Q1.

(b) Define the term mutagenic agent.

_____

_____

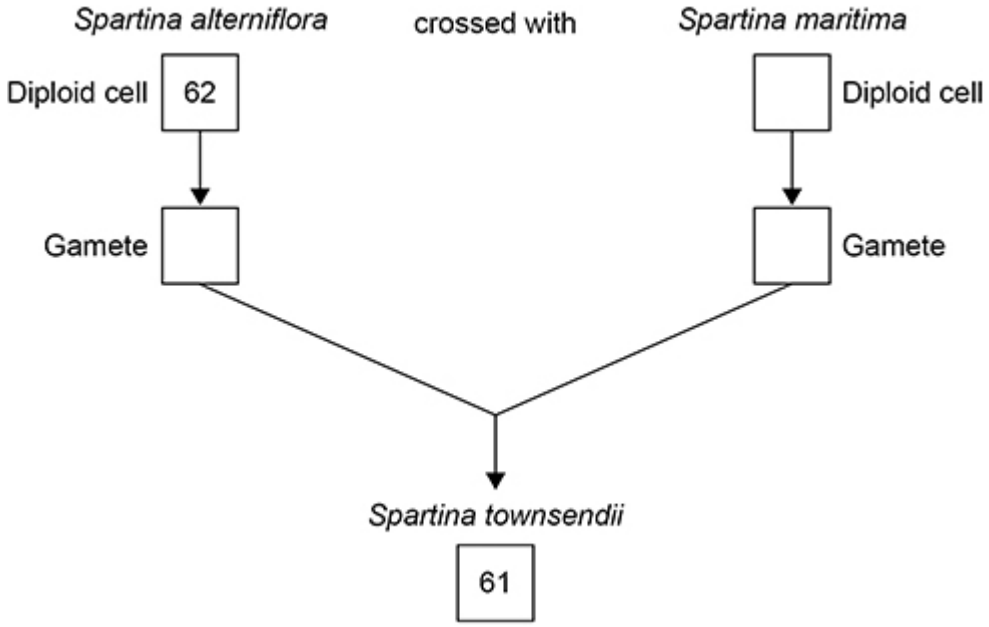
_____

(1)

(c) **Figure 1** shows how the species *Spartina townsendii* is produced.

The number of chromosomes in cells is shown in some of the boxes.

Figure 1



Complete **Figure 1** by giving the correct number of chromosomes in each of the boxes.

(1)

A mutation in the number of chromosomes in a *S. townsendii* cell produced a new species, *Spartina anglica*.

Figure 2 shows the number of chromosomes in leaf cells of these species.

Figure 2

(d) Name the type of mutation that changed the number of chromosomes in *S. townsendii* to produce *S. anglica*. Explain your answer.

Name of mutation _____

Explanation _____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(e) Genetic variation within a species is increased during meiosis by crossing over and the independent segregation of homologous chromosomes.

Apart from mutation, explain **one** other way genetic variation within a species is increased.

_____

_____

_____

_____

_____

(2)

Q2.

The table below shows **mRNA** codons for some amino acids.

Serine	Proline	Glycine	Threonine	Alanine
UCU	CCU	GGA	ACU	GCA
UCC	CCA	GGG	ACC	GCG

(c) **Figure 1** shows the DNA template nucleotide base sequence that determines the sequence of four amino acids.

Figure 1

AGG CGT CCT GGA

Use information from the table and **Figure 1** to give the amino acid sequence determined by this sequence of nucleotides.

_____

(1)

(d) A mutation in the nucleotide sequence shown in **Figure 1** resulted in the following amino acid sequence.

Figure 2

Serine Glycine Glycine Proline

A student concluded that the mutation involved the addition of one nucleotide within the sequence shown **Figure 1**. Does information in this question support the student's conclusion? Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(2)

Q3.

Trout is a type of fish, often produced commercially in trout farms.

(b) A trout body cell contains 80 chromosomes.

The table below shows the number of chromosomes and the mass of DNA in different nuclei. All the nuclei are from the same trout.

Complete the table below.

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At prophase of mitosis	80	
At telophase of mitosis		25
From an egg cell		

(2)

(c) Give **one** reason why trout eggs produced by meiosis are genetically different.

