Allama Iqbal Open University
Solved Guess Paper (100% Work)

Course Code:	**1421/5998/5443 Code**
Course Name:	**Introduction to Environment**
Class:	**BA /B.Com/BS/A.D**

Question No. 1: Differentiate between climate and weather. Also explain the difference between soil texture and soil structure. (Ch. 3 & 4)

Part A: Difference between Climate and Weather

Introduction

Weather and climate are two terms that people often use interchangeably, but they have different meanings in environmental science. Understanding the difference between them is important for studying atmosphere and environmental changes.

Definition of Weather

According to your book on page 66, **weather** is a description of the physical conditions of the atmosphere at a specific time and place. These conditions include:

- Moisture (humidity and precipitation)
- Temperature (how hot or cold it is)
- Air pressure (the weight of air)
- Wind (movement of air)

The book clearly states that "daily weather is determined by movement of air masses." Weather changes from day to day, hour to hour, and even minute to minute. For example, a morning might be sunny and warm, but by afternoon it could become cloudy and rainy. This is weather changing.

Definition of Climate

On the same page (page 66), your book defines **climate** as "a description of the long-term pattern of weather in a particular area." Climate is what you expect to happen based on many years of weather observations.

The book further explains that "climate undergoes cyclic changes over decade, centuries and millennia." This means climate changes very slowly over long periods of time, unlike weather which changes quickly.

Key Differences Between Climate and Weather

Based on your book, here are the main differences:

Aspect	Weather	Climate
Time Period	Short-term (hours, days, weeks)	Long-term (decades, centuries, millennia)
Description	Current atmospheric conditions	Average pattern of weather
Change Rate	Changes rapidly and frequently	Changes very slowly
What It Tells Us	What to wear today	What kind of clothes to keep in your closet
Example	Today's temperature is 35°C	Summers in Pakistan are generally hot

Simple Example to Understand

Think of it this way: If you visit a city for one day and it rains, that is the **weather**. But if that city receives rain for only 20 days every year on average over the past 50 years, that is its **climate**. One day of rain does not change the climate; climate is the big picture over a long time.

Part B: Difference between Soil Texture and Soil Structure

Introduction

Soil is not just simple dirt. It has different properties that determine how it behaves, how well plants grow in it, and how it responds to water and air. Two very important properties of soil are texture and structure. Your book discusses these in detail on pages 116-118.

Definition of Soil Texture

According to your book on page 116, **soil texture** "involves the size of individual mineral particles and specifically refers to the relative proportions of various-sized particles in a given soil."

The book further explains on page 115 that "soil texture is not readily subject to change. Thus, a sandy soil remains sandy, and a clay soil remains clayey. Since the proportion of each size group in a given soil (the texture) cannot be easily altered, it is considered a basic property of a soil."

The Three Main Soil Particles (Soil Separates)

Your book describes three main sizes of soil particles on pages 116-117:

1. **Sand** - The largest particles. They feel gritty when you rub soil between your fingers. Water passes through sand quickly.
2. **Silt** - Medium-sized particles. They feel smooth like flour or powder. Silt particles are smaller than sand but larger than clay.

3. **Clay** - The smallest particles. They feel sticky when wet and hard when dry. Clay particles are so small you need a microscope to see them.

Soil Textural Classes

Based on the percentage of sand, silt, and clay, soils are given different names called **textural classes**. Your book on page 118 and Box 4.8 describes four broad categories:

1. **Sandy Soils** - Contain at least 70% sand and 15% or less clay. These soils feel gritty, drain water quickly, and are easy to work with but may dry out fast.
2. **Silty Soils** - Contain at least 80% silt and 12% clay. These soils feel smooth and hold water better than sand.
3. **Clayey Soils** - Contain at least 35% clay. These soils feel sticky when wet, become hard when dry, and hold water for a long time.
4. **Loamy Soils** - The most balanced soils with a mixture of sand, silt, and clay. These are best for agriculture because they have good properties of all particle types.

Definition of Soil Structure

On page 116, your book defines **soil structure** as "the arrangement of soil particles into groups or aggregates." On page 118, it further explains that structure "relates to grouping or arrangement of soil particles. It describes the gross; overall arrangement of the primary soil separates into secondary groupings called aggregates or pads."

Unlike texture, soil structure can be changed by human activities like plowing, cultivating, adding manure, and other farming practices. Your book states on page 118: "The important physical changes imposed by the farmer in plowing, cultivating, draining, liming and manuring his land are structural rather than textural."

Types of Soil Structure

Soil particles can arrange themselves in different shapes:

- **Granular structure** - Small, rounded aggregates like crumbs. This is good for plant growth.
- **Blocky structure** - Block-like pieces that fit together.
- **Platy structure** - Thin, flat plates stacked horizontally.
- **Prismatic structure** - Vertical columns or pillars.
- **Structureless** - Particles exist separately with no visible arrangement (common in sandy soils).

Key Differences Between Soil Texture and Soil Structure

Aspect	Soil Texture	Soil Structure

Definition	Size distribution of individual mineral particles	Arrangement of particles into groups or aggregates
Can it be changed?	Cannot be easily altered; considered a basic property	Can be changed by farming practices and natural processes
What it describes	How much sand, silt, and clay is present	How these particles are held together
Examples	Sandy soil, clayey soil, loamy soil	Granular structure, blocky structure, platy structure
Determined by	Parent material and weathering	Organic matter, biological activity, and management
Importance	Affects water movement and nutrient holding	Affects root penetration, air movement, and water infiltration

Why Both Are Important

Your book emphasizes on page 118: "Soil conditions and characteristics such as water movements, heat transfer, aeration, and porosity are much influenced by structure." Both texture and structure together determine:

- How much water soil can hold
- How easily air moves through soil
- How well plant roots can grow
- How susceptible soil is to erosion
- How much nutrients are available for plants

Question No. 2: What are the major environmental concerns of Pakistan? Discuss how public awareness can play a major role in improving the environment. (Ch. 1 & 9)

Part A: Major Environmental Concerns of Pakistan

Introduction

Pakistan faces numerous environmental challenges that threaten its natural resources, economy, and the health of its people. Your book provides detailed information about these concerns in Unit

1 (pages 10-19) and Unit 9 (pages 190-204). The book states on page 10: "One of the contributing factors to the growing poverty in Pakistan is environmental degradation."

1. Water Pollution and Scarcity

According to your book on page 10: "Environmental issues including safe drinking water scarcity, water pollution... resulting in rapid depletion and degradation of these resources thus having adverse impacts on livelihoods."

The book further explains on page 19: "Factors like community wastes, industrial effluents, chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater." This means that:

- Rivers and lakes are polluted by industrial waste
- Groundwater is contaminated by chemicals from agriculture
- Many people lack access to clean drinking water
- Waterborne diseases are common

On page 10, your book states: "diarrhoeal diseases and typhoid due to inadequate water supply, sanitation and hygiene [account for] about 30% of the total damage cost" of environmental degradation in Pakistan.

2. Deforestation

Your book discusses deforestation in detail on page 18: "Forests in Pakistan have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were green once, stand today as wastelands."

The causes of deforestation mentioned in the book include:

- Clearing land for agriculture
- Using trees for fuel wood and timber
- Population pressure
- Overgrazing by livestock

On page 169, your book states: "Principle cause of deforestation in Pakistan is the consumption of fuel wood and timber." Forests cover only about 4% of Pakistan's land area according to page 191, which is very low compared to international standards.

3. Land Degradation and Soil Erosion

Your book provides extensive information about land degradation on pages 18-19 and 121-122:

"The major causes of land degradation in Pakistan include: poor irrigation and drainage practices, deforestation, over-grazing, water scarcity, drought, migration and permanent settlement, intensification of agriculture, flash flooding, population pressures, and prevailing poverty."

Regarding soil erosion specifically, the book states on page 121: "About 13.05 million hectares of area is affected by water erosion and about 6.17 million hectares by wind erosion." Table 4.3 on page 122 shows detailed figures for water erosion across provinces:

- Punjab: 1.90 million hectares affected
- Sindh: 0.058 million hectares affected
- NWFP: 4.29 million hectares affected
- Balochistan: 4.58 million hectares affected
- Northern Areas: 2.21 million hectares affected

Table 4.4 on page 122 shows wind erosion affects:

- Punjab: 3.80 million hectares
- Sindh: 2.05 million hectares
- NWFP: 0.036 million hectares
- Balochistan: 0.28 million hectares

4. Loss of Biodiversity

Your book discusses biodiversity loss in Unit 7 and specifically for Pakistan on pages 169-171. Table 7.1 on page 171 shows the rich biodiversity of Pakistan:

- Over 6,000 plant species
- 188 mammal species
- 666 bird species
- 174 reptile species
- 525 fish species
- 20,000 insect species

However, many species are threatened. The book lists endangered species including Indus Dolphin, Chiltan Markhor, Pakistan Sand Cat, Suleiman Markhor, Punjab Urial, and Balochistan Bear.

On page 169-170, the book identifies major reasons for biodiversity loss in Pakistan:

- **Deforestation** - Loss of forest habitats
- **Grazing** - "Rapidly increasing domestic livestock population is the direct cause of degradation on rangelands and forests"
- **Soil erosion and desertification** - Loss of vegetation cover

- **Pollution** - "Pakistan faces a serious challenge of growing pollution in urban areas and water courses"
- **Hunting** - "There is a strong tradition of illegal hunting and sports hunting in Pakistan. This has resulted into the decline of bird and mammal species"
- **Agricultural practices** - "Pesticide use in Pakistan has increased 7 fold in quantity between 1981 and 1992"

5. Air Pollution

Your book mentions air pollution on pages 10 and 19. On page 10, it states that "air and water pollution and land degradation cost US$ 2.2 billion or about 4 percent of GDP to Pakistan's economy." The book further notes that "illness and premature mortality caused by air pollution [accounts for] almost 50% of the total damage cost."

On page 19, it states: "Majority of our industrial plants are using outdated and pollution technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution."

6. Climate Change and Global Warming

Your book discusses climate change impacts on Pakistan in Unit 3. On page 129, it specifically mentions glaciers: "The glaciers are the primary fresh water resource on the earth. They feed the streams and the rivers with adequate amounts of water that is used up mainly for irrigation purposes. In Pakistan, agriculture and power generation are fully dependent on the fresh water supply fed by the discharges of the Karakorum glaciers."

The book warns on page 129: "Continued climate change is predicted to lead to major changes in fresh water flows with dramatic impacts on biodiversity, people and their livelihood... as glacier mass decrease there will be a decrease in the runoff with massive implications. Perennial rivers could be changed into seasonal streams giving rise to fresh water scarcity."

7. Urbanization Problems

On page 19, your book discusses urbanization: "Over the next 25 years, the urban population in Pakistan is likely to increase by 140%. This dramatic increase in urban populations will add another 80 million to the urban population in Pakistan."

Problems of urbanization listed include:

- Inadequate and crowded housing
- Poor public services (water, sanitation, waste disposal)
- Increased crime rates

- Inadequate transport system

On page 202-203, the book adds: "Rapid and unplanned urban expansion has resulted in deterioration of living conditions, degradation of physical environment and excessive pressures upon the existing urban facilities. Water supply and sewerage systems are inadequate, of poor quality, and mostly unhygienic."

8. Economic Costs of Environmental Degradation

Your book provides alarming statistics on page 10: "According to a conservative estimate environmental degradation cost Pakistan at least 6 percent of GDP or about Rs. 365 billion (US $6.05 billion) per year and all these costs fall disproportionately upon the poor."

The breakdown of these costs is:

- Air pollution: almost 50% of total damage cost
- Water-related diseases: about 30% of total damage cost
- Soil degradation: about 20% of total cost

Part B: Role of Public Awareness in Improving the Environment

Introduction

Your book strongly emphasizes the importance of public awareness and environmental education throughout Unit 1. On page 10, it states: "Rapid degradation of environment in Pakistan and the ensuring poverty can be attributed to a number of key factors including the utter lack of environmental awareness and education."

Objectives of Environmental Education

On page 9, your book lists the key objectives of environmental education:

1. "To create environmental awareness"
2. "To disseminate knowledge and skills"
3. "To initiate new behavioral approach at individual/or groups levels towards environment"
4. "To develop inter disciplinary view of environment as a dynamic system and to emphasis its complexity"
5. "To help in promotion of environmentally sound development program towards sustainable growth"
6. "To create an atmosphere of national, international understanding and global cooperation in the areas of environmental priority"

How Public Awareness Improves Environment

1. Changing Attitudes and Behaviors

On page 9, your book states that environmental objectives "can be achieved firstly by bringing about positive attitudinal and behavioral changes in teachers and students in respect of environmental problems and conservation."

When people are aware of environmental issues, they change their daily behaviors:

- They waste less water
- They dispose of waste properly
- They use fewer harmful chemicals
- They plant trees and protect green areas

2. Creating Knowledge about Problems and Solutions

According to page 9, awareness means "creating awareness about past, current and expected situations of environmental considerations in pursuit of sustainable environment." When people know about problems, they can:

- Understand the causes of pollution
- Recognize the importance of natural resources
- Learn about solutions they can apply
- Make informed decisions

3. Information Sharing and Exchange

Page 9 mentions the importance of "disseminating information and exchange knowledge and experience gained in achieving the goals of sustainable development." When aware citizens share information:

- Communities learn from each other's successes
- Best practices spread from one area to another
- Traditional knowledge combines with modern science
- People feel empowered to take action

4. Developing Critical Thinking

Your book emphasizes on page 9: "encouraging and developing critical thinking among students in dealing with real world environmental challenges in general and of local origin in particular." Critical thinking helps people:

- Question harmful practices
- Analyze environmental problems
- Evaluate proposed solutions
- Make better choices for their communities

5. The Domino Effect of Environmental Education

Your book introduces an important concept called the "Domino Effect" on page 9. Box 1.1 explains: "The domino effect is a chain reaction that occurs when a small change causes a similar change nearby, which then will cause another similar change, and so on in linear sequence."

Figure 1.1 on page 12 shows how environmental education leads to sustainable development in Pakistan. This means:

- One educated person influences their family
- The family influences neighbors
- Neighbors influence the community
- Communities influence the whole society
- The whole society moves toward sustainable development

6. Understanding the Link Between Environment and Poverty

On page 10, your book explains that "one of the contributing factors to the growing poverty in Pakistan is environmental degradation." When people understand this link:

- They realize environmental protection is not just about nature but about their own survival
- Poor communities learn to use resources sustainably
- People protect natural resources that provide their livelihoods
- Communities work together to prevent environmental damage

7. Enforcing Environmental Laws

On page 19, your book discusses environmental laws: "Acts are enforced in the country, but their implementation is not so easy. The reason is their implementation needs great resources, technical expertise, political and social will. Again the people are to be made aware of these rules. Their support is indispensable to implement these rules."

When people are aware:

- They follow environmental laws voluntarily
- They report violations
- They support government efforts
- They demand better enforcement from authorities

8. Protecting Biodiversity

On pages 18-19, your book mentions: "The tribal communities inhabiting forests respect the trees and birds and animal that give them sustenance. We must recognize the role of these people in restoring and conserving forests. The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities."

This shows that:

- Local communities already have valuable knowledge
- Awareness programs should respect and build on traditional wisdom
- Community involvement is essential for conservation
- Joint management of resources works best

9. Creating Environmental Literacy

On page 14, your book defines the criteria for environmental awareness (environmental literacy):

- "awareness of natural and built environment"
- "knowledge of natural systems and ecological concepts"
- "understanding of current environmental issues"
- "the ability to critically analyze and develop a problem solving approach"

10. Empowering Citizens

Throughout Unit 1, your book emphasizes that aware citizens can:

- Participate in environmental decision-making
- Protect their own health from pollution
- Demand better services from government
- Hold industries accountable for pollution
- Contribute to sustainable development

Expert Requirement in Pakistan

Your book provides an interesting statistic on page 11, Table 1.1: Pakistan needs about 13,000 environmental experts but currently produces only about 300 annually. This shows:

- There is a huge gap in environmental expertise
- Environmental education needs to expand
- Every citizen needs basic environmental knowledge, not just experts
- Public awareness can partially fill this gap until more experts are trained

Question No. 3: Define ecosystem. Explain the components of an ecosystem with suitable examples. (Ch. 2)

Part A: Definition of Ecosystem

Introduction

The concept of ecosystem is central to environmental science. Your book introduces this important term in Unit 2 and provides a comprehensive explanation.

Simple Definition

On page 29, your book gives the simplest definition: **"Ecosystem is a set of components (living and non living) interacting with each other."**

This means an ecosystem is not just a collection of plants and animals, but includes everything around them and all the ways they connect and affect each other.

Detailed Definition

On page 35, your book provides a more complete definition: "Any ecological unit that includes all the organisms (i.e., the communities in a given area) which interact among themselves and with the physical environment, so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle (i.e. exchange of materials) within the system is known as ecological system or ecosystem."

Origin of the Term

According to page 35, "The term ecosystem was proposed by A. G. Tansley in 1935." Other scientists have used different names for similar concepts:

- Biooceanosis (Karl Mobius, 1877)
- Microcosm (S.A. Forbes, 1887)
- Geobiocoenosis (Sukhachev, 1944)
- Bioinert body (Vernadsky, 1944)

Essential Characteristics of an Ecosystem

On page 35, your book states that "a complete ecosystem must exhibit following characters":

1. **Living organism** - Presence of biotic components
2. **Physical environment** - Presence of abiotic components

3. **Flow of energy** - Energy moves through the system
4. **Cycling of materials** - Nutrients are recycled

Size and Scale of Ecosystems

Your book explains on page 35 that ecosystems can be very different in size: "An ecosystem may, thus be as small as a single log, a pond, a cropland, or as large an ocean, desert or forest. Though these unit ecosystems are separated from each other with time and space, but functionally they all are linked with each other, forming an integrated whole."

Types of Ecosystems

On page 36, your book classifies ecosystems into:

1. **Natural ecosystems** - Operate without major human interference
   - Terrestrial ecosystems (forests, grasslands, deserts)
   - Aquatic ecosystems (fresh water and marine)
2. **Artificial ecosystems** - Man-made or man-engineered
   - Croplands, orchards, gardens, villages, cities, dams, aquarium
3. **Micro ecosystems** - Small models created in laboratories for study

Part B: Components of an Ecosystem with Examples

Introduction

On page 36, your book states: "The structure of an ecosystem is basically a description of the species of organisms that are present, including information on their life histories, populations and distribution in space." An ecosystem has two major components: Abiotic (non-living) and Biotic (living).

