

## Coordination, Response and Gene Technology - Questions by Topic

Q1.

A number of insects can transmit disease when they bite their hosts.

The photograph shows *Rhodnius prolixus*, a blood-sucking insect that transmits Chagas disease between humans.

This insect feeds on blood by extending its proboscis and pushing it through the skin of a person. It is thought to do this when it detects body warmth.



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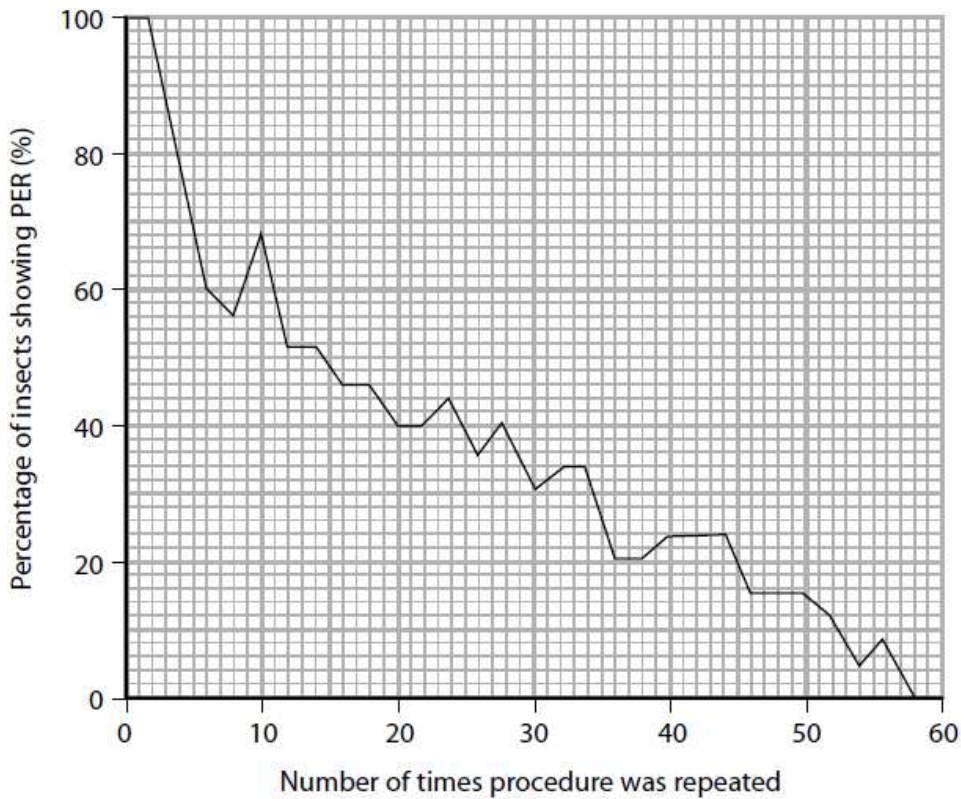
An investigation was carried out to study the effect of a heat stimulus on the proboscis extension response (PER).

Insects were kept in a temperature-controlled container with a heat pad placed in front of them. The heat pad could be touched by the proboscis when fully extended.

The heat pad was initially set at 25 °C. It was then heated up to 35 °C and the number of insects with a fully-extended proboscis were counted. It was then returned to a temperature of 25 °C.

This procedure was repeated a number of times.

The graph shows the results of this investigation.



(a) In this investigation, 350 insects were used.

Calculate the mean decrease in the number of insects showing PER each time the procedure was repeated.

(3)

Answer .....

(b) Explain the results of this investigation.

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(c) Suggest why a drop in PER to a heat stimulus could be an advantage to these insects.

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**(Total for question = 8 marks)**

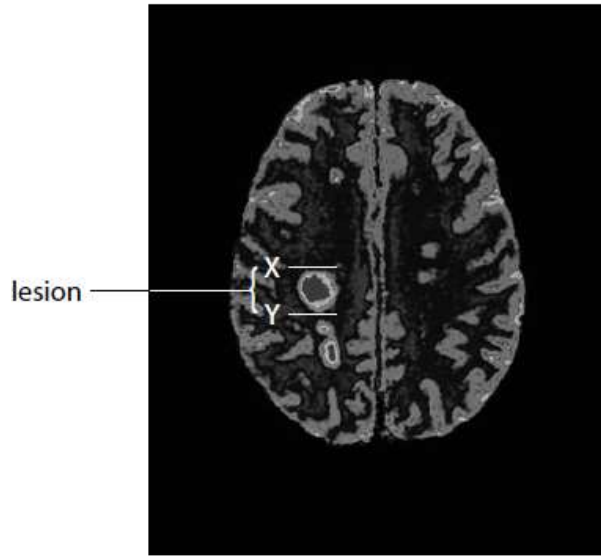
Q2.

Multiple sclerosis (MS) is a disease that causes the destruction of the myelin sheaths around neurones.

This destruction is caused by the person's own immune system.

Lesions form in the brain where myelin is destroyed.

(a) The photograph shows lesions in the brain of a person with MS, as seen using magnetic resonance imaging (MRI).



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The actual length of this brain is 15 cm.

Calculate the actual diameter, in mm, of the lesion between X and Y.

