

Education Division
Department of Curriculum and Management



**BIOLOGY FORM IV SYLLABUS
FOR STATE
SECONDARY SCHOOLS**

September 2007

Introduction

The syllabus for the form IV students is the second step towards re-structuring the State Schools' Biology syllabi, following the launch of the Biology SEC 2009 syllabus. The complete version of the SEC Biology syllabus can be accessed either through the University of Malta homepage (www.um.edu.mt) or directly from the URL address www.home.um.edu.mt/matsec

General Aims

The following syllabus should enable students to:

- develop an awareness of the various forms of life (with special emphasis on the locally occurring organisms)
- develop a knowledge and understanding of basic anatomical and physiological characteristics of organisms
- develop an awareness of the different interactions between organisms as well as between the organisms and their environment
- develop a scientific approach to problem solving that incorporates the analysis and interpretation of experimental data
- acquire a range of communicative and manipulative skills appropriate for biology
- enhance a working knowledge of other fields of study (e.g. mathematics, chemistry, physics and geography) that are vital for a proper understanding of biological concepts
- attain a positive educational experience that can serve to motivate students to further their studies in biology

Required Background

Students taking up the study of biology are expected to be familiar with the following concepts:

- mathematical concepts including the use of fractions; decimals; percentages; ratios; graphical data(line graphs, barcharts, histograms, pie charts)
- energy and its different forms
- heat transfer and insulation
- evaporation and the effects of temperature, humidity and air currents on its rate; latent heat of evaporation
- relationship between surface area and volume
- atoms, molecules, ions, compounds, acids, alkali, p.H
- solubility, concentration gradients, diffusion and osmosis

Scheme of assessment

The annual examination paper consists of a 1 hour 30 minutes written paper. The paper has two sections: Section A and Section B. Section A comprises about eight questions with a total of 55 marks. All the questions in this section are compulsory. Section B includes one compulsory question of the comprehension type and four other questions of which the students are asked to

select two. Each question in Section B carries 15 marks. Thus section B includes 45 marks. The questions in both sections shall test both the recall of biological concepts as well as the application of knowledge. The questions in the annual examination paper will comprise all the topics covered in form IV.

The final mark of the annual examination is worked out by calculating the total theory mark out of 85% and then adding to it the mark attained by the student in the practical/laboratory work (out of 15%).

Practical work

The mark attained for the practical work is based on an average of all the practical reports presented by the student during the academic year. During the second year of biology studies students must at least work out and present a total of **SIX** practicals, one of which **must** involve a problem solving investigation. The students' laboratory report files must be available for the possibility of moderation by the education officer or subject coordinator at least a week before the annual examination.

Students are asked are reminded to adopt practical report files with five distinct sections as outlined by the SEC Biology 2009 Syllabus, namely:

- Section 1 – Problem Solving Investigations
- Section 2 – Visits and Fieldwork
- Section 3 – Investigations of Life Processes
- Section 4 – Identification and Classification of Organisms
- Section 5 – Other practicals

The write up for an experiment should be about two pages of a foolscap long including diagrams where possible. The write up for problem solving investigations and biology site visits should be the authentic work of the student; teachers are encouraged to advise students to avoid the blind copying of information out of textbooks/journals or the mere down loading of information from the internet.

The Syllabus

Part 1: Keeping Alive		
Learning outcomes:		
<ul style="list-style-type: none"> ✓ To list the constituents and know the functions of each in a balanced diet ✓ To understand the function of each of the components of a balanced diet ✓ To explore the deficiency diseases related to a general lack of one or more basic food component ✓ To understand the structure and function of enzymes 		
Topic	Subject content	Knowledge expected
a. The chemicals of life	Composition and properties of carbohydrates, lipids and proteins.	<p><i>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.</i></p> <p><i>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.</i></p> <p><i>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.</i></p> <p><i>Proteins are needed for growth and repair of cells and as enzymes. Candidates should be aware that excess protein is deaminated in the liver.</i></p>
	Sources and functions of vitamins A, C and D in a human diet.	<i>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.</i>
	Mineral salts requirements of organisms.	<i>Functions of nitrogen and magnesium in plants. Sources and functions of calcium, phosphorus and iron in humans. Students should be familiar with the related deficiency disorders particularly rickets and anaemia.</i>
	The importance of water in organisms.	<i>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.</i>
	A balanced diet in humans.	<i>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.</i>
	General characteristics of enzymes and their role in metabolic reactions.	<i>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.</i>

Learning outcomes:

