

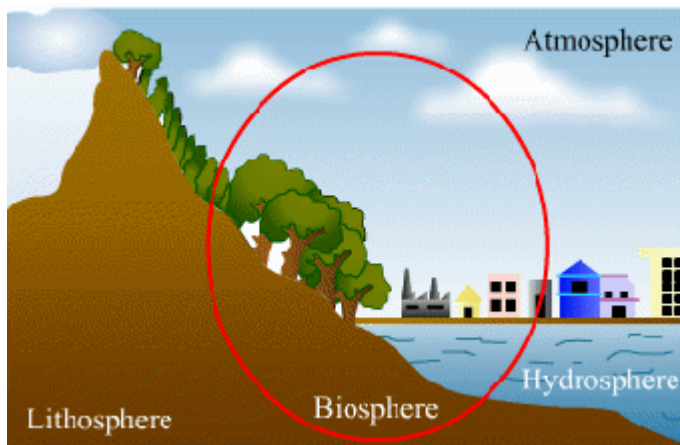
Natural Resources

Atmosphere and Climate

Natural Resources

Life is possible on Earth due to the presence of favourable factors or resources such as air, water, solar energy and ambient temperature.

What are natural resources?



Natural resources are the naturally occurring substances that are valuable to mankind, e.g., air, water, soil, coal, minerals, plants and animals.

These resources are divided into two categories—renewable resources (e.g., air, water, sunlight and soil) and non-renewable resources (e.g., coal and petroleum).

Where does life exist on Earth?

Life on Earth exists in the planet's life-supporting zone called the **biosphere**. In this region, the atmosphere, hydrosphere and lithosphere interact and make life possible.

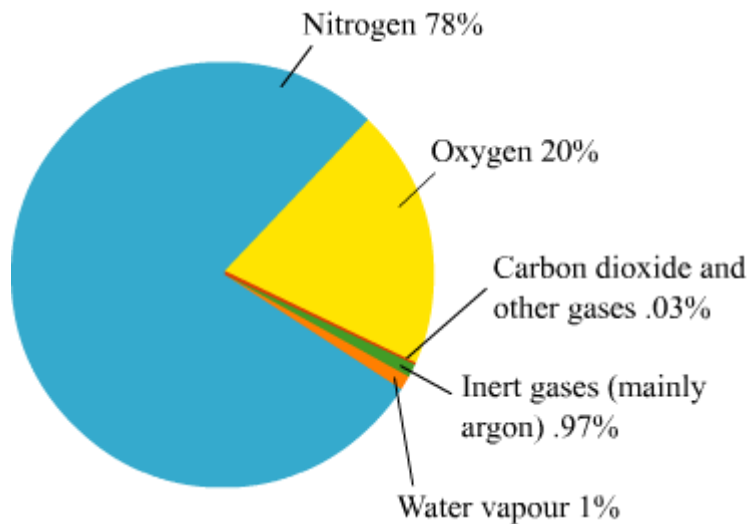
What are the atmosphere, hydrosphere and lithosphere?

The major components of Earth can be divided into air, water and dry land. Earth's dry surface is called the **lithosphere**. Water covers about 75% of Earth's surface and is called the **hydrosphere**. The air which covers both land and water is known as the **atmosphere**. These are the abiotic (non-living) components of Earth. These interact with the biotic (living) components in the biosphere.

Composition of Air

It is the composition of air that helps in sustaining life on earth. Let us study how.

- **Presence of ample amount of oxygen:** Oxygen is required for the survival of most of the living organisms (all eukaryotes and some prokaryotes). It is constantly added into the atmosphere by green plants and trees.
- **Presence of less amount of carbon dioxide:** On earth, carbon dioxide is used by green plants and some other photosynthesising organisms. It is also utilised by some marine animals to manufacture their shells. The percentage of CO₂ is very less on earth. It makes up only 0.03% of the earth's atmosphere.

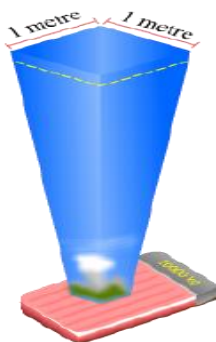


Do you know why the atmosphere of earth is held in place?

The atmosphere of earth is held in place due to the pull of gravity. The atmosphere of the earth contains 78% nitrogen, about 20% oxygen, 0.03% CO₂, and other gases.

The Atmosphere

On an average, a person can survive for a few weeks without food, a few days without water, but only a few minutes without air. Air is important for all living things. The thin blanket of air that lies above Earth is called the atmosphere.



Earth's atmosphere is more than just the air we breathe. It protects us from being peppered by meteorites; it is a screen against deadly radiations; it is also the reason **radiowaves** can be bounced for long distances around the planet.

Some other functions of the atmosphere

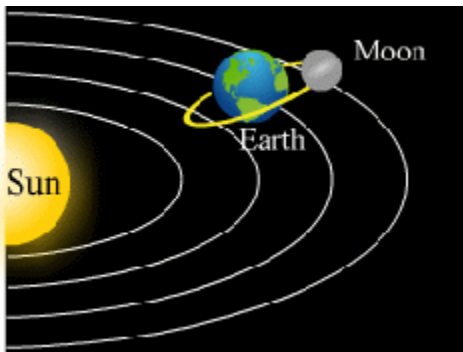
- It controls the climate or temperature of Earth.
- It helps in the movement of air.
- It also helps in causing rains.

Knowledge tree
The mass of a 1 metre × 1 metre cross-sectional column of Earth's atmosphere is approx. 10000 kg.
In case of Venus and Mars, where no life is known to exist, the major component of the atmosphere (95%–97%) is found to be carbon dioxide.

Atmosphere and Life on Earth

Earth's location at an optimal distance from the sun and the envelope of gases surrounding the planet are together responsible for maintaining Earth's temperature so that life can flourish on it.

How does the atmosphere help in maintaining the temperature of Earth?

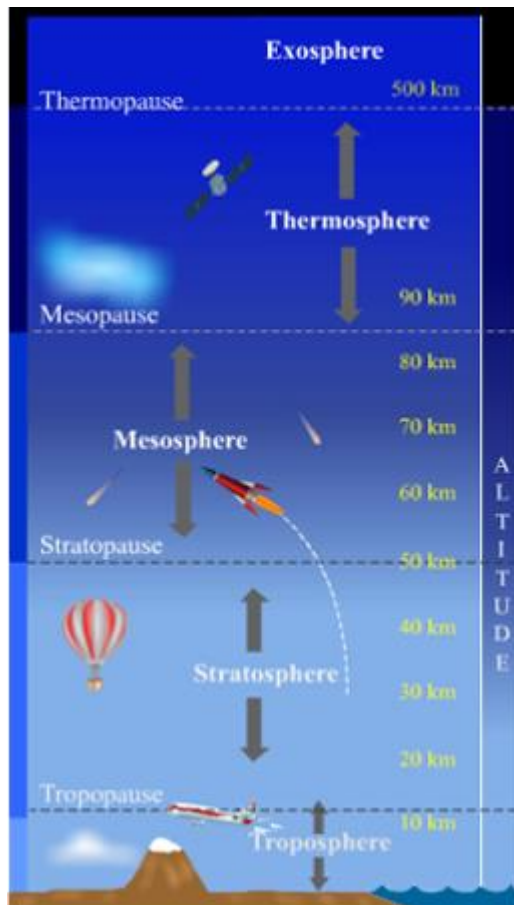


Air is a bad conductor of heat. During the day, it prevents most of the heat from the sun from passing through to Earth's surface. At night, it prevents the heat radiated off the surface of Earth from passing through into outer space. In this way, the atmosphere prevents a sudden increase in temperature during the day and a sudden decrease in temperature at night. As a result, a moderate temperature is maintained on Earth and this is essential for sustaining life on the planet.

