

Cough Syrup

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

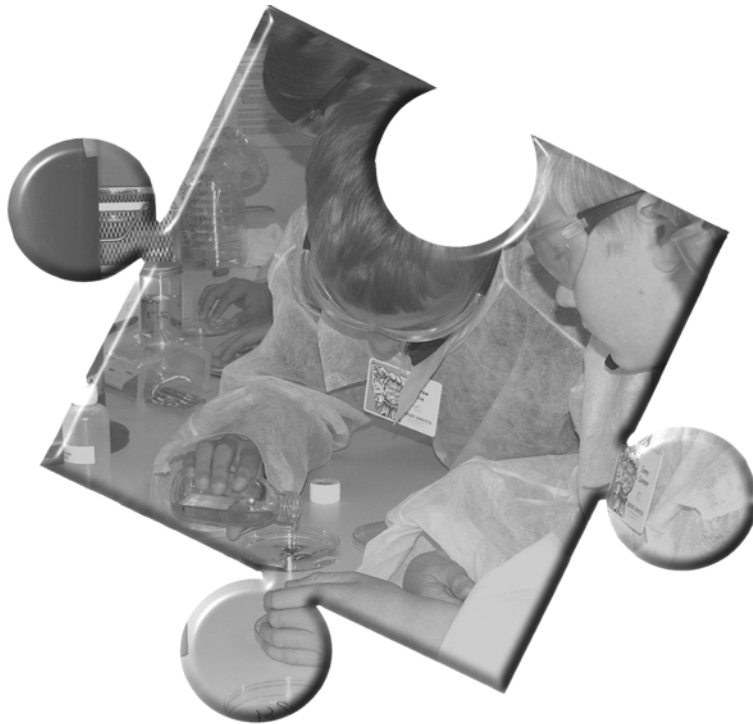


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**A science investigation pack for teachers of
9–11 year olds**



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Introduction

Age range

The activities in this book give upper Key Stage 2 children the opportunity to explore some of the processes that are followed by the pharmaceutical industry in the production of new medicines. The activities can be adapted to suit the needs of the children, staff and planning requirements of the school. They may also be modified for use in lower Key Stage 2.

Context

The activities are based on the development of a new cough syrup. Having discovered an active ingredient that will relieve the symptoms of a cough, a fictitious pharmaceutical company wishes to manufacture a syrup containing the new ingredient. The new ingredient is produced during the fermentation of a particular micro-organism. They contact the children and request that they carry out some further research and development on their behalf.

The children work to identify the best conditions for growing micro-organisms to produce the active ingredient, the most effective and efficient way to collect it and the ideal consistency for the syrup to be administered.

The children also need to consider economic factors involved in production and the commercial importance of effective branding for the new product.

Activities

The activities take approximately 5 hours to complete and can be covered in 3-4 half day sessions. They should be completed in the order given as they follow a process from initial research through development to production of the final product. Intermediate products resulting from the children's investigations are referred to in subsequent activities. However, each activity could be easily adapted as a stand alone lesson. Ideally, children should work in mixed ability groups of 4. As all of the activities involve the measuring of liquids, additional adults would support learning and skills development.

Activity Summary

	Title	Description	Page	Timing
1	Investigating food sources for microbes	<p>Children adopt the role of scientists working on behalf of a pharmaceutical company to develop a new cough syrup.</p> <p>They investigate a range of food sources for cultivating yeast. This information about growing conditions can then be used to grow a micro-organism for extraction of an active ingredient.</p>	7	1 hour 30 minutes
2	Investigating the effect of temperature on microbial growth	<p>Children investigate how the growth of a micro-organism is affected by temperature.</p>	12	1 hour 30 minutes
3	Filtration	<p>Having grown the yeast, children find the best method of separating the growth medium from the micro-organisms.</p> <p>The effectiveness of filters is investigated using a flour and water mix.</p>	17	1 – 2 hours
4	Viscosity testing	<p>Children investigate the effect of altering the ratios of specific ingredients on the viscosity of the resulting syrups.</p> <p>The aim is to find the best consistency of a cough medicine.</p>	20	1 hour 30 minutes

Curriculum links for England and Wales

The following **National Curriculum** areas are supported by this work:

Scientific Enquiry: Sc1	
1a	That science is about thinking creatively to try to explain how living and non-living things work, and to establish links between causes and effects.
1b	That it is important to test ideas using evidence from observation and measurement.
2a	Pupils should ask questions that can be investigated scientifically and decide how to find answers.
2b	Pupils should consider what sources of information, including first-hand experience and a range of other sources they will use to answer questions.
2c	Pupils should think about what might happen or try things out when deciding what to do, what kind of evidence to collect, and what equipment and materials to use.
2d	Pupils should make a fair test or comparison by changing one factor and observing or measuring the effect while keeping other factors the same.
2e	Pupils can use simple equipment and materials appropriately and take action to control risks.
2f	Pupils can make systematic observations and measurements, including the use of ICT for data-logging.
2g	Pupils can check observations and measurements by repeating them where appropriate.
2h	Pupils can use a wide range of methods, including diagrams, drawings, tables, bar charts, line graphs and ICT to communicate data in an appropriate and systematic manner.
2j	Pupils can use observations, measurements and other data to draw conclusions.
2l	Pupils can use their scientific knowledge and understanding to explain observations, measurements or other data or conclusions.
2m	Pupils can review their work and the work of others and describe its significance and limitations.

Life processes and living things: Sc2	
1a	Pupils should know that the life processes common to humans and other animals include nutrition, growth and reproduction.
5f	Pupils should know that micro-organisms are living organisms that are often too small to be seen, and that may be beneficial or harmful.

Materials and their properties: Sc3	
2a	Pupils can describe changes that occur when materials are mixed.
3c	Pupils know how to separate insoluble solids from liquids by filtering.

Design and Technology – Developing, planning and communicating ideas	
1a	Pupils should be taught to generate ideas for products after thinking about who will use them and what they will be used for, using information from a variety of sources.
1c	Pupils should be taught to plan what they have to do suggesting a sequence of actions and alternatives, if needed.

Curriculum links for Scotland

Science		
Investigating food sources for microbes	Living things Investigating	Variety and Characteristic features Preparing for tasks Carrying out tasks Reviewing and reporting on tasks
Investigating the effect of temperature on microbe growth	Living things Investigating	Variety and Characteristic features Preparing for tasks Carrying out tasks Reviewing and reporting on tasks
Filtration	Earth and Space Investigating	Changing materials Preparing for tasks Carrying out tasks Reviewing and reporting on tasks
Viscosity testing	Earth and Space Investigating	Changing materials Preparing for tasks Carrying out tasks Reviewing and reporting on tasks

Useful websites

www.abpischools.org.uk

www.psep.org

www.ase.org.uk

www.patienthealthinternational.com

www.kidshealth.org

www.ciec.org.uk

www.industryanimated.org

Resource Requirements

Quantities are given per group of 4 children, unless otherwise stated:

Activity 1

Activity sheets 1-2 (one per child)
4 sachets dried yeast
300 ml warm water (approx 50°C, i.e. in thermos flask)
5 ml sugar
5 ml salt
5 ml flour
5 ml lemon juice
4 small plastic drinks bottles
4 balloons **or** air-locks available from brewing outlets
100 ml measuring cylinders **or** suitably graded bottles
Measuring spoons or teaspoons
Blank sticky labels

Activity 2

Activity sheet 3 (one per child)
3 sachets dried active yeast
300 ml warm water (approx 50°C, can be stored in a thermos flask)
Cold, iced water
100g sugar
3 balloons
100 ml measuring cylinders **or** suitably graded bottles
3-4 small plastic pop bottles
1 litre jugs
3-4 plastic spoons
3-4 plastic containers
2-litre ice-cream tubs, or similar
Blank sticky labels
1 thermometer -10°C to 110°C

