BIOLOGY

HIGHER 1 (2017)

(Syllabus 8875)

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Singapore Examinations and Assessment Board

CAMBRIDGE International Examinations

PREAMBLE

This preamble sets out the approach, objectives, directions and philosophy of the design of the new H1 syllabus.

With recent advancements in the Life Sciences, changes in knowledge have been tremendous. Many new and important fields of Biology have emerged as evident from the sprouting of scientific journals catering to niche areas of study and research. This poses a challenge in the development of Biology education in integrating the fundamental concepts, skills and new knowledge in Biology into a framework that is made accessible to students at different levels.

The approach we have taken to organise Biology education from Primary to A Levels is as follows:

(a) Primary 3 to Primary 6: How life works at the systems level

(b) Lower Secondary Science to O Level Biology: How life works at the physiological level

(c) A Level: How life works at the cellular and molecular level.

The proposed framework will chart a new direction in Biology education in schools.
Starting at the Primary school levels, the focus is for the students to be exposed at the systems level. At the Secondary school levels, the syllabus will help the students relate concepts at the systems level to the micro-level. In addition, at the A Level, the syllabus will enable the students to look deeper into how life works at the molecular level, yet balanced with the study of Evolution.

At the A Level, students have the choice of offering Biology at H1 or H2 levels. The H1 Biology syllabus is distilled from the H2 Biology syllabus. It is designed as a contrasting subject and is intended for foundational study to provide students with a sufficient understanding of the subject rather than just for appreciation. The H1 Biology syllabus has about half the content load of the H2 Biology syllabus, while maintaining the same rigour.

In teaching the H1 syllabus, the following should be noted:

(a) H1 Biology should provide some fundamental knowledge to enable students to understand some major emerging fields of knowledge in Biology

(b) H1 Biology should equip the students with scientific skills and abilities relevant to the study and practice of biological science

(c) The Biology syllabus is developed as a continuum from the O to A Levels. The H1 and O Level Biology syllabuses are designed to be seamless without the need for topics to be revisited at the A Level. The O Level syllabus is foundational and thus should provide the necessary background for the study at the A Level

(d) The teaching of H1 Biology should relate information on the cellular and molecular level to the systems level.

INTRODUCTION

Candidates will be assumed to have knowledge and understanding of O Level Biology, as a single subject or as part of a balanced science course.

The syllabus has been arranged in the form of Core and Applications content to be studied by all candidates.

Experimental work is an important component and should underpin the teaching and learning of Biology.

The syllabus places emphasis on the applications of Biology and the impact of recent developments on the needs of contemporary society.

All candidates following this syllabus should be encouraged to:

- use secondary sources of information
- use information technology (I.T.) to analyse, store and retrieve data and to model biological phenomena
- communicate biological information orally, as well as in writing.

It is intended to keep the syllabus under frequent review, to ensure that it keeps abreast of knowledge in the biological sciences and other needs.

AIMS

The syllabus aims to:

1. provide, through well designed studies of experimental and practical biological science, a worthwhile educational experience for all students, whether or not they go on to study Biology beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to:

    1.1 become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific import

    1.2 recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life

    1.3 be suitably prepared for studies beyond A Level in biological sciences and in further education.

2. stimulate students, create and sustain their interest in Biology, and understand its relevance to society.

3. develop abilities and skills that:

    3.1 are relevant to the study and practice of biological science

    3.2 are useful in everyday life

    3.3 encourage efficient and safe practice

    3.4 encourage effective communication.

4. develop attitudes relevant to Biology such as:

    4.1 concern for accuracy and precision

    4.2 objectivity

    4.3 integrity.

5. assist the development of:

    5.1 the skills of scientific inquiry

    5.2 initiative

    5.3 inventiveness.

6. stimulate interest in and care for the local and global environment, and understand the need for conservation.

7. promote an awareness:

    7.1 that scientific theories and methods have developed, and continue to do so, as a result of co-operative activities of groups and individuals

    7.2 that the study and practice of biological science is subject to social, economic, technological, ethical and cultural influences and limitations

    7.3 that the applications of biological science may be both beneficial and detrimental to the individual, the community and the environment

    7.4 that biological science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal

    7.5 of the importance of the use of I.T. for communication, as an aid to experiments and as a tool for the interpretation of experimental and theoretical results.

