SEC SYLLABUS (2013)

BIOLOGY SEC 04

SYLLABUS

Biology SEC 04 Available in September (Paper I and Paper II B only)

Syllabus Paper I (2hrs) + Paper II (2hrs) + Practical

Introduction

1. This syllabus places much emphasis on understanding biological principles and the techniques for studying them rather than on knowledge of descriptive detail and technical terms. In fact, the syllabus implies that candidates will spend more time on practical work, which will aid understanding, rather than on learning to recall biological facts. It is expected that candidates will be familiar with the skills necessary for practical work. This is why, at various sections of the syllabus, practical work is indicated as an integral part of the course.
2. The course incorporates personal, social, political, economic, technological and environmental aspects of biology. It is expected that where possible the teaching of biology treats these considerations with particular reference to Maltese situations. To achieve this, various syllabus items refer to locally occurring organisms as well as local situations to illustrate biological principles.
3. Live animals may be brought in the laboratory for study provided that they are kept unstressed in suitable conditions and should whenever possible be returned unharmed to their habitats. Nothing in this syllabus requires candidates or teachers to kill animals. Studies of organisms in their natural habitats should aim to minimal disturbance. Mammalian organs, which may be required for dissection, should be obtained from the abattoir or butchers.

Aims

A course based on the following syllabus should enable candidates to:

(a) develop an awareness of various forms of life (particularly locally occurring) and promote a respect for them;

(b) develop a knowledge and understanding of basic anatomical and physiological characteristics of organisms;

(c) become aware of the interactions (i) between organisms, and (ii) between organisms and their environment;

(d) become aware of the role that humans have in the conservation and destruction of the environment;

(e) become aware of the personal, social, political, economic, technological and environmental implications of biology;

(f) develop a scientific approach to problem solving which includes the assessment and interpretation of experimental data;

(g) acquire a range of manipulative and communicative skills appropriate to biology;

(h) develop a working knowledge of other fields of study (e.g. mathematics, chemistry, physics, geography etc.) which are necessary for a proper understanding of biological concepts; and

(i) obtain a worthwhile educational experience, whether or not they intend to study biology beyond this level or pursue a career requiring knowledge of biology.

Assessment Objectives

The examination will be designed to assess the candidate's ability to:

(a) Demonstrate knowledge and understanding of:

i. biological facts and principles and use of appropriate terminology;

ii. appropriate practical techniques and safety precautions;

iii. the personal, social, political, economic, technological and environmental applications of biology particularly in the Maltese society.

(b) Acquire skills in:

i. formulating hypotheses, designing and conducting simple experiments to test them;

ii. making constructive criticisms of experimental designs;

iii. planning and conducting simple experiments to test given hypotheses;

iv. making, recording and communicating accurate observations in the form of tables, charts, graphs, diagrams and concise logical prose;

v. interpreting data represented in tables, charts, graphs, diagrams, and photographs;

vi. applying elementary mathematics, chemistry and physics to biology; and

vii. problem solving by applying biological knowledge and understanding to problems, including those of a personal, social, political, economic, technological and environmental nature.

Required Background

1. Candidates are expected to be able to:

(a) work with decimals and fractions;

(b) calculate percentages, arithmetic means and simple rates and ratios;

(c) present numerical data in tables and graphs (line, bar, histograms); and

(d) interpret numerical information in tables, graphs (line, bar, histograms) and pie charts.

2. Candidates are also expected to be familiar with the following terms and concepts:

(a) Energy and its different forms;

(b) Heat transfer and insulation;

(c) Evaporation and the effects of temperature, humidity and air currents on its rate. Latent heat of evaporation;

(d) Relationship between surface area and volume;

(e) Atoms, molecules, ions, compounds, salts, acids, alkalis and pH; and

(f) Solubility, concentration gradients, diffusion and osmosis.

Scheme of Assessment

The examination will consist of two written papers and an assessment of practical work. The questions will be set in English and must be answered in English. Candidates are reminded of the necessity for good English and orderly presentation in their answers. The examination will be structured as follows:

Paper I (55% of the total marks) consists of a written paper (40% of the total marks) and a practical component (15% of the total marks) and is to be taken by all candidates registered for the examination.

The written paper of a two hour duration will consist of a number of compulsory short and longer structured questions testing the candidates' breadth of knowledge and understanding of the whole subject content as well as a range of skills. Questions may involve the analysis and interpretation of photographs, diagrams, graphs and data as well as the working out of simple mathematical calculations. Questions testing the application of biological principles to everyday situations will be included in this paper.

The practical component is assessed separately by a continuous method during the course of instruction.

There will be two versions of ***Paper II***: *Paper II A* or *Paper II B*, each of a two-hour duration. Questions in Paper II A will be more difficult than those in Paper I. Questions in Paper II B will be easier than those in Paper I. In the September supplementary session only Paper I and Paper II B will be offered. Candidates will be required to indicate on the registration form which option in Paper II (A or B) they wish to sit for. No change in the choice of paper will be allowed after the registration period.

Paper II A (45% of the total marks) will be divided into two sections and questions may be set on any part of the syllabus.

Section A will consist of two compulsory structured questions which will involve the design, planning, and analysis of simple experiments, or the critical evaluation of an investigation or the interpretation of a passage relating to an area of applied biology, or they may test the candidates' experience of practical skills.

Section B will consist of five structured essay-type questions of which candidates will be required to answer three. Questions will be set to test the candidates' knowledge and understanding of biological topics.

Paper IIB (45% of the total marks) will consist of eight structured essay-type questions of which candidates will be required to answer four.

Content

The distribution of syllabus content in the combined papers will be approximately as follows:

Syllabus Section	Approximate mark allocations
Part 1: The Living World	20%
Part 2: Keeping Alive	50%
Part 3: Living Together	30%

The balance will be approximately similar in each of the written papers.

The papers will cover the whole syllabus and will test the candidates' abilities according to the following scheme:

Ability	Paper I	Paper IIA or IIB
Knowledge	•	•
Comprehension	•	•
Application, Analysis and Evaluation	•	•
Practical Assessment	•	
Approx. % of marks	55	45

Approximately equal weighting will be given to the cognitive skills listed in the table above.