Activity 3

Activity sheet 4 (1 per child)
400 ml water
60 ml flour
Plastic jug or container
Transparent containers – marked at the 50 ml level
Measuring cylinders
Funnels
Spoons
Timer (stop clock)
Various of materials that could be used as a filter such as:
Filter paper
Paper towels
Cotton wool
Kitchen roll
Felt
Cotton
Tights

Activity 4

Activity sheet 5 (1 per child, optional)
50 ml liquid glucose (available from most supermarkets or pharmacists)
50 ml glycerine
50 ml water
20 ml measuring cylinder
Small containers
Plastic spoons or stirrers
Measuring spoons
Pipettes
Blank sticky labels

For the viscosity testing (depending on the test chosen)
3-4 marbles
1 plastic funnel
1 stop clock
1 30 cm length of dowel marked in centimetres
1 30 x 20 cm board (or other smooth surface)

Activity One: Investigating food sources for microbes

Learning objectives

- To identify factors in a controlled investigation and carry out a fair test by changing one factor and observing or measuring the effect while keeping other factors the same.
- To observe and record the results of an investigation and draw conclusions from the data recorded.
- To understand that micro-organisms are living things that are often too small to be seen individually and that they may be beneficial or harmful.
- To understand some of the processes used in biotechnology.

Approximate duration

1 hour 30 minutes

Preparing resources

(per group of 4 children unless otherwise stated)

Activity sheets 1-2 (one per child)
4 sachets dried yeast
300 ml warm water (approx 50°C, i.e. in thermos flask)
5 ml sugar
5 ml salt
5 ml flour
5 ml lemon juice
4 small plastic drinks bottles
4 balloons **or** air-locks available from brewing outlets
100 ml measuring cylinders **or** suitably graded bottles
Measuring spoons or teaspoons
Blank sticky labels

Advance preparation

Place sugar, salt, flour and lemon juice in separate labelled containers so that children can collect them easily when needed. Sugar and salt may be confused if care is not taken.

Provide water at about 50°C. By the time the children have measured and transferred the water it will have cooled to about 40-45°C. If thermometers are available the exact temperature can be recorded after the bottles are set up.

Balloons will inflate with the carbon dioxide produced. The production of gas can also be demonstrated by the bubble of air passing through the water in an air lock.

Introducing the topic



Basic advice about medicines not being taken unless prescribed should be given at this point.

Introduce the topic of medicine by asking the children to think about medicines they have taken. Ask for ideas about who makes medicines and what kinds of processes are important in developing new ones. How do the companies know that their medicines will help to make sick people well? Posters that introduce medicines in a child friendly format are available from the Association of the British Pharmaceutical Industry website, www.abpischools.org.uk. Appendix 1 provides background information about the pharmaceutical industry.

Give each group some real boxes that have contained medicine bottles. These can be obtained from pharmacies. Ensure the boxes are empty and contain **no trace** of medicine. Identify that

each medicine has an active ingredient. Explain that this is the substance that works on the cause of the illness to make the patient better. Many active ingredients are derived from plant sources. You could illustrate this by reminding children that dock leaves can be rubbed on nettle stings to ease the stinging. The substance that does this may be extracted from the dock leaves and could form the active ingredient in an ointment. Although many illnesses are caused by micro-organisms, some active ingredients are derived from others. Penicillin, an antibiotic, is an example of this, as it is produced by a type of mould. The story of Alexander Fleming could be introduced in literacy as a piece of non-fiction writing, to illustrate the work of scientists.

Introducing the activity

Read the letter from *Medivelop Ltd* (Activity sheet 1) and ask children for their initial thoughts and ideas.

Discuss with children the first requirement: finding the most effective method of producing the active ingredient. In an industrial setting, this would be the primary manufacturing stage.

A possible introduction to the investigation would be to smell freshly baked bread or a yeast extract jar and talk about the contribution that yeast has made to these products. In bread the fermentation produces a gas that makes the bread rise, and in yeast extract the yeast itself adds flavour. There are different types of yeast, just like there are different types of plants, and different types of yeast are used for different purposes. Other micro-organisms also produce useful by-products, e.g. dairy products.

Some micro-organisms produce substances that will kill other micro-organisms. If they can do this without harming the patient, they can be used in medicines. Many tests will be carried out throughout the development of a new medicine. From the very beginning safety is of greatest importance. In the first stages of this investigation we are going to use yeast because it is safe and easy to grow in the classroom and can be used to investigate optimum growth conditions.

Yeast is a one celled micro-organism that grows by reproducing itself and dividing into two. To grow, it needs the right conditions, the same as animals and plants do. Ask the children for suggestions as to what these may be: food, oxygen, water and warmth are needed, whereas light is not.

Organise the children into working groups of four. Their task is to find the conditions in which the yeast will be most productive.

The Post-It planning method can be used to plan both this and the next investigation – to establish a procedure for finding out (i) the effects of food type, and (ii) the effects of temperature, on the growth of yeast. The PSEP website has many examples

of how Post-It note planning can be used to collect all possible variables and select the right elements of control to answer the question. A subsidiary question can be:

- *How can the most yeast be grown in the shortest time?*

Show the children the resources that will be available and allow each group time to consider how the problem can be investigated. Ask each group to explain how they think the investigation might be carried out. This first investigation can be used as an opportunity to model how to conduct a fair test.

Here is one possible investigation, though children may suggest suitable variations to this:



Children should wash their hands carefully after handling the bottles of yeast.

- Label four identical containers or small pop bottles each with one of *sugar*, *salt*, *lemon juice* and *flour* and also the name of the group.
- Add the same quantity (by volume) of food to the bottles using a teaspoon or measuring spoon. A clean spoon must be used each time.
- Add 1 sachet or 1 heaped teaspoon of dried yeast to each bottle.
- Top up each with an equal volume of warm water to about $\frac{1}{3}$ full and place a balloon over the open neck of the bottle or add an airlock if used.
- Observe each of the mixtures and record initial observations. There should be frothing in the sugar mixture quite soon after setting up.
- Leave the bottles in a warm place where they can be easily observed. As the yeast feeds on the sugar and produces carbon dioxide, the children will observe the balloons inflating.

Note: Don't stress the importance of temperature at this point as children will investigate this next.

Balloons will inflate with the carbon dioxide produced. The production of gas can also be demonstrated by the bubble of air passing through the water in an air-lock.

The children should make observations every ten minutes and record their findings (using Activity sheet 2).

Encourage the children to observe the bottles carefully and record information about what is happening. This can be done by using digital cameras and sequencing the images or by drawing diagrams and adding accurate label descriptions.

Examples of children's recording are provided to illustrate the minimum amount of information that should be gathered.

The information recorded in Figure 1 is limited and does not provide evidence for what the child is claiming.

Figure 1

blown up	nothing happening?	Risen a bit	Growing
Sugar	Salt	Flour	Lemon Juice

After 10 minutes

Really big Now!	Nothing happening?	Growing a bit	Growing
Sugar	Salt	Flour	Lemon Juice

After 30 minutes

In Figure 2 more information is given specifically about the contents of the bottle and the balloon. These observations will provide evidence to support the conclusion made.

Figure 2

The Balloon on the bottle blew up. And is real frothy	The Salt has not changed.	The Flour is starting to get frothy.	The lemon Juices balloon is a Bit inflatable
Sugar	Salt	Flour	Lemon Juice

After 10 minutes

The Sugar froth is right at the top.	The Salt is the same	The Flour is the same too	The Balloon is quite blown up. its got quite a lot of froth.
Sugar	Salt	Flour	Lemon Juice

After 30 minutes

In between observations, children could begin to think of a marketing campaign for the new medicine. The samples of packaging, introduced on page 7, can be a starting point for this. Advertising a product needs careful wording to attract buyers, as well as safety messages and warnings.

- *How would the new cough syrup be packaged?*
- *What would be a good name for a new cough syrup?*

They should avoid existing brand names but could think about the kind of names used and how these portray a certain brand image. An opportunity exists here for links with design technology and literacy.

