

Mark scheme

Q1.

(a) any **two** from:

- sterilise equipment / surfaces (before use)
- (use) sterilised agar

ignore 'clean' unqualified

ignore wash hands

allow description of how to sterilise equipment

allow description of how to sterilise agar

- secure lid of the Petri dish with (adhesive) tape
- only lift lid of Petri dish a little (when setting up plate) **or** lift lid of Petri dish at an angle (when setting up plate)

2

(b) B

and

it kills the fewest bacteria

or

it has the smallest area where no bacteria were growing

allow it has the smallest clear / white area

an incorrect answer for one step does not

prevent allocation of marks for subsequent steps

ignore calculation and subtraction of filter paper

disc area from total area

1

(c) (correct measurement)

Note: In Exampro, the measurement of 1.1 cm or 2.2. cm will depend on the printing of the exported diagram and should therefore be checked by the teacher/student using this mark scheme.

$r = 1.1$ (cm)

or

$r = 11$ (mm)

allow $d = 2.2$ (cm)

or

$d = 22$ (mm)

allow a tolerance of ± 1 mm

1

(recall of the equation)

πr^2

1

(calculation/substitution)

3.14×1.1^2

or

3.14×11^2

allow correct calculation / substitution using an incorrect measurement

1

= 3.799(4) (from 3.14×1.1^2)

or

= 379.9(4) (from 3.14×11^2)

allow 3.8

allow 380

1

correct unit

(3.7994) cm²

or

(379.94) mm²

do not accept unit with no attempt at working / answer

1

(d) any **one** from:

- repeat **and** calculate a mean
- repeat **and** eliminate anomalies
- use a control disc

allow description of control disc e.g. disc with water / nothing ignore set up a control

- use different types of bacteria

1

[9]

Q2.

(a) any **two** from:

- regular hand washing

or

use hand sanitiser / alcohol gel

- cover nose / mouth when coughing / sneezing

allow wear a face mask

- put used tissues (straight) in the bin
- don't kiss uninfected people

allow isolate patient from others

or

don't share cutlery / cups / drinks with uninfected people

- clean / disinfect / sterilise surfaces regularly

ignore responses referring to infected people

2

(b) any **three** from:

- stimulate (mouse) lymphocytes to produce antibody

for marking points 1 and 2 lymphocyte must be used at least once

- combine (mouse) lymphocyte with tumour cell

or

(create a) hybridoma

- clone (hybridoma) cell

- (hybridoma) divides rapidly **and** produces the antibody

3

- (c) any **two** from:
- (monoclonal) antibody binds to virus **or** antibody binds to antigen on surface of virus
 - (monoclonal) antibody is complementary (in shape) / specific to antigen (on surface of virus)
 - white blood cells / phagocytes kill / engulf the virus(es)

2

- (d) as a control
or
to see / compare the effects of the treatment (vs. no treatment)

1

- (e) $(4.8 + 10.4) \div 2 \div 100 \times 1500$
or
 $(4.8 \div 100 \times 750) + (10.4 \div 100 \times 750)$

1

114

an answer of 114 scores 2 marks

allow 228 for 1 mark

1

- (f) **(supports the conclusion because)**
over double the number / % of patients (in the trial) were hospitalised with the placebo (compared to MAB)

1

(does not support the conclusion because)

no information on patients not hospitalised / still unwell at home

or

other factors may have affected those admitted to hospital

allow correct named factor e.g. age / gender / other illness

or

don't know if it was a double blind trial

1

[12]

Q3.

