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Biology Specification

Assessment Objectives

Content from any part of the subject content can be assessed in each GCSE biology equivalency exam. Each exam has been designed to match the approximate percentage breakdown of Assessment Objectives (AO):

Assessment Objectives		
AO1	Knowledge and understanding of biology	38-42%
AO2	Application of knowledge and understanding, analysis and evaluation of biology	38-42%
AO3	Experimental skills, analysis and evaluation of data and methods in biology	19-21%
	Total	100%

Each exam consists of around 10% of marks that require the use of mathematical skills to Level 2 or above.

Exam Summary

Format	Description
Exam type	Online or paper-based
Exam Location	Sat at home/work - invigilated online
Exam availability	All year round
Exam structure	1 paper
Exam timing	2 hours
Number of marks	100 marks
Tiers	None
Level	9-1
Exam content coverage	Any content covered in the subject content section
Question types	Long written-answer questions, short-answer questions, multiple choice questions, matching questions and calculations
Additional equipment required	An appropriate scientific calculator

Biology Content

1 The Nature and Variety of Living Organisms

This section covers the following sub-topics:

(a) Characteristics of Living Organisms
Students should:

1.1 Understand how living organisms share the following characteristics:

- They require nutrition
- They respire
- They excrete their waste
- They respond to their surroundings
- They move
- They control their internal conditions
- They reproduce
- They grow and develop

(b) Variety of Living Organisms
Students should:

1.2 Describe the common features shown by eukaryotic organisms: plants, animals, fungi, and protoctists.

- Plants: Multicellular organisms; their cells contain chloroplasts and are able to carry out photosynthesis; their cells have cellulose cell walls; they store carbohydrates as starch or sucrose. Examples: Flowering plants such as a cereal (e.g. maize) and a herbaceous legume (e.g. peas or beans).
- Animals: Multicellular organisms; their cells do not contain chloroplasts and cannot carry out photosynthesis; they have no cell walls; they usually have nervous coordination and are able to move from one place to another; they often store carbohydrates as glycogen. Examples: Mammals (e.g. humans) and insects (e.g. housefly and mosquito).
- Fungi: Organisms that cannot carry out photosynthesis; their body is usually organised into a mycelium made from thread-like structures called hyphae, which contain many nuclei. Some are single-celled; their cells have walls made of chitin; they feed by extracellular secretion of digestive enzymes onto food material and absorption of organic products (saprotrophic nutrition); they may store carbohydrate as glycogen. Examples: Mucor, which has the typical fungal hyphal structure, and yeast, which is single-celled.
- Protoctists: Microscopic, single-celled organisms. Some, like Amoeba, which lives in pond water, have features similar to animal cells, while others, like Chlorella, have chloroplasts and are more like plants.
- Pathogenic. Example: Plasmodium, responsible for causing malaria.

1 The Nature and Variety of Living Organisms

Students should:

- 1.3 Describe the common features shown by prokaryotic organisms such as bacteria.

Bacteria
Microscopic, single-celled organisms; they have a cell wall, cell membrane, cytoplasm, and plasmids; they lack a nucleus but contain a circular chromosome of DNA. Some bacteria can carry out photosynthesis, but most feed off other living or dead organisms. Examples: Lactobacillus bulgaricus, a rod-shaped bacterium used in yoghurt production, and Pneumococcus, a spherical bacterium that causes pneumonia.

- 1.4 Understand the term pathogen and know that pathogens may include fungi, bacteria, protoctists, or viruses.

Viruses
Not living organisms. They are small particles, smaller than bacteria; they are parasitic and can reproduce only inside living cells; they infect every type of living organism. Viruses have no cellular structure but have a protein coat and contain one type of nucleic acid, either DNA or RNA. Examples: The tobacco mosaic virus that causes leaf discolouration in tobacco plants by preventing chloroplast formation, the influenza virus that causes flu, and the HIV virus that causes AIDS.

