

### Unit plan

#### Context

This unit is for KS4 (age 14-16 pupils) and examines the role of science and technology in preserving food as an important part of global food security.

It considers the scale of food spoilage across the globe and the consequences of this for people and their diets. The students investigate simple ways of preserving food relating their scientific understanding of microbial growth to food spoilage by microbes.

#### Structure

The unit is divided into three pairs of lessons as shown below. The first lesson in each pair can be used in isolation, each pair can be taught, or the unit can be taught as a sequence of six lessons. Each lesson is designed to fit into normal science curriculum time but there are opportunities for further work with each lesson and these can be used in off timetable activities.

#### 1: Food preservation

**Why preserve food?**

This lesson explores what happens when food is left to 'go off'.

**My food cupboard**

This lesson looks at how foods can be preserved for use at a later date.

#### 2: Keep it cool

**Chill!**

Looking at the effect of temperature on the growth of microbes.

**Zeer pots**

Using evaporation to cool a storage pot - the electricity-free fridge.

#### 3: Dried up

**Drying stuff**

In this lesson students design a solar dryer used in many countries as a way to preserve foods.

**Osmosis**

Students explore how salt can be used to preserve a range of foods by dehydrating microbes osmotically.

#### Lessons

Each pair of lessons includes a variety of activities from whole class discussions to individual work - both practical and theoretical. The tables on the next page give an overview of the various tasks. Each pair of lessons also includes a suggestion for a homework or out-of-school learning activity.

# Food preservation

## 1: Food preservation

Lesson	Activities	Time / mins	Group size	Format
<b>Why preserve food?</b> This lesson explores what happens when food is left to 'go off'.	Going off	10	Whole class	Discussion following video clip
	Why preserve food / Preserving food	10	Whole class	Discussion
	Investigating spoilage	25	Pairs	Laboratory practical
Homework / out-of-school activity	My food cupboard	20	Individual	Individual research
<b>My food cupboard</b> This lesson looks at how foods can be preserved for use at a later date.	Green or grungy?	10	Pairs	Laboratory practical
	Food preservation techniques	30	Small groups	Desk research
	Summary / review	5	Whole class	Discussion
Homework / out-of-school activity	What works?	20	Individual	Writing activity

## 2: Keep it cool

Lesson	Activities	Time / mins	Group size	Format
<b>Chill</b> Looking at the effect of temperature on the growth of microbes.	Food wastage	10	Pairs	Discussion
	Chilled food	30	Pairs	Laboratory practical
	Beyond the fridge	5	Whole class	Discussion
Homework / out-of-school activity	Poster	20	Individual	Creative task
<b>Zeer pots</b> Using evaporation to cool a storage pot - the electricity-free fridge.	Cool	10	Whole class	Discussion
	Making zeer pots	20	Individuals	Sequencing
	Why are zeer pots so good?	15	Whole class	Discussion
Homework / out-of-school activity	Researching zeer pots	20	Individual	Data response

## 3: Dried up

Lesson	Activities	Time / mins	Group size	Format
<b>Drying stuff</b> In this lesson students design a solar dryer used in many countries as a way to preserve foods.	Too dry to rot	10	Individual	Video and questions
	Designing a solar dryer	25	Small groups	Research and development task
	Presenting the dryer	10	Whole class	Display
Homework / out-of-school activity	It's good business	20	Individual	Question sheet
<b>Osmosis</b> Students explore how salt can be used to preserve a range of foods by dehydrating microbes osmotically.	Introducing osmosis	10	Whole class	Discussion
	Checking our prediction	30	Pairs	Investigative practical
	Salting it away	5	Whole class	Discussion
Homework / out-of-school activity	Osmotic drying at home	20	Individual	Individual research

### Key vocabulary

Microbes, decay, preservation, evaporation, drying, pickling, osmosis, cooling, food, zeer pot, food technology, global food security

### Curriculum links

This project has been designed to link to a wide range of GCSE courses. The exact details of the links will depend on the specific course, the awarding body and how individual classes and teachers tackle the topic.

### Lesson 1: Why preserve food?

#### Learning objectives

- Understand the reasons for preserving food.
- Be aware of the consequences of not preserving food.
- Understand the impact of different factors in preventing the growth of microbes.

#### Lesson sequence

For the first 20 mins of the lesson choose either option A or option B to introduce ideas around food preservation, then continue to Investigating Food spoilage. In both cases begin by introducing students to the overall context of the lessons, that they will be looking at preserving food and its importance across the globe.

