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CHAPTER

26

# Some Major Ecosystems

*Animation 26: Some major Ecosystem  
Source & Credit: Wikispaces*

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In the previous chapter, you have learned about the ecosystem. In this chapter, we will discuss the aquatic and terrestrial ecosystems, climate and weather.

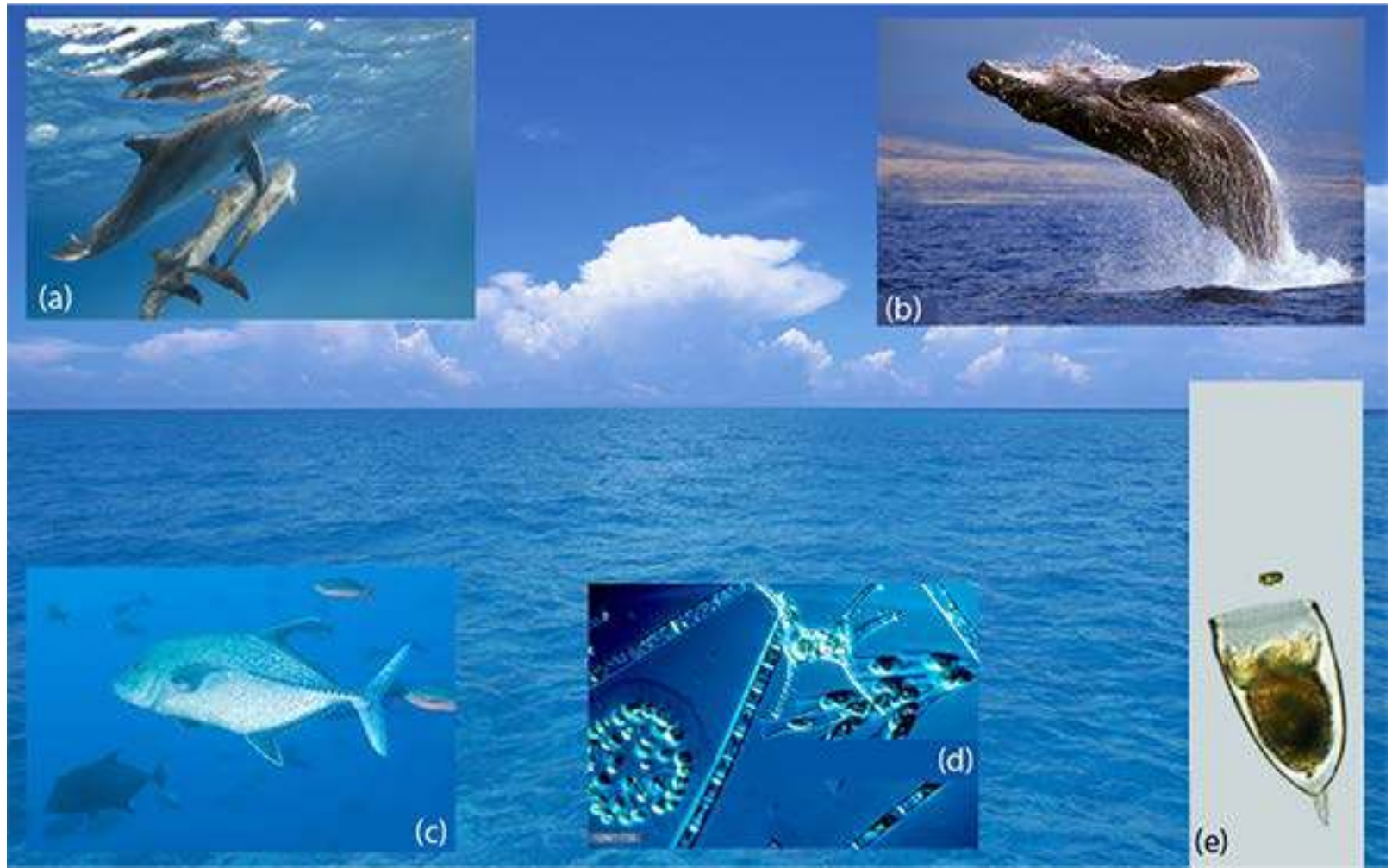
## CLIMATE

Life on earth, specially on land, is affected by both weather and climate. Weather refers to short-term fluctuations in temperature, humidity, cloud cover, wind and precipitation over periods of hours or days. Climate, in contrast, refers to overall patterns of weather that prevail from year to year even century-to-century in a particular region.

## AQUATIC OR HYDROSPHERIC ECOSYSTEM

Hydrospheric ecosystem is a “system in water where living and non-living components exchange materials and transfer of energy also takes place within water”. Salt-water ocean and sea are the largest ecosystems on the earth forming about 71% of its surface. Fresh water ecosystems, in contrast, covers less than 1%. The unique properties of water lend some common features to aquatic ecosystem.

