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Biology

Assessment Unit A2 3A

assessing

Module 6A: Synoptic Paper

[A2B31]



TUESDAY 26 MAY, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this question paper.

Answer **all four** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.

Section A carries 35 marks.

Section B carries 15 marks.

You should spend approximately **20 minutes** on Section B.

You are expected to answer Section B in continuous prose.

Quality of written communication will be assessed in **Section B**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A **data sheet** is provided for use with this paper.

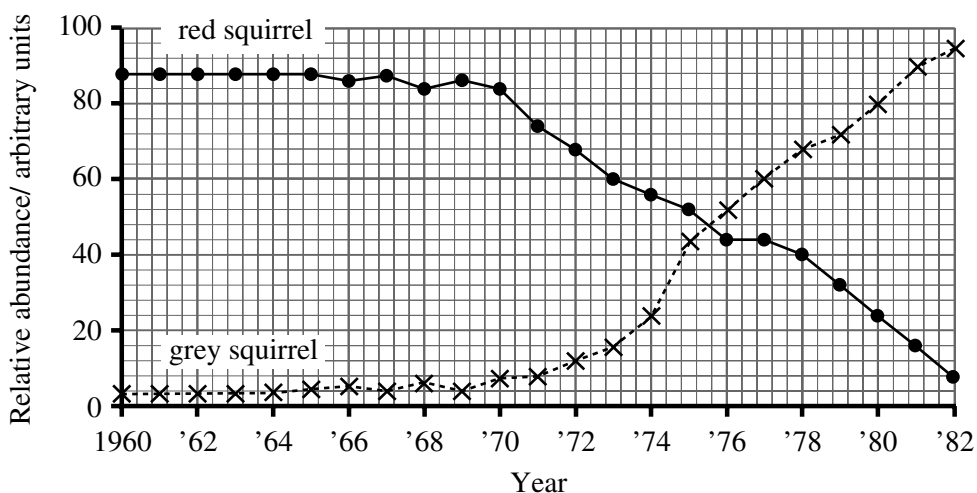
| For Examiner's use only | |
|-------------------------|-------|
| Question Number | Marks |
| 1 | |
| 2 | |
| 3 | |
| 4 | |

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| Total Marks | |
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Section A

1 Throughout much of Britain and Ireland, the introduction of the grey squirrel (*Sciurus carolinensis*) from North America has led to an increase in its numbers, correlated with a decrease in the numbers of the native red squirrel (*S. vulgaris*). Red and grey squirrels occupy a similar ecological niche. They are both tree-dwelling mammals that rely on similar food sources (including fruit and nuts). The red squirrel is now confined to isolated pockets of woodland through most of Britain and Ireland.

The graph shows estimates of population densities of red and grey squirrels in Norfolk, England from 1960 to 1982.



(a) Describe the trends shown in the graph.

[2]

(b) Red squirrels are vulnerable to the parapox virus, dying within four days of infection. The virus was found in red squirrel populations prior to the arrival of the grey squirrel, though grey squirrels may aid the spread of the disease, without themselves being affected. How might this information be used to explain the apparent replacement of red squirrels by greys?

[2]

Both the red and the grey squirrel are found in Northern Ireland. A study of habitat associations revealed the results shown in the following table.

| | Conifer plantations | Mixed deciduous woodland |
|----------------------|----------------------------|---------------------------------|
| Red squirrel | 29 | 13 |
| Grey squirrel | 3 | 24 |

(c) Use the information provided to explain why both species of squirrel are found in N. Ireland.

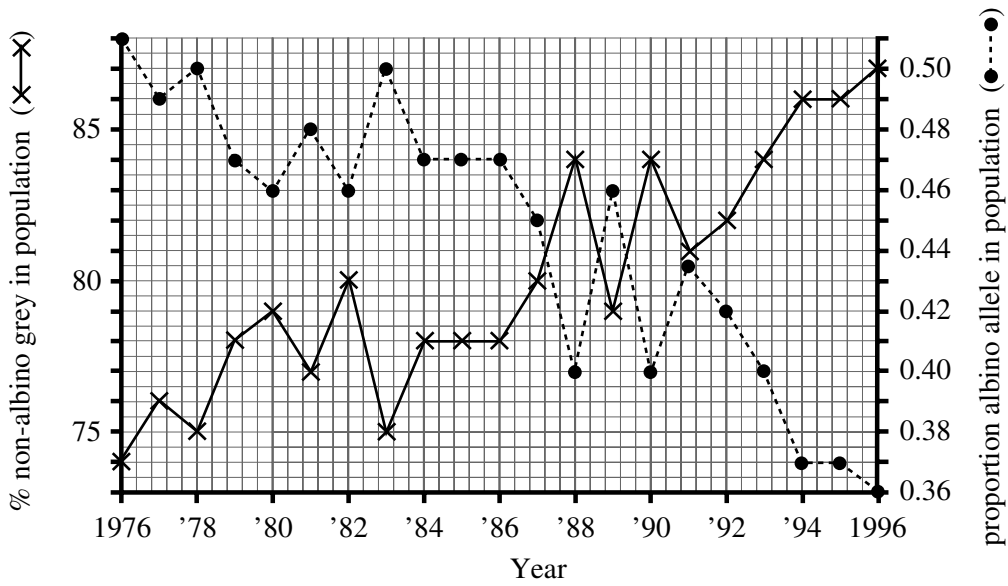
[1]

Red squirrels are confined to isolated woodlands in Wales, including those in mid-Wales and the island of Anglesey. DNA analysis of the population in mid-Wales has revealed a significant amount of genetic variability, while the small population on Anglesey has little variability and includes animals with deformities.

