1. Nov/2021/Paper_41/No.6

(a) Cotton, *Gossypium hirsutum*, and false flax, *Camelina sativa*, are crop plants that are grown in different parts of the world.

Rubisco activase is an enzyme in the stroma of chloroplasts that is needed to maintain the activity of a second enzyme, rubisco.

Scientists measured the activity of rubisco activase in cotton and in false flax at a range of temperatures.

Fig. 2.1 shows the results.

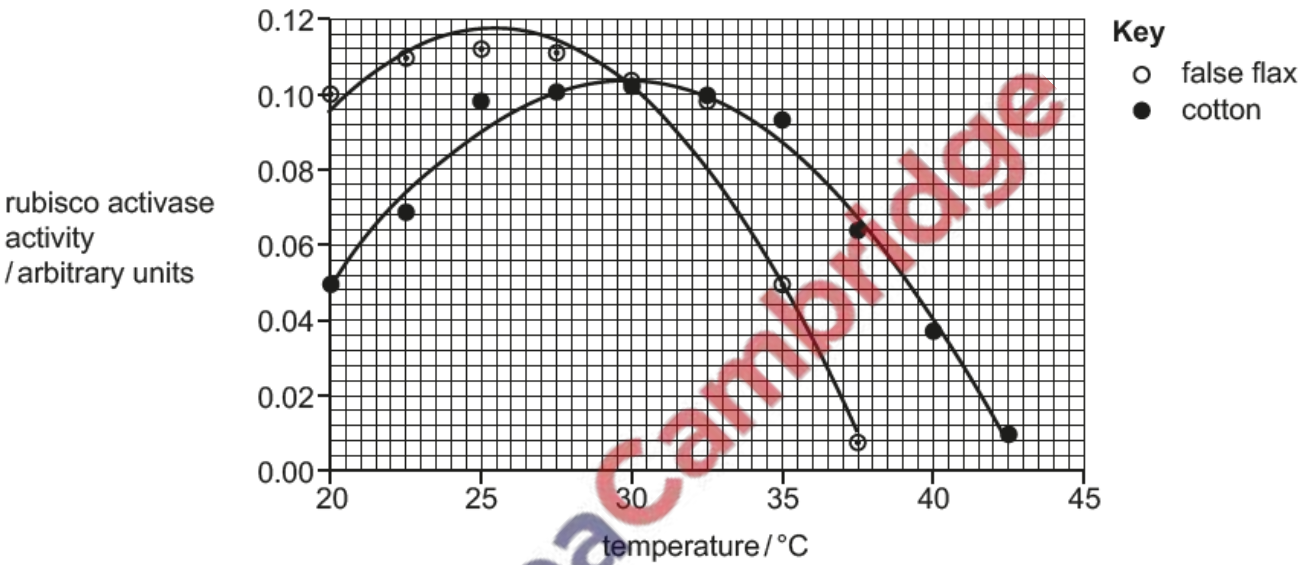

Fig. 2.1

(i) With reference to Fig. 2.1, compare the results obtained for cotton and false flax.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Suggest reasons for the differences shown in Fig. 2.1.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Rubisco enzymes from cotton and false flax are active at temperatures up to 45 °C and will denature at 45 °C.

Explain how the Calvin cycle is affected when rubisco denatures.

.....

.....

.....

.....

.....

.....

..... [3]

(c) One goal of genetic engineering is to make crops that are heat tolerant. This means that crops can grow and produce a good yield at high environmental temperatures.

Use the information given in Question 2 to suggest **and** explain a way to improve the tolerance of a crop to high temperatures.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 12]

2. Nov/2021/Paper_42/No.2

Scientists are researching new ways to reduce the global atmospheric carbon dioxide (CO_2) concentration. There are concerns that an increasing atmospheric CO_2 concentration may lead to effects that decrease biodiversity.

(a) Give **one** example of a human activity, other than deforestation, that contributes greatly to the increase in global atmospheric CO_2 concentration.

..... [1]

Algae are aquatic photosynthetic protoctists. Some researchers genetically modified the unicellular alga, *Chlorella vulgaris*, to try to increase the rate of the light independent stage of photosynthesis.

