# MEDICINES FOR PETS

## A science investigation pack for teachers of 9-11 year olds

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

# Contents

# Introduction

## AGE RANGE

The activities in this book provide opportunities for children in key stage two to develop their knowledge and understanding of properties and uses of materials through a series of practical investigative activities that develop a progression of enquiry skills involved in working scientifically. It will develop their understanding of science and how it applies to life outside the classroom, making strong links between the science curriculum and research and development processes involved in the pharmaceutical industry.

## CONTEXT

The activities use the pharmaceutical industry as a real life context, and in particular the development of a new medicine for pets. We have chosen a dog because it is a common family pet that most children are familiar with. The procedures referred to would apply to the development of medicines for all types of pet.

The context relates to the challenges faced by research scientists in the pharmaceutical industry, the research and development in the 'lifecycle of a medicine', and industrial processes involved in manufacturing medicines. Specifically these are:

- extraction and purification of the active ingredient
- formulation of a tablet
- testing the best shape
- development of a suitable coating for the tablet

The key ideas developed in this unit are *Properties and Uses of Materials, States of Matter and Working Scientifically.*

## ACTIVITIES

Each activity will take 1-2 hours to complete, with ideas for extending the activities for more able or older pupils. The activities should be completed in the order given as they offer progression in the investigative process leading from identification of a problem to a solution.

It is advised that children work in mixed ability groups of four. Some sessions (particularly activities 3 and 5) would benefit from additional adult support such as teaching assistants or parent helpers.

The activity sheets provide an initial stimulus and help guide children through the investigation process; planning, recording ideas, observations and measurements, and drawing conclusions. By providing a suitable framework, this should improve children's understanding of all that is involved in the investigation process, as well as increasing children's enjoyment of science by solving real life problems. They are also intended to support differentiated teaching and can be adapted to suit your needs.

## ACTIVITY SUMMARY

| Title | Description | Timing |
|---|---|---|
| **1 The lifecycle of a pet medicine** | This activity introduces the industrial context by exploring the manufacture of pet medicine. | 1-1 ½ hours |
| **2 Extracting the active ingredient** | The children face the challenge of purifying crystals of salt using dissolving and evaporating techniques. | 1 ½ hours |
| **3 Mixing the medicine** | The focus of the session is tablet production. Children grind the active ingredient and combine it with others, before moulding into a range of tablet shapes. | 1 hour |
| **4 Testing the tablet shape** | The children investigate the effects of a range of tablet shapes on 'swallowing'. | 1 hour |
| **5 Creating a coating** | The final activity looks at planning and carrying out a fair test to delay dissolving in the mouth. | 1 hour |

# Resource requirements

Quantities are given per group of 4 children unless otherwise stated.

## ACTIVITY 1

- Activity sheets 1-4 (Sheets 1 and 4 need to each be made into a set of cards; Activity sheet 3 enlarged to A3 or copied on to flipchart paper)
- One soft toy dog or photograph of a dog
- Scissors
- Glue stick

## ACTIVITY 2

- Activity sheets 5-8
- Hand lenses
- Petri dish (or similar shallow dish) Powder samples
- Filter paper
- Funnel
- 2 Beakers or yoghurt pots Teaspoon or stirrer
- Water (200 ml approx.)
- Tall collecting vessel Disposable/protective gloves Digital camera (optional)
- Digital microscope (optional)

## ACTIVITY 3

- Activity sheets 6 and 9
- Crystals from Activity 2
- Teaspoon (optional use of pipettes for measuring the water) 3 heaped tablespoons of plaster of Paris
- Water (200 ml approx.)
- Modelling clay (enough to make three marble sized moulds) Marble
- Multilink cube
- Clay tools
- Disposable/protective gloves
- Freezer bag (or similar)
- Beaker or yogurt pot
- Rolling pin
- Digital camera (optional)

## ACTIVITY 4

- **Approach 1**
- Activity sheet 10
- Stop watch
- 250 ml measuring cylinder or
- 1 litre pop bottle
- Jug or 1 litre pop bottle
- Water or cellulose paste

**Approach 2**

- 50 cm x 15 mm diameter plastic tubing (just wide enough for plaster tablets to pass through)
- Funnel (to fit in tubing)
- Cup or beaker
- Water

- **Both approaches**
- Plaster shapes from Activity 3 (or modelling clay to form new tablets)
- Clay tools
- Sand paper
- Range of sweets and tablets
- Range of sweet and tablet packaging types

## ACTIVITY 5

- Activity sheet 11
- 5 Alka-Seltzer© tablets
- Vegetable oil (approx. 50 ml)
- Chocolate button
- Sugar coated chocolate button
- Disposable/protective gloves
- 1 teaspoon of three of the following materials: icing sugar, PVA glue, honey, flour, sugar syrup, poster paint.

# 1. The lifecycle of a pet medicine

1-1 ½ hours

This activity introduces the industrial context by exploring the manufacture of pet medicine from the problem to production of the final product.

## OBJECTIVES

- Asking relevant questions and using different types of scientific enquiries to answer them
- Using straightforward scientific evidence to answer questions or to support their findings
- To understand the uses and implications of science, today and for the future

## RESOURCES

(Per group of 4 children, unless otherwise stated)

- Activity sheets 1-4 (Sheets 1 and 4 need to each be made into a set of cards; Activity sheet 3 enlarged to A3 or copied on to flipchart paper, sheet 2)
- One soft toy dog[1] or photograph of a dog
- Scissors
- Glue stick

## INTRODUCING THE ACTIVITY

Show the children a soft toy dog, or show a photograph of a dog as a stimulus, and ask which children have pet dogs. Explain that this dog is not feeling very well.

Ask the children to discuss in groups their own experiences of having an ill pet. Ask what they would do, including where they would take it and what would happen next. You may give them the following questions as discussion prompts.

- *What could a vet do to help?*
- *How would the vet find out what is the matter with the pet?*

The vet would ask the owner questions to identify the pet's symptoms. The owners would answer questions on behalf of their pet having observed their pet for abnormalities and unusual behaviour.