(d) Explain the importance of genetic variability to a population.

[2]

Populations of the grey squirrel in its native North America exhibit colour morphs including melanistic (black) forms and albinos. A population of grey squirrels in Illinois, U.S.A. has a surprisingly large frequency of albino forms. A study of this population between 1976 and 1996 revealed results shown in the graph below.



(e) Describe the trends evident in the graph and suggest an explanation.

[3]

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(Questions continue overleaf)

2 In an experiment into the effect of nutrients on the productivity of phytoplankton populations, a series of artificial ponds was created in a lake.

Forty ponds were created as follows

- 10 left untreated as a control
- 10 enriched with nitrate (NO_3^-)
- 10 enriched with phosphate (PO_4^{3-})
- 10 enriched with a combination of both nitrate and phosphate.

The mean annual productivity for the different groups was measured. Statistical tests were then used to determine the probability that the difference between phytoplankton productivity in the enriched and control groups was due to chance. The results are summarised in the table below.

| Experimental treatment | Mean annual productivity/mg chlorophyll <i>a</i> m ⁻³ year ⁻¹ | Comparison of treatment mean with control | |
|---|---|---|-----------------|
| | | <i>t</i> -value | <i>p</i> -value |
| Control | 10.33 | – | – |
| NO_3^- enriched | 13.98 | 1.471 | |
| PO_4^{3-} enriched | 18.76 | 2.384 | $p < 0.05$ |
| NO_3^- & PO_4^{3-} enriched | 25.26 | 3.986 | $p < 0.001$ |

(a) Describe the role of nitrate and phosphate in plants.

- Nitrate _____

- Phosphate _____

[2]

- 3 Read the passage below and then use the information in the passage, and your understanding, to answer the questions which follow.

Many plants contain an array of chemically unrelated compounds which are noxious or toxic, and appear to play a role in restricting the palatability of the plants in which they occur. Each of these chemicals exhibits a toxic effect on grazing animals by interfering with the normal operation of some physiological process. The effect is often dependent on the concentration of the chemical ingested, and in some cases the chemical, and the plant that produces it, may have a medicinal use in low concentration. Some examples of plants and their toxins are provided below.

5

Individual plants of white clover (*Trifolium repens*) may contain cyanide. The toxicity of these plants deters grazing by invertebrate herbivores such as slugs, though it does not appear to be effective against large herbivores. Cyanide acts as an inhibitor of the enzyme cytochrome oxidase, in the cristae of the mitochondria of cells, so preventing the transfer of electrons to oxygen.

10

Atropine is contained within the deadly nightshade (*Atropa belladonna*). In low dosage atropine has been used by ophthalmologists to prevent the constriction of the pupil during the examination of the eye's interior (when a bright light is shone into the eye). Atropine blocks the action of acetylcholine by combining with receptors on the post-synaptic membrane, including neuromuscular junctions.

15

The common foxglove (*Digitalis purpurea*) contains glycosides collectively called digitalis. Digitalis inhibits the sodium–potassium–ATPase pump in muscle cells which causes a rise, not only in intracellular sodium ions, but also in intracellular calcium ions which results in greater activation of contractile proteins. At the right dosage, digitalis increases the force of contraction of heart muscle and has been used medically to regulate an irregular heart beat although, with a normal heart and in toxic doses, it leads to cardiac arrest.

20

Aconitine is the toxic component of monkshood (*Aconitum napellus*). It facilitates the opening of sodium channels in neurones. The overall effect of this opening of sodium channels is to initially cause excitation and repetitive firing of impulses. This eventually gives way to permanent depolarisation, membranes which are then inexcitable and finally paralysis. Aconitine poisoning, again, can result in cardiac arrest.

25

30

(a) As stated in lines 10 and 11, cyanide inhibits cytochrome oxidase. Explain how this leads to the death of an animal which has eaten large quantities of cyanogenic clover.

[2]

(b) Cyanide is stored in vesicles within the cells of cyanogenic white clover. On the other hand, digitalis, aconitine and atropine are all located within the cytoplasm of the plants which produce them. Explain the differences in location of the substances within the plant cell.

[2]

(c) Atropine has been used in low dosage to relieve pain. Explain how atropine would act as a pain reliever.

[2]

(d) Atropine is used before eye examinations to dilate (open) the pupil. Explain how atropine causes the dilation of the pupil [lines 14 and 15].

[2]

(e) Explain how digitalis would cause muscle tissue to contract more strongly [line 22].

[2]

(f) Explain how aconitine would ultimately lead to the cessation of neural impulses and so paralysis [line 29].

[2]

(g) The toxins referred to in the passage all have different effects. Cyanide affects an enzyme, digitalis affects a membrane pump, aconitine affects a membrane channel while atropine affects a membrane receptor. State the type of molecule of which these structures are composed and suggest why toxins may so readily affect the action of this type of molecule.

[2]

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