_____

_____

_____

_____

(1)

A trout body cell contains 80 chromosomes.

Farmed female trout are treated so that they produce diploid egg cells.

(d) Give the number of chromosomes in body cells of the offspring produced from treated farmed female trout and untreated farmed male trout.

Number of chromosomes _____

(1)

(e) The offspring produced from farmed trout are sterile. Suggest and explain why.

(2)

Q4.

(c) Define 'gene mutation' and explain how a gene mutation can have:

- no effect on an individual
- a positive effect on an individual.

(4)

Q5.

A scientist crossed a strain of the fungus *Neurospora* producing pink spores with a strain of *Neurospora* producing white spores.

In the life cycle of *Neurospora* most stages are haploid. Fusion of two haploid strains of this fungus produces diploid zygotes. Nuclear division in these zygotes occurs by meiosis.

(b) Give **two** differences between mitosis and meiosis.

1 _____

_____

_____

_____

_____

2 _____

_____

_____

_____

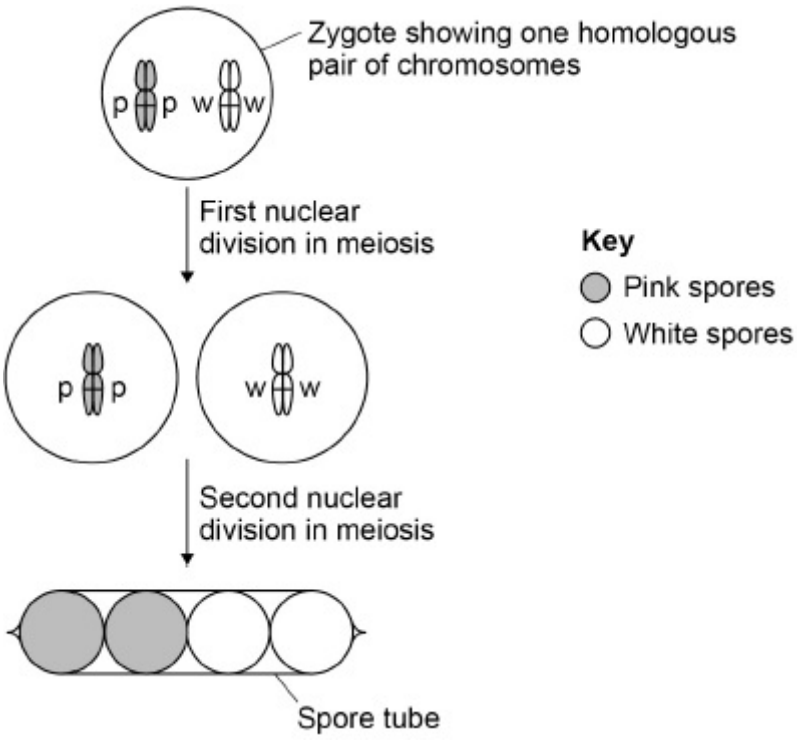
_____

(2)

At the end of meiosis, this fungus produces cells called spores.
The spores are produced in narrow tubes that restrict their movement. As a result, each tube contains a single line of spores. The spores are coloured either pink or white.

The spore colour gene is located on a pair of homologous chromosomes. Each zygote produced in this cross has one chromosome with a pink allele (p) and one chromosome with a white allele (w).

This is shown in the diagram.



(c) There are seven chromosomes in a spore nucleus.

Place a tick (✓) in the box next to the number that represents the number of **chromatids** present in the zygote shown in the diagram above.

7 ☐

14 ☐

21 ☐

28 ☐

(1)

The scientist recorded the arrangement of coloured spores inside many narrow tubes. His results are shown in the table.

Type of spore tube	Arrangement of coloured spores	Number of narrow tubes
1		81
2		78
3		10

(d) Using all the information in this question, what can you conclude from the scientist's results about the movement of chromosomes in meiosis in this fungus?

(3)

(Total 9 marks)

Q6.

(a) Draw the general structure of an amino acid.

(1)

Table 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

Table 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gin		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the properties of the R group of each amino acid

No overall change Positively charged Negatively charged

A scientist investigated changes in the amino acid sequence of a human enzyme resulting from mutations. All these amino acid changes result from single base substitution mutations.
This enzyme is a polypeptide 465 amino acids long.

