AQA GCSE BIOLOGY (HIGHER) · 8461

BIOLOGY



MARK SCHEME

4.6.3 THE DEVELOPMENT OF UNDERSTANDING OF GENETICS AND EVOLUTION (PACK 4)

SCORE	PERCENTAGE
/210	%

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Q1.

Level 3: Relevant points (advice / reasons) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (advice / reasons) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

precautions with reasons

- do not prescribe fluroquinolone / antibiotics for mild infections
- because they will get better due to the body's normal immune system

- do not prescribe fluroquinolone / antibiotics for viral infections / colds / flu
- because antibiotics do not kill viruses

- if you do prescribe fluroquinolone / antibiotics make sure the patient finishes the course
- because any bacteria left may develop resistance, survive and reproduce rapidly (due to lack of competition)

- only prescribe fluroquinolone if the patient has the new strain
- because routine use would lead to an increase in resistant bacteria

other relevant content

- doctors and nurses in the practice / hospital should be using antibacterial / alcohol hand wash between each patient **and / or** disinfectant to clean wards
- to kill (resistant) bacteria

- doctors should isolate patients with this strain of bacteria
- to prevent other patients getting the resistant infection

[6]

Q2.

(a) a short section of DNA

1

(b) a sequence of amino acids

1

(c) genome

1

(d) phenotype

1

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(e) (parents genotype shown one homozygous recessive, one heterozygous dominant)
rr and Rr

may be on diagram

1

(possible offspring genotypes shown) Rr Rr rr rr

allow correct derivation of offspring genotypes from incorrect gametes

1

all offspring with Marfan syndrome phenotype circled / labelled

1

probability 0.5 / ½ / 50%

allow correct probability from incorrectly derived offspring

1

(f) gametes / sperm / eggs are produced by meiosis (cell division)

1

when gametes fuse this mutation is in the fused / new cell

allow at fertilisation for when gametes fuse
allow zygote for fused cell

1

(after fertilisation) <u>mitosis</u> produces every cell of embryo / offspring

1

(which) will be genetically identical
or
(mutated) DNA from gamete is in every cell of offspring

1

[12]

Q3.

(a) (boil ethanol) in a water bath

1

(b) (test) add iodine (solution)

1

(result) blue-black

allow black
allow blue / black
allow dark blue
ignore purple unqualified

1

(c) solvent moves through paper

1

different pigments have different solubilities in solvent
or
different pigments have different attractions for the paper

1

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(and so) are carried different distances

1

allow references to solvent as the mobile phase and paper as the stationary phase

(d) any **one** from:

- R_f values overlap
  or
  0.20 is within range for two pigments
- R_f ranges overlap
- could be chlorophyll b or xanthophyll
- there may be other pigments (that are not in table 2)

1

(e) $$(R_f \text{ value}) = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

1

$$0.89 = \frac{\text{distance moved by substance}}{140}$$

or

$$0.98 = \frac{\text{distance moved by substance}}{140}$$

1

(distance moved by substance)
= 0.89 × 140
or
= 0.98 × 140

1

= 125 / 124.6 **or** 137 / 137.2

1

(from) 125 / 124.6 (mm to) 137 / 137.2 (mm)

1

*an answer of (from) 125 / 124.6 (mm to) 137 / 137.2 (mm) scores **5** marks*

*calculation using an incorrect distance moved by solvent scores a maximum of **4** marks*

(f) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

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No relevant content

0

Indicative content

- variation arising from mutations
- mutations occurring randomly
- produce a different protein / pigment / enzyme responsible for pigment production
- produce if more likely to survive
- will pass on favourable genes
- idea of timescale
- if more light captured, faster rate of photosynthesis
- increased photosynthesis causes faster growth
- outcompete neighbouring plants
- different colours of light have different wavelengths
- absorbing wider range of wavelengths means more light is absorbed
- more likely to survive in changing conditions

[18]

Q4.

