

# ABOUT

## US AND THIS BOOK

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# Introduction

**Environmental Science Basics** is a course designed for Myanmar adults. It provides a comprehensive introduction of essential environmental concepts and an overview of Myanmar's natural environment. It offers a wide variety of practical activities to equip learners with skills to research and analyze their natural surroundings. It also encourages the learners to actively protect and conserve the habitats and ecosystems we live in.

This book makes up Part I of the "**Sustainable Development and Environmental Conservation curriculum**" series. The curriculum aims to prepare learners to conduct projects and activities for healthy ecosystems and locally sustainable development.

**Environmental Science Basics** is designed primarily for a taught course but can be used as a self-study resource. It is written at a low intermediate level of English and takes between 22 to 30 hours (excluding additional activities) to complete.

## Who is it for?

The book is useful for anyone interested in the subject. Specifically it's for people who:

- Want the skills to analyze their natural environment
- Want to expand or refresh their knowledge of the subject
- Are involved in environmental protection activities
- Are involved in environmental education

It is a useful resource for:

- Various classroom settings including community schools, religious schools, etc.
- Environmental education programs and environmental NGOs and CBOs.

## Components

### 1. Student's Book

The student's Book has 10 lessons. Each lesson should take between 90 to 120 minutes to complete under an instructor's guidance. It contains readings, activities, exercises and practice, discussion and reflection questions. Each lesson suggests an additional activity- mostly beneficial when conducted outside the classroom.

Supplementary material at the back of book includes:

- a **Projects Package** from which students pick an extended project to conduct individually or in groups usually.
- a **Glossary** with definitions and translations.
- **Translations**

### 2. Teacher's Book

The Teacher's Book provides detailed teaching instructions and answers to exercises as well as additional explanations and examples. It also includes advice on **how to use the book**, explanations for **teaching methods used** and an outline of the **learning objectives** for each lesson.

# Structure and methodology

Each of the first 9 lessons focuses on a specific environmental concept. Lesson 10 is longer than the other 9 lessons and gives an overview of Myanmar's natural environment. Projects are to be conducted throughout the course to actively explore real-world environmental issues and problems, to gain deeper knowledge and use newly acquired skills.

This book uses various teaching methods to achieve the desired learning outcomes while catering to the nature of the content and the different learning styles of students. It focuses particularly on an experiential learning methodology to allow students to use their acquired competencies in real situations related to their natural environment. The experiential learning methods used are:

- Practical activities, including observation, experimentation and practice
- Research, including surveys and interviews
- Reflection through discussion, journals
- Projects

## How to use this book

- Use the lessons that are most relevant to your course, curriculum and students.
- Take time to review the learning objectives before each lesson so that you better understand the lesson's aims and can communicate these clearly to the students.
- Read each lesson thoroughly beforehand. Some need additional resources or material.
- The book is written at mostly low intermediate level of English. Depending on your students' level, you might need to use the glossary or dictionary.
- To check students' understanding use the questions provided in the teacher's pages.
- Time indications are approximate. Allow enough time according to your students' abilities and needs.
- Additional activities can be used as homework, assignments or projects. They can be conducted individually or in groups.

Recommendations for the Projects Package:

- It might be beneficial to assign projects from the Projects Package early on in the course, so that students can work on the projects on an ongoing basis (utilizing newly acquired skills in the process). These projects can be completed on an individual basis or in groups. At the end of the course students can present results and conclusions from their projects.
- It is also a good idea to read through the projects beforehand to decide which ones are suitable for individuals and which ones are more appropriate for groups. Additionally, you can plan out how much time you want students to spend on each project.

# Teaching methods used

## Reading

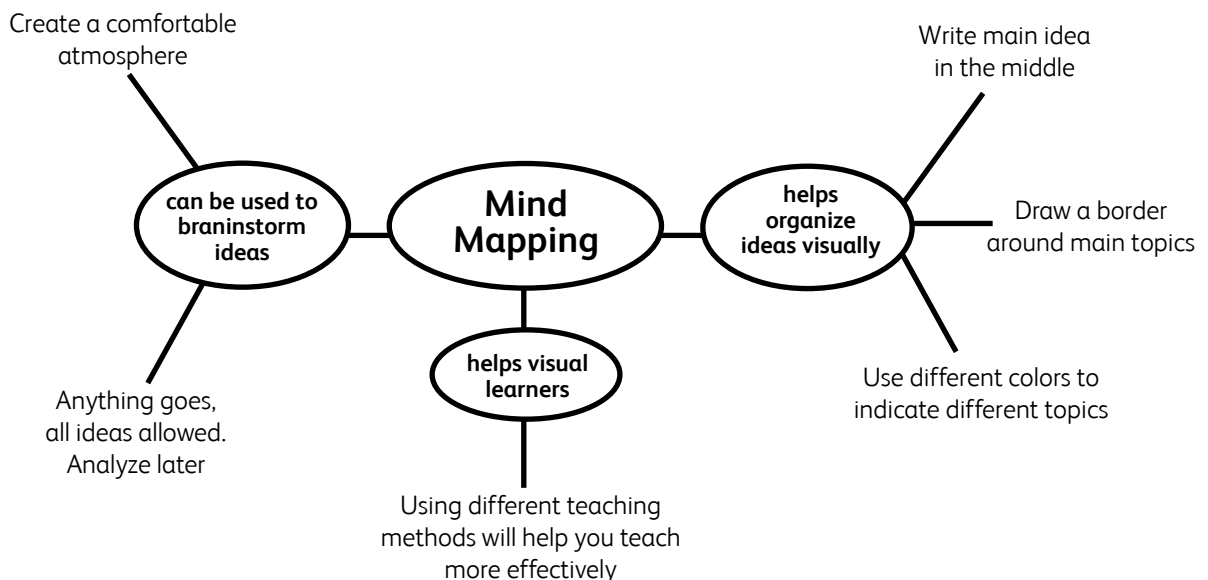
Readings explain new concepts and provide examples. Most readings are followed by questions students may answer individually, in pairs or in small groups. Answers are provided in the teacher's book. The teacher's book also contains additional questions and answers that the teacher may use to measure comprehension (these questions are not contained in the student's book). Teachers can employ a variety of reading techniques such as: 1) teacher reads the text out loud, 2) one student reads out loud, 3) students read quietly. Readings are sometimes in the form of a case study. Case studies give students real world exposure to the concepts covered in the book.

## Brainstorm

Brainstorming is a process for generating ideas and solutions. It is helpful for teachers to check students' previous knowledge. It is usually done in a group setting, but participants can also brainstorm individually or in pairs. During effective brainstorming sessions every participant is encouraged to share as many ideas as they can. There should be no criticism or censure during the brainstorming session. Only when the session is over should ideas be further analyzed or discussed.

## Mind-map

Mind mapping is a technique used to visually organize information. Mind mapping enables students to see the links between different ideas and concepts. It can also be used to generate ideas. Usually the main idea or topic is written in the center of a blank page. The participants add ideas leading off of the central concept, using lines to connect related ideas. Participants should be encouraged to write and draw freely - spelling and tidiness do not matter.



## ★ **Exercise**

Exercises give the opportunity to solidify information contained in the text. Students answer exercises individually, in pairs or in small groups. Once they have completed the exercise the teacher should ask students to share answers out loud or on the board for the whole class.

## 🏃 **Activity**

Activities give the opportunity to apply concepts and practice skills, including in real-life situations. These activities include problem-solving, teamwork, experiments and critical thinking. There are two types of activities. 1) Activities for the classroom focus on teamwork, debate, and presentations. 2) Activities for outside the classroom focus on research, observation, and analysis.

## 🗣️ **Discussion**

Discussions help students formulate ideas, share opinions and gain a deeper understanding of the information covered. Discussions can be done in large groups, small groups or in pairs. Respectful debate is encouraged although students may not always agree with one another. Teachers should create a friendly, supportive environment in which all students feel free to share their ideas.

## 💡 **Reflection**

Reflective questions are designed to encourage students to think about their own opinions and values. There are no right or wrong answers. Teachers should create a supportive atmosphere where all students feel free to share their thoughts. Reflections should be done individually and then be shared in pairs or in small groups.

### **Projects**

Projects allow the acquisition of deeper knowledge, apply newly learned concepts and practice skills through active exploration of real-world challenges and problems. Projects combine and enhance other skills including: leadership, research, problem-solving, creativity and communication skills. Projects are to be conducted over an extended period of time, either individually or in groups.

# Learning Objectives

	Lessons	Objectives
1.	What is Environment?	<ol style="list-style-type: none"> <li>1) Describe what an environment is and provide examples</li> <li>2) Identify the different environments and provide examples</li> <li>3) Explain the interactions between the different environments</li> </ol>
2.	Ecosystems, Habitats & Biomes	<ol style="list-style-type: none"> <li>1) Explain what ecosystems are</li> <li>2) List and describe the major biomes</li> <li>3) Explain how ecosystems change and are affected</li> </ol>
3.	Classification and Biodiversity	<ol style="list-style-type: none"> <li>1) Use the classification system to classify species</li> <li>2) Explain what biodiversity is and its importance</li> <li>3) Identify and analyze biodiversity threats</li> </ol>
4.	Matter, Atoms and Molecules	<ol style="list-style-type: none"> <li>1) Explain what matter is in its various forms</li> <li>2) Recognize chemical and physical changes</li> <li>3) Debate the differences between organic and inorganic food</li> </ol>
5.	Food Chains & Food Webs	<ol style="list-style-type: none"> <li>1) Describe food chains and food webs</li> <li>2) Identify and describe the role of producers, consumers, and decomposers</li> <li>3) Describe how energy and nutrients move along the food chain</li> </ol>
6.	Earth's Cycles	<ol style="list-style-type: none"> <li>1) Explain water, carbon, nitrogen and oxygen cycles</li> <li>2) Recognize the stages of earth cycles</li> </ol>
7.	Natural Resources	<ol style="list-style-type: none"> <li>1) Categorize natural resources</li> <li>2) Explain natural resources management</li> <li>3) Explain the difference between renewable and non-renewable resources</li> </ol>
8.	Energy	<ol style="list-style-type: none"> <li>1) Explain and identify the different types of energy</li> <li>2) Explain the difference between renewable and non-renewable energy</li> </ol>
9.	What is a Healthy Ecosystem?	<ol style="list-style-type: none"> <li>1) Explain the importance of healthy ecosystems</li> <li>2) Determine how healthy an ecosystem is using key indicators</li> <li>3) Indicate how to promote a healthy ecosystem</li> </ol>
10.	Overview of Myanmar's Natural Environment	<ol style="list-style-type: none"> <li>1) Describe Myanmar's biodiversity, climate and its various ecosystems</li> <li>2) Determine the interactions between Myanmar people and their various ecosystems</li> <li>3) Explain major human environments in Myanmar</li> <li>4) Analyze major issues in Myanmar's environments and propose solutions</li> </ol>





Use this page for your notes.

## What is around us?

### Activity: observation



- A** Ask students to look around, both inside and outside the room and answer the questions either verbally or silently to themselves. Students work individually.

**Answers will vary according to your environment.**

- B** Students work in pairs and try to write at least 10 things in each column of the table below. Then, they will share their responses while the teacher records it on the board.

Students work in pairs and then as a class.

**Answers will vary according to your environment. Possible answers:**

Inside, I can see...	Outside, I can see...	I can hear...	I can smell...
Table	Trees	Music	Burning trash
Other student	Dogs	Telephone	Garbage
Shoes	Corn fields	Adults talking	Wet earth from the irrigated fields
TV	Motorbike	Children crying or laughing	Dust
Blackboard	Trash	Traffic	Food cooking
Desks	Plastic bags	Birds singing	Smoke
Chairs	Kids	Dogs barking	Flowers
Pictures	Pagoda	Rain	Perfume
Walls	Football field	Wind	Smog
Plants	Smoke		

Note: Examples such as smoke can be put in more than one column as you can both see and smell it.

## What is environment?

### Reading



Allow enough time for students to read and understand the text. You could also read the text aloud. Read the vocabulary definitions out loud. If students have difficulty to understand the definitions, ask them to look them up in the translated glossary. Students work individually.

Provide additional explanations about the text, if necessary.

To check students' understanding, you can ask questions such as:

- What is a human or built environment?
  - Everything made by humans. Places where humans work, worship and study.
- Provide examples of a socio-cultural environment.
  - Giving alms to monks, the Muslim call to prayer.
- How do the climate, elevation and latitude affect the climate?
  - Higher places and places far from the equator are colder than low places near the equator.

## What is around us?

### Activity: observation

- A** Look around you, both inside and outside the room you are in. What do you see? Close your eyes and take a deep breath. Listen. What do you hear? What do you smell?
- B** Complete the table below and share your answers. Try to write at least 10 things in each column.  
Work in pairs.

Inside, I can see...	Outside, I can see...	I can hear...	I can smell...



Everything you listed is part of your environment. Your environment includes everything that surrounds you, from the ground you walk on to the air you breathe.

## What is environment?

### Reading

Environment is a very broad term and there are many different kinds of environments. An environment can be as small as a few inches of water in a bucket (a great environment for a mosquito to lay her eggs in) or as large as the Himalayan Mountain range; as small as a single classroom or as large as a city such as Yangon. Your digestive system, home to millions of bacteria, is an environment, as is the ocean.



There are different ways to categorize environments:

1. **Human environments or built environments** are the areas where humans live, work, worship and study. The human environment includes everything made by people. Farms, villages, and factories are human environments as are hospitals, pagodas, mosques and mines. All products made by humans such as plastic bags, computers, charcoal, and diesel are all part of the human environment.
2. **Socio-cultural environments** are a society's beliefs, customs, traditions, and practices. Education, religion, politics, and language all affect the socio-cultural environment. People both affect and are affected by the socio-cultural environment in which they live.
3. The **natural environment** is what this book will focus on. The natural environment includes all naturally occurring living and nonliving things in an area - everything on earth that is not created by humans. The land, the sea, the air, and all living organisms are part of the natural environment. The natural environment is affected by several different factors:

- **Climate and weather:** A place with lots of rain will have a different environment from a place with very little rain.
- **Elevation:** Places that have a high elevation are usually colder than places at sea level.
- **Latitude:** Places near the equator are usually warmer than places north or south of the equator.

## Vocabulary

**Climate:** the weather conditions prevailing in an area in general or over a long period

**Elevation:** height above a given level, especially sea level

**Latitude:** distance of a place north or south of the earth's equator

## ★ Exercise

**C** Write each of the items below in the appropriate column. After you complete the exercise with your partner, share your results with the rest of the class. Work in pairs.

- |                      |                      |                         |
|----------------------|----------------------|-------------------------|
| - Plastic bags       | - The call to prayer | - A dam                 |
| - Coal               | - River bank         | - Electricity           |
| - A community forest | - A pagoda           | - Smoke                 |
| - Rubber plantation  | - Marriage           | - An elephant           |
| - A rice paddy       | - Bay of Bengal      | - Taking your shoes off |
| - Wind               | - Voting             | - Man-made fish pond    |
| - Shaking hands      | - Coral reef         |                         |
| - A school           |                      |                         |

Human/Built Environment	Socio-Cultural Environment	Natural Environment



**★ Exercise**

- C** Students in pairs classify each of the items in the appropriate column. Then, they will share their responses as a class while the teacher records it on the board.  
Students work in pairs and then as a class.

Answers:

Human/Built Environment	Socio-Cultural Environment	Natural Environment
<ul style="list-style-type: none"><li>- Plastic bags</li><li>- A community forest</li><li>- Rubber Plantation</li><li>- A rice paddy</li><li>- A school</li><li>- A pagoda</li><li>- A dam</li><li>- Electricity</li><li>- Man-made fish pond</li><li>- Smoke</li></ul>	<ul style="list-style-type: none"><li>- Shaking hands</li><li>- The call to Prayer</li><li>- Marriage</li><li>- Voting</li><li>- Taking your shoes off</li></ul>	<ul style="list-style-type: none"><li>- Coal</li><li>- Wind</li><li>- River bank</li><li>- Bay of Bengal</li><li>- Coral reef</li><li>- An elephant</li><li>- Smoke</li></ul>

# Interacting environments

Read the text and provide as many explanations as possible.

## Discussion



**D** Students discuss and answer the following questions. Students work in groups and then as a class.

**Possible answers:**

- 1) How does the natural environment affect how people build homes?
  - People build homes on poles in flood areas
  - People build homes with thicker walls and glass windows in cold areas
  - Nomads build homes of light materials that are easily transportable
  - People build extra strong homes in earthquake prone areas
  
- 2) How has the natural environment in your area been affected by the human environment?  
Answers will differ depending on your location but may include the following:
  - Forest has been cleared for new rice paddies
  - Mining or industry has polluted the river
  - A new community forest has been planted so we do not have to cut trees in the natural forest
  
- 3) What are some examples of how the socio-cultural environment affects the daily life of people in your community?
  - There are lots of dogs around monasteries because people feed them
  - There are many small teashops and restaurants because many people eat some meals outside of the home
  - There are many different newspapers because people like to keep up with the news

# You and your environment

## Discussion



**E** Students answer the questions or the issues silently on their own. Then, they will share the results with their partners. The final step is to share the answers with the rest of the class.

Think/Pair/Share.

**Answers will vary according to your environment.**

# Interacting environments

Each of these three environments affect and are affected by each other. Here are some examples:

- Expanding a human environment such as building a new housing development will destroy parts of the natural environment.
- The natural environment influences the types of homes people build and the types of materials homes are made out of.
- The natural environment affects human culture. Human diet and clothing is affected by the climate.

## Discussion

**D** Discuss and answer the following questions. Work in groups.

- 1) How does the natural environment affect how people build homes? Give examples.
- 2) How has the natural environment in your area been affected by the human environment?
- 3) What are some examples of how the socio-cultural environment affects the daily life of people in your community?

# You and your environment

## Discussion

**E** What sort of environment do you live in? The questions below will help you better understand the environment in your area. First, answer the questions or the issues silently on your own. Then, share your results with your partner. The final step is to share your answers with the rest of the class.

1. What is the approximate temperature outside? Is this temperature normal for this time of year?
2. When did it last rain? Does it rain a lot in your area? Do you know how much rain your area gets on an average year? Is there a rainy season, or does it rain throughout the year?
3. If you walk from your school for 10 minutes how many different kinds of trees will you see?
4. List the different birds that are common in your area (birds that you see every day). Now, list birds that you see, but only rarely.
5. What kinds of wild animals live in your area? How often do you see a wild animal?
6. Is there a body of water nearby, such as a river, lake or the sea? Is there a forest you can walk to?
7. Are there many crops grown in your area? If so, what kind? Do you grow any of your own food?
8. What sort of fuel do most people use to cook?
9. Where do you get your drinking water from?
10. What happens to the waste in your community? Is there a pick-up service, or do you burn it? Bury it?
11. Where does most of the food you eat come from? Is it grown in the local area? Does it come from somewhere else in Myanmar or from a different country?



# Humans and our natural environment

## Reading

Humans depend on our natural environment for survival. Different people have very different opinions on how much humans depend on our natural environment for survival. Here are some opinions expressed by two different people.

**F** Read the written speeches from an environmental studies teacher and an environmental activist and answer the questions that follow. Work in pairs.

Like all livings, humans depend on the natural environment for our survival. Unlike all other animals though, humans have great power to affect our natural environment. Humans are causing tremendous damage, but we also have the power to make changes that can help to protect, **conserve** and **preserve** our natural environment, rather than harm it. You can have a huge impact on your environment. You can help to improve the natural environment or hurt it. Which do you prefer? The choice is yours.



## Vocabulary

**Conserve:** protect (something, especially an environmentally or culturally important place or thing) from harm

**Preserve:** maintain (something) in its original or existing state

**Habitat:** the natural home or environment of an animal, plant, or other organism

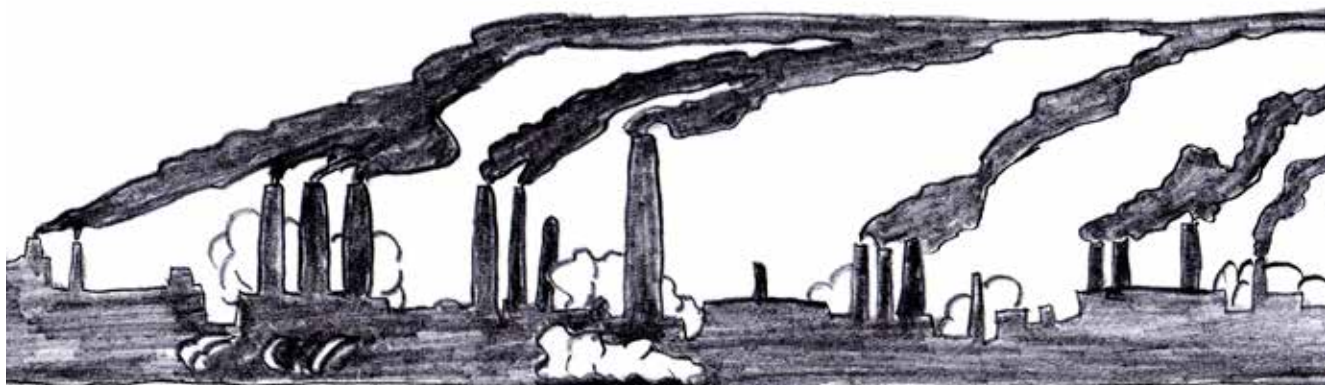
**Fertile:** producing or capable of producing abundant vegetation or crops

**Carbon dioxide:** a colorless, odorless gas produced by burning carbon and organic compounds and by respiration



Our natural environment is in trouble. There are many problems that are harming our natural environment. Most of these problems are caused by humans. For example, cutting down natural forests to plant palm oil plantations or building homes destroys the **habitat** for many animals. Building dams stops **fertile** soil from flowing downstream. Driving cars produces **carbon dioxide**, which contributes to global warming. Plastic bags kill animals (such as turtles), cause pollution and block drains.

- 1) How are humans impacting the environment?
- 2) What other environmental problems can you think of?
- 3) What major environmental problems are in your community? in Myanmar?





# Humans and our natural environment

## Reading



- F** Students read the written speeches from an environmental studies teacher and an environmental activist and answer the questions that follow. Students work in pairs and then as a class.

You could also read the text aloud. Read the vocabulary definitions a loud. If students have difficulty to understand the definitions, ask them to look them up in the translated glossary. Provide additional explanations about the text, if necessary.

### **Possible answers:**

- 1) How are humans impacting the environment?
  - Humans are expanding industry factories
  - Humans throw and burn rubbish
  - Humans cut trees and build more cities
  - Humans drive cars
  
- 2) What other environmental problems can you think of?
  - Pollution decreases the well-being and health of living things
  - Mining pollutes the rivers
  - Factory waste damages the soil, water and air
  
- 3) What major environmental problems are in your community? in Myanmar?
  - Pollution from mining and factories, which is harming our health and wellbeing
  - Forests are being cut for agriculture and to build new houses
  - Families are cutting trees for fire wood
  - There is a lot of trash all over town
  - People are burning trash which is making the air very smoky
  - People are getting sick because sewage from poorly built toilets is leaking into our freshwater supplies

## Reflection



- G** Students answer the first question. If the answer is yes, they then list the reasons why we should protect the environment. The class should try to agree on the most important actions that should be taken to protect the environment. Students discuss in groups or as a class.

### Possible answers:

- 1) Should we try to protect our natural environment? If yes, why?
  - A damaged environment is ugly and hurts humans by causing disease and sickness
  - Destruction of habitat is causing many animals and plants to become extinct
  - Once an environment is very damaged, it is difficult or impossible to get it healthy again
  
- 2) How can we protect our natural environment?
  - Compost organic waste instead of burning it
  - Use less water
  - Clean the trash in my neighborhood
  - Educate people in my community
  - Plant trees
  - Stop using plastic bags

## **Additional Activity**

The activity could be set as homework.

## Reflection

**G** Answer the following questions. Discuss as a class.

- 1) Should we try to protect our natural environment? If yes, why?
- 2) How can we protect our natural environment?

### **Additional Activity**

List all the positive and negative aspects of your human/ built, socio-cultural and natural environment. You can collect information by brainstorming, observing your neighbourhood/ city? village and interviewing your community members.



## Ecosystems

### Brainstorm

- A** Read the definition of “ecosystem” in the box and its translation in the glossary and brainstorm all the words you associate with it. Work in pairs.

### Vocabulary

A **habitat** is the natural home or environment of a plant or animal. It is similar to an ecosystem, except that **ecosystems** emphasize community and the interaction of plants and animals living in that community.

### Reading

#### What is an ecosystem?

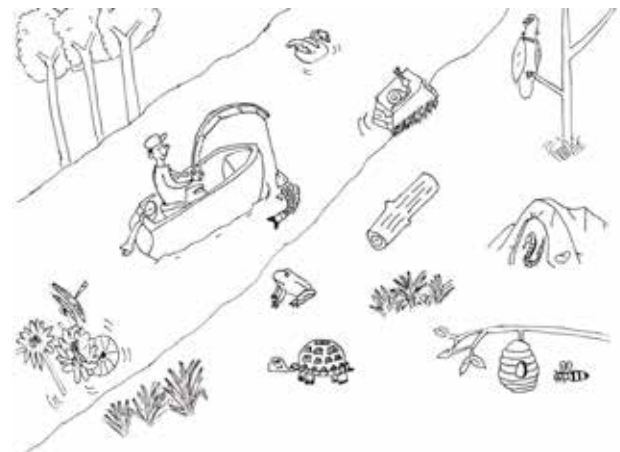
An ecosystem is a community of living organisms and nonliving factors interacting as a system in a particular area. All parts of the community, both the living and the nonliving, affect one another. Examples of different ecosystems include a mangrove forest growing along the Irrawaddy river in the delta, a rice paddy, and a coral reef. Even the inside of your body is an ecosystem, alive with many different kinds of bacteria.

All the living organisms within an ecosystem have a role to play in the health of an ecosystem.

Just as a bird needs two strong wings to fly, the health of an ecosystem depends on all parts working together. Ecosystems are also affected by non-living things as well as natural forces and conditions. For example, due to climate change, the oceans are changing – they are getting warmer and more acidic. This is harming the coral reef ecosystem. Changing any part of the community – whether that part is living or nonliving - can have a huge impact on the entire ecosystem’s health and nature.

### ★ Exercise

- B** Look at the picture of the river ecosystem and list the different organisms. Work in pairs.



### Discussion

- C** Discuss and answer the following questions. Work in groups.

- 1) Eagles do not actually live in the river. Why are they part of the river ecosystem?
- 2) Imagine that a large factory is built on the edge of the river. List five ways this might harm the river ecosystem.
- 3) List at least 3 nonliving factors that affect a river ecosystem.

## Ecosystems

 **Brainstorm**

- A** Students read the definition of “ecosystem” in the box and its translation in the glossary and brainstorm all the words they associate with it. Students work in pairs and then share as a class

**Possible answers:** Oceans, desert, river, animals, forest, rice paddy

 **Reading**

Students read the text. If students have difficulty understanding it, provide more explanation.

 **Exercise**

- B** Ask students to study the picture of the river ecosystem then ask them to add additional organisms that may live there. Examples may include dragonflies, crayfish, and turtles. Work in pairs.

**Answers:**

Snails Frogs Fishermen	Fish Plankton Snakes	Insects Water lilies Eagles	Bacteria Water birds Marsh grass
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 **Discussion**

- C** Students discuss and answer the questions. Student work in groups.

**Answer:**

- 1) Eagles do not actually live in the river. Why are they part of the river ecosystem?
  - Because they depend on river animals such as fish and frogs for their food
- 2) Imagine that a large factory is built on the edge of the river. List five ways this might harm the river ecosystem .

List at least 3 nonliving factors that affect a river ecosystem.

- Grass and other plants growing on the riverbank would be destroyed
- Young fish, frogs and other animals living in the grass would lose their habitat and may die
- Animals that eat frogs and young fish such as snakes, eagles and large fish, would lose their food source.
- The factory may pollute the river, harming many organisms
- Fishermen may lose their livelihood as the population of large fish decreases

3) List at least 3 nonliving factors that affect a river ecosystem.

**Answer:**

- The amount of rainfall – if there is too much rain the river may flood. If there is too little, the river may dry up.
- The elevation (how steep) the land is where the river flows – If the area is very steep, the river will flow quickly. If the land is flat, the river will be shallower and flow more slowly. The speed of the river flow affects the types of animals that live in that part of the river.
- Temperature – if the area is cold, the river will freeze. If the temperature of the river rises due to global warming the organisms that live there will be affected.
- How close the river is to the sea – The end of a river that flows into the sea will be partly especially if there are high tides. Some organisms can tolerate partly salty water but other organisms cannot.
- A dam – dams will change the way a river flows. They stop the flow of nutrient rich sediment downstream and prevent fish from swimming from one side of the dam to the other.

 **Case study**



**D** Ask the students to read the case studies individually and answer the questions in pairs. Then, they will share with the class. Students work in groups.

Ask students if any of them have ever seen a Burmese python. Tell them that these snakes can grow 19 feet long. If possible measure 19 feet on the classroom floor to show students how long that is.

**Answer:**

- 1) Why are native birds, rabbits, foxes and raccoons so easy for the Burmese pythons to catch?
  - Because they never learned how to protect themselves from large snakes such as the Burmese Python.
- 2) Burmese pythons rarely eat bobcats, panthers, and coyotes. Why did the population of these animals decrease due to the invasion of the Burmese python?
  - Because the pythons ate most of the food these predators eat.
- 3) What kind of climate do Burmese pythons like?
  - They like hot wet climates.

**E** Ask students to read the second case study and complete the mind map on their own. Ask a volunteer to draw the Mind Map on the board. Students work individually.



## Case study

- D** Read the case studies individually. Then, work in pairs answer the questions. Share your ideas with the class. Think/Pair/Share.

### Burmese Pythons cause damage in Florida!

A new visitor, the Giant Burmese Python, is killing off the native mammals of the Florida Everglades national park. In areas where the python is well established, rabbits and foxes have completely disappeared. Sightings of animals such as raccoons, opossums, and deer are down by more than 90% since the Burmese Pythons were first seen in the Florida Everglades in the 1980s.

How did the Giant Burmese Python travel thousands of miles from the tropical forests of Myanmar to Florida?

With the help of humans! Perhaps afraid of the snake as it grew so large, people released their pet pythons into the wild. Other snakes escaped.

The snakes loved their new ecosystem. They adapted very well to the hot, wet climate of the Florida Everglades because it was similar to their native environment. There were many animals to eat including birds, rabbits, foxes, raccoons, and baby deer. The pythons discovered that these animals were easy to catch because they never learned to be afraid of large snakes since there were none in the area. So, the pythons had a very easy life, grew and reproduced. Now they are very well established in the Florida Everglades.

The creatures of all ecosystems are interconnected. As the population of prey animals such as rabbits, opossums and deer declined, the population of predators, which rely on those animals, such as bobcats, panthers and coyotes, declined as well.

