Gold Paper

Question Paper 8

Level	A Level
Subject	Biology
Exam Board	OCR
Paper	Gold Paper
Booklet	Question Paper 8

Time allowed: **78 minutes**

Score: **/58**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

This question is about aspects of genetic engineering.

The remains of Ice-Age mammoths are often found in permafrost and tar pits. The high state of preservation allows DNA to be extracted and analysed. Genes can be sequenced and compared with other specimens to see how closely they might be related.

Some of the steps required for gene sequencing are listed below.

One step is out of order, and one step contains an error in the technical term(s) used.

1. Take a tissue sample from the mammoth's remains and send it, deep-frozen, to the laboratory.
2. Digest the DNA with a transferase enzyme that will cut at either side of the cytochrome c gene.
3. Extract DNA from the cells.
4. Amplify the DNA fragments by the polymerase chain reaction using Taq polymerase.
5. Obtain cytochrome c DNA specimens from other mammoth populations.
6. Run the samples side by side in gel electrophoresis.
7. Compare the banding patterns.
8. The new mammoth is most closely related to the population whose cytochrome c gene banding pattern is most similar.

(a) (i) Using the numbers listed above, state which step is in the wrong order, and between which steps it should go.

[1]

(ii) State which step contains the error and state the correct technical term(s) that should have been used.

[1]

(b) Genetic engineering often takes the form of extracting a gene from one organism to put into another organism. Genes can also be supplied by cDNA libraries.

Suggest one **other** way to obtain a gene. **[1]**

(c) A useful vector for moving and storing genes is the bacterial plasmid. Plasmids are closed loops of DNA. Plasmids in bacterial cells are separate from the main chromosome.

(i) Bacteria can transmit plasmids from one cell to another, or take up plasmids from the surrounding medium.

What is the benefit to bacteria of having these abilities? **[2]**

(ii) In genetic engineering, DNA fragments can be inserted into plasmids, which are then taken up by bacteria. The plasmid is cut open and the DNA fragment is sealed in using an enzyme.

Name the enzyme used to seal a DNA fragment into a plasmid.

[1]

(d) Scientists used a transformed plasmid to insert genes into Golden Rice™, via the plant-infecting *Agrobacterium*.

Fig. 7.1 outlines the metabolic pathway by which early types of Golden Rice™ made β carotene, the precursor of vitamin A.