The moon is at a similar distance from the sun as Earth. Yet it does not have an ambient temperature to support life. Instead, the moon has extreme temperatures, ranging from

about -190°C to 110°C . The reason for this is the absence of an atmospheric covering. **Unlike Earth, the moon does not have a blanket of air around it to help maintain a moderate temperature on it.**

Layers of the Atmosphere



The principal layers of the atmosphere are:

- **Troposphere:** It is the first layer above the Earth's surface and contains more than half of Earth's atmosphere. Although its depth varies, its average depth is from 0 km–10 km above the surface of Earth. Weather occurs in this region.
- **Stratosphere:** This layer extends from the top of the troposphere to about 50 km. Many jet aircrafts fly in the stratosphere as it is very stable. The ozone layer in this zone absorbs harmful rays from the sun.
- **Mesosphere:** This layer extends from the top of the stratosphere. Here, the air is especially thin and molecules are great distances apart. Meteors or rock fragments burn up in the mesosphere.
- **Thermosphere:** This layer extends from the top of the mesosphere. Ionosphere is a part of the thermosphere and contains electrically charged gas particles called ions. It reflects and transmits radio signals and is used for communication purposes. A space shuttle can orbit here.

- **Exosphere:** This layer extends from the top of the thermosphere. It has very few atmospheric molecules, and these can escape into outer space. The atmosphere merges with outer space in the extremely thin exosphere. This is the upper limit of Earth's atmosphere.

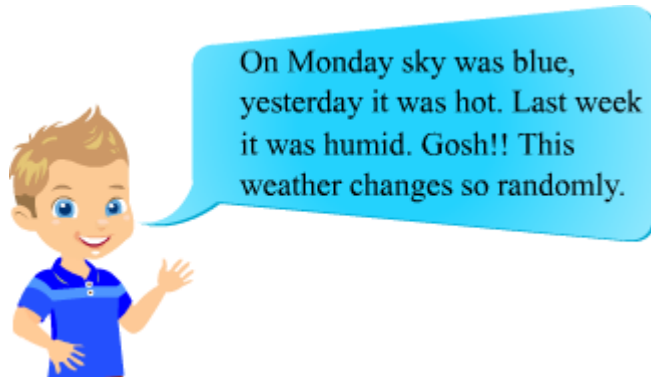
The region of space surrounding the earth in which magnetic field of the earth is dominant is known as **Magnetosphere**. This layer acts as a shield that protects us from the harmful charged particles of the sun.

Know More

There is a boundary between each layer of the atmosphere. The **tropopause** lies between the troposphere and stratosphere; the **stratopause** lies between the stratosphere and mesosphere; the **mesopause** lies between the mesosphere and thermosphere; and the **thermopause** lies between the thermosphere and exosphere.

Weather and Climate

Weather



On Monday sky was blue,
yesterday it was hot. Last week
it was humid. Gosh!! This
weather changes so randomly.

The day-to-day atmospheric conditions of a particular place with respect to factors such as rainfall, humidity, temperature and wind speed, is called the weather of that place. Weather can vary from one place to another.

Climate

The average weather condition of a place taken over a long period of time is called the climate of that place.

Factors other than atmosphere which influence climate

- **Angle of the sun's rays:** In the Arctic and Antarctic, there are times during a year when the sun is above the horizon twenty-four hours a day (called midnight sun); there are also times when it does not rise at all. Even during summers in these regions, the sun is low

enough for the temperatures to be lower than in the tropics, but the seasonal changes are much greater than in the equatorial regions.

- **Winds:** They bring moisture to land. These moisture-laden winds converge in the tropics, forcing the air to rise. This results in thunderstorms, humidity and monsoons.
- **Mountains:** They force wind to rise as it crosses over them. This cools the air, causing the moisture to condense into clouds and then fall as rain. As a result, a wet climate is produced on the **upwind** side of mountains and an arid **rain shadow** is produced on the **down wind** side.
- **Oceans:** They provide moisture and also buffer the temperatures in coastal regions, regardless of latitude.

Solved Examples

Example1: How do scientists forecast weather?

Solution: Weather forecasting means predicting what the weather will be, say, in the next hour or much later during the day. Weather forecasting is done with the help of computer models, satellite information, observations, and trends and patterns.

Formation of Wind and Rain

Wind and Rain

Wind and rain are two common atmospheric phenomena. Do you know the mechanics behind their occurrence? **Rain** is actually droplets of water falling on Earth's surface. But where do these water droplets come from? As the water above Earth's surface heats up, water vapours get formed. These vapours rise in the air. As they rise higher in the cooler atmosphere, they condense to form water droplets. These droplets fuse to form clouds and, ultimately, fall as rain.

Winds are actually air currents or moving air. They are formed due to the unequal heating up of air in the atmosphere above land and water all through the day.

The direction of movement of wind is observed using a wind vane. An anemometer is used to measure the speed of wind.

Activity Time

Take two beakers—one filled with water and the other filled with soil (/sand). Measure and record the temperatures of the beakers. Keep the beakers in bright sunlight for three hours. After that, measure and record the temperatures once again. *Which beaker shows a greater rise in temperature?* Next, place the beakers in shade. After thirty minutes, again measure the temperatures of the containers. *Which one shows a greater fall in temperature?*

Based on this activity, can you ascertain as to which would heat up faster in sunlight—water or soil (/sand)? Also, can you say which of these would cool down quicker in shade?

The activity demonstrates two facts:

- ***Soil and sand both heat up and cool down faster than water.*** So, we can conclude that compared to the watery layer of Earth's surface, its dry surface is hotter during the day and cooler during the night.
- ***Hot objects radiate heat energy, thereby heating up their surroundings.*** Further, an object that heats up faster also heats up its surroundings faster. So, we can conclude that the air present in the atmosphere above both land and water is heated up during the day, though at different rates. This results in unequal heating, which as we know is the cause of wind formation.

Did You Know?

Do you know why soil (sand/land) heats up faster than water?

The heat energy required to raise the temperature of water by 1°C is greater than that required for raising the temperature of soil (/sand/land) by the same degree. This is called **specific heat**. Specific heat is the amount of heat required to raise the temperature of one unit mass of a substance by 1°C. It is denoted by the letter 'C'. Now, since the specific heat of soil is less than that of water, the former heats up faster than the latter.

Solved Examples

Example: Why is the lower atmosphere hotter than the upper atmosphere?

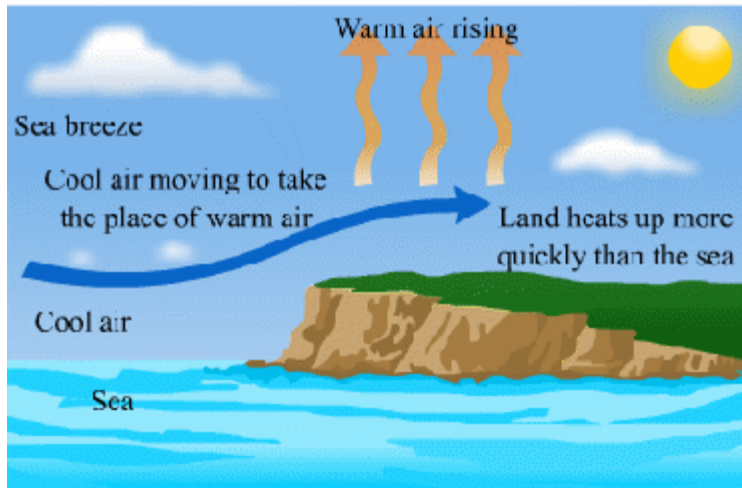
Solution: The sunlight entering through the atmosphere falls on Earth's surface and heats it up. The surface in turn radiates heat energy, thereby heating up the air present in the atmosphere above it. Since the atmosphere gets heated from below, the lower atmosphere is hotter than the upper atmosphere.

What Is Wind and How Is It Formed?

Wind can be defined as the air that moves horizontally over Earth's surface. Winds are formed as a result of the differential heating of the air in the atmosphere. A part of the solar radiation that reaches Earth's surface is radiated back into the atmosphere. This heats up the atmosphere. The extent of this heating up of the atmosphere varies across land and water.

What is the direction of wind? Wind flows horizontally from a high pressure zone to a low pressure zone.

How are these high pressure and low pressure zones created?



