Bio Factsheet

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Why Students Lose Marks I: Ecology

This Factsheet analyses students' real answers to exam questions. Some of the students received an A grade, some received an E. We'll look at how these two groups tackled the ecology question. By the end of this Factsheet, you should be more confident about:

- What the examiners want
- The kinds of things you are likely to be asked
- Common mistakes and misunderstandings

Table 1 lists the most common AS/A2 exam questions on ecology. A ✓ indicates the topic is on a particular specification.
This Factsheet will look at students' answers on food chains, nitrogen cycle and eutrophication, since they are on every specification.

Table 1. Common AS/A2 exam questions

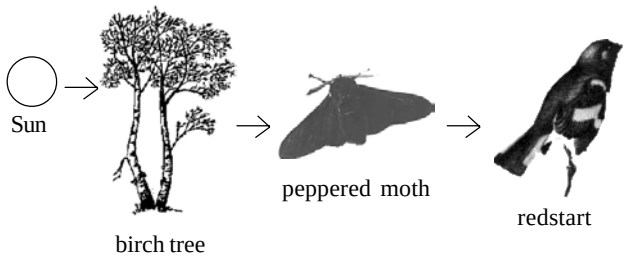
	AQA A	AQA B	CCEA	Edexcel	OCR	WJEC
Food chains/webs	✓	✓	✓	✓	✓	✓
Carbon cycle	✓	✓	✓	✓		✓
Nitrogen cycle	✓	✓	✓	✓	✓	✓
Eutrophication	✓	✓	✓	✓	✓	✓
Predator-prey graphs		✓	✓	✓	✓	
Ecosystem etc definitions	✓	✓	✓	✓	✓	✓
Acid rain		✓*	✓	✓	✓*	

* = option module only

Food chains and webs

The examiners want you to understand the fundamental principle that energy from the sun, captured by green plants in photosynthesis, is then available – in chemical form – to herbivores and thus to carnivores.

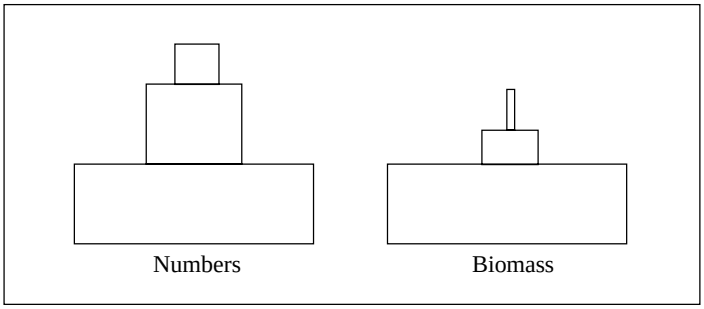
Fig 1. Food chain



Typical exam questions want you to know that:

- The arrows show the transfer of energy
- Energy is lost at each stage because: organisms respire and therefore lose energy as heat; the peppered moth doesn't eat all of the birch tree; the peppered moth can't digest all of the birch leaves it does eat – energy is lost in the egested material
- As a consequence of these preceding points, both the numbers and biomass of organisms usually decrease as you move along a food chain. Fig 2 illustrates pyramids of numbers and biomass.

Fig 2. Ecological pyramids



Common mistakes

As you read the students' answers to the questions, imagine that you are the examiner and mark the answers. Do this first without looking at the markscheme. Then read the markscheme and mark it again.

Explain the shape of the pyramid of numbers

The biomass decreases at each level. Biomass is lost at each level because of respiration and heat.

..... [3]

Markscheme

There is less energy available at each (trophic) level;
Respiration;
Not all preceding organism eaten;
Not all food digested/ref to faeces/egestion;

- The student gained one of the three marks.
- Their first sentence describes but doesn't explain.
- The first part of their second sentence almost repeats the first.
- "Biomass is lost at each level" doesn't gain credit because the examiners want a reference to energy.
- The student gained one mark by mentioning respiration.
- Reference to heat doesn't get a mark – energy is lost as heat during respiration, so this is the same marking point.

