

EDEXCEL BIOLOGY 1

A-Level Year 1/AS

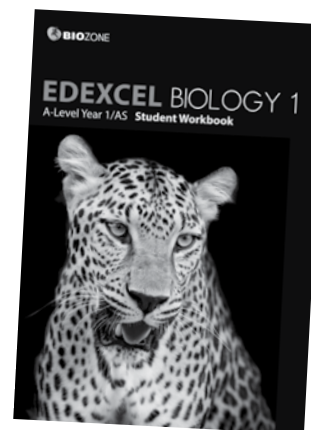
CLASSROOM
GUIDE



Making the most of Edexcel BIOLOGY 1

Creating Lifelong Learners	2
The Contents: A Plan of Action	3
Introducing the Edexcel Biology Content .	4
The Activity Page Format	5
Addressing Mathematical Requirements .	6
Addressing the Required Core Practicals	8
Engage, Explore, Explain, Elaborate, Evaluate	10
Links - Making Connections	12
Making Use of Weblinks	14
Teaching Strategies for Classroom Use ..	15
Choosing Activities for Home Study	17
Focus on Scientific Literacy	18
The Teacher's Digital Edition	19
Resources on BIOZONE's Website	20

FAQs ABOUT OUR EDEXCEL BIOLOGY 1 STUDENT WORKBOOK



What is its pedagogical approach?	2
What are the five Es?	2
How do I use the tab system?	5
How are mathematical skills addressed?	6
How are the core practicals supported?	8
How does it address the Edexcel learning outcomes?	10
How do students demonstrate understanding of ideas?	10
How can I evaluate student performance?	10
What are weblinks?	14
How do I use the workbook in the classroom?	15
How can I use it to build scientific literacy?	18



2 Creating Lifelong Learners

We want today's biology students to be self-motivated, lifelong learners, to develop a sound grasp of biological knowledge, to plan and evaluate their work, and to think critically and independently. In developing the Edexcel Biology series, we have utilised the 5Es instructional model as a basis for developing materials to specifically address the Edexcel Biology syllabus.

By successfully completing the activities, which make up the bulk of the student workbook, students can demonstrate competence in skills and knowledge across the entire scope of the programme. This is central to meeting the requirements of Edexcel AS and A Level Biology.



BIOZONE encourages the development of an engaged and enquiring learner using the 5 Es model

The Five Es

- Engage:** make connections between past and present learning experiences.
- Explore:** become actively involved in the activity.
- Explain:** communicate the learning experience.
- Elaborate:** expand on the concepts learned.
- Evaluate:** assess understanding of the concepts.

ENGAGE: Highly visual activities	Use activities in class to engage a student when introducing a topic, or to consolidate student understanding and summarise the material covered by other methods. Using activities in class provides valuable opportunities for peer-to-peer learning.
ENGAGE: A connected plan of study	The check-box format of the contents and the chapter introductions provides a focus for planning achievement. Required learning outcomes are succinctly but comprehensively covered, so students can be confident about their progress through the course content.
EXPLORE: Independent, self directed study	Activities are self-contained so students are encouraged to be independent learners and seek the answers to questions posed by the activity. Capable students can work quickly and independently through the core material and can use the time for extension. Less able students can review or finish activities at home. Most activities are supported by web-based resources in the form of animations and video clips.
EXPLAIN: Communicating is the key to consolidation	All activities first engage the student with a key idea and a visually inviting delivery of content. Student engagement with this material leads them to the questions in which they must communicate their understanding of the content. Students are encouraged to use appropriate biological terms as referenced in the chapter introduction (key terms).
ELABORATE: Building up	Most introductory activities are supported by activities in which students apply their understanding of ideas to a new situation. These 'follow-on' activities often involve data analysis, and support scientific practices.
EVALUATE: Easy assessment	Encourage self assessment with chapter reviews (these can be marked if desired) or use specific activities to evaluate a student's skills and understanding or scientific ideas.
WHAT ABOUT HOMEWORK?	Assign activities as homework to review a completed topic, explore a related concept, or introduce a topic prior to in-class practical work or extension.

The Contents: A Plan of Action

The contents pages are not merely a list of the activities in the workbook. Encourage your students to use them as a planning tool for their programme of work. Students can identify the activities they are to complete and then tick them off when completed. The teacher can also see at a glance how quickly the student is progressing through the assigned material.

Contents	
Using This Workbook	v
Using the Tab System	1
Using BIOZONE's Website	2
Mathematical and Practical Skills in Biology	
<i>Learning Outcomes</i>	
<input type="checkbox"/> 1 How Do We Do Science?	3
<input type="checkbox"/> 2 Hypotheses and Predictions	5
<input type="checkbox"/> 3 Types of Data	6
<input type="checkbox"/> 4 Making A Qualitative Investigation	7
<input type="checkbox"/> 5 Making A Quantitative Investigation	8
<input type="checkbox"/> 6 Accuracy and Precision	9
<input type="checkbox"/> 7 Working with Numbers	11
<input type="checkbox"/> 8 Fractions, Percentages, and Ratios	12
<input type="checkbox"/> 9 Logs and Exponents	13
<input type="checkbox"/> 10 Properties of Geometric Shapes	14
<input type="checkbox"/> 11 Practising With Data	15
<input type="checkbox"/> 12 Apparatus and Measurement	16
<input type="checkbox"/> 13 Recording Results	17
<input type="checkbox"/> 14 Constructing Tables and Graphs	18
<input type="checkbox"/> 15 Which Graph to Use?	19
<input type="checkbox"/> 16 Drawing Bar Graphs	20
<input type="checkbox"/> 17 Drawing Histograms	21
<input type="checkbox"/> 18 Drawing Line Graphs	22
<input type="checkbox"/> 19 Correlation or Causation	23
<input type="checkbox"/> 20 Drawing Scatter Plots	24
<input type="checkbox"/> 21 Interpreting Line Graphs	25
<input type="checkbox"/> 22 Which Test to Use?	26
<input type="checkbox"/> 23 Spearman Rank Correlation	27
<input type="checkbox"/> 24 Mean, Median, Mode	28
<input type="checkbox"/> 25 Spread of Data	29
<input type="checkbox"/> 26 Interpreting Sample Variability	30
<input type="checkbox"/> 27 Biological Drawings	32
<input type="checkbox"/> 28 Test Your Understanding	33
<input type="checkbox"/> 29 KEY TERMS: Did You Get it?	35
<input type="checkbox"/> 30 The Biochemical Nature of Cells	37
<input type="checkbox"/> 31 Organic Molecules	40
<input type="checkbox"/> 32 Sugars	41
<input type="checkbox"/> 33 Condensation and Hydrolysis of Sugars	43
<input type="checkbox"/> 34 Colorimetry	44
<input type="checkbox"/> 35 Polysaccharides	45
<input type="checkbox"/> 36 Starch and Cellulose	46
<input type="checkbox"/> 37 Lipids	47
<input type="checkbox"/> 38 Phospholipids	48
<input type="checkbox"/> 39 Amino Acids	49
<input type="checkbox"/> 40 Chromatography	50
<input type="checkbox"/> 41 Protein Shape is Related to Function	52
<input type="checkbox"/> 42 Protein Structure	53
<input type="checkbox"/> 43 Comparing Globular and Fibrous Proteins	54
<input type="checkbox"/> 44 Biochemical Tests	55
<input type="checkbox"/> 45 Nucleotides	56
<input type="checkbox"/> 46 Nucleic Acids	57
<input type="checkbox"/> 47 Determining the Structure of DNA	58
<input type="checkbox"/> 48 Constructing a DNA Model	59
<input type="checkbox"/> 49 DNA Replication	60
<input type="checkbox"/> 50 Enzyme Control of DNA Replication	62
<input type="checkbox"/> 51 Meselson and Stahl's Experiment	63
<input type="checkbox"/> 52 Modelling DNA Replication	67
<input type="checkbox"/> 53 Genes to Proteins	71
<input type="checkbox"/> 54 The Genetic Code	74
<input type="checkbox"/> 55 Cracking the Genetic Code	75
<input type="checkbox"/> 56 Transcription in Eukaryotes	76
<input type="checkbox"/> 57 Translation	77
<input type="checkbox"/> 58 Protein Synthesis Summary	78
<input type="checkbox"/> 59 The Nature of Mutations	79
<input type="checkbox"/> 60 Sickle Cell Mutation	80
<input type="checkbox"/> 61 Enzymes	81
<input type="checkbox"/> 62 Models of Enzyme Activity	82
<input type="checkbox"/> 63 How Enzymes Work	83
<input type="checkbox"/> 64 Enzyme Kinetics	84
<input type="checkbox"/> 65 Investigating Catalase Activity	85
<input type="checkbox"/> 66 Enzyme Inhibition	87
<input type="checkbox"/> 67 Inorganic Ions	89
<input type="checkbox"/> 68 Water	91
<input type="checkbox"/> 69 The Properties of Water	92
<input type="checkbox"/> 70 Chapter Review	93
<input type="checkbox"/> 71 KEY TERMS: Did You Get It?	94
<input type="checkbox"/> 72 The Cell Theory	96
<input type="checkbox"/> 73 Types of Living Things	99
<input type="checkbox"/> 74 Levels of Organisation	100
<input type="checkbox"/> 75 Cell Sizes	101
<input type="checkbox"/> 76 Prokaryotic Cells	102
<input type="checkbox"/> 77 The Gram Stain and Antibiotic Sensitivity	103
<input type="checkbox"/> 78 Measuring Antibiotic Sensitivity	104
<input type="checkbox"/> 79 Plant Cells	106
<input type="checkbox"/> 80 Identifying Structures in a Plant Cell	107
<input type="checkbox"/> 81 Animal Cells	108
<input type="checkbox"/> 82 Identifying Structures in an Animal Cell	109
<input type="checkbox"/> 83 Identifying Organelles	110
<input type="checkbox"/> 84 Cell Structures and Organelles	111
<input type="checkbox"/> 85 Specialisation in Human Cells	112
<input type="checkbox"/> 86 Specialisation in Plant Cells	114
<input type="checkbox"/> 87 Animal Tissues	115
<input type="checkbox"/> 88 Plant Tissues	116
<input type="checkbox"/> 89 Optical Microscopes	117
<input type="checkbox"/> 90 Measuring and Counting Using a Microscope	118
<input type="checkbox"/> 91 Calculating Linear Magnification	121
<input type="checkbox"/> 92 Preparing a Slide	122
<input type="checkbox"/> 93 Staining a Slide	123
<input type="checkbox"/> 94 Practising Biological Drawings	124
<input type="checkbox"/> 95 Electron Microscopes	125
<input type="checkbox"/> 96 Viruses	127
<input type="checkbox"/> 97 Life Cycle of a Bacteriophage	128
<input type="checkbox"/> 98 Life Cycle of a Retrovirus	129
<input type="checkbox"/> 99 Antiviral Drugs	130
<input type="checkbox"/> 100 Controlling Viral Disease	131
<input type="checkbox"/> 101 Cell Division	133
<input type="checkbox"/> 102 Mitosis and the Cell Cycle	134
<input type="checkbox"/> 103 Recognising Stages in Mitosis	136
<input type="checkbox"/> 104 Regulation of the Cell Cycle	137
<input type="checkbox"/> 105 Meiosis	138
<input type="checkbox"/> 106 Crossing Over Problems	140
<input type="checkbox"/> 107 Modelling Meiosis	141
<input type="checkbox"/> 108 Mitosis vs Meiosis	143
Cells, Viruses, and Reproduction	
<i>Learning Outcomes</i>	
<input type="checkbox"/> 72 The Cell Theory	97
<input type="checkbox"/> 73 Types of Living Things	99
<input checked="" type="checkbox"/> 74 Levels of Organisation	100
<input checked="" type="checkbox"/> 75 Cell Sizes	102
<input checked="" type="checkbox"/> 76 Prokaryotic Cells	103
<input checked="" type="checkbox"/> 77 The Gram Stain and Antibiotic Sensitivity	104
<input checked="" type="checkbox"/> 78 Measuring Antibiotic Sensitivity	106
<input checked="" type="checkbox"/> 79 Plant Cells	107
<input checked="" type="checkbox"/> 80 Identifying Structures in a Plant Cell	108
<input checked="" type="checkbox"/> 81 Animal Cells	109
<input checked="" type="checkbox"/> 82 Identifying Structures in an Animal Cell	110
<input checked="" type="checkbox"/> 83 Identifying Organelles	111
<input type="checkbox"/> 84 Cell Structures and Organelles	112
<input type="checkbox"/> 85 Specialisation in Human Cells	114
<input type="checkbox"/> 86 Specialisation in Plant Cells	115
<input type="checkbox"/> 87 Animal Tissues	116
<input type="checkbox"/> 88 Plant Tissues	117
<input type="checkbox"/> 89 Optical Microscopes	118
<input type="checkbox"/> 90 Measuring and Counting Using a Microscope	120
<input type="checkbox"/> 91 Calculating Linear Magnification	121
<input type="checkbox"/> 92 Preparing a Slide	122
<input type="checkbox"/> 93 Staining a Slide	123
<input type="checkbox"/> 94 Practising Biological Drawings	124
<input type="checkbox"/> 95 Electron Microscopes	125
<input type="checkbox"/> 96 Viruses	127
<input type="checkbox"/> 97 Life Cycle of a Bacteriophage	128
<input type="checkbox"/> 98 Life Cycle of a Retrovirus	129
<input type="checkbox"/> 99 Antiviral Drugs	130
<input type="checkbox"/> 100 Controlling Viral Disease	131
<input type="checkbox"/> 101 Cell Division	133
<input type="checkbox"/> 102 Mitosis and the Cell Cycle	134
<input type="checkbox"/> 103 Recognising Stages in Mitosis	136
<input type="checkbox"/> 104 Regulation of the Cell Cycle	137
<input type="checkbox"/> 105 Meiosis	138
<input type="checkbox"/> 106 Crossing Over Problems	140
<input type="checkbox"/> 107 Modelling Meiosis	141
<input type="checkbox"/> 108 Mitosis vs Meiosis	143

The teacher can see at a glance how this student is progressing through this unit of work. Any concerns with progress can be addressed early.

Students can mark the check boxes to indicate the activities they should complete. This helps them to quantify the work to be done and plan their work.

Ticking off the activities as they are completed gives students a sense of progression and helps them to be more personally organised in their work.

