

Answer Key

Unit 1: Biomolecules, Reproduction and Development

Module 1: Cell and Molecular Biology

1.1.1: Aspects of Biochemistry

No.	Answers	Further explanations
1	B	
2	B	In the formation of sucrose, a glycosidic bond is formed between the carbonyl group of glucose and the keto group of fructose. They are not free to take part in the reaction to give a positive Benedict's test.
3	C	
4	A	
5	D	
6	B	S-S bonds and peptide bonds are covalent bonds.
7	B	
8	B	Figure 1.3 represents an amino acid which polymerises to produce a protein. Positive results with the Biuret test (copper sulfate and potassium hydroxide).
9	A	Different amino acids have different side chains. The position they occupy in the chain will determine the type of bonds that can be formed among side chains. This results in the unique folding of different polypeptide chains.
10	D	

1.1.2: Cell Structure

No.	Answers	Further explanations
1	B	
2	D	
3	B	
4	B	The chloroplasts share similarities with prokaryotes. They contain circular DNA and 70S ribosomes and are capable of reproduction. The theory put forward the idea that the chloroplast may have been a bacterium that was incorporated into a cell.
5	D	
6	C	
7	A	
8	A	
9	B	
10	D	The vascular bundle is made up of different tissues – phloem, xylem and cambium – and is the organ of transport in plants.

1.1.3: Membrane Structure and Function

No.	Answers	Further explanations
1	B	
2	B	Carbohydrate chains on the glycolipids and glycoproteins act as cell recognition sites and therefore must be on the outer surface.
3	A	
4	B	
5	D	
6	C	

No.	Answers	Further explanations
7	B	
8	B	Although ATP is required for the movement of the vesicle, a concentration gradient does not determine the direction of the movement.
9	D	The smallest change in mass occurs in D. This indicates the smallest water intake to achieve equilibrium and therefore the smallest difference in water potential between the cells and the solution.
10	A	

1.1.4: Enzymes

No.	Answers	Further explanations
1	B	
2	D	
3	C	
4	C	
5	D	Lipase is a pancreatic enzyme that works in the duodenum in alkaline pH (around 9). Intracellular enzymes, such as catalase, function at neutral pH (around 7) and enzymes in the stomach, e.g. pepsin, work in acid pH (around 2).
6	A	The activation energy is the energy required to initiate the reaction. Line 'b' represents the activation energy for the non-enzyme-catalysed reaction. In the presence of the enzyme the activation energy is lowered to 'a'.
7	D	Accumulation of Z will inhibit the first enzyme in the series to slow down then stop the process. End-product inhibition is a feedback mechanism that regulates the level of the product in the system.
8	B	
9	D	
10	C	A competitive inhibitor is structurally similar to the substrate and binds reversibly to the active site of the enzyme. It competes with the substrate for the active site.

Module 2: Genetics, Variation and Natural Selection

1.2.1: Structure and Roles of Nucleic Acids

No.	Answers	Further explanations
1	B	T pairs with A. $T + A = 23\% + 23\% = 46\%$ G pairs with C. $G + C = 100 - 46 = 54\%$ $\% G = 54/2 = 27\%$
2	D	
3	D	
4	B	DNA polymerase only works in a $3' \rightarrow 5'$ direction. It therefore continuously adds nucleotides making a $5' \rightarrow 3'$ strand off the $3' \rightarrow 5'$ DNA strand. When it copies the $5' \rightarrow 3'$ strand it starts further up the molecule, working backwards copying small segments. It still works in $3' \rightarrow 5'$ direction but discontinuously.
5	A	
6	C	
7	A	Each amino acid may be carried by a different tRNA molecule. The smallest number of tRNA molecules required is 17.
8	D	
9	A	
10	B	RNA does not contain T but U instead. Base pairing of the template strand produces an mRNA molecule with the sequence AUGCAUAGACCU. The tRNAs for the four codons will be complementary to the mRNA codons.