(2)

Answer ..... mm

(b) The table shows the speed of conduction of an impulse along non-myelinated and myelinated neurones with axons of different diameters.

Type of neurone	Diameter of axon / $\mu\text{m}$	Speed of conduction of impulse / $\text{m s}^{-1}$
non-myelinated	1	2.3
non-myelinated	2	3.1
non-myelinated	4	4.2
myelinated	1	2.6
myelinated	2	8.5

(i) Show that the effect of diameter on the speed of conduction of an impulse is six times greater in a myelinated neurone than in a non-myelinated neurone.

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(ii) Explain the effect of the myelin sheath and the diameter of the axon on the speed of conduction of an impulse.

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(iii) Symptoms of MS can include blindness in one eye and lack of coordination.

Suggest why a person with MS could have these symptoms.

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**(Total for question = 11 marks)**

Q3.

The scientific document you have studied is adapted from an article in nature.com:  
*Microgravity elicits reproducible alterations in cytoskeletal and metabolic gene and protein expression in space-flown Caenorhabditis elegans.*

Use the information from the scientific document and your own knowledge to answer the following questions.

(a) Suggest why the authors of this article have named the species of nematode used in this study (paragraph 2).

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(b) State **one** ethical issue of using nematodes in this study.

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(c) Describe how microgravity can cause changes in gene expression in these nematodes (paragraph 4).

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(d) Suggest why there was a lower fat accumulation and shorter body length in nematodes grown in microgravity (paragraph 4).

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(e) Explain why there were reduced levels of a number of metabolic proteins in nematodes grown in microgravity (paragraph 6).

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(f) Explain why microarrays could be used to show that mitochondrial electron transport genes are downregulated, whereas the sirtuin gene was upregulated (paragraph 7).

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(g) Explain why Sudan Black was used in this study (paragraph 8).

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(h) Comment on the reliability of the data presented in Table 1 (paragraph 9).

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**(Total for question = 20 marks)**

Q4.

Some groups of living organisms produce neurotoxins.

Neurotoxins act at synapses, preventing the generation of nerve impulses.

Some scientists have been studying neurotoxins using a combination of computer science, statistics and mathematics.

(a) What is the name of a study that combines computer science, statistics and mathematics?

(1)

- A** bioinformatics
- B** computed tomography
- C** epigenetics
- D** forensic entomology

(b) Some neurotoxins act in these ways:

- inhibiting the release of acetylcholine
- blocking of ion channels
- blocking of acetylcholine receptors.

Explain how these neurotoxins prevent the generation of nerve impulses.

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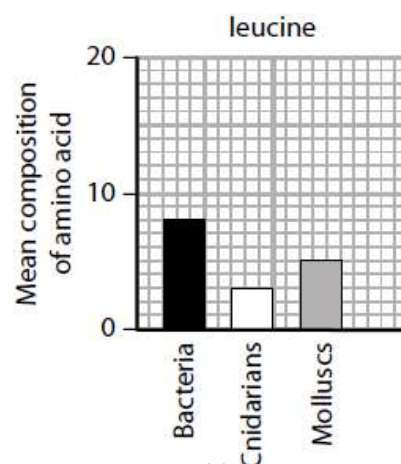
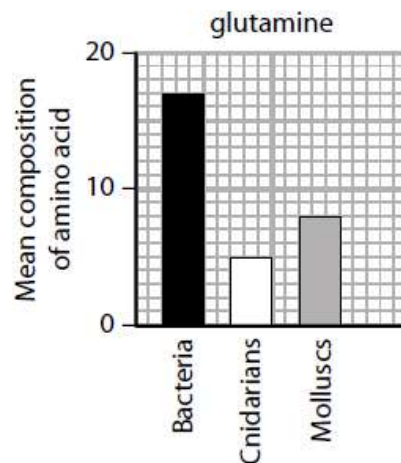
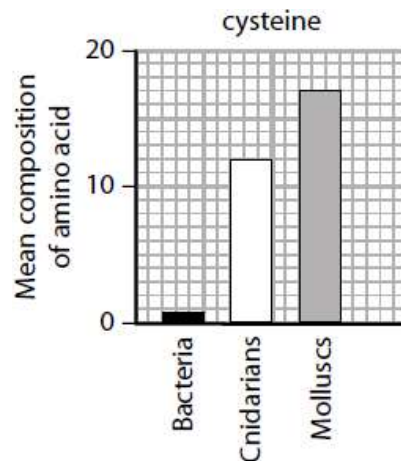
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(c) The table shows the mean composition of three amino acids, in neurotoxins and non-toxins.

Type of amino acid	Mean composition of amino acid in neurotoxins	Mean composition of amino acid in non-toxins
Cysteine	13.69	1.95
Glutamine	2.35	4.16
Leucine	5.53	10.17

The graphs show the mean composition of these amino acids in neurotoxins produced by three groups of organisms: bacteria, cnidarians and molluscs.



\*(i) Comment on the amino acid composition of these neurotoxins. Use the information in the table and in the graphs to support your answer.

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(ii) Explain why the replacement of one amino acid in a neurotoxin could decrease its toxicity.

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**(Total for question = 12 marks)**