Exampro A-level Biology (7401/7402)

Name:

Class:

Genetic diversity QP

Author:

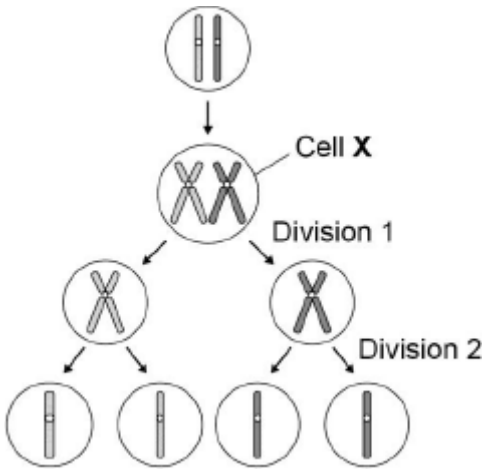
Date:

Time: **101**

Marks: **85**

Comments:

Q1. The figure below summarises the process of meiosis. The circles represent cells and the structures within each cell represent chromosomes.



(a) Describe and explain the appearance of **one** of the chromosomes in cell **X**.

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(3)

(b) Describe what has happened during division 1 in the figure above.

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(2)

(c) Identify **one** event that occurred during division 2 but **not** during division 1.

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(1)

(d) Name **two** ways in which meiosis produces genetic variation.

1 .....

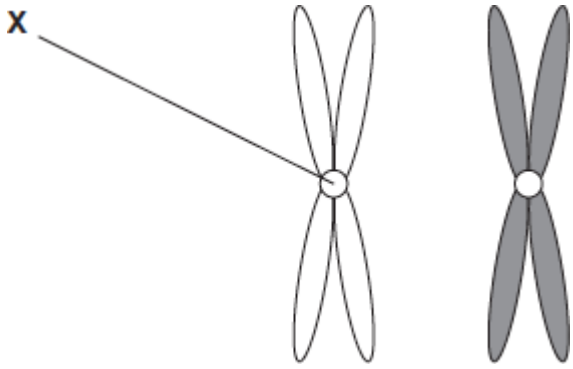
2 .....

(2)

(Total 8 marks)

Q2.(a) **Figure 1** shows one pair of homologous chromosomes.

Figure 1



(i) Name **X.**

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(1)

(ii) Describe the role of **X** in mitosis.

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(2)

(iii) Homologous chromosomes carry the same genes but they are **not** genetically identical.Explain why.

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(1)

(b) **Figure 2** shows three pairs of homologous chromosomes in a cell at the end of cell division.

Figure 2

(i) The appearance of each chromosome in **Figure 2** is different from those shown in **Figure 1.** Explain why.

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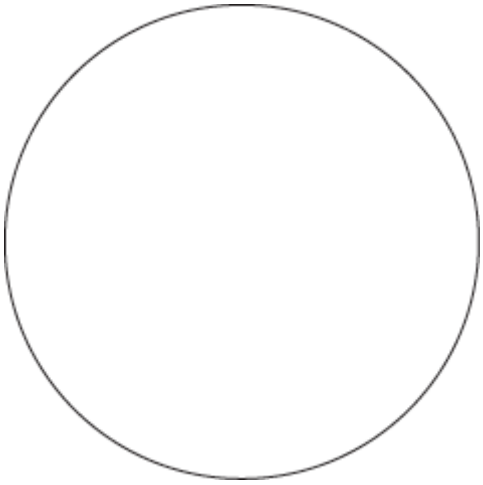
(1)

(ii) Complete the diagram to show the chromosomes in one cell that could be produced from the cell in **Figure 2** as a result of meiosis.



(2)

(iii) Other than independent segregation, give **one** way in which meiosis allows the production of genetically different cells.

