VICTORIA JUNIOR COLLEGE

JC 2 PRELIMINARY EXAMINATION 2017

NAME : _____

CT CLASS : _____

H2 BIOLOGY **9744/3**

Paper 3 Longer Structured and Free-response Questions **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your Name and CT Class on the cover page of this paper.
Write in dark blue or blue pen.
You may use a soft pencil for any diagrams or graphs.
Do not use any staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the question paper.

Section B
Answer any one question on the writing paper provided.
Indicate the question number of the essay that you have attempted in the box on the left.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use the appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
Section B	
Total	

Section A

Answer **all** the questions in this section.

1 Huntington's disease (HD) is a rare neurodegenerative disease. Fig. 1.1 shows a pedigree of HD across three generations (**I** to **III**).

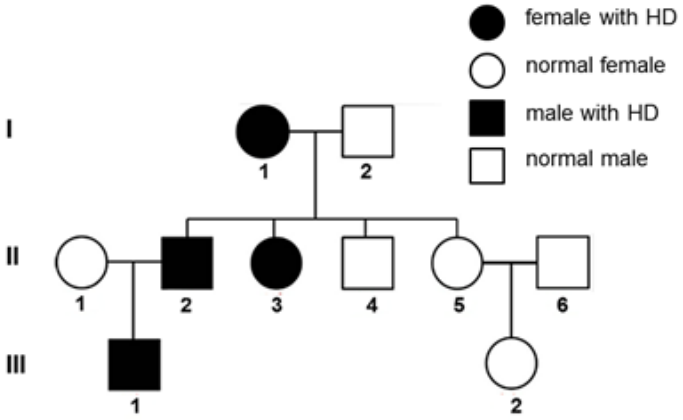

Fig. 1.1

(a) With reference to Fig. 1.1, account for the mode of inheritance of the disease.

[3]

HD strikes in adulthood when disease symptoms appear between the ages of 30 and 50 in 90% of cases. The disease involves the progressive loss of particular nerve cells in the brain leading to loss of motor control and a decline in cognitive function.

HD is caused by alteration in the Huntingtin (*HTT*) gene located on human chromosome 4. The genetic alteration is an increase in the number of repeats of three nucleotide bases (CAG) in the first exon of the HTT gene. This CAG triplet is normally repeated about 20 times, but an approximate doubling in the number of repeats to 40 or more results in the expression of the disease. The number of CAG repeats also correlates with age of onset of HD and severity of disease.

(b) The CAG repeat codes for the amino acid glutamine.

(i) Explain the likely effect of the abnormal increase in CAG repeats on HTT protein structure and function.

[3]

(ii) Suggest possible reasons why individuals having number of repeats ranging from 21-39 do not develop the disease.

[2]

(c) The genetic test for HD involves taking a small sample of DNA from the individual, to look for abnormally expanded CAG repeats, through polymerase chain reaction (PCR).

(i) Explain why PCR can be used for the diagnosis of HD.

[2]

(ii) Explain how gel electrophoresis was used to detect the band patterns of the offspring in Fig.1.1.

[4]

Fig. 1.2 shows the pedigree of a male parent who developed HD when he was 40 years old. The results of electrophoresis of PCR fragments of some of the individuals are shown. The age onset of HD is shown in brackets below the individuals who developed HD.

