GCE Biology

S21-A400U30-1

Assessment Resource 24

Requirements for Life- Options Resource F

SECTION B: OPTIONAL TOPICS

Option A: **Immunology and Disease** ☐

Option B: **Human Musculoskeletal Anatomy** ☐

Option C: **Neurobiology and Behaviour** ☐

Answer the question on one topic only.

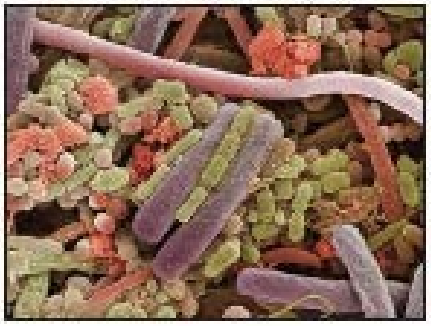
Place a tick (✓) in one of the boxes above, to show which topic you are answering.

You are advised to spend about 30 minutes on this section.

Option A: Immunology and Disease

1. *(a)* Although micro-organisms can cause disease in humans, scientists believe that up to 10^{16} symbiotic microbial cells live in or on the human body. Up to 90% of all diseases can be traced back in some way to the composition of this microbiome. Figure 1.1 shows bacteria on the surface of a human tongue.

Figure 1.1



An average adult has 10^{13} cells in the body. Suggest why it is often said that we are more microbe than human in terms of our genomes and describe how the micro-organisms living inside our bodies and on the skin surface help protect us from infectious disease.

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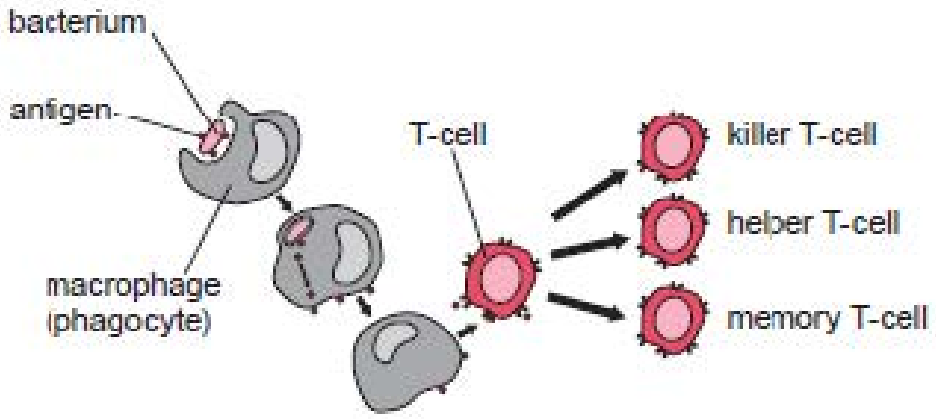
(b) Figure 1.2 shows part of the T-cell immune response when the body is infected with a pathogenic bacterium, such as *Vibrio cholerae*.

Figure 1.2



(i) Explain the role of the macrophage in the T-cell response. [3]

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(ii) Describe the roles of each of the T-cell types shown in figure 1.2 as part of the immune response. [3]

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(c) B-cells are activated in a similar way but synthesise antibodies that are specific protein molecules that can bind to foreign antigens. These antibodies can be of different types, as shown in figure 1.3.

Figure 1.3

IgM is made up of five antibody molecules bonded together. A more detailed diagram of IgG is shown in figure 1.4 along with a bacterial cell, showing antigens on the surface.

Figure 1.4

(i) The hinged sections of the IgG molecule give it some structural flexibility. Suggest an advantage of this. [2]

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(ii) Suggest an advantage of the IgM molecule over IgG [1]

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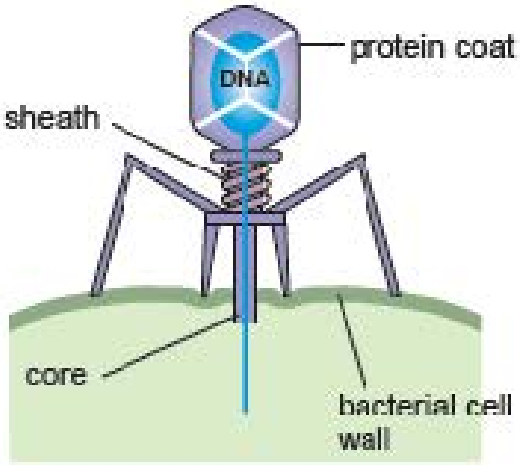
(d) Bacteriophages are viruses which infect bacteria specifically. When they infect bacteria, they result in cell lysis. Bacteriophages are harmless to humans. A typical bacteriophage is shown in figure 1.5.

