

A level Biology A
H420/03 Unified biology

Question Set 15

1 Fig. 2.1 shows a naked mole rat, *Heterocephalus glaber*.



Fig. 2.1

The naked mole rat is a mammal. However, it has several features that are unusual for mammals.

(a) Naked mole rats regulate their temperature in a way that is different from most mammals.

(i) Some features of thermoregulation in naked mole rats are listed below:

- They live in complex underground tunnel systems, which tend to have a stable temperature of 30–32 °C. However, sometimes the environmental temperature can increase or decrease outside this range.
- In experiments that examine environmental temperature changes, the core body temperature of naked mole rats remains close to that of the environmental temperature.
- When tunnel temperature increases they often move to cooler parts of the tunnel system.
- When tunnel temperature decreases they often lie together in large groups.

Outline **two** ways in which thermoregulation in naked mole rats is different from thermoregulation in most mammals. [2]

- naked mole rats have a lower body temperature
- naked mole rats use more behavioural responses and uses fewer physiological responses

(ii) In humans, when core body temperature falls below 35 °C, positive feedback causes this decrease in core body temperature to continue. This process is known as hypothermia.

Explain how positive feedback could accelerate the process of hypothermia. [4]

- positive feedback is when an initial biological change is increased further
- lower temperature reduces kinetic energy of molecules
- enzyme activity reduced - metabolism reduced
- less heat generated - so body temperature drops further

- (iii) Mammals, including naked mole rats, have temperature receptors that play a role in thermoregulation.

The table below lists four statements about mammalian temperature receptors.

Write either 'true' or 'false' in the empty boxes to indicate whether each statement is true or false.

Statement	True or False?
Peripheral temperature receptors detect the temperature of internal organs	<i>false</i>
Receptors in the hypothalamus detect core body temperature	<i>true</i>
Blood temperature is detected by the receptors in the hypothalamus	<i>true</i>
Temperature receptors send impulses to the medulla oblongata, which regulates body temperature	<i>false</i>

[2]

- (b) Another unusual characteristic of naked mole rats is their tolerance of pain.

Acid causes pain responses in most mammals. Naked mole rats are tolerant of the pain caused by acid.

This tolerance can be explained by the type of pain receptor found in naked mole rats.

Fig. 2.2 shows a representation of the ion channels present in the pain receptors of naked mole rats and other mammals.