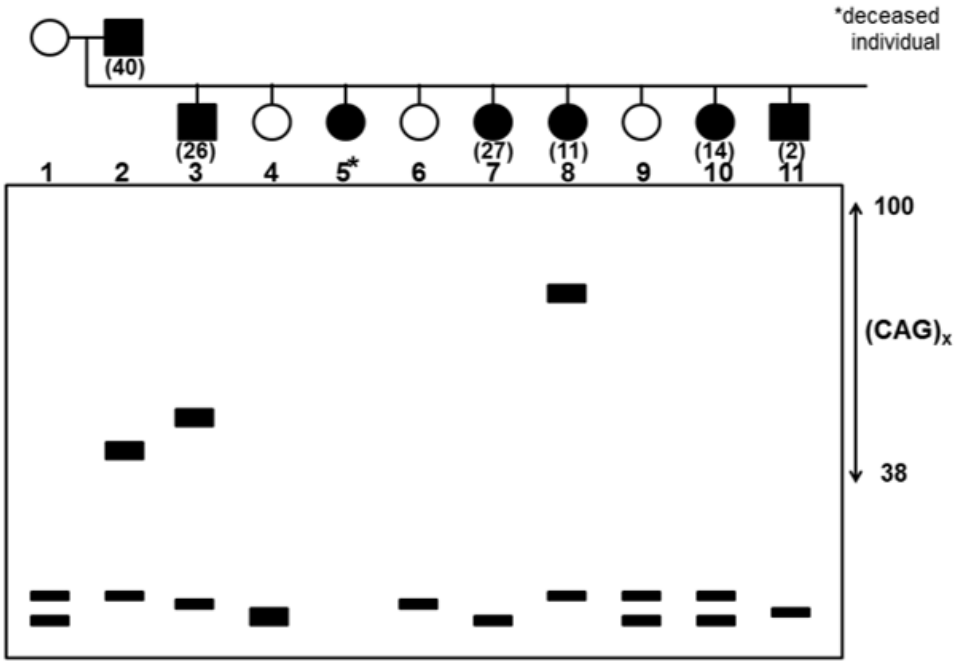

Fig. 1.2

(d) Based on the information you have been given, draw in the band patterns (in Fig. 1.2) for individuals #6, #10 and #11. [2]

(e) Individuals with 6-35 CAG repeats will be unaffected. Offspring of individuals with 36-39 repeats are at increased risk for HD.

Suggest how this increased risk can occur.

[2]

[Total: 18]

2 In many multicellular organisms, such as mammals, the time taken for the mitotic cell cycle varies considerably between different tissues, but is very carefully controlled in each cell.

(a) Explain how the loss in the control of the cell cycle can lead to cancer.

[3]

(b) Most mammals possess an internal defence mechanism that can target and destroy cancerous cells.

Outline how such a mechanism is activated to be effective in its function.

[4]

The effectiveness of anti-cancer drugs may be determined by growing different tumours in culture. The effectiveness of two drugs on two human tumours (A and B) from different tissues was assessed.

The two drugs, T138067 and vinblastine, were added to the tumours in culture on days 5, 12 and 19. The volumes of the tumours were compared with the volumes of tumours that were not treated with any drugs. The results are shown in Fig. 2.

