

**ADVANCED GCE  
 BIOLOGY**

**2805/05**

Mammalian Physiology and Behaviour

**MONDAY 28 JANUARY 2008**

Morning

Time: 1 hour 30 minutes

Candidates answer on the question paper.

**Additional materials:** Electronic calculator  
 Ruler (cm/mm)



Candidate Forename

Candidate Surname

Centre Number

Candidate Number

**INSTRUCTIONS TO CANDIDATES**

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	15	
3	15	
4	15	
5	15	
6	16	
<b>TOTAL</b>	<b>90</b>	

This document consists of **20** printed pages.

Answer **all** the questions.

1 In a controlled experiment, dogs were trained to discriminate between urine from people with bladder cancer and urine from healthy people.

- After several months of training, nine trials were carried out with each of the dogs.
- In each trial, a dog was required to smell seven urine samples, one of which came from a person with bladder cancer.
- The success rate of 40.7% was significantly higher than could be expected by chance.

(a) (i) Calculate the percentage of correct identifications that would be expected based on chance alone.  
Show your working.

Answer = ..... % [2]

(ii) What kind of stimulus activates sensory receptors in the dogs' noses?

..... [1]

(b) Describe a technique that could be used to train dogs to detect bladder cancer.

In your answer, you should refer to conditioning and learned behaviour.

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..... [4]

- (c) Most dogs can taste sweet food and will eat it readily. Cats appear to dislike sweet food because they do not possess effective receptors for sugar molecules on their taste buds.

The sugar receptors in mammals are made of two protein subunits TIR2 and TIR3 which are coded for by genes TIR2 and TIR3. In cats, a small section of DNA is missing from the TIR2 gene.

Using the information above, explain why the protein subunit **TIR2** in cats is non-functional whereas in dogs it is functional.

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..... [3]

- (d) Mice on Gough Island in the South Atlantic are up to three times larger than mice of the same species on nearby islands. Gough Island is home to large populations of the Tristan albatross.

During the albatross breeding season many of the albatross chicks are attacked in the nest by the mice and are eaten alive as they cannot defend themselves while their parents are away feeding.

This species of mouse is not usually carnivorous and the mice on Gough Island are not displaying their innate behaviour.

Fig. 1.1 shows a mouse on Gough Island with the remains of a chick.



Photo in black and white on original Question Paper.  
© Andrea Angel / Ross Wanless

**Fig. 1.1**

- (i) Explain why the carnivorous behaviour of the mice is thought **not** to be innate.

.....  
.....  
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..... [2]

- (ii) Suggest why the mice on Gough Island are up to three times larger than those on other islands.

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..... [2]

- 2 (a) The wolf, *Canis lupus*, is a carnivore and hunts in packs. A common prey animal for the wolf is the moose, *Alces alces*, a large member of the deer family.

A research project has been carried out over the past 50 years on the relationship between wolf and moose populations on Isle Royale in North America.

Fig. 2.1 shows how the numbers of both animals have changed between 1960 and 2000.

