Sponsored by AstraZeneca Science Teaching Trust.

SCIENCE ACTIVITY FIVE: TAKE YOUR MEDICINE

DO YOU NEED SO MANY DIFFERENT KINDS OF PILLS?

Students investigate the rate of dissolution of different tablets in water and dilute hydrochloric acid (stomach strength, pH 2).
They record and interpret their observations by answering questions.

DELIVERY

01 Introduction 5-15 minutes
02 Practical activity ~40 minutes
03 Plenary 10-15 minutes

It would be useful to give the school some information about yourself in advance of the session. You may be able to bring photographs, equipment or other means to illustrate your work. The session should help students to recognise that the science they do in school relates to science in the real world, scientists are real people, and that they could be scientists too.

Throughout the session, try to refer to your own personal experience as a scientist as much as possible.

Younger KS3 students may need more guidance and work more slowly. The time taken to complete the activity could be shortened by reducing the number of time intervals for testing the pills (say three or four tests at five minute intervals instead of five). Ensure that all available pill types are tested by assigning them around the groups. Class results can then be compared. Ask students to stop and clear up in order to allow sufficient time for the plenary discussion.

The students could also convert the number of drops of DCPIP decolourised to vitamin C concentrations. A procedure is provided which might be attempted by more experienced students or as a follow up to the main activity.

During the practical work you will be able to walk round and talk to students to gain an idea of what level you will need to adopt for the discussion and plenary.

01 INTRODUCTION

Introduce yourself as a professional scientist.

Explain, using examples from your own experience, that:

- Scientists collect data and make sense of it.
- They learn how things work through observation and experiment. They try to explain observations and test their explanations through experiments. When they have a good explanation they can use it to solve problems.

The task

Background info

You could use the following information, or you may have your own ideas that relate more directly to your own work and expertise.

Why do medicines come in so many different forms? You might like to ask the students for as many different ways as they can think of for taking medicine, or how many different kinds of 'pill' they can think of. The problem for pharmacists is to get the active ingredient in a medicine into your bloodstream and to where it's needed in the correct dose. Many are taken by mouth. Rates of disintegration, dissolution, absorption and distribution to the target cells and tissues need to be taken into account. That's how quickly the pills break up, dissolve, pass from the gut into the blood and travel to their site of action.

As medicines pass through the gut, the pH changes from very low and acid in the stomach to slightly alkaline or neutral in the intestine. So they have to be designed for this too.

Getting started

How can we use science to improve something to make it work better?

In this activity you are going to work as scientists to try to discover if vitamin C tablets really do what they 'say on the tin'.

Do we really need different ways for taking vitamin C (by mouth – 'orally')? Is one method better than the rest? Can you work as scientists to find out?

You will investigate how quickly different kinds of vitamin C get into solution, including looking into the effect of stomach acid.

Explain that they will compare different types of pill and the effect of acid. They will test how quickly vitamin C has dissolved by counting how many drops of DCPIP lose their colour in 1 cm^3 of vitamin C solution. Vitamin C reacts with the blue dye DCPIP (short for dichlorophenolindophenol), turning it colourless. You may want to check with the teacher if they would like the concept of reducing agent introduced.

You will collect data – working accurately and recording your observations as precisely as you can.

Explain to the students that they will be working in pairs and briefly run through the procedure, emphasising any safety precautions and pointing out any other important information. For example, they need to be organised and work carefully to get all the results they need in the time available.

You will need to make sense of your data – using your scientific knowledge to try to explain what has happened.

02 PRACTICAL ACTIVITY

What you will need

Discuss this with the teacher and/or technician at the school. Make sure that everything will be available on the day.

For each student

- Student Instruction Sheet (may be printed separately, or you may wish to modify this to suit your own circumstances)

For class use

- A selection of vitamin C tablets or capsules (e.g. 500 mg, 1000 mg or 1500 mg, standard or time release)
- Balances (to 0.1 g)
- Weighing boats

For each pair of students

- 100 cm^3 measuring cylinder
- 250 cm^3 beaker
- 0.1% and 0.01% DCPIP
- 0.1% HCl
- Deionised water
- Stop clock or timer
- Teat pipettes (or 5 cm3 graduated syringes)
- Test tubes
- Test tube rack

The DCPIP should be made up fresh. 1 cm^3 of 1% DCPIP (molecular weight 290) is decolourised by 0.00607 g of vitamin C (molecular weight 176).

The rate of dissolution of tablets and capsules may vary considerably. It is worth trialling in advance of the lesson and adjusting the concentration of the DCPIP, if necessary, to use reasonable numbers of drops of vitamin C solutions. If tablets are slow dissolving, a lower concentration of DCPIP (e.g. dilute 1 part to 4 parts water to give 0.2% or 1 part to 9 parts water for 0.1%) can be used.

