

IGCSE

London Examinations IGCSE

Biology (4325)

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Specification

London Examinations IGCSE

Biology (4325)

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Changes from Issue 1 are indicated by marginal lines.

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Authorised by Elizabeth Blount

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Introduction

The London Examinations IGCSE in Biology is designed as a two-year course of study combining the best of London Examinations O-Level Biology and Edexcel GCSE Biology. It is designed to be an interesting and inspiring modern specification, suitable both for those for whom it is a final qualification in the subject and those who require a sound foundation for further study.

Key features

- closely based on the content of the equivalent Edexcel GCSE examination in Biology
- incorporates elements of London Examinations GCE O-level Biology
- comprehensive and detailed subject content, with amplification to guide teachers
- no prior knowledge of Biology is required
- includes aspects of modern Biology, appropriate for the 21st century
- straightforward linear assessment
- assessment of practical work through coursework (Edexcel-approved Teaching Institutions only) or through a written alternative paper
- choice of Foundation and Higher tiers of entry allow students to be entered at the appropriate level
- a full range of teacher support
- provides a sound foundation for progression to Edexcel GCE Advanced Subsidiary(AS) and Advanced level Biology, and other comparable post-16 qualifications.

Availability of examination sessions

The specification will be examined twice a year, in May and November.

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Summary of scheme of assessment

Paper/ Component	Mode of assessment	Weighting	Length
1 OR	Examination Paper 1F, targeted at grades C – G (Foundation Tier)	80%	1½ hours
	2 Examination Paper 2H, targeted at grades A* – D (Higher Tier)		
3 OR	Examination Paper 3, targeted at grades A* – G (Common to both tiers)	20%	1 ¼ hours
	4 Coursework, targeted at grades A* – G (Common to both tiers)		

Students are entered either at Foundation Tier or Higher Tier.

Students will be required to take **two** components:

Foundation Tier students take Paper 1F (targeted at grades C – G) and either Paper 3 or Component 4 (coursework).

Higher Tier students take Paper 2H (targeted at grades A* – D) and either Paper 3 or Component 4 (coursework).

Use of calculators is permitted in all written examinations.

Summary of the specification content

There are five areas of content where students will be required to demonstrate specified knowledge and critical understanding:

Section 1: Nature and variety of living organisms

Section 2: Structures and functions in living organisms

Section 3: Reproduction and inheritance

Section 4: Ecology and the environment

Section 5: Use of biological resources

In the section 'Specification content,' statements in bold type are for the Higher Tier only and will not be assessed at Foundation Tier.

In addition, students will be assessed on the investigative skills described on pages 28 to 34, either through written assessment (Paper 3) or by teacher-assessed coursework (Component 4).

Specification aims and assessment objectives

Aims

This specification gives students opportunities to

- acquire knowledge and understanding of biological facts, concepts and principles
- develop an appreciation of the significance of biological facts, concepts and principles and the skills needed for their use in new and changing situations
- appreciate the importance of accurate experimental work to scientific method and reporting
- form hypotheses and design experiments to test them
- sustain and develop an enjoyment of, and interest in, the study of living organisms
- appreciate the significance of biology in personal, social, environmental, economic and technological contexts, and consider ethical issues
- evaluate, in terms of their biological knowledge and understanding, the benefits and drawbacks of scientific and technological developments, including those related to social, environmental and economic issues.

Assessment objectives

This specification requires that all students demonstrate the following assessment objectives in the contexts of the content and skills prescribed.

AO1 Knowledge and understanding

In the examination, students will be tested on their ability to

- recognise, recall and show understanding of specific biological facts, terminology, principles, concepts and practical techniques including aspects of safety
- draw on existing knowledge to show understanding of the ethical, social, environmental, economic and technological applications and implications of biology
- select, organise and present relevant information clearly and logically, using appropriate vocabulary.

AO2 Application of knowledge and understanding, analysis and evaluation

In the examination, students will be tested on their ability to

- describe, explain and interpret phenomena, effects and ideas in terms of biological principles and concepts, presenting arguments and ideas clearly and logically
- interpret and translate data presented as continuous prose or in tables, diagrams drawings and graphs, from one form to another
- carry out relevant calculations
- apply biological principles and concepts in solving problems in unfamiliar situations, including those related to the ethical, social, economic and technological applications and implications of biology
- assess the validity of biological information, experiments, inferences and statements and make informed judgements from them.

AO3 Investigative skills

In the assessment of these practical skills, students will be tested on their ability to

- devise and plan investigations, drawing on biological knowledge and understanding in selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically, and present them in a suitable form
- analyse and interpret data to draw conclusions from experimental activities which are consistent with the evidence, using biological knowledge and understanding, and to communicate these findings using appropriate specialist vocabulary, relevant calculations and graphs
- evaluate data and methods.

Scheme of assessment

Tiers of entry

Candidates are entered at **either** Foundation Tier **or** Higher Tier.

Questions in the Foundation Tier Paper are targeted at grades in the range C – G. The highest grade which will be awarded at Foundation Tier is grade C.

Questions in the Higher Tier Paper are targeted at grades in the range A* – D. There is a 'safety net' grade E for candidates who narrowly fail to achieve grade D.

