AFoCO
Asian Forest Cooperation Organization

EXPLORING THE FOREST

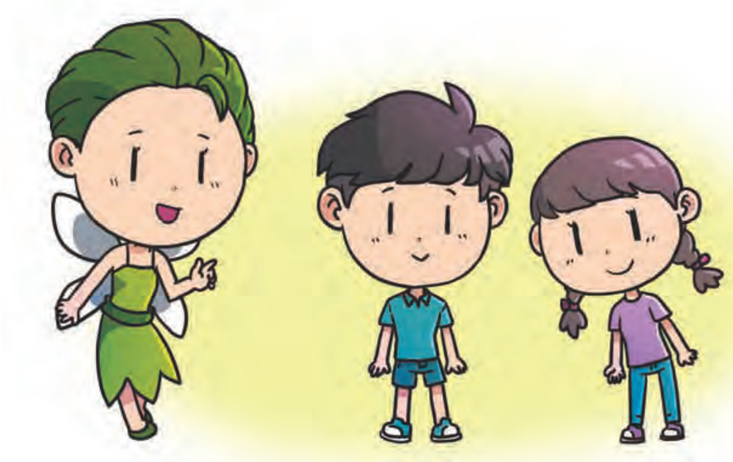
with Tory and Sully

ASIAN FOREST COOPERATION ORGANIZATION

ENGLISH VERSION

EXPLORING THE FOREST

with Tory and Sully



2019

ASIAN FOREST COOPERATION ORGANIZATION

This book is suitable for ages 10 to 16.

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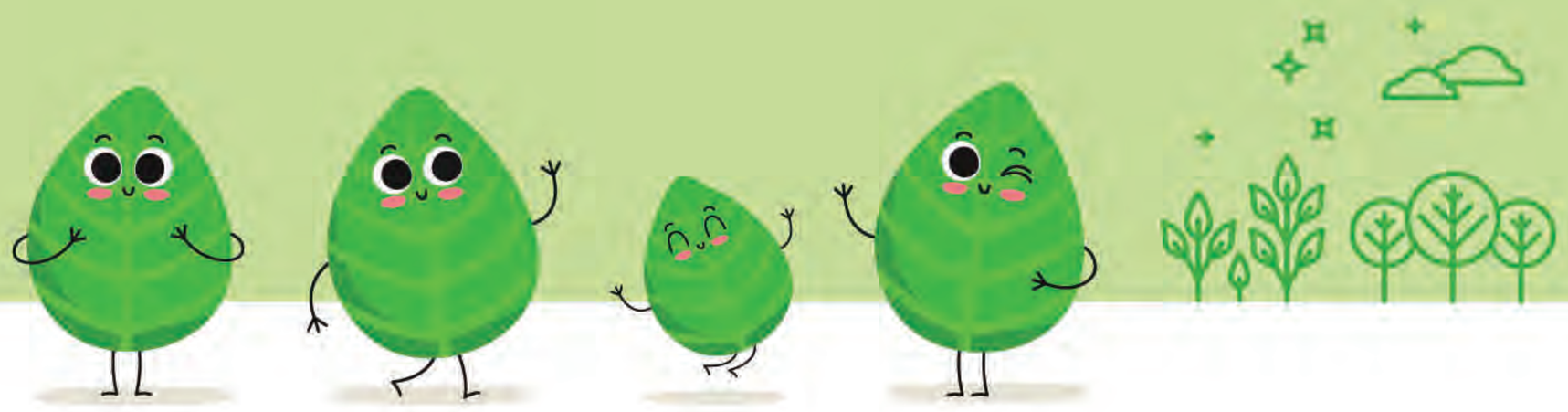

FOREWORD

Educating our younger generation about forests and their importance is crucial in ensuring that our forests continue to provide healthy ecosystem services in perpetuity.

This comic-based book aims to help children understand how to plant, raise and care for a forest tree. The role of forests in combating climate change and land degradation, conserving biological diversity and providing other environmental benefits is also incorporated. This book has five chapters, and each chapter consists of three parts: a comic strip and an activity page intended for 10–12 year olds, and a section on further learning for 13–16 year olds.

The contents of this book were mostly retrieved from the archives of the Korea Forest Service and also from various online sources. This book is published purely for educational purposes to be used by our children. Our aim is to inspire and encourage our future leaders to explore, nurture and appreciate the benefits provided by a healthy forest through experiential learning that transcends the walls of the classroom.

Mr. Chencho Norbu
Executive Director
Asian Forest Cooperation Organization (AFoCO)

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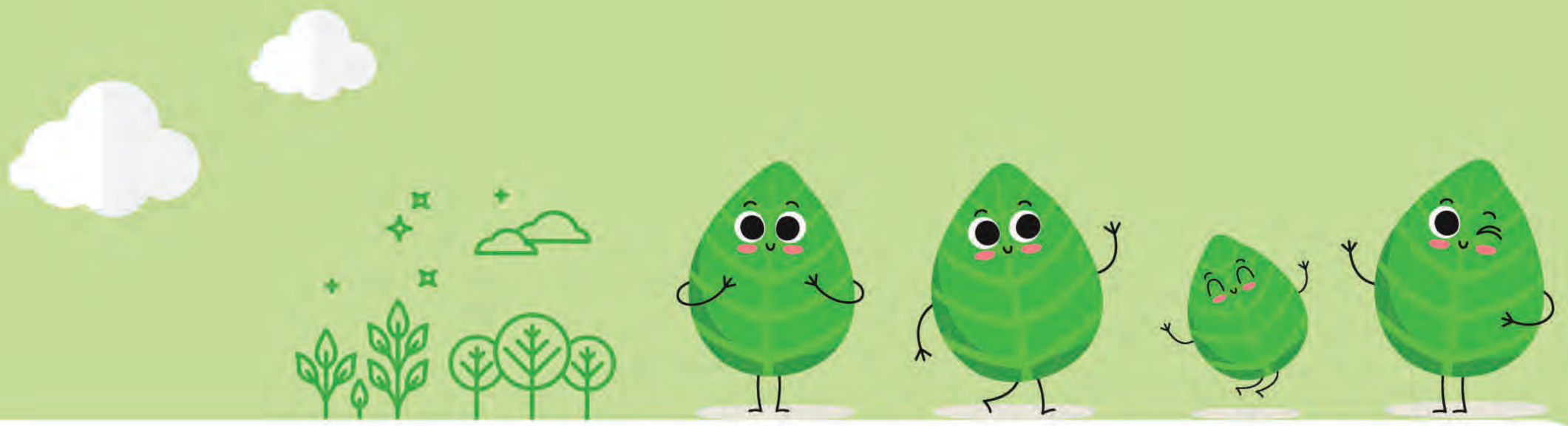
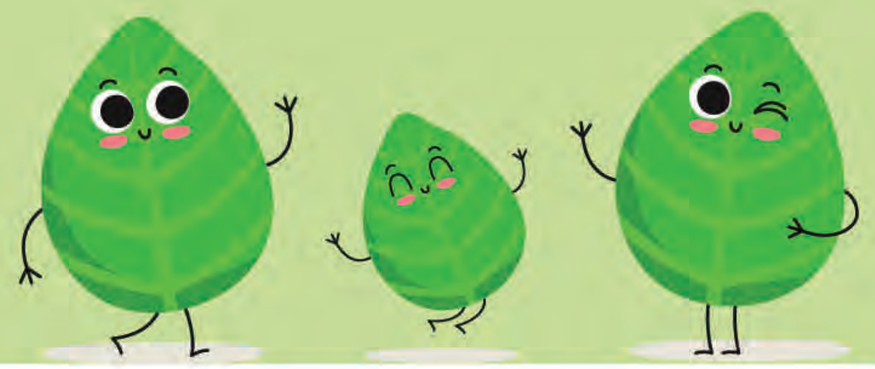


CHARACTERS

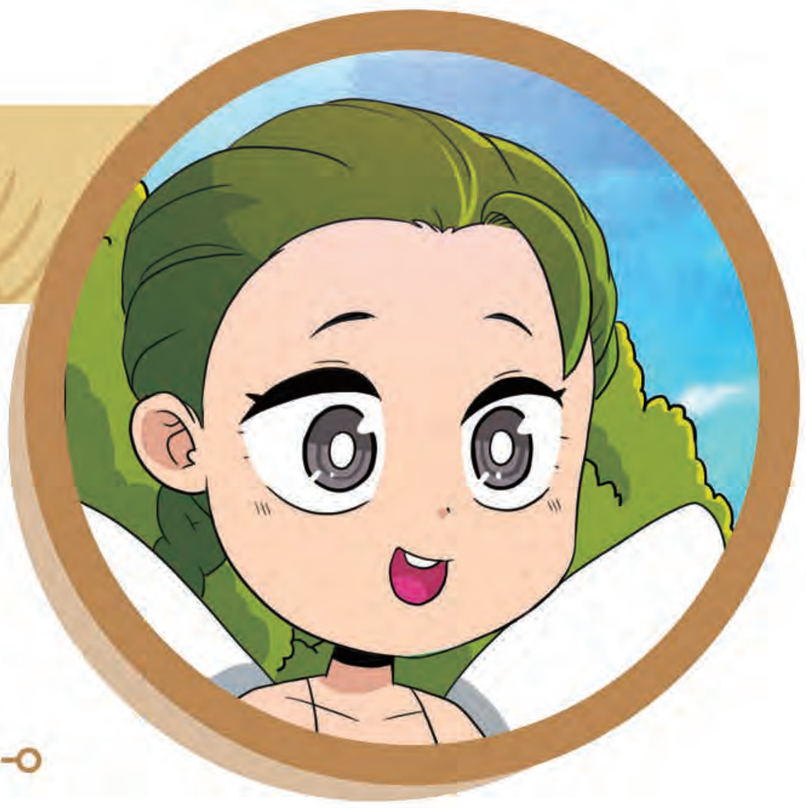


Tory

An adventurous middle schooler who cannot see enough of the world, Tory loves being outdoors and his enthusiasm is infectious! But he does not know too much about trees and forests...

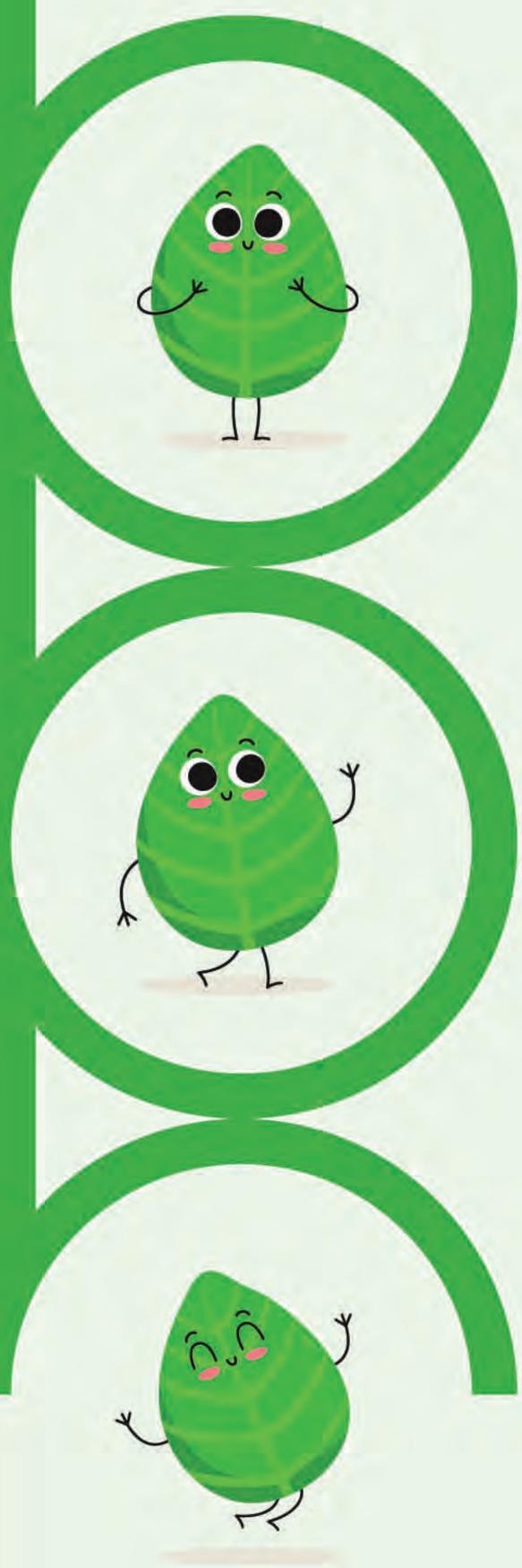
Sully

Younger sister of Tory, Sully is a bright and precocious child who cares for all living things. Always eager to learn more, her curiosity knows no bounds!



Forest Fairy

Protector of the forest, the Forest Fairy teaches people about the wonders and benefits of trees and forests and encourages them to conserve and manage forests sustainably.



CHAPTER

01

What is a tree?

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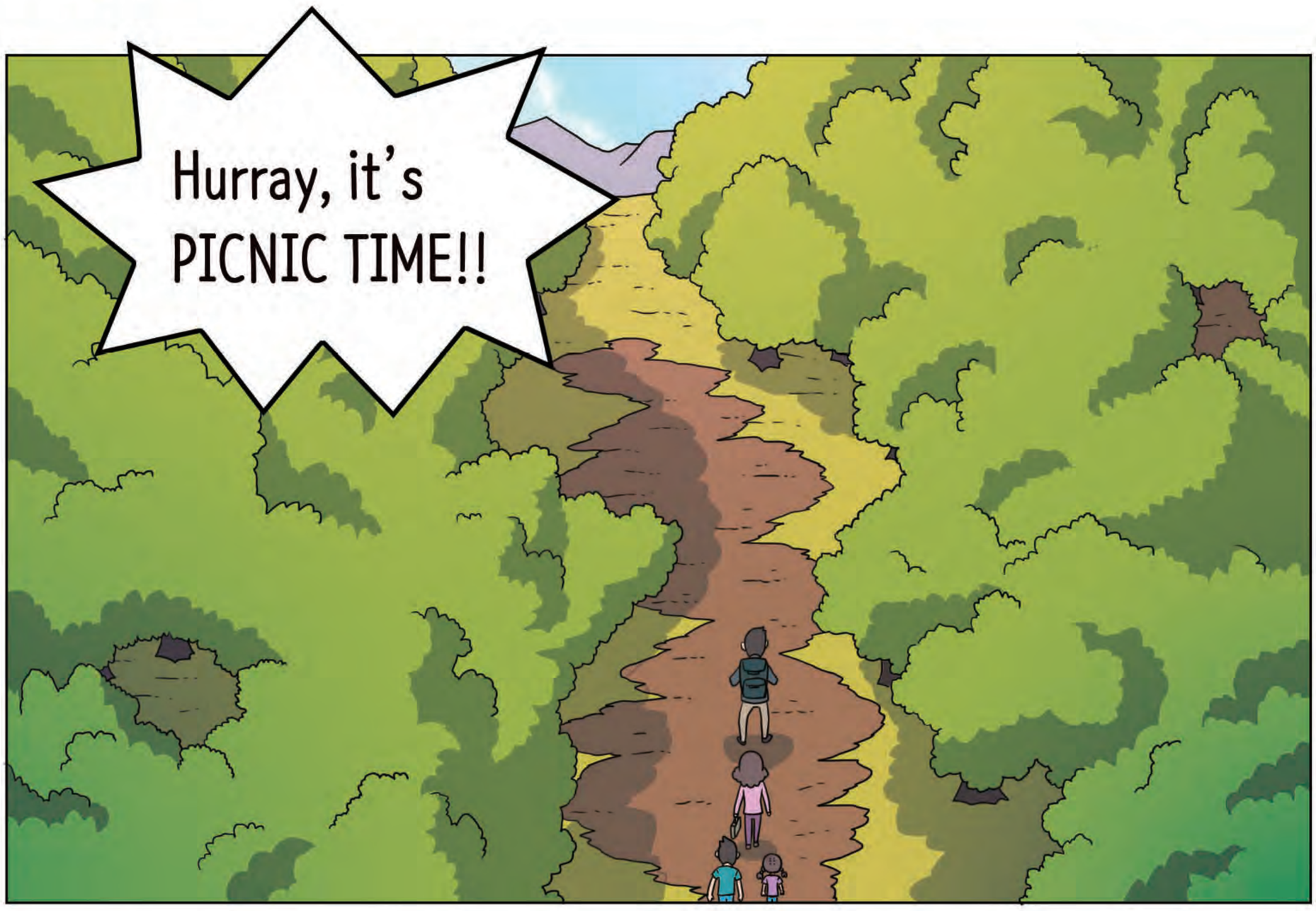
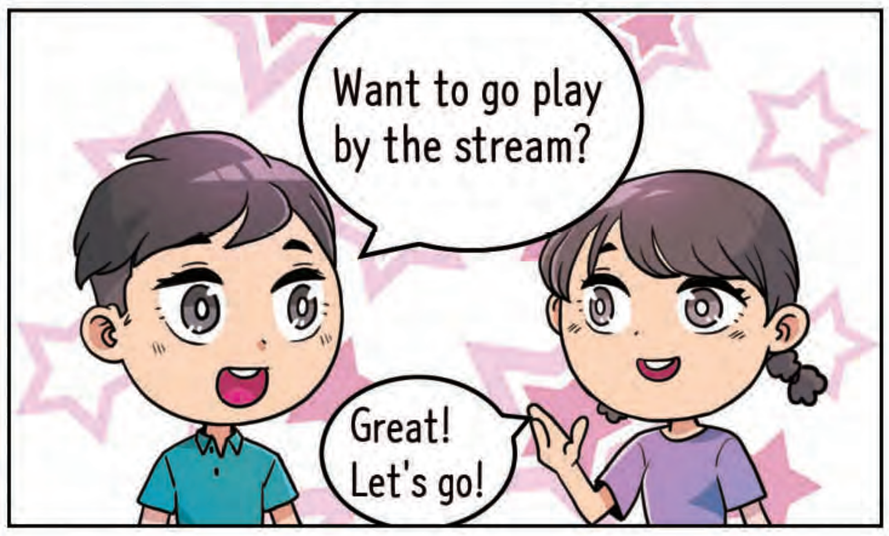
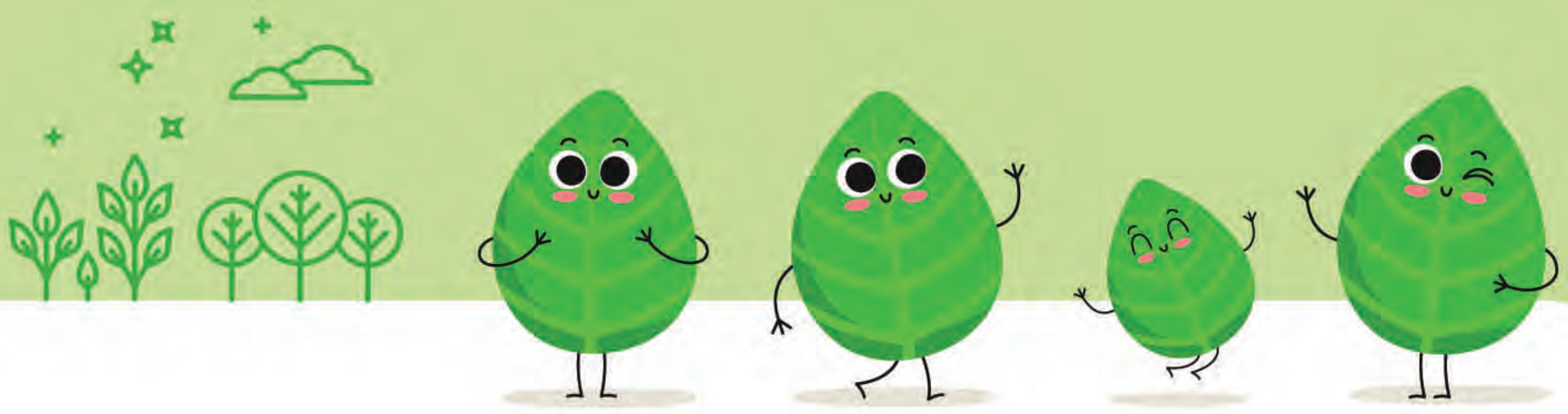
CHAPTER 01

What is a tree?







Don't go too far and be careful!

Ok!

Slow down, Tory!

Sully! There are so many trees here!!

YAHOO~

Tory, get down! It's dangerous!

YIPEE!

CRAACK!

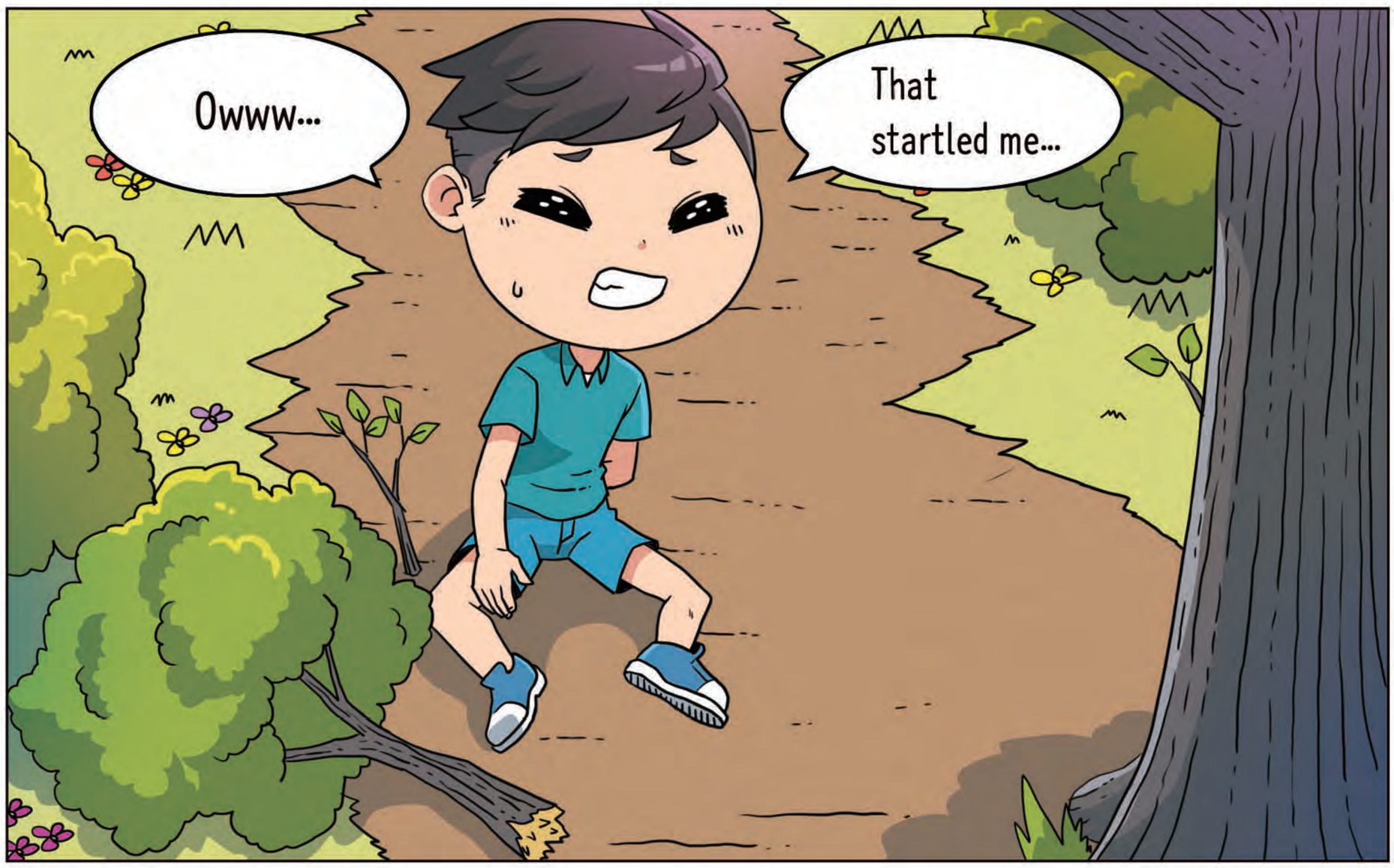
ACKKK!

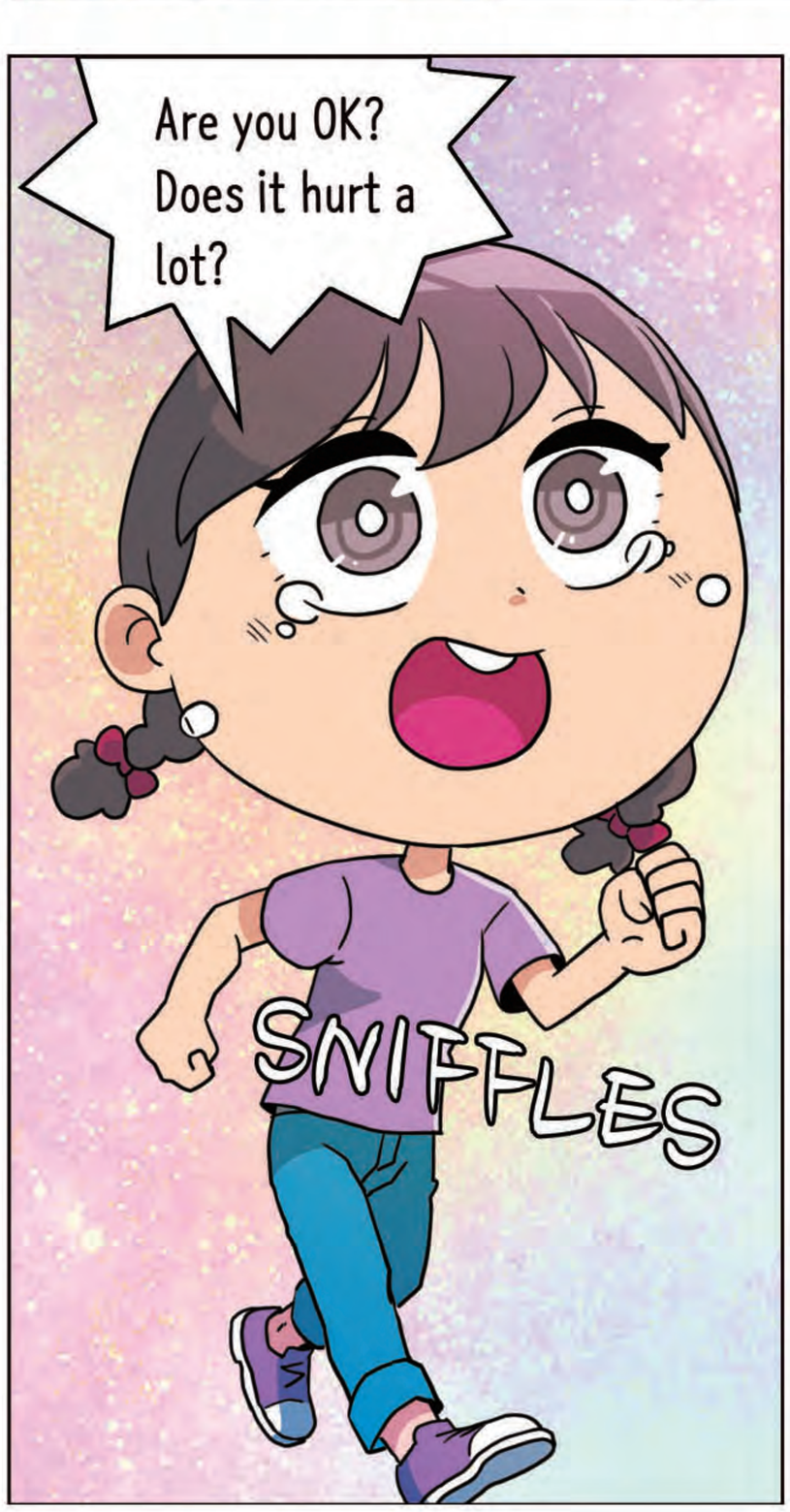
THUMP!

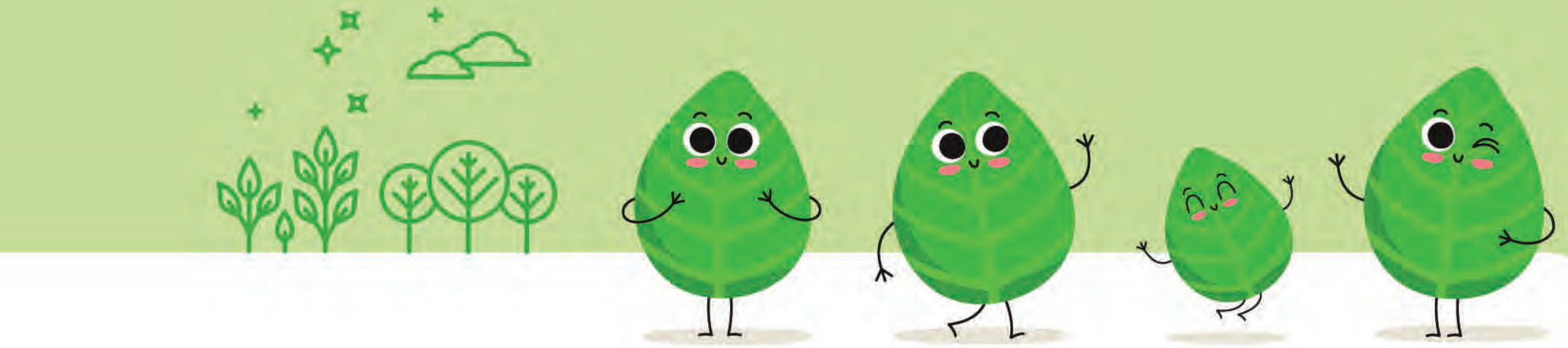
OUCH!

CHAPTER 01

What is a tree?





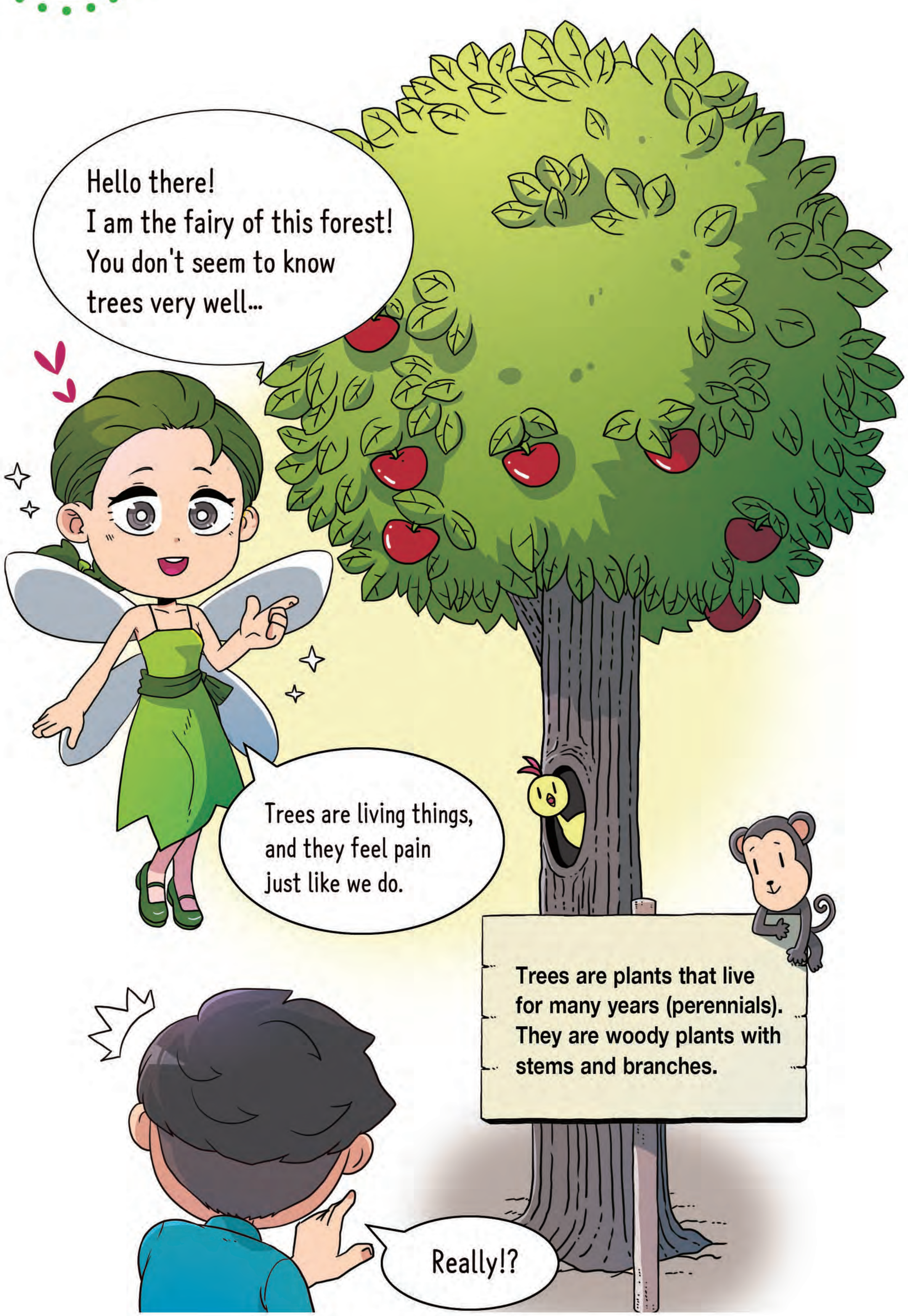


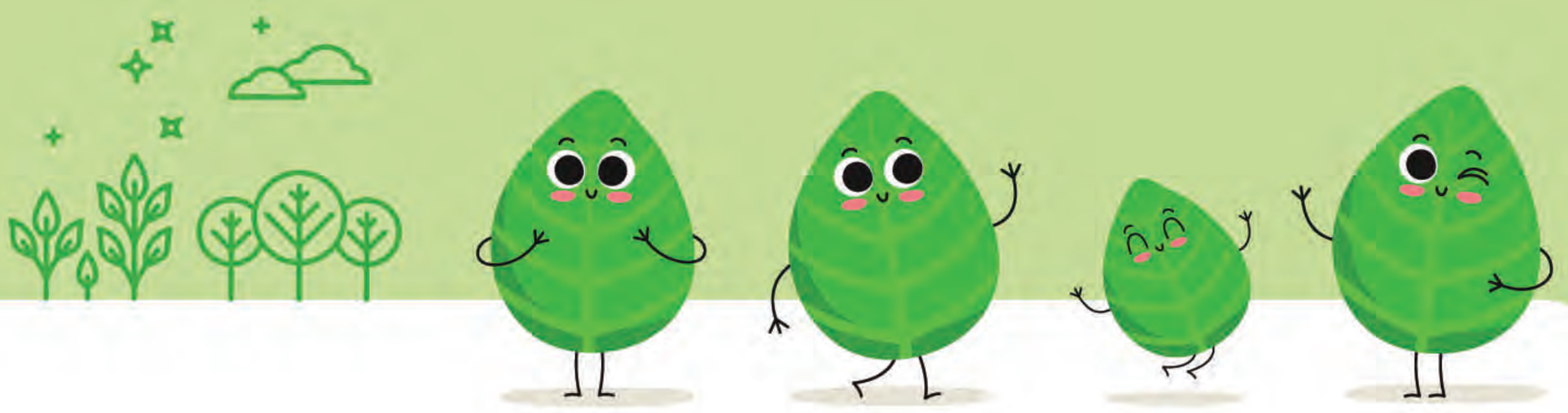

Oh no, dear tree, it must have hurt...
What!? You're more concerned about the tree?
HMPH! Who was the one who broke the tree's branches?
BOOHOO~
So what if I break some branches? Trees can't talk anyway!!
MUAHAHA!!
PRRAKK!
Arghh! Don't do that, Tory!


STOP!!
Huh!?
Trees are our friends.
POOF!
Whh-- who are you?

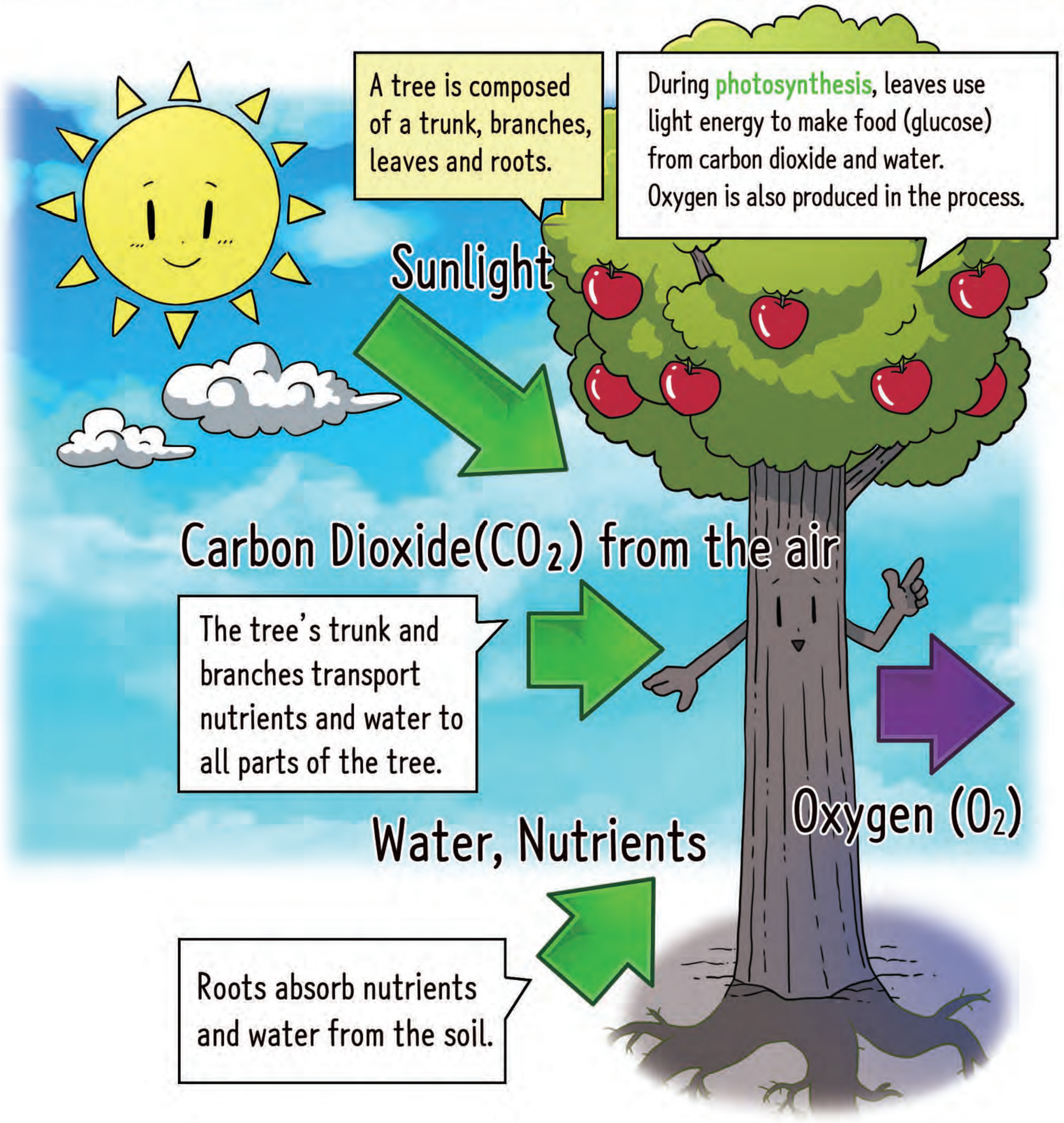
CHAPTER 01

What is a tree?



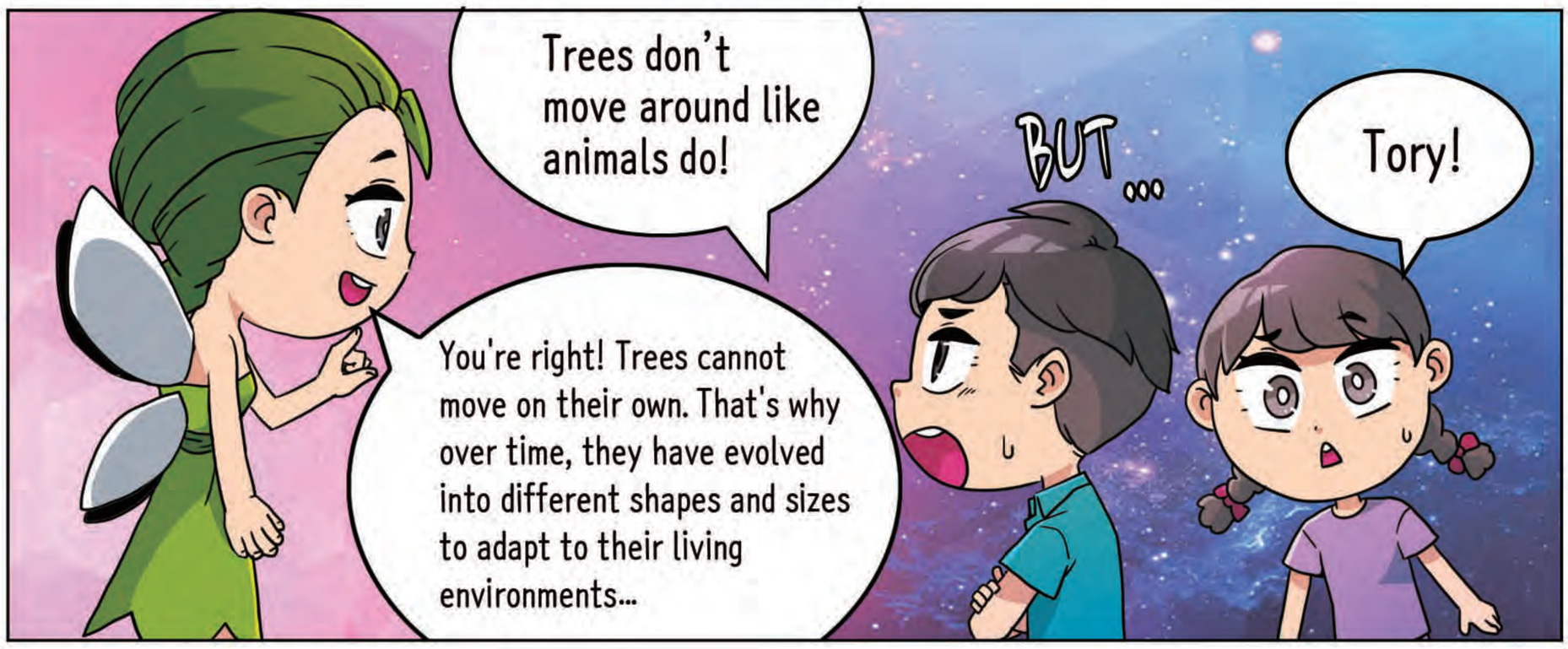



Hmm, but trees don't eat like humans do!
Please tell me more!
GASPS
Well, trees need nutrients to grow well!
They also make their own food through photosynthesis.