Cells, Viruses, and Reproduction	
<i>Learning Outcomes</i>	
<input type="checkbox"/> 72 The Cell Theory	97
<input type="checkbox"/> 73 Types of Living Things	99
<input checked="" type="checkbox"/> 74 Levels of Organisation	100
<input checked="" type="checkbox"/> 75 Cell Sizes	102
<input checked="" type="checkbox"/> 76 Prokaryotic Cells	103
<input checked="" type="checkbox"/> 77 The Gram Stain and Antibiotic Sensitivity	104
<input checked="" type="checkbox"/> 78 Measuring Antibiotic Sensitivity	106
<input checked="" type="checkbox"/> 79 Plant Cells	107
<input checked="" type="checkbox"/> 80 Identifying Structures in a Plant Cell	108
<input checked="" type="checkbox"/> 81 Animal Cells	109
<input checked="" type="checkbox"/> 82 Identifying Structures in an Animal Cell	110
<input checked="" type="checkbox"/> 83 Identifying Organelles	111
<input type="checkbox"/> 84 Cell Structures and Organelles	112
<input type="checkbox"/> 85 Specialisation in Human Cells	114

Introducing the Edexcel Biology Content

Each chapter is prefaced with a list of learning outcomes pertaining to the content in the chapter. These represent the skills, knowledge, and understanding requirements for the topic and are supported by a key terms list from which students can compile a glossary. The learning outcomes, generally covered over two pages, are drawn from the syllabus document and encourage students to approach each topic confidently. Familiarity with the scientific terms used in each topic is implicit in this.

This identifies the Edexcel Biology topic to which this chapter applies.

The list of **key terms** can be used to create a glossary for revision and encourages appropriate use of the correct terms when answering questions.

For students: The learning outcomes are purposefully brief, with enough information to provide a framework, but not so much that students are overwhelmed.

Topic 2

Cells, Viruses, and Reproduction

Key terms
acrosome reaction
anaphase
aneuploidy
antibiotic
cell
cell cycle
cell division
cell theory
cell wall
cortical reaction
crossing over
cytokinesis
electron microscope
embryo
endosperm
eukaryotic cell
fertilisation
homologue
interphase
latency
lytic cycle
magnification
meiosis
metaphase
mitosis
monosomy
oogenesis
optical microscope
organ
organ system
organelle
pollination
polysomy
prokaryotic cell
prophase
recombination
reduction division
resolution
spermatogenesis
telophase
tissue
virus

2.1 Eukaryotic and prokaryotic cells
Learning outcomes

- Describe the structure and function of a cell.
- Describe the structure and function of a prokaryotic cell.
- Describe the structure and function of a eukaryotic cell.
- Distinguish between gram positive and gram negative bacterial cell walls and relate these differences to different responses to antibiotics.
- Use aseptic techniques, e.g. in measuring antibiotic sensitivity.
- Describe the ultrastructure of eukaryotic cells and the functions of the organelles found in plant and animal cells. Include the nucleus, nucleolus, 80S ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, Golgi apparatus, cell wall, chloroplasts, vacuole, and tonoplast.
- Describe the principles and limitations of optical (light) microscopes, transmission electron microscopes, and scanning electron microscopes. Include reference to magnification, resolution, and features of the images produced.
- Calculate the magnification of drawings and the size of cell structures seen with a light microscope.
- Explain the importance of staining specimens in microscopy.
- Use a light microscope, including a stage micrometer and eyepiece graticule to view and draw cells from a specialised tissue.

2.2 Viruses
Learning outcomes

- Describe how viruses are classified according to structure and type of nucleic acid, as illustrated by lambda phage, tobacco mosaic virus, tobacco etch virus, and human immunodeficiency virus.
- Describe the life cycle of a virus (e.g. lambda phage). Describe the phenomenon of latency (e.g. in lambda phage and in a retrovirus, such as HIV) and explain its implications to the host cell.
- Explain the action of antiviral drugs with reference to the key features of viral replication. Contrast their activity with drugs used to control cellular pathogens.
- Explain why viral diseases can be difficult to treat and how they are most effectively controlled, as exemplified by the 2014 Ebola epidemic.
- Using a specific example, such as Ebola, evaluate the ethical implications of using untested drugs during epidemics.

Activity number

cell types	72	73	75
cell types into	74	85-88	
including			76
viruses.			77
			78
			79-84
			89-91
			91
			92-93
			89-90-94

Activity number

	96
	97-98
	99
	100
	100

Chapter introductions may cover two pages.

The activities pertaining to the corresponding learning outcomes.

Mathematical skills are addressed in many activities: These are fully outlined in the first chapter and their corresponding activities identified (see page 6).

Required core practicals: Activities supporting the required core practicals (1-8 for AS) are clearly identified by the code CP-# (see page 8).

Introduce the understanding with grounding activities

Follow with an activity that builds on that understanding

96 Viruses

Key Idea: A virus is an infectious, highly specialised intracellular parasite. They are acellular and non-living. Viruses are disease-causing agents (pathogens), which replicate (reproduce themselves) only inside the living cells of other organisms. Viruses are acellular, meaning they are not made up of cells, so they do not conform to the existing criteria upon which a tree of life classification is based.

Viruses are not organisms: Viruses are non-living particles and they are made of the host cell and building up metabolic systems to make new viral particles. However, they are often called microorganisms.

Chaperonin helps mediate attachment to the host cell receptors.

Two capsid proteins (capsid) form a shell around the nucleic acid.

Reverse transcriptase forms viral DNA from viral RNA.

Structure of HIV an enveloped retrovirus.

Structure of Ebola virus, an RNA virus that causes Ebola haemorrhagic fever.

Structure of a lambda phage a bacteriophage that infects E. coli.

1. What is the significance of viruses being non-living?

2. Describe the basic structure of a generalised virus, identifying the features they all have in common.

3. Describe the purpose of the following:

(a) Chaperonin spikes
(b) A bacteriophage's tail fibres
(c) Protein capsid

147 146 98 97 96 KNOW

98 Life Cycle of a Retrovirus

Key Idea: A retrovirus can integrate into the host's genome by generating DNA from its own RNA using reverse transcription. Animal viruses exhibit a number of different mechanisms for replicating, i.e. entering a host cell and producing and releasing new viruses. Enveloped viruses bud out from the host cell, whereas those without an envelope are released by the lysis of the host cell.

How HIV infects a helper T cell

HIV, an RNA virus, is a retrovirus (DNA not DNA). It is able to splice its genes into the host cell's chromosomes.

1. HIV particle binds to CD4 receptors and CXCR4 receptors on the surface of the host cell.

2. The viral envelope fuses with the cell membrane, releasing the viral RNA and reverse transcriptase into the cytoplasm.

3. Reverse transcriptase converts the viral RNA into DNA using reverse transcriptase.

4. A complementary strand of DNA is formed, producing double-stranded DNA.

5. The DNA is integrated into the host's chromosomes. The new DNA is now called a provirus. A prophage is not integrated into the chromosomes. However, it may remain as a latent infection, remaining dormant with the host's DNA.

6. The viral genes are transcribed and translated into proteins.

7. The HIV RNA is transcribed into HIV genomes. Some HIV RNA also provides the genome for the next generation of viruses.

8. Budding of the new virus from the host cell.

9. Assembly of the capsids around the viral genomes.

1. (a) How does an HIV particle enter a host cell?

(b) What is the role of reverse transcriptase in the life cycle of a retrovirus?

(c) Explain the significance of the formation of a provirus.

2. (a) Explain why retroviral infections are difficult to treat.

(b) Some of the drugs for treating HIV inhibit reverse transcriptase. Why is this an effective strategy?

147 98 KNOW

99 Antiviral Drugs

Key Idea: Antiviral drugs target key points in a viral life cycle. Because viruses do not display the characteristics of living things, antiviral drugs do not focus on destroying the virus itself, but on preventing completion of the viral life cycle. This is done by blocking the entry of the virus into cells or by inhibiting key steps in viral replication (shown).

Actions of antiviral drugs

Currently, antiviral drugs are available for use against HIV, hepatitis, influenza, and the herpes virus. Most antiviral drugs work by inhibiting replication of the virus. The drug stops the virus replicating using the immune system line to destroy the virus. Antiviral drugs work on several parts of which the cycle (right).

Block receptor binding

Block virus entry into cell

HIVB binding, reverse and synthesis, transcription, and translation

Block exit from cell

Chaperonin (produced as T400) allows the spread of influenza A and B viruses in the body by preventing a newly formed virus particle from budding from an infected cell. However, virus particles have about 1000 of whether the drug products are not bound to the surface.

HIV is treated using highly Active Antiretroviral Therapy (HAART). HAART usually consists of two different nucleoside analogue reverse transcriptase inhibitors (NRTIs) and a protease inhibitor. NRTIs block the reverse transcriptase enzyme used to generate DNA from viral RNA. Protease inhibitors block the HIV protease enzyme, which is essential to the virus from entering the cell.

Influenza is caused by either the influenza A or influenza B virus. Influenza A is treated using the drug oseltamivir and zanamivir which block the uncoating of the virus inside the host cell. Influenza B is treated using the drug zanamivir and oseltamivir which also block the uncoating of the virus. These two drugs inhibit the actions of neuraminidase, a glycoprotein on the viral surface, and block the virus from entering the cell.

Resistance to groups of antiviral drugs includes the viruses that cause cold sores and chickenpox. It is treated with drugs that interfere with DNA replication by blocking the end-glycosylase enzyme. Some drugs are activated by oral enzymes and therefore are only active in infected cells, providing a targeted treatment. Others are active in all cells and are less specific.

1. For each of the following mechanisms used by antiviral drugs explain how it prevents the virus's spread:

(a) Blocking receptor binding

(b) Inhibiting assembly

2. Why is using a combination of antiviral drugs with different actions more effective than using a single drug?

KNOW 146 147

The Activity Page Format

The content of the Edexcel Biology 1 Student Workbook is organised into 5 chapters. Each chapter begins with an introduction and concludes with a student's self-test of understanding and vocabulary. Inviting, concept-based activities make up the bulk of each chapter, with each activity focussing on understanding a fundamental concept or developing a mathematical or practical skill. An important feature of each activity is the **key idea**, which encapsulates the main focus of the content provided. Clear annotated diagrams and photographs are a major part of almost all activities and the student's understanding of the information is tested through a series of questions and/or data handling and interpretation tasks. The tabs for each activity identify the nature of the activity, and identify related material and external weblinks, which provide support for the activity.

37 Lipids

Key Idea: Lipids are non-polar, hydrophobic organic molecules, which have many important biological functions. Fatty acids are the building blocks of more complex lipids.

Lipids are organic compounds which are mostly nonpolar (have no overall charge) and hydrophobic, so they do not readily dissolve in water. Lipids include fats, waxes, steroids, and phospholipids. Fatty acids are a major component of animal fats and phospholipids. Most fatty acids consist of an even number of carbon atoms, with hydrogen bound along the length of the chain. The carboxyl group (-COOH) at one end makes them an acid. They are generally classified as saturated or unsaturated fatty acids (below).

Triglycerides

Glycerol Ester bond Fatty acids

Triglyceride: an example of a neutral fat.

Neutral fats and oils are the most abundant lipids in living things. They make up the fats and oils found in plants and animals. They consist of a glycerol attached to one (mono-), two (di-) or three (tri-) fatty acids by ester bonds. Lipids have a high proportion of hydrogen present in the fatty acid chains. When the molecule is metabolised, the chemical energy is released. Being so reduced and anhydrous, they are an economical way to store fuel reserves, and provide more than twice as much energy as the same quantity of carbohydrate.

Lipids containing a high proportion of saturated fatty acids tend to be solids at room temperature (e.g. butter). Lipids with a high proportion of unsaturated fatty acids are oils and tend to be liquid at room temperature (e.g. olive oil). This is because the unsaturation causes kinks in the straight chains so that the fatty acid chains do not pack closely together.

Saturated and unsaturated fatty acids

Fatty acids are carboxylic acids with long hydrocarbon chains. They are classified as either saturated or unsaturated. **Saturated fatty acids** contain the maximum number of hydrogen atoms. **Unsaturated fatty acids** contain some double-bonds between carbon atoms and are not fully saturated with hydrogens. A chain with only one double bond is called monounsaturated, whereas a chain with two or more double bonds is called polyunsaturated.

Formula (above) and molecular model (below) for a saturated fatty acid (palmitic acid).

Formula (above) and molecular model (right) for an unsaturated fatty acid (oleic acid). The arrows indicate double bonded carbon atoms that are not fully saturated with hydrogens.

1. Identify the main components (a-c) of the symbolic triglyceride below:

(a) _____
 (b) _____
 (c) _____

2. Why do lipids have such a high energy content? _____

3. (a) Distinguish between saturated and unsaturated fatty acids: _____
 (b) Relate the properties of a neutral fat to the type of fatty acid present: _____

KNOW **37** **38** LINK

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37 Lipids

Key Idea: Lipids are non-polar, hydrophobic organic molecules, which have many important biological functions. Fatty acids are the building blocks of more complex lipids.

The **key idea** provides a focus for each activity. It summarises the focus of the activity and provides a clear take-home message for the student.

Annotated diagrams, sometimes including photo panels, explain the content of the page, providing the information necessary to complete the activity.

Understanding of content is tested through questions, data handling, analysis, prediction, or summary. Students are often required to apply their understanding to a new scenario or make connections to related content. Students must interact with the information on the page in order to complete the activity. It is this interaction that provides the valuable learning experience and reinforcement and explanation of the key idea.

Related content is identified through the tab system. This activity also has a weblink assigned to it (see below).

KNOW **37** **38** LINK

Weblinks
 Bookmark the weblinks page:
www.biozone.co.uk/Edx-1-9254
 Access the external URL for the activity by clicking the link.
 See page 14 for more details.

Links
 This tab indicates activities that provide content which is related to or builds on the content on the page.

THE TASK CODE

This indicates the main focus of the activity:

- COMP** = comprehension of text
- DATA** = data handling and interpretation
- KNOW** = content you need to know
- PRAC** = a paper practical or a practical focus
- REFER** = reference - use this for information
- REVISE** = review the material in the section
- TEST** = test your understanding
- VOCAB** = learning your biological vocabulary

Addressing Mathematical Requirements

The mathematical requirements of Edexcel AS and A Level Biology are met through activities in an introductory chapter and throughout the workbook, applied in the context of the relevant biology. Students are provided with numerous ways in which to develop competence in computation, algebra, graphing, and data handling and analysis. Having an introduction to basic skills provides a reference for students needing to refresh their memory with respect to any particular skill. The following examples provide just a sample of those written to address each of the skills identified.

Practical & Mathematical Skills in Biology
Also supported in Edexcel Biology 2

Key terms
accuracy
assumption
bar graph
chi-squared test
control
controlled variable
correlation
dependent variable
fair test
histogram
hypothesis
independent variable
line graph
mean
median
mode
observation
percentage error
precision
prediction
quantitative data
quantitative data

CP AS core practical activities
Core practicals supported as indicated

- 1 Investigate the effect of a named variable (e.g. temperature) on the rate of an enzyme controlled reaction.
- 2 Set up and use a light microscope, including simple eyepiece graticule, to examine and measure specific cells from a specialised plant or animal tissue.
- 3 Prepare stained squashes of cells from a plant root in the meristem under a light microscope.
- 4 Investigate the effect of sucrose concentrations on osmosis in plant tissue.
- 5 Investigate the effect of temperature on the permeability of a membrane.
- 6 Determine the water potential of plant tissue, e.g. based on a dilution series of a solute.
- 7 Dissect an insect to show the structure of the gas exchange system.
- 8 Use a potometer to investigate factors affecting water uptake.