Each group should find that the solution containing the sugar caused the balloon to inflate most. There may be some partial inflation of the balloons from the solutions containing the flour and the lemon juice as these contain starch and sugar for the yeast to feed on but it will be noticeably less. The salt solution should not produce any inflation. Leave the solutions to settle so that the yeast forms a layer at the bottom. The yeast in sugar solution should have increased and so form a thicker layer. After approximately 30 minutes the children should look at the data they have collected and discuss what conclusions can be drawn from it.

Plenary

Ask each group to present their findings to the whole class. The following questions can be used to stimulate discussion, and to encourage the use of appropriate vocabulary:

- *Have all the balloons expanded?*
- *Have they all expanded to the same size?*
- *If not, what may account for the variation?*
- *What caused some of the balloons to inflate?*
- *What conclusions are the children able to draw from their investigation?*

Explain that, as yeast is a living micro-organism, it needs to feed. As it feeds on the sugar, it produces a gas called carbon dioxide. It is this gas that inflates the balloon. Flour will not harm the yeast but salt in the water would. This could be investigated by repeating the conditions for growth with sugar and salt in the same bottle.

Extension

The children have been told that the gas produced by yeast is carbon dioxide. Although they have no reason to doubt your word, can they think of any way to demonstrate this? This would be very challenging work and would depend on children having a high level of knowledge. One way may be to carefully pour the gas from the balloons over a tea light placed in a shallow container to extinguish the flame. Carbon dioxide being heavier than air will sink to the bottom of the container. This does not necessarily *prove* that the gas is carbon dioxide, and not some other heavier than air gas, but it reduces the possibilities and encourages creative thinking.

Further investigations could be carried out to explore the effect that using artificial sweetener in place of sugar would have.

Activity Two: Investigating the effect of temperature on microbial growth

Learning objectives

- Carry out a fair test by changing one factor and observing or measuring the effect while keeping other factors the same.
- Observe the results of an investigation and use the data to draw conclusions
- Ask questions that can be investigated scientifically and decide how to find answers.

Approximate duration

1 hour 30 minutes

Preparing resources

(per group of 4 children, unless otherwise stated)



60 °C is the maximum temperature for water used by primary aged children.

Activity sheet 3 (one per child)
3 sachets dried active yeast
300 ml warm water (approx 50°C, can be stored in a thermos flask)
Cold, iced water
100g sugar
3 balloons
100 ml measuring cylinders **or** suitably graded bottles
3-4 small plastic pop bottles
1 litre jugs
3-4 plastic spoons
3-4 plastic containers
2 x 2-litre ice-cream tubs, or similar
Blank sticky labels
1 thermometer -10°C to 110°C

Advance preparation

This investigation should be carried out using a range of water temperatures (at least 3) between 10°C and 50°C. Children can prepare different temperatures by mixing warm and cold water.

During the experiment, it will be possible to maintain the temperature of the water in each container for a longer period of time by sitting them in a larger container half filled with water. Put the warm bottles in a water bath at 55-60°C and the cool bottles in a water bath at 10°C cooled with ice. By doing this, the warm water will take longer to cool down, the cold water longer to heat up, and a more constant temperature will be maintained.

Introducing the activity

Introduce the session by discussing the findings of the previous lesson. Ask children to discuss in their groups the conclusions they reached.

- *Which type of food promotes the most yeast growth?*
- *How do we know this?*

Remind children that yeast is a living micro-organism that feeds, and that sugar is the best food source.

- *What else might have an impact on the amount of yeast growth?*
- *What other conditions may affect the growth rate?*
- *What else could we change that may affect growth?*

Use Post-It note planning to consider all of the variables. The investigation outlined here is to find the optimum temperature for maximum growth. Children may choose to investigate the best amount of food or volume of water to promote growth. Increasing the concentration of sugar will speed up growth provided that the solution is not too concentrated. Increasing the water volume will make little difference. Starting off with more yeast will establish growth more quickly.

Look back at the conditions for growth of living things. Encourage children to think about the temperature of the liquid in which the micro-organism is grown.

They need to find the conditions in which the yeast will be most productive. They have already investigated the effect of different foods, and they now need to find the best temperature for the growth medium.

Dried yeast becomes active when it is re-hydrated. If food is available, it will then grow. At a certain size each cell will split into two. The number of cells will double about every twenty minutes as long as there is food available and the temperature does not become too low or too high. The children need to find out which temperature is most effective for promoting growth.

Provide each group with the resources listed on page 12.

After looking at the equipment available, give each group time to discuss how they will carry out their investigation. Having been shown how to conduct an investigation in the first activity, allow flexibility of approach and let children make decisions about how the experiment will be undertaken. When the group is in agreement, and has explained how to proceed, the children should assemble their chosen equipment and begin.

Ask children to discuss how they will decide at which temperature the yeast is most active. Some may suggest repeating the use of balloons because they will have learned that more activity means more carbon dioxide. Some may suggest simple observation (photographs could be taken every ten minutes with a digital camera to keep a record of the data), and some may suggest measuring the height of the foam produced or the depth of the layer of yeast when the mixture settles. Give children the opportunity to use their own ideas as the effectiveness of the different methods can be discussed during the plenary.

Some groups may still need guidance and those children can be directed towards the following approach:

- Label three identical containers or small pop bottles with one each of *cold*, *room temperature*, *warm* and also the name of the group.

Note: labels should be placed as high up the bottle as possible if water baths are being used.

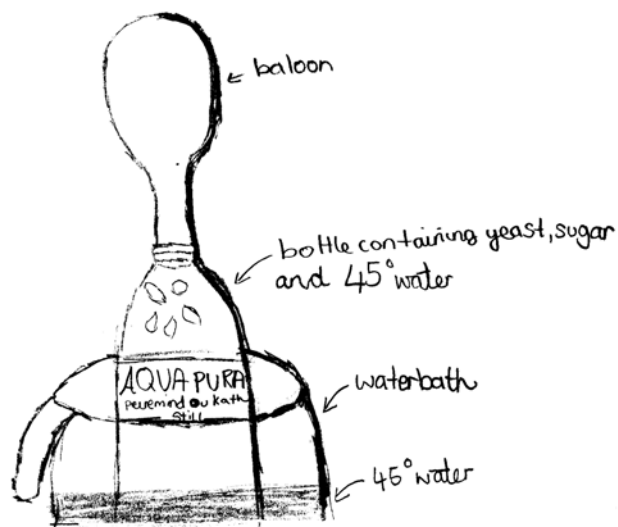
- Add equal quantities of sugar (about 2 teaspoons) to each bottle.
- Add equal quantities of yeast (1 sachet or heaped teaspoon).
- Prepare a range of water temperatures. Water baths may be needed to maintain the temperatures. Higher temperatures are more difficult to maintain.
- Top up the bottles to $\frac{1}{3}$ full with the same volume of each temperature of water.
- Place balloons over the open necks of the bottles and swirl to mix the contents thoroughly.

The children need to observe each of the mixtures and record their initial observations. They should make observations every ten minutes and record their findings using Activity sheet 3. Figures 3-5 below are examples of this recording.

Children may also wish to design their own tables for recording information.

In Figure 3 information is provided about the contents and temperature of the bottle as well as recording the resulting inflation of the balloon.

Figure 3



The diagrams produced will vary according to ability but accuracy is the important factor.

In Figure 4 there is a comparative representation of the carbon dioxide collected in the balloons but the information about the water is inaccurate stating the warmest water as 'boiling'. The temperature was in fact 47°C. There is a teaching point here about the use of standard measures.

