Biology

JAMB UTME Syllabus: topics and objectives

Aim. This syllabus prepares you for the UTME in Biology. It tests whether you can: (1) show sound knowledge of the diversity, interdependence and unity of life; (2) account for the continuity of life through reproduction, inheritance and evolution; and (3) apply biological principles to everyday life, especially matters affecting living things, individuals, society, the environment, community health and the economy. It has five sections: Variety of Organisms, Form and Functions, Ecology, Heredity and Variations, and Evolution.

How to use it. The left column lists what the topic covers. The right column lists what you should be able to do after studying it. Tick each objective off as you master it, and practise past questions on each topic.

SECTION A: VARIETY OF ORGANISMS

1. LIVING ORGANISMS

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Characteristics of living things • Cell structure and the functions of cell components • Levels of organisation: cell (Euglena, Paramecium), tissue (epithelial tissue, Hydra), organ (onion bulb), system (reproductive, digestive, excretory), organism (Chlamydomonas)	1. Differentiate living from non-living things 2. Identify the structures of plant and animal cells and analyse the functions of their components 3. Compare and contrast plant and animal cells 4. Trace the five levels of organisation of living organisms in order

2. EVOLUTION AMONG ORGANISMS

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Monera (prokaryotes): bacteria and blue-green algae • Protista: Amoeba, Euglena, Paramecium • Fungi: mushroom, Rhizopus • Plantae: Thallophyta (Spirogyra), Bryophyta (mosses and liverworts), Pteridophyta (ferns, e.g. Dryopteris), Spermatophyta (gymnosperms such as cycads and conifers; angiosperms: monocots such as maize, dicots such as water leaf); plants classified by life-cycle span • Animalia, invertebrates: coelenterates (Hydra), flatworms (Taenia), roundworms, annelids (earthworm), arthropods (mosquito, cockroach, housefly, bee, butterfly), molluscs (snails) • Animalia, vertebrates: fish (cartilaginous and bony), amphibia, reptilia, aves, mammalia	1. Analyse the external features and characteristics of the listed organisms 2. Show increasing structural complexity across the groups 3. Trace life-history stages and the gradual move from life in water to life on land 4. Trace the evolution of the listed plants and the advancement of invertebrates and multicellular animals 5. Classify plants as annuals, biennials and perennials 6. State the economic importance of the insects and animals studied and their value to the environment

3. ADAPTATIONS OF ORGANISMS	
TOPICS / CONTENTS	**OBJECTIVES: candidates should be able to**
• Adaptive colouration and its functions • Behavioural adaptations in social animals • Structural adaptations in organisms	1. Describe how structure, function and behaviour fit organisms to their environment and way of life 2. Categorise countershading in fish, toads and snakes, and warning colouration in mushrooms 3. Differentiate the castes in social insects such as termites and their functions in the colony 4. Account for basking in lizards, territorial behaviour, hibernation and aestivation 5. Account for adaptations for getting food (beaks and legs of birds, insect mouthparts), protection and defence (stick insects, praying mantis, toad), securing mates (Agama lizards, bird feather displays), controlling body temperature (skin, feathers, hair) and conserving water (spines in plants, scales in mammals)

SECTION B: FORM AND FUNCTIONS

1. INTERNAL STRUCTURE OF ORGANISMS	
TOPICS / CONTENTS	**OBJECTIVES: candidates should be able to**
• Flowering plant: root, stem, leaf • Mammal: internal structure	1. Identify transverse sections of root, stem and leaf and relate structure to function 2. Identify supporting tissues in plants (collenchyma, sclerenchyma, xylem and phloem fibres) and where they sit in root, stem and leaf 3. Examine how the internal organs of a mammal are arranged and describe the position of the digestive, reproductive and excretory organs

