FOR OFFICIAL USE

National Qualifications 2017

Mark

X707/77/01

Biology
Section 1 — Answer Grid and Section 2

TUESDAY, 23 MAY
9:00 AM – 11:30 AM

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. You should 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

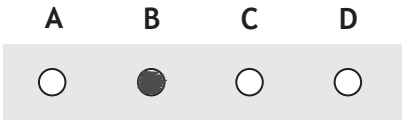
A humerus

B femur

C tibia

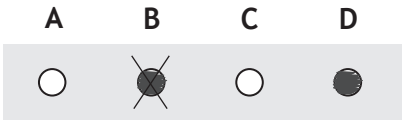
D fibula.

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

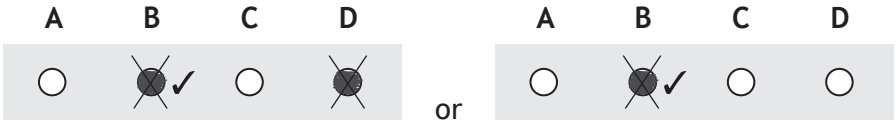


Changing an answer

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

It should be noted that question 11 contains a choice

1. Read through the Supplementary Sheet for Question 1 before attempting this question.

(a) **Refer to Figure 2 in the Supplementary Sheet for Question 1.**

Describe the trend shown in Figure 2. **1**

(b) Describe the action of caspases in cell destruction. **1**

(c) **Refer to Figure 3 in the Supplementary Sheet for Question 1.**

(i) Explain how the data supports the conclusion that the intrinsic pathway for apoptosis is triggered by the extract. **2**

(ii) Describe what the three negative values in Figure 3 indicate about the level of apoptosis in these treatments. **1**

1. (continued)

(d) **Refer to Figures 4A and 4B in the Supplementary Sheet for Question 1.**

(i) Calculate the percentage increase in the number of cells with 400 units of DNA in the cells treated with extract compared to the control cells. **1**

Space for calculation

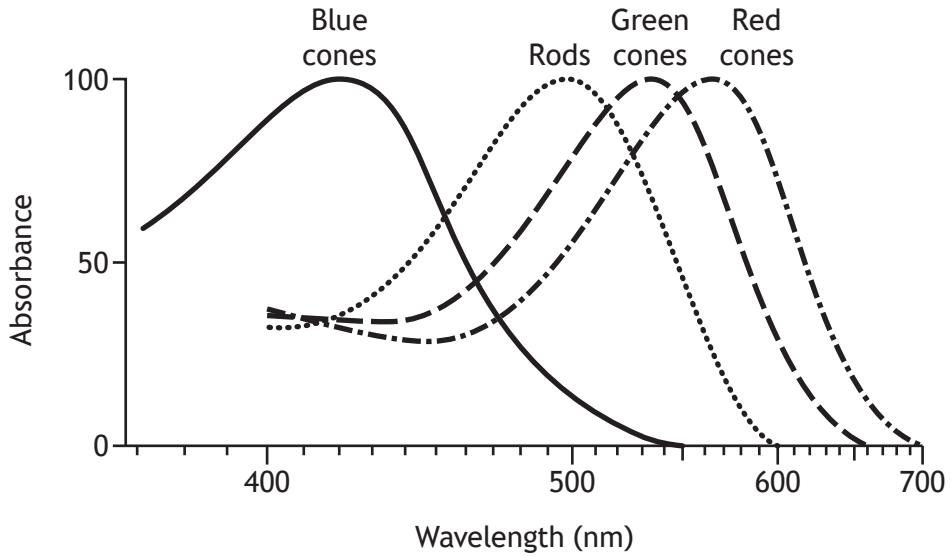
(ii) It was concluded that the extract initiated cell cycle arrest at a checkpoint after DNA replication but prior to cell division in these cells.

Explain how the data in Figures 4A and 4B support this hypothesis. **2**

[Turn over

2. The light sensitive layer at the back of the human eye is called the retina. It is able to detect light due to the presence of photoreceptor cells called cones and rods. There are three types of cone cells (blue, green and red) which are sensitive to different wavelengths of light as shown in Figure 1. Different wavelengths of light are perceived as different colours.

