AQA – Genetic information, variation and relationships between organisms – A2 Biology P3

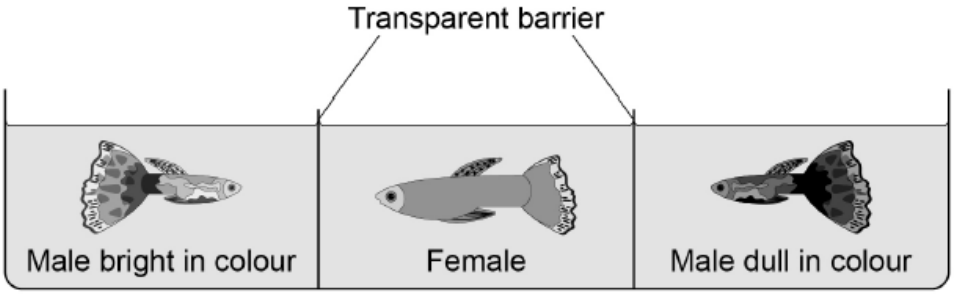
1. June/2020/Paper_3/No.1

0 1 Guppies are small fish. Female guppies are dull in colour. Male guppies can be bright or dull in colour.

Scientists investigated the effect of female brain size on choosing a mate. They used laboratory-bred female guppies with large brains and with small brains.

They set up a fish tank as shown in **Figure 1**.

Figure 1



They observed each female for 10 minutes and recorded which male they were attracted towards. They repeated this with 45 large-brained females and 45 small-brained females.

0 1 . 1 Suggest **three** possible limitations of this investigation.

[3 marks]

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Guppies with large brains are better at identifying predators.

The scientists found that **only** female guppies with large brains were attracted to male guppies bright in colour.

0 1 . 2 Suggest and explain the advantage of this behaviour to the population of guppies.

[3 marks]

0 1 . 3 Describe how the behaviour of female guppies could result in sympatric speciation.

[3 marks]

2. June/2020/Paper_3/No.2

0 2 In northern India, there is a conflict of interests between farmers of livestock (eg cows) and people trying to conserve ibex (a type of wild goat).

When livestock are given extra food, their populations can grow too large and compete with ibex.

0 2 . 1 Name the type of competition between livestock and ibex.

[1 mark]

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Livestock will outcompete ibex if they:

- are in the same habitat
- eat a similar diet.

Scientists investigated this conflict of interests.

Table 1 summarises some of the scientists' findings.

Table 1

Type of livestock	Difference between livestock food and ibex food*	Difference between livestock habitat and ibex habitat*
Cow	1.0	1.5
Horse	0.5	0.0
Yak	0.0	2.0

* A score of 0.0 indicates that the food or habitat is the same.

0 2 . 2 There must be a balance between the need for conservation of the ibex and the need for farmers to keep livestock.

Using **all** the information, suggest and explain **three** actions that the farmers could take to achieve this balance.

[3 marks]

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3. June/2020/Paper_3/No.5

0 5 . 1 In the UK in 2016, there were 525 048 deaths. Cancer caused 30.4% of all deaths. Throat cancer caused 5% of all deaths from cancer.

Calculate the mean number of people who died of throat cancer per month in 2016.

Show your working.

[2 marks]

Answer _____ people per month

Increased methylation of the promoter region of a tumour suppressor gene causes one type of human throat cancer.

In this type of throat cancer, cancer cells are able to pass on the increased methylation to daughter cells. The methylation is caused by an enzyme called DNMT.

Scientists have found that a chemical in green tea, called EGCG, is a competitive inhibitor of DNMT. EGCG enables daughter cells to produce messenger RNA (mRNA) from the tumour suppressor gene.

0 5 . 2 Suggest how EGCG allows the production of mRNA in daughter cells.

[3 marks]

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The scientists investigated the effect of different amounts of EGCG on the growth rate of the throat cancer cells grown *in vitro*. Their results are shown in **Figure 2**.

Figure 2

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0 5 . 3 A reporter who reviewed all of this work concluded that drinking green tea could be a cure for cancer.