1.2.2: Mitotic and Meiotic Cell Division

No.	Answers	Further explanations
1	B	Without spindle fibres, the separation of the chromosomes is impossible.
2	C	
3	B	

No.	Answers	Further explanations
4	C	The membrane breaks up into small vesicles and therefore is not seen.
5	B	
6	D	
7	A	
8	A	
9	C	
10	D	Chromosome number is restored to the quantity before nuclear division.

1.2.3: Patterns of Inheritance

No.	Answers	Further explanations
1	D	
2	B	
3	A	<p>The degree of freedom is the number of classes minus 1 (i.e. $4 - 1 = 3$). A χ^2 value of 7.32 has a probability between 5% and 10%. Any deviation with a probability of 5% and over (i.e. it occurs at least 5% of the time) is accepted as due to chance alone and not significant. Therefore, there is no difference between the observed and the expected ratio of the phenotypes.</p> <p>A χ^2 value of 10.46 falls below 5%.</p>
4	B	
5	B	Individual 1 must be $X^H X^h$ as the couple have a daughter with haemophilia, $X^h X^h$, and son with haemophilia, $X^h Y$. The daughter received one X^h allele from each parent and the son received the X^h allele from his mother.
6	D	Individual 4 is homozygous $X^h X^h$, so all her sons will receive the X^h allele and suffer from haemophilia.
7	C	

No.	Answers	Further explanations
8	B	
9	C	
10	C	Only genotypes with the dominant allele E will express colour. Those with ee will be albino as the homozygous recessive prevents expression of colour at the other locus. Black will have to be B_E_ genotype. As this is an example of dihybrid inheritance (epistasis), the heterozygous cross will produce 9 black: 3 cream: 4 albino offspring. $4/16 = 25\%$.

1.2.4: Aspects of Genetic Engineering

No.	Answers	Further explanations
1	D	Restriction endonucleases cut DNA only at points where specific base sequences occur. These are called restriction sites. Ligase joins/seals DNA fragments together.
2	C	
3	C	
4	B	Reverse transcriptase is used to make a complementary DNA (cDNA) from the mRNA. DNA polymerase is responsible for making the double-stranded DNA.
5	C	
6	B	
7	C	
8	B	If one triplet codes for 1 amino acid, DNA is double stranded so $4200/2 = 2100$. One strand of DNA is used for protein synthesis. Therefore $2100/3 = 700$ amino acids.
9	D	
10	D	

1.2.5: Variation and Natural Selection

No.	Answers	Further explanations
1	B	
2	A	
3	B	All codons following the deletion will be altered causing a change in the amino acid sequence in the protein chain. A different protein is formed.
4	D	
5	B	
6	C	
7	D	
8	C	
9	B	Y shows directional selection where one set of characteristics is selected for. Organisms with these characteristics will survive and reproduce. Selection pressures at the other end of the distribution results in death/failure to reproduce among this extreme phenotype and moves the distribution right towards a new optimum.
10	B	Babies with low and high birthweight have a lower chance of survival than those of average birthweight. The selection pressure is against the two extremes in the population; an example of stabilising selection.

Module 3: Reproductive Biology

1.3.1: Asexual Reproduction and Vegetative Propagation

No.	Answers	Further explanations
1	C	All offspring produced asexually are genetically alike. Because no variation exists there will be no gene present in the population that will allow for the adaptation necessary to survive in the changing environment.
2	C	

No.	Answers	Further explanations
3	B	
4	D	
5	D	
6	C	C = cambium. Undifferentiated tissue which continuously divides to form cells that will differentiate.
7	C	
8	A	
9	A	An error in the replication of DNA or meiotic division can produce a change in the genetic makeup of an organism. If this organism reproduces asexually the mutation is passed to all offspring.
10	D	

