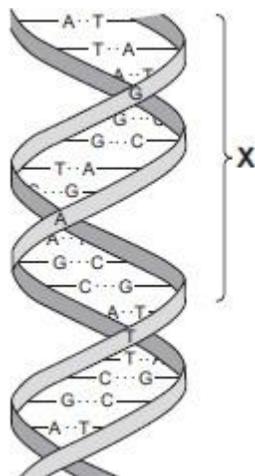


1 The diagram shows part of a DNA molecule.



(a) (i) In which part of an animal cell is DNA found?

(1)

(ii) Complete the following sentence.

The letters **A**, **C**, **G** and **T** in the diagram represent four different compounds called _____.

(1)

(iii) One strand of the DNA, in the section labelled **X**, contains the following sequence of these compounds:

T A T G G G T C T T C G

How many amino acids would this section of the DNA code for?

(1)

(iv) The section of DNA described in part **(a) (iii)** is a small part of a gene.

The sequence of compounds **A**, **C**, **G** and **T** in the gene is important.

Explain why.

(2)

(b) Read the following information about genetic engineering.

The caterpillar of the European Corn Borer moth feeds on the fruits of maize (sweet corn). There is a chemical called Bt-toxin which is poisonous to the corn borer caterpillar but not to humans.

Scientists carried out the following steps.

1. The Scientists made a bacterial plasmid to which they added two genes:
 - **Bt** gene, which coded for production of the Bt-toxin
 - **kan^r** gene, which coded for resistance to an antibiotic called kanamycin.
2. They used this plasmid to produce genetically modified bacteria which could invade plant cells.
3. They mixed these genetically modified bacteria with pieces cut from maize leaves.
4. They placed the pieces of maize leaf on agar jelly in a Petri dish. The agar jelly contained the antibiotic, kanamycin. The kanamycin killed most of the pieces of maize leaf, but a few survived.
5. They took some cells from the surviving pieces of maize leaf and grew them in tissue culture.

The result was maize plants that now contained the **Bt** gene, as well as the **kan^r** gene, in all of their cells.

(i) What is a **plasmid** (Step 1)?

(2)

(ii) Why did the scientists add **kanamycin** to the agar jelly (Step 4)?

(2)

- (iii) The scientists grew each Bt-maize plant from a single cell which contained the **Bt** gene.

Explain why **all** the cells in the Bt-maize plant contained the **Bt** gene.

(2)

- (iv) Kanamycin is an antibiotic.

Some scientists are concerned that the gene for kanamycin resistance has been put into maize.

Suggest why.

(2)

(Total 13 marks)

2

An animal called *Tiktaalik* became extinct about 360 million years ago.

The photograph shows the fossilised skeleton of *Tiktaalik* and a model of what scientists think *Tiktaalik* looked like.

