Name	Date started	Target end date

GCE A LEVEL — BIOLOGY UNIT 3 QUESTION PACK

1074 (Legacy BY4) + 1075 (Legacy BY5) · New spec Unit 3 Topic 12 · A2 unit, first sat 2017, 90 marks, 2h paper

REVISE
.wales

BIOLOGY — UNIT 3 · POPULATION SIZE & COMMUNITY DYNAMICS

3.7 Population size and ecosystems — growth curves, carrying capacity, predator-prey and succession

Population growth curves (lag, log, stationary, death), abiotic and biotic limiting factors, carrying capacity, intra- and interspecific competition, the Lotka-Volterra predator-prey relationship, and the stages of ecological succession from pioneer species to a climax community.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~1 h 6 min

Derived from the legacy BY4 / BY5 papers' pace of ~1.3 min/mark, padded for long-prose answers (41 marks over 4 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY4 (and BY5, where relevant) papers (2008 modular spec, 2011–2017) that maps onto new-spec A2 Unit 3 Topic 12 (3.7).

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

For Examiner's use only

Q	Source	Max	Mark
1	BY4 Jun 13 Q2	7	
2	BY4 Jan 13 Q3	10	
3	BY5 Jun 12 Q8	8	
4	BY5 Jun 13 Q2	16	
Total		**41**	

Population Size & Community Dynamics — what the new spec asks

WJEC GCE A Level Biology (from 2015) · Unit 3: Energy, Homeostasis & the Environment · Topic 3.7.

Population growth curve

- Lag phase — small numbers, slow growth.
- Exponential phase — rapid growth, resources unlimited.
- Stationary phase — growth rate matches death rate at carrying capacity (K).

Limiting factors

- Density-dependent: food, disease, competition, predation.
- Density-independent: temperature, drought, fire.
- Carrying capacity (K) = maximum sustainable population.

Competition

- Intraspecific: within a species — strongest at high density.
- Interspecific: between species — can drive competitive exclusion.
- Gause: two species with identical niches cannot coexist.

Predator-prey

- Predator numbers lag behind prey numbers (Lotka-Volterra).
- Cyclic oscillations — lynx / snowshoe hare classic example.
- Reductions in predator allow prey to recover (and vice versa).

Succession

- Primary: starts on bare rock; pioneers (lichens, mosses).
- Secondary: starts on disturbed but soil-rich land (e.g. after fire).
- Each seral stage modifies the environment for the next; ends in climax community.

Conservation case studies

- Red kite reintroduction in Wales — numbers recovered with legal protection.
- Grand Banks cod collapse — overfishing crashed reproductive population.
- Heather moorland succession — management with burning resets pioneer stages.

Crib sheet »

Population Size & Community Dynamics in one page

Quick-reference notes — revisit before each question.

Growth phases

Lag — small numbers, slow.

Exponential — doubling, resources unlimited.

Stationary — at carrying capacity (K).

Death — conditions deteriorate.

Carrying capacity

Maximum sustainable population.

Set by abiotic + biotic factors.

Can shift if conditions change.

Density-dependent

Stronger as population grows.

Examples: food, disease, predation, competition.

Density-independent

Same effect regardless of density.

Examples: temperature, drought, fire, flood.

Competition

Intraspecific: same species — strongest near K.

Interspecific: between species — can drive exclusion.

Gause's principle: no two species share an identical niche.

Predator-prey

Predator lags prey numbers.

Cyclic oscillations (lynx-hare classic).

Removing predator ⇒ prey rises then crashes.

Succession

Primary: from bare rock.

Secondary: from disturbed soil.

Pioneers → seral stages → climax community.

Conservation case studies

Red kite: legal protection ⇒ recovery in Wales.

Grand Banks cod: overfishing ⇒ collapse.

Heather: succession managed by controlled burning.

Examiner only

1. *(a)* State the general role of muscles and glands in simple reflexes. [1]

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(b) The phylum Cnidaria includes animals with a relatively simple body plan such as sea anemones, jellyfish and hydra. They respond to stimuli but these responses are slower than in humans. Suggest a reason for the slower speed of response. [1]

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(c) Name the substance that plants use to detect day and night length. [1]

