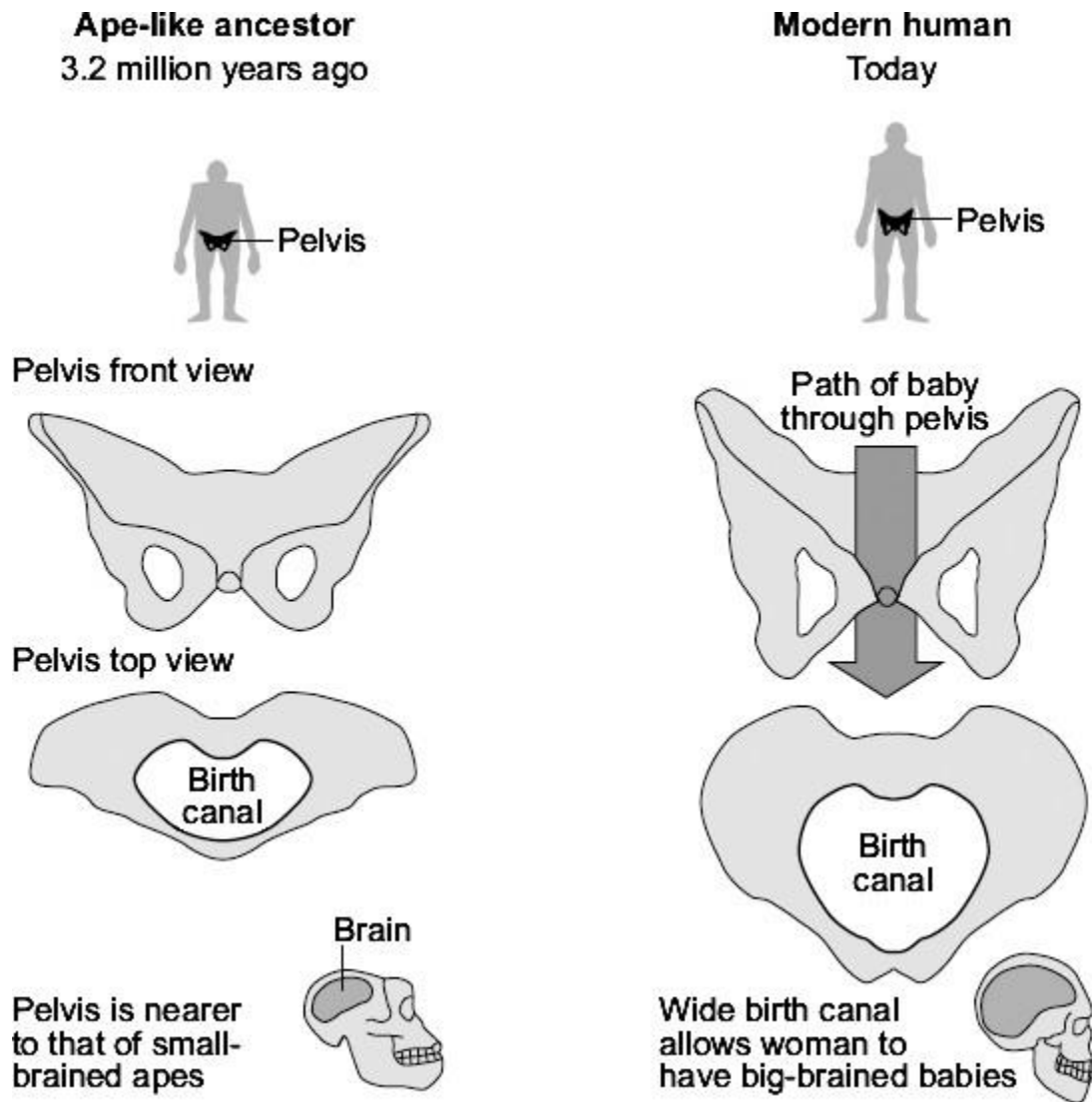**1** Humans have evolved from ape-like ancestors by natural selection.

The drawing shows the pelvis of an ape-like ancestor and a modern human.

The skull and brain of the new born baby are also shown to the same scale.

Modern humans are much more intelligent than their ape-like ancestors.