Table 2 shows the result of three of the base substitutions.

Table 2

Amino acid number	Correct amino acid	Amino acid inserted as a result of mutation
203	Val	Ala
279	Glu	Lys
300	Glu	Lys

(c) What is the minimum number of bases in the gene coding for this polypeptide?

Answer = _____

(1)

(d) Use information from **Table 1** to tick (✓) one box that shows a single base substitution mutation in DNA that would result in a change from Val to Ala at amino acid number 203

CAA ⟶ CGA ☐

GUU ⟶ GCA ☐

GUU ⟶ GUC ☐

CAC ⟶ CGG ☐

(1)

(e) A change from Glu to Lys at amino acid 300 had no effect on the rate of reaction catalysed by the enzyme. The same change at amino acid 279 significantly reduced the rate of reaction catalysed by the enzyme.

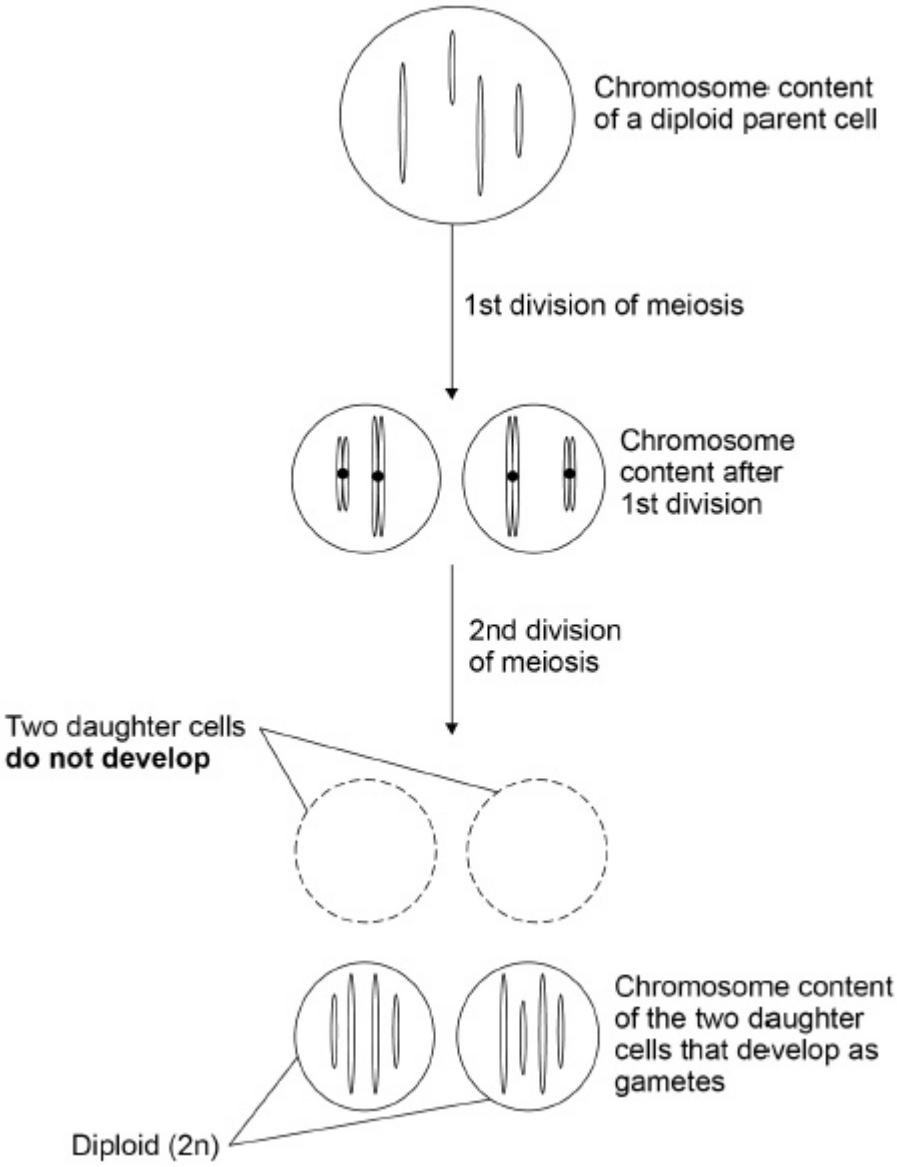
Use all the information and your knowledge of protein structure to suggest reasons for the differences between the effects of these two changes.