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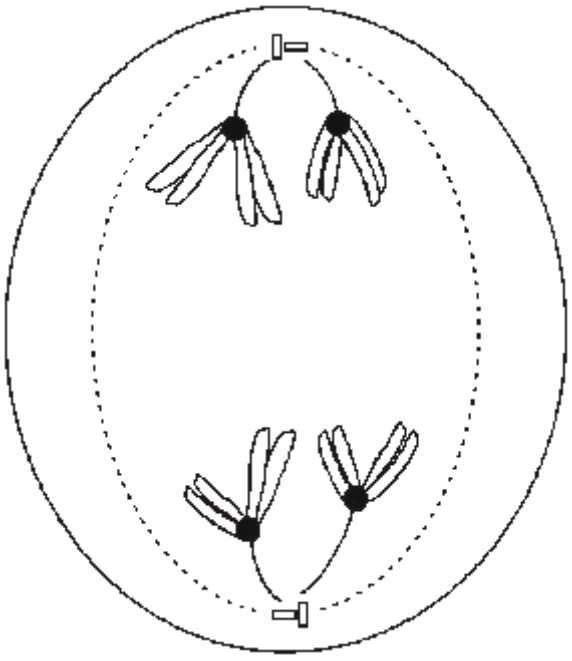
(1)
(Total 8 marks)

Q3. (a) The diagram shows a cell undergoing cell division.



Identify the type and stage of cell division shown. Give evidence from the diagram to support your answer.

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(3)

(b) Describe how crossing over occurs during meiosis I.

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(2)
(Total 5 marks)

Q4. Two pairs of alleles **A** and **a**, and **B** and b are found on one pair of homologous chromosomes. A person has the genotype **AaBb**. **Figure 1** shows the chromosomes at an early stage of meiosis. The position of two of the alleles is shown.

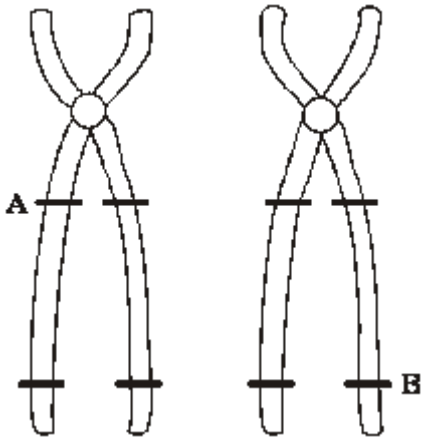

Figure 1

(a) Complete **Figure 1** to show the alleles present at the other marked positions.

(1)

Crossing over occurs as shown in **Figure 2**.

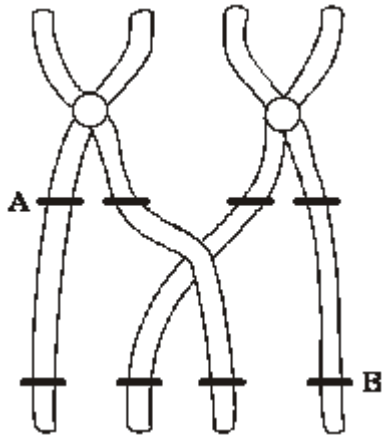

Figure 2

(b) What term is used to describe the pair of homologous chromosomes shown in **Figure 2**?

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(1)

(c) From **Figure 2**, give the genotypes of the gametes produced containing the chromatids

(i) that have **not** crossed over;

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(ii) that have crossed over.

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(2)

(d) Give **two** processes, other than crossing over, which result in genetic variation. Explain how each process contributes to genetic variation.

Process .....

Explanation .....

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(2)

Process .....

Explanation .....

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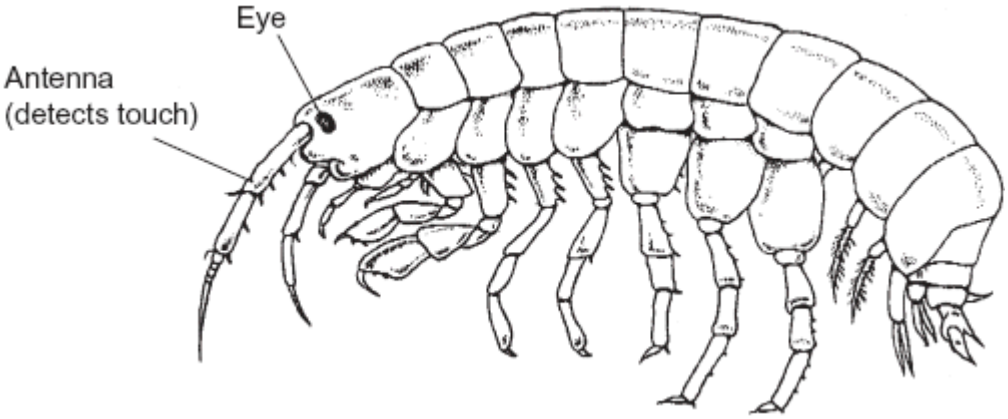
(2)
(Total 8 marks)

Q5. **Figure 1** shows a fresh-water shrimp.