Formation of winds during the day

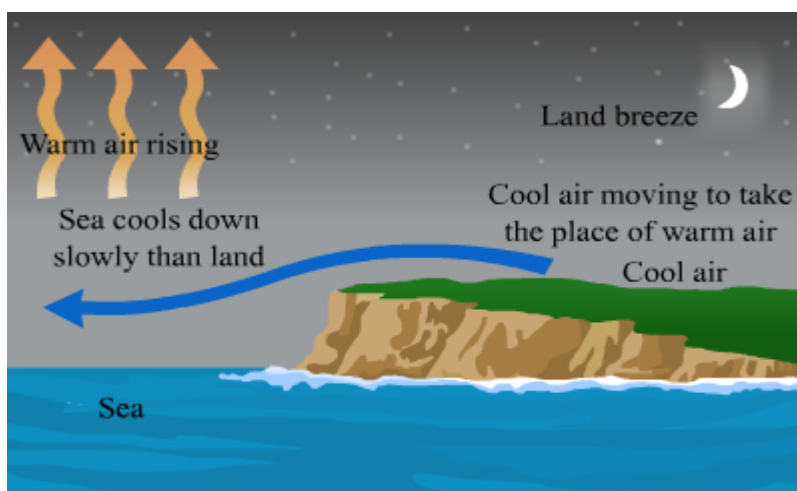
As is observed in coastal regions, solar radiations heat up land faster than the sea. Consequently, the air above land becomes hot faster and then moves upward. As the air rises, it expands and cools down. This vertical movement of air is known as **convection**

current. The convection current causes a **low pressure** area to be created over land.

Meanwhile, a **high pressure** area is formed over the watery surface. This is because the air over the sea is relatively cooler and so, does not move upward.

The rising hot air leaves behind a vacant space above land. The air present over water moves toward this vacant space to occupy it. In other words, wind blows from the high pressure area over the sea to the low pressure area over land.

Formation of Winds During Night



Formation of winds at night

At night, this situation gets reversed. Land cools down faster than water. Therefore, the air over land is cooler than that over the sea. The warm air above water rises, leaving behind a low pressure zone with a vacant space. At the same time, since the air above land is relatively cooler, it does not rise; consequently, a high pressure zone is formed. The air over land moves toward the vacant space above water to occupy it. So, wind blows from the high pressure zone above land to the low pressure zone above the sea.

<p>Did You Know?The windiest place on Earth is Commonwealth Bay, Antarctica where the average wind speed over a year is 240 km/h (150 mph).</p>
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Factors Influencing Wind

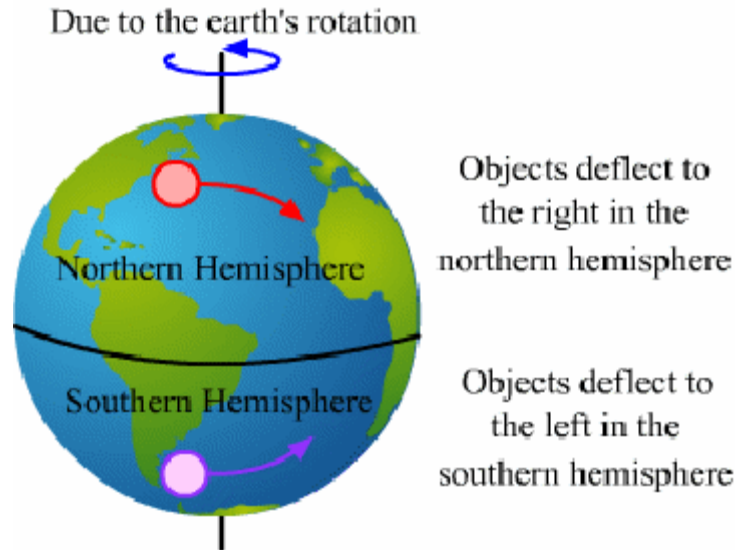
Some factors influencing the flow of wind are:

- **Air pressure:**Wind blows from a high pressure area to a low pressure area. Wind speed is determined by the rate of the pressure difference between the two regions. The greater the pressure difference, the faster will be the wind.
- **Temperature:**The energy that drives wind originates in the sun for it is the sun's radiations that heat up Earth's surface unevenly, creating hot and cold spots. A region with a higher temperature is characterised by a lower air pressure. This is because the hot air in this region moves up and leaves behind a vacant space. Cooler air then rushes in to fill the vacant space. This flow of air is nothing but wind.
- During the day, wind blows from sea to land. This is known as **sea breeze**.
- At night, wind blows from land to sea. This is known as **land breeze**.

Factors Influencing Wind

Some other factors influencing the flow of wind are:

- **Earth's rotation:**The rotation of Earth causes winds to shift their direction. So, winds in the northern hemisphere tend to shift to the right, while those in the southern hemisphere tend to shift to the left. This shifting of wind is an example of the Coriolis effect.
- **Mountain ranges:** The presence of a mountain range in the path of winds prevents the winds from moving forward and induces them to change their direction. For example, the presence of the Aravalli Range prevents winds containing sand from reaching Delhi.



Formation of Rain

How is rain formed?

When the water present over Earth's surface heats up, water vapours are formed. These vapours rise along with the hot air. The rising vapours cool down at lower temperatures in the upper atmosphere and start condensing. This leads to the formation of droplets of water. The droplets combine to form clouds. The millions of droplets in the clouds keep growing in size due to condensation. When these drops become so large that they can no longer be held in the clouds, they fall down as rain. At lower temperatures, the droplets freeze and precipitate as snow, hail or sleet.

Solved Examples

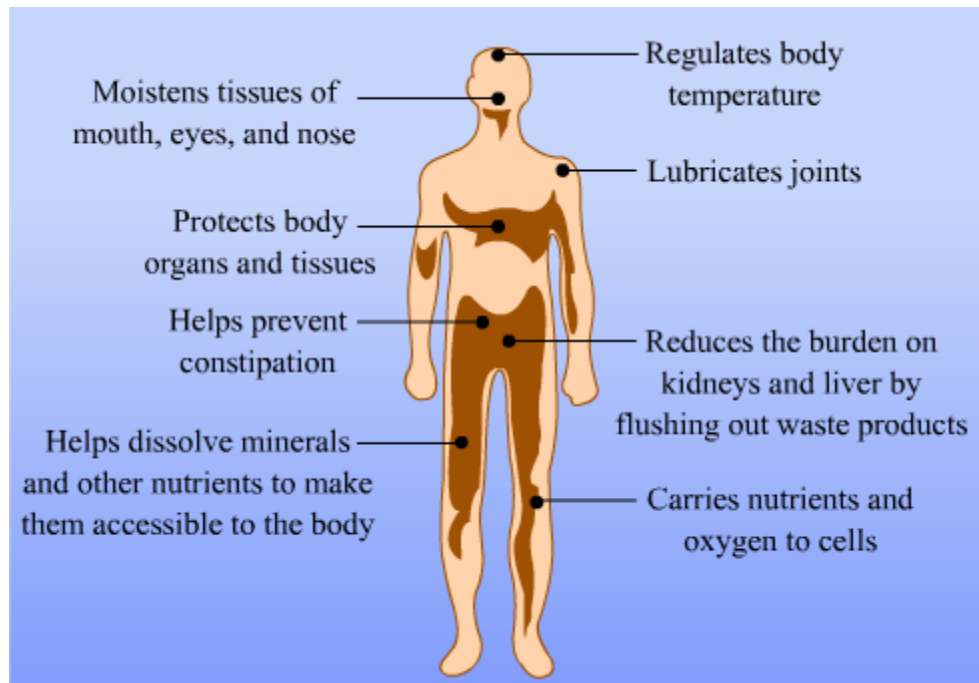
How are air currents or winds important for causing rains?

Winds are important because they bring rain. Rainfall patterns are decided by the prevailing wind patterns. In large parts of India, rains are mostly brought by the southwest or northeast monsoons. You must have heard weather reports speaking of how 'depressions' in the Bay of Bengal have caused rains in some areas. Depressions are responsible for the strong winds.

Importance of Water

Importance of Water

About 60% of our body is made up of water. Water plays an important role in various vital processes that are carried out by our body. All cellular processes take place in water medium. Read the given graphic to understand the importance of water in our body.



Importance of Water

Water and other life forms

- Aquatic animals live in water. Water is thus central to their lives. Although terrestrial animals live on land, they do need fresh water for carrying out various life processes such as excretion of waste products. Terrestrial life forms require fresh water because their bodies cannot tolerate or get rid of the high amounts of dissolved salts in saline water.
- The availability of water plays an important role in deciding the number of individuals of each species that will be able to survive in a particular area, and also the sustainability of life in the region. The availability of water also decides the diversity of life in that place.