ASSESSMENT OBJECTIVES

These describe the knowledge, skills and abilities which candidates are expected to demonstrate at the end of the course. They reflect those aspects of the aims which will be assessed.

A Knowledge with understanding

Students should be able to demonstrate knowledge and understanding in relation to:

1. biological phenomena, facts, laws, definitions, concepts, theories

2. biological vocabulary, terminology, conventions (including symbols, quantities and units)

3. scientific instruments and apparatus used in biology, including techniques of operation and aspects of safety

4. scientific quantities and their determination

5. biological and technological applications with their social, economic and environmental implications.

The syllabus content, examples and elaborations define the factual materials that candidates need to recall and explain. Examiners will assume that candidates have studied these and questions may refer to content, examples and elaborations. Questions testing the objectives above will often begin with one of the following words: *define, state, name, describe, explain* or *outline.* (See the Glossary of Terms.)

B ***Handling information and solving problems***

Students should be able – using written, symbolic, graphical and numerical material – to:

1. locate, select, organise and present information from a variety of sources
2. translate information from one form to another
3. manipulate numerical and other data
4. use information to identify patterns, report trends, draw inferences and report conclusions
5. present reasoned explanations for phenomena, patterns and relationships
6. make predictions and propose hypotheses
7. apply knowledge, including principles, to novel situations
8. solve problems.

The assessment objectives above cannot be precisely specified in the syllabus content because questions testing such skills are often based on information which is unfamiliar to the candidate. In answering such questions, candidates are required to use principles and concepts that are within the syllabus and apply them in a logical, deductive manner. Questions testing these objectives may begin with one of the following words: *discuss, predict, suggest, calculate* or *determine.* (See the Glossary of Terms.)

SCHEME OF ASSESSMENT

Paper	Type of Paper	Duration	Marks	Weighting (%)
1	Multiple choice	1 hour	30	33
2	Structured and free-response	2 hours	60	67

Paper 1 (1 hour, 30 marks)

This paper consists of 30 compulsory multiple choice questions. All questions will be of the direct choice type with four options.

Paper 2 (2 hours, 60 marks)

This paper comprises two sections.

Section A will consist of a variable number of structured questions including at least one data-based or comprehension-type question, all compulsory. These include questions which require candidates to integrate knowledge and understanding from different areas of the syllabus.

Section B will consist of two free-response questions of 20 marks each from which candidates will choose **one**. The question requires candidates to integrate knowledge and understanding from different areas of the syllabus.

MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

This is given in the following Assessment Grid.

Assessment Objective		Weighting (%)	Assessment Components
A	Knowledge with understanding	55	Papers 1, 2
B	Handling information and solving problems	45	Papers 1, 2

Fifteen percent of the total marks will be awarded for awareness of the social, economic, environmental and technological implications and applications of Biology. These will be awarded within the 'Knowledge with understanding' and the 'Handling information and solving problems' categories.

DISALLOWED SUBJECT COMBINATIONS

Candidates may not simultaneously offer Biology at H1 and H2 levels.

ADDITIONAL INFORMATION

Modern biological sciences draw extensively on concepts from the physical sciences. It is desirable therefore that, by the end of the course, candidates should have a knowledge of the following topics, sufficient to aid understanding of biological systems. No questions will be set directly on them.

The electromagnetic spectrum
Energy changes (potential energy, activation energy, chemical bond energy)
Molecules, atoms, ions, electrons
Acids, bases, pH, buffers
Isotopes, including radioactive isotopes
Oxidation and reduction
Hydrolysis, condensation

Questions set in the examination may involve the basic processes of mathematics for the calculation and use of decimals, means, ratios and percentages. Students will be expected to be familiar with the nomenclature used in the syllabus. The proposals in '*Signs, Symbols and Systematics*' (The Association for Science Education Companion to 16–19 Science, 2000) and the recommendations on terms, units and symbols in '*Biological Nomenclature*' (2000) published by the Institute of Biology, in conjunction with the ASE, will generally be adopted although the traditional names sulfate, sulfite, nitrate, nitrite, sulfurous acid and nitrous acid will be used in question papers. Sulfur (and all compounds of sulfur) will be spelt with f (not with ph) in question papers, however students can use either spelling in their answers.

Candidates may be required to (i) construct graphs or present data in other suitable graphical forms, (ii) calculate rates of processes. Candidates should be aware of the problems of drawing conclusions from limited data.