- 1) Why are native birds, rabbits, foxes and raccoons so easy for the Burmese pythons to catch?
- 2) Burmese pythons rarely eat bobcats, panthers, and coyotes. Why did the population of these animals decrease due to the invasion of the Burmese python?
- 3) What kind of climate do Burmese pythons like?

- E** Read the case study and mind map all the changes that happened when the wolves disappeared from Yellowstone. Work individually.

### Re-introduction of Wolves Causes an Avalanche of Change

Many years ago, wolves lived in the area that is now Yellowstone National Park in northern USA. But hunters and farmers killed them all. Wolves love to eat elk, a large deer like animal. When there were no more wolves left, the elk population grew and the elk didn't have to move around so much since there were no more wolves to run away from. In the wintertime they stayed near rivers and streams where they could eat willow trees. Since they had plenty of food, the elk population grew. As the years went by, more and more willow trees disappeared.

Beavers also eat willow trees. As the willow trees disappeared, the population of beavers declined because they did not have enough to eat. Beavers build dams across streams out of sticks. These dams provide still, deep water, which is a good ecosystem for young fish. As the population of beavers declined, the number of beaver dams did as well. This caused the population of fish to decline.

Then in 1995, the wolves were re-introduced to Yellowstone Park. The wolves hunted the elk, so the elk had to move all the time. They could no longer stay all winter near the streambeds eating all the willow trees. So the willow trees grew back. What do you think happened then?

There was more food for the beavers, so the beaver population increased. They built more dams so there were more ecosystems suitable for young fish, so the population of fish increased as well. The population of songbirds also increased, because they like to live in the willow trees during the summer. In addition, there was less erosion along the stream banks because the willow trees helped to prevent it.

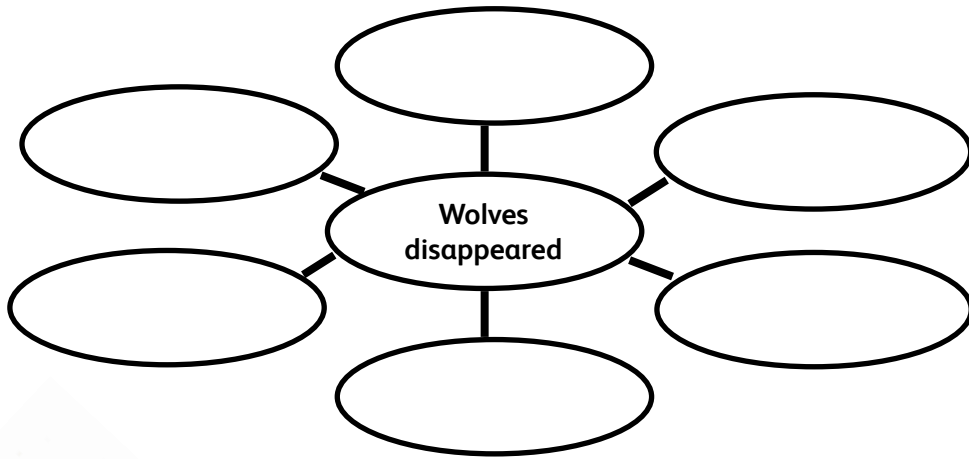
## Vocabulary

A **native species** is an organism that has been living in an area for many years.

They live in the area naturally and were not brought there by humans.

An **invasive species** is a plant, insect, or animal that was 1) brought to an area, usually by humans, and 2) causes serious environmental change.





All members of an ecosystem community are interconnected. When one community member changes, the other community members change in response. Each cause (change) has an effect.

### **Activity: cause and effect**

**F** Based on the case studies, complete the effect chains individually and then share with the class.

Burmese Pythons were released into the Florida Everglades.	➔	Effect A	➔	Effect B	➔	Effect C
		_____		_____		_____
		Because		Because		Because
		_____		_____		_____

Wolves are reintroduced	➔	Effect A	➔	Effect B	➔	Effect C	➔	Effect D
		_____		_____		_____		_____
		_____		_____		_____		_____

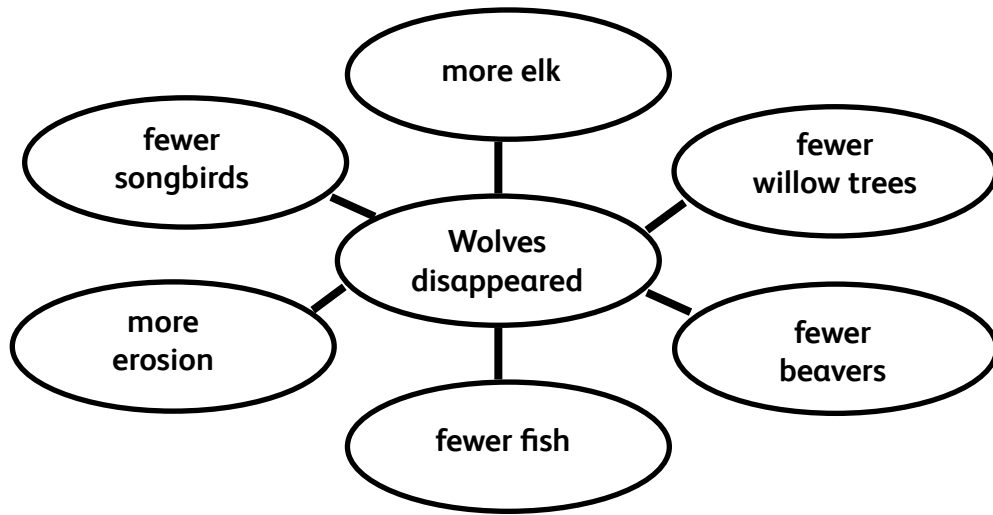
## What are biomes?

The natural environment can be categorized into biomes. Biomes are regions in the world with similar climate (rainfall, temperature, and elevation). This means that the plants and animals that live in a particular biome are also similar. Both plants and animals are well adapted for the particular biome they live in. On our planet, there are 6 major biome types. Each biome contains many different ecosystems.

### **Reading**

**G** Read about one biome and teach the class about it. Work in groups.





**Activity: cause and effect**



**F** Based on the case studies, students complete the effect chains individually and then share with the class. Think/share

**Answer:**

Burmese Pythons were released into the Florida Everglades.	<b>Effect A</b>	<b>Effect B</b>	<b>Effect C</b>
	The pythons could easily kill the small mammals in the area <b>because</b> they never learned to fear large snakes since no large snakes used to live in the area before the introduction of Burmese pythons	The populations of birds and animals such as racoons, opossum and rabbits decreased significantly <b>because</b> they were eaten by the pythons.	The populations of predators decreased <b>because</b> their prey was significantly reduced.

Wolves are reintroduced	<b>Effect A</b>	<b>Effect B</b>	<b>Effect C</b>	<b>Effect D</b>
	The elk are forced to keep moving in order to escape the wolves. They no longer can settle down near the streambeds during the winter	The willow trees increased in size and number.	The population of beavers increased.	The population of fish increases as the beaver dams provide more cold, shaded water.

## What are biomes?

**Reading**



**G** Divide the class into 6 groups. Each group reads and discusses one biome and then teaches the class about it. Students work in groups.

### **Additional information about some biomes.**

**According to your students' level, you can choose whether to provide the additional information or not.**

#### **Marine/aquatic:**

Estuaries, areas where freshwater streams or rivers merge with the ocean, are another important ecosystem. The water, a mixture of salty and fresh, supports many types of organisms including shellfish, crabs, and birds.

Oceans have three layers or zones: The topmost layer, called the **Sunlit zone** averages about 600 feet deep. There is enough sunlight to support plants and small organisms called plankton, which are an important food source for many marine animals. About 90% of all marine life lives in the sunlit zone. The middle layer is called the twilight zone. Its average thickness runs from about 600 to 3000 feet deep. There is not enough sunlight here to support plant life, but it is home to some animals, which have adapted to low light settings. Some of these animals produce their own light through a chemical process called bioluminescence. The bottom layer of the ocean, everything below 3000 feet is called the **midnight zone**. About 90% of ocean water is in this zone, but it is home to very few animals. Here the water pressure is extremely high and it is completely dark and very cold. The few animals that live here feed on bacteria and get their energy from cracks in the earth at the bottom of the ocean.

#### **Fresh Water**

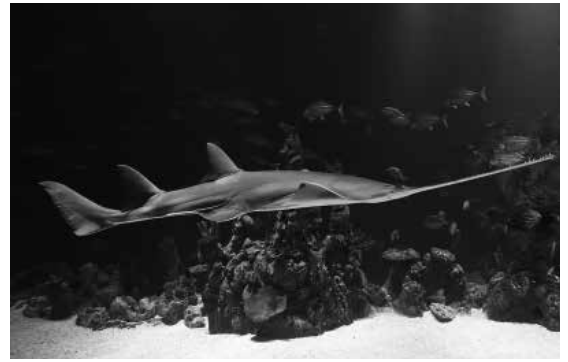
About 70% of all available fresh water is used for agriculture. This is causing some rivers and underground water sources to run dry.

#### **Grassland**

Animals that live in grasslands have adapted to the grassland environment, which offers plenty of food in the form of grass but little shelter from predators. Many wild grassland animals have hooves and long legs so they can run fast to escape predators. Examples include deer, antelope, buffalo, and horses. Other grassland animals such as prairie dogs burrow underground. In North America grasslands are called prairies. The North American prairies found in the center of the country are valuable farmland as they provide some of the richest soil in the world. In Eurasia grasslands are called the steppes.

**Marine/aquatic:**

The marine biome is the largest biome on earth, covering about 70 % of the earth's surface. It includes 5 oceans (the Pacific, Atlantic, Indian, Arctic, and Southern) as well as many gulfs and bays. Coral reefs are one of the most important parts of the marine biome as they provide food and shelter to many types of marine creatures. This biome is changing due to **global warming** which is raising ocean temperatures and making the ocean more acidic. Humans are also harming the ocean biome through pollution and over fishing.

**Freshwater**

The freshwater biome is essential to all life forms except for those that live in the sea. Most of the fresh water (non salty water) on earth is either frozen (in glaciers or icecaps) or is underground. The freshwater biome includes lakes, rivers, and wetlands. The freshwater biome provides homes to many different kinds of plants and animals, including fish. This biome also provides water for drinking and irrigation. Many rivers and lakes are becoming polluted and some are shrinking because humans are using so much water. In addition, many rivers are used for dams to provide electricity.

**Forest**

There are different types of forests on our planet, but all forests have two things in common: they have lots of trees and they breathe. While humans and animals breathe in oxygen and breathe out carbon dioxide, trees breathe in carbon dioxide and breathe out oxygen. Three of the most important types of forests are tropical, temperate or deciduous, and mangrove. **Tropical** are warm and wet and most grow near the equator. There are some tropical rain forests in Myanmar. Amazon is the largest tropical forest in the world. **Temperate or deciduous** forests have four distinct seasons: winter, spring, summer and fall. Most of trees growing in temperate forests are deciduous trees, they lose their leaves every year. **Mangrove forests** are found in warm, muddy areas along the equator. They grow where land, freshwater and the ocean meet. Mangroves provide homes to many marine creatures such as fish, crabs, and shrimp. Because forests, especially tropical forests, provide so much oxygen, **deforestation** is damaging our earth's atmosphere.

**Tundra**

The tundra is the coldest of all biomes and covers about one fifth of the earth's surface. **Arctic tundra** is located in the Arctic, encircling the north pole. **Alpine tundra** is located around the world on mountaintops where the elevation is too high for trees to grow. Most plants are short and almost no trees grow in the tundra due to the short growing season and permafrost, which is a layer of permanently frozen subsoil. Animals adapt to the long cold winters by breeding and raising their young very quickly during the summer. Many animals hibernate in the winter. There are very few reptiles or amphibians in the tundra biome due to the very cold temperatures.



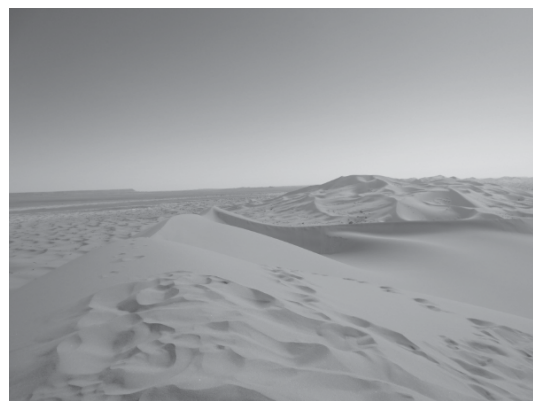
### Grassland

Grasslands, found in every continent except Antarctica, are large, rolling open spaces. In grasslands, the average annual precipitation is great enough to support grasses, and in some areas a few trees. The precipitation is so irregular that drought and fire prevent large forests from growing. Trees grow only near rivers and streams. There are two different types of grasslands; tall-grass, which are humid and very wet, and short-grass, which are dry, with hotter summers and colder winters than the tall-grassland.



### Desert

A desert is an area with very little rain. Like the tundra, deserts cover about one fifth of the earth's surface. There are both hot deserts, such as the Sahara Desert in northern Africa and cold deserts, located near the Arctic. Animals in this biome are so well adapted to the lack of water that some never drink water at all. They get all the water they need from the plants they eat. Most animals live in holes underground and are nocturnal (meaning they are awake at night and sleep during the day) to avoid the fierce sun. Plants that live in the desert are also well adapted to the lack of water. Some store water in their stems. Other plants have very large roots systems or few leaves.



## Activity: matching

**H** In groups of six (each student having studied a different biome), read and match the facts with the appropriate biome. Work in groups.

Marine	Freshwater	Forest	Tundra	Grassland	Desert

A	The coral reef is one of the most important parts of this biome
B	This biome provides one of the most important natural resources
C	This is the coldest of all biomes
D	This biome has the shortest growing season
E	Wetlands are an important part of this biome
F	Animals hibernate in this biome
G	Most animals that live in this biome live underground and come out at night
H	This biome "breathes"
I	Trees in this biome grow near rivers and streams
J	This covers a very large surface of the earth
K	This biome is being harmed by pollution
L	This biome is found everywhere except in one continent
M	This biome is found in two types in Myanmar
N	Animal in this biome are active at night

**Activity: matching**

- H** Divide the students into group of 6. In one group, each student should have studied a different biome. Students read and match the facts with the appropriate biome.  
Students work in groups and then share with the class.

**Answers:**

Marine	Freshwater	Forest	Tundra	Grassland	Desert
AJK	BE	HM	CDF	IL	GN

Note : Some of the answers can go into more than one category.



**I** Students answer the questions and discuss how these biomes and ecosystems affect their life.  
Students discuss in groups or as a class.

**Answers:**

- 1) What biomes are found in Myanmar?
  - Tropical and mangrove forests, marine, freshwater (rivers, lakes), and grassland biomes
- 2) What biome is your community in?

**Answers will vary. Possible answers may include:**

- Rice paddies, fish ponds, streams and rivers, a marsh or swamp, an unused lot that has become overgrown, a community forest, a bamboo forest, the monastery garden, wheat fields, rubber or palm oil plantations
- 3) How does the biome affect the lives of people who live there?
    - People living near a marine biome or freshwater biome may eat lots of fish and may make their living from fishing. They also probably have to take precautions against flooding and storms.
    - People living in a desert biome need to conserve water.
    - People living in a grassland biome may raise horses, cattle, sheep and other grass-eating animals.
    - People in grassland biomes may use animal dung for fuel instead of wood.
    - People in the tundra depend on warm clothes and heating fuel for their survival.

**Additional Activity**

This activity could be set as homework.

## Reflection

**I** Answer the questions below and discuss how these biomes and ecosystems affect your life. Discuss in groups.

- 1) What biomes are found in Myanmar?
- 2) What biome is your community in?
- 3) How does the biome affect the lives of people who live there?

## Additional Activity

Research more information (**online or in a library**) about the ecosystems and write in the table the types of plants, animals and soil you might expect to find in those environments.

Ecosystem (Biome)	Plants	Animals	Soil



## Classification

### Activity: observation

- A** Look around, both inside and outside the room you are in, and classify the things you see, hear and smell. Work in pairs.

Living organisms			Non-living things	
People	Animals	Plants	Natural	Built

### Reading

#### CLASSIFICATION

**Classification** or Taxonomy is a system scientists have developed to categorize all living things, from mushrooms to humans. There are 7 different levels. The top level is called Kingdom and the bottom level is called Species. (See FAST FACTS: How Humans are classified.)

#### SPECIES

A **species** is a group of living organisms (including plants, animals, birds, insects and bacteria) that can produce fertile young together. No one knows exactly how many species there are on our planet. New species are still being discovered. Sadly, many more species are disappearing, often through human interference. When a species has entirely disappeared, it is called extinct. A species is called **endangered** or **threatened** when very few members of that species are left. An endangered species may soon become extinct unless steps are made to protect it. Some countries make laws to protect endangered species. These laws include forbidding hunting of threatened species and protecting their natural habitat.

#### Animal Classification

- Mammals** = give birth to live young and nurse them with milk. They have hair or fur and they are warm-blooded.
- Birds** = have feather and wings. They are warm-blooded and lay eggs.
- Fish** = breath underwater. They have scales and fins. They are cold-blood and lay eggs.
- Reptiles** = have scales and dry skin. They lay eggs and they are cold-blooded.
- Amphibians** = live on land and water. They have moist skin and webbed feet.
- Invertebrates** = have no bones and they are cold-blooded.

### ★ Exercise

- B** List the animals in the corresponding categories. Work in pairs.

Mammals	Birds	Fish	Reptiles	Amphibians	Invertebrates	
						Owl, dog, iguana, ant, cat, catfish, lizard, hornbill, shark, toad, spider, dolphin, parrot, salmon, frog, butterfly, salamander, boa, constrictor

#### FAST FACTS

##### How Humans are classified

**Kingdom:** Animalia

**Phylum:** Chordata

**Class:** Mammalia

**Order:** Primate

**Family:** Hominida

**Genus:** Homo

**Species:** Homo sapiens

#### Vocabulary

**Extinct** – A species of animal, insect, bird or other living organism that no longer exists

**Endangered:** a species of plant or animal that may soon become extinct.



## Classification

### Activity: observation



- A** Students look around, both inside and outside the room, and classify the things they see, hear and smell. Students work in pairs.

Answers will vary according to your environment. Possible answers:

Living organisms			Non-living things	
People	Animals	Plants	Natural	Built
Little boy Teacher Students	Dog Mouse Fish	Flower Rice plant Bamboo	Metals Mineral Clay	Furniture Paper Cars

### Reading



Students read the text individually. To check their understanding, ask:

- How are humans are classified?
- What is an extinct species?
- How can endangered species be protected?

### Exercise



- B** Students list the animals in the corresponding categories. Students work in pairs.

Answers:

Mammals	Birds	Fish	Reptiles	Amphibians	Invertebrates
Dog Cat Dolphin	Owl Hornbill Parrot	Catfish Shark Salmon	Lizard Iguana Boa constrictor	Salamander Frog Toad	Butterfly Spiders Ant

## **Activity: guess**



**C** Using the numbers on the right, students guess the answers to the questions. Students work individually and then share as a class.

- 1) How many different species of living organisms are there in the world? 8.7 million
- 2) How many different species do you think there are in each of the following categories:

Mammals 5,416

Fungi 5.1 million

Flowering plants about 400,000

Insects 950,000

Fish 29,300

## **Biodiversity**

### **Brainstorm**



**D** Students read the definition of “biodiversity” in the box and its translation in the glossary and brainstorm all the words they associate with it. Students work in pairs.

### **Reading**



Students read the text individually. To check their understanding, ask:

- What is a biodiverse place like?
  - It is an area with many different kinds of plants, animals, insects, birds and other organisms.
- Why is biodiversity important?
  - Because biodiversity helps protect the health and well being of our entire planet and all the creatures that live here.
- How many new species were recently discovered in the Greater Mekong?
  - 139
- What countries are included in the Greater Mekong?
  - Myanmar, Cambodia, Laos, Thailand, Vietnam.

## Activity: guess

**C** Using the numbers on the right, guess the answers to the questions. Work individually.

- 1) How many different species of living organisms are there in the world? \_\_\_\_\_
- 2) How many different species do you think there are in each of the following categories:

Mammals \_\_\_\_\_      Insects \_\_\_\_\_  
Fungi \_\_\_\_\_      Fish \_\_\_\_\_  
Flowering plants \_\_\_\_\_

29,300	5.1 million
about 400,000	8.7 million
5,416	950,000

# Biodiversity

## Brainstorm

**D** Read the definition of “biodiversity” in the box and its translation in the glossary and brainstorm all the words you associate with it. Work in pairs.

## Reading

**Biodiversity** refers to the many different kinds of species of living organisms on Earth including plants, animals, insects, algae and **bacteria**. Biodiversity can also exist within the same species of an organism.

A bio-diverse area has many different kinds of animals, plants, and other organisms, all of which work together to create a healthy ecosystem. Rain forests and coral reefs are the most bio-diverse environments on earth.

### WHY IS BIODIVERSITY IMPORTANT?

Biodiversity is very important to the health of our planet and loss of biodiversity is one of the most damaging environmental problems. People are an important factor in changing biodiversity - we are the only living thing that can change or destroy biodiversity on such a large scale. On the other hand, we are also the only species that can take action to protect biodiversity.

#### *An example of biodiversity's importance:*

A patch of forest can grow more and bigger trees if the soil is biodiverse, full of many different organisms that improve the quality of the soil, such as earthworms and microbes.

#### **Fast Fact: New species in the Greater Mekong**

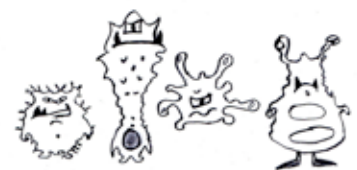
139 new species including 90 plants, 23 reptiles, 16 amphibians, 9 fish, and 1 mammal were discovered in 2014 in Myanmar and the rest of the Greater Mekong region (Myanmar, Cambodia, Laos, Thailand and Vietnam). Newly discovered species in Myanmar include the Myanmar snub-nosed monkey, a new species of dragon fish, a new frog, and a new type of ginger plant.

## Vocabulary

The word **biodiversity** is a combination of 2 words: bio + diversity. Bio comes from the Greek word bios, which means life. **Diversity** means varied, multiplicity, many different elements.

#### **FAST FACTS: Bacteria**

Bacteria are tiny organisms made of a single cell. They are so small they can only be seen in a microscope. But bacteria are very important to all life forms. Some bacteria can cause disease, even death. But other bacteria support the health of humans, plants and animals.



## Case study

Species that have more genetic diversity are more adaptable and are more likely to survive problems. In the 1800s, potatoes were the most important part of the diet for the Irish people. Most farmers grew only one species of potato - the “lumper” potato species. In the 1840s, the lumper potatoes were attacked by potato disease which killed almost all the lumper potato plants. Because potatoes were a major part of the diet, many people starved to death – it is estimated that 1 out of 8 Irish people died of starvation during the 3 years of the potato disease. If there were different species of potatoes, some potato plants probably would have survived. This meant there would have been more food so fewer people would have died.

## Activity: survey

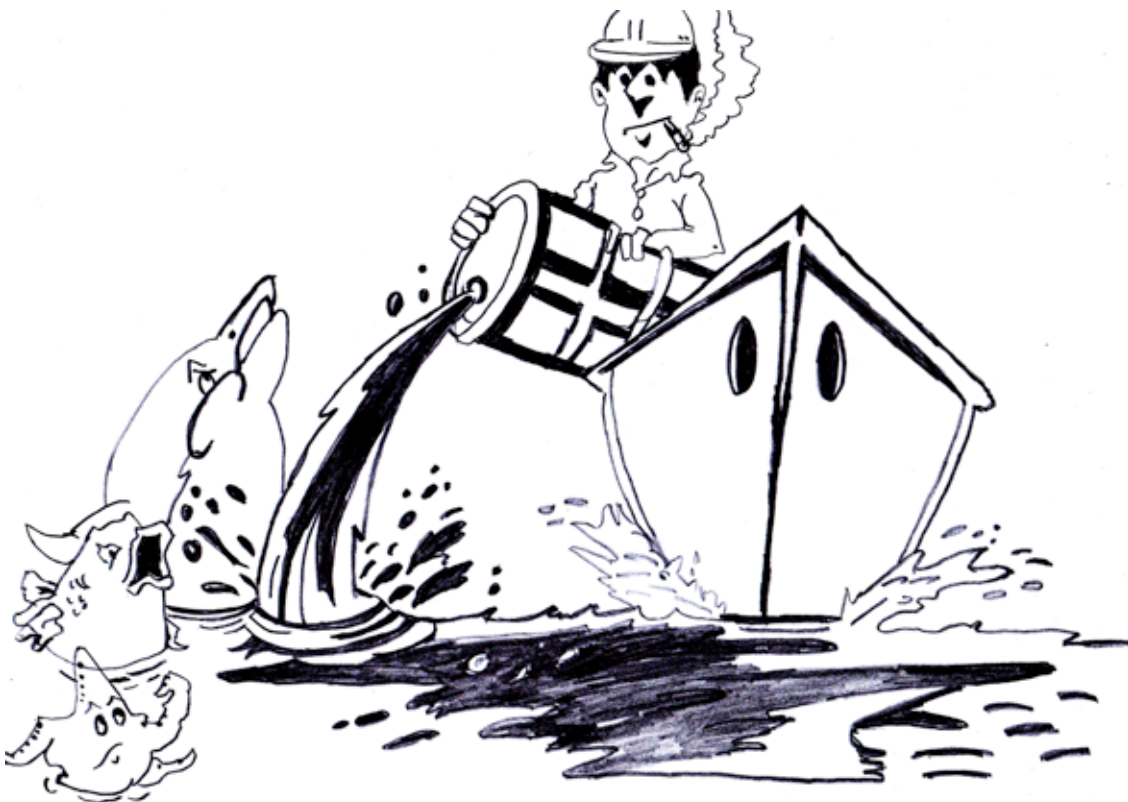
- E** How many different kinds of trees grow in your area? In small groups collect a leaf from as many different types of trees as possible. Bring the leaves back to class and compare them with the leaves other groups collected. Work in groups.

## Reading

### BIODIVERSITY IS BEING THREATENED

Unfortunately, biodiversity is declining all around the world. There are several important reasons for this:

- 1) **Global warming and climate change.**
- 2) **Habitat destruction and loss.** Humans are destroying the natural habitat in many ways, including clearing land to grow crops and build houses, flooding land by building dams, cutting down forests for wood, and clearing mangroves to build aquafarms.
- 3) **Habitat fragmentation** is when a large area of land is broken into little pieces; for example, by building roads and housing developments. This harms animals by forcing them to live in a smaller areas meaning (there is less food for those that remain) reducing genetic diversity, and increasing conflict between animals and people.
- 4) **Over killing or over fishing.**
- 5) **Pollution.**





## Case study



Students read the two case studies individually. To check their understanding, ask:

- Why did so many Irish people starve to death in the 1840s?
  - Because a disease killed off the lumper potato plant.
- Why could biodiversity have helped save these people from starvation?
  - Because the disease may not have killed another type of potato so people would have enough food to eat.



## Activity: survey



- E** In small groups, students collect a leaf from as many different types of trees as possible. In class, students compare them with the leaves other groups collected. If there are no trees near your school, ask students to collect the leaves in their free time and bring it back to class in a following session. Student work in groups.



## Reading



### BIODIVERSITY IS BEING THREATENED

Students read the text individually. To check their understanding, ask:

- What is habitat fragmentation?
  - It is when people break a large natural area into small pieces by building roads, factories, housing developments and other kinds of built environments.
- List four ways humans are destroying natural habitats.
  - They are cutting down forests, polluting water, land, and air, building dams, clearing land, hunting wild animals, and clearing mangrove forests.
- How are humans reducing biodiversity?
  - They are destroying the natural habitat by polluting it and clearing it to create human environments. Humans are also killing wild animals and overfishing.

**BIODIVERSITY HOTSPOTS**

Students read the text individually. To check their understanding, ask:

- What are the two key aspects of a biodiversity hotspot?
  - A) It is an area with lots of biodiversity and
  - B) This biodiversity may soon be destroyed due to human interference.
- Where are most biodiversity hotspots located?
  - In tropical rain forests.
- Myanmar is part of which biodiversity hotspot?
  - The Indo-Burman biodiversity hotspot.

 **Activity: survey**

**F** Students work in pairs. Partner A looks at Extra # 1, Part A. Partner B looks at Extra # 1, Part B. Students ask each other for the missing information/numbers to complete the table.

**Answers:**

Species	Global Threat Status				Distribution by Country					
	Critically Endangered	Endangered	Vulnerable	Total	Cambodia	China	Lao PDR	Myanmar	Thailand	Vietnam
Mammals	12	37	39	<b>88</b>	31	35	40	43	47	46
Birds	12	19	54	<b>85</b>	28	37	24	41	46	42
Reptiles	13	20	14	<b>47</b>	14	20	16	23	19	25
Amphibians	0	16	32	<b>48</b>	4	33	5	0	4	15
Fishes	25	28	58	<b>111</b>	31	17	44	16	58	34
Invertebrates	9	21	36	<b>66</b>	0	10	6	4	28	25
Plants	69	89	151	<b>309</b>	33	153	25	45	98	148
<b>Total</b>	<b>140</b>	<b>230</b>	<b>384</b>	<b>754</b>	<b>141</b>	<b>305</b>	<b>160</b>	<b>172</b>	<b>300</b>	<b>335</b>

 **Case study**

To check students' understand, ask:

- 1) How many species were discovered in 2013?
- 2) What are some of the endangered species in Myanmar?

**Reading**

**BIODIVERSITY HOTSPOTS**

A biodiversity hotspot is an area that has lots of biodiversity and is in danger of losing this biodiversity through human interference. These are special areas, full of many different kinds of plants, birds, insects and animals. Some of these organisms are endangered, and will become extinct unless humans stop causing so much harm. Once an organism becomes extinct it is gone forever – it can never come back. Most biodiversity hotspots have two things in common: 1) they are located in moist tropical forests and 2) they include a range of different elevations from sea level to high mountains.



Myanmar is part of the **Indo-Burman Hotspot**, one of the 34 hotspots around the world. The Indo-Burman Hotspot includes almost all of Myanmar, Thailand, Laos, Cambodia and Vietnam plus a bit of China, India and Bangladesh.

**Activity: survey**

**F** Work in pairs. Partner A looks at Extra # 1, Part A. Partner B looks at Extra # 1, Part B. Ask your partner to give you the missing information/numbers to complete the table.

Species	Global Threat Status				Distribution by Country					
	Critically Endangered	Endangered	Vulnerable	Total	Cambodia	China	Lao PDR	Myanmar	Thailand	Vietnam
Mammals										
Birds										
Reptiles										
Amphibians										
Fishes										
Invertebrates										
Plants										
Total										

**Case study**

**26 NEW SPECIES DISCOVERED IN MYANMAR**

Twenty-six new species of life were recently discovered in Myanmar (2013). These species include 14 plants, 7 fish, 4 amphibians and 1 reptile.

