AQA GCSE BIOLOGY (HIGHER) · 8461

BIOLOGY



MARK SCHEME

4.6.2 VARIATION AND EVOLUTION (PACK 5)

SCORE	PERCENTAGE
/246	%

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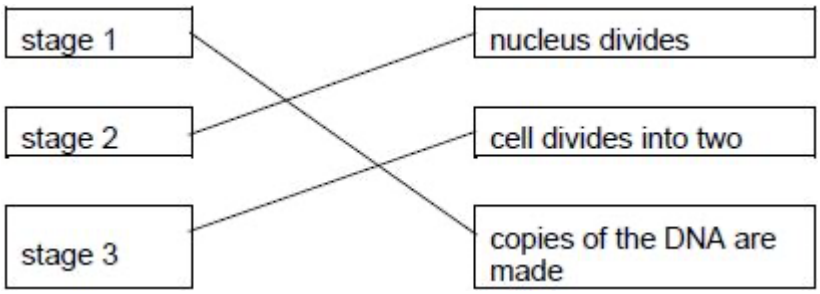
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Q1.

(a)



*allow **1** mark for 1 or 2 correct*

credit can be given where students have matched the boxes correctly, for example numbering the boxes

2

(b) 6 picograms

1

(c) meristem cells in plants can differentiate throughout the life of the plant

1

(d) any **two** from:

- may cure / treat diseases
  or
  cure medical conditions
  or
  produce replacement cells / tissues / organs

  allow example e.g. diabetes / paralysis
  allow cells can be stored for future use
  ignore used in medical treatments
  ignore patient makes / grows cells / tissues / organs

- cells unlikely to be **rejected** by patient)

  ignore same genetic information

- cells / tissues of any type can be produced

  ignore differentiated into most types of cells

- many cells produced

- cells produced could be used for research

- would reduce waiting time for transplants

2

ignore references to cost
ignore all reference to producing babies / IVF

(e) any **two** from:

- (potential) life is killed / destroyed

  allow embryo is killed

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ignore embryo is destroyed
ignore embryo is a life / becomes a baby

- shortage of donors / eggs
- egg donation / collection has risks
- do not yet know risks / side effects of the procedure on the patient

  ignore long term effects are not well understood
  allow may cause tumours / cancer
- may transfer (viral) infection
- poor success rate

  allow in terms of viable egg / embryo / cell / tissue / organ production

2

ignore references to cost
ignore unethical unqualified
Ignore reference to religion / beliefs

[8]

Q2.

(a) any **one** from:

- meristem(s)
- **tip** of shoot

  ignore stem and embryo
- **tip** of root

1

(b) to produce large numbers of identical plants

1

(c) 6×10^{-12} (grams)

1

(d) $\frac{28}{360} \times 15$

or

1.166666666(r)

allow $\frac{7}{90} \times 15$

allow correct rounding
allow 1.16

1

1.17 (hours)

*allow **1** mark for 1 hour 10 minutes **or** 1 and 1/6 hours **or** 70 minutes **only** if units given*

1

*an answer of 1.17 (hours) scores **2** marks*

(e) **stage 1**

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cell growth
or
increase in number of organelles

allow increase in named organelle e.g. ribosomes / mitochondria

1

DNA replicates*
or
two copies of each chromosome form*

**allow DNA duplicates / doubles*
**ignore genetic information replicates*
if this statement given as part of stage 2 allow **max 4 marks*

1

stage 2 / mitosis
one set of chromosomes moves to each end of cell

allow chromosomes separate or are pulled apart

1

nucleus divides

allow nucleus splits into two

1

stage 3
cytoplasm / cell membrane divides to form two (genetically) identical cells

allow cytokinesis

1

***max 4** if correct sequence but no reference to stage numbers*

***max 4** marks if no stage numbers given*
ignore names of phases

marks can be awarded for labelled diagrams

(f) any **two** from:

advantages:

- may be used to cure / treat (current / future) diseases
  or
  cure medical conditions
  or
  produce replacement cells / tissues / organs

  allow example e.g. diabetes / paralysis
  ignore used for medical treatments

- cells / tissues of any type could be produced

  allow cells differentiate into many types

- cells / tissues of any type could be produced

  ignore identical cells are produced unqualified

- many cells produced
- cells produced could be used for research
- would reduce waiting time for organ transplants

2

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any **two** from:

ignore references to cost
ignore unethical unqualified
ignore references to religion / beliefs

disadvantages:

- potential life is killed / destroyed

  allow embryo is destroyed
  ignore cells destroyed or wasted

- shortage of donors / eggs
- egg donation / collection has risks
- do not yet know risks /side effects of the procedure on the patient

  allow may cause tumours / cancer

- may transfer (viral) infection
- poor success rate to produce viable eggs / embryo

2

ignore references to cost

[14]

Q3.

