

B.PHARM SEMESTER III · BP302T

BP302T Environmental Sciences

Unit I — Environmental Pollution

Types · Sources · Effects · Control Measures

From-zero textbook notes for pharmacy students

PILLS & PYTHON

Pharmacy • Data • AI • Healthcare

Chapter 1 — Unit I: Environmental Pollution

1.1 Learning objectives

After studying this chapter, you will be able to:

1. Define environment, environmental studies, pollution and pollutant in simple words.
2. Describe the scope and importance of environmental studies for a pharmacy student.
3. Classify and explain the causes, effects and control measures of air, water, soil, noise and nuclear pollution.
4. Describe solid waste and hazardous waste management with pharmaceutical examples.
5. Explain the role of pharmacists in conservation and sustainable use of resources.

1.2 Definitions (start from zero)

- **Environment:** Everything that surrounds us — air, water, land, plants, animals, microorganisms and human-made surroundings. It is the "neighbourhood" in which we live.
- **Environmental studies:** The study of how living beings interact with their surroundings, and how human activities affect air, water and land. It is a multidisciplinary subject — it takes help from biology, chemistry, physics, engineering, economics, law and sociology.
- **Pollution:** An unfavourable change in the physical, chemical or biological quality of air, water or land, caused mainly by human activities, which harms living beings.
- **Pollutant:** Any substance (solid, liquid or gas) or form of energy (heat, sound, radiation) that causes pollution. Example: smoke from a factory chimney, untreated factory wastewater, loud machinery sound.

1.3 Terminology you must know

- **Biodegradable waste:** Waste that nature can break down (rotten vegetables, paper). **Non-biodegradable waste:** Waste nature cannot easily break down (plastic, glass).
- **Point source:** Pollution coming from one fixed place (a factory pipe). **Non-point source:** Pollution coming from many spread-out places (rain washing fertilisers from many farms).
- **Primary pollutant:** Released directly into air (carbon monoxide from vehicles). **Secondary pollutant:** Formed in air by reactions of primary pollutants (smog, ozone at ground level).
- **Effluent:** Wastewater flowing out of a factory. **Emission:** Gas or smoke released into air.
- **Eutrophication:** Over-growth of algae in water due to excess nutrients (nitrates, phosphates), which uses up oxygen and kills fish.
- **Biomagnification:** Increase in concentration of a harmful chemical as it moves up the food chain (small fish → big fish → humans).
- **dB (decibel):** Unit for measuring sound loudness.
- **TSDF:** Treatment, Storage and Disposal Facility — an authorised site where hazardous waste is safely treated and buried.

1.4 Explanations

1.4.1 Scope and importance of environmental studies

Technical concept: Environmental studies is multidisciplinary and covers natural resources, ecosystems, pollution, waste management, policies and human–environment relationships. **Simple explanation:** No single subject can explain pollution fully — you need chemistry (what is in the smoke), biology (how it harms fish), engineering (how to clean it), law (what punishment applies) and economics (what it costs). That combined study is "environmental studies". **Example:** To control pollution from a tablet factory, a pharmacist needs chemistry (effluent contents), engineering (effluent treatment plant) and law (Pollution Control Board permission). **Key takeaway:** Environmental studies gives a pharmacist the full picture — science + law + responsibility.

1.4.2 Air pollution — causes

Technical concept: Presence of harmful gases or particles in air above safe levels. **Simple explanation:** Air becomes dirty when factories, vehicles and burning release more smoke and gases than nature can clean. **Example:** A pharma boiler burning coal releases smoke (particles), sulphur dioxide and nitrogen oxides. **Diagram (draw):** A factory with chimney → arrows labelled "SO_2, NOx, SPM, CO, VOCs" going into a cloud; below, a car and a burning garbage heap adding to the same cloud. **Key takeaway:** Main causes = industries, vehicles, burning of fuel/waste, construction dust.

1.4.3 Air pollution — effects and control

Effects: On health — cough, asthma, bronchitis, eye irritation; on environment — acid rain (SO_2 + NOx dissolve in rain), smog, damage to plants and buildings (Taj Mahal's marble yellowing is a famous Indian example). **Control measures:** (1) At source — use cleaner fuels (LPG/CNG instead of coal), (2) Equipment — electrostatic precipitators and bag filters catch dust, scrubbers wash gases with water/chemicals, catalytic converters in vehicles, (3) Green belt — trees around factories absorb gases and dust. **Key takeaway:** Control = cleaner fuel + catching equipment + trees.

