



# Techniques from Nature

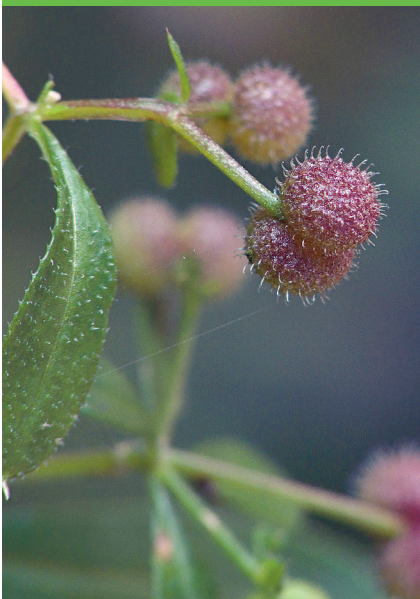
## Biomimicry at the schoolyard

The educational set 'Technique from nature' is about Biomimicry. Biomimicry is the science and art of mimicking the best ideas from nature to solve human problems. Examples of biomimicry are: imitating a shark skin to create faster swimsuits, or designing a helicopter landing equipment inspired by the legs of locusts (a grasshopper).

This teaching package is not only about Biomimicry, it's also about technology! After all, in 2020 science & technology must be implemented in primary education (National Technology Pact 2020, 2013) in the Netherlands. With this package we offer a low-threshold way of educating nature and technology around design-based learning.

This design-based learning fits in our Dutch and maybe also your curriculum (Science and technology in primary and special education, SLO The Netherlands, 2014). By combining it with Biomimicry, technology is not only low-threshold but also much more fun!

There is already a lot of information about Biomimicry on the internet, but teaching and education material about Biomimicry are still rare. This teaching material is based on inspiration in the immediate vicinity of the school. The pupils look for solutions from nature in their own schoolyard. With this curriculum, students learn how to design, test and evaluate solutions, using examples from nature.





## Learning objectives

The teaching package focuses on the following learning objectives:

- After completing the lessons in this package, pupils can follow a design cycle in which they make, test and evaluate a design.
- After using this curriculum, students can explain what Biomimicry is and give examples of this in plants and animals in the schoolyard.
- After completing this curriculum, pupils can find and use solutions from nature to solve technical problems.

## Core goals

This curriculum fits in with the following core objectives of the Dutch curriculum:

- 40 - The pupils learn to distinguish and name many common plants and animals in their own environment and to learn how they function in their environment.
- 41 - The pupils learn about the construction of plants, animals and people and about the shape and function of their parts.
- 44 - The pupils learn to establish relations between products, their use and use of materials in their own environment.
- 45 - The pupils learn to design solutions for technical problems, to execute them and to evaluate them.

In addition, during the elaboration of the lessons, explicit connection was sought with the intermediate goals for group 5/6 (TULE).

## Overview

This teaching package consists of 1 introduction assignment (Learning from nature) and 5 biomimicry lessons. You can do them all, or make a choice for or with the students.

	Title	Content	Period	Intermediate seats TULE group 5/6
1	Learning from nature	Introduction to biomimicry	Spring and autumn	<ul style="list-style-type: none"> <li>• properties and characteristics of organisms match the environment in which they live (protective colour, shape)</li> </ul>
2	Hands off!	Protection	Spring	<ul style="list-style-type: none"> <li>• properties and characteristics of organisms match the environment in which they live</li> <li>• some parts of the body have a protective function</li> </ul>
3	Soft landing	Seed distribution	Spring and autumn	<ul style="list-style-type: none"> <li>• properties and characteristics of organisms match the environment in which they live</li> <li>• form of distribution in plants is related to environment</li> </ul>
4	Find me then	Being invisible	Spring and autumn	<ul style="list-style-type: none"> <li>• properties and characteristics of organisms match the environment in which they live (protective color, shape)</li> </ul>
5	Wet suit	Stay dry	Autumn	<ul style="list-style-type: none"> <li>• some parts of the body have a protective function</li> </ul>
6	Survival	A place to live	Spring and autumn	<ul style="list-style-type: none"> <li>• some parts of the body have a protective function</li> <li>• function of root, stem and leaf of a plant</li> </ul>



