Surname	Date	Tutor
First name(s)		

BioWelsh

GCE A LEVEL

BW-A2-3.5-W1

TOPIC WORKSHEET 1 – 3.5 POPULATIONS AND ECOSYSTEMS

BIOLOGY – A2 unit 3

Energy, Homeostasis and the Environment

Suggested time: 3 hours 15 minutes

For Tutor's use only

Question	Maximum Mark	Mark Awarded	Question	Maximum Mark	Mark Awarded
1.	9		9.	8	
2.	11		10.	11	
3.	10		11.	10	
4.	10		12.	10	
5.	12		13.	10	
6.	8		14.	9	
7.	9		15.	9	
8.	11		Total	147	

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 **147** 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 3.5). It is not an official WJEC paper.

Tutor only

Answer **all** questions.

1. Otters have returned to many Welsh rivers after decades of decline. **Table 1.1** shows data from a model of the otter population in one river catchment, based on survey records.

Table 1.1

Year	Number at start of year	Births	Deaths	Immigrants	Emigrants
2018	24	10	6	5	2
2019	.....	12	7	4	3
2020	.....	–	–	–	–

(a) State what is meant by the term population. [1]

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(b) Complete **Table 1.1** by calculating the number of otters at the start of 2019 and 2020. [2]

(c) Calculate the percentage increase in the population between the start of 2018 and the start of 2020. Give your answer to **1 decimal place**. [2]

Percentage increase = ... %

(d) Suggest why immigration is especially important when a species first returns to a river. [2]

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(e) Otters defend territories along rivers. Suggest why the otter population will eventually stop increasing. [2]

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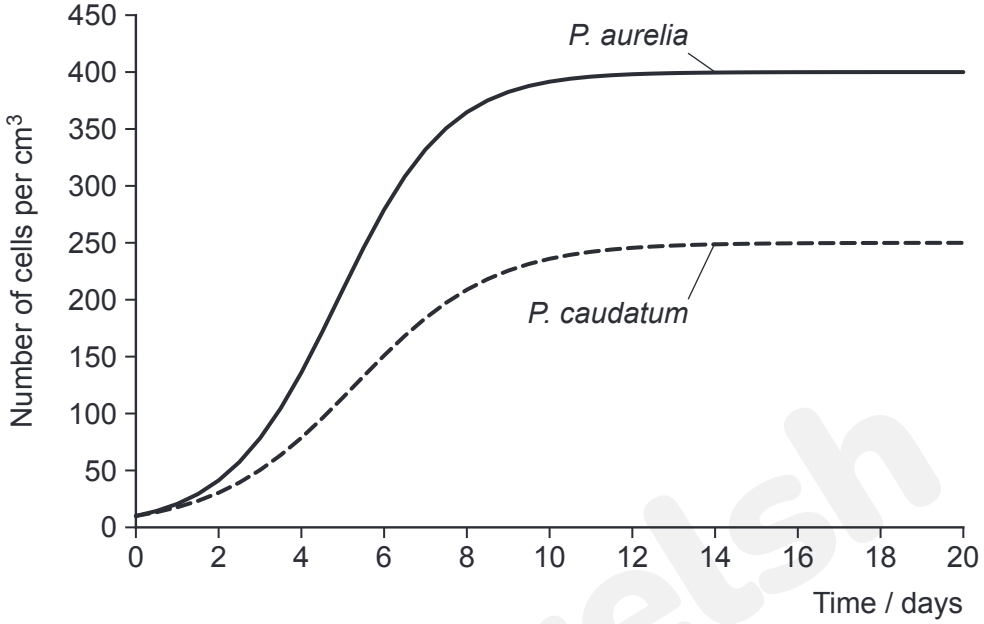
Tutor only

2. *Paramecium aurelia* and *Paramecium caudatum* are single-celled organisms that feed on bacteria. In an experiment of the type first carried out by Gause, each species was grown on its own in a culture containing a fixed daily supply of bacteria. **Graph 2.1A** shows the results.



Graph 2.1A

(a) Describe the growth of the population of *P. aurelia* shown in **Graph 2.1A**. [2]

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(b) State the carrying capacity of the culture for *P. caudatum*. [1]

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(c) Explain why the population of *P. caudatum* stops increasing. [2]

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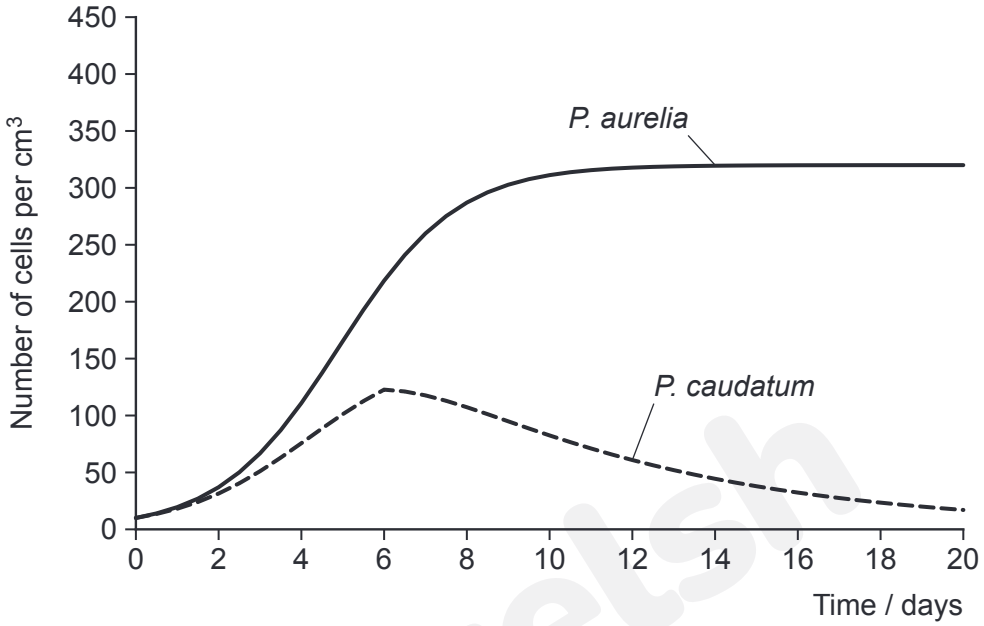
Turn over.