Practical skills for assessment
Supported as indicated but also throughout Edexcel Biology 1 & 2

Activity number

- a Independent thinking
Solve problems in a practical context. Apply scientific knowledge to practical contexts. Apply investigative approaches and methods to practical work. 5 29
- b Use and application of scientific methods and practices
Evaluate experimental design and methods. Use practical equipment and materials, following written instructions, and making and recording observations and measurements. Collect, process, and present data appropriately. Evaluate results and draw conclusions with reference to measurement errors. 5 12-14
28 213
- c Research and referencing. Use of mathematics in a practical context
Plot and interpret graphs. Process and analyse data. Consider margins of error, and accuracy and precision of data. Use online and offline research skills. Correctly cite sources of information. 1 6 15-24
- d Instruments and equipment
Demonstrate an understanding of how a range of instruments, equipment, and techniques are used in experimental work. 65 92 93
168 213

Mathematical skills
Supported as indicated but also throughout Edexcel Biology 1 & 2

Activity number

A0: Arithmetic and numerical computation

- 1 Recognise and use appropriate units in calculations. 6 7
- 2 Recognise and use expressions in both decimal and standard form. 7 11
- 3 Carry out calculations involving fractions, percentages, and ratios. 8 11
- 4 Estimate results to assess if calculated values are appropriate. 7
- 5 Use a calculator to find and use power, exponential, and logarithmic functions (AL). 9

A1: Handling data

- 1 Use an appropriate number of significant figures in reporting calculations. 6
- 2 Find arithmetic means for a range of data. 24 28
- 3 Represent and interpret frequency data in the form of bar graphs and histograms. 16 17 26
- 4 Demonstrate an understanding of simple probability. 150
- 5 Show understanding of the principles of sampling as applied to scientific data and analyse random data collected by an appropriate sampling method. 150-153
- 6 Calculate or compare mean, mode, and median for sample data. 24 26 28
- 7 Plot and interpret scatter graphs to identify correlation between two variables. 19 20
- 8 Make order of magnitude calculations, e.g. in calculating magnification. 91
- 9 Select and apply appropriate statistical tests to analyse and interpret data, e.g. the chi-squared test, the Student's *t* test, and Spearman's rank correlation. 22 23
& Edx2
- 10 Understand and use measures of dispersion, e.g. standard deviation and range. 25 26
- 11 Identify and determine uncertainties in measurements. 12

A2: Algebra

- 3 Substitute numerical values into algebraic equations using appropriate units. 21 152
- 4 Solve algebraic equations. 8 196
- 5 Use logs in relation to quantities ranging over several orders of magnitude (AL). 9

A3: Graphs

- 1 Translate information between graphical, numerical, and algebraic forms. 21
- 2 Select an appropriate format to plot two variables from experimental or other data. 15
- 3 Predict or sketch the shape of a graph with a linear relationship ($y = mx + c$). 21
- 4 Determine the intercept of a graph (AL). 21
- 5 Calculate rate of change from a graph showing a linear relationship. 21 64
- 6 Draw and use the slope of a tangent to a curve as a measure of rate of change. 64

A4: Geometry and trigonometry

- 1 Calculate the circumferences, surface areas, and volumes of regular shapes. 10

Mathematical skills A0-A4, as outlined in the Edexcel specification, are fully identified and aligned to activities that support that skill development.

Most skills have an introductory 'how-to' activity and are then supported by application of the skill in different ways in different biological contexts.

9 Select and apply appropriate statistical tests to analyse and interpret data, e.g. the chi-squared test, the Student's *t* test, and Spearman's rank correlation. **22 23 & Edx2**

In the example highlighted above, activity #22 introduces how to choose a test, while activity #23 covers Spearman Rank Correlation activities. Other statistical activities are covered in Edexcel Biology 2.

A0: Arithmetic and numerical computation

Working with Numbers covers many of the basic skills in A0.1-A0.4, and students then apply their understanding and application of these skills in subsequent activities, e.g. Fractions, Percentages, and Ratios, and Practising with Data. They can check back on procedure if they need help.

7 Working with Numbers

Key Message: Using common mathematical symbols and conversion factors is essential for working with numbers in biology. Understanding the use of scientific notation and estimation is also important.

Commonly used mathematical symbols:
+ Addition
- Subtraction
× Multiplication
÷ Division
= Equality
≠ Not equal to
< Less than
> Greater than
≤ Less than or equal to
≥ Greater than or equal to
% Percentage
° Celsius
m, km, g, mg, μg, ng, pg, fg, kg, t, μm, nm, μm², m², cm², mm², μm², nm², μm³, m³, cm³, mm³, μm³, nm³

Conversion factors and expressing units:
Remember to use the correct number of significant figures when converting units. Always include the units in your answer.

Estimation:
Use the following rules to estimate the size of a number:
1. Round each number to one significant figure.
2. Multiply or divide the rounded numbers.
3. Round the final answer to one significant figure.

8 Fractions, Percentages, and Ratios

Key Message: Fractions, percentages, and ratios are used to describe the relative amounts of different components in a mixture or solution. Understanding how to convert between these different representations is essential.

Fractions:
A fraction represents a part of a whole. The numerator is the top number and the denominator is the bottom number.

Percentages:
A percentage is a fraction where the denominator is 100. It is used to express a part of a whole as a percentage of that whole.

Ratios:
A ratio compares two or more quantities. It is often written as a:b or a:b:c.

11 Practising with Data

Key Message: This activity allows you to practise working with data and applying the skills you have learned in previous activities.

1. Complete the table below for each of the tables below. The first value is provided in each case.

Group	Area	Volume	Mass	Percentage	Ratio
100	10	0.001	10	0.01	1:100
1000	100	0.001	10	0.01	1:100
10000	1000	0.001	10	0.01	1:100
100000	10000	0.001	10	0.01	1:100
1000000	100000	0.001	10	0.01	1:100
10000000	1000000	0.001	10	0.01	1:100

2. Complete the following table for each of the tables below.

Group	Area	Volume	Mass	Percentage	Ratio
100	10	0.001	10	0.01	1:100
1000	100	0.001	10	0.01	1:100
10000	1000	0.001	10	0.01	1:100
100000	10000	0.001	10	0.01	1:100
1000000	100000	0.001	10	0.01	1:100
10000000	1000000	0.001	10	0.01	1:100

3. Complete the following table for each of the tables below.

Group	Area	Volume	Mass	Percentage	Ratio
100	10	0.001	10	0.01	1:100
1000	100	0.001	10	0.01	1:100
10000	1000	0.001	10	0.01	1:100
100000	10000	0.001	10	0.01	1:100
1000000	100000	0.001	10	0.01	1:100
10000000	1000000	0.001	10	0.01	1:100

22 Which Test to Use?

Key Idea: This flowchart is a useful reference on the test to use for statistical investigations. It is based on the following criteria:

- 1. Are the data categorical or numerical?
- 2. Are the data paired or unpaired?
- 3. Are the data normally distributed?
- 4. Are the data from a single population or two populations?

The flowchart guides the user through various statistical tests such as Chi-squared, Spearman Rank Correlation, and t-tests based on these criteria.

23 Spearman Rank Correlation

Key Idea: The Spearman rank correlation is a test used to work out whether there is a relationship between two variables. It is used when the data is not normally distributed or when the data is ranked.

Step 1: Rank the data

Year	Number of visits to the museum	Number of visits to the library
1	10	15
2	15	20
3	20	25
4	25	30
5	30	35
6	35	40
7	40	45
8	45	50
9	50	55
10	55	60
11	60	65
12	65	70
13	70	75
14	75	80
15	80	85
16	85	90
17	90	95
18	95	100
19	100	105
20	105	110

Step 2: Calculate the Spearman rank correlation coefficient

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

Where d is the difference between the ranks of each pair of data, and n is the number of pairs of data.

12 Apparatus and Measurement

Key Idea: This section provides information on the correct use of various pieces of apparatus and measurement techniques. It includes diagrams and text for:

- Measuring the correct apparatus
- Recognising potential sources of error
- Percentage errors

It also includes a table for calculating percentage error and a diagram of a measuring cylinder.

A1: Handling data

What Test to Use? provides students with a tool for selecting a test based on the data (A1.9). *Quantitative Investigation of Variation* is one example of a statistical test applied in an appropriate context. *Apparatus and Measurement* looks at simple techniques for evaluating uncertainties in measurement (A1.11).

91 Calculating Linear Magnification

Key Idea: This section explains how to calculate linear magnification. It includes a diagram of a beetle and its magnified image.

Calculating linear magnification:

Worked example:

1. Measure the body length of the real beetle (right). Your measurement should be 2.5 mm.

2. Measure the body length of the magnified beetle (left). The magnification of the image is 100 times.

3. Calculate the magnification of the image using the formula:

$$\text{Magnification} = \frac{\text{Image size}}{\text{Actual size}}$$

152 Assessing Species Diversity

Key Idea: This section introduces the concept of species diversity and how to assess it. It includes a diagram of a pond and a table of species diversity indices.

Calculating and using of diversity indices

Example of species diversity in a pond

Species	Number of individuals
1	10
2	10
3	10
4	10
5	10
6	10
7	10
8	10
9	10
10	10

153 Investigating Biodiversity

Key Idea: This section provides information on how to investigate biodiversity. It includes a diagram of a pond and a table of species diversity indices.

Calculating the Simpson's index of Diversity

$$D = \frac{1}{\sum \frac{1}{n_i^2}}$$

Where n_i is the number of individuals of each species.

A2: Algebra

Calculating Linear Magnification develops skills in using and manipulating an equation (A2.2). *Assessing Species Diversity* introduces students to Simpson's index of Diversity and is followed by *Investigating Biodiversity* in which students apply their skills to calculate diversity indices for real populations (A2.3).

15 Which Graph to Use?

Key Idea: This flowchart is a useful reference on the test to use for statistical investigations. It is based on the following criteria:

- 1. Are the data categorical or numerical?
- 2. Are the data paired or unpaired?
- 3. Are the data normally distributed?
- 4. Are the data from a single population or two populations?

The flowchart guides the user through various statistical tests such as Chi-squared, Spearman Rank Correlation, and t-tests based on these criteria.

21 Interpreting Line Graphs

Key Idea: This section provides information on how to interpret line graphs. It includes a diagram of a line graph and a table of line graph types.

Interpreting gradients

Worked example:

1. State the gradient for the line in the graph.

2. Calculate the gradient for the line in the graph.

64 Enzyme Kinetics

Key Idea: This section provides information on how to investigate enzyme kinetics. It includes a diagram of an enzyme reaction and a table of enzyme kinetics data.

Graph 1

Graph 2

A3: Graphs

Which Graph to Use? provides students with a tool to select a graph based on the data (A3.2). It is followed by activities in which students apply their skills to plotting second hand data. *Interpreting Line Graphs* covers A3.3 (linear relationships) and A3.4 (determining intercepts). These skills are applied in activities associated with enzyme kinetics (A3.3 and A3.6).

10 Properties of Geometric Shapes

Key Idea: This section provides information on the properties of various geometric shapes. It includes a diagram of a sphere and a table of geometric shapes.

Properties of Geometric Shapes

Shape	Volume	Surface Area	Perimeter	Area
Sphere	$\frac{4}{3}\pi r^3$	$4\pi r^2$		
Cylinder	$\pi r^2 h$	$2\pi r^2 + 2\pi r h$		
Rectangular prism	lwh	$2(lw + lh + wh)$		
Triangle			$s + s + s$	$\frac{1}{2}bh$

170 Diffusion and Cell Size

Key Idea: This section provides information on how to investigate diffusion and cell size. It includes a diagram of a cell and a table of diffusion data.

Single-celled organisms

Multicellular organisms

Properties of Geometric Shapes

Key Idea: This section provides information on the properties of various geometric shapes. It includes a diagram of a sphere and a table of geometric shapes.

Properties of Geometric Shapes

Shape	Volume	Surface Area	Perimeter	Area
Sphere	$\frac{4}{3}\pi r^3$	$4\pi r^2$		
Cylinder	$\pi r^2 h$	$2\pi r^2 + 2\pi r h$		
Rectangular prism	lwh	$2(lw + lh + wh)$		
Triangle			$s + s + s$	$\frac{1}{2}bh$

A4: Geometry and trigonometry

Properties of Geometric Shapes introduces students to the calculation of circumference, surface area, and volumes of regular shapes (MS4.1). They then apply this understanding to the calculation of surface area and volume ratios in cells (exemplification).

Addressing the Required Core Practicals

Activities addressing the practical activity requirements of Edexcel AS and A Level Biology are divided between Edexcel Biology 1 and Edexcel Biology 2. Required core practicals 1-8 are supported in Edexcel Biology 1. The basic techniques and skills required for the required practical work are addressed in the introductory chapter (*Practical and Mathematical Skills in Biology*) and in context throughout the workbook. Activities to directly support each of practicals 1-8 are identified (CP-#) in the relevant chapters.

Practical skills for assessment
Supported as indicated but also throughout Edexcel Biology 1 & 2

- a Independent thinking
Solve problems in a practical context. Apply scientific knowledge to practical contexts. Apply investigative approaches and methods to practical work. 5 29
- b Use and application of scientific methods and practices
Evaluate experimental design and methods. Use practical equipment and materials, following written instructions, and making and recording observations and measurements. Collect, process, and present data appropriately. Evaluate results and draw conclusions with reference to measurement errors. 5 12-14
28 213

Supported as indicated but also throughout Edexcel Biology 1 & 2

AD: Arithmetic and numerical computation

- 1 Recognise and use appropriate units in calculations. 6 7
- 2 Recognise and use expressions in both decimal and standard form. 7 11
- 3 Carry out calculations involving fractions, percentages, and ratios. 8 11
- 4 Estimate results to assess if calculated values are appropriate. 7
- 5 Use a calculator to find and use power, exponential, and logarithmic functions (AL). 9

A1: Handling data

- 1 Use an appropriate number of significant figures in reporting calculations. 6
- 2 Find arithmetic means for a range of data.
- 3 Represent and interpret frequency data in the form of histograms.
- 4 Demonstrate an understanding of simple probability.
- 5 Show understanding of the principles of sampling and how to analyse random data collected by an appropriate method.
- 6 Calculate or compare mean, mode, and median for a set of data.
- 7 Plot and interpret scatter graphs to identify correlation.
- 8 Make order of magnitude calculations, e.g. in cell biology.
- 9 Select and apply appropriate statistical tests to analyse data.

Practical skills to be assessed are clearly outlined in the introduction to the first chapter. Each is aligned to activities that support that skill development.

a Independent thinking 5 29

Solve problems in a practical context. Apply scientific knowledge to practical contexts. Apply investigative approaches and methods to practical work.

In the example highlighted above, activity #5 introduces the protocols for quantitative investigations, while activity #29 allows the student to apply their skills and understanding to the analysis of an investigation involving second hand data.

