Name: _____

Class: _____

Date: _____

Inheritance, Variation and Evolution part 3 AQA Triple Biology

Time: **85 minutes**

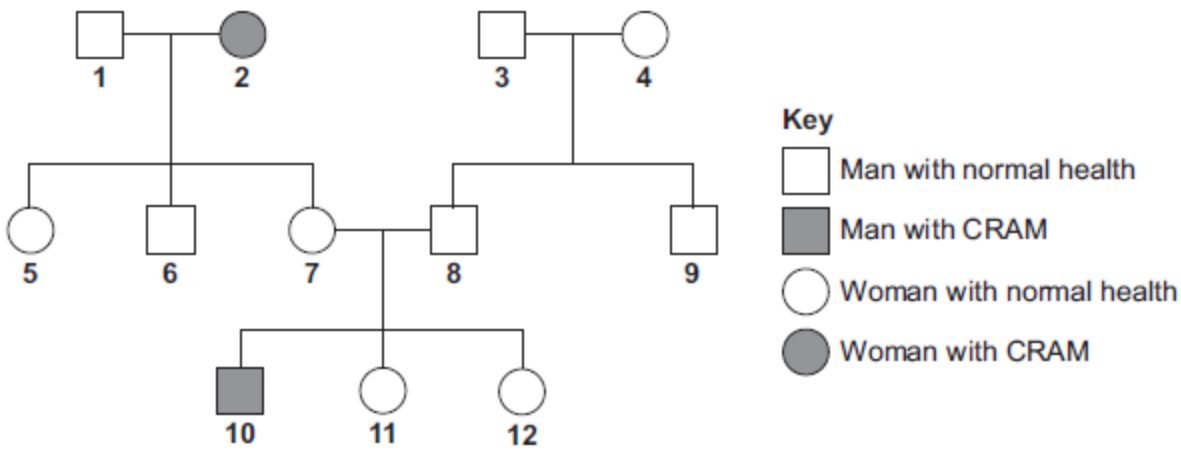
Marks: **85 marks**

Comments:

1. CRAM is an inherited condition which causes muscle breakdown.

The breakdown products enter the urine, making it dark-coloured.

The diagram below shows the inheritance of CRAM in one family.



CRAM is caused by a recessive allele, **n**.

The allele for normal health is **N**.

(a) (i) What is an **allele**?

_____

_____

(1)

(ii) What does **recessive** mean?

_____

_____

(1)

(iii) Give evidence from the diagram that CRAM is caused by a **recessive** allele.

_____

_____

(1)

(b) (i) Person **2** is homozygous for CRAM.

What does **homozygous** mean?

_____

_____

(1)

(ii) None of person **2**'s children have CRAM.

Explain why.

_____

_____

_____

(2)

(c) Persons **7** and **8** want to have another child.

(i) What is the probability that this child will have CRAM?

Draw a genetic diagram to explain your answer.

Probability = _____

(4)

(ii) To avoid having another child with CRAM, persons **7** and **8** may decide to use embryo screening.

Two ways of doing this are:

- PGD (pre-implantation genetic diagnosis)
- CVS (chorionic villus sampling).

PGD involves IVF (in vitro fertilisation) of a few eggs, then taking a cell from each embryo when it is 3 days old.

The image below shows how the cell is removed.

The DNA in the cell can then be tested. An unaffected embryo can be implanted in the woman's uterus. The possibility of a false positive result is around 1 in 6. The procedure costs about £6000. Affected embryos would be discarded. Extra unaffected embryos might be frozen and kept for later implantation. Alternatively, the extra embryos might be used in scientific research.

CVS involves taking a sample of blood from the placenta a few weeks into pregnancy. DNA from white blood cells can then be tested.
If an affected embryo is detected, the parents then have to decide whether to terminate the pregnancy or allow it to continue.

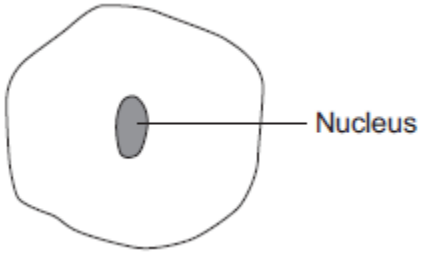
CVS has a 1 percent chance of giving an incorrect result and a 0.9 percent chance of causing a miscarriage. CVS costs about £600.