## Design Learning

**Except the introduction lesson, everything in this package is set up according to the seven-step plan of design-based learning. Sometimes not all steps in a lesson are discussed. If one step is skipped, it is indicated in the notes per lesson in the instructions. Each lesson has a worksheet for the students on which the seven-step plan are seen again (in parts). Below you see the overview of the seven steps and how they return in the worksheets. You will find tips on how to guide the students in each lesson. These tips are for all lessons. Specific indication are given when necessary.**

### 1 Identify the problem

In this step the problem or you could say challenge of this lesson is explained for which the children have to design a solution. Also in this step the criteria that the solution have to meet (design requirements) are explain.

#### *Worksheet*

The students write down the problem in their own words.

#### *Teacher instruction*

Introduce the problem of the lesson in class. This can be found in the explanation per lesson later in the manual. Please have a look before starting the lesson. Take time for this explanation and make sure that students understand the problem. Do they recognize the problem? Do they understand? When could this occur? Tell students that they are going to design a solution for the problem inspired by nature. Make groups of 3-4 students. Tell them that they are going to make a design for that problem. Give each group a worksheet. If necessary, take them through the assignment step by step. Let the groups fill in the first step.

### 2 Explore: Ask nature!

The children explore the problem and are asked to think about solutions. In this lesson 'Asking Nature' is our central approach. The students go outside to explore how nature solves this problem. They use nature as a source of inspiration for their design. They will come up with different solutions and choose the best idea.

#### *Worksheet*

their worksheet, the pupils are going to explore nature around the school. Some lessons have additional questions (knowledge questions and / or in-depth assignments). See explanation per lesson. After they have done their research work outside, the group will write down one or more possible solutions on their worksheet. They will then choose their best idea.

#### *Teacher instruction*

Tell the children that they are going outside to see how nature is solving this problem solves. They can use their worksheet. Give each group a board. Discuss in advance the rules outside such as: where are the children allowed to come, where can they go with questions, how much time do they have and so on. Back in class discuss the work with the children. Which solutions did they find outside? What solutions did they find? Thinking of multiple solutions is good for the creativity development of children. It's important that the students feel free to come up with ideas. Nothing is stupid or wrong at this stage.

### 3 Create a design

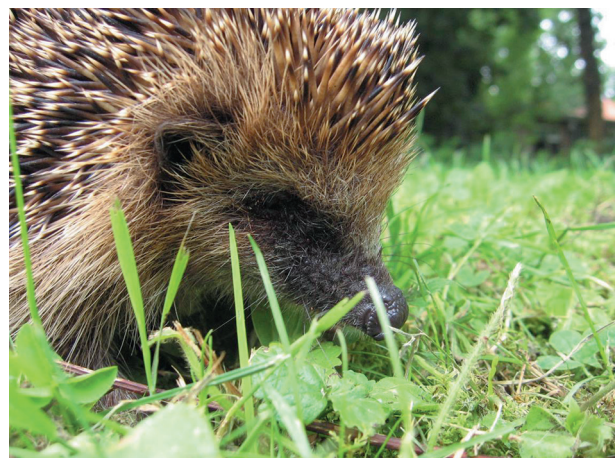
The students will put their best idea, or maybe 2 ideas into a design (drawing) making clear the shape, materials and tools needed.

#### *Worksheet*

On their worksheet the groups will make a design drawing of their (best) solution. They make a list of what they need in terms of materials and tools. They may have to actually built (step 4) their design. If so, instructions will be on the worksheet. They have to submit their design to you before they are going to build it

#### *Teacher instruction*

If they are going to build their design in class, it is important that all groups submit their design drawing to you first. Then you can you see if it is feasible. In case groups find it difficult to make a design, you can you already prepare the available materials. This is sometimes possible inspire, for example, thumbtacks for spines or thorns imitate.