1.4.4 Water pollution — causes

Technical concept: Addition of harmful substances to water bodies making water unsafe for use. **Simple explanation:** Rivers become dirty when factories, homes and farms pour waste into them. **Example:** Untreated coloured effluent from a bulk-drug unit changes river colour and kills fish; sewage adds germs causing cholera and typhoid. **Flowchart (draw):** Factory pipe → river → [fish die, water undrinkable] ; Farm runoff → river → [algal bloom → oxygen finish → fish die (eutrophication)]. **Key takeaway:** Main causes = industrial effluents, domestic sewage, agricultural runoff (fertilisers/pesticides), oil spills.

1.4.5 Water pollution — effects and control

Effects: Water-borne diseases (cholera, typhoid, dysentery), oxygen depletion killing aquatic life, biomagnification of pesticides/mercury in fish eaten by humans. **Control:** Treat wastewater in ETP/STP before discharge, reuse treated water, strict "no direct discharge" discipline, regular water-quality monitoring (pH, BOD, COD). **Key takeaway:** Every drop of factory wastewater must be treated before it meets a river.

1.4.6 Soil (land) pollution — causes, effects, control

Causes: Dumping of industrial solid waste and sludge, excessive pesticides/fertilisers, plastic litter, biomedical waste, oil spills. **Effects:** Soil loses fertility, harmful chemicals enter crops → food chain, groundwater contamination by leachate (dirty liquid seeping from waste dumps). **Control:** Sanitary landfills (scientific burial with lining), composting of organic waste, recycling, reducing pesticide use, bioremediation (using microorganisms to clean soil). **Key takeaway:** What we bury in soil comes back to us through food and water.

1.4.7 Noise pollution — causes, effects, control

Causes: Industrial machinery, generators, traffic horns, construction, loudspeakers. **Effects:** Hearing loss, headache, high blood pressure, disturbed sleep, reduced concentration; animals also suffer. **Control:** Silencers on machines, sound-proof walls/barriers, green belt (trees absorb sound), zoning (factories away from homes/hospitals), limiting horn use. **Key takeaway:** Noise is invisible pollution — it harms health without leaving smoke or colour.

1.4.8 Nuclear (radioactive) pollution — causes, effects, control

Causes: Nuclear power plants, uranium mining, improper disposal of radioactive waste, medical/industrial use of radioisotopes, accidents (leakage). **Effects:** Radiation damages cells — burns, cancer, genetic damage passed to next generations; contamination stays dangerous for very long periods. **Control:** Thick shielding, strict handling rules, deep safe disposal of radioactive waste, continuous radiation monitoring, emergency preparedness. The guiding rule is ALARA — keep exposure **A**s **L**ow **A**s **R**easonably **A**chievable. **Key takeaway:** Nuclear pollution is the most long-lasting — prevention and shielding are the only real protections.

1.5 Classifications

Types of pollution (by medium): Air, water, soil/land, noise, thermal, nuclear/radioactive, light. **Air pollutants:** Gaseous (SO_2, NOx, CO, VOCs) and particulate (dust, smoke, SPM). **Water pollutants:** Organic (sewage, food waste), inorganic (acids, heavy metals), biological (bacteria, viruses), thermal (hot water from plants). **Solid waste:** Municipal (household), industrial, biomedical, hazardous, e-waste, construction waste.

1.6 Mechanisms / processes

- **Acid rain formation:** SO_2 + NOx released → dissolve in rainwater → acidic rain → damages crops, buildings, water life.
- **Eutrophication steps:** Nutrients enter water → algae grow fast → algae die → bacteria decompose them using oxygen → oxygen finishes → fish die.
- **Biomagnification steps:** Factory releases mercury → small fish absorb little → big fish eat many small fish → humans eat big fish → highest concentration in humans.

1.7 Diagrams (describe for drawing)

1. **Types of pollution mind-map:** Centre circle "Pollution" with five branches — Air (chimney), Water (pipe to river), Soil (dumped drums), Noise (speaker), Nuclear (radiation symbol).
2. **Air pollution control equipment:** Chimney with three boxes in series — "Bag filter (catches dust)" → "Scrubber (washes gases)" → "Clean air out".
3. **Eutrophication pond:** Four panels — clean pond → green algal layer → dead fish floating → "oxygen finished".

