Pearson Edexcel

Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Level In Biology (WBI15)
Paper 01: Respiration, Internal Environment, Coordination and Gene Technology

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Answer	Additional guidance	Mark
1(a)	• B is the correct answer A is not the correct answer glycolysis, Krebs cycle and link reaction is not the correct order. C is not the correct answer as link reaction, Krebs cycle and glycolysis is not the correct order. D is not the correct answer as Krebs cycle, glycolysis and link reaction is not the correct order.		(1)

Question number	Answer	Additional guidance	Mark
1(b)	An answer showing the following steps: • equation (1) • balanced equation (1)	accept incorrect formula e.g. CO2 accept correct word equation e.g. $C_6H_{12}0_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ ignore ATP / ADP 1 mark if equation correct but not balanced	(2)

Question number	Answer	Additional guidance	Mark
1(c)(i)	• B is the correct answer A is not the correct answer as 0.67 is not the RQ value C is not the correct answer as 1.06 is not the RQ value D is not the correct answer as 1.42 is not the RQ value		(1)

Question number	Answer	Additional guidance	Mark
1(c)(ii)	A calculation showing the following steps: • calculation of energy in ATP (1) • calculation of percentage useable energy with answer given to **three** significant figures (1)	(122 x 30.51) = 3722.22 kJ (122 ÷ 12244) = 0.009964 (3722.22 ÷ 12244) x 100 = 30.4% (0.009964 x 30.51) x 100 =30.4% Correct answer gains both marks	(2)

Question number	Answer	Additional guidance	Mark
2(a)(i)	• D is the correct answer A is not the correct answer the sodium channel is not closed in depolarisation B is not the correct answer the sodium channel is not closed in depolarisation C is not the correct answer as the membrane potential is not decreasing in depolarisation		(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes the following points: • sodium (ion) {channels / voltage-gated channels} close (1) • potassium **ions** move **out** of cell via (voltage gated) potassium channels (1) • the inside of the axon becomes negatively charged (compared with the outside) (1)	accept (voltage-gated) potassium (ion) channels open **reject** contradictions e.g. potassium ion moving in through open channels {decrease in membrane potential / back to (below)-70mv} ignore back to resting potential	(3)

Question number	Answer	Additional guidance	Mark
2(b)(i)	A calculation showing the following steps: • measurement of scale bar converted to μm (1) • calculation of magnification and answer given in standard form (1)	9.5mm = 9500 (μm) ACCEPT 9000 to 10000 (μm) (9500÷50) = 190 = 1.9×10^2 accept 1.8×10^2 to 2.0×10^2 accept 2×10^2 180 to 200 gets 1 mark correct answer gains full marks	(2)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that includes: • light (microscope) (1)	mark first answer	(1)

Question number	Answer	Additional guidance	Mark
2(b)(iii)	An explanation that includes three of the following points: • ions cannot cross axon membrane in myelinated regions (1) • as myelin acts as an insulator (1) • therefore {**action potentials / depolarisation**} (only) occur at nodes **of Ranvier** (1) • so {nerve impulses / action potentials} jump from node to node / saltatory conduction (1)	ignore myelinated neurone {has / creates} insulation accept gaps between local currents are longer	(3)

Question number	Answer	Additional guidance	Mark
3(a)(i)	• D is the correct answer A is not the correct answer as baroreceptors detect pressure changes B is not the correct answer as chemoreceptors detect changes in chemical stimuli C is not the correct answer as osmoreceptors detect changes in osmolarity stimuli		(1)

Question number	Answer	Additional guidance	Mark
3(a)(ii)	A description that includes three of the following points: • receptors synapse with sensory neurones (1) • impulse transmitted via sensory neurone towards the {CNS / spinal cord} (1) • which passes through dorsal root ganglion (1) • where sensory neurone synapses with {relay / motor} neurone (1) • (synapse / relay neurone) located in the grey matter (1)	accept impulse transmitted along sensory neurone accept **impulse /action potential** transmitted via sensory neurone to relay neurone	(3)

Question number	Answer	Additional guidance	Mark
3(b)(i)	A calculation showing the following steps: • correct difference from the graph (1) • correct percentage difference (1)	20 – 12 = (-) 8 (8 ÷ 16) x 100 = (-) 50% OR 0.5 x 100 = (-) 50% correct answer gains both marks	(2)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	A description that includes three of the following points • all the groups {recover / start changing direction} after 0.5 mins (1) • recovery increases as time increases (1) • steeper increase up to 10 mins / slower increase after 10 mins (1) • the shorter the habituation interval the {faster the recovery time / higher number of worms changing direction} (1) • all three groups have worms that have not {recovered / started changing direction} (after 30 mins)ii(1)	accept the number of roundworms changing direction increases as time increases {gradient / graph} steeper up to 10 minutes accept converse accept group {1 / 60 taps at 2s intervals} had the highest number changing direction / group {3 / 60 taps at 60s intervals} had the lowest number changing direction	(3)

