Extended Response Questions (Topics 5 to 8): Edexcel SNAB A Level Biology Exam Questions

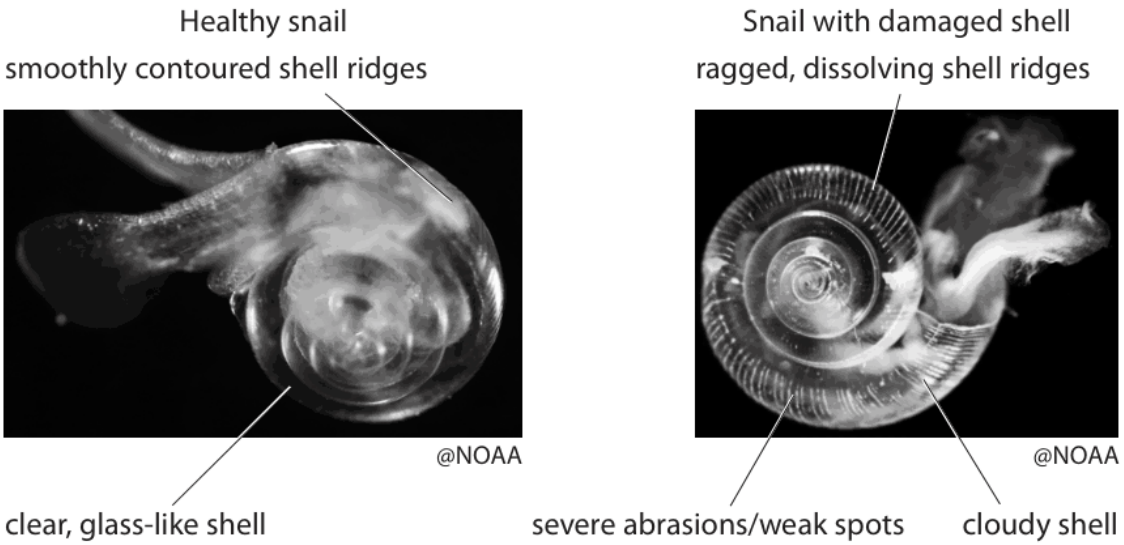
12 questions · 81 marks · about 97 minutes. Answer in the spaces, then check the mark schemes at the end.

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*(b) Pteropods are small free-swimming snails found in oceans throughout the world. They are a food source for a variety of fish including salmon, mackerel and herring.

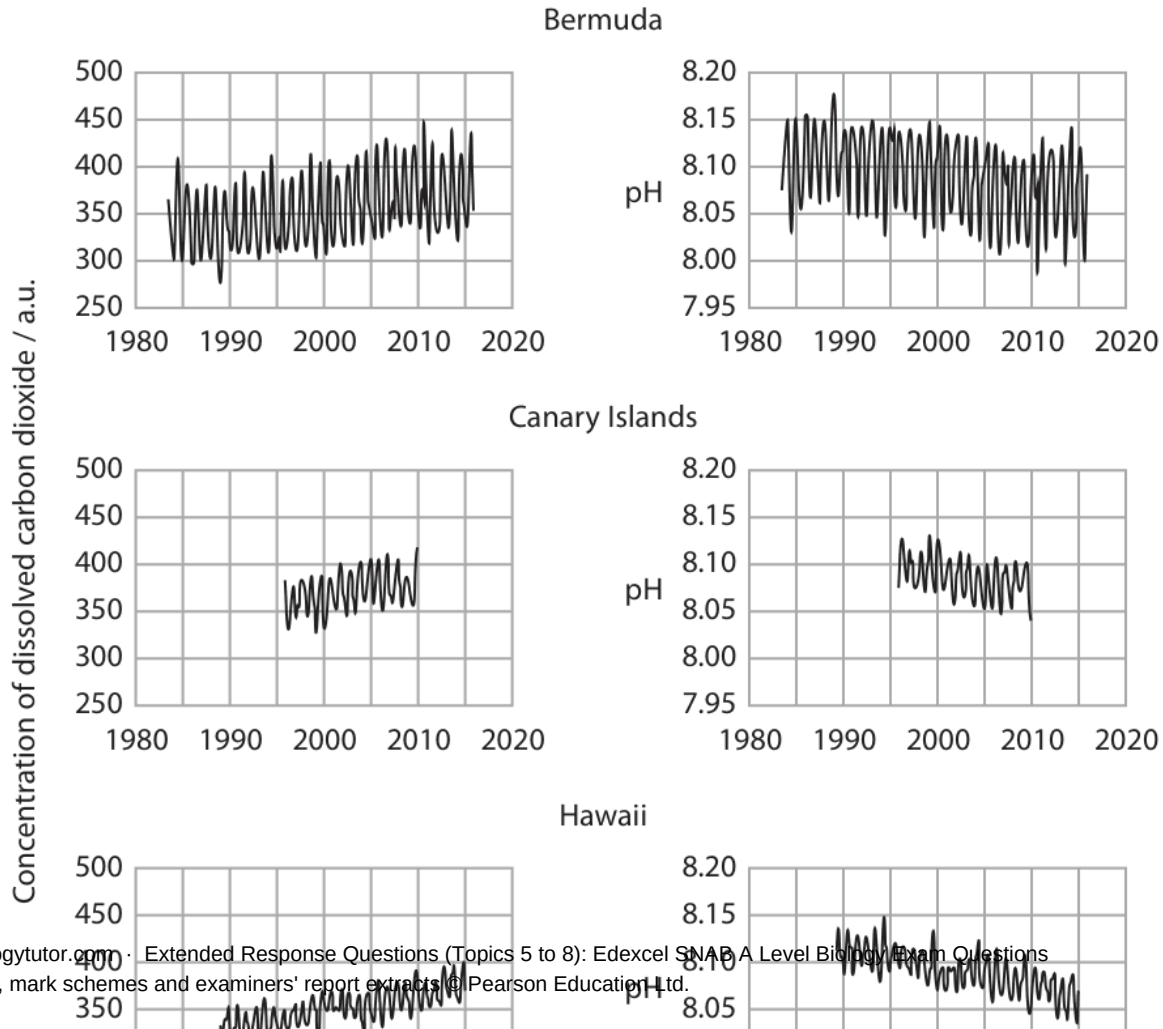
In 2011, the health of these snails was studied in the ocean around Hawaii. A sample of these snails showed that 53% of them had damaged shells.

