Genetic diversity Pack

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Genetic diversity Pack

1 (a) Describe the appearance and behaviour of chromosomes during mitosis.

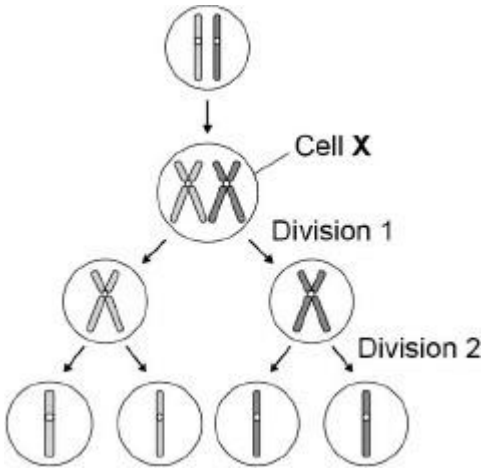
(5)

(b) Describe and explain the processes that occur during meiosis that increase genetic variation.

(5)

(Total 10 marks)

2 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**.

(Extra space)

(3)

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

_____

_____

_____

_____

_____

_____

(2)

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

_____

(1)

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

1. _____

2. _____

(2)

(Total 8 marks)

3 The table shows the taxons and the names of the taxons used to classify one species of otter. They are **not** in the correct order.

	Taxon	Name of taxon
J	Family	Mustelidae
K	Kingdom	Animalia
L	Genus	Lutra
M	Class	Mammalia
N	Order	Carnivora
O	Phylum	Chordata
P	Domain	Eukarya
Q	Species	lutra

(a) Put letters from the table above into the boxes in the correct order. Some boxes have been completed for you.

		O	**M**			**L**	**Q**

(1)

(b) Give the scientific name of this otter.

_____

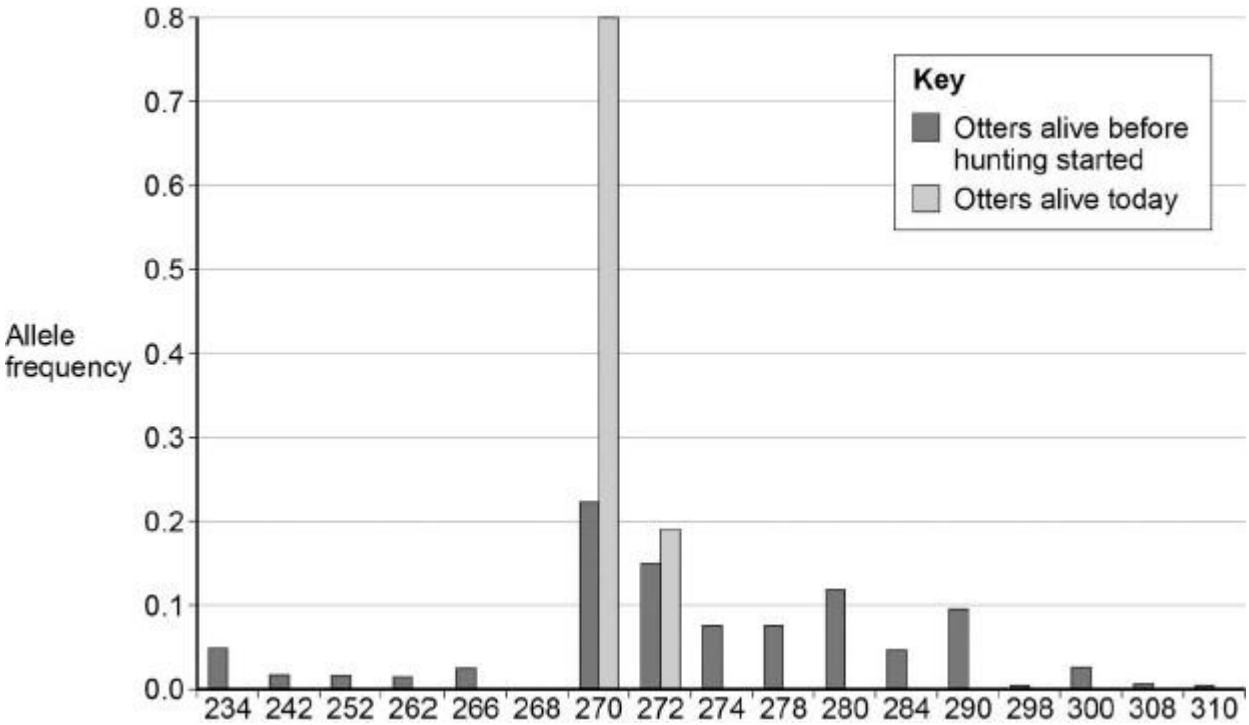
(1)

Scientists investigated the effect of hunting on the genetic diversity of otters. Otters are animals that were killed in very large numbers for their fur in the past.

The scientists obtained DNA from otters alive today and otters that were alive before hunting started.

For each sample of DNA, they recorded the number of base pairs in alleles of the same gene. Mutations change the numbers of base pairs over time.

The figure below shows the scientists' results.



(c) The scientists obtained DNA from otters that were alive before hunting started.

Suggest **one** source of this DNA.

_____

_____

(1)

(d) What can you conclude about the effect of hunting on genetic diversity in otters? Use data from the figure above to support your answer.

_____

_____

_____

(2)

(e) Some populations of animals that have never been hunted show very low levels of geneticdiversity.

Other than hunting, suggest **two** reasons why populations might show very low levels of genetic diversity.

1. _____

_____

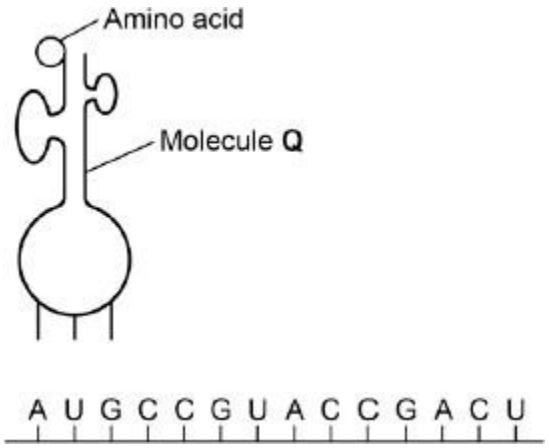
2. _____

_____

(2)

(Total 7 marks)

4 The diagram below represents one process that occurs during protein synthesis.



(a) Name the process shown.

_____

(1)

(b) Identify the molecule labelled **Q**.

_____

(1)

(c) In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence _____

the missing anticodon _____

(2)

The table below shows the base triplets that code for two amino acids.

Amino acid	Encoding base triplet
Aspartic acid	GAC, GAU
Proline	CCA, CCG, CCC, CCU

(d) Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

_____

_____

_____

(1)

(e) Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

(3)

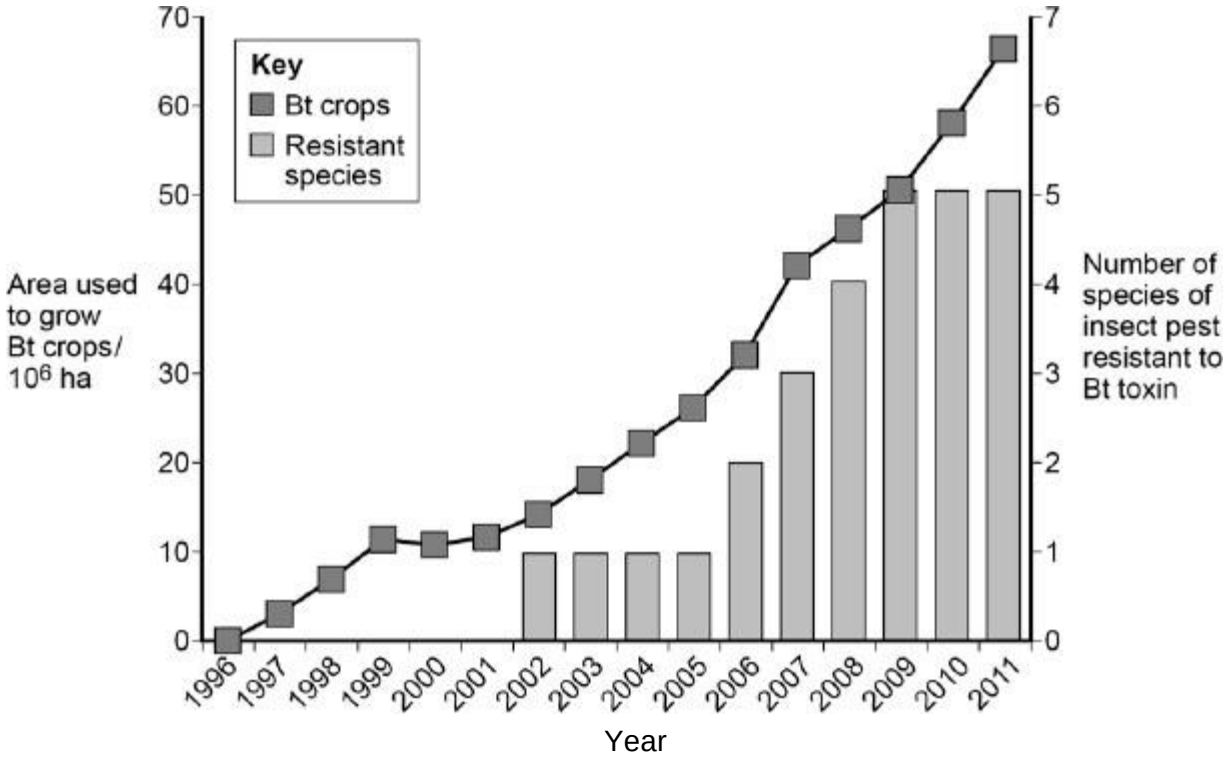
(Total 8 marks)

5 To reduce the damage caused by insect pests, some farmers spray their fields of crop plants with pesticide. Many of these pesticides have been shown to cause environmental damage.

Bt plants have been genetically modified to produce a toxin that kills insect pests. The use of Bt crop plants has led to a reduction in the use of pesticides.

Scientists have found that some species of insect pest have become resistant to the toxin produced by the Bt crop plants.

The figure below shows information about the use of Bt crops and the number of species of insect pest resistant to the Bt toxin in one country.



(a) Can you conclude that the insect pest resistant to Bt toxin found in the years 2002 to 2005 was the same insect species? Explain your answer.

_____

(1)

(b) One farmer stated that the increase in the use of Bt crop plants had caused a mutation in one of the insect species and that this mutation had spread to other species of insect. Washe correct? Explain your answer.

(Extra space)

(4)

(c) There was a time lag between the introduction of Bt crops and the appearance of the first insect species that was resistant to the Bt toxin.
Explain why there was a time lag.

(3)

(Total 8 marks)

6 **Table 1** shows how a bird called the bluethroat (*Luscinia svecica*) is classified by biologists.

Table 1

Taxon	Name of taxon
Domain	Eukaryota
	Animalia
	Chordata
	Aves
	Passeriformes
	Muscicapidae
Genus	
Species	

(a) Complete **Table 1** by filling the seven blank spaces with the correct terms.

(2)

A group of scientists investigated genetic diversity in different species of bird. For each species, the scientists:

- collected feathers from a large number of birds
- extracted DNA from cells attached to each feather
- analysed the samples of DNA to find genetic diversity.

Table 2 summarises their results.

Table 2

Species of bird	Number of genes examined	Number of genes examined that showed genetic diversity
Willow flycatcher	708	197
House finch	269	80
Bluethroat	232	81

(b) In this investigation, what is meant by **genetic diversity?**

_____

_____

(1)

(c) The scientists concluded that the bluethroat showed greater genetic diversity than the willow flycatcher. Explain why they reached this conclusion. Use calculations to supportyour answer.