1. **Temperature:** Water changes its temperature slower than air, so temperature in aquatic ecosystem is more moderate to support life.
2. **Absorption of energy:** Although water may appear quite transparent, it absorbs a considerable amount of the light energy that sustains life. Even in clearest water, the intensity of light decreases rapidly with depth, so at the depth of 600 feet or more, a little light is left to power photosynthesis.
3. **Nutrients :** The nutrients in aquatic ecosystem tend to be concentrated near the bottom sediments supporting life where light levels often are too low to support photosynthesis.
4. **Abundant water with appropriate temperature :** Water is an essential requirement for life. It is available abundantly in aquatic ecosystem to support life. The major factors that determine the quantity and type of life in aquatic ecosystems are energy and nutrient. Appropriate temperature is present in aquatic ecosystem to carry out all metabolic processes.



*Fig. 26.1 The open ocean (a) Porpoises skim the surface, (b) rare humpback whales leap on the clear water (c) and fish such as this blue jack swim, (d) the photosynthetic phytoplankton are the producers on which most other life ultimately depends, (e) phytoplankton are eaten by zooplankton, represented by this microscopic crustacean, a copepod. The spiny projections on these planktonic creatures help to keep them from sinking below the photic zone.*

Animation 26.1: Aquatic Ecosystem  
Source & Credit: Water System

### Productivity of Aquatic Ecosystem

The productivity can be indicated by consumption of  $\text{CO}_2$  and evolution of oxygen in the process of photosynthesis.

The productivity of aquatic ecosystem is basically determined by the light and nutrients. Light intensity and quality vary with the water depth, so the primary productivity also varies with light. The amount of nutrients also changes with season. Productivity also varies from zone to zone. Aquatic environment can easily be classified into fresh water and marine (salty) water.

### Fresh Water Lakes

Fresh water lakes vary tremendously in size, depth, and nutrient content, including distinct life zones and temperature stratification.

**Life zones are based on access to light and nutrients :** The distribution of life in lakes depends on access to light, to nutrients and to place for attachment. The lake ecosystem can be divided into three main zones.

**Littoral zone (Near-shore):** In this zone, the water is shallow, and plants find abundant light, anchorage and adequate nutrients from the bottom sediments. Plants in littoral zone communities are the most diverse; water lilies and entirely submerged vascular plants and algae flourish at the deepest region of the littoral zone.. The plants of this zone trap sediments carried by stream, increasing the nutrient content in this region. Living among the anchored plants are microscopic organisms called **plankton**. These can be divided into two groups. **Phytoplankton** (Greek “drifting plants”): these include photosynthetic protista, bacteria and algae. **Zooplankton** (Greek “drifting animals”): such as protozoa and tiny crustaceans. The greatest diversity of animals in the lake is also found in this zone. Littoral invertebrate animals include small crustaceans, insect larvae, snails flatworms, Hydra; vertebrates include frogs, aquatic snakes and turtles. As the water increases in depth farther from the shore, plants are unable to anchor to the bottom and still collect enough light for photosynthesis. This open water area is divided into two regions: the upper limnetic zone and the lower profundal zone.

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**Limnetic zone** : In this zone enough light penetrates to support photosynthesis. Here, phytoplankton includes cyanobacteria (blue green algae) which serve as producers. These are eaten by protozoa and small crustaceans, which in turn are consumed by fishes.

