

**Mapping grid showing how the IBO Biology Diploma Core syllabus (first examinations 2009) is covered by Boardworks A-Level Biology products**

## **Topic 1: Statistical analysis**

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
1.1.1	State that error bars are a graphical representation of the variability of data.		
1.1.2	Calculate the mean and standard deviation of a set of values.		
1.1.3	State that the term standard deviation is used to summarize the spread of values around the mean, and that 68% of the values fall within one standard deviation of the mean.		
1.1.4	Explain how the standard deviation is useful for comparing the means and the spread of data between two or more samples.		
1.1.5	Deduce the significance of the difference between two sets of data using calculated values for t and the appropriate tables.		
1.1.6	Explain that the existence of a correlation does not establish that there is a causal relationship between two variables.		

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## Topic 2: Cells

### 2.1 Cell theory

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
2.1.1	Outline the cell theory.	Cell Structure	
2.1.2	Discuss the evidence for the cell theory.	Cell Structure	
2.1.3	State that unicellular organisms carry out all the functions of life.		
2.1.4	Compare the relative sizes of molecules, cell membrane thickness, viruses, bacteria, organelles and cells, using the appropriate SI unit.	Cell Structure	
2.1.5	Calculate the linear magnification of drawings and the actual size of specimens in images of known magnification.	Cell Structure	
2.1.6	Explain the importance of the surface area to volume ratio as a factor limiting cell size.		
2.1.7	State that multicellular organisms show emergent properties.	Cell Division	
2.1.8	Explain that cells in multicellular organisms differentiate to carry out specialized functions by expressing some of their genes but not others.	Cell Division	
2.1.9	State that stem cells retain the capacity to divide and have the ability to differentiate along different pathways.	Cell Division	Genetic Technologies
2.1.10	Outline one therapeutic use of stem cells.		Genetic Technologies

### 2.2 Prokaryotic cells

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
2.2.1	Draw and label a diagram of the ultrastructure of <i>Escherichia coli</i> ( <i>E.coli</i> ) as an example of a prokaryote.	Cell Structure	
2.2.2	Annotate the diagram from 2.2.1 with the functions of each named structure.	Cell Structure	
2.2.3	Identify structures from 2.2.1 in electron micrographs of <i>E.coli</i> .	Cell Structure	
2.2.4	State that prokaryotic cells divide by binary fission	Cell Structure	

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## 2.3 Eukaryotic cells

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
2.3.1	Draw and label a diagram of the ultrastructure of a liver cell as an example of an animal cell.	Cell Structure	
2.3.2	Annotate the diagram from 2.3.1 with the functions of each named structure.	Cell Structure	
2.3.3	Identify structures from 2.2.1 in electron micrographs of liver cells.	Cell Structure	
2.3.4	Compare prokaryotic and eukaryotic cells.	Cell Structure	
2.3.5	State three differences between plant and animal cells.	Cell Structure	
2.3.6	Outline two roles of extracellular components.	Cell Structure	

## 2.4 Membranes

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
2.4.1	Draw and label a diagram to show the structure of membranes.	Cell Membranes	
2.4.2	Explain how the hydrophobic and hydrophilic properties of phospholipids help to maintain the structure of cell membranes	Cell Membranes	
2.4.3	List the functions of membrane proteins.	Cell Membranes	
2.4.4	Define <i>diffusion</i> and <i>osmosis</i> .	Transport Across Membranes	
2.4.5	Explain passive transport across membranes by simple diffusion and facilitated diffusion.	Transport Across Membranes	
2.4.6	Explain the role of protein pumps and ATP in active transport across membranes.	Transport Across Membranes	
2.4.7	Explain how vesicles are used to transport materials within a cell between the rough endoplasmic reticulum, Golgi apparatus and plasma membrane.	Cell Structure	
2.4.8	Describe how the fluidity of the membrane allows it to change shape, break and re-form during endocytosis and exocytosis.	Transport Across Membranes	

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**2.5 Cell division**

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
2.5.1	Outline the stages in the cell cycle, including interphase (G <sub>1</sub> , S, G <sub>2</sub> ), mitosis and cytokinesis.	Cell Division	
2.5.2	State that tumours (cancers) are the result of uncontrolled cell division and that these can occur in any organ or tissue.		
2.5.3	State that interphase is an active period in the life of a cell when many metabolic reactions occur, including protein synthesis, DNA replication and an increase in the number of mitochondria and/or chloroplasts.	Cell Division	
2.5.4	Describe the events that occur in the four phases of mitosis (prophase, metaphase, anaphase and telophase).	Cell Division	
2.5.5	Explain how mitosis produces two genetically identical nuclei.	Cell Division	
2.5.6	State that growth, embryonic development, tissue repair and asexual reproduction involve mitosis.	Cell Division	