Rhinopithecus strykeri, named in honor of Jon Stryker, president and founder of the Arcus Foundation, is the first snub-nosed monkey to be reported from Myanmar and is believed to be critically endangered. It is distinctive for its mostly black fur and white beard and for sneezing when it rains.



**ENDANGERED SPECIES IN MYANMAR**

Unfortunately, there are more than 400 endangered species of animals and plants in Myanmar including many species of coral, the Tonkin toad, tufted deer, Temminck's flying squirrel, the smooth coated otter, and the saltwater crocodile. Many of these plants and animals may become extinct unless people take steps to protect them.

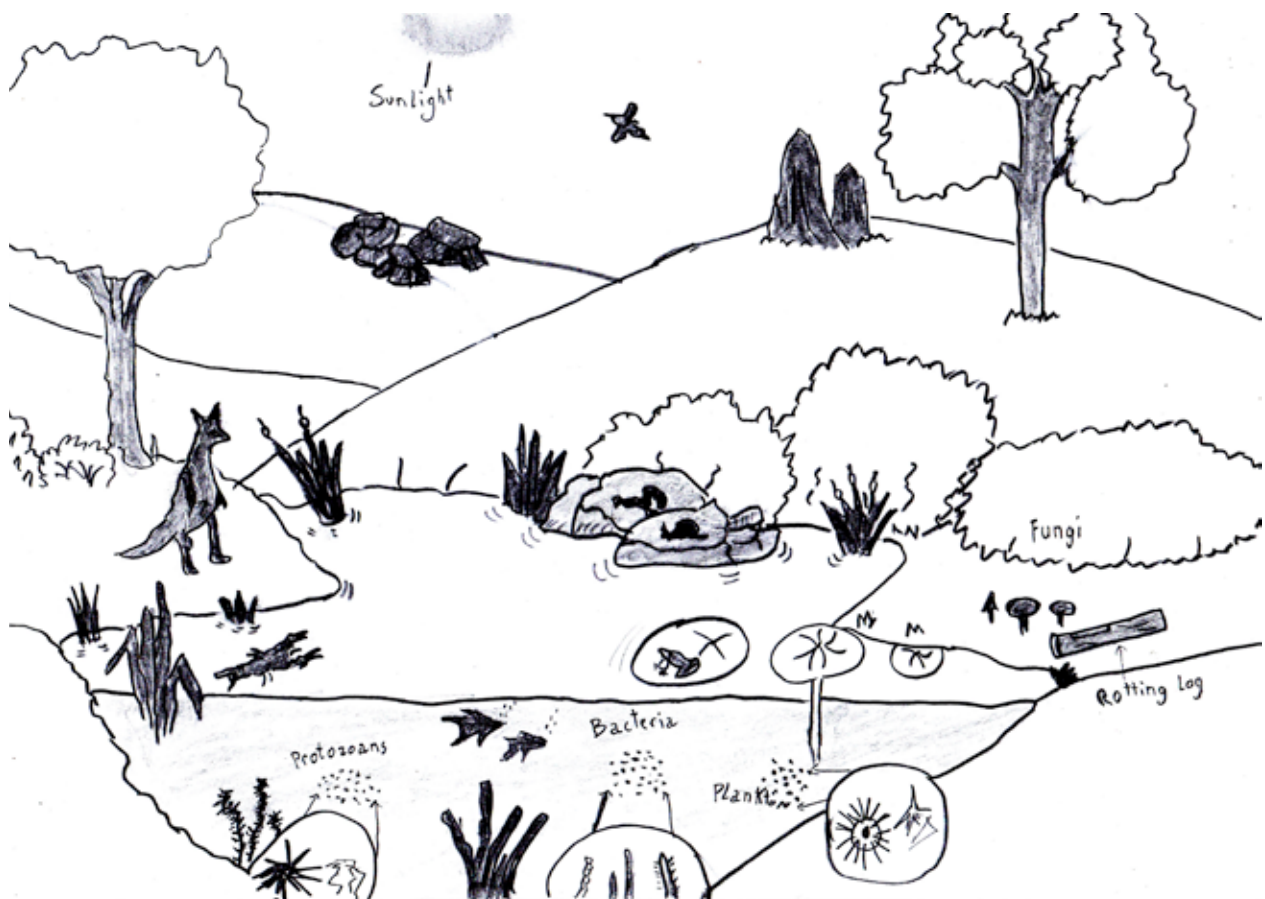
## Reflection

**G** Answer the questions below. Discuss in groups then as a class.

- 1) Is our area biodiverse? Why or why not?
- 2) Has the biodiversity of your area changed very much in the past 50 years? 25 years? 5 years?
- 3) What actions do you think you can do to help protect biodiversity in your area? In the rest of Myanmar?
- 4) The following are all threats to biodiversity in different parts of the world. How do these issues affect the biodiversity in your area? Rank them in order from least to most.
  - a) A mine has destroyed and polluted the habitat
  - b) There is a lot of illegal hunting
  - c) A factory has polluted the land, air and water
  - d) Mangroves were cleared for aqua farms
  - e) Land has been cleared to build more houses
  - f) New roads have been built
  - g) An invasive species has eaten many animals
  - h) Animals and/or plants have been harmed by disease

## Additional Activity

Survey the biodiversity in your area and write a letter to your community leaders/council/committee explaining the importance of biodiversity and the threats faced in your area. Then, suggest ways to conserve the biodiversity.





 **Reflection**



- G** Students answer the questions and discuss with their class.

***Additional Activity***

This activity can be such as homework. Students can submit this as a letter or give a presentation

## What is matter?

### **Brainstorm**



**A** Student brainstorm and answer the following questions. Students work in small groups.

- 1) What is water made of? 2) What is air made of? 3) What is soil made of?

**Answer: Matter**

### **Reading**



**B** Students read the text and answer the questions. Students work in pairs.

Allow enough time for students to read and understand the text. You could also read the text out loud. If students have difficulty to understand, provide more explanation. To check their understanding you can ask:

- What causes matter to change from one form to another?
  - Temperature and pressure
- What happens to the form of matter as the temperature gets hotter?
  - Solids melt into liquids and liquids turn into gas.

**Answers :**

- 1) What form is water in at room temperature?
  - Water is liquid at room temperature.
- 2) How does liquid water change into gas?
  - As water warms or evaporates it turns into a gas called water vapor.
- 3) How does water vapor turn into liquid? How does this relate to rain?
  - A gas will turn into a liquid as the temperature cools. Liquid water turns into a gas (water vapor) as it evaporates. The gas rises and forms into clouds. As the water vapor turns back into a liquid it falls to earth as rain. If the temperature is below zero, the water will freeze into solid – snow or hail

## What is matter?

### Brainstorm

- A** Brainstorm and answer the following questions. Work in small groups.  
 1) What is water made of? 2) What is air made of? 3) What is soil made of?

### Reading

- B** Read the text and answer the questions below. Work in pairs.

Everything on earth, everything you can see, taste, touch or smell, from the air you breathe to the water you drink is made out of **matter**. Even you are made of matter. Matter is anything that takes up space and has **mass**. Though you cannot see or touch air, you can prove that it is matter by blowing up a balloon – there is something inside the balloon even though you cannot see it.

### Vocabulary

**Mass** is the amount of matter in an object (the amount of stuff a substance contains). In common language, mass means weight.



Even though you may not be able to see or touch or feel the air, you can prove it has mass by blowing the balloon

Matter can be in one of three states – solid, liquid or gas. All types of matter change from one state to another depending upon the temperature and the pressure applied. As the temperature gets hotter, solid matter (e.g. ice) melts into a liquid (water). If the temperature continues to rise the liquid will turn into a gas (water vapor). The opposite happens as the temperature gets colder. Gases condense into liquid and then freeze into a solid.

Some substances, such as water, easily change from one state to another. Other substances require extreme temperatures to change. For example, oxygen is usually a gas but it will freeze into a solid when you bring its temperature down to -219 degrees Celsius (219 degrees below zero).

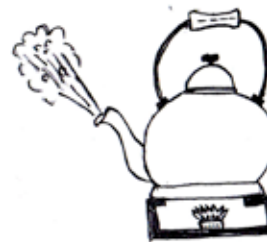


- 1) What form is water in at room temperature?
- 2) How does liquid water change into gas?
- 3) How does water vapor turn into liquid? How does this relate to rain?

## Activity: experiment

**C** Conduct the experiments below and note what you observe. Work in small groups.

- 1) Experiment 1: Boil some water in a kettle. Notice the steam that rises when the water begins to boil. Place a plate over the steam and note what happens.



- 2) Experiment 2: Put a glass of ice water or a very cold bottle of soda on a desk or table. Note what happens outside the bottle.



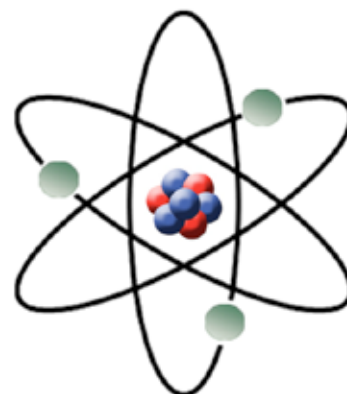
# Atoms and molecules

## Reading

**D** Read the text and answer the questions below. Work in pairs.

All matter is made out of atoms. Atoms are the basic building blocks of matter- of you, water, air, salt, dirt and elephants. You can think of atoms like mud bricks. Bricks can be used to build a house, factory, road or a wall.

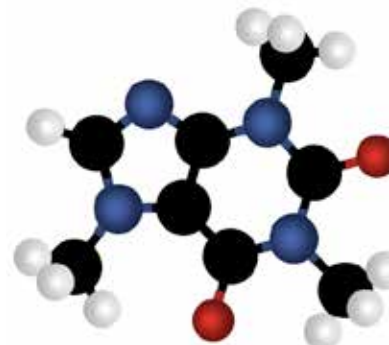
Atoms are very, very tiny – about 100,000 times thinner than a human hair. They are made out of protons, neutrons and electrons. The protons and neutrons are packed together in the middle of the atom inside something called the nucleus. The electrons orbit around the outside of the atom. The rest of the atom is empty space. Every atom has the same number of electrons as it does of protons, but the number of neutrons can be different.



The amazing thing is that atoms are neither created nor destroyed. All atoms that are on earth now have been here since the beginning of time. Your toenail could be made of atoms that were once part of a dinosaur's eyelash or in the cup of tea your great grandmother drank 100 years ago.

### How do you make a molecule?

Atoms join together to create molecules by sharing electrons. Molecules join together to create matter. Molecules are created and broken apart continuously through chemical processes. This releases the atoms so that they can form new molecules of a different substance. It is lucky for us that this happens, because we would soon run out of oxygen if trees and plants did not break down molecules of carbon dioxide, releasing the oxygen for us to breathe.



- 1) What are atoms?
- 2) How do atoms join together?
- 3) How do molecules break apart?

## Activity: experiment



- C** Students in groups conduct the experiments and note what they observe.
- 1) Experiment 1: prepare a kettle and boil some water. Ask students to notice the steam that rises when the water begins to boil. Place a plate over the steam and show students how the steam condenses into droplets on the plate.  
*Explanation: when heat is applied to water it changes from a liquid to a gas. This is called evaporation.*
  - 2) Experiment 2: Put a glass of ice water or a very cold bottle of soda or water on a desk or table. Ask the students to note the water that condenses on the outside.  
*Explanation: water vapor in the air cools when it touches the surface of the glass or bottle and changes from a gas to a liquid. This is called condensation*

## Atoms and molecules

### Reading



- D** Students read the text and answer the questions. Students work in pairs.

#### Answers :

- 1) What are atoms?
  - The smallest parts of matter, of any substance.
- 2) How do atoms join together?
  - They join together by sharing electrons.
- 3) How do molecules break apart?
  - Through chemical process.

# Elements and compounds

## Reading



Allow enough time for students to read and understand the text. You could also read the text out loud.

**E** Students refer to the text and the chart and answer the questions . Students work in pairs.

### Answers:

- 1) What is the difference between an element and a compound?
  - An element is made out of one type of substance (atom) but compounds are made out of two or more substances (types of atoms)
- 2) What makes one element different from another?
  - How many protons it has
- 3) How many elements occur naturally on earth? How many have been created by humans?
  - 92 elements are occur naturally. 22 are created by humans
- 4) How do you determine the atomic number of a substance?
  - The atomic number of each element is based on how many protons it has
- 5) When oxygen and carbon are combined what compound do they form?
  - Carbon dioxide

# Elements and compounds

## Reading

**Matter is either an element or a compound:**

- An **element** is a pure substance, something made out of only one thing, one type of atom. Examples of common elements include Oxygen(O), Hydrogen (H), Helium (He), and Carbon (C). Only 92 different kinds of elements occur naturally on earth. Humans have produced at least 22 more elements. Every single thing that is on, above and inside our planet is made out of one of these elements or a combination of several different elements. What makes one element different from another is the number of protons contained in each atom. Every element has a different number of protons. Scientists have organized the elements into the periodic table (found in Extra #2).
- When two or more different kinds of elements combine they form a compound. Water (H<sub>2</sub>O), for example, is a compound made out of two gases: Hydrogen (H) and Oxygen (O).

About 96 % of the human body is made up of just four elements: carbon, oxygen, nitrogen, and hydrogen.



A single element is like a letter in the alphabet – just as letters can be combined to form thousands of different words, single elements can be combined to form millions of different compounds.

Scientists have developed a way to write the chemical formula of different compounds. First is the letter(s) representing the element, and then a number representing the number of atoms of that element each molecule contains. For example: H<sub>2</sub>O is water. Each molecule contains 1 Hydrogen atom and 2 Oxygen atoms. But if you add one atom of Hydrogen to each molecule it becomes Hydrogen peroxide: H<sub>2</sub>O<sub>2</sub>.



Here are some common elements and the state they are in at room temperature.

Element	Symbol	State at room temperature (21C)
Carbon	C	Solid
Oxygen	O	Gas
Hydrogen	H	Gas

And here are some common compounds made of these elements.

Compound	Chemical formula	Made out of	State at room temperature (21C)
Propane	C <sub>3</sub> H <sub>8</sub>	Carbon and hydrogen	Gas
Carbon dioxide	CO <sub>2</sub>	Carbon and oxygen	Gas
Water	H <sub>2</sub> O	Oxygen and hydrogen	Liquid
Ethanol (alcohol)	C <sub>2</sub> H <sub>6</sub> O	Carbon, Oxygen and Hydrogen	Liquid

**E** Refer to the text and the chart above and answer the questions below. Work in pairs.

- 1) What is the difference between an element and a compound?
- 2) What makes one element different from another?
- 3) How many elements occur naturally on earth? How many have been created by humans?
- 4) How do you determine the atomic number of a substance?
- 5) When oxygen and carbon are combined, what compound do they form?

# Organic versus inorganic matter

## Reading

Matter is either organic or inorganic. Only compounds (not elements) are classified as organic or inorganic.

Organic matter is matter made out of the remains of living organisms. Molecules of organic material always contain carbon. In common language, organic means natural. Healthy soil contains lots of organic material such as dead leaves. Plants grown in soil rich with organic material are usually more nutritious than plants grown in soil with little organic material. Organic foods are grown with only natural fertilizers such as manure and compost. Many people believe that organic food is healthier than food grown with chemical fertilizers and pesticides. However, organic food is usually more expensive. Biofuel, which can be used to power cars and other vehicles, is a type of organic fuel made out of crops such as corn and sugar cane.

Everything that is not organic is inorganic. Inorganic matter can be natural or human made. All chemicals made in a laboratory are inorganic. Salts, metals and minerals such as rubies and diamonds are inorganic as well. Only a few types of inorganic matter are made from molecules containing carbon. Examples include diamonds, carbon dioxide and carbon monoxide.

## Activity: survey

- F** Classify the items below as either organic or inorganic. Then, look around you, both inside and outside the room you are in, and add 8 other items in each column. Work in pairs.

Biofuel, iron, rubies, leather, paper, salt, wooden table, air, glass, sugar, compost, a metal hammer

Organic Matter	Inorganic matter

**Bio** comes from the ancient Greek word *bios* which means life. Bio refers to anything that is or was alive.



	Word	Definition
1	Biology	The study of living organisms
2	Biodegradable	Something that can be decomposed by bacteria or another living organism
3	Biodiversity	The variety of life in the world or a particular ecosystem
4	Biodynamic	A type of farming that uses only natural, organic fertilizer
5	Biohazard	Something biological that can harm the health of humans or the environment
6	Biomass	a) The total amount of living or recently living organisms in a given area b) A type of fuel made out of living or recently living organisms



# Organic versus inorganic matter



If students have difficulty to understand, provide more explanations.

## **Activity: survey**

- F** Give students time to write each item in the appropriate column, and then review the answers as a class. Students work in pairs and then as a class.  
Add more examples to the chart, if necessary.

**Answer:**

Organic Matter	Inorganic matter
1. Biofuel	1. Iron
2. Leather	2. Rubies
3. Paper	3. Salt
4. A wooden table	4. Glass
5. Sugar	5. A metal hammer
6. Compost	

## **Reflection**



- G** Divide the class into two groups. One group thinks it is worth paying more money for organic food. The other group has the opposite opinion. Encourage a debate where each group shares their arguments and backs up their opinions. Discuss as a class.

# Chemical and physical changes

## **Reading**



Ask a few questions to test comprehension such as:

- Which type of change does NOT create a new type of material?
  - A physical change
- Which type of change releases atoms so that they can form new substances?
  - A chemical change

## **Exercise**



- H** Ask students to indicate if the changes are physical or chemical by writing either a C or P. Work in pairs.

### Answers:

- C Burning a piece of paper
- P Ripping paper into tiny pieces
- C Digesting food
- P Dissolving sugar into water
- C Baking a cake

## **Additional Activity**

Students can conduct this activity individually or in pairs. This could be done as homework and presented in a following session.

## Reflection

- G** Do you think it is worth paying more money for organic food? Why or why not?  
Discuss as a class.



# Chemical and physical changes

## Reading

Matter is neither created nor destroyed but is always changing. Nothing, not even rocks and mountains, stay the same.

Changes are either physical or chemical. A **physical change** affects the size, shape, or form of a substance, but does not change what the substance is made out of. An ice cube melting into water is a physical change because the actual substance – water – stays the same. It just changes from one form to another.

A **chemical change** happens on a molecular level. Chemical changes create new substances. A chemical change causes the molecules of a substance to break apart. This releases or frees the atoms contained in the molecule. These atoms can then join with other atoms to create new substances. Chemical changes make it possible for the same atom to be recycled again and again. This means that the same atom can form one substance today and then another substance next week and then another three years from now. Chemical changes include things like burning and digestion.

## ★ Exercise

- H** Determine which of the following are physical changes and which are chemical changes.  
Work in pairs.

_____	Burning a piece of paper
_____	Ripping paper into tiny pieces
_____	Digesting food
_____	Dissolving sugar into water
_____	Baking a cake

## Additional Activity

Prepare a short and simple presentation explaining the difference between organic matter/ food and inorganic matter/food and advocating your opinion on whether it's worth paying more money for organic food or not.

## Overview

### Brainstorm

**A** Brainstorm and answer the following questions. Work in small groups.

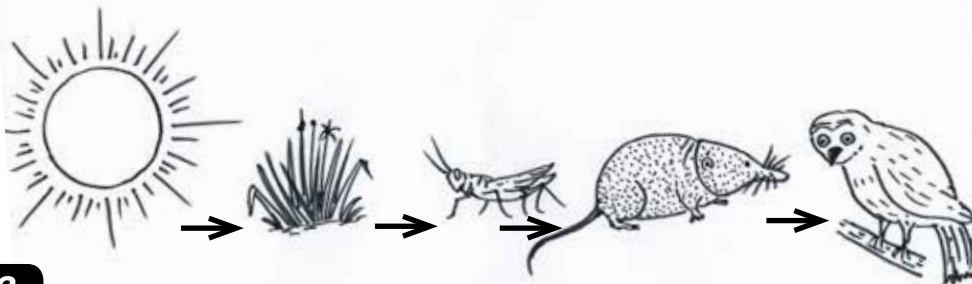
- 1) Where does the energy you need to live come from?
- 2) Where does the energy that creates the food you eat come from?
- 3) What is the main difference between animals and plants?

### Reading

A **food chain** shows the movement of energy and nutrients from one organism to another. Food chains are sequential, meaning that each link of the food chain follows another in order.

A **food web** is similar to a food chain as shows the movement of energy and nutrients from one organism to another. However, it is more complex in that it shows interconnected food chains that link all organisms in an ecosystem together in a huge web or network.

Example of a food chain:

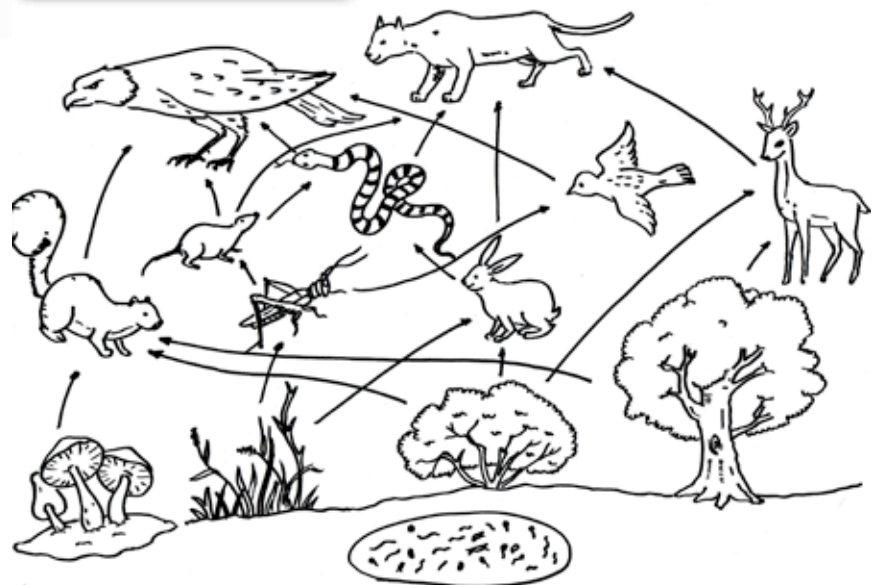


### ★ Exercise

**B** Following the example above, list at least three food chains that can be found in your environment. Work in small groups.

- 1)
- 2)
- 3)

Example of a food web:



### ★ Exercise

**C** Following the example here, draw one simple food web that can be found in your environment. Work in small groups.

## Overview

### Brainstorm



- A** Students brainstorm and answer the following questions. Students work in small groups.

#### Answers:

- 1) Where does the energy you need to live come from?
  - The food you eat is the source of energy you need to live
- 2) Where does the energy that creates the food you eat come from?
  - The energy that creates the food you eat comes from the sun
- 3) What is the main difference between animals and plants?
  - One important difference is that plants can create their own food

### Reading



If students have difficulty to understand, provide more explanations.

To check their students' understanding you can ask:

- What is the difference between a food chain and food web?
  - A food web is a large group of interconnected food chains.
- What do all food chains begin with?
  - They all begin with plants.

You can provide additional examples of a food chain:

Rice seed > Insect > Bird > Cat

### Exercise



- B** Following the example, students list at least three food chains that can be found in their environment. Students work in small groups.

Answers will vary according to your environment. **Possible answers:**

- 1) Algae growing in a pond > small insect > large insect > Fish > Human
- 2) Rice > Chicken > Dog
- 3) Wheat > Mouse > Eagle
- 4) Grass > grasshopper > frog > snake

### Exercise



- C** Following the example, students draw one simple food web that can be found in their environment. Students work in small groups.

Answers will vary according to your environment. **Possible answers:**

The frog can eat all the insects.

The eagle can eat the frog, the mouse and the chicken.

The snake can eat the frog, all the insects, the mouse and the fish.

The human can eat the frog, the fish, and the chicken.

The chicken can eat the worms, the wheat, all the insects and the rice.

The dog can eat the chicken, the fish, the frogs, the mouse, and the grasshopper.

# Energy versus nutrient

## Reading



Allow enough time for students to read and understand the text. You could also read the text aloud. If students have difficulty to understand, provide more explanations. Provide definitions for new words. Some have their translations in the glossary.

To check their understanding you can ask:

- What are carbohydrates made out of?
  - Carbon, hydrogen, and oxygen
- Where does all energy originally come from?
  - The sun
- What is the name of the process plants use to create their own food?
  - Photosynthesis
- What do carbohydrates break down into?
  - Sugars

## Reflection



**D** Students think and discuss in pairs.

### Answers might include:

- 1) How you feel when you miss a meal?  
Feeling tired, dizzy, weak
- 2) How do you feel when you don't eat properly (amount or kind of food)?  
Lose weight, feel tired

# Energy versus nutrient

## Reading

All organisms need both energy and nutrients in order to survive. **Energy** is fuel, like gasoline for a car. Organisms use energy to grow and move and reproduce.

Almost all energy that fuels life on earth comes originally from the sun. Green plants and algae take energy directly from sunlight and use it to create their own food – **carbohydrates** - in a process called **photosynthesis**. The plant uses some carbohydrates to fuel its own growth and stores the rest.

Many organisms get most of their energy from carbohydrates, which break down into sugars. Humans, animals, birds and insects cannot make their own food. Instead, they must get energy by eating plants or by eating other living beings that eat plants.

In addition to energy, all living organisms need **nutrients**. All organisms including plants and humans will get sick and may die if they do not get enough of the right kind of nutrients.

Even though plants can create their own food, they still need additional nutrients to grow properly. They get these nutrients from the soil.

Important nutrients for plants include phosphorus, nitrogen and potassium. Therefore these three minerals are the key ingredients of most fertilizers. Humans also need these three nutrients, which we get by eating plants. Humans need additional nutrients including calcium, used to build strong bones and teeth, potassium, used to maintain healthy blood pressure, and Vitamin A, used to protect eyesight. Water is an essential nutrient that all organisms need.

## Vocabulary

**Energy:** the capacity or strength needed to sustain an activity

**Nutrient:** Nutrients are substances that organisms need to function properly

What do you notice about the word **carbohydrate**? What elements do you think it is made out of? If you guessed **carbon** and **hydrogen** you are correct. Plants are able to take hydrogen atoms from water and carbon atoms from carbon dioxide and combine them into carbohydrates.



### Energy is used up or lost

Much of the sun's energy is used up and lost as it moves from one organism to another. Energy is lost as heat and when an organism moves or grows. Energy is replaced by the sun.

### But nutrients are not

Do you remember from Lesson 4 that matter is neither created nor destroyed? Atoms and molecules that make up matter are constantly being **recycled**. Molecules break apart, move around and create new substances. In contrast to energy, the nutrients are not lost as they move along the food chain but are turned into new substances. You will learn more about how this happens in Lesson 6 – The Earth's Cycles.

## Reflection

- D** Think about how you feel when you miss a meal? How do you feel when you don't eat properly (amount or kind of food). Work in pairs.

# Levels in food chains

## Reading

There are three major levels in all food chains. All food chains begin with **producers**. Producers are green plants that capture energy from the sun and convert it into energy in the form of food during photosynthesis. This energy is passed on when an animal, insect or bird eats the plant. In the next level of the food chain are the **consumers**. These organisms cannot create their own food but must get it by eating a plant or another animal. There are three levels of consumers:

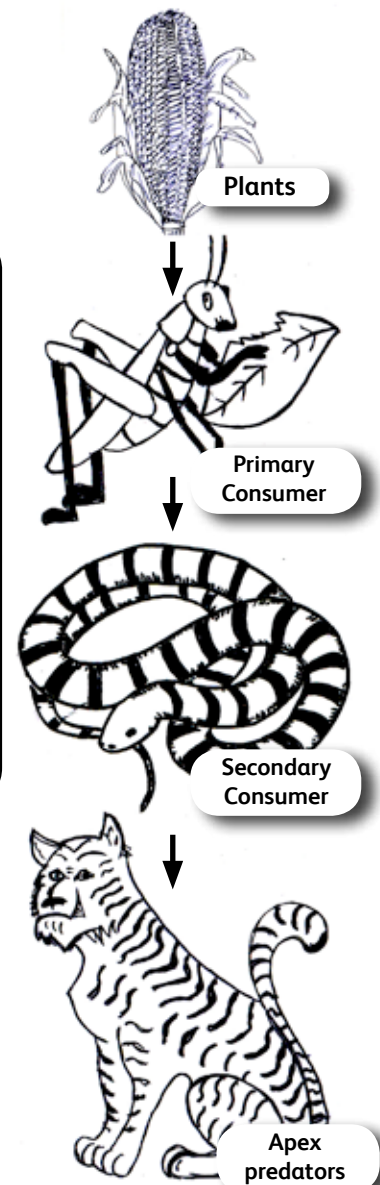
- **Primary consumers** (herbivores) get their energy from eating plants.
- **Secondary consumers** (carnivores or omnivores) get their energy from eating animals that eat plants.
- **Apex predators** (carnivores or omnivores) – Also called alpha predators or super predators, are animals that no other animal eats. They are at the very top of the food chain.

## Vocabulary

**Herbivores:** animals which eat only plants. Grasshoppers, cows, water buffalos, deer and elephants are examples of Herbivores.

**Carnivores:** animals that eat only meat. Sharks, eagles, tigers and lions are examples of Carnivores.

**Omnivores:** creatures which eat both plants and animals. Humans, bears, rats, and crows are examples of Omnivores.



All carnivores are **predators**, meaning that they kill and eat other organisms. **Prey** are the living beings that are eaten.

The last link of the food chain is the **decomposers**. Most decomposers live in the soil or in dead trees. You can see some decomposers such as worms, fungus (mushrooms), slugs and snails. But bacteria, tiny organisms too small to see without a microscope, are the most important decomposers. Decomposers get their nutrients and energy from eating – or breaking apart - manure, dead plants and animals. By doing so, they release nutrients stored in the dead plant or animal and return them to the soil. The producers (plants) then absorb the nutrients through their roots and the cycle begins all over again.



Decomposers turn what most organisms consider waste into usable nutrients. If you die, decomposers eat you. If you poop, they eat that. If a tree loses a leaf, they eat it. Whenever something that was alive dies, the decomposers get it.

## ★ Exercise

- E** List some animals that are both predator and prey. **Work in pairs.**  
For example: frogs (they eat insects and are eaten by hawks and snakes)



# Levels in food chains

## Reading



Provide definitions for new words. Some have their translations in the glossary.

To check students understanding you can ask:

- Why are plants called producers?
  - Because they can make their own food
- What do plants make carbohydrates out of?
  - Carbon dioxide and water using energy from the sun

## Exercise



- E** Students list some animals that are both predator and prey. Work in pairs.  
For example: frogs (they eat insects and are eaten by hawks and snakes)

**Answers will vary. Possible answers:**

**Spiders** (which eat insects but might be eaten by birds or other insects)

**Snakes** (which eat mice but can be eaten by eagles and mongooses)

**Some birds** (which might eat insects but be eaten by a cat or another bird)

## Activity: observation



- F** Students go to the closest potted plant, garden, or forest, look under the leaves and into the soil and survey all the decomposers they find. Work in small groups.

