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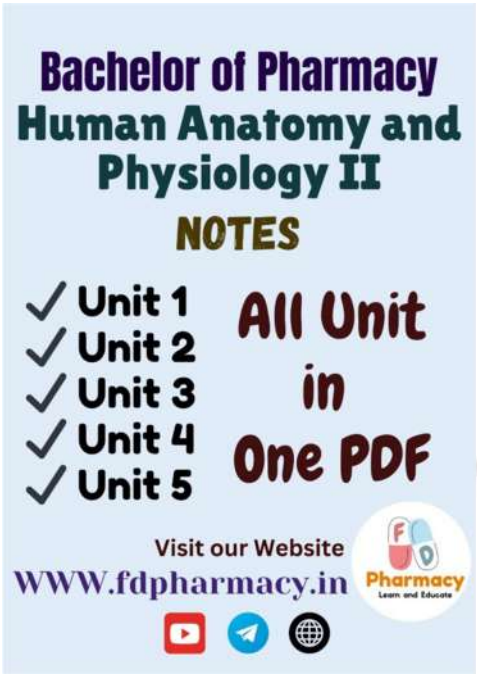
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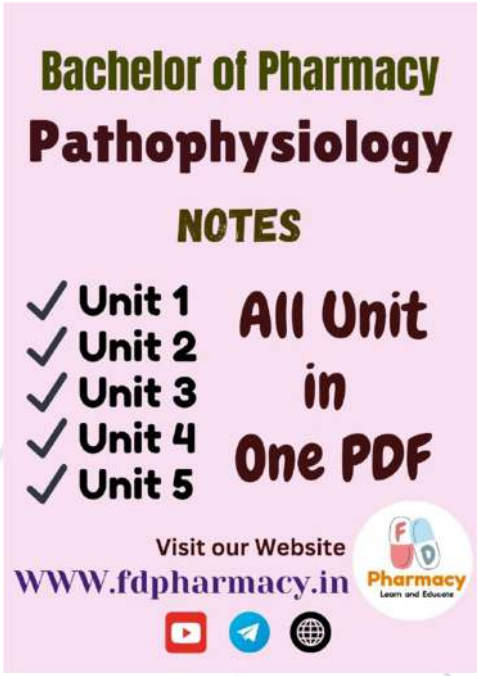
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ENVIRONMENTAL SCIENCES

UNIT 3

TOPIC :

- **Environmental Pollution :** Air pollution; Water pollution; Soil pollution

Environmental Pollution

→ The environment refers to the surroundings or conditions in which all living and non-living things exist and interact. It consists of air, water, land, animals, plants, and man-made structures. The environment plays a crucial role in supporting life on Earth by providing air to breathe, water to drink, food to eat, and resources for shelter and development.

→ Environmental pollution is defined as the introduction of harmful substances or products into the natural environment that cause adverse changes. It occurs when pollutants contaminate the environment, leading to undesirable effects on living organisms and the ecosystem.

→ A pollutant is any solid, liquid, or gaseous substance that is present in the environment in such a concentration that it has harmful effects on health, comfort, or the survival of living organisms.

Causes of Environmental Pollution

Environmental pollution arises from both natural causes and human activities. Some common causes include:

- Industrial activities (release of gases and effluents)
- Vehicular emissions
- Agricultural chemicals (pesticides, fertilizers)
- Waste disposal (plastic, sewage, garbage)
- Mining and construction
- Deforestation and urbanization

Types of Environmental Pollution

1. **Air Pollution**
   – Contamination of air due to smoke, dust, gases (CO_2, SO_2, NOx)
   – Causes respiratory diseases, acid rain, ozone depletion
2. **Water Pollution**
   – Contamination of water bodies through sewage, chemicals, oil spills
   – Leads to waterborne diseases and loss of aquatic life
3. **Soil Pollution**
   – Degradation of soil by pesticides, industrial waste, plastic, etc.
   – Results in reduced fertility and food contamination
4. **Noise Pollution**
   – Unwanted sound from traffic, industry, loudspeakers
   – Causes stress, hearing loss, sleep disturbance
5. **Radioactive Pollution**
   – Caused by nuclear power plants and radioactive waste
   – Long-lasting effects on health and environment
6. **Thermal Pollution**
   – Rise in water temperature due to industrial discharge
   – Affects aquatic life and ecological balance

Effects of Environmental Pollution

- **Health Hazards**: Pollution causes various diseases like asthma, cancer, heart problems, and infections.
- **Ecosystem Imbalance**: Disrupts the food chain, damages biodiversity.
- **Climate Change**: Greenhouse gases lead to global warming and extreme weather.
- **Economic Impact**: Increases healthcare costs, reduces agricultural productivity, and damages infrastructure.
- **Aesthetic Damage**: Degradation of the beauty of natural landscapes and cities.

