Q1.

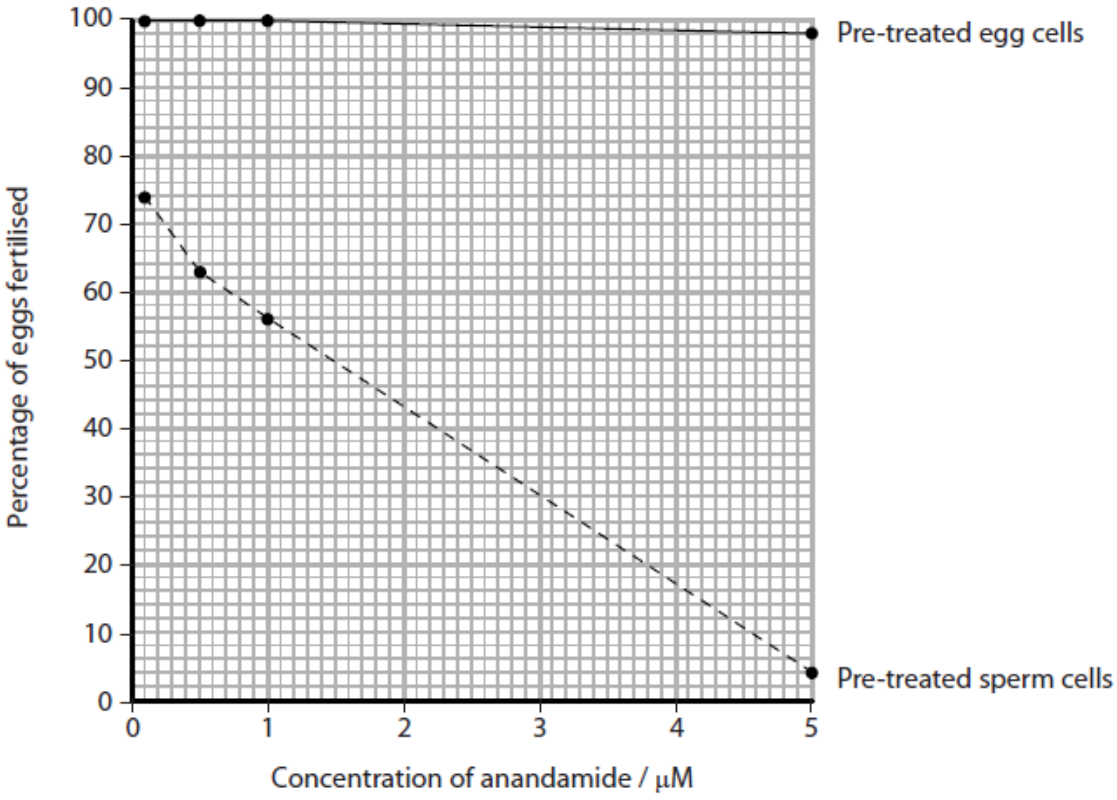
Fertilisation can be affected by anandamide, a chemical found in cannabis.

The effect of anandamide on fertilisation in sea urchins was investigated.

Sperm cells were pre-treated with different concentrations of anandamide.
These sperm cells were then mixed with untreated egg cells. The percentage of successful fertilisations was calculated.

A separate investigation was carried out using pre-treated egg cells that were then mixed with untreated sperm cells. The percentage of successful fertilisations was calculated.

The graph shows the results of the investigations.



Compare and contrast the acrosome reaction and the cortical reaction.

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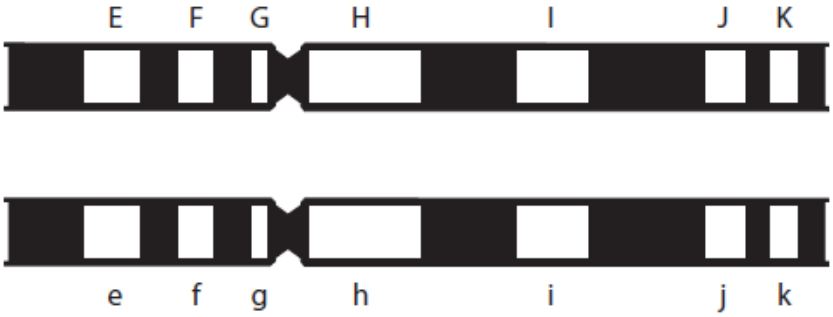
Q2.

The diagram shows two homologous chromosomes from a man.



The white regions are the loci of seven genes involved in different phenotypic traits.
The letters E-K and e-k represent the alleles present at each locus.

Alleles F and G are

(1)

☒ **A** autosomal and complementary

☒ **B** autosomal and linked

☒ **C** sex-linked and dominant

☒ **D** sex-linked and epigenetic

(Total for question = 1 mark)

Q3.

At the start of fertilisation, many sperm cells will surround the ovum.

