

Guidance Module overview and maps

This module is equivalent in extent to three of the earlier modules B1–B3 or B4–B6.

There are three broad aims:

- to extend the coverage of key biological science explanations (e.g. photosynthesis), and to develop a more holistic view of biological systems;
- to explore selected ideas about science further in biological contexts (validity and reliability of data, weighing arguments in decision making);
- to illustrate examples of biological research, and its applications.

In this way the module features key characteristics of the *Science*, *Additional Science* and *Additional Applied Science* courses in *Twenty First Century Science*.

The Textbook presents the content of the specification in six topics:

- The first topic develops understanding of photosynthesis and the interdependence of organisms.
- The second topic describes different approaches to heterotrophic nutrition (mutualism,

commensalism, parasitism), and draws together students' ideas about inheritance in the context of sickle-cell anaemia.

- The third topic explains the science behind genetic testing and genetic modification, and describes potential uses for these technologies in the future.
- The fourth topic introduces human physiology, focusing on the transport system,
- The fifth topic develops understanding of respiration, linked to students' knowledge of the cardiovascular system via concept of supply and demand.
- The final topic explores the skeletal-muscular system, and the application of scientific knowledge and ideas about science in the work of medical and fitness professionals.

The 'Biology in action' examples in the Textbook are not examinable but are included to show how the ideas developed in the text are put to work in the twenty-first century.

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Topic 1

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
	Harvesting the Sun	All organisms are ultimately dependent on energy from the Sun. Distinction between autotrophs and heterotrophs.	
	Trapping light energy	A small percentage of the Sun's energy is absorbed by plants and stored as organic chemicals via photosynthesis. Main stages and word equation for photosynthesis.	
Relationship between photosynthesis and respiration is introduced in P2 <i>Radiation and life</i> .	Using glucose from photosynthesis	Fates of glucose produced during photosynthesis. Use of energy released from respiration for synthesis of plant polymers. Advantages of starch as storage molecule. Absorption of nitrates for protein synthesis by active transport.	Nitrogen cycle is introduced in C3 <i>Food matters</i> .
laS1 <i>Data and its limitations</i>	The rate of photosynthesis	Effect of limiting factors, and limitations of data measuring rate of photosynthesis. Interpretation of data on limiting factors.	Factors affecting rates of reaction are explored in C6 <i>Chemical synthesis</i> .
Carbon cycle and global warming are introduced in P2 <i>Radiation and life</i> .	Balancing respiration and photosynthesis	Effect of human activity on level of atmospheric carbon dioxide.	
Food chains and webs are introduced in B3 <i>Life on Earth</i> .	Feeding relationships	Transfer of energy between organisms in an ecosystem. Pyramids of number and biomass, including advantages of each. Percentage efficiency of energy transfers between trophic levels. Composition of soil; importance of decomposers.	

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Topic 2

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
<p>Basic inheritance principles are introduced in B1 <i>You and your genes</i>. Natural selection is introduced in B3 <i>Life on Earth</i>.</p>	<p>Living together</p> <p>Tapeworms and other parasites</p> <p>Parasites that cause disease</p>	<p>Heterotrophic relationships (mutualism, commensalisms, parasitism).</p> <p>Importance of parasites as causes of human disease; impact on food production.</p> <p>Features which enable parasites to be successful.</p> <p>Link between evolution of host and parasite.</p> <p>Malaria as example of disease caused by a parasite.</p> <p>Symptoms and basic inheritance of sickle-cell anaemia. Increase in frequency of sickle-cell allele in certain populations as result of natural selection.</p>	