Question number	Answer	Additional guidance	Mark
4(a)(i)	• D is the correct answer A is not the correct answer as the ratio is incorrect B is not the correct answer as the ratio is incorrect as it is rounded incorrectly C is not the correct answer as the ratio is incorrect as it is rounded incorrectly		(1)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An answer that includes four of the following points • thermoreceptors produce action potentials below 42 (°C) / no action potentials for nociceptors below 42(°C) (1) *accept nociceptor produces action potentials after 42*(°C) • the number of action potentials from thermoreceptors does not increase after 44(°C) (1) • thermoreceptors produce action potentials over a greater range of temperatures than nociceptors (1) • nociceptors have larger increase in number of impulses for each degree rise in temperature / are more sensitive to a change in temperature (1) • comment on information missing on methodology (1)	accept nociceptors {produce more action potentials / more sensitive} at higher temperatures / above 45(.6)(°C) accept levels off / flattens out / peaks accept 34(.2)-50(°C) for thermoreceptor 42 – 50(°C) for nociceptor accept graph for nociceptors is steeper greater increase in number of action potentials for nociceptors e.g. size / age / area of skin / no sample size / no statistical analysis / no mean calculated accept comment on no error bars so no comment on significance	(4)

Question number	Answer	Additional guidance	Mark
4(b)	An explanation that includes four of the following points: • nicotine causes an increase in the number of action potentials (in post synaptic neurone) (1) • as nicotine binds to acetylcholine receptors causing action potential (1) • Groups B and C have similar number of action potentials (1) • if nicotine given {to mice with gene for acetylcholine receptor deleted / group C} then number of action potentials stays same (1) • as {no / less} acetylcholine receptor (on post synaptic membrane) (1)	accept if nicotine is not given the number of action potentials stays the same group A has the highest number of action potentials accept nicotine has a similar structure to acetylcholine ignore nicotine blocks receptors accept fewer action potentials in group C ignore no action potentials generated	(4)

Question number	Answer	Additional guidance	Mark
5(a)	A description that includes two of the following points: • use a microarray (1) • to detect mRNA (1) • ref to use of cDNA / fluorescent {**labels /probes/ tags**}		(2)

Question number	Answer	Additional guidance	Mark
5(b)(i)	• C is the correct answer A is not the correct answer as histones are not acting as a transcription factor B is not the correct answer as histones do not form pores in the nuclear membrane D is not the correct answer as histones do not produce RNA polymerase.		(1)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	• B is the correct answer A is not the correct answer as crossing over does not regulate gene expression C is not the correct answer as post transcriptional changes do not regulate gene expression D is not the correct answer as post translation changes do not regulate gene expression		(1)

Question number	Answer	Additional guidance	Mark
5(c)(i)	An explanation that includes three of the following points: • (section of DNA / gene) has methyl groups added to the {cytosine bases / CPG sites} (1) • {codons / gene / locus / base sequence / promotor region} deleted (in parental chromosome) (1) • {reduces / inhibits} {binding / action} of RNA polymerase (1) • {less / no} {transcription / mRNA production} (1) • so {less / no} {protein synthesis / translation} (1)	accept different mRNA (sequence) produced accept {different / non-functional protein} formed / different amino acid sequence formed	(3)

Question number	Answer	Additional guidance	Mark
5(c)(ii)	A description that includes four of the following points: • {isolated / extracted} gene for **HGH** (1) • cut plasmid using **same** restriction {enzyme / endonuclease} (1) • gene inserted into plasmid using **ligase** (enzyme) (1) • plasmid introduced into E coli (1) • E coli is grown in a fermenter and **HGH** {extracted / purified} (1)	accept {isolate / cut(out)} gene for **HGH** using restriction enzyme accept extract mRNA, use reverse transcriptase and form cDNA accept sticky ends (of gene and plasmid) joined using ligase accept vector taken up by {E coli / bacterium} accept bacteria given heat shock ignore gene gun	(4)

Question number	Answer	Additional guidance	Mark
6(a)(i)	• fast twitch (1)	accept type 2 / type II / type IIa / type IIb / type IIx	(1)

Question number	Answer	Additional guidance	Mark
6(a)(ii)	A description that includes three of the following points: • lactate diffuses (from muscle) into blood (1) • {oxidation of lactate / lactate converted} to pyruvate (1) • (and then) used in {link reaction / aerobic respiration} (1) • (taken up by the liver where it is) converted to {glucose / glycogen} (1)	accept lactate goes to the liver accept {removal of hydrogen atoms / dehydrogenation} to convert to pyruvate ignore Krebs cycle accept stored as glycogen in the liver	(3)

