

Exercise walk-through

20.3.1

Sewage, fertiliser, plastics and the greenhouse gases

IGCSE Biology

You must be able to

- describe the effects of untreated sewage and excess fertiliser on **aquatic ecosystems** 水生生态系统
- explain the process of eutrophication: more **nitrate** 硝酸盐 and other ions, more growth of producers, more **decomposition** 分解 after they die, more **aerobic respiration** by **decomposers** 分解者, less **dissolved oxygen** 溶解氧, and the death of organisms that need it
- describe the effects of non-biodegradable plastics in aquatic and **terrestrial** 陆生 ecosystems
- describe the sources and effects of air pollution by methane and carbon dioxide, limited to the enhanced greenhouse effect and **climate change** 气候变化

1

The method

Method — Two pollutants, one result

Untreated sewage and **excess fertiliser** reach a river by different routes but do the same two things:

pollutant	where it comes from	what it adds to the water
untreated sewage	drains and waste pipes that run straight into a river	nitrate and other ions, and a large amount of organic waste for decomposers to feed on
excess fertiliser	rain washes it off farmland into the river – this is leaching 淋溶	nitrate and phosphate ions

- Both raise the concentration of **nitrate ions** in the water, which is where the eutrophication chain begins.
- Sewage does something extra: the organic waste itself feeds bacteria, so the decomposers multiply immediately, before any plant has grown.
- Untreated sewage also carries **pathogens**, which is a separate problem – cholera and typhoid are water-borne.

Method — Eutrophication, one arrow at a time

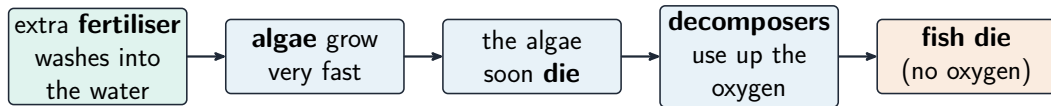
more nitrate → more producers → they die → more decomposers → less oxygen → fish die

Write it as six numbered steps and the marks follow:

- 1 The water gains **nitrate and other ions**.
 - 2 **Producers** – algae and water plants – grow much faster, and cover the surface.
 - 3 Plants below them are **shaded**, so they cannot photosynthesise, and they **die**.
 - 4 **Decomposers** feed on the dead material and multiply.
 - 5 The decomposers carry out **aerobic respiration**, which uses up the **dissolved oxygen** in the water.
 - 6 Fish and other organisms that need dissolved oxygen **die**.
- △ The fish die because of the **decomposers' respiration**, not because the algae used the oxygen up and not because the algae are poisonous. Step 4 is the step students leave out.

Method — Eutrophication, one arrow at a time

[more nitrate more producers they die more decomposers less oxygen fish die] Write it as six numbered steps...



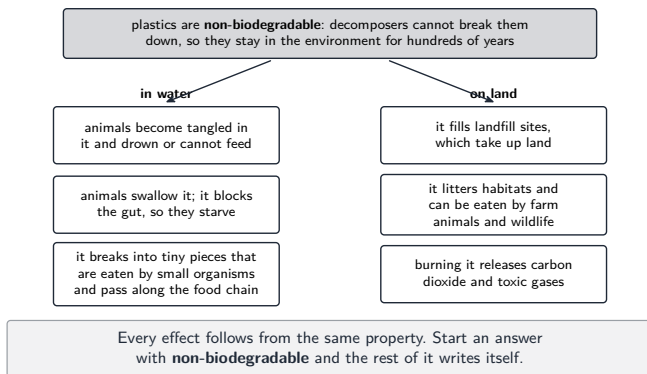
Method — Plastics: everything follows from one word

Plastics are **non-biodegradable**: **decomposers cannot break them down**, so they stay in the environment for hundreds of years.

- **In water**: animals become **tangled** in it and drown or cannot feed; animals **swallow** it and it blocks the gut, so they starve; it breaks into tiny pieces that small organisms eat, so it passes **along the food chain**.
- **On land**: it fills **landfill** sites, taking up land; it litters habitats and is eaten by farm animals and wildlife; **burning** it releases carbon dioxide and toxic gases.

Method — Plastics: everything follows from one word

Plastics are non-biodegradable : decomposers cannot break them down , so they stay in the environment for...