The photographs show a healthy snail and a snail with a damaged shell found in the ocean around Hawaii.



The pH of sea water affects shell formation in these snails. The changes in carbon dioxide concentration and pH have been recorded in oceans surrounding several islands.

These records are shown in the graphs.



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Question 2 · A level Paper 1 · June 2025 · Q10(c) · 6 marks

*(c) The effect of temperature on germinating seeds can be demonstrated by measuring the Q_{10} value for enzyme activity.

When seeds germinate, amylase is produced.

This enzyme can be extracted from the seeds and used to break down starch.

Devise an experiment to compare the Q_{10} of amylase from germinating seeds of *Veronica* and *Oxyria*.

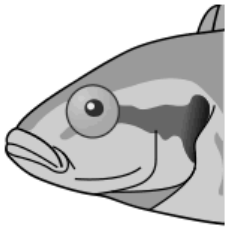
(6)

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7 More than 2000 different species of cichlid fish have been identified in lakes and rivers in Africa.

The different species of cichlid fish have evolved from a common ancestor over a short period of time.

The table shows some of the different species of cichlid fish found in lakes and rivers in Africa.

Species	Information	Mouth shape
Oreochromis niloticus	Lives in rivers across northern Africa. Herbivore feeding on plankton and plants. Lays eggs in gravel.	
Neolamprologus brichardi	Lives in shallow but steep rocky habitat in Lake Tanganyika. Carnivore feeding on small crustaceans and invertebrates. Lays eggs between rocks.	
Astatotilapia burtoni	Lives in muddy rivers flowing into Lake Tanganyika. Omnivore feeding on small fish, insect larvae, algae and plant debris. Lays eggs in gravel.	
Pundamilia nyererei	Lives in shallow water in Lake Victoria. Omnivore feeding on insect larvae and zooplankton. Lays eggs between rocks.	
Maylandia zebra	Lives in deep, clear waters of Lake Malawi. Herbivore feeding on plant material. Lays eggs in gravel.	

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*(b) The genomes of some species of cichlid fish have been sequenced and analysed.

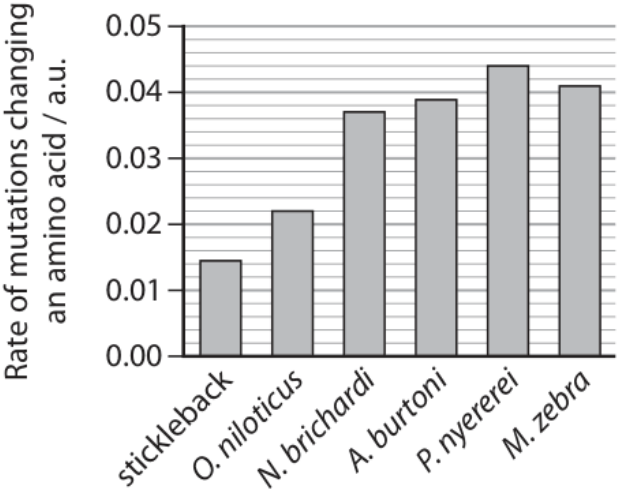
The data collected included:

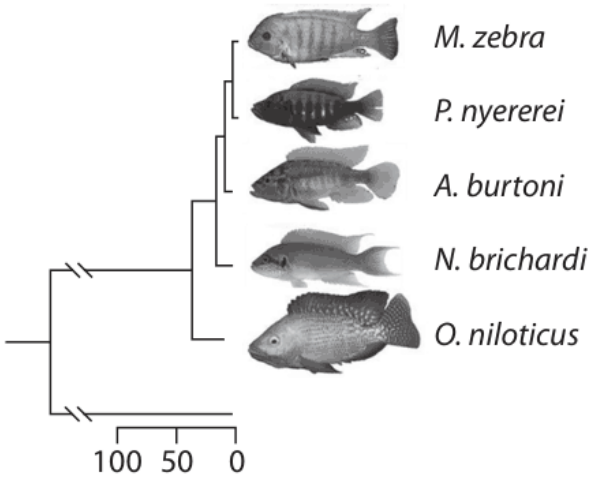
- the rate at which genes have been duplicated to produce additional copies of genes on a chromosome
- the frequency of mutations in transcription factor binding sites
- the rate of mutations that result in a change of an amino acid in a protein.

This information was used to produce a phylogenetic tree.

A comparison was made with a stickleback, which is a slowly evolving fish.

Speed of evolution	Fish	Rate of gene duplication / a.u.	Number of mutations in transcription factor binding sites (compared to *O. niloticus*)
Rapidly evolving cichlid fish	*O. niloticus*	45	0
	N. brichardi	45	214
	A. burtoni	55	140
	P. nyererei	45	129
	M. zebra	60	142
Slowly evolving fish	stickleback	10	0





Phylogenetic tree

Analyse all the data provided to discuss how several species of cichlid fish have evolved over a short period of time.

(9)

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Question 4 · A level Paper 1 · June 2023 · Q7(c) · 6 marks

*(c) Antibiotics can be used to prevent death from bacterial infections.

They act in a number of ways, but all affect a target site in the bacteria.

Many bacteria are developing resistance to antibiotics.

Antibiotic resistance is likely to cause 300 million premature deaths by 2050.

The table gives examples of some antibiotics and the development of resistance.

Mechanism of resistance	Example of antibiotic	How bacteria develop resistance to antibiotic	Example of resistant bacteria
Destruction of the antibiotic	penicillin	Produces enzymes that destroy the drug	*Staphylococcus*
Decrease in antibiotic uptake	vancomycin	Changes in the permeability of the cell membrane prevent the drug entering the bacterial cell	*Pseudomonas*
Activation of a transport mechanism	tetracycline	Pumps develop in the cell membrane to remove toxic substances from the cell	*Escherichia coli*
Modification of target site	linezolid	Mutations in the bacterial DNA causes a change in the target site so the antibiotic can no longer bind to it	*Escherichia coli*

Discuss the mechanisms bacteria have developed to become resistant to antibiotics and the codes of practice used to overcome this resistance.

(6)

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*(c) Another type of virus that causes liver disease is hepatitis B.

Infection with hepatitis B can be treated with drugs and a vaccine is available.