Suggest **three** reasons why his conclusion might **not** be valid.

[3 marks]

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4. June/2020/Paper_3/No.7(7.2)

0 7 Write an essay on **one** of the topics below.

0 7 . 2 The causes and importance of variation and diversity in organisms.

[25 marks]

5. June/2019/Paper_3/No.4

0 4 Mitochondrial DNA (mtDNA) is a small circular DNA molecule located in mitochondria. It is 16 569 nucleotides long and contains 37 genes and a control region.

Sports scientists investigated whether a mutation in the control region of mtDNA in human males was related to an ability to exercise for longer.

- The males in Group **T** had thymine at nucleotide position 16 519
- The males in Group **C** had a mutation resulting in cytosine at nucleotide position 16 519

0 4 . 1 The control regions of Group **T** and Group **C** were the same length.

Name the type of gene mutation that is most likely to have occurred at nucleotide position 16 519

[1 mark]

Group **T** and Group **C** completed the same 8-week training programme. The following measurements were taken at the start of the 8-week programme, and again at the end.

1. $VO_{2\,max}$ (a measure of maximal oxygen uptake).
2. Citrate synthase (CS) activity (CS is an enzyme involved in the Krebs cycle).

The scientists then calculated the percentage increase in each measurement in both groups.

Figure 4 and **Figure 5** show their results.

Figure 4

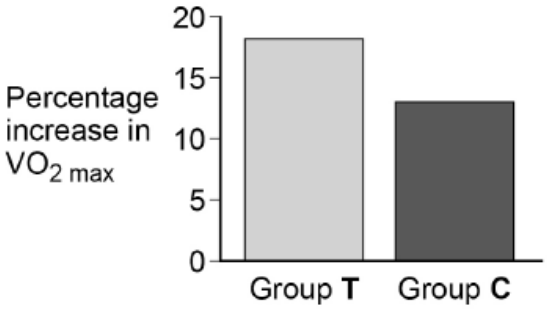
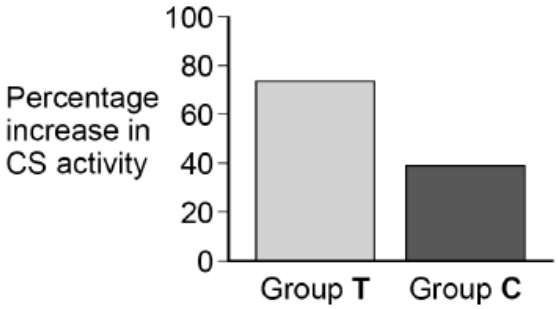


Figure 5



0 4 . 2 A student concluded from **Figure 4** and **Figure 5** that training has a positive effect on VO_{2max} and CS activity.

Evaluate the student's conclusion.

[3 marks]

0 4 . 3 The mitochondrial DNA (mtDNA) control region is an area of mtDNA that is non-coding. This region stimulates the synthesis of both mtDNA and mitochondrial messenger RNA.

Use this information to suggest **two** reasons why the mutation at nucleotide position 16 519 could lead to the differences seen in **Figure 5**.

[2 marks]