Control Measures

- Use of eco-friendly technologies
- Proper waste disposal and recycling
- Afforestation and reforestation
- Strict environmental regulations and monitoring
- Public awareness and education
- Use of public transport and non-conventional energy sources

Air Pollution

→ Air pollution is defined as the presence of unwanted substances (pollutants) in the air in quantities that are harmful to human health, animals, plants, or property. These substances may be in the form of gases, dust, fumes, or smoke, and can be both natural or man-made.

Major Air Pollutants

Pollutant	Source	Effect
Carbon monoxide (CO)	Incomplete combustion of fossil fuels	Reduces oxygen transport in blood
Sulfur dioxide (SO_2)	Burning of coal and oil	Causes acid rain, respiratory problems
Nitrogen oxides (NOx)	Vehicle emissions, power plants	Forms smog and acid rain
Particulate matter (PM)	Dust, smoke, soot, industrial processes	Lung damage, heart issues
Ozone (O_3) (at ground level)	Photochemical reaction of NOx and VOCs	Eye irritation, asthma
Lead	Battery manufacturing, leaded petrol	Damages nervous system
Volatile Organic Compounds (VOCs)	Solvents, paints, fuel vapors	Causes cancer, smog formation

Sources of Air Pollution

Natural Sources:

- Volcanic eruptions
- Forest fires
- Pollen and dust storms

Man-Made (Anthropogenic) Sources:

- **Industries** – emit SO_2, NOx, PM, VOCs
- **Vehicles** – release CO, NOx, hydrocarbons
- **Burning fossil fuels** – coal, diesel, petrol
- **Construction activities** – cause dust and PM
- **Household emissions** – burning wood, LPG, aerosols
- **Agricultural activities** – stubble burning, pesticide sprays

Effects of Air Pollution

On Human Health:

- Respiratory diseases: asthma, bronchitis, COPD
- Heart diseases and increased blood pressure
- Neurological effects from heavy metals (lead)
- Eye irritation, headaches, fatigue
- Reduced lung function and immunity

On Environment:

- **Acid Rain** – SO_2 and NOx form acids that damage soil, water bodies, and buildings
- **Global Warming** – CO_2 and other greenhouse gases trap heat
- **Ozone Layer Depletion** – CFCs lead to thinning of ozone in stratosphere
- **Smog Formation** – harmful fog mixed with pollutants
- **Damage to crops** – Reduced yield and growth due to toxic air

Control Measures

Government and Policy-Level:

- Enforcing **Air (Prevention and Control of Pollution) Act, 1981**
- Promoting **Bharat Stage Emission Standards (BS-VI)**
- Banning of **firecrackers and stubble burning**
- Development of **public transport and electric vehicles**

Technological Measures:

- Installation of **Electrostatic Precipitators**, **Scrubbers**, and **Filters** in industries
- Use of **unleaded petrol** and **low-sulfur fuels**
- Adoption of **clean and renewable energy** sources (solar, wind)

Individual Actions:

- Carpooling and use of public transport
- Use of energy-efficient appliances
- Planting trees and avoiding waste burning
- Reducing indoor air pollution by avoiding aerosols, incense sticks

Water Pollution

→ Water pollution is defined as the contamination of water bodies (like rivers, lakes, oceans, groundwater, and aquifers) due to the introduction of harmful substances that degrade the quality of water, making it unfit for drinking, domestic, agricultural, and industrial use.

Sources of Water Pollution

Natural Sources

- Volcanic eruptions (ash, sulfur compounds)
- Erosion of soil and rock (adds sediments and minerals)
- Decomposition of organic matter (algae blooms)

Man-Made (Anthropogenic) Sources

Source	Examples
Industrial Waste	Discharge of heavy metals, dyes, and chemicals
Sewage & Domestic Waste	Untreated human waste and detergents into rivers
Agricultural Runoff	Fertilizers, pesticides, and animal waste
Oil Spills	Leakage from oil tankers and offshore drilling
Thermal Pollution	Hot water from power plants harming aquatic life
Plastic Pollution	Non-degradable plastics dumped into water bodies