Candidates who fail to achieve grade G on Foundation Tier or Grade E on Higher Tier will be awarded 'Ungraded'.

Some examination questions will be common to both tiers.

Weighting of assessment objectives

Assessment objective		Weighting
AO1	Knowledge and understanding	45 – 55% (of which about one third for recall)
AO2	Application of knowledge and understanding, analysis and evaluation	25 – 35% (evenly distributed across all aspects of the objective)
AO3	Investigative skills	20%

The percentages are not intended to provide a precise statement of the number of marks allocated to particular assessment objectives.

Relationship of assessment objectives to scheme of assessment

Paper / Component	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Paper 1F (Foundation)	45 – 55%	25 – 35%	0
OR			
Paper 2H (Higher)	45 – 55%	25 – 35%	0
Paper 3	0	0	20%
OR			
Component 4 (Coursework)	0	0	20%

Assessment components

Paper 1F (Foundation Tier, 1 hour 30 minutes)

There will be ten multiple choice questions followed by a variety of structured questions. All questions are compulsory and are designed to test the specification content for Foundation Tier.

The Paper carries 100 marks that will be scaled to 80% of the assessment and tests Assessment Objectives AO1 and AO2.

Candidates may be required to perform simple calculations, draw graphs in which the axes are given, and describe, explain and interpret biological phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess simple data-processing skills and the ability to apply biological principles to unfamiliar information.

Approximately 45 of the 100 marks available are from questions targeted at grades C – D, and these questions also appear on Paper 2H (see next paragraph). The remaining questions are targeted at grades E – G.

Paper 2H (Higher Tier, 2 hours)

There will be a range of compulsory structured questions. The questions cover the whole of the specification content, including content given in bold type.

The Paper carries 120 marks that will be scaled to 80% of the assessment and tests Assessment Objectives AO1 and AO2.

Candidates may be required to perform calculations, draw graphs and describe, explain and interpret biological phenomena. Some of the question content will be unfamiliar to candidates; these questions are designed to assess data-handling skills and the ability to apply biological principles to unfamiliar information.

Approximately 45 of the 120 marks available are from questions targeted at grades C – D. The remaining questions are targeted at grades A* – B, and will include questions designed to test knowledge, understanding and skills at a higher level, including some questions requiring longer prose answers.

Paper 3 – Alternative to coursework (common to both tiers, 1 hour 15 minutes)

This is a written Paper and is an alternative to coursework (Component 4).

There will be a range of compulsory questions based on Assessment Objective AO3, targeted at grades A* – G. The questions will test the investigative skills gained by candidates from practical work undertaken during the course.

Candidates will be required to show the ability to: plan experimental procedures (P), obtain evidence (O), analyse this evidence and draw conclusions (A), and evaluate evidence (E). These four skill areas (P, O, A and E) are described later under 'Investigative Skills'. The four skill areas (P, O, A and E) that will be assessed are described later under 'Investigative Skills'.

The Paper carries a total of 50 marks which will be scaled to 20% of the assessment.

Component 4 Coursework (Both tiers)

Candidates are required to submit coursework that will be assessed by the teacher and moderated by Edexcel International. Candidates will be required to show the ability to: plan experimental procedures (P), obtain evidence (O), analyse this evidence and draw conclusions (A), and evaluate evidence (E). These four skill areas (P, O, A and E) are described later under 'Investigative Skills'.

The Component is targeted at grades A* – G. It carries a total of 30 marks that will be scaled to 20% of the assessment.

The coursework, Component 4 of this specification, is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Mathematical skills

Candidates need to have been taught and to have acquired competence in the areas of mathematics set out below in order to develop knowledge, understanding and skills in the subject content.

Candidates are permitted to use calculators in all written papers, in accordance with the current regulations. For full details, please refer to the Teacher's Guide.

For the purpose of this course it will be assumed that candidates will be able to

- add, subtract, multiply and divide
- use simple proportion, decimals, fractions and percentages
- **manipulate formulae, equations and expressions (Higher Tier only)**
- plot and draw graphs from suitable data, **selecting appropriate scales for the axes (Higher Tier only)**
- interpret a range of graphs and diagrams
- **understand and use direct and inverse proportion (Higher Tier only)**
- use an electronic calculator in connection with any of the above, as appropriate.

Note that statements in bold type are for the Higher Tier only.

Forbidden combinations

Candidates entering for this specification may not, in the same series of examinations, enter for Edexcel International's IGCSE in Double Award Science, specification code 4437 (first examination May 2006).

Awarding and reporting

The grading, awarding and certification of this specification will comply with the requirements of the IGCSE for courses first examined in 2005.

Assessment of this specification will be available in English only. All written work for examination must be submitted in English.

Availability of coursework to international centres

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. Candidates studying on their own or at centres recognised as Private Centres are not normally permitted to enter for the coursework component of the specification.

Private Centres may not undertake school-based assessment without the written approval of Edexcel International. This will only be given to centres that satisfy Edexcel International requirements concerning resources/facilities and moderation. Teachers at these centres will be required to undertake special training in assessment before entering candidates. Edexcel International offers centres in-service training in the form of courses and distance learning materials. Private centres that would like to receive more information on school-based assessment should, in the first instance, contact the International Customer Relations Unit.