Figure 1



(a) (i) In cone cells, the light sensitive molecule retinal combines with a membrane protein to form photoreceptor proteins.

Name this membrane protein. **1**

_____

(ii) One percent of human males do not have functional red cone cells, a colour vision deficiency called *protanopia*.

Affected individuals would perceive a red object reflecting light of a wavelength of 670 nm as black.

Use Figure 1 to explain this observation. **1**

_____

_____

_____

2. (continued)

(b) Rod cells are more sensitive than cone cells at low light intensities.

State how this sensitivity is achieved. **1**

_____

_____

(c) Most birds have four types of cone cells.

Name the additional wavelength range to which these organisms are sensitive. **1**

_____

[Turn over

3. Cortisol is a hydrophobic signalling molecule, produced by the human adrenal gland, that affects a number of different tissues in response to stress. It has a role in increasing blood sugar levels, in suppressing the immune system, and in promoting the metabolism of fats, proteins, and carbohydrates.

(a) (i) Cortisol is a steroid hormone.

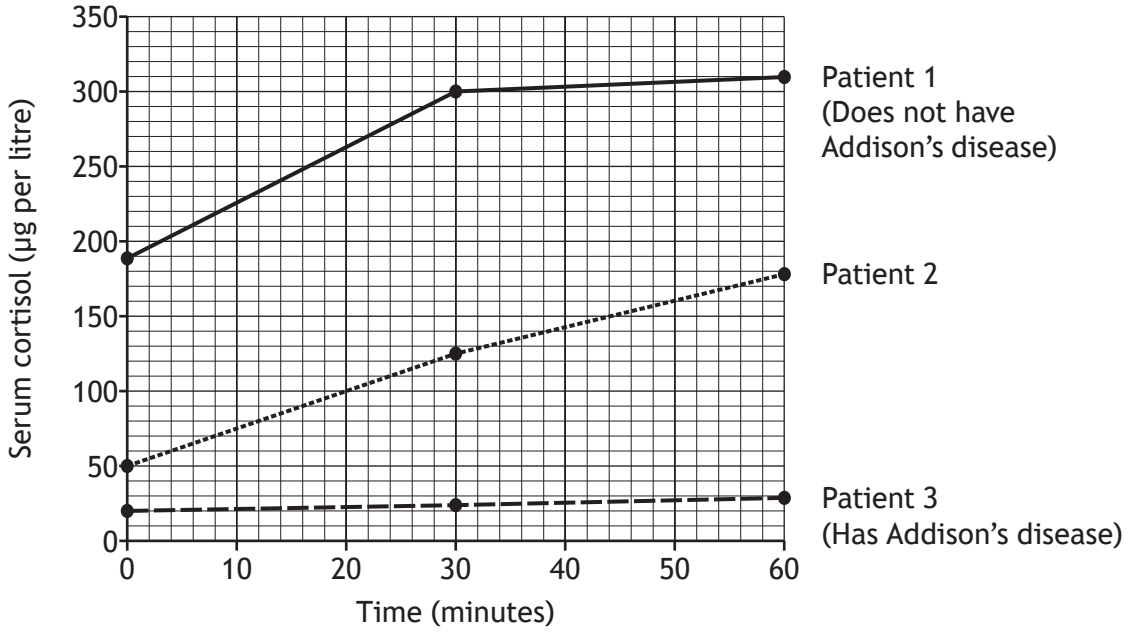
Describe the mechanism by which this type of signalling molecule causes an effect within the target cell. **2**

(ii) Suggest a way in which cortisol might have different effects in different tissues. **1**

3. (continued)

(b) Addison's disease is a disorder in which the adrenal glands do not produce sufficient cortisol. One test for this disease is to give the patient an injection of a hormone called ACTH, which stimulates the adrenal gland to release cortisol. In a healthy person, cortisol levels should rise by at least 70 µg per litre after 30 minutes **and** 110 µg per litre after 60 minutes.

The graph shows the results of this test on three patients who were investigated for Addison's disease.