2 Structure and Functions in Living Organisms

This section covers the following sub-topics:

(a) Level of organisation
(b) Cell structure
(c) Biological molecules
(d) Movement of substances into and out of cells
(e) Nutrition
(f) Respiration
(g) Gas exchange
(h) Transport
(i) Excretion
(j) Coordination and response

(a) Level of Organisation
Students should:

- 2.1 Describe the levels of organisation in organisms: organelles, cells, tissues, organs, and systems.

(b) Cell Structure
Students should:

- 2.2 Describe cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, mitochondria, chloroplasts, ribosomes, and vacuole.
- 2.3 Describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, mitochondria, chloroplasts, ribosomes, and vacuole.
- 2.4 Know the similarities and differences in the structure of plant and animal cells.
- 2.5B Explain the importance of cell differentiation in the development of specialised cells.
- 2.6B Understand the advantages and disadvantages of using stem cells in medicine.

(c) Biological Molecules
Students should:

- 2.7 Identify the chemical elements present in carbohydrates, proteins, and lipids (fats and oils).
- 2.8 Describe the structure of carbohydrates, proteins, and lipids as large molecules made up of smaller basic units: starch and glycogen from simple sugars, protein from amino acids, and lipid from fatty acids and glycerol.
- 2.9 Practical: Investigate food samples for the presence of glucose, starch, protein, and fat.
- 2.10 Understand the role of enzymes as biological catalysts in metabolic reactions.
- 2.11 Understand how temperature changes can affect enzyme function, including changes to the shape of the active site.
- 2.12 Practical: Investigate how enzyme activity can be affected by changes in temperature.
- 2.13 Understand how enzyme function can be affected by changes in pH altering the active site.

2 Structure and Functions in Living Organisms

- 2.14B Practical: Investigate how enzyme activity can be affected by changes in pH.

(d) Movement of Substances into and out of Cells
Students should:

- 2.15 Understand the processes of diffusion, osmosis, and active transport by which substances move into and out of cells.
- 2.16 Understand how factors affect the rate of movement of substances into and out of cells, including the effects of surface area to volume ratio, distance, temperature, and concentration gradient.
- 2.17 Practical: Investigate diffusion and osmosis using living and non-living systems.

(e) Nutrition
Students should:

- 2.18 Understand the process of photosynthesis and its importance in the conversion of light energy to chemical energy.
- 2.19 Know the word equation and the balanced chemical symbol equation for photosynthesis.
- 2.20 Understand how varying carbon dioxide concentration, light intensity, and temperature affect the rate of photosynthesis.
- 2.21 Describe the structure of the leaf and explain how it is adapted for photosynthesis.
- 2.22 Understand that plants require mineral ions for growth, and that magnesium ions are needed for chlorophyll and nitrate ions are needed for amino acids.
- 2.23 Practical: Investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch, and the requirements of light, carbon dioxide, and chlorophyll.

(f) Respiration
Students should:

- 2.34 Understand how the process of respiration produces ATP in living organisms.
- 2.35 Know that ATP provides energy for cells.
- 2.36 Describe the differences between aerobic and anaerobic respiration.
- 2.37 Know the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms.
- 2.38 Know the word equation for anaerobic respiration in plants and in animals.
- 2.39 Practical: Investigate the evolution of carbon dioxide and heat from respiring seeds or other suitable living organisms.

(g) Gas Exchange
Students should:

- 2.40B Understand the role of diffusion in gas exchange.
- 2.41B Understand gas exchange (of carbon dioxide and oxygen) in relation to respiration and photosynthesis.

2 Structure and Functions in Living Organisms

- 2.42B Understand how the structure of the leaf is adapted for gas exchange.
- 2.43B Describe the role of stomata in gas exchange.
- 2.44B Understand how respiration continues during the day and night, but that the net exchange of carbon dioxide and oxygen depends on the intensity of light.
- 2.45B Practical: Investigate the effect of light on net gas exchange from a leaf, using hydrogen-carbonate indicator.