Treatment		Comment
Drug	Entecavir	Tablet taken daily that inhibits hepatitis B viral polymerase
	Interferon	Weekly injection required
Hepatitis B antibodies		Can be given to newborn babies at risk of infection
Vaccination		Three doses provide long-term protection for 95% of those vaccinated

Discuss the use of these different hepatitis B treatments.

(6)

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Question 6 · information from earlier in the question

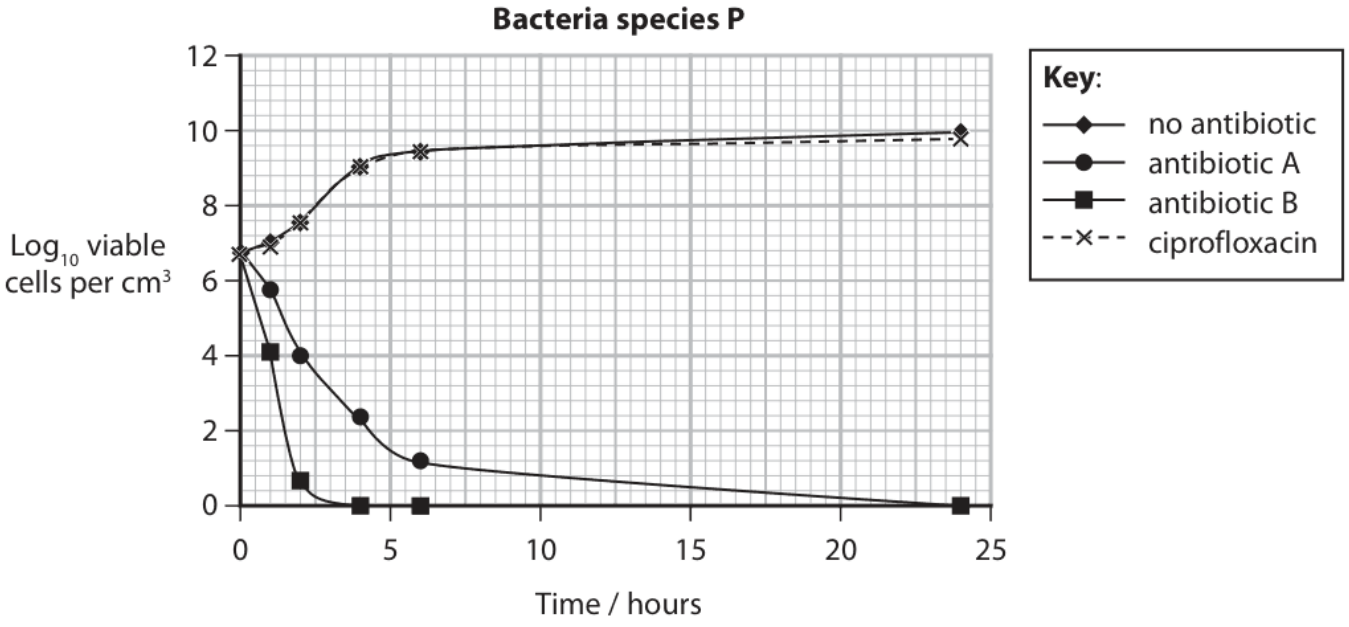
(b) Two new antibiotics have been developed: antibiotic A and antibiotic B. These were tested against two species of bacteria resistant to the antibiotic ciprofloxacin.

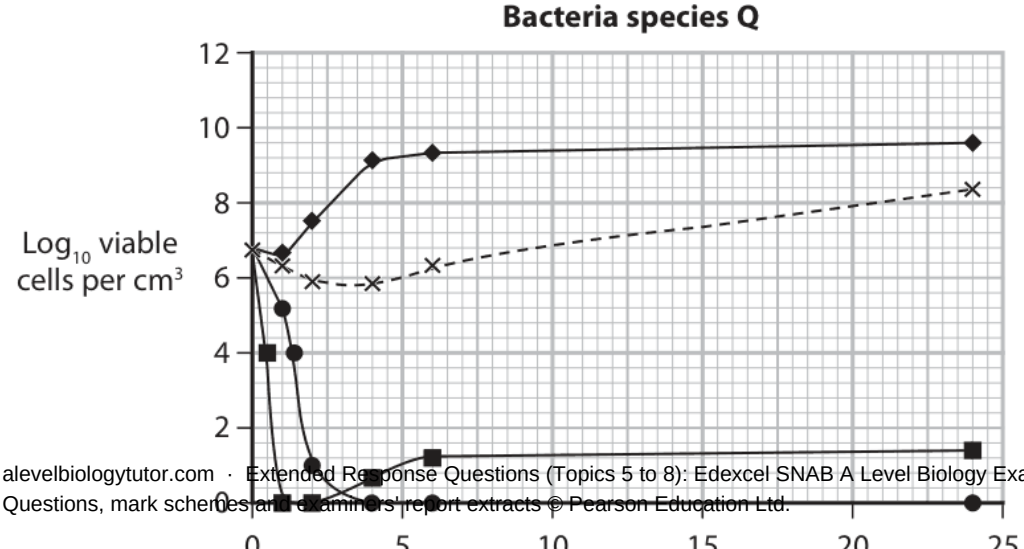
Each species of bacteria (P and Q) was grown in cultures containing:

- antibiotic A
- antibiotic B
- ciprofloxacin
- no antibiotic

Each culture was sampled at 0, 1, 2, 4, 6 and 24 hours and the number of viable cells was recorded.

The results of this investigation are shown in the graphs.





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Question 6 · A level Paper 1 · June 2024 · Q10(b)(iii) · 6 marks

*(iii) A further investigation found the optimum concentration needed to kill bacteria for each of the new antibiotics using cultures on agar plates.

Devise a procedure that could be used to find the optimum concentration for each antibiotic.

(6)

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10 Nandrolone is an anabolic steroid, it is a molecule with a similar shape to testosterone. Nandrolone has been used as a performance-enhancing substance by athletes in the past.

(a) A number of investigations with mice have been carried out to study the effect of nandrolone on the structure and function of the aorta.

In these investigations, all the mice were of one type and were all supplied with the same amount of food and water. These mice were placed into four groups.

Each group was treated differently for eight weeks. The treatments are shown in the table.