A tree is composed of a trunk, branches, leaves and roots.
During photosynthesis, leaves use light energy to make food (glucose) from carbon dioxide and water. Oxygen is also produced in the process.
Sunlight
Carbon Dioxide(CO_2) from the air
The tree's trunk and branches transport nutrients and water to all parts of the tree.
Oxygen (O_2)
Water, Nutrients
Roots absorb nutrients and water from the soil.

CHAPTER 01

What is a tree?



TREE SIZE

Tree
Tall trees usually with a single main trunk

Shrub
Shorter bushy plants usually with multiple stems

LEAF TYPE

Broad-leaved Trees
Flat leaves; seeds usually enclosed within a fruit (angiosperm)

Coniferous Trees
Needle-like leaves; seeds usually unenclosed and borne in woody cones (gymnosperm)

SEASONALITY OF FOLIAGE

Evergreen Trees
Leaves grow throughout the year

Deciduous Trees
Leaves are shed seasonally

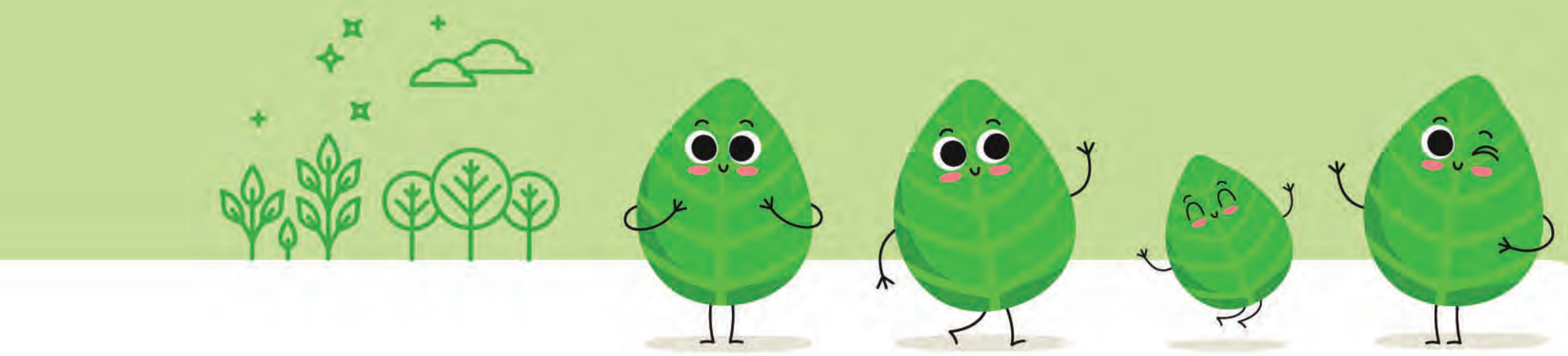
Forests are large areas of land that are covered with trees.

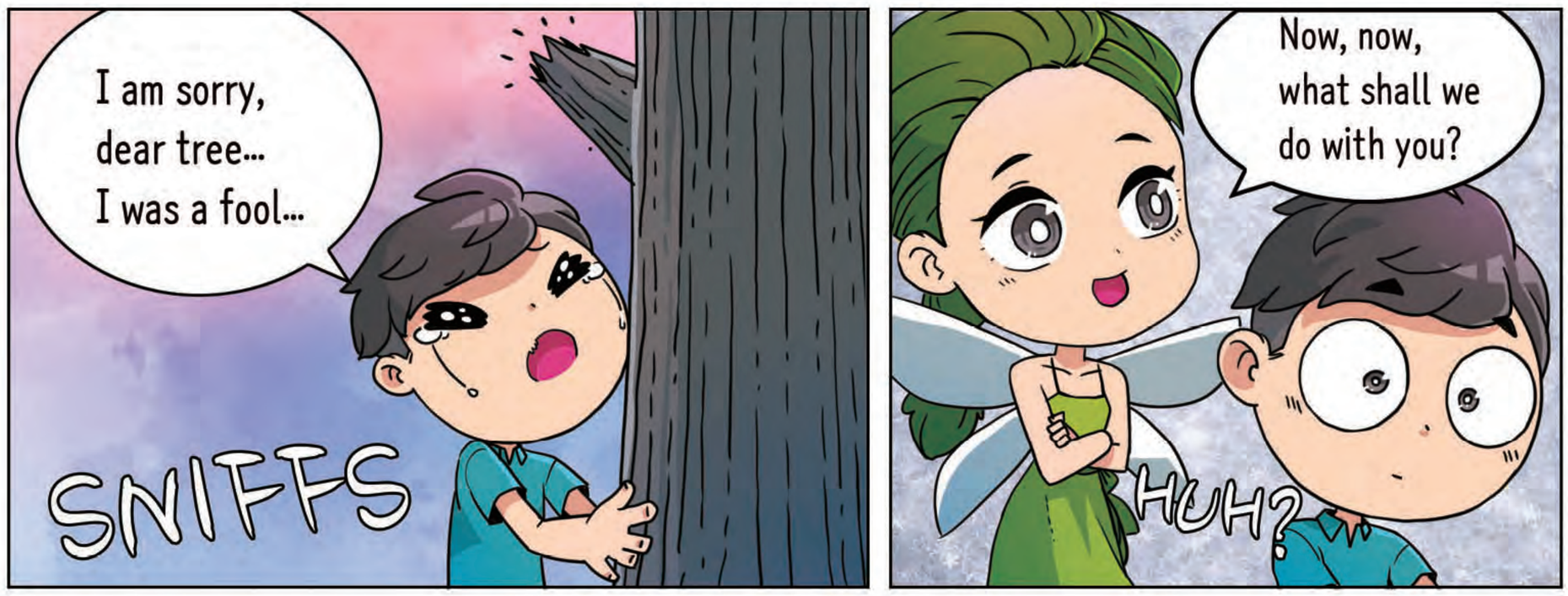
FORESTS IN DIFFERENT CLIMATIC ZONES

Boreal forests are found in the northernmost regions of Canada, North America, Europe and Asia, mainly between latitudes 50° and 60° north. The mean annual temperature in these regions ranges from -7 to -10°C.

Temperate forests are found between 40° and 60° north and south of the equator where the average temparature varies from 6 to 13°C. These forests are composed of a large variety of deciduous trees.

Tropical forests occur near the equator, within the area bounded by latitudes 23.5° north and 23.5° south, and are composed mostly of evergreen broad-leaved trees.Temperatures in this region are stable year-round (around 20 to 25°C).




I am sorry, dear tree... I was a fool...
SNIFFS
Now, now, what shall we do with you?
HUH?


To show your love for trees, you must conserve, protect and plant trees.


If we destroy or harm our trees, we will hurt ourselves too and suffer from the effects of environmental degradation.
WHOOSH~


So let's start showing our love for trees today!
Ok! Let's do it!

CHAPTER
01

What is a tree?

FIND YOUR WAY THROUGH THE MAZE!

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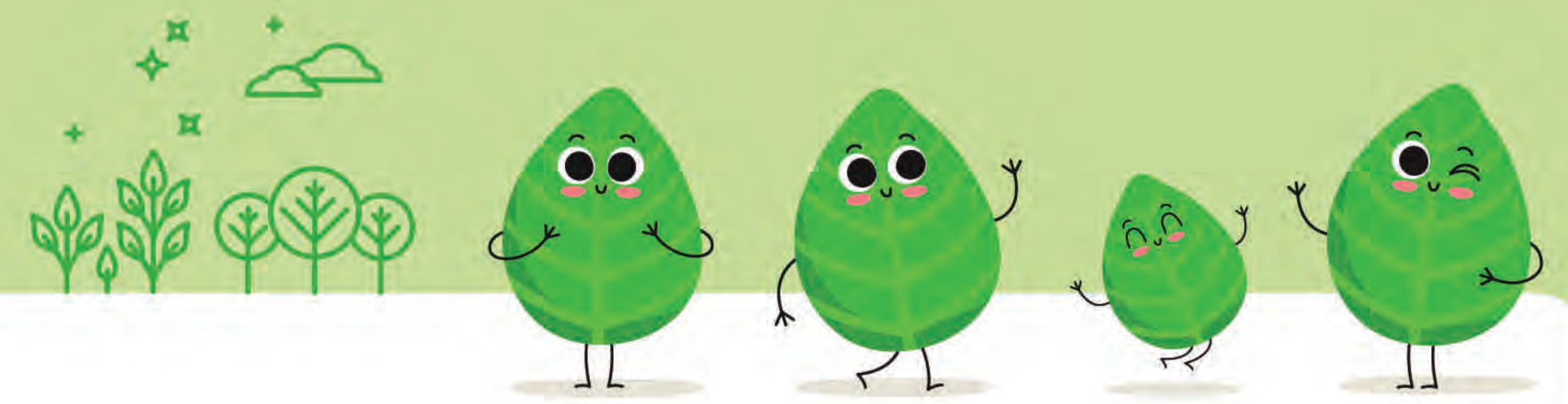
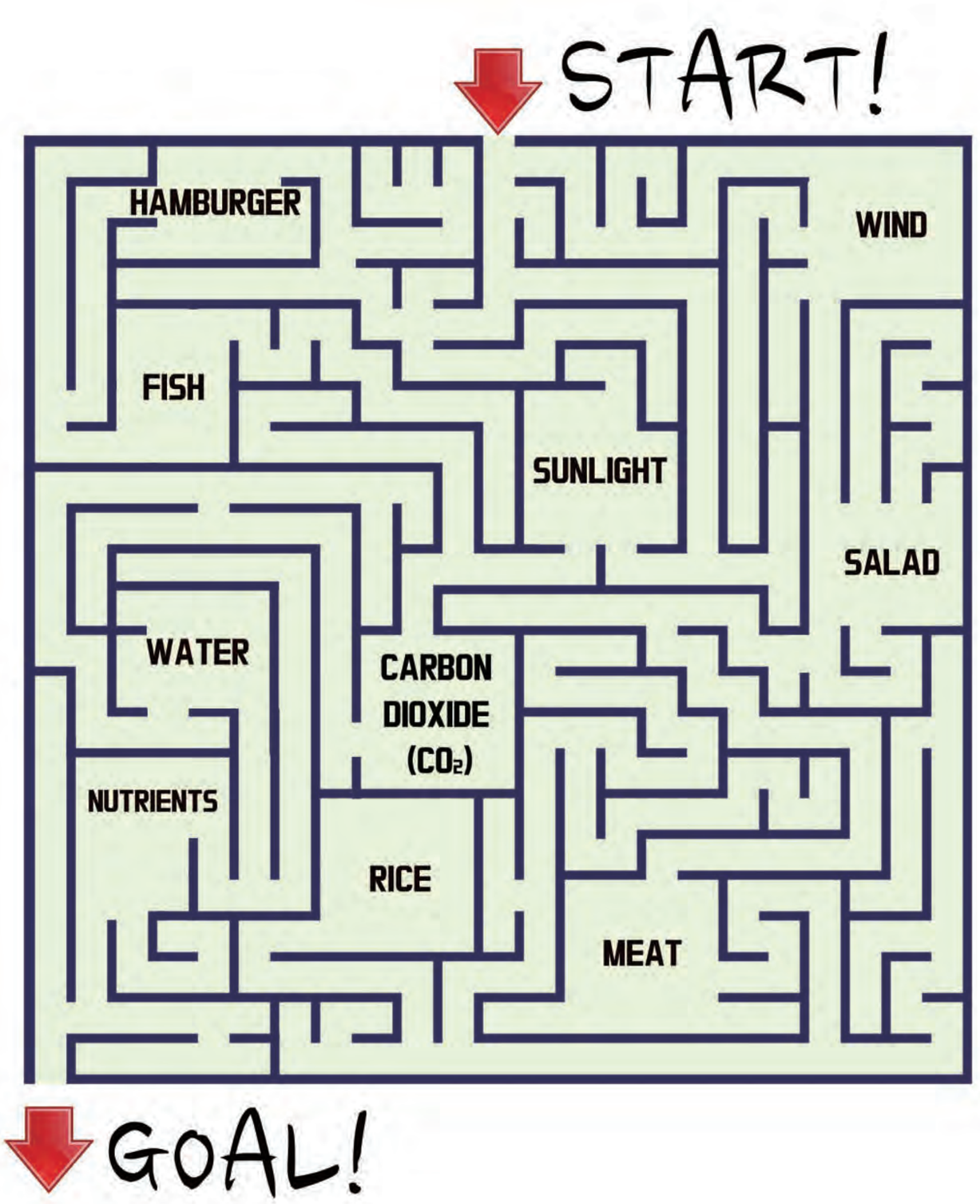




ANSWER: SUNLIGHT, CARBON DIOXIDE, WATER, NUTRIENTS

01 CHAPTER

What is a tree?

What are trees and how are they different from other plants? To answer this question, you should first know that trees are not a species of their own. Instead, trees are classified into two main groups: gymnosperms (non-flowering trees that do not produce flowers and bear seeds that are exposed to the air) and angiosperms (flowering trees that have seeds hidden inside a fruit).

A tree is a perennial plant with an elongated woody stem or trunk supporting branches and leaves. Trees are different from grasses – they can live for many, many years. Have you heard of the world's oldest living tree? It is a bristlecone pine in California, and it is 4,848 years old!

The trees you see in tropical forests in Southeast Asia are very different from those in the temperate forests of Northeast Asia (parts of China, Korea, Japan and Russia). Although trees vary considerably in their growth habits depending on the climate and environment, they share some common traits that allow us to identify them as trees. In this chapter, we will learn about the parts and functions of trees.

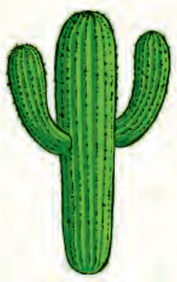
1 Parts and Functions of a Tree

A tree has structures that facilitate both growth (nutrient regulation) and propagation (reproduction). The growth structure of a tree consists of leaves, stems (trunk, branch) and roots, while its propagative structure consists of flowers, fruits and seeds.

LEAF

Leaves combine water absorbed from the roots, carbon dioxide and sunlight into sugars through a process known as photosynthesis. Trees and plants make their own food through photosynthesis, and this is why they are known as "producers." The nutrients produced by trees and plants are transferred along the food chain to insects, animals and finally to humans at the top of the food chain.

Flowering and non-flowering trees and plants have different leaf shapes. Non-flowering trees that bear cones have needles, while flowering trees have broader leaves. These leaves can be grouped into net-veined simple leaves, compound leaves and parallel-veined simple leaves.

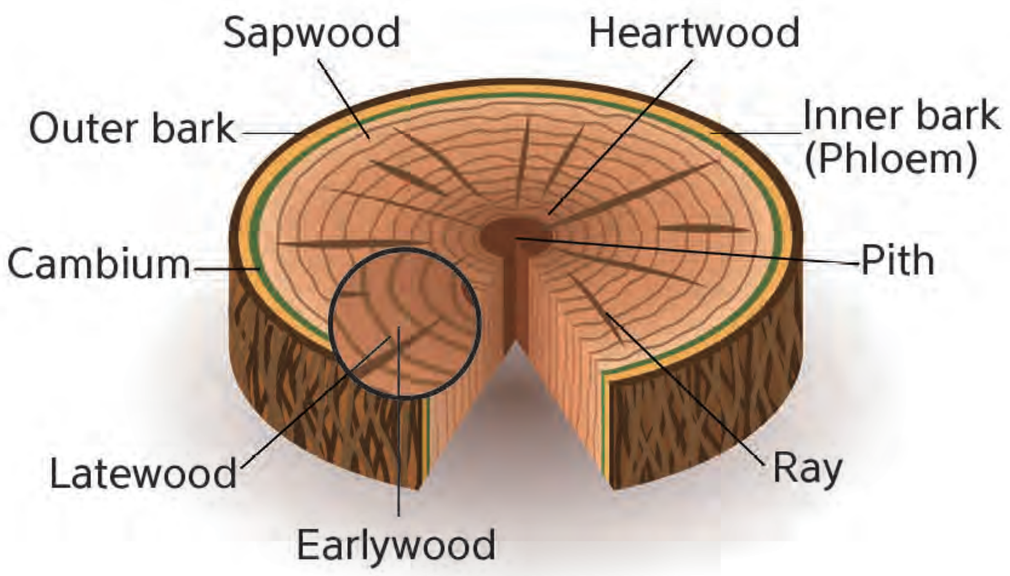


What are cactus spines? Which part of the plant is a spine?
The sharp spines of a cactus are actually modified leaves. Cactuses developed spines to adapt to extremely dry desert environments. Water vapor in the air condenses on the spines before dripping to the ground, where it is absorbed by the roots. The spines of a cactus also provide shade and protect it from being eaten by animals.

■ TRUNK (main stem)

The trunk of a tree supports the branches and serves as a highway for transporting water, nutrients and food. The trunk is covered by a tough outer covering of bark that protects the tree from insects, diseases and extreme temperatures.

Cross Section of a Tree Trunk



- The **phloem** acts as a food supply line that transports food from the leaves to the other parts of the plant
- **Sapwood** contains thick-walled xylem cells that transport water and nutrients from the roots to the leaves and other parts of the plant
- **Heartwood** is the darker, inner section of the trunk consisting of dead xylem cells that provide structural support

Growth rings can be seen in many wooden products and furniture. Every growth season, the **cambium** adds a new layer of cells to its trunk, forming a layer of wood known as a growth ring. During spring and summer when the majority of growth occurs, trees produce numerous large thin-walled cells, forming light-colored **earlywood**. Towards the end of summer, they produce smaller cells with thicker walls, forming dark-colored **latewood**. In autumn and winter when trees are not as active, they stop making growth rings. A year of growth is represented by an annual growth ring composed of a light-colored part (earlywood) and a dark-colored part (latewood). Hence, you can tell a tree's age by counting the number of annual growth rings in its trunk!

Growth rings come in different colors and density because of the different growth rates in different seasons. A tree may produce two growth rings in one season if there is a sudden change in weather that affects the growth of the tree. During an extreme drought, there may be insufficient growth to produce a noticeable ring. In tropical regions where the temperature is consistent and trees grow in a similar way all year round, growth rings are not clearly visible.

01 CHAPTER

What is a tree?

Other factors may affect the formation of growth rings too!
In the northern hemisphere, tree growth rings tend to be wider on the southern side of the tree due to high exposure to sunlight. Similarly, in the southern **hemisphere, wider growth rings are found on the northern side of the tree.**

Supposing that the tree in the picture on the right is in the northern hemisphere, can you tell which direction it is facing? You may guess that the right side of the tree is facing south. However, to make an accurate guess, you will need to know about other factors such as the slope and wind direction.

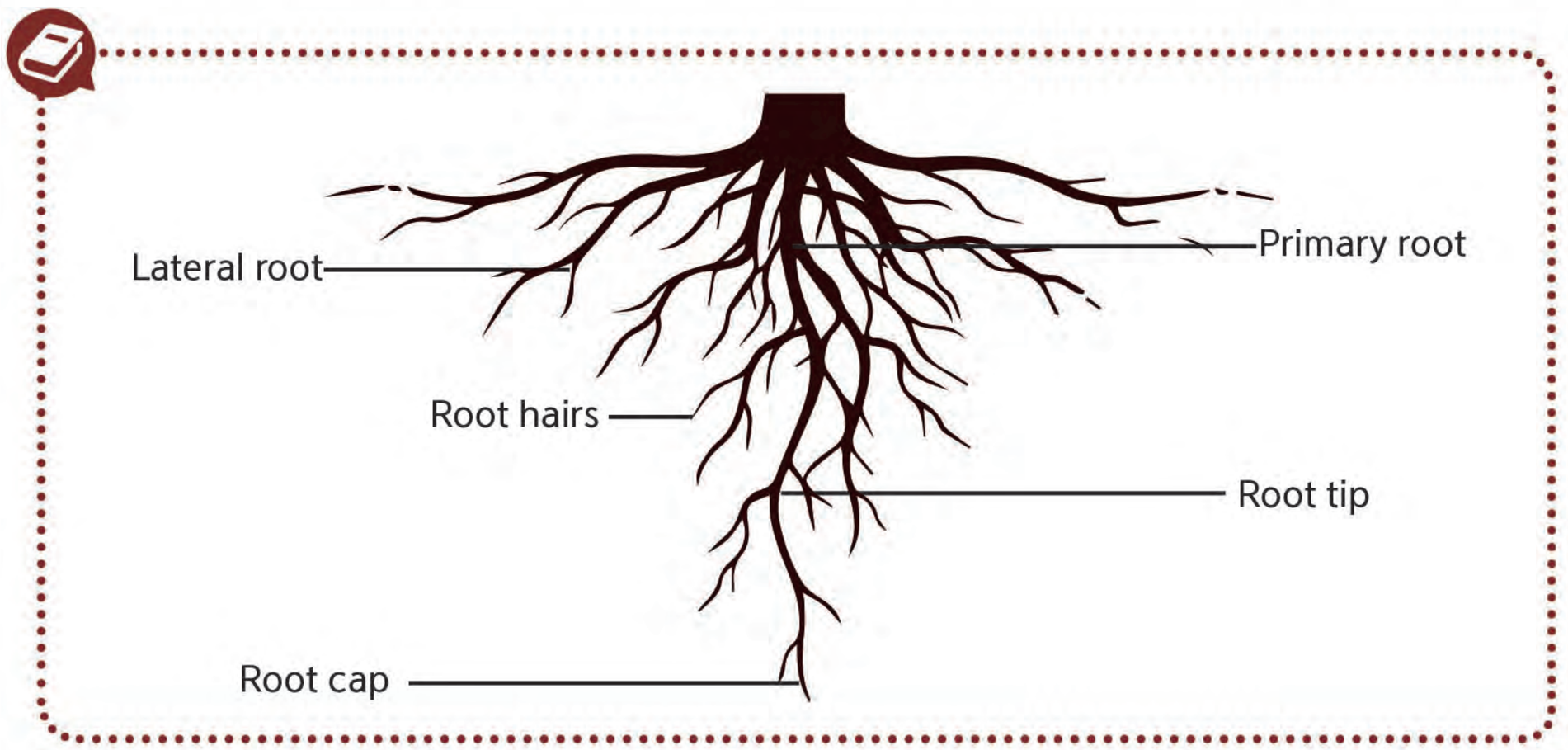
Broad-leaved trees in upper slope areas have wider growth rings, while conifers in lower slope areas have wider growth rings. In addition, the windward side (side facing the wind) of broad-leaved trees develops wide growth rings, while the leeward side (side facing away from the wind) of conifers develops wide growth rings.

■ BRANCH (lateral stem)

A **branch** of a tree carries water and nutrients from its trunk to its leaves, and moves the nutrients made from photosynthesis to the trunk. Because branches are thinner than the trunk, they do not produce wood of good quality. Nonetheless, they have many other uses such as handicrafts, sawdust and fuel.

■ ROOTS

Roots support the tree and absorb the water and minerals needed for growth, delivering them to the other parts of the tree. The depth and width of root structures vary according to tree types, but roots usually spread across an area that is wider than the crown of the tree.



CHAPTER

02

How do trees grow and propagate?

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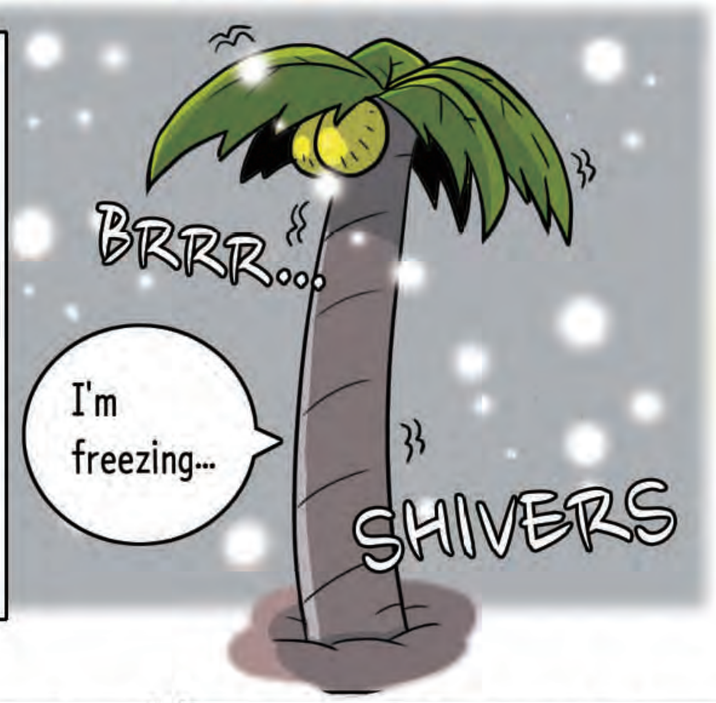
CHAPTER 02

How do trees grow and propagate?

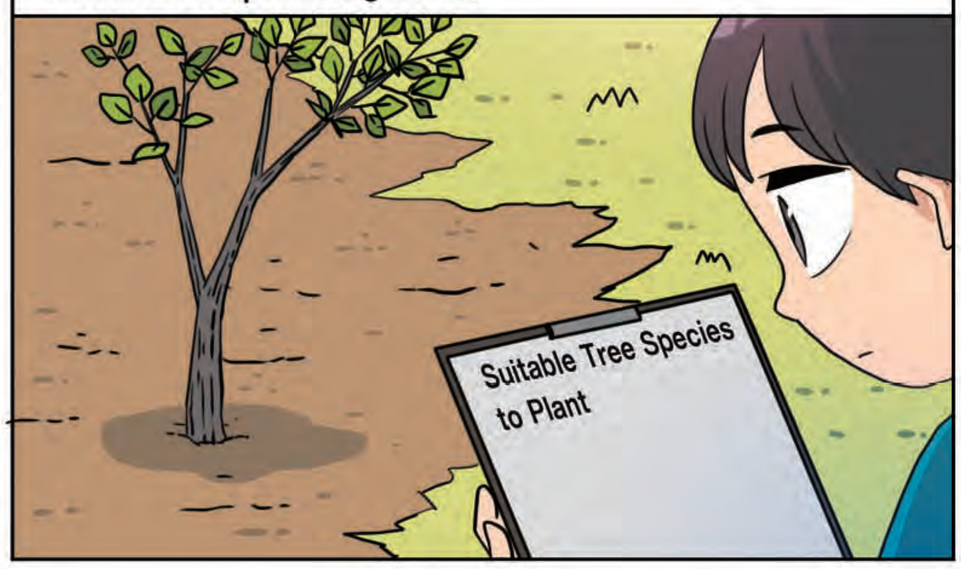
No, you can't... Before planting, you must think of the type of tree species, the period of planting and why you want to plant the tree.

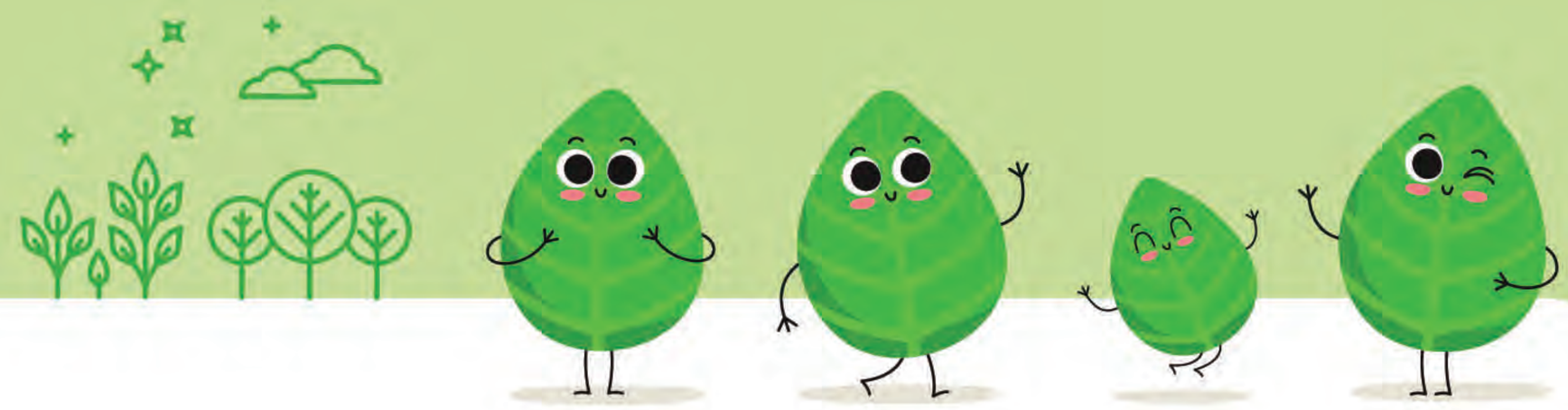
A tropical tree cannot grow well in a cold place. A boreal tree will not be able to survive in a warm place.



Humans have different thermal preferences and are sensitive to the temperature of their surroundings. Likewise, trees suffer if they are grown in environments that they dislike or that are unsuitable for them.

That is why before planting a tree, we need to check whether it can grow and reproduce on its own in the planting area.





It is also important to know when is the best time to plant trees.

Each country organizes its own tree-planting event during the optimum tree-planting period.

ARBOR DAY DATES
Rep. of Korea: April 5
Kazakhstan: Third Week of April
Thailand: May (Full Moon Day)
Laos: June 1
Cambodia: July 9
Philippines: Second Saturday of September
Indonesia: November 28
Mongolia: Second Week of May & October

The purpose of tree planting is also important.

In gardens, we usually plant beautiful trees of different shapes, sizes and colors...

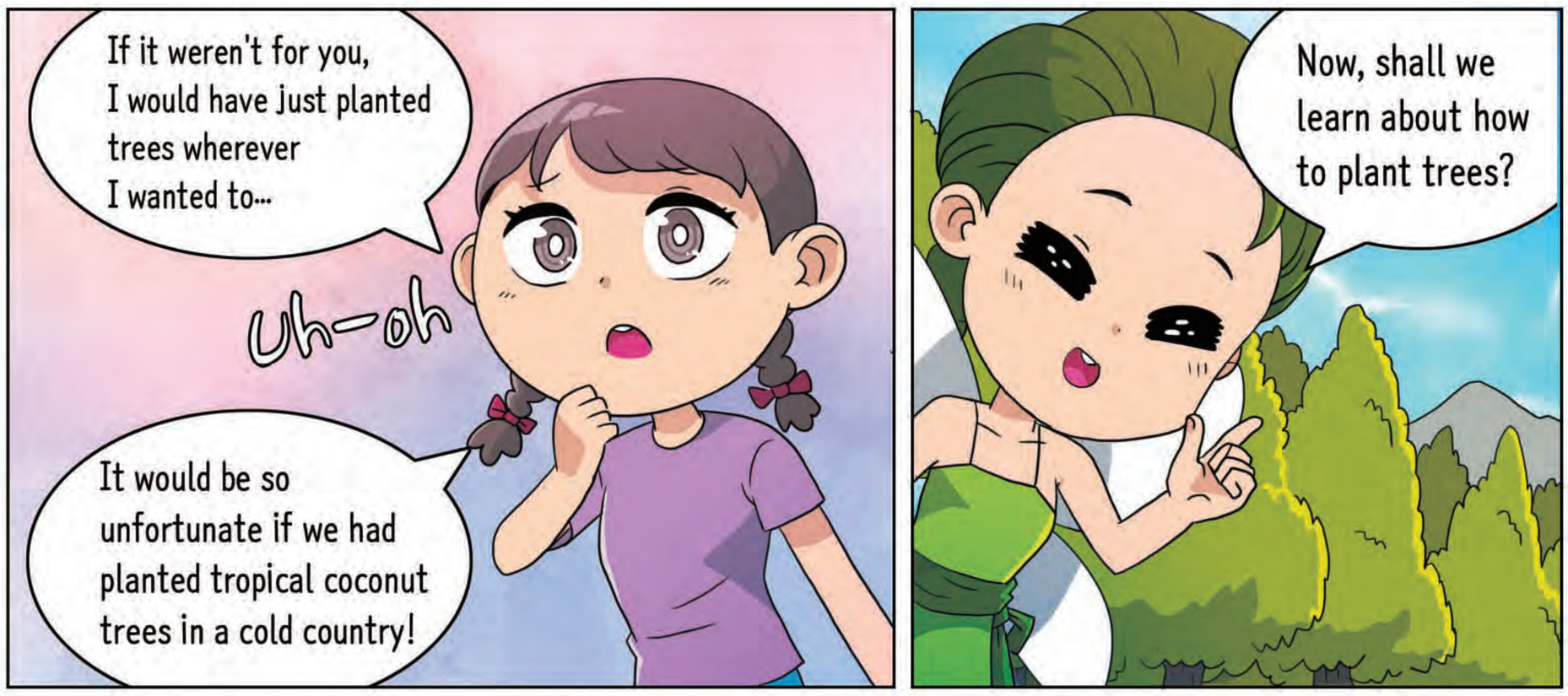
...while fast-growing tree species with thick trunks are preferred for timber production.

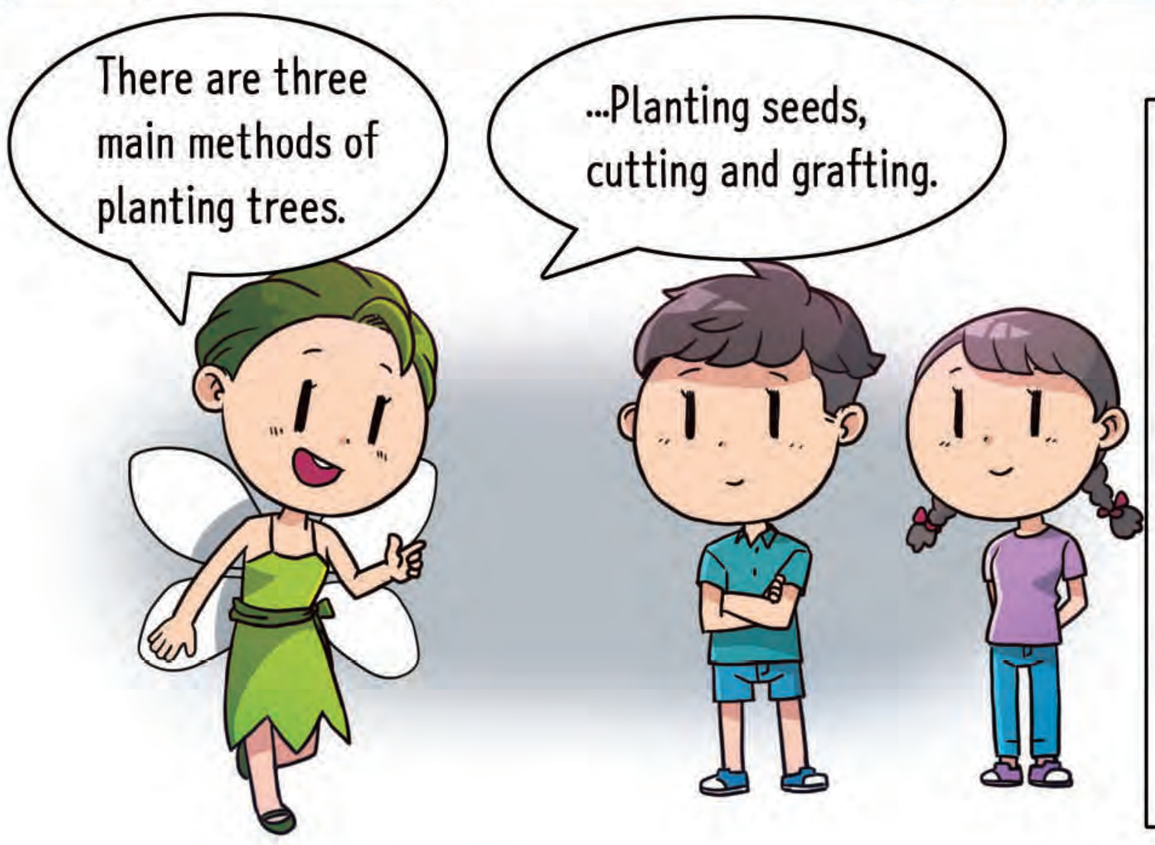
Trees are also planted to control floods. The roots of trees hold the soil in place and improve drainage of the soil. Rainwater seeps into the ground, and less of it flows into rivers and streams.

When planting forests on barren hills, fast-growing and hardy trees such as Black Locusts and East Asian Alders are recommended. These tree species can survive in harsh environments.

CHAPTER 02

How do trees grow and propagate?

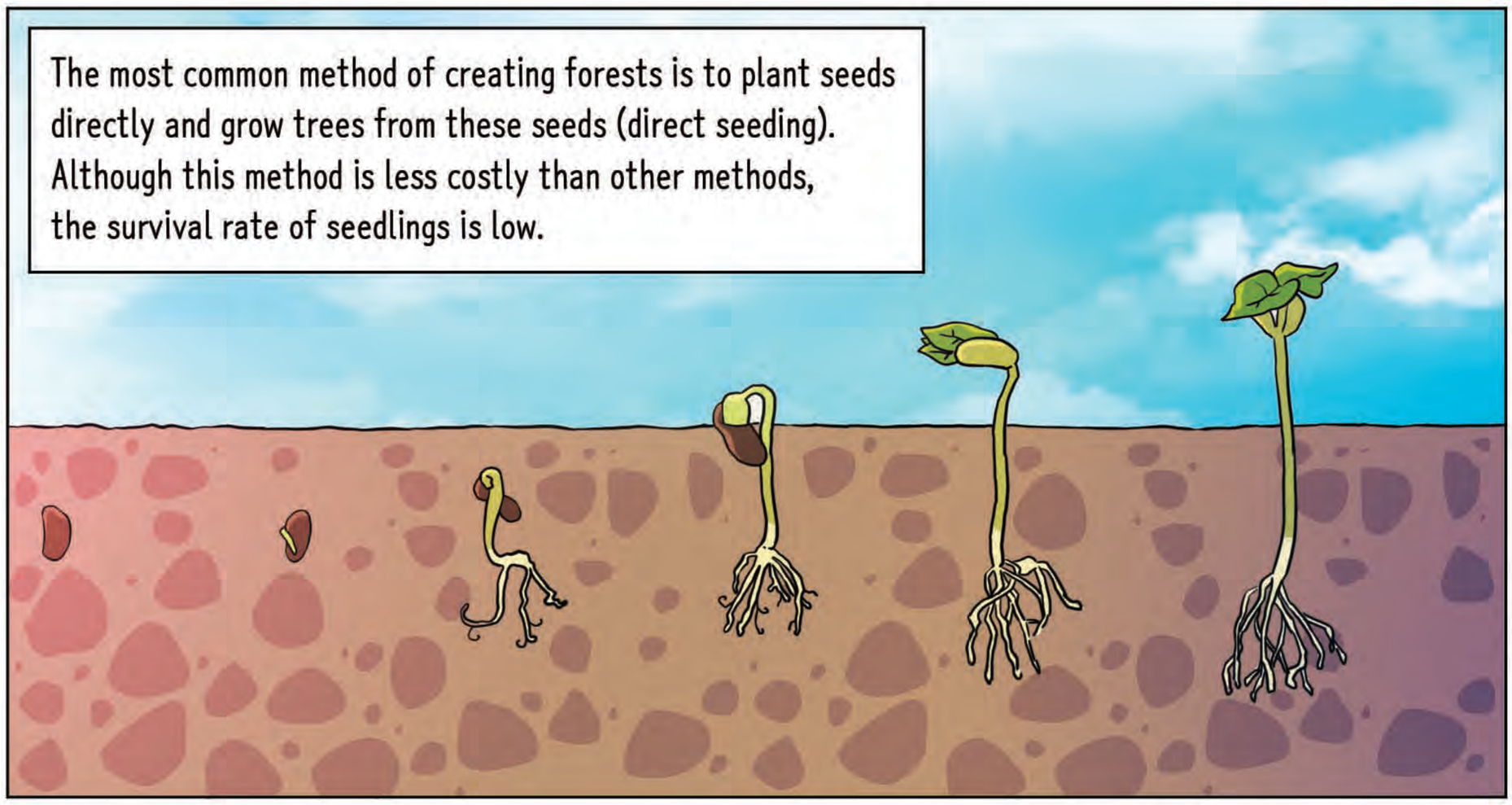


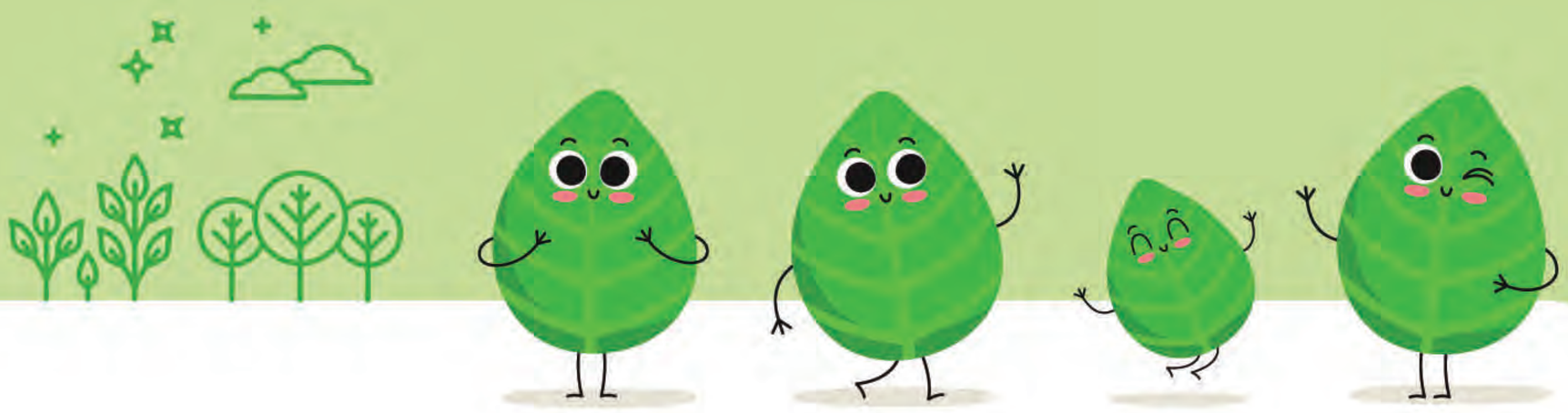


HOW TO PLANT TREES

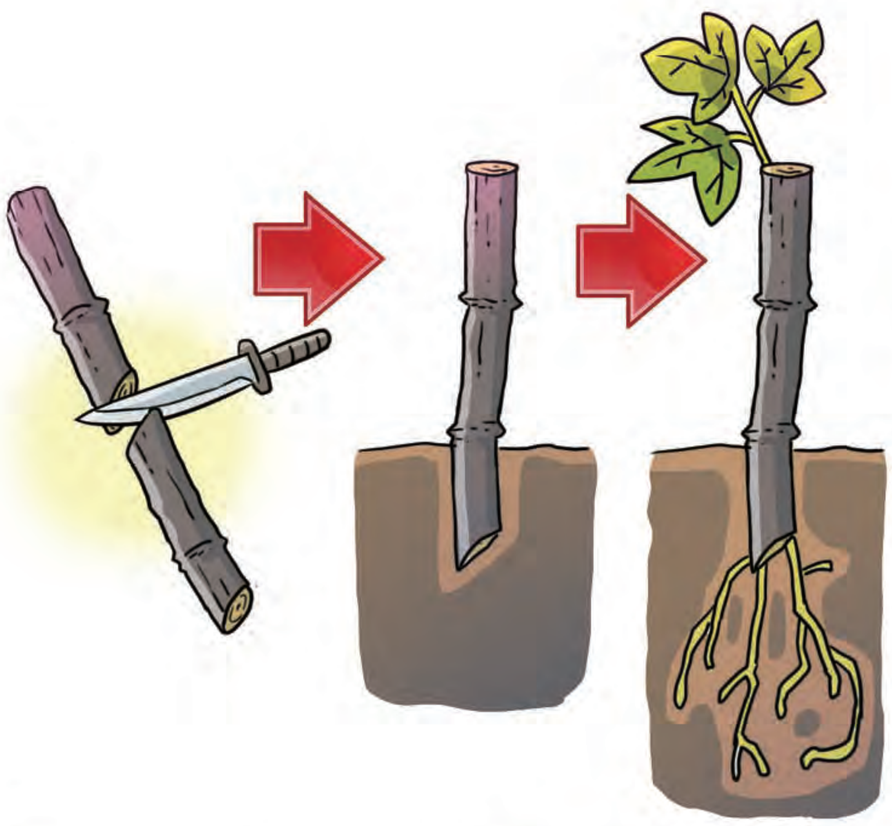
- Planting seeds
- Cutting (A stem, root or leaf cut of a plant is grown in soil)
- Grafting (A cutting of a branch from a tree is attached to a branch or rootstock of another tree and grown as a single plant)

The most common method of creating forests is to plant seeds directly and grow trees from these seeds (direct seeding). Although this method is less costly than other methods, the survival rate of seedlings is low.