key:  
 — moose  
 - - - - - wolves

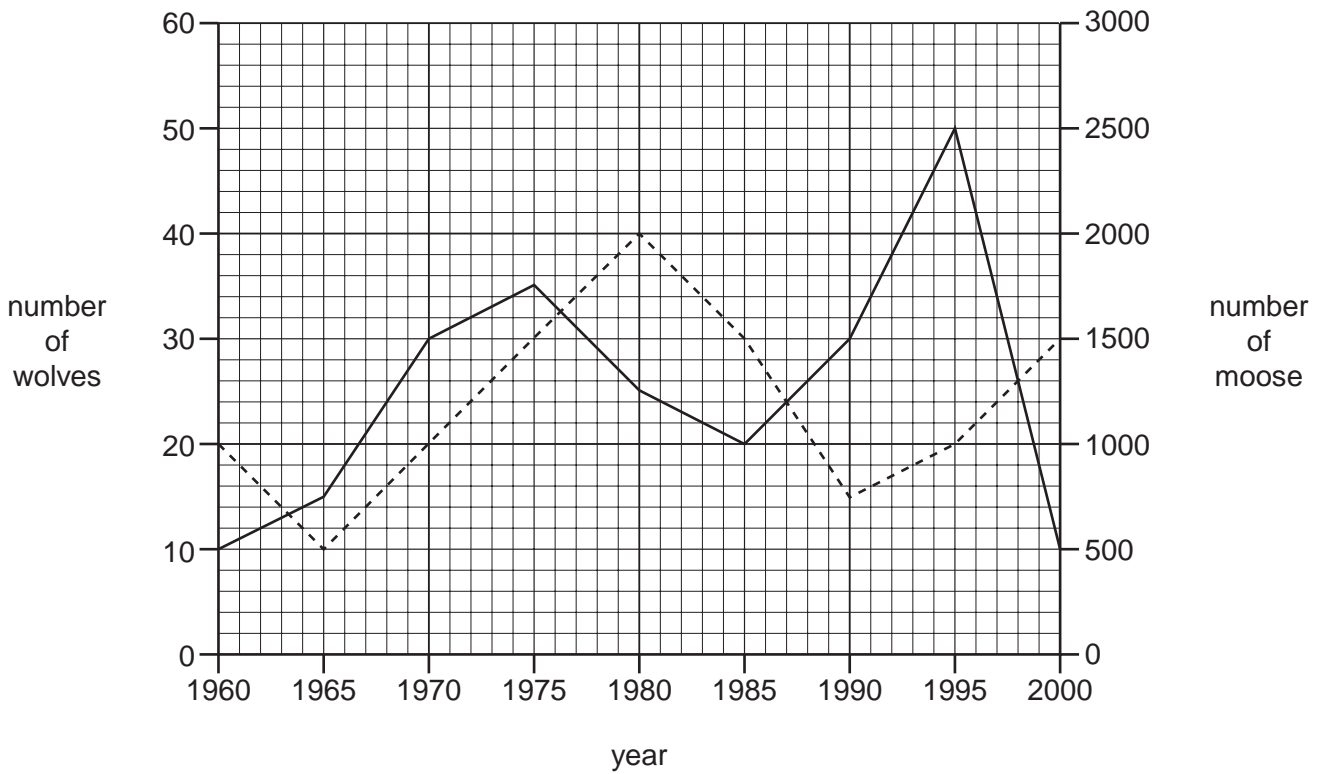


Fig. 2.1

Describe the trend shown in Fig. 2.1.

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..... [2]

(b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Fig. 2.2 shows the skull of a wolf. Fig. 2.3 shows the skull of a moose. The moose is a herbivore and its teeth are different from those of the wolf. Both mammals have teeth with features that enable them to carry out specific functions associated with their diets.



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**Fig. 2.2**



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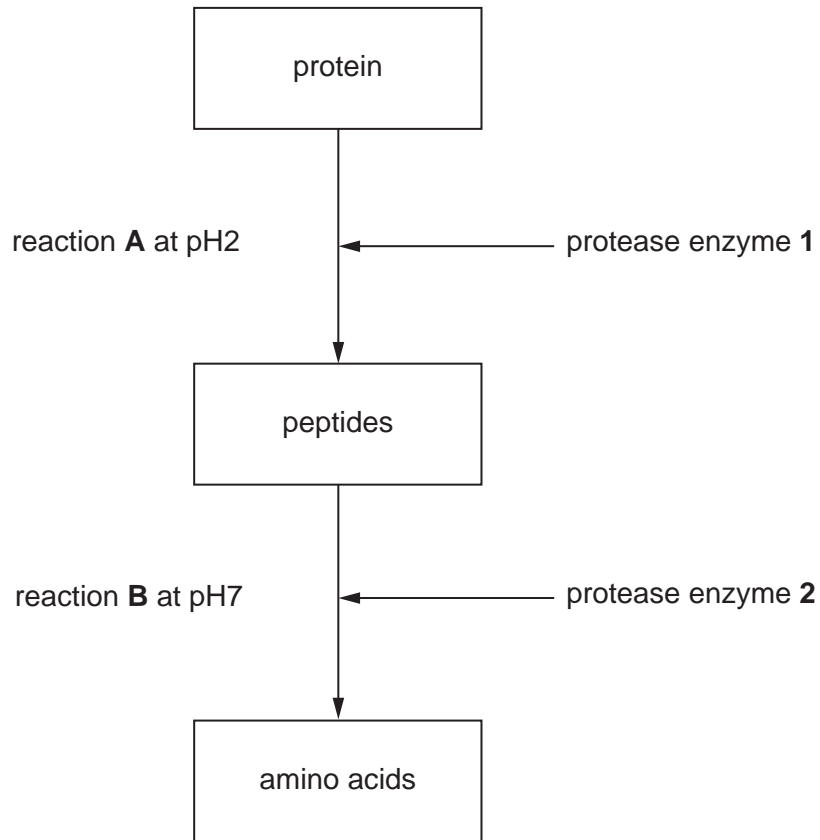
**Fig. 2.3**

*Fig. 2.2 and Fig. 2.3 are not shown to the same scale.*



(c) The main component of the diet of a wolf is protein.