(a) ionising radiation

allow UV / X-rays / gamma (radiation)
allow environmental factors qualified e.g. carcinogenic chemicals

1

(b) enzymes

1

vectors

1

(c) **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

4–6

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–3

No relevant content

0

Indicative content

- pre-clinical trials of the new drug on cells / tissues / live animals
- to test for toxicity / dosage / efficacy

- clinical trials / tests on healthy volunteers
- clinical trials / tests on children with Dravet syndrome at very low doses
- so you can monitor for safety / side effects
- and only after these stages trial to find optimum dosage / test for efficacy

- trial could be double blind / use a placebo
- which does not contain the new drug
- children with Dravet syndrome would be randomly allocated to the test

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groups
- so no one knows who has the drug / placebo
- comparison to existing drugs

- peer review of data
- to help prevent false claims
- approval by NICE

to access **level 2** the key ideas of testing on healthy volunteers followed by testing on patients must be given

[9]

Q5.

(a) between 200 and 500 million years ago

2

(b) the organism was replaced by minerals

1

(c) there are no organisms of that species alive todays

1

(d) DNA analysis

1

(e) (Carl) Linnaeus

1

(f) Protoceratops **and** Triceratops

allow
*Coronosaurus **and** Triceratops*
or
*Protoceratops **and** Coronosaurus*
or
*Marginocephalia **and** Pachycephalosaurus*

1

(g) Marginocephalia

1

(h) older fossils have a simpler structure

1

[8]

Q6.

(a) remains / traces of organisms

1

from millions of years ago

1

(b) no individuals of a species still alive

1

(c) microorganisms have a simpler structure than a trilobite

1

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stromatolites are found in older rock than trilobites

1

(d) Marginocephalia

1

(e) Protoceratops **and** Triceratops
(in either order)

allow

*Coronosaurus **and** Triceratops*

or

*Coronosaurus **and** Protoceratops*

or

*Marginocephalia **and** Pachycephalosaurus*

1

(f) any **one** from:

- the fossil record is not complete
- new fossils may have been found since 1970s
- DNA / chemical analysis may have given new information

1

[8]

Q7.

(a) glucagon

correct spelling only

1

(b) if glucose too high (insulin causes) glucose to enter liver / muscle cells
or
glucose to be converted to glycogen

1

so blood glucose levels fall

1

when glucose gets too low (glucagon causes) glycogen breakdown in liver / muscle cells

allow ecf from part (a)

1

so glucose enters blood and raises level again

1

this is called negative feedback

1

(c) any **two** from:

- polymer
- made of two strands
- (twisted) in a double helix

allow:

- *backbone of strands contains sugar and phosphate groups*
- *(cross) linked by pairs of bases*

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- *correct names of four bases or base pairs*

2

(d) contains a code

1

for a sequence of amino acids which forms a specific protein

1

(e) mother **A** (polydactyly)

50% / half of children will have polydactyly if parent is heterozygous as it only takes one allele to show the disorder and half the sperm / ova / gametes will have faulty allele.

1

(and) all / 100% will have polydactyly if parent is homozygous as faulty gene will always be passed on

1

(but) for mother **B** (cystic fibrosis) none / 0% of children will have cystic fibrosis as it would need a second allele from the other parent before the disorder would be present

allow genetic diagram(s) if correct and offspring ratio clearly indicated.

1

[13]

Q8.

(a) platelets

1

white blood cells

1

plasma

this order only

1

(b) 5500 000

1

(55 000 000 × 1000 000 =) 5500 000 000 000

1

5.5×10^{12}

1

(c) $(5.5 \times 10^{12} \times 5.2 =) 2.86 \times 10^{13}$

allow ecf from part (b)

allow 28 600 000 000 000

1

(d) it is recessive

allow it is not dominant

1

(e)

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Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content • red blood cells carry oxygen • rbc contain haemoglobin • haemoglobin carries / binds to oxygen • sickle cells are smaller or have smaller volume • sickle cells contain less haemoglobin • less oxygen carried • smaller SA:volume ratio • oxygen enters rbc by diffusion • slower / decreased diffusion • less oxygen delivered per minute or slower rate of delivery • blood vessels blocked (due to cell shape)	

6

(f) any **one** from:
- breathlessness
- tiredness
- less able to do exercise
- pain (in muscles)
- muscle fatigue
- anaemia

1

[15]

Q9.