- (a) mechanical

allow physical

allow structural

1

- (b) any **one** from:

- to deter herbivores

ignore to injure animals, unqualified

allow to deter animals eating it

*do **not** accept to deter predators*

- to prevent animals damaging it

1

- (c) chemical

1

- (d) any **two** from :
- lack of magnesium (ions) (1)

(so) not enough chlorophyll for (efficient) photosynthesis (1)

(so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1)

allow (so) lack of chlorophyll produced causes yellow leaves (1), (so) not enough photosynthesis to produce glucose which is used to make proteins for growth (1)
 - infection by pathogen / bacteria / virus / fungus (1)

allow correctly named pathogen

allow has rose black spot / TMV

(so) leaves become discoloured / yellow so less photosynthesis (1)

allow other symptoms of named pathogens / disease

(so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1)

award once only
 - infected by aphids (1)

(which) remove sugars from phloem (1)

(so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1)

award once only
 - lack of (available) light (1)

(so) chlorophyll breaks down (1)

(so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1)

award once only

5

[8]

Q4.

(a) A

1

(b) cerebral cortex

allow cerebrum

allow cerebral hemisphere(s)

ignore D

1

(c) any **three** from:

<ul style="list-style-type: none"> • can ask people to do different tasks (while taking scan) <i>allow can ask person to do a (specific) task</i> • to see which part of brain is active / inactive <i>allow to see which part of the brain is working</i> • to compare with a person without brain damage • to see (exactly) where the damage is • (traditional) MRI scanner cannot be used if people can't stay still <i>allow examples such as children or patients with Parkinson's disease</i> <i>allow may be better for people who are claustrophobic</i> 	3
<p>(d) (cells in) retina sensitive to light <i>allow retina detects light</i> <i>allow rods / cones detect light</i></p>	1
<p>impulse passes along (sensory) neurone <i>allow electrical signal or electrical message</i> <i>passes along (sensory) neurone</i></p>	1
<p>(along) optic nerve <i>allow chemical transmission across synapse</i></p>	1
<p>(e) Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.</p>	5-6
<p>Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.</p>	3-4
<p>Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.</p>	1-2
<p>No relevant content</p>	0
<p>Indicative content</p>	
<ul style="list-style-type: none"> • mutation (in gene / DNA) • randomly or due to chance • causes new / different protein / (visual) pigment to be made in the retina of bird • (so more) variation in the wavelengths of light birds retinas could detect • birds with the mutation or birds able to detect UV are more likely to see fruits (that reflect UV) • birds with the mutation or birds able to detect UV are more likely to see where small mammals are or have been • therefore get more food (small mammals or fruit) • avoid being eaten (by small mammals) • out competing those birds without the mutation or birds not able to detect UV 	

- so more likely to survive **and** reproduce **or** have offspring
- by natural selection
- passing on allele / gene / mutation to offspring
- repeated over many generations

For Level 3 a link to UV vision is required

[14]

Q5.

blood vessels supplying skin 1

constrict

allow vasoconstriction
*do **not** allow capillaries /veins constricting*
*do **not** allow moving blood vessel*

1

less blood flow (to / through capillaries / to skin)

allow blood flows further away from skin surface

1

so less energy is lost (to the surroundings)

allow less heat is lost

1

'shivering' by muscle (contraction)

allow muscles contract (and relax) rapidly

1

releasing energy **or** respiring (more)

allow 'heat produced'
*do **not** allow energy produced / made*
*do **not** allow energy **for** respiration*
allow sweating stops / reduces

ignore hair erection

1

[6]

Q6.

(a) pituitary 1

(b) ADH 1

(c)
allow ecf for name of hormone from part (b)
ignore name of gland

high(er) concentration of blood **causes** (more) ADH / hormone release

allow low(er) water potential of blood causes
(more) ADH / hormone release

*allow alternative descriptions in terms of – eg
low(er) water concentration / level **or** high(er)
osmotic pressure **or** high(er) solute concentration
/ level*

1

(and hormone / ADH causes) increased permeability of kidney tubules (to water)

*allow increased permeability of collecting duct /
distal convoluted tubule*

1

(so) increased water reabsorption

*allow more water taken back into blood
ignore reference to urine*

1

(d)

*allow converse if clearly describing dialysis
explanation must match reason*

changes in concentrations / levels of substances / urea are minimised

*allow no change in concentration / level of
substances / urea
allow correctly named substances*

1

(so) less / no chance of causing damage to body cells / tissues

*allow eg less / no osmotic stress **or** not poisoned
by urea*

1

not repeatedly puncturing skin **or** blood not in contact with machine

allow blood does not leave the body

1

(so) less / no chance of infection **or** less / no chance of blood clots **or** no need to take anti-clotting drugs

*allow less / no chance of microorganisms
entering body
allow only one operation so less chance of
infection for 2 marks
allow dialysis requires anti-clotting drugs and so
may lose more blood if cut for 2 marks*

1

[9]

Q7.