Practical & Mathematical Skills in Biology

Also supported in Edexcel Biology 2

Key terms	AS core practical activities	Activity number
accuracy	<input type="checkbox"/> 1 Investigate the effect of a named variable (e.g. temperature or substrate concentration) on the rate of an enzyme controlled reaction.	63
assumption	<input type="checkbox"/> 2 Set up and use a light microscope, including simple stage micrometer and eyepiece graticule, to examine and measure specimen material. Draw cells from a specialised plant or animal tissue.	89 90 94
bar graph	<input type="checkbox"/> 3 Prepare stained squashes of cells from a plant root tip to show stages of mitosis in the meristem under a light microscope..	93 101
chi-squared test	<input type="checkbox"/> 4 Investigate the effect of sucrose concentrations on the growth of pollen tubes.	119
control	<input type="checkbox"/> 5 Investigate the effect of temperature on the permeability of plasma membranes, e.g. in beetroot.	164
controlled variable	<input type="checkbox"/> 6 Determine the water potential of plant tissue, e.g. by using a calibration curve based on a dilution series of a solute.	168 169
correlation	<input type="checkbox"/> 7 Dissect an insect to show the structure of the gas exchange system.	182
dependent variable	<input type="checkbox"/> 8 Use a potometer to investigate factors affecting water uptake (and loss) by shoots.	213
fair test		
histogram		
hypothesis		
independent variable		
line graph		
mean		
median		
mode		
observation		
percentage error		
precision		
prediction		
quantitative data		
qualitative data		
sample		
scatter graph		
standard deviation		
statistical test		
Student's t test		
variable		

AT Use of apparatus and techniques

Supported as indicated but also throughout Edexcel Biology 1 & 2

Activity number	Description	Activity number
12 90	<input type="checkbox"/> 1 Use appropriate apparatus to record a range of quantitative data, including mass, time, volume, temperature, length, and pH.	
34 213	<input type="checkbox"/> 2 Use appropriate instrumentation, such as a colorimeter or potometer, to record quantitative data.	
12 168	<input type="checkbox"/> 3 Use laboratory glassware for a range of techniques, including serial dilution.	
89 90	<input type="checkbox"/> 4 Use a light microscope (including graticule) at high and low power.	
27 94	<input type="checkbox"/> 5 Make annotated scientific drawings from observations.	
4 44	<input type="checkbox"/> 6 Use qualitative reagents to identify biological molecules.	
40 126	<input type="checkbox"/> 7 Separate biological compounds, e.g. mixtures of monosaccharides, amino acids, or pigments, using thin layer or paper chromatography or gel electrophoresis.	
180 197	<input type="checkbox"/> 8 Record physiological functions and plant or animal responses safely and ethically.	
78 Edx 2	<input type="checkbox"/> 9 Use aseptic techniques in microbiological investigations.	
182 194	<input type="checkbox"/> 10 Use dissection equipment safely.	
151 Edx2	<input type="checkbox"/> 11 Use sampling techniques e.g. quadrats, transects, in fieldwork.	
13 23	<input type="checkbox"/> 12 Use ICT, e.g. in computer modelling or to collect or process data.	

The required **core practical activities** for Edexcel AS Biology are identified in the introduction to the first chapter. In some cases, the required practical is supported by several activities.

Many required core practicals will rely on an understanding of basic skills and techniques that have been covered elsewhere in the workbook.

Skills in the use of apparatus and techniques are fully addressed, often in an appropriate biological context and supporting the required core practicals.



65 Investigating Catalase Activity CP-1

Key Idea: Catalase activity can be measured in germinating seeds. Activity changes with stage of germination. This activity involves an experiment in which germinating seeds of different ages were used to test the effect of catalase on hydrogen peroxide.

The aim and hypothesis:
To investigate the effect of germination age on the level of catalase activity in germinating seeds. The hypothesis was that germination age would have an effect on catalase activity.

Background:
Germinating seeds are metabolically very active and the respiration rate increases. This is because the seeds are using stored reserves (mainly starch) to provide energy for the growth of the embryo. The rate of respiration is measured by the rate of oxygen production. The rate of oxygen production is measured by the rate of oxygen production in a closed system. The rate of oxygen production is measured by the rate of oxygen production in a closed system.

Method:
In this experiment, 10 g germinating seeds from seeds (D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z) were used. The seeds were placed in a beaker and the water was added. The seeds were placed in a beaker and the water was added. The seeds were placed in a beaker and the water was added.

Stage	Temp	Volume of oxygen collected after 10 min (cm ³)	Mean	Standard Deviation	Mean rate of oxygen production (cm ³ min ⁻¹)
1	21.0	1.0	1.0	0.0	0.10
2	21.0	1.5	1.5	0.0	0.15
3	21.0	2.0	2.0	0.0	0.20
4	21.0	2.5	2.5	0.0	0.25
5	21.0	3.0	3.0	0.0	0.30
6	21.0	3.5	3.5	0.0	0.35
7	21.0	4.0	4.0	0.0	0.40
8	21.0	4.5	4.5	0.0	0.45
9	21.0	5.0	5.0	0.0	0.50
10	21.0	5.5	5.5	0.0	0.55

Core practical 1: Investigate a factor (stage of germination) affecting the rate of an enzyme controlled reaction (decomposition of H₂O₂ by catalase).

89 Optical Microscopes CP-2

Key Idea: Light microscopes use light focused through a lens to magnify objects up to around 1000 times. The resolution of light microscopes is limited by the wavelength of light. Light microscopes are used to study small organisms and tissues.

Typical compound light microscope: Includes diagrams of the eyepiece, objective lenses, stage, and base.

What is Magnification?
Magnification is the ratio of the size of the image to the size of the object. It is calculated as: $M = \frac{\text{Image size}}{\text{Object size}}$

What is Resolution?
Resolution is the ability of a microscope to distinguish between two points. It is the minimum distance between two points that can be distinguished as separate points.

Dissecting microscope: Used for low magnification viewing of larger specimens.

Practical 2: Use a light microscope, including using simple stage and eyepiece micrometers and drawing a small number of cells from a specialised tissue (blood).

92 Preparing a Slide CP-3

Key Idea: Creating temporary and mounting a specimen on a slide is essential for viewing under a light microscope. This involves preparing a temporary mount and then mounting it on a slide.

Preparing a specimen: Shows the process of cutting a thin section of a specimen and staining it.

Mounting a specimen: Shows the process of placing the specimen on a slide and covering it with a cover slip.

Viewing: Shows the process of viewing the specimen under a light microscope.

Core practical 3: Make a temporary squash preparation of a root tip to show stages of mitosis (under light microscope (see also activity #89)).

119 Sucrose Concentration and Pollen Tube Growth CP-4

Key Idea: The pollen tube has reached the stigma to deliver the sperm cells and to grow. The rate of pollen tube growth is affected by the concentration of sucrose in the medium.

Method: Pollen grains were placed in a solution of sucrose of different concentrations. The length of the pollen tube was measured after a fixed time.

Sucrose concentration (g dm ⁻³)	Mean length of pollen tube (mm)
0	0.0
10	0.5
20	1.0
30	1.5
40	2.0
50	2.5
60	3.0
70	3.5
80	4.0
90	4.5
100	5.0

Core practical 4: Investigate the effect of sucrose concentrations on pollen tube growth.

164 Factors Altering Membrane Permeability CP-5

Key Idea: Beetroot tubers contain a large amount of water-soluble pigments. The amount of pigment that leaks out of the beetroot is affected by temperature and membrane permeability.

Method: Beetroot tubers were cut into discs and placed in water at different temperatures. The amount of pigment that leaked out was measured.

Temperature (°C)	Absorbance	ESD (mm)
0	0.000	0.000
10	0.000	0.000
20	0.000	0.000
30	0.000	0.000
40	0.000	0.000
50	0.000	0.000
60	0.000	0.000
70	0.000	0.000
80	0.000	0.000
90	0.000	0.000
100	0.000	0.000

Core practical 5: Investigate the effect of temperature on beetroot membrane permeability (extension provided: effect of solvent).

168 Making Dilutions CP-6

Key Idea: Dilutions involve the combination of a stock solution and a solvent to produce a solution of a known concentration. This is done by serial dilution.

Method: A stock solution of 1.00 mol dm⁻³ was diluted to produce a series of solutions of decreasing concentration.

Dilution	Volume of stock solution (cm ³)	Volume of solvent (cm ³)	Final concentration (mol dm ⁻³)
1	10	0	1.00
2	10	10	0.50
3	10	20	0.33
4	10	30	0.25
5	10	40	0.20
6	10	50	0.17
7	10	60	0.14
8	10	70	0.12
9	10	80	0.11
10	10	90	0.10

Core practical 6: Determine the water potential of a plant tissue (potato). Includes serial dilution to produce a calibration curve (practical techniques #3).

182 Dissection of an Insect CP-7

Key Idea: The insect tracheal system can be readily removed. This allows the structure of the tracheal system to be studied.

Method: A cockroach was dissected to reveal the tracheal system. The tracheal system was then stained and cleared for viewing under a light microscope.

Core practical 7: Dissect an insect (cockroach) to show the structure of the gas exchange system.

213 Investigating Plant Transpiration CP-8

Key Idea: The relationship between the rate of transpiration and environmental conditions can be investigated using a potometer. This involves measuring the volume of water taken up by a plant shoot.

Method: A plant shoot was placed in a potometer and the volume of water taken up was measured over time under different environmental conditions.

Core practical 8: Investigate factors (temperature, light, humidity) affecting water uptake by plant shoots using a potometer.

Engage, Explore, Explain, Elaborate, and Evaluate

In developing Edexcel BIOLOGY 1, we have focussed on the learning outcomes and skills identified in the Edexcel Biology specification. The activities in Edexcel BIOLOGY 1 have been specifically written to address this content. Our focus is student engagement through the use of a concept-based, highly visual design and opportunity to demonstrate skills and understanding.

Topic 1 Biological Molecules

1.1 Carbohydrates

Learning outcomes

- Describe examples, distinguish between the structure and biological roles of monosaccharides, disaccharides, and polysaccharides.
- Describe the ring structure and properties of glucose (a hexose monosaccharide) and the structure of fibre (a polymer monosaccharide). Recognise sources of glucose in glucose and fructose, and explain their biological significance.
- Describe how monosaccharides (glucose, galactose, fructose) are joined by condensation reactions to form disaccharides (e.g. sucrose, lactose, maltose) and polysaccharides (e.g. glycogen, amylose, amylopectin). Explain how the glycosidic bonds in α - and β -glucosylsaccharides are broken through hydrolysis.
- Compare and contrast the structure of glucose and its polymers: starch, cellulose, and glycogen. Assess the structure to biological function in each case.
- Use a colorimetry test to produce a calibration curve with which to identify the concentration of glucose in an unknown solution.
- Use and interpret the results of qualitative tests for carbohydrates.

1.2 Lipids

Learning outcomes

- Recognise triglycerides and phospholipids as classes of lipid and describe the basic structure of each. Explain how triglycerides are formed by condensation from fatty acids and glycerol with the formation of ester bonds.
- Distinguish between saturated and unsaturated fatty acids (and their lipids).
- Describe how the structure and properties of lipids relate to their role in energy storage, waterproofing, and insulation.
- Explain how the structure and properties of phospholipids relate to their functional role in biological membranes.
- Use and interpret the results of a colorimetry test for lipids.

1.3 Proteins

Learning outcomes

- Describe the structure of an amino acid, including the significance of the R group.
- Explain how amino acid monomers are linked by peptide bonds in condensation reactions and how polypeptides are broken apart by hydrolysis.
- Use chromatography to separate a mixture of amino acids.
- Explain how a functional protein may consist of one or more polypeptides. Explain the role of hydrogen bonds, ionic bonds, and disulfide bridges in protein structure.

The introduction to each chapter provides a summary of the learning outcomes and, where appropriate, core practicals, presented as a series of short student learning aims. The students achieve understanding of each statement by completing its corresponding activity.

Activities are written and presented so that students progressively extend and deepen their understanding, using what they have learned in earlier activities to complete later related activities and to solve new problems.

1.2 Lipids

Learning outcomes

- Recognise triglycerides and phospholipids as classes of lipid and describe the basic structure of each. Explain how triglycerides are formed by condensation from fatty acids and glycerol with the formation of ester bonds.
- Distinguish between saturated and unsaturated fatty acids (and their lipids).
- Describe how the structure and properties of lipids relate to their roles in energy storage, waterproofing, and insulation.
- Explain how the structure and properties of phospholipids relate to their functional role in biological membranes.
- Use and interpret the results of the emulsion test for lipids.

1.3 Proteins

Learning outcomes

- Describe the structure of an amino acid, including the significance of the R group.
- Explain how amino acid monomers are linked by peptide bonds in condensation reactions and how polypeptides are broken apart by hydrolysis.
- Use chromatography to separate a mixture of amino acids.
- Explain how a functional protein may consist of one or more polypeptides. Explain the role of hydrogen bonds, ionic bonds, and disulfide bridges in protein structure.

37 Lipids

Key Idea: Lipids are non-polar, hydrophobic organic molecules which have many important biological functions. Fatty acids are the building blocks of more complex lipids. Lipids are organic compounds which are mostly non-polar (they do not dissolve and hydrophilic, so they do not readily dissolve in water. Lipids include fats, waxes, sterols, and phospholipids. Fatty acids are a major component of neural fats and phospholipids. Saturated fatty acids consist of an even number of carbon atoms, with hydrogen bonded along the length of the chain. The central group (-COOH) at one end makes them so acidic. They are generally classified as saturated or unsaturated fatty acids (satur).

Saturated and unsaturated fatty acids

Fatty acids are carboxylic acids with very long hydrocarbon chains. They are classified as saturated or unsaturated. Saturated fatty acids contain some double bonds between carbon atoms and are not fully saturated with hydrogen. A chain with only one double bond is called monounsaturated, whereas a chain with two or more double bonds is called polyunsaturated.

Triglycerides

Triglycerides are the most abundant lipids in living things. They are made of the fatty acids linked to glycerol and storage. The glycerol part of a triglyceride is one (glycerol, has 3 C) and the fatty acids are ester bonds. Lipids have a high proportion of hydrogen present in the hydrocarbon chains. The hydrocarbon chains are saturated or unsaturated, and provide more than twice as much energy as the same amount of carbohydrates.

Lipids containing a high proportion of saturated fatty acids tend to be solid at room temperature (e.g. butter). Lipids with a high proportion of unsaturated fatty acids are oils and are liquid at room temperature. Unsaturated lipids are more flexible and can be packed more closely together.

Phospholipids and molecular model (bilayer for a membrane) and aqueous solution.

Phospholipids and aqueous solution. Phospholipids are made up of a hydrophilic head and a hydrophobic tail. In an aqueous solution, the hydrophilic heads are attracted to water and the hydrophobic tails are not. This causes the phospholipids to form a bilayer.