Vitamin C formulations are obtainable from supermarkets or chemists.

Optional

- If the concentration of vitamin C is to be found, rapid dissolving powdered vitamin C (you could grind up tablets) will be needed.

Health and safety

All activities have been trialled and tested by 4science (www.4science.org.uk) and every reasonable effort made to ensure that the activities are safe when conducted as instructed.

However, a full risk assessment should be carried out before any practical work is undertaken. The supervising teacher should be able to advise on this and any local requirements, such as procedures recommended by Local Authorities or safety advisers used by the institution.

4science assume no responsibility for any damage or injury caused or sustained while carrying out these activities to the full extent permitted by law.

For this practical you may wish to discuss with the teacher issues such as the safe handling of glassware.

Students must be supervised at all times during practical work by a teacher (and/or responsible adult).

1% and 0.1% DCPIP (Low hazard)

0.1M HCl (Low hazard)

You may wish to seek more advice (for example, CLEAPSS Hazcards) on the use of DCPIP and hydrochloric acid.

03 PLENARY

What happened?

Exactly what happens depends on the type of pills investigated. However, students should be able to find a significant difference between the rate of dissolution of pills and powders. Time release pills should show a significantly slower rate than ordinary pills.

Explanations

If you have sufficient data, plot graphs of the changes in vitamin C concentration over time.

The concentration of the initial solution tested for powdered vitamin C is known, so the DCPIP solution can be standardised as the vitamin C concentration needed to decolourise 1 drop of 1% DCPIP and the vitamin C concentrations over time can be calculated. Some students will need help with this.

Would you say that there was a significant difference between the time taken for the powdered vitamin C to dissolve and the pills? Suggest an explanation for any differences you observed.

Powdered vitamin C should dissolve readily. The pills should take much longer. One factor is the difference in surface area in contact with the solvent. In pills there are other ingredients which can inhibit dissolution.

Did the acid have any effect on the rate at which vitamin C was released? What significance does this have in the body?

Any increase or decrease in rate will be significant because the pills are likely to spend a long time in the stomach, especially if the advice is to 'take with food'.

Was there any difference between ordinary pills and time release pills? Does this have any significance in the body?

Time release pills make it possible for the vitamin C to be taken up over a long period so the concentration in the blood is maintained but never gets very high. This is significant because excess vitamin C is excreted and it is not stored by the body.

Would you recommend any type of pill? Use your data to explain your answer.

The time release pills seem the best option for the reasons given above. The vitamin C is available over a long period. However, this might not be helpful if someone was very deficient. There could be a discussion of the need for vitamin pills over a balanced diet.

FOLLOW UP

If time did not permit (or it was not attempted), students could find the concentration of vitamin C required to decolourise one drop of DCPIP, calculate vitamin C concentrations and plot graphs to compare pills.

Students could be asked to research and report on vitamin C, its sources and uses in the body.

Other 'pills' (for example, iron tablets) could be investigated using suitable chemical tests.

>> CURRICULUM LINKS

There is an opportunity for curriculum links to be made. You may like to discuss with the supervising teacher whether they would like specific examples to be used or any issues to be raised.

KS3 Science: Programme of Study for Key Stage 3

Key concepts

a. using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.

b. critically analysing and evaluating evidence from observations and experiments.

1.2 Applications and implications of science

a. exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.

Key processes

2.1 Practical and enquiry skills

a. use a range of scientific methods and techniques to develop and test ideas and explanations.

b. assess risk and work safely in the laboratory, field and workplace.

c. plan and carry out practical and investigative activities, both individually and in groups.

2.2 Critical understanding of evidence

a. obtain, record and analyse data from a wide range of primary and secondary sources, including ICT sources, and use their findings to provide evidence for scientific explanations.

b. evaluate scientific evidence and working methods.

2.3 Communication

a. use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.

Range and content

3.2 Chemical and material behaviour

a. the particle model provides explanations for the different physical properties and behaviour of matter.

b. elements consist of atoms that combine together in chemical reactions to form compounds.

c. elements and compounds show characteristic chemical properties and patterns in their behaviour.

3.3 Organisms, behaviour and health

a. life processes are supported by the organisation of cells into tissues, organs and body systems.

Curriculum opportunities

a. research, experiment, discuss and develop arguments.

b. pursue an independent enquiry into an aspect of science of personal interest.

c. use real-life examples as a basis for finding out about science.

e. experience science outside the school environment, including in the workplace, where possible.

f. use creativity and innovation in science, and appreciate their importance in enterprise.

i. prepare to specialise in a range of science subjects at key stage 4 and consider career opportunities both within science and in other areas that are provided by science qualifications.

k. make links between science and other subjects and areas of the curriculum.

>> CHECKLIST

You will need to liaise closely with the teacher.

