# Is salt bad for plants?

# Volunteer guidance (Higher KS3)

## Notes

## a) This guidance is for KS3 students of higher ability. As a result, the method

## sheets, results tables and graphs are different to those for lower ability students.

**b) You should make a stock solution of 0.5 M concentration before the lesson.**

**Use 29 g of salt in 1L of water. Each group will need to use 60 mL of this solution**  **in total, so 1L should be sufficient for 1 class.**

## Key Stages

* Key Stage 3 comprises Years 7 - 9, with pupils aged between 11 and 14.

## SESSION 1

### Introduction

1. Ask the pupils to write their first names on them. You can wear one too! Try to use the pupils’ names whenever you’re talking to them.
2. Introduce yourself and your team to the group. You can talk briefly about the university and what you all do there. You could ask if they know the link between the characters in the ‘Monster Inc’ movies and the University of Birmingham – it’s rumoured that the Monster University was based on UoB – note the clock tower! Slides 1 – 3 can be used here. You could then ask the pupils what they know about universities. This would also be a useful way to break the ice. Based upon their responses, you could discuss the following:

* A university is a place where you can go to once you’ve finished normal school, to continue studying subjects they’re interested in.
* People normally go to university when they are 18 and have taken their A-levels.
* You can go to a university in Birmingham, but they’re all over the UK and the rest of the world.
* Pupils at KS3 may be aware that science can be broadly divided into the subjects of biology, chemistry and physics. Some schools do this at KS3, others wait until students have begun their GCSEs. Explain that within these three subjects, there are a huge number of other areas – like engineering, medicine, materials etc. This could be a good opportunity for the volunteer team to discuss what they studied at A-level and what they are doing now. It’s nice to involve the children, ask them what they’d like to learn about!

1. At this stage, you can ask the pupils to complete the 3 survey sheets regarding their attitudes towards science.
2. Introduce the project. Don’t mention ‘toxicology’; instead say that we are going to investigate which things stop plants from growing.

**The science of seeds**

1. Start by asking the pupils about what plants need to grow. At KS2, pupils will have learnt about how seeds and bulbs grow into plants and that plants need water, light, air and nutrients from the soil. They will also have been taught about habitats and environments and how these can change – often as a result of human impact – which can sometimes pose dangers to living things.

During KS3, pupils look at seed formation as part of their work on reproduction in plants and also begin to study photosynthesis – though this will depend upon the Year Group; pupils in Year 7 may not have encountered the topic yet.

At this stage, knowledge of the process of photosynthesis is limited to the word equation:

carbon dioxide + water ® oxygen + glucose

They will know that light is required and that the process occurs in the chloroplasts of a plant. They may also have studied adaptations of plant leaves, though this knowledge is not required for this project.

1. You could ask the class how things that are bad for plants might get into soil. During the winter for example, salt is used to get rid of snow and ice. Does salt affect the growth of plants? This is what we are going to investigate!

The pupils may well have grown cress from seeds when they first started learning about plants. You can show them what these seeds look like before discussing the actual experiment (perhaps give them the small beaker of seeds which they will be using). They could even hold some seeds in their hands – can they remember what’s inside these tiny seeds?

Describe how a seed is like a tiny parcel. It contains everything a new plant needs to start growing. Slides 5 – 7 feature this information and the pictures below, taken from BBC Bitesize.

A diagram of a bean

Description automatically generated



When your cress seeds **germinate**, they will send roots down to take up water and nutrients – but what if there is something poisonous in the water…?

### Introducing the experiment

Show / discuss the experimental set up, with the four different pieces of **filter paper** in the tray. Each tray will also contain a small beaker of cress seeds.

Each piece of filter paper will be soaked in salt water of different **concentrations**. KS3 students should have an idea about what this word means and will probably have studied how **solutes** dissolve to form **solutions**, but will not have encountered the use of **moles** or **moles per litre / M**. The PhET simulation (link on slide 8) can be used to help explain this, after you have discussed bullet points 1 – 4 below:

* The students will know that everything is made of atoms and/or molecules, and that these are incredibly small. You could use the analogy that inside one grain of sand, there are more atoms than there are grains of sand on an entire beach!
* Because the numbers of atoms are so huge, we use a unit of measurement called the **mole**. This is a bit like using ‘pair’ to mean 2, or ‘dozen’ to mean 12. But 1 mole contains 6.02 ´1023 particles! (KS3 students will not have encountered the use of standard form, so you could simply ask them to imagine 602 followed by 21 zeroes!)
* Needless to say, they’ll probably find the use of the word ‘mole’ amusing and may also ask why chemists use such a strange word! It’s a translation of the German unit ‘Mol’, which in turn comes from the term ‘Molekűle’.
* Because we measure volumes of liquid in litres, we can measure the **concentration** (the amount of dissolved substance in 1 litre), in moles / litre or ‘M’