Tutor only

The two species were then grown together in the same type of culture. **Graph 2.1B** shows the results.



Graph 2.1B

(d) (i) Describe and explain what happened to the population of *P. caudatum* when it was grown with *P. aurelia*. [3]

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(ii) Calculate the percentage decrease in the final population of *P. aurelia* when grown with *P. caudatum* compared with when grown alone. [2]

Percentage decrease = ... %

(e) Explain why competition is described as a density-dependent factor. [1]

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Tutor only

11

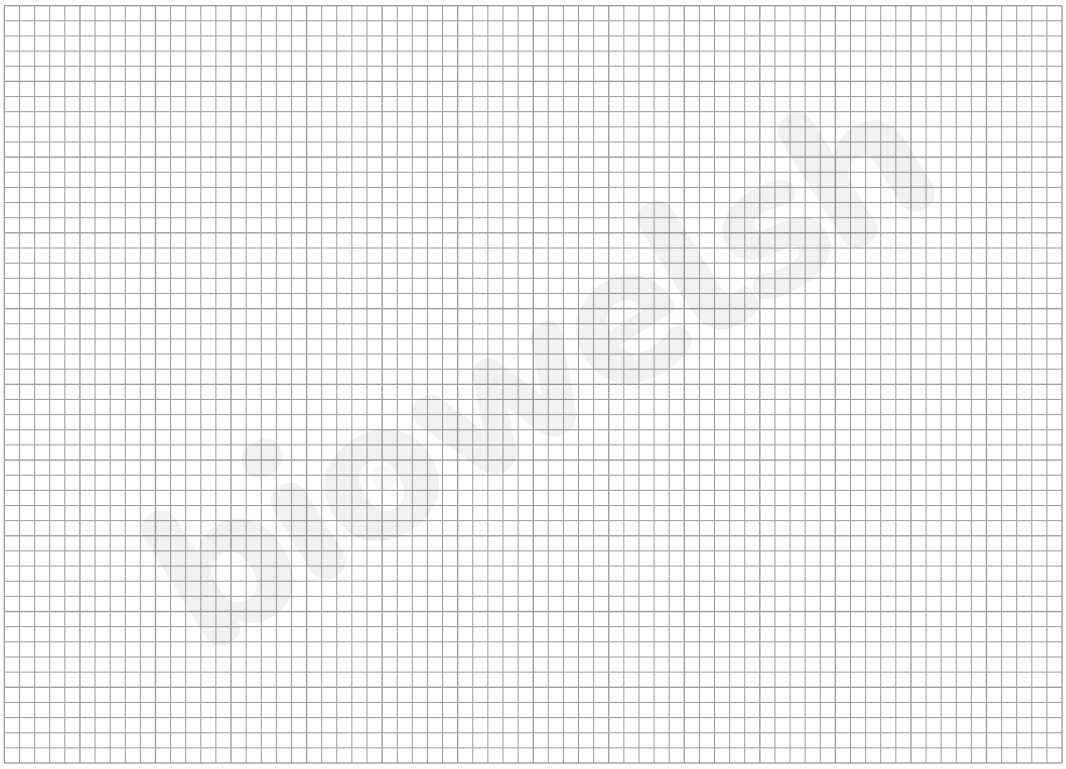
Tutor only

3. The wren is a small woodland bird. Many wrens die in winter. **Table 3.1** shows the percentage of wrens that died during mild winters and severe winters in woods with different breeding densities. The data come from a model based on a long-term study.

Table 3.1

Breeding density / pairs per km^2	10	20	30	40	50	60
Mortality in mild winters / %	18	24	31	38	45	52
Mortality in severe winters / %	71	70	72	69	71	70

(a) Plot a graph of the data in **Table 3.1** on the grid below. Use a ruled line of best fit for each set of data and label each line. [4]



(b) Describe the relationship between breeding density and mortality in mild winters. [2]

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Tutor only

(c) Using **Table 3.1**, explain whether the main cause of death in each type of winter is density dependent or density independent. [3]

Mild winters .....

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Severe winters .....

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(d) Suggest why the wren population rises quickly again in the years after a severe winter. [1]

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Tutor only

4. Students investigated the abundance of white clover in a school playing field. They placed 0.5 m × 0.5 m quadrats divided into 100 squares. **Image 4.1** shows one of these quadrats.

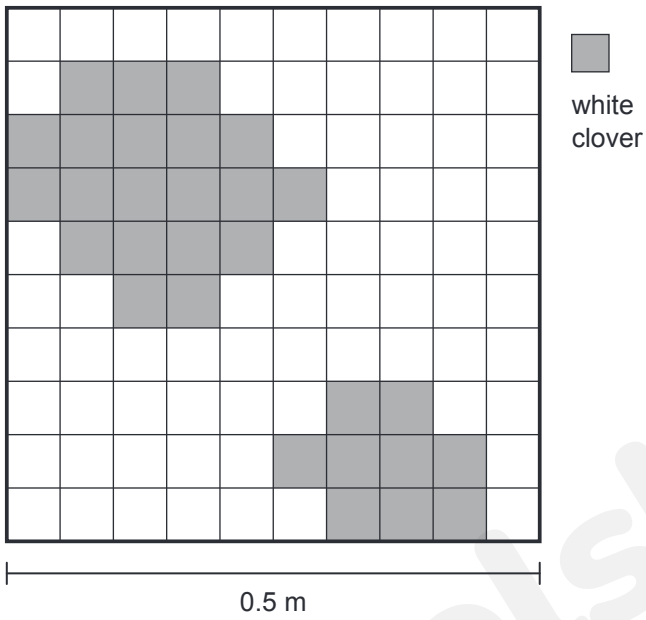

Image 4.1

(a) Estimate the percentage cover of white clover in **Image 4.1**. [1]