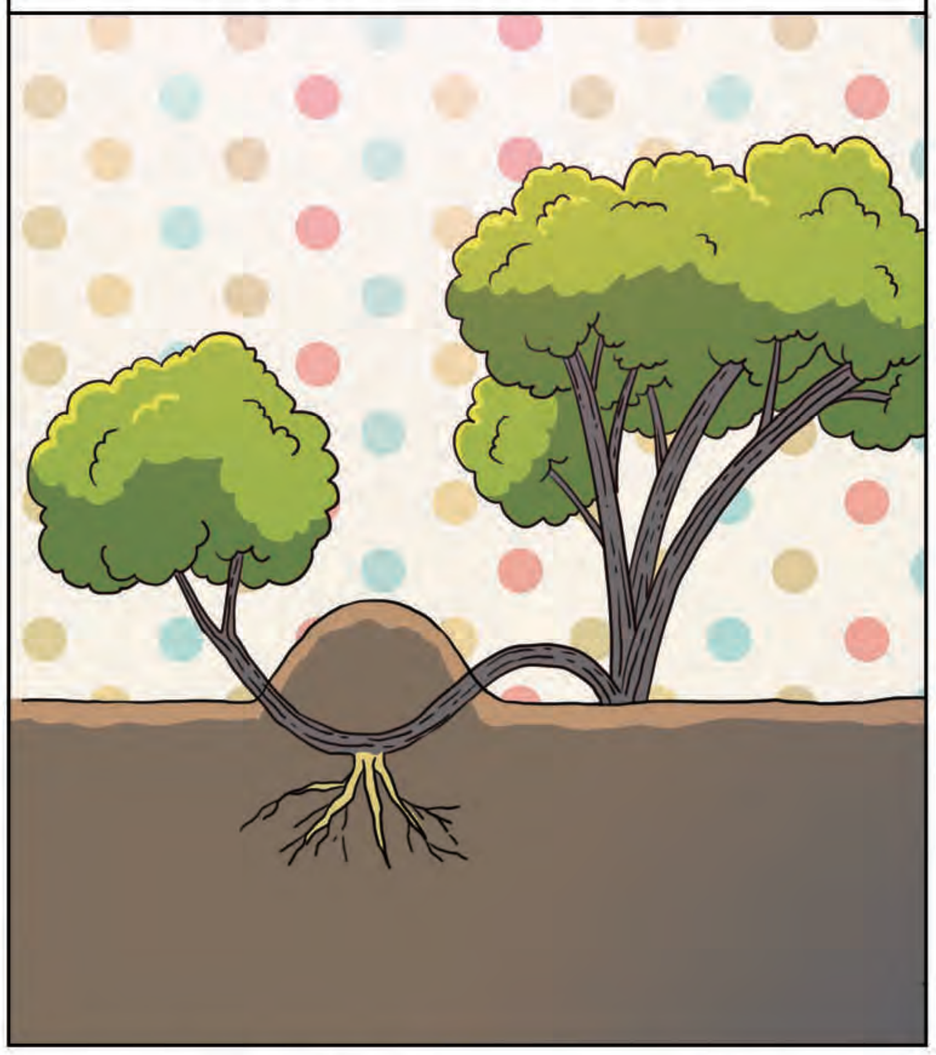




Cutting is a method where a part of a stem cut from a parent plant is planted in soil.



Layering is a similar method. Layering involves bending and burying a part of a stem that grows close to the ground.

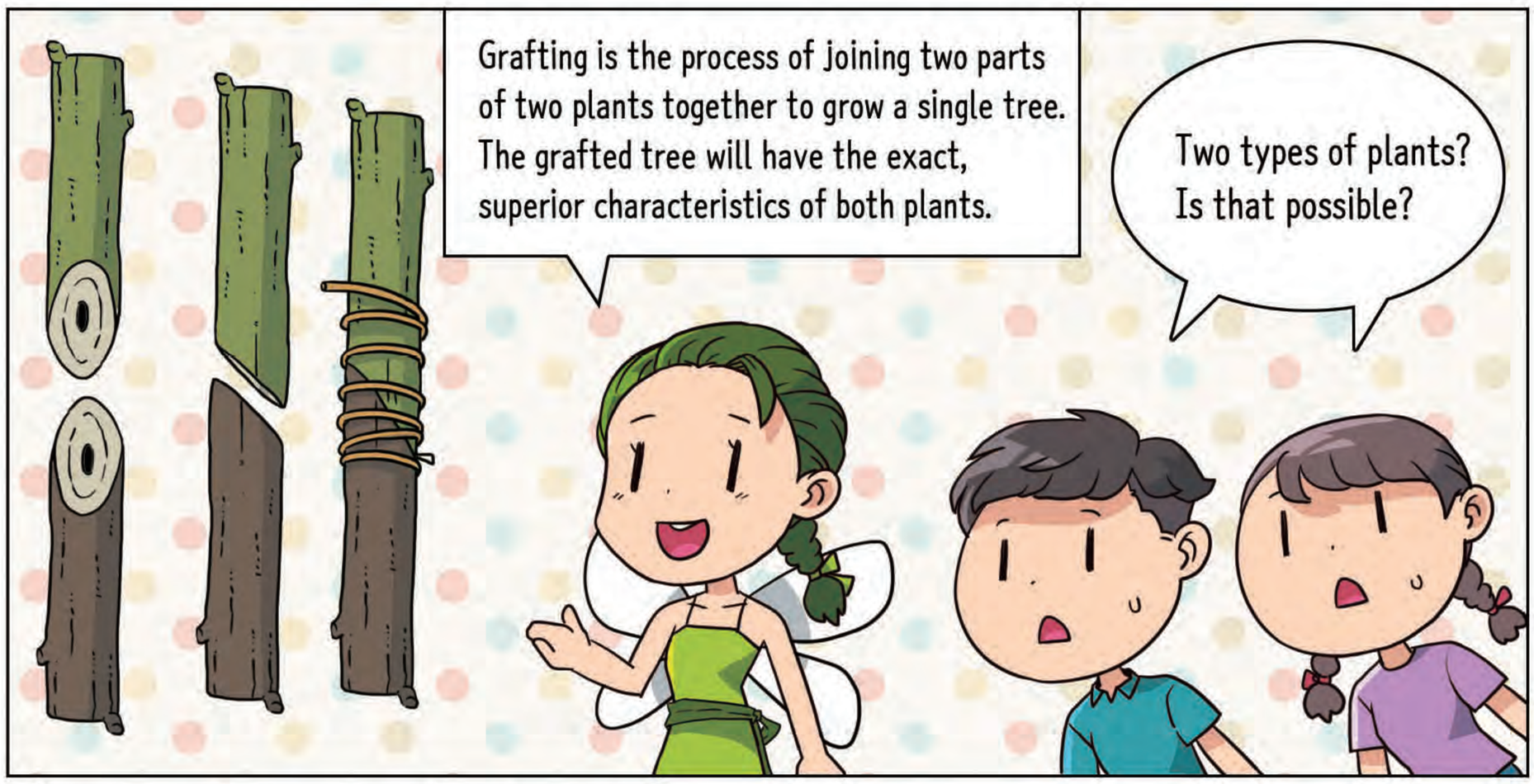


Through propagation by cutting, young plants that have the same characteristics (identical) as the parent plant are produced!

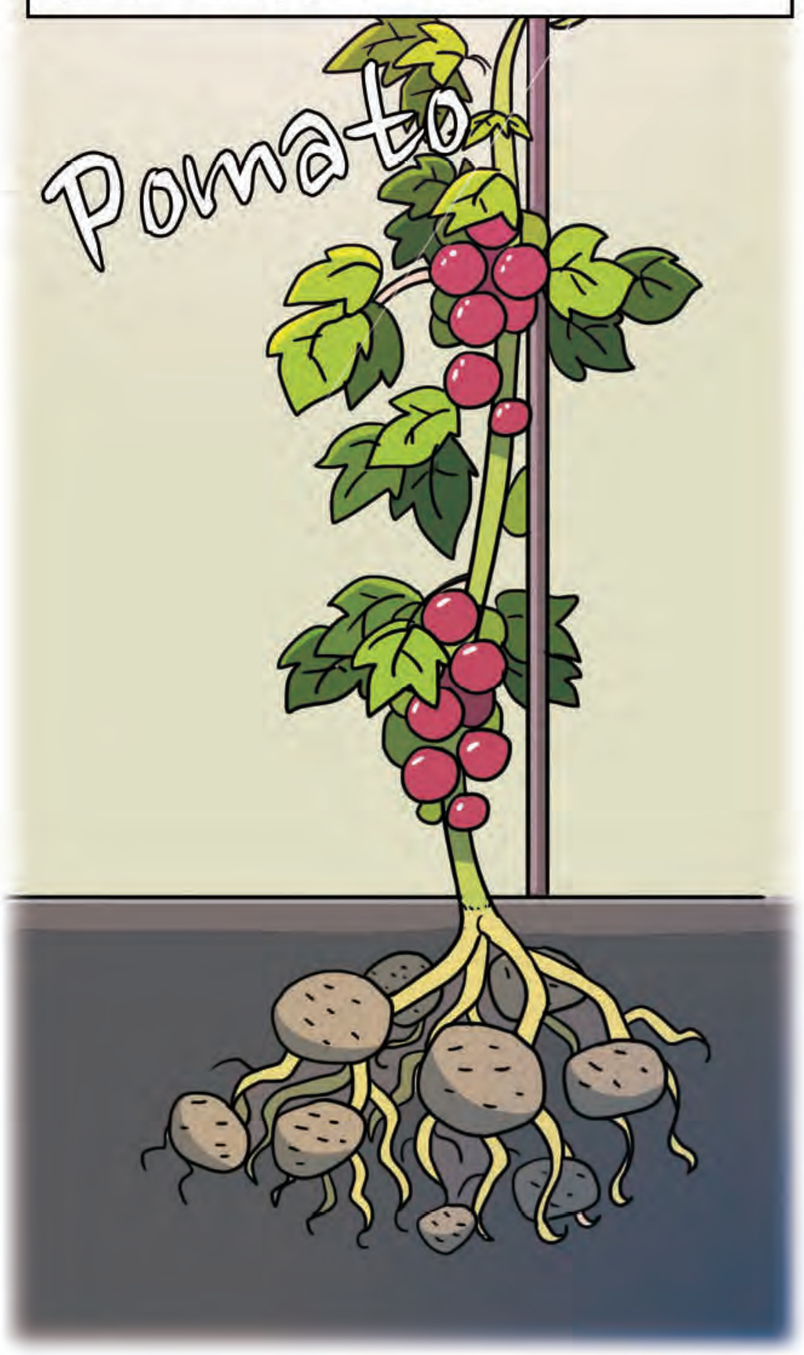
However, pine and oak tree species do not grow easily from cuttings.

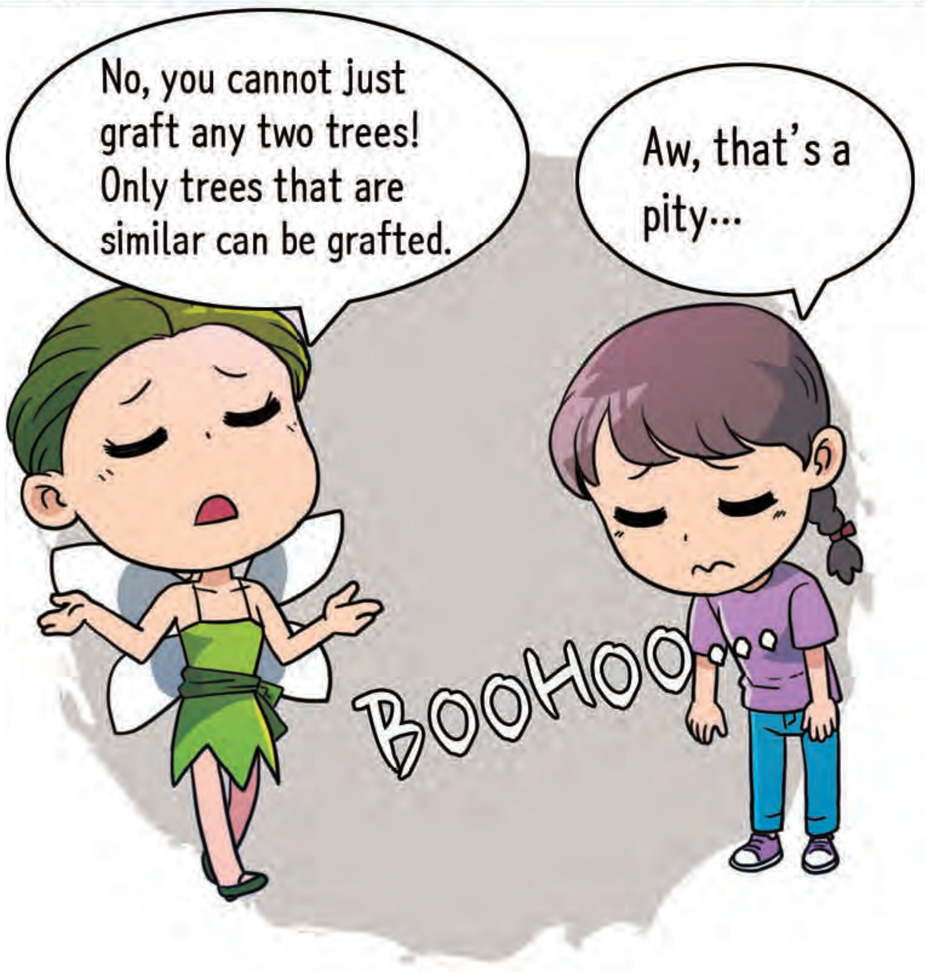
CHAPTER 02

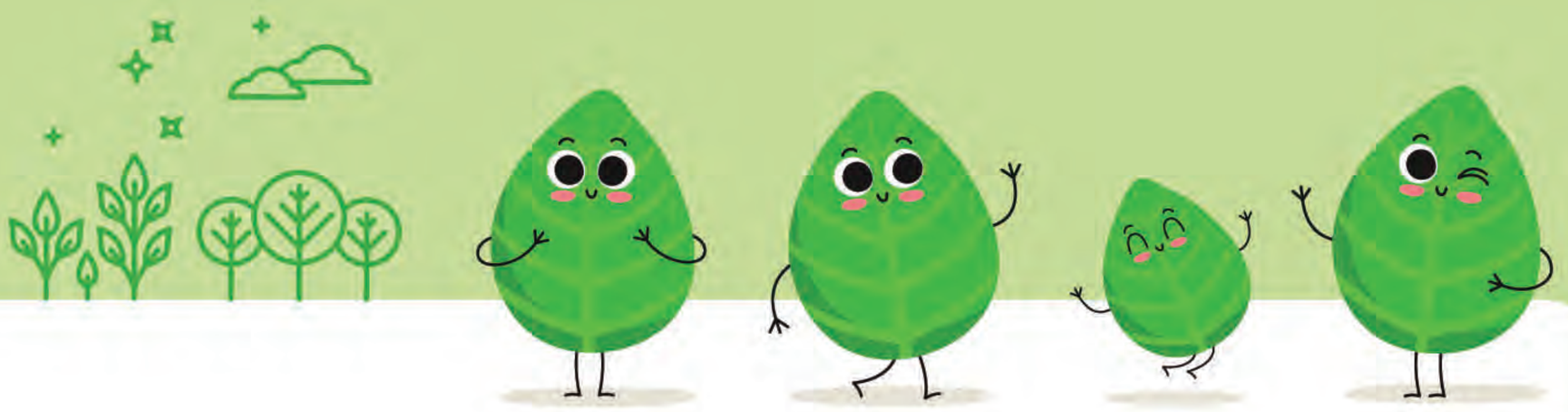
How do trees grow and propagate?



Grafting a tomato plant and a potato plant results in a grafted plant that produces both tomatoes and potatoes.
The grafted fruit tree of a persimmon tree and a date-plum tree has a stable base and produces many persimmons.





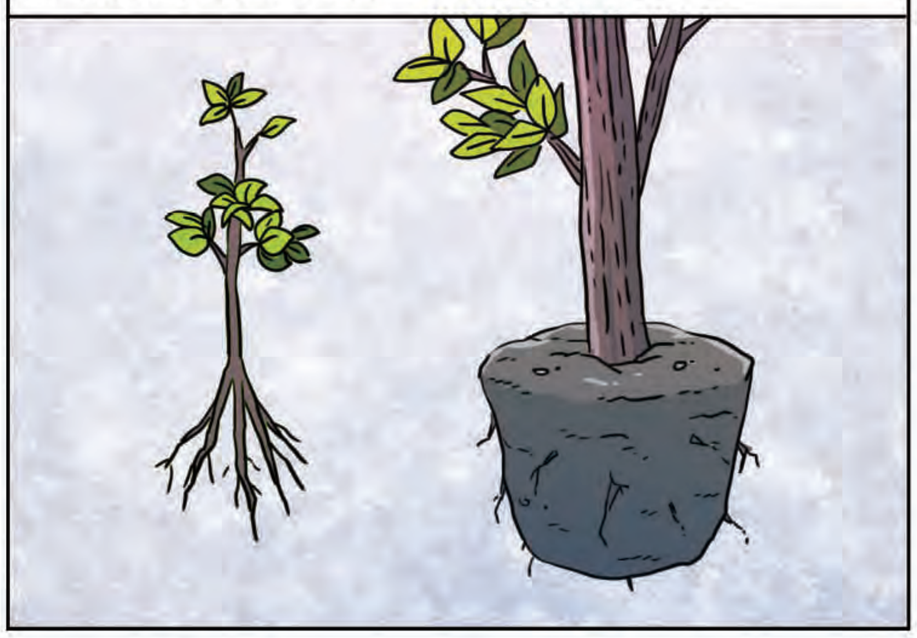


The order of tree planting is also important. When planting in areas where forest fires occur or when planting over large areas of land, seeds are usually planted directly in the soil.

Seeds are also planted in plant nurseries. After they have grown into seedlings (young plants), they are transplanted to the main planting site.

Depending on the tree species, seedlings are grown for 1 to 3 years till they reach heights of 3 cm to 2 m. Then, healthy seedlings are selected for planting in the planting sites.

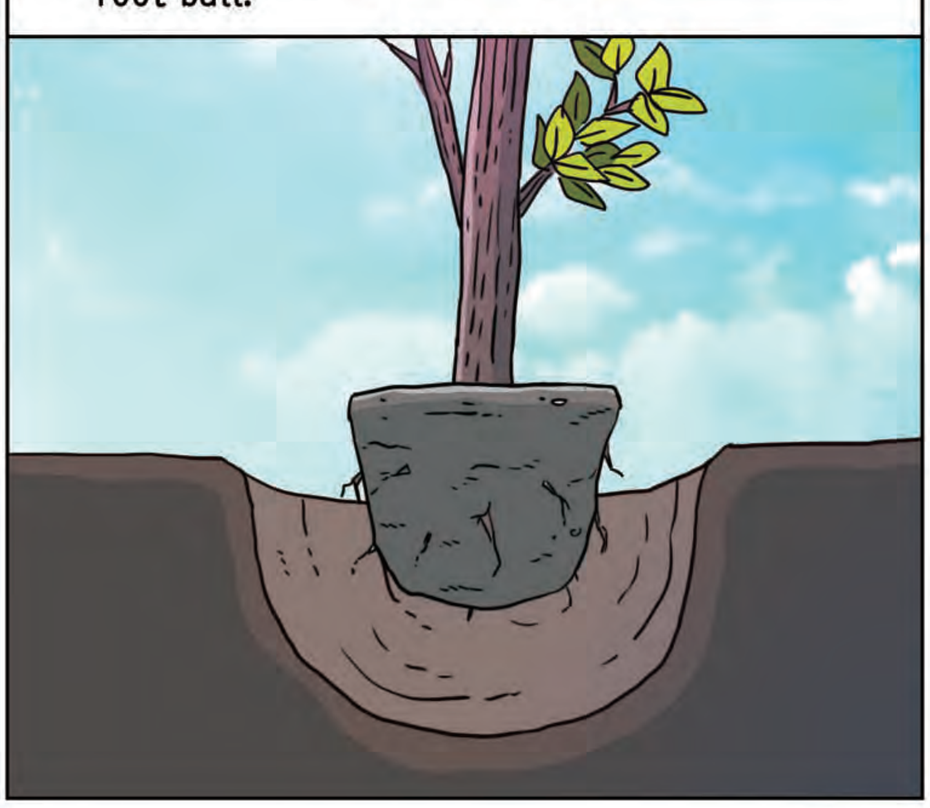
After the roots have grown out, seedlings are transplanted together with the surrounding soil. Try to keep as much of the original soil attached to the roots. This reduces transplant stress and ensures that the seedlings can adapt and survive well in their new surroundings.



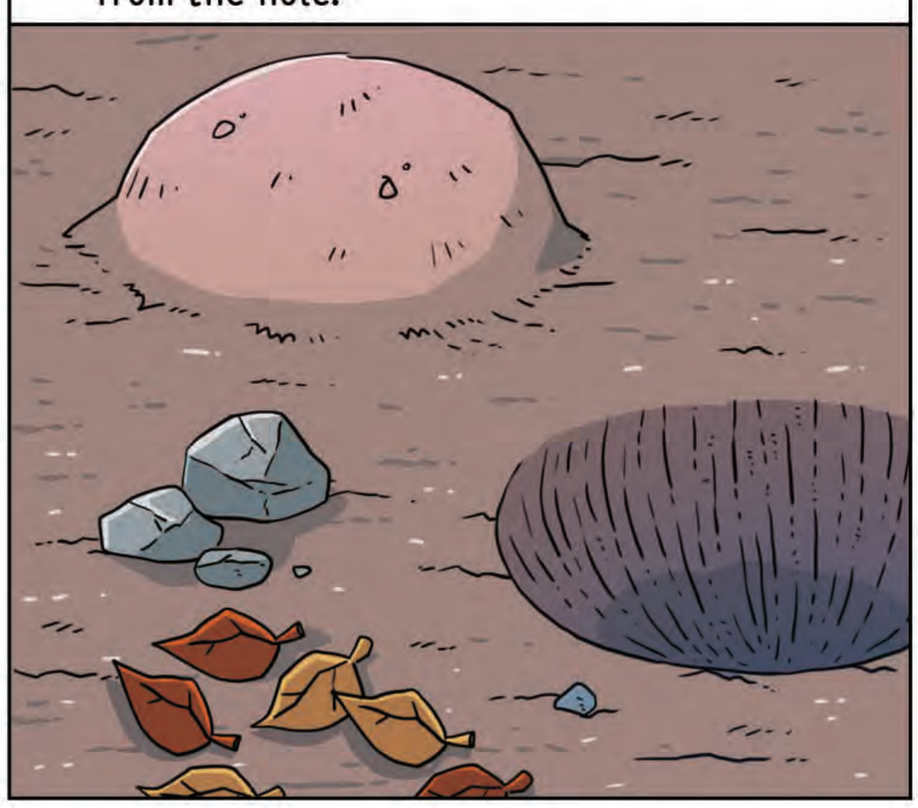
CHAPTER 02

How do trees grow and propagate?

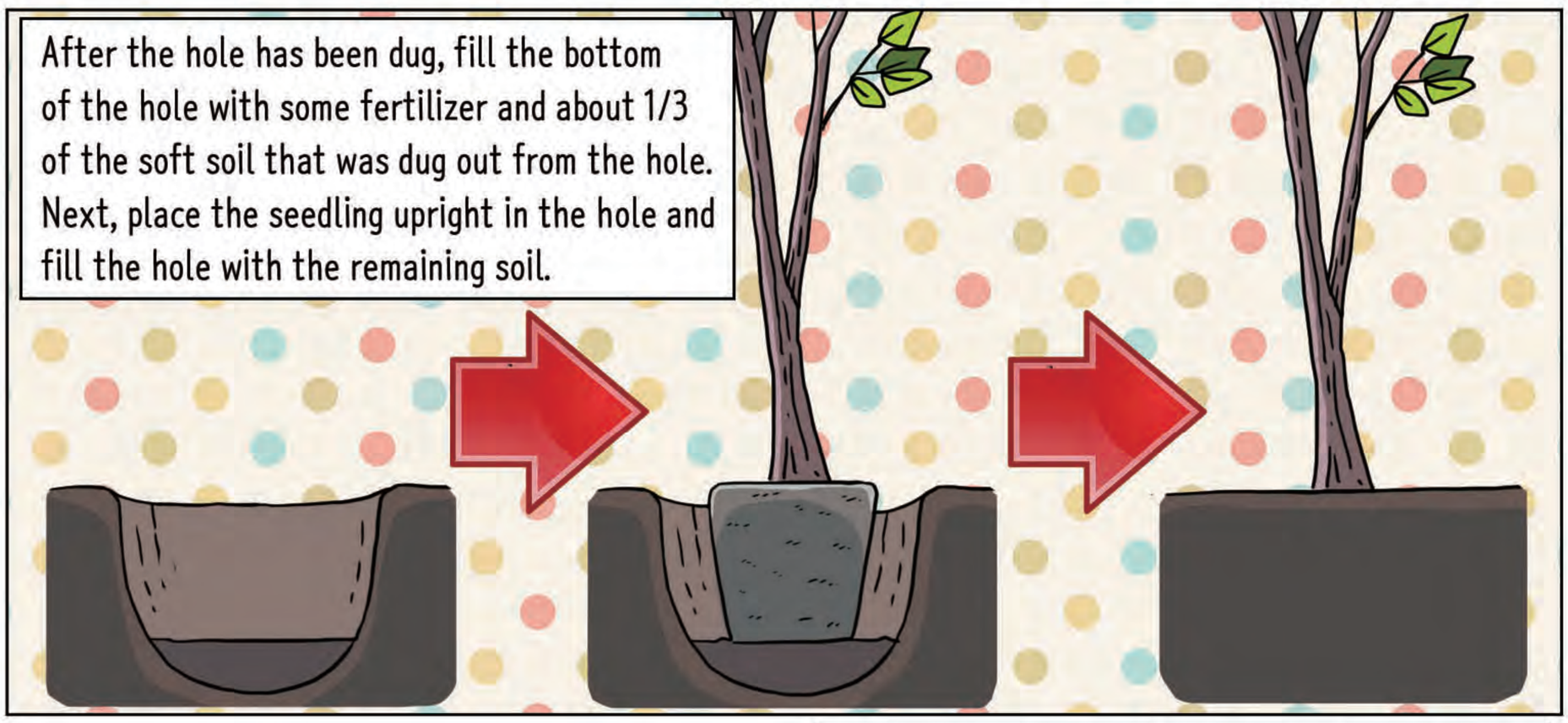
Dig a hole that is 1.5 times as large as the root ball.



Remove any large stones and dead leaves from the hole.

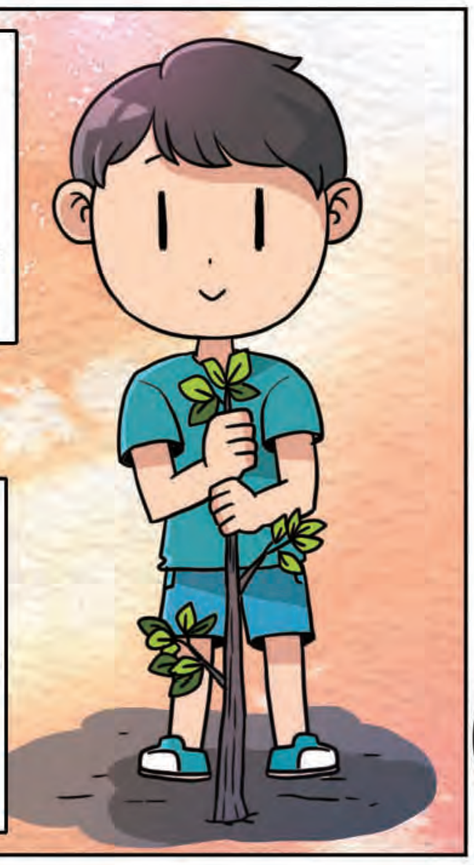


After the hole has been dug, fill the bottom of the hole with some fertilizer and about 1/3 of the soft soil that was dug out from the hole. Next, place the seedling upright in the hole and fill the hole with the remaining soil.

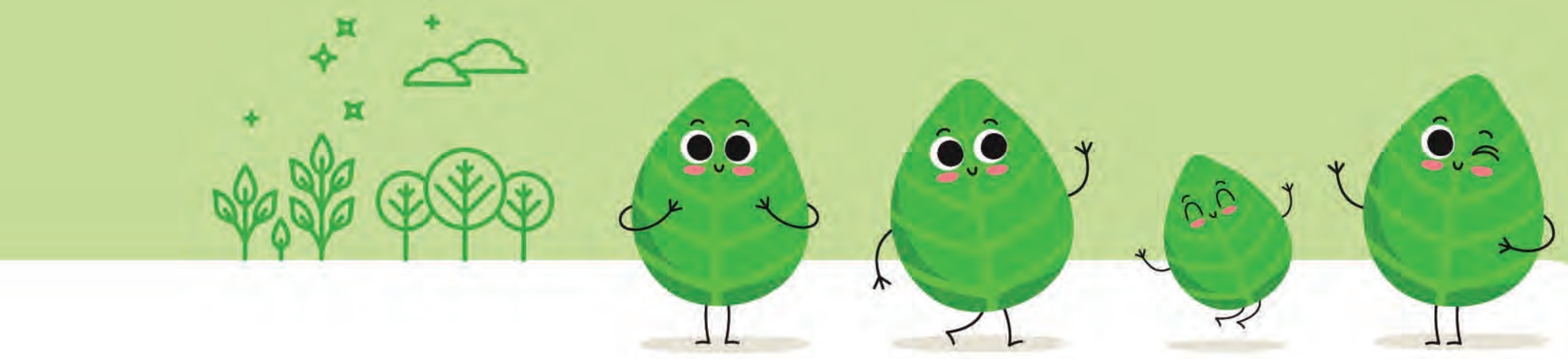


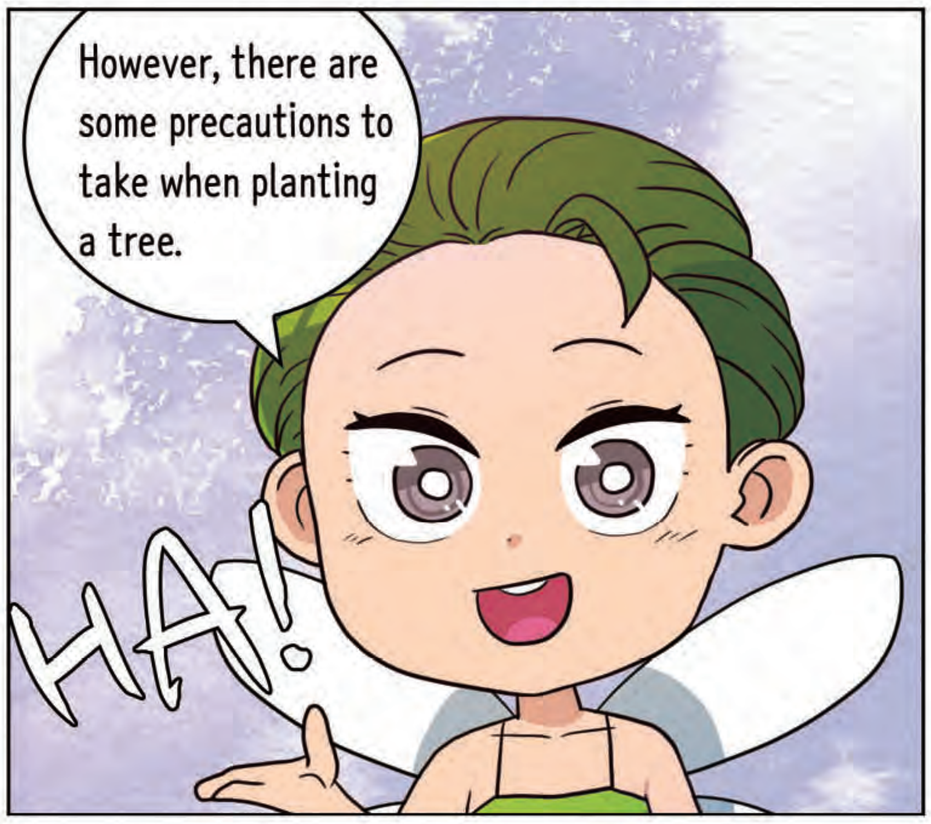
Hold the plant upright gently and step on the soil with some strength.

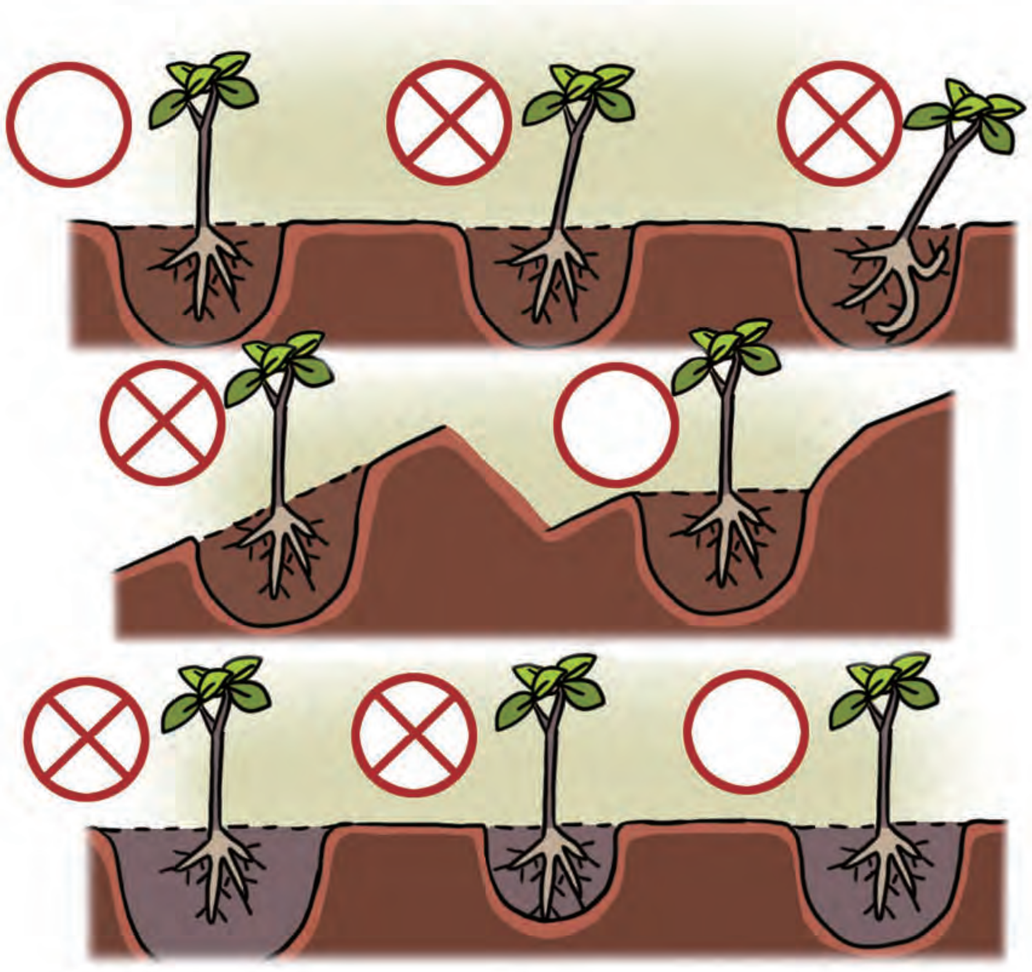
Step on or press the soil firmly around the roots to ensure stability and good soil-to-root contact.



Using too much strength when stepping on the soil removes air pockets in the soil, and the seedling will not grow well.
On the other hand, if too little strength is applied, the seedling will not be firmly secured in the soil.







TIP 1
- Make sure that both the seedling and roots are not bent
- Ensure that the hole is not too shallow and check that the roots are not lying outside of the hole

TIP 2
- When planting on a steep slope, make sure that the soil surface is not sloping but level to the ground

TIP 3
- Do not dig a hole that is too deep or too shallow

CHAPTER

02

How do trees grow and propagate?

NAME THE METHOD OF PROPAGATION!

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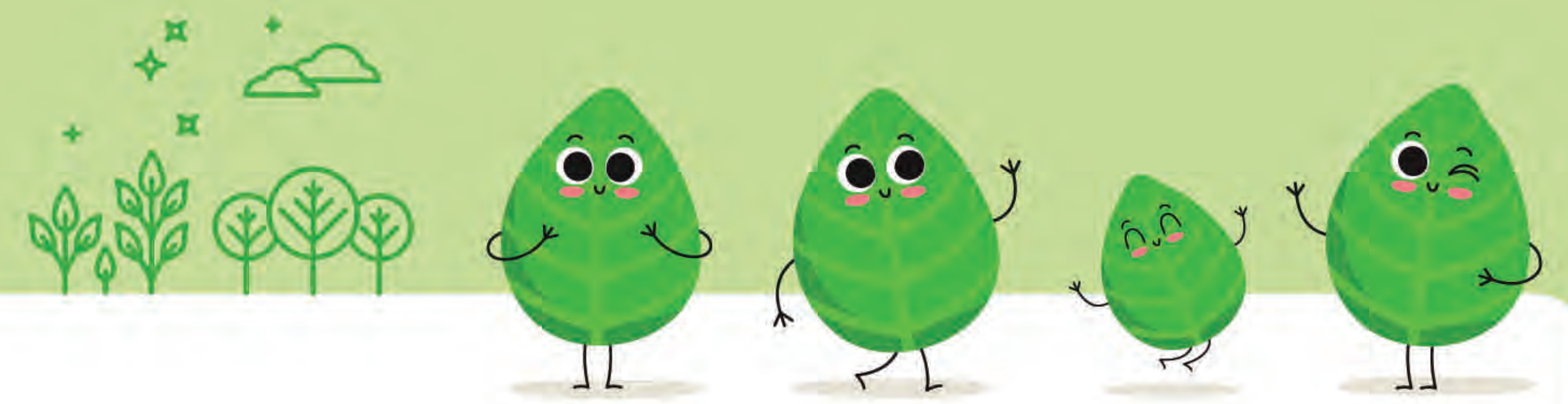
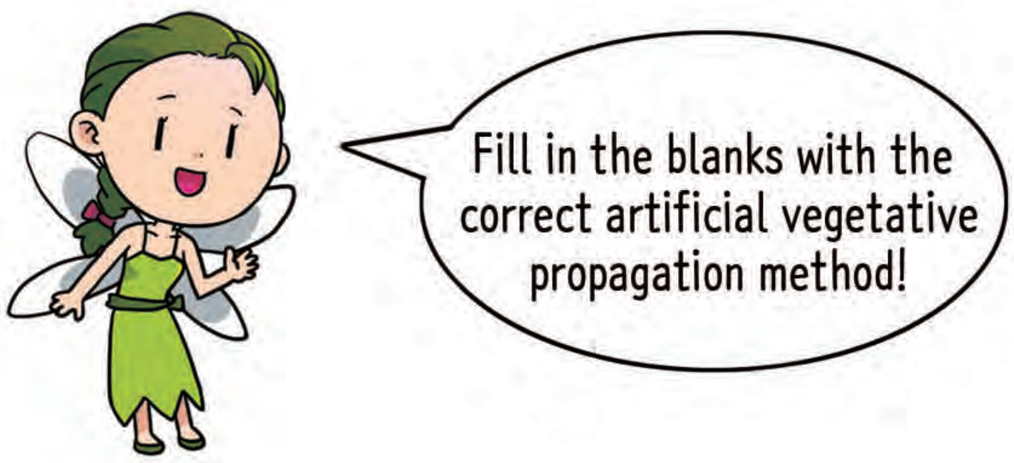
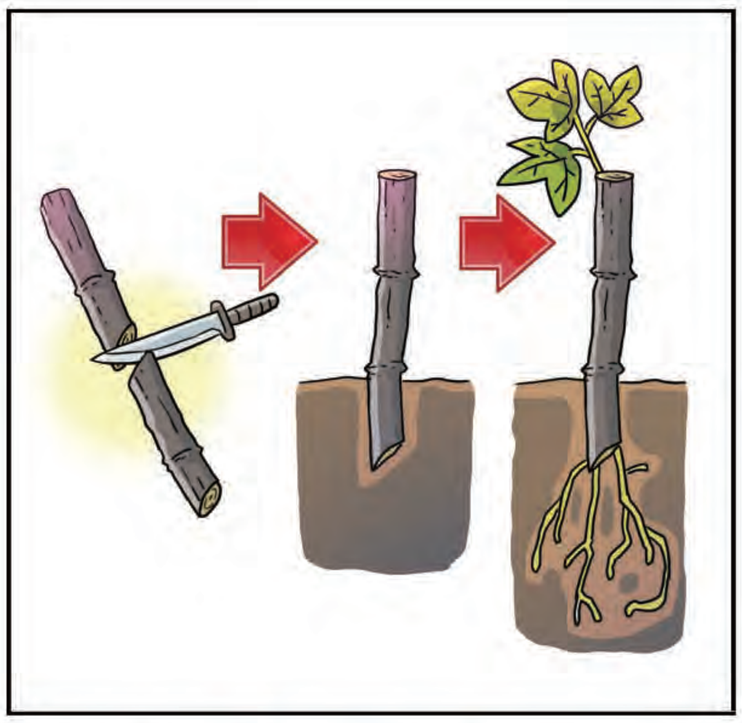
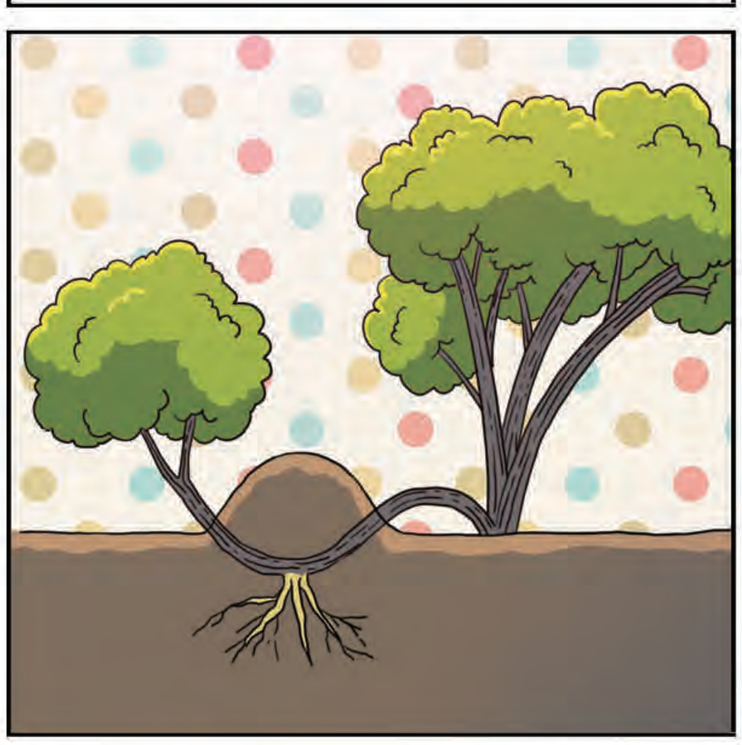






_____ is where a piece of stem is cut and planted in moist soil. The cut end produces new roots and stems and grows into a plant that is identical to the parent plant.