(a)

	Genes	Environment	Both	
Brown…	✓			**1**
Light…			✓	**1**
Short…		✓		**1**

(b) bb

1

(c) brown

*allow light brown **or** dark brown*

1

(d) (using bb for mother's gametes)

correct combination in all four boxes, e.g.

	(b)	*(b)*
(B)	Bb	Bb
(b)	bb	bb

allow any combination of mother's gametes as mark is for filling in boxes correctly

1

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(e) 50%, 0.5, ½

*the award of this mark is consequential to the answer in part **(d)***

ignore ratios

1

(f) phenotype

1

(g) almost certainly have no effect

1

[9]

Q4.

(a) (the scientists)

chose / used (traditional varieties of) rice plants with short stems and rice plants with large grains
or
chose rice plants with short stems and large grains.

1

(cross) bred the rice plants

allow cross pollinated the rice plants

1

(from the offspring) chose the plants with best / desired characteristics
or
chose plants with short(est) stems and big(gest) grains

1

bred repeatedly until all plants had desired characteristics
or
bred repeatedly until they bred true
or
bred repeatedly until they produced IR8

1

(b) agree (**max 3** marks)

- resistance to disease / pests / pathogens
  so higher yield
- resistant to herbicides
  so less competition for (sun)light / water / minerals / ions (from weeds)
- larger / more grains per plant or higher yield
  so more food for people or more income for farmers
- better nutritional content (vitamins / protein / low GI index)
  so will improve health

  allow improved survival in harsh conditions so can be grown in wider area

disagree (**max 3** marks)

- may affect wild plants (if genes transfer)
  so making them herbicide resistant
- use of herbicides may reduce biodiversity

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because other plants are killed

- traditional varieties no longer grown
  so reduction in biodiversity
- may affect health of people who eat the rice
  because not enough research done yet

allow (GM) seeds are expensive for farmers because they have to buy new seeds every year ***or*** *because farmers have to buy specific herbicide*

if no explanations allow ***1*** *mark for one agree reason* ***and*** *one disagree reason*

4

each reason must be explained to gain credit

[8]

Q5.

(a) *Triticum spelta*

1

(b) (pig) 2
and
(wheat) 4

both needed for ***1*** *mark*

1

(c) pig

allow ecf from part ***(b)***

1

(d) only a small sample (of DNA)

ignore references to structure and appearance

1

(e) any **three** from:

- (farmer) selects heaviest / largest chickens / parents

  allow (farmer) selects chickens with the best / most meat

- (cross) breeds these chickens together
- (farmer) selects the heaviest / largest offspring (to breed)
- repeats this many times (until you have the desired chicken)

3

(f) high(er) income / profit

1

(g) the chickens may weigh too much to be able to stand

1

[9]

Q6.

(a) ionising radiation

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

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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 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]

Q7.

(a) antigen (in vaccine) stimulates white blood cells

allow leucocytes / lymphocytes
*do **not** accept phagocytes*

1

to produce specific antibodies

1

(so) if the person ingests salmonella

allow idea of secondary exposure

1

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(so on secondary exposure to antigen / bacteria white blood cells) produce the (correct) antibodies faster or in larger quantities

allow idea of memory cells produced

1

(so) toxins (produced by the bacteria) don't reach high enough concentrations / levels (to make the person have symptoms)

1

(b) (random) mutations (in the population of bacteria)

*do **not** accept bacteria deliberately mutate*

1

(so that) resistant salmonella / bacteria are not killed by the antibiotic / nalidixic acid

allow those bacteria without the mutation are killed by antibiotic / nalidixic acid
*do **not** accept immune bacteria*

1

(so) these bacteria reproduce to pass on the gene for resistance (to their offspring)

1

[8]

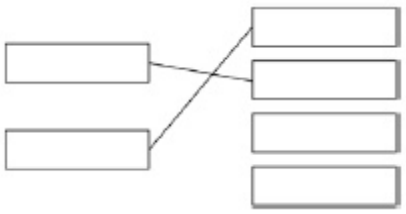
Q8.

(a) chlorophyll

ignore chloroplast

1

(b)



*do **not** accept more than one line from each method*

1
1

(c) black spot / fungus has evolved / mutated to be resistant (to the fungicide)

1

(d) (6200 – (3300 + 1750) =) 1150 (Mg)

1

(e) 1150 × 1000 = 1150000 (kg)

1

(f) power stations use less coal

1

(g) less sulfur dioxide from all sources / total

1

(h) any **one** from:

- data only shown from 1970

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- fewer power stations (therefore fewer emissions)

1

(i) less sulfur dioxide

or

less acid rain

1

(that) destroyed fungus / spores

1

[11]

Q9.