(a) (small section of) DNA

1

(b) rr

1

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(c) persons **6** and **7** (don't have Pompe but) have a child with Pompe disorder

1

(therefore) each parent must be a carrier
or
have a copy of the recessive gene

allow neither parent has Pompe disorder

1

(d)

		mother (number 7)	
		R	r
father (number 6)	R	**RR**	**Rr**
	r	**Rr**	**rr**

***1** mark for first row*

1

***1** mark for second row*

1

(e) ring drawn around **rr**

1

(f) 0.25

allow 1 in 4
*do **not** accept 1:4*

1

(g) tested on healthy volunteers

1

(then) tested on patients

1

any **two** from:
- monitored for safety
- monitored for dosage
- monitored for efficacy
- carried out as a double-blind trial
- use of placebo

2

[12]

Q10.

(a) gene for the malarial protein is removed from the malarial pathogen

allow gene for the malarial protein is removed from the malarial protist

1

goat DNA / chromosome is cut open

1

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using an enzyme

1

goat and malarial DNA are combined (and put back into the goat cell)

1

(b) only females produce milk

allow males don't produce milk

1

(c) ensure all the offspring are female (to produce milk)

1

ensure all goats will have the malarial protein gene

or

all will produce the malarial protein / vaccine

1

(d) any **two** from:

- everyone who drinks milk will get the vaccine
- no need for storage / refrigeration of the vaccine
- cheaper production of the vaccine
- less risk of infection from injections
- no needles which some people are scared of

2

(e) pathogens are engulfed (destroyed) via phagocytosis

1

antibodies are produced to kill the pathogens

1

(and) antitoxins are made (to stop the symptoms of malaria)

1

[12]

Q11.

(a) animal cells also have cell membrane

1

(b) 1945–1955

allow 1946–1956

or *1947–1957*

1

(c) $(2 / 22 =) 9.0\dot{9}$

*allow 9.09 (%) or 9 (%) with no working shown for **1** mark*

1

9.1 (%)

*allow 9.1 (%) with no working shown for **2** marks*

1

(d)

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More likely	Less likely
	✓
	✓
✓	
✓	
✓	

*allow **3** marks for 4 correct*
*allow **2** marks for 3 correct*
*allow **1** mark for 2 correct*

4

more than one tick in a row negates a mark

[8]

Q12.

(a) human cells have cell membrane
or
human cells have no cell wall

1

(b) can no longer synthesise proteins

1

(c) antibiotics are being developed at a slower rate than emergence of new resistant strains

1

resistant strains mean we cannot treat (common) infections

1

reduce (future) cost of antibiotic resistant infections

1

[5]

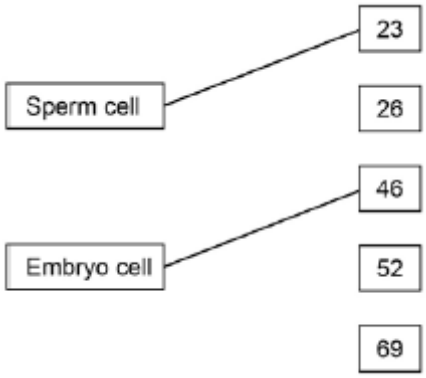
Q13.

(a) Nucleus

1

(b) **Type of cell** **Number of chromosomes**

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extra lines from left cancel the mark

2

(c)

	X	X
X	XX	XX
Y	XY	XY

*all three correct for **2** marks*
*one or two correct for **1** mark*
allow XY or YX in correct places

2

(d)

	X	X
X	XX	XX
Y	(XY)	(XY)

either circled

1

(e) 1 in 2

1

[7]

Q14.

(a)

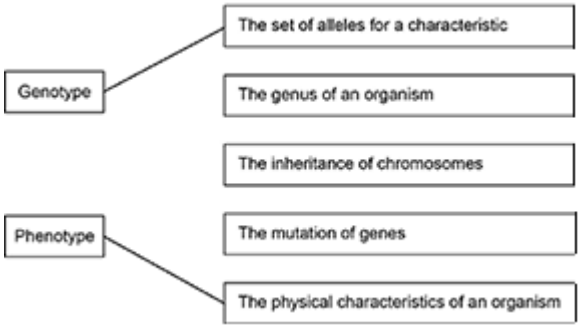
Characteristic	Environmental	Genetic	Both

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Eye colour		✓	
A scar	✓		
Weight			✓

3

(b) **Key term** **Definition**



extra lines from the left negate the mark

2

(c)