**Answers will vary. Possible answers:**

Worms, fungus, ants, termites, mites

Note: Most of the decomposers cannot be seen

## Activity



- G** Students place each organism in the right category. Work in small groups. **Answers:**

Producers	Primary consumers	Secondary consumers	Apex predators	Decomposers
Algae, rice, banana leaf, teak tree, corn	Caterpillar, rabbit ant, grasshopper buffalo, mouse shrimp	Snake, shrimp, pig, fish, spider, frog	Tiger, human, eagle, Lion	Worm, bacteria, ant, mushroom

- H** Students arrange these organisms into 5 food chains. Work in small groups.

Note: There may be more possible combinations. **Answers:**

Group #1: Banana leaf (producer) → Caterpillar (consumer) → Frog (consumer) → Snake (consumer) → Worm (Decomposer)

Group #2: Rice (producer) → Mouse (consumer) → Snake (consumer) → Eagle (consumer) → Bacteria (Decomposer)

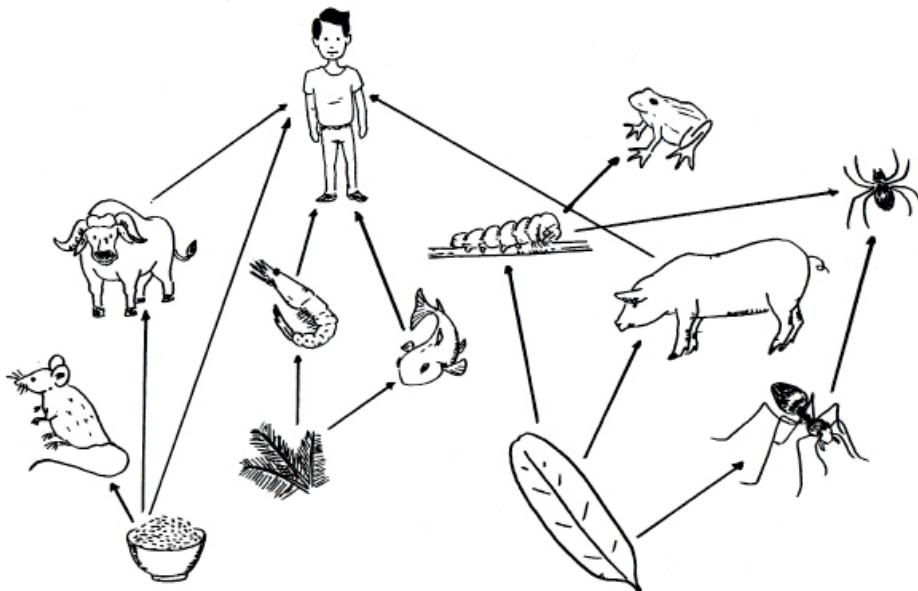
Group #3: Banana leaf (producer) → Ant (consumer) → Spider (consumer) → Frog (consumer) → Eagle (consumer)

Group #4: Algae (producer) → Shrimp (consumer) → Fish (consumer) → Human (consumer)

Group #5: Banana leaf (producer) → Pig (consumer) → Human (consumer)

- I** Students arrange these livings into a single food web. Work as a class.

Note: There are more connections in the food web than there are in the food chain



## Activity: observation

- F** Go to the closest potted plant, garden, or forest, look under the leaves and into the soil and survey all the decomposers you find. Work in small groups.

## Activity

- G** Place each organism in the right category. Then add other organisms. Work in small groups.

Frog	Snake	Eagle	Tiger	Spider	Shrimp
Caterpillar	Worm	Buffalo	Mouse	Banana leaf	Algae
Rice	Pig	Bacteria	Human	Ant	Fish
Rabbit	Teak tree	Mushroom	Grasshopper	Corn	Lion

<b>Producers</b>	<b>Primary consumers</b>	<b>Secondary consumers</b>	<b>Apex predators</b>	<b>Decomposers</b>

- H** Arrange these organisms into 5 food chains. Work in small groups.

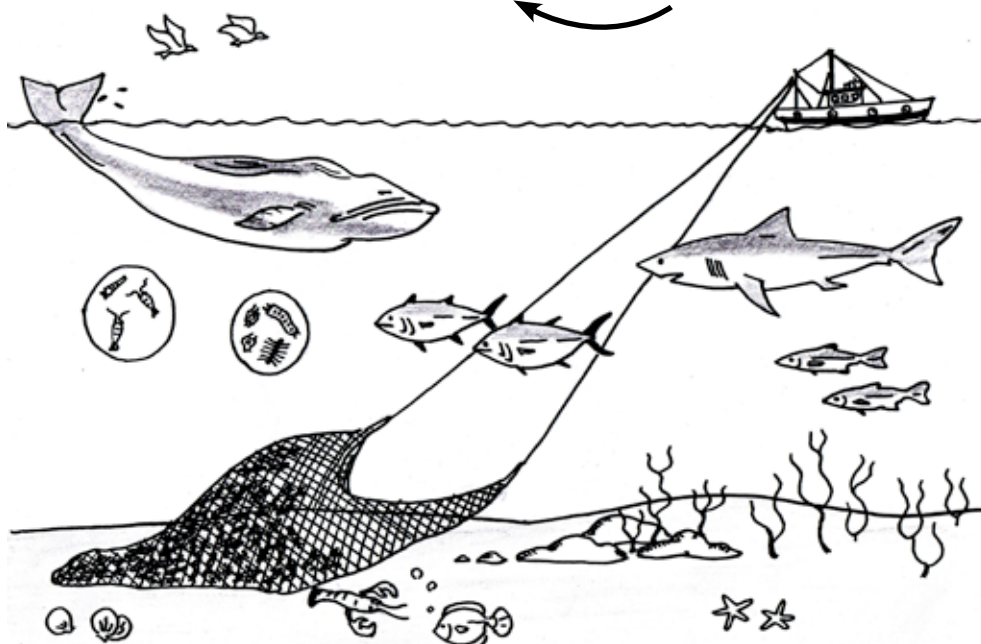
- I** Arrange these organisms into a single food web. Work as a class.

**Note:** There are more connections in the food web than there are in the food chain.

**Producers** are plants that are able to make their own food by capturing energy from the sun. All food chains begin with a producer.

**Decomposers** are organisms that get their energy and nutrients by eating dead consumers and producers. Decomposers complete the food chain, returning essential molecules to the producers. Capturing energy from the sun. All food chains begin with a producer.

**Consumers** cannot create their own food. Instead they get the energy and nutrients they need by eating plants or organisms that eat plants.



# Role of decomposers

The decomposers complete the system, returning essential molecules to the producers



## Reflection

**J** Reflect and answer the questions. Work in small groups.

1) What would the world be like, if there were no decomposers?



### Composting instead of burning!

As the decomposers munch away on dead organic matter including leaves, stalks and stems they create very valuable nutrients. These nutrients can be used to feed a new crop of plants. When plants are burned, much of the energy and nutrients the plant contains is lost as heat energy. Burning also adds pollution to the atmosphere. So instead of burning plant leaves, stalks and other parts, pile them in a big heap. Bacteria and other decomposers will break the plant parts down, and in doing so, will release lots of nutrients, excellent food for new plants. You can then work this compost back into the soil in a new field to give new plants valuable food.

## Mind-map

**K** Mind map the usefulness of composting. Work in small group.

# The importance of bacteria

**Bacteria plays a very important role all along the food chain.**

Bacteria are decomposers. Trillions of trillions of bacteria live in the ocean, in the soil, and in the atmosphere. Bacteria grow on dead creatures, but they also live inside you and every other living organism. Though some bacteria can make you sick, "good" bacteria help you and other animals digest food and stay healthy. You have billions of bacteria living in your intestine. They help break apart the food you eat so that you can use the nutrients contained in the food.

**If all the bacteria living inside you died you would probably die as well.**

Scientists estimate that there are five million trillion trillion bacteria on earth - 50000000000000000000000000000000



# Role of decomposers

## Reflection



**J** Students reflect and answer the question. Work in small groups.

**Answers:**

If there were no decomposers, we would have no room left! The earth would be full of dead plants and animals since nothing would rot or decompose.

## Mind-map



**K** Students mind map the usefulness of composting. Work in small groups.

**Possible answers:**

Reduce the need for landfills for compiling rubbish  
Reduce the volume of rubbish  
Obtain fertilizers for plants.

# The importance of bacteria



Provide definitions for new words. Some have their translations in the glossary.

To engage students more, ask them to read the number in their own language:

5 00000000000000000000000000000000

# Factors affecting food webs

## ★ Exercise



- L** Students remember the case study of the wolves in Yellowstone National Park in the USA. Answer: The population of elk increased. They ate the willow trees and other trees growing along the river banks. This had a big ripple effect - the rivers banks eroded, the population of beavers and birds which depended on the willow trees declined. Populations for fish, amphibians, and reptiles also declined as waters became broader, shallower, and warmer without shade from streamside vegetation.

## 🧑 Case study



To check students' understanding you can ask:

- How does mercury get into water systems?
  - First, mercury is released into the atmosphere by burning coal. Then the mercury comes back to earth with rain and snow. Then it is washed into streams, rivers, and the ocean.
- Why do poisons become more concentrated as they move up the food chain?
  - The poisons do not go away but become part of the plant or animal. There are only small amounts of poison in small plants and plankton. But larger creatures eat lots of plants and plankton. As they do, these larger creatures such as fish end up eating lots of poison. The poison stays in the tissues of the fish so as the fish eats more and more poisoned plants it eats more and more poison.

## 💡 Reflection



- M** Students answer the questions individually. They then share with a partner and discuss as a class.  
**Possible answers.**

- 1) Why are bacteria so important to you and your environment ?
  - They break down dead matter. If there were no bacteria our planet would be overrun with so much dead matter that there would be no room left for the living!
  - They free nutrients from dead material. Without bacteria plants would not be able to get nitrogen and other important nutrients from the soil.
  - They help humans and other animals digest food and keep us healthy. (Though some bacteria can also make us sick.)
- 3) What is the major difference between the movement of energy and nutrients between organisms?
  - As energy moves from one organism to another, much of it is used up and lost. The atoms that make up nutrients are recycled.

## Additional Activity

This can be done as homework. You can hang these food webs on your classroom walls.

# Factors affecting food webs

A food web can be misbalanced and changed due to various factors such as lack or absence of bacteria. Another example is the loss of a top predator. Top predators such as lions, wolves, and eagles help to keep ecosystems in balance by eating herbivores. When most top predators in an ecosystem are killed off, the ecosystem gets out of balance.

## ★ Exercise

- L** Remember the case study of the wolves in Yellowstone National Park in the USA? What happened when the wolves were killed off?

## Case study

### What Happens When a Chemical is Added to the Food Web?

To explain the true impacts of chemicals on the food web, we're going to use the real world example of mercury poisoning.

Coal-fired power plants burn coal and release mercury into the atmosphere as a **byproduct**. Over time, mercury falls to Earth through rain, snow and natural settling. Rain carries the mercury to streams and rivers and it eventually settles in lakes and ponds. After mercury enters lakes and ponds, bacteria transform mercury into a more easily absorbed toxic substance called Methylmercury. Aquatic plants, bacteria and plankton absorb Methylmercury from the surrounding water.

It's at this point that mercury becomes added to the food web. Eventually, the contaminated plants, bacteria and plankton will be eaten by predators, such as fish. The Methylmercury toxins will move into the tissues of the fish and poison a new level of the food web.

### Magnifying Up the Food Web

Individual plants, plankton and bacteria only have a small amount of Methylmercury. The problem begins at the next level of the food web. Fish don't eat just one plankton or plant – they can eat hundreds or thousands of them! All the mercury in each of the plankton or plants has now been eaten by a fish and absorbed into the fat and tissues. After eating 100 planktons, the amount of Methylmercury in the fish is now 100 times of what it was in the plankton!

It doesn't stop there. The higher and higher up the food chain you go, the more food is necessary to maintain energy and activity. If a small fish eats 50 mercury contaminated plants, a large fish might eat 100 small fish, and an eagle or a human eats 100 large fish.

$50 \times 100 \times 100 = 500,000$  = The concentration of mercury in the eagle or human is 500,000 times larger than it was in the plankton!!

The process that causes the concentration of a substance to increase as it moves up the food web is called bioaccumulation. Methylmercury is a famous example of bioaccumulation, because mercury poisoning causes neurological disorders, reduced reproduction and even death in raptors and mammals. People are susceptible to mercury poisoning by eating too much contaminated fish.

Adapted from: <https://www.nwf.org/Wildlife/Wildlife-Conservation/Food-Webs.aspx>

## Reflection

- M** Answer the question individually. Share with your partner and then discuss as a class.
- 1) Why are bacteria so important to you and your environment?
  - 2) What is the major difference between the movement of energy and nutrients between organisms?

## Additional Activity

Research online or in the library for types of organisms living in the different biomes and draw a food web that can be found in each biome.

## Major cycles on earth



Remember that the smallest parts of matter – atoms – are neither created nor destroyed. Instead, molecules are continuously breaking apart, releasing the atoms to rejoin and form new molecules, which creates new kinds of matter. This happens through a variety of different cycles, including the carbon, oxygen, and nitrogen cycles.

## The water cycle

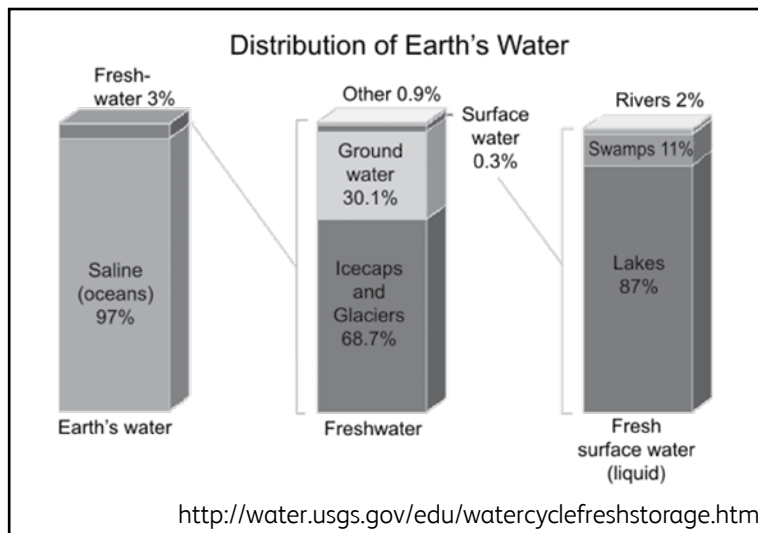
### Brainstorm

**A** Brainstorm and answer the following questions. Work in small groups.

- 1) In what form does water exist?
- 2) Where can it be found and how does it travel?

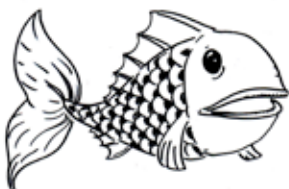
### Activity

**B** Look at the following chart and answer the questions. Work in pairs.



**Note:** The 0.9% of water counted as other refers to water that exists as water vapor in the air or water that is in the soil and thus not accessible by humans.

- 1) Where is most of earth's water located?
- 2) Where is most of the earth's fresh water located?
- 3) How much water is fresh water on the surface?



Fill a large glass of water and take a small sip. The water you just drank represents about how much fresh water exists on earth. All the water that remains in your glass represents salt water.



## Major cycles on earth

Briefly review the explanation in the bubble and answer any questions, as needed.

### The water cycle



#### **Brainstorm**

**A** Students brainstorm and answer the questions. Work in small groups.

**Answer:**

- 1) In what form does water exist?
  - Water can exist as a solid, liquid and gas.
- 2) Where can it be found and how does it travel?
  - Water travels in rivers, sea, and under the soil.

#### **Activity**

**B** Students look at the chart and answer the questions. Work in pairs.

**Answers:**

- 1) Where is most of earth's water located?
  - In the oceans
- 2) Where is most of the earth's fresh water located?
  - Frozen in glaciers and icecaps
- 3) How much water is fresh water on the surface?
  - 0.3%

## Reading



To check students' understanding you can ask:

- What is water vapor?
  - Water in the form of a gas
- How does water vapor turn into a cloud?
  - It rises up into the air. Then the water vapor cools and condenses into clouds.
- What is water run off?
  - Water that is not absorbed by the earth
- What human activities are causing more water run off?
  - Deforestation and the building of human environments such as parking lots and roads

## Discussion



**C** Students answer the questions. Work in groups and then share as a class.

### Possible answers:

- 1) What steps of the water cycle can you observe in your area?
  - Rain, snow, hail, drainage, evaporation
- 2) How does water quantity in your nearby river or lake change throughout the year?
  - It increases in the rainy season. It decreases in the dry season.
- 3) How do you access water in your area?
  - Irrigation system, tap water, springs, wells, from nearby rivers and streams, from a government source (water is piped directly into homes from a public source), from a delivery truck
- 4) What affects the quality of this water?
  - Pollution, erosion

## Reading

Most of the water (H<sub>2</sub>O) on earth – about 97% is salty ocean water. Only 3% of earth's water is fresh water. Most of this fresh water is frozen in glaciers and ice caps (though these are melting rapidly due to global warming). Only about 1% of all water on earth is usable by humans. Most of this usable water is stored underground. Only a tiny percentage of earth's water exists in lakes and rivers.

The total amount of water on earth is always the same, but water molecules are constantly moving around the world and changing form from liquid to gas (water vapor) to solid (ice). The process of moving the water and changing its form is called the **water cycle**.

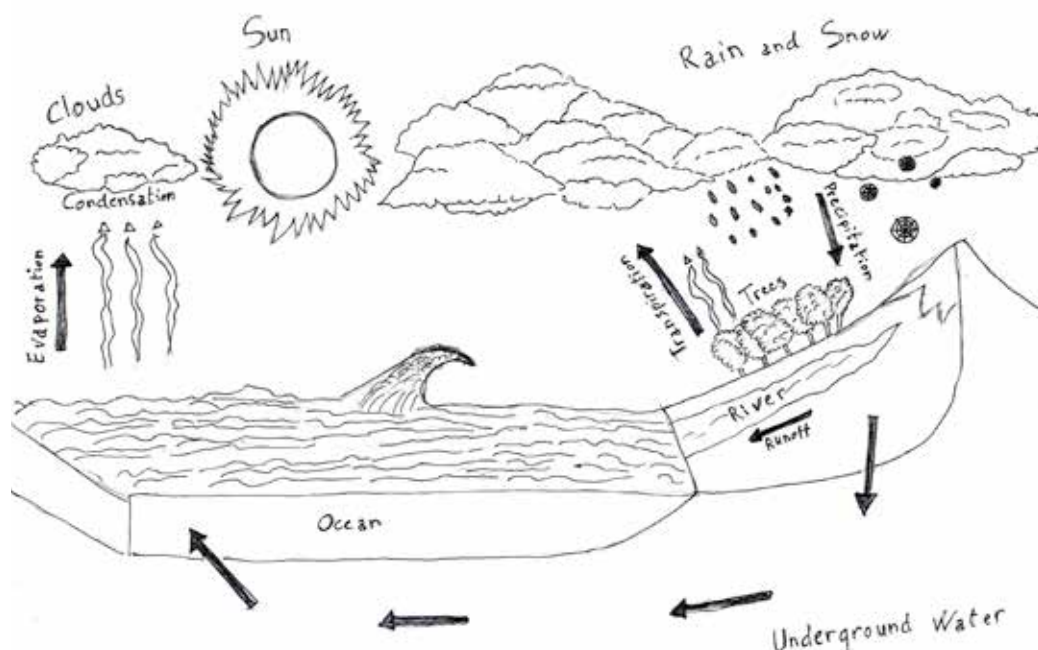
Here are the main steps of the water cycle.

- Energy from the sun makes water in oceans, lakes and rivers **evaporate**, meaning that liquid water is turned into a gas called water vapor.
- The water vapor rises up into the atmosphere until it cools and **condenses** into clouds.
- The water vapor becomes a liquid or solid and falls back to earth as rain, snow or hail. Once water falls to earth there are a variety of different things that can happen to it:
  - Most water falls into the ocean, where it will evaporate and rise up into the atmosphere once again.
  - Some falls into rivers and lakes. Much of this water evaporates or flows into the ocean.
  - Some is drunk by animals and humans. And a lot of this fresh water is used by humans for irrigation – about 70% of all accessible fresh water used by humans is used for irrigation.
  - Water that falls on earth:
    - Is absorbed by the roots of plants
    - Sinks deep down into underground reservoirs
    - Becomes runoff water. Runoff water is water that is not absorbed into the earth. This can cause flooding and erosion. Runoff happens naturally when a lot of rain falls too quickly or in places where the land is very steep. Human development is also causing increased runoff. Deforestation increases runoff as do things humans build such as roads and parking lots.
  - Underground water may be pumped back to the surface through wells and used for drinking, washing or irrigation. Or it may naturally be released through springs.

## Discussion

**C** Discuss and answer the questions. Work in groups.

- 1) What steps of the water cycle can you observe in your area?
- 2) How does water quantity in your nearby river or lake change throughout the year?
- 3) How do you access water in your area?
- 4) What affects the quality of this water?



# The carbon cycle

## Reading

Carbon is the main building block of life. All living things on earth, both plants and animals, contain carbon and need a continuous supply of carbon to survive. The human body is about 18% carbon and carbon is found in almost every cell in our body. Carbon is also found in some nonliving things, including diamonds, graphite and plastic. All carbon atoms that are here now were here when the earth began billions of years ago. But carbon atoms are constantly moving and changing form in a complex process called the **carbon cycle**. Carbon changes from gas to solid and back to gas as it moves from the atmosphere to the oceans, from plants to animals, and from living things to non-living things.

Here are the major parts of the carbon cycle:

- Carbon moves from the atmosphere to plants: Plants, both on land and in the sea, absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere. Plants use energy from the sun to separate carbon atoms from oxygen atoms. The oxygen is released back into the atmosphere and the plant converts the carbon into sugars, which is as food.
- Carbon moves from plants to humans and animals: Humans and animals get carbon from eating plants (or from eating animals that eat plants)
- Carbon moves from animals and humans to the atmosphere: Humans and other animals release carbon in the form of carbon dioxide when they breathe.
- Carbon moves from plants and animals to the ground: When plants and animals die the carbon in their bodies is released into the ground.
- Carbon moves from the soil to the air: Tiny organisms called microorganisms create carbon dioxide by combining carbon atoms with oxygen atoms. When soil is turned over this carbon dioxide is released back into the atmosphere. Carbon can also be released into the atmosphere during a volcanic eruption.
- Carbon moves from fossil fuels to the atmosphere: When fossil fuels such as coal, oil and kerosene are burned to power factories, vehicles or cook stoves, carbon is released into the atmosphere as carbon dioxide. About 5.5 billion tons of carbon is put into the atmosphere each year by burning fossil fuels. This is one of the main causes of climate change and global warming.
- Carbon moves from the atmosphere into the oceans: Much of the carbon dioxide (CO<sub>2</sub>) released into the air is later absorbed by the ocean. In recent years, the ocean has been absorbing too much CO<sub>2</sub>. High levels of CO<sub>2</sub> are causing the ocean to become more and more acidic, which is harmful to marine life. More than 3 trillion tons of carbon dioxide (CO<sub>2</sub>) exists in the atmosphere.

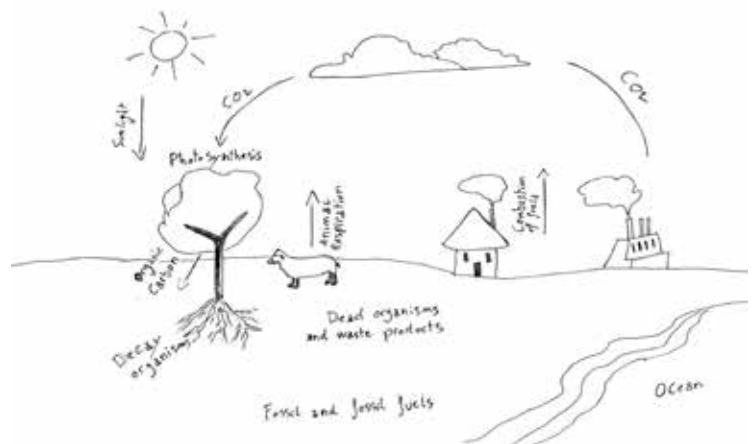
## Discussion

**D** Discuss and answer the questions. **Work in groups.**

- 1) What would happen if all the plants on earth died?
- 2) Why do fossil fuels release CO<sub>2</sub> into the atmosphere when they are burned?
- 3) How has human activity added more CO<sub>2</sub> to the atmosphere?
- 4) Why is too much CO<sub>2</sub> harmful for the environment?

## Activity

**E** Many millions of years ago a particular carbon atom was in the bone of a dinosaur. Today the same carbon atom is in your eye lash. Using pictures and words show how this carbon could have changed form and location to move from the dinosaur to you. Describe at least five different steps. **Work in pairs.**



# The carbon cycle

## Reading



To check students' understanding you can ask:

- Where does the carbon in fossil fuels come from?
  - From plants that died millions of years ago
- How is carbon released into the ground?
  - Carbon is released into the ground when plants and animals die.
- How do humans and animals get the carbon they need?
  - By eating plants or animals that eat plants.

## Discussion



**D** Students discuss and answer the questions. Work in groups and then share as a class.

### Answers:

- 1) What would happen if all the plants on earth died?
  - All the oxygen would be used up and all air breathing organisms would die
- 2) Why do fossil fuels release CO<sub>2</sub> into the atmosphere when they are burned?
  - Because they contain a huge amount of carbon since they are made out of the remains of plants that died millions of years ago. When fossil fuels are burned, they release carbon into the atmosphere in the form of CO<sub>2</sub>.
- 3) How has human activity added more CO<sub>2</sub> to the atmosphere?
  - By burning fossil fuels such as coal and petroleum.
- 4) Why is too much CO<sub>2</sub> harmful for the environment?
  - Because it is a greenhouse gas and contributes to global warming.

## Activity



**E** Students work in pairs.

There are many **possible answers**. For example:

- 1) When the dinosaur died, its body decayed and the carbon atom became part of the soil.
- 2) Microorganisms turned the carbon atom into carbon dioxide and it floated up into the air.
- 3) The carbon dioxide molecule was "breathed" in by a wild mango tree and became part of a mango. The mango fell to the ground and was eaten by a mouse. Moments later the mouse was eaten by an eagle and the carbon atom became part of the eagle. The eagle breathed out the carbon atom during respiration. Later, this carbon atom was "breathed" in by a bean plant and became part of a bean. You ate that bean two months ago and the carbon atom ended up in your eye lash.

# The nitrogen cycle

## Reading



Provide definitions for new words. Some have their translations in the glossary. To check students understanding, you can ask:

- What two things does the nitrogen cycle do?
  - It converts nitrogen into forms different organisms can use. It also moves nitrogen from the atmosphere to the soil, into plants, and finally into animals.
- Why is nitrogen important for your health?
  - It is an important part of amino acids, which your body uses to make hair, muscles and skin.

## Discussion



**F** Students discuss and answer the questions. Work in groups and then share as a class.

### Answers:

- 1) Describe the significance of legumes in the global nitrogen cycle.
  - The roots of legumes convert nitrogen into a form that other plants can absorb.
- 2) How can farmers return nitrogen to the soil?
  - By planting legumes such as soybeans and lentils and by using manure as fertilizer.
- 3) What is the importance of the nitrogen cycle?
  - Nitrogen is an essential nutrient for plants and animals. In order for nitrogen to be used by different types of organisms it must change into different states. The nitrogen cycle changes nitrogen into forms that can be absorbed by different organisms.
- 4) How do human activities affect the nitrogen cycle?
  - Nitrogen does not disappear. If too much fertilizer containing nitrogen is applied to fields, the excess may be washed off the fields and flow into streams and eventually into the ocean. The nitrogen contained in the fertilizer stimulates algae and other sea plants to grow too much. This blocks the sunlight, which kills fish and other sea creatures.

# The oxygen cycle

## Activity: experiment



**G** Students try the experiment. Work in small groups.

Light a candle, let it burn for a few moments and then cover it with a glass turned upside down. Ask students what they think will happen. The candle turns off.

Explanation: Oxygen is necessary for combustion. Without oxygen, nothing can burn.

# The nitrogen cycle

## Reading

Like oxygen and carbon, living things also need nitrogen to survive. Plants use nitrogen to create stems, leaves, flowers and seeds. In humans and animals, nitrogen is an important part of amino acids, which are the basic building blocks of the proteins in our hair, muscles, and skin. Nitrogen is also an important part of our DNA. About 80% of earth's atmosphere is made up of nitrogen, making nitrogen the most common gas on our planet. But most living creatures cannot take in nitrogen gas directly from the atmosphere.

The nitrogen cycle converts nitrogen into different states so that it can be absorbed by different organisms. It also moves nitrogen between the atmosphere, soil, plants and animals.

- Plants get their nitrogen from the soil. Bacteria in the soil converts or fixes nitrogen into a form that plants can absorb. Most of these bacteria live on the roots of legumes such as peas, lentils and soybeans.
- Humans and animals get nitrogen from plants. Even carnivores such as tigers get nitrogen indirectly from plants, since the animals they eat contain nitrogen that originally came from plants.
- Nitrogen is returned to the earth when the plant dies or when animals defecate.

Since nitrogen stimulates plant growth it is often used in chemical fertilizers. This causes problems when excess nitrogen flows into lakes, rivers and ultimately the ocean. The excess nitrogen causes algae and other aquatic plants to grow too much. These plants can block the sun from deeper water, killing fish and causing other problems.

Organic farming methods are better for the environment because they don't use chemicals, which can be harmful to the environment. There are two organic methods farmers use to add nitrogen to the soil.

1. They plant a crop of legumes (peas, soybeans, lentils) as part of crop rotation, since legumes add more nitrogen to the soil
2. There is also a lot of nitrogen in animal manure and urine, which is often used to fertilize crops organically.



## Discussion

**F** Discuss and answer the questions. Work in groups.

- 1) Describe the significance of legumes in the global nitrogen cycle.
- 2) How can farmers return nitrogen to the soil?
- 3) What is the importance of the nitrogen cycle?
- 4) How do human activities affect the nitrogen cycle?

# The oxygen cycle

## Activity: experiment

**G** Try this experiment. Work in small groups.

Light a candle, let it burn for a few moments and then cover it with a glass turned upside down. Observe what happens.