- 🔒 **To understand that energy is needed to carry out work**
- 🔒 **To describe how the process of respiration releases energy from food**
- 🔒 **To distinguish between aerobic and anaerobic respiration**
- 🔒 **To appreciate the economic importance of anaerobic respiration by microorganisms**
- 🔒 **To understand the significance of the properties of a gas exchange surface**
- 🔒 **To understand the role and mechanism of breathing**
- 🔒 **To appreciate that tobacco smoking is harmful to health**
- 🔒 **To list some of the harmful components of tobacco smoke and the damage they cause**
- 🔒 **To identify the main air pollutants and their effects**

b. Getting energy from food	Aerobic and anaerobic respiration.	<i>A simple consideration of respiration with emphasis on the comparative release of energy (as ATP) from both types of respiration.</i> <i>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.</i>
	Economic importance of products derived from anaerobic respiration of certain microorganisms.	<i>The use of alcoholic fermentation by yeast in bread making, beer and wine production. The use of bacteria to produce biogas (methane), vinegar and lactic acid for yoghurt, butter and silage production</i>
	Anaerobic respiration in muscle cells.	<i>The production of lactic acid and the resultant oxygen debt due to the anaerobic respiration of muscle cells.</i>
	Characteristics of respiratory surfaces.	<i>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.</i>
	Gaseous exchange in a protist, in an insect, in a fish, in a human and in a flowering plant.	<i>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.</i>
	Health hazards associated with breathing: smoking and air pollution.	<i>Health hazards due to smoking should mention lung cancer, bronchitis, emphysema and the dangers of passive smoking.</i> <i>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.</i>

Learning outcomes:		
<ul style="list-style-type: none"> ✓ To understand that living cells produce excretory wastes ✓ To name the organs involved in excretion ✓ To understand the functions of the kidneys as an osmoregulatory organ-with emphasis on the functional unit of the kidney, that is the nephron 		
c. Conditions supporting life	(ii) The importance of osmoregulation as exemplified by the activity of the contractile vacuole in a named protist and the kidney in humans.	<i>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.</i>

Learning Outcomes:		
<ul style="list-style-type: none"> ✓ To understand the need of a transport system in multicellular organisms ✓ To know the role of specialised transport tissues in plants ✓ To know the structure and functions of the main components of blood ✓ To understand that blood is directed around the body via a network of different vessels ✓ To appreciate the structure related to the function of the main blood vessels (i.e. arteries, veins and capillaries) and the heart ✓ To understand that human beings have a double circulatory system ✓ To know the names of the main arteries and veins in the human body ✓ To understand the importance of the lymphatic system 		
d. Functioning as a whole	The need for a transport system in multicellular organisms.	<i>An appreciation of the need for an efficient transport system as the organism increases its complexity and body functions are carried in localised areas.</i>
	The role of phloem and xylem as vascular tissues. Transport of water and mineral ions from the root. Translocation of products of photosynthesis.	<i>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.</i>
	The structure and functions of the human circulatory system.	<i>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.</i>
	Body fluids: blood, tissue fluid and lymph.	<i>Structure and function of blood components. Tissue fluid as a medium for diffusion between blood and tissues.</i>

Part 2: Living Together

Learning outcomes:

- ✓ To define the terms population, community and ecosystem
- ✓ To know that the feeding relationships in an ecosystem can be expressed in various ways (i.e. food chains, food webs and food pyramids)
- ✓ To understand why energy transfer through an ecosystem is inefficient
- ✓ To be able to describe pyramids of numbers and biomass
- ✓ To be able to provide a basic definition of photosynthesis
- ✓ To know the word and chemical equation for photosynthesis
- ✓ To understand that the structure of a leaf is adapted for photosynthesis
- ✓ To know the sequence and function of each stage in holozoic nutrition
- ✓ To understand the role of digestive enzymes
- ✓ To list examples of enzymes involved in the digestion of carbohydrates, proteins and fats
- ✓ To understand the fate of assimilated food and undigested matter
- ✓ To appreciate that herbivores have specialised dentition and guts to deal with a cellulose-rich diet

Topic	Subject content	Knowledge expected
a. Feeding relationships	Understanding of the terms: ecosystem, habitat, community and population.	<i>Candidates are encouraged to study a local ecosystem and to relate concepts mentioned below to actual situations observed during the study.</i>
	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.	<i>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.</i>
	External and internal features of a leaf as an organ for photosynthesis.	<i>Candidates are expected to draw simple diagrams of the external and internal structure of the leaf.</i>
	Animals as consumers. The characteristics of animal (holozoic) nutrition.	<i>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.</i>
	Structure and function of the human gut and its associated glands.	<i>Role of digestive enzymes and other gut secretions in the digestion of food. No physiological detail of the digestive organs is required.</i>
	Cellulose digestion as an adaptation of herbivorous mammals as primary consumers.	<i>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.</i>
	Ways of representing feeding relationships.	<i>Food chains, food webs, and pyramids of numbers and pyramids of biomass.</i>
	Energy flow through an ecosystem.	<i>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.</i>

List of suggested practicals

The following is a list of suggested practical sessions that complements the courseware outlined in the syllabus. The list is by no means exhaustive and the students together with their teachers can work out and present other valid practicals.

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

1. 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.

2. 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.

3. 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.

4. 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.

5. Investigation of transport system in plants.

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

7. 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.

8. 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.

9. Pollution:

- * Conducting a long-term air pollution study in a particular habitat.

10. 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.

11. Visits to various places of biological interest:

- a. Nature reserves
 - b. Brewery/winery
 - c. Dairy plant
 - d. Blood banks.
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