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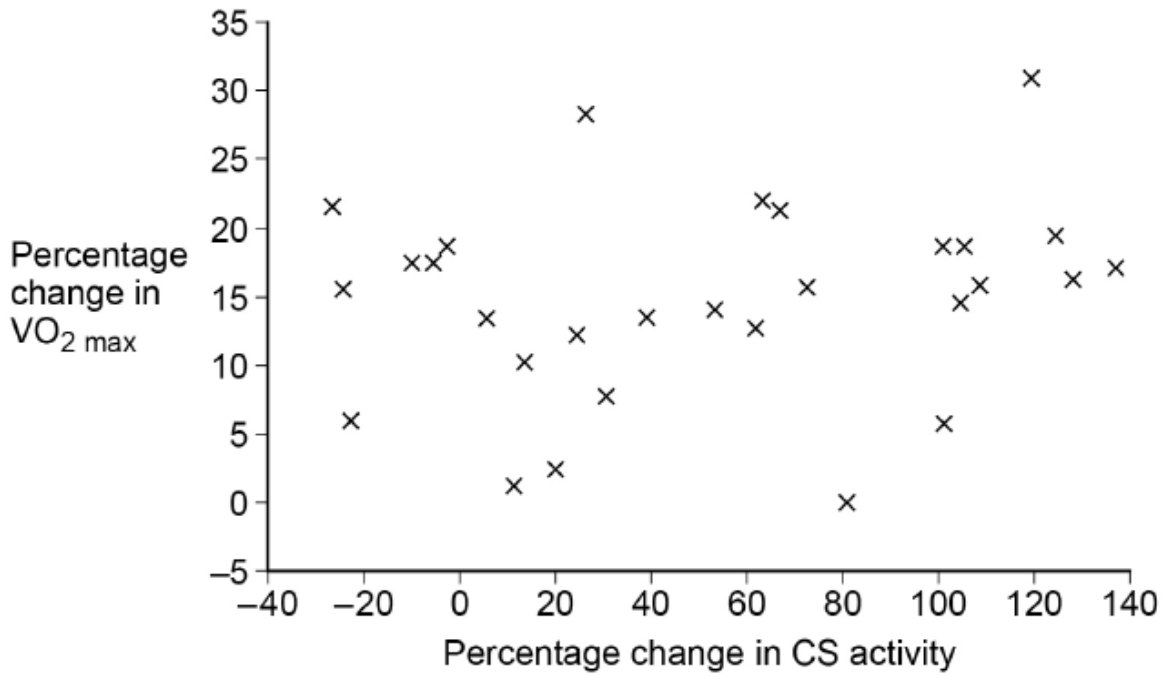
2

The sports scientists investigated whether there was a correlation between the percentage change in VO_{2max} and percentage change in CS activity in Group **T**.

Figure 6 shows their results.

Figure 6



0 4 . 4 'Having thymine at nucleotide position 16 519 in Group **T** causes an increase in ability to exercise for longer.'

Evaluate this conclusion.

Use **all** the data in this question.

[3 marks]

[Extra space]

6. June/2019/Paper_3/No.5

0 5 The crown-of-thorns starfish (COTS) is one of the main causes of the decline of the world's coral reefs.

Marine biologists used a choice chamber to investigate the effects of flashing and constant light on the behaviour of COTS.

Table 1 shows their results as they presented them. The P values show results from a statistical test.

Table 1

Behaviour of COTS	**Type of light used in choice chamber**	
	Flashing	**Constant**
COTS moving towards the stimulus	22	12
COTS moving away from the stimulus	28	38
P value	0.69	0.02

0 5 . 1 State a null hypothesis the marine biologists tested in this investigation.

[1 mark]

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0 5 . 2 The natural habitat of COTS is coral reefs of tropical oceans.

Suggest **two** factors that should be kept constant in the choice chambers so that COTS display normal behaviour.

[1 mark]

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2 _____

0 5 . 3 A journalist studying **Table 1** suggested that **either** type of light could be used to cause COTS to move away from coral reefs.

Evaluate the journalist's suggestion.

[3 marks]

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0 5 . 4 One of the reasons COTS can destroy coral reefs in a short time is because COTS move quickly, allowing them to move from one reef to another.

Table 2 shows the maximum speeds recorded of COTS in constant light.

Table 2

Response to light	**Maximum speed / mm min^{-1}**
COTS moving towards constant light	259
COTS moving away from constant light	564

Calculate the shortest time one COTS would take to move up a coral reef from 66 m under water to 18 m under water in hours of daylight.

Give your answer to the nearest hour.

