PRINCIPLE 4:
NATURE RECYCLES EVERYTHING

There is no waste in nature

AGE RANGE

11–13

DURATION

Preparation:
about 20 min.

Activity:
about 45 min. / 1 lesson

KEYWORDS

Biomimicry principles; recycling; waste; compost; decomposing

SUMMARY

What can we learn from the way nature recycles? In natural systems like a forest, there is no waste. Everything, when it has come to the end of its life, becomes raw materials for something else. In the activities below students will observe how nature deals with waste.

BIOMIMICRY PRINCIPLES

4 – Nature recycles everything

LEARNING OBJECTIVES

- Students understand the importance of recycling.
- Students understand that 'waste' is valuable raw material in nature.
- Students understand the function of different cycles in nature.

LEARNING OUTCOMES

- Students observe how fallen leaves become soil.
- Students explore what we can compost and what we cannot.
- Students discuss cycles in nature.

SUBJECT(S)

This module is part of a series of modules introducing the nine principles of biomimicry. The table below shows possible KS3 Programme of Study links for all the modules. Many of the activities will also be suitable for upper KS2.

This learning module can be used flexibly within the curriculum to support key knowledge about Biology and develop working scientifically competences. The learning links with the Sustainable Development Goals and provides a broader context for student learning. It is suitable for adapting as a STEM activity or Eco Club.

Programme of Study Reference	Working Scientifically
Biology: Material cycles and energy - Photosynthesis • the reactants in, and products of, photosynthesis, and a word summary for photosynthesis. • the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere. • the adaptations of leaves for photosynthesis. Interactions and interdependencies – Relationships in an ecosystem • the interdependence of organisms in an ecosystem, including food webs and insect pollinated crops. • how organisms affect, and are affected by, their environment, including the accumulation of toxic materials. Genetics and evolution – Inheritance, chromosomes, DNA and genes • changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction. • the importance of maintaining biodiversity and the use of gene banks to preserve hereditary material.	Students successfully completing this module will have had the opportunity to access these statements: **2a, 2b, 3b, 3c, 3d, 3f**. See Annex 1 for full statements.

BIOLEARN COMPETENCES

- Students are able to abstract principles of sustainability from the way the natural world functions.
- Students are able to assess the consequences of applying biomimicry solutions (values).
- Students are able to work in groups.
- Students are more motivated in learning STEAM and experience that knowledge of STEAM can be widely used.

SUMMARY OF THE ACTIVITIES

	Activity Name	Short description	Method	Duration	Location
1	Introduction	Presenting the principle 9_principles.ppt	• Teacher presentation • Discussion	10	Indoor
2	Soil ladder	Investigating the decomposition of leaves	• Hands-on activity	25	Outdoor (best in autumn)
3	Compost game (optional extension)	Sorting compostable and non-compostable waste	• Game	25	Indoor
4	Review	Discussion after the activity/ies	• Discussion	10	Indoor/ outdoor

Note: You can choose either Activity 2 or 3, or both if you have time.

BACKGROUND FOR TEACHERS

See at Activity 1: Introduction.

For interconnections see *Nine Principles of Biomimicry* module.

Health and Safety
Appropriate consideration needs to be given to health and safety when working outdoors, but this should not prohibit regular use of the outdoor learning environment.

For guidance on using the outdoor learning environment review the Council for Learning Outside the Classroom suggestions on Plan and Deliver. CLEAPSS also provides guidance for members. We recommend you read and act on L196 – Managing Risk Assessment in Science. Finally, check your school policy on learning outside the classroom.

The Institute for Outdoor Learning provides a good overview into the risks and benefits of outdoor learning here. They also offer specific guidance and advice for schools here.

ACTIVITY DETAILS

LOCATION
Indoor

TOOLS AND MATERIALS

- 9_principles.ppt; 5th slide

PREPARATIONS

Arrange classroom for presentation and discussion.

RESOURCES

Benyus, J. M. (2002): Biomimicry – *Innovation inspired by nature.* HarperCollins Publisher, New York, U.S.A.

1| INTRODUCTION

» QUESTION

Present the slide about Principle 4: 9_principles.ppt, slide 5.

There is no 'away' to throw things. Everything produced in nature is biodegradable, there is no waste. There can still be abundance, look at all the blossom on a cherry tree, but that all serves a purpose and will be food and nutrients for others. Once the natural life of a pinecone has come and gone, it breaks down into essential elements that are repurposed into new life.

Explanation to 9_principles.ppt, 5th slide:

The combination of plants, herbivores, predators and decomposers maintain a cycle of natural materials. In this system plants get their energy from the sun, which then becomes food for other organisms in the food chain. All minerals are recycled and are returned to the soil by decomposers. A dynamic balance is maintained. Humans do things differently; raw materials are mined and manufactured into products for consumption. During and at the end of this process, natural resources are transformed into new materials which do not easily biodegrade. These waste materials create pollution and damage the balance of natural systems.

When we hear of decomposers, mushrooms often come to our mind. However, many more groups of living organisms are involved. For example, large vertebrates such as crows and vultures, insects such as beetles, and many bacteria living in soil are members of this group.

The soil (= storage layer) in a rainforest is thin because the process of digestion and the recycling of mineralized biomass is very fast. Deforestation, therefore, quickly results in the destruction of the soil layer which is difficult to regenerate.