Stage in selective breeding	**Order of stage**
Cows are bred over many generations	4
Parents are bred together	2
Cows with the desired characteristics are chosen	1
Calves with the most desired characteristics are bred together	3

*all 3 correct for **2** marks*
*1 or 2 correct for **1** mark*

max. 2

(d) beef / meat

allow hardiness, disease resistance

1

milk yield

1

(e) higher veterinary costs

1

less income from sale of (milk and meat) products

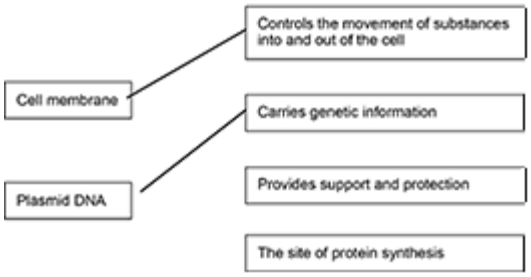
1

[11]

Q15.

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(a) **Feature** **Function**



extra lines from the left negate the mark

2

(b) Contaminated food

1

(c) any **two** from:

- cook food (thoroughly)
- pasteurise food
- wash hands properly
- disinfect work surfaces
- keep raw and cooked foods separate
- only drink clean water

2

(d) It will not cause sickness and diarrhoea side effects

1

(e) **E**

1

B

1

D

1

[9]

Q16.

(a) cross / breed / mate different breeds of horse

1

if the offspring are fertile then the two breeds are of the same species

1

(b) select the fastest male and female to cross / mate

allow any relevant characteristic, eg stamina

1

select the fastest offspring and breed them

1

repeat over several generations to produce faster horses

1

(c) gene for the Bt poison is cut from the bacterial DNA / plasmid / chromosome

ignore characteristic

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accept Bacillus thuringiensis

1

using enzymes(s)

1

and transferred to cotton plant cells / DNA / chromosome

*do **not** allow to cotton plant plasmid*

1

(d) any **four** from:

must have both advantages and disadvantages for full marks

advantages

- increased yield as less eaten by insects
- fewer pesticides need to be used
- (so) producer can make more money

this point may only be gained if linked to one of the points above

Disadvantages:

- gene (for poison) could be passed on to wild plants
- may kill useful insects

allow named insect eg bees

- ecosystem / food chain could be affected
- gene pool of cotton plants could be reduced

allow less variation in cotton plant population

max. 4

[12]

Q17.

(a) Man's genotpe **Hh**

both needed for the mark

Woman's genotype **hh**

1

(b) gametes correctly derived from parents genotypes in 05.1

1

offspring genotypes correctly derived from gametes

1

all Hh circled

Man's gametes		**Woman's gametes**	
		h	h
	H	Hh	Hh
	h	hh	hh

1

(Probability =) any **one** from:

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- 50%
- ½
- 2 / 4
- 0.5
- 1 in 2
- 2 in 4
- 1:1
- 2:2

1

(c) **Level 3 (5–6 marks):**
A detailed and coherent evaluation is provided which considers a range of relevant points and comes to a conclusion consistent with the reasoning.

Level 2 (3–4 marks):
An attempt is made to relate relevant points and come to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.

Level 1 (1–2 marks):
Discrete relevant points made. The logic may be unclear and the conclusion, if present,
may not be consistent with the reasoning.

0 marks:
No relevant content

Indicative content

- adoption / gamete donation unsuitable as offspring not biologically theirs
- natural conception too risky / only 50% chance of healthy offspring
- natural conception would cause worry whether baby would be healthy or not
- (therefore) choice is between PGD and PND

pros of PGD

- baby would be theirs
- results obtained at an early stage
- high chance baby produced would be healthy
- parents would have confidence of having a heathy baby from start of pregnancy
- lower risk of miscarriage compared to PND
- frozen embryos can be used to have another healthy child
- PGD occurs before pregnancy / implantation
- PGD does not involve abortion so less trauma / less pain / ethical comparison
- spare healthy embryos may be used for research / medical treatment

cons of PGD

- slight / 0.2% chance of misdiagnosed embryo
- expensive procedure
- cost to NHS of non-essential procedure
- (unhealthy) embryos might be destroyed
- large number of embryos produced so healthy embryos may be destroyed
- ethical issues of using embryos for research
- some people are opposed to IVF due to their religious beliefs

pros of PND

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- natural conception less invasive for mother
- psychological benefit of producing child naturally
- 99% / high chance that result of test will be conclusive

cons of PND

- sampling technique invasive to mother
- risk of miscarriage
- risk of infection
- long wait before test can be carried out
- 50% chance baby will have allele for Huntington's disease
- parents will have a difficult decision to make if baby is unheathly
- baby may be aborted
- ethical / religious issues of abortion
- a justified conclusion

6

[11]

Q75.