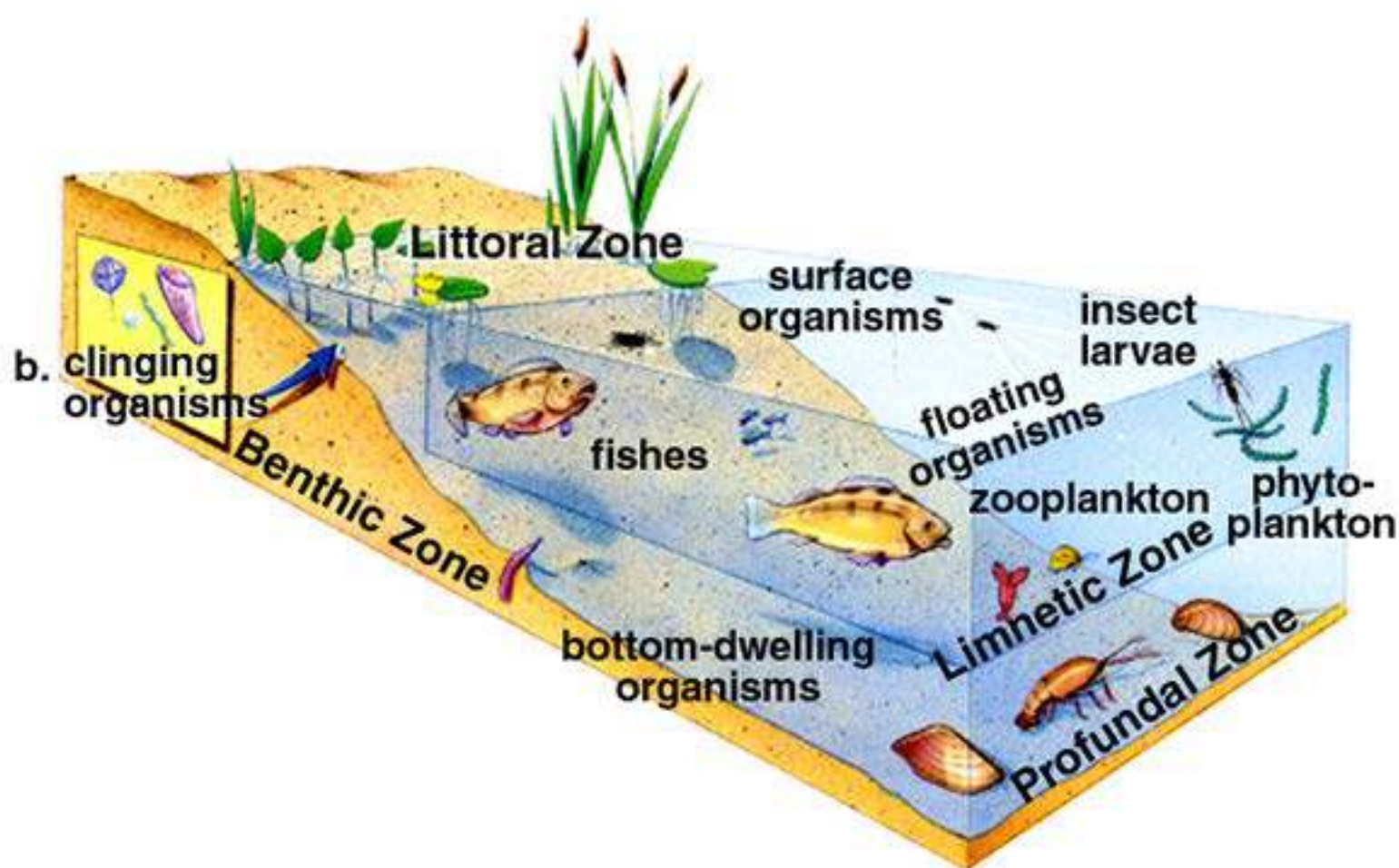


Fig. 26.2 Lake, life zones There are three life zones in a typical lake : a near-shore littoral zone with rooted plants, an open-water limnetic zone, and a deep, dark profundal zone.

**Profundal zone** : Here, light is insufficient to support photosynthesis. The organisms of this zone are mainly nourished by detritus that falls from the littoral and limnetic zone and by incoming sediment. Decomposers and detritus feeders, such as, snails and certain insect larvae, bacteria, fungi and fishes, inhabit it.

### Intervention of Man in Aquatic Ecosystem

Human activities may greatly accelerate the process of eutrophication (adequate nutrition), because nutrients are carried into lakes from farm feedlots and sewage. Even if solid wastes are removed, water discharged from sewage treatment plant is often rich in phosphate and nitrates dissolved from wastes and detergents. Rain water washes off fertilizer from fields where the manure of thousands of cattle is accumulated. The water therefore, becomes highly enriched. The added nutrients support excessive growth of phytoplankton. Producers like blue-green algae form a scum on the lake surface, depriving the submerged plants of sun light; as a result they die. The dead plants bodies are decomposed by bacteria, utilizing the oxygen present in the water, deprived of oxygen, fish, snails and insect larvae die and their decaying bodies fuel more bacterial growth, further depleting oxygen. Even without oxygen, certain bacteria that produce foul smelling gases thrive. Although it is full of life and nutrients, polluted lake smells bad. Most of the trophic levels including the fish are eliminated and the bacteria and blue- green algae dominate the community. Another very serious cause of polluted water is the acid produced by burning of fossil fuels, which poses a different threat to fresh-water ecosystem. Few organisms can withstand the low pH of acidified lakes.

### TERRESTRIAL OR LITHOSPHERIC ECOSYSTEM

#### Light, Nutrients and Water

The ecosystem present on land or soil is called terrestrial or lithospheric ecosystem. Terrestrial ecosystem receives plenty of light, and the soil provides abundant nutrients. Water, however, is limited and very unevenly distributed both in place and in time. Factors which influence life on land are given below :

**Temperature:** Like water, favourable temperatures are very unevenly distributed on land in place and time. On poles, the average temperature is below freezing. In temperate zones, only during certain seasons of the year it is quite favorable, but in tropical zones uniformly, warm, moist climate is present.

**Air:** In terrestrial ecosystem, air is in constant motion, so its composition is more uniform. The amount of  $O_2$  and  $CO_2$  in air is much constant and most beneficial to terrestrial ecosystem.

#### Adaptations for Terrestrial Ecosystem

Plants and animals shifting from water to land developed various types of adaptations for land habitat e.g.

**Supporting tissues :** Both plants and animals have evolved supporting tissues like vascular bundles (xylem-phloem) in plants and skeleton in animals to support them on land against the force of gravity.

**Conservation of water :** Plants and animals evolved various methods to conserve water in their body e.g. homeostasis. The mechanism of temperature regulation was developed by land plants and animals by developing bark and skin respectively.

