

Practice Paper 2

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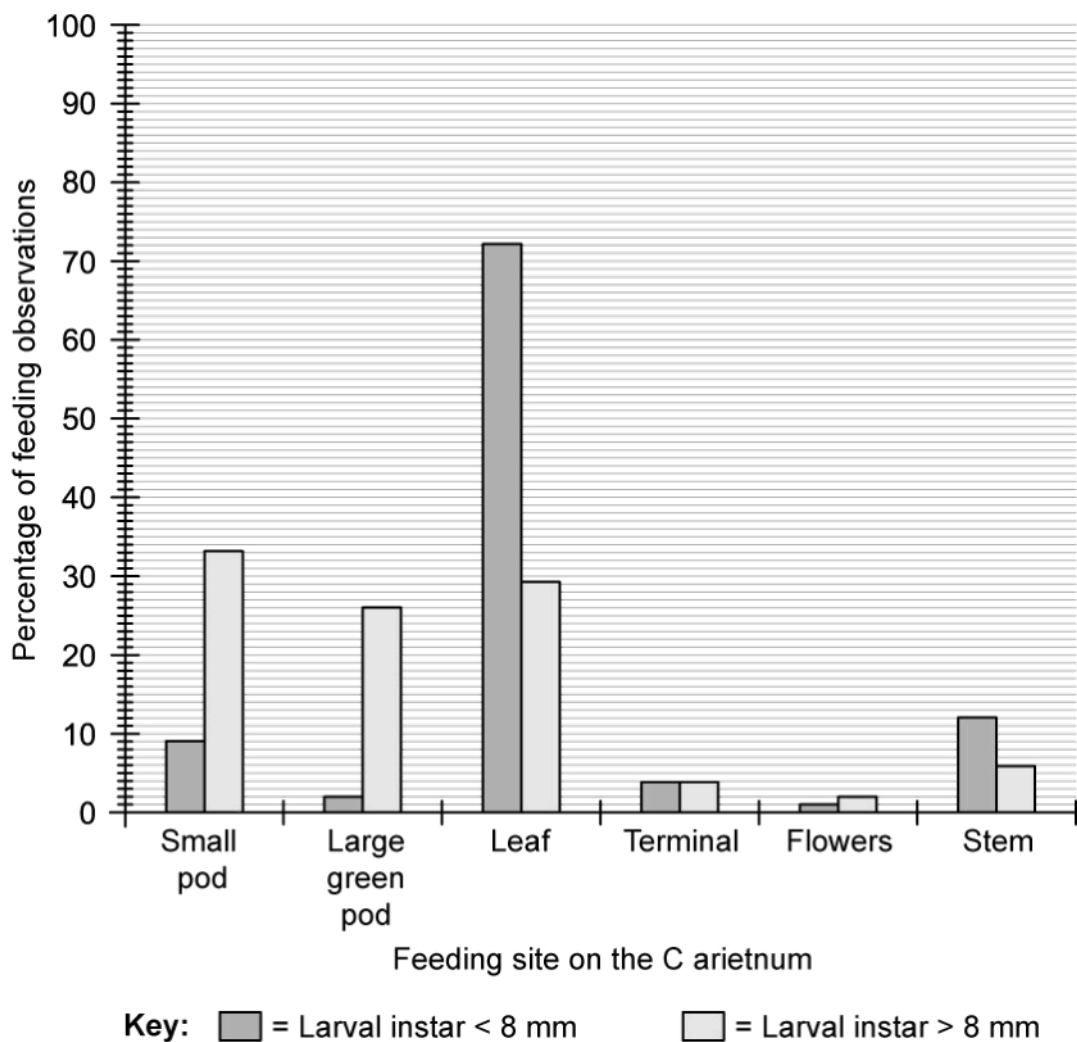


Total Marks

/72

1 (a) The *Helicoverpa punctigera* (native budworm) caterpillar is a major insect pest for *Cicer arietinum* (chickpeas). Reduction to crop yield and seed quality occurs when the larvae density reaches 10 to 20 per m². The larvae primarily cause damage to the leaf surface area, flower buds and fruiting bodies and are classified into 4 instars (sizes); very small (VS) - 1 to 2 mm, small (S) - 4 to 7 mm, medium large (ML) - 8 to 23 mm and large (L) - 24 to 30+ mm. The smaller instars prefer foliage, however it is the larger instars (greater than 8 mm), who prefer the pods, that cause the most economical damage. Farmers regularly monitor their *arietinum* crop to determine when insecticides are required to control the *H.punctigera*.