(a) (i) 3 billion years ago

1

(ii) any **one** from:

- the theory challenged religious beliefs
- there was insufficient evidence at the time

  allow no evidence / proof
- mechanism of inheritance / variation not known

  accept genes not known about
- people believed in different theories.

1

(b) (i) 2 (million years ago)

1

(ii) Snow leopard

*do **not** allow leopard*

1

(c) camouflaged

allow description of camouflage,

eg blends in with background

allow less likely to be seen

1

[5]

Q76.

(a) toxins

1

(b) (i) bacteria

1

(ii) mutate

1

(iii) new / different antibiotic

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allow new / different drug
*do **not** allow vaccine*

1

[4]

Q77.

(a) (i) 3 (million years ago)

1

(ii) orangutans

1

(b) (i) natural selection

1

(ii) any **one** from:

- went against religious beliefs
- insufficient evidence (at the time)
  allow no proof
- mechanism of inheritance / variation not known (at the time)
- there were other theories e.g. Lamarck
  allow people couldn't accept the idea of evolving from other animals

1

[4]

Q78.

(a) (i) 3 (millions of years)

1

(ii) orangutans

1

(b) natural selection
ignore survival of the fittest

1

[3]

Q79.

(a) ingest pathogens

1

produce antibodies

1

produce antitoxins

1

*deduct **1** mark for each extra box ticked*

(b) are not killed / affected (by antibiotic)

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allow antibiotic does not work / does not cure
allow bacteria immune (to antibiotic)
allow infection not killed
ignore bacteria mutated

1

(c) (i) (antibiotic) Y

1

(ii) 8

*allow 54 − 46 for **1** mark*

2

(iii) any **two** from:

- overuse / widespread use/ over prescription
  OWTTE
- inappropriate use / use for eg sore throats / viral infections
- mutation / change to DNA (in bacteria)
- natural selection /description
  ignore people not finishing course of antibiotics
  ignore wrong antibiotic given

2

[9]

Q80.

(a) 3 billion

1

(b) mutation

1

selection

1

evolution

1

(c) (i) crocodile

1

80 (million years ago)

*do **not** accept 80 years*

1

[6]

Q81.

variation exists in the population / a mutation occurred

ignore adaptation

1

so some head lice resistant to chemical / not killed by it

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ignore immune

1

these survive and breed
or
pass on gene / allele / DNA (for resistance) to next generation

ignore characteristic / chromosome

1

[3]

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Q1.

Foundation

This 'level response' question asked for advice that doctors should be given in order to prevent the spread of a new strain of bacteria. Many students answered it in terms of advice that patients should be given by doctors and this was acceptable if relevant points were given. The majority of lower-attaining students responded in terms of general hygiene and separation. In the case of the former, washing hands was commonly seen with the additional reference to antibacterial hand washes or similar less frequent. The reason for the precaution which is to kill bacteria was rarely seen. Isolation was described in a great variety of ways and a lot of the time there was a correct reason given for it. There were also frequent additional comments about face masks, gloves and various other types of protective clothing. Some students also gave descriptions of how to stop the spread of STDs.

Of the more scientific / biological reasons completing the course of antibiotics was the most common and this frequently had a weak link with references to immune rather than resistance. There were a few very good scientific explanations for this precaution.

Lots of students described in various ways that doctors should not overuse the antibiotic and in some cases, there were appropriate weak links. Some students also referred to not using them for viral infections or mild infections but on these occasions there were rarely any relevant attempted links.

A lot of students decided the whole population needed to take the antibiotic so large stocks had to be available at pharmacies, so they could get them. Again many were under the assumption that if they were given the antibiotic in advance, it would prevent them from getting the infection rather than treating the infection once they got it.

