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## GCE A LEVEL

BW-A2-OptionC-W1

### WORKSHEET 1 – OPTION C NEUROBIOLOGY AND BEHAVIOUR

## BIOLOGY – A2 unit 4

### Variation, Inheritance and Options

Suggested time: 3 hours 30 minutes

For Tutor's use only

| Question | Maximum Mark | Mark Awarded | Question | Maximum Mark | Mark Awarded |
|----------|--------------|--------------|----------|--------------|--------------|
| 1.       | 10           |              | 9.       | 12           |              |
| 2.       | 11           |              | 10.      | 10           |              |
| 3.       | 11           |              | 11.      | 10           |              |
| 4.       | 10           |              | 12.      | 11           |              |
| 5.       | 11           |              | 13.      | 11           |              |
| 6.       | 10           |              | 14.      | 10           |              |
| 7.       | 10           |              | 15.      | 9            |              |
| 8.       | 10           |              | Total    | 156          |              |

### ADDITIONAL MATERIALS

In addition to this worksheet, you will require a calculator and a ruler.

### INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name and the date in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you are working on screen, write your answers on paper and number each one clearly.

### INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question. The worksheet is out of **156** marks.

The assessment of the quality of extended response (QER) will take place in question **15**.

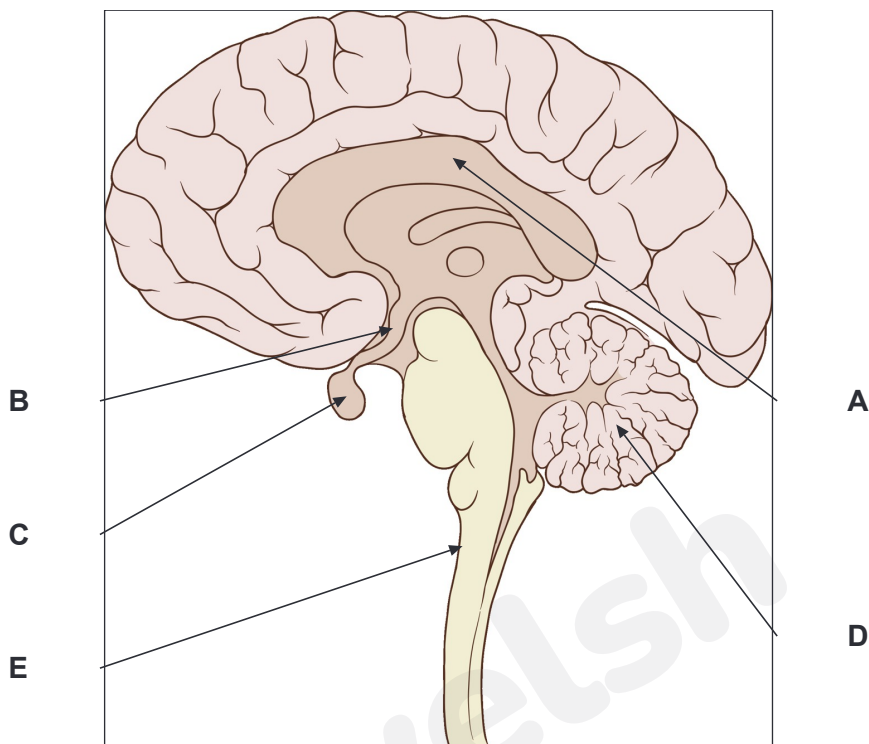
The quality of written communication will affect the awarding of marks.

This worksheet is written by BioWelsh in the style of the WJEC A level Biology examination, following the WJEC specification (topic Option C). It is not an official WJEC paper.



Answer **all** questions.

1. **Image 1.1** shows a section through the middle of the human brain, cut from front to back. The front of the head is on the left.



**Image 1.1**

- (a) Identify the structures labelled **A**, **C**, **D** and **E**.

[4]

A .....

C .....

D .....

E .....

- (b) Structure **B** is the hypothalamus. State **two** of its functions.

[2]

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- (c) A tumour is pressing on structure **E**. Suggest **two** effects this could have on the patient. [2]

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- (d) The hippocampus is not visible in **Image 1.1**. Describe where it is found and state **one** of its functions. [2]

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2. A beta blocker is a drug that blocks the receptors for noradrenaline on the cells of the sinoatrial node (SAN). Eight healthy volunteers took either a beta blocker or a placebo on different days. Their heart rate was measured at rest and at the end of 5 minutes of cycling. **Table 2.1** shows the results.