- *What sort of things may the owner have noticed, that will help the vet to work out what is wrong?*

The owner would look for any marks, lumps, loss of fur, cuts, sores or changes in behaviour. This may include loss of appetite, being sick, changes in their toilet habits, withdrawn or aggressive behaviour etc. The vet would then consider the symptoms, use them to find out what the illness is and prescribe the right medicine to cure the illness.

1 If you have Discovery Dog or Naughty Nora in school, you may wish to use one of them. Visit www.millgatehouse.co.uk or www.lancsngfl.ac.uk for further information.

## MAIN ACTIVITY

In each group, one child takes on the role of a vet and 3 others are pet owners. The groups' discussions could be initiated by one sample role- play in front of the whole class. Cut out and distribute the cards (Activity sheet 1) among the 'pet owners'. The 'vets' have a copy of the branching key (Activity sheet 2). The pet owners then describe their pet's signs of illness to the vets. The vets then use the information with the key to identify the illness. Discuss the outcomes of this task with the class.

Read the final information on Activity sheet 2 to explain what happens if the medicine does not work well. Appendix 1 has detailed information.

## PLENARY

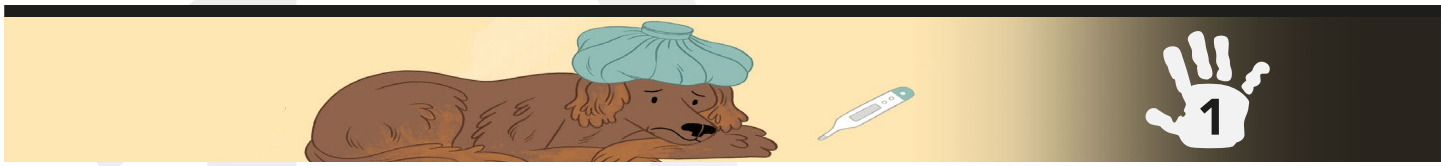
Explain that the children will now take on the role of scientists in a medicine company who are researching a more effective medicine for the dog's illness.

Use the enlarged version of Activity sheet 3 and the cards from Activity sheet 4 to explain to the class that they are going to model the development cycle of a new pet medicine. Talk through the process, and read each card out to the class in turn. The children then decide where to place or stick each card on the sheet.

The importance of scientists in all aspects of this process should be emphasised wherever possible. Key questions to aid this discussion are:

- *What do you think 'active ingredient' means?*
- *Why do scientists need to do lots of tests on the medicine before it is finally made?*
- *What different tests do you think scientists need to do?*
- *Why do you think different medicines are made in different forms, e.g. tablet, liquid, spray, etc.?*

# Activity Sheet 1: Pet 'signs of illness' cards



1) Your dog is very hot and tired and looks sad. It may look thin and does not want to eat. It has pale gums.

2) Your dog is coughing, wheezing and breathing fast.

3) Your dog has a runny nose and weepy eyes. It does not want to eat. It is very hot, coughs a lot and sometimes wheezes.

4) Your dog goes to the toilet a lot, it drinks and eats more than normal, but is getting thinner.

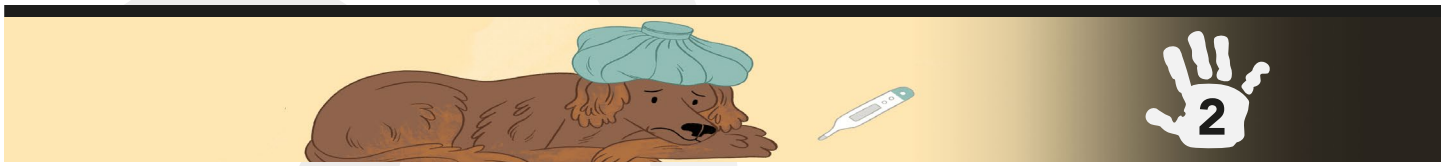
5) Your dog scratches itself a lot and has little black dots in its fur.

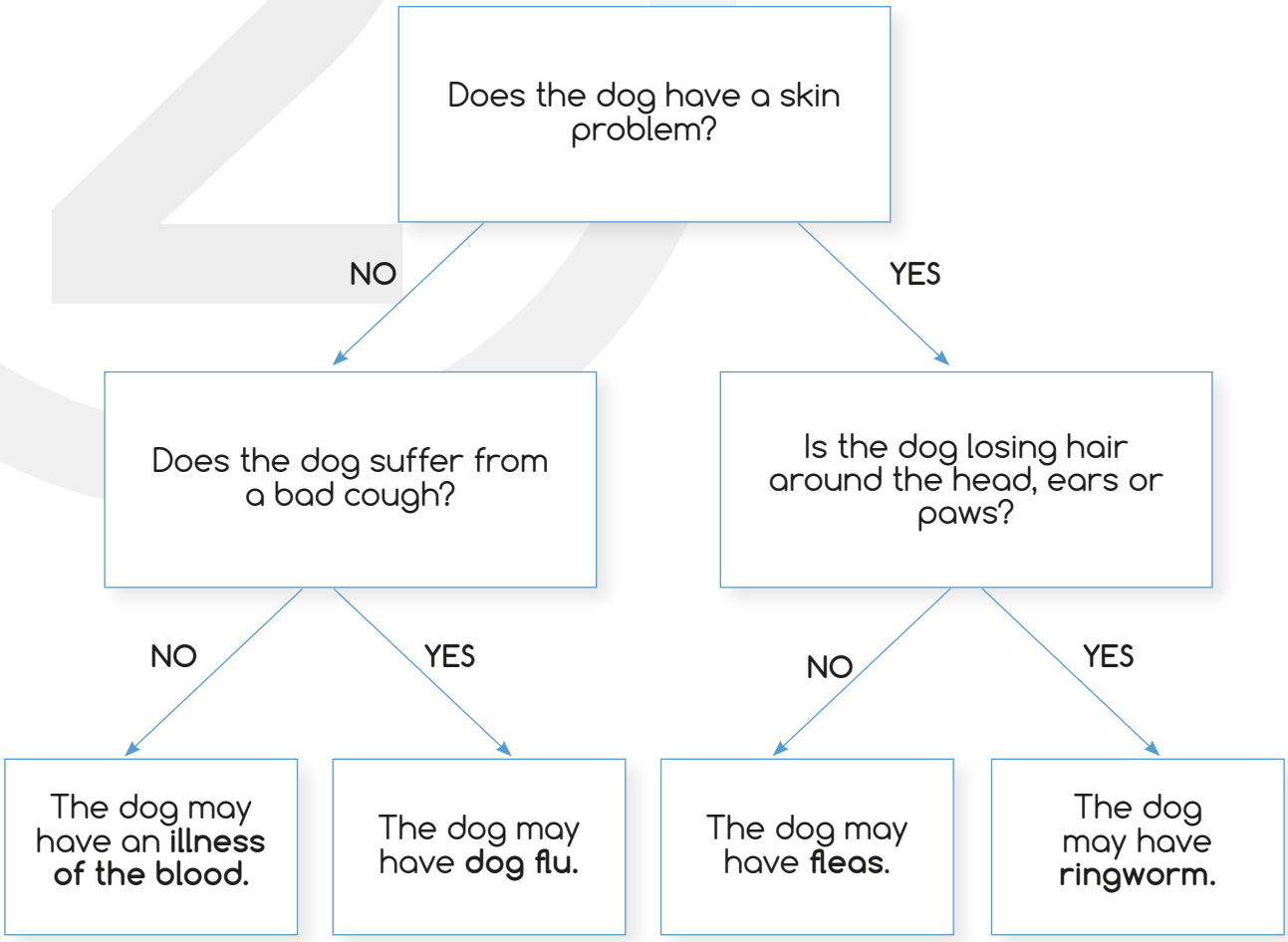
6) Your dog is seven years old or more, is eating a lot but is still losing weight.

