Cambridge Assessment

O Level

Biology

Session: 1974
Type: Syllabus
Code: 550

BIOLOGY (550)

The intention of this syllabus is to lead to an understanding of biological processes. The similarity of the basic life processes in animals and plants has been stressed in Section I. In Section II, attention should be focussed more on the study of the interdependence of organisms. Where possible all observations should be made on living organisms and, if appropriate, in their natural surroundings, so that the relationships among animals and plants become apparent. In order that the study of ecology in the field may be further encouraged, an optional fieldwork project scheme is now available for centres in the United Kingdom.* The section on reproduction has been enlarged to include a study of genetics.

As the cell is the basis of life, reference should be made wherever appropriate to the structure of cells and tissues, particularly in relation to their functions. When the cellular structure of particular animal or plant organs is being considered, this should, wherever possible, be demonstrated by means of a microscope or microprojector.

An experimental approach to all physiological work is expected. An understanding of controls is essential, together with the realization that, when there are several variables, these must be investigated one at a time. Where appropriate, quantitative experiments should also be carried out. Practical work both in and outside the laboratory is of great importance, and one of its main educational values is the stimulation of interest in biology. It is impossible to over-emphasize the importance of accuracy and detail both in drawing plants and animals and in keeping other records.

The syllabus is not meant to be a teaching syllabus and the notes which are printed in smaller type are intended to help teachers to appreciate the scope of the examination. It is expected that teachers will develop a sequence of lessons that appeals to their own teaching methods. Knowledge of the differences between living and non-living matter, characteristics of living organisms and differences between plants and animals has been assumed, whilst from previous elementary courses many pupils may be familiar with some details of the life-cycles and natural habitats of certain organisms.

There will be two papers.

Paper 1 will be a 2½-hour paper containing eight questions. Candidates will answer Question 1 (40 *marks*) and any three of the remaining questions (60 *marks*). It should be understood that candidates need not repeat in writing information that has already been included in diagrams or drawings, but if these are chosen as the best means of giving information they should be suitably annotated.

Paper 2 will be a 1½-hour practical test (45 *marks*) in which there will be no choice of question.

* To allow for the fact that this scheme is not available in the Caribbean area, an extra question on ecology (Section II 4) may be set for Caribbean candidates only. If such a question is included on Paper I, there will be 9 instead of 8 questions.

DETAILED SYLLABUS

I. LIFE PROCESSES

1. NUTRITION. Proteins, carbohydrates and fats, mineral salts, vitamins. Importance of water. Enzymes.

> Tests for protein, starch, sugar and fat should be carried out by the pupil himself. Digestive enzymes and other enzymes should be discussed, and their fundamental importance stressed, e.g. the action of catalase may be demonstrated readily by allowing a few drops of blood to fall into hydrogen peroxide solution.

Nutrition of green plants: (*a*) photosynthesis; the form and internal structure of leaves in relation to photosynthesis, (*b*) mineral nutrition.

> (*a*) Experiments should be performed to show the necessity for light, carbon dioxide and chlorophyll, and the formation of starch and oxygen. (*b*) Experiments showing the importance of major elements, using water or sand-cultures, should be carried out.

Nutrition and structure of a common mould (*Mucor* or *Rhizopus*).

Nutrition of animals: ingestion, digestion, absorption and assimilation of food in (*a*) *Amoeba* and (*b*) a mammal, including the alimentary canal and associated glands.

> Candidates should be made familiar with the appearance and position of the internal organs referred to in the syllabus through actual dissections shown them by the teacher. They will not be expected to reproduce from memory drawings of complete dissections they have seen.

Transport of materials within the organism: (*a*) the circulatory

system of a mammal as a transport system; structure of the heart, arteries, veins and capillaries.

Names will be required only of main blood vessels of the liver and kidney and those entering and leaving the heart. Blood should be examined microscopically. A tadpole's gill or tail, or alternatively the web of a frog's foot, may be used to demonstrate capillary circulation.