1. Abiotic or Non-living Components

According to page 37, the abiotic component comprises three sorts of components:

a. Climatic Conditions and Physical Factors

These include:

- Air
- Water

- Soil
- Temperature
- Light (duration and intensity)
- Moisture (relative humidity)
- pH (acidity or alkalinity)

Example from Pond Ecosystem: On page 38, your book mentions that in a pond ecosystem, abiotic substances include "heat, light, pH value of water" and other physical factors.

b. Inorganic Substances

These are elements and compounds involved in nutrient cycling:

- Water (H_2O)
- Carbon (C)
- Nitrogen (N)
- Sulfur (S)
- Phosphorus (P)
- Calcium (Ca)
- Other minerals

On page 37, your book explains: "The amount of these inorganic substances, present at any given time in an ecosystem, is designated as the standing state or standing quality."

Example from Pond Ecosystem: On page 38, the book lists "carbon dioxide gas, oxygen gas, calcium, nitrogen, phosphates" and inorganic salts like "phosphates, nitrates and chlorides of sodium, potassium and calcium."

c. Organic Substances

These are compounds present in biomass or environment:

- Proteins
- Carbohydrates
- Lipids (fats)
- Humus (decayed organic matter)

Example from Pond Ecosystem: On page 38, the book mentions "amino acids, humic acid" as organic compounds present in the pond.

2. Biotic or Living Components

On page 37, your book explains that living organisms are distinguished based on their nutritional relationships into two main categories:

a. Autotrophic Component (Producers)

The word "autotrophic" comes from "auto" meaning self and "trophic" meaning nourishing. On page 37, your book defines autotrophs as "the producers which convert solar energy into chemical energy that becomes locked in complex organic substances such as carbohydrate, lipid, protein, etc."

Autotrophs are further divided into:

Photoautotrophs - Use sunlight energy

- Contain green pigment called chlorophyll
- Trap solar energy to make food
- Examples: trees, grasses, algae, photosynthetic bacteria, cyanobacteria (blue-green algae)

Chemoautotrophs - Use chemical energy

- Use energy from oxidation-reduction processes
- Less significant in ecosystems
- Examples: Beggiatoa, sulfur bacteria

Example from Pond Ecosystem: On page 39, your book describes producers in a pond:

1. **Macrophytes** - Rooted large-sized plants
   - Partly or completely submerged: Hydrilla
   - Floating: Azolla, Salvinia, Lemna
   - Emergent aquatic plants: Trapa, Typha, Eleocharis, Sagittaria, Marsilea
2. **Phytoplankton** - Microscopic floating plants
   - Examples: Spirogyra, Ulothrix, Volvox, Diatoms, Anabaena, Oscillatoria, Chlamydomonas

b. Heterotrophic Component (Consumers)

On page 37, your book defines heterotrophs as organisms where "hetero" means other and "trophic" means nourishing. These organisms "predominate the activities of utilization, rearrangement and decomposition of complex organic materials."

Heterotrophs are also called **consumers** because "they consume the matter built up by the producers (autotrophs)."

Types of Consumers:

1. Macroconsumers (Phagotrophs)

On page 38, your book explains: "These are also called phagotrophs (phago = to eat) and include mainly animals which consume other organisms or chunks of organic matter."

Based on food habits, macroconsumers are:

Consumer Level	Name	Food Source	Examples
Primary consumers	Herbivores	Eat plants directly	Insects, zooplankton, deer, cattle, elephant
Secondary consumers	Carnivores (first order)	Eat herbivores	Insects like dragon flies, spiders
Tertiary consumers	Carnivores (second order)	Eat other carnivores	Tiger, lion, leopard, wolf

Example from Pond Ecosystem: On page 39, your book describes three types of consumers:

a. **Herbivores (Primary consumers)** - Feed directly on plants

- **Benthos**: Bottom-dwelling forms like fish, insect larvae, beetles, mites, molluscs
- **Zooplankton**: Rotifers like Brachionus, Asplanchna, Lecane
- Also cows, buffaloes that visit pond, birds that feed on hydrophytes

b. **Carnivore order-I (Secondary consumers)** - Feed on herbivores

- Chiefly insects, fish, and amphibians (frog)
- Water beetles feed on zooplankton
- Dragonfly nymphs feed on aquatic insects

c. **Carnivore order-II (Tertiary consumers)** - Top consumers

- Large fish (game fish) that feed on smaller fish

2. Microconsumers (Decomposers, Reducers, Saprotrophs, Scavengers)

On page 38, your book explains: "Microconsumers include microorganisms such as bacteria, actinomycetes and fungi. Microconsumers breakdown complex organic compounds of dead or living organisms, absorb some of the decomposition or breakdown products and release inorganic nutrients in the environment, making them available again to autotrophs or producers."

The book also notes: "The decaying dead organic matter is also known as organic detritus (Latin word deterere means to wear away)."

Importance of Decomposers:

- Break down dead organic matter
- Release nutrients back to environment
- Complete the nutrient cycle
- Make nutrients available for producers again

Example from Pond Ecosystem: On page 40, your book states: "Decomposers of pond ecosystem include chiefly bacteria, actinomycetes and fungi." They "bring about the decomposition of dead organic matter of both producers (plants) as well as consumers (animals) to simple forms" and "help in returning of mineral elements again to the medium of the pond and in running biogeochemical cycles."

Summary Table: Ecosystem Components with Pond Examples

Component	Sub-category	Definition	Examples from Pond
Abiotic	Physical factors	Non-living conditions	Light, temperature, pH, water
	Inorganic substances	Minerals and elements	Carbon dioxide, oxygen, calcium, nitrogen, phosphates
	Organic substances	Carbon-based compounds	Amino acids, humic acid
Biotic - Producers	Photoautotrophs	Use sunlight to make food	Macrophytes (Hydrilla, Typha), Phytoplankton (Spirogyra, Diatoms)
	Chemoautotrophs	Use chemical energy	Beggiatoa (minor role)
Biotic - Consumers	Primary consumers (Herbivores)	Eat producers	Zooplankton, insect larvae, beetles
	Secondary consumers	Eat herbivores	Water beetles, dragonfly nymphs
	Tertiary consumers	Eat other carnivores	Large game fish
Biotic - Decomposers	Microconsumers	Break down dead matter	Bacteria, actinomycetes, fungi

The Pond as a Complete Ecosystem

Your book uses a pond as an example of a complete, self-sufficient ecosystem on page 38: "A pond as a whole serves as a good example of an aquatic and freshwater ecosystem. In fact, it represents a self-sufficient and self-regulating system."

In a pond ecosystem:

- **Producers** (plants and algae) capture sun energy and make food
- **Consumers** (animals) eat the producers or each other
- **Decomposers** (bacteria and fungi) break down dead material
- **Abiotic components** (water, minerals, light) provide the physical environment
- Energy flows from sun → producers → consumers → decomposers
- Nutrients cycle continuously between organisms and environment

This shows how all components work together as one functional unit, which is exactly what an ecosystem means.

Question No. 4: What is environmental pollution? Describe the major types of pollution and their effects on human life.

Definition of Environmental Pollution

According to your book, environmental pollution refers to the contamination of air, water, and land by harmful substances. On page 10, the book mentions "pollution of air, water and land" as a major cause of environmental degradation. On page 19, it states that industrial plants use "outdated and pollution technologies" and release wastes without treatment, causing pollution.

Simple Definition: Environmental pollution is the addition of harmful substances to the environment that damage air, water, land, and negatively affect living organisms including humans.

Major Types of Pollution and Their Effects on Human Life

1. Air Pollution

Definition: Contamination of the atmosphere by harmful gases, particles, and chemicals.

Sources according to your book:

- Page 10: Burning of fossil fuels, industrial emissions

- Page 19: "Majority of our industrial plants are using outdated and pollution technologies"
- Page 79-80: "Major sources are the burning of fossil fuels, car exhaust fumes"
- Page 80: "Photochemical smog... forms when oxides of nitrogen and un-burnt hydrocarbons from vehicle exhaust react with sunlight"

Effects on Human Life:

- Page 10: "Illness and premature mortality caused by air pollution [accounts for] almost 50% of the total damage cost" of environmental degradation in Pakistan
- Page 10: Air pollution costs Pakistan about Rs. 365 billion per year
- Page 80: "Asthma and other breathing problems may be intensified"
- Page 80: Pollution contributes to "learning disabilities, feeble immune systems, asthma, cancer, and developmental problems"
- Respiratory diseases, lung cancer, heart problems

2. Water Pollution

Definition: Contamination of water bodies such as rivers, lakes, oceans, and groundwater.

Sources according to your book:

- Page 10: "Water pollution" from industrial and municipal wastes
- Page 17: "Factors like community wastes, industrial effluents, chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater"
- Page 19: "Acts are enforced in the country, but their implementation is not so easy"
- Page 203: "Unplanned industrialization has destroyed natural resources. In many places, industry has polluted soil, water and air"

Effects on Human Life:

- Page 10: "diarrhoeal diseases and typhoid due to inadequate water supply, sanitation and hygiene about 30% of the total damage cost"
- Page 10: "over 3 million deaths each year are traced to waterborne diseases (mostly in children under 5)"
- Page 126: "In the developing world... over 1 billion people still lack access to clean drinking water"
- Waterborne diseases: cholera, typhoid, diarrhea, hepatitis
- Contamination of drinking water sources
- Accumulation of toxic chemicals in food chain

3. Land/Soil Pollution

Definition: Degradation of land surface through improper waste disposal, chemicals, and erosion.

Sources according to your book:

- Page 18: "The major causes of land degradation in Pakistan include: poor irrigation and drainage practices, deforestation, over-grazing, water scarcity, drought"
- Page 19: "Soil erosion implies loss or removal of surface soil material"
- Page 111: "Soils are used to absorb wastes from sewage systems, wastes from other municipal, industrial, and animal sources"
- Page 203: "industry has polluted soil, water and air"

Effects on Human Life:

- Page 10: "reduced agricultural productivity due to soil degradation about 20% of the total cost"
- Page 17: "High yielding varieties have caused soil salinity and damage to physical structure of soil"
- Reduced food production and food security
- Contamination of food crops with toxic chemicals
- Loss of agricultural livelihoods
- Page 10: Environmental degradation "adversely affecting the health of the poor and hence increasing the burden of disease"

4. Noise Pollution

Definition: Harmful or annoying levels of noise in the environment.

Sources according to your book:

- Page 203: "The unplanned and unchecked system of traffic results in air and noise pollution"

Effects on Human Life:

- Hearing loss and damage
- Sleep disturbance
- Stress and anxiety
- Reduced工作效率
- Cardiovascular problems

Summary Table: Pollution Types and Effects

Pollution Type	Main Sources (from book)	Effects on Human Life
Air Pollution	Industries, vehicles, fossil fuel burning	Respiratory illness, asthma, cancer, premature death

Water Pollution	Industrial effluents, sewage, fertilizers, pesticides	Diarrhea, typhoid, waterborne diseases, child mortality
Land/Soil Pollution	Poor irrigation, deforestation, waste dumping	Reduced crop yields, food contamination, loss of livelihoods
Noise Pollution	Traffic, urban activities	Hearing damage, stress, sleep disorders

Question No. 5: Explain the importance of natural resources. How can natural resources be conserved for future generations?

Importance of Natural Resources

Definition: Natural resources are materials and components from nature that are useful to humans. Your book discusses various natural resources including water, soil, forests, minerals, and biodiversity.

Importance According to Your Book:

1. Water Resources

- Page 125: "Water is absolutely fundamental to life as we know it"
- Page 126: "Fresh water is a vital resource for all land ecosystems"
- Page 126: "They provide drinking water, water for industries, and water to irrigate crops"
- Page 126: "Bodies of water furnish energy through hydroelectric power and control flooding"
- Page 129: "The glaciers are the primary fresh water resource on the earth. They feed the streams and the rivers with adequate amounts of water that is used up mainly for irrigation purposes. In Pakistan, agriculture and power generation are fully dependent on the fresh water supply"

2. Soil Resources

- Page 111: "People are dependent on soils... They provide the starting point for successful agriculture"
- Page 111: "Soils also have other meanings for humankind. They underlie the foundations of houses and factories"
- Page 111: "Most great civilizations have depended on good soils"
- Page 111: "Just as good soils helped to build flourishing civilizations, soil destruction or mismanagement was a contributing factor in their downfall"

3. Forest Resources

- Page 162: "Wood is a basic commodity used worldwide... It is a primary source of fuel, is used in construction, furniture, and forms the basis for paper production"
- Page 163: "Vegetation influences the climate at macro and micro levels"
- Page 163: "Undisturbed forests can help to maintain the rainfall in its immediate vicinity"
- Page 18: Forests provide sustenance to tribal communities

4. Biodiversity (Plants and Animals)

- Page 160: "Five thousand plant species have been used as food by humans"
- Page 160: "A significant proportion of drugs are derived, directly or indirectly, from biological sources"
- Page 161: "About 80% of the world population depends on medicines from nature for primary healthcare"
- Page 162: "Numerous insects pollinate crops"
- Page 162: "Termites and earthworms aerate the soil"
- Page 160: "Species are the key working parts of natural ecosystems"

5. Minerals and Rocks

- Page 104: "Minerals and rocks are the foundation materials for the Soils"
- Page 103: "The processes have produced many earth materials necessary for human survival"
- Page 106: "Minerals are a natural resource for any country. The availability and extraction of minerals determine the technological development as well as economic and political power for the nation"

6. Economic Importance

- Page 10: Natural resources contribute to livelihoods, especially for rural populations
- Page 133: Pakistan's irrigation system "accounts for a 1/4 of the country's GDP, 2/3 of employment and about 80% of exports"
- Page 10: "Livelihoods of a considerable portion of country's population, especially those living in the rural areas, depend on goods and services provided by natural resources"

How Natural Resources Can Be Conserved for Future Generations

1. Sustainable Development Approach

- Page 7: "By sustainability we mean that meeting our needs judiciously and sensibly, so that our future generations get the equal share of resources that we have today"
- Page 181: "Natural systems use solar energy as the ultimate source and the nutrients, water, etc. are substantially recycled"

2. Reduce Dependence on Fossil Fuels

- Page 182: "Reduce dependence upon fossil fuels, underground metals and minerals"
- Page 182: "Mining and burning fossil fuels generate unsafe levels of many different pollutants"
- Page 186: "Solar energy is extremely abundant... we already have the technology to obtain much more of our energy needs from sunlight"

3. Reduce Encroachment Upon Nature

- Page 182: "Reduce encroachment upon nature" through:
  - Protecting natural habitats
  - Smart growth
  - Supporting sustainable fishing, agriculture and timber harvesting practices
- Page 182: This principle "addresses the physical destruction and manipulation of the biosphere"

4. Water Conservation

- Page 17: "It is essential of rationalizing the use of groundwater"
- Page 17: "finding our suitable strategies for consecration of water, provision of safe drinking water and keeping water bodies clean"
- Page 140: "Water-efficient drip irrigation and other low-volume distribution systems can save significant amounts of water"

5. Forest Conservation

- Page 18: "The strategies for the joint management of forests should be evolved in a well planned way"
- Page 18: "The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities"
- Page 163: Protecting forests maintains rainfall and climate stability

6. Soil Conservation

- Page 119: "No soil phenomenon is more destructive worldwide than soil erosion"
- Page 122: Controlling erosion through vegetation cover
- Page 163: "Soil protection can preserve the productive capacity of the soil, prevent landslides, safeguard coastlines and riverbanks"

7. Biodiversity Conservation

- Page 19: "Proper measures to conserve genetic diversity need to be taken"

- Page 19: "The protected areas network like sanctuaries, national parks, biosphere reserves... need to be developed"
- Page 169: Pakistan has "225 Protected Areas (PAs): 14 national parks, 99 wildlife sanctuaries, and 96 game reserves"

8. Reduce Dependence on Synthetic Chemicals

- Page 183: "Reduce dependence upon chemicals and synthetic compounds"
- Page 183: "using safe, biodegradable alternatives which can be reintegrated into natural cycles"
- Page 183: "decreasing the amount of waste generated by society"

9. Meet Human Needs Fairly and Efficiently

- Page 182: "Meet human needs fairly and efficiently, giving priority to basic needs"
- Page 183: "We can shift from linear models of infinite resource use and infinite growth to cyclical models of infinite transformation and change"

10. Environmental Education and Awareness

- Page 9: Environmental education creates "awareness about past, current and expected situations of environmental considerations"
- Page 9: It helps in "promotion of environmentally sound development program towards sustainable growth"
- Page 10: Lack of environmental awareness is a key factor in environmental degradation

11. Reduce, Reuse, Recycle

- Page 186: In natural ecosystems, nutrients are recycled. Human systems should copy this model
- Page 187: "Ecosystems dispose of wastes and replenish nutrients by recycling the elements. This maintains their sustainability, indefinitely"

Question No. 6: What is sustainable development? Discuss its importance in protecting the environment.

Definition of Sustainable Development

Definition from Your Book:

On page 7, your book clearly defines sustainability: **"By sustainability we mean that meeting our needs judiciously and sensibly, so that our future generations get the equal share of resources that we have today."**

On page 10, it further states: **"Sustainable Development in the context of Pakistan demands justice in the use of resources by the present generations keeping in view the needs of future generations."**

Key Elements of the Definition:

1. Meeting current human needs
2. Using resources wisely (judiciously and sensibly)
3. Ensuring future generations get equal share of resources
4. Justice in resource use
5. Long-term thinking

The Domino Effect Concept:

On page 9, your book introduces the "Domino Effect" (Box 1.1): "The domino effect is a chain reaction that occurs when a small change causes a similar change nearby, which then will cause another similar change, and so on in linear sequence."

Figure 1.1 on page 12 shows how **environmental education → positive attitudes → sustainable development** creates a domino effect toward sustainability in Pakistan.