7) Your dog has round marks on its skin. It has lost some of its hair on its head, ears and paws.

8) Your dog is not eating much and is losing weight. It is very hot and has patchy red skin.

# Activity Sheet 2: Dog diagnosis branching key

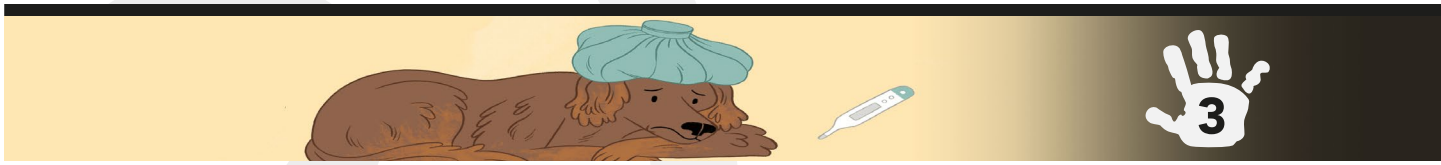





When they have discovered the illness, the vet will then suggest a medicine to cure it. Many diseases can be prevented by medicines before a dog gets sick. If there is not a medicine to prevent a disease, or if the medicines do not seem to work well, then the vet may telephone a medicine company to explain the problem.

If enough vets telephone the medicine companies with the same problems, they may try to make a better medicine or create a new one.

# Activity Sheet 3: The lifecycle of a pet medicine



1. Problem.

2. Test other medicines.

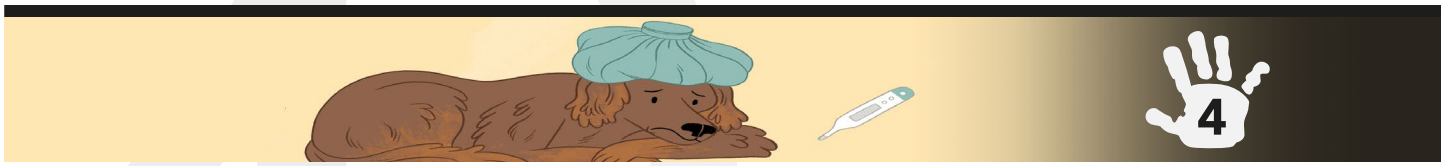
3. Make a new medicine and work out the best amounts to give and the way to give it.

4. Decide the best way to give the medicine.

5. Pilot test and get permission from the government's expert scientists to make the medicine.

6. Make large amounts of the final medicine recipe to sell.

# Activity Sheet 4




**Cut these out and stick them on the chart in the boxes you think they belong to.**

There is no medicine to treat or stop a disease, or the medicine is not working well enough. The vet contacts a medicine company.

The company decides whether to make a tablet, spray, liquid medicine or injection. The 'active' ingredient is mixed with other ingredients to make the new medicine.

The new medicine is tested to find out how well it cures the animal's illness. Permission is given by government scientists to make and sell the medicine.

The medicine is made, packaged, advertised and sold to vets around the country.

The medicine company tests other medicines that cure similar illnesses. They need to find out which active ingredient works the best.

A new medicine is made using the best active ingredient found. The scientists then test how much to give to the animal, and the best way to give it.

# 2. Extracting the active ingredient

1 ½ hours

The children face the challenge of separating crystals of salt from waste materials using dissolving and evaporating techniques.

## OBJECTIVES

- To separate soluble and insoluble materials by dissolving and filtering.
- To know that you can recover a solid from a solution by evaporating water.
- To select suitable equipment for the task from a range of options.

## RESOURCES

(Per group of 2-4 children, unless otherwise stated)

- Activity sheets 5-8
- Hand lenses
- Petri dish (or similar shallow dish)
- Powder samples[1]
- Filter paper
- Funnel
- 2 Beakers or yoghurt pots
- Teaspoon or stirrer
- Water (200 ml approx.)
- Tall collecting vessel
- Disposable/protective gloves
- Digital camera (optional)
- Digital microscope (optional)

## INTRODUCING THE ACTIVITY

Read the letter from Pets Paws plc, a company developing a new pet medicine (Activity sheet 5). It explains that the company have identified the active ingredient and have provided a sample in an impure form. The children's task is to separate the active ingredient from the mixture.