STRUCTURE OF SYLLABUS

The syllabus is divided into two parts: the Core syllabus and the Applications syllabus, to be studied by all candidates.

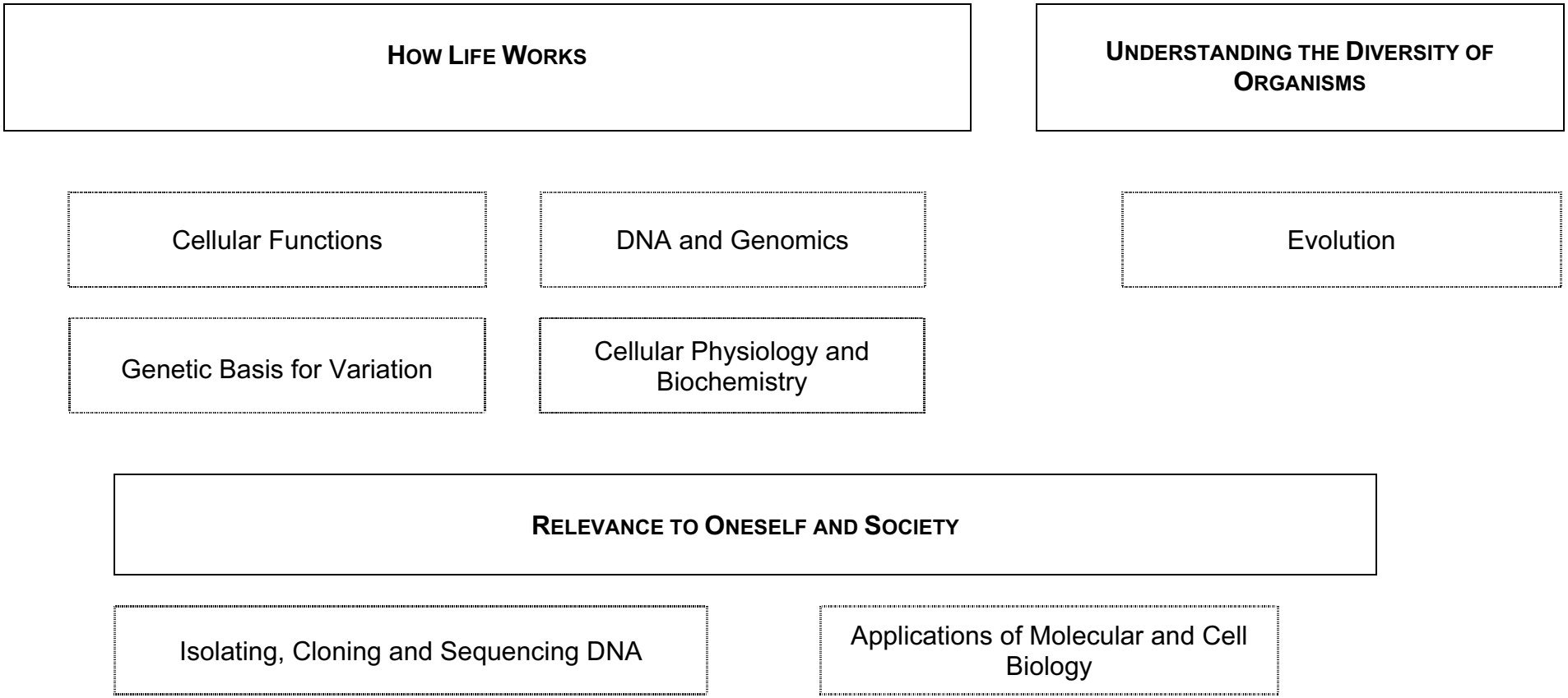
A. The Core syllabus. There are **5 core topics:**

1. Cellular Functions
2. DNA and Genomics
3. Genetic Basis for Variation
4. Cellular Physiology and Biochemistry
5. Evolution

B. The Applications syllabus. There are **2 application topics**:

6. Isolating, Cloning and Sequencing DNA
7. Applications of Molecular and Cell Biology

OVERALL FRAMEWORK FOR BIOLOGY H1 LEVEL SYLLABUS FOR 2017



CORE SYLLABUS

1 Cellular Functions

Content

- Detailed structure of typical animal and plant cells, as seen under the electron microscope
- Outline functions of organelles in plant and animal cells
- The structure of carbohydrates, lipids and proteins and their roles in living organisms
- Mode of action of enzymes
- Replication and division of nuclei and cells
- Understanding of chromosome number and variation