## Topic 3: The chemistry of life

### 3.1 Chemical elements and water

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
3.1.1	State that the most frequently occurring chemical elements in living things are carbon, hydrogen, oxygen and nitrogen,		
3.1.2	State that a variety of other elements are needed by living organisms, including sulfur, calcium, phosphorus, iron and sodium.		
3.1.3	State one role for each of the elements mentioned in 3.1.2.		
3.1.4	Draw and label a diagram showing the structure of water molecules to show their polarity and hydrogen bond formation.	Biological Molecules: Water and Carbohydrates	
3.1.5	Outline the thermal, cohesive and solvent properties of water.	Biological Molecules: Water and Carbohydrates	
3.1.6	Explain the relationships between the properties of water and its uses in living organisms as a coolant, medium for metabolic reactions and transport medium.	Biological Molecules: Water and Carbohydrates	

### 3.2 Carbohydrates, lipids and proteins

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
3.2.1	Distinguish between <i>organic</i> and <i>inorganic</i> compounds.		
3.2.2	Identify amino acids, glucose, ribose and fatty acids from diagrams showing their structure.	Biological Molecules: Water and Carbohydrates Biological Molecules: Proteins and Lipids	
3.2.3	List three examples each of monosaccharides, disaccharides and polysaccharides.	Biological Molecules: Water and Carbohydrates	
3.2.4	State one function of glucose, lactose and glycogen in animals, and of fructose, sucrose and cellulose in plants.	Biological Molecules: Water and Carbohydrates	
3.2.5	Outline the role of condensation and hydrolysis in the relationships between monosaccharides, disaccharides and polysaccharides; between fatty acids, glycerol and triglycerides; and between amino acids and polypeptides.	Biological Molecules: Water and Carbohydrates Biological Molecules: Proteins and Lipids	
3.2.6	State three functions of lipids.	Biological Molecules: Proteins and Lipids	
3.2.7	Compare the use of carbohydrates and lipids in energy storage.	Biological Molecules: Proteins and Lipids	

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### 3.3 DNA structure

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
3.3.1	Outline DNA nucleotide structure in terms of sugar (deoxyribose), base and phosphate.	Nucleic Acids and the Genetic Code	
3.3.2	State the names of the four bases in DNA.	Nucleic Acids and the Genetic Code	
3.3.3	Outline how DNA nucleotides are linked together by covalent bonds into a single strand.	Nucleic Acids and the Genetic Code	
3.3.4	Explain how a DNA double helix is formed using complementary base pairing and hydrogen bonds.	Nucleic Acids and the Genetic Code	
3.3.5	Draw and label a simple diagram of the molecular structure of DNA.	Nucleic Acids and the Genetic Code	

### 3.4 DNA replication

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
3.4.1	Explain DNA replication in terms of unwinding the double helix and separation of the strands by helicase, followed by formation of the new complementary strands by DNA polymerase.	Nucleic Acids and the Genetic Code	
3.4.2	Explain the significance of complementary base pairing in the conservation of the base pairing of DNA.	Nucleic Acids and the Genetic Code	
3.4.3	State that DNA replication is semi-conservative.	Nucleic Acids and the Genetic Code	

### 3.5 Transcription and translation

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
3.5.1	Compare the structure of RNA and DNA.	Nucleic Acids and the Genetic Code	
3.5.2	Outline DNA transcription in terms of the formation of an RNA strand complementary to the DNA strand by RNA polymerase.	Nucleic Acids and the Genetic Code	Gene Expression and Protein Synthesis
3.5.3	Describe the genetic code in terms of codons composed of triplets of bases.	Nucleic Acids and the Genetic Code	
3.5.4	Explain the process of translation, leading to polypeptide formation.	Nucleic Acids and the Genetic Code	Gene Expression and Protein Synthesis
3.5.5	Discuss the relationship between one gene and one polypeptide.	Nucleic Acids and the Genetic Code	

### 3.6 Enzymes

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	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
3.6.1	Define <i>enzyme</i> and <i>active site</i> .	Enzymes	
3.6.2	Explain enzyme–substrate specificity.	Enzymes	
3.6.3	Explain the effects of temperature, pH and substrate concentration on enzyme activity	Enzymes	
3.6.4	Define <i>denaturation</i> .	Enzymes	
3.6.5	Explain the use of lactase in the production of lactose-free milk.		

### 3.7 Cell respiration

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
3.7.1	Define <i>cell respiration</i> .		Respiration
3.7.2	State that, in cell respiration, glucose in the cytoplasm is broken down by glycolysis into pyruvate, with a small yield of ATP.		Respiration
3.7.3	Explain that, during anaerobic cell respiration, pyruvate can be converted in the cytoplasm into lactate, or ethanol and carbon dioxide, with no further yield of ATP.		Respiration
3.7.4	Explain that, during aerobic cell respiration, pyruvate can be converted in the mitochondrion into carbon dioxide and water, with a large yield of ATP.		Respiration

