Education Division
Department of Curriculum and Management

BIOLOGY FORM III SYLLABUS
FOR STATE
SECONDARY SCHOOLS

September 2006

Introduction

In view of the launch of the Biology SEC syllabus for the academic year 2008/09 there has been the need to update the state school biology syllabi. This syllabus for the form III students reflects the changes taking place in the SEC syllabus. The choice of topics for the form III syllabus draws upon the suggestions put forward by the teachers participating in the in-service course entitled *Biology Update* (C08/06) organized by the Curriculum Department during the July (2006) INSET session. The complete version of the SEC Biology syllabus can be accessed 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) and promote a respect for them
- 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, pH
- 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 III.

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The final mark of the annual examination is worked out by calculating the total theory/exam 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. In the first 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. It is vital that practical work is ongoing and laboratory reports are regularly marked throughout the scholastic year, such that the average mark for the coursework is finalised prior to the Annual Examination. The students' laboratory report files must be available for the possibility of moderation by the education officer or subject co-ordinator at least a week before the annual examination.

In conformity with the requirements of the new SEC Biology 2009 Syllabus, schools are asked to replace the practice of using bound laboratory books for practical work with a file that is organised in the following five distinct sections in which students can NEATLY file their practical work:

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 downloading of information from the internet.

The syllabus

Part 1: The Living World

Learning outcomes:

- **To identify the vital functions characteristic of all living things**
- **To recognize the cell as the basic unit of any living organism**
- **To comprehend the common features of all cells as well as the basic differences between animal and plant cells**
- **To analyze the relation between the structure and function of specialized cells**
- **To understand that cells, tissues, organs and systems represent increasing degree of organization in living organisms**
- **To develop an understanding of the principles of diffusion, osmosis and active transport**
- **To develop the necessary skills to use the microscope effectively**

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.* *Students are expected to know how to draw simple diagrams of a typical animal and a typical plant cell as seen under the light microscope.*
	Movement of substances in and out of cells: diffusion; osmosis; active transport	*Students are expected to be familiar with simple experiments to demonstrate diffusion and osmosis.*

<table>
<tr><td colspan="3">Learning outcomes:
▪ To understand that evolution provides a basis for classification
▪ To appreciate why classification is necessary
▪ To name the five major kingdoms and describe their distinguishing features
▪ To identify viruses as borderline cases between living and non –living things</td></tr>
<tr><td>b. Different forms of life</td><td>The evolutionary development of unicellular life forms into multicellular life forms.</td><td>The concept of division of labour in multicellular organisms.
Students are required to be familiar with specialized cells including the muscle cell, nerve cell, red blood cell, white blood cell, sperm, egg, palisade cell, root hair cell
Surface area to volume ratio in relation to problems of increased size in multicellular organisms. Students are expected to know how to calculate the surface area to volume ratio of a cube.</td></tr>
<tr><td rowspan="6"></td><td colspan="2">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 <u>not</u> be required. Students 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.</td></tr>
<tr><td>Viruses</td><td>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.</td></tr>
<tr><td>The bacteria kingdom</td><td>Outline structure of a bacterium as an example of a prokaryotic cell.</td></tr>
<tr><td>The protist kingdom</td><td>Outline structure of a unicellular plant-like and a unicellular animal-like protist.</td></tr>
<tr><td>The fungus kingdom</td><td>Outline structure with reference to a unicellular and a filamentous fungus.</td></tr>
<tr><td>The plant kingdom</td><td>Cellular and functional features characteristic of plants.</td></tr>
<tr><td rowspan="3"></td><td colspan="2">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:</td></tr>
<tr><td>Bryophytes (as exemplified by mosses)</td><td>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).</td></tr>
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	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. Students 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.*
Learning outcomes: ▪ **To use the binomial system of nomenclature** ▪ **To use a key effectively**		
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

Learning outcomes:

- **To recognize the different parts of a typical flower and their functions**
- **To distinguish between sexual and asexual reproduction**
- **To identify the main methods of asexual reproduction**
- **To define the term pollination and understand the difference between self and cross pollination**
- **To describe how flowers are adapted to pollination by insects and wind**
- **To outline the sequence of events involved in fertilisation, leading to the formation of fruits and seeds**
- **To define the term dispersal and identify the different methods of fruit and seed dispersal**
- **To define the term germination and describe the changes taking place during germination together with the conditions necessary for germination**

a. 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.	*Students 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.	*Students should be able to distinguish between epigeal and hypogeal germination.* *Students are expected to have performed simple experiments investigating factors affecting germination.*

Learning outcomes: ▪ **To understand that living organisms require certain conditions for their survival** ▪ **To distinguish between biotic and abiotic factors** ▪ **To understand that living organisms interact with one another and with their environment** ▪ **To identify the effect/s of biotic factors including predator – prey relationships; inter and intra-specific - competition and parasitism and mutualism** ▪ **To recognize the effect/s of different biotic and abiotic factors on human population**		
b. 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. Students 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.	*Students 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	
	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. Students 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.* *Students are expected to be familiar with simple controlled experiments demonstrating these tropisms.*
	Biotic factors should include: (i) predator-prey relationships	*Students 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	*Students 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	*Students 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. Details about differing Birth and Death Rates is not required.*

Part 3: Living together **Learning outcomes** ▪ **to appreciate the interrelatedness of biotic and abiotic features occurring within soil** ▪ **To identify the main components of soil** ▪ **To become familiar with both beneficial and harmful soil organisms** ▪ **To know the role of saprophytic digestion in the recycling of nutrients** ▪ **To identify the role of roots in the uptake of water and mineral ions**		
a. 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.	*Students 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.*

Appendix

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. Cells: use of a microscope to observe prepared slides of plant and animal cells

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. 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.

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

8. 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.

9. 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.

10. Sensitivity to Temperature

(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.

11. 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.

12. 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

13. 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.

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

15. 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.

16. Biology site visits:

    a. Experimental farm

    b. Fish farm

    c. Plant Nursery

    d. Nature reserves

    e. Water treatment plant

    f. Reverse osmosis plant

    g. Natural history museum

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