Importance of Sustainable Development in Protecting the Environment

1. Prevents Resource Depletion

- Page 7: Ensures "future generations get the equal share of resources that we have today"
- Page 181: Natural systems achieve sustainability by "using renewable solar energy" and "recycling chemical nutrients"
- Without sustainability, we would use up all resources and leave nothing for future generations

2. Reduces Environmental Degradation

- Page 10: Environmental degradation costs Pakistan "at least 6 percent of GDP or about Rs. 365 billion per year"
- Page 10: Degradation "adversely affects the health of the poor and hence increasing the burden of disease"
- Sustainable development aims to stop this degradation

3. Protects Biodiversity

- Page 19: "Proper measures to conserve genetic diversity need to be taken"
- Page 169: Pakistan has established protected areas to conserve species
- Sustainable development ensures species do not become extinct due to human activities

4. Maintains Ecosystem Services

- Page 180, Figure 8.1 shows ecosystem services that support life:
  - Purification of air and water
  - Production of food and medicine
  - Climate regulation
  - Nutrient cycling
  - Waste treatment
- Page 180: "Without these services performed by diverse communities of species we would be starving, gasping for breath and drowning in our own wastes"

5. Guides Human Activities

- Page 181: "To move in the direction of sustainability, activities need to be oriented to meet our human needs efficiently, fairly, and within the means of nature to support those needs"
- Page 188: "We must maintain a balance between simplified, human-altered ecosystems and the neighboring, more complex natural ecosystems"

6. Four Principles of Sustainability (from page 182-183)

These principles directly protect the environment:

Principle	How It Protects Environment
Reduce dependence on fossil fuels	Reduces air pollution, global warming, and mining damage
Reduce encroachment upon nature	Protects habitats, prevents deforestation, stops urban sprawl
Meet human needs fairly and efficiently	Reduces overconsumption and waste
Reduce dependence on synthetic chemicals	Prevents pollution, protects ecosystems from toxic substances

7. Lessons from Nature for Sustainability (page 188)

Your book states that learning from nature helps us live more sustainably:

- "Our lives, lifestyles, and economies are totally dependent on the sun and the earth"

- "Everything is connected to everything else"
- "We can never do merely one thing. Any human intrusion into nature has mostly unpredictable side effects"
- "We should reduce and minimize the damage we do to nature and help heal some of the ecological wounds we have inflicted"

8. Creates Cyclical Rather Than Linear Systems

- Page 187, Figure 8.4 shows that in man-made ecosystems, flow is one-directional (resources → use → waste)
- Page 187: Natural ecosystems are cyclical (nutrients are recycled)
- Page 183: "We can shift from linear models of infinite resource use and infinite growth to cyclical models of infinite transformation and change. This is how nature works"

9. Reduces Vulnerability to Disasters

- Page 10: Environmental degradation causes "increased vulnerability to disasters such as droughts, floods and landslides"
- Page 10: "The drought incidence of 2000-2001, for instance, resulted in elimination of livestock worth US$ 247 million"
- Sustainable development reduces this vulnerability

10. Addresses the Link Between Poverty and Environment

- Page 10: "One of the contributing factors to the growing poverty in Pakistan is environmental degradation"
- Page 17: "The poverty and environmental degradation have a nexus between them"
- Page 17: "The challenge of poverty and the challenge of environment degradation are two facets of the same challenge"
- Sustainable development addresses both together

11. Ensures Long-term Economic Stability

- Page 10: Environmental damage costs Pakistan billions annually
- Page 133: Agriculture based on sustainable water use accounts for "1/4 of the country's GDP, 2/3 of employment and about 80% of exports"
- Without sustainability, these economic benefits will be lost

12. Protects Future Generations

- Page 7: The core of sustainability is ensuring "our future generations get the equal share of resources that we have today"

- Page 10: "Justice in the use of resources by the present generations keeping in view the needs of future generations"
- This is both an environmental and moral imperative

Summary Table: Importance of Sustainable Development

Aspect	How It Protects Environment
Resource Conservation	Ensures resources last for future generations
Pollution Reduction	Minimizes waste and harmful emissions
Biodiversity Protection	Preserves species and ecosystems
Ecosystem Services	Maintains natural processes that support life
Disaster Prevention	Reduces vulnerability to floods, droughts, landslides
Economic Benefits	Saves billions in environmental damage costs
Social Justice	Addresses poverty-environment nexus
Cyclical Systems	Promotes recycling over linear consumption

Question No. 7: Write short notes on the following: (a) Biodiversity (b) Deforestation (c) Global Warming

(a) Biodiversity

Definition:

- Page 158: "The variety of life in all its forms, levels and combinations is known as Biological Diversity or Biodiversity"

Key Points:

- Can be measured at different levels: genetic diversity, species diversity, and ecosystem diversity
- Most commonly refers to number of different species in a defined area
- Recent estimates of total species range from 7 to 20 million, but only about 1.75 million have been scientifically described

Benefits of Biodiversity (Page 160-164):

- **Biological Resources:** Food (5000 plant species used as food), medicinal resources (80% of world population depends on nature for medicine), wood products, ornamental plants
- **Ecosystem Services:** Protection of water resources, soil formation and protection, nutrient cycling, pollution breakdown, climate stability
- **Social Benefits:** Research, education, tourism, recreation, cultural identity

Threats to Biodiversity (Page 164-167):

- Natural causes: climate change, natural disasters
- Human causes: habitat loss, overharvesting, hunting, introducing exotic species, diseases, pollution

Biodiversity in Pakistan (Page 169-171):

- Pakistan has 5 global ecoregions
- 225 Protected Areas (14 national parks, 99 wildlife sanctuaries, 96 game reserves)
- Table 7.1 shows Pakistan has over 6000 plant species, 188 mammals, 666 birds, 174 reptiles, 525 fish species

(b) Deforestation

Definition:
Clearing or removal of forests and trees from land.

Causes in Pakistan (Page 169):

- "Principle cause of deforestation in Pakistan is the consumption of fuel wood and timber"
- Clearing land for agriculture
- Population pressure
- Urbanization and development

Extent of Forests in Pakistan:

- Page 191: "Forests, both natural and man-made, cover about 4% of its land area" (very low compared to international standards)

Consequences of Deforestation (Page 18, 163-164):

- Page 18: "Vast areas that were green once, stand today as wastelands"
- Soil erosion increases
- Loss of biodiversity and habitat
- Disruption of water cycle
- Climate change impacts

- Loss of livelihood for forest-dependent communities

Affected Areas (Hot Spots) in Pakistan (Page 199-200):

- Juniper Forests of northern Balochistan: heavily harvested for timber and fuel wood
- Indus River Zone: riverain forests cleared for agriculture
- Himalayan Temperate Forests: under severe pressure from logging

(c) Global Warming

Definition:
Page 85: "Global warming is caused primarily by carbon dioxide from burning coal, oil and gas. Certain gases that trap heat are building up in Earth's atmosphere."

Greenhouse Gases (Page 85):

1. **Carbon dioxide (CO_2)** - from burning coal, oil, natural gas in power plants, cars, factories
2. **Methane (CH_4)** - from rice paddies, cattle, rotting garbage, mining, gas pipelines
3. **Chlorofluorocarbons (CFCs)** - from refrigerators, air conditioners, sprays
4. **Nitrous oxide** - from fertilizers and chemicals

Greenhouse Effect Explained (Page 85-86):

- Greenhouse gases form a layer in atmosphere that traps infrared radiation (heat) emitting from earth
- This layer behaves like a blanket, holding heat close to earth's surface
- As CO_2 concentration increases, it's like adding more blankets, continuously increasing warmth

Impacts of Global Warming (Page 83-85):

1. **Hydrology and Glaciers:** Glaciers retreating, snow cover decreasing (Page 129: Pakistan's agriculture and power generation dependent on Karakorum glaciers)
2. **Animals:** Species shifting pole-ward, extinction risk (over million species predicted to become extinct by 2050)
3. **Plants:** Changes in flowering time, growth patterns, crop yields affected
4. **Rainfall:** More heat waves, fewer frosts, more wildfires in dry regions, floods in wet regions
5. **Sea Level Rise:** Low-lying coastal areas at risk of inundation

Temperature Rise:

- Page 82: World has warmed 0.74°C in past hundred years
- Page 83: Global average temperature forecast to rise 4°C toward end of 21st century

Question No. 8: What are renewable and non-renewable resources? Explain with examples.

Renewable Resources

Definition:
Resources that can be replenished naturally over short periods of time and are continuously available.

Characteristics:

- Can be used repeatedly
- Naturally renewed through ecological cycles
- Sustainable if not overexploited
- Solar energy is the ultimate source for most renewable resources

Examples from Your Book:

Renewable Resource	Description	Book Reference
Solar Energy	Page 186: "Solar energy is extremely abundant... we already have the technology to obtain much more of our energy needs from sunlight"	Page 46, 186
Water (Fresh water)	Page 125: "Fresh water is a continually renewable resource" through the hydrologic cycle	Page 125, 134
Forests/Trees	Can be regrown through replanting and natural regeneration	Page 18, 198-199
Air	Atmosphere is constantly renewed through biogeochemical cycles	Page 66-67
Soil	Formed through weathering processes, though very slowly	Page 112-113
Biodiversity	Populations can reproduce and maintain themselves if habitats protected	Page 158-160
Wind Energy	Caused by solar heating of atmosphere, continuously available	Page 186
Agricultural Crops	Can be planted and harvested each season	Page 160-161

Sustainable Use of Renewable Resources:

- Page 7: Use "judiciously and sensibly, so that our future generations get the equal share"
- Page 182: "Reduce encroachment upon nature" to maintain renewable resources

Non-Renewable Resources

Definition:
Resources that exist in fixed amounts and cannot be replenished once used up, or take millions of years to form.

Characteristics:

- Finite supply
- Formation takes geological time (millions of years)
- Once depleted, cannot be replaced within human timeframes
- Extraction often causes environmental damage

Examples from Your Book:

Non-Renewable Resource	Description	Book Reference
Fossil Fuels (Coal, Oil, Natural Gas)	Page 85: "burning coal, oil and natural gas" are primary sources of CO_2. Page 152: Formed from ancient organic matter over millions of years	Page 85, 152
Minerals	Page 104-105: Silicates, carbonates, sulfides, metal oxides. Page 106: "Minerals are a natural resource for any country"	Page 104-106
Metals (Iron, Aluminum, Copper, Gold)	Page 105: Mined from ore deposits. Page 106: Box 4.6 discusses environmental effects of mining	Page 105-106
Phosphate Rocks	Page 154: "Phosphate ores that now are mined to make detergents and inorganic fertilizers represent exposed ocean sediments that are millennia old"	Page 154
Groundwater (fossil water)	Page 130: Some aquifers are filled very slowly; water being removed faster than replenished	Page 130
Limestone and Marble	Page 109: Formed over long geological periods. Pakistan has extensive marble deposits	Page 109

Problems with Non-Renewable Resource Use (Page 182):

- "Mining and burning fossil fuels generate unsafe levels of many different pollutants"
- "Mining operations threaten national parks, require massive amounts of energy and chemicals that leak into groundwater"
- Page 106: "The environmental impact will continue to increase" as we mine lower grade deposits

Comparison Table

Aspect	Renewable Resources	Non-Renewable Resources
Replenishment	Naturally renewed in short time	Cannot be replenished; fixed supply
Examples	Solar, wind, water, forests, soil	Fossil fuels, minerals, metals
Sustainability	Can be used indefinitely if not overexploited	Will eventually run out
Environmental Impact	Generally lower if used wisely	High impact from extraction and use
Time to Form	Days to decades	Millions of years
Book Reference	Page 125, 186	Page 85, 105-106, 152

Question No. 9: Describe the causes and effects of water pollution.

Definition of Water Pollution

Page 10: "Water pollution" is contamination of water bodies including rivers, lakes, groundwater, and oceans by harmful substances.

Page 126: "In the developing world... over 1 billion people still lack access to clean drinking water."

Causes of Water Pollution

1. Industrial Effluents (Wastes)

- Page 10: "water pollution" from industrial sources
- Page 17: "industrial effluents" pollute surface water and groundwater
- Page 19: "Majority of our industrial plants are using outdated and pollution technologies... devoid of any provision of treating their wastes"

- Page 203: "Unplanned industrialization has destroyed natural resources. In many places, industry has polluted soil, water and air"

2. Domestic Sewage and Community Wastes

- Page 17: "community wastes" pollute surface water
- Page 126: "2.5 billion do not have access to adequate sanitation services"
- Page 203: "Water supply and sewerage systems are inadequate, of poor quality, and mostly unhygienic"

3. Agricultural Chemicals

- Page 17: "chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater"
- Page 170: "Pesticide use in Pakistan has increased 7 fold in quantity between 1981 and 1992"
- Page 154: Excess phosphates from fertilizers wash into water bodies

4. Municipal Waste

- Page 19: Cities lack proper waste disposal systems
- Page 111: "Soils are used to absorb wastes from sewage systems, wastes from other municipal, industrial, and animal sources"

5. Oil Spills and Marine Pollution

- Page 163: "oil spills" are mentioned as pollutants that ecosystems help break down

6. Lack of Treatment Facilities

- Page 19: Implementation of environmental laws is difficult because it "needs great resources, technical expertise, political and social will"

Effects of Water Pollution

1. Human Health Effects

- Page 10: "diarrhoeal diseases and typhoid due to inadequate water supply, sanitation and hygiene about 30% of the total damage cost"
- Page 10: "over 3 million deaths each year are traced to waterborne diseases (mostly in children under 5)"
- Page 126: Waterborne diseases include cholera, typhoid, diarrhea

2. Economic Costs

- Page 10: Water pollution contributes to environmental degradation costing Pakistan "at least 6 percent of GDP or about Rs. 365 billion (US $6.05 billion) per year"
- Page 10: Diarrheal diseases and typhoid account for 30% of this cost

3. Groundwater Contamination

- Page 17: "Factors like community wastes, industrial effluents, chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater"
- Page 130: "seepage of pollutants into recharge zone have polluted aquifers in many areas"

4. Eutrophication (Nutrient Over-enrichment)

- Page 148: "In surface waters, added nitrogen can lead to nutrient overenrichment"
- Page 154: "excess phosphates can stimulate explosive growth of algae and photosynthetic bacteria populations, upsetting ecosystem stability"
- Results in algal blooms, fish kills, loss of aquatic life

5. Loss of Biodiversity

- Page 170: "discharge of sewage and industrial effluent into aquatic and marine ecosystems is also on the rise"
- Page 199-200: Reduced fresh water flow in Indus delta has "caused reduction of fresh water flow in the delta resulting in increased salinity which in turn has damaged the mangrove forests and thus eliminated several tree species"

6. Drinking Water Scarcity

- Page 10: "safe drinking water scarcity" is a major environmental issue
- Page 126: "over 1 billion people still lack access to clean drinking water"

7. Food Chain Contamination

- Page 167: "Pesticides are one of the major pollutants that adversely affect the aquatic fauna and the fish-eating birds"
- Page 167: "The pesticides and fertilizers are washed along with run off water into nearby water bodies hence increasing the toxic levels"

8. Damage to Aquatic Ecosystems

- Page 148: Water pollution leads to "species shifts within coastal ecosystems"
- Page 149: Affects fish populations and aquatic habitats

Summary Table: Causes and Effects of Water Pollution

Causes	Effects
Industrial effluents	Waterborne diseases (diarrhea, typhoid)
Domestic sewage	Child mortality (over 3 million/year)
Agricultural fertilizers	Groundwater contamination
Pesticides	Eutrophication and algal blooms
Municipal waste	Loss of biodiversity
Oil spills	Drinking water scarcity
Lack of treatment plants	Food chain contamination
	Economic losses (billions of rupees)
	Damage to mangrove forests
	Fish kills and species loss

Question No. 10: What are the major causes of climate change? Explain its impacts on the environment. (Ch. 3)

Major Causes of Climate Change

1. Natural Causes (Page 81):

- "These variations may come from processes internal to the Earth, be driven by external forces (e.g. variations in sunlight intensity)"
- Volcanic eruptions release gases and particles into atmosphere
- Changes in Earth's orbit and solar radiation

2. Anthropogenic (Human) Causes (Page 81):

- "Through widespread use of land, use of fossil fuels and the building of cities, we have changed our climate"
- "The major technological and socioeconomic shift of the industrial era, the accelerated uptake of fossil fuels, and broad scale deforestation, means we have contributed to the natural greenhouse effect"

3. Greenhouse Gas Emissions (Page 85):

Greenhouse Gas	Sources	Book Reference
Carbon Dioxide (CO_2)	Burning coal, oil, natural gas in power plants, cars, factories; clearing forests	Page 85
Methane (CH_4)	Rice paddies, cattle, rotting garbage in landfills, mining operations, gas pipelines	Page 85
Chlorofluorocarbons (CFCs)	Refrigerators, air conditioners, aerosol sprays	Page 85
Nitrous Oxide	Fertilizers and other chemicals	Page 85

4. Deforestation (Page 153):

- "By clearing forests, we reduce the ability of photosynthesis to remove CO_2 from the atmosphere, also resulting in a net increase"
- Page 81: "broad scale deforestation" contributes to climate change

5. Burning of Fossil Fuels (Page 153):

- "Burning oil and coal releases carbon into the atmosphere far more rapidly than it is being removed, and this imbalance causes atmospheric carbon dioxide concentrations to increase"

6. Agricultural Activities (Page 85):

- Methane from rice paddies and livestock
- Nitrous oxide from fertilizers

Impacts of Climate Change on Environment

1. Temperature Rise (Page 82-83):

- Page 82: "The world has warmed 0.74°C in the past hundred years"
- Page 83: "Global average temperature is forecast to rise 4°C (7.2°F) toward the end of the 21st century"
- Page 82: "Temperatures across the globe are most certainly rising; the 1990s was the warmest decade in the last thousand years"

2. Glaciers Melting (Page 83-84):

- Page 83: "Glaciers are retreating, and snow cover is decreasing"
- Page 84, Figure 3.6 shows impacts of climate change including glacier retreat

- Page 129: "Glaciers are highly sensitive to minor changes in the atmospheric temperatures"
- Page 129: "Continued climate change is predicted to lead to major changes in fresh water flows with dramatic impacts on biodiversity, people and their livelihood"

3. Sea Level Rise (Page 85):

- Page 85: "sea levels will rise over the coming decades"
- Page 129: "If the Greenland ice sheet melted, it would cause sea levels to rise some six meters (20 feet) all around the world. If the Antarctic ice sheet melted, sea levels would rise up to 65 meters (210 feet)"
- Page 85: "Some low-lying coastal areas and islands are already feeling the effect, and will be more prone to inundation from storm surges"

4. Impacts on Animals (Page 84):

- "Pole-ward and elevational shifts in range and alteration in species abundance"
- "Over a million species are predicted to become extinct by 2050"
- Temperature sensitive species like Boyd's Forest Dragon, Cassowaries expected to become extinct
- Changes in breeding time, migration patterns

5. Impacts on Plants (Page 84):

- "Change in abundance... shift in plant diversity"
- "Change in phenology (including earlier flowering), change in growth patterns"
- Serious threat to crops like wheat, affecting food availability and economy

6. Changes in Rainfall Patterns (Page 84-85):

- "A few degrees of increase in temperature will lead to more heat waves and fewer frosts"
- "More wildfires and droughts are expected in drier regions"
- "Regions of the world with higher rainfalls would receive increased rains thus resulting in floods"
- "Higher latitudes of the globe would receive more rainfall while middle latitudes are likely to receive less"

7. Extreme Weather Events (Page 85):

- "Tropical hurricanes and cyclones may become stronger"
- More floods, landslides, storm surges

8. Impacts on Water Resources (Page 83):

- "Hydrology and Glaciers - Glaciers are retreating"

- Page 129: "Perennial rivers could be changed into seasonal streams giving rise to fresh water scarcity in the summer months when melt water contributes the most"

9. Impacts on Pakistan (Page 129):

- Agriculture and power generation dependent on Karakorum glaciers
- Current increased melting causes floods and landslides
- Long-term decrease in runoff will cause water scarcity

Question No. 11: Define environmental science. Discuss its scope and importance in the context of Pakistan. (Ch. 1)

Definition of Environmental Science

Definition from Your Book:

Page 13: **"Environmental science is the systematic study of our environment and our proper place in it. Environmental science is highly interdisciplinary and multidisciplinary; integrating natural sciences, social sciences, and humanities in a broad, holistic study."**

Page 7: "Environmental science stands at the interface between human and earth. It is an interdisciplinary as well as multidisciplinary study that describes problems caused by human use of the natural world. It also seeks remedies for these problems."