2. NUTRITION	
TOPICS / CONTENTS	**OBJECTIVES: candidates should be able to**
• Modes of nutrition: autotrophic and heterotrophic • Plant nutrition: photosynthesis, chemosynthesis, mineral requirements (macro- and micro-nutrients) • Animal nutrition: classes of food, food tests (starch, reducing sugar, protein, oil, fat) • Mammalian tooth: structure, types and functions • Mammalian alimentary canal; ingestion, digestion, absorption and assimilation	1. Compare autotrophic and heterotrophic nutrition, giving examples from flowering and non-flowering plants 2. Compare photosynthesis and chemosynthesis and tell the light reaction from the dark reaction 3. Show that light, carbon(IV) oxide and chlorophyll are needed for photosynthesis and test a leaf for starch 4. Differentiate holozoic, parasitic, saprophytic and carnivorous-plant feeding with examples 5. Identify macro- and micro-elements for plants and the deficiency symptoms of nitrogen, phosphorus and potassium 6. Identify sources of each class of food, its nutritional value, and diseases from deficiency (scurvy, rickets, kwashiorkor); explain a balanced diet 7. Detect a food type from experimental results 8. Describe the mammalian tooth, relate tooth types to function and compare dental formulae of man, sheep and dog 9. Relate the parts of the alimentary canal and its accessory organs (liver, pancreas, gall bladder) to their functions 10. Identify the features of digestive enzymes, link enzymes to carbohydrate, protein and fat digestion, and give the end products

3. TRANSPORT

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Need for transportation • Materials transported: excretory products, gases, manufactured and digested food, nutrients, water, hormones • Channels: mammalian circulatory system (heart, arteries, veins, capillaries); plant vascular system (phloem and xylem) • Media and mechanisms of transport	1. Relate increase in size and complexity to the need for a transport system 2. Determine the sources of materials and the forms in which they travel 3. Describe the circulatory system and compare the functions of the hepatic portal vein, pulmonary vein and artery, aorta, and renal artery and vein 4. Identify the organs of the plant vascular system and the functions of phloem and xylem 5. Identify media of transport (cytoplasm, cell sap, body fluid, blood, lymph) and state the composition and functions of blood and lymph 6. Describe diffusion, osmosis, plasmolysis and turgidity as transport mechanisms 7. Compare open circulatory systems in animals, and transpiration pull, root pressure and active transport in plants

4. RESPIRATION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Respiratory organs and surfaces • Gaseous exchange in plants and animals • Aerobic respiration • Anaerobic respiration	1. Explain the significance of respiration and outline glycolysis and the Krebs cycle with reference to ATP 2. Work out gaseous exchange, products and heat from experimental set-ups 3. Describe body surface, gills, trachea, lungs, stomata and lenticels and the organisms that have them 4. Describe how stomata open and close and compare respiratory mechanisms in plants and animals 5. Examine the role of oxygen in releasing energy and the effect of too little oxygen on muscles 6. Use yeast and sugar solution to show fermentation and state the economic importance of yeast

5. EXCRETION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Excretory structures: contractile vacuole, flame cell, nephridium, Malpighian tubule, kidney, stoma, lenticel • Excretory mechanisms: kidneys, lungs, skin • Excretory products of plants	1. Define excretion and state its significance 2. Relate each structure's characteristics to its function and the kidney's structure to excretion and osmoregulation 3. Identify the functions and excretory products of the lungs and skin 4. Deduce the economic importance of plant excretory products such as carbon(IV) oxide, oxygen, tannins, resins, gums, mucilage and alkaloids

6. SUPPORT AND MOVEMENT

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Tropic, tactic, nastic and sleep movements in plants • Supporting tissues in animals • Skeletons: exoskeleton, endoskeleton, functions	1. Explain the need for support and movement in organisms 2. Relate plant responses to light, water, gravity and touch 3. Identify the growth regions of roots and shoots and the role of auxins in tropism 4. Relate chitin, cartilage and bone to support 5. Relate the mammalian skeleton to support, movement and breathing and differentiate types of joints 6. Apply the protective, supportive, locomotive and respiratory roles of the skeleton to the animal's wellbeing

7. REPRODUCTION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Asexual reproduction: fission (Paramecium), budding (yeast), natural and artificial vegetative propagation • Sexual reproduction in flowering plants: floral parts and functions, pollination and fertilisation, products • Reproduction in mammals: structure and function of male and female organs; fertilisation and development	1. Differentiate asexual from sexual reproduction 2. Apply natural vegetative propagation, grafting, budding and layering in agriculture 3. Relate flower parts to function and state the advantages of cross pollination 4. Deduce the types of placentation that develop into simple, aggregate, multiple and succulent fruits 5. Differentiate male from female reproductive organs and relate structure to function 6. Describe fertilisation as fusion of gametes 7. Relate the mother's health, nutrition and drug use to embryo development, and explain methods of regulating reproduction such as in-vitro fertilisation and birth control