Learning Outcomes

Candidates should be able to:

(a) describe and interpret drawings and photographs of typical animal and plant cells as seen under the electron microscope, recognising the following membrane systems and organelles: rough and smooth endoplasmic reticulum, Golgi body, mitochondria, ribosomes, lysosomes, chloroplasts, cell surface membrane, nuclear envelope, centrioles, nucleus and nucleolus (knowledge of the principles of TEM and SEM are **not** required)

(b) outline the functions of the membrane systems and organelles listed in (a)

(c) describe the formation and breakage of a glycosidic bond

(d) analyse the molecular structure of a triglyceride and a phospholipid, and relate these structures to their functions in living organisms

(e) describe the structure of an amino acid and the formation and breakage of a peptide bond

(f) explain the meaning of the terms *primary structure, secondary structure, tertiary structure* and *quaternary structure* of proteins, and describe the types of bonding (hydrogen, ionic, disulfide and hydrophobic interactions) which hold the molecule in shape

(g) analyse the molecular structure of a protein with a quaternary structure, e.g. haemoglobin, as an example of a globular protein, and collagen, as an example of a fibrous protein, and relate these structures to their functions

(h) explain the mode of action of enzymes in terms of an active site, enzyme/substrate complex, lowering of activation energy and enzyme specificity

(i) investigate and explain the effects of temperature, pH, enzyme concentration and substrate concentration on the rate of enzyme-catalysed reactions, and explain these effects

(j) explain the effects of competitive and non-competitive inhibitors (including allosteric inhibitors) on the rate of enzyme activity

(k) explain the importance of mitosis in growth, repair and asexual reproduction

(l) explain the need for the production of genetically identical cells and fine control of replication

(m) explain how uncontrolled cell division can result in cancer, and identify causative factors (e.g. genetic, chemical carcinogens, radiation) which can increase the chances of cancerous growth (knowledge that dysregulation of checkpoints of cell division can result in uncontrolled cell division and cancer is required, but detail of the mechanism is **not** required)

(n) describe, with the aid of diagrams, the behaviour of chromosomes during the mitotic cell cycle and the associated behaviour of the nuclear envelope, cell membrane and centrioles (names of the main stages are expected)

(o) explain the need for reduction division (meiosis) prior to fertilisation in sexual reproduction

(p) explain how meiosis and random fertilisation can lead to variation (detailed description of the behaviour of chromosomes during meiosis and information about the stages and associated behaviour of the nuclear envelope, cell membrane and centrioles are **not** required).

Use the knowledge gained in this section in new situations or to solve related problems.

2 DNA and Genomics

Content

- DNA – structure and function
- Central dogma – DNA to RNA, RNA to protein

Learning Outcomes

Candidates should be able to:

(a) describe the structure and roles of DNA and RNA (tRNA, rRNA and mRNA) (mitochondrial DNA is **not** required)

(b) describe the process of DNA replication and the experimental evidence for semi-conservative replication

(c) describe how the information on DNA is used to synthesise polypeptides in eukaryotes (description of the processes of transcription, formation of mRNA from pre-mRNA and translation is required)

(d) describe the eukaryotic processing of pre-mRNA in terms of intron splicing

(e) explain how a change in the sequence of the DNA nucleotide (gene mutation) may affect the amino acid sequence in a protein, and hence the phenotype of the organism, e.g. sickle cell anaemia (knowledge of substitution, addition, deletion and frameshift mutations may be required).

Use the knowledge gained in this section in new situations or to solve related problems.

3 Genetic Basis for Variation

Content

- Genotypes and phenotypes
- Mutations
- The effect of genotype and environment on phenotype

Learning Outcomes

Candidates should be able to:

(a) explain the terms, *locus, allele, dominant, recessive, codominant, homozygous, heterozygous, phenotype* and *genotype*

(b) explain how genotype is linked to phenotype and how genes are inherited from one generation to the next via the germ cells or gametes

(c) explain, with examples, how the environment may affect the phenotype

(d) use genetic diagrams to solve problems in dihybrid crosses, including those involving sex linkages, codominance and multiple alleles (but **not** involving autosomal linkage or epistasis)

(e) use genetic diagrams to solve problems involving test crosses (use of chi-squared test is **not** required)

(f) explain what is meant by the terms *gene mutation* and *chromosome aberration* (for chromosome aberration, knowledge of numerical [aneuploidy] and structural [translocation, duplication, inversion, deletion] changes is required).