Figure 1



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.

They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

	Shrimps from the stream	
	Inside the cave	In the open
Mean diameter of eye /mm	0.09	0.24
Mean length of antenna /mm	8.46	5.81

(a) The biologists measured the maximum diameter of each shrimp's eye.

Explain why they measured the **maximum** diameter.

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(1)

(b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

(i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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(2)

(ii) The data in **Figure 2** are mean values. Explain how standard deviations of these cmean values would help you to interpret the data in **Figure 2**.

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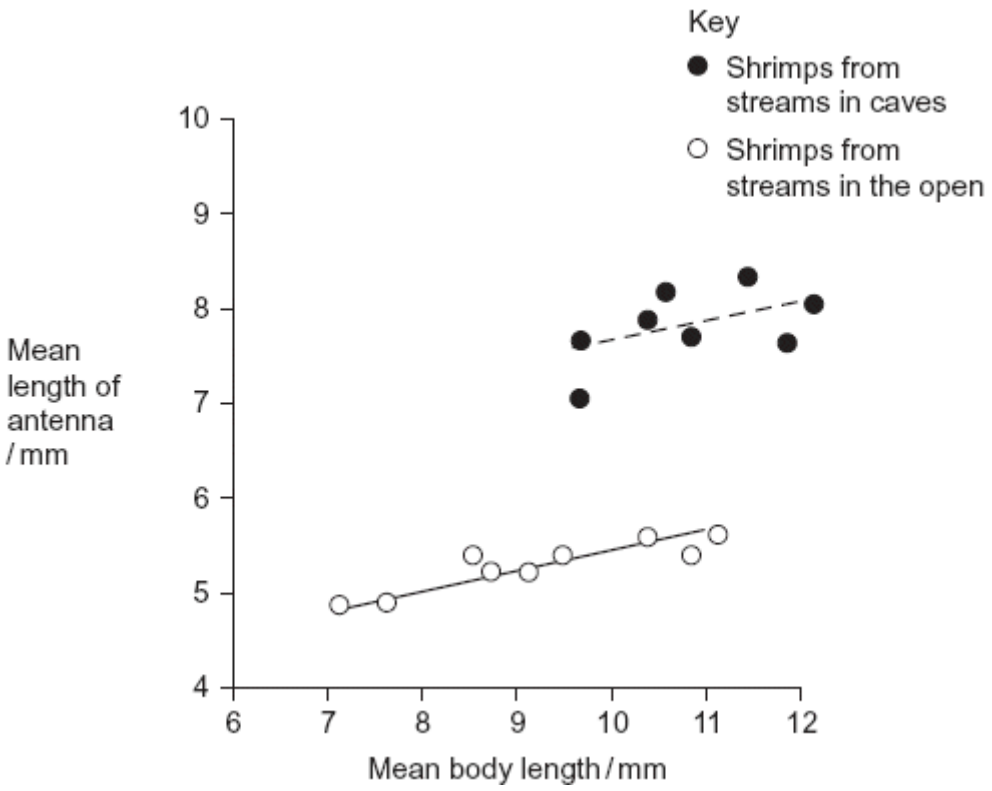
(2)

(c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length.

Figure 3 shows the mean antenna length plotted against mean body length for each site.

Figure 3



(i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

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(2)

(ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

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(1)

Other biologists investigated the genetic diversity of these shrimps. **Figure 4** shows some of the data they collected.

Figure 4

Gene	Allele	Percentage of shrimps with this allele in steam	
		Inside a cave	In the open
PGI	**A**	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	**J**	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

(d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

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(1)

(e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3)

(f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding

experiments to investigate this.