The monitoring involves beating the plants to determine the mean number of larvae per metre row and making observations of the type of damage.



Identify the feeding site on the *C. arietinum* that has the least percentage of feeding by

larvae smaller than 8 mm.

(1 mark)

- (b)** Calculate the difference between the percentage of feeding by larvae less than and greater than 8 mm, on *C. arietinum* leaves.

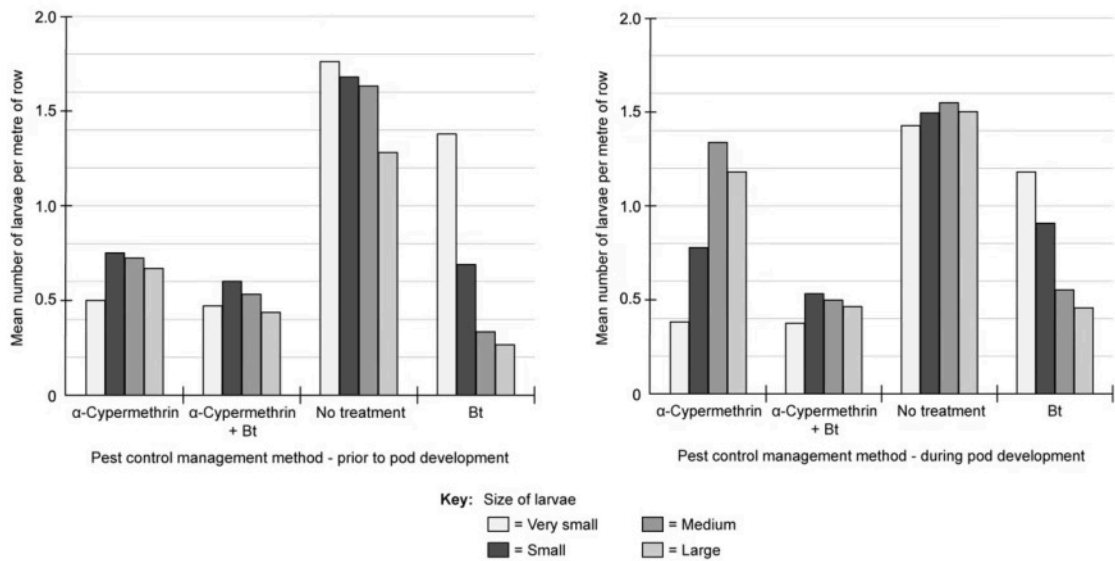
(1 mark)

- (c)** Suggest a reason for the preference of the small larvae feeding on the leaves.

(1 mark)

- (d)** Pest management is economically and environmentally important to farmers. Insecticides can be costly, insect resistance can develop and broad-spectrum insecticides can cause beneficial insects (e.g. pollinators) to be killed when applied. Scientists have been researching the most appropriate method to manage pests of chickpea crops. They have genetically engineered *C. arietinum* plants with the bacterium *Bacillus thuringiensis* (Bt), which results in the plants releasing a toxin that kills insects that ingest it. Scientists have also been developing synthetic pyrethroids (e.g. α -Cypermethrin) that *H. punctigera* currently have a low resistance to.

In this study, scientists explored four different pest management methods over one growing season. The graphs below represent data from the experiments undertaken.



State which pest control management method was most successful in controlling larvae less than 8 mm prior to pod development.

(1 mark)

(e) Suggest why Bt *C.arietinum* appear to be more effective at controlling the larger larvae of *H.punctigera*.

(1 mark)

(f) Compare the effectiveness of the three methods used in limiting the damage caused by *H.punctigera*, prior to pod development and during pod development.