(3)

Q7.

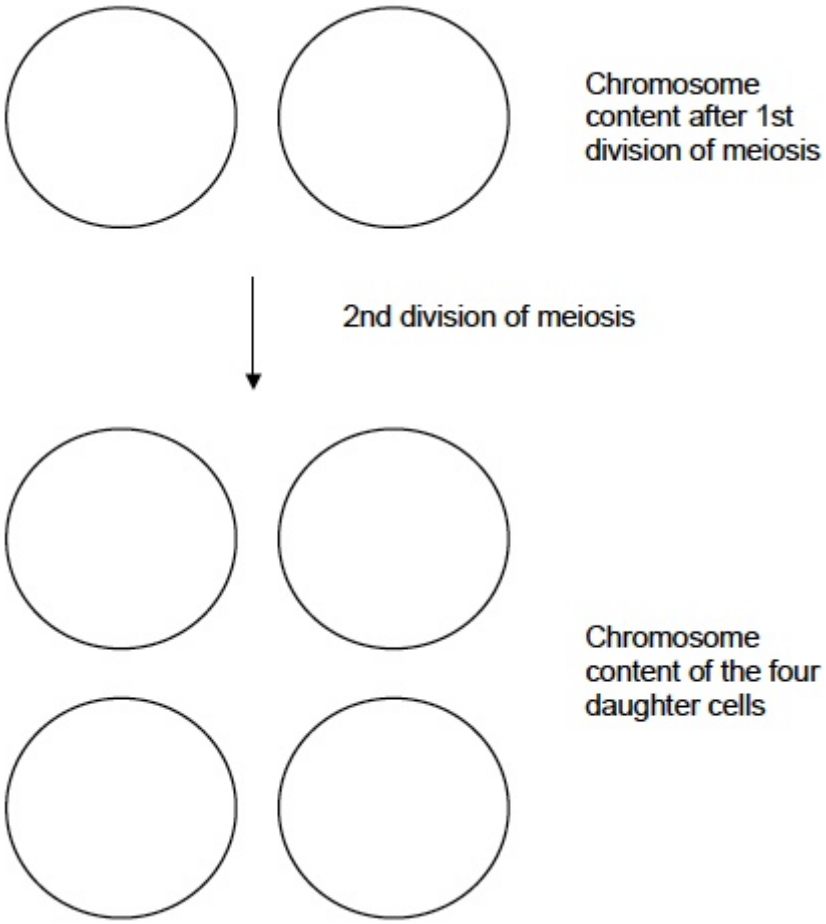
Figure 1 shows a faulty form of meiosis that can occur in some plants.

Figure 1



(a) Complete **Figure 2** to show the chromosome content of the cells that would result from a normal meiotic division of the diploid parent cell shown in **Figure 1**.

Figure 2



(2)

(b) If two diploid (2n) gametes fuse at fertilisation, it can result in the growth of a tetraploid plant which has 4 copies of each chromosome.

Red clover is a plant grown to produce cattle feed. Tetraploid red clover plants produce a higher yield than diploid red clover plants.

Whether a red clover plant produces 2n gametes is genetically controlled.

Scientists investigated the possibility of breeding red clover plants that only produced 2n gametes.

- In breeding cycle 0, they grew red clover plants and identified plants that produced 2n gametes.
- In breeding cycle 1, they used the plants producing 2n gametes to produce offspring.
- In breeding cycles 2 and 3, they identified plants producing 2n gametes and used these to produce offspring.

Their results are shown in the table.

	Observed		**Expected**	
Breeding cycle	Number of plants that **did not** produce 2n gametes	Number of plants that **did** produce 2n gametes	Number of plants that **did not** produce 2n gametes	Number of plants that **did** produce 2n gametes
0	50	4	50	4
1	14	42		
2	2	44		
3	0	56		

The scientists used the following null hypothesis.

'The proportion of plants that produce 2n gametes will not change from one breeding cycle to the next.'