Now you know why the number of animals found in rainforests is high and the number of animals inhabiting deserts is very low!

Fresh water is utilized by humans for consumption. The Municipal Corporation supplies water to our homes. In rural areas, people collect water from different water sources such as wells and ponds to meet their day-to-day requirements.

Know More

Conserving water

One way by which we can help reduce the demand for water is to conserve water round the year.

We can conserve water:

1. By turning off the tap while brushing.
2. By not using more water than what is required while bathing.
3. By closing the tap while washing utensils.
4. By washing vehicles using a mug and a bucket of water and not with a hosepipe.
5. By storing rainwater in tanks or other storage areas for future use.

Uses of Water

Water is very useful in our day to day life. Let's see some uses of water:

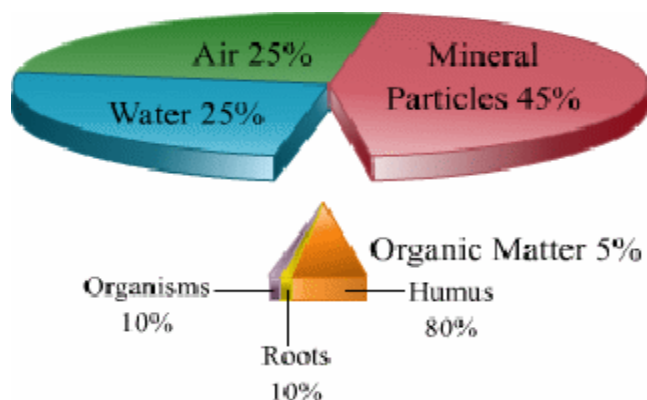
1. It is used for drinking.
2. For washing purposes we use water.
3. It is used in fields for irrigation.
4. For bathing we use water.
5. Today, water is also used for generation of electricity.

Soil: Its Formation and Importance

Soil

An important factor that influences the living components of Earth's various ecosystems is the nature of soil present in them. Soil is the layer of earth that results from the degradation of the basement rock— also known as bedrock—due to certain physical, chemical and biological processes. It is the major substrata of life on Earth. It supports plant growth. It acts as a **reservoir**

of air, water and nutrients.



Some components of soil are:

- Small particles of rock
- Humus
- Microscopic life
- Nutrients

An important constituent of soil is its organic component, comprising dead and decaying leaves and parts of plants and animals. This organic material decomposes to form **humus**

, which in turn determines the structure and fertility of soil. It is porous in nature and allows water and air to pass through.

The quality of a soil is influenced by the microscopic organisms found in it. Many of these help in making soil fertile.

The parent rock of a soil determines its mineral component. The type of a soil is decided by the average size of particles found in it.

Humus and the nutrient content of soil play an important role in determining the type of plant that a soil can support. These components are found in the topmost layer of soil, called **topsoil**

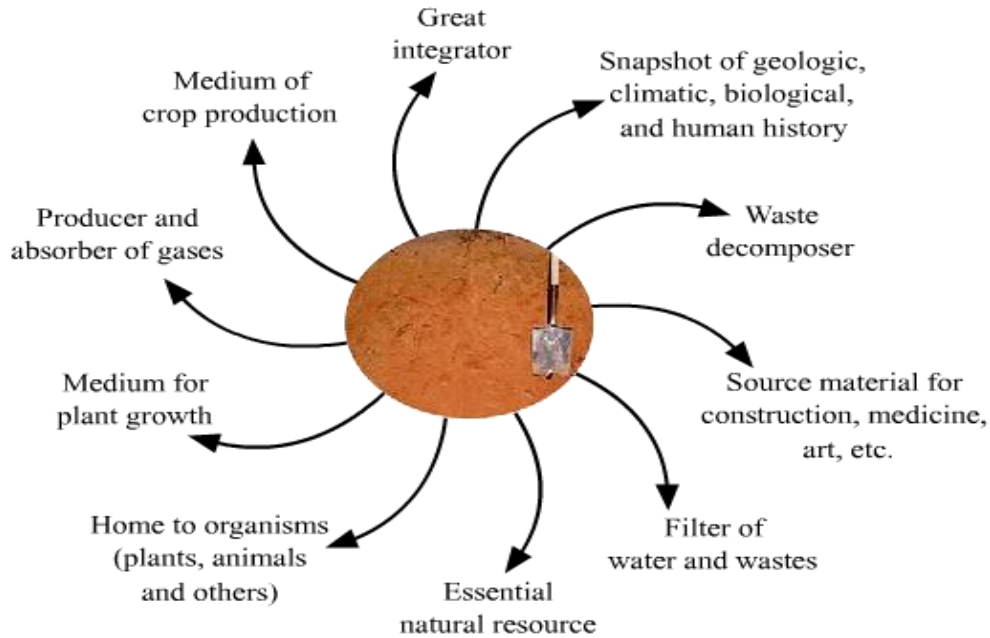
. So, it is topsoil which decides the type of plant and animal life that will be found on it.

Solved Examples

Example: Can we alter the nutrient and humus content of soil to support plant life?

Solution: It is possible to increase the nutrient and humus content of soil by using manures and fertilizers. Manures are naturally decomposed organic materials that increase soil fertility. Fertilizers are mostly chemical in nature and add essential nutrients to soil. The use of manures and fertilizers is a common practice in agriculture.

Importance of Soil



Soil-Forming Factors

The following factors influence soil formation.

1. **Parent material:** It is the material from which soil is made. This parent material is mostly bedrock and, to a lesser extent, organic materials, volcanic ash and sediments deposited by wind and water.
2. **Climate:** Climatic factors such as rain, snow, heat and wind help break down bedrock over a period of time, which then leads to the formation of soil.
3. **Topography:** This includes the surface features of an area such as land type and water bodies. It also affects soil formation.
4. **Organisms:** The dead remains of plants and animals form the organic matter that enriches soil. Living organisms like mosses and lichen release chemicals that break down rocks. Plant roots enter rocks through the cracks on them. With time, they expand and grow and thereby break the rocks down into smaller pieces.
5. **Time:** Soil is formed over hundreds and thousands of years.

As mentioned before, the weathering or breaking down of rocks over a period of millions of years results in the formation of soil. This weathering can be physical, chemical and biological.

Role of Climatic Factors in Soil Formation

Role of the sun in soil formation: Sunlight heats up the rocks on Earth's surface, thereby expanding them. At night, the rocks cool down and contract. This repeated and unequal heating and cooling of rock parts induces cracks to be formed on them. Ultimately, the huge rocks break up into smaller pieces, thus resulting in the formation of soil.

Role of wind in soil formation: Strong winds wear down or erode rocks. The soil particles thus formed are carried along with the winds and get deposited at places where the winds slow down.

Role of water in soil formation: Water enters rocks through the cracks on them. The water freezes at low temperatures, thereby expanding the rocks. The rocks contract when the frozen water melts. This repeated expansion and contraction of rocks over time leads to their breaking down into smaller pieces. Water also wears down rocks by flowing over them. The flow of water creates friction between the water and the rocks. This friction breaks down the rocks and, ultimately, soil is formed. The resultant soil particles may flow along with the water and get deposited elsewhere.

Soil Pollution

The introduction of the substances like toxic compounds, chemicals, salts, radioactive materials in the soil that alter its quality is called **soil pollution**. Various human activities pollute the soil. These pollutants destroy the fertility of the soil and harm the useful organisms living in the soil. Some of the important causes of the soil pollution are given below:

- Pesticides
- Plastic products
- Chemical fertilizers
- Water logging and salinisation of soil.

The preventive measures that can be adopted to reduce soil pollution are as follows.

- Treating waste material before its disposal.
- Reducing use of plastic and polythene bags.
- Minimizing the use of chemical fertilizers and pesticides.
- Using proper irrigation systems to prevent water logging and salinisation of soil.

Soil Erosion

The removal of the top layer of soil is known as soil erosion. It is one form of soil degradation. It may be a slow process that continues relatively unnoticed; or it may occur at an alarming rate, causing serious loss of topsoil.

The factors causing soil erosion are of two types—**natural** and **human-induced**.

Natural factors of soil erosion

- **Rainfall:** High-intensity rainfall loosens soil particles and disperses them. Erosion increases unexpectedly with severity of rainstorms.