Use the knowledge gained in this section in new situations or to solve related problems.

4 Cellular Physiology and Biochemistry

Content

- The need for energy in living organisms
- Photosynthesis as an energy-trapping process
- Respiration as an energy-releasing process
- Aerobic respiration
- Anaerobic respiration
- The fluid mosaic model of membrane structure

Learning Outcomes

Candidates should be able to:

(a) with reference to the chloroplast structure, explain the light dependent reactions (**no** biochemical details are needed but will include the outline of cyclic and non-cyclic light dependent reactions and the transfer of energy for the subsequent manufacturing of carbohydrates from carbon dioxide)

(b) outline the three phases of the Calvin cycle: (i) CO_2 uptake, (ii) carbon reduction and (iii) ribulose bisphosphate (RuBP) regeneration and indicate the roles of ATP and NADP in the process

(c) discuss limiting factors in photosynthesis and carry out investigations on the effects of limiting factors, such as light intensity, CO_2 concentration and temperature, on the rate of photosynthesis

(d) list and give an overview of the four stages of aerobic respiration and indicate where each stage takes place in eukaryotic cells and mitochondria, and add up the energy captured (as ATP, reduced NAD and reduced FAD) in each stage

(e) explain the production of a small yield of ATP from anaerobic respiration and the formation of ethanol in yeast and lactate in mammals

(f) compare the storage and structural forms of starch, glycogen and cellulose and their roles in plants and animals

(g) describe and explain the fluid mosaic model of membrane structure, including an outline of the roles of phospholipids, cholesterol, glycolipids, proteins and glycoproteins

(h) outline the roles and functions of membranes within cells and at the surface of cells (knowledge of diffusion, osmosis, facilitated diffusion, active transport, endocytosis and exocytosis is required).

Use the knowledge gained in this section in new situations or to solve related problems.

5 Evolution

Content

- The neo-Darwinian revolution
- Evidence of evolution

Learning Outcomes

Candidates should be able to:

(a) explain why variation is important in selection

(b) explain, with examples, how environmental factors act as forces of natural selection

(c) explain how natural selection may bring about evolution

(d) explain how homology (anatomical, embryological and molecular) supports Darwin's theory of natural selection (with emphasis on descent with modification).

Use the knowledge gained in this section in new situations or to solve related problems.

APPLICATIONS SYLLABUS

6 Isolating, Cloning and Sequencing DNA

Content

- DNA cloning (genetic engineering)
- DNA analysis and genomics
- Human Genome Project

Learning Outcomes

Candidates should be able to:

(a) describe the natural function of restriction enzymes

(b) explain the formation of recombinant DNA molecules

(c) outline the procedures for cloning a eukaryotic gene in a bacterial plasmid and describe the properties of plasmids that allow them to be used as DNA cloning vectors

(d) explain how eukaryotic genes are cloned using *E. coli* cells to produce eukaryotic proteins to avoid the problems associated with introns

(e) outline two important proteins that can be produced by genetic engineering technique (e.g. human growth hormone and insulin)

(f) describe the polymerase chain reaction (PCR) and explain the advantages and limitations of this procedure

(g) explain how gel electrophoresis is used to analyse DNA

(h) discuss the goals and implications of the Human Genome Project, including the benefits and difficult ethical concerns for humans (knowledge of the technical procedure of the Human Genome Project and DNA sequencing is **not** required).

Use the knowledge gained in this section in new situations or to solve related problems.

7 Applications of Molecular and Cell Biology

Content

- Stem cells
- Use of microorganisms and chemicals for yield improvement
- Genetic engineering and genetically modified organisms (GMOs)

Learning Outcomes

Candidates should be able to:

(a) describe the unique features of zygotic stem cells, embryonic stem cells and blood stem cells (correctly using the terms totipotency [zygotic stem cells which have ability to differentiate into any cell type to form whole organisms and so are also pluripotent and multipotent], pluripotency [embryonic stem cells which have ability to differentiate into almost any cell type to form any organ and so are not totipotent but are multipotent] and multipotency [blood stem cells which have ability to differentiate into a limited range of cell types and so are not pluripotent or totipotent])

(b) explain the normal functions of stem cells in a living organism (e.g. embryonic stem cells and blood stem cells)

(c) explain the significance of genetic engineering in improving the quality and yield of crop plants and animals and also in solving the demand for food in the world (e.g. Bt corn, golden rice and GM salmon)

(d) discuss the ethical and social implications of genetically modified crop plants and animals (e.g. Bt corn, golden rice and GM salmon).