**Table 2.1**

|                                                               | Placebo | Beta blocker |
|---------------------------------------------------------------|---------|--------------|
| <b>Mean heart rate at rest / beats min<sup>-1</sup></b>       | 68      | 57           |
| <b>Mean heart rate after cycling / beats min<sup>-1</sup></b> | 142     | 108          |

- (a) Name the part of the brain that contains the cardiovascular centre. [1]

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- (b) Explain how heart rate increased during cycling in the placebo group. [3]

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- (c) Calculate the percentage decrease in the mean heart rate after cycling caused by the beta blocker, compared with the placebo. Give your answer to **1 decimal place**. [2]

Percentage decrease = ..... %

- (d) Explain why the beta blocker reduced the heart rate after cycling. [2]

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- (e) Atropine is a drug that blocks acetylcholine receptors on the SAN. Suggest the effect of atropine on the resting heart rate. Explain your answer. [2]

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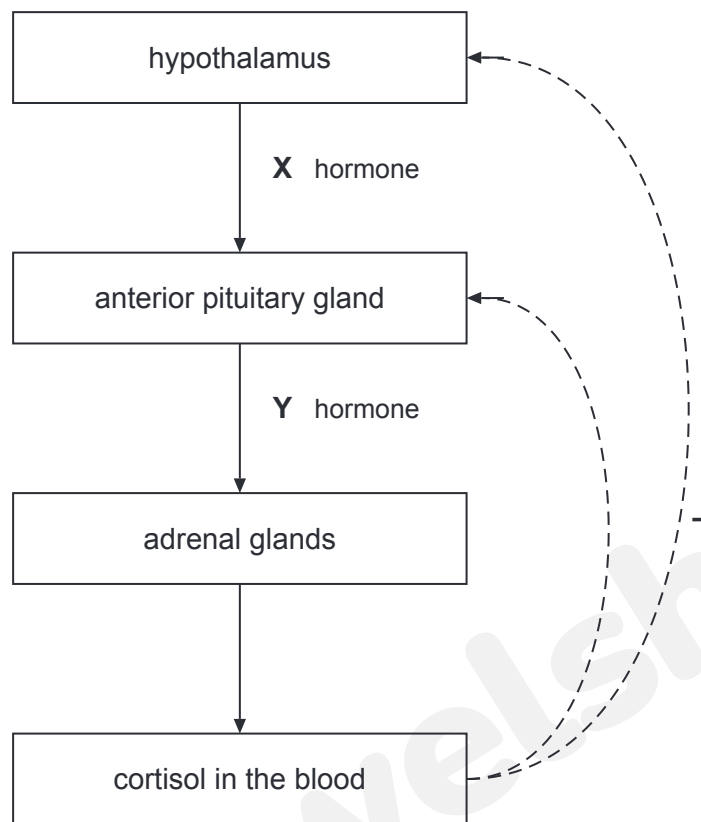
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- (f) State **one** variable that should have been controlled in this investigation. [1]

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3. Cortisol is a hormone released during stress. **Image 3.1** shows how its release is controlled.



**Image 3.1**

(a) Name hormones **X** and **Y**. [2]

X .....

Y .....

(b) Using **Image 3.1**, explain why the hypothalamus is described as the link between the nervous system and the endocrine system. [2]

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In the dexamethasone suppression test, a person takes a tablet of dexamethasone, a synthetic hormone that acts like cortisol, at 11 pm. Their blood cortisol concentration is measured at 8 am the next morning. **Table 3.2** shows results for three people.

**Table 3.2**

| Person   | Cortisol at 8 am without the drug<br>/ $\text{nmol dm}^{-3}$ | Cortisol at 8 am after the drug /<br>$\text{nmol dm}^{-3}$ |
|----------|--------------------------------------------------------------|------------------------------------------------------------|
| <b>P</b> | 420                                                          | 35                                                         |
| <b>Q</b> | 390                                                          | 410                                                        |
| <b>R</b> | 450                                                          | 50                                                         |

- (c) (i) Explain why the cortisol concentration of person **P** fell after taking dexamethasone. [2]

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- (ii) Person **Q** has a tumour of the pituitary gland. Suggest why their cortisol concentration did not fall. [2]

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- (iii) Calculate the percentage decrease in the cortisol concentration of person **R**. [1]

