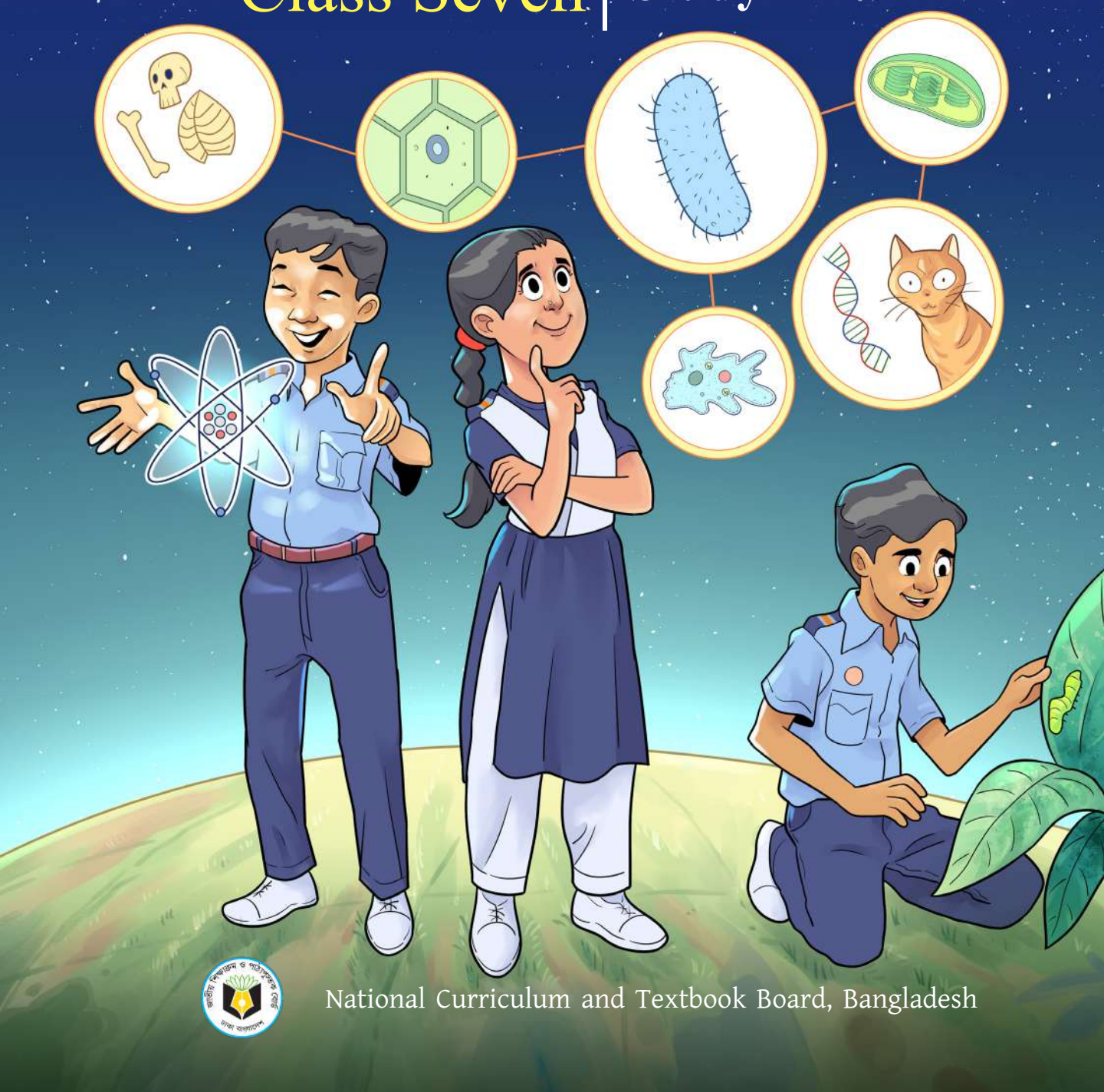
Science
Class Seven

Investigative Study



National Curriculum and Textbook Board, Bangladesh

ডিজিটাল বাংলাদেশের অর্জন

- প্রধানমন্ত্রী শেখ হাসিনার একটি স্বপ্ন 'ডিজিটাল বাংলাদেশ' যার ভিশন হলো তথ্য ও যোগাযোগ প্রযুক্তির বহুমুখী ব্যবহার নিশ্চিত করার মাধ্যমে জ্ঞানভিত্তিক সমাজ প্রতিষ্ঠায় সহায়তা প্রদান। ২০০৮ সালে আওয়ামী লীগের নির্বাচনী ইশতেহার 'দিন বদলের সনদ' এ প্রথম ঘোষণা করা হয় যে ২০২১ সালে স্বাধীনতার ৫০ বছরে বাংলাদেশ ডিজিটাল বাংলাদেশে পরিণত হবে।
- তথ্যপ্রযুক্তি খাতে বিশেষ অবদানের জন্য প্রধানমন্ত্রী শেখ হাসিনা ২০১৫ সালে 'আইসিটি টেকসই উন্নয়ন পুরস্কার' অর্জন করেন। প্রধানমন্ত্রীর আইসিটি বিষয়ক উপদেষ্টা সজীব আহমেদ ওয়াজেদ এক্ষেত্রে তাঁর অনন্য কৃতিত্বের জন্য ২০১৬ সালে 'উন্নয়নে আইসিটি পুরস্কার' অর্জন করেন ।
- বিগত এক দশকে দারিদ্র্য বিমোচনসহ কৃষি, শিক্ষা, স্বাস্থ্য, মানবসম্পদ উন্নয়ন প্রভৃতি ক্ষেত্রে বাংলাদেশ এক অনুকরণীয় সাফল্যের দৃষ্টান্ত স্থাপন করেছে। এ সাফল্যের ধারাবাহিকতায় জুন ২০১৯ পর্যন্ত ইন্টারনেট সেবা নিশ্চিতে সারাদেশে ইউনিয়ন পর্যায় পর্যন্ত ১৮ হাজার ৯৭৫ কি. মি. অপটিক্যাল ফাইবার ক্যাবল স্থাপন, ২ হাজার ৪টি ইউনিয়নে ওয়াইফাই রাউটার (Wifi Router) স্থাপন এবং ১ হাজার ৪৮৩টি ইউনিয়নকে নেটওয়ার্ক মনিটরিং সিস্টেমে সংযুক্ত করা হয়েছে।
- ই-কমার্স ও ডিজিটাল প্রযুক্তির বিকাশের ফলে আইটি সেক্টরে বহুমানুষের কর্মসংস্থান নিশ্চিত হয়েছে ও প্রচুর বৈদেশিক মুদ্রা আয় হচ্ছে। ২০১০ সাল থেকে সব শ্রেণি ও পেশার মানুষকে ই-সেবার সঙ্গে পরিচিতকরণের লক্ষ্যে প্রতিবছর ডিজিটাল উদ্ভাবনী মেলার আয়োজন করা হচ্ছে।

Developed by the National Curriculum and Textbook Board as a textbook according to the National Curriculum 2022 for Class Seven from the academic year 2023

Science | Investigative study

Class Seven

(Experimental Version)

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Published by
National Curriculum and Textbook Board

69-70 Motijheel Commercial Area, Dhaka-1000

Published: December 2022

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For free distribution by the Government of the People's Republic of Bangladesh

Printed by:

Preface

In this ever-changing world, the concept of livelihood is altering every moment. The advancement of technology, in accordance with knowledge and skill, has accelerated the pace of change. There is no alternative to adapting to this fast changing world. The reason is, the development of technology is at its zenith compared to any time in the human history. In the fourth industrial revolution era, the advancement of artificial intelligence has brought a drastic change in our employment and lifestyles and this will make the relationship among people more and more intimate. Varied employment opportunities will be created in near future which we cannot even predict at this moment. We need to take preparation right now so that we can adapt ourselves to that upcoming future.

Although a huge economic development has taken place throughout the world, the problems of climate change, air pollution, migrations and ethnic violence have become much more intense than before. The epidemics like COVID 19 has appeared and obstructed the normal lifestyle and economic growth of the world. Different challenges and opportunities have been added to our daily life.

Standing on the verge of these challenges and possibilities, implementation of sustainable and effective solutions is required for the transformation of our large population into a resource. It entails global citizens with knowledge, skill, values, vision, positive attitude, sensitivity, capability to adapt, humanity and patriotism. Amidst all these, Bangladesh has graduated into a developing nation from the underdeveloped periphery and is continuously trying to achieve the desired goals in order to become a developed country by 2041. Education is one of the pivotal instruments to attain the goals and there is no alternative to the modernization of our education system. Developing an effective and updated curriculum has become crucial for this modernization.

Developing and revising the curriculum is a regular and vital activity of National Curriculum and Textbook Board. The last revision of the curriculum was done in 2012. Since then, a lot of time has passed. The necessity of curriculum revision and development has emerged. For this purpose, various research and technical exercises were conducted under the supervision of NCTB during the year 2017 to 2019 to analyze the prevalent situation of education and assess the learning needs. Based on the researches and technical exercises, a competency-based incessant curriculum from K-12 has been developed to create a competent generation to survive in the new world situation.

In the light of the competency based curriculum, the textbooks have been prepared for all streams (General, Madrasah and Vocational) of learners for grade VII. The authentic experience driven contents of this textbook were developed in such a way that teaching learning becomes comprehensible and full of merriment. This will connect textbooks with various life related phenomenon and events that are constantly taking place around us. We hope that learning will be profound and life-long now.

Issues like gender, ethnicity, religion, caste, the disadvantaged and students with special needs have been taken into special consideration while developing the textbook. I would like to thank all who have put their best efforts in writing, editing, illustrating and publishing the textbook.

If any one finds any errors or inconsistencies in this experimental version and has any suggestions for improving its quality, we kindly ask them to let us know.

Professor Md. Farhadul Islam
Chairman
National Curriculum and Textbook Board, Bangladesh

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Index

A few words for the students –

Students, how are you all? Welcome to the Science subject of Class seven!

You can see, there is going to be a big change in the way you have been studying for so long! Your books on all subjects are also a little different this time. You must have got two books on Science! Along with this 'Investigative Study' book you are given another 'Exercise Book'. If you have a look, you will realize that there is a big difference between this book and the Exercise book. Honestly speaking, the way you used to try to learn science by reading different chapters of textbooks, now this way of learning is completely changing. Throughout the year, you will go through several new experiences, solve some new problems. These new experiences and problem solving steps are detailed in your work book. In solving these problems, you will need to know different aspects of science at different stages. This 'Investigative Study' book will help you in this regard. At school or at home, wherever you are, you can use this book to solve problems yourself if needed!

This book covers the topics of Science that you will need to know in Class seven. The topics are organized in fifteen chapters. Many of these things will be useful to you at different times in the experiences that you will go through throughout the year.

So let us start, what do you say?

Chapter 1

Biodiversity

Chapter 1 Biodiversity

By the end of the lesson, students will be able to learn—

- ☑ what is biodiversity
- ☑ origin of biodiversity
- ☑ nature of biodiversity
- ☑ interrelationships of organisms
- ☑ how to measure biodiversity
- ☑ biodiversity of Bangladesh
- ☑ risks and remedies of biodiversity

"Why is this earth so beautiful?" There are many answers to the question. If we compare it with other known planets, we can understand that its diverse biosphere plays a role in the beauty of the Earth. Whether we talk about Mars, Jupiter or Moon, these planets and satellites have a rough lifeless environment. Compared to that, this alive, lively environment of the Earth creates an entirely different feeling in us.

There are billions of organisms on Earth, including humans, with different characteristics. Their size, shape, colour, habitat, diet etc. are all different. An important area of scientific research is to know about this diversity of organisms. Scientists want to know how various organisms survive in different environments, how their reproduction or increase in number is regulated, and how they ensure their nutrition or diet. It is a matter of great wonder how various organisms have adapted to the extremely cold Polar Regions, hot sandy deserts or the deep bottom of the sea without a trace of sunlight.

This chapter will give us a basic idea of this amazing biodiversity. You will know these things in more detail gradually in the upper classes.

What is Biodiversity?

The term biodiversity describes the great variety of life on Earth. Biodiversity refers to the variety of living things, including plants, animals, and microorganisms. We don't know for sure exactly how many different organisms there are on Earth. However, scientists estimate that there are about 8-14 million (80 to 140 lakh) different species of organisms on this Earth. Some believe that the number is higher. But whatever the number, most of these organisms are unknown to us. Only 1.2 million (12 lakh) species have been identified and described so far, most of which are insects. This means that billions of other organisms are still mysterious and unknown to us.

Origin of Biodiversity

The unique characteristics of all species alive today have evolved over generations over thousands of years. The strategies and methods followed by an organism to adapt itself to its environment are called adaptation. On the other hand, without any specific reason, some changes occur during the transition of an organism from one generation to the next. That's why we don't look exactly like our parents and are a bit different! Siblings do not look exactly alike unless they are twins, even though they are children of the same parents! From parent to child, this difference in appearance is a minimal change in one generation. But as these small changes occur over millions of years from generation to generation, at some point, new organisms appear with characteristics that are very different from their original ancestors. Thus, the change process in organisms over a long period is called evolution. The characteristics acquired through the process of evolution and adaptation distinguishes the members of the organism from one another. Any

animal keeps its species alive by creating its copy during its lifetime. This process is known as reproduction. Organisms are there who have evolved and adapted over time and become so different from each other that they can no longer breed with one another. They are considered separate species. Organisms that can interbreed are usually included in the same species.

Nature of Biodiversity

Scientists have endless interest in knowing how much biodiversity there is worldwide because they still have so much left to discover. Different organisms in different regions of the world are adapted to the environment of that region. The system formed by combining these regional organisms and the non-living elements of their environment is called an ecosystem. This ecosystem is also called a biome. Different ecosystems develop in different regions of the world. For example, the types of an ecosystem are very different from one another in a green forest, in a snow-covered Tundra region, or under the water of a pond, lake or ocean. Species whose characteristics are best adapted to the environment of a particular area survive and reproduce successfully there.

Simply speaking, a biome is a large area marked by the area's vegetation, soil, climate, and wildlife. There are five main types of biomes: aquatic, grassland, forest, desert, and the tundra. However, some of these biomes can be divided into more specific categories, such as freshwater, marine, rainforest, which is tropical or temperate, and swamp pine forest or the taiga.

Walking by a pond, you will see fish, frogs, kingfishers, grasshoppers and other insects. There may be species such as rats, snakes, earthworms, and insects in grasslands. Again, if you compare grassland in Bangladesh with grassland in Canada, you will see that their biodiversity is different. Ecosystems that contain the most biodiversity have ideal environmental conditions for the growth of animals, plants, and microorganisms.

Some regions of the world, such as Mexico, South Africa, Brazil, the southwestern United States, and Madagascar, have more biodiversity than others. These parts of the world have a large number of endemic species. Endemic species are those that exist only in a particular place.

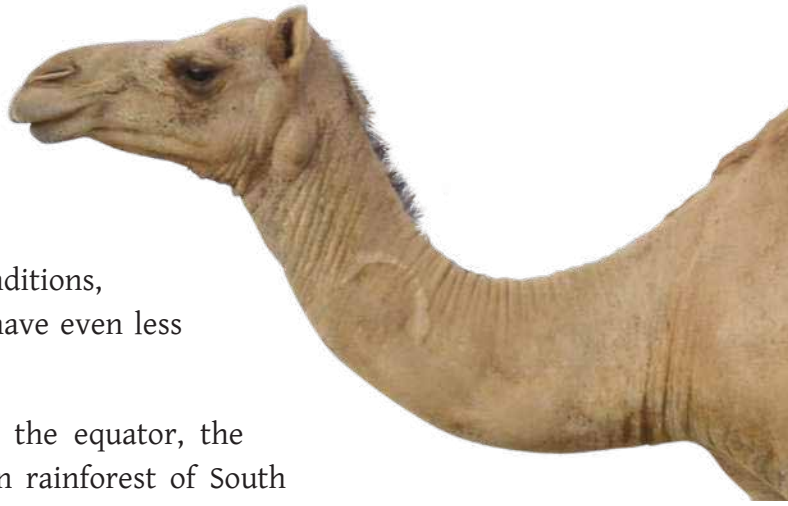
For example, about 6200 plant species in the Cape Floristic region of South Africa are not found anywhere else in the world. Areas with high numbers of endemic species are called hotspots of biodiversity.

Interrelationships of organisms

All species on Earth work together to survive and to maintain the balance of their ecosystems. For example, the grass of pasture is consumed by cattle. The dung left by the cattle creates manure. This manure returns nutrients to the soil, which helps grow more grass. This fertilizer can also be applied in croplands. Many species on Earth play essential roles for humans providing various materials, including food, clothing, and medicine.

Ways to measure Biodiversity

A common way to measure biodiversity is to count the total number of species living within a given area. Tropical regions, which are warm all year round, have the highest biodiversity. Temperate regions, with hot summers and cold winters, have low biodiversity. Areas with dry conditions, such as mountain tops and deserts, have even less biodiversity.



Generally, the closer a region is to the equator, the greater the biodiversity. The Amazon rainforest of South America is home to at least 40,000 different plant species. It is one of the most biologically diverse regions on our planet Earth.

The warm waters of the western Pacific and Indian oceans have the most diverse marine environments with many species of fish, corals, etc. Many corals combine to form coral reefs, which are home to hundreds of other species of organisms. These coral reefs are home to many things, from tiny seaweeds to big sharks.

Another way to measure biodiversity is genetic diversity. In the following chapters, we will know more in detail, but for now, let's know that the gene resides inside the nucleus of the living cell. Whether you are a two-legged human or a four-legged cat, whether your hair is curly or straight — all this information is stored in some gene hidden within your cells. Some species have as many as 400,000 genes. Humans have about 25,000 genes. Some of these genes are the same for all members of a species. These genes determine a rose to be a rose and a dog to be a dog. But among a species of genes, some genes are different. This genetic variation causes some roses to be pink while others are white. In humans, such genetic differences cause some people to have brown eyes and some to have blue eyes.

Greater genetic diversity in species can make plants and animals more resistant to disease. Genetic diversity allows species to adapt better to changing environments.

Biodiversity of Bangladesh

As a part of the Indus-Gangetic plain, Bangladesh is a beautiful land of biodiversity. Bangladesh is surrounded by greenery, where the soil, water, forests, and natural environment are suitable for the living of various types of organisms. The rich biota of the Sundarbans and the underwater fauna of Cox's Bazar and Saint Martin's are all bio-resources of this country.

Indus-Gangetic Plain

The Indus-Gangetic Plain is a large fertile plain that covers part of Pakistan, most of northern and eastern India, and almost all of Bangladesh. The region is named after the rivers Indus and Ganges that flow through the region.

Bangladesh has a rich collection of flowering plants, fishes, amphibians, reptiles, birds and mammals. The natural forest areas of the country are rich in biodiversity due to their location. For example, more than 5000 flowering plant species are found in the forests of Bangladesh. Forest regions of Chattogram alone have about 2,260 plant species. These plants include wood-producing plants, fibre-producing plants and medicinal plants.

So far, 132 species of mammals, 578 species of birds, 154 species of reptiles and 19 species of amphibians have been identified in Bangladesh.

Risks and Remedies of Biodiversity

Much of the world's biodiversity is threatened by humans' use and other activities, which disrupt and sometimes destroy ecosystems. Pollution, climate change and population growth are all threats to biodiversity. These threats play a role in the extinction of species. Some scientists estimate that half of all species on Earth will be extinct within the next century.

Even though Bangladesh is rich in biodiversity, many species are under threat. According to the information of the International Union for Conservation of Nature (IUCN), the existence of 23 species of wildlife in Bangladesh is under the threat of extinction. Moreover, about 29 wild animals in this country are endangered. The safe habitats of organisms are being destroyed mainly due to urbanization, the arrangement of food and shelter, and the collection of medicinal and clothing materials.

Human beings are reducing all the natural resources like water bodies, oceans, and forests for their own interests. Animals and fauna, such as Royal Bengal Tiger, spotted deer, reptile, python, wild duck, black duck, Belgian Blue (nilgai), king vulture, wild buffalo, fresh water crocodile, and Gharial in different forest areas, including Sundarbans, Madhupur and BhawalGarh, are almost extinct and living under threat today.About 39 species of animals in Bangladesh are in danger. According to forestry scientists, about 125 tree species are endangered in Bangladesh.

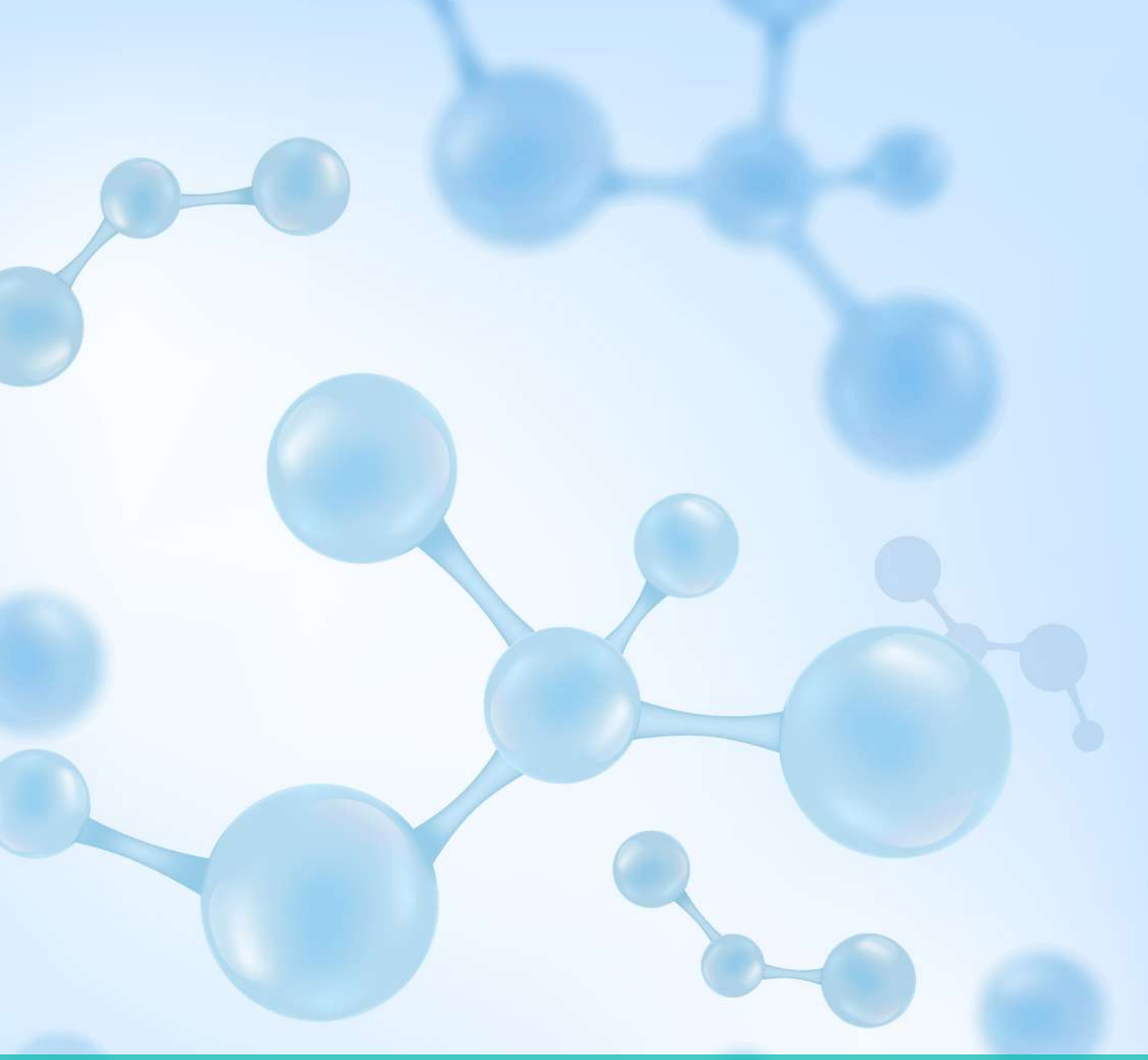
We need our collective efforts to conserve biodiversity and protect the same endangered species and their habitats. Countries worldwide, including Bangladesh, should take appropriate steps to conserve biodiversity. The need for wildlife conservation has been widely felt due to the problems

of environmental pollution, killing wildlife to make products from their skin or bones and animal trafficking etc. Various international and regional organizations, government and non-government organizations, and renowned organizations outside the country, including the United Nations, play an important role in conserving this attempt.

Realizing the importance of biodiversity, we should encourage conservation and enhancement of biodiversity. In different countries, natural forests have been developed as safe sanctuaries for the native flora and fauna, where human movement is restricted if necessary, prioritizing biodiversity. To conserve biodiversity in Bangladesh, the government has declared some parts of the country's forests as protected areas. In addition, collecting trees from protected natural forest areas and collecting old trees from man-made forests have been stopped with the aim of conservation of biodiversity. A new law enforcement agency has been created to combat poaching and trafficking wildlife. By taking such integrated initiatives, many countries have given new hope for protecting diversity of life. However, scientists and environmental organizations call for greater measures. Only government initiatives are not enough in this regard; mass awareness is also needed. Species that have already become extinct over time may not be brought back, but if everyone is careful, it may be possible to preserve the current world's biodiversity. Everyone needs to pay attention to that. Then maybe the diversity of life of the beautiful world will become rich and colourful again.

Exercise ?

1. Why biodiversity is more regions near equator line?



Chapter 2

Molecules and Atoms

Chapter 2 Molecules and Atoms

By the end of the lesson, students will be able to learn—

- ☑ atoms and molecules
- ☑ elements
- ☑ electron, proton and neutron
- ☑ electron configuration of atoms
- ☑ nucleus
- ☑ conductors, insulators and semiconductors
- ☑ solid, liquid and gas

Atoms

Elements

We can never really finish counting the kinds of matter that surround us like clouds-oceans, soil-rocks, houses, people, plants, canals-rivers, animals, and machinery etc. You must have sometimes wondered that these millions of substances must be made of millions of elements.

But you will be surprised to know that these millions and billions of substances are made of only 98 elements. When you break down a substance and do not anymore get another substance other than that is called an element. In total, 118 elements have been discovered or created in laboratories so far. But the 20 elements other than the 98 are artificially created, and their quantity is so small in nature that even if they are not considered, it will not affect much.

A few common elements

Hydrogen	Hydrogen
Oxygen	Oxygen
Iron	Iron
Gold	Gold
Silver	Silver
Carbon	Carbon
Chlorine	Chlorine
Aluminium	Aluminium

The table beside enlists the names of some known

elements. We take in oxygen when we breathe. Iron is a very familiar metal. You've all seen aluminium cookware. Jewellery is made with gold and silver. Water is made of hydrogen and oxygen. So, even though hydrogen and oxygen are elements, water is not an element; it is a compound. Compounds are those substances that, when broken down, produce two or more elements. You will know more about this in the next chapter.

Electrons, Protons and Neutrons

There's more good news for those of you who think that just by having this list of 98 elements, you'll have a complete list of what everything on Earth is made up of. These elements are made up of their 'atoms', and those atoms are made up of only three particles, namely electron, proton and neutron.

So, it is no overstatement to say that the entire known world around you is made of only three basic particles. That's why, if you want to understand how this whole world is made, first of all you have to know how the atoms of these different elements are made with electrons, protons and neutrons.

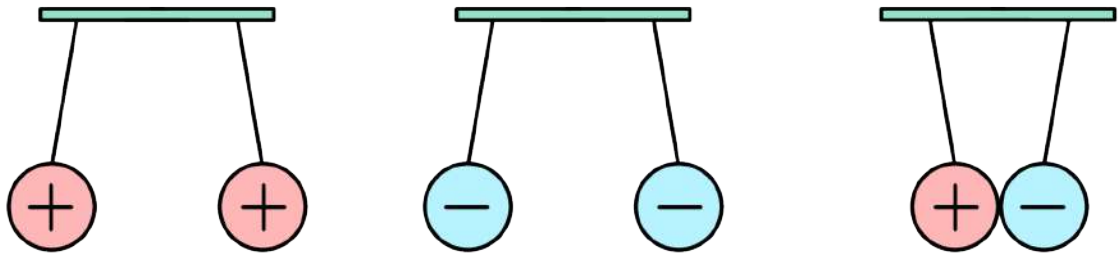
Structure of atoms

An atom is the smallest unit of an element made up of electrons, protons and neutrons. Atoms are so small that you can never see them, but if you could see, there is a very small nucleus made of protons and neutrons in the middle of atoms and electrons orbiting around them! In this one line, you are told about the formation of the atom; you cannot even imagine for how many thousands of years, how many hundreds of scientists have researched it to finally figure it out.

Whenever you see something moving, you have to understand that a force is pulling it towards you. The Earth revolves around the Sun because the Sun pulls the Earth, the Moon revolves around the Earth because the Earth pulls the Moon. Just like that, the very small nucleus in the centre of the atom pulls the electrons towards it, so the electrons revolve around the nucleus.

Now the question is why the very small nucleus inside the atom pulls the electron towards itself? The reason for this is electrical attraction. Neutrons indeed have no actual charge, but protons have a positive charge. So, the total charge of the nucleus is always positive. Electrons,

The logo of the International Atomic Energy Agency uses a picture of an atom. Although such pictures of atoms are used everywhere, the real atom does not look like this at all!



Same charges repel each other and opposite charges attract each other

on the other hand, have a negative charge and the characteristic of the electric force is that opposite charges attract each other (and the same charges repel each other). So, the electron revolves around the nucleus due to its attraction. You will read more about this electric force and energy; know more and use it in many ways later. For now, know that everything starts with the negative charge of electrons and the positive charge of protons inside an atom.

It can be said that by now we know the basic structure of the atom. In the centre of an atom, there is a very small nucleus made up of protons and neutrons, where protons have a positive charge and neutrons have no charge. Electrons revolve around this nucleus because electrons are negatively charged, and the positively charged protons in the nucleus attract the electrons towards themselves.

Atomic Number: As stated at the opening of this chapter, 118 elements have been discovered so far. These 118 elements have 118 different atoms. What is the difference between atoms? How are they separated?

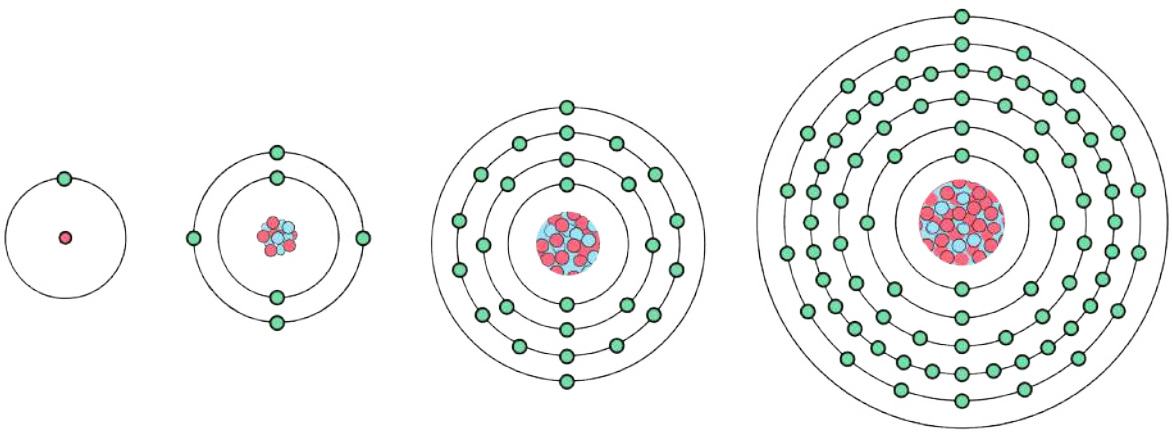
That method is really very easy! The first atom in the list has a proton in the nucleus, so there is an electron outside. Its name is hydrogen. The next atom has two protons (and two neutrons) in its nucleus and two electrons outside; its name is helium. The next atom has three protons (and three neutrons) in its nucleus, and so there are three electrons outside; it is called lithium. In this way, gradually, one proton in the nucleus and one electron on the outside have increased. The last atom found so far has 118 protons in the nucleus and 118 electrons on the outside (and the number of the neutron is equal or more than the number of protons in the nucleus). The number of protons in the nucleus of an atom is the atomic number of that atom.

You must have understood that the number of electrons outside an atom must be the same number of protons in that atom. Because protons and electrons have the same charge, only one is positive, and the other is negative. Therefore, if the number of both is equal, the total amount of positive and negative charge is zero

or no charge! You may think that since neutrons have no charge, it doesn't matter if the number is more or less. But still, there is a very important reason why the number of protons in the nucleus must be equal to or more than neutrons. You will get to know it a bit later.

Electron configuration: As we said, the number of electrons outside an atom must be the same number of protons in that atom. Naturally, we want to know how they are arranged. Are all the electrons randomly arranged in one place, or are they arranged in the way each planet orbits in the solar system?

Electrons are not actually randomly arranged at all; they are in fixed orbitals at fixed distances from the nucleus. But there is not only one electron in an orbital; there are many more, and the laws of physics have determined how many electrons will be there in an orbital. Just know that the energy of an electron depends on the orbital it occupies. So, orbitals can be thought of as energy levels. For example, if we think of an atom of gold, the orbiting electrons within it are very strongly bound by attraction to the nucleus. So, it takes a lot of force to move it. Again, the electrons in the outer orbitals are very weakly bound—they can be easily released! Gold is a very good conductor of electricity because it needs free electrons to conduct electricity.



There are 1, 6, 26 and 79 electrons in the atoms of hydrogen, carbon, iron and gold respectively and equal number of protons in the neucleus.

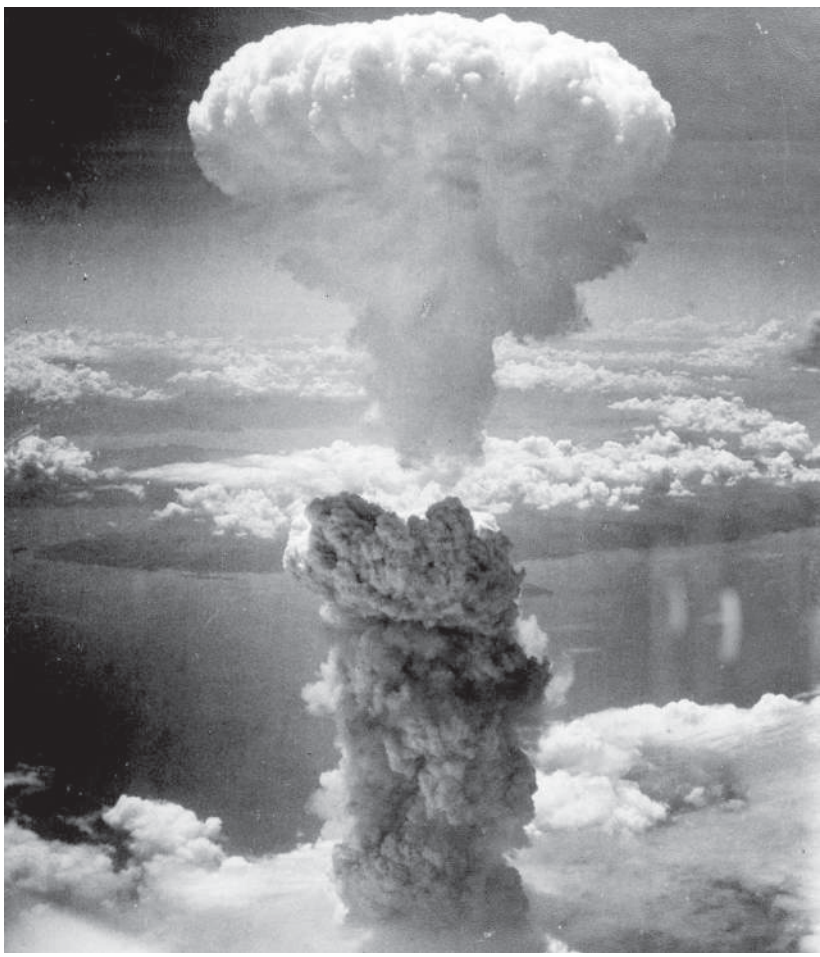
So, now you can roughly say two things. The larger the number of electrons in an atom, the larger its size; as more orbits are needed to arrange the electrons. Again, its characteristics are determined by means of how the electrons in the outermost orbit are arranged. That is why some atoms are metals, some are non-metals, some are gases, some are liquids or solids, some are inert, and some are highly reactive.

Nucleus

You must have noticed that every time we talk about the nucleus, you are reminded that the nucleus is very small. You will undoubtedly be surprised to hear how small it is compared to atoms. The radius of the nucleus is about a million times smaller than the radius of an atom. So, as for area, it is million × million × million times smaller! You can say that the inside of an atom is entirely vacant. If the vacant space could be filled up squeezing the earth, then the whole world could be placed on a football field!

So, the protons must be piled up in a very small space in the nucleus! In the meantime, you have known that in the case of electric force, opposite charges attract each other, but the same charges repel each other. So, the positively charged protons piled up in a nucleus repel each other strongly. To reduce this repulsion, the nucleus always has an equal number or more neutrons than protons. The number of electrons and protons in an atom of a particular element is fixed, but the number of neutrons is not exact; it can be more or less. The same element can have different numbers of neutrons. Each of them is called an isotope of the other. You will know them in more detail in the upper classes. Only an atom has no neutrons in its nucleus. That nucleus doesn't even have a second proton to repel. You must have understood that it's a hydrogen atom.

The mass of a neutron is very close to that of a proton and is about two thousand times more than the mass of an electron. That is, the electron is so light that actually, the mass of the atom is the mass of its neutron and proton or nucleus.



The explosion of the nuclear bomb in Nagasaki released a large number of radioactive rays.

Radioactivity: As we mentioned at the beginning of this chapter, although 118 atoms have been found so far, 98 are stable, while others are synthetically made and unstable. When we call an atom unstable, we mean its nucleus is unstable.

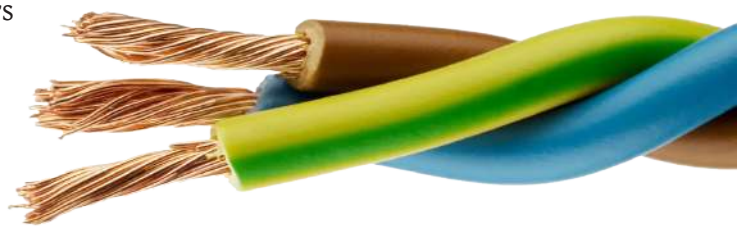
In the meantime, you have known that the nucleus cannot be formed from only protons because of the strong electric repulsion. It should have about an equal number or more neutrons. Even then, nuclei (plural of nucleus) are often unstable—and emit different types of rays. Such nuclei are called radioactive nuclei. During the explosion of a nuclear bomb, such radioactive rays are released and cause terrible destruction to human life.

The rays emitted from radioactive nuclei are called alpha, beta and gamma rays. You can know the structure and properties of these rays in the upper classes.

Conductors, Insulators and Semiconductors

In the meantime, you have known that everything around us is made of only 98 atoms found naturally. You now know the structure of these atoms- a very small nucleus in the centre and electrons orbiting it. The electrons are arranged in different orbits according to the rules. The electrons that are in the last orbital are the electrons that determine the property of the atom. Some atoms are completely inert, and some are terribly active. You will understand these things better by reading about how atoms are made up.

