Pearson Edexcel

Mark Scheme (Results)

Summer 2019

Pearson Edexcel Advanced Level

In Biology (9BN0) Paper 03
General and Practical Applications in Biology

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.
- In questions marked with an **asterisk** (*), marks will be awarded for the ability to structure answers logically showing how the points are related or follow on from each other where appropriate.

Question Number	Answer	Additional guidance	Mark
1(a)	• correct calculation of heart rate as 60 bpm	Heart rate and units required for the mark ALLOW 1 beat per second / 1 bps	**(1)**

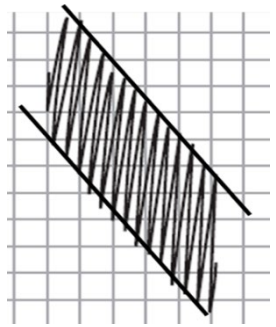
Question Number	Answer	Additional guidance	Mark
1(b)(i)	An answer the makes reference to the following: • (use of anabolic steroids) reduces {ventricular fraction / ejection fraction /stroke volume / cardiac output } (1) • {83 % / 10 out of 12} of users have ventricular fraction below {55% / the healthy value} (1)	ALLOW less blood leaving the ventricle when it contracts ALLOW more users of anabolic steroids have a ventricular fraction below 55% than non-users ALLOW other valid quantitative values e.g. comparing mean values for each group 51.25 and 60.6%	**(2)**

Question Number	Answer	Additional guidance	Mark
1(b)(ii)	An answer the makes reference to the following: • test the drug on { healthy individuals / animals / cell cultures } (1) • (then) test on group of individuals with cancer (1) • (gradually increasing the dose) to determine dose that does not reduce ventricular ejection fraction (1)	ALLOW test on a group of patients ALLOW to determine the dose that does not cause side effects	**(3)**

Question Number	Answer	Additional guidance	Mark
2(a)	• calculation of cross sectional area (1) • percentage difference in area (1)	<u>Example of calculation</u> $\pi \times 11^2 = 380.1\ (mm^2)$ ALLOW 379.94 to 380.133 [(380.1 — 193.6) ÷ 193.6] x 100 = 96.3 (%) ALLOW answers between 96.25 and 96.40 Correct answer with no working gains full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to two of the following: • more elastic tissue to allow recoil (1) • more collagen to withstand high pressure (1) • more muscle tissue to maintain pressure in the aorta (1)	ALLOW converse argument for vena cava ALLOW 'to withstand high pressure' ALLOW converse argument for vena cava	**(2)**

Question Number	Answer	Additional guidance	Mark
2(c)	A description that makes reference to three of the following: • cut a {strip / ring} of aorta (1) • record thickness of the piece of aorta (1) • hang masses on the (strip / ring) until aorta splits (1) • tensile strength determined by dividing force by cross sectional area (1)	ALLOW 'take a section of aorta' ALLOW repeats with same dimensions, e.g. length and { width / thickness} ALLOW 'breaks' or 'snaps' for 'splits' ALLOW 'weights' for 'masses'	**(3)**

Question Number	Answer	Additional guidance	Mark
3(a)	• correct slope drawn on the chart (1) • correct calculation (1)	 e.g. 1 ÷ 15 = 0.0667 ALLOW 0.06 to 0.075 Correct answer with no working gains full marks	**(2)**

Question Number	Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to four of the following: • (exercise will) increase oxygen consumption (1) • (because there is) increased aerobic respiration (1) • because (more) {energy / ATP} is needed by muscles (1) • oxygen required to convert { lactate / lactic acid } into { glucose / pyruvate } (1) • oxygen consumption begins to decrease after exercise (1)	ALLOW more oxygen is needed with exercise ALLOW oxygen consumption after exercise is higher than at rest	**(4)**

Question Number	Answer	Additional guidance	Mark
3(c)	An explanation that makes reference to the following: • exercise initiates impulses from the {motor cortex / stretch receptors in muscles / proprioceptors } (1) • (impulses sent to or from the) { ventilation centre / respiratory control centre / medulla oblongata } (1) • leading to increased impulses to { intercostal muscles / diaphragm } (1)	**IGNORE** reference to chemoreceptors and changes in carbon dioxide or temperature receptors	**(3)**