Percentage decrease = ..... %

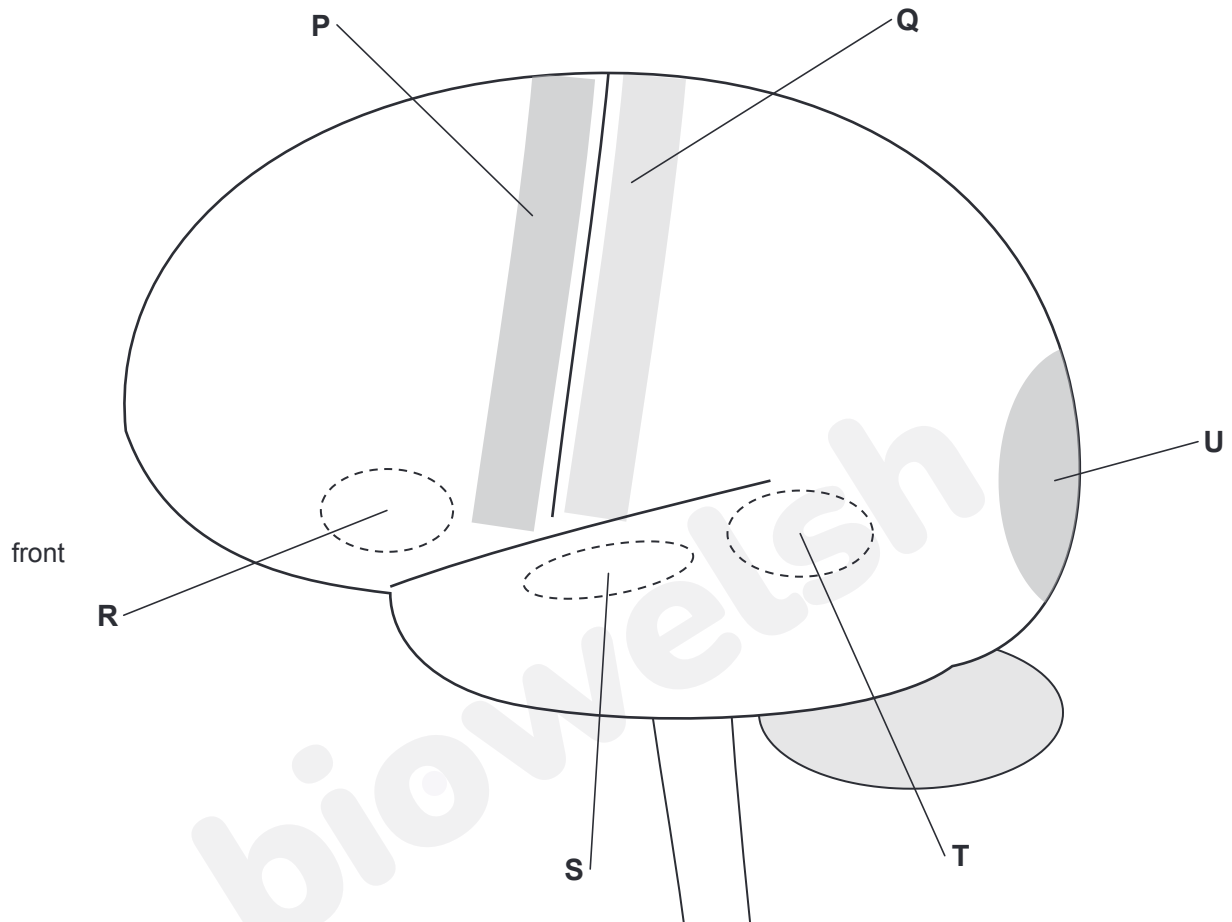
- (d) Adults who suffered severe stress as young children often have a raised cortisol concentration all the time. Suggest how altered gene expression in childhood could explain this. [2]

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4. **Image 4.1** is a diagram of the left cerebral hemisphere seen from the side. Some areas of the cortex are labelled **P** to **U**.



**Image 4.1**

- (a) Identify areas **P**, **Q** and **U**. [3]

P .....

Q .....

U .....

- (b) Name the lobe that contains area **U**. [1]

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- (c) Identify the letter of the area that is needed to understand spoken language. [1]

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- (d) A woman had a small stroke that damaged area **U** of the left hemisphere only. She could not see objects on her right side, but she could still recognise them by touch. Suggest an explanation for these observations. [2]

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- (e) Explain the role of association areas when she recognises the face of a friend. [2]

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- (f) Another patient cannot move the fingers of the left hand. State which lettered area is damaged and in which hemisphere. [1]

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5. A student investigated how sensitive different areas of skin are. A volunteer with closed eyes was touched gently with either one or two blunt points of a pair of dividers. The student recorded the smallest distance between the points that the volunteer could feel as two separate points. This was repeated three times at each site. **Table 5.1** shows the results.

**Table 5.1**

| Site              | Trial 1 / mm | Trial 2 / mm | Trial 3 / mm | Mean / mm |
|-------------------|--------------|--------------|--------------|-----------|
| <b>Fingertip</b>  | 2            | 3            | 2            | .....     |
| <b>Lower lip</b>  | 4            | 5            | 4            | 4.3       |
| <b>Palm</b>       | 10           | 11           | 12           | 11.0      |
| <b>Forearm</b>    | 36           | 39           | 42           | 39.0      |
| <b>Upper back</b> | 44           | 52           | 48           | .....     |

- (a) Complete **Table 5.1** by calculating the **two** missing means. Give each to **1 decimal place**. [2]
- (b) Identify the independent variable and the dependent variable in this investigation. [2]
- Independent variable .....
- Dependent variable .....
- (c) Suggest **two** ways in which the student could improve the validity of the results. [2]
- .....
- .....
- .....
- .....
- (d) Using your knowledge of the sensory homunculus, explain the difference between the results for the fingertip and the upper back. [3]
- .....
- .....
- .....
- .....
- .....
- .....
- .....