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Students with particular requirements

Regulations and guidance relating to candidates with special requirements are published annually by the Joint Council for General Qualifications in the UK and are circulated to examinations officers. Further copies of guidance documentation may be obtained from the International Customer Relations Unit (ICRU) at the address below or by telephoning +44 (0) 190 884 7750

London Examinations will assess whether or not special consideration or concessions can be made for candidates with particular requirements. Requests should be addressed to

International Customer Relations Unit (ICRU)
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Specification Content

Some of the content is designated for the **Higher Tier** candidates only. This content is printed in **bold**.

Practical work is printed in *italics*.

Section 1: The nature and variety of living organisms

- a) Characteristics of living organisms
- b) Variety of living organisms

a) Characteristics of living organisms

Candidates will be assessed on their ability to

- recall that living organisms share the following basic 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

Candidates will be assessed on their ability to

- understand that there is a wide variety of living organisms and that modern biology classifies organisms on the basis of their structure and how they function
- describe the common features shared by organisms within the five main groups, plants, animals, fungi, bacteria and viruses, and for each group describe examples and their features as follows, (details of life cycle and economic importance are **not** required).

Plants: These are multicellular organisms; they contain chloroplasts and are able to carry out photosynthesis; they have cellulose cell walls; they store carbohydrates as starch or sucrose.

Examples include flowering plants, such as a cereal (e.g. maize) and a herbaceous legume (e.g. peas or beans).

Animals: These are multicellular organisms; they do not contain chloroplasts and are not able to 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 carbohydrate as glycogen.

Examples include mammals (e.g. humans) and insects (e.g. housefly).

Fungi: These are organisms that are not able to carry out photosynthesis; their body is usually organised into a mycelium made from thread like structures called hyphae, which contain many nuclei; some examples are single-celled; they have cell walls made of chitin; they feed by extracellular secretion of digestive enzymes onto food material and absorption of the organic products; this is known as saprotrophic nutrition; they may store carbohydrate as glycogen.

Examples include *Mucor*, which has the typical fungal hyphal structure, and yeast which is single-celled.

Bacteria: These are microscopic single celled organisms; they have a simple cell structure that lacks a nucleus but contains a circular chromosome of DNA; some bacteria can carry out photosynthesis but most feed off other living or dead organisms.

Examples include *Lactobacillus bulgaricus*, a rod shaped bacterium used in the production of yoghurt from milk, and *Pneumococcus*, a spherical bacterium that acts as the pathogen causing pneumonia.

Viruses: These are small particles, smaller than bacteria; they are parasitic and can only reproduce inside living cells; they infect every type of living organism. They have a wide variety of shapes and sizes; they have no cellular structure but have a protein coat and contain one type of nucleic acid, either DNA or RNA.

Examples include the tobacco mosaic virus that causes discolouring of the leaves of tobacco plants by preventing the formation of chloroplasts, and the influenza virus that causes 'flu' in humans.

Section 2: Structures and Functions in Living Organisms

- a) Levels 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) Levels of organisation

Candidates will be assessed on their ability to

- describe the levels of organisation within organisms: organelles, cells, tissues, organs and systems.

b) Cell structure

Candidates will be assessed on their ability to

- recognise cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole
- describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole
- describe the differences between plant and animal cells.

c) Biological molecules

Candidates will be assessed on their ability to

- recall the chemical elements present in carbohydrates, proteins and lipids (fats and oils)
- describe the structure of carbohydrates, proteins and lipids as large molecules made up from smaller basic units: starch and glycogen from simple sugars; protein from amino acids; lipid from fatty acids and glycerol
- *describe the tests for glucose, starch, lipid and protein*
- understand the role of enzymes as biological catalysts in metabolic reactions
- understand how the functioning of enzymes can be affected by changes in temperature and pH.

- *describe how to carry out simple controlled experiments to illustrate how enzyme activity can be affected by changes in temperature.*

d) Movement of substances into and out of cells

Candidates will be assessed on their ability to

- recall simple definitions of diffusion, osmosis and active transport
- understand that movement of substances into and out of cells can be by diffusion, osmosis and active transport
- understand the importance in plants of turgid cells as a means of support
- **understand the factors that affect the rate of movement of substances into and out of cells to include the effects of surface area to volume ratio, temperature and concentration gradient**
- *describe simple experiments on diffusion and osmosis using living and non-living systems.*

e) Nutrition

Candidates will be assessed on their ability to

Flowering plants

- describe the process of photosynthesis and understand its importance in conversion of light energy to chemical energy
- recall the word equation **and the balanced chemical symbol equation** for photosynthesis
- understand how carbon dioxide concentration, light intensity and temperature affect the rate of photosynthesis
- explain how the structure of the leaf is adapted for photosynthesis
- recall that plants require mineral ions for growth and that magnesium ions are needed for chlorophyll and nitrate ions are needed for amino acids
- *describe simple controlled experiments to investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch and the requirements of light, carbon dioxide and chlorophyll.*

