FOR OFFICIAL USE

National Qualifications 2019

Mark

X707/77/01

Biology
Section 1 — Answer grid and Section 2

TUESDAY, 30 APRIL
1:00 PM – 3:30 PM

X7077701

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day		Month		Year		Scottish candidate number								

Total marks — 90

SECTION 1 —25 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on *page 02*.

SECTION 2 — 65 marks

Attempt ALL questions.

A supplementary sheet for question 1 is enclosed inside the front cover of this question paper.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

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SECTION 1 — 25 marks

The questions for Section 1 are contained in the question paper X707/77/02.

Read these and record your answers on the answer grid on *page 03* opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

2. There is **only one correct** answer to each question.

3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample question

The thigh bone is called the

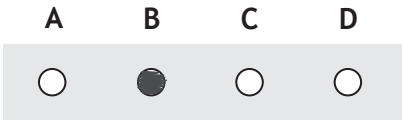
A humerus

B femur

C tibia

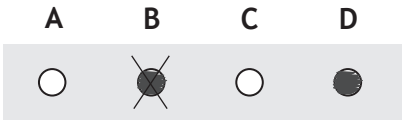
D fibula.

The correct answer is **B** — femur. The answer **B** bubble has been clearly filled in (see below).

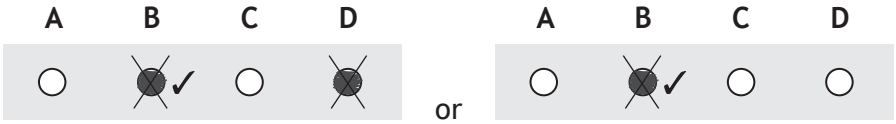


Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:



SECTION 1 — Answer grid

OBJ25AD1

	A	B	C	D
1	○	○	○	○
2	○	○	○	○
3	○	○	○	○
4	○	○	○	○
5	○	○	○	○
6	○	○	○	○
7	○	○	○	○
8	○	○	○	○
9	○	○	○	○
10	○	○	○	○
11	○	○	○	○
12	○	○	○	○
13	○	○	○	○
14	○	○	○	○
15	○	○	○	○
16	○	○	○	○
17	○	○	○	○
18	○	○	○	○
19	○	○	○	○
20	○	○	○	○
21	○	○	○	○
22	○	○	○	○
23	○	○	○	○
24	○	○	○	○
25	○	○	○	○

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SECTION 2 — 65 marks

Attempt ALL questions

Question 10 contains a choice

1. Read through the supplementary sheet for question 1 before attempting this question.

(a) **Refer to Figure 2.**

Within a species there is usually a positive correlation between size and age, where larger organisms are older.

Use **Figure 2** to explain if the data support this for veined squid. **1**

(b) The researchers used evidence published by other scientists to support their work on ageing squid.

Give the term used to describe published summaries of current knowledge and recent findings in a particular field. **1**

(c) (i) Explain why many marine organisms use external fertilisation. **1**

(ii) Give one cost of this type of fertilisation. **1**

1. (continued)

(d) **Refer to Figure 3.**

(i) Explain how **Figure 3a** suggests that larger males may have a reproductive advantage. **1**

(ii) Does the data in **Figure 3b** also support this conclusion? **1**

Justify your answer.

(e) **Refer to Figure 4.**

(i) Identify the month that would have the highest breeding activity. **1**

(ii) Squid eggs can take 30 days to hatch.