Key Characteristics (Page 13):

- Comprises branches of science like chemistry, physics, medicine, agriculture, public health, sanitary engineering
- Studies "sources, reactions, transport, effect and fate of physical and biological species in the air, water and soil"
- Studies "the effect of human activity upon these"
- **Mission-oriented:** "It seeks new, valid, contextual knowledge about the natural world and our impacts on it, but obtaining this information creates a responsibility to get involved in trying to do something about the problems we have created"

Scope of Environmental Science

1. Interdisciplinary Nature (Page 13, Figure 1.2):

- Natural sciences (biology, chemistry, physics, geology)
- Social sciences (economics, politics, sociology)
- Humanities (ethics, philosophy, culture)
- Technology and engineering

2. Study of Earth's Spheres (Page 14-15):

- Atmosphere (protective blanket of gases)
- Hydrosphere (water resources: oceans, lakes, rivers, groundwater)
- Lithosphere (solid earth: minerals, rocks, soil)
- Biosphere (realm of living organisms)

3. Elements of Environment (Page 15):

- Physical elements: space, landforms, water bodies, climate, soils, rocks
- Biological elements: plants, animals, microorganisms
- Cultural elements: economic, social, political features

4. Study of Environmental Issues (Page 16):

- Global issues: global warming, ozone depletion, acid rain, biodiversity loss
- Local issues: pollution, deforestation, water scarcity
- Solutions and remedies

5. Human-Environment Interactions (Page 7, 180-189):

- How humans modify environment
- Impacts of human activities
- Path to sustainability

Importance of Environmental Science in Context of Pakistan

1. Economic Importance (Page 10):

- Environmental degradation costs Pakistan "at least 6 percent of GDP or about Rs. 365 billion (US $6.05 billion) per year"
- Air pollution: almost 50% of total damage cost
- Water-related diseases: about 30% of total damage cost
- Soil degradation: about 20% of total cost

2. Poverty-Environment Nexus (Page 10):

- "One of the contributing factors to the growing poverty in Pakistan is environmental degradation"
- Rural poor depend on natural resources for livelihoods
- Environmental degradation "adversely affects the health of the poor and hence increasing the burden of disease"

3. Agriculture and Food Security (Page 133):

- Agriculture accounts for "1/4 of the country's GDP, 2/3 of employment and about 80% of exports"
- Pakistan has "world's largest irrigation system"
- Soil degradation, water pollution, and climate change threaten food production

4. Water Scarcity (Page 10, 126):

- "safe drinking water scarcity" is a major issue
- Over 1 billion people globally lack clean drinking water; Pakistan faces similar challenges
- Groundwater depletion and pollution

5. Health Impacts (Page 10):

- "diarrhoeal diseases and typhoid due to inadequate water supply, sanitation and hygiene"
- Air pollution causes respiratory illnesses
- Environmental health problems include "learning disabilities, feeble immune systems, asthma, cancer"

6. Disaster Vulnerability (Page 10):

- Environmental degradation causes "increased vulnerability to disasters such as droughts, floods and landslides"
- Drought 2000-2001 caused livestock loss worth US$ 247 million

7. Biodiversity Loss (Page 169-171):

- Pakistan has rich biodiversity but faces threats
- 225 Protected Areas established but degradation continues
- Endemic species at risk: Indus Dolphin, Chiltan Markhor, etc.

8. Need for Experts (Page 11, Table 1.1):

- Pakistan needs about 13,000 environmental experts
- Currently produces only about 300 annually
- Huge gap in environmental education and awareness

9. Sustainable Development (Page 10):

- "Sustainable Development in the context of Pakistan demands justice in the use of resources by the present generations keeping in view the needs of future generations"
- Environmental science provides knowledge for sustainable development

10. Environmental Awareness (Page 10):

- "Rapid degradation of environment in Pakistan... can be attributed to a number of key factors including the utter lack of environmental awareness and education"
- Environmental science education is essential for creating awareness

Question No. 12: Describe the structure and composition of the atmosphere. (Ch. 3)

Composition of the Atmosphere

Major Gases (Page 67, Table 3.1):

Gas	Symbol	Percent by Volume	Role/Importance
Nitrogen	N_2	78.08%	Largely inert; does not readily react
Oxygen	O_2	20.94%	Required for respiration of all animal life; extremely reactive
Argon	Ar	0.934%	Inert noble gas; no chemical reactions
Carbon dioxide	CO_2	0.035%	Affects climate; required for photosynthesis; greenhouse gas
Neon	Ne	0.00182%	Trace gas
Helium	He	0.00052%	Trace gas
Methane	CH_4	0.00015%	Greenhouse gas
Other gases	Various	Small amounts	Krypton, hydrogen, nitrous oxide, xenon

Together, three gases (N_2, O_2, Ar) account for 99.96% of the atmosphere.

Trace Gases (Page 67-69):

1. **Carbon Dioxide (CO_2):**
   - Affects Earth's climate
   - Required for photosynthesis

- Greenhouse gas that absorbs and emits infrared radiation
- Page 67: Without greenhouse gases, Earth's surface would be 90°F (32°C) cooler

2. **Water Vapor (H_2O):**

- Page 67-68: Found in small and highly variable amounts (up to 4% in warm, humid areas)
- Participates in hydrologic cycle
- Drives erosion and weathering
- Determines weather and climate
- Important greenhouse gas

3. **Ozone (O_3):**

- Page 68: Found in layer about 15-60 km altitude
- "Absorbs most of the high energy radiation from the sun that is harmful to plants and animals"
- Protects Earth from damaging UV radiation

Aerosols (Page 69, Table 3.2):

- Tiny particles suspended in air (liquid or solid)
- Examples: soil bits, desert sand, sea salt, smoke particles, pollen
- Affect atmospheric heat balance, cloud growth, optical properties
- Size range: smoke particles (0.0001 mm) to rain drops (1-6 mm)

Structure of Atmosphere (Layers)

Page 70-71: The atmosphere is divided into layers according to major changes in temperature.

1. Troposphere (0 to 12 km):

- Page 70: "Contains over 80% of the mass of the atmosphere, along with nearly all of the water vapor"
- "Contains the air we breathe, the winds we observe and the clouds that bring our rain"
- "All of what we know as 'weather' occurs in the troposphere"
- Temperature decreases with height (drops about 6.5°C per kilometer)

2. Tropopause:

- Located at top of troposphere
- Temperature remains fairly constant
- Contains jet stream (strong eastward winds)

3. Stratosphere (12 to 50 km):

- Page 70-71: "Contains most of the ozone found in the earth's atmosphere"
- Temperature increases with height due to ozone absorbing UV radiation
- Very little water
- Page 71: "Polar stratospheric clouds (PSCs) play a key role in the development of the ozone hole"

4. Mesosphere (50 to 80 km):

- Page 71: Temperature drops to about -100°C (coldest region)
- "This layer protects the earth from meteoroids. They burn up in this area"

5. Thermosphere (80 km and up):

- Page 71: "Thermosphere means 'heat sphere'"
- Temperature very high (up to 2000°C) because ultraviolet radiation turns into heat
- Air is very thin

Sub-layers of Thermosphere:

Sub-layer	Altitude	Characteristics
Ionosphere	80 to 550 km	Gas particles absorb UV and X-ray radiation; become electrically charged (ions); radio waves bounce off ions
Exosphere	550 km to thousands of km	Air very thin; area where satellites orbit Earth

6. Magnetosphere:

- Page 71: "The area around the earth that extends beyond the atmosphere"
- Begins at about 1000 km
- Earth's magnetic field operates here
- Made up of positively charged protons and negatively charged electrons
- Traps particles given off by the sun

Summary Table: Atmospheric Layers

Layer	Altitude	Key Characteristics	Temperature Trend
Troposphere	0-12 km	Weather occurs; 80% of mass; contains water vapor	Decreases with height
Stratosphere	12-50 km	Contains ozone layer; protects from UV	Increases with height

Mesosphere	50-80 km	Meteoroids burn up; coldest layer	Decreases to -100°C
Thermosphere	80 km+	Very high temperature; contains ionosphere and exosphere	Increases dramatically
Magnetosphere	1000 km+	Magnetic field; traps solar particles	N/A

Important Note: Page 70: "99% of the total mass of the atmosphere is below 32 kilometers."

Question No. 13: Explain the processes of nitrogen and carbon cycles with the help of labeled diagrams. (Ch. 6)

Part A: Nitrogen Cycle

Definition:
Page 144: Nitrogen is "an essential component of DNA, RNA, and proteins, the building blocks of life." The movement of nitrogen between atmosphere, biosphere, and geosphere in different forms is described by the nitrogen cycle.

Key Fact:
Page 144: Although air is 78% nitrogen (N_2), "most of the nitrogen in the atmosphere is unavailable for use by organisms" because of the strong triple bond between N atoms.

Five Main Processes of Nitrogen Cycle (Page 144-145):

Process	Conversion	Description
Nitrogen Fixation	$N_2 \rightarrow NH_4^+$ (ammonia)	Conversion of inert nitrogen gas to reactive compounds
Nitrogen Uptake	$NH_4^+ \rightarrow$ Organic N	Plants take up inorganic nitrogen and form organic compounds
Nitrogen Mineralization	Organic N $\rightarrow NH_4^+$	Breakdown of complex organic compounds back to simpler form (decay)
Nitrification	$NH_4^+ \rightarrow NO_3^-$ (nitrate)	Conversion of ammonia to nitrate
Denitrification	$NO_3^- \rightarrow N_2$ gas	Conversion of nitrate back to nitrogen gas

1. Nitrogen Fixation (Page 145-146):

- Only way organisms can attain nitrogen directly from atmosphere
- Carried out by bacteria (e.g., Rhizobium) that form symbiotic relationships with legume plants (beans, peas)
- Page 146, Figure 6.2 shows nitrogen-fixing bacteria in root nodules
- Free-living nitrogen fixers: cyanobacteria (blue-green algae)
- Natural events: lightning, forest fires also fix small amounts
- Human activities: burning fossil fuels, synthetic fertilizers now fix more nitrogen than natural sources

2. Nitrogen Uptake (Page 146):

- Ammonia produced by bacteria is incorporated into protein and other organic compounds
- Used by host plants, bacteria, or other soil organisms
- Passes through food chain when organisms are eaten

3. Nitrogen Mineralization (Decay) (Page 147):

- After nitrogen is incorporated into organic matter, decomposers (bacteria, fungi) break it down
- Converts organic nitrogen back to ammonium (NH_4^+)
- Makes nitrogen available again for plants

4. Nitrification (Page 147):

- Bacteria convert ammonium to nitrate (NO_3^-)
- Requires oxygen (occurs in oxygen-rich environments)
- Important consequence: Ammonium (positive charge) sticks to soil particles; nitrate (negative charge) can be washed out (leached) from soil

5. Denitrification (Page 147-148):

- Bacteria convert nitrate to nitrogen gas (N_2) and nitrous oxide (N_2O)
- Anaerobic process (occurs without oxygen)
- Sequence: $NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$
- Only process that removes nitrogen from ecosystems
- Nitrous oxide (N_2O) is a greenhouse gas

Human Alteration of Nitrogen Cycle (Page 148-149):

- Page 148: Fritz Haber developed method to fix nitrogen chemically for fertilizers
- Excess nitrogen washes into water causing eutrophication

- Page 148: "In groundwater... excess nitrogen can lead to cancer in humans and respiratory distress in infants"
- Nitrous oxide contributes to global warming
- Nitrogen oxides contribute to acid rain and smog

[Diagram Description: The nitrogen cycle should show:

- **Atmospheric N_2** at the top
- **Nitrogen fixation** arrow pointing to **Ammonium (NH_4^+)** in soil
- **Nitrification** arrow from NH_4^+ to **Nitrate (NO_3^-)**
- **Assimilation/Uptake** arrows from NH_4^+ and NO_3^- to **Plants** (Organic N)
- **Feeding** arrow from Plants to **Animals**
- **Decomposition/Mineralization** arrow from dead plants/animals back to NH_4^+
- **Denitrification** arrow from NO_3^- back to atmospheric N_2
- **Lightning** and **Industrial Fixation** (fertilizer production) arrows to NH_4^+/NO_3^-]

Part B: Carbon Cycle

Definition:
Page 149: "The movement of carbon, in its many forms, between the atmosphere, oceans, biosphere, and geosphere is described by the carbon cycle."

Importance of Carbon:

- Page 149: Carbon "is absolutely essential to life on earth"
- Fourth most abundant element in universe
- Found in CO_2, limestone, wood, plastic, diamonds, graphite

Two Components of Carbon Cycle (Page 149):

Component	Time Scale	Description
Geological Carbon Cycle	Millions of years	Operates through weathering, sedimentation, subduction
Biological Carbon Cycle	Days to thousands of years	Operates through photosynthesis and respiration

Geological Carbon Cycle (Page 150-151):

1. **Weathering:**
   - CO_2 in atmosphere reacts with water to form carbonic acid (weak acid)

- Acid rain dissolves minerals at Earth's surface
- Ions are carried by rivers to oceans

2. **Sedimentation:**

- Ions precipitate as minerals like calcite ($CaCO_3$)
- Through deposition and burial, forms limestone rock

3. **Subduction and Volcanism:**

- Page 150: Seafloor spreading pushes seafloor under continental margins (subduction)
- Carbon heats up, melts, rises back to surface
- Released as CO_2 through volcanic eruptions, vents, hot springs

Biological Carbon Cycle (Page 151-152):

1. Photosynthesis:

- Page 151: "Plants take in carbon dioxide (CO_2) from the atmosphere during photosynthesis and produce carbohydrates"
- Chemical equation: Energy (sunlight) + $6CO_2 + H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
- Removes CO_2 from atmosphere

2. Respiration:

- Page 151: "The metabolic breakdown of those sugars to produce the energy needed for movement, growth, and reproduction"
- Chemical equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy
- Releases CO_2 back to atmosphere

3. Carbon Deposition in Oceans (Page 152):

- Phytoplankton use carbon to make calcium carbonate ($CaCO_3$) shells
- Shells settle to ocean bottom when organisms die
- Buried and compressed over time form limestone
- Organic matter buried over time forms fossil fuels (coal, oil)

Seasonal Imbalance (Page 152):

- In northern hemisphere winter: photosynthesis decreases, respiration continues → atmospheric CO_2 increases
- In spring: photosynthesis resumes → atmospheric CO_2 decreases

Human Alteration of Carbon Cycle (Page 152-153):

1. **Burning of Fossil Fuels:**

- Page 153: Releases carbon faster than it can be removed
- Causes atmospheric CO_2 concentrations to increase

2. **Deforestation:**

- Page 153: Reduces ability of photosynthesis to remove CO_2
- Results in net increase of atmospheric CO_2

3. **Consequences:**

- Page 153: CO_2 is a "greenhouse gas" that increases atmosphere's ability to hold heat
- 0.6°C increase in global temperature over past century mainly due to CO_2 increases
- Changes in plant growth patterns; shrubs may replace grasses

[Diagram Description: The carbon cycle should show:

- **Atmospheric CO_2** at center/top
- **Photosynthesis** arrow from atmosphere to **Plants**
- **Respiration** arrows from plants, animals, decomposers back to atmosphere
- **Feeding** arrow from plants to **Animals**
- **Death and Decomposition** arrows from dead organisms to **Soil Organic Matter**
- **Fossil Fuel Formation** arrow from buried organic matter to **Coal, Oil, Gas**
- **Combustion** arrow from fossil fuels to atmosphere
- **Ocean Uptake** arrows between atmosphere and **Ocean** (dissolved CO_2)
- **Volcanic Emissions** arrow from **Rocks** to atmosphere
- **Weathering** arrow from rocks to ocean]

Question No. 14: What is the internal structure of the Earth? Differentiate between the Earth's crust, mantle, and core. (Ch. 4)

Internal Structure of Earth

Introduction:
Page 92: "The solid component of earth is called Lithosphere. It consists of layers, the outermost cool, lightweight and brittle 'crust'. Inside the crust is present a flexible layer of rock known as the Mantle. The Core or interior of earth is composed of a dense, intensely hot mass of metal."

Page 92, Figure 4.1 shows the layered Earth.

The Three Main Layers

Layer	Thickness	Composition	Key Characteristics
Crust	5-70 km	Oxygen, silicon, aluminum, calcium, sodium, potassium	Outermost layer; solid and brittle; supports life
Mantle	~2,900 km	Oxygen, silicon, magnesium	Flexible, hot enough to bend and flow; denser than crust
Core	~3,470 km radius	Mostly iron and nickel	Intensely hot; generates Earth's magnetic field

Detailed Description of Each Layer

1. Crust

Thickness:

- Page 92: "The thickness of the lithosphere is considered to be less than 20 kilometers near the mid-ocean ridges to about 50 km in old oceanic regions. Under the continents the lithosphere is thicker, as much as 150 km."