Ape-like ancestor
3.2 million years ago

Pelvis

Pelvis front view

Pelvis top view

Birth canal

Brain

Pelvis is nearer to that of small-brained apes

Modern human
Today

Pelvis

Path of baby through pelvis

Birth canal

Wide birth canal allows woman to have big-brained babies

Suggest an explanation for the evolution of the size and shape of the pelvis of modern humans.

Use information from the drawing to help you.

_____

_____

_____

_____

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_____

_____

_____

(Total 4 marks)

2 (a) Mr and Mrs Smith both have a history of cystic fibrosis in their families.
Neither of them has cystic fibrosis.
Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

(3)

(b)   Mr and Mrs Smith decided to visit a genetic counsellor who discusses embryo screening.

Read the information which they received from the counsellor.

- Under an anaesthetic five eggs will be removed from Mrs Smith's ovary.

- The eggs will be fertilised in a dish using Mr Smith's sperm cells.

- The embryos will be grown in the dish until each embryo has about thirty cells.

- One cell will be removed from each embryo and tested for cystic fibrosis.

- A suitable embryo will be placed into Mrs. Smith's uterus and she may become pregnant.

- Any unsuitable embryos will be killed.

(i)   Suggest why it is helpful to take five eggs from the ovary, rather than just one.

_____

_____

(1)

(ii)   Evaluate the use of embryo screening in this case.

Remember to give a conclusion as part of your evaluation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)
(Total 8 marks)

3 The table shows the number of chromosomes found in each body cell of some different organisms.

Animals		Plants	
Species	**Number of chromosomes in each body cell**	**Species**	**Number of chromosomes in each body cell**
Fruit fly	8	Tomato	24
Goat	60	Potato	44
Human	46	Rice	24

(a) Nearly every organism on earth has an even number of chromosomes in its body cells.
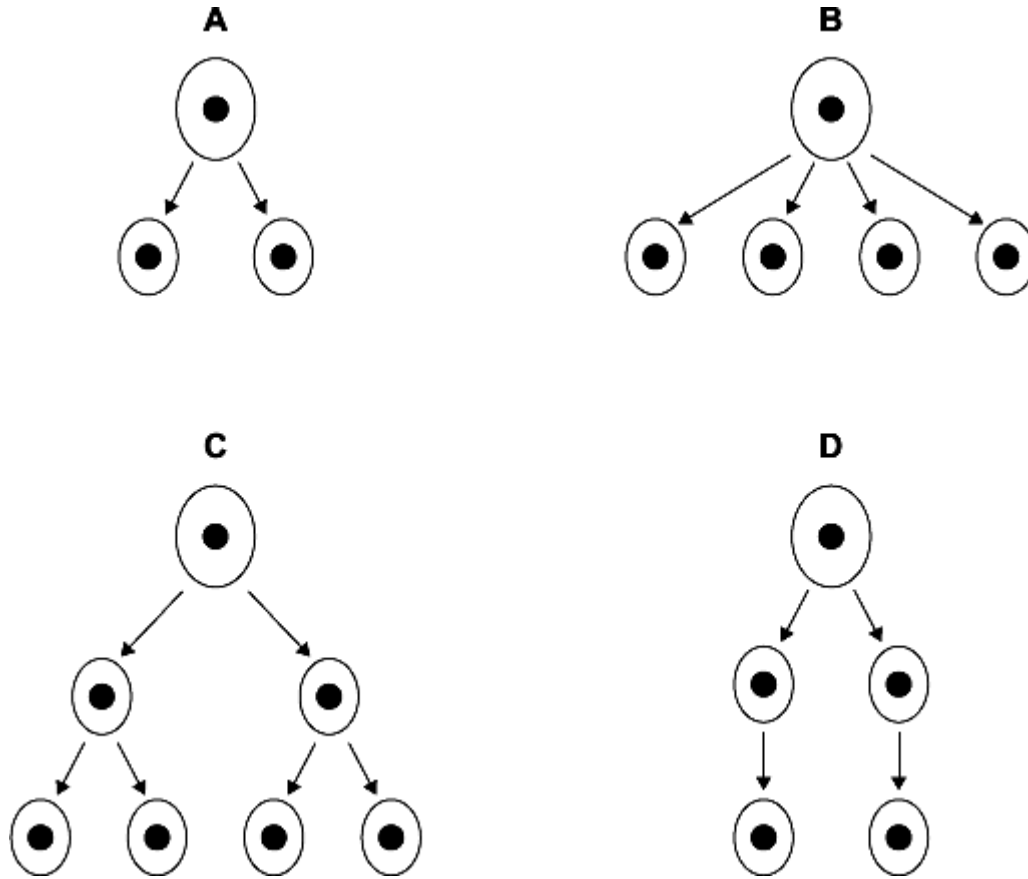
Suggest why.