### Division of Terrestrial Ecosystem

It can be divided into following main types such as

1. **Forest ecosystem.** It is further sub-divided into :

- (a) tropical rain forests      (b) temperate deciduous forests
- (c) coniferous alpine and boreal forests

2. **Grass land ecosystem.** 3. **Desert ecosystem.** 4. **Tundra ecosystem.**

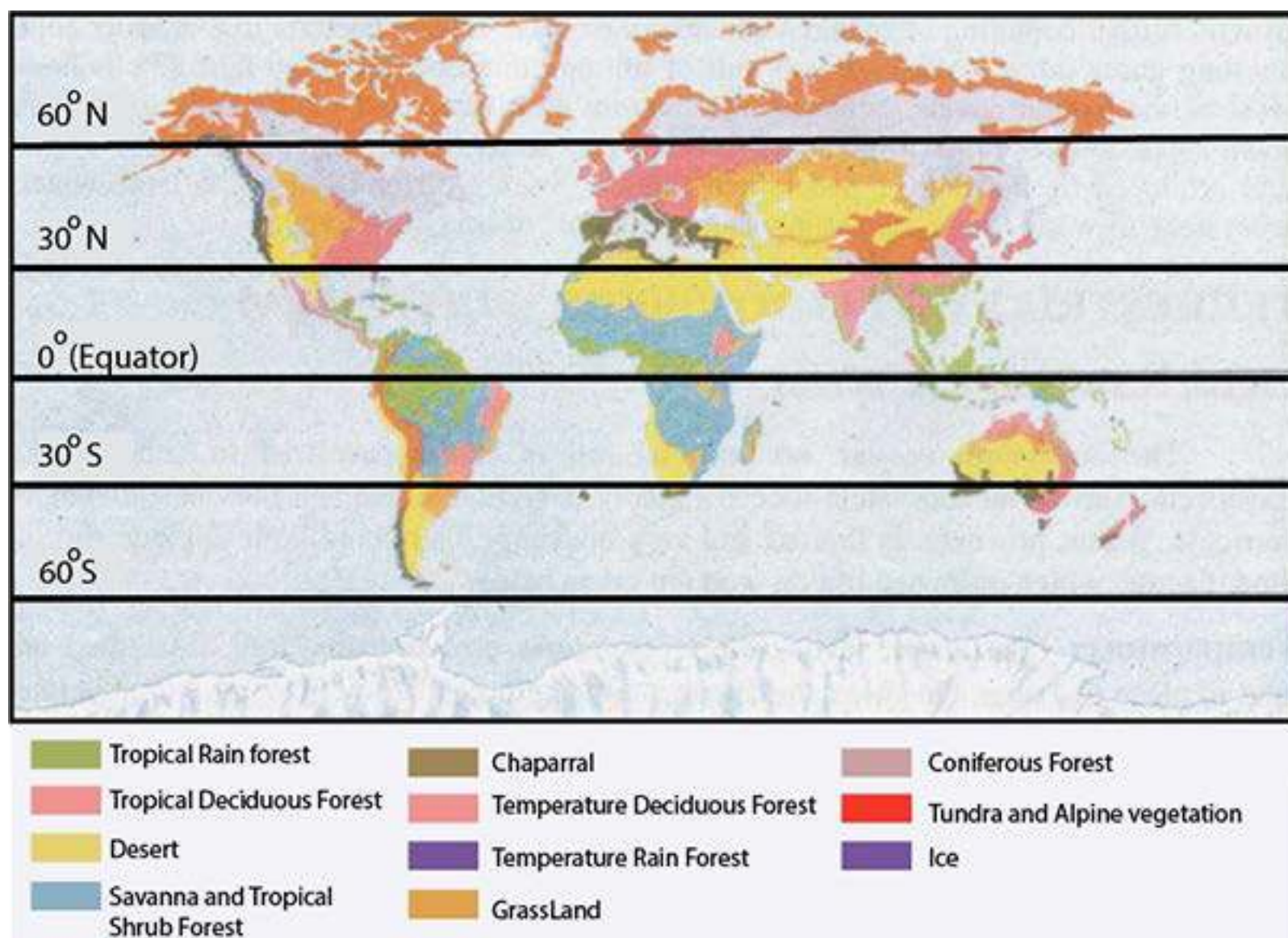


Fig. 26.3 The distribution of biomes Although mountain ranges and the sheer size of the continents complicate their pattern, note the overall consistencies. Tundra and coniferous forest always occur in the northernmost parts of the Northern Hemisphere, while the deserts of Mexico, the Sahara, Saudi Arabia, South Africa, and Australia are located around 20° to 30° North and South latitude