(h) Transport
Students should:

- 2.51 Understand why simple, unicellular organisms can rely on diffusion for movement of substances in and out of the cell.
- 2.52 Understand the need for a transport system in multicellular organisms.
- 2.53 Describe the role of phloem in transporting sucrose and amino acids between the leaves and other parts of the plant.
- 2.54 Describe the role of xylem in transporting water and mineral ions from the roots to other parts of the plant.
- 2.55B Understand how water is absorbed by root hair cells.
- 2.56B Understand that transpiration is the evaporation of water from the surface of a plant.
- 2.57B Understand how the rate of transpiration is affected by changes in humidity, wind speed, temperature, and light intensity.
- 2.58B Practical: Investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot.

(i) Excretion
Students should:

- 2.70 Understand the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf.
- 2.71 Know the excretory products of the lungs, kidneys, and skin (organs of excretion).
- 2.72B Understand how the kidney carries out its roles of excretion and osmoregulation.
- 2.73B Describe the structure of the urinary system, including the kidneys, ureters, bladder, and urethra.
- 2.74B Describe the structure of a nephron, including the Bowman's capsule and glomerulus, convoluted tubules, loop of Henle, and collecting duct.
- 2.75B Describe ultrafiltration in the Bowman's capsule and the composition of the glomerular filtrate.
- 2.76B Understand how water is reabsorbed into the blood from the collecting duct.
- 2.77B Understand why selective reabsorption of glucose occurs at the proximal convoluted tubule.
- 2.78B Describe the role of ADH in regulating the water content of the blood.
- 2.79B Understand that urine contains water, urea, and ions.

2 Structure and Functions in Living Organisms

(j) Coordination and Response
Students should:

- 2.80 Understand how organisms are able to respond to changes in their environment.
- 2.81 Understand that homeostasis is the maintenance of a constant internal environment, and that body water content and body temperature are both examples of homeostasis.
- 2.82 Understand that a co-ordinated response requires a stimulus, a receptor, and an effector.
- 2.83 Understand that plants respond to stimuli.
- 2.84 Describe the geotropic and phototropic responses of roots and stems.
- 2.85 Understand the role of auxin in the phototropic response of stems.
- 2.86 Describe how nervous and hormonal communication control responses and understand the differences between the two systems.
- 2.87 Understand that the central nervous system consists of the brain and spinal cord and is linked to sense organs by nerves.
- 2.88 Understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses.
- 2.89 Understand the role of neurotransmitters at synapses.
- 2.90 Describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object.
- 2.91 Describe the structure and function of the eye as a receptor.
- 2.92 Understand the function of the eye in focusing on near and distant objects, and in responding to changes in light intensity.
- 2.93 Describe the role of the skin in temperature regulation, with reference to sweating, vasoconstriction, and vasodilation.
- 2.94 Understand the sources, roles, and effects of the following hormones: adrenaline, insulin, testosterone, progesterone, and oestrogen.
- 2.95B Understand the sources, roles, and effects of the following hormones: ADH, FSH, and LH.

3 Reproduction and Inheritance

This section covers the following sub-topics:

(a) Reproduction
(b) Inheritance

(a) Reproduction
Students should:

- 3.1 Understand the differences between sexual and asexual reproduction.
- 3.2 Understand that fertilisation involves the fusion of a male and female gamete to produce a zygote that undergoes cell division and develops into an embryo.

Flowering Plants
- 3.3 Describe the structures of an insect-pollinated and a wind-pollinated flower and explain how each is adapted for pollination.
- 3.4 Understand that the growth of the pollen tube followed by fertilisation leads to seed and fruit formation.
- 3.5 Practical: Investigate the conditions needed for seed germination.
- 3.6 Understand how germinating seeds utilise food reserves until the seedling can carry out photosynthesis.
- 3.7 Understand that plants can reproduce asexually by natural methods (illustrated by runners) and by artificial methods (illustrated by cuttings).