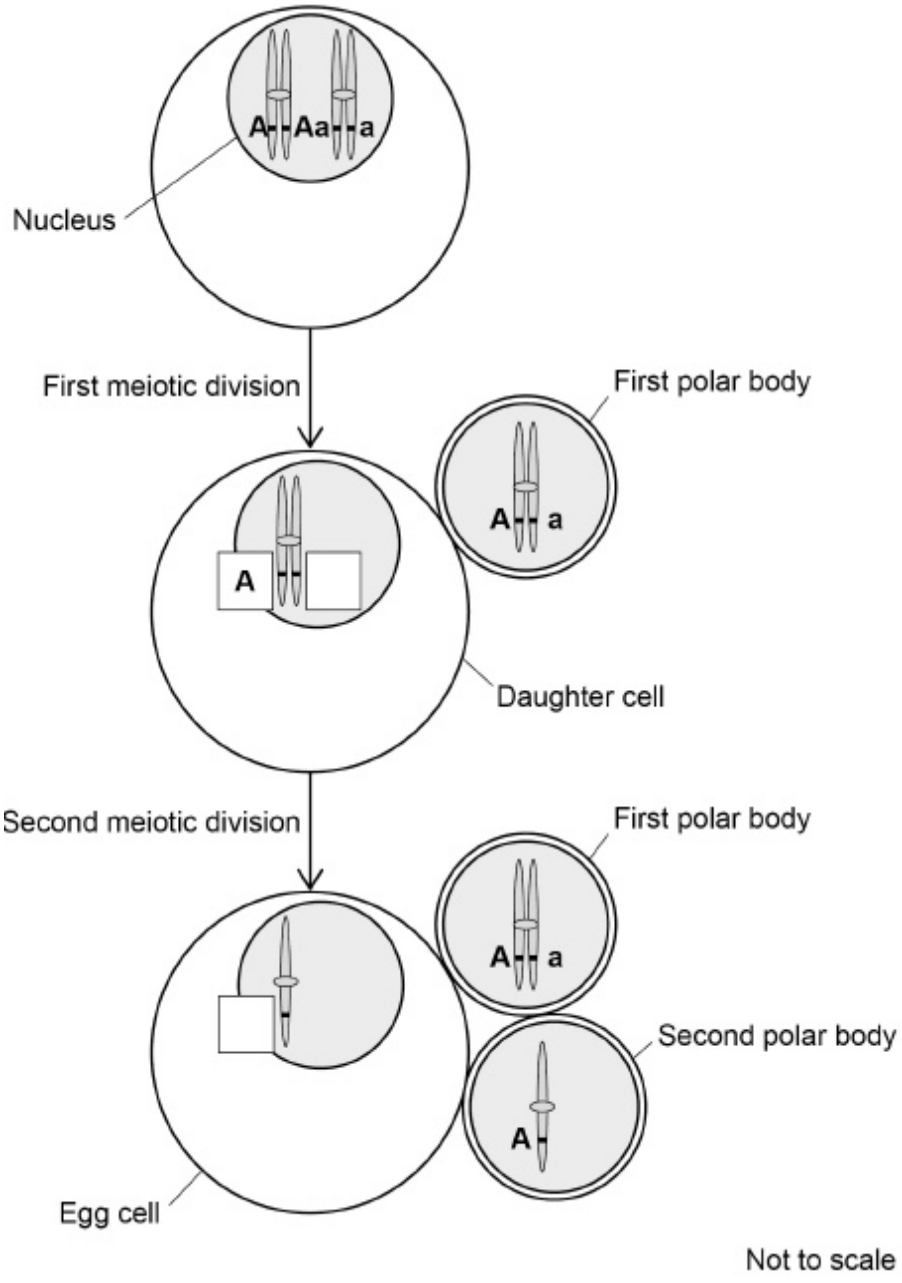
Complete the table to show the **expected number** of plants that **did not** produce 2n gametes and the expected number of plants that **did** produce 2n gametes after 1 cycle.
Give each answer to the nearest whole number.

(2)

Q8.