Nitrogen cycle

Different specifications require different levels of knowledge (Table 2)

Table 2. Specification content

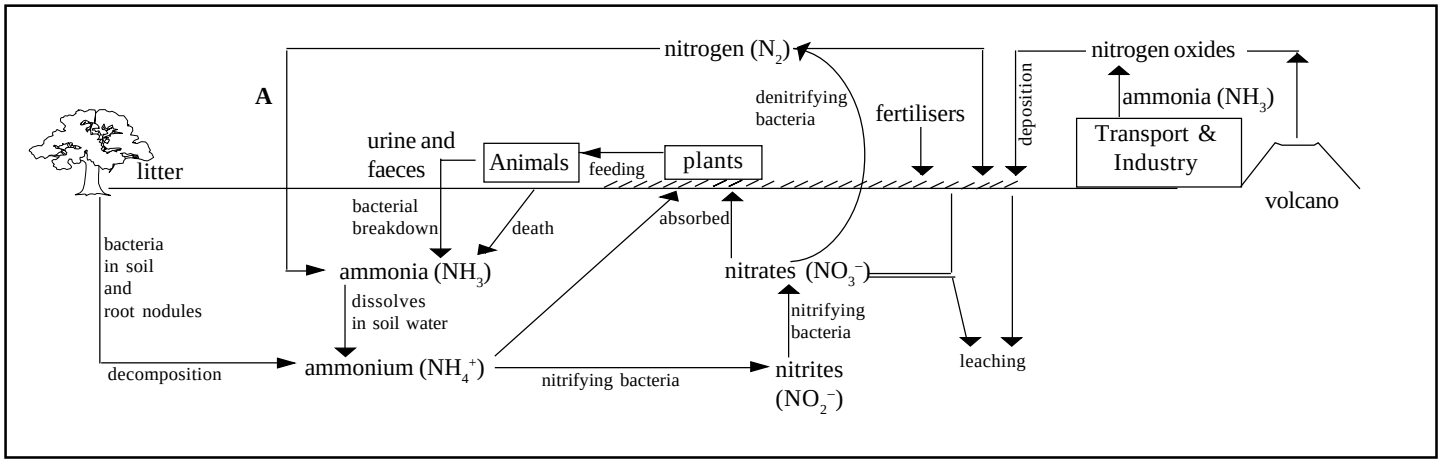
	AQA A	AQA B	CCEA	Edexcel	OCR	WJEC
Know names of bacteria			✓	✓	✓	
understand : fixation	✓	✓	✓	✓	✓	✓
nitrification	✓	✓	✓	✓	✓	✓
denitrification	✓	✓	✓	✓	✓	✓

Typical exam questions expect you to be able to label a diagram of the nitrogen cycle and explain each of the stages. The fundamental principle is that all living organisms need nitrogen (proteins, DNA etc) but only certain species of bacteria can use the nitrogen gas in the atmosphere. Gaseous N_2 makes up 78% of the atmosphere. Every day, huge amounts of N_2 gas are added to the atmosphere because of denitrification (conversion of NO_3^- or NH_4^+ into N_2) .To balance this, nitrogen-fixing bacteria such as *Rhizobium* take gaseous N_2 and convert it to NH_3 (ammonia gas). The ammonia gas then dissolves in water to form ammonium ions which can form ammonium compounds. A third process, nitrification, converts ammonium ions (NH_4^+) into nitrite ions (NO_2^-) and then nitrate ions (NO_3^-).

Common mistakes

The diagram shows the nitrogen cycle.

Fig 3. The Nitrogen cycle



Is this an A, C or E candidate?

Comment on the significance of:
(i) Stage A

Too vague!

No. Bacteria fix nitrogen

Legumes fix nitrogen. *Plants need nitrogen for growth*

Get the spelling right!

Legumes contain bacteria ✓ – *Rhizonium* – *which fixes nitrogen.*

Without these bacteria the plant could not get nitrogen and would die. ✓

..... [4]

Most nitrogen fixing bacteria live freely in the soil, not in legumes. Legumes attract bacteria to them by secreting a substance into the soil. When the bacteria enter the root a nodule forms around them.

Correct, but the question asked about the **significance** of the process. It's significant for more than just plants – animals rely on nitrogen-fixing bacteria too.

Here's the markscheme:

Nitrogen in atmosphere is unavailable to higher organisms;
Nitrogen fixers/nitrogen-fixing bacteria convert N_2 into NH_3;
NH_3 then converted into ammonium compounds/nitrates;
Makes nitrogen available to plants;
Nitrogen then available to herbivores and then carnivores;

The examiner gave the student marking point 3 (MP3) for their reference to "bacteria…fixes nitrogen" and MP5 for their reference to "without these… the plant could not get nitrogen". So 2 out of 4 – this is the C candidate.