Using the simulation:

* Select ‘sodium chloride’ as your solute using the drop-down menu on the right of the screen.
* Drag the concentration sensor into the beaker of water – it should read 0.00 mol/L. Explain that we will be using ‘M’ instead.
* ‘Shake’ the salt cellar so that a few grains fall into the water. The sensor will register the new concentration. The students will see how the value increases as more particles are dissolved. Aim to reach a concentration of 0.50 M, as this will be the value of our stock solution. (You can pull the blue plungers on the two taps to add or remove water from the beaker!)
* Explain that chemists use stock solutions like this to prepare the working solutions which they will use, and that’s what the class will be doing. You can ask the students how they think they’ll do this – they should work out that they will need to add more water. You can do this on the simulation – aim to reach values of around 0.3 M and 0.2 M, as these will be the ones the students need to achieve.
* Don’t worry if you don’t quite reach these precise values on the simulation – this shows that we need to be very careful when measuring the volumes required and will (hopefully!) encourage the pupils to work accurately.

At this stage, the pupils could label each piece of paper with ‘0 (0.0M)’, ‘low (0.2 M)’, ‘medium (0.3 M)’ and ‘high (0.5 M)’. This describes how much salt there will be.

Describe how we will place 10 seeds on each piece of filter paper, and leave them for a week to germinate…

### Variables and controls

* Students should have used the concept of variables in years 5 and 6. It’s worth checking with the member(s) of staff to see if they are familiar with the terms independent, dependent and control variables. If so, use these terms during the following discussion.

Ask the pupils to think about:

* What we are going to change (amount of salt)
* What we are going to measure (see what they come up with here – if their ideas are limited to “how many seeds grow”, ask them if there is something they can measure. The presence of the ruler might help here!)
* What we need to control / keep the same (type of seed, number of seeds on each piece of paper, how much they are spread out, amount of water used (they may be familiar with the terms capacity and/or volume), time we leave the seeds to germinate, amount of light – we will leave the trays in a dark place to control this.

This would be ideal for discussion in small groups with your help and prompting. Having the apparatus there in front of them is really helpful.

Mention that you need to think about exactly the same things when you are planning and carrying out experiments at university! It’s a vital part of ‘working scientifically’.

### Predictions

You may wish to ask the groups to raise their hands in order to indicate which set of seeds they think will grow most successfully. There are opportunities for some interesting discussions here. Given that they should know that salt is a nutrient – and that plants need nutrients – will some predict that the ‘low’, ‘medium’ or even ‘high’ concentration will work best? Or will they use their knowledge that eating too much salt can cause health problems to predict that the ‘zero’ concentration will produce the most successful results? Encourage the pupils to give reasons for their predictions.

**Carrying out the experiment**

You should already have prepared 2 – 3 large beakers of the stock 0.5 M solution. One student from each group should collect just over 60 mL in a beaker – this only needs to be approximate, so shouldn’t take too long.

Once the pupils have begun to prepare their working solutions, check that they are doing so correctly and that they use the correct concentration for each piece of filter paper.

Pupils can continue to write about their aim and method while they are waiting. There is a wordsearch at the end of the worksheet if required.

The pupils will probably find it easier to pick up the cress seeds if they empty the beaker of them onto their worksheet – encourage them not to pour them all out though, as this can lead to spillages!

Remind them to count out exactly 10 cress seeds for each piece of filter paper.

There are two different ways of storing the experiments for the subsequent lesson, depending on availability of resources:

1. Students use small trays (holding one group’s pieces of filter paper). This is the preferred method, as the seeds are less likely to dry out.

Ask them why we need to cover the tray with another one and then cover them with a bin bag.

They can stick their name tags to the top tray to identify which one belongs to them.

Adults should take the trays and use Sellotape to attach them together (a couple of small pieces should be sufficient).

The trays can then be left in a dark place. It’s for the adults to do this to avoid overcrowding.

1. If students are using larger Gratnell trays (holding two groups’ pieces of filter paper):

Ask them why we need to cover the tray with clingfilm and then place it in a bin bag. (Note that it is useful to place a small beaker of water in the tray to help avoid the seeds drying out. The base of the beaker can be sellotaped to the tray to avoid

spillages.)

They can stick their name tags to each half of the tray to identify which sets of seeds belongs to them. Students could also use a Sharpie pen to divide the tray into two sections, one for each set of pieces of filter paper.

Adults should take the trays and cover them in clingfilm (after adding the small beaker of water to each).

The trays can then be left in a dark place. It’s for the adults to do this to avoid overcrowding.

### Finishing off

Congratulate the pupils on their attitude and tell them how much you’ve enjoyed working with them (hopefully you have!)

Give a brief description of what you will be doing next time – looking at the different pieces of paper and seeing how well the cress seeds have grown on each one, before drawing some graphs to display their results.