Practical work

(a) 15% of the total marks for this examination are allocated to the practical experience of the candidate. This would be assessed by the schools on the basis of a set of laboratory reports on experiments performed during the candidates' course of study.

(b) The mark for the practical work is to be based on the average mark of the best 15 experiments.

(c) Laboratory Report Books are to be available at the candidates' schools for moderation by the Markers' Panel.

(d) The school assessments should reach the MATSEC Examinations Board on a date stipulated by the MATSEC Board.

(e) *Private Candidates*

(i) Private candidates who left school before 1994 will not be expected to present their laboratory report books. Their mark will be obtained by pro-rating of the written papers.

(ii) Candidates who studied the subject at school and are re-sitting the subject may carry forward the practical report mark from a previous session.

(iii) Candidates who have never studied the subject at school but have covered the coursework privately will be expected to present their coursework to the MATSEC Board by the date indicated by the board. Candidates will be asked to attend for an oral examination about their practical work.

Results

Candidates sitting for Paper I and Paper IIA may qualify for grades 1, 2, 3, 4 or 5. The results of candidates who do not obtain at least a grade 5 shall remain unclassified (U). Candidates sitting for Paper I and Paper IIB may qualify for grades 4, 5, 6 or 7. The results of candidates who do not obtain at least a grade 7 shall remain unclassified (U).

Grade Descriptions

Grade descriptions are provided to give a general indication of the standard of achievement likely to have been shown by candidates awarded particular grades. The grade awarded will depend upon the extent to which the candidate has met the 'Assessment Objectives' over-all and it might conceal weakness in one aspect of the examination, which is balanced by above average performance in some other.

	Grade 1	**Grade 5**	**Grade 7**
	Candidates achieving Grade 1 are expected to demonstrate sufficient knowledge and understanding to make judgements on biological statements. More specifically, candidates are likely to be able to demonstrate the ability to:	Candidates achieving Grade 5 are expected to demonstrate sufficient knowledge and understanding of a range of biological facts to allow insight into the significance of biological statements or problems. More specifically, candidates are likely to be able to demonstrate the ability to:	Candidates achieving Grade 7 are likely to be familiar with simple biological facts to be able to understand straightforward biological statements. More specifically, candidates are likely to be able to demonstrate the ability to:
1	recall a wide range of biological facts and principles and use appropriate terminology in the subject content from all areas of the syllabus.	recall a good range of biological facts and principles and use appropriate terminology in the subject content.	recall the basic biological facts and principles and have limited use of appropriate terminology in the subject content
2	perform, describe and evaluate a wide range of simple biological experiments with precision and skill, and comment with supporting arguments on the validity of procedure.	perform, describe and evaluate a good range of simple biological experiments with some precision and skill.	perform and describe a limited range of simple biological experiments.
3	understand simple safety precautions in laboratory work.	understand simple safety precautions in laboratory work.	understand simple safety precautions in laboratory work.
4	recall a wide range of simple applications (namely social, political, economic, technological and environmental) of Biology with emphasis on the Maltese context and explain the principles underlying them.	recall simple applications (namely social, political, economic, technological and environmental) of Biology with emphasis on the Maltese context and explain the principles underlying them.	recall simple applications (namely social, political, economic, technological and environmental) of Biology with emphasis on the Maltese context.
5	make, record and communicate accurate detailed observations from a wide variety of sources in the form of tables, charts, graphs, diagrams and concise logical prose. The use of apparatus to measure accurately weight, length and temperature is essential.	make, record and communicate accurate detailed observations from a variety of sources in the form of tables, charts, graphs, diagrams and concise logical prose. The use of apparatus to measure with some accuracy weight, length and temperature is required.	make simple observations from a variety of sources in the form of tables, charts, graphs, diagrams and concise logical prose. The use of apparatus to measure weight, length and temperature is required.
6	analyse and interpret biological information and data represented in	analyse and interpret simple biological information and data	draw simple references from biological information and data.

	tables, charts, graphs, diagrams and photographs.	represented in tables, charts, graphs, diagrams and photographs.	
7	use a knowledge of biological processes and principles in familiar situations, apply it to unfamiliar situations and formulate hypotheses.	use a knowledge of biological processes and principles in familiar situations, and apply it to unfamiliar situations.	use a knowledge of biological processes and principles in familiar situations.
8	apply a wide range of chemistry and physics when dealing with biological processes and principles and elementary mathematics to carry out necessary calculations.	apply essential chemistry and physics when dealing with biological processes and principles and elementary mathematics to carry out the necessary calculations.	apply some elementary chemistry and physics when dealing with biological processes and principles and sufficient mathematics to carry out simple calculations.
9	use a wide range of biological terms accurately all throughout their work when communicating biological information.	use essential biological terms accurately throughout most of their work when communicating biological information.	use sufficient biological terms accurately when communicating biological information.
10	present a wide range of biological information in a variety of ways.	present biological information in a variety of ways.	present biological information in a straightforward manner.
11	describe links between related phenomena.	describe links between simple related phenomena.	understand the links between simple related phenomena.

The Syllabus

Part 1: The Living World		
Topic	***Subject content***	***Knowledge expected***
a. Characteristics of living things	Characteristics common to organisms.	*The vital functions as criteria for distinguishing between living and non-living things.*
	The **cell** as the basic unit of life.	*Study of the eukaryotic cell should be confined to the function of the nucleus, the cytoplasm, the cell membrane and the mitochondrion.* *Candidates are expected to know how to draw simple diagrams of a typical animal cell and a typical plant cell as seen under the light microscope.*
b. Different forms of life	The evolutionary development of unicellular life forms into multicellular life forms.	*The concept of division of labour in multicellular organisms.* *Surface area to volume ratio in relation to problems of increased size in multicellular organisms. Candidates are expected to know how to calculate the surface area to volume ratio of a cube.*
	*The groups listed below are intended to familiarise the candidate with the various main groups of living organisms. **Only** the major physical characteristics of the group are required. Details of physiology and life cycles will **not** be required. Candidates should also be able to name (vernacular names are sufficient) an organism as an example for each group. Whenever possible, **locally** occurring organisms should be cited.*	
	Viruses	*Viruses as being borderline between living and non-living. Outline structure of viruses (i.e. genetic material surrounded by a protein cover) as differing from the usual cellular structure of living things.*
	The bacteria kingdom	*Outline structure of a bacterium as an example of a prokaryotic cell.*