Explain how the data for April support this finding. **1**

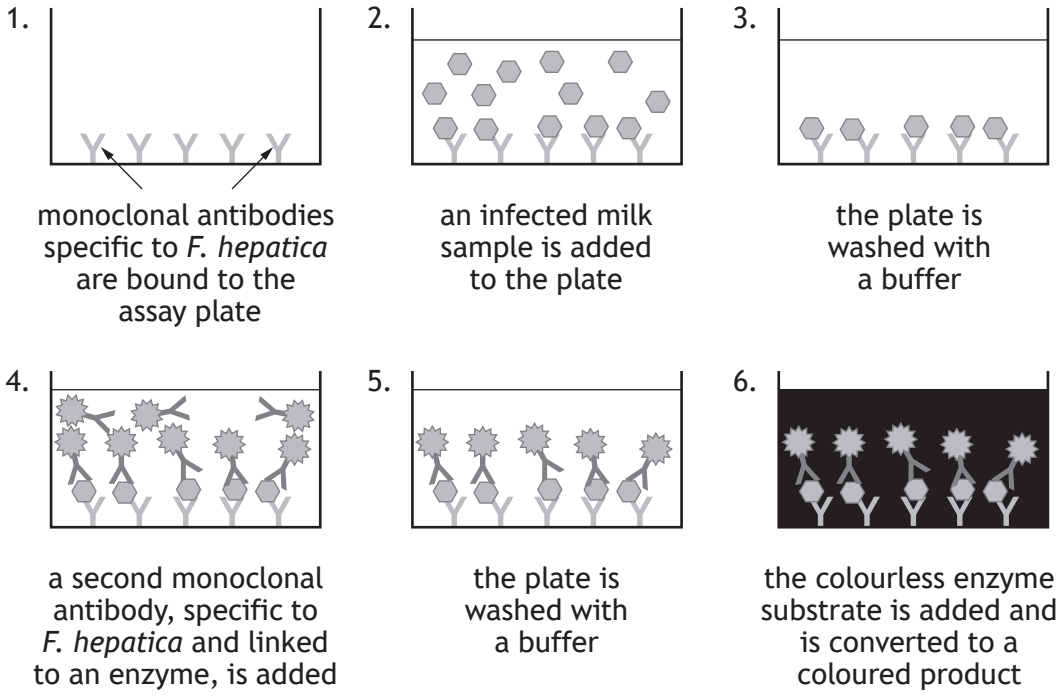
(iii) The squid take over a month to mature from stage 2 to stage 3.

Suggest a reason for the unexpected decrease in the proportions of squid at stage 2 caught in May. **1**

[Turn over

2. *Fasciolosis* is a disease of cattle caused by the flatworm *Fasciola hepatica* (*F. hepatica*).

F. hepatica antigens are found both in the blood and the milk of infected cattle and their presence is the basis of an enzyme-linked immunoassay used to identify infected animals. A positive assay is described in the figure.



(a) (i) The antibody added at step four is a monoclonal antibody.

State the meaning of the term monoclonal. **1**

_____

_____

(ii) Monoclonal antibodies can be produced in a laboratory using hybridomas that are prepared by fusing together B lymphocytes and myeloma cells.

Name the chemical used to fuse these two cell types together. **1**

_____

2. (continued)

(b) If the procedure was not carried out correctly a positive result could occur in the absence of *F. hepatica* antigens; a *false positive* result.

Suggest a possible cause for this false positive result. **1**

(c) A pH buffer was used in all reagents and wash solutions.

Explain why it is important to control pH in immunoassays. **2**

(d) Infection with *F. hepatica* in cattle results in weight loss and a reduction in milk yield.

Suggest a reason for the reduced milk yield in infected cattle. **1**

[Turn over

3. Photoreceptor system proteins are found across the three domains.

(a) (i) Name the light sensitive molecule in animals that combines with the protein opsin to form photoreceptors of the eye. **1**

_____

(ii) Rod cells contain rhodopsin.

