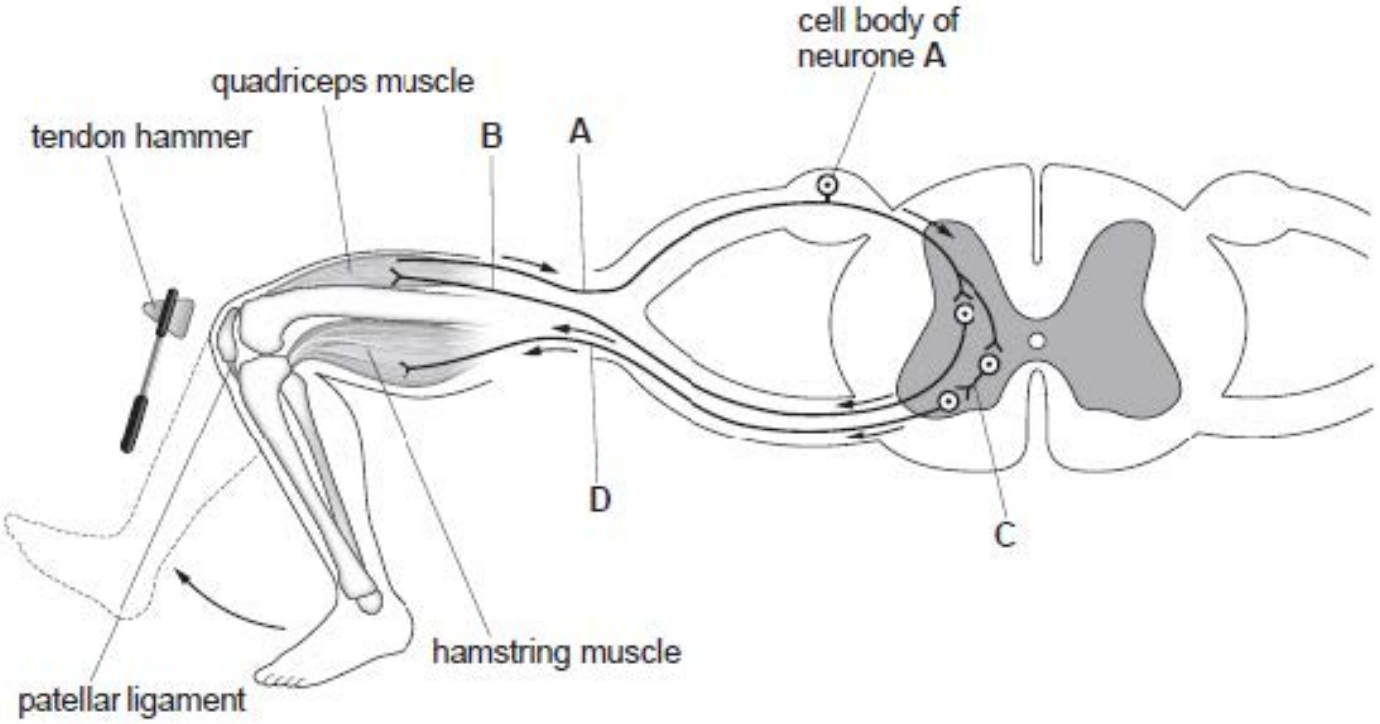
GCE Biology

S21-A400U30-1

Assessment Resource 20

Requirements for Life Resource B

1. The patellar reflex (commonly known as the knee-jerk reflex) can be used to identify problems in neural communication between the quadriceps muscle and the spinal cord. The patellar ligament joins the quadriceps muscle to the lower leg bone. Normally, when the leg is tapped sharply on the patellar ligament (just below the knee cap) the quadriceps muscle contracts involuntarily. Contraction of the hamstring then returns the lower leg to its original position.



(a) Four neurones, A, B, C and D, are labelled on the diagram above.

(i) Using the letters A to D, identify the neurones involved in the reflex arcs involving: [1]

I. the quadriceps muscle .....

II. the hamstring muscle .....

(ii) With reference to the neurones involved, explain why the contraction of the hamstring muscle occurs after the quadriceps muscle, in response to the same stimulus. [2]

.....

.....

.....

.....

(b) Impulses are transmitted through the neurones as a wave of action potentials. Explain how the movement of ions results in the **generation** of an action potential. [4]

.....

.....

.....

.....

.....

.....

.....

Question is continued on the next page

(c) An experiment was carried out to determine the time taken for a person to kick their leg in response to the following stimuli:

Stimulus **1**. direct stimulus of the patellar ligament by the tendon hammer

Stimulus **2**. hearing the tendon hammer hitting the table

The reaction times to both stimuli were collected for a group of ten people. Mean reaction times were calculated and used to calculate the standard deviations for each stimulus. A t-test value was calculated to assess whether any difference in the results was significant. The results are summarised in the table below.

	STIMULUS 1	**STIMULUS 2**
mean reaction time / s	0.026	0.236
number of measurements	$n_1 = 10$	$n_2 = 10$
standard deviation	0.006	0.108
t-test value	2.41	

(i) Explain why a t-test was used to assess the significance of the differences in the results and not a Chi-squared test. [2]

.....