(3 marks)

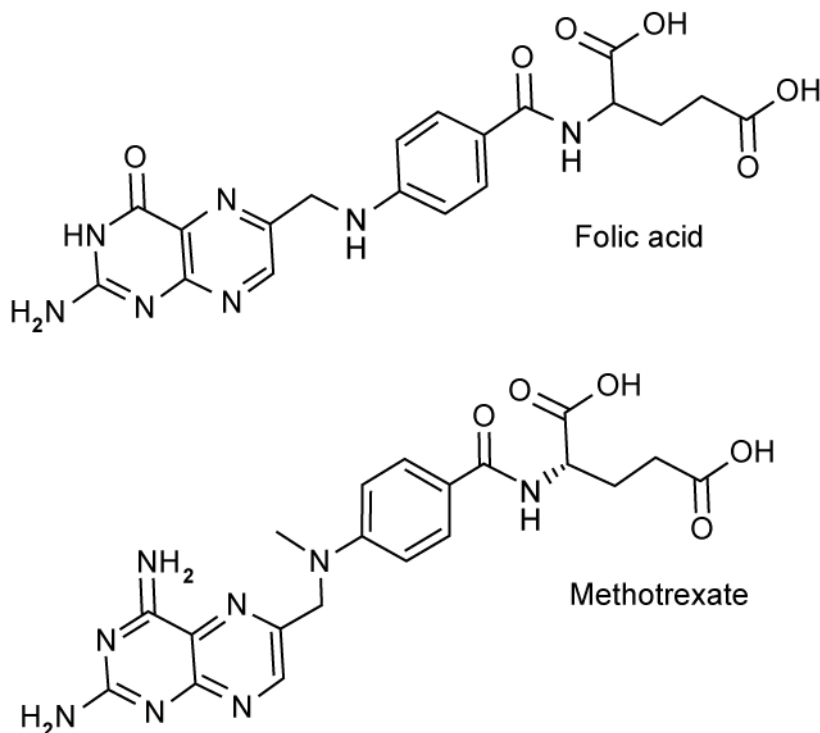
(g) Using all the data provided, evaluate the hypothesis that the most sound pest management method is a combination of using a synthetic pyrethroid (α -Cypermethrin) on a genetically engineered (Bt) chickpea crop.

(3 marks)

- 2 (a)** Folate is a chemical used by cancer cells to make DNA during cell division. Folate is produced through the conversion of folic acid catalysed by the enzyme dihydrofolate reductase.

Methotrexate is a medicinal drug given to people with cancer, and other autoimmune diseases, as it acts as an inhibitor for the enzyme dihydrofolate reductase.

The image below shows the chemical structure for the enzyme's normal substrate, folic acid, as well as the structure of its inhibitor, methotrexate.



Using the images, suggest the method of inhibition used by methotrexate. Explain your answer.

(2 marks)

(b) Folate is not just used by cancer cells during replication, but by any cells of the human body that replicate quickly.

Methotrexate is commonly used as part of chemotherapy treatment for cancer sufferers.

Using this information, suggest why people that undergo chemotherapy lose their hair.

(3 marks)

3 (a) State the aspect of the molecular behaviour of water that is used to explain why it is highly important to living organisms.

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(1 mark)

(b) Two of the properties of water are its **cohesive** and **adhesive** forces.

Describe how these properties are useful to living organisms.

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(3 marks)

(c) Both water and methane are small molecules containing single covalent bonds between their atoms.

State two differences between these two molecules that make their physical properties very different.

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(2 marks)

(d) List two physical properties, associated with their state of matter, that differ between water and methane.

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(2 marks)

- 4 (a) Ecologists studied a rocky shore habitat which contained, among other organisms, several barnacle species, purple topshell snails (*Gibbula umbilicalis*), seaweeds, and lichens.

State, with a reason, which of the organisms listed above make up a single population.

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(2 marks)

- (b) The ecologists wanted to find out whether there was an association between the distributions of purple topshell snails and the common rock barnacle, *Semibalanus balanoides*.

Outline the method ecologists would use to collect data to determine whether or not such an association existed.

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(3 marks)

- (c) A chi-squared test was carried out to determine whether or not there was a significant association between purple topshells and common rock barnacles on a rocky shore. When the calculated chi-squared value was compared to values in a critical values table it was found to be smaller than the critical value at a 0.05 probability level.