### 3.8 Photosynthesis

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
3.8.1	State that photosynthesis involves the conversion of light energy into chemical energy.		Photosynthesis: The Reaction
3.8.2	State that light from the Sun is composed of a range of wavelengths (colour).		
3.8.3	State that chlorophyll is the main photosynthetic pigment.		Photosynthesis: The Reaction
3.8.4	Outline the differences in absorption of red, blue and green light by chlorophyll.		Photosynthesis: The Reaction
3.8.5	State that light energy is used to produce ATP, and to split water molecules (photolysis) to form oxygen and hydrogen.		Photosynthesis: The Reaction
3.8.6	State that ATP and hydrogen (derived from the photolysis of water) are used to fix carbon dioxide to make organic molecules.		Photosynthesis: The Reaction
3.8.7	Explain that the rate of photosynthesis can be measured directly by the production of oxygen or the uptake of carbon dioxide, or indirectly by an increase in biomass.	Photosynthesis: Limiting Factors	

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3.8.8	Outline the effects of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis.	Photosynthesis: Limiting Factors	
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## Topic 4: Genetics

### 4.1 Chromosomes, genes, alleles and mutations

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
4.1.1	State that eukaryote chromosomes are made of DNA and proteins.	Nucleic Acids and the Genetic Code	
4.1.2	Define <i>gene</i> , <i>allele</i> and <i>genome</i> .	Nucleic Acids and the Genetic Code	Inheritance
4.1.3	Define <i>gene mutation</i> .	Nucleic Acids and the Genetic Code	Gene Expression and Protein Synthesis
4.1.4	Explain the consequences of a base substitution mutation in relation to the processes of transcription and translation, using the example of sickle-cell anaemia.	Nucleic Acids and the Genetic Code	Gene Expression and Protein Synthesis

### 4.2 Meiosis

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
4.2.1	State that meiosis is a reduction division of a diploid nucleus to form haploid nuclei.	Cell Division	
4.2.2	Define <i>homologous chromosomes</i> .	Cell Division	
4.2.3	Outline the process of meiosis, including pairing of homologous chromosomes and crossing over, followed by two divisions, which results in four haploid cells.	Cell Division	
4.2.4	Explain that non-disjunction can lead to changes in chromosome number, illustrated by reference to Down syndrome (trisomy 21).		
4.2.5	State that, in karyotyping, chromosomes are arranged in pairs according to their size and structure.	Cell Division	
4.2.6	State that karyotyping is performed using cells collected by chorionic villus sampling or amniocentesis, for pre-natal diagnosis of chromosome abnormalities.		
4.2.7	Analyse a human karyotype to determine gender and whether non-disjunction has occurred.		

### 4.3 Theoretical genetics

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
4.3.1	Define <i>genotype</i> , <i>phenotype</i> , <i>dominant allele</i> , <i>recessive allele</i> , <i>codominant alleles</i> , <i>locus</i> , <i>homozygous</i> , <i>heterozygous</i> , <i>carrier</i> and <i>test cross</i> .		Inheritance
4.3.2	Determine the genotypes and phenotypes of the offspring of a monohybrid cross using a Punnett grid.		Inheritance

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4.3.3	State that some genes have more than two alleles (multiple alleles).		Inheritance
4.3.4	Describe ABO blood groups as an example of codominance and multiple alleles.		Inheritance
4.3.5	Explain how the sex chromosomes control gender by referring to the inheritance of X and Y chromosomes in humans.		Inheritance
4.3.6	State that some genes are present on the X chromosome and absent from the shorter Y chromosome in humans.		Inheritance
4.3.7	Define <i>sex linkage</i> .		Inheritance
4.3.8	Describe the inheritance of colour blindness and hemophilia as examples of sex linkage.		Inheritance
4.3.9	State that a human female can be homozygous or heterozygous with respect to sex-linked genes.		Inheritance
4.3.10	Explain that female carriers are heterozygous for X-linked recessive alleles.		Inheritance
4.3.11	Predict the genotypic and phenotypic ratios of offspring of monohybrid crosses involving any of the above patterns of inheritance.		Inheritance
4.3.12	Deduce the genotypes and phenotypes of individuals in pedigree charts.		Inheritance

#### 4.4 Genetic engineering and biotechnology

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
4.4.1	Outline the use of polymerase chain reaction (PCR) to copy and amplify minute quantities of DNA.		Studying Genomes
4.4.2	State that, in gel electrophoresis, fragments of DNA move in an electric field and are separated according to their size.		Studying Genomes
4.4.3	State that gel electrophoresis of DNA is used in DNA profiling.		Studying Genomes
4.4.4	Describe the application of DNA profiling to determine paternity and also in forensic investigations.		Studying Genomes
4.4.5	Analyse DNA profiles to draw conclusions about paternity or forensic investigations.		
4.4.6	Outline three outcomes of the sequencing of the complete human genome.		Studying Genomes
4.4.7	State that, when genes are transferred between species, the amino acid sequence of polypeptides translated from them is unchanged because the genetic code is universal.		
4.4.8	Outline a basic technique used for gene transfer involving plasmids, a host cell (bacterium, yeast or other cell), restriction enzymes (endonucleases) and DNA ligase.		Genetic Technologies