In women, the first division of meiosis produces one daughter cell that has almost all of the cytoplasm. The other daughter cell consists of a nucleus surrounded by a very small amount of cytoplasm and a cell-surface membrane. This very small daughter cell is called a polar body. Polar bodies do not usually divide. The same process occurs in the second division of meiosis, resulting in one egg cell and two polar bodies.

The diagram shows the formation of an egg cell and two polar bodies during meiosis. It also shows what happens to one pair of homologous chromosomes. This pair carries two alleles of gene A.



(a) Complete the diagram by putting **A** or **a** in the boxes. One box has been

completed for you with **A**.

(1)

(b) Put a tick (✓) in the box next to the name of the process that produced the combination of alleles on the chromosome in the first polar body in the diagram.

Anaphase ☐

Crossing over ☐

Independent assortment ☐

Semi-conservative replication ☐

(1)

(c) A scientist measured the diameter of a polar body and the diameter of the nucleus inside it. The diameter of the polar body was 10.4 μm and the diameter of the nucleus was 7.0 μm. The density of mitochondria in the cytoplasm of the polar body (outside of the nucleus) was 0.08 mitochondria per μm^3.

Calculate the number of mitochondria in the polar body. You should assume polar bodies and nuclei are spherical.

The formula for the volume of a sphere is $\frac{4}{3}\pi r^3$ where $\pi = 3.14$

Show your working.

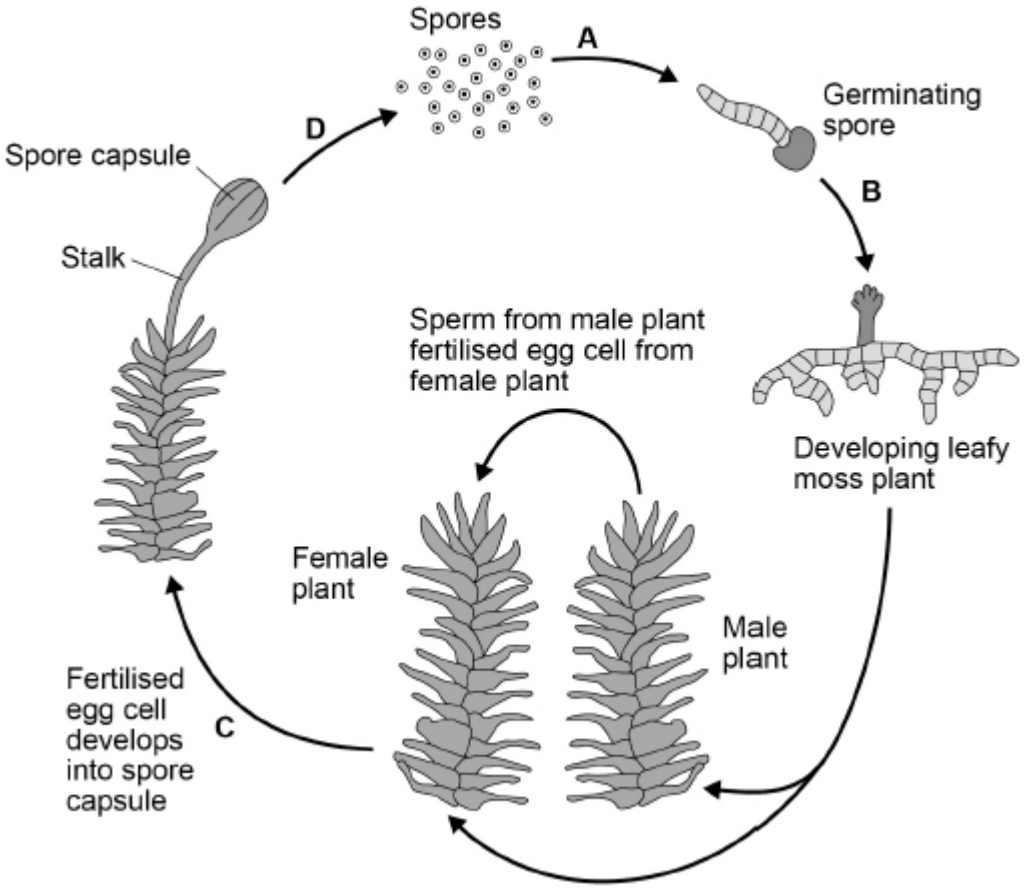
Number of mitochondria =_____

(2)

Q9.