	The protist kingdom	*Outline structure of a unicellular plant-like and a unicellular animal-like protist.*
	The fungus kingdom	*Outline structure with reference to a unicellular and a filamentous fungus.*
	The plant kingdom	*Cellular and functional features characteristic of plants.*
	*The characteristics of the following plant groups should illustrate the **evolutionary development** from an aquatic environment to a terrestrial existence.* General characteristics of the following groups:	
	Bryophytes (as exemplified by mosses)	*Plants having a very simple structure (thallus) having no proper roots, leaves and stems. Hair-like structures (rhizoids) on the lower surface to absorb moisture. Size limited by the absence of vascular tissue. Spread limited because of a heavy dependency on water (no means of preventing water loss and reproduction requires a watery medium).*
	Pteridophytes (as exemplified by ferns)	*Plants having roots, stems and leaves. Because they possess vascular tissue, ferns can attain considerable sizes. A waxy layer allows them to colonise drier areas, however reproduction still requires a damp environment.*
	Conifers	*Plants that are able to conserve water. They reproduce by seeds that are formed in cones. This group is also called 'Gymnosperms' (naked seeds) because the seeds are not enclosed in an ovary.*
	Flowering plants (angiosperms)	*Plants whose seeds are formed within the ovaries of flowers. There are two main groups:* i. *Monocotyledonous plants: tend to have a fibrous root system, long parallel-veined leaves, floral parts in multiples of three and a seed having one cotyledon* ii. *Dicotyledonous plants: tend to have a tap-root system, broad net-veined leaves, floral parts are often grouped in groups of fours or fives, and a seed having two cotyledons*
	The animal kingdom	*Cellular and functional features characteristic of animals*
	*The characteristics of the following animal groups should illustrate the **evolutionary development** from an aquatic environment to a terrestrial existence.* General characteristics of the following groups:	
	Coelenterates (Cnidarians)	*Animals that have a sac-like body with a single opening surrounded by tentacles armed with stinging cells. They live in a watery environment.*
	Flatworms (platyhelminthes):	*Due to the absence of a circulatory system, the body of these animals is thin and flat to facilitate the diffusion of oxygen. Many are animal parasites.*
	Roundworms (nematodes)	*Animals that have a long thread-like body, round in cross-section. Some live in soil, but many are plant or animal parasites.*
	Segmented worms (annelids)	*Animals that have a long segmented body and a*

		digestive tract with a mouth and anus.
	Molluscs	*Animals that have a soft unsegmented body. Most have an external or an internal shell. They live in aquatic or moist environments.*
	Arthropods	*Animals that have a segmented body covered by a hard cuticle (exoskeleton) that is shed and replaced by a new one when the animal outgrows it (moulting). They have jointed appendages. The phylum includes Crustaceans, Insects, Myriapods and Arachnids in which the number of legs is a major distinguishing feature.* *Insects as a group of Arthropods having a body divided into a head, a thorax and an abdomen, three pairs of jointed legs and generally two pairs of wings. Their waterproof exoskeleton made them very successful in terrestrial environments. Development involves either a complete (egg, larva, pupa, adult) or an incomplete (egg, various instars/nymphs, adult) metamorphosis (details of life cycles are not required).*
	Vertebrates	*Animals that have a vertebral column extending to form a tail. Have an internal skeleton usually made up of bone. The group is divided into five classes:* *i. Fish: vertebrates adapted for an aquatic environment having a streamlined body with fins, gills and scales covering the body. They are ectothermic. Candidates are expected to know how to draw a simple diagram of a typical bony fish showing its major characteristics.* *ii. Amphibians: have thin moist skins without scales. They are adapted for a terrestrial environment, but have to return to water to lay eggs. They are ectothermic.* *iii. Reptiles: very successful terrestrial vertebrates with dry scaly skins. They lay eggs on land in leathery shells. They are ectothermic.* *iv. Birds: have a body covered with feathers. Their forelimbs are modified into wings; they have toothless beaks and lay eggs in hard protective shells. They are endothermic.* *v. Mammals: have a body covered with hair. They have mammary glands that produce milk, external ears and a diaphragm separating the thorax from the abdomen. They are endothermic.*
c. Grouping living things	The standard system of classifying and naming organisms.	*The emphasis should be on the advantages of having a standard classification / naming system, rather than on the recall of nomenclature.*
	The use of identification keys.	*The use of identification keys should aim at developing observation skills.*

Part 2: Keeping Alive		
Topic	***Subject content***	***Knowledge expected***
a. The chemicals of life	Composition and properties of carbohydrates, lipids and proteins.	*Composition should include knowledge of elements present. An appreciation of monosaccharides, fatty acids and glycerol and amino acids as structural components of polysaccharides, lipids and proteins respectively. Candidates are expected to have performed a chemical test for each of the following: reducing sugar, starch, lipid and protein.* *Carbohydrates as an energy source and as the main constituent of plant cell walls. Starch and glycogen as the main carbohydrate storage in plants and animals respectively.* *Lipids as efficient energy stores. In mammals, fat layers under the skin and around certain organs offer protection and heat insulation. Lipids are a constituent of cell membranes.* *Proteins are needed for growth and repair of cells and as enzymes. Candidates should be aware that excess protein is deaminated in the liver.*
	Sources and functions of vitamins A, C and D in a human diet.	*Vitamins as essential components in the diet for the normal functioning of the body. Sources and functions of vitamins A, C and D (and the associated deficiency symptoms) in humans.*
	Mineral salts requirements of organisms.	*Functions of nitrogen and magnesium in plants. Sources and functions of calcium, phosphorus and iron in humans.*
	The importance of water in organisms.	*Water needed as a reactant in certain metabolic reactions, as a medium for chemical reactions occurring in solution and for the transport of substances in solution.*
	A balanced diet in humans.	*A diet containing the right balance of the different foods that meet the hanging needs of individuals. These needs are dependent on the lifestyle, activity and developmental stage of an individual.*
	General characteristics of enzymes and their role in metabolic reactions.	*The activity and characteristics of enzymes should be investigated through simple controlled experiments with a suitable enzyme. Economic uses of enzymes should include biological washing powders and the production of cheese.*
	Movement of substances in and out of cells: diffusion; osmosis; active transport.	*Candidates are expected to be familiar with simple experiments to demonstrate diffusion and osmosis.*
b. Getting energy from food	Aerobic and anaerobic respiration.	*A simple consideration of respiration with emphasis on the comparative release of energy (as ATP) from both types of respiration.* *Candidates are expected to have performed simple controlled experiments to demonstrate the production of carbon dioxide and heat from the respiration of yeast, germinating seeds and small animals.*
	Economic importance of	*The use of alcoholic fermentation by yeast in bread*