(a) auxin

accept other named plant hormones

1

(b) (i) any **three** from:

- no (fusion of) gametes / fertilisation
*allow no meiosis **or** new cells only produced by mitosis*

- only one parent
allow not two parents
- no mixing of genetic material
- no genetic variation **or** genetically identical offspring
allow clones

3

[5]

Q8.

- (a) many (joined) nucleotides **or** monomers
allow (long) molecule / chain made of repeating units

1

- (b) phosphate

1

(phosphate attached to a) sugar

1

(which has 1 of 4) base(s) (attached to sugar)

ignore phosphorus

allow deoxyribose / pentose

allow 2 marks if position of sugar / phosphate / base is incorrect

1

(bases) are A, C, G **and** T

*allow bases are adenine, cytosine, guanine **and** thymine do **not** accept thiamine / adenosine*

allow description of a pair of nucleotides

1

- (c) $0.34 \times 12\,000\,000\,000$

an incorrect answer for one step does not prevent allocation of marks for subsequent steps

1

4 080 000 000

1

$$\begin{array}{r} 4\,080\,000\,000 \\ \hline 1\,000\,000\,000 \end{array}$$

allow conversion from nm to m at any point in the calculation

1

4.08 (m)

1

2.04 (m)

(divided by 2 due to base pairs)

allow division by 2 at any point in the calculation

(d) (non-coding parts) can switch genes on / off

1

1

[11]

Q9.

(a) any **two** from:

- most people still believed that God made all the animals / plants on Earth
allow against their 'religion'
- insufficient evidence
do not allow no proof / evidence
ignore 'fossil'
- the mechanism of inheritance / genes unknown (at the time)

2

(b) any **four** from:

- finches separated / isolated
- genetic variation / mutation (in finch population(s))
- finches with alleles / genes best suited to their environment survive
Do not allow 'characteristics'
- advantageous alleles / genes passed on (to offspring)
- after many generations / a long time, the populations can no longer successfully interbreed
Ignore 'speciation'

4

(c) (i) vegetarian finch

1

(ii) **R**

1

(iii) mangrove **and** woodpecker finches

1

[9]

Q10.

(a) from light / sunlight

ignore sun unqualified

1

absorbed by chlorophyll / chloroplasts

if no other mark awarded allow by photosynthesis for 1 mark

1

(b) krill / herring / copepod

1

(c) algae

1

(d)	1 algae 2 krill or copepod 3 squid 4 mackerel (5 Human) <i>all correct for 1 mark</i>	1
(e)	any two from: (losses due to) <ul style="list-style-type: none"> • non-eaten parts (of squid / krill) <i>allow bones / shells</i> <i>allow eaten by other animals</i> • <u>respiration</u> or <u>respiring</u> (in mackerel) <i>do not accept respiration produces / makes / creates energy</i> • excretion (by mackerel) <i>allow loss of a named waste product such as CO₂ / urea</i> <i>ignore loss of waste unqualified</i> <i>ignore faeces</i> 	2
(f)	2.3 and 0.1 (million) <i>allow in the range 2.25 to 2.3 for 2.3 (million)</i>	1
	$\frac{2.3 - 0.1}{2.3} \times 100$ or $\frac{220}{2.3}$	1
	95.65217..... <i>allow answer from correct substitution of incorrect values from Figure 3</i>	1
	96 <i>allow student's calculated answer correctly rounded to the nearest whole number</i>	1
(g)	Level 3: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4
	Level 1: Relevant points are made. They are not logically linked.	1–2
	No relevant content	0