C. vulgaris was modified to increase the expression of the gene coding for aldolase. Aldolase is an enzyme that causes an increase in the concentration of rubisco.

Two cultures of *C. vulgaris*, one that was not genetically modified (unmodified) and one genetically modified, were grown under controlled conditions for 14 days. Samples were taken from the cultures at regular intervals during the 14 days to obtain measurements of dry mass.

The results are shown in Fig. 2.1.

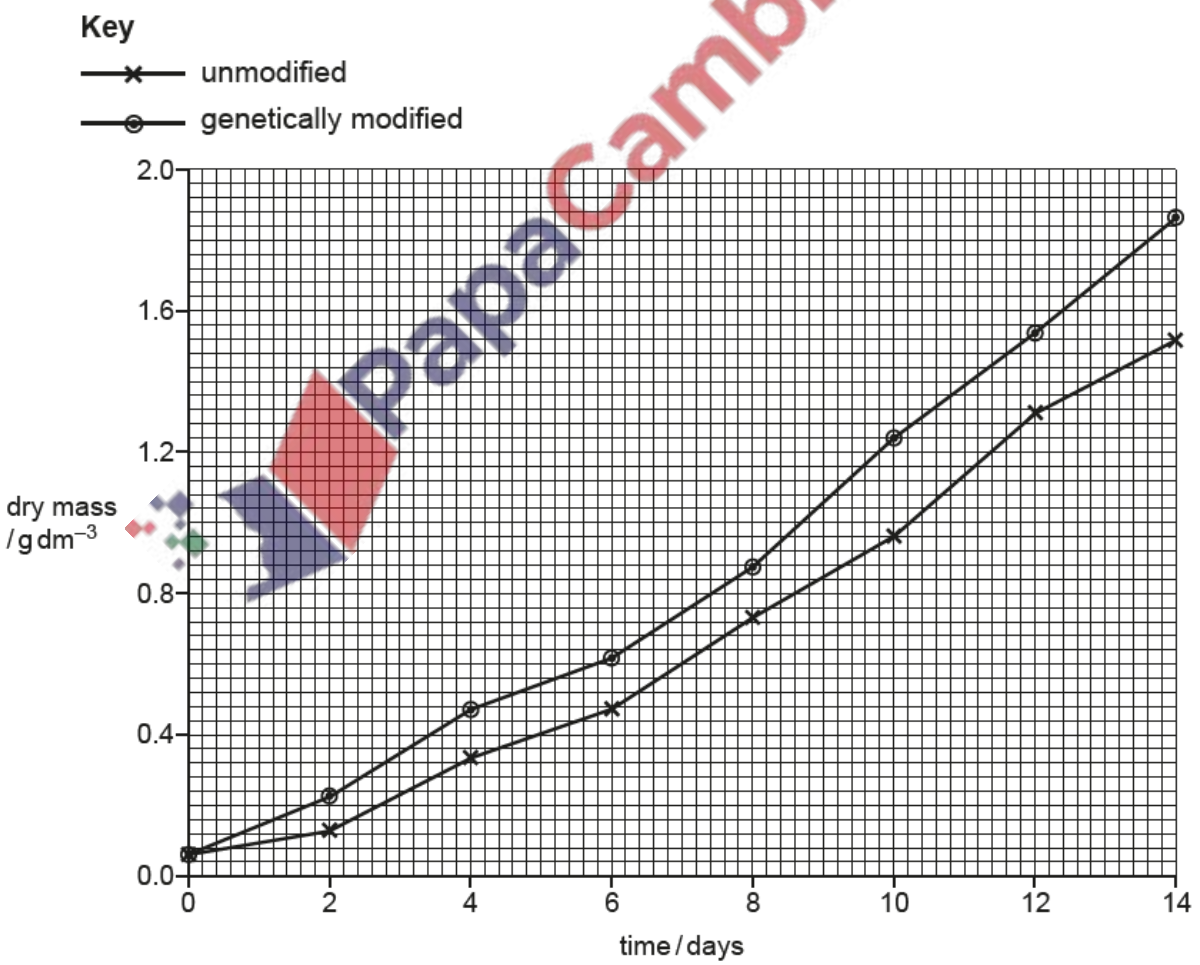

Fig. 2.1

(b) With reference to Fig. 2.1, describe the differences between the results for the two cultures.