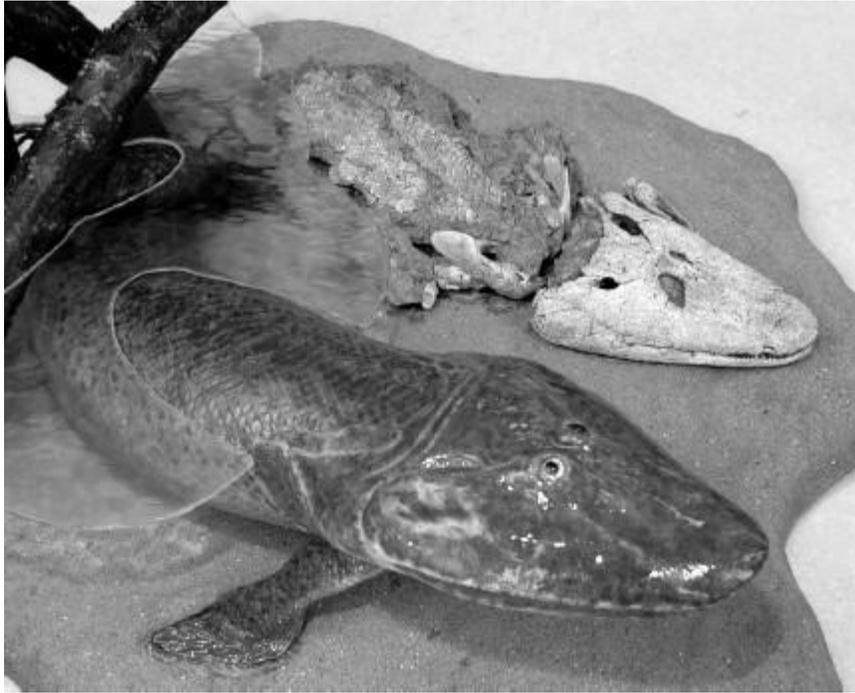


Image © University of Chicago, Shubin Lab. Model by Tyler Keillor

(a) Scientists found only the fossilised skeleton of *Tiktaalik*.

Explain why.

(2)

(b) Scientists think that *Tiktaalik* lived mostly in water, but that it was one of the first animals to be able to move onto land.

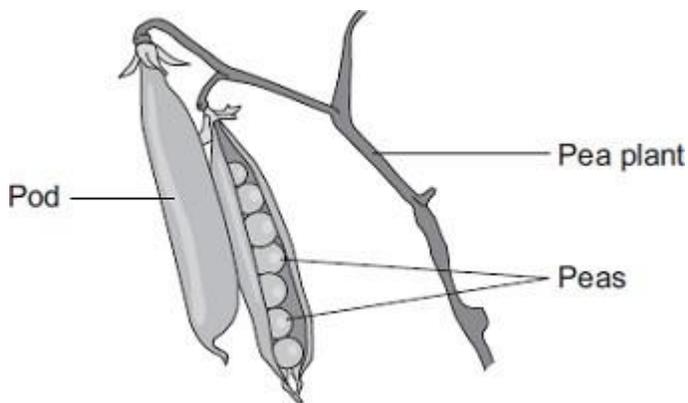
Use evidence from the photograph to suggest why.

(2)

(Total 4 marks)

3

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.

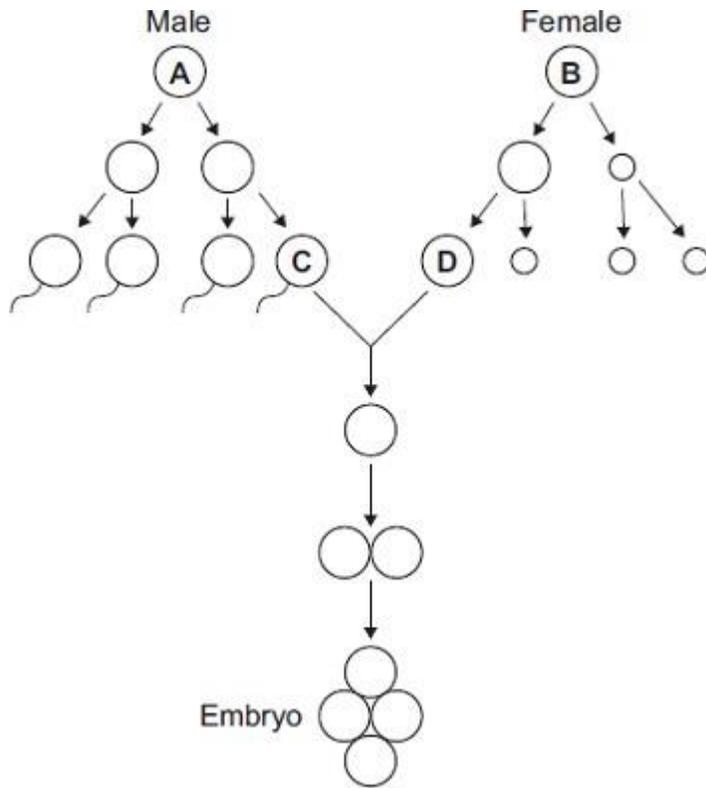
Over the next few months, the carbon in the carbon compounds from the pea plants is returned to the air.

