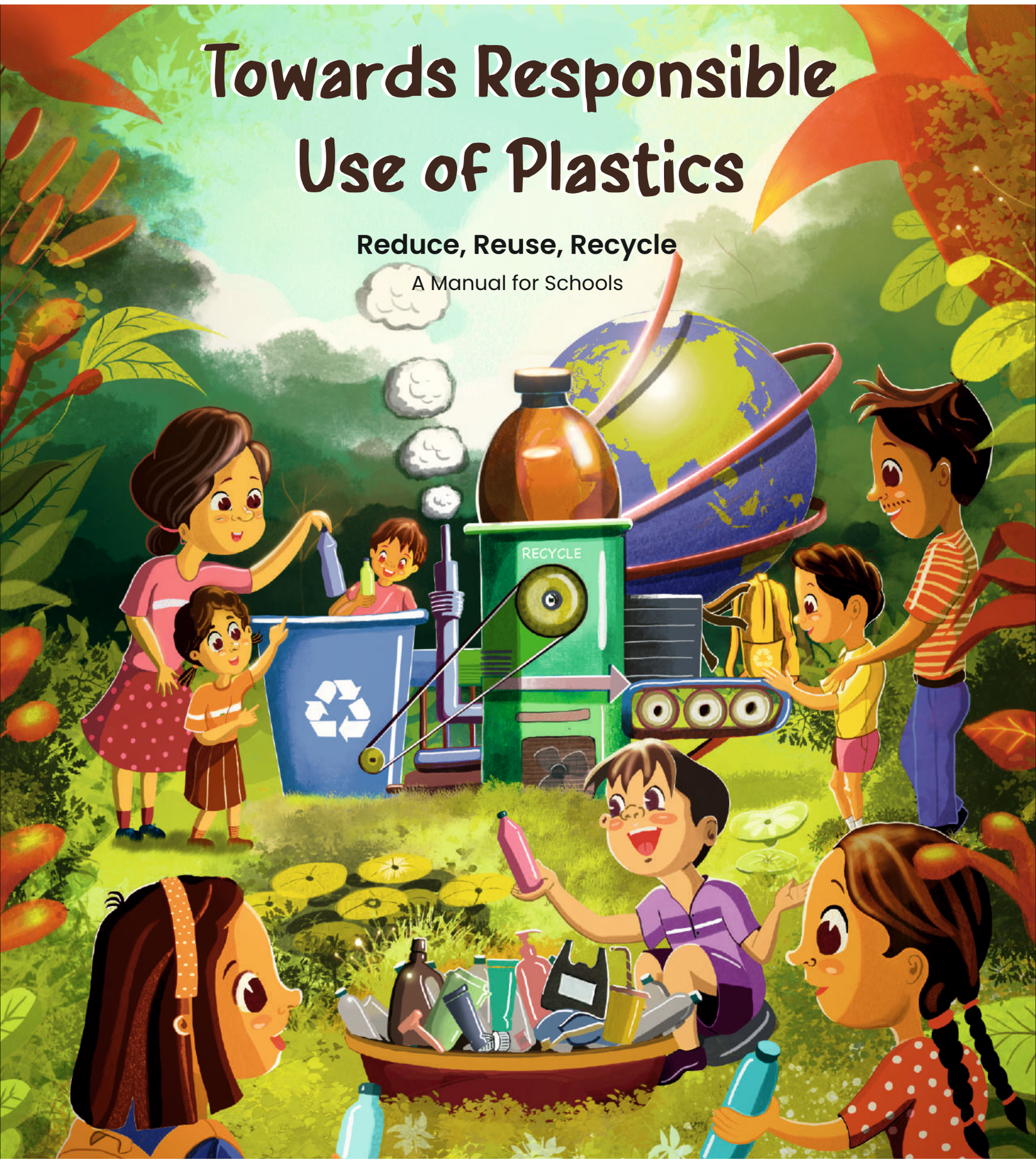
LiFE
Lifestyle for Environment

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Towards Responsible Use of Plastics

Reduce, Reuse, Recycle

A Manual for Schools



Bisleri

CEE
Centre for Environment Education

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Acknowledgements

The book “Towards Responsible Use of Plastic : Reduce, Reuse, Recycle” was originally developed in 2018 on the occasion of World Environment Day in Partnership with MoEF&CC, Govt. of India, and UNEP as a teachers manual. The book was part of a larger resource kit for schools on the same theme also containing a set of posters and a booklet for students. This edition of the book has been redesigned for a younger audience.

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Contents

03

04

05

Preface

Plastics, when invented in the early 1900s were seen as a miracle product. Since then, its presence has become all pervasive with the vast range of products being made from it. But the very characteristics that made it the most sought after material for product development- it's low-cost, light-weight, water resistance, durability, non-reactivity, non-biodegradability, became reasons for its indiscriminate use leading to the huge and growing challenge of managing plastic waste.

With global plastic waste touching 400 million tons of plastic waste annually, plastic pollution has now become one of the most pressing environmental challenges of our time. From vast ocean gyres filled with plastic debris to chocked sewage systems and overflowing landfills, the impact of plastic pollution is disastrous. Single-use plastics, in particular, have become ubiquitous in our daily lives, contributing significantly to environmental degradation and the endangerment of wildlife.

Recognising the important impact of individual choices, actions and lifestyles on the environment, the Hon'ble Prime Minister of India Shri Narendra Modi announced Mission LiFE (Lifestyle for Environment) as a global mass movement towards achieving the goals of sustainability. Stopping use of Single Use Plastics (SUP) is among the seven key themes of Mission Life.

In 2018, “Beat Plastic Pollution” was announced as the theme of the World Environment Day. Aligning with the WED theme, CEE in partnership with the United Nations Environment Programme (UNEP) and Ministry of Environment Forests and Climate Change (MoEFCC), developed a resource kit “Towards responsible use of plastics: Reduce, Reuse, Recycle”. The current publication was first developed at the time, as a teachers' manual. The current publication is a revised edition with updated contents and a new look. In the face of the plastic crisis, the core principles of the circular economy - 3Rs: Reduce, Reuse, Recycle – offer a practical framework for addressing the problem of plastic pollution. Reducing our consumption of single-use plastics, finding innovative ways to reuse, and ensuring proper recycling practices are key towards addressing the global issue of plastic waste.

This handbook is designed to equip high school youth with the knowledge, tools, and strategies necessary to become agents of change in their communities. Through engaging activities, informative articles, and practical tips, our goal is not only to raise awareness about the issue of plastic pollution but also to inspire action and foster a sense of responsibility towards the environment.

As you embark on your journey towards the responsible use of plastics, through this handbook, we encourage you to approach the material with an open mind and a willingness to learn. Together, we have the power to make a difference and create a world where plastic pollution is no longer a threat to our planet.

Kartikeya V. Sarabhai
Director, CEE

MESSAGE FROM

Ramesh Chauhan

Chairman, Bisleri

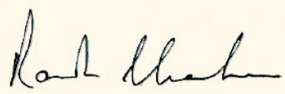
Congratulations to CEE for developing a learning module for students to understand the wonderful material 'Plastic' which has become an integral part of our daily life. This book elaborates on how plastic is to be used judiciously and disposed of sensibly post use, to ensure a sustainable future for all. It's a great initiative to create a cleaner, healthier planet.

At Bisleri, sustainability has always been a fundamental aspect of our approach to business. Our commitment to a 'Greener promise' is demonstrated by being an environmentally conscious organisation, driving sustainable initiatives - from sourcing of raw materials to final packaging of products. We use only those materials that are 100% recyclable. We are one of the first consumer goods companies in India to become plastic neutral and water positive. We collect and recycle more plastic than we put in the market. Also for every litre of water we draw from the ground, we replenish 1.08 litres.

Our 'Bottles for change' initiative is a comprehensive effort to address the issues related to used plastic. We believe used plastic is a valuable resource that can be recycled. Our programme focuses on building awareness about cleaning, sorting and recycling used plastic and we provide enabling infrastructure to collect the used plastic and send it directly for recycling. We have collaborated with leading educational institutions, corporates, municipal corporations, housing societies and hotels and restaurants to create awareness about the value of used plastic and bring about behaviour change among people to build a circular economy.

Bisleri is delighted to be part of this initiative to raise awareness and educate consumers about this wonderful material called plastic and the importance of promoting sustainable practices.

Let us all join hands in this journey to create a greener world for generations to come.



Ramesh Chauhan

CHAPTER 01

An Introduction to Plastics

Introduction

It is very difficult to realise how important plastics have become in our everyday lives. We always seem to have known these materials, and we tend to take it for granted that they occur every day and all around us, for example in our clothing, the pen that we write with, the chair that we sit on or the wrapping of the food that we eat. Look around you; how much plastic do you see? So it is sometimes hard to believe that plastics have only been commonly available for the last one hundred years.

Yet in this time the impact that they have made upon the quality of our lives and on the products that we have access to has been enormous.

Plastics give us the possibility of manufacturing well-designed, beautiful products from the many different types of plastics materials that are commonly available today. The very properties that make them valuable have, within a century after their introduction into the market, made them into a life-threatening menace.

This book aims to show you a little of what can be done to use this miracle product more judiciously.

*The word plastic comes from the Greek word **plastikos**, which means 'able to be shaped or moulded'. Plastics are polymers that can be moulded.*

Polymer

'***Poly***' *means* '***many***' *and* '***mer***' *means* '***segment***' *or* '***part***'. *Hence polymers are long chains formed of tiny molecules. Molecules that can be made into polymers are called monomers.*

What are Plastics made of ?

Polymers

Plastics are a relatively recent development, but in fact, you would be surprised to know that the more prominent family of polymers are part of a primary ingredient of animal and plant life! Polymers encompass a large class of natural and synthetic materials with various properties.

Different polymers exhibit different properties based on the characteristics of the molecules that they are made of. Hence, we have things made of polymers that can look and feel rubbery like a bouncing ball, sticky and gooey like slime or rigid like furniture.

Because of the extraordinary range of properties of polymeric materials, they play an essential role in everyday life. This role ranges from the familiar synthetic plastics and elastomers (which exhibit elastic properties, like rubber) to natural biopolymers such as proteins, cellulose, and DNA. Naturally occurring polymers have been used for thousands of years throughout the world. However, it was in the 19th century that attempts were made to develop synthetic plastics.

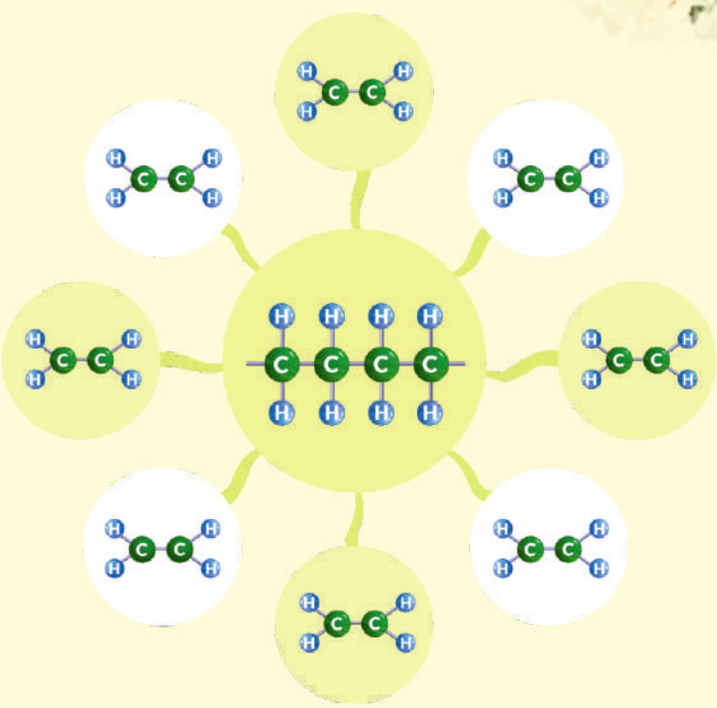
Types of Polymers

Based on the source of availability, polymers are classified into three types:

Natural

Semi-Synthetic

Synthetic



Ethylene is a monomer molecule, several of them joining together to make polyethylene, a polymer, the most common plastic.

Natural Polymers

Natural polymers occur in nature and can be extracted. They are often water-based. Most natural polymers are condensation polymers, i.e., they are formed through a condensation reaction, with water or methanol being the by-products.

Types of Natural Polymers

Natural Polymers	Found in	Characteristics	Use
Proteins	All animals	Large complex molecules, which like fats and carbohydrates, are long polymer chains. They are made from amino acids	Wool, silk are mainly used for clothes
Cellulose	Plant fibres (cotton, hemp, flax, jute) and wood	It has no taste, is odourless, is insoluble in water and most organic solvents and is biodegradable	Major constituent of paper, paperboard, card stock; main ingredient in textiles made from cotton, linen and other plant fibres
Chitin	Cell walls of fungi; exoskeletons (rigid outer covering of animals, like some anthropods) of crustaceans, insects and spiders	Polysaccharide (a carbohydrate like starch made up of bonded sugar molecules) similar to cellulose; second most abundant organic compound on earth	Making of edible plastic food wrap and cleaning of industrial waste water
Starch	Plants – it is the food reserve for all plants	Most abundant carbohydrate food material in the biosphere. It is white, tasteless and odourless and is insoluble in cold water or alcohol	Converted to sugars by malting; Used to produce sugars that are used in processed foods; Used to produce ethanol in the manufacture of beer, whisky and biofuel; Made into a thickening, stiffening and gluing agent by mixing with warm water; Used as adhesive in the paper making process

Natural Polymers	Found in	Characteristics	Use
Rubber	Tree latex	Sticky, non durable (rots easily); Usually vulcanised (heated in the presence of sulphur) to improve its elasticity, resilience and durability	Natural rubber is used in the making of surgical and medical examination gloves, catheters, balloons, medical tubes, elastic thread, and also in some adhesives. It is used in making pet toys, flooring materials, wetsuits etc. It is also used in the making of automobile parts including tyres
Pectin	Citrus peels and remains of apples	A carbohydrate polymer which is present in virtually all plants where it contributes to the cell structure	Main use is as a gelling agent, thickening agent and stabiliser in food. Its classical application is to give a jelly like consistency to jams and marmalade

Semi synthetic polymers

These are made from naturally occurring materials that have been modified or changed by mixing other materials with them. An example of this is cellulose acetate, which is a reaction of cellulose fiber and acetic acid and is used to make cinema film.

Synthetic polymers

Synthetic polymers are polymers which humans artificially make in the lab. The most widely used synthetic polymer is plastic. Nylon used in the making of our clothes, fishing nets is also a synthetic polymer.

Plastics are derived from breaking down, or 'cracking' carbon based materials, usually crude oil, coal or gas, so that their molecular structure changes. This is generally done in petrochemical refineries under heat and pressure, and is the first of the manufacturing processes that is required to produce most of our present day, commonly used plastics.

Synthetic and semi synthetic polymers can be further divided into two other categories based on the ways in which they react when heated.

Thermoplastics

These are polymers that can be softened and formed using heat, and when cooled, will take up the shape that they have been formed into. On applying heat again, it softens and can be moulded again. Examples of thermoplastics are acrylic and styrene.

Thermosetting plastics

These are polymers that soften when heated, and can be moulded when soft, and when cool they will set into the moulded shape.

But if heat is reapplied they will not soften again, they remain permanently in the shape that they have been moulded into.

Examples of thermosetting plastics are polyester resins used in glass reinforced plastics work, and melamine formaldehyde used in the manufacture of Formica for kitchen work surfaces.

‘Polymers’ is a general term for all plastic materials and means that they are carbon based compounds whose molecules are linked together in long chain patterns.

When we talk about plastics in general we will call them polymers, and when we talk about specific plastic materials we will give them their real names, such as nylon or polythene.

All plastics are polymers,
but all polymers are not plastics.

Types of Synthetic Plastics

The Society of the Plastics Industry (SPI) established a classification system in 1988 to allow consumers and recyclers to identify different types of plastic. Manufacturers place an SPI code, or a number, on each plastic product, usually on the bottom. The table below provides a basic guide to the different plastic types associated with each code number.

Plastics Type	General Properties	Household Uses
Polyethylene Terephthalate 1 PET	Commonly recycled. High heat resistance, clear, hard, tough, microwave, transparency, solvent resistant	
High Density Polyethylene 2 HDPE	Commonly recycled. Chemical resistant, semi flexible and strong, stress resistant	
Polyvinyl Chloride 3 PVC	Sometimes recycled. Chemical resistant, hard and rigid (can be made flexible too), stable in the long term, good weathering, harmful if ingested	
Low Density Polyethylene 4 LDPE	Sometimes recycled. Tough and flexible, durable, low melting point	
Polypropylene 5 PP	Occasionally recycled. Chemical resistance, hard but flexible, strong, high melting point	
Polystyrene 6 PS	Commonly recycled. Rigid or foamed, hard, brittle, affected by fats and solvents	
Other 7 OTHER	Difficult to recycle. Miscellaneous types of plastics not defined by the six codes above, including Polycarbonate and Polylactide	

Bioplastics

A polymer that is manufactured into a commercial product from a natural source or renewable resource.

While synthetic plastic is derived from fossil fuels, raw materials for bioplastics are natural polymers derived from natural sources such as plants, and microorganisms they can be biodegraded in much shorter time.

Bioplastics as an alternative to petroleum based plastics

The first known bioplastic, polyhydroxybutyrate (PHB), was discovered in 1926 by a French researcher, Maurice Lemoigne, from his work with the bacterium Bacillus megaterium. But the significance of his work was not realised until recently, when the disposal of plastic waste started becoming a great environmental threat.

In India, Centre of Excellence-Sustainable Polymers (CoE-SusPol) of IIT-Guwahati under the Department of Chemicals and Fertilizers, and DRDO were among the pioneers in the production of biodegradable plastic bags in India. Several manufacturers are now producing compostable bags and other packaging material to replace Single Use Plastic (SUP).[2]

Bioplastics provide businesses with eco-friendly options for packaging and other single use plastic needs. Though the bioplastic industry in India is still in its early stages, the products made from bioplastics are replacing several single use plastic items such as packaging material, plastic bags, straws etc.

Bioplastics are considered biodegradable, and they fall into a few different categories based on their end-of-life plan.

Degradable – All plastics, even conventional petroleum-based plastics, are technically degradable. Given the right amount of time and environmental conditions, they will break into tiny fragments. However, such plastics will never fully return to their "natural" organic state, thus they remain a source of pollution, leaking chemicals, and micro fragments into the environment.

Biodegradable – Bioplastics that are considered "biodegradable" can be broken down by microorganisms such as bacteria, fungi and algae into water, carbon dioxide, methane, biomass, and inorganic compounds. As stated above, types of bioplastics that can be completely broken down within a few months are considered biodegradable.

Compostable – Compostable bioplastics can be broken down by microorganisms just like biodegradable bioplastics, but they will decompose into nutrient-rich biomass often in as little as three months, leaving behind no toxins or residue. Some compostable bioplastics can be composted naturally in home gardens while others may require the high temperatures of a specialised composting facility.

The Evolution of Plastics

Prevailing over traditional and natural materials, plastics evolved as a strong alternative. Low cost, chemical stability, lightweight, ductility, versatility, and imperviousness to water are some of the properties that make plastic one of the most sought after materials used in a multitude of products of different scales, ranging from paper clips to spacecraft, water pipes to mobile phones, packaging material to the silicon that is used for plastic surgery.

The multi-purpose uses were also because of the constant innovation in developing synthetic polymer materials and combining them with naturally occurring polymers such as cellulose, proteins, and starch. This gave way to various new materials such as nylon, polyester, kevlar, and many others. Moreover, the improvement in polymers, while using existing technologies, pioneered the extensive use of plastics in the medical field.

The First Synthetic Plastic – Celluloid

John Wesley Hyatt, an American inventor and industrialist, discovered the process for making celluloid, the first practical artificial plastic. In 1863, attracted by a reward of $10,000 offered by a New York billiards company to anyone who could invent a satisfactory substitute for ivory billiard balls, Hyatt Experimented with several compositions, none of which produced a successful billiard ball, but eventually led to an attractive and practical plastic material, which he and his brother patented in ***1870 as celluloid.***

The First Thermosetting Plastic – Bakelite

Leo Baekeland, a US industrial chemist, founded the modern plastics industry through his invention of ***Bakelite,*** the first ***thermosetting plastic.*** His search, begun in 1905, for a synthetic substitute for shellac (an electric insulator) led to the discovery of ***Bakelite*** in ***1907,*** which was not only a good insulator, but could also be moulded and shaped as required, and was suitable for mass production. It was used to make bowling balls, phonograph records, telephone housings, cookware and billiard balls.

The First Synthetic Fibre – Nylon

Wallace Hume Carothers, an American chemist, Director of Research in Organic Chemistry with DuPont, developed ***nylon*** in ***1938,*** the first synthetic polymer fibre to be produced commercially and one that laid the foundation of the synthetic-fibre industry. Nylon is an artificial fibre with properties similar and in many ways superior to such natural fibres as wool, cotton and silk, and to neoprene, a synthetic rubber derived from vinylacetylene.