From this, you can see that markschemes are good things to revise from. You can get a catalogue to buy markschemes for your board online, or by post. The web addresses are given at the end of the Factsheet.

Eutrophication

The examiners expect you to know that nitrates are very soluble and will therefore readily leach/ be washed into rivers, ponds and reservoirs. Phosphates are much less soluble and are more likely to be blown (i.e. erode) into water courses. Once there, NO_3^- and PO_4^{3-} will act as fertilisers, promoting rapid growth of algae/phytoplankton. These phytoplankton have a short life, many die and are then broken down by bacteria.

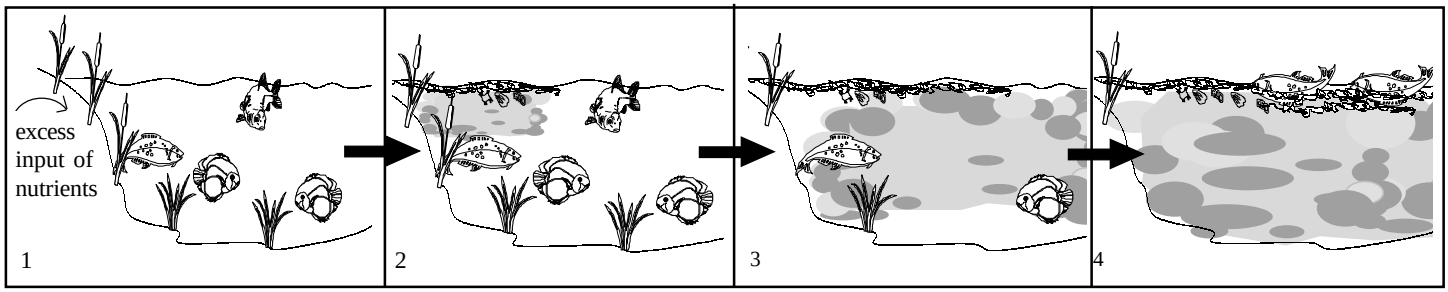
In doing this breakdown, the bacteria use up a lot of oxygen from the water. In other words, there is a high biological oxygen demand (BOD). Other aerobes – such as fish – may then die as a result of a lack of oxygen. In addition, the phytoplankton may cover the water surface (algal bloom) stopping light getting to the plants that grow below the water surface. These plants die and they too are broken down by aerobic bacteria.

If plants that are growing on the sides of the river/pond/reservoir die, their roots will no longer hold soil in place. The soil will crumble into the water, increasing its turbidity (murkiness), reducing light levels further. The addition of excess NO_3^- and PO_4^{3-} ions to water is **eutrophication**. The algal blooms, increasing turbidity and decreasing O_2 are the consequences of eutrophication.

Common mistakes

The diagrams show the consequences of excess fertiliser application near a natural pond (Fig 4)

Fig 4. Excess fertiliser application



Is this an A, C or E student?

Outline the process that has occurred in this pond

MP1 ✓ *The fertiliser has got into the pond and caused an algal bloom.* ✓ MP2

This bloom has used all the oxygen in the pond. ✗

No. Phytoplankton are plants. They photosynthesise. They produce O_2!

The fish and plants that need oxygen have died.

why?

..... [6]

Here's the markscheme

Fertiliser/nitrates/phosphates have entered pond/reference to eutrophication;
Stimulated algal bloom/growth of phytoplankton;
Phytoplankton has high turnover rate/reference to many phytoplankton/algae dying;
Broken down/decomposed by aerobic/oxygen-consuming bacteria;
Created high BOD/oxygen levels have fallen;
Aerobes/fish/plants/macrophytes die because they cannot respire;
Dead/sinking phytoplankton/soil increase water turbidity/reduce light penetration;
Max 6

The student has 2 out of 6 – this is the E candidate. Apart from the weak Biology, this is a good example of poor exam technique. The student has produced three sentences containing four points. The question is out of six, so to be sure of getting all the marks, the student should be looking to make seven or eight clear, different points.

Web References:

www.aqa.org.uk
www.edexcel.org.uk
www.ocr.org.uk
www.wjec.co.uk
www.ccea.org.uk

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