Evaluate the benefits of these two methods of embryo screening.
You should include a conclusion to your evaluation.

(5)

(Total 15 marks)

2. The diagram below shows a cell.



(a) Draw a ring around the correct answer to complete each sentence.

(i) In the nucleus of a cell, genes are part of

chromosomes.
membranes.
receptors.

(1)

(ii) Different genes control different

characteristics
gametes
nuclei

of an organism.

(1)

(iii) Studying the similarities and differences between organisms allows us to

classify
clone
grow

the organisms.

(1)

(b) Complete the following sentence.

Living things can be grouped into animals, microorganisms and _____ .

(1)

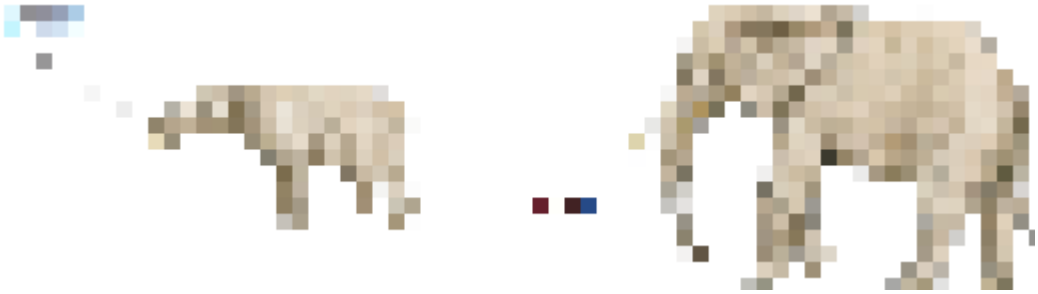
(Total 4 marks)

3. The image below shows:

- *Phiomia*, an ancestor of elephants
- a modern African elephant.

Phiomia lived about 35 million years ago.

Phiomia **African elephant**



Both *Phiomia* and the African elephant reach up into trees to get leaves.

In the 1800s, Darwin and Lamarck had different theories about how the long nose of *Phiomia* evolved into the trunk of the African elephant.

(a) (i) Use Darwin's theory of natural selection to explain how the elephant's trunk evolved.

(4)

(ii) Lamarck's theory is different from Darwin's theory.

Use Lamarck's theory to explain how the elephant's trunk evolved.

(2)

(b) (i) In the 1800s, many scientists could **not** decide whether Lamarck's theory or Darwin's theory was the right one.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(ii) Before the 1800s, many people had a different idea to explain where all the living things on Earth came from.

What idea was this?

_____

_____

(1)

(Total 9 marks)

4. The MMR vaccine is used to protect against measles.

(a) Apart from measles, which **two** other diseases does the MMR vaccine protect against?

_____ and _____

(1)

(b) Read the information.

> Measles is a dangerous disease caused by a virus.
> Normally, MMR vaccinations are given at 1 year old and again at 4 years old.
> Each vaccination is 90% effective in protecting against the measles virus.
>
> In April 2013, there were 630 cases of measles in children aged 4 and over in a small area of the UK. Of these cases, 504 children had not been vaccinated against MMR at all and only a few had been given a second vaccination.

(i) Calculate the percentage of the children who caught measles in April 2013 who had **not** been vaccinated against MMR.

_____

_____

_____

Percentage = _____

(2)

(ii) Suggest **one** advantage to the population as a whole of children having the second MMR vaccination.

_____

(1)

(c) (i) What does a vaccine contain?

_____

_____

(1)

(ii) Explain how a vaccination prevents infection.

_____

_____

_____

_____

_____

_____

_____

(3)

(d) (i) Antibiotics can only be used to treat some infections.

Explain why antibiotics **cannot** be used to treat measles.

_____

_____

_____

_____

(2)

(ii) Why do antibiotics become less useful at treating an infection if the antibiotic is overused?