SOME MAJOR ECOSYSTEMS IN PAKISTAN

Pakistan has a variety of seasons and climate ranging from hot dry in plains to cold snowy on mountains. Some major ecosystems existing in Pakistan are;

| S. No. | Major Terrestrial Ecosystems         | Location in Pakistan                                                                                    |
|--------|--------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1      | Temperate Deciduous Forests.         | Shogran and Neelum valley.                                                                              |
| 2      | Coniferous Alpine and Boreal Forests | Northern mountains of Kaghan, Malam Jabba (Swat) Dir and Chilas                                         |
| 3      | Grassland Ecosystem.                 | Gilgit and Kashmir. Waziristan, lower Chitral and North Kallat.                                         |
| 4      | Desert Ecosystem                     | (Mianwalli, Bakhar) (Fort Abbas, Bahawal Nagar, Yazman, Bahawal Pur, Khan Pur and RahimYar- Khan. Sind. |
| 5      | Tundra Ecosystem.                    | Mountains Kara-Koram and Hindukush.                                                                     |

## Temperate Deciduous Forests

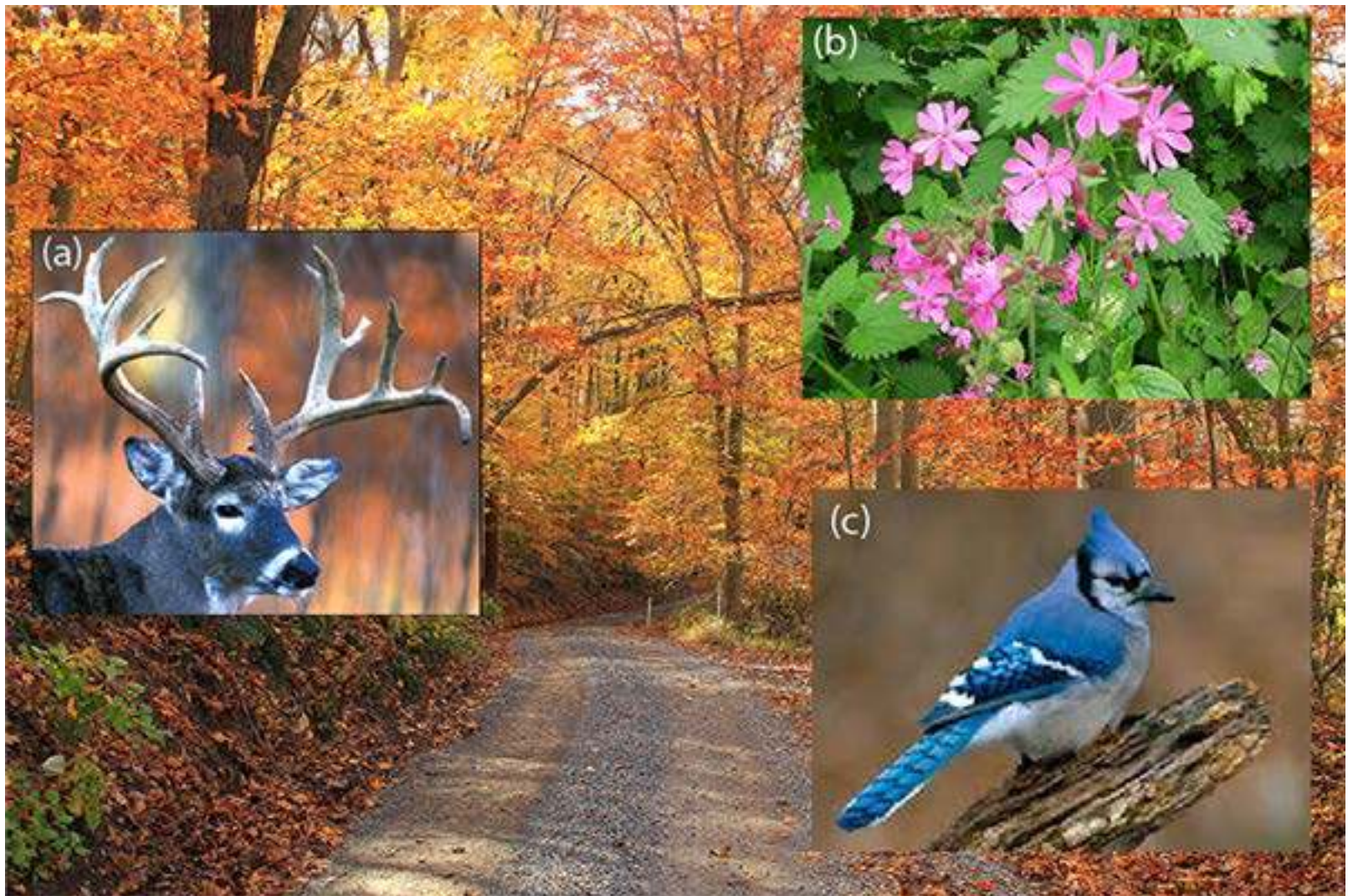
In Pakistan, temperate moist conditions are present in Neelum valley and Shogran. These forests originally covered India, Southeast Asia, eastern North America, Europe, China, Australia, Japan, North and South America. Slightly farther away from the equator, the rainfall is not nearly as constant, and there are pronounced wet and dry seasons that means distinct summer and winter seasons. During dry season, the trees cannot get enough water from the soil to compensate for evaporation from their leaves. As a result, the plants have adapted to the dry season by shedding their leaves, thereby minimizing water loss. If the rains fail to return on schedule, the trees delay forming new leaves until the drought passes.

