalism, competition, predation and cooperation among organisms. ii. associate the distribution of organisms with food chains and food webs in particular habitats. Candidates should be able to explain: i. food chains and webs
(b) Nutrient cycling in nature i. carbon cycle ii. water cycle iii. Nitrogen cycle	Candidates should be able to: i. describe the cycle and its significance including the balance of atmospheric oxygen and carbon (IV) oxide and global warming. Candidates should be able to:

	i. assess the effects of water cycle on other nutrient cycles. Candidates should be able to: i. relate the roles of bacteria and leguminous plants in the cycling of nitrogen.
3. Natural Habitats (a) Aquatic (e.g. ponds, streams, lakes seashores and mangrove swamps) (b) Terrestrial/arboreal (e.g. tree-tops of oil palm, abandoned farmland or a dry grassy (savanna) field, and burrow or hole.	Candidates should be able to: i. associate plants and animals with each of these habitats. Candidates should be able to: i. relate adaptive features to the habitats in which organisms live.
4. Local (Nigerian) Biomes) a**.** Tropical rainforest b. Guinea savanna (southern and northern) c. Sudan Savanna d. Desert e. Highlands of montane forests and grasslands of the Obudu, Jos, Mambilla Plateau.	Candidates should be able to: i. locate biomes in regions ii. apply the knowledge of the features of the listed local biomes in determining the characteristics of different regions of Nigeria.
5. **The Ecology of Populations**: (a) Population density and overcrowding. (b) Adaptation for survival i. Factors that bring about competition ii. Intra and inter-specific competition iii. Relationship between competition and succession. (c) Factors affecting population sizes: i. Biotic (e.g. food, pest, disease, predation, competition, reproductive ability). ii. Abiotic (e.g. temperature, space, light, rainfall, topography, pressure, pH) etc. (d) Ecological succession i. primary succession ii. secondary succession	Candidates should be able to: i. determine the reasons for rapid changes in human population and the consequences of overcrowding. ii. compute/calculate density as the number of organisms per unit area. Candidates should be able to: i) Relate increase in population, diseases, shortage of food and space with intra- and inter-specific competition. Candidates should be able to: i) Determine niche differentiation as a means of reducing intra-specific completion. Candidates should be able to: i) Relate competition to succession. Candidates should be able to: i. deduce the effect of these factors on the size of population. i. determine the interactions between biotic and abiotic factors, e.g. drought or scarcity of water which leads to food shortage and lack of space which causes increase in disease rates. Candidates should be able to: i. trace the sequence in succession to the climax stage of stability in plant population.
6. SOIL a) (i) characteristics of different types of soil (sandy, loamy, clayey) i. soil structure ii. porosity, capillarity and humus content iii. Components of the soil	Candidates should be able to: i. identify physical properties of different soil types based on simple measurement of particle size, porosity or water retention ability. ii. determine the amounts of air, water, humus and capillarity in different soil types experimentally.

i. inorganic ii. organic iii. soil organisms iv. soil air v. soil water Soil fertility: i. loss of soil fertility ii. renewal and maintenance of soil fertility	Candidates should be able to: i. relate soil characteristics, types and components to the healthy growth of plants Candidates should be able to: i. relate such factors as loss of inorganic matter, compaction, leaching, erosion of the top soil and repeated cropping with one variety. Candidates should be able to: i. apply the knowledge of the practice of contour ridging, terracing, mulching, poly-cropping, strip-cropping, use of organic and inorganic fertilizers, crop rotation, shifting cultivation, etc. to enhance soil conservation.
7. Humans and Environment (a) Diseases: (i) Common and endemic diseases. ii. Easily transmissible diseases and disease syndrome such as: - poliomyelitis - cholera - tuberculosis - sexually transmitted disease/syndrome (gonorrhea, syphilis, AIDS, etc. b. Pollution and its control (i) sources, types, effects and methods of control.	Candidates should be able to: i. identify ecological conditions that favour the spread of common endemic and potentially epidemic diseases e.g. malaria, meningitis, drancunculiasis, schistosomiasis, onchocerciasis, typhoid fever and cholera etc. ii. relate the biology of the vector or agent of each disease with its spread and control. Candidates should be able to: i. use the knowledge of the causative organisms, mode of transmission and symptoms of the listed diseases to their prevention/treatment/control. ii. apply the principles of inoculation and vaccination on disease prevention. Candidates should be able to: i. categorize pollution into air, water and soil. ii. relate the effects of common pollutants to human health and environmental degradation. iii. determine the methods by which each pollutant may be controlled.
(ii) Sanitation and sewage	Candidates should be able to: i. examine the importance of sanitation with emphasis on solid waste, sewage disposal, community health and personal hygiene. ii assess the roles and functions of international and national health agencies (e.g. World Health Organization (WHO), United Nations International Children Emergency Fund (UNICEF), International Red Cross Society (IRCS), and the ministries of health and environment.
(c) Conservation of Natural Resources	Candidates should be able to: (i) apply the various methods of conservation of both the renewable and non-renewable natural resources for the protection of our environment for present and future generations. (ii) outline the benefits of conserving natural resources, prevention of desertification.