1. Identify the main components (ac) of the symbolic triglyceride below:

2. Which of the lipids have such a high energy content?

41 Protein Shape is Related to Function

Key Idea: Interactions between amino acid R groups, about a polypeptide chain, lead to its functional shape. When a protein is denatured, it loses its functionality. A protein may consist of one polypeptide chain, or several polypeptide chains linked together. Hydrogen bonds between amino acids cause it to form its secondary structure, either an α -helix or a β -pleated sheet. The interaction between R groups causes a polypeptide to fold into its tertiary structure. A three-dimensional shape held by ionic bonds and disulfide bridges. Bonds formed between sulfur-containing amino acids. If bonds are broken through denaturation, the protein loses its tertiary structure, and its functionality.

The shape of a protein reflects its biological role

Channel proteins have been shown to be the primary membrane transport protein in groups of proteins. Channel proteins are made up of several polypeptide chains that are linked together. They form a pore through which small molecules and ions can pass. Channel proteins are found in the membranes of cells and organelles.

Enzymes are proteins that catalyze specific biochemical reactions. They are made up of one or more polypeptide chains that are folded into a specific three-dimensional shape. The shape of an enzyme is determined by the sequence of amino acids in its primary structure. Enzymes are found in all living organisms and are essential for life.

Soluble proteins are proteins that are dissolved in water. They are made up of one or more polypeptide chains that are folded into a specific three-dimensional shape. Soluble proteins are found in the cytoplasm of cells and in the extracellular fluid.

Protein denaturation is the process by which a protein loses its functional shape. This can be caused by heat, pH changes, or the addition of chemicals. Denaturation is reversible, and the protein can often refold back into its functional shape.

1. Explain the importance of the amino acid sequence in protein folding.

2. Why do channel proteins often fold with non-polar R groups to the channel's exterior and polar R groups to its interior?

3. Why does denaturation often result in the loss of protein functionality?

42 Protein Structure

Key Idea: The sequence and type of amino acids in a protein determines the protein's three-dimensional shape and function.

Primary (1°) structure (amino acid sequence)

The sequence and type of amino acids in a protein determines the protein's three-dimensional shape and function.

Secondary (2°) structure

Secondary structure is the local structure of a protein. It is determined by hydrogen bonds between the amino and carboxyl groups of the amino acids. The amino acids determine the type and arrangement of the protein's secondary structure.

Tertiary (3°) structure (folding of the 2° structure)

Tertiary structure is the three-dimensional shape of a protein. It is determined by interactions between the side chains of the amino acids. These interactions include hydrogen bonds, ionic bonds, and disulfide bridges.

Quaternary (4°) structure

Quaternary structure is the overall three-dimensional shape of a protein. It is determined by interactions between the subunits of the protein.

1. Describe the main features that aid the formation of each part of a protein:

(a) Primary structure

(b) Secondary structure

(c) Tertiary structure

(d) Quaternary structure

2. How are proteins built up into a functional structure?

The KEY IDEA provides a focus for each activity. The key ideas through a chapter provide a concise summary of the chapter content.

Engage, explore and explain

Elaborate

Engage, explain, elaborate, and evaluate: Activities are nested. An introductory activity introduces and builds understanding of a specific core idea, and a subsequent activity involves applying that understanding to a new situation, e.g. analysing data, finding a solution, or interpreting new information.

Students become actively involved in the learning activity by interacting with the material, answering the question and completing the set tasks. Many activities are suitable as assessment tasks.

61 Enzymes

Key Idea: Enzymes are biological catalysts. The active site is central to this functional role. Most enzymes are globular proteins. Enzymes are biological catalysts because they speed up biochemical reactions, but the enzyme itself remains unchanged. The substrate is a

The active site
Enzymes have an active site which specifically attracts their substrate and lowers the activation energy of a reaction. The shape and chemistry of the active site is a function of the protein's complex tertiary structure.

Enzymes can be intracellular or extracellular
Enzymes can be defined based on where they are produced and where they are active. An **intracellular enzyme** is an enzyme that performs its function within the cell that produces it. Most enzymes are intracellular enzymes, e.g. catalase and amylase. Example: Catalase. Catalase is an intracellular enzyme which is found in liver cells. Catalase converts hydrogen peroxide into water and oxygen to prevent damage to cells and tissues.

Substrates collide with an enzyme's active site
For a reaction to occur, substrate molecules must collide with sufficient speed and with the correct orientation to provide a site for reaction to occur. Collisions between substrate molecules are frequent, but a reaction will occur only if the molecules are moving in the right direction and have sufficient energy to overcome the activation energy barrier. Enzymes orientate the substrate molecules making it easier for a reaction to occur.

1. What is meant by the active site of an enzyme and relate it to the enzyme's tertiary structure?
2. Why are enzymes specific to their substrates?
3. How do substrate molecules come to collide with an enzyme's active site?
4. Suggest why digestion (the breakdown of large macromolecules) is largely performed by extracellular enzymes.
5. Why would an extracellular enzyme be produced and secreted in an inactive form?

Explain

63 How Enzymes Work

Key Idea: Enzymes increase the rate of biological reactions by lowering the reaction's activation energy. Chemical reactions in cells are accompanied by energy changes. The amount of energy released or taken up is directly related to the bond energy of a reaction to start to completion for all the reactants to form products. Any reaction needs to take the energy of the substrate to an unstable transition state before the reaction will proceed (below). The amount of energy needed to do this is the **activation energy (E_a)**. Enzymes lower the E_a by stabilising bonds in the substrate so that it is more mobile. Enzyme reactions can break down an single substrate molecule into smaller substrate molecules (catabolic reactions), or join two or more substrate molecules together (anabolic reactions).

Lowering the activation energy
The presence of an enzyme simply makes it easier for a reaction to take place. All catalysts speed up reactions by lowering the stability of bonds in the reactants. They may also provide an alternative reaction pathway that lowers the activation energy (E_a) needed for a reaction to take place (see the graph below).

1. How do enzymes lower the activation energy for a reaction?
2. Describe the difference between a catabolic and anabolic reaction.

Elaborate

71 KEY TERMS: Did You Get It?

1. The diagram (right) symbolically represents a phospholipid.
(a) Label the hydrophilic and hydrophobic regions of the phospholipid.
(b) Explain how the properties of hydrophilic regions of the phospholipid molecule result in the bilayer structure of membranes.

2. (a) What general reaction combines two molecules to form a larger molecule?
(b) What general reaction cleaves a large molecule by the addition of water?
3. (a) Which class of biological molecules contains carbon, hydrogen, and oxygen only?
(b) In addition to carbon, hydrogen, and oxygen, name the other element that all proteins contain.
(c) Some proteins also contain sulfur. What is the effect of sulfur on a protein's structure?

4. For the following DNA sequence, give the mRNA sequence and then identify the amino acids that are encoded. For the question you may consult the mRNA-anticodon table earlier in the chapter.
DNA: G A A C C C T T A C A T A T G G T G T
mRNA: _____
Amino acids: _____

5. Complete the following paragraph by inserting one of the words in the bracketed () pairs below.
In eukaryotes, gene expression begins with **(transcription/translation)** which occurs in the **(cytoplasm/nucleus)**. **(Transcription/Translation)** is the copying of the DNA code into the **(mRNA/tRNA)**, which is then transported to the **(cytoplasm/nucleus)** where **(transcription/translation)** occurs. Ribosomes attach to the **(mRNA/tRNA)** and help match the codons on **(mRNA/tRNA)** with the anticodons on **(mRNA/tRNA)**. The **(mRNA/tRNA)** transports the amino acids to the ribosome where they are added to the growing **(polypeptide/polysaccharide)** chain.

6. (a) Label the graph, right, with appropriate axes and the following labels: Reactants, products, activation energy, transition state.
(b) Assume the reaction has had no enzyme added to the reaction. Draw the graph of the amount of enzyme added to the reaction. Label the axes and the curve.

7. (a) Label the graph, right, with appropriate axes and the following labels: Reactants, products, activation energy, transition state.
(b) Assume the reaction has had no enzyme added to the reaction. Draw the graph of the amount of enzyme added to the reaction. Label the axes and the curve.

Evaluate

179 Breathing in Humans

Key Idea: Breathing provides a continual supply of air to the lungs to maintain the concentration gradients for gas exchange. Different molecules are used in inspiration and expiration to force air in or out of the lungs. Breathing is achieved by the action of muscles.

1. Describe the sequence of events involved in quiet breathing.
2. What is the essential difference between this and the situation during forced breathing?
3. During inspiration, which muscles are active?
4. Explain the role of antagonistic muscles during breathing.

Engage the student with what is familiar to them

Explore and explain

180 Investigating Ventilation in Humans

Key Idea: Vital capacity can be affected by several factors, including age, gender, height, and physical condition. Vital capacity is the greatest volume of air that can be expelled from the lungs after the deepest possible inspiration.

Measuring vital capacity
Vital capacity can be measured using a spirometer. The spirometer is filled with water and the subject breathes into it. The volume of air inhaled and exhaled is measured by the displacement of water in a graduated cylinder.

Gender	Height (m)	Vital Capacity (litres)
Female	1.5	2.0
Female	1.6	2.2
Female	1.7	2.4
Female	1.8	2.6
Female	1.9	2.8
Female	2.0	3.0
Male	1.7	2.5
Male	1.8	2.8
Male	1.9	3.1
Male	2.0	3.4
Male	2.1	3.7
Male	2.2	4.0

1. Calculate the mean vital capacity for:
(a) Females
(b) Males
(c) Explain if these results are what you would expect.

2. Plot the height versus vital capacity as a scatter graph on the grid provided (right).

Interpretive tasks require students to apply their basic understanding to a new problem

19 Correlation or Causation

Key Idea: A correlation is a mutual relationship or association between two or more variables. A correlation between two variables does not imply that one causes change in the other. Correlation does not imply causation. You may see a correlation between two variables, but you cannot assume that change in one variable caused change in the other. Example: When data from the organs found associations and the effect of genetic inheritance on a person's height, there is a strong correlation between the two. However, it is unlikely that using organs found associations, it can be assumed that genetic inheritance causes a person's height.

Correlation does not imply causation
You may see a correlation between two variables, but you cannot assume that change in one variable caused change in the other. Example: When data from the organs found associations and the effect of genetic inheritance on a person's height, there is a strong correlation between the two. However, it is unlikely that using organs found associations, it can be assumed that genetic inheritance causes a person's height.

Drawing the line of best fit
Some graphs require you to be followed when drawing a line of best fit on your scatter plot.
• Your line should follow the trend of the data points.
• Roughly half of your data points should be above the line of best fit and half should be below.
• The line of best fit does not necessarily pass through any of the data points.
• The line of best fit should pass around the point that represents the mean of the x and the mean of the y variables.

1. What does the phrase 'correlation does not imply causation' mean?
2. A student measured the hand span and foot length measurements of 21 adults and plotted the data as a scatter graph (right).
(a) Draw a line of best fit through the data.
(b) Describe the results.
(c) Using your line of best fit as a guide, comment on the correlation between handspan and foot length.

A link to *Correlation or Causation* provides students with help to plot or interpret the results of their investigation.

Groups of activities build knowledge and understanding by giving students the chance to learn and apply their knowledge in a series of linked activities.

- Engage:** make a model
- Explore:** relate structure to function
- Elaborate:** examine supporting evidence
- Evaluate:** build a model as proof

48 Constructing

Key Idea: Constructing a model involves creating a representation of a system or process. The model can be used to test hypotheses and make predictions.

1. Identify and label each of the following structures:
(a) Phospholipid bilayer
(b) Membrane protein
(c) Channel protein
(d) Carrier protein
(e) Glycoprotein
(f) Glycolipid
(g) Lipid bilayer
(h) Hydrophilic head
(i) Hydrophobic tail

49 DNA R

Key Idea: DNA replication is a process by which a cell makes a copy of its DNA. The process involves the unwinding of the DNA double helix and the synthesis of new DNA strands.

1. Describe the general role of enzymes in DNA replication.
2. State the specific role of each of the following:
(a) DNA helicase
(b) DNA polymerase I
(c) DNA polymerase III
(d) DNA ligase
(e) RNA primase
(f) DNA gyrase

50 Enzyme Co

Key Idea: Enzymes are biological catalysts that speed up chemical reactions. They are highly specific and their activity is affected by temperature and pH.

1. Describe the general role of enzymes in DNA replication.
2. State the specific role of each of the following:
(a) DNA helicase
(b) DNA polymerase I
(c) DNA polymerase III
(d) DNA ligase
(e) RNA primase
(f) DNA gyrase

51 Meselson ar

Key Idea: Meselson and Stahl's experiment demonstrated that DNA replication is semi-conservative. They used heavy and light isotopes of nitrogen to track the fate of the original DNA strands.

1. Describe each of the DNA replication processes:
(a) Denaturation
(b) Replication
(c) Separation
(d) Ligation

52 Modelling DNA Replication

Key Idea: Modelling DNA replication involves creating a physical representation of the process. This can help students understand the complex molecular interactions involved in DNA replication.

1. Describe each of the DNA replication processes:
(a) Denaturation
(b) Replication
(c) Separation
(d) Ligation

Elaborate and evaluate

Explore

Engage

LINKS - Making Connections

The Link tabs help students to connect ideas between different topics in the Edexcel Biology programme. Connections may be made to activities that build on or develop an idea, utilise the same core principles in another biological context, or examine the evidence for a biological process such as DNA replication or ATP synthesis. The connections help students to appreciate that the same core principles underlie many biological phenomena and there is evidence to support them. Understanding these core principles brings understanding to a wide range of contexts and situations, even if they are unfamiliar.

24 Mean, Median, and Mode

Key Idea: Mean, median, and mode are measures of central tendency. The mean is the average, the median is the middle value, and the mode is the most frequent value.

Mean: The sum of all values divided by the number of values.

Median: The middle value when the data is ordered from smallest to largest.

Mode: The value that appears most often.

Worked Example 1: Calculate the mean, median, and mode for the following data: 12, 15, 18, 20, 22, 25, 28, 30, 32, 35, 38, 40.

Worked Example 2: Calculate the mean, median, and mode for the following data: 10, 10, 12, 15, 18, 20, 22, 25, 28, 30, 32, 35, 38, 40.

Table 1: Mean, Median, and Mode

Measure	Definition	Method of Calculation
Mean	The average of all values.	Sum of all values divided by the number of values.
Median	The middle value when the data is ordered from smallest to largest.	Order the data from smallest to largest. If there is an even number of values, the median is the average of the two middle values.
Mode	The value that appears most often.	Count the frequency of each value. The value with the highest frequency is the mode.

25 Spread of Data

Key Idea: Spread of data refers to the range, interquartile range, and standard deviation. The range is the difference between the highest and lowest values. The interquartile range is the difference between the 25th and 75th percentiles. The standard deviation is a measure of the average distance of each data point from the mean.

Range: The difference between the highest and lowest values.

Interquartile Range (IQR): The difference between the 25th and 75th percentiles.

Standard Deviation: A measure of the average distance of each data point from the mean.

Worked Example: Calculate the range, IQR, and standard deviation for the following data: 12, 15, 18, 20, 22, 25, 28, 30, 32, 35, 38, 40.

28 Test Your Understanding

Key Idea: Test your understanding of the concepts of mean, median, and mode by applying them to real-world data.

