Markscheme

(paper 2 HL)

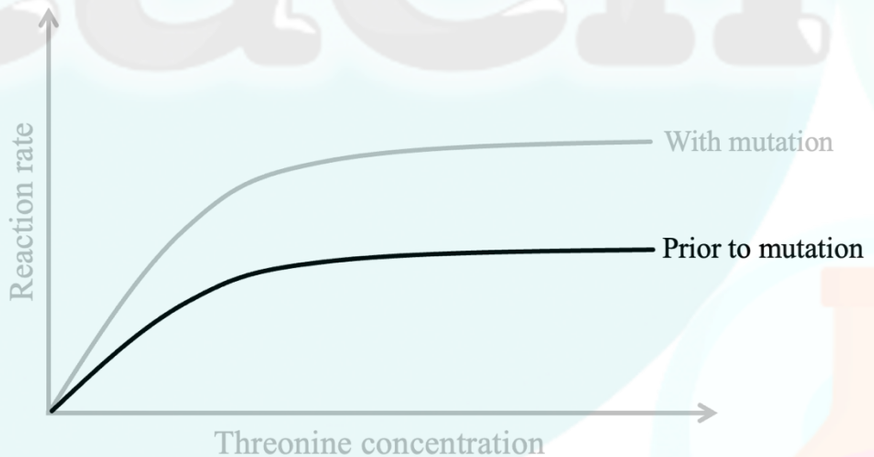
Question			Answers	Notes	Total
Section A					
1	a		• As gestational age increases the percentage of infants diagnosed with RDS decreases; • The is a negative correlation between gestational age and infants diagnosed with RDS;		1
	b		• (as seen on graph) Low birth weight is associated with a higher incidence of RDS, suggesting that lung maturity improves with increasing birth weight; • This correlation is likely due to greater surfactant production in more developed infants;		2
	c		• Approximate percentage for 500-749g is 90% • Approximate percentage for 1,250-1499 is 50% • % Difference 90-50 = 40%	Mark is only awarded for final answer Accept answer within ± 5%	1
	d		• 1.150kg (1,150g) falls in the category of very low birth weight (VLBW); • RDS risk is approximately 65%;	Accept answer within ±5%	2
	e		• High birthweight does not ensure/guarantee lung maturation in infants; • RDS is not solely due to surfactant insufficiency (other causes of RDS); • High birthweight may have its own complications relating to lung maturation;	Accept other valid reason	1
	f		• Alveofact;		1
	g		• Curosurf decreases GBS bacterial growth (significantly) more than Pumactant; • Curosurf decrease *S.aureus* growth, whereas Pumactant increase its growth; • Both Curosurf and Pumactant decrease *K.pneumoniae* growth (relatively) equally;		2
	h		• Saline serves as the control group; • Allows comparison of the effects of the surfactant to a neutral environment (saline); • This avoids interfering/external (environmental) effects impacting the data;		1

	i		• The statement may not be true (OR is incorrect);; • The data we have does not tell us the magnitude of its impact relative to other components of surfactant; • Other components such as proteins may play a significant role as well; • If phospholipids played the biggest role, then Pumactant would be the best antibacterial surfactant (which it is not according to the data);	Accept other valid example from the data to illustrate/emphasize a point	2
	j		• Curosurf can help improve lung function, which is crucial for premature infants with undeveloped lungs; • However, widespread use of Curosurf is costly, and may not be justified if only a subset of premature infants are at high risk (low birth weight AND extent of prematurity) for pneumonia; • Additionally, as suggested from the data, administration of surfactant may exacerbate certain species of bacterial growth compared to the control group; • It may be more appropriate to use Curosurf selectively, based on individual risk;		2

2	a	i	• Greenlight is reflected rather than absorbed by chlorophyll; • The reflected green light enters our eyes thereby appearing green;		1
		ii	• Red OR Blue light;		1
	b	i	• Electrons are transferred to NADP+ forming NADPH; • Electrons are used to drive proton pumping across the thylakoid membrane; • This creates a proton gradient that powers ATP synthesis (via ATP synthase);		2
		ii	• Water (by photolysis);		1
	c		• Triose Phosphate (OR glyceraldehyde-3-phosphate); • Glucose;	Also accept the chemical structure E.g. $C_6H_{12}O_6$	1

