

Task 2 – “The Secret of Roots”



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What is it all about?

In the second part of the competition you will investigate roots. Roots normally are invisible for us and therefore might not be of interest. Nevertheless, roots are essential for plants and plants are essential for our ecosystem, finally for all of us.

The goal of this task is to figure out an experiment which allows you to get an insight into a rather physiological or biochemical aspect of a root. What should a root be able to achieve? How can a root fulfill these tasks? We are curious to see your approaches. Supposing that you are not familiar with root investigations we provide you with some ideas as food for thought.

Please take into consideration that you are allowed to talk and discuss ideas with experts of your choice, even though your biology teacher is directly involved just during the first phase in the process of establishing a promising design of your two experiments.

In contrast to the first task, you will present the results of your investigation by **designing a poster**. In the appendix you will find some hints how to create a poster and a PowerPoint template will be available on our website.

It is crucial to first read some information about roots and - in addition - about the procedure of this assessment.

Before you do anything else, please read ALL instructions for ALL parts (1-5) carefully! You will find clear instructions on how to proceed during your investigations (see also aspects 1 - 3 for parts 3-5). At the end of this document you will find the scoring list with the evaluation criteria.

What you have to do...

Part 1

Getting some background information: Studying the literature

Search for information about roots. Try to find out as much as possible. To get your first points you will have to write a short text about the relevance of this - at first view - unspectacular part of a plant. This information will help to shape the introduction on your poster. Try to integrate the following aspects:

- A** Roots in sciences. Why may they be of interest in respect of **physiology, biochemistry and economy**?
- B** How is dew formation (guttation) connected to activities in roots?

Try to integrate your answer to question B into the general introduction about roots. Take into consideration that your poster gets attractive by showing graphical elements rather than text only.

An important aspect will be the citation of your sources and establishing a bibliography (reference list) on your poster. **Note: Chose the five most important sources!**

Please read the following instructions on how to cite carefully and use the examples as a model for your own list:

„In-text“ citations: Numerical markers

To let the reader know where you have used a piece of information in your work, please use the numerical marker. Here is an example:

“Monkeys⁽¹⁾ prefer ripe bananas to unripe bananas⁽²⁾. This is due to the extra sugars present in ripe bananas⁽³⁾, and scientists think that monkeys may have a similar range of tastes to humans⁽⁴⁾. It has yet been unproven whether or not monkeys find it funny when someone slips and falls on a discarded banana skin⁽²⁾.”

Bibliography (reference list)

Supply complete details of the source you have used – so that the reader could easily find it to check it or to learn more. Add the bibliography to your poster. You must list your sources in the order in which they appear in your text on the poster. The very first source you cite in your text is listed in position 1 in your bibliography, the second in position 2 and so on. If you use a source again later on, cite it in the text with the same number as the first time you used it. You don't need to write the same source twice in your bibliography. Here an example referring to the “in-text” citations above:

1. Monkey

<http://en.wikipedia.org/wiki/Monkey>, retrieved March 7, 2015

2. Taylor, S. 2006. *Monkey Nutrition Handbook*. 2nd edition. pp 198-199. Primate Press, Bandung.

3. Triandafillou, A. 2011. *Livestrong* – Article: “Nutritional difference in ripe bananas”. Retrieved February 22, 2013 from www.livestrong.com.

4. Murphy, R. et al. 2005. “A Study into the taste pallet of primates”. *Monkey Journal*, vol. 2, issue 12. Dec.2005. pp 12-15

Part 2

How to get started...

- In your lab, you may have obtained (as advised) seeds of different species already in advance. If you keep them in fluent water for some hours followed by a transfer into a wet chamber you will soon detect the appearance of the primary root and the shoot. Try to avoid a situation where seeds are lying in standing water if this is not a specific aspect you would like to investigate.
Cress seeds normally do not even need to be watered to germinate. A wet surface and a wet climate are sufficient and you will detect the growing primary root in less than 24h.
- Usually, roots grow hidden in the earth. If you are interested in investigating roots you have to think about visibility. Depending on what you finally want to measure you have to establish a suitable grow-up system. Roots can grow under different conditions, including gelatin, agar and humid air or even in a liquid. The following sketches and pictures might inspire you and your teacher to make your first decisions.