_____

_____

(1)

(b) Chromosomes contain DNA molecules.

Describe the function of DNA.

_____

_____

_____

_____

(2)

(c)   Gametes are made in the testes by meiosis.

    (i)   Look at the diagrams.

       Which diagram, **A**, **B**, **C** or **D**, represents how cell division by meiosis

       produces gametes in the testes?

(1)

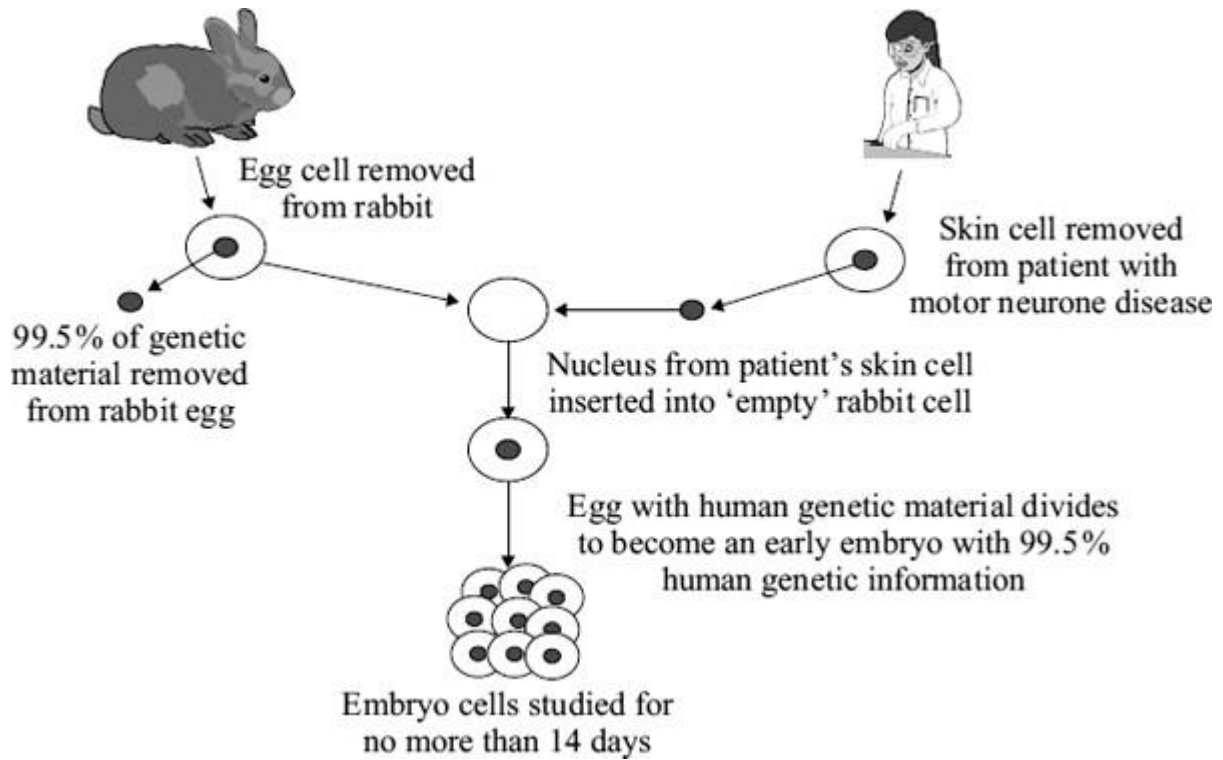   (ii)   How many chromosomes will each goat gamete contain?