	products derived from anaerobic respiration of certain microorganisms.	*making, beer and wine production. The use of bacteria to produce biogas (methane), vinegar and lactic acid for yoghurt, butter and silage production*
	Anaerobic respiration in muscle cells.	*The production of lactic acid and the resultant oxygen debt due to the anaerobic respiration of muscle cells.*
	Characteristics of respiratory surfaces.	*Candidates should appreciate that the characteristics of different respiratory surfaces vary due to the complexity and the surrounding environment of the respective organism. Different respiratory surfaces share common characteristics to increase the efficiency of gaseous exchange and transport.*
	Gaseous exchange in a protist, in an insect, in a fish, in a human and in a flowering plant.	*Candidates are expected to use simple diagrams and sketches to explain how gaseous exchange occurs in the organisms cited. Detailed diagrams of the respiratory systems are not required.*
	Health hazards associated with breathing: smoking and air pollution.	*Health hazards due to smoking should mention lung cancer, bronchitis, emphysema and the dangers of passive smoking.* *Examples of air pollution should include carbon monoxide, carbon dioxide, sulphur dioxide, oxides of nitrogen and lead as components of smoke produced from the burning of fossil fuels in power stations, industry and motor vehicles. The use of chimney filters and catalytic converters to reduce pollution.*
c. Conditions supporting life	Abiotic and biotic factors as conditions supporting life. Abiotic factors should include:	*Abiotic and biotic factors limit the population size and spread. Candidates should appreciate that the uncontrolled growth of any species has negative effects on the environment and the survival of the same species.*
	Availability of water (i) Transpiration and adaptations of plants to reduce water loss.	*Candidates are expected to have performed experiments investigating environmental factors that affect the rate of transpiration.*
	(ii) The importance of osmoregulation as exemplified by the activity of the contractile vacuole in a named protist and the kidney in humans.	*Structure of the human urinary system including the kidney, nephrons and associated blood vessels. Ultrafiltration, selective reabsorption of glucose, mineral ions and water (candidates are expected to use simple diagrams and sketches to explain how these processes occur). The major constituents of urine.*
	Temperature (i) Major temperature variations on Earth (polar, temperate and tropic regions) and their effect on the distribution of vegetation.	*Only an appreciation of the fact that the type of vegetation is influenced by temperature need be considered.*
	(ii) Temperature control in humans.	*Structure of the skin and its role in temperature regulation. Candidates should appreciate the characteristics of endothermic (homoiothermic) animals, such as humans, and ectothermic (poikilothermic) animals.*

	Response of plants to abiotic factors	*Positive phototropism of stems, geotropism of roots and stems.* *Candidates are expected to be familiar with simple controlled experiments demonstrating these tropisms.*
	Biotic factors should include: (i) predator-prey relationships	*Candidates should be able to illustrate these principles through specific examples, ideally taken from the local environment.*
	(ii) inter- and intraspecific competition for space, food and mate	*Candidates should be able to illustrate these principles through specific examples, ideally taken from the local environment.*
	(iii) parasitism and mutualism	*Adaptations of a named parasite to its parasitic mode of life. Mutualism as demonstrated by the relationship between gut flora and herbivorous mammals, and root-nodule bacteria and leguminous plants.* *Principles, use and implications of biological pest control.*
	Human population	*Candidates should appreciate that the great increase in the human population is mainly the result of its success in controlling most of the abiotic and biotic factors controlling it. Detail about differing Birth and Death Rates is not required.*
d. Functioning as a whole	The need for a transport system in multicellular organisms.	*An appreciation of the need for an efficient transport system as the organism increases its complexity and body functions are carried in localised areas.*
	The role of phloem and xylem as vascular tissues. Transport of water and mineral ions from the root. Translocation of products of photosynthesis.	*Internal anatomy of stems and roots to show the distribution of vascular tissue. (Detailed knowledge of cell structure is not required).* *Candidates are expected to use simple diagrams and sketches to explain how water is absorbed at the roots and is transported up the stem.*
	The structure and functions of the human circulatory system.	*Map of the human circulatory system with the names of the major blood vessels to and from the heart (and its valves), lungs, liver and kidney. Structure and functioning of the heart, arteries, veins and capillaries (no histological details are required).* *Candidates are expected to have performed investigations on the variation of heartbeat under different conditions. The dissection of a mammalian heart to illustrate heart structure is suggested.*
	Body fluids: blood, tissue fluid and lymph.	*Structure and function of blood components. Tissue fluid as a medium for diffusion between blood and tissues.*
	Co-ordination of body functions in humans involving hormonal and nervous control.	*Appreciation of the need for the co-ordination of body functions. That two co-ordinating systems are required: (i) one involving a slow but sustained action that usually has long-term effects on the body, and (ii) one that is quick and achieves immediate, short-term control over specific body parts.*
	Positions of the main endocrine glands: pituitary,	*Candidates are expected to show the position of the main endocrine glands through the use of a simple*