Percentage cover = ... %

(b) Describe how the students should place the quadrats so that the sample is random. [3]

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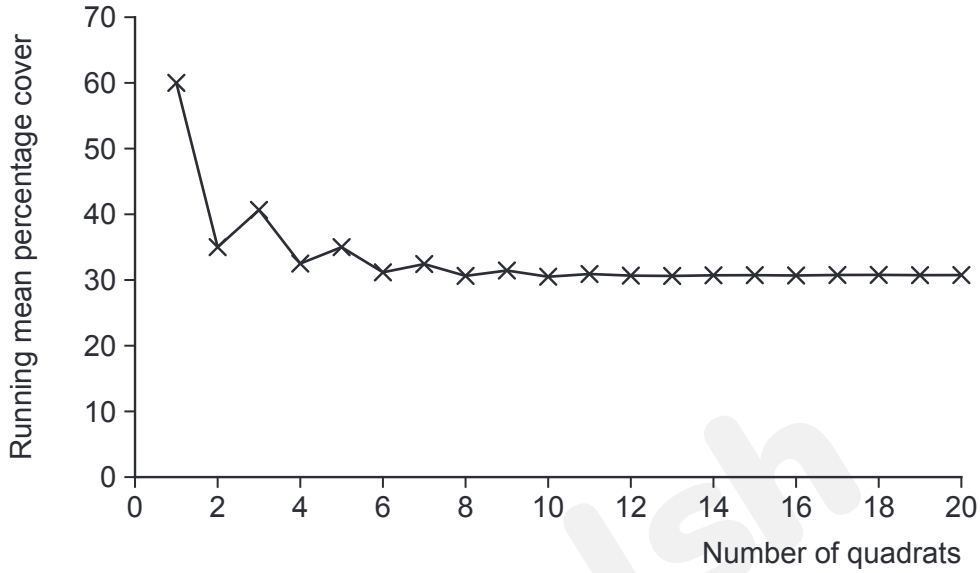
Tutor only

Graph 4.2 shows the running mean of the percentage cover as more quadrats were sampled in the mown part of the field.



Graph 4.2

(c) Use **Graph 4.2** to suggest the minimum number of quadrats that should be sampled. Explain your answer. [2]

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The students sampled 20 quadrats in a mown area and 20 in an unmown area. **Table 4.3** shows their results.

Table 4.3

Area	Mean percentage cover of white clover	Standard deviation
mown	31	6
unmown	9	5

(d) (i) Explain what the standard deviations suggest about the difference between the two areas. [2]

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Tutor only

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(ii) Suggest why there was more white clover in the mown area. [2]

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Tutor only

5. Students used an interrupted belt transect to study the plants from inside a woodland into a meadow. **Image 5.1** is a kite diagram of their results. **Table 5.2** shows the light intensity at each station.

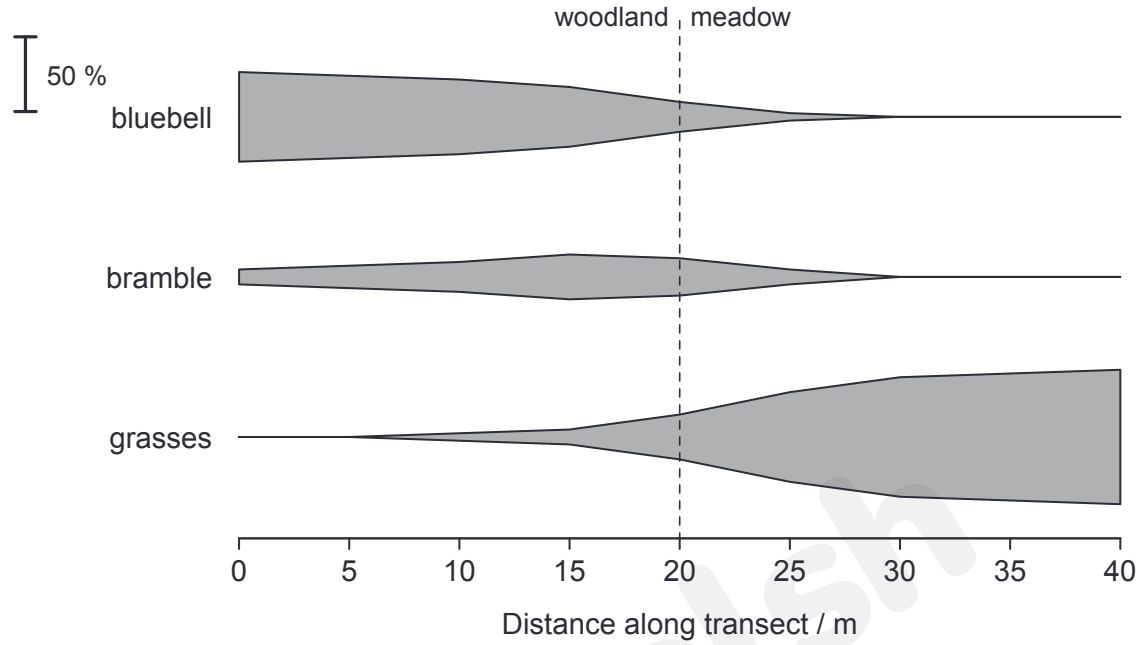

Image 5.1

Table 5.2

Distance / m	0	5	10	15	20	25	30	35	40
Light intensity / % of full daylight	8	10	14	25	45	75	95	100	100

