# 2. Investigating the effect of temperature on microbial growth

1.5 hour activity

Children set up a fair test to investigate how the growth of a micro-organism is affected by temperature.

## TYPE OF ENQUIRY

- Fair test
- Observation over time

## OBJECTIVES

- To plan different types of scientific enquiry including recognising and controlling variables where necessary.
- To record data and results using scientific diagrams and tables
- 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.
- To use test results to make predictions to set up further comparative and fair tests.
- To develop their understanding of micro-organisms as living things.

## SCIENCE VOCABULARY

| | | |
|---|---|---|
| Micro-organism | Ingredients | Change |
| Investigation | Fair test | Factor |
| Compare | Improve | Evaluate |
| Results | Temperature | |

## RESOURCES

(per group of 4 children unless otherwise stated)

- 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

## PRIOR KNOWLEDGE/EXPERIENCE

Children should have had opportunities to set up simple practical enquiries, comparisons and fairs tests. They should be able to recognise when a fair test is necessary and help to do some of the planning required for this.

## 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.

## ACTIVITY NOTES

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 the CIEC interactive planning tool 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 on the list.

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 ⅓ 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.

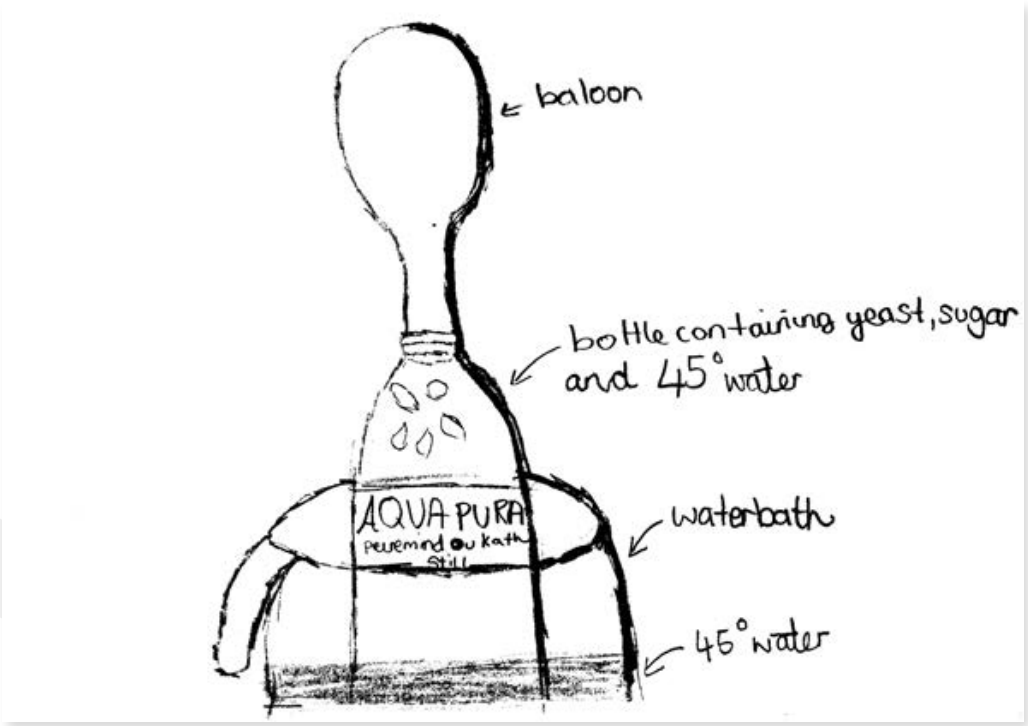



**Figure 3**

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

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