- **Flooding:** Frequent flooding of rivers causes the topsoil of the fields near the river banks to be carried away by the flood waters.
- **Wind:** Wind causes soil erosion by carrying away topsoil particles.
- **Slope gradient:** The steeper the slope of a field, the greater will be the amount of soil loss from erosion by water.

Human-induced factors of soil erosion

- **Deforestation:** Intentional and large-scale cutting down of trees leads to the destruction of permanent vegetation. In the absence of trees, the chances of soil erosion by water increases. This is because there are no roots to hold down topsoil.
- **Overcropping :** Continuous growing of crops on a particular field year after year causes the soil to deplete in its nutritional quantity. This practise reduces the ability of soil to produce valuable humus which helps in regaining the fertility of soil. Thus, it causes the soil to become drier and open for wind erosion.

Prevention of Soil Erosion

The following steps can be taken to prevent soil erosion.

- **Afforestation:** The roots of trees bind the top layer of soil. Thus, large-scale planting of trees in barren tracts helps prevent the erosion of soil by the actions of water and wind.
- **Terrace farming:** When water flows with speed on mountains, it carries along with it precious topsoil. To avoid this, the sides of mountains can be cut out into steps. This slows down the flow of water.
- Proper irrigation techniques should be used to avoid washing away of topsoil by water.
- Proper embankments should be constructed around rivers to prevent soil erosion during floods.



Air, Water and Soil Pollution

Pollution

Why do people in cities cover their faces while travelling? Why do they use water purifiers in their homes? The answer to both these questions is 'pollution'. Pollution is the addition of contaminants to the environment. Such addition can be a result of some natural phenomena or certain human activities. Let us learn about the different kinds of pollution.



Wild forest fire



Animal bathing
in lake



Volcanic ash



Aerosol spray



Oil spill

'I am going out to get some fresh air!' You must have heard people speak so; perhaps you yourself might have said this one time or another. But don't you think 'fresh air' is becoming more of a myth in the context of the present-day city life? Every time you step out of your house, you are subjected to the city air contaminated by the emissions from vehicles and factories. This contamination of air by chemical, biological and physical agents is called **air pollution**. The substances that contaminate or pollute air are called air pollutants, for example, the oxides and acids of nitrogen and sulphur, and **suspended particles** like carbon particles.

Air Pollution

Causes of air pollution

- Automobile and industrial emissions
- Burning of fossil fuels such as coal and petroleum
- Thermal power plants and smoke
- Aerosol sprays and spray paints
- Forest fires and acid rains
- Volcanic eruptions

The given table lists the different air pollutants released by the different sources of air pollution.

Causes of air pollution	Air pollutants released
Burning of fossil fuels such as coal and petroleum	Oxides of nitrogen and sulphur, unburnt carbon particles or suspended particles
Burning of wood; automobile exhaust	Carbon monoxide, smoke
tion	Carbon dioxide
Refrigerants such as freon, aerosol sprays	Chlorofluorocarbons (CFCs)
Nuclear explosions, leakage of radioactive materials	Radioactive pollutants

Did You Know?

1. We breathe approximately two gallons of air in one minute.
2. On average, air pollution takes 1–2 years off the typical human lifespan.

Effects of Air Pollution

The different pollutants of air affect the respiratory system, causing breathing problems and diseases such as bronchitis, asthma, lung cancer and tuberculosis.



- Different oxides of nitrogen and sulphur are released into the atmosphere when fossil fuels are burnt. These are dangerous to inhale. **Acid rains** are caused when these oxides dissolve in rainwater. Acid rains adversely affect plant and animal life as well as buildings and monuments.
- Combustion of fossil fuels also increases the level of suspended particles (unburnt carbon particles/ hydrocarbons) in air. An increased level of these pollutants results in allergies. They also lower visibility, especially in winters when water also condenses out of air. This is known as **smog**
 - . The level of smog indicates the level of air pollution.
- Chlorofluorocarbons induce the **depletion of the ozone layer**, thereby exposing various life forms to the harmful ultraviolet rays of the sun.
- Carbon dioxide and carbon monoxide may cause cancer and heart diseases. These gases are also responsible for **global warming**.
- Regular breathing of polluted air increases the incidence of allergies, cancer and heart diseases.

Air Pollution: Control Measures

We can control the air pollution :

- By getting the pollution levels of our vehicles checked
- By not creating smoke unnecessarily

- By not buying products that come in aerosol spray cans
- By using public transport and car pools for travelling
- By constructing factories and industries away from populated areas in a sustainable manner
- By avoiding the use of fossil fuels to obtain energy and using clean fuels instead

Lichens are bio-indicators. If the air of a particular area is polluted, then there may be no lichens present; if, on the other hand, the air is clean, then lichens become abundant.

Water Pollution

A change in the quality of water due to the addition of harmful substances is termed as **water pollution**.

Causes of water pollution

- **Fertilizers and pesticides:** It is a common agricultural practice to add fertilizers and pesticides to soil. These substances are chemical in nature. On flowing along with the water used for irrigation or rainwater, these chemicals enter water bodies and pollute them.
- **Sewage from towns and cities:** If unchecked, it flows directly into water bodies and pollutes them.
- **Waste from factories/industries:** Such types of waste matter are also called effluents. When these effluents are released into water bodies without being treated, they pollute the water.
- **Temperature change:** Coolant used by industries when discharged increases the temperature of water bodies upon flowing into them, thereby affecting the aquatic organisms.

Water Pollution

Effects of water pollution

- When an excess of chemicals such as fertilizers and pesticides enter water bodies, they cause an increase in the growth of algae. This process is called eutrophication. This excess algal growth causes the surface of water to be covered, which in turn reduces the amount of oxygen available to the aquatic organisms.

Sewage water may contain harmful bacteria that cause diseases such as cholera, dysentery and typhoid.

- A change in the temperature of water affects not only aquatic organisms but also their eggs and larvae.
- Toxic chemicals released by factories (e.g., mercury salts released by paper factories) poison water bodies, thereby causing serious harm to both aquatic and terrestrial life forms.

- Sometimes contaminated water may become mixed with ground water. People who consume this ground water may become sick. They might also develop liver or kidney problems.

Control Measures

- Industrial waste water can be recycled and reused. The waste water from industries should be treated in sewage treatment plants. Similarly, sewage should be treated before being disposed into rivers.
- Potable water is the water that is safe for drinking. Although the water we drink may look clean to the naked eye, it may contain disease-carrying microorganisms. In order to prevent the occurrence of diseases, water should be cleaned by filtration or boiling. Filtration helps to remove the solid impurities from water and boiling kills the various disease-causing germs in water.
- **Chlorination:** Adding chlorine to water is one of the most commonly used methods of water purification. Chlorine, when used in the prescribed amount, kills the germs present in water and makes it safe for consumption.

Think About Water!

Unhealthy Streams:

Land-based activities increases nutrients, toxicants and sediments entering in the stream.

Factors that degrade streams:

- Toxic acid mine drainage and sediments
- Low oxygen and algal blooms
- Altered water flow due to construction of dams
- Water runoff from roads and buildings
- Sediment runoff from livestock operations
- Poluted water due to air pollution
- Suffocation from sediment disruption
- Bloodworms
- Loss of bottom-dwellers

Healthy Streams:

Well-managed land-based activities reduces the amount of nutrients, toxicants, and sediments entering in the stream.

Factors that protect streams:

- Water retention in pond
- Crops management practices
- Debris
- Sufficient oxygen
- Rocky stream bottom
- Livestock management
- Shady stream banks

Bottom-dwellers

- Mayfly larvae
- Caddisfly larvae
- Freshwater mussels
- Stonefly
- Snails
- Dragonfly

Soil Pollution

The addition of harmful substances to soil whereby both soil fertility and the useful life forms present in soil are adversely affected is called **soil pollution**.

Most fertilizers and pesticides are made of chemicals. Excessive use of these can kill the microorganisms that naturally occur in soil and recycle its nutrients. The harmful chemicals also affect earthworms, which help convert organic matter into humus. Uncontrolled use of fertilizers and pesticides may cause soil to lose its fertility and make it incapable of sustaining life.