Also a significant number thought mass vaccinations were the answer. In some cases these were accompanied by very good scientific explanations about how vaccines work, but more often they suggested the fluoroquinolone should be used as the vaccine. Another common incorrect response was to describe drug trials and although some used appropriate science this was irrelevant and did not gain marks.

Overall students found this question difficult with 18% achieving level 2 or 3.

Higher

This was an 'extended response' question, marked using a holistic 'levels of response' mark scheme. Students were asked to explain the advice that doctors should be given to prevent the spread of a new strain of *Pseudomonas*

.

They were told that infections caused by the strain occurred in hospitals and that they could only be treated with one antibiotic, fluoroquinolone.

Most students who took this paper showed good appreciation of how best to prevent the spread of such an infection and achieved at least a level 2 mark (47% of students). There were some excellent answers which easily accessed the highest award within level 3 (2% of students).

Many students failed to supply good biological explanations for the precautions they gave

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and so restricted themselves to the level 2 criteria of attempted logical linking and a not fully clear account. Common examples of this were references to bacteria becoming 'immune' to the antibiotic, or even the patient becoming immune to the antibiotic and the bacteria becoming 'stronger' if they were not all killed. Basic hygiene rules to 'stop the spread' as given in the stem were restricted to level 1. Many students gave no relevant content (0 marks) because they suggested that all hospital patients, or everyone in the world, should be given the new antibiotic. Many thought that it should be used as a vaccine to immunise everyone.

There were several misunderstandings:

- The question asked for advice that should be given to doctors. Answers based on advice to patients rarely gained above level 1. Doctors are not responsible for developing vaccines, so answers that focused on this alone could not be given credit.

- Answers that suggested that 'everyone should be given antibiotics' because they are a protective, preventative measure were inappropriate.

- Bacteria may develop resistance to an antibiotic but not 'immunity'. Some students also implied that that any bacteria remaining after use of antibiotics might simply be 'stronger'.

- Some students believed that the 'patient' developed resistance to the antibiotic or that the 'antibiotic became resistant to the bacteria', as opposed to the resistance being developed 'by the bacteria' and 'against the antibiotic'.

- Some students thought that antibiotic resistance only developed 'over time' and, therefore, suggested that antibiotics should only be administered for short periods. Others believed that dosage was significant and argued for either small or large doses of antibiotics to be given.

Q2.

(a) 83% of students could identify that the best description of a gene from the options given was a short section of DNA.

(b) 71% of students incorrectly selected that a gene codes for a DNA helix, rather than a sequence of amino acids.

(c) 12% of students could give the scientific term 'genome'.

(d) 44% of students knew that the term phenotype describes the observable characteristics of an individual.

(e) Most students attempted to draw a Punnett square diagram, as stated in the specification. Credit could still be awarded for other genetic diagrams, but mistakes were seen more frequently if other methods were used.

Students were asked to use a genetic diagram to show the probability of the offspring inheriting Marfan syndrome. Few students identified which offspring genotypes would inherit Marfan syndrome, therefore marking point three was awarded infrequently.

This question discriminated well with a good spread across the mark range. The most frequent mark achieved was three (40% of students).

(f) Students found this high demand question challenging with 3% of students

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achieving two or more marks. Many misconceptions regarding mutations, meiosis and mitosis were seen.

The most frequently awarded mark was for recall that meiosis produces gametes. Few students could go on to explain how a mutation in a gamete could be present in every cell of an individual.

Q3.

(a) 65% of students could not describe how to safely boil ethanol. Some referred to safety glasses, despite being directed not to in the question. Others thought that using a beaker above a Bunsen burner is sufficient, or suggested mixing the ethanol with water.

(b) This question tested knowledge of a Required Practical Activity and generally, this was answered well with 51% of students achieving some credit.

Students should be reminded not to describe the positive result of a test for starch as purple, as this could be confused with the Biuret test for protein.

(c) Students were asked to explain how chromatography causes different pigments to separate. It was clear that most students had good understanding of chromatography and detailed descriptions of methods were seen. Students must ensure they take notice of the command word in the question. 'Explain' questions require students to make something clear, or state the reasons for something happening. Descriptions of detailed methods often failed to answer the question.