Fig. 2.4 outlines the digestion of protein.



**Fig. 2.4**

(i) Name the type of reaction at **A** and **B**.

..... [1]

(ii) Name protease enzyme **1**.

..... [1]

(iii) Name the specific group of enzymes to which protease enzyme **2** belongs.

..... [1]

(iv) Name the location of reaction **B**.

..... [1]

[Total: 15]



- 3 (a) The arrangement of bones in the forelimb of all mammals is similar. There is one upper limb bone, two lower limb bones, several wrist bones and bones that make up the digits.

State the name given to this type of limb bone arrangement.

..... [1]

- (b) This bone arrangement has been modified through evolution to fulfil different roles in different mammals. Fig. 3.1 shows the forelimb of a porpoise and Fig. 3.2 shows the forelimb of a bat.

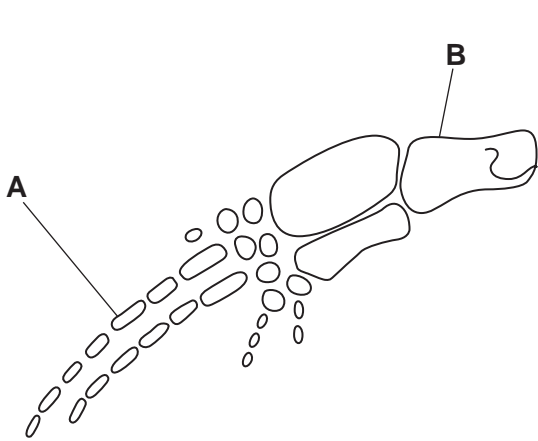


Fig. 3.1

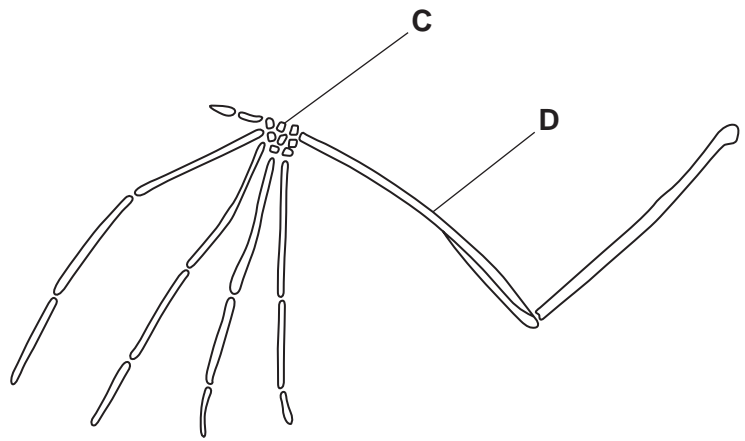


Fig. 3.2

Name bones A to D.

A .....

B .....

C .....

D .....

[4]

- (c) Describe the type of joint between the upper limb bone and the shoulder blade **and** its mode of action.

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[2]

- (d) Osteoarthritis is a disease that affects the joints of mammals, causing pain and restricted movement of the joint.

Outline why some people may develop arthritis and others may not develop the disease.

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..... [3]

- (e) The pain associated with osteoarthritis can be relieved using transcutaneous electrical nerve stimulation (TENS). It uses electrical impulses to stimulate the nerve endings at, or near, the site of the pain. Self-adhesive electrodes are stuck on the skin and attached to a small, portable power unit.

It is thought that TENS triggers the release of natural painkillers called endorphins which are released by neurones within the spinal cord and are similar in shape to opiate drugs.

Fig. 3.3 shows synapses in a pain pathway from a damaged joint to the brain.