#### OPTION A:

##### Going off

10 mins

Show students the video clip from Youtube found at [bit.ly/decaying-watermelon](https://bit.ly/decaying-watermelon) . Ask them to describe the process they can see in the clip and note down the key stages / features on the board. What do we mean when we say food has 'gone off'?

##### Why preserve food?

10 mins

Write 'food preservation' in the centre of the whiteboard or on a large sheet of paper and then ask students to suggest topics or ideas related to it. These might include ways to preserve food (e.g. pickling, freezing, drying etc.), reasons to preserve food (e.g. to save for seasons when no food is available, to make new sorts of food like cheese from milk etc.) or even ideas that preserved food is not as 'good (taste, nutrient quality) as fresh food. Encourage students to suggest as many ideas as possible and create a mind map of the class ideas. Show that food preservation is something that is done all over the world in all cultures. Introduce the next activity, Investigating food spoilage.

#### OPTION B:

##### Preserving food

10 mins

Divide class into groups of four or five. Put two pieces of fruit or vegetable in the middle of the table for each group, on top of a piece of A3 paper and a spare piece of paper. Ideally one piece that can be preserved in many ways e.g. onions and another that cannot e.g. lettuce.

Ask pupils to brainstorm all the different ways their fruit and veg can be preserved. They can choose another of their own and write this in the middle for the third piece of paper.

Have a class discussion about why some food stuffs can be preserved in lots of different ways and other cannot. Why is this? They should be able to come up with the idea that some have a higher water content. Maybe some food could be made into jams e.g. mushrooms but we wouldn't like the taste!



Other ideas may include vacuum packing or simply covering with cling film, putting in a bag. Prepared salad is preserved by vacuum packing in Nitrogen.

## Going off

10 mins

Show students the video clip from Youtube found at [bit.ly/decaying-watermelon](https://bit.ly/decaying-watermelon). Ask them to describe the process they can see in the clip and note down the key stages / features on the board. What do we mean when we say food has 'gone off'? Introduce the next activity, Investigating food spoilage.

## Investigating food spoilage

25 mins

Hand out the worksheet *Investigating peas*. This is an investigation that introduces the pupils to the concept of food spoilage and preservation. They also get the opportunity to practice their investigative skills. Working in pairs they set up a series of test tubes with different conditions. They are asked to predict what they think will happen, together with other questions that test their understanding of investigative procedures and techniques.

Encourage the students to make predictions about what will happen to the peas based on their common sense understanding and their scientific knowledge. They will be able to check the results in the next lesson.

## Differentiation

### All students will:

- understand why food should be preserved

### Most students will also:

- explain how different factors affect microorganism growth
- link food preservation techniques to some basic scientific principles

### A few students will make more progress and:

- link food preservation techniques to their everyday lives

## Resources

### Worksheets

- Keeping the peas
- My food cupboard

### Equipment

#### For Option A

- A selection of fruit and vegetables (two per group)

## For both options

- Soaked peas (so they are soft)
- Enough test tubes and droppers for pupils working in pairs to have 8 test tubes each
- Labels
- Dilute salt solution
- Concentrated salt solution
- Concentrated sugar solution
- Vinegar
- Sodium nitrite solution
- Distilled water
- Cotton wool

## Useful websites

<http://youtu.be/S12zZhdOckc>

This is the YouTube link for the rotting watermelon clip. Clips of other fruits and foods rotting are visible in the column of suggestions. Be aware that some YouTube suggestions may not be suitable for school use so preview before using in the class.

[bit.ly/use-by-or-best-before](http://bit.ly/use-by-or-best-before)

This video clip distinguishes between 'use by' and 'best by' dates. It can be useful when setting homework.

## Homework suggestions

Ask the students to look at food packages that they have at home and complete the table on the worksheet *My food cupboard*. They need to understand the difference between 'use by' and 'best before'.

**Use-by:** These dates refer to safety. Food can be eaten up to the end of this date but not after even if it looks and smells fine.

**Best before:** These dates refer to quality rather than food safety. Foods with a 'best before' date should be safe to eat after the 'best before' date, but they may no longer be at their best.



## Lesson 2: My food cupboard

### Learning objectives

- Understand that microbes can cause food to decay.
- Understand that controlling the growth of microbes helps to preserve food.
- Explain some different methods of food preservation.

### Lesson sequence

#### Green or grungy?

10 mins

Ask students to look at the pea experiment from the previous lesson to find out which preservation techniques have been most successful. The cloudier the liquid above the peas the more decay will have occurred.

Review the class results and draw out the idea that decay is linked to the activity of microbes and that food preservation often works by controlling the growth of these microbes. Draw in any insights from the homeworks as well where freezing or canning or drying may have figured heavily - all with clear links to reducing microbial growth.