_____

_____

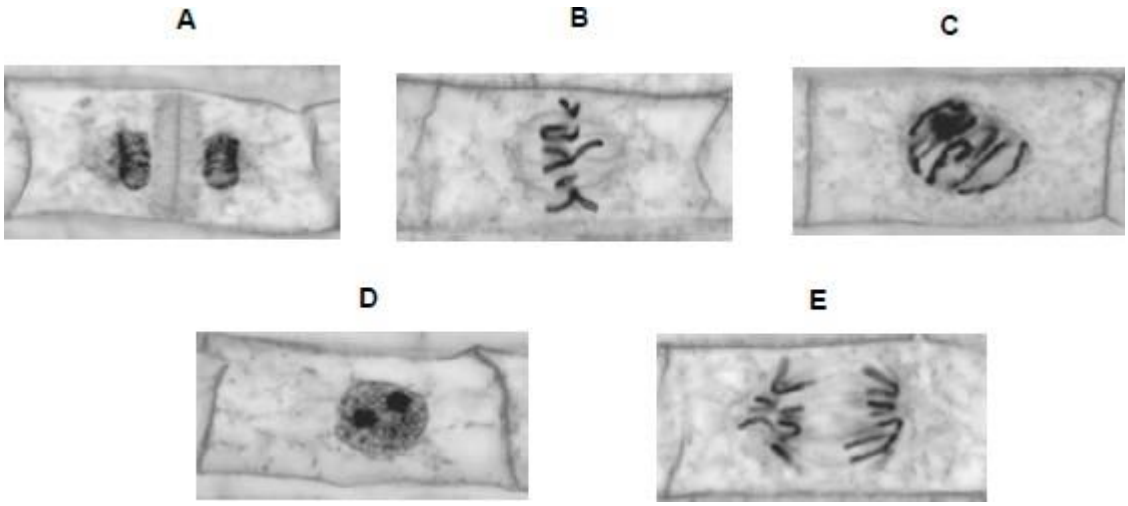
_____

_____

(2)

(Total 5 marks)

7 The figure below shows some cells from an onion root tip at different stages of the cell cycle.



(a) Place stages **A** to **E** in the correct order. Start with stage **D**.

D

_____

(1)

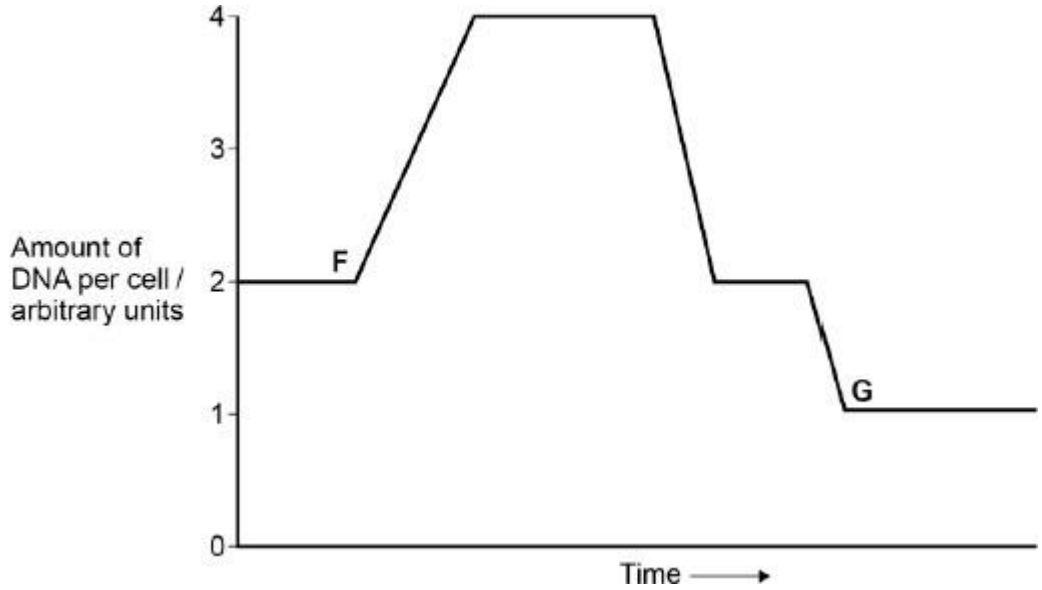
To obtain these images, the onion root tip was cut off, stained and put on a microscopeslide. A cover slip was placed on top. The root tip was then firmly squashed and viewedunder an optical microscope.

(b) Complete the table below to give **one** reason why each of these steps was necessary.

Step	Reason
Taking cells from the root tip	
Firmly squashing the root tip	

(2)

The figure below shows how the amount of DNA per cell changed during interphase andmeiosis in an animal.



(c) Explain how the behaviour of chromosomes causes these changes in the amount of DNA per cell between **F** and **G**.

(Extra space) _____

(3)

(d) What would happen to the amount of DNA per cell at fertilisation of cell **G?**

(1)

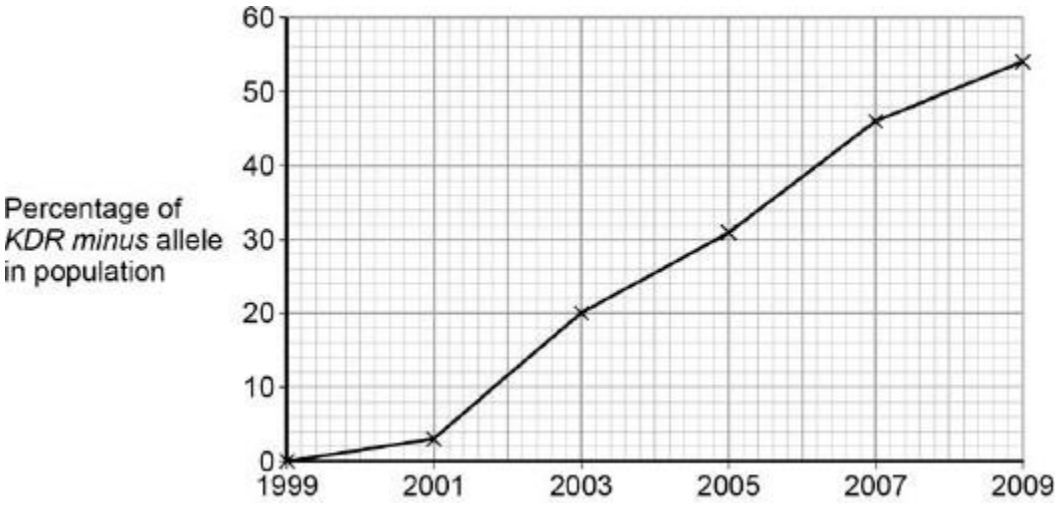
(Total 7 marks)

8 Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticideused to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR plus*, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



(a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygous for the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003 _____

(2)

(b) Suggest an explanation for the results in the figure above.

(Extra space)

(4)

The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time. Use this information to suggest how DDT kills insects.

(2)

(d) Suggest how the *KDR minus* allele gives resistance to DDT.

(2)

(Total 10 marks)

9 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.

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.

(Extra space)

(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrialdisease. 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** _____

_____

_____

_____

Couple **B** _____

_____

_____

_____

(Extra space) _____

_____

_____

_____

(4)

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

(Extra space)

(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.

(Extra space)

(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used totry 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?

_____

_____

_____

_____

(2)

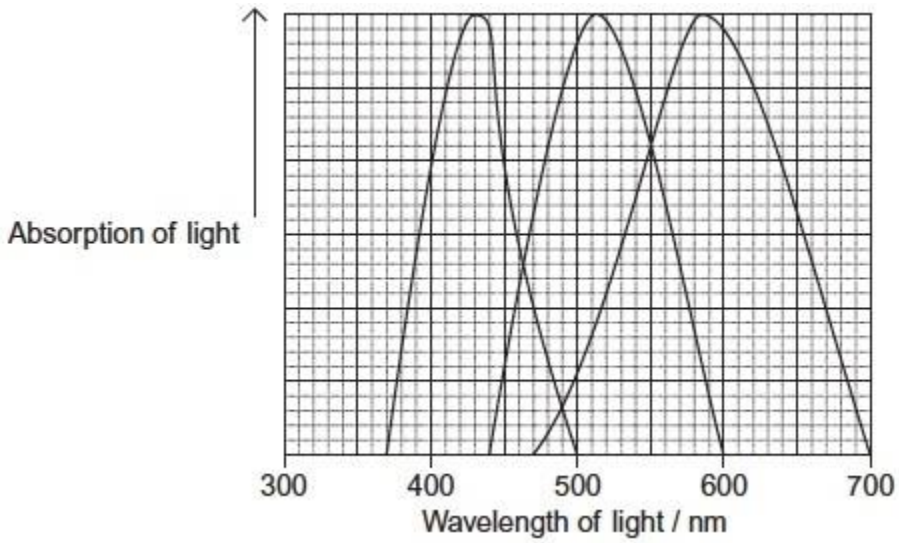
(Total 15 marks)

10 The retinas in the eyes of humans and birds have cone cells that absorb light of differentwavelengths.

Resource A

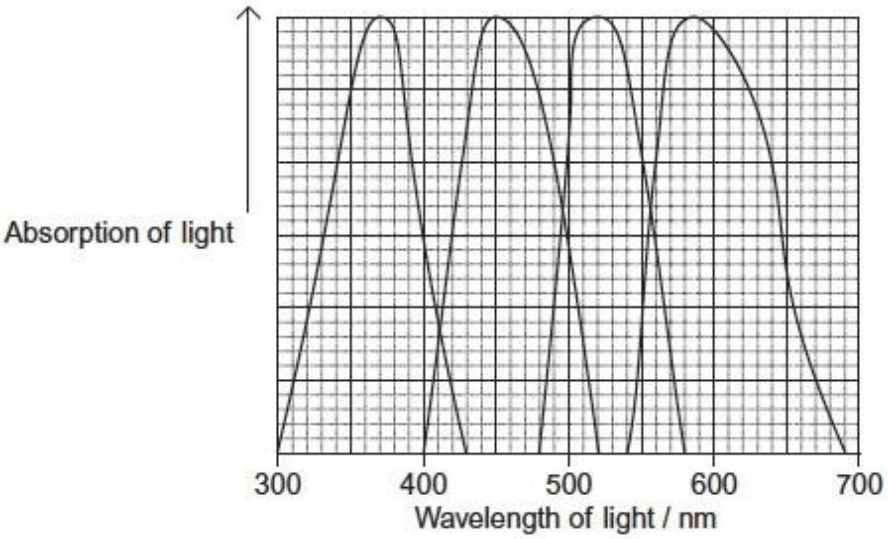
A scientist recorded the absorption of light of different wavelengths by different types of human cone cells. Her results are shown in **Figure 1**. Each curve shows the absorption of light by one type of cone cell.

Figure 1



She also recorded the absorption of light of different wavelengths by different types of bird cone cells. These results are shown in **Figure 2**. Each curve shows the absorption of light by one type of cone cell.

Figure 2



Resource B

Bluethroats are a species of small brightly coloured bird. The feathers on the throats of male birds reflect UV light (370 nm). Scientists investigated the response of female bluethroats to this reflected UV light.