Humans
- 3.8 Understand how the structure of the male and female reproductive systems are adapted for their functions.
- 3.9 Understand the roles of oestrogen and progesterone in the menstrual cycle.
- 3.10B Understand the roles of FSH and LH in the menstrual cycle.
- 3.11 Describe the role of the placenta in the nutrition of the developing embryo.
- 3.12 Understand how the developing embryo is protected by amniotic fluid.
- 3.13 Understand the roles of oestrogen and testosterone in the development of secondary sexual characteristics.

(b) Inheritance
Students should:

- 3.14 Understand that the genome is the entire DNA of an organism and that a gene is a section of a molecule of DNA that codes for a specific protein.
- 3.15 Understand that the nucleus of a cell contains chromosomes on which genes are located.
- 3.16B Describe a DNA molecule as two strands coiled to form a double helix, the strands being linked by a series of paired bases: adenine (A) with thymine (T), and cytosine (C) with guanine (G).
- 3.17B Understand that an RNA molecule is single stranded and

3 Reproduction and Inheritance

contains uracil (U) instead of thymine (T).
- 3.18B Describe the stages of protein synthesis including transcription and translation, including the role of mRNA, ribosomes, tRNA, codons, and anticodons.
- 3.19 Understand how genes exist in alternative forms called alleles, which give rise to differences in inherited characteristics.
- 3.20 Understand the meaning of the terms: dominant, recessive, homozygous, heterozygous, phenotype, and genotype.
- 3.21B Understand the meaning of the term codominance.
- 3.22 Understand that most phenotypic features are the result of polygenic inheritance rather than single genes.
- 3.23 Describe patterns of monohybrid inheritance using a genetic diagram.
- 3.24 Understand how to interpret family pedigrees.
- 3.25 Predict probabilities of outcomes from monohybrid crosses.
- 3.26 Understand how the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male.
- 3.27 Describe the determination of the sex of offspring at fertilisation, using a genetic diagram.
- 3.28 Understand how division of a diploid cell by mitosis produces two cells that contain identical sets of chromosomes.
- 3.29 Understand that mitosis occurs during growth, repair, cloning, and asexual reproduction.
- 3.30 Understand how division of a cell by meiosis produces four cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes.
- 3.31 Understand how random fertilisation produces genetic variation of offspring.
- 3.32 Know that in human cells the diploid number of chromosomes is 46 and the haploid number is 23.
- 3.33 Understand that variation within a species can be genetic, environmental, or a combination of both.
- 3.34 Understand that mutation is a rare, random change in genetic material that can be inherited.
- 3.35B Understand how a change in DNA can affect the phenotype by altering the sequence of amino acids in a protein.
- 3.36B Understand how most genetic mutations have no effect on the phenotype, some have a small effect, and rarely do they have a significant effect.
- 3.37B Understand that the incidence of mutations can be increased by exposure to ionising radiation (for example, gamma rays, x-rays, and ultraviolet rays) and some chemical mutagens (for example, chemicals in tobacco).
- 3.38 Explain Darwin's theory of evolution by natural selection.
- 3.39 Understand how resistance to antibiotics can increase in bacterial populations, and appreciate how such an increase can lead to infections being difficult to control.

4 Ecology and the Environment

This section covers the following sub-topics:

(a) The organism in the environment
(b) Feeding relationships
(c) Cycles within ecosystems
(d) Human influences on the environment

(a) The Organism in the Environment
Students should:

- 4.1 Understand the terms population, community, habitat, and ecosystem.
- 4.2 Practical: Investigate the population size of an organism in two different areas using quadrats.
- 4.3B Understand the term biodiversity.
- 4.4B Practical: Investigate the distribution of organisms in their habitats and measure biodiversity using quadrats.
- 4.5 Understand how abiotic and biotic factors affect the population size and distribution of organisms.

(b) Feeding Relationships
Students should:

- 4.6 Understand the names given to different trophic levels, including producers, primary, secondary, and tertiary consumers, and decomposers.
- 4.7 Understand the concepts of food chains, food webs, pyramids of number, pyramids of biomass, and pyramids of energy transfer.
- 4.8 Understand the transfer of substances and energy along a food chain.
- 4.9 Understand why only about 10% of energy is transferred from one trophic level to the next.