#### Food preservation techniques

30 mins

Sort the class into groups of four and hand out one copy of the worksheet *Microbial growth* to each group. This uses an approach called Home and Expert groups which may be unfamiliar to students. Explain the stages as given on the worksheet emphasising that the Home group should be an active group - it is not just a place to gather together all the information. Encourage them to make sure all members of their Home groups understand what they will have to do in their Expert groups. The different Expert cards will help but encourage the Home groups to generate their own questions and issues that their expert will explore.

After 25 minutes bring the expert stage to an end and send students back to their Home groups to share their knowledge and understanding.

#### Summary

5 mins

Draw the class together and review the advantages and disadvantages of the various methods used to reduce microbial growth. Draw out key features in the class discussion while stressing that there is no one perfect solution and that the key issue is always 'what works?' in the specific circumstances of the individual users.

## Differentiation

### All students will:

- review the results from a practical activity

### Most students will also:

- link food preservation to microbial growth
- appreciate that food spoilage involves a wider range of effects than just microbial decay

### A few students will make more progress and:

- assess food preservation techniques for suitability for different contexts

## Resources

### Worksheets

- Microbial growth
- Food preservation techniques (print single sided and provide scissors for students to cut the cards out)
- What works?

### Equipment

- Access to experiments set up in previous lesson.
- Access to the internet, textbooks or a library would be useful for research into food preservation techniques.

## Useful websites

<http://practicalaction.org/technical-briefs-schools-food>

A useful summary page with links to lots of materials about preserving food.

## Homework suggestions

Hand out the worksheet *What works?* which gives some examples of people in different situations who need to preserve food. Ask the students to complete the sheet for homework giving their suggestions for suitable food preservation techniques for each situation and an explanation of why they have chosen that method and how it will reduce microbial growth.

### Lesson 1: Chill!

#### Learning objectives

- Understand the role temperature plays in microbial growth.
- Understand the role temperature can play in preserving food.
- Plan and carry out an investigation.

#### Lesson sequence

##### Food wastage

10 mins

Show slide 1 of the presentation *Food wastage* and ask students to suggest the likely figures before moving on to reveal the answers. Encourage students to appreciate the scale of the problem in the UK in terms of financial cost, environmental damage etc.

Ask students to consider what might lead to so much wastage in the UK. They might come up with: poor management of food (not putting milk in the fridge etc.), buying too much food in the first place (tempted by multiple buys and special offers), buying the wrong food (people will not eat it) or any other sensible suggestion. Encourage the widest range of suggestions.

Finally show the slide about the number of people who could be fed from this wasted food. Emphasise that for many people in the world food wastage is not just about a waste of money it is a matter of life and death.

##### Chilled food

30 mins

Review the factors that might cause food spoilage and list these on the board. Ask students to suggest which of those factors are affected by temperature.

The students are using yeast as an example of a micro-organism and investigating the effect of temperature on their growth. Introduce the yeast growth investigation by showing the slide showing reaction tubes in the *Food wastage* presentation. You may also want to demonstrate the construction of reaction tubes yourself with some classes. These reaction tubes are a very good way to convert a simple qualitative investigation (the yeast grew/did not grow) into a more complex quantitative one (measure the height of the small tube above the mixture as an indicator of carbon dioxide produced and so respiration).

Once you are confident that students can produce yeast reaction tubes effectively invite them to explore the effect of temperature on the rate of yeast respiration. Give as little guidance as possible. This is a fairly simple investigation and generally works well. Some students may want to explore further (does freezing kill yeast? does boiling kill yeast? does yeast need air - cover the reacting mixture with a layer of oil to prevent air getting to the yeast) and this should be allowed.

The yeast will react fairly quickly and you should be able to get results within 20 minutes if you use water baths at a variety of temperatures.

## Beyond the fridge

5 mins

Review the data from the investigation and ask students to suggest a temperature that will reduce the growth of microbes sufficiently to keep food fresh for a few days. Show the slides of a chilled food cabinet in a restaurant/shop and ask them why this method of preservation may not be appropriate across the whole world. Ask them to suggest methods of food preservation which are more readily applicable across the world from their homework lists. Explain that in the next lesson they will be looking at a food chiller that does not need electricity.