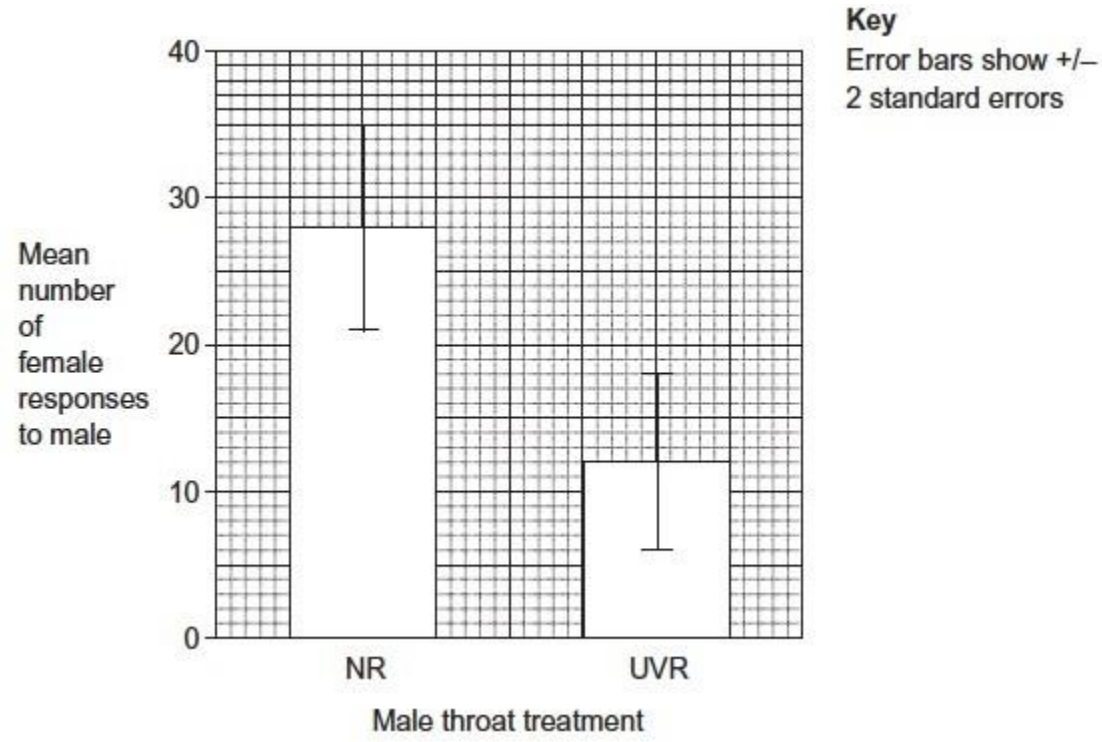
The scientists used 40 male birds selected because they were very similar to each other. The scientists treated the throat feathers of male birds as follows:

- they put a clear oil on the throat feathers of 20 males. They described these males as no UV reduction (NR).
- they put the same oil on the throat feathers of another 20 males but the oil contained a substance that absorbs UV light. They described these males as UV reduced (UVR).

In each experiment, the scientists placed two males where a female could see them. One male was NR and the other was UVR. During the next 5 minutes, they recorded how many times the female responded by moving towards each male.

Their results are shown in **Figure 3**.

Figure 3



Use **Resource B** to answer Questions (a) to (d).

(a) The male birds were selected because they were very similar to each other.
Suggest **two** reasons why it was important that they were of similar age.

1 _____

_____

_____

2 _____

_____

_____

(2)

(b) Of the 40 male birds the scientists selected 20 to receive the NR treatment. They selected these birds at random.
Suggest how.

_____

_____

_____

(1)

(c) The scientists recorded how many times each female moved towards a male.

In designing the experiment, suggest **two** assumptions the scientists made when they decided to record this movement.

1 _____

_____

2 _____

_____

(2)

(d) The pigment in the throat feathers of the male birds that reflects UV light is a protein. This protein arose by a gene mutation.
Explain how a gene mutation could result in a new protein.

(3)

Use **Resources A and B** to answer Question (e).

(e) A student who read both resources concluded that female bluethroats are attracted to the blue throat feathers of males when selecting a mate.
Do these data support this conclusion? Give reasons for your answer.

(4)

(Total 12 marks)

11 Read the following passage.

Alzheimer's disease leads to dementia. This involves small β-amyloid proteins binding together to form structures called plaques in the brain.

Nerve cells in the brain produce a large protein called amyloid-precursor protein that has a complex shape. This protein is the substrate of two different enzymes, α-secretase and β-secretase. These enzymes are normally produced in the brain. One product of the reaction catalysed by β-secretase is a smaller protein that can lead to β-amyloid protein formation. Many people with Alzheimer's disease have mutations that decrease α-secretase production, or increase β-secretase production.

One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase. When some of these types of drugs were trialled on patients, the trials had to be stopped because some patients developed serious side effects.

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

(a) Suggest how amyloid-precursor protein can be the substrate of two different enzymes, α-secretase and β-secretase (lines 3–5).

_____

_____

_____

_____

_____

(2)

(b) One product of the reaction catalysed by β-secretase is a smaller protein (lines 6–7).

Describe what happens in the hydrolysis reaction that produces the smaller protein from amyloid-precursor protein.

_____

_____

_____

_____

_____

(2)

(c) Many people with Alzheimer's disease have mutations that decrease α-secretaseproduction, or increase β-secretase production (lines 8–9).

Use the information provided to explain how these mutations can lead to Alzheimer's disease.

(3)

(d) One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase (lines 10–11).

Explain how this type of drug could prevent Alzheimer's disease becoming worse.

(2)

(e) When some of these types of drugs were trialled on patients, the trials were stopped because some patients developed serious side effects (lines 11–13).

Using the information provided, suggest why some patients developed serious side effects.

(1)

(Total 10 marks)

12 (a) HIV attaches to a specific protein receptor on helper T cells.
A low percentage of peoplehave a mutation of the *CCR5* gene which codes for this protein receptor. This mutation results in a non-functional protein receptor.

Explain how this mutation can result in the production of a non-functional protein receptor.

(4)

(b) People with the *CCR5* mutation show a greater resistance to developing AIDS.

Explain why.

(2)

(c) The frequency of the *CCR5* mutation is highest in Europe. Scientists have collected data onthe history and number of HIV infections in Europe. Using these data, scientists have concluded that the high frequency of the *CCR5* mutation is not due to natural selection in response to HIV.

Suggest **two** reasons why scientists reached this conclusion.

1. _____

_____

2. _____

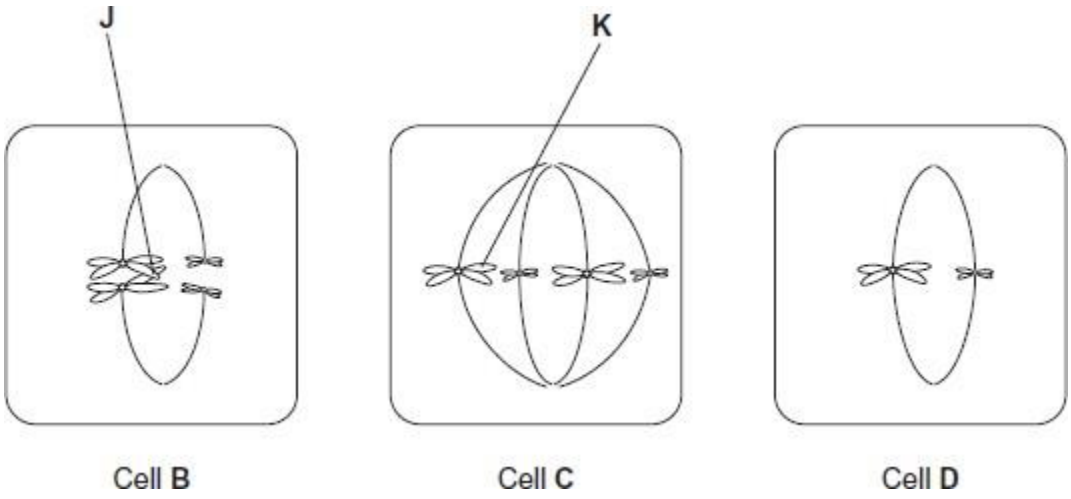
_____

(2)

(Total 8 marks)

13 **Figure 1** shows three cells, **B**, **C** and **D**, from tissues in the same organism. Each cell is in a stage of either mitosis or meiosis.

Figure 1



(a) Complete the table with a tick if the cell shows the feature.

	Cell B	Cell C	Cell D
homologous chromosomes are present			
a stage of mitosis			

(2)

(b) Describe and explain the appearance of chromosome **K** in cell **C**.

_____

_____

_____

_____

(2)

(c) Explain what is happening at point **J** in cell **B**.

_____

_____

_____

_____

(2)

(d) Use information from all three cells in **Figure 1** to explain how the number of chromosomes in cell **D** was produced.

_____

_____

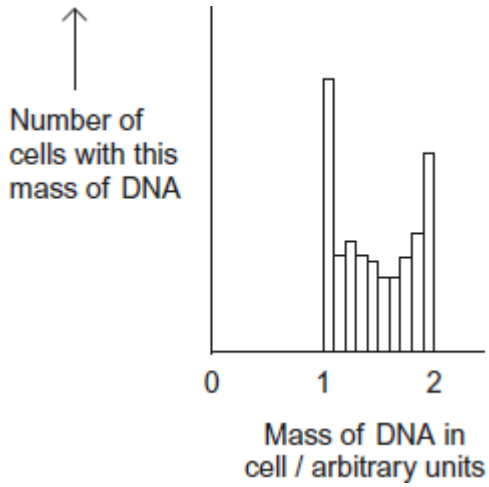
_____

_____

(1)

(e) **Figure 2** shows the mass of DNA present in cells of a population of healthy cells wheremitosis is occurring.

Figure 2



Explain why some cells contain a mass of DNA between 1 and 2 arbitrary units.

_____

_____

_____

(1)

(Total 8 marks)

14 (a) A mutation can lead to the production of a non-functional enzyme. Explain how.

(6)

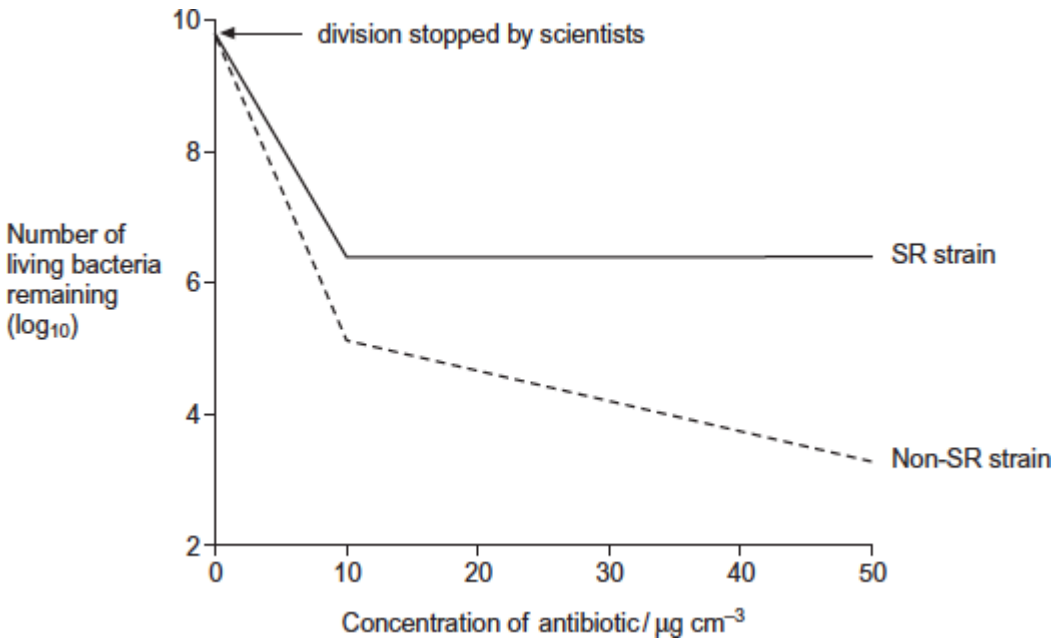
Scientists investigated the effect of a specific antibiotic on two strains of the same species of bacterium.

- One strain, SR, shows a **stringent response** in the presence of this antibiotic. Part of this response involves stopping cell division. This gives this strain a greater resistance to the effects of this antibiotic.
- The other strain, non-SR, cannot carry out a stringent response.