(a) *Oryx*

1

(b) any **two** from:
- white / light colour (to reduce thermal gain)
- short fur (to reduce thermal insulation)
- little body fat
- large hooves (to walk in sand)
- camouflaged (against sand by light colour)

2

(c) any **three** from:
- variation in population
- animals with longest horns more likely to survive / reproduce
- passing on alleles for long horns
- repeated over many generations

3

(d) breeding programme

1

(e) any **one** from:
- to increase genetic diversity

  *do **not** accept to increase biodiversity*
- species may be unable to cope if environment changes
- all susceptible to same diseases / inbreeding problems

  allow otherwise all offspring would have similar genes or a decreased gene pool
- prevents inbreeding

1

[8]

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) *Bubo*

1

(b) (individuals of one species) can interbreed to produce fertile offspring

allow converse if clearly stated

1

(c) owls have become geographically isolated from each other

or

arctic ice / temperature in different areas have separated the original population

1

northern area is much colder and has snow / ice

allow examples – biotic (eg food / predators) or abiotic

1

genetic variation / mutations in each population

allow gene(s) / mutation

1

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(natural selection occurs so) better adapted survive to reproduce

1

passing on their favourable allele(s)

1

until individuals of the two populations can no longer interbreed (to produce fertile offspring)

1

[8]

Q12.

(a) **only genetic causes**

any **one** from:

- pattern of scales
- number of fins
- eye colour

1

only environmental causes:

- scar

1

both genetic and environmental causes:

- length

1

(b)

	B	**b**
b		bb
b	Bb	bb

*allow 2 correct for **1** mark*

2

(c) any bb circled

1

(d) 0.5

*allow ecf from **04.2***

1

(e) (260 000 / 2 =) 130 000

*allow ecf from **04.4***

1

(f) mutation

allow change in diet / hormones / DNA

1

[9]

Q13.

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(a) wolves

1

(b) moose and wolves are on different scales

1

(c) wolf population has increased so more moose are eaten

*do **not** accept there are more wolves than moose*

1

(d) any **two** from:

- (other) predators
  allow correct examples
  allow 'humans hunting moose'
- (new) pathogens
  allow diseases
- competition

2

(e) any **four** from:

- variation (within species) of antler size
  allow description relating to antlers
- (caused by) different genes
- as a result of sexual reproduction / process of meiosis / mutation
- (phenotype) most suited to environment most likely to survive and breed
  ignore natural selection unqualified
- genes for large antlers (more likely to be) passed on to next generation

4

reference to mate selection
or
fighting
or
gaining territory
or
competition for mates
or
avoiding predation

1

[10]

Q14.

(a) a change in the DNA / gene

1

(b) produces a different protein / enzyme that is responsible for colour

1

(c) parents genotype both Bb

allow correctly derived gametes

1

offspring genotypes correctly derived

1

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bb identified as blue

allow ring around bb only

1

65 000

allow ecf or 260 000 × 0.25

1

6.5×10^4

1

(d) cross with **bb** / blue carp

*allow annotated Punnett square diagram(s) of cross with **bb** carp*

1

if any offspring are blue, the parent was **Bb** / heterozygous

allow converse

1

*allow cross with known **Bb** carp*

*if any offspring are blue, other parent was **Bb** / heterozygous*

[9]

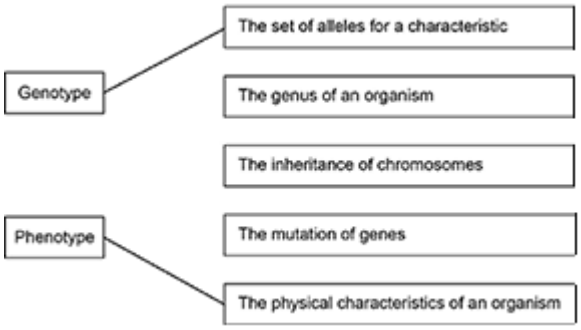
Q15.

(a)

Characteristic	Environmental	Genetic	Both
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	4

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generations	
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

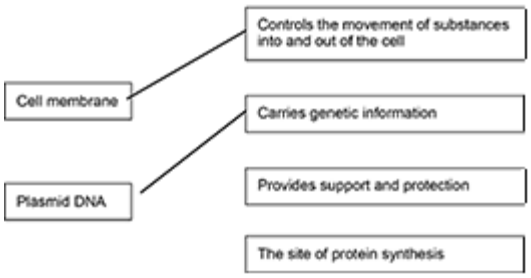
less income from sale of (milk and meat) products

1

[11]

Q16.

(a)



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

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(e) **E**

1

B

1

D

1

[9]

Q17.

(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

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

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allow less variation in cotton plant population

max. 4

[12]

Q89.

(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]

Q90.