Composition (Page 92-93):

- Oceanic crust: "composition somewhat like that of the mantle but is richer in Silicon"
- Continental crust: "thicker, lighter regions of crust rich in calcium, sodium, potassium and aluminum"

Table 4.2 (Page 93) - Most Common Elements in Crust:

Element	Percentage
Oxygen	45.2%
Silicon	27.2%
Aluminum	8.2%
Iron	5.8%
Calcium	5.1%
Magnesium	2.8%
Sodium	2.3%
Potassium	1.7%

Characteristics:

- Page 92: "This layer supports life and allows the plants to grow"
- Coolest layer
- Broken into tectonic plates

2. Mantle

Thickness:
Page 93, Table 4.1: "From base of crust to 2,900 km"

Composition (Page 92):

- "denser than the crust and contains elements like oxygen, silicon and magnesium"
- Made of solid but flexible rock

Characteristics:

- Page 92: "hot enough to bend and flow"
- Page 93-94: Through movements (tectonic processes), the hot mantle exerts enormous pressure on crust, breaking it into tectonic plates
- Temperature increases with depth

Table 4.1 (Page 93):

- Mean density: 4.5 g cm^{-3}
- Mass: 68.1% of Earth's total mass

3. Core

Thickness:
Page 93, Table 4.1: "From 2,900 km to 6,370 km" (Earth's radius)

Composition (Page 92):

- "composed of a dense, intensely hot mass of metal, mostly iron spread over thousands of kilometers in diameter"
- Page 93, Table 4.2: Whole Earth composition - Iron (33.3%), Oxygen (29.8%), Silicon (15.6%), Magnesium (13.9%), Nickel (2.0%)

Structure:

- Outer core: liquid/molten metal
- Inner core: solid

Characteristics:

- Page 92: "Solid in the centre, this immense mass of the core region generates the magnetic field that surrounds the earth"
- Extremely hot (temperatures up to 5,500°C)
- Very dense

Table 4.1 (Page 93):

- Mean density: 10.7 g cm^{-3} (highest of all layers)
- Mass: 31.5% of Earth's total mass

Summary Table: Differentiation of Crust, Mantle, and Core

Feature	Crust	Mantle	Core
Thickness	5-70 km	~2,900 km	~3,470 km radius
State	Solid, brittle	Solid but flexible (plastic)	Outer core liquid; inner core solid
Main Elements	O, Si, Al, Ca	O, Si, Mg	Fe, Ni
Density	2.8 g cm^{-3}	4.5 g cm^{-3}	10.7 g cm^{-3}
Mass Percentage	0.4%	68.1%	31.5%
Temperature	Cool (0-1000°C)	Hot (1000-3700°C)	Extremely hot (4400-6000°C)
Function	Supports life	Drives plate tectonics	Generates magnetic field

Additional Concepts

Lithosphere:
Page 92: "The crust and the upper mantle together constitute the Lithosphere."

Tectonic Cycle (Page 93-95):

- Mantle movements exert pressure on crust
- Crust breaks into tectonic plates
- Plates move and interact, causing earthquakes, volcanoes, mountain formation

Question No. 15: Describe the hydrological (water) cycle. How do human activities impact this cycle? (Ch. 5)

Part A: Hydrological (Water) Cycle

Definition:
Page 134: "The hydrological cycle describes the circulation of water as it evaporates from land, water (evaporation) and organisms specially plants (transpiration); enters the atmosphere; and is precipitated back (rainfall) to the earth's surface; then moves underground by infiltration or over the surface by run off into rivers, lakes and sea (overland flow) from where it is evaporated once again."

Importance:
Page 134: "This cycle supplies fresh water to the land masses, maintain a habitable climate and moderates world temperature."

Driving Forces:

- Page 135: "Solar energy is the main driving force behind the hydrological cycle which evaporates surface water"
- Page 134, Figure 5.2: "driven by solar energy and gravity"

Processes of Hydrological Cycle

Process	Description	Book Reference
Evaporation	Liquid water changes to vapor (gas) at temperatures below boiling point	Page 135
Transpiration	Evaporation of water from plant surfaces	Page 135
Evapotranspiration	Combined evaporation from land and transpiration from plants	Page 135
Condensation	Water vapor changes to liquid droplets or ice crystals when air cools to dew point	Page 135
Precipitation	Water falls to earth as rain, snow, hail, etc.	Page 136
Infiltration	Water on ground surface enters the soil	Page 135, Box 5.2
Percolation	Water moves through porous surfaces from upper to deeper soil layers	Page 135, Box 5.2
Runoff	Water flows over surface into rivers, lakes, oceans	Page 134
Groundwater Flow	Underground movement of water through aquifers	Page 130

Key Terms Explained:

Box 5.3 (Page 135): "Evaporation is the process in which a liquid is changed to vapor (gas phase) at temperatures well below its boiling point"

Box 5.4 (Page 135): "The amount of water vapor in the air is called humidity."

Dew Point (Page 135): "The temperature at which condensation occurs is known as dew point."

Cloud Formation (Page 136): "An accumulation of condensed water vapors into water droplets or ice crystals is what we call a cloud."

Factors Affecting Rainfall (Page 136):

- Topography: mountains act as "cloud formers and rain catchers"
- Wind patterns: monsoon winds carry moisture-laden air
- Air pressure and temperature

Water Residence Times (Page 127, Table 5.1):

Compartment	Average Residence Time
Oceans	3,000 to 30,000 years
Ice and Snow	1 to 16,000 years
Groundwater	Days to thousands of years
Lakes and Reservoirs	1 to 100 years
Rivers and Streams	10 to 30 days
Biological moisture	About 1 week
Atmospheric water	About 1 week

Part B: Human Impacts on Hydrological Cycle

Page 136: "The human impacts on the hydrological cycle can be classified into four categories."

1. Changes to Earth's Surface (Page 136-137)

Natural Process:

- Page 136: "In most natural ecosystem, precipitation is intercepted by vegetation and infiltrates into porous topsoil"
- Water provides for ecosystems, absorbed by plants, evapotranspired back
- Some percolates to recharge groundwater
- Dirt and pollutants are filtered out as water percolates

Human Impacts:

- Page 137: "Human beings keep on cutting the forests to clear the land for urbanization or agricultural use"
- **Consequences:**
  - Water infiltration decreases
  - Runoff increases
  - Less evapo-transpiration
  - Less groundwater recharge
  - "Lowered evapo-transpiration means less moisture for local rain fall"
  - "insufficient ground water resources results in dry, lifeless and barren streams during the dry periods"

2. Climate Change (Page 137)

- Page 137: "There is now unmistakable evidence that earth climate is warming because of the rise in green houses gases"
- Deforestation lowers infiltration and groundwater recharge
- Loss of groundwater results in dry streams and lakes
- Page 137: "An increase in global temperature increases evapo-transpiration hence making the drought prone regions drier"
- Page 137: "the regions will sufficient forest cover and high precipitation will experience increased rainfall"
- "Global warming tends to make dry regions drier and the wet region of the globe, wetter"

3. Atmospheric Pollution (Page 137)

- Page 137: "The suspended particles in the atmosphere forming a brownish haze especially in the industrial area are called aerosols"
- "The aerosol particles support the formation of clouds but suppress rainfall"
- "With suppressed rainfall comes drier conditions so more dust and smoke are the result"
- Unlike greenhouse gases, aerosol impact is "more local and have a lifetime measured in days"

4. Withdrawal for Human Use (Page 137)

- Page 137: "Human consumption of surface and ground water resources is increasing day by day"
- "since the resource recharge is not on a similar rate, an overall depletion of water resources has taken place"
- "Humans, therefore, are major players in the hydrological cycle"

Additional Human Impacts from Other Sections

5. Deforestation Effects (Page 137, 163)

- Page 163: "Vegetation removal results in siltation of catchment waterways, loss of water quality, and degradation of aquatic habitat"
- Affects hydrological cycle by reducing water infiltration and increasing runoff

6. Urbanization (Page 19, 130)

- Page 130: "Urbanization, road building often blocks recharge zones and prevent replenishment of important aquifers"
- Page 19: Increased urbanization leads to more paved surfaces, reducing infiltration

7. Water Withdrawal by Sector (Page 139-140)

- Page 139-140: Agriculture claims about 69% of total water withdrawal worldwide
- Inefficient irrigation loses 60-70% of water before reaching crops
- Industrial use accounts for about one-fourth of all water use
- Over-extraction of groundwater

8. Pollution of Water Resources (Page 10, 17, 130)

- Page 130: "seepage of pollutants into recharge zone have polluted aquifers in many areas"
- Contaminated water cannot be used, further stressing water resources

Summary Table: Human Impacts on Hydrological Cycle

Impact Category	Specific Activities	Consequences
Land Surface Changes	Deforestation, urbanization, agriculture	Reduced infiltration, increased runoff, less groundwater recharge
Climate Change	Greenhouse gas emissions	Altered rainfall patterns, increased evaporation, droughts and floods
Atmospheric Pollution	Aerosols from industry	Suppressed rainfall, drier conditions
Water Withdrawal	Agriculture, industry, domestic use	Groundwater depletion, reduced river flows
Pollution	Industrial effluents, sewage, agricultural chemicals	Contamination of water sources, reduced usable water
Infrastructure	Dams, canals, roads	Altered water flow, blocked recharge zones

Question No. 16: What are the different types of rocks? Explain the rock cycle. (Ch. 4)

Types of Rocks

Introduction:

Page 106: "A rock is an aggregate of one or more minerals. Within a rock individual crystals or grains are mixed together and held firmly forming a solid mass."

Page 107: "There are three major rock classifications: igneous, sedimentary and metamorphic."

1. Igneous Rocks

Definition:

Page 107: "Igneous rocks are called fire rocks and are formed either underground or above ground."

Formation:

Type	Formation Process	Cooling Rate	Grain Size	Examples
Intrusive Igneous	Magma trapped underground, cools slowly	Slow	Coarse-grained (large crystals)	Granite, Gabbro
Extrusive Igneous	Lava erupts from volcano, cools quickly	Fast	Fine-grained (small crystals)	Basalt

Page 107: "Underground, they are formed when the melted rock, called magma, deep within the earth becomes trapped in small pockets. As these pockets of magma cool slowly underground, the magma becomes igneous rocks."

Page 107: "Igneous rocks are also formed when volcanoes erupt, causing the magma to rise above the earth's surface. When magma appears above the earth, it is called lava."

Texture and Composition:

- Page 107: "In most cases, the resulting grain size depends on how quickly the magma cooled"
- Page 107-108: Composition depends on elements in magma (produces basalt, gabbro, granite)

2. Sedimentary Rocks

Definition:

Page 108: "Sedimentary rocks are called secondary, because they are often the result of the accumulation of small pieces broken off by the pre-existing rocks."

Formation Process:

Page 108: "For thousands, even millions of years, little pieces of our earth have been eroded-broken down and worn away by wind and water. These little bits of our earth are washed downstream where they settle to the bottom of the rivers, lakes, and oceans. Layer after layer of eroded earth is deposited on top of each. These layers are pressed down more and more through time, until the bottom layers slowly turn into rock."

Three Main Types of Sedimentary Rocks (Page 108-109):

Type	Formation	Examples
Clastic	Accumulation of broken rock pieces (clasts) compacted over time	Sandstone, Shale
Chemical	Form when standing water evaporates, leaving dissolved minerals behind	Salt, Gypsum
Organic	Accumulation of organic debris from living organisms (shells, bones, teeth)	Limestone (from calcium carbonate shells)

Page 109, Figure 4.6 shows sedimentary rocks with clear layers.

3. Metamorphic Rocks

Definition:

Page 109: "The metamorphic rocks get their name from 'meta' (change) and 'morph' (form). Any rock can become a metamorphic rock whether it is igneous or sedimentary."

Formation Process:

Page 109: "All that is required is for the rock to be moved into an environment in which the minerals which make up the rock become unstable and out of equilibrium. In most cases, this involves a rise in temperature and pressure."

Page 109: "Under high temperature and pressure metamorphic changes in the minerals occur to give rise to a third form of rock the metamorphic rocks."

Types of Metamorphic Rocks:

Type	Characteristic	Formation	Examples
Foliated	Layered or banded	Compressed along one axis; platy structure forms	Slate (from shale)
Non-foliated	No layering	Uniform pressure from all sides	Marble (from limestone/calcite)

Marble in Pakistan:

Page 109: "A well known example of metamorphic rock that exists in Pakistan and is being used frequently as a building material is Marble."

Page 109: "Pakistan is known for onyx (a high quality form of decorative marble) which is exported. White, whitish-gray black-silky, Jet-black, pink, grayish-green, black-zebra, green-zebra, camel and cream color varieties are being mined and marketed locally."

Page 109-110: "A great variety of parent rock types occur in Pakistan, which exert considerable influence on the properties of the soil. All the three rocks types are found in Pakistan viz. the igneous rocks, the sedimentary rocks and the metamorphic rocks."

The Rock Cycle

Definition:

Page 107: "The formation of rocks is a continuous process. The crust of earth is being continuously created, maintained and destroyed under the influence of internal as well as external forces."

Page 107: "We call this cycle of creation, destruction and reformation the Rock Cycle."

Processes in the Rock Cycle (Based on Page 110, Figure 4.6):

Process	Description	Result
Cooling and Solidification	Magma cools and becomes solid	Forms Igneous Rocks
Weathering and Erosion	Rocks broken down by wind, water, ice	Sediments formed
Transportation and Deposition	Sediments carried and deposited in layers	Layers of sediment accumulate
Compaction and Cementation	Layers pressed and cemented over time	Forms Sedimentary Rocks
Heat and Pressure	Rocks subjected to high temperature and pressure	Forms Metamorphic Rocks
Melting	Rocks melt under extreme heat	Forms Magma (completes cycle)

The Complete Cycle (Page 110):

1. "The cooling down of magma inside the earth (intrusive) or after eruption as lava (extrusive) forms igneous rocks."
2. "The igneous rocks under the forces like water, air gravity etc. are broken, weathered or torn into pieces which are transported and deposited layers after layer thus forming sedimentary rocks."
3. "The igneous or sedimentary rocks when subjected to high temperature and pressure form metamorphic rocks."
4. "The metamorphic rocks under increased temperature and pressure may again liquefy to form pliable magma."

Figure 4.6 (Page 110) shows the complete rock cycle with all transformations.

Summary Table: Types of Rocks

Rock Type	How Formed	Examples	Key Feature
Igneous	Cooling of magma or lava	Granite, Basalt	Formed from fire (volcanic)
Sedimentary	Compression of sediments over time	Sandstone, Limestone	Show visible layers
Metamorphic	Changed by heat and pressure	Marble, Slate	Altered from original form

Question No. 17: What is soil erosion? Describe its major types, causes, and impacts on the environment. (Ch. 4)

Definition of Soil Erosion

Box 4.9 (Page 119): "Detachment or movement of soil or rock by water, wind, ice or gravity is known as soil erosion. Soil erosion removes the upper fertile layers of soil thus damaging the quality and richness of soil."

Page 119: "No soil phenomenon is more destructive worldwide than soil erosion. It involves loosing not only water and plant nutrients but ultimately the soil itself. Furthermore the soil that is removed finds its way into streams rivers and lakes and pollutes those resources and bodies."

Two Steps of Erosion (Page 120):

1. Loosening or detachment of soil particle
2. Transportation of soil with running water

Major Types of Water Erosion

Page 120: "Three types of water erosion are generally recognized: sheet, rill and gully."

Type	Description	Characteristics

Sheet Erosion	Soil removed more or less uniformly from every part of the slope	Less noticeable; responsible for most field soil deterioration
Rill Erosion	Small, tiny channels (rills) irregularly dispersed	Can be eliminated by tillage, but soil already lost
Gully Erosion	Formation of larger channels or gullies by downward cutting	Cannot be removed by ordinary tillage practices

Page 120, Figure 4.9 (a, b, c) shows all three types of erosion.

Important Note (Page 120): "While all types may be serious, the losses through sheet and rill erosion, although less noticeable, are responsible for most of the field soil deterioration."

Wind Erosion

Page 121: "Wind erosion is a serious problem in many parts of the world. It is worse in arid and semiarid regions. Wind erosion is a natural process, but can also be induced or magnified via indiscriminate land use, deforestation, construction, overgrazing and urbanization."

Factors Affecting Wind Erosion (Page 121):

- Precipitation
- Temperature
- Wind speed
- Soil and rock type
- Vegetation cover

Consequences of Wind Erosion (Page 121):

- Removal of sediment and silt from slopes
- Decreased permeability leads to reduced infiltration
- Less water penetrates soil; more carried away as runoff
- Accelerates water erosion

Causes of Soil Erosion

1. Deforestation (Page 121, 169):

- Page 121: "When the trees are removed for construction of roads and buildings the rate of wind erosion increases enormously"
- Page 169: Deforestation removes protective cover
- Roots no longer hold soil in place

2. Overgrazing (Page 18, 60, 121):

- Page 18: "over-grazing" is a major cause of land degradation
- Page 60: Heavy grazing reduces vegetation cover
- Soil becomes exposed to wind and water

3. Poor Agricultural Practices (Page 18, 121):

- "poor irrigation and drainage practices"
- Intensification of agriculture
- Removing natural vegetation for crops

4. Water Scarcity and Drought (Page 18):

- Reduces vegetation cover
- Soil becomes dry and easily eroded

5. Urbanization and Construction (Page 121):

- Removal of trees and vegetation
- Soil exposed during construction

6. Natural Factors (Page 119-120):

- Heavy rainstorms
- Running water
- Wind
- Steep slopes

Erosion in Pakistan (Page 121-122)

Statistics:

Page 121: "About 13.05 million hectares of area is affected by water erosion and about 6.17 million hectares by wind erosion."

Water Erosion (Page 121-122, Table 4.3):

Province	Area Affected (000 hectares)
Punjab	1,904.0
Sindh	58.9
NWFP	4,292.2
Balochistan	4,583.0
Northern Areas	2,212.1
Total	**13,050.2**

Wind Erosion (Page 122, Table 4.4):

Province	Area Affected (000 hectares)
Punjab	3,804.5
Sindh	2,052.0
NWFP	36.5
Balochistan	280.5
Total	**6,173.5**

Severe Erosion:

Page 121: "The highest recorded rate of erosion is estimated to be 150-165 tonnes/hectare/year."

Indus River Sediment:

Page 121: "The Indus River carried the fifth largest load of sediment (4.49 t/h) in the world in 1990. According to some estimates the Indus is adding 500,000 tonnes of sediment to the Tarbela Reservoir every day, reducing the life of the dam by 22% and the capacity of reservoir by 16%."

Productivity Loss:

Page 121: "This reduces the productivity of the land by 1.5 - 7.5% per year. This affects almost one-fifth of the Punjab."

Impacts of Soil Erosion on Environment

1. Loss of Fertile Topsoil

- Page 119: Removes "upper fertile layers of soil"
- Loss of nutrients and organic matter
- Reduced soil fertility

2. Reduced Agricultural Productivity

- Page 10: "reduced agricultural productivity due to soil degradation about 20% of the total cost" of environmental damage
- Page 121: 1.5-7.5% productivity loss per year

3. Water Pollution

- Page 119: Soil "finds its way into streams rivers and lakes and pollutes those resources"
- Sedimentation of water bodies
- Page 121: Indus carries huge sediment load to reservoir

4. Reservoir Sedimentation

- Page 121: Tarbela Reservoir losing capacity daily
- Reduces life of dams
- Affects water storage and power generation

5. Loss of Soil Nutrients

- Page 18: "The fertility of soils is rapidly depleting"
- Nitrogen deficiency in 100% soils

- Phosphorus deficiency in more than 90% soils
- Potassium and micronutrient deficiencies increasing

6. Desertification

- Page 18: "More than one-third of the country area has been classified as under risk of desertification"
- Page 186: Overgrazing converts grasslands to semideserts or deserts

7. Increased Flooding

- Loss of soil reduces water infiltration
- More surface runoff
- Increased flood risk

8. Economic Losses

- Page 10: Soil degradation accounts for 20% of environmental damage costs
- Loss of agricultural income
- Dam reservoir sedimentation costs

Summary Table: Soil Erosion

Aspect	Details
Definition	Detachment and movement of soil by water, wind, ice, or gravity
Main Types	Sheet erosion, rill erosion, gully erosion, wind erosion
Major Causes	Deforestation, overgrazing, poor agriculture, urbanization, drought
Areas Affected (Pakistan)	13.05 million ha (water), 6.17 million ha (wind)
Key Impacts	Loss of fertility, reduced crop yields, water pollution, reservoir sedimentation, desertification
Economic Cost	20% of environmental damage cost; 1.5-7.5% productivity loss/year

Question No. 18: Define biological diversity. Explain its three main levels: genetic, species, and ecosystem diversity. (Ch. 7)

Definition of Biological Diversity

"The variety of life in all its forms, levels and combinations is known as Biological Diversity or Biodiversity."