_____ is a means of reproducing plants by burying an intact branch or stem in soil. Once the layered stem develops new roots, it can be detached from the parent plant and planted elsewhere.

_____ involves joining the shoot system of a plant (the "scion") to the root system of another plant (the "stock"). The result is a single individual plant that has the qualities of both parent plants.

ANSWER: CUTTING, LAYERING, GRAFTING

02 CHAPTER

How do trees grow and propagate?

It is hard to think of trees as moving creatures, but they actually move very slowly. You will notice the changes if you observe a group of trees over a long period of time. Plants and trees do not truly migrate. Instead, they disperse their seeds, which can take root in new locations under suitable conditions. This form of migration is slow and is often facilitated by wind, gravity, and animals and birds that transport seeds as they move from place to place.

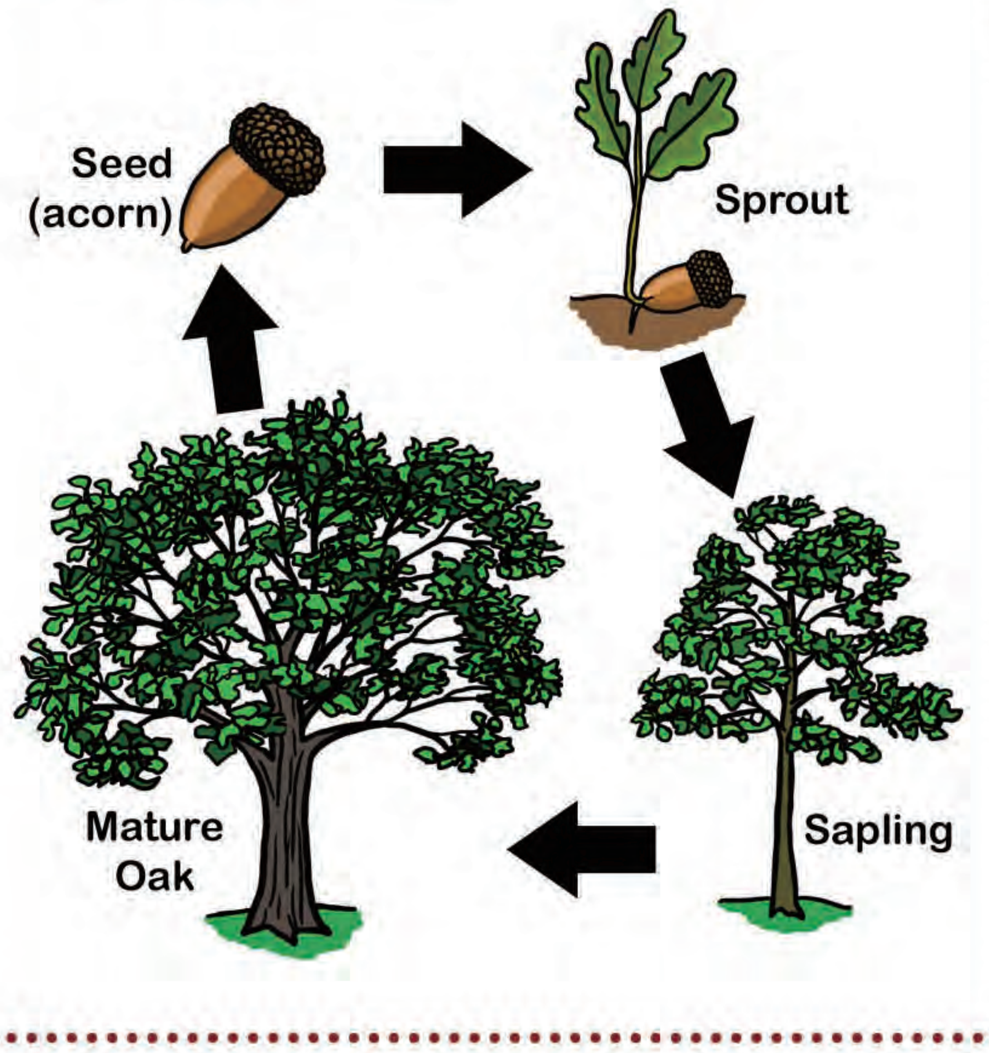
Tree migration is a natural event. However, some factors accelerate this process and put trees at risk. For example, scientists warn of the speed and adverse effects of tree migration in changing climate conditions. As trees are a key component of any ecosystem, the movement of trees will impact overall ecosystem health. We will discuss more about the relationship between forests and climate change in the last chapter.

To understand the process of tree migration better, it is important to learn about the life cycle of trees and how they propagate by dispersing their seeds.

1 Life Cycle of a Tree

The life cycle of a tree starts when a **seed** starts to grow in a process called germination. With the right amount of sunlight, water and soil, the seed grows into a **sprout**. The sprout develops a stem, roots and leaves, and it gradually grows into a **sapling**. The sapling continues growing but is unable to reproduce at this stage. Finally, it reaches the adult stage and becomes a **mature tree**. The tree is now fully grown and can grow seeds, fruits or nuts for reproduction. When the new seeds are planted, the life cycle of the tree repeats. Eventually, the tree approaches the last stage of its life – it dies and becomes a **snag**.

Life Cycle of an Oak Tree



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2 Propagation by Seed Dispersal

Trees have a reproductive system consisting of flowers, fruits and seeds. Every tree has a different flowering period, but after a flower blooms and wilts, a fruit containing seeds grows in its place. Trees cannot move from place to place as they are rooted to the ground. Hence, they disperse their seeds far and wide through a variety of ways. The dispersal of seeds is very important for the survival of a tree species. If trees and seedlings grow too closely together, they have to compete for sunlight, space, water and nutrients. Dispersing seeds as far as possible increases the seedlings' chances of survival. Seeds are typically dispersed by wind, gravity, animals or water.

■ DISPERSAL BY WIND

After the petals of the dandelion flower fall off, a puffy, white seed head grows from its base. The dandelion seeds have light, feathery bristles that allow them to float away in the **wind**. Each dandelion seed is attached to about 100 feathery bristles (pappus). This structure helps the seed to stay afloat in the air for a longer time by functioning like a parachute. Without these feathery bristles, the seed would fall to the ground near the spot where the flower bloomed. The seeds of trees such as the red pine, maple tree and ash tree bear wings that twirl and spin through the air before falling to the ground (propeller seeds).

Dandelion seeds & Maple tree seeds

02 CHAPTER

How do trees grow and propagate?

■ DISPERSAL BY GRAVITY

Fruits of trees such as oak, walnut and chestnut that fall to the ground by **gravity** are picked up by animals such as squirrels and carried to other places. These seeds may also sprout where they have fallen and grow near their parent trees.

■ DISPERSAL BY ANIMALS

Many flowering trees and plants use animals, birds or insects to carry seeds around. These seeds may have handy hooks that attach to an animal's fur or a bird's feathers. Spanish needles, for instance, have needle-like seeds with two to six barbed hooks at the end. Alternatively, plants might develop tasty fruits to encourage animals to eat them and thereby aid in the propagation process.

Spanish needles / Spanish needles clinging onto clothing / A bird eating a seed

■ DISPERSAL BY WATER

Seed dispersal by water is possible due to the presence of air pockets in a fruit, which allows it to float on water for a long time. The seeds of palm trees, poison bulbs and golden rain trees are light and can stay afloat in water easily. They also have thick shells that prevent decay. In Korea, the golden rain trees along the coast of Anmyeondo and the crinum lilies endemic to Jeju's Rabbit Island are examples of plants that disperse their seeds by water.

■ DISPERSAL BY SPLITTING/EXPLOSIVE ACTION

Some plants, such as peas and flax, disperse their seeds by violently ejecting them away from the parent plant. These plants typically have pod-like structures that dry out and split open when the fruit is ripe. The explosive splitting results in the seeds being dispersed around the parent plant.

CHAPTER

03

How do we care for our forests?

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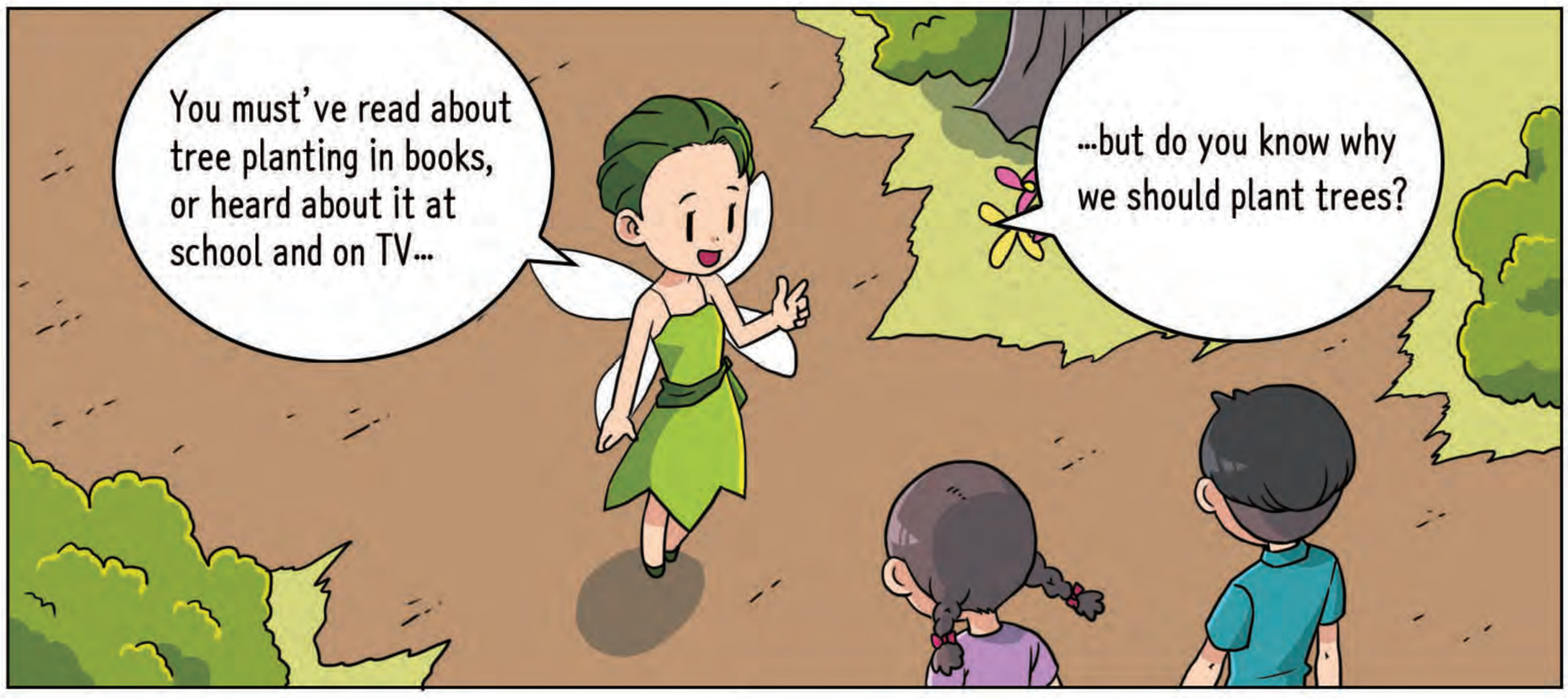
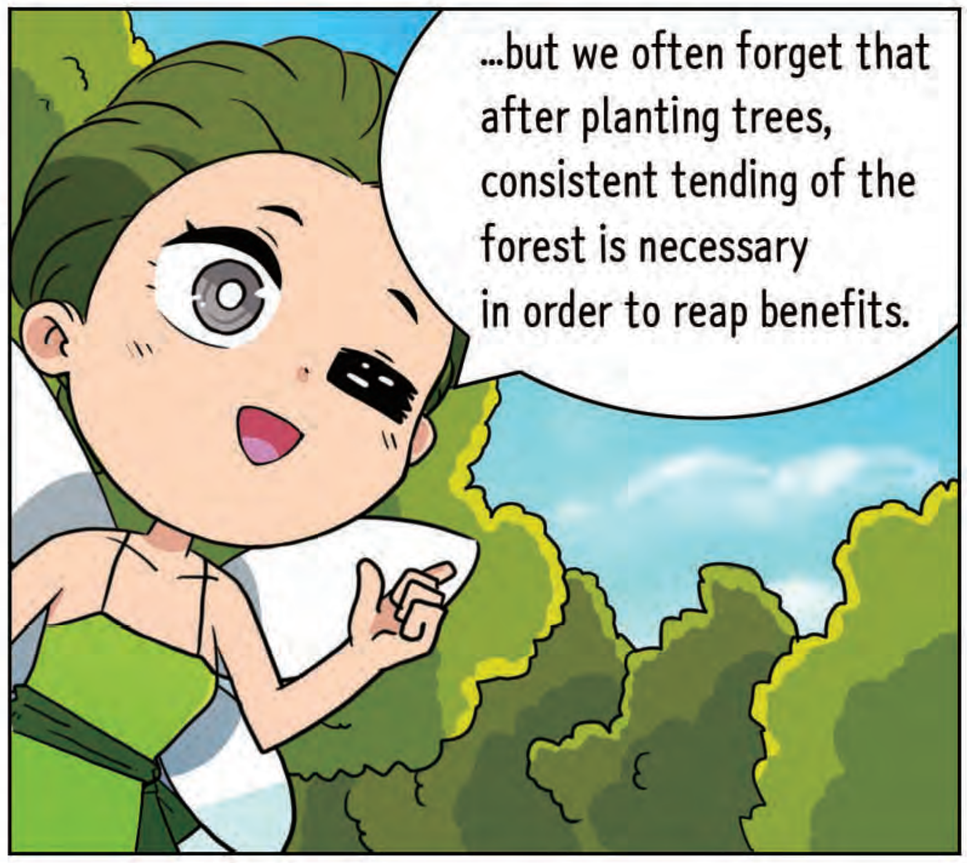
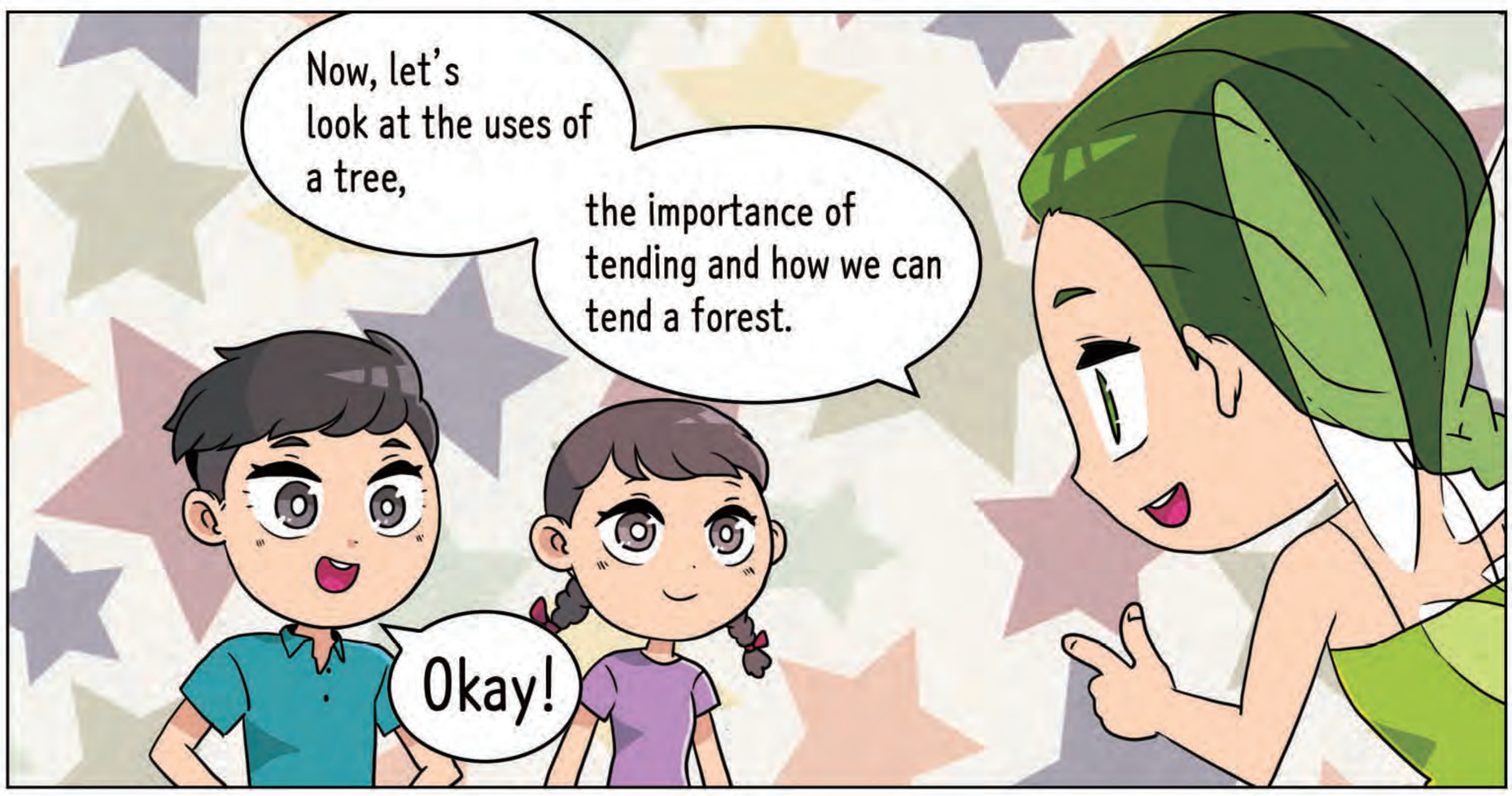
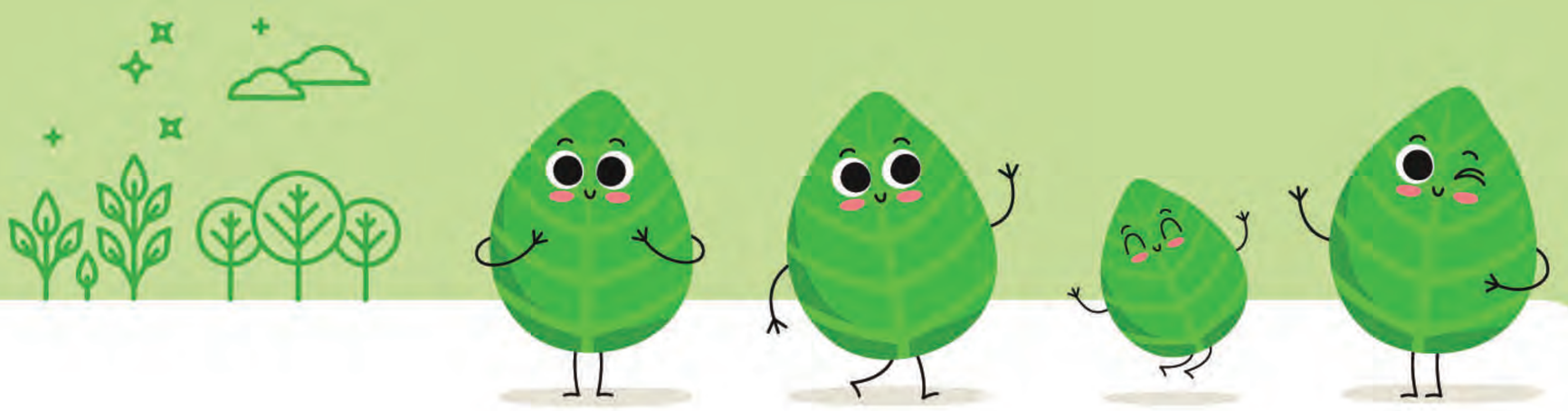
CHAPTER 03

How do we care for our forests?





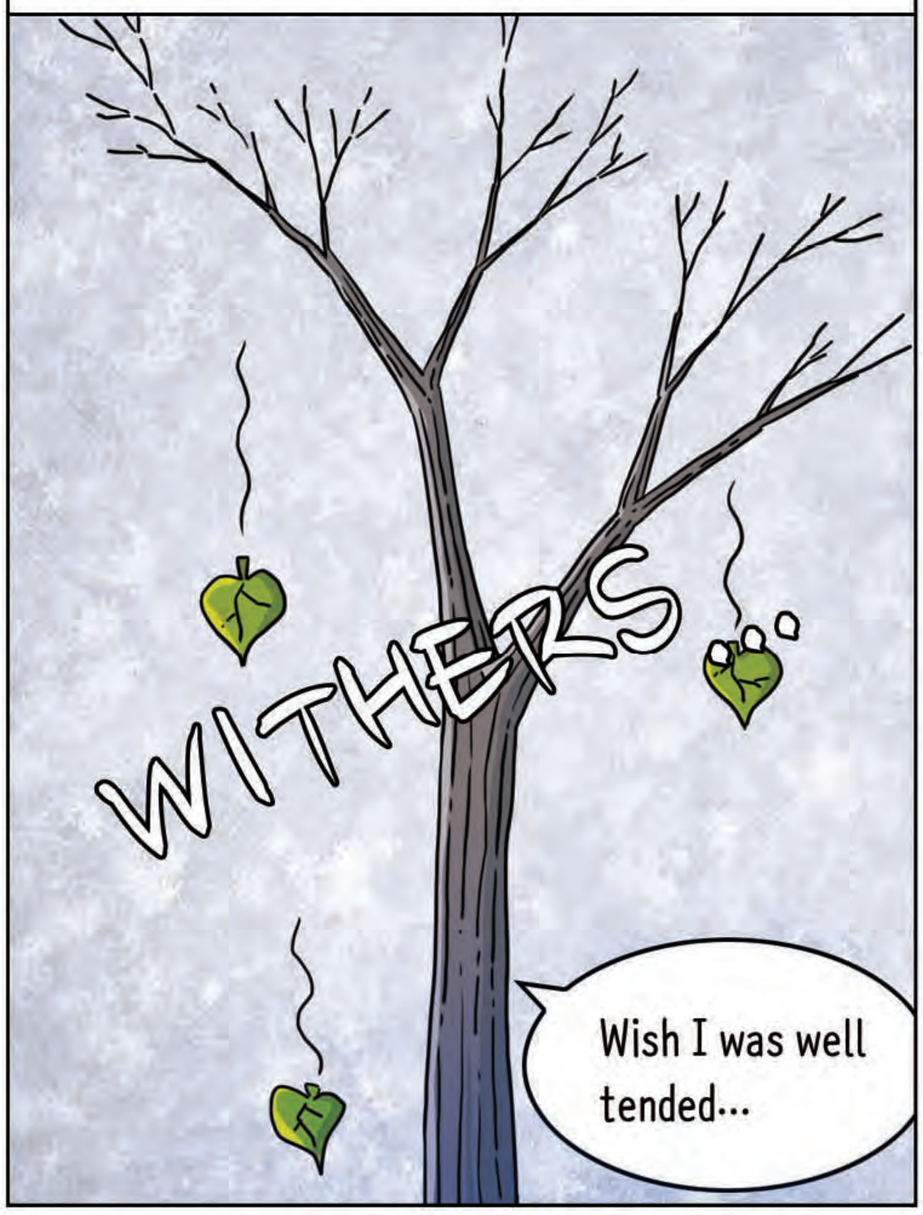




Forest tending is a set of tasks that are performed to stimulate healthy forest growth and improve tree form and wood quality.

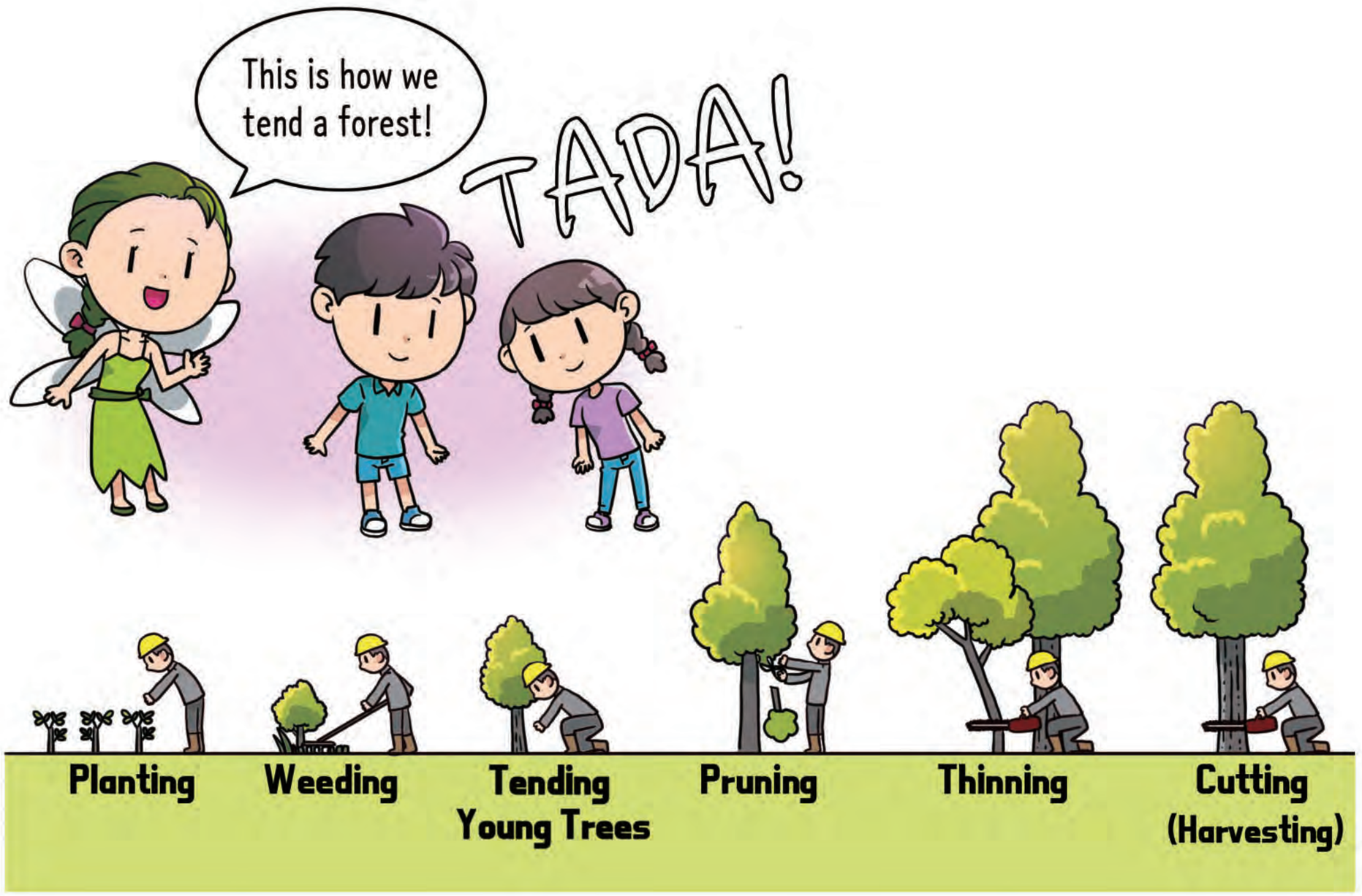
Operations like pruning, tending of young trees, thinning and tending of a natural forest can enhance the economic and environmental value of a forest.

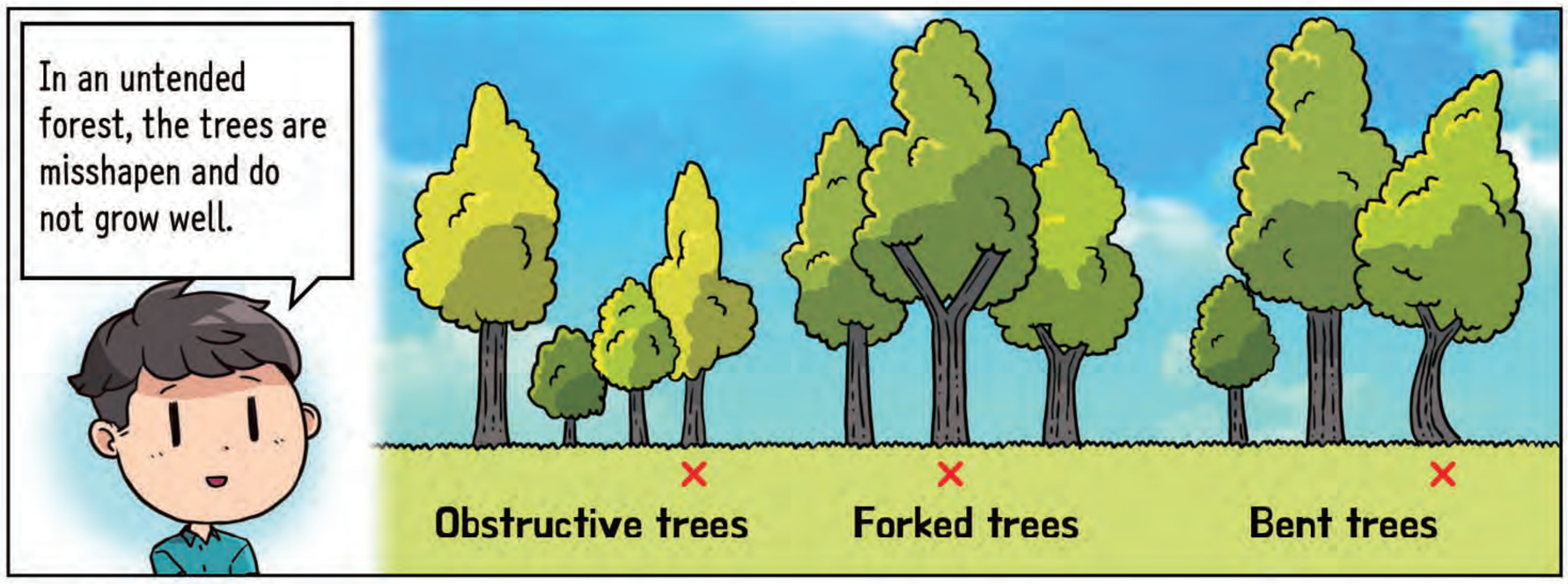
A forest that has not been tended or which has missed the optimal tending time is vulnerable to natural disasters such as forest fires and typhoons, as well as pests and diseases. A poorly or improperly managed forest loses its value.

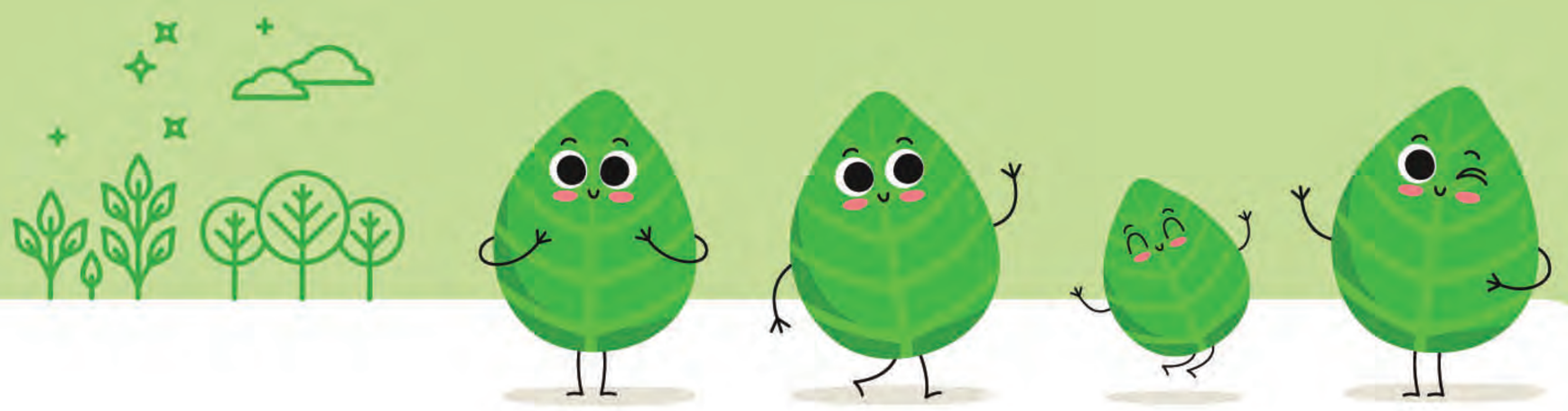


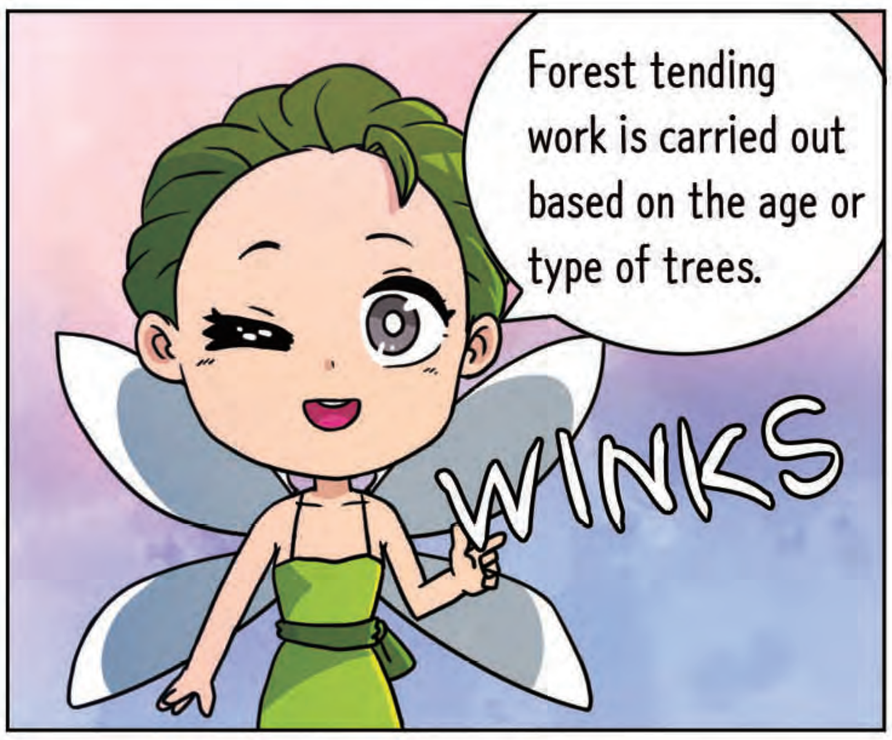
CHAPTER 03

How do we care for our forests?

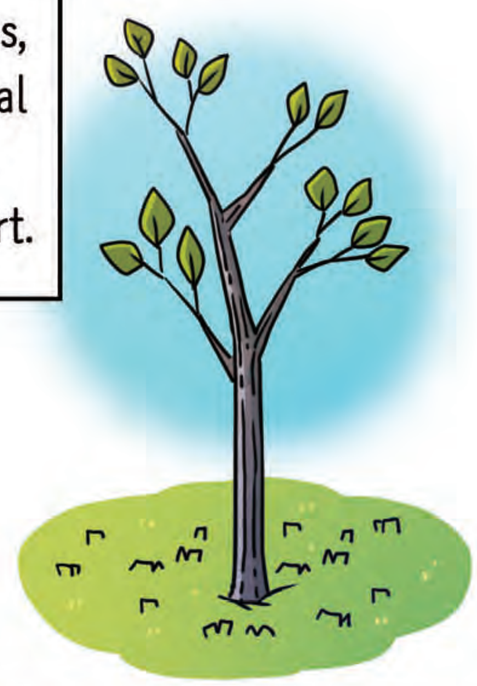




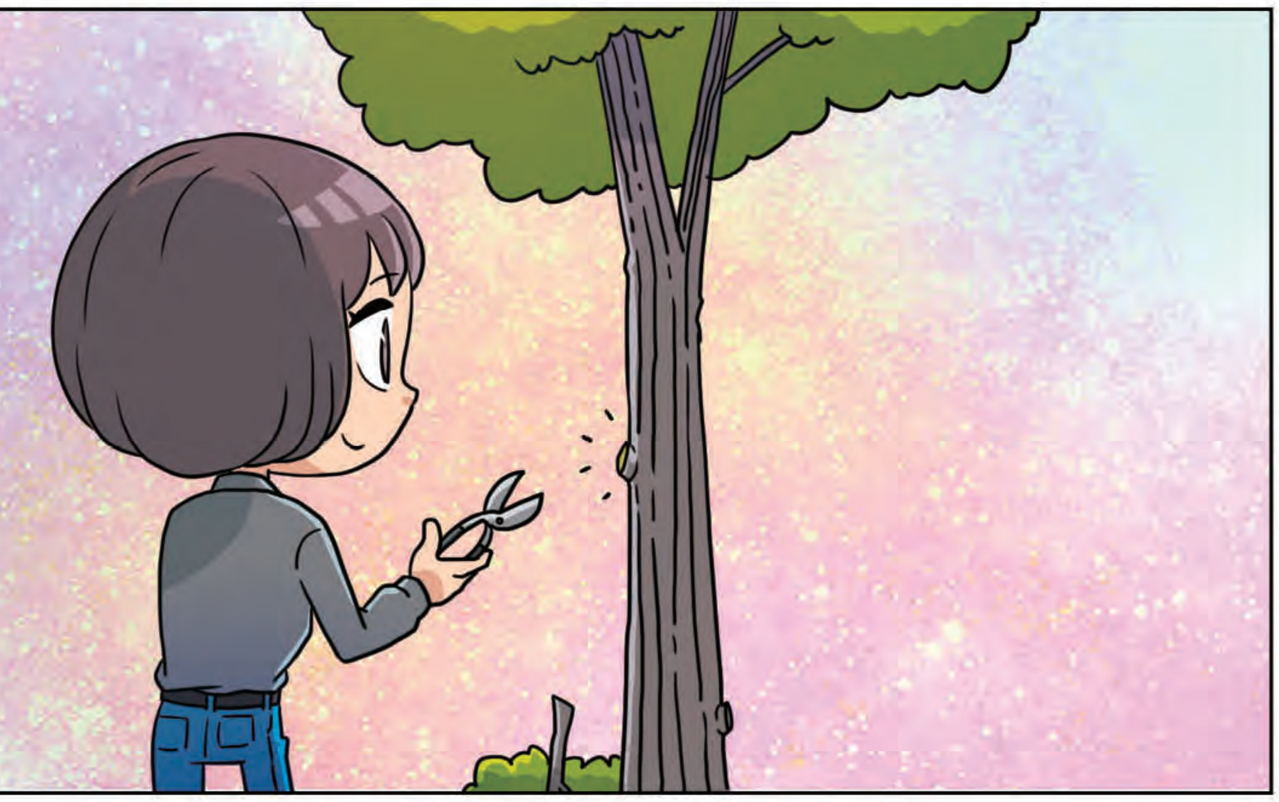




After planting the trees, weeding and the removal of vines can help them grow well from the start.

