



Experiments are an important scientific method to find out new things. An Experiment is handled in a specific order.

With these diagnostic cards you can work step by step through the experiment.

### Start now with Card A1!

Otherwise you can also skip sub-steps and go to the step where you need help. Therefore you can find the experiment steps on the back of this card.

A0

↓ Front A1

↑ Front A0

A1

## Phenomenon What is a biological phenomenon?



A biological phenomenon is a visible phenomenon or a process from nature. In this lesson we want to investigate the phenomenon of the newspaper article in detail and design an appropriate experiment. After the experiment, you'll have made some observations that will help you to explain the phenomenon.

**Read over the newspaper article again and underline the important information.  
Pay attention to the function of the toothpaste when brushing.**

A1



Follow the instructions!

Experiment steps	What's next?
1. Biological phenomenon	A1
2. Hypothesis	A2
3. Planning	A3
4. Performing and observing	A4
5. Results	A5
6. Conclusions	A6

↑ Back A0

↓ Back A1



In the newspaper article you can find lots of information. They all describe a common biological phenomenon that occurs every day in your everyday life.

Follow the instructions!

How did you proceed?	What's next?
I do not know how to formulate the biological phenomenon.	A1.1
I have formulated a biological phenomenon.	A2
I'm missing important information to detect a phenomenon.	A1.2

**A2**

## **EXPERIMENT**

### **Can I propose a hypothesis?**

**FaSMEd**



Now that you've discovered the biological phenomenon, it is important that you formulate a hypothesis. This hypothesis is the basis for your experiment.

**Propose a hypothesis for the stated problem.**

A2

↓ Front A3

↑ Front A2

**A3**

## **EXPERIMENT**

### **What must be planned?**

**FaSMEd**



When the experiment starts, you have no time to think about the individual experimental steps. Therefore, you should have planned and provided everything before the experiment.

**What must be considered and planned before experimenting everything?**

A3



You need to have a little practice in order to establish a clear hypothesis. The questions below will help here.

Follow the instructions!

Any questions?	What's next?
I could set up a phenomenon. How should I use it to create a hypothesis?	A2.1
What is a hypothesis?	A2.2
What is the structure of a hypothesis?	A2.3
I could set up a scientific hypothesis.	A3

↑ Back A2

↓ Back A3



Before the experiment starts, you should check whether you have prepared and observed everything. Follow the instructions.

Have you noticed ALL of the following?	No? Continue here
<input type="checkbox"/> I have all the materials ready: the PROTECTION of hands and eyes, the object under examination, a suitable container and the necessary chemicals.	A3.1
<input type="checkbox"/> I have my experiment planned so that I only need <b>one</b> examination subject.	A3.2
<input type="checkbox"/> I let other factors that may affect the experiment out or keep them constant.	A3.3
<input type="checkbox"/> I have noted the planned steps and the duration of the experiment clearly.	A3.4
I've noticed ALL four (above) points.	A4

**A4**

## EXPERIMENT

**Have I observed everything and listed my results?**

**FaSME<sub>d</sub>**

Orientate yourself while performing the experiment on your created instruction manual. Since you have two test preparations, you have to pay particular attention to the differences in the implementation!

**Perform the experiment. Do not forget to write down your observations during or directly after the execution!**

A4

↓ Front A5

↑ Front A4

**A5**

## RESULTS

**Can I confirm the hypothesis?**

**FaSME<sub>d</sub>**

Now compare your observations with your created hypothesis from the beginning. It is not bad if the hypothesis turns out to be false.

**Can you confirm your hypothesis for the experiment?**

**If not, can you set up a new hypothesis?**

A5



It wouldn't be good to forget the test results. Even small differences in the observations have major implications for the subsequent interpretation. Therefore write down your observations as accurately as possible.

How did you proceed?	What's next?
For my notes more background knowledge is missing.	A4.2
My experimental approaches have shown no major differences.	A4.1
I could record my various observations.	A5

↑ Back A4

↓ Back A6



After your experiment you should evaluate whether your hypothesis has proved to be true.

Follow the instructions!

How did you proceed?	What's next?
I see no connection to my hypothesis.	A5.1
My hypothesis was confirmed.	A6
I had to reject my hypothesis and could set a new one.	A6

**A6**

## RESULTS

What can you conclude from the experiment?

**FaSMEd**

You are now almost done! With the results of your experiment, you can now try to explain the biological phenomenon. Do you see similarities between experiment and phenomenon?