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4.4.9	State two examples of the current uses of genetically modified crops or animals.		Genetic Technologies
4.4.10	Discuss the potential benefits and possible harmful effects of one example of genetic modification.		Genetic Technologies
4.4.11	Define <i>clone</i> .		Genetic Technologies
4.4.12	Outline a technique for cloning using differentiated animal cells.		Genetic Technologies
4.4.13	Discuss the ethical issues of therapeutic cloning in humans.		Genetic Technologies

## Topic 5: Ecology and evolution

### 5.1 Communities and ecosystems

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
5.1.1	Define <i>species</i> , <i>habitat</i> , <i>population</i> , <i>community</i> , <i>ecosystem</i> and <i>ecology</i> .	Biodiversity	Ecosystems and Populations
5.1.2	Distinguish between <i>autotroph</i> and <i>heterotroph</i> .		Energy Transfer
5.1.3	Distinguish between <i>consumers</i> , <i>detritivores</i> and <i>saprotrophs</i> .		Nutrient Cycling and Global Warming
5.1.4	Describe what is meant by a food chain, giving three examples, each with at least three linkages (four organisms).		Energy Transfer
5.1.5	Describe what is meant by a food web.		
5.1.6	Define <i>trophic level</i> .		Energy Transfer
5.1.7	Deduce the trophic level of organisms in a food chain and a food web.		
5.1.8	Construct a food web containing up to 10 organisms, using appropriate information.		
5.1.9	State that light is the initial energy source for almost all communities.		Energy Transfer
5.1.10	Explain the energy flow in a food chain.		Energy Transfer
5.1.11	State that energy transformations are never 100% efficient.		Energy Transfer
5.1.12	Explain reasons for the shape of pyramids of energy.		Energy Transfer
5.1.13	Explain that energy enters and leaves ecosystems, but nutrients must be recycled.		Nutrient Cycling and Global Warming
5.1.14	State that saprotrophic bacteria and fungi (decomposers) recycle nutrients.		Nutrient Cycling and Global Warming

### 5.2 The greenhouse effect

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
5.2.1	Draw and label a diagram of the carbon cycle to show the processes involved.		Nutrient Cycling and Global Warming
5.2.2	Analyse the changes in concentration of atmospheric carbon dioxide using historical records.		Nutrient Cycling and Global Warming
5.2.3	Explain the relationship between rises in concentrations of atmospheric carbon dioxide, methane and oxides of nitrogen and the enhanced greenhouse effect.		Nutrient Cycling and Global Warming
5.2.4	Outline the precautionary principle.		

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5.2.5	Evaluate the precautionary principle as a justification for strong action in response to the threats posed by the enhanced greenhouse effect.		
5.2.6	Outline the consequences of a global temperature rise on arctic ecosystems.		Nutrient Cycling and Global Warming

### 5.3 Populations

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
5.3.1	Outline how population size is affected by natality, immigration, mortality and emigration.		Ecosystems and Populations
5.3.2	Draw and label a graph showing a sigmoid (S-shaped) population growth curve.		Ecosystems and Populations
5.3.3	Explain the reasons for the exponential growth phase, the plateau phase and the transitional phase between these two phases.		Ecosystems and Populations
5.3.4	List three factors that set limits to population increase.		Ecosystems and Populations

### 5.4 Evolution

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
5.4.1	Define <i>evolution</i> .		Evolution and Natural Selection
5.4.2	Outline the evidence for evolution provided by the fossil record, selective breeding of domesticated animals and homologous structures.		Evolution and Natural Selection
5.4.3	State that populations tend to produce more offspring than the environment can support.		Evolution and Natural Selection
5.4.4	Explain that the consequence of the potential overproduction of offspring is a struggle for survival.		Evolution and Natural Selection
5.4.5	State that the members of a species show variation.		Evolution and Natural Selection
5.4.6	Explain how sexual reproduction promotes variation in a species.	Cell Division	Evolution and Natural Selection
5.4.7	Explain how natural selection leads to evolution.		Evolution and Natural Selection
5.4.8	Explain two examples of evolution in response to environmental change; one must be antibiotic resistance in bacteria.		Evolution and Natural Selection

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## 5.5 Classification

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
5.5.1	Outline the binomial system of nomenclature.	Classification	
5.5.2	List seven levels in the hierarchy of taxa—kingdom, phylum, class, order, family, genus and species—using an example from two different kingdoms for each level.	Classification	
5.5.3	Distinguish between the following phyla of plants, using simple external recognition features: <i>bryophyte</i> , <i>filicinophyta</i> , <i>coniferophyta</i> and <i>angiospermophyta</i> .		
5.5.4	Distinguish between the following phyla of animals, using simple external recognition features: <i>porifera</i> , <i>cnidaria</i> , <i>platyhelminthes</i> , <i>annelida</i> , <i>mollusca</i> and <i>arthropoda</i> .		
5.5.5	Apply and design a key for a group of up to eight organisms.		