[2 marks]

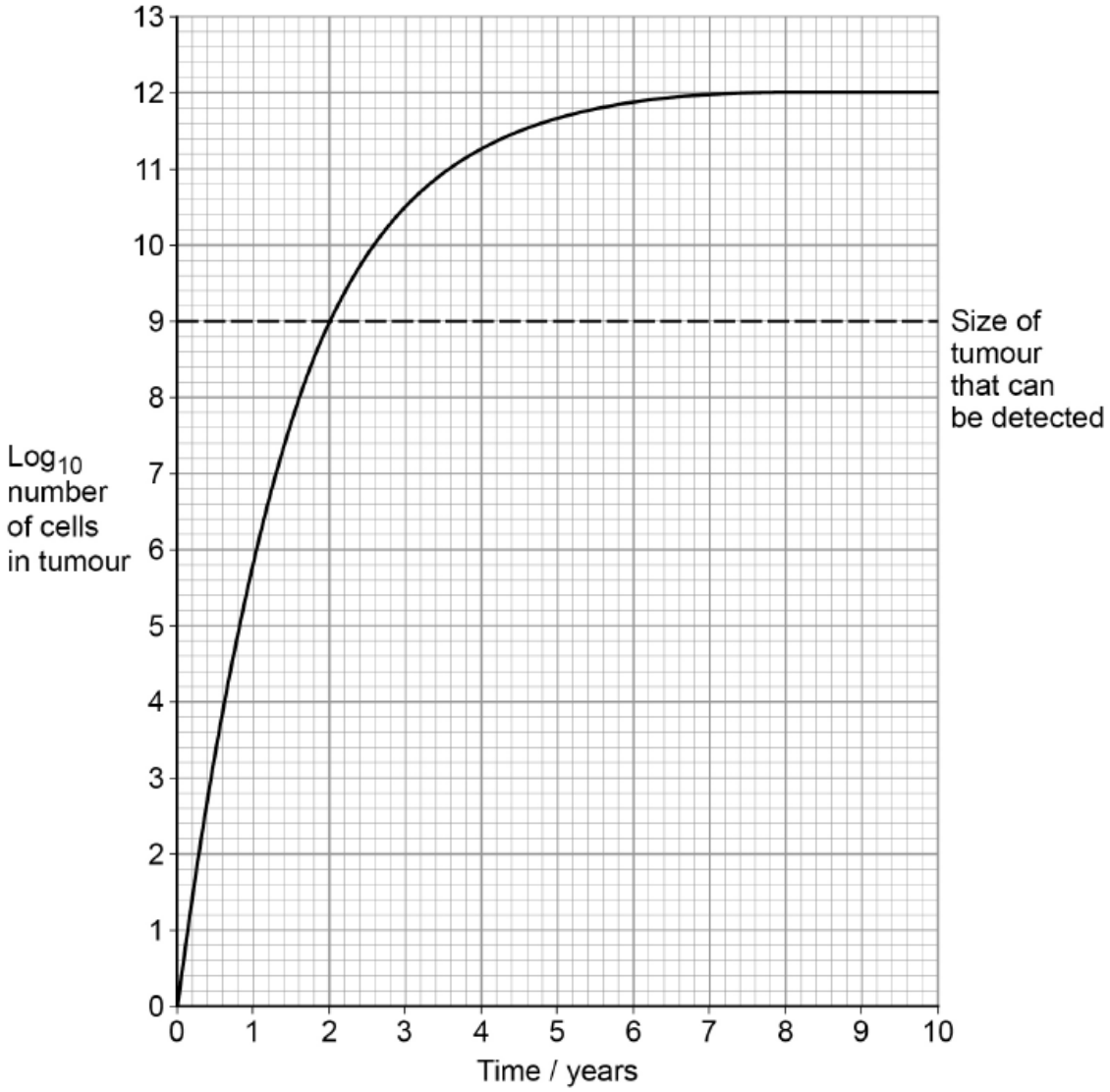
Answer = _____ hours

7. June/2019/Paper_3/No.6

0 6 Uncontrolled cell division can cause tumours to form.

Figure 7 shows the growth pattern followed by a type of tumour.

Figure 7



0 6 . 1 Use **Figure 7** to calculate the percentage of maximum growth this type of tumour reaches before it can be detected.

You will need to use the 10^x button on your calculator.

[1 mark]

Answer = _____ %

0 6 . 2 **Figure 7** can also be used to calculate the age of this type of tumour.

At diagnosis, a patient had a tumour of 3.98×10^{11} cells.
Calculate the age of the tumour.