Question number	Answer	Additional guidance	Mark
6(a)(iii)	• B is the correct answer A is not the correct answer as reduced capillary network is not correct C is not the correct answer as reduced capillary network and low myoglobin are not correct D is not the correct answer as low myoglobin is not correct		(1)

Question number	Answer	Additional guidance	Mark
6(a)(iv)	• D is the correct answer A is not the correct answer as Flick's law does not explain how muscles contract B is not the correct answer as fluid mosaic model does not explain how muscles contract C is not the correct answer as lock and key hypothesis does not explain how muscles contract		(1)

Question number	Answer	Mark
*6(b) 1 2 3 4	**Indicative content** **consideration of data in table** • resting heart heart rate in athletes lower • peak heart rate higher in non athletes • maximum, volume of oxygen used higher in athletes in both aerobic and anaerobic conditions **explanation of data in table** • athletes have a lower resting heart rate as have greater {heart muscle / greater stroke volume / greater cardiac output} • non athletes peak heart rate is higher than athletes as heart needs to contract {more / faster} to get oxygen to tissues as {less developed heart muscle / lower peak flow} • athletes use more oxygen due to greater quantity of muscle cells (to be used in aerobic respiration) **consideration of data in graph** • as power generated increases oxygen used increases • athletes use more oxygen than non-athletes • athletes generate more power than non-athletes • in the graph non athletes have lower VO2 at the same power **explanation of data in graph** • athletes use more oxygen • meaning that the metabolic efficiency / circulatory system efficiency athletes is higher • athletes have greater lung capacity • athletes have more muscles so can achieve greater power • resulting from years of training • athletes have more slow twitch fibres which give greater power • leading to increased muscle growth / development:/ increased lung capacity and gas exchange: increased metabolism /increased energy production in cells/ increased aerobic respiration/increased ATP production / more mitochondria / more myoglobin	

5	**circulatory and respiratory system** • circulatory and respiratory system work together to enable exercise • heart rate in athletes lower than non athletes compensates for by having an increase in strength of beats – bigger heart – more heart muscle. • increase in arterial pressure caused by increased cardiac output. • cardiac output = heart rate x stroke volume • ref to lung capacity / peak flow of athletes / ventilation rate	
6	**muscles** • training increases muscle growth / repair / replacement / capillary network • athletes muscle have greater capillary network • depending on exercise will increase amount of slow and fast twitch muscle fibres • more ATP can be used for breaking cross bridges / movement of calcium ions • contain more myoglobin to store oxygen • in non athletes muscles atrophy which affects the ability to do exercise and venous flow back to the heart	
7	**biochemistry** • more ATP due to more mitochondria / aerobic respiration / more oxygen available • athletes have greater tolerance to lactic acid from anaerobic respiration due to training • more oxygen carried to cells for aerobic respiration • BMR higher in athletes to release energy	
8	**consideration of methodology** • in table no SD / error bars / statistical test so no indication of validity or range of data • in graph no SD/error bars / statistical test so no indication of validity or range of data • comment on range of data in graph / overlap between athletes and non athletes • comment on methodology – age / gender / amount of training Level 1: Description of (a minimum of 2 specific) results from table and graph Level 2: Reference to all of level one plus one explanation of the effects of exercise / training with some details on physiological processes Level 3: Reference to all of level one and two plus one detailed explanation of the effects of exercise / training with significant details on physiological processes at cellular / genetic level.	(6)

Question number	Answer	Additional guidance	Mark
7(a)	An explanation that includes four of the following points: • reference to negative feedback (1) • thermoreceptors detect {increase / change} in temperature / temperature above 37°C} (1) • impulses to {thermoregulatory centre / hypothalamus / heat loss centre} (1) • (thermoregulatory centre) sends impulses {to correctly named effector / via motor neurones / via sympathetic neurones} (1) • correct response by named effectors to {increase heat loss / decrease heat energy gain} from the body (1)	ignore signals / messages accept receptors detecting temperature change ignore control centre unqualified e.g. sweat glands, hair erector muscles, liver, smooth muscles in skin blood vessels e.g. vasodilation, sweat production, decreased / change metabolic rate	(4)

Question number	Answer	Additional guidance	Mark
7(b)	An answer that includes three of the following points: • the loop of Henle is (very) long / more juxtamedullary nephrons (1) • (more) sodium ions pumped out of the ascending limb / {lower water potential / higher solute concentration} of tissue fluid (1) • more water reabsorbed results in concentrated urine production (1) • accept correct behavioural adaptation (1)	 accept more counter current multiplication accept kangaroo rats have **more** {aquaporins / ADH} accept increased permeability of {descending limb / collecting duct} e.g. nocturnal / stays underground during day	(3)