The scientists grew cultures of the SR strain and the non-SR strain containing the same number of bacterial cells. They then stopped each strain from dividing and exposed them to different concentrations of the antibiotic. After a fixed time, the scientists estimated the number of living bacteria remaining in the cultures.

Figure 1 shows their results.

Figure 1



(b) Describe differences in the effect of increasing the concentration of antibiotic on the SRstrain and the non-SR strain.

[Extra space]

(2)

(c) One way in which the stringent response gives resistance to this antibiotic is by stopping cell division.

The scientists concluded that stopping cell division is not the **only** way in which the stringent response gives resistance to this antibiotic.

Explain how **Figure 1** supports this conclusion.

[Extra space]

(2)

(d) The stringent response involves a number of enzyme-catalysed reactions.

Explain how scientists could use this knowledge to design drugs that make the treatment of infections caused by the SR strain more successful.

_____

_____

_____

_____

_____

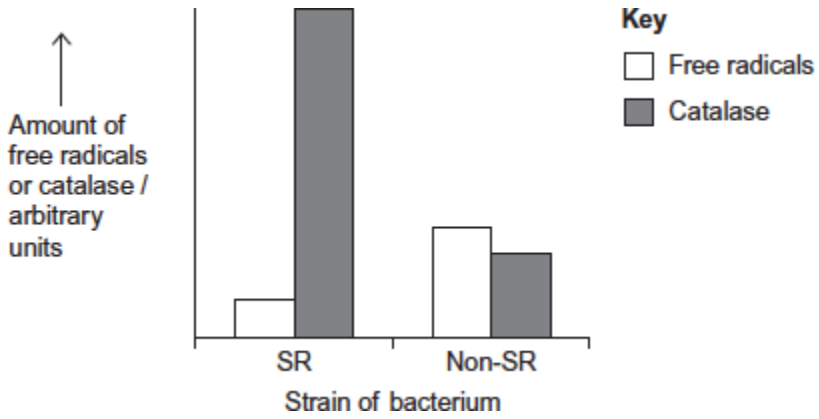
(2)

The antibiotic damages the bacterium by causing the production of substances called free radicals.

The scientists exposed the SR strain and the non-SR strain to the antibiotic. They then measured the amounts of free radicals and an enzyme called catalase in both strains.

Figure 2 shows their results.

Figure 2



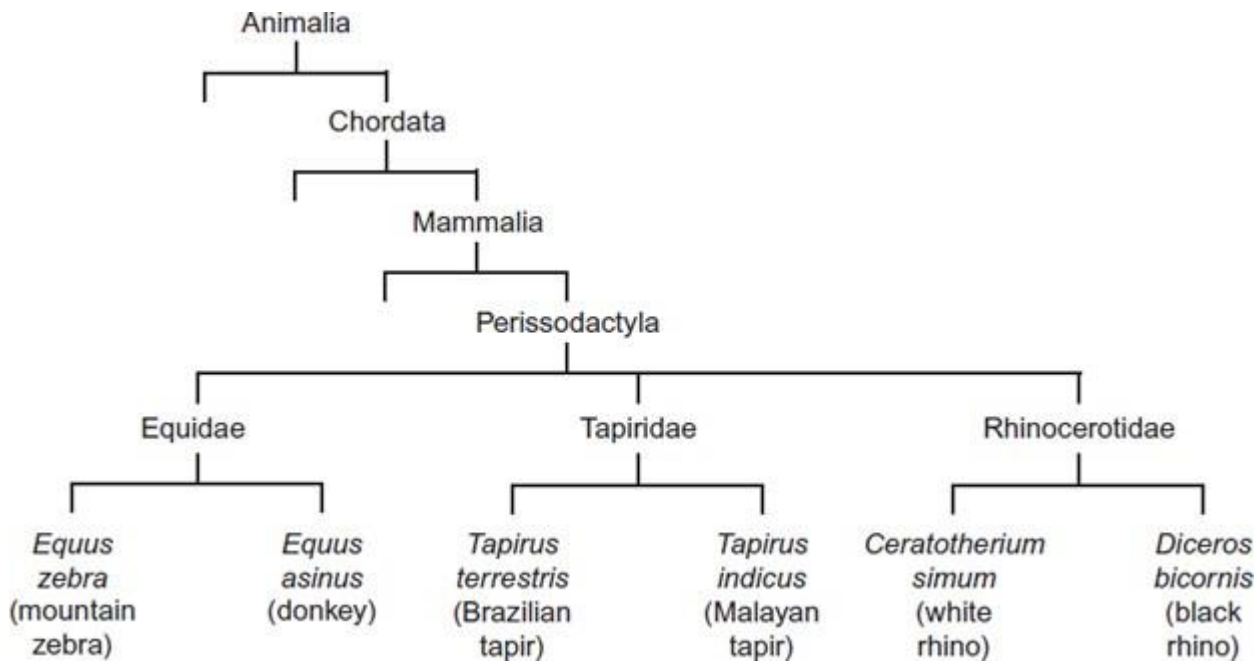
(e) Use the information provided and **Figure 2** to suggest an explanation for the greaterresistance of the SR strain to this antibiotic.

[Extra space]

(3)

(Total 15 marks)

15 The following figure shows how some animals with hooves are classified.



(a) This type of classification can be described as a phylogenetic hierarchy.

(i) What is meant by a **hierarchy**?

_____

_____

_____

_____

(Extra space) _____

_____

(2)

(ii) How many different families are shown in the figure?

☐

(1)

(iii) To which phylum does the white rhino belong?

_____

(1)

(b) (i) Explain the role of independent segregation in meiosis.

_____

_____

_____

_____

(2)

(ii) A zedonk is the offspring produced from breeding a mountain zebra with a donkey.

- The body cells of a mountain zebra contain 32 chromosomes.
- The body cells of a donkey contain 62 chromosomes.

Use this information to suggest why zedonks are usually infertile.

_____

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(2)

(Total 8 marks)

16 (a) Explain how the structure of DNA is related to its functions.

(Extra space)

(6)

Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division.
They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk.
The following table shows the scientists' results.

Gene C	Gene D	Gene E	Risk of developing lung cancer
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present
M = two copies of the mutant allele are present

(b) What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

_____

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_____

(3)

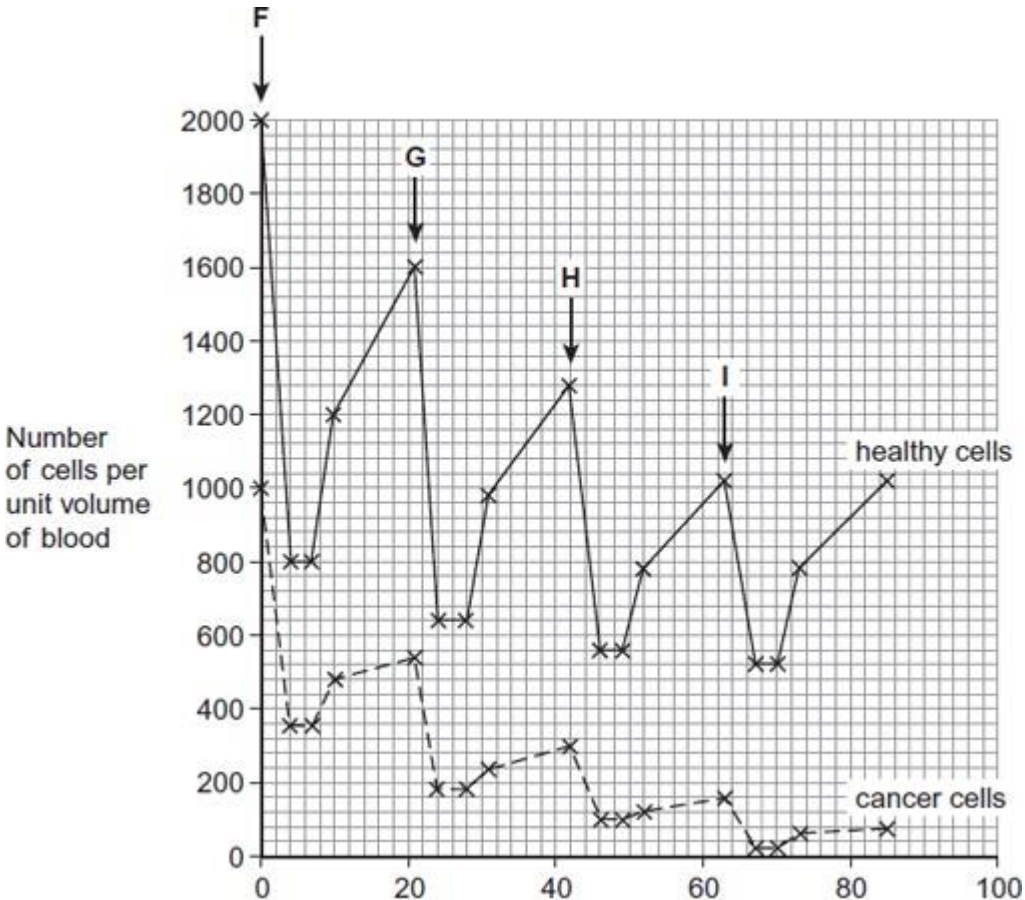
Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells.
The figure below shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.

Time / days

(c) Calculate the rate at which healthy cells were killed between days 42 and 46.

_____cells killed per unit volume of blood per day

(1)



(d) Describe similarities and differences in the response of healthy cells and cancer cells to thedrug between times **F** and **G**.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(e) More cancer cells could be destroyed if the drug was given more frequently.

Suggest why the drug was **not** given more frequently.

_____

_____

_____

_____

(2)

(Total 15 marks)

17 (a) (i) Why is the genetic code described as being universal?

_____

_____

(1)

(ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

(1)

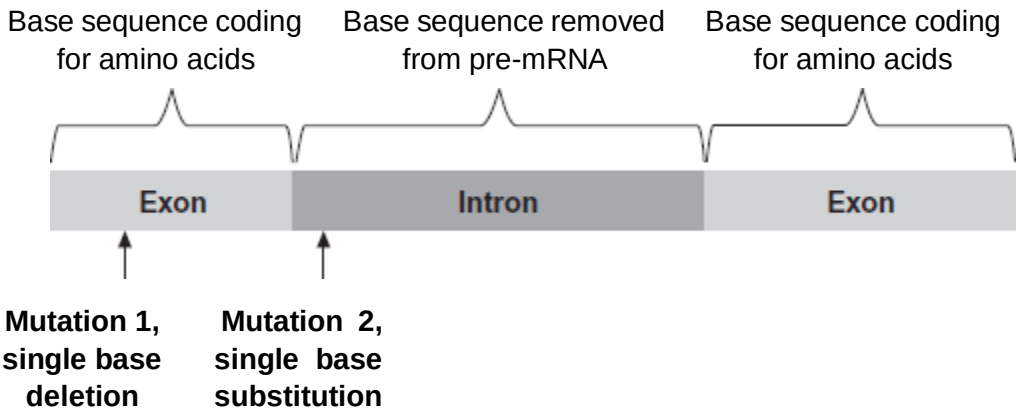
Transcription of a gene produces pre-mRNA.

(b) Name the process that removes base sequences from pre-mRNA to form mRNA.

_____

(1)

(c) The figure below shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in the figure.



(i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(ii) What effect might **mutation 2** have on the protein produced?

Explain your answer.