(a) (i) egg (cell)
accept ovum
allow ova
ignore gamete

1

(ii) gamete

1

sexual reproduction

1

(b) (i) *Labrador father*
any **one** from:
- (fur) colour
- (shape of) nose / face / head.
  allow (shape of) eyes
  *do **not** allow references to ears / tail*

1

(ii) *Poodle mother*
any **one** from:

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- curly fur
- furry legs
- (shape of) tail
- (shape of) legs
- (shape of) ears.

allow same body shape

1

[5]

Q91.

any **four** from:

- mutation (produces striped fur)

  *do **not** allow intention to mutate*
- there is variation in fur pattern / colour
- camouflaged / striped animals (more likely to) survive **or** catch food / prey

  *do **not** allow intention to adapt / become camouflaged*

  allow stripes give a <u>selective advantage</u>

  ignore natural selection unqualified
- (survivors) reproduce / breed

  allow mate
- gene / allele / mutation passed on to offspring / next generation.

  *max **3** marks if no reference to tiger / stripes*

  *allow characteristic / trait passed on **or** inherited by next generation*

4

[4]

Q92.

(a) genetic engineering

allow genetic modification

ignore GE or GM

1

(b) any **three** from:

(advantages):

*maximum **two** advantages*

- increases yield
- longer growing period
- (grower) can make more money
- can produce plants with desired characteristics.

  allow example eg develop plants with pest resistance

(disadvantages):

*maximum **two** disadvantages*

- gene could be passed onto wild plants
- effects on ecosystem / food chain

  allow example, eg bee population
- adverse effects on gene pool

  allow example eg less genetic variation, ignore clones
- possible adverse effects on human health.

  ignore damage to soil

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ignore references to cost
ignore references to ethical issues

3

[4]

Q93.

(a) sexual reproduction

1

(each embryo produced from) different sperm and egg
or
from different gametes

1

(so have) different genetic information
allow (so have) different genes / DNA / chromosomes / alleles

1

(b) any **one** from:

- *idea* that not all individuals would be killed by a change in the environment eg disease
  allow species less likely to die out
- more variation in the population increases chance of survival.
  allow idea of restricted gene pool makes species more vulnerable to diseases

1

[4]

Q94.

(a) categoric
extra words circled negates mark

1

(b) (i) 11

1

(ii) 25
*allow ecf from part **(i)***
ie (i) +14

1

(iii) any **one** from:

- blue is the most common eye colour
- green is the least common eye colour

ignore figures
allow mode / modal
allow more have blue eyes

1

(c) (i) a gene

1

(ii) sex cells

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1

[6]

Q95.

variation

must be in correct order

1

natural selection

1

(sexual) reproduction

1

[3]

Q96.

(a) different numbers of people were surveyed (in each country)

allow difference in number shown using quoted figures

1

(b) (i) 62.77(%)

allow 62.8 or 62.771 or 63

*allow **1** mark only for 62.7 / 62.78*

*allow **1** mark for (145 / 231) x 100*

or

100 – (9.52 + 8.23 + 19.48)

or 100 – 37.23

2

(ii) any **one** from:

- blue eye colour is less common in Italy than in other countries
- brown eye colour is more common in Italy than in other countries
- green eye colour is the least common in all the countries
- *Ireland has* the highest percentage of blue and / or green eyes

answers should compare the different countries

allow ecf from (i)

1

(iii) any **one** from:

- survey more people

  ignore survey same number of people from each country

  ignore survey more countries
- record the other eye colours separately (rather than group them together)

  allow carry out a random survey

1

[5]

Q97.

(a) the soil bacterium

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1

an enzyme

1

cotton plant

1

(b) **economic advantage**

any **one** from:

- (higher yield) so can <u>sell more</u>
  allow farmer makes more <u>money</u>

1

- <u>less spent</u> (on pesticides)

1

environmental disadvantages

any **two** from:

- may kill useful / other insects
- may cause wild plants to produce the poison
  allow example eg bees
- may affect ecosystem / food chain
  ignore environment

2

[6]

Q98.

(a) (i) any **two** from:

- food
- mates
- territory / space
  ignore habitat, land
  ignore water

2

(ii) any **two** adaptations with explanations from:
__1__ mark for adaptation
__1__ mark for correct explanation
ignore prevents / no heat loss

- <u>long / thick</u> hair or wool
  allow a lot of
  allow <u>long / thick / a lot of</u> fur
  ignore fat although reason can still be credited
  ignore coat

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(for) insulation

allow (to) trap energy / heat / air

allow to keep warm

- small surface area : volume ratio

  ignore large body mass although reason can still be credited

(therefore) lose less energy

allow (to) keep warm

allow heat for energy

ignore (to) insulate

- small ears / tail

  allow (to) keep warm

  allow heat for energy

(therefore) lose less energy

ignore (to) insulate

*only allow big tusks if qualified eg digging through <u>snow / ice</u> for(food) for **2** marks*

ignore references to predators and prey

*only allow big feet if qualified eg for walking on <u>snow / ice</u> for **2** marks*

4

(b) (i) natural selection

1

(ii) if some animals grew a long nose / acquired characteristic (during their lifetime)

ignore answers about Darwin's theory

allow trunk for nose

allow used trunk / nose / it a lot

allow stretched trunk / nose / it

1

their offspring would inherit / also have a long nose

*do **not** accept references to genes / DNA / chromosomes*

1

[9]

Q99.