Figure 1.5



Bacteriophage therapy has been successful in trials against a range of bacterial infections, including chronic skin infections caused by bacteria such as MRSA. Their use in medicine to treat infectious disease in humans is called phage therapy.

Bacteriophages can be isolated from bacterial cultures and they can be grown on nutrient agar plates in a lawn of bacteria. Clear zones (plaques) appear on the plates as bacteria are lysed by the bacteriophages as shown in figure 1.6.
Each plaque is assumed to originate from a single bacteriophage.

Figure 1.6

The plate in figure 1.6 was prepared by mixing 0.02 cm^3 of a 10^{-5} dilution of bacteriophages with a bacterial culture and spreading it on an agar plate. This plate was incubated for 24 hours at 37 °C.

(i) On the plate shown in figure 1.6 there are 25 plaques. Calculate the number of bacteriophages per cm^3 in the original sample. [2]

Number of bacteriophages = ...

(ii) Describe two techniques that could have been used to maintain sterile conditions when inoculating the plates. [2]

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(iii) Explain why 37 °C was used as the incubation temperature. [1]

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(iv) Using the information provided and your own knowledge, suggest two disadvantages of antibiotic use that could be overcome by phage therapy. [2]

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(v) Suggest an ethical issue that should be considered before widespread use of phage therapy in humans. [1]

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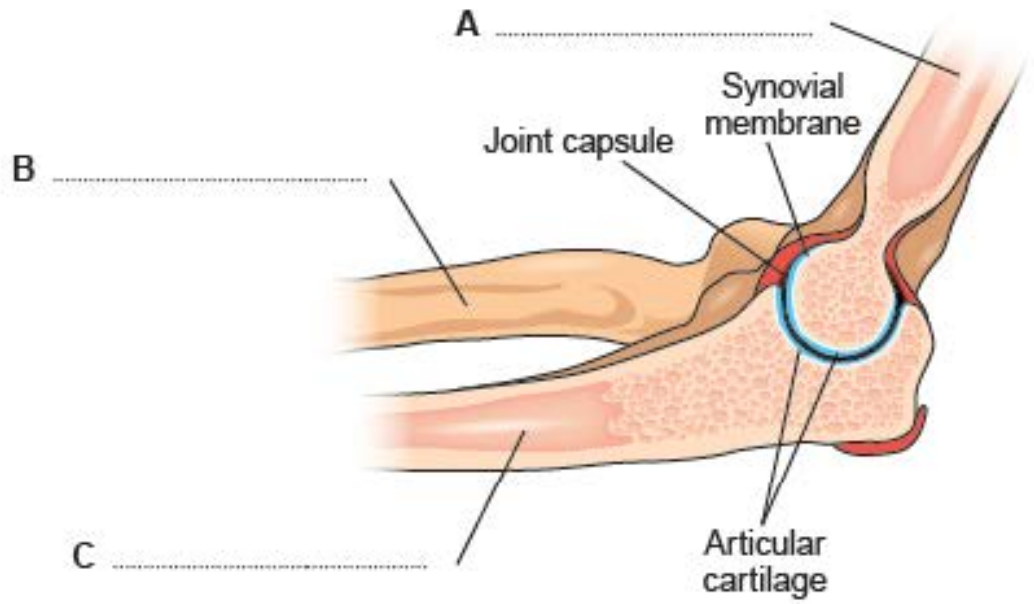
Option B: Human Musculoskeletal Anatomy

2. *(a)* Figure 2.1 shows the elbow joint, which is part of the appendicular skeleton. Muscles are attached to the bones and move the bones at the joint.