A Miracle Product

1885

EASTMAN American Film was patented to be further developed by George Eastman Kodak

1940

With the introduction of PVC, radar cable insulations started using Polyethelene

1950

Polyethylene bags with handles make their first appearance

1925

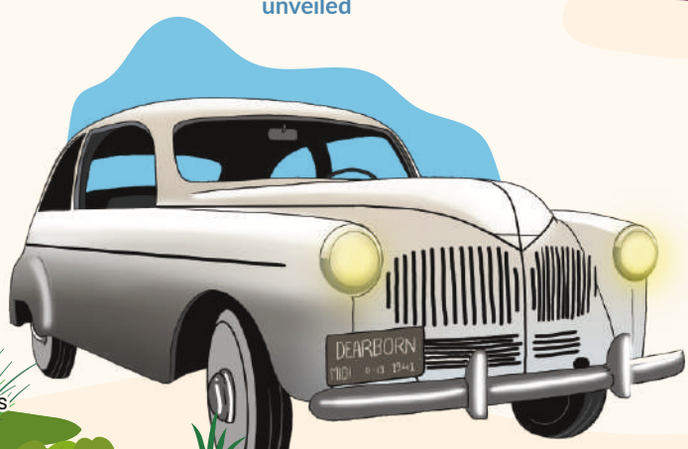
Leo Baekeland introduces the word 'Plastic'

1941

Henry Ford's 'Soybean Car', that used soybean fibre in a phenolic resin with formaldehyde for the plastic panels, was unveiled

1958

Lego patented its stud and block coupling system and went on to produce toys



1965

'Kevlar' is first developed by DuPont and used in tyres

1973

Motorola's Martin Cooper designs DynaTAC, the first ever handheld and portable phone

1988

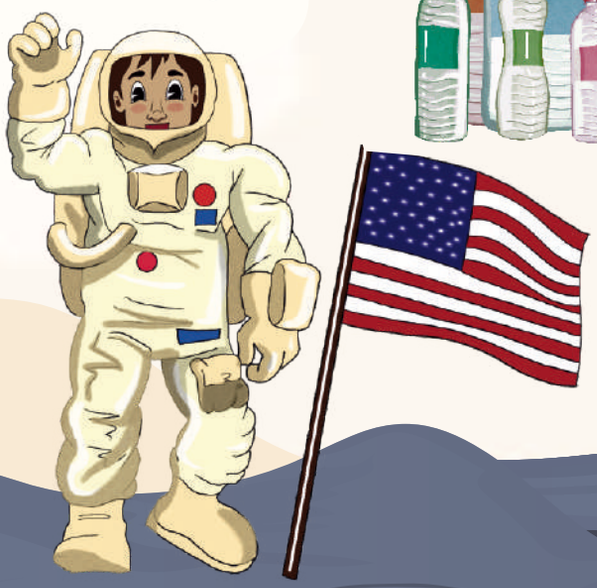
Recycling symbols for plastics introduced

2010

An e-reader, Amazon Kindle, designed using a resilient plastic outer body case

1969

The first man on moon Neil Armstrong plants a nylon flag of the United States of America to mark his landing

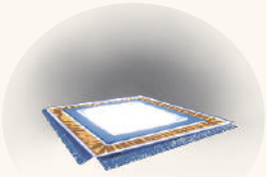


1977

PET (Polyethylene terephthalate) bottles introduced

2000

Nanotechnology starts being applied to polymer and composite applications



But.....

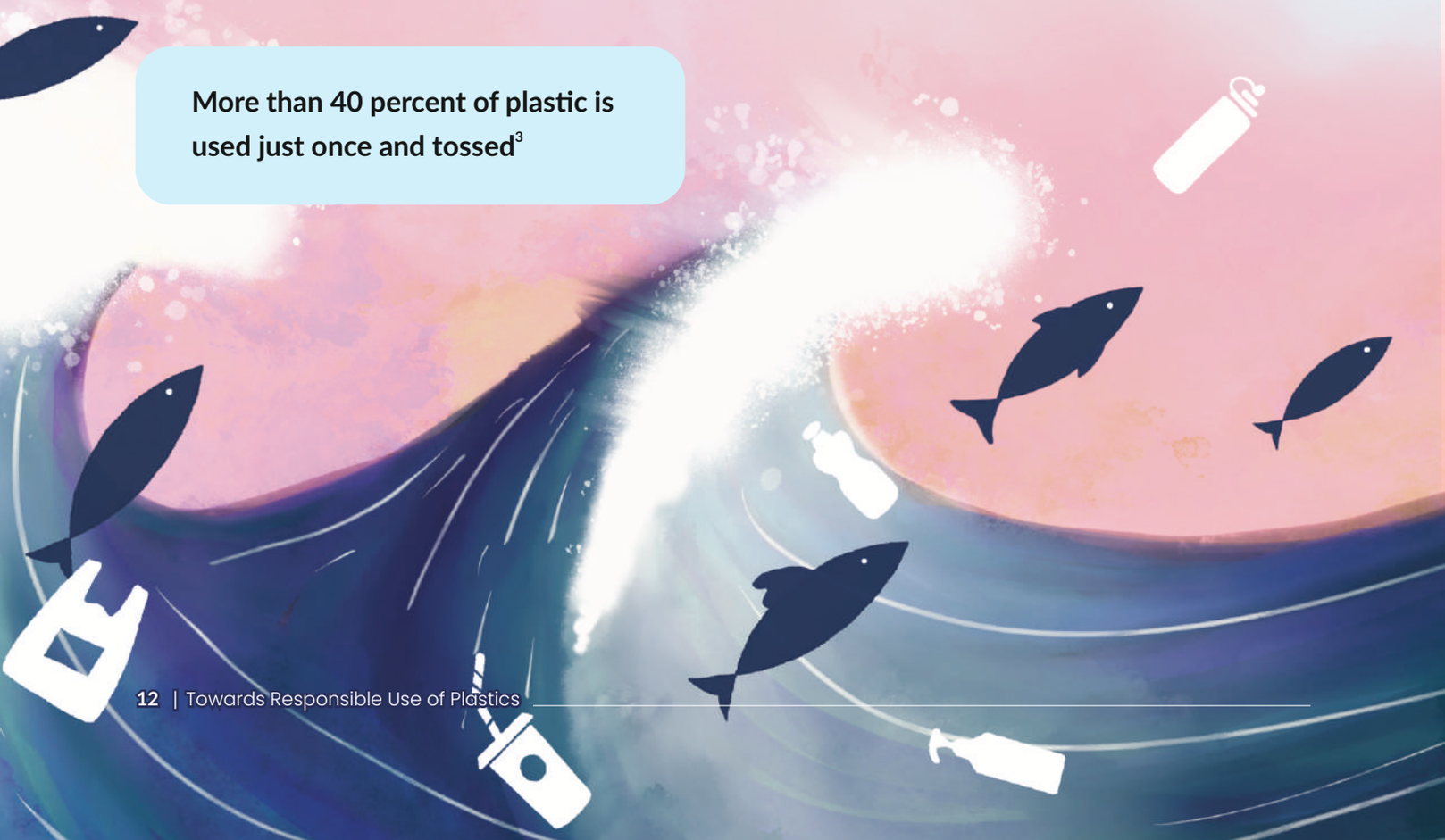
By 2050, virtually every seabird species on the planet will be eating plastic[3]

More than eight million tonnes of plastic is estimated to enter the ocean each year[3]

Globally, 400 million tonnes of plastic waste is generated every year[3]

At least 267 different animal species are known to have suffered from entanglement and ingestion of plastic debris[4]

More than 40 percent of plastic is used just once and tossed[3]



Advantages and Disadvantages

We live in an age of plastics - bright, attractive, colourful, long-lasting, relatively inexpensive substances whose invention has revolutionised the manufacturing industry. They are also responsible for the enormous amount of environmental and health problems the world is facing today.

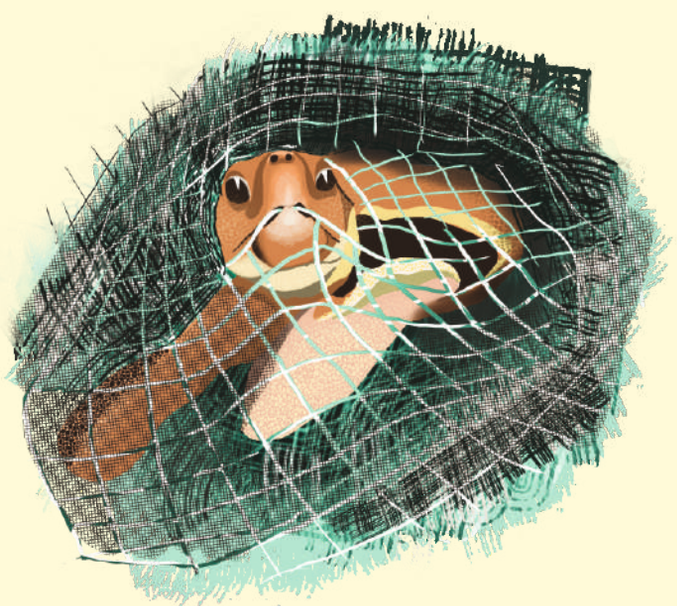
Advantages

- Mostly Recyclable
- Corrosion resistant
- Flexible - Can easily be moulded and given any shape and have excellent finishing
- Durable
- Low cost
- Water resistant
- Light in weight but strong
- Less wear and tear
- Can be roughly handled (as compared to glass)
- Wide range of use in industry, agriculture, construction, electronics, packaging, transportation, medical field and household sectors
- Good strength and toughness
- Good shock absorption capacity
- Can be reused and restored
- Has thermal and electrical insulating property

Disadvantages

- **Non-degradable:** Plastics takes anywhere from 500-1000 years to degrade, thus causing a huge waste problem especially in landfills and oceans.[5]
- **Accumulation of plastics in the oceans:** Plastic waste (including carry bags) reaches the oceans through the coast, causing problems for marine life. Microplastics (eg. microbeads in toothpaste, gels, face wash) gets released into rivers, lakes and oceans.
- **Threat to life forms:** Since plastics are non-degradable and persist in the environment for hundreds of years, they cause blockages in water bodies and systems, as well as the death of animals and birds due to ingestion, suffocation and entanglement.
- **Air pollution:** Manufacture of plastics (releases high amounts of CO_2), incineration (emits CO_2, methane, etc.), as well as burning (releases gases harmful to the environment and the health of human and other life).

Because of its harmful effects on the environment, it is essential that we use plastics judiciously and not use disposable or single-use plastics.



What happens to the plastic we use?

Every year, we throw away enough plastic to encircle the Earth four times.[6] According to the UN, in 1950, the world's population of 2.5 billion produced 1.5 million tons of plastic[7] whereas in 2021, a global population of nearly 8 billion people[8] produced over 400 million tons of plastics.[9] Roughly half of the annual plastic produced is used in the making of single use products. Where does all this plastic go once we are done with it? The brief life cycle of single use plastics has consequences: every day, the equivalent of over 2,000 garbage trucks full of plastic are dumped into our oceans, rivers and lakes. [10] As a result, plastic pollution is set to triple by 2060 if no action is taken.[11]

The problem with plastics is that they do not degrade easily. They only break down into smaller pieces called microplastics which enter the food chain and cause harm to living beings and the environment.

The three major ways to dispose of plastic waste are landfills, thermal destruction and recycling, each of which have unique consequences.

Since 1950, approximately 9.2 billion tonnes of plastic have been produced, resulting in the generation of some 6.9 billion tonnes of primary plastic waste.[12]

Landfills and the Natural Environment

The final destination of more than three quarters of non-degradable plastic waste is landfills and the natural environment.[13] The plastics in landfills take as long as thousand years to break down into smaller pieces called microplastics that are extremely hazardous to the environment. Animals, both marine and land, eat the plastic pieces mistaking them for food and thus they eventually enter our food chain. A large part of the plastics lands up in our water bodies and may ultimately get trapped in one of the five plastic-filled gyres in the world's seas, where the ocean currents trap millions of pieces of debris.

Thermal Destruction

People find burning household garbage a convenient way to get rid of accumulating trash including plastic waste. But incineration or burning in the open air, releases hazardous substances like dioxins into the atmosphere creating a significant public health risk. Dioxin is extremely toxic to humans and animals as it is known to cause cancer and birth defects that are passed down from generation to generation. Dioxin also ends up in the soil poisoning the food of humans and animals.

Recycling

Recycling is one of the most important ways to reduce the impact of plastic on the environment and represents an opportunity for the plastics industry. But recycling has its limitations too. Different types of plastics cannot be mixed while recycling.

Separating plastics from non-plastics before the recycling process, and the different types of plastics from each other, is a labour- intensive process. The best solution, therefore, for our plastics problem is to reduce our use of plastics, and to reuse and recycle whenever possible.

Of the total 6.9 billion tonnes of primary and secondary (recycled) plastic waste generated since 1950, around 9% has been recycled and 12% incinerated, with the remaining 79% either being stored in landfills or released directly into the natural environment.[14]

Plastics and Our Oceans

Plastic pollution is a global problem and one of the top concerns for ocean health. Most of the marine debris (80%) comes from land-based sources.[15]

According to UNEP, it is estimated that our seas now contain about 51 trillion microplastic particles.[16] Also, as per a study by the Ellen MacArthur Foundation, there will be more plastic in the ocean than fish by 2050.[17] Plastic pollution in oceans and other bodies of water continues to grow sharply and could more than double by 2030.[18]

It is estimated that 19-23 million tonnes of plastic leaks into aquatic ecosystems annually – from lakes to rivers to seas – from land-based sources.[19] Exacerbated by contributions from sea-based sources, this combined plastic leakage is having major impacts on ecosystems, economies & society - including human health. A sizeable fraction of plastic in oceans, leads to 'floating garbage patches' in the major ocean central gyres as well as visible impacts on nearly all the world's coasts and beaches!

Fisheries, aquaculture, recreational activities and global wellbeing are all negatively affected by plastic pollution, with an estimated 1-5% decline in the benefit[20] humans derive from oceans. The resulting loss in such benefits, known as marine ecosystem value, is about $2.5tn a year, according to a study published in the Marine Pollution Bulletin.[20]

Plastic waste will soon weigh as much as all the fish in the ocean

Current Ratio
1:5

Ratio by 2050
>1:1

According to UNEP, actions to tackle marine plastic pollution could include reducing the use of single-use plastics at the individual level such as by using reusable shopping bags and water bottles, choosing products without microbeads and plastic packaging, and not using straws to drink.

Every day, the equivalent of 2,000 garbage trucks full of plastic are dumped into the world's oceans, rivers, and lakes.[10]

India

Single-use plastic (SUP) waste generated per person in selected countries in 2019 (in kg)[21]

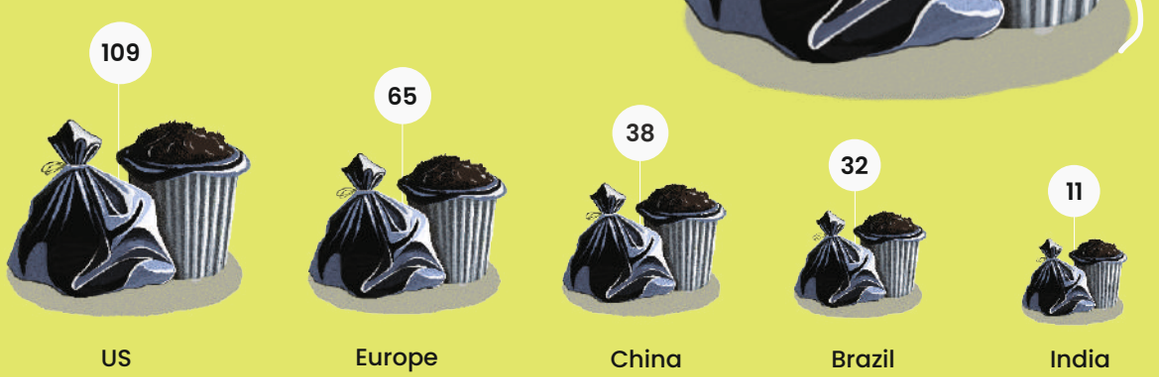
The Annual Report on implementation of the Plastic Waste Rules, 2016, compiled by the Central Pollution Control Board (CPCB), provides an estimate of the quantity of plastic waste generated in India. According to this report in 2020-21 India generated around 4.1 million TPA (Tonnes Per Annum), roughly 11,300 TPD (Tonnes Per Day) of plastic waste in the country.[22] This accounts to four kg of single-use plastic (SUP) waste generated per person per annum.

Given that the total municipal solid waste generated in the same year is approximately 58 million metric tonnes (MMT),[23] it can be estimated that plastic waste is roughly around seven per cent of the total municipal solid waste generated in the country.

According to PlastIndia Foundation, 5.5 MMT of plastic gets recycled every year in India. This is about 60 percent of the total plastic waste that is generated in the country.[24] The remaining 40 percent of the total plastic waste in India ends up uncollected, littering and choking our drains, waterbodies and land.

India's plastic consumption is one-tenth that of the US

Per capita plastic consumption in 2014-15 (in kgs)



(Global Average 28)

Efforts to address the issue

Currently, the plastic crisis has environmental, health, economic and social impacts. We need to redesign the products that use plastic and how we use them in our daily lives.

Concrete steps are being taken to address the global plastic problem. The Intergovernmental Negotiating Committee convened to establish an international legally binding instrument focused on plastic pollution, particularly in marine environments. The second Committee met in Paris in (May 29 to June 2) 2023, with an aim to finalise negotiations by the end of 2024. Their primary objective is to comprehensively tackle the entire life cycle of plastic, ensuring accountability from manufacturing to disposal. In parallel, the United Nations Environmental Programme has released a report titled *"Turning off the Tap,"* proposing a systemic approach to combat plastic pollution. These combined efforts reflect significant progress in the battle against plastic pollution on a global scale.

The UN Environment Programme identifies three market shifts to bring about a change to the legacy that plastic has left – reuse, recycle, and reorient and diversify. These three shifts would result in an 80 percent decrease in plastic pollution and could present the net creation of 700,000 additional jobs by 2040. However, action will still be required to manage 100 million metric tons of plastics from short-lived products annually, by 2040.[25]

Sustainable Development Goals and Plastics

In 2015, the UN adopted 17 Sustainable Development Goals (SDGs) that establish a new framework for the global development efforts towards 2030. The SDGs, otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) with 169 targets define global sustainable development priorities and aspirations for 2030 and seek to mobilise global efforts around a common set of goals and targets. The SDGs call for worldwide action among governments, business and civil society to end poverty and create a life of dignity and opportunity for all, within the boundaries of the planet.

Waste management and plastic pollution impacts several of the SDGs. Some of the goals and targets that directly link to plastic pollution and its impacts are:

Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

Target 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

Target 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.

Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment.

Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.

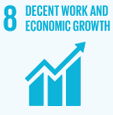
Target 12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

Goal 13: Take urgent action to combat climate change and its impacts.

Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

Goal 17: Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.

Solid Waste Management - Opportunities for moving towards achieving SDGs

	A new model of inclusive waste management addressing livelihood concerns, such as the generation of employment (eg. waste collection and recycling), increased income generation, improved occupational health, promotion of human development opportunities and environmental health in general.
	Reduced food waste. Increased use/recycling of organic waste.
	Less diseases caused by open dumping and burning.
	Building new value in the education and promotion activities in waste management in households, schools, universities, public and private sectors. Environmental and health training and awareness.
	Increasing social acceptance and reducing the stigma associated with waste-related work, ensuring parity of resources, safer working environments and approach to formalising the sector.
	Good sanitation and resilience to environmental risks due to Solid waste. Low waste production. Better SWM practices will enhance WASH practices.
	Improved resource use and waste-to-resources recovery. Bio energy opportunities from organic waste.
	Waste management is one of the world's largest industries. New technologies, green enterprises, recycling technologies to support the development of new markets and create job opportunities.
	Innovation in the sound management of Solid waste through eco-design and product life cycle management. Recycling innovations to reduce the amount of natural resources used and waste produced. Waste as key factor for achieving the Green enterprises.

Poorest are harmed most by poor SWM. Recognise the critical role of waste management in efforts and policies that tackle inequality and ensure development is inclusive.

Better SWM is vital for healthy and resilient communities. City planning and urban design parameters for health and safety of communities. Low waste production and Initiatives to treat, recycle, reuse and dispose of wastes at the source of generation. Regulatory mechanisms and pollution monitoring to be effective.

Practice of 3Rs of Waste management and development of circular economies and promotion of sustainable pattern of production, consumption and lifestyles. Need to shift from waste to resource management. Resource-efficient production and consumption.

Sound management of waste to help prevent and mitigate climate active substances like methane and CO_2 from entering the environment and reduce the need for difficult and costly environmental remediation.

Less plastic pollution in ocean and reduced threat to sea life.

Less pollution on land, healthier environments. Minimise ecosystem disruption through open dumping and contamination of air, water, soil. flora and fauna.

Institutional frameworks and coordination mechanisms among relevant stakeholders is essential to the attainment of the sound management of waste. Producer responsibility, governance and improved public participation is recommended.

Sound management of waste can contribute to enhanced policy coherence for sustainable development through public-private partnerships, capacity building and technology innovation. Working together of formal and informal; wealthy and poor.

ACTIVITY 1.1

Plastics - Then & Now

Introduction

Many children, as they grow up, take the current use and disposal of plastic for granted. Milk in pouches, use and throw pens, polythene carry bags to bring purchases in, are a part of their daily lives. It can often be a discovery for them when they come to know that this was not the case during their parents' and grandparents' time.