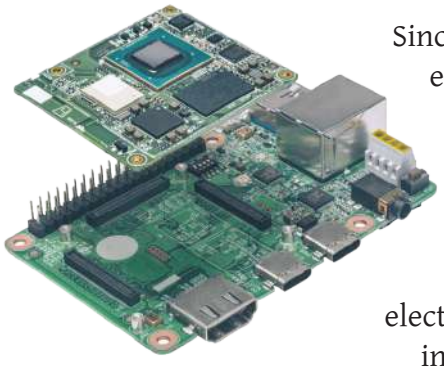
However, we have divided several atoms into two categories, namely metals and non-metals, by the properties of the last orbital of the atom. You all must be familiar with these two words. Gold, silver, iron, and copper are examples of metals. Metals have several properties. The most well-known properties are that they are conductors of heat and electricity. Now that you know the structure of atoms, you can now explain why metals are conductors of electricity and heat. Electrons in the last orbits of metallic atoms are usually very weakly bound or 'almost-free', and can easily move from one atom to another. Since heat and electricity are transported through these electrons, electricity can be easily transported through the almost- free electrons in the atoms of the metal.



Use of copper as electric conductor

So, you can explain the properties of insulators. Atoms of insulators have no almost-free electrons in their outermost orbits, so there are no electrons to conduct electricity. Sulphur, phosphorus, nitrogen are examples of insulators.

In addition to conductor and insulator atoms, some atoms are called semiconductors. Metals conduct electricity, so they are called conductors. So, from the word semiconductor, you can understand that these are a type of atoms that are not completely conductors, but in special conditions, they can be conductors. That's why they are called semiconductors.



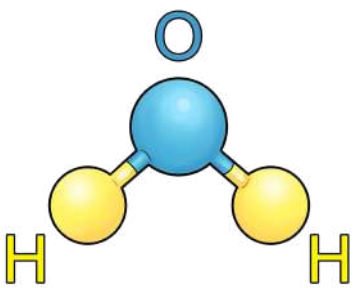
Use of semi conductor in electronics goods

Since you know the structure of atoms, you can now explain the structure of semiconductors if you wish. Such atoms do not have almost-free electrons to conduct electricity in the last orbital. But if the atom can be heated, the thermal energy can almost free an electron from the last orbital of the atom. That almost-free electron can conduct electricity. In other words, certain types of electric insulator atoms can be converted into electricity-conducting atoms by heating. Such atoms are called semiconductors. Silicon is one of the most widely used semiconductor atoms.

Electronics have played a vital role in today's civilization. Without semiconductors, this electronic technology would never have been developed so wonderfully.

Molecule

The Bengali alphabet has only 40 different letters, but these 40 letters can make many words. In the same way, only 118 different atoms can be used to make many molecules, and these molecules are the smallest units of matter that have all the properties of compounds. A molecule is called a molecule if chemical bonds join two or more atoms.



A water molecule has two hydrogen atoms attached to one oxygen atom.

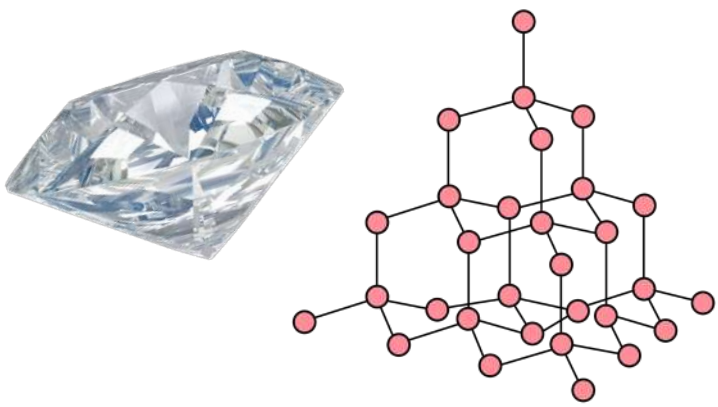
For example, water is made up of oxygen and hydrogen gases. If we take a drop of water and divide it, eventually, we will reach a point of water

where the properties of water will be found. If we try to divide it further, it will no longer be water; it will split into two hydrogen atoms and one oxygen atom.

Both elements and compounds can have molecules. In the case of our familiar hydrogen, oxygen or nitrogen gas, they do not exist as separate atoms. Always two atoms are united as a single molecule.

Atoms don't usually remain free; they bond with other atoms and form molecules or compounds. But there are some exceptions. You know that the arrangement of electrons in the last orbital of the atom determines how active the atom will be. The number of electrons in different orbitals of an atom is determined by the laws of physics. So, if the number of electrons possible in the last orbital is filled, then the atom does not want to join with other atoms by exchanging electrons. So those atoms are called inert atoms and they remain as gases. Examples of such inert gases are helium, argon, neon, xenon etc. These gases remain as free atoms rather than remaining as molecules or compounds by bonding with other atoms.

Again, many atoms of elements are grouped together, but they do not always form molecules. In metals such as gold, silver, or iron, the atoms are tightly bound together, and the almost-free electrons in their outer orbitals move about within the atoms, but they do not form molecules. Again, in the case of a diamond, the carbon molecules bond with each other to form crystals, but no molecules are formed.

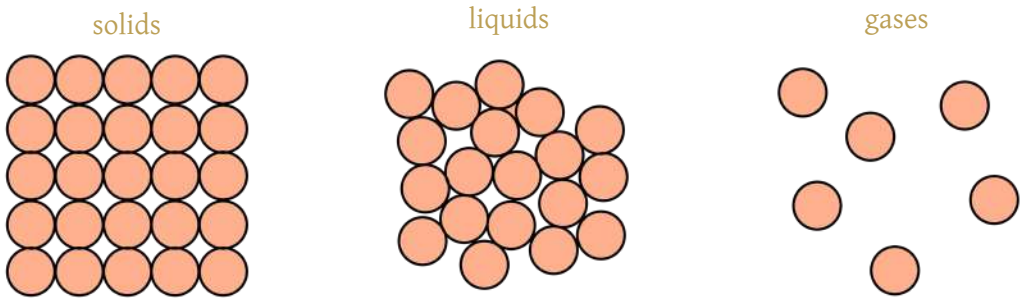


In diamond, the carbon atoms are arranged in a specific pattern inside the crystal.

Solid, liquid and gas

Substances have a mass and occupy some space. At standard temperature, some substances are solid, some are liquid, and some are gaseous. Changing the temperature can convert the same substance into a solid, liquid or gaseous state.

You have already learned that a substance comprises very small particles called molecules and atoms. Whether a substance is solid, liquid or gas depends on how these particles are in that substance. A familiar example is water, which is the same substance but can exist as a solid, liquid, or gas at different temperatures. Whether it is ice, water or vapour depends on the state of its molecules.



Particles of solids, liquids and gases

Solid: The particles of a solid substance remain very close and in fixed positions, one cannot move relative to the other. So, the solid substances have a fixed shape. Because of their proximity, they do not compress and flow like gases or liquids when pressure is applied to solids.

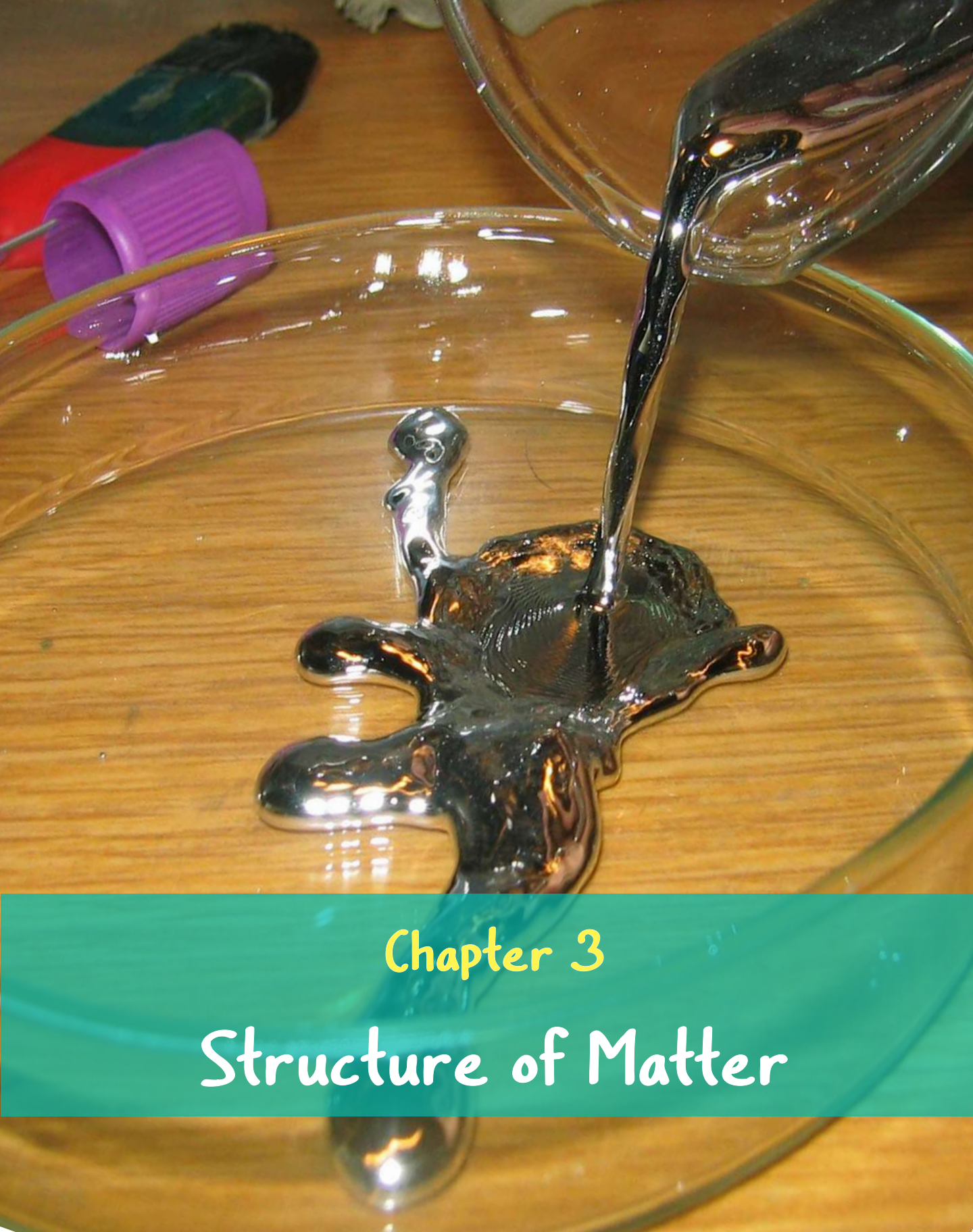
Liquid: When a substance is in a liquid state, the particles are relatively close, but one particle can move relative to another. So, they have a definite volume, but no regular shape and the liquid flows easily. Liquid takes the shape of the container in which the liquid is kept. There is no space among the particles of liquid substances. So, pressure cannot compress liquid because the substances remain very close.

Gas: When a substance is in a gaseous state, its particles are free and far apart. Hence, they have no regular shape or volume. The gas occupies the entire container volume in which it is kept. As there is a lot of space among the gas particles, gases can easily be compressed by applying pressure. Gases flow easily because gas particles can run relative to other particles.

Exercise ?

1. 1 teaspoon holds approximately 1 cc of material. The mass of one liter of water is 1 kg, so 1 cc of water weighs 1 gram. Then, can you estimate the mass of the nucleus of a teaspoon of water?

2. If you could discover the atom with atomic number 119, what would you name it? Why?



Chapter 3

Structure of Matter

Chapter 3 Structure of Matter

By the end of this chapter students will be able to learn—

- ☑ structure of Matter
- ☑ difference between atom and molecule
- ☑ difference among elements, compounds and mixtures
- ☑ identification of pure matters
- ☑ identification of specific elements and compounds using symbols and formulae

In different spheres of our daily life, we use various objects like air, water, iron, food, books etc. They look different. Some are gases; some are liquids; some are soft, some are solid, some are heavy, some are light, some are shiny—you cannot finish saying. The reason for these different forms of matter is their composition. Since the composition of substances is different from each other, they look different and have different properties. Substances are used in various applications according to their properties.

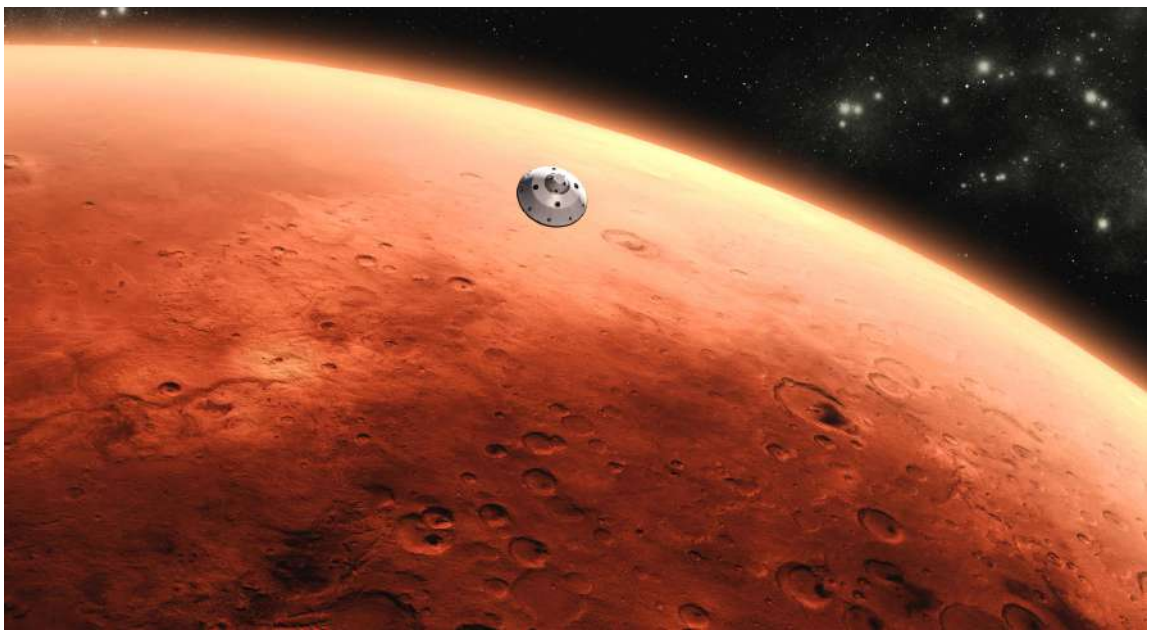
Elements

Let's look at the structure of some of our most commonly used matters. In this case, we can talk about iron and copper first. No matter how you break pure iron, you will find nothing but iron there. A substance that, when broken down, does not create any substance other than that substance is called an element. Like iron, copper is an element because no matter how broken a piece of copper is, we will find nothing but copper in it. The oxygen we take in for our breath is also an element because no matter how much this gas is divided, nothing but oxygen can be obtained. Iron and copper, gold or silver or hydrogen or nitrogen are made up of only one component and they are also elements.

Compounds

If we break down an element, we get only that matter. You already know that if water is broken down, we will get oxygen and hydrogen, two different elements. It is because water is not an element; it is a compound. That is, the matters that can be broken down into two or more elements are called compounds. The properties of a compound can be completely different from the properties of the element from which the compound is made. Water is a liquid, but oxygen and hydrogen are gases. Like water, salt and sugar are compounds. Salt is made from the elements sodium and chlorine; sugar is made from carbon, hydrogen and oxygen.

Who does not know about rust on iron? If a rod made of dark-grey iron (an element) is left outside for a few days, a red or brown layer called rust will appear. In fact, in the presence of steam, the element of iron reacts with oxygen and forms a compound called rust or iron oxide.



Mars is red in colour due to the presence of reddish iron oxide.

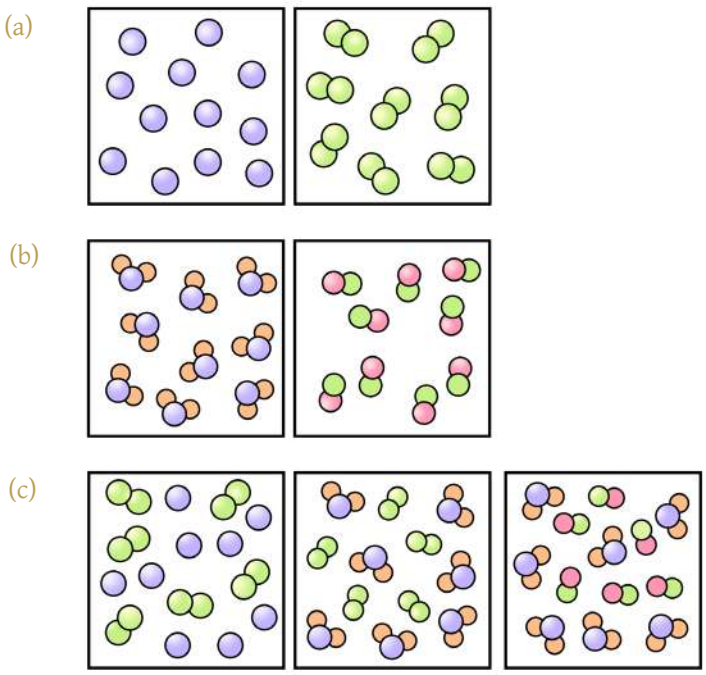
Mixtures and pure matters

Mix some salt in a glass of water and stir. Here, mixing two or more matters like salt and water is called a mixture. Although salt and water are mixed, they retain their properties within the mixture. That is, a mixture consists of two or more different matters that do not combine with each other. Different matters of the mixture may remain as elements or compounds. Similarly, air is also a mixture, where various

matters like nitrogen, oxygen, carbon dioxide or steam etc. exist. Note that in a mixture of salt and water, both water and salt are compounds. On the other hand, air is a mixture in which both elements and compounds exist.

Nitrogen, and oxygen are the elements; carbon dioxide and steam are compounds.

A mixture consists of two or more different matters which are not chemically linked. On the other hand, by pure matter, we mean that it consists of only one component or a compound. The word pure is used here in a different way from its everyday meaning. For example, when a store sells 'pure' mango juice, it means that it contains only mango juice, with no other matters added. However, 'pure' mango juice is not pure in the chemical sense, as it contains various matters mixed together.



(a) Atoms and molecules of an element

(b) Two types of molecules of a compound

(c) Mixtures of elements, mixtures of elements and compounds and mixtures of compounds with compounds

Identification of pure matters

The physical properties of a matter are properties that can be observed without changing the actual form of the matter. Colour, smell, density, melting point, boiling point and solubility are examples of physical properties.

Physical properties can be used to identify a pure matter. For example, pure matters have a specific melting point, but mixtures do not. So, by measuring the melting point, we can say whether a matter is a mixture or a pure matter. If the components of a mixture need to be separated, they can usually be separated without chemical reactions.

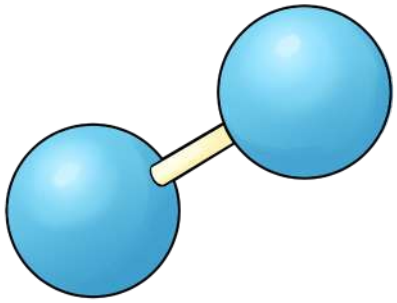
So, we can divide the different types of chemicals as:

Element: Elements contain only one type of atom. For Example, Gold, Silver, Oxygen, Nitrogen.

Compound: A compound consists of two or more atoms joined together. For example,water, salt, carbon dioxide etc.

Mixture: A mixture consists of two or more different matters that are not joined. We can divide the mixture into three parts.

- Mixture of different elements, such as the mixture of oxygen and helium.
- Mixture of different elements and compounds, such as Air: mixture of oxygen, nitrogen and carbon dioxide.
- Mixture of different elements and compounds, such as the mixture of water and salt



Oxygen molecule is formed with two oxygen atoms.

Atoms, molecules and compounds

Scientist Dalton first stated in his atomic theory that a matter is made up of extremely small particles called atoms. Atoms, with exception to inert gases cannot normally remain free or independent. They combine and form molecules. An atom is the smallest unit of a matter that retains the properties of an element.

A molecule can remain free or independent. In the case of a compound, a molecule is the smallest unit (particle) that carries that compound's physical and chemical properties. In the case of elements, only atoms of the same matter combine and form molecules. For example, two oxygen atoms combine and create an oxygen molecule.

Atoms and symbols

From the previous lesson, you have learned that 118 elements have been discovered so far, out of which 98 are found in nature, and the remaining 20 are artificially created. Each element has a name. We use symbols for each of them to express them concisely and easily. Usually, the symbols are expressed by the first one or two letters of the English or Latin name of the element. Capital letters are used to express a symbol with a letter. In the case of expressing a symbol with two letters, the first will be in uppercase and the second in lowercase. If two or more elements have the same first letter of the English name, then one element is represented by the first letter of the name (in the upper case of the English alphabet). In others,

the symbol is written in two letters. Examples of the symbols of some atoms and their English or Latin names are given.

Molecule and Formula

We have learned that molecules are made up of two or more atoms. The number of atoms in a molecule is known from the formula. A formula is an abbreviation for a molecule. A formula is written with the signs of the atoms that make up the molecule. Now we will know the rules of writing a formula and what is understood from the formula.

Examples of elements

The elements that normally remain in liquid and solid states have numerous atoms packed together, but they do not form any molecule. So, as molecules, there is no formula for the elements such as sodium, copper and iron. But except for a few inert gases, in most gaseous matters, two elements combine and form a molecule. As a result, as a sign of these elements, 2 is written as a subscript with their symbols. For example, the symbol for oxygen is O_2 and the symbol for nitrogen is N_2. However, there are some elements which combine two of their atoms and form a molecule even in solid and liquid states. Their formulae are also written exactly as before. For example, the symbol for bromine (liquid) is Br_2.

Examples of molecules and compounds

Water: From the formula of the compound, we know that the compound is made up of atoms of any element and what the ratio of atoms of those elements in that compound is. For example,

Naming of elements (English name)

Element	English Name	Symbol
Hydrogen	Hydrogen	H
Oxygen	Oxygen	O
Nitrogen	Nitrogen	N

Naming of elements (Latin name)

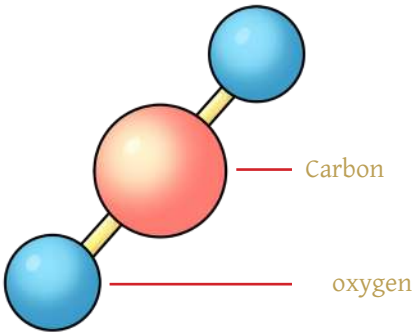
Element	Latin name	Symbol
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Gold	Aurum	Au
Silver	Argentum	Ag
Sodium	Natrium	Na

Naming of elements (First letter same)

Element	English Name	Symbol
Carbon	Carbon	C
Chlorine	Chlorine	Cl
Calcium	Calcium	Ca

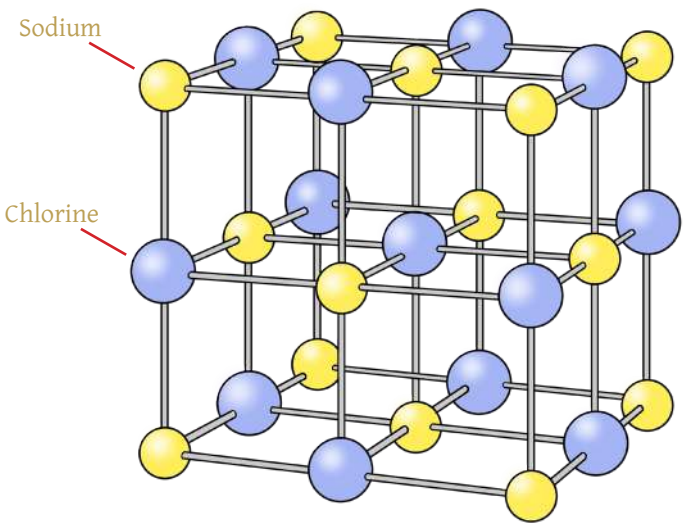
Element	Symbol	Formula
Hydrogen	H	H_2
Nitrogen	N	N_2
Oxygen	O	O_2
Florine	F	F_2
Chlorine	Cl	Cl_2
Bromine	Br	Br_2
Iodine	I	I_2

from the formula H_2O, we understand that a water molecule is formed by combining two hydrogen atoms and one oxygen atom.



The molecules of carbon dioxide are made up of one carbon and two oxygen atoms.

Carbon dioxide: Another gas we know is carbon dioxide. When we breathe, we take in oxygen, giving up carbon dioxide. Due to the increase in carbon dioxide in the atmosphere, the temperature of the Earth is increasing through the greenhouse effect, and the climate of the world is changing terribly. The molecule of carbon dioxide is made up of carbon and oxygen atoms. This molecule consists of one carbon atom and two oxygen atoms. The symbol for carbon is C, for oxygen is O, so the symbol for carbon dioxide is CO_2. Carbon and oxygen atoms form another molecule called carbon monoxide. Carbon monoxide has an oxygen atom attached to a carbon atom and is symbolized as CO. Carbon dioxide gas is a fairly harmless gas, but carbon monoxide is a highly toxic gas. So, you can see that you can make a very common molecule using the same atom. Similarly, you can make a completely different molecule of a very toxic gas.



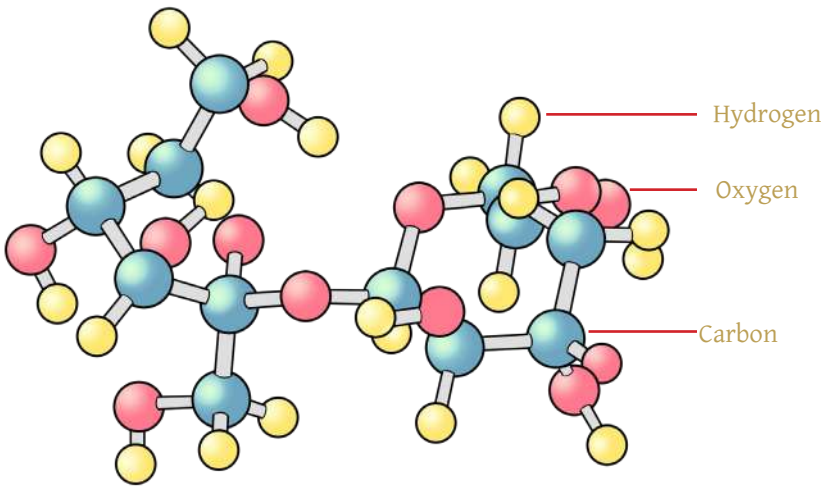
Well-formed crystal of sodium and chlorine in salt.

Salt: We have discussed the properties of water and various gases as a liquid. Now we will give examples of the properties of solids. We all use salt with our food every day. Salt is made up of sodium (Na) and chlorine (Cl) atoms. Since salt compounds contain one sodium and one chlorine atom, the formula for salt is NaCl. Molecules in liquids or gases do not have a fixed position, so they are constantly moving. But in solids, the molecules are stuck in certain places. Salt has a surprising property in that respect. The salt molecules are not randomly arranged but very neatly arranged as chelates or crystals.

The sodium atom is a highly reactive metal that can catch fire when exposed to open air. Again, it reacts violently with water, so sodium must always be immersed

in kerosene. Similarly, chlorine is also a highly reactive and toxic gas. But you all know that sodium and chlorine atoms combine to form a compound called salt or sodium chloride. This compound is not a reactive or dangerous matter at all. We eat salt daily, which is an essential matter for our body. Also, sodium and chlorine are so tightly bound in salt cells that sodium and chlorine can't be released suddenly and create any danger.

Soda: We have, so far, given examples of a molecule made up of only two atoms. But it is possible to form a molecule with more than two atoms. For instance, washing soda comprises sodium, carbon and oxygen atoms. The scientific name of washing soda is sodium carbonate, and its formula is Na_2CO_3. So, looking at the formula, you can guess that the molecule of sodium carbonate has two sodium atoms, one carbon



The molecule of sugar is made up of carbon, hydrogen and oxygen

atom and three oxygen atoms.

Sugar: We are all familiar with sweet sugar. Because we like to eat sweets, we often suffer from various health problems due to consuming too much sugar. The molecule of sugar is made up of carbon (C), hydrogen (H) and oxygen (O) atoms. The formula for sugar is ($C_{12}H_{22}O_{11}$) and as you can see, the sugar molecule has 12 carbon, 22 hydrogen and 11 oxygen atoms. It comprises the most atoms of all the examples you have been given so far!

Hydrochloric acid: You all must have heard the word acid more or less. Lemon juice or vinegar contains weak acids, and we use them in food. In addition, there are some very strong acids that can dissolve iron and can burn the skin immediately if it comes in contact. Some such acids are hydrochloric acid, sulfuric acid and nitric acid. These acids must be used carefully; no one can buy them from the market if they want.

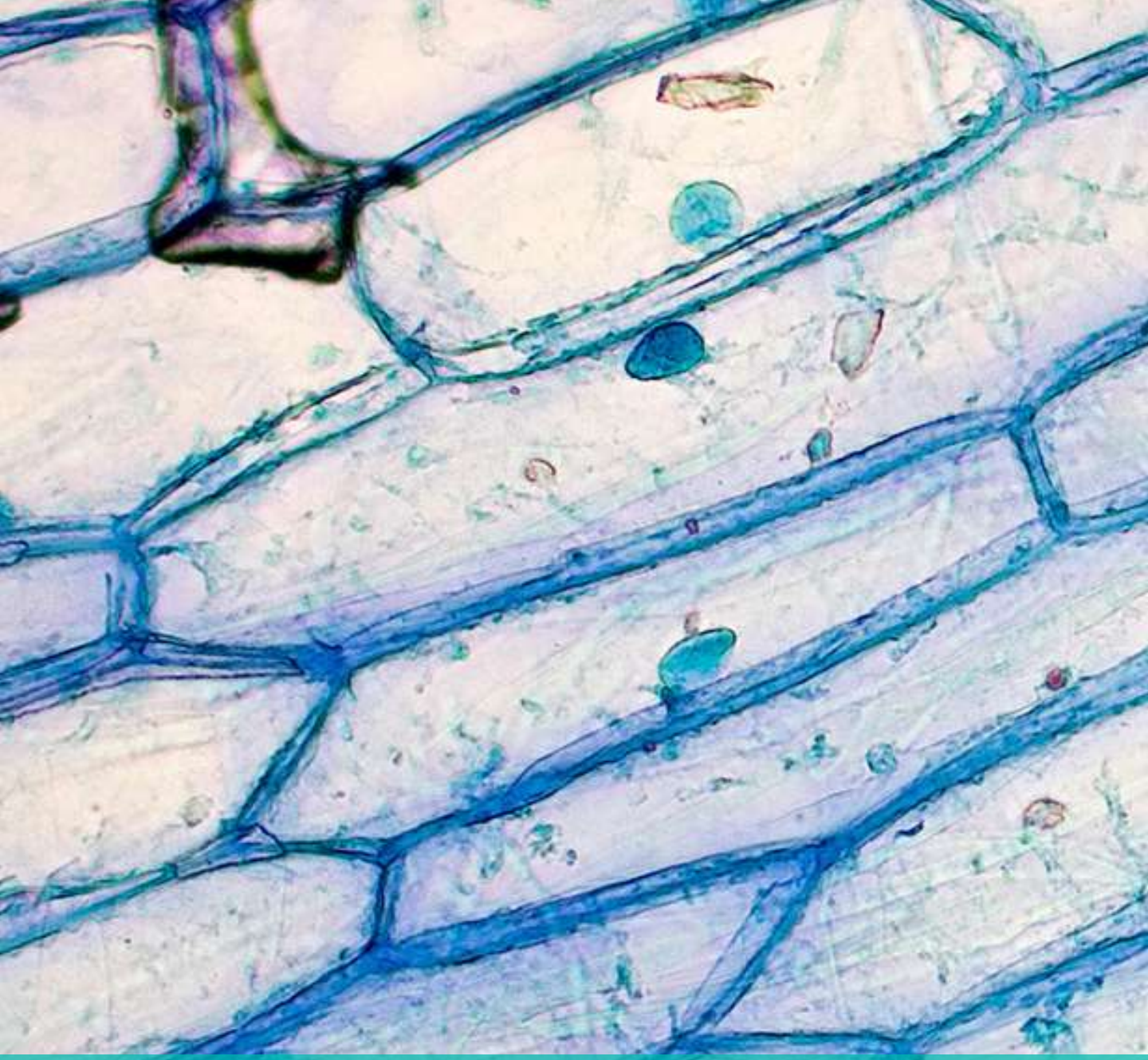
But do you know a wonderful thing? Among these three hazardous acids, one acid is carried by you although you may not know and you are using it all the time. Hydrochloric acid is made up of one hydrogen (H) atom and one chlorine (Cl) atom. Its formula is (HCl). Your stomach contains this acid to digest food. Although it burns the skin on contact with the skin, it can be stored in the stomach without damaging its covering.

While talking about elements, compounds, molecules and atoms, we have tried to give examples of the known matters only. These matters are around you, and you use them daily or regularly. When you are in the upper classes, you will learn more about elements, compounds, atoms, molecules and the various chemical bonds within them. For example, you will know that the water molecule always has two hydrogen atoms along with one oxygen atom. Why not more or less than two? Similarly, you will know why a chlorine atom is always attached to a sodium atom in a salt molecule. Why not more or less?

The more you will study science, the more wonderful mysteries of nature will be revealed to you.

Exercise ?

1. Atoms are fundamental substance, but fundamental substances are not always atoms. Is it true? Give examples if true.



Chapter 4

Cell Science

Chapter 4 Cell Science

By the end of this lesson, students will be able to learn—

- ☑ structure and function of the major organelles of plant and animal cells
- ☑ cell division and multiplication
- ☑ consequences of abnormal cell division

Looking outside the school and house, you will see how many kinds of life are around us! There are small trees, colourful birds, pets, and people. These creatures grow from small to large before our eyes. An inanimate object (for example book, pen, or house) does not grow by itself. But an organism grows little by little over time. How does this happen? To find the answer to this question, we must go back to smaller levels. We have to know the identity of the structural unit of life.

You must have known that cells are the structural unit oforganisms. All the organisms we see, small and large, have cells as their structural unit. As organisms grow, they need to make new cells. How are these new cells made? How does the number of cells increase, keeping the characteristics of organisms? Such questions come to our minds naturally. Scientists have thought about these questions, and it is a matter of joy that they have found the answers through research. We will discuss those issues here. We will know the identity of cells, the method of their multiplication, if there is any mistake in the process of cell multiplication, what the consequences are for the organism, etc. But before that, we need to know about the cell's structure, elements, and properties.

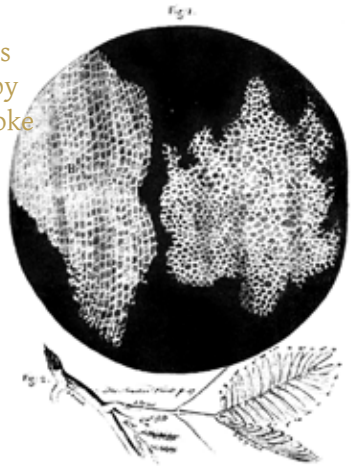
Introduction to Cell

All living things are made up of cells. The English word 'Cell' literally means a small room or chamber. The cell was named by the scientist Robert Hooke, the inventor of the microscope. He was observing the cork (a type of wooden stopper used to close the mouth of a bottle) of the bottle after inventing the microscope. He used the power of the microscope to see what could not be seen with the bare eye. The

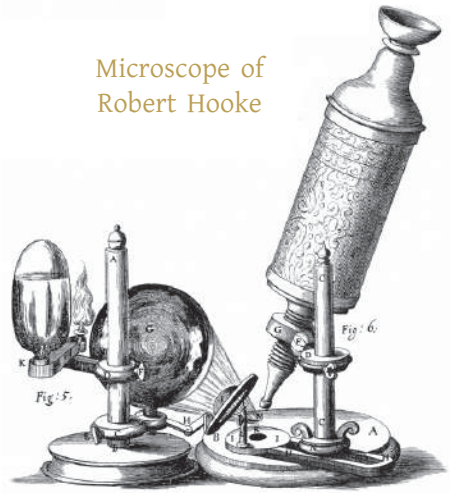
cells of the cork's wood were arranged like small houses, one after another. So, Robert Hooke named them cells.

Just as we see a large house built brick by brick, cell after cell joins together and forms the body of a multicellular organism. The body of multicellular organisms can

Cork cells viewed by Robert Hooke



Microscope of Robert Hooke



Robert Hooke observed plant cells using a microscope

have billions of cells. However, cells vary in shape and function in different organs and at various stages of growth of the body of an organism. For example, brain and kidney cells in the human body look different; their functions are also different. But their structural elements are almost similar. We will discuss these elements a bit later.

A cell is called the structural and functional unit of an organism. That is, an organism's unit of the physical structure is the cell, and the cell is also the primary place for any of its work to be completed. There are some organisms that are unicellular, such as bacteria, amoeba, yeast, etc. Unicellular organisms are so tiny that they cannot usually be seen without a microscope. All organisms we see with our bare eyes are multicellular. For example, plants, humans, poultry, etc. are all multicellular organisms. These organisms are made up of many cells.

Although different organisms look different, the basic components of the cells that make up their structure and function are the same. Cells of all organisms are made

Carbohydrate is a type of organic chemical substance in which each molecule consists of carbon (C) with hydrogen (H) and oxygen (O). Here, the ratio of hydrogen atoms to oxygen atoms is 2:1, just like water. It acts as the main source of energy in the body of an organism.

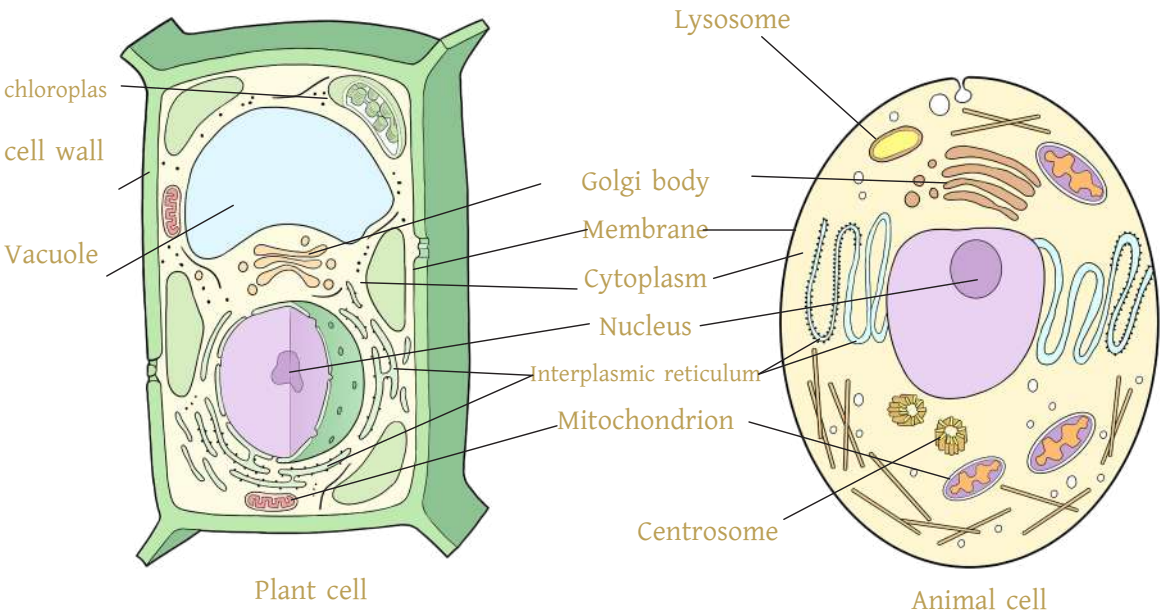
Lipid is the name of an important biochemical substance in living organisms, which consists of carbon, hydrogen and oxygen. The main functions of lipids are to store energy, act as structural components of cell membranes, etc.
Protein is a type of large-scale organic molecule, which is formed by the chemical connection or bond between several amino acids (a type of organic molecule). Different proteins perform and control different functions inside the body of an organism.

of organic molecules called carbohydrates, lipids and protein.