Learning the oxygen cycle will help you understand why oxygen is so important

## Reading

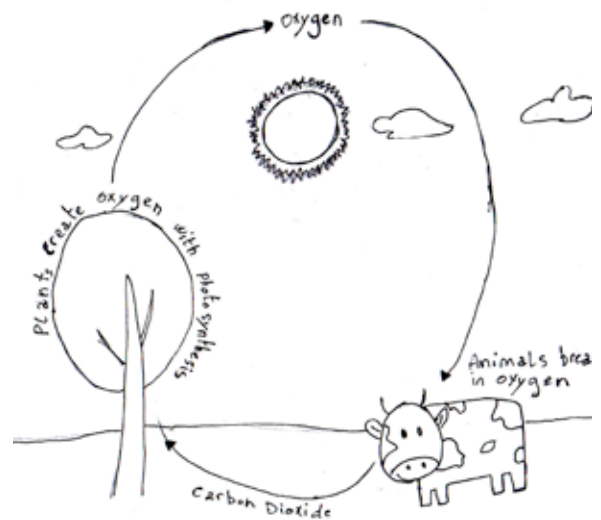
Most of you is oxygen! And most of this oxygen is in the form of water (H<sub>2</sub>O). About 65 % of your body is water. Oxygen is the most common element on earth. All animals need oxygen to survive and the earth is the only planet in our solar system with enough oxygen to sustain life. Though most often thought of as a gas, oxygen can also be solid or liquid. Oxygen makes up about 30 % of the earth's crust and 20 % of the earth's atmosphere. Oxygen plays a very important role in the atmosphere when it is in the form of O<sub>3</sub>, otherwise known as ozone. The ozone layer helps to protect life on earth by blocking some of the sun's harmful UV rays. Unfortunately, the ozone layer is being damaged by a variety of chemicals made by humans.

The **oxygen cycle** is closely linked with the carbon cycle. Plants absorb carbon dioxide (CO<sub>2</sub>) from the air. Using energy from the sun, plants split oxygen atoms from carbon atoms during photosynthesis. They use the carbon to make carbohydrates for food. The oxygen is mostly a waste product to the plants so they release it back to the atmosphere. That's great for us and for most animals on earth, including fish, as we need this oxygen to survive. Our cells use oxygen to burn food and produce energy.

These processes release oxygen:

- **Respiration** – Humans and animals use oxygen during the process of respiration, otherwise known as breathing. Fish breathe oxygen that has been dissolved in water through their gills.
- **Decomposition** - When plants and animals die they decompose (rot, decay) and this process uses oxygen.
- **Combustion** – Oxygen is also needed to make something burn in a process called combustion. Without oxygen nothing can burn.

Most of the oxygen we breathe comes from ocean plants, called phytoplankton. Trees growing in the Amazon Rainforest provide about 20 % of the earth's oxygen



## Discussion

**H** Answer the questions. Work in pairs.

- 1) Why do you run out of breath when you exercise hard?
- 2) Where does most of the oxygen you breathe come from?
- 3) What is the purpose of the Ozone layer?

## Additional Activity

Follow the instructions by your teacher and build your mini water cycle.



## Reading



To check students' understanding, you can ask

- Why is ozone (O<sub>3</sub>) so important for the health of our planet?
  - Because it blocks harmful UV rays.
- How many oxygen atoms are there in each molecule of ozone?
  - 3
- Why do your cells need oxygen?
  - So that they can burn food to produce energy.

## Discussion



After students have finished reading, break them into pairs or small groups and ask them to answer the questions. Afterwards, discuss the answers as a class.

### Answers:

- 1) Why do you run out of breath when you exercise hard?
  - Because hard exercise requires a lot of energy so your cells need to burn a lot of food. This means you need lots of oxygen
- 2) Where does most of the oxygen you breathe come from?
  - Most of the oxygen comes from ocean plants and the amazon rainforest
- 3) What is the purpose of the Ozone layer?
  - To protect life on earth by blocking some of the sun's harmful or rays.

## Additional Activity

Adapted from <http://www.sdcoastkeeper.org>

Build a mini water cycle

If you have enough time in the classroom you can conduct this activity. Otherwise it could be done as homework.

To create your own water cycle, you will need:

- 1 plastic tub
- 1 plastic cup
- 1 small rock or marble
- Wrap plastic (or similar)
- 1 roll of wide tape to seal the still
- Soil or sand
- 1 – 2 cups of water

### Directions:

- 1) Add your soil to the plastic tub.
- 2) Position the plastic cup in the center of the tub, partially submerged in the soil for stability.
- 3) Pour 1-2 cups of water over the soil.
- 4) Seal the tub with wrap and tape. Add a pebble or large marble directly above the cup forming a depression in the cling wrap.
- 5) Place what you have created in a sunny location.

Ask the students to observe the project throughout the day and write down what they notice happening.

## What are natural Resources?

### Brainstorm



- A** Students brainstorm and answer the following questions. Work in groups.

#### Possible answers:

- 1) What are natural resources?
  - Natural resources are the resources that naturally exist and are useful for humans.
- 2) Water is one of the most important natural resources. What are some others?  
List at least 10 natural resources.
  - Sunlight, gas, oil, wind, water, air, wood, gold, iron, sand, animals,

### Exercise



- B** Students classify the items. Work in pairs.

#### Answers:

Not a natural resource	Natural Resource
Mosquitos, plastic, paper, stainless steel, cars, computers, glass	Solar power, fish, teak trees, firewood, land, copper, iron, petroleum, coal, shrimp, diamonds, soil, wind, worms

- 1) Why are the items in the first column not considered to be natural resources?

**Answer:** Mosquitos are not useful to humans. The other examples are products that do not exist naturally.

## Classifying natural resources



### Reading

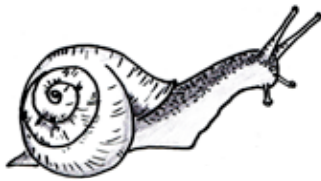
Provide more examples if necessary

## What are natural Resources?

### Brainstorm

#### A Brainstorm and answer the following questions. Work in groups.

- 1) What are natural resources?
- 2) Water is one of the most important natural resources. What are some others? List at least 10 natural resources.



A natural resource is something in nature that people can use. People do not make natural resources, but gather them from the earth. Natural resources:

- 1) Exist naturally in the environment
- 2) Are required for human survival or are useful to humans in some way

### Exercise

#### B Classify the following items then answer the question below. Work in pairs.

Mosquitoes	Fish	Teak trees	Plastic	Copper
Land	Coal	Cars	Worms	Soil
Solar power	Petroleum	Firewood	Paper	Stainless steel
Shrimp	Diamonds	Wind	Iron	Glass

Not a natural resource	Natural Resource

- 1) Why are the items in the first column not considered to be natural resources?

## Classifying natural resources

### Reading

There are several ways of classifying natural resources.

#### 1) Natural resources can be biotic or abiotic

- **Biotic** natural resources are those that come from living organisms such as trees, plants, animals or fish. Fossil fuels - coal, natural gas and oil – are biotic natural resources since they come from plants that died millions of years ago.
- **Abiotic** natural resources are those that come from non-living sources. These include land, sunlight, air, water, minerals (such as silver, tin, and iron) and gems (such as rubies and diamonds).

**C** Complete the table below and list at least 5 biotic and 5 abiotic natural resources. Work in pairs.

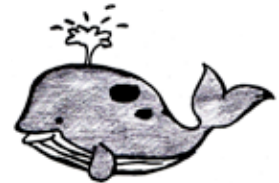
Biotic	Abiotic

**2) Natural resources can be renewable or nonrenewable**

- **Renewable natural resources:** The name says it all – these are resources that can **re-new** themselves. Renewable resources can replenish or replace themselves fairly quickly after they are used. Or they are resources that can never be used up. There are two types:

**Plentiful:** These natural resources are always available and are not affected by human consumption. Plentiful natural resources will never run out. Examples include sunlight, wind and air.

Although air will never run out, it can become polluted or contaminated by toxins. We must treat this resource carefully.



**Limited:** These resources can come back. However, if they are not used wisely, they could be used up and disappear. Examples include wild fish, fresh water, and forests.

- **Non-renewable** – these are natural resources that take millions of years to make. They are used faster than they can be replaced and eventually will be used up. Fossil fuels and diamonds are an example of non-renewable natural resources.

**Question:** What are fossil fuels?



**D** Complete the table below and list at least 5 items in each column. Work in pairs. Refer to the list of natural resources at the end of the book or think of your own

Renewable: Limited	Renewable: Plentiful	Nowrenewable

**3) Natural resources can be global, national, or multinational**

- **Global** natural resources are found all over the world and cannot be owned by one nation. Examples include air, wind, and sunlight.
- **National** natural resources are found entirely within the boundaries of one country. Crude oil is one of the most important national resources and can bring great wealth to individual countries. Sometimes countries go to war in order to get control of natural resources owned by another country.
- **Multinational** natural resources cross international boundaries, such as rivers.

- C** Students complete the table and list at least 5 biotic and 5 abiotic natural resources. Work in pairs. Students can refer to the list of natural resources at the end of this lesson or think on their own.

**Answers will vary but may include:**

Biotic	Abiotic
<ul style="list-style-type: none"> <li>- Coal</li> <li>- Water buffalos</li> <li>- Meat</li> <li>- Mushrooms</li> <li>- Mangrove forests</li> <li>- Wood</li> <li>- Crabs</li> <li>- Natural gas</li> </ul>	<ul style="list-style-type: none"> <li>- Land</li> <li>- Water</li> <li>- Solar energy</li> <li>- Aluminum</li> <li>- Silver</li> <li>- Clay</li> <li>- Gravel</li> <li>- Diamonds</li> </ul>

**Questions:** What are fossil fuels? Coal, oil, and natural gas which were made from the remains of plants that died hundreds of millions of years ago.

- D** Students complete the table and list at least 5 items in each column. Work in pairs. Students can refer to the list of natural resources at the end of this lesson or think on their own.

**Answers will vary but may include:**

Renewable: Limited	Renewable: Plentiful	Nowrenewable
<ul style="list-style-type: none"> <li>- wild animals such as deer</li> <li>- mangrove forests</li> <li>- teak forests</li> <li>- rhinos</li> <li>- wetlands</li> <li>- water</li> <li>- fish</li> <li>- shrimp</li> </ul>	<ul style="list-style-type: none"> <li>- sunlight</li> <li>- solar energy</li> <li>- air</li> <li>- wind</li> </ul>	<ul style="list-style-type: none"> <li>- setroleum</li> <li>- diamonds</li> <li>- copper</li> <li>- rubies</li> <li>- natural gas</li> <li>- coal</li> </ul>

**E** Students answer the questions. Work in small groups.

**Answers:**

- 1) What natural resource has made many countries in the Middle East including Saudi Arabia, Kuwait and the United Arab Emirates very wealthy?
  - Oil and natural gas
- 2) What are some of the most important natural resources of Myanmar?
  - Copper, jade, rubies, timber (wood), tin, petroleum and natural gas, zinc and limestone

## Natural resource management

### Activity



**F** Read the passages aloud and have students answer the question.

- 1) What is Natural Resource Management?

#### **Natural resource management - the big picture**

Every moment of our lives we use the resources that nature provides. We breathe the air that encircles our earth. We eat plants grown in the soil and other living species. We use vegetation for food, pasture and shelter. We live in houses made from wood that was once trees, brick that was once clay, steel that was once minerals in the earth. We drink water that falls from the heavens and use it to irrigate the land. We use energy provided by coal and oil or the sun.

We depend on nature to supply all our basic needs - air, food, water, shelter, warmth, energy - yet few of us consciously acknowledge these gifts or think about the price nature pays for such generosity.

If we are to be a truly sustainable society we need to understand the impact our lives have on nature and the resources it provides. We need to make decisions that minimise our impact so that the natural systems we are part of can continue.

From <http://www.landlearnsw.org.au/production-chains/nrm>  
Adapted from text by Rebecca Lines-Kelly, I&I NSW

#### **What is Natural Resource Management?**

**Natural resource management** means the management of natural resources such as water, land, plants and animals. This management has a focus on the interaction between people and natural landscape.

**Natural resource management** includes land use planning, water management, sustainable development and biodiversity conservation and industries like agriculture, fisheries, forestry, mining and forestry. It focuses on improving the quality of life of the present and future generations as people rely on natural resources for their livelihood and health.

Rivers are a multinational resource because they often begin in one country but flow through other countries. Problems and conflict occur when countries near the top of the river dam the river or divert it for irrigation.



**E** Answer the following questions. Work in small groups.

- 1) What natural resource has made many countries in the Middle East including Saudi Arabia, Kuwait and the United Arab Emirates very wealthy?
- 2) What are some of the most important natural resources in Myanmar?

## Natural Resource Management

The air we breathe, the food we eat, the petrol we put in our cars, the water we drink, the wood and metal and cement we use to build our homes and schools and hospitals, are all made from natural resources.

If we do not use natural resources carefully they could be destroyed or used up entirely.

Effective natural resource management will help protect our existing natural resources so that they will last and future generations will be able to enjoy them as well.

**Natural resource management**

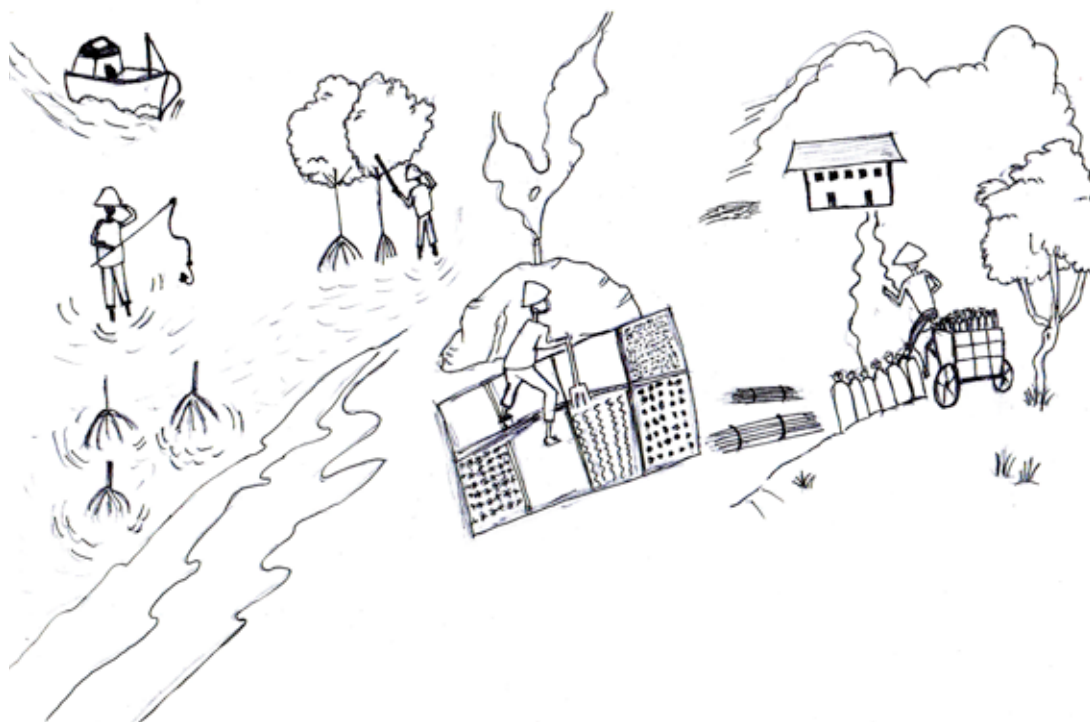
means using our natural resources such as land, water, soil, plants and animals wisely, sustainably and responsibly, so that these resources will benefit humans now and in the future



### Activity

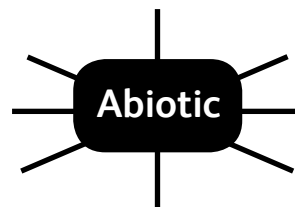
**G** Listen to the passages read by your teacher, and answer the following questions.

- 1) What is Natural Resource Management?



## \* **Mind-map**

- G** Complete the following mind map. Do one about Myanmar and one about your community.  
Work in groups.



## 💡 **Reflection**

- H** Think and answer the questions individually. Then, share with your partner and discuss as a class.
- 1) How are natural resources managed in Myanmar?
  - 2) How are natural resources managed in your community?
  - 3) How can these resources be managed better?

## **Additional Activity**

List all the items in your Room/ Kitchen or Classroom and name the natural Resources used to make each item. Then rank the items according to Main Resource type: Renewable limited, Renewable, plentiful or non-renewable.



## **Mind-map**



- G** Students complete one mind map about Myanmar and one mind map about their communities.  
Students work in groups.

## **Reflection**



- H** Students think and answer the questions individually, Then, they share with a partner and discuss as a class.
- 1) How are natural resources managed in Myanmar?
  - 2) How are natural resources managed in your community?
  - 3) How can these resources be managed better?

## **Additional Activity**

This activity can be done as homework.

## What is energy?

### **Brainstorm**



**A** Student brainstorm and answer the questions. Work in pairs.

#### Answers:

- 1) How do plants get their fuel?
  - During a process called photosynthesis plants free carbon atoms from carbon dioxide using energy from the sun. This carbon is turned into carbohydrates, which plants can use as fuel to make the energy they need.
- 2) What do people and animals use as fuel?
  - The food we eat.
- 3) What do vehicles use for fuel?
  - Petrol, diesel, natural gas, electricity, and biofuels
- 4) What do phone and laptops use for energy?
  - Electricity which can come directly from an electric outlet or from electricity stored in a battery.

### **Reading**



To check students' understanding, ask:

- What is energy?
  - Energy is what makes something move or grow or change or work.
- What does fuel do?
  - Fuel creates energy and stores it for later use.
- What is the major type of non-renewable energy?
  - Fossil fuels.

## What is energy?

### Brainstorm

**A** Brainstorm and answer the following questions. Work in pairs.

- 1) How do plants get their fuel?
- 2) What do people and animals use as fuel?
- 3) What do vehicles use for fuel?
- 4) What do phone and laptops use for energy?

### Reading

**Energy** is the force that makes something change or move or grow. All living organisms, including plants, need energy to live. Cars and trains and planes need energy to move. Lights and computers, fridges and phones all need energy to work. We need energy to transport and cook our food. Energy is a very important part of life! Fuel is used to create energy and to store energy until it is used.

Electricity is a very important source of energy. It can be made from many different fuels including coal, oil, nuclear energy, sunlight, and moving water. Electricity is useful because it is easy to transport (through electric wires) and store (in batteries).



There are many different kinds of fuel. Many but not all fuels are made out of carbon. Like other natural resources, energy:

- Is renewable or nonrenewable
  - **Renewable energy** is made from unlimited natural resources such as sunlight or natural resources that can be easily replenished such as bamboo.
  - **Non-renewable energy** is made from fuels that cannot be replenished in our lifetime. Fossil fuels are the major non-renewable fuel.

There are many different kinds of fuel, including the following:

- |                |   |
|----------------|---|
| 1) Wood        | 9) Sunlight   |
| 2) Natural gas | 10) Moving water  |
| 3) Coal        | 11) Wind energy   |
| 4) Charcoal    | 12) Geo-thermal   |
| 5) Kerosene    | 13) Dried animal manure   |
| 6) Diesel      | 14) Methane gas made out of animal manure                         |
| 7) Garbage     | 15) Ethanol, a type of alcohol based fuel                         |
| 8) Gasoline    | 16) Biodiesel (a fuel made out of vegetable oils and animal fats) |



Even garbage can be used as a fuel! Sometimes garbage is burned and the heat is captured and turned into energy.

# Non-renewable energy- Fossil fuels

## Reading

Fossil fuels are so named because they come from the remains of plants and algae that died hundreds of millions of years ago. That's right – coal, oil and natural gas are made out of the remains of dead plants. Remember the carbon cycle? Plants take in carbon atoms from carbon dioxide gas in the atmosphere. They then use these carbon atoms to build their stems and leaves, their flowers and seeds. These carbon atoms never go away, even when the plant dies. Instead – over hundreds of millions of years – the carbon atoms change from plants into fossil fuels. When fossil fuels are burned, the carbon atoms are released back into the atmosphere and turn in carbon dioxide. Carbon dioxide harms our natural environment since it is one of the greenhouse gases that causes **global warming** and **climate change**.

Why are fossil fuels non-renewable?



# Renewable energy

## Reading

The energy sources listed below are renewable since they are made from unlimited natural resources. They are considered to be cleaner than fossil fuels as they do not release greenhouse gases when used or extracted from the earth. However, even though these sources are cleaner they can still cause environmental damage.

<p><b>Solar energy</b> (Fuel Source: Sunlight) Energy from the sun is captured by solar panels and turned into electric energy. This electricity is then sent to the electric grid or stored in batteries. Electricity stored in batteries can be used to power lights, laptops, phones, TVs and small appliances.</p>	A black and white photograph showing a vast field of solar panels installed in a desert-like environment under a clear sky.
<p><b>Hydroelectric energy</b> (Fuel Source: Rivers) Hydro power is a very old form of energy. These days, spinning wheels convert river energy into electricity. There are very small hydroelectric generators that can be placed in rivers to produce small amounts of energy. These cause very little environmental damage. However, most hydroelectric energy is made by building big dams across an entire river. The water is then forced through a small opening in the dam where it spins wheels that produce energy which is converted into electricity.</p>	A black and white photograph of a large concrete dam with multiple spillways. Water is cascading over the spillways, creating white foam.
<p><b>Wind energy</b> (Fuel Source: Wind energy) Large spinning turbines capture wind energy and convert it into electricity. Wind energy has one of lowest environmental impacts of all energy sources. However, the large turbines sometimes kill birds. Currently wind produces only about 1.5% of all international electricity, but it is growing rapidly.</p>	A black and white photograph of a wind farm with several large, three-bladed wind turbines standing in a flat, open landscape.

# Non-renewable energy- Fossil fuels

 **Reading**



Question: Why are fossil fuels non-renewable?

- Because it takes so long to make them.

# Renewable energy

 **Reading**



If students have difficulty to understand, provide more explanations.

Provide definitions for new words. Some have their translations in the glossary.

To check students' understanding, you can ask:





- What is renewable energy?
  - It is energy made from natural resources that will not run out like water, wind and the sun.
- Hydroelectric energy is a clean, renewable form of energy. But producing it can have negative environmental impacts. How does hydroelectric energy harm the natural environment?
  - When dams are built across rivers they change the natural ecosystem of the river. They prevent fish from moving up and down the river and stop sediment from flowing downstream. Dams also flood large areas of land.
- How is nuclear energy made?
  - By splitting atoms of uranium and plutonium.

★ **Exercise**



**B** Students refer to the chart and list examples of renewable and non-renewable energy.  
Students work individually.

<b>Renewable</b>	<b>Non-renewable energy</b>
<ul style="list-style-type: none"><li>- Windpower</li><li>- Solar power</li><li>- Hydroelectric</li><li>- Geothermal</li><li>- Tidal</li><li>- Nuclear</li><li>- Biofuels</li></ul>	<ul style="list-style-type: none"><li>- Coal</li><li>- Natural gas</li><li>- Oil</li></ul>

<p><b>Geothermal</b> (Fuel Source: Energy from the center of the earth)          Steam from very hot water deep inside the earth is captured and used to turn turbines which then create electricity. As of 2012, five countries (USA, Philippines, Indonesia, Mexico and Italy) produce most of their electricity from geothermal sources.</p>	
<p><b>Tidal power</b> (Fuel Source: Ocean tides)          As ocean tides rise and fall the moving water rotates generators under water which produce electricity. Tidal power has great potential for the size of oceans. However its availability is still limited for its high cost.</p>	
<p><b>Biofuels</b> (Fuel Source: Living and recently dead biological matter)          Biofuels - literally biological fuels - are created from plants and plant parts including sugarcane, corn, and wood chips. Ethanol is one of the most common biofuels. Biofuels are renewable and are cleaner than fossil fuels as they do not release as much carbon dioxide. However, biofuels might cause environmental damage since natural rain forests are cut down to grow corn and sugar cane.</p>	
<p><b>Nuclear energy</b> (Fuel Source: Uranium and plutonium)          Nuclear energy is created by splitting atoms of uranium and plutonium. This creates a huge amount of energy which is used to heat water to create steam which is then used to generate electricity. Currently there are 439 nuclear reactors operating in 31 countries. Nuclear energy does not produce carbon emissions so many people consider it to be a clean and renewable source of energy. However, it does produce radio-active waste which must be stored very carefully.</p>	

★ **Exercise**

**B** Refer to the chart above and list examples of renewable and non-renewable energy in the chart. Work individually.

Renewable	Non-renewable energy

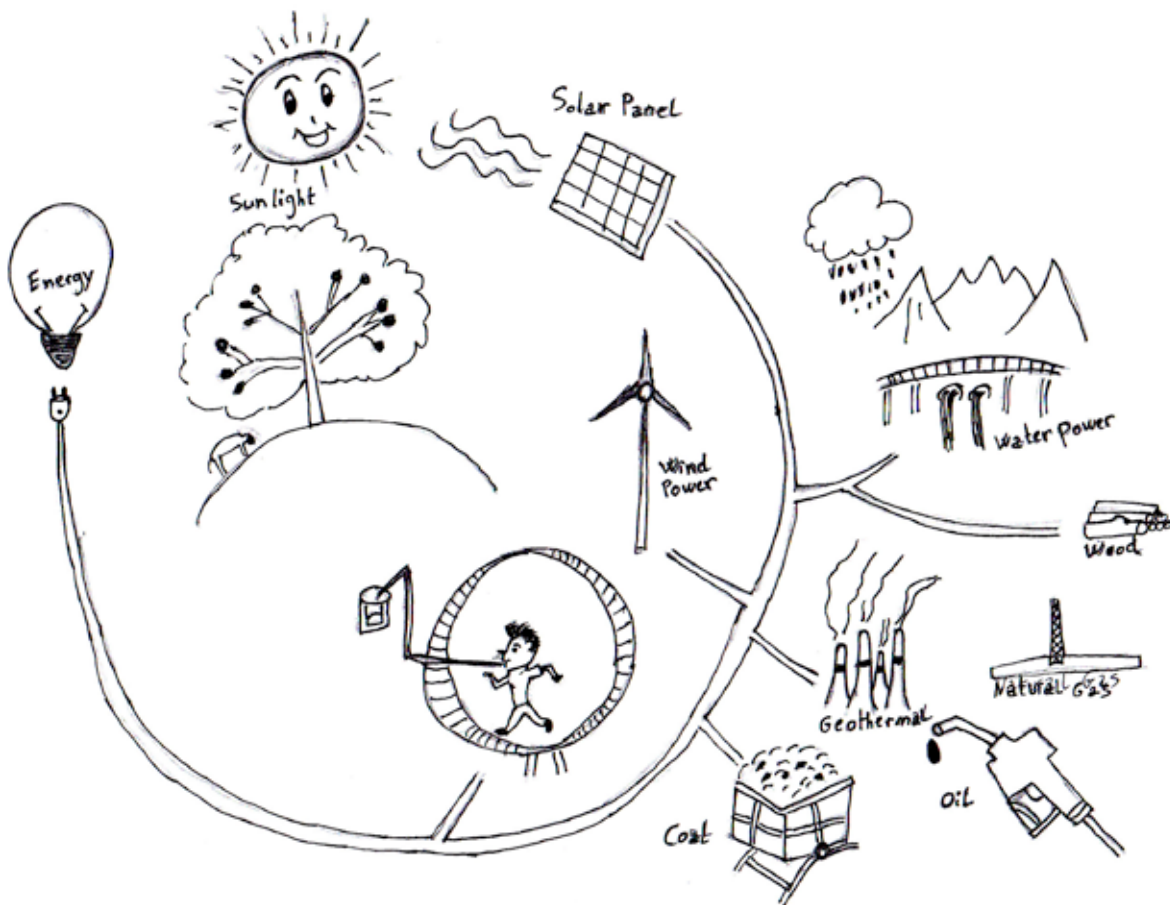
## Discussion

### C Discuss your answer in groups.

- 1) Which forms of energy do you use on a daily basis?
- 2) Which of the studied sources of energy have you never heard of before?
- 3) What does your household use to cook food?
- 4) Have you ever used solar power?
- 5) What do you think is the best source of energy for:
  - a) Lighting your home
  - b) Cooking
  - c) Powering a vehicle

## Additional Activity

- Pick one of the studied examples of energy and imagine the scenario where the only energy available on earth is the energy you picked.
- Mind map the advantages, disadvantages and impact of the only use of that energy.





 **Discussion**



- C** Students answer the questions in groups and share in class.

**Additional Activity**

This activity can be set as homework and students can work in groups.

## Overview

### **Brainstorm**



**A** Students brainstorm and answer the questions. Work in small groups.

- 1) How is the concept of an ecosystem different from a natural environment?

**Answer:** The main difference is that the word ecosystem emphasizes the interaction of all living organisms - plants, animals, insects, birds, and microorganisms – with each other and with nonliving factors such as the weather, soil, surrounding water sources and the local atmosphere.

- 2) Provide some examples of small ecosystems.

**Answers may include:** your digestive tract, a rice paddy, a decaying tree trunk, a water ditch by the edge of a road, a small pond

- 3) Provide some examples of large ecosystems.

**Answers may include:** an ocean, the Amazon rainforest, the Irrawaddy River river, the delta, the Arctic, the Sahara Desert

- 4) List five ecosystems that exist in the area where you live.

**Answers will vary but may include:** natural forest, community/planted forest, streams and/or rivers, a lake, sesame fields, mangrove forest, beach, rice paddy

- 5) What can you do to protect and promote the health of ecosystems in your area?

**Answers will vary but may include:** do not pollute, educate others, use fewer resources, dispose of trash properly, do not use harmful pesticides and fertilizers

- 6) Why are healthy ecosystems important?

**Answer:** for the survival of all living beings

## Why are healthy ecosystems important?

### **Reading**



Provide definitions for new words. Some have their translations in the glossary.

### **Discussion**



**B** Students work in small groups and then share as a class.

## Overview

### Brainstorm

- A** Brainstorm and answer the following questions. Work in small groups.
- 1) How is the concept of an ecosystem different from a natural environment?
  - 2) Provide 3 examples of very small ecosystems.
  - 3) Provide 3 examples of large ecosystems.
  - 4) List at least five ecosystems that can be found in your area.
  - 5) What can you do to protect and promote the health of ecosystems in your area?
  - 6) Why are healthy ecosystems important?

## Why are healthy ecosystems important?

### Reading

Our lives and the lives of all living organisms depend on healthy ecosystems! We do not live in isolation but in a **community** of other living organisms as well as nonliving elements such as water, air and soil. We are all **interconnected**. If one member of an ecosystem sickens or dies the health of the entire ecosystem may be affected. An ecosystem may also be changed by the addition of a new organism, especially an invasive species.

Among other reasons, healthy ecosystems are important because they:

- 1) Sustain the life of all organisms living in that ecosystem
- 2) Support biodiversity
- 3) Provide food, wood, clean water and other resources
- 4) Maintain good air, soil, and water quality
- 5) Protect us from natural disasters like erosion and floods
- 6) Help an area recover from natural disasters
- 7) Help maintain a stable climate
- 8) Promote healthy, fertile soil which helps produce more fertile crops
- 9) Provide aesthetic, social, cultural, recreational and spiritual benefits
- 10) Help reduce insect pest infestation

### Discussion

- B** What are the most important benefits of healthy ecosystems? Select three of the reasons listed and explain why you think each reason is especially important. Work in groups.