1.3.2: Sexual Reproduction in the Flowering Plant

No.	Answers	Further explanations
1	C	The eight nuclei are derived from mitotic divisions of a haploid nucleus. Just before fertilisation the two central polar nuclei (U and V) fuse to produce a diploid nucleus.
2	B	
3	A	
4	B	
5	C	
6	D	
7	A	One male gamete fuses with the ovum to produce a diploid zygote and the second male gamete fuses with the diploid nucleus to produce a ($3n$) triple fusion or endosperm nucleus.
8	D	

No.	Answers	Further explanations
9	B	
10	A	

1.3.3: Sexual Reproduction in Humans

No.	Answers	Further explanations
1	C	
2	B	Although four cells are produced in meiotic division only one gamete is produced. There is disproportionate division of the cytoplasm resulting in three polar bodies, which disintegrate, and the secondary oocyte.
3	A	
4	A	
5	D	
6	A	X is the zona pellucida, which forms the fertilisation barrier once a sperm penetrates the oocyte.
7	B	
8	D	
9	A	
10	C	

Answer Key

Unit 2: Bioenergetics, Biosystems and Applications

Module 1: Bioenergetics

2.1.1: Photosynthesis and ATP Synthesis

No.	Answers	Further explanations
1	B	
2	A	
3	B	
4	D	
5	B	The photolysis of water produces the electrons that are used to stabilise P680 in PS II.
6	A	
7	B	Less CO ₂ to react with RuBP, so less RuBP used. Less product (GP) formed. GP also converted to TP.
8	D	NADP in the Calvin cycle is returned to the non-cyclic phase of photophosphorylation to be reduced. When the supply is low, little or no ATP is produced by this route. When this occurs ATP from the cyclic phase is used to keep the Calvin cycle operating.
9	B	P700 in PS I loses (donates) 2 electrons to an electron acceptor. Electrons are passed via carriers back to the P700 in PS I (acceptor) to stabilise the chlorophyll molecule.
10	A	

2.1.2: Cellular Respiration and ATP Synthesis

No.	Answers	Further explanations
1	B	
2	D	
3	B	
4	C	The conversion of ATP to ADP and Pi is a hydrolysis reaction.
5	C	
6	B	<p>The rate of O₂ uptake by the peas is measured in mm³ g⁻¹ min⁻¹. To calculate the rate, use the formula $\pi r^2 d$ where $\pi = 3.142$; r = radius = diameter of bore of tube/2; d = distance the fluid travelled in the tube per minute. This volume is divided by the mass of the tissue to determine the volume per gram.</p> <p>Volume of oxygen = $3.142 \times 0.2^2 \times 2.5/5 = 0.06 \text{ mm}^3 \text{ g}^{-1} \text{ min}^{-1}$</p>
7	A	
8	C	
9	B	
10	C	

2.1.3: Energy Flow and Nutrient Cycling

No.	Answers	Further explanations
1	B	
2	D	
3	B	Herbivores feed on primary producers which get energy from the Sun... largest available energy source.
4	C	

No.	Answers	Further explanations
5	B	<p>Only a small percentage of the energy available to a trophic level is passed on to the consumers. In this item, the percentage energy transfer at each level is first calculated and then the average of the results determined.</p> <p>$3360/20\ 800 \times 100 = 16.15\%$; $390/3360 \times 100 = 11.61\%$; $20/390 \times 100 = 5.13\%$.</p> <p>Average: $16.15 + 11.61 + 5.13 = 32.89/3 = 10.96\%$</p>
6	D	<p>Photosynthetic production is the energy of producers: $20\ 800/800\ 000 \times 100 = 2.6\%$.</p>
7	D	
8	B	<p><i>Nitrosomonas</i> – ammonium compounds to nitrite.</p> <p><i>Rhizobium</i> – nitrogen-fixing bacteria convert nitrogen gas to ammonium compounds.</p> <p><i>Pseudomonas</i> – denitrifying – convert nitrates to nitrogen gas – popular in water-logged soils.</p> <p><i>Nitrobacter</i> – converts nitrite to nitrate.</p>
9	B	
10	C	