(*b*) The transport of materials in higher plants: the internal structure of roots and stems in relation to transport. Diffusion, osmosis and turgor in relation to absorption of water and solutes. The transpiration stream in plants.

Diffusion and osmosis should be shown with an artificial cell and with living material. Experiments on transpiration and transpiration rates should be performed both by weighing methods, and by using cobalt chloride paper (or cobalt thiocyanate paper). The rise of water in the xylem should be demonstrated by the use of dyes.

The storage of food in the liver, in two plant vegetative structures, in fruits and in seeds.

2. RESPIRATION. The process of respiration, involving oxidation of food substances and the release of energy in green plants, seeds, micro-organisms and animals.

Breathing mechanisms in an insect, a bony fish and a mammal.

Experiments should be carried out to demonstrate gaseous exchange and production of heat. Anaerobic respiration is not required.

3. EXCRETION. Elimination of metabolic by-products in (*a*) *Amoeba*; (*b*) a mammal: excretion through the lungs and the kidneys; elimination of heat, temperature regulation by the skin.

The kidney should be treated as comprising cortex and medulla and consisting of a branched system of tubules, well supplied with blood-vessels, leading to the ureter. Details of the courses of the tubules and their blood-vessels will not be required.
Reference should be made to the incidental small losses of nitrogenous products and mineral salts from the skin and to osmo-regulation.

Gaseous exchange in flowering plants.

4. GROWTH AND DEVELOPMENT: regions of growth in stems and roots. Germination of one named seed: life history of a housefly.

Experiments should be performed to show regions of growth in stems and roots. The structure and division of the cell should be considered simply. Details of the structure of organelles other than the nucleus are not required (see I 8, *mitosis*).

5. RESPONSE. Tacit responses to light, water and contact exhibited by invertebrates.

Simple experiments on responses should be performed, e.g. with earthworms, woodlice, blowfly larvae.

Tropic responses to light and gravity exhibited by plants.

Experiments on phototropism and geotropism in shoots, and geotropism in roots, should be performed.

The control of response in plants: the hormone (auxin) explanation.

The effects of decapitating the coleoptiles of germinating cereals and applying indolyl acetic acid should be demonstrated.

The control of response in animals: endocrine organs and hormones.

Reference should be made to insulin, adrenalin, thyroxine and secretin.

The nervous system: structure of the nerve cell (neurone), synapses, reflex arcs, simple and conditioned reflexes. Gross structure of the brain and spinal cord of a mammal related very simply to function.

Receptor organs: receptors in the skin and organs of special sense:

(*a*) the eye: accommodation; correction of long-sight and short-sight;

(*b*) the ear: hearing and balance.

Simple experiments on reflexes should be performed by the pupil, e.g. 'knee jerk' (simple reflex), salivation on smelling food (conditioned reflex).

6. LOCOMOTION. Locomotion in an insect or other arthropod.

A consideration of the action of muscles on the exoskeleton is required and may be studied in an insect, but a larger arthropod (e.g. crayfish) may be used with advantage to demonstrate this.

The skeleton in a mammal. Locomotion in a mammal. The axial and appendicular skeleton.

A vertebra should be regarded as being composed of a body (centrum) carrying arches, neural spine and transverse processes with facets for articulation. The names of the articulatory processes will not be required.
A functional treatment is required. Different types of joint illustrated by shoulder or hip, elbow or knee, and the way muscles act on bones to cause movement, should be considered. Details of the skull, the bones of the carpus and the names of the individual bones of the pelvis are not required.

7. REPRODUCTION. Binary fission in *Amoeba* and asexual reproduction in a mould (*Mucor* or *Rhizopus*).

Sexual reproduction in a vertebrate that has external fertilization, a bird and a mammal.

Breeding habits of these animals should be considered together with the parental care for the young organism. A simple study of the reproductive organs in a mammal, together with a general outline of the development, nutrition and respiration of the embryo.

Sexual reproduction in higher plants; the structure of flowers; pollination and fertilization; development of fruit and seed; dispersal. One natural example and one artificial example of vegetative reproduction in flowering plants.