_____

_____

(1)

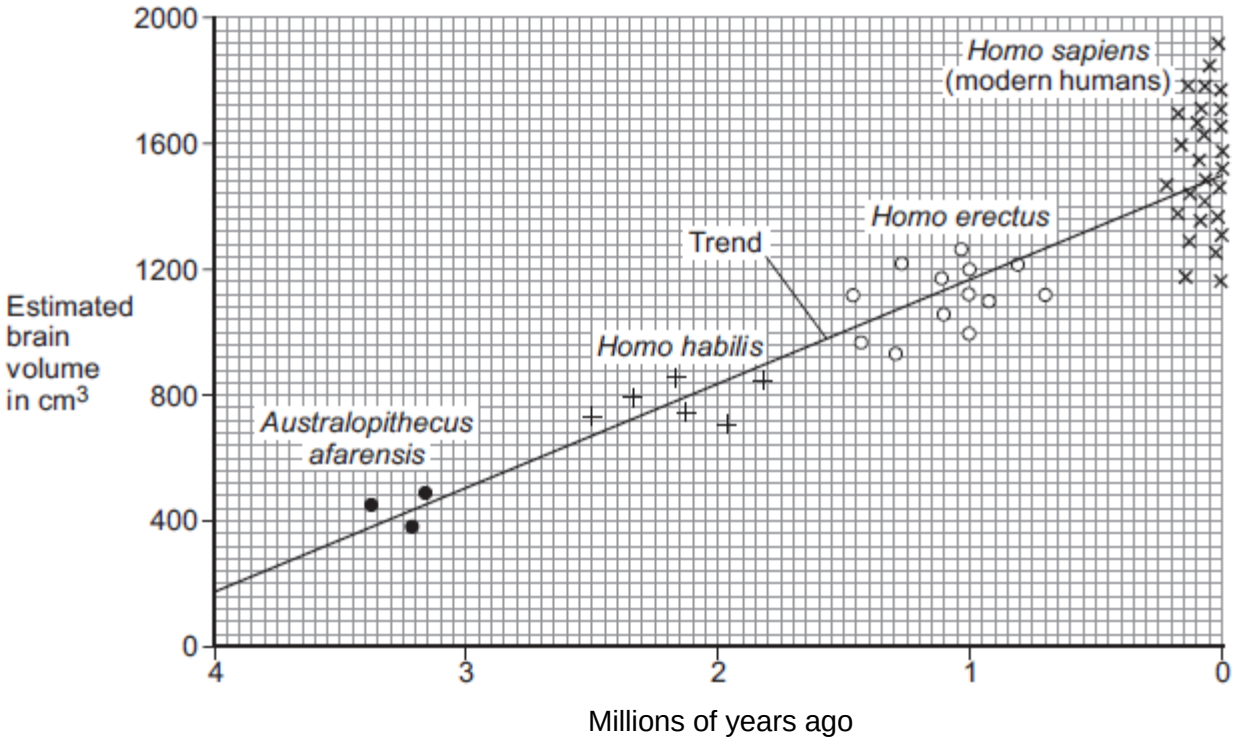
(Total 11 marks)

5. This question is about evolution in humans.

The graph shows:

- the estimated brain volume of different species of humans
- the time when the different species existed on Earth.

The data is plotted for modern humans (Homo sapiens) and for three types of extinct ancestors of humans.



Key
Each point plotted on the graph shows the estimate for one human.

(a) (i) As humans evolved, their brain volume changed.

What has happened to human brain volume over the past 4 million years?

_____

_____

(1)

(ii) Why is the evidence for estimated brain volume for *Homo sapiens* stronger than the evidence for *Australopithecus afarensis*?

_____

_____

(1)

(b) In a book, the brain volume of a different species, *Australopithecus africanus*, is stated to be about 600 cm^3.

Use evidence from the graphic above to estimate when *Australopithecus africanus* lived on Earth.

Estimate = _____ million years ago

(1)

(c) Scientists believe that modern humans evolved by natural selection from *Australopithecus afarensis.*

(i) Complete the following sentence.

In the nineteenth century, the scientist who suggested the theory of evolution by natural selection was Charles _____ .

(1)

(ii) In the nineteenth century, many people did not accept this scientist's theory.

Give **one** reason why.