Causes of soil pollution

- Industrial wastes such as harmful chemicals
- Agricultural wastes containing pesticides, fertilizers and insecticides
- Acid rain
- Inadequate knowledge of soil management
- Garbage disposal
- Undesirable irrigation practices

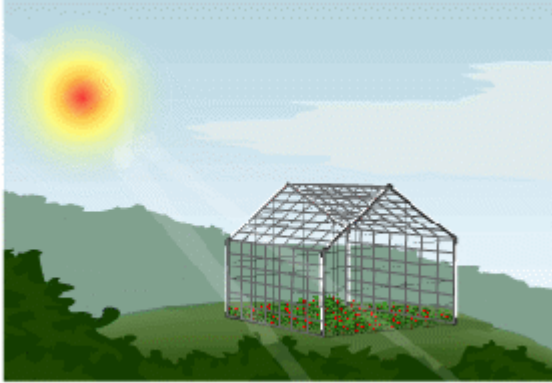
Prevention of soil pollution

We can prevent soil pollution:

- By avoiding the use of chemicals as much as possible
- By treating sewage before moving it to other areas
- By disposing garbage to proper dump areas
- By avoiding the use of non-biodegradable substances

Greenhouse Effect

What is a greenhouse?



You may have seen **transparent structures made of plastic or glass that house small plants**. These transparent structures are called greenhouses. A greenhouse allows sunlight to enter, but prevents the heat from escaping. This results in an increase in the temperature inside the greenhouse.

Greenhouses help maintain climatic conditions such as temperature and humidity at the levels that are conducive for the optimum growth of plants. Specially designed greenhouses keep tropical plants warm during the winters in colder climates. Apart from this, greenhouses also provide protection to plants against factors that are adverse to their growth, for example, pests and strong winds.

Greenhouse effect

Greenhouse effect is an atmospheric phenomenon named after the heat-trapping transparent structures. Sunlight passes through Earth's atmosphere to warm Earth's surface, but the heat radiated back from the warmed surface is absorbed by certain gases present in the atmosphere. This trapping of heat increases Earth's temperature, much the same way as the temperature inside a greenhouse rises. This is called greenhouse effect and the gases responsible for this phenomenon are called **greenhouse gases**.

Greenhouse Effect: Causes



The amount of greenhouse gases in the atmosphere has been on the rise for centuries. This has in turn increased Earth's average temperature and resulted in the phenomenon known as **global warming**.

Some of the factors responsible for this increase in greenhouse gases in the atmosphere.

- **Deforestation:** The cutting down of trees on a large scale negatively affects the amount of carbon dioxide getting converted into oxygen. This increases the concentration of carbon dioxide in the atmosphere.
- **Burning of fossil fuels:** The burning of fossil fuels such as coal and petroleum releases greenhouse gases such as carbon dioxide and methane into the atmosphere.
- **Industrial emissions:** Gases released by various industries also contribute to the rise in the amount of greenhouse gases in the atmosphere.

Importance of Ozone layer

The Ozone Layer

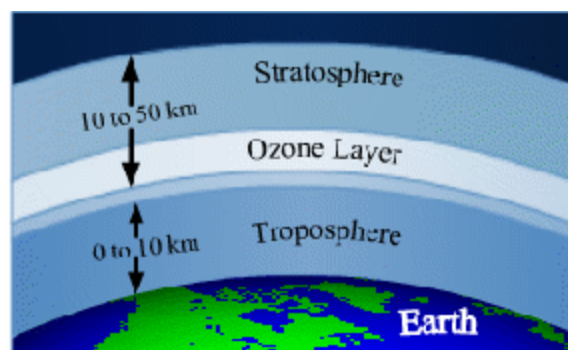
According to WHO (World Health Organization), many instances of skin cancer are diagnosed among the cancer cases that occur globally each year.

Do you know the reasons behind the occurrence of skin cancer?

One of the main reasons of skin cancer is overexposure to ultraviolet radiations due to the depletion of the ozone layer.

What is this ozone layer?

We have previously studied that the atmosphere is divided into various layers. The lowest layer, which extends up to 10 km from Earth's surface, is the troposphere. The next layer, which extends from 10 km to 50 km, is the stratosphere. Most of the ozone gas is concentrated in this region as the **ozone layer**. The ozone layer is a protective layer of molecules, each containing three atoms of oxygen (O_3).



Ozone Layer

Role of the Ozone Layer

Ozone (O_3) is a tri-atomic molecule of oxygen and, luckily, it is unstable as compared to diatomic oxygen (O_2). The ozone layer is found in the atmosphere at a height of about 15 km to 30 km from Earth's surface. This **stratospheric ozone** protects us from the harmful **ultraviolet radiations** of the sun. The ozone layer prevents these ultraviolet radiations from reaching the Earth's surface.

Some of the harmful effects of ultraviolet radiations are:

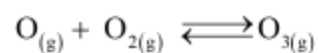
- Skin cancer
- Cataract (clouding of the natural lens of the eye, resulting in impairment of vision or blindness)
- Reduction in plant growth
- Decrease in the productivity of crops
- Reduction in the number of phytoplankton
- Weakening of the immune system
- Eye cancer

There is another type of ozone called bad ozone. It is found near Earth's surface and, hence, is called **tropospheric ozone**. It is formed as a result of various human activities. It is a poisonous gas that has a harmful effect on the respiratory system of animals. It also causes greenhouse effect.

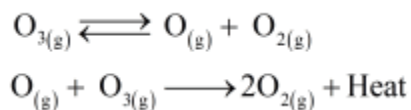
Solved Examples

Example 1: On the one hand, stratospheric ozone protects us from harmful UV radiations; on the other hand, it is these same UV radiations that help in forming ozone. Explain how this is possible.

Solution: The stratosphere consists of a considerable amount of ozone (O_3) which protects us from the harmful ultraviolet radiations coming from the sun. In the upper atmosphere, ozone is produced when ultraviolet radiations act on molecules of diatomic oxygen (O_2) according to the following reactions.



Ozone is thermodynamically unstable. It absorbs the UV radiations to give a molecule of diatomic oxygen. Heat is liberated during the process, which raises the temperature of the stratosphere.



There exists a dynamic equilibrium between the production and decomposition of ozone, through the utilization of UV radiations. In this manner, the ozone layer prevents the harmful UV radiations from reaching Earth's surface.

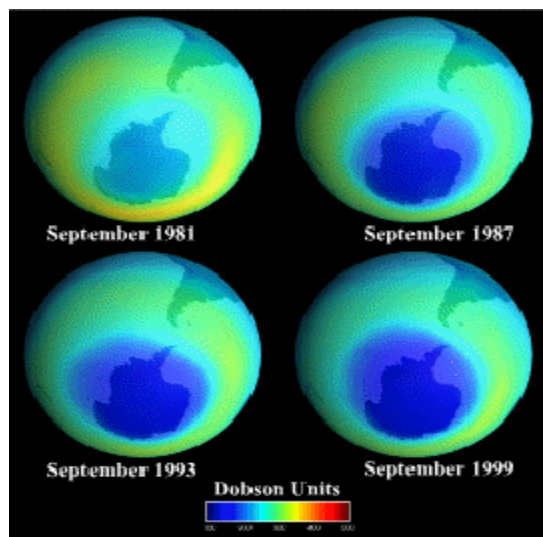
Example 2: Ozone is one of the gases that cause greenhouse effect. However, it is also what protects us from the harmful UV rays of the sun. So, what do you think ozone gas is—harmful or useful?

Solution: There are two types of ozone—bad ozone and good ozone. Bad ozone is found in the troposphere and is a greenhouse gas. It is produced due to different human activities. Good ozone is found in the stratosphere where it protects us from the harmful ultraviolet radiations of the sun. Thus, the usefulness and harmfulness of ozone depend upon where it is found in the atmosphere.

Example 3: How is bad ozone formed near Earth's surface?

Solution: Bad ozone is found much nearer the ground, in the troposphere. It is an indirect result of air pollution. It is formed when the pollutants emitted by cars, power plants, industrial boilers, refineries and chemical plants react chemically in the presence of sunlight. For example, when gasoline and coal are burned, nitrogen oxide gases (NO_x) and volatile organic compounds (VOC) are released into the air. During warm and sunny days, NO_x and VOC combine with oxygen to form bad ozone. Bad ozone harms animal as well as plant life.

Depletion of the Ozone Layer



Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is disturbed.