Structure can best be examined in a *large* flower, e.g. tulip. Structure and pollination should be studied in an 'open' flower, e.g. tulip, a flower with protected essential organs, e.g. antirrhinum, and also in a flower that is wind-pollinated. Fertilization should be considered without reference to microscopic detail other than the growth of the pollen tube and fusion of nuclei.
Dispersal in the types used to illustrate flower structure should be studied, and examples of wind, animal and self dispersal.

8. GENETICS. Variation within plant and animal species.

Candidates should be aware of genetic and environmental causal factors, and reference should be made to some human characters such as eye colour, skin colour, finger prints and tongue rolling.

Monohybrid inheritance.

Monohybrid crosses to illustrate complete and incomplete dominance should be studied, and the several examples should include some involving human characters such as albinism and the ABO blood groups. Reference should be made to the pioneer work of Mendel and of Morgan.

Chromosomes and genes. Mitosis and meiosis.

The main stages of mitosis and meiosis should be known. In mitosis, emphasis should be laid on the exact duplication of the genetic material. In meiosis the pairing of the homologous chromosomes and their subsequent separation, with the resultant halving of the chromosome number and segregation of characters, should be stressed. The characteristic appearance of chiasmata, as seen in pictures of meiotic prophase in grasshoppers or in preparations of fresh material, may be explained as homologous pairs of chromosomes exchanging parts by breakage and reunion (crossing over).
Structural details of the DNA molecule are not required.

Sex chromosomes and sex linkage.

Sex linkage should be exemplified by reference to haemophilia and red-green colour blindness in Man.

Mutation and natural selection.

The natural occurrence and the artificial induction of mutations should be considered. The role of mutations as the raw material upon which natural selection operates to produce evolutionary change should be emphasised. Attention might be drawn to blood groups and even red-green colour blindness as variations within the normal range of human functions; for none of these is it appropriate to refer to any genotype as abnormal.
Candidates should be familiar with practical work on variation and on monohybrid crosses.

II. INTERDEPENDENCE OF LIVING ORGANISMS

1. FOOD RELATIONSHIPS. Nutritional dependence of all life on photosynthesis. Food chains; biological equilibrium.

Reference should be made to the consequences of natural disturbances of, as well as man's interference with, nature, e.g. the consequence of the destruction of rabbits in the United Kingdom through the epidemic of myxomatosis in 1954–55; the destruction of bird life by means of poisonous sprays used for pest control and the possible implications.

The carbon and nitrogen cycles, showing the roles of green plants, animals and microorganisms.

2. PARASITISM. Disease organisms; a general treatment of protozoa, fungi, bacteria and viruses.

Reference should be made to the housefly and one other insect carrier of disease. Candidates should have sufficient knowledge of the life-history of these insects for an understanding of the methods of control that are adopted. Details of the life cycle of the parasite **within** the vector are not required. Disease of both plants and animals should be mentioned.

3. SOILS. Physical and chemical properties of soils. The soil as a medium for plant and animal life.

Candidates should make a practical study of the physical and chemical properties of soils. When considering soil as a medium for life attention should be paid to the effects of differing physical and chemical characteristics of soils on soil animals and plants and on crop production.

4. *RELATIONSHIP OF PLANTS AND ANIMALS TO THEIR ENVIRONMENT. Candidates will be expected to have made one of the following simple ecological studies: **either** (*a*) a study in some detail of a single animal species **and** a single plant species in their **natural** habitats, **or** (*b*) a study of the animal and plant population in one **natural** habitat.

Where appropriate, studies in (*a*) or (*b*) should include such features as:

(i) identification and characteristics of the species;

(ii) quantitative sampling, methods of collecting;

(iii) recognized methods of survey, e.g. line or belt transects, quadrats, capture-recapture;

(iv) methods of estimating frequency, density, percentage cover, etc.;

(v) experimental approach to solving problems of adaptation;

(vi) problems posed by the environment and adaptation of species;

(vii) physical features of the environment and their effect on the life of the organisms;

(viii) seasonal change, colonization and succession;

(ix) food chains or webs, pyramid of numbers, primary producers, primary and secondary consumers, interdependence of species. Influence of man. (See also Section II, 1.)