	thyroid, pancreas, adrenals, ovaries and testes.	*diagram of the body plan of a human.*
	Feedback control in hormonal secretion	*The role of insulin and glucagon in the control of blood-glucose level as a specific example of feedback control in hormone secretion.*
	The central nervous system: The structure and functioning of different parts of the brain	*Structure and functioning of the cerebral hemispheres, the cerebellum and the medulla oblongata. Functioning of the motor, sensory and association areas in the brain.*
	The spinal cord and associated spinal nerves. Transmission of impulses by neurones.	*The reflex arc including the types of neurones involved. Details of impulse transmission are not required.* *Candidates are expected to use simple diagrams to explain the path taken by a nerve impulse as it travels along the reflex arc.*
e. The blueprint of life	The DNA molecule. Chromosomes as the sites of DNA. A gene as a section of DNA controlling an identifiable characteristic. The role of DNA in protein synthesis. Alleles as alternative forms of a gene. Mutations and mutagens.	*Only a basic knowledge of nucleic acids and the structure of DNA is required. Details of protein synthesis are not required. Candidates should appreciate that the sequence of bases on the DNA strand determines the sequence of amino acids and therefore the type of protein (i.e. characteristics) that will be produced.*
	Mitosis as a process of cell division leading to the exact duplication of genetic material. Meiosis as a process of cell division leading to halving of chromosome number and the production of variations in genetic material.	*Knowledge of cell division should be confined to an understanding of the significance of both processes and the sites where they occur, in flowering plants and humans.* *Candidates are not expected to draw the different stages of Mitosis or Meiosis. However, they are expected to be able to put diagrams representing the different stages of Mitosis and Meiosis in sequence.*
	Diploid and haploid nuclei. Fusion of gametes. Variation resulting from exchange of genetic material and random fertilisation.	*An awareness of variation within a species and recognition that not all variation is inherited.*
	Inherited and non-inherited variation. Continuous and discontinuous variations. Monohybrid cross, dominant and recessive alleles. Codominance. Phenotypes and genotypes, homozygous and heterozygous genotypes.	*Monohybrid ratios illustrated by simple breeding experiments with a quantitative treatment of results. The recessive backcross related to the monohybrid experiment.*
	Sex determination in humans and sex-linked characteristics.	*It is suggested that candidates become familiar with the identification of sex-linked characteristics through the study of specific cases, like haemophilia and colour blindness .*
	Principles, uses and possible hazards of genetic engineering. Cloning of plants of economic importance. Principles of tissue culturing.	*Treatment of the process of genetic engineering should include the use of enzymes to cut and join gene DNA and vector DNA to form recombinant DNA. The use of plasmids and viruses as vectors to insert recombinant DNA into cells. Production of human insulin by*

		genetically engineered bacteria.

f. Increasing in numbers	Differences between asexual and sexual reproduction, their advantages and disadvantages.	*Asexual reproduction is very fast and produces a vast number of offspring that are genetically identical to the parent. Sexual reproduction ensures genetic diversity hence promoting adaptation to changing environments.*
	Main methods of asexual reproduction: binary fission, budding, spore formation and vegetative reproduction.	*Candidates are expected to be familiar with the various methods of asexual reproduction with reference to specific named examples (particularly those studied in Part 1b).*
	Sexual reproduction in flowering plants: The structure of an insect-pollinated flower. Differences between insect-pollinated and wind-pollinated flowers. Pollination, fertilisation, seed and fruit formation and dispersal, seed structure, germination and the conditions controlling germination.	*Candidates should be able to distinguish between epigeal and hypogeal germination.* *Candidates are expected to have performed simple experiments investigating factors affecting germination.*
	Sexual reproduction in humans: Structure and function of the male and female reproductive organs. Menstrual cycle, copulation, fertilisation, nutrition and protection of the embryo, birth and parental care.	*Anatomical details of embryological development are not required.*
	The role of hormones in the menstrual cycle, gametogenesis and the development of secondary sexual characteristics.	*Hormones studied should include FSH, LH, oestrogens, progesterone and testosterone.*
	Methods of family planning.	*Natural family planning as exemplified by the thermal and the mucus (Billing's) method.* *Artificial family planning as exemplified by the use of the condom, diaphragm and contraceptive pill.*

Part 3: Living Together		
Topic	***Subject content***	***Knowledge expected***
a. Feeding relationships	Understanding of the terms: ecosystem, habitat, community and population.	*Candidates are encouraged to study a local ecosystem and to relate concepts mentioned below to actual situations observed during the study.*
	Plants as producers. The process of photosynthesis and its importance in the conversion of light energy to chemical energy. Factors affecting the rate of photosynthesis. Fate of carbohydrate products in the plant.	*Candidates should be aware that there are other producers (e.g. algae), but these will not be examinable.* *A simple treatment of photosynthesis (reference to light and dark reactions is not required). Equation for photosynthesis.* *Candidates are expected to have carried out simple controlled experiments to demonstrate the production of oxygen and the need for chlorophyll, light and carbon dioxide during photosynthesis.*
	External and internal features of a leaf as an organ for photosynthesis.	*Candidates are expected to draw simple diagrams of the external and internal structure of the leaf.*
	Animals as consumers. The characteristics of animal (holozoic) nutrition.	*Phases in animal (holozoic) nutrition: ingestion, digestion, absorption, assimilation and egestion. Comparison between nutrition in a named animal-like protist and in humans to show similarities between them.*
	Structure and function of the human gut and its associated glands.	*Role of digestive enzymes and other gut secretions in the digestion of food. No physiological detail of the digestive organs is required.*
	Cellulose digestion as an adaptation of herbivorous mammals as primary consumers.	*Adaptation of herbivorous mammals should be restricted to dentition, relative proportions of the gut and gut flora in a named ruminant (e.g. cow) or a named hind gut fermenter (e.g. rabbit).* *Candidates should be aware of the functions of the different teeth in a dentition.*
	Ways of representing feeding relationships.	*Food chains, food webs, and pyramids of numbers and pyramids of biomass.*
	Energy flow through an ecosystem.	*The fate of light incident on green plants. The various ways energy is transferred (explaining why only 10% is transferred from one trophic level to the next). Understanding of quantitative examples from food chains and food webs.*
b. Soil as an ecosystem	*The soil provides a clear example of an ecosystem: a series of interactions between different abiotic and biotic factors. It is suggested that the items listed below are not studied in isolation, but as different components making up a whole.*	
	Components of a fertile soil. Different types of soil: sandy, clay and loam soils.	*Candidates are expected to have performed experiments investigating the various inorganic particles of soil, its water, humus and air content; as well as experiments which compare the water retaining abilities / drainage of various soil types.*