Describe the events of fertilisation that occur after the acrosome reaction.

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(Total for question = 3 marks)

Q4. Several processes lead up to fertilisation in animals and plants.

*(a) Describe and explain how, in mammals, events following the acrosome reaction prevent more than one sperm fertilising an egg.

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(b) Animals produce haploid gametes by meiosis.

Explain how meiosis gives rise to genetic variation in gametes.

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(c) In flowering plants, the growth of pollen tubes is affected by many factors. An investigation was carried out to study the effect of the concentration of a chemical called methylpurine on pollen tube growth.

Pollen grains from lily flowers were exposed to 0.01 mol dm^{-3} methylpurine at pollination.

Lily flowers
Magnification × 0.2

After 48 hours, the lengths of the pollen tubes formed were measured and the mean length calculated.

This was repeated with two other concentrations of methylpurine and a control with no methylpurine.

The results are shown in the table below.

Concentration of methylpurine / mol dm^{-3}	Mean length of pollen tube after 48 hours / mm
0.0000	94
0.0001	95
0.0010	90
0.0100	28

(i) The investigation was carried out at a constant temperature of 22.5 °C.

Suggest why the temperature was kept constant.

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(ii) Using the information in the table, describe the effect of methylpurine concentration on the mean length of pollen tubes from lily flowers.

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(iii) Methylpurine can inhibit messenger RNA (mRNA) synthesis.

Suggest how this can cause the change in mean pollen tube length.

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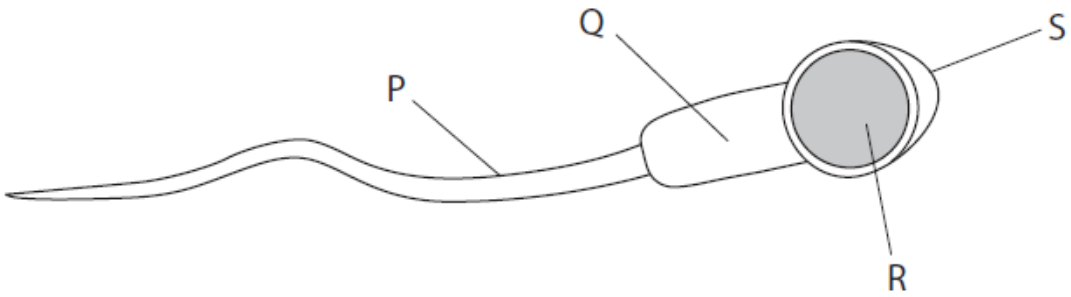
(Total for Question = 13 marks)

Q5.

Many animals reproduce sexually.

The diagram shows a healthy human sperm cell.



Magnification ×4000

(i) In which part of the sperm cell are the mitochondria located?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) Which of the following is the approximate diameter of the sperm cell nucleus?

(1)

☒ **A** 0.4 µm

☒ **B** 4 µm

☒ **C** 0.4 nm

☒ **D** 4 nm

(iii) Which of the following describes the chromosome number in this human sperm cell?

(1)

☒ **A** diploid

☒ **B** haploid

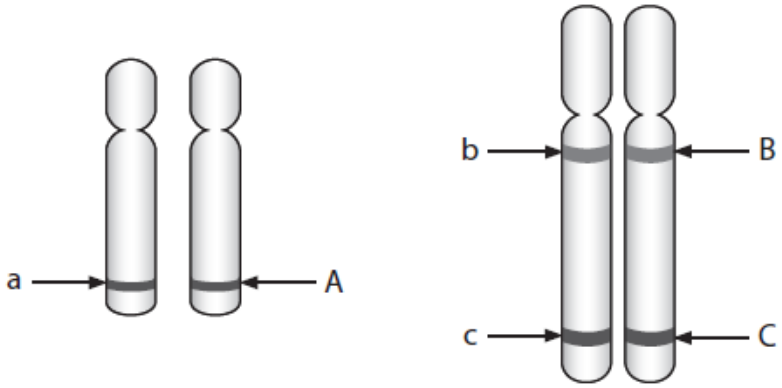
☒ **C** polyploid

☒ **D** tetraploid

Q6.

Linked genes are usually inherited together.

The process of meiosis gives rise to genetic variation. Genes A, B and C are located on two different pairs of chromosomes, as shown in the diagram.



Which combination of alleles could only be present if crossing over has occurred?

(1)

☒ **A** ABC

☒ **B** aBC

☒ **C** ABc

☒ **D** Abc

(Total for question = 1 mark)

Q7.

(i) Which row shows the correct events that take place at each stage of cell divisi

(1)

	Stage of cell division	
	Interphase	**Prophase**
☒ **A**	DNA replicates	chromosomes condense
☒ **B**	centromeres separate	nuclear membrane breaks down
☒ **C**	chromatids are formed	spindle formation begins
☒ **D**	chromosomes decondense	nuclear membrane reforms

(ii) Which of the following occurs during metaphase?