## SESSION 2

### Introduction

1. Greet the students and congratulate them on how well they worked last time. Give a brief reminder of what they did last time (see slides 1 – 3; there are separate slides for the small trays and Gratnell trays, depending on which ones were used) and an overview of what they’ll be doing today – looking at what has happened to the different seed sets and using bar charts to present their results. They’ll really be looking forward to seeing what’s happened to their seeds!
2. Pupils first begin to use bar charts in Year 3, so should not have too many difficulties producing them. Do tell them about the importance of using graphs to make the results of your experiments clearer to understand – pictures are easier than tables of numbers!

### Results and Graphs

1. Collect the trays. The adults should do this to prevent overcrowding and jostling. Students’ names should be on a Post-It or sticker on the top tray / inside the Gratnell tray.
2. Ask the group to predict what has happened – which set of seeds will have grown most successfully? Again, this could be done via a show of hands.
3. By now, they will be desperate to see what’s happened! Remind them to be sensible when you place the tray down…there’s sure to be a lot of excited discussion. Allow them a little time for this before refocussing.
4. Students should compare their predictions to the results. The different pieces of filter paper can then be shared out – remind the students to be careful with these.
5. Students need to calculate the percentage of seeds that have not germinated. Slides 6 – 9 explain how in some detail; some students may need help here, but most should be confident with the calculation of percentages.

**Note: even if a seed has only split open a little bit, with a tiny bit of white root showing, they can count it as having germinated.**

1. Slides 10 – 12 show how to present results as a line graph. It is possible that a similar percentage of seeds will not have germinated for each salt concentration. This is a useful starting point for discussion with the class or small groups about how they can produce a graph which will show the results more clearly.

7. There are a series of questions about how and why scientists measure toxicity; you

may prefer to leave them for the time being. Alternatively, pupils who have progressed quickly could discuss these with you.

8. Each group member should select one or two pieces of filter paper, depending on the

number of pupils in each group. There are two results tables on each worksheet, in case pupils are taking measurements for two concentrations. Once they have measured the length of the roots and shoots for their concentration(s), they should calculate a mean. Slide 14 has a worked example of how to do this, including the need to write the final value to the nearest mm. Group members can then compare results and plot their second graph – see slide 15.

Keep an eye on how well the pupils are doing and help when needed – ideally, you want to avoid one group finishing well in advance of the others, but this could occur. Discuss the second graph with any groups / individuals who do finish quickly. They can then continue with the wordsearch or move onto one of the additional activities (see below).

## Conclusions

1. Students should describe the **pattern** shown on their graphs. Some may not be familiar with this term – slide 16 can be used to help.
2. Slides 17 – 19 feature an introduction to the idea of toxic chemicals. KS3 students should have encountered the safety symbol but may need to be reminded that ‘toxic’ does not mean ‘deadly’! They can then answer the two questions in the conclusion section of the worksheet.
3. Slides 20 and 21 can be used if you wish to discuss how scientists use measurements of toxicity to determine a LOAEL value.

**Finishing off**

Volunteers should collect in trays. Clingfilm, filter paper, seeds and shoots can be disposed of. If possible, give any damp trays a wipe to dry them off.

Ask pupils to complete the survey sheets about attitudes toward science; this could also be done during the additional activities below.

**Additional activities - Animal and plant cells**

1. Introduce the idea of cells (see slide 22). KS3 students (especially those in years 8 and 9) should be familiar with these and will also have studied different types of animal and plant cells. Slides 23 – 27 should serve as a reminder and show how microscopes can be used to view cells in more detail (see also 3(d) below). Depending on time, you can move straight on to the activities in 3 instead.
2. Briefly discuss how and why scientists use plants to investigate and predict the effects of chemicals on animals. At this stage, you can limit discussion to the idea that all living things are made of cells, which have similarities as well as differences. Students will already be aware that scientists can group living things according to these criteria – for example, the different classes of vertebrates and invertebrates.
3. Dependent on time remaining, there are several activities which pupils can attempt.
4. Show the models of plant and animal cells – groups of students can examine these and identify parts which appear in both.
5. Slide 27 features a hyperlink to a short (2.45 minute) video about plant and animal cells. This could be used in conjunction with (a) so that pupils can check their answers.
6. The ‘Plant and Animal Cells’ worksheet asks students to identify each type of cell and label the various parts. Answers are on slides 28 - 30.

The ‘Plant Cell Functions’ sheet has explanations of the role of the different parts. This is for information only – it’s probably a little too early to ask pupils to study this in detail.

1. The hyperlink on slide 31 takes you to a BBC Bitesize page about cells. There are various activities which can be presented to the class – the most suitable are the ‘Animal Cell Structure’ and ‘Plant Cell Structure’ ones (about halfway down the page).