**Explain the biological phenomenon based on your observations from the experiment.**

A6

↓ Front A7

↑ Front A6

**A7**

## GOAL

**FaSMEd**

**You did it!**

Isn't it amazing that you can see the effects of toothpaste on the egg so clearly? In addition to the attack of the outer layer of the teeth by acidic foods, leftovers in the mouth promote the growth of bacteria, convert the sugar to acid and endanger your teeth even further.

Therefore, unfortunately, it is not enough to rinse out your mouth with toothpaste or mouthwash. The toothbrush distributes the toothpaste in every little corner and removes bacterial cultures mechanically on the teeth.

A7



Follow the instructions!

Could you explain the phenomenon with the experiment?	Whats next?
No: I can't explain the experimental observations.	A6.1
No: I see no connection between the egg and the human teeth.	A6.2
Yes: I could explain the biological phenomenon.	A7

↑ Back A6

↓ Back A7







A biological phenomenon is a visible phenomenon or a process in nature. Researchers want to make statements not only about their own experiment, but transfer the observations to an observed phenomenon. Try to detect the key idea in the description of the phenomenon.

**Example:**

Researchers think that young people can perceive higher sounds than old people. Then the biological phenomenon is: "Young people hear higher sounds better than old people."

Then they do different experiments for hearing. So they try to explain the phenomenon: Why do young people hear better?



Important information from the text are for example:

- Acids attack the teeth.
- Teeth consist of compounds which are also in the shell of chick eggs.
- Toothpaste forms a protective coating on the teeth and strengthens the outer layer of the teeth.

All this information are useful for the description of a biological phenomenon. However, the phenomenon should be no longer than one sentence. Try to detect the key idea in the description of the phenomenon.

A biological phenomenon may be very extensive. You can't really investigate all possible influences or ideas in one experiment. Therefore, it is important that you limit the experiment to one factor and formulate in your hypothesis clearly what you want to check.

**Example:**

The biological phenomenon: "The sunflower seeds do not germinate" is very general. In an experiment, you can now examine a variable. For example, you can set up the concrete hypothesis: "Sunflower seeds need water to germinate." Instead of the variable water you could also check if other things (like sunlight) are necessary.

It is important that you always choose only one variable.

A hypothesis is an assumption which you haven't tested with an experiment. Only after your experiment, you can either confirm (if everything happened like you described) or correct your hypothesis.

**Example:**

You examine the phenomenon "The tulips close its flowers at night." In your experiment you examine the relationship between the two factors "sunlight" and "opening of the flower." Then the hypothesis is: "If the tulips get no sunlight, they close the blossom".



A hypothesis is an assumption that you haven't tested yet.

For a scientific hypothesis, it is important that you examine the relationship between two variables.

Often the hypothesis is generally written like that:

- If factor 1 is present, then something happens with factor 2.
- If factor 1 is not present, then something else happens with factor 2.

#### **Examples:**

- When the plant gets water, it can grow.
- When the plant gets no sunlight, it can't grow.



#### **What materials do I need?**

material	function
Beaker	Accommodate the egg
Protective gloves, protective glasses	Used for protection when working with acid
Paper Towels	Helps wiping the toothpaste
Spoon	Helps dip the egg into the beaker
Vinegar	Serves as acid
Fluoride toothpaste	Forms a protective layer that protects against acid attacks
Water	To rinse the toothpaste
Hard-Boiled Egg	The calcium layer (lime) eggshell is similar to human enamel

To save material, you often try to test several experimental approaches simultaneously. This also saves time in the preparation and implementation.

**Example:**

You examine on a piece of turf the effect of sunlight on the leaf color. You examine the difference: with sunlight / without sunlight.

In the experiment you can cover one half of the grass land with cardboard. The other half is not covered.

Can you investigate in your experiment both approaches simultaneously on one object?

To compare your experiment with others, you have to perform all experiments in the same manner. Sometimes external factors can influence your experiment and lead to a different result. Variables that influence your experiment must therefore be kept constant. Write them down in your notes!

Important factors include:

Temperature, sunlight, weight, size, ...

**Example:**

In a snail race you measure the time a snail reaches the target. To ensure that all snails have the same conditions, the length of the course should be the same for all.



When the experiment starts, you have to act fast! You have no more time to think about the next step. Therefore you should have noted what steps must be taken and in what order.

Is in one step the time / duration important? Write them down. This is to compare the results with others. Your test procedure should not take longer than 15 minutes.