## 4 Build design

In this step the students create (build) a real product based on their design.

### *Worksheet*

The groups are instructed to make their design (steps to build it). Make sure all groups have enough workspace and materials and have made a decision on what design there are going to make. Take care of safety when they are using tools. Assist the groups if necessary.

## 5 Testing

In this step students are testing their product. Does it work? Does it satisfy the requirements? In most modules this step is often combined with step 6: presenting.

### *Worksheet*

The groups will test their own and/or each other's solutions and evaluate them. In the lessons in which is built, the products are tested. In the other lessons the groups will evaluate and discuss each other's design drawings. They will fill in the worksheet and write down on which plant or animal is every solution based, how the design works and how it could possibly be improved.

### *Teacher instruction*

For each lesson it is indicated whether the testing takes place in class or in the form of an exhibition, in which the groups pass by run each other's products or design drawings.



## 6 Presenting

The students present their solution to the rest of the class and present their ideas and tell whether their solution meets the problem and any design requirements. The solutions of the different groups are compared with each other.

In some modules this step is often combined with step 5: to test.

### *Worksheet*

In step 5, each group has filled in the worksheet for all solutions. Let them give each other tips and tops based on their presentations.

### *Teacher instruction*

Discuss all solutions in class. Let each group briefly explain their the design: on which plant or animal it is based and why did they choose this? Let the other groups respond to this on the basis of their worksheet: what worked good to the solution and what is less good? How could it be improved?

Optionally choose the best solutions, for example, the most original, the one that works best, the one who best reflects nature, the one with the most different materials and so on.

## 7 Deepening

Finally, the teacher reflects on the entire design cycle and on the natural/technical principles, materials and materials used tools. In this lesson you will discuss what else they want to 'ask nature': what else would the students want to learn from the nature?

### *Worksheet*

The groups write improvements on the worksheet for their own design and formulate new questions for nature.

### *Teacher instruction*

Go through the entire design cycle: what was the problem again, what did we learn from nature about this, what solutions did we come up with, etc. Discuss which new questions to ask nature do the groups have written down on the worksheet. This can possibly lead to a new lesson.

# 1 Learning from Nature

**There is a lot to learn from nature. Not only by looking at nature, but also by using other senses. In this introductory lesson, students will explore the nature around the school with all the senses. This will help them later in the research phase of the other Biomimicry lessons.**

## Targets

The students can:

- Indicate that good observation is important for learning from nature.
- Observe by looking, feeling, listening and smelling.

## Materials

- Worksheet 'Learning from Nature'.
- Three towel/scarf (one for each couple for inside assignment 3).
- Board to put your papers on.
- Pencil
- If possible, camera or phone (with camera).

## Organization

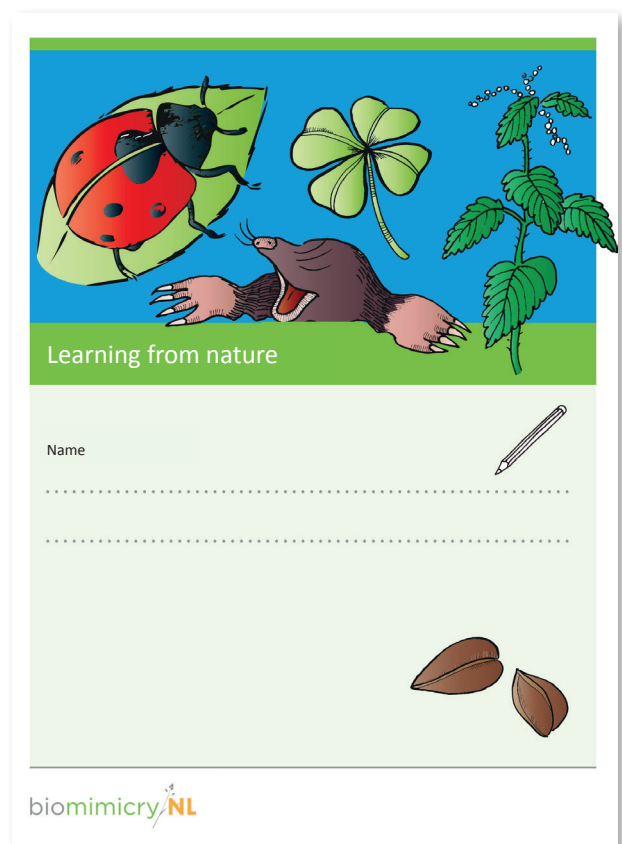
- **Group size:** groups of 3-4 pupils.
- **Preparation:** check in advance what can be found on the schoolyard regarding plants and animals, read the sheet carefully and make the necessary materials ready.
- **Duration:** introduction: 5 minutes, core: 45 minutes, conclusion: 10 minutes.
- **Location:** in the classroom and on the schoolyard.