Figure 4

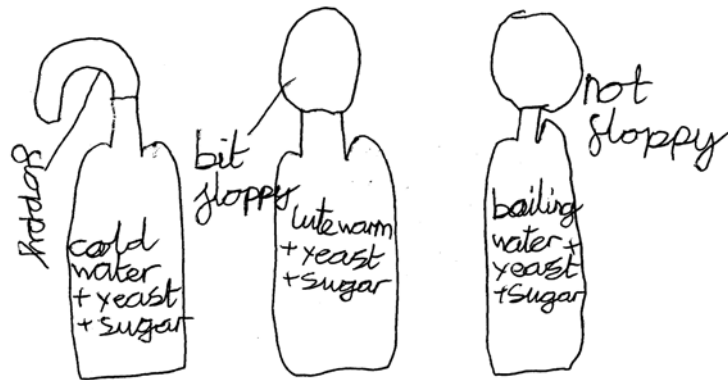


Figure 5 provides accurate information in the statements. This could be improved by adding a detailed labelled diagram as in Figure 3 and adding extra diagrams as in Figure 4.

Figure 5

Yeast Growth Recording Sheet - Water Temperature

How did the temperature of the water affect how well the yeast grew?

Write a statement to describe what you observed was the effect of water at different temperatures.

In the cold water temperature 18 °C The Balloon is slightly
inflatable but there isn't much froth
 In the water at room temperature 22 °C there's a little bit of
froth and the balloons just flat
 In the hot water temperature 45 °C warm has got a bit of froth
and the balloon has inflated, the froth is in the balloon
 In the very hot water temperature 55 °C The froth is nearly
to the top and the balloon is inflatable.

Each group should find that the yeast in the warm solution was more productive than the others. This indicates greater growth.

After approximately 30 minutes the children should look at the data they have collected and discuss what conclusions can be drawn from it.

Plenary

Ask each group to present their findings to the whole class.

- *What was the effect of temperature on the growth of the micro-organism?*

Encourage the use of appropriate vocabulary.

- *Why does an increase in temperature increase growth?*

Relate this to plants growing more quickly when it is warm but remind the children that plants also die when it is too hot.

- *What would happen if the water became too hot?*

There is a maximum temperature above which the yeast cells will die. It would not be possible for the higher temperatures to be maintained in classroom conditions. A demonstration could be set up using very hot water, 80+°C at a maintained temperature. It will require temperatures in excess of 100°C to kill all of the yeast cells but no growth will be observed.

If different groups used different methods of measuring and recording, did any methods have any advantages? Were some more accurate than others? If using a measurement that gave a numerical value such as measuring the height of foam produced, this could be used to produce a line graph.

Re-read the *Medivelop Ltd* letter. With the information they have gathered from their investigations into food source and temperature, children can begin to draft the first part of their report to *Medivelop Ltd* on the optimum conditions needed to produce the active ingredient required.

Extension

Simple airlocks of the type used in brewing could be attached to the bottles and a count of bubbles per minute could provide continuous data for graphing. Using this method to investigate what happens when the sugar concentration increases should produce a steady increase in growth rate until the solution becomes too concentrated.

Research how the effect of food sources and temperature on growing yeast is used in food production. For example, the need to keep bread dough at a certain temperature in order for it to rise or the fact that it does not continue to rise because the cooking temperature kills the yeast. When bread dough is mixed, a small amount of sugar is added to the yeast to start it growing. Make different types of bread in the classroom using a bread maker. Ensure that health and safety policies are followed at all times.

Ask children to carry out research into yeast and how it is used. What other common uses can they find for yeast or carbon dioxide? They could present their findings in the form of a poster or a presentation.

Activity Three: Filtration

Learning objectives	<ul style="list-style-type: none">• To separate insoluble solids from liquids by filtration.• To consider the properties of different materials to be used as filters.• Use a wide range of methods to communicate data in an appropriate and systematic manner.
Approximate duration	1 hour and 30 minutes
Preparing resources	Activity sheet 4 (1 per child) 400 ml water 60 ml flour Plastic jug or container Transparent containers – marked at the 50 ml level Measuring cylinders Funnels Spoons Timer (stop clock) Various materials that could be used as a filter such as: Filter paper Paper towels Cotton wool Kitchen roll Felt Cotton Tights
Advance preparation	The filtering process can be very slow as the pores become blocked by the flour. Collecting the first 50 ml to come through makes the process more manageable. To do this the collecting cups need to be marked at the 50 ml level. This preparation can be done by the children as it is an opportunity to practice measuring skills. Pour a measured 50 ml of water into each cup and accurately mark the level using a permanent marker pen. Funnels and collectors can be made by cutting plastic bottles in half and upturning the neck into the base.
Introducing the activity	<p>Read again the letter from <i>Medivelop Ltd</i> and remind children that they are investigating the processes that are used when making some medicines. They are modelling these processes in each of their investigations. During the previous lessons, they looked at how a micro-organism could be cultivated to maintain optimum growth. Discuss the fact that the active ingredient is in the liquid in which the micro-organism lives. The next step in the process is to suggest ways of getting the active ingredient out of the liquid. This is still part of the primary manufacturing stage.</p> <p>The purpose of this activity is to find the most effective and efficient way to separate the micro-organism from the liquid in which it is cultivated; this should be done by testing different materials as filters.</p>

Explain that rather than using the liquid from the yeast, which in a commercial environment may be expensive to produce, they are going to use a mixture of flour and water to represent the micro-organism and growth solution.

When carrying out their investigation, they will need to consider several criteria to judge the effectiveness of their method.

Planning for the investigation can be carried out using the same principles as the previous two activities. The question that we are trying to answer is: Which material will make the most efficient filter? The following factors need to be considered.

- *How clear is the filtrate?* (The filtrate is the liquid that remains when it has passed through the filter.)
- *How long did the filtration take?*
- *Could the process be replicated on a larger scale?*

Allow the children time to discuss which materials they are going to test as filters and how the investigation is going to be carried out. When they are in agreement, they should collect the equipment and materials they will need.

Each group should try to test four different materials to find the most effective filter. If resources are limited they may test two, and then share their findings with the class. Try to ensure that each material is tested by at least two groups so that comparisons can be made, or allow repeat tests to be carried out by the groups.

The following guidelines are provided for less able children.

- Choose the materials that you think will be the best filters.
- Place the material in a funnel or upturned bottle and hold it over a marked cup to collect the water.
- In a different cup mix one heaped teaspoon of flour with 100 ml water.
- It is important that you stir the mixture just before it is poured.
- Pour the suspension through the filter and collect the liquid that comes through.
- Start the clock when you start to pour the liquid and stop it when the liquid has reached the mark.
- Repeat this for each of the filters mixing a new suspension each time.

After pouring the liquid into the filter, children should record how long it takes for the filtrate to be collected. The time taken can be shown in the form of a bar chart using Activity sheet 4.

When the filtration is complete, a test must be devised to assess the clarity of the filtrate (and therefore the effectiveness of the filter). This may be done by straightforward observation or by placing the filtrate in front of a dark background and placing them in order of clarity. A torch could be used to light up the filtrates. Torch light will highlight any particles in the liquid and

make it easier to judge how cloudy it is. If appropriate ICT resources are available, light sensors may be used for increased accuracy and to produce quantifiable results that can be presented in a bar chart or, if comparing time and clarity, a scatter graph. There are many programs available for analysing and presenting data.

Plenary

The groups should be given time to discuss results and decide whether they are able to draw any conclusions from their investigation. They should then present their findings to the rest of the class and be prepared to answer questions from their peers on their methods or results. This could be done as ‘hot seating’ where one child is the research scientist and the class ask him/her questions about his/her work. Questions from the teacher may prompt children’s thinking.

- *Which material was the most efficient filter?*
- *Do efficient and effective mean the same thing?*
- *Was one material noticeably quicker at filtering out the flour particles?*
- *Was the filtrate more clear with the slower or faster filters?*
- *Which material gives the best combination of speed and effectiveness?*
- *Why do you think this is?*
- *How can the company get the ingredient they need out of the liquid?*

The results of the filtration test need to be reported back to *Medivelop Ltd* and suggestions made about how the active ingredient can be extracted from the filtrate. As the active ingredient is produced by the micro-organism, it will be contained in the growth liquid that remains when the micro-organism has been filtered out.