- (e) The lips and hands are also drawn very large in the motor homunculus. Suggest why. [2]

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6. Two patients had strokes that damaged different areas of the left cerebral hemisphere. Each was asked what they did at the weekend. **Table 6.1** shows their replies and how well each understood simple spoken instructions.

**Table 6.1**

|                  | Reply                                                                                                               | Understanding of instructions |
|------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------|
| <b>Patient 1</b> | 'Weekend ... son ... car ... drive ... park. Good.'<br>Spoken slowly with great effort.                             | Good                          |
| <b>Patient 2</b> | 'Oh yes, the weekend was a clock that the green went sailing, and we had the ten of it.' Spoken quickly and easily. | Poor                          |

- (a) Name the area of the brain damaged in each patient. [2]

Patient 1 .....

Patient 2 .....

- (b) State the lobe of the cerebrum in which each of these areas is found. [2]

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- (c) A third patient understands speech and speaks fluently, but cannot repeat a sentence that is spoken to him. Suggest which structure is damaged. Explain your answer. [2]

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Before surgery to treat epilepsy, some patients have the Wada test. A drug is injected into the artery supplying one cerebral hemisphere, which anaesthetises that hemisphere for a few minutes. The patient is then asked to name pictures. When the left hemisphere was anaesthetised, one patient could not name any pictures. When the right hemisphere was anaesthetised, the patient named them all.

- (d) (i) State the conclusion that can be drawn from these results. [1]

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- (ii) Suggest why surgeons need to know this before operating. [1]

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- (iii) Suggest **two** advantages of using fMRI instead of the Wada test to find the language areas. [2]

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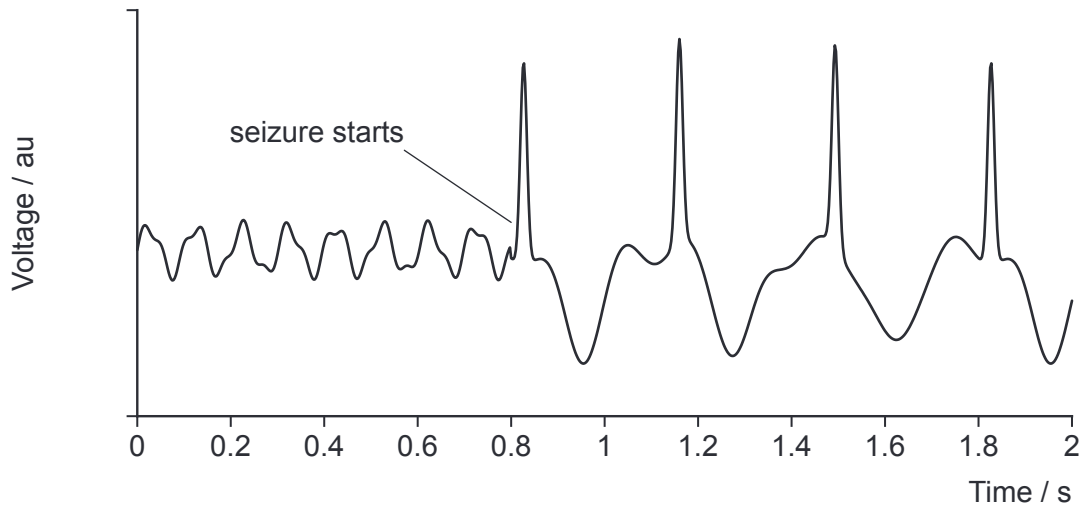
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7. A child has absence seizures, a type of epilepsy in which the child stares blankly for a few seconds. An electroencephalogram (EEG) was recorded. **Graph 7.1** shows part of the trace from one electrode before and during a seizure.



**Graph 7.1**

- (a) State what is detected by the electrodes during EEG. [1]

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- (b) Use **Graph 7.1** to calculate the frequency of the large spikes during the seizure. [2]

Frequency = ..... Hz

- (c) Explain why EEG, rather than computerised tomography (CT), is used to diagnose epilepsy. [2]

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- (d) Give **one** limitation of EEG. [1]

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- (e) An elderly man fell and hit his head. He was brought to hospital unconscious. Suggest **two** reasons why a CT scan, rather than MRI, was used. [2]

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- (f) A week later he had an MRI scan. Describe how MRI produces an image. [2]

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8. Twelve volunteers had fMRI scans while carrying out three language tasks. **Table 8.1** shows the mean percentage increase in the fMRI signal in four areas of the left hemisphere during each task.