Plastics, have over the years become an intrinsic part of life. Students need to understand why people have shifted to plastics and whether there are alternatives which can be used instead.

Objective	To help students understand that much of the plastic which is considered essential, is a relatively recent phenomenon
Grade level	Primary
Group Size	Individual
Place	At home followed by group discussion in classroom
Duration	20 minutes in classroom, survey over the weekend at home
Materials	Black board, chalk, survey sheet, list of plastic items

Methodology

- The teacher could make a list of commonly used disposable plastic items at home on the black board. Each student, could be asked to name one item and once everyone has contributed, anyone can name more.
- The teacher could share the Home Survey Sheet with the students and explain how they can use it. The students could then fill up the survey sheet after discussion with their grandparents, parents and siblings. The list they made in the class can be used as a reference to discuss with the respondents to understand whether the items in it were the same in each generation or a different item was used for the same purpose.
- The teacher could discuss the timeline of these items in class as to when the use of a particular disposable plastic item began and in which generation.
- The teacher could then discuss in groups the possible reasons for why plastic items replaced natural products or have become such an intrinsic part of life.

Conclusion

At the end of this activity, the students will be able to understand that plastic use is a relatively new phenomenon and many of the naturally degradable products used earlier that were replaced by non-biodegradable disposable plastic products can still be used in the place of plastics.

Evaluation

Discuss the alternatives and check which one students think can be easily replaced.

Survey Sheet (answer Yes or No and if No, name/describe the alternatives used)

Name of product	Either of the parents used it when they were the student's present age	If no, what was the alternative they had?	Either of the grandparents used it when they were the student's present age	If no, what was the alternative they had?
• Polythene bags				
• Chips and snack pouches				
• Disposable diapers				
• Disposable ball point pens				
• Disposable cups				
• Disposable shaving razor				
• Disposable water bottles/soft drink bottles				
• Plastic shampoo/oil bottles				
• Plastic toothbrush				
• Plastic buttons				
• Band-Aid				
• Ear buds				
• Styrofoam (Thermocol)				
• Plastic straw				
• Tetra pack				
• Milk pouches				
• Disposable plates & spoons				
• Plastic toys				
• Balloons				
• Plastic flip-flops				
• Plastic wraps for books & notebooks				
• Products with plastic packaging				

ACTIVITY 1.2

When do plastics degrade?

Introduction

Different materials in the environment take different periods of time to degrade. Some materials like plastics, thermocol, etc. do not biodegrade and continue to exist in the environment. Materials such as wood, grass and food scraps can break down in the presence of microbes, and transform into useful compounds. Plastics on the other hand cannot be degraded by microbes and these generally end up in landfills or water bodies, polluting them. Despite the problems associated with its disposal, we cannot avoid using plastics because of their use in a variety of areas. It is, therefore, essential that we use and dispose of these responsibly.

Objective	To make students understand what is degradation and the time different materials take to degrade
Grade level	Middle school
Group Size	Class
Place	School and Home
Duration	• 20 minutes for introduction to the activity, instructions and making of groups • 10 minutes at school (once every week) for 12 weeks (the groups can do this activity during recess time)
Materials	Waste materials produced by students during school hours (plastic, paper, food scraps, glass, metal items like pins etc), small shovel, metal scale, gloves, record book/worksheet, pen

Before you begin

Introduce the term bio-degradable and non-biodegradable materials in class. Explain how degradation takes place and mention the agents of degradation in nature. Explain the role of bacteria and other microbes in decomposition.

Methodology

- Ask the students to help in digging out a small pit in the garden area of the school, about 8-10 inches in depth. Also give a copy of the worksheet provided below to every group to enter their observations.
- The teacher could ask the students to place the different kinds of waste collected in the pit. Close the pit once there is a variety of waste in it.
- After a week, the students should be asked to dig up the pit to check the condition of each waste item they have buried and enter their observations on the worksheet.
- They should continue the cycle for 12 weeks and note the gradual changes (if any) in each item

Week	Observation
1	**Paper:**
	Food:
	Plastic:
	Metal:
	Glass:
	Others (specify):
2	**Paper:**
	Food:
	Plastic:
	Metal:
	Glass:
	Others (specify):
....	
12	**Paper:**
	Food:
	Plastic:
	Metal:
	Glass:
	Others (specify):

buried. They should also record changes in terms of quantity, colour, texture, smell, etc.

- At the end of the experiment, students should make a chart presenting their observations and recordings of: what has degraded, which material has not and the gradual changes they have observed in the items, if any.

Conclusion

Students understand that degradation is a natural process and different materials take different periods of time to degrade.

Evaluation

Discuss which materials are biodegradable based on

ACTIVITY 1.3

Categorisation of Plastics

Introduction

Most of the items used everyday contain plastics. It is present in our clothing, the pen that we write with, the chair that we sit on or the wrapping of the food that we eat. Different plastics are made from different monomers and accordingly divided into different categories. This activity will help students to identify the different types of plastics and understand their characteristics.

Objective	To help students understand different categories of plastics and their properties
Grade level	Middle school
Group Size	5-6 students
Place	School
Duration	40 minutes
Materials	1. Chart on types of plastics 2. List of commonly used disposable items (Activity1.1)

Before you begin

The teacher could give a brief introduction about how plastics are made, how different plastics are identified for recycling and discuss the plastics identification list with the students. The teacher must ensure that items made from different categories of plastics are available in the classroom before beginning the activity.

Methodology

- The teacher could divide the class into groups of 5-6 students.
- Ask groups to look around and list the plastic items they see around them.
- Based on the appearance, texture and other characteristics observed, the students are asked to group the items into different categories.
- The students try to code the categories based on the plastics identification list and background information given by the teacher.
- The teacher should then guide the groups to organise their information collected into categories of plastic waste (the list of commonly used items is available in Activity 1.1).
- The groups can also identify and record the recyclable products from the list using the plastics identification code.
- The groups then present their findings in the classroom.

Conclusion

Plastics are petroleum products and different types of synthetic monomers are used in the manufacturing of different plastics. Knowledge about the type is essential to understand the plastics and their properties.

Evaluation

Discuss which item is used for different material and why.

ACTIVITY 1.4

Segregation at Source

Introduction

Segregation of waste must begin at home. Some amount of segregation already happens in most of our homes. For example, old newspapers and magazines, used bottles, metal cans etc are sometimes kept aside and sold to the kabadiwalla (junk dealer). This is a form of segregation that children may get to observe at their homes.

According to the Municipal Solid Waste Management Rules 2016, solid wastes must be segregated into dry and wet waste. Segregation at source is critical to its recycling and disposal. Collection and transportation of unsegregated mixed waste to the landfills has an impact on the environment. When we segregate waste, it reduces the amount of waste that reaches landfills, thereby taking up less space. Pollution of air and water can be considerably reduced when hazardous waste is separated and treated separately.

The rules also specify the color coding for the bins for Dry waste, Wet waste and Hazardous waste. It is essential that the waste is put in the correctly coded bins so that it can be appropriately dealt with.

Objective	To help students understand the importance of waste segregation and learn to categorise and dispose of the waste correctly
Grade level	Primary
Group Size	Class
Place	School
Duration	40 minutes
Materials	1. Three Dustbins: (Blue for dry waste, Green for wet waste and Red/Black for hazardous waste) 2. Paper chits – one chit per student 3. Pen

Before you begin

- The teacher will need to prepare paper chits with the names of different degradable and non-biodegradable waste: vegetable, fruits, flowers, leaves from the garden, plastics, paper, glass, tetra packs, aluminium foil, pencil shavings, band aid, pins, metal clips, chip packet, chocolate wrapper, polythene bag, plastic water bottle, plastic soft drink bottle, cotton U pins, used battery, etc.
- The teacher may add a few more items if required to ensure that each student has one chit. Some of the listed items can be repeated.

Methodology

- The teacher could introduce the topic to the class and show them the three colour coded bins and explain what kind of waste can go into each bin.
- After the topic has been introduced, the teacher could ask each student to pick one chit from the pile of chits placed in a box.
- The teacher could then ask the students to put their chits in the appropriate bins (blue labelled for dry waste, green labelled for wet waste and red/black labelled for hazardous).
- The students will then identify the right bins for each product and put them into the bin.

Conclusion

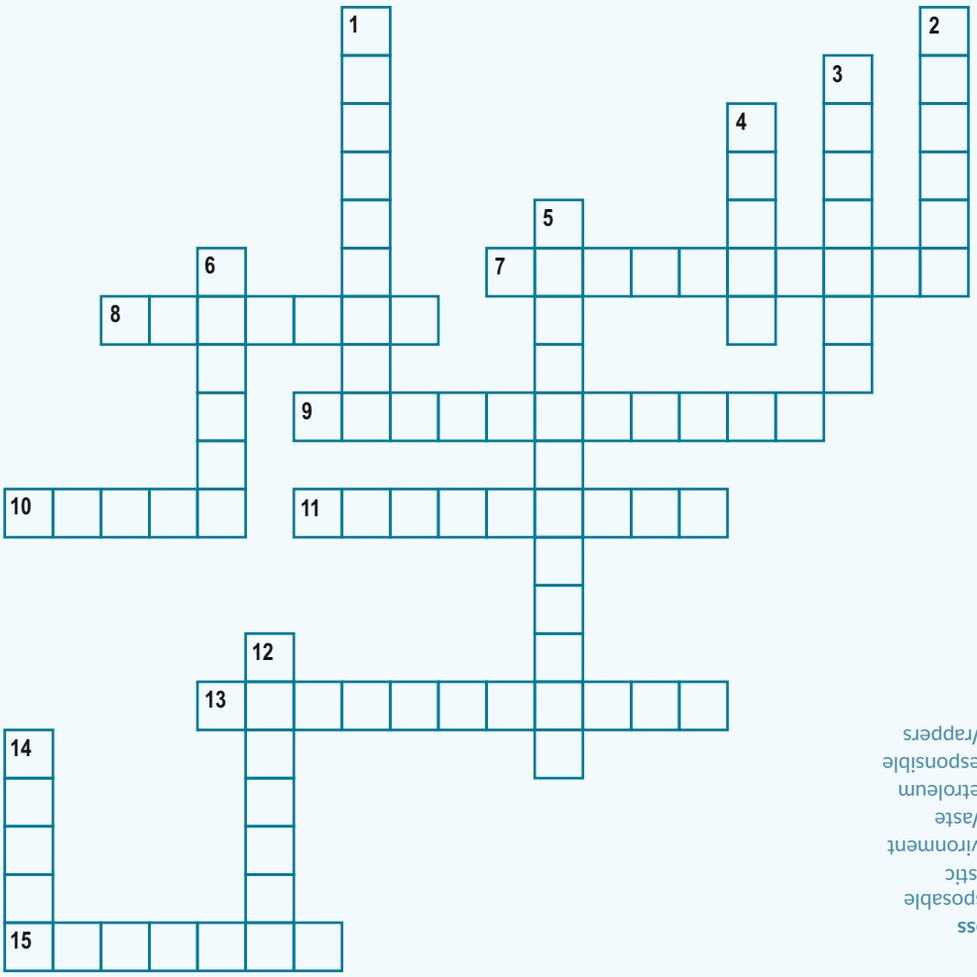
After the activity has been completed the teacher could check the chits in the dustbins and in case of a mistake, the teacher will need to explain why the items belongs to a particular bin.

Evaluation

In this way students will understand the concept of segregation and how to prioritise it correctly.

All about Plastics

Complete the crossword below



Across

7. Use of _____ plastics should be completely avoided
8. _____ is made up of synthetic polymer
9. Irresponsible use of plastic harms the _____
10. Segregation of _____ is necessary for clean environment
11. Plastic is a by product of _____
13. _____ consumption of plastic is necessary for a cleaner planet
15. You should dispose the of food items in _____ the appropriate bin

Down

1. Burning of plastic causes air _____
2. We should _____ the use of plastic bag and always use a cloth bag for shopping
3. Waste should always be disposed in the appropriate _____
4. It is always advisable _____ to plastic items
5. Plastic less than the size of 5 mm diameter is called _____
6. Plastic in water bodies harms the _____ ecosystem
12. 3R's of waste management include Reduce, Reuse & _____
14. Use of _____ for drinking cold drinks should be completely avoided

Answers

Down
1. Pollution
2. Reduse
3. Dustbins
4. Reuse
5. Microplastic
6. Marine
12. Recycle
14. Straw

Across
7. Disposable
8. Plastic
9. Environment
10. Waste
11. Petroleum
13. Responsible
15. Wrappers

Word Search

A collection of words related to things made of plastics is hidden in this puzzle. Try to find as many as you can by searching across and down. Answers are given below.

A	D	S	H	U	W	V	P	X	S	T	V	U	F	A	U
P	C	H	A	I	R	Z	Z	O	M	P	L	A	T	E	S
O	Q	O	G	X	O	Y	G	Z	M	E	D	O	I	A	C
L	M	E	I	M	Y	R	U	I	V	N	K	Q	F	A	W
M	S	S	J	L	N	B	H	K	I	S	E	H	F	M	R
N	L	T	M	R	B	R	U	S	H	B	D	C	I	A	A
F	R	R	K	Q	O	M	A	C	G	S	T	H	N	X	P
J	O	I	L	P	T	A	B	A	T	O	P	R	G	R	P
G	N	I	O	S	T	J	C	L	I	P	S	M	L	A	E
Z	N	S	P	B	L	U	K	E	G	I	R	C	S	D	R
L	P	T	S	C	E	K	F	A	D	B	N	Q	O	Q	S
O	L	I	U	F	N	E	C	A	C	B	U	C	K	E	T
D	U	S	T	B	I	N	U	B	Q	P	T	I	P	L	O
I	T	N	E	O	W	M	P	D	L	M	O	J	B	T	Y
L	K	Y	H	X	D	L	O	F	W	Y	Z	K	A	P	S
O	R	W	F	U	Q	Y	X	C	T	A	B	L	E	B	C

Answers

Down: SHOES, PEN, TIFFIN, WRAPPER, TOYS, BOX, BOTTLE, SCALE

Across: CHAIR, PLATES, BRUSH, CLIPS, BUCKET, DUSTBIN, TABLE

CHAPTER 02

Issues and Challenges

Introduction

The earth's ecosystem, with its various resources like water, soil and air makes our survival possible.

Unfortunately, one of our own discoveries – plastic - has become a major threat to our ecosystem. It has many adverse impacts on living organisms and the environment. It is a fact that plastics take several hundred years to degrade.

A huge amount of plastic waste is generated in India. Much of this is discarded and enters our waste management system placing it under great strain. Plastic waste management reduction, reuse, involves collection, storage, transportation, recycling, recovery and disposal in an environmentally safe manner.

Issues and Challenges of Plastic Waste Management

As we saw in Chapter 1, plastics are a very useful material with wide-ranging applications in domestic and industrial sectors. Then why have plastics suddenly become a challenge to our environment?

It is the indiscriminate use and irresponsible disposal of plastics that pose the challenge. Let us look at how plastics have become a problem.

Proliferation of Plastics – A Lifestyle Issue

From just 1.5 million tons in 1950 to 400 million tons of plastics in 2021, the earth has seen an exponential growth in the production and use of plastics.[9] This amounts to a total of approximately 9.2 billion tons of plastics produced in just 70 years.[12] This rapidly increasing production overwhelms the world's ability to deal with it.

Single use products like plastic bags and food wrappers, have a lifespan of mere minutes to hours, yet they persist in the environment for hundreds of years finding their way into our marine, freshwater and terrestrial systems impacting environmental, social, and economic sustainability globally.

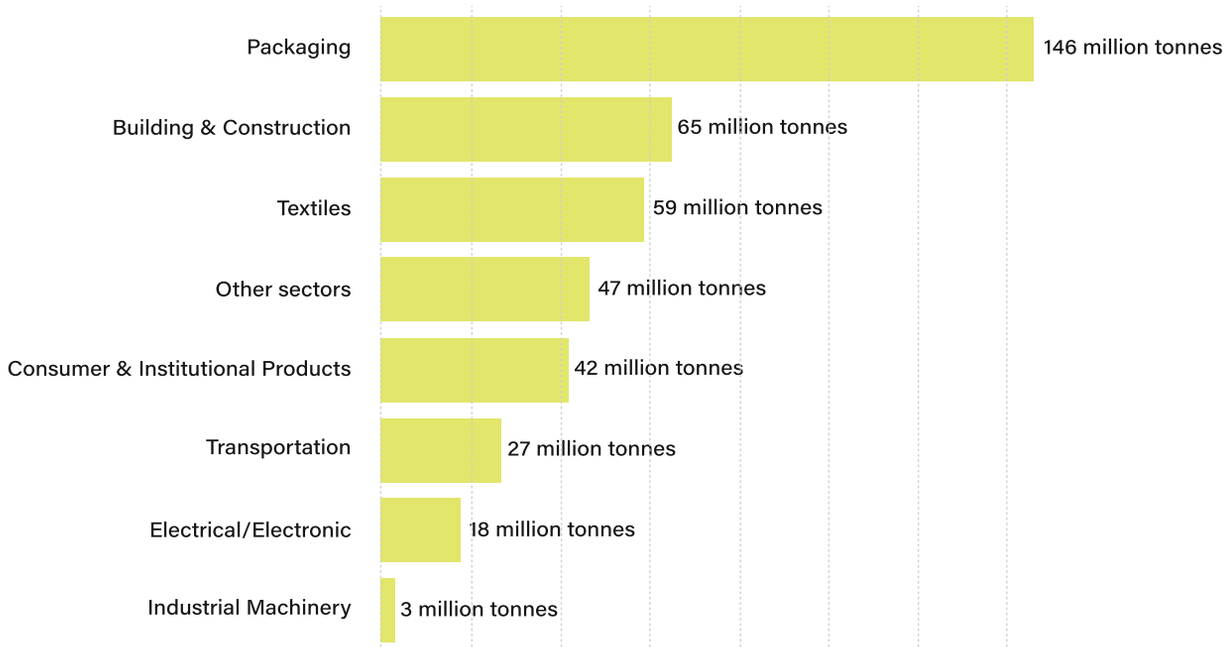
Widespread Use of Plastics in all Sectors

The use of plastics is widespread. They are found in everyday items- from toothbrushes, water bottles and storage containers in households, to pipes, tubes and fittings in the electrical and plumbing industry.

Plastics are also being widely used in the packaging of consumer products including food products. Their durability and strength make them ideal for packaging and transporting all kinds of consumer and industrial products.

Primary plastic production

Primary global plastic production by industrial sector in 2015[26]



Disposable, one time use plastic or single use plastic (SUP) is the root cause of plastic pollution. More than half of all plastics are produced and designed for single use. While plastics have amazing qualities, what is causing havoc to the environment is the use of disposable or single use plastics which include food packets, cups, cutlery (plates, spoons, forks and straws) etc. With lifestyle changes like eating out and take away / food delivery, plastic is becoming the main material for packaging, storing and delivering food items.

According to UNEP, about 36 % of plastics produced is used in packaging.[11] Packaging with multi layered plastic is especially difficult to recycle.

One of the most commonly used disposable plastic item is the carry bag that is used to carry anything from vegetables, fruits and milk, to textiles and other lifestyle products. Additionally, most of the daily groceries are packed in plastic bags or covers. Plastic wastes such as multilayer, metallic pouches and thermoset plastics which are disposed after a single use, are generally non-recyclable.

Disposable plastic bags

Single-use disposable plastic bags are suffocating the planet and it takes a huge amount of energy to manufacture, transport and recycle them. They do not break down in landfill sites but over time they release dangerous chemicals. They are incredibly difficult to recycle, causing problems such as blocking the sorting equipment used by most recycling facilities. Plastic bags being one of the most common types of litter worldwide, they contribute to a widespread, global litter problem.

The indiscriminate use and discarding of plastic bags cause blockage of local drainage systems in developing countries. This situation can lead to floods and related issues. Littering plastic bags causes serious health hazards to humans and also chokes and kills animals and birds.

The scale of this issue along with insufficient recycling measures, calls for urgent action at both individual and collective levels.

Packaging

Packaging is ubiquitous in our daily lives. It helps to minimise food waste, increase shelf life, enable easy transportation, and all this at low costs. Over the past decade, the global packaging industry has enjoyed strong growth especially with plastic entering this sector.

Plastic packaging is extremely wasteful and impacts earth's ecosystems being one of the greatest generators to plastic pollution, for its shortest life-span. Most food packaging is multilayer and then there is tetra packaging used for packaging various beverages and semi-liquid food items. These items are easy to throw away but difficult to collect. They end up in a landfill or in waterways creating issues. Owing to the difficulty to clean and separate into its constituents, these are not usually recycled but downcycled or used for energy recovery.

Manufacturers need to look for alternatives like in the past when chips came in metal cans or chocolate was sold in paper wrappers.