_____

(1)

(d)   Body cells divide by mitosis.

    (i)   Why is the ability of body cells to divide important?

_____

_____

(1)

(ii)   When a body cell of a potato plant divides, how many chromosomes will each of the new cells contain?

_____

(1)

(Total 7 marks)

4   Soay sheep live wild on an island off the north coast of Scotland. No people live on the island.

Over the last 25 years, the average height and mass of the wild Soay sheep have decreased.

The scientists think that climate change might have affected the size of the sheep.

Suggest an explanation for the evolution of the wild Soay sheep over the last 25 years.

_____

_____

_____

_____

_____

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_____

_____

_____

(Total 4 marks)

5 Scientists in Korea have discovered a method of producing rabbit-human embryos. Rabbit-human embryos could provide cells for research into human diseases such as motor neurone disease. Rabbits produce large numbers of eggs. Rabbit–human embryos could overcome a shortage of human embryo cells for research.

The diagram shows how rabbit-human embryos are produced.

(a)   Which structures in the nucleus contain 99.5% of a cell's genetic information?

_____

(1)

(b)   Use the above information and your own knowledge and understanding to evaluate how the production of rabbit–human embryos may help research into human diseases.

Remember to give a conclusion as part of your evaluation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)
(Total 5 marks)

6 Cystic fibrosis and Huntington's disease are inherited disorders.

(a) Someone can be a carrier of cystic fibrosis.

Explain how.

You may include a genetic diagram in your answer.

_____

_____

_____

_____

(2)

(b) Why does only one parent need to have the Huntington's disease allele for a child to inherit Huntington's disease?

_____

_____

(1)
(Total 3 marks)

7 A certain allele increases the chance of women developing one type of breast cancer.

A woman has this allele. She wants to be sure that she will not have daughters who also have the allele.

Doctors:

- collect several eggs from her ovaries

- fertilise the eggs with sperm, in dishes.

(a) The doctors expect half the embryos produced to be female.

Explain why.

_____

_____

_____

_____

(2)

(b) The embryos grow to around 100 cells.

Doctors:

- remove one cell from each embryo

- check the cell for the allele.

Complete the sentence.

This process is known as embryo _____.

(1)

(c)   One of the female embryos did not have the allele.
        This female embryo was implanted into the woman's uterus.

        Evaluate the advantages and disadvantages of the whole procedure.

        Use information from all parts of this question and your own knowledge.

        Remember to give a conclusion to your evaluation.

        _____

        _____

        _____

        _____

        _____

        _____

        _____

        _____

        _____

        _____

        _____

        _____

                                                                    (4)
                                                        (Total 7 marks)

8   Cats normally have four toes on each back paw.

The picture shows the back paw of a cat with an inherited condition called polydactyly.

By Onyxrain (Own work) [Public domain], via Wikimedia Commons

The family tree shows the inheritance of polydactyly in three generations of cats.

Key

■ Male with polydactyly   □ Male without polydactyly

● Female with polydactyly   ○ Female without polydactyly
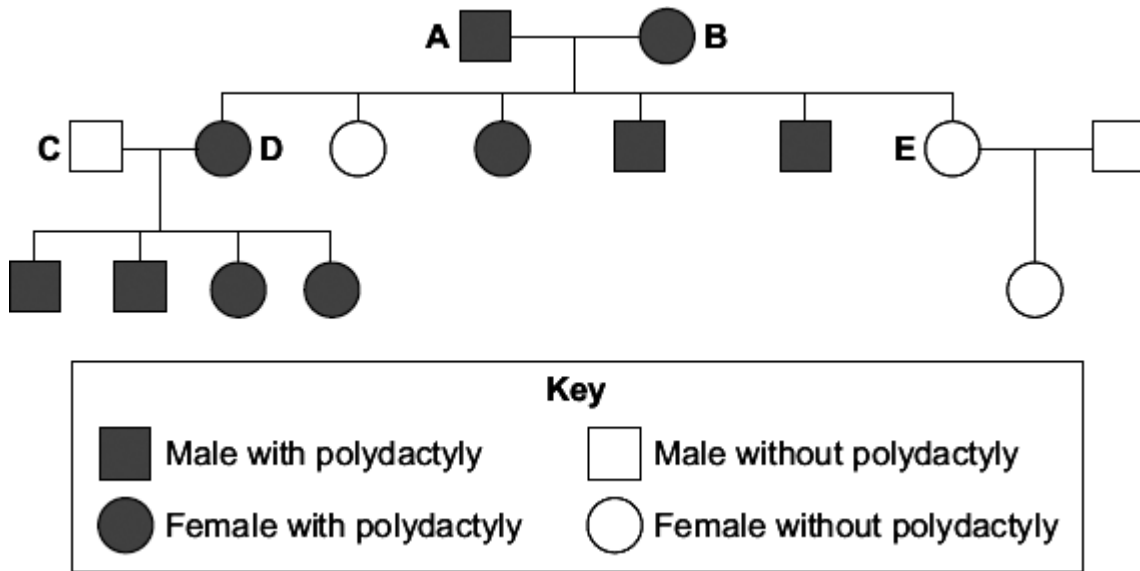
(a)   What combination of alleles did the original parents, **A** and **B**, have?