**Table 8.1**

| Area                   | Reading words silently | Listening to words | Repeating heard words aloud |
|------------------------|------------------------|--------------------|-----------------------------|
| <b>Visual cortex</b>   | 2.4                    | 0.1                | 0.2                         |
| <b>Auditory cortex</b> | 0.2                    | 2.1                | 2.3                         |
| <b>Wernicke's area</b> | 1.6                    | 1.8                | 1.9                         |
| <b>Broca's area</b>    | 0.4                    | 0.3                | 2.2                         |

- (a) Explain how fMRI shows which areas of the brain are active. [2]

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- (b) Use **Table 8.1** and your own knowledge to explain the results for Wernicke's area and Broca's area. [3]

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- (c) Suggest why the results from twelve volunteers were used rather than one. [1]

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- (d) Positron emission tomography (PET) can also show active areas. Explain how PET using radioactive glucose (FDG) does this. [2]

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**Table 8.2** shows typical radiation doses from three procedures.

**Table 8.2**

| Procedure                    | Radiation dose / mSv |
|------------------------------|----------------------|
| <b>Chest X-ray</b>           | 0.02                 |
| <b>CT scan of the head</b>   | 2                    |
| <b>PET scan of the brain</b> | 7                    |
| <b>MRI scan of the head</b>  | 0                    |

- (e) (i) Calculate how many times greater the dose from a PET scan of the brain is than the dose from a CT scan of the head. [1]

Number of times greater = .....

- (ii) Suggest why fMRI, rather than PET, is used in research on healthy volunteers. [1]

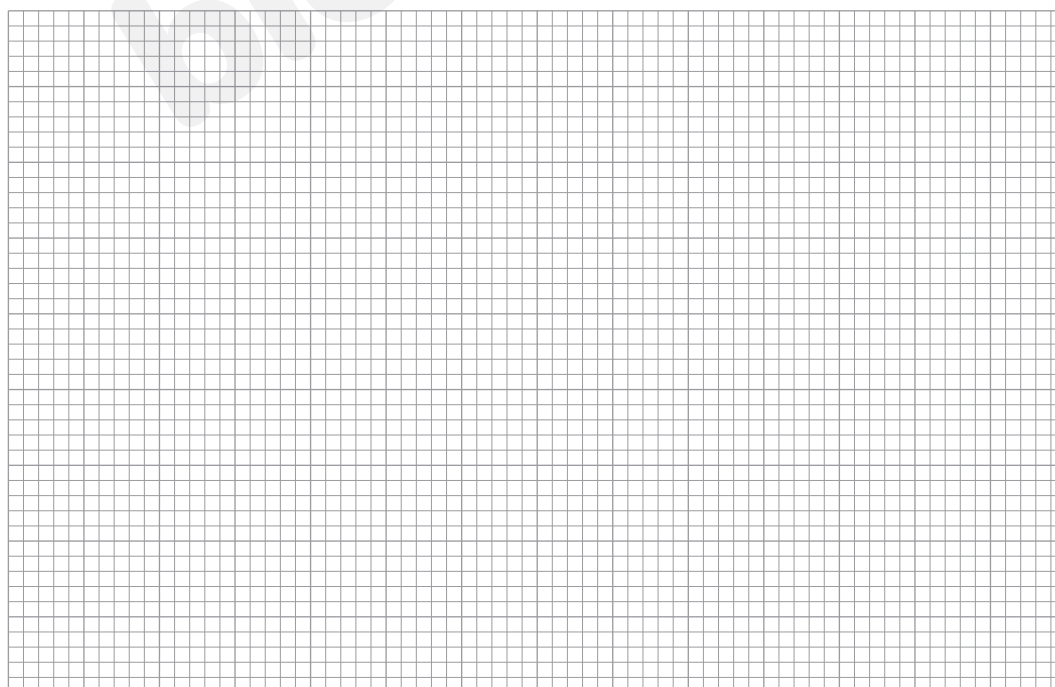
9. Some babies are born with dense cataracts, which stop light reaching the retina. The cataracts can be removed by surgery. A study measured the vision of children at the age of 10 who had surgery on both eyes at different ages. A visual acuity score of 1.0 is normal vision. **Table 9.1** shows the results.

**Table 9.1**

| Age at surgery / months | Mean visual acuity score at 10 years |
|-------------------------|--------------------------------------|
| 1                       | 0.95                                 |
| 2                       | 0.90                                 |
| 3                       | 0.72                                 |
| 4                       | 0.60                                 |
| 6                       | 0.42                                 |
| 9                       | 0.30                                 |
| 12                      | 0.22                                 |
| 18                      | 0.18                                 |

- (a) Plot a graph of the data in **Table 9.1** on the grid below. Join the points with straight lines.

[4]



(b) Describe the relationship shown by your graph.

[2]

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(c) Use your knowledge of critical periods to explain these results.

[3]

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(d) Children who are born deaf can be given a cochlear implant, which stimulates the auditory nerve. Children given implants before the age of 2 develop much better spoken language than those given implants at the age of 5. Suggest an explanation.

