

Grade 12 (Bilingual) Biology

Learning outcomes

Textbook: Advanced Biology for you

Semester 1

Topic 9: Gas Exchange

Learning outcomes

Candidates should be able to:

- a. Define and explain the meaning of respiration.
- b. Distinguish between gas exchange and respirations.
- c. Describe the features of gas exchange surfaces.
- d. Adaptations in humans and mammals for an efficient gas exchange system.
- e. Describe the process of gas exchange in unicellular organisms.
- f. Name the gas exchange surface in other animals; namely, the sea anemone, the nematodes, the flatworms, the lugworms and the tadpoles, and describe the way in which it makes gas exchange efficient.
- g. Understand the relationship of surface area to volume ratio, and show how this enables the skin of annelids to act as an efficient respiratory surface.
- h. Describe the adaptations in the skin of annelids that enable it to act as an efficient respiratory surface.
- i. Describe the structure of the tracheal system in insects and show how it provides an efficient gas exchange surface.
- j. Describe the structure of the gas exchange system in fish and how ventilation is achieved through the gills.
- k. Show how the counter current system in gills of fish ensures efficient gas exchange.
- l. Describe how the human lungs are adapted for efficient exchange of gases.
- m. Describe the mechanisms of breathing-in and breathing-out in humans.

- n. Describe the process of gas exchange in the alveoli.
- o. Describe the role of the nasal passages, cilia and goblet cells in the trachea in conditioning the breathed-in air.
- p. Show how the respiratory centre in the brain controls the breathing.
- q. Describe the role of carbon dioxide and chemoreceptors in the medulla of the brain in increasing the depth and rate of breathing during exercise.
- r. Recall the structure and function of the different parts of a leaf.
- s. Describe the adaptations of the leaf that make it an efficient gas exchange surface.
- t. Describe the structure and adaptations of the stomata and its that makes it an efficient respiratory surface.
- u. Describe the mechanism of opening and closing of the stomata.
- v. Define lenticels and understand their function.
- w. Biology at work: Describe asthma, its causes, symptoms and treatment.
- x. Biology at work: Describe hypoxia, its causes, and show how the body responds to it.
- y. Biology at work: Discuss the reasons behind the reduction in the performance of athletes in the 1968 Olympics held in Mexico City, who were trained near sea level and show how the benefits of altitude training at sea level.

Topic 11: Transport in animals

Learning outcomes

Candidates should be able to:

- a. Explain how endurance training can improve the efficiency of the respiratory and cardiovascular systems.
- b. Describe what a mass flow transport system is.
- c. List the main structures of the human circulatory system.
- d. Distinguish between a open and a closed blood circulation systems
- e. Distinguish between single and double circulation systems.

- f. List the ways by which the flow of blood is maintained in mammals.
- g. Describe the structure of arteries, veins and capillaries and relate their structure to their function.
- h. Understand the histology of the cardiac muscle.
- i. Describe the structure and function of the different parts of the heart.
- j. Understand the myogenic stimulation.
- k. Describe what cardiac output is, and show how it can be modified by the sympathetic and parasympathetic nervous systems by negative feedback from the cardiac centre in the medulla of the brain.
- l. Describe the roles of carbon dioxide, pH, the carotid body, stretch and pressure receptors in regulating cardiac output.
- m. List the functions of the blood and name its components.
- n. Describe the composition of blood as plasma and blood cells, to include erythrocytes and leucocytes (neutrophils and lymphocytes)
- o. Describe the structure of red blood cells and understand their role in transport;
- p. Understand the roles of white blood cells in phagocytosis and secretion of antibodies;
- q. Explain the mechanism of blood clotting.
- r. Understand the transport of oxygen and carbon dioxide;
- s. Describe the roles of respiratory pigments (haemoglobin, fetal haemoglobin and myoglobin);
- t. Understand and interpret dissociation curves of haemoglobin and the Bohr effect;
- u. Describe the interchange of materials between capillaries and tissue fluid, including the formation and reabsorption of tissue fluid and the formation of lymph.
- v. Biology at work: Understand the use of the artificial pacemaker in replacing a malfunctioning sino-atrial node or a damaged heart conductive tissue.
- w. Biology at work: Understand the role of the electrocardiogram in detecting a variety of cardiac disorders.
- x. Biology at work: Define hypertension, understand its risks, show how it can be reduced and explain the role of beta blockers in reducing blood pressure.

