



A

## Plant Growth – The Life of Bernd the Bean



## INTRODUCTION

The teaching unit „The Life of Bernd the Bean“ deals with the topics germination and plant growth.

### Key concepts:

Anatomy and physiology of plant seeds, germination, performing a monitoring protocol, making morphological drawings.

### Age:

14–16 years. Younger students surely also have fun with this set of experiments, but they need a higher level of support for the evaluation of the data.

In this example students learn about development, germination and growth. Bean seeds (*Phaseolus coccineus*) are investigated in the dry and swollen state and the changes are described. The conditions of germination will be determined with experiments under deficient conditions and then compared to a control experiment. An experimental protocol is applied. Particular consideration is given to the competence-oriented science. Students can organise knowledge by acquiring, displaying and communicating. Germination is described as a process in nature. Students have to use different media sources for technical information and present it in various forms. They learn to carry out observation processes about phenomena in nature, to take measurements and to describe them. The test results need to be captured, illustrated and interpreted. You should be able to detect dependencies [Competency Model Science in Grade 8, Austria, 2011/ Kompetenzmodell Naturwissenschaften 8. Schulstufe, Österreich 2011].

### List of materials:

*Phaseolus coccineus*, pots, soil, petri dishes, a magnifying glass, binoculars, a smartphone, a camera, a PC with internet access, paper, pencils, overhead pen, a spray bottle.

Before students can describe these experimental series in a long-term log, the supervisor must first create a wiki with a title.

Useful link: [www.wikia.org](http://www.wikia.org).

## RESOURCES

The measurement results are presented in various forms on the basis of calculation programs.

For the protocol, the different growth phases are photographed and recorded in the form of photo documentation. Based on records of the analysed test results, the student groups each compile a wiki for the project on „Plant Growth“ together.



- ▮ Use of smart phones (for obtaining information, photo documentation).
- ▮ Growth measurement of a bean plant by way of photographs that show growth in motion (e.g. with the free online service “Animoto” that allows you to make short films from photos).
- ▮ With the parameters of light, temperature and water, the germination and growth process can be visualised in an animation program (Scratch, see annex).
- ▮ Cartoon on the growth of Bernd the bean: [toon-boom-studio.softonic.de](http://toon-boom-studio.softonic.de).
- ▮ The components above are entered in the wiki and published.

## CORE

### Input

10 bean seeds are investigated. Each bean seed is placed, measured and photographed on graph paper in its dry state. The measurement results are recorded on a spread sheet. The average length and width is calculated. The swelling of the seeds is the starting point of germination. The bean seed must now be placed in water to start the process. The water absorption takes place through the micropyle. After 24 hours in the water, the swollen seeds are again measured and the average length and width calculated again. The values are compared.



For the germination tests dry (A series) and soaked seeds (B series) are used and handled according to precise instructions. The plant pots A1, B1 are placed in a box, A2, B2 in the fridge, A3, B3, A4 and B4 on the windowsill. All plant pots are watered with 25cm<sup>3</sup> of tap water each day. (These approaches are only suggestions and students can try out other variations for themselves). The following parameters will be investigated: light-darkness germinators, dependence on temperature, and water demand.

During the following week, the students must look after the experiment carefully. Data should be collected daily and entered in the long-term protocol. As soon as the first shoots appear, it is important to document the growth in photos.

### Output

In this long-term test students learn how to generate scientific knowledge. On the basis of a scientific inquiry, students learn through their own experiments. This will happen in accordance with detailed instructions during class. All data must be recorded carefully. On the one hand, this is achieved in the form of measured values,

which are then presented in a spread sheet and analysed. On the other hand the students use photo documentation.

Students learn about the conditions of germination from these experiments. From the results they can read the parameters that affect the beans. Using the Scratch program (see annex), they also learn, for example, what the law of the minimum for organisms means. Students should counter-check the results obtained in experiments on germination and growth with a computer program.





The biological parameters that could be used here can be, for example: the temperature [T], the distance from the window [d], the amount of water needed per day [w], and the use of non-swollen or swollen seeds [yes/no]. Students recognise plant height [h] as a function of time [t in days]. The program requires the input of the constant „w“ and „h“ and then shows the estimated values of plant growth for ten days.

The students must try to determine an ideal combination of the conditions above that make the plants germinate better and grow faster.

This could look as follows:

$$h(t) = k \times \frac{w}{d} \times t$$

In this function, „t“ is the number of days for germination, „w“ is the need for water in cm<sup>3</sup>, „d“ stands for the distance to the window, and „k“ stands for a constant that can be changed. The solution is the growth of height „h“ in centimetres [cm]. Students can also add other factors and observe the effects on growth, and discuss the effects of these factors with each other.



#### CONCLUSION

The experiment of „The Life of Bernd the Bean“ provides experimental access to important topics such as germination and plant growth. With a series of experiments, the growth conditions are investigated. Media, which dominates the lives of the students, is used for monitoring the obtained results. A wiki replaces the protocol. The process of „growth“, a movement unperceivable to the bare eye, can be visualized with the photographs made into a movie. An animated cartoon with the title character „Bernd the Bean“ supports creativity.