[2]

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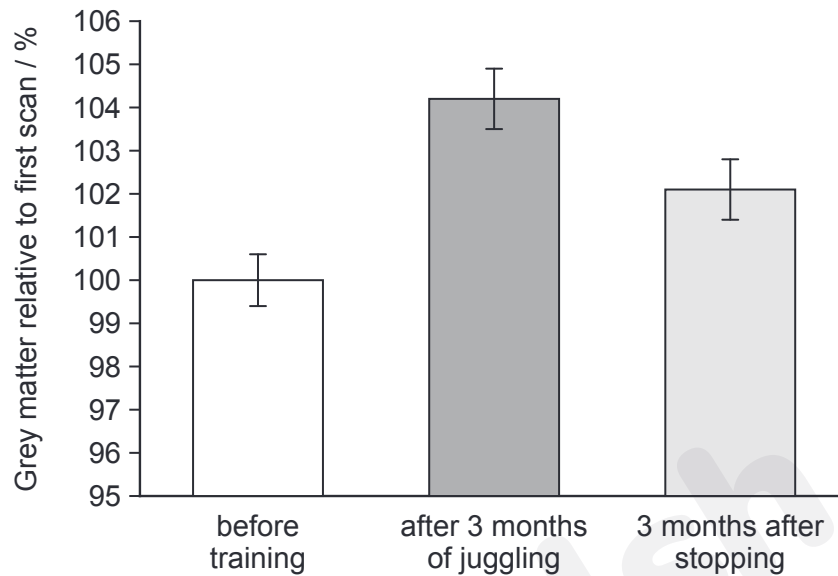
(e) Young children learn many words by imitation. State what is meant by imitation.

[1]

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10. Twelve adults who could not juggle had MRI scans of the brain before training, after three months of juggling practice, and three months after they stopped practising. **Graph 10.1** shows the mean amount of grey matter in an area of the cortex that processes moving objects. The bars show  $\pm 1$  standard deviation.



**Graph 10.1**

- (a) Calculate the percentage change in grey matter between the second and third scans. [2]

Percentage change = ..... %

- (b) Explain the changes in grey matter shown in **Graph 10.1**, using your knowledge of neuroplasticity. [3]

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- (c) Use the bars in **Graph 10.1** to suggest whether the increase after training is likely to be significant. Explain your answer. [2]

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- (d) After a stroke that damaged part of the motor cortex, a patient wore a mitt on the unaffected hand for most of the day for two weeks, so that he had to use his weak arm. Explain how this treatment improves movement of the weak arm. [2]

- (e) Suggest why this treatment works better in younger patients. [1]

11. Schizophrenia is a mental illness. **Table 11.1** shows the chance that a person develops schizophrenia if a relative has it (the concordance).

**Table 11.1**

| Relationship                              | Concordance / % |
|-------------------------------------------|-----------------|
| Identical twin                            | 45              |
| Non-identical twin                        | 14              |
| Brother or sister                         | 9               |
| No affected relative (general population) | 1               |

- (a) Explain what the data in **Table 11.1** suggest about the causes of schizophrenia. [3]

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- (b) Schizophrenia is described as polygenic. State what this means. [1]

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- (c) Explain how an environmental factor in childhood could change the expression of genes in the brain. [2]

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Male fruit flies, *Drosophila melanogaster*, court females by following them, tapping them and vibrating one wing to produce a song. A protein made from the *fruitless* gene is found in about 2000 neurones of males. Males in which this gene does not work do not court females.

- (d) (i) Males reared on their own court females correctly the first time they meet one. State the type of behaviour this shows. [1]

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- (ii) Suggest how the *fruitless* gene affects this behaviour. [1]

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- (iii) Females are more likely to mate with males whose song has the pulse pattern of their own species. Explain how this increases reproductive success. [2]

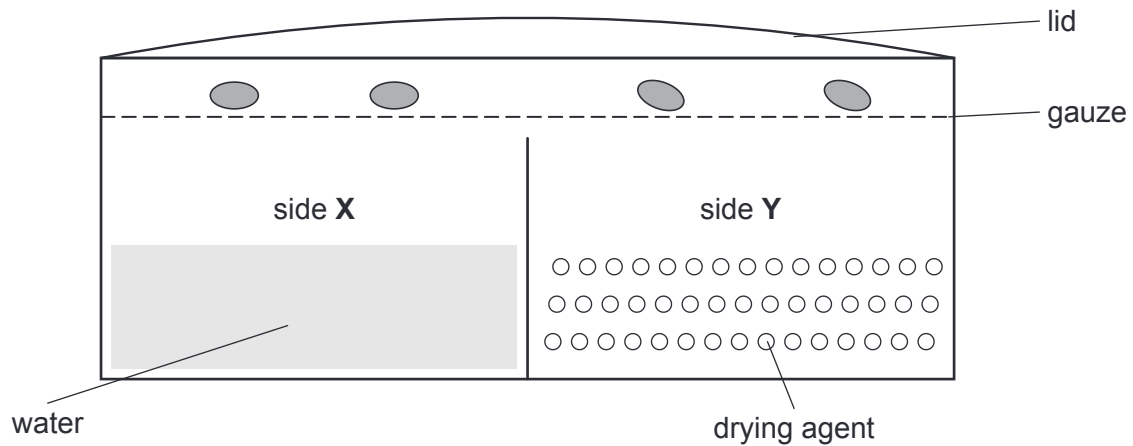
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12. A student investigated the response of woodlice to humidity using the choice chamber shown in **Image 12.1**. The chamber was left for 10 minutes before 20 woodlice were placed on the gauze in the centre. After 10 minutes the student counted the woodlice on each side. This was carried out three times with different woodlice. **Table 12.2** shows the total numbers counted.