Explain how you work out your answer.

You may use a genetic diagram in your answer.

Use the symbol **H** to represent the dominant allele.

Use the symbol **h** to represent the recessive allele.

_____

_____

_____

_____

_____

_____

A =_____**B =** _____

(4)

(b)   (i)   Give **two** possible combinations of alleles for cat **D**.

1._____2. _____

(1)

(ii)   You cannot be sure which one of these two is the correct combination of alleles for cat **D**.

Why?

_____

_____

_____

(1)
(Total 6 marks)

9   People with cystic fibrosis make large amounts of thick, sticky mucus in their lungs.
Cystic fibrosis is caused by the inheritance of recessive alleles.

(a)   What do each of the following mean?

(i)   Alleles

_____

_____

(1)

(ii)   Recessive

_____

_____

(1)

(b)   Mr and Mrs Brown have a child with cystic fibrosis. They hope to have another child. They want to know the probability that their next child will have cystic fibrosis. They visit a genetic counsellor who explains, "You are both heterozygous for cystic fibrosis. There is a 1 in 4 (25%) chance that your next child will have cystic fibrosis."

Use the following symbols in answering the questions.

N = allele for being unaffected by cystic fibrosis
n = allele for cystic fibrosis

(i)   Mr and Mrs Brown both have the same genotype.

What is their genotype? _____

(1)

(ii)   There is a 1 in 4 chance that Mr and Mrs Brown's next child will have cystic fibrosis. Use a genetic diagram to explain why.

(3)

(c)   Mr and Mrs Brown do **not** want to have another child with cystic fibrosis. The genetic counsellor explains two different methods for finding out whether an embryo has cystic fibrosis. The methods are:

* pre-implantation genetic diagnosis (**PGD**)

* chorionic villus sampling (**CVS**).

In **PGD**, eggs are fertilised in dishes and allowed to grow into embryos. A cell is taken from each embryo when the embryo is 3 days old. The photograph shows how the cell is taken.
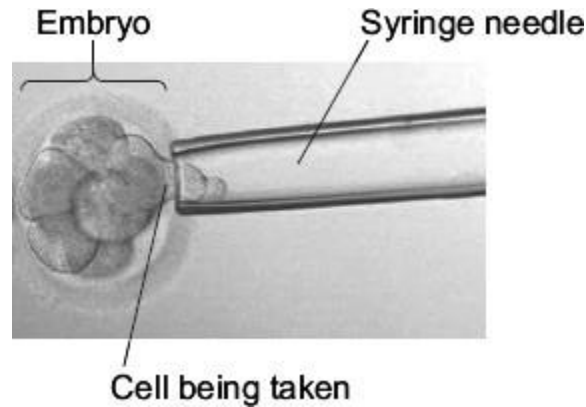
Photograph:© Pascal Goetgheluck/
Science Photo Library

The DNA in the cell can then be tested. The possibility of a false positive result is about 1 in 6. An unaffected embryo can then be placed in the woman's uterus. The procedure costs about £6000.