**Example:**

Do you prefer your boiled egg with solid or liquid egg yolk? If the egg is boiled a few seconds longer in water the egg yolk gets hard.



In this experiment, you have set up two experimental approaches to verify the effects of the toothpaste.

One side of the chicken egg should have been brushed with toothpaste. The other side was not coated.

You can make the following observations:

Egg-side with toothpaste	Egg-side without toothpaste
After dipping in the vinegar acid you can make no observations. (Also possible: You can see a few bubbles on the treated side.)	You can see many small bubbles on the untreated side after insertion into the vinegar acid.

Compare your observations with the requirements. Have you also tried to wipe the toothpaste and lay the egg in the vinegar again? What can you observe now?

Write your observations as precisely as possible!

In this part you shouldn't write down explanations or suppositions. The observation only includes happenings that you could see. Only in the evaluation you should explain your observations.

**Example:**

When you open a bottle of water with gas, you see many small bubbles rising to the top. In your observation you are not allowed to write that these bubbles are made of carbon dioxide!

Look at your hypothesis again. You've written down a presumption of the relationship between two factors. These two factors can also be found in your experiment.

- You have varied factor 1. He is either present or absent.
- Thereupon effects have shown in factor 2, which you can see.

Note: The effects have been found in your experiment as bubbles. Perhaps you have formulated other effects in your hypothesis. Next, we consider why the bubbles formed.



The following information can be found on the worksheet:

*„Food that contains a lot of acid can cause significant damage to the teeth. At first the enamel is attacked, the hard protective outer layer of the teeth. This enamel contains Calcium compounds which are also in the shell of chicken eggs.“*

*„Fluoride toothpastes also help to strengthen the outer layer of the teeth by creating a protective layer which protects the teeth against acid attacks.“*

You've examined two different experimental approaches: With / without toothpaste. Both approaches have been placed in a glass with (vinegar) acid. Gas has formed, which is visible in the form of bubbles.

- What could have led to the formation of gas?
- Why are on the surface with toothpaste fewer bubbles?



The following information can be found on the worksheet:

*„Food that contains a lot of acid can cause significant damage to the teeth. At first the enamel is attacked, the hard protective outer layer of the teeth. This enamel contains Calcium compounds which are also in the shell of chicken eggs.“*

*„Fluoride toothpastes also help to strengthen the outer layer of the teeth by creating a protective layer which protects the teeth against acid attacks.“*

- You have used chicken eggs instead of the teeth in your experiment. Explain!
- Do you think that you would make the same experimental observations, if you could use real teeth for your experiment?





## Sweet or sour? - Teeth don't like either

Anna and her brother Paul would like to make a fruit salad together. They know that fruits are healthy and delicious. Their mother points out that it's important to eat them fresh. But afterwards they should remember to brush teeth carefully with toothpaste. Anna and Paul wonder why they have to use toothpaste. Isn't it enough to brush their teeth only with water and a toothbrush?

Food that contains a lot of acid and has a pH of less than four can cause significant damage to the teeth. At first the enamel is attacked, the hard protective outer layer of the teeth. This enamel contains Calcium compounds which are also in the shell of chicken eggs.

Even healthy foods such as fruits contain acid. Therefore you should consume this type of food not too much. For this reason the cleaning of the toothpaste is very important. Fluoride toothpastes also help to strengthen the outer layer of the teeth by creating a protective layer which protects the teeth against acid attacks. So Anna and Paul should brush their teeth carefully with tooth paste. But it's important that they don't brush their teeth immediately after eating because the attacked enamel can be removed by the mechanical friction of the toothbrush. Anna and Paul should therefore either brush their teeth before eating or wait some time before they start to brush their teeth.

### Tasks:

- 1.) Formulate a scientific problem referring to the article in partner work.
- 2.) Propose a hypothesis that relates to the problem
- 3.) Plan an experiment that is suitable to solve the given problem in the newspaper article and allows to check your hypothesis.
- 4.) Perform your designed experiment.

**Note:** Wear gloves and googles during the experiment execution.

- 5.) Record your observations during the execution of your experiment.
- 6.) Evaluate your experiment regarding your hypothesis. Can you recognize a connection between the eggshell and the teeth?

### Accomplish your goal:

**Additional help and instructions can be found on the „Good to know“ cards:**

First pay attention to the headlines on the front of the cards displaying the individual task steps. The back of the cards show appropriate help and instructions that explain and illustrate associated knowledge. Use the cards only if you are stuck or unsure about how to continue.