**Image 12.1**

**Table 12.2**

|                                 | Side X (humid) | Side Y (dry) |
|---------------------------------|----------------|--------------|
| <b>Total number of woodlice</b> | 44             | 16           |

- (a) Explain why the chamber was left for 10 minutes before the woodlice were added. [1]

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The null hypothesis was that there is no difference between the numbers of woodlice on the two sides. Chi-squared ( $\chi^2$ ) is calculated using the formula:

$$\chi^2 = \sum (O - E)^2 \div E$$

- (b) Calculate the value of  $\chi^2$  for the results in **Table 12.2**. Give your answer to **1 decimal place**. [3]

$$\chi^2 = \dots\dots\dots$$

**Table 12.3** shows critical values of  $\chi^2$ .

**Table 12.3**

| Degrees of freedom | p = 0.05 | p = 0.01 | p = 0.001 |
|--------------------|----------|----------|-----------|
| 1                  | 3.84     | 6.63     | 10.83     |
| 2                  | 5.99     | 9.21     | 13.82     |

- (c) Use **Table 12.3** and your answer to part (b) to reach a conclusion for this investigation. [3]

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- (d) Explain the advantage to woodlice of this response. [2]

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- (e) The student concluded that woodlice show a kinesis. Explain why the results in **Table 12.2** cannot show whether the response is a kinesis or a taxis, and suggest what should be measured instead. [2]

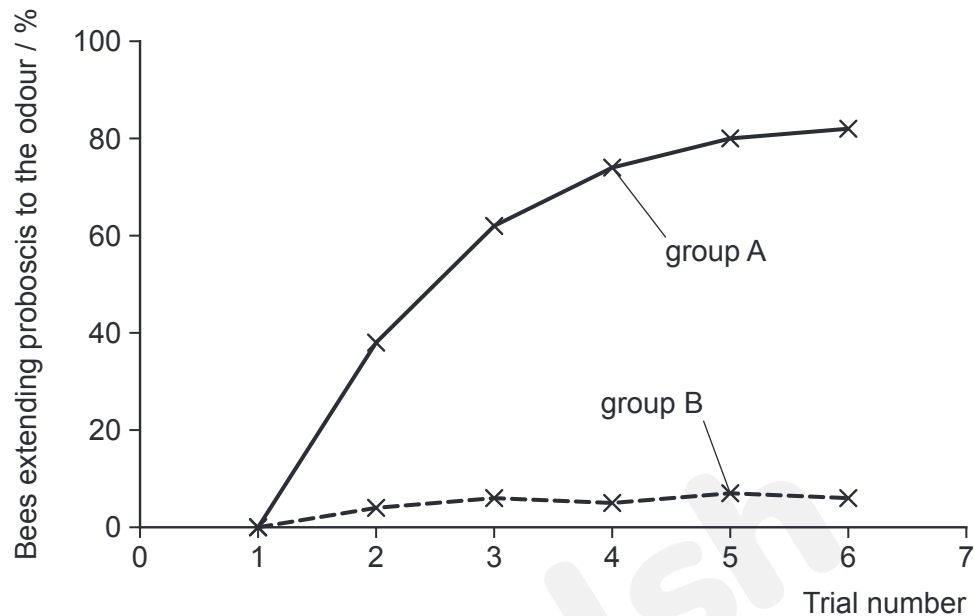
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13. When the antennae of a honeybee are touched with sugar solution, it extends its proboscis (tongue). This is an innate reflex. In an investigation, bees in group A were exposed to an odour for 3 seconds, followed immediately by sugar solution. Bees in group B were given the odour and sugar solution the same number of times, but separately, several minutes apart. **Graph 13.1** shows the percentage of bees that extended their proboscis when the odour alone was presented.



**Graph 13.1**

- (a) State what is meant by an innate reflex. [1]
- .....
- (b) Name the type of learning shown by group A and explain the results, using the terms stimulus and response. [3]
- .....
- .....
- .....
- .....
- .....
- .....
- .....
- (c) Explain why group B was included in the investigation. [1]
- .....
- .....