# What is a healthy ecosystem?

## Reading

There are some important characteristics common to all healthy ecosystems.

### A healthy ecosystem:

1) Provides for the needs of all organisms living within that ecosystem. What do all organisms need to survive? To survive and thrive, most organisms need:

- clean air
- clean water
- the right temperature
- enough sunlight
- enough quality food
- a balance of predators and prey
- suitable habitat

2) **Is biodiverse.** This means that there are many different species of plants, insects, animals, birds, and other organisms living in the ecosystem. A biodiverse ecosystem also has a lot of genetic diversity within a single type of organism. There are several reasons why biodiversity is an important ingredient of a healthy ecosystem:

- Biodiversity helps the entire ecosystem be more sustainable. A sustainable ecosystem is one that can survive and thrive, an ecosystem that supports itself without outside support or assistance. Biodiversity helps an ecosystem be sustainable because different species depend upon one another. If one particular species disappears from an ecosystem there can be a lot of environmental damage.
- Biodiverse ecosystems are stronger than ecosystems with limited biodiversity. They are better able to survive and recover from damage. This is true both in natural environments and in manmade environments such as farms. Disease, climate change or another problem may kill or damage one particular species, but not affect another similar species. If there are a wide variety of different species, some species will survive and the damage will be much less.
- Biodiversity helps ensure that an ecosystem stays well balanced

3) **Has mostly native, not invasive species.**

Native species are living organisms that are originally from that ecosystem. They are well adapted to their environment and live in harmony with other organisms. Invasive species are those that move into an ecosystem from somewhere else and cause harm by killing native species or by consuming the space or resources (such as food) native species need to survive.

To protect the country from the negative effects of invasive species, some countries, particularly Australia and New Zealand, have very strict laws about what types of agricultural products you can bring into the country.



4) **Is sustainable.** A sustainable ecosystem will last as it is into the future without outside assistance. A sustainable ecosystem has all it needs to survive.

Biodiversity is one important factor sustainable ecosystems need, but other factors are needed as well. For example, sustainable ecosystems need the right kind of habitat for all organisms living in that ecosystem. If the habitat a particular species depends on disappears, that species will eventually disappear as well. For example, a polar bear needs thick ice to hunt seals. But due to global warming, polar ice is melting. The population of polar bears is declining as the habitat they need melts.

# What is a healthy ecosystem



Allow enough time for students to read and understand the text. You could also read the text aloud.

Provide definitions for new words. Some have their translations in the glossary.

To check students understanding, you can ask the following questions:

- What are the two characteristics of an invasive species?
  - It comes from somewhere else and it causes harm.
- What is an example of an invasive species we studied earlier in this course?
  - The Burmese python in Florida.
- How does biodiversity help an ecosystem stay healthy?
  - **Answer will vary.**

## Discussion



**C** Students discuss and answer the questions. Work as class.

1) Why are biodiverse ecosystems stronger than ecosystems with little biodiversity?

**Answer:** They are better able to survive and recover from damage.

2) Do you think poisonous snakes should be killed? Why or why not?

**Answers will vary.**

3) Are there poisons in your local ecosystems? In your air, water or soil? Explain.

**Answers will vary.**

4) How can you educate your local community about the importance of healthy ecosystem?

**Answers will vary but may include:** By modeling – by acting in a way that shows others you care about the health of surrounding ecosystems (i.e. picking up trash); by encouraging teachers in local schools to instruct their students about the importance of healthy ecosystems, by writing letters to local newspapers; by explaining to shop keepers why you choose not to use plastic bags.

- 5) **Is non-toxic.** A healthy ecosystem does not have harmful chemicals or poisons in the land, air or water. Some toxins are easy to see, while others are invisible. Tests need to be done to determine the levels of invisible toxins.
- 6) **Has apex predators.** Healthy ecosystems include top-level predators to keep the whole system in balance.
- 7) **Is in balance** – All the organisms in a healthy natural ecosystem are interconnected so that the whole system is in balance. There is not too much of one particular species.
- 8) **Is protected by concerned and informed citizens.** There are many factors damaging ecosystems around the world. Some include climate change, deforestation, mining, and population growth. It is up to people – including you! – to learn how to protect the environment and take steps to do so.

## Discussion

### **C** Discuss and answer the following questions. Work as class.

- 1) Why are biodiverse ecosystems stronger than ecosystems with little biodiversity?
- 2) Do you think poisonous snakes should be killed? Why or why not?
- 3) Are there poisons in your local ecosystems? In your air, water or soil? Explain.
- 4) How can you educate your local community about the importance of healthy ecosystems?



# How can we promote and protect healthy ecosystems?

There are many things you can do, as individuals, communities and nations, to preserve and protect the health of the ecosystems around us.



## **Activity**

**D** Look at the two action categories below and complete the table by answering the questions.

### 1) Don't cause harm

Don't do things that harm the natural environment. Here are five suggestions. Try to list five more.

<ol style="list-style-type: none"><li>1. Don't pollute</li><li>2. Don't overfish</li><li>3. Don't destroy critical habitats</li><li>4. Don't kill off apex predators</li><li>5. Don't use more than necessary (from wood to water to plastic bags)</li></ol>	<b>List five more</b>
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### 2) Actively help

Take action, take responsibility, and make a difference! You can take active steps to help sustain a healthy ecosystem. Here are five things you can do. Try to list five more.

<ol style="list-style-type: none"><li>1. Educate others in your family and community about the importance of protecting our natural environment</li><li>2. Build a fuel-efficient stove (so you use less wood when cooking)</li><li>3. Use more solar energy and less fossil fuels</li><li>4. Reduce, Reuse and Recycle</li><li>5. Determine what the problems are so you can take appropriate action</li></ol>	<b>List five more</b>
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# How can we promote and protect healthy ecosystems?

## Activity



**D** Students look at the two action categories below and complete the table by answering the questions.

**Possible answers:**

**1) Don't cause harm**

Students list five more.

<ol style="list-style-type: none"> <li>1. Don't pollute</li> <li>2. Don't overfish</li> <li>3. Don't destroy critical habitats</li> <li>4. Don't kill off apex predators</li> <li>5. Don't use more than necessary (from wood to water to plastic bags)</li> </ol>	<p><b>List five more</b></p> <p><b>Possible answers:</b></p> <ol style="list-style-type: none"> <li>1. Don't use plastic bags</li> <li>2. Don't burn your trash</li> <li>3. Don't kill endangered animals</li> <li>4. Don't engage in slash and burn agriculture</li> <li>5. Don't use poisonous chemicals on your crops</li> <li>6. Don't waste water</li> <li>7. Don't plant crops that need to be heavily irrigated in dry areas</li> </ol>
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**2) Actively help**

Students list five more.

<ol style="list-style-type: none"> <li>1. Educate others in your family and community about the importance of protecting our natural environment</li> <li>2. Build a fuel-efficient stove (so you use less wood when cooking)</li> <li>3. Use more solar energy and less fossil fuels</li> <li>4. Reduce, Reuse and Recycle</li> <li>5. Determine what the problems are so you can take appropriate action</li> </ol>	<p><b>List five more</b></p> <p><b>Possible answers:</b></p> <ol style="list-style-type: none"> <li>1. Plant trees</li> <li>2. Use organic farming techniques</li> <li>3. Eat less meat (meat production contributes to carbon emissions)</li> <li>4. Write to local leaders and/or owners to protest against polluting mines and/or factories</li> <li>5. Boost the populations of endangered fish and turtles by raising them and then releasing them into the wild</li> <li>6. Build composting toilets</li> <li>7. Investigate the possibility of creating cooking fuel out of rice husks</li> <li>8. Start a mud brick activity</li> </ol>
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# Evaluation and Monitoring of the ecosystems around you



## Reading



To check students' understanding, you can ask the following questions:

- What does environmental monitoring mean?
  - Measuring air, soil, and water quality over time.
- Why should you evaluate and monitor the air, land, and water of your local ecosystems?
  - Because doing so will help you overcome the problems harming the ecosystems.
- Can you think of anything else that should be tested or monitored?
  - Answers will vary. This could include things like the changes in average temperature and rainfall, as well as the building of dams, mines, large factories and other developments that could harm the environment.



## Reflection



- E** Students discuss as a class. Encourage the students to think individually and mind map their ideas before the discussion.

## Additional Activity

This activity can be conducted in small groups. Students can present their assignment at the end of the course after studying lesson 10.

# Evaluation and Monitoring of the ecosystems around you

## Reading

In order to overcome the problems harming an ecosystem, we need to know what those problems are. We need to **evaluate** how healthy an ecosystem is now and **monitor** how it changes over time.

To evaluate the health of the ecosystem, scientists and concerned citizens conduct quality tests to measure factors such as:

- Water - How clean is the water? What, if any, toxins are present? How much water is there? How fast is it flowing (for rivers)? What organisms are living in the water and how healthy are they? What is the average temperature? How acidic is it (for oceans)?
- Air – What toxins are present? What greenhouse gases are present and how much of each? What is the temperature?
- Soil – How much organic matter is in the soil? What living creatures live in the soil? Are any poisons present?
- Invasive species – Are there any invasive species? If so, how are they damaging the ecosystem?

Environmental monitoring means systematically measuring the quality of air, water, soil, and the health of living organisms over time.



When trying to determine the environmental health of a region or country people will look at the following:

- 1) Number and extent of protected areas.
- 2) Extent of wetlands
- 3) Status of fish stocks
- 4) Amount of wildlife
- 5) Waste disposal
- 6) Sewage treatment

## Reflection

- E** Discuss as a class.  
What are the social and economic costs/problems of unhealthy ecosystems?

## Additional Activity

Map two ecosystems near you and evaluate how healthy there are. Use as many of the indicators you learned in this lesson as possible. Then write a proposal answering the following questions:

- 1) What action should be taken to improve the health of your environment?
- 2) Who should be involved?
- 3) Outline an action plan or strategies to realize these actions.



# Overview of Myanmar's Natural Environment



# Overview of Myanmar's Natural Environment

This lesson consists of 8 readings on various topics about Myanmar's environment. Each reading is followed by discussion questions and an activity.

This lesson is slightly different from the others. The teacher should decide which readings are the most relevant or useful to their students, while others may be skipped.

To go through the entire lesson may take up to 5-6 hours. Thus, it may not be possible to complete everything in the classroom. Some readings/activities can be assigned for homework or as a group project outside the classroom.

# Myanmar: A Land of Rich Biodiversity

## Reading

Provide definitions for new words. Some have their translations in the glossary.

## Discussion

- 1) Why does Myanmar have so much biodiversity?

**Answer:** For several reasons. Myanmar has a wide range of elevation (from 0 to almost 6000 meters), different kinds of forests, a long coastline and many islands. This means that Myanmar is home to many different ecosystems, that provide habitats for a wide variety of organisms. Myanmar also has four major river systems and in most of the country there is a lot of rain. Areas with plenty of fresh water support more types of life than areas with little rain.

- 2) What are some of the reasons why Myanmar's biodiversity is threatened?

**Answers will vary. Examples:** Deforestation, because trees are so important to the health of the natural environment and by destroying forests you are destroying habitat for many animals. Mining, because it causes so much pollution. Habitat destruction, because if you destroy the home where animals live they will die.

- 3) How should Myanmar's biodiversity be protected?

**Answer:** Include environmental education as part of the school curriculum; Serve as role models within our community; Write to community leaders about the importance of environmental preservation and conservation; Make more national parks; Make and enforce more stringent environmental laws.

## Activity: survey

Encourage students to use the internet or local library as well as interviewing people involved in environmental protection. Students can prepare the presentation on a flipchart or just simple A4 papers. This activity can be given as homework.

# Myanmar: A Land of Rich Biodiversity

## Reading

Myanmar is among the most biodiverse countries in southeast Asia. Almost all of Myanmar is located inside the Indo-Burma Biodiversity Hotspot, one of the world's 34 "richest and most threatened reservoirs of plant and animal life" as identified by Conservation International. Myanmar's terrain ranges from glaciers in the north to coral reefs in the south. It has four main physical areas: mountains in the north, highlands in the east and west, plains in the central area, and fertile delta regions in the south. It is rich in natural resources and home to a wide variety of wildlife.

Here are some reasons why Myanmar is so biodiverse:

- It has a wide range of elevation - from 0 meters along the coast to 5,881 meters at the top of Hkakabo Razi, the tallest mountain in Myanmar. This wide range of elevation provides many different ecosystems and habitats.
- Myanmar has almost 2,000 km of coastline and 800 islands.
- About 45% of Myanmar's land is forested, and there are a variety of different types of forests providing habit for many different kinds of plants and animals
- It has four major river systems

Some of the factors endangering Myanmar's biodiversity include:

Deforestation, habitat destruction, increased agriculture, mining, growth of rubber and palm oil plantations, population growth, pollution, overfishing, and wildlife trade

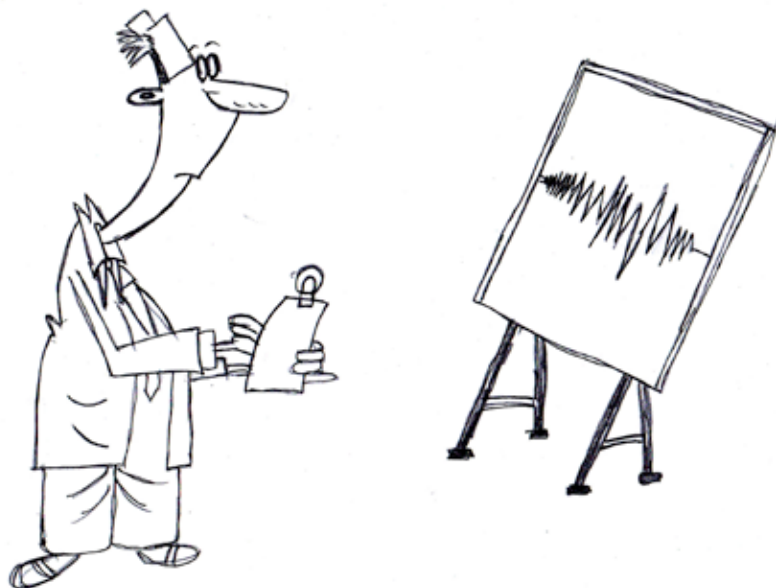
## Discussion

- 1) Why does Myanmar have so much biodiversity?
- 2) What are some of the reasons why Myanmar's biodiversity is threatened?
- 3) How should Myanmar's biodiversity be protected?

## Activity: survey

Survey the biodiversity of your environment by answering the questions below and prepare a simple presentation to share with your family and neighbors.

- 1) How biodiverse is you environment?
- 2) What are the main threats to biodiversity in your region?
- 3) How should biodiversity be protected in your environment?



# Animal Species in Myanmar

## Reading

The varied ecosystems of Myanmar provide habitats for many different kinds of animals and birds. There are 257 mammal species in Myanmar, ranging from flying lemurs to gibbons, and from bats to dolphins, and from elephants to the closely related dugong (a large, gentle vegetarian mammal that lives in the sea). Of these, 14 mammals are endangered, such as tigers, Red Pandas and the Javan Rhinoceros. Myanmar is home to almost 300 different species of reptiles including the Burmese python, the Indochinese spitting cobra, the Elongated tortoise and the Siamese crocodile. Twenty species of these reptiles are classified as endangered. More than 1,060 species of birds have been recorded in Myanmar, including the grey peacock-pheasant, the national bird of Myanmar. Of these, 51 birds are endangered.

## Discussion

- 1) What animals or trees have disappeared in your area?
- 2) Are there any endangered animals in your area?
- 3) What would happen if some species disappear from Myanmar? From the earth?

## Activity

Learn about and list the names of trees/plants and animal species found in your area. Complete the table and compare with a partner.

	Common	Rare
Tree/plant species		
Animal species		

Smooth-coated Otter  
 Red Goral  
 Red Panda  
 Eurasian Otter  
 Fishing Cat  
 Asiatic Black Bear  
 Malayan Tapir  
 Javan Rhinoceros  
 Clouded Leopard  
 Sumatran Rhinoceros  
 Capped Leaf Monkey  
 Hoolock Gibbon  
 Flat-headed Cat  
 Tiger  
 Sikkim Rat  
 Long-tailed Goral  
 Asiatic Golden Cat  
 Irrawaddy Squirrel  
 Eld's Deer  
 Takin  
 Marbled Cat  
 Red Climbing Mouse  
 Fin Whale  
 Blue Whale  
 Asian Elephant  
 Anderson's Squirrel  
 Particolored Flying Squirrel



# Animal Species in Myanmar

## **Discussion**

All answers will vary

## **Activity**

This activity can be done as homework

# Myanmar's Climate

## Activity

1) Students complete the following table:

1	Hottest months	April, May
2	Coolest month	January
3	Wettest 3 months	June, July, August
4	Driest 2 months	January and December

# Myanmar's Climate

## Reading

Most of Myanmar has a tropical monsoon climate. It has high humidity, lots of sunlight, and high rainfall (during the rainy season). This type of climate is affected by the monsoons. The monsoons are the seasonal change in wind direction, which controls how much rain there is. Winds blow from the ocean to the land during the hot summer months, bringing rain. In the winter, the winds blow from the land to the oceans and there is little rain. There are three seasons in most of Myanmar: it is cool and dry from November to February, hot and dry during March and April, and hot, rainy and humid from May through October.

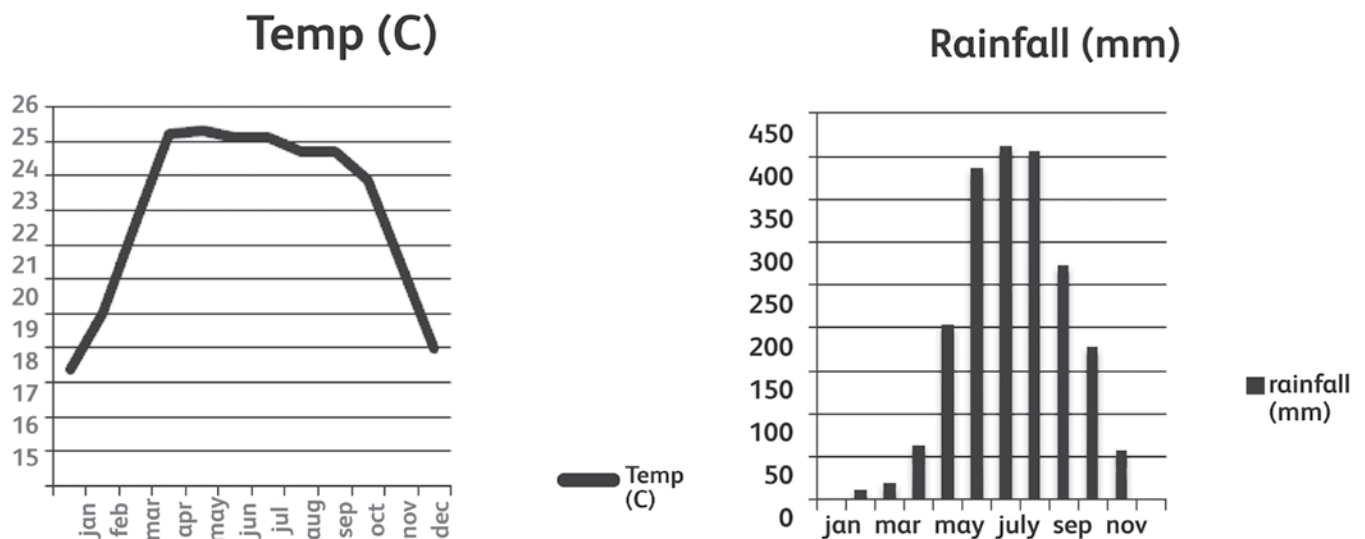
Myanmar's climate changes as the elevation climbs. Both temperatures and humidity (the total amount of water in the air) drop as the elevation gets higher. In the highlands of Shan State and Chin State temperatures can drop to near freezing in the winter. Above 4,000 meters, the climate is cold enough for snow.

The average annual rainfall in Myanmar ranges from 5,000 mm along the coast to 840 mm in Mandalay, which is in the Dry Zone. The annual temperature averages between 22 and 27 degrees C, though in the mountains the temperature drops below 0 C.

Because of global warming (the accumulation of greenhouse gases such as carbon dioxide in the atmosphere), Myanmar has become hotter over the past 75 years.

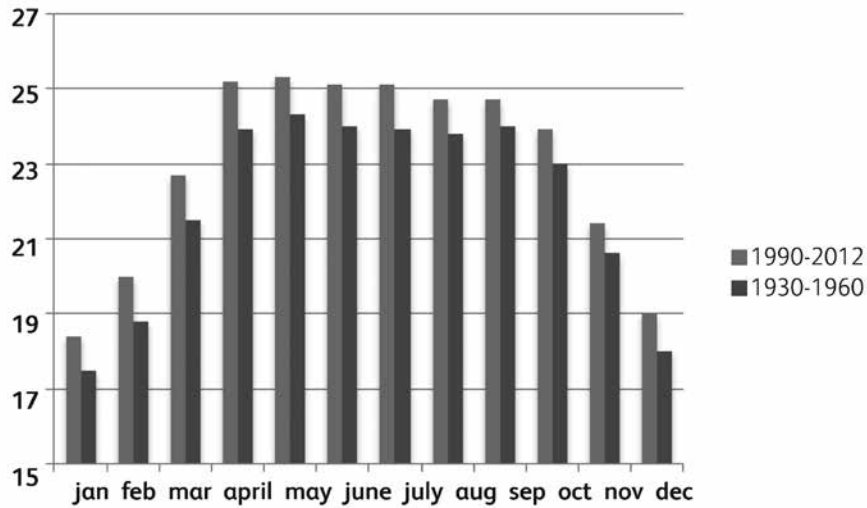
## Activity

1) Look at the charts and complete the following table:



1	Hottest months	
2	Coolest month	
3	Wettest 3 months	
4	Driest 2 months	

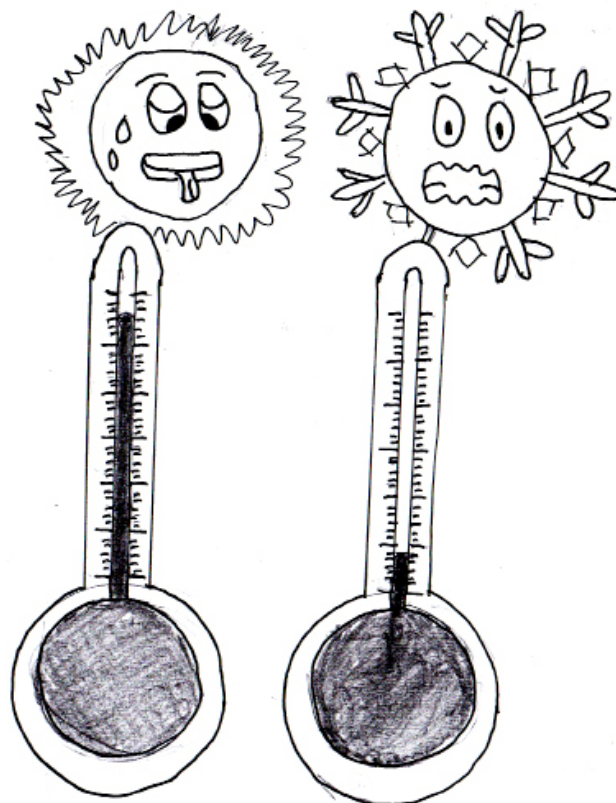
2) Look at the graph to complete the following table. The first cell has been completed for you.



	Jan	July	Oct	
1990-2012	18.5			Temperature in degrees C
1930-1960				

### Discussion

- 1) Which part of Myanmar has the most rain?
- 2) Which season do you like the best? Why?
- 3) Have you, or your older neighbors or family members noticed that the temperatures are getting warmer over the past few years?
- 4) What do you think will happen if temperatures continue to rise?
- 5) What human activities do you think cause global warming?



2) Students look at the graph to complete the following table.

	Jan	July	Oct	
1990-2012	18.5	25.1	24	Temperature in degrees C
1930-1960	17.5	24	23	

### Discussion

- 1) Which part of Myanmar has the most rain?  
**Answer:** along the coast
- 2) Which season do you like the best? Why?  
**Answers will vary.**
- 3) Have you, or your older neighbors or family members noticed that the temperatures are getting warmer over the past few years?  
**Answers will vary.**
- 4) What do you think will happen if temperatures continue to rise?  
**Answers will vary. Examples may include:** Some crops will not grow as well, which could cause farmers to make less money. It could also lead to food insecurity and widespread malnutrition and hunger. Water evaporates more quickly in hot weather, so higher temperatures could lead to reduced water supplies. The old and the young can be harmed by hotter weather. People may use more electricity in an attempt to stay cool with fans and air conditioners.
- 5) What human activities do you think cause global warming?  
**Answer:** The burning of fossil fuels by cars, factories and power plants is one of the most important causes. Agriculture is another important cause.

# The Marine Ecosystem

## Reading

Provide definitions for new words. Some have their translations in the glossary.

## Discussion

- 1) Where are most of the mangrove forests located in Myanmar?  
**Answer:** Most grow in the Ayeyarwady and the Tanintharyi Regions. Some also grow in Rakhine State.
- 2) Why are coral reefs an important ecosystem?  
**Answer:** Because they provide food and habitat for many marine creatures.
- 3) What benefits do seagrass beds provide?  
**Answer:** They provide food and habitat for marine creatures, protect the coast from waves and currents, stabilize the sea floor and clean ocean water.

## Activity

Encourage the students to do their mind-maps on flipcharts and hang them on the classroom walls. This activity can be given as homework.

# The Marine Ecosystem

## Reading

The marine environment is one of the largest and most important ecoregions in Myanmar. The coastline stretches 2,000 km from Bangladesh to Thailand. More than 800 islands belong to Myanmar including many in the Mergui **Archipelago**, off the coast of southern Myanmar. There are several bodies of water along Myanmar's coast, including the Bay of Bengal, the Andaman Sea and the Gulf of Martaban. All of these are part of the Indian Ocean. The marine environment is made up of different ecosystems. The following are important to Myanmar:

- **Coral Reefs**

Coral reefs and rain forests are the most biodiverse ecosystems in the world. Healthy coral reefs are essential to the health of the marine ecosystem since they provide habitat and food that support thousands of species of fish and other marine creatures. They are important economically for Myanmar since many Myanmar people depend on fishing for their food and income. Coral reefs also protect the coastline from big waves and erosion. Unfortunately, coral reefs all over the world are being killed for a variety of reasons including rising ocean temperatures and acidity.

- **Mangrove forests**

The mangrove ecosystem is also a very important part of the marine environment. Mangrove forests stabilize the shoreline, protecting it from erosion and from the effects of cyclones and seasonal flooding. Mangrove forests provide an important habitat for migratory birds and, like coral reefs, protect the young of many different types of sea organisms. Thus, these forests are also crucial for the fishing industry that is an important livelihood for many people living near the coast. Mangrove forests grow in river deltas and in muddy coastal areas. The trees can tolerate salt and are flooded by seawater during high tide. Of the total mangrove areas in Myanmar, 46% is located in the Ayeyarwaddy Region, 37% in the Tanintharyi Region and 17% in Rakhine State. Unfortunately, mangrove forests are being cut down at a rapid rate to provide space for shrimp farms and other human activities.

- **Seagrass Beds**

Seagrasses are flowering plants that grow in shallow marine waters near the coast. Seagrass beds are also an important part of the marine ecosystem. They provide food and shelter for many sea creatures including crabs, fish and the endangered dugong. Seagrass beds also stabilize the sea floor and protect the coastline by reducing waves and the effects of currents. They also trap small particles floating in the seawater, which would otherwise harm coral reefs.

## Discussion

- 1) Where are most of the mangrove forests located in Myanmar?
- 2) Why are coral reefs an important ecosystem?
- 3) What benefits do seagrass beds provide?

## Activity

Research and draw a mind-map of all the consequences of damaging the marine ecosystem. You can use categories such as : environmental, economic, or social damages/ consequences.

# Myanmar's Forests

## Reading

Forests are one of Myanmar's most important natural resources. In comparison to neighboring countries, Myanmar still has large areas of natural forest. Currently about 45 % of Myanmar is forested, which is down 70 % since the time of independence in 1947. About 10 % of Myanmar forest is primary forest, which are forests that have never been cut down and are the most biodiverse type of forests.

Forests are important for several reasons. First of all, if well managed, forests provide important resources for people in the form of valuable timber or wood for fuel. They also help protect the health of the natural environment in several ways. Forests provide oxygen as well as habitat for many species of birds and animals. They also help prevent erosion and flooding by holding the soil and absorbing water.

Forests adapt to their environment. Different types of forests grow in different areas depending on how high the area is, how much rain falls, what the soil is like and how close to the sea it is. Because Myanmar has such a wide range of different climates, it has many different types of forests.

Here are the most common types of natural forests:

- Mixed deciduous forest, which covers 39 % of forested areas, across all of central Myanmar. Deciduous trees are those that lose their leaves seasonally.
- Hill and temperate evergreen forests cover 26 % of forested areas. This type of forest is located at higher elevations in western, eastern and northern Myanmar. Evergreen trees are those that have leaves all year long.
- Tropical evergreen forest, which covers 16 % of Myanmar's forested areas.
- Dry forest (10 %) can survive with little water and grow mostly in the dry zone.
- Mangrove and swamp forests, which grow in the delta, along the eastern and southern coasts, and on Myanmar's many islands. Much of this type of forest has been cut to make room for agriculture.
- Pine forests grow in northwest Myanmar at elevations between 1,500 and 2,500 meters.

People have been planting forests to produce valuable timber in Myanmar since 1856, and managed forests are an important type of agriculture. Teak trees are the most common species planted. Other commercially planted species include pyinkado, padauk, pines, acacias and eucalypts.

### Fast Fact

Myanmar is home to:

- 2,088 tree species of which 1,347 species are big trees and 741 species are small trees
- 85 of these species provide premium quality timber
- 1,696 species of shrubs
- 96 species of bamboo

Source: [www.fao.org](http://www.fao.org)



# Myanmar's Forests

## *Reading*

Provide definitions for new words. Some have their translations in the glossary.

## **Discussion**

- 1) What is the most common type of forest in Myanmar?

**Answer:** Mixed deciduous

- 2) Which type of forests grow in the delta and along the coasts of Myanmar?

**Answer:** Mangrove and swamp forests.

- 3) How do forests help protect the health of the natural environment?