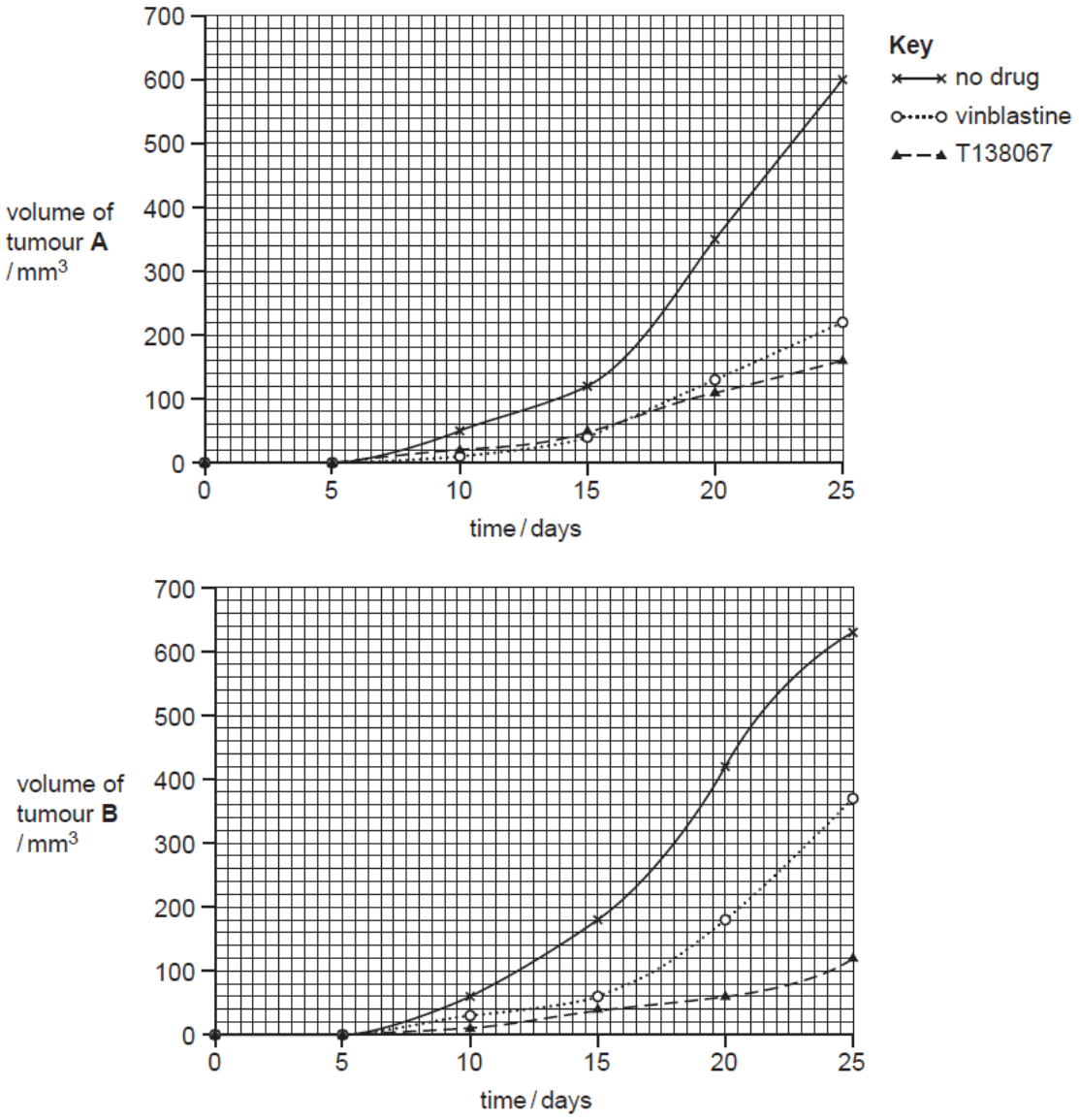

Fig. 2

(c) **(i)** Use the data in Fig. 2 to compare the effectiveness of the two drugs used to treat the tumours.

[4]

(ii) Both Vinblastine and T138067 were able to bind to tubulin.

Explain the effects of Vinblastine and T138067 as anti-cancer drugs.

[3]

(iii) Suggest why the same tumor cells may respond differently to these two drugs?

[3]

[Total: 17]

3 Fig. 3.1 shows the rate of carbon dioxide uptake by Barley and Sugarcane at a range of carbon dioxide concentrations.

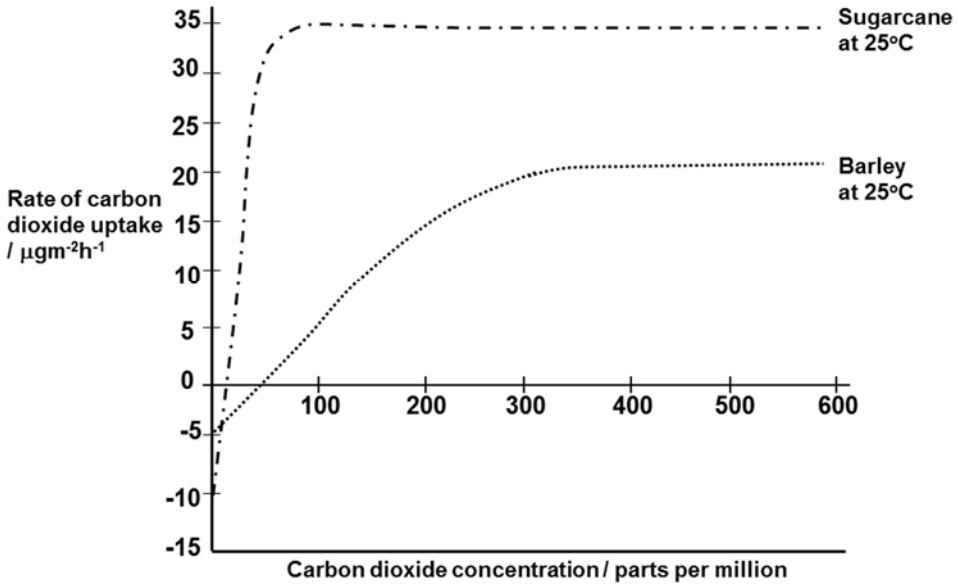

Fig 3.1

(a) With reference to the curve for Barley, explain the meaning of limiting factor.

[3]

Plants, in general, utilise either the C3 or C4 photosynthetic pathways. C3 plants (eg. barley) produce triose phosphate as their first product in Calvin cycle. The enzyme ribulose bisphosphate carboxylase (Rubisco) is a key enzyme in the C3 pathway.