Describe how.

(4)
(Total 7 marks)

4

The diagram shows some of the cell divisions that occur during human reproduction.



(a) (i) Name the type of cell division that produces cell **D** from cell **B**.

(1)

(ii) Which organ in the male body produces cell **C** from cell **A**?

(1)

(b) (i) Cells **A** and **B** each contain 46 chromosomes.

How many chromosomes would there be in the nucleus of cell **C**?

(1)

(ii) Why is it important that cell **C** has this number of chromosomes?

(2)

(Total 5 marks)

5

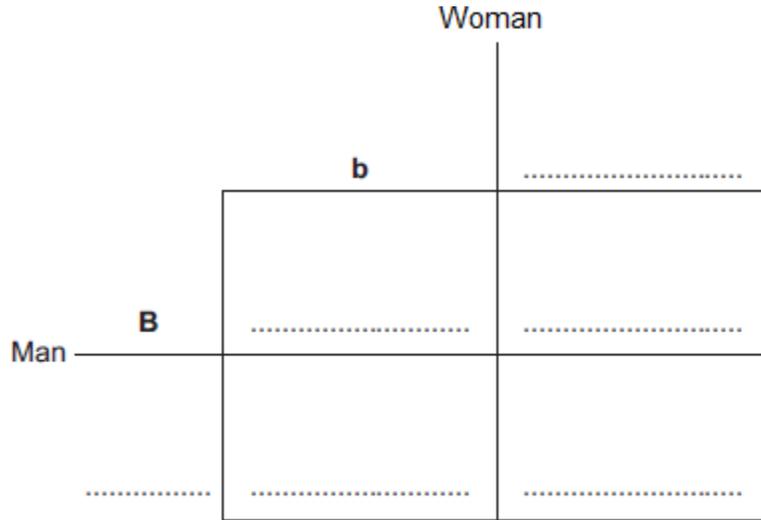
Eye colour is controlled by genes.

The dominant allele of the gene (**b**) produces brown eyes. The recessive allele (**b**) produces blue eyes.

A homozygous blue-eyed woman married a homozygous brown-eyed man.

All of their three children had brown eyes.

(a) (i) Complete the genetic diagram.



(2)

(ii) Give the reason why all of the children had brown eyes.

(1)

- (b) The couple's brown-eyed son and his brown-eyed partner had five children. Two of the children had blue eyes and three of the children had brown eyes.

Use a genetic diagram to show how two of their children came to have blue eyes.

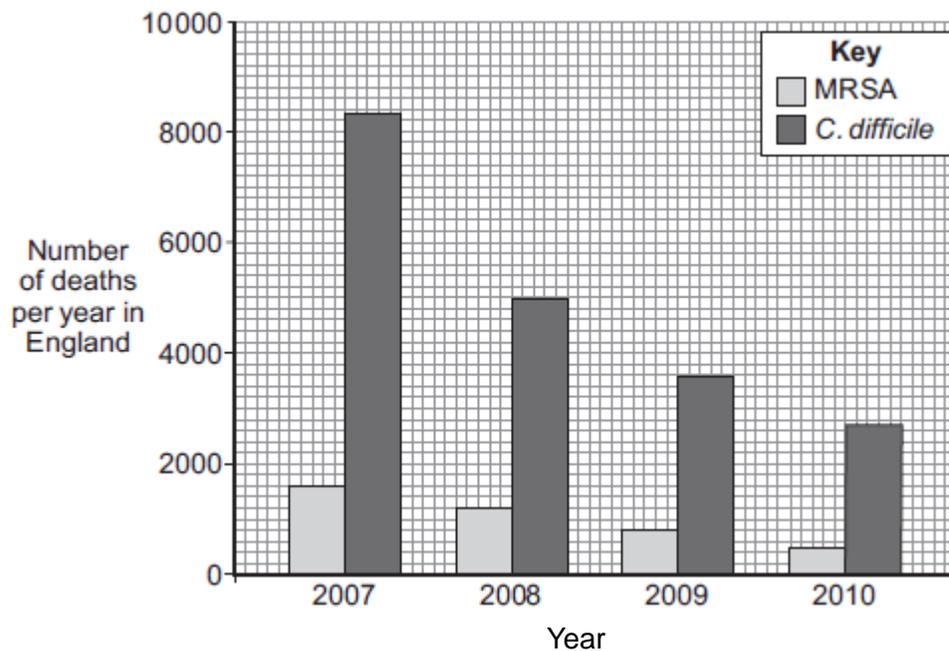
(3)