1 Mix 3 heaped tablespoons of dry, soluble material (e.g. Epsom salts, table salt) with 3 heaped tablespoons of dry, insoluble material (e.g. chalk dust, sand).

Ask the children if there are any words that they would like help with. Gather the children's ideas for words and phrases such as:

- Laboratory
- Active ingredient
- Crystal
- Waste material
- Separate

Display these words and include the children's definitions.

Provide pairs or groups of 4 children with their powder samples. Children should wear protective gloves to carry out the 'finger test', a test often used in industry to compare the textures of different powders. Children rub the mixture between their fingers to feel the texture.

Using hand lenses or a digital microscope, children observe the mixture. Digital images can be displayed on an interactive white board. The children can then draw and label what they observe (texture, colour, particle size and shape etc). The children could take digital images of the dry mixture to compare with the pure substance at the end of the process in Activity 3, *Mixing the medicine*. The children can record their observations at the top of Activity sheet 6 (the rest of this sheet is used in Activity 3).

Ask the children to discuss their observations and thoughts about the mixtures. You may list the following questions on the board as discussion prompts:

- How many different materials can you see?
- How do you know they are different?

There are at least two different types of particle in the mixture. Some are different colours. The bits are different sizes. Some bits are shiny and some are dull.

Describe the appearance of the active ingredient (shiny crystals - salt, or Epsom salts), but they are mixed with materials that they do not want (waste materials or impurities).

- How could you separate the crystals from the other waste materials?

Children should consider different methods to extract the active ingredient from the sample (such as sieve it, wash it with water, pick out the active ingredient with tweezers etc). They could use Activity sheet 7 to prompt their discussion, allowing them to make their own suggestions.

## MAIN ACTIVITY

Discuss different ideas and identify an extraction process or allow them to carry out the process they decide on from Activity sheet 7. More able children could plan their investigation independently.

Using the sample from *Pets Paws plc*, the children add water a teaspoon at a time and stir until all the white crystals have dissolved. The aim is to make a solution near to saturation to produce crystals quickly. To achieve this, the children can be asked to add *just enough* water for the crystals to dissolve, and no more.

Display the following discussion questions and ask the groups to feedback:

- What do you notice happens to the white crystals (active ingredient) when water is added?

They have dissolved which means that they have changed into tiny little pieces that are too small to see.

- What happens to the other material (sand or chalk) when water is added?

It has made the mixture 'cloudy' and eventually settles at the bottom of the container. It is insoluble and therefore will not dissolve in water; it does not break into tiny pieces.

- How do we know they haven't completely disappeared?

Discuss examples of where a dissolved material changes the colour of a solution, e.g. instant coffee granules, or brown sugar. The change of colour shows that the dissolved material is still in the solution.

Following subsequent evaporation of the water from the solution, the children will see that the crystals were there all the time.

- How can scientists tell if a substance is pure?

The ingredients for making medicines must be very pure. Even if they look pure, companies need to carry out tests on every batch that comes into the stores. The scientists use special equipment that shows them if there are any unwanted ingredients in the medicine.

The children can now separate the material that has not dissolved from the solution, using a filter paper that acts like a very fine sieve. You could show a filter paper under the digital microscope to show the holes.

Demonstrate how to fold a filter paper or paper towels into a cone (e.g. fold in half, then in half again, and open out one fold to make a conical shape). Ask the children to do it, place it in a funnel and put the funnel into a tall container, such as a measuring cylinder, to collect the filtrate (the 'stuff' left behind after the insoluble solid has been removed). Explain that the children should pour a small amount at a time of the mixture into the filter paper, as it drips through slowly. Otherwise, the insoluble material can run down the outside of the filter paper. Care must also be taken not to tear the paper, as the insoluble chalk or sand will go through the holes. Children should not touch the paper once it is wet.

When the children have a pure solution, ask questions like:

- Now we have filtered the solution, how can we get the active ingredient back?

By allowing the water to evaporate (turn into a vapour), leaving the crystals behind.

- What is evaporation? When does evaporation happen?

It is when a liquid changes state into a gas e.g. water changes to water vapour.

- Where does the water go?

Into the air around us.

- Where else can they think of examples of evaporation?

Puddles drying, drying towels or clothes on the washing line, tumble driers, the water cycle, out of the kettle as it heats up and boils.

Ask the children to pour a small amount of the solution into a Petri dish or shallow tray/dish and put in a cool place to evaporate the water very slowly (the slower the evaporation, the bigger the crystals, hence a cool rather than warm location). Using shallow, black plastic food trays will give the crystals a contrasting background to make them easier to see. You could choose to allow the children to investigate which conditions allow the biggest crystals to be formed.

Ensure that children label their experiments.

The crystals should have begun to form the next day, and all the water should evaporate after 2-3 days.

Encourage the children to observe the crystals formed using hand lenses and/or the digital microscope. They can compare the new crystals with those that were seen in the mixture. Copies of Activity sheet 8 can be shared with the class, which shows two types of salt crystals at a higher magnification than they might be able to see in the classroom.

## PLENARY

Ask children to report their findings to the company, describing the extraction process and their observations. This can be done by making a scrapbook of digital photographs taken during the sessions, which the children annotate. They can write the captions, comments, headings or speech bubbles to give further information. Provide key vocabulary (on classroom displays, word cards, class dictionaries, etc.) including mixture, dissolve, filter, evaporate. Ask the children to feedback to the class their ideas about the processes.

Explain to the children that the active ingredient is what helps the dog to get better. This can be found naturally as a mixture with other materials. The active ingredient must be extracted from the mixture before it can be used to make a tablet.

## EXTENSION

The questions below can be used to extend the work with more able children, or with Year 5-6 children in mixed classes:

- Why have we put the solution into a flat dish and not left it in the tall measuring cylinder?

Children can investigate the relationship between surface area and evaporation.

- How can we speed up or slow down evaporation (to get smaller or bigger crystals)?