Extension

Could the best filter material be adapted for use on a larger scale?

Repeat the investigation using the chosen filter with a larger quantity of mixture and larger apparatus.

Can children think of examples from other industries where filters may be used? (Look at the CIEC resource *Water for Industry* and the following websites for animations and interactive resources on filtration: www.psep.org, www.industry-animated.org, www.ciec.org.uk).

What other methods can be used for separating a solid from a liquid?

Evaporation may be suggested but this is not appropriate in this case as the active ingredient would be left behind with the solid. Allowing the solid to settle and siphoning off the liquid is a possibility. Industry can use a centrifuge to spin the mixture so that the solid sinks more quickly or sometimes special liquids can be added to make the solid form clumps which are heavier and sink more quickly.

Activity Four: Viscosity testing

Learning objectives

- Use observations, measurements or other data to draw conclusions.
- Know that changes occur when materials are mixed.
- Use systematic investigations to produce a syrup of the correct viscosity to be taken as a medicine.

Approximate duration

1 hour and 30 minutes

Preparing resources

(per group of 4 children, unless otherwise stated)

Activity sheet 5 (1 per child, optional)
50 ml liquid glucose (available from most supermarkets or pharmacists)
50 ml glycerine
50 ml water
20 ml measuring cylinder
Small containers
Plastic spoons or stirrers
Measuring spoons
Pipettes
Blank sticky labels

For the viscosity testing (depending on the test chosen)

3-4 marbles
1 plastic funnel
1 stop clock
1 30 cm length of dowel marked in centimetres
1 30 x 20 cm board (or other smooth surface)

Advance preparation

Consider that children are likely to need three or four identical containers per group plus any measuring cylinders and jugs. The utensils used for measuring the liquids are suggestions and can be substituted with what is available.

When mixing ingredients, containers with firmly fitting lids are ideal as they can be shaken. If lids are not available make sure containers have a wide enough mouth to allow for vigorous stirring.

Liquid glucose is very difficult to pour and is very sticky. Children may need assistance to pour a measured amount accurately or they may use measuring spoons.

Introducing the activity

Discuss the meaning of viscosity and explain that it is the correct word to describe the ‘runniness’ of a liquid.

Encourage discussion about how runny a medicine would need to be, based on children’s own experience. Make reference to familiar liquids such as water, oils, shampoo or washing up liquid. Polymers are added to these products to produce the correct consistency.

A cough syrup needs to be of the correct consistency to coat the inside of the throat instead of going straight into the stomach.

Show children the three ingredients that could be used to produce a syrup to carry the active ingredient in the medicine they are producing (liquid glucose, glycerine and water). Make sure children know they have to devise and record a recipe for the syrup they produce in this activity to make the final product. In the pharmaceutical industry, this would form part of the secondary manufacturing stage.

None of the three liquid ingredients individually has the desired viscosity, so the children will need to devise a way of mixing the liquids in different combinations and proportions to achieve the best result. Stress the need to measure accurately and to label and record each combination. Ask children why, in a commercial environment, it is vital that the recipe be systematically recorded and reproduced so that it is identical each time. Relate this to other products they may be familiar with such as tomato ketchup or toothpaste. Ensure that children understand the importance of potential customers knowing that a product will be as they expect each time they buy it.

- *How would a company check this is the case?*

Discuss with children the need for quality control and constant sampling in all forms of manufacturing. More information about the industrial production of liquids can be found in the PSEP resource *Runny Liquids* (see www.ciec.org.uk).

Allow each group time to discuss the task and to produce ideas about how the viscosity of a syrup could be tested. Discuss ideas and ask groups to consider any advantages or disadvantages of the suggestions that are put forward.

There are several ways that children may decide to test viscosity.

- They may pour a measured amount of each liquid into a ‘bunged’ funnel and time how long it takes for all of it to run through, when the bung is removed.
- They may use a ‘spoon’ test, scooping a measured amount of each liquid and observing or timing how long it takes to pour or drop from the spoon.
- A similar method is to measure and mark a length (between 5 and 10 cm) on to separate pieces of dowel, dip the dowel into the liquid up to the measurement and then transfer it straight to a measuring jug. The run off of liquid can then be measured. The more viscous the liquid, the more will be picked up by the dowel.
- Time how long it takes an object, such as a marble, to sink through a measured amount of each liquid.
- Time how long it takes for a measured amount of the liquid to spread out to fill a circle.
- Measure the length of time it takes the liquid to run down an angled slope.

When the merits of each method of investigation have been

discussed, each group should decide how to carry out their test and collect their resources. Each group should design a recording sheet and have it approved before beginning their investigation. Alternatively use Activity sheet 5.

Children do not need to test large quantities. A total of 50 ml of any of the liquids combined is enough to obtain results. This may be measured out using a spoon, a pipette or a measuring cylinder, depending on what the children decide to do and the resources available.

Remind the children that they need to combine two or more of the ingredients in measured amounts, testing and recording each combination until they arrive at what they consider to be the ideal viscosity for their medicine. Once a sample has been tested and recorded it can be changed to dilute or thicken and then retested, as long as the changes are recorded.

Plenary

Each group should discuss how successful their investigation was.

- *What problems were encountered?*
- *How were they resolved?*

In the examples below two different groups of children have a completely different perception of what the best liquid will be like. In the first example the focus is on swallowing quickly to avoid the bad taste. In the second example the children understand that the medicine needs to stay in contact with the throat to be most effective.

Which combination do you think would make the best cough mixture? Explain your conclusion
We thought that the best cough mixture would be the 2nd one because it goes down your throat quickly and it wasn't very thick. The time that the mixture goes down your throat is important because if the person doesn't like the taste they can take it quickly.

Which combination do you think would make the best cough mixture? Explain your conclusion
We thought the Liquid Glucose and Glycerine, with 10mls of water, is the best solution, because it has two medicines mixed with it, and the 10ml of water helps it easily go down. The Liquid Glucose will give it the sugary taste. Because the Liquid Glucose is thick, it will coat the throat very well.

An opportunity should then be given to present their findings to the whole class and the outcomes discussed. A comparison could be made between the final syrup that each group has produced. Ask what other ingredients may need to be added before the medicine goes into production. If needed, prompt children to think about flavouring and colouring to make the medicine more palatable and more visually appealing.

Children can visit the PSEP website to carry out a virtual viscosity test, www.psep.org.

This is also an opportunity to discuss the effects of glucose on tooth decay and obesity. They have used glucose (a form of sugar) as one of the ingredients, but many medicines are now sugar free. Introduce the idea that scientists have developed an alternative to glucose to sweeten medicines because of these issues.

Extension

In what other instances is the viscosity of a liquid important?

Ask children to think about, discuss and research this question. Oil for lubrication of machines is an obvious example. On an industrial scale, it is also a consideration for the petrochemical industry and any company that has to move liquid from place to place. Chocolate manufacturers need to move liquid chocolate around a site. Molten glass and metal are moved around while at a very high temperature. Discuss examples that may be familiar to children, for example sucking a milkshake through a straw, squeezing toothpaste from a tube. Why is viscosity important in ice cream sauces or tomato ketchup?

MEDIVELOP LTD

Dear Researchers,

Here at Medivelop Ltd we work with many companies that are as committed as we are to producing medicines of the highest quality.

We have discovered an active ingredient that soothes coughing. This ingredient can be made from the liquid produced when a particular micro-organism is grown.

To help us to use this discovery we would like you to carry out some further research and help us to develop a new cough medicine.

We require you to carry out the following investigations:

- Find the most effective method of growing the micro-organism to produce the active ingredient.
- Find the most efficient way to collect the active ingredient.
- Produce the final product in the form of a syrup containing the active ingredient. This should be soothing when swallowed and pleasant to take.