Method — The greenhouse gases: sources, then effects

gas	where it comes from
carbon dioxide	burning fossil fuels 化石燃料 and wood; deforestation 森林砍伐, which also removes the trees that would absorb it
methane	cattle and other livestock; rice fields; landfill sites; decaying waste

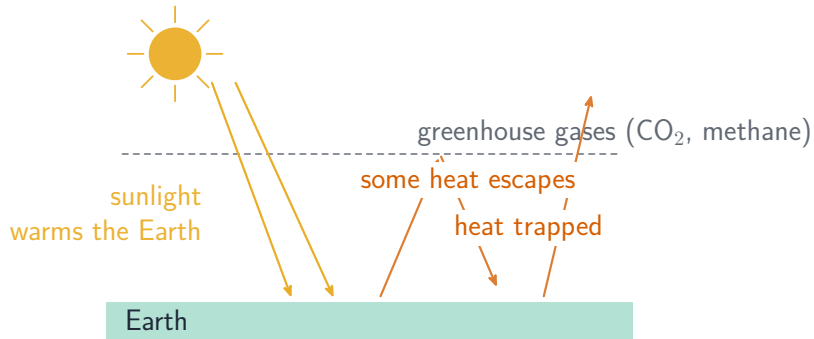
Method — The greenhouse gases: sources, then effects

The enhanced greenhouse effect. Both gases let sunlight through to the Earth's surface, but **absorb the heat the Earth radiates back out**. More of these gases means **more heat is trapped**, so the average temperature of the atmosphere rises. That is **climate change**, and its consequences are melting ice, rising sea level, shifting rainfall and habitats becoming unsuitable for the species living in them.

- “The greenhouse effect” on its own is natural and keeps the Earth warm enough to live on. The exam is asking about the **enhanced** effect: the extra warming caused by the gases we add.

Method — The greenhouse gases: sources, then effects

center The enhanced greenhouse effect.



greenhouse gases trap heat, so the Earth gets warmer

2

Practice

Practice 2.1 ■ 2 marks

State **two** substances that untreated sewage adds to a river.

Solution 2.1

Method: Two pollutants, one result — p.4

Worked steps

- **nitrate ions** (and other mineral ions) **B1**
- **organic waste**, which decomposers feed on – also acceptable: **pathogens**
B1

Practice 2.2 ■ 2 marks

Explain how excess fertiliser applied to a field ends up in a river.

Solution 2.2

Method: Two pollutants, one result — p.4

Worked steps

- fertiliser that the crop does not take up stays in the soil (B1)
- **rain washes it through the soil** and into the river; this is **leaching** (B1)

Practice 2.3 ■ 2 marks

In eutrophication, explain why the water plants growing near the river bed die.

Solution 2.3

Method: Eutrophication, one arrow at a time — p.5

Worked steps

- the algae at the surface multiply and **cover the water**, shading the plants below (B1)
- those plants cannot **photosynthesise** enough, so they die (B1)

Practice 2.4 ■ 3 marks

Explain why the fish in a eutrophic river die.

Solution 2.4

Method: Eutrophication, one arrow at a time — p.5

Worked steps

- **decomposers** feed on the dead algae and water plants, and multiply (B1)
- they carry out **aerobic respiration**, which uses up the **dissolved oxygen** in the water (B1)
- the fish need dissolved oxygen for their own respiration, so they die or leave (B1)

Practice 2.5 ■ 2 marks

State what is meant by a non-biodegradable plastic.

Solution 2.5

Worked steps

- **decomposers cannot break it down** **B1**
- so it stays in the environment for hundreds of years **B1**

Practice 2.6 ■ 2 marks

Name one source of methane and one source of carbon dioxide.

Solution 2.6

Method: The greenhouse gases: sources, then effects — p.9

Worked steps

- methane: **cattle, rice fields, landfill sites** or decaying waste **B1**
- carbon dioxide: burning **fossil fuels**, burning wood or **deforestation** **B1**

3

Exam-style

Exam-style 3.1 ■ 1 mark

In a river polluted by fertiliser, the fish die because

- A** the algae release a poison into the water.
- B** the algae use up the dissolved oxygen at night.
- C** decomposers use up the dissolved oxygen as they respire.
- D** the nitrate ions are poisonous to fish.