Page 158: "Biodiversity can be measured on many biological levels ranging from genetic diversity within a species to the variety of ecosystems on Earth, but the term most commonly refers to the number of different species in a defined area."

Key Facts:

- Recent estimates of total species: 7 to 20 million
- Only about 1.75 million species scientifically described
- Best-studied groups: plants and vertebrates
- Poorly described groups: fungi, nematodes, arthropods
- Diversity increases from Poles to Equator

Three Levels of Biodiversity

Page 175: "Three kinds of biodiversity are essential to preserve the ecological system:

1. Genetic Diversity
2. Species Diversity
3. Ecological / Ecosystem Diversity"

Page 175: "These levels are all interrelated yet distinct enough that they can be studied as three separate components."

1. Genetic Diversity

Definition:

Page 175: "Genetic diversity is the variety present at the level of genes. Genes, made of DNA, are the building blocks that determine how an organism will develop and what its traits and abilities will be."

Page 175: "This level of diversity can differ by alleles (different variants of the same gene, such as blue or brown eyes), or by entire genes or by units larger than genes such as chromosomal structure."

Importance (Page 176):

- "represents the raw material for evolution and adaptation"
- "More genetic diversity in a species or population means a greater ability for some of the individuals in it to adapt to changes in the environment"
- "Less diversity leads to uniformity, which is a problem in the long term"

Example from Book (Page 176):

"modern agricultural practices use monocultures, which are large cultures of genetically identical plants. This is an advantage when it comes to growing and harvesting crops, but can be a problem when a disease or parasite attacks the field, as every plant in the field will be susceptible. Monocultures are also unable to deal well with changing conditions."

Factors Affecting Genetic Diversity:

- Increases with environmental variability
- In communities, increases with diversity of species
- Closely related species contribute less genetic diversity than remotely related species

2. Species Diversity

Definition:

Page 175: "Species Diversity describes the number of different kinds of organisms within an individual community or ecosystem."

Why Species Diversity is Most Studied (Page 176-177):

1. "Species are relatively easy to identify by eye in the field" (unlike genetic diversity needing laboratories)
2. "Species are also easier to conceptualize"
3. "have been the basis of much of the evolutionary and ecological research"
4. "Each species can be considered to have a particular 'role' in the ecosystem"
5. "a change in the number of species in an ecosystem is a readily obtainable and easily comprehensible measure of how healthy the ecosystem is"

Species in Pakistan (Page 171, Table 7.1):

Group	Number of Species in Pakistan
Plants	Over 6,000 species
Mammals	188 species
Birds	666 species
Reptiles	174 species
Amphibians	16 species
Fishes	525 species
Insects/Invertebrates	20,000 species

Endemic Species (Page 170-171):

- Indus Dolphin
- Chiltan Markhor
- Pakistan Sand Cat
- Suleiman Markhor
- Punjab Urial
- Balochistan Bear

3. Ecosystem Diversity

Definition:

Page 175: "Ecological / Ecosystem Diversity assesses the richness of a biological system, trophic levels, ecological processes that capture energy, sustain food webs and recycle materials within this system."

Page 177: "Ecosystem-level deals with species distributions and community patterns, the role and function of key species, and combines species functions and interactions."

Scope of Ecosystem Diversity (Page 177):

- Includes "associations, communities, ecosystems"
- May be divided into community level and ecosystem level
- "This is the least-understood level of the three described here due to the complexity of the interactions"

Challenges in Studying Ecosystem Diversity (Page 177):

- Transitions between communities are usually not sharp
- "open communities" (gradual shifts) vs "closed communities" (sudden transitions)
- Complex interactions between species and environment

Ecosystems in Pakistan (Page 169):

Pakistan covers several eco-regions:

- Rann of Kutch flooded grasslands
- Tibetan Plateau
- Western Himalayan Temperate Forests
- Indus Delta Ecosystem
- Arabian Sea

Page 169: "Pakistan has 225 Protected Areas (PAs): 14 national parks, 99 wildlife sanctuaries, and 96 game reserves."

Ecosystem Services (Page 180, Figure 8.1):

- Purification of air and water
- Production of food and medicine
- Climate regulation
- Nutrient cycling
- Waste treatment
- Soil formation

Summary Table: Three Levels of Biodiversity

Level	Definition	Examples	Importance
Genetic Diversity	Variety of genes within a species	Different eye colors; different crop varieties	Raw material for evolution and adaptation
Species Diversity	Number of different species in an area	666 bird species in Pakistan; 188 mammal species	Species have roles in ecosystem; easy to measure
Ecosystem Diversity	Variety of ecosystems and ecological processes	Forests, deserts, wetlands, marine ecosystems	Maintains ecological functions and services

Threats to Biodiversity (Page 164-167, 169-170)

Threat	Description
Habitat Loss	Deforestation, urbanization, agriculture
Overharvesting	Hunting, fishing, poaching
Exotic Species	Invasive species outcompete native species
Pollution	Pesticides, industrial effluents, sewage
Climate Change	Alters habitats and conditions
Deforestation (Pakistan)	Fuel wood and timber consumption
Grazing (Pakistan)	Overgrazing by livestock
Hunting (Pakistan)	Illegal hunting and sports hunting

Biodiversity Loss in Pakistan (Page 169-170):

- Deforestation
- Grazing
- Soil erosion and desertification
- Pollution
- Hunting and fishing
- Agricultural practices (pesticide use increased 7-fold between 1981-1992)

Question No. 19: Describe the geographical location, extent, and major climatic regions of Pakistan. (Ch. 9)

Geographical Location of Pakistan

Coordinates:

Page 191: "Geographically, Pakistan lies between **24° and 37° N latitude** and **61° and 75° E longitude**."

Boundaries:

Page 191: "It is bordered by:

- **China** in the north
- **Arabian Sea** in the south
- **Iran** in the west
- **Afghanistan** in the north-west
- **India** in the east"

Figure 9.1 (Page 190) shows the location map of Pakistan.

Extent of Pakistan

Area:

Page 191: "The land area of Pakistan is about **796,000 sq. km**."

Population (as of June 1996):

Page 191: "an estimated population of 134 million, having a population density of 168 persons per sq. km."

Land Use:

Page 191: "Of the 79.6 million hectares land area:

- Only about **22 million hectares (23%)** are available for cultivation
  - 18 million ha irrigated
  - 4 million ha rain-fed
- Forests, both natural and man-made, cover about **4%** of its land area"

Administrative Divisions:

Page 191: "It is a federation of four provinces:

- NWFP (North West Frontier Province)
- Punjab
- Sindh
- Balochistan

with its capital at Islamabad"

Climate of Pakistan

General Climate:

Page 191: "Depending on the topography, there is an extreme variation in the temperature ofPakistan. The country is essentially **arid** except for the southern slopes of the Himalayas and the sub-mountainous tract where the annual rainfall varies between 760 and 1270 mm."

Page 191: "This area has **humid sub-Tropical climate**. In the extreme north - because of great heights - **Highland climate** prevails."

Controlling Factors of Pakistan's Climate (Page 191-192)

Factor	Description
Sub-tropical location	Tends to keep temperature high, particularly in summer
Oceanic influence of Arabian Sea	Keeps down temperature contrast between summer and winter at the coast
Higher altitudes in west and north	Keep temperatures down throughout the year
Monsoon winds	Bring rainfall in summer
Western Depression	Originates from Mediterranean region, brings rainfall in winter
Temperature inversion layer	At about 1,500 m in south during summer; prevents moisture-laden air from rising and condensing

Temperature Regions of Pakistan (Page 192)

Pakistan can be divided into four broad temperature regions:

Region	Summer Temperature	Winter Temperature
Hot summer and mild winter	32°C or more	10 to 21°C
Warm summer and mild winter	21-32°C	10 to 21°C
Warm summer and cool winter	21-32°C	0 to 10°C
Mild summer and cool/cold winter	10 to 21°C	0 to 10°C

Figure 9.2a (Page 192) shows maps of maximum and minimum temperature regimes in Pakistan.

Rainfall in Pakistan (Page 193)

General Pattern:

Page 193: "The major part of Pakistan experiences **dry climate**. Humid conditions prevail but over a small area in the north."

Rainfall Distribution:

Area	Annual Rainfall

Whole of Sindh, most of Balochistan, major part of Punjab, central parts of Northern Areas	Less than 250 mm
Northern Sindh, southern Punjab, northwestern Balochistan, central parts of Northern Areas	Less than 125 mm
True humid conditions appear	Above 750 mm in plains; above 625 mm in highlands

Sources of Rainfall (Page 193):

1. **Monsoon** - from July to September
2. **Western Depression** - from December to March

Figure 9.2b (Page 193) shows Pakistan's precipitation regime.

Summary Table: Pakistan's Climate

Aspect	Description
Location	24-37°N latitude, 61-75°E longitude
Total Area	796,000 sq. km
Provinces	Punjab, Sindh, NWFP, Balochistan
General Climate	Arid, with humid sub-tropical in north
Rainfall Sources	Monsoon (summer), Western Depression (winter)
Temperature Range	Hot summers (32°C+) to cold winters (0-10°C in north)

Question No. 20: What are the four principles of ecosystem sustainability? How can they guide human activity? (Ch. 8)

Introduction

Page 181: "To move in the direction of sustainability, activities need to be oriented to meet our human needs efficiently, fairly, and within the means of nature to support those needs."

Page 182: "Four principles can guide our actions to move in this direction. Those principles are based upon several years of scientific discussion and consensus about what needs to happen to reorient human activity toward a sustainable society."

The Four Principles of Ecosystem Sustainability

Principle 1: Reduce dependence upon fossil fuels, underground metals and minerals

Explanation (Page 182):
"Today we are living in a fossil fuel-based society and are largely dependent upon mining operations for energy, transportation, and a multitude of natural resources."

Problems with Current Approach:

- "mining operations threaten national parks"
- "require massive amounts of energy and chemicals that leak into groundwater"
- "produce radioactive waste and noxious emissions"
- "can even displace communities"
- "Mining and burning fossil fuels generate unsafe levels of many different pollutants causing acid rain, smog, ozone depletion, and global climate change"
- Contribute to "learning disabilities, feeble immune systems, asthma, cancer, and developmental problems"

The Sustainability Goal:
"the balance of flows between the ecosphere and the lithosphere must be such that concentrations of substances from the lithosphere do not systematically increase in the whole ecosphere, or in parts of it."

How It Guides Human Activity:

- Shift from fossil fuels to renewable energy (solar, wind)
- Reduce mining and consumption of minerals
- Use energy more efficiently
- Develop alternative technologies

Principle 2: Reduce encroachment upon nature

Explanation (Page 182):

"This principle addresses the physical destruction and manipulation of the biosphere, and, consequently, the services nature provides to society."

Activities to Reduce:

- "paving over productive bioregions"
- "over harvesting of natural resources such as forests and fisheries"
- "development leading to urban sprawl"

Positive Actions:

- "protecting natural habitats"
- "smart growth"
- "supporting sustainable fishing, agriculture and timber harvesting practices"

How It Guides Human Activity:

- Limit urban expansion into natural areas
- Practice sustainable harvesting of resources
- Protect forests, wetlands, and natural habitats
- Plan cities to minimize environmental impact

Principle 3: Meet human needs fairly and efficiently, giving priority to basic needs

Explanation (Page 182-183):

"From a systems perspective, natural systems are inherently efficient. Unfortunately, human systems today are not."

Learning from Nature (Page 183):

"A tree throws off branches and leaves, blows off water and oxygen, and finally falls flat and sprawls on the ground. Yes, it makes a huge mess, but a tree is still efficient within the system because the 'waste' it produces is used as a resource for something, or someone, else."

The Shift Needed (Page 183):

"We can shift from **linear models** of infinite resource use and infinite growth to **cyclical models** of infinite transformation and change. This is how nature works."

How It Guides Human Activity:

- Prioritize basic needs of all people (food, water, shelter)
- Reduce waste and inefficiency
- Design systems where waste becomes resource for others
- Ensure fair distribution of resources
- Move from linear consumption to cyclical systems

Principle 4: Reduce dependence upon chemicals and synthetic compounds

Explanation (Page 183):

"in order for a society to be sustainable, the production and accumulation of human-made substances must not happen faster than they can be reintegrated back into natural cycles."

Why This Matters:

- "the earth has a limited capacity to assimilate waste"

- "the volume of material produced by humans today is building up at a rate that far exceeds the earth's capacity"
- "nature has no experience with the synthetic compounds humans are introducing and often has no way of breaking them down"
- "it is often impossible to predict the consequences"
- "the damage done is often irreversible or may take long periods of time to rectify"

Solutions (Page 183):

- "reducing our dependence on synthetic materials"
- "using safe, biodegradable alternatives which can be reintegrated into natural cycles"
- "decreasing the amount of waste generated by society in general"

How It Guides Human Activity:

- Use biodegradable products
- Avoid toxic chemicals
- Reduce waste generation
- Choose natural alternatives over synthetic
- Design products that can be safely recycled by nature

Summary Table: Four Principles of Ecosystem Sustainability

Principle	What It Means	How It Guides Human Activity
1. Reduce fossil fuel dependence	Use less coal, oil, gas; mine fewer minerals	Shift to solar, wind; use energy efficiently
2. Reduce encroachment on nature	Stop destroying natural habitats	Protect forests, wetlands; sustainable harvesting
3. Meet needs fairly and efficiently	Prioritize basic needs; reduce waste	Cyclical systems; fair distribution; efficiency
4. Reduce synthetic chemical dependence	Use fewer human-made substances	Biodegradable alternatives; less waste

Additional Guidance from Nature (Page 188)

Page 188: "Many biologists believe the best way for us to live more sustainably is to:

- Learn about the processes and adaptations by which nature sustains itself
- Mimic these lessons from nature"

Lessons from Nature (Page 188):

1. "Our lives, lifestyles, and economies are totally dependent on the sun and the earth"
2. "We need the earth, but the earth does not need us"
3. "Everything is connected to everything else"
4. "We can never do merely one thing. Any human intrusion into nature has mostly unpredictable side effects"
5. "We should reduce and minimize the damage we do to nature and help heal some of the ecological wounds we have inflicted"
6. "Use care, restraint, humility, and cooperation with nature"

Creating a Sustainable Society (Page 188-189):
By using these guidelines, we can create a society that lives within its ecological means by:

1. "taking no more than we need"
2. "using renewable resources no faster than they can be replenished"

Question No. 21: Explain the concept of a food chain and a food web. Differentiate between the grazing and detritus food chains. (Ch. 2)

Part A: Food Chain

Definition:
Page 42: "The patterns of eating and being eaten forms a linear chain called food chain, which can always be traced back to the producers."

Page 42: "In an ecosystem one can observe the transfer or flow of energy from one trophic level to other."

Trophic Level:

Page 42: "A trophic level can be defined as the number of links by which it is separated from the producer, or as the position of the organism in the food chain."

Energy Transfer in Food Chain (Page 42-43):

- Primary producers trap solar energy and convert to chemical energy
- When herbivore eats plant, energy is transferred
- When carnivore eats herbivore, energy is transferred again
- At each transfer, some energy is released as heat (not useful energy)

Limitation on Food Chain Length (Page 43):

"The number of steps in a food chain is always restricted to four or five, since the energy available decreases with each step."

Why Limited? (Page 43):

- Out of 1000 calories reaching plant, only 10 calories (1%) are stored
- Of those 10 calories, only 1 calorie passes to carnivore
- 99% energy lost at each level for maintenance and as heat

Example from Book (Page 43):

"In a typical food chain of a river, a diatom may be eaten by a copepod which is eaten by a small fish, which in turn is eaten by a large fish that may be finally eaten by a human being."

Figure 2.2 (Page 43) shows the food chain concept.

Part B: Food Web

Definition:

Page 45: "In nature simple food chains occur rarely. The same organism may operate in the ecosystem at more than one trophic level, i.e., it may derive its food from more than one source."

Page 45: "Thus, in a given ecosystem various food chains are linked together and intersect each other to form a complex network called **food web**."

Characteristics of Food Web:

- Same organism may be eaten by several organisms of higher trophic level
- An organism may feed on several different organisms of lower trophic level
- Kind of food may change with age of organism and food availability

Figure 2.3 (Page 45) shows various food chains linked together to form a complex food web.

Part C: Grazing Food Chain vs Detritus Food Chain

Two Types of Food Chains (Page 44):

"In nature, basically two types of food chains are recognized—grazing food chain and detritus food chain."

1. Grazing Food Chain

Definition:

Page 44: "This type of food chain starts from the living green plants goes to grazing herbivores and on to the carnivores."

Energy Source:

Page 44: "Ecosystems with such type of food chain are directly dependent on incoming solar radiation."

Significance:

Page 44: "This type of food chain depends on autotrophic energy capture and the movement of

this energy to herbivores. Most of the ecosystems in nature follow this type of food chain. These chains are very significant from energy standpoint."

Example:

Green plants (producers) → Grasshopper (herbivore) → Frog (carnivore) → Snake (carnivore) → Eagle (top carnivore)

2. Detritus Food Chain

Definition:

Page 44: "The organic wastes and dead matter derived from the grazing food chain are generally termed **detritus**."

Page 44: "The energy contained in this detritus is not lost to the ecosystem as a whole; rather it serves as the source of energy for a group of organisms the **detritivores**."

Importance:

Page 44: "The detritus food chain represents an exceedingly important component in the energy flow of an ecosystem. Indeed in some ecosystems, considerably more energy flows through the detritus food chain than through the grazing food chain."

Organisms in Detritus Food Chain (Page 44):

- Algae, bacteria, slime molds, actinomycetes, fungi
- Protozoa, insects, mites, Crustacean, centipedes
- Mollusks, rotifers, worms, nematodes
- Some vertebrates

Energy Storage:

Page 44: "In contrast to the grazing food chain, in which energy storage is entirely within the tissues of living organisms, energy storage for the detritus food chain may be largely external to the organisms, and in the detritus itself."