(a) gene / DNA for poison

allow genetic information for DNA

ignore characteristic

1

is cut from bacterial DNA / chromosome

accept Bacillus thuringiensis / Bt accept plasmid

1

<u>using enzyme(s)</u>

1

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and transferred to cotton plant <u>cells / DNA / chromosome</u>

allow <u>genes</u>

ignore plasmid

1

(b) any **two** from:

- gene (for poison) could be passed onto wild plants

  allow named insect eg bees

- toxin may kill other / useful insects

- concern about effects on ecosystem / food chain

  allow example eg less variation ignore clones

- concern about adverse effects on gene pool of cotton plants

  ignore references to humans or quality of cotton

  ignore damage soil

  ignore diseases

2

[6]

Q100.

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

1

(ii) orangutans

1

(b) natural selection

ignore survival of the fittest

1

[3]

Q101.

(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]

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Q102.

(a) A – nucleus

1

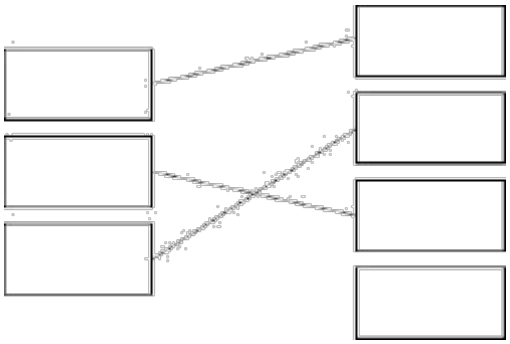
B – chromosome

1

C – gene

1

(b)



extra line from statement cancels the mark

3

[6]

Q103.

variation exists in the population / a mutation occurred

ignore adaptation

1

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

ignore immune

1

these survive and breed

or

pass on gene / allele / DNA (for resistance) to next generation

ignore characteristic / chromosome

1

[3]

Q104.

(a) idea of survival of the fittest

1

(b) (the hypothesis should be rejected because)

- having a long neck for feeding would not be an advantage for feeding in the dry season

1

- and would not be an advantage most of the time for females

1

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- therefore the feature would be unlikely to be selected for

1

(c) - the feature that could explain the evolution of long neck is that males with longer necks are more likely to win fights with other males

1

- the winning males are more likely to mate with females

1

- this means the allele for long neck is more likely to be passed to the next generation

1

[7]

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Q1.

(a) 33% of students achieved both marks for knowing the sequence of events in the cell cycle. 51% of students achieved one mark, which was usually for realising that in the final stage the cell divides into two.

(b) The majority of students thought the mass of DNA in the new cells produced by mitosis would be half of that in the cell at the start of the cell cycle. 30% of students said the mass would be the same.

(c) The majority of students incorrectly thought that animal stem cells divide by meiosis. 31% of students correctly said that meristem cells in plants can differentiate throughout the life of the plant.

(d) The majority of students copied sentences from the information given in the question. There had to be some added value in order to be awarded marks. A fifth of students scored 1 mark. This was often for saying therapeutic cloning would produce replacement cells or could treat some diseases. Very few gained 2 marks. A lot of students confused therapeutic cloning with IVF treatment.

(e) The majority of students copied the sentence about the embryo being destroyed, which had no added value, and so it was ignored. Those who rephrased this to say a life is killed or destroyed were awarded a mark. Another common correct response was that the procedure may not work.

Q2.

(a) 26% of students achieved the mark for saying stem cells are found in meristems or the tips of roots or shoots. A variety of incorrect organs or tissues were named, the most common being root, stem, xylem and embryo. Some students named parts of a cell, such as chloroplast or cytoplasm.

(b) 49% of students correctly identified producing a large number of identical plants as one economic use of plant stem cells. There was some confusion of genetic engineering and stem cell technology, as most other students selected to create genetically modified crops as their answer.

(c) This question was targeted at grades 8−9. 4% of students correctly converted 6 picograms into grams and wrote the answer in standard form.

Some students did not understand the term standard form and gave a number written in decimal form. This value was usually an incorrect conversion of picograms to grams. Common incorrect attempts at writing the value in standard form included 6×10^{-6} or 6×10^{-9}

(d) 15% of students achieved both marks for calculating the number of hours the cell spent in mitosis and giving the answer to three significant figures. 20% of students achieved one mark because they rounded the number incorrectly or gave their answer in hours and minutes. Many students referred to both 28 and 15 but used an incorrect calculation or did not realise there are 360° in a circle.

(e) 14% of students achieved more than two marks. The majority of students gained a mark for stating that the cell would grow during stage 1, or two copies of each chromosome form. The latter of these events was often included in stage 2, rather

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than stage 1. This error, or if stage numbers were omitted, limited the response to a maximum of four marks.