The best answers referred to solvent moving through the paper, rather than assuming the solvent was water. Most students could explain that different pigments have different solubilities in the solvent and therefore are carried different distances.

Responses using the terms from the specification: stationary and mobile phase, often achieved all three marks, but there were some misconceptions regarding these terms. Some students incorrectly describe the pigment as the stationary phase.

12% of students achieved either two or three marks.

(d) This high demand question required application of knowledge of Rf values to a novel context. 14% of students answered correctly. Many of these students could identify that the pigment could be xanthophyll or chlorophyll b, or describe that the Rf value ranges overlap.

A significant number thought the pigment could be chlorophyll a or chlorophyll b, which was incorrect. It's possible these students used the distance moved (24 mm) and interpreted this as an R_f value of 0.24.

(e) 26% of students demonstrated an excellent understanding of Rf values in a difficult context. Those who did not achieve full marks often recalled the equation incorrectly. If the equation was recalled correctly and then rearranged incorrectly, the first marking point could be awarded. Again, this demonstrates that students should show every stage of their calculations.

Usually, when a mark is awarded for recall of an equation, the full equation should be given. In this instance, because the question was phrased in terms of R_f value, the whole equation was not required.

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(f) This 'extended response' high demand question was not answered well. Students often simply repeated the stem of the question, which will never gain marks.

- Level 1 responses included aspects of the indicative content, but with no attempts at linking, or developing simple statements to give a complete answer to the question.
- Level 2 responses included ideas from the indicative content, with some attempt at logical linking, but were not fully clear.
- Level 3 responses require relevant points to be given in detail and linked to give a clear account. Few students were awarded level three marks.

8% of students gave level 2 or 3 answers. To award level 2 or 3, the answer had to apply to the situation given, rather than straight recall of the process of evolution, without application to the context given.

Weaker answers frequently gave confused accounts of photosynthesis, often confused with respiration. Some responses stated all the student could remember regarding photosynthesis, without engaging with the command word of the question.

Misconceptions regarding mutations, adaptation and evolution were common. Incorrect references to plant camouflage, plant breeding and genetic modification were seen.

Q4.

Foundation

(a) 4% of students were able to give a correct answer. Some students who were on the right track just wrote 'radiation' which was insufficient. Other common answers were 'extra chromosomes', 'Down's syndrome' or specific genetic disorders which may be the result of a mutation but do not cause a mutation.

(b) Enzymes were commonly identified as used in genetic engineering, but vectors less often. Placebos were often given instead. 74% of students achieved at least one mark.

(c) This 'extended response' question was challenging to students and discriminated well. Only the highest-attaining students were able to access level 3 (3%). 18% of students were able to access level 2 by giving the key ideas of testing on healthy volunteers followed by testing on patients. Most students in level 2 achieved three marks.

Few students appear to have a completely clear grasp of the sequence of drug testing. Many students missed the testing on healthy volunteers and / or those with Dravet syndrome. Those who gained credit seemed to be familiar with the use of a placebo and / or a double blind trial with some students describing it in detail.

Higher

(a) This question required a specific answer, 'ionising radiation', or an example. Many students gave 'radiation' which was insufficient at this level. A few students correctly suggested mutagenic chemical. 14% of students achieved this mark.

(b) 52% of students achieved one mark here, with 33% of students achieving two marks. 'Enzymes' was the most common one mark answer, with 'white blood cells' being the most common incorrect answer.

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(c) ‘The quality of answers seen would suggest that a significant number of students struggled with this ‘extended response’ question. Answers were generally poorly structured, with points not in a logical sequence. It was often difficult to interpret student’s meaning because of weak knowledge and understanding of the topic, and limited powers of expression.

However, the question did discriminate between students well. 7% of students were able to access level 3, 32% of students were able to access level 2, and 50% of students accessed level 1.

Q75.

(a) (i) Two thirds of the students correctly said that simple life forms first developed on Earth more than 3 billion years ago.

(ii) Most students said that Darwin’s theory of evolution was not accepted at first because there was not enough evidence, or they referred to religious beliefs to gain the mark.

(b) (i) The majority of students correctly said that the lion evolved 2 million years ago.