Group	Treatment	
	Allowed to exercise	**Given nandrolone**
P	No	No
Q	No	Yes
R	Yes	No
S	Yes	Yes

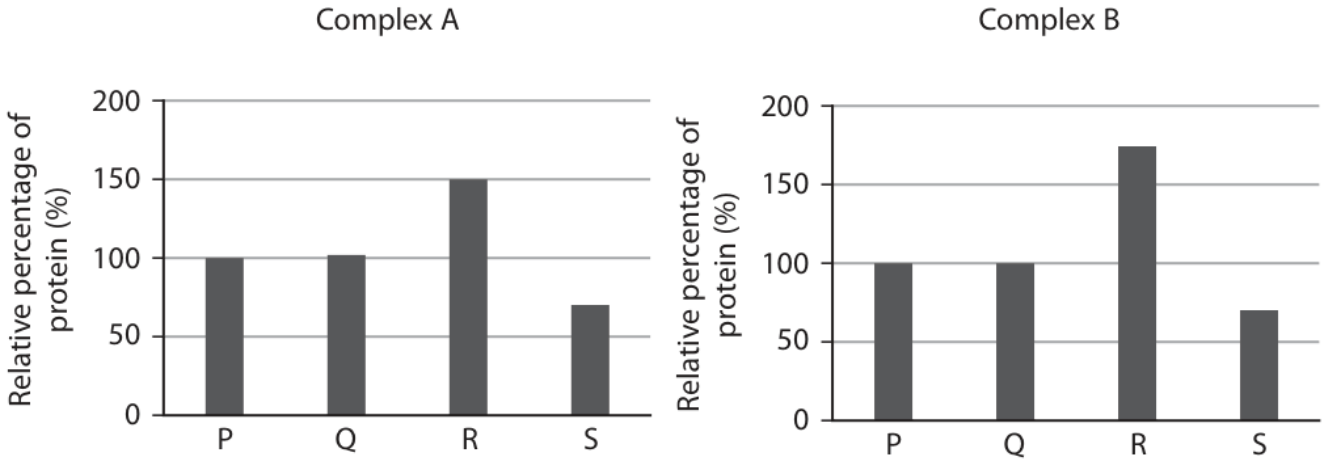
After eight weeks, the aorta of each mouse was studied.

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(ii) In investigation 2, some of the cells from the middle layer of the aortas of the mice were removed.

Two protein complexes, A and B, are found in the cells of the middle layer. These protein complexes are involved in the electron transport chain.

The graphs show the relative percentage of these two protein complexes in each group of mice.



Comment on the effects of nandrolone on the production of ATP.

(3)

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(iii) The transcription factor Tfam is involved in the production of mitochondria.

In investigation 3, some of the cells from the middle layer of the aortas of the mice were removed. The quantity of mRNA per cell coding for Tfam was measured.

The results are shown in the table.

Group	Quantity of mRNA per cell coding for Tfam / a.u.
P	100 ± 20
Q	75 ± 10
R	170 ± 25
S	85 ± 15

A student concluded that nandrolone affects the quantity of mRNA per cell coding for Tfam.

Explain why this conclusion is not valid for all the mice.

(2)

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Question 7 · A level Paper 2 · June 2019 · Q10(b) · 6 marks

*(b) Analyse the data from these three investigations to discuss the advantages of an exercise programme without nandrolone.

(6)

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*(iii) The photograph shows athletes competing in the modern triathlon.



© Gonzalo Arroyo Moreno / Stringer

The modern triathlon involves three sports: swimming, cycling and running.

An investigation was carried out to compare the level of demand on the body of these three sports during a triathlon.

The investigation involved 12 athletes who were all males of the same age.

Each athlete carried out the triathlon as shown in the flow diagram. There was no rest period between each sport.



The heart rate for each athlete was measured as they completed each sport.

The mean heart rate for each sport was then calculated and is shown in the table.

Sport	Mean heart rate / bpm
Swimming	163
Cycling	165
Running	159

The results are shown in the graph.

The blood lactate level for each athlete was also measured as they completed each sport. Means for lactate level after each sport were calculated.

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Question 9 · information from earlier in the question

(b) The transcription factor STAT3 is involved in regulating the activity of macrophages and T cells.

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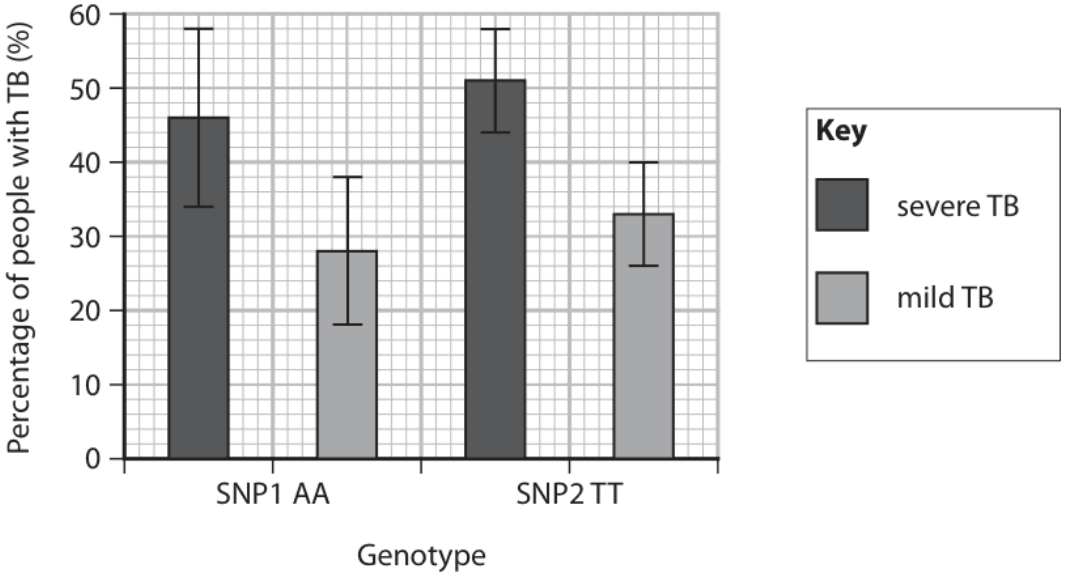
*(ii) The gene for STAT3 can have alternative bases at two sites, SNP1 and SNP2.

- The base at SNP1 is either A or G and the base at SNP2 is either T or C.
- The SNP1 and SNP2 sites are in the introns of the STAT3 gene.