(1)

☒ **A** separation of chromatids

☒ **B** breakdown of the nuclear membrane

☒ **C** division of the centromeres

☒ **D** alignment of chromosomes at the equator of the cell

(Total for question = 2 marks)

Q8.

In 1886, Sir Francis Galton claimed that the height of a child could be predicted by working out the mean height of its parents.

Scientists have since discovered that the inheritance of height is an example of polygenic inheritance.

(a) Explain what is meant by the term **polygenic inheritance**.

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(b) Some scientists have suggested that diet may affect the growth of a child.

Explain how the height of an adult human demonstrates how environmental factors interact with genotype.

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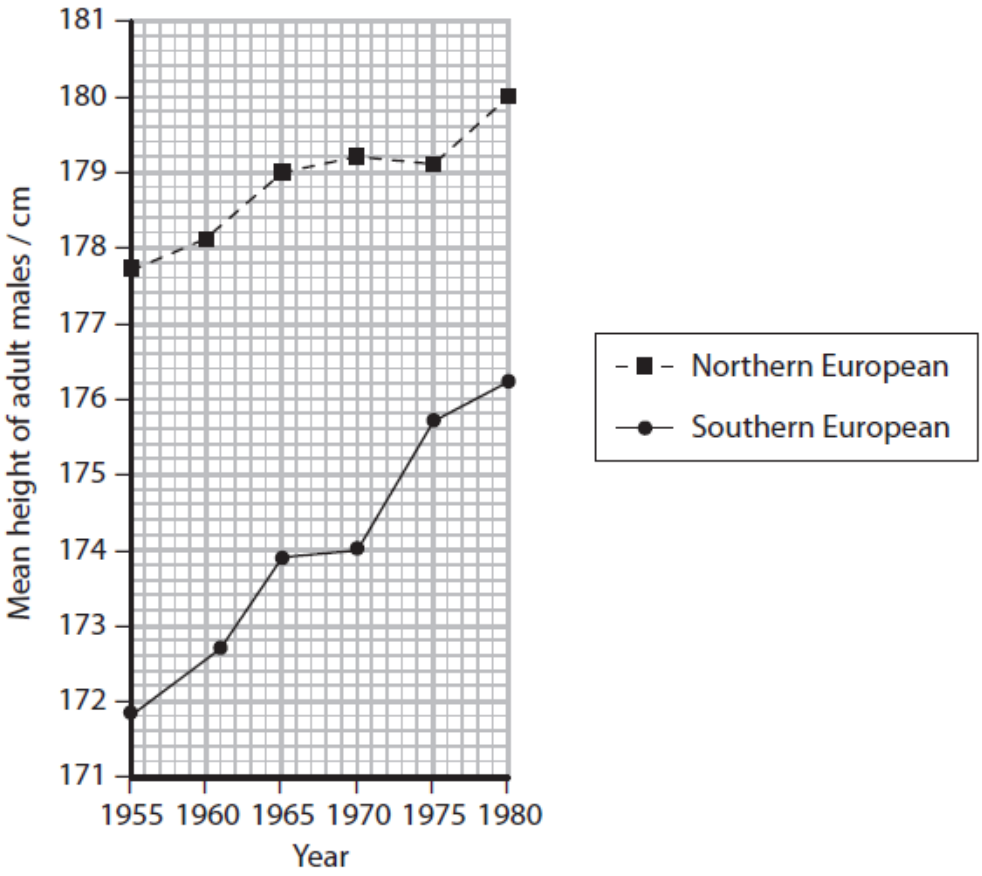
(c) The graph below shows the mean height of populations of adult males in Northern and Southern Europe from 1955 to 1980.



(i) Using the information in the graph, describe the changes in mean height for adult European males from 1955 to 1980.

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(ii) Suggest an explanation for the changes in mean height of these two groups of adult males.

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(Total for question = 10 marks)

(1)

Q9.

Which adaptation allows a sperm cell to digest the zona pellucida?

- ☒ **A** acrosome
- ☒ **B** flagellum
- ☒ **C** haploid nucleus
- ☒ **D** streamlined shape

(Total for question = 1 mark)

Q10.

Gametes are specialised for their role in sexual reproduction.

The purpose of the cortical reaction is to

(1)

- ☒ **A** allow the haploid nuclei to fuse
- ☒ **B** attract the sperm towards the egg cell
- ☒ **C** cause the sperm cell membrane to fuse with the egg cell membrane
- ☒ **D** ensure that only one sperm fertilises the egg

(Total for question = 1 mark)

Q11.

Domestic cats have a gene for fur colour that is found only on the X chromosome. This gene has two alleles, one producing orange fur and the other producing black fur.

Tortoiseshell cats have patches of orange fur and patches of black fur. This pattern of fur colouration is usually found only in female cats.

With the help of a genetic diagram to explain why the tortoiseshell cat in the photograph is unlikely to be male.

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