(a) Explain why a transect was used rather than random sampling. [2]

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(b) Describe how an interrupted belt transect is carried out. [2]

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Tutor only

(c) Describe the distribution of bluebells in relation to light intensity. [2]

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(d) Suggest why bluebells are absent from the meadow, even though light intensity is high there. [2]

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(e) Using this study, explain the difference between a habitat and a community. [2]

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(f) The meadow will no longer be mown. Suggest what will happen to the vegetation in the meadow over the next 50 years and name the process. [2]

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12

Tutor only

6. A student estimated the population of a species of ground beetle in a hedgerow using pitfall traps, as shown in **Image 6.1**.

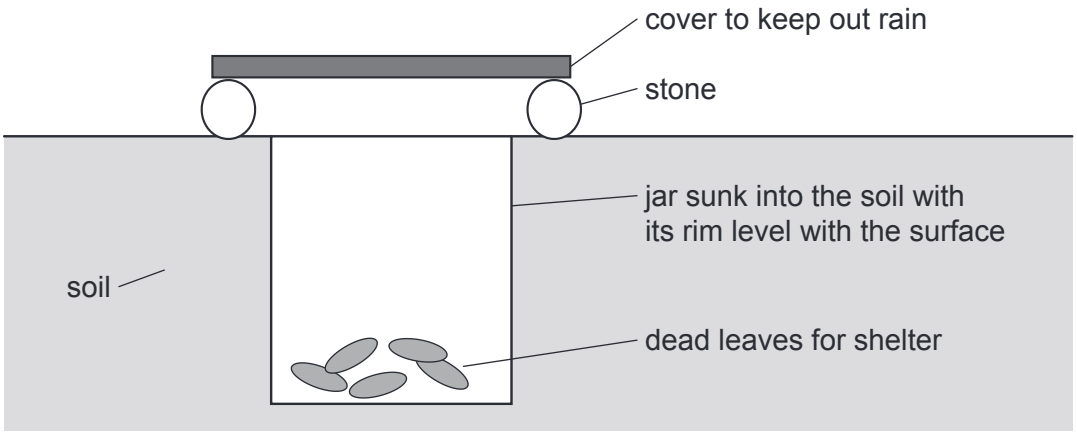

Image 6.1

On the first night, 48 beetles were caught. Each was marked with a small dot of non-toxic paint under its wing case and released. On the second night, 60 beetles were caught, of which 12 were marked.

(a) Calculate the estimated size of the beetle population. Show your working. [2]

Population = ...

(b) State **two** assumptions made when using this method. [2]

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(c) Explain why the paint was placed under the wing case rather than on top. [1]

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(d) Suggest why the traps contained dead leaves but no liquid. [1]

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Tutor only

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(e) A year later the estimate was 420. Suggest **two** reasons for the increase. [2]

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Tutor only

7. A rock pool on a Welsh shore contains many different organisms. **Image 7.1** shows a food web for one rock pool.

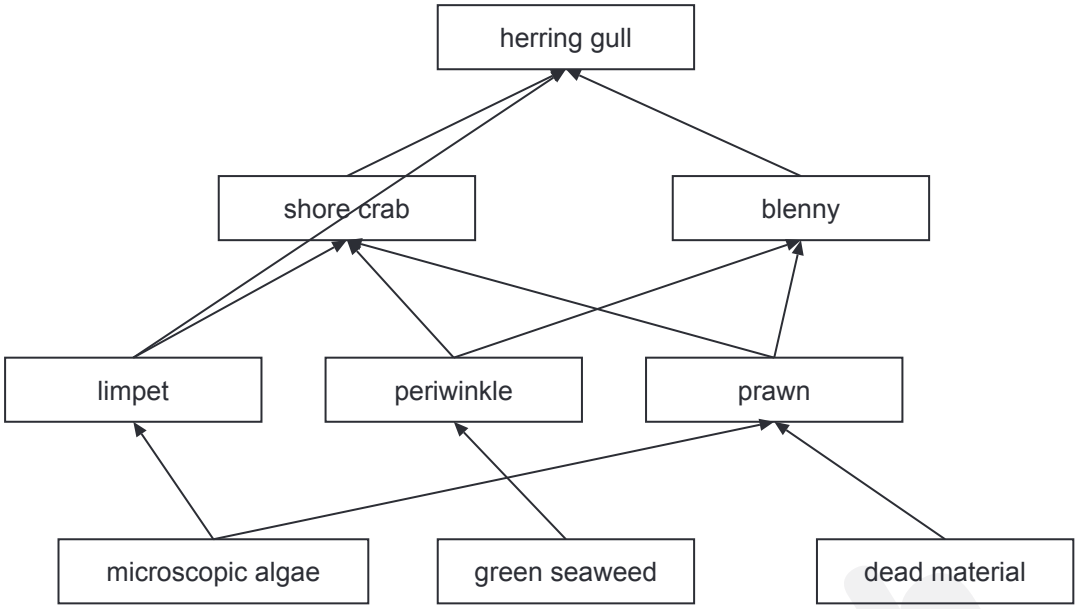

Image 7.1

(a) A rock pool can be described as an ecosystem. Explain what is meant by the term ecosystem. [2]

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(b) Ecosystems range in size. Give **one** example of an ecosystem much larger than a rock pool. [1]

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(c) State the original source of energy for this food web and explain how the energy enters it. [2]

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Tutor only

(d) Identify the organism that feeds at more than one trophic level and name the levels. [2]

Organism .....