_____

_____

_____

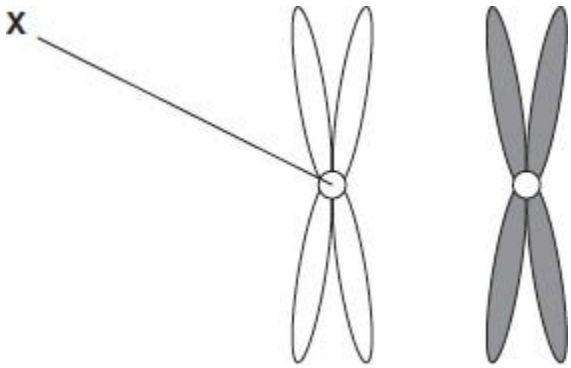
_____

(2)

(Total 8 marks)

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

Figure 1



(i) Name **X.**

_____

(1)

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

_____

_____

_____

_____

_____

(2)

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

_____

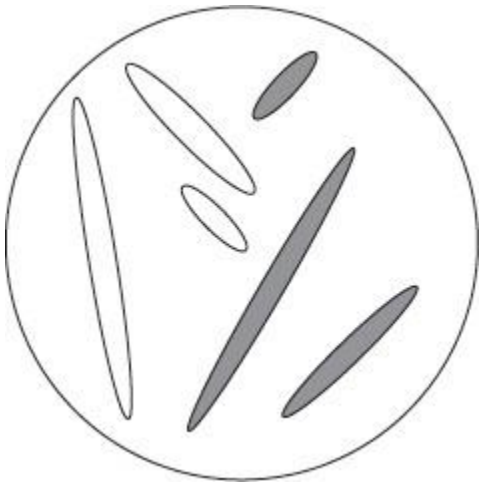
_____

_____

(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.

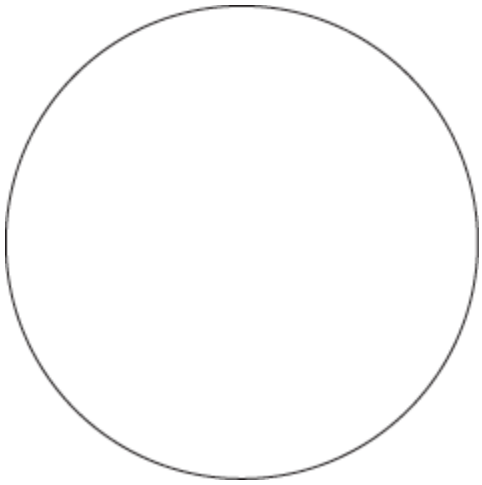
_____

_____

_____

(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.

_____

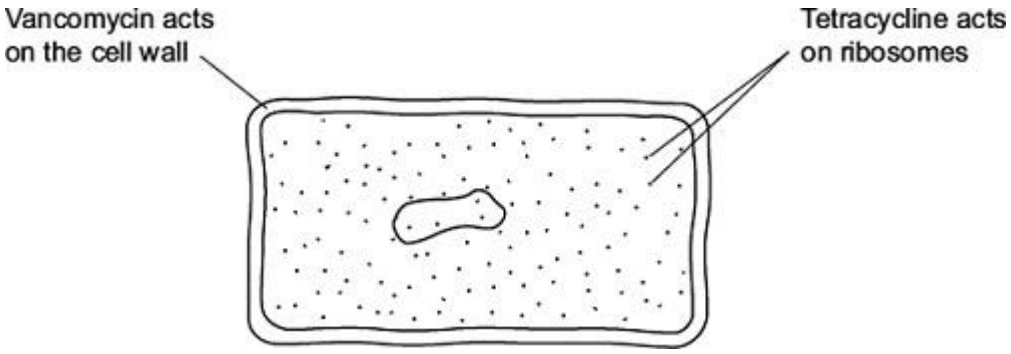
_____

_____

(1)

(Total 8 marks)

19 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



(a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

_____

_____

(1)

(ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

_____

_____

(1)

(b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(2)

(Total 4 marks)

20 Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

(a) (i) What is the maximum number of amino acids for which this base sequence could code?

☐

(1)

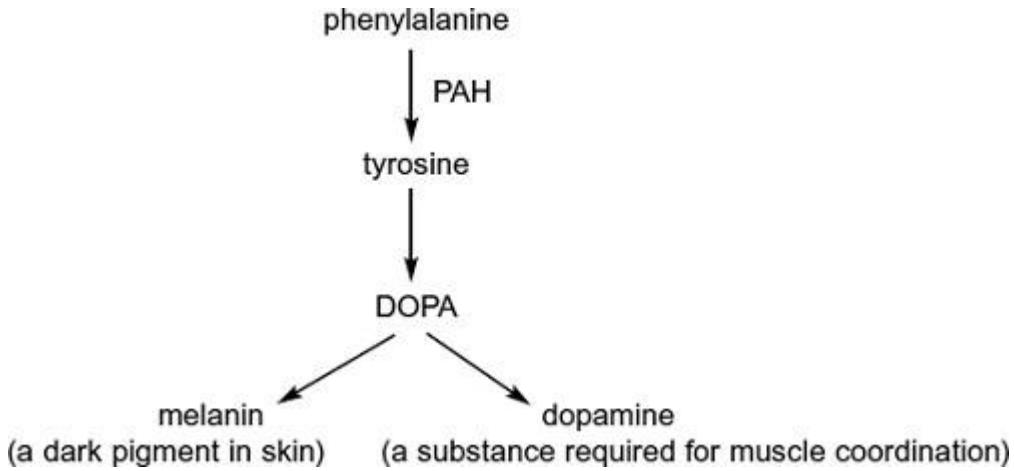
(ii) Explain how this mutation leads to the formation of non-functioning PAH.

(*Extra space*)

(3)

PAH catalyses a reaction at the start of two enzyme-controlled pathways.

The diagram shows these pathways.



(b) Use the information in the diagram to give **two** symptoms you might expect to be visible in

a person who produces non-functioning PAH.

1. _____

2. _____

(2)

(c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how thespread of this mutation may have occurred.

_____

_____

_____

(1)

21 (a) Explain what is meant by genetic diversity.

_____

_____

(1)

(b) Apart from genetic factors what other type of factor causes variation within a species?

_____

(1)

(c) The spotted owl is a bird. Numbers of spotted owls have decreased over the past 50 years. Explain how this decrease may affect genetic diversity.

_____

_____

_____

_____

_____

(2)

(Total 4 marks)

22 (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adultsand 66% of healthy infants.

(i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

_____

_____

_____

_____

_____

(2)

(ii) Suggest why older people are more likely to be affected by *C. difficile*.

_____

_____

_____

(1)

(b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

_____

_____

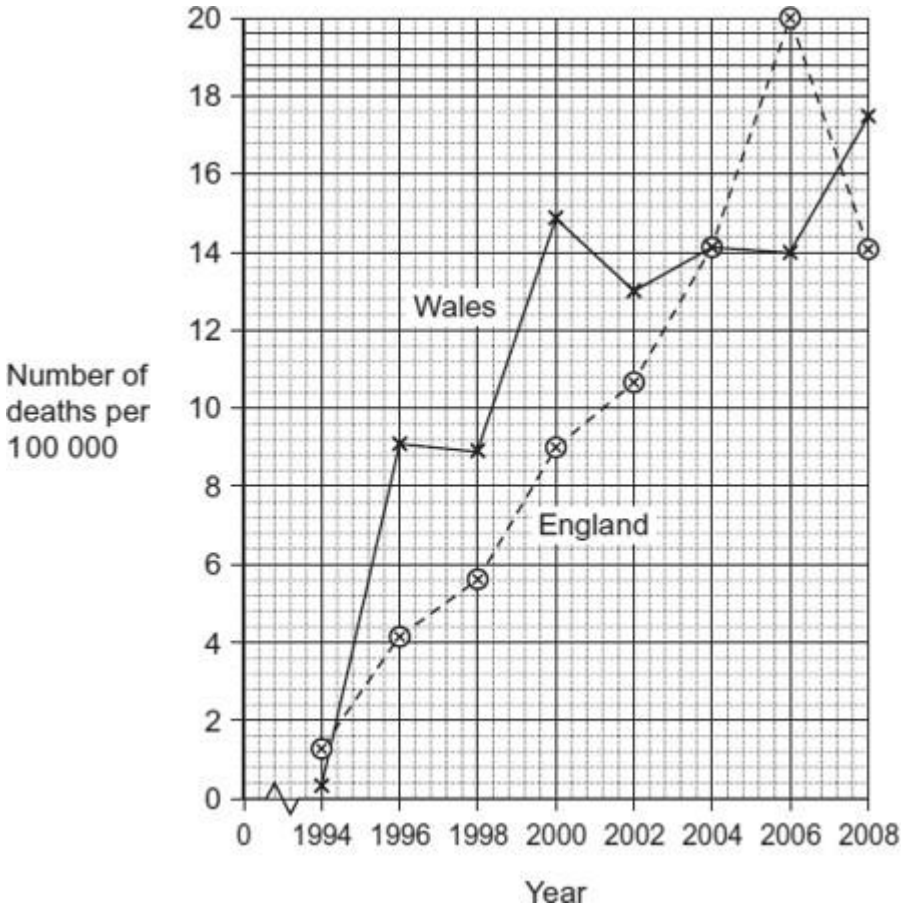
_____

_____

_____

(2)

(c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by thisbacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 causedby MRSA.



(i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

_____

_____

_____

(1)

(ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

_____

_____

_____

(1)

(iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

Answer _____

(2)

(Total 9 marks)

23 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.

_____

_____

_____

_____

(2)

In some countries very strong winds may occur. Banana growers in these countries choose togrow 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**.

_____

_____

_____

(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**.

_____

_____

_____

(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.

_____

_____

_____

_____

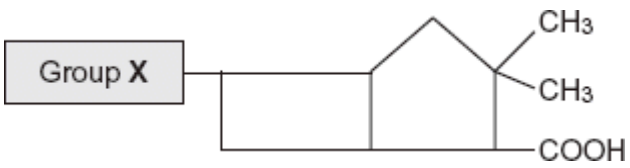
_____

(2)

(Total 7 marks)

24 Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

(a) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with adifferent sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

(3)

(b) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

(i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

(2)

(ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

(2)

(Total 7 marks)

25 (a) What name is used for the non-coding sections of a gene?

(1)

Figure 1 shows a DNA base sequence. It also shows the effect of two mutations on this basesequence. **Figure 2** shows DNA triplets that code for different amino acids.

Figure 1

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation **1** DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation **2** DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Figure 2

DNA triplets	Amino acid
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

(b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence.

(1)

(c) Some gene mutations affect the amino acid sequence. Some mutations do not.
Use the information from **Figure 1** and **Figure 2** to explain

(i) whether mutation **1** affects the amino acid sequence

_____

_____

_____

_____

(2)

(ii) how mutation **2** could lead to the formation of a non-functional enzyme.

_____

_____

_____

_____

_____

_____

(3)

(d) Gene mutations occur spontaneously.

(i) During which part of the cell cycle are gene mutations most likely to occur?

_____

(1)

(ii) Suggest an explanation for your answer.

_____

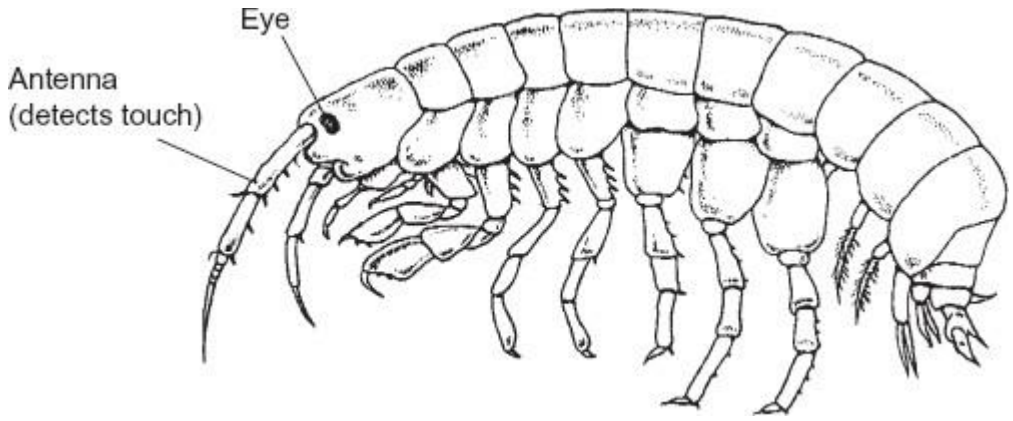
_____

(1)

(Total 9 marks)

26 **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.