Explain why these cells can function in low light intensity. **1**

_____

_____

(iii) Describe the role of bacteriorhodopsin in archaea. **2**

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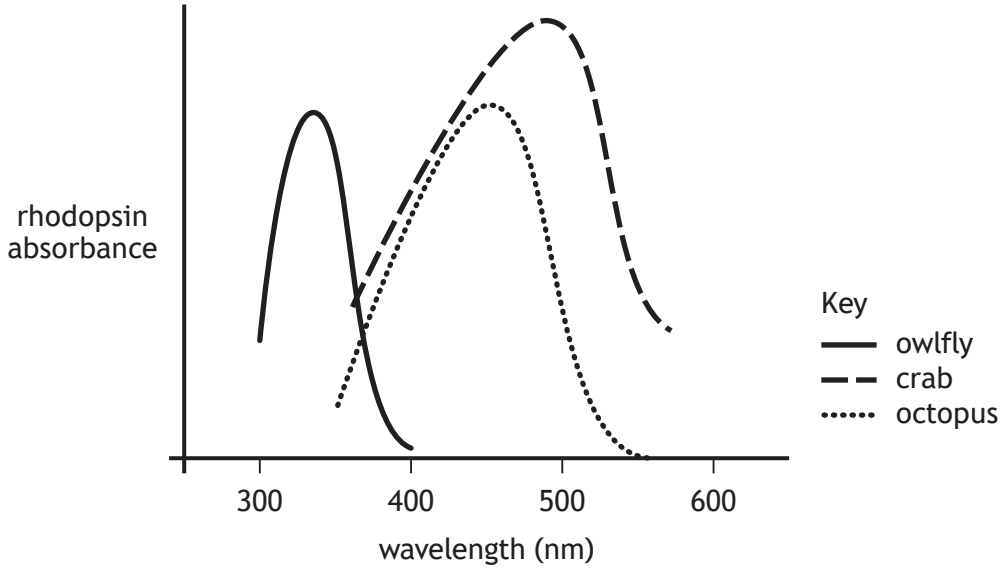
Figure 1 shows the absorption spectra of rhodopsin in a variety of organisms.

Figure 1



(b) Owlflies have rhodopsin that is sensitive to light of 345 nm (UV).

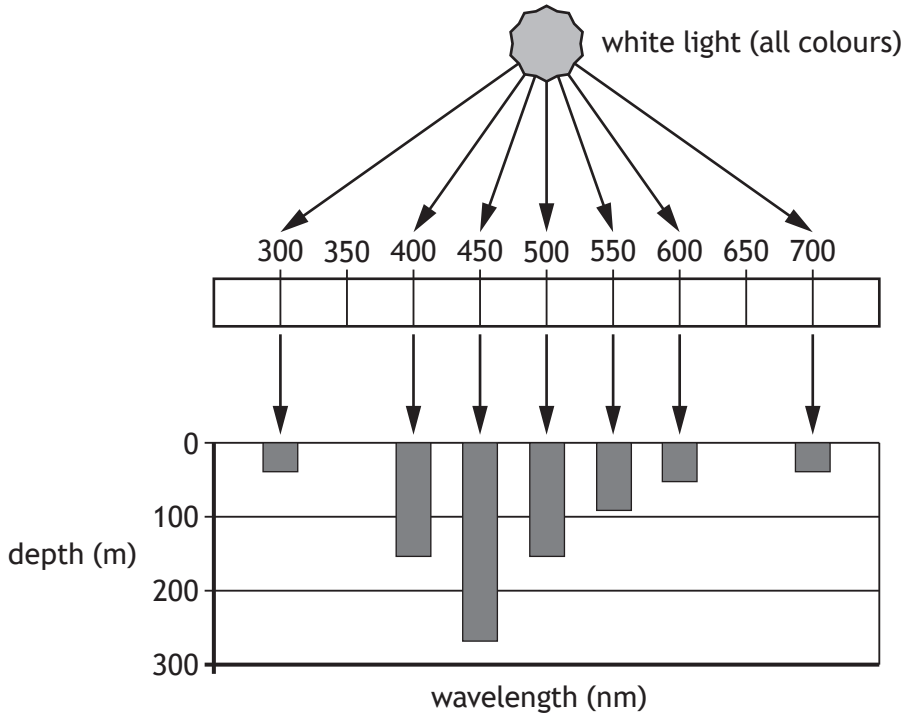
Suggest how the photoreceptor proteins of owlflies differ from those of crabs. **1**

_____

3. (continued)

Figure 2 shows the depth of penetration in water of the wavelengths in daylight.

Figure 2



(c) Crab species tend to live in shallower coastal waters, whereas octopus species can live in open seas.