1.8 Flowcharts

Solid waste management hierarchy (best → last option): Reduce (make less waste) → Reuse (use again) → Recycle (make new product) → Recover energy (incineration with power) → Safe disposal (sanitary landfill).

1.9 Infographic concept box

"The 5 Pollutions in 5 Lines" — one icon + one cause + one control per pollution type: Air = chimney + ESP/scrubber; Water = pipe + ETP; Soil = drum + sanitary landfill; Noise = speaker + green belt; Nuclear = radiation trefoil + shielding/ALARA. Footer line: "Pollution control starts at the source, not at the river."

1.10 Tables

Table 1.1 — Five pollutions at a glance

Pollution	Main causes	Main effects	Key control measures
Air	Industries, vehicles, fuel burning	Asthma, acid rain, smog	ESP, bag filter, scrubber, catalytic converter, green belt
Water	Industrial effluents, sewage, farm runoff	Water-borne disease, fish kill, eutrophication	ETP/STP, no direct discharge, monitoring
Soil	Industrial waste, pesticides, plastics	Lost fertility, food-chain contamination	Sanitary landfill, composting, recycling, bioremediation
Noise	Machinery, traffic, generators	Hearing loss, hypertension, sleep loss	Silencers, barriers, green belt, zoning
Nuclear	Nuclear plants, mining, isotope misuse	Cancer, genetic damage, long-term contamination	Shielding, safe disposal, monitoring, ALARA

Table 1.2 — Waste disposal methods

Method	What it is	Best for
Sanitary landfill	Scientific burial with lining and leachate collection	Non-hazardous solid waste
Composting	Biological breakdown of organic matter	Food/plant waste
Incineration	Burning at high temperature	Infectious/biomedical waste
Recycling	Converting waste into new products	Paper, plastic, glass, metal
Deep burial	Burial in deep pits with lime	Sharps, certain infectious waste in rural areas

1.11 Examples

1. A pharma company installs a scrubber on its boiler chimney — air pollution control at source.
2. A factory's ETP treats coloured effluent before discharge — water pollution control.
3. Expired tablets are sent for incineration, not thrown in a dustbin — hazardous waste discipline.
4. Trees planted around an industrial estate reduce both dust and noise — green belt double benefit.
5. A hospital uses colour-coded bins for infectious waste — segregation at source.

1.12 Analogies

- **Pollution is like overfilling a dustbin:** Nature can clean a little waste, but when we dump faster than it can clean, the surroundings overflow with harm.
- **Eutrophication is like overfeeding fish in an aquarium:** Extra food rots, water turns green and smelly, and fish die — same happens in a nutrient-loaded lake.
- **Biomagnification is like a pyramid scheme of poison:** Each level collects the poison of all the levels below, so the top (humans) gets the heaviest dose.

1.13 Pharmacy relevance

- Pharma manufacturing is a pollution-prone industry — solvents, effluents, emissions and solid waste all need control.
- Pharmacists handle expired drugs, chemical waste and biomedical waste — wrong disposal pollutes soil and water.
- Knowledge of pollution laws keeps the pharmacy/industry legally safe (consent from Pollution Control Boards).
- Pharmacists counsel patients on proper medicine disposal ("do not flush tablets").

1.14 India context

- The Ganga and Yamuna receive industrial effluents and sewage — cleaning them is a national mission (see Chapter 5).
- Delhi's winter smog shows how vehicles + stubble burning + industry combine into severe air pollution.
- India's hospitals generate large quantities of biomedical waste daily — segregation at source is a legal duty.
- The Taj Mahal's marble discolouration from air pollution led to strict industrial controls around Agra.

1.15 Key points

1. Environment = surroundings (living + non-living); environmental studies is multidisciplinary.
2. Five main pollutions: air, water, soil, noise, nuclear — each has causes, effects and controls.
3. Control hierarchy: prevent at source → treat → dispose safely.
4. Solid waste: reduce, reuse, recycle, recover, dispose.
5. Hazardous pharma waste (solvents, expired drugs, sludge) needs segregated, authorised disposal via TSDF.
6. Pharmacists protect the environment through correct waste handling, green purchasing and patient counselling.