(Total 6 marks)

6

Infections by antibiotic resistant bacteria cause many deaths.

The bar chart below shows information about the number of deaths per year in England from *Methicillin-resistant Staphylococcus aureus* (MRSA) and from *Clostridium difficile* (*C.difficile*) over 4 years.



(a) (i) Describe the trend for deaths caused by *C. difficile*.

(2)

(ii) Suggest a reason for the trend you have described in part (a)(i).

Explain your answer.

(2)

(iii) Calculate the percentage change in deaths caused by MRSA from 2009 to 2010.

Percentage change in deaths caused by MRSA = _____%

(2)

(iv) Numbers have not yet been published for 2011.

When the numbers are published, scientists do **not** expect to see such a large percentage change from 2010 to 2011 as the one you have calculated for 2009 to 2010.

Suggest **one** reason why.

(1)

(b) Before 2007 there was a rapid increase in the number of deaths caused by MRSA.

Describe how the overuse of the antibiotic methicillin led to this increase.

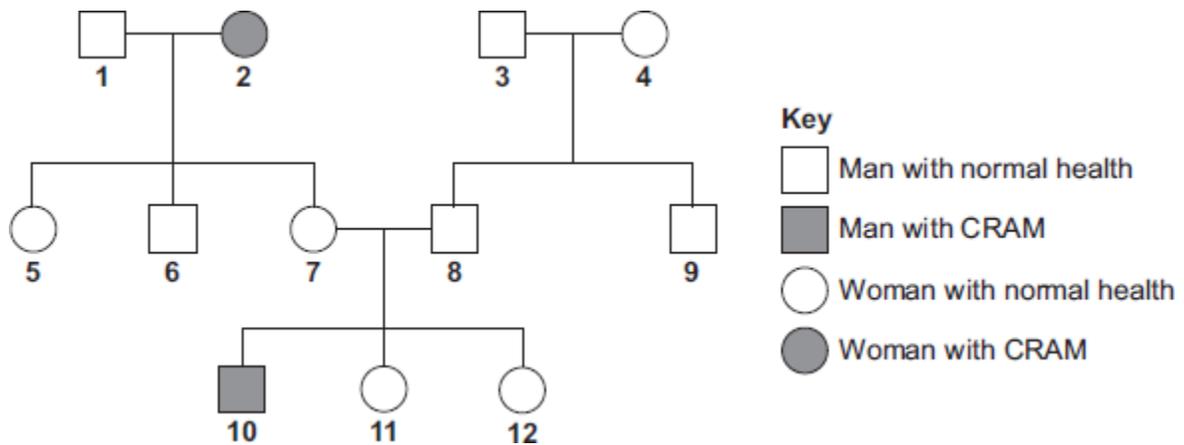
(3)
(Total 10 marks)

7

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.



© Rtimages/iStock/Thinkstock

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.