Topic 12: Transport in plants

Learning outcomes

Candidates should be able to:

- a. Explain why plants need a mass flow system for transport.
- b. Distinguish the different tissues found inside the stem.
- c. Describe the structure of the xylem tissue composed of vessels, tracheids, fibres and xylem parenchyma; understand the role of vessels in relation to transport.
- d. Describe the functioning and understand the roles of the transpiration stream; roles of stomata; understand the effect of different environmental conditions on the transpiration stream.
- e. Use a potometer to measure the rate of transpiration.
- f. Describe the mechanism of the opening and closing of the stomata.
- g. Describe the structure of a dicotyledonous root.
- h. Understand the uptake of water and its transport across the root to the xylem.
- i. Understand the way in which water is moved through the plant; the apoplast and symplast pathways; the role of the endodermis.
- j. Describe how root pressure helps in forcing water upwards.
- k. Describe how diffusion and active transport play a role in mineral uptake.
- l. Understand the structure of vessels in relation to the cohesive and adhesive forces of water and their contribution to the movement of water through the plant.
- m. Describe the adaptations of xerophytes in reducing water loss by plants.
- n. Describe the structure of the phloem tissue composed of sieve tube elements and companion cells.
- o. Describe how the mass flow theory explains the transport of substances in the phloem.
- p. Biology at work: Describe the connection between aphids and plant viruses and discuss ways of controlling them.
- q. Biology at work: Describe the causes of the Dutch Elm Disease, how it attack the host and the methods used in combating it.

Topic 18: Homeostasis

Learning outcomes

Candidates should be able to:

- a. Define homeostasis and explain the need for a receptor, a coordinator and an effector.
- b. Describe the ways in which heat is gained and lost from the body by conduction, convection and radiations.
- c. Describe how thermoregulation takes place in ectotherms and in endotherms.
- d. Describe the methods for controlling body temperature upon overcooling and overheating.
- e. Discuss the role of the pancreas in controlling the levels glucose in the blood by controlling the levels of insulin and glucagons.
- f. Discuss the causes of diabetes mellitus, its symptoms and treatment.
- g. Define excretion. List the excretory products in fish, birds, insects and mammals.
- h. Describe the structure of the human urinary system and the structure of the kidneys.
- i. Describe the structure of the nephron and understand how it filters the blood from urine by ultrafiltration and reabsorption. Describe the way the loop of Henle functions to produce concentrated urine, by the countercurrent multiplier mechanism. Describe the function of the distal convoluted tubule.
- j. Show the adaptation in the loop of Henle in desert mammals to minimize water loss from their bodies.
- k. Understand how the control of the water and solute content of the blood is achieved; the role of osmoreceptors in the hypothalamus; the pituitary gland; the action of antidiuretic hormone; the principle of negative feedback.
- l. Biology at work: Understand the reasons behind performing kidney dialysis, the differences between haemodialysis and peritoneal dialysis and describe how each is performed.
- m. Biology at work: Understand the reasons behind kidney transplants, how it is performed, and compare between kidney transplants and dialysis.

Semester 2

Topic 16: Respiration

Learning outcomes

Candidates should be able to:

- a. Understand that energy is needed by living things for movement, maintaining a constant body temperature, anabolic process, active transport, bioluminescence and secretion.
- b. Distinguish between aerobic and anaerobic respiration.
- c. Define respiration and distinguish between gas exchange and respiration.
- d. Understand the structure of ATP and its significance in metabolism as the immediate supply of energy for biological processes.
- e. Describe glycolysis, the link reaction, Krebs cycle and the electron transport chain as stages of aerobic respiration.
- f. Describe the conversion of glucose to pyruvate during glycolysis; the phosphorylation of glucose molecules, breakdown of glyceralate 3-phosphate; production of reduced coenzyme (NADH + H⁺) and ATP (details of intermediate compounds and reactions, other than those specified, are not required).
- g. Understand the role of the electron-transport chain in generating ATP (oxidative phosphorylation); understand the role of molecular oxygen as a hydrogen acceptor forming water.
- h. Recall the structure of the mitochondrion; identify inner and outer membranes and the inter membrane space.
- i. Describe and understand the role of mitochondria as the site of Krebs cycle and electron-transport chain; understand the location of enzymes and electron carriers.
- j. Explain how ATP is synthesized using the chemiosmotic theory.
- k. Describe the processes of alcoholic fermentation in yeast and lactic acid fermentation in muscle cells.

- l. Describe the processes by which lipids and proteins can be used as respiratory substrates.
- m. Show what is meant by a respiratory quotient.
- n. Describe why and how a respirometer is used.
- o. Biology at work: Describe the batch culture process used in the brewing of beer.
- p. Biology at work: Define biofuels and show how biogas and biodiesel are produced to be used as biofuels.