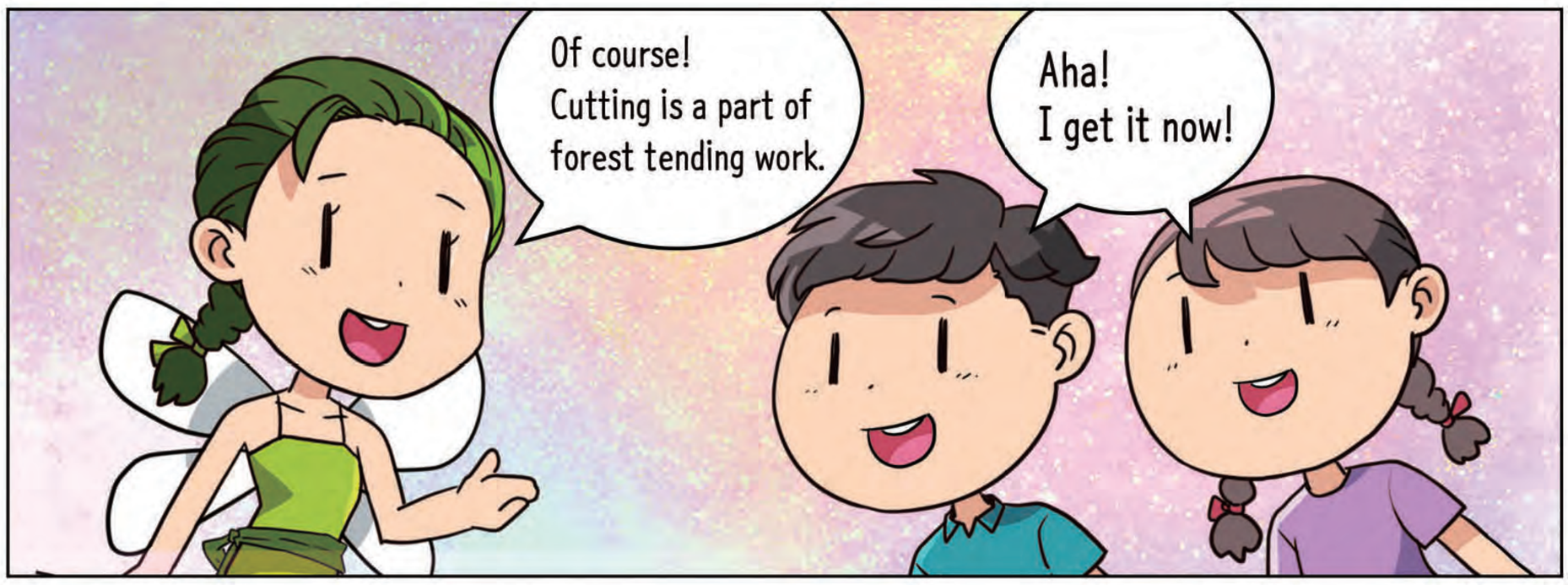


Pruning and thinning have to be done when a tree has grown to a certain height and its branches start intertwining with those of neighboring trees, obstructing their growth.

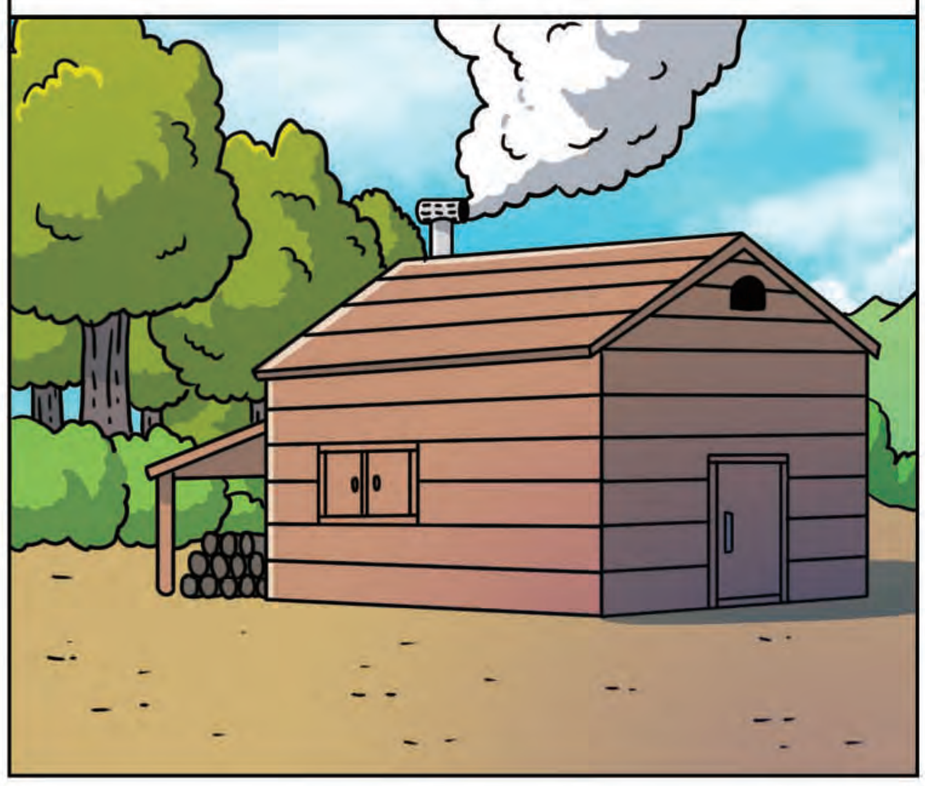


CHAPTER 03

How do we care for our forests?

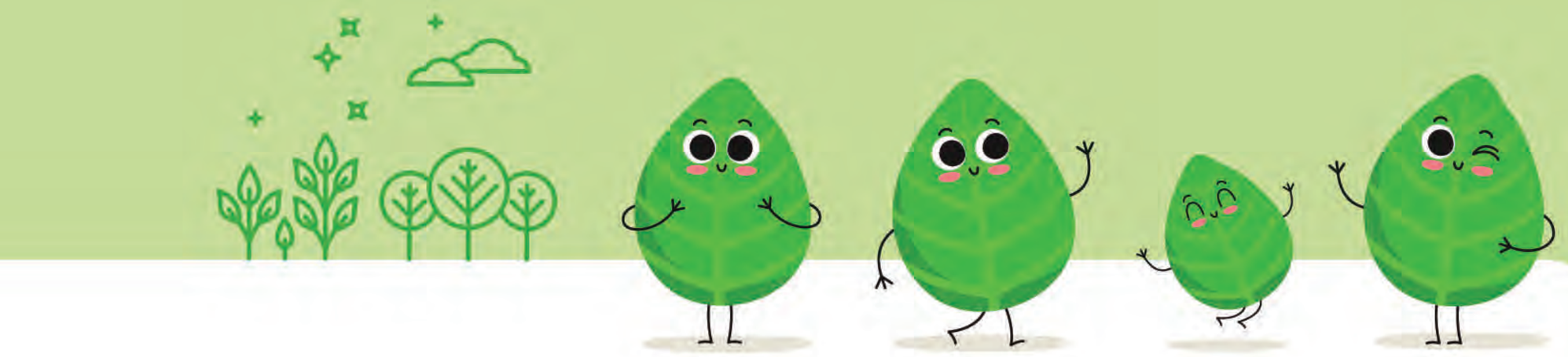


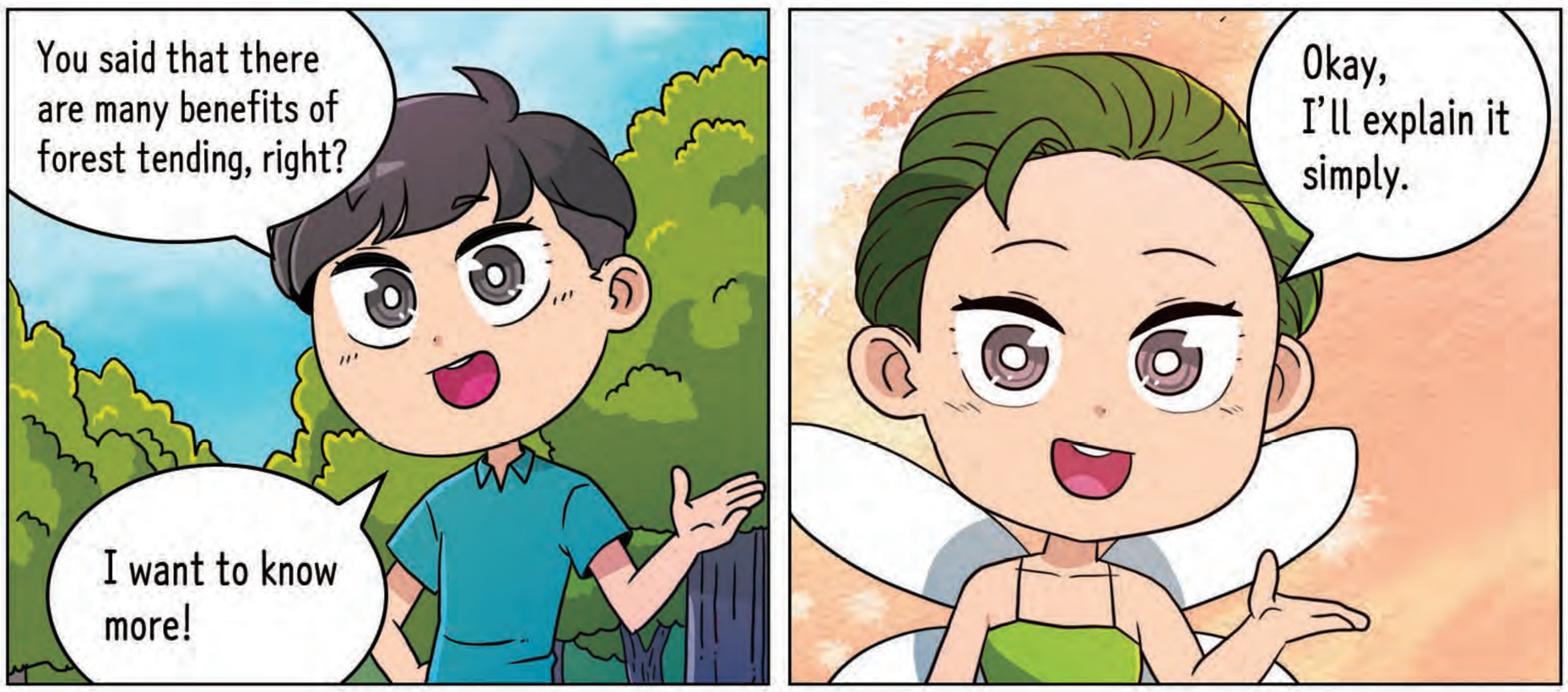
By cutting, we can make use of the wood to build houses or make furniture.



After cutting, sunlight is able to reach the space where the cut tree used to be, and various trees and plants can grow in its place.

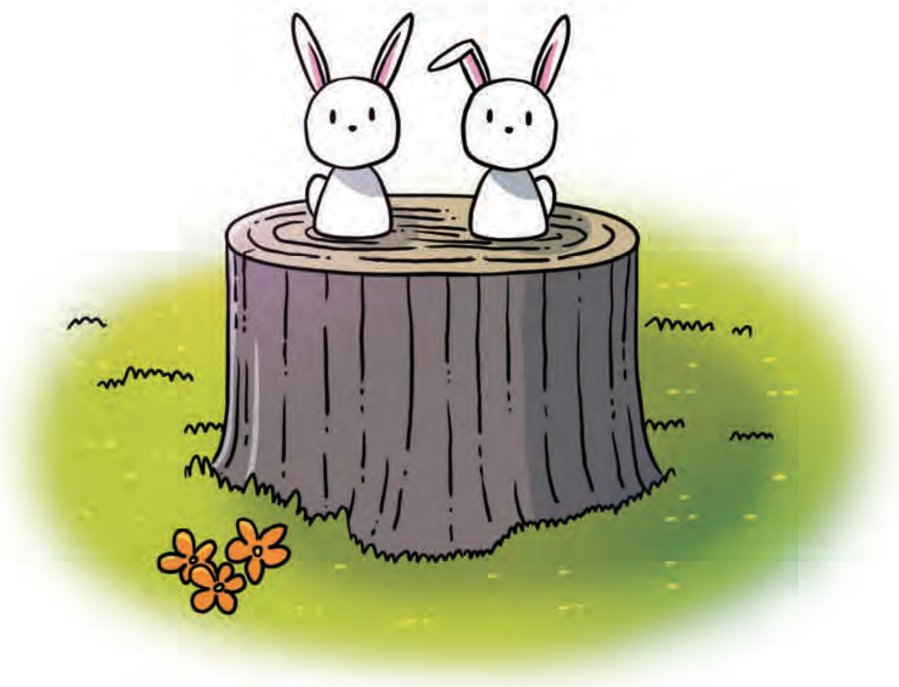
A tree should also be cut if it is dying or if it poses a hazard to people.





1. The ecological health of the forest is enhanced.

Thinning exposes smaller trees and shrubs in the forest to sunlight and helps them grow healthily, thereby making the forest a good place for animals and plants to live in.



2. The economic value of the forest is increased.

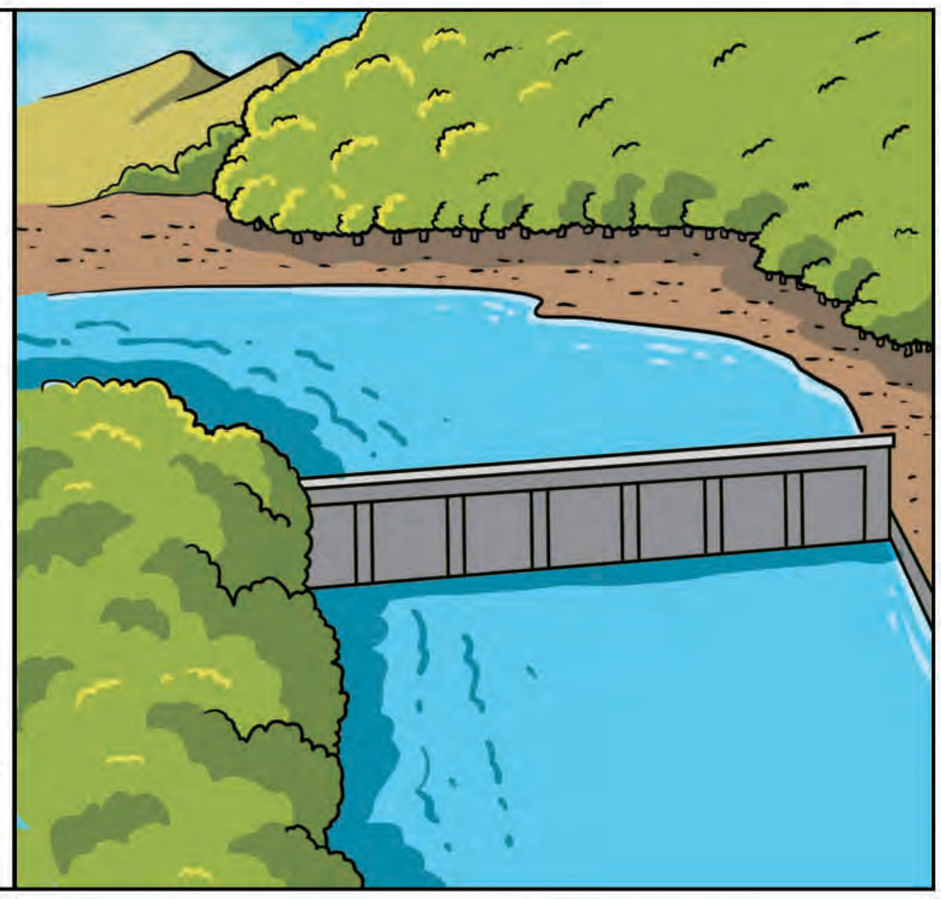
Without tending, tree branches tend to grow upwards to get more sunlight, and the tree resembles the shape of a stick.
Thinning, which is the process of removing unhealthy and unproductive trees to create space for the healthier trees, helps the remaining trees to grow better.

CHAPTER 03

How do we care for our forests?

3. Forests can protect watersheds and generate clean drinking water better.

The ability of a forest to store water in its soil and root systems is increased by 20-30% in a well-tended forest, and the flood control and water purification functions of the forest are also enhanced.

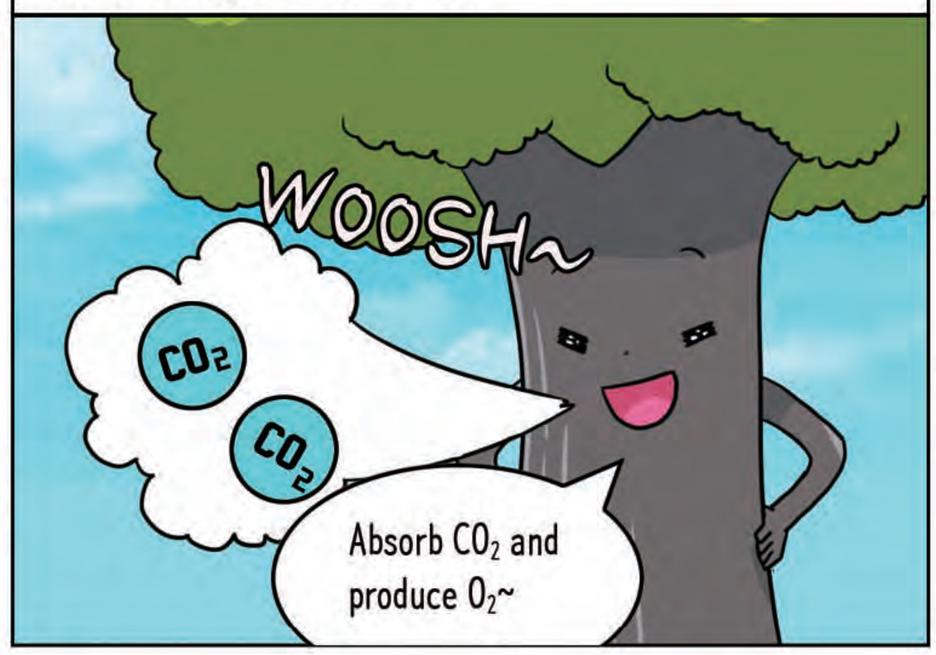


4. Landslides and other flood damages can be prevented.

Tending helps in the development of tree roots. Root systems beneath the ground hold onto the surrounding soil, preventing soil particles from being washed away.

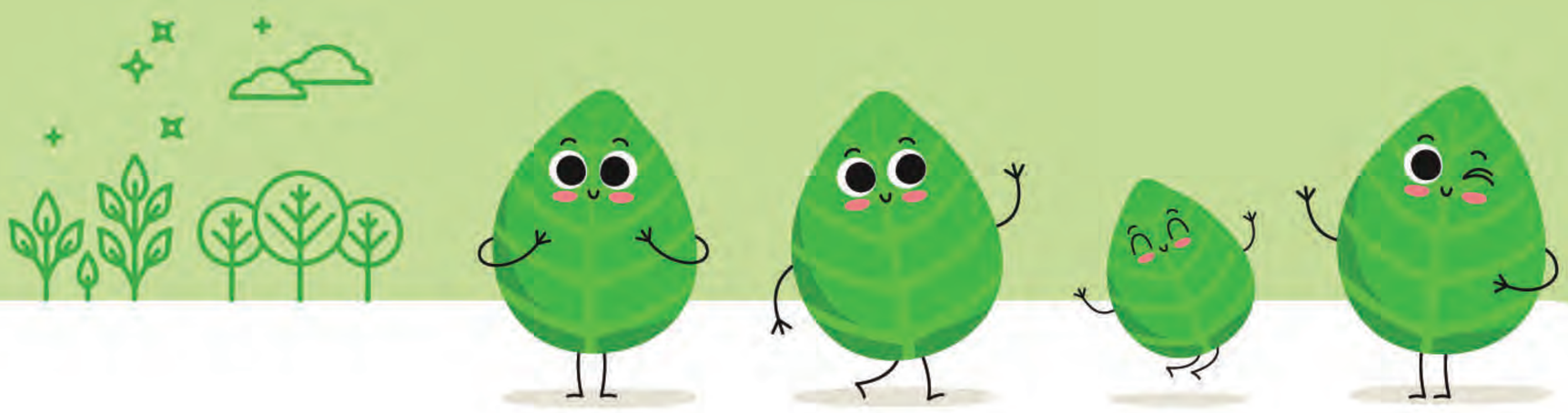
5. The forest's ability to absorb carbon dioxide is enhanced.

Forest tending makes trees healthier, increasing their ability to absorb carbon dioxide by about 20%.



6. The products of forest tending can be reused.

Cut trees from tending work are used as valuable resources like industrial materials, sawdust and firewood.



There are many other tending operations such as disease and pest control, as well as the planting of superior trees!

Wow! The tending of forests is really important!

PSSS!

We need to think beyond the simple idea of just planting trees.

HEHE!

Moreover, we need to think about how to tend and make use of the planted trees.

This can broaden our perspectives and allow us to gain more insight on the importance of forests.

Next, let me tell you about the role of forests.

TADAA~

CHAPTER
03

How do we care for our forests?

LOOK FOR THE TREES THAT NEED TENDING!

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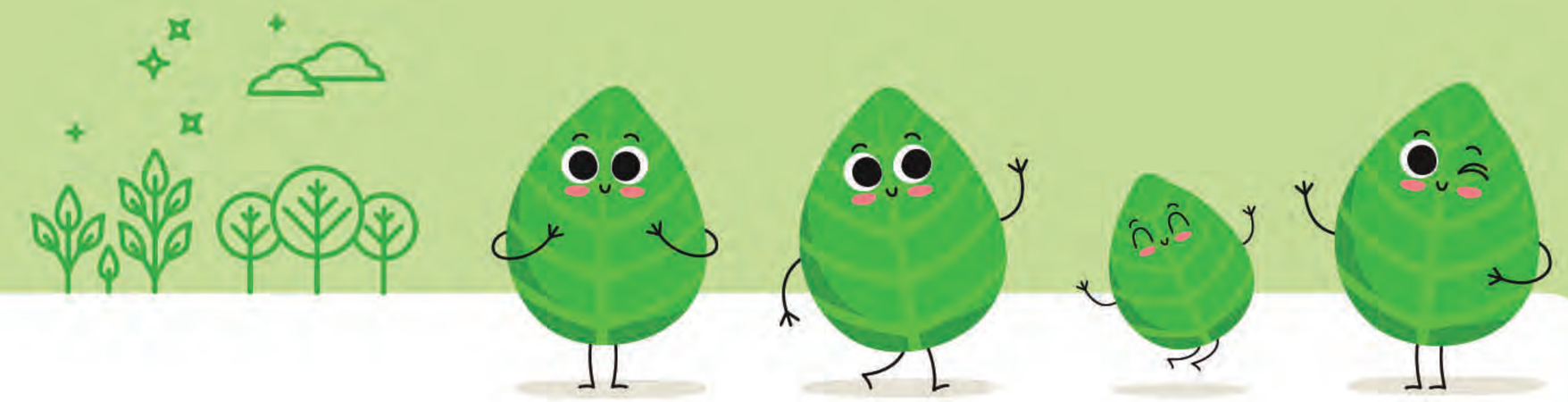


Obstructive trees/ Forked trees / Slanted trees

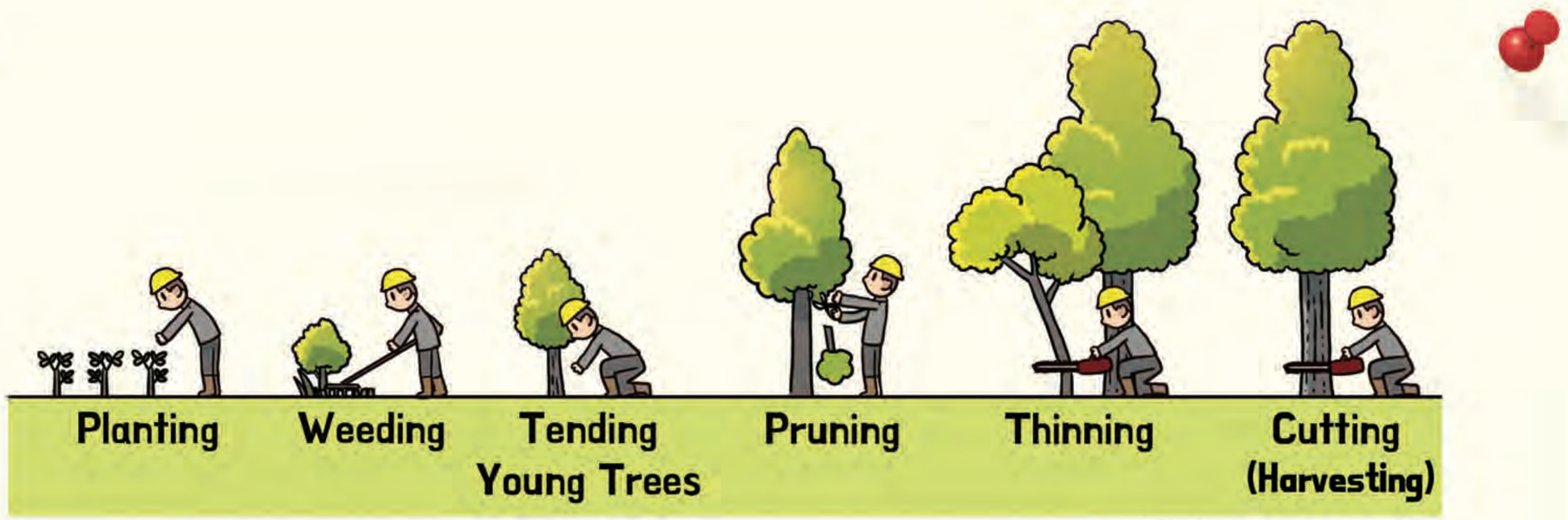
CHAPTER 03

How do we care for our forests?

Today's forests are quite different from the old-growth forests that had little or no human influence except for some natural disturbances such as fires and pests. As our forests now face a great deal of threats from development and other economic purposes, we need to care for and maintain the health of our forests so they can grow beautifully and continue to provide benefits and ecosystem services. We call the process of caring for our forests "tending." In this chapter, we will learn about the various forest tending operations and how they are done.

1 Forest Tending

Forest tending work refers to the tasks that are carried out after planting to cultivate and nurture forest stands so that plantation forests and natural forests can grow healthily with trees of good form and quality. Tending operations such as pruning, thinning and improvement cutting are carried out at different stages of growth in order to provide a healthy environment for tree development. However, unmanaged or mismanaged forests are vulnerable to natural disasters such as forest fires, pests and typhoons that will eventually reduce the economic and environmental value of the forests.



(Refer to page 38)

■ WEEDING

After you plant trees, you should remove or cut back any weeds and shrubs that may interfere with the growth of planted trees. Weeding may be controlled through mechanical, biological or chemical methods.

■ TENDING OF YOUNG TREES

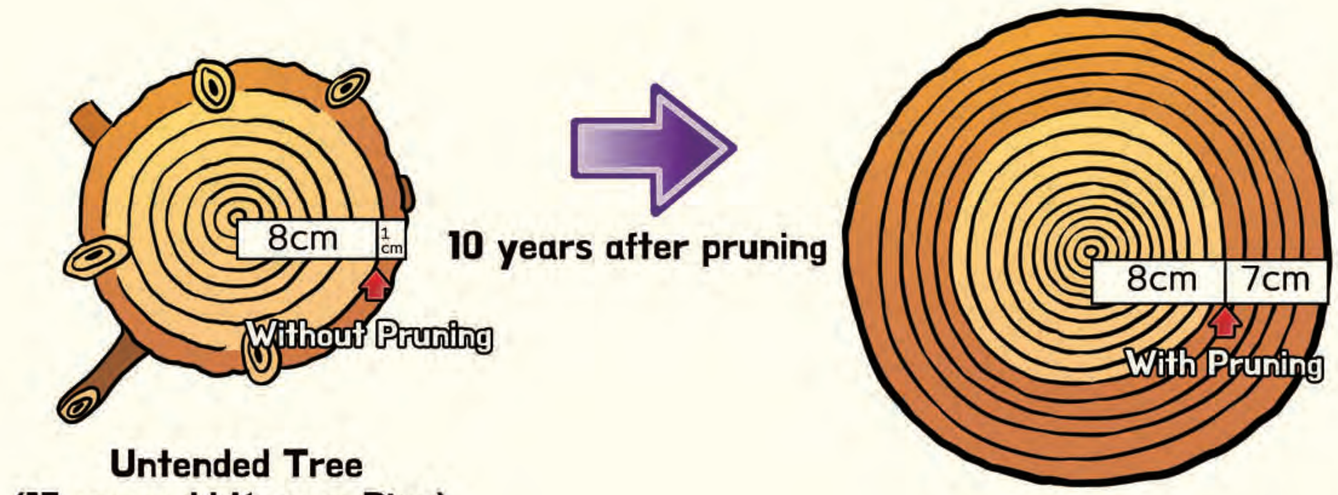
Young trees are monitored and underdeveloped trees are cut down to help promote the growth of other healthy trees.

PRUNING

Pruning is a practice that involves the selective removal of certain parts of a tree, such as branches, buds or roots. For instance, landscape trees are pruned from the seedling stage to ensure that the tree grows to form the desired shape.

What are knots and how are they formed?

A knot in a tree is a common defect or blemish that leads to the formation of a lump or hole within the tree trunk. Knots are usually caused by the natural growth of the tree.



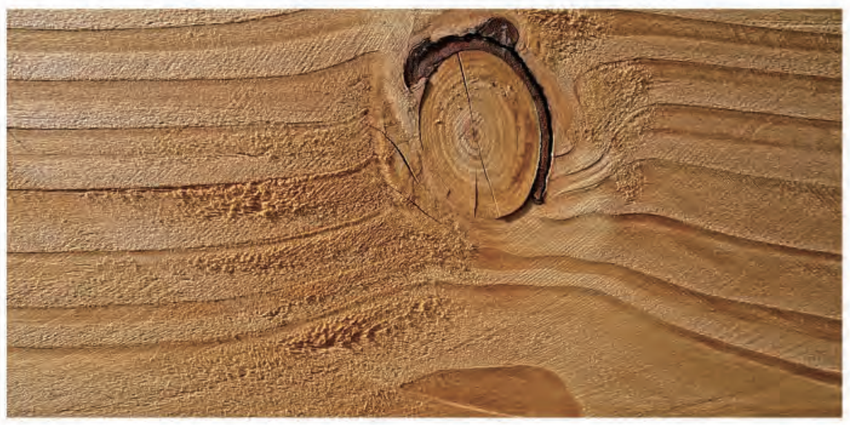
Untended Tree
(15-year-old Korean Pine)

Tended Tree
(25-year-old Korean Pine)

As the tree grows taller, the crown blocks sunlight from reaching the older and lower branches. The leaves on the lower branches fall off, and the branches tend to die off. The bases of the dead branches may become enclosed and buried by the growing wood of the trunk. This leads to the formation of knots, which are imperfections in a tree trunk.

In general, pruning can help produce trees of higher quality timber with fewer knots as compared to trees grown without pruning. Cutting off lower branches and growing shoots can help get rid of possible knots. Wood that is knot-free is sturdier and has a higher value. On the other hand, though knots are generally not a good characteristic of wood, they are useful in creating unique designs and patterns.

Wood knots add to the aesthetic appeal of wooden furniture.



CHAPTER 03

How do we care for our forests?

■ THINNING

Thinning is the selective felling of trees (usually the smaller, weaker and poor quality trees) to provide more living space and improve the growth rate of the remaining higher quality trees. Thinning lowers the density of forests and results in high value forest stands with trees that have thick and straight trunks.

Thinning should be carried out carefully because removing too few trees results in a forest consisting of many smaller diameter trees of limited timber value. On the other hand, removing too many trees allows sunlight to shine through the canopy, resulting in the growth of heavy branches and the formation of knots. This reduces the wood quality and the range of uses of the wood.

Overgrown Forest

Before thinning, the forest is overgrown with trees of different sizes. The forest floor is densely covered with shrubs, bushes and debris. Competition for light and nutrients is fierce.

Thinned Forest

Thinning involves the removal of smaller or diseased trees to improve the growth rate or health of the remaining trees. This results in a forest with large trees and spaces in between.

Source: The Nature Conservancy (2018)

CHAPTER

04

Why are forests important to us?

AFoCO
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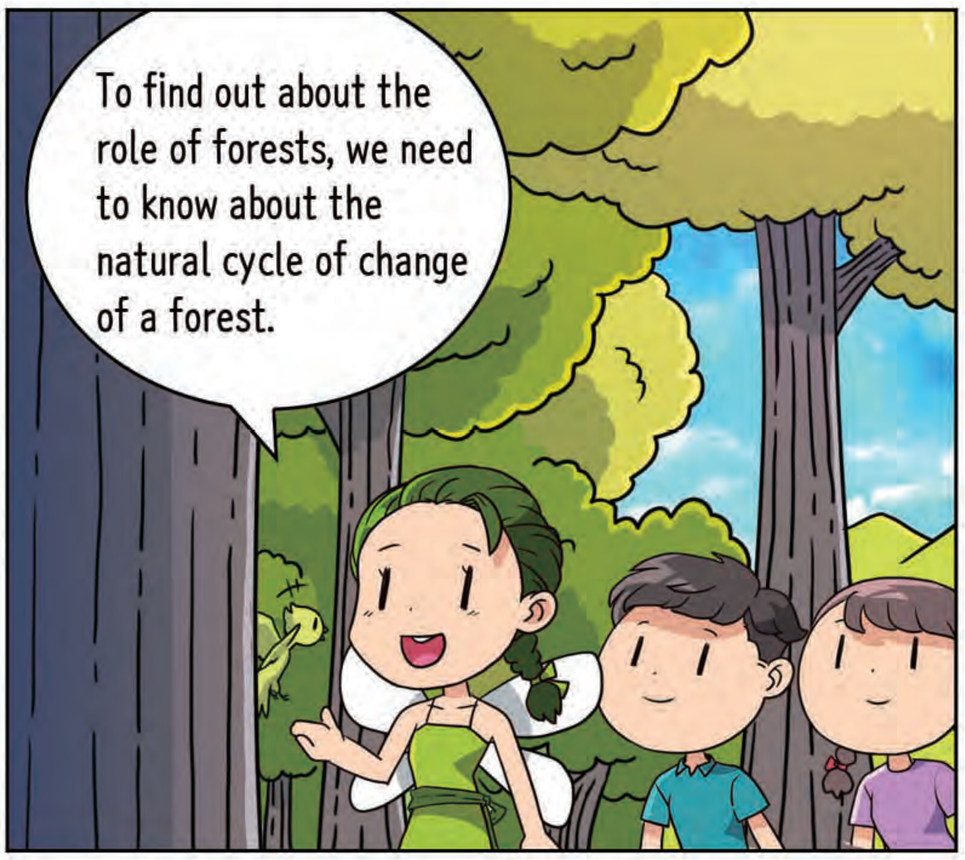
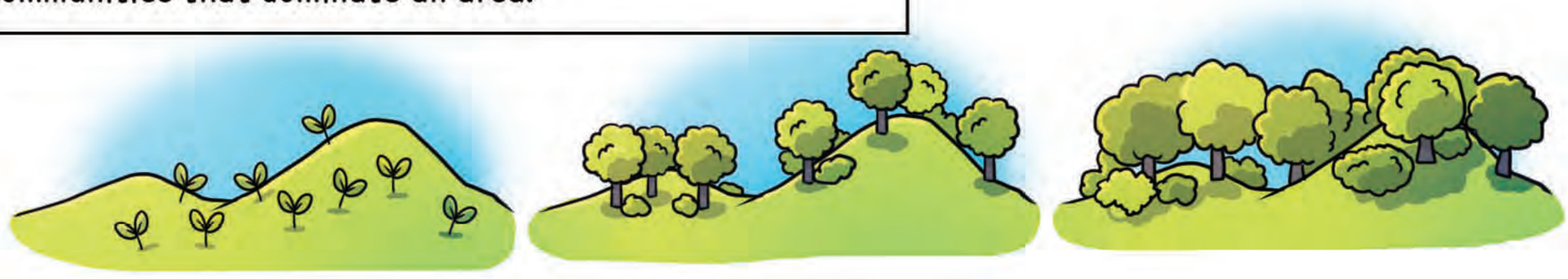
CHAPTER 04

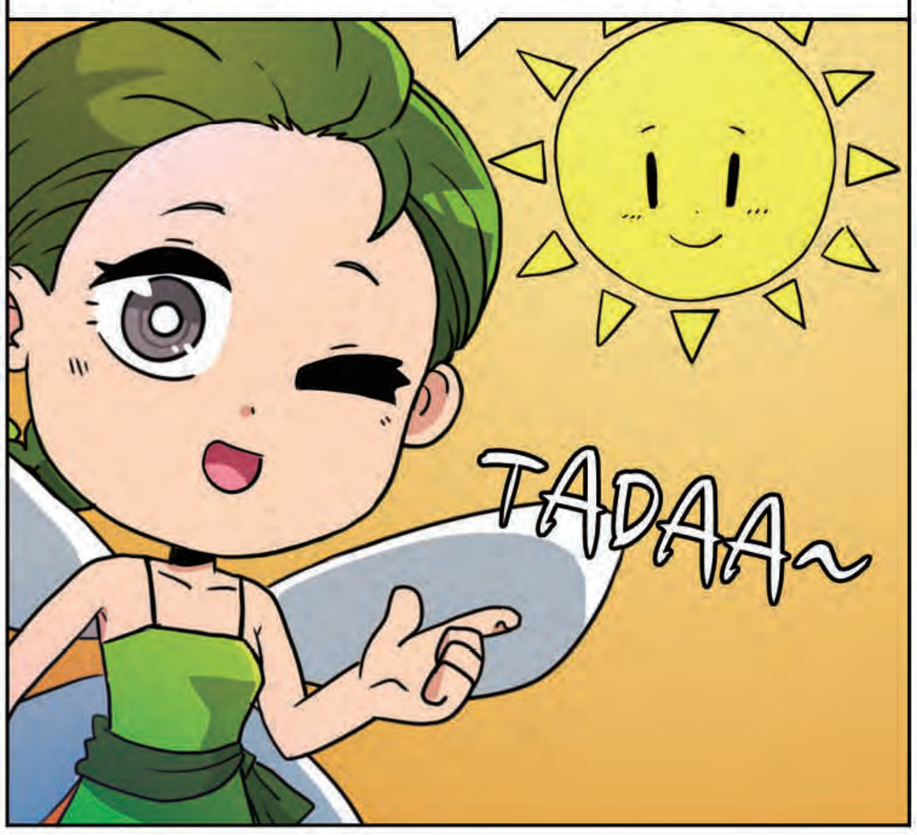
Why are forests important to us?



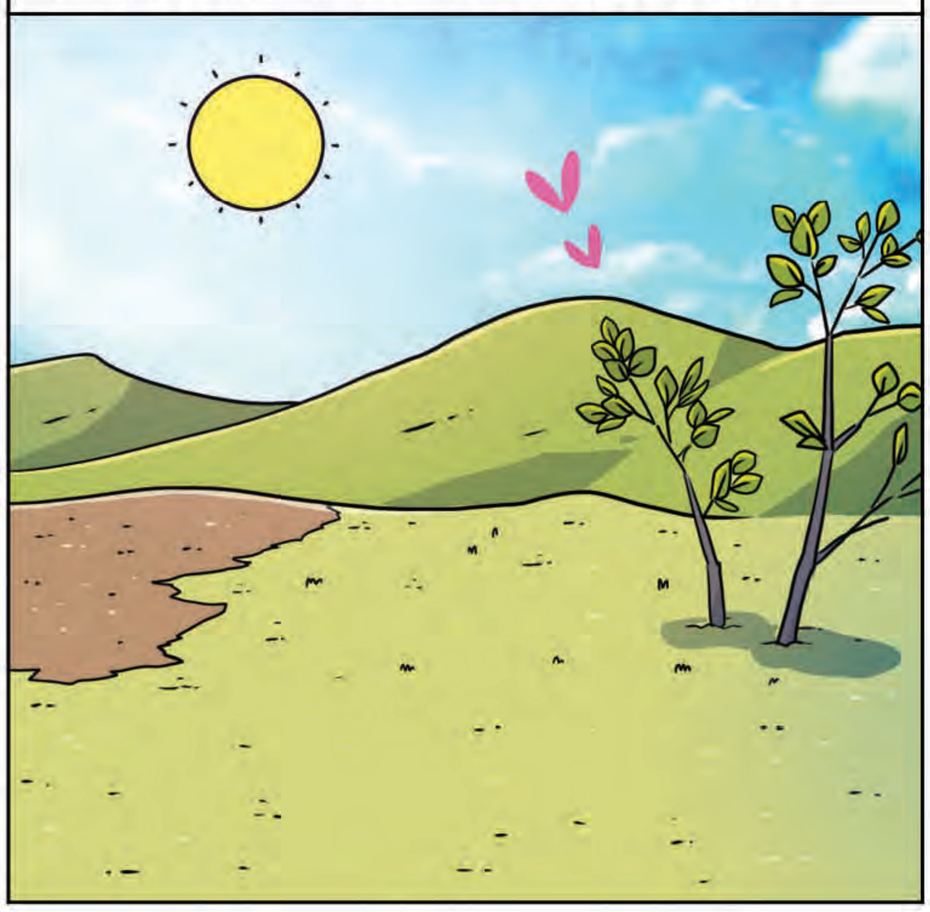
A forest in its natural state may not seem to be changing, but it keeps changing and developing until it reaches a stable state — this is called forest succession. Succession is the process of change in the plant communities that dominate an area.

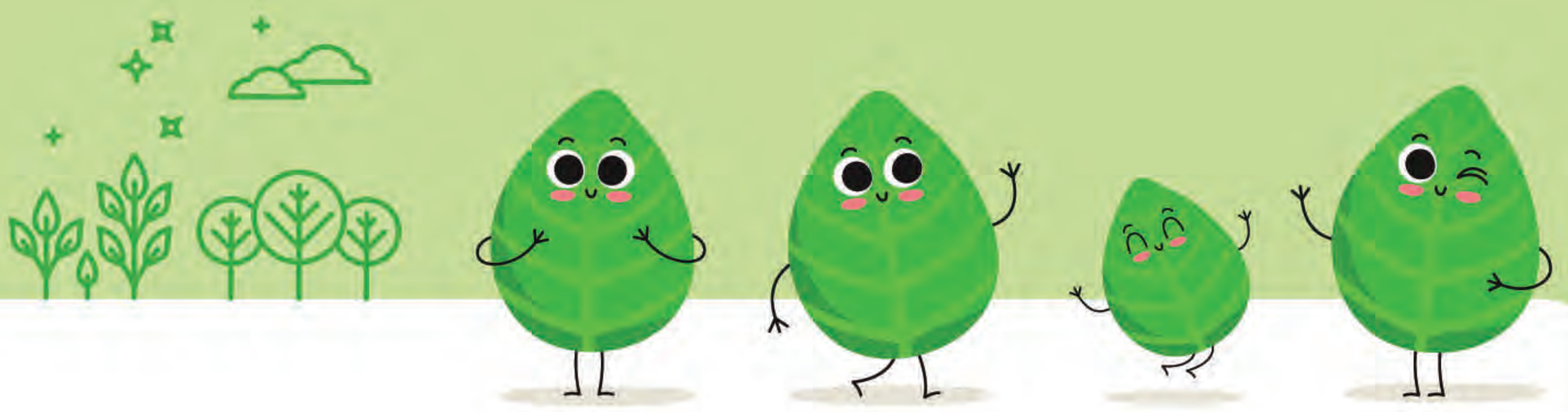


Trees are classified into shade-tolerant and shade-intolerant trees depending on whether they require little or abundant sunlight.