Figure 2.1



(i) Label the bones **A**-C of the arm as indicated in figure 2.1. [1]

(ii) The cartilage in the elbow joint is made of hyaline cartilage. Describe the role of the hyaline cartilage in the elbow joint and how the structure of the joint allows it to perform its function. [2]

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(iii) The external ear in mammals contains yellow elastic cartilage. Compare the structure of hyaline cartilage to yellow elastic cartilage. Explain the benefits of each type of cartilage. [3]

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(iv) When cartilage is damaged, it does not heal quickly, unlike bone and muscle. Use your knowledge of the structures of these tissues to explain why. [1]

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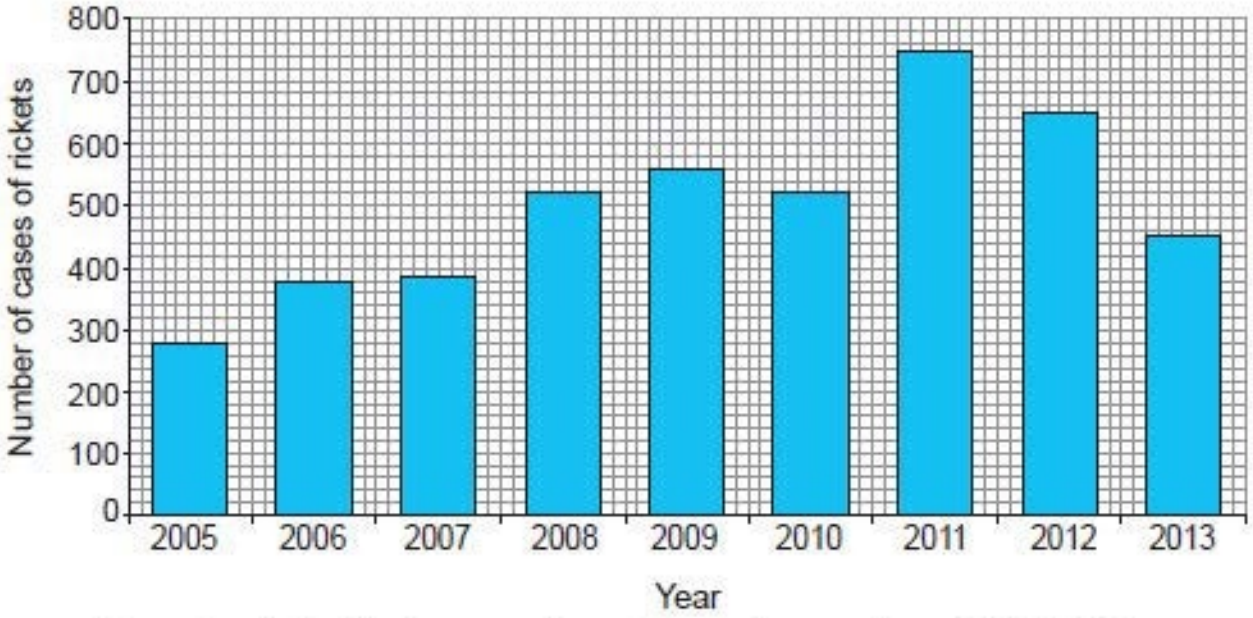
(b) Rickets is a deficiency disease associated with malnutrition resulting from lack of vitamin D or calcium in the diet. The bones in growing children become weak and bend as shown in figure 2.2.

Figure 2.2

From 2012, vitamin D supplements were offered to children under the age of five. Figure 2.3 shows the number of cases of rickets reported in the UK from 2005-2013.

Figure 2.3



(i) I. Calculate the percentage increase in cases from 2005 to 2011. [2]

Percentage increase = ... %

II. Explain the reason for this increase. [1]

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(ii) Suggest why the data collected may be inaccurate in representing the total number of cases in the UK. [1]

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(iii) Some scientists wanted to examine the effects of vitamin D supplements on prevention of rickets in children. They gave 500 children the supplement and compared them to another group of 500 children not taking the supplement. Suggest how the test should be managed to generate valid data and explain **one** ethical issue involved in this study. [3]

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(iv) State the name that is given to the similar, milder condition seen in adults. Explain why it is a less serious condition in adults. [1]