**Rain fall:** The average rainfall is between 750 - 1500 mm.

**Temperature :** Moderate temperature ranges from 4°C - 30°C.

**Plants :** Some dominant plants are *Taxus baccata*, *Pinus wallichiana*, *Berberis lyceum*. Many herbs and shrubs are with height of 5m. Some grasses, ferns and other herbaceous plants make up field layer. At the bottom or floor level many mosses liverworts and lichens covered with litter layer are present.

**Animal life :** Some very common animals are *Macca multata* (rhesus monkey), *Solenorctos ubetanus* (black bear), *Felis bengalensis* (leopard cat), deer, and wolves with various types of microorganisms to convert the litter into organic matter such as bacteria, fungi, and earthworms.



*Fig. 26.4 Temperate deciduous forest (a) White tailed deer is the largest herbivore, (b) Woodland wildflowers (c) Blue Jay (bird)*

**Soil condition :** The soil of temperate deciduous forest is grayish brown in colour, very fertile and rich in organic matter, with maximum water holding capacity.

**Human impact :** On temperate deciduous forest large mammals such as black bear, deer, wolves, bobcats and mountain lions were formerly abundant, but the predators have been largely wiped out by humans. Need of lumber and its use in agriculture has reduced many deciduous forests from the world.

### **Coniferous Alpine and Boreal Forests**

In Pakistan these forests are in upper Kaghan, Dir and Chilas, Malam Jaba in Swat valley. In the world, they stretch across Eurasia (Europe + Asia) and North America, Canada just south of the tundra. Northern coniferous forests are also called Taiga. Conditions in taiga are harsher than those in the temperate deciduous forest. The winters are longer and colder, and the growing season is shorter. The few months of warm weather are too short to allow trees the luxurious growth of regrowing. As a result, evergreen coniferous trees populate this type of forest, almost entirely with small waxy needles. The waxy coating and small surface area of the needles reduce water loss by evaporation during cold months, and leaves remain on the trees year around. Coniferous forests located at high altitude are called alpine while coniferous forests located at high latitude are called boreal. Can you differentiate between altitude and latitude?



Fig. 26.5 The Taiga The small needles and pyramidal shape of conifers allows them to shed heavy snows. Winter is a challenge not only for the trees but also for animals such as this snowshoe hare and the bobcat that preys on it (a). The hare is also prey for the great horned owl (b). Taiga animals face diminished food supply but increased energy requirements during subfreezing weather.

**Snow cover and temperature :** There is a constant cover of snow characterized by long severe winter. Temperatures may be below freezing point, up to  $10^{\circ}\text{C}$ .

**Animal and plant life :** Because of its harsh climate, the diversity of life is much low. Large mammals, bison, wolf, black bear, deer, Marco polo sheep and smaller animals such as small Kashmir flying squirrel, snowshoe hare, wolverine, crossbills, are present.' Plants like *Pinus wallichiana*, *Pinus roxburgii*, *Abies pindrow*, *Picea smithianci* *Cedrus deodara* are present.

**Human impact:** Due to severity of climate and remoteness most of the coniferous forests remains undisturbed, but these forests are major source of lumber for construction, so forests have been cleared in the world.

## The Grass Land Ecosystem

Grassland ecosystems are found in Gilgit, Kashmir, Waziristan, lower Chitral and North Kallat. In the world, you can see a large grassland in the center of Eurasian continents. Grassland present in temperate climates are also called Prairies, such as Prairies of North America, Pampas of Argentina. These grasslands do not have woody plants so they are known as Prairies. But the grassland in tropical climates have woody trees and are called Savanna.



*Fig. 26.6 Grass land ecosystem (a) Pronghorn antelope (b) Prairie dogs (c) Bison herds (d) Coneflower*

**Rain fall:** The grasslands usually face severe droughts(26.7). Annual rainfall is about 250 to 750 ml. In tropical and subtropical grasslands, rainfall reaches about 1500 mm (60 inches). Thus grassland occurs in regions where mean annual rainfall is midway between a forest and a desert. In general, they have a continuous cover of grass and virtually no trees at all except along the rivers. Water and Fire are the crucial factors in the competition between grasses and trees.

**Plant life:** The dominant species are graminoids i.e. grasses, and grass-like plants. Certain forbs such as composites, legumes and many other herbaceous plant species are also associated with grasses.

**Layering:** Layering is the characteristic of grassland. Tall grasses (Andropogon, Panicum) form the first layer, mid high grasses (Stipa, Sporobolus, Oryzopsis) form the second layer and third layer is formed by short grasses and forbs and warfare species (Poa, Bromus) with mosses and lichens.



Drought



Rising sea levels

Fig 26.7

**Soil conditions :** The soil moisture is limited on account of low precipitation and high evaporation. Upper soil layer in which grasses are rooted is normally moist but deeper layers are constantly dry. The soil of grassland is basically impermeable with excessive salinity.