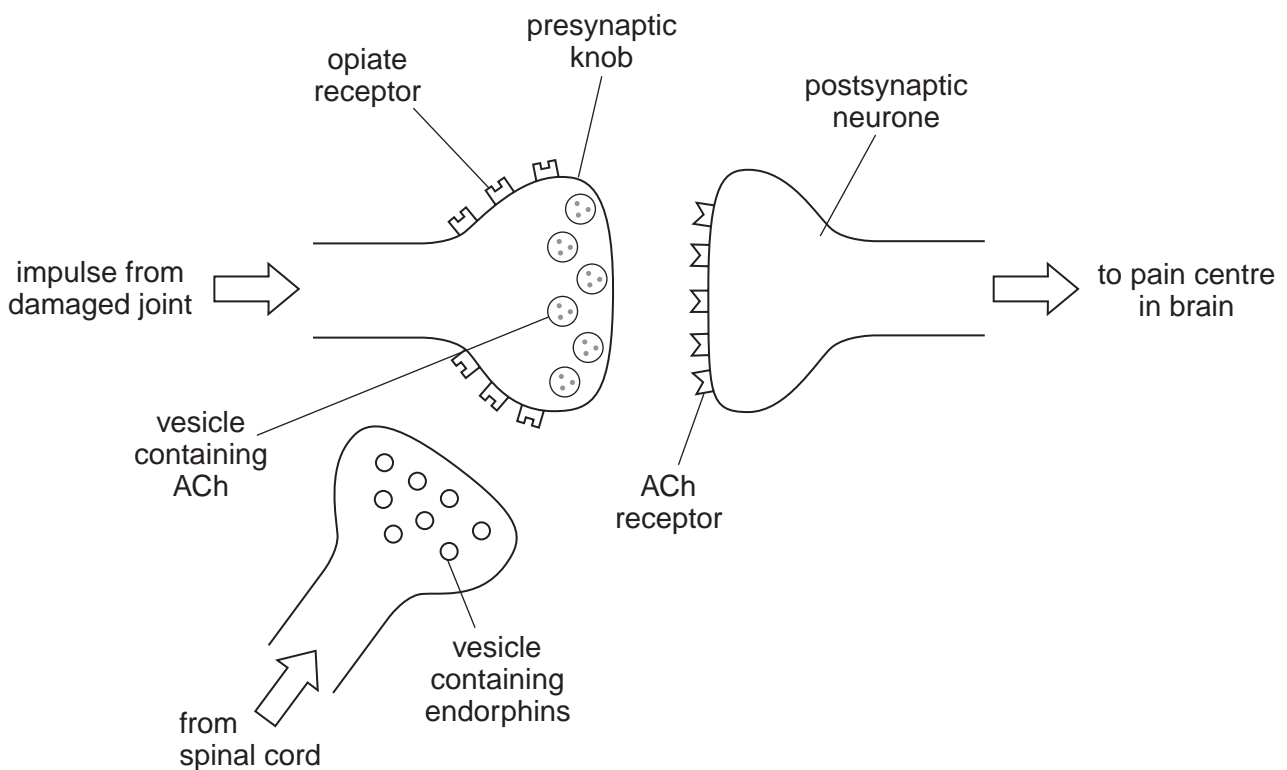


Fig. 3.3

(i) Suggest how endorphins may act to reduce pain.

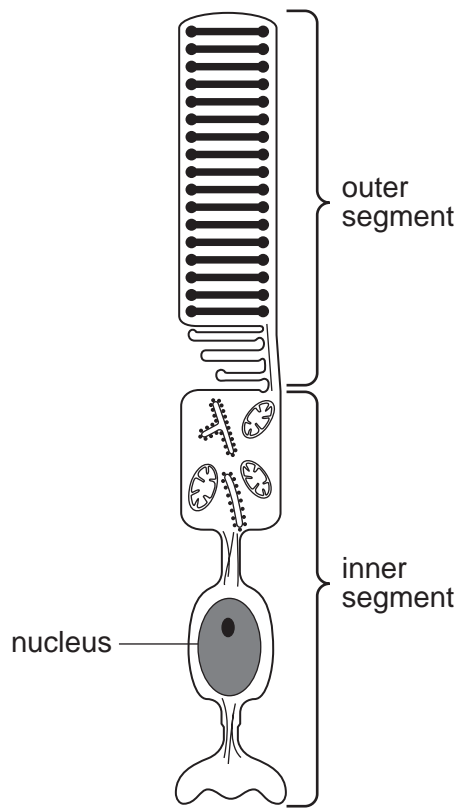
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..... [4]

(ii) Suggest an advantage of using TENS for pain relief instead of more conventional treatment.