In one investigation, the association of different bases at these two SNP sites with tuberculosis (TB) infection was studied.

The table and graph show some of the results of this investigation.

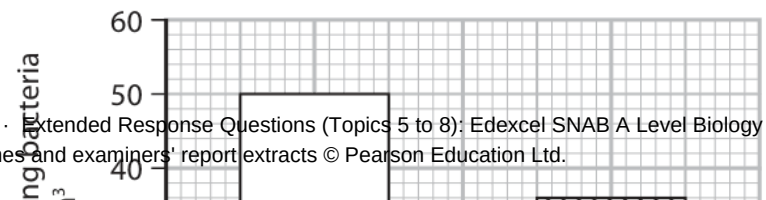
SNP	Bases present in each allele	Chance of this SNP in a person with TB compared with a healthy person
SNP1	AA	increased chance
	AG or GG	same chance
SNP2	TT	increased chance
	TC or CC	same chance



In a second investigation, white blood cells with different SNP1 genotypes were grown in culture with cells infected with *Mycobacteria*.

After three days the number of surviving bacterial cells was determined.

The graph shows the results of the second investigation.



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(c) Studies were carried out to investigate the withdrawal response in earthworms.

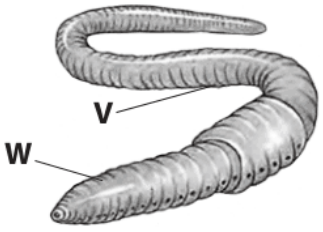
The duration of the withdrawal response is the length of time that the muscles remain contracted. If the stimulus is repeated, the withdrawal response is either reduced in duration or lost.

In one study, an earthworm was touched 20 times in one minute at point **V** as shown in the diagram. The shortening of the earthworm's body was measured after 20 stimuli.

The effect of touching point **W** in the same way was recorded and also the effect of alternating touches between points **V** and **W**.

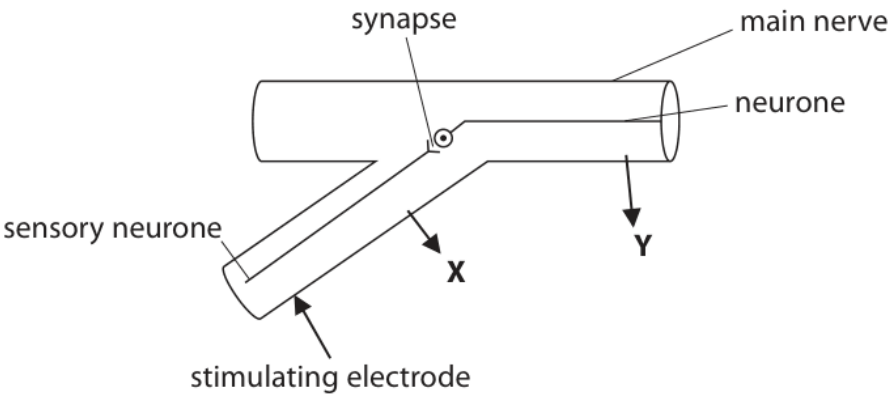
The results of this study are shown in the table.

Nature of stimulus	Change in body length after 20 stimuli / mm
All stimuli at point **V**	0
Stimuli alternating between points **V** and **W**	17
All stimuli at point **W**	0

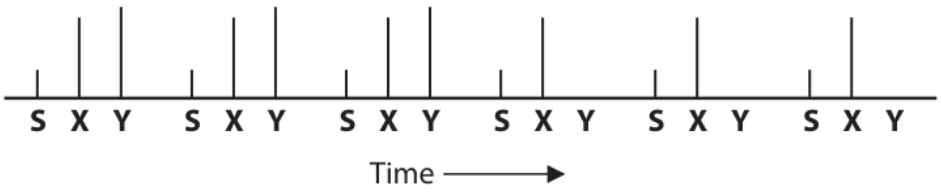


In another study, sensory neurones of an earthworm were stimulated by an electrode six times.

Nerve impulses were recorded at positions **X** and **Y** as shown in the diagram.



Nerve impulses recorded at **X** and **Y** are shown in the diagram below. The presence of a line indicates that an impulse was detected. **S** shows the stimulus.



*(i) Analyse the data from these two studies to evaluate the most likely cause of the loss of the withdrawal response.

(6)

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Question 11 · A level Paper 2 · June 2017 · Q10(e) · 6 marks

*(e) New varieties of plants with desirable combinations of characteristics can be produced using the methods shown in the table.

Method	Example
Formation of hybrids	In wheat, genome D includes genes for a tolerance of harsh conditions and genome A promotes large starch stores in seeds.
Genetic modification	Production of specific molecules in plant cells.
Selective breeding	Plants with desired characteristics can be used for breeding to produce plants with combinations of desired characteristics.

Evaluate the risks and benefits of producing varieties of plants using these methods.

(6)

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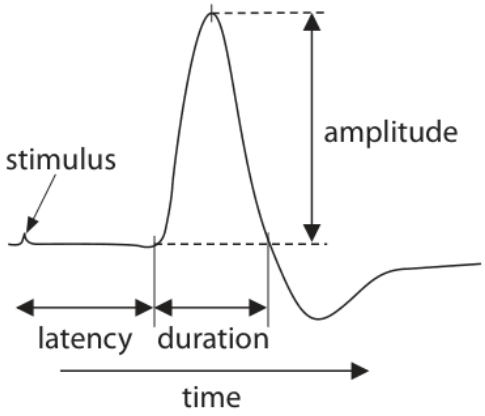
***7** Sports injuries can be treated to reduce pain caused by muscle cramp.

Ice massage, ice pack and cold-water immersion are three different types of treatment.

The compound action potential (CAP) is a measure of the sum of all action potentials in a muscle.