Explain how the data from **Figures 1 and 2** support this statement. **2**

_____

_____

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[Turn over

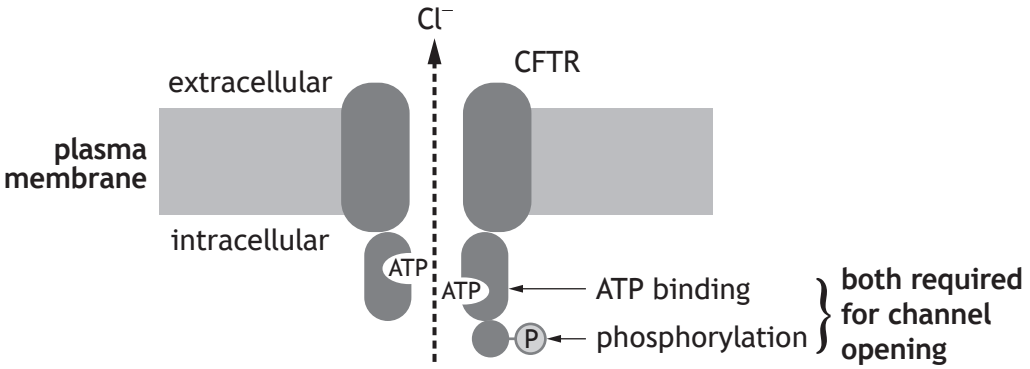
4. The *CFTR* gene encodes a large transmembrane protein (CFTR) with a symmetrical structure. This is composed of two transmembrane regions and two ATP-binding regions.

(a) Name the class of R-groups that predominate in the transmembrane regions of proteins. **1**

_____

(b) The protein CFTR is involved in the regulation of water content of extracellular mucus in the lungs and digestive system.

The figure represents the action of CFTR. It regulates the passage of chloride ions (Cl^-) across membranes of epithelial (lining) cells. In order for this ion channel to open, the protein must bind two ATP molecules, as well as a phosphate group. The increased concentration of Cl^- outside the cell draws water out of the epithelial cells into the mucus, maintaining its fluidity.



(i) What name is given to a molecule that binds to a protein? **1**

_____

(ii) Suggest how the binding of ATP results in the opening of the chloride ion channel. **1**

_____

_____

4. (continued)

(c) Cholera is a disease caused by the bacterium *Vibrio cholerae*. It causes severe watery diarrhoea, which can lead to dehydration and even death. The bacterium produces *cholera toxin* which interferes with the control of the CFTR protein channel by constantly activating a kinase enzyme.

(i) Describe the reaction catalysed by a kinase enzyme. **1**

(ii) Explain how the production of cholera toxin by *Vibrio cholerae* can lead to more water being drawn out of the epithelial cells. **2**

[Turn over

5. It is thought that the level of fruit and vegetable consumption could influence the risk of some diseases in humans. One large study has examined the relationship between the level of fruit and vegetable consumption and the risk of mortality. This was a *meta-analysis*, which is a type of observational study that combines and summarises data from several previous similar studies.

(a) Meta-analyses provide good evidence and are widely used in epidemiological studies.

State what is meant by the term 'epidemiology'. **1**

A search of previously published research papers was used to identify studies for inclusion in the meta-analysis. However, not all possible studies were included. In most of the studies used, fruit and vegetable consumption was assessed using questionnaires.

(b) Suggest why the use of questionnaires to collect information about fruit and vegetable consumption may have led to some errors in the data. **1**