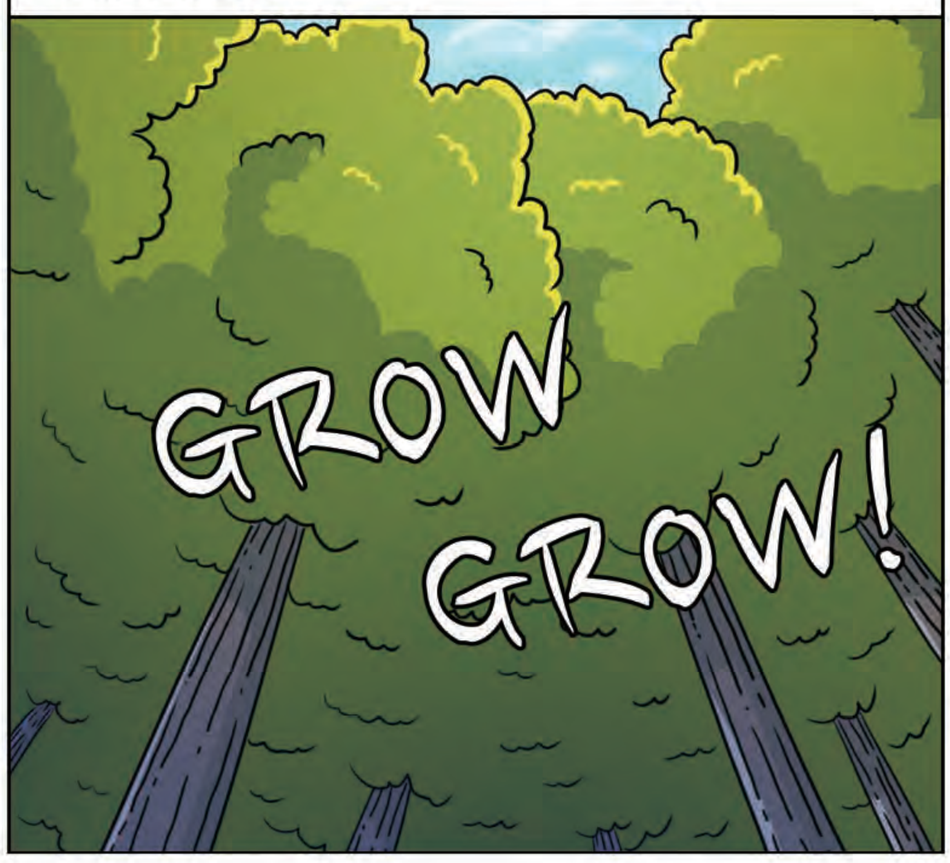
A tree that starts growing on an empty plain is a shade-intolerant tree that likes sunlight.

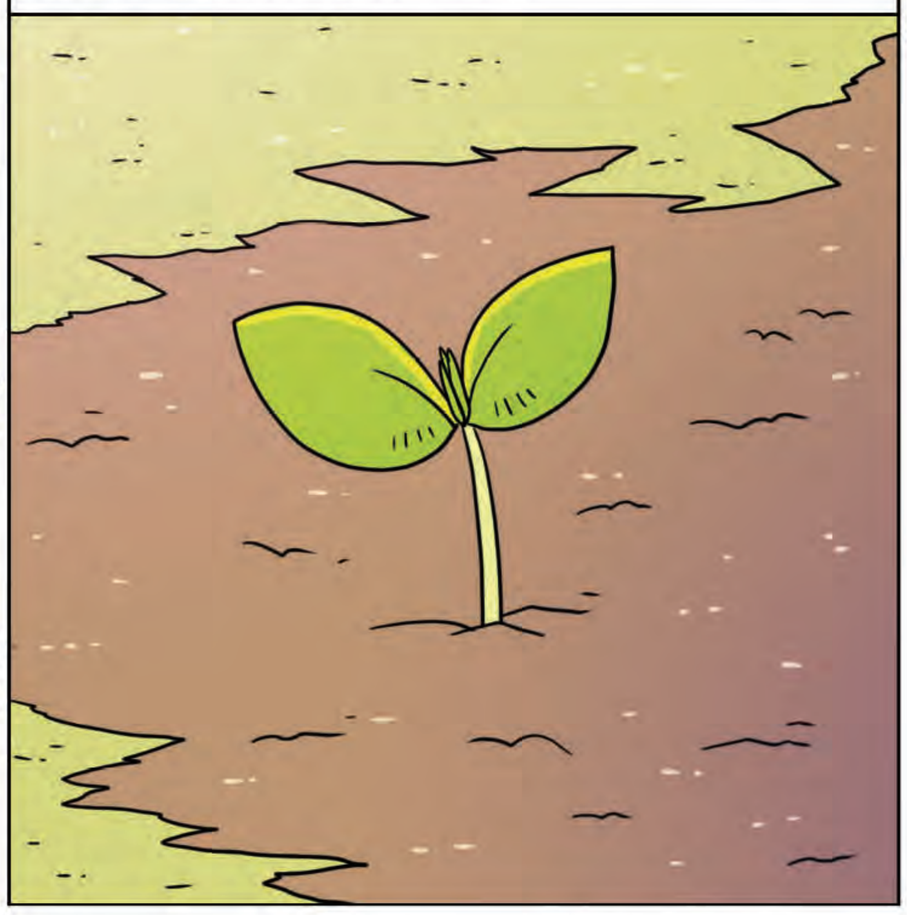


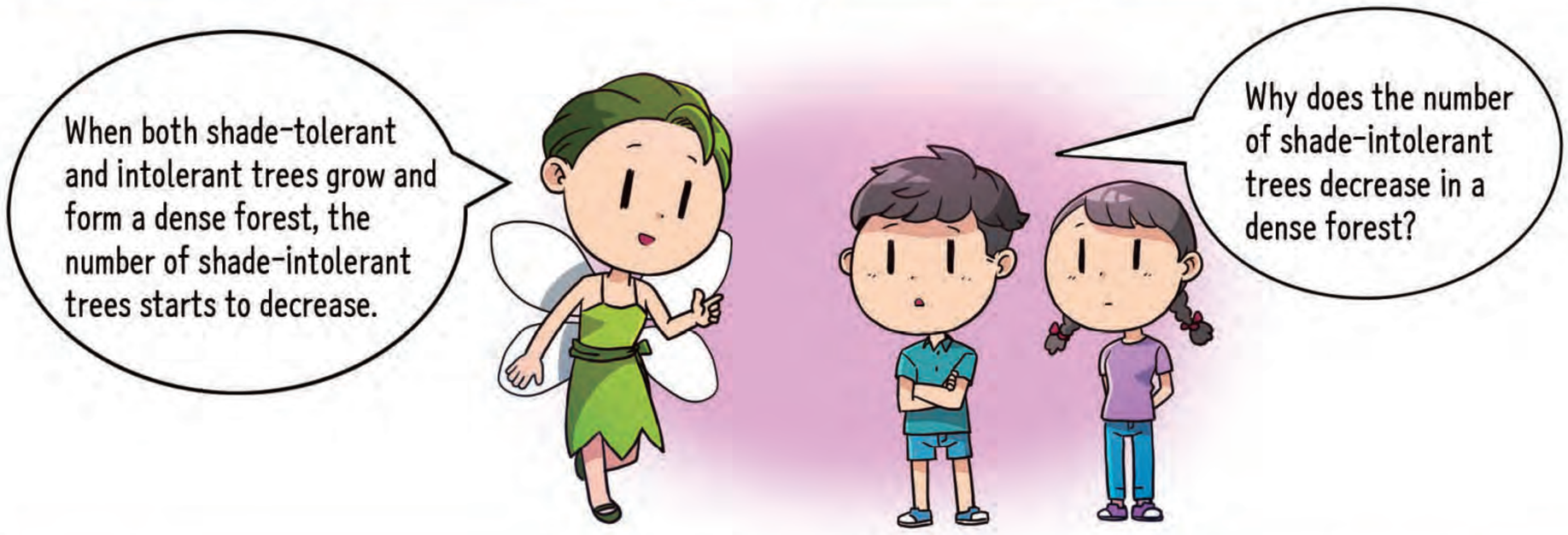


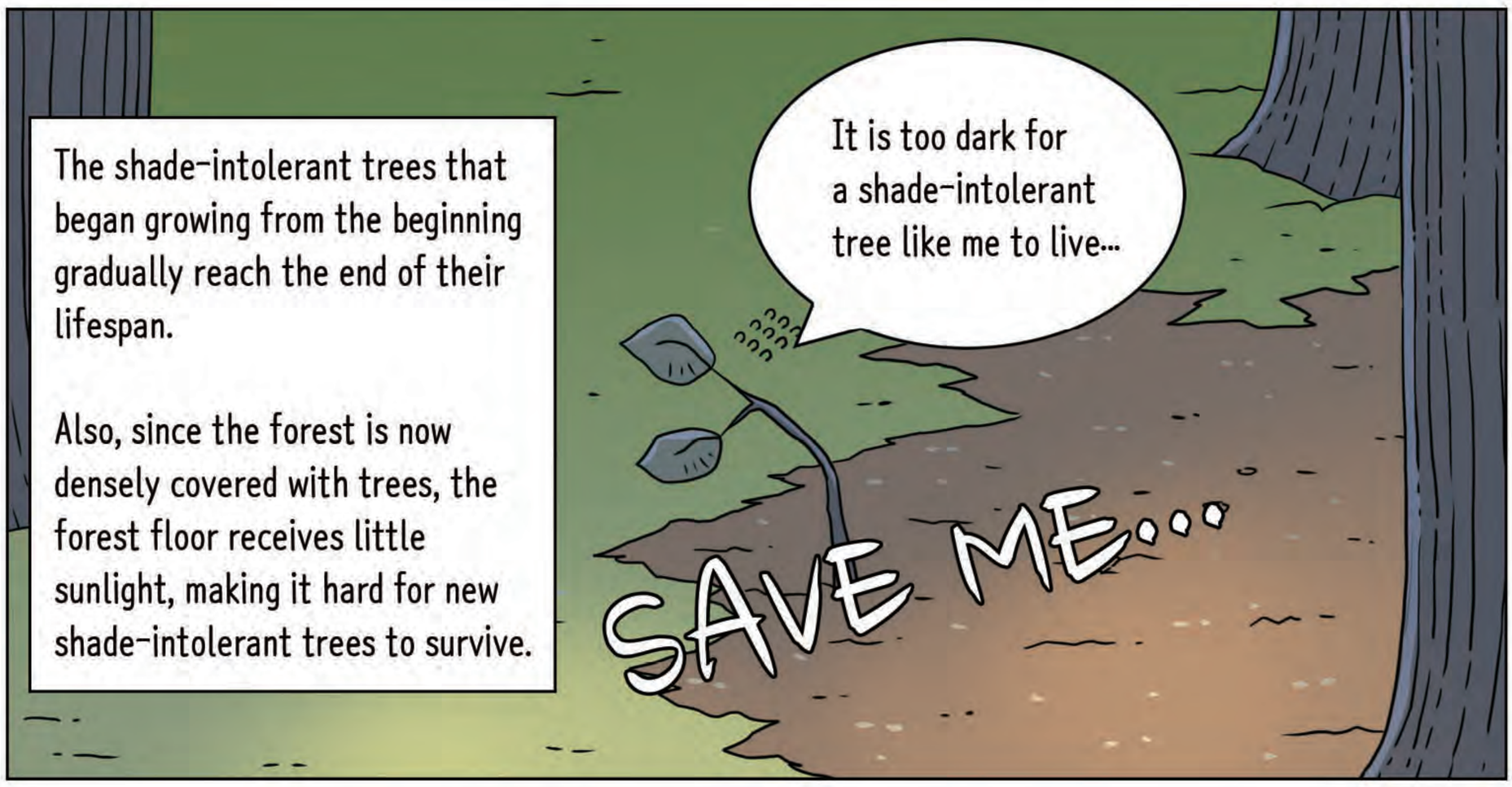
Shade-intolerant trees that thrive in full sunlight grow well and flourish, bringing about change in the forest.

Then, shade-tolerant trees that require relatively less sunlight start appearing.



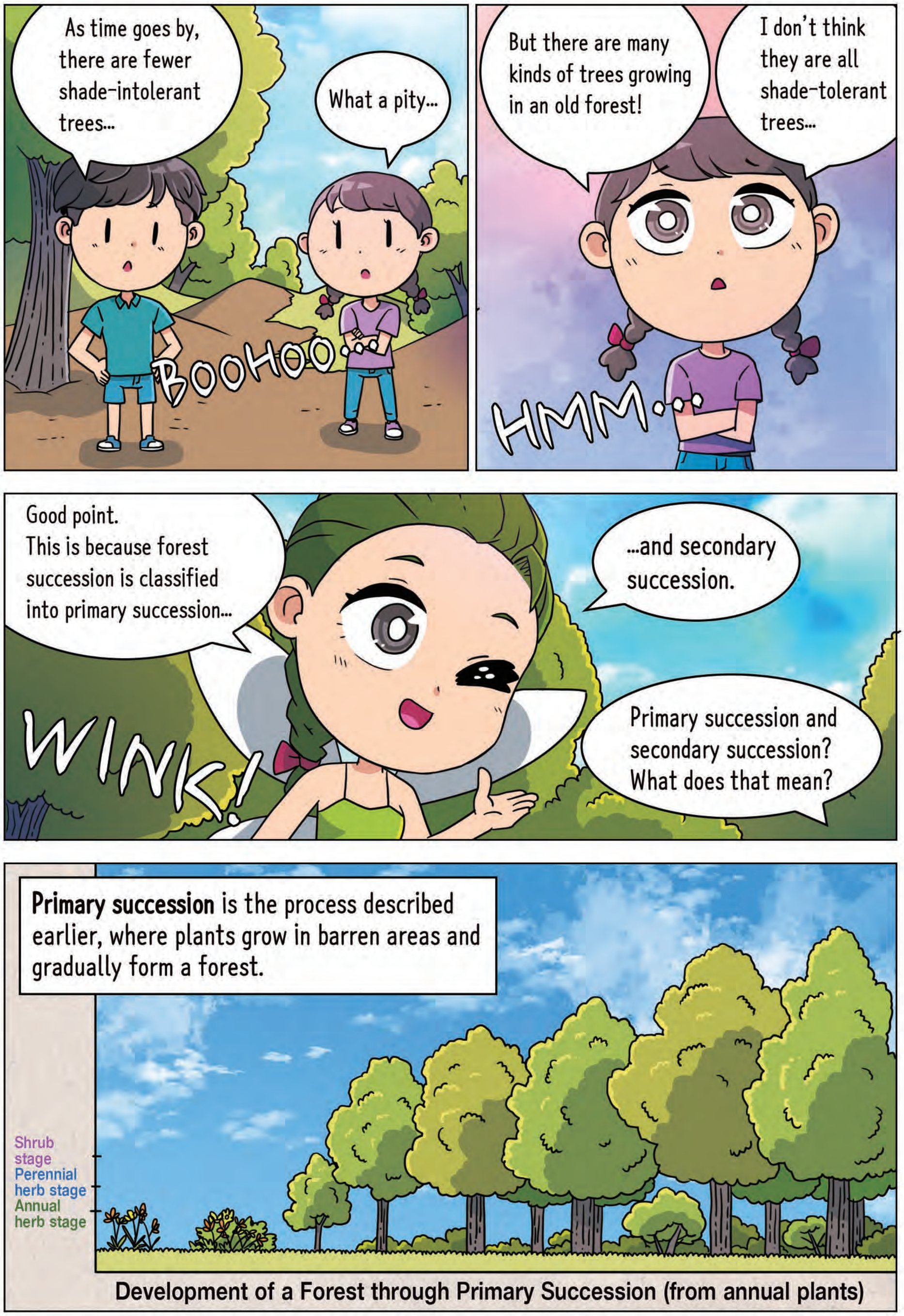




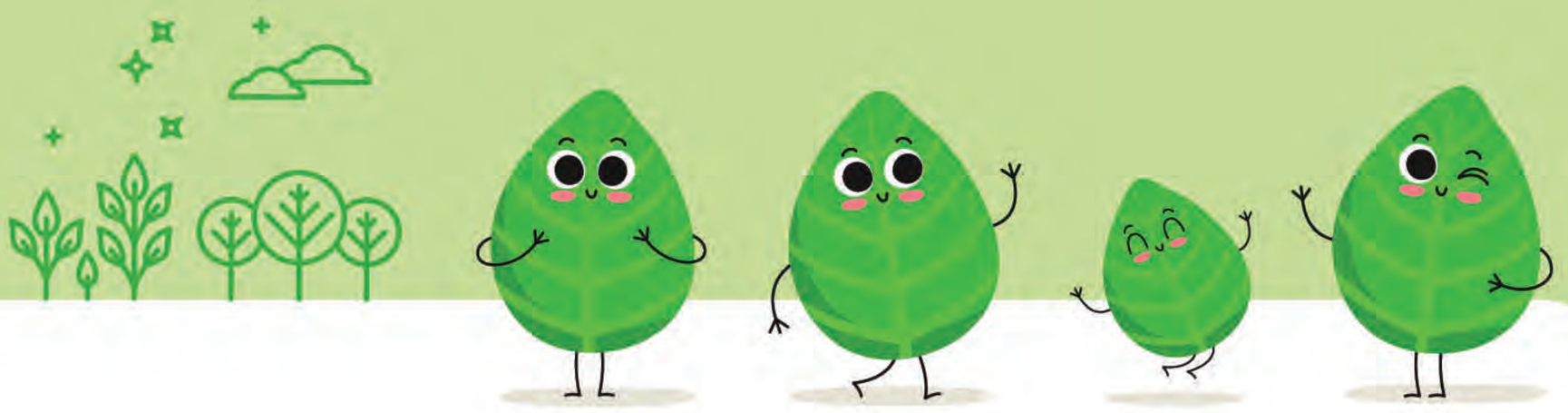


CHAPTER 04

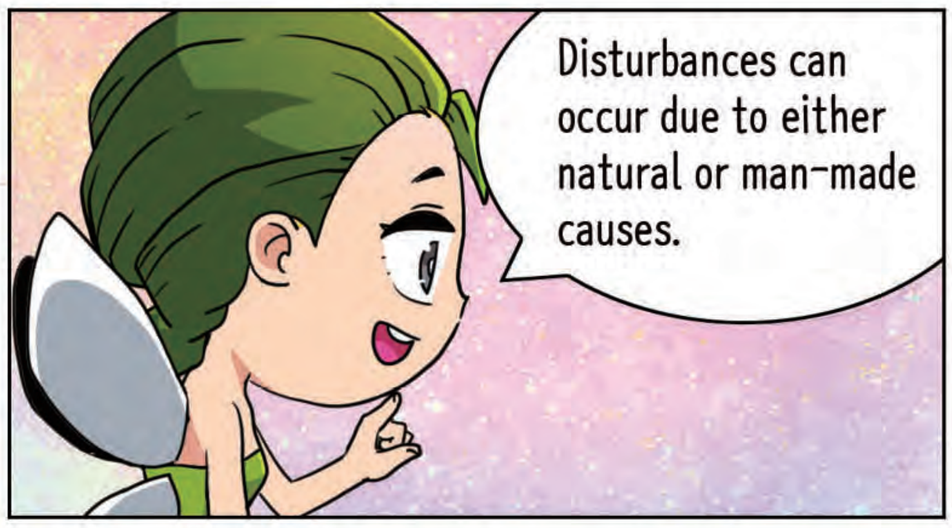
Why are forests important to us?

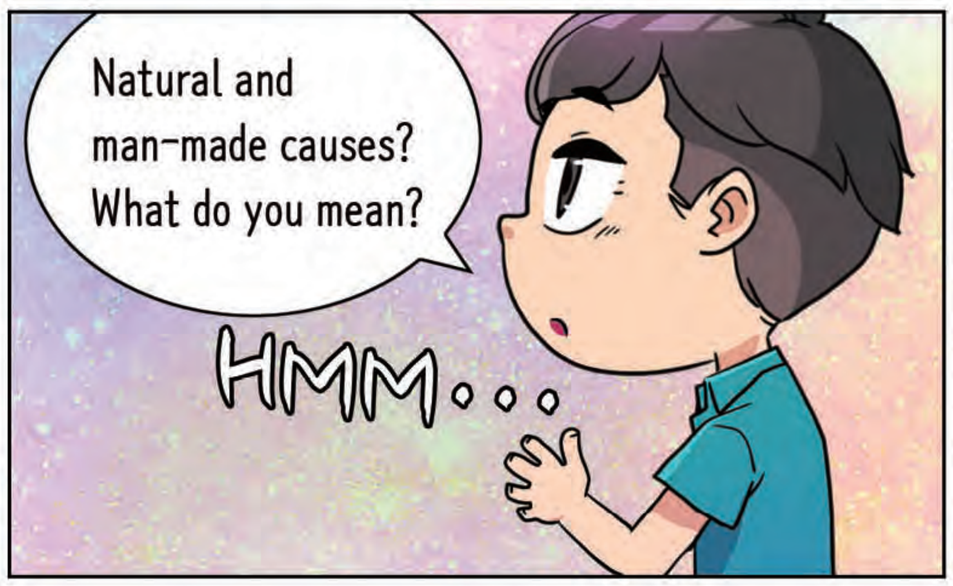


Development of a Forest through Primary Succession (from annual plants)



But sometimes, an area may be disturbed by various events during primary succession. Secondary succession is a response to a major disturbance. In **secondary succession**, a previously occupied area that has been disturbed or damaged undergoes a series of changes.





Natural Disturbances

Natural forest fires, landslides, typhoons, tornados, increases in the number of herbivores, pests and diseases, etc.

Man-made (Anthropogenic) Disturbances

Logging, human-caused forest fires, excessive use of pesticides, etc.

CHAPTER 04

Why are forests important to us?

Too much cutting can kill the forest and destroy the ecosystem...

WHRRR...

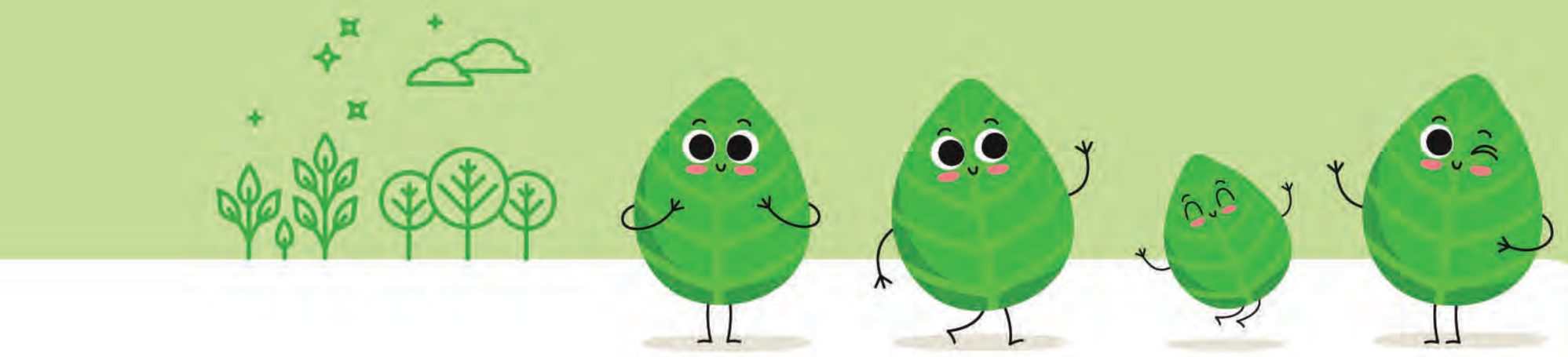
...but planned and appropriate cutting enables new vegetation to grow, thereby enhancing the diversity of living things.

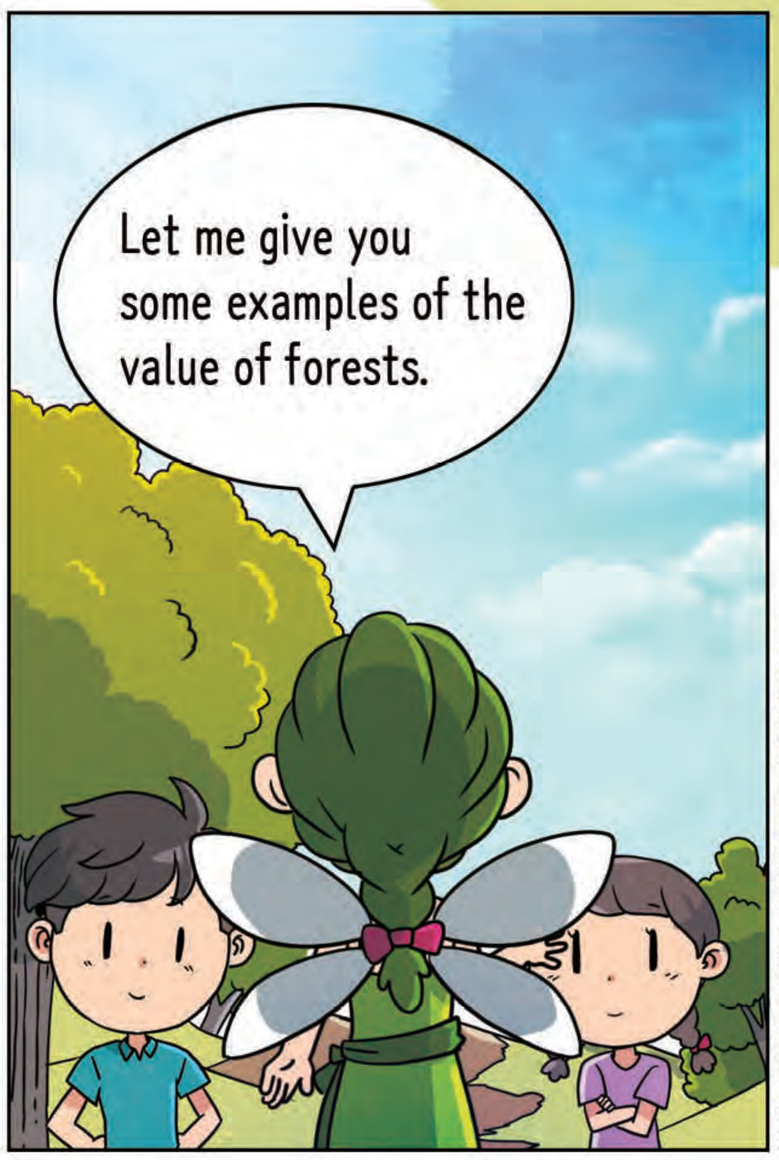
This is a great place to live!

YIPEE~

Trees uprooted by typhoons or that die from old age also play important roles in the ecosystem.

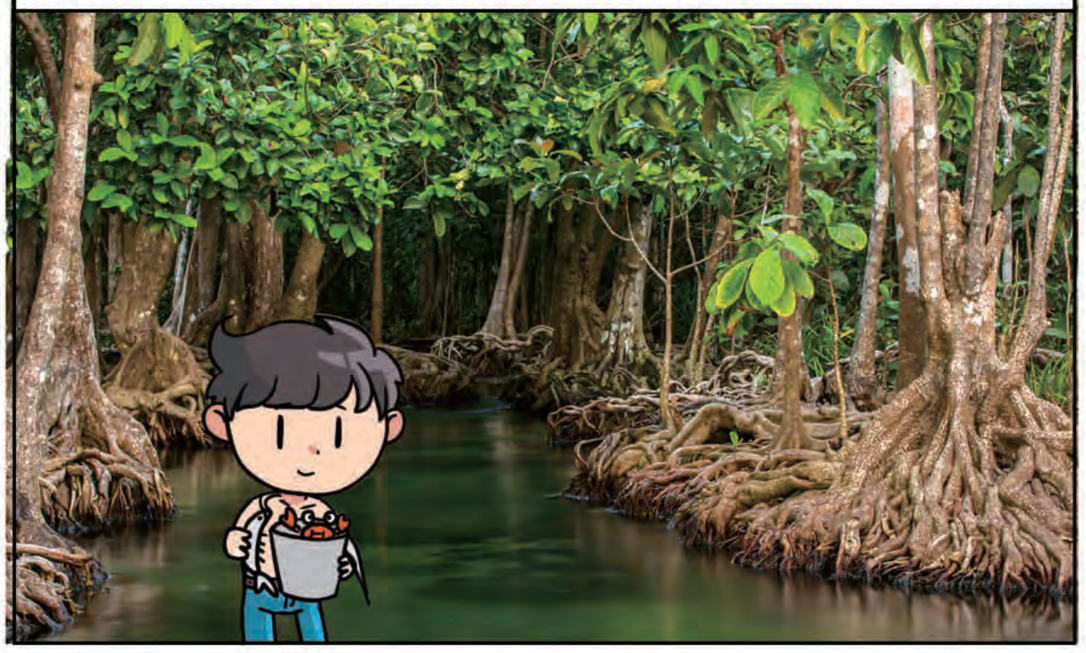
These dead trees are habitats for many animals, including woodpeckers. When there are many different types of animal species living in a forest, the biodiversity of the forest increases and it becomes healthier too.





1. Mangrove forests protect our coasts

Mangroves are mainly found in tropical and subtropical regions. Trees in mangrove forests provide firewood, construction materials and food. They are also home to various species of fish, herons, shrimp and crabs. Mangroves store much more carbon than other forest types and play critical roles in preventing coastal erosion and disasters such as tsunamis and floods.

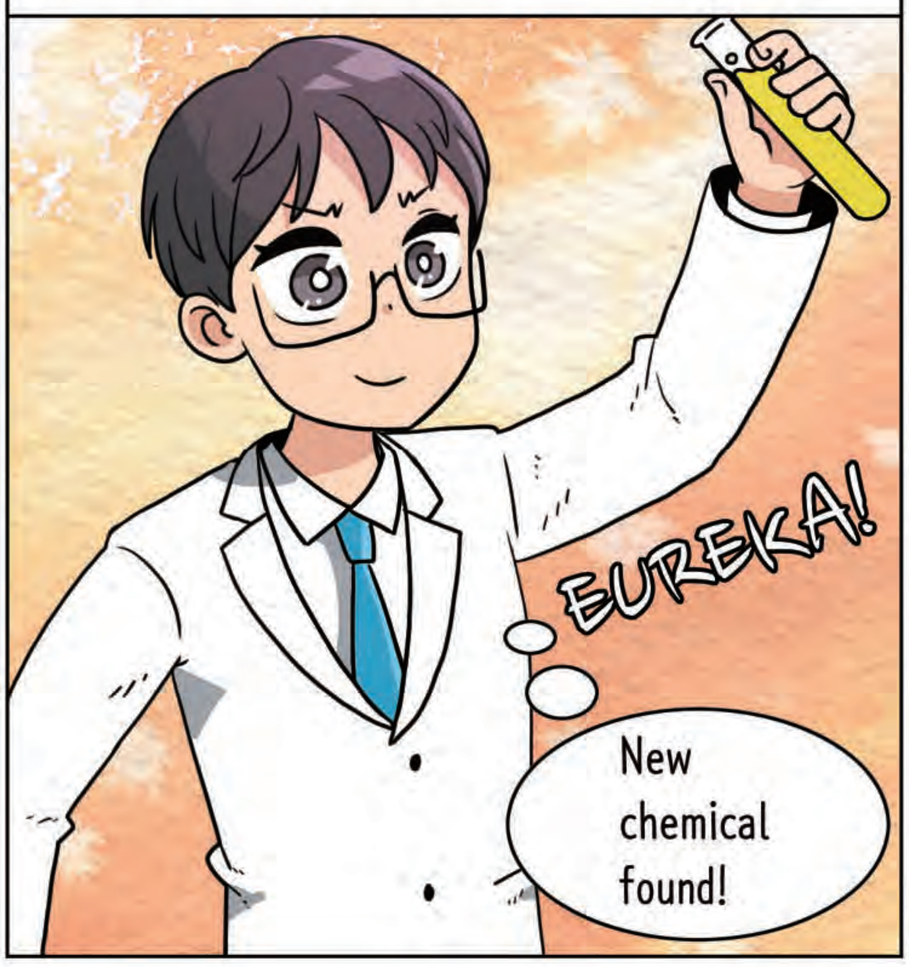


CHAPTER 04

Why are forests important to us?

2. "The Giving Forest" that sustains our livelihoods

Humans benefit from forests by harvesting fruits and gathering construction materials and firewood. Also, with advancements in science and technology, studies and research on tree species are widely used in the fields of medicine and cosmetics.

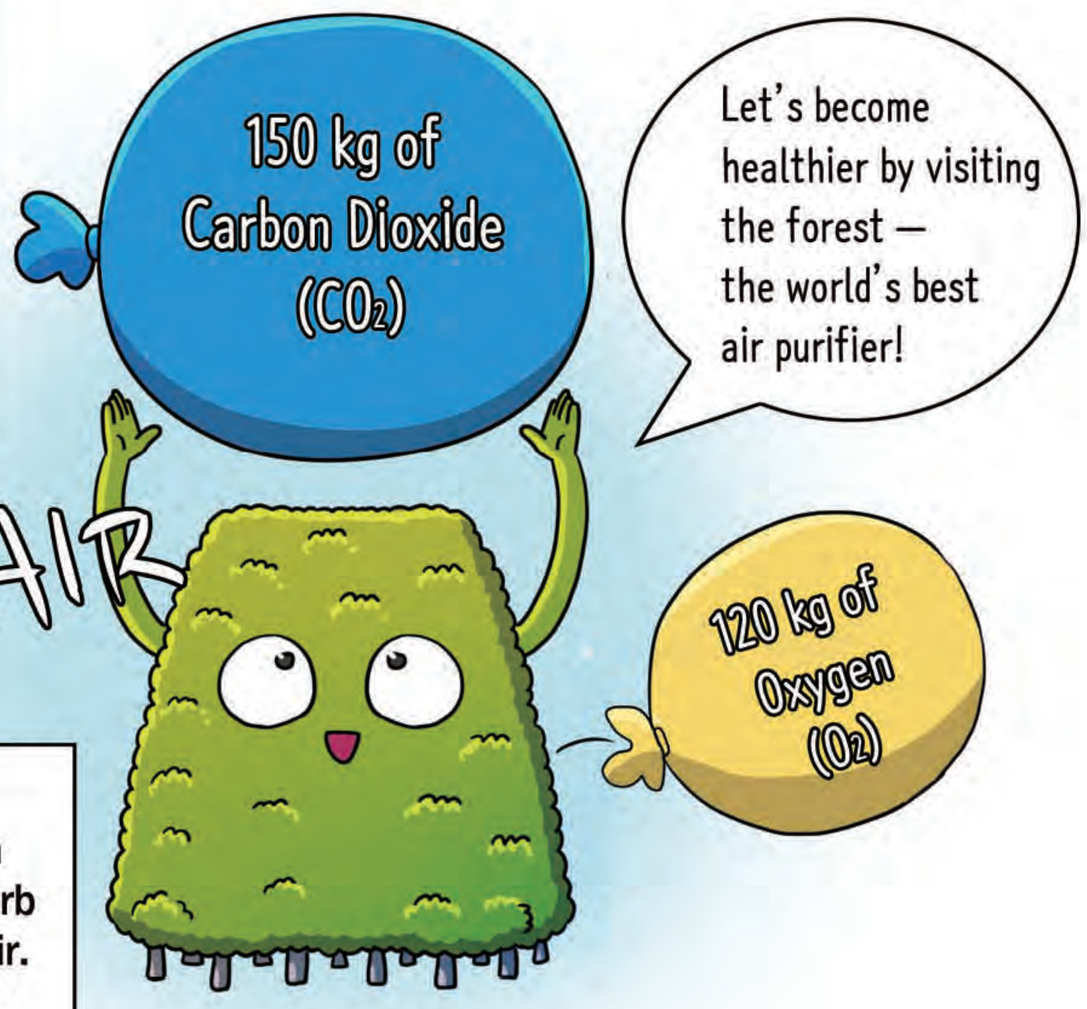


3. Forests and trees help reduce the Urban Heat Island Effect

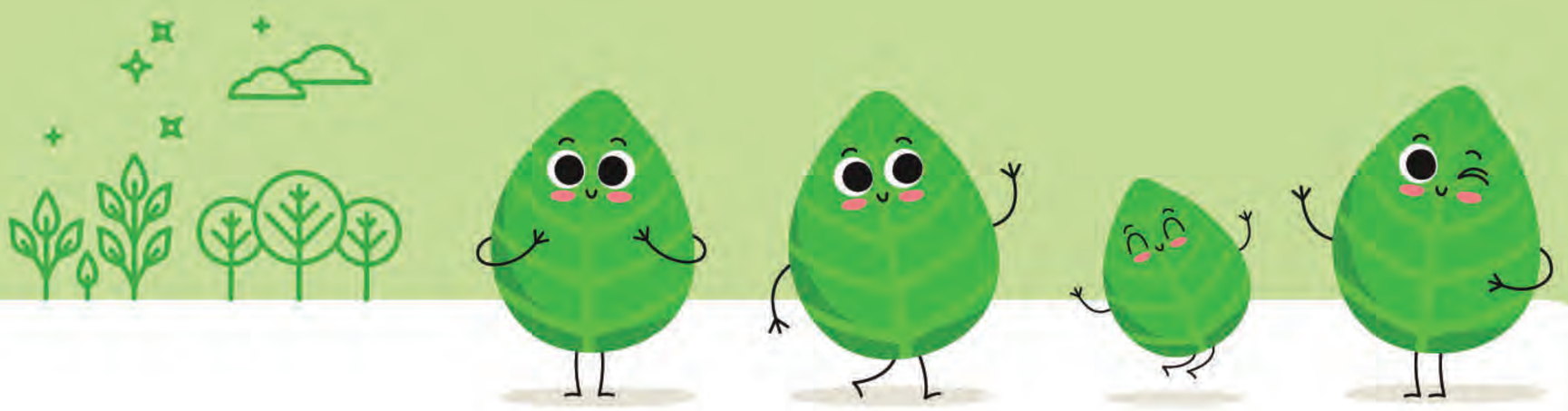
An urban heat island occurs when a city or urban area (with a large population and many skyscrapers) experiences much warmer temperatures than its surrounding rural areas. Urban forests and trees help reduce the heat island effect by cooling the air.

4. Forests, a natural air purifier

The Amazon rainforest in Brazil, known as the "lungs of the Earth," absorbs 2.2 billion tonnes of carbon dioxide every year!
A fully grown tree can absorb up to 150 kg of carbon dioxide per year, and produce about 120 kg of oxygen.



The air inside a forest contains a few thousand times less dust than that in an urban area. This is because leaves absorb dust and other contaminants from the air. Dust particles are also known to attach themselves to leaf surfaces.



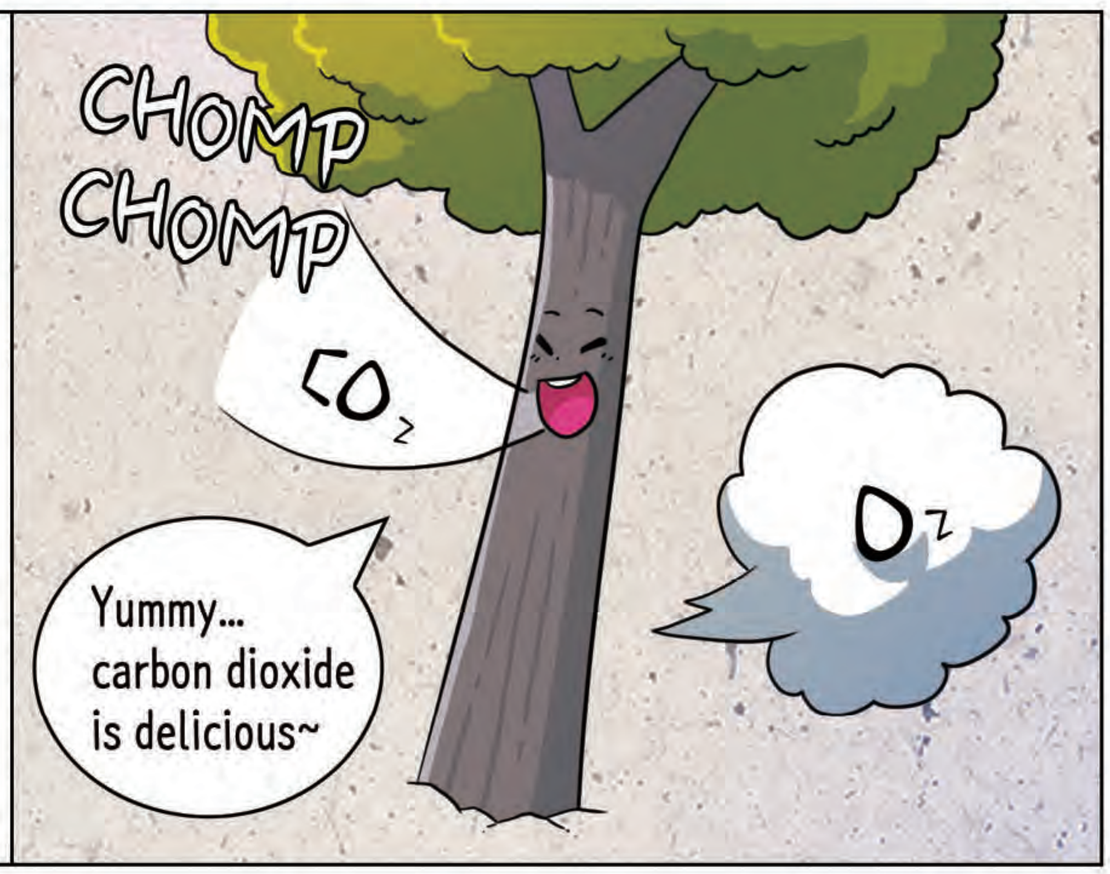
5. Forests act as a green dam that helps prevent natural disasters

A mountain with a healthy forest is called a green dam due to its large water storage capacity.
Just like a dam, forests help prevent runoff and damage from flooding, and regulate water flow during droughts.
Forests also act as a buffer against harsh winds that might harm human populations and damage houses.

6. Forests are huge carbon sinks that can help fight climate change

The world's forests cover about 30% of the earth's surface, and they store about 296 billion tonnes of carbon in biomass (wood, stems, leaves and roots).
On average, every hectare of forest sequesters about 73 tonnes of carbon!