.....

.....

(ii) The null hypothesis for this experiment was that *'there was no significant difference between the results for Stimulus **1** and Stimulus **2**'*. The degrees of freedom for this t-test were 18.

Use the t-test value and the information given in the table below to decide whether to accept or reject the null hypothesis at a suitable probability level. Explain your answer. [4]

degrees of freedom	probability			
	0.1	**0.05**	**0.01**	**0.005**
1	6.31	12.71	63.66	127.32
5	2.02	2.57	4.03	4.77
8	1.86	2.31	3.36	3.83
10	1.81	2.23	3.17	3.58
18	1.73	2.10	2.88	3.20
20	1.73	2.09	2.85	3.15

.....

.....

.....

.....

.....

.....

.....

.....

.....

2. *Erwinia* is a genus of Gram-negative bacteria that causes a disease called soft-rot in many different plant species.

The bacteria usually enter the tissues of a plant through wounds in the exterior surface. They obtain respiratory substrates from the host plant by secreting a range of enzymes, including cellulases and phospholipases.

As the infection continues it first induces plasmolysis of the surrounding tissue and then rotting of the tissues. This spreads inwards from the site of infection until it reaches the vascular tissues. The infection then spreads upwards through the plant causing the parts of the plant above the initial site of infection to wilt.

(a) (i) Describe the biochemical breakdown of cellulose to release the respiratory substrates for the bacteria. [2]

.....

.....

.....

(ii) Explain how the products of cellulose breakdown result in the plasmolysis of cells in the plant tissue surrounding the site of infection. [2]

.....

.....

.....

.....

(b) (i) Describe how the enzymes produced by the bacteria enable them to reach the vascular tissue. [2]

.....

.....

.....

.....

(ii) What conclusions can be reached regarding which vascular tissue is responsible for the spread of *Erwinia* infections through a plant? Explain your answer [2]

.....

.....

.....

.....

.....

.....

.....

.....

(c) Until recently, the main species of *Erwinia* that caused soft-rot in the UK was *E. carotovora*. This species spreads rapidly in the cool, wet conditions usually found in this country in the spring. Recently, infections caused by another species of the same genus, *E. chrysanthemi* has been identified at over 40 sites in the south of England and Wales but so far has not been found in the colder climate of Scotland. *E. chrysanthemi* is more common in warm countries where it causes far more destruction of fruit and vegetables than *E. carotovora*.

Suggest how human impact on the climate change planetary boundary could be a reason for the distribution of *E. chrysanthemi* in the UK. [3]

.....

.....

.....

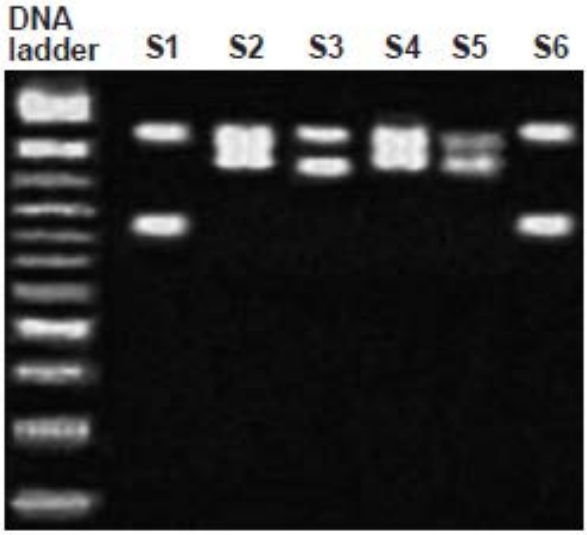
.....

.....

.....

(d) Identification of different species of *Erwinia* is difficult as the symptoms caused are very similar and there are few differences in the range of organisms infected. DNA analysis is now used to identify different species.

Gel electrophoresis was carried out on samples of DNA, **S1** to **S6**, isolated from six different bacteria all believed to be the same species of *Erwinia*.
The image below shows the result of this analysis. A DNA ladder was included for reference.



(i) Explain the purpose of the DNA ladder on the image. [2]

.....

.....

(ii) With reference to the quality and validity of the results, identify how many species of bacteria could be represented by the six samples and explain how you arrived at your conclusion. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

3. **MDMA** (Ecstasy) is an illegal recreational drug which has side-effects including:

- increased body temperature and sweat production
- increased ADH secretion
- increased thirst
- decreased urine output

Furosemide is a prescription drug used to reduce hypertension (high blood pressure) by lowering blood volume. It acts as an inhibitor of sodium ion transport proteins in the ascending limb of the loop of Henle and increases urine output.

Hyponatraemia (low plasma concentration of Na^+) is a condition where the concentration of sodium ions in the plasma falls below normal levels. This can disrupt the transmission of action potentials and lead to muscle weakness, seizures and even coma.

Using your knowledge of urine production, explain how ecstasy reduces urine output and furosemide increases urine output and how misuse of both drugs can result in hyponatraemia.

[9 QER]

Examiner only