2.1.4: Ecological Systems, Biodiversity and Conservation

No.	Answers	Further explanations
1	A	
2	D	
3	D	
4	A	
5	C	
6	C	<p>The greater the number of plant species, the more food options for consumers. A decrease in a population or extinction of a species will not have a drastic effect on other populations.</p>

No.	Answers	Further explanations
7	C	
8	C	When there is only a small difference in the alleles representing the genes in a species, there is less variation and therefore less chance of surviving changes in the environment.
9	D	
10	B	

Module 2: Biosystems Maintenance

2.2.1: The Uptake and Transport of Water and Minerals

No.	Answers	Further explanations
1	D	Water enters passively by osmosis while ions enter by active uptake, requiring ATP from respiration.
2	D	
3	C	
4	B	A water potential gradient exists from the soil to the inside of the plant. Water moves down the gradient from the highest water potential (least negative) to the lowest water potential (most negative).
5	B	
6	A	
7	A	
8	C	
9	B	The rate is calculated as the volume of gas used per minute. The volume can be calculated by the equation: $V = \pi r^2 h$ where h = distance moved by the bubble.
10	B	

2.2.2: Transport in the Phloem

No.	Answers	Further explanations
1	D	
2	B	
3	A	Young leaves act as sinks and therefore sucrose is translocated into the young leaves. Mature leaves are sources, i.e. areas where sugars are produced. This will cause a decrease in the water potential of mature leaves.
4	B	B – phloem transports sucrose on which the aphids feed.
5	B	Companion cells upload sucrose into the sieve tube elements. This is an active mechanism requiring energy supplied by the mitochondria.
6	B	
7	A	As sucrose concentration increases in the phloem, the water potential decreases, resulting in water being pulled in by osmosis. This increases the hydrostatic pressure, causing material to be pushed to low pressure areas along the tube.
8	A	
9	C	
10	B	

2.2.3: The Circulatory System of Mammals

No.	Answers	Further explanations
1	B	
2	B	The key phrase here is to <i>directly</i> stimulate. While high CO ₂ and low O ₂ will stimulate the heart via the medulla oblongata, the adrenaline will act directly on the pacemaker (SAN).
3	B	Higher elastic fibre component is essential for the aorta to withstand and maintain the surges of ventricular systolic pressure, through expansion and recoil of the walls.

No.	Answers	Further explanations
4	C	
5	B	
6	A	
7	C	
8	D	When the ventricles contract during systole, blood is forced upwards and the AV valves slam shut making the 'lub' sound. The SL valves are forced open to allow blood into the arteries. During ventricular diastole, when the muscles relax and the pressure falls, some blood in the great arteries falls back onto and shuts the SL valves, causing the 'dub' sound.
9	B	
10	B	

2.2.4: Homeostasis and Hormonal Action

No.	Answers	Further explanations
1	B	
2	D	
3	C	
4	C	Steroid hormones are fat-soluble. They cross the cell membrane, attach to their receptors, which then bind to a specific point on the DNA.
5	D	
6	B	
7	B	
8	C	

No.	Answers	Further explanations
9	D	When fasting occurs, the blood glucose will fall. This stimulates glucagon secretion and the glucose level rises. The rise in concentration will initiate insulin secretion and the concentration falls. These fluctuations occur because glucagon and insulin are antagonistic (work in opposition to each other).
10	C	

2.2.5: The Kidney, Excretion and Osmoregulation

No.	Answers	Further explanations
1	C	
2	D	
3	B	
4	C	
5	A	
6	B	The gaps found between the capillary endothelial (squamous) cells and the foot processes of the podocytes in the inner capsule wall provide free passage for substances in the blood. The only barrier is the basement membrane on which the cells rest.
7	C	The kidneys process 1200 cm^3 blood containing 700 cm^3 plasma per minute. The 125 cm^3 of filtered fluid is plasma (no blood cells or large proteins). This means $125/700 \times 100 = 17.9\%$ of the plasma is filtered into the Bowman's capsule.
8	B	
9	B	Kidneys with thicker medulla can accommodate nephrons with longer loops of Henlé and are therefore able to generate lower (more -ve) medullary water potentials. Desert-dwelling mammals rely on this super-concentrated medulla for conserving body water.
10	A	