8. GROWTH

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Meaning of growth • Germination of seeds and the conditions needed	1. Apply the conditions for germination to plant growth 2. Differentiate epigeal from hypogeal germination

9. CO-ORDINATION AND CONTROL

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Nervous coordination: central nervous system, peripheral nervous system, impulse transmission, reflex action • Sense organs: skin, nose, tongue, eye, ear • Hormonal control: animal hormones (pituitary, thyroid, parathyroid, adrenal, pancreas, gonads); plant hormones • Homeostasis: body temperature and salt and water regulation	1. Apply the structure and function of the central nervous system to the coordination of body functions 2. Illustrate reflex actions (blinking, knee jerk) and tell reflex from voluntary actions and conditioned reflexes (salivation, riding a bicycle, swimming) 3. Relate each sense organ to its function and use that to detect and correct defects 4. State where the listed endocrine glands are and relate each hormone to its function 5. Examine the effects of auxins, gibberellins, cytokinins and ethylene on growth, tropism, flowering, fruit ripening and leaf fall 6. Relate the function of hormones to homeostasis

SECTION C: ECOLOGY

1. FACTORS AFFECTING THE DISTRIBUTION OF ORGANISMS

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Abiotic factors • Biotic factors	1. Relate temperature, rainfall, humidity, wind, altitude, salinity, turbidity, pH and soil conditions to where organisms live 2. Use a secchi disc, thermometer and rain gauge to measure abiotic factors 3. Describe how the activities of plants and animals, especially humans, affect distribution

2. SYMBIOTIC INTERACTIONS AND NUTRIENT CYCLING

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Symbiosis, parasitism, saprophytism, commensalism, mutualism, amensalism, competition, predation, cooperation • Energy flow: food chains, food webs, trophic levels • Nutrient cycles: carbon, water, nitrogen	1. Give examples of each type of interaction between organisms 2. Explain distribution of organisms with food chains and webs and define them 3. Describe the carbon cycle, including oxygen/carbon(IV) oxide balance and global warming 4. Assess the effect of the water cycle on other cycles and the role of bacteria and legumes in the nitrogen cycle

3. NATURAL HABITATS

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Aquatic: ponds, streams, lakes, seashores, mangrove swamps • Terrestrial and arboreal: tree-tops, abandoned farmland, dry grassy savanna, burrows and holes	1. Associate plants and animals with each habitat 2. Relate adaptive features to the habitats organisms live in

4. LOCAL (NIGERIAN) BIOMES

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Tropical rainforest • Guinea savanna (southern and northern) • Sudan savanna • Desert • Highlands: montane forests and grasslands of the Obudu, Jos and Mambilla plateaus	1. Locate the biomes in their regions 2. Use the features of each biome to describe the characteristics of different regions of Nigeria

5. THE ECOLOGY OF POPULATIONS

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Population density and overcrowding • Adaptation for survival: competition factors, intra- and inter-specific competition, competition and succession • Factors affecting population size: biotic (food, pests, disease, predation, competition, reproductive ability) and abiotic (temperature, space, light, rainfall, topography, pressure, pH) • Ecological succession: primary and secondary	1. Explain rapid changes in human population and the results of overcrowding; calculate density as organisms per unit area 2. Relate population growth, disease, and shortage of food and space to intra- and inter-specific competition 3. Use niche differentiation to explain how competition within a species is reduced 4. Deduce the effect of biotic and abiotic factors on population size and how they interact 5. Trace the sequence of succession to the climax stage in plants

6. SOIL

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Soil types: sandy, loamy, clayey; structure, porosity, capillarity, humus content • Components: inorganic, organic, soil organisms, soil air, soil water • Soil fertility: loss, renewal and maintenance	1. Identify the physical properties of soil types from simple measurements of particle size, porosity or water retention 2. Find the amounts of air, water, humus and capillarity in different soils by experiment 3. Relate soil characteristics to healthy plant growth 4. Relate loss of fertility to loss of inorganic matter, compaction, leaching, erosion and repeated single-crop farming 5. Apply conservation methods: contour ridging, terracing, mulching, poly-cropping, strip-cropping, fertilisers, crop rotation, shifting cultivation