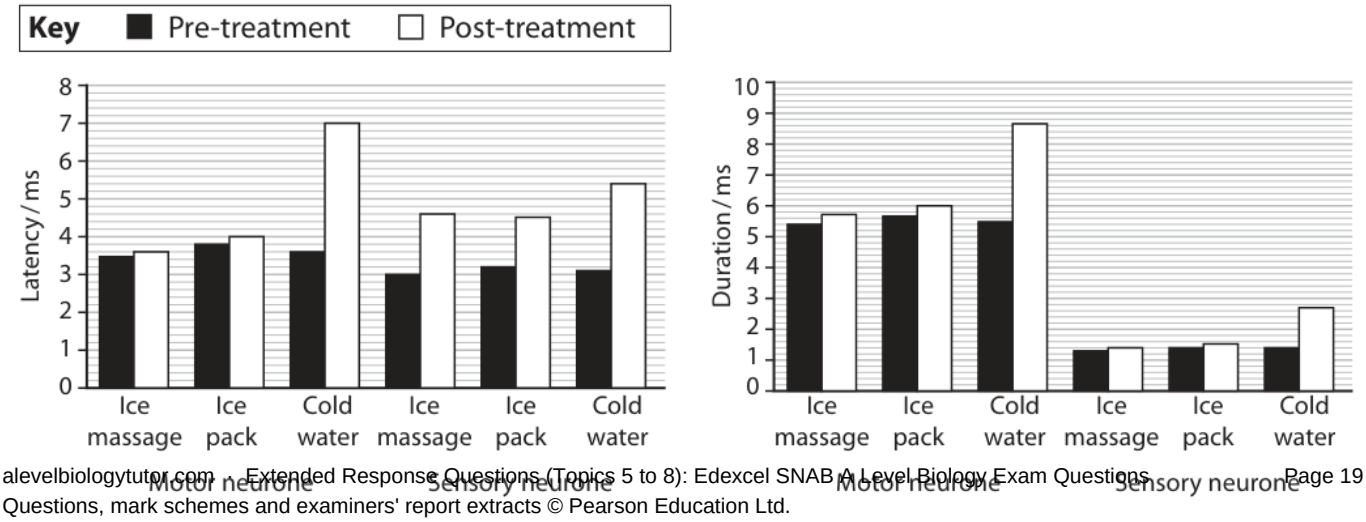
In one investigation, the effects of these treatments on the CAP in a leg muscle were investigated.

The diagram shows the latency, duration and amplitude for a CAP.



- Latency is the time taken from application of stimulus to the start of a CAP
- Duration is the length of time the CAP shows depolarisation
- Amplitude is the sum of depolarisation of all individual action potentials in the CAP
- Conduction velocity is the mean speed at which the CAP travels along the neurones.

The effects of the different treatments on the CAP for motor and sensory neurones are shown in the graphs.



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Mark schemes

Question 1 · A level Paper 1 · June 2019 · Q10(b) · 6 marks

Question Number	Answer
10*(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. <u>Indicative content</u> • Human activity increasing carbon dioxide levels e.g. burning fossil fuels such as oil, coal, gas • Therefore human activity is increasing the level of carbon dioxide in the atmosphere, which then dissolves in the oceans • Graphs show that as carbon dioxide levels increase, pH of the oceans decreases • Reduction in pH increases the percentage of snails with damaged shells • These will not survive therefore less food available for fish / impact on food chains and food webs in the oceans • There may be an initial increase in fish population due to snails becoming more vulnerable to predation • Therefore reduction in fish populations

Level	Mark	Descriptor	Additional Guidance
Level 0	Marks	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	One study focussed on Increase in CO_2 / pH in oceans becoming lower or effect of lower pH on snail shells
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Reference to effect of pH on shells of snails linked to CO_2 and changes in pH in oceans Links made to effects on food chains due to fewer snails
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Analysis of both studies linked to human activity and change in pH of oceans. Explanation of the effect on fish populations. Snails with damaged shells do not survive

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Question 2 · A level Paper 1 · June 2025 · Q10(c) · 6 marks

Question Number	Answer	Mark
10(c)	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. Indicative content **Generalised comments** • Seeds of plants germinated / at the same stage of germination • Same mass of seeds for both species • Same volume / concentration of amylase extract added to starch of the same concentration • Suitable range of temperatures for the reaction, NOT for germination • Use of water bath to control temperature for the reaction, NOT for germination **Explanation of how investigation modified** • Stated temperature values up to 50°C for the reaction, NOT for germination • Equilibrating both solutions separately before mixing • Use of pH buffer to maintain pH • Sensible time frame for initial rate of reaction (up to 10 minutes) • Method to determine break down of starch e.g. testing with iodine • Identification of end point • Repeat at each temperature to calculate mean initial rate **Scientific reasoning linked to determination of Q_{10}** • Rate of reaction calculated for each temperature • Graph plotted to support calculation of Q_{10}– temperature on x-axis, initial rate of reaction on y-axis • Calculation of Q_{10} by dividing rate at T+10 °C by rate at T °C	(6)

Level	Marks	
0	0	No awardable content
1	1-2	An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
2	3-4	An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
3	5-6	An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.

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Question 3 · A level Paper 3 · June 2019 · Q7(b) · 9 marks

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 referre to Consequences of each piece of data explained Linkages to evolution discussed, e.g. the types of adaptations that may arise due to mutations

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Question 4 · A level Paper 1 · June 2023 · Q7(c) · 6 marks

Question Number	Answer
*7(c)	Answers will be credited according to candidate's 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. Indicative content • Use of antibiotics is a selection pressure allowing evolution of antibiotic-resistance • Antibiotics kill/stop growth of all non-resistant bacteria • Only bacteria with a mechanism of resistance will survive and reproduce • Examples of mechanisms which have evolved – destruction of antibiotic/ decrease antibiotic uptake/ activation of transport mechanism/ modification of target site • Explanation of how a mechanism would protect the bacteria from the antibiotic – enzyme produced/ reduced cell membrane permeability/ pumps to remove toxic substances / mutations so antibiotic no longer binds to DNA • ~~Bacteria have single DNA molecule so any mutation is expressed~~ • Conjugation/ exchange of plasmids allows mutations to pass between bacteria • Each antibiotic has a specific target in the bacterial cell, so resistant mechanism specific for that bacteria and that antibiotic • Discussion of hospital practices to reduce development of resistance and why they are effective – hygiene / screening and isolation of patients / management of antibiotic use 6 marks

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Description of one mechanism of resistance from the table. One hospital practice to reduce resistance.
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Description of more than one mechanism of resistance from the table. Description of at least two hospital practices. Description of how antibiotic resistance evolves linked to {natural selection /selection pressures}.
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	ALL of level 2 plus: Details of how resistance is spread between bacteria e.g. conjugation. Explanation of how a hospital practice reduce resistance.