Humans

- understand that a balanced diet should include carbohydrate, protein, lipid, vitamins, minerals, water and dietary fibre
- recall sources and describe functions of carbohydrate, protein, lipid (fats and oils), vitamins A, C and D, and the mineral ions calcium and iron
- understand that energy requirements vary with activity levels, age and pregnancy
- recognise the structures of the human alimentary canal and describe in outline the functions of the mouth, oesophagus, stomach, small intestine, large intestine, and pancreas
- understand the processes of ingestion, digestion, absorption, assimilation and egestion
- explain how and why food is moved through the gut by peristalsis
- understand the role of digestive enzymes to include the digestion of starch to glucose by amylase and maltase, the digestion of proteins to amino acids by proteases and the digestion of lipids to fatty acids and glycerol by lipases
- recall that bile is produced by the liver and stored in the gall bladder, and understand the role of bile in neutralising stomach acid and emulsifying lipids
- explain how the structure of a villus helps absorption of the products of digestion in the small intestine
- *recall how to carry out a simple experiment to determine the energy content in a food sample.*

f) Respiration

Candidates will be assessed on their ability to

- recall that the process of respiration releases energy in living organisms
- describe the differences between aerobic and anaerobic respiration
- recall the word equation **and the balanced chemical symbol equation** for aerobic respiration in living organisms
- recall the word equation for anaerobic respiration in plants and in animals
- *describe simple controlled experiments to demonstrate the evolution of carbon dioxide and heat from respiring seeds or other suitable living organisms.*

g) Gas exchange

Candidates will be assessed on their ability to

- understand the role of diffusion in gas exchange.

Flowering plants

- understand gas exchange (of carbon dioxide and oxygen) in relation to respiration and photosynthesis
- **understand that respiration continues during the day and night, but that the net exchange of carbon dioxide and oxygen depends on the intensity of light**
- explain how the structure of the leaf is adapted for gas exchange
- describe the role of stomata in gas exchange
- *describe simple controlled experiments to investigate the effect of light on net gas exchange from a leaf, using hydrogen-carbonate indicator.*

Humans

- recall the structure of the thorax, including the ribs, intercostal muscles, diaphragm, trachea, bronchi, bronchioles, alveoli and pleural membranes
- understand the role of the intercostal muscles and the diaphragm, in ventilation
- explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries
- understand the biological consequences of smoking in relation to the lungs and the circulatory system
- *describe a simple experiment to investigate the effect of exercise on breathing in humans.*

h) Transport

Candidates will be assessed on their ability to

- understand why simple, unicellular organisms can rely on diffusion for movement of substances in and out of the cell
- understand the need for a transport system in multicellular organisms.

Flowering plants

- describe the position of phloem and xylem in a stem
- describe the role of phloem in transporting sucrose and amino acids between the leaves and other parts of the plant
- describe the role of the xylem in transporting water and mineral salts from the roots to other parts of the plant

- explain how water is absorbed by root hair cells
- recall that transpiration is the evaporation of water from the surface of a plant
- **explain how the rate of transpiration is affected by changes in humidity, wind speed, temperature and light intensity**
- *describe experiments that investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot.*

Humans

- recall the composition of the blood: red blood cells, white blood cells, platelets and plasma
- understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy
- describe the adaptations of red blood cells for the transport of oxygen, including shape, structure and the presence of haemoglobin
- describe the role of white blood cells in preventing disease by ingestion of microorganisms and the production of antibodies to destroy microorganisms
- recall that platelets are involved in blood clotting, which prevents blood loss and the entry of microorganisms
- describe the structure of the heart and how it functions
- understand that the heart rate changes during exercise and under the influence of adrenaline
- describe the structure of arteries, veins and capillaries and understand their roles
- recall the general plan of the circulation system to include the blood vessels to and from the heart, the lungs, the liver and the kidneys.

i) Excretion

Candidates will be assessed on their ability to

Flowering plants

- recall the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf.

Humans

- recall that the lungs, kidneys and skin are organs of excretion
- understand how the kidney carries out its roles of excretion and of osmoregulation
- describe the structure of the urinary system, including the kidneys, ureters, bladder and urethra
- describe the structure of a nephron, to include Bowman's capsule and glomerulus, convoluted tubules, loop of Henlé and collecting duct

- describe ultrafiltration in the Bowman's capsule and the composition of the glomerular filtrate
- understand that water is reabsorbed into the blood from the collecting duct
- **understand that selective reabsorption of glucose occurs at the proximal convoluted tubule**
- **describe the role of ADH in regulating the water content of the blood**
- recall that urine contains water, urea and salts.

j) Coordination and response

Candidates will be assessed on their ability to

- understand that organisms are able to respond to changes in their environment
- understand that homeostasis is the maintenance of a constant internal environment and that body water content and body temperature are both examples of homeostasis
- understand that a coordinated response requires a stimulus, a receptor and an effector.

Flowering plants

- understand that plants respond to stimuli
- describe the geotropic responses of roots and stems
- describe positive phototropism of stems
- **understand that phototropic responses in stems are the result of differential growth caused by auxin**
- *recall controlled experiments to demonstrate phototropic and geotropic plant growth responses.*

Humans

- describe how responses can be controlled by nervous or by hormonal communication and understand the differences between the two systems
- recall that the central nervous system consists of the brain and spinal cord and is linked to sense organs by nerves
- 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
- **describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object**
- describe the structure and function of the eye as a receptor
- understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity

- **describe the role of the skin in temperature regulation, with reference to sweating, vasoconstriction and vasodilation**
- understand the sources, roles and effects of the following hormones: **ADH**, adrenaline, insulin, testosterone, progesterone and oestrogen.