Some very good descriptions of mitosis, including spindle formation, were seen. However, a lot of students did not mention the nucleus dividing. A few students gained the final mark for saying cytokinesis occurred in stage 3. Few gave the full description of the cytoplasm or membrane dividing to form two identical cells.

42% of students did not achieve any marks. This was usually because they described the process of IVF. Some confused the cell cycle with meiosis and fertilisation.

(f) 31% of students achieved two or more marks.

Marks were generally awarded for advantages, rather than disadvantages. Common correct advantages given included:

- how stem cells can be used in patients
- diseases stem cells can be used to treat, for example paralysis
- that the cells would not be rejected by patients.

The most common disadvantage mentioned was that an embryo or potential life was destroyed. Saying the cells were wasted was insufficient.

A lot of students confused the process with that of IVF.

Q3.

(a) Students were asked for the cause of three types of variation. 58% of students gave all three correctly. Many identified eye colour but less were able to correctly identify skin colour and short hair.

(b) Students were generally good at identifying the alleles for blue eyes with 82% answering correctly.

(c) 78% of students got the eye colour of the man when given the alleles. ‘Green eyes’ was also seen a fair number of times even though only brown and blue had been mentioned in the question stem.

(d) 78% of students were able to complete the Punnett square correctly. A very small number appeared to be confused about inserting the alleles for the woman and hence could not gain credit.

A large number of students used Bb or BB as their female’s gametes and gained credit for the correct derivation.

(e) When the Punnett square was completed correctly using bb, the student generally also gained this mark. However, where the student had used BB or Bb then the percentage quoted was usually incorrect.

Many students gave their response in the form of a ratio; often 2/4 was encountered, rather than 1/2. Students need to understand the difference between probability and ratios.

(f) The most common misconception for this question was that genotype, rather than phenotype, was the scientific term used for the child’s eye colour. 23% of students

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answered correctly.

(g) The effect of a mutation as usually having no effect was not a common response from students (14%). Most responses were ‘definitely change appearance’ or ‘probably cause a disease’.

Q4.

(a) The basic principle behind selective breeding was understood by a good number of students with 49% credited with at least one mark. However, they missed marks by not being precise enough in relating their answer to the particular context of this question. Many referred to ‘a bigger yield’ or the general ‘desired characteristics’ instead of short stems and large grains.

The question was often misread as a genetic modification (GM) question. Students who followed this route seldom achieved any marks. There were a lot of answers in terms of GM, cutting out enzymes, injecting genes, asexual reproduction and cloning. A large number wrote about breeding the plants together using asexual reproduction and generally showed little understanding of how asexual and sexual reproduction are different. Often these students would go on to talk about transfer of pollen being a part of the asexual process.

Marking points two and three were most often given. However, some students went on to incorrectly describe breeding as adding pollen to seeds. The most common error for marking point three was to breed all the offspring together rather than choosing the ones with short stems and large rice grains. If students answered a generic question instead of this one about IR8 rice they were still able to achieve a maximum of three marks.

In marking point four many students demonstrated an understanding of continuing to breed, but only a minority obtained the mark by also referring to an end point. ‘Bred true’ was not seen but ‘until IR8 is produced’ or ‘until all plants have this characteristic’ was noted. 3% of students achieved all four marks.

(b) This high demand question was not well answered due to lack of biological detail in explanations. 4% of students achieved two or more marks. A great many students only provided half of any mark point. The compensation mark was awarded a few times, but was often missed because the 'for' response gave only the explanation, not the reason. Many students did not give explanations. Answers only listing statements or explanations tended to be weak suggesting that students were not as strong with regards to the issues surrounding GM.

A typical answer gaining no marks was ‘agree as can provide enough food to feed the population so less people are starving in India but disagree because it uses chemicals’.

Many students made references to unnatural, going against nature, against god, dangerous due to the use of chemicals, against religion, unethical, scientists playing god or the idea that an embryo is a potential life which is killed. Other ideas put forward which did not gain credit were rice producing methane which affects global warming, inbreeding causing diseases to spread so if one plant gets it they all will die and vague references to biodiversity.

‘Superweeds’ were mentioned occasionally, which if correctly described with reference to transfer of herbicide resistant genes a mark was achieved. Those students who referred to the concern about the effect on people’s health rarely gained the mark because they did not talk about ‘not enough research having been

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done yet'.

Q5.

(a) The use of the binomial naming system did not appear to be well known to students. 23% of students were able to use the data in the table to give a correct answer.

(b) This exercise in observation and interpretation was generally well done with 57% of students achieving the mark.

(c) Even those students who did not successfully answer part **(b)** used their own knowledge to suggest that the pig was most closely related to humans. Some students gained credit by giving 'chicken' if their number in the previous question for pig and wheat were above 3. 81% of students achieved this mark.

(d) Students found this tough with 2% achieving the mark. 19% of students made no attempt to answer. The main response seen was 'pigs are not like humans'. Very few made the link between the lack of data and the validity of the conclusion.