## Topic 6: Human health and physiology

### 6.1 Digestion

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.1.1	Explain why digestion of large food molecules is essential.		
6.1.2	Explain the need for enzymes in digestion.		
6.1.3	State the source, substrate, products and optimum pH conditions for one amylase, one protease and one lipase.		
6.1.4	Draw and label a diagram of the digestive system.		
6.1.5	Outline the function of the stomach, small intestine and large intestine.		
6.1.6	Distinguish between <i>absorption</i> and <i>assimilation</i> .		
6.1.7	Explain how the structure of the villus is related to its role in absorption and transport of the products of digestion.		

### 6.2 The transport system

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.2.1	Draw and label a diagram of the heart showing the four chambers, associated blood vessels, valves and the route of blood through the heart.	The Heart	
6.2.2	State that the coronary arteries supply heart muscle with oxygen and nutrients.	The Heart	
6.2.3	Explain the action of the heart in terms of collecting blood, pumping blood, and opening and closing of valves.	The Heart	
6.2.4	Outline the control of the heartbeat in terms of myogenic muscle contraction, the role of the pacemaker, nerves, the medulla of the brain and epinephrine (adrenaline).	The Heart	Homeostasis
6.2.5	Explain the relationship between the structure and function of arteries, capillaries and veins.	Circulation and Blood	
6.2.6	State that blood is composed of plasma, erythrocytes, leucocytes (phagocytes and lymphocytes) and platelets.	Circulation and Blood	
6.2.7	State that the following are transported by the blood: nutrients, oxygen, carbon dioxide, hormones, antibodies, urea and heat.	Circulation and Blood	

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### 6.3 Defence against infectious disease

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.3.1	Define <i>pathogen</i> .	Immunology Infectious Diseases	
6.3.2	Explain why antibiotics are effective against bacteria but not against viruses.	Infectious Diseases	
6.3.3	Outline the role of skin and mucous membranes in defence against pathogens.	Immunology	
6.3.4	Outline how phagocytic leucocytes ingest pathogens in the blood and in body tissues.	Immunology	
6.3.5	Distinguish between <i>antigens</i> and <i>antibodies</i> .	Immunology	
6.3.6	Explain antibody production.	Immunology	
6.3.7	Outline the effects of HIV on the immune system.	Infectious Diseases	
6.3.8	Discuss the cause, transmission and social implications of AIDS.	Infectious Diseases	

### 6.4 Gas exchange

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.4.1	Distinguish between <i>ventilation</i> , <i>gas exchange</i> and <i>cell respiration</i> .	Gas Exchange	
6.4.2	Explain the need for a ventilation system.	Gas Exchange	
6.4.3	Describe the features of alveoli that adapt them to gas exchange.	Gas Exchange	
6.4.4	Draw and label a diagram of the ventilation system, including trachea, lungs, bronchi, bronchioles and alveoli.	Gas Exchange	
6.4.5	Explain the mechanism of ventilation of the lungs in terms of volume and pressure changes caused by the internal and external intercostal muscles, the diaphragm and abdominal muscles.	Gas Exchange	

### 6.5 Nerves, hormones and homeostasis

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.5.1	State that the nervous system consists of the central nervous system (CNS) and peripheral nerves, and is composed of cells called neurons that can carry rapid electrical impulses.		The Nervous System
6.5.2	Draw and label a diagram of the structure of a motor neuron.		The Nervous System

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6.5.3	State that nerve impulses are conducted from receptors to the CNS by sensory neurons, within the CNS by relay neurons, and from the CNS to effectors by motor neurons.		The Nervous System
6.5.4	Define <i>resting potential</i> and <i>action potential</i> (depolarization and repolarization).		The Nervous System
6.5.5	Explain how a nerve impulse passes along a non-myelinated neuron.		The Nervous System
6.5.6	Explain the principles of synaptic transmission.		The Nervous System
6.5.7	State that the endocrine system consists of glands that release hormones that are transported in the blood.		Hormones
6.5.8	State that homeostasis involves maintaining the internal environment between limits, including blood pH, carbon dioxide concentration, blood glucose concentration, body temperature and water balance.		Homeostasis
6.5.9	Explain that homeostasis involves monitoring levels of variables and correcting changes in levels by negative feedback mechanisms.		Homeostasis
6.5.10	Explain the control of body temperature, including the transfer of heat in blood, and the roles of the hypothalamus, sweat glands, skin arterioles and shivering.		Homeostasis
6.5.11	Explain the control of blood glucose concentration, including the roles of glucagon, insulin and $\alpha$ and $\beta$ cells in the pancreatic islets.		Hormones
6.5.12	Distinguish between <i>type I</i> and <i>type II</i> diabetes.		Hormones

## 6.6 Reproduction

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
6.6.1	Draw and label diagrams of the adult male and female reproductive systems.		
6.6.2	Outline the role of hormones in the menstrual cycle, including FSH (follicle stimulating hormone), LH (luteinizing hormone), estrogen and progesterone.		Hormones
6.6.3	Annotate a graph showing hormone levels in the menstrual cycle, illustrating the relationship between changes in hormone levels and ovulation, menstruation and thickening of the endometrium.		Hormones
6.6.4	List three roles of testosterone in males.		
6.6.5	Outline the process of <i>in vitro</i> fertilization (IVF).		
6.6.6	Discuss the ethical issues associated with IVF.		