Table 2: Mass of 1000 seeds of different varieties of beans

Seed Variety	1	2	3	4	5	6	7	8	9	10
Mean mass (g)	89.1	89.2	89.3	89.4	89.5	89.6	89.7	89.8	89.9	90.0

EXAMPLE 1

Descriptive statistics

Calculate measures of central tendency and variability in data. Then apply these principles to real, second-hand data. Students can then progress to applying these skills to the analysis of primary data collected through their own practical work.

79 Plant Cells

Key Idea: Plant cells are eukaryotic cells. They have a nucleus, a cell wall, and a large central vacuole. The cell wall is made of cellulose and provides structural support. The large central vacuole is filled with cell sap and helps maintain turgor pressure.

Cell Wall: A rigid layer of cellulose that surrounds the cell.

Central Vacuole: A large, fluid-filled sac that occupies most of the cell's volume.

Chloroplasts: Organelles that capture light energy and convert it into chemical energy through photosynthesis.

Worked Example: Label the parts of a plant cell and describe their functions.

80 Identifying Structures in a Plant Cell

Key Idea: Identify the structures in a plant cell using an electron micrograph. The structures include the cell wall, nucleus, chloroplasts, and vacuole.

Worked Example: Identify the structures in the electron micrograph and describe their functions.

83 Identifying Organelles

Key Idea: Identify the organelles in a plant cell using an electron micrograph. The organelles include the nucleus, chloroplasts, and vacuole.

Worked Example: Identify the organelles in the electron micrograph and describe their functions.

EXAMPLE 2

The plant cell and organelles

Apply the understanding of plant cell structure to label organelles in an electron micrograph.

89 Optical Microscopes

Key Idea: Optical microscopes use light to magnify objects. They consist of an objective lens and an eyepiece lens. The objective lens is close to the specimen, and the eyepiece lens is close to the eye. The magnification is the product of the magnifications of the objective and eyepiece lenses.

Magnification: The ratio of the size of the image to the size of the object.

Worked Example: Calculate the magnification of an optical microscope.

90 Measuring and Counting Using a Microscope

Key Idea: Measure and count cells using a microscope. The microscope is used to observe a grid of cells. The number of cells is counted, and the area of the grid is measured. The number of cells per unit area is calculated.

Worked Example: Measure and count cells using a microscope.

95 Electron Microscopes

Key Idea: Electron microscopes use electrons to magnify objects. They consist of an electron gun, a condenser lens, and a detector. The electron gun emits a beam of electrons, which is focused by the condenser lens onto the specimen. The detector captures the electrons that pass through the specimen.

Worked Example: Calculate the magnification of an electron microscope.

EXAMPLE 3

Microscopy

Learn the basics of light microscope function and use this understanding to correctly use an eyepiece micrometer and graticule. Compare light microscopes to electron microscopes.

37 Lipids

Key idea Lipids are non-polar, hydrophobic organic molecules that form energy-dense storage molecules. Lipids are organic compounds that are mostly hydrophobic and are soluble in organic solvents and insoluble in water. Lipids include fats, oils, waxes, phospholipids, and steroids. Lipids function in energy storage, as structural components of cell membranes and many other biological functions.

Triglycerides

Triglycerides are the most abundant lipids in living organisms. They are composed of three fatty acid chains esterified to a glycerol backbone. The hydrophobic tails of the fatty acids are the main component of the lipid bilayer in cell membranes.

Phospholipids

Phospholipids are a class of lipids that are a major part of all cell membranes. They are composed of two hydrophobic tails and one hydrophilic head. The hydrophilic head is attached to a phosphate group, which is further attached to a hydrophilic molecule, such as a sugar or a protein.

1. Identify the main components of the lipid bilayer in cell membranes.

2. Why do lipids have such a high energy content?

3. Explain how lipids are used in the body.

4. Describe the structure of phospholipids and how they form a bilayer.

5. Explain why phospholipids are so important in cell membranes.

38 Phospholipids

Key idea Phospholipids are essential for the formation of cell membranes. They are composed of two hydrophobic tails and one hydrophilic head. The hydrophilic head is attached to a phosphate group, which is further attached to a hydrophilic molecule, such as a sugar or a protein.

Phospholipids

Phospholipids are a class of lipids that are a major part of all cell membranes. They are composed of two hydrophobic tails and one hydrophilic head. The hydrophilic head is attached to a phosphate group, which is further attached to a hydrophilic molecule, such as a sugar or a protein.

Phospholipids and membranes

Phospholipids are essential for the formation of cell membranes. They are composed of two hydrophobic tails and one hydrophilic head. The hydrophilic head is attached to a phosphate group, which is further attached to a hydrophilic molecule, such as a sugar or a protein.

1. (a) Explain the structure of phospholipids in their natural state and how they form a bilayer in cell membranes.

(b) Explain how the self-membrane structure of phospholipids is different from that of typical fat droplets.

2. Explain why phospholipids are so important in cell membranes.

162 The Structure of Membranes

Key idea The plasma membrane is composed of a lipid bilayer with embedded proteins. The lipid bilayer is formed by phospholipids, which have hydrophilic heads and hydrophobic tails. The proteins are embedded in the bilayer and perform various functions, such as transport and signaling.

The fluid mosaic model of membrane structure

The fluid mosaic model of membrane structure describes the plasma membrane as a phospholipid bilayer with embedded proteins. The phospholipids are in constant motion, and the proteins are also mobile within the bilayer.

1. Identify the components of the plasma membrane in a cell.

(a) Phospholipids

(b) Proteins

2. How do the properties of phospholipids contribute to their role in forming the structural framework of membranes?

3. (a) Describe the modern fluid mosaic model of membrane structure.

EXAMPLE 4
Lipids
 Make connections between the structure of lipids and their modification for use in the plasma membrane.

122 Classification Systems

Key idea Classification systems are used to organize and identify living organisms. They are based on shared characteristics and evolutionary relationships.

Naming an organism: genus and species

The scientific name of an organism consists of its genus and species. The genus is capitalized and the species is lowercase. Both are italicized.

What are subgroups?

Subgroups are smaller groups within a larger classification system. They are used to further categorize organisms based on shared characteristics.

1. Identify the main components of a classification system.

2. Explain how classification systems are used to identify organisms.

3. Describe the importance of classification systems in biology.

123 How Do We Assign Species?

Key idea Species are groups of organisms that can interbreed and produce fertile offspring. They are defined based on shared characteristics and evolutionary relationships.

Different species may look the same

Some species may look very similar to each other, but they are not the same species. This is because they do not share the same genetic information and cannot interbreed.

1. In what way have traditional methods of classification based on morphology been replaced?

2. What are the implications of species complexes and cryptic species in conservation?

133 Classification Systems: The Old and The New

Key idea Classification systems have evolved over time. The old system was based on morphology, while the new system is based on genetics and evolutionary relationships.

A changing view of classification

The old classification system was based on morphology, while the new system is based on genetics and evolutionary relationships. This has led to a more accurate understanding of the relationships between organisms.

1. Explain how classification systems have evolved over time.

2. Describe the differences between the old and new classification systems.

EXAMPLE 5
Classification
 Understand how (and why) living organisms are grouped together and how this helps us understand their evolutionary relationships.

171 Active Transport

Key idea Active transport is the movement of molecules across a cell membrane from a region of low concentration to a region of high concentration. This process requires energy in the form of ATP.

Active transport

Active transport is the movement of molecules across a cell membrane from a region of low concentration to a region of high concentration. This process requires energy in the form of ATP.

1. What is active transport?

2. Where does the energy for active transport come from?

3. What is the difference between passive and active transport?

172 Ion Pumps

Key idea Ion pumps are proteins that use energy to move ions across a cell membrane. They are essential for maintaining the cell's internal environment.

Proton pump

The proton pump uses energy to move protons (H⁺) across a cell membrane. This creates a proton gradient that is used for various cellular processes.

Sodium-potassium pump

The sodium-potassium pump uses energy to move sodium (Na⁺) and potassium (K⁺) ions across a cell membrane. This is essential for maintaining the cell's resting potential.

1. Why is ATP required for membrane pump systems to operate?

2. (a) Explain what is meant by cotransport.

(b) How are cotransport used to move glucose into the intestinal epithelial cell?

3. Describe how cotransport of the mitochondrial accumulation of sodium ions.

175 ATP Supplies Energy for Work

Key idea ATP is the energy currency of the cell. It is produced in the mitochondria and used to power various cellular processes.

The structure of ATP

ATP is composed of three phosphate groups and a ribose sugar. The phosphate groups are attached to the ribose sugar, and the energy is stored in the bonds between the phosphate groups.

1. In which organelle is ATP produced in the cell?

2. Which organ contains the highest level of ATP?

3. Which enzyme catalyses the synthesis of ATP?

4. On the space following, draw the structure of ATP at the top right of the page.

5. Label the three components of an ATP molecule.

6. Show which phosphate bond is hydrolysed to provide the energy for cellular work.

7. In what way is the ADP/ATP system like a rechargeable battery?

EXAMPLE 6
Active transport
 Explain how ATP is produced and used in transporting substances across cellular membranes.

135 Mechanism of Natural Selection

Key idea Natural selection is the process by which organisms with favorable traits are more likely to survive and reproduce. This leads to the evolution of a population over time.

Natural selection in the case of the peppered moth

The peppered moth is a classic example of natural selection. In a polluted environment, the dark-colored moths were more likely to survive because they were better camouflaged against the soot-covered trees.

1. Identify the four factors that interact to bring about evolution in populations.

138 Natural Selection in Pocket Mice

Key idea Natural selection is the process by which organisms with favorable traits are more likely to survive and reproduce. This leads to the evolution of a population over time.

Natural selection in pocket mice

The pocket mouse is a classic example of natural selection. In a dark environment, the dark-colored mice were more likely to survive because they were better camouflaged against the dark rocks.

1. (a) What are the genotypes of the dark-colored mice?

(b) What is the genotype of the light-colored mice on the living island. Show colour graphs of the parent, F1 and F2 populations and explain the results of the natural selection.

139 Selection for Skin Colour in Humans

Key idea Skin color in humans is determined by the amount of melanin in the skin. This trait is influenced by natural selection, particularly in relation to UV radiation and vitamin D synthesis.

Selection for skin colour in humans

Dark skin is favored in high-UV environments because it provides protection against UV radiation. Light skin is favored in low-UV environments because it allows for the synthesis of vitamin D.

1. Explain how natural selection has acted on skin color in humans.

2. Describe the relationship between skin color and UV radiation.

3. Explain how skin color is related to vitamin D synthesis.

EXAMPLE 7
Natural selection
 Learn the mechanisms by which natural selection operates, then use real data to see its effect on real populations.

Making Use of Weblinks

79 Plant Cells

Key Idea: Plant cells are eukaryotic cells. They have features in common with animal cells, but also several unique features. Eukaryotic cells have a similar basic structure, although they may vary tremendously in size, shape, and function. Certain features are common to almost all eukaryotic cells, including their three main regions: a nucleus, surrounded by a watery cytoplasm, which is itself enclosed by the plasma membrane. Plant cells are enclosed in a cellulose cell wall, which gives them a regular, uniform appearance. The cell wall protects the cell, maintains its shape, and prevents excessive water uptake. It provides rigidity to plant structures but permits the free passage of materials into and out of the cell.

Generalised plant cell

Starch granule: Carbohydrate stored in amyloplasts (starch granules) for storage. Plants are not found in animal cells. Non-polymerisable starch is usually used for storage.

Mitochondrion: 1.5 µm x 2-8 µm. They are the cell's energy transformers, converting chemical energy into ATP. Mitochondria contain 70S ribosomes.

Plasma membrane: Located inside the cell wall in plants. It is 3 to 10 nm thick.

Endoplasmic reticulum (ER): Consists of a network of tubes and flattened sacs. ER membranes are continuous with the nuclear membrane and the plasma membrane and they may be smooth or have attached ribosomes (rough ER).

Nuclear pore: 100 nm diameter.

Nuclear membrane: a double layered structure.

Nucleolus: A conspicuous organelle 0.5 µm diameter.

Nucleus:

Ribosome: 80S ribosomes. These small (20 nm) structures manufacture proteins. They may be free in the cytoplasm or associated with the surface of the endoplasmic reticulum.

Golgi apparatus:

The vacuole: is surrounded by a special membrane called the tonoplast.

Cytoplasm: A watery solution containing dissolved substances, enzymes, and the cell organelles and structures. The site of translation in the cell.

Chloroplast: Specialised plastids, 2 µm x 5 µm, containing the green pigment chlorophyll. They contain dense stacks of membranes (granum) within a colorless fluid which is much like cytosol. They are the sites for photosynthesis and occur mainly in leaves. Chloroplasts contain 70S ribosomes.

Cell wall: A semi-rigid structure outside the plasma membrane, 0.1 µm to several µm thick. It is composed mainly of cellulose. It supports the cell and binds to others.

Middle lamella (seen here between adjacent cells left): The first layer of the cell wall formed during cell division. It contains pectin and protein, and provides stability. It allows the cells to form plate-like structures (PL), special structures that allow communication and transport to occur between cells.

Cytoplasm: A watery solution containing dissolved substances, enzymes, and the cell organelles and structures. The site of translation in the cell.

1. What are the functions of the cell wall in plants?
2. (a) What structure takes up the majority of space in the plant cell?
(b) What are its roles?
3. (a) Distinguish between the cytoplasmic ribosomes and the ribosomes found in chloroplasts and mitochondria.
(b) What might this suggest about the origins of these organelles?
4. Identify two structures in the diagram that are not found in animal cells.

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The tab system at the base of each activity identifies if there is a weblink available to support the activity's content. The weblinks are distinct from the general Biolinks site on BIOZONE's website. They are coded with the activity number and are only accessible through a specific url (below), so bookmark the address at the beginning of your teaching year and always have them on hand. The weblinks comprise short video clips or animations aimed specifically at the activity content. These are external sites from a wide range of reputable sources and are invaluable as support to explain content or view an animation of a complex process such as DNA packing or translation. It's easy and we've done the hard work for you. Just click and view.

Eucaryotic Cell Interactive Animation

Animal Cell Model | Cell Game | The Cell | Cell Alive

CELLS alive! Interactive Animal and Plant Cells

ROUGH ENDOPLASMIC RETICULUM

Animal Cell | Plant Cell

Nucleus, Nucleolus, Cytoplasm, Centriosome, Centriole, Golgi, Lysosome, Peroxisome, Secretory Vesicle, Cell Membrane, Mitochondrion, Vacuole, Cell Wall, Chloroplast, Smooth Endoplasmic Reticulum, Rough Endoplasmic Reticulum, Ribosome, Cytoskeleton

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Weblinks exist for most of the activities in the workbook, from cells to evolution.

www.biozone.co.uk/weblink/Edxl-1-9254

This WEBLINKS page provides links to **external web sites** with supporting information for the activities. Almost exclusively, they are narrowly focussed animations and video clips relevant to the activity on which they are cited. They offer great support to aid student understanding of basic concepts, especially for visual learners.

