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 8 · A2 unit, first sat 2017, 90 marks, 2h paper

REVISE
.wales

BIOLOGY — UNIT 3 · MICROBIOLOGY — DISEASE & BIOLOGICAL CONTROL

3.4 Microbiology — microbial disease and biological control

Selected bacterial diseases and their control: Vibrio cholerae (cholera) and Mycobacterium leprae (leprosy) including modes of transmission, antibiotic action and the public-health response; plus biological control using Bacillus thuringiensis (Bt) as an alternative to chemical insecticides.

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~56 min

Derived from the legacy BY4 / BY5 papers' pace of ~1.3 min/mark, padded for long-prose answers (35 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 8 (3.4).

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 11 Q4	14	
2	BY4 Jun 16 Q4	8	
3	BY4 Jun 16 Q5	6	
4	BY4 Jun 17 Q3	7	
Total		**35**	

Microbiology — Disease & Biological Control — what the new spec asks

WJEC GCE A Level Biology (from 2015) · Unit 3: Energy, Homeostasis & the Environment · Topic 3.4.

Vibrio cholerae

- Faecal-oral transmission; contaminated water in outbreaks.
- Cholera toxin opens Cl^- channels in intestinal epithelium.
- Massive water loss into gut → severe diarrhoea, dehydration.

Mycobacterium leprae

- Gram-positive, intracellular, aerobic bacillus.
- Slow-growing; affects skin, nerves & mucosa.
- Multidrug therapy (rifampicin + dapsone ± clofazimine).

Antibiotic action

- Penicillins: inhibit peptidoglycan cross-linking (Gram-positive).
- Tetracyclines: block bacterial ribosomes (broad spectrum).
- Resistance arises by mutation + selection of resistant alleles.

Biological control — Bt

- *Bacillus thuringiensis* produces toxic crystal proteins.
- Toxins paralyse the gut of susceptible caterpillars on ingestion.
- Selective for target insects; persists on foliage < 1 week.

Crib sheet »

Microbiology — Disease & Biological Control in one page

Quick-reference notes — revisit before each question.

Cholera

Vibrio cholerae — faecal-oral, contaminated water.

Cholera toxin opens Cl^- channels.

Water lost into gut ⇒ severe diarrhoea, dehydration.

Leprosy

Mycobacterium leprae — Gram-positive, intracellular.

Slow-growing aerobic bacillus.

Multidrug therapy: rifampicin + dapsone (± clofazimine).

Antibiotics

Penicillin blocks peptidoglycan cross-linking (Gram+).

Tetracyclines block 30S ribosome (broad).

Resistance: mutation + selection.

Biological control

Living predator / parasite / pathogen vs pest.

Pros: selective, low resistance, no chemical residues.

Cons: slow, may itself become invasive.

Bt

Bacillus thuringiensis — crystal proteins (Cry toxins).

Toxin paralyses caterpillar gut on ingestion.

Selective; persists < 1 week on foliage.

Bt vs chemical

Cheaper insecticides cost less in short term.

Bt + IPM reduces long-term pest control cost.

Avoids harm to pollinators & non-target insects.

Examiner only

4. Following the Haiti earthquake in 2010 there was an outbreak of cholera. A web site describes the cause as follows:

'**Cholera** is caused by the bacterium *Vibrio cholerae* – a curved bacillus each with one flagellum. The genus *Vibrio* is a member of the family Vibrionaceae, which include Gram-negative, motile, facultative anaerobes that utilize glucose as a source of energy.
The bacteria are typically spread by contaminated drinking water.'

(a) Describe what is meant by the following terms used in the article:

(i) Bacillus, [1]

.....

(ii) Gram-negative, [2]

.....

.....

(iii) Facultative anaerobes. [2]

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(b) Scientists might be able to determine the extent of contamination by counting the number of bacterial cells in water samples.

(i) What is the difference between a total count and a viable count? [1]

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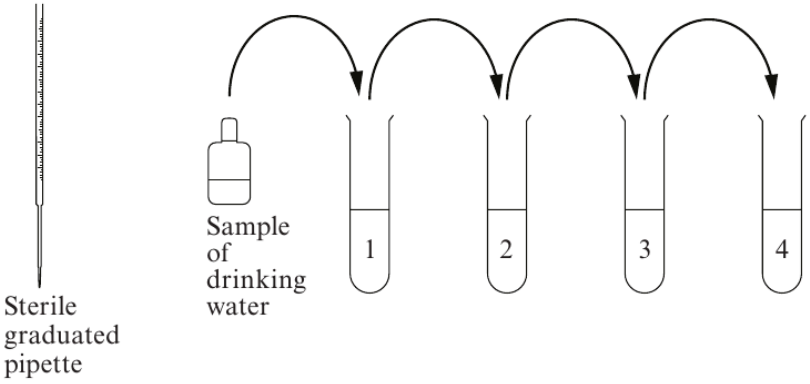
(ii) Both techniques involve serial dilution.
Annotate the diagram below to explain how you would obtain a series of ten fold dilutions of the drinking water sample. [3]



