

Organisms respond to changes in their internal and external environments – A2 Biology

1. No.2

0 2 . 1

Glutamate is a neurotransmitter involved in the transmission of nerve impulses from pain receptors to the brain. Ziconotide is a drug that can reduce severe, constant pain. Ziconotide blocks the calcium ion channels at some of the synapses which use glutamate.

The transmission of glutamate at synapses is similar to that of acetylcholine.

Explain how ziconotide reduces severe, constant pain.

[5 marks]

When ziconotide blocks calcium ion channels, few Ca^{2+} ions enter the synaptic knob. So, fewer synaptic vesicles move and fuse with presynaptic membrane. This ensures less glutamate is released. Then less glutamate diffuses across synaptic cleft. So, less glutamate will be available to attach to the receptors on the post-synaptic membrane. This ensures fewer Na^+ ions enter the post-synaptic neurone. This generates fewer impulses.

Ziconotide is a polypeptide and acts on synapses in the spinal cord. Scientists investigated the effectiveness of ziconotide in reducing severe, constant pain.

Ziconotide was injected into each patient's cerebrospinal fluid that bathes the brain and spinal cord. Patients recorded the intensity of their pain using a statistically valid scale.

0 2 . 2

Suggest **two** reasons why the patients had ziconotide injected into their cerebrospinal fluid rather than taking a pill containing the drug.

[2 marks]

- 1 The pill is a polypeptide and so it is digested by proteases into amino acids.
- 2 The pill reaches the brain faster if injected at cerebrospinal fluid.

- 0 2 3 Ziconotide was injected at $3 \text{ ng kg}^{-1} \text{ h}^{-1}$ for 8 days into each patient.

$$1 \text{ ng} = 1 \times 10^{-9} \text{ g}$$

Calculate the total mass in grams of ziconotide injected after 8 days into a patient with a body mass of 82 kg

Show your working.

8 days $\rightarrow 24 \times 8 = 192 \text{ hours}$
 Body mass = $82 \text{ kg} \times 1000 \text{ g/kg} = 82000 \text{ g}$

[2 marks]

injection rate = 3 ng/kg/hr
 $\& \text{ days} = 24 \times 8 = 192 \text{ hrs}$
 $1 \text{ nanogram} = 1 \times 10^{-9} \text{ g}$
 $3 \text{ ng kg}^{-1} \text{ hr} \times 82 = 246 \text{ ng/hr}$
 mass of ziconotide injected in 192 hrs = $246 \text{ ng/hr} \times 192 = 47,232 \text{ ng}$
 $47,232 \text{ ng} \times 1 \times 10^{-9} \text{ ng} = 4.7232 \text{ g}$
 Answer 4.7232 g

- 0 2 4 When the patients recorded the intensity of pain, suggest **two** reasons why it was important to use a statistically valid scale.

[2 marks]

- 1 Sensation of pain subjective
To ensure differences in pain sensitivity are statistically significant
- 2 Pain sensitivity varies from person to person

2. No.6

0 6 . 1

Describe and explain how **three** features of the cells in the proximal convoluted tubule allow the rapid reabsorption of glucose into the blood.

[3 marks]

- 1 They have many mitochondria that generate (ATP) energy for active transport.
- 2 There are many carrier proteins for active transport.
- 3 They have micro-villi to provide large surface area for rapid re-absorption.

0 6 . 2

Antidiuretic hormone (ADH) binds to V receptors found in cell-surface membranes in two parts of a nephron.

Name the **two** parts of a nephron where V receptors are found.

[1 mark]

Collecting duct
Distal convoluted tubule.

0 6 . 3

V receptors only bind with ADH.

Suggest and explain why.

[2 marks]

V receptors are complimentary to the ADH. The v receptors have specific shape that is recognised by ADH

06.4

A decrease in blood pressure stimulates the release of ADH.

Give the location of the receptors that detect a decrease in blood pressure and explain how the release of ADH will affect blood pressure.

[3 marks]Location AortaExplanation ADH increases re-absorption of water. This increases volume of blood and pressure. This returns blood pressure back to normal.