Question Number	Answer	Additional guidance	Mark
4(a)	An answer the makes reference to four of the following: • in alkaline soil the number of worms is greater (1) • in alkaline soil the (total) mass of worms is greater (1) • in alkaline soil the mass of individual earthworms is less (1) • earthworms reproduce more in alkaline soil (1) • in alkaline soil earthworms are smaller due to greater competition (for resources) (1)	ALLOW mean mass of ALLOW converse arguments for each point ALLOW higher pH for alkaline soil an earthworm is 1.96g in acidic soil and 1.52g in alkaline soil	**(4)**

Question Number	Answer	Additional guidance	Mark
4(b)	A description that makes reference to four of the following: • (record) a named relevant variable factor associated with the soil (1) • use of quadrats of stated area (1) • detail of random sampling within the areas (1) • standardised method for collecting earthworms (1) • recording the number and the mass of the earthworms in each quadrat (1)	e.g. temperature, humidity, soil water content, soil type, humus content e.g. one square metre, $0.5m^2$ e.g. random co-ordinates IGNORE transects e.g. digging to the same depth, same time frame ALLOW 'count and weigh' earthworms	**(4)**

Question Number	Answer	Additional guidance	Mark
4(c)	A description that makes reference to three of the following: • find mean values (1) • use a t-test/ calculate a t-value (1) • (calculated) t-value needs to be greater than the critical value (1) • (compared to cv for) probability of { 0.05 / 5% } (1)	ALLOW use of mean values IGNORE chi-squared test ALLOW compare the t-value to the critical value	**(3)**

Question Number	Answer	Additional guidance	Mark
5(a)	An answer the makes reference to three of the following: • no offspring from the cross between weary and upright lettuce had the weary phenotype (1) • the ratio of weary to upright lettuce in the F_2 generation was 1: 3 (1) • the chi-squared test value was below the critical value (1) • result not statistically different from expected result (1)	ALLOW none of the F_1 generation had the weary phenotype / all the F_1 generation were upright ALLOW {25% / ¼ / 27.7%} of the F_2 generation were weary lettuce ALLOW less than a critical value of 3.84 IGNORE degrees of freedom or incorrect cv ALLOW the null hypothesis can be accepted	**(3)**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	An explanation that makes reference to the following: • plants respond to light / plants show phototropic responses (1) • (therefore) light must be excluded in order to study the effects of gravity (1) • (putting plants in the dark) therefore prevents light having an effect (1)	ALLOW plant shoots grow towards light ALLOW 'geotropism' for 'effects of gravity' ALLOW to control light	**(3)**

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	• correct values selected from the graphs (1) • correct calculation of mean rate of curvature with units (1)	<u>Example of calculation</u> 58 and 9 49 ÷ 23 = 2.1 {degrees per day / ° day^{-1}} ALLOW 2.13 degrees per day Correct answer without working gains full marks Correct value without units gains 1 mark	**(2)**

Question Number	Answer	Additional guidance	Mark
5(b)(iii)	An answer the makes reference to two of the following: • do not have allele conferring ability to respond to gravity / only have alleles that confer a lack of response to gravity (1) • (so) do not produce {IAA / auxin} (1) • (therefore) lack of stimulation of cell elongation on side of stem facing downwards (1)	ALLOW cells present in the stem fail to detect gravity ALLOW there is no auxin present	**(2)**

Question Number	Answer	Additional guidance	Mark
6(a)	An answer the makes reference to two of the following: • {biological / protein} catalyst (1) • lowers the activation energy (for a reaction) (1) • increasing the rate of reaction (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	An explanation that makes reference the following: • hydrolysis of ATP (1) • provides energy for the reaction (1) • provides phosphate group for phosphorylation of F-6-P (1)	ALLOW as the reaction requires energy ALLOW provides {phosphate / Pi} that is added to F-6-P	**(3)**