Deduce what can be concluded from this analysis?

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(2 marks)

5 (a) A scientist obtained the mitotic index for a tissue sample taken from a patient.

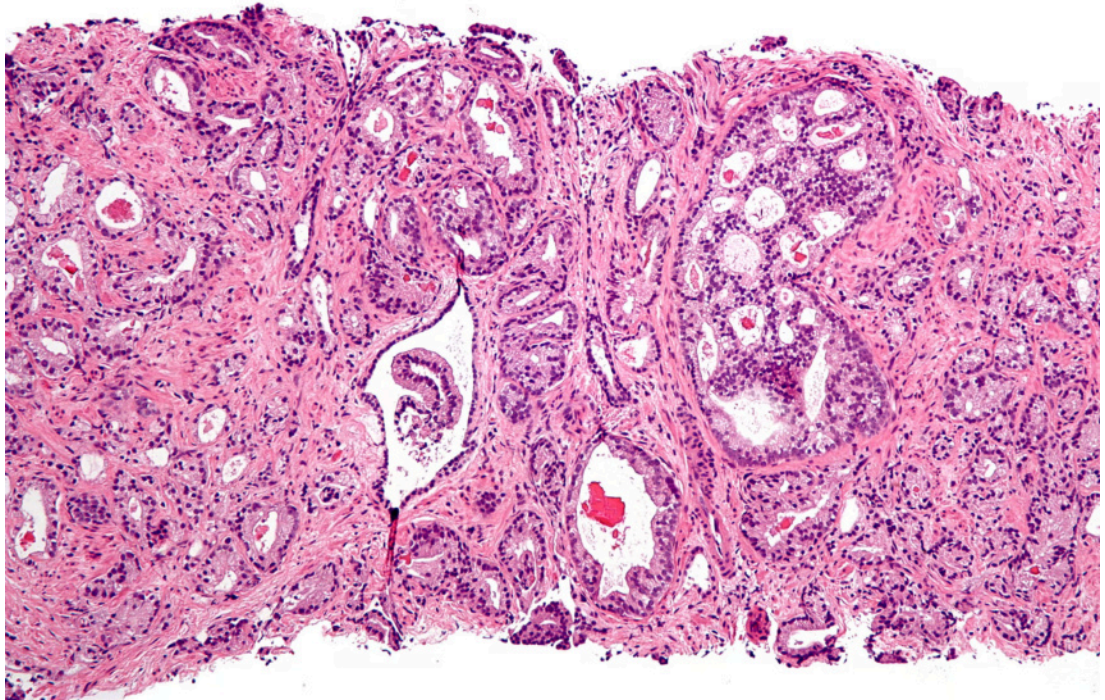


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i) Define the term mitotic index.

[1 mark]

ii) Suggest how the mitotic index could be used to indicate the presence of cancer in a tissue sample.

[2 marks]