Question number	Answer	Additional guidance	Mark
7(c)(i)	A calculation showing the following steps: • calculation of weekly urine produced (1) • calculation of difference and answer given in standard form **with units** (1)	 (0.45 x 7) =3.15 **AND** (1500 x 7) = 10500 (10.500 – 3.15) = 10496.85 cm^3 = 1.0497 x 10^4 cm^3 accept 1.05 x 10^4 cm^3 / 1.0 x10^4 cm^3 10496.9 = 1 mark or 10.5 dm^3 no units max 1 mark	(2)

Question number	Answer	Additional guidance	Mark
7(c)(ii)	An answer that includes four of the following points • kangaroo rat has a lower water balance (1) • • a correct difference / comparison (1) • with an appropriate linked explanation (1) • a second correct difference / comparison (1) • with an appropriate linked explanation (1)	 accept converse for human accept in both water gain = water loss per day e.g. more water is gained (as a percentage) through metabolic reactions in kangaroo rat (than human) because kangaroo rat drinks no liquid / lives in desert e.g. kangaroo rat produces very little urine as it has a very long loop of Henle / produces concentrated urine / rat lives in {dry place / desert}	 (4)

Question number	Answer	Additional guidance	Mark
8(a)	An answer that includes the following point: • (sarcopenia is a progressive) **decrease** in muscle {mass / function} that is associated with **aging** (1)		(1)

Question number	Answer	Additional guidance	Mark
8(b)	An explanation that includes the following points: • due to a {specific stimulus / transcription factor / epigenetic modification} (1) • activating (specific /muscle cell / some) genes which are transcribed (1) • translation resulting in the synthesis of **named** proteins required by **muscle** cells (1)	accept chemical accept differential gene expression accept mRNA produced from active genes ignore some genes inactivated e.g. actin, myosin, troponin, tropomyosin	(3)

Question number	Answer	Additional guidance	Mark
8(c)	A description that includes the following points: • lower testosterone concentration in the blood (1) • less testosterone {enters (muscle) cell / crosses membrane / present in (muscle) cell nucleus} (1) • forming fewer {hormone-receptor complexes / transcription factors} (1) • (therefore) reduced {transcription / translation} (of muscle protein) (1)	to get full marks they have to mention reduced / less / fewer **at least ONCE** or it is max 3 marks accept less testosterone in blood accept less testosterone diffuses into (muscle) cell accept fewer muscle protein genes activated accept less testosterone binds to receptor accept less mRNA produced ignore protein synthesis unqualified	(4)

Question number	Answer	Additional guidance	Mark
8(d)	An explanation that includes the following points: • change in condition is detected by a receptor (1) • stimulating an **effecto**r that counteracts the **change** (1)	e.g. {high / low} blood glucose levels detected by (chemo)receptor e.g. pancreas stimulated to release insulin which results in {lower blood glucose / glucose being converted to glycogen} insulin released which results in {lower blood glucose / glucose being converted to glycogen} pancreas releases glucagon which results in {increase in blood glucose} / glycogen being converted to glucose} glucagon released} which results in {increase in blood glucose} / glycogen being converted to glucose}	(2)

Question number	Answer	Additional guidance	Mark
8(e)	An answer that includes two of the following points: • insulin binds to receptors on (muscle) cell (surface) **membrane** (1) • insulin increases the {number / production / activity} of {glucose transport molecules / glucose channels / GLUT4 (molecules)} (in the cell membrane) (1) • glucose is taken up by (facilitated) diffusion (1)	accept (insulin) stimulates {cAMP / formation of secondary messenger}	(2)

Question number	Answer	Additional guidance	Mark
8(f)	A description that includes the following points: • {uses X rays (and computer) to give {cross sectional / 2D / 3D} image (1) • {measure / compare} size (on images taken) before and after aerobic exercise (1)		(2)

Question number	Answer	Additional guidance	Mark
8(g)	An explanation that includes the following points: • mitochondria perform {aerobic respiration / produce **ATP**} (1) • {more / more active} mitochondria supply the increased **ATP** required (for aerobic exercise / increased aerobic respiration) (1) • ATP is needed {to break the cross-bridge / active transport of calcium ions / for muscle contraction} (1)	accept aerobic respiration produces **ATP** accept more mitochondria supply more **ATP** more aerobic respiration provides more **ATP** accept {ATP / energy} needed for protein synthesis	(3)

Question number	Answer	Additional guidance	Mark
8(h)	An explanation that includes three of the following points: • (whey / egg protein) **contain** non-essential amino acids (1) • non-essential amino acids not necessary {for (stimulation of) muscle protein anabolism / for (stimulation of) protein synthesis} (1) • (excess) non-essential amino acids can be converted into fats (1) • (therefore they) may not {increase / prevent loss of} muscle mass (1)	accept increase of **fat**s increases the risk of cardiovascular disease / diabetes /obesity	(3)

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