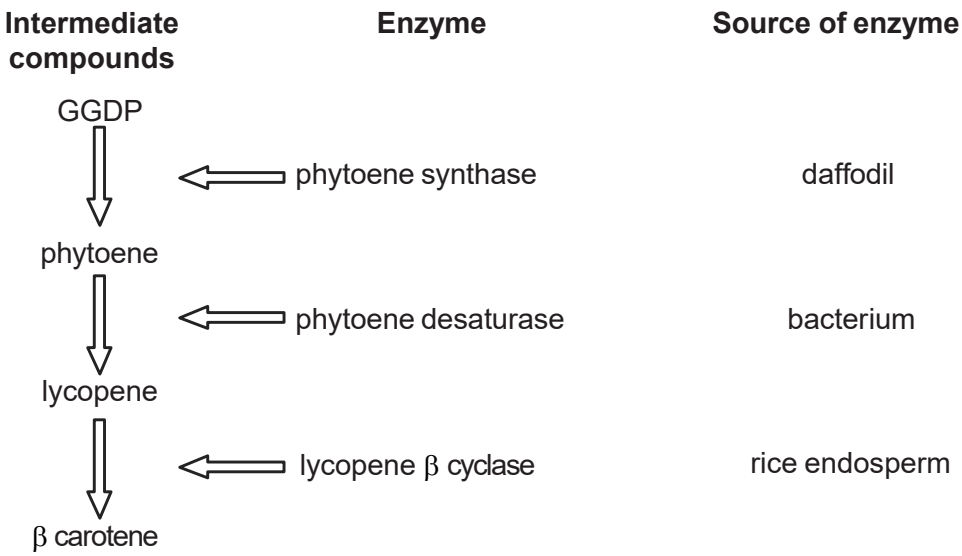


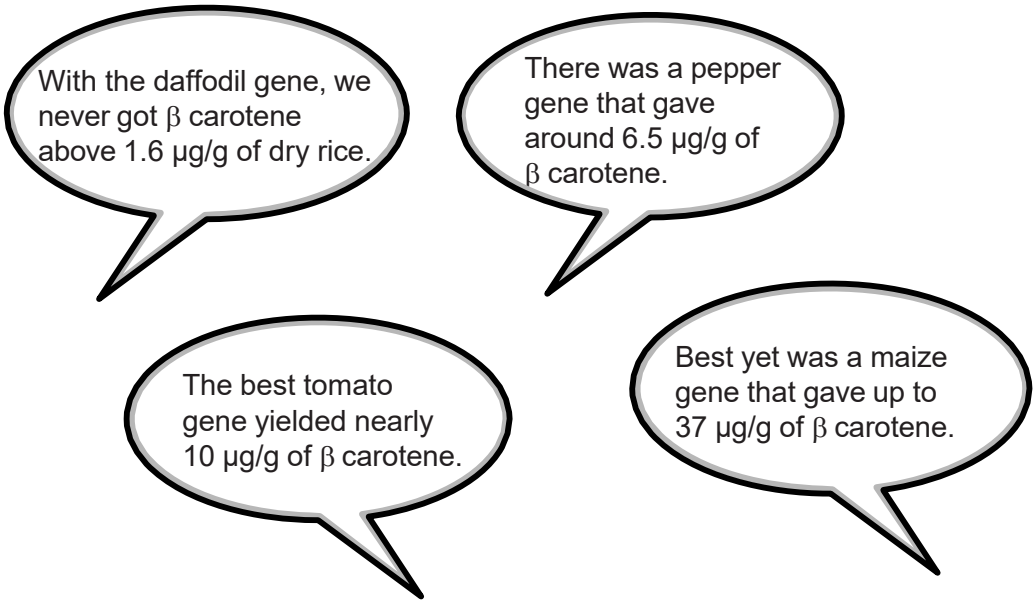
Fig. 7.1

At first, conversion to β carotene was very inefficient. Analysis of quantities of intermediate compounds in the rice showed a build-up of GGDP and little phytoene.

(i) Explain how the information above shows that the enzymes phytoene desaturase and lycopene β cyclase were **not** limiting the manufacture of β carotene.

[2]

(ii) Phytoene synthase genes from other sources were then tried with these results:



The gene that makes phytoene synthase enzymes has slight differences between the species.

Suggest explanations for the different performances of these enzymes. **[2]**

(e) State two ethical arguments, one **for** and one **against** this example of genetically manipulating a plant. **[2]**

Argument for

Argument against

(f) Another objective of genetic engineering is to produce animals whose organs might be used for transplantation to humans.

- The pig is an animal viewed as promising for xenotransplantation. But it grows rather slowly, and is objectionable to some religious faiths.
- The rat grows much faster, and is easy to feed and house.

Suggest a **technical** difficulty that might prevent the rat becoming useful in xenotransplantation of organs into humans.

[1]

(g) Genetic engineering is successful in isolating healthy alleles of a gene and putting them into suitable vectors. This opens exciting possibilities for treating human genetic diseases.

Explain the difference between **somatic cell gene therapy** and **germ line cell gene therapy**.

[2]

[Total: 15]

(a) Complete Table 5.1 below which compares different types of cell. **[4]**

Place a tick (✓) or a cross (✗) in each box to indicate whether the feature is present or absent. The first row has been completed for you.

	Cell type		
Feature	**Plant cell**	**Animal cell**	**Bacterial cell**
mitochondria	✓	✓	✗
chloroplasts			
cellulose cell wall			
centrioles			
ribosomes			

Table 5.1

(b) In an investigation, cells were broken up (homogenised) and the component organelles were separated into tubes.

Each tube was then tested to determine the identity of the component organelle(s).

The observations are shown in Table 5.2.