(d) Game reserves and National parks	(iii) identify the bodies responsible for the conservation of resources at the national and international levels (e.g. Nigerian Conservation Foundation (NCF), Federal Ministry of Environment, Nigeria National Parks, World Wildlife Foundation (WWF), International Union for Conservation of Nature (IUCN), United Nations Environmental Programme (UNEP) and their activities. (iv) asses their activities. Candidates should be able to: i. Know the location and importance of game reserves and National parks in Nigeria

D: HEREDITY AND VARIATIONS

1. Variation In Population a. Morphological variations in the physical appearance of individuals. (i) size (height, weight) (ii) Colour (skin, eye, hair, coat of animals, scales and feathers. (iii) Fingerprints	Candidates should be able to: i. differentiate between continuous and discontinuous variations with examples. ii. relate the role of environmental conditions, habitat and the genetic constitution to variation. Candidates should be able to: i) measure heights and weights of pupils of the same age group; ii) plot graphs of frequency distribution of the heights and weights. Candidates should be able to: i) observe and record various colour patterns in some plants and mammals. Candidates should be able to: i) apply classification of fingerprints in identity detection.
b. Physiological variation (i) Ability to roll tongue (ii) Ability to taste phenylthiocarbamide (PTC) (iii) Blood groups c. Application of discontinuous variation in crime detection, blood transfusion and determination of paternity.	Candidates should be able to: i) identify some specific examples of physiological variation among human population. ii) categorize people according to their physiological variation. Candidates should be able to: i) apply the knowledge of blood groups in blood transfusion and determination of paternity. ii) use discontinuous variation in crime detection.
2. Heredity a) Inheritance of characters in organisms; i) Heritable and non-heritable characters. b) Chromosomes – the basis of heredity;	Candidates should be able to: i. determine heritable and non-heritable characters with examples. Candidates should be able to: i. illustrate simple structure of DNA

(i) Structure (ii) Process of transmission of hereditary characters from parents to offspring. c) Probability in genetics and sex determination. a) Application of the principles of heredity in: i) Agriculture (ii) Medicine b. Sex – linked characters e.g. baldness, haemophilia, colour blindness, etc.	Candidates should be able to: i. illustrate segregation of genes at meiosis and recombination of genes at fertilization to account for the process of transmission of characters from parents to offsprings. Candidates should be able to: i) deduce that segregation of genes occurs during gamete formation and that recombination of genes at fertilization is random in nature. Candidates should be able to: i. analyze data on cross-breeding experiments. ii. apply the principles of heredity in the production of new varieties of crops and livestock through cross-breeding. iii. deduce advantages and disadvantages of out-breeding and in-breeding. iv. analyze elementarily the contentious issues of genetically modified organisms (GMO) and gene therapy and biosafety. Candidates should be able to: i) apply the knowledge of heredity in marriage counselling with particular reference to blood grouping, sickle-cell anaemia and the Rhesus factors. ii) examine the significance of using recombinant DNA materials in the production of important medical products such as insulin, interferon and enzymes. Candidates should be able to: i) identify characters that are sex linked.

E: EVOLUTION

TOPICS/CONTENTS/NOTES	OBJECTIVES
1. Theories of evolution a) Lamarck's theory b) Darwin's theory c) organic theory	Candidates should be able to: i.) relate organic evolution as the sum total of all adaptive changes that have taken place over a long period of time resulting in the diversity of forms, structures and functions among organisms. ii.) examine the contributions of Lamarck and Darwin to the theory of evolution. iii.) know evidences in support of organic evolution
2. Evidence of evolution	Candidates should be able to: i.) provide evidences for evolution such as fossil records, comparative anatomy, physiology and embryology. ii.) trace evolutionary trends in plants and animals.

	iii.) provide evidence for modern evolutionary theories such as genetic studies and the role of mutation.

RECOMMENDED TEXTS

- Ndu, F.O. C. Ndu, Abun A. and Aina J.O. (2001) *Senior Secondary School Biology: Books 1 -3,* Lagos: Longman
- Odunfa, S.A. (2001) *Essential of Biology*, Ibadan: Heinemann
- Ogunniyi M.B. Adebisi A.A. and Okojie J.A. (2000) *Biology for Senior Secondary Schools: Books 1 – 3*, Macmillan
- Ramalingam, S.T. (2005) *Modern Biology, SS Science Series. New Edition*, AFP
- Stan. (2004) *Biology for Senior Secondary Schools. Revised Edition, Ibadan*: Heinemann
- Stone R.H. and Cozens, A.B.C. (1982) *Biology for West African Schools.* Longman
- Usua, E.J. (1997) *Handbook of practical Biology 2nd Edition*, University Press, Limited