For example, there are some structural differences between plant and animal cells. Even the cells of various parts of the human body have different characteristics in terms of structure and function. Small portions of a cell are called organelles. Below we will learn about the function of various organelles in plant and animal cells.

Structure and function of the major organelles of plant and animal cells

Although cells are tiny in size and volume, their structural components are very diverse. And the range of work of these structural components of the cell is also vast. Some of the most important cell parts seen in the electron microscope are- (a) cell wall, (b) cell membrane, and (c) protoplasm. Their structure and function are



described briefly -

(A) Cell wall: Cell wall is a unique feature of plants and some microbial cells. The tough covering on the outermost part of the cell is called the cell wall. Animal cells do not have cell walls. The main chemical component of the cell wall of plant cells is a carbohydrate called cellulose. At the same time, a type of organic material called lignin (which helps build the key structure of most plants) is found in plant cell walls.

On the other hand, the main components of a bacteria's cell wall are some proteins and lipids. The cell wall of fungi contains a type of carbohydrate called chitin. Thus, although many organisms have cell walls, their structural components vary somewhat.

The cell wall gives the cell its specific shape, protects the internal material from external adverse conditions, provides the necessary rigidity to the cell and helps in the absorption and transport of water and mineral salts. The wall keeps internal components of two cells separate although the cells remain connected because of the same wall.

(B) Cell /plasma membrane: Cell membrane keeps the cell safe. So, it is a two-layered flexible covering or membrane that surrounds the cell and keeps the internal components of the cell separate from the external environment. It is mainly composed of lipids and proteins. Since animal cells do not have a cell wall, the cell membrane is the outermost layer of the animal cell. On the other hand, this membrane is located just below the cell wall in cells with a cell wall. One of the main characteristics of the cell membrane is that not all substances can pass through them from the inside of the cell or enter from the outside. Instead, only certain substances can pass through this membrane from outside the cell to inside the cell.

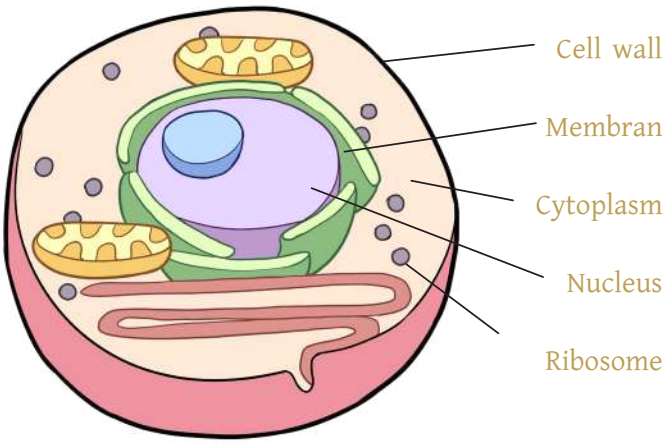
(C) Protoplasm: The transparent, thick and jelly-like substance of the cell surrounded by cell walls and membranes is called protoplasm. Protoplasm contains 75 to 95 percent water. All the biochemical functions of the cell are done in the protoplasm. Protoplasm is mainly divided into two parts. They are 1. Nucleus and 2. Cytoplasm.

Those who have read the fairy tale in 'Thakurmar Jhuli' must have seen that it is tough to kill the monster in the story because its soul is hidden inside a bee kept in a small container in the middle of a big deep pond. The identity of cytoplasm and nucleus can be understood very easily by remembering the tale of the big deep pond and the container in it.

If we think of the cell's protoplasm as the story's pond, the container at the center of the pond is the cell's nucleus, and the pond's water is the cell's cytoplasm. Besides, the chromosomes inside the nucleus can be compared to the bee. Notice, even though the container is inside the pond, it has its own boundaries, and cover. The same is true of the cell nucleus.It also has its own membrane that separates

it from the cytoplasm. This time we will go beyond the fairy tale and know this structural feature in more detail.

1. Nucleus: The nucleus is a thick, non-transparent organelle surrounded by a double-layered membrane in various cells' protoplasm. Not all living cells have a nucleus. Cells whose nucleus is well-structured, i.e. surrounded and organized by a nuclear membrane, are called Eukaryotic cells. There are two types of Eukaryotic cells: body and reproductive cells. On the other hand, cells that do not have a well-formed nucleus are called prokaryotic cells. For example, bacteria are a type of protocell.



The protected location of the nucleus in the cell. The nucleus has its own membrane that separates it from the rest of the cytoplasm.

Robert Brown (1831) discovered and named the nucleus in the cells of the orchid leaf. Each cell usually has a nucleus. However, some algae and fungi have multiple nuclei in one cell. The nucleus is mainly located in the center of the cell, and depending onthe cells, the nucleus is usually spherical, ellipsoidal or cylindrical.

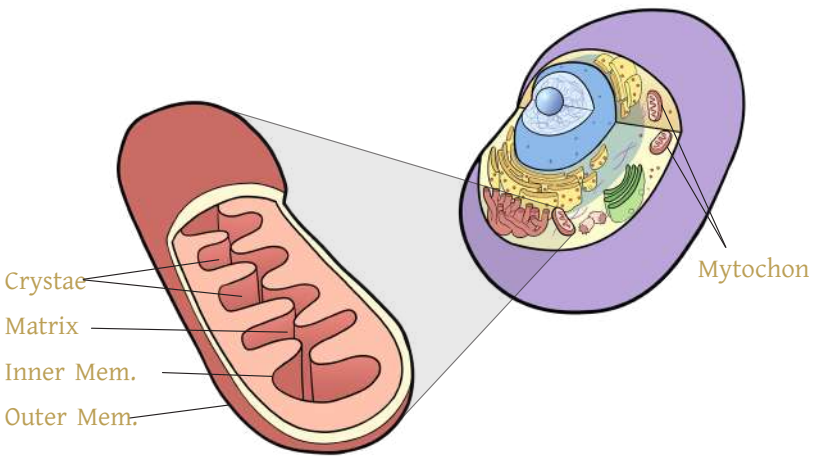
The nucleus is the control center of all cell activities. Inside the nucleus is a special object called a chromosome (much like the bee fly in the story above), which controls the genetic characteristics of the organism.In fact, this chromosome contains DNA (Deoxyribonucleic acid), the genetic material of organisms. If there is any damage to the DNA i.e., chromosomes, it also brings harmful consequences for the organism. So, it is located inside the nucleus to protect the DNA. Inherited characteristics of parents are passed on to offspring by maintaining continuity of structure and function of DNA.

2. Cytoplasm: The remaining part of the protoplasm located outside the cell nucleus and surrounded by the cell membrane is called cytoplasm. It is mainly composed of proteins. The cytoplasm is not an empty space. When viewed with an electron microscope, several types of organelles can be seen in this cytoplasm. These are Mitochondria, Ribosome, Golgi body, Endoplasmic reticulum, Vacuole, Lysosome, etc. In addition, plant cells have plastids, and animal cells have centrosomes and centrioles.

The cytoplasm contains these organelles of the cell. In addition, various important biochemical processes for the cell, such as energy production, resistance to microbial attack, sensitivity to the environment (for example, read about vacuole in the box given beside) etc. are all done in the cytoplasm. All the chemical reactions in the body of any organism are collectively called Metabolism. Cells must maintain a certain acidity or alkalinity level to carry out metabolic processes. The cytoplasm also controls the acidic or alkaline state of the cell.

We often use the leaves of the Touch-Me-Not (shameplant) as an example to show that plants have feelings, or that plants are sensitive. Do you know the reason? Cell vacuole has a great role behind this.There are many cells at the base of the leaf of Touch-Me-Not. The vacuoles of all those cells are filled with water. Due to waterlogging, the leaf stalks of Touch-Me-Not plants are straight. But suddenly when the leaves are touched, the water goes out of the cells. As a result, the swollen cells become flaccid and the Touch-Me-Not leaf stalks droop downwards. This effect gradually affects the cells of all the leaves and thus all the leaves droop down.

As mentioned earlier, several essential organelles reside in the cytoplasm. But in this category, we will not know the identity of all of them in detail. We will discuss the structure and function of only two organelles - mitochondria and chloroplast. We will learn about the rest of the organelles in the upper classes.



Mitochondria inside a cell. The position of matrix, membrane etc. is shown here.

Mitochondria:

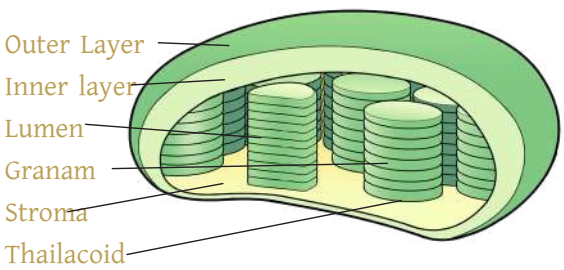
It is an essential organelle located in the cell's cytoplasm where several steps of energy production are completed in the process of respiration. In respiration, the organism's usable energy is generated by breaking down the glucose molecules inside the cells. You will learn more about this process in the bioenergy chapter of this book. Mitochondria play this important role

in energy production and are called the cell's powerhouse. Both plant and animal cells contain mitochondria.

A two-layered membrane surrounds each mitochondrion (plural form mitochondria). This membrane is made up of proteins and lipids. The outer covering of the mitochondrial membrane is smooth, but the inner cover is folded in places and hangs inwards. These folds are called cristae. The semi-fluid granular material inside the mitochondria is called a matrix. The important point is that mitochondria have their own DNA, which stays in their matrix. The number of mitochondria in a cell can range from hundreds to thousands. Carl Benda named mitochondria in 1898.

Plastid: Plastid is a unique feature of plant cells. Small, granular plastids of various sizes are found within the cytoplasm of plant cells. Due to its presence, the plant's leaves, flowers, and fruits show different colours. Plant cells generally have three plastids: chromoplast, chloroplast, and leucoplast. A plastid carrying colours other than green, such as red and yellow, is called chromoplast. Flower petals and fruits contain chromoplasts. That is why flowers and fruits are seen in different colours due to the presence of chromoplasts. The plastids which are colourless in plants are

Different types of plastids.



Detailed structure of chloroplast.

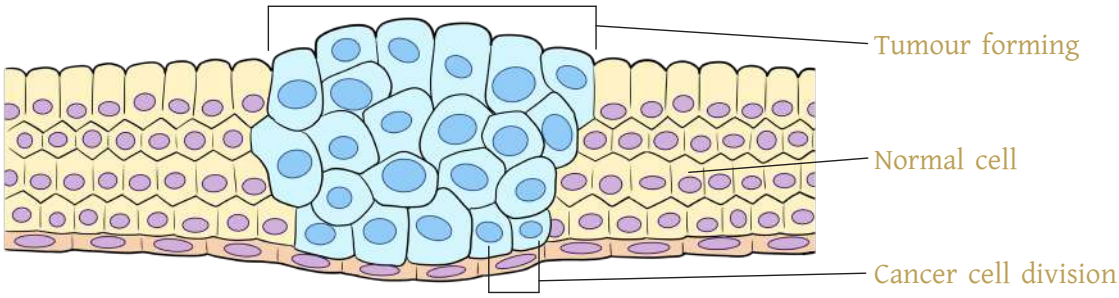
called leucoplast. Leucoplasts are present in underground parts, underground stems, roots of plants,etc. They store food.

The most important plastid in plants is the chloroplast. Chloroplasts contain green molecules called chlorophyll. Leaves and young branches of plants appear green due to the presence of chloroplasts. Photosynthesis, the process by which most living organisms, including humans, get their energy, occurs in the chloroplast. That is why chloroplasts occupy a particular position among all the cell organelles. Only plant cells have chloroplasts, not animal cells.

Like mitochondria in cells, chloroplasts have their own DNA. So, if the question is, which other cell organelles contain DNA apart from the nucleus, then the names of mitochondria and chloroplasts will come up. Scientists are now doing a lot of research on the DNA of mitochondria and chloroplasts in addition to the nucleus to achieve characteristics such as increasing crop production, disease resistance, etc.

Cell division and multiplication

An organism needs its cells to multiply for physical growth. Cells increase in number through division. That is, one cell divides into two, two into four, and so on. Somatic cells are needed for the formation of the body of organisms. On the other hand, reproductive cells are required for reproduction. The process by which cells divide in higher organisms, such as humans, is called mitosis cell division. On the other hand, the process of making reproductive cells is called meiosis cell division.



Abnormal cell growth can lead to cancer.

Consequences of abnormal cell division

Cell division is a highly regulated process. Any organism wants its cells not to grow uncontrollably. The cells must have normal characteristics not only in terms of number but also in terms of quality. If a cell increases in number with abnormal characteristics, it can have fatal consequences for the organism. An important example of such harmful consequences is cancer. In the process of mitosis, cells are divided into one to two, and two to four. Cells die at a particular stage in the process of multiplication. In this way, a balance is maintained in the number of cells in the organism. But if, for some reason, the cell does not die, but new cells continue to form, the body can develop a tumour, which at some point takes the form of cancer.

We have learned above about the formation of reproductive cells in the process of meiosis. A gamete needs to have a certain number of chromosomes. If a cell has more or less chromosomes than usual, then these germ cells will give birth to children with abnormal characteristics. Some of the many symptoms include difficulty expressing language, problems sitting and walking, and behavioural-emotional problems. You and your friends can make a change in your area by helping those around you who have similar issues.

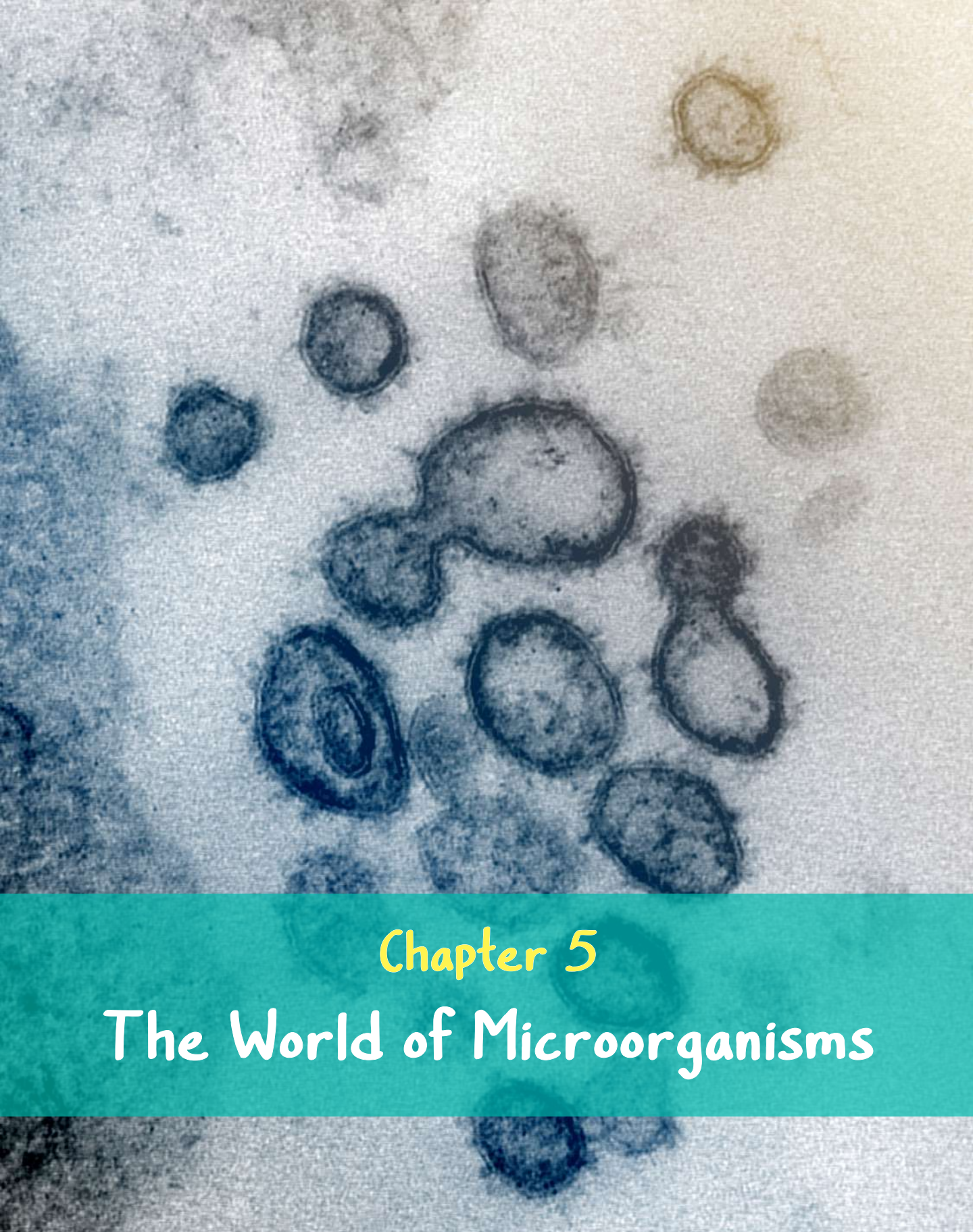
From this discussion, it can be said that normal cell division is essential for normal reproduction and growth of organisms.

Exercise

?

1. What difference do you find most attractive between a plant cell and an animal cell? Why?

2. Cells die at a certain stage in our body. If they do not die on time, what problems can we have? Why does this irregularity occur, and what should we do to prevent it?



Chapter 5
The World of Microorganisms

Chapter 5 The World of Microorganisms

By the end of the lesson, students will be able to learn—

- ☑ microorganisms and classification of them
- ☑ introduction to some common microorganisms
- ☑ virus and bacteria
- ☑ fungi, algae and amoeba
- ☑ microbes living inside organisms

At the very beginning, let's start with an interesting food item. You must have eaten yogurt. If you go to any grocery or sweets shop, you will get yogurt there. Even many of our parents or elder siblings can make yogurt at home. Do you know how to prepare yogurt? Those who make yogurt might say that yogurt is made from milk. They are not mistaken in saying so- but there are some invisible artisans whom we cannot see behind the preparation of yogurt from milk,. They turn the liquid milk into yogurt. These invisible artisans are none other than one (or more than one) type of microorganism. In this chapter we will learn about the world of surprising microorganisms that we cannot see with our bare eyes.

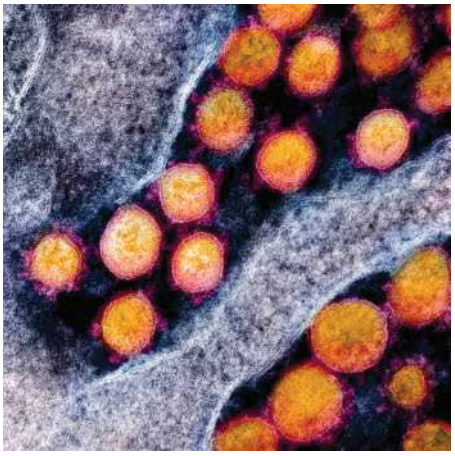
We see many small and big organisms around us. Some of them are plants, and some are animals. We can see them with bare eyes. Apart from these, the very part of organism that we cannot see with bare eyes but can see using especially powerful microscope is the world of microorganism or the microbial world. This world of microorganism is extended everywhere around us. Even a small amount of soil in the premises of the house or the school, may contain millions of microorganism that can only be seen under microscope. Not only are they smaller in size, but the structure of these microorganisms is also different. Many microorganisms are unicellular, that is, composed of only one cell. But some microorganisms can be multicellular. Some microorganisms do not even have well-organized cells with a definite nucleus. We will learn more about the nucleus later, but for now, know that the nucleus controls all the functions of the cell.Microorganisms are relatively simple in structure. Scientists have researched and shown that in the course of evolution (compared to complex organisms), these simple microorganisms have emerged earlier on earth. So microorganisms are also termed asprokaryotic. We have read a bit about the members of the world of microorganism in the previous class. There we have learned about bacteria, viruses, fungi. All of these are the

types of microorganism. We will learn in more detail about microorganisms in this chapter.

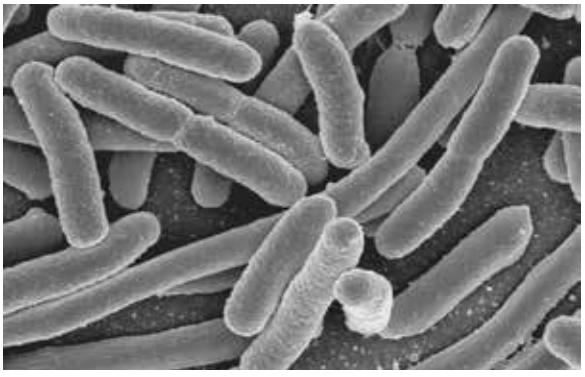
Classification of the World of Microorganisms

While classifying microorganisms, their sizes and their nucleus are given special importance. Based on these considerations, microorganisms are mainly divided into three kingdoms. The parts are-

Kingdom-1: Akaryota or acellular: These microorganisms are so tiny that they cannot be seen even under a electro-microscope. To see them, a special microscope (electron microscope) that can see very tiny things is needed. Example: virus.



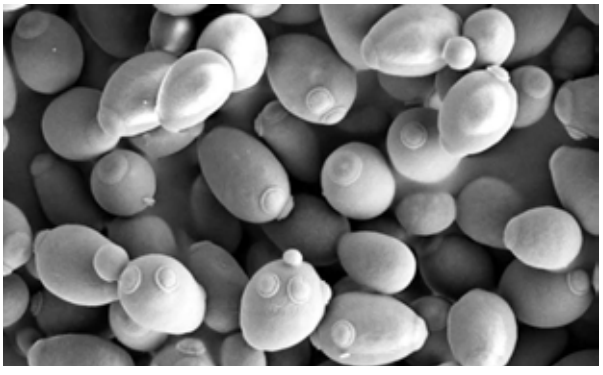
SARS-CoV-2 virus, observe in electron Microscope



Bacteria named *E. coli* observe in electron Microscope

Kingdom-2: Prokaryotae primitive celled: Microorganisms whose cells do not have a well-formed nucleus are the members of this kingdom. Their cells are called primitive cells because they do not have a well-formed nucleus. Example: Bacteria.

Kingdom-3: Eukaryota or true-celled: Microorganisms whose cells have a well-structured nucleus are called protocells or true cells. Examples: Microorganisms such as algae, fungi and protozoa.



Yeast observe in Microscope, microorganism use in baking

Introduction to some common microorganisms

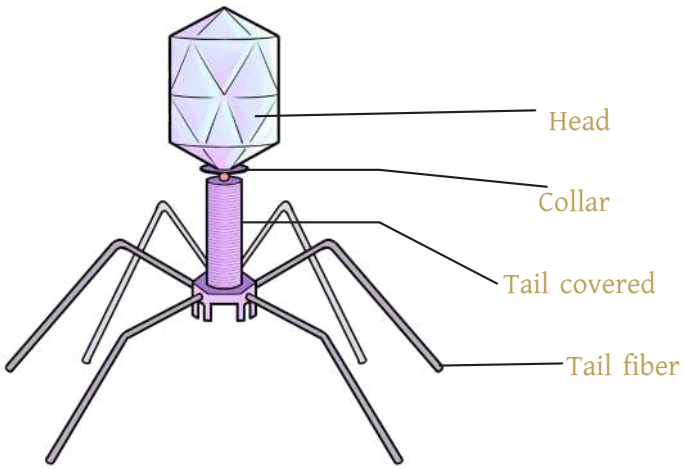
Different types of microorganisms such as viruses, fungi, bacteria, algae, protozoa etc. are scattered in our environment. Most of them benefit us. But there are some microorganisms that cause disease in our body. Now we will learn about some of the microorganisms.

Viruses and Bacteria

Viruses

Viruses cannot be seen without a highly powerful microscope. Although viruses are considered to be microorganisms, they do not actually have an independent life. They exist in the environment as non-living particles. But after entering the cells of another organism, the viruses can behave like an organism. Virus body has no cell wall, organized nucleus, cytoplasm etc. For this reason, the virus body is also called acellular. They consist only of a protein coat and nucleic acid (DNA or RNA). When the nucleic acid is released from their protein coat, they lose all properties of life. However, after entering another organism, whenever they can assemble the protein coat and nucleic acid, they regain all the properties of life. That is, they do not show any property of life without a living host or outside the living host. This is why viruses are true parasites.

Bacteriophage is one of the known viruses. Viruses that feed on bacteria are bacteriophages. They show properties of life after entering the bacterial cell. The image gives an idea about their structure.



A common bacteriophage

Viruses may be round, rod-shaped, tadpole-like etc. However, virus-borne disease that comes to our mind at this moment is COVID-19, commonly known as 'Corona'. There are different types of corona viruses, one such type is SARS-CoV-2 which is mainly responsible for the disease Covid-19. You already know the symptoms of Covid-19. The disease spreads at an incredible speed. The infected patients can

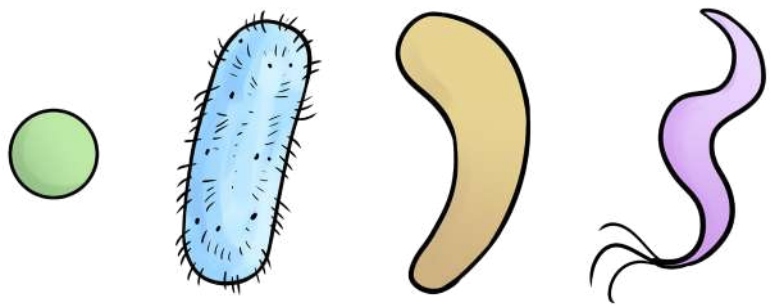
develop from common cold to more complex lung problems. Even in the last few years, this particular type of corona virus has caused deaths of millions of people around the world.

Viruses invite danger to not only humans. Rather various viruses are responsible for many diseases of plants along with humans or other animals; For example, Tungro disease of rice and mosaic disease of tobacco are caused by viruses.

Reading up to this, it may seem to you that viruses have no role in nature other than causing disease and suffering. But that's not true. Rather viruses like all other organisms are needed to maintain balance in nature. In fact, among many viruses that live on earth, very few viruses cause us disease.

Bacteria

We have learnt some things about bacteria in the previous class. Now we will know a little more detail. Bacteria are non-green, unicellular microscopic organisms with primitive nucleus (that means, they cannot be seen without a microscope). Scientist Antonie van Leeuwenhoek (1632–1723) was the first to observe bacteria using a microscope. Bacterial cells can be round, rod shaped, comma shaped, spiral etc. Bacteria are classified on the basis of their shape as follows:



Bacteria of different shapes

a) Coccus: Some bacterial cells are round / spherical shaped. They are coccus bacteria. They remain single or in groups; such as pneumonia-causing bacteria which are called pneumococcus.

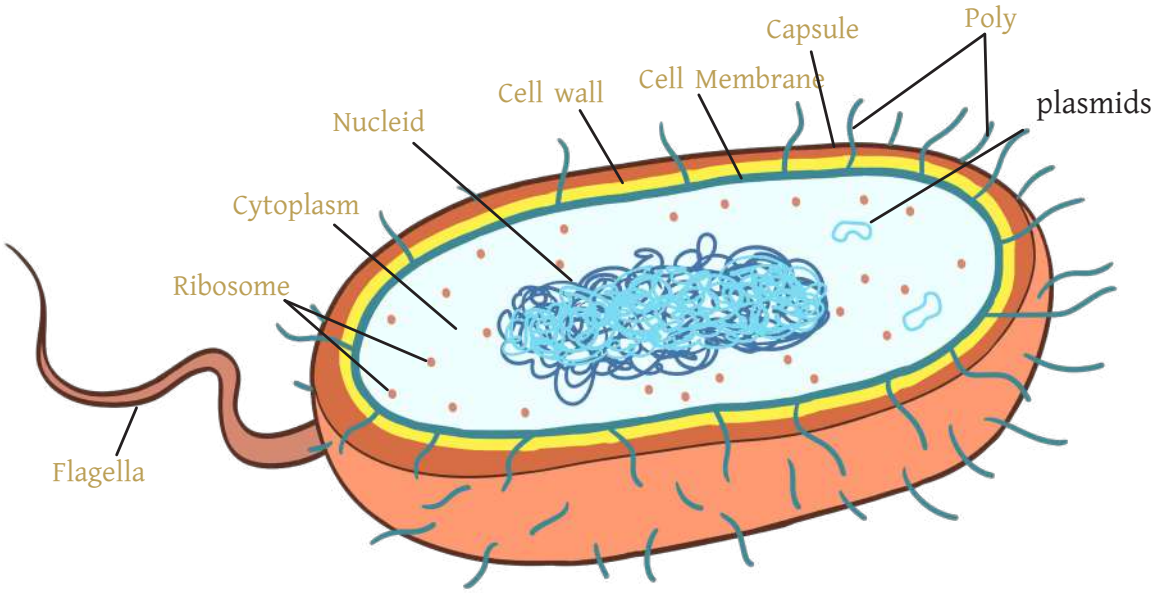
b) Bacillus: They look like long rods. They cause diseases such as scurvy, blood dysentery etc.

c) Comma: These bacteria are like bent rod in shape. This type of bacteria causes cholera for humans.

d) Spirillum: This type of bacteria has a spiral shape. They enter our body through rat bites and generate fever and other symptoms.

Although bacteria are simple microscopic organisms, they have a well-organized cellular structure. Their cells have certain properties that cannot be found in other organisms, either unicellular or acellular.

Bacteria are primitive celled organisms. This means, their cells do not have a well-formed nucleus. As we have learned in the Cell Science chapter, an ideal nucleus has its own membrane, which separates the nucleus from the rest of the cell. But this is not the case with bacteria. Their main nuclear material or DNA is located in the protoplasm of the cell. They are called Nucleoid.



A simple diagram of bacterial cell structure

Another very important point is that bacterial cells have structures made up of one or more circular DNAs in addition to their basic nuclear material. They are called Plasmid. We have known that the nucleus controls all the metabolic activities of the cell DNA. DNA contains a lot of information to control everything. The different parts of DNA that work to control different types of information are called genes. Plasmids also contain some genes. We will know in detail about this in the upper class. For now, just know that a gene is a part of DNA that controls an organism's characteristics.

Genes located on plasmids produce such proteins that give the bacteria various characteristics and capabilities. For example, the enemy of bacteria is virus. Genes

contained in plasmids deal with enemies like viruses. Moreover, plasmids play a role against the drugs we use to kill bacteria.

You might have heard the name of an important branch of biology called genetic engineering. Genetic engineering has made it possible for scientists to create organisms with new characteristics by changing the genes that control the characteristics of organisms. Plasmids have played an important role in the development of this genetic engineering.

In addition to DNA, bacterial cells, just like other living cells, contain organelles like mitochondria, ribosomes, Golgi bodies, endoplasmic reticulum, etc.

Bacteria have a cell wall. However, some bacteria have another layer on their cell wall to survive in the hostile environment. It is called a capsule. The capsule is basically a polysaccharide coating which is not easy to be penetrated. When we become sick from the infections with bacteria that have a capsule coating, it is relatively difficult to treat because, this capsule coating prevents the medicine from entering the bacterial cells.

Along the cell, Bacteria have numerous thread-like extensions called flagella wall to help bacteria move. Bacteria can move in the aquatic environment through the movements of these extensions.

Usefulness of bacteria

It is true that bacteria cause us many diseases. But they also have many useful roles. For example:

- Various life-saving antibiotics are produced from bacteria.
- Only bacteria do nitrogen fixation in soil from nature. Nitrogen in the environment generally remains inactive; does not usually participate in the formation of compounds. The fixation process makes nitrogen oxides reactive. As a result, the fertility of soil increases.
- Bacteria help in removing fibers from jute.
- Bacteria also help us make yogurt.

Fungi, Algae and Amoeba

Fungi

Fungi are non-green organisms without chlorophyll. As you may remember, chlorophyll is very essential organic molecule that plays an important role in photosynthesis and helps plants collect energy from sunlight. Once fungi were considered non-

green plants but now they are considered separate from plants. They cannot take part in photosynthesis because they do not have chlorophyll. Therefore, they depend on other organisms or parts of organisms for food (heterophytic characteristic) or they obtain nutrients from the remaining organic matter of dead organisms (saprophytic characteristic). Heterophytic fungi grow on stale and rotting food items, fruits, vegetables, wet bread or leather, cow dung etc. Saprophytic fungi grow on dead organisms or in soil full of humus.

Yeast Agaricus

Fungi can be microscopic or large in size. The yeast used to leaven bread can only be seen under a microscope. Agaricus, commonly known as mushroom, are quite large and we can see them easily.

Fungi have a well-structured nucleus. Their cell walls contain a special material called chitin which protects them from the hostile environment or from the attack of other microbes.

Usefulness of Fungi

Fungi are very important microorganisms. Many of you may have heard the name of the antibiotic Penicillin. Antibiotics are medicines that usually work against bacteria. A scientist named Alexander Fleming invented the world's first antibiotic penicillin from a type of fungus called Penicillium.

Yeast is used to make bread. The yeast rapidly increases in number through cell division, and the large amount of carbon dioxide bubbles, which are created by the respiration process, fills the yeast dough. That's why, the volume of the yeast increases, i.e. the yeast swells. In this way, the bread that we eat is soft enough. Yeast is also used as tablet because it is rich in vitamins. A type of mushroom called Agaricus is considered to be a delicious food. Currently, it is cultivated in many countries including our country. Fungi also play a major role in creating organic fertilizers by decomposing garbage and mixing it with the soil.

Harmfulness of Fungi

There are many types of fungi that are responsible for many diseases in humans, animals and plants. Fungi play a role in ringworm, ringworm, urticaria (Chuli in Bangla) and human respiratory infections. Fungi cause diseases of important crops

like potato, jute, sugarcane etc. Besides, they easily rot wooden, cane or bamboo furniture.

Prevention of fungal infections

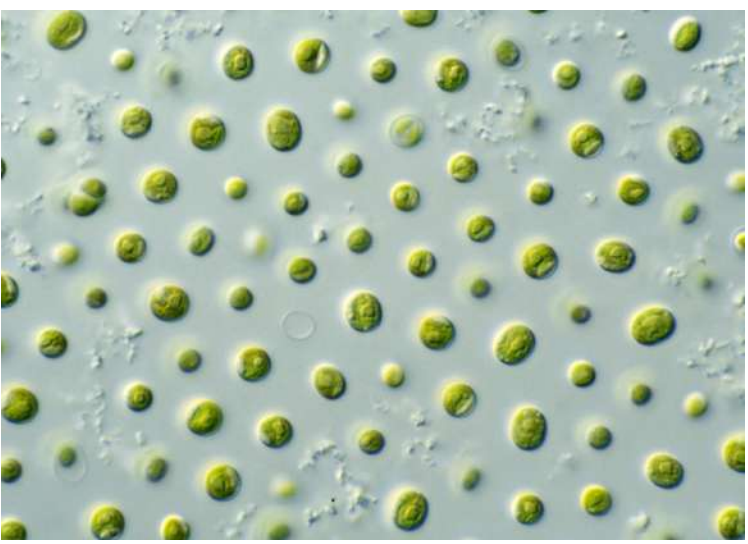
Fungal diseases are highly contagious. This means, the disease can spread in contact with an infected person. We need to do the following to stay safe from these diseases:

- To avoid using items (clothes, combs, hats, sandals) used by people with fungal diseases.
- To minimize the contact with people with fungal infections.
- To spray fungicides on infected plants or to burn the plants.

Algae

Algae are chlorophyllllous and autophytic plant-like organisms. Algae cannot be fully considered as plants, because their roots, stems, etc. are not fully plant-like. They grow on soil, water and other plants. Algae are seen in green, red and brown colours. The diversity of algae in terms of size and shape is surprising. There are algae that cannot be seen except under a microscope. These are called microalgae. On the other hand, there are many large algae that grow in the ocean and can reach an average length of 100 feet. They are called Kelp.

Giant kelp grown in the ocean



Algae seen only under a microscope.

Structure of Algae: Algae can be unicellular or multicellular. They can form chains consisting of many cells. There are also very large algae that

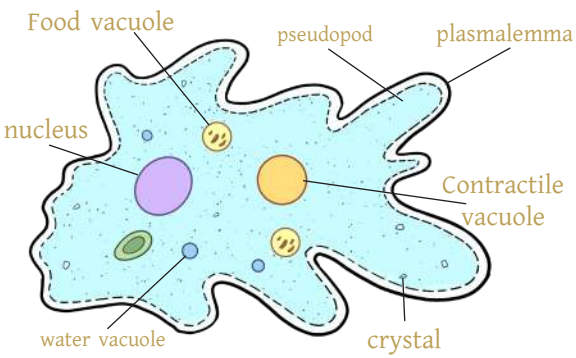
look almost like plants. Algae cells have cell walls. Besides, their nucleus is well structured. That is, the nucleus is separated from the cytoplasm of the cell by their nuclear membrane. Algae also contain chloroplasts and mitochondria organelle.

Usefulness of Algae: Algae are very useful microorganisms. Elgin, extracted from marine algae, is used to make ice cream. Marine algae are a good source of iodine and potassium. Algae are used as feed in fish farming. The commercially cultivated algae called Spirulina is particularly rich in protein and other nutrients.

Harmfulness of Algae: Algae are responsible for causing various diseases in humans and plants. For example, a type of algae causes red rust disease of tea leaves. Aquatic animals and fish can die from lack of oxygen, if an excess of algae occurs in water bodies. Many people get sick every year after eating seafood poisoned by algal toxins.

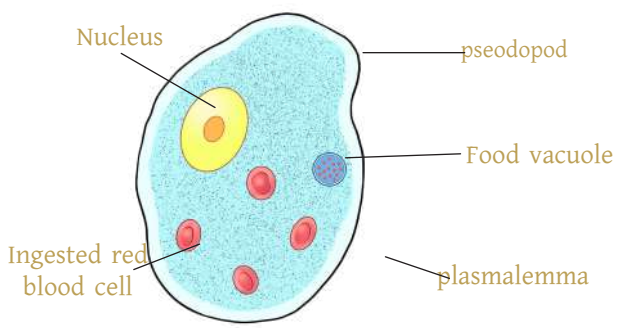
Amoeba

Amoeba is a unicellular organism, a member of the kingdom Protista. Their bodies are very small. They cannot be seen without a microscope. They change their body shape when necessary. Finger-like projection produced from their bodies is called pseudopodia. Amoeba eats and moves with the help of these pseudopodia. Their whole body is surrounded by a thin and transparent membrane which is called plasmalemma. Amoeba grows in water, wet soil, rotten waste material, organic debris at the bottom of ponds.



An amoeba. In the image, pseudopodia and food vacuole in cells are particularly noticeable.

Entamoeba



Entamoeba found in our intestines. Like amoebae, they also have pseudopodia and food vacuole. However, they also contain blood cells taken from human intestines.

Entamoeba is another type of unicellular organism belonging to the kingdom Protista. They cannot be seen with the bare eyes. They have no fixed body shape,because they are constantly changing size and shape like amoeba. Their bodies are like transparent jelly. But sometimes in adverse environment, they cover their bodies with round

and hard covering. This condition is known as cyst.