	Organisms living in the soil: saprophytes, earthworms, harmful soil organisms and plants.	*The saprophytic mode of nutrition, as shown by a named fungus or bacterium, involving the external digestion of organic matter leading to release of minerals in the soil.* *A brief outline of the habits of earthworms and their beneficial effect on soil.* *Specific examples of organisms (e.g. millipedes and insect larvae) and the type of damage they cause.* *The role of passive and active transport in the absorption of water and mineral ions from the soil by roots.*
c. Management of resources	Natural cycles: carbon, nitrogen and water cycles.	*The emphasis should be on the fact that in natural cycles, resources are being used and replenished continuously. Candidates should appreciate that when natural cycles are upset, resources start depleting and wastes accumulate resulting in pollution problems. Moreover, remedial steps tend to re-establish upset natural cycles.*
	Use and misuse of living resources.	*Extinction of a species due to habitat destruction and / or overhunting. The need for nature reserves and the enforcement of laws to preserve wildlife. Unequal distribution and wastage of food leading to famine in certain world regions. Finding alternative food sources (e.g. fish farming and animal husbandry).*
	Land use and misuse in agriculture and urbanisation.	*Overgrazing, deforestation and bad agricultural practices leading to soil erosion and the spread of desertification. Contour ploughing, strip cropping and terracing as ways of reducing soil erosion. Use of persistent and biodegradable pesticides in agriculture. Population explosion leading to an increased need for land clearing for more food production (through agriculture) and more living space.*
	Specific examples of air, sea water, fresh water and land pollution and their effects on the environment. Possible solutions to prevent pollutant levels from increasing.	*CFC's and activities leading to the depletion of ozone from the atmosphere. The environmental effects of the thinning out of the ozone layer. Use of ozone-friendly products and the economic ban of products containing substances that damage the ozone layer.* *Eutrophication, oil spillage and sewage as examples of water pollution. Causes, effects on the environment and possible solutions to these problems (e.g. the role of aerobic saprophytic bacteria in sewage treatment plants).* *Examples of land pollution should include dumping of rubbish and building debris, land reclamation projects on garigue, increased lead content in soils and high nitrate levels in the water table due to the excessive use of artificial fertiliser in agriculture. Possible solutions to these problems could include reducing waste production, recycling of waste, making better use of available space and the use of natural fertiliser.*

Nature of practical investigations

The aim of this Section is to provide candidates and teachers of biology with a clear set of guidelines on how to present reports of work done in relation to the practical component of the SEC Biology syllabus. The guidelines are based on specific needs identified during the examiners' moderation visits and on suggestions made during consultations with biology teachers during in-service courses. It is hoped that this section will provide answers to a lot of questions that candidates and teachers raise in relation to the reporting of practical work in biology and that it will help to provide schools with common standards and criteria hence increasing the consistency in marking the candidates' work and comparability between schools.

(a) ***Aims and Objectives***

The overall aim of the practical component is to instil in candidates a favourable attitude toward the subject by:

- generating interest, enthusiasm and enjoyment;
- encouraging initiative and imagination;
- developing self-reliance;
- introducing, developing and reinforcing theoretical concepts;
- developing a critical awareness of experimental design;
- developing an ability to interpret data; and
- foster a scientific approach to life.

Through practical work, candidates are expected to have developed:

- manipulative skills – how to handle chemicals, assemble apparatus, and use a hand lens and a microscope to observe living or preserved material;
- an ability to follow instructions carefully – complete an investigation in accordance with a specified procedure. This involves understanding instructions in a way that enables candidates to adjust the method if necessary;
- observation, identification, recording and interpretation – identification of biological material at both the macroscopic and the microscopic levels. Candidates should record their findings clearly and accurately;
- presentation of experimental results with calculations – select and implement the most appropriate method of recording the data collected;
- interpretation of data – analyse results of both a qualitative and a quantitative nature to draw significant conclusions; and
- experimental design – recognise a problem, formulate a hypothesis, devise a logical work plan and choose appropriate equipment and techniques with suitable controls so as to test the hypothesis.

It is worth pointing out that candidates who have not attained the objectives and developed the skills outlined above will be at a disadvantage when answering questions in the written paper. Examiners' reports have regularly pointed out that candidates who were exposed to and actively engaged in practical work during their biology course gave better answers to the questions set in the written papers. Consequently examiners have specifically identified practices that are **not conducive** to the attainment of these benefits. Therefore:

- teachers should not accept excessively lengthy reports that, more often than not, are based on blind copying from textbooks and internet based material;
- grading of a report should be based on the quality of its content and not on its 'thickness' and aesthetic value;
- reports should be read and corrected carefully by the marker before being graded;
- teachers should avoid dictating reports to the whole class as this actively hinders candidates from developing their communication skills;
- the uncritical adoption of traditional practices (e.g. drawing 'endless' lists of diagrams of organisms, tissues and glands) makes practical work boring and irrelevant, and should hence be avoided; and

- experiments of an investigative nature should be promoted because they help candidates to develop the necessary cognitive skills enabling them to become critical thinkers and experienced problem solvers.

(b) ***Moderation criteria for Biology practical books***

The examiners adopt the following criteria during the moderation exercise:

Criterion	**Description**
Variety	The practicals presented have to represent a reasonable sample of biology practicals so as to ensure the development of various practical skills.
Difficulty	Only practicals which require a reasonable effort (for a SEC candidate) will be accepted and considered for marking.
Reports	Lab reports are expected to be in good English and in the proper scientific write-up procedure (where applicable). Where required these write-ups should be accompanied by graphs and diagrams.
Diagrams	(Where applicable) diagrams are expected to be neat, large, accurate and clearly labelled.
Authenticity	Evidence of practicals that are truly the candidate's own work and that are of an investigative nature – actively involving the learner in his/her understanding of biological principles.

CANDIDATES MAY BE CALLED FOR AN INTERVIEW ABOUT THEIR WORK.