.....

.....

.....

.....

.....

..... [3]

(c) Explain how the Calvin cycle was affected by the genetic modification of *C. vulgaris*.

.....

.....

.....

.....

.....

..... [3]

(d) Intermediate products of the Calvin cycle are needed to produce organic molecules for use by the cell.

Describe how these organic molecules are used by cells.

.....

.....

.....

.....

.....

..... [3]

(e) Planting large numbers of trees is one way to reduce global atmospheric CO_2 concentration. Large scale culture of genetically modified *C. vulgaris* could also reduce global atmospheric CO_2 concentration.

Suggest **one** advantage of using genetically modified *C. vulgaris* instead of trees to reduce global atmospheric CO_2 concentration.

.....

..... [1]

[Total: 11]

3. Nov/2021/Paper_42/No.6

(a) ATP is needed for many metabolic processes in living organisms.

(i) Describe the properties of ATP that make it suitable for its role as the universal energy currency.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Suggest why ATP is needed for protein synthesis.

.....

.....

.....

.....

..... [2]

(b) Fig. 6.1 is a diagram of mitochondrion.

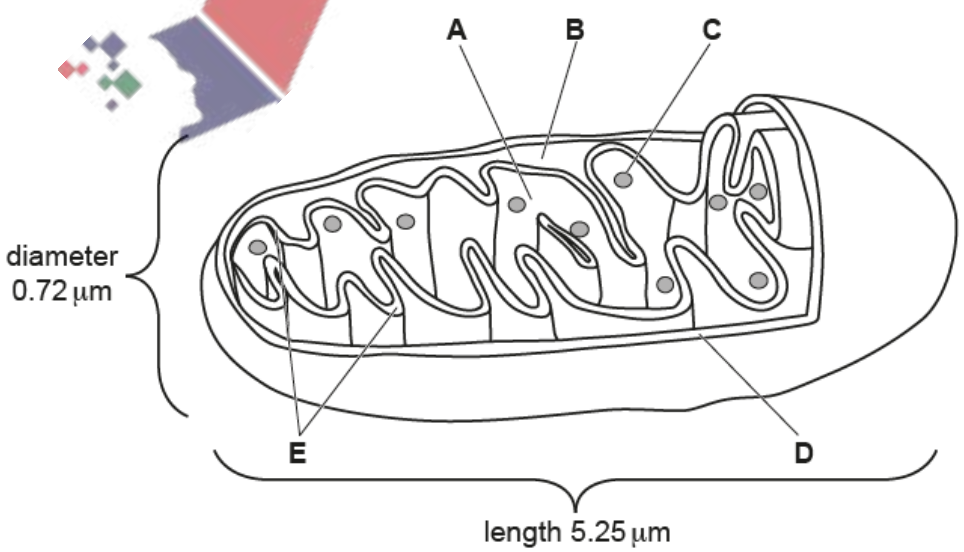

Fig. 6.1

(i) Complete Table 6.1 using the letters **A** to **E** from Fig. 6.1.

Each letter may be used once, more than once, or not at all.

Table 6.1

statement	letter
the site of the Krebs Cycle	.....
a phospholipid bilayer impermeable to H^+ ions	.....
the site of translation	.....

[2]

(ii) Assume that the mitochondrion in Fig. 6.1 is a cylinder.

Calculate the surface area of this mitochondrion.

Use the formula: Surface area of cylinder = $2\pi r^2 + 2\pi rh$

Show your working.

surface area = ... μm^2 [2]

(iii) The inner membrane of the mitochondrion has a much larger surface area than the outer membrane because of the presence of cristae.

Different cell types vary in the number of cristae present per mitochondrion. Cardiac muscle cells have mitochondria with a very large number of cristae.

Suggest **and** explain why cardiac muscle cells have mitochondria with very large numbers of cristae.

.....

.....

.....

.....

..... [2]

[Total: 12]