**Answer:** They provide habitats for many kinds of plants and animals. They also provide oxygen and help prevent erosion and flooding because they stabilize soil and absorb water

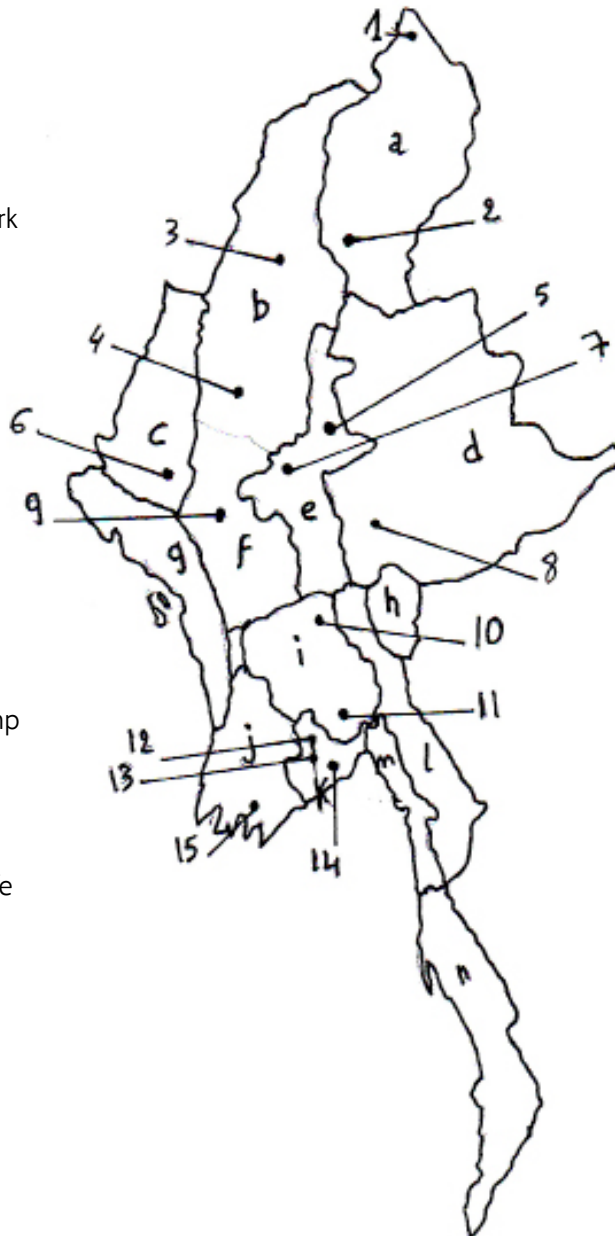
- 4) How many different species of trees are there in Myanmar?

**Answer:** 2,088

## **Activity: survey**

Students should be encouraged to go to their local municipality and collect information from relevant functionaries. This activity can be given as homework.

1. Khakaborazi national park
2. Indawgyi lake wildlife sanctuary
3. Chatthin wildlife sanctuary
4. Alaungdaw Kathapa national park
5. Maymyo botanical garden
6. Nat Ma Taung (Mt Victoria) national park
7. Popa mountain park
8. Inle lake wetland sanctuary
9. Shwesettaw wildlife sanctuary
10. Sein Ye forest camp
11. Moneyingyi wetland wildlife sanctuary
12. Myaing Hay Wun elephant camp
13. Hlawaga park
14. Yangon zoological garden
15. Meinmahla Kyun (island) wildlife sanctuary



### **States and divisions**

- a = Kachin state
- b = Sagaing division
- c = Chin state
- d = Shan state
- e = Mandalay division
- f = Magwe division
- g = Rakhine state
- h = Kayah state
- i = Bago division
- j = Ayeyarwaddy division
- k = Yangon division
- l = Kayin state
- m = Mon state
- n = Thaninthayi division

### **Discussion**

- 1) What is the most common type of forest in Myanmar?
- 2) Which type of forests grow in the delta and along the coasts of Myanmar?
- 3) How do forests help protect the health of the natural environment?
- 4) How many different species of trees are there in Myanmar?

### **Activity: survey**

Survey the types of forest that grow in your township or state. Investigate how these forests are managed and how trees are used.

# Dry Zone

## Reading

A dry zone is an environment which has less than 40 inches (101.6 cm) of rain per year. Myanmar's dry zone is in the center of the country and includes the regions of Mandalay, Magway and Lower Sagaing. It is a flat area at a low elevation between the Shan Highlands to the east and the Rakhine, Yoma and Chin Hills to the west. It covers a little over 10% of the total area of Myanmar and is home to 1/3 to 1/4 of the population of Myanmar (figures vary depending on the source).

It is hot and dry - much of the dry zone is totally rainless for 7 months of the year. Because of poor soil, lack of water and other issues, most people who live there are very poor and struggle to support themselves. Myanmar's dry zone is one of the poorest areas of the country. Many people are food insecure, which means they do not have a dependable food supply.

Myanmar's dry zone is sometimes called the "oil pot" of Myanmar because a lot of edible oil crops such as sesame and groundnut, which can survive with little water, are grown in the area.

The Irrawaddy River, the most important Myanmar river, flows through the dry zone. Near its banks, where irrigation is possible, farmers are able to grow rice.

### **Australian Centre for International Agricultural Research (ACIAR) Report**

Across the Central Dry Zone (CDZ), rainfall variability is high, water-use efficiency is low, vegetation cover is sparse and the soil is severely degraded – eroded and of low fertility. Smallholders farming in these environments face considerable challenges in achieving food security, while land managers lack the resources and capacity to support sustainable agricultural development. ...Salinity (salt) is a particularly serious issue in the CDZ due to saline sub - soils, high evapotranspiration rates and restricted outward drainage of groundwater.

Official blog from ACIAR on 16 April 2014

## Discussion

- 1) How much of Myanmar is designated as Dry Zone?
- 2) Why is the soil of the dry zone of such poor quality?
- 3) What do you think "water-use efficiency is low" means?
- 4) Why is Myanmar's Dry Zone called the "oil pot" of Myanmar?
- 5) What does "food insecure" mean? Do you know anyone who is food insecure? Explain.

## Activity

Refer to the ACIAR Report. Brainstorm and propose solutions and strategies to overcome the challenges faced in the dry zone.

# Dry Zone

## Discussion

- 1) How much of Myanmar is designated as Dry Zone?

**Answer:** 10%

- 2) Why is the soil of the dry zone of such poor quality?

**Answer:** It is salty, it is eroded, it is not very fertile, meaning that it does not have the nutrients plants need to thrive.

- 3) What do you think “water-use efficiency is low” means?

**Answers will vary:** Water is wasted because the people do not have the knowledge, skills and resources to use it effectively.

- 4) Why is Myanmar’s Dry Zone called the “oil pot” of Myanmar?

**Answer:** Because oil producing crops such as sesame and groundnuts are grown there.

- 5) What does “food insecure” mean? Do you know anyone who is food insecure? Explain

**Answers will vary.**

## Activity

This activity can be done in the classroom in small groups.

# Fresh Water

## *Reading*

Bring to the classroom a map of myanmar and show the location of the various fresh water ecosystems.

# Fresh Water

## Reading

Fresh water ecosystems include wetlands, lakes, and rivers:

### **Wetlands**

Wetlands are areas covered with shallow water at least part of the year. The water is shallow enough for water loving plants to grow. In Myanmar there are two types of wetlands, both of which are an important part of a healthy environment: coastal and inland. Coastal wetlands form a border between the sea and the land. Coastal wetlands in Myanmar are mostly mudflats, swamp forests and mangroves forests. They exist in the delta, along the coasts and on the edges of islands. Inland wetland ecosystems have fresh water and include rivers, lakes and fishponds, marshes, and seasonally flooded plains.

Wetlands are an important part of a healthy ecosystem because they:

- Provide food and protection for many kinds of fish and other aquatic animals
- Provide essential food and habitat for many bird species, especially for migratory birds. A series of wetlands along the flying routes of migratory birds is essential to their survival. Without wetlands to provide food and shelter, some birds will soon become extinct.
- Help prevent flooding and erosion
- Filter and clean water

Wetland ecosystems are also directly beneficial to humans because they:

- Stop sea water from getting into the agricultural areas
- Help prevent coastal land from erosion and storms
- Provide medicinal plants
- Support the fishing industry by providing habitat for young fish
- Can boost ecotourism because many tourists enjoy bird watching

Some of the most important inland wetlands in Myanmar are located:

- In the Irrawaddy, Chindwin and Sittoung river basins
- Around the edges of Indawgyi Lake in northern Myanmar. During the winter, these wetlands provide food and habitat for almost 100 species of migratory birds, including some that come from as far away as Siberia.
- Around the edges Inle Lake
- In Moe Yun Gyi Wildlife Sanctuary, near Bago, about an hour north of Yangon.

### **Rivers**

There are four important rivers in Myanmar:

- The Irrawaddy (Ayeyarwady) is Myanmar's largest river and most important commercial waterway. It starts at the junction of the N'mai and Mali Rivers, in Kachin State and flows south for 2,170 kilometers (1,350 miles) to the Andaman Sea. The volume of the Irrawaddy changes during the year, becoming much higher in the summer because of the monsoon rains and melting glacier ice in northern Myanmar. It is a major transportation route for both passengers and goods. It is also a very important source of irrigation water required to grow rice and other crops. It is home to 43 fish species and the rare Irrawaddy dolphin. The Irrawaddy River brings fertile sediment and soil as it flows south through the delta and then into the Andaman Sea, which helps to make the delta very valuable agricultural land.
- The Chindwin River flows through difficult to access mountain ranges and forests so it has not been very damaged by humans.

- Sittaung River flows for 420 kilometers from the Shan Plateau southeast of Mandalay to the Gulf of Martaban. At its mouth it is strongly affected by the ocean tides, which makes it difficult for boats to navigate. It is used mostly to float timber. Less soil washes down than the Irrawaddy so its delta is not as fertile.
- Salween (Thanlwin) River begins in China and flows 1,325 km south across the Shan Plateau in eastern Myanmar.

### Lakes

- Indawgyi Lake located in Kachin State in northern Myanmar covers an area of 116 square kilometers (45 square miles) and is Myanmar's largest lake. It was probably created by an earthquake many years ago. It is still very pristine, meaning that it has not yet been damaged very much by humans. It is an important feeding ground for migrating birds.
- Inle Lake, a shallow lake located on the Shan Plateau covers 67 square kilometers (26 square miles) and is Myanmar's second largest lake. It is the remains of an inland sea that is still shrinking. It is being damaged by the facilities built for the huge numbers of tourists who visit the area each year. In June, 2015, Inle Lake was designated as the first UNESCO Biosphere Reserve in Myanmar. It provides habitat for turtles, fish, otters, and many birds, including the endangered Sarus crane.

## **Discussion**

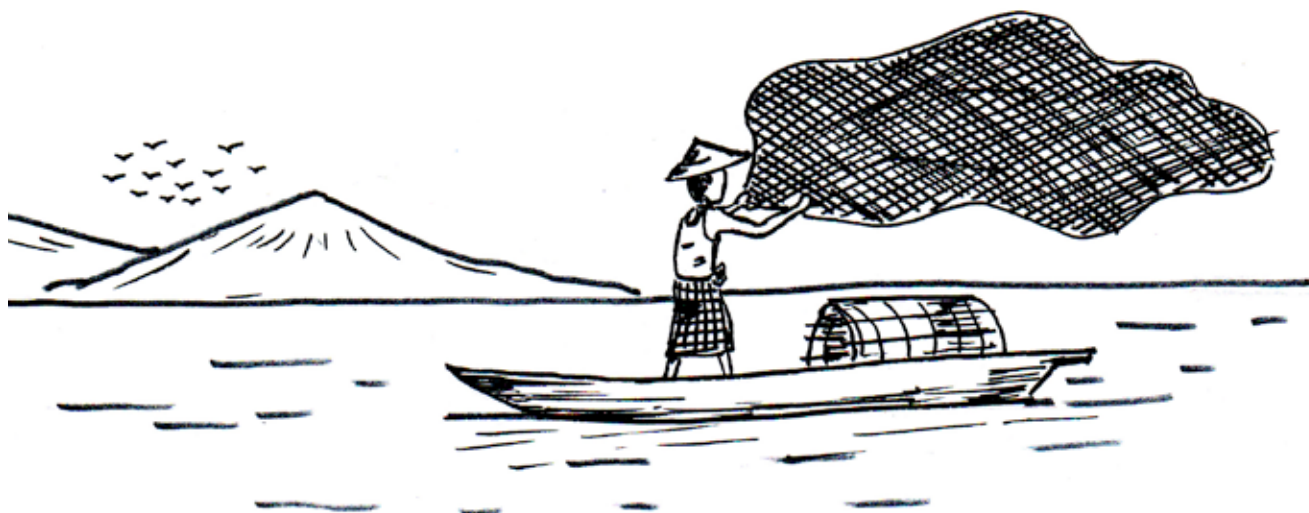
ated?

- 2) What is the volume of the Irrawaddy River?
- 3) Complete the table below.

Wetlands are beneficial to the natural environment because:	Wetlands are beneficial for humans because:

## **Activity: research**

Research online or in your local library to better understand the economic and social benefits of wetlands, lakes and rivers in Myanmar.





## Discussion

- 1) What is the name of Myanmar's largest lake? Where is it situated?

**Answer:** Indawgyi Lake. It is situated in Kachin State in northern Myanmar.

- 2) What is the volume of the Irrawaddy River?

**Answer:** It changes during the year, becoming higher in the summer because of the moonsoon rains and melting glacier ice in northern Myanmar.

- 3) Complete the table below.

**Answer:**

Wetlands are beneficial to the natural environment because:	Wetlands are beneficial for humans because:
1) They provide food for migrating birds 2) They provide food and homes for aquatic animals 3) They clean water 4) They help to stop flooding and erosion	1) They can make money for local people 2) They help stop flooding and erosion 3) They form a barrier between the sea and the land 4) They provide useful plants 5) They help the fishing industry

## Activity: research

Encourage the students to focus on one type of fresh water or to focus on one region.

# Human Environments

## Discussion

- 1) What are the advantages of hydroelectricity?

**Answer:** It is a clean and renewable source of energy

- 2) What do you think? Should the Myitsone Dam be built or not? Is the energy it could produce worth the damage it causes?

**Answers will vary**

- 3) Why is agriculture so important?

**Answer:** Because we need to eat! Without agriculture most people in the world would starve to death. In Myanmar, agriculture is the biggest single employer and forms more than half of the nation's Gross National Product.

# Human Environments

## Reading

The human or built environment has a huge impact on Myanmar's natural environment. In addition to urbanization (towns and cities), three human activities that have a huge impact on the natural environment include agriculture, mining, and hydroelectric dams.

### Agriculture

Agriculture is essential to human life as it provides the food people need to live. Agriculture is also a major source of income for Myanmar, both on the national and individual level. Agriculture is the main source of national income. It provides 60% of Myanmar's Gross National Product (the total value of goods and services produced by a country in one year) and employs 65% of Myanmar's labor force. Rice is the primary crop. Other important crops include beans, sesame, groundnuts, sugar cane, timber as well as fish. In recent years, extensive rubber and palm oil plantations have been planted and these are likely to expand. The biggest environmental impact of agriculture is that so many forests are cut down, wetlands are drained and other natural habitats are destroyed to make room for crops. In Rakhine state for example, many hectares of mangrove forests have been cut to establish shrimp farms. Other problems include the use of harmful pesticides, herbicides and fertilizers. A third problem is that so much water is being used to irrigate crops that some water sources are beginning to run dry.

### Dams

There are almost 200 large dams in Myanmar that have been built to produce electricity. Hydroelectricity has many advantages. Unlike fossil fuels, it is an environmentally friendly, clean source of energy because it doesn't pollute the air and it produces no greenhouse gases. It is also renewable because water itself is not reduced or used up in the process of creating it. However, dams harm the natural environment and negatively affect people living nearby. Dams prevent fish and other aquatic life from moving freely and stop the movement of nutrient rich sediment from flowing downstream. Dams also flood large areas of land forcing many people to move. Dams can break during natural disasters such as earthquakes. One of the reasons the Myitsone dam is so controversial is because it is located near the Sagaing fault line. If an earthquake destroyed the Myitsone Dam, the lives of hundreds of thousands of people living there it would be endangered.

### Mines

Myanmar is enriched with valuable minerals such as copper and jade. As these minerals are buried deep in the earth, large mines are built to bring these precious minerals up to the surface. The minerals bring important income, but there is a large environmental and social cost. Chemicals used in the mining process contaminate the soil and groundwater nearby. This often harms people and animals in the area. People are often forced to relocate from areas where mines are dug. The most controversial mine in Myanmar is probably the Letpadaung copper mine project in the Sagaing region of northern Myanmar.

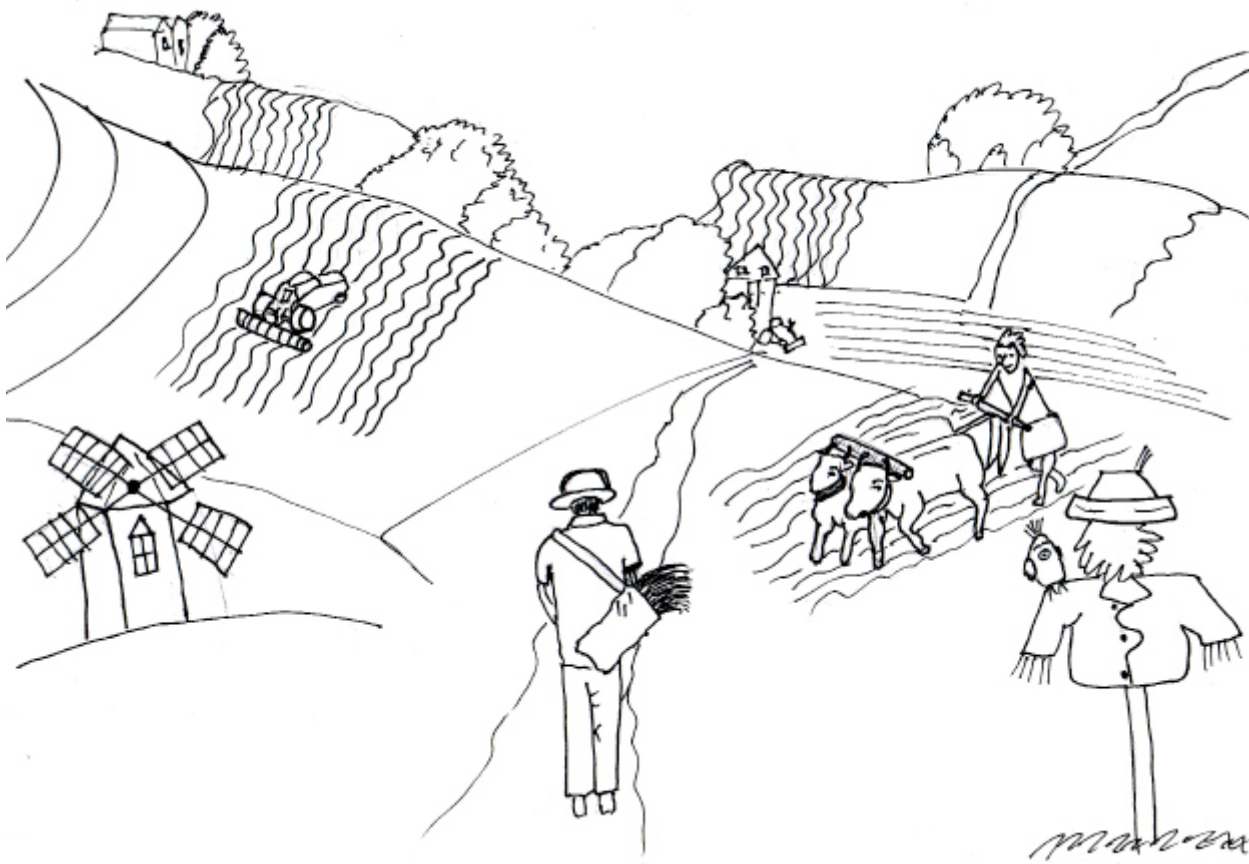
## Discussion

- 1) What are the advantages of hydroelectricity?
- 2) What do you think? Should the Myitsone Dam be built or not? Is the energy it could produce worth the damage it causes?
- 3) Why is agriculture so important?

## **Activity: research**

Pick one of the following topics, conduct research on it and share your findings in a presentation.

- 1) **The product chain of a mineral (jade, gold, etc).** What is the extraction site location and conditions? What is the production process? What is the commercialization process? What are the exportation destinations? What is the price variation; between price at production and exportation prices? What are the environment and social costs?
- 2) **The agricultural activities in your community or nearby where you live.** What crops are cultivated? What farming methods are used? Is it organic farming or chemical farming? Are there any environmental problems due to agriculture? Are there large-scale rubber or palm oil plantations? Are the crops mostly sold locally, or transported to distant locations? Is there fish farming in your location? Is there slash and burn agriculture? Has farmland been damaged by flooding? Do many people grow food for their own consumption?



***Activity: research***

Students can conduct this activity as homework or a project assignment in small groups.



Use this page for your notes.

# Projects Package

The projects below are designed to help you improve your knowledge as well as practice the skills you have acquired in this course.

- A) **Research project:** Topic of choice
- B) **Survey:** Environmentally friendly practices in your context
- C) **Survey:** How healthy is your environment?
- D) **Interviews:** Public opinion on a topic of choice
- E) **Observation:** Study your local environment
- F) **Personal action**



## A) Research project: Topic of choice

The research project aims to expand your knowledge on specific topics. This project can be done individually or in small groups (2-3 students).

To finish this project, follow the steps below:

- 1) Select an environmental topic of your interest (examples below)
- 2) Formulate a question of research
- 3) Conduct the research: collecting and analyzing information
- 4) Prepare a written paper (2-4 pages), answering a question on the topic
- 5) Give an oral presentation (5-10 minutes), allowing time for questions and answers.

Tips: Resources to find information include: internet, books available in your school or town library and materials contained this course. You may also interview experts in the subject you are researching.

Topics could include:

- 1) Myanmar forests
- 2) Timber production in Myanmar
- 3) Managed forests
- 4) The islands of Myanmar
- 5) The rivers of Myanmar
- 6) The mountains of Myanmar
- 7) Waste disposal
- 8) Solar energy
- 9) Wind energy
- 10) Hydroelectric energy
- 11) A particular animal
- 12) Organic agriculture



## B) Survey: Environmentally friendly practices in your context

The survey project will help you to learn more about local practices in your community. This project can be done individually or in small groups (2-3 students sharing the same community).

This survey is a list of questions designed to gather information from a group of people. Respondents may fill out the survey themselves, or the researcher can ask the questions orally and record the answers. Respondents may include farmers, villagers, government officers, young people, and environmental activists.

Questionnaires should be simple and easy to fill out; each question should ask only one thing and the data should be easily quantifiable.

For the survey, you can use the example questionnaires below or make your own according to your topic of choice. You can use more than one questionnaire for the same topic.

Topics could include:

- 1) Environmentally friendly farming practices
- 2) Plastic bag use
- 3) Natural resources use and management
- 4) Water cycle and use in the household
- 5) Transportation means
- 6) Toilet systems

### Survey #1: Environmentally friendly farming practices

Farmer: \_\_\_\_\_

	Questions	Answers	
		Yes	No
1	Do you use organic farming methods	Yes	No
2	Do you know what compost is?	Yes	No
3	Do you use compost to fertilize your fields?	Yes	No
4	Do you use chemical fertilizers?	Yes	No
5	If so, what kind do you use?		
6	Do you use manure as fertilizer?	Yes	No
7	Do you use chemical pesticides?	Yes	No
8	Do you rotate crops?	Yes	No
9	What do you do with your organic waste? Check all that apply.	<input type="checkbox"/> Feed it to animals <input type="checkbox"/> Burn it <input type="checkbox"/> Compost it <input type="checkbox"/> Just leave it on the ground Other:	

## Survey #2: Plastic bag use:

Plastic bags are very damaging and this is a relatively easy form of pollution to give up. Choose a location and determine how many plastic bags are used and what happens to plastic bags. Example locations are: markets, villages, and in the household.

Location: \_\_\_\_\_

	Questions	Answers
1	What do you sell or buy?	<input type="checkbox"/> Vegetables and Fruit <input type="checkbox"/> Packaged goods <input type="checkbox"/> Other
2	How many plastic bags do you use per week?	<input type="checkbox"/> 0 – 24 <input type="checkbox"/> 25 – 49 <input type="checkbox"/> 50 – 100 <input type="checkbox"/> 100 – 200 <input type="checkbox"/> More than 200
3	How much money do you spend on plastic bags per week?	
4	How many people refuse plastic bags and bring their own re-usable plastic bags or a basket? or How often do you refuse plastic bags and bring your own re-usable plastic bags or a basket?	Out of every 100 customers/time per month: <input type="checkbox"/> 0 - 4 people/times per month <input type="checkbox"/> 5 – 10 <input type="checkbox"/> 11 – 20 <input type="checkbox"/> 21 – 30 <input type="checkbox"/> 31 – 50 <input type="checkbox"/> More than 50
5	Do you automatically give people a plastic bag or do you ask them first?	<input type="checkbox"/> Ask <input type="checkbox"/> Automatically give
6	How do you use the old plastic bags?	
7	Where do you put the destroyed plastic bag?	

## C) Survey: How healthy is your environment?

The survey project will help you to better understand the health of your environment. This project can be done individually or in small groups (2-3 students sharing the same environment).

To maximize learning from this project, follow the steps below:

- 1) Complete questionnaire # 1: What is your local natural environment like?
- 2) Complete questionnaire # 2: How healthy is your natural environment?
- 3) Discuss your summarized findings with your class
- 4) Take actions to improve the health of your environment

### Questionnaire # 1: What is your local natural environment like?

Before deciding where to go, you need to know where you are. Here are some questions to get you thinking about the natural environment in your area:

- 1) What is the temperature outside? Is this temperature normal for this time of year, or is it hotter or colder than usual?
- 2) When did it last rain? Does it rain a lot in your area? Do you know how much rain your area gets in an average year? Is there a rainy season, or does it rain throughout the year? Is flooding a problem in your area?
- 3) If you walk from your school for 10 minutes how many different kinds of trees will you see?
- 4) Have you ever seen a wild animal in your area?
- 5) Is there a body of water nearby, such as a river, lake or the sea?
- 6) Is there a forest you can walk to?
- 7) Are there many crops grown in your area? If so, what kind?
- 8) What sort of fuel do most people use to cook?
- 9) What happens to the sewage in your community?
- 10) Where do you get your drinking water from?
- 11) Do most people in your community use toilets? Are they flush toilets or pit toilets?
- 12) What happens to the waste in your community? Is there a pick up service, do you burn it? Bury it?
- 13) Do you grow any of your own food?
- 14) Where does most of the food you eat come from? Is it grown in the local area? Does it come from somewhere else in Myanmar or from a different country?
- 15) Do you have running water in your home? If not, how far away is your water source?

## Questionnaire #2: How healthy is your natural environment?

Determining factors harming your local ecosystems will help you to decide what type of project you would like to do. Here are some questions to get you thinking.

	Questions	Answers
1	Overall, how healthy is your local environment/ecosystem?	1 2 3 4 5 6 7 8 9 10 Very sick Very healthy
2	How informed and aware are people in your local community about the importance of environmental health?	1 2 3 4 5 6 7 8 9 10 Not at all Very aware
3	How much do people in your community care about the health of the natural environment?	1 2 3 4 5 6 7 8 9 10 Not at all They care a lot
4	How much non-biodegradable litter (trash made out of plastic, metal and other materials that do not rot) do you see as you walk around your neighborhood?	1 2 3 4 5 6 7 8 9 10 A lot Not much
5	How much non-biodegradable trash do you see in local water sources?	1 2 3 4 5 6 7 8 9 10 A lot Not much
6	What happens to most of the garbage in your community?	1. It is burned 2. It is buried 3. It is just dumped in a stream bed or by the side of the road 4. The government municipality collects it and takes it away 5. Other _____
7	Where do you get your drinking water?	1. From a tap inside my house 2. I buy it 3. From a tap or well outside the house but less than a 5 minute walk away 4. From a well more than a 5 minute walk away 5. From a river or lake 6. Other _____
8	Where do you get your washing water?	1. From a tap inside my house 2. I buy it 3. From a tap or well outside the house but less than a 5 minute walk away 4. From a well more than a 5 minute walk away 5. From a river or lake 6. Other _____
9	What do you or your family use for cooking fuel?	1. Electric stove 2. Gas/kerosene stove 3. Charcoal 4. Wood we buy 5. Other _____

10	What do most people use for power?	<ol style="list-style-type: none"> <li>1. Electricity provided by the government</li> <li>2. Solar power from solar panels on/around our homes</li> <li>3. Kerosene</li> <li>4. Other _____</li> </ol>
11	Where does the raw sewage go?	<ol style="list-style-type: none"> <li>1. To a town septic system</li> <li>2. To a septic tank buried under the ground</li> <li>3. Into an unsealed pit dug into the earth</li> <li>4. It just drops onto the ground</li> <li>5. Directly into a river or lake</li> <li>6. Other _____</li> </ol>
12	Do you know of any farmers who compost and use compost as fertilizer?	
13	Where do farmers get chemical fertilizer from? Are the directions in a language local people can read?	
14	List all the wild animals you or any of your group members have ever seen in the local area.	
15	List any wild animals that used to live in the area that no longer do so (i.e. Animals that older members of your community may have seen long ago).	
16	If you live near the sea or a river or a lake – has the fish population changed much in recent years? How so?	
17	Are there any invasive species that you are aware of? (plants, animals or insects)	
18	Do you live near a large dam?	
19	Are there mines in the area?	
20	Are there large factories or power plants in the area?	
21	What are the biggest environmental problems in your community?	
22	To your knowledge has there ever been any environmental tests or surveys done to measure the environmental health in your local community?	
23	Are there any people or organizations currently working to protect the natural environment?	
24	Are there any national parks or protected areas nearby?	
25	Has your local environment been damaged by floods in recent years?	

## D) Interview: Public opinion on a topic of choice

Conducting in-depth interviews is similar to conducting surveys and questionnaires but enables you to get more detailed information. You can ask open-ended questions and ask for more information which is not really possible when using questionnaires or surveys. Respondents may include farmers, villagers, government officers, young people, and environmental activists.

Here are some questions you could ask:

- 1) What are the most serious environmental problems in your area? Why?
- 2) If you could solve one environmental problem, what would it be? How?
- 3) Would you be willing to pay more money for organic food? Why or why not?
- 4) Would you be willing to teach others about environmental problems and what can be done to overcome them?
- 5) What is global warming? What impact does it have?
- 6) What is climate change? What impact does it have?
- 7) Should land be protected with laws? Why and how?
- 8) Is the government doing enough to protect the environment? Why or why not?

## E) Observe: Study your local environment

This project will help you learn about a local environment by actively observing human actions and seasonal change and their impacts.

To maximize learning from this project, follow the steps below:

- 1) Choose a topic or question
- 2) Develop your observation plan (elements, location, period, etc.)
- 3) Compare your findings with a different location and period.
- 4) Compare your findings with a partner and in class

You can pick a question/topic from other projects or take one of the following ideas:

- 1) Sit in a teashop near a market and watch the shoppers to see how many take plastic bags from shopkeepers and how many bring a basket or re-usable plastic bag.
- 2) Observe how many people throw trash on the ground rather than put it in a trash bin.
- 3) Walk around your neighborhood and observe. Is there a lot of trash? What is most of it – plastic bags, food wrappers, plastic bottles, glass bottles, cans?
- 4) Walk around your neighborhood and observe. Are there any recyclers? What do they pick up? Where do they take it?
- 5) Collect a leaf from as many different kinds of trees/plants as you can. What kinds of trees are they? Are they edible?