(c) ***Guidelines on the general presentation of biology reports***

A candidate's laboratory report book should give evidence of a variety of practical experiences. The 15 investigations presented in the report book should roughly be based according to the following scheme:

Experiments involving …	**No. of practicals**
… identification and classification of organisms	0 - 2
… investigation of life processes	Up to 10
… problem solving situations	At least 3
… fieldwork investigations	1 - 3
... visits to sites of biological interest	1 - 3

The report books submitted should thus contain at ***least*** 15 practical session reports. The submitted reports should be neatly filed and organised into sections as outlined below:

Front Sheet: containing a list of the ***best*** 15 practicals, the mark assigned to each practical and the overall average mark.

Section 1: Problem Solving Investigations – containing the reports of at least 3 problem solving investigations. Only one of the problem solving situations may be a survey.

Section 2: Visits and Fieldwork – compiling the reports from:

1-3 visits to sites of biological significance, and

1-3 fieldwork investigations.

Section 3: Investigations of Life Processes – including up to 10 practicals investigating life processes.

Section 4: Identification and Classification of Organisms – up to 2 practicals involving the identification and classification of organisms.

Section 5: Other Practicals – this section may include other practical investigations performed by the candidates during the biology course.

A report for one experiment should normally not be longer than two pages of a foolscap and should include (where applicable) a labelled diagram of the mounted apparatus and a concise account covering the most essential steps/points of the experiment. The write-ups for problem solving situations, fieldwork and visits should approximately consist of 1500-2000 words. Candidates are expected to develop the report in their own words and to supplement their account with appropriate statistics, graphs and photos/sketches/diagrams (with appropriate captions). While candidates are encouraged to use the available literature and the Internet for their research, they are reminded that plagiarised work will be penalised.

The use of the computer to manipulate and interpret data as well as in the compilation and writing of the reports is accepted. On the other hand, teachers should discourage candidates from downloading information blindly by helping them develop skills in handling information.

The following experiments (and hence their reports) will not be accepted:

- experiments that could facilitate the spread of pathogens (e.g. making use of saliva),
- experiments that could generate emotional distress (e.g. the use of candidates' characteristics in genetics lessons), and
- practicals involving dissections and the capture/collection of wild fauna and flora.

(d) ***Specific guidelines for the different types of practicals***

A. <u>Identification and classification of organisms</u>

Each report should include a clear well-labelled and annotated diagram of the organism being identified/classified. The annotations should highlight the characteristics that led the candidate to identify/classify the organism.

Reports of microscope work should include large well-labelled diagrams of what the candidates are able to observe using the light microscope. Copying of diagrams from textbooks is not permitted.

B. <u>Investigation of life processes</u>

Reports for these experiments should be presented under the following headings:

- **Aim of the experiment** – specifically outlining what the experiment is all about.
- **Apparatus** – a list of the apparatus used during the experiment.
- **Method** – a brief account (can also be presented in point form) of the procedure adopted. This account can (if applicable) be supplemented with a two-dimensional labelled diagram of the way the apparatus was assembled. Precautions adopted during the experiment (including any safety measures) should be included in this section.
- **Results** – candidates are expected to present their experimental results in an orderly manner, particularly through the use of tables and graphs (where applicable).
- **Conclusions** – a brief account highlighting the patterns that emerged from the results obtained and their relevance to the biological process being investigated.

C. <u>Problem solving situations</u>

The main aim of these investigations is to help candidates develop an inquiring mind and to develop research skills. After identifying a particular research problem, candidates can explore it by choosing one of the following research methods that best suits the investigation:

(a) devising experiments that explore the different facets of a research question; and

(b) organising a survey that helps the researcher to delve deeper into a particular enquiry.

Reports of each problem solving investigation should have the following sections:

I. **Identifying the problem** – focus on the problem being investigated, decide upon and plan an investigation, and predict the expected outcome of the investigation

II. **Experimental design** – plan what factors will be changed, what factors will be kept constant, what measurements will be taken, what apparatus will be required and how it will be used.

III. **Evaluation of the investigation** – decide on how to present the data collected, watch out for and explain trends and patterns that emerge from the investigation, and criticise the methodology to suggest ways how it could be improved.

D. Visits of biological interest

Reports must be compiled by individual candidates and based on experience gained during the visit and from research. When appropriate, the report should be supplemented with statistics, graphs and photos/sketches/diagrams. Each report should be organised under the following headings:

- **Aim of the visit** – what was the aim of the visit?
- **Observations and data collected** – in the form of tables and graphs (if applicable).
- **Summary and evaluation of experience** – to include background information about any biological principle/s employed during the visit.

E. Fieldwork investigations

The guidelines suggested for the reports for this set of practicals are similar to the ones adopted for site visits.

(e) ***List of suggested biology practicals***

The following list is a suggested list of practical sessions that complement the courseware outlined in the syllabus. The list is by no means exhaustive and the candidates can propose other ideas as long as they satisfy the above criteria.

Practicals marked with an asterisk (*) are possible problem solving investigations.

1. Cells: use of a microscope to observe prepared slides of plant and animal cells and of mitotic and meiotic cell division.

2. Protists: observation of various organisms (e.g. amoeba and chlorella) from slides and/or pond samples.

3. Fungi: (e.g. Mould) Observation of the growth of a common fungus with special reference to growth of the mycelium, its structure and its effect on the substrate.

4. Flowering plants: Observing and comparing external features of monocots and dicots.

5. Grouping and classification of organisms. The use of identification keys.

Note: *Practicals from 2 – 5 may be easily integrated with fieldwork programmes and visits.*

6. Food Tests:

(a) Chemical tests for reducing sugars, starch, lipid and protein.

(b) Identification of substances that make up a selection of common foods.

(c)* To investigate the Vitamin C content in different foods.

(d)* To investigate the effect of cooking on Vitamin C content.

(e)* To investigate the energy content in different foods.

7. Finding out the importance of the minerals needed for normal plant growth with special reference to nitrogen and magnesium. The use of water culture kits as an introduction to hydroponics.

8. Enzymes:

(a) To investigate the action of enzymes in relation to digestion. Use of different enzymes on different substrates (e.g. protein, starch, etc.) and under different conditions (e.g. pH and temperature).