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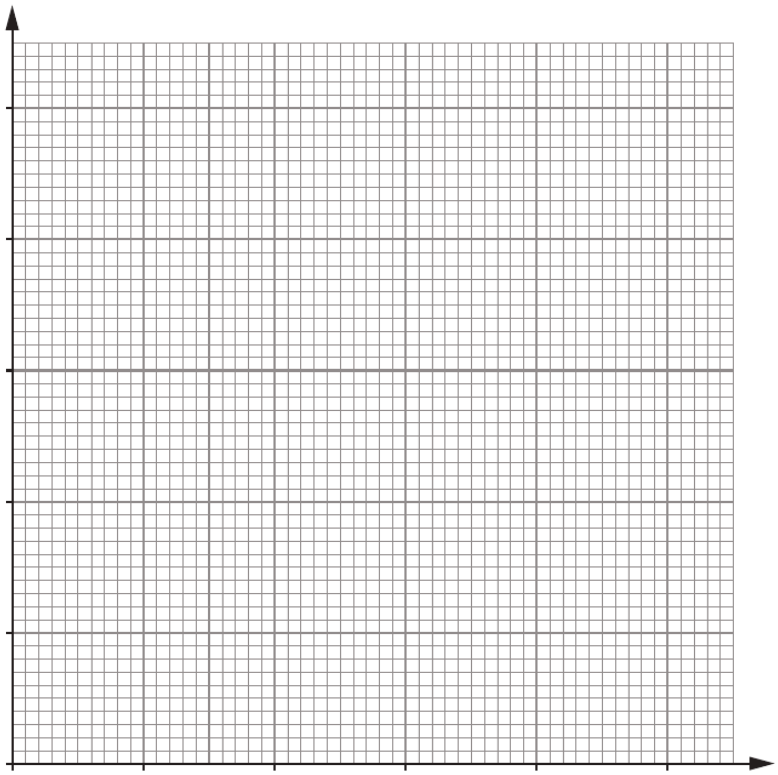
2. The red kite *(Milvus milvus)* was at one time a common bird of prey in Britain, but by the end of the 19th century it had been driven almost to extinction and just three pairs survived in mid-Wales. As a result of conservation efforts, numbers rose during the 20th century. The table below shows numbers of breeding pairs for years when accurate counts or estimates are available.

Year	Number of breeding pairs
1933	4
1962	15
1976	34
1986	48
1995	100
2009	1000

Examiner only

(a) Use the data opposite to draw a graph to show the increase in the number of breeding pairs of red kites in Wales between 1933 and 2009. [3]



(b) Assuming no net migration, state with a reason whether it was the **birth rate** or the **death rate** which was greater between 1976 and 1986. [1]

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(c) (i) Suggest **two** density dependent factors, which might prevent numbers of red kite continuing to rise. [2]

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(ii) Suggest **one** density independent factor that might cause the population of red kite in Wales to crash in the future. [1]

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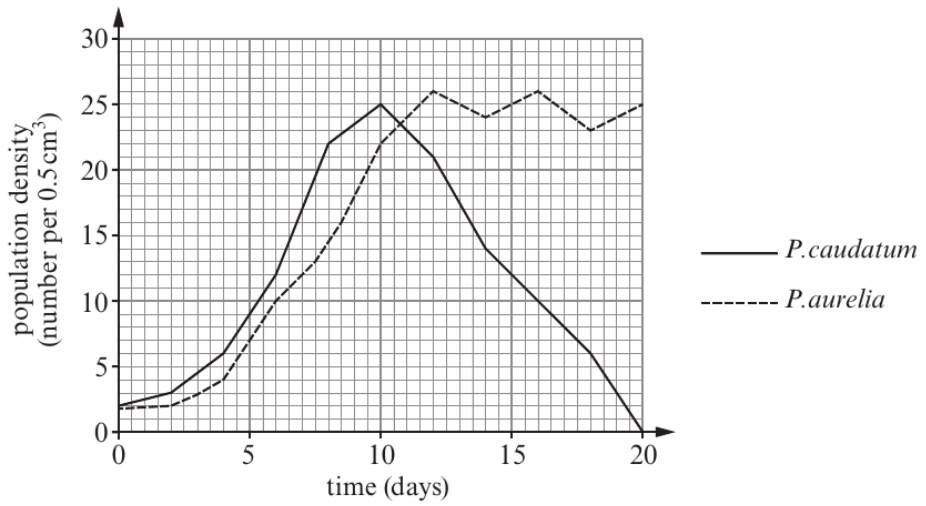
Examiner only

3. In the 1930s G.F.Gause investigated the population dynamics of different species of a protoctistan of the genus *Paramecium*. These single-celled organisms live in ponds and feed mainly on yeast. Two species, *P.aurelia* and *P.caudatum* swim freely and feed in all parts of a pond while another species, *P.bursaria* feeds mostly at the bottom of the habitat.