This list is offered as a guide, and it is not expected that every student will be familiar with every method, but teachers are asked to make sure that candidates are acquainted with the technical terms applicable to their method of study.

The following studies are given as suitable examples but the list is not intended to be exhaustive.

Garden weeds. The following is a suggested outline of procedure, suitable for a group of, say, 4–12 pupils:

On a given area of garden, examine five or six of the commonest weed species present, accurately identify, carefully record the characteristic morphological features of each and classify as annual, biennial or perennial.

Make careful records of the growth and development of each throughout the year. The following records are suggested – date of

* For centres in the United Kingdom, section II 4 will be examined by an optional field-work project scheme only. Questions on this section will no longer be set in Paper I.

emergence of seedlings or start of vegetative growth, date of opening of first flower, length of the period over which the individual plant and the species flowers and fruits, accurate drawings of the appearance of seedlings, vegetative plants, flowers, fruits and seeds, mechanism of fruit or seed dispersal.

Describe what happens to the plants if the land on which they are growing is disturbed by man, whether or not they are killed and, if so, whether, and when, new seedlings or plant parts arise.

Quantitative data should be collected on numbers of seedlings or vegetative shoots of each species emerging in a prescribed area and the numbers surviving to produce seeds. Using a small number of plants, an estimate can be made of the number of seeds produced per plant and per unit area studied; some estimate can also be made of the differing numbers of seeds per plant and per unit area when weeds have grown alone and in close proximity to other crop and weed plants.

Seeds might be collected from plants and an attempt made to germinate a proportion of these at different times after harvesting. After seed dispersal, cores of soil might be taken, spread out to a depth of about $\frac{1}{2}$ in. in boxes, kept moist and the number of young plants emerging and the time of their appearance recorded. Seedlings should be removed after identification. After the above records have been taken, the teacher should discuss with the pupils the ecological significance of the results, showing which ecological factors are important in the habitat studied, why the plants considered survive in that environment, in which other environments would they be likely to be found and how they could be controlled.

Trees. A study of trees could be conducted in public gardens or parks, or copses, and could be restricted to coniferous or deciduous species, or even a single species. Suitable aspects for study include pests, galls, modes of seed dispersal.

Animals in a particular habitat, e.g. soil animals; or animals in a pond, or stream; or arthropods, or birds of a selected habitat. It is important that some attention be paid to the physical conditions that prevail.

Special habitats in which the flora and fauna are relatively restricted e.g. rock pools, tree stumps, sand dunes, shingle beaches, old walls.

FIELD WORK PROJECT SCHEME

The scheme is optional and applies only to centres in the United Kingdom.

Project Approval

Suggested outlines of projects must be submitted to the Syndicate not later than 1 November in the year preceding the examination. After approval by the Syndicate's examiners, final application should be made on the appropriate form by 20 December.

Size of Work Group

No limit is set on the numbers of candidates permitted to undertake any one project, although it is anticipated that most studies will be carried out by groups of four to twelve students. However, *individual reports* must be submitted in all cases.

Teacher Assessment

Teachers will be asked to award marks on the following bases.

1. Knowledge and understanding.
2. Ingenuity, initiative and persistence.
3. Results.
4. Evaluation.
5. Presentation of report.

The Syndicate will invite comments from the teacher with regard to facilities for field work in and around the school premises. These comments may be taken into consideration by the Moderator.

Moderation

1. The teacher's assessment must reach the Syndicate not later than 1 May in the year of the examination, and should be accompanied by three reports (from the top, bottom and middle of the class).

2. The Syndicate's moderators will check these sample reports against the teacher's assessment, and will visit schools where some discrepancy is evident.

3. The moderators will visit 20 per cent of those schools submitting projects (including those mentioned in 2).

4. All reports and other evidence of field work should be available for moderation during the month of May.

Bonus

Projects will be awarded a bonus mark which may raise a candidate's over-all performance in the subject by a maximum of one grade.