State the diagnosis that would be appropriate for Patient 2, using data to justify your answer. **1**

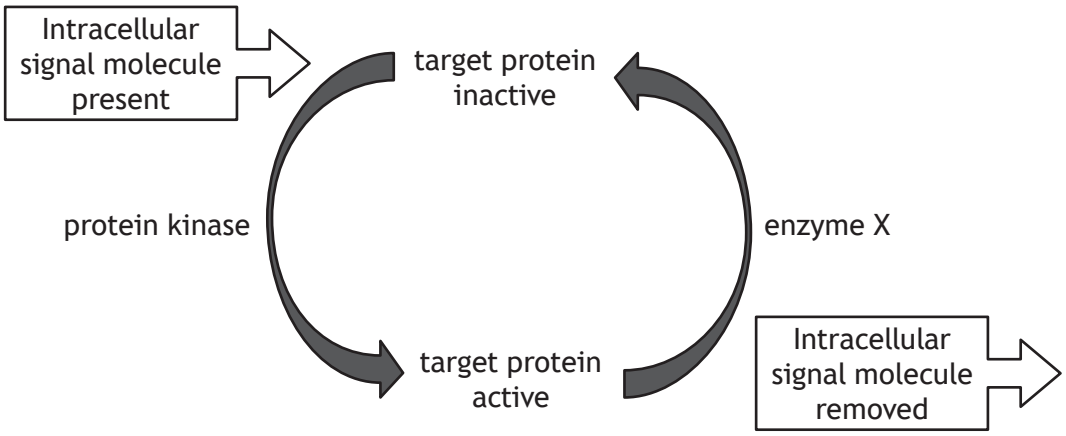
_____

_____

_____

[Turn over

4. The diagram shows how two types of enzyme can be involved in controlling the activity of a protein in response to the presence of a signalling molecule within the cell (intracellular signal molecule). Intracellular signalling molecules are often produced as a result of extracellular signals received by cell-surface receptors.



(a) (i) Explain how the action of protein kinase can switch a target protein from inactive to active. **1**

(ii) Name the type of enzyme represented by enzyme X. **1**

(iii) Explain the importance of the system being able to return the target protein to its inactive state. **1**

4. (continued)

(b) Protein kinase A (PKA) is an enzyme that is involved in this type of signalling. To test the hypothesis that PKA is found in a variety of cell types, cell extracts were prepared from different cell types and the proteins in the extracts separated by electrophoresis in a gel. The proteins were blotted onto a solid support and an antibody recognising PKA (anti-PKA antibody) was used to detect the presence of PKA.

(i) Describe how protein electrophoresis is used to separate proteins. **1**

(ii) Explain how the anti-PKA antibody would be used to detect the presence of PKA. **2**

[Turn over

5. The water vole (*Arvicola amphibius*) was common in Scotland but has declined markedly in recent years due to habitat loss and predation by American mink (*Neovison vison*).

A survey was carried out to estimate the population of water voles on a Scottish river system by counting the number of latrines (droppings sites) on a river bank at the water's edge. Water vole latrines are created as part of a territorial behaviour where a water vole will revisit the same site over and over again to deposit its droppings.

Water vole

American mink

(a) Suggest one reason why counting latrines is an appropriate indirect sampling technique for water voles. **1**

_____

_____

(b) The survey team worked on a total of 518 km, using survey sites of 500 m at 5 km intervals along the river system. The number of latrines per kilometre of waterways was counted.

Name the type of sampling used. **1**

_____

5. (continued)

(c) All surveys were conducted in June, July and August of the same year. There was heavy rainfall for three days in August. Any survey site too deep to walk into was omitted. The remains of one water vole that had been preyed upon were discovered at one survey site. Of the 92 sites sampled, only one site showed any latrines.

Identify one aspect of the experimental design that shows:

(i) High reliability; **1**

(ii) Low reliability. **1**

(d) It was concluded that the water vole population on this river had become extremely low due to predation by American mink.

Give two reasons why this may **not** be a valid conclusion. **2**

1 _____

2 _____

[Turn over

6. The mechanism of sex determination is not the same for all species.

(a) In most mammals the sex of the organism is determined by its genotype.

Describe how genetic control determines the phenotype of maleness **in mammals**. **1**

(b) In some reptile species the sex of offspring is environmentally rather than genetically controlled.

