PRINCIPLE 6:
NATURE BANKS ON DIVERSITY

Variety is the spice of life

Erasmus+

AGE RANGE

11–13

DURATION

Preparation:
about 20 min.

Activity:
about 45 min. / 1 lesson

KEYWORDS

Biomimicry principles; diversity; cooperation; monoculture

SUMMARY

Diversity is very important in nature, it helps create stable ecosystems. In this module students experience what happens when we do not have diversity. We suggest Principle 5 and 6 are delivered in order.

BIOMIMICRY PRINCIPLES

6 – Nature banks on diversity

LEARNING OBJECTIVES

- Students understand the importance of diversity in nature.
- Students understand why diversity is necessary in human societies.
- Students understand that monocultures are not sustainable without human inputs.

LEARNING OUTCOMES

- Students explore how natural habitats are influenced by human activities.
- Students make connections between organisms in a community.
- Students see how vulnerable a monoculture can be.

SUBJECT(S)

This module is part of a series of modules introducing the nine principles of bio-mimicry. 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 identify functional design in nature, develop greater awareness and appreciation for design excellence in nature, and appreciate how nature works as a system which is elegant and deeply interconnected.
- Students are able to work in groups.

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	Playing a black locust forest	Students become members of a black locust forest and search for interconnections	• Role play	25	Indoor/ outdoor
3	Review	Discussion after the activity	• Discussion	10	Indoor/ outdoor

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.

LOCATION
Indoor

TOOLS AND MATERIALS

- 9_principles.ppt; 7th 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 6: 9_principles.ppt, slide 7.

Diversity is one of nature's best insurance policies. When one food source is unavailable, others can be found. Plants use several different strategies to spread seed or defend against predators. We know that species with limited genetic diversity have more difficulty adapting to environmental change, and that ecosystems rich with diversity are more stable.

Explanation to 9_principles.ppt, 7th slide:

Biodiversity – the diversity of the plants and animals, which may include the whole of the Earth's wildlife (species, genetic richness, habitat diversity) or the ecosystem of a particular area (e.g. the Carpathian Basin).

A more diverse ecosystem is more resilient and less vulnerable. When the environment changes, individuals who are able to adapt to the changes will survive and multiply. The greater the diversity the greater the opportunity for adaptation. This process is also evident on a larger scale; habitats with high species diversity are more able to adapt to change.

The existence of biodiversity is important for ecosystem services (e.g. pollination, soil fertility, climate control) as our food, clean water and air could not exist without it. Therefore, protecting biodiversity is critical to our future.

Tropical rainforests – terrestrial ecosystems have the largest biodiversity. Two thirds of all the species on Earth are in rainforests. Unfortunately, the area of tropical rainforest is reducing rapidly. Trees are cut down mainly to create space for agricultural production, i.e. monocultures are created on the site of what was once a species rich area.

Coral reef – the largest biodiversity in the marine ecosystem. They are home to 25% of species living in marine habitats. Overfishing and pollution are the biggest threats to the marine ecosystem, and global warming can lead to the destruction of coral reefs. Corals live in symbiosis with single-celled algae which are sensitive to high water temperatures and pollution. Increasing carbon dioxide levels in the air increases the acidity of water, and causes the coral vase to dissolve.

Monoculture – the less biodiversity in an ecological system the more vulnerable the system is, and the less flexibility it has in response to change. That is, the fewer species the system has (e.g. agricultural monocultures), the more likely it is that a small change will have a big impact (e.g. the appearance of a pest).

Oak forest and robinia forest – the diversity of the oak forest is higher than of a robinia forest. The former is home of more species.

2| PLAYING A BLACK LOCUST FOREST

» DISCOVER

LOCATION
Indoor / Outdoor

TOOLS AND MATERIALS

- ball of string
- student worksheet: W2.1
- clips (one per student)

PREPARATIONS

This activity can be implemented indoors or out, ensuring there is space for a circle of all students.

Cut W2.1 into cards, with one per student.

RESOURCES

Sweenex, L. B.; Meadows, D., Mehers, G. M. (2011): *The System Thinking Playbook for Climate Change.* Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Eschborn, Germany p. 136–142.

This game is very similar to the one in principle 5, but instead uses the elements of a black locust forest.

Use the cards from W2.1 (organisms in a black locust forest) or cards with organisms from any living community in your locality. Note that unlike the oak forest used in principle 5, the black locust forest has less diversity. Students can draw pictures of their organism to become more familiar with them.

Give one card to each student, asking them to clip it onto their clothing. Form students into a circle. They will form the living community of an oak forest and the inorganic surroundings. The first student (the Sun) holds the string and searches for someone who he/she is connected e.g. one of the plants. The student (Sun) keeps the end of the string in one hand and gives the ball to the 'plant'. The next student (plant) does the same: looks for someone with a connection, holds the string and give the ball to the next connection. Continue until everybody holds the string and in connected.

Talk about the role of this web of connections and each element within it. What will happen if we withdraw one or two organisms? Are some elements more important than others? How many elements can be removed without losing the sustainability the forest? There are fewer organisms in a black locust forest, so that if one organism is lost the impact on the system is far greater.

The same result will apply to any ecosystem which has low biodiversity such as a cornfield or apple orchard.

Discuss the differences between activities in principle 5 and 6.

ACTIVITY DETAILS

LOCATION
Indoor / Outdoor

PREPARATIONS

Arrange classroom for a discussion

3| REVIEW

» DISCOVER

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

- Think about the role of diversity in resilience of organisms and ecosystems.
- Where could we easily use this knowledge? (Permaculture could be considered as a good example.)

W2.1 – PLAYING A BLACK LOCUST FOREST

Cards

Sun	Water	Soil	Air
Black locust	Black locust	Black locust	Black locust
Squirrel	Fox	Wild boar	Roe-deer
Deer	Decaying wood	Great spotted woodpecker	Woodworm
Black elder	Black elder	Black elder	Chervil
Chervil	Chervil	Celandine	Celandine

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