Indicative content

figures may be given without units (million tonnes) throughout

points for:

- small fish are not caught so can live long enough to reproduce
- biomass / stocks have generally increased after these laws introduced
- '77-'81 law (total ban) resulted in increase in biomass, eg 0.1 to 0.48 **or** to 0.9 by '84
- '84 law (mesh size) resulted in increase in biomass, eg 0.9 to 1.8 (by '90)
- '97 law (quotas) resulted in increase, eg 1.15 to 1.25
- '98 law (ban in breeding season) resulted in increase, eg 1.25 to 2.5

points against:

- could be a cause other than the law **or** correlation does not necessarily indicate causal relationship **or** other factors
- laws superimposed so can't necessarily tell the effect of each
- each law results in an increase followed by a decrease
- quotas lead to dead fish being thrown back into sea

For **Level 3** points both for and against must be considered together with appropriate use of data

[17]

Examiner reports

Q3.

Some students referred incorrectly to herbivores as predators in (b). In (d), many students were able to correctly name two reasons for the symptoms, but explanations were either not worded well or underdeveloped. Several students were unclear about the distinctions between chlorosis, chloroplasts and chlorophyll.

Very few students answered (e) correctly (89% scored zero marks), because they were so focussed on the nitrates mentioned in the question that they missed the other requirements of the bacteria. Many students found the novel context regarding root nodules perplexing and didn't score any marks.

Q4.

This question was about the brain and vision, and applications to the use of MRI scanners and to the evolution of a sight adaptation in birds. Many students lacked precision in their explanations for (c). In order to explain the advantage of the functional MRI (fMRI) scanner, using the given information, the majority of successful students stated that it would enable doctors to see which part of the brain was active / inactive in a certain situation in order to ascertain the location of any brain damage. Some were more explicit and explained that the context for this would be having the patient perform a particular task. Some suggested, correctly, that the scan could be compared with one from a person without brain damage, or that the fMRI scanner could be used on a person who had difficulty staying still such as a young child or a person with Parkinson's.

Part (d) was not answered at all well by many students. The question asked for how the brain received information from the eye, *not* how the eye produced an image or made adjustments for different light intensities, *nor* for the coordination of any response, some or all of which were included in the answers of many. Several important details were also omitted in many answers – e.g. light is not just focused on 'the back of the eye' but on the *retina*, and the latter is actually *sensitive* to the light or contains *receptors* rather than just being the passive recipient of an image; *impulses* are then sent along *neurones* (not just 'messages' or 'signals' in 'nerves') in the *optic nerve*.

Given that some birds had an adaptation allowing them to detect UV light, and that some fruits and the urine of small mammals reflected UV light, students had to explain how this feature in the birds might have evolved in (e). Many students suggested correctly that a mutation might have occurred in an ancestral bird, although very few went on to state that this would have been a random occurrence. Very few students related this to a possible structural change in the cells of the retina. However, many did realise that the mutation, or ability to detect UV, would enable the birds to see fruits and thus obtain more food than non-mutant birds and/or see where small mammals had been and hence either avoid predation or manage to catch these mammals as food. Many students then went on to explain that the birds with UV vision would be more likely to survive and reproduce, passing on their favourable allele (or 'the mutation') to their offspring, perhaps over many generations, and that this was an example of natural selection. Some students interpreted this as a 'speciation' question and hence gave an answer they had prepared previously. Students need to read the question carefully in order to assess what aspects of their knowledge may be applied *appropriately* in answering it. The question differentiated very well across the entire ability range of the students.

Q5.

The vast majority of students demonstrated some knowledge and understanding in this

question and the discrimination of the question was very good, for example approximately one sixth of students gained five or six marks, a further third gained three or four marks and another third gained one or two marks.

Students appeared to understand many aspects of the mechanisms involved but a significant number are still losing marks for the following misconceptions:

- blood vessels move
- capillaries or veins constrict
- energy being 'made'.