Entamoeba lives as parasites in large intestines of humans, monkeys, cats, dogs, pigs and rats. Basically, the main difference between Amoeba and Entamoeba is their habitat. Amoeba lives as a free organism in fresh water. But Entamoeba lives inside other organisms as intestinal parasites. They are responsible for a type of dysentery in humans.

Entamoeba reproduces by cell division and the sporulation process. The process by which a spore divides into many parts is called sporulation. The protoplasm of the Entamoeba cell divides and forms tiny spores.

Role of Microbes in Health Hazards

Microorganisms are the cause of many diseases in humans and other organisms. Bacteria, viruses, fungi enter our body and make us sick. Bacterial germs can enter the body through various processes. Unclean hands are a convenient carrier for germs through which they can easily enter the mouth. Bacterial spores can be transferred with the clothes we use.

Bacteria or its spores can easily move from one place to another with the dust that flies in the air. Bacteria can also be easily transferred from one person to another through shaking hands. Germs easily spread through rotten and stale food.

Every year many people of our country are affected by cholera and typhoid. These are bacterial diseases. Apart from bacteria, viruses appear to be the most harmful. For example, AIDS is caused by the HIV virus. Again in 2020, the Covid-19 epidemic spread across the world through a virus called SARS-CoV-2. Mumps, measles, pox etc. are also very painful viral diseases. These viral diseases spread through the air through sneezing, phlegm, spitting and coughing, and enter our respiratory tract.

If infected with a virus, the disease is many times cured in 2/4 days. However, there are some serious diseases that require long-term treatment. Once AIDS is diagnosed, there is no cure. The disease spreads from taking the blood of sick people, taking drugs, multiple use of the same needle by many people for taking injections, and having unsafe sex. Diseases like dengue fever, covid-19 are also the cause of death of many people.

Viral, bacterial and amoebiasis diseases were once very rampant. This used to be due to lack of safe water. Defecation and urination hither and thither causes public health hazards. Animals feeding on fecal matters spread the germs in such excrement. Besides, they spread far and wide through rain or tidal water. We can prevent many of these diseases by keeping the environment clean and following proper hygiene practices. We will know more about this below.

Prevention and remedy of health hazards caused by microbes in the human body

For the prevention and treatment of diseases caused by viruses, bacteria, fungi and Entamoeba, the rules of health and hygiene need to be followed collectively and carefully. It should be kept in mind that a person in poor health carries a higher risk of being attacked by diseases. Therefore, everyone should take a balanced diet regularly as per the requirement.

Using or touching anything used by the affected person should be avoided. Ensuring safe drinking water is very important. Safe water must be used to avoid bacterial diseases like cholera, typhoid etc. Safe water should be used for drinking, bathing and washing clothes, washing dishes etc. Arsenic free tube well water is safe. Clean water from ponds and rivers should also be boiled well before use. If people and animals are affected, they have to be treated.

In order to prevent diseases caused by microbes, everyone in the area should be encouraged to lead a healthy life. Everybody should know well how these germs enter the human body and what can be done to prevent them. In schools, mosques, temples, playgrounds, markets, where there is a large crowd, discussions about this issue can be started. The best prevention is to make people aware of this. If sick, the patient must consult a good doctor. If necessary,medicines should be taken on doctor's advice. Many medical services are available free of cost at community clinics in villages or upazila-level government hospitals. These services must be availed. We should try to get treatment from an approved hospital and the doctor with appropriate knowledge. If treated by a quack in the village or neighborhood, the disease reaches a critical level, instead of getting cured. It is our responsibility of all of us to be aware of this.

Microbes living inside organisms

If it is said that your body has more microbes than your own cells, then surely you would not want to believe it. But the information is true. Many microbes live in our body. They have their habitats in our stomach, under the skin and in various parts of the body. They affect us in many ways. As the billions of bacteria in our digestive system maintain the health of our digestive system, they play a role in properly digesting our food. Scientists have recently discovered that the chemical signals released by these bacteria in the digestive system also affect our brain.

There are bacteria and fungi not only in humans, but also inside plants. An excellent example is the endophyte. Endophytes are bacteria and fungi that live inside plant cells without harming them. Most of the time, this coexistence of microbes inside

plant cells is beneficial for both of them, but sometimes they can cause almost harmful consequences for the plants.

Almost all plants contain endophytes. These endophytes produce a variety of biochemical substances. You must have heard the name of antibiotics. Many endophytes living inside plants produce a variety of antibiotics. We still don't know much about these things. Scientists are doing a lot of research on this. You will be happy to know that such research is also going ahead in Bangladesh. In a study led by Professor Haseena Khan of the Department of Biochemistry and Microbial Sciences of Dhaka University, an antibiotic called homicorcin was discovered from the bacteria living in jute. You will know more details of such research when you grow up.

Exercise ?

1. Why is it easier to make curd in summer than in winter?

Chapter 6

Heat and Temperature

Chapter 6 Heat and Temperature

By the end of the lesson, students will be able to learn—

- ☑ heat and temperature
- ☑ measurement Scales of Temperature
- ☑ transmission of Heat
- ☑ specific heat
- ☑ heat flow
- ☑ effect of heat on change of state of matter
- ☑ expansion of matter for the application of heat

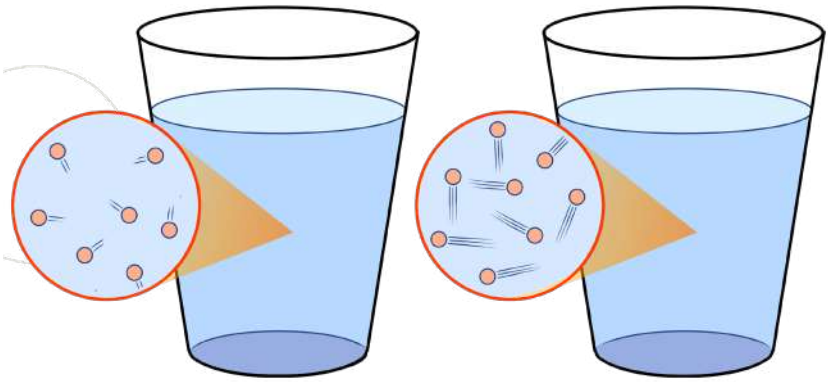
Heat

We see different types of energy around us. We use energy in different ways in our daily life. Heat is just such an energy which is familiar to all and we have used this energy somewhere in our lives.

We apply heat to cook, heat water for tea and coffee, wash clothes and put them in the sun to dry them quickly. Sometimes we try to avoid excess heat for personal comfort, sit in the shade to avoid the sun and rest, and try not to wear black clothes during hot weather. This list can be extended as much as desired.
But do you know how the heat energy came? What is the difference between a glass of cold water and a glass of hot water? Exactly why is the heat energy related to hot water, not in cold water?

Once people were very curious about this matter but now we know that all matters are made of molecules-atoms. The motion or vibration of these molecules-atoms is collectively known as heat. The more the molecules move around, the hotter they appear to be. The water molecules in a glass of cold water are not stationary; they are also moving around. But when heat is applied, the flow or movement rate of that water

increases a lot. If more heat is applied, the speed of some water molecules can increase so much that they can get free from the water. We call it evaporation.



Cold water Hot water

Hot water molecules move faster than cold water molecules.

Temperature

In order to understand heat, we must first understand what temperature is. Heat is the measure of energy and temperature is the measure of how hot or cold something is.

We say tea is hot and ice cream is cold—by hot and cold we actually mean that the quantity called 'temperature' is higher in the tea and lower in the ice cream. So if it is within our tolerance level, we can sense the temperature with our physical sensation. But it is not true that only if the temperature is high, the amount of heat will be high.

Let's say, you take some water in a pot and hold it over a candle flame for a minute. Then touching the water in the pot may feel slightly warmer than before. But if you hold a needle in a candle flame for a minute, it will become so hot that you will not be able to touch it. This means that despite providing the same amount of heat, the temperature of the water was lower and the temperature of the needle was much higher. If we try to explain the matter by the moving of the molecules and atoms of the substance, then this is to say that after applying heat, the speed of the water molecules in the pot increases, but the vibration of the atoms in the needle increases much more.

Therefore, it can be said that you have learned the most important thing about heat. That is, heat is a type of energy and this energy comes from the combined kinetic energy or vibration energy of the molecules of matter. The higher the speed or vibration of the molecules is the higher the temperature of the object. In the case of solids, heat means vibration of molecules. In the case of liquids, it is the movement of molecules and in the case of gases, it is the free flight of one compared to another. The more vibration, movement, or flight is the higher the temperature.

Measurement Scales of Temperature

The international unit of temperature is Kelvin (K), although we never use it in our daily life. Celsius (C) is the most commonly used unit for the measurement of temperature in our daily life and sometimes we use Fahrenheit (F) scale along with Celsius to measure fever. Normal body temperature on the Fahrenheit scale is 98.4°*F*, which is 37°C in Celsius. Below is a comparison between the three scales.

Scale	Unit	The temperature at which water freezes.	The temperature at which water boils and vaporizes.	The temperature difference between the evaporation temperature of water and the melting point of ice
Celsius	°C	0	100	100
Kelvin	K	273.15	373.15	100
Fahrenheit	°F	32	212	180

If you compare the Celsius and Kelvin scales, you will see that there is no difference in the Kelvin scale, except for the addition of 273.15° to the Celsius scale temperature.

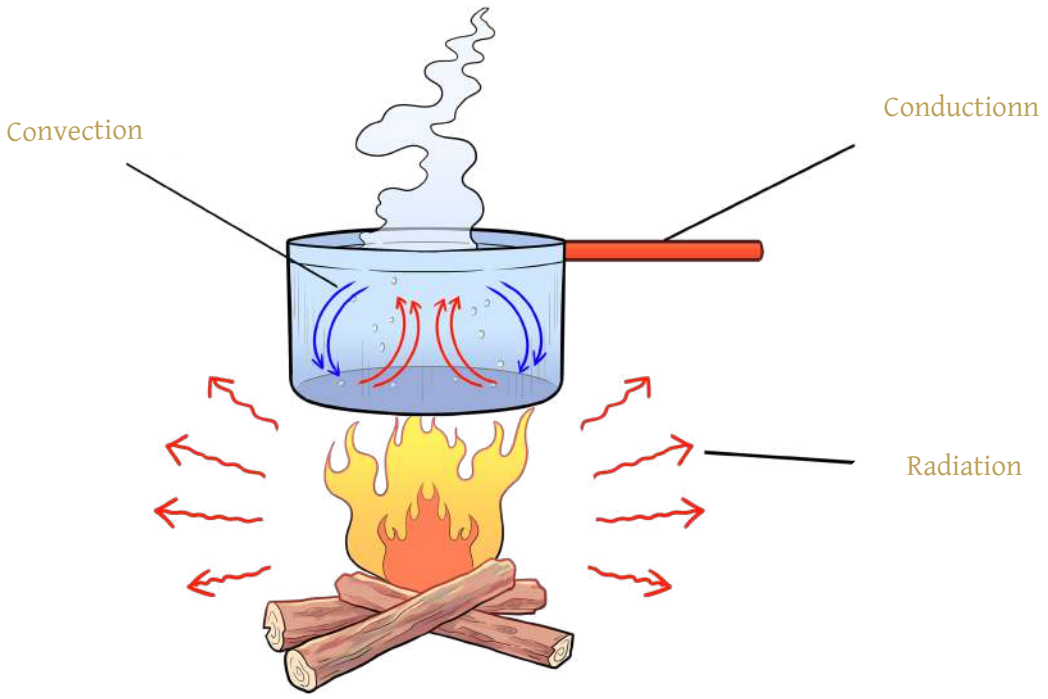
Naturally, you must ask what the reason is for developing the Kelvin scale by adding 273.15 numbers to the Celsius scale.

The reason is very surprising. You can increase the temperature of anything as much as you want, there is no limit! But you cannot decrease the temperature as much as you want. Temperature has a lowest value. Honestly speaking, you can get close to this temperature but never reach it. This is called absolute zero temperature. In fact, the Kelvin scale is developed to take this absolute zero temperature as zero degrees. In the Celsius scale this temperature is -273.15°. So by adding 273.15 to the Celsius scale, we get the Kelvin scale. However, in addition to the Celsius scale, another temperature scale called Fahrenheit is used in some countries and in fever measuring thermometers. On that scale, the temperature of ice is 32°F and the temperature of boiling water is 212°F.

Transmission of Heat

Heat is a form of energy and we use this heat energy in our various activities. To use something properly, it must be taken from one place to another. So we have to take or transferheat energy from one place to another. Heat is transferred in three ways which are Conduction, Convection and Radiation.

Conduction: We are all familiar with cooking. You all have seen that a pot (dekchi)



Examples of conduction, convection and radiation of heat

is placed on the fire of a stove for cooking and the heat of the fire is transferred through the pot to whatever is inside the pot. We have all seen that such pots (dekchis) are made of thermally conductive materials so that heat can conduct properly.

Since we have known that heat is the vibration of molecules in the case of solids, we can easily understand heat conduction. When one end of the solid is heated, the molecules of that end vibrate from their own place. You can imagine that one molecule is connected to another molecule by a spring. So when one molecule vibrates, it also causes another molecule next to it to vibrate. That another one then vibrate the next molecule. Thus, the vibration is transferred or conducted from one end of the solid to the other.

Convection: If you put water in a kettle and heat it on the stove, it starts boiling within a few minutes. But in order for all the water in the kettle to be heated, the heat conduction process has not worked. Those of you who have jumped into a pond on a summer afternoon have noticed that the water on the surface level of the pond is fairly hot, but the water below is quite cool. If the water in the pond was heated by the conduction process, then the water below the surface would gradually start heating up.

In the case of liquid, when it is heated, there works a different process which is called convection. Before understanding this process, we need to know one more thing; when a liquid or gas is heated, its density decreases and it becomes lighter. We can now explain why. If a liquid is heated, it takes up more space because its molecules are to move faster—so the same amount of liquid takes up a little more space and becomes less dense, or lighter. So when water is heated in a kettle, the water touching the bottom of the kettle heats up and rises to the top, then the cooler water on that side also appears there and mixes up. Thus an internal convection starts in the water, which mixes all the water very well and heats the water.

When the gas is heated, it becomes lighter- we can understand it by looking at the flame. All flames always rise upwards. A flame is hot burning gas, so it rises by being lighter. You will never see the flames spread in any other direction, except in a weightless spaceship, the flames spread evenly around instead of upwards.

Radiation: If we stand near a burning fire, we feel a kind of heat. This heat has not come to you through conduction, nor through convection. Even the heat we feel when we stand in the sun, has not reached you from the through conduction, nor through convection. This process of heat transfer is called radiation.

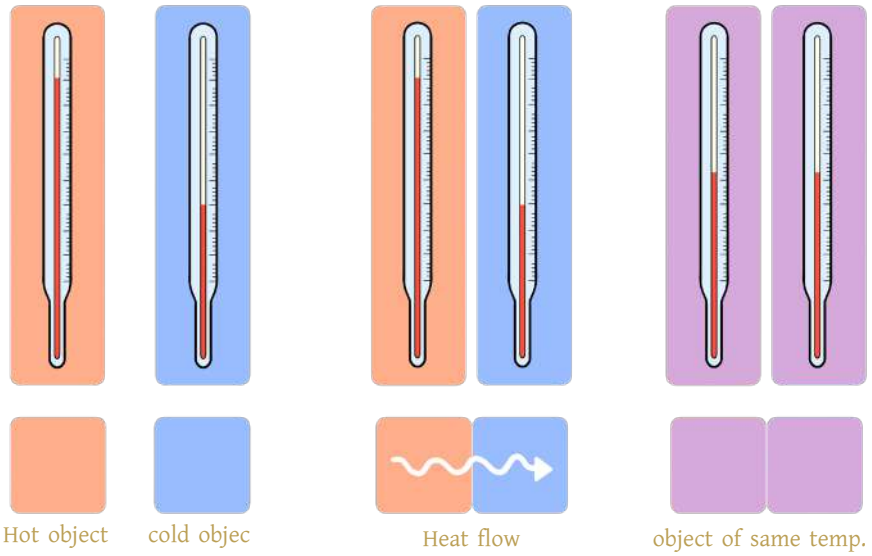
You have read about visible light as well as invisible light in the previous class. A part of this invisible light's infrared part can be felt as heat, even though we cannot see it with our eyes. So when we stand near the fire, we feel the invisible heat rays which we call radiation. Radiation does not require a medium. Therefore, visible light along with invisible infrared and ultraviolet rays can reach the earth, even though the Sun and Earth remain in space.

Specific Heat

If a drop of hot tea or coffee falls on your hand while taking hot tea or coffee, you must move your hand immediately. But the interesting thing is that if someone blows air of the same temperature on your hand, you will feel only a little heat, but your hand will not feel the burning heat at all. Those who prepare cakes in hot ovens are very careful not to let their hands touch the metal parts of the oven. But they don't bother about the oven's hot air, even though both are at the same temperature.

Now the question is why do we feel pain, when we come in contact with water or metal at hot temperature? Why don't we feel that intense heat, when we come in contact with air of the same temperature?

That is because when we come in contact with a hot place, our skin will feel that heat, but the amount of heat that will flow into our body depends on how much



When a hot object is brought into contact with a cold object, heat will flow from the hot object to the cold object until the temperature is equal.

heat those objects contain. If it has a high heat capacity, it can deliver too much heat to your body and cause pain in your hands. But if the object has a low heat capacity, it will conduct little heat to your body and you will probably feel nothing but a little heat.

The amount of heat stored in an object depends on the object's temperature, its mass, and its specific heat. Since air has very little mass, it has very little heat capacity to hold. If the relative temperature of a substance is low, a much higher temperature can be obtained from it by applying little heat. On the other hand, if an object has a high relative heat, a lot of heat must be applied to reach the same temperature.

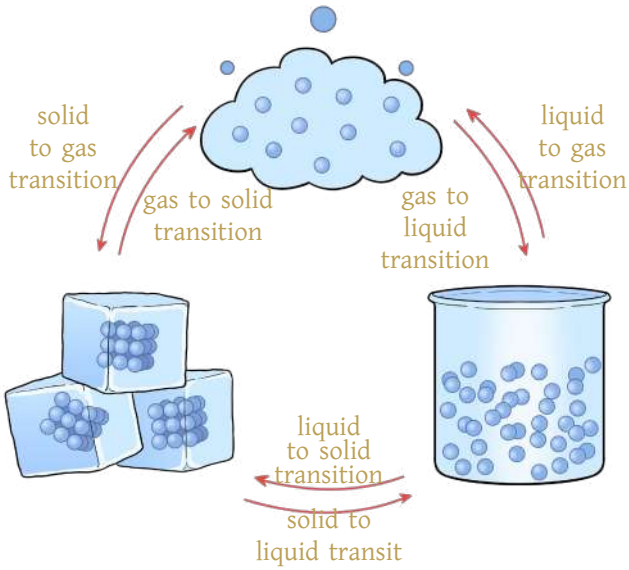
Heat flow

If two objects have different temperatures and are brought into contact with each other, heat will flow from the object with the higher temperature to the object with the lower temperature. For that reason, temperature is often defined in terms of heat flow. Temperatures will continue to flow, until the two temperatures reach the same point.

If a needle is heated in fire, the total amount of heat inside it will not be very high. Compared to that, the amount of heat in a bucket full of water is much higher. If the hot needle is left in the water, the needle will transfer its heat to the water in the bucket, even though the heat capacity of the needle is low.

Effect of heat on change of state of matter

You have already known that all matters are made of molecules, and that in solids the molecules hold each other in their specific places. When heat is applied, their vibrations increase and the molecular bonds loosen and they roll over each other and move, and this is what we call a liquid. If the temperature rises further, the molecules break free and begin to flow, which we call gases. However, if certain solids are heated, they can directly be converted into gases. These are physical changes, so it is possible to cause the opposite changes of these three states by removing heat. The image below shows the changes in these three states of matter by the application of heat.



Solids, liquids and gases can interconvert.

Solid to liquid and liquid to solid: When a solid is heated, its temperature increases. When the temperature reaches a certain value, the solid starts to melt. This process is called melting. When we leave a piece of ice outside, it melts by absorbing heat from the surrounding air. The temperature at which melting begins is called the melting point. The melting point of ice is 0 degree Celsius.

The reverse process of solid-to-liquid conversion also occurs with the application of heat. If heat is removed, a liquid can solidify itself. The transformation from the liquid state to the solid state is called solidification. The melted wax that falls from a burning candle cools and solidifies- this is an example of solidification.

Liquid to gas and gas to liquid: Heating a liquid causes its temperature to rise, and when the temperature rises, the liquid changes into gas. This process is called evaporation and the temperature at which evaporation occurs is called boiling point. The boiling point of water is 100 degrees Celsius.

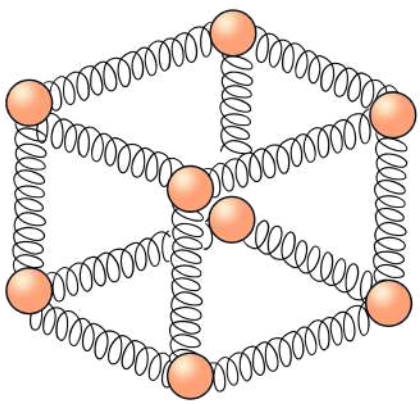
The reverse process of liquid to gas conversion also occurs with the application of heat. A gas can become a liquid if heat is removed. If we put a few pieces of ice in a glass, we can see that the water vapor on the glass cools down and gathers as droplets of water. This conversion from the gaseous state to the liquid state is called

liquefaction.

Solid to Gas and Gas to Solid: The process in which heat is applied to a solid substance in order to directly turn into a vapour instead of turning into a liquid, that process is called sublimation. We have seen naphthalene to be used to keep insects away from the clothes. When solid naphthalene is heated, it turns directly into a gaseous substance rather than a liquid.
The process opposite to evaporation is called deposition where the vapour of a substance is cooled directly into a solid rather than a liquid. Iodine is a sublimely matter in iodized table salt. Therefore, heating this mixture of iodized table salt easily evaporates the iodine. Then the vapour can be cooled to directly convert the iodine vapour into solid iodine.

Expansion of matter for the application of heat

You have already known that all matters are made up of molecules and atoms. You have also known that in solids the molecules are held together in fixed positions by molecular forces. We can compare this force with the spring shown in the image. When heated, their vibration increases; so they take up a little more space to vibrate and it seems that themass has increased. Heat can soften and melt many solid materials, especially metals. This allows them to be shaped into objects of various shapes.



The molecules of a solid can be thought of as connected to each other by springs.

In liquids and gases, the particles move faster and require more space; so their diameters seem to have expanded. This nature of mercury expansion is used in making thermometers.

The amount of expansion or contraction of solids, liquids and gases can vary by due to adding or removing heat.

Exercise ?

1. There is no temperature at which the Celsius and Kelvin scale values can be equal. (Why?) But the Fahrenheit and Celsius scale values are the same at a specific temperature. How much could that be?

Chapter 7

Changes around Us

Chapter 7 Changes around Us

By the end of this chapter, students will be able to learn—

- ☑ various physical and chemical changes in the environment
- ☑ importance of metal preservation
- ☑ photosynthesis, water cycle, carbon cycle, oxygen cycle
- ☑ various practical applications of chemical change

Many things are happening around us every moment. Some of them are necessary for our life; some are unnecessary; some can cause harm. Physical and chemical changes of various substances continue to occur in these events of nature.

Physical changes: melting and boiling

All of you have seen ice melt into water at any time. As you all know, water and ice are the same matter. They are not different, only their states are different. When it exists as water it is liquid and when it exists as ice it is solid.

Again all of you know that if you heat water, the temperature of the water will rise and at a certain temperature it will start boiling. Do you think that the boiling of water is a physical change? Yes, of course, it's a physical change, because, in that case, it has just changed from a liquid to a gas. It has not turned into a new matter and its properties have not changed at all. You have already learned about physical changes of matter earlier. So, it can be said that the change of matter in which only the state or shape changes but no new type of matter is created and the properties remain the same is called physical change.

The change of ice into water is a physical change of matter.

Chemical Changes: Rust of Iron

You have learnt about the rust of iron in the previous chapter, and have known that if a piece of iron is left outside in the presence of vapour, it reacts with oxygen. Consequently it rusts, and then it continues to corrode. Thus, rusting in iron is a chemical change. To understand how rust is formed, you can do the following experiment.

Task: Take a pot half filled with water. Carefully drop several nails into the water so that some are completely submerged, some are half under water and half above water. Leave the pot for 2/3 days. Have you seen any change in the nails? Yes, you will find that the nails are rusted, some more, some less. Can you somehow explain why one has more rust and the others have less rust?

Now think about what kind of change has happened to the iron. Here, iron and water have reacted to form ferric oxide. This ferric oxide is called rust. Here it is clear that the iron has transformed into a completely different ferric matter called ferric oxide. Ferric oxide or rust tears off and thus iron is corroded. So it can be said that rusting process damages iron.

The process of changing one or more such matters into a matter with completely different

The copper built Statue of Liberty during the construction time and at present

properties is called chemical change.

Not all metals corrode equally, like iron. Aluminum reacts with oxygen to form an oxide layer outside, and it is strong enough to protect the aluminum inside. Contaminants in the air slowly attack the copper and turn it green. The Statue of Liberty in New York is green for that reason. But some metals such as gold, platinum etc do not corrode when left in open air. For this reason they are valuable and are used in making various ornaments and coins.

A chemical reaction

You can observe for example, an experiment of a simple chemical change— the reaction of acid with carbonate compound. The following simple experiment can be done to understand chemical reactions and changes.

Task: First, crush some chalk and then take it in a bowl or a spoon. Now add vinegar drop by drop with a dropper or otherwise. Vinegar contains acetic acid, so you will see that the acetic acid in the vinegar is reacting with the chalk powder to form bubbles.

Chalk is essentially calcium carbonate ($CaCO_3$). In fact, the bubbles are caused by the chemical reaction of chalk and vinegar (acetic acid) to form carbon dioxide. We see the bubbles because of this carbon dioxide.

What kind of change is it then? Definitely a chemical change, because the products (calcium acetate, carbon dioxide and water) are completely different and have different properties compared to calcium carbonate and acetic acid.

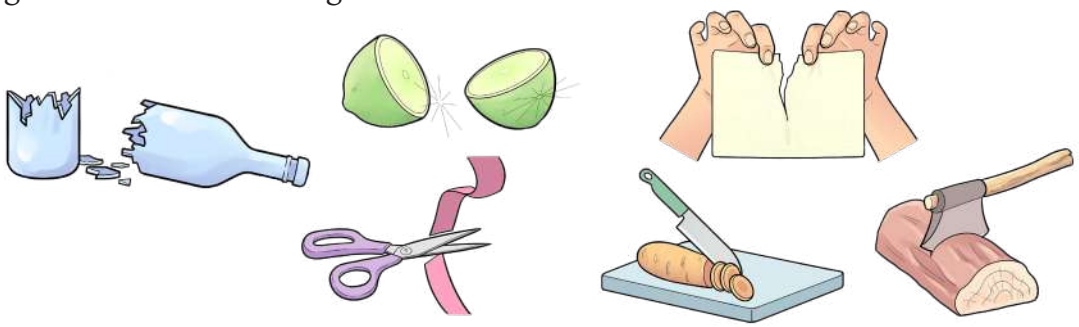
You can also use eggshell instead of chalk in this experiment because it is full of calcium carbonate.

Reversible change

Apart from physical and chemical changes, we can also divide the changes in matter into reversible and irreversible changes. A change, that is not permanent, and the

changed object can be restored to its previous state while retaining its properties, is called a reversible change. Such a change involves only a change in external state or shape, but does not create a new type of substance. Melting, boiling, evaporation, cooling, condensation, dissolution are some examples of reversible processes. Reversible change allows the changed object to be returned to its previous state by following one or more methods.

In a previous chapter, you have learnt about the change of state of matter and its expansion by the application of heat. These changes are simultaneously physical changes and reversible changes.



Physical change but not reversible

Irreversible change

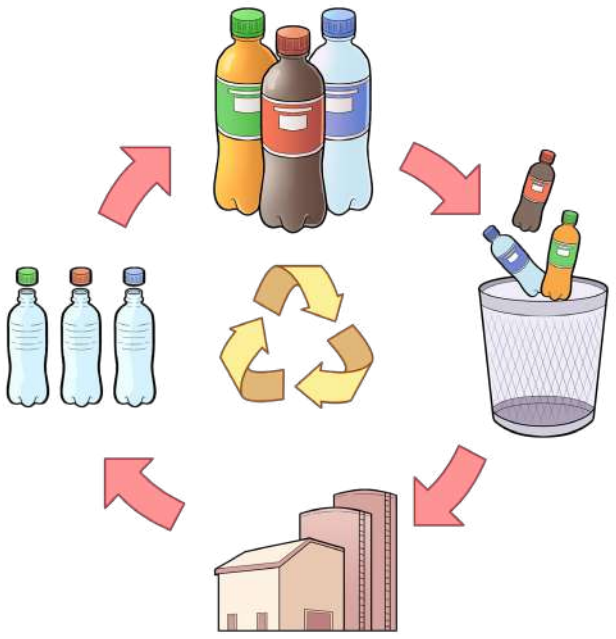
On the other hand, the type of change that is permanent and the changed object cannot be reverted back to its previous state by any physical or chemical process is called irreversible change. The creation of new matter involves such changes. Cooking, burning, grinding etc. are some of the methods which cause irreversible changes. For example, if a raw egg is boiled, it cannot be returned to its original state.

You must have guessed that the reversible changes are physical changes. But not all physical changes are reversible. For example, a rubber band can be enlarged by stretching, and when released, it returns to its original state. It is a physical change and a reversible change at the same time. If the rubber band is pulled too far and torn, it is still a physical change, but not a reversible change. The image above shows some examples of physical changes that are not reversible changes.

On the other hand, chemical changes are always irreversible changes, as they cannot be reversed.

Recycling the matter with the help of reversible process

Plastics can be recycled or reused through reversible change. The image below shows the plastic recycling cycle. Plastic items such as water bottles, food storage containers, etc. can be reshaped to create new types of containers. Again, with the help of recycled plastic, various types of furniture, playground equipment, etc. can be made. We all know how important it is to recycle and reuse as many materials as possible; it helps to reduce the amount of garbage in the environment. It also helps in conserving natural resources used in making new materials.



Plastic recycling cycle

It should be mentioned here that glass and plastic are recyclable, because their chemical properties are such that they can be heated and cooled, and their properties remain the same even after heating or cooling.

Like glass, the process of making paper is also reversible, and paper can be recycled. Around the world, recycled paper is produced through such recycling methods from large amounts of used paper. Waste paper is again made into paper by following certain procedures including adding water and certain chemicals and cleaning.

Prevention of corrosion of metals

If something made of metal continues to corrode, it eventually becomes unusable. If we are aware enough about their proper use, it is possible to prevent this decay or corrosion.

Task: Make a list of metal items used in the household regularly, and note which ones are subject to gradual corrosion and which ones are not. You may search the reasons for these.

Naturally, the question may arise, how can corrosion of iron be stopped from rusting? In our daily life, if we keep various iron items such as Khonta, hammers, hooks, nails etc away from water, then it is possible to save them from rust. Also, keeping them covered with oil or grease can reduce rust. However, rust can be prevented with the help of galvanizing, painting or electroplating. In special cases, stainless steel can be used, if possible.

Galvanizing: Zinc is used in many ways in our daily life. One of these uses is the use of zinc for galvanizing. Galvanizing is the coating of zinc on iron made items. In this case, the zinc coating forms a barrier that protects the iron from water and oxygen, thereby preventing it from rusting. Metals can also be protected from rust by coating them with tin instead of zinc.

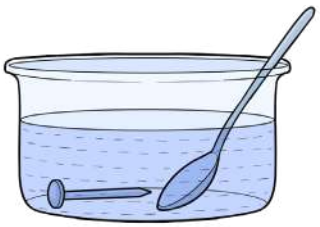
Electroplating: Electroplating is a process. Here, the more active metal is protected from rust by creating a coating of a less active metal on top of the more active metal. Iron made objects are usually electroplated with copper, chromium, tin, or nickel. Through this, the beauty and decoration of jewelry can be enhanced, and the durability of cutlery and motor parts can also be increased. It not only prevents corrosion of the metal, but also makes it attractive and shiny.

Pinting: Metal corrosion can also be prevented by painting. Railings of our houses, shelves, cars or various steel items are painted to prevent corrosion. The colour eventually fades over time. Then it is better to repaint these things immediately.

Stainless steel

Do you know what stainless steel is and why it doesn't rust? Stainless steel is made by alloying carbon, nickel and chromium with iron. Basically it is an alloy that is several times harder than iron. Interestingly, it does not rust. This can be confirmed through experiment beside.

Task: Take two-thirds of water in a container and immerse a nail and a stainless steel spoon in it for a few days.



Did you see any rust on the spoon? No, because the properties of stainless steel are different from those of ordinary iron. Since has not reacted with water and oxygen, has not rusted. But the nail has rusted because was made of ordinary iron.

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Combustion

Combustion is a chemical reaction in which an object reacts with oxygen to produce light and heat. Naturally this is an irreversible change. You have always seen fire burning as an example of combustion in your daily life. If you observe closely at how a candle burns, you will understand combustion better.

When the wax burns, some part of the wax melts into liquid and rises up the wick and burns. The heated-vaporized wax reacts with oxygen to form carbon dioxide and water, and produces light and heat. We cannot see them as produced carbon-dioxide is colourless and the water turns into vapour on heating. In this case, chemical changes take place, because the carbon dioxide and water produced by burning wax are completely different substances and their properties are also different from wax.

Combustion of wax

On the other hand, the part, that has melted and cooled down and solidified, has undergone a physical change rather than a chemical change. Because, by changing the state of wax by melting and without any change in properties, it has cooled down and solidified again to its former state. Naturally this melting and condensation is a reversible change, because it is possible to collect the wax and renew it again to make a candle.

Cooking by burning natural gas and wood or straw in our household is also an example of combustion. In each case, light and heat are produced.

Physical energy

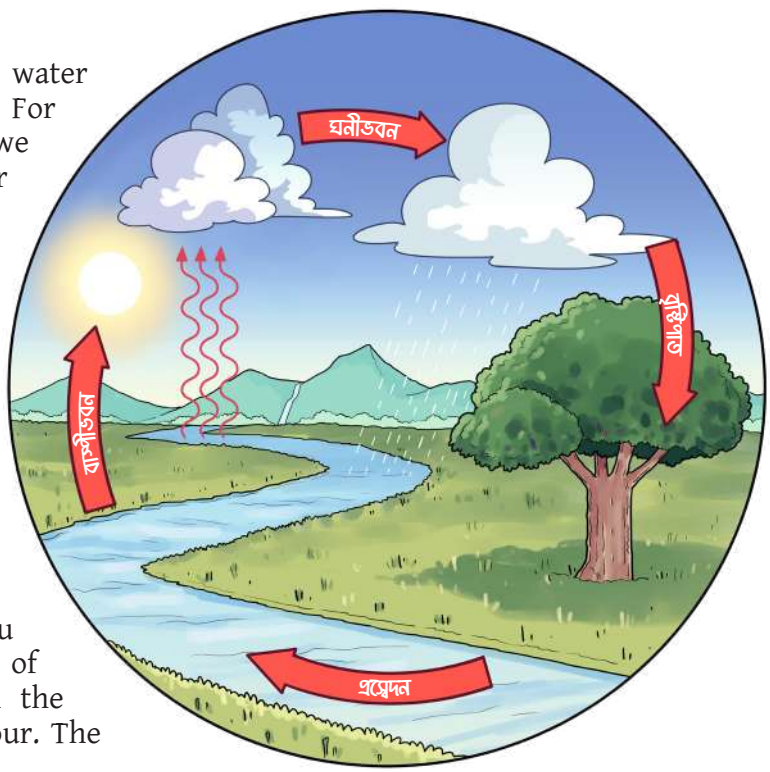
The different types of food that we eat accumulate in our stomach. After digestion, nutrients are absorbed into our body. Those elements break down in our body cells and generate a lot of heat energy. This process is similar to combustion, because in order to complete it, blood in the body cells supplies oxygen. After the process is completed, carbon dioxide and water are produced along with heat. We use the energy generated by this process to perform various tasks throughout the day. If heat energy were not generated, we would have no energy to do work.

Wildfire, a small candle or the combustion of our body cells, all are actually some kind of chemical change.

Water cycle, carbon cycle and oxygen cycle

Water cycle

All of you know that we get water from different sources. For example, during monsoon, we get water from rain in our country. At times, different regions of the country are submerged in flood water from the upstream. Where does the flood water come from and where does the rain water go after the monsoon? From where do they come back again next year?



Water moves from one source to another in a cycle. You know how it rains. The heat of the sun turns the water on the surface of the earth into vapour. The

water vapour created from the water in ponds, rivers, seas, canals goes up and cools down into water particles. Water particles combine to form clouds that float across the sky. The smaller particles combine to form larger particles which then return to our earth's surface as rainwater. When the cloud water particles cool too much, they freeze and turn into ice particles, and sometimes they fall to the surface as hailstone. Rainwater flows into the river and slowly flows from the river to the sea. Thus, the surface water evaporates and turns into clouds and returns to the surface as rain again. This rain water goes back to the river, then back to the sea. Such movement of water is called water cycle, which is shown in the adjacent picture.

We know that a part of water is stored under the ground, it is called sub-surface water. We often use it for drinking, washing and irrigation.

In some places, the wind carries some of the water vapour to the mountain tops as clouds. Clouds cool down and form snow there. In summer, the heat of the sun melts the snow into water and slowly flows down the mountain. Thus, small rivers are formed on the mountain slopes. These small rivers flow down to the plains and form big rivers. Finally, that water flows into the sea. From surface water to clouds, from clouds to mountain snow; thus water comes in water cycle. Once again the snow melt, water flows into the river and finally falls into the sea. This is how the water cycle circulates.

Two processes involved in the water cycle are evaporation and condensation. Through evaporation, water comes from rivers, canals, lakes, ponds, etc. in the form of vapour in the atmosphere due to the heat of the sun. When this water vapour gradually rises, the temperature is relatively low, and the water vapour condenses into small water particles and transforms into clouds.

Two other processes involved in the water cycle are solidification and liquefaction. In particular, in the water cycle, small water droplets solidify and freeze into ice, which accumulates on mountain tops. During summer, this ice melts and flows into water through liquefaction.