Cosmetics and Fast Fashion

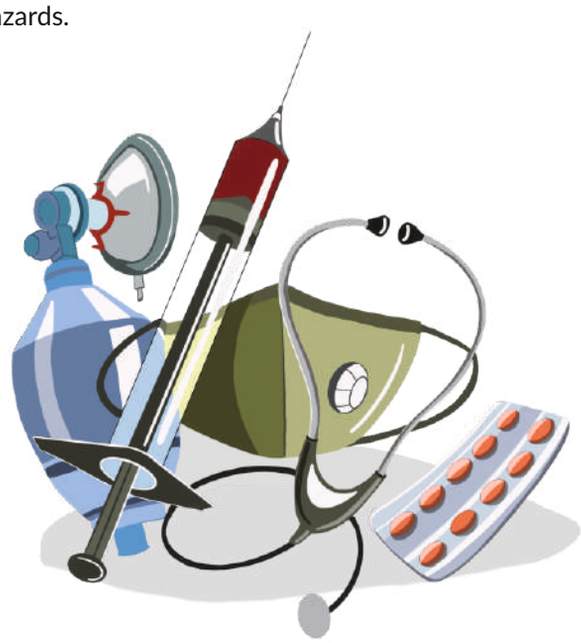
Cosmetic products also use a lot of disposable plastics – containers for cosmetics and even microplastics in the form of microbeads in face cleansers, body washes etc. Similarly, fast fashion also contributes in a big way to greater consumption of plastic and generation of plastic waste including microplastics.

Plastic in the Medical Sector

The medical sector has been greatly enhanced by plastics. The global medical plastic market size was valued at $29.93 Bn in 2019 and is projected to reach $54.29 Bn by 2027.[38] Medical plastics are products specifically designed for applications in the health care industry to be temperature, chemical and corrosion resistant making them amenable to regular sterilisation for the efficient storage of medical fluids. The Covid-19 pandemic has also led to the high use of plastic products.

From blood bags and disposable syringes to prosthetics, heart valves and numerous other medical devices, the impact of plastic is far-reaching. Plastic has made the healthcare industry safer and cost-efficient. It provides enhanced sterility and safety, helps boost hygiene at medical facilities and has also helped make healthcare affordable.

Though necessary when no alternatives are available, disposables are not always essential for the safer delivery of healthcare, as safe and cost-effective reusable alternatives are available and offer the same levels of hygiene and safety. The unnecessary use of disposables creates economic, environment and social hazards.



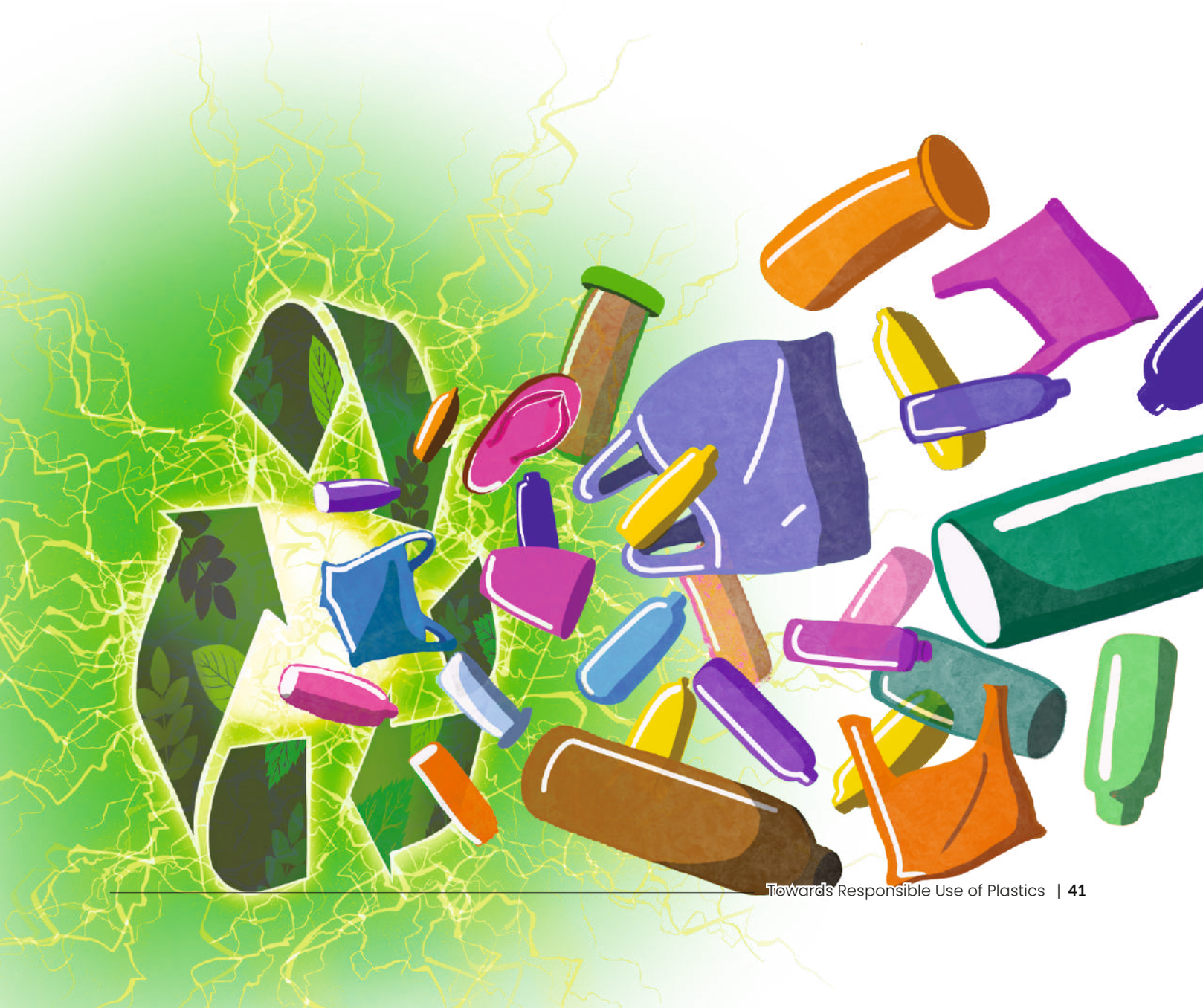
Approximately 90% of PET bottles are recycled in India which is the highest global average.[27]

Plastics Waste Mismanagement

It is not uncommon to see waste dumps including different forms of plastics especially plastic bags and wrappers. Burning of waste including plastic waste is also practiced as a quick disposal method to get rid of plastic. Since plastics are not biodegradable, they pose a challenge to the solid waste management system. When they enter the landfill they remain there for hundreds of years. Others litter our environment.

Disposal of solid waste near water bodies, results in plastics getting into our waterways and rivers and eventually finding their way into the oceans. In low and middle-income countries where waste management capacity is surpassed by consumption and plastic waste generation, people choose to burn their discarded plastics in open uncontrolled fires. Globally, mismanaged plastic waste threatens the health and wellbeing of billions. Understanding where plastic is being mismanaged is crucial for mitigating leakage and informing intervention strategies.

The key to managing plastic waste lies in applying principles of the circular economy where the emphasis is on reduce, reuse and recycle. The type of plastics being used is also a concern. But most importantly, the quantity of waste that is not disposed of correctly or does not even enter the waste management system are the major problems. This happens because of the following reasons:



Lack of Waste Segregation at Source

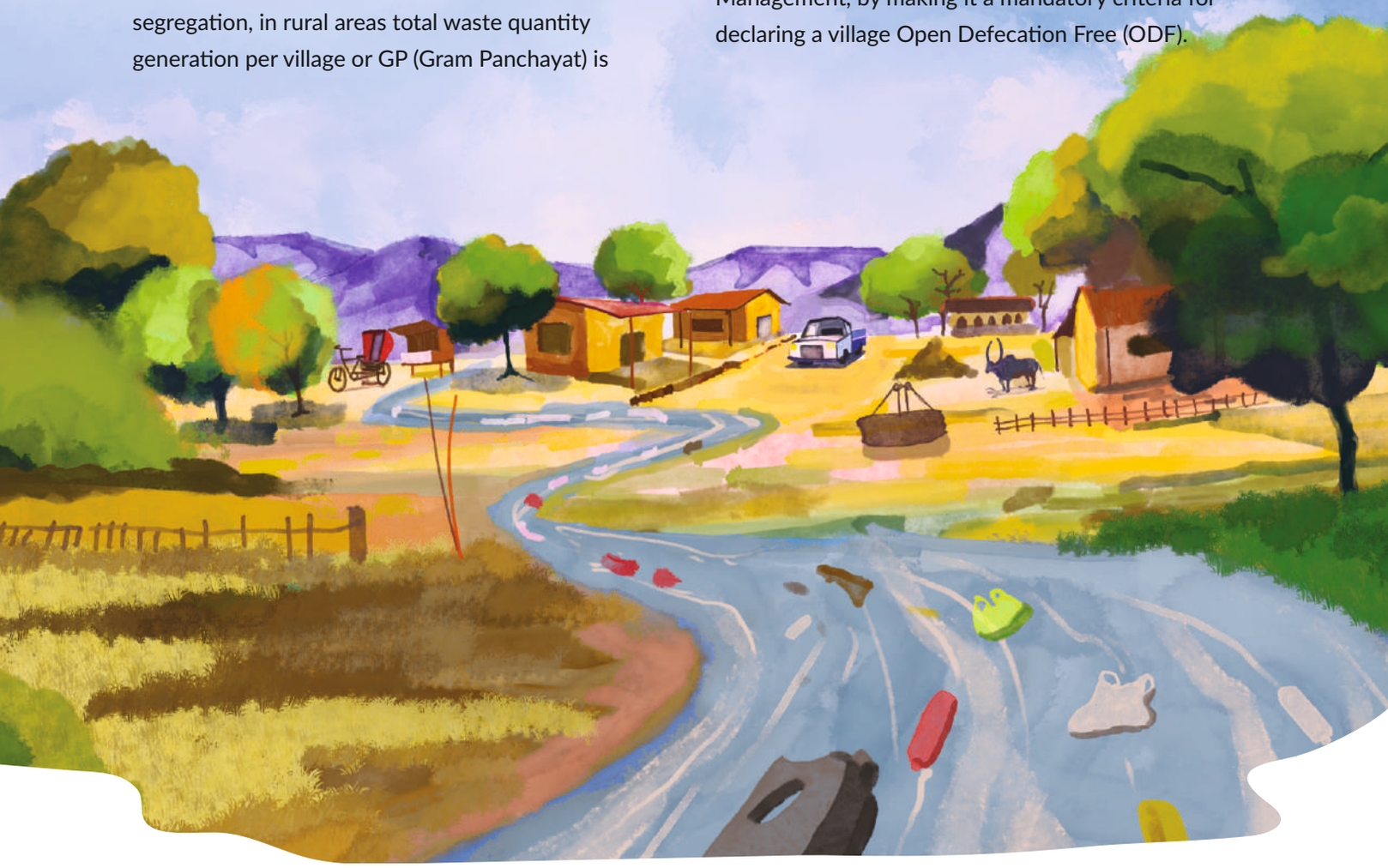
Segregation of waste at source ensures that different kinds of wastes are disposed of appropriately. But segregation of waste at source is not commonly being practiced. When food and wet waste (which can be composted) is mixed with dry waste like plastics and paper (which can be recycled) it reduces the efficiency of the municipal waste management system resulting in a major part of the waste being dumped in landfills. This, on one hand, strains the capacity of the landfills, and on the other, being non-biodegradable, plastics take up space without a chance of degrading for a few hundred years. With land becoming more valuable and less available, finding a place to dump garbage is a problem. Moreover one must remember, that when the plastic which could have been recycled if segregated, ends up in landfills, it is also a waste of valuable fossil fuel resources.

Difficulty in Sorting

Sorting is a significant bottleneck in the plastic recycling process. Not all plastics are recyclable, and not all recyclable plastics are fit to be recycled. Flexible plastic packaging such as plastic bags, films, and labels that constitute a significant portion of daily plastic waste are very tough to recycle. Even if recyclable plastics can be isolated at collection, they will still need to be sorted to make sure that they do not cause problems with recycling equipment. It should be clean and free from food residue while plastic bottles must be crushed and their caps removed. There are also composite plastic containers that use two different plastics. These have to be either separated by hand or by special equipment. A classic example is the standard disposable coffee cup, which is made of paper with a thin film of polypropylene for water-resistance. The sheer diversity and complexity of different plastic products remains a problem that is yet to be fully addressed.

Plastic Disposal in Rural Areas

Plastic disposal in rural areas pose another type of challenge linked with availability of system of collection, disposal and management. Apart from challenges related to awareness and education about source segregation, in rural areas total waste quantity generation per village or GP (Gram Panchayat) is sometimes much less making it financially difficult to set up the collection systems. Plastic in rural areas clogs drains, sewers, pollutes water bodies and agricultural soil. Swachh Bharat Mission-Gramin (SBM-G) has laid special emphasis on Plastic Waste Management, by making it a mandatory criteria for declaring a village Open Defecation Free (ODF).



Plastic Pollution

Plastics are a major pollutant, especially when not disposed of responsibly. It pollutes water, land and air causing diseases and even loss of life when not disposed of in the right manner.

Water Pollution

Oceans, rivers, lakes and ponds have become sites for dumping waste and are in great danger because of leachates from the plastics waste. Chlorinated plastics can release harmful chemicals into the surrounding soil, which then seep into the groundwater and cause serious harm to the species that drink the water.

A 2017 study observed that 83 percent of tap water samples were found to contain plastic particles out of 159 samples collected from around the world.[28]

Plastics in oceans break down into smaller particles – microplastics and nano-plastics which are easily ingested by marine life. These have adverse consequences on marine species, even leading to death. Other living beings including humans who eat fish and other marine species are also affected by this due to bioaccumulation.

Land Pollution

When plastics are dumped in unscientifically managed landfills, the chemical leachate produced by plastics or the landfill leachate containing chemicals from plastic decomposition, enters the soil, making it dangerous for other organisms. Some of the key chemicals thus leached include Bisphenol A (cause negative impact on reproductive systems), Phthalates (disrupt endocrine function), and Brominated Flame Retardants (affect hormones involved in the development of the reproductive and nervous systems).

Air Pollution

One of the ways people tend to dispose of plastics is by burning them. But burning of plastics in the open leads to air pollution as they release poisonous gases like carbon monoxide, dioxins and furans into the air.

Fires in the landfill are also a major source that contributes to air pollution. Carbon monoxide is a well-known poison; dioxins and furans are Group- 1 carcinogens, which means that they are known to cause cancer and are responsible for a variety of abnormalities in gender development and behaviours and reproductive capabilities.

Climate Change

Plastic industry accounts for about 6 percent of global oil consumption and is expected to reach 20 percent by 2050.[29] Manufacturing of ready to sell plastic products from raw materials is energy intensive thereby contributing to extensive GHG (Greenhouse Gas) emissions. New scientific studies have shown that plastic is responsible for almost 4.5% of the world's total greenhouse gas emissions.[30] Energy-intensive processes are required to extract and distill oil, its transportation, deforestation and clearing of the surrounding for fossil fuel extraction all leads to to enormous amounts of GHG emissions and impact climate change.

Dumped plastic wastes generates greenhouse gas emissions when exposed to solar radiation, both in air and water. Marine plastic pollution breaks down into microplastics and contributes to climate change both through direct GHG emissions and indirectly by negatively affecting ocean organisms. Burning of waste in open fires leads to the production of a serious air pollutant, black carbon and is responsible for half of the visible smog in cities like New Delhi. The global warming potential of black carbon is up to 5,000 times greater than that of carbon dioxide (CO_2).[29]

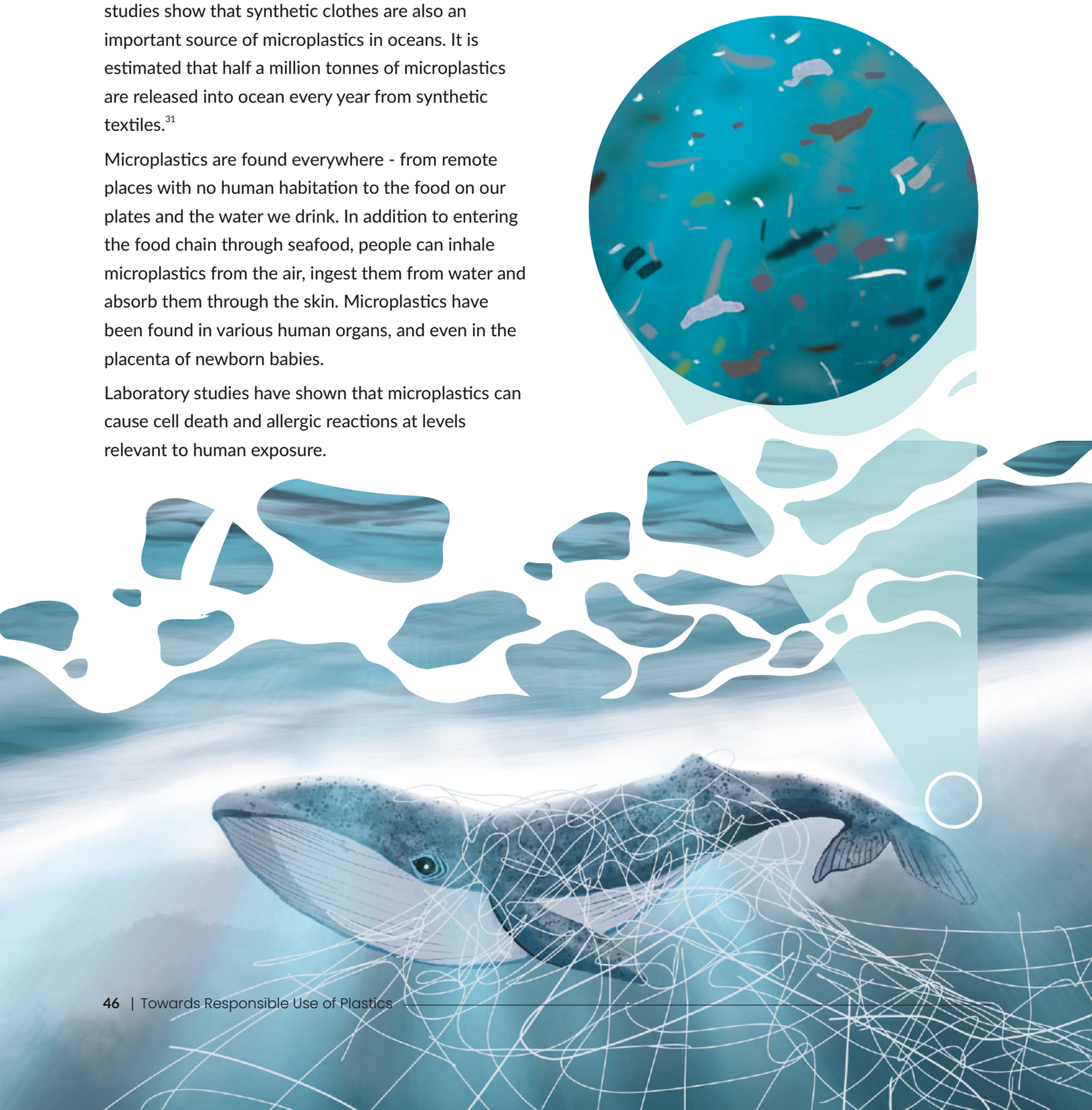
Microplastics

Microplastics, tiny particles of plastic, less than 5 mm (0.2 inch) in size are a major pollutant, harmful to the environment and animal health. They are formed as a result from both commercial product development (eg: microbeads, plastic pellets and plastic fibres) and the breakdown of larger plastics when they undergo weathering, through exposure to wave action, wind abrasion, or ultraviolet radiation from sunlight. Recent studies show that synthetic clothes are also an important source of microplastics in oceans. It is estimated that half a million tonnes of microplastics are released into ocean every year from synthetic textiles.[31]

Microplastics are found everywhere - from remote places with no human habitation to the food on our plates and the water we drink. In addition to entering the food chain through seafood, people can inhale microplastics from the air, ingest them from water and absorb them through the skin. Microplastics have been found in various human organs, and even in the placenta of newborn babies.

Laboratory studies have shown that microplastics can cause cell death and allergic reactions at levels relevant to human exposure.

However, the health impact to the human body is uncertain because it is not known how long microplastics remain in the body before being excreted. Due to their considerable adsorption capacity, they are also found to act as a means of transportation for various organic and inorganic contaminants including microbes, chemicals and metals, into the environment.



Impact on Ecosystems and the Food Chain

When littered and mismanaged plastic waste enters the natural environment, it affects different ecosystems in different ways, altering habitats, harming wildlife, and disrupting nutrient cycles.

Plastic has already entered the food chain. Since one animal eats another, plastics can move through the food chain. This process is called 'trophic transfer' of plastics. Moreover, as plastic, especially microplastics tends to bind with environmental pollutants as they move through the food chain, the attached toxins also move and accumulate in animal fat and tissue through a process called bio-accumulation. In addition, chemicals added to plastic during the production process (to give them desired properties) can leak from the plastic, even when it is inside the body of an animal.