**Animal life :** Dominant species are herbivores; invertebrates including insects are very numerous, grasshoppers become so numerous that they can compete with other herbivores for plant foliage. The predators are reptiles, amphibians and mammals. For example, lizards, toads and turtles prey on insects; foxes and wolves among mammals are very common. Among decomposers many bacteria, actinomycetes and fungi like molds, yeasts, mushrooms, bracket fungi are most common. Large animals like zebras, wild horses, bison are important.

**Productivity** ; In temperate grassland the rate of primary production is about 700 - 1500 g/m<sup>2</sup> annually. In sub-humid tropical grassland it is more than 4000 g/m<sup>2</sup> . In annual grasslands, large grazing animals consume relatively small amount (5 - 10%) of the total herbage produced. Invertebrates, rodents and birds may consume an equal amount or a little more.

**Human impact:** The natural grasslands in the world are used for crop production and live stock management. Only a small fraction of the world's grasslands has been in cultivation due to acid climatic condition with soil erosion and salinity. Grazing has prominent effects on grassland; over-grazing causes reduction in herbage cover and result is soil erosion. Many lands are converted into deserts by a process called desertification due to over grazing

### Desert Ecosystem

In Pakistan you can find the desert ecosystem in western Punjab (Mianwali and Bukhar) where it is known as "Thai".



Fig 26.8

In southern Punjab, areas like Fort Abbass, Bahawal Nagar, Yazman, Bahawal Pur (Cholistan), Khan pur and Rahim yar khan also have deserts.

In Sindh, this desert ecosystem is called "Thar".

These biomes are found on every continent often around 20 to 30 north and south latitude and also in the rain shadows of major mountain ranges. Desert includes a variety of environments. At one extreme are certain areas of the Sahara or Chile, where it virtually never rains and there is no vegetation at all (Fig. 26.8a).

The more common deserts, however, are characterized by widely spaced vegetation and large areas of bare ground.

**Rain fall:** Less than 25 to 50 cm (10 - 20 inches) or not at all.

**Plant life:** The plants are often spaced evenly as if planted by hand (Fig 26.8b) Frequently, the perennial plants are bushes or cacti with large shallow root systems.

Plants are covered with the waterproof waxy coating to prevent evaporation of precious water. Water is stored in thick stems of cacti and other succulents. Desert plants conserve water in a variety of ways. Cacti and Euphorbia have fleshy stems in which water is stored for use during the period of drought.

**Animal life:** Like plants, animals are also specially adapted to survive on little water. Most deserts appear to be almost completely devoid of animal life during day, because the animals seek relief from the sun and heat in cool under ground burrows. In the dark, when desert cools down, homed lizards, snakes and other reptiles emerge to feed, as do mammals such as kangaroo, rat, and birds such as burrowing owl.

Most of the smaller animals survive without ever drinking at all, getting all the water they need from their food and what produced during cellular respiration in their tissues. Large animals such as desert bighorn sheep and camel are dependent on permanent water holes during the driest times of the year.

**Human impact:** While human activities are reducing the extent of many biomes, they are causing the spread of deserts, a process called desertification.

A dramatic example is occurring in the Sahel, which borders the southern edge of the Sahara desert in Africa. Twenty-five years of below average rainfall, coupled with rapid growth of the human population have caused a steady southward spread of desert. The Sahel is an example of a human population exceeding the carrying capacity of the land. The loss of the productivity of the ecosystem is nearly irreversible and massive famines, such as occurred in Ethiopia in the mid 1980s are a tragic result.

## Tundra Ecosystem

The last biome seen before reaching the polar ice-caps is the arctic tundra, a vast treeless region bordering the Arctic ocean. It is used to describe types of vegetation in treeless high latitudes between taiga and polar ice caps, and at high altitude across the mountain above timberline such as mountain of Karakoram and Koh Hindu Kush in Pakistan.



*Fig. 26.9 Tundra : Vegetation and animals, (a) Caribou (b) Arctic foxe (c) Dwarf clover (wild flower)*

Arctic tundra stretches across Northern North America, Northern Europe and Siberia (with high latitude).

**Plant and animal life :** The ground is carpeted with small perennial flowers and dwarf willows no more than a few centimeters tall often with large lichen called reindeer moss. The standing pools provide superb mosquito habitat. The mosquitoes and other insects provide food for numerous birds (ducks and geese) most of which migrate a long distance to nest and raise their young during the brief summer feast. The tundra vegetation supports lemmings, which are eaten by wolves, snowy owls, arctic foxes and even grizzly bears.

**Human impact:** The tundra is perhaps the most fragile of all the biomes because of its short growing season. A willow 10 centimeter (4 inches) high may have a trunk 7 centimeter (3 inches) in diameter and be 50 years old. Human activities in the tundra leave scars that persist for centuries. Fortunately, for the tundra inhabitants, the impact of civilization is localized around oil drilling sites, pipelines, mines and military bases.