(ii) Almost two thirds of the students gained the mark for saying that the snow leopard is the closest relative to the tiger. Others lost the mark because they just said ‘leopard’, which was incorrect.

(c) Most students said that the stripes help to camouflage the tiger, or gave a description of this to gain the mark, for example, ‘so the tiger could blend in with its surroundings’. References to a disguise were ignored. Some mistakenly thought that the stripes acted as warning colours to deter predators.

Q76.

(a) Three quarters of the students correctly stated that toxins produced by bacteria and viruses make us feel ill.

(b) (i) Only just over half of the students knew that antibiotics only kill bacteria; many thought they killed both bacteria and viruses.

(ii) Just under two thirds of the students said that new strains are produced when pathogens mutate.

(iii) The question asked what scientists will have to develop to kill new, resistant strains of bacteria. The most common error was to mention an antibiotic or a drug without any indication of it being new or different. A stronger antibiotic or new treatment was insufficient. Other incorrect responses included antitoxins and antiviruses. Many thought that a new vaccine was needed, but as this would not directly kill the bacterium it was not allowed. Responses highlighted a misunderstanding of immunity and resistance, and once again, some students thought that antibiotics could be used to kill viruses.

Q77.

(a) (i) Most students interpreted the evolutionary tree correctly and said chimpanzees evolved 3 million years ago.

(ii) Almost three quarters of students identified orangutans as being the most

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distant relative of hominids.

(b) (i) Two thirds of students knew that Darwin's theory states that evolution happens by natural selection. The most common incorrect answer was mutation.

(ii) The most common correct responses said that there wasn't enough proof or it went against religious beliefs. Saying they didn't believe him (Darwin) was insufficient.

Q78.

(a) (i) The majority of students interpreted the diagram correctly and gave an answer of 3 million years.

(ii) The majority of students identified orangutans as being the most distant relative of chimpanzees.

(b) The majority of students knew that Darwin's theory states that evolution happens by the process of natural selection. A few said it happens by survival of the fittest, which was ignored.

Q79.

(a) Most students were able to gain at least two marks for this question. A common incorrect response was 'stop pathogens entering the body'. Some students confused antibodies and antibiotics.

(b) Many students answered in terms of bacteria fighting the antibiotic or being stronger than the antibiotic. Others thought the body was resistant or rejected the antibiotic.

(c) (i) About half of all students gained a mark for this question. Some students shaded the box as indicated by the key, rather than giving the letter. These answers gained credit.

(ii) A lot of responses gave values greater than 100%. A common mistake was to use figures from the wrong years or to misread the scale. Some students thought they had to calculate a percentage rather than just do a simple subtraction. They appeared not to understand the term 'difference' or had not read the label on the y-axis. Some wrote down 54–46 but did not get the correct answer. Students who have poor maths skills should be encouraged to check all their answers using a calculator.

(ii) A wide range of incorrect responses was given and less than a fifth of students were able to score at least one mark. Many thought the bacteria got used to the antibiotic, could fight it or got stronger. Others said the wrong antibiotic or dose had been given or that a new antibiotic was used instead. Once again, many students thought the body became immune to the drug. Some thought it was related to more or less people catching pneumonia. Antibiotic resistance and immunity are misunderstood and often confused.

Q80.

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(a) Most students selected the correct answer, but a few thought that simple life forms first developed on Earth more than 3 million years ago, rather than 3 billion years ago.

(b) Some students did not use the words from the box and many confused the terms mutation and evolution. Almost two-thirds of students were credited at least two marks for this question.

(c) (i) Some students gave more than one answer so could not be given the mark, even if crocodile was one of them. Some said reptiles, but if crocodile was not mentioned they could not gain credit as the question asked for an animal. It is important to use the words given in the question. Some gave the name of a bird as the answer, when the question asked for the animal most closely related to birds.

(ii) Most students answered this question correctly. An answer of 120 million years ago was often given as students had read the scale on the diagram the wrong way up. Answers of 80 years ago did not gain credit.

Q81.

To gain full marks students were required to explain why most head lice are no longer killed by the chemical. Many students gave pre-prepared answers for natural selection but did not link mutation / variation with the production of resistant head lice. Most students, as expected, gained the mark for survivors breeding / passing on resistance gene. However, many stated that the characteristic was passed on.

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