Example:

Dead leaves (detritus) → Earthworm (detritivore) → Bird (carnivore)

Comparison: Grazing vs Detritus Food Chain

Feature	Grazing Food Chain	Detritus Food Chain
Starting Point	Living green plants (producers)	Dead organic matter (detritus)
Energy Source	Solar radiation (sunlight)	Energy stored in dead organic waste
First Organisms	Herbivores (primary consumers)	Detritivores (decomposers, scavengers)
Energy Storage	Within living organisms	External (in detritus) and in organisms
Examples	Plant → Grasshopper → Frog → Snake	Dead leaf → Earthworm → Bird
Dependence	Directly on sun	Indirectly on sun (through dead matter)
Significance	Main energy flow path in most ecosystems	Major path in some ecosystems; recycles nutrients

Significance of Food Chain Studies (Page 44)

Page 44: "The food chain studies help understand:

1. The feeding relationships and the interaction between organisms in any ecosystem
2. They also help us to appreciate the energy flow mechanism and matter circulation in ecosystem
3. Understand the movement of toxic substances in the ecosystem and the problem of biological magnification (e.g. DDT)"

Ecological Pyramids (Page 46)

Page 46: "In the successive steps of grazing food chain - photosynthetic autotrophs, herbivorous heterotrophs, carnivores heterotrophs, decay bacteria - the number and mass of the organisms in each step is limited by the amount of energy available."

Page 46: "This relationship is sometimes called 'ecological pyramid'. The ecological pyramids represent the trophic structure and also trophic function of the ecosystem. In many ecological pyramids, the producer form the base and the successive trophic levels make up the apex."

Figure 2.4 (Page 46) shows an ecological pyramid.

Energy Flow in Ecosystems (Page 46-48)

Important Note (Page 41, Box 2.1):
"In an ecosystem, energy flows in non-cyclic manner (unidirectional) from sun to the decomposers via producers and macroconsumers (herbivores and carnivores), whereas the minerals keep on moving in a cyclic manner."

Question No. 22: What are the major types of species interactions? Explain mutualism, commensalism, predation, and parasitism with examples. (Ch. 2)

Introduction to Species Interactions

Page 50: "Organisms do not exist alone in nature but in a matrix of other organisms of many species... in some cases two or more species will interact."

Page 50: "The evidence for such interactions is quite direct: population of one species is different in the absence and in the presence of the second species."

Two Main Categories of Interactions (Page 50):

- **Positive Interactions** - populations help one another; either one or both species are benefited
- **Negative Interactions** - one or both species are harmed in any way during their life period

A. Positive Interactions

1. Mutualism

Definition:
Page 50: "Mutualism is an obligatory positive interspecific interaction that is strongly beneficial to both species."

Page 50-51: "In this case, both of the species derive benefit and there exists a close and often permanent and obligatory contact which is more or less essential for survival of each."

Characteristics:

- Both species benefit
- Close and often permanent contact
- Essential for survival
- Involves physiological exchange
- Leads to co-evolution of both species

Examples from Your Book:

Example	Description	Book Reference
Pollination by animals	Bees, moths, butterflies, birds derive food (nectar, pollen) from plants and in return bring about cross pollination	Page 51, Figure 2.7
Dispersal of fruits and seeds	Birds and mammals eat seeds and eliminate them unharmed in feces, or seeds attach to feathers/fur; animals get food, plants get distribution	Page 51, Figure 2.8
Lichens	Close association of fungus and algae; fungus provides moisture and minerals, algae prepares food by photosynthesis; neither can grow alone independently	Page 51-52
Symbiotic nitrogen fixation	Rhizobium bacteria form nodules in legume roots; bacteria get protective space and food, fix atmospheric nitrogen into nitrates for plant	Page 52, Figure 6.2
Mycorrhizae	Fungi associate with tree roots; fungi derive food from tree roots, supply water and minerals to tree; common in pines, oaks, orchids	Page 52, Figure 2.9

2. Commensalism

Definition:
Page 52: "Commensalism defines the co-action in which two or more species are associated and

one species at least, derives benefit from the association, while the other associates are neither benefited nor harmed."

Characteristics:

- One species benefits
- Other species is neither benefited nor harmed
- Association may be external or internal

Examples from Your Book:

Example	Description	Book Reference
Lianas	Woody plants rooted in ground but climb up trees for support to reach light; tree not harmed or benefited	Page 52-53
Epiphytes	Plants growing on other plants for support only (not for water or food); examples: orchids, bromeliads, hanging mosses	Page 53, Figure 2.10
Internal commensalism	Harmless protozoans in intestinal tract of mammals; E. coli in human colon	Page 53
Pitcher plant	Provides breeding site for midge flies, mosquitoes, tree toads	Page 53, Figure 2.11
Animals in sponges	Small crabs, shrimps live in canal system of sponges	Page 53
Nest commensalism	Some birds place nests near wasps, bees for protection; woodchuck burrows used by rabbits, skunks, raccoons	Page 54

B. Negative Interactions

3. Parasitism

Definition:
Page 54: "Parasitism is a relation between two individuals wherein one individual called **parasite** receives benefit at the expense of other individual called **host**."

Characteristics:

- Parasite benefits, host is harmed

- Parasite usually smaller than host
- Parasite does not kill host immediately (at least not until reproductive cycle complete)
- Host may suffer stunted growth, weakness, sterility, or death from secondary infection

Classification of Parasites (Page 54-55):

Classification Type	Categories	Examples
By type	Viral, microbial, phytoparasites, zooparasites	Viruses, bacteria, protozoa, nematodes
By location	Ectoparasites (outside host), Endoparasites (inside host)	Ticks (ecto), Tapeworms (endo)
By duration	Permanent, temporary	Plasmodium (permanent), Mosquitoes (temporary)

Examples from Your Book:

Parasite Type	Example	Host	Effect
Ectoparasite	Ticks, fleas, lice, mosquitoes	Animals	Suck blood; may transmit diseases
Endoparasite	Tapeworm	Humans/animals	No digestive system; absorbs food through body wall
Endoparasite	Plasmodium	Humans	Causes malaria
Plant parasite	Nematodes	Plant roots	Infest roots, damage plants
Insect parasite	Wasps	Oaks, willows	Form galls on plants

Parasitic Adaptations (Page 55-56):

Adaptation	Description
Clinging organs	Hooks, suckers for attachment to host
Piercing and sucking organs	For sucking blood or sap
Anaerobic respiration	Endoparasites respire without oxygen
Loss of digestive system	Tapeworms absorb food through body wall
High reproduction rate	Produce enormous offspring to ensure survival

Cyst formation	Resistant to host's digestive enzymes

Effects of Parasites on Host (Page 56-57):

- Cause damage to body structures
- Disturb balance of vital processes
- Cause disease
- Examples: viruses (hoof and mouth disease), bacteria (tuberculosis), protozoa (Leucocytozoon in birds), worms (mechanical injury)

Figure 2.12 (Page 55) shows endoparasites in sheep.

4. Predation

Definition:
Page 57: "Predation occurs when members of one species eat those of another species. Often, but not always, this involves the killing of the prey."

Four Types of Predation (Page 57-58):

Type	Description	Example
Herbivory	Animals prey on green plants or their seeds/fruits	Deer eating grass
Typical predation	Carnivores prey on herbivores or other carnivores	Lion eating deer
Insect parasitism	Insect parasite lays eggs on/near host insect, which is later killed and eaten	Parasitic wasps
Cannibalism	Predator and prey are from same species	Some fish species

Characteristics of Successful Predators (Page 58-59):

- Well-developed hunting ability
- Specialized predators hunt few species (Peale's falcon prefers ducks)
- Generalized predators adjust to other food sources (foxes eat vegetables)
- Can switch to more abundant prey when preferred prey is scarce
- Select prey based on age, size, strength
- Hunt only when necessary to procure food

Prey Defense Strategies (Page 59):

Defense	Description	Example
Aposematic coloration	Bright colors warning of toxicity	Poisonous frogs
Group living	Many eyes detect predators early; group can stop attack; confusion during escape	Birds in flocks, ungulates in herds

Predation in Plants (Page 59):

- Insectivorous plants (Nepenthes, Utricularia, Drosera, Dionaea)
- Depend on insects for nitrogen requirements
- Have specialized structures to attract, trap, and digest insects

Predation Importance (Page 58):

1. May restrict distribution or reduce abundance of prey
2. Affects community structure
3. Major selective force; leads to coevolution

Comparison Table: Types of Interactions

Interaction	Species A	Species B	Example	Book Reference
Mutualism	+ (benefited)	+ (benefited)	Lichens (fungus + algae)	Page 50-52
Commensalism	+ (benefited)	0 (no effect)	Epiphytes on trees	Page 52-54
Parasitism	+ (benefited)	- (harmed)	Tapeworm in human	Page 54-57
Predation	+ (benefited)	- (killed/eaten)	Lion eating deer	Page 57-60

Key: + = benefit, - = harm, 0 = no effect

Question No. 23: What is the greenhouse effect? Differentiate it from global warming and discuss their consequences. (Ch. 3)

Part A: The Greenhouse Effect

Definition:
Page 73: "This phenomenon is called the 'greenhouse effect' because the atmosphere, like the glass or roof of a greenhouse, transmits sunlight while trapping heat inside."

The Mechanism (Page 73):

- Solar energy reaching earth is mainly visible light (atmosphere is transparent to it)
- Earth absorbs this energy and re-radiates it as infrared radiation (heat)
- Greenhouse gases (CO_2, water vapor, methane) absorb this infrared radiation
- These gases re-emit some of the heat back toward earth's surface
- This traps heat close to the earth's surface

Natural Greenhouse Effect (Page 67):
Page 67: "If the atmosphere had no greenhouse gases, it is estimated that the earth's surface would be 90°F (32°C) cooler."

Greenhouse Gases (Page 67-68, 85):

Greenhouse Gas	Sources	Role
Carbon dioxide (CO_2)	Burning fossil fuels, deforestation	Major greenhouse gas; absorbs infrared
Water vapor (H_2O)	Evaporation from oceans, lakes	Most abundant greenhouse gas; concentrated near surface
Methane (CH_4)	Rice paddies, cattle, landfills, mining	Potent greenhouse gas
Chlorofluorocarbons (CFCs)	Refrigerators, air conditioners, sprays	Also deplete ozone layer
Nitrous oxide (N_2O)	Fertilizers, chemicals	Greenhouse gas

The Blanket Analogy (Page 85):
"These gases behave like a blanket. As a blanket warms you up by holding the heat of your body within it, similarly the greenhouse gases hold or trap the heat emitted by the earth to the lower atmosphere making it warmer."

Page 85-86: "As the carbon dioxide concentration keep on increasing day by day due to burning of fossil fuels it is exactly like taking one blanket over the other and thus continuously increasing the warmth."

Figure 3.2 (Page 72) shows the solar-energy balance and greenhouse effect.

Part B: Difference Between Greenhouse Effect and Global Warming

Aspect	Greenhouse Effect	Global Warming
Definition	Natural process where gases trap heat in atmosphere	Increase in Earth's average temperature due to enhanced greenhouse effect
Cause	Naturally occurring greenhouse gases	Human activities increasing greenhouse gas concentrations
Nature	Natural phenomenon essential for life	Anthropogenic (human-caused) phenomenon
Historical Context	Has existed for billions of years	Began with Industrial Revolution (~150 years ago)
Effect	Makes Earth habitable (32°C warmer than without it)	Causes rapid temperature rise beyond natural levels
Book Reference	Page 67, 73	Page 85

Page 85: "Global warming is caused primarily by carbon dioxide from burning coal, oil and gas. Certain gases that trap heat are building up in Earth's atmosphere."

Page 81: "Through widespread use of land, use of fossil fuels and the building of cities, we have changed our climate. The major technological and socioeconomic shift of the industrial era, the accelerated uptake of fossil fuels, and broad scale deforestation, means we have contributed to the natural greenhouse effect."

Part C: Consequences of Greenhouse Effect and Global Warming

1. Temperature Rise

Page 82: "The world has warmed 0.74°C in the past hundred years"
Page 83: "Global average temperature is forecast to rise 4°C (7.2°F) toward the end of the 21st century"
Page 82: "Temperatures across the globe are most certainly rising; the 1990s was the warmest decade in the last thousand years"
Page 82: "Sea surface temperatures have increased 0.4-0.8°C since the late 19th Century"

Figure 3.5 (Page 82) compares temperature variation over the past 1000 years and 140 years.

2. Melting of Glaciers and Ice

Page 83: "Glaciers are retreating, and snow cover is decreasing"
Page 129: "Glaciers are highly sensitive to minor changes in the atmospheric temperatures"
Page 129: "Continued climate change is predicted to lead to major changes in fresh water flows with dramatic impacts on biodiversity, people and their livelihood"

Impact on Pakistan (Page 129):

- Agriculture and power generation dependent on Karakorum glaciers
- Current increased melting causes floods and landslides
- Long-term: decreased runoff, fresh water scarcity

Sea Level Rise (Page 85, 129):
Page 85: "sea levels will rise over the coming decades"
Page 129: "If the Greenland ice sheet melted, it would cause sea levels to rise some six meters (20 feet) all around the world. If the Antarctic ice sheet melted, sea levels would rise up to 65 meters (210 feet)"

3. Impacts on Animals

Page 84: "Pole-ward and elevational shifts in range and alteration in species abundance"
Page 84: "Over a million species are predicted to become extinct by 2050"
Page 84: "Temperature sensitive species like Boyd's Forest Dragon, Cassowaries are expected to become extinct"
Page 84: "Changes in phenology (including earlier reproduction and migration), physiological and morphological adaptation may also occur"

4. Impacts on Plants

Page 84: "Change in abundance... shift in plant diversity"
Page 84: "Change in phenology (including earlier flowering), change in growth patterns can be a serious threat to crops"
Page 84: "If extended winters, lack of rainfall... delay flowering and subsequently fruiting in the wheat crop, it would impart significant and direct impacts on the availability of food and economy of the country"

Page 153: "under high CO_2 concentrations, shrubs are thought to respond more favorably than certain grass species... some scientists have hypothesized that grasslands will be invaded by CO_2-responsive shrubby species"

5. Changes in Rainfall Patterns

Page 84-85: "A few degrees of increase in temperature will lead to more heat waves and fewer frosts"
Page 84: "More wildfires and droughts are expected in drier regions"
Page 84: "regions of the world with higher rainfalls would receive increased rains thus resulting in floods"
Page 85: "Higher latitudes of the globe would receive more rainfall while middle latitudes, are likely to receive less"
Page 85: "For these areas the changes will pose significant problems for water resource management"

6. Extreme Weather Events

Page 85: "Tropical hurricanes and cyclones may become stronger"
Page 85: "Some low-lying coastal areas and islands are already feeling the effect, and will be more prone to inundation from storm surges"

7. Human Displacement

Page 82: "only 1°C rise in temperature may displace millions of people"
Page 82: "There are already people who have become climate refugees, and millions more are expected in the future"

8. Impacts on Water Resources

Page 83: "Hydrology and Glaciers - Glaciers are retreating, and snow cover is decreasing"
Page 83: "Glaciers are major fresh water resources available on earth"
Page 83: "If the glaciers retreat at a higher rate than desired not only we ought to loose the water reservoir, but also face the destruction through excessive flooding in the rivers"

Summary Table: Greenhouse Effect vs Global Warming

Aspect	Greenhouse Effect	Global Warming
Definition	Natural heat-trapping process	Human-caused acceleration of greenhouse effect

Cause	Natural greenhouse gases	Increased CO_2, methane, CFCs from human activities
Beneficial/Harmful	Beneficial (makes Earth habitable)	Harmful (causes climate change)
Time Scale	Always present	Since Industrial Revolution (~150 years)
Temperature Impact	Makes Earth 32°C warmer than without it	Causing additional 0.74°C rise (past 100 years)

Main Consequences:

1. Global temperature rise
2. Glacier melting and sea level rise
3. Species extinction and habitat loss
4. Changes in plant growth and crop yields
5. Altered rainfall patterns (droughts and floods)
6. Stronger hurricanes and cyclones
7. Human displacement and climate refugees
8. Water scarcity

Question No. 24: Describe the major water compartments of the hydrosphere (oceans, glaciers, groundwater, lakes, and rivers). Why is freshwater a vital resource? (Ch. 5)

Introduction to Hydrosphere

Page 127: "The hydrosphere is composed of all of the water on or near the earth. This includes the oceans, rivers, lakes, and even the moisture in the air."

Page 125: "A total volume of some 325 million cubic miles (1.4 billion cubic kilometers) covers 71% of Earth's surface."

Global Water Distribution (Page 125, Figure 5.1):

- **97.5%** - Salt water (oceans and seas)
- **2.5%** - Fresh water
  - Of this 2.5%, **87%** is bound in polar ice caps and glaciers
  - Only **0.77%** of total earth water is found in lakes, wetlands, rivers, groundwater, biota, soil, and atmosphere

Major Water Compartments of the Hydrosphere

Table 5.1 (Page 127): Earth's Water Compartments

Compartment	% of Total Water	Average Residence Time
Oceans	97.6%	3,000 to 30,000 years
Ice and Snow	2.07%	1 to 16,000 years
Groundwater (down to 1 km)	0.28%	Days to Thousands of Years
Lakes and Reservoirs	0.009%	1 to 100 Years
Rivers and Streams	0.0001%	10 to 30 Days

Additional compartments:

- Biological moisture (plants and animals): ~0.005%, residence time ~1 week
- Soil moisture: 0.005%
- Atmospheric water vapor: 0.001%

1. Oceans

Description:
Page 127: "Together the oceans contain more than 97 percent of all the liquid water in the world."

Characteristics:

- Too salty for most human uses
- Contain 90% of the world's living biomass
- Different compositions, climatic effects, and surface elevations due to limited water exchange

Role in Climate (Page 127):
"Oceans play an important role in moderating the earth's temperature. Huge currents transport warm water from the equator to higher latitudes and cold water flows from the poles to the tropics."

Box 5.1 (Page 128) - Interesting Facts:

- Tropical surface waters: warmed by sun, diluted by rain → lighter density
- Higher latitude surface waters: cold and much denser → sink to bottom
- Warm tropical water floats on top of cold dense water
- Sharp boundaries form between different water densities, salinities, and temperatures

Residence Time:
Page 128: "The average residence time of water in the ocean is about 3000 years. In the deepest ocean trenches, water may remain undisturbed for tens of thousands of years."

Pakistan's Coastal Importance (Page 128):

- Located at mouth of Indian Ocean
- Gateway for Central Asian states to reach Indian Ocean
- 75% world trade passes through Arabian Sea
- 700 km of coastline
- Deep sea port of Gwadar (strategic location between Middle East, South Asia, Central Asia)
- Considered "Special Economic Zone"

2. Glaciers, Ice and Snow

Description:
Page 128: "About 2.4 percent of all water that is fresh, nearly 90% is tied up in glaciers, ice caps and snowfields."