_____

_____

(1)

(Total 5 marks)

6. In sexual reproduction, an egg fuses with a sperm.

(a) (i) Draw a ring around the correct answer to complete the sentence.

An egg and a sperm fuse together in the process of

cloning.
fertilisation.
mitosis.

(1)

(ii) Egg cells and sperm cells each contain the structures given in the box.

chromosome	**gene**	**nucleus**

List these three structures in size order, starting with the smallest.

1 _____ (smallest)

2 _____

3 _____ (largest)

(2)

(iii) The egg and the sperm contain genetic material.

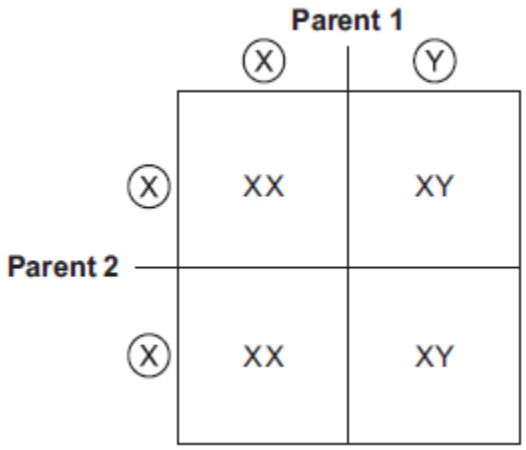
Draw a ring around the correct answer to complete the sentence.

The genetic material is made of

carbohydrate.
DNA.
protein.

(1)

(b) The diagram below shows the inheritance of **X** and **Y** chromosomes.



(i) Draw a tick (✓) on the part of the diagram that shows a sperm cell.

(1)

(ii) What is the chance of having a female child?

Give the reason for your answer.

_____

_____

_____

_____

(2)

(Total 7 marks)

7. Phenylketonuria (PKU) is an inherited condition. PKU makes people ill.

(a) PKU is caused by a recessive allele.

(i) What is an allele?

_____

_____

(1)

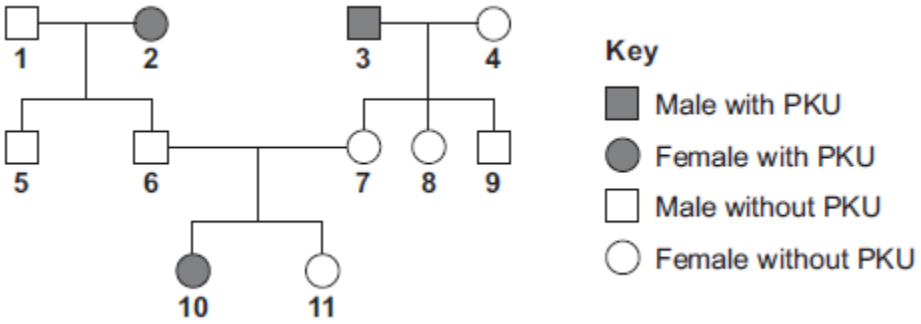
(ii) What is meant by recessive?

_____

_____

(1)

(b) The diagram below shows the inheritance of PKU in one family.



(i) Give **one** piece of evidence from the diagram that PKU is caused by a recessive allele.

_____

_____

(1)

(ii) Persons **6** and **7** are planning to have another child.
Use a genetic diagram to find the probability that the new child will have PKU.

Use the following symbols in your answer:

N = the dominant allele for **not** having PKU

n = the recessive allele for PKU.

Probability = _____

(4)

(c) Persons **6** and **7** wish to avoid having another child with PKU.

A genetic counsellor advises that they could produce several embryos by IVF treatment.

(i) During IVF treatment, each fertilised egg cell forms an embryo by cell division.

Name this type of cell division.

_____

(1)

(ii) An embryo screening technique could be used to find the genotype of each embryo.

An unaffected embryo could then be placed in person **7**'s uterus.

The screening technique is carried out on a cell from an embryo after just three cell divisions of the fertilised egg.

How many cells will there be in an embryo after the fertilised egg has

divided three times? ☐

(1)

(iii) During embryo screening, a technician tests the genetic material of the embryo to find out which alleles are present.