Section 3: Reproduction and inheritance

a) Reproduction

b) Inheritance

a) Reproduction

Candidates will be assessed on their ability to

- describe the differences between sexual and asexual reproduction
- understand that fertilisation involves the fusion of a male and female gamete to produce a zygote.

Flowering plants

- describe the structures of an insect-pollinated and a wind-pollinated flower and explain how each is adapted for pollination
- describe pollination and the growth of the pollen tube
- understand that fertilisation leads to seed and fruit formation
- recall the conditions needed for seed germination
- understand how germinating seeds utilise food reserves until the seedling can carry out photosynthesis
- understand that plants can reproduce asexually by natural methods (illustrated by runners), and by artificial methods (illustrated by cuttings).

Humans

- recall the structure and function of the male and female reproductive systems
- understand the roles of oestrogen and progesterone in the menstrual cycle
- recall that fertilisation produces a zygote that undergoes cell division and develops into an embryo
- describe the role of the placenta in the nutrition of the developing embryo
- understand how the developing embryo is protected by amniotic fluid
- recall the roles of oestrogen and testosterone in the development of secondary sexual characteristics.

b) Inheritance

- recall that the nucleus of a cell contains chromosomes on which genes are located
- understand that a gene is a section of a molecule of DNA

- understand that genes exist in alternative forms called alleles which give rise to differences in inherited characteristics
- recall the meaning of the terms dominant, recessive, homozygous, heterozygous, phenotype, genotype and **codominance**
- describe patterns of monohybrid inheritance using a genetic diagram
- **understand how to interpret family pedigrees**
- **predict probabilities of outcomes from monohybrid crosses**
- recall that the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male
- describe the determination of the sex of offspring at fertilisation, using a genetic diagram
- understand that division of a diploid cell by mitosis produces two cells which contain identical sets of chromosomes
- understand that mitosis occurs during growth, repair, cloning and asexual reproduction
- understand that 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
- understand that random fertilisation produces genetic variation of offspring
- recall that in human cells the diploid number of chromosomes is 46 and the haploid number is 23
- understand that variation within a species can be genetic, environmental, or a combination of both
- recall that mutation is a rare, random change in genetic material that can be inherited
- understand that many mutations are harmful but some are neutral and a few are beneficial
- **understand that mutant organisms can increase in a population by natural selection**
- understand that the incidence of mutations can be increased by exposure to ionising radiation (e.g. gamma rays, X-rays and ultraviolet rays) and some chemical mutagens (e.g. chemicals in tobacco).

Section 4: Ecology and the environment

- 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

Candidates will be assessed on their ability to

- understand the terms population, community, habitat and ecosystem
- describe the use of quadrats as a technique for sampling the distribution of organisms in their habitats
- *recall the use of quadrats to estimate the population size of an organism in two different areas.*

b) Feeding relationships

Candidates will be assessed on their ability to

- recall the names given to different trophic levels to include producers, primary, secondary and tertiary consumers and decomposers
- understand the concepts of food chains, food webs, pyramids of number, pyramids of biomass and **pyramids of energy transfer**
- understand the transfer of substances and of energy along a food chain
- **explain why only about 10% of energy is transferred from one trophic level to the next.**

c) Cycles within ecosystems

Candidates will be assessed on their ability to

- describe the stages in the water cycle, including evaporation, transpiration, condensation and precipitation
- describe the stages in the carbon cycle, including respiration, photosynthesis, decomposition and combustion
- **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

Candidates will be assessed on their ability to

- understand the biological consequences of pollution of air by sulphur dioxide and by carbon monoxide
- recall that water vapour, carbon dioxide, nitrous oxide, methane and CFCs are greenhouse gases
- understand how human activities contribute to greenhouse gases
- understand how an increase in greenhouse gases results in an enhanced greenhouse effect and that this may lead to global warming and its consequences
- understand the biological consequences of pollution of water by sewage including increases in the number of microorganisms causing depletion of oxygen
- **understand that eutrophication can result from leached minerals from fertiliser**
- understand the effects of deforestation, including leaching, soil erosion, disturbance of the water cycle and of the balance in atmospheric oxygen and carbon dioxide
- **explain the biological consequences of overfishing and overgrazing.**

Section 5: Use of Biological Resources

- a) Food production
- b) Selective breeding
- c) Genetic modification
- d) Cloning

a) Food production

Candidates will be assessed on

Crop plants

- describe how glasshouses and polythene tunnels can be used to increase the yield of certain crops
- understand the effects on crop yield of increased carbon dioxide and increased temperature in glasshouses
- understand the use of fertiliser to increase crop yield
- understand the reasons for pest control and the advantages and disadvantages of using pesticides and biological control with crop plants.