Question Number	**Answer**	**Additional guidance**	**Mark**
6(b)(ii)	An answer that makes reference to three of the following: • as concentration of { F-6-P / F-2,6-BP } increases so does the (initial) rate of reaction of the phosphofructokinase (1) • an increasing in the concentration of { F-6-P / F-2,6-BP } will increase the rate of glycolysis (1) • up to a maximum (rate) (1) • increasing the concentration of F-2,6-BP reduces the concentration of F-6-P required to achieve the maximum rate of glycolysis (1)	ALLOW 'enzyme' for 'phosphofructokinase' ALLOW F-2,6-BP provides positive feedback to the enzyme activity	**(3)**

Question Number	Answer	Additional guidance	Mark
6(c)	An answer the makes reference to four of the following: • use pH buffers at a range of pH values below 7 (1) • provide an excess of ATP (1) • (use) F-6-P at an appropriate concentration (1) • suitable variable controlled (1) • measure quantity of F-2,6-BP produced per unit time (1)	e.g. 2 mmol dm^{-3} (values between 1 and 2.5 mmol dm^{-3}) e.g. {enzyme / phosphofructokinase } concentration / temperature ALLOW measure change in concentration of F-2,6-BP / phosphate incorporated	**(4)**

Question Number	Answer	Additional guidance	Mark
7(a)	A description that makes reference to five of the following: • (random) mutations are responsible for variation (1) • different selection pressures (in different habitats) (1) • an example of an adaptation to the habitat that enables the fish to survive (1) • (fish that survive) pass on beneficial alleles to offspring (1) • reduced gene flow between populations (1) • sympatric speciation of fish in same lake / allopatric speciation of fish in different {lakes / rivers} (1)	IGNORE mutations as a response to selection pressures ALLOW a description of different selection pressures e.g. different water quality / food availability or substrate for egg laying e.g. anatomical – mouth shape and food eaten, behavioural – egg laying habit ALLOW 'advantageous' or 'favourable' for 'beneficial' IGNORE genes ALLOW change in allele frequencies ALLOW geographical isolation due to being in different {lakes / rivers}	**(5)**

Question Number	Indicative content
7*(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Section of relevant data** • higher rate of mutations than in {slowly evolving fish / sticklebacks} • relatively high rate of mutations that change amino acids compared to slowly evolving fish • low rate of gene duplication in slowly evolving fish / high rate of gene duplication in cichlid fish • higher rate of mutations in regulatory sequences in cichlid fish • variety of habitats available providing different selection pressures **Consequences of data described** • more {amino acid changes / gene duplications} the greater number of alleles in gene pool • altered amino acids result in altered protein function • changes in regulatory sequences allow for different gene expression in tissues etc • duplicated genes can be used for new functions without loss of original function / polygenic phenotypes • variety of habitats provide a number of niches suitable for cichlid fish with different adaptations to exploit **Linkages made to rate of evolution** • example of an altered protein function e.g. enzymes that work at different pH / temperature tolerance • development of new phenotypes • {new enzymes/ different mouth shapes} allow new food types to be exploited • changes in {pigmentation / mouth shape} allow speciation

Level	Mark	Descriptor	Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	At least one relevant piece of data described e.g. higher mutation rate. A consequence described for the data – e.g. linking mutations to protein structure Basic clear conclusion attempted e.g. different proteins are produced
Level 2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	At least two pieces of relevant data referred to. Consequences of at least two pieces of data explained Linkages made to evolution of the fish e.g. changes in phenotype

Level 3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	At least three pieces of relevant data referred to Consequences of each piece of data explained Linkages to evolution discussed, e.g. the types of adaptations that may arise due to mutations

Question Number	Answer	Additional guidance	Mark
8(a)	An answer the makes reference to the following: • cells capable of unlimited division (1) • (they are undifferentiated) cells that can give rise to specialised cells (1)	ALLOW cell capable of self-renewal / cell that does not have a Hayflick limit	**(2)**

Question Number	Answer	Additional guidance	Mark
8(b)	A description that makes reference to three of the following: • mitosis gives rise to new cells (1) • different (sets of) genes are {activated / switched on} (in different cells) (1) • different proteins synthesised which determine {structure / function } of the cell (1) • resulting in differentiation (1)	IGNORE meiosis ALLOW genes {deactivated / switched off / genes expressed / differential gene expression}	**(3)**