(c) Cycles within Ecosystems
Students should:

- 4.10 Describe the stages in the carbon cycle, including respiration, photosynthesis, decomposition, and combustion.
- 4.11B Describe the stages in the nitrogen cycle, including the roles of nitrogen-fixing bacteria, decomposers, nitrifying bacteria, and denitrifying bacteria (specific names of bacteria are not required).

(d) Human Influences on the Environment
Students should:

- 4.12 Understand the biological consequences of air pollution by sulfur dioxide and carbon monoxide.
- 4.13 Understand that water vapour, carbon dioxide, nitrous oxide, methane, and CFCs are greenhouse gases.
- 4.14 Understand how human activities contribute to greenhouse gases.
- 4.15 Understand how an increase in greenhouse gases results in

4 Ecology and the Environment

an enhanced greenhouse effect and that this may lead to global warming and its consequences.

- 4.16 Understand the biological consequences of water pollution by sewage.
- 4.17 Understand the biological consequences of eutrophication caused by leached minerals from fertilisers.
- 4.18B Understand the effects of deforestation, including leaching, soil erosion, disturbance of evapotranspiration, and the carbon cycle, and the balance of atmospheric gases.

5 Use of Biological Resources

This section covers the following sub-topics:

(a) Food production
(b) Selective breeding
(c) Genetic modification (genetic engineering)
(d) Cloning

(a) Food Production
Students should:

Crop Plants
- 5.1 Describe how glasshouses and polythene tunnels can be used to increase the yield of certain crops.
- 5.2 Understand the effects on crop yield of increased carbon dioxide and increased temperature in glasshouses.
- 5.3 Understand how the use of fertiliser can increase crop yield.
- 5.4 Understand the reasons for pest control and the advantages and disadvantages of using pesticides and biological control with crop plants.

Micro-organisms
- 5.5 Understand the role of yeast in the production of food, including bread.
- 5.6 Practical: Investigate the role of anaerobic respiration by yeast in different conditions.
- 5.7 Understand the role of bacteria (Lactobacillus) in the production of yoghurt.
- 5.8 Understand the use of an industrial fermenter and explain the need to provide suitable conditions in the fermenter, including aseptic precautions, nutrients, optimum temperature and pH, oxygenation, and agitation for the growth of microorganisms.

Fish Farming
- 5.9B Understand the methods used to farm large numbers of fish to provide a source of protein, including maintaining water quality, controlling intraspecific and interspecific predation, controlling disease, removing waste products, controlling the quality and frequency of feeding, and selective breeding.

(b) Selective Breeding
Students should:

- 5.10 Understand how selective breeding can develop plants with desired characteristics.
- 5.11 Understand how selective breeding can develop animals with desired characteristics.

(c) Genetic Modification (Genetic Engineering)
Students should:

- 5.12 Understand how restriction enzymes are used to cut DNA at specific sites, and ligase enzymes are used to join pieces of DNA together.

5 Use of Biological Resources

- 5.13 Understand how plasmids and viruses can act as vectors, which take up pieces of DNA, and then insert this recombinant DNA into other cells.
- 5.14 Understand how large amounts of human insulin can be manufactured from genetically modified bacteria that are grown in a fermenter.
- 5.15 Understand how genetically modified plants can be used to improve food production.
- 5.16 Understand that the term transgenic means the transfer of genetic material from one species to a different species.

(d) Cloning
Students should:

- 5.17B Describe the process of micropropagation (tissue culture) in which explants are grown in vitro.
- 5.18B Understand how micropropagation can be used to produce commercial quantities of genetically identical plants with desirable characteristics.
- 5.19B Describe the stages in the production of cloned mammals involving the introduction of a diploid nucleus from a mature cell into an enucleated egg cell, illustrated by Dolly the sheep.
- 5.20B Understand how cloned transgenic animals can be used to produce human proteins.

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