Trophic levels .....

(e) Ecosystems around deep-sea hot vents receive no sunlight. Suggest how energy enters these ecosystems. [2]

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Tutor only

8. **Table 8.1** shows the energy flow through part of a salt marsh ecosystem.

Table 8.1

Energy flow	Energy / kJ m^{-2} $year^{-1}$
light energy reaching the producers	2 000 000
gross primary production (GPP)	30 000
respiration by producers	18 000
energy taken in by primary consumers	1 200
energy lost in faeces of primary consumers	190
respiration by primary consumers	850
energy taken in by secondary consumers	132

(a) Calculate the net primary production (NPP). [1]

NPP = ... kJ m^{-2} $year^{-1}$

(b) Explain the difference between gross primary production and net primary production. [2]

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(c) Calculate the percentage of the light energy reaching the producers that is converted into GPP. [1]

Percentage = ... %

Tutor only

(d) Calculate the efficiency of energy transfer from producers (NPP) to primary consumers. [2]

Efficiency = ... %

(e) Using **Table 8.1**, explain why only a small percentage of the energy taken in by primary consumers is passed to secondary consumers. [3]

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(f) Suggest why food chains rarely have more than five trophic levels. [2]

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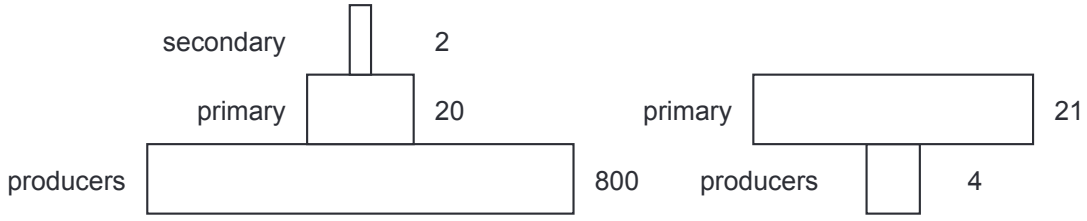
Tutor only

9. **Image 9.1** shows pyramids of biomass for two ecosystems. Pyramid **B** was measured in the English Channel in winter.



A grassland **B** English Channel

Values are dry biomass in g m^{-2}. The bars in **B** are drawn to scale; the bars in **A** are not.

Image 9.1

(a) Explain why the biomass is measured as dry mass. [1]

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(b) Calculate the biomass of primary consumers in pyramid **A** as a percentage of the biomass of producers. [1]

Percentage = ... %

(c) Explain how the small biomass of phytoplankton in pyramid **B** can support a larger biomass of zooplankton. [3]

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(d) Suggest how pyramid **B** might differ if it were measured in late spring. [1]

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Tutor only

(e) Explain why a pyramid of energy can never be inverted. [2]

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Tutor only

10. As glaciers retreat in Glacier Bay, Alaska, they expose bare rock. **Image 10.1** shows lichens, the first organisms to grow on this rock.

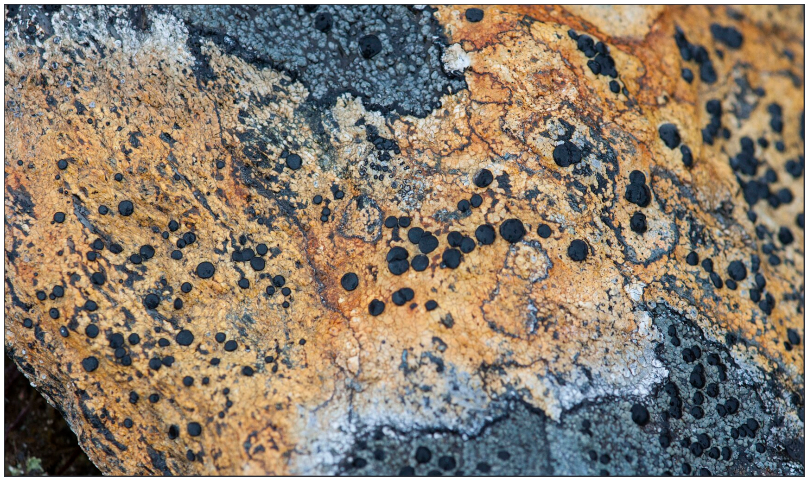

Image 10.1

Table 10.2 shows changes in the area over time. The values are based on published studies.

Table 10.2

Years since ice retreated	Mean soil depth / cm	Number of plant species	Main plants
0	0	4	lichens and mosses
20	1	14	mosses and small flowering plants
50	5	27	alder shrubs
100	12	36	spruce trees
200	25	28	spruce and hemlock forest

(a) Name the type of succession taking place and give a reason for your answer. [2]

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(b) Explain how lichens make it possible for other plants to grow. [3]

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Tutor only

(c) Describe the changes in soil depth and number of plant species shown in **Table 10.2**. [2]

(d) Suggest why the number of plant species falls between 100 and 200 years. [2]

(e) Explain the meaning of the terms sere and climax community. [2]