What are Glaciers? (Page 128):
"Glaciers are really rivers of ice flowing downhill very slowly. They now occur only at higher altitudes and high latitudes."

Types of Glaciers (Page 129):

Type	Description	Location
Alpine glaciers	Found in mountain terrains	Mountain ranges
Continental glaciers	Cover large areas as enormous ice masses; not visibly affected by landscape	Antarctica, Greenland

Ice Sheets (Page 129):

- Antarctica: up to 2 km thick, contains 85% of all ice in world
- If Greenland ice sheet melted: sea levels rise 6 meters (20 feet)
- If Antarctic ice sheet melted: sea levels rise 65 meters (210 feet)

Glaciers in Pakistan (Page 129, Table 5.2):

Glacier	Region	Length (km)	Area (km^2)
Siachen	Karakoram (Baltistan)	75	1,180.00

Biafo	Karakoram (Shigar)	68	625.00
Baltoro	Karakoram (K-2)	62	755.00
Batura	Karakoram (Hunza)	58	290.00
Hesper	Karakoram (Nagar)	53	620.00
Trich	Hindukush (Chitral)	29	500.00

Importance (Page 129):
"The glaciers are the primary fresh water resource on the earth. They feed the streams and the rivers with adequate amounts of water that is used up mainly for irrigation purposes. In Pakistan, agriculture and power generation are fully dependent on the fresh water supply fed by the discharges of the Karakorum glaciers."

Climate Change Impact (Page 129):

- Glaciers highly sensitive to temperature changes
- Good indicators of climate change
- Current increased melting: gradual increase in discharge, increased land sliding and floods
- Long term: decreased runoff, fresh water scarcity, perennial rivers becoming seasonal streams

3. Groundwater

Description:
Page 130: "After glaciers, the next largest reservoir of fresh water is held in the ground as ground water."

Definition (Page 130):
"Ground water is the part of precipitation that seeps down through the soil until it reaches rock material that is saturated with water. Water in the ground is stored in the spaces between rock particles."

Key Processes (Page 130):

Process	Definition
Percolation	Seepage of rain water into the soil
Infiltration	Inward movement through permeable rocks

Zones of Groundwater (Page 130):

Zone	Description

Zone of Aeration	Upper soil layers holding both air and water; moisture for plant growth
Zone of Saturation	Deeper layers where all spaces filled with water; almost no air
Water Table	Top of the zone of saturation; undulates according to surface topography; rises and falls with seasons

Aquifers (Page 130):
"Underneath the water table lie a porous layer of sand, gravel, etc. known as aquifers. Under the aquifer lie a relatively impermeable layer of rock and clay that keep water from seeping out at the bottom."

Recharge Zone (Page 130):
"The infiltrated water penetrates to refill the aquifers at specific areas known as recharge zone."

Problems (Page 130):

- "The rate at which most aquifers are filled is very slow, and the ground water presently is being removed faster then it can be replenished"
- "Urbanization, road building often blocks recharge zones and prevent replenishment"
- "seepage of pollutants into recharge zone have polluted aquifers in many areas"

4. Lakes, Ponds and Reservoirs

Lake Definition (Page 131):
"A lake is an inland depression that holds standing fresh water round the year."

Lake Characteristics:

- Maximum depths: few meters to over 1600m (Lake Baikal)
- Surface area: less than half hectare to hundreds of thousands sq km (Caspian Sea)

Ponds (Page 131):
"Ponds are generally considered to be small temporary bodies of water shallow enough for rooted plants to grow over most of the bottom."

Temporary Nature (Page 131):
"Both lakes and ponds are relatively temporary features on the land because they are eventually filled with silt or are emptied by cutting out an outlet to consume water."

Reservoirs (Page 131):
"Reservoirs are lakes created artificially to meet specific needs such as provision of water for

domestic use, irrigation, industrial use, hydroelectricity production, flood control and for recreation."

Important Lakes in Pakistan (Page 131-132, Table 5.3):

Lake	Location	Notes
Ansoo Lake	Kaghan Valley	High-altitude lake (16,490 feet)
Hadero Lake	Thatta District	Brackish water; wildlife sanctuary (1977)
Haleji Lake	Thatta, Sindh	Largest water fowl reserve in Asia
Karambar Lake	Northern Areas	31st highest lake in world
Keenjhar Lake	Thatta, Sindh	One of largest freshwater lakes in Pakistan
Lower Kachura Lake	Skardu	Also known as Shangrila Lake
Manchar Lake	Sindh	Largest freshwater lake in Pakistan, one of largest in Asia
Rawal Lake	Islamabad	Man-made; major water source for Islamabad and Rawalpindi
Rush Lake	Northern Areas	Highest lake in Pakistan (over 4,694 m)
Saiful Muluk	Kaghan Valley, NWFP	Famous for fairytale of Saiful Maluk
Satpara Lake	Skardu Valley	One of largest freshwater lakes; supplies water to Skardu
Simli Lake	Islamabad	Largest drinking water source for Islamabad
Sheosar Lake	Deosai Plains	Located in Deosai Plateau

5. Rivers and Streams

Formation (Page 133):
"Small rivulets accumulate to form streams, and streams join to form rivers."

Discharge (Page 133):
"The best measure of the volume carried by a river is its discharge, the amount of water that passes a fixed point in a given amount of time. This is usually expressed as liters or cubic feet of water per second."

The Indus River System (Page 133):

Page 133: "The longest and the largest river in Pakistan is the Indus River, which is also called the **'Lifeline of Pakistan'**, as Indus and its tributaries are probably the largest water source in Pakistan. Around two-thirds of water supplied for irrigation and in homes come from the Indus and its associated rivers."

Tributaries of Indus (Page 133):

- **From west:** Astore River, Gomal River, Gilgit, Kurram, Shigar River
- **From east:** Panjnad (formed by confluence of 5 rivers of Punjab: Jhelum, Chenab, Ravi, Beas and Sutlej)
- Other rivers: Soan, Swaan

Rivers not directly falling into Indus:

- Dasht River (Gawadar)
- Haro (Abbotabad)
- Hub (Lasbela)
- Lyari and Malir rivers (Karachi)

Importance (Page 133):
"Pakistan's economic and social wellbeing is built on this water system despite the scant average annual rainfall of just 240 millimeters. Over the years, Pakistan has harnessed the Indus River to bring 35.7 million acres under irrigation to cultivate land in otherwise desert conditions."

Page 133: "Today, the country has the world's largest irrigation system, one of great technical, institutional and social complexity. This irrigated agriculture system accounts for a 1/4 of the country's GDP, 2/3 of employment and about 80% of exports."

Why Freshwater is a Vital Resource

1. Essential for Life (Page 125):
"Water is absolutely fundamental to life as we know it. It is difficult even to imagine a form of life that might exist without water."

2. Drinking Water (Page 125-126):
"Streams, rivers, ponds, lakes... provide drinking water" for humans and all terrestrial biota

3. Agriculture and Food Production (Page 126):
"irrigation makes it possible to grow 40% of the world's food"
Page 133: Pakistan's irrigation system accounts for 1/4 of GDP and 2/3 of employment

4. Industrial Use (Page 126):
"water for industries"

5. Energy Production (Page 126):
"Bodies of water furnish energy through hydroelectric power" - one-fifth of all electricity generated through hydropower

6. Climate Regulation (Page 126):
"modulating the climate through evaporation"

7. Transportation (Page 126):
"They provide transportation"

8. Ecosystem Services (Page 126):
"provide... habitats for aquatic plants and animals"
"control flooding by absorbing excess water"

9. Renewable Nature (Page 125):
"evaporation from the oceans combines with rainfall to re-supply that small percentage continually through the solar-powered hydrologic cycle. Thus, fresh water is a continually renewable resource."

10. Global Warming Connection (Page 126):
"essential global warming (when the fresh water is in the atmosphere as water vapor)"

11. Sanitation and Health (Page 126):
"waterborne diseases have been brought under control" in developed countries through water infrastructure

12. The Scarcity Challenge (Page 126):
"In the developing world, by contrast, over 1 billion people still lack access to clean drinking water, 2.5 billion do not have access to adequate sanitation services, and over 3 million deaths each year are traced to waterborne diseases (mostly in children under 5)"

Summary Table: Water Compartments

Compartment	% of Total Water	Residence Time	Key Facts
Oceans	97.6%	3,000-30,000 years	Contain 90% of living biomass; moderate climate
Glaciers/Ice	2.07%	1-16,000 years	90% of fresh water; Pakistan's agriculture depends on them
Groundwater	0.28%	Days-thousands years	Stored in aquifers; being depleted faster than replenished

Lakes	0.009%	1-100 years	Temporary features; Pakistan has many important lakes
Rivers	0.0001%	10-30 days	Indus is Pakistan's lifeline; world's largest irrigation system

Question No. 25: Discuss the major threats to biodiversity, highlighting the specific challenges faced in Pakistan. (Ch. 7 & 9)

Introduction to Biodiversity Threats

Page 158: "Human activities, such as direct harvesting of species (for food, wool and hunting, etc.), introduction of alien species, habitat destruction, and various forms of habitat degradation (including environmental pollution), have caused dramatic losses of biodiversity; current extinction rates are estimated to be 100-1000 times higher than pre-human extinction rates."

Page 164-165: "extinction, the elimination of a species, is a normal process of the natural world. Species die out and is replaced by others. In undisturbed ecosystems, the rate of extinction appears to be about one species lost every decade. In this century however, human impacts on populations and ecosystem share accelerated the rate, causing hundreds of species, sub-species and varieties to become extinct every year."

Major Threats to Biodiversity (General)

A. Natural Causes of Extinction (Page 165)

Page 165: "Studies of fossil record suggest that more then 99 percent all species that ever existed are now extinct. Most of these species were gone before human came on the scene."

Natural Cause	Description
Climate change	Long-term changes in temperature and weather patterns
Unavailability of food	Resources become scarce
Natural disasters	Floods, fires, volcanic eruptions

Natural Cause	Description
Asteroid impact	Striking of large asteroids (e.g., dinosaurs 65 million years ago)

Page 165: "Many ecologists worry that 'global climate change' caused by release of green house gases in the atmosphere could have similar catastrophic impacts."

B. Human-Caused Extinction (Page 165-167)

1. Habitat Loss and Fragmentation

Description (Page 165):
"Most human induced extinction is due to habitat lost. Once the habitat is fragmented for human use, the species population divides into isolated groups that are vulnerable to catastrophic events."

Page 184-185, Figure 8.2 shows how fragmentation destroys habitat for many species.

Consequences:

- Very small populations may not have enough breeding adults
- Species become vulnerable to catastrophic events
- Page 184: "Fragmentation eliminates habitat for those species requiring large unbroken blocks of habitat"
- Page 185: "small habitat patches... often do not provide the food and cover resources"
- Increased risk of predation and starvation

2. Overharvesting

Description (Page 165-166):
"Over harvesting is another major reason of source depletion."

Examples:

- "fish stocks have been seriously depleted by over harvesting in many parts of the world"
- "game animals are prone to extinction due to over hunting"

Wildlife Trade (Page 166):
"Despite international ban on trade in products from endangered species, smuggling of furs, hides, horns, live specimens and medicines amounts to million of dollars each year."

Box 7.5 (Page 166) - Ivory Trade:

- 1980: about 1.3 million African elephants
- Decade later: only half left
- Poachers killed 600,000 elephants in 1980s for ivory
- International ban in 1989 greatly reduced poaching

3. Hunting and Poaching

Description (Page 166):
"Some animal populations have been greatly reduced because they are regarded as danger to humans or livestock."

Example:
"Wolves were common in Pothwar Region of Pakistan a few decade ago. The local residents considering it as a threat to themselves and their livestock tend to kill every animal they encounter."

4. Introducing Exotic (Alien) Species

Definition (Page 166):
"Aliens introduced into habitats where they are not native — are one of the greatest threats to native biodiversity."

Why Exotic Species are Harmful (Page 166):
"The exotic species become free from their natural predators, parasites, pathogens and competitors that keep them in check in their native home. Even mild species can turn into super aggressive weedy invasives."

Box 7.6 (Page 167) - Paper Mulberry in Islamabad:

- Planted in 1960s to make city green and control erosion
- Became invasive, replaced native flora
- Threat to biodiversity and human health (pollen causes asthma and allergies)
- Difficult to eradicate (new shoots sprout when older trees removed)

5. Diseases

Description (Page 166):
"Diseases organisms or pathogens may also be considered predators."

Conditions for Epidemic (Page 166):
"When a disease is introduced in a new environment, or if the host weakens down due to other ecological factors, the host-predator balance may be lacking and an epidemic may sweep through the area."

6. Pollution

Description (Page 167):
"Toxic pollutants can have disastrous effects on local populations of organisms."

Examples:

- **Pesticides:** "adversely affect the aquatic fauna and the fish-eating birds. The pesticides and fertilizers are washed along with run off water into nearby water bodies hence increasing the toxic levels."
- **Lead poisoning:** "Water fowl such as ducks, cranes, swans, etc. swallow the spent shotgun pellets that fall into lakes and marshes. From these pellets, the lead slowly accumulates in their blood and other tissues."

Specific Challenges Faced in Pakistan

Introduction:
Page 169: "The country lies at the western end of the South Asian subcontinent, and its flora and fauna are composed of a blend of Palearctic and Indomalayan elements, with some groups also containing forms from the Ethiopian region."

Page 169: "Pakistan covers a number of the world's eco-regions, ranging from the mangrove forests stretching from the Arabian Sea to the towering mountains of the western Himalayas, Hindukush and Karakoram."

Global Eco-regions of Pakistan (Page 169):

1. Rann of Kutch flooded grasslands
2. Tibetan Plateau
3. Western Himalayan Temperate Forests
4. Indus Delta Ecosystem
5. Arabian Sea

Protected Areas (Page 169):
"Pakistan has 225 Protected Areas (PAs): 14 national parks, 99 wildlife sanctuaries, and 96 game reserves."

Major Reasons for Biodiversity Loss in Pakistan (Page 169-170)

1. Deforestation

Page 169: "Principle cause of deforestation in Pakistan is the consumption of fuel wood and timber."

Impact:

- Loss of forest habitats
- Destruction of wildlife homes
- Soil erosion increases

2. Grazing

Page 169: "Rapidly increasing domestic livestock population is the direct cause of degradation on rangelands and forests."

Impact:

- Overgrazing removes vegetation
- Prevents natural regeneration
- Soil becomes exposed to erosion

3. Soil Erosion and Desertification

Page 169: "Agricultural activities and overstocking has lead to the reduction of vegetation cover, resulting in the acceleration of both wind and water erosion."

Statistics (Page 121-122):

- Water erosion: 13.05 million hectares affected
- Wind erosion: 6.17 million hectares affected

4. Salinity and Water Logging

Page 170: "Being a serious problem faced by the agriculture sector, pockets of forests of the Indus basin could be threatened."

5. Pollution

Page 170: "Pakistan faces a serious challenge of growing pollution in urban areas and water courses. Likewise discharge of sewage and industrial effluent into aquatic and marine ecosystems is also on the rise."

Impact:

- Water pollution affects aquatic life
- Industrial effluents contaminate habitats
- Marine ecosystems degraded

6. Hunting and Fishing

Page 170: "There is a strong tradition of illegal hunting and sports hunting in Pakistan. This has resulted into the decline of bird and mammal species."

Species Affected (Page 165-166):

- Urial
- Markhor
- Ibex (mountain goats)
- Partridges
- Chakur
- Cranes
- Various water fowls

7. Agricultural Practices

Page 170: "Pakistan faces degradation of agro-ecosystems caused by irrigation. The agricultural use of pesticides and fertilizers has rapidly increased in recent years."

Alarming Statistic:
"Pesticide use in Pakistan has increased 7 fold in quantity between 1981 and 1992."

Impact:

- Pesticides kill beneficial insects
- Chemicals contaminate water bodies
- Affect non-target species

Hot Spots (Areas of Major Land Cover Transformations) - Page 199-200

1. Juniper Forests of Northern Balochistan:

- Heavily harvested for timber and fuel wood
- Unrestricted grazing hampers natural regeneration
- Categorized as Protected Forests but still under threat

2. Indus River Zone:

- Ecological changes drastically affected Riverain Forests and Coastal Mangrove Forests
- Large tracts cleared for agriculture
- River dammed and dyked, confined
- Drop in river level left forests high and dry
- Upstream dams reduced fresh water flow to delta
- Increased salinity damaged mangrove forests
- Several tree species eliminated
- Uncontrolled cutting for firewood and fodder accelerates degradation

3. Himalayan Temperate Forests:

- Under severe pressure from logging for timber and firewood
- Clearings for agriculture due to population pressure

Biodiversity of Pakistan (Page 171, Table 7.1)

Group	Number of Species in Pakistan	Endemic Species
Plants	Over 6,000 species	About 400 species
Mammals	188 species	Indus Dolphin, Chiltan Markhor, Pakistan Sand Cat, Suleiman Markhor, Punjab Urial, Balochistan Bear
Birds	666 species	Western Himalayan Endemic Bird Area
Reptiles	174 species	13 endemic species

Amphibians	16 species	9 endemic species
Fishes	525 species	29 endemic species
Insects/Invertebrates	20,000 species	Limited research done

Consequences of Biodiversity Loss (Page 167)

Page 167: "Biodiversity refers to all diversity of species found in a given ecosystem. These are the structural components of the ecosystem. The structural components are responsible for the functioning of ecosystem i.e. they determine major ecosystem processes such as energy flow and nutrient cycling."

Keystone Species (Page 167):
"Certain species play an absolutely vital role to the survival of many other species in an ecosystem. These are known as the keystone species."

Umbrella Species (Page 167):
"Large animals like wolves, elephants, tigers, etc. are considered umbrella species for the whole ecosystem. If they survive, there will likely still be enough undisturbed habitat for other living species."

Expected Consequences (Page 167):

- Loss of biodiversity is costly
- Natural ecosystems provide vital services to human societies
- Recreational, aesthetic and commercial losses will be inevitable
- Linked directly to degradation and disappearance of ecosystems

Summary Table: Threats to Biodiversity in Pakistan

Threat	Description	Affected Areas/Species
Deforestation	Fuel wood and timber consumption	Juniper forests, Himalayan forests
Overgrazing	Increasing livestock population	Rangelands, forests
Soil Erosion	Water and wind erosion	19.22 million hectares total

Threat	Description	Affected Areas/Species
Pollution	Industrial effluents, sewage	Water bodies, marine ecosystems
Hunting	Illegal and sports hunting	Markhor, Urial, Ibex, birds
Agricultural Practices	Pesticide use (7-fold increase)	Agro-ecosystems, beneficial insects
Exotic Species	Invasive species	Paper mulberry in Islamabad
Water Scarcity	Reduced flow to delta	Mangrove forests, Indus Delta