We also require you to provide ideas and samples of possible names and packaging designs that will quickly identify the product to consumers.

When conducting your research please consider the cost of production, how to keep the medicine the same each time and the need to produce the medicine in large quantities. Remember that it is very important to keep careful records of everything that you do.

Please report to me directly when your research is complete.

Yours sincerely

Dr. J Brown
Director of Research and Development
Medivelop Ltd

Yeast Growth Recording Sheet - Food Type

Look closely at the bottles containing the solutions you made.
Draw or write about your observations for each of the foods you placed in the solution.

Sugar	Salt	Flour	Lemon Juice

After 10 minutes

Sugar	Salt	Flour	Lemon Juice

After 20 minutes

Sugar	Salt	Flour	Lemon Juice

After 30 minutes

Yeast Growth Recording Sheet - Water Temperature

How did the temperature of the water affect how well the yeast grew?

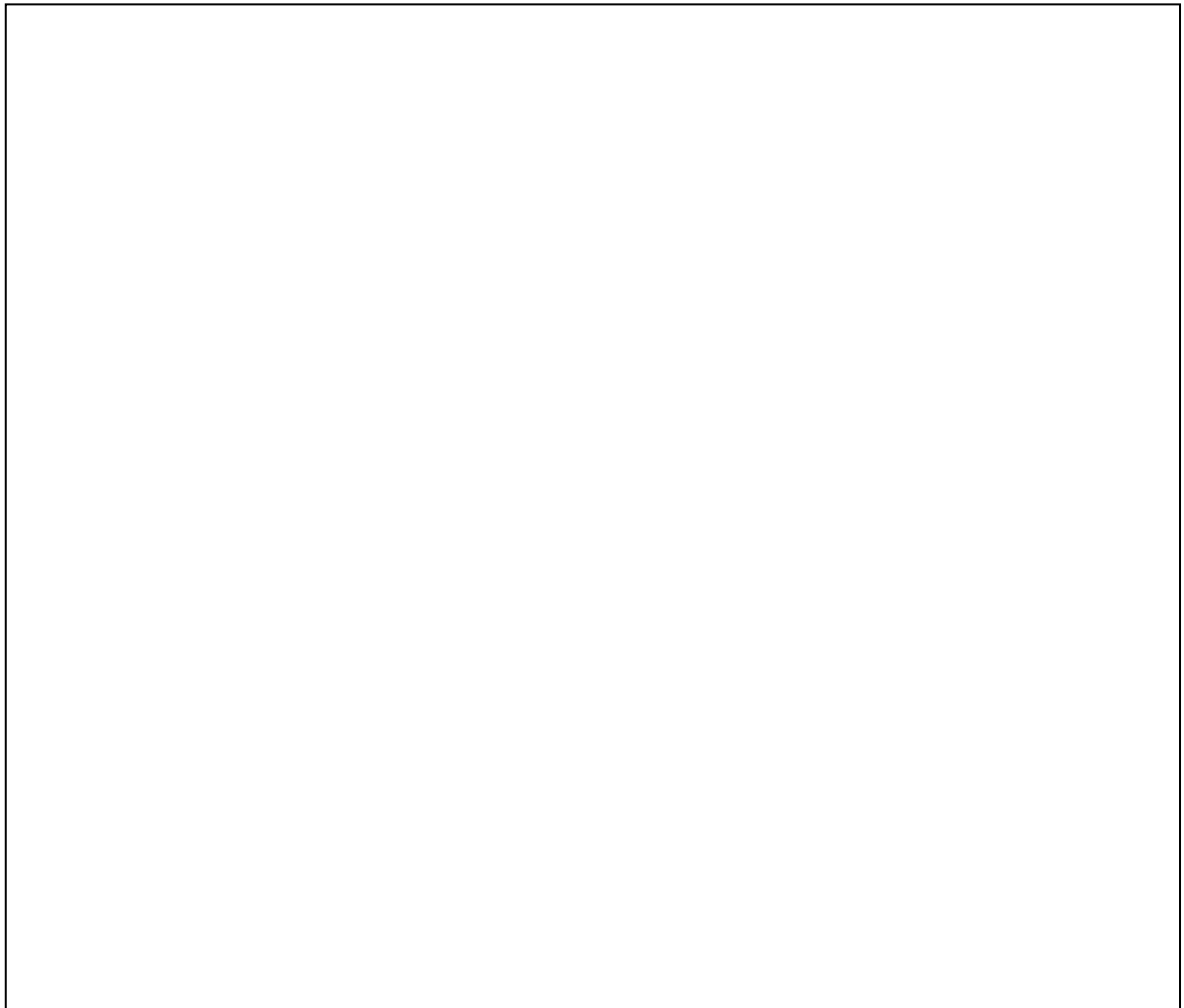
Write a statement using your observations to describe the effect of water at different temperatures.

In the cold water temperature ___ °C _____

In the water at room temperature ___ °C _____

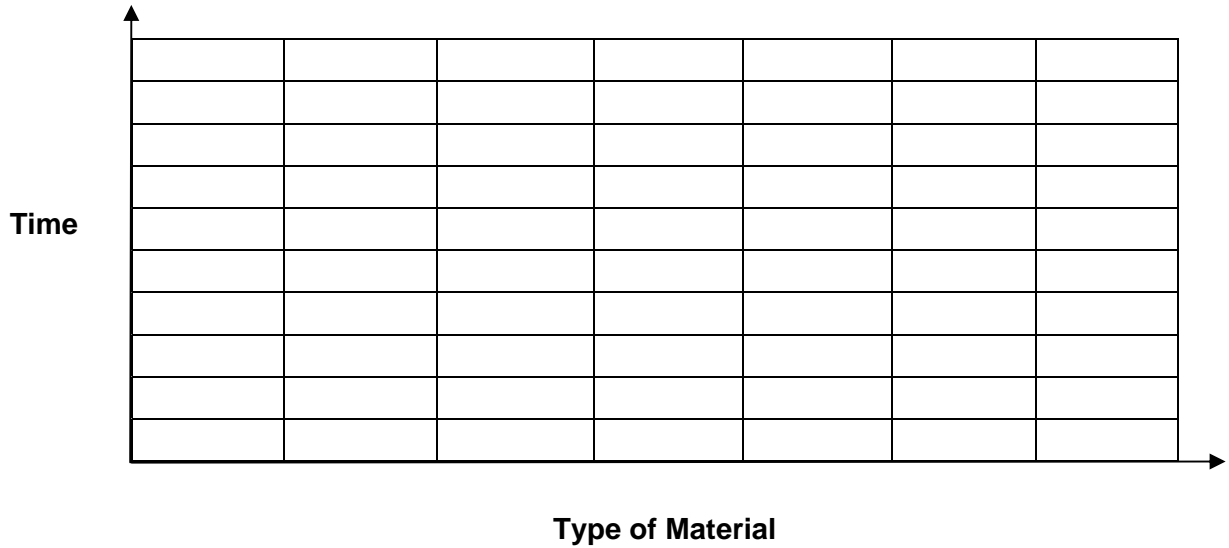
In the warm water temperature ___ °C _____

Use the space below to draw and label diagrams of what is happening in the bottles.



Filtration Investigation

Create a bar chart to show the time taken for each material to filter 100 ml of water and flour suspension/mixture.



What conclusions can you draw from the information in the bar chart?

Does the material that took the longest time to filter produce the clearest filtrate?

The Right Thickness - Testing Viscosity

Mix different combinations of the three ingredients - you don't have to use all three each time - and record your observations. Take care to measure the amount of each ingredient accurately and include your measurements in your recording.

If you have chosen a way to measure the viscosity, include your measurement of that too.