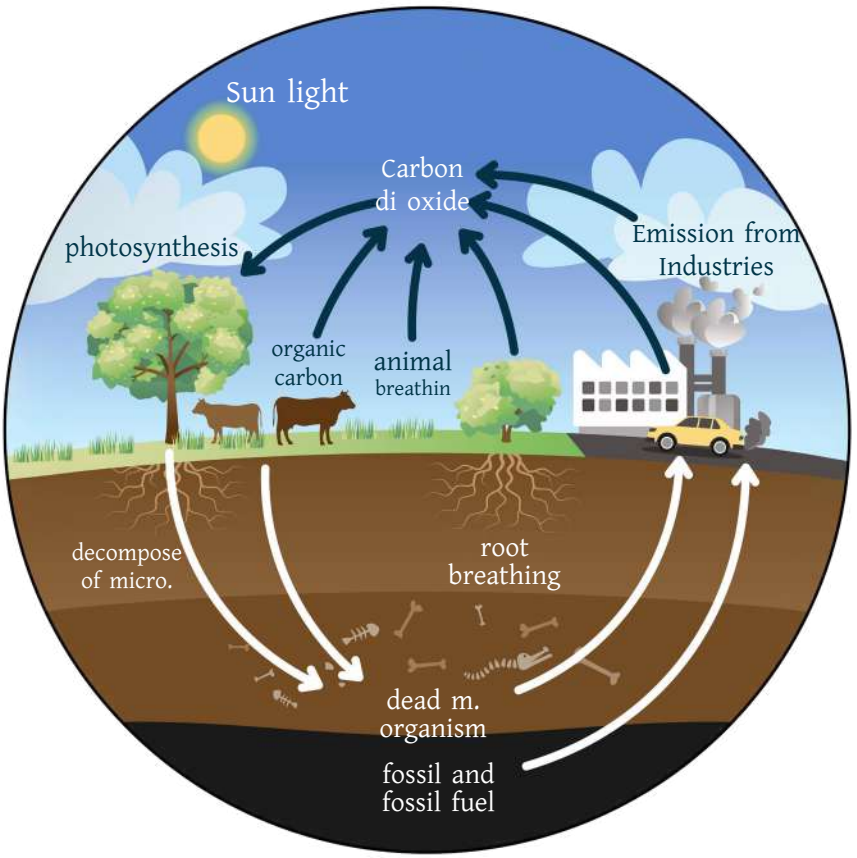
This is to be noted here that all these four processes are physical changes.

Carbon cycle

The carbon cycle basically shows how carbon atoms move from one state or medium to another in a cyclic process. An image of the carbon cycle is given next.

The main steps of the carbon cycle are:

(১) In the first step, carbon-dioxide enters the plants from the atmosphere. In the process of photosynthesis, plants react with water and carbon dioxide with the help of sunlight to produce their food (glucose) and oxygen for us.
(২) In the second step, various animals eat these plants and these carbon atoms are stored in the animals' body.
(৩) In the third step, after death, these animals and plants are rotted down by



bacteria. A portion of it directly converts into carbon dioxide and enters the atmosphere, completing the carbon cycle.

Another important part of the third phase is the conversion of plants and animals to fossil fuels. Fossil fuels contain carbon and hydrogen and are made from decaying plants and animals. Dead plant bodies are broken down by bacteria and stored underground as fossil fuel under certain conditions. Natural gas, coal, kerosene, or petrolare produced in this process.

(8) We use fossil fuels for cooking, in cars, factories, and many more. Fossil fuels complete this cycle by converting into carbon dioxide and water, and thusby entering the atmosphere.

Plants or trees then start the cycle again by absorbing carbon dioxide from the atmosphere through photosynthesis.

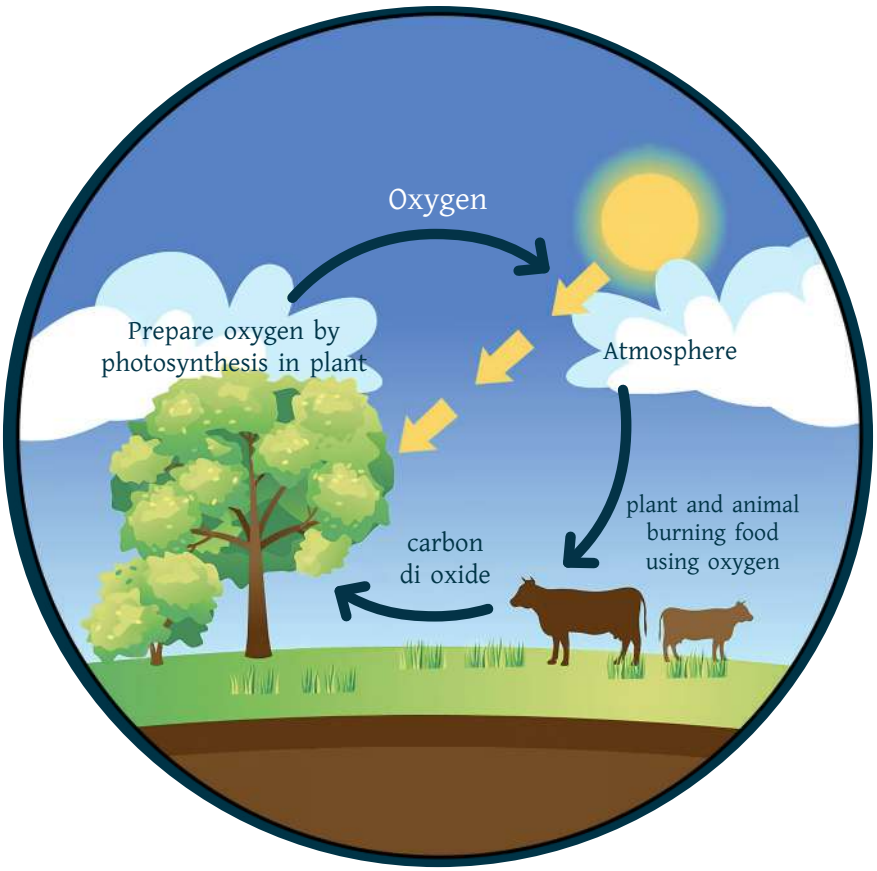
In addition, organisms and plants, like humans, release carbon dioxide into the atmosphere during respiration. On the other hand, seawater absorbs a large amount of carbon dioxide gas, which is returned to the atmosphere by marine organisms.

You must understand that the carbon cycle is different from the water cycle. The changes in various stages are not physical changes. Every change in the carbon cycle is a chemical change.

Oxygen cycle

The oxygen cycle is the biochemical cycle of oxygen. This cycle mainly works to maintain the level of oxygen in the atmosphere. You know that plants release oxygen through photosynthesis and store food (glucose or starch) for themselves. On the other hand, other animals including humans take the oxygen released by plants and generate energy for themselves by burning food with oxygen. Other animals, including humans, release carbon dioxide, which plants re-use to make their food and oxygen.

Therefore, here it is seen that either directly or indirectly, photosynthesis, water cycle, carbon cycle and oxygen cycle are very closely related to our life.



Exercise ?

1. Apart from glass, plastic, and paper, what other things available around you can be recycled?

2. Different types of fuel are used for cooking at home. Which fuel is less polluting among them? Why?

3. Both physical and chemical changes occur when a candle burns. What are the changes? Give another example of such a familiar process in which both physical and chemical changes occur.

4. What can happen if the amount of carbon dioxide in the air increases? What causes the amount of carbon dioxide in the air to increase?

Chapter 8

Work, Energy and Power

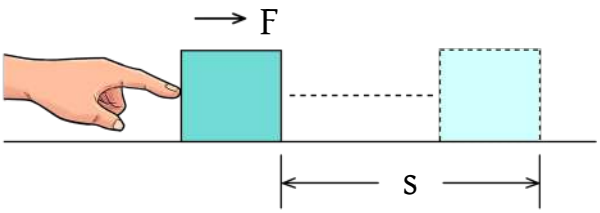
Chapter 8 Work, Energy and Power

By the end of this lesson, students will be able to learn—

- ☑ work power and energy
- ☑ different forms of energy
- ☑ universality of energy
- ☑ transformation of energy

Work

We use the word work in many ways in our daily life. A gateman sitting on a tool in front of the gate and guarding the house all day may claim to have done a lot of work, but in physics terms that is no work. In terms of physics, the word 'work' has a specific meaning. If a force applied to an object causes the object to move a distance in the direction to which the force is applied, then the applied force is said to have done work! By force, we mean pushing, pulling, attracting or repelling something. That is, if a force F moves the object at a distance s towards direction of the force, then the amount of work done by the force W is:



When an object is moved a distance s by a force F, then the amount of work done is Fs

$$W = Fs$$

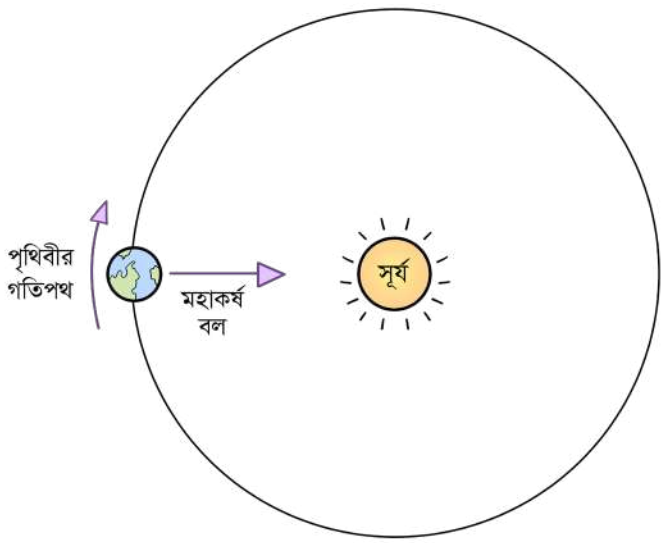
Here the unit of work is joule. So, if we can't displace the object by applying a force, then no matter

No matter how much work is done to move a heavy object, the total amount of work done is zero if the object cannot be moved.

how much effort we put in, we have to assume that no work has been done. Similarly, if the object moves at right angles to the force instead of in the direction in which the force is applied, then no work has been done as well. This happens when an object rotates around itself due to the attraction of the force. This means that no work is done when the earth revolves around the sun or when the moon revolves around the earth!

Energy

We all have a superficial idea of what energy means, because we frequently talk about electrical energy, thermal energy. Sometimes we also hear about chemical energy or nuclear energy. Although light is not called energy as such, we can assume that light is also a form of energy. The energy that is not talked about much in everyday conversation, but the energy that will be talked about countless times in physics is kinetic energy! So, we may think that there are many types of energy in nature, but the interesting thing is that all types of energy are same, and we only convert one type of energy into another! So, what is energy?



When the Earth revolves around the Sun for the Sun's gravitational force, no work is done because the Earth moves at right angles to the force!

Energy is the ability to work! Not only that, when force is applied to an object, the force actually imparts an energy in the object. So, the same amount of energy is created in the object, as the work done on it. Moreover, the same amount of energy is dissipated as the force exerted. That is why the unit of energy applied is also the same as the unit of work, the joule. So, after an object is pushed to a certain distance by force, sometimes kinetic energy is created in it due to speed, sometimes thermal energy is created due to friction, sometimes static energy is created due to position change. Therefore, the amount of work that is done is never wasted. It is somehow converted into some other form of energy.

Since no work is done when the Earth revolves around the Sun, no energy is spent by the Sun, and no energy is added to the Earth.

Power

In scientific terms, power is the rate of doing work. That is, if work W is done in time t, the power P is:

$$P = \frac{W}{t}$$

We have already seen that work means the transformation of energy. Since there is no destruction of energy, energy is only transformed through doing work. So, if we want, we can say power is the rate of conversion of energy. Some energy is always wasted in converting energy from one form to another. So, the amount of work that we want to do always requires a little more energy, not the same amount of energy.

The unit of energy is not very familiar to us, but the unit of power is quite familiar to us. If 1 joule of work is done per second, then we say 1 watt ('W') of work has been done or 1 watt of energy has been converted. If we light a lamp of 100 W, it means that the lamp consumes 100'W' of energy every second. A nuclear power plant generating 1000 'MW' of electricity means that this nuclear power plant produces 1000 ×106 'joules' of electricity per second.

Different forms of energy

In our life, we use different types of energy every moment. For example, heat energy is needed to heat water, we need light energy to see, we hear with sound energy. We use electrical energy to run machines and use chemical energy to generate electricity in battery cells. We also generate electricity with the nuclear energy that we get from disintegrating heavy nucleus. With nutrition from food, energy is created in our body, we work!

The most common form of energy is mechanical energy. The energy that results from the position, size and motion of an object is called mechanical energy. Two forms of mechanical energy can be kinetic energy and static energy.

Kinetic Energy: As we said earlier, the ability to do work is energy. We all have noticed that when an object is in motion, it can push another object and push it to some distance. Pushing another object to move it some distance must have worked there! So, we can definitely say that there is one kind of energy inside the object for motion and that is called kinetic energy. If the mass of an object is m and its velocity is v, then its kinetic energy is

$$\frac{1}{2}mv^2$$

Therefore, you must understand that if the velocity is doubled, its kinetic energy

is not doubled, but its kinetic energy is 4 times. That's why most of the fatal accidents we see on the roads are caused by kinetic energy which is more than required. A bus, truck or car has huge kinetic energy, when it runs at a great speed. During the crash, this total energy causes the car to crash, killing people.

A running cricket can store a lot of kinetic energy.

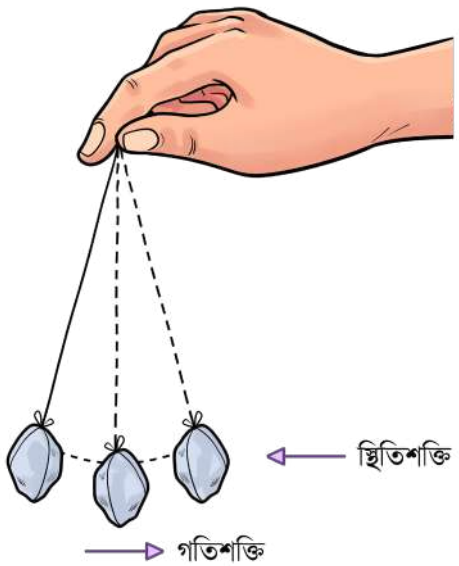
Potential energy or static energy: If we move something to some distance by applying force, i.e. work is done on it, then some energy is imparted to it. If the velocity of the object increases, then we can say that the work has been converted into kinetic energy; if it is heated due to friction, we say that the work has been converted into thermal energy. But if we apply force to lift an object up and leave it somewhere, then it neither moves nor heats up. It must have gained some energy, since it was worked on, so where did the energy go? If you think a little, you will understand that the power has not lost. It exists within the object as potential energy. If you drop the object from above, you will see that it will continue to be in motion when it falls. That means, the potential energy will start converting into kinetic energy.

In fact, when the object was above, a kind of potential energy or stability was accumulated in it for this 'upper' position.

Conservation of energy

The energy we see around us is imperishable. It has no destruction; it transforms only from one form to another. When a stone is lifted up, static energy is generated in it. When the stone is released, static energy decreases and kinetic energy increases. The entire energy is converted into kinetic energy just before it hits the ground. But when the stone stops after touching the ground, there is no kinetic energy in it, norstatic energy, so where does the energy go? You must have noticed that when the stone hits the floor, it makes a sound and creates heat where it hits, i.e. the kinetic energy is converted into sound or heat energy.

If a small stone is suspended by a string and pulled a little to one side, it rises a little above its fixed position.Then a kind of static energy is created in it. Now, when the stone is released, motion is transmitted in it. Just when it reaches the middle, all the static energy is converted into kinetic energy, and it continues to move without stopping and goes up until the velocity comes to the end i.e. static energy is created in it again. When it reaches the highest point, it stops, and then motion is transmitted inside it at opposite direction. Thus, the stone continues to oscillate and its energy continues to convert from static to kinetic and from kinetic to static. This process would go on forever, if energy was not destroyed for the loss of energy due to friction and other causes!



When a stone is swung by a string, there is an exchange between static energy and kinetic energy.

So, energy conversion is a very natural process. Not just the conversion can occur between static energy and kinetic energy, all forms of energy known to us can convert from one form to another. In our daily life, the energy we see around us can neither be created nor be destroyed; it only changes from one form to another. This is the law of conservation of energy.

Conversion of energy

We see many examples of energy conversion around us, such as:

Electrical Energy: To give an example of energy conversion, we can first give the example of electrical energy, because this energy can be easily converted into other forms of energy. We see electrical energy converted into mechanical energy in an electric fan. It is converted into heat energy in an electric iron or heater. Electrical energy is converted into light in a bulb, tube light or LED. Electrical energy is converted into sound energy in the speaker. We all charge the battery in our mobile phone with electricity, where actually electrical energy is converted into chemical energy.

Electrical energy convert to mechanical energy in electrical fan

Chemical Energy: Chemical energy is also very important as an example of energy conversion. The gas we use for cooking in our homes is an example of the conversion of chemical energy into heat energy. In candles, we convert chemical energy into light. Using gas, petrol, diesel or similar fuels, we see chemical energy converted into mechanical energy in various engines. However, the greatest example of chemical energy conversion in the modern technology era is the battery, where this energy is converted into electrical energy.

Chemical energy convert to electrical energy in battery

Heat energy: In terms of quantity, undoubtedlythe most energy conversion in the world takes place from heat energy. In all engines of all machines, heat energy is converted into mechanical energy. In a thermocouple, electricity can be generated directly from heat by providing heat at the junction of two dissimilar metals. We see heat converted to light energy in chemicals, in the flame or in the filament of a light bulb.

Mechanical Energy: When electricity is produced in a generator, the generator uses mechanical energy to rotate the coil of wire in a magnetic field and actually converts into electrical energy by. Heat energy is always being generated due to friction, where mechanical energy is actually converted into heat energy.

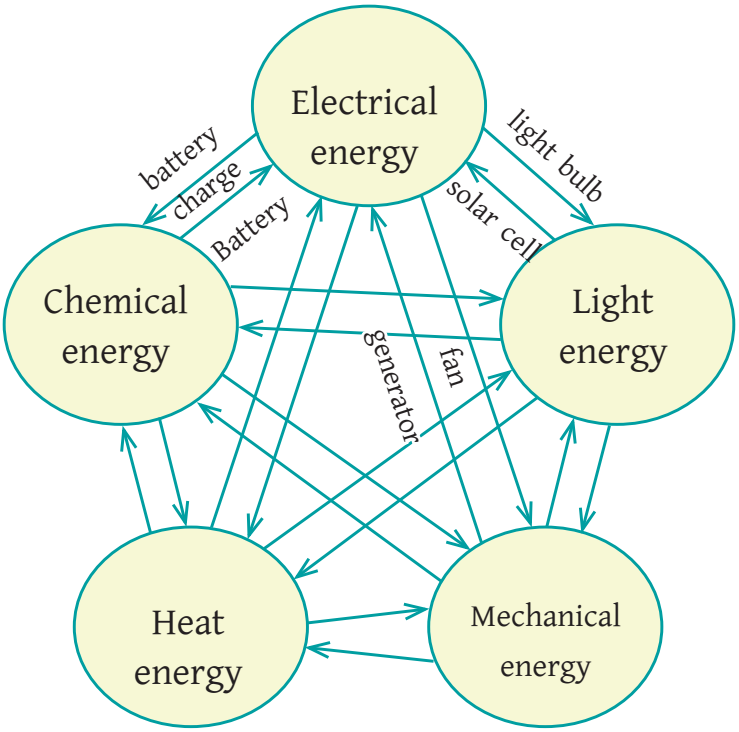
Electricity directly produce from sun light in solar panel

Light energy: Nowadays electricity is generated directly from light using solar cells. Though these days the use of photographic plate is decreasing day by day, we all know that the presence of light in photosensitive photographic plate or film generates chemical energy.

Though this kind of conversion of energy is happening all around us, we need to know one very important thing. Even though there is energy, that energy cannot be used all the time. Earth's oceans contain vast amounts of thermal energy that we cannot use. Again, whenever energy is converted from one form to another, some amount of energy is wasted.

Exercise

1. In the picture beside, there is an example of mutual transformation between three type of energy. Can you show the others?



Chapter 9

Disasters Caused by Geo-natural Causes and Their Remedies

Chapter 9
Disasters Caused by Geo-natural Causes and Their remedies

By the end of this chapter, students will be able to learn—

- ☑ local folklore, traditional rituals and beliefs about various geo-natural phenomena
- ☑ various geo-natural disasters occurred in Bangladesh and different countries in Asia
- ☑ effect of various geo-natural phenomena on living and non-living elements of the environment

The upper part of the earth consists of the oceans and the land, which we call the earth's surface. Various geo-natural phenomena occur on this surface which make us wonder. Eruptions, earthquakes, tsunamis, cyclones, tidal waves, tornadoes, floods, etc. are some such geo-natural phenomena.

Some of the processes that cause these geo-natural phenomena come from below the earth's surface and some from above-surface sources. For example, eruptions, earthquakes, and tsunamis occur mainly due to forces coming from the earth's interior. Cyclones or tornadoes occur due to changes in the force of the atmosphere above the earth's surface. These disasters cause huge loss of life as well as destroy a lot of resources. Therefore, if the causes of these disasters are known, it will be possible to reduce the damages by taking necessary precautions.

Local folklore, traditional rituals and beliefs about various geo-natural phenomena

When people did not know the reasons behind various geo-natural phenomena, they used to create various folk tales to explain these geo-natural phenomena. Since earthquakes used to strike suddenly without any warning, there were different folktales about earthquakes in almost all the countries of the world. For example, in many places in our country, there is a story that this massive Earth is actually placed on one of the horns of a gigantic bull. When the bull gets tired of carrying the mass of this Earth, it moves the Earth from one horn to the other. The Earth has to pass through a tremor while moving from one horn to another. Then an earthquake is felt.

There is also a folk tale in our Chattogram hilltracts about floods. It is said that the villagers who used to live on the top of the hills killed and ate a dragon though they were warned. As punishment, the ground erupted and flooded the entire area late at night.

In our region, there is a tradition of Frog Wedding to bring down rain from the sky during drought. Even in 2022, when there was not enough rain in some parts of Bangladesh and India, frog weddings were conducted with many festivities.

Hailstorm causes a lot of damage to crops. For this reason, gossip was there that a kind of sorcerer used to be found who could move dark clouds in the sky from one place to another by chanting spells. So farmers invited them to their area, and local people believed that during heavy storms, they looked at the sky and chanted spells to control the storm!

Various geo-natural disasters occurred in Bangladesh and different countries in Asia

Eruptions: There is no volcano in Bangladesh. The only active volcano in South Asia is located on the Barren Island of the Andaman Sea. Besides, many volcanoes exist in Japan, Indonesia, the Philippines, and at the bottom of the Pacific Ocean. Basically, these volcanoes are located around the Pacific Ring of Fire. Volcanic eruptions release large volumes of lava, gas, water vapor, ash, and rock fragments. If the volcano is explosive in nature, the material released from it can be thrown from the volcano into the surrounding area.

Volcanic Eruption

To avoid the disaster of a volcanic eruption, moving away from that place to somewhere else is the safest. Various signs are found before a volcano erupts. For example, frequent earthquakes, changes in the shape of mountains, smoke and gas coming out through the cracks in the mountains, etc. By observing these precisely, geologists predict eruptions. In that case, quick evacuation for the safety of the family members and other plans should be made in advance. As the lava, gas, etc. flows down the mountain, the path or river below the hill should be avoided. Besides, the doors and windows of the house should be closed during the eruption. Small children and pets should be kept indoors.

An earthquake-damaged city in Nepal

Earthquakes: The energy stored within the plates due to the movement of tectonic plates is occasionally released in the form of earthquakes. Earthquakes of various magnitudes occur almost throughout the year in different places worldwide. Some of these earthquakes are of such magnitude that they cause loss of life and property. Due to several fault lines around and inside Bangladesh, the people of different districts are at risk of earthquakes.

Various changes occur to Earth's surface due to earthquake. Roads and houses can be destroyed due to tremor on earth surface. Cracks in the ground can be seen in some places. During an earthquake in any area, the increased amount of water can soften the soil under a building; thus, the building can go underground. Landslides

may occur in hilly areas. In this case, if the soil or stone is loose on any side of the mountain, it falls down with great speed due to the tremor of the earthquake. Earthquakes under the sea or ocean can cause massive waves called tsunamis. Somewhere the course of the river changes. For example, the Brahmaputra river's course changed due to the Arakan earthquake of 1762. Causes of earthquakes, measurements, and do's for safety during earthquakes are discussed for you in detail in another chapter.

Tsunamis: Earthquakes at the bottom of deep seas or oceans cause a great stir in the water in that area. The shock waves travel hundreds or thousands of kilometers from the source of the earthquake and hit the seashore at different places. In some cases, these waves are several meters high and can rush in at 700 kilometers per hour. Tsunamis can wreak havoc in coastal areas due to the high speed. In 2004, a tsunami caused by a massive earthquake in the Indian Ocean killed more than 2,40,000 people in different countries. More than 165,000 people died only in Indonesia. Another tsunami in 2011 damaged a nuclear power plant in Fukushima, Japan.

The moment the 2004 tsunami hit the seabed

Tsunamis occur so quickly that there is little time for preparation. A tsunami warning is issued when an earthquake occurs under the sea. In this case, a quick warning is spread among people through radio, television, or the internet. As soon as you receive a tsunami warning, moving away from the coast as quickly as possible would be best. In addition, if there is no opportunity to go away, one should take shelter in a high place or building.

Cyclones: Cyclones occur every year in Bangladesh. Cyclones occur not only in Bangladesh but in different parts of the world and have other names depending on the region. For example, cyclones that form in the Bay of Bengal are called cyclones. Hurricanes are storms that form in the Atlantic Ocean to the east of the United States. Cyclones formed on the east coast of China are known as Typhoons. Regardless of

the name, all these are cyclones and can last for days; and affect large areas.

Variations in atmospheric pressure can cause cyclones. However, cyclones are formed in the sea and gradually move towards the land. In this case, the temperature of the sea surface water should be at least 26.5 degrees Celsius. At one stage, the cyclone becomes weak after losing its wind strength due to rain.

Image of cyclone taken from satellite

A vast area is damaged due to a cyclone. Houses and agricultural land in coastal areas are damaged due to the flood caused by a cyclone. Water logging occurs in some places. Forests can be damaged due to the destruction of forest plants; and the death of animals and birds. Of all the cyclones caused in the coastal region of Bangladesh, the 1970 cyclone recorded the highest death toll.

Some precautions are needed to be taken in cyclone-prone areas during cyclones. For example, quick evacuation plan to shelters during a cyclone should be planned. At the same time, dry food, bottled water, some money, medicine, etc. should be stored on the floor of the house or under the ground for the period after the cyclone in such a way that they last for a few days until the relief comes after the cyclone.

Tidal Bore

Tidal Bore: People living in coastal areas are familiar with tidal bores. Another disaster that occurs with cyclones is a tidal bore. Much higher waves than regular waves are created in the sea during a tidal bore. On a full moon or new moon a tidal bore

can create even higher waves. Again, the higher is the wind speed in a cyclone, the higher the height of the tidal wave is.

In the case of tidal bores, the same precautions for cyclones should be taken.

Tornado

Tornado: Tornado is another atmospheric storm. However, the difference between tornadoes and cyclones is their location and duration. Tornadoes are caused by the excess increase in the surface temperature. In this case, being hot and light, the air at that place rises upwards, and the air pressure decreases further. Then the cold and heavy air from its vicinity rushes towards the low-pressure area. As a result, the wind blows at a speed of 250-300 km per hour. The duration of tornadoes is much less than that of cyclones. In cases where cyclones last for three to four days, tornadoes last only 2 to 3 minutes. But tornadoes can cause massive destruction in small areas due to their high wind speeds. No precaution can be found for tornadoes as cyclones.

The best way to survive a tornado is to take shelter in a nearby strong building. For this reason, people in different countries build their own tornado shelters underground in tornado-prone areas.

Small Children are going for shelter due to flood

Floods: Floods are a well-known phenomenon in Bangladesh. A flood refers to an excessive flow of water that generally inundates a dry area. Floods can occur for various reasons, including heavy rain, reduction of river navigability (i.e., reduction in the capacity of the river to carry water), tidal bores, etc. There are different types of floods. For example, rainfall in mountainous areas can cause flash-flood that can quickly overflow a place.

In such floods, water recedes as quickly as the flood occurs. In other parts of the country, the flood water rises slowly, remains stagnant for days, and recedes gradually. In coastal areas, floods can occur due to waterlogging created by tidal bores and heavy rain. In densely populated urban areas, waterlogging occurs due to the blockage of drainage channels during rains. Due to floods, people suffer in many ways. Many people who do not know how to swim drown during floods. Flood waters cause extensive property damage. Apart from this, people are also affected by a lack of food and various water-borne diseases.

Pre-preparedness is essential to reduce flood damage. For example,

- The foundation of the houses should be built higher than the regular height so that flood water does not enter in the house.
- Tube wells should be placed at high places, so they do not submerge in flood water.
- Livestock is a valuable resource. For this reason, they should be sent to higher or distant places to protect them.
- Necessary items, including dry food and crop seeds, should be stocked before the beginning of the month of the flood.
- House and yard should be kept clean and dry regularly to avoid snake bites. Avoid moving in the dark at night unless there is an emergency. Carbolic acid reduces snake nuisances.
- Young children should be taught how to swim.

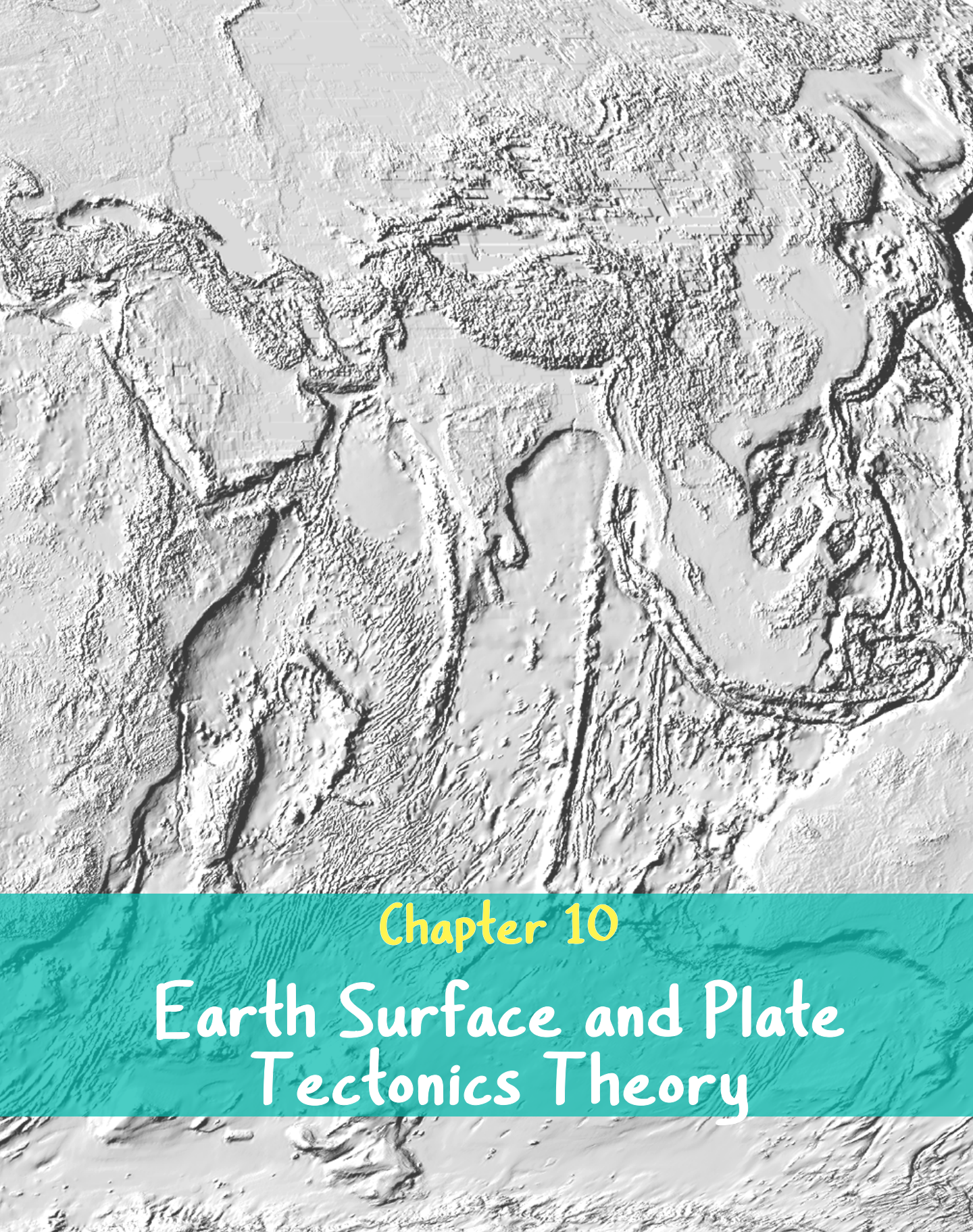
Effect of various geo-natural phenomena on living and non-living elements of the environment

All the geo-natural phenomena we learned about in this chapter affect different elements of the environment in different ways. For example, volcanic eruptions cover large areas with lava and ash. As a result, a layer of volcanic rock is created on top of the soil there. Again, in many cases, soil fertility changes, resulting in the growth of new types of plants or crops there. The course of a river can be changed if it falls in the path of lava. Again, all the toxic gases that come out of a volcano are harmful to humans and other animals. If there is a forest near a volcano, it may catch fire due to extreme heat.

Earthquakes can cause landslides and even change the course of rivers, as happened in the case of the Brahmaputra River in Bangladesh. In many cases, during an earthquake, the soil in a place can rise up and form hills. Again, the soil can get cracked or go down to create wetlands in many areas. All types of natural disasters mentioned above cause loss of property and lives.

Exercise ?

1. Why do cyclones occur annually in October-November and April-May in Bangladesh?



Chapter 10

Earth Surface and Plate Tectonics Theory

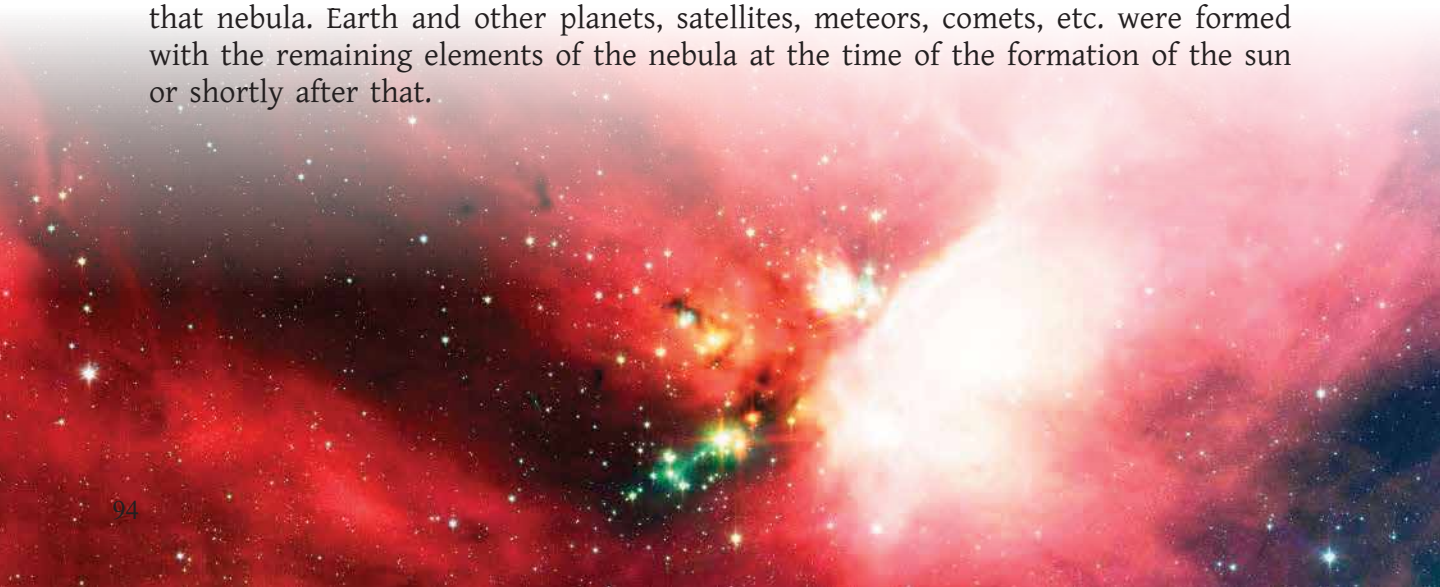
Chapter 10 Earth Surface and Plate Tectonics Theory

By the end of this chapter, students will be able to learn—

- ☑ creation of the Earth
- ☑ different layers of the earth
- ☑ continents and Tectonics
- ☑ shifting of the continents
- ☑ creation of oceans and expansion of seafloor

Creation of the Earth

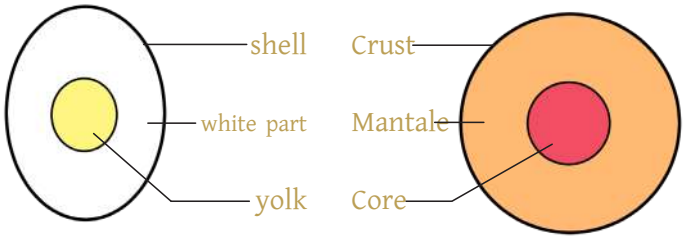
On earth, we see different kinds of clouds in the sky throughout the year. During the monsoons, the sky remains overcast and heavy rainfall occurs in different regions. The reason is that the earth's atmosphere mainly comprises microscopic water particles. But there is a type of cloud in space outside the earth called nebula. These nebulae are much larger than the earth's clouds, the Earth, the Sun, or the Solar System. A nebula is composed mainly of hydrogen, helium, and small amounts of other elements. The solar system was formed from such a nebula. The sun, the only star in the solar system, was created about 5 billion years ago with most of that nebula. Earth and other planets, satellites, meteors, comets, etc. were formed with the remaining elements of the nebula at the time of the formation of the sun or shortly after that.



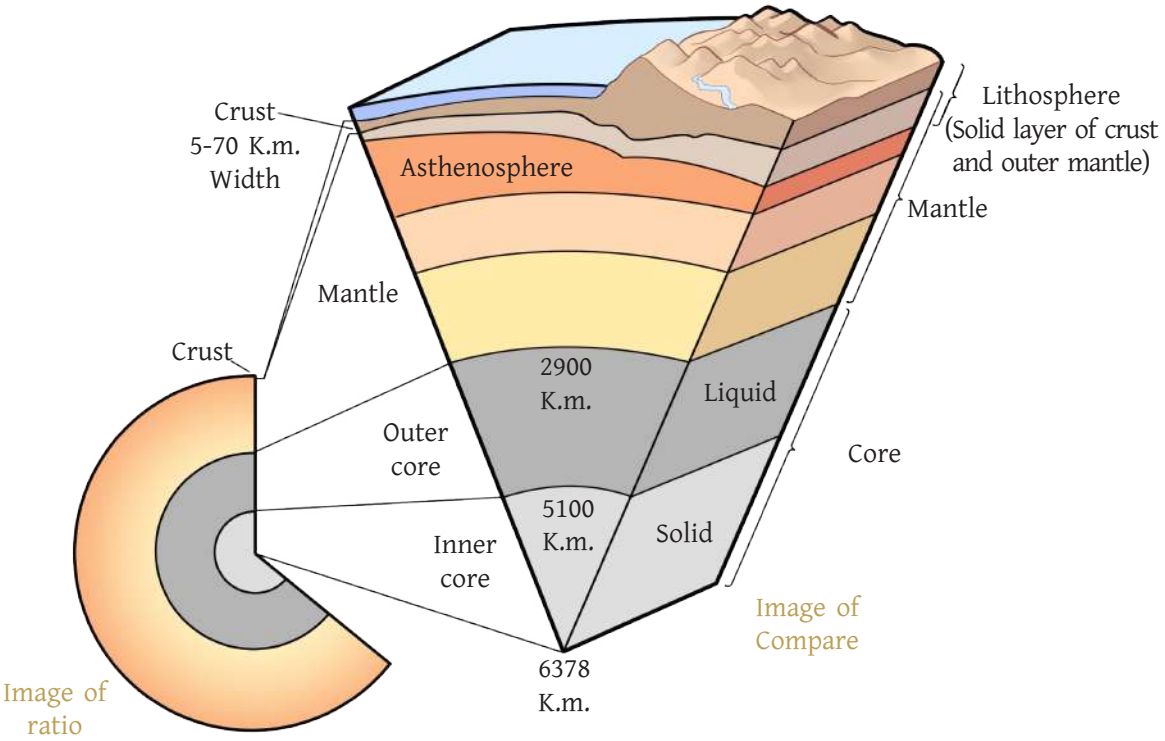
Now the question may arise in our mind of how the solar system was formed from the nebula. Every object in the universe attracts every other object with gravitational force. This attraction depends on the mass of the objects and the distance between them. Due to this attraction, if we jump up we fall back to the ground, or if a rock is thrown towards the sky, it falls back down. Similarly, in the case of a nebula, where the gas was denser or the sub-atoms of the gas were close to each other, the remaining gas began to gather there due to the force of gravity. As the nebular gas accumulates, the centre's mass increases, attracting more gas and cosmic dust. At some point, the heat and pressure increases so much that heat and light are produced through a reaction called fusion, and the sun emerges as a star. The rest of the gas and dust revolves around the Sun and eventually forms the Earth and other planets. This entire process began to be completed at least 4.5 billion years ago. The earth was very hot in the beginning. At that time, the earth's surface was liquid and flowing. Over time, the earth continued to cool. The outer part became hard and made the crust. The crust is again divided into smaller and bigger plates. Although very slowly, these plates are constantly moving.

