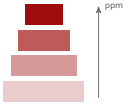
Aquatic and Terrestrial Pollution

AP Environmental Science ▪ Unit 8

AP Environmental Science

What we will cover

1. Point and nonpoint sources
2. Eutrophication
3. Persistent toxins
4. Waste and sewage
5. Toxicology
6. Pollution and health



1 Sources

Point and nonpoint sources

Pollution is sorted by whether we can trace it:

- **point source** 点源: one clear pipe or stack
- **nonpoint source** 非点源: many spread-out places

> Nonpoint (farm run-off) is far harder to control – no single pipe to plug.

Mangroves

Thermal pollution

what it is	**heat** 热 added to water, usually from power-station cooling
why it harms	warm water holds less dissolved oxygen, and stresses species adapted to a cooler range
who suffers first	cold-water fish – trout and salmon – and the invertebrates they feed on
the fix	cooling towers and holding ponds, so the water sheds its heat before it returns to the river

> Thermal pollution adds no substance at all. It is the one pollutant you cannot filter out – only let go of.

Human Impacts on Ecosystems

Human activities – pollution, habitat destruction, overharvesting, introducing species – degrade ecosystems and reduce biodiversity.

> Because species are interconnected, harming one part can ripple through the whole system.

Endocrine Disruptors

Endocrine disruptors 内分泌干扰物 are chemicals (some pesticides, plasticizers like BPA) that mimic or block hormones, disrupting growth, reproduction.

Human Impacts on Wetlands and Mangroves

Wetlands 湿地 and **mangroves** 红树林 filter pollutants, store floodwater, and nurse young fish, but they are drained and cleared for farms, shrimp ponds, and development.

> Losing them removes valuable ecosystem services and coastal protection.

2 Eutrophication

Eutrophication

Too many nutrients set off a chain that suffocates the water:

- nutrients run off → **algal bloom** 藻华
- algae die, bacteria decay → **hypoxic** 缺氧 dead zone

> **Cultural eutrophication** 文化富营养化: human phosphorus and nitrogen speed it up.

Algal bloom: nutrient run-off fuels hypoxia

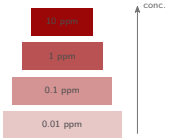
3 Toxins

Persistent toxins

POPs 持久性有机污染物 (DDT, PCBs) **resist breakdown** 抗分解, so they last decades and travel far.

- **bioaccumulation** 生物累积: builds up in one body
- **biomagnification** 生物放大: rises up the food chain

> **Top predators** 顶级捕食者 (and people who eat them) carry the highest **mercury** 汞 dose.



Pollutants that do not go away

Persistent organic pollutants	**Persistent organic pollutants** resist breakdown, dissolve in fat and so bioaccumulate – DDT, PCBs, dioxins.
Biomagnification	Each trophic level concentrates what it eats, so top predators carry the highest burden.
Algal blooms	**Algal blooms** follow nutrient runoff; when the algae die, decomposition strips the oxygen and the fish suffocate.
Disease and water	Contaminated water spreads cholera and dysentery; crowding spreads **tuberculosis (TB)** – both are pollution problems as much as medical ones.

Persistence, solubility in fat, and trophic position. Those three predict where a toxin ends up.

Worked example – DDT up the food chain

Lake water holds DDT at 0.01 ppm. Plankton reach 0.5, small fish 2, large fish 25 ppm. How concentrated is the top predator's dose?

- $\frac{25}{0.01} = 2{,}500\times$ the water concentration
- **bioaccumulation** 生物累积: one organism builds it up over its life
- **biomagnification** 生物放大: each trophic level concentrates what it eats

The water can test almost clean while the top predator is poisoned. Persistent, fat-soluble compounds are the ones that do this.

4 Waste

Waste and sewage

Landfills 垃圾填埋场 bury waste; a sanitary landfill lines the base and captures leachate & methane.

Best order: reduce, reuse, recycle; compost food scraps.

Landfill: line, capture leachate, manage methane

Where solid waste actually goes

sanitary landfills 卫生填埋场	buried in lined cells to limit **leachate** 渗滤液; takes land and can still leak
incinerators 焚烧炉	burning cuts the *volume* sharply but emits air pollutants and leaves toxic ash
composting 堆肥	organic waste returned to soil – the cheapest diversion there is
e-waste 电子垃圾	phones, computers, televisions – small in volume, but loaded with toxic metals
garbage patches 垃圾带	ocean-dumped plastic gathered by currents into vast floating fields far out at sea

The hierarchy is reduce, reuse, recycle – and reducing is best because waste you never make needs no disposal at all.

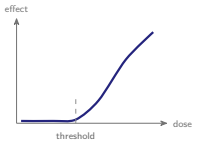
5 Toxicology

Toxicology

LD_{50} 半数致死剂量 is the dose that kills half a test group.