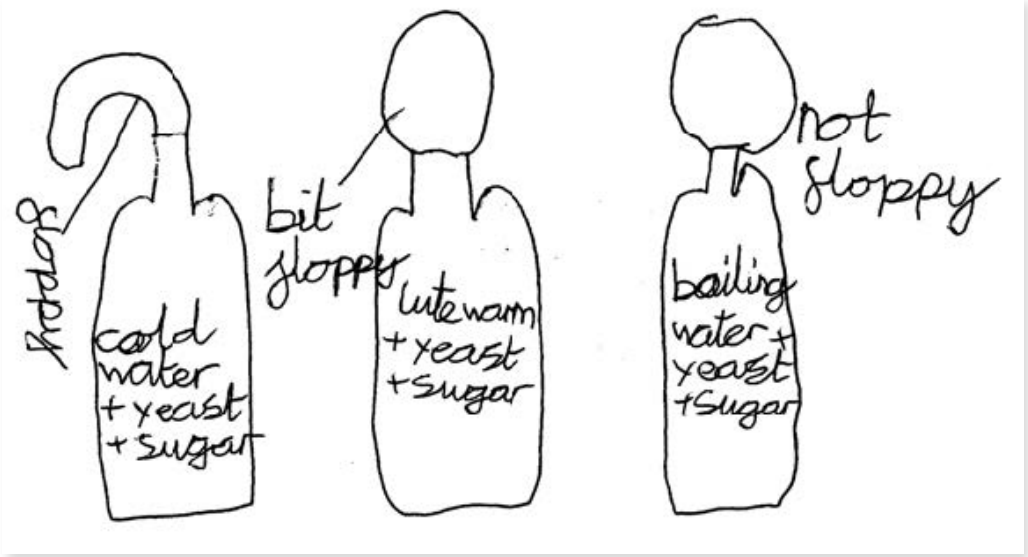
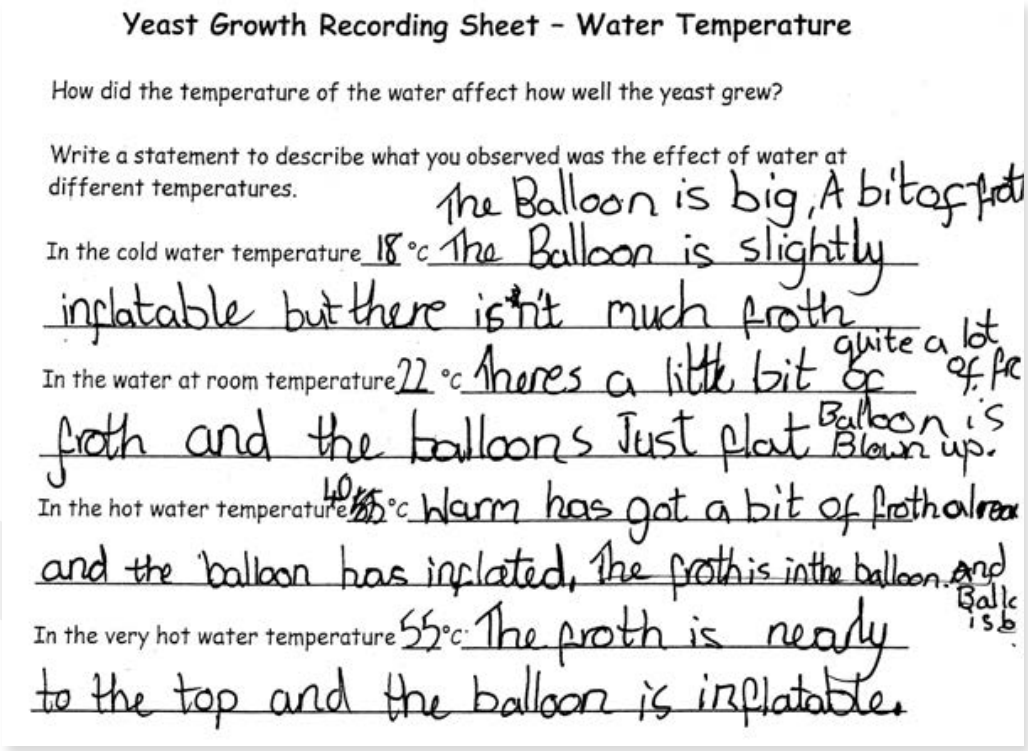



**Figure 4**

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.



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.

The Balloon is big, A bit of froth

In the cold water temperature 18 °C The Balloon is slightly inflatable but there is'nt much froth

In the water at room temperature 22 °C theres a little bit of froth and the balloons just flat quite a lot of fro Balloon is Blown up.

In the hot water temperature 40 °C Warm has got a bit of froth and the balloon has inflated. The froth is in the balloon. and Ballo is b

In the very hot water temperature 55°C The froth is nearly to the top and the balloon is inflatable.

**Figure 5**

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

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.

## QUESTIONS FOR THINKING

- What was the effect of temperature on the growth of the micro-organism?
- Why does an increase in temperature increase growth?
- What would happen if the water became too hot?
- 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.

## SAFETY GUIDANCE

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

## INDUSTRY LINKS AND AMBASSADORS

Like the previous activity this one mimics some of the research and development that would be needed at an early stage when developing a new medicine that has an active ingredient derived from a micro-organism. Manufacturers need to find out not only under what conditions the micro-organism will grow but what conditions will allow it to grow as fast as possible and produce the most active ingredient. This makes the production of the medicine as cost effective as possible.

## 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.