_____

_____

_____

(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.

_____

_____

_____

_____

_____

(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**.

_____

_____

_____

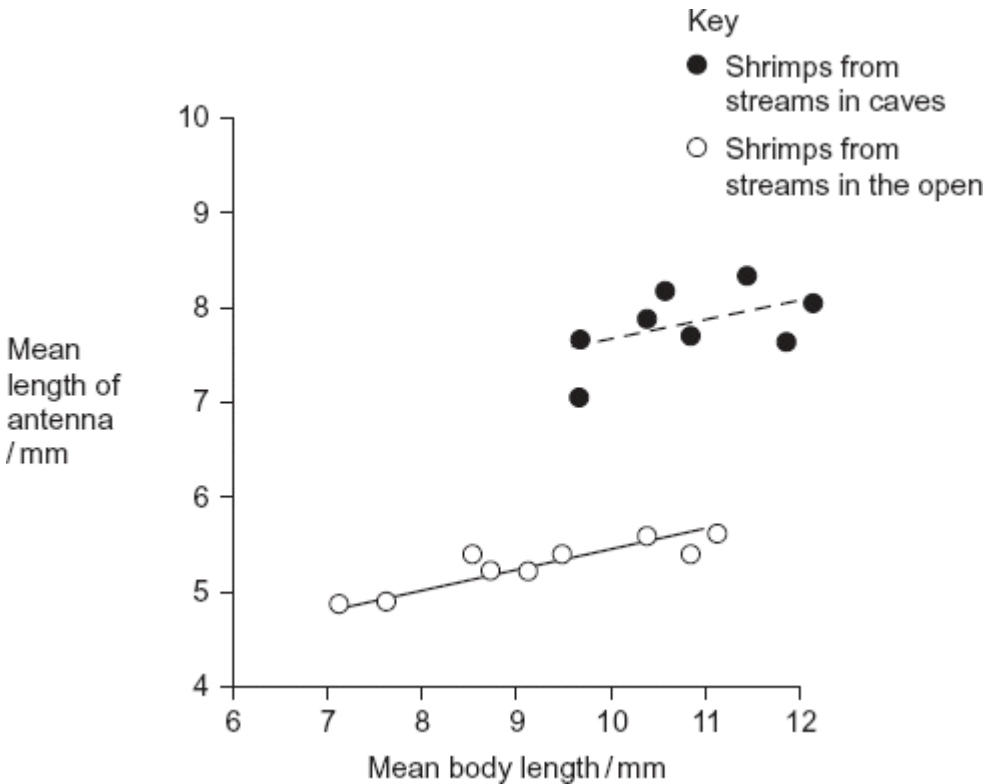
_____

_____

(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 shrimpsliving in caves and living in the open?

_____

_____

_____

_____

_____

(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.

_____

_____

_____

(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.

_____

_____

_____

(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 areason for this difference.

_____

_____

_____

_____

_____

_____

(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.

_____

_____

_____

_____

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

_____

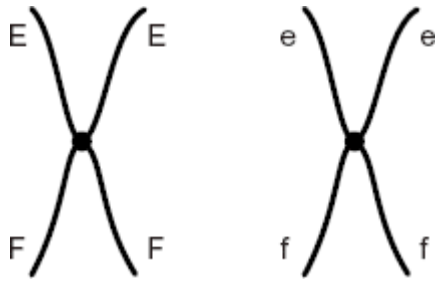
_____

(3)

(Total 15 marks)

27 **Figure 1** shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

Figure 1



(a) What is an allele?

_____

_____

(1)

(b) Explain the appearance of one of the chromosomes in **Figure 1**.

_____

_____

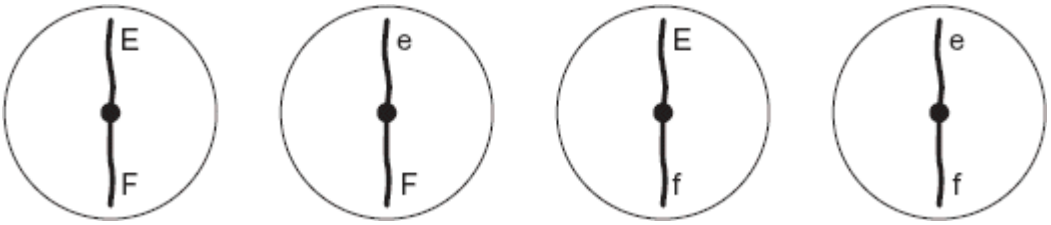
_____

_____

(2)

(c) The cell containing this pair of chromosomes divided by meiosis. **Figure 2** shows the distribution of chromosomes from this pair in four of the gametes produced.

Figure 2



(i) Some of the gametes formed during meiosis have new combinations of alleles.

Explain how the gametes with the combinations of alleles Ef and eF have been produced.

_____

_____

_____

_____

(2)

(ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

_____

_____

(1)

(d) **Figure 3** shows a cell with six chromosomes.

Figure 3

(i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2)

(ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes?

(1)

(Total 9 marks)

28 (a) The number of patients infected with the bacterium MRSA has increased in some hospitals. Scientists have suggested ways to reduce the transmission of MRSA in hospitals. Suggest **two** ways to reduce the transmission of MRSA in hospitals.

1. _____

_____

2. _____

_____

(2)

(b) The minimum inhibitory concentration (MIC) is the lowest concentration of a substance thatprevents the growth of a microorganism.

When antibiotics are prescribed for treating patients, higher doses than the MIC are recommended. Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

	Minimum inhibitory concentration / µg cm^{-3}			
Drug	*Escherichia coli*	*Staphylococcus aureus*	*Enterococcus faecalis*	*Pseudomonas aeruginosa*
P	0.39	0.049	0.049	3.13
Q	1.54	0.049	0.195	3.13
R	0.39	0.049	0.195	1.56
S	1.56	0.098	0.390	12.50

(c) Which of the four drugs is

(i) most effective against *Enterococcus faecalis*?

☐

(1)

(ii) least effective against all the species of bacteria used?

☐

(1)

(d) The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

(i) Suggest **two** ways in which a double-blind trial improves reliability.

1. _____

_____

2. _____

_____

(2)

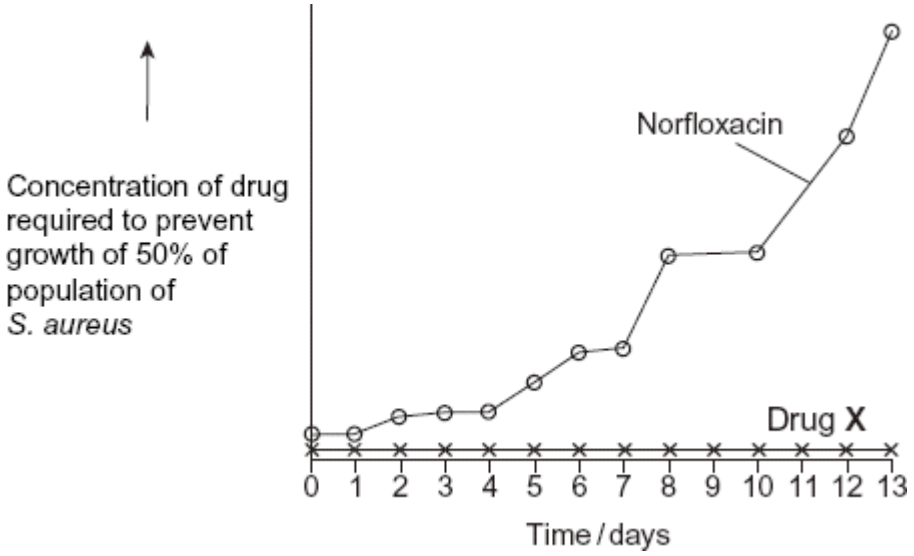
(ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1. _____

2. _____

(2)

(e) Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They testedthe sample to find the concentration of Norfloxacin that prevented the growth of 50 % of thebacteria in the sample.
The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug **X**. The results of both investigations are shown in the graph.



Describe the results obtained with Norfloxacin.

_____

_____

(1)

(Total 11 marks)

Mark schemes

1

(a) (During prophase)

1. Chromosomes
coil / condense / shorten / thicken / become visible;

2. (Chromosomes) appear as (two sister) chromatids joined at the centromere;

(During metaphase)

3. Chromosomes line up on the equator / centre of the cell;

4. (Chromosomes) attached to spindle fibres;

5. By their centromere;

(During anaphase)

6. The centromere splits / divides;

7. (Sister) chromatids / chromosomes are pulled to opposite poles / ends of the cell / separate;

(During telophase)

8. Chromatids / chromosomes
uncoil / unwind / become longer / thinner.

No marks for naming the stages

Reject references to homologous chromosomes / pairing of chromosomes

Ignore references to spindle formation during prophase

5 max

(b) 1. Homologous chromosomes pair up;

2. Independent segregation;

3. Maternal and paternal chromosomes are re-shuffled in any combination;

4. Crossing over leads to exchange of parts of (non-sister) chromatids / alleles between homologous chromosomes;

5. (Both) create new combinations of alleles;

5

[10]

2

(a) 1. Chromosome is formed of two chromatids;
2. (Because) DNA replication (has occurred);
3. (Sister) chromatids held together by centromere.

3

(b) 1. Chromosomes in homologous pair;
2. One of each into daughter cells / haploid number.

2

(c) Separation of (sister) chromatids / division of centromere.

1

(d) 1. Independent segregation (of homologous chromosomes);

Accept random assortment

2. Crossing over / formation of chiasmata.

2

[8]

3

(a) PKNJ.

1

(b) *Lutra lutra.*

1

(c) Bone / skin / preserved remains / museums.

1

(d) 1. (Hunting) reduced population size(s), so (much) only few alleles left;

Accept bottleneck

2. Otters today from one / few surviving population(s);

Accept founder effect

3. Inbreeding.

*Allow any **two***

2 max

(e) 1. Population might have been very small / genetic bottleneck;
2. Population might have started with small number of individuals / by one pregnant female / founder effect;
3. Inbreeding.

*Allow any **two***

2 max

[7]

4

(a) Translation.

1

(b) Transfer RNA / tRNA.

1

(c) TAC;

UAC.

2

(d) Have different R group.

Accept in diagram

1

(e) 1. Substitution would result in CCA / CCC / CCU;
2. (All) code for same amino acid / proline;
3. Deletion would cause frame shift / change in all following codons / change next codon from UAC to ACC.

3

[8]

5

(a) (No – no mark)
Graph / bar chart only shows number of species, not the name of the species.

1

(b) (No – no mark)
1. Mutations are spontaneous / random;
2. Only the rate of mutation is affected by environment;
3. Different species do not interbreed / do not produce fertile offspring;
4. So mutation / gene / allele cannot be passed from one species to another.

Ignore references to correlation does not prove causation

4

(c) 1. Initially one / few insects with favourable mutation / allele;
2. Individuals with (favourable) mutation / allele will have more offspring;
3. Takes many generations for (favourable) mutation / allele to become the most common allele (of this gene).

3

[8]

6

(a) 1. Kingdom, Phylum, Class, Order, Family;
2. *Luscinia svecica.*

1 mark for each correct column

Allow Genus and Species if both placed in box for species but not if both placed in genus box

2

(b) Number of different alleles of each gene.

Accept number of different base sequences (found) in each gene

1

(c) 1. Has greater proportion of genes / percentage of genes showing diversity;
2. Percentage is 35% compared with 28% / proportion is 0.35 compared with 0.28.