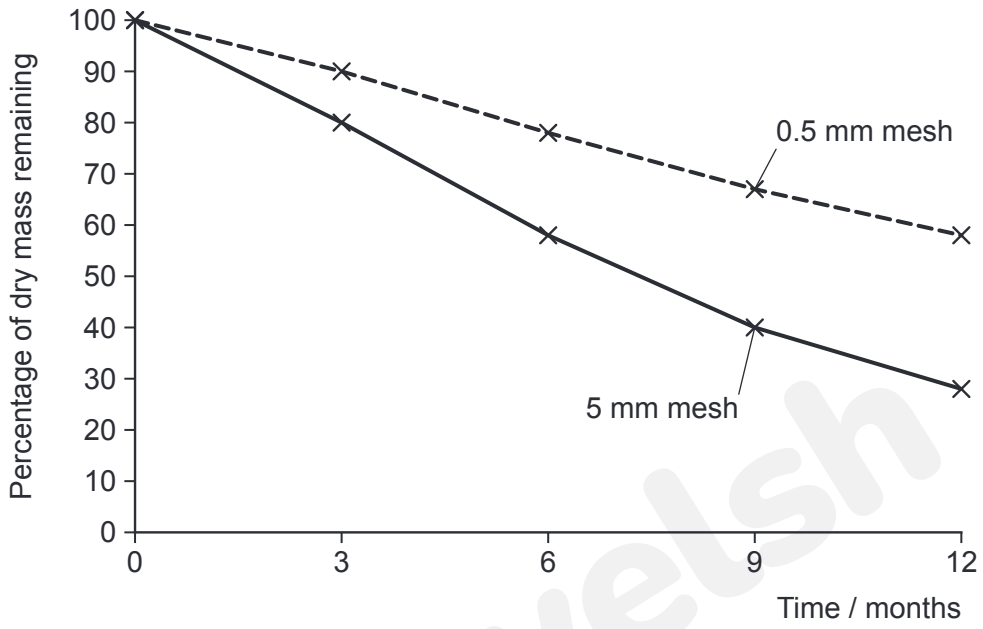
Sere

Climax community

11

Tutor only

11. Students buried mesh bags containing dried oak leaves in a woodland. Some bags had 5 mm mesh, which lets earthworms and other detritivores in. Others had 0.5 mm mesh, which lets only microorganisms in. Bags were removed every three months and the dry mass of the remaining leaves was measured. **Graph 11.1** shows the results.



Graph 11.1

(a) Calculate the mean rate of loss of dry mass from the 5 mm mesh bags during the first 6 months. [2]

Rate = ... % per month

(b) Explain the difference between the results for the two mesh sizes. [2]

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(c) Explain how decomposers break down the leaves and why this is important for the woodland. [3]

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Tutor only

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(d) Explain why the leaves were dried before they were weighed. [1]

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(e) Climate change is raising soil temperatures. Suggest how this could affect the concentration of carbon dioxide in the atmosphere. [2]

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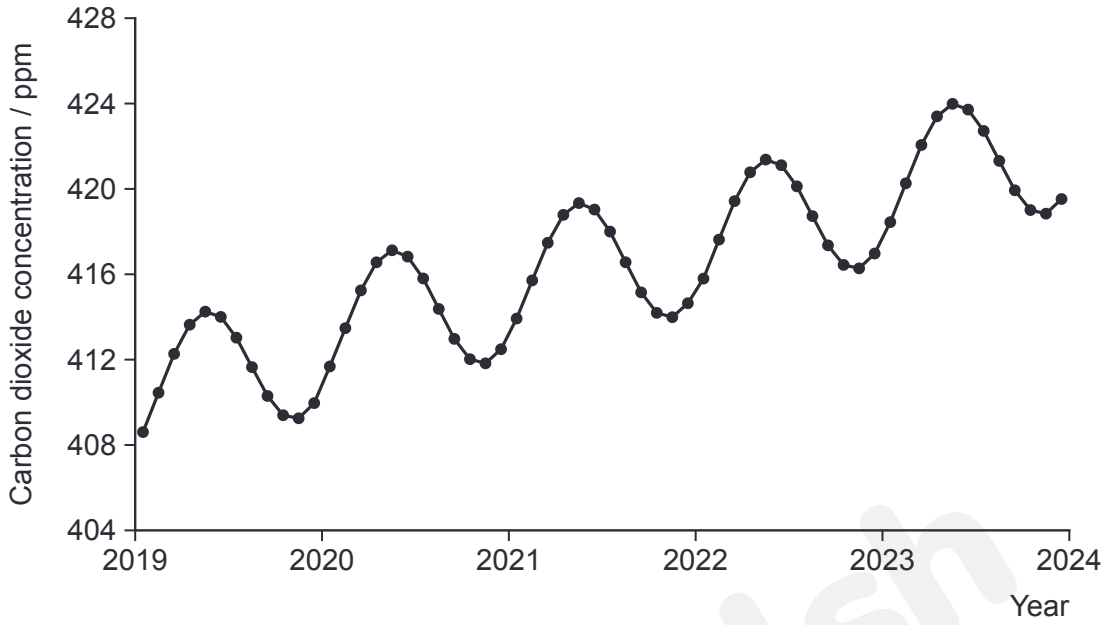
Tutor only

12. **Graph 12.1** shows the monthly mean concentration of carbon dioxide in the atmosphere at a monitoring station in the northern hemisphere from 2019 to 2023. It is a model based on published measurements. The annual mean concentration was 411.4 ppm in 2019 and 421.1 ppm in 2023.



Graph 12.1

(a) Calculate the mean increase in the annual mean carbon dioxide concentration per year between 2019 and 2023. [2]

Mean increase = ... ppm year^{-1}

(b) Explain why the concentration falls every year between May and October. [2]

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(c) Describe **two** human activities responsible for the long-term increase. [2]

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Tutor only

Table 12.2 shows the lowest altitude at which a mountain plant species was found on one mountain in different years.

Table 12.2

Year	1970	1990	2010	2020
Lowest altitude / m	550	600	660	690

(d) (i) Calculate the mean rate of change in the lowest altitude between 1970 and 2020, in metres per decade. [1]

Rate = ... m per decade

(ii) Explain how climate change could cause this change and why it could lead to the extinction of this species. [3]

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13. **Image 13.1** shows the roots of a soya bean plant. **N** is one of many swellings on the roots.