C4 plants (eg. sugarcane) produce oxaloacetate (OAA), a 4 carbon compound, as their first product. This reaction is catalysed by Phosphoenolpyruvate carboxylase (PEPC). Photosynthesis for these C4 plants then continues in much the same way as C3 plants.

The K_m values for carbon dioxide for Rubisco and PEPC is shown below.

K_m CO_2 for Rubisco = 12 µM
K_m CO_2 for PEPC = 2 µM

Fig 3.2 below shows morphological differences in the leaf of a C3 and C4 plants.

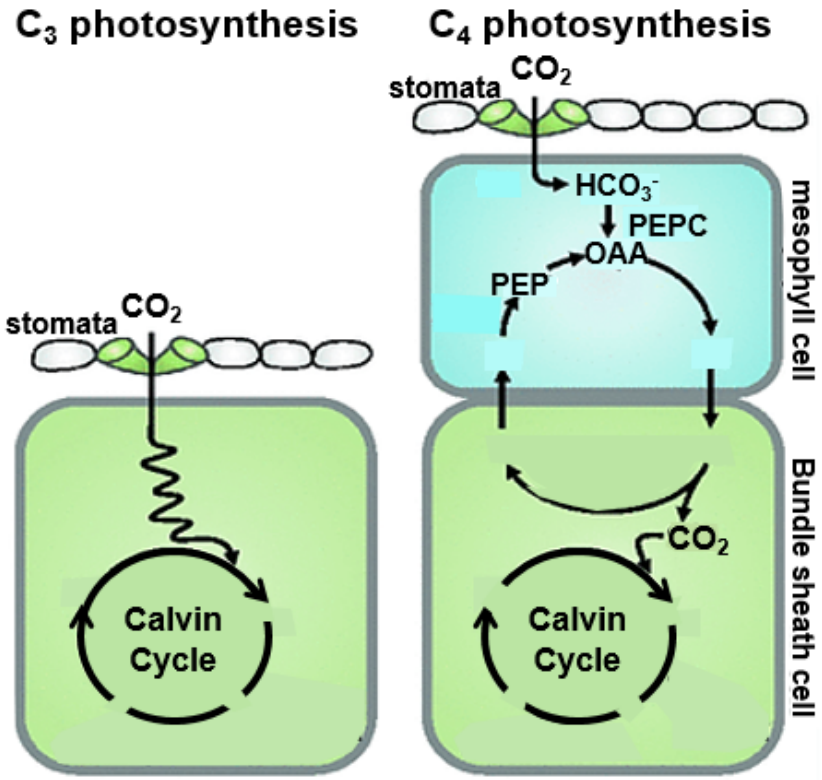

Fig 3.2

(b) Based on the morphological differences shown in Fig 3.2 and the K_m values for both enzymes, suggest reasons for the difference in rate of CO_2 uptake for Sugarcane (C4 plant) and Barley (C3 plant) shown in Fig 3.1.

[5]

(c) Suggest another structural difference in the leaf morphology between C3 and C4 plants.

[1]

Table 3.3 shows the mass of water absorbed by six crop plants, three of which are C3 and three of which are C4.

crop	C3 or C4	mass of water absorbed per gram dry mass produced /g
rice	C3	682
potato	C3	575
wheat	C3	542
maize	C4	350
sorghum	C4	304
millet	C4	285

Table 3.3

(d) In view of all the information that is given above, discuss the likely impact of predicted changes in carbon dioxide concentration, global temperatures and rainfall patterns on the distribution of C3 and C4 plants.

[6]

[Total: 15]

Section B

Answer **one** question in this section

Write your answer on the writing paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in parts **(a), (b)** as indicated in the question.

4 **(a)** Discuss the effectiveness of a live, attenuated vaccine against an RNA virus. [13]

(b) Discuss the various ways in which the concentration of an enzyme in a cell can be regulated. [12]

[Total: 25]

5 **(a)** Describe the functions of various components found in the plasma membrane and explain, using named examples, why there is a different composition of these components in membranes of different cells and organelles. [13]

(b) Hyperglucagonemia is a condition where there is excess glucagon secretion. Using your knowledge of how glucagon works and how HIV infects a cell, explain how drugs can be used to target the different stages in each condition. Highlight in your answer, similarities in the mechanism of the drugs. [12]

[Total: 25]