A substantial number of students did not relate their answer to humans and therefore discussed hairs erecting and trapping air. This was often well explained but not credit worthy.

Some students began 'the story' at the thermoregulatory centre and how blood temperature was monitored and whilst this wasn't credit worthy it did potentially waste students' time.

The mechanisms of reduced heat loss by radiation and evaporation of sweat were well explained by a number of students. The most commonly missed marking point was marking point 1, as students were not clear and precise in terms of explaining that it is the blood vessels **supplying** the skin capillaries that constrict and often wrote fairly vague answers referring to blood vessels near the skin.

Q6.

- (a) About 71% of students correctly selected the pituitary gland as the hormone-producing gland for the control of water loss from the body.
- (b) Around 85% of students knew that the hormone that helps the kidneys control water loss was called ADH.
- (c) How the hormone stimulated the kidneys to reduce water loss was fully understood by about 3% of students and less than a half gained any credit in this question.

The scenario was a man walking in a desert without any drinking water, hence he would need to conserve water. Thus, his blood would have become more concentrated which would have stimulated ADH release by the pituitary to increase the permeability of the walls of the kidney tubules so that more water would have been reabsorbed. Some students referred to 'how much' water was in the blood rather than mentioning concentration (or water potential) or wrote about the 'body' having a reduced water content, rather than the blood.

Some students thought that the rate of 'filtration' of the blood would have been reduced while others thought that less water would be 'absorbed' from the blood into the kidney tubules. It was evident that many students had limited knowledge of how the kidneys work in this challenging question.

- (d) Explanations of two reasons why a kidney transplant was preferable to treatment by dialysis were required by this question, with the proviso that cost and convenience should not be included. This meant that biological explanations had to be given. Many students still answered just in terms of cost and convenience.

Higher-attaining students understood that concentrations of urea and salts, and the volume of water, would increase between dialysis sessions and hence had the potential for causing damage to body cells. A second reason was that the skin would be repeatedly punctured with needles with dialysis treatment, thus increasing the

chance of infection or blood clots. A very small minority of students scored three or four marks in this question.

Q7.

- (a) A large proportion of students were able to correctly identify 'auxin'. Examiners did not report any other plant hormones being given, although a number of mammalian hormones were suggested.
- (b) (i) Some students had revised this part of the specification well and gave all four marking points thus gaining the three marks. The last point on the mark scheme was the most commonly attempted, although many fell short because they simply stated 'no variation in offspring', rather than no *genetic* variation or 'identical offspring', rather than *genetically* identical offspring; 'produces clones' was an easier way of gaining this mark and was seen in a relatively high proportion of responses. It was clear that some students had failed to recognise the number of lines available and the '3 mark' tariff as an indication of the extent and detail required in the answer, offering just one or two ideas.
- (ii) It was surprising how many students were unaware that cuttings, like tissue culture, produce genetically identical offspring. It was hoped that students would use the diagram to infer (if they did not already know) that tissue culture is able to produce many more offspring per parent plant than taking cuttings. There were several further misconceptions, such as that 'taking a cutting would kill the plant' or that using tissue culture would 'cause no damage', despite the diagram showing the removal of a leaf. Many thought it an advantage that 'only tissue culture could be done all the year round', that 'tissue culture is more successful', that 'tissue culture is cheaper / quicker' or that 'tissue culture takes up less space'.

Q8.

This question was about DNA. (c) is a five-step calculation, which differentiated very well between students. Most were able to multiply the number of nucleotides in the cell (given as 1.2×10^{10}) by the length of one pair of nucleotides (given as 0.34 nm) – although some divided these. The main errors came from attempts to convert nanometres to metres (as required by the question) and in not realising that the answer had to be divided by 2 as the nucleotides came in pairs. Many students wrote out long strings of zeros in their calculations and consequently made transfer errors from one line to the next in their calculation; others did not know how many nanometres there are in a metre and used factors of a thousand or a million to interconvert the units (this being covered by the 'Working Scientifically' section of the Specification, part 4, WS4.4 and 4.5). An eighth of students scored all 5 marks, although nearly 60% scored 3 marks and above. It was also evident that some students had little concept of the sizes of molecules and cells and, although the correct answer was 2.04 m of DNA per cell, the most extreme was 1.76×10^{17} m.