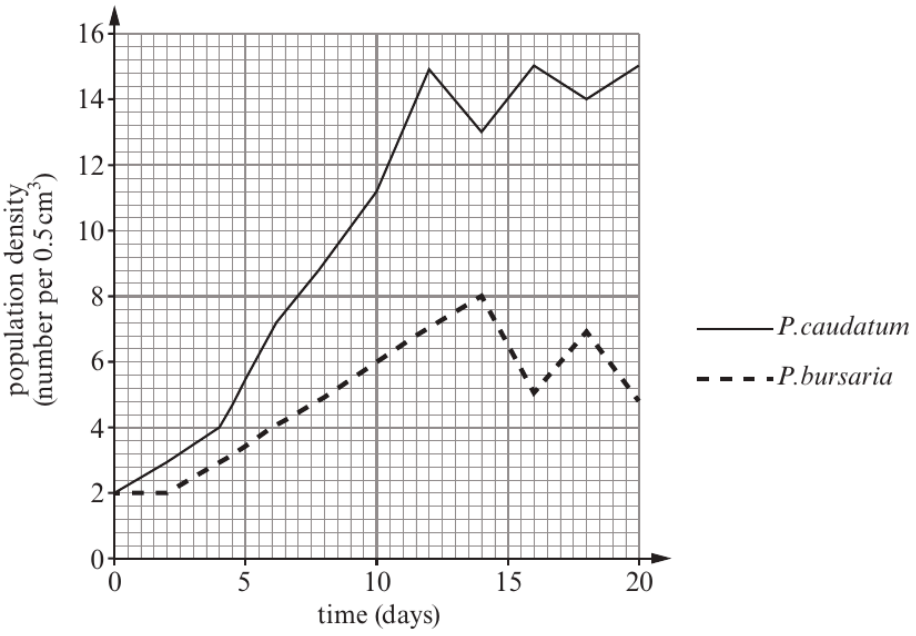
In a series of experiments Gause grew different species of *Paramecium* together in the same container, under the same conditions, to investigate interspecific competition.

The graphs below show results from two of his experiments.

Graph 1 shows the change in population densities of *P.caudatum* and *P.aurelia* when grown together.



Graph 2 shows the change in population densities of *P.caudatum* and *P.bursaria* when grown together.



Examiner only

(a) (i) Explain what is meant by the term **carrying capacity**. [2]

(ii) From **Graph 1** opposite estimate the carrying capacity for *P.aurelia* in this experiment. [1]

(iii) Describe **TWO** density dependent factors and **ONE** density independent factor that could have prevented the population of *P.aurelia* from exceeding its carrying capacity.

I. Density Dependent [2]

II. Density Independent [1]

(b) (i) Explain how interspecific competition caused the decrease in the population of *P.caudatum* shown in **Graph 1**. [2]

(ii) Suggest why *P.caudatum* and *P.bursaria* could co-exist when grown in the same container but *P.caudatum* became extinct when grown with *P.aurelia*. [2]

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Examiner only

8. *(a)* Explain what is meant by the following terms:

(i) Succession [2]

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(ii) A climax community. [1]

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(b) Heather plants are small shrubs and are the dominant species in the climax community of some moorlands. The structure and shape of the heather plant changes as it ages. This results in changes in the species composition of the community. A large area of moorland was burnt leaving bare ground. The table shows four stages of succession in this area.

Time after burning/ years	Appearance of heather plant	Mean percentage cover of heather	Other plant species present
4		10	Many
12		90	Few
19		75	Several
24		30	Many

Examiner only

Explain why the number of other plant species decreases between 4 and 12 years after burning. [2]

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(c) The rate at which a heather plant produced new biomass was measured in g per kg of heather per year. As the plant aged the ratio of leaves to woody parts decreased. Use the information in the table to explain why. [3]

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(Total 8 marks)

Examiner only

2. The Grand Banks is an area of sea off the coast of Newfoundland in Canada. It was once one of the most productive fishing grounds in the world for Atlantic cod.

The cod was fished heavily for about 50 years.

About 60% of the total cod population of reproductive age was harvested annually.

Cod fishing in the Grand Banks was closed in 1992 but by then the population was less than 1% of what it had been.

Cod grow evenly throughout their life.

The cod that remained when fishing was finally closed were much smaller and grew more slowly than the cod that lived in the Grand Banks several decades previously.

Graph to show the median age of cod at sexual maturity in the same location during the time of heaviest fishing.

Examiner only

(a) (i) Use the information provided opposite and your own knowledge of natural selection to describe and explain how the phenotype of the cod has changed since 1960. [5]

(ii) The cod fisheries have been closed for nearly 20 years but there has been little change in the phenotype and no population recovery. Suggest why there has been little change in the phenotype and no population recovery. [3]

Examiner only

(b) Other than restricting the mesh size of nets, give **two** other methods which are used to prevent overfishing. [2]

(c) (i) One solution to overfishing is aquaculture or fish farming.
Give **two** problems associated with producing fish in this way. [2]

(ii) Wild trout are diploid **(2n)**. Some trout used in fish farming are triploid **(3n)**.
Suggest why triploid trout are infertile. [4]

END OF QUESTION PACK

4 questions · 41 marks · ~1 h 6 min
Source: WJEC BY4 + BY5 (2008 modular spec, 2011–2017)
Curated for WJEC Biology 2015 spec A2 Unit 3 — Topic 12 (3.7)