## F) Personal Action

This project will help foster an attitude of protecting the environment on a daily basis. Learners are invited to join two challenges: A Personal Practice Challenge and a Community Action Challenge. It is useful to keep track of your environmentally friendly actions. You can also keep track of the frequency and quality of your actions.

### Personal Practice Challenge

I will:

- Use reusable bags instead of plastic bags
- Compost organic waste instead of burning it
- Use less water
- Eat less meat, especially beef
- Recycle plastic, glass and aluminum

### Community Action Challenge

I will:

- Clean the trash in my neighborhood
- Use filtered water instead of water from small plastic bottles
- Build a pit latrine
- Purchase or make a more fuel efficient cooking stove
- Educate people in my community
- Plant trees

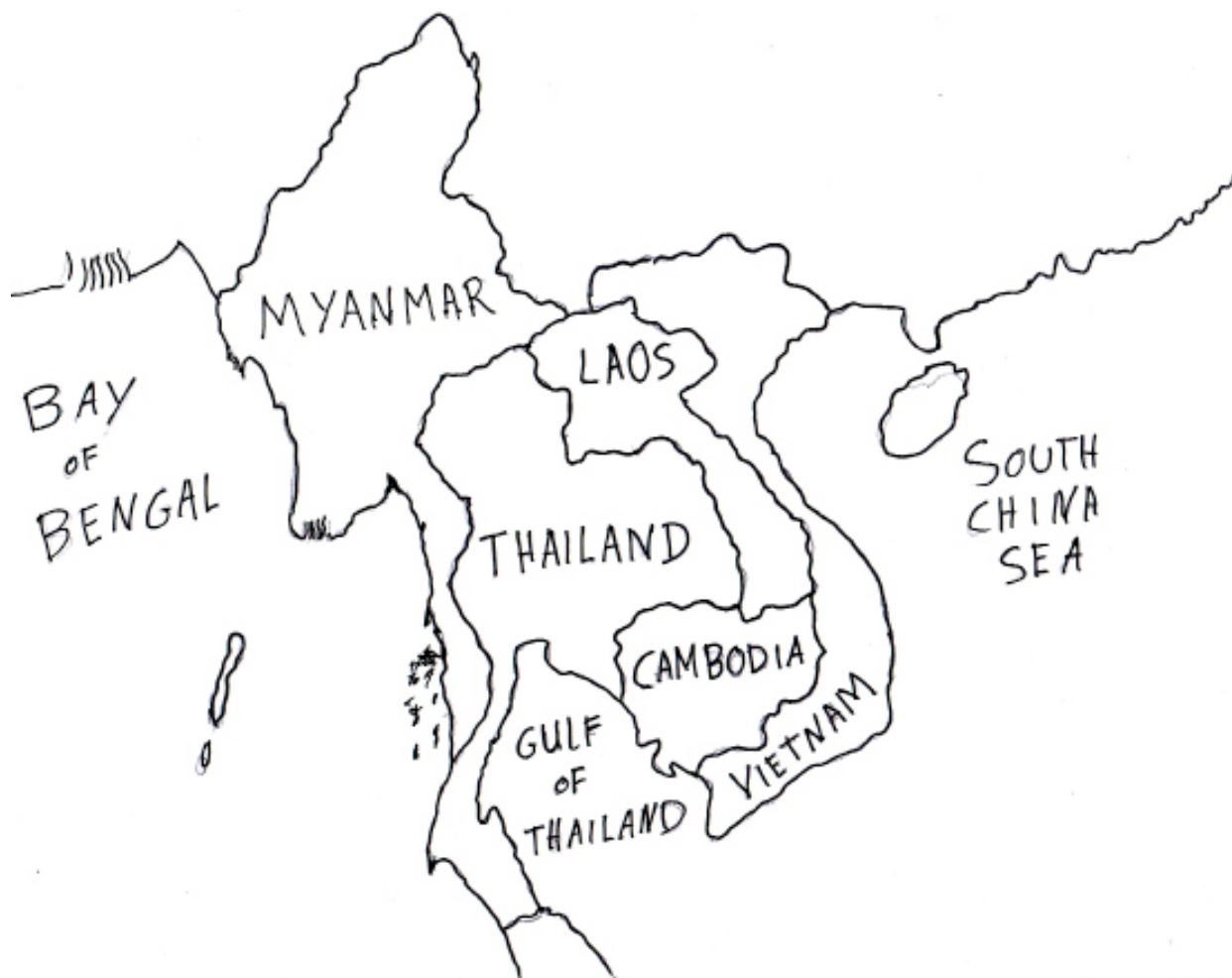




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# Extras

## Extra #1: Globally Threatened Species in the Indo-Burma Hotspot



### Part A

Species	Global Threat Status				Distribution by Country					
	Critically Endangered	Endangered	Vulnerable	Total	Cambodia	China	Lao PDR	Myanmar	Thailand	Vietnam
Mammals	12		39		31		40		47	
Birds		19		<b>85</b>		37		41		42
Reptiles	13		14		14		16		19	
Amphibians		16		<b>48</b>		33		0		15
Fishes	25		58		31		44		58	
Invertebrates		21		<b>66</b>		10		4		25
Plants	69		151		33		25		98	
<b>Total</b>		<b>230</b>		<b>754</b>		<b>305</b>		<b>172</b>		<b>335</b>

## Part B

Species	Global Threat Status				Distribution by Country					
	Critically Endangered	Endangered	Vulnerable	Total	Cambodia	China	Lao PDR	Myanmar	Thailand	Vietnam
<b>Mammals</b>		37		<b>88</b>		35		43		46
<b>Birds</b>	12		54		28		24		46	
<b>Reptiles</b>		20		<b>47</b>		20		23		25
<b>Amphibians</b>	0		32		4		5		4	
<b>Fishes</b>		28		<b>111</b>		17		16		34
<b>Invertebrates</b>	9		36		0		6		28	
<b>Plants</b>		89		<b>309</b>		153		45		148
<b>Total</b>	<b>140</b>		<b>384</b>		<b>141</b>		<b>160</b>		<b>300</b>	

Periodic Table of the Elements

1 1A 11A	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A	
1 H Hydrogen 1.008	2 Li Lithium 6.941	3 Na Sodium 22.990	4 K Potassium 39.098	5 Rb Rubidium 84.468	6 Cs Cesium 132.905	7 Fr Francium 223.020	8 Be Beryllium 9.012	9 Mg Magnesium 24.305	10 Ca Calcium 40.078	11 Sr Strontium 87.62	12 Ba Barium 137.327	13 Ra Radium 226.025	14 B Boron 10.811	15 C Carbon 12.011	16 N Nitrogen 14.007	17 O Oxygen 15.999	18 F Fluorine 18.998	19 Ne Neon 20.180
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.833	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80	
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29	
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]	
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Nh Nihonium [284]	114 Fl Flerovium [289]	115 Uup Ununpentium [295]	116 Lv Livermorium [293]	117 Uus Ununseptium [294]	118 Uuo Ununoctium [294]	

57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium [144.913]	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [262]

- Alkali Metal
- Alkaline Earth
- Transition Metal
- Semimetal
- Nonmetal
- Basic Metal
- Halogen
- Noble Gas
- Lanthanide
- Actinide



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# Glossary

## A

**Aquatic (adj):** Of a plant or animal that lives in water

**Atmosphere (n):** The thick blanket of gases surrounding the earth and other planets

**Atom (n):** The smallest part of matter

## B

**Bacteria (n):** Very simple single-celled organisms; the smallest of all living creatures

**Biodiversity (n):** The variety of life forms (including plants, animals, insects, birds, bacteria) living on our planet

**Biodiversity hotspot:** An area that 1) is home to many different kinds of species and 2) is in danger of being destroyed

**Biome (n):** A group of similar ecosystems in the same area. A biome has similar weather, rainfall, plants and animals. Examples of biomes include the desert, rainforest, grassland, and tundra.

## C

**Carbon (n):** A chemical element that is found in all living organisms; it's abbreviation is C

**Carbon cycle:** Several natural processes that continuously move carbon atoms through the oceans, atmosphere, plants and other living organisms

**Carbon dioxide:** CO<sub>2</sub> - A colorless, odorless gas made out of carbon and oxygen. It is produced by burning fossil fuels such as coal and petroleum and is a greenhouse gas.

**Carnivore (n):** An animal that eats only meat from other animals

**Classification/ taxonomy (n):** The process by which scientists group living organisms based on how similar they are

**Climate (n):** The weather conditions including temperature and rainfall in an area over a long period of time

**Climate change:** The global climate changes such as rising temperature and increased or decreased rainfall caused by global warming

**Combustion (n):** The process of burning something

**Compost (v):** Decayed organic material used as a fertilizer

**Compound (n):** A substance made out of different elements combined together

**Condense (v):** To change from gas to liquid

**Conserve (v):** Protecting something from damage, especially something of environmental or cultural value

## D

**Deforestation (n):** Cutting down forests to provide land for human use such as agriculture, cattle grazing, and building houses or other buildings

## E

**Ecosystem (n):** A community of all the living organisms in an area interacting with each other and with the physical environment

**Element (n):** Matter that is made out of only one kind of substance

**Elevation (n):** The height of a place above sea level

**Endangered (adj):** Of a species of plants, animals, or insects in danger of becoming extinct, meaning that there will be no member of that species left alive

**Endemic (adj):** When a plant, animal or insect naturally occurs in an area

**Energy (n):** The capacity of strength needed to sustain an activity

**Erosion (n):** The gradual destruction of soil/land by wind or water

**Evaporate (v):** To change from liquid to gas

**Extinct (adj):** When an animal, insect, bird, plant or other organism no longer exists

## F

**Fertile (adj):** (Of land/soil) having a lot of nutrients and thus being capable of growing strong healthy crops

**Food insecure:** People who do not have a dependable food supply

**Fossil fuels:** Fuels such as coal, oil, petroleum, or natural gas that are made out of the remains of plants which died millions of years ago

## G

**Global warming:** Hotter temperatures in the atmosphere and ocean caused by greenhouse gases such as carbon dioxide

**Greenhouse gas:** Gases in the earth's atmosphere which trap the heat of the sun and make the earth warmer, leading to global warming. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor.

## H

**Habitat (n):** The natural home or environment of an animal, plant, insect, or bird

**Herbivore (n):** An animal that eats only plants

**Human environment:** Areas built by humans such as cities, towns, factories, mines, and farms

**Humidity (n):** The amount of water vapor in the air

## I

**Invasive species:** A living organism that moves into a new ecosystem from somewhere else and causes a lot of harm to other living organisms in that ecosystem

## J-

## K-

## L

**Landfills (n):** A place where trash is buried in a deep hole

**Latitude (n):** How far a place is north or south of the equator

## M

**Mass (n):** The amount of matter in an object

**Matter (n):** Anything that takes up space and has mass

**Molecule (n):** A group of two or more atoms combined together

**Monsoon (n):** The seasonal change in wind direction in South and Southeast Asia. Wind blows from the southwest between May and September, bringing lots of rain, and from the northeast between October and April (the dry season)

## N

**Native species:** A living organism that originally comes from the ecosystem where it lives

**Natural environment:** All the living and nonliving things that occur naturally on earth

**Natural resource:** Materials and substances that 1) exist naturally in nature and 2) are beneficial to humans. Examples include water, trees, oil, and gold.

**Nitrogen cycle:** The continuous circulation of nitrogen through the atmosphere, soil, plants, and animals (that eat the plants) and then back to the atmosphere

**Nutrients (n):** A substance that provides the nourishment a living organism needs to live

## O

**Omnivore (n):** An animal that eats both plants and animals

**Organic (adj):** Something that comes from living matter. Organic farming is farming without chemical fertilizers or pesticides.

**Oxygen cycle:** The process which continuously moves oxygen through the atmosphere, plants, animals, and the earth's crust

**Ozone layer:** A layer in the upper atmosphere that prevents dangerous radiation from the Sun from reaching the surface of the Earth

## P

**Periodic table:** A table which organizes all the known chemical elements according to the atomic number of each element

**Photosynthesis (n):** The process by which green plants convert sunlight, carbon dioxide and water into food

**Pollution (n):** The process of harmful or poisonous substances affecting the environment

**Predator (n):** A creature that hunts and eats other creatures

**Preserve (v):** The act of maintain something (e.g. a forest or other wild area) at its original or existing state

**Prey (n):** A creature that is eaten by other creatures (by predators)

## R

**Renewable energy:** Energy from a source that does not run out such as wind or solar energy

## S

**Species (n):** A group of living organisms similar to one another. Members of the same species can produce offspring (i.e. children) together.

**Sustainable (adj):** Maintaining something at its current level; of something that can exist on its own without requiring outside support



T-  
U-  
V -

**W**

**Water cycle:** The movement of water between the earth's oceans, fresh water, atmosphere and land

X-  
Y-  
Z-

# Translations

**Aquatic (adj)** a&aeow/Dg/

**Atmosphere (n)** av x/k/

**Atom (n)** t u/iw/r/

**Bacteria (n)** bu/iw/b&&, m:/

**Biodiversity (n)** ZD r&st u/i rsm:/

**Biodiversity hotspot** ZD r&st u/i rsm; & b n&e&m/

**Biome(n)** obmOv/i yi/

**Carbon (n)** umAe/

**Carbon cycle** umAe/i b&m/

**Carbon dioxide** umAe/ i fa t mu/i q/ /

**Carnivore (n)** tom;pm;ow/Dg/

**Classification/ taxonomy (n)** ou& i rsm; d; crf; plw/ zmjci f/

**Climate (n)** &moDw/k/

**Climate change** &moDw&jymi f;v r/

**Combustion (n)** avmi fu/ r/ fji f/

**Compost (n)** obmOajr/ b&Zm/

**Compound (n)** aygi f; pyjci f/

**Condense (v)** ai & n&jymi f; on/

**Conserve (v)** x&e/ or/ fon/

**Deforestation (n)** op&awmij/ k&f; w/ dji f/

**Ecosystem (n)** a\* [ pep/

**Element (n)** j' ypi/

**Elevation (n)** jri i rsm; on/ i w n&e&m/

**Endangered (adj)** aysmu/ uG i r n/ ft E&m, & b&om/

**Endemic (adj)** t p/ k/ u/

**Energy (n)** p&f; t i/

**Erosion (n)** ajr w/ u/ p m; r/

**Evaporate (v)** tai/ y/ s/ b n/

**Extinct (adj)** r&st o/ e/ aysmu/ uG faom/

**Fertile (adj)** ajraumi f; ajr q/ i/ jz p&apaom/

**Food insecure** t p m; taom u/ r z/ v/

**Fossil fuels** avmi f&om/

**Global warming** ʊnˈɡlɔːbəl wɔːmɪŋ

**Greenhouse gas** ɡriːnˈhʌʊs ɡæs

**Habitat (n)** ˈhæbɪtət

**Herbivore (n)** ˈhɜːbɪvɔːr

**Human environment** ˈhjuːmən ɪnˈvaɪrənmənt

**Humidity (n)** ˈhʌmɪdɪti

**Invasive species** ɪnˈveɪsɪv spɪˈʃiːz

**Landfills (n)** ˈlændfɪl

**Latitude (n)** ˈlætɪtʊd

**Mass (n)** mæˈs

**Matter (n)** ˈmætər

**Molecule (n)** ˈmɒlɪkʊl

**Monsoon (n)** ˈmɒnsuːn

**Native species** ˈneɪtɪv spɪˈʃiːz

**Natural environment** ˈnætʃrəl ɪnˈvaɪrənmənt

**Natural resource** ˈnætʃrəl riːˈsɔːs

**Nitrogen cycle** ˈnɪtrədʒɪn saɪkl

**Nutrients (n)** ˈnjuːtriənts

**Omnivore (n)** ˈɒmnɪvɔːr

**Organic (adj)** ɔːɡənɪk

**Oxygen cycle** ˈɒksɪdʒən saɪkl

**Ozone layer** ˈoʊzən leɪər

**Periodic table** ˈpɪərɪdɪk ˈteɪbəl

**Photosynthesis (n)** ˈfəʊtəʊsɪnθəsɪs

**Pollution (n)** ˈpɒljʊʃən

**Predator (n)** ˈpreɪdətər

**Preserve (v)** ˈprezəv

**Prey (n)** ˈpreɪ

**Renewable energy** ˈriːnəwəbəl ɪnˈdʒɪni

**Species (n)** ˈspɪːʃiːz

**Sustainable (adj)** ˈsʌstəneɪbəl

**Water cycle** ˈwɔːt saɪkl

# အဓိပ္ပာယ်ဖွင့်ဆိုချက်

ရေနေသတ္တဝါ/ / a&x.lwfi haxll haom tyi f(ol) owDy/

လေထု/ /urhijr buD ES fit jcm;aomj\*lvfsm;u ll Oef&h m;aomxlxbnh "mwai fsm;/

အက်တမ်/ /t & mOwkwpcN tao;i , fqlhaom t plwft yll f/

ဘက်တီးရီးယား/ /t v f&h&S faomqlwvpcbomyg&bnh ou&fsm;? ou&fowDgrsm; t m;v hxlwfi tao;i , fqlh jzpbh/

ဇီဝမျိုးကွဲများ/ /u fElwN urhij\*lvwfi ft ou&S haxll haom ou&fplht rtt rtt (tyi fsm;? owDgrsm;? ti fiquifsm;? i s uifsm;? bufwD&D, m;wlygOibn/

ဇီဝမျိုးကွဲများရှိသည့်နေရာ/ 1) ou&fplwft rtt rtt wn&bnhe, fy, f&d mES h  
2) zsupbc&rnh t E&m, ft ajc t aewfi &bnhe, fy, f&d m/

သဘာဝလွင်ပြင်/ /wh h aom{&d mwfi &bnha\* [ pepft zlvpc k obmOvfi fyi lwfi fwh h&bnh &moDwl rha&ce? tyi fsm;ES h owDgrsm;&bn/ O yrm- ou E h&? r h opawm? jrubi f vfi fyi fsm;ES h vfi f wDacgi fyi fsm;/

ကာဗွန်/ /ou&fsm; t m;v hwlwfi f&h azaw&E h haom "mwj' ypi f wpc k umAeN t \*f v ypmv h t w h aum u f h pljzpygon/

ကာဗွန်သံသရာ/ /umAeft ufwrfsm;u ll ork & m ? avxl tyi fsm;ES h t jcm;ou&fsm; qbl t quifjywf y h qmi fay;onh obmOjzppO fsm;/

ကာဗွန်ဒိုင်အောက်ဆိုဒ်/ /umAe ES h a t mupf si f wlyaygi fpyjci frs x u&bnh t a&mi f r& t e h&haom

ဓာတ်ငွေ့တစ်မျိုး/ 4i f u ll avmi fpmrsm;jzpaom a u s u f r h a o f a e e S h i z e l v h t r f " m w a i f s m ;  
avmi f u r f j c i f r & & b n /

အသားစားသတ္တဝါ/ /t jcm;aomw&pinft om;u ll b m p m ;onh owDy/

သက်ရှိမျိုးများခွဲခြမ်းစိတ်ဖြာခြင်း/ /o l y n m & S f r s m ; r s o u & f p l w r f s m ; u l l r t w & m p l o n h v y i e t j z p p O /

ရာသီဥတု/ /ae&mwpcwfi ft c s e l u m & S n p h & h e o n h t y c e E S h r h a & c e f t a j c t a e /

ရာသီဥတုပြောင်းလဲမှု/ /urhij buya E f v m r h l u m i j z p a y ; o n h t y c e f r i h w u f v m r E S h y h r i h w u ( o l )  
a v s m e n f v m o n h r h a & c e f /

လောင်ကျွမ်းခြင်း/ /wpp h w p c l u l l a v m i f u r f a p o n j z p p O /

သဘာဝမြေဩဇာ/ /a q f a j r l o n h a t m i f e p y p i n f r s m ; u l l a j r l o z m t j z p f t o h y j c i f /

ပေါင်းစပ်ခြင်း/ /r w h h o m j ' y p i f s m ; t m ; a y g i f p n f j c i f r s x u & v m a o m t & m O w k w p c k

ငွေ့ရည်ပြောင်းသည်/ / " m w a i f s t & n f t j z p a j y m i f v b h ; o n /

ထိန်းသိမ်းသည်/ /wpp h w p c l y s u p b , h G f j c i f ? t x t o j z i h o b m O y w D e f ; u s i E S h , O a u s ; r f s m ;  
y s u p b , h G f j c i f u l l u m u G f o n /

သစ်တောပြုန်းတီးခြင်း/ /v l o m ; r s m ; t w l u f p l u y h a j r r s m ; ? o h E h ; u s u p m ; & m a j r r s m ; ? t r f r s m ; E S h  
t j c m ; t a q m u f t O b r s m ; a q m u f v y & e f t w l u f o p a w m r s m ; c k w x G & S f v i f j c i f /

ဂေဟစနစ်/ /ou&fsm;wpc&E&fwpck t r b [ jylæxll ionhe, fy, f{&d m/  
 ခြင်္သေ့/ /t &m0wkt r t pm;wpc&x&fjy&vlyonft &m/  
 မြင့်မားသည့်တည်နေရာ/ /yi v, b&rsu&E&fjyift x u w l & b n h e & m t j r i f a y/  
 ပျောက်ကွယ်မည့်အန္တရာယ်ရှိခြင်း/ /r t o e f a y s u f u g f o n h ; r n i t E & m, f u s a & m u a e a o m t y i ? w & p m i e f  
 (o) t i f q u i r s t p l w r s m ; ? q l v b n r f n 4 i f r s t p l w r w p c k v l a y s u f u g f  
 o n h ; j c i f y i j z p l o n f /  
 အစုလိုက်/ / t y i ? w & p m i e f (o) t i f q u i r s m ; o b m 0 t a v s m u f a e & m w p c k w l i j z p a y : v m a o m t c y /  
 စွမ်းအင်/ /vly&h;v n f y w r w p c k u h x m u f y h a y : & e f v l t t y o n p o f t t m ; /  
 မြေတိုက်စားမှု/ /a v (o) a & w l u p m ; r a l l u m i f a j r ^ a j r q l v t i r s m ; w j z n f j z n f ; y s u p d v m j c i f /  
 အငွေ့ပျံသည်/ /t & n i r s t a i t t j z p l o h j y m i f v b o n ; o n f /  
 မျိုးသုန်းပျောက်ကွယ်သော/ / t y i ? w & p m i e f t i f q u i f i s u f (o) t j c m ; o u & l w p p l w p c k l & s f o e a e x l l r i  
 v l O r & h a w m l o n f t c y /  
 မြေကောင်းမြေဆီလွှာဖြစ်သော/ /a j r ^ a j r q l v t i r w l i f a j r m u f r m ; p h a o m t m [ m & " m v f r s m ; & f y d l u d x h ;  
 o e r m a o m t y i f r s m ; u l l & s f o e p a o m /  
 အစားအသောက် မပူလုံမှု/ /t p m ; t p m v l v h a v m u h a v m u f r & & r /  
 လောင်စာ/ /E p i o e f a y g i f r s m ; p h u y i f a o q l d o n f t y i f r s m ; \ & k y l u d f r s m ; r s k w f , h o m a u s m u f h a o g ?  
 a & e l (o) o b m 0 " m w h a i v /  
 ကမ္ဘာကြီးပူနွေးလာမှု/ /r e l v t t r f " m w h a i f r s m ; O y r m - u m A e f l l h a t m u f q l l a l u m i j z p a y : a o m a v x E s h  
 o r k & m t y l c e f r s m ; j r i f w u f m r l /  
 မှန်လုံအိမ်ဓာတ်ငွေ့/ /u r h a v x l x & l " m w h a i f r s m ; r s a e t y l c e f u l l p l y f , l x m ; j y d u r h l u d y a E g v m a t m i f  
 j y k v j c i f r n u r h a j r l u d y a E g v m r l u j z p a y : a p o n f / r e l v t t r f " m w h a i f r s m ; x l w l f  
 u m A e f l l h a t m u f q l l ? r i o e f ? E l u x & y a t m u f q l l E s h a & a i l w l y o i o n f /  
 ကျက်စားရာနေရာ/ / t y i ? w & p m i e f t i f q u i (o) i s u f w l o b m 0 t a v s m u h e x l l i o n h e & m  
 အပင်စားသတ္တဝါ/ / t y i f w p c k w n f u b m p m ; o h a o m o w d y /  
 လူသားတို့၏ပတ်ဝန်းကျင်/ /v b m ; r s m ; w n h a x m i h a o m { & d m j z p l o n h j r f r s m ; ? p u l f r s m ; ? r l f r s m ; E s h  
 v , h a w m r s m ; /  
 စိုစွတ်မှု/ / a v x w l l & b o n h a & a i l y r m P /  
 ရွှေ့ပြောင်းနေထိုင်သည့်သက်ရှိမျိုးစိတ်/ /w p h a e & m r s a \* [ p e p t o p l w p c k x b l l o n h ; a & m u a e x l l j y d  
 4 i f a \* [ p e p f u l t E & m , j y k e l h a o m o u & l w p f r s t /  
 အမှိုက်တွင်း/ /w l f e u f w p c k x w l f t r l u f r s m ; p l y l x m ; a o m a e & m /  
 လတ္တီကျူ/ /w n h a e & m w p c k b o n f t h a u f w m r h a e i a w m i f (o) a j r m u l b u b l r n r l u h a 0 ; o n f u l  
 w l f w m j c i f /

ထုထည်/ /t&moWkwpcK\ yrmP/

ရုပ်ဝတ္ထု/ /ae&m, jyb xlx n&hom rnfonft &moWkrq/

မော်လီကျူးလ်/ / t y p E p p k (o) E p p k u y h o m t u w r r s m ; u l l a y g i f p n f ; x m ; j c i f /

မှတ်သန်/ /awmi ft m&ES h t a&Bawmi ft m&Swi f &modt ajymi f ; t v a l u m i h a v w l u c w i r v r f a l u m i f ;  
ajymi f j c i f / a r v E S h i p u l w i f o m v t l u m ; w i f a v o n i t a e m u h a w m i f b o u r s  
w l u c w j c i f a l u m i h r r s m ; j y b a t m u l w l o m v E S h i j y b ( a j c m u a o h o m & m o d ) t l u m ; w i f  
t a & h a j r m u l b o u r s w l u c w i o n /

ကနဦးနေထိုင်သည့်မျိုးစိတ်များ/ /4i faex l l &mae&ma' o&l a\* [ pepft w i f u r l w n & & s f o e a o m  
o u & l l p w l w p c k

သဘာဝပတ်ဝန်းကျင်/ /urmfay: w i f o b m 0 t a v s m u j z p a y : a o m o u & l b u i r l i t m ; v w /

သဘာဝအရင်းအမြစ်/ / 1) o b m 0 t a v s m u l w n & j y b 2) v l o m ; w l u t t u s t j y l a o m t & m r s m ; t m ; v w /  
O y r m - a & ? o p l y i ? a v m i p m q b E S h a & r s m ; y g O i f y g o n /

နိုက်ထရိုဂျင်သံသရာ/ /avx l a j r x l t y i r s m ; E S h w & p m e r s m ; ( t y i l u p m ; o h o n ) r s w q i h  
t q u i r j y w b n ; v m v n i y w b n h E l u x & l s i E S h 4 i f a e m u f a v x l x b l  
w p z e j y e l v n h & m u & j c i f /

အာဟာရ/ /ou & l l p w l w p c k t o u & s f o e & e f v t t y a o m t p m t m [ m & u l l j z n h q n f a y ; o n l i t & m /

အစုံစားသတ္တဝါ/ /t y i E S h w & p m e E p c k w l u l p m ; o h a o m o w D y /

အော်ဂဲနစ်/ /o b m 0 t a v s m u j z p a y : a o m w p p l w p c k a t m i \* e p l v , f , m p l u l y l a & ; w i f  
" m w l a j r l o z m r s m ; E S h y l l o w f a q ; r s m ; r y g O i f y g /

အောက်ဆီဂျင်သံသရာ/ /a t m u q l s i l o n f a v x l t y i r s m ; ? w & p m e r s m ; E S h a j r r s u E h j y i f  
t a y : , h i r s w q i h t q u i r j y w a & l s m ; o n j z p p O /

အိုဇုန်းလွှာ/ / a e r s v m o n l i t E & m , & h o m " m w f a m i j c n r s m ; u r h a j r l u d a y : o h & m u & l r o h i ; a t m i f  
u m u g f a y ; o n h a v x l t w i f & t v i r w p c k

ဓာတ်ငွေ့ထုတ်သတ္တဝါ/ / " m w k ' y p i r s m ; t m ; v l u l 4 i f w l \* l p o w t t v l u i t p d t p o l w u s  
p l x m ; o n z , m ; /

အပင်တို့အစာချက်ခြင်း/ / t p r f a & m i & h o m t y i r s m ; r s a e a & m i j c n ? u m A e l l f a t m u q l E S h a & w l u l  
t p m t j z p a j y m i f v b n j z p p O /

ညစ်ညမ်းမှု/ /o b m O y w D e f u s i f u k t u l a p E l l a o m ( o ) t q u l t a w m u j z p a p a o m t & m r s m ; /

အသားစားသတ္တဝါ/ / t j c m ; w & p m e r s m ; u l l t r l u b o w j z w p m ; a o m u h a o m o w D y /

ကာကွယ်ထိန်းသိမ်းသည်/ / w p p l w p c l u l 4 i f \ r l v t a j c t a e t w i l f w n & h a p l y b r y s u p l a p & e l  
u m u g f a e f o r t o n / ( O y r m ? o p a w m ( o ) a w m & l f w & p m e e , h a j r r s m ; )

သားကောင်/ / t j c m ; w & p m e ( t o m ; p m ; o w D y ) w l o w j z w p m ; a o m u j c i f u l l o n h o m ; a u m i /

အပန်တလဲလဲအသုံးပြုနိုင်သည့်စွမ်းအင်/ / r u l e c e f a o m p l t i f t & i f t j r p l r s m ; j z p l o n h  
a v ( o ) a e p l f t i /

မျိုးစိတ်များ/ / w p c E S h w p c l w n h & b o n h o u & l o w D y t y p k r p w l w o u & l r s m ; o n i  
r & E G l o p ( q l m b n r h o m ; o r b r s m ; ) u l l t w l u a r f x k w a y ; E l l o n /

ရေရှည်ထိန်းသိမ်းရေးသော/ /wpp\wpb\l\4if\nrv tw\fxefortjci f? jyi fyr\haxmuf\hrv\bl  
wn&E\fr/

ရေသံသရာ/ / ur\hjr\ub\ ork &m? a&c\ avx\ES\ulefajrwt\um; a&\vm;ajymi f\vbom  
a&ob&mpuDef/

# References

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