Deforestation releases carbon stored in trees back into the atmosphere as carbon dioxide. It also reduces the number of trees available to absorb carbon dioxide. Without forests, the amount of carbon dioxide in the air will increase drastically.
(FAO, 2016)



7. Forests provide opportunities for education, places to rest and relax, and homes for animals

Forests provide educational opportunities as well as places for us to enjoy leisure activities. Many people visit forests to rest and learn more about nature by observing various animals and plants.

CHAPTER
04

Why are forests important to us?

FIND THE HARMFUL OBJECTS!

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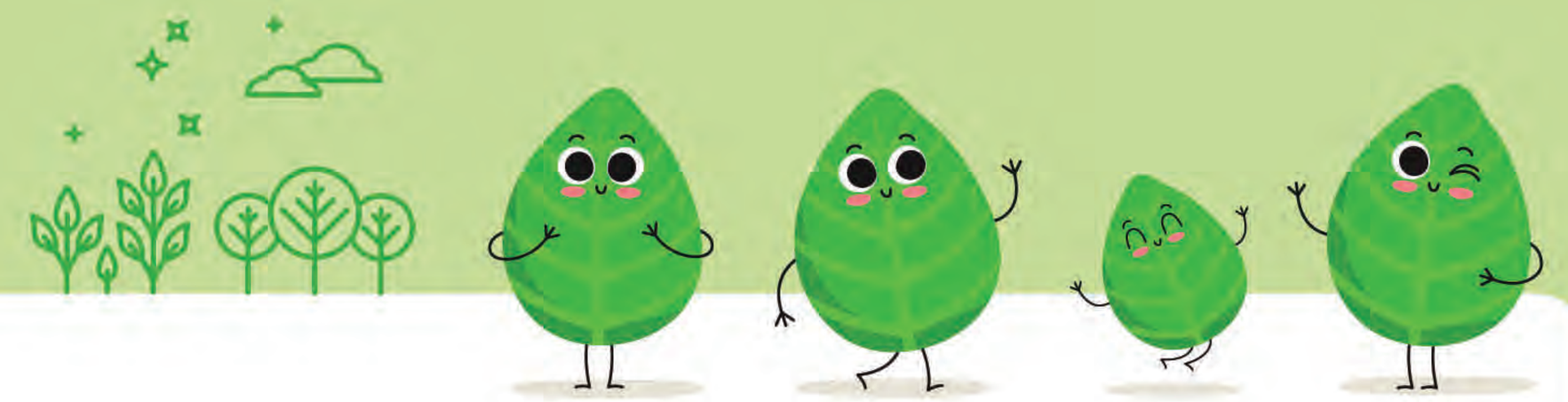


Circle the harmful objects!

ANSWER: PESTICIDE, FLAME, INSECT PEST, AXE, CIGARETTE BUTT, OIL CAN

04 CHAPTER

Why are forests important to us?

Forests are more than just trees – they are complex and rich ecosystems consisting of living things that interact with and depend on one another for survival. Trees and forests are essential for life on earth. They give us fuel, fiber, medicine, food, water, clean air and other resources. Hence, they are important sources of income to many people.

Forests are home to more than 80% of terrestrial plants, animals and insects. More than 300 million people reside in forests, and about 1.6 billion people depend on forest resources to sustain their livelihoods. Forests also help us fight climate change! (World Bank, 2004; United Nations, 2015)

In this chapter, we will talk about the key elements of forest ecosystems and the roles they play. Then, we will discuss what healthy forests are like and why they are important to us!

1 Components of Forest Ecosystems

■ ABIOTIC COMPONENTS

Abiotic components are the non-living components of an ecosystem that provide materials and space to support the lives of the living components. These include sunlight, temperature, water, air and soil.

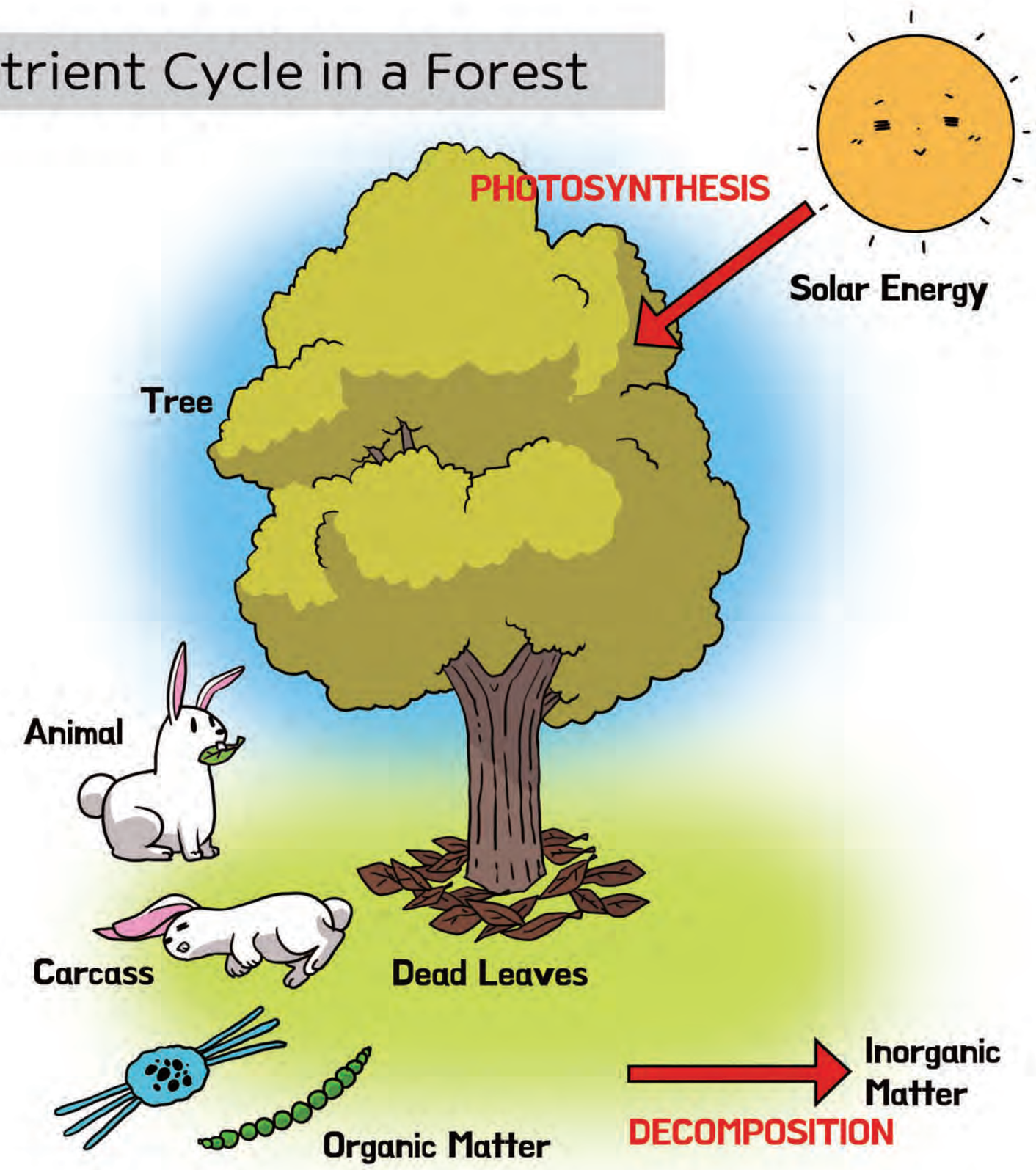
Air	Trees and plants use oxygen in the air during respiration and absorb carbon dioxide in the air during photosynthesis. The wind also helps spread seeds from place to place.
Light	Trees and plants absorb light during photosynthesis to make energy and nutrients.
Soil	Soil is a mixture of organic matter, minerals, gases and organisms that support life.
Temperature	Trees and plants thrive in different temperatures and have a preferred temperature range.
Water	Water is a vital source of life for all living organisms.

■ BIOTIC COMPONENTS

Biotic components are the living components of an ecosystem, such as plants, animals, insects, fungi and bacteria. They are categorized into producers, consumers and decomposers.

Producers	Producers are trees, plants and microorganisms that use energy from the sun to make nutrients by themselves. They become food for the consumer animals.
Consumers	Consumers are animals and cannot make their own food, so they need to consume (eat) other plants and/or animals in order to obtain energy. They contribute to adjusting the sizes of other living populations in order to maintain ecological balance.
Decomposers	Decomposers are microorganisms, such as fungi and bacteria, that eat decaying matter (dead plants and animals) and convert organic matter into inorganic nutrients. This process is known as decomposition. The decomposition process creates nutrients that return to the soil and are reused by the producers.

Nutrient Cycle in a Forest



2 Healthy Forests and Their Benefits

Our forests face great challenges like deforestation (the removal of trees to convert forestland for other purposes), wildfires and invasive forest pests. It is important to understand what healthy forests are and what kinds of benefits they provide us with when their health is maintained.

■ HEALTHY FORESTS

Healthy forests have both biological and non-biological elements interacting in a complex way. They are a diverse mix of young and old trees, dead trees and openings. The interactions among different elements help achieve a good balance between material circulation and energy flows, and eventually increases resilience, which is the ability to recover quickly from stress or difficulties.

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Why are forests important to us?

■ CHARACTERISTICS OF HEALTHY FORESTS

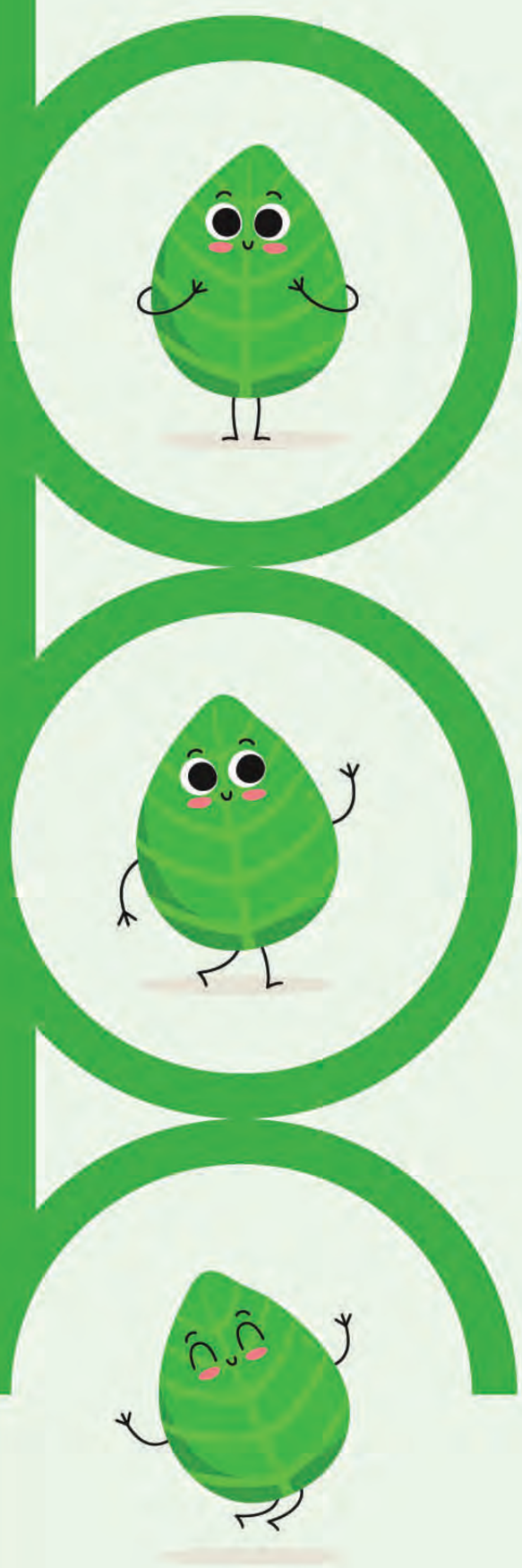
Healthy forests promote the interaction of various species. They maintain life in their own little physical environment and help maintain stable ecosystems. Some examples of the evidence of healthy forests you may find near you are as follows:

- Conifers and broadleaf trees are found growing in the same area.
- Trees in the forest are evenly distributed across several distinct layers: the canopy layer, the lower canopy layer, the understory layer and the forest floor. Trees in the upper layer are tall and mature trees that can be used as wood for various purposes. The understory consists of usually shade-tolerant younger trees, shrubs, plants and grasses. They help minimize soil erosion and prevent soil water evaporation.
- Healthy forests are likely to have a greater number of tree species with high conservation value.
- Healthy forests have healthy soil: The soil depth is deep, with the presence of organic matter, insects and small animals. A well-developed soil system can provide sufficient nutrients and water for trees and grasses. It also helps trees to fight against pests and diseases.

■ BENEFITS OF HEALTHY FORESTS

There are many benefits that healthy forests can provide us with! Here are just some of them:

- Forests give us wood to build furniture or houses. They also provide other valuable raw materials for paper, rubber and textile industries.
- Forests provide clean water for drinking, washing and other household needs.
- Forests help keep our air clean by absorbing dust and other pollutants.
- Forests are places for relaxation and leisure.
- More than 80% of all terrestrial animals, plants and insects live in forests.
- On top of maintaining high water quality, forests also help prevent floods and landslides because tree roots absorb water and keep soil intact.
- As one of the largest storehouses of carbon, forests absorb harmful greenhouse gases that cause climate change.



CHAPTER

05

How do forests help fight climate change?

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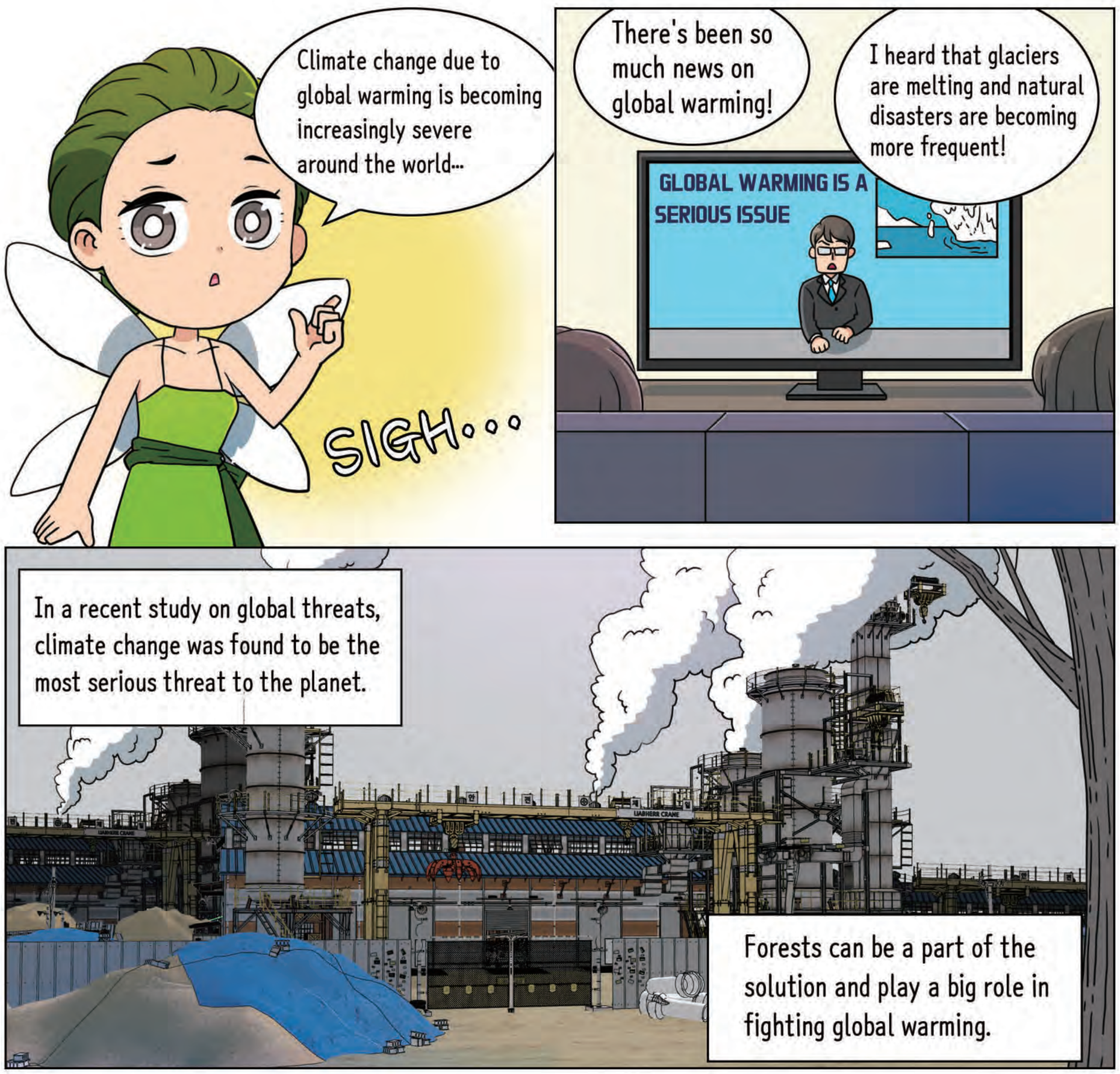
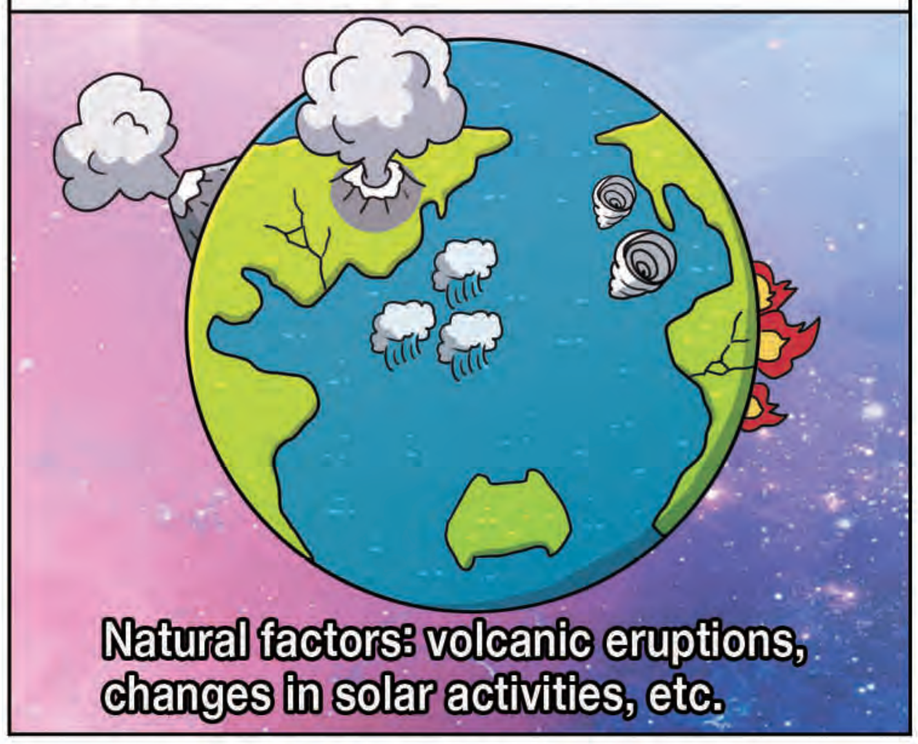
CHAPTER 05

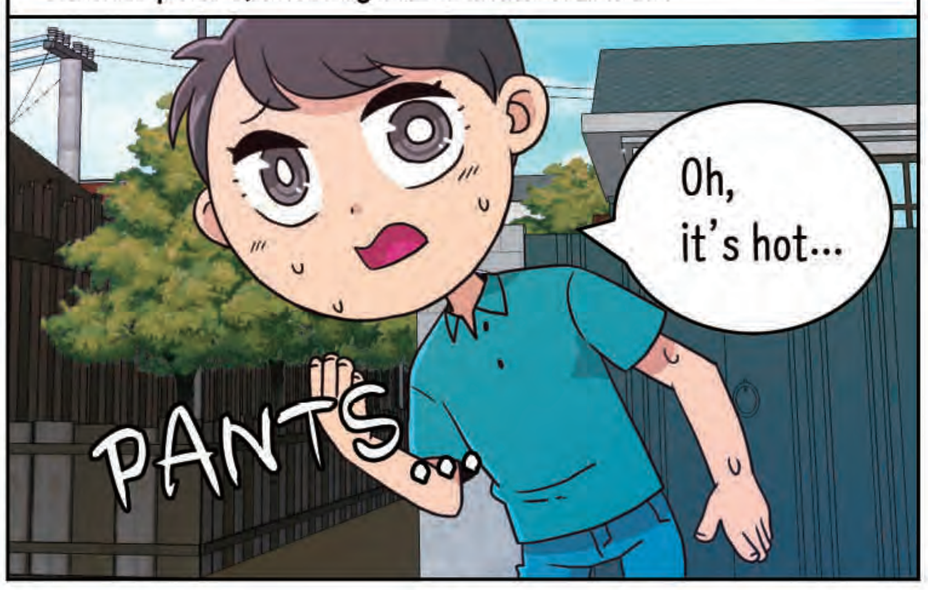
How do forests help fight climate change?

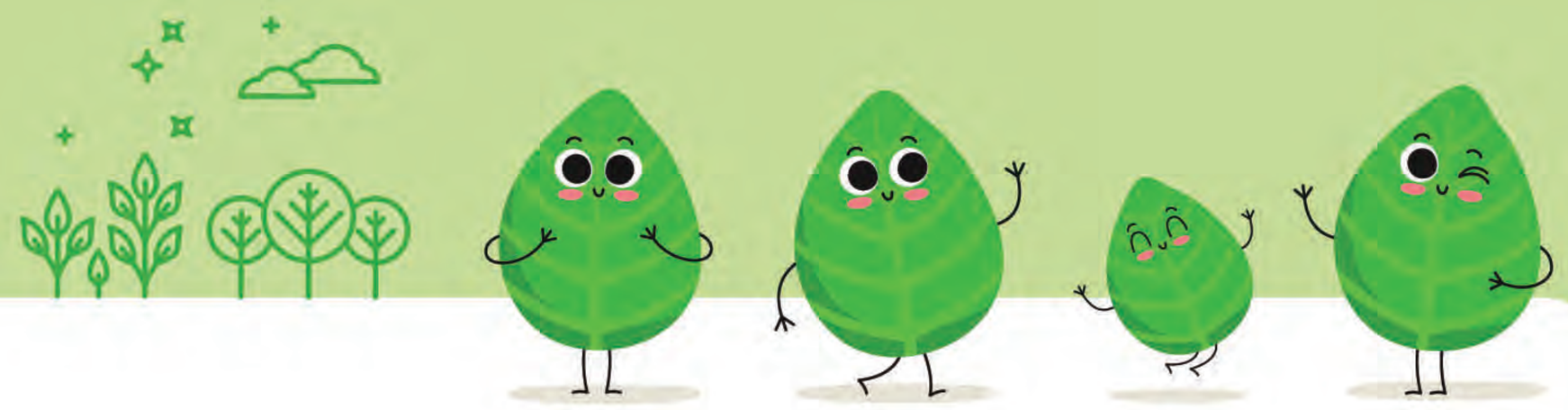


There are natural and man-made causes of global warming.



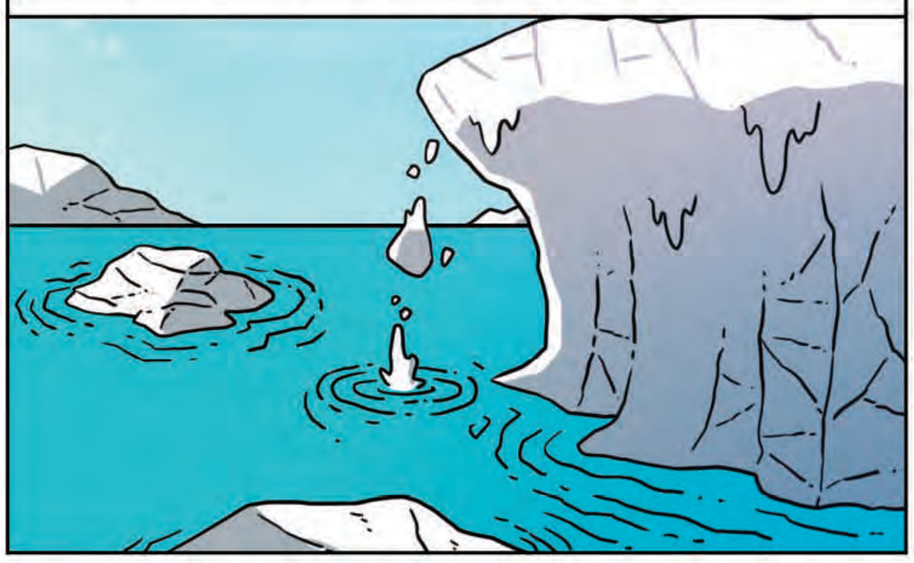
The main cause of global warming is man-made. The excessive amount of greenhouse gases (carbon dioxide, methane and fluorinated gases) produced by human activities is becoming a serious concern. These gases trap heat in the Earth's atmosphere, making the Earth warmer.





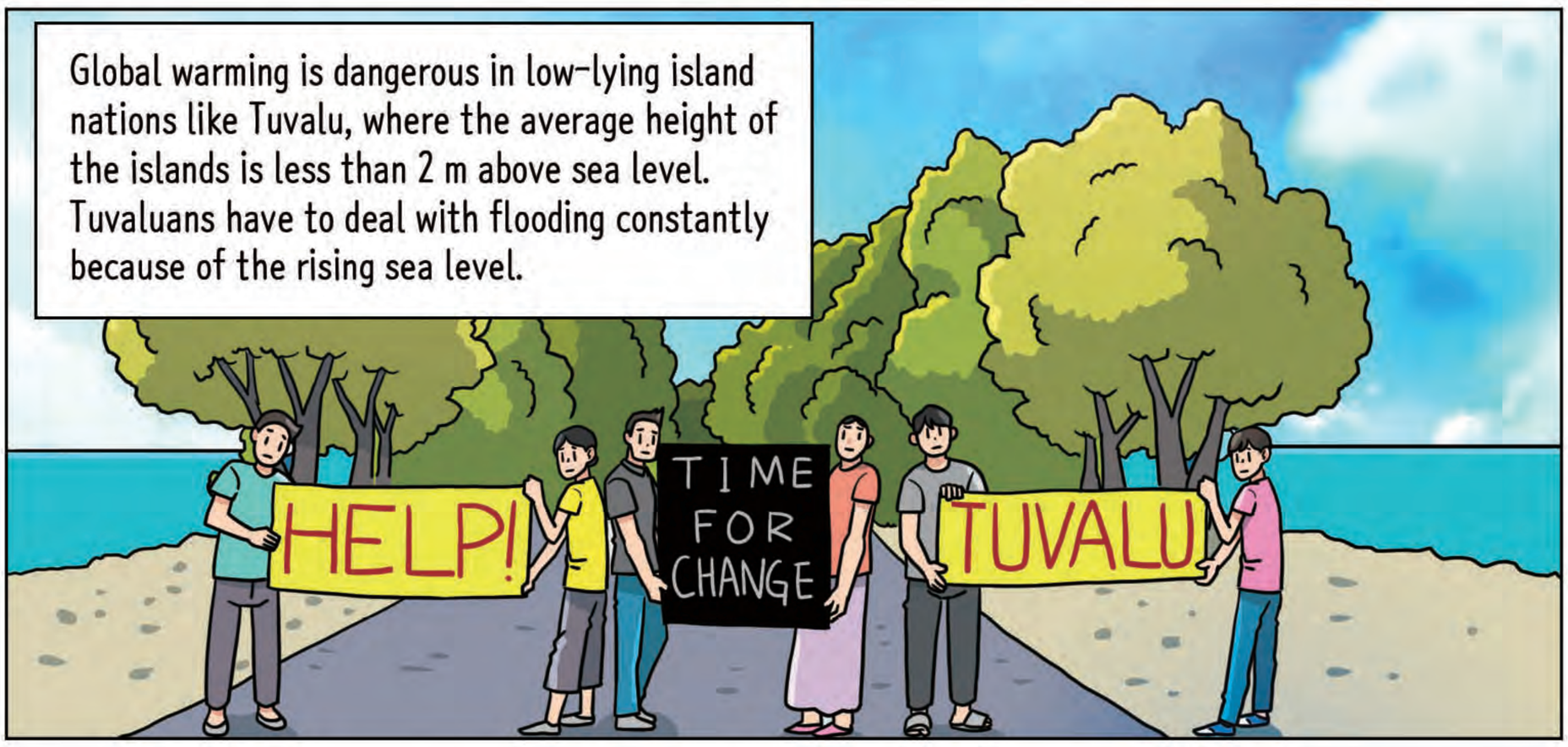
In the past, there was a lack of awareness of environmental degradation, and fossil fuels such as coal and petroleum, as well as fluorinated gases that damage the environment, were widely used.

A typical example of climate change is the rise in sea levels due to the melting of glaciers in polar regions, which is caused by increasing temperatures.



The higher the temperature, the faster the glaciers melt.

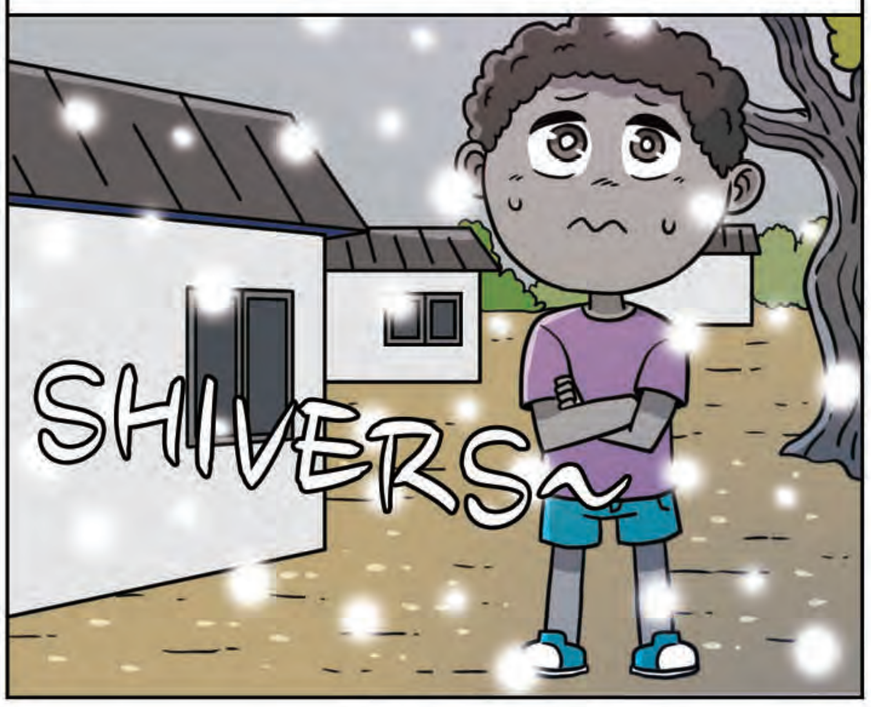
Global warming is dangerous in low-lying island nations like Tuvalu, where the average height of the islands is less than 2 m above sea level. Tuvaluans have to deal with flooding constantly because of the rising sea level.



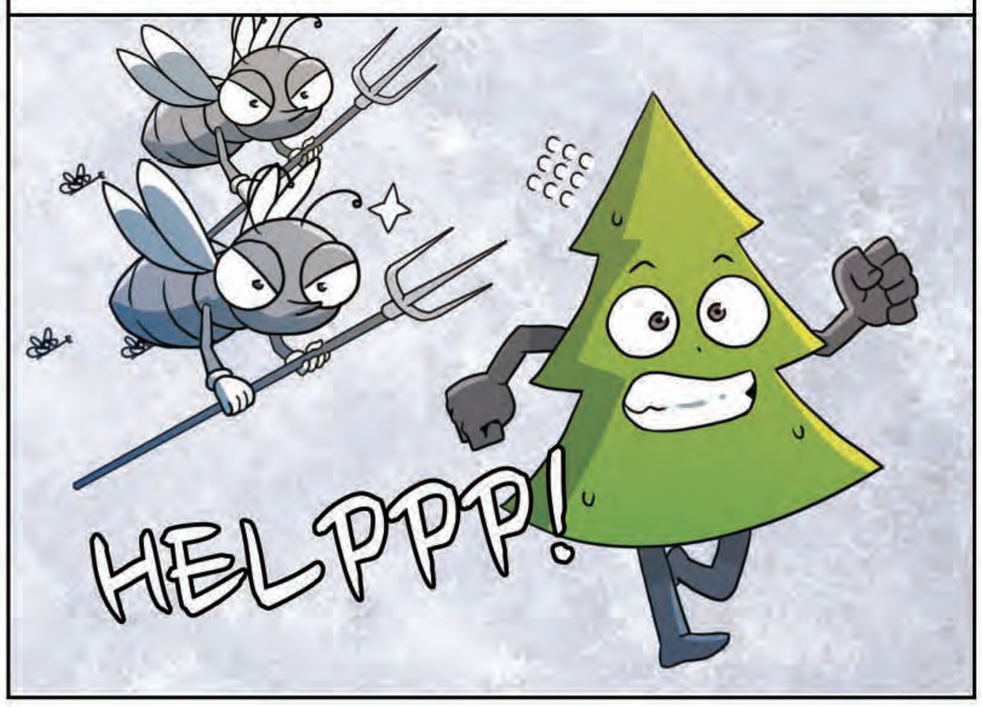
CHAPTER 05

How do forests help fight climate change?

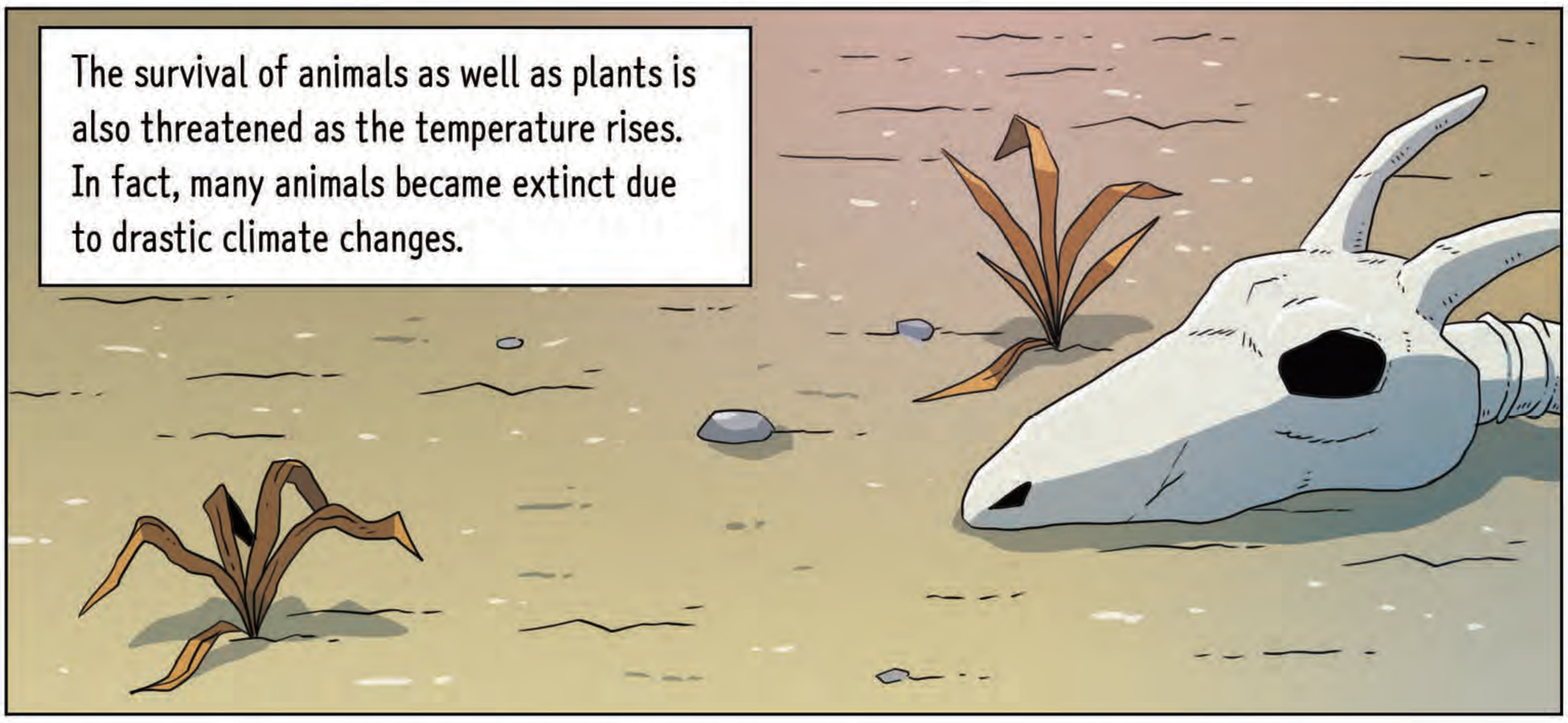
When the temperature rises, the air flow also starts to change. Snow may occur in warm regions, and dry regions may experience heavy rainfall.

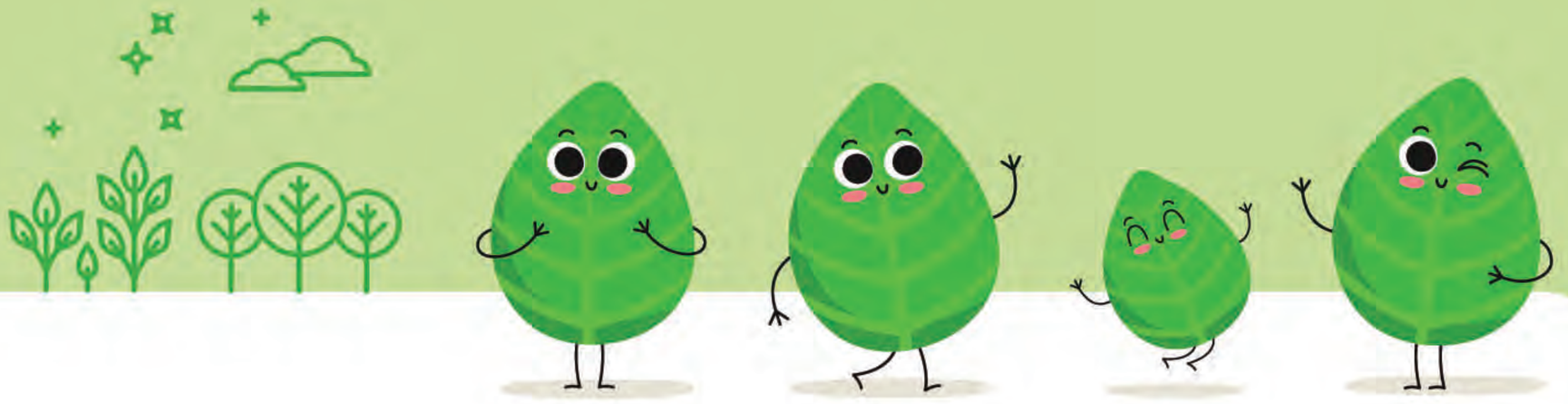


Due to the higher temperatures, pathogens that attack trees as well as subtropical diseases and pests (such as the stick insect) are gradually moving into temperate forests.



The survival of animals as well as plants is also threatened as the temperature rises. In fact, many animals became extinct due to drastic climate changes.

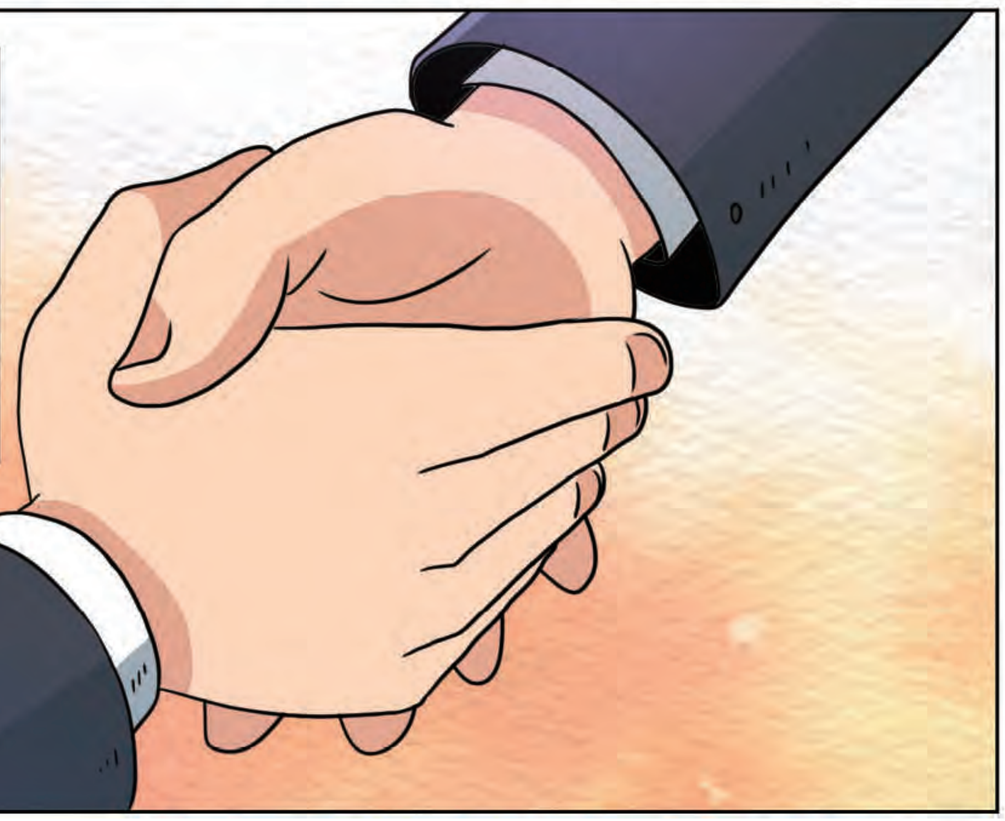




In 1992, in order to reduce greenhouse gas emissions, 154 countries around the world signed the Convention on Climate Change (UNFCCC).

United Nations Framework Convention on Climate Change

The Convention is meaningful in that countries that are economically and culturally different joined hands to solve a global problem by reaching an agreement on emissions reductions.