Microorganisms

- understand the role of yeast in the production of beer
- *describe a simple experiment to investigate carbon dioxide production by yeast, in different conditions*
- understand the role of bacteria (*Lactobacillus*) in the production of yoghurt
- **interpret and label a diagram 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

- **explain the methods which are used to farm large numbers of fish to provide a source of protein, including maintenance of water quality, control of intraspecific and interspecific predation, control of disease, removal of waste products, quality and frequency of feeding and the use of selective breeding.**

b) Selective breeding

Candidates will be assessed on their ability to

- understand that plants with desired characteristics can be developed by selective breeding (illustrated by increased yield and reduction of stem length in wheat)
- understand that animals with desired characteristics can be developed by selective breeding (illustrated by increased yield of meat and milk in cattle).

c) Genetic Modification (Genetic engineering)

Candidates will be assessed on their ability to

- **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)**
- **describe the use of restriction enzymes to cut DNA at specific sites and ligase enzymes to join pieces of DNA together**
- **describe how plasmids and viruses can act as vectors, which take up pieces of DNA, then insert this recombinant DNA into other cells**
- understand that large amounts of human insulin can be manufactured from genetically modified bacteria that are grown in a fermenter
- evaluate the potential for using genetically modified plants to improve food production (illustrated by plants with improved resistance to disease)
- **recall that the term transgenic means the transfer of genetic material from one species to a different species.**

d) Cloning

Candidates will be assessed on their ability to

- describe the process of micropropagation (tissue culture) in which small pieces of plants (explants) are grown *in vitro* using nutrient media
- understand how micropropagation can be used to produce commercial quantities of identical plants (clones) with desirable characteristics
- 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
- **evaluate the potential for using cloned transgenic animals, for example, to produce commercial quantities of human antibodies or organs for transplantation.**

Grade descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the specification content; they are not designed to define that content. The grade awarded will depend, in practice, upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others.

Grade F

Candidates can

- recall a limited range of information: for example, they state the main functions of organs of the human body, they know that plants need light for photosynthesis
- use and apply knowledge and understanding in some specific everyday contexts: for example, they describe how the heart rate increases with exercise
- make some use of scientific and technical vocabulary and make simple generalisations from information
- devise fair tests in contexts which involve only a few factors. They can recall or use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs. Candidates obtain information from simple tables, charts and graphs and identify simple patterns. They offer explanations consistent with the evidence obtained.

Grade C

Candidates can

- recall a range of scientific information from all areas of the specification: for example, they explain how the lungs are ventilated
- use and apply biological knowledge and understanding in some general contexts: for example, they describe how a leaf is adapted to its functions
- describe links between related phenomena in different contexts: use diagrams, charts and graphs to support arguments, use appropriate scientific and technical vocabulary in a range of contexts
- use scientific knowledge and understanding to identify an approach to a question: for example, identifying key factors to vary and control. Candidates can recall or use a range of apparatus to make careful and precise measurements and systematic observations and recognise when it is necessary to repeat measurements and observations. They present data systematically e.g. in graphs, and use lines of best fit. Candidates identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions using scientific knowledge and understanding and evaluate how strongly their evidence supports the conclusions.

Grade A

Candidates can

- recall a wide range of knowledge from all areas of the specification
- use detailed scientific knowledge and understanding in a range of applications relating to scientific systems or phenomena: for example, they explain how temperature or water content is regulated in humans.
- draw together and communicate knowledge from more than one area, use routinely scientific or mathematical conventions in support of arguments and use a wide range of scientific and technical vocabulary throughout their work
- use scientific knowledge and understanding to select an appropriate strategy for a practical task, identifying the key factors to be considered. They make systematic observations and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and can recall or use a range of apparatus to make appropriately precise measurements. They select a method of presenting data appropriate to the task; they use information from a range of sources where it is appropriate to do so. They identify and explain anomalous observations and measurements and the salient features of graphs
- use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to methods used that would enable them to collect more reliable evidence.

Investigative skills

Experimental work is an integral part of the study of any scientific subject, and it is important that a candidate's practical investigative skills form part of the final assessment. To reflect this importance, the investigative skills described in Assessment Objective 3 carry 20% of the final mark for the subject. For the IGCSE, investigative skills may be assessed by two alternative routes, which allow all candidates access to the qualification. Candidates either take the written alternative to coursework examination (Paper 3) or submit internally-assessed coursework, which is assessed by the teacher and moderated by Edexcel International. These alternatives are described below.

Written alternative to coursework (Paper 3)

The examination paper will consist of a range of compulsory questions targeted at grades A* - G and based on the skills listed in Assessment Objective AO3. The questions will be designed to test the four main skill areas P, O, A and E, described in the following section.

Candidates will be assessed on the ability to

- plan experimental procedures (P)
- describe practical techniques and take measurements (O)
- analyse evidence and draw conclusions communicating findings using calculations, tables and graphs (A)
- evaluate evidence (E).

It would be helpful for candidates preparing for the examination to carry out experimental work and investigations as described below for coursework. Candidates should be encouraged to become familiar with the criteria used to assess the coursework, as the examination questions will reward skills in a similar way.

The specimen paper and mark scheme (available from September 2003) will illustrate the type of questions and the way in which they will be marked. The paper carries a total of 50 marks that will be scaled to 20% of the final assessment.

Coursework (Component 4)

The coursework option is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Candidates who submit coursework are required to produce evidence in the four skill areas P, O, A and E, described in the next section. The coursework will be assessed by the school or college according to the principles described below and will be moderated by Edexcel International.

Coursework carries a total of 30 marks that will be scaled to 20% of the assessment.