Use the knowledge gained in this section in new situations or to solve related problems.

TEXTBOOKS AND REFERENCES

Teachers may find reference to the following books helpful.

CORE SYLLABUS

1. Arms, K and Camp, P S (1995) *Biology* (Fourth Edition) (Harcourt Brace College Publishers) ISBN 0030154340
2. Barret, D and Spencer, P (1992) *Genetics and Evolution* Biology Advanced Studies (Nelson) ISBN 0174481977
3. Burnet, L (1986) *Essential Genetics – a Course Book* (CUP) ISBN 0521313805
4. Burnet, L (1988) *Exercises in Applied Genetics* (CUP) ISBN 0521338832
5. Boyle, M and Senior, K (2008) *Biology* (Third Edition) Collins Advanced Science (Collins Educational) ISBN 0007267452
6. Calladine, C R, Drew, H R, Luisi, B F and Travers, A A (2004) *Understanding DNA* (Third Edition) (Academic Press) ISBN 0121550893
7. Campbell, N A and Reece, J B (2007) *Biology* (Eighth Edition) (Pearson) ISBN 0321536169
8. Campbell, N A, Reece, J B, Taylor, M R and Simon, E J (2005) *Biology: Concepts and Connections* (Fifth Edition) (Benjamin Cummings) ISBN 0805371605
9. Carr, M and Cordell, R (1992) *Biochemistry* Biology Advanced Studies (Nelson Thornes) ISBN 0174481969
10. Clegg, C J with MacKean, D J (2000) *Advanced Biology, Principles and Applications* (Second Edition) (Hodder Education) ISBN 0719576709
11. Cummings, S (Ed.) (1998) *Current Perspectives in Biology* (Wadsworth Pub) ISBN 0314206388
12. Drlica, K (2003) *Understanding DNA and Gene Cloning: A Guide for the Curious* (Fourth Edition) (Wiley and Sons) ISBN 0471451630
13. Gould, J L and Keeton, W T (1996) *Biological Science* (Sixth Edition) (New York: W W Norton) ISBN 0393981215
14. Gregory, J (2000) *Applications of Genetics* (Second Edition) Cambridge Advanced Sciences (CUP) ISBN 0521787254
15. Hayward, G (1996) *Applied Genetics* (Bath Science 16–19) (Nelson Thornes) ISBN 0174385110
16. Hogan, K and Palladino, M A (2008) *Stem Cells and Cloning* (Second Edition) (Benjamin Cummings) ISBN 0321590023
17. Jones, M, Fosbery, R and Taylor, D (2000) *Biology 1* Cambridge Advanced Sciences (CUP) ISBN 052178719X
18. Jones, M and Gregory, J (2001) *Biology 2* Cambridge Advanced Sciences (CUP) ISBN 0521797144
19. Jones, M and Jones, G (1997) *Advanced Biology* (CUP) ISBN 0521038030
20. Kent, M (2000) *Advanced Biology* (Oxford University Press) ISBN 0199141959
21. Kimball's Biology Pages (2008). E-textbook available free online at: http://home.comcast.net/%7Ejohn.kimball1/BiologyPages/ http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/
22. Kreuzer, H and Massey, A (2001) *Recombinant DNA and Biotechnology: A Guide for Teachers* (Second Edition) (American Society for Microbiology) ISBN 1555811752
23. Kreuzer, H and Massey, A (2001) *Recombinant DNA and Biotechnology: A Guide for Students* (Second Edition) (American Society for Microbiology) ISBN 1555811760

24. Kreuzer, H and Massey, A (2008) *Molecular Biology and Biotechnology: A Guide For Teachers* (Third Edition) (American Society for Microbiology) ISBN 1555814719

25. Lowrie, P and Wells, S (2000) *Microbiology and Biotechnology* (Second Edition) Cambridge Advanced Sciences (CUP) ISBN 0521787238

