3. Filtration

1.5 hour activity

Children are asked by a pharmaceutical company to test several materials to determine which is the most effective filter. They are encouraged to plan and carry out a fair test to determine how effective the different materials are at removing flour from a mixture of flour and water considering both the time taken to filter the liquid and also how much of the flour was removed from the sample.

TYPE OF ENQUIRY

- Fair test

OBJECTIVES

- To use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.
- Give reasons, based on evidence from comparative and fair tests for the particular uses of everyday materials.
- To report and present findings from enquiries including conclusions, causal relationships and explanation of and degree of trust in results in oral and written forms.

SCIENCE VOCABULARY

Micro-organism	Ingredients	Change
Investigation	Fair test	Factor
Compare	Improve	Evaluate
Results	Filter	Filtration
Scale		

RESOURCES

(1 per group of 4 unless otherwise stated)

- 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

PRIOR KNOWLEDGE/EXPERIENCE

Children should have carried out fair tests and had opportunities to make decisions about what observations to make. They should have had experience of evaluating their own investigations and making suggestions as to how they could be improved.

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.

ACTIVITY NOTES

Read the letter from Medivelop Ltd again 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.

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.

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. 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 children who might need more support.

- 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.

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.

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?

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.

QUESTIONS FOR 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 clearer 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?

INDUSTRY LINKS AND AMBASSADORS

Like the previous two activities, this one mimics one of the initial phases of research and development in the production and extraction of the active ingredient in a medicine. However, this is only one stage of a process which can take up to 12 years from initial research to the launch of a new product.

CROSS CURRICULAR LINKS

English: Opportunities to use spoken language to develop understanding through speculating, hypothesising, imagining and exploring ideas. Also, links to writing whereby pupils identify audience and purpose, as well as selecting the appropriate form.

Mathematics: Opportunities to practice taking and recording measurements and performing simple calculations