Allow correct figures that are not rounded up, i.e., 34.9% / 0.349 and 27.8% / 0.278

2

[5]

7

(a) (D)CBEA.

1

(b)

Step	Reason
(Taking cells from the root tip)	Region where mitosis / cell division occurs;
(Firmly squashing the root tip)	To allow light through / make tissue layer thin;

2

(c) (Increase)

1. Chromosomes / DNA replicates;
   (First decrease)

2. Homologous chromosomes separate;
   (Second decrease)

3. Sister chromatids separate.

3

(d) 1. (DNA would) double / go to 2 (arbitrary units).

1

[7]

8

(a) 0.32.

Correct answer = 2 marks

Accept 32% for 1 mark max

Incorrect answer but identifying 2pq as heterozygous = 1 mark

2

(b)
1. Mutation produced *KDR minus* / resistance allele;
2. DDT use provides selection pressure;
3. Mosquitoes with *KDR minus* allele more likely (to survive) to reproduce;
4. Leading to increase in *KDR minus* allele in population.

4

(c)
1. Neurones remain depolarised;
2. So no action potentials / no impulse transmission.

2

(d)
1. (Mutation) changes shape of sodium ion channel (protein) / of receptor (protein);
2. DDT no longer complementary / no longer able to bind.

2

[10]

9

(a)
1. Reduction in ATP production by aerobic respiration;
2. Less force generated because fewer actin and myosin interactions in muscle;
3. Fatigue caused by lactate from anaerobic respiration.

3

(b) Couple **A**,

1. Mutation in mitochondrial DNA / DNA of mitochondrion affected;
2. All children got affected mitochondria from mother;
3. (Probably mutation) during formation of mother's ovary / eggs;

Couple **B**,

4. Mutation in nuclear gene / DNA in nucleus affected;
5. Parents heterozygous;
6. Expect 1 in 4 homozygous affected.

4 max

(c)
1. Change to tRNA leads to wrong amino acid being incorporated into protein;
2. Tertiary structure (of protein) changed;
3. Protein required for oxidative phosphorylation / the Krebs cycle, so less / no ATP made.

3

(d)
1. Mitochondria / aerobic respiration not producing much / any ATP;
2. (With MD) increased use of ATP supplied by increase in anaerobic respiration;
3. More lactate produced and leaves muscle by (facilitated) diffusion.

3

(e)
1. Enough DNA using PCR;
2. Compare DNA sequence with 'normal' DNA.

2

[15]

10

(a) 1. (So) age not a factor in female choice;

2. (So) will attract a mate;

3. (So similar) sexual maturity;

4. (So) have the correct feathers;

4. Accept 'have blue feathers'

2 max

(b) Number the birds, then numbers out of hat / random number generator;

Both aspects needed for mark

1

(c) 1. That movement was not related to some other factor (than the male);

2. That movement (towards the male) indicated mating behaviour;

3. (Females) only respond to throat feathers (of the male) / do not respond to other visual display / sounds / calls (by the male);

2 max

(d) 1. Change in sequence of bases / nucleotides;

2. (As a result of a) deletion / substitution;

3. Change in amino acid sequence / primary structure;

4. Change in tertiary structure of protein;

1. Do not accept 'change in the DNA sequence'

2. Accept e.g. addition / inversion / duplication / translocation

3

(e) Yes

1. (From resource A) birds can detect UV light;

2. (From resource B) difference between UVR and NR significant / not due to chance;

3. As error bars do not overlap;

*3 max if only **No** marks awarded*

2. Reject idea that 'results' in resource B are significant / not due to chance, must include idea of 'difference'

3. Reject 'as standard deviations do not overlap'

No

4. UV light may not be involved in mating / other factors may be involved in mating;

5. Some birds in UVR group were attractive to females;

6. (Experiment in resource B) carried out in artificial conditions / only 40 birds used / small sample size;

6. Neutral: idea that this is only one study / that there are no repeats

4 max

[12]

11 (a) 1. Different parts/areas/amino acid sequences (of amyloid-precursor) protein;

Accept APP

2. Each enzyme is specific/fits/binds/complementary to a different part of the APP;

Point 2 subsumes point 1 and is worth 2 marks total.

2

(b) 1. Peptide bond broken;

2. Using water;

Hydrolysis in stem

2

(c) 1. Mutations prevent production of enzyme(s)/functional enzyme;

2. (Increase in β-secretase) leads to faster/more β-amyloid production**OR** (Decrease in α-secretase) leads to more substrate for β-secretase;

'This' must refer to α-secretase

3. (Leads to) more/greater plaque formation;

3

(d) 1. (Inhibitor) binds to/blocks active site of β-secretase/enzyme;Stops/reduces

2. production of β-amyloid/plaque;

2

(e) 1. Some β-amyloid required/needed (to prevent side effects)
OR
(Some) β-secretase needed;

Accept 'Both enzymes needed'

2. Leads to build-up of amyloid-precursor protein (that causes harm)
OR
Too much product of α-secretase (causes harm);

Accept build-up of substrate (leads to harm)

1 max

[10]

12 (a) 1. Change in DNA base/nucleotide (sequence);

Accept: mutation in DNA base (sequence).

Accept: deletion/substitution/addition of a DNA base/nucleotide.

2. Change in amino acid (sequence)/primary structure;

Reject: different amino acid formed.

Ignore: change in code for amino acid.

3. Alters (position of) hydrogen/ionic/disulfide bonds;

4. Change in tertiary structure (of receptor);

Reject: any reference to active site.

Ignore: 3°.

4

(b) 1. (Receptor) is not complementary

OR

(HIV) cannot bind/attach and enter/infect (helper) T cell;

Accept: 'complimentary'.

Accept: invade as alternative to infect.

2. No replication (of virus)

OR

No destruction of (helper) T cell;

Accept: reproduction (of virus).

2

(c) 1. Low/lower exposure to HIV (in Europe)

OR

Low/lower number of HIV/AIDS (infections/cases);

Accept: converse.

2. (HIV) has only been present for a short time period

OR

(HIV relatively) recently evolved;

3. Mutation/CCR5 has been around for many years;

Accept: frequency of mutation has always been high.

4. Mutation/CCR5 is advantageous (for something else);

2 max

[8]

13 (a)

	Cell B	Cell C	Cell D
homologous chromosomes are present	✓	✓	
a stage of mitosis		✓	

Mark horizontally

1 mark for each correct row

2

(b) Mark as pairs, do not mix and match

1. (Chromosomes consist of) two chromatids connected at centromere;

   Accept: sister chromatids for two chromatids

2. (Because) DNA has replicated;

OR

3. K is on equator of spindle;

   Ignore: 'middle'

4. (because) attached at centromere;

   Ignore reference to meiosis / bivalents / homologous pairs

2

(c) 1. Crossing over / exchange of alleles /lengths of DNA / recombination;

   Accept: description of crossing over eg sections of chromatids break and re-join

   Accept: reference to chiasma/ chiasmata

2. Between (chromatids of) homologous chromosomes;

   Accept: 'between non-sister chromatids'

   Accept: 'bivalent' for homologous

   Ignore: genes exchanged

2

(d) Separation/segregation of pairs/homologous chromosomes;

Accept: result of meiosis I / result of division of cell B

Accept: pulled to opposite poles for 'separation'

Ignore ref to chromatids

1

(e) (DNA) replication taking place/not finished;

Accept: they are cells in S phase

1

[8]

14 (a) 1. Change / mutation in base / nucleotide sequence (of DNA / gene);

Q.

Ignore: references to changing base-pairing

Accept: affect for change, if in correct context

Accept: changes triplets / codons

2. Change in amino acid sequence / primary structure (of enzyme);

Accept: different amino acid(s) coded for

***Q** Reject: different amino acids produced / formed / made*

3. Change in hydrogen / ionic / disulfide bonds;

Accept: references to sulfur bonds

4. Change in the tertiary structure / shape;

Neutral: alters 3D structure / 3D shape

5. Change in active site;

6. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme-substrate complexes form.

Accept: no E S complexes form

6

(b) 1. Non-SR strain falls more / SR strain falls less / up to 10(µg / cm−3);

Must include 10 but only required once in either MP1 or MP2

Ignore: units or absence of

This must be a comparative statement

2. Above 10(µg / cm^{-3}), SR strain levels out / off and non-SR strain continues to decrease;

3. Greater difference between strains with increasing concentration of antibiotic.

This must be a comparative statement

2 max

(c) 1. Division stopped (of both strains by scientist);

Reject: references to mitosis stopping

2. SR strain still more resistant / fewer die / none die (at higher concentrations of antibiotic).

Accept: SR strain and non-SR strain would be similar if resistance is due to only stopping division

Need some comparison with non-SR

2

(d) 1. Make a competitive / non-competitive inhibitor;

Mark in pairs

either MP1 and MP2 OR MP3 and MP4

2. Competitive competes with / blocks active site / non-competitive inhibitor affects / changes active site;

Do not mix and match

OR

3. (Make a drug) that inhibits / denatures / destroys enzyme / stringent response;

Accept: drug that 'knocks out' / destroys enzyme

4. Give at the same time as / before an antibiotic.

2 max

(e) (SR strain)

1. Fewer free radicals (than non-SR);

Note: has to be comparative statement

2. Produces more catalase (than non-SR);

Accept converse statements for non-SR.

3. Catalase (might be) linked to production of fewer free radicals / breaking down / removing free radicals.

Accept: hydrolysis of radicals by catalase.

3

[15]

15

(a) (i) 1. Groups within groups;

*Accept: idea of larger groups at the top **or** smaller groups at the bottom*

2. No overlap (between groups);

2

(ii) **3**;

1

(iii) Chordata;

Accept: if phonetically correct eg 'Cordata'

1

(b) (i) 1. (To provide) genetic variation;

Genetic variation must be directly stated and not implied

2. (Allows) different combinations of maternal and paternal chromosomes / alleles;

Accept: any allele of one gene can combine with any allele of another gene

2

(ii) 1. (Zedonk has) 47 / odd / uneven number of chromosomes;

Accept: diploid number would be odd

Reject: if wrong number of chromosomes is given

2. Chromosomes cannot pair / are not homologous / chromosome number cannot be halved / meiosis cannot occur / sex cells / haploid cells are not produced;

Accept: cannot have half a chromosome

***Q** Reject: meiosis cannot occur **in** sex cells*

2

[8]

16

(a) 1. Sugar-phosphate (backbone) / double stranded / helix **so** provides strength / stability / protects bases / protects hydrogen bonds;

Must be a direct link / obvious to get the mark

Neutral: reference to histones

2. Long / large molecule **so** can store lots of information;

3. Helix / coiled **so** compact;

Accept: can store in a small amount of space for 'compact'

4. Base sequence allows information to be stored / base sequence codes for amino acids / protein;

Accept: base sequence allows transcription

5. Double stranded **so** replication can occur semi-conservatively / strands can act as templates / complementary base pairing / A-T and G-C so accurate replication / identical copies can be made;

6. (Weak) hydrogen bonds **for** replication / unzipping / strand separation / many hydrogen bonds **so** stable / strong;

Accept: 'H-bonds' for 'hydrogen bonds'

6

(b) 1. (Mutation) in **E** produces highest risk / 1.78;

2. (Mutation) in **D** produces next highest risk / 1.45;

3. (Mutation) in **C** produces least risk / 1.30;

Must be stated directly and not implied

***E** > **D** > **C** = 3 marks*

Accept: values of 0.78, 0.45 and 0.30 for MP1, MP2 and MP3 respectively

If no mark is awarded, a principle mark can be given for the idea that all mutant alleles increase the risk

3

(c) **180**;

1

(d) (Similarities):

1. Same / similar pattern / both decrease, stay the same then increase;

2. Number of cells stays the same for same length of time;

Ignore: wrong days stated

(Differences):

(Per unit volume of blood)