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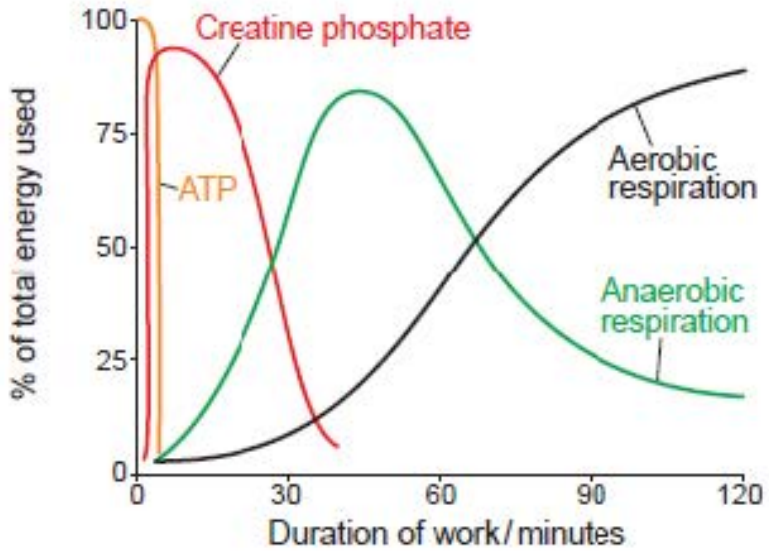
(c) The percentages of energy used from different energy sources in the muscle of a runner during exercise are shown in figure 2.4:

Figure 2.4



(i) Using figure 2.4 and your own knowledge, explain the shape of the graph for ATP and creatine phosphate and explain why aerobic respiration takes over from anaerobic respiration during sustained exercise. [3]

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(ii) The runner is interested in finding out which distance is suited to her muscle type and undertakes a muscle biopsy. The biopsy showed that her muscles contained 60% fast twitch fibres and 40% slow twitch fibres. State the conclusion that could be made based on this result. [1]

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(ii) The runner is concerned over the shape of her feet. Her footprint on the ground is not entirely normal and is shown next to a normal footprint in figure 2.5:

Figure 2.5

Normal footprint Runner footprint

Suggest which condition the runner maybe suffering from and suggest a treatment that would help. [1]

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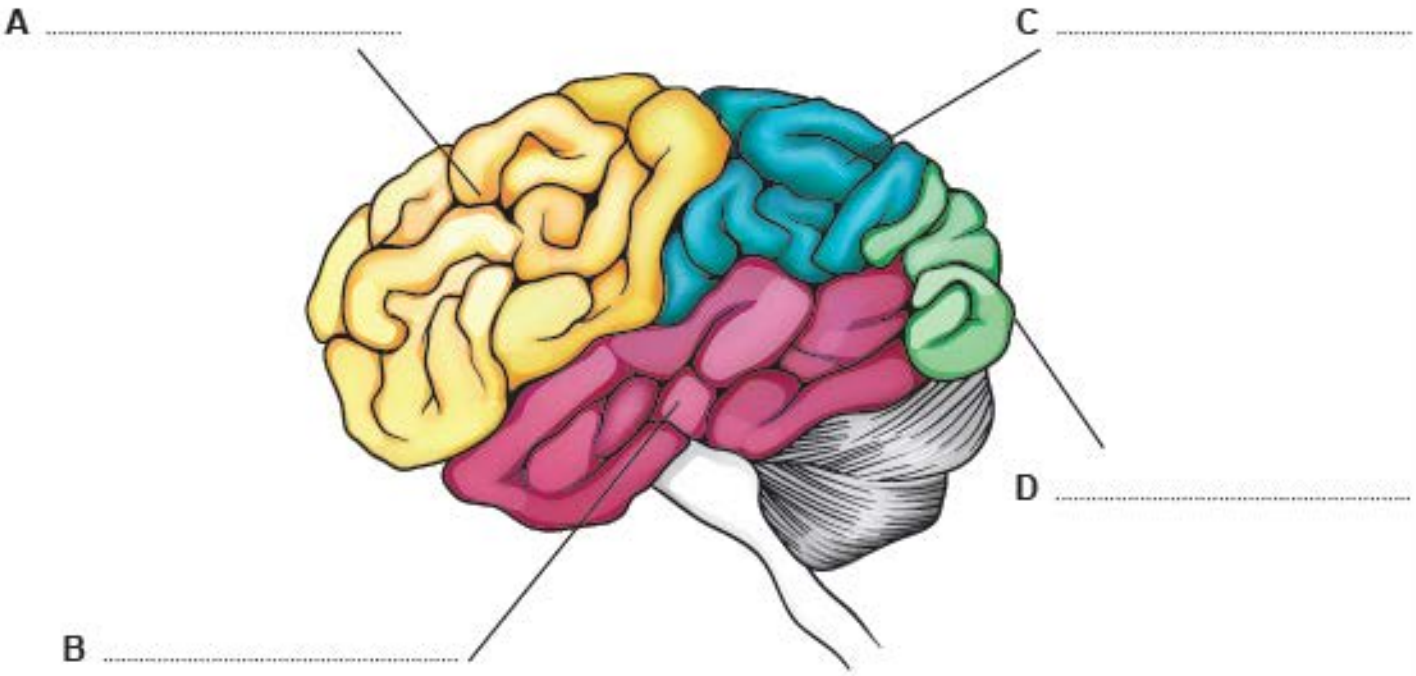
Option C: Neurobiology and Behaviour

3. *(a)* Figure 3.1 shows the lobes of the cerebral hemispheres of the human brain.