- lower LD_{50} = *more* **toxic** 毒性
- below the **threshold dose** 阈值剂量: no effect

> **Acute** 急性: one big dose.
> **Chronic** 慢性: small doses over years.



Harm only past the threshold.

Worked example – reading an LD50

Chemical A has an LD_{50} of 5 mg/kg of body mass; chemical B, 500 mg/kg. Which is more toxic?

- LD_{50} = the dose that kills half a test population
- $500/5 = 100$: A needs a hundredth of the dose
- so A is 100 times more toxic

> A smaller LD_{50} means a more toxic chemical – the scale runs backwards, and the exam checks that you know it. Dose, duration and individual sensitivity all shape the real effect.

6 Health

Pollution and health

Harm depends on **dose** 剂量, time, and sensitivity.

- **acute** 急性 vs **chronic** 慢性 effects
- **risk analysis** 风险分析 sets safe limits

> **Infectious disease** 传染病 spreads by **pathogens** 病原体; **environmental change** 环境变化 widens its reach.

dirty water → cholera

air → flu

vectors 病媒: mosquito → malaria

Pathogens and Infectious Diseases

Pathogens 病原体 (bacteria, viruses, parasites) spread through contaminated water and food.

> The exam names specific diseases and expects you to know **how each one is transmitted**, because the transmission route decides the defence:

The pathogens the exam names, and how each travels

dysentery 痢疾	bacterial – untreated sewage in streams and rivers
plague 鼠疫	bacterial – an infected flea's bite, or infected fluids
tuberculosis 结核病	bacterial – breathing in an infected person's bacteria
malaria 疟疾	parasitic – an infected **mosquito** 蚊子; sub-Saharan Africa
West Nile / Zika	viral – an infected mosquito again; Zika also passes sexually
SARS / MERS	viral – infected fluids; MERS crosses from animals

> Poverty deepens all of it: low-income areas often lack sanitary waste disposal and clean water in the first place.

Eutrophication, continued

extra **fertiliser** washes into the water → **algae** grow very fast → the algae soon **die** → **decomposers** use up the oxygen → **fish die** (no oxygen)

Extra fertiliser makes algae bloom, then the water loses its oxygen

Sewage Treatment

sedimentation — large bits settle to the bottom
↓
filtration — remove the remaining solid bits
↓
pass through **carbon** — removes bad tastes and smells
↓
chlorination — chlorine kills harmful microbes
↓
safe drinking water

Treating water to make it safe: sedimentation, filtration, then disinfection

Sewage treatment in three stages

primary 一级	physical: solids settle out in tanks
secondary 二级	biological: bacteria break down the remaining organic matter
tertiary 三级	chemical: removes nutrients (N and P) and disinfects, where the discharge needs it

Skip the tertiary stage and the outflow is clean of solids and pathogens but still nutrient-rich – which is how treated sewage still causes **eutrophication** 富营养化.

Dose Response Curve

A **dose–response curve** 剂量反应曲线 plots the effect against the dose.

Generally, a higher dose causes a greater effect.

Exam tips

- Trace **eutrophication** step by step: nutrient runoff → algal bloom → decay → oxygen depletion → fish die.
- **Bioaccumulation** builds up in one organism; **biomagnification** increases up the food chain, so top predators are hit hardest.
- Read an **LD50**: a **lower** value means **more** toxic; multiply by body mass for a lethal dose.
- Order the waste hierarchy **reduce** > **reuse** > **recycle**, and the stages of sewage treatment.
- Link pathogens to contaminated water and to clean-water/sanitation defences.

7 Recap

Worked example – reading a BOD result

A river below a sewage outfall has high BOD and almost no fish. Explain the link.

- BOD = the oxygen decomposer bacteria use to break down organic waste.
- Sewage feeds the bacteria ⇒ they multiply and respire hard.
- Dissolved oxygen crashes ⇒ fish suffocate and only tolerant species survive.
- Further downstream the waste runs out ⇒ oxygen recovers ⇒ a classic oxygen sag curve.

High BOD = dirty water: it means a big oxygen demand, not a lot of oxygen. Fish die of suffocation, not poisoning.

Unit 8 – key takeaways

1. **Sources** — point (one pipe) vs nonpoint (spread-out run-off)
2. **Water harm** — eutrophication dead zones; biomagnified toxins
3. **Waste** — sanitary landfills; reduce/reuse/recycle; 3-stage sewage
4. **Toxicology** — lower LD_{50} = more toxic; threshold; acute vs chronic

Check yourself

1. Is farm run-off a point or nonpoint source?
2. What uses up the oxygen in a eutrophic dead zone?
3. Who carries the highest biomagnified toxin dose?
4. Does a lower LD_{50} mean more or less toxic?

Answers **1.** nonpoint **2.** bacteria decomposing dead algae **3.** top predators **4.** more toxic