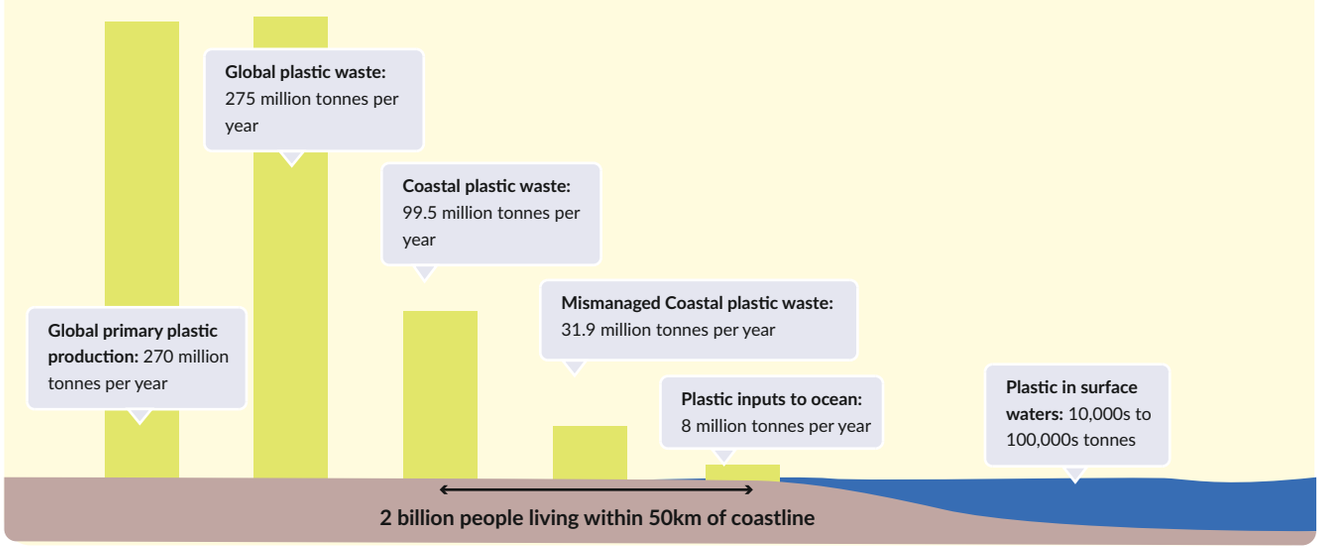
Cows dying by feeding on plastic waste, whales being found dead with their bellies full of plastic waste, turtles and other wildlife getting caught in plastic bags and nets, are now part of common lore. Millions of animals are killed by plastics every year, from birds to fish to other marine organisms. Nearly 700 species, including endangered ones, are known to have been affected by plastics.[32] Most of the animal deaths are caused by choking, entanglement or starvation.

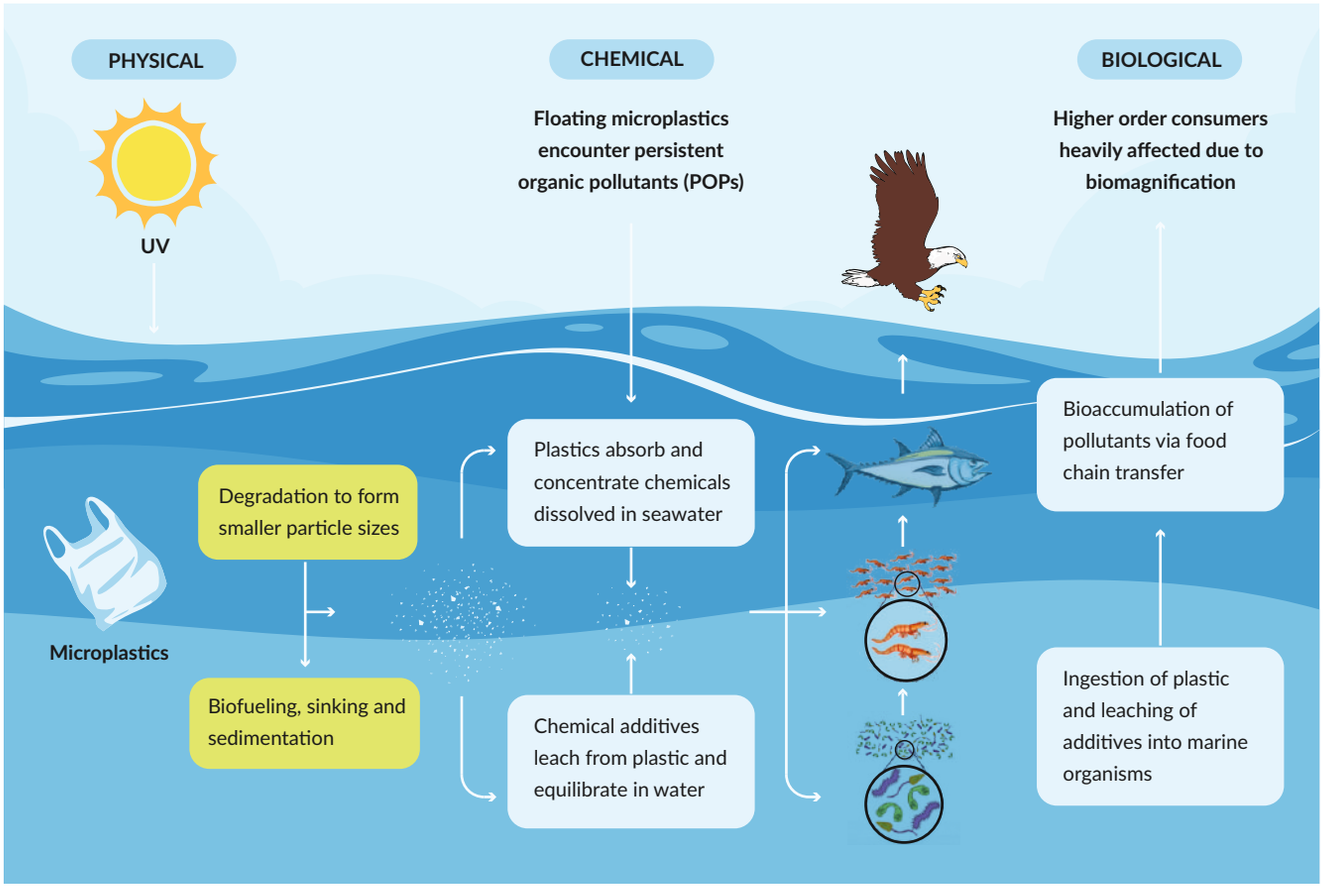
It has been estimated that plastic pollution kills 100,000 marine mammals every year.[33] Out of 123 marine mammal species, 81 are known to have been impacted by plastic.[34] According to an estimate by National Geographic nearly every species of seabird on earth is eating plastic. Plastic trash is found in 90 percent of seabirds and there has been a nearly 67 percent decline in seabird populations between 1950 and 2010.[35] Plastics also enters the human system through food and water. Microplastics have been found in foodstuff including honey, tea, sugar and other everyday food items.

The solution is to prevent plastic waste from entering the natural systems in the first place. This could be accomplished with responsible use and disposal of plastic products, especially Single Use Plastics. Improved waste management systems and recycling, better product design that takes into account the short life of disposable packaging, and reduction in the manufacturing of unnecessary single-use plastics is recommended.

The pathway by which plastic enters the oceans

Estimates of global plastics entering the oceans from land-based sources based on the pathway from primary production through to marine plastic inputs (2010)





Health Hazards of Plastics

Plastics have become an integral part of our daily life. For example, plastic containers help keep food fresh, but if the right kind of plastics are not used, they can release neurotoxins such as BPA in the human body. BPA is associated with a number of health problems in human beings such as reproductive health issues, rapid changes in immune system, Type 2 diabetes, cardiovascular disorder, obesity, etc. Some studies also claim that BPA increases the risk of cancer and metabolic disorders. Phthalates, the main component of PVC, have been implicated in reproductive disorders in human beings, increased fat accumulation and insulin resistance. Dioxins, released when plastics are burnt, are known to cause cancer.

Some of the more familiar compounds related to plastics include vinyl chloride (in PVC), dioxins (in PVC), benzene (in polystyrene), phthalates (in PVC and others), formaldehyde, and Bisphenol-A (BPA, in polycarbonates).

Many of these are persistent organic pollutants (POPs)— some of the most damaging toxins on the planet, owing to a combination of their persistence in the environment and their high levels of toxicity. Their unmitigated release into the environment affects all terrestrial and aquatic life.

According to UNEP, around the world, nearly a million plastic beverage bottles are sold every minute.[36]

ACTIVITY 2.1

Needs & Wants

Introduction

India is developing rapidly; hence there is also a rapid growth in the consumption of resources. While this is happening in our cities, villages too are increasingly following the same path. However, the ease and convenient availability of resources leads to haphazard consumption, especially of disposable plastics. This activity aims to differentiate between the needs and wants of disposable plastic products, some of which may not be necessary but are bought anyway.

Objective	To help students understand that use of certain disposable plastic products can be avoided.
Grade level	Middle school
Group Size	4 to 5 students in each group
Place	School and Home

Duration	• 30 minutes for a brainstorming session with students
	• 8 days in total for the following tasks
	  • Audit of household disposable plastic consumption (1 week)
	  • Reflection and action worksheet (1 day)

Materials	• 1. Writing material • 2. Observation sheet for household consumption • 3. Reflection and Observation worksheet • 4. Access to Internet

Before you begin

The teacher could introduce students to the concept of sustainable consumption and its importance. The teacher could discuss with the students the difference between, long term plastic products and disposable ones.

Methodology

- The teacher could ask each student to prepare a personal household consumption checklist using the exemplar sheet provided.
- In groups, the students should then prepare a consolidated list using their personal consumption checklists.
- The teacher could ask the groups to share their consumption checklist with another group of students in the class.
- Each group will come forward and share their list.
- The teacher could discuss how choice of products, packaging and usage, contribute to the differences in the lists.
- Following the discussion, the teacher could provide the Reflection and Action Worksheet to each student.
- The teacher could then ask a few students to share what they have written in these sheets with the class.

Task 1: Household plastic consumption checklist

Fill in the observation sheet to note your household plastic consumption pattern (over the period of a week)

Date of Purchase	Types of items purchased			
	Food & Drinks	Toys/Games	Stationery	Others
Eg: February 1, 2023	Packet of Cookies Bottled Water & Beverages	Blocks (Plastic) Laminated Board Games with plastic dice	Blocks (Plastic) Pencil Box	Blocks (Plastic) Photo frames

Task 2: Reflection and Action Worksheet - Think about the following

Refer to Task 1, think about the different plastic products mentioned in the table below and fill in with appropriate actions that you can take

Product	Can the packaging/ product be used again or does it have to be disposed of?	If to be disposed of, how?	Could I do without this? Yes/ No	Is there a better alternative? Mention it
Bottled water & beverage plastic bottle	Disposed	Separately from biodegradable waste	Yes	Use a 20 litre reusable jar

Conclusion

Students will understand more about their household consumption patterns of plastic products and plastic packaging.

They may become motivated to avoid/reduce their own consumption of plastics and plastic packaging.

Evaluation

Students can be asked to suggest alternatives to SUPs.

ACTIVITY 2.2

Litter... Why does it Matter?

Introduction

Littering is one of the biggest environmental as well as social challenges faced today. It is important for the students to know about the impacts of littering as plastic is present in practically every product. This activity will help students understand how litter contributes to the problem of plastic pollution.

Objective	To make students understand: • The impact of littering. • Co-relation of plastic pollution with littering.
Grade level	Middle school
Group Size	Individual
Place	Home assignment
Duration	• 10 min for background introduction and screening a film • 30 min to discuss the problem of littering and how it contributes to plastic pollution • Writing an essay - home assignment
Materials	• An award winning short film on the impact of litter - Khat Aaya Hai (https://www.youtube.com/watch?v=6SZ-ZWjdrO8&t=93s) • Stationery material - notebooks, writing material • Access to Internet

Before you begin

The students can watch the short film about littering and the impact of plastic pollution mainly on wildlife and marine organisms. They can also be briefed about how littering contributes to plastic pollution.

Methodology

- The teacher could facilitate a discussion with students about the problems associated with littering and how it leads to plastic pollution.
- The students could then be asked to observe the littering behaviour of people. They could choose to observe littering on roads, in commercial places, in open places and parks or in schools. The students can then select a suitable spot for their observation.
- Some indicators for observation could include:
  - Are there waste bins in this spot?
  - Are people tossing waste into the bins?
  - What is the kind of material littered most frequently?
  - Was the littered material consumed by any animal?
- Following this, students could track how littering leads to a set of problems which ultimately contribute to polluting the land, water and atmosphere.
- Based on their observations and background research, students could then write an essay on the issues relating to the management of waste.

Conclusion

The students will be able to relate littering behaviour to the problem of plastic pollution.

Evaluation

Discuss the consequences of littering.

ACTIVITY 2.3

Litter Blitz

Introduction

Litter is a social and environmental challenge. It is important to understand all the aspects of this challenge. This questionnaire will help students understand what issues relate to this challenge.

Objective	To help students understand what leads to littering along with the perspectives of people regarding litter and how it affects them
Grade level	Middle & school
Group Size	6-8 Students
Place	Public Places, Home and School

Duration	• 15 min to contextualise and discuss the survey questionnaire with students
	• 3 consecutive periods of 60 min each
	  • Going out and collecting data
	  • In class, analyse the data
	  • Presentation and discussion
	• 60 min for analysing the results of the survey (Homework)
	• 40 min for classroom interaction and discussion

Materials	• Pre-survey questions

Before you begin

The teacher could brief the students about the process of conducting the survey.

The teacher could also introduce the students to the method of making a data sheet for the answers obtained during the survey.

Methodology

- The teacher could divide the class into groups of 4-5 members.
- The teacher could ask the groups to select a spot and conduct a local survey. The students can also do it individually at public spots near their respective homes.
- Each group could survey 2-3 spots and interview people of three different age groups.
- The students could compile their individual results with their group and make a joint data sheet.
- The groups could then compare their data with the other groups.

Survey Form for Interviews at Litter Spots

Age Group:

Below 12 ☐ 12 to 21 ☐ 21 & above ☐

Ask the following questions and note the responses:

1. Do you think that there is a problem associated with litter?

- The problem is increasing
- It is the same as before
- There never was a problem

2. Have you ever littered?

- Yes
- No

If yes, why?

- Didn't find a bin
- Didn't think it could cause problems
- Didn't care

3. If there was a fine for littering, would you still litter

- Yes
- No
- Couldn't be bothered / Won't get caught

4. Why do you think people litter?

- Inadequate dustbins at public spaces
- It's accepted behaviour
- Dirty public spaces trigger people to litter more

5. Whose responsibility do you think it is to keep public spaces clean?

- Our responsibility
- Housing association
- Municipal Corporation

6. What do you think are the major problems with litter? (You may tick more than 1)

- It looks unaesthetic
- It stinks
- It causes environmental pollution
- It might be consumed by stray animals and harm them

7. Do you think plastic pollution can be controlled if people stop littering?

- Yes
- No
- Partially

8. Will you carry your trash with you until you find a bin if you don't find one immediately?

- Yes
- No
- If no, why not?

Conclusion

The data that is generated will help students understand how attitudes differ when it comes to littering.

Evaluation

Discuss why people litter and what could help change this behaviour.

ACTIVITY 2.4

Making a Poster on Marine Pollution

Introduction

While plastic pollution affects all life on the planet, the situation in the ocean is particularly bad. This is because the ocean is the final sink for all the plastics that flow into the rivers and eventually into the sea. If access to the internet is available, there is considerable information available online about marine pollution along with graphic images of the damage it is doing to our ocean and marine life. This activity aims to get students to make a poster about marine pollution. Two options are given. If the school is near the coast, or any water body like a river or lake, a field trip is also suggested. The activity can otherwise be done through an internet search, or consulting reference books, articles or materials which can then be discussed.

Objective	To help communicate awareness through a creative exercise about plastic pollution in the oceans
Grade level	All
Group Size	Small Groups
Place	School or school plus a field trip
Duration	One period
Materials	Paper and sketch pens/pencils to make a poster

Before you begin

The teacher can introduce the issue of marine pollution and ask students how and why it happens, whether they know the extent of it and the possible harm it causes. The teacher can then instruct them about the activity and get them started on developing a poster that will create awareness on this issue.

Methodology

- If internet is available, the teacher should ask the students to search for images and short films or alternatively go to the school library to review books and magazines for ideas relating to marine pollution.
- The teacher can then get the students to form small groups. Each group can then work on designing a poster to create awareness on an aspect relating to marine pollution.

Conclusion

Display the posters at school and get other students to evaluate how effective the posters were in communicating their message.

Evaluation

The content of poster and design will help students to understand and communicate on key issues relating to marine pollution.

CHAPTER 03

Solutions to Plastic Waste

Managing plastic waste in a responsible manner ensures that it does not cause environmental and health problems. Waste management, including plastic waste management, requires collective efforts from all stakeholders – individuals, organisations, institutions, communities, producers, manufacturers, local/state/central governments and enforcing agencies. The various issues discussed in the previous chapter can be addressed through an integrated plastic waste management system for which all stakeholders need to be actively involved.

The Three R's: Reduce, Reuse, Recycle

There is no single or simple solution to manage plastics waste. A variety of waste management practices are required to ensure that plastic waste does not become a threat to the environment and the health of human beings and other organisms on earth.

The 3 R's – 'Reduce, Reuse, and Recycle' – are a commonly adopted formula that can help manage plastics waste in a sustainable manner.

Sometimes we do not realise that so many of the products we use in our daily life are made from plastics. This includes materials such as polyester textiles, toothbrush, buckets, mugs, laminated paper and other stationery. By reducing, reusing, and recycling, we can help conserve the earth. Individual behavioural change plays a vital role in managing plastic pollution and contamination.

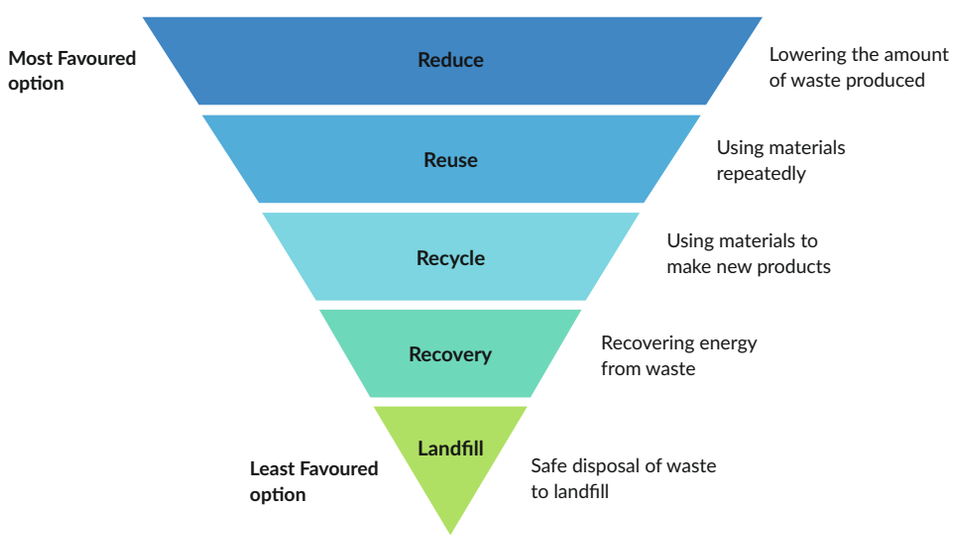
Reduce: Reducing the use of plastics in our lives is the first step to manage plastic waste. We can start with giving up using single use plastics like disposable cups, cutlery, and carry bags. We can carry our own bags /containers when buying food. This will reduce plastic waste considerably.

Reuse: We need to change our habit of instant disposal of plastics and start reusing them. This will reduce plastic waste generation and its impact on the environment. Instead of throwing away the plastic bag you have, reuse it a few times for shopping or carrying things. Storage containers can be reused for storing various items around the house or school/classroom. Reusing will ensure the reduction of plastic consumption.

Recycle: Recycling refers to the process of recovering waste plastic which can then be processed to make useful materials/products. A considerable amount of plastic waste can be recycled to make newer products. Plastic containers, buckets, etc. are usually recycled to make similar products.

Plastic water bottles are often converted into fabric or yarn used in textile industries or recycled PET to make bottles from bottle (Circular Economy).

Recycling is now an industry, with all waste material being segregated and then processed; it provides employment to people including rag pickers and those working on recycling. Recycling helps reduce the use



of valuable resources which can then be put to use for other purposes and made available for longer periods.

Recycling has several benefits. It reduces the amount of waste that reaches the roadside bins, reduces the amount of energy needed to make new products and reduces the requirement for original material. Recycling reduces pollution while releasing new raw materials.

Besides the three R's, several other R's are also popular guidelines for dealing with plastics waste. These include: Refuse, Replace, Repair, Repurpose, and Rethink.

Invisible waste warriors - Safai Sathis

The critically important role of waste pickers or rag pickers in the informal-unorganised sector in managing waste in India is not often recognised or acknowledged. More than four million[39] waste pickers or Safai Sathis form the backbone of the country's informal waste management ecosystem. An observant person may notice women, children and sometimes men scouring garbage for plastics, papers, glass and other valuable waste. Typically, a waste-picker works for about 8–10 hours and on an average, collects about 60–90 kg of valuable waste per day,[40] They pick up waste before it enters the formal waste stream, i.e., from roads and community bins before it is collected by municipal authorities. They also look for valuable waste material from the waste dumps at the Municipal Solid Waste (MSW) disposal sites of Urban Local Bodies (ULB).