- Without being forced to carry out a set of pretests you will get points during this period for describing and explaining precisely what happened between the different first suggestions in your team and the finally defined main experiments you carried out during part 3-5. Track your discussions and first observations during your first experiments.
For us it is crucial to **understand the process** you got through during this part of the task. (Is there a strategy which was finally helpful and successful leading to an interesting experiment or have decisions been made rather randomly? What did you take into consideration? Asking an expert? Checking different books in your school library?)
- This part will **not** appear on the poster! We expect a second PDF document called "Activity & Progress Report". The first part of this document will be your report about how you came to the idea of the design of your experiment. The text should not be longer than one A4 page (around 3000 characters, including spaces).
- **Take your time to share your ideas with your biology teacher. Your teacher may support you in finally establishing an interesting design for your investigations. As soon as you have decided on what to investigate, your teacher is not supposed to support you anymore.**

Part 3

Design of your experiment

The main goal of your investigations is to find out more about the secrets happening hidden in the earth (or any kind of substrate) when a plant is growing. Basically you are looking for one of these two aspects (chose **one** of them!):

A physiological approach:

Which factors determine the 'behavior' of a root? How can roots orientate without light surrounded by soil? How are signals detected and transmitted into a reaction?

A biochemical approach:

Find out what happens in between the root of a plant and its environment (rhizosphere). Think about the needs of a plant and how a plant could achieve these goals.

Think carefully about an interesting question. Get inspired by studying the literature. Think about quantifying your results. How can you measure the results of your investigations?

A design is made not only by describing an experiment by words, we would appreciate to see sketches and tables. Give us a short insight into your evolving ideas.

Aspect 1: Defining the problem and selecting variables

- Based on the knowledge you acquired in Part 1 and Part 2 you should now identify a specific research question. This may even be the title of your poster.
- Define and write down the three types of variables (we would like to see them!). Variables are factors that can be measured and controlled. Independent variables are those that are manipulated, and the result of this manipulation leads to the measurement of the dependent variable. A controlled variable is one that should be held constant so as not to obscure the effects of the independent variable on the dependent variable.
- Example of a specific scientific research question: 'How does the speed of movement of chloroplasts in *Elodea* cells vary with light intensity?' The independent variable is the light intensity; the dependent variable is the speed of movement. Relevant controlled variables would include temperature, preparation of *Elodea* cells, sample size and light quality.

Aspect 2: Materials & Methods

- Describe carefully how the experiment was performed. Another person should be able to repeat your experiment using your descriptions.
- Take two pictures: one picture of your root lab including your grow-up system and one meaningful picture of a beautiful root which allows a close view of the interactions between a plant and the substrate. Show that the exchange surface is an important issue. Integrate these two pictures into your poster.

Aspect 3: Reasonable data collection

- The planned investigation should provide sufficient data so that the research question can be suitably addressed and an evaluation of the reliability of the data can be made.
- Be sure to collect enough data in part 4 to enable an error analysis that involves the calculation of a mean value and a standard deviation.

Part 4

Data collection, processing and presenting

In parts 1-3 you have collected a lot of information about roots and made a design for your experiment you are going to conduct. Now it's time to transfer your idea into a setup for a challenging experiment. You may feel what it means to be a scientist 😊. It is absolutely crucial to collect enough and reliable data!

Aspect 1: Recording raw data

- Raw data are the actual data measured. The number of significant digits should reflect the precision of the measurement.
- Think about a suitable way to display your raw data on your poster (e.g. table).

Aspect 2: Processing raw data

- Data processing involves, for example, combining and manipulating raw data to determine the value of a physical quantity (such as adding, subtracting, squaring, dividing), or taking the average of several measurements and transforming data into a form suitable for graphical representation. It might be that the data are already in a form suitable for graphical presentation. If the raw data are represented in this way and a best-fit line graph is drawn, the raw data have been processed. Plotting raw data (without a graph line) does not constitute data processing.

Aspect 3: Presenting processed data

- You are expected to decide upon a suitable presentation format yourself (for example spreadsheet, table, graph, chart, flow diagram and so on). There should be clear and unambiguous headings for calculations, tables or graphs. **Graphs need to have appropriate scales, labeled axes with units, and accurately plotted data-points with a suitable best-fit line or curve (not a scatter graph with data-point to data-point connecting lines).** You should present the data in a way that all the steps to the final result can be followed. The way you present your data is not only a matter of design. It should be meaningful and prove that you didn't choose the type of diagram by chance.
- You should include a treatment of uncertainties and errors with your processed data, wherever relevant.