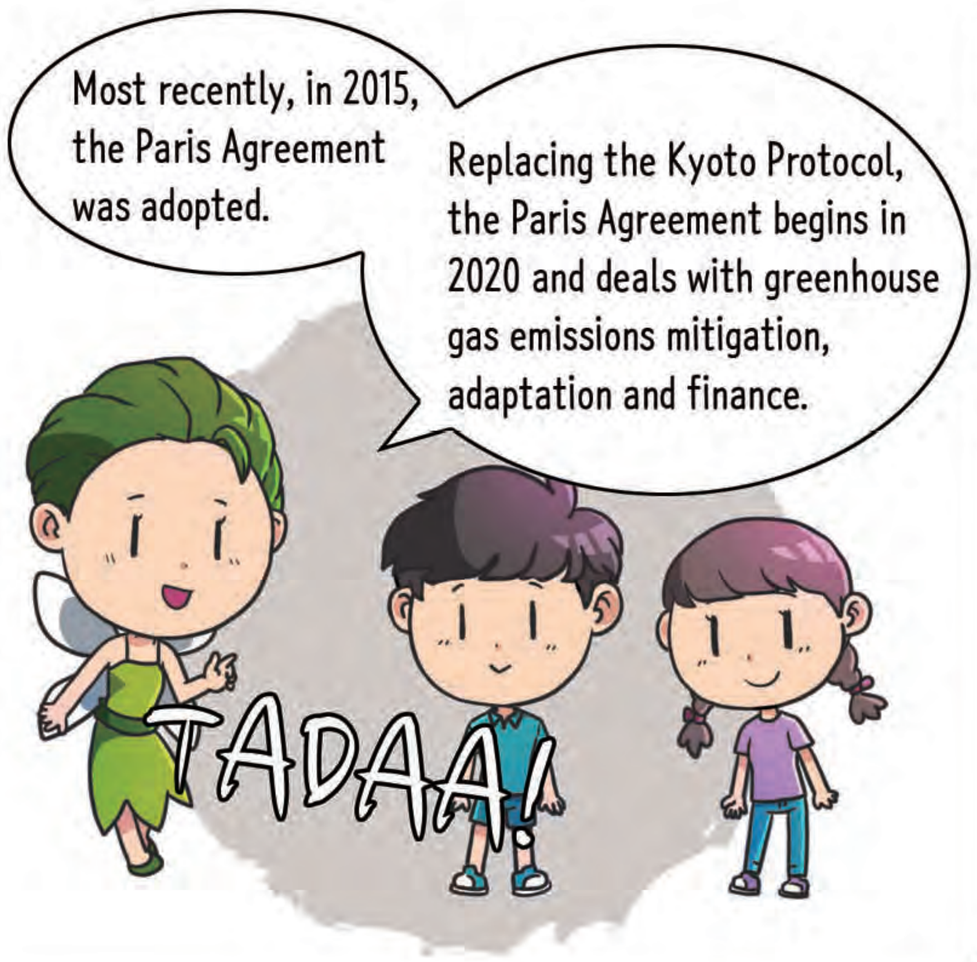


The Kyoto Protocol, an international agreement adopted in 1997, contains specific measures to carry out the Convention on Climate Change.

In particular, the Kyoto Protocol mandates that developed countries reduce their emissions of greenhouse gases that cause climate change.

CHAPTER 05

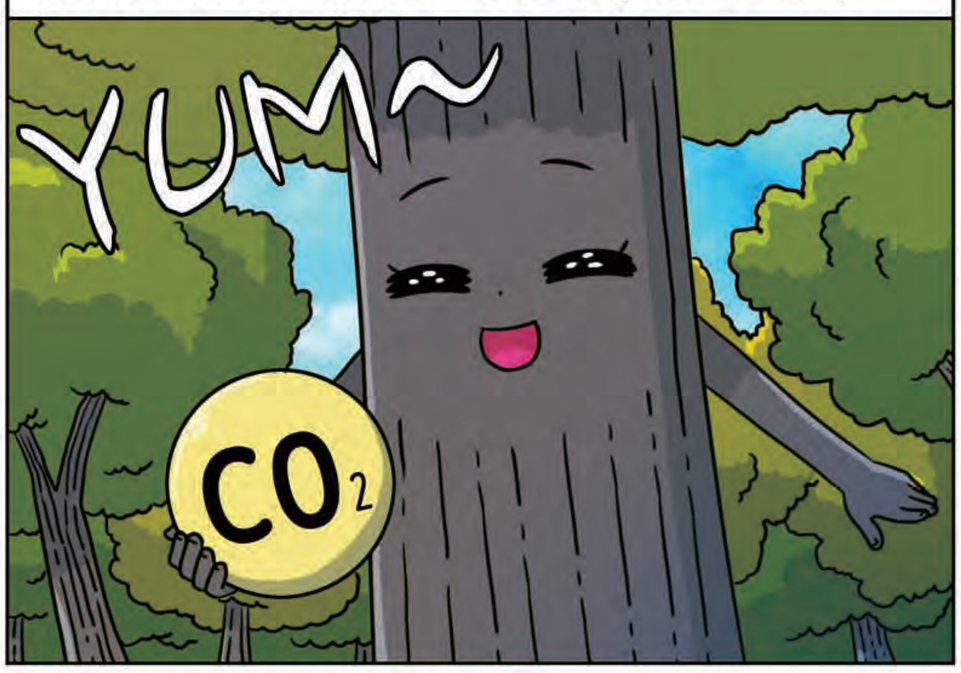
How do forests help fight climate change?



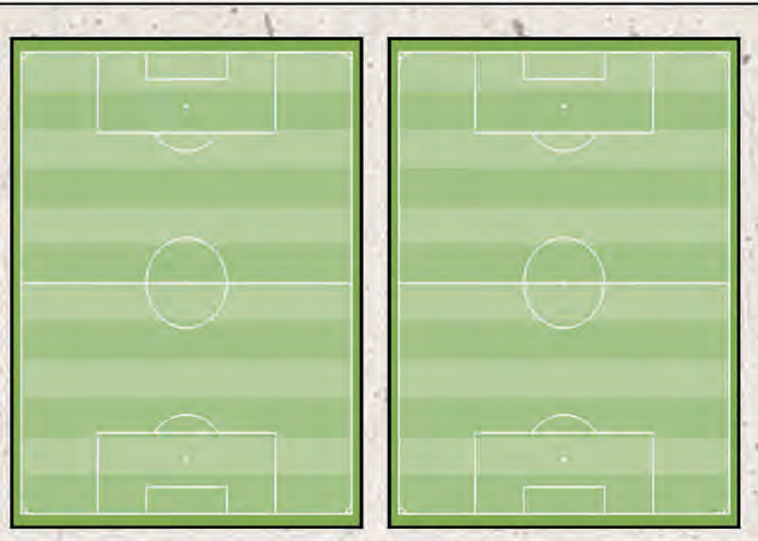
Unlike the Kyoto Protocol, the Paris Agreement requires not only developed countries but all parties to the agreement to cut down on greenhouse gas emissions.

As of May 2019, 185 parties have ratified the Paris Agreement (out of the 197 parties to the UNFCCC).

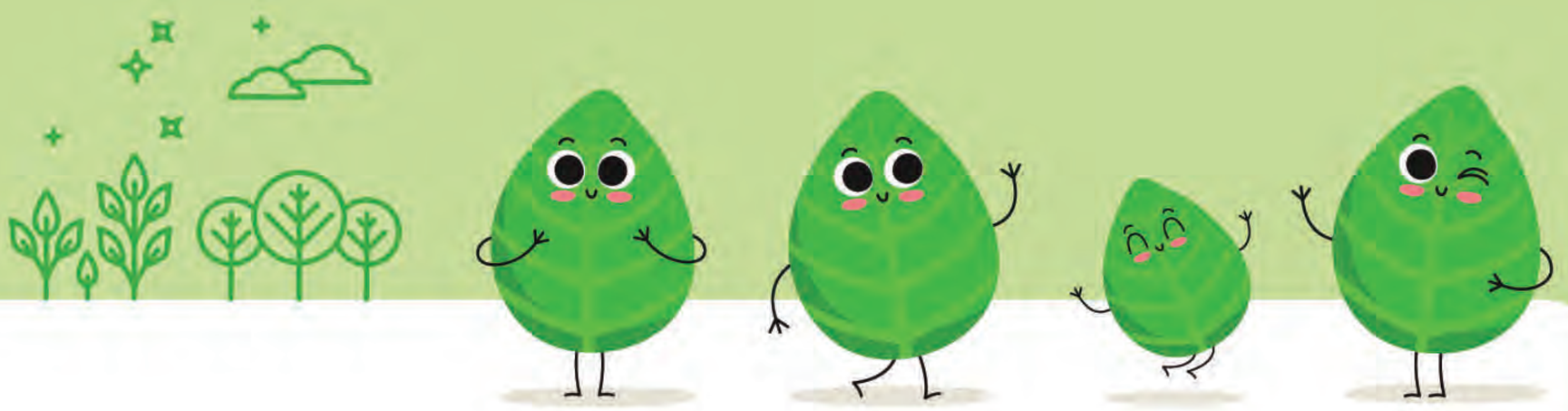
The forests of the world form a huge carbon sink, storing about 650 billion tonnes of carbon in their biomass, dead wood and litter, as well as in the soil! Every year, they absorb about 2.6 billion tonnes of carbon dioxide — the main cause of global warming.



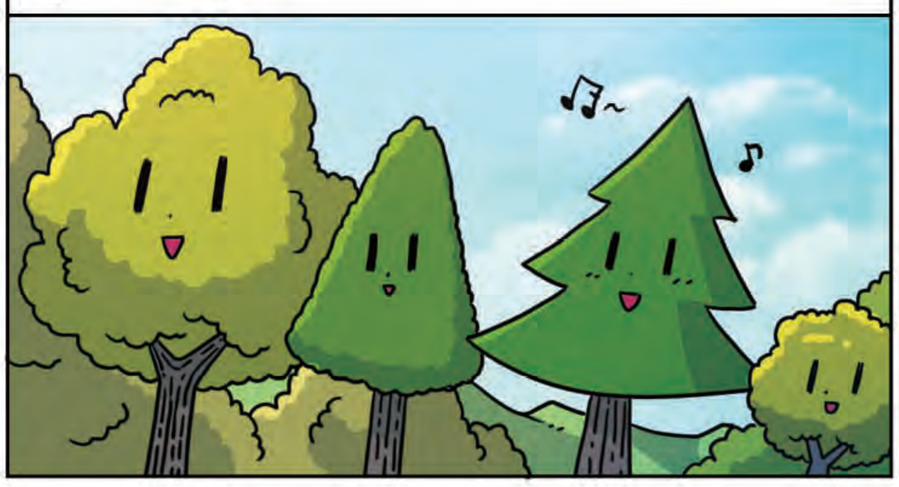
Depending on the location, tree species and growth rate, it is estimated that a hectare of forest can absorb 5 to 10 tonnes of carbon dioxide per year as the trees photosynthesize and grow.



A forest the size of 2 soccer fields can absorb as much as 30 tonnes of CO_2 per year!



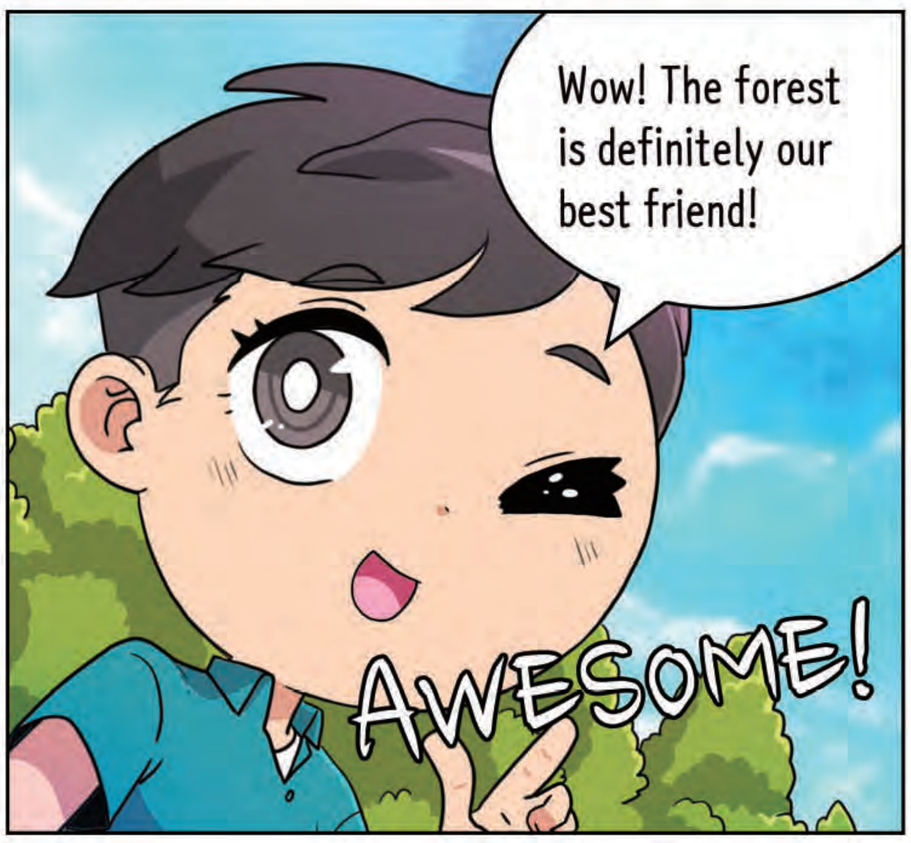
According to a recent study, the amount of carbon absorbed when various tree species are planted is double that of when only a single tree species is planted.

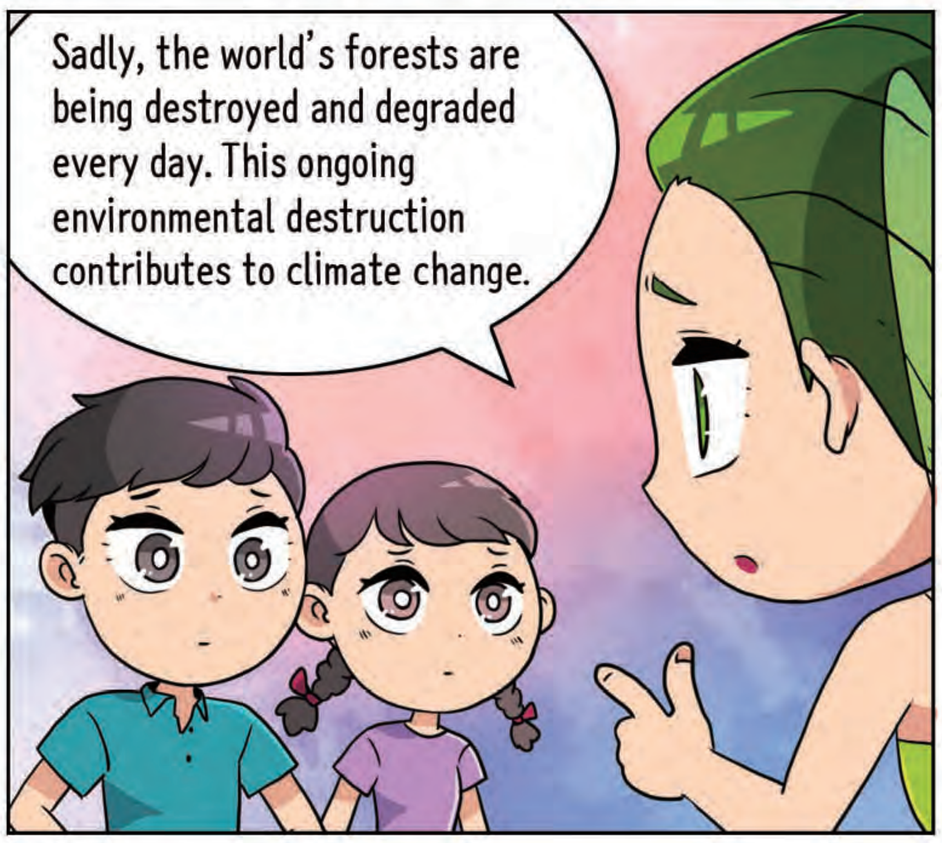


Research also shows that if we increase the number of tree species in just 10% of the world's forests, the estimated value of the reduction in greenhouse gases could reach up to 20 billion U.S. dollars a year.

A recent study in Korea revealed that a single tree can absorb enough fine dust in a year to fill an espresso cup, and a hectare of forest can absorb up to 168 kg of fine dust and air pollutants.

Hence, we must protect our forests as they are the most natural carbon capture technology that captures and stores carbon. They also help cool the Earth and absorb dust and other pollutants.

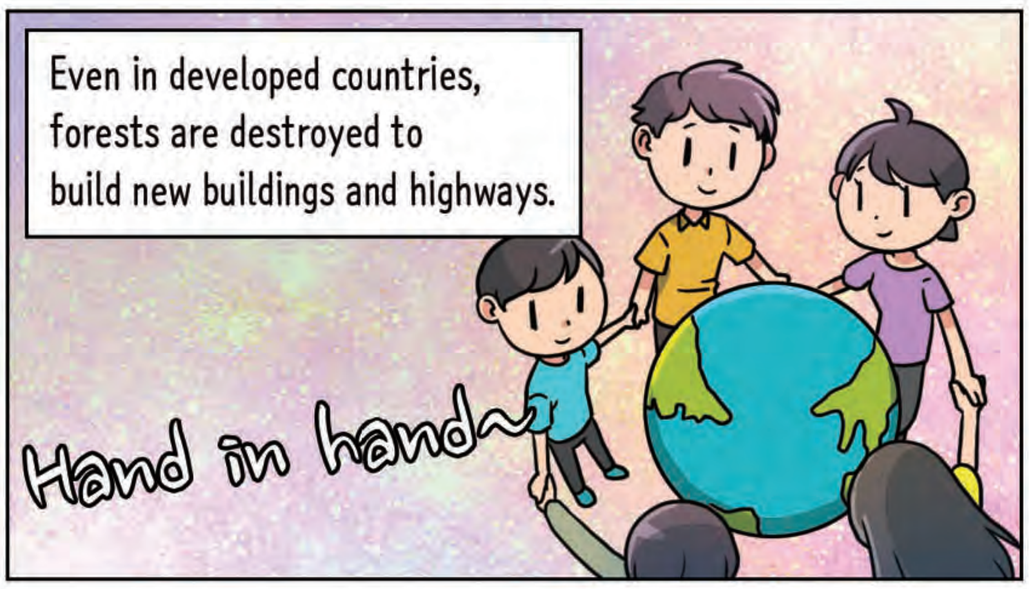


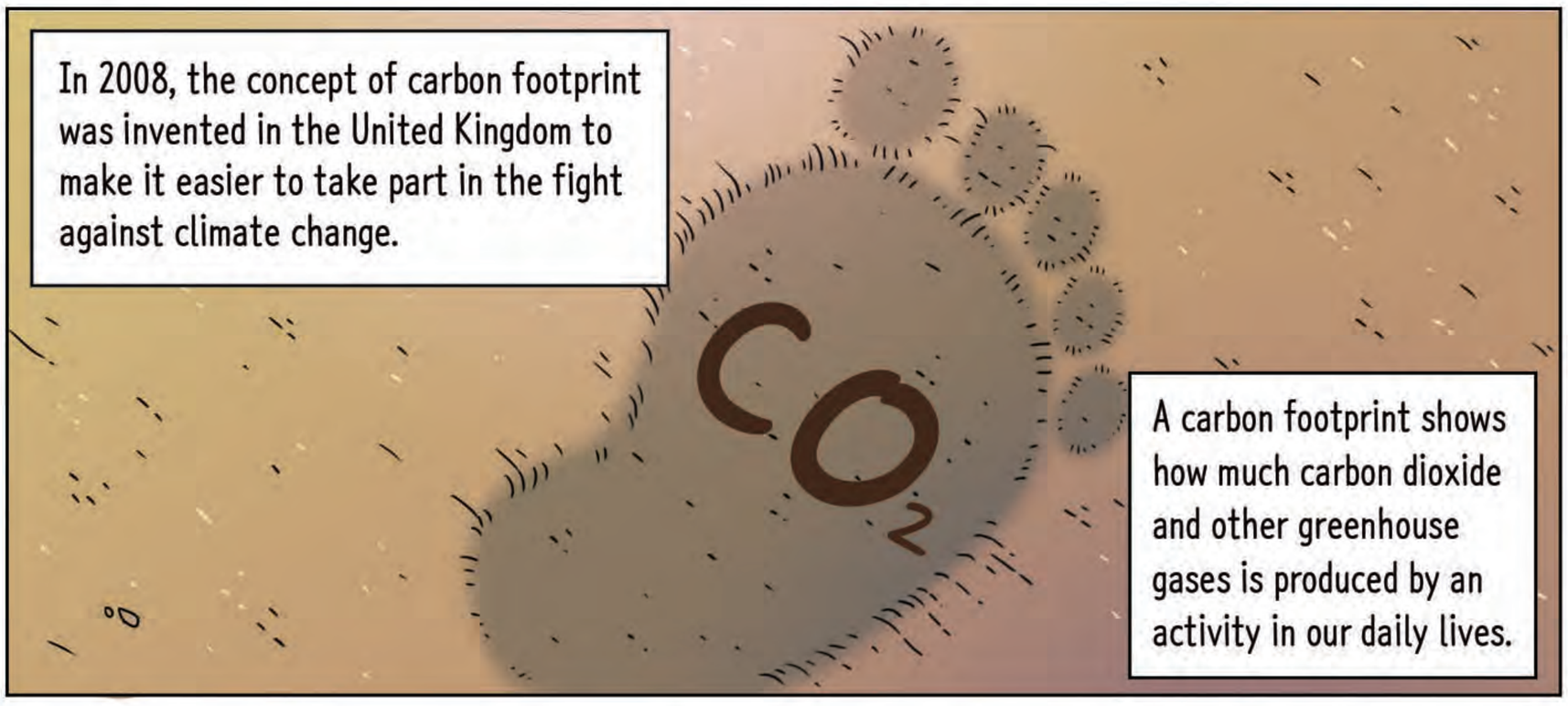


CHAPTER 05

How do forests help fight climate change?

A report by the Intergovernmental Panel on Climate Change (IPCC) highlighted a shocking statistic: About 25% of the world's greenhouse gases comes from the destruction of forests.



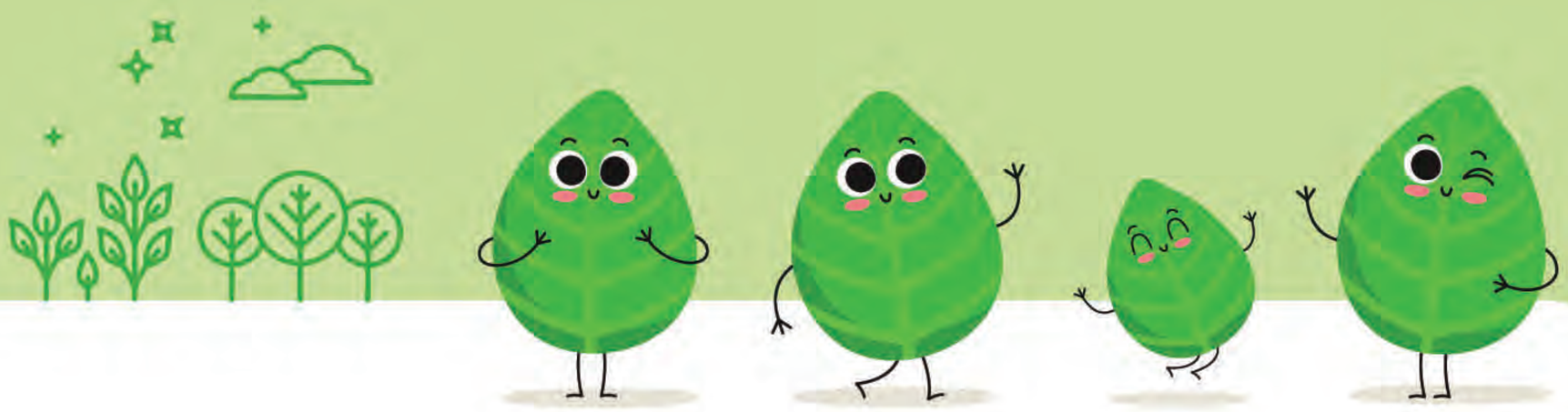


Amount of carbon dioxide produced from daily activities

Reducing the usage of air conditioners by 1 hour every day = CO_2 absorbed by 2 trees per year

Watching 1 hour less of television every day = CO_2 absorbed by 1 tree per year

Using public transportation instead of private vehicles once a week = CO_2 absorbed by 4 trees per year



Small actions can play a big part in protecting our forests.

Turning off the lights when not in use can create the same impact as the planting of trees!

CLICK!

Our actions can make a big difference in fighting climate change and protecting our environment.

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Think of your carbon footprint and reduce the amount of carbon dioxide and other greenhouse gases you produce.

And don't forget forest tending!

Okay! I'll lead by example and tend the forest!

I love trees and forests, and I will try my best to save the Earth!

You are such great kids!

CHAPTER
05

How do forests help fight climate change?

MATCH EACH AGREEMENT TO THE CORRECT GOAL!

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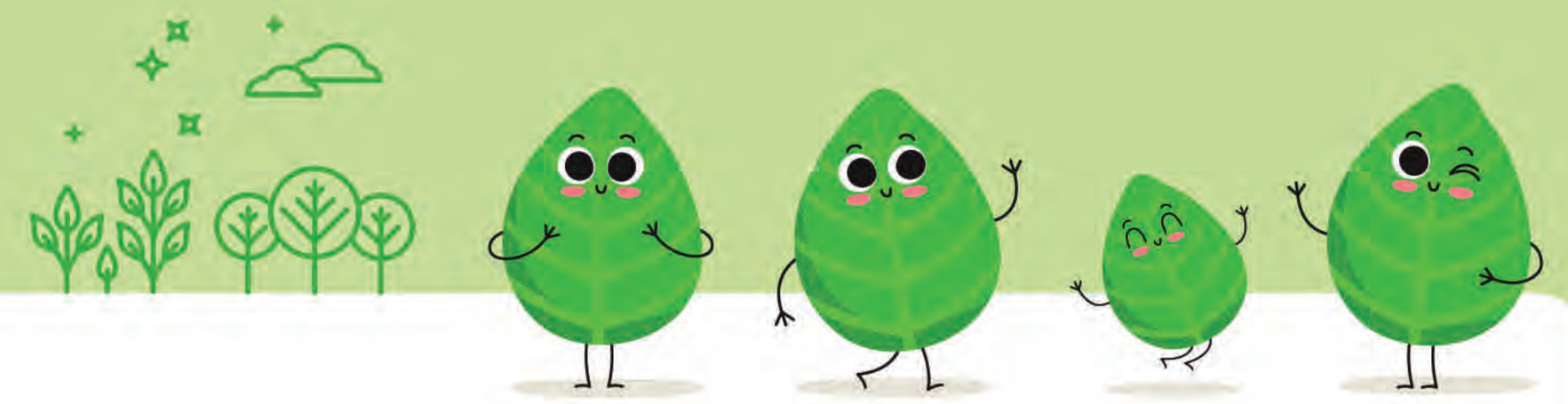

1

United Nations Framework Convention on Climate Change (1992)

2

Kyoto Protocol (1997)

3

Paris Agreement (2015)

A

Sets binding targets for industrialized countries to reduce their greenhouse gas emissions, recognizing that developed countries are mainly responsible for the current high levels of greenhouse gas emissions.

B

Aims to keep global warming below a 2°C increase by the end of the 21st century, and pursues efforts to limit the temperature rise to 1.5°C.

C

154 countries agree to stabilize the amount of greenhouse gases in the atmosphere and keep them at a level that would prevent dangerous climate change.

ANSWER: 1C, 2A, 3B

05 CHAPTER

How do forests help fight climate change?

Climate change is one of the biggest challenges facing the world today. As mentioned in Chapter 4, forests help fight climate change by absorbing harmful greenhouse gases from the atmosphere. Greenhouse gases are certain gases that trap energy from the sun and warm the Earth like a blanket. This is known as the **greenhouse effect.**

Without greenhouse gases, the Earth would be too cold for us to live on! However, if the concentration of greenhouse gases is too high, too much heat is trapped in the atmosphere and the earth warms up, resulting in global warming and **climate change**. Climate change can result in devastating and widespread impacts such as rising sea levels (drowning of low-lying islands), extreme weather events (flash floods, droughts, heavy snow, wildfires) and the extinction of plant and animal species.

Despite forests' potential to reduce greenhouse gases, more and more forests around us are facing a greater threat of being cleared and converted into land for economic or development purposes. In this chapter, we will learn about the interaction between forests and carbon dioxide, one of the most abundant greenhouse gases, as well as some global climate change agreements.

1 Carbon Cycle and Forests

■ CARBON CYCLE

Carbon is everywhere and can be found in many different forms. The carbon cycle shows how carbon, in all of its various forms, moves between plants, animals, oceans and the atmosphere. In the atmosphere, carbon combines with two oxygen atoms to form carbon dioxide (CO_2). As the food we eat contains carbon, our bodies contain carbon too. Carbon is constantly moving and changing from one form to another within the Earth's system. Although nature does a great job in balancing carbon through the carbon cycle, many human activities are upsetting the carbon cycle and leading to global climate change.

■ FORESTS

The role of forests in climate change is twofold! Forests are a sink of carbon dioxide and also a source of greenhouse gas emissions. Trees and soils in forests store carbon. When we cut down forests and convert the land for agriculture or other uses, the carbon stored in trees is released into the air as carbon dioxide again. 25% of global greenhouse gas emissions come from the land use and forestry sector, and about half of this comes from deforestation and forest degradation (EPA, 2017)! Hence, forests act as both a cause and a solution for greenhouse gas emissions.

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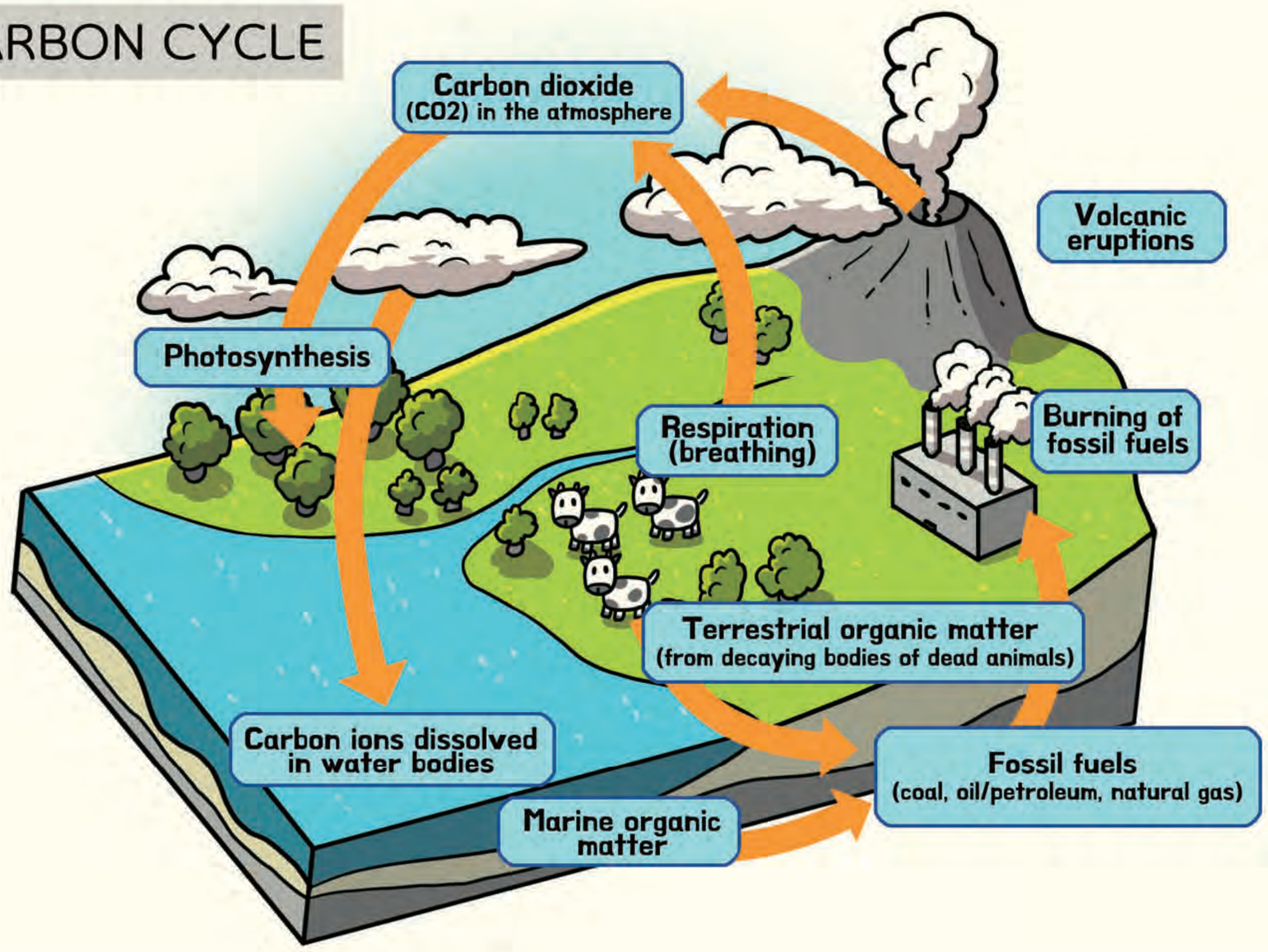
CARBON CYCLE



- During **photosynthesis**, trees and plants absorb carbon dioxide, sunlight and water to make their own food. Carbon becomes part of the plant, and the plant releases oxygen. When trees and plants die and are buried under the soil for many years, they may turn into fossil fuels like coal, oil and natural gas.
- Plants, animals and all other living things **respire** to obtain energy! When they breathe, they inhale air, use the oxygen and exhale carbon dioxide.
- When we **burn fossil fuels** to create energy and electricity, carbon is released back into the atmosphere as carbon dioxide. (Some of it is released as carbon monoxide, a poisonous gas!)
- Ocean water does a lot to remove excess carbon from the atmosphere. Carbon dioxide in the air **dissolves** in seawater to make carbonic acid in the ocean.

Stopping the loss, conversion and degradation of forests provides a cost-effective solution to climate change. Restoring degraded forest land can also help us fight climate change as healthy trees and soils capture carbon. Approximately 2.6 billion tonnes of carbon dioxide (one-third of the CO_2 released from burning fossil fuels) are absorbed by forests every year (IUCN, 2017). Increasing and maintaining forests is therefore an essential solution to climate change. Preventing and controlling forest disasters, such as forest fires and landslides, can also help combat climate change.

How do forests help fight climate change?

2 Global Agreements on Climate Change

To combat climate change, countries of the world have agreed to meet the goals set by agreements under the United Nations Framework Convention on Climate Change (UNFCCC). Member countries of the Convention must provide information on sources and sinks of greenhouse gases in their country, and report on their efforts to reduce emissions. Here's a summary of two major global climate agreements:

■ KYOTO PROTOCOL (adopted in 1997, entered into force in 2005)

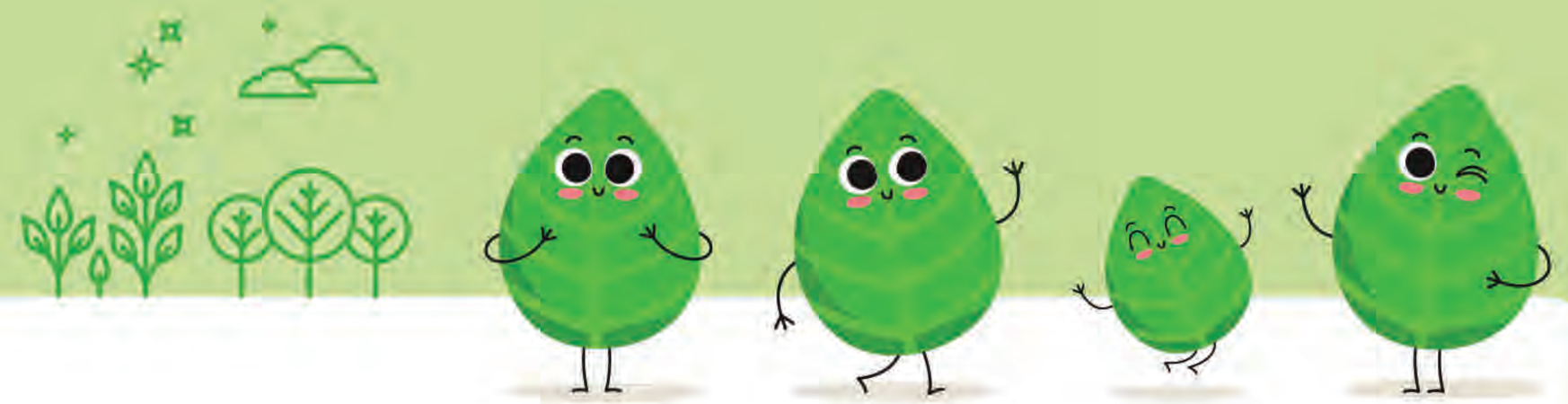
The Kyoto Protocol is the first international agreement that requires industrialized country parties (such as Japan, Russia and the European Union) to reduce their greenhouse gas emissions and set emission reduction targets. As many major emitters (developing countries such as China and India) are not part of the Protocol, it covers only about 18% of total global emissions (European Commission, n.d.). The Protocol established an international trading system that allows countries to earn credits toward their emission targets by investing in emission reduction projects outside the country. The Kyoto Protocol will end in 2020 and be replaced by the Paris Agreement.

■ PARIS AGREEMENT (adopted in 2015, entered into force in 2016)

In hopes of drecreasing the effects of climate chinage, countries around the world came together and promised to reduce their carbon emissions over time by signing the Paris Agreement. The Paris Agreement aims to keep the global temperature rise below 2°C. Unlike the Kyoto Protocol, the Paris Agreement covers both developed and developing countries. If implemented as designed, it has the potential to substantially reduce the risks and effects of climate change. (UNFCCC, 2015)

How can YOU help fight climate change? There are plenty of ways you can take action. In fact, you are already taking an important step towards that effort!

- Learn more about our forests and environment! Talk to your friends and family or write about what you have learned on social media. If everyone understands more about the science, we can work together to find solutions!
- Reduce your carbon footprint by reducing the amount of energy you use! Turn off the lights and unplug appliances when they are not in use.
- Start growing trees and plants in your home or school gardens.
- Walk or bike as much as you can! The transport sector accounts for about 14% of global greenhouse gas emissions.
- Reduce and reuse as much as possible! Factories emit carbon dioxide when making new products. Instead of buying new stuff, trying reusing or fixing things!
- When you are a little older, consider pursuing a career in the environmental sector and help design policies that protect the environment.



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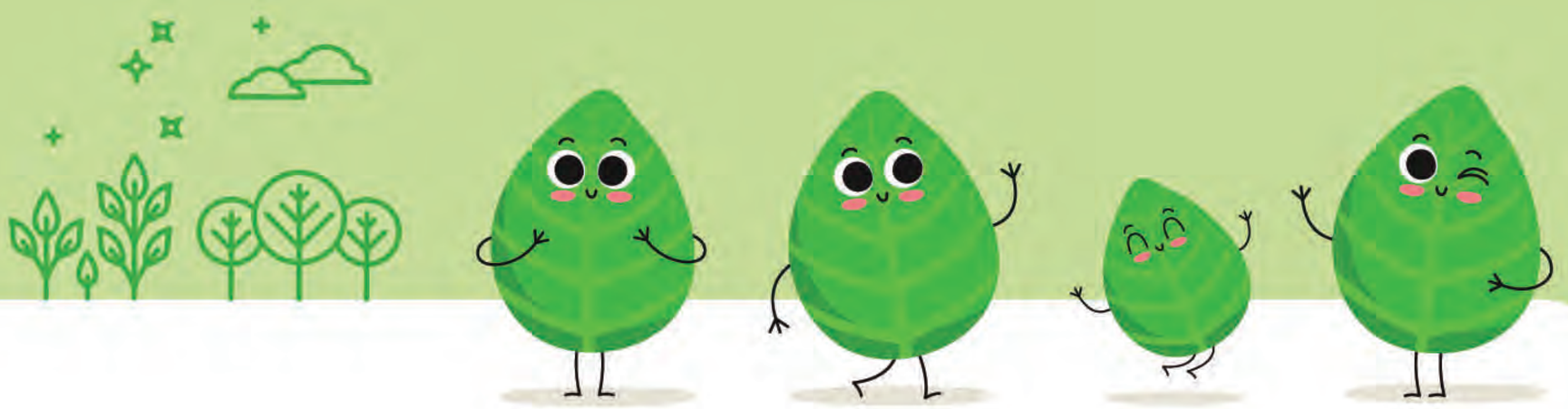
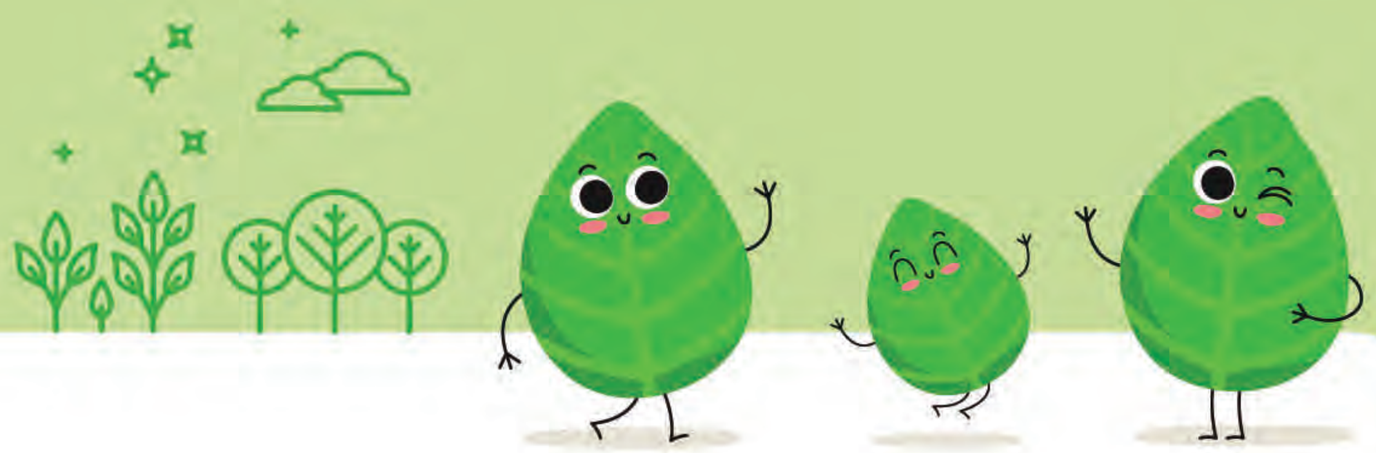



Forests are more than just trees. They provide countless benefits to nature and society! We all need to work together to protect our forests for future generations.

NOTES



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