Have you checked:

- that all the necessary materials and resources, including worksheets, will be available?
- the meeting arrangements at the school (for example: time, place, people's names, contact numbers, parking)?
- the length of the session?
- that risk assessments have been made and any appropriate safety measures are in place?
- how your experiences as a working scientist can be related to the activity?
- if and how any curriculum links should be made to the activity (this might also be related to your experience if you have provided the school with information about your work and interests)?
- what kind of follow up (if any) would be useful?

TAKE YOUR MEDICINE

Do you need so many different kinds of pills?

A. TESTING VITAMIN C CONCENTRATION AS A PILL DISSOLVES

WHAT YOU NEED TO DO

Work with a partner to test how quickly vitamin C is released from different types of pill and test the effect of an acid solution.

1. Measure 50 cm^3 of deionised water into a beaker and 50 cm^3 of dilute hydrochloric acid into a second beaker. The dilute hydrochloric acid has pH 2, the same as is normally found in the stomach. *Note: One person should carry out tests using the water and the other one using the acid.*

2. There are different types of vitamin C pills. You will be given some of a particular type. Add one pill to each beaker, start a stop clock and stir gently.

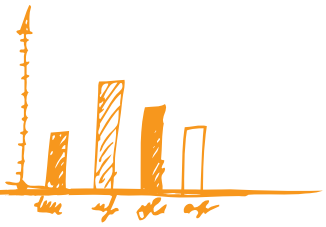
3. After 5 minutes take 1 cm^3 of the vitamin C solution from your beaker and put it into to a test tube.

4. Add one drop of blue 1% DCPIP solution to the vitamin C solution in the test tube. Shake very gently. If the solution is acid, the blue colour will become pink. If vitamin C is present, the colour should disappear.

5. Continue to add DCPIP one drop at a time. Shake the tube very gently to mix after each drop is added, until the colour does not disappear. Count the total number of drops of DCPIP added and record in the data table (see *Results and questions*). *Note: If the first drop of DCPIP is not decolourised, use 0.1% DCPIP instead.*

6. Take 1 cm^3 samples every 5 minutes for 25 minutes and repeat the test on them. *Note: If the same number of drops of DCPIP are needed for two samples in a row, there is no need to test further samples.*

RESULTS AND QUESTIONS



DATA TABLE		
Type of pill:		
Time / minutes	**Drops of DCPIP decolourised**	
	In water	**In acid**
5		
10		
15		
20		
25		

1. Did the acid have any effect on the speed at which vitamin C was released? Why might this be important in the body?

2. Was there any difference between the different kinds of pills tested? Is this important in the body?

3. Would you recommend any type of pill? Use your data to explain your answer.

4. If you have some graph paper (and know how to), plot graphs showing the changes in vitamin C concentration over time.

B. FINDING HOW MUCH DCPIP IS DECOLOURISED BY VITAMIN C

WHAT YOU NEED TO DO

Follow the procedure and convert the number of drops of DCPIP decolourised to vitamin C concentrations.

1. Measure 100 cm^3 of deionised water into a beaker.

2. Weigh out 1 g of powdered vitamin C.

3. Add the vitamin C to the water and stir until it dissolves completely.

4. Take 1 cm^3 of the vitamin C solution and put it in a test tube.

5. Add one drop of blue 1% DCPIP solution (or 0.1% if used in test) to the vitamin C in the test tube. The colour should disappear.

6. Continue to add DCPIP one drop at a time, shaking the tube very gently to mix, until the colour does not disappear. Count the number of drops of DCPIP added and record in Data table A (below).

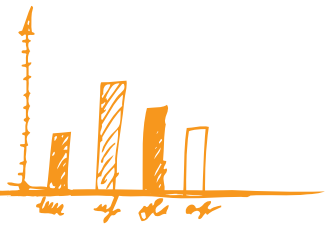
7. Test a second sample of the vitamin C solution and record the average number of drops of DCPIP used. If your results are not consistent, test a third sample. Record the average number of drops for the two closest results in Data table A.

8 Calculate the concentration of the vitamin C you used and add this to the table.

9 You now know how much vitamin C was used in the test tube to decolourise the DCPIP drops. How much is this per drop? Write this in the table.

10 You can now calculate vitamin C concentrations for your dissolving pills. Use Data table B (below). Multiply by the vitamin C needed to decolourise each drop of DCPIP.

RESULTS AND QUESTIONS



DATA TABLE A				
Number of drops of DCPIP used				average
Concentration of vitamin C				per cm^3
Vitamin C to decolourise 1 drop of 1% (or 0.1%) DCPIP				grams

DATA TABLE B				
Type of pill:				
	In water		**In acid**	
Time / minutes	**Drops of DCPIP decolourised**	**Vitamin C concentration /g**	**Drops of DCPIP decolourised**	**Vitamin C concentration /g**
5				
10				
15				
20				
25				