Major Categories of Waste Pickers (Safai Sathis)

- Individual/Independent:
  a) RWAs/Societies or Households Waste Pickers
  b) Landfill or Transfer stations Waste Pickers
  c) Street Waste Pickers
- Waste Pickers engaged/on-boarded with Swachh Centres Material Recovery Facility (MRF) & Material Resources Centre (MRC)
- Working with ULBs or informal waste collectors engaged with collection vehicles

Studies on waste collection in the informal sector have revealed some surprising results. One such study, 'Recycling livelihoods' conducted by GIZ, SNDT women's University and Chintan, an environmental NGO, estimates that the informal sector saves about ₹20.06 crores for the ULB of Pune.[41] According to a study by Waste-to-Energy Research and Technology Council (WTERT) of Columbia University, in Delhi about 1,088 TPD of waste is collected by informal sector workers before the waste gets to the municipal system. It is estimated that every ton of recyclable material collected, saves the ULB approximately ₹24,500 per annum and prevents the emission of 721 kg CO_2 per annum.[42] According to the CPCB 2017-18 report, the unorganised sector recycles a whopping 20% of the plastic waste generated in India.[43]

These studies highlight the significant contribution of waste-pickers in reducing the burden on formal waste management systems and promoting resource recovery and a circular economy.

Despite their substantial contributions, waste- pickers continue to face low wages, lack of access to healthcare and education, and social stigma. They suffer from health issues including respiratory disorders, chronic cough, diarrhea and physical injuries from sharp objects in the waste according to a study in Mumbai.

Creating awareness about the importance of waste pickers, recognising their contributions, and providing them with support, resources, and opportunities, will

not just improve their livelihoods but also enhance the efficiency and effectiveness of waste management efforts in India.

Circular Economy

You might have heard it said that in nature nothing is waste. Everything returns to nature in some form or another through nature's own processes. Nature is what the concept of circular economy takes its inspiration from. The circular economy aims at increasing the useful life of a material or product. A circular economy keeps materials, products, and services in circulation for as long as possible.

Use 100% recyclable plastic in packaging so that recycling can be done efficiently. Reducing, reusing and recycling decreases both the demands on natural resources, as well as the rate at which they are consumed.

It is a systemic approach towards sustainability. It is based on three core principles:

1. Eliminate waste and pollution.
2. Circulate products and materials (at their higher value).
3. Regenerate nature.

In a linear economy we take material from earth, make products out of them and eventually throw them away at the end of its 'intended' use cycle. In a circular economy, where the emphasis is on extending the 'life' of the materials, efforts are not only on how to enhance intended use through repair and reuse, but once the product is post its intended use, to recover/repurpose/redesign/recycle it for a new use. Thus, while managing plastic waste through principles of circular economy, the emphasis is on keeping the products and materials in circulation through processes like maintenance, reuse, recovery, refurbishment, repair and recycling.

The circular economy considers every stage of a product's journey – before and after it reaches the customer. Creating a circular economy for plastic requires a strong commitment from all stakeholders from consumers to producers and policymakers. One way of designing a circular economy solution for plastic waste is to take action in three broad ways: Eliminate, Innovate, and Circulate.

Adopting these practices in our daily life can help decrease both the demands on natural resources, as well as the rate at which they are consumed. Fewer resources are used, limited supplies are conserved, and regeneration of renewable resources can occur. In addition, less waste is generated, thereby reducing the amount of trash that must be landfilled or incinerated. As the amount of trash buried or burned decreases, so, too, does the potential for water and air pollution which can occur as a result of burning or improper disposal of wastes.

Our world has a limited supply of natural resources, including land used for landfills. Thus, the circular economy approach towards managing waste can inspire innovative technological and design ideas that can help in dealing with the challenge of dealing with plastic waste.

Material Recovery Facility

Recovering dry waste from Municipal Solid Waste (MSW) provides valuable resources while reducing the burden on the final waste disposal facility. The Material Recovery Facility (MRF)-swachhata Kendra offers a systemic approach for the segregation and recovery of all kinds of dry recyclable waste including plastics, from MSW.

A Material Recovery Facility (MRF) is a space/area with a covered shed which receives pre- and post-consumer non-bio-degradable, non-compostable (dry) materials that are recyclable. MRF is a dedicated space providing the facilities to process and sort recyclable materials collected from various waste streams, from residential, commercial, and industrial waste. Its primary function is to separate, sort, and prepare these materials for sale to end buyers. This concept has gained importance through the Swachh Bharat Mission Grameen (SBM-G) guidelines by the Ministry of Jal Shakti 2019 which makes it mandatory to set up one MRF in every block in the country.

Depending on the level of mechanisation and scale of operation, MRF facilities can be manually operated, semi-automatic or fully automatic. Manual material recovery facilities are suitable for urban local bodies generating small quantities of municipal solid waste, varying from 5–10 TPD.

Semi-automatic material recovery facilities can have a capacity of 10–100 TPD or more, but only segregated dry waste can be brought to such facilities. Such facilities can also work as intermediate storage points at a pre-processing unit where segregated dry waste can be further cleaned to extract better value in those cities where centralised material facilities are not available. Various components of a semi-automatic material recovery facility are a weighbridge, sorting platform (primary sorting), conveyor belt (secondary sorting), bottle perforator, baling machine and forklift.

Once sorted, the recovered materials are baled or processed into marketable commodities that can be sold to manufacturers for use in producing new products.

As per Central Pollution Control Board (CPCB), the total number of existing solid waste Material Recovery Facilities in the country is 4,446 with a capacity of 31,427 TPD.[44]

MRFs have emerged as vital contributors, reshaping how communities handle their waste. They integrate

informal waste pickers through registration giving them the identity and recognition they deserve making it possible to work towards their safety, health, education and training. Representing a cornerstone in the circular economy, MRFs exemplify a significant shift towards resource recovery and environmental stewardship.

Modern Technologies for Reuse of Plastics on a Large Scale

While the 3R's are actions that any individual or organisation can take, industry has the potential to reuse/recycle larger quantities of plastics. While an accepted technology for plastic disposal is incineration, it is not a preferred option as it releases toxic gases like chlorinated dioxins and furans, raising several environmental and health issues. CPCB has consolidated a few innovative technical options for the safer disposal of plastic waste. For adopting any such technology, the prerequisite is that the plastic waste should be segregated and cleaned. Four such examples are given here.

Utilisation of Plastic Waste in Road Construction:

To reduce the problem of plastics disposal, the government has now made it mandatory for road developers to use waste plastic along with bituminous mixes for road construction. This is being implemented successfully for the construction of roads in various places in India. The use of plastic in roads is believed to add to their longevity by making them water resistant and increasing their resistance to changes in weather. A kilometer of road can use about one tonne of plastic.

The technology for utilisation of plastic waste in road construction was developed by the 'Plastic Man' of India, Prof Rajagopalan Vasudevan, Professor of Chemistry at Thiagarajar College of Engineering, Madurai, India, who developed a patented method to reuse plastic waste to construct roads and has laid around 1 lakh kilometers of the road across 11 states in the country with support from the government.

Co-processing of Plastic Waste as Alternative Fuel and Raw Material (AFR) in Cement Kilns, Steel and Power Plants:

Co-processing is the use of plastic waste materials either as a fuel or as raw material(s) in cement, steel and power plants. The cement producers or power plants can save valuable fossil fuel and raw material consumption leading to more eco- efficient production and less environmental pollution.

Conversion of Plastic Waste into Liquid RDF – Refuse-Derived Fuel (Oil):

This involves segregation of plastic waste from municipal solid waste, removing dust and impurities from high and low density plastics except PVC, processing the plastic waste using additives and collecting the liquid RDF. This fuel can be used in various industries like cement and coal power plants as secondary or substitute fuels.

Plasma Pyrolysis Technology (PPT): Plasma Pyrolysis is a process that integrates the thermochemical properties of plasma with the pyrolysis process (decomposition of materials brought about through high temperatures). The intense and versatile heat generation capabilities of PPT enable it to dispose of all types of plastic wastes including polymeric, biomedical and hazardous waste, in a safe and reliable manner.

Innovations in plastic waste management: Upcycling

Upcycling essentially is an innovative approach to manage plastic waste, embedded within principles of circularity and sustainability, that combines technology with product design in a way that results in product which is sometime of higher value than the original product, e.g. discarded PET bottles are being converted to recycled PET bottles, textiles, clothing and accessories.

Programmes, Policies and Laws in India

Mission LiFE and Plastics

The concept of 'Lifestyle for the Environment (LiFE)' was introduced globally by the Hon'ble Prime Minister of India, Shri Narendra Modi, at COP26 in Glasgow on November 1, 2021, calling upon the global community of individuals and institutions to drive LiFE as an international mass movement towards "mindful and deliberate utilisation, instead of mindless and destructive consumption" to protect and preserve the environment. Mission LiFE encourages environmentally positive actions under seven themes, one of which is "Say No to Single Use Plastics". Reducing waste is another theme, highlighting how the mission focuses on sustainable ways of living.

The Ministry of Environment, Forests, and Climate Change has launched several programmes under the LiFE initiative, demonstrating the country's proactive commitment towards sustainability, climate change, and promoting eco-friendly behaviours. The Eco mark Scheme and the Green Credit Programme (GCP) are two programmes that aim to promote eco-friendly practices that are based on tradition and conservation and align with the LiFE concept.

Green Credit Programme (GCP): Incentivising Environmental Actions

In line with the goal of 'Green Growth' which is one of the seven goals for the 'Amrit Kaal', in 2023-24 Green Credit Programme (GCP) has been announced. It aims to leverage a market-based approach for Green Credits and incentivise voluntary environmental actions of various stakeholders. The GCP will encourage private sector industries, companies, and other entities to meet their obligations from other legal frameworks.

Eco mark Scheme: Promoting Eco Friendly Products

In line with the LiFE approach, the MoEF&CC has amended the Ecomark rules with the objective that consumers can make choices among products and thereby opt for eco-friendly products in their design, processes.

It provides accreditation and labelling for household and consumer products that meet specific environmental criteria while maintaining quality standards as per Indian norms. Products accredited under the Ecomark Scheme will adhere to specific environmental criteria, ensuring minimal environmental impact. It will build consumer awareness of environmental issues and encourage eco-conscious choices. It will also motivate manufacturers to shift towards environmentally friendly production. The scheme seeks to ensure accurate labelling and prevent misleading information about products.

The Central Pollution Control Board administers the Ecomark Scheme in partnership with the Bureau of Indian Standards (BIS), which is the national body for standards and certification.

In addition, under GCP, manufacturers who obtain the Ecomark label can contribute to generating Green Credits.

Swachh Bharat Mission 2.0

Under Swachh Bharat Mission 2.0, Swachh Bharat Mission Urban (SBM-U) and Swachh Bharat Mission Gramin (SBM-G) being implemented by the Ministry of Housing and Urban Affairs (MoHUA) and Jalshakti Ministry respectively, there is a particular emphasis on addressing the problem of plastic waste.

SBM Urban key focus areas include source segregation

of waste; segregated collection and transportation; processing of segregated waste; setting up of Material Recovery Facility (MRF) in all Urban Local Bodies (ULBs) ; continuous awareness generation for reducing Single Use Plastic (SUP) and use of substitute products 'Swachh Survekshan' and 'Star Rating Protocol' have been introduced which have been aligned with Plastic Waste Management (amendment) Rules 2021 to encourage cities to phase out single-use plastic.

For effective monitoring of the ban on identified single-use plastic (SUP) items and plastic waste management in the country, online platforms such as the National Dashboard on the elimination of single-use plastics and effective plastic waste management; Central Pollution Control Board (CPCB) Monitoring Module for Compliance on Elimination of Single-Use Plastic and CPCB Grievance Redressal App has been launched. The list of eco-alternative manufacturers on eliminating single-use plastics and effective plastic waste management is available on the National Dashboard. SBM Gramin supports GPs in creating awareness on curbing the use of SUP and effective plastic waste management in line with the rules. It requires GPs to include a Solid and Liquid Waste Management Plan (SLWMP), which has plastic waste management as one of the components as part of its Gram Panchayat Development Plan (GPDP). Key steps suggested for plastic waste management at the GP level are:

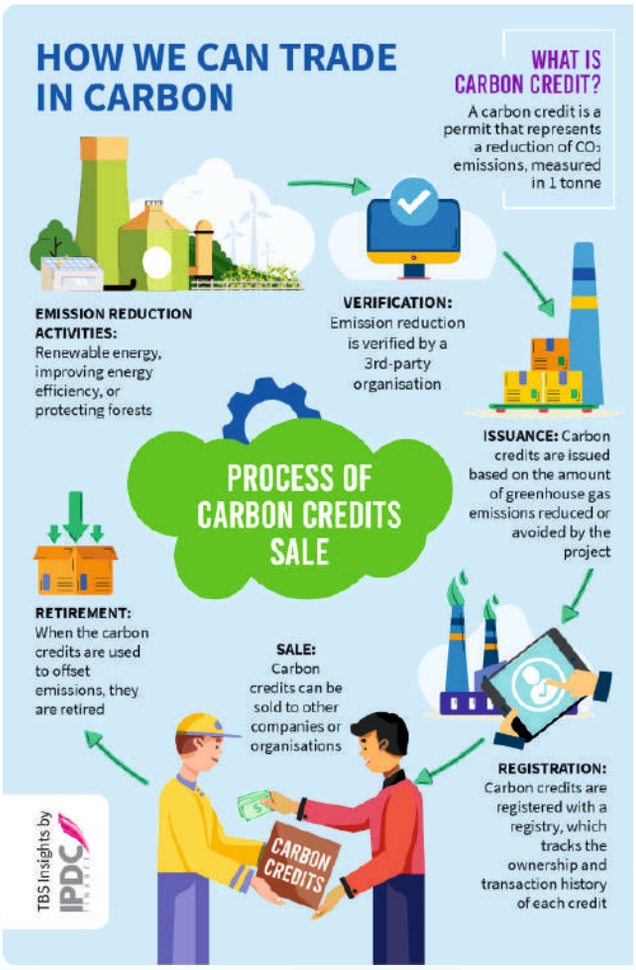
- Source segregation of waste into dry and wet waste.
- Door to door collection by authorised collectors.
- Village-level shed for separately storing biodegradable and non-biodegradable waste.
- Secondary segregation and storage of plastic waste for further processing and disposal. Different categories of waste are handed over to the authorised recyclers.
- Transportation to PWMUs at District / Block levels

Swachh Survekshan

Swachh Survekshan, conducted by MoHUA since 2016, is the world's largest urban sanitation and cleanliness survey. It has been instrumental in fostering a spirit of healthy competition among towns and cities to improve their service delivery to citizens and towards creating cleaner cities.

The primary goal of Swachh Survekshan is to encourage large scale citizen participation and create awareness amongst all sections of society about the importance of working together towards making towns and cities better places to reside in.

Conducted under the ambit of the Swachh Bharat Mission (Urban), the annual survey has managed to mobilise people, resources and authorities in an effort to prove that their city, of all cities in India, is the cleanest and that sustainable practices, both by citizens and ULBs, are being encouraged and promulgated.



Carbon Credit

Plastic pollution and climate change pose significant environmental challenges of our time. Initiatives such as Plastic Credits and Carbon Credits help reduce the impact of these issues and support the promotion of environmental sustainability.

Plastic Credit is dedicated to addressing the issue of plastic waste and pollution by creating incentives for reducing, recycling, and managing plastic waste. This system allows organisations to assume responsibility for their plastic consumption and contribute to a more sustainable future.

Carbon credits on the other hand primarily focus on mitigating greenhouse gas emissions, the key contributors to climate change. These credits serve as a quantifiable measure reflecting the removal or reduction of carbon dioxide (or its equivalent) from the atmosphere. A single credit represents one tonne of CO_2 (or carbon dioxide equivalent) that the company is allowed to emit.

National Laws

To address the challenge of the mounting waste crisis in the country, India started setting up its regulatory framework on waste management almost two decades ago with the introduction of Municipal Solid Waste (Management and Handling) Rules, 2000. However, it was only in 2011 that specific rules focusing on managing plastic waste were formed when MoEF&CC notified Plastic Waste (Management & Handling) Rules 2011 (PWMHR 2011). In 2016, the rural areas were also covered under the new rules- PWMHR, 2016. This rule provides the statutory framework for plastic waste management in an environmentally sound manner throughout the country. It also included the provisions of EPR (Extended Producer Responsibility). PWMHR 2016 was further amended in 2018, 2021, and 2022 to strengthen the system of managing and handling plastic waste in India further.

Draft Notification Proposing Amendments to the Plastic Waste Management Rules, 2016

The Ministry of Environment, Forest and Climate Change's recent issuance of a draft notification proposing amendments to the Plastic Waste Management Rules, 2016, holds great significance in addressing the escalating plastic waste crisis in India. These amendments aim to revamp the existing rules to adapt to the changing landscape of plastic usage and waste management. The revised draft regulations emphasise the inclusion of a separate category as 'Category-V' for biodegradable plastics.

Furthermore, it emphasises the significance of EPR compliance as well as the importance of collection back systems for used multi-layered plastic sachets. They introduce new definitions and clarifications for various terms, including importer, manufacturer, multi-layered packaging, and plastic packaging.

- Mar 2016 – Plastic Waste Management Rules.
- Mar 2018 – 1st Amendment (CPCB EPR Regulation).
- Aug 2021 – 2nd Amendment (BAN on SUP's).
- Sept 2021 – 3rd Amendment (Use of Recycled Plastics).
- Feb 2022 – 4th Amendment (EPR Guidelines).
- Jul 2022 – 5th Amendment (Plastic Waste Management Rules on EPR).
- Oct 2023 – Plastic Waste Management Amendment Rules and Plastic Waste Management Second amendment.
- Oct 2023 – MoEFCC notification (Green Credit Rules 2023).

Local bodies and Gram Panchayats are also given clear responsibilities, highlighting the importance of involving grassroots institutions in the fight against plastic pollution. The creation of new rules for Panchayati Raj Institutions at the district level further empowers local authorities to take action against the use of single-use plastic items and assess waste management infrastructure.

To ensure compliance and quality control, the amendments introduce sample testing and certification requirements. These measures are designed to ensure that biodegradable plastics meet the necessary standards and that the use of compostable plastics aligns with environmental considerations.

Some of the key features of these rules are:

- The rules are applicable to every waste generator, local body, gram panchayat, manufacturer, importer, and producer.
- The minimum thickness of plastic carry bags made of virgin or recycled plastics shall be 120 microns.
- Carry bags or products made of recycled plastic shall not be used for storing, carrying, dispensing, or packaging ready-to-eat or drink foodstuff.
- The concept of Extended Producer Responsibility (EPR) says that the primary responsibility for the collection of multi-layered plastic sachets or pouches or packaging is of producers, importers, and brand owners are required to establish a system for collecting back the plastic waste generated due to their products.
- Ban on SUP (Single-Use Plastic) items.
- Clarifying EoL (End of Life Disposal), which includes using plastics in road construction or for energy generation.

Roles and Responsibilities of Various Agencies

Local Bodies (such as municipal corporations, municipalities, gram panchayats, etc.) have to:

- Develop and set up infrastructure and systems for segregation, collection, storage, transportation, processing and disposal of plastic waste.
- Send recyclable plastic waste to recyclers.
- Create awareness among all stakeholders about their responsibilities.
- Ensure there is no burning of plastic waste in the open.

Waste Generators must:

- Take steps to minimise the generation of plastic waste.
- Segregate plastic waste at source and handover this segregated storage of waste to the local body/gram panchayat, or authorised waste processing facilities/agencies.

Producers, Importers & Brand Owners must:

- Establish a system for collecting back the plastic waste generated due to their products and implement the same.

Single Use Plastics (SUP) Banned under Law

The following identified single use plastic items, which have low utility and high littering potential, have been prohibited, with effect from July 1, 2022, vide Plastic Waste Management Amendment Rules, 2021:

- Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, icecream sticks, polystyrene [Thermocol] for decoration;
- Plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

The notification also prohibits manufacture, import, stocking, distribution, sale and use of plastic carry bags having thickness less than seventy-five microns with effect from September 30, 2021, and having thickness less than thickness of one hundred and twenty microns with effect from the December 31, 2022.

To enforce the ban through citizen action, the Central Pollution Control Board (CPCB) has launched an app (SUP-CPCB) urging citizens to act as watchdogs and help authorities to take appropriate action against violators. Through the app, citizens can report SUPs being manufactured in industry, used in restaurants, sold in shops, stored and distributed by the supplier.

Link to app: SUPApp.pdf (cpcb.nic.in)

Extended Producer Responsibility

In Feb 2022, MoEFCC released comprehensive guidelines on Extended Producer Responsibility (EPR). The Guidelines provided the framework to strengthen the circular economy of plastic packaging waste, promote the development of new alternatives to plastic packaging, and provide the next steps for moving towards sustainable plastic packaging by businesses.

Plastic Waste Management Rule 2022

Extended Producers Responsibility (EPR) means the responsibility of producers, importers and brand owners for the environmentally sound management of the product until the end of life- under Plastic Waste Management Rules, 2016 (Amended 2023).

Category of Plastic - Definition

Category I **-** Rigid Plastic Packaging

Category II **-** Flexible Packaging of single layer or multi layer (more than one layer with different types of plastics), plastic sheets, carry bag, plastic sachet or pouches.

Category III **-** Multilayered plastic packaging (at least one layer of plastic and at least one layer of material other than plastic).

Category IV **-** Plastic sheets used for packaging as well as carry bags made of compostable plastics.

Category V **-** Packaging made from biodegradable plastic.