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..... [1]

[Total: 15]

4 Fig. 4.1 shows the structure of a rod cell from the mammalian retina.



**Fig. 4.1**

**(a)** Label, on Fig. 4.1:

- (i) **P** for a structure where protein is synthesised; [1]
- (ii) **Q** for a structure containing rhodopsin; [1]
- (iii) **R** for a part of the cell where neurotransmitters would be found. [1]

**(b)** Draw on Fig. 4.1 an arrow to show the direction of light. [1]

**(c)** In this question, one mark is available for the quality of use and organisation of scientific terms.

Describe **and** explain how a rod cell responds to dim light of only a few photons.

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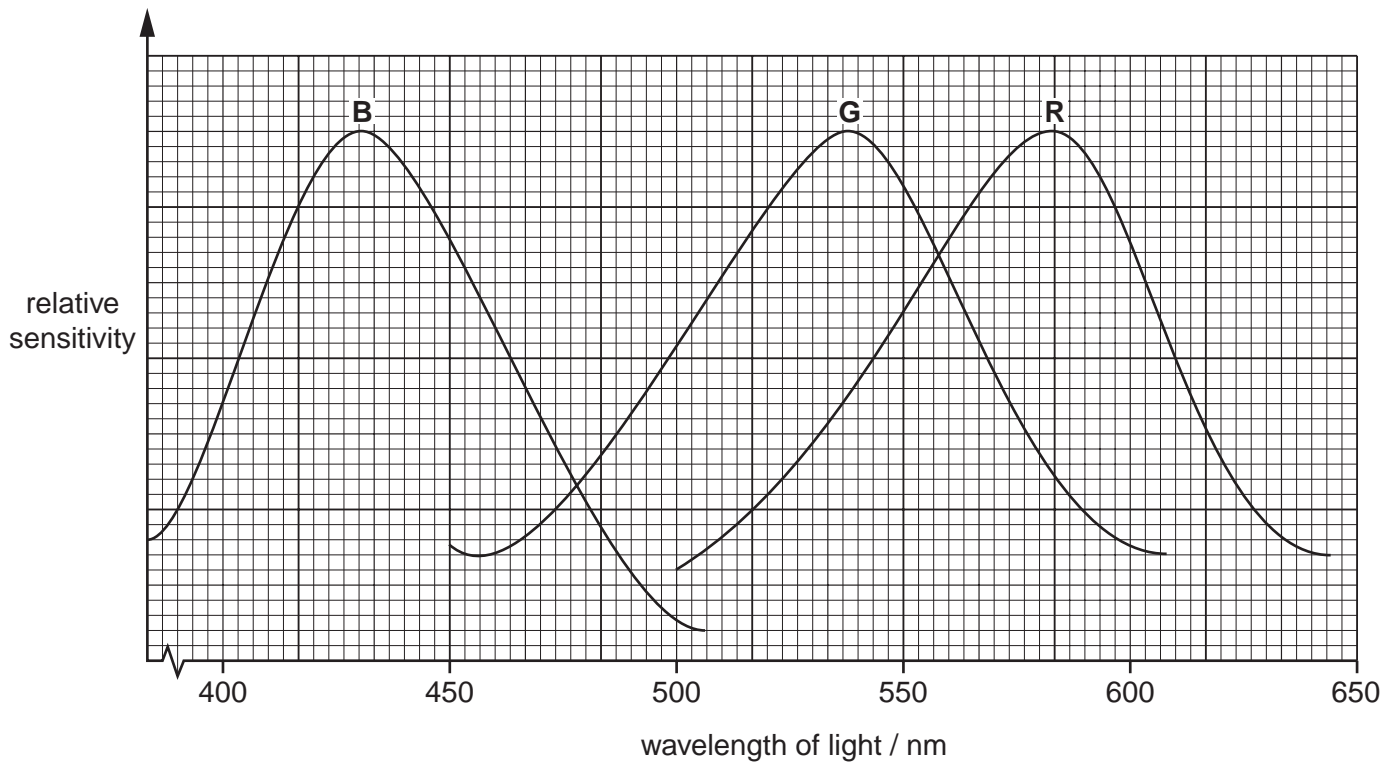
..... [7]

Quality of Written Communication [1]

**[Turn over**

(d) A cone cell contains one of three different types of light-sensitive pigment.

Fig. 4.2 shows how each of these three pigments, **B**, **G** and **R**, responds to light of different wavelengths.