Part 5

Conclusion, discussion and evaluation

You have now acquired your data. How to proceed? It is up to you to find an interpretation.

Although your results may seemingly fit your hypothesis, be prudent in concluding and try to reconsider premature deductions. Nevertheless – this part may be very satisfactory ☺.

Aspect 1: Conclusion & Discussion

- First of all, neutrally describe the results without any interpretation. What do you see? This may include comparisons of different graphs or descriptions of trends shown in graphs. The explanations should contain observations, trends or patterns revealed by the data.
- As a second step, an interpretation of the results follows. Think about possible explanations of your results. You may even take the literature into consideration.

Aspect 2: Evaluation

- The design and method of the investigation must be analyzed as well as the quality of the data. You must not only list the weaknesses but must also appreciate how significant the weaknesses are. Comments about the precision and accuracy of the measurements are relevant here. When evaluating the applied procedure, you should especially look at the processes, use of equipment and time management.

Aspect 3: Improving the investigation

- Suggestions for improvements that could be made in a future experiment should be based on the weaknesses and limitations identified in aspect 2. Modifications to the experimental techniques and the data range can be addressed here. The modifications proposed should be realistic and clearly specified. It is not sufficient to state generally that more precise equipment should be used.

Scoring List

Part	Subject	Score (%)
1	Searching the literature, background information (For your short text and the correct references to the literature you can get 10% of the total score. Try to connect the basic information with the topic of your investigation in Parts 3-5).	10
2	Progress Report: Describing the complex process from a bunch of ideas to one promising experiment (Provide us with information about the process which finally led to the poster. What was your strategy, where did you struggle, how did you organize yourself). Note: This part will not appear on the poster but on the separate PDF document "Activity & Progress Report"!	10
3	Design (If you fulfill all 3 aspects perfectly you will get 15% of the total score).	15
4	Data collection, processing and presenting (If you fulfill all 3 aspects perfectly you will get 15% of the total score).	15
5	Conclusion, discussion and evaluation (If you fulfill all 3 aspects perfectly you will get 15% of the total score).	15
Poster Layout	Quality of your poster (The following aspects are crucial for judging the quality of a poster: captivating title; eye catcher; packing density; proportion of graphic element, pictures and text; pleasant setup of the whole poster and the "red thread" . If you consider these aspects and if all pictures and tables are labeled and numbered correctly and the quality of your pictures, charts and diagrams is convincing, you will get 25% of the total score).	25
Extra Points	Extra points for a fancy and exciting approach (You will get these extra-points (10% of the total score) if you convince us with a unique, interesting idea that finally leads to a successful investigation and meaningful results).	10
Total		100

Don't forget...

Reference List

List your five most important **references** as mentioned on your poster according to the guidelines explained in Part 1.

Activity List

Add the **activity list** to your “Activity & Progress Report” (separate PDF file!). Each class needs to report which member was or is responsible for which portion or aspect of the work. Each person in the class must have participated at least once during Task 2 (no matter what kind of work she/he did).

Take 2 digital photos showing the class involvement. Place them next to the activity list.

Expected documentations and further information

1. POSTER (PDF file)

- To create the poster, use our PowerPoint template which will be available on our website next to Task 2. **Feel free to adapt the whole layout** according to your taste but **do not change** the format (A0, **portrait** format) and the font size for the main text.
Save your poster as PDF file and send it in (the size of the PDF file must not exceed **6 MB!**).
- Your poster should include:
 - Title, name of school, name of class
 - Results of Part 1 and Parts 3-5
 - Reference List
- Use **at least font size 24 for the main text** in the columns
You are free to choose the font, but it should be easily readable (e.g. Arial, Calibri).
- Name the PDF file following strictly these conventions:
 1. Name of School
 2. Name of Class (same as on application form or homepage)
 3. Number of Task
 4. Date (year/month/day)
 → Please use underlines instead of spaces!

Here is an example: **Kantonsschule_Muster_Class3b_Task2_Poster_20150408.pdf**

2. ACTIVITY & PROGRESS REPORT (PDF File)

You have to send in a second PDF file called “Activity & Progress Report”. This file includes the **answer to Part 2** and the **activity list**.

Name the file according to the following example:

Kantonsschule_Muster_Class3b_Task2_Report_20150408.pdf

Closing Date of Task 2: Wednesday, 13.5.2015, 23.59h