Different layers of the earth

We can see with our own eyes everything from the various objects in front of us to the sky, moon, stars, etc. But we cannot directly see the structure of the earth's interior. That's why geologists observe the special waves created during earthquakes called Seismic Waves. These waves are generated at the center of the earthquake and get reflected from different



Inner structure of the Earth and egg



Internal structure of the earth

types of objects inside the earth in different ways, and travel at different speeds. Just as doctors take the help of ECG, X-Ray or CT Scan to understand the condition of the patient's body, geologists get an idea of the earth's internal structure through seismic waves.

There is a similarity between the earth's structure and an egg's structure. Like an egg has a thin and hard outer shell, the earth has a crust outside. Like the inner white part of an egg after the shell, there is also a mantle inside the earth. Like the yolk in the middle of the egg, the earth has a core at the center. That is, the internal structure of the earth can be divided into three main parts: crust, mantle and core.

Crust: The uppermost layer of the earth is called the crust. We live above this level and naturally know the most about this layer. This layer is thinner and more fragile than other layers. The thickness ranges from a minimum of 5 to a maximum of 70 km. This crust can be divided into two parts, (1) the relatively thick and low-density continental crust and (2) the relatively thin but high-density oceanic crust. Both these types of crust are made up of different kinds of rocks.

Mantle: The next layer of crust is called mantle. The mantle layer adjascent to the crust is hard and fragile. The solid part made up of the upper crust and the adjascent layer of the mantle is called the lithosphere.This layer of lithosphere is

divided into several large pieces and these are called tectonic plates.

The next layer of the lithosphere is not completely solid because the rock is molten due to the high temperature. So the tectonic plates floating on it are not stationary at all; they move in different directions at 3 to 5 cm per year. This movement of tectonic plates plays a crucial role in the formation of our earth. Due to the movement of tectonic plates, mountains and deep ocean trenches are formed. For this reason earthquakes and volcanic eruptions occur on earth.

The rest of the mantle is the thickest layer of earth's interior. It is about three thousand kilometers thick; and about 85 percent of the earth is made up of this mantle. Heat and pressure are extremely high at this level. The convection of heat coming out from the mantle's inner layer, i.e. core, provides the required energy to move the lithosphere floating above the mantle.

Core: The core is situated just beneath the mantle. When it was very hot and liquid at the time of the Earth's creation, iron, nickel, and other heavy elements were gathered into the earth's centre by gravitational pull. So this layer is dominated by iron, nickel, and other heavy metals. The marrow or core is divided into two parts; the upper part or outer marrow is liquid and can flow. The pressure is also high here due to the upper mantle and mass of the other layers. The flow of iron and nickel causes electrical flow here, and that electricity creates the earth's magnetic field. You all know that if you hang a magnet on Earth, it hangs along north-south for this magnetic field. As this magnetic field protects the Earth's atmosphere from the sun's damaging solar storms, this magnetic field is crucial for the survival of various organisms on Earth.

Deep inside the earth is the inner core. This layer has properties similar to the outer core, but heat and pressure are higher here. This layer is hard due to high pressure. It is believed that the radioactivity of the elements that make up the inner and outer cores is the source of the Earth's internal heating.

Continents and Tectonics

The drifting of the continents

Continents are meant for the parts of the Earth above the seas (or oceans). Three-fourth of the earth's surface is water; only one part is land.

The hot liquid surface of the early earth gradually cooled to form the present solid crust. But even though its surface is hard and cold, the earth's interior below the crust is still hot. The lithosphere, which consists of the crust and the solid upper mantle, is moving very slowly over the relatively liquid or fluid part of the lower mantle. The lithosphere is divided into many continental and oceanic plates. The movement of these plates in different directions is called plate tectonics. An example

will make it easier to understand. You may have seen cream while boiling milk in a pot on the stove at home. You will see that the cream moves if you boil the milk in low flame. As the movement of milk cream is high, it is visible to our eyes. But as the speed of tectonic plates is very low (only 3 to 5 cm per year), we cannot see it directly. However, if this movement continues for several hundred thousand years, it causes many changes in the earth's surface. As a result of this movement of tectonic plates, the continents above those plates also move. Sometimes the continents move towards each other; sometimes they move away from each other. This is called continental drift. Due to such events, South America was separated from the African continent within a few million years. As evidenced by different types of fossils obtained from both continents, once these two continents were together,.

About 2.5 billion years ago, all the continents of the world were together in one

About 2.5 billion year ago

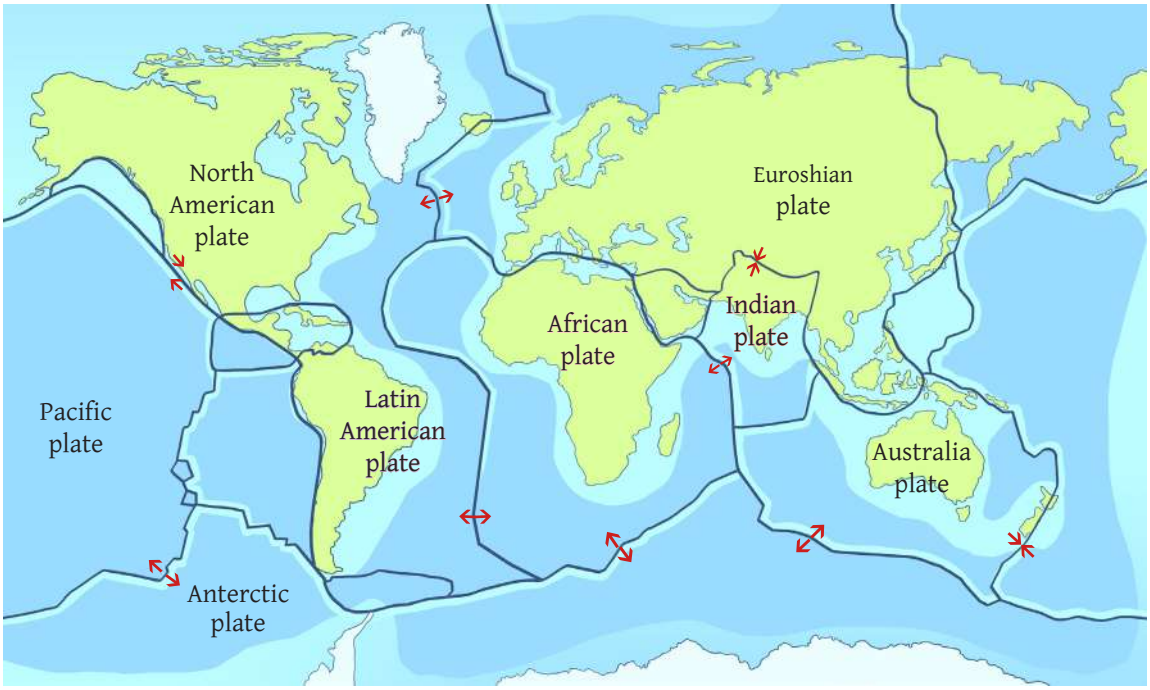
About 1.5 billion year ago

About 1.o billion year ago

At Present

Slowly movement of continent

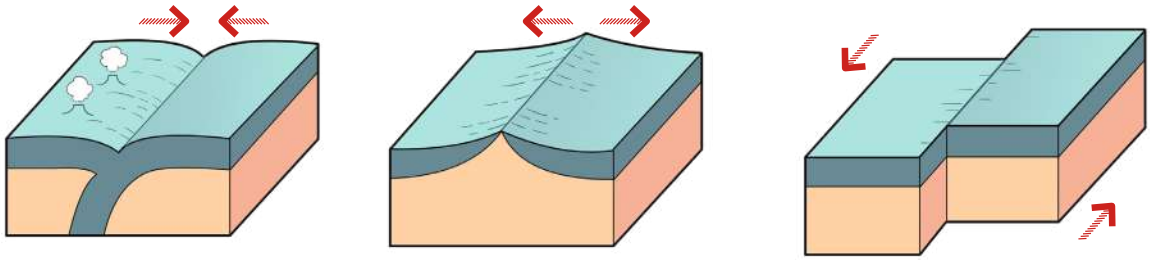
giant continent called Pangaea. Over time it it has broken into many continents. Due to the same reason, present India was separated from Australia and became part of the current continent of Asia. The present high Himalayas were formed at their connection point.



Location of Earth's various tectonic plates. Here the direction of movement of tectonic plates

Shifting of tectonic plates

You already know that the lithosphere is divided into several large and small tectonic plates; and they are moving slowly in different directions. When you read about the three kinds of heat flow, you have read 'Convection heat flow'; which also happens inside the mantle. Convection currents in the mantle cause the tectonic plates floating above it to move in different directions. In the areas where two tectonic plates lie side by side, they experience any of the following three types of displacement between them.



Shifting of tectonic plate

Formation of Himalayan from collision of Indian and Eurasian tectonic plate

Subduction: Plates can come towards each other and collide. The relatively heavier plate then slides under the other plate. At the collision boundary, the one above forms the ridge as it rises. The collision of the Indian tectonic plate and the Eurasian plate thus formed the Himalayas. The Indian plate is subducted under the Eurasian plate at the collision boundary. Subduction motion causes the creation of different types of volcanoes and earthquakes of varying magnitudes.

Mid Atlantic Ridge

Spreading: When tectonic plates move away from each other, their boundaries are called spreading plate boundaries. The Mid-Atlantic Ridge is the most striking example of a spreading plate boundary, which runs right through the middle of the Atlantic Ocean. It can also be seen on land when it exits the ocean floor and passes through Iceland. Different types of volcanoes are usually formed under the sea due to spreading motions.

Lateral: When two plates slide past each other, the junction of the two plates is called a lateral plate boundary. This type of relocation causes a lot of energy to be stored at that plate boundary, and when that energy exceeds the boundary's capacity, that energy is released through earthquakes. For example, a well-known neutral plate boundary is the San Andreas Fault Line running through the state of California, USA. An incredible amount of energy is estimated to be stored in this boundary and is expected to be released by a major earthquake at any time.

Sun Andreas Fault Line

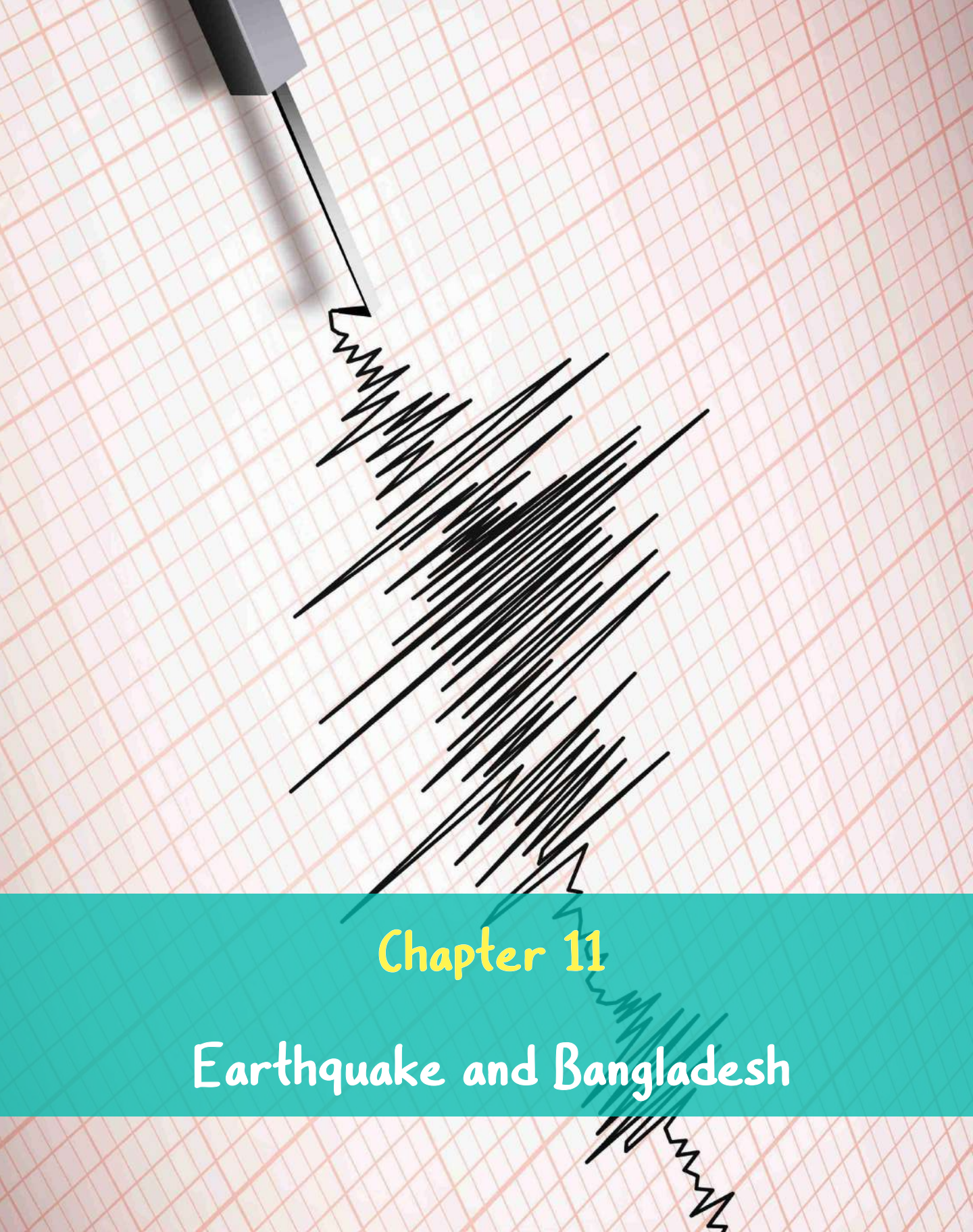
Creation of oceans and expansion of seafloor

During the supercontinent Pangaea, there was only one ocean in the whole world which was called Tethis sea. It took billions of years to create this ocean. Originally, after the earth was formed from the nebula, it experienced many meteor showers for millions of years; the water contained there was the source of the ocean. In addition, the gaseous water that came out of the earth's crust after the formation of the earth is also the source of the water of the earth's oceans.

We have seen earlier that the movement of tectonic plates can be of three types. When one plate moves away from the other, new oceanic plates may form in the gap. As a result, the seafloor expands. Because of this, the present-day South America and Africa continents moved far from each other and the Atlantic Ocean was formed between the two continents.

Exercise ?

1. Earth's radius is 6000 km. Among them, Earth's mantle is half (3000 km) as thick as Earth's radius. But this mantle contains 85% of the Earth. What is the reason for that?



Chapter 11

Earthquake and Bangladesh

Chapter 11 Earthquake and Bangladesh

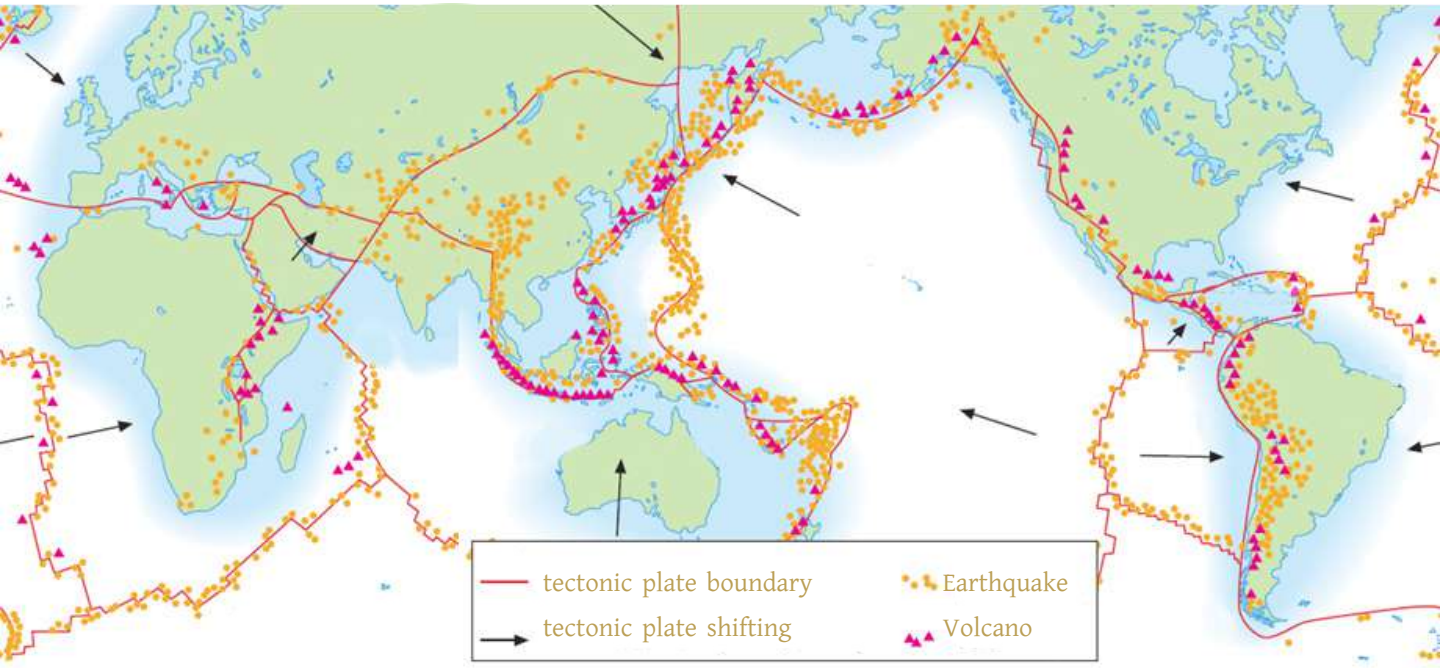
By the end of this lesson students will be able to learn—

- ☑ relation of earthquakes and volcanism with tectonic plates
- ☑ evolution of tectonic plates in Bangladesh and surrounding regions over time
- ☑ measurements of earthquakes
- ☑ earthquake safety

Many of you may have been startled when the ground beneath your feet or your house suddenly trembled. In many a cases, such a tremor instills such fear in the mind that it seems like the ground will continue to shake again. The phenomenon of such a tremor on the ground or land is known as Earthquake. Since the ground is tremoring, it is natural to think that there is something underground or something is happening that is shaking the large area, including the trees and houses above. Again, although not in Bangladesh, there are some areas of the world where molten rock or magma comes out from inside the soil and rocks (when magma comes out of the crust, it is called lava). Sometimes it happens quietly and sometimes with massive explosions. We call it a volcanic eruption. To know how these events occur, first we need to know why and how earthquakes occur.

Relation of earthquakes and volcanism with tectonic plates

Although earthquakes are not very frequent in Bangladesh, earthquakes are common in many parts of the world, such as Japan and the western United States. Currently, there are no volcanoes in Bangladesh and India. But in other parts of the world, there are volcanoes several kilometers under the ocean floor, and volcanic eruptions are continuing to happen. Geologists have found from research that earthquakes and volcanoes are closely related to tectonic plates. Earthquakes and volcanoes have been found to occur at places where two plates have separated (plate boundaries). If earthquakes and volcanisms are marked with dots (.) on world map they will correspond to boundaries between different plates.



Tectonic plate boundary black line, Earthquake site red dot and volcanic silr blue dot shows in the map

Since plate motion is very slow, a large amount of energy is stored at the boundary between the two plates over a long period of time. When plate boundaries can no longer hold that energy, it is released causing earthquakes. It is more when one plate keeps moving touching the other one.

Again, when one plate collides with another or moves away from each other, apart from earthquakes, volcanic eruptions also occur. There are volcanoes in countries like Iceland, New Zealand, Italy, Japan, the Philippines, etc. Even there are many volcanoes under the Pacific Ocean. Pacific Ocean lies on the largest tectonic plate i.e. Pacific Plate. Along the boundary of this plate are many volcanoes that look like a string of beads on maps together. Thus, this volcano-prone area is called "Pacific ring of fire".

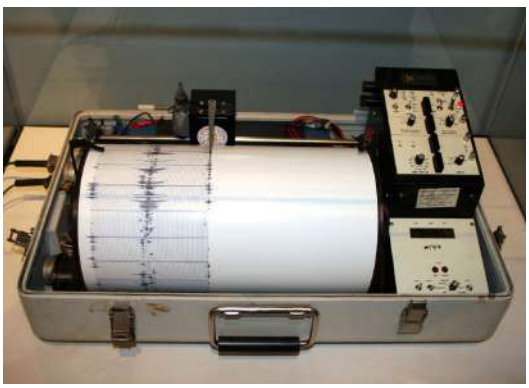
Evolution of tectonic plates in Bangladesh and surrounding regions over time

Although Bangladesh has no volcano, earthquakes occur in different regions. Bangladesh is earthquake-prone due to its geological structure, location of tectonic plates, and geographical location. Bangladesh is located in the northeastern part of the Indian subcontinent and north of the Bay of Bengal. In terms of tectonic structure, the junction of the Indian plate, Eurasian plate, and Burmese micro plate

is located in Bangladesh and nearby areas. For this reason, one or more earthquakes occur in a year in the larger Sylhet, Mymensingh, and even in Dhaka of Bangladesh.

Plate boundaries have many fault lines. The earthquakes that occur along these lines depend mainly on the motion of the plates and how long ago the last earthquake occurred. Because energy accumulates over a long period of time at the plate boundaries. The active fault lines in and around Bangladesh can produce moderate to strong earthquakes at any time. These fault lines are the Dauki fault line, Shillong plateau, Modhupur fault, Assam-Sylhet fault, and Chattogram-Myanmar plate boundary fault.

Measurements of earthquakes



সিসমোগ্রাফ

Ordinary people in our country have wrong ideas about earthquakes. When an earthquake occurs, most people think it is happening right under their feet. In fact, most of the time, it occurs hundreds of kilometers or more away; and we feel its vibrations from a distance. All of you who have experienced an earthquake in your life have noticed that the ground beneath your feet seems to move or shake. Earthquake magnitude is measured by how far the ground actually shakes and how far from the epicenter the ground shakes. This simple and common method is called the Richter scale. If we are 100 kilometers away from the epicenter and feel the tremor of approximately 100 mm (or 10 cm) stretch during the earthquake, it is called a 5 Richter Scale earthquake. The instrument used to measure such earthquakes is called a seismograph

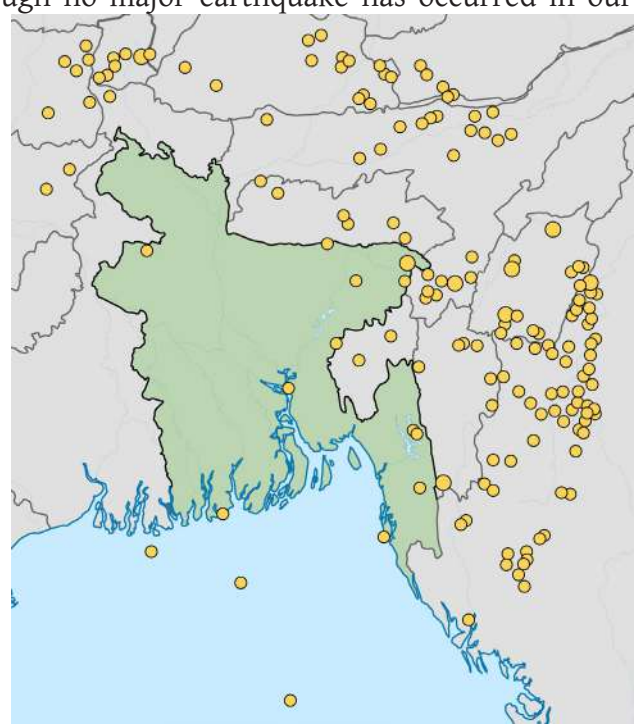
An earthquake measuring 5 on the Richter scale is a moderate earthquake. An earthquake of lesser magnitude cannot be felt in that way. When an earthquake increases one level on the Richter scale, the tremors increase tenfold! So a 6 Richter Scale earthquake is 10 times more than that of 5; that is a strong earthquake. Again, an earthquake of 7 Richter Scale vibrates ten times more than that of 6, so it is a major earthquake. A 7 Richter Scale earthquake in 2010 killed three hundred thousand people in Heiti due to a lack of earthquake preparedness. An earthquake of 8 Richter Scale vibrates ten times more than that of 7, so it can be called a terrible or great earthquake. There is hardly any examples of 8 Richter Scale earthquakes in the world. Though there are many examples of the destruction of an entire property by a 8 Richter Scale earthquake. There is also an example that in 2014 only six people died in Chile due to proper earthquake preparedness.

The farther we are from the epicenter of an earthquake, the less tremors we will experience. For example, a 5 Richter Scale earthquake can be felt 100 km away, while a 7 Richter Scale earthquake can be felt 600 km away from the epicenter.

During an earthquake, large amounts of energy are released from tectonic boundaries over a wide area. A 6 Richter Scale earthquake releases the same amount of energy as the nuclear bomb that was dropped on Hiroshima . You know that the tremor increases by 10 times per unit on the Richter scale, but the amount of energy released increases by about 32 times per unit! That is, the amount of energy released in an earthquake of 8 Richter Scale is 1000 times more than the energy released in an earthquake of 6 Richter Scale! So a 8 Richter Scale earthquake releases the same energy as 1000 nuclear bombs used on Hiroshima.

Earthquake safety

An earthquake is a terrible natural disaster that can completely destroy a country or region in just a few seconds. Even large earthquakes can change the course of rivers. At some point in the past, an earthquake changed the course of one of our major rivers, the Brahmaputra. Although no major earthquake has occurred in our country so far, according to experts, Bangladesh is at risk of major earthquakes.



The earthquakes that happened in and around Bangladesh are shown in the picture beside. As you can see in the picture, there have been no major earthquakes in Bangladesh recently, only earthquakes in neighboring countries have been felt. Since there have been major earthquakes in this region in the past, we have to assume there will also be future ones. Since we never know when that will happen, we must always be prepared.

No pre-warning for earthquakes can be found like floods or cyclones. It can strike anywhere at any time. So we should always be alert for earthquakes. The most important thing for an earthquake is to build houses and other structures according to the rules. Our country's high-rise buildings must be built according

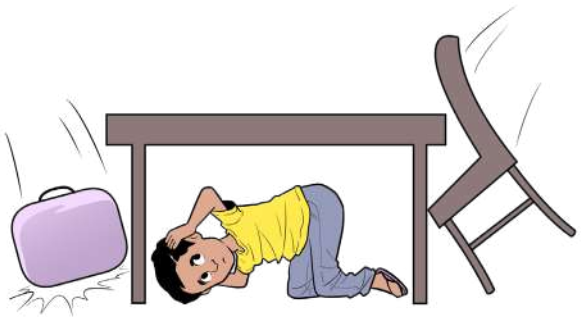
to earthquake prevention principles. If not, a major earthquake can cause terrible consequences. In general, the following points can be followed for earthquake safety.

Before an earthquake

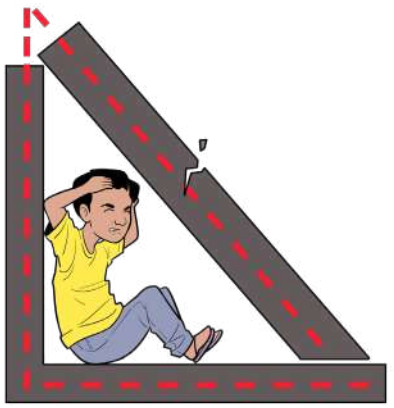
1. Fire extinguishing system should be kept in the house.
2. An arrangement of first aid kit, dry food and water should be there.
3. Know how to shut off gas, electricity and water supply at home.

During an earthquake

1. In our country we almost always feel the tremors of an earthquake of hundreds of kilometers away. Therefore, one should not lose their mind out of unnecessary fear and anxiety. If you keep cool, you can protect yourself from the danger of an earthquake.
2. If the earthquake is a major one and you are inside your house, stay there; do not try to go outside. Never try to go down using the elevator. Stay away from glass windows and stand next to walls. Take shelter under a sturdy table if necessary.

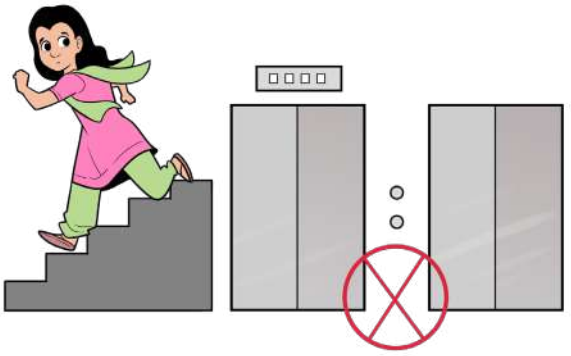


Shelter under sturdy table



If you inside of house stay next to wall and piller of house. This tringle save you.

If you outside do not lose your mind avoid fear



If go outside is necessary use step instead of elevator

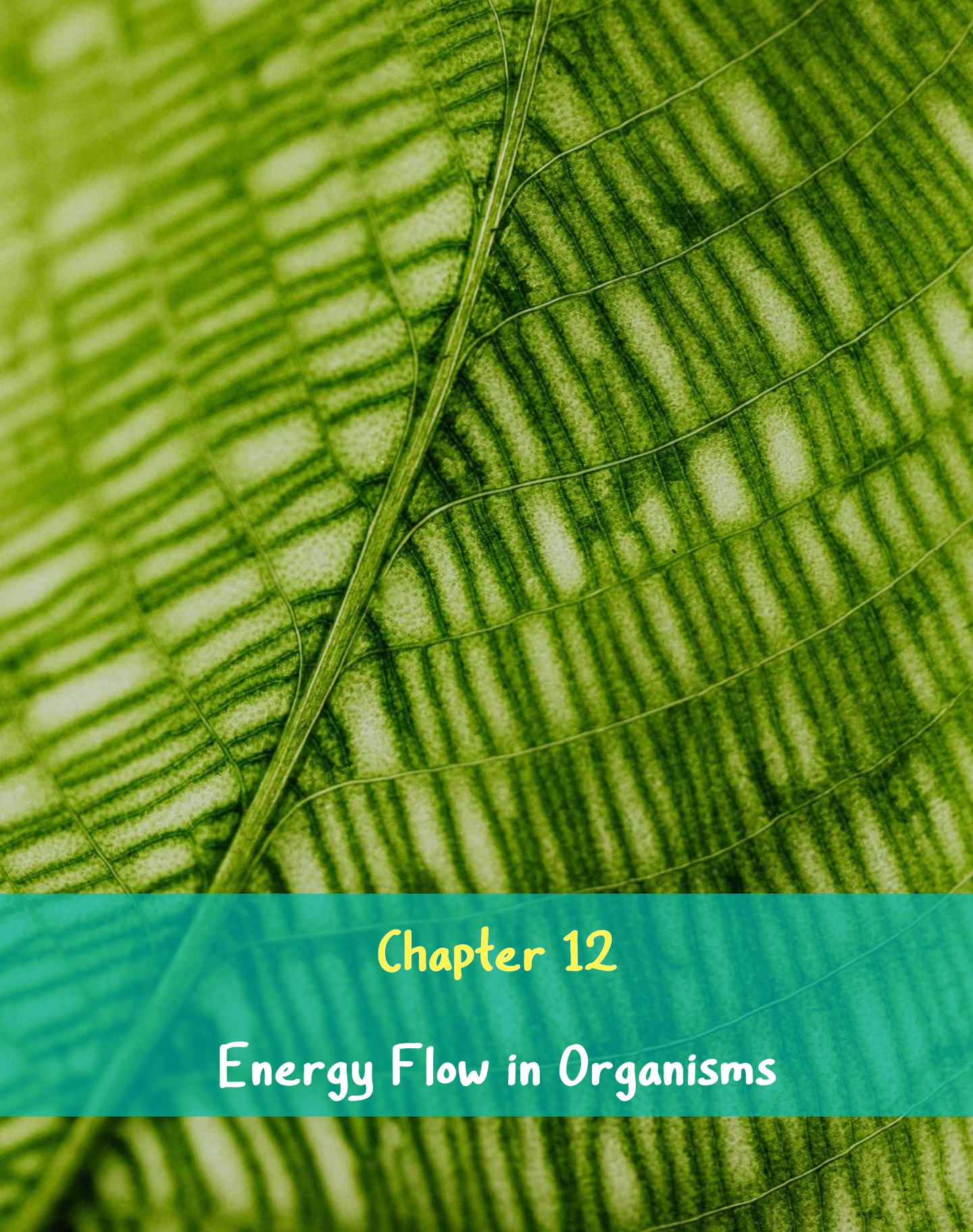
3. If you are outside, stay outside; don't try to enter the house. Move away from electric poles or large buildings. Otherwise, something can fall on your head.
4. Do not light a match under any circumstances. Gas pipes may break down, and gas can get mixed with air which is very dangerous for fire.

After an earthquake

1. If it is a major earthquake and someone is injured, provide primary treatment. If someone is seriously injured, take them to the hospital; but remember that in a really terrible earthquake many people need emergency treatment in the hospital. So those who need more will be treated first in the hospital.
2. Check water, electricity and gas lines. Shut off the supply if the line is damaged. If you can smell gas in the house, open the door and window; and go out.
3. Try listening to the news on the radio. Use telephone as little as possible. Allow relief forces to use the telephone network for emergency operations.
4. Stay out of damaged buildings. Don't walk around barefoot to avoid injuring your feet on glass sherds.
6. If you are trapped under a collapsed building, attract the attention of rescuers by hitting something regularly to signal them.
7. If there is a great earthquake, there may be more aftershocks. So, be prepared.

Exercise ?

1. During an earthquake, will you feel more shaking if you stay at a tall building's lower or higher level?



Chapter 12

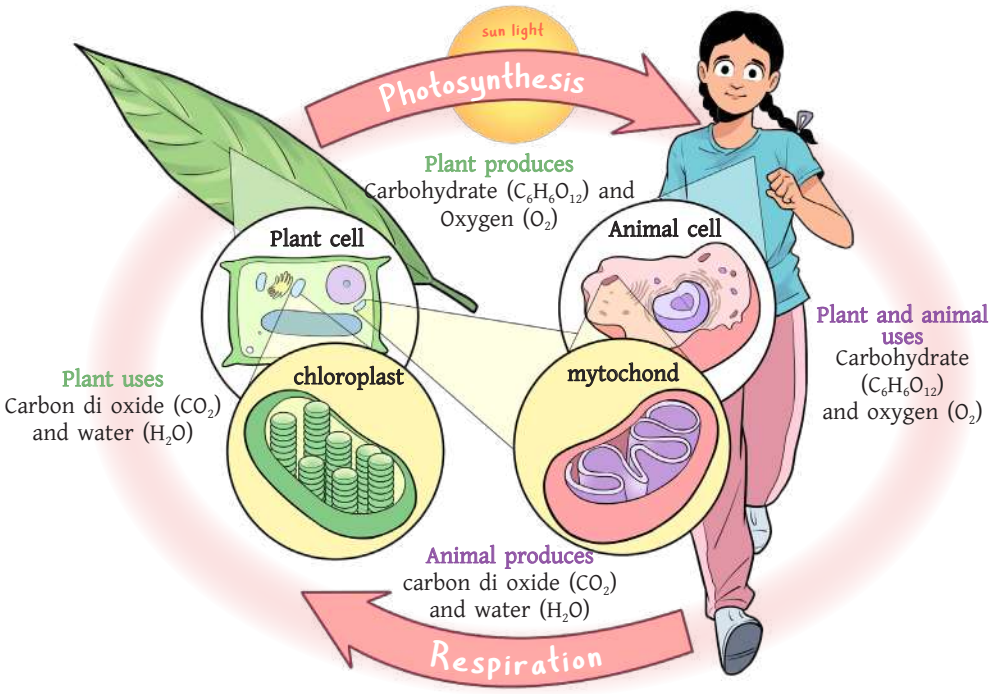
Energy Flow in Organisms

Chapter 12 Energy Flow in Organisms

By the end of this lesson students will be able to learn—

- ☑ photosynthesis and Respiration
- ☑ experiment to prove that oxygen evolves in the process of photosynthesis
- ☑ site of photosynthesis
- ☑ importance of photosynthesis
- ☑ evidence of energy production during respiration
- ☑ human respiration
- ☑ importance of respiration

Photosynthesis and Respiration



The entire living world is surviving based on photosynthesis and respiration

The diverse biosphere of the earth needs energy to survive. Do you know from where does this energy come? All the energy of the earth comes from the sun. This most important process for life on Earth is called photosynthesis. Through this, the sun's light energy is converted into chemical energy and stored in large organic molecules, especially as carbohydrates in living cells.

However, energy should not only be accumulated but also be used in various activities of the organism. For this purpose, another process works to break down carbohydrates and turn them into energy that can be used in various cell functions. The name of this process is respiration.

Photosynthesis and respiration are almost opposite processes in nature; in one process energy is stored; in the other,energy is broken down into usable energy by the cell. However, it must be remembered that photosynthesis and respiration reactions are not exactly the opposite. If the photosynthesis and respiration processes are compared, it can be understood that all living things on earth are connected. The materials involved in photosynthesis are used as the raw materials for respiration; and the materials produced in respiration are used in photosynthesis. Common substances involved in both processes are carbon, hydrogen, and oxygen. These two processes have been discovered after the long-term research of scientists. Several scientists who were associated with this research have received the Nobel Prize. Among them, the names of scientists such as Melvin Calvin, Robert Huber, Hans Krebs, Otto Warburg are notable.

Photosynthesis

The word ‘Photosynthesis’comprises two Greek words: photos (Meaning: light; here sunlight) and synthesis (Meaning: making). The Bangla word for photosynthesis is সালোকসংশ্লেষণ (স+ আলোক + সংশ্লেষণ). In a word, photosynthesis means a chemical synthesis in the presence of sunlight.

What happens at this time? What chemicals or raw materials are involved or produced in this process? Where does this most important process for the living world take place? In the following discussion we will try to find answers to these questions.

Reactions of Photosynthesis

Photosynthesis is a biochemical process that takes place in the cells of green plants and certain microorganisms (eg: green algae, cyanobacteria, etc.). The process is done in the following steps:

১. Carbon dioxide (CO_2) from the air enters the plant leaves
২. The absorbed water by the plant roots is transported to the leaves
৩. CO_2 and water react and form complex carbohydrate molecules in the chloroplast, a specialized organelle of leaf cells in the presence of sunlight. In this process, oxygen is released into nature.