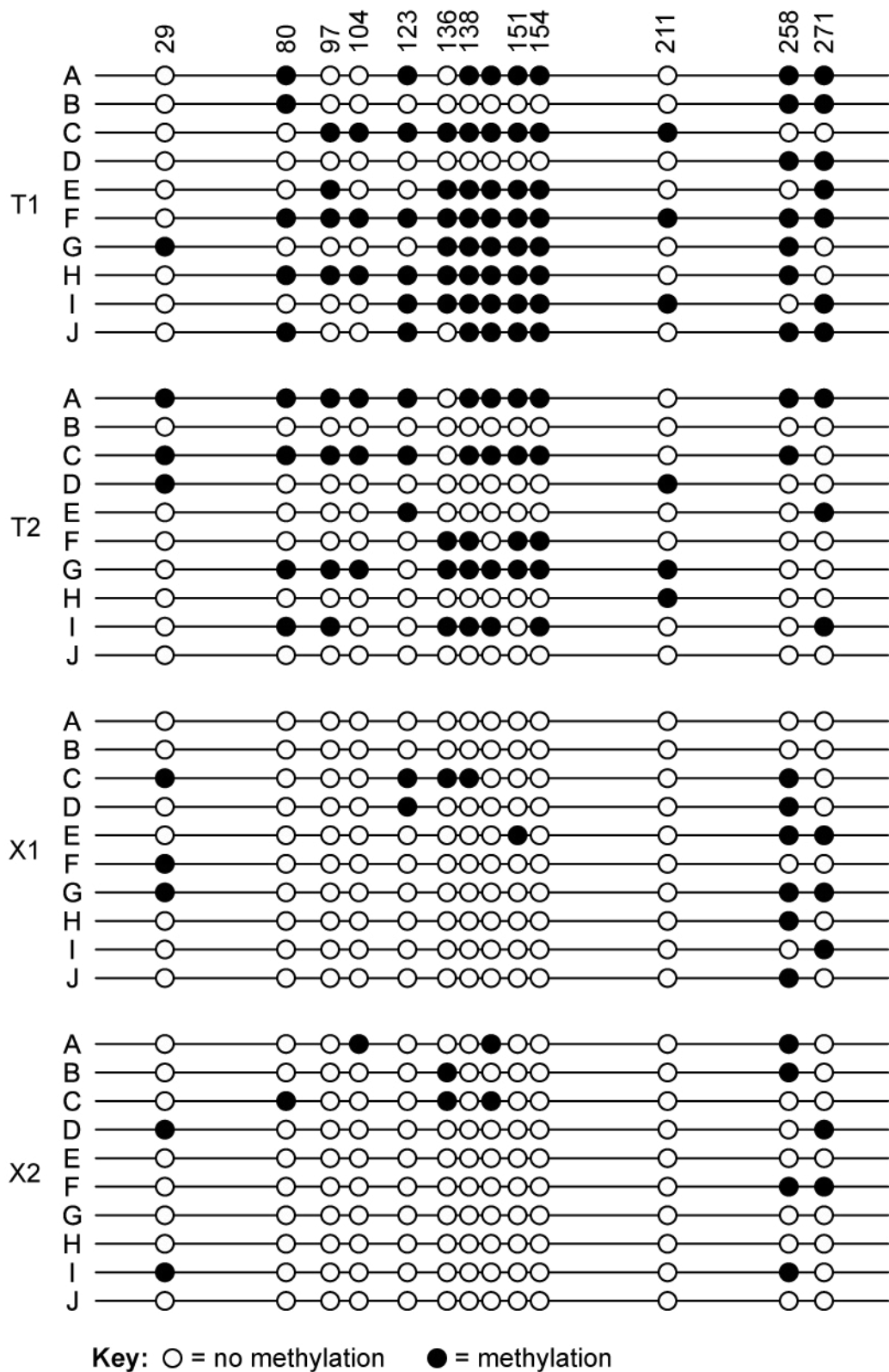
(3 marks)

(b) DNA contains several non-coding regions.

State **two** functions of these regions.

(2 marks)

- (c)** DNA methylation plays a vital role in gene regulation by affecting transcription. Tissue samples were obtained from two prostate cancer tumours (T1 and T2) and two normal prostate samples (X1 and X2). A specific gene was indicated as a plausible cause of cancer. The promoter of this specific gene was cloned several times (A-J). The data below shows the DNA methylation patterns from these samples. The numbers (29–271) represent different markers in the promoter region.



Use the information above to compare and contrast the methylation patterns in tumorous and normal tissue samples.

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(3 marks)

(d) Predict the effect DNA methylation could have on tumour cell genes.

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(2 marks)

6 (a) *One mark is available for clarity of communication throughout the last two questions.*

Describe and explain the changes that take place to the cell ultrastructure of a B-cell after activation to ensure it is adapted for its function.

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(4 marks)

(b) Outline the process which occurs in a pregnancy test to give a positive test result.

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(5 marks)

(c) Discuss the benefits and risks associated with vaccination programmes.

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(6 marks)

7 (a) *One mark is available for clarity of communication throughout the last two questions.*

Describe the process of crossing over in prophase I.

(7 marks)

(b) Compare and contrast meiosis II and mitosis.

(5 marks)

(c) Draw a diagram to show how chiasmata are formed.

(4 marks)