### Humans and Ecosystems

The expanding human population has left relatively few ecosystems undisturbed. Our impact on natural ecosystem are so diverse and wide ranging that they far exceed the scope of this book. Ecosystems dominated by people tend to be simple, that is, they have fewer species and fewer community interactions than an undisturbed ecosystem

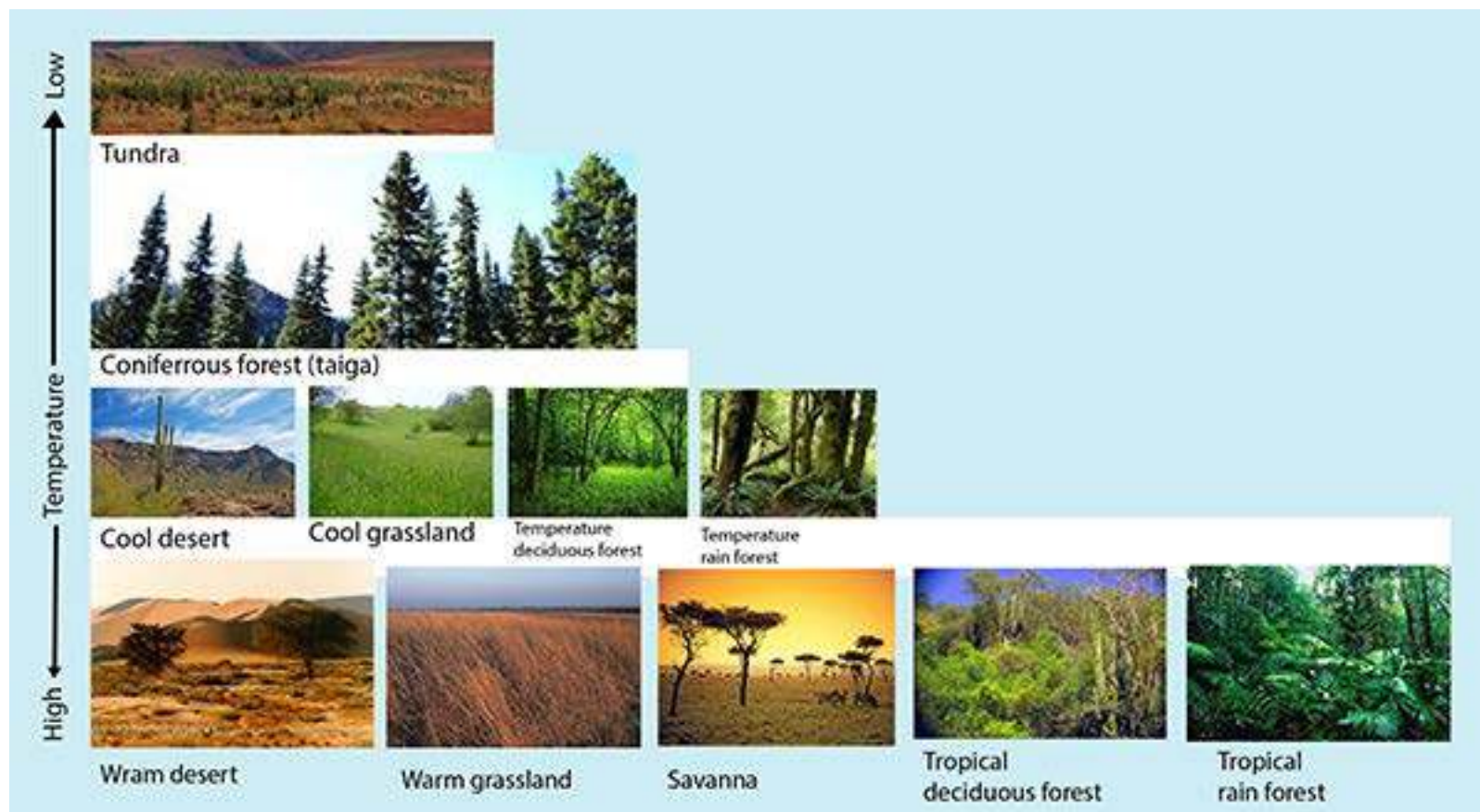


Fig. 26.10 Temperature and rainfall influence on biome distribution

**EXERCISE****Q1 Fill in the blanks.**

1. Water is slower to heat and \_\_\_\_\_ than air.
2. The distribution of life in lakes depends on access to \_\_\_\_\_, and to place for attachment.
3. Ecosystem on land is also known as \_\_\_\_\_ ecosystem.
4. Ecosystem in water is also called as \_\_\_\_\_ ecosystem.

**Q.2 Short questions.**

1. Define productivity of an ecosystem.
2. List four adaptations in plants and animals for terrestrial ecosystem.
3. Name three zones in lake ecosystem.
4. How many biomes are present in the world, name only five of them.
5. Give the names of some major ecosystems on land in Pakistan.

**Q.4 Extensive Questions**

1. What are the four major requirements for life? Which two are limiting in terrestrial ecosystem?
2. List some adaptations of
3. (a) desert plants (b) desert animals to heat and drought.
4. Where is life in oceans (hydrospheric ecosystem) most abundant and why?
5. Distinguish between three different zones in the lake - ecosystem.