Ingredients Code name	Liquid Glucose	Glycerine	Water	Result

From your results, which combination do you think would make the best cough mixture?
Explain your conclusion

Background information about the pharmaceutical industry

The development and manufacture of medicines is a lengthy and expensive process. It requires a huge investment of time, expertise and money if a new drug is ever to reach production. The pharmaceutical industry in the UK is very successful at developing new medicines; around one in five of the world's top one hundred medicines were discovered and developed in the UK. Investment in research and development is greater in the pharmaceutical industry than any other manufacturing sector and accounts for almost a quarter of the investment in research and development in the UK.

All systems for drug manufacture have three basic elements:

INPUT \longrightarrow **PROCESS** \longrightarrow **OUTPUT**

Explanation of terms

The inputs include information about diseases, specification for new medicine, the capital investment needed, training requirements, raw materials needed, the machinery and technology required.

The processes include the manufacturing process, how equipment is used, the scale of production, quality control systems, company organisation, schedules of production.

The outputs include the manufactured medicine, any by-products or waste and the storage and transportation of the medicine.

The process for producing a medicine can also be broken down into three main stages, as follows.

Research and development (R&D) are the identification of an opportunity and the research to develop the idea into a potential new drug.

Primary manufacture is the manufacture of the active ingredient.

Secondary manufacture is the incorporation of the active ingredient into a form that can be taken or applied.

The active ingredient that is produced in the primary manufacturing stage will usually only be present in the medicine in small amounts. However, it is the part of the medicine that acts on the illness to treat the patient. These are produced in two main ways; (i) chemical technology, combining substances to produce chemical reactions or (ii) biotechnology, the use of biological matter such as the cultivation and extraction of penicillin.

When an active ingredient has been produced, it then progresses to the secondary stage of manufacture where it is mixed with other substances known as excipients. These form the main bulk of the medicine and are the medium in which the active ingredient is carried, whether in the form of a tablet, a syrup, a cream or an injection.

Due to the nature of its products, quality control is particularly

important to the pharmaceutical industry. Products are carefully tracked through each stage of the manufacturing process. Medicines are made in batches, with each batch clearly identified. If any problems do occur, it is easy to identify when and where the batch was made and all other medicines made in the same batch.

Throughout the manufacture of each batch, tests are continually carried out on the ingredients and the manufacturing process.

Drug development

The development and manufacture of a new medicine is a complex procedure that may take up to 12 years from initial research to the launch of a new product. After new compounds have been identified as having potential, in computer models and biological tests, they undergo preclinical development in which they are first tested in small quantities on cell cultures in a laboratory. This is to establish their likely effectiveness, and possibly harmful effects. Promising compounds will then be tested on animals to check for toxicity, and to find out how the substance is absorbed, metabolised and excreted by the animal.

Following the completion of preclinical tests and government approval being given, phase 1 of clinical trials can begin in which the substance is given to a small number of healthy humans under medical supervision, and the results observed.

During phase 2 of clinical trials, a small number of patients with the targeted illness are treated with the drug and its effects monitored. Checks are made to assess the drug's effectiveness and to see whether any unacceptable side effects are produced. A control group of patients are given a placebo or the best currently available medicine to help identify the effectiveness of the new medicine.

Phase 3 involves continuing the trials with a much larger group of patients. If this shows the medicine to be effective and within limits of safety, then the company is able to apply for a commercial licence, allowing them to manufacture and market the new medicine.

At this stage the process is still not complete as phase 4 of the clinical trials continues once the medicine is on the market and doctors have started to prescribe it.

Source of information: The Association of the British Pharmaceutical Industry; www.abpi.org.uk.

Lesson plans

<p>Cough Mixture Session 1: Investigating food sources for microbes</p>	<p>National Curriculum Links Sc1: 1a, 1b, 2b, 2c, 2d, 2e, 2j, 2l, 2m, Sc2: 1a, 5f D&T: 1a, 1d</p>
<p>Learning Objectives</p> <ul style="list-style-type: none"> • Make a fair test by changing one factor and observing or measuring the effect while keeping other factors the same. • Observe the results of an investigation and use the data to draw conclusions. • Know that micro-organisms are living organisms that are often too small to be seen and that they may be beneficial or harmful. • Understand some of the processes used in biotechnology. 	
<p>Introduction</p> <p>Discuss with children what types of medicines are commonly taken by children or adults. Medicines are manufactured by the pharmaceutical industry and undergo extensive testing to ensure they are effective and safe. Read the letter from Medivelop Ltd (Activity sheet 1) asking children to undertake some R&D* work for the company. Discuss the criteria specified in the letter and establish with children the need to undertake a series of processes and investigations to achieve an end result. Begin with the first stage of finding the optimum conditions to cultivate a micro-organism, in this case yeast, to harvest the resulting by-product.</p> <p>The question being asked is <i>Which foods promote the most growth in yeast?</i></p> <p>*R&D – research and development</p>	
<p>Group or Individual Activities</p> <p>Working in groups of four, children consider the variables involved and plan an investigation which controls all variables apart from the food source. The group's feedback to the class, and teacher, and the plans are modified through discussion until all are agreed.</p> <p>Each group should then collect their equipment and allocate responsibilities to the team members. A typical investigation would be to measure 5 ml of one of the foods into separate plastic bottles. Each bottle should be labelled with its contents. Next, add a teaspoonful of dried active yeast and stir thoroughly. Add the same amount of water to each container and place a balloon tightly over the open neck.</p> <p>Make and record initial observations (using Activity sheet 2)</p> <p>The bottles should be placed in a warm, easily accessible place where they are unlikely to be disturbed but can be easily observed.</p> <p>Observe and record every ten minutes for approximately thirty minutes.</p> <p>Opportunities for design and technology exist in the production of packaging and promotional materials.</p>	
<p>Plenary Session</p> <p>Each group presents their findings to whole class.</p> <p><i>Which balloon expanded most?</i> <i>What conclusions can be drawn?</i> <i>How did the type of food affect the growth of the yeast?</i></p> <p>Sugar is the only one of the foods that would provide enough energy for substantial growth. The increase in yeast will result in more respiration (conversion of food to energy) in the bottles and more CO₂ gas is produced.</p> <p>With information gathered begin to draft a report to Medivelop Ltd with initial findings.</p>	<p>Resources</p> <p>Activity sheets 1-2 Dried active yeast Warm water (50°C) Sugar Salt Flour Lemon juice Small plastic drinks bottles Balloons or air-locks Measuring cylinders Measuring spoons or teaspoons Blank sticky labels</p>

Lesson plans

<p>Cough Mixture Session 2: Investigating the effect of temperature on microbial growth</p>	<p>National Curriculum Links Sc1: 1a, 1b, 2a, 2b, 2c, 2d, 2e, 2j, 2l, 2m, Sc2: 1a, 5f</p>
<p>Learning Objectives</p> <ul style="list-style-type: none"> • Ask questions that can be investigated scientifically and decide how to find answers. • Think about what might happen or try things out when deciding what to do, what kind of evidence to collect, and what equipment and materials to use. • Make a fair test by changing one factor and observing or measuring the effect while keeping other factors the same. • Observe the results of an investigation and use the data to draw conclusions. 	
<p>Introduction</p> <p>Discuss with children the conclusions drawn from investigating different types of food sources for growing yeast. Ask what else might affect the growth of a micro-organism. What factors could be controlled? Encourage children to think about how temperature may affect growth of yeast. How could this be investigated? Show children the resources that are available.</p>	
<p>Group or Individual Activities</p> <p>Allow children to discuss and plan how they will carry out their investigation. As part of their planning, they need to think about what they are going to observe and measure and how they are going to record it. An alternative investigation into quantity of food provided would also be appropriate if children chose this as an alternative. When they are able to agree and explain how the investigation will be done, they should collect their equipment and begin.</p> <p>Allow children to devise their own investigation but a method may be suggested or guidance given as set out on page 13.</p> <p>Each group should use water at different temperatures while keeping all other variables the same. They should record their observations carefully and present their data in their chosen form.</p>	
<p>Plenary Session</p> <p>Each group presents their findings to whole class.</p> <p><i>How did the temperature affect the growth?</i></p> <p>The best temperature for growth would be between 35 and 50°C. Production of bubbles and gas will be the greatest and the layer of yeast in the bottle should increase most at these temperatures. At room temperature growth would be very slow and below 10°C little change will be seen. With information gathered begin to draft a report to Medivelop Ltd with initial findings.</p> <p>Tell the children that companies that produce and sell medicines have many scientists working for them to investigate problems like this for every new product.</p>	<p>Resources</p> <p>Activity sheet 3 Dried active yeast Sugar Balloons Measuring cylinders or suitably graded bottles Small plastic bottles 1 litre jug Plastic spoons Plastic containers/jugs 2-litre ice-cream tubs or similar Blank sticky labels Thermometer Water at different temperatures- cold - 10°C, room temperature - 20°C, warm - 50°C.</p>