## The lesson

The introduction assignment consists of 3 inside and 6 outside assignments. The students make all internal assignments and 2-3 external assignments of their choice. The internal assignments are short exercises about 'making good observations'. In the outdoor assignments the children learn to observe nature in the schoolyard with all their senses.

The students do the first two indoor exercises individually. For the 3rd internal assignment you make couples. These pairs also work together during the outdoor assignments. Make sure that each couple has a board, pencil and if possible a camera (or phone with camera). Every pupil does pages 1 and 2 individually, so you copy a worksheet for each student.

Then students make a selection from the assignments. You can therefore copy the various pages about 15 times (not all students do everything), after which the assignments can be cut loose on the dotted lines. Put these papers outside in a place where the couples can always choose a new assignment. The students all fill in their own leaf. They can keep the completed assignments and can make a personal book out of it.





## 2 Hands off!

**Yes! A snack! But how do you make sure that others stay away from your snack? The students design a solution to this problem by examining how nature solves such problems. Here they get acquainted with two solution strategies in nature: protecting (spines, thorns, sting, warning colours) and defending (shield, house, shell).**

### Targets

The students can:

- From examples tell how in general plants and animals defend themselves.
- Design a solution to protect their snack against others pupils.

### Materials

- Board
- Pencil
- Worksheet per lesson
- Snacks, 1 per group (muesli bar, sultana or similar). Don't choose a fruit because that is a nature object and a little confusing in this assignment.
- Material such as glue, tape, scissors, thumbnails, bags, paper, wool, cardboard, wire, paint.

### Optional

- Camera or phone with camera.



### Organization

- **Group size:** groups of 3-4 pupils .
- **Preparation:** take a look in advance at the schoolyard to find plants and animals, read through worksheet, prepare materials.
- **Duration:** introduction: 5 minutes, core: 45 minutes, conclusion: 10 minutes.
- **Location:** in the classroom and on the schoolyard.

### The lesson

In this lesson the pupils go through all the steps of designing learning. They start with the problem definition and from there go to research at the schoolyard, they design, carry out, test and evaluate. Give the children 1 snack per group. They are going to build their design around it. Put all the snacks together in a row during the test round so that they can be compared.

Prepare the fieldwork by speaking about three categories of how nature defends itself. Write on the blackboard: deter, defend and otherwise. Look together with the children which found solution in which category should. Hide (camouflage) would also be a solution, but because this will come back in the lesson called 'find me then' the children should use the strategy hide. For the testing phase, put all the solutions on the tables, so that the groups can walk along all of them. The groups will be testing each other's design by viewing them and (try) to touch. They would like to take this snack? They fill in the worksheet.