(e) Some students did well with 19% achieving two or three marks. But the majority did not get past breeding the first selected chickens together. Students were vague in their descriptions of how the process continued from there. There was evidence of confusion with genetic modification and cloning.

(f) 32% of students were clear that this would generate more money or profit for the farmer. Many felt it would make it easier for him to obtain the chickens he wanted, implying that the farmer carried out the selective breeding himself.

(g) 57% of students identified the problem with overweight chickens.

Q6.

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

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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.

(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.

Q7.

(a) 68% of students were unable to achieve any marks in this question. Most students did not seem to be aware of:

- antigens on bacteria
- specific antibody production by lymphocytes
- rapid response by white blood cells on second exposure which prevents the production of sufficient bacterial toxins to cause illness.

Common misconceptions included:

- antibodies engulfing pathogens
- antigens (in common with enzymes) are not alive so cannot be killed
- antigens engulfing bacteria.

Many responses were not accurate and precise enough to gain credit. The body ‘making stuff to kill bacteria’ is not sufficient for ‘white blood cells produce specific antibodies against salmonella antigens’. And ‘the vaccine teaches the body to fight off disease’ without further amplification is not enough either.

(b) 74% of students were unable to achieve any marks in this question.

A creditworthy answer follows the sequence of:

- **random** mutation
- survival of the organism with mutation
- reproduction by survivors to pass on the resistance gene.

Students must take care not to imply that the mutation was a conscious act. ‘A mutation caused the bacteria to become resistant’, not, ‘the bacteria mutated to become resistant’.

Many students inaccurately wrote about bacteria becoming **immune** to antibiotics.

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Q89.

(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.

Q90.

(a) (i) Most students correctly named the cell as an egg, and a few said 'ovum'. Some said that the cell was a gamete, but this did not name the cell so was insufficient. Incorrect responses included ovary, uterus, embryo and sperm cell.

(ii) Most students gained at least 1 mark, usually for realising that the type of reproduction was sexual.

(b) (i) The most obvious similarity between the Labrador and the puppy was probably the fur colour, but students often selected more obscure characteristics such as shape of face, nose or eyes, all of which were credited. Quite a lot of students did not use the drawings to guide them and gave answers such as 'both are male', 'both are friendly', 'soft mouth for shooting'. These characteristics could not be seen on the drawings so were not credited.

(ii) As the Labrador and the poodle both have fur, 'fur' on its own could not gain credit as a characteristic common with the mother and not with the father. Some feature of the fur had to be stated, for example, 'curly fur'.

Q91.

Many students gave confused responses implying that the tiger intended to adapt in order to survive. Very few referred to variation in fur pattern within the population, although a few said that a mutation could have occurred to produce striped fur. Some wrote answers about the giraffe, which did not explain how the tiger evolved to have stripes. Quite a lot mentioned natural selection, but they had to explain what this meant in relation to the tiger in order to gain a mark.

Q92.

(a) Just under half of the students answered the question correctly giving 'genetic engineering' or 'genetic modification' as their response. Common incorrect terms included 'cloning', 'asexual reproduction', 'gene transplant' and 'genetic variation'.

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(b) The most common points that gained credit were related to an increase in yield and that the tomatoes could be poisonous if eaten. Students often said that the tomatoes could be grown in cold conditions but did not relate this to a longer growing period. Others did not understand that different genes affect different properties and thought that adding a gene from a fish would also alter the taste. Both advantages and disadvantages had to be given in order to gain full marks.

Q93.

(a) A surprising number of students did not mention that the wolf cubs were produced by sexual reproduction, although most students gained a mark for saying that the cubs would have different genes or chromosomes. The question referred to the biological parents, but many missed this and gave answers that related to a surrogate mother.

(b) Students who obtained the mark usually did so by explaining that it would be better to produce wolves that were different from each other because then there would be less chance of the population being wiped out by a disease.

Q94.

(a) Over three quarters of the students gained the mark for recognising that eye colour is a categoric variable. The most common distractor was control variable.

(b) (i) The majority of students correctly read the bar chart.

(ii) The majority of students answered this question correctly. A few errors in the addition of the correctly read numbers from the bar chart were seen, mainly resulting in an answer of 24 or 26. A few gave an answer of 12, and some who had incorrectly read the number of people with blue eyes in part (i), then correctly added this figure to 14 to gain this mark.

(c) The question was well answered with most students gaining the mark for saying that more people had blue eyes. Only a few didn't attempt to make a conclusion.

Q95.

Almost all students scored at least 1 mark, with well over half gaining full marks.

Q96.

(a) Less than a fifth of students gained this mark. There were many responses that stated that it was better to compare the results using the percentage of people with each eye colour rather than the number of people because it was more accurate, more precise or easier to understand smaller numbers. Others said it would be easier to plot a graph. All these were ignored. Only a few said that the number of people sampled, or the population sizes, were different in the different countries to gain the mark.