1.16 Common confusions

- **Pollution vs pollutant:** Pollution is the dirty condition; pollutant is the dirty substance causing it.
- **Primary vs secondary pollutant:** Primary is released directly (CO); secondary forms in air later (smog).
- **Biodegradable vs non-biodegradable:** Paper rots (biodegradable); plastic stays for decades (non-biodegradable).
- **ETP vs STP:** ETP treats industrial effluent; STP treats domestic sewage.
- **Recycling vs reuse:** Reuse = same item used again (glass bottle refilled); recycling = melted/remade into a new product.

1.17 Common mistakes

1. Saying "noise is not pollution" — it is; it damages health.
2. Thinking dilution ("pour it in the river, it will mix") is treatment — it is not; treatment is compulsory.
3. Throwing expired medicines in household dustbins or flushing them.
4. Confusing eutrophication (nutrient overgrowth) with biomagnification (poison increasing up the food chain).
5. Believing air pollution is only about visible smoke — invisible gases (CO, NOx) are equally harmful.

1.18 Mnemonics

- **Five pollutions:** "**A**ll **W**ater **S**ources **N**eed **N**urturing" → Air, Water, Soil, Noise, Nuclear.
- **Waste hierarchy:** "**R**educe, **R**euse, **R**ecycle, **R**ecover, **D**ispose" → "4Rs then D".
- **Noise control:** "**S**ilencer, **B**arrier, **G**reen belt, **Z**oning" → "SBGZ — Silence Brings Good Zzz (sleep)".

1.19 Exam summary

Environmental studies is the multidisciplinary study of human–environment interaction. Pollution is an unfavourable change in air, water or land quality. Air pollution (SO_2, NOx, CO, SPM) is controlled by ESPs, bag filters, scrubbers, catalytic converters and green belts; water pollution (effluents, sewage, runoff) by ETPs and discharge discipline; soil pollution (industrial waste, pesticides, plastics) by sanitary landfills, composting and bioremediation; noise pollution by silencers, barriers and zoning; nuclear pollution by shielding, safe disposal and the ALARA principle. Solid waste follows the reduce–reuse–recycle–recover–dispose hierarchy, while hazardous pharmaceutical waste needs segregated authorised disposal. Pharmacists contribute through correct waste handling, green procurement and patient counselling on medicine disposal.

1.20 One-minute revision

Environment = our surroundings. Pollution = dirty air/water/land harming life. Five types: Air (chimney smoke → ESP/scrubber), Water (factory pipe → ETP), Soil (dumped waste → landfill/compost), Noise (machines → silencer/green belt), Nuclear (radiation → shielding/ALARA). Waste rule: 4Rs then safe disposal. Pharmacist's duty: segregate waste, never flush medicines, counsel patients.

1.21 Exam questions

Short/long questions:

1. Define pollution and pollutant with two examples each.
2. Describe the causes, effects and control measures of air pollution.
3. Explain eutrophication and biomagnification with labelled diagrams.
4. Write a note on solid waste management methods.
5. Explain the role of pharmacists in conservation of natural resources.

MCQs:

1. Which of the following is a secondary air pollutant? (a) CO (b) SO_2 (c) Smog (d) SPM — **Ans: (c)**
2. Eutrophication is mainly caused by excess of: (a) plastics (b) nitrates and phosphates (c) noise (d) radiation — **Ans: (b)**
3. ALARA principle is related to: (a) air pollution (b) noise pollution (c) nuclear pollution (d) soil pollution — **Ans: (c)**
4. Which unit measures sound loudness? (a) BOD (b) dB (c) pH (d) ppm — **Ans: (b)**
5. The best first step in waste management hierarchy is: (a) landfill (b) incineration (c) reduce (d) recycling — **Ans: (c)**

Viva questions:

1. What is the difference between ETP and STP?
2. Name two devices used to control air pollution from chimneys.
3. Why should expired medicines not be thrown in household waste?
4. What does TSDF stand for?
5. Give one example each of biodegradable and non-biodegradable waste.

Application-based questions:

1. A tablet factory is located near a residential area and residents complain of dust and noise. As the pharmacist-manager, list five control measures you would implement.
2. A clinic has no segregation system for its waste. Design a simple colour-coded bin plan for it.
3. A river near an industrial estate shows fish deaths every summer. Analyse the probable causes and suggest an investigation plan.

1.22 References

1. Bharucha, E. *Environmental Studies*. UGC, New Delhi.
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3. Joseph, B. *Environmental Studies*. Tata McGraw Hill.