The genetic material is made up of large molecules of a chemical substance.

Name this chemical substance.

_____

(1)

(d) Some people have ethical objections to embryo screening.

(i) Give **one** ethical objection to embryo screening.

_____

(1)

(ii) Give **one** reason in favour of embryo screening.

_____

(1)

(Total 12 marks)

8. Read the information.

Insects can be both useful and harmful to crop plants.
Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants.
Some insects eat crops and other insects eat the insects that eat crops.

Corn borers are insects that eat maize plants.
A toxin produced by the bacterium *Bacillus thuringiensis* kills insects.
Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.

A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.

(a) Describe how scientists can transfer the gene from *Bacillus thuringiensis* to maize plants.

(3)

(b) Would you advise farmers to grow GM maize plants?

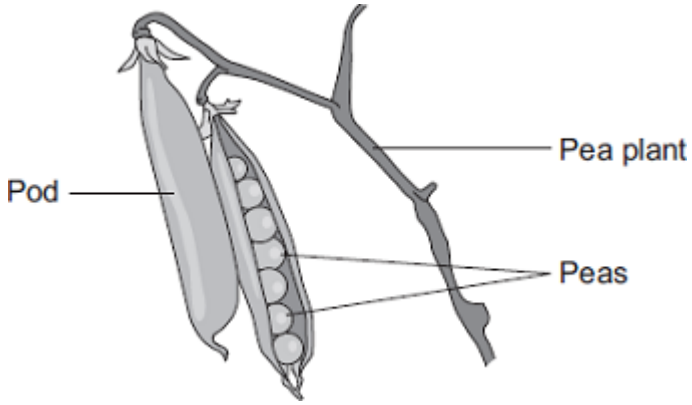
Justify your answer by giving advantages and disadvantages of growing GM maize plants.

Use the information from the box and your own knowledge to help you.

(4)

(Total 7 marks)

9. Peas grow in pods on pea plants.



A gardener grew four varieties of pea plants, **A** , **B** , **C** and **D** , in his garden.
The gardener counted the number of peas in each pod growing on each plant.

The table shows his results.

Variety	Range of number of peas in each pod	Mean number of peas in each pod
A	2–6	4
B	3–7	5
C	3–8	6
D	6–8	7

(a) Give **one** environmental factor and **one other** factor that might affect the number of peas in a pod.

Environmental factor _____

Other factor _____

(2)

(b) The gardener thinks that he will get the largest mass of peas from his garden if he grows variety **D**.

Why is the gardener **not** correct?

Suggest **one** reason.

_____

_____

(1)

(c) It is important that carbon is cycled through living things.

After he has picked the peas, the gardener puts the dead pea plants onto a compost heap.

Over the next few months, the carbon in the carbon compounds from the pea plants is returned to the air.

Describe how.

(4)

(Total 7 marks)

10. (a) Complete the sentences about evolution.

Draw a ring around the correct answer to complete each sentence.

(i) Darwin suggested the theory of evolution by [artificial / natural / asexual] selection.

(1)

(ii) Darwin's theory of evolution says that all species of living things have evolved from [artificial / complex / simple] life forms.

(1)

(iii) Most scientists believe that life first developed about

three billion
three million
three thousand

years ago.

(1)

(b) Darwin's theory of evolution was only slowly accepted by other people.

Give **two** reasons why.