Therefore, the whole matter can be said like this - Photosynthesis is the process of making carbohydrates and oxygen by the reaction between carbondioxide (CO_2) and water using solar energy. A very small simple reaction can show the whole process,

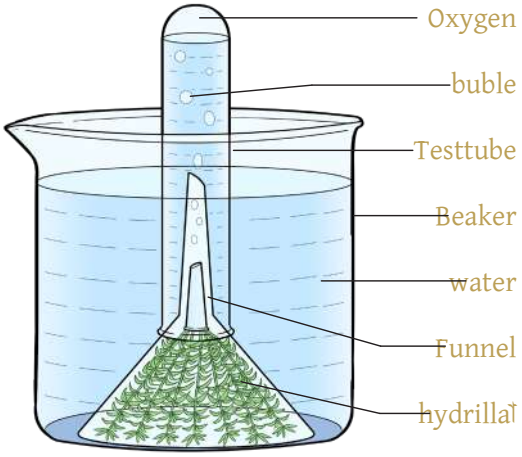
$$CO_2 + H_2O + \text{Light} \rightarrow [CH_2O] + H_2O + O_2$$

Here CH_2O on the right-hand side refers to carbohydrates.

That oxygen is produced in the process of photosynthesis can be shown through a very simple experiment.

Experiment to prove that oxygen evolves in the process of photosynthesis

Apparatus: A beaker, a funnel, a test tube, water, fresh aquatic plant hydrilla, and a firebox.



Experiment procedures: Let us fill two-thirds of the beaker with water. Placing fresh hydrilla plants in the water of the beaker, cover the hydrilla stems with a funnel in such a way so that the stems of the hydrilla remain upward in the funnel tube. Then pour more water into the beaker until the funnel tube is completely submerged. Now, filling the test tube with water and closing it with the thumb, invert it on the tube of the funnel in such a way that the water in the test tube does not come out. Then put everything in sunlight. After a while, you will see gas coming out of the stems of the hydrilla plants in the form of bubbles and accumulating in the test tube; and the water in the test tube is going down. When the test tube is almost filled

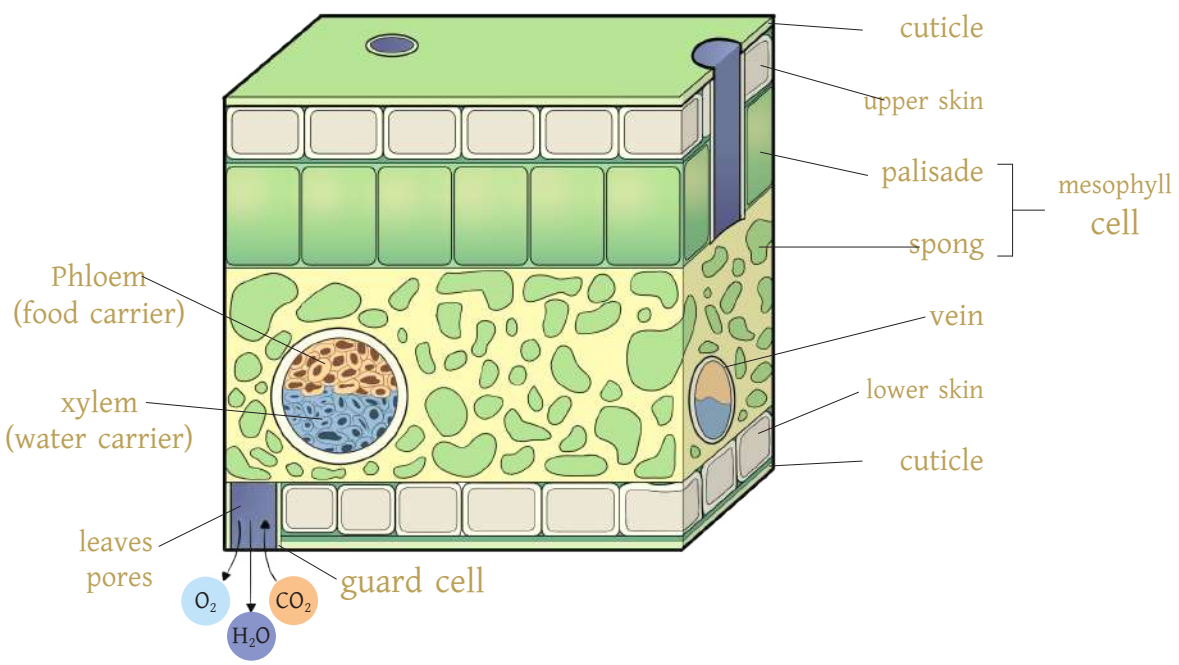
with gas, if a just blown out stick of firebox is inserted into the mouth of the test tube, the blown out stick will burst into flame. Why will the stick of the firebox burst into flames? We know that oxygen is such a gas that ignites any flammable substance when it comes in contact with it. In the above experiment, the stick of the firebox burst into flames; which proves that the gas produced in the beaker is oxygen.

Site of Photosynthesis

Photosynthesis takes place in organisms that can convert sunlight into biochemical energy. This list also includes some bacteria and algae. But most important of all are the green leaves of plants, where the ideal condition for photosynthesis is found. We will discuss only photosynthesis in plants here.

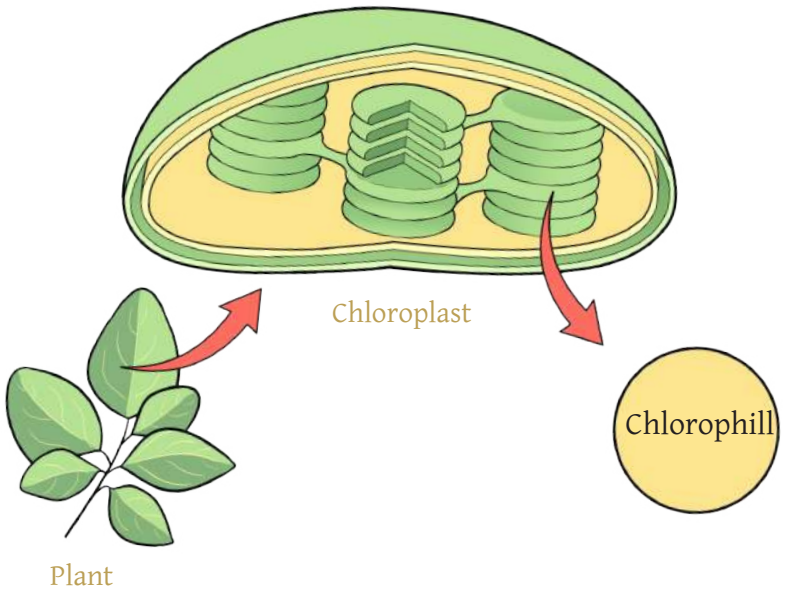
Most of the plants we see around us have green leaves. But there can be leaves of other colors as well. Leaves are the main organ of photosynthesis in plants. One of the most important characteristics of leaves is that they have small pores on their surface through which carbon dioxide from the air can enter the leaf cells. These small pores are called stomata. The stomata are protected by a special type of cell. These cells are called guard cells (photo).

Do you know why the leaves are green? Because leaf cells contain a type of



Cross section of leaf

green pigment called chlorophyll. The presence of chlorophyll is responsible for the green color of leaves. These chlorophyll particles are not scattered inside the cells. Rather, it resides in a special organelle of the plant cell called the chloroplast. The structure of chloroplast is such that it has two layers of membranes that are specially folded inside. Chlorophyll molecules are arranged in specific positions on this membrane (picture). The presence of these chloroplasts is a unique feature of plant cells. Animal cells do not have chloroplasts. Chlorophyll-rich green leaf is the main photosynthetic organ of plants. However, photosynthesis can take place in any green living cell apart from leaves, i.e. green stem (cactus, gourd, pumpkin, pui, etc.), the green calyx of flowers, and the green part of the orchid root.



Presence of chlophyll in plant

Importance of photosynthesis

Photosynthesis is a fundamental biochemical process in plants. In this process, plants produce food. The significance of photosynthesis is immense in the living world. Briefly, its importance is discussed below:

1. From the Earth's energy source sun, plants receive solar energy and convertit into chemical energy in photosynthesis.
2. This energy is transmitted to all living things through the food chain.
3. All foods on Earth for plants and animals are produced through the process of photosynthesis.
4. Photosynthesis plays a special role by balancing the ratio between CO_2 and O_2 to maintain balance in the environment.
5. Various materials necessary for human survival, such as coal, petrol, rayon, paper, rubber, medicine, etc. result from the photosynthesis process.

Respiration

Every organism constantly needs energy for various biological processes. This energy comes from sunlight in the process of photosynthesis. Energy is stored in carbohydrates, proteins, and lipid molecules in our food. Respiration is the process of converting this energy contained in food into kinetic and thermal energy in the presence of oxygen in the body. By this kinetic and thermal energy, living organisms complete physiological functions such as food intake, movement, excretion, growth, reproduction, etc.

Respiration is a metabolic process. Most organisms inhale oxygen from the environment during this process and exhale carbon dioxide. However, some simple plants and animals can carry out respiration without oxygen. Respiration that takes place in the presence of oxygen is called aerobic respiration. On the other hand, the process of respiration in the absence of oxygen is called anaerobic respiration.

Carbon dioxide is produced in both types of respiration. In every living cell of plants and animals, respiration function happens day and night.

The main reason we humans cannot live without oxygen is that our energy production is impossible without oxygen. In the presence of oxygen, the food we consume is oxidized (the reaction of oxygen with the chemical components of the food) to produce energy, and carbon dioxide is released simultaneously.

From the above discussion, it can be said that respiration is the biochemical process in which the chemical energy of food in an organism is converted into kinetic and heat energy and released after being deoxidized in the presence (or absence) of oxygen resulting in the releases of carbon dioxide and water.

The process of respiration is basically the same in different living cells of plants and animals. However, oxygen inhalation and carbon dioxide exhalation systems vary from organism to organism. The process of exchanging oxygen and carbon dioxide during respiration in the plant body is relatively simple. Plants have no specific respiratory organs. Air enters the plant body through leaf stomata, stem pores, and intracellular cavities.

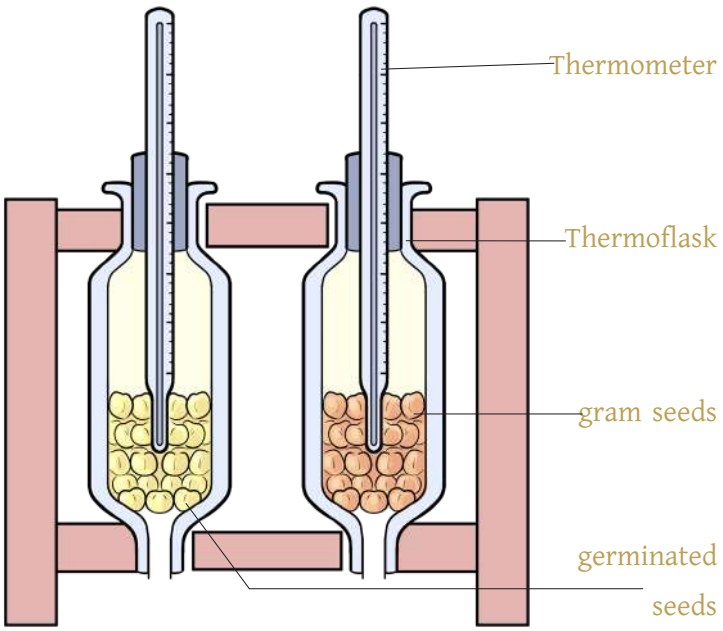
Respiration in animals is also done in different ways through different organs. In simple animals, respiration is done mainly through the skin and trachea. Complex animals have specialized respiratory organs for the exchange of oxygen and carbon dioxide in respiration. For example, fish and tadpoles perform respiration with the help of gills; and terrestrial vertebrates perform with the help of lungs.

The energy produced during respiration can be proved by the experiment described below.

Evidence of energy production during respiration

Requirements: Two thermo flasks, two thermometers, germinated gram seeds, boiled gram seeds and perforated rubber cork.

Experiment: Keeping the germinated gram seeds in a thermo flask the mouth should be closed with a perforated cork. Then a thermometer should be inserted through the hole of the cork in such a way that the lower end of the thermometer enters the germinated gram seeds. Similarly the boiled gram seeds to be kept in the other thermo flask and the other thermometer should be placed. The mercury temperature position of each thermometer should be marked.



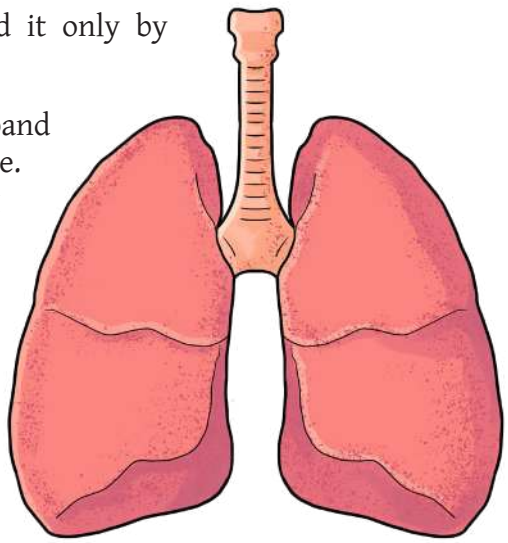
Thermometer observation:

After a while, as warmth increases in the thermo flask of the living germinated gram seed, the temperature in the thermometer also changes. The temperature of the thermo flask containing boiled seeds has not increased. That means the temperature of the thermometer placed in this thermo flask remains unchanged.

The cells of boiled grams are not alive. As a result, the respiration process is not happening there. On the other hand, in living gram seeds the process of respiration is going on in the living cells. The heat energy generated there is increasing the temperature. This proves that heat energy is produced as a result of respiration in living cells.

Human respiration

You must have noticed that when we exhale through the nose (and mouth), we see the air coming out like light smoke in winter. We usually inhale air through the nose and exhale. Our chest constantly contracts and expands like a blower. Thus, the size of the lung increases and decreases. You will feel the matter if you put your hand on the chest. Take a deep breath and let it out. This is essentially a visible step of your respiratory system. However, we cannot see the part of the respiration process that takes place inside the cells with the naked eye. We can understand it only by experimenting.



lungs

The lungs continuously contract and expand inhaling oxygen and exhaling carbon dioxide. This continuous intake of oxygen and exhaling carbon dioxide is known as the breathing process. It is a phase of respiration. The respiration process is divided into two parts. For example, 1. External respiration, and 2. Internal respiration.

1. External respiration: The process of gaseous exchange in the lungs is called external respiration. At this phase, oxygen and carbon dioxide are exchanged between the lungs and the blood. External respiration is done in two phases, namely inhalation and exhalation.

(i) Inhalation: The oxygenated air we take in from the environment is called inhalation.

(ii) Exhalation: The exhalation phase begins immediately after inhalation. At this phase, our lungs become contracted and small in size. Thus, air and carbon dioxide gas of alveoli is transported out from the lungs through the nose.

2. Internal Respiration: In internal respiration, the food inside the body's cells is oxidized with the help of oxygen and converted into kinetic and heat energy. The oxygen that enters the lungs is carried to each cell's interior. It then produces energy by reacting with food inside the cell chemically. As a result, heat energy and carbon dioxide are produced. This carbon dioxide is again carried by the blood and returned to the lungs.

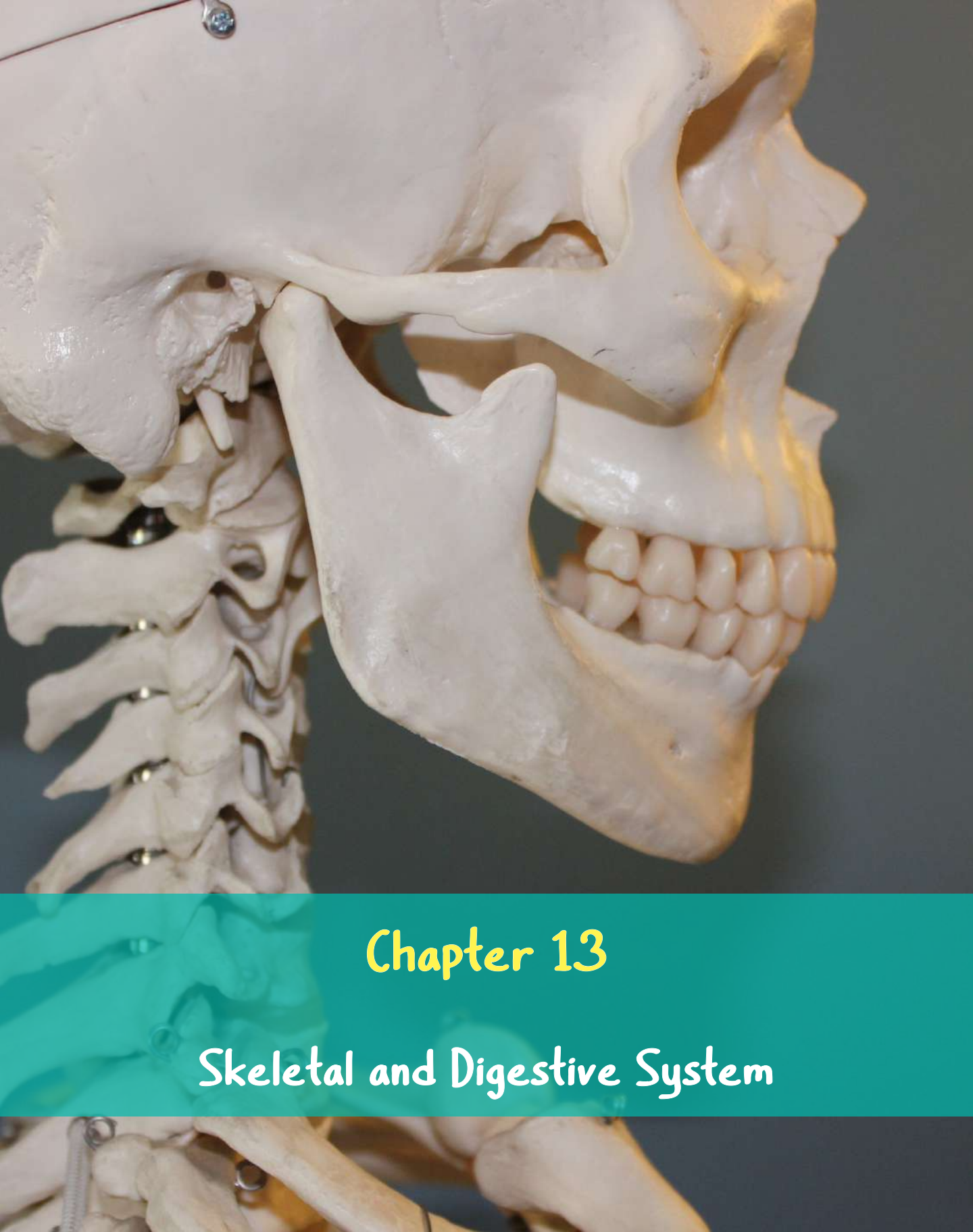
Importance of respiration

Respiration is vital for the energy utilization of organisms. An organism needs energy

to keep every biochemical process active; and this energy comes from respiration. The carbon dioxide exhaled during respiration is used directly or indirectly in photosynthesis; and the carbohydrates are produced. This prepared food saves the life of the entire living world. The process of respiration is crucial for the normal functioning of our cells. If there is any abnormality in this process, our body's balance is hampered and we get affected by various diseases.

Exercise

1. What would the world be like without photosynthesis?



Chapter 13

Skeletal and Digestive System

Chapter 13 Skeletal and Digestive System

By the end of this chapter, students will be able to learn—

- ☑ skeletal system
- ☑ bones
- ☑ bone joints
- ☑ functions of the skeletal system
- ☑ digestive system
- ☑ digestive glands and their functions
- ☑ some common digestive diseases and their remedies
- ☑ care of the digestive system

In our country, those who study in schools like you, each of them has a different kind of school. Some are in the middle of a busy city; some are in the quiet countryside. Someone's school is a massive building; someone's is some tiny building. But have you noticed how the school building is made? Who keeps the school running?

A building is made on this type of skeletal

If you search, you will know that, first of all, a structure is required to construct a school building. The structure is made of strong iron or steel rods in brick-built buildings. Then bricks, broken pieces of bricks, etc. are used in this structure. Then, walls, roofs, doors, windows, etc. are consistently built. The structure of a thatched or semi-brick building is made of bamboo, wood, or iron poles. A tin fence is added on this structure; a tin roof is set on top. After all, to make a usable house, a structure is a must. After the completion of the schoolhouse, teachers and students come here. They keep the school running by doing their individual work.

As you have seen in this example, you will get the similarity of it to our body. Like the example of the schoolhouse, our body has a structure. The structure of the human body is called the skeleton. Our body has muscles, skin, etc. on this skeleton.

Organs like lungs, heart, liver, etc. are there in a body. Different body organs are doing their jobs properly - one part is helping another. Thus they keep our bodies active.

In the 11th chapter of grade 6 book, there is a brief introduction to the human body. If you want, you can quickly have a look at that chapter managing it from the juniors. Starting from the body's cells, how different organs and systems are formed is briefly discussed there. When several organs are employed together in the same function, they are considered a system.

Human body form on the skeletal system

So it can be said from the above discussion that the skeleton and the related organs of our body form a system. Because they collectively do the job of providing a structure to our human body. Our muscles are directly attached to the skeleton. The muscles join the skeleton in all the activities like moving, eating and reading books. For this reason, skeleton and muscles can be discussed as musculoskeletal systems.

It is not enough to have only a structure of the body. It needs growth; it needs to be kept alive. Everything we do to stay alive requires energy. This energy comes from our food. Another system in our body breaks down the food we eat and extracts nutrients for sendingto our cells. It is called the digestive system.

In this chapter, we will learn about the skeletal and digestive systems in detail. Some new names and words may come into the discussion. But first of all, notice what they are doing and how they are doing it. Then familiarizing yourself with new names or words will not be a problem.

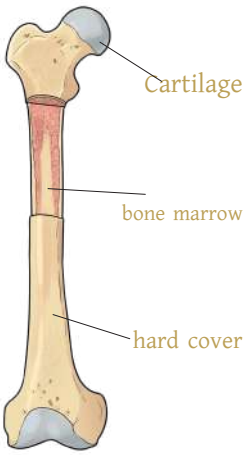
Skeletal system

The hard and soft bones of the body provide a structure to our body. Many of you may know that the meaning of 'bone' in Bangla may be হাড় বা অস্থি. In discussing the skeletal system we will use the term 'bone'.

The skeletal system comprises bones and cartilage (soft bones), which form the body's main structure and protect the internal vital and soft organs from external injury. The skeletal system of the human body consists of an exoskeleton and an

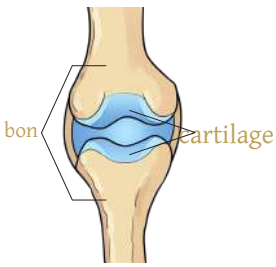
endoskeleton. As you can understand from the name, the endoskeleton stays inside our body. So it cannot be seen from the outside. On the other hand, the exoskeleton refers to the visible hard organs of the body like nails, teeth, fur, hair, etc.

Bones



Parts of bone

If you press your own hands and feet a little hard, you will feel the presence of hard bones under the skin. A bone may seem to be solid and lifeless. But it is not true; bone is a living tissue. This tissue is formed with both hard and spongy material. The outer part of a bone is hard, but spongy materials lie in the inner part called bone marrow. 40 percent of bone marrow is organic and the remaining 60 percent are inorganic materials. The inorganic part is composed of calcium phosphate and calcium carbonate. Bones normally contain 40-50% water. Like other organs, each bone has a blood and nerve supply. Note that through the nerves we, as well as all animals, can receive any stimulus or excitement and respond to it by adapting to the environment; and can coordinate with other body parts.



Cartilage at junction of two bones

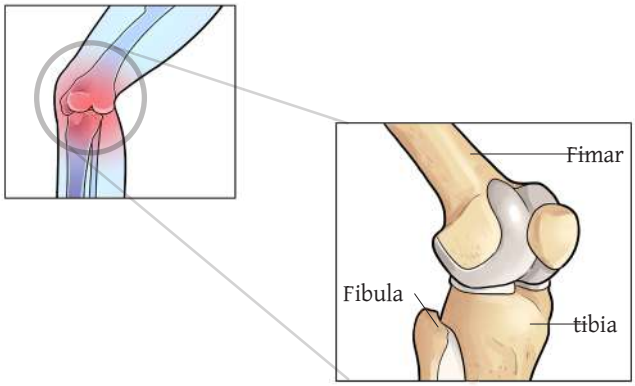
Cartilage: Cartilage is relatively flexible and lively compared to bone. Generally, cartilage is foundat the end of a bone likea bluish coating. Cartilage facilitates bone movement. It stays at the junction of two or more bones which is called bone joints. The surface of the cartilage is usually smooth. You must have seen that the body of a newborn baby is very flexible. This is because its body is mainly made up of cartilage. With age, these cartilages gradually turn into hard bones.

Periosteum: The strong and thin covering that surrounds the bone is called the periosteum. Blood vessels and nerves can travel through the outer layer i.e. periosteum. Moreover, the muscles and tendons necessary for bone movements or circulation get attached here. Here let us briefly inform you that the body muscles work for the movement of different organs of the body. A tendon is a connective tissue that connects bones with muscles. You will know more about these in the upper classes.

Bone joints

The bones of the human body are connected to each other in various ways to form the endoskeleton. The junction of two or more bones is called a bone joint. The bone edges of each joint are held tightly by a flexible string-like brace so that the bones

cannot easily move out of the joint.



synovial joint in human knee

Some joints are quite rigid, such as the joint of the skull and the pelvic joint at the waist. Some joints can move slightly allowing us to bend the body forwards, backward, and sideways, such as the spine's joints. Apart from these, the body has more than 70 muscles that can be easily moved. These are called synovial joints. At the synovial joint, a ball-like circular part is placed within the hole of the other bone in such a way that the joint can move in all directions. The bones can move easily due to the oily substance called synovial fluid in such joints. Elbow, knee, and shoulder joints are included in synovial joints.

Functions of the skeletal system

- A skeleton helps to give the body a definite shape and forms a strong structure of the body.
- It helps in movement by forming joints.
- The skeleton helps the body stand upright.
- From the embryonic stage until the end of life, the skeletal marrow produces different types of blood cells. For this reason, bones are called the factory of blood production.
- It plays a special role in controlling all internal pressures in the body.
- The related part of our skeletal system provides primary protection to our body's highly sensitive and soft organs, like the brain, heart, lungs, stomach, etc., from any external damage.

Digestive system

Eating food is one of the most common activities we do every day. But, have you ever thought about how our body uses the various foods we eat? Those cells by which all our body functions are carried out, none of them can directly utilize the food we consume. Instead, it breaks down all the food and extracts some elements that provide energy and nutrients to the body. Through this, the body's survival and repair work is done. In this process, the body takes in what the body needs and the rest is excreted as waste or unnecessary. The system that works to do this is called the digestive system. All living things need energy to survive; this energy comes from digesting food.

We eat food with the mouth. After swallowing, we no longer can see the food. Within hours, this food is digested into simpler substances, which the body absorbs. The body excretes undigested waste in the form of stool or waste. The mouth is an open end of our body. And the stool or waste is removed from the body through another open end of our body. It is called the anus. We do not have direct control over the conversion of the food staff inside our body that happens between food intake and excretion. We can not even see these functions from outside the body. This happens automatically in a healthy body.

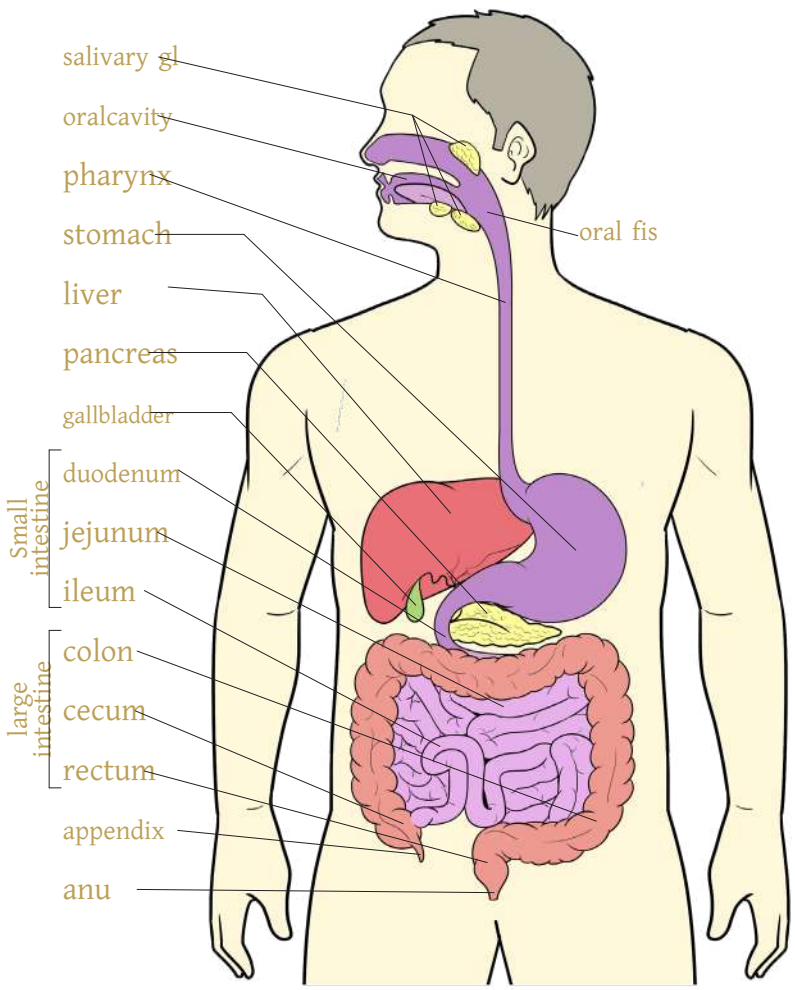
The digestive system is one of our body's most clearly defined systems. This system starts from our oral cavity. The hollow tube-like portion from the end of this oral cavity is called the esophagus. This tube runs through our stomach and ends at the anus through which stool is excreted from the body as waste. The different parts of the tube that starts from the mouth to the end of the esophagus are divided into different names. In addition, some other organs are involved with this esophagus which helps in the digestion of food. The digestive system refers to the esophagus and its associated organs.

Now, we will know about the names and functions of different parts and organs of the digestive system.

1. Oral fissure: The gap between our upper and lower lip is the oral fissure. In the conventional sense, we simply call it 'mouth'. We take food by opening our lips. The food we eat enters the esophagus through the oral fissure.

2. Oral cavity: The position of the oral cavity is just after the oral fissure. Two jaws of teeth surround the oral cavity at the front. The number of permanent teeth in adults is 32; 16 in the lower jaw and 16 in the upper jaw.

Above the oral cavity is the



Parts of digestive system

palate and below is the fleshy tongue. Inside the jaw there are three glands which we know as salivary glands. The juices secreted from there helps in the ingestion, deglutition, and digestion of food. Teeth help cut up large food items into small pieces and crush them to soften. During this, the tongue tastes the food and passes the food repeatedly under the teeth to help to chew. The saliva secreted by the salivary glands lubricates the food and helps in swallowing the food. Saliva contains an enzyme called amylase, which partially breaks down carbohydrates. Later, the organs of the digestive system break down carbohydrates completely to produce energy.

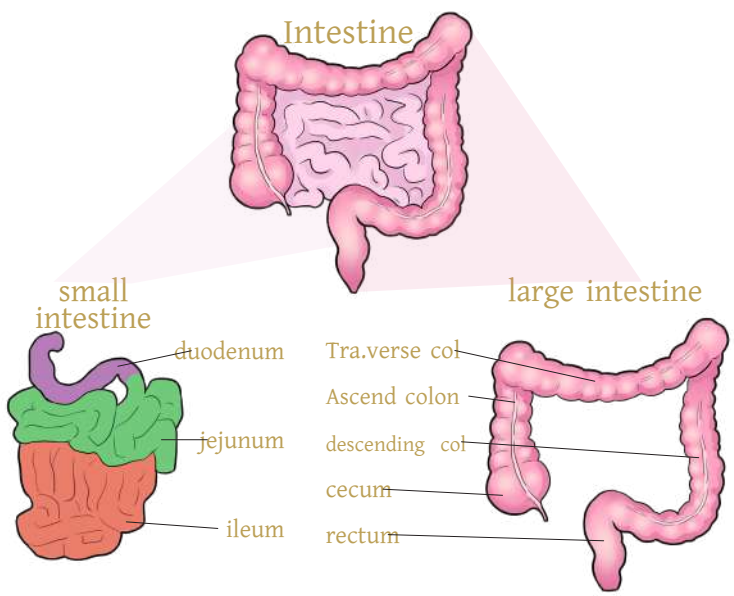
3. Pharynx: It is located just after the oral cavity. Through this, food passes from the oral cavity to the esophagus. No enzymes are secreted in the pharynx. So, no food is digested here.

4. Esophagus: It is located between the pharynx and the stomach. Food passes through it from the pharynx to the stomach.

5. Stomach: It is located between the esophagus and the small intestine. As a result of continuous contraction of the pharynx and esophagus, the slippery food material is stored here. The stomach is shaped like a bag. Its wall is quite thick and muscular. The stomach wall contains many glands called gastric glands. Food is temporarily stored here. A type of juice is secreted from the gastric gland which contains various enzymes. This juice, known as gastric juice, helps digest carbohydrates, protein, and fatty foods.

6. Small intestine: The small intestine is the next part of the stomach. It is also the longest part of the digestion tube. The small intestine is divided into three parts, namely (a) duodenum (b) jejunum and (c) ileum.

(a) Duodenum: It is the first part of the small intestine. It is located just after the stomach and 'C' shaped. Bile from the gallbladder and pancreatic juice from the pancreas come here through the duct and mix with food. These juices also take part in digestion. Digestion of protein, carbohydrates,



parts of intestine

and fatty food takes place here.

(b) Jejunum: It is the part between the duodenum and ileum. It is the widest part of the small intestine where the digestion of food continues.

(c) Ileum: It is the last part of the small intestine. The inner wall of the ileum contains the absorption mechanism. Through diffusion, the wall contains finger-like projections (which help increase absorption). Together they are called villi. After digestion, the essence of food is absorbed by villi.

7. Large intestine: The large intestine starts just after the small intestine. It extends from the ileum to the anus. Although called the large intestine, it is shorter than the small intestine in length. But the internal diameter is greater than the internal diameter of the small intestine. The large intestine is divided into three parts. They are, (a) cecum (b) colon and (c) rectum. The rectum is the end of the large intestine. It looks like a bag. The undigested part of the food is stored here as stools.

Food is not digested in the large intestine. No digestive juices or enzymes are produced here. Instead, the large intestine mainly absorbs water from the aqueous portion of food. This work is very essential. As a result, excessive drainage of water from the body is prevented.

8. Anus: This is the end of the digestive tract. By this end the digestive tract opens to the outside of the body. That waste portion of the food stored in the rectum as the stool is expelled out of the body through this anus as needed.

Digestive glands and their functions

The glands associated with the digestive tract whose secreted juices participate in the digestion of food are called digestive glands. Digestive glands include salivary glands, liver, and pancreas.

Salivary gland: This gland secretes saliva. Saliva contains enzymes and water. Water softens food. The enzyme of saliva is amylase.

Liver: The largest gland in the body is the liver. Bile is produced from the liver. Bile is stored in the gallbladder. During digestion, bile enters the duodenum through the bile duct and mixes with food. Bilehelps digest fatty foods.

Pancreas: Mainly three types of enzymes are produced in the pancreas-amylase, protease and lipase. They enter the duodenum and mix with food. Two protease enzymes, trypsin and chymotrypsin, help the digestion of protein. Lipase helps in the digestion of fatty food, and amylase helps in the digestion of carbohydrates.

Gastric gland: The gastric gland is located on the inner wall of the stomach. The juice secreted by this gland is called gastric juice or digestive juice.

Intestinal gland: The villi of the wall of the small intestine contains numerous intestinal glands. The juice secreted by this gland is called intestinal juice.

Some common digestive diseases and their remedies

The health of our whole body greatly depends on the health of our digestive system. If we do not follow proper hygiene and do not live our life properly, several common diseases can be noticed in our digestive system. The fact is briefly discussed below.

1. Gastritis: Usually, eating more spicy and oily food and irregularity of taking food causes heartburning and acidity. It produces excess acid in the stomach and causes discomfort or a burning sensation in the middle of the stomach or chest. As a result, various symptoms occur, including throat and stomach irritation and abdominal pain. If this disease is not treated in time, it can cause ulcers in the stomach and intestines. Then it is called a gastric ulcer.

This disease can be prevented if you regularly eat less spicy and less oily food and eat on time.

2. Dysentery: Dysentery is a well-known disease in our country. Dysentery is mainly caused by bacterial infection. There are two types of dysentery: (a) Amoebic dysentery and (b) Bacillary dysentery.

(a) Amoebic dysentery: This type of disease occurs mainly when a type of unicellular organism called Entamoeba enters the human intestine. The symptoms of this disease are pain in the lower abdomen, blood or mucus in the stool.

This disease can be prevented by drinking tubewell or boiled water, ensuring water and vegetables are not contaminated,and protecting food items from flies and cockroaches. However, the patient suffering from this disease needs to take medicine on the doctor's advice.

(b) Bacillary dysentery: This type of dysentery occurs when a type of bacteria called Shigellaattacks our intestines. These bacteria attack the membrane of the largeintestine. This results in frequent bowel movements and the discharge of slimy mucus. Sometimes blood comes out with stool. That is why this disease is called blood dysentery. It is not right to ignore the disease. Treatment should be taken on the advice of a doctor. This disease can be prevented by following general hygiene rules.

3. Constipation: It is an abnormal physical condition when a person cannot discharge stool easily. Constipation is usually characterized by: bowel movements in one to two days and discharge of dry and hard stools. Constipation is not a disease. But sometimes, it can be a symptom of other diseases. Various reasons can cause constipation. For example, slow movement of food through the alimentary canal, not eating fresh fruits and vegetables, not discharging stools when emergency, etc. Prolonged constipation can damage the anus and can cause severe pain. Most people may encounter this experience at some point in their lives.

By doing some exercise regularly, regular bowel habits, and regular consumption of vegetables, fruits and fibrous food, this difficulty can be removed to a large extent. However, if this problem persists long, one should consult a doctor for treatment.

Care of the digestive system

Digesting food gives us all the energy needed to keep us alive. That is why our healthy digestive system is so crucial for our healthy life. We can keep our digestive system healthy by following some simple rules.

Care of the digestive system starts with our mouth. Teeth should be brushed and cleaned after every meal. If food particles get stuck between the teeth, it rots and gives terrible breath. Teeth decay. It is not right to overeat sweet food. Sweets are responsible for tooth decay.

The food we eat should be clean and well cooked. Stale and rotten food should not be eaten. Fingernails must be kept short, and dishes and hands must be cleaned before eating. Food should be eaten at regular intervals. Do not eat more food at once. Always try to eat a balanced diet. Adequate water should be consumed shortly after eating. Always drink boiled water or safely filtered water. Food should be chewed slowly and thoroughly. Foods with more spices and oil should be avoided. Fast food is harmful to our bodies. You should never get addicted to such food.