Test for the…	**Tube**			
	1	**2**	**3**	**4**
ability to make ATP	no ATP produced	ATP produced	no ATP produced	no ATP produced
presence of DNA	DNA present	trace amount	no DNA present	no DNA present
ability to produce proteins	no proteins made	no proteins made	no proteins made	proteins made
ability to digest bacteria	none	some ability	none	none

Table 5.2

(i) Identify the tube that contains the following organelles: **[4]**

nuclei .....

ribosomes .....

mitochondria .....

lysosomes .....

(ii) Which of the organelles listed in **(i)** is the smallest in size? **[1]**

[Total: 9]

Two students investigated the growth of bacteria at different temperatures.

Three flasks containing identical solutions of nutrient broth were used.

- Flask 1: inoculated with 1cm^3 of broth containing the bacterium *Bacillus subtilis* and incubated at 20 °C.
- Flask 2: inoculated with 1cm^3 of broth containing *B. subtilis* and incubated at 30 °C.
- Flask 3: inoculated with 1cm^3 of broth containing no bacteria and incubated at 30 °C.

Aseptic techniques were used throughout.

At set times over the next 3 days the students removed samples from each flask and measured the number of viable bacteria present.

(a) State one further variable the students should have controlled in their investigation in order to produce **valid** results.

..... **[1]**

(b) The students used the following procedure to determine the number of viable bacteria in each flask at a given time.

From each flask, 0.1 cm^3 was removed and mixed with 9.9 cm^3 of sterile water in a test tube. This was labelled **Tube A**. A serial dilution then proceeded, as shown in Table 19.1.

Tube	Contents	
B	1cm^3 of Tube A mixture	9 cm^3 of sterile water
C	1 cm^3 of Tube B mixture	9 cm^3 of sterile water
D	1 cm^3 of Tube C mixture	9 cm^3 of sterile water
E	1 cm^3 of Tube D mixture	9 cm^3 of sterile water
F	1 cm^3 of Tube E mixture	9 cm^3 of sterile water

Table 19.1

From each tube, A–F, 0.1 cm^3 of mixture was cultured on nutrient agar for 24 hours at 30 °C.

The results from Flask 2 after 7 hours of incubation are shown in Fig. 19.