Topic 17: Photosynthesis

Learning outcomes

Candidates should be able to:

- a. Understand the effect of increased carbon dioxide levels in the atmosphere on the effectiveness of glyphosate (a herbicide) in controlling weed growth.
- b. Describe the experiments performed by Englemann by which he detected the site of photosynthesis.
- c. Describe the external and internal structure of a dicotyledonous leaf; the location of the palisade tissue; recall the structure of a palisade cell; recall the structure of a chloroplast as revealed by electron microscopy; identify the envelope, stroma, grana and lamellar structure; understand the location of the chloroplast pigments.
- d. Understand the nature of the chloroplast pigments; chlorophyll a and b; carotenoids; (details of chemical formulae not required); understand absorption and action spectra for chloroplast pigments.
- e. Describe the process of chromatography as a technique used in separating photosynthetic pigments.
- f. Describe the processes of light-dependent and understand the processes of cyclic and non-cyclic photophosphorylation in the production of reduced NADP (NADPH + H⁺) and ATP; the evolution of oxygen.

- g. Understand that the light-independent stage the fixation of carbon dioxide onto a 5C compound (ribulose bisphosphate) to give glycerate 3-phosphate (GP); the use of reduced NADP and ATP from the light-dependent reaction in the synthesis of carbohydrate from GP; the regeneration of the 5C compound.
- h. Understand how the Hill reaction proved that the oxygen released from photosynthesis comes from the splitting of water.
- i. Describe the process by which Calvin analyzed the stages of the light-independent stage.
- j. Name the factors that affect the rate of photosynthesis and describe how a photosynthometer is used to measure the effects of light intensity on photosynthetic rate.
- k. Understand how limiting factors can influence the rate of photosynthesis.
- l. Biology at work: Describe how limiting factors can be manipulated to obtain the highest possible yield from a crop.
- m. Biology at work: Describe how greater food production in developing countries can come from the active input of local farmers and the integration of traditional and alternative agricultural methods.

Topic 15: Infectious disease and immunity

Learning outcomes

Candidates should be able to:

- a. Show that antibiotics are becoming ineffective in controlling bacterial and viral diseases are becoming increasingly effective, using the examples of MRSA and *E.coli*.
- b. Describe the structure and function of neutrophils, monocytes and lymphocytes.
- c. Describe the function of B-lymphocytes and T-lymphocytes in providing immunity.

- d. State the functions of eosinophils and basophils.
- e. Describe the four main phases of bacterial growth.
- f. Show how temperature, pH, oxygen and nutrients affect bacterial growth.
- g. Describe the process of culturing bacteria, stating the precautions and aseptic techniques used while handling bacteria.
- h. Describe the techniques used in the monitoring the growth of bacteria, using a haemocytometer, dilution plating and turbidimetry.
- i. Describe how pathogenicity, infectivity and invasiveness can influence the ability of bacteria to produce disease.
- j. Describe the symptoms caused by *Salmonella* poisoning.
- k. Show how *Salmonella* can be transmitted and describe the precautions that need to be taken to avoid food contamination by *Salmonella*.
- l. Describe how cholera spread and how it gets transmitted.
- m. Describe how cholera is treated.
- n. Discuss the factors that make Cholera spread only in some developing countries.
- o. Describe the causes of tuberculosis, its symptoms and its mode of transmission.
- p. Discuss the factors that contributed to the increased incidence of TB in developed countries, recently.
- q. List the ways by which viruses cause disease.
- r. Distinguish between the three types of influenza virus: A, B and C.
- s. Show how influenza virus gets transmitted and describe its symptoms.
- t. Describe the method for the treatment of influenza, and the methods used in preventing the spread of the virus.
- u. Describe the structure of the HIV retrovirus, and show how it attack and replicated inside helper T-cells.

- v. Describe the signs, symptoms and treatment of AIDS.
- w. Show how AIDS is treated and list the precaution that need to be taken to prevent its spread.
- x. Name the organism that causes malaria, and show how it gets transmitted through the *Anopheles* mosquito.
- y. Describe the symptoms of malaria and list the control measures that need to be taken to control its spread.
- z. Show how malaria is treated.
- aa. Describe how physical defence, mechanical defence, chemical defence and biological defence help prevent the entry of pathogens into the body.
- bb. Describe the process by which antigens and antibodies work to produce an immune response.
- cc. Describe how macrophages and lymphocytes work to produce cell-mediated immunity.
- dd. Describe the roles of plasma B-cells, memory B-cells and dividing B-cells in producing antibody-mediated immunity.
- ee. Describe the stages in antibody-mediated immunity.
- ff. Distinguish between primary and secondary responses of antibody production.
- gg. Describe how the reaction between antigen and antibody help in defending the body against pathogens.
- hh. Distinguish between active and passive immunity.
- ii. Show how vaccines produce active immunity.
- jj. Describe the different ways by which vaccines are made.
- kk. Distinguish between the different ABO blood groups.
- ll. Explain how the blood transfusion compatibility between donor and recipient is explained.