Figure 1 shows the life cycle of a moss plant. In this life cycle, **only** the stalk and spore capsule are **diploid**. All the cells in all the other stages of the life cycle of the moss are **haploid**.

Figure 1



(a) Which letter, **A**, **B**, **C** or **D**, in **Figure 1**, shows where meiosis occurs in the life cycle of the moss? Write the appropriate letter in the box provided.

(1)

(b) Explain how the chromosome number is halved during meiosis.

(2)

(c) **Figure 2** shows a cell from the moss plant.

The cell is in the **second** meiotic division.

Figure 2

What is the haploid number of chromosomes for this species of moss?

(1)

(d) Crossing over greatly increases genetic diversity in this species of moss.

Describe the process of crossing over and explain how it increases genetic diversity.

_____

_____

(4)

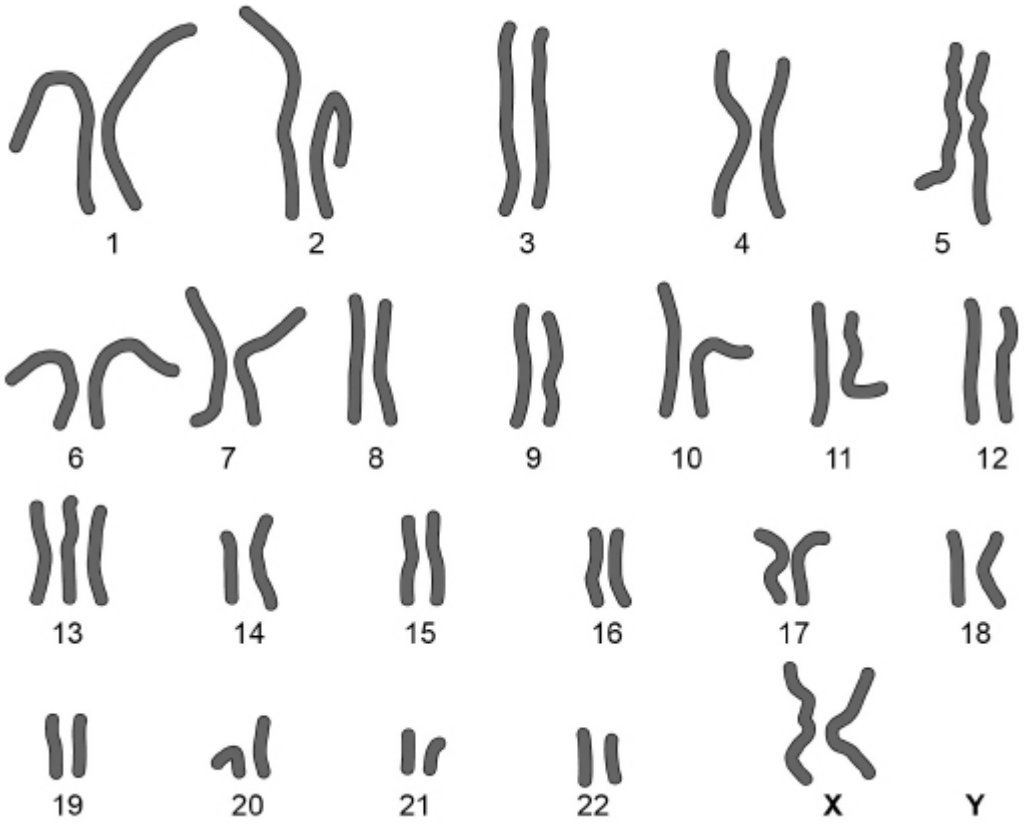
(Total 8 marks)

Q10.

Patau syndrome is a condition caused by a mutation affecting chromosome number. All the cells of the body will have this mutation.

Figure 1 shows the chromosomes from one of the cells of a female who has Patau syndrome.

Figure 1



(a) What is the effect of Patau syndrome on the chromosomes of this female?

_____

_____

(1)

(b) Describe how the change in chromosome number in Patau syndrome was produced.

_____

_____

_____

(2)

(c) Explain why all the cells of the body will have this mutation.

(2)