Lesson plans

<p>Cough Mixture Session 3: Filtration</p>	<p>National Curriculum Links Sc1: 1b, 2a, 2b, 2c, 2d, 2e, 2f, 2g, 2h, 2j, 2l, 2m, Sc3: 3c</p>
<p>Learning Objectives</p> <ul style="list-style-type: none"> • Be able to separate insoluble solids from liquids by filtration. • Consider the merits of different materials to be used as filters. • Use a wide range of methods to communicate data in an appropriate and systematic manner. 	
<p>Introduction</p> <p>Begin by reviewing work from previous session. Explain that having created the optimum conditions for cultivating the micro-organism it now needs to be separated from the growing medium as it is this that contains the active ingredient.</p> <p>In an industrial setting using the real ingredients to test methods of separation may not be economical so a simulation may be used to test a process. Explain that a mixture of flour and water will be used to simulate the yeast suspension. Having established the material and equipment available, set children the task of planning and finding the most efficient method of filtering out the solid.</p>	
<p>Group or Individual Activities</p> <p>After discussion about which materials to test and how the investigation is to be carried out, each group should collect the appropriate equipment.</p> <p>They then need to produce four identical suspensions of flour and water. This can be done as required and must always be stirred just before pouring.</p> <p>Each group should test four different materials to find the most effective filter. To judge effectiveness they will need to consider</p> <ul style="list-style-type: none"> • The clarity of the filtrate. • The length of time taken to filter. • The possibility of replicating the process on a larger scale. <p>The first 50 ml of each filtration (see Advance preparation page 17) should be carefully timed and times recorded.</p> <p>After filtration is complete, groups need to devise a test to assess the clarity of the filtrate.</p>	
<p>Plenary Session</p> <p>Each group should be given time to discuss their results and draw conclusions. These should be presented to the class and discussed.</p> <p><i>Which material was the most efficient filter?</i> <i>Which had best combination of speed and effectiveness?</i> <i>How well could these materials be used to filter very large volumes?</i> <i>What happened when the flour settled in the filter?</i></p> <p>Very large filtering systems are used for industrial production. Often suction is used to draw the filtrate through the filter. Separation can also be achieved by centrifugation.</p> <p>Prepare second part of the report to Medivelp Ltd.</p>	<p>Resources</p> <p>Activity sheet 4 Water Flour Plastic jug or container Transparent containers marked at the 50 ml level Measuring cylinders Funnels Spoons Timers Variety of materials to act as filters filter paper, paper towels, cotton wool, kitchen roll, felt, cotton, tights.</p>

Lesson plans

Cough Mixture Session 4: Viscosity Testing	National Curriculum Links Sc1: 1b, 2a, 2b, 2c, 2d, 2e, 2g, 2h, 2j, 2l, 2m, Sc3: 1a, 2a
Learning Objectives <ul style="list-style-type: none"> • Use observations, measurements or other data to draw conclusions. • Know that changes occur when materials are mixed. • Use systematic investigations to produce a syrup of the correct viscosity to be taken as a medicine. 	
Introduction Ask children to discuss what would be the best consistency for a cough medicine. Make reference to familiar liquids such as water, oils, shampoo or washing up liquid. Introduce the word viscosity as the correct term to describe the ‘runniness’ of a liquid. Refer to the letter of contract (Activity sheet 1) and identify criteria for the syrup. Show the three ingredients that could be used to produce the syrup needed to carry the active ingredient. Establish that none of these liquids individually has the desired viscosity. Set children the task of finding and testing the best combination of ingredients to produce a syrup they consider to be the best consistency.	
Group or Individual Activities Give each group time to discuss how they would test the viscosity of a liquid. Draw together ideas (you may need to make some suggestions in which case see Activity sheet 5 page 21 for ideas) and discuss the merits or drawbacks of each. When children have a bank of ideas from which to draw ask them to agree a method for their group and to design a suitable recording sheet to collect their data. Alternatively groups could use Activity sheet 5. When the format of the recording sheet has been approved each group should collect their resources and begin their investigation. Remind children that they need to combine two or more of the ingredients in measured amounts, testing and recording each combination until they achieve what they consider to be the best viscosity for their medicine. This should be kept in a sealed, labelled container for later use. They do not need to test large quantities, a total of 50 ml of any of the liquids combined is sufficient to obtain results. Explain that in an industrial setting small scale trials would be the norm. The same ratio of ingredients would then be used to produce the product on a larger scale.	
Plenary Session Each group presents the syrup they consider to be the most suitable viscosity for a cough mixture. They should explain what the proportions of each ingredient are, how they arrived at this combination and how they carried out their tests. A comparison could be made between the final product of each group.	Resources Activity sheet 5 Liquid glucose Glycerine Water Measuring cylinder Small containers Plastic spoons Measuring spoons Blank sticky labels Marble Funnel Stop clock Dowel Board

Viscosity testing Experimental and investigative science: Assessment of performance					
	Level 1	Level 2	Level 3	Level 4	Level 5
Fair testing 2d: Fair testing	Talks about how they made the test fair. <i>We used the same amount of liquid every time we tested the runniness.</i>	With help, suggests how to plan a fair test. <i>Let's use the same amount of liquid each time.</i>	Carries out a fair test, with help, and recognises and explains why it is fair. <i>We kept the amount of liquid the same, to make sure it was fair. If we used lots of some, and not much of others, we couldn't compare the times.</i>	Decides that a fair test is appropriate. <i>We need to carry out a fair test, so that we can compare the runniness of the different liquid mixtures. We should keep everything the same except the liquid being tested.</i>	Identifies key factors to be considered. <i>We could either, keep the time constant and measure how much liquid we collect, or we could keep the volume constant and measure the time it takes to run through the funnel.</i>
Obtaining evidence 2f: Make systematic observations and measurements	Responds to events they observe. <i>The first one was really runny, and the next one was very thick and slow.</i>	Drops marbles through bottles of liquids, observes which reaches the bottom, first, next, etc, and lists them in order of runniness.	Measures the liquid to the nearest 10 ml, and uses sand timers. Describes the relative viscosities of the liquids (<i>runnier than, thicker than, etc.</i>)	Decides which size of measuring cylinder to use for the test. Measures the volume of liquid in ml. Selects a stop watch to time the event. Makes observations of several liquid recipes.	Decides on own method of testing and equipment to make accurate measurements of time in seconds and volume in millilitres.
Considering evidence 2j: Using data to draw conclusions	Uses simple words to describe the viscosity of liquids. <i>It was thick, thin, runny, slow, fast, gloopy.</i>	Compares observations. <i>The marble went really slowly through the thick liquids, and zoomed through the thin ones.</i>	Identifies patterns in observations. <i>The thicker the liquid, the longer it takes to pour.</i>	Relates their conclusions to the task. <i>The best liquid for a cough syrup had a mixture of all three ingredients. The liquid should be viscous enough to coat the throat.</i>	Sees patterns in observations and draws conclusions using supporting evidence. <i>Using more liquid glucose increased the viscosity. However, too much glucose might make it too hard to swallow.</i>