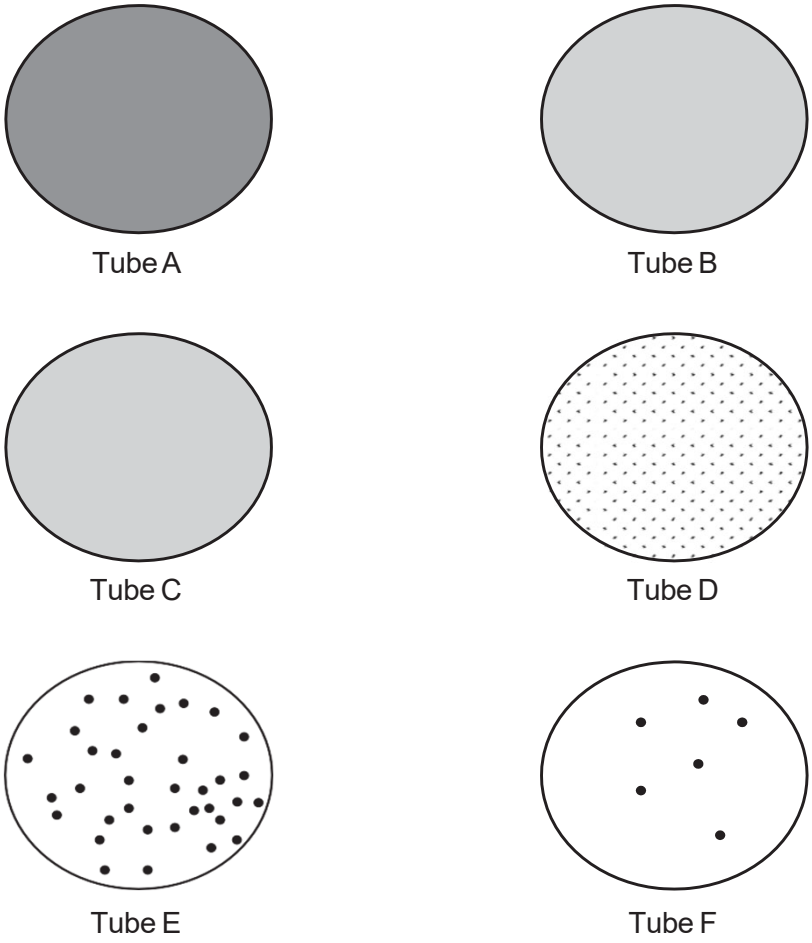


Fig. 19

The students used Tube F to calculate the number of viable bacteria present in the original sample.

(i) Use Tube F to calculate the number of viable bacteria present in the original 0.1 cm^3 sample from Flask 2 after 7 hours of incubation.

Give your answer in standard form. **[2]**

(ii) The students disagreed about which tube's result to use as a starting point for their calculation.

Discuss whether the petri dish resulting from Tube F was the most appropriate for them to use.

[3]

(c) The processed results from the students' investigation are shown in Table 19.2.

Time after incubation started (hours)	**Number of viable bacteria present in Flask 1 at 20°C**	**Number of viable bacteria present in Flask 2 at 30°C**
0	7.0×10^2	7.1×10^2
2	6.8×10^2	7.4×10^2
4	4.7×10^4	2.5×10^6
8	6.5×10^7	9.2×10^{10}
12	2.4×10^9	1.8×10^{11}
18	7.8×10^{10}	1.8×10^{11}
24	9.2×10^{10}	5.5×10^8
36	8.6×10^{10}	4.2×10^4
48	6.0×10^9	6.7×10^2
60	5.7×10^7	5.2×10^2
72	1.3×10^5	3.1×10^2

Table 19.2

(i)* Using the information in Table 19.2, compare and explain the patterns of growth seen at 20 °C and at 30 °C.

[6]

(ii) No bacteria were detected at any time in the flask that was inoculated with nutrient broth that did not contain bacteria.

Explain the purpose of this flask. **[2]**

(iii) The teacher told the students they should not investigate the growth of bacteria at 35 °C.

Suggest why the teacher told them not to grow bacteria at 35 °C. **[1]**

(iv) The teacher also suggested that the students should have carried out the investigation using three flasks at each temperature.

Explain how this suggestion would have improved the students' investigation. **[3]**

[Total: 18]

Fig. 1.1 shows a metabolic pathway involving the amino acid, phenylalanine. One of the products of this pathway is melanin, the pigment that gives a brown colour to hair, skin and the iris of the eyes. This metabolic pathway also produces thyroid hormones.