Describe how an environmental factor can influence the sex ratio of offspring in such species. **1**

(c) Diabetes insipidus is a condition characterised by the production of an excessive volume of dilute urine. An hereditary form of the disease in humans is the result of an X-linked mutation in the gene coding for the receptor for the hormone ADH. The mutated allele (X^a) is recessive to the normal allele (X^A).

(i) Explain why males are more likely to be affected by diabetes insipidus than females. **1**

(ii) Explain why carrier females are usually not affected by diabetes insipidus even though they carry a mutated copy of the gene. **2**

6. (c) (continued)

(iii) A man who is not affected by diabetes insipidus has a partner who is a carrier.

State the proportion of their sons that would be predicted to have the condition. **1**

Space for working

_____%

[Turn over

7. Students observed a group of California sea lions (*Zalophus californianus*) that were situated on a rocky outcrop off the coast of California. During each observation period, ten sea lions were observed for six minutes each. The sea lions were watched from a distance using binoculars. The checklist was used as a reference when recording the behaviours observed.

California sea lion

Behaviour	*Description of behaviour*
grooming	Licking, smoothing self with tongue, scratching
observing	Sitting up on flippers looking around
resting	Lying down with some head raising, barking or yawning
movement, aggressive	Barking, aggressive charging or chasing
movement, non-aggressive	Moving for better position on rock
other	Behaviours not specified above

(a) State the term used for a behavioural checklist of this kind. **1**

_____

(b) As they observed the sea lions the students noted the time at which each new behaviour started.

Describe how the data could be used to construct a time budget. **1**

_____

_____

7. (continued)

(c) One student noted, "Sometimes the sea lions tried to annoy each other."

Explain why anthropomorphic statements such as this should be avoided in behavioural studies. **1**

(d) Observing the sea lions from a distance made distinguishing some details of behaviour difficult.

Suggest an improvement to the method, other than direct observation, that would reduce this source of error. **1**

[Turn over

8. "So sex exists to keep parasites at bay." (Lane, 2009)

With reference to the Red Queen hypothesis, discuss the importance of sexual reproduction in defence against parasites. **5**

[Turn over for next question

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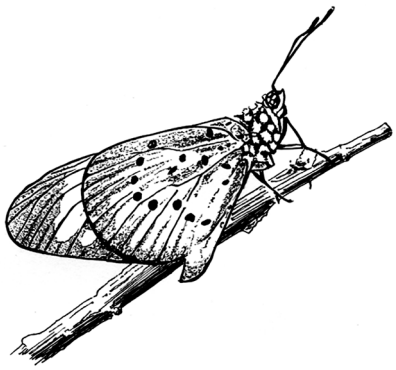
9. *Acraea encedon* is a butterfly found in tropical Africa.



Females of this species can be one of two types: either producing broods that are entirely female or producing broods that have males and females in an approximate 1:1 sex ratio. One hypothesis proposed to explain the all-female broods was that bacteria inherited from the mother kill male embryos only.

(a) Explain how antibiotics that kill bacteria could be used in a controlled trial to test this hypothesis. **2**

(b) Research has shown that the rapid evolution of male-killing bacteria from non-male-killing strains has been enabled by horizontal gene transfer.

Explain what is meant by "horizontal gene transfer". **1**

9. (continued)

(c) Some populations of the butterfly are extremely female-biased with over 90% being infected with this bacterium. These females form lekking swarms at landmarks. This has been described as *sex-role-reversal*. Butterfly populations that are not female-biased do not have lekking swarms.