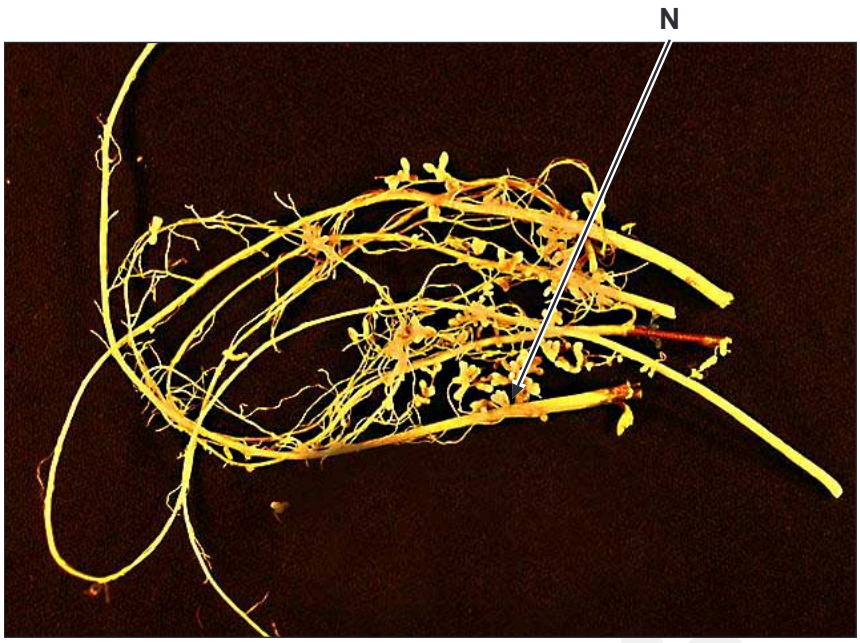

Image 13.1

Image 13.2 shows part of the nitrogen cycle. The numbers **1** to **5** show processes carried out by bacteria.

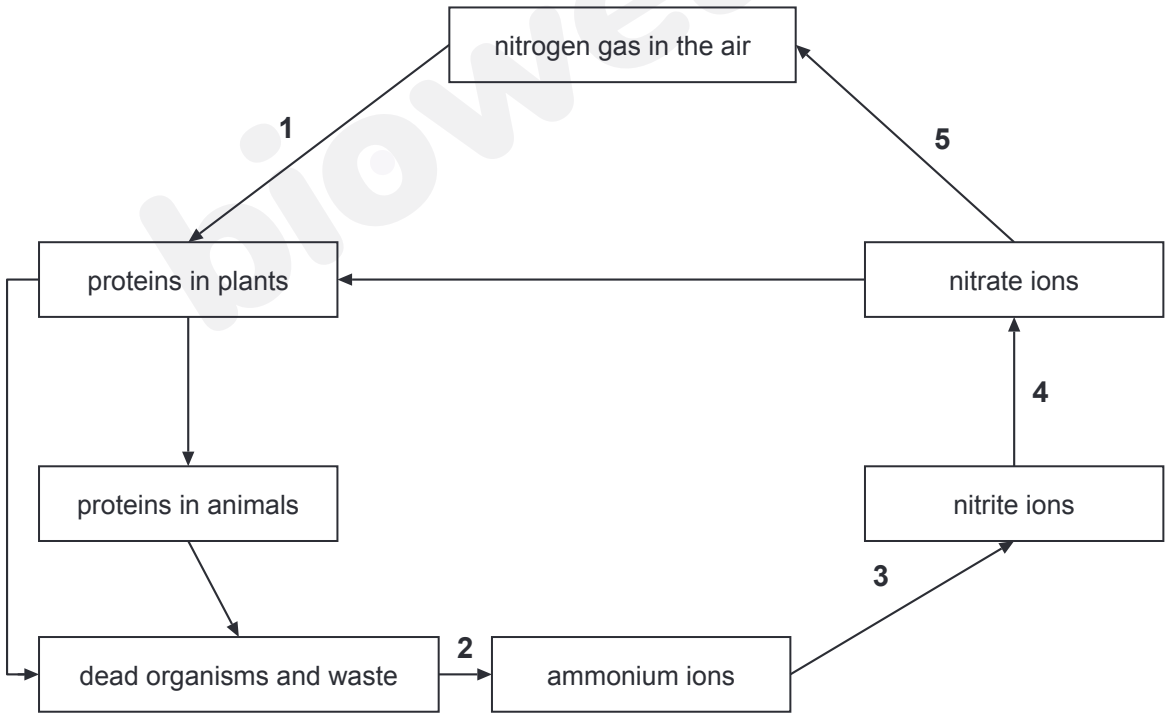

Image 13.2

Tutor only

(a) Name structure **N** and the genus of bacterium it contains. [2]

Structure .....

Bacterium .....

(b) Name processes **1**, **2** and **5**. [2]

1 .....

2 .....

5 .....

(c) Name the bacteria that carry out processes **3** and **4**. [1]

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(d) Explain why plants need nitrate ions. [2]

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(e) Explain how ploughing and draining fields increase the amount of nitrate in the soil. [3]

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Tutor only

14. Farmers add nitrogen fertiliser to increase crop yield. **Table 14.1** shows the yield of winter wheat and the nitrate lost by leaching from fields given different amounts of fertiliser.

Table 14.1

Fertiliser applied / kg N ha^{-1}	0	50	100	150	200	250
Yield of wheat / t ha^{-1}	4.0	6.0	7.5	8.3	8.6	8.7
Nitrate leached / kg N ha^{-1}	5	8	12	18	35	60

(a) Calculate the increase in yield for each extra kg of fertiliser between 0 and 50 kg N ha^{-1} and between 200 and 250 kg N ha^{-1}. [2]

0 to 50 .....

200 to 250 .....