The chemicals that lead to ozone destruction are known as ODS (ozone-depleting substances). The main ODS are chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), methyl chloroform and carbon tetrachloride. Halons (brominated fluorocarbons) also play a large role in ozone depletion.

When CFCs reach the upper atmosphere, they are broken down by the UV rays of the sun. This results in the release of free chlorine. The chlorine becomes actively involved in the process of ozone destruction whereby ozone is converted into oxygen. In this process, two molecules of ozone are replaced by three of molecular oxygen and the chlorine is left free to repeat the process.

This cycle of reaction continues to cause ozone depletion.

The given images show the depletion of ozone over Antarctica. The greater the intensity of the blue area, the greater is the depletion of ozone.

Ozone hole observed over

Antarctica



Solved Examples

Example 1: How come there is a hole in the ozone layer over Antarctica—a place where there is no pollution?

Solution: The chlorofluorocarbons released into the atmosphere are responsible for the hole in the ozone layer. These compounds have long life spans; hence, they persist in the atmosphere for long. They reach the stratosphere and are evenly distributed across the globe. However, it is the stratospheric clouds in the Antarctic region that specially favour the breakdown of chlorofluorocarbons in the presence of UV light, thereby resulting in the destruction of ozone and the formation of the ozone hole. During the winter season, when the temperatures in this region decrease to a great extent, thin clouds of ice are formed in the atmosphere.

Biogeochemical Cycles

Biogeochemical Cycles

We know that plants absorb nitrogen from the soil. Assuming that all plants do so, the nitrogen in the soil should have been completely exhausted ages ago. However, this is not the case.

Similarly, organisms breathe in oxygen and breathe out carbon dioxide. Since all organisms inhale oxygen from the atmosphere, this oxygen should have got used up long time back. However, once again, this is not true.

To maintain the concentrations of different naturally occurring substances in the environment, there are mechanisms that constantly recycle these substances. These recycling mechanisms are called **biogeochemical cycles**. So, biogeochemical cycles are the cyclic flow of nutrients between non-living environment and living organisms.

The two important components of biogeochemical cycle are:

Reservoir pool: It is the component of the biogeochemical cycle where the given substances are stored in the biosphere. In this component of the cycle, the movement of substances is very slow and involves non-living components. For example, atmosphere, hydrosphere and lithosphere.

Exchange pool: It is the component of the biogeochemical cycle where the movement of given substances is very fast and involves living components like bacteria, fungi, plants and animals.

The movement of substances from the reservoir pool to exchange pool is referred to as **fixation** and the return of substances from the exchange pool to reservoir pool is called **recycling**.

Types of Biogeochemical Cycles

There are two major types of biogeochemical cycles

1. Gaseous cycle: These are the biogeochemical cycles in which the reservoir pool is the atmosphere or hydrosphere. For example, carbon cycle, nitrogen cycle etc.

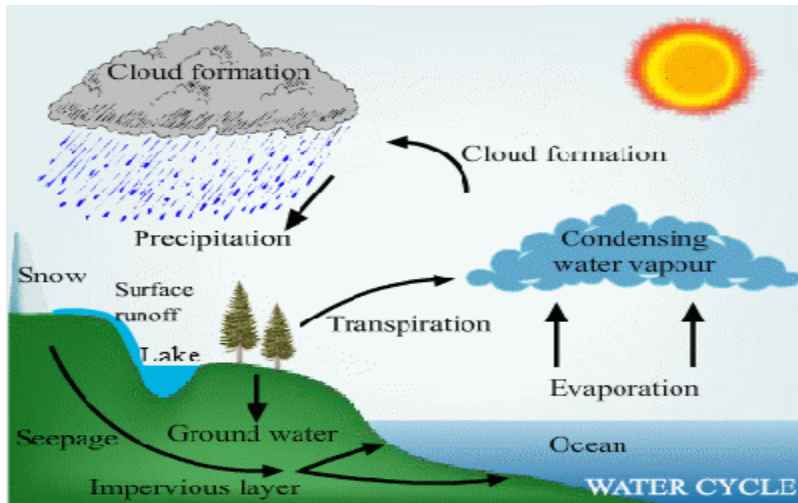
2. Sedimentary cycles: These are the biogeochemical cycles in which the reservoir pool is generally lithosphere. For example, Phosphorous cycle, Sulphur cycle etc.

Some important Gaseous biogeochemical cycles existing in nature are:

- Water cycle
- Nitrogen cycle
- Carbon cycle

- Oxygen cycle

Water Cycle



The earth has a limited amount of water which gets recycled continuously. This recycling of water is called the water cycle. Broadly, water cycle comprises evaporation of water, its falling on land as rain and its flowing into the sea via the rivers.

To understand the water cycle, we should know:

- How water is lost from the environment
- The processes of change and the different states of water
- The method by which water is returned to the environment

Steps involved in the water cycle are:

- Evaporation and transpiration
- Condensation
- Precipitation
- Surface runoff

Water Cycle

Step 1: Evaporation and transpiration

Water molecules change into water vapours and move up the atmosphere by the process of **evaporation**. The excess water absorbed by plant roots is released through the pores on the surface of leaves by the process of **transpiration**.

Step 2: Condensation

The process by which water vapours move upward, cool down in the higher atmosphere and form clouds is called **condensation**.

Step 3: Precipitation

As condensation proceeds, water vapours change into water droplets. When enough water droplets accumulate, they fall down as rain. This process is called **precipitation**.

Step 4: Surface runoff

Rains replenish the water in the ponds, lakes, rivers and oceans. The process wherein rainwater enters the soil is known as infiltration. The process in which rainwater flows over the surface of land before entering different water bodies is called surface runoff.

At very low temperatures, water droplets freeze and fall down as hail, snow or sleet.

Did You Know?

There is another aspect to the water cycle.

The water cycle also helps in the movement of nutrients from one place to another. As water flows through or over rocks containing soluble minerals, some of them get dissolved in the water. This nutrient-containing water is then carried off by the rivers to the sea and there the dissolved nutrients are used by marine organisms.

Nitrogen Cycle

The concentration of nitrogen in the atmosphere is about 78%. Nitrogen is essential for all life forms. It is a structural component of many important bio-molecules such as DNA, RNA and vitamins.

Animals obtain nitrogen by eating plants, but how do plants obtain nitrogen? Plants cannot absorb atmospheric nitrogen. Instead, they depend upon biological nitrogen fixers, physical processes and fertilizers for nitrogen. The process whereby atmospheric nitrogen is converted into usable forms such as nitrates and nitrites is called nitrogen fixation.

Methods of nitrogen fixation

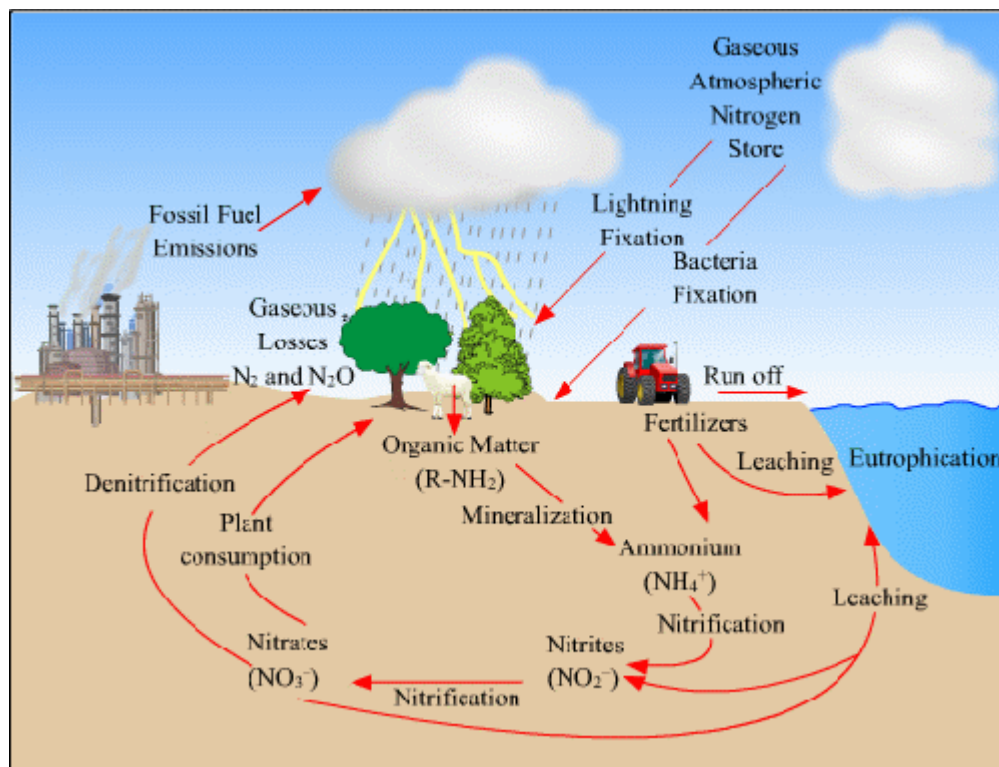
- **Physical process:** During lightning and thunder, the high temperature and pressure in the air convert atmospheric nitrogen into oxides of nitrogen. These oxides can dissolve in water to produce nitric and nitrous acids. The acids fall along with rain and are then utilised by various life forms.
- **Biological process:** Certain forms of bacteria and other organisms such as algae are able to convert atmospheric nitrogen into usable forms such as nitrates and nitrites. Nitrogen-fixing bacteria are commonly found in the roots of legumes (plants of pulses), inside special