The evidence for assessment will be coursework carried out by the candidate, in the context of the specification content. The assessment scheme caters for a wide range of experimental and investigative work. Candidates should undertake experimental and investigative work during the course and be assessed on several occasions in both types of activity. The aim is to allow them to achieve their highest potential in such work. Candidates are required to produce the evidence for assessment based on the guidelines in the following pages.

- The term 'evidence' is used throughout the assessment scheme to mean data, observations or measurements
- An activity can take the form of experimental work or an investigation. Experimental work may be used to assess one, two or three skill areas
- An investigation consists of work that covers each of the four skill areas, although not all of these need to be used for assessment.

The scheme of internal assessment is designed to encourage a wide variety of activities. These include those based on the collection of first-hand evidence and those which depend on secondary evidence. The term 'evidence' has been used consistently throughout the assessment scheme to mean observations, measurements or other data. Through the teaching of investigative skills, candidates may be given opportunities to apply and develop their ICT capability. For example, candidates could: use data-handling software to analyse data from fieldwork or to create, analyse and evaluate charts and graphs; use dataloggers in investigations; use spreadsheets for data analysis; use the internet or CD ROM software as sources of secondary evidence.

Assessment of investigative skills

Four skill areas are used to assess activities, as appropriate.

Candidates will be expected to

	Mark scale
Plan experimental procedures (P)	0 – 8
Obtain evidence (O)	0 – 8
Analyse this evidence and draw conclusions (A)	0 – 8
Evaluate evidence (E)	0 – 6

Mark descriptions are defined at steps 0, 2, 4, 6 and 8 as appropriate. Mark descriptions comprising a number of statements are provided in each skill area. Activities chosen for assessment should, wherever possible, provide opportunities for all the statements in a mark description to be addressed. It should be noted that some of the statements in a mark description contain a phrase such as 'where appropriate' and therefore may not apply to a particular activity.

Descriptions are provided for 2, 4, 6 and 8 marks in skill areas P, O and A and 2, 4 and 6 marks in skill area E. The performance needed to gain 6 marks in skill area E is commensurate with that for 8 marks in the other skill areas.

Whenever assessments are made, the mark descriptions should be used to judge which mark best fits the candidate's performance. The statements should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within a skill area are designed to be hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. It is assumed that activities that access higher marks will involve a more sophisticated approach and/or a more complex treatment. Adjacent descriptions should be considered when making judgements and use made of the intermediate marks (ie 3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

A candidate who fails to meet the requirements for 2 marks but who has made a creditworthy attempt in a skill area should be given 1 mark for that skill. Zero marks should only be awarded for a skill area in the unlikely event of a candidate failing to demonstrate any achievement in that skill.

The professional judgement of the teacher in making these assessments is important.

The scheme is supported by materials with suggested experiments and investigations, plus exemplar assessed work.

Safe practice

Attention is drawn to the need for safe practice when candidates carry out laboratory investigations or observe demonstrations. Particular attention is drawn to the possible hazards associated with electrical equipment, the handling of microorganisms, and ionising radiations. Strict aseptic conditions should be used when undertaking practical work. Reference must be made to local health and safety regulations, and widely accepted publications such as

COSHH; Guidance for Schools (HSC ,1989) (HMSO) ISBN 011 885 5115

Topics in Safety – 3rd Ed, Association for Science Education (ASE, 2001)
ISBN 086 357 3169

CLEAPSS Laboratory Handbook and Hazards, available from Consortium of Local Education Authorities for the Provision of Service Sciences (CLEAPSS). School Science to members or associates only.


Skill Area P: Plan experimental procedures

Skill Area P	
Candidates should be encouraged to	
a	use scientific knowledge and understanding to turn ideas into a form that can be investigated, and to plan an appropriate strategy
b	decide whether to use evidence from first-hand experience or secondary sources
c	carry out preliminary work and make predictions, where appropriate
d	consider key factors that need to be taken into account when collecting evidence, and how evidence can be collected in contexts in which the variables cannot readily be controlled
e	decide the extent and range of data to be collected, and the techniques, equipment and materials to use.

Mark descriptions for internal assessment		
The mark descriptions are designed to be hierarchical.		
All work should be assessed in the context of the specification content.		
Candidates		Increasing demand of activity
2 marks	P.2a	outline a simple procedure
4 marks	P.4a	plan to collect evidence which will be valid
	P.4b	plan the use of suitable equipment or sources of evidence
6 marks	P.6a	use scientific knowledge and understanding to plan and communicate a procedure, to identify key factors to vary, control or take into account, and to make a prediction where appropriate
	P.6b	decide a suitable extent and range of evidence to be collected
8 marks	P.8a	use detailed scientific knowledge and understanding to plan and communicate an appropriate strategy, taking into account the need to produce precise and reliable evidence, and to justify a prediction, when one has been made
	P.8b	use relevant information from preliminary work, where appropriate, to inform the plan


Skill Area O: Obtaining evidence

Skill Area O	
Candidates should be encouraged to	
f	use a wide range of equipment and materials appropriately, and manage their working environment to ensure the safety of themselves and others
g	make observations and measurements, to a degree of precision appropriate to the context
h	make sufficient observations and measurements to reduce error and obtain reliable evidence
i	judge the level of uncertainty in observations and measurements
j	represent and communicate qualitative and quantitative data using diagrams, tables, charts and graphs.