### Background info

Plants and animals have all kinds of ways to protect themselves from being eaten. These can be subdivided into:

<b>Scare away</b>	Spines and thorns	rose, hawthorn, blackthorn, shrub, blackberry, holly, thistle, hedgehog
	Fire hairs	nettle
	Wax layer	holly, rhododendron, ivy
	Smell	mint, thyme, basil, ant
	Poison	yew, bittersweet, dandelion
	Angel	wasp, bee, bumblebee
	Warning colours	ladybug, wasp, flytrap
	Mimic	hover fly, peacock
<b>To defend</b>	House/shell/shield	snail, mussel
	Roll up	armadillo bug, hedgehog
	Solid armor	centipede, beetle, ladybug
	Height	many predators cannot go high in the tree with leaves
<b>Different</b>	Tools such as a web	

## 3 Soft landing

Many students have a mobile phone. A common problem with this is that if the phone falls, the screen quickly breaks down. How do you make sure your phone makes a soft landing when it drops? In this lesson the students design a solution to this problem. They look at how nature solves such problems and get to know different forms of seed dispersal via the wind.

### Targets

The students can:

- Explain why plants spread their seeds.
- Explain that plants use different techniques to spread their seeds by the wind.
- Come up with a solution to be sure that a phone has a soft landing when falling.

### Materials

- Board
- Pencil
- Worksheet
- Boiled egg or scoop of clay.
- Watch or alarm.
- Material such as glue, tape, scissors, bags, paper, cardboard, thread, wool, leaves, grass, sate sticks, foil.

### Organization

- **Group size:** groups of 3-4 pupils.
- **Preparation:** take a look at what is in the schoolyard to see seeds, worktop, prepare materials.
- **Duration:** introduction: 5 minutes, core: 45 minutes, conclusion: 10 minutes.
- **Location:** in the classroom and on the schoolyard.

### The lesson

See 'design learning'. For this lesson pay specific attention to: introduce the problem. Tell the students that they are going to design a solution which they watch how nature solves such problems. Please let them look on internet at the dandelion (also available on [www.schooltv.nl](http://www.schooltv.nl), type in the search bar on the website 'Dandelion'. 1 movie) will appear. Then give each group a (cooked) egg or a scoop of clay they can use for creating a safe landing. They build their design around it.

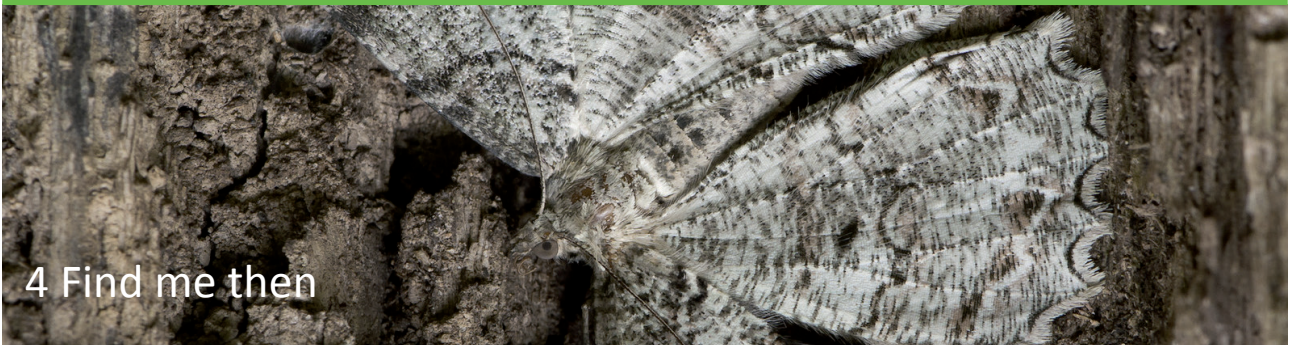
In the testing phase all the groups should present their design for the class dropping it while standing on a chair. All groups fill the worksheet in.



### Background info

Plants have different ways to spread their seeds through the wind. Examples are:

Plant	Solution	Time seed distribution
Dandelion	Fluff as a parachute	May - sept
Willow/poplar	Fluff as a parachute	May - June
Elm	Wings	May - June
Maple/ash	Wings	Sept - Oct
Birch	Small winged seeds in catkins together	Aug - Sept



There is always a birthday or other party to celebrate! Or father's day or mother's day. Have your gift already? How do you keep it hidden? Ideally you would make the gift completely invisible until the moment you give it. That is difficult, but luckily we can get inspiration from nature to stand out as little as possible. In this lesson, students are dealing with this problem and are introduced to different ways to make things invisible.