By heating or cooling the solution. Explain that water changes into water vapour quicker the hotter it is, and that the quicker the water evaporates, the smaller the crystals that are formed. In industry, they will vary the temperature to form crystals of the sizes they require and will monitor and regulate it in order to produce uniform crystals.

**Pets Paws plc,**

Longclaw Industrial Estate,
Lower Steppinton,
LS11 8K9

Dear Scientists,

We at the laboratory of Pets Paws plc produce medicines for animals. We are making a new medicine and have found an active ingredient that we think can cure illness. It is similar to one that we already use but we hope that it will be better.

The active ingredient is in the form of crystals mixed with other materials. We have sent you a sample of this mixture and would like you to separate the active ingredient from the other materials, ready to put into the medicine.

We would then like you to follow our recipe so that each tablet contains the right amount of active ingredient. The tablets should also be a shape that a pet would swallow easily.

Please find enclosed some forms that we would like you to fill in to tell us the information you find out.

We thank you for any help you can give us and look forward to reading your report.

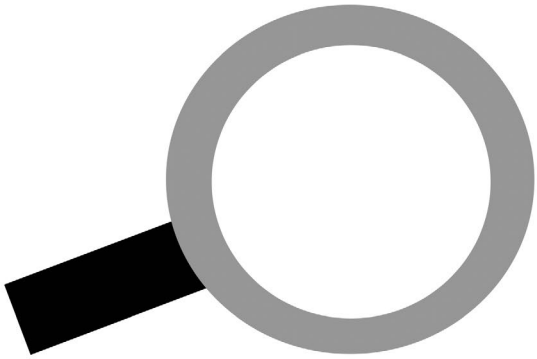
Yours sincerely,

*Dr Janette Smith*

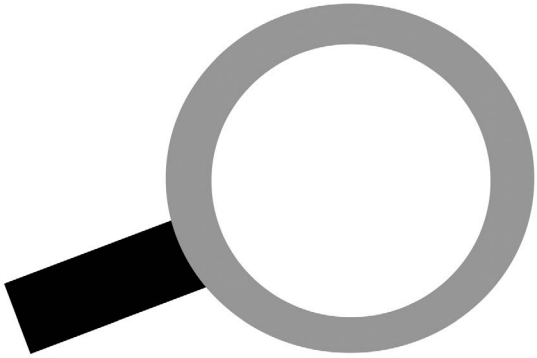
# Activity Sheet 6: Mixing the medicine

Look carefully at the crystals and draw what you see:

Salt crystals

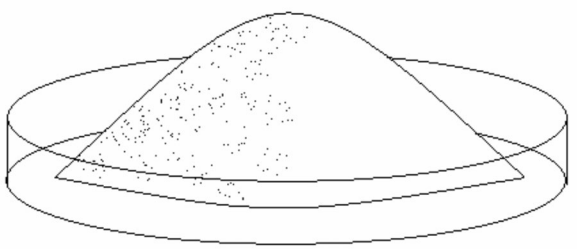


Active ingredient



# Activity Sheet 7: Separating the active ingredient

Look at the dry mixture with a hand lens or microscope. Draw what you see and write down words that describe the shapes, colours, sizes and feel of the bits.



The mixture contains two different materials. One dissolves in water, and one does not. How can you separate them? Talk to your group about which of these you might choose:

Pour the mixture through a sieve to collect the bigger bits.

Put the **mixture** in a sieve and pour cold water over it to wash away the **material** you don't want.

As you pour the **mixture** into another container, pick out the biggest bits with tweezers.

Put the **mixture** in **filter paper** and pour water over it. Leave the liquid to **evaporate** to leave the material you want.

Add water to the **mixture** and stir so that some of it **dissolves**. Pour the liquid through a **filter paper** into a dish. Leave it until the water **evaporates**, and the **active ingredient** will be left.

We would choose ...

Because ...

# 3. Mixing the medicine

1 ½ hours

The focus of the session is tablet production. Children grind the active ingredient and combine it with others, before moulding into a range of tablet shapes.

## OBJECTIVES

- Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible.
- Planning different types of scientific enquiries to answer questions.

## RESOURCES

(Per group of 3-4 children, unless otherwise stated)

- Activity sheets 6 and 9
- Crystals from Activity 2
- Teaspoon(optional use of pipettes for measuring the water)
- 3 heaped tablespoons of plaster of Paris
- Water (200 ml approx.)
- Modelling clay (enough to make three marble sized moulds) Marble
- Multi-link cube
- Clay tools
- Disposable/protective gloves
- Freezer bag (or similar)
- Beaker (or yogurt pot)
- Rolling pin
- Digital camera (optional)

## ADVANCED PREPARATION

You may wish to use groups of 3 children, so each child makes one shape. Alternatively, all children can make 3 shapes.

Time is needed to remove the crystals from the Petri dishes. This can be difficult for the children, and it may be preferable to ask a teaching assistant to do this prior to the lesson, or helping each group in turn to do so.

Teacher assistant support for this activity is useful. The plaster sets quickly, and some children may need adult help in spooning the mixture into the moulds.

Addition of a small quantity of PVA glue to the plaster of Paris mixture will prevent the finished tablets from being too crumbly.

## INTRODUCING THE ACTIVITY

Two key ideas are explored in this activity:

1. Only a small fraction of the tablet cures illness (the 'active ingredient').
2. Moulds are used to make tablets of different shapes and sizes.

Give the children their crystals from the last activity and Activity sheet 6. Ask children to record (drawing or digital images) their observations, ensuring that they record the shape, relative size, colour and texture of the crystals.

Using the images or drawings from Activity 2, ask children to compare how the ingredients have changed. These changes could include: bigger crystals, not all the same size, all white, no fine powder, etc.

Remind the children of the industrial story by re-reading the letter, Activity sheet 5, and asking the children questions such as:

- This is the active ingredient of the new medicine, would it be safe to give it to a sick dog now? Why do you think this?

No, because:

- Too little might not cure the dog, too much might be dangerous.
- The wrong dosage could poison the dog.
- It may have dangerous side effects.
- The best way to administer the medicine is not known.
- The number of doses needed and how long to administer the medicine for is not known.