Question Number	Answer	Additional guidance	Mark
8(c)	myogenic		**(1)**

Question Number	Answer	Additional guidance	Mark
8(d)	An explanation that makes reference to three of the following: • {screen / produce} a (large) population of mice (1) • cross (two) heterozygous mice (1) • select the homozygous recessive mice (1) • and breed from these for subsequent generations (1)	ALLOW labelled genetic diagrams ALLOW carriers for heterozygous ALLOW breed for select ALLOW select mice expressing the recessive trait	**(3)**

Question Number	Answer	Additional guidance	Mark
8(e)	An explanation that makes reference to the following: • (retinoic acid / chemicals) acts as a transcription factor (1) • (transcription factors) bind to regulator regions of DNA (1) • allowing {the production of mRNA / transcription} (1)	ALLOW converse for each marking point ALLOW activates a transcription factor / acts as a repressor / acts as an enhancer / unwinds DNA from histones ALLOW bind to promotor / polymerase binding site on genes IGNORE translation	**(3)**

Question Number	Answer	Additional guidance	Mark
8(f)	An explanation that makes reference to three of the following: • virus binds to receptors on (neural) cells (1) • { virus / genetic material } is taken into the cell (1) • virus replicates (1) • causing (neural) cells to {die / burst} / inhibiting replication of (neural) cells / spreads to other (neural) cells (1)	(It must be clear that the answer refers to either neural cells or brain cells to gain the first or last marking point) IGNORE viral DNA / RNA replicated IGNORE virus reproduces	**(3)**

Question Number	Answer	Additional guidance	Mark
8(g)	An explanation that makes reference to four of the following: • (donated) { proteins / cells / tissues / organs} act as antigens (1) • (which are) presented by {macrophages / phagocytic cells / antigen presenting cells} (1) • (leading to) activation of T helper cells (1) • (leading to) activation of {T killer cells / cytotoxic T cells / B cells / plasma cells to produce antibodies} (1) • (resulting in) destruction of the transplanted tissue (1)	ALLOW { proteins / cells / tissues / organs} are recognised as being foreign ALLOW cells { destroyed / marked for destruction }	**(4)**

Question Number	Answer	Additional guidance	Mark
8(h)	An answer the makes reference to five of the following: • description of how temperature will be controlled (1) • identification of another appropriate abiotic factor to control (1) • provide nutrients (for cells) (1) • use of aseptic technique (to prevent contamination of cell culture) (1) • culture for a stated period of time (1) • description of method of measuring growth (1)	e.g. set temperatures using a {water bath / incubator} e.g. pH / humidity/ carbon dioxide concentration / oxygen concentration ALLOW description of aseptic technique ALLOW times greater than 2 hours ALLOW culture at each temperature for the same period of time ALLOW e.g. measure {mass / number / area} of cells at beginning and end of culture	**(5)**

Question Number	Answer	Additional guidance	Mark
8(i)	An answer the makes reference to two of the following: • gastruloids show { a greater extent of differentiation / more types of cell } (1) • (only) gastruloids develop (three) germ layers (1) • the cells in gastruloids are organised {along an axis / with left – right patterning } (1)	ALLOW converse statements ALLOW stem cells in the gastruloid {are pluripotent / can give rise to more cell types ALLOW gastruloids are more like an embryo / organoids are only a single organ ALLOW gastruloids have a node	**(2)**

Question Number	Answer	Additional guidance	Mark
8(j)	A description that makes reference to two of the following: • embryonic stem cells have the potential to develop into a human being (1) • embryo is unable to give consent (1) • potential benefits of using embryonic stem cells outweigh the disadvantages (1)	ALLOW harvesting embryonic stem cells destroys {embryos / potential life}	**(2)**

Question Number	Answer	Additional guidance	Mark
8(k)	An explanation that makes reference to three of the following: • iPSCs avoid {ethical issue / example of an ethical issue } associated with use of embryos (1) • (transplant material from) iPSCs will be { genetically identical / have the same antigens } (1) • iPSCs can be collected when needed / no need to produce embryos to collect iPSC (1) • iPSCs have less potential to {proliferate / form cancers } (1)	ALLOW iPSCs are obtained from the patient ALLOW iPSCs will not trigger an immune response	**(3)**

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