1. Nov/2021/Paper_41/No.2

(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.

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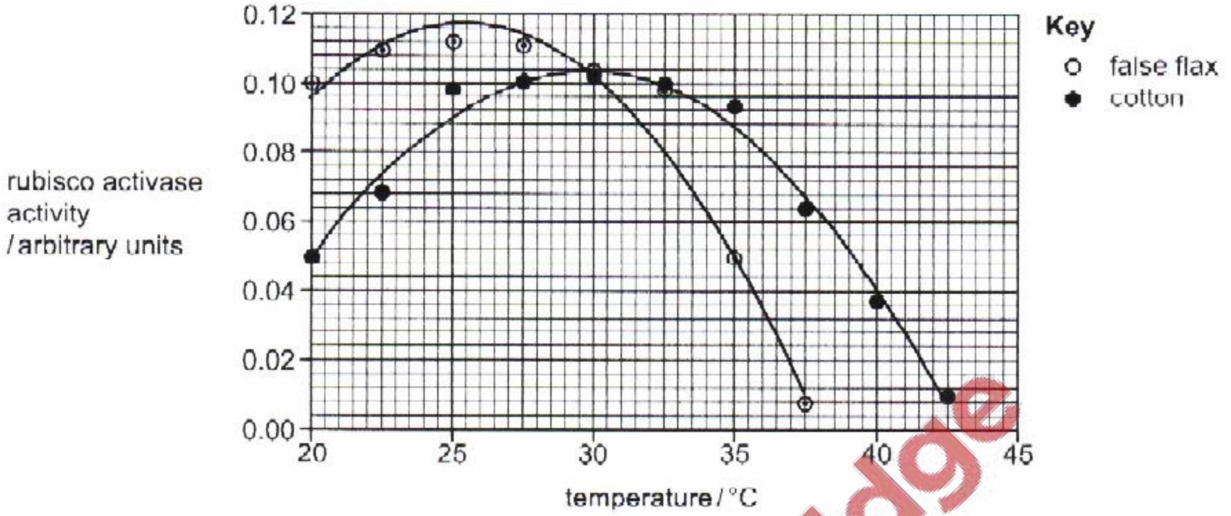

Fig. 2.1

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

Cotton Rubisco activase has a higher optimum temperature than false flax. Maximum peak activity is higher in flax enzyme than in cotton.
Cotton rubisco activase can work at a higher temperature than flax. However, both enzymes' activity increases and then decreases as the temperature increases. At 0.104 au (30°C), activity of rubisco activase stays the same.

[4]

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

Cotton (G. hirstum) is adapted to regions with higher temperatures. Cotton and flax have different alleles. The rubisco activase has different tertiary structures in cotton and flax

[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.

When rubisco denatures, there will be carbon fixation. This means that RuBP will not be carboxylated. So, Glycerate phosphate will not be converted to triose phosphate. Therefore, less of RuBP will be generated. Then the triose phosphates will not react to form glucose.

[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.

A gene of rubisco activase can be identified in the DNA of Cotton. Then it is transfered to embryo of a crop of interest. An endonuclease is used to cut the DNA of cotton to remove gene for rubisco activase, Then it is transfered by vector to embryo of crop of interest. This gene helps plant to maintain activity of rubisco at high temperatures.

[2]

[Total: 12]

2. Nov/2021/Paper_41/No.9

(a) Describe **and** explain the mechanism by which guard cells open stomata. [7]

(b) Explain how the anatomy **and** physiology of the leaves of maize or sorghum are able to maximise carbon dioxide fixation at high temperatures. [8]

[Total: 15]

9b. C_4 plants have prominent bundle sheath cells surrounding vein. The mesophyll cells are arranged side by side to form a tightly packed ring around bundle sheath cells. The C_4 plants stop photorespiration but use PEP enzyme during the first step of carbon fixation. This happens in the mesophyll cells that are located close to the stomata where carbon dioxide and oxygen enter the plant. C_4 plants are found in conditions where water is scarce. The C_4 pathway builds up high concentrations of carbon dioxide in the chloroplasts of bundle sheath cells. The higher level of internal CO_2 in chloroplasts increase carboxylation. This helps to decrease photorespiration in cells. So Rubisco in sheath cells cannot reach air. Then CO_2 combines with PEP carboxylase in mesophyl to form oxaloacetate (malate). The malate releases carbon dioxide in sheath cells. The CO_2 released react with RuBP. PEP carboxylase is tolerant to high temperature. PEP carboxylase will catalyse catalyse carbon fixation even at high temperatures.

10 a.

When sodium ion channels along axon open, sodium ions enter the axon. This depolarises the nerve cell. A membrane potential of 40mV is then created. The sodium ions chanells close after repolarisation. Then K^+ ion channels open so that K^+ ions are moved out of the cell. This creats a membrane potential of -90mV. So the neurone becomes repolarised. Sodium ion channels open when neuron is stimulated. The neurones are myelinated to speed up the rate of nerve transmission (action potential). The myeline sheath on axon breaks into nodes of Ranvier. Action potential jumps from node to node. This speeds up transmission of action potential on the axon length. Nerve stimulation must reach a threshold. The action potential occurs only at nodes. This reduces distance travelled by the action potential. The impulses are transmitted along one-way only. At action potential, there are more positive charges on the outside of the neurone while the inside of the neuron has more negative charges than positive charges. This creates a wave of depolarisation along the length of an axon. This forms an electric signal that moves along the axon.