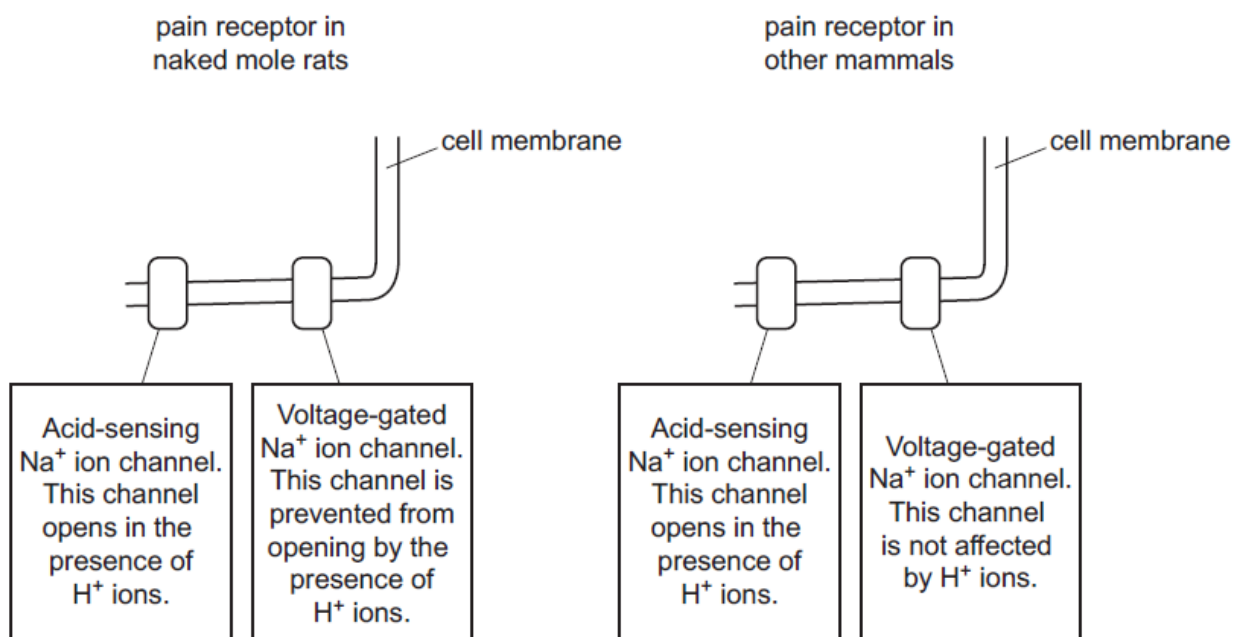


Fig. 2.2

- (i) Use the information in Fig. 2.2 to suggest why naked mole rats do not feel pain when exposed to acid. [2]
 - no action potentials / electrical impulses - along sensory neurones to CNS
 - as no voltage-gated Na^+ channels open - less depolarisation of receptor membrane
- (ii) Explain how a pain receptor is an example of a transducer. [1]
 converts stimulus to action potential

- (c) Fig. 2.3 shows the relationship between body mass and lifespan in a range of mammal species.

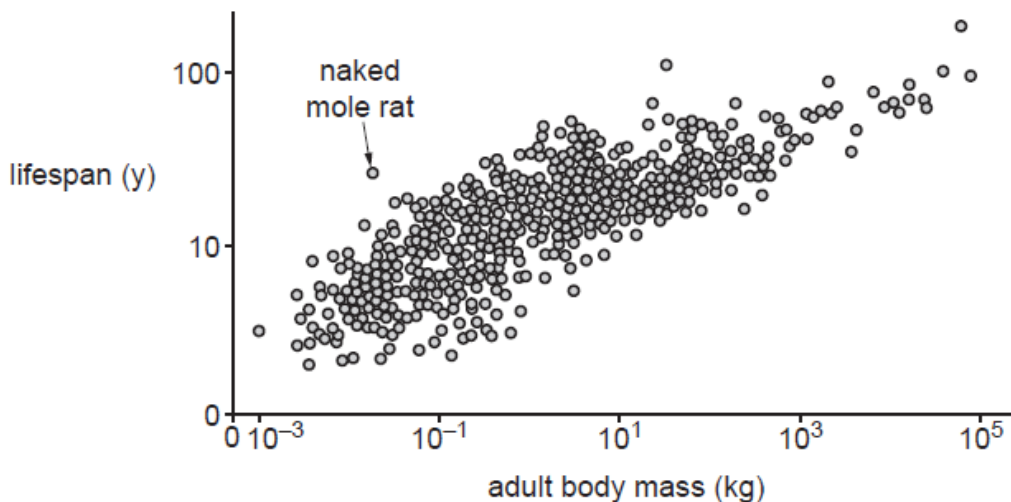


Fig. 2.3

- (i) Describe the relationship between body mass and lifespan shown in Fig. 2.3. [1]
 positive correlation: higher the body mass, longer lifespan
- (ii) What conclusion can you draw from Fig. 2.3 about the lifespan of naked mole rats in comparison to other mammals? [1]
 lifespan is greater than expected for its mass
- (d) Naked mole rats can survive without oxygen for up to 18 minutes. This is several times longer than other mammals of a similar size.

The following information might help to explain how naked mole rats can survive without oxygen for a long time:

- In normal glycolysis, the enzymes needed to convert glucose to triose phosphate may be inhibited by lactate.
 - Naked mole rats can use fructose as a respiratory substrate.
 - Fructose is converted to triose phosphate.
 - Triose phosphate can then enter the glycolysis pathway.
- (i) Suggest why the use of fructose allows naked mole rats to survive without oxygen for a long time. [2]
 - glycolysis can continue as conversion of glucose to TP is not needed
 - ATP is produced when TP is converted to pyruvate
- (ii) Suggest one other aspect of the physiology of naked mole rats that explains how they are able to survive without oxygen for a long time. [1]
 low body temperature so less energy spent on thermoregulation

Total Marks for Question Set 15: 16



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