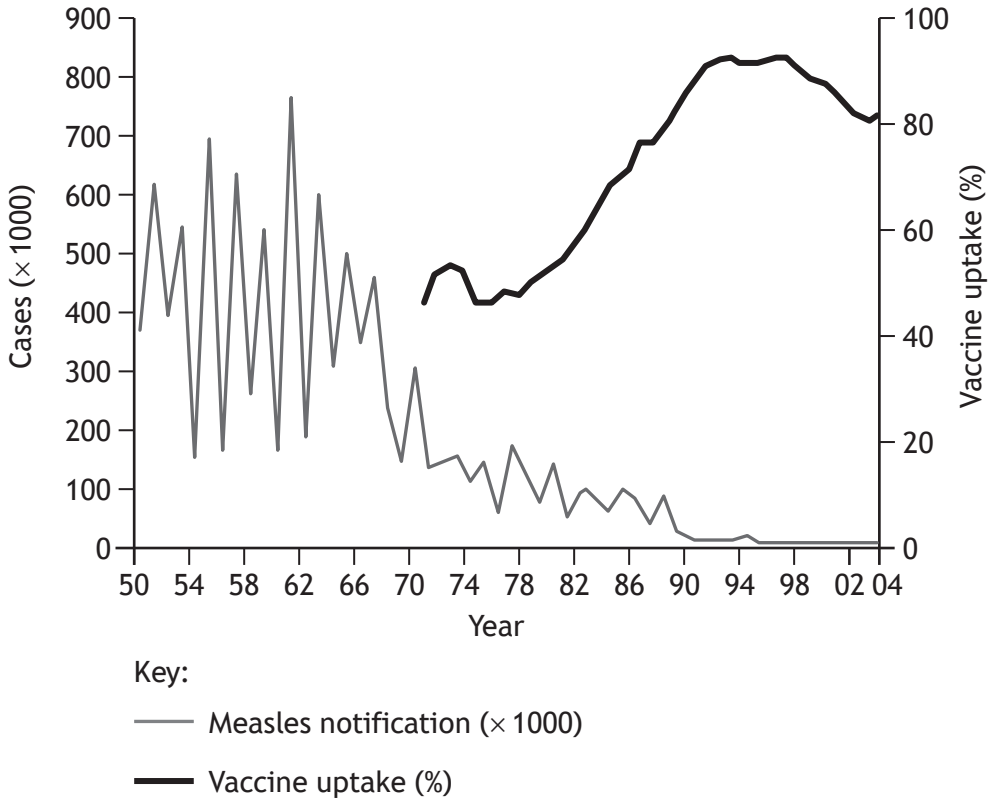
Suggest the purpose of the lekking swarms and explain why they are only found in female-biased populations of the butterfly. **2**

(d) Other sex-role-reversed mating systems are usually associated with males investing more than females in offspring, but this is not the case with *A. encedon*.

Suggest **one** way in which males might demonstrate greater reproductive investment than females in a sex-role-reversed mating system. **1**

[Turn over

10. The graph shows the number of measles notifications (reported cases) since 1950 and vaccination rates since 1970.



(a) State the term used to describe the study of data concerned with the outbreak and spread of infectious disease. **1**

(b) Describe the pattern of measles notifications prior to the introduction of vaccination. **1**

(c) Describe the correlation suggested by the graph. **1**

10. (continued)

(d) The MMR vaccine was introduced in 1988 to combat the infectious viral diseases of measles, mumps and rubella. In 1998, a report, published in a peer reviewed medical journal, claimed to establish a link between the MMR vaccine and the disorder known as autism.

(i) Explain what is meant by the term "peer reviewed". **1**

(ii) Although criticised heavily and eventually discredited, this research led to a considerable reduction in the number of children being vaccinated. In some areas, such as Swansea in South Wales, vaccination rates fell as low as 67·5%. Over the same period, a huge increase in the number of measles notifications occurred in that area.

Account for the spread of measles in the Swansea epidemic. **1**

(iii) Explain how the events in Swansea confirm that the graph not only shows correlation but also shows causation. **1**

(e) The World Health Organisation (WHO) recommends 95% of children should be immunised (vaccinated) against measles in order to protect all.

State the term used to describe this WHO threshold. **1**

[Turn over for next question

11. Answer **either A or B** in the space below and on *Page 27*.

A Discuss the role of amino acid R-groups in:

(i) the determination of tertiary structure of proteins; **3**

(ii) influencing the location of proteins within cells. **6**

OR

B Discuss cell membranes under the following headings:

(i) the phospholipid bilayer as a selective barrier; **2**

(ii) types of transport proteins and their functions. **7**

MARKS | DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWER FOR QUESTION 11

[END OF QUESTION PAPER]

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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