### Targets

The students can:

- Explain what camouflage is.
- Explain how plants and animals can hide themselves in a variety of ways.
- Create a solution to make an object 'invisible'.

### Materials

- Board
- Pencil
- Worksheet
- Familiar object that must be made invisible. This can be anything. Give them an extra challenge by taking objects that are big, that make a sound (ticking clock) or smell quite strong (food or a plant).
- Material such as glue, tape, scissors, bags, paper, cardboard, wire, paint.
- Watch or alarm clock.

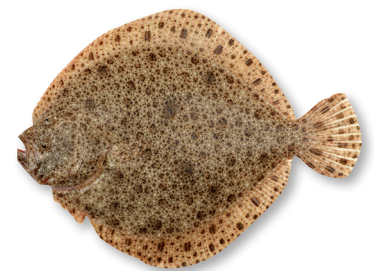
### Organization

- **Group size:** groups of 3-4 pupils.
- **Preparation:** take in advance a look at the schoolyard to find plants and animals, read through worksheet, prepare materials.
- **Duration:** introduction: 5 minutes, core: 45 minutes, conclusion: 10 minutes.
- **Location:** in the classroom and on the schoolyard.

### The lesson

See 'design learning'. For this lesson pay specific attention to: introduce the problem. Tell the students that they are going to design a solution based on how nature solves such problems. Give each group an object that they should make invisible. Because camouflage especially should be tailored to the environment, it is useful to designate a specific area for each group within which they have to make their object invisible. The pupils start making a list of how plants and animals are hiding. Then they go out to the schoolyard to investigate. They can choose between research on plants or animals.

In the test phase all groups exchange their ideas to other groups. This they fill in on the worksheet. Keep track of time.



### Background info

Plants and animals have all kinds of ways not to stand out. These strategies can be subdivided into:

<b>Become invisible</b>	Equal movement:	leaves, groups of birds
	Camouflage:	female duck, female blackbird, woodlice, plaice on the bottom of the sea, walking branch, chameleon
<b>To hide</b>	Below the ground:	mole, some insects
	Above ground:	birds in trees, animals under leaves
	Under stones:	many insects such as woodlice





## 5 Wet suit

Autumn is back! That means a lot of rain and a lot of wind! Oops, your umbrella is pulled from your hands and raincoats start to leak. How does nature stays dry? What can we learn from nature to design a raincoat never leaks? In this lesson, the students are concerned with this question and are introduced to different ways to get rid of water as quickly as possible.



### Targets

The students can:

- Give examples of how plants and animals stay dry.
- Create a solution to make sure they stay dry when it rains.

### Materials

- Board
- Pencil
- Worksheet of this lesson.
- Cups or water cans (something that the children can use to take water along the schoolyard).
- Adhesive tape or glue.
- Resources (books, internet) for research.

### Organization

- **Group size:** groups of 3-4 pupils.
- **Preparation:** take a look at what can be found in the schoolyard at plants and animals, go through the worksheet, prepare materials, if necessary. Make reservations for computers.
- **Duration:** introduction: 10 minutes, core: 30 minutes, conclusion: 20 minutes.
- **Location:** in the classroom and on the schoolyard.

### The lesson

See 'design learning'. In this lesson the pupils do not through all the steps of designing learning. Instead of building their design they do a in-depth research. Introduce the problem. Tell the children that they are going to design a solution based on how nature solves this problems. They can start by thinking of first examples of how plants and animals make sure they don't get soaked. Then they go outside to investigate. They can choose between research into plants or animals. After the outdoor work they will do more research. The pupils use books, computers or consult an expert. To view the groups instead of a test phase each other's designs. In doing so, they fill in the worksheet.