- mm. Define antibiotics and distinguish between broad spectrum antibiotics and narrow spectrum antibiotics.
- nn. Describe the ways by which antibiotics inhibit or destroy pathogens.
- oo. Describe how antibiotic resistance is brought about and suggest how reduce the appearance of resistant strains.
- pp. Show the importance of antibiotic screening and describe how it is performed.
- qq. Biology at work: Describe the method by which signs of pregnancy are detected by binding antibodies to human chorionic gonadotrophin from urine samples.
- rr. Biology at work: Describe what meningitis is, how it spread and its symptoms.

Topic 19: Control and coordination

Learning outcomes

Candidates should be able to:

- a. Explain the importance of potentially successful brain transplants in treating many forms of brain damage.
- b. List the structures and functions of the main parts of the nervous system; central and peripheral nervous systems.
- c. Describe the structure and functions of sensory, relay and effector neurones; the role of Schwann cells and myelination.
- d. Understand the nature of the nerve impulse; describe the propagation of action potentials in terms of changes in the permeability of the membrane to sodium ions, resulting in a wave of depolarisation propagating an action potential. Understand the all or nothing law and the refractory period.
- e. List and describe the factors that affect the speed of transmission of a nerve impulse. Describe saltatory conduction and its advantages.
- f. Describe the structure and functions of a synapse; understand the role of acetylcholine as a transmitter substance; post-synaptic potentials.
- g. List the different kinds of receptors and describe their function. Understand the structure and function of the Pacinian corpuscle.
- h. Describe the structure and function of the different parts of the eye.

- i. Show how light is focused on the retina. Describe the structure of the retina and show how photoreception and colour vision take place.
- j. Describe the gross structure of the brain and the spinal cord.
- k. Describe the location and functions of the medulla, cerebellum, hypothalamus and cerebral hemispheres.
- l. Describe the functioning of a spinal reflex arc and the types of neurone involved; understand the value of such reflexes in response to changes in the external environment.
- m. Distinguish between cardiac, smooth and skeletal muscles.
- n. Describe the structure of a muscle; muscle fibre, myofibril, actin, myosin, sarcomere, A band, I band, H zone and Z line.
- o. Describe the mechanism by which muscles contract using the sliding filament theory.
- p. Biology at work: Describe the effect of excitatory and inhibitory drugs on the nervous system.
- q. Biology at work: Understand what Motor neurone disease is, its symptoms, its causes including the role of excitotoxic chemical neurotransmitters and the possibility of using riluzole to treat it.
- r. Define plant growth substances and explain the terms synergic and antagonistic.
- s. Describe the role of auxin in phototropism and geotropism, positive phototropism, negative phototropism, positive geotropism, negative geotropism. Explain how auxin brings about apical dominance.
- t. Describe the functions of gibberellins.
- u. Define photoperiodism, and distinguish between 'day neutral plants', 'long day plants' and 'short day plants' in terms of the phytochrome.
- v. Biology at work: Describe the uses of synthetic auxins as selective weedkillers, ethane and cytokinins.

Grade 12
Semester 1
Subject: Biology

Chapter	Practical	Resource
1. Gas exchange	1. Ventilation of the lungs in humans	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 71
	2. Composition of inspired and expired air.	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 60
Transport in animals	Effect of various factors on human blood pressure	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 157
Transport in plants	Demonstration and measurement of transpiration	Legacy AS Biology, Nelson and Thornes, Exchange and transport
Homeostasis	Microscopic structure of the mammalian kidney	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 140

Grade 12
Semester 2
Subject: Biology

Chapter	Practical	Resource
1. Respiration	1. Using a simple respirometer	Legacy AS Biology, Nelson and Thornes, Exchange and transport
2. Photosynthesis	1. Effect of light intensity on the rate of photosynthesis	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 94
	2. Separation of photosynthetic pigments by paper chromatography	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 97
	3. Structure of leaves	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 98
3. Infectious disease and immunity	Determination of human blood groups	Biology, a functional approach, Students' manual, MBV Roberts and TJ King, p. 163