3. Greater / faster decrease in number of healthy cells / more healthy cells killed / healthy cells killed faster;

Accept: converse for cancer cells

Accept: greater <u>percentage</u> decrease in number of cancer cells / greater <u>proportion</u> of cancer cells killed

4. Greater / faster increase in number of healthy cells / more healthy cells replaced / divide / healthy cells replaced / divide faster;

Accept: converse for cancer cells

*For **differences**, statements made must be comparative*

3 max

(e) 1. More / too many healthy cells killed;

2. (So) will take time to replace / increase in number;

Neutral: will take time to 'repair'

3. Person may die / have side effects;

2 max

[15]

17 (a) (i) (In all organisms / DNA,) the same triplet codes for the same amino acid;

Accept codon / same three bases / nucleotides

Accept plurals if both triplets and amino acids

Reject triplet<u>s</u> code for an amino acid

Reject reference to producing amino acid

1

(ii) 64;

1

(b) Splicing;

Ignore deletion references

Accept RNA splicing

1

(c) (i) 1. (Mutation) changes triplets / codons after that point / causes frame shift;

Accept changes splicing site

Ignore changes in sequence of nucleotides / bases

2. Changes amino acid sequence (after this) / codes for different amino acids (after this);

Accept changes primary structure

Reject changes amino acid formed / one amino acid changed

3. Affects hydrogen / ionic / sulfur bond (not peptide bond);

4. Changes tertiary structure of protein (so non-functional);

Neutral 3-D structure

3 max

(ii) 1. Intron non-coding (DNA) / only exons coding;

*Context is the **intron***

Do not mix and match from alternatives

Neutral references to introns removed during splicing

1.and 2. Ignore ref. to code degenerate and get same / different amino acid in sequence

2. (So) not translated / no change in mRNA produced / no effect (on protein) / no effect on amino acid sequence;

Accept does not code for amino acids

OR

3. Prevents / changes splicing;

4. (So) faulty mRNA formed;

Accept exons not joined together / introns not removed

5. Get different amino acid sequence;

2 max

[8]

18 (a) (i) Centromere;

Accept: if phonetically correct

Reject: centriole

1

(ii) 1. Holds chromatids together;

2. Attaches (chromatids) to spindle;

3. (Allows) chromatids to be separated / move to (opposite) poles / (centromere) divides / splits at metaphase / anaphase;

*3. **Q** Neutral: chromosomes or chromatids split / halved / divided*

3. Reject: reference to homologous chromosomes being separated

Accept 'chromosomes' instead of 'chromatids'

*Ignore incorrect names for **X***

2 max

(iii) (Homologous chromosomes) carry different alleles;

Accept alternative descriptions for 'alleles' eg different forms of a gene / different base sequences

Neutral: reference to maternal and paternal chromosomes

1

(b) (i) (In **Figure 2**)

1. Chromatids have separated (during anaphase);

*1. **Q** Neutral: split / halved / divided*

1. Reject: reference to homologous chromosomes being separated

or

2. Chromatids have not replicated;

1. & 2. Accept 'chromosomes' instead of 'chromatids'

or

3. Chromosomes formed from only one chromatid;

*Accept converse arguments for **Figure 1***

Ignore references to the cell not dividing as in the question stem

Ignore: named phases

1 max

(ii) 1. Three chromosomes;

Ignore shading

2. One from each homologous pair;

Only one mark for three chromosomes shown as pairs of chromatids

2

(iii) Crossing over / alleles exchanged between chromosomes or chromatids /chiasmata formation / genetic recombination;

Accept: description of crossing over eg sections of chromatids break and rejoin

Neutral: random fertilisation

Reject: reference to sister chromatids

***Q** Neutral: genes exchanged*

Neutral: mutation

1

[8]

19

(a) (i) (Human cells) don't have a cell wall;

Accept "they" refers to human cells.

1

(ii) (Affects) protein synthesis;

Allow description e.g. 'amino acids not joined together / translation.

Reject: affects transcription.

1

(b) 1. Mutation present / occurs;

Ignore antibiotic causes mutation.

2. Resistance gene / allele;

1. or 2.

Reference to immunity disqualifies first credited marking point.

3. Resistant bacteria (survive and) reproduce;

Reference to mitosis negates marking point 3.

2

[4]

20

(a) (i) 4;

1

(ii) 1. Change in amino acid / (sequence of) amino acids / primary structure;

1. Reject = different amino acids are 'formed'

2. Change in hydrogen / ionic / disulphide bonds alters tertiary structure / active site (of enzyme);

2. Alters 3D structure on its own is not enough for this marking point.

3. Substrate not complementary / cannot bind (to enzyme / active site) / no enzyme- substrate complexes form;

3

(b) 1. Lack of skin pigment / pale / light skin / albino;

2. Lack of coordination / muscles action affected;

2 max

(c) Founder effect / colonies split off / migration / interbreeding;

Allow description of interbreeding e.g. reproduction between individuals from different populations 1

[7]

21 (a) Difference in DNA / base sequence / difference in alleles / genes / gene pool;

Neutral: 'fewer alleles' unless qualified e.g. fewer different alleles. 1

(b) Environmental;

Accept: Environment 1

(c) Reduced (genetic diversity);

As fewer different / varied alleles / genes / reduced gene pool; 2

[4]

22 (a) (i) Antibiotics kill other bacteria / *Clostridium* is resistant;

Less / no competition so (*Clostridium*) reproduces / replicates / multiplies / increases in number;

Reference to bacteria being 'immune' negates first marking point.

Reference to mitosis negates second marking point. 2

(ii) Immune system less effective / more likely to have other infections / been in hospital;

Accept: 'Weak / lower' immune system'. 1

(b) Attaches to <u>active site</u> (of enzyme);
(Methicillin) is a competitive inhibitor / prevents monomers / substrate attaching (to enzyme);

'Competes for active site' = 2 marks.

Neutral: 'Prevents monomers joining / attaching to each other'.

Allow one mark max for answers relating to non-competitive inhibitor changing active site / preventing substrate attaching.

Do not penalise Methicillin forms an enzyme / substrate complex. 2

(c) (i) Have other illness / medical condition / 'weak' immune system / disease / infection;

Reject: Due to 'other factors', 'are smokers', 'are obese' unless related to disease or illness. 1

(ii) Increase up to 2006 / 20 (per 100 000) then decreases;

1

(iii) Correct answer in range of 52 – 59.1% = two marks;

Incorrect answer but shows change as between 4.8 – 5.2 / shows correct subtraction giving this change e.g. 14 – 9 = one mark.

2

[9]

23 (a) (i) 22;

1

(ii) 1. Odd number of chromosomes / 33 chromosomes (in leaf cell);

2. Chromosomes cannot pair / cannot undergo meiosis / would result in half chromosomes / cannot form haploid cells;

2

(b) (i) Fast growth / produces crop fast / produces large crop;

Do not insist on relative statement.

Accept similar terms for fast. E.g. "better" growth

Do not accept unqualified references to profit.

1

(ii) Leaves less likely to break / higher breaking strength;

1

(c) Low genetic diversity because they are produced by mitosis;

Will all have the same DNA / genes / alleles / will be genetically identical / will be clones;

OR

Low genetic diversity because they are not produced by meiosis;

No crossing over / independent segregation / will not be genetically different;

Independent segregation is the specification term. Accept other such as random assortment.

2

[7]

24 **(a)** **Shape**

1. Different penicillin has different shape / structure / enzyme / active site has specific shape / structure;

Not different

Binding

2. No longer fits / binds to active site / not complementary to active site / does not form E-S complex;

Consequence

3. (Different) penicillin not broken down;

3

(b) (i) 1. Kills pathogenic / harmful bacteria / pathogens;

2. Disease less likely / improves health / animals healthier / reduces spread of infection;

3. Faster growth / more productive animals / more food converted to meat / greater survival / lower vet's bills / increased yield / less energy (for "fighting infection");

Principles:

Action of antibiotic. Do not accept stops all disease

Action on health

Effect on production

2 max

(ii) 1. (Adding antibiotics) selects in favour of antibiotic resistance / resistant bacteria more likely to survive;

2. Increase in numbers / higher proportion of resistant bacteria;

Penalise immune only on the first occasion it occurs in this part of the question.

2

[7]

25 (a) Introns;

1

(b) Ile Gly Val Ser;

1

(c) (i) Has no effect / same amino acid (sequence) / same primary structure;

Q *Reject same amino acid formed or produced.*

1

Glycine named as same amino acid;

1

It still codes for glycine = two marks.

(ii) Leu replaces Val / change in amino acid (sequence) / primary structure;

Change in hydrogen / ionic bonds which alters tertiary structure / active site;

Q *Different amino acid formed or produced negates first marking point.*

Substrate cannot bind / no longer complementary / no enzyme-substrate complexes form;

Active site changed must be clear for third marking point but does not need reference to shape.

3

(d) (i) Interphase / S / synthesis (phase);

1

(ii) DNA / gene replication / synthesis occurs / longest stage;

Allow 'genetic information' = DNA.

Allow 'copied' or 'formed' = replication / synthesis

1

[9]

26 (a) (So results) can be compared / so measurement is the same each time / because eye is not perfectly round / uniform;

Accept eye opens to different amounts

1

(b) (i) 1. Eye (diameter) is smaller and antennae longer;

2. Antennae detecting touch;

3. Data only refers to shrimps / data may not apply to all animals / only in one area;

The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.

2 max

(ii) 1. Standard deviation gives a measure of spread / variation;

2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;

Do not accept range

Accept converse.

Although we are looking for the idea of significance, we cannot require this term.

2

(c) (i) Qualitative statement about

difference in size /

difference in variation /

overlap in size;

Quantitative statement about

difference in size /

difference in variation /

overlap in size;

Supported by relevant two sets of figures from graph;;

Note simplistic answer involving a quantitative statement gains 1 mark.

More specific answer involving quantitative information gains 2 marks.

2

(ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

OR

(Yes) positive correlation in open / in cave;

Habitat not critical as a term.

Must refer to idea of same habitat

Accept description

1

(d) More alleles of each gene / shrimps in open have all the alleles;

Candidates are required to use the information from the table. Must therefore refer to alleles.

1

(e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

(f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out

reciprocal crosses / large number of crosses / isolate beforehand;

Other valid equivalent suggestions should be accepted.

(ii) If same species the shrimps would breed, producing fertile young / courtshipspecies specific;

Accept any form of evidence – mating / laying eggs / giving birth to young.

3

[15]

27 (a) (Different) form / type / version of a gene / different base sequence of a gene;

1

(b) Two / sister chromatids joined by a centromere;

Due to DNA replication;

2

(c) (i) Crossing over;

1

Exchange (of alleles) between chromatids / chromosomes;

Negate first marking point for answers which refer to independent segregation.

Chiasma / chiasmata = first marking point

1

(ii) Is infrequent / rare;

References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.

1

(d) (i) Three chromosomes shown;

1

One from each homologous pair;

For first mark point allow drawings showing three chromosomes as single or double structures.

1

(ii) 8;

1

[9]

28 (a) Isolation / quarantine / 'kept separate';

Screening / testing (of patients / doctors etc);

Sterilisation of wards / equipment / method to improve hygiene;

Do not allow improve 'hygiene' or 'cleanliness' without named example such as 'washing hands' use of gloves etc.

2 max

(b) May not all be absorbed;

May be broken down / metabolised / excreted quickly;

To kill the microorganisms / bacteria;

Reference to antibiotic resistance;

Reference to becoming 'immune' negates last marking point.

2 max

(c) (i) P;

1

(ii) S;

1

(d) (i) Prevents bias;

Vested interest (of scientists);

Prevents 'placebo' / positive / negative / psychological effects / 'demand characteristics' (in volunteers);

2 max

(ii) Age;

Ethnicity;

Lifestyle;

Body mass;

Health;

Sex of person;

Ignore references to same or different

2 max

(e) Gradual / slight increase followed by rapid / greater increase;

Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.

1

[11]