structures called root nodules. Some nitrogen fixers also live freely in the soil. These usable forms of nitrogen are absorbed by plants to produce many compounds such as amino acids, which in turn form proteins.

When plants and animals die, they start decomposing after some time. During this process, proteins are converted into nitrates and nitrites by the action of decomposing bacteria. Certain other forms of bacteria convert nitrates and nitrites into elemental nitrogen. Thus, nitrogen flows between the various components of the biosphere in a cyclical manner.

Nitrogen Cycle

The nitrogen cycle involves conversion of nitrogen from its elemental form in the atmosphere into simpler molecules in the soil and water. These further get converted into more complex molecules in living beings. Finally, the complex molecules are reduced and released back into the atmosphere as simple nitrogen molecules.



Nitrogen Cycle

There are basically five steps involved in the fixing of atmospheric nitrogen.

1. Nitrogen fixation: $N_2 \longrightarrow NO_3^-$ or NH_4

It is the process wherein atmospheric nitrogen is converted into water-soluble nitrates. This step is performed by organisms like *Rhizobium*, *Azotobacter* and blue-green algae.

2. **Nitrification:** $\text{NH}_3 \longrightarrow \text{NO}_2^- \longrightarrow \text{NO}_3^-$

It is the process in which ammonia is first converted into nitrites and then into nitrates. This step is performed by nitrifying bacteria like *Nitrosomonas* and *Nitrobacter*.

3. **Assimilation:** In this step, NH_3 and NO_3^- are incorporated into the biological tissues.

4. **Ammonification:** Organic nitrogen compounds $\longrightarrow \text{NH}_4^+$

It is the process in which complex, dead organic matter is decomposed into ammonia. This step is performed by organisms like decay bacteria and fungi.

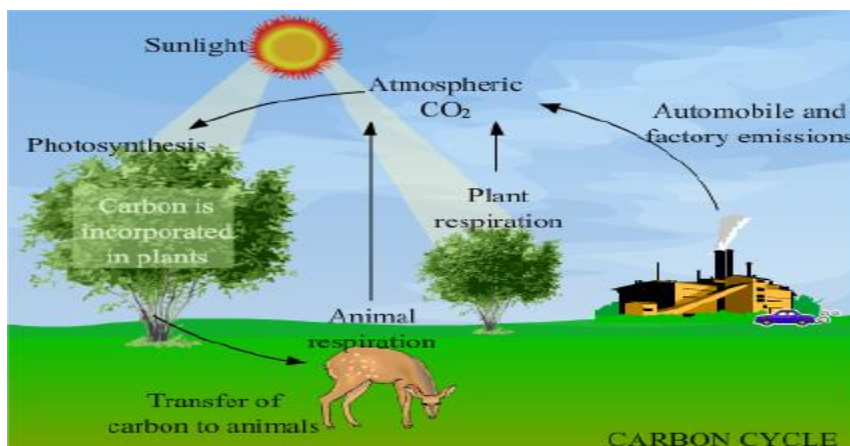
5. **Denitrification:** $\text{NO}_3^- \longrightarrow \text{N}_2$

It is the process wherein the nitrates present in the soil are reduced to release nitrogen back into the atmosphere. This step is performed by denitrifying bacteria like *Psuedomonas*.

Alteration of the nitrogen cycle

Certain human activities alter the nitrogen cycle. For example, the application of nitrogen fertilizers to crops increases the leaching of nitrate into groundwater during rains. Excess nitrogen in water bodies can lead to eutrophication.

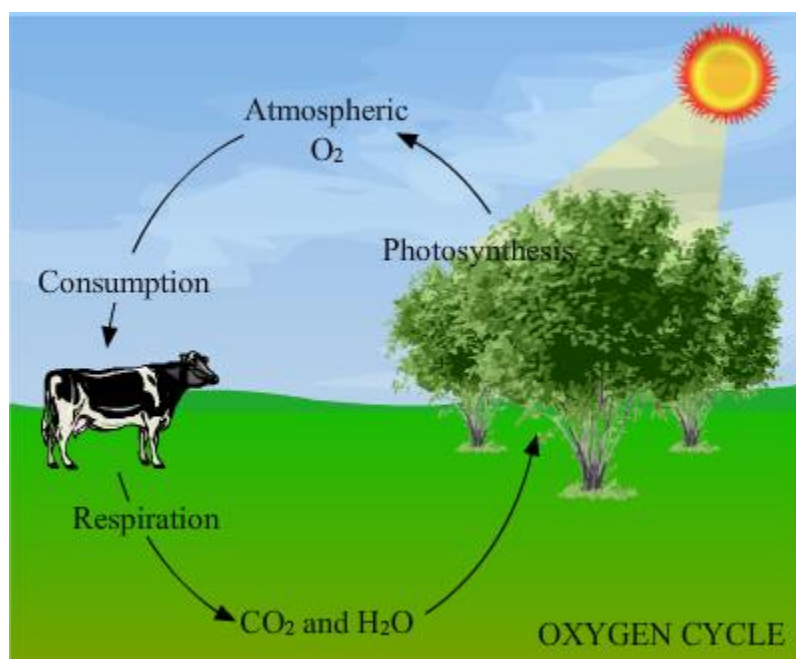
Carbon Cycle



All organic substances are made up of carbon. Fats, vitamins, nucleic acids, carbohydrates and proteins contain carbon as a structural component. Carbonate salts form **endoskeletons** and **exoskeletons** of many animals.

- Carbon enters life forms through the process of photosynthesis. During photosynthesis, carbon dioxide and water combine to produce glucose and oxygen. This changes the atmospheric carbon into glucose molecules.
- Glucose, which is a source of food, is utilized by organisms to produce energy during respiration. During this process, glucose is broken down in the presence/absence of oxygen to produce carbon dioxide.
- Another process that releases carbon dioxide is combustion or burning. Many substances release carbon dioxide on burning. Vehicular emissions, industrial fumes and the gases released during the process of cooking are some instances of release of carbon dioxide through combustion.
- Thus, carbon is cycled repeatedly through different forms by the various physical and biological activities.

Oxygen Cycle



Oxygen is an important component of life. We cannot survive without oxygen. It comprises about 21% of atmospheric air. It is also present in dissolved form in water bodies and helps in the survival of aquatic life. In combined form, it is found both in Earth's crust and in the air. In the air, it occurs as carbon dioxide. In the crust, it is present as oxides of most metals and silicon and also as carbonate, sulphate, nitrate and other minerals.

Oxygen is also a part of several essential biomolecules such as carbohydrates, proteins, nucleic acids and fats.

Oxygen cycle

There are processes that utilize atmospheric oxygen. At the same time, the balance of oxygen in the atmosphere is also maintained.

- Oxygen is utilized during respiration, combustion and formation of oxides of nitrogen.
- Oxygen is returned to the atmosphere in only one major way, and that is photosynthesis.

Did You Know?

Did you know that there are some life forms that do not require oxygen at all?

Such life forms which survive in the absence of oxygen are called anaerobic organisms. Certain bacteria fall in this category, for example, *Fusobacterium nucleatum*.