**Fig. 4.2**

Using Fig. 4.2 to help you, indicate the colour perceived by the brain when different combinations of the pigments are stimulated to their maximum sensitivity.

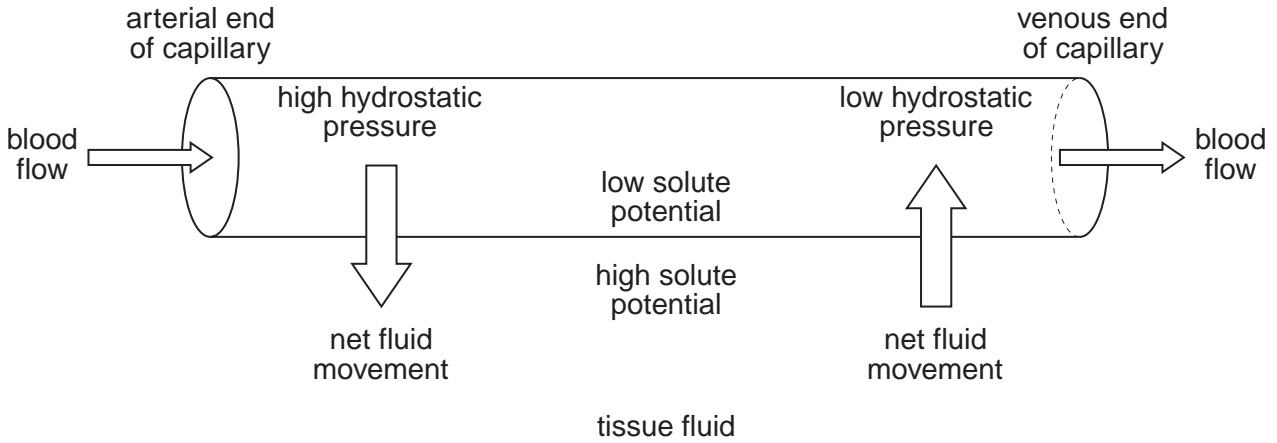
pigment stimulated to maximum sensitivity			colour perceived by brain
<b>B</b>	<b>G</b>	<b>R</b>	
yes	yes	yes	white
yes	yes	no	.....
yes	no	yes	.....
yes	no	no	.....
no	yes	yes	.....
no	yes	no	.....
no	no	yes	.....
no	no	no	black

[3]

[Total: 15]

5 Albumin is a plasma protein produced by the liver. The main function of albumin is to maintain the water potential of the blood by preventing too much water from leaving the blood. This role is carried out mostly in capillary networks.

Fig. 5.1 shows an outline of fluid movement in a capillary.



**Fig. 5.1**

**(a)** Using Fig. 5.1, explain why fluid moves out of the capillary at the arterial end and into the capillary at the venous end.

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(b) Kwashiorkor, a protein deficiency disease, has symptoms such as a bloated abdomen and fluid retention in all tissues.

Suggest why a diet which is low in protein can result in these symptoms.

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..... [2]

(c) Describe the metabolic reactions in **liver cells** that reduce the amount of fat (lipid) in people who are dieting and exercising.

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..... [3]

(d) Leptin is a hormone produced by adipose (fatty) tissue.

- Low blood leptin concentrations indicate that fat (lipid) stores are low.
- The hypothalamus responds to the concentration of leptin in the blood.

Scientists have discovered that injections of leptin can help people who have lost weight, by dieting and exercising, to maintain their lower weight.

Suggest how the response of the hypothalamus to a **low** concentration of leptin in the blood may affect behaviour.

.....  
..... [1]



(e) One way to determine if a person is obese is to calculate body mass index (BMI).

A BMI of 30+ indicates that the person is obese.

BMI is calculated by using the following formula:

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in m})^2}$$

Table 5.1 shows the body mass and height of two students, **S** and **T**. The BMI for student **S** has also been calculated.

**Table 5.1**

	<b>S</b>	<b>T</b>
body mass/kg	60	80
height/m	1.65	1.60
BMI	22	

(i) Calculate the BMI for student **T**.  
Show your working and give your answer **to the nearest whole number**.

Answer = ..... [2]

(ii) Leptin is coded by an autosomal dominant allele.

The parents of student **T** have BMI values of about 21, and have never been overweight.

Suggest why student **T** became obese.