## Topic 7: Nucleic acids and proteins

### 7.1 DNA structure

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
7.1.1	Describe the structure of DNA, including the antiparallel strands, 3'–5' linkages and hydrogen bonding between purines and pyrimidines.	Nucleic Acids and the Genetic Code	
7.1.2	Outline the structure of nucleosomes.	Nucleic Acids and the Genetic Code	
7.1.3	State that nucleosomes help to supercoil chromosomes and help to regulate transcription.	Nucleic Acids and the Genetic Code	
7.1.4	Distinguish between <i>unique or single-copy genes</i> and <i>highly repetitive sequences</i> in nuclear DNA.		
7.1.5	State that eukaryotic genes can contain exons and introns.		Gene Expression and Protein Synthesis

### 7.2 DNA replication

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
7.2.1	State that DNA replication occurs in a 5' → 3' direction.	Nucleic Acids and the Genetic Code	
7.2.2	Explain the process of DNA replication in prokaryotes, including the role of enzymes (helicase, DNA polymerase, RNA primase and DNA ligase), Okazaki fragments and deoxynucleoside triphosphates.	Nucleic Acids and the Genetic Code	
7.2.3	State that DNA replication is initiated at many points in eukaryotic chromosomes.	Nucleic Acids and the Genetic Code	

### 7.3 Transcription

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
7.3.1	State that transcription is carried out in a 5' → 3' direction.		Gene Expression and Protein Synthesis
7.3.2	Distinguish between the <i>sense</i> and <i>antisense</i> strands of DNA.		
7.3.3	Explain the process of transcription in prokaryotes, including the role of the promoter region, RNA polymerase, nucleoside triphosphates and the terminator.		Gene Expression and Protein Synthesis
7.3.4	State that eukaryotic RNA needs the removal of introns to form mature mRNA.		Gene Expression and Protein Synthesis

### 7.4 Translation

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	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
7.4.1	Explain that each tRNA molecule is recognized by a tRNA-activating enzyme that binds a specific amino acid to the tRNA, using ATP for energy.		
7.4.2	Outline the structure of ribosomes, including protein and RNA composition, large and small subunits, three tRNA binding sites and mRNA binding sites.		
7.4.3	State that translation consists of initiation, elongation, translocation and termination.		
7.4.4	State that translation occurs in a 5' → 3' direction.		Gene Expression and Protein Synthesis
7.4.5	Draw and label a diagram showing the structure of a peptide bond between two amino acids.	Biological Molecules: Proteins and Lipids	
7.4.6	Explain the process of translation, including ribosomes, polysomes, start codons and stop codons.		Gene Expression and Protein Synthesis
7.4.7	State that free ribosomes synthesize proteins for use primarily within the cell, and that bound ribosomes synthesize proteins primarily for secretion or for lysosomes.		

## 7.5 Proteins

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
7.5.1	Explain the four levels of protein structure, indicating the significance of each level.	Biological Molecules: Proteins and Lipids	
7.5.2	Outline the difference between fibrous and globular proteins, with reference to two examples of each protein type.	Biological Molecules: Proteins and Lipids	
7.5.3	Explain the significance of polar and non-polar amino acids.	Biological Molecules: Proteins and Lipids	
7.5.4	State four functions of proteins, giving a named example of each.	Biological Molecules: Proteins and Lipids	

## 7.6 Enzymes

	<b>Assessment statements</b>	<b>Boardworks AS Biology</b>	<b>Boardworks A2 Biology</b>
7.6.1	State that metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.	Enzymes	
7.6.2	Describe the induced-fit model.	Enzymes	
7.6.3	Explain that enzymes lower the activation energy of the chemical reactions that they catalyse.	Enzymes	

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7.6.4	Explain the difference between competitive and non-competitive inhibition, with reference to one example of each.	Enzymes	
7.6.5	Explain the control of metabolic pathways by end-product inhibition, including the role of allosteric sites.	Enzymes	

## Topic 8: Cell respiration and photosynthesis

### 8.1 Cell respiration

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
8.1.1	State that oxidation involves the loss of electrons from an element, whereas reduction involves a gain of electrons; and that oxidation frequently involves gaining oxygen or losing hydrogen, whereas reduction frequently involves losing oxygen or gaining hydrogen.		Respiration
8.1.2	Outline the process of glycolysis, including phosphorylation, lysis, oxidation and ATP formation.		Respiration
8.1.3	Draw and label a diagram showing the structure of a mitochondrion as seen in electron micrographs.		Respiration
8.1.4	Explain aerobic respiration, including the link reaction, the Krebs cycle, the role of NADH + H <sup>+</sup> , the electron transport chain and the role of oxygen.		Respiration
8.1.5	Explain oxidative phosphorylation in terms of chemiosmosis.		Respiration
8.1.6	Explain the relationship between the structure of the mitochondrion and its function.		Respiration