Solution 3.1

Method: Eutrophication, one arrow at a time — p.5

- A the algae release a poison into the water.
- B the algae use up the dissolved oxygen at night.
- C decomposers use up the dissolved oxygen as they respire. 
- D the nitrate ions are poisonous to fish.

Worked steps

C

- the extra nitrate makes the algae grow, and when they die the **decomposers** multiply and use up the dissolved oxygen in their respiration **B1**

Exam-style 3.2 ■ 5 marks

A stretch of river runs past a farm and then past a town where untreated sewage enters it.

Exam-style 3.2 (a) ■ 2 marks

Explain the effect of the excess fertiliser from the farm on the number of algae in the river.

Solution 3.2 (a)

Worked steps

- the fertiliser adds **nitrate ions** to the water (B1)
- so the algae have more of the mineral ions they need and **grow and reproduce faster**, increasing in number (B1)

Exam-style 3.2 (b) ■ 2 marks

Explain why untreated sewage lowers the dissolved oxygen concentration more quickly than fertiliser does.

Solution 3.2 (b)

Worked steps

- fertiliser only adds **ions**, so the decomposers cannot multiply until the algae have grown and died first **B1**
- sewage adds **organic waste** as well, which decomposers can feed on **immediately**, so they multiply and use up the oxygen straight away **B1**

Exam-style 3.2 (c) ■ 1 mark

State one other danger of untreated sewage in a river used for drinking water.

Solution 3.2 (c)

Worked steps

- it carries **pathogens**, which cause water-borne diseases such as **cholera**

B1

Exam-style 3.3 ■ 13 marks

A survey of a river measured the concentration of nitrate ions and of dissolved oxygen at five points downstream of a sewage outflow.

Exam-style 3.3 ■ 13 marks

distance downstream / km	nitrate ions / mg per dm ³	dissolved oxygen / mg per dm ³
0 (the outflow)	2	9
1	18	5
2	24	1
5	16	3
10	5	8

Exam-style 3.3 (a) ■ 3 marks

Describe how the dissolved oxygen concentration changes with distance downstream.

Solution 3.3 (a)

Method: Two pollutants, one result — p.4

Worked steps

- it **falls** from 9 mg per dm^3 at the outflow to **1 mg per dm^3** at 2 km **B1**
- it then **rises** again, to 8 mg per dm^3 at 10 km **B1**
- so it is lowest at **2 km**, a little way downstream of the outflow, not at the outflow itself **B1**

Exam-style 3.3 (b) ■ 4 marks

Explain why the dissolved oxygen concentration is lowest at 2 km.

Solution 3.3 (b)

Worked steps

- the nitrate concentration is **highest** at 2 km (24 mg per dm^3), so the algae grew most there (B1)
- the algae and shaded plants then **died** (B1)
- **decomposers** fed on the dead material and multiplied (B1)
- their **aerobic respiration** used up the dissolved oxygen faster than it could be replaced (B1)

Exam-style 3.3 (c) ■ 2 marks

Suggest why the dissolved oxygen concentration has recovered by 10 km.

Solution 3.3 (c)

Worked steps

- by 10 km most of the nitrate has been used up or diluted, so far fewer algae die **B1**
- the decomposers therefore use less oxygen, and oxygen dissolves back into the water from the air as the river flows **B1**

Exam-style 3.3 (d) ■ 2 marks

Only one species of fish was found at 2 km, but eleven species were found at 10 km. Explain this difference.

Solution 3.3 (d)

Worked steps

- at 2 km there is almost **no dissolved oxygen**, so only a species that can survive at 1 mg per dm^3 can live there **B1**
- by 10 km the oxygen has recovered to 8 mg per dm^3 , so many more species can respire and survive, giving greater **biodiversity** **B1**

Exam-style 3.3 (e) ■ 2 marks

Plastic waste was also found along the river bank. Describe **two** effects this plastic could have on the animals living in and beside the river.

Solution 3.3 (e)

Worked steps

- any **two** of: animals become **tangled** in it and drown or cannot feed; animals **swallow** it and it blocks the gut, so they starve; it breaks into small pieces that are eaten and pass along the **food chain** **B1** **B1**