Explain that the medicine company would then decide the best type of medicine to make e.g. a syrup, spray, tablet, injection etc. (refer back to section 4 of the life-cycle of a pet medicine, Activity sheets 3-4).

Tell the children that they are going to make a tablet. Read through the rest of Activity sheet 9 that explains that they will mix the active ingredients with other materials to make a tablet that is hard and holds together and is a suitable shape for the animals to swallow without discomfort. Explain that tablets contain the active ingredient and other ingredients to give flavour, colour and to bind it together.

## MAIN ACTIVITY

Tell the children that, before they make the tablets, they will need to find the best tablet shape. This must be an easy shape for a pet to swallow. The children can use multi-cubes, marbles, beads, fingers, etc to make impression in the modelling clay. If possible, the different shaped moulds should have a similar volume. This can be helped by giving the children similar sized lumps of modelling clay to use. Remind the children that they are trying to make the most suitable shape for a pet to swallow and not necessarily a novel shape. They can record their shapes on Activity sheet 6. These shapes will probably be much larger than the tablets used in real life.

Provide children with the recipe for making the final tablet (Activity sheet 9). Using a freezer bag and rolling pin the children follow instructions to powder the active ingredient so that it will bind to the excipient. Children can repeat the 'finger test' to check that the ingredient is consistently fine. They then mix with the given amount of plaster of Paris powder. (See Appendix 2 for information about how they create the shape in industry.)

Water is then added to the powder to give a smooth, yoghurt like consistency. This must be spooned carefully into the moulds making sure it is pushed into every corner. This needs to be done quickly before it begins to set.

## PLENARY

Explain to children that testing of the different shapes will be carried out in the next activity when the tablets have set.

Show a copy of 'The lifecycle of pet medicines' chart (Activity sheet 3) and ask the children to think about which part of the process they are working on (the formulation). Explain that it would be the job of the scientists in the medicine company to work out the best way to make the tablets.

# Activity Sheet 8: Photographs of Epsom and table salt


Table salt crystals (Magnification x30)

Epsom salt crystals (Magnification x28)

# Activity Sheet 9: Recipe to make three pet medicine tablets


| | |
|---|---|
| Brief: | To make a tablet that is easy for a dog to swallow |
| Ingredients: | • The active ingredient crystals you have separated<br>• Plaster of Paris (3 heaped teaspoonfuls)<br>• Water (up to 5 teaspoonfuls)<br>• PVA glue (1 teaspoonful dissolved in the water first) |
| Tools: | • Small freezer bag (or similar plastic bag)<br>• Rolling pin<br>• Beaker (or yogurt pot)<br>• 2 teaspoons<br>• Modelling clay moulds |
| Method: | 1. Put the crystals into plastic bag and crush with the rolling pin into a fine powder.<br>2. Put 1/4 teaspoonful of the powder in the beaker or yogurt pot.<br>3. Mix in 3 heaped teaspoonfuls of plaster of Paris.<br>4. Stir in water, one teaspoon at a time, until it is a thick, creamy paste.<br>5. Carefully spoon the mixture right to the top of the modelling clay moulds.<br>6. Seal the mould with a small piece of modelling clay, being careful not to change its shape.<br>7. Leave the plaster to set for 2-3 hours before carefully taking off the modelling clay mould.<br>8. You now have three shapes of pet medicine tablets to test. |

# 4. Testing the tablet shape

1 ½ hours

The children investigate the effects of a range of tablet shapes on 'swallowing' as they compare the speed at which different shapes travel through liquid.

## OBJECTIVES

- To identify the effects of air resistance, water resistance and friction, that act between moving surface.
- Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

## RESOURCES

(Per group of 4 children, unless otherwise stated)

**Approach 1**

- Activity sheet 10
- Stop watch
- 250 ml measuring cylinder or
- 1 litre pop bottle
- Jug or 1 litre pop bottle
- Water or cellulose paste

**Approach 2**

- 50 cm x 15 mm diameter plastic tubing (just wide enough for plaster tablets to pass through)
- Funnel (to fit in tubing)
- Cup or beaker
- Water

**Both approaches**

- Plaster shapes from Activity 3 (or modelling clay to form new tablets)
- Clay tools
- Sand paper
- Range of sweets and tablets
- Range of sweet and tablet packaging types

## INTRODUCING THE ACTIVITY

The tablets are carefully removed from the moulds. Unless children have designed 'lumpy' tablets, the children can smooth their tablets with clay tools and sand paper. This can lead to discussion of 'real' moulds. The design of machinery/ moulds for industry is a highly skilled job involving the use of computerised design packages and cutting tools.

Modelling clay can be used for this investigation, as an alternative to the plaster of Paris tablets.

Groups spend five minutes discussing the success of the tablet making exercise:

- *Are your tablets all perfect shapes?*
- *Are they all exactly the same size and shape?*
- *Are they hard or do they crumble?*
- *How could you improve the next batch that you make?*
- *What are the implications for making moulds for industrial production of tablets?*

The investigation is to discover which of the shapes that have been made would be the easiest for a dog to swallow, and the children can predict which would be the best for this. They could draw their predictions in order from the best to worst; discuss their reasoning with talk partners and then the rest of the class. They should be prompted to explain how and why they have made their decisions. For example, the sphere might be a good shape to swallow because it is rounded whereas the cube shape might be unpleasant to swallow due to corners and sharp edges.

Ask the class how they might test the shapes and discuss the advantages and disadvantages of their ideas.

The use of plaster or clay tablets and a representation of the throat can provide the context for discussing the difficulties companies face when trialling new medicines. Every effort is made to try things in the laboratory before animal testing is used. This investigation lends itself to a thorough evaluation by the children because they make comparisons between what they did and what it represented, in addition to commenting on how well they performed the investigation and what they would try to improve in future testing.

Two approaches are provided here, but the children may devise tests of their own that you wish to pursue.

**Safety note**

Emphasise to the children that they are not to actually put the tablet shapes in their mouths.