### 8.2 Photosynthesis

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
8.2.1	Draw and label a diagram showing the structure of a chloroplast as seen in electron micrographs.		Photosynthesis: The Reaction
8.2.2	State that photosynthesis consists of light-dependent and light-independent reactions.		Photosynthesis: The Reaction
8.2.3	Explain the light-dependent reactions.		Photosynthesis: The Reaction
8.2.4	Explain photophosphorylation in terms of chemiosmosis.		Photosynthesis: The Reaction
8.2.5	Explain the light-independent reactions.		Photosynthesis: The Reaction
8.2.6	Explain the relationship between the structure of the chloroplast and its function.		Photosynthesis: The Reaction
8.2.7	Explain the relationship between the action spectrum and the absorption spectrum of photosynthetic pigments in green plants.		Photosynthesis: The Reaction
8.2.8	Explain the concept of limiting factors in photosynthesis, with reference to light intensity, temperature and concentration of carbon dioxide.		Photosynthesis: Limiting Factors

## Topic 9: Plant science

### 9.1 Plant structure and growth

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
9.1.1	Draw and label plan diagrams to show the distribution of tissues in the stem and leaf of a dicotyledonous plant.	Transport in Plants	
9.1.2	Outline three differences between the structures of dicotyledonous and monocotyledonous plants.		
9.1.3	Explain the relationship between the distribution of tissues in the leaf and the functions of these tissues.		Photosynthesis: The Reaction
9.1.4	Identify modifications of roots, stems and leaves for different functions: bulbs, stem tubers, storage roots and tendrils.		
9.1.5	State that dicotyledonous plants have apical and lateral meristems.		
9.1.6	State that dicotyledonous plants have apical and lateral meristems.		
9.1.7	Explain the role of auxin in phototropism as an example of the control of plant growth.		Plant Hormones and Responses

### 9.2 Transport in angiospermophytes

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
9.2.1	Outline how the root system provides a large surface area for mineral ion and water uptake by means of branching and root hairs.	Transport in Plants	
9.2.2	List ways in which mineral ions in the soil move to the root.		
9.2.3	Explain the process of mineral ion absorption from the soil into roots by active transport.		
9.2.4	State that terrestrial plants support themselves by means of thickened cellulose, cell turgor and lignified xylem.		
9.2.5	Define <i>transpiration</i> .	Transport in Plants	
9.2.6	Explain how water is carried by the transpiration stream, including the structure of xylem vessels, transpiration pull, cohesion, adhesion and evaporation.	Transport in Plants	
9.2.7	State that guard cells can regulate transpiration by opening and closing stomata.	Transport in Plants	
9.2.8	State that the plant hormone abscisic acid causes the closing of stomata.		Plant Hormones and Responses
9.2.9	Explain how the abiotic factors light, temperature, wind and humidity, affect the rate of transpiration in a typical terrestrial plant.	Transport in Plants	

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9.2.10	Outline four adaptations of xerophytes that help to reduce transpiration.	Transport in Plants	
9.2.11	Outline the role of phloem in active translocation of sugars (sucrose) and amino acids from source (photosynthetic tissue and storage organs) to sink (fruits, seeds, roots).	Transport in Plants	

### 9.3 Reproduction in angiospermophytes

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
9.3.1	Draw and label a diagram showing the structure of a dicotyledonous animal-pollinated flower.		
9.3.2	Distinguish between <i>pollination</i> , <i>fertilization</i> and <i>seed dispersal</i> .		
9.3.3	Draw and label a diagram showing the external and internal structure of a named dicotyledonous seed.		
9.3.4	Explain the conditions needed for the germination of a typical seed.		
9.3.5	Outline the metabolic processes during germination of a starchy seed.		
9.3.6	Explain how flowering is controlled in long-day and short-day plants, including the role of phytochrome.		

## Topic 10: Genetics

### 10.1 Meiosis

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
10.1.1	Describe the behaviour of the chromosomes in the phases of meiosis.	Cell Division	Inheritance
10.1.2	Outline the formation of chiasmata in the process of crossing over.	Cell Division	Inheritance
10.1.3	Explain how meiosis results in an effectively infinite genetic variety in gametes through crossing over in prophase I and random orientation in metaphase I.	Cell Division	Inheritance
10.1.4	State Mendel's law of independent assortment.		
10.1.5	Explain the relationship between Mendel's law of independent assortment and meiosis.	Cell Division	

### 10.2 Dihybrid crosses and gene linkage

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
10.2.1	Calculate and predict the genotypic and phenotypic ratio of offspring of dihybrid crosses involving unlinked autosomal genes.		Inheritance
10.2.2	Distinguish between <i>autosomes</i> and <i>sex chromosomes</i> .		Inheritance
10.2.3	Explain how crossing over between non-sister chromatids of a homologous pair in prophase I can result in an exchange of alleles.		Inheritance
10.2.4	Define <i>linkage group</i> .		Inheritance
10.2.5	Explain an example of a cross between two linked genes.		Inheritance
10.2.6	Identify which of the offspring are recombinants in a dihybrid cross involving linked genes.		Inheritance