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Topic 3

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
<p>Concept of genetic modification is introduced in B1 <i>You are your genes</i>.</p> <p>laS5 <i>Risk</i></p> <p>laS6 <i>Making decisions about science and technology</i></p> <p>Concept of genetic testing is introduced in B1 <i>You and your genes</i>.</p>	<p>Living factories</p>	<p>Examples of products from fermentation of microorganisms (antibiotics, enzymes, single-cell protein).</p>	<p>Enzymes as proteins in B5 <i>Growth and development</i> and function in B4 <i>Homeostasis</i>.</p>
	<p>Genetic modification</p>	<p>Basic structure of bacterial cell (cell wall, cell membrane, circular DNA chromosome, DNA plasmid).</p> <p>Main steps in genetic modification (isolating and replicating required gene, transferring gene into a new cell, use of virus or plasmid as vector).</p> <p>Examples of genetic modification (bacterial synthesis of drugs and hormones, e.g. insulin, disease resistance in crop plants).</p>	
	<p>How risky are GM crops?</p>	<p>Economic, social, and ethical implications for the release of genetic modifications organisms.</p>	
	<p>Genetic testing</p>	<p>Use of DNA technology for genetic testing (isolation of DNA from white blood cells, production of gene probe, use of UV or autoradiography to locate probe).</p>	<p>Structure of DNA is introduced in B5 <i>Growth and development</i>.</p>

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Topic 4

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
<p>Basic inheritance patterns are introduced in B1 <i>You and your genes</i>.</p> <p>Function of heart and importance of coronary arteries introduced in B2 <i>Keeping healthy</i>.</p>	<p>Blood</p> <p>How are blood types inherited?</p> <p>The heart</p> <p>Valves and tissue fluid</p>	<p>Composition of blood (red blood cells, white blood cells, platelets).</p> <p>ABO blood type system. Importance of matching donor and recipient for blood transfusions. Interpretation of compatibility data for the ABO system.</p> <p>ABO blood type determined by single gene with three alleles. Co-dominance of A and B alleles. Draw and interpret genetic diagrams illustrating inheritance patterns of ABO blood type.</p> <p>Main structures and blood vessels of the heart.</p> <p>Double circulatory system.</p> <p>Function of valves in heart and veins.</p> <p>Formation of tissue fluid, and its role in assisting exchange of chemicals between blood and tissues.</p>	

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Topic 5

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
Respiration is introduced in P2 <i>Radiation and life.</i>	Energy for life	Role of respiration. Word equation for aerobic respiration. Gas exchange occurs by diffusion.	Diffusion is introduced in B4 <i>Homeostasis.</i>
laS1 <i>Limitations of data</i>	The effect of exercise	Contraction of muscle tissue requires energy (ATP). Increase in respiration rate in muscle cells during exercise demands faster supply of oxygen and glucose, and removal of carbon dioxide from muscle cells. Additional requirements met by increased breathing and heart rate. Measurements for factors such as heart rate and blood pressure show individual variation and are therefore given within a normal range.	
	Anaerobic respiration and ATP	Anaerobic respiration occurs with shortage of oxygen. Word equation for anaerobic respiration in human body cells. Lactic acid build up as a consequence of anaerobic respiration in muscles. Oxygen debt. Energy released during respiration is used to synthesize ATP (the 'energy currency' of living things.) Aerobic respiration releases more ATP per glucose molecule than anaerobic respiration. Advantage of anaerobic respiration to human beings and other organisms in certain environmental conditions.	

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Topic 6

GCSE Science	Module story	Science ideas and explanations	GCSE Additional Science
<p>laS1 <i>Limitations of data</i></p> <p>laS5 <i>Risk</i></p>	<p style="text-align: center;">The skeleton</p> <p style="text-align: center;">Joints and movement</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Sports injuries</p> <p style="text-align: center;">↓</p> <p style="text-align: center;">Following a training programme</p>	<p>Function of internal skeleton.</p> <p>Outline structure of a joint (including function of cartilage and synovial fluid).</p> <p>Relationship between bones, ligaments, muscles, tendons. Properties of ligaments, cartilage, and tendons which enable them to function as required.</p> <p>Common joint injuries as a result of excessive exercise (sprains, dislocations, torn ligaments or tendons).</p> <p>Symptoms and basic treatment for sprains.</p> <p>Role of physiotherapist in treatment of skeletal-muscular injury, and example of set of treatment exercises.</p> <p>Importance of recording medical and/or lifestyle factors prior to commencement of fitness regime or medical treatment. Why such information should be stored and available to others in fitness or health practitioner team.</p> <p>Importance of regular contact between fitness or health practitioners and patients or clients, and accurate record-keeping of progress. Assessment of progress should take into account accuracy of monitoring technique and reliability of data.</p> <p>Potential for side-effects from medical treatments, weighed against benefits.</p> <p>Alternative programmes for particular medical treatments or fitness programmes may be available. Reasons why modification of treatment or fitness programme may be required.</p>	