EDEXCEL BIOLOGY 1 WEBLINKS

Some of the activities in your BIOZONE workbook have references to specific websites, listed below under the relevant chapters. These websites (blue links) provide material, generally either animations or video clips, to help you visualize and understand the material presented on the relevant activity page.

Activity #	Title	Weblinks Title
1	Mathematical and Practical Skills in Biology	
2	Hypotheses and Predictions	Hypotheses
3	Types of Data	Types of Data: Nominal, Ordinal, Interval/Ratio
4	Logis and Exponents	Power Functions
9	Logis and Exponents	Introduction to Exponential Functions
20	Drawing Scatter Plots	Correlation vs Causation
24	Mean, Median, and Mode	Statistics of Central Tendency
24	Mean, Median, and Mode	Measures of Central Tendency Rap
25	Spread of Data	Statistics of Dispersion
26	Interpreting Sample Variability	Introduction to Descriptive Statistics
27	Biological Drawings	Scientific Drawings for Biological Courses

Chapter in the workbook

Activity in the workbook

Weblink Animation

Consider Graphing...
An "Exponential" Function
 $y = 2^x$

x	y
1	2
2	4
3	8
4	16
0	1
-1	1/2
-2	1/4
-3	1/8

Introduction To Exponential Functions

Bookmark weblinks by typing in the address: it is not accessible directly from BIOZONE's website
Corrections and clarifications to current editions are always posted on the weblinks page

Teaching Strategies for Classroom Use

Achieving effective differential instruction in classes is a teaching challenge. Students naturally have mixed abilities, varying backgrounds in the subject, and different language skills. Used effectively, BIOZONE's workbooks and supporting products can make teaching a mixed ability class easier. Here, we offer three approaches for differential instruction.



MAKING A START

Regardless of which activity you might be attempting in class, a 5-10 minute introduction to the task by the teacher is useful orientation for all students. For collaborative work, the teacher can then divide the class into appropriate groups, each with a balance of able and less able students. Depending on the activity, the class may regroup at the end of the lesson for collaborative discussion.

1 Peer to peer support

- Use **peer-to-peer learning** for more challenging activities where the content may be more complex and the questions require students to draw on several areas of their knowledge to synthesise an answer. Examples of such activities include those with a graphing component followed by an evaluation task.
- Stronger peers can assist weaker students and both groups benefit from verbalising their thoughts and presenting them to a group. ESL students can ask their peers to explain unfamiliar terms (both scientific and English) and this benefits both parties. **Paper practicals** (e.g. *Modelling Meiosis*, *Modelling DNA Replication*) are another ideal vehicle for this kind of peer-to-peer learning.

In *Modelling Meiosis*, students can collaborate in pairs to determine the outcome of a mating between two individuals with different traits. This tests and creates understanding by putting theory into practice.

Encourage able students to extend their knowledge by visiting the **recommended weblinks** for the activity.

107 Modelling Meiosis

Key Idea: We can simulate crossing over, gamete production, and the inheritance of alleles during meiosis using ice-block sticks to represent chromosomes.

This practical activity simulates the production of gametes (sperm and eggs) by meiosis and shows you how crossing over increases genetic variability. This is demonstrated by studying how two of your own alleles are inherited by the child produced at the completion of the activity. Completing this activity will help you to visualise and understand meiosis. It will take 25-45 minutes.

Background

Each of your somatic cells contain 46 chromosomes. You received 23 chromosomes from your mother (**maternal chromosomes**), and 23 chromosomes from your father (**paternal chromosomes**). Therefore, you have 23 homologous (same) pairs. For simplicity, the number of chromosomes studied in this exercise has been reduced to four (two homologous pairs). To study the effect of crossing over on genetic variability, you will look at the inheritance of two of your own traits: the ability to tongue roll and handedness.

Chromosome #	Phenotype	Genotype
10	Tongue roller	TT, Tt
10	Non-tongue roller	tt
2	right handed	RR, Rr
2	Left handed	rr

Record your phenotype and genotype for each trait in the table (right).
NOTE: If you have a dominant trait, you will not know if you are heterozygous or homozygous for that trait, so you can choose either genotype for this activity.

BEFORE YOU START THE SIMULATION: Partner up with a classmate. Your gametes will combine with theirs (fertilisation) at the end of the activity to produce a child. Decide who will be the female, and who will be the male. You will need to work with this person again at step 6.

- Collect four ice-block sticks. These represent four chromosomes. Colour two sticks blue or mark them with a P. These are the maternal chromosomes. The plain sticks are the paternal chromosomes. Write your initials on each of the four sticks. Label the maternal chromosome number (right).
- Label four sticky dots with the alleles for each of your phenotypic traits, and stick it onto the appropriate chromosome. For example, if you are heterozygous for tongue rolling, the sticky dots will have the alleles T and t, and they will be placed on chromosome 10. If you are left handed, the alleles will be r and r and be placed on chromosome 2 (right).
- Randomly drop the chromosomes onto a table. This represents a cell in either the testes or ovaries. Duplicate your chromosomes (to simulate DNA replication) by adding four more identical ice-block sticks to the table (below). This represents interphase.

over increases genetic variability. This is demonstrated by studying how two of your own alleles are inherited by the child produced at the completion of the activity. Completing this activity will help you to visualise and understand meiosis. It will take 25-45 minutes.

Dominant: Tongue roller **Dominant: Right hand**

Recessive: Non-roller **Recessive: Left hand**

Trait	Phenotype	Genotype
Handedness		
Tongue rolling		

Paternal chromosome: Your initials, Homologous pair

Maternal chromosome: Your genotype, Homologous pair

Paternal chromosome: Chromosome number

1. Simulate prophase I by lining the duplicated chromosome pair with their homologous pair (below). For each chromosome number, you will have four sticks touching side-by-side (A). At this stage crossing over occurs. Simulate this by swapping sticky dots from adjoining homologs (B).

(A)

(B)

on the metaphase plate (as occurs in metaphase I). Simulate anaphase I, two are pulled to each pole.

each intermediate cell will contain a mixture of maternal and paternal chromosomes.

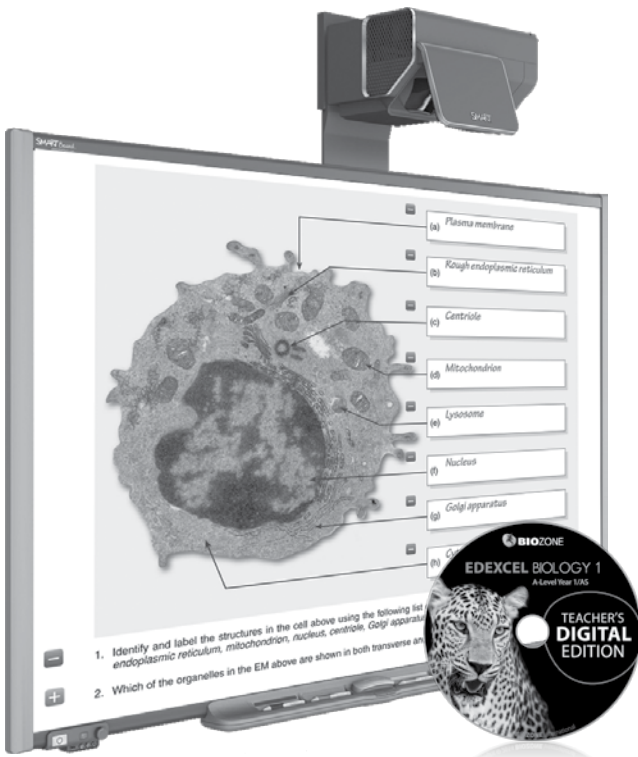
II, metaphase II, anaphase II, and telophase II. Each of the two cells will have produced two haploid gametes.

each one sperm and one egg gametes. You have created four cells.

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105 107 PRAC

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2 Interactive revision of tasks in class

- Use the workbook PDFs with HIDE/SHOW answers on the **Teacher's Digital Edition** to review activities in class using a data projector or interactive whiteboard.
- Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.
- This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.

3 Gaining confidence

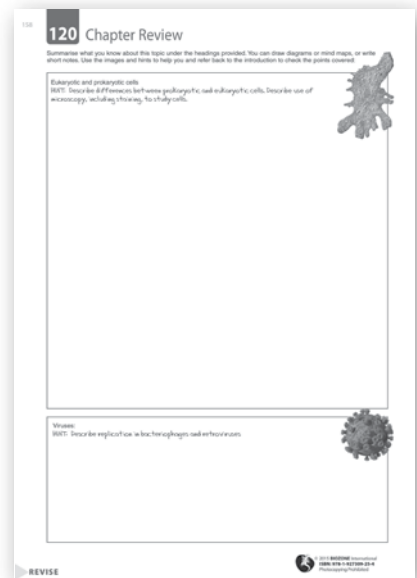
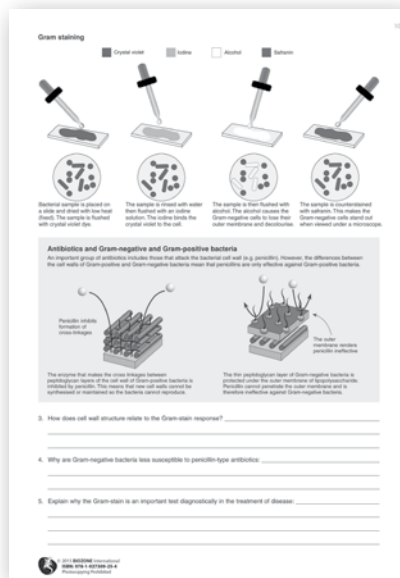
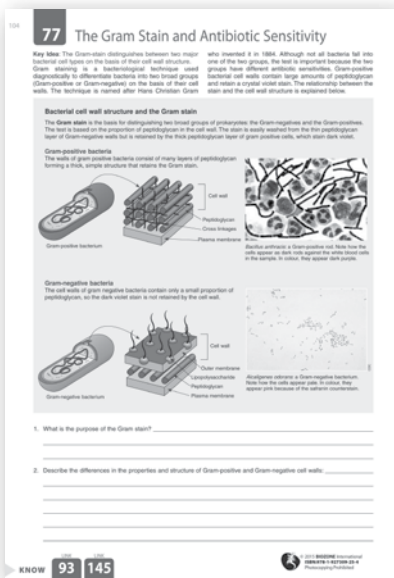
- The questions in BIOZONE's workbook activities have generally been written in a direct questioning style, e.g. "What are the differences between A and B", or "Why are A and B different?". This makes it easier for the students to understand what is required to answer the question.
- Questions are also arranged so that simpler questions (describe, what, identify, name) are generally asked first, followed by questions demanding an explanation (explain, how, why, account for). This allows students to gain confidence from answering the simpler questions first before attempting the questions that require more comprehensive answers.
- This arrangement also allows teachers to direct students appropriately so that some may attempt only the simpler questions themselves and work with peers to attempt the more challenging questions.

Students A and B will work through simpler questions themselves but may require assistance with the more challenging questions in an activity.

Student C is capable. She completes all of an activity including the more challenging questions.



Student D (above) is capable and completes the set work quickly. She can assist her peers and demonstrate her understanding in the relevant section of the review sheets.



Choosing Activities for Home Study

Many of the workbook activities are ideal for homework or as vehicles for a quick synoptic assessment. Chapter reviews, literacy activities, and follow-on activities are ideal as homework. They provide a way in which to review and consolidate material that has recently been completed, helping learners by presenting the material in a slightly different way. The information for review activities can be found in the content of the chapter, although stronger students may not need to refer back to source material to complete the set work.

120 Chapter Review
Summarise what you know about this topic under the headings provided. You can draw diagrams or mind maps, or write short notes. Use the images and hints to help you and refer back to the introduction to check the points covered:

80 Identifying Structures in a Plant Cell
Key Idea: Organelles can be identified in an electron micrograph by their size, position, and appearance.
1. Study the diagrams on the other pages in this chapter to familiarise yourself with the structures found in eukaryotic cells. Identify the 11 structures in the cell below using the following word list: cytoplasm, smooth endoplasmic reticulum, mitochondrion, starch granule, chromosome, nucleus, vacuole, plasma membrane, cell wall, chloroplast, nuclear membrane

79 Plant Cells
Key Idea: Plant cells are eukaryotic cells. They have features common with animal cells, but also several unique features. Eukaryotic cells have a similar basic structure, although they may vary tremendously in size, shape, and function. Certain features are common to almost all eukaryotic cells, including their three main regions: a nucleus, surrounded by a watery cytoplasm, which is itself enclosed by the plasma membrane. Plant cells are enclosed in a cellulose cell wall, which gives them a regular, uniform appearance. The cell wall protects the cell, maintains its shape, and prevents excessive water uptake. It provides rigidity to plant structures but permits the free passage of materials into and out of the cell.

73 Types of Living Organisms
Key Idea: There are two broad types of cell: bacterial cells and eukaryotic cells. Living things (organisms) are made up of cells. They are divided into two broad groups: (bacterial) cells and the more complex (eukaryotic) cells. Plant cells, animal cells, fungal cells, and protists are all eukaryotic cells.

Generalised plant cell
Starch granules: Carbohydrate stored in amyloplasts (leaves specialised for storage). Plants are not found in animal cells. No other photosynthetic plastids are usually used for storage.
Chloroplast: Specialised plastids, 2 µm x 5 µm, containing the green pigment chlorophyll. They contain dense stacks of membranes (grana) within a colourless fluid which is much like cytosol. They are the sites for photosynthesis and occur mainly in leaves. Chloroplasts contain 70S ribosomes.
Cell wall: A semi-rigid structure outside the plasma membrane, 0.1 µm to several µm thick. It is composed mainly of cellulose. It supports the cell and limits its volume.
Middle lamella (seen here between adjacent cells): The first layer of the cell wall formed during cell division. It contains pectin and protein, and provides stability between the cells to form plasmodesmata (P), special channels that allow communication and transport to occur between cells.
Mitochondrion: 1.5 µm X 2-8 µm. They are the cell's energy transformers, converting chemical energy into ATP. Mitochondria contain 70S ribosomes.
Plasma membrane: Located inside the cell wall in plants, 3 to 10 nm thick.
Endoplasmic reticulum (ER): Comprises a network of tubes and flattened sacs. ER is continuous with the plasma membrane and the nuclear membrane and may be smooth or have attached ribosomes (rough ER).
Nuclear pore: 100 nm diameter
Nuclear membrane: a double layered structure.
Nucleus: A conspicuous organelle 5 µm diameter.
Nucleolus
Ribosomes: 80S ribosomes. These small (20 nm) structures manufacture proteins. They may be free in the cytoplasm or associated with the surface of the endoplasmic reticulum.
Golgi apparatus
Cytoplasm: A watery solution containing dissolved substances, enzymes, and the cell organelles and structures. The site of translation in the cell.