### 10.3 Polygenic linkage

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
10.3.1	Define <i>polygenic inheritance</i> .		Inheritance
10.3.2	Explain that polygenic inheritance can contribute to continuous variation using two examples, one of which must be human skin colour.		Inheritance

## Topic 11: Human health and physiology

### 11.1 Defence against infectious disease

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
11.1.1	Describe the process of blood clotting.	Circulation and Blood	
11.1.2	Outline the principle of challenge and response, clonal selection and memory cells as the basis of immunity.	Immunology	
11.1.3	Define <i>active</i> and <i>passive</i> immunity.	Immunology	
11.1.4	Explain antibody production.	Immunology	
11.1.5	Describe the production of monoclonal antibodies and their use in diagnosis and in treatment.	Immunology	
11.1.6	Explain the principle of vaccination.	Immunology	
11.1.7	Discuss the benefits and dangers of vaccination.	Immunology	

### 11.2 Muscles and movement

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
11.2.1	State the roles of bones, ligaments, muscles, tendons and nerves in human movement.		The Nervous System
11.2.2	Label a diagram of the human elbow joint, including cartilage, synovial fluid, joint capsule, named bones and antagonistic muscles (biceps and triceps).		
11.2.3	Outline the functions of the structures in the human elbow joint named in 11.2.2.		
11.2.4	Compare the movements of the hip joint and the knee joint.		
11.2.5	Describe the structure of striated muscle fibres, including the myofibrils with light and dark bands, mitochondria, the sarcoplasmic reticulum, nuclei and the sarcolemma.		Muscles
11.2.6	Draw and label a diagram to show the structure of a sarcomere, including Z lines, actin filaments, myosin filaments with heads, and the resultant light and dark bands.		Muscles
11.2.7	Explain how skeletal muscle contracts, including the release of calcium ions from the sarcoplasmic reticulum, the formation of cross-bridges, the sliding of actin and myosin filaments, and the use of ATP to break cross-bridges and re-set myosin heads.		Muscles
11.2.8	Analyse electron micrographs to find the state of contraction of muscle fibres.		

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### 1 1.3 The kidney

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
11.3.1	Define <i>excretion</i> .		
11.3.2	Draw and label a diagram of the kidney.		
11.3.3	Annotate a diagram of a glomerulus and associated nephron to show the function of each part.		
11.3.4	Explain the process of ultrafiltration, including blood pressure, fenestrated blood capillaries and basement membrane.		
11.3.5	Define <i>osmoregulation</i> .		Homeostasis
11.3.6	Explain the reabsorption of glucose, water and salts in the proximal convoluted tubule, including the roles of microvilli, osmosis and active transport.		
11.3.7	Explain the roles of the loop of Henle, medulla, collecting duct and ADH (vasopressin) in maintaining the water balance of the blood.		Homeostasis
11.3.8	Explain the differences in the concentration of proteins, glucose and urea between blood plasma, glomerular filtrate and urine.		
11.3.9	Explain the presence of glucose in the urine of untreated diabetic patients.		

### 1 1.4 Reproduction

	Assessment statements	Boardworks AS Biology	Boardworks A2 Biology
11.4.1	Annotate a light micrograph of testis tissue to show the location and function of interstitial cells (Leydig cells), germinal epithelium cells, developing spermatozoa and Sertoli cells.		
11.4.2	Outline the processes involved in spermatogenesis within the testis, including mitosis, cell growth, the two divisions of meiosis and cell differentiation.		
11.4.3	State the role of LH, testosterone and FSH in spermatogenesis.		
11.4.4	Annotate a diagram of the ovary to show the location and function of germinal epithelium, primary follicles, mature follicle and secondary oocyte.		
11.4.5	Outline the processes involved in oogenesis within the ovary, including mitosis, cell growth, the two divisions of meiosis, the unequal division of cytoplasm and the degeneration of polar body.		
11.4.6	Draw and label a diagram of a mature sperm and egg.		

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11.4.7	Outline the role of the epididymis, seminal vesicle and prostate gland in the production of semen.		
11.4.8	Compare the processes of spermatogenesis and oogenesis, including the number of gametes and the timing of the formation and release of gametes.		
11.4.9	Describe the process of fertilization, including the acrosome reaction, penetration of the egg membrane by a sperm and the cortical reaction.		
11.4.10	Outline the role of HCG in early pregnancy.		
11.4.11	Outline early embryo development up to the implantation of the blastocyst.		
11.4.12	Explain how the structure and functions of the placenta, including its hormonal role in secretion of estrogen and progesterone, maintain pregnancy.		
11.4.13	State that the fetus is supported and protected by the amniotic sac and amniotic fluid.		
11.4.14	State that materials are exchanged between the maternal and fetal blood in the placenta.		
11.4.15	Outline the process of birth and its hormonal control, including the changes in progesterone and oxytocin levels and positive feedback.		