(i) Describe how the biologists should carry out these breeding experiments.

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(ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

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(3)
(Total 15 marks)

Q6. The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

(a) (i) How many chromosomes are there in a male gamete from variety **C**?

(1)

(ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

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(2)

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

(b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

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(1)

(ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

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(1)

(c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

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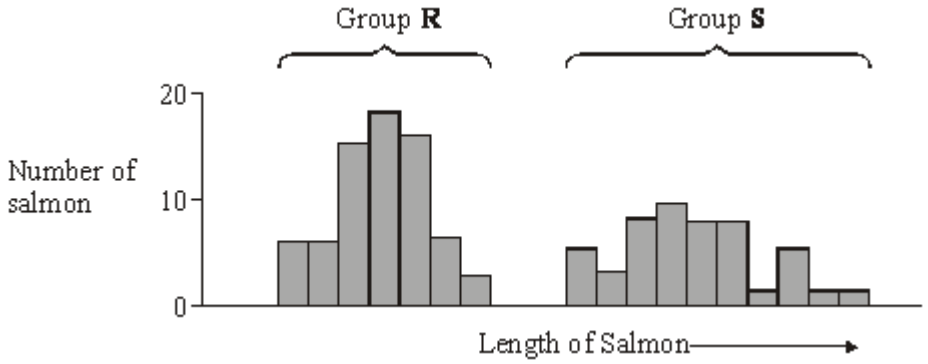
(2)
(Total 7 marks)

Q7. The graph shows the variation in length of 86 Atlantic salmon.



(a) Give **two** possible causes of this variation that result from meiosis during gamete formation.

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2 .....

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(2)

(b) When comparing variation in size between two groups of organisms, it is often considered more useful to compare standard deviations rather than ranges. Explain why.

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(2)
(Total 4 marks)

Q8. (a) Describe what happens to chromosomes in meiosis.

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(6)

(b) Meiosis results in genetic variation in the gametes which leads to variation in the offspring formed by sexual reproduction. Describe how meiosis causes this variation and explain the advantage of variation to the species.

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(5)

(c) An old form of wheat, emmer wheat (*Triticum turgidum*), has a diploid chromosome number of 28 (2n = 28). A wild wheat, einkorn wheat (*Triticum tauschii*), has a diploid chromosome number of 14 (2n = 14). These two species occasionally

crossed and produced sterile hybrid plants. Due to an error during cell division, one of these hybrid plants formed male and female gametes with 21 chromosomes. Fusion of these gametes resulted in viable offspring. These plants were a new species, *Triticum aestivum* (2n = 42), our modern bread wheat.

(i) How many chromosomes would there have been in each of the cells of the hybrid plant produced by crossing *Triticum turgidum* with *Triticum tauschii*?

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(1)

(ii) Explain why *Triticum aestivum* is fertile while the majority of hybrid plants were not.

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(3)
(Total 15 marks)

Q9. Read the following passage carefully.

A large and growing number of disorders are now known to be due to types of mitochondrial disease (MD). MD often affects skeletal muscles, causing muscle weakness.

We get our mitochondria from our mothers, via the fertilised egg cell. Fathers do not pass on mitochondria via their sperm. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria. These mutations of nuclear DNA produce recessive alleles. 5

One form of mitochondrial disease is caused by a mutation of a mitochondrial gene that codes for a tRNA. The mutation involves substitution of guanine for adenine in the DNA base sequence. This changes the anticodon on the tRNA.
This results in the formation of a non-functional protein in the mitochondrion.

There are a number of ways to try to diagnose whether someone has a mitochondrial disease. One test involves measuring the concentration of lactate in a person's blood after exercise. In someone with MD, the concentration is usually much higher than normal. If the lactate test suggests MD, a small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation.

Use information in the passage and your own knowledge to answer the following questions.

(a) Mitochondrial disease (MD) often causes muscle weakness (lines 1–3). Use your knowledge of respiration and muscle contraction to suggest explanations for this effect of MD.

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(Extra space) .....

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(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A** .....

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Couple **B** .....

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(Extra space) .....

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(4)

(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

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(Extra space) .....

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(3)

(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

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(Extra space) .....

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(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

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(2)
(Total 15 marks)