## MAIN ACTIVITY: APPROACH 1

The children observe and measure the time taken for different shaped tablets to reach the bottom of a measuring cylinder or pop bottle filled with liquid. This represents the journey the tablet takes when swallowed. Water can be used, but cellulose paste more closely replicates industrial practice, and also provides more accurate results.

Provide children with the equipment listed and ask them to decide which variables they would keep the same to make it a fair test, and add this information to Activity sheet 10.

The children test the shapes of the tablets by dropping them into the liquid and timing how long it takes to get to the bottom. Encourage children to practice this technique to ensure accurate measurement. (Please note: use of cellulose paste results in more accurate results, as it takes longer for the shapes to drop through this liquid. As the tablets fall through the water quickly, it is difficult to measure accurately. Because of this, cellulose paste is the preferred liquid to use in industrial tests.)

One child can use the stopwatch while another holds the tablet at the liquid's surface and counts down to ensure the drop and timing occur simultaneously. This affects the accuracy of their measurements.

They can retrieve the tablet by pouring the liquid into a jug or pop bottle, catching the tablet and re-filling the measuring cylinder/bottle to the same level to start again.

Discuss the fact that repeating the test makes the results more reliable. They can do this by taking three measurements, and selecting the middle one (median). Very able children can calculate the mean. The children can record their results on Activity sheet 10.

## MAIN ACTIVITY: APPROACH 2

Each group is provided with a length of tubing, which they can bend to represent the bend in the throat. They test the different shaped tablets to see which will pass through the tubing most easily. They need to work out a method that they will repeat for each shape, keeping the technique as constant as possible. This could involve 'washing' the tablet down the tube with a constant volume of water. The time for each tablet to pass through the tube can be recorded on a table similar to that provided on Activity sheet 10. The children should be encouraged to collect repeat results so that they have a sound indication of the reliability of their results.

## PLENARY

Discuss the success of the investigation with the children:

- *How much do you think that the tube, bottle or cylinder is like the throat?*
- *Was it easy to keep the test fair?*
- *Are the results that they have achieved reliable?*
- *If their results were not reliable, what prevented them from repeating results accurately?*

Can they show that for each shape the time was usually about the same, and that they got different times for the different shapes? The investigation may be more successful using tablets made from modelling clay as the size and shape can be more easily controlled.

The children would probably say that the tablet that travelled through the tube/cylinder most easily would be the best for the dog to swallow but do they think that the tube/bottle is a close enough model to the real thing? For example, the throat has a 'squeezing action' that moves the tablet along, which is very difficult to represent.

Ask the children for suggestions for the company to carry out a more reliable test. One possible suggestion would be to make the tablet shapes out of something harmless that the dogs could eat and ask pet owners to volunteer to give these to their pets for a period of time and report back their observations on how easily the pet swallowed each shape.

- *Which tablet shapes do you think are made in industry?*

They are usually a flat rounded shape. The dry ingredients are bound together with a moulded stamp that creates the shape as the ingredients are forced together.

- *Other than the tablet's shape, what else will industry need to think about when making dog tablets?*

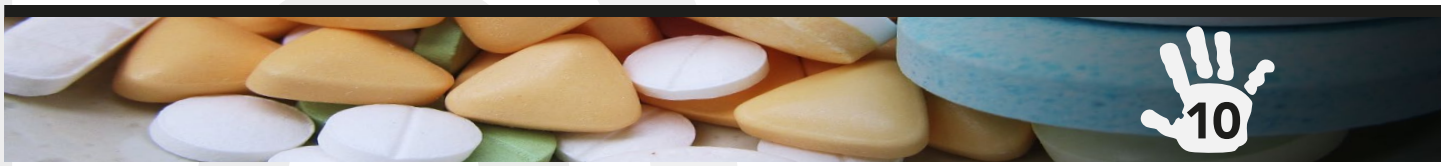
Pharmaceutical companies need to consider the flavour, fragrance, coating and packaging.

## SAFETY WITH MEDICINES

Show examples of sweets that look like tablets. Cut them, look at the coating, colour, etc. Ask the children how to tell the difference between sweets and tablets. Children may come up with responses such as smell, colour, hardness, etc. Explain that these are not fool proof and the only way to really know is from the packaging. Show children packaging of sweets and tablets and discuss the differences. The tablets have secure and distinctive packaging with dosage instructions. Emphasise the importance of knowing sweets should come from a sealed package. They have a right to choose to say no if offered 'sweets', as they should not eat anything that looks like sweets unless certain of their origin. Advise the children only to take tablets/medicines from adults who are responsible for them. This could lead to a circle time or role play activity.

1 Note: The Association of the British Pharmaceutical Industry produces two posters on 'safety with medicine', which are available free of charge from their website, www.abpi.org.uk

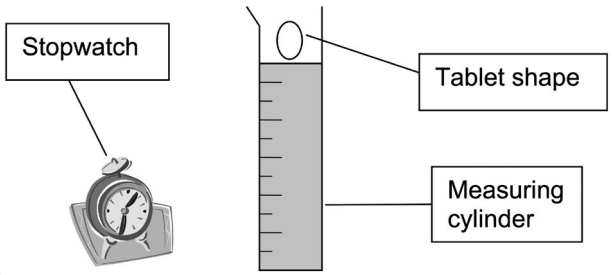
# Activity Sheet 10: Tablet shape investigation



## What would be the best tablet shape for a dog to swallow?

To find this we will measure how long it will take for each shape to reach the bottom of a large measuring cylinder filled with liquid.

We will need:




To keep the test fair, we will_____

_____

_____

## Results

| Shape | Time it takes | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | Average |
| | | | | |
| | | | | |
| | | | | |

## What we found out

Which was the best shape for a dog to swallow?

How do you know?

# 5. Creating a coating

1 ½ hours

The final activity looks at planning and carrying out a fair test to delay dissolving in the mouth.