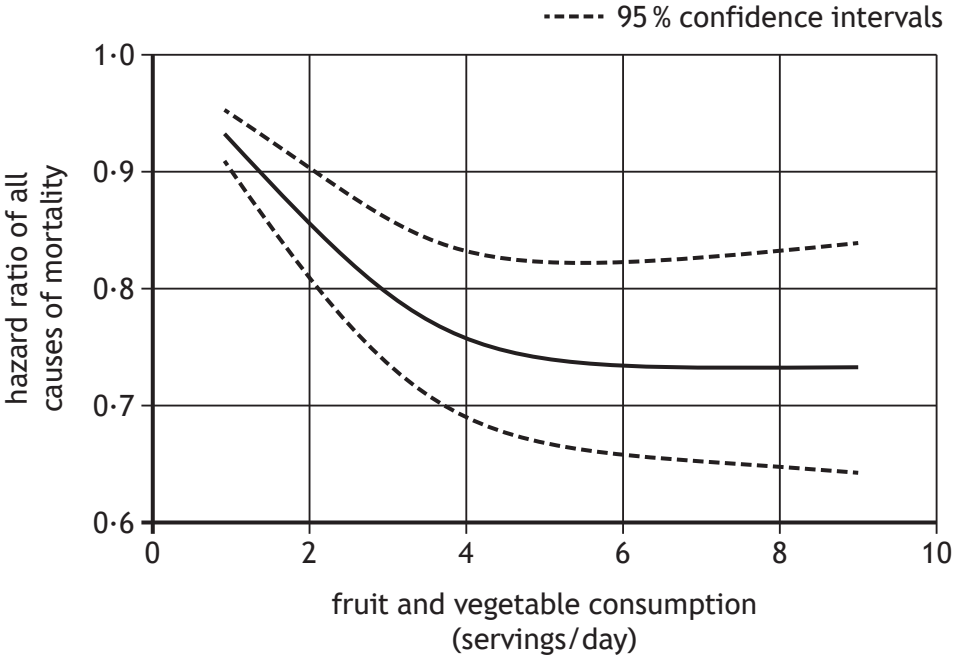
(c) One possible criticism of meta-analyses is that the people carrying them out select the previous studies to include, which could result in selection bias.

(i) Suggest **one** reason why an individual study might be considered invalid and therefore excluded from the meta-analysis. **1**

(ii) State the effect that selection bias would have on the sample obtained. **1**

5. (continued)

The results from this meta-analysis are shown in the graph. The risk of mortality was expressed as a hazard ratio, with a hazard ratio of 1·0 indicating no effect on the risk of mortality.



(d) The graph shows the 95 % confidence intervals for the data.

The confidence interval for six servings per day is wider than that for two servings.

What does this indicate about these two sets of data? **1**

(e) This study is consistent with the hypothesis that higher fruit and vegetable consumption is associated with a reduced risk of mortality over time.

Explain why this observational study can only suggest a possible link between fruit and vegetable consumption and mortality risk over time. **1**

6. Behaviour is an animal's response to internal and external stimuli.

Discuss how animal behaviour can be measured and recorded. **4**

[Turn over for next question

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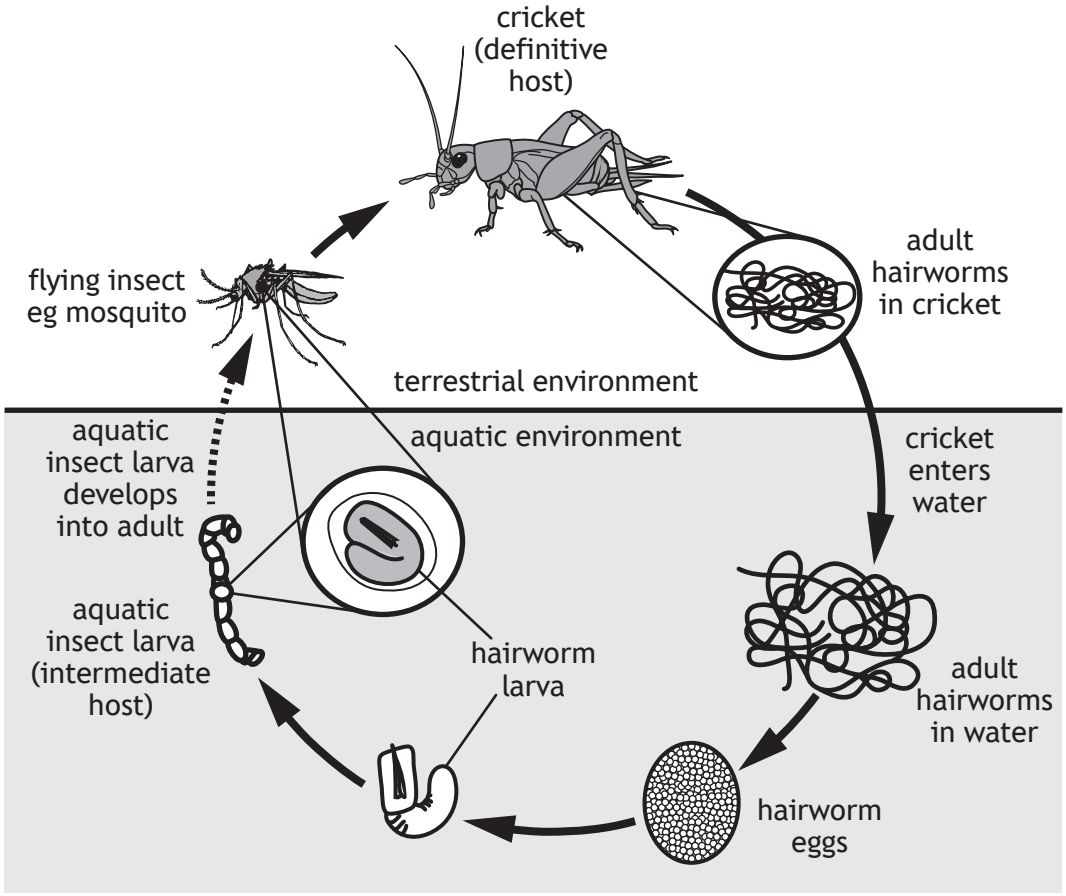
7. The figure shows the life cycle of the parasitic hairworm, *Paragordius varius*, found in lakes throughout North and South America.