Extended Producer Responsibility Targets for Brand Owners

Plastic Consumption vs Collection & Recycling

S.No	FY	Target
1	2021-22	25%
2	2022-23	70%
3	2023-24 & onwards	100%

Reuse

Category I **-** Rigid plastic packaging with volume or weight equal to more than 0.9 litre or kg but less than 4.9 litres or kg

S.No	FY	Target
1	2025-26	10%
2	2026-27	15%
3	2027-28	20%
4	2028-29 & onwards	25%

Category I **-** Rigid plastic packaging with volume or weight equal to more than 4.9 litres or kg

S.No	FY	Target
1	2025-26	70%
2	2026-27	75%
3	2027-28	80%
4	2028-29 & onwards	85%

Recycling

Minimum level of recycling (excluding end of life disposal)

S.No	Category	2024-25	2025-26	2026-27	2027-28 & onwards
1	I	50%	60%	70%	80%
2	II	30%	40%	50%	60%
3	III	30%	40%	50%	60%
4	IV	50%	60%	70%	80%

Use of recycled plastic content

S.No	Category	2025-26	2026-27	2027-28	2028-29 & onwards
1	I	30%	40%	50%	60%
2	II	10%	10%	20%	20%
3	III	5%	5%	10%	10%

- In case utilising plastic packaging, 100% biodegradable which meets the CPCB (Central Pollution Control Board) standards - EPR Target will not be applicable.
- EPR targets - category wise and state wise can use the surplus for offsetting previous year shortfall or carry forward for use in succeeding year or sell to other PIBOs (Producers, Importers and Brand Owners).
- Micro and Small Brand Owners - EPR target will not be applicable.

Action towards sustainability by Bisleri[37]

- Understanding human behaviour relating to handling used plastic, Bisleri International launched **'Bottles For Change.'** The initiative aims to create awareness among people to treat used plastic as a valuable resource that can be recycled through responsible disposal thus preventing it from getting to dump yards. The programme educates people to clean and segregate plastic and provides enabling mechanisms to sell it directly to local kabadiwalas, who will, in turn, sell it to the recyclers. The entire chain generates more value by using cleaner used plastic to produce items such as fabric, handbags, window blinds, and public benches.
- Bisleri is one of the first consumer goods company in the country to be plastic-neutral as it recycles more plastic than it puts into the market.
- Bisleri uses recycled plastic for its secondary packaging which reduces the consumption & production of virgin plastic.

The case of Bisleri's "Bottles for Change" initiative in India serves as an example of how a company can successfully integrate its corporate responsibility with sustainability needs. This initiative demonstrates how innovative and responsible business practices can lead to significant environmental and social benefits.

The following case study delves into the details of this initiative, highlighting its role in promoting plastic circularity and its impact on both the environment and the community.

Bottles for Change: A Case Study

Bisleri's "Bottles for Change" initiative serves as an exemplary case study in the context of promoting plastic circularity in India. This initiative, launched by Bisleri International, aims to address the burgeoning issue of plastic waste by fostering a circular economy model.

The Initiative

Bisleri International launched "Bottles for Change" in 2018 to educate citizens about the importance of plastic recycling and encourage them to participate actively in waste management. The initiative operates on the principle that plastic is not a problem but a resource that can be used efficiently.

Strategies and Implementation

"Bottles for Change" employs a multifaceted approach:

1. Awareness and Education: The programme conducts educational workshops and awareness campaigns in schools, colleges, corporate offices and housing societies to inform people about the importance of recycling and proper waste segregation.
2. Collection and Recycling: Bisleri has set up collection centres where individuals can deposit used plastic bottles. These bottles are then sent to NGO partners for recycling. The recycled plastic is used to create a range of products, including clothes, bags, and furniture, thus helping to promote a circular economy.
3. Partnerships and Collaboration: Bisleri collaborates with NGOs, waste picker communities and local authorities to streamline the collection and recycling process. This collaboration not only aids in effective recycling but also helps uplift the socio-economic status of waste pickers.

Impact and Results

The "Bottles for Change" initiative has achieved a number of milestones:

- **Environmental Impact:** Millions of plastic bottles have been recycled, reducing landfill waste and environmental pollution. The program has demonstrated the feasibility of a circular approach to plastic use.
- **Social Impact:** By involving communities and providing income opportunities to waste pickers, the initiative has had a positive social impact.
- **Educational Impact:** The awareness campaigns have reached thousands of individuals, creating a shift in mindset towards plastic use and recycling.

This programme by Bisleri is a stellar example of how corporate responsibility can align with environmental sustainability. The initiative not only addresses the immediate issue of plastic waste but also educates and involves the community in sustainable practices. It sets a precedent for other corporations in India and globally to adopt and promote circularity in plastic use, making a significant contribution to both environmental conservation and societal well-being.

Managing Plastic Waste: International Frameworks

The United Nations Environmental Assembly (UNEA) works toward an international legally binding instrument to end plastic pollution. International Union for Conservation of Nature (IUCN) engages in the negotiations, providing science-based expertise and evidence to ensure the development of a robust mechanism with high environmental integrity.

In 2017, UNEA-3 established the Ad-hoc Open-Ended Expert Group on marine litter and microplastics. In 2019, Basel convention which aims to prevent transboundary movement of hazardous waste, was amended to make global plastic waste trade more regulated and transparent, under the legally binding framework of the convention. Plastic Waste Partnership was established to mobilise resources, interests and expertise from all parts of society to improve and promote the environmentally sound management of plastic waste at the global, regional and national levels and to prevent and minimise its generation. In May 2023, Parties to the Basel Convention adopted technical guidelines on the environmentally sound management of plastic waste along with POPs waste, and e-waste.

In March 2022, 175 countries participating in UNEA-5.2 adopted the resolution 'End plastic pollution: towards an international legally binding instrument' based on a comprehensive approach that addresses the full life cycle of plastics. India negotiated for including collective global action while respecting national circumstances and capabilities, which was agreed upon in the resolution. In line with this resolution, World Trade Organisation has initiated The Informal Dialogue on Plastics Pollution and Environmentally Sustainable Plastics Trade (IDP) which focuses on trade related aspects of plastic pollution.

Creating Awareness about Plastic Waste

The school can create awareness about managing plastic waste by involving community members and local government representatives. Different kinds of waste – Municipal Solid Waste (MSW), Electronic Waste (E-waste), Bio Medical Waste (BMW), Construction and Demolition (C&D) waste – the need for segregation at source; ways to reduce, reuse and recycle plastics and other waste; the dangers of improper disposal of plastic waste like burning; sustainable options for packaging and storing items inplace of plastics: these are some of the topics that could be dealt with in awareness programes. Campaigns to clean up plastic waste in the neighborhood and to advocate substitutes to plastic items like cloth bags can be conducted with the help of school children. Awareness sessions to understand the law related to plastic waste management help people take action to prevent the misuse of plastics (such as using bags of less than 50 microns thickness).

Some tips to reduce plastic waste

- Buy in bulk – in a bigger container/bag to avoid using several smaller ones
- Use a cloth bag when taking garments to laundry/dry cleaning
- Choose homemade meals instead of junk food which use a lot of plastic packaging (it is also good for health and saves money!)
- Buy second hand items like toys, electronic gadgets, where feasible
- Use reusable menstrual and sanitary products instead of disposable ones

Help End Plastic Pollution!

Reduce	**Use Less**
Refuse	**Say No to Single-Use Plastic Items**
Reuse	**Use products again and again**
Recycle	**Give for recycling**

My Responsibilities: Actions I take

- **I will segregate plastic waste at my residence from other wastes.**
- **I will use cotton/jute bags for shopping instead of plastic bags.**
- **I will not use plastic bags that have less than 50 microns thickness.**
- **I will oppose the burning of waste in the open and report to the competent authorities.**
- **I will dispose of plastic/paper or any other waste in a responsible manner.**
- **I will use metal/reusable plastic bottles.**
- **I will choose home cooked food over packaged food to reduce plastic waste generation.**
- **I will avoid the use of all single use plastic goods.**
- **I will try to purchase second hand items, commodities in bulk and support tax on plastic.**

ACTIVITY 3.1

Giving plastic products a new life: The Indian way of living

Introduction

A 'Use and Throw' approach to materials is at the root of the immense plastic waste disposal and management challenge of our time. However, the traditional Indian ethos of circularity or the habit of reusing and repurposing a product is embedded so deeply in our culture, making it truly representative of Lifestyle for Environment or LiFE as it is now called. The current activity aims to help students understand how through re-use and recycle, one can enhance the life span of the product thereby conserving resources. It also aims to help them appreciate and respect the values of reuse-repurpose and recycle/upcycle embedded in the traditional Indian way of life.

Objective	Help students understand how traditional Indian ways of living encourage reuse, repurpose and recycle
Grade level	Middle grade
Group Size	Class
Duration	Two sessions over two consecutive weeks
Materials	Observation sheet

Before you begin

Discuss with the class how a careless attitude towards the use of materials contributes towards increasing waste. Use examples of how the Indian lifestyle encourages the reuse of materials-products such as making cloth bags from old clothes or floor mats from discarded plastic bags.

Methodology

After a brief discussion about the concept of reuse, repurpose and recycle, ask children to think about innovative ways of reusing any products/materials in daily life.

Children can be asked to observe at home or in school how various items of packaging such as plastic jars, boxes, glass bottles, pet bottles, plastic bags, paper cups, etc. are reused. The observation sheet given here may be used to record their observations.

Children could also observe any reuse/repurpose examples from school campus/class such as use of PET bottles for irrigation, or reusing empty boxes to store stationary items.

Based on the observation sheets, the teacher could discuss the following:

- What items are reused the most and how? How many times or how long is the item being used?
- Are there products which are modified before putting it to another use? (Repurposed)
- What are the ways you can modify a product?
- When is it unsafe to reuse a product, for example storing prepared food in reused plastic containers in fridge and then heating it directly in the micro-wave as the container may not be micro-wave safe or intended for multiple use or made of non-food grade plastic.

Observation Sheet

Reused/ repurposed item	What was the original use	How is it being used currently	Modification for Reuse	Duration/No of times of use	Method of Final Disposal

Additionally, teacher could also ask children to collect pictures of reused/repurposed product and the class could create a collage of various items being reused.

Also, help the student understand that once products are no longer usable, one should give them to the 'Kabadiwala' or 'waste-pickers' who can then take it for further recycling. This way one can reduce waste coming out of our homes.

Conclusion

Children get to understand the importance of the Indian tradition of 'reuse-repurpose' in promoting circularity and are encouraged to reuse-recycle products towards a 'zero waste' home.

ACTIVITY 3.2

Regulating the use of plastics

Introduction

Laws play a critical role in regulating the use and disposal of plastics. For instance, India has regulations against the use of plastic bags below 50 microns. This activity is designed to create a discussion in class about developing a set of rules for the school that will help reduce the use of plastics and promote appropriate disposal.

Objective	To help students understand how laws are made through a parliamentary process and how different points of view need to be solicited and incorporated before it is approved by the legislature
Grade level	Secondary school
Group Size	Class to be divided into two groups
Place	School
Duration	45 Minutes
Materials	Pen & Book

Before you begin

The teacher can start by explaining the importance of legislation and current rules and regulations for plastic waste disposal. Students can then be asked to draft their own laws regarding the use and disposal of plastics.

Methodology

A group of students should be chosen to lead the discussion. Their task will be to prepare a draft set of rules and legislation for using and disposing of plastics in the school.

Meanwhile, the rest of the class can elect a student to play the role of a speaker who will conduct the proceedings. The speaker should then invite discussion on the draft rules. All students must be encouraged to argue and suggest modifications to the draft. The group that has drafted the legislation can also present their suggestions. Finally, the class can vote on the corrected draft.

In case of no agreement, item-wise votes can be taken to decide which suggestions should form a part of the school rules.

The approved draft as the recommended set of rules that govern the use and disposal of plastics for the school can then be handed over to the principal.

Conclusion

The students will derive a clear understanding of the parliamentary process of lawmaking.

This activity will also help the students to comprehend the need for and impact of laws and regulations on plastic use and disposal.

Evaluation

It can focus on the quality of the discussion:

- Are the different points of view being articulated and received, and how?
- How are these views being integrated towards a consensus?

The following questions can be used for discussion:

Can we get unanimity on the plastic policy?

Is there any part of the suggested rules that might affect some students unfairly? If yes, how can the rules be modified to avoid doing so?

ACTIVITY 3.3

Smart shopping choices based on packaging

Introduction

Plastic packaging is becoming an increasingly large part of the total waste generated. Nearly half of the polymer plastics produced are used as packaging materials with a short shelf life. They are redundant once the package is opened. The amount of plastic packaging waste depends on our product choices. This activity will help us understand the quantity of waste generated through a student's own household shopping choices and the scope for reduction.

Objective	1. To help students identify unnecessary packaging and the waste it generates 2. Ways to reduce plastic waste through smart shopping choices by individuals
Grade level	Middle & Secondary
Group Size	Class
Place	School, shops and home
Duration	• 20 minutes for background, introduction and questions related to the activity • Two week's time provided to each student/group to undertake the activity • 20 minutes of class time per week for two weeks to discuss student's observations with reference to survey sheet • 20 minutes discussion in the following week on result and conclusions
Materials	Survey sheets, Stationery

Before you begin

The teacher can start by talking about the problems caused by plastic packaging waste and then present and discuss the survey sheets with the students.

Methodology

Throughout the first week, the teacher should guide students to work on their own using the survey sheets to evaluate the amount and the type of packaging material that they find in their homes while discussing with their parents the possible ways to reduce the amount of packaged products being purchased by the family. In the case of online purchases, the students should evaluate the amount of packaging involved in these purchases.

The students should present their findings and initiate a discussion on how purchasing products with excess packaging could be reduced.

The teacher should guide students to work on developing an effective campaign to reduce packaging waste based on the analysis of the data compiled from the survey sheets.

Consumer Survey Form

- It will help assess the amount of disposable plastic packaging and how it varies from shop to shop and product to product.
- It will help understand whether the consumers are concerned about how the packaging waste affects the environment.
- It is designed to lead to making intelligent shopping choices based on packaging.

Packaging Waste Survey

The students should fill out this form in consultation with their parents.

Do you purchase from

Street vendors /small kirana shops /supermarkets / online (circle the ones which are applicable)

Name any 3 products which generate the most amount of packaging waste

Name of the product	Bought from
1.	
2.	
3.	

Name any 3 products which generate the least amount of packaging waste

Name of the product	Bought from
1.	
2.	
3.	

Name 5 different types of packaging material that you can think of

How do you dispose milk pouches, tetrapaks and/or soft drink PET bottles?

1. Milk pouches

- Common garbage bin
- Garbage bin for plastics
- Sell to a *Kabadiwala*
- Return to the supplier

2. Tetra Pak

- Common garbage bin
- Garbage bin for plastics
- Sell to a *Kabadiwala*
- Return to the supplier

3. Soft drink PET bottles

- Common garbage bin
- Garbage bin for plastics
- Sell to a *Kabadiwala*
- Return to the supplier

When you buy a product, do you think of the waste it generates?	**Yes / No**
When you shop, do you look for packaging which is made from recycled material?	**Yes / No**
Do you save the packaging material for reuse?	**Yes / No**
When you go for shopping, do you carry a bag with you?	**Yes / No**

How do you dispose of different packaging items like plastic bottles, corrugated sheets, glass bottles, tetra pak, aluminium cans etc. Please mention the names of the packaging waste against the options that apply to you.

- Segregate for recycling
- Throw away as mixed garbage
- Sell to a *kabadiwalla*

Return to the recycler

What kind of packaging material are you most likely to return for recycling?

- Plastic bottles
- Corrugated sheets
- Glass bottles
- Tetra pak
- Aluminum cans

Conclusion

This activity will demonstrate how packaging waste is a function of the products we buy and establish that there is scope for reduction.

Evaluation

- They should be able to analyse, with the help of their families, the shopping practices and choices made in their households and develop ways of reducing plastic waste.
- The students can also be evaluated on the effectiveness of the ideas in their campaign.

ACTIVITY 3.4

Identifying alternatives to plastics

Introduction

This activity focuses on identifying alternatives to the most commonly used disposable plastic products while making students aware of the harm caused by disposable plastics.

Before you begin

The teacher should introduce the concept of disposable plastic.

Objective	To get the students to reduce the use of plastic products by finding better alternatives for disposable plastics
Grade level	Middle & Secondary
Group Size	Individual
Place	Home & School
Duration	45 Minutes
Materials	Blackboard and chalk

Methodology

- Following the introduction of the concept, the teacher could ask the students to name any disposable plastic products they can think of. One of the students can write the names of these products on the board.
- Initially, each student can be asked to name only one product so that each student has a chance to give their contribution to the list on the board.
- After all the answers are up on the board, the teacher could initiate a discussion on whether and why any of the products need to be removed from the list.
- The teacher could begin the second round. Take each item on the list and ask any students to suggest an alternative to that product and explain why the alternative is a better option. If the class agrees that this product is a better alternative, then erase that product from the list. Go through the entire list in this way.
- The teacher should check that all the products have disappeared from the list. If not, then how many remain?
- The students could then be asked to think it over, in their own time and see if they can come up with an alternative to those products for which no alternative could be found.

Conclusion

The students will understand that while plastics are extensively used, they can find alternatives for most of them. For those products for which options have yet to be found, the students should be reminded that such products must be disposed of appropriately in the bin, which is marked for dry waste.

Evaluation

Assess if every student has thoroughly understood the concept of disposable plastics and the fact that alternatives to them are available.

ACTIVITY 3.5

Swap your Stuff

Introduction

If we look into our cupboards, we would likely find several things that we do not need any longer. These could be given away or exchanged for something else that may be useful to us, thus sharing resources and helping reduce overall consumption.

Before you begin

Teachers could discuss the issue of consumption with the students. The questions that can be asked to initiate the discussion:

- What are some of the things you have in excess or do not use, and which could be possibly be used by others?
- Have you ever received or exchanged any used products?
- Have you ever thrown something away that someone else could have used?

Objective	To demonstrate to the students that 'one person's waste can be another person's resource', and that a product's life can be extended by treating it as a resource
Grade level	Secondary
Group Size	An entire class
Place	In school
Duration	30 Minutes
Materials	Tables, containers to display used products, space for the swapping centre, banner or poster

Methodology

- The teacher could introduce the 'Swap your stuff' activity to the students. The activity would include setting up a space in the school to exchange the used products by students with each other.
- Form groups of students to plan the activity in the school. The planning would need to include:
    - Deciding the time and the place for the activity;
    - Setting up the space for 'Swap your stuff';
    - Developing the mailers, announcements, banners, and posters;
    - Getting the information to the parents or the students, and
    - Managing the event on the day of the execution.
- Discuss and set rules for the classification of products that can be brought, as well as the terms and measures of exchange.
- On the activity day, get the students who have brought products to display these at the 'Swap center.' The class must identify a couple of students stationed at the display center to oversee the exchange. This activity can be organised for an hour during the school assembly or recess.
- All the items that are not exchanged can be donated to a charitable trust.

Conclusion

As a result, the class can review the number of items that did not go to the landfill. They can design a chart and put it up on the school bulletin board.

Evaluation

Discuss whether each and every student understood the concept of one's waste can be another's resource.

ACTIVITY 3.6

A pen has many lives!

Introduction

The easy availability of inexpensive plastics has led to the casual use and disposal of reusable products. One such example is a ball pen, which is meant to be reused with a refill. However, this is rarely done, as most people tend to toss it away once it runs out of ink, only to grab a new pen. This activity is intended to create awareness about how a product's life can be extended.

Objective	To get students to find effective ways of reusing products
Grade level	Middle school
Group Size	10
Place	Home assignment
Duration	One Week
Materials	Collection of used or discarded pens, boxes for collection, refills for pens, paper and paint to make posters

Before you begin

Discuss the impact of plastic pollution and how recycling can make a difference.

Methodology

The students can form groups and undertake a collection drive for old pens, using a carton as the collection unit. Each group can prepare an informative and colorful poster requesting everyone to drop their used pens in the carton. Students can also be encouraged to bring used pens from their homes.

The students can then sort through the pens and procure appropriate refills for them. The refilled pens are now ready for use and the students can sell them within and outside the school and use the proceeds for environmental activities at the school.