26. Mader, S S (2006) *Biology* (Ninth Edition) (McGraw-Hill) ISBN 0073301132

27. Marieb, E N (2012) *Human Anatomy and Physiology* (Ninth Edition) (Pearson) ISBN 0321802187

28. Micklos, D, Freyer, G A and Crotty, D A (2003) *DNA Science – A First Course* (Second Edition) (CSHL) ISBN 1936113171

29. Minkoff, E C and Baker, P J (2004) *Biology Today: An Issues Approach* (Third Edition) (Garland Science) ISBN 0815341571

30. Nicholl, D S T (2008) *An Introduction to Genetic Engineering* (Third Edition) (CUP) ISBN 0521615216

31. Palladino, M A (2005) *Understanding the Human Genome Project* (Second Edition) (Benjamin Cummings) ISBN 0805348778

32. Purves, W K, Gordon, H O, Sadava, D E and Heller, C H (2004) *Life: The Science of Biology* (Seventh Revised Edition) (W H Freeman) ISBN 0716788519

33. Raven, P H et al (2013) *Biology* (Tenth Edition) (McGraw-Hill) ISBN 0073383074

34. Roberts, M B V, Reiss, M and Monger, G (2000) *Advanced Biology* (Nelson Thornes) ISBN 0174387326

35. Rowland, M (2000) *Biology* (Bath Science 16–19) (Nelson Thornes) ISBN 0174384254

36. Salters Nuffield *Advanced Biology AS Student Book* (2008) (Edexcel A Level Sciences) University of York Science Education Group and Nuffield Curriculum Centre ISBN 1405896078

37. Smith, J E (2009) *Biotechnology* (Studies in Biology) (Fifth Edition) (CUP) ISBN 0521711932

38. Solomon, E, Berg, L R and Martin, D W (2010) *Biology* (Ninth Edition) (Brooks Cole) ISBN 0538741430

39. Starr, C, Taggart, R, Evers, C and Starr, L (2008) *Biology: The Unity and Diversity of Life* (Twelfth Edition) (Brooks Cole) ISBN 0495557927

40. Taylor, D J, Green, N P O, Stout, G W and Soper, R (1997) *Biological Science 1 and 2* (Third Edition) (CUP) ISBN 0521561787

41. Taylor, J (2001) *Microorganisms and Biotechnology* (Bath Science 16–19) (Nelson Thornes) ISBN 0174482558

42. Tomkins, S (1989) *Heredity and Human Diversity* (CUP) ISBN 0521312299

43. Tobin, A J and Dusheck, J (2004) *Asking About Life* (Third Edition) (Cengage Learning) ISBN 053440653X

44. Vardy, P and Grosch, P (1999) *The Puzzle of Ethics* (Second Revised Edition) (Fount) ISBN 0006281443

45. Wallace, R A, Sanders, G P, and Ferl, R J (1999) *Biology: The Science of Life* (Fifth Edition) (Harper Collins) ISBN 0201502941

46. Wood, E J and Myers, A (1991) *Essential Chemistry for Biochemistry* BASC I (The Biochemical Society) Available free online at http://www.biochemistry.org/Portals/0/Education/Docs/BASC01_full.pdf

The following may also be useful.

47. Cadogan, A (Ed.) *Biological Nomenclature: Standard Terms and Expressions Used in the Teaching of Biology* (2000) (Third Edition) (Institute of Biology) ISBN 0900490365

48. Cadogan, A and Sutton, R (1999) *Maths for Advanced Biology* (Nelson Thornes) ISBN 0174482140

49. Edmondson, A and Druce, D (1996) *Advanced Biology Statistics* (OUP) ISBN 0199146543

50. Ennos, R (2006) *Statistical and Data Handling Skills in Biology* (Prentice Hall) ISBN 0131955845
51. Garvin, J W (1986) *Skills in Advanced Biology 1: Dealing With Data* (Nelson Thornes) ISBN 085950588X
52. Garvin, J W and Boyd, J D (1994) *Skills in Advanced Biology 2: Observing, Recording and Interpreting* Student Text and Teacher's Supplement (Nelson Thornes) ISBN 085950817X and 0748700439
53. Garvin, J W (1995) *Skills in Advanced Biology 3: Investigating* (Nelson Thornes) ISBN 0748720480
54. Jones, R, Reed, R and Weyers, J (2002) *Practical Skills in Biology* (Third Edition) (Prentice Hall) ISBN 013045141X
55. King, T J, Reiss, M and Roberts, M (2001) *Practical Advanced Biology* (Nelson Thornes) ISBN 0174483082
56. Morgan, S (2002) *Advanced Level Practical Work for Biology* (Hodder Education) ISBN 0340847123
57. Powell, S (1996) *Statistics for Science Projects* (Hodder Education) ISBN 0340664096
58. Stewart, A (1995) *Lab Notes: Your up-to-date Guide to Research in Genetics* The Wellcome Trust (http://wellcomelibrary.org/)
59. Webb, N and Blackmore, R (1985) *Statistics for Biologists: A Study Guide* (CUP) ISBN 0521317126