1 _____

_____

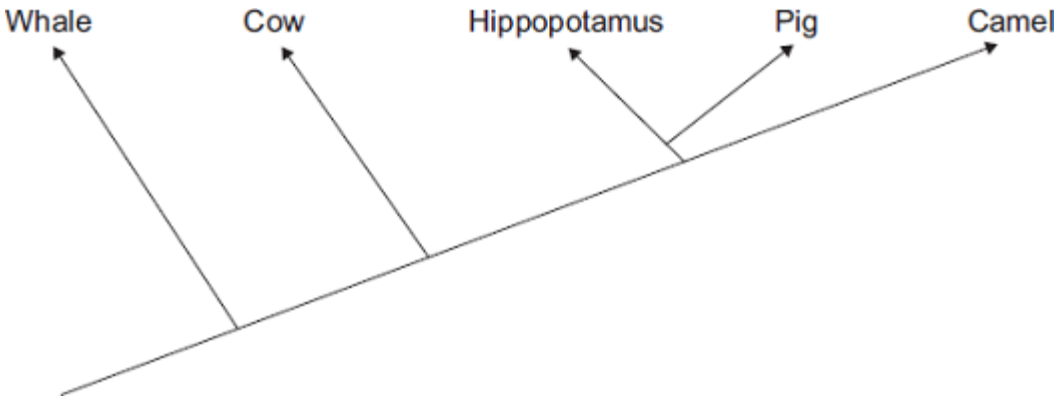
2 _____

_____

(2)

(c) **Diagram 1** shows one model of the relationship between some animals.

Diagram 1



(i) Complete the sentence.

The model shown in **Diagram 1** is an evolutionary _____ .

(1)

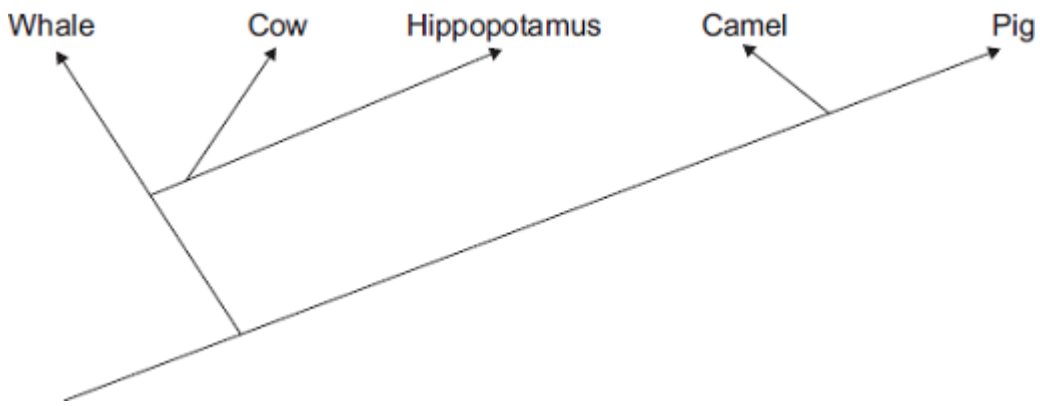
(ii) Which **two** of the animals in **Diagram 1** are most closely related?

_____ and _____

(1)

(iii) Diagram **2** shows a more recent model of the relationship between the animals.

Diagram 2



Suggest **one** reason why scientists have changed the model of the relationships between the animals shown in the diagram.

Draw a ring around the correct answer.

more powerful computers	**new evidence from fossils**	**new species discovered**

(1)

(Total 8 marks)

1.

(a) (i) alternative / different / one form of a gene

or

a mutation of a gene

do not allow a type of gene

(For info: CRAM = Childhood Recurrent Acute Myoglobinuria)

1

(ii) not expressed if dominant / other allele is present or it is heterozygous

or

only expressed if dominant allele not present / no other allele present or it is homozygous

need two copies to be expressed / not expressed if only one copy

allow 'gene' for allele

1

(iii) unaffected parents have an affected child

*allow **7** and **8** have **10***

allow skips a generation

1

(b) (i) has two alleles that are the same

*accept (person is) **nn** / **NN** or has two recessive / dominant alleles*

1

(ii) (all) inherit **N** / normal / dominant allele from **1** / from father

ignore they are carriers

1

all are **Nn** / none are **nn** / all are heterozygous

1

(c) (i) genetic diagram including:

1 gametes correct **or** parental genotypes correct:

N and **n** + **N** and **n** **or** **Nn** + **Nn**

accept alternative symbols, if defined

1

2 derivation of offspring genotypes:

NN + Nn + Nn + nn

allow alternative if correct for parental gametes

1

3 **nn** identified as CRAM

accept ¼ / 25% / 1 in 4 / 1 out of 4 / 1:3

1

4 correct probability: 0.25

*do **not** accept 3:1 / 1:4*

1

(ii) any **four** points + conclusion:

pro PGD:

detected at earlier stage / at 3 days c.f. several weeks / before becoming pregnant

no / less chance of miscarriage c.f. CVS

does not involve abortion / less trauma / less pain / ethical comparison

higher chance of having unaffected child – eg ref to use of spare embryos

provides embryos for research

4

pro CVS:

PGD may destroy some embryos

ethical implications of research on embryos (with PGD)

lower incidence of false positives / false results

low(er) financial cost

conclusion:

must relate to candidate's argument

must have at least one point from each technique for max marks

1

[15]

2. (a) (i) Chromosomes

1

(ii) Characteristics

1

(iii) Classify

1

(b) Plants

ignore algae

1

[4]

3. (a) (i) variation (in population) / mutation

1

longer nosed individuals get more food / leaves

allow longer nosed individuals more likely to survive

1

(these) survivors breed (more)

1

pass on genes / alleles / DNA (for long nose)

allow pass on mutation

1

(ii) Phiomia / ancestor stretched its nose (during its lifetime) to reach food / leaves

1

passed on (stretched nose) to offspring

allow offspring inherit (stretched nose)

*do **not** allow ref to genes*

1

(b) (i) insufficient evidence / no proof

ignore other theories, eg religion

*do **not** allow no evidence*

1

mechanism of inheritance not known

allow genes / DNA not discovered

1

(ii) God made all living things / them

allow creationism

ignore religion

1

[9]

4. (a) mumps

in either order rubella / German measles

both needed for the mark

ignore measles unqualified

1

(b) (i) 80(.0)

*allow **1** mark for* $\frac{504}{630}$ ***or** 0.8*

2

(ii) less chance of epidemic / pandemic

or

less chance of spread of disease / measles / mumps / rubella

allow idea of herd immunity (increased protection for those who are not vaccinated)

*ignore less chance of getting the disease **or** to eradicate the disease*

1

(c) (i) dead / inactive pathogens / viruses / bacteria

allow antigens / proteins from pathogens / viruses / bacteria

ignore microorganisms

1

(ii) white blood cells produce antibodies

1

antibodies produced rapidly (on re-infection) **or** response rapid (on re-infection)

allow ecf if antibodies incorrectly identified in first marking point

1

these antibodies kill pathogens / viruses / bacteria

*do **not** accept idea that original antibodies remain in blood and kill pathogens*

1

(d) (i) antibiotics don't kill viruses

allow antibiotics only kill bacteria

1

(because measles) virus / pathogen lives inside cells

*allow antibiotics do not work inside cells **or** killing virus / pathogen would kill / damage cell*

1

(ii) (bacteria / pathogens) develop resistance (to antibiotic)

ignore reference to immunity

ignore viruses develop resistance

1

[11]

5. (a) (i) (volume) increases (with time)

ignore numbers

1

(ii) there is more evidence / specimens / results (for Homo sapiens)

allow examples of this, eg more / better fossils

allow converse if clearly referring to Australopithecus

ignore reference to being 'more recent'

1

(b) 2.5 – 3.15 (million years ago)

accept any number in range

1

(c) (i) Darwin

1

(ii) any **one** from:

- they believed in other theories

  allow they believed that God made all life
- insufficient evidence

  ignore 'no evidence'
- no proof

  allow not enough proof
- genes / mechanism of inheritance not known / discovered

1

[5]

6. (a) (i) fertilisation

1

(ii) in sequence:

accept 1 next to gene, 2 next to chromosome and 3 next to nucleus in box

1 gene
2 chromosome
3 nucleus

*allow 1 mark for smallest **or** largest in correct position*

2

(iii) DNA

1

(b) (i) On diagram:

tick drawn next to **X** and / or **Y** from Parent 1

tick(s) must be totally outside grid squares

allow ticks around "parent "

extra ticks elsewhere cancel

1

(ii) 0.5 / ½ / 50% / 1:1 / 50:50 / 1 in 2

allow 2/4 / 2 in 4 / 2 out of 4 / 'even(s)' / 'fifty – fifty'

*do **not** allow 1:2 or '50 / 50' or '50 – 50'*

1

2 (out of 4) boxes are **XX**

or

half of the sperm contain an **X**-chromosome

*allow **XY** is male and 2 (out of 4) boxes are **XY***

1

[7]