Examiner only

(iii) If 1 cm^3 of the drinking water sample contained 80 000 living bacterial cells, how many bacterial cells would there be in 0.5 cm^3 of the liquid in tube 4, after this technique had been completed? [1]

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(iv) How would you use the dilutions produced to carry out a viable count? [4]

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(Total 14 marks)

Examiner only

4. *Mycobacterium leprae* is a gram positive, intracellular, aerobic bacillus that causes leprosy (Hansen's disease) and has never been successfully cultured on an artificial cell culture medium. The main reason for this appears to be that it is an obligate parasite that lacks many of the genes necessary for independent survival.

One form of *M. leprae* invades and multiplies in Schwann cells. Loss of sensation develops as a result of invasion of the peripheral sensory nerves.

Use the text above to answer the following questions.

(a) How would these bacteria appear under the light microscope following Grams staining? [2]

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(b) Explain what is meant by the description *'intracellular aerobic'*. [2]

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(c) Explain why *M. leprae* is an *'obligate parasite'*. [1]

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(d) Suggest why there is a loss of sensation in the extremities in cases of leprosy. [3]

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8

Examiner only

5. Leaf feeding caterpillars may be controlled by *Bacillus thuringiensis* (Bt), a naturally occurring pathogen of insects.

- Bt acts by producing toxic proteins that react with the cells of the gut lining of susceptible insects. These toxic proteins paralyse the digestive system and the infected insect stops feeding within hours.
- Bt must be eaten to be effective and application coverage of the leaves must be thorough.
- If Bt is ingested by other species it is digested without producing toxic proteins.
- Bt persists on foliage for less than a week following application.

Use the text above to answer the following questions.

(a) (i) What type of insect control is described? [1]

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(ii) Explain the advantage of using Bt as described above. [2]

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(iii) Explain **two** disadvantages of using Bt as described above. [2]

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(b) The plum sawfly lays its egg in the embryonic plum fruit at flowering time and its larvae burrow through the young fruit as it develops. Suggest why Bt would be ineffective in this case. [1]

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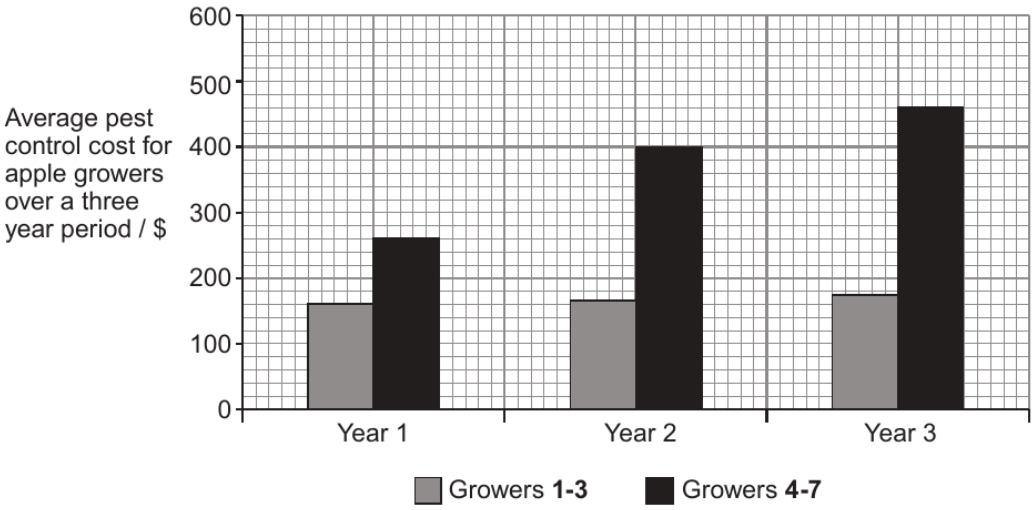
Examiner only

3. *(a)* State **one** advantage and **one** disadvantage of biological control. [2]

Research was carried out which analysed the cost of insecticide use by seven apple growers over three years. On average, nine different insecticides were applied by each grower.

The results of this research are shown below.



Growers **1-3** had moved away from organophosphate insecticides and used a combination of biological control and low risk alternatives to organophosphates. Growers **4-7** continued to use organophosphates.

(b) What advice would you give to growers **4-7**? Explain your answer. [3]

Examiner only

(c) Explain the health implications of using organophosphate insecticides. [2]

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END OF QUESTION PACK

4 questions · 35 marks · ~56 min
Source: WJEC BY4 + BY5 (2008 modular spec, 2011–2017)
Curated for WJEC Biology 2015 spec A2 Unit 3 — Topic 8 (3.4)