Exercise ?

1. Apart from the diseases related to digestion mentioned in your book, can you name some other diseases you know?

2. Which of our joints can move in all directions?

Chapter 14

Different Types of Rocks

Chapter 14 Different Types of Rocks

By the end of this chapter students will be able to learn—

- ☑ sedimentary, Igneous and Metamorphic Rocks: Structure and Uses
- ☑ identification of rock types based on physical and chemical properties
- ☑ different elements of rocks
- ☑ role of force and energy in the formation of rocks and minerals
- ☑ various mineral resources and ores

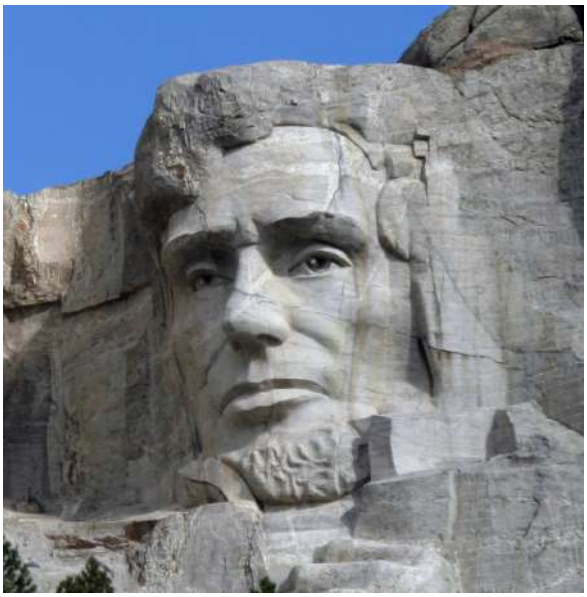
The outermost or uppermost layer of the Earth is known as the crust. This crust is made up of different types of rocks. The rocks found in the Earth's crust are divided into three main categories: (1) igneous rocks, (2) sedimentary rocks and (3) metamorphic rocks. Among the three types of rocks mentioned above, igneous rocks are the most abundant in the world. Besides, small amounts of sedimentary and metamorphic rocks can also be found in different areas.

Sedimentary, Igneous and Metamorphic Rocks: Structure and Uses

Igneous Rocks: Igneous rocks are formed when molten lava from volcanic eruptions or the molten magma under the Earth's surface cools and hardens. They can be formed on the Earth's surface or below the Earth's surface. If formed on the Earth's surface, it is called extrusive rock; if formed below the Earth's surface, it is called intrusive rock. The main difference between these two types of rocks is that the lava cools very quickly and hardens in extrusive rocks. Large crystals are not seen in this type of rock because the lava cools quickly. Granite is an example of such a rock.

On the other hand, intrusive rocks are formed when magma under the crust gradually cools and hardens. As it cools slowly, crystals of various types of minerals are formed in this type of rock. Different precious gemstones are found in this type of rock in some parts of the world.

The major constituents of the crust are igneous rocks (about 90% to 95%). In most places, the igneous rock is not visible due to sedimentor sedimentary rock layers.



A large granite statue of Abraham Lincoln at Mount Rushmore in the United States

However, various types of igneous rocks can be seen over a wide crust area in volcano-prone areas.

People have used igneous rocks for various purposes since ancient times. Granite is commonly used for constructing large buildings and sculptures. Granite tiles are very hard and durable. Exogenous igneous rock called pumice is so light that it floats in water due to gas trapped inside it when it is formed. Light stains on jeans fabric are made by rubbing pumice. Pumice powder is used in toothpaste for easy cleaning of teeth.

Sedimentary Rocks: You must have seen muddy water flowing in rivers during monsoons. Water appears muddy due to the different sizes of clay particles in the water. If you fill this water in a clean bottle and keep it somewhere for two days without shaking it, you will see that the water in the bottle looks clear, and a thin layer of soil has fallen on the bottom of the bottle. This residue is called sediment. Sedimentary rock is formed by the accumulation of sediments over millions of years. All these sediments include pebbles, sand, mud, remains of dead organisms etc. Besides, when the water dries up, various chemicals dissolved in it combine and form sedimentary rocks.

Most of the sediments are transported by river water. These sediments in the flowing water tend to accumulate along the riverbanks and where the river ends. When these layers harden, they preserve that layer of sediment and become sedimentary rocks. More layers of sediment fall on top of that sedimentary rock, which later becomes new sedimentary

Layers of sedimentary rock

Fossils in sedimentary rocks

rock. In this case, the latest layer is at the top, and older sediment or sedimentary rock layers are progressively lower. Fossils are found in sedimentary rocks, and by seeing which fossils are found in which layers, scientists can understand how long ago an animal survived on the Earth and how it evolved.

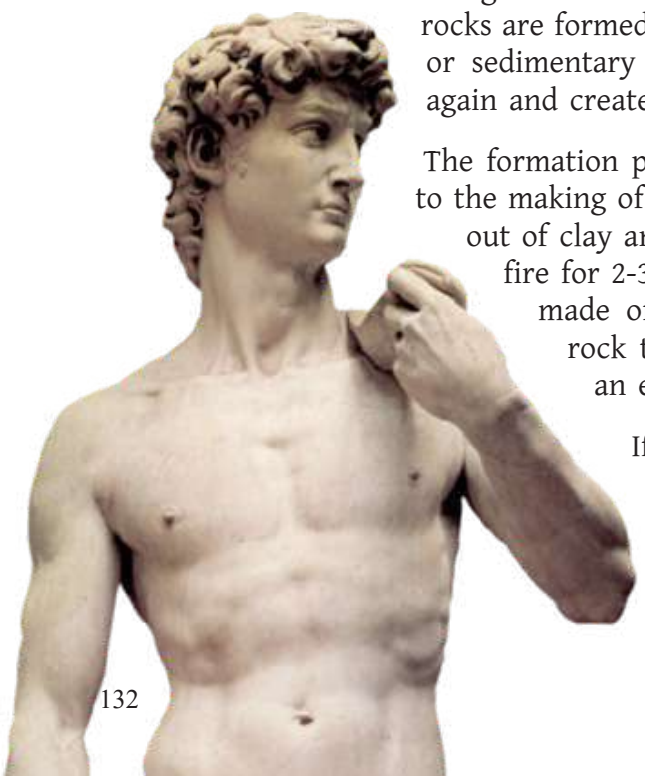
For example, fossils of Tyrannosaurus Rex and Pisanosaurus were found in two different sedimentary rock layers. From that, we know that Pisanosaurus came to Earth long before Tyrannosaurus rex. If you ever go to an area with sedimentary rock, you will see that it is formed in layers.

Sedimentary rocks can be formed by mechanical, chemical and biological means. Coal, limestone, etc., are examples of organically developed sedimentary rocks.

Sedimentary rocks are significant to us because these rocks contain fuels like mineral oil, natural gas, coal etc. Besides, limestone is used as raw material in cement factories. As mineral oil is found in such rocks, they are called petroleum.

Metamorphic Rocks: Heat and pressure applied to any rock play a significant role in the rock's metamorphosis (transformation). Therefore, the change of rock due to heat and pressure is called the metamorphic process. In this case, the rock undergoes structural or chemical changes or both. Metamorphic rocks are formed through the transformation process of igneous or sedimentary rock. Metamorphic rocks can be transformed again and create new metamorphic rocks.

The formation process of metamorphic rocks can be compared to the making of earthen pots. Potters first make shapes of pots out of clay and dry them in the sun. Then it is burnt in the fire for 2-3 days. As a result, pots or other containers are made of hard clay. Naturally, any of the three main rock types is altered in such a way that it becomes an entirely new rock.



Michelangelo's world-famous sculpture David is made of metamorphic rock marble.

If heat or a combination of heat and pressure is applied to the rock, the crystal structure of the previous rock changes and forms an entirely new metamorphic rock with a wholly new and stronger crystal structure than the

previous rock. Again, if heavy pressure is applied from one side of a rock, its crystals rearrange and form band-like layers called foliation.

Quartzite and marble are the most commonly used metamorphic rocks. They are regularly used as building materials and in the arts. Tiles, various pots and sculptures are made from marble. Marble powder is used to make toothpaste, plastics and paper. Quartzite is a tough rock and is used under the railway track.

Foliations in metamorphic rocks

Identification of rock types based on physical and chemical properties

There are different methods of identifying different types of rocks.

Igneous Rocks: Intrusive igneous rocks are usually tough and contain crystals of various minerals. In extrusive igneous rocks, the size of crystals may be tiny, or even the crystals may be absent.

Sedimentary Rocks: Layers are usually observed in sedimentary rocks. Such rocks may contain fossils.

Metamorphic Rocks: Foliations or bands are seen in metamorphic rocks.

Different elements of rocks

The constituents of rocks are called minerals. Minerals are naturally created, inorganic, solid, and composed of one or more elements. Minerals have a specific chelate structure. The main difference between minerals and rocks is that a rock is formed from one or more minerals and minerals have a particular chemical composition that is not generally found in rocks. More than 4,000 types of minerals are found in the Earth's crust, but more than ninety percent of the crust is made up of silicate minerals, the main components of which are silicon (27%) and oxygen (46%). This is why oxygen and silicon are found in the highest amount in Earth.

Different minerals can be distinguished by their physical properties like colour, shininess, hardness, relative importance, taste, smell, magnetism etc. Again, various chemical properties, such as reaction with acid, radioactivity, etc., also play a role in mineral identification. The sand or stone we see around us used for construction mainly consists of quartz and feldspar, which are tough minerals. Apart from these two minerals, Mica is also found in sand. Mica is a relatively soft mineral. In some

parts of the world, precious gemstones are found in a combination of quartz and other elements. Even metals like gold, silver, platinum, copper etc., are found in mineral form in mines. Precious diamonds are found in the rocks of dormant volcanoes. This diamond is the hardest substance found naturally.

Gold ore

Role of force and energy in the formation of rocks and minerals

Various forces and energies play an essential role in the construction of rocks and minerals. For example:

Igneous Rocks: Igneous rocks are formed from molten lava and magma that cools and hardens into rock. In this case, the internal thermal energy plays a role in creating magma or lava, the material of igneous rock production.

Sedimentary Rocks: The fragmented part of rock or sediment that contributes to the formation of sedimentary rocks mainly comes from mechanical energy i.e., pressure and thermal energy. The constant cooling and heating cause many hard rocks to crack and crumble. Again, when transported by rivers or glaciers, the rock is crushed and transformed into relatively small grains. Changes in pressure and heat play an important role in this weathering (breakdown) of rocks.

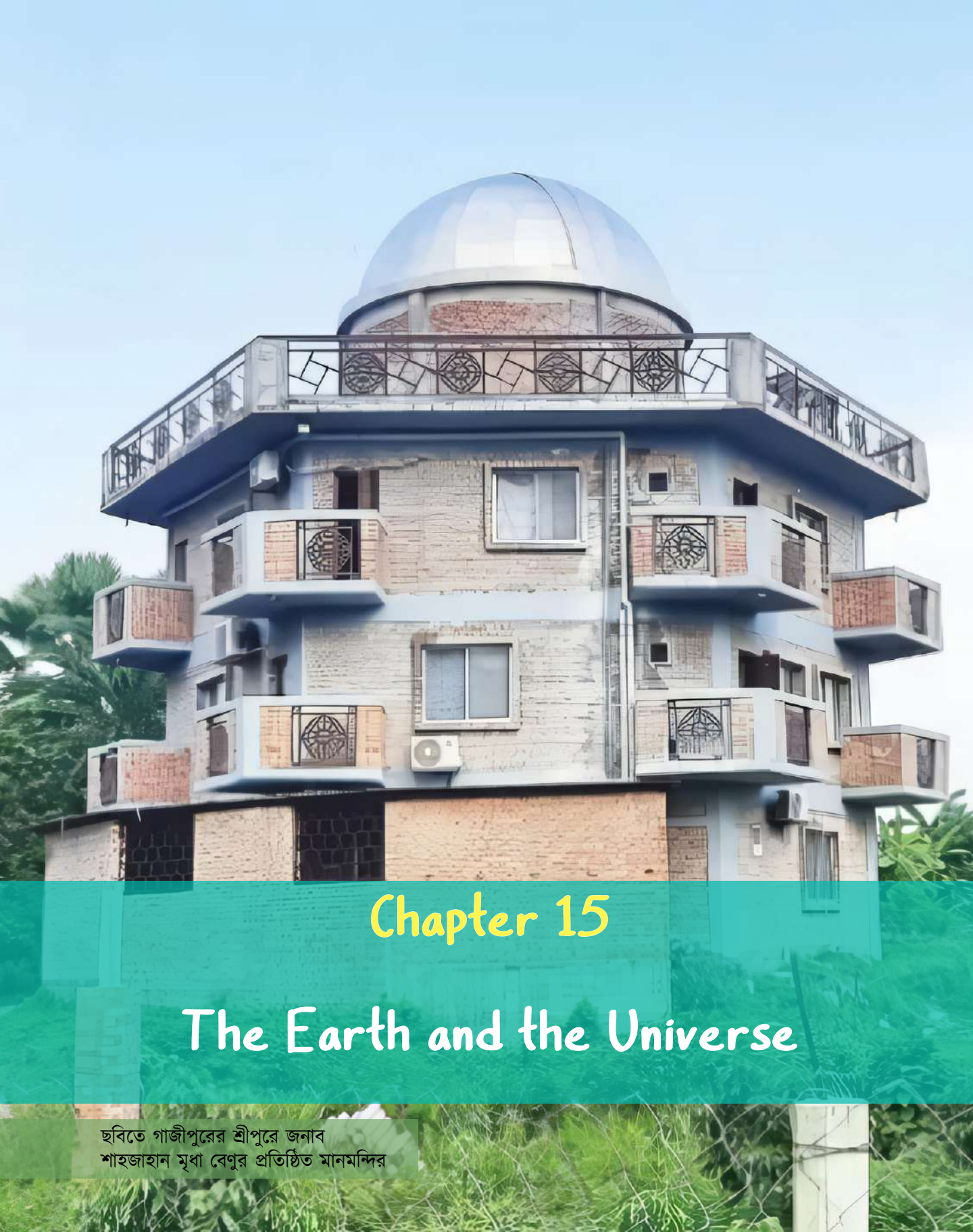
Metamorphic Rocks: In metamorphic rocks, either pressure or heat or both play an active role. The metamorphic rock exhibits special layers called foliation if extreme pressure is applied only on one side.

Various mineral resources and ores

You have already learned that rocks are made up of different minerals. Ore refers to rocks that contain minerals of economic value and from which valuable minerals can be easily extracted. All these ores are mined underground, and valuable minerals are collected there.Energy includes mineral resources such as natural gas, mineral oil, coal etc. Besides, various metals are also gathered from the ore. There are multiple methods of separating valuable substances from the soil after extraction. In this case, the ore is usually melted.

Exercise ?

1. Intrusive igneous rocks contain crystal, but extrusive igneous rocks usually do not contain crystal. What is the reason?



Chapter 15

The Earth and the Universe

ছবিতে গাজীপুরের শ্রীপুরে জনাব
শাহজাহান মৃধা বেণুর প্রতিষ্ঠিত মানমন্দির

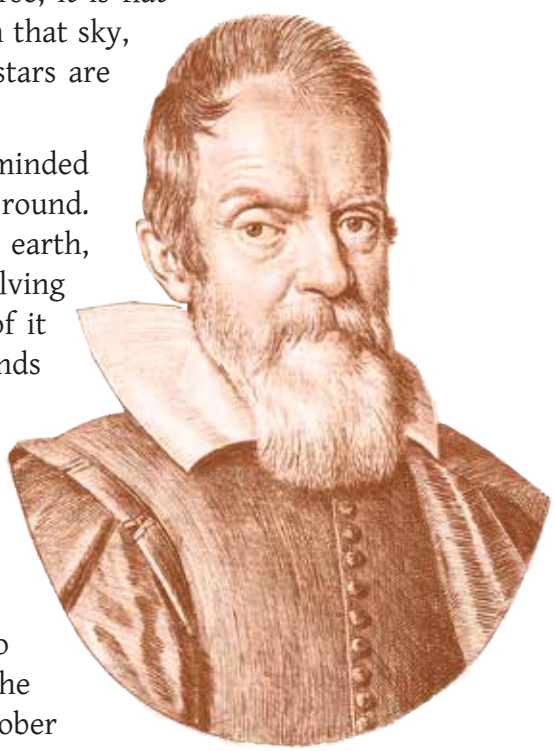
Chapter 15 The Earth and the Universe

By the end of this chapter students will be able to learn—

- ☑ evolution of the concept of the universe
- ☑ creation of the universe
- ☑ the birth and death of star
- ☑ image of the past

Evolution of the concept of the universe

Humans have always been curious, so in ancient times when people looked at nature around them, they created a universe at their own imagination. It seemed to them that the earth is the whole universe, it is flat and the sky covers the earth like a bowl. In that sky, the moon, the sun and small planets and stars are attached and they move there.



Gradually the thoughtful and science-minded people realized that the earth is not flat, it is round. That's why they assumed that outside the earth, the planets, stars, moon and sun are revolving around the earth. They argued in favour of it with various religious books. After thousands of years, scientists realized that the earth is not the center of everything, the sun is the centre and the earth and other planets are revolving around the sun. This fact was so against conventional belief that scientists were burned just for believing it. A great scientist like Galileo was convicted and imprisoned, and finally the Catholic Church pardoned him on 31October

1992!

Scientists began to discover new information by observing space through telescopes. Newton's laws of space made it possible to accurately explain the motion of the planets. With the progress of science, scientists realized that the sun is a very common star; there are many more stars like the sun in this universe.

Creation of the universe

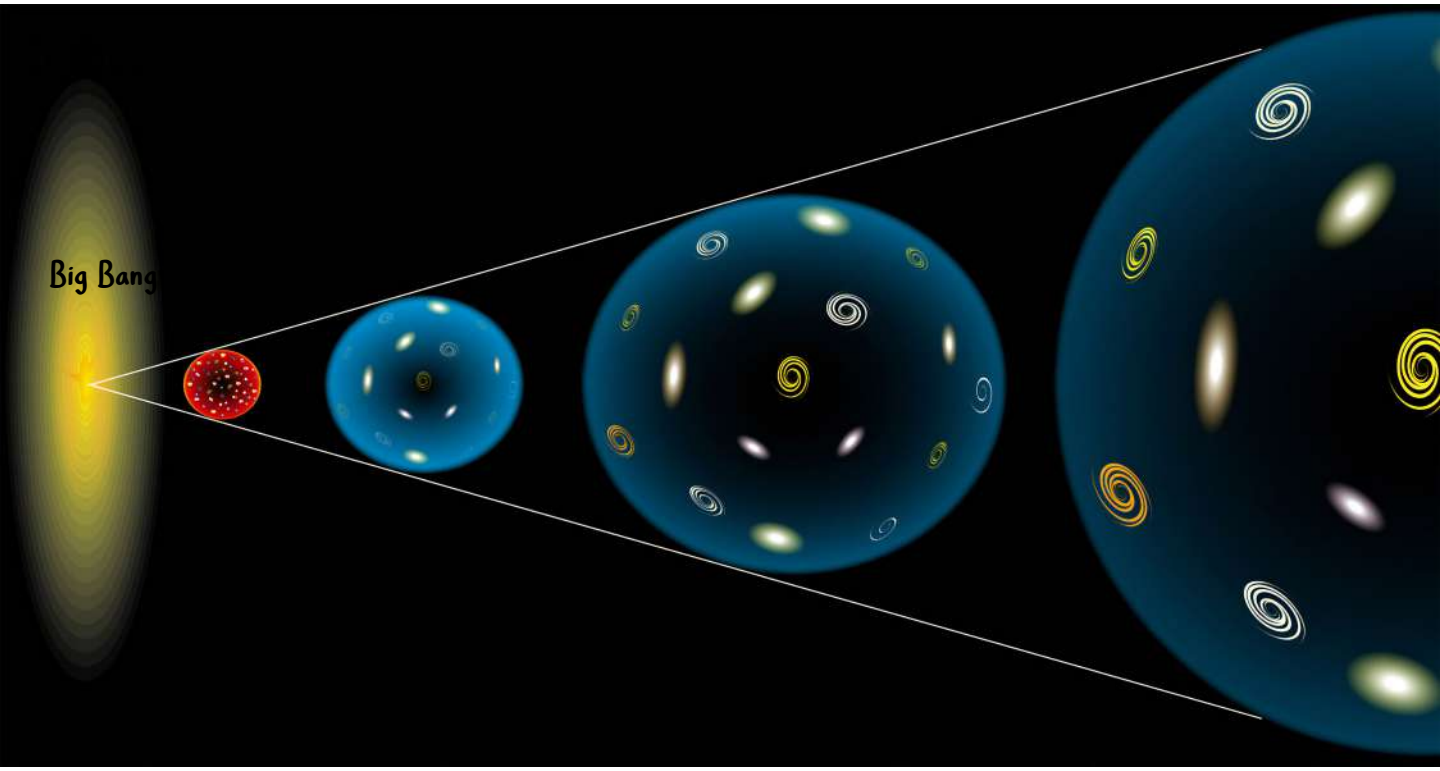
You must have looked up at the night-time sky and seen countless stars shining there. You may have wondered where these stars came from and how far away they are.

On a cloudless night when there is no moon in the sky, numerous stars can be seen spreading like a white sheet of fog from one end of the dark sky to the other. This is our galaxy. When many stars are stuck together by gravity, it is called a galaxy. If you are inside a building, you cannot understand what it looks like from the outside. Just like this we do not know what it looks like when we are inside our galaxy. But scientists have guessed what it looks like, and they now know that among one hundred billion of stars in this galaxy, one very simple star is our Sun.

If we look at the sky in autumn or winter, we will see that the closest galaxy to us is Andromeda. If we look through the telescope, we will see not only Andromeda but many other galaxies. If you can look deeper into the space with a very good telescope, you will see many more galaxies- it would seem that there is no end of galaxies. It is assumed that there are about one trillion galaxies in the part of the universe that we can see.

Our Milky Way galaxy will collide with the Andromeda Galaxy in about 4 billion years.

A scientist named Hubble observed these galaxies and first noticed that they were moving away from



The Universe starts expansion after Big Bang

one another. If it is seen that all the galaxies are moving away from one another, it means that once all the galaxies must have been in one place! From Hubble's epoch-making observations, Earth scientists realized that the universe must have begun with an expansion—they calculated that the expansion began 13.8 billion years ago. Scientists named that Big Bang!

It can be said that our universe was born with this Big Bang. In the beginning, it was a tiny universe of unimaginable density and incredible temperature, and its expansion began with the Big Bang. It is assumed that the portion of our visible universe that we now see was as big as an orange in the beginning! As the universe grew, its temperature began to decrease. Because of that expansion, our universe, the size of a small orange, is now a hundred billion light-years. (The distance that light travels in one year is one light-year; when measuring much larger distances, it is measured in light-years rather than in metres and kilometres.)

light travels in one year; one light-year, when measuring much larger distances, it is measured in light-years rather than in metres and kilometres.

Within a second of the starting of the Big Bang, electrons, protons and neutrons were created, but no atom could be formed together. The temperature was so high

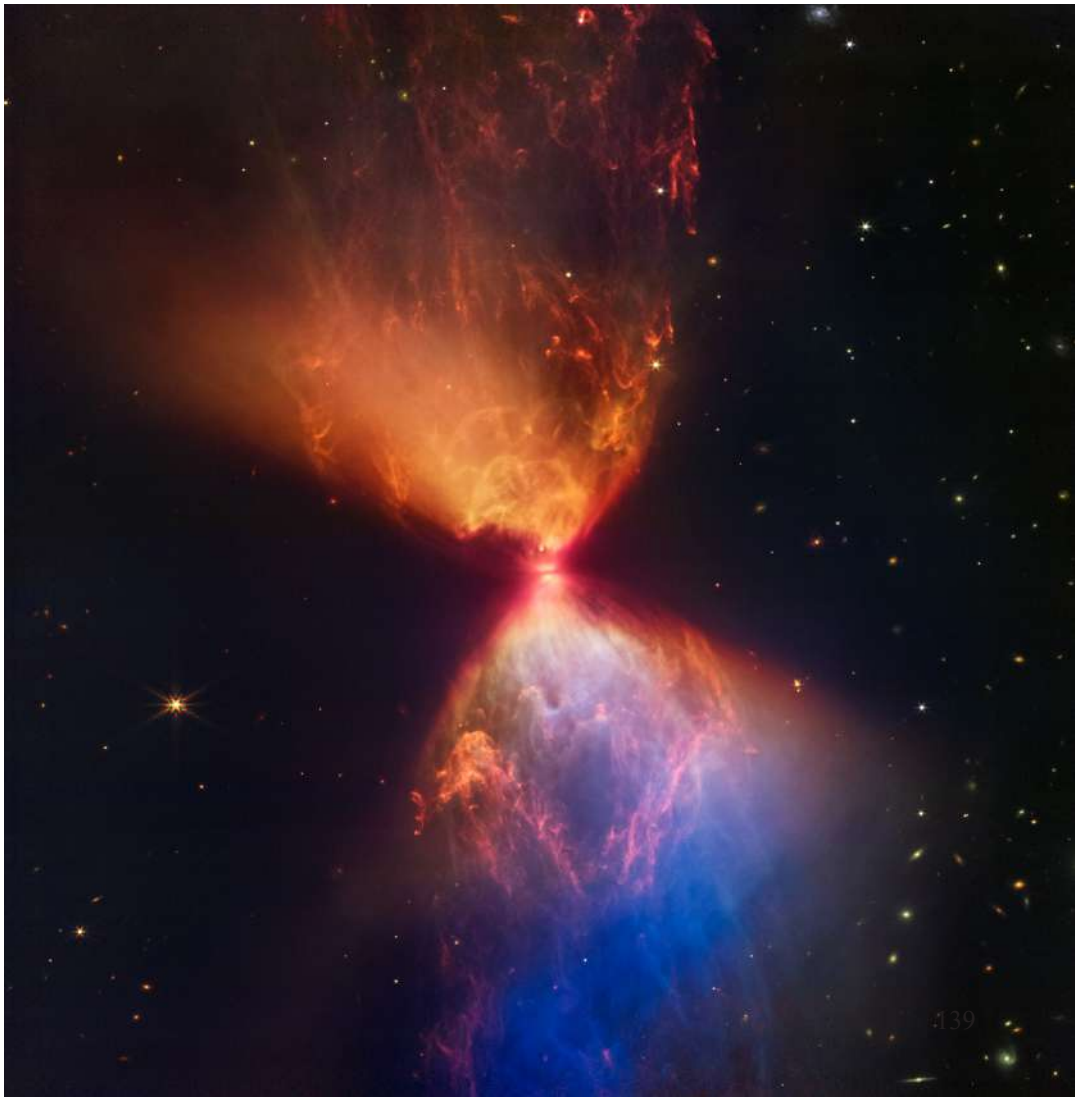
that the atoms were breaking apart at that temperature. So the universe had to wait for the temperature to decrease. The more time passed, the more the universe began to expand and its temperature to decrease. After 3,80,000 years, when the temperature dropped enough, atoms began to form. You can probably guess, the simplest atom, hydrogen was formed first!

But the entire universe was still deep dark. That's because, no star was born until then, no star lit up to illuminate the universe.

The birth and death of stars

A star is not a living being, yet we use both the terms, birth and death, for a star. Because, indeed, a star is born; has a very eventful life; and then at some point dies.

At first, there was only hydrogen in the universe. This hydrogen got together in some



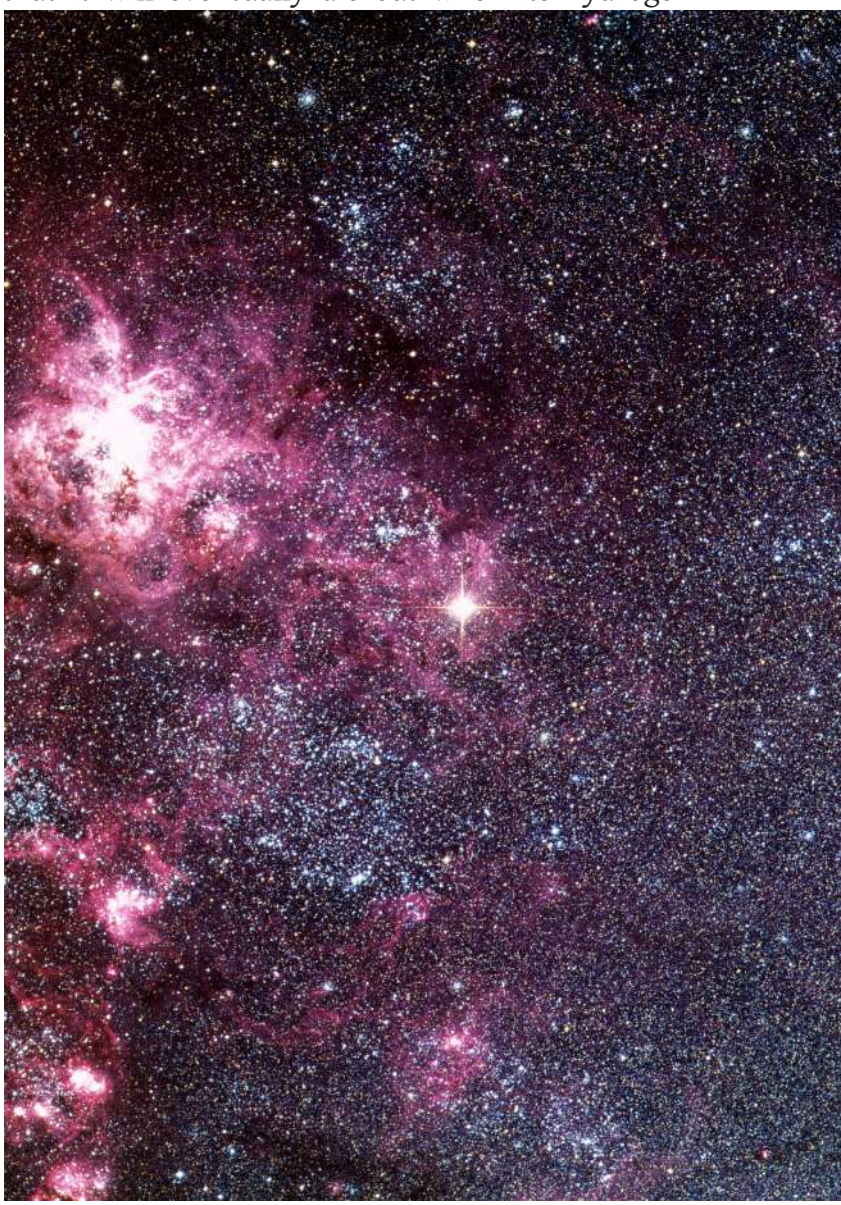
The adjacent image shows the birth of a star, most recently captured by NASA's James Webb Telescope. Right in the middle of the picture, the masses are concentrated and taking the form of stars.

places due to the force of gravity and took the form of a gaseous body. If the volume of the gaseous body is more, then it starts to compress due to the force of gravity. The more it compresses, the more its temperature increases. When the temperature increases, it eventually becomes so high at one point that the inner hydrogen nuclei (plural of nucleus) begin to fuse with one another. This process is called nuclear fusion. At that time enormous amount of energy is released, and the star begins to emit heat and light—we say a star is born! Five billion (five hundred crore) years ago, our Sun was born just like this. The Sun will continue to shine like this for another five billion years. After that it will eventually die out when its hydrogen fuel runs out. Such is the life of most stars in the universe. They are born, give light to a long life and then die.

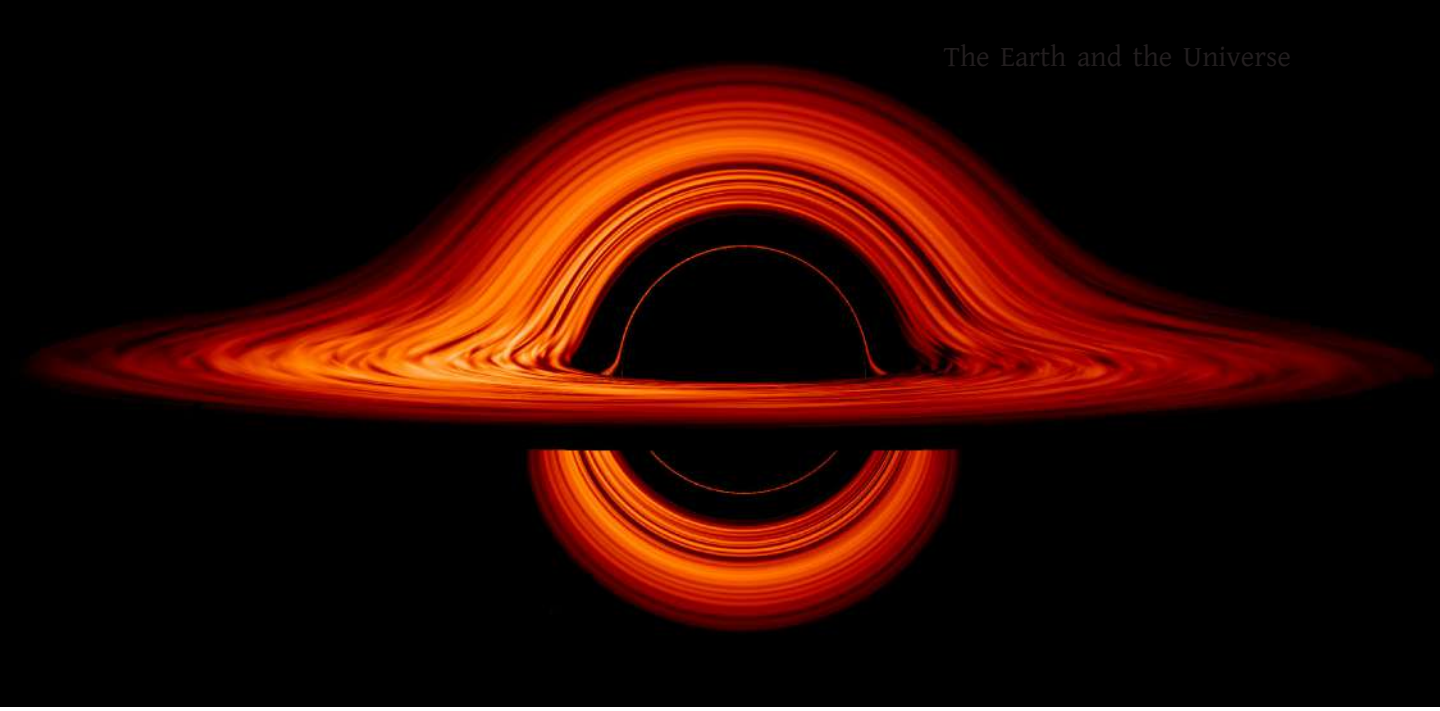
A star's life is very interesting- the more massive the star, the shorter its lifespan and the faster it runs out of fuel. If the star is very large, it runs out of fuel and creates many types of chemical elements inside it, and finally ends its life through one incredible explosion. That explosion is called a supernova explosion, and the light of the supernova explosion lights up the entire universe!

In a supernova explosion, the outer part of the star is blown apart. But the interior is sometimes transformed into a black hole, as it contracts under the strong pull of gravity. It is called a black hole because even light cannot pass due to the strong attraction of a black hole.

The mystery of black holes is even more fascinating. You will know more about it when you



The bright star, middle of the picture, Supernova 1987A, The explosion was watch with human eye.



NASA's imaginary drawing of Black Hole

are older.

Remember one thing, we only see a small part of the universe, called the visible universe— we cannot see the outer part and never will. If the universe had not expanded, then sooner or later light would have reached us from any part of the universe. But since the universe is expanding; beyond a certain distance, its light will never reach us—it will remain beyond our reach and knowledge. The magnitude of that particular distance we call the visible universe is one hundred billion light years.

Image of the past

A little while ago you were told that distance is measured in light years. Light has a certain speed, so it takes time to travel a distance. When we look at the Sun, we don't see the sun at this moment, we see the sun eight minutes ago, because it takes eight minutes for light from the Sun to reach the Earth. If the sun suddenly disappears for some strange reason, we will know it eight minutes later. Just like when we look at the sky and see a twinkling star but it is not the star of the moment. How far away it is depends on the star of how many hundreds or thousands of years ago we see! For example, when we look at the Orion constellation, we see the star of 1,300 years ago. Again, when we look at the closest Andromeda galaxy to us, we do not see Andromeda of this moment. We see what Andromeda looked like 25 million years ago.

The image taken by the James Webb Telescope shows the universe 13 billion years ago.

So, the next time when you look at the sky, remember that you are looking at thousands or millions of years into the past.

Exercise

১। Andromeda and our galaxy will collide after four billion years. Will one galaxy pass through another galaxy during the collision, or will the two galaxies collide like two pieces of rock? Justify your answer.

কেন্দ্রীয় বর্জ্য পরিশোধনাগার

● বর্জ্য ব্যবস্থাপনা হলো আর্বজনা সংগ্রহ, পরিবহণ, প্রক্রিয়াজাতকরণ, পুনর্ব্যবহার ও নিষ্কাশনের সমন্বিত প্রক্রিয়া। বাংলাদেশ থ্রি-আর (3R-Reduce, Reuse, Recycling) কৌশলে বর্জ্য ব্যবস্থাপনা কার্য সম্পাদন করে থাকে।

● বাংলাদেশে সাভারে প্রথম সিঙ্গাপুরের একটি কোম্পানির সাথে যৌথ উদ্যোগে কেন্দ্রীয়ভাবে বর্জ্য পরিশোধনাগার স্থাপন করা হয়। চামড়াশিল্প থেকে ঢাকা শহর ও বুড়িগঙ্গা নদীর পরিবেশ দূষণ রোধকল্পে কেন্দ্রীয়ভাবে বর্জ্য পরিশোধনাগার স্থাপনপূর্বক হাজারীবাগের ট্যানারিগুলো সাভারের হরিণধরা এলাকায় স্থানান্তর করা হয়েছে। আইন করে ২০২১ সালের মধ্যে সকল শিল্প-কারখানার সঙ্গে বর্জ্য পরিশোধনাগার স্থাপন করা বাধ্যতামূলক করা হয়েছে।

● পরিবেশ-প্রতিবেশ, জীববৈচিত্র্য, জলজ প্রাণী সংরক্ষণ, পরিবেশ দূষণ নিয়ন্ত্রণ, জলবায়ু পরিবর্তনের ঝুঁকি মোকাবিলা এবং বনজসম্পদ উন্নয়নের মাধ্যমে টেকসই পরিবেশ ও সবুজ-শ্যামল বাংলাদেশ গড়ার লক্ষ্যে কেন্দ্রীয়ভাবে বর্জ্য পরিশোধনাগার স্থাপন করা হয়।

Academic Year 2023

Class Seven Science

সমৃদ্ধ বাংলাদেশ গড়ে তোলার জন্য যোগ্যতা অর্জন কর

– মাননীয় প্রধানমন্ত্রী শেখ হাসিনা

মিতব্যয়ী হওয়া ভালো

তথ্য, সেবা ও সামাজিক সমস্যা প্রতিকারের জন্য **'৩৩৩'** কলসেন্টারে ফোন করুন

নারী ও শিশু নির্যাতনের ঘটনা ঘটলে প্রতিকার ও প্রতিরোধের জন্য ন্যাশনাল হেল্পলাইন সেন্টারে **১০৯** নম্বর-এ (টোল ফ্রি, ২৪ ঘণ্টা সার্ভিস) ফোন করুন

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