Figure 3.1



(i) **Label the lobes A-D of the cerebral cortex** shown in figure 3.1. [2]

(ii) In humans the cortex is greatly folded and contains around 1.6×10^{10} neurones. Figure 3.2 shows the values for some other mammals.

Figure 3.2

Mammal	Number of cortical neurones
mouse	4×10^{6}
dog	1.6×10^{9}
long-finned pilot whale	3.72×10^{10}

The human has ten times more cortical neurones than the dog. Calculate how many times more cortical neurones are present in the human compared to the mouse. [1]

Answer = ...

(iii) State the conclusion you could make about the cognitive function of a long-finned pilot whale when compared to the other mammals. [2]

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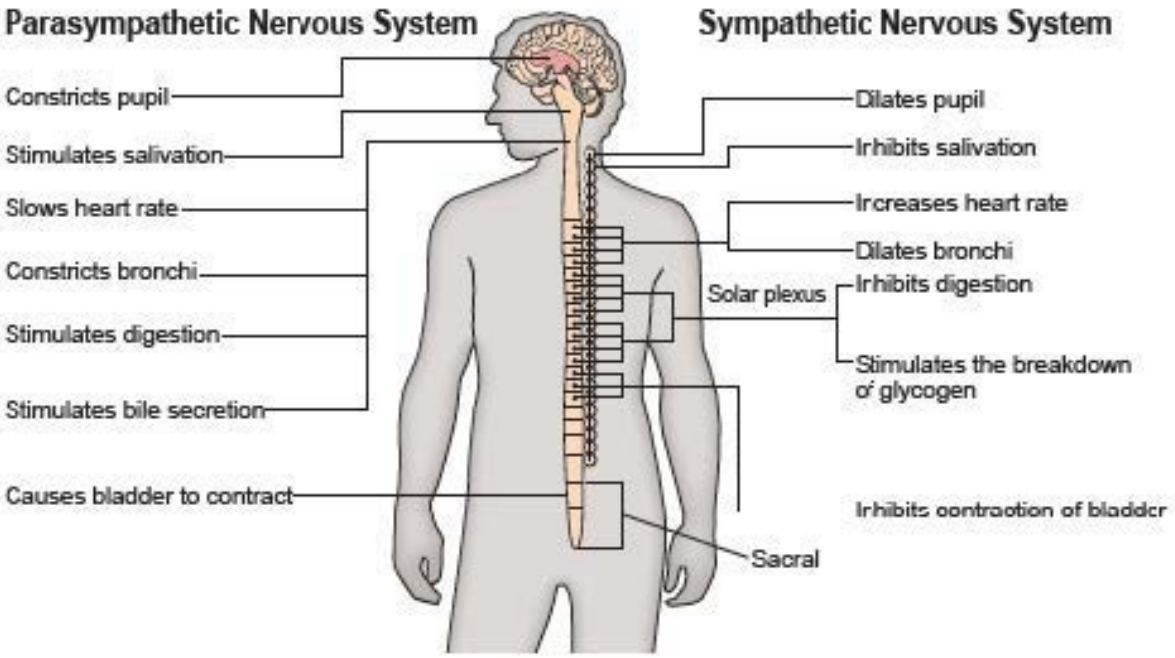
(iv) Damage to the cerebral cortex, through either injury or disease, produces different symptoms according to which lobe of the cerebral cortex is affected. Consider the case studies below and complete figure 3.3: [2]

Figure 3.3

Description of damage	Symptoms	Lobe of cerebral cortex affected
A steel bar went through the head of the patient in an accident in the 19th century.	Personality affected so he was rude to friends and lost all inhibitions, exhibiting very aggressive behaviour.	.....
Road traffic accident, the patient suffered head trauma.	Inability to distinguish colours and reported hallucinations.	.....
Injury sustained falling from mountain bike and banging his head against a tree.	The patient could not remember his children's names and forgot how to read a map.	.....

(b) Figure 3.4 shows the autonomic nervous system.