Integrating modules B1–B6 and B7

The following listing of lessons suggests where module B7 might be integrated into modules B1–B6 to create a single teaching scheme. All the lessons for B1–B7 are included, but it is clear that this approach makes it possible to cover the ground in fewer lessons, especially with students able to make effective use of private study. This could be a help where separate sciences are taught in the time allowed for two GCSEs. Two teaching orders are suggested as a starting point for planning. The order does depend on when students will be taking Unit examinations. Clearly if students are to complete all Units at the end of Year 11 the order of topics is not restricted.

Units B1–B3 June Year 10 and Units B4–B6 and ‘Ideas in context’ June Year 11

You and your genes

- B1 lessons 1 – 10
- B7 lesson 13 Genetic testing (1)
- B7 lesson 14 Genetic testing (2)
- B1 lesson 11 Cloning
- B1 lesson 12 Stem cells
- B5 lesson 3 Differences in plant and animal growth
- B5 lesson 8 Switching genes
- B5 lesson 9 Stem cells and gene switching

Keeping healthy

- B2 lessons 1–9
- B7 lesson 15 Blood groups
- B7 lesson B Inheritance of blood groups
- B2 lesson 9 The circulatory system
- B7 lesson 16 Circulation
- B7 lesson 17 Capillary exchange
- B7 lesson 18 Anaerobic respiration
- B2 lessons 10–12

Life on Earth

- B3 lessons 1–7
- B7 lesson 9 Sickle cell – a deadly advantage
- B7 lesson 1 Interdependence
- B7 lesson 6 Energy transfers
- B7 lesson 7 Going underground
- B3 lessons 8–12

Nutrition

- B7 lesson 2 Harvesting the Sun
- B4 lesson 7 Diffusion and osmosis
- B4 lesson 8 Investigating osmosis
- B7 lesson 3 What happens to glucose?
- B7 lesson 4 Rate of photosynthesis
- B7 lesson 5 Limiting factors

B7 lesson A Explaining photosynthesis

B7 lesson 8 Heterotrophic relationships

Homeostasis

B4 lessons 1–6, 9–12

Growth and development

B5 lessons 1–2, 4–7, 10–12

Brain and mind

B6 lessons 1–12

Genetic technologies

B7 lesson 10 Microbial products

B7 lesson 11 Genetic modification (1)

B7 lesson 12 Genetic modification (2)

Skeletal muscular system

B7 lesson 19 Movement

B7 lesson 20 Muscle action

B7 lesson 21 Skeletal muscular injuries

B7 Lesson C Fitness training

B7 Lesson D Monitoring progress

Unit B1–B3 Jan or June Year 11 and Unit B4–B6 and ‘Ideas in context’ June Year 11

Inheritance

B1 lessons 1–9

Health and disease

B2 lessons 1–7

Growth and development

B5 lessons 1–2, 4–7, 10–12

B1 lesson 11 Cloning

B1 lesson 12 Stem cells

B5 lesson 3 Differences in plant and animal growth

B5 lesson 8 Switching genes

B5 lesson 9 Stem cells and gene switching

Genetic technologies

B7 lesson 10 Microbial products

B7 lesson 11 Genetic modification (1)

B7 lesson 12 Genetic modification (2)

B1 lesson 8 How can people find out about their genes?

B1 lesson 10 Decision making – gene therapy

B7 lesson 13 Genetic testing (1)

B7 lesson 14 Genetic testing (2)

Ecosystems

B7 lesson 1 Interdependence

B7 lesson 6 Energy transfers

B7 lesson 7 Going underground

B3 lessons 8–12

Natural selection

B3 lessons 1–3, 5–8

B7 lesson 9 Sickle cell – a deadly advantage

Nervous system

B3 lesson 4 How do cells in the body communicate?