Mark schemes

- 1** (a) (i) nucleus
correct spelling only
accept mitochondrion
ignore genes / genetic material / chromosomes 1
- (ii) base(s)
Accept all four correct names of bases
ignore nucleotides and refs to organic / N-containing 1
- (iii) 4 1
- (iv) codes for sequence / order of amino acids
ignore references to characteristics 1
- codes for a (specific) protein / enzyme
- or**
- the sequence / order of three bases / compounds / letters
- codes for a specific amino acid
- or**
- the sequence / order of 3 bases / compounds / letters
- codes for the order / sequence of amino acids 1
- (b) (i) DNA 1
- circular / a ring **or** a vector / described 1
- (ii) kills any cells not having **kan^r** gene / so only cells with **kan^r** gene survive 1
- hence surviving cells will also contain **Bt** gene / plasmid 1
- (iii) cells divide by mitosis
ignore ref to asexual reproduction
correct spelling only 1
- genetic information is copied / each cell receives a copy of (all) the gene(s) / all cells produced are genetically identical / form a clone 1

(iv) any **two** from:

- gene may be passed to pathogenic bacteria
 - cannot then kill these pathogens with kanamycin
- or**
- cannot treat disease with kanamycin
 - may need to develop new antibiotics
 - gene may get into other organisms
 - outcome unpredictable

2

[13]

2

(a) (soft) body parts / other parts / named parts

accept flesh

1

decayed / decomposed / rotted / eaten

or

bones do not decay / decompose / rot / get eaten

ignore disintegrated / dissolved

ignore microorganisms

1

(b) any **one** aquatic feature from: eg

- streamlined body shape
- long tail
- eyes on top of head
- scales
- fins / paddles / flippers / webbed feet

ignore gills

1

any **one** terrestrial feature from:

- (front) legs / limbs / hands
- could lift front end upwards

ignore feet

accept for 2 marks eg fin / flipper can be used for walking

or *fins like legs*

1

[4]

3

(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]

4

(a) (i) meiosis

allow mieosis

1

(ii) testis / testes

allow testicle

1

(b) (i) 23

1

(ii) fuses / joins with cell D / with egg cell **or** used in fertilisation

allow fuse with another cell

1

prevents doubling of chromosome number / restores original no. / 46 / diploid no. / normal no. / full no.

accept 23 from each parent / from each gamete

1

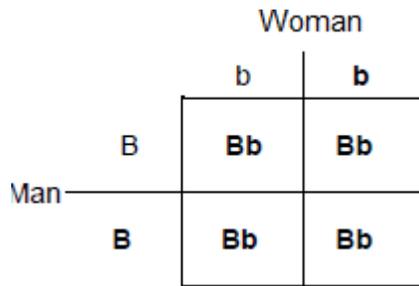
[5]

5

(a) (i) correct parental genotypes (man BB and woman bb)

1

all offspring Bb



ignore 'brown' or 'brown eyes' on diagram

1

(ii) they have one B / dominant allele / heterozygous

or

B / brown allele / dominant allele is expressed even if only on one chromosome

1

(b) correct parental genotypes (both Bb)
can be shown in a diagram
can be shown as gametes

1

correct derivation of offspring genotypes from gametes
allow correct derivation from wrong gametes

1

bb identified as blue-eyed

1

[6]

6

(a) (i) decrease

1

rate of decrease slows

1

(ii) any **one** from:

- more use of disinfectant
allow any reasonable increase in hygiene or sterilisation precautions
- more use of hand washing
- more careful / more often cleaning of patient facilities
- raised awareness / education about hygiene

1

Explanation:

stops / reduces the bacteria being transferred / spreading

1

(iii) $800 - 500 / 800 \times 100 =$

1

37.5 (%)

correct answer with or without working gains 2 marks

1

(iv) any **one** from:

- numbers quite low now so hard to reduce further
- was a big campaign / much publicity (in 2009) so more people already doing it
- hygiene / cleaning now good so hard to improve
- hospitals short of money so less staff to clean

1

(b) mutation occurred giving resistance (to methicillin)

*do **not** accept overuse caused mutation*

1

resistant bacteria not able to be treated / not killed

1

these bacteria multiplied / reproduced / spread quickly

1

[10]

7

(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 1/4 / 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]