Figure 3.4



(i) Identify the neurotransmitters involved in the following divisions of the autonomic nervous system. [1]

parasympathetic .....

sympathetic .....

(ii) Using figure 3.4, describe and explain how the sympathetic nervous system helps an individual during a fight or flight response. [2]

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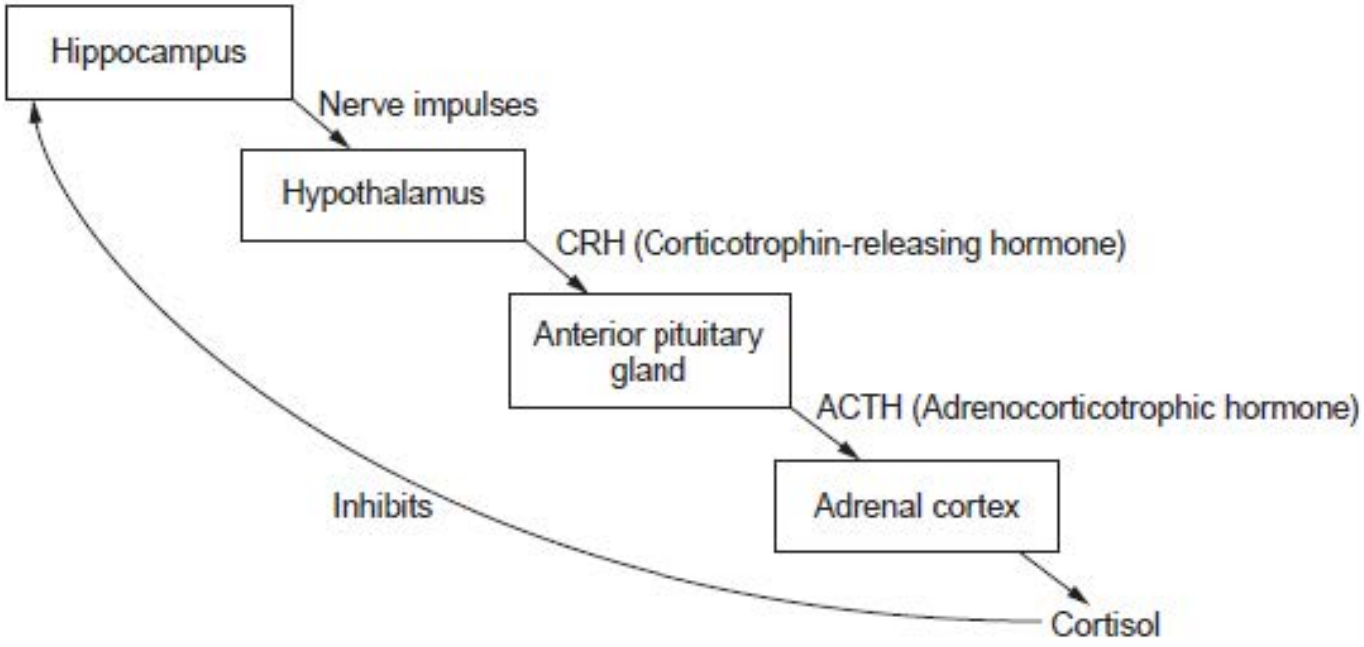
(c) The hypothalamus releases a hormone, which leads to the production of cortisol as shown in figure 3.5:

Figure 3.5



(i) Using the diagram and your own knowledge, explain the role of the brain in preventing the individual becoming overstressed. [2]

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(ii) The blood cortisol levels of an individual who had suffered a traumatic childhood would be expected to be higher than normal. Explain why such individuals may be pre-disposed to mental illnesses throughout their lives. [1]

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(d) Bees show a variety of behaviour patterns which are innate and instinctive. On returning to their colonies, worker honeybees perform a dance to communicate to other bees the direction and distance of a food source.

(i) Explain why this social behaviour benefits the colony. [1]

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Karl von Frisch discovered much of what we know today about honeybee communication. He studied thousands of bees and collected data from more than one hive.