- (d) Calculate the percentage increase in the bees responding in group A between trial 2 and trial 5. [2]

Percentage increase = ..... %

- (e) Female larvae fed only on royal jelly develop into queens; the others become sterile workers. When the enzyme that adds methyl groups to DNA is blocked in larvae, most of them develop into queens. Suggest how diet determines whether a larva becomes a queen or a worker. [2]

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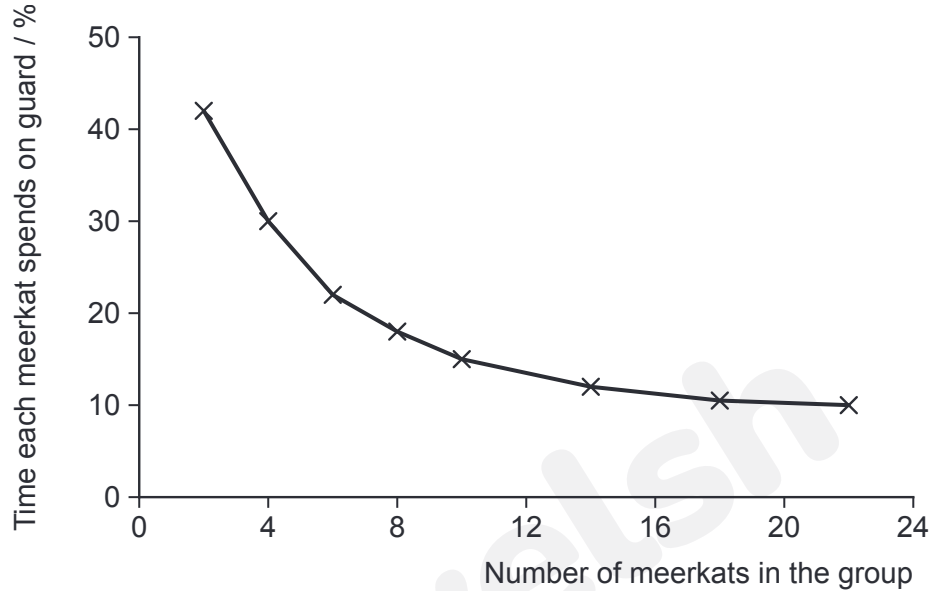
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- (f) In one colony, each second of a waggle run represents about 750 m. A forager's waggle run lasted 2.4 s and pointed 30° to the left of vertical on the comb. State the distance and direction of the food. [2]

Distance .....

Direction .....

14. Meerkats live in groups of up to 50 animals. A dominant pair produces most of the pups, and the other adults help to raise them. While the group feeds, individuals take turns to stand guard and give alarm calls. **Graph 14.1** shows how the time each meerkat spends on guard changes with group size.



**Graph 14.1**

- (a) Describe the relationship shown in **Graph 14.1** and suggest why it is an advantage to meerkats living in large groups. [2]
- .....
- .....
- .....
- .....
- (b) Suggest **one** disadvantage to a meerkat of living in a large group. [1]
- .....
- .....
- (c) Explain why a dominance hierarchy can only exist in animals that recognise each other as individuals and can learn. [2]
- .....
- .....
- .....
- .....

- (d) Adult helpers first give pups dead scorpions, then live scorpions with the sting removed, and finally whole live scorpions. Suggest how this helps pups learn to hunt scorpions, and **one** advantage of learning in this way. [2]

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- (e) A meerkat on guard sees an eagle and gives an alarm call, and the group runs to its burrows. Explain how the autonomic nervous system prepares the meerkats' muscles for running. [2]

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- (f) State **one** difference between the social structure of a meerkat group and that of a honeybee colony. [1]

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15. In spring, male black grouse gather at traditional display sites called leks. Each male defends a small patch of ground, where he fans his lyre-shaped tail and calls, and males often fight. Females visit the lek, watch the males and mate with only one or two of them. **Table 15.1** shows observations of the males on one lek over a breeding season.

**Table 15.1**

| Position of the male's patch | Number of males | Mean number of fights won | Matings observed / % |
|------------------------------|-----------------|---------------------------|----------------------|
| <b>Centre of the lek</b>     | 3               | 7.2                       | 68                   |
| <b>Middle</b>                | 5               | 3.1                       | 26                   |
| <b>Edge of the lek</b>       | 8               | 0.8                       | 6                    |

Use **Table 15.1** to explain how dominance determines which males mate, and explain why rank is often settled by displays rather than fights. Explain how defending a patch and courtship displays on the lek increase the reproductive success of the males and females. Explain how sexual selection has led to the evolution of the males' large size, ornamental tail and displays, and why natural selection limits these features. [9 QER]

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Handwriting practice area with 15 horizontal dotted lines.

END OF WORKSHEET





## A Tutor Meets Tutee project

BioWelsh worksheets are written and checked by Tutor Meets Tutee tutors for WJEC A level Biology students.

Mark this worksheet with the BioWelsh mark scheme **BW-A2-OptionC-W1** (MS).

### Acknowledgements

**Image 1.1:** Illustration: Patrick J. Lynch, CC BY 2.5 (Wikimedia Commons, 'Brain human sagittal section.svg'). Background whitened, resized, letters and label lines added.

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