### Background info

Plants and animals have all kinds of ways to stay dry (or as dry as possible). These can be subdivided into:

<b>Structural</b>	Grooves:	leaves of plants, wings of a butterfly
	Coat:	rabbits, dogs, cats
	Scales:	pine cone, fish, woodlice
<b>Chemical</b>	Greasiness:	feathers of birds, some plant species

### Optional extra demonstrations for when there is time left

- Use vaseline or another type of grease on the hand to demonstrate how greasiness ensures that water is quickly drained, remains on the skin. The pupils can then be given the opportunity to feel in addition to looking.
- Use patches of different fabrics to demonstrate that different substances take longer or shorter to get dry again. The pupils then get the opportunity to feel, in addition to looking.



Many TV programs are about surviving in the wild. That is an exciting challenge that begins with making a safe place where you can live and stay overnight. How can you live and/or build a shelter in the forest? The children design a solution for this problem in which they use inspiration from nature. They will encounter different ways of living and surviving in nature.

### Targets

The students can:

- Give different ways in which animals ‘living’ in nature.
- Explain what the advantages and disadvantages are of these different ways.
- Explain how nature creates strength (give examples).
- Create a ‘home’ to be able to survive in nature.

### Materials

- Per group a worksheet, pencil, some paper and board to put papers on.

### Organization

- **Group form:** groups of 3-4 pupils.
- **Preparation:** see for yourself in advance what can be found in the schoolyard for animals (insects, birds, snails) and plants (bamboo, herbs with large leaves).
- **Duration:** introduction: 5 minutes, core: 45 minutes, conclusion: 10 minutes.
- **Location:** in the classroom and on the schoolyard.

### Performance

See ‘design learning’. For this lesson pay specific attention to: In this lesson the pupils do not go through all the steps of design learning. They make a design drawing but do not build. Introduce the problem. Tell the children that they are going to design a solution based on how nature solves this problem. In doing so, they look at natural ways of living in animals and structure and stiffness in plants. Instead of testing, the groups will review each other’s designs. In doing so, they fill in the worksheet.

### Achtergrondinfo

Animals have different ways to live. Animals that build a ‘house’ (nest, hiding place) use natural materials, mostly plants.

<b>Create own home</b>	Snail, mussel
<b>Make nest</b>	Birds, ducks, wasps, bees, ants, squirrel
<b>Burrow in the ground</b>	Mouse, rabbit, ant, fox
<b>Live underground</b>	Earthworm, mole
<b>Other ‘houses’</b>	Hollow in a tree by a woodpecker, hole of spider web (because the web is not a house but a safety net for food), castle of a beaver
<b>Curl up</b>	Pill bugs and other small creatures under stones and in dead wood



Plants provide in different ways for stiffness or firmness without heavy or fragile. Plants provide strength in various ways without being heavy or fragile. Check out all their strategies.

<b>Firmness</b>	Wood, veins
<b>Flexibility</b>	(Young) branches, stems, leaves
<b>Profiles</b>	Hollow steel of dandelion, reed, bamboo
<b>Using tools</b>	Vines or climbing and creeping plants that attaches to branches and trees



## Colophon

### More information about and examples of biomimicry:

<http://ben.biomimicry.net/curricula-and-resources/youthcurricula/resource>

[www.biomimicry.nl.org/-toolkit-for-k-12-educators/BiomimicryEducatorsToolkit](http://www.biomimicry.nl.org/-toolkit-for-k-12-educators/BiomimicryEducatorsToolkit)

[www.asknature.org](http://www.asknature.org)

### More information about designing learning:

[www.slo.nl/primair/leergebieden/wereldoriëntatie/natuur/vtb/LOOLbasis.pdf/download](http://www.slo.nl/primair/leergebieden/wereldoriëntatie/natuur/vtb/LOOLbasis.pdf/download)

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All lessons are tested on a number of schools in around the Hague.

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### Foto's

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### Design

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