3	a	i	• Glomerulus;		1
		ii	• Glucose; • Proteins (e.g Albumin); • RBC (red blood cell OR erythrocyte)	Accept other valid answer; Two answers must be stated to earn the point.	1
	b		• Microvilli – increase the surface area for reabsorption; • Once cell thick – less travelling distance; • Numerous mitochondria – provide ATP for active transport (during reabsorption); • Tight junctions – proteins in between the cells of the PCT that ensure a strict barrier so that no unwanted substances can enter the bloodstream freely;	Explanation is not needed to earn the mark. Just the feature.	3
	c	i	• Located in the cortex, and medulla; • Loop of Henle (and collecting duct) is in the medulla; • Glomerulus, PCT and DCT is in the cortex;		2
		ii	• Loop of Henle may be longer (to increase urine concentration and water reabsorption);		1

4	a		• X^HX^h (heterozygous);		1
	b		• Males have only one X-chromosome, so if they inherit the defective allele, they will express the disorder; • Females need two copies of the mutant allele to be affected;		2
	c		• Autosomal recessive disorders would affect males and females equally; • In autosomal recessive disorders both males and females can be carriers; • In autosomal recessive disorders males need two recessive alleles to express the disorder;		2

5	a		• Proteins that catalyze biological reactions; • By lowering the activation energy; • They are not consumed during the chemical reaction;		2
	b	i	• Negative feedback;		1
		ii	• Allosteric site;		1
	c	i	• Mutation results in a change in protein amino acid sequence, thereby the allosteric site; • (Thereby) isoleucine is no longer able to bind to the allosteric site (as enzyme-substrate specificity is influenced) (and thus cannot cause end-product inhibition); • (Hence) Isoleucine concentration would continuously increase as negative feedback does not occur; • As active site is not influenced by the mutation, threonine concentration would continuously decrease as its being converted to isoleucine;		2
		ii		Accept any curve which has a plateau AND is found below the curve labelled “with mutation”.	1

6	a	i	• Red blood cell (OR RBC);	Accept “erythrocyte”	1
		ii	• Membrane active transport; • Synthesis of macromolecules; • Cellular movement; • Intracellular component movement; • Muscle contraction;	Accept “anabolism” Accept “biosynthesis” Accept other valid examples	1
	b		• Mother, as the sperm passes on nothing other than paternal DNA when it fertilizes the egg;		1

7	a	i	• Lipids;		1
		ii	• Unsaturated fatty acids increase fluidity (By preventing tight packing of phospholipids due to kinks in their fatty acid tails); • Cholesterol has a dual role in membrane fluidity; • At high temperatures it reduces membrane fluidity, whereas at low temperatures it increases membrane fluidity;	Information in brackets not required.	2
	b		• The sodium-potassium pump actively transports Na^+ out of the cell, lowering intracellular sodium concentration; • This creates a concentration gradient that drives Na^+ influx through sodium glucose cotransporters (OR sodium dependent glucose transporter OR SGLT); • This allows glucose to move (along with sodium) against its concentration gradient into the intestinal cell; • This is an example of indirect active transport;		3

Section B

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(Steroid) Hormones travel long distances (by bloodstream) from source to target cell;
(Steroid) Hormones speed of action is slow;
(Steroid) Hormones have a long duration of action;
Because they are lipid-soluble (OR lipophilic OR hydrophobic), they bind to intracellular receptors;
Binding to receptor forms a hormone-receptor complex, which acts as a transcription factor;
The hormones receptors complex moves (OR translocated) into the nucleus (if not there already);
Here it can bind to DNA and influence gene expression (OR protein synthesis);

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<td>b</td>
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<table>
<tr><th></th><th>Spermatogenesis</th><th>Oogenesis</th></tr>
<tr><td>What</td><td>Production of mature sperm (spermatozoa);</td><td>Production of mature egg (ova);</td></tr>
<tr><td>Where</td><td>In the testis (OR seminiferous tubules);</td><td>In the ovaries (mostly);</td></tr>
<tr><td>When does it start</td><td>At puberty (OR adolescence);</td><td>During fetus (OR embryo) development;</td></tr>
<tr><td>Continuity</td><td>Proceeds through entire life;</td><td>Stops at menopause;</td></tr>
<tr><td>Frequency</td><td>Constantly making sperm (millions daily);</td><td>One egg per month;</td></tr>
<tr><td>Number of gametes</td><td>Four gametes produced;</td><td>One gamete produced;</td></tr>
<tr><td>Break in meiosis</td><td>No breaks in meiosis;</td><td>Has breaks in meiosis; (Prophase I, & Metaphase II)</td></tr>
<tr><td>Cytokinesis</td><td>Equal cytokinesis;</td><td>Unequal cytokinesis;</td></tr>
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<td>Answers do not need to be in a table format.