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Question 5 · A level Paper 1 · June 2024 · Q9(c) · 6 marks

Question Number	Answer	Mark
*9(c)	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. **Indicative content** Basic information • drugs such as Entecavir and Interferon treat infection • antibodies and vaccine protects against infection • reference to ease of application e.g. vaccine of 3 doses needed / drugs need taking daily or weekly • vaccination leads to production of memory cells Linkages • vaccine provides long lasting protection • drugs provide short term protection • antibodies provide artificial passive immunity • vaccination provides artificial active immunity • vaccination produces memory cells whereas antibodies will not • entecavir prevents virus replicating and spreading to other cells • interferon inhibits protein synthesis / formation of new virus particles Sustained line of scientific reasoning • drugs reduce viral load • vaccine and antibodies lead to destruction of the virus by agglutination • drugs useful if people have potentially been infected / exposed to the virus • vaccine useful for people working in high-risk environment • interferon an option for the 5% not protected by vaccine • antibodies useful for new-born babies whose immunity is limited	(6)

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	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.	Basic information referred to – e.g. which treatments are for active infection or protecting against infection reference to comparative ease of application basic reference to memory cells from vaccines
2	3-4	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.	Linkages made: e.g. mode of action discussed for the two drugs how the vaccination or antibodies protect against infection type of immunity from antibodies and vaccine relevant discussion of a drug and vaccination / antibodies
3	5-6	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.	Sustained reasoning e.g. discussion of how different treatments can be applied depending on need to treat or protecting against infection relevant discussion of all four treatments

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Question 6 · A level Paper 1 · June 2024 · Q10(b)(iii) · 6 marks

Question Number	Answer	Mark
*10b(iii)	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. **Indicative content** Basic • aseptic technique described • agar plates with bacteria • method to assess effectiveness of antibiotics – zone of inhibition / largest zone is most effective concentration • repeats used for each antibiotic • incubate at same temperature or same lengths of time Linkages • range of antibiotic concentrations • method of applying antibiotics – wells, paper discs • standardised incubation of plates for 24 - 48 hours at 25 - 40°C • variables controlled e.g. species of bacteria, time paper soaked in antibiotic, volume of antibiotic placed in well in agar • measure zone of inhibition e.g. diameter • standardised bacterial cultures tested same volume of bacteria cultures e.g. seeding, bacterial lawn Sustained • calculation of (mean) area of zone of inhibition / calculate mean diameter of zone of inhibition • repeat with smaller concentration intervals around that dose • identification of minimum effective dose	(6)

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Basic detail such as: • preparation of agar plates with bacteria • largest zone is most effective concentration • repeats for each antibiotic
2	3-4	An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Specific details of investigation such as: • incubated for standardised time and temperature quoted • method of adding antibiotic • control of variables
3	5-6	An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.	Linkages to knowledge as listed in indicative content in addition to the following: • calculation of area of zone of inhibition • determination of minimum effective dose as concentration at which zone of inhibition shows no further increase • repeat with smaller intervals above and below the minimum effective dose to determine the optimum concentration.

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Question 7 · A level Paper 2 · June 2019 · Q10(b) · 6 marks

Question Number	Answer
*10(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. Indicative content Investigation 1 • comparison of data for no exercise/exercise without nandrolone: maximum recoil of {aorta / artery} is {higher / 23% greater} • discuss outcome of this difference as an advantage: so (oxygen-rich) blood can flow more rapidly (at the correct pressure) {from the heart / to the muscles} • less likely to get atherosclerosis / CVD / strokes Investigation 2 • comparison of data for P and R for both protein complexes: more present due to exercise • discuss advantageous outcome: so more {oxidative phosphorylation / ATP synthesis / chemiosmosis} so more ATP for muscle contraction / breaking of the bond between actin and myosin (in aorta wall) Investigation 3 • compare P and Q for mRNA coding for Tfam: more Tfam per cell so more mitochondria produced so more {respiration / ATP formed }

Level	Marks	Descriptor	Additional Guidance
0	0	No awardable content	
1	1-2	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.	Results of one investigation described e.g. comparing P and R groups General comments about production of ATP or respiration
2	3-4	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.	Results of at least two investigations considered Discussion of results of one of these investigations in terms of consequences
3	5-6	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.	Results of all three investigations discussed Discussion of the consequences of the data from the investigations in terms of respiration / ATP synthesis Links the consequences to muscle contraction

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Question 8 · A level Paper 2 · November 2021 · Q7(b)(iii) · 6 marks

Question Number	Answer	
***7(b)(iii)**	Answers will be credited according to candidates' deployment of knowledge and understanding of 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 relevant. Additional content included in the response must be scientific and relevant. **Indicative content** **Valid because:** • {sufficient replicates / 12 individuals} used and a mean calculated • All same gender • Means of both heart rate and blood lactate agree with conclusion • Spread of data (standard deviation / error bars) between cycling and running does not overlap **Not valid because:** • Insufficient / only 12 individuals involved • Insufficient detail relating to the athletes e.g. they maybe athletes that focus on different sports/ have done more than one previous triathlon / more experienced • The three disciplines are always done in the same order / different distances covered • Spread of cycling data (standard deviation / error bars) for blood lactate overlaps with swimming • As no time allowed to recover between sports, some of blood lactate shown for cycling could have been produced during swimming • Agree or not agree with conclusion	**(6)**

			Additional Guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Considers one area only e.g. comparing mean data or spread of data only Conclusion based on only one set of data or only one sport considered e.g. cycling is most demanding
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Considers both a valid and an invalid aspect e.g. relevance of spread of data for lactate concentrations overlap in some cases or elements of the study Conclusion given that takes both valid and invalid aspects into account
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Considers both a range of valid and invalid aspects A conclusion based on a range of considered evidence

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Question 9 · A level Paper 3 · June 2023 · Q7(b)(ii) · 9 marks