Mark descriptions for internal assessment		
The mark descriptions are designed to be hierarchical.		
All work should be assessed in the context of the specification content.		
Candidates		Increasing demand of activity
2 marks	O.2a collect some evidence using a simple and safe procedure	
4 marks	O.4a collect appropriate evidence which is adequate for the activity	
	O.4b record the evidence	
6 marks	O.6a collect sufficient systematic and accurate evidence and repeat or check where appropriate	
	O.6b record clearly and accurately the evidence collected	
8 marks	O.8a use a procedure with precision and skill to obtain and record an appropriate range of reliable evidence	


Skill Area A: Analysing and considering evidence

Skill Area A	
Candidates should be encouraged to	
k	use diagrams, tables, charts and graphs, and identify and explain patterns or relationships in data
l	present the results of calculations to an appropriate degree of accuracy
m	use observations, measurements or other data to draw conclusions
n	explain to what extent these conclusions support any predictions made, and enable further predictions to be made
o	use scientific knowledge and understanding to explain and interpret observations, measurements or other data, and conclusions.

Mark descriptions for internal assessment		
The mark descriptions are designed to be hierarchical.		
All work should be assessed in the context of the specification content.		
Candidates		Increasing demand of activity
2 marks	A.2a state simply what is shown by the evidence	
4 marks	A.4a use simple diagrams, charts or graphs as a basis for explaining the evidence	
	A.4b identify trends and patterns in the evidence	
6 marks	A.6a construct and use suitable diagrams, charts, graphs (with lines of best fit, where appropriate), or use numerical methods, to process evidence for a conclusion	
	A.6b draw a conclusion consistent with the evidence and explain it using scientific knowledge and understanding	
8 marks	A.8a use detailed scientific knowledge and understanding to explain a valid conclusion drawn from processed evidence	
	A.8b explain the extent to which the conclusion supports the prediction, if one has been made	

Skill Area E: Evaluating evidence

Skill Area E	
Candidates should be encouraged to	
p	consider anomalous data, giving reasons for rejecting or accepting them, and consider the reliability of data in terms of uncertainty of measurements and observations
q	consider whether the evidence collected is sufficient to support any conclusions or interpretations made
r	suggest improvements to the methods used
s	suggest further investigations.

Mark descriptions for internal assessment		
The mark descriptions are designed to be hierarchical.		
All work should be assessed in the context of the specification content.		
Candidates		Increasing demand of activity
2 marks	E.2a make a relevant comment about the procedure used or the evidence obtained	
4 marks	E.4a comment on the quality of the evidence, identifying any anomalies	
	E.4b comment on the suitability of the procedure and, where appropriate, suggest changes to improve it	
6 marks	E.6a consider critically the reliability of the evidence and whether it is sufficient to support the conclusion, accounting for any anomalies	
	E.6b describe, in detail, further work to provide additional relevant evidence	

Textbooks and other resources

Biology text books

Title	ISBN
Particularly recommended:	
<i>Longman Biology for IGCSE</i> – S Potter and P Bradfield (Longman, 2004)	1405 80206 5
Also recommended:	
<i>Biology</i> – Michael Roberts and Neil Ingram (Nelson Thornes, 2001)	0 7487 6238 8
<i>IGCSE Biology</i> – D. G. Mackean (John Murray, 2002)	0 7195 8053 6
<i>Biology</i> –Mary Jones and Geoff Jones (Cambridge University Press, 2002)	0 521 89117 5

Support and training

Training

A programme of INSET courses covering various aspects of the specifications and assessment will be arranged by Edexcel International on a regular basis. Full details may be obtained from the International Customer Relations Unit (ICRU)

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The following support materials will be available from 2003

- Specimen papers and markschemes (Publication code: UG013058)
- Teacher's Guide (Publication code: UG013046)

Subject-specific requirements

Units and nomenclature

In the written papers and tests, the units and the nomenclature used will conform to the recommendations contained in the following booklets:

Biological Nomenclature: Recommendations on Terms, Units and Symbols (Institute of Biology (IOB), 2000)

Signs, Symbols and Systematics, The ASE Companion to 16-19 Science – 1st Ed (Association of Science Education (ASE), 2000)

Appendices

Appendix 1 - Assessment of practical skills - final mark aggregation sheet

Month and year of examination:	Specification title:
Specification number:	
Centre:	Candidate name:
	Teaching group:
Centre number:	Candidate number:

Marks should be reported for each of the skill areas P, O, A and E.

One mark is required for **each** skill area. Thus four marks are required in total to give a maximum mark of 30. These marks should be drawn from **not more than two** pieces of work. At least **one** mark must be from a practically based whole investigation.

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E

Please indicate whether the reported mark(s) are taken from an investigation by putting an asterisk next to the appropriate mark(s).

The skill area marks are reported in the appropriate Centre Mark boxes in the table below and then aggregated to give a total reported mark.

	Skill area P		Skill area O		Skill area A		Skill area E		Total mark	Max mark
Centre mark										30
Moderator Mark										
Team leader Mark										

Declaration of Authentication

I declare that the work submitted for assessment has been carried out without assistance other than that which is acceptable under the scheme of assessment.

Candidate's signature.....Date.....

Teacher's signature.....Date.....

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