ACTIVITY DETAILS

LOCATION
Outdoor

2| SOIL LADDER

» DISCOVER

TOOLS AND MATERIALS

- small spades for each group
- simple identification key for animals living in soil

PREPARATIONS

Outdoor activity: an area with trees and with decaying leaves.

Nature does not bulk mine the Earth's crust for materials to make things. It uses the materials of dead organisms as the raw material for new life. In this activity students investigate the process of decomposition of vegetation to soil. This activity works well in a woodland where the decomposition of leaves into soil is usually very clear (option a). Alternatively, by digging into soil a soil profile will demonstrate the same results (option b).

Divide the students into groups of 4–5. Ask each group create a 'ladder' on the ground from sticks as below, with each square 40–50 cm wide.

1	2	3	4

Option a: After marking the squares, follow the instructions below.

1. Leave untouched.
2. Remove whole, not decaying, leaves, needles, sticks, herbaceous plants.
3. See 2 and also remove decaying leaves needles, which can be still identified.
4. See 3 and also remove humus (dark layer with organic materials in it) down to mineral soil level (no organic ingredients).

Option b: Using a small spade, students take samples from each square at different depths as follows:

1. Collect a sample of vegetation from the surface.
2. Take a sample of soil/decaying vegetation from 5 cm depth.
3. Take a sample of soil from 10 cm depth.
4. Take a sample of soil from 15 cm depth.

Ask each group to observe the steps of humus formation. Investigate the animals living in the different levels (it is good if you have a simple identification key) and the different size of soil particles.

Before carrying out the activity, ensure you are in a place where no rare or protected species can be found. After completing the activity, ensure all soil and vegetation is replaced as you found it.

LOCATION
Indoor

TOOLS AND MATERIALS

- Student worksheet: W3.1
- Teacher's page: T3.1

PREPARATIONS

Arrange classroom for group work.

Cut W3.1 into cards with one set per group.

3| COMPOST GAME (OPTIONAL EXTENSION)

» DISCOVER

Garden composting is common way humans use natural processes to recycle waste. To build your own find instructions here: https://www.youtube.com/watch?v=fW_DVNUt7ms.

To compost successfully, we need to select the best ingredients. Provide a set of cards from W3.1 for each group of students. Ask them to decide what can and cannot go into the compost bin. See T3.1for answers.

LOCATION
Indoor / Outdoor

PREPARATIONS

Arrange classroom for a discussion.

4| REVIEW

» QUESTION

After the activity/ies talk with students about the principle:

- This principle is one of the most important things we can learn from nature. In what ways can we mimic nature's example?
- What existing examples are there?
- What other cycles are there in nature?

LITERATURE, ADDITIONAL INFORMATION

https://www.youtube.com/watch?v=fW_DVNUt7ms

T3.1 COMPOST GAME

Solution

WE CAN COMPOST:
Used tissue; potato peel; rotten vegetables and fruits; thin bones, fishbones; cut grass; mouldy bread; wood ash (not too much); fallen leaves; twigs; apple-core; used table napkin

WE SHOULDN'T PUT TO COMPOST:
Plastic bag; used oil; soup leftovers; orange peel; rotten fruits; cigarette stub; meat; weeds; cooked potatoes; coloured magazines

W3.1 – COMPOST GAME

Cards

Plastic bag	Used oil	Used tissue
Potato peel	Soup leftovers	Rotten vegetables and fruits
Orange peel	Thin bones, fishbones	Rotten fruits
Cut grass	Mouldy bread	Wood ash
Fallen leaves	Cigarette stub	Meat
Twigs	Apple-core	Weeds
Cooked potatoes	Used table napkin	Coloured magazines

ANNEX 1

Key Stage 4 Working Scientifically Statements

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

1. THE DEVELOPMENT OF SCIENTIFIC THINKING	a. the ways in which scientific methods and theories develop over time b. using a variety of concepts and models to develop scientific explanations and understanding c. appreciating the power and limitations of science and considering ethical issues which may arise d. explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments e. evaluating risks both in practical science and the wider societal context, including perception of risk f. recognising the importance of peer review of results and of communication of results to a range of audiences
2. EXPERIMENTAL SKILLS AND STRATEGIES	a. using scientific theories and explanations to develop hypotheses b. planning experiments to make observations, test hypotheses or explore phenomena c. applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments d. carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations e. recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative f. making and recording observations and measurements using a range of apparatus and methods g. evaluating methods and suggesting possible improvements and further investigations
3. ANALYSIS AND EVALUATION	a. applying the cycle of collecting, presenting and analysing data, including: i. presenting observations and other data using appropriate methods ii. translating data from one form to another iii. carrying out and representing mathematical and statistical analysis iv. representing distributions of results and making estimations of uncertainty v. interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions vi. presenting reasoned explanations, including relating data to hypotheses vii. being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error b. communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations

4. VOCABULARY, UNITS, SYMBOLS AND NOMENCLATURE	a. developing their use of scientific vocabulary and nomenclature b. recognising the importance of scientific quantities and understanding how they are determined c. using SI units and IUPAC chemical nomenclature unless inappropriate d. using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano) e. interconverting units f. using an appropriate number of significant figures in calculations