Q9.

- (a) Roughly half of the students gained two marks, almost all of whom gained the 'religious' mark. Many had the idea of insufficient evidence or proof – although a few said 'no proof' which was incorrect. Far fewer students gave the answer about genetics. There were answers where students talked about people not wanting to believe that we were descended from apes or simple life forms. These responses were not creditworthy.
- (b) This four mark question on natural selection gave a wide spread of marks and less

than one-third of students gained three or more marks. Students seemed to find expressing their ideas in this area of the specification difficult and wrote too generally about variation and inheritance. Specifically students should have described alleles or genes as being key to finch survival and that these are passed on to offspring. Too many students described the benefit and inheritance of characteristics. Some students expressed the idea that mutations were caused by the environment, or that the finches actively adapted themselves to new circumstances, both of which were incorrect.

- (c) (i) Overall, interpretation of the evolutionary tree was not as straightforward for students as anticipated. Nearly three-quarters were able to correctly interpret the evolutionary tree showing the vegetarian finch as the least closely related to all other finches.
- (ii) Just under half of the students were able to recognize **R** as the correct branching point as the most recent common ancestor of all tree finches (small, medium and large).
- (iii) Two-thirds could identify the two finches with the most recent common ancestor.

Q10.

This question was about a marine food web and legislation to ensure sustainable fishing of herring in the North Sea. In (a), almost two-thirds of students scored 1 mark for stating either that light was the source of energy for the algae or that the algae used photosynthesis. Many stated that the energy came 'from the Sun' which did not distinguish between light and other forms of solar energy. Incorrect answers included carbon dioxide, water, mineral ions and even from eating other organisms. 1% of answers mentioned that chlorophyll or chloroplasts absorbed the light energy.

Most students were able to identify a primary consumer and the producer in the food web in (b) and (c), respectively. A common incorrect answer for the primary consumer was the 'human', presumably confusing primary with top. Similarly, around three-quarters of students were able to assign 5 organisms from the food web to a food chain ending in the human.

In (e), although one reason for the lower biomass of the mackerel than that of the combined biomass of the krill and squid was given as non-digestibility of parts of these animals, many students suggested 'lost in faeces' as an additional reason. Around one-third of students gained some credit for their answers by suggesting losses due to respiration or excretion or, alternatively, that some parts of the krill and squid were not even eaten or they were eaten by other animals.

(f) was a 4-mark calculation of percentage decrease using figures read from a graph. Fewer than half of students were completely successful. Errors included the use of an incorrect starting point – the first and highest value on the graph for the year 1950 was quite a common error, or reading the value for 1977 as '0.2' or '0.05' instead of 0.1. Many students did not get credit for not rounding their answer to the nearest whole number as instructed in the question. Some calculated a percentage reduction in excess of 100%, the highest such value being '2300%'. Around one-sixth of students scored no marks.

(g) was a 6-mark extended response question requiring the evaluation of the data from the graph in relation to various acts of legislation introduced at different times. Many students found this very difficult with more than two-thirds attaining no higher than Level 1. The question instructed students to use data from the graph and information from the diagram showing the relationship between mesh size of fishing nets and the sizes of

herring of different ages. Many students did not cite any data, or did not consider all four pieces of legislation and their subsequent effects on herring biomass. It was rare to read any negative points – the most common being the decrease in biomass at certain times despite the legislation that had been introduced – and hardly any students thinking that causes in addition to the given legislation might have been responsible for the changes in biomass or that, since the acts of legislation overlapped in their application, it was hard to ascertain the effect of each. Very few students attempted to make a judgement on the basis of the points they had made and no-one scored all 6 marks.