Do not accept any similarities between the two processes.</td>
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	c		• (Auxin) is produced at the tip of the shoot or stem; • The shoot tip senses light directionality (OR the direction of the source of light); • Auxin is transported to the side of the stem that has the lowest light intensity (OR shaded side); • Auxin causes the cells on the shaded side to elongate; • Thereby causing bending the plant towards light; • (Positive) phototropism is growth towards (a source of) light;		4

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The rate of exchange of gas/nutrients/heat/waste into and out of a cell depends on its surface area;
As a cell increase in size, its surface area to volume ratio decreases (proportionally less surface area relative the volume as cell size increases);
More metabolic activity in a larger cell means more food/oxygen required AND waste/heat produced;
As a cell gets larger its volume gets larger, and this means longer diffusion time of gas/nutrients/waste/heat;
Excess heat/waste generated will not be lost efficiently as a cell gets too large (low SA:V ratio);
Additionally nutrient/gas requirements will not be met as a cell gets too large (low SA:V ratio);
Eventually with continual growth, the surface area can no longer serve the requirements of the cell;
This critical ratio stimulates mitosis;
Thus the size of the cell is reduced and kept within size limits;

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<table>
<tr><th>Adaptation</th><th>Reason</th></tr>
<tr><td>Outer membrane</td><td>Structural support, and control of material exchange;</td></tr>
<tr><td>Matrix</td><td>Contain enzymes for the Krebs cycle and link reaction;</td></tr>
<tr><td>Inner membrane (OR Cristae)</td><td>Increased (large) SA for oxidative phosphorylation/electron transport/proton pumping/ATP production;</td></tr>
<tr><td>Narrow intermembrane space</td><td>Narrow (small) space allows for rapid (fast) proton gradient accumulation, creating a concentration gradient essential for oxidative phosphorylation;</td></tr>
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<td>Answers do not need to be in a table format</td>
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	c		**pH** • Optimal pH exists for each protein (enzyme); • Excessive pH to either extreme can lead to protein denaturation; **Temperature** • Optimal temperature exists for each protein (enzyme); • Excessively high temperatures can lead to protein denaturation; • Low temperature (less kinetic energy) results in lower odds of substrate collision with active site; **Presence of inhibitors or activators** • Inhibitors (competitive or non-competitive) can reduce the activity of proteins;	Marks may be earned with the use of a properly annotated graph.	4

10	a		• DNA replication is a **semi-conservative** process OR DNA contains one old and one new strand; • Helicase (enzyme) unzips/unwinds the DNA double helix OR separates the DNA strands; • Forming replication fork; • Separated strands become templates for the new strands; • SSBP's keeps the bases from reforming hydrogen bonds after helicase action; • **RNA primase** will add an RNA primer (OR short sequence of RNA nucleotides); • Free DNA nucleotides will join to the template strand by means of complementary base pairing; • **DNA polymerase III** (enzyme) binds to the primer, and synthesizes the new DNA strands by linking nucleotides together in the 5' to 3' direction; • By forming covalent bonds between adjacent nucleotides (of the new strand); • DNA is synthesized towards the replication fork on the **leading strand** and away on the **lagging strand**; • Synthesis is **continuous** on the leading strand and **discontinuous** (OR Okazaki fragments form) on the lagging strand; • **DNA polymerase I** then replaces the RNA primers with DNA nucleotides; • **Ligase** joins (or seals) the fragments together on the lagging strands OR seals the DNA stands; • Once DNA is synthesized by replication it will rewind into double helix conformation;		8
	b		**Independent assortment** • During meiosis I, homologous chromosomes assort randomly creating different combinations of alleles in gametes; **Crossing over** • During prophase I, exchange of genetic material between homologous chromosomes creates new allele combinations; **Random fertilization** • Fusion of gametes from different parents leads to unique genetic combinations in offspring; **Mutations** • (While rare) mutations in gametes (germline mutations) introduces new alleles;	Key words in **bold** are necessary in order to earn the mark.	3

	c		• Antibiotics are chemicals (medication) used to treat bacterial infections; • A population of bacteria, will have genetic variation due to random mutations; • Hence, some may exhibit resistance to certain antibiotics; • Prescribed antibiotics will be effective at eliminating/killing antibiotic sensitive bacteria; • Resistant bacteria will survive (natural selection); • Resistant bacteria can reproduce and spread the gene mutation (increase allele frequency); • This leads to a population of bacteria that are resistant to mentioned antibiotic;		4