(a) Hairworm eggs develop into larvae that hatch and move slowly through water at the bottom of the lake, where they may be ingested by aquatic insect larvae. The insects act as intermediate hosts, transporting the parasites into the terrestrial environment when the aquatic insect larvae become flying adults. If the flying insects are eaten by crickets, the parasite larvae penetrate the gut of the cricket to enter the body cavity.

(i) Explain why the hairworm and the cricket can be described as symbionts. **1**

(ii) Explain why the cricket, and not the aquatic insect larva, is the definitive host. **1**

7. (continued)

(b) In the presence of water, the hairworm exits the cricket's body and commences the next stage of its life-cycle. Researchers have shown that the hairworm adults produce 'mind-controlling' chemicals, which cause their normally terrestrial cricket hosts to jump into bodies of water.

(i) Suggest how this modification of host behaviour benefits the parasite. **1**

_____

_____

(ii) Give another example of a host behaviour that can be altered as part of the extended phenotype of a parasite. **1**

_____

_____

(c) Adult hairworms are free-living in aquatic environments where they mate. Males die almost immediately after mating so only mate once. Females die shortly after laying eggs fertilised by a single male.

State the term used to describe this type of reproductive strategy. **1**

_____

(d) Hairworms are closely related to members of the phylum Nematoda.

Name the phylum to which both their hosts belong. **1**

_____

[Turn over

8. The 1918 'Spanish flu' pandemic was caused by the influenza virus and is thought to have killed approximately 50 million people.

(a) (i) Humans have many defences that prevent viruses from entering the body including physical barriers and chemical secretions.

Name one of the non-specific immune responses that may result if the virus is able to bypass these defences. **1**

(ii) Annual flu vaccinations are designed to give immunity to some strains of influenza for vulnerable individuals. The vaccines typically contain inactivated virus particles that have been purified to leave only two of the proteins that are found on the surface of the virus coat.

Suggest why a new flu vaccine needs to be developed annually. **2**

8. (continued)

(b) Scientists have predicted that another flu pandemic is highly likely in the future. They are particularly concerned that this might arise from the *H5N1* strain of influenza virus, which is common in wild bird species, and is able to pass from birds to humans.

(i) What term is used to describe the level of harm caused to the host species by a virus? **1**

_____

(ii) The *case fatality rate* (CFR) is the proportion of infected individuals who die as a result of a disease. Spanish flu had an estimated CFR of 2·5 % but the *H5N1* flu strain has a CFR of 55 %.

If Spanish flu had been caused by the *H5N1* strain, and it had infected a similar number of people, what would have been the resulting number of deaths? **1**

Space for calculation

_____

[Turn over

9. The sandperch, *Parapercis cylindrica*, is a fish that lives on the sea floor. Each female defends a territory in which it feeds and reproduces. Dependent on the population density of the species, a single male may defend a group of up to 10 neighbouring females.

(a) All sandperch begin life as hermaphrodites and mature into females.