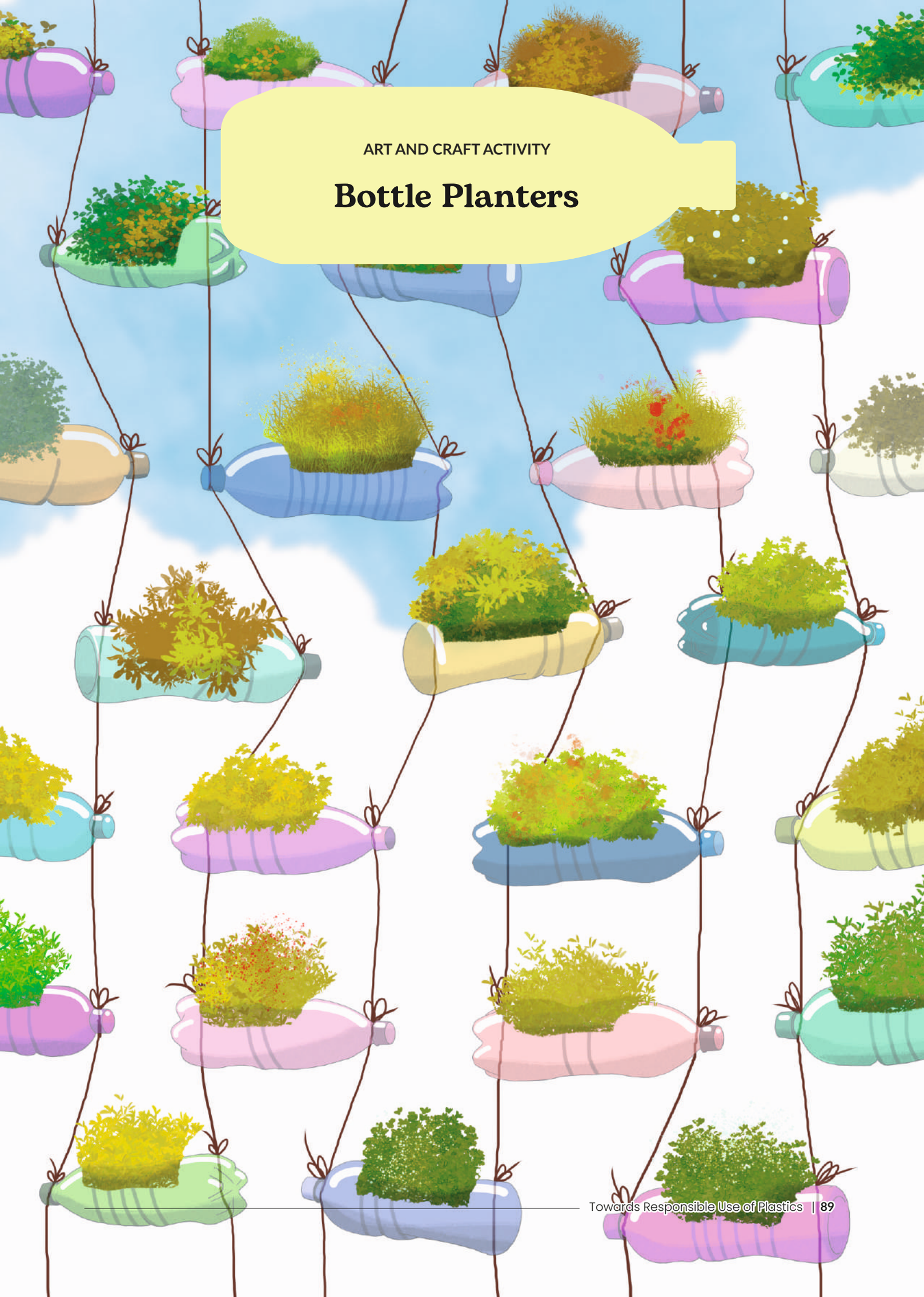
Conclusion

The students will learn that with proper care and responsible use, the refilled pens not only save money but can also last much longer without adding waste to the landfills.

The students will also learn about devising sustainable business models that promote reuse.

Evaluation

Identify other products and find methods for promoting reuse.



ART AND CRAFT ACTIVITY

Bottle Planters

ART AND CRAFT ACTIVITY

Bottle Planters

Introduction

Bottled water and soft drink PET bottles come in different shapes and sizes. These bottles can be used to create planters as an art and craft activity.

Before you begin

The teacher should ask the students to collect at least one used PET bottle and bring it to class.

Objective	To introduce students to creative ways of using packaging waste
Grade level	Middle
Group Size	Individual
Place	In school
Duration	20 Minutes
Materials	Plastic water bottle (1 ltr size), scissors, seeds, soil, string

Methodology

- A student can do this activity even at their home. Placing the bottle horizontally, the student can cut out a rectangular section from one side of the plastic bottle. The bottle should have its cap on.

The following steps are suggested:

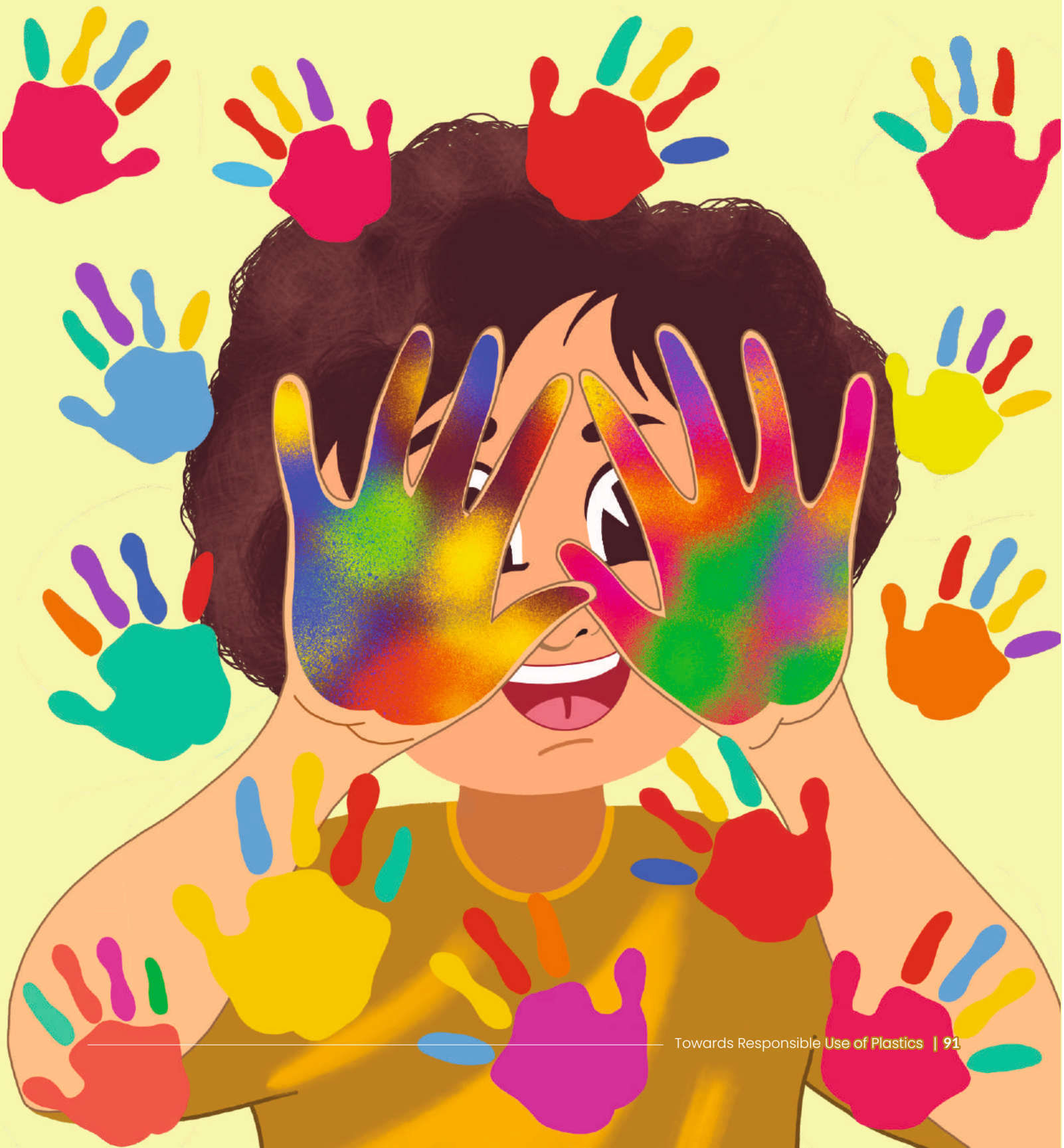
- Fill the bottle with soil.
- Plant seeds of flowers or vegetables in the soil.
- Use the string to hang the bottle in an appropriate place with maximum sunlight.
- Water the plant to see it grow.
- The teacher could encourage the students to share pictures of the reusable bottle planters in class.

Evaluation

Did the students understand the concept of reusing a plastic product? Did they come up with more ideas for the reuse of plastic waste?

CHAPTER 04

Handprint Activities



Handprint for Responsible Use of Plastics

In a short period, products made from plastics have become part of our everyday life. It is present in our clothing, the pen that we write with, the chair that we sit on, or the wrapping of the food that we eat. Plastics offer advantages such as lightness, resilience, resistance to corrosion, color fastness, transparency, and ease of processing. But plastics also carry many disadvantages. It does not degrade quickly, and hence, it is filling up our landfills, natural environment, and oceans, causing severe ecological, human, and economic impacts.

As consumers, the overuse of plastics and their careless disposal is a problem. Therefore, it is essential to use plastics responsibly. We can make a difference in this situation through our actions.

The Basic 5

- Always segregate waste! Remember that nothing can be done if we mix it up.
- Audit plastic use and waste and set an achievable target for plastic waste reduction at both school and home.
- Resolve to not litter our surroundings with plastic waste during our outings or picnics. Always carry a garbage bag to collect and dispose of plastic waste in the dustbin or designated garbage collection point.
- Remember to waste less and segregate recyclables before handing them over to waste collectors, compost wet/green waste, and carefully deposit e-waste with authorised collectors!
- Never burn or allow anybody to burn plastic waste.

For School

Reduce

1. Reduce food package waste

- Carry homemade food and do not wrap it in plastic
- Minimise the consumption of packaged foods
- Dispose of food wrapping in the right bin

2. Refuse disposable cups/ cutlery

- Carry your own ceramic or reusable cup/cutlery; wash after use & store

3. Avoid plastic marker pens

- Ask your school to install chalk-boards instead of white-boards

Re-use

1. Refill & Reuse Pens

- Buy ball pens that are refillable or ink pens if available
- Do not throw away/discard pens which can be refilled

2. Reuse paper

- Use newspapers/old magazines/old calendars to cover books
- Also use for wrapping gifts

Re-cycle

1. Segregate waste

- Throw wet waste (left over food, fruit peels), recyclable (plastic, tin, etc.) & hazardous (sanitary pads, battery, other electronic items) in separate bins designated for each category of waste

For Home

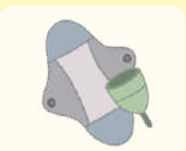
Reduce

1. Carry your own bags

- Refuse plastic bags from shops
- Always carry a shopping bag with you which can be used for various purposes

2. Minimise buying bottled water

- Carry your own refillable water bottle while traveling
- In hotels and restaurants which have a water purifying system in place, ask for regular water and not bottled water



3. Avoid plastic lined sanitary napkins

- Use organic disposal cotton pads or cotton layered pads

4. Reduce waste at parties

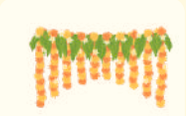
- Store decorations after use for your next party
- Avoid using disposable plastics, use reusable, recyclable or natural materials

5. Avoid plastic lined diapers

- If there is an infant in your family, suggest that cloth diapers be used instead of synthetic diapers

6. Disposable plates

- When disposable plates are necessary, use bowls and plates made from the leaves & sheaths of trees



7. Minimise or avoid the use of plastic or thermocol in projects/models & decorations

Re-use

1. Repair

- Repair toys & increase their life span instead of buying a new product
- Ensure a proper disposal when they are beyond repair

2. Reusable razors

- Ask your family members to avoid using disposable razors instead use reusable ones

3. Carry your own containers

- If buying food from outside, take your own containers along instead of asking the restaurant to pack it in plastic or foil containers

4. Upcycle clothes

- Don't throw away clothes made of polyester fabrics. Try making other products like bags out of them

Re-cycle

1. Collect separately

- Separate plastics from wet waste before disposing of wet waste. Do not carelessly throw them in together

Talk about your Handprint with friends and family! Motivate them to take Handprint actions!

Project Ideas

- Make a list of all the plastic products around you at home, school and the neighbourhood. Try to find out what products were in use before plastics appeared in your home, school or neighbourhood. How were those products made?
- Ask people at home and in the neighbourhood what impact industrial plastic products have had on their lives and livelihoods. Share your knowledge about the problems with plastics if they are not aware of them. Talk about how large scale, industrial, or cheap plastic products end up polluting the environment. Explain how they harm humans and animals and how they have often destroyed local economies of eco-friendly, de-centralised cottage industries.
- 'Not just individual level action but political education too is needed to 'beat plastic pollution'. Learn about and discuss with peers, family, teachers about the responsibility of local, state and central governments towards creating a plastic free and pollution free environment for all citizens.
- Invite an expert or state pollution control body representative for an interactive talk in your school or community to better understand the various laws and rules related to plastic manufacturing, waste management responsibilities and pollution.

- Be an alert and aware citizen who understands the Right to Information (RTI) Act. You can try learning more about it by actually filing an RTI query, e.g. seeking information about budget allocation/expenditure and human power related to waste management in your local Panchayat or Municipality.
- Learn about the National Green Tribunal (NGT), the NGT Act and the tribunal's role in ensuring the 'beat plastic pollution' goal as well as the regulations put in place by the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India.
- Investigate patterns of plastic product consumption at your home, apartment complex, neighbourhood and school and develop a waste reduction and management plan for implementation with help from all involved.
- Take up action projects such as creating cloth bags from old and clean clothes, as well as paper bags of various sizes from newspapers or used paper to replace plastic bags wherever they are being used.
- Get in touch with women self-help groups in your neighbourhood and interest them in the business of making and selling eco-friendly bags and other alternative packaging products. Help them get orders and support them in whatever way you can.
- Research on trade in plastic waste.
- Organise a clean-up drive.

ACTIVITY 4.1

The School 100m Campaign

Introduction

It is important that schools are kept clean and free from plastic pollution. Keeping the school and its vicinity clean is one of the most efficient ways to contribute to “Swachh Bharat Abhiyan.” Besides the campuses, it is also essential to keep the surroundings outside the campus clean.

Objective	1. The “100 Metres Clean-up Challenge” promotes the idea that keeping the school surroundings clean lies in the hands of students and the school authorities. The challenge encourages students to identify a 100-metre stretch outside school and ensure it is clean. 2. The students, as well as the school management, both have to ensure that the stretch becomes a “Plastic and Litter Free Zone.” It should also be ensured that regular maintenance of the stretch is done to keep it clean and plastic-free.
Grade level	Middle & Secondary
Group Size	All classes
Place	School and 100 metre stretch outside the school
Duration	One year and ongoing
Materials	• Two sign boards to mark the 100 metre stretch • Cleaning material • Three bins to segregate the waste

Before you Begin

For this activity, a stretch of 100 metres outside the school premises should be identified. Each grade in the middle and secondary level can engage in this activity.

The school must also provide safety equipment like masks, gloves etc. It is also recommended that colored bins are provided so that the collected waste is kept appropriately (Blue for dry waste, Green for wet waste, and Black for hazardous waste).

Methodology

The classes in the middle and secondary school should be given the responsibility of ensuring different parts of the school have been kept plastic and litter-free. They may be encouraged to put up necessary signage posters and bins to achieve this. Together with the school management, a 100-metre stretch, ideally with a road length of 50 metres on either side of the school gate, can be selected. A sign board should be put up on either side stating that this area is being kept clean by the school.

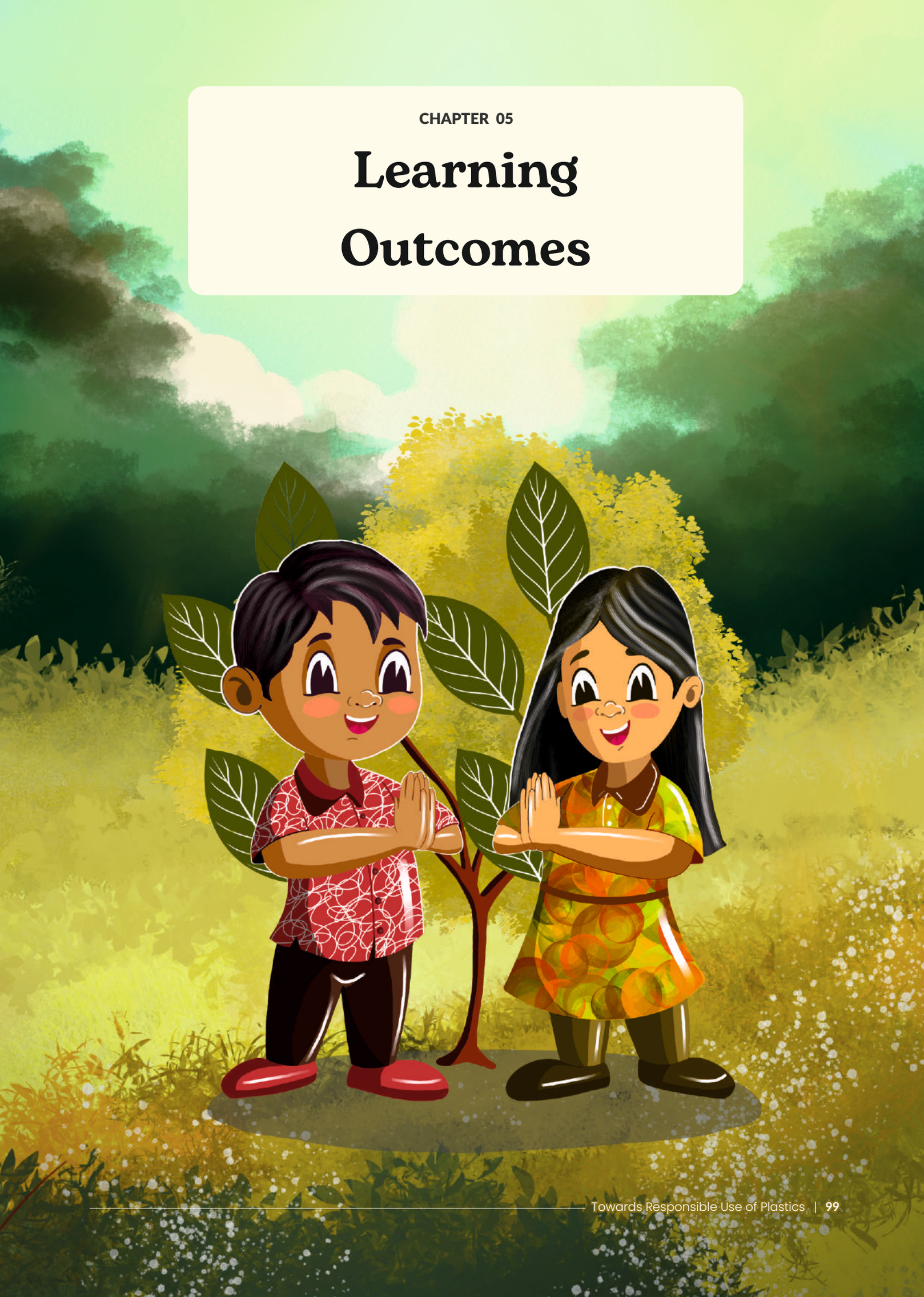
School children should also be encouraged to talk to the Municipal and other cleaners who usually clean this stretch and get them to say what problems they face.

If there is a problem of not having bins correctly marked as Blue, Green, and Black, these need to be installed, or the existing bins should be colour-coated with proper signage.

The students should work out a budget required for the activity and think of how to raise funds/contributions from the community with the assistance of school management.

CHAPTER 05

Learning Outcomes



Learning Outcomes for Addressing the Problem of Plastics

This publication is intended to enhance literacy with respect to plastics amongst the students and to achieve the same by setting the expectations for performance and achievement. The expectations, expressed as learning outcomes, can be easily integrated or infused with the existing curriculum. The content and activities of the publication are designed in a way that the students are active participants in building the required knowledge, attitude, and competencies to influence the behaviours or actions of addressing the problems associated with plastics. The students must be encouraged to think independently, act responsibly, develop communication skills, and resolve to demonstrate their learnings and influence people in their immediate surroundings.

Creative and critical thinking are two crucial aspects for any environmentally literate student as this helps logically organise the new information with previous experience and knowledge to make reasoned judgments and solve real-world problems.

The expected learning outcomes would also aid the teachers in assessing students' literacy and seeing the change. They can design formative and summative assessments based on the desired learning outcomes. The learning outcomes to Beat Plastic Pollution are listed below :

Students will be able to

- Appreciate the properties that have made plastic such a strong and versatile material
- Recall the history and evolution of plastic as a material
- Conclude that the chemical composition of the 'monomers' determines the properties, including degradability
- List the impacts of plastic pollution on water bodies, flora, fauna, and human health
- List the alternatives that were being used before the plastic era
- List the reasons for the problems associated with plastic waste
- Explain the problems associated with one-time plastic use
- Identify the challenges associated with plastic waste
- Identify problems associated with microplastics
- Estimate the scale of the problem
- Compare the impact of plastics based on the use/product
- Explain the R's (Reduce, Reuse and Recycle)
- Recall innovative ways to reduce, reuse, and recycle plastic waste
- Know which single-use plastic items are banned
- Identify the challenges in plastic waste disposal
- Draw up the process for effective waste management
- Identify strategies to regulate the use of plastic in school
- Conduct a survey/audit of plastic use
- Set up a collection system
- Conclude that our choices/behaviour can help manage the problem of plastic
- Describe the individual handprint positive actions towards sustainability that can beat plastic pollution
- Resolve to minimise plastic use in one's life
- Demonstrate behaviour that reduces consumption and littering
- Identify a 100-metre stretch outside school and take part in the 100-metre plastic-free challenge
- Aware of the national rules and regulations and international framework to regulate and manage plastic waste

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स्वच्छ भारत

एक कदम स्वच्छता की ओर

Swachh Bharat Abhiyan is a campaign in India that aims to clean up the streets, roads and infrastructure of India's cities, smaller towns, and rural areas. Handprint Actions to Beat Plastic Pollution contribute towards Swachh Bharat.

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