You will need to use the $\log_{10}$ button on your calculator.

[1 mark]

Answer = _____ years

Trexall is a drug that can be used to slow the development of various forms of cancer.

Trexall slows cell division by interacting with an enzyme called dihydrofolate reductase (DR).

DR is involved in making nucleotides; the substrate for DR is folic acid.

Figure 8 shows the chemical structure of Trexall.

Figure 9 shows the chemical structure of folic acid.

Figure 8

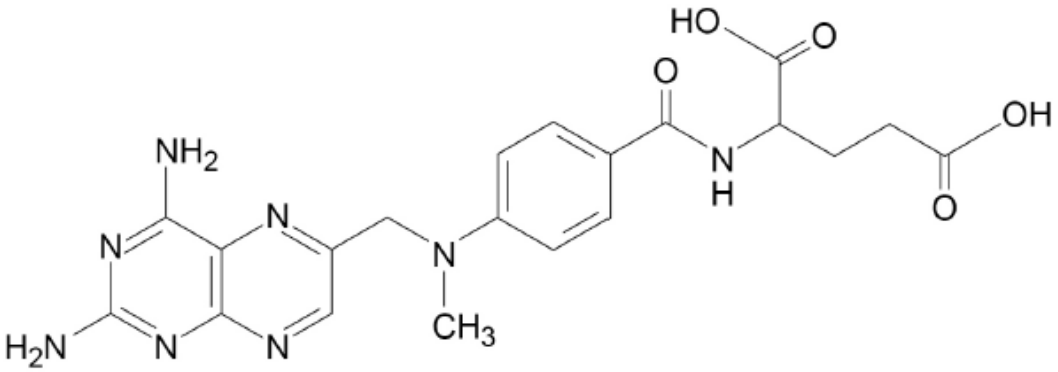
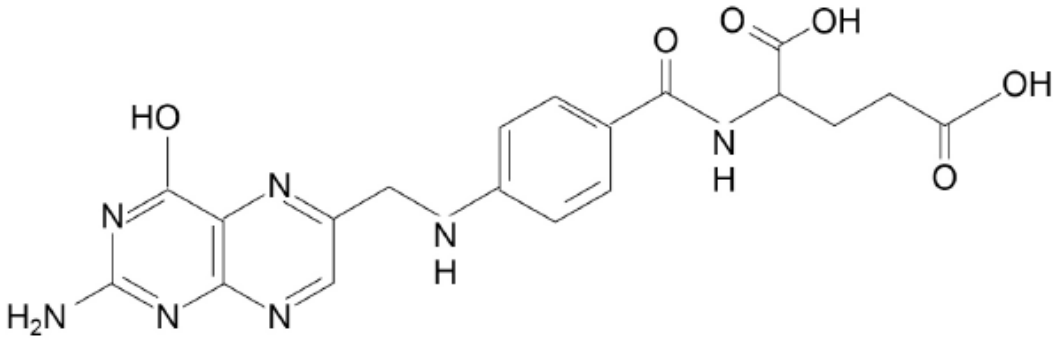