Question number	Indicative content
7(b)(ii)	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. **Indicative content** • Bullet points ○ STAT3 is involved in gene regulation of macrophages and T helper cells ○ The SNP1 and SNP2 {polymorphisms / mutations} are in non-coding part of gene • Table ○ (SNP1) AA and (SNP2) TT genotype are more common in people with TB ○ allow people with AA and TT genotype more likely to {have / be infected with} TB • Graph 1 ○ AA and TT genotypes are more common in people with severe TB than mild TB ○ error bars for TT do not overlap / error bars for AA do overlap • Graph 2 ○ white blood cells from people with AA genotype are less effective at killing mycobacteria ○ no results for SNP2 (polymorphism) ○ no error bars • Comments on the results ○ some results do not have error bars / some error bars overlap ○ effects are relatively small ○ data is incomplete / examples of missing data ○ no information about combination of SNP1 and SNP2 polymorphisms • Conclusions ○ these SNPs may affect synthesis of the transcription factor and not the function of the protein ○ genotype at SNP1 and SNP2 affects effectiveness of immune response to mycobacteria ○ macrophage (and T cell) activity affected ○ genotype at SNP1 and SNP2 affects susceptibility to infection/severity of infection

Level	Mark	Descriptor	Additional Guidance
0	**0**	No awardable content	Nothing credit worthy
1	**1 – 3**	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	• One source of information • Two different sources of information or one source and one interpretation • Three different sources of information
2	**4 - 6**	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	• Two different sources of information + one interpretation • Three different sources of information + one interpretation- some irrelevant / incorrect information • Three different sources of information + one interpretation
3	**7 - 9**	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	• Three different sources of information + two interpretation • Three different sources of information + three interpretation- some irrelevant / incorrect information • Three different sources of information + three interpretation

Sources of information:		Interpretation:	
• location of SNP sites • genotype prevalence table • genotype / severity graph • bacteria culture graph	(L) (T) (S) (B)	• comment on validity of the results • overall conclusion about AA / TT based on more than one source of information • consider role of STAT3 in immune response / macrophage activity in TB	(V) (C) (R)

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Question 10 · A level Paper 2 · June 2017 · Q8(c)(i) · 6 marks

Question number	Answer
***8(c)(i)**	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. Indicative content from table: • stimulated at just one point (V or W) – response lost after repeated stimulation • if the repeated stimulation is alternated between two points (V and W) the worm still responds by contracting its muscles / no habituation when stimuli alternated between different locations • different nerves / neurones / stimulated (by V and W) from diagrams: • there is a response at X every time the neurone is stimulated • { repeated stimulation / after three stimuli } there is no longer an impulse recorded at Y • electrode X is close to where the stimulus is applied and it detects an impulse each time • electrode Y is further from where the stimulus is applied • there is a synapse between the stimulus and the neurone monitored at Y Knowledge and understanding of habituation: • after repeated stimulation the impulse cannot cross the synapse • lack of neurotransmitter / not enough time to produce more neurotransmitter • calcium ion channels not opening when impulse arrives at the synapse • threshold not reached on the post-synaptic neurone and no action potential produced

Level	Mark	Descriptor	Additional Guidance
0	0	No awardable content	
1	1-2	Limited scientific judgement made with a focus on mainly just **one** study. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	One study focused on – probably the table of data Idea of different nerves involved
2	3-4	A scientific judgement is made through the application of relevant evidence from **both** studies. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Analysis refers to the table of data – idea of difference when stimulus at one place or alternating **and** the diagrams showing effects of stimulating nerves X and Y. Links made to impulses not present post synapse and an explanation for that
3	5-6	A scientific judgement is made, which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Analysis of both studies **linked** to knowledge and understanding of habituation, **links** made to location of synapse and reasons why neurotransmitter not released.

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Question 11 · A level Paper 2 · June 2017 · Q10(e) · 6 marks

Question number	Answer
10 (e)	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. Indicative content: Benefits Described: • crops have increased yield due to pest control or resistance to disease • reduced need to use pesticides • crops can be grown in a wider range of conditions, e.g. harsh conditions, drought etc Discussed: • hybridisation could allow crop plants to have genes for tolerance to harsh conditions from genome D • crops have higher nutrient content, or produce a greater range of useful chemicals e.g. pharmaceutical products • genetic modification can be beneficial if crops are resistant to herbicides - crops can be sprayed with herbicide without { being harmed / causing reduction in yield } Risks Hybridisation: • hybridisation can lead to pest species which have ability to grow in wide range of conditions • hybridisation could allow genes for tolerance to harsh conditions from genome D to enter pest species GM: • genetic modification may result in genes entering pest species, making control difficult or into food chains • GM can introduce antibiotic resistant genes to other species Selective breeding • selective breeding reduces { genetic diversity / size of gene pool }, or causes genetic drift • leading to loss of useful alleles / reducing the ability of the crops to adapt to environmental change

Level	Mark	Descriptor	Additional Guidance
0	0	No awardable content	
1	1-2	Limited scientific judgement made with a focus on **one** side of the argument only. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Only considered one benefit **or** one risk without further explanation beyond a brief description.
2	3-4	A scientific judgement is made through the application of relevant evidence to **both** sides of the argument. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Considers at least one risk **and** one benefit with some discussion.
3	5-6	A scientific judgement is made, which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Benefits generally described and specific risks discussed. Conclusions described for each of the three methods – hybrids, GM and selective breeding.

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Question 12 · A level Paper 3 · June 2024 · Q7 · 9 marks

Question number	Indicative content
*7	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. **Judgments from data** Latency • cold water (treatment) increased latency of motor neurone (CAP) • all treatments increased latency of sensory neurone (CAP) Duration • cold water (treatment) increased duration of motor neurones (CAP) • cold water (treatment) increased duration of sensory neurone (CAP) Amplitude • ice massage and ice pack decrease amplitude of sensory neurone (CAP) • cold water (treatment) had no / little effect on amplitude (CAP) Conduction velocity • all three treatments decreased conduction velocity in sensory neurone (CAP) • cold water treatment produced small decrease in conduction velocity in motor neurones Linkages based on own biological knowledge and understanding • increased latency of neurone may result in {fewer impulses / longer time to generate action potential} • decreased conduction velocity of neurone may result in fewer impulses • reduced amplitude may indicate fewer impulses being transmitted {across synapses / along neurones} • increased duration of motor neurone CAP may result in prolonged muscle contraction • increased duration of neurone CAP may result in delayed repolarisation (of neurones) Conclusions • {all 3 treatments / ice pack / ice massage} are likely to reduced sensory nerve conduction and would reduce pain • cold water treatment is likely to be effective at reducing (motor and sensory neurone) conduction and will be effective at reducing the cramping and reducing the pain • comments on limitations of the study

Level	Mark	Descriptor
0	**0**	No awardable content
1	**1 – 3**	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
2	**4 - 6**	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
3	**7 - 9**	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

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