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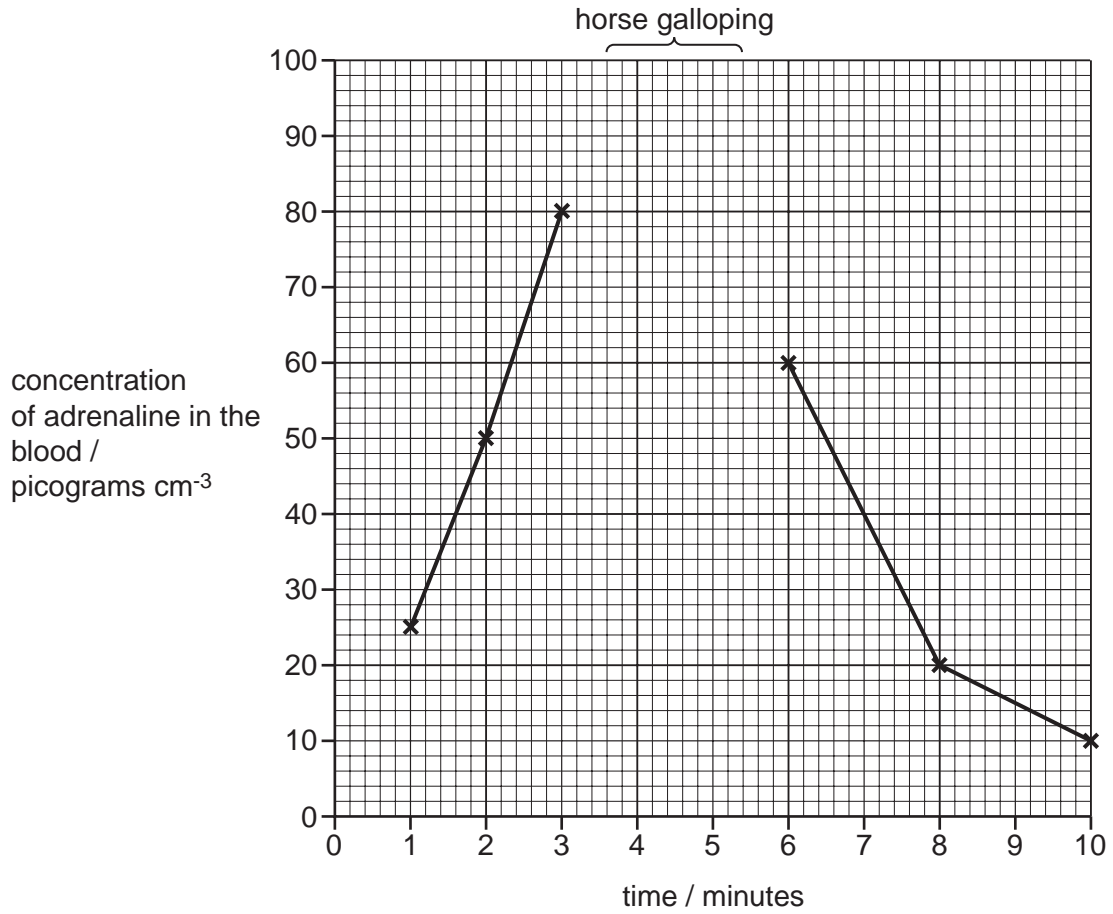
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..... [2]

[Total: 15]

- 6 Racehorses were used in an investigation into the concentration of the hormone adrenaline in their bloodstreams. Blood samples were taken at intervals **before** and **after** a gallop.

Fig. 6.1 shows the concentration of adrenaline in the blood of one racehorse before and after a gallop.



**Fig. 6.1**

- (a) Describe **and** explain the results shown by Fig. 6.1.

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[5]

(b) Describe how the autonomic nervous system controls a racehorse's heart **immediately after** a race.

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(c) Occasionally a racehorse, like a human, may develop a cancerous growth in its medulla oblongata.

(i) Suggest **two** factors that can increase the chances of a racehorse developing cancer.

1. ....  
2. .... [2]

(ii) Explain how **one** of the factors you have suggested in (c)(i) may lead to the development of cancer.

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..... [2]

(iii) State **two** physiological functions, **other than the control of heart rate**, that could be affected by cancer of the medulla oblongata.

1 .....  
2 ..... [2]

(iv) Suggest a suitable treatment for cancer of the medulla oblongata.

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..... [1]

[Total: 16]

END OF QUESTION PAPER

**PLEASE DO NOT WRITE ON THIS PAGE**

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