What is meant by the term hermaphrodite? **1**

(b) There is a strict size-based dominance hierarchy in the social groups; the mean size of males is greater than that of females.

State the term used to describe this difference in mean size. **1**

(c) If the male dies, the largest female will undergo a period of growth and will then change sex.

State one **other** cause of sex change in organisms. **1**

(d) A study was conducted to measure the growth of female fish undergoing sex-change. Social groups were created in a laboratory by placing groups of similar sized fish in tanks with identical environmental conditions.

Two treatments were set up, each with 10 groups.

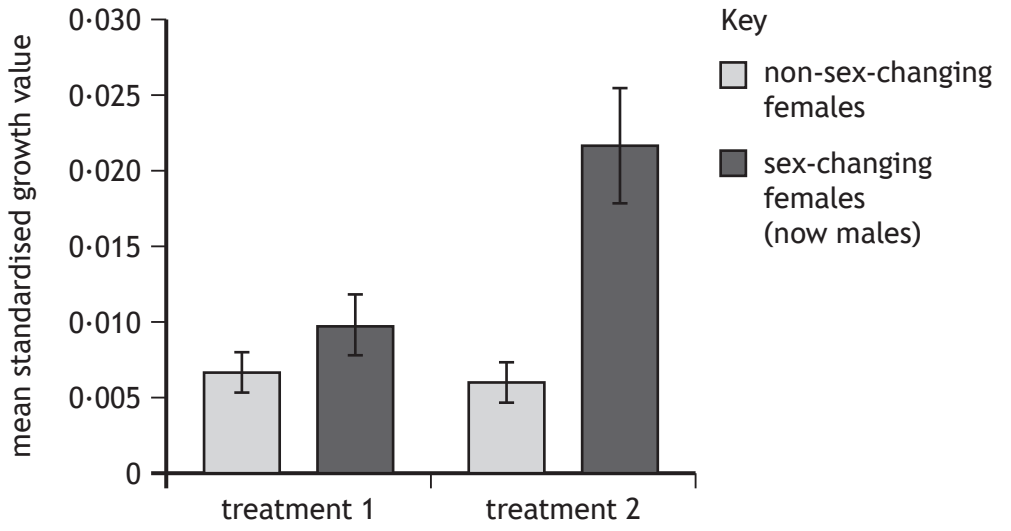
- Treatment 1 with 2 females and 1 male in each group
- Treatment 2 with 4 females and 1 male in each group

On day 5, the male was removed from half of each of the treatment groups to create experimental groups. On day 35 the sex and growth of each fish was determined. The structure of the groups is shown in the table.

		Treatment 1 (10 groups)		**Treatment 2 (10 groups)**	
		Control (5 groups)	**Experimental (5 groups)**	**Control (5 groups)**	**Experimental (5 groups)**
Group structure	**Day 1**	2 females 1 male	2 females 1 male	4 females 1 male	4 females 1 male
	Day 5	2 females 1 male	2 females	4 females 1 male	4 females
	Day 35	2 females 1 male	1 female 1 male	4 females 1 male	3 females 1 male

9. (d) (continued)

At day 35 the growth of fish in each experimental group was compared to its control group. This was used to calculate a standardised value that took into account growth in the control group. The figure shows the mean standardised growth values for the experimental groups in treatments 1 and 2. Error bars represent standard error of the mean.



(i) Suggest why it was necessary to have separate control groups for treatments 1 and 2. **1**

(ii) Give one conclusion that could be drawn about the effect of treatment 2 on the growth of sex-changing females compared to treatment 1. **1**

(iii) Suggest an advantage of greater size in sex-changed females. **1**

10. Answer **either A or B** in the space below and on *page 25*.

A Discuss signalling between cells under the following headings.

(i) Hydrophilic signalling molecules and signal transduction **6**

(ii) Insulin signalling and diabetes **4**

OR

B Discuss control of the cell cycle under the following headings.

(i) Phases of the cell cycle and the importance of cell cycle checkpoints **6**

(ii) The role of cyclins and cyclin-dependent kinases **4**

MARKS | DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWER FOR QUESTION 10

[END OF QUESTION PAPER]

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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