(b) Wheat sells for £200 per tonne and fertiliser costs £1.20 per kg N. Use **Table 14.1** to suggest the most profitable amount of fertiliser to apply. Explain your answer. [2]

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(c) Explain why the amount of nitrate leached increases sharply at high rates of fertiliser application. [2]

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Tutor only

Image 14.2 shows a farm pond in summer.

Image 14.2

(d) Name the process that has caused the layer of algae shown in **Image 14.2** and suggest how fertiliser use in nearby fields contributed to it. [2]

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(e) Draining wet fields can increase the nitrate reaching ponds and rivers. Suggest **one** other adverse effect of drainage on wildlife. [1]

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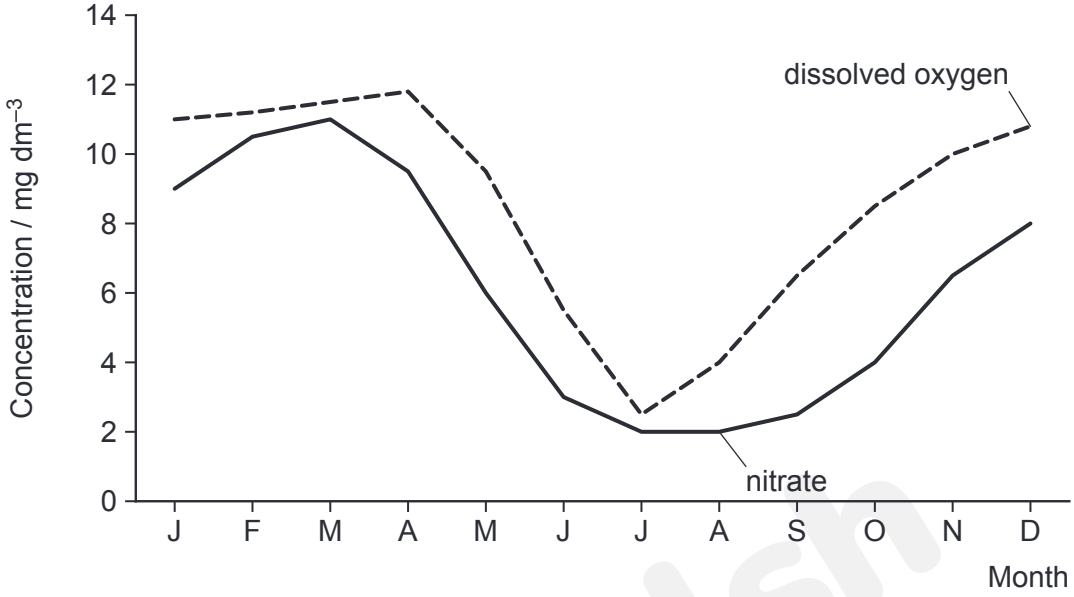
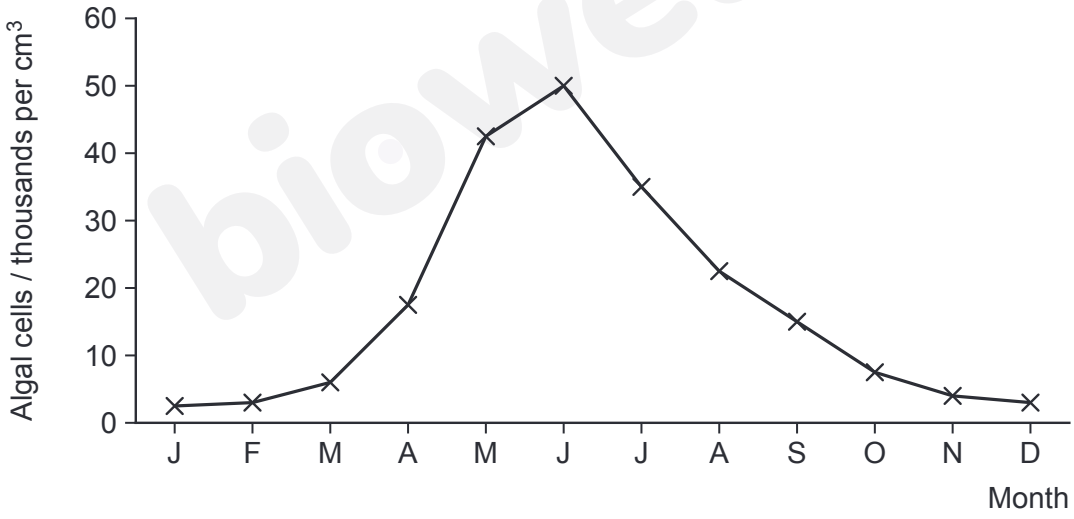
Tutor only

15. A lake lies in a catchment of arable farmland, much of which has been ploughed and drained. **Graph 15.1A** shows the concentrations of nitrate and dissolved oxygen in the lake during one year. **Graph 15.1B** shows the density of algae in the lake. Many fish died in July.



Graph 15.1A



Graph 15.1B

Explain how fertiliser use, ploughing and drainage in the catchment can increase the nitrate entering the lake. Describe and explain the sequence of events by which high nitrate concentrations lead to the death of fish. Use **Graphs 15.1A** and **15.1B** to describe and explain the changes in the lake during the year. [9 QER]

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Turn over.

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Tutor only

END OF WORKSHEET

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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-A2-3.5-W1** (MS).

Acknowledgements

Image 10.1: Photo: Bering Land Bridge National Preserve, CC BY 2.0 (Wikimedia Commons), https://creativecommons.org/licenses/by/2.0. Cropped and resized.

Image 13.1: Photo: soybean root nodules, public domain (Wikimedia Commons). Letter added.

Image 14.2: Photo: Eric Vance, United States Environmental Protection Agency, public domain (Wikimedia Commons).