2.2.6: Nervous Coordination

No.	Answers	Further explanations
1	B	
2	B	
3	A	
4	C	
5	D	Depending on which neurotransmitter (chemical) is released from the pre-synaptic knob, the post-synaptic membrane (D) can either be depolarised or hyperpolarised. When ACh causes an influx of Na^+ into the post-synaptic neurone, depolarisation, called an excitatory post-synaptic potential (EPSP), is generated. Other neurotransmitters lead to hyperpolarisation, i.e. the membrane potential becomes more negative. This is an inhibitory post-synaptic potential and it makes the membrane more difficult to depolarise.
6	D	
7	C	
8	B	
9	C	Preventing ACh from reaching or binding to the receptor sites will prevent muscle contraction. Inhibition of ACh esterase will sustain a contraction as the ACh will remain in the receptor indefinitely.
10	D	Curare blocks the acetylcholine receptors on the post-synaptic membrane of the neuromuscular junction, preventing depolarisation, and hence muscle contraction.

Module 3: Applications of Biology

2.3.1: Health and Disease

No.	Answers	Further explanations
1	A	
2	C	

No.	Answers	Further explanations
3	A	
4	B	
5	B	
6	D	The increase in the spread of HIV caused a resurgence of TB but the higher incidence of TB did not contribute to the spread of HIV.
7	C	The disease is due to the transmission of a pathogen/organism and is therefore infectious.
8	D	
9	A	
10	D	

2.3.2: Immunology

No.	Answers	Further explanations
1	C	
2	D	
3	D	
4	A	
5	D	
6	C	Antibodies are made up of four polypeptide chains and therefore their amino acid monomers are held together by peptide bonds.
7	C	
8	B	Vaccination results in an initial production of antibodies. A second exposure to the same pathogen will result in a faster and higher production of antibodies.
9	D	

No.	Answers	Further explanations
10	A	The greater the number of plasma cells, the higher the production of antibodies, making the cell more effective in destroying that pathogen.

2.3.3: Social and Preventive Medicine

No.	Answers	Further explanations
1	D	
2	B	$BMI = \text{body mass (kg)}/\text{height (m)}^2 = 60/1.6^2 = 23.4$
3	A	
4	B	
5	B	In anaerobic conditions, pyruvate acts as the hydrogen acceptor and becomes reduced to lactate. Reduced NAD supplies the H for the reaction, releasing the NAD to facilitate further oxidation of glucose.
6	C	
7	C	
8	D	
9	C	The oxygen requirement for the activity is $3.0 \text{ dm}^3 \text{ min}^{-1}$. This value is not reached until late in the race due to the need for body systems to adjust. Anaerobic methods of obtaining energy have to be employed until the body is able to supply the amount of oxygen needed (by 5 minutes). For the first 5 minutes therefore, the individual is in oxygen deficit.
10	B	

2.3.4: Substance Abuse

No.	Answers	Further explanations
1	B	
2	C	

No.	Answers	Further explanations
3	B	
4	C	Large holes are formed as a result of tar substances killing macrophages in the alveolar tissue. The enzymes released from the macrophages digest the cells of the alveolar wall, causing disintegration of the tissue.
5	A	The large holes in the lungs reduce the surface area and increase the amount of dead space making breathing and gas exchange difficult.
6	A	
7	C	Tar paralyses cilia and increases mucus secretion. Tar would therefore affect cells II (ciliated epithelial cell) and III (mucous-secreting goblet cell).
8	D	
9	B	
10	C	