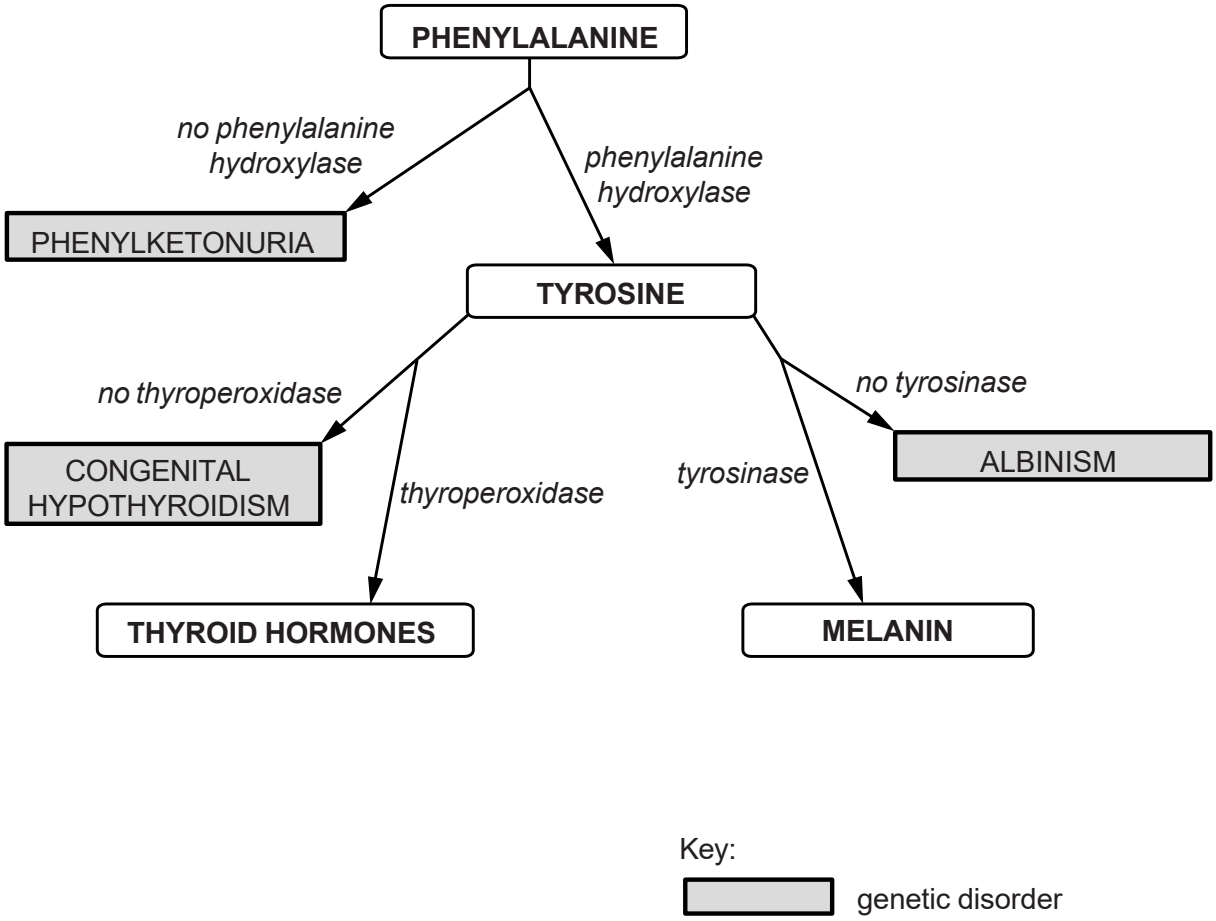


Fig. 1.1

(a) Use Fig. 1.1 to name:

(i) the **enzyme** that catalyses the last step in melanin production **[1]**

(ii) the **genetic disorder** resulting from the absence of the enzyme at the start of the metabolic pathway for melanin production.

[1]

(b) Phenylalanine and tyrosine are both amino acids.

Explain why phenylalanine and tyrosine are classified as amino acids. **[2]**

(c) One effect of thyroid hormones is to increase the activity of mitochondria within cells. Suggest how the metabolism of a person with the condition congenital hypothyroidism might differ from that of a person who does not have this condition.

[3]

(d) Albinism is a genetic disorder in which a person lacks melanin pigment in their skin, hair and the iris of their eyes. A person with this disorder is called an albino. The genotype of an albino has two copies of a recessive allele of the gene for an enzyme involved in melanin production.

(i) State the term used to describe a genotype that has two copies of the same allele at a particular gene locus.

[1]

(ii) Explain what is meant by the following terms: **[4]**

genotype

allele

(e) The Hardy-Weinberg principle can be used to predict the expected frequencies of albino and non-albino alleles in a population. However, this principle can only be applied to populations which fulfil all of the following criteria:

- sexually reproducing organisms
- diploid organisms
- large populations
- randomly-mating populations.

The tiger, an endangered species of mammal, is undergoing a worldwide captive breeding programme in zoos.

Suggest why the Hardy-Weinberg principle cannot be used to predict the expected frequencies of albino and non-albino alleles in the worldwide zoo population of tigers.

[2]

(f) A change in allele frequencies in a population is described as an evolutionary change.

List **two** factors that might cause allele frequencies to change from generation to generation in a population that meets the Hardy-Weinberg criteria.

[2]

[Total: 16]