Types of Water Pollutants

- **Pathogens** – bacteria, viruses, parasites (from sewage)
- **Organic matter** – biodegradable waste from homes and industries
- **Chemical pollutants** – pesticides, heavy metals (like Hg, Pb)
- **Nutrients** – nitrates and phosphates causing eutrophication
- **Plastics and microplastics**
- **Radioactive substances**
- **Suspended solids and sediments**

Effects of Water Pollution

On Human Health:

- Waterborne diseases: **Cholera, Typhoid, Dysentery**
- Poisoning by heavy metals (e.g., mercury → Minamata disease)
- Skin problems and reproductive issues

On Environment:

- **Eutrophication**: Excess nutrients → algal bloom → oxygen depletion → death of aquatic life
- **Loss of biodiversity** in aquatic ecosystems
- **Bioaccumulation** and **biomagnification** of toxins in food chain

Prevention and Control of Water Pollution

Governmental and Regulatory Actions:

- **Water (Prevention and Control of Pollution) Act, 1974**
- Setting up **Effluent Treatment Plants (ETPs)**
- **Ban on single-use plastics**
- Strict regulation on industrial discharge and sewage treatment

Technological Measures:

- Installation of **Sewage Treatment Plants (STPs)**
- **Recycling and reuse** of wastewater
- Adoption of **bioremediation** and **phytoremediation**
- Use of **eco-friendly pesticides** in agriculture

Individual and Community Actions:

- Avoid dumping waste into water bodies
- Use eco-friendly household products
- Planting trees along water bodies (reduces erosion)
- Creating awareness about water conservation and pollution

Important Case Studies/Examples

- **Ganga Action Plan (1986)** – to clean River Ganga
- **Yamuna Cleaning Mission** – focused on wastewater management
- **Minamata Bay, Japan** – Mercury poisoning disaster

Soil Pollution

→ Soil pollution is defined as the presence of toxic chemicals (pollutants or contaminants) in the soil in high concentrations that pose a risk to human health, plant and animal life, and the environment. It results from the addition of harmful substances, which degrade the quality, structure, and fertility of the soil.

Sources of Soil Pollution

Natural Sources

- Volcanic eruptions (ash and sulfur compounds)
- Natural leaching of heavy metals
- Decomposition of organic matter in excess

Anthropogenic (Man-Made) Sources

Source	Pollutants
Industrial waste	Heavy metals (Pb, Cd, Hg), petroleum, acids, solvents
Agricultural practices	Pesticides, herbicides, chemical fertilizers
Urban waste	Plastics, e-waste, garbage, packaging materials
Mining activities	Toxic sludge, radioactive materials, acid drainage
Sewage sludge disposal	Organic waste, heavy metals
Oil spills and leakage	Hydrocarbons

Types of Soil Pollutants

- **Heavy metals** – Lead (Pb), Mercury (Hg), Cadmium (Cd)
- **Pesticides and fertilizers** – DDT, urea, phosphate compounds
- **Industrial chemicals** – Hydrocarbons, solvents, PCBs
- **Plastics and non-degradable waste**
- **Biological agents** – pathogenic microorganisms
- **Acidic or alkaline industrial discharge**

Effects of Soil Pollution

On Environment:

- **Loss of soil fertility** and nutrient content
- **Disruption of microbial life** (e.g., nitrogen-fixing bacteria)
- **Water pollution** through leaching and runoff
- **Reduction in agricultural productivity**
- **Damage to plant root systems** and vegetation death

On Human and Animal Health:

- Exposure to toxic metals can cause **neurological, kidney, and reproductive issues**
- Consumption of **contaminated crops** leads to bioaccumulation
- Skin and respiratory problems in people working in polluted areas

Prevention and Control of Soil Pollution

Legislative and Government Actions:

- **Hazardous Waste Management Rules**
- **Ban on persistent pesticides like DDT**
- **Regulation of industrial discharge** and waste treatment

Agricultural Measures:

- **Use of bio-fertilizers and organic farming**
- **Integrated Pest Management (IPM)**
- Controlled use of chemical fertilizers and pesticides

Waste Management Strategies:

- **Proper disposal of solid and hazardous waste**
- **Recycling and composting of biodegradable waste**
- **Landfills designed with leak-proof lining**

Soil Remediation Techniques:

- **Bioremediation** – using microbes to degrade toxins
- **Phytoremediation** – using plants to absorb and clean contaminants
- **Soil washing** and stabilization techniques

Important Case Studies/Examples

- **Love Canal, USA** – Toxic waste dumping led to public health crisis
- **Bhopal Gas Tragedy (India)** – Soil still contaminated with toxic chemicals
- **Arsenic contamination in West Bengal** – From excessive pesticide use