(b) To find out the economic importance of enzymes as demonstrated by the production of cheeselets, and yoghurt. (This section may be integrated with a visit to the Dairy Plant).

(c)* To find out whether pH affects the rate of browning of apples.

(d)* To investigate factors affecting the rate at which rennin clots milk.

(e)* To investigate the effects of changing the amount of substrate or enzyme on the rate of reaction.

(f)* To compare the action of biological and non-biological washing powders.

(g)* To investigate the effect of temperature on the action of a biological washing powder.

(h)* To investigate different techniques which can be used to follow enzyme catalysed reactions.

(i)* To find ways of extracting different enzymes from natural sources.

9. Osmosis:

(a) Demonstration of osmosis (i) through living tissue (potato, carrot or eggs after removing the shell with hydrochloric acid), (ii) through dialysis or visking tubing, (iii) as turgor pressure in potato tissue

(b)* To investigate how to get most dye out of beetroot cells.

(c)* To investigate which concentration is most similar to potato cells.

10. Demonstration of diffusion in (a) gases, (b) in liquids

11. Respiration:

(a) Aerobic respiration:

i. To find out if germinating seeds produce heat during respiration.

ii. To investigate the production of carbon dioxide during respiration in plants and small animals.

(b) Anaerobic respiration:

i. To find out the products of anaerobic respiration using yeast.

ii. To find out the economic importance of the products of anaerobic respiration. (This topic may be integrated with a visit to a brewery, winery and/or bakery).

iii.* To investigate the factors affecting the rates at which fermentation takes place

(c) * To investigate whether both aerobic and anaerobic respiration release energy in the form of heat

(d) Breathing:

i.* To investigate if there is a relationship between lung volume and 'fitness'.

ii* To compare the amount of oxygen and carbon dioxide in inhaled and expired air.

iii* To investigate smoking habits and their effect on health through a survey.

12. Transpiration in plants:

(a) Investigating the adaptations of certain plants to reduce water loss by measuring the transpiration rate of these plants under the same conditions.

(b) Comparing the rate of transpiration under different environmental conditions. (In these experiments either the weighing or the potometer method can be used).

(c)* To investigate whether transpiration takes place through the upper surface of the leaf, or its lower surface or both its surfaces.

13. Tropisms:

(a) Response of plants to abiotic factors with special emphasis on light and gravity.

(b)* To investigate if hormone rooting powder makes plant cuttings root more quickly.

14. Investigation of transport system in plants.

15. Observation of the external and internal structure of the mammalian heart.

16. Heart beat:

(a) Investigating the heartbeat and breathing rate under different conditions (e.g. when sitting down, after heavy exercise).

Caution: *Candidates may be precluded from participating in these activities on medical grounds*

(b)* To conduct a survey dealing with the risk factors associated with heart disease.

17. Sensitivity in animals:

(a) To investigate the skin's sensitivity to temperature

(b)* To investigate various skin covers as insulators against heat loss.

(c)* To investigate the cooling effect of evaporation.

(d) Simple experiments to show co-ordination of body functions in humans involving nervous control. Reaction time measurement.

(e) Examination of a T.S. of the spinal cord

18. Variation in humans and/or other organisms

Caution: *Great care must be exercised when genetic data (e.g. eye colour, hair colour and blood groups) is collected and discussed as it may highlight cases of adoption or illegitimacy. Furthermore, variation studies (e.g. on height, weight and heart beat) may highlight widely divergent individuals in a group. Use of data obtained from anonymous sources is suggested.*

19. Reproduction in Plants:

(a) Detailed structure of the flower. Differences between wind-pollinated and insect-pollinated flowers. (This work can be easily integrated with the fieldwork programme).

(b)* To investigate if insects are attracted more by the scent than by the colour of flowers.

(c) Examination of seed structure and seed dispersal mechanisms using different seeds/fruits.

(d)* To investigate the effectiveness of 'wings' in seeds as a means of dispersal.

(e)* To investigate the rate at which different types of wind dispersed seeds/fruits fall to the ground.

(f)* Is there any correlation between seed weight and the number of seeds in a barley/oat/wheat 'ear'?

(g)* To compare rachis strength and seed dispersal in wild and cultivated barley/oat/wheat.

20. Germination:

(a) Conditions necessary for germination.

(b) Changes occurring during germination.

(c)* To show that barley seeds contain starch and that this is converted to sugar during germination.

(d)* To study the effect of temperature on germination.

(e)* To study if seeds germinate more quickly if they have been soaked in water before planting.

(f)* How do different wavelengths of light affect seed germination and growth?

(g)* Is there a seed germination inhibitor in tomatoes?

(h)* To study the effect of planting density on productivity.

(i)* To investigate the effect of fertilisers on the final crop yield

21. Photosynthesis:

(a) Testing a leaf for starch

(b) The importance of (i) light, (ii) carbon dioxide and (iii) chlorophyll in photosynthesis.

(c) Production of oxygen during photosynthesis.

(d)* To investigate the effect of different leaf colours on photosynthesis.

(e)* To investigate the effect of light intensity on the rate of photosynthesis.

22. Soil:

(a) Physical composition of different types of soil.

(b) Experiments to determine water content, humus content and air content in a soil sample.

(c) Comparing the water permeability of different types of soil.

23. Pollution:

(a)* Conducting a long-term water/air pollution study in a particular habitat.

24.* Behaviour: Do woodlice have particular habitat preferences?

25. Fieldwork: If possible this should be done on a regular basis at different times of the year and in different habitats to include land, freshwater and marine habitats. Fieldwork reports should include write-ups of the

investigations carried out in the field. These write-ups should relate and apply theoretical biological knowledge to the results obtained from the investigations.

26. Visits to various places of biological interest:

a. Experimental farm

b. Fish farm

c. Plant Nursery

d. Recycling of solid waste and sewage treatment plant

e. Nature reserves

f. Brewery/winery

g. Water treatment plant

h. Dairy plant

i. Reverse osmosis plant

j. Natural history museum

k. Blood banks

Note: *Lengthy reports based on uncritical downloading of information about the theme being studied should be discouraged. Candidates are expected to present concise write-ups relating and applying biological principles to the observations made during the visit.*