7. HUMANS AND THE ENVIRONMENT

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Diseases: common and endemic diseases; easily transmitted diseases such as poliomyelitis, cholera, tuberculosis and sexually transmitted infections (gonorrhoea, syphilis, AIDS) • Drug abuse: addiction, commonly abused drugs, prevention • Pollution and its control: sources, types, effects, methods; sanitation and sewage • Conservation of natural resources; game reserves and national parks	1. Identify the conditions that favour the spread of diseases such as malaria, meningitis, guinea worm, schistosomiasis, onchocerciasis, typhoid fever and cholera 2. Relate the biology of each vector or agent to how the disease spreads and is controlled; apply vaccination and inoculation 3. Define drug abuse and addiction, list commonly abused drugs and state their effects on health 4. Categorise pollution into air, water and soil, relate pollutants to health and environmental damage and say how each can be controlled 5. Explain the importance of sanitation, including solid waste, sewage, community health and personal hygiene 6. Assess the roles of WHO, UNICEF, the Red Cross and the ministries of health and environment 7. Apply conservation methods for renewable and non-renewable resources and outline their benefits, including preventing desertification 8. Identify the bodies responsible for conservation (NCF, Federal Ministry of Environment, Nigeria National Parks, WWF, IUCN, UNEP) and the location and importance of game reserves and national parks in Nigeria

SECTION D: HEREDITY AND VARIATIONS

1. VARIATION IN POPULATION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Morphological variation: size (height, weight), colour (skin, eye, hair, animal coats, scales, feathers), fingerprints • Physiological variation: tongue rolling, tasting PTC, blood groups • Uses of discontinuous variation in crime detection, blood transfusion and paternity	1. Differentiate continuous from discontinuous variation with examples 2. Relate environment, habitat and genes to variation 3. Measure heights and weights of pupils of the same age and plot frequency graphs 4. Observe and record colour patterns in plants and animals 5. Apply fingerprint classification to identity detection 6. Identify and categorise physiological variation among people 7. Apply blood groups to blood transfusion and paternity, and use discontinuous variation in crime detection

2. HEREDITY

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Inheritance of characters: heritable and non-heritable • Chromosomes as the basis of heredity: structure, transmission of characters from parents to offspring • Probability in genetics and sex determination • Applying heredity in agriculture and medicine • Sex-linked characters: baldness, haemophilia, colour blindness	1. Tell heritable from non-heritable characters with examples 2. Illustrate the simple structure of DNA 3. Illustrate gene segregation at meiosis and recombination at fertilisation and deduce that recombination is random 4. Analyse data from cross-breeding experiments 5. Apply heredity to produce new crop and livestock varieties; give the advantages and disadvantages of out-breeding and in-breeding 6. Examine issues around GMOs, gene therapy and biosafety 7. Apply heredity to marriage counselling (blood groups, sickle-cell anaemia, Rhesus factor) 8. Describe the use of recombinant DNA in making insulin, interferon and enzymes 9. Identify sex-linked characters

3. BIOTECHNOLOGY

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Applications in agriculture, medicine, pharmaceuticals and the food industry	1. Define biotechnology 2. List its applications in agriculture, medicine, pharmaceuticals and the food industry

SECTION E: EVOLUTION

1. THEORIES OF EVOLUTION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Lamarck's theory • Darwin's theory • Organic theory	1. Relate organic evolution to the adaptive changes that over a long time produced the diversity of forms, structures and functions 2. Explain the contributions of Lamarck and Darwin to the theory of evolution

2. EVIDENCE OF EVOLUTION

TOPICS / CONTENTS	OBJECTIVES: candidates should be able to
• Fossil records, comparative anatomy, physiology and embryology • Modern evidence: genetic studies and the role of mutation	1. State the evidence in support of organic evolution 2. Trace evolutionary trends in plants and animals 3. State the evidence for modern evolutionary theories, such as genetic studies and mutation