## OBJECTIVES

- Demonstrate that dissolving, mixing and changes of state are reversible changes.
- planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

## RESOURCES

(Per group of 4 children, unless otherwise stated)

- Activity sheet 11
- 5 Alka-Seltzer© tablets
- Vegetable oil (approx. 50 ml)
- Chocolate button
- Sugar coated chocolate button
- Disposable/protective gloves
- 1 teaspoon of three of the following materials: icing sugar, PVA glue, honey, flour, sugar syrup, poster paint.

## INTRODUCING THE ACTIVITY

Show the class an urgent memo from a second medicine company department (Pets Paws plc) explaining that they have found a problem with the tablet (Activity sheet 11). After tests they have found that the tablets are fizzing in the dogs' mouths instead of in the dogs' stomachs. Drop an Alka-Seltzer© tablet into some water to show what happens, and ask the children to describe what they see; it fizzes as soon as it touches the water. Explain that the tablet is both dissolving and changing when it mixes with the water, and that a gas is made, which is the 'fizz'. (This change is irreversible, due to the nature of the chemical change and the production of carbon dioxide.)

The children discuss the problem and come up with suggestions of how to delay the fizzing of the tablet until it gets into a dog's stomach. A mind-map of their responses can be created.

Place a chocolate button in one hand and a sugar coated chocolate in the other. Ask the children which they think will melt first? Ask them what slows the melting of the sugar coated chocolate? Explain that it has a coating over the chocolate.

**Safety note**

Children should not eat the chocolate, but wash it off their hands on completion of the activity.

## MAIN ACTIVITY

Explain that the children are going to test different materials to find out which one would provide the most suitable coating to delay the fizzing until it reached the dog's stomach. Discuss the investigation question:

- *Which material would be best for coating the tablet to slow down the dissolving?*

Ask the class what variable they would change, e.g. coating, and how they would measure it (e.g. by timing how long it takes to start fizzing when placed in water). This could be done using Post-it planning, by those teachers familiar with this method. Examples are available on the CIEC web site.

Provide the children with three Alka-Seltzer© tablets, some vegetable oil and some materials for coatings, e.g. icing sugar, PVA glue, paint etc. Because many of these coatings are water based, the tablets need to be coated in vegetable oil first to provide a temporary coating and then quickly coated in the chosen material. Demonstrate first by dipping an Alka-Seltzer© in vegetable oil and then coating it by dipping in one of the other materials. The tablets should ideally be left overnight for the coatings to dry. Ask a child to start the stopwatch as soon as it touches the water and to stop as soon as it starts to fizz.

This activity can be fiddly for the children to carry out and may lead to different groups getting different results. It can be difficult to ensure that the tablet is completely covered in vegetable oil before you add the other coating. It is also difficult to create an even layer of each coating. The vegetable oil alone is not enough because it will rub off onto hands and the packaging. Once again coatings such as PVA glue and poster paint are used to discover the properties of a material that will be suitable. Obviously these could not be used because they are inedible. However, the investigation will give children an idea of the processes and difficulties involved in trialling different ideas in order to solve a problem and will provide plenty of scope for evaluation in the plenary.

The children plan and carry out a test to investigate the time it takes before the first fizz.

## PLENARY

Discuss findings and then report back to the company (by replying to the memo) regarding which coating works the best to delay the tablet from fizzing. Tell the children that tablets often have a sugar coating that stays intact until it reaches the stomach and helps the medicine to taste nice.

Ask the children to evaluate the investigation by highlighting the things that went well, what went badly and how they would improve it next time.

**From:** "Pets Paws plc Testing division" <iswallow@petspawsplc.co.uk>
**To:** "Medicine research group" <mresearch@healthrp.org>
**Subject:** Problem with the tablet

Dear Scientists,

Thank you for your research. We have tested your ideas and they have been successful.

Our pilot tests have shown that the tablets have been fizzing in the dogs' mouths and dissolving before they get to their stomachs. Although no dogs have been harmed during the tests, this means that they haven't received the right amount of the active ingredient.

We would like you to suggest a good coating to put onto the tablet, to slow down the dissolving until it reaches the dog's stomach.

Thanks for your help. I look forward to hearing from you soon.

Dr Isla Swallow
Research Manager
Pets Paws plc- Testing Division
iswallow@petspawsplc.co.uk

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# Appendix 1: Further information for teachers about the industrial process

## LIFECYCLE OF A PET MEDICINE

Medicine companies go through formation and development when producing new medicines. Human medicines can take around 12 years, at costs of up to £550 million. This timescale and cost is less for pet medicines, but can take even longer for medicines for farm animals. This process is nicknamed the 'lifecycle of a medicine' and this is the first thing that the children consider in Activity 1 of the unit. The 'lifecycle of a medicine' involves the following processes: it starts with the problem of an animal disease or a situation where existing medicines have limited success. Then existing medicines are researched and tested and the effects analysed. From this, active ingredients are found and developed into a dosage. This may involve fermentation and the growth of microbes, or the active ingredient may be extracted from other materials. The correct dosage is developed and is then tested on animals. When the effects have been analysed, it moves onto the formulation process. Here, the form of the medicine is decided (e.g. syrup, tablet, patch, intravenous liquid, spray etc.) and developed as a pilot scale manufacture. It is then tested in quality control to ensure the right yield, purity etc. The final stage of the process is the full scale manufacturing of the medicine. This involves mass production, packaging, marketing and distributing.

## ANSWERS FOR ACTIVITY SHEET 3

**1. Problem**

There is no medicine to treat or stop a disease, or the medicine is not working well enough. The vet contacts a medicine company.

**2. Test other medicines**

The medicine company tests other medicines that cure similar illnesses. They need to find out which active ingredient works the best.

**3. Make new medicine and work out the best amount and way to give it.**

The best active ingredient is found and made. The scientists then test how much to give to the animal, and the best way to give it.

**4. Make the medicine**

The company decides whether to make a tablet, spray, liquid medicine or injection. The 'active' ingredient is mixed with other ingredients to make the new medicine.

**5. Pilot Testing**

The new medicine is tested to find out how well it cures the animal's illness. Permission is given by government scientists to make and sell the medicine.

**6. Make large amounts**

The medicine is made, packaged, advertised and sold to vets around the country.

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