These titles represent some of the texts available at the time of printing this syllabus. Teachers are encouraged to choose texts for class use which they feel will be of interest to their students and which will support their own teaching style.

LIST OF READINGS FOR ENRICHMENT: BOOKS, LANDMARK PAPERS, JOURNALS

1. Genome: The Autobiography of a Species in 23 Chapters (1999) – Matt Ridley
2. The Red Queen: Sex and the Evolution of Human Nature (1993) – Matt Ridley
3. Nature via Nurture: Genes, Experience and What makes us Human (2003) – Matt Ridley
4. DNA: the Secret of Life (2003) – James Watson
5. The Double Helix (1968) – James Watson
6. A Passion for DNA (2001) – James Watson
7. My Life in Science (2001) – Sydney Brenner
8. The Blind Watchmaker (1986) – Richard Dawkins
9. The Selfish Gene (1976) – Richard Dawkins
10. The Eighth Day of Creation (1979) – Harold Judson
11. The Second Creation: Dolly and the Age of Biological Control (2000) – Ian Wilmut, Keith Campbell and Colin Tudge
12. Genethics: The Clash between the New Genetics and Human Values (1990) – David Suzuki and Peter Knudtson
13. Life on Earth (1979) – David Attenborough
14. Trials of Life (1990) – David Attenborough
15. The Living Planet (1984) – David Attenborough
16. The Private Life of Plants (1994) – David Attenborough
17. On the Origin of Species (1859) – Charles Darwin
18. The Silent Spring (1962) – Rachel Carson
19. The Beak of the Finch: A Story of Evolution in Our Time (1994) – Jonathan Weiner

GLOSSARY OF TERMS USED IN SCIENCE PAPERS

It is hoped that the glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide, i.e. it is neither exhaustive nor definitive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend in part on its context.

1. *Define* (*the term(s)...*) is intended literally. Only a formal statement or equivalent paraphrase is required.

2. *What do you understand by/What is meant by (the term(s)...)* normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3. *State* implies a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained 'by inspection'.

4. *List* requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified, this should not be exceeded.

5. *Explain* may imply reasoning or some reference to theory, depending on the context.

6. *Describe* requires candidates to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena.

   In other contexts, *describe and give an account of* should be interpreted more generally, i.e. the candidate has greater discretion about the nature and the organisation of the material to be included in the answer. *Describe and explain* may be coupled in a similar way to *state and explain.*

7. *Discuss* requires candidates to give a critical account of the points involved in the topic.

8. *Outline* implies brevity, i.e. restricting the answer to giving essentials.

9. *Predict* implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an early part of the question.

10. *Deduce* is used in a similar way to *predict* except that some supporting statement is required, e.g. reference to a law/principle, or the necessary reasoning is to be included in the answer.

11. *Comment* is intended as an open-ended instruction, inviting candidates to recall or infer points of interest relevant to the context of the question, taking account of the number of marks available.

12. *Suggest* is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may not be specifically referred to in the syllabus.

13. *Find* is a general term that may variously be interpreted as calculate, measure, determine etc.

14. *Calculate* is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

15. *Measure* implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. length, using a rule, or angle, using a protractor.

16. *Determine* often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula, e.g. relative molecular mass.

17. *Estimate* implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

18. *Sketch,* when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value.

    In diagrams, sketch implies that a simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

19. *Compare* requires candidates to provide both the similarities and differences between things or concepts.

20. *Recognise* is often used to identify facts, characteristics or concepts that are critical (relevant/ appropriate) to the understanding of a situation, event, process or phenomenon.

21. *Classify* requires candidates to group things based on common characteristics.

SPECIAL NOTE

Units, significant figures. Candidates should be aware that misuse of units and/or significant figures, i.e. failure to quote units where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an inappropriate number of significant figures, is liable to be penalised.