7. (a) (i) one form of a / one gene

*do **not** allow 'a type of gene'*

allow a mutation of a gene

1

(ii) not expressed if dominant / other allele is present / if heterozygous

or

only expressed if dominant allele not present / or no other allele present

allow need two copies to be expressed / not expressed if only one copy / only expressed if homozygous

1

(b) (i) two parents without PKU produce a child with PKU / **6** and **7** → **10**

allow 'it skips a generation'

1

(ii) genetic diagram including:

accept alternative symbols if defined

Parental gametes:

6: **N** and **n**
and 7: **N** and **n**

1

derivation of offspring genotypes:

NN **Nn** **Nn** **nn**

allow genotypes correctly derived from student's parental gametes

1

identification: **NN** and **Nn** as non-PKU

OR nn as PKU

allow correct identification of student's offspring genotypes

1

correct probability only: 0.25 / ¼ / 1 in 4 / 25% / 1 : 3

*do **not** allow 3 : 1 / 1 : 4*

*do **not** allow if extra incorrect probabilities given*

1

(c) (i) mitosis

correct spelling only

1

(ii) 8

1

(iii) DNA

allow deoxyribonucleic acid

*do **not** allow RNA / ribonucleic acid*

1

(d) (i) may lead to damage to embryo / may destroy embryos / embryo cannot give consent

allow avoid abortion

allow emotive terms – eg murder religious argument must be qualified

allow ref to miscarriage

allow idea of avoiding prejudice against disabled people

allow idea of not producing designer babies

1

(ii) any **one** from:

- prevent having child with the disorder / prevent future suffering / reduce incidence of the disease

  ignore ref to having a healthy child

  ignore ref to selection of gender
- embryo cells could be used in stem cell treatment

  allow ref to long term cost of treating a child (with a disorder)

  allow ref to time for parents to become prepared

1

[12]

8. (a) any **three** from:

- (gene) cut out
- (gene / cut out) from (bacterial) chromosome / DNA

  accept (gene / cut out) from (bacterial) plasmid
- ref to enzymes (at any point)
- (gene spliced) into maize chromosome / DNA
- (gene added) at an early stage of development

3

(b) any **four** from:

- justification based on comparison of the relative merits of at least one advantage and one disadvantage

  *max **3** marks if only advantages or disadvantages given*

Advantages:

- less effort for farmer **or** less likely to harm farmer
  ignore ref to cost
- (pesticide) always there **or** doesn't wash away
  allow examples eg no need to spray
- less insects to eat crop / maize **or** carry disease
  allow pesticide doesn't contaminate water courses
- so greater crop production / yield

Disadvantages:

- (toxin) kills other insects
  ignore ref to cost
- so (some) crops don't get pollinated / (sexually) reproduce
  allow maize not pollinated
- possible harm when eaten by humans / animals
  allow may have unpleasant taste
- damage to food chains
  allow reduced biodiversity
- gene may spread to other species

4

[7]

9. (a) any correct named physical environmental condition, e.g. light / water / rain / temperature / minerals / nutrients / space (between plants)
ignore carbon dioxide / climate / weather / sun / pollution

1

genes / inheritance
ignore 'variety'

OR

any correct named biotic factor e.g. predation / disease

1

(b) mass of crop also depends on number of pods (per plant) / size / mass of each pea
ignore number of plants

1

(c) microorganisms / bacteria / fungi / decomposers / detritus feeders / named

1

decompose / rot / break down / decay / digest
ignore feed / eat

1

(these organisms) respire
*do **not** allow respiration by pea (plants)*

1

(decay / respiration / microorganisms etc) releases carbon dioxide

*do **not** allow combustion / fossilisation*

1

[7]

10. (a) (i) natural

1

(ii) simple

1

(iii) three billion

1

(b) any **two** from:

- reference to religion
- insufficient evidence / couldn't prove it / no proof

  ignore no evidence
- mechanism of inheritance / variation not known

  allow genes / DNA not known about
- reference to other theories
- reference to Darwin's status

2

(c) (i) tree

1

(ii) hippopotamus **and** pig

both required, either order

allow hippo

1

(iii) new evidence from fossils

1

[8]