CVS can only be done after 9 weeks of pregnancy. A tiny piece of the placenta is taken out using a tube attached to a syringe. This is grown in tissue culture for about 7 days. The diagram below shows how **CVS** is done.
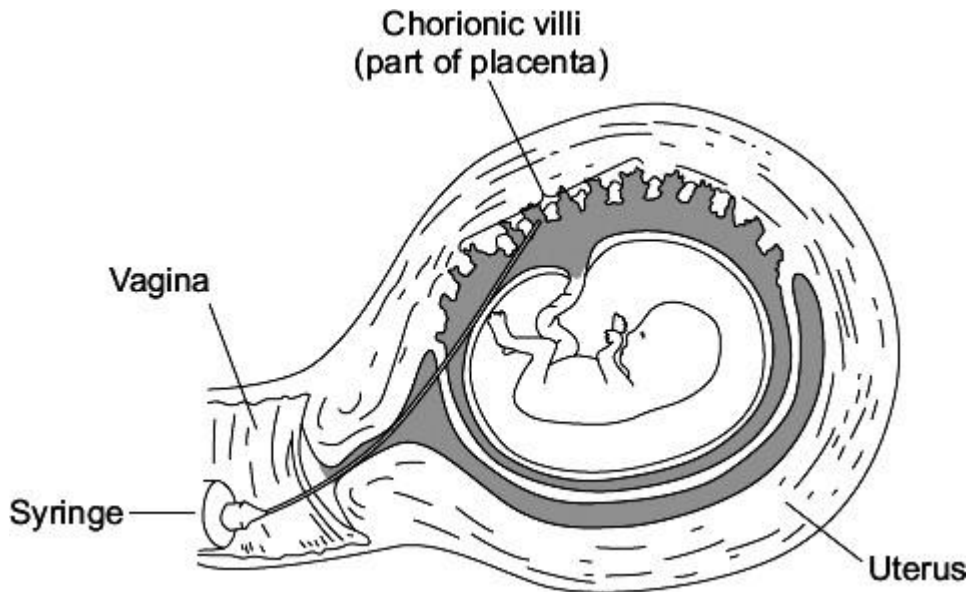
The DNA in the cells can then be tested. About 2 in every 100 women have a miscarriage because of **CVS**. The possibility of a false positive result is about 1%. The procedure costs about £600. Following a positive result, the parents must then decide whether to terminate the pregnancy.

The genetic counsellor thinks that **PGD** is a better method than **CVS** for detecting cystic fibrosis in an embryo.

Evaluate this opinion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)
(Total 10 marks)

10 Many strains of bacteria have developed resistance to antibiotics.

The table shows the number of people infected with a resistant strain of one species of bacterium in the UK.

Year	2004	2005	2006	2007	2008
Number of people infected with the resistant strain	3499	3553	3767	3809	4131

(a)   Calculate the percentage increase in the number of people infected with the resistant strain between 2004 and 2008.

Show clearly how you work out your answer.

_____

_____

Percentage increase = _____

(2)

(b)   Explain, in terms of natural selection, why the number of people infected with the resistant strain of the bacterium is increasing.

_____

_____

_____

_____

_____

_____

_____

_____

(3)
(Total 5 marks)

Mark schemes

1 a mutation occurs **or** variation in size / shape of pelvis

allow idea that walking upright needs larger pelvis to bear weight

1

large / wide birth canal / pelvis allowed passage of wide skull / brain

*do **not** allow pelvis became larger to enable birth of larger-skulled babies*

1

link between brain size and intelligence

1

those with larger pelvis / brain more likely to survive / reproduce

1

[4]

2 (a) both parents **Aa**

accept other upper and lower case letters without key or symbols with a key

allow shown as gametes in punnet square

1

aa in offspring correctly derived from parents /
aa correctly derived from the parents given

ignore other offspring / gametes for this mark parents do not have to be correct

1

offspring **aa** identified as having cystic fibrosis

*may be the only offspring shown **or** circled / highlighted / described*

1

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

accept converse if clear eg if you (only) took one it might have cystic fibrosis / might not be fertilised

• sure / greater chance of healthy / non-cystic fibrosis egg / embryo /child
accept some may have the allele
reference to suitable embryo is insufficient