B6 lessons 1–6

Transport

B7 lesson 15 Blood groups

B7 lesson B Inheritance of blood groups

B2 lesson 9 The circulatory system

B7 lesson 16 Circulation

B7 lesson 17 Capillary exchange

B7 lesson 18 Anaerobic respiration

B2 lessons 10–12

Nutrition

B7 lesson 2 Harvesting the Sun

B4 lesson 7 Diffusion and osmosis

B4 lesson 8 Investigating osmosis

B7 lesson 3 What happens to glucose?

B7 lesson 4 Rate of photosynthesis

B7 lesson 5 Limiting factors

B7 lesson A Explaining photosynthesis

B7 lesson 8 Heterotrophic relationships

Homeostasis

B4 lessons 1–6, 9–12

Skeletal muscular system

B7 lesson 19 Movement

B7 lesson 20 Muscle action

B7 lesson 21 Skeletal muscular injuries

B7 Lesson C Fitness training

B7 Lesson D Monitoring progress

The brain

B6 lessons 7–12

Guidance Resource list

Activity	ICT	(type)	Item title (in scheme-of-work order)	Activity sheet (A)	Guidance (G)
	IB7.1	Video		<i>The voyages</i>	
	IB7.2	Video		<i>Life in the water</i>	
	IB7.3	Presentation		<i>Energy from the Sun</i>	
AB7.1			Chloroplasts		
AB7.2			Collecting evidence		
AB7.3			Making models		
AB7.4			Separating plant pigments		
AB7.5			How do different wavelengths affect photosynthesis?		
AB7.6			How plants use glucose		
AB7.7			Demonstrating osmosis		
AB7.8			Effect of light intensity on photosynthesis		
AB7.9			24 hours in the life of a plant		
	IB7.4	Spreadsheet		<i>Rate of photosynthesis</i>	
	IB7.5	Presentation		<i>Carbon dioxide crisis?</i>	
	IB7.6	Video		<i>The hypothesis</i>	
	IB7.7	Video		<i>Plankton and global warming</i>	
	IB7.8	Presentation		<i>Energy transfers</i>	
	IB7.9	Video		<i>Measuring the oceans</i>	
	IB7.10	Video		<i>Analysis</i>	
AB7.10			From food chains to pyramids		
	IB7.11	Spreadsheet		<i>From food chains to pyramids</i>	
AB7.11			Where does the energy go?		
AB7.12			Analysis of a soil sample		
	IB7.12	Spreadsheet		<i>Analysis of a soil sample</i>	
AB7.13			Beyond reasonable doubt		
AB7.14			Recognizing relationships		
AB7.15			Perfect parasite		
AB7.16			Sickle cell: a deadly advantage		
AB7.17			Survival		
	IB7.14	Spreadsheet		<i>Survival</i>	
	IB7.15	Presentation		<i>New instructions</i>	
AB7.18			Fermenting sugars		
	IB7.16	Presentation		<i>Fermenting sugars</i>	
AB7.19			Genetic modification		
AB7.20			Can we? Should we?		
AB7.21			Working with DNA		
	IB7.17	Presentation		<i>ABO blood types</i>	
AB7.22			Blood typing		
AB7.23			In the blood		
	IB7.18	Video		<i>The heart</i>	
	IB7.19	Audio		<i>Heartbeat</i>	
	IB7.20	Animation		<i>The heart</i>	
AB7.24			The heart		
AB7.25			In a heartbeat		
AB7.26			Capillary exchange		
AB7.27			Peak performance		
	IB7.21			<i>Peak performance</i>	
	IB7.22			<i>Anaerobic respiration</i>	
AB7.28			Anaerobic respiration		
AB7.29			Contractions		
AB7.30			Chicken wings		
AB7.31			Unravelling the equation		
AB7.32			Simulations of photosynthesis		
	IB7.23	Spreadsheet		<i>Simulating photosynthesis</i>	
AB7.33			Bloodlines		
	IB7.24			<i>Bloodlines</i>	
AB7.34			Artificial blood		
	IB7.25			<i>Training for Everest</i>	
AB7.35			Fitness training – before you start		
AB7.36			Physical activity readiness		
AB7.37			Assessing aerobic fitness		