(b) (i) Just over half the students gained 2 marks for the correct answer. Others made mistakes such as incorrect rounding of the answer, 62.7 being a common error, or showing the correct working then making an error in the calculation, which only gained 1 mark.

Common incorrect answers were:

8.23 where students had added up the values for the brown eye colour

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(31.51 + 30.97 + 29.29 = 91.77) then taken it away from 100 (100 – 91.77 = 8.23)

29.29 where students had looked at Table 3 and found Ireland and Italy had the same number of brown eyes (145) and so then gave the same percentage for brown eyes as Ireland had.

29.29 where students had looked at Table 3 and found Ireland and Italy had the same number of brown eyes (145) and so then gave the same percentage for brown eyes as Ireland had.

29 where students had used the correct figures but incorrectly (231 – 145 = 86 86 / 3 = 29)

(ii) The question asked for a conclusion about the variation in eye colour between different countries, but many students just talked about one country. A lot of students answered in terms of the number of people in the countries, rather than the percentage of people, or how common a particular eye colour was in one country. Without knowing the total population of each country the number of people could not be compared.

(iii) Only a quarter of the students gained this mark, usually for saying survey more people. A few said specify what the other eye colours were, to gain the mark. Many students confused accuracy with fair testing and said the results would be more accurate if equal numbers of people had been surveyed. Other incorrect responses included sampling more countries, repeating the investigation and calculating a mean.

Q97.

(a) This question was well answered. Some students thought the gene coding for the poison was cut from the cotton plant, rather than the bacterium, and that it was done using scissors, rather than an enzyme.

(b) The first marking point required some reference to money, for example more cotton could be sold, or less money spent on pesticides. Simply saying there would be a higher yield of cotton, or less pesticide would need to be used was not enough to gain the mark. The environmental disadvantages were usually well expressed.

Q98.

(a) (i) Most students gave food and mates as their answers. Females or males were allowed for mates. Students who said habitat did not gain the third marking point as this is not competed for. Many gave water, which was ignored. Quite a lot of students wrote a list of answers, which sometimes led to a loss of a mark if one of the things listed was incorrect. It is better not to write a long list to avoid the negation of marks.

(ii) Two adaptations with correctly linked explanations were needed for full marks. They had to say the woolly mammoth had thick or long hair or wool for the first marking point, not just hair. A thick coat was ignored. The required explanation for this was for insulation, although to trap air or heat was allowed. Most students just said to keep warm, which was also allowed. Some students mentioned the small surface area to volume ratio reducing heat loss, but many got the ratio confused. Small ears reducing heat loss were mentioned quite often. If students talked about large feet or tusks they had to relate these to survival in the cold, as this is what the question asked for. Some students did

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not understand the term adaptation, and talked about the habitat or cold conditions. Some very vague explanations were seen, many repeated the question stating'….so helped it survive in the cold' or said'….. protected it from the cold'.

(b) (i) Some students answered this well. Several said'survival of the fittest', but the question asked for the name of the process, which is natural selection. Others demonstrated some knowledge of the process using terms like adaptation, variation, mutation and reproduction, but these were not enough for the mark.

(ii) Some students gained the marks for saying the elephant used its trunk a lot or stretched it during its lifetime, and this was passed on to the offspring. Many students rewrote the stem of the question and explained Darwin's theory of evolution, talking about those elephants with more useful characteristics surviving and passing on the gene. Along similar lines, others mentioned mutations or breeding. Some explained Lamarck's theory in terms of God. This area of the specification is not well understood.

Q99.

(a) Many students confused cloning and genetic engineering. They started with a plant that already produced the poison and cloned this, usually by tissue culture. The question asked how a cotton plant could be genetically modified to produce the poison. Some students gained a mark for mentioning the gene for the poison was needed, and others mentioned the use of enzymes. Generally responses were confused and it was not clear where the gene came from or into which part of a plant it was transferred. Many students talked about cuttings, or injecting the poison into a plant. Others put the poison into the soil for the plants to absorb.

(b) The most common correct responses were that other insects might be killed or that the food chain could be affected. The question should have cued students in to talking about effects on the environment, but many talked about the effect on humans if they ate the cotton plants, or made vague statements about it being unnatural or against God's will.

Q100.

(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.

Q101.

(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

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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.

Q102.

(a) This question was well answered with nucleus being the most common correct label. The most common error was to mix up chromosome and gene. ‘Gamete’ was sometimes incorrectly used to label the gene, but ‘characteristic’ was rarely used for any label.

(b) Once again, with linking boxes the most common error was to have extra lines drawn. Students should be encouraged to do these in pencil first so they can be erased. Quite a lot of responses had a characteristic linked to ‘affected by neither genes nor the environment’, suggesting a lack of understanding. However, most students gained at least one mark for this question.

Q103.

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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