Figure 9



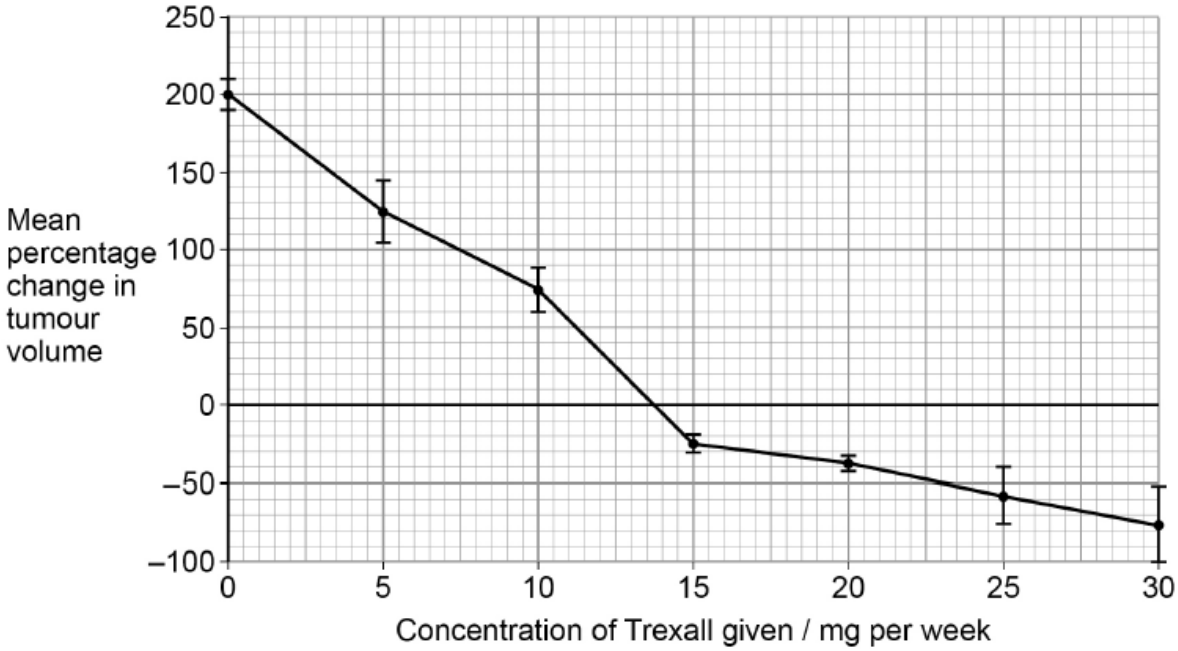
0 6 . 3 Use the information provided to suggest how Trexall slows cell division.

[3 marks]

Doctors investigated how the concentration of Trexall given to patients affected the growth of lung tumours. The doctors measured the volume of tumours at the beginning of the study and after 8 months.

Figure 10 shows the results of this investigation. The bars represent ± 2 standard deviations. A value of ± 2 standard deviations from the mean includes over 95% of the data.

Figure 10



0 6 . 4 The scientists measured the percentage change in tumour volume.

Suggest why they recorded both percentage change **and** tumour volume.

[2 marks]

Percentage change _____

_____

_____

_____

Tumour volume _____

_____

_____

_____

0 6 . 5 A lung cancer patient received 15 mg of Trexall per week. After treatment, the diameter of his lung tumour was 35.8 mm

Assuming the tumour was spherical, use the mean percentage change in tumour volume shown in **Figure 10** to calculate the volume of the patient's tumour **before treatment** with Trexall.

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

[2 marks]

Answer = _____ mm^3

0 6 . 6 To reduce the size of tumours, would it be better to use 30 mg of Trexall per week, or 20 mg of Trexall per week?

Explain your answer.

[2 marks]

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Trexall can also be used to slow the development of rheumatoid arthritis (a pain-causing joint disease).

Scientists investigated the effectiveness of Trexall as a pain relief treatment in 12 rheumatoid arthritis patients. All of the patients were female. They randomly divided the patients into two groups:

- Group **R** received Trexall tablets for 35 days
- Group **S** was a control group.

They asked both groups to rate their pain on a scale of 0–10 (0 being no pain and 10 being the worst pain possible) at the start and then every 7 days for 35 days. They calculated mean scores for each group.

Their results can be seen in **Table 3**.

Table 3

Number of days of treatment	Mean score for severity of pain (scale 0–10)	
	Group R	Group S
0	9.7	9.8
7	8.2	9.1
14	8.4	8.6
21	7.6	7.2
28	6.3	7.5
35	5.1	7.8

0 6 . 7 Apart from age and general health, give **two** important factors when choosing patients for this investigation.

[1 mark]

1 _____

2 _____

0 6 . 8 A student analysed **Table 3** and concluded that Trexall was effective in reducing pain in arthritis patients.

Evaluate the student's conclusion.

[3 marks]

8. June/2019/Paper_3/No.7(7.1)

0 7 Write an essay on **one** of the topics below.

0 7 . 1 The importance of DNA as an information-carrying molecule **and** its use in gene technologies.

[25 marks]