• greater chance of fertilisation

1

(ii) ***to gain 3 marks both advantages <u>and</u> disadvantages must be given***

advantages
any **two** from

ignore references to abortion unless qualified by later screening

• greater / certain chance of having child / embryo without cystic fibrosis / healthy

• child with cystic fibrosis difficult / expensive to bring up

• cystic fibrosis (gene / allele) not passed on through generations

disadvantages
any **two** from:

• operation dangers eg infection
  ignore risk unqualified

• ethical or religious issues linked to killing embryos
  accept wrong / cruel to kill embryos accept right to life

• (high) cost

• possible damage to embryo (during testing for cystic fibrosis / during operation)

3

plus

conclusion

a statement that implies a valued, qualified judgement

eg it is right because the risk of infection is small

or
eg it is wrong because embryos are killed
Note: the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage has (already) been made
*do **not** award the mark if the conclusion only states that advantages outweigh disadvantages*

1

[8]

3 (a) any **one** from

- chromosomes in pairs

- inherited one of each pair from each parent

- one of each pair in egg **and** one of each pair in sperm

- so sex cells / gametes can have half the number
  allow need to pair during cell division / meiosis

1

(b) any **two** from:

- <u>code</u>

- combination / sequence of amino acids

- forming specific / particular proteins / examples
  *If **no other mark** gained allow reference to controlling characteristics / appearance for **1** mark*

2

(c) (i) C

1

(ii) 30

1

(d) (i) for growth / repair / replacement / asexual reproduction
  *do **not** accept incorrect qualification, eg growth of cells **or** repair of cells*
  they equals cells therefore do not accept they grow etc

1

(ii) 44 **or** 22 pairs

1

[7]

4 mutation **or** <u>variation</u> **or** <u>range</u> of sizes
  *do **not** accept deliberate mutation **or** factor caused mutation*

1

warm(er) / dry(er) now
  allow global warming

1

if warmer more smaller lambs / sheep survive winter
  award 'survival' point only if linked to warmer / dryer conditions

1

or if warmer sheep do not need fat / wool / fur to keep warm

or if warmer smaller sheep can lose heat more readily / do not overheat / keep cool (so survive)

> *do **not** accept smaller sheep retain more heat*

or if warmer smaller sheep have larger SA / V ratio (so survive)

> *do **not** accept smaller sheep have smaller SA / V ratio*

or if dryer smaller lambs / sheep need less grass (to survive)

> *ignore small sheep feed easier on grass*

small sheep breed / pass genes / mutations / characteristics to next generation

> *do **not** accept if Lamarckian*
>
> *ignore competition / predation / human influence*

1

[4]

5 (a)   chromosomes

> *ignore gene / DNA*

1

(b)   *to obtain **3** marks candidates must give **one** reasonable pro **and one** reasonable con*

pros eg

any **two** from:

- overcomes shortage of human eggs / rabbits produce lots of eggs

> *ignore all embryos identical*

- ethical / religious issues with using human embryos

- reduces tests on (adult) humans

- may provide cure for / cause of disease

- embryo not allowed to develop beyond 14 days

- no harm to rabbit

- 99.5 % human genetic information so very similar to human or will react in the same way

max 2

cons eg

any **two** from:

- ethical / religious objections to mixture of human and rabbit genes

- ethical issues with experimenting with rabbits
    allow some people object to using rabbits / cruel to rabbits

- ethical / religious objections to killing embryos

- 0.5% of rabbit genetic information might affect results

- 14 days too short a time to get results

max 2

plus

conclusion eg

- possibility of cure does / does not outweigh ethical / religious objections
    Note: *the conclusion mark cannot be given unless both an advantage and a disadvantage have (already) been given*

- cure does not justify mixing human and animal genes / killing embryos
    *do **not** award the mark if the conclusion only states that advantages outweigh disadvantages*

1

[5]

6 (a) cystic fibrosis (allele / gene) recessive
    allow an annotated genetic diagram

1

carrier has <u>only</u> one cystic fibrosis allele / gene
    accept carrier is heterozygous
    accept any symbol with key or
    accept conventional use of symbols
    penalise use of chromosome once only

1

(b) any **one** from:

- Huntington's (allele / gene) dominant

- (to have Huntington's) need only one Huntington's allele / gene

1

[3]

7 (a) <u>half</u> / <u>50%</u> sperm have X (chromosome)
or
<u>half</u> / <u>50%</u> sperm have Y (chromosome)
penalise incorrect use of gene / allele once only

1

all eggs have X (chromosome)
*annotated genetic diagram could gain **2 marks***

1

(b) screening
ignore selection

1

(c) any **three** from:
*max 2 if only advantages **or** only disadvantages discussed*

advantages:(**max 2**)

•   (girl / children / women) don't / less likely to get / inherit (breast) cancer / this / the disease
*do **not** accept reference to allele alone for this point*

•   future generations get less cancer **or** less likely to have the allele

•less expensive (for NHS) than treating cancer

disadvantages:(**max 2**)

•   (wrong / immoral to) reject / kill embryos
ignore wrong / immoral / religious argument unqualified

•   possible harm to embryo (that is implanted) / miscarriage
ignore reference to termination

•   possible harm to mother (due to operational procedure)
allow reference to needing hormone treatment

3

argued conclusion
*must refer to **both** advantages and disadvantages and must be at end of answer*

1

[7]

8 (a) **A** = Hh   **B** = Hh
may not be in answer space
accept heterozygous or description

1

(allele for) polydactyly is dominant **or** polydactyly is H,

> *for marking points 1, 2 and 3 accept evidence in clearly labelled / annotated genetic diagram*

1

cats with polydactyly have H

> *accept if polydactyly was recessive all offspring would have polydactyly*

1

E or (some) offspring of **A** and **B**, does not have polydactyly,
so **A** and **B** must both have h

1

(b) (i)   HH **and** Hh **or**
homozygous dominant **and** heterozygous

> *both required, in either order*
> *allow description*

1

(ii)   any **one** from:

> *accept annotated genetic diagram to explain answer*

- polydactyly is dominant

- parents are both Hh

- if D is Hh all offspring <u>could</u> inherit H

1

[6]

9 (a) (i)   (alternative) forms / types of <u>a</u> / the same gene

1

(ii)   only expressed if 2 copies inherited
or not expressed if other allele present

> *allow over ruled / over powered by the other allele*

1

(b) (i)   **Nn**

> *ignore heterozygous*

1

(ii)   genetic diagram including:

> *accept alternative symbols, if defined*

gametes: **N** and **n** from <u>both</u> parents

> *accept alternative symbols if correct for answer to (b)(i)*

1

correct derivation of offspring genotypes:
   NN Nn Nn nn

> *allow if correct for candidate's parental genotypes / gametes*

1

identification of **nn** as having cystic fibrosis

1

(c) **Argued evaluation**

any **four** from:

- PGD <u>higher</u> financial cost
    accept CVS <u>only</u> costs £600

- PGD occurs before pregnancy / implantation
    accept detected at <u>earlier</u> stage so less unethical / less trauma

- PGD does not involve abortion so less trauma / less pain / ethical •   PGD higher
    incidence of false positive / use of numbers so higher risk of
    destroying healthy embryo
    accept PGD has (surplus) embryos so some destroyed / unethical

- PGD no chance of miscarriage whereas CVS does
    or PGD less chance of miscarriage

4

[10]

10   (a)   18.06 / 18 / 18.1
    *correct answer gains **2** marks*
    if answer incorrect evidence of
    (4131 - 3499) ÷ 3499 × 100
    ***or** 632 ÷ 3499 × 100*
    ***or** ((4131 ÷ 3499) × 100) - 100*
    ***or** 0.18*
    *gains **1** mark*

2

   (b)   antibiotics kill non-resistant strain
    or resistant strain bacteria survive
    accept resistant strain the successful competitor
    *do **not** accept intentional adaptation*
    ignore strongest / fittest survive
    ignore mutation
    ignore people do not finish antibiotic course

1

resistant strain bacteria reproduce
or resistant strain bacteria pass on genes

1

population of resistant strain increases **or** proportion of resistant bacteria increases

allow high numbers of resistant bacteria

or

people more <u>likely</u> to be infected by resistant strain (than non-resistant strain)

1

[5]