(ii) Identify the main risk associated with the study and how the risk could be minimised. [1]

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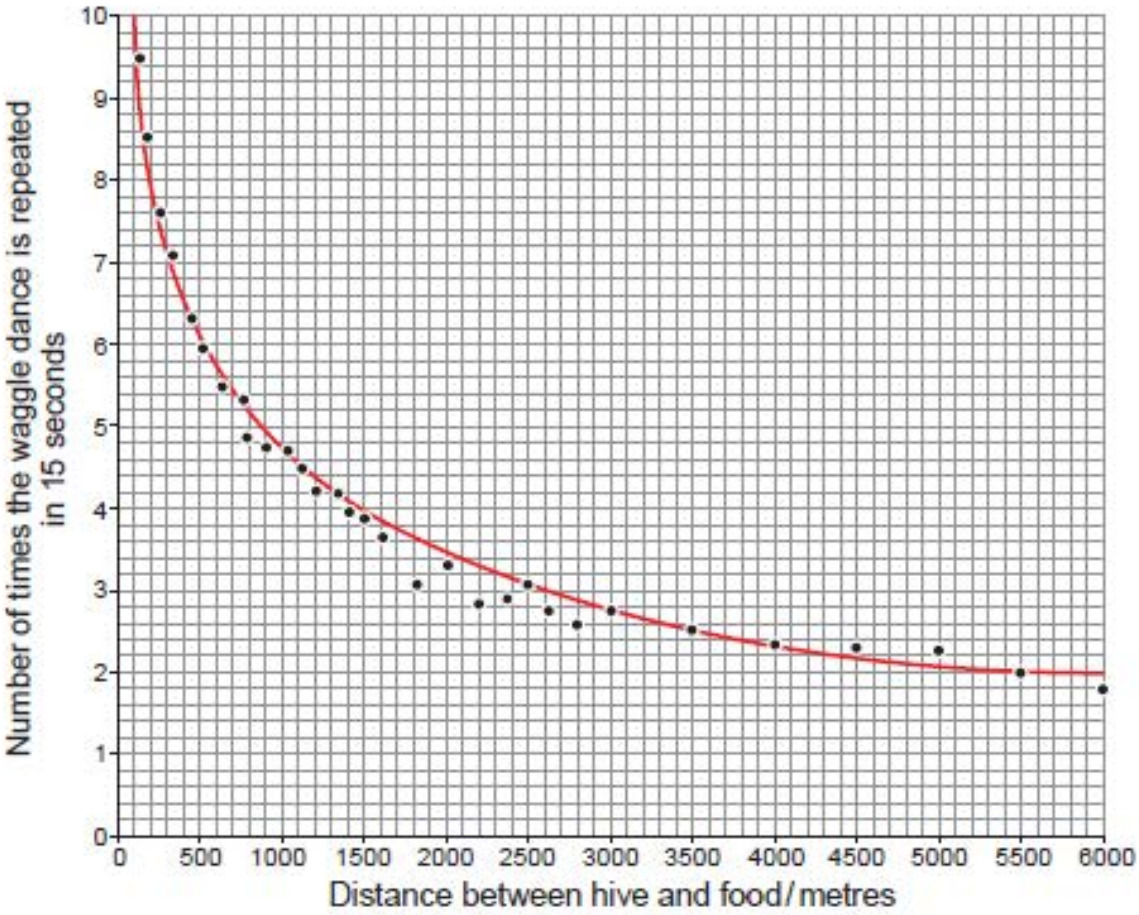
He observed that when food is more than 70 m away from the hive they perform a "waggle dance" in the hive. As shown in figure 3.6.

Figure 3.6

waggle dance
(food more than 70 m away)

The number of times the waggle dance is repeated in a unit of time depends on the distance between the hive and the food. This is shown in figure 3.7.

Figure 3.7



(iii) I. Using the graph, complete the table below by calculating the difference in the number of times the waggle dance is repeated in 15 seconds between 100 and 500 m. [1]

Distance between hive and food/m	Difference in number of times the waggle dance is repeated in 15 seconds
100-500	.....
3000-3500	0.2

II. Use the values from the table to conclude what happens to the accuracy of the waggle dance for finding food as the distance of the food from the hive increases. [1]

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(iv) There were two factors which were important in terms of making a valid conclusion.

1. Karl von Frisch studied thousands of bees and collected data from more than one hive.
2. His study has also been repeated by other scientists many times.

Explain why these two factors were important in terms of making a valid conclusion. [2]

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(e) Different groups of chimpanzees obtain food in a variety of ways. One group of chimpanzees was observed trapping colobus monkeys in order to eat them. Other groups use tools to get food; the way they do this varies from group to group. This is an example of social learning.
Explain the advantages of social learning to the different groups of chimpanzees. [1]

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END OF PAPER