PRACTICAL EXAMINATION

1. The practical examination is designed to test candidates for the following abilities:

(*a*) to follow carefully a sequence of instructions within a set time allowance;

(*b*) to use familiar, and unfamiliar, techniques to record their observations and make deductions from them;

(*c*) to recognize and observe features of familiar and unfamiliar biological specimens, record their observations and make deductions about functions of whole specimens or their parts;

(*d*) to make clear line drawings of the specimens *provided*, indicate magnification and to label familiar structures;

(*e*) to interpret unfamiliar data and draw conclusions from their interpretation;

(*f*) to employ manual skills in assembling apparatus, in using chemical reagents and in using such instruments as mounting needles, scalpels and razor blades, forceps and scissors;

(*g*) to observe reactions, read simple measuring instruments and perform simple arithmetical calculations.

2. Candidates may be asked to carry out simple physiological experiments involving tests for food substances, enzyme reactions, bicarbonate indicator solution, decolourising leaves, etc. It is expected that glassware and instruments normally found in a laboratory, e.g. beakers, test-tubes, test-tube racks, funnels, thermometers, droppers and so on, should be available for these experiments.

3. Candidates may be asked to carry out simple operations involving the use of the above mentioned instruments (1*f*) on plant or animal material. Accurate observations of these specimens will need a hand lens of not less than $\times 6$ magnification for each candidate and a low power microscope at the rate of one per three candidates.

4. The material set will be closely related to the subject matter of the syllabus, but will not necessarily be limited to the particular types mentioned therein. In order to assist their own practical work, and to supply possible examination specimens, schools are asked to build up a reference collection of material, e.g. bones of the rabbit or rat.

Footnote

The food tests expected in paragraph 2 above are as follows.

Reducing sugars - Fehling's or Benedict's solution.

Non-reducing sugars - Fehling's or Benedict's solution after hydrolysis with dilute hydrochloric acid.

Starch - Iodine solution.

Fats - Ethanol emulsion test.

Protein - Millon's reagent or *biuret* test.

AGRICULTURAL SCIENCE* (523)

The aim of this subject is to provide a course in Elementary Science for those whose interests lie in agriculture. The subject is normally restricted to candidates in schools that have been inspected and approved as being suitably equipped to provide a course of practical work. *Applications **must** be made in advance and should include details of the facilities for practical work both at the school and on a farm.*

It is expected that the subject-matter will be treated practically in the laboratory as well as in the field. Some of the practical work will be in the form of demonstrations or visits to farms, but candidates will also be expected to have carried out individual practical work.

Part I of the detailed syllabus deals with basic scientific principles, a knowledge of which is essential to a proper understanding of agricultural practices. Part II is concerned with these agricultural practices.

DETAILED SYLLABUS

PART I. ELEMENTARY SCIENTIFIC PRINCIPLES

1. ELEMENTS OF PHYSICS AND CHEMISTRY. Throughout this section the subject-matter should be studied only in sufficient detail to provide an understanding of the other parts of the syllabus.

(*a*) Elements, compounds and mixtures. Atoms and molecules. Formulae and equations as a means of giving a picture of chemical changes. Solid, liquid and gaseous states. Solutions of solids and gases in liquids. Saturation. The air as a mixture containing oxygen, nitrogen, carbon dioxide, water vapour.

(*b*) Properties of oxygen. Oxides; oxidation, including rusting of iron. Combustion and release of energy. Water as an oxide of hydrogen.

* An alternative syllabus (**526**) for candidates in the Caribbean area is available on request.

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For communication to members of staff concerned

UNIVERSITY OF CAMBRIDGE

LOCAL EXAMINATIONS SYNDICATE

GENERAL CERTIFICATE OF EDUCATION

Subject Syllabuses S 1974—'O' Level Biology Syllabus 550

Amendment

1. Page 65. For 'tacit' read 'tactic'.

2. Page 71 Practical Examination paragraph 3. Delete the phrase "and a low power microscope at the rate of one per three candidates".