1. What are the functions of the cell wall in plants?
2. (a) What structure takes up the majority of space in the plant cell?
(b) What are its roles?
3. (a) Distinguish between the cytoplasmic ribosomes and the ribosomes found in chloroplasts and mitochondria.
(b) What might this suggest about the origins of these organelles?
4. Identify two structures in the diagram that are not found in animal cells:

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LINK 85 WEB 80 KNOW 79

KNOW 76 LINK 79 LINK 81 LINK 96

Review activities are ideal as homework. Students can produce their own review and then have it checked by the teacher or compare and discuss it with peers if they want to check their thinking.

Set simpler activities or preparatory reading (REFER activities) for homework. This encourages less able students to achieve and to be properly prepared for in-class lessons.

Most students will have internet access. Encourage them to visit the assigned **weblinks** if they are having trouble understanding a subject or visualising a process. They should also check activities indicated as **links**.

Focus on Scientific Literacy

Within all areas of science, scientific literacy is an important area of focus. With it, communication in the topic is more effective, more concise, and less cumbersome. BIOZONE's aim is to provide a method by which students would encounter and become familiar with scientific terms in various contexts. Beginning with the list of KEY TERMS at the beginning of each chapter, students can create their own glossary of commonly used terms. They can learn to use these key terms appropriately by encountering them in context within the activities, and reinforce their understanding of the term by completing the literacy activities throughout the workbook. These take several forms:

Mix and match activities ask students to match each key term to its best definition. Finding the correct definition increases retention of the terms and their meanings.

Literacy activities use a range of question types to test vocabulary and understanding of basic principles. Questions include analysis or completion of flow charts, drawings or photographs, mix and match definitions, cloze questions and other vocab builders, and multiple choice.

Comprehension activities require the students to read a short section of text, e.g. a mock article, and then answer some questions based on understanding and correctly interpreting the information provided. The aim is to provide high-interest material in a way that encourages engagement and focus.

161 KEY TERMS: Did You Get It?

1. Test your vocabulary by matching each term to its correct definition, as identified by its preceding letter code.

- | | |
|--|---|
| <p>_____ adaptation</p> <p>_____ allopatric speciation</p> <p>_____ biodiversity</p> <p>_____ bioinformatics</p> | <p>A Statistics used to quantify the heterogeneity of a system. Often used in ecological studies to assess environmental health.</p> <p>B A formal system of naming species of organisms by giving each a Latin name composed of two parts</p> <p>C Speciation in which the populations are physically separated.</p> <p>D The number or variety of species living within given ecosystem, biome, or on the entire Earth. Incorporates species richness as well as genetic and habitat diversity.</p> |
|--|---|

71 KEY TERMS: Did You Get It?

- The diagram (right) symbolically represents a phospholipid.
 - Label the hydrophobic and hydrophilic regions of the phospholipid.
 - Explain how the properties of the phospholipid molecule result in the bilayer structure of membranes.
- What general reaction combines two molecules to form a larger molecule?
 - What general reaction cleaves a larger molecule by the addition of water?
- Which class of biological molecules contains carbon, hydrogen, and oxygen only?
 - In addition to carbon, hydrogen, and oxygen, name the other element that all proteins contain.
 - Some proteins also contain sulfur. What is the effect of sulfur on a protein's structure?
- For the following DNA sequence, give the mRNA sequence and then identify the amino acids that are encoded. For this question you may consult the mRNA-amino acid table earlier in the chapter.

DNA: G A A A C C C T T A C A T A T C G T G C T

mRNA: _____

Amino acids: _____
- Complete the following paragraph by deleting one of the words in the bracketed () pairs below:



163 How Do We Know? Membrane Structure

Key Idea: The freeze-fracture technique for preparing and viewing cellular membranes has provided evidence to support the fluid mosaic model of the plasma membrane. Cellular membranes play many extremely important roles in cells and understanding their structure is central to understanding cellular function. Moreover, understanding the structure and function of membrane proteins is essential to understanding cellular transport processes, and cell recognition and signalling. Cellular membranes are far too small to be seen clearly using light microscopy, and certainly any detail is impossible to resolve. Since early last century, scientists have known that membranes were composed of a lipid bilayer with associated proteins. The original model of membrane structure, proposed by Davson and Danielli, was the unit membrane (a lipid bilayer coated with protein). This model was later modified by Singer and Nicolson after the discovery that the protein molecules were embedded within the bilayer rather than coating the outside. But how did they find out just how these molecules were organised?

The answers were provided with electron microscopy, and one technique in particular – freeze fracture. As the name implies, freeze fracture, at its very simplest level, is the freezing of a cell and then fracturing it so the inner surface of the membrane can be seen using electron microscopy. Membranes are composed of two layers of phospholipids held together by weak intermolecular bonds. These split apart during fracture.

The procedure involves several steps:

- ▶ Cells are immersed in chemicals that alter the strength of the internal and external regions of the plasma membrane and immobilise any mobile macromolecules.
- ▶ The cells are passed through a series of glycerol solutions of increasing concentration. This protects the cells from bursting when they are frozen.
- ▶ The cells are mounted on gold supports and frozen using liquid propane.
- ▶ The cells are fractured in a helium-vented vacuum at -150°C. A razor blade cooled to -170°C acts as both a cold trap for water and the fracturing instrument.
- ▶ The surface of the fractured cells may be evaporated a little to produce some relief on the surface (known as etching) so that a three-dimensional effect occurs.
- ▶ For viewing under an electron microscope (EM), a replica of the cells is made by coating them with gold or platinum to ~3 nm thick. A layer of carbon around 30 nm thick is used to provide contrast and stability for the replica.
- ▶ The samples are then raised to room temperature and placed into distilled water or digestive enzymes, which separates the replica from the sample. The replica is then rinsed in distilled water before it is ready for viewing.

Cleaving the membrane

Razor blade

Proteins leave bumps and holes in the membrane when it is cleaved

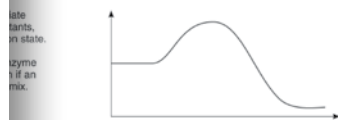
50 nm — Photo: Louise Howard and Chuan Dinghan, DePaul University

The freeze fracture technique provided the necessary supporting evidence for the current fluid mosaic model of membrane structure. When cleaved, proteins in the membrane left impressions that showed they were embedded into the membrane and not a continuous layer on the outside as earlier models proposed.

- Explain how freeze-fracture studies provided evidence for our current model of membrane structure: _____
- The Davson and Danielli model of membrane structure was the unit membrane: a phospholipid bilayer with a protein coat. Explain how the freeze-fracture studies showed this model to be flawed: _____

223

with (transcription/translation) which occurs in the (cytoplasm/nucleus). _____ of the DNA code into (mRNA/tRNA). The (mRNA/tRNA) is then transported to (splicing/translation) occurs. Ribosomes attach to the (mRNA/tRNA) and help match anticodons on (mRNA/tRNA). The (mRNA/tRNA) transports the amino acids to the growing (polypeptide/carbohydrate) chain.



term to its correct definition, as identified by its preceding letter code.

- _____ molecule consisting of many millions of units containing a phosphate group, sugar base (A, T, C or G). Stores the genetic information of the cell.
- _____ carbohydrate molecules made up of monosaccharide units joined together by glycosidic bonds
- _____ naturally found macromolecules composed of chains of nucleotides. These molecules store genetic information within cells.
- _____ of organic compounds with an oily, greasy, or waxy consistency. Important as storage molecules and as components of cellular membranes.
- _____ soluble proteins with a spherical tertiary structure. They are involved in many functions including as catalysts and in transport and regulation.

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COMP

The Teacher's Digital Edition

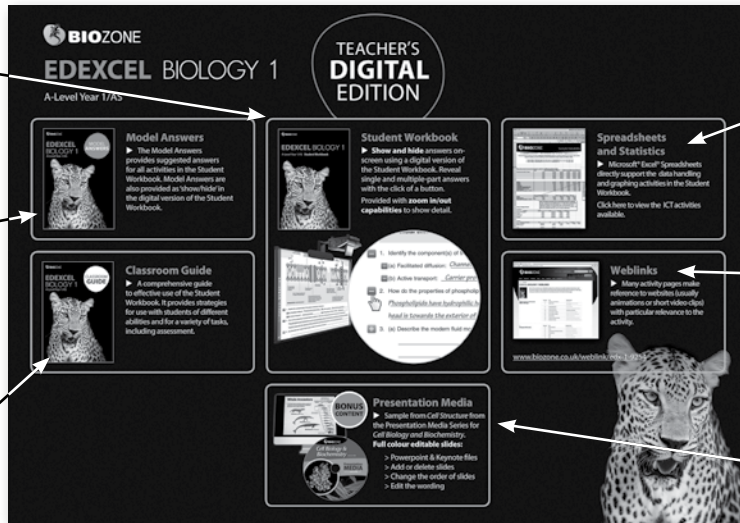
The *Teacher's Digital Edition* is aimed primarily at extending the pedagogical tools at a teacher's disposal. Many of the features of this resource have been developed in response to requests from teachers themselves.



A digital (PDF) version of the workbook (non-printable). Use the interactive buttons to HIDE or SHOW the answers.

Digital copy of the Model Answers (non-printable). Suggested answers are provided to all activities. Some include explanatory detail.

This Classroom Guide is provided as a printable PDF (no restrictions).



Link to **Excel®** spreadsheets for most activities with a data analysis component.

Access the **Weblinks** directly from this link for a range of animations and video clips to support the activities.

A **BONUS** sample of fully editable ppt slides from the Presentation Media series for 'Cell Biology and Biochemistry'.

171 Active Transport
 Key Idea: Active transport uses energy to transport molecules against their concentration gradient across a partially permeable membrane. Active transport is the movement of molecules (or ions) from regions of low concentration to regions of high concentration. This process requires energy being moved against the concentration gradient.

172 Ion Pumps
 Key Idea: Ion pumps are transmembrane proteins that use energy to move ions and molecules across a membrane against their concentration gradient. Sometimes molecules or ions are needed in concentrations that diffusion alone cannot supply to the cell, or they cannot diffuse through the plasma membrane. In this case ion pumps move ions (and some molecules) across the plasma membrane. The sodium-potassium pump (below) is found in almost all animal cells and is common in plant cells also. The concentration gradient created by ion pumps is often coupled with other transport processes.

Mean, Median, Mode
 This worksheet has been provided by Biozone International Ltd or use in preparing the calculation of some basic descriptive statistics. Examples are taken from the workbook.

- Select View > Formulae bar from the menu to view/hide the formulas for each cell.
- Select View > Comments from the menu to view/hide the comments for each cell.

Calculation of basic descriptive statistics

MEAN	180.03
MEDIAN	178.00
MODE	176.00
RANGE	176.00
STANDARD DEVIATION (SD)	15.39
STANDARD ERROR (SE)	4.79
TRUNC (SE)	0.88
TRUNC (SE * 2)	1.76
TRUNC (SE * 3)	1.44

Excel contains a programming error in formulae (i.e. a "bug"). This makes a difference to the calculation error in the 90% Confidence Interval (CI) and the 95% Confidence Interval (CI) which are shown in the margin. If any effect on the conclusion is to be best to calculate Confidence Intervals at the appropriate degrees of freedom.

Use the interactive buttons to reveal the answers as you work through the activity on-screen.

The answer provided in the electronic answer is the minimum expected answer. Sometimes, further explanatory details is included in the Model Answers booklet.

Many activities with data handling are supported by working spreadsheets, which include all data and comments on graphical analysis.

Resources on BIOZONE's Website

BIOZONE's web site should be the first stop for biologists. As well as providing all our product information (including shipping dates) and updates, www.biozone.co.uk provides quick access to the latest RSS newsfeeds and podcasts from around the world. The Resource hub also provides quick links to access the websites of publishers of references cited in the workbooks. Perhaps of greatest value to students and teachers is the BIOLINKS area of Biozone's website. The BIOLINKS pages are distinct from *Weblinks* (which are specific to each workbook edition) and provide a database of well organised hyperlinks pertaining to topics of interest in biology. The database is updated regularly, so that outdated, not operational, or no longer relevant sites are removed and new sites are added as they appear.

The screenshot shows the BIOZONE website interface. At the top, there is a navigation bar with the BIOZONE logo, a search bar, and links for Cart (0), Wishlist (0), Admin, Log Out, and My Account. Below this is a secondary navigation bar with links for Home, About Us, Products, Store, News, Biolinks, FAQ, and Contact Us. The main content area is titled 'Home > Biolinks' and features a grid of 20 topic-based icons, each with a small image and a label. A sidebar on the left lists all the topics under the heading 'BIOLINKS'. A large black arrow points from the 'Cell Biology' icon in the grid to a detailed view of the 'CELL BIOLOGY' page. This page includes a product advertisement for 'CELL BIOLOGY & BIOCHEMISTRY' with a 'View Product' button. Below the advertisement, there is a disclaimer, a section for 'General Sites for Cell Biology' with several links and brief descriptions, and a 'RSS Newsfeeds' section with links to 'NewScientist.com' and 'nature.com'.

BIOLINKS

- Anatomy and Physiology
- Animal Behaviour
- Animal Biology
- Biochemistry
- Biodiversity
- Biotechnology
- Cell Biology
- Conservation
- Ecology
- Earth Science
- Evolution
- Genetics
- Health & Disease
- Human Evolution
- Human Impact
- Microbiology
- Plant Biology
- Resource Management & Agriculture
- Space Biology
- Student Projects
- Biology Glossaries
- Examination Boards

CELL BIOLOGY

- Student Review Series for iPad and iPod
- Student Workbook
- Presentation Media

General Sites for Cell Biology

- BBC News:** Cell discovery clues to body clock and beating jet lag. New discoveries into how the body clock works could provide clues to help combat jet lag, research suggests.
- Kimball's Biology Pages:** A comprehensive biology site created and maintained by John W. Kimball, a retired graduate of Harvard College where he taught immunology.
- Molecular Biology Web Book:** A free web book, covering such topics as Cells and viruses, protein structure, DNA and Cell division.
- NIH:** Using technology to study cellular and molecular biology. Using Technology to Study Cellular and Molecular Biology—developed with the the National Center for Research Resources (NCRR)—is a creative, inquiry-based instruction program designed to promote active learning and stimulate student interest in medical topics.
- DNA Replication and Mutation:**
 - DNA Replication by John Kyrk
 - Karyotype Activities Genetic Science Learning Center
 - DNA Repair Nature

RSS Newsfeeds

- From NewScientist.com:**
 - European Commission sues UK over polluted air
 - Electric heart sock could kick out pacemakers
 - Space Images reveal California's vanished snowpack
 - Today on New Scientist
 - UK's carbon plans make up for oil and gas splurge
- From B B C NEWS:**
 - Scientists track Fukushima plume
 - Crystal is 'oldest scrap of crust'
 - 'Biggest meteorite impact' hits Moon
 - Rare 'pollo-like' disease reports
 - Farmers' union condemns flood plans
- From nature.com:**
 - Lateral junction dynamics lead the way out

RSS Newsfeeds and Podcasts in the right hand column provide the latest news and information from the world of science.

Click on the link to access the named site. The brief description tells you how the site may be of interest, as well as any country specific bias, if this is relevant.