## Differentiation

### All students will:

- understand how temperature can affect the growth of microbes

### Most students will also:

- complete an investigation into the effect of temperature on yeast growth

### A few students will make more progress and:

- understand the link between temperature and food spoilage

## Resources

### Presentation

- Food wastage

### Equipment

- Boiling tubes
- Small test tubes that can fit inside the boiling tubes
- Water baths set at 5°C, 15°C and 25°C. (An alternative if these are not available is to supply thermometers for students to monitor and control the temperature in a water bath manually)
- A supply of powdered yeast
- Sugar solution - the exact concentration is not crucial, two level tablespoonfuls stirred into a litre of water is suitable and will produce enough solution for the whole class
- Dropping pipettes

## Homework suggestions

Design a poster to encourage people not to waste food. This should be appropriate for use in a large supermarket. Suggest places where the poster should be placed - for example it is unlikely to have an effect if it is used after the checkouts when people have already paid for the food.

## Lesson 2: Zeer pots

### Learning objectives

- Understand how evaporation can be used to keep food cool.
- Understand how zeer pots can increase food security.

### Lesson sequence

#### Cool!

10 mins

The lesson starts with a recap of the students' understanding of the principle of evaporation. Ask students to apply a little hand sanitiser to their hands and then wave them around. What do they notice? Is the cooling effect greater if they use more sanitiser? Or move their hands less? Or more? What do they think is causing the cooling?

Ensure students are familiar with the idea that evaporation causes cooling before introducing them to the zeer pot.

#### Making zeer pots

20 mins

Show the video clip about zeer pots found at <http://youtu.be/ZNKifJHqScc> and hand out the worksheet *Making a zeer pot*. Ask students to assemble the photographs into the correct sequence to show how a zeer pot is made. They should then add labels to explain what is happening in the photograph and give details of the scientific principles in use in each photograph.

#### Why are zeer pots so good?

15 mins

Ask students to consider why fruit and vegetables kept inside the pot seem to last longer than those outside. They will have to draw together their understanding both of evaporative cooling and the effect of lowering temperature on microbial growth - a key determinant of food spoilage.

There are 1.6 billion or 1 in 3 people in the world who do not have access to electricity . Ask students to stand up. Ask them to imagine they represent all the people in the world. One by one ask about a third of the students to sit down. Tell the class that is how many people in the world have no electricity at all. 587 million people in Africa alone do not have access to electricity. So the zeer pot fridge is a really useful technology for them.

Compare a zeer pot to a typical refrigerator from the UK. What are the advantages and disadvantages for each in the context in which they are used? Encourage students to see that zeer pots have the added advantage of easy manufacture and maintenance compared with the refrigerator which makes them particularly suitable for countries where wages may be low or electricity supplies might be intermittent.

## Differentiation

### All students will:

- appreciate that evaporation can cause cooling

### Most students will also:

- appreciate that the cooling effect of evaporation can be used in a zeer pot to help reduce food spoilage

### A few students will make more progress and:

- understand how the construction of the zeer pot maximises cooling by evaporation

## Resources

### Worksheets

- Making zeer pots
- Researching zeer pots

### Equipment

- Scissors
- Glue

## Useful websites

[practicalaction.org/zeer-pot-fridge](http://practicalaction.org/zeer-pot-fridge)

This webpage gives details of how zeer pots can be used to extend the shelf life of foodstuffs.

<http://youtu.be/ZNKifJHqScc>

The source for the video clip mentioned in Making zeer pots.

## Homework suggestions

Students should complete the worksheet *Researching zeer pots* for homework.

## Suggestions for out-of-school activity

Make two full size zeer pots, put one inside and one outside and see which is better at preserving fruit.

### Lesson 1: Solar dryers

#### Learning objectives

- Understand the role the sun can play in preserving food.
- Demonstrate how a solar dryer works.

#### Lesson sequence

##### Too dry to rot

10 mins

This lesson asks students to consider a natural form of food preservation - solar drying. They already know that dehydrated food lasts longer but they are going to examine how the Sun is used all over the world as a drying agent. Show the video clip at <http://practicalaction.org/drying-vegetables-practical-action-southern-africa> concentrating on the section from 2.27 - 8.20. They should then answer the questions on the worksheet *Solar drying*.

##### Designing a solar dryer

25 mins

Sort the students into teams of four or five and ask each group to design a solar dryer suitable for the people they have seen in the video clip. This dryer will have to be easy and cheap to manufacture and maintain, will be able to handle a variety of foods and keep them safe from dust or microbes in the air while they are drying.

Allow them time to explore the possible dryer types on the internet and possibly explore some of the scientific principles involved in absorbing solar radiation and evaporation (look for link to the zeer pots here). The technical brief from Practical Action listed overleaf may be useful here.

When they have designed their dryer they will be expected to present them to the rest of the class explaining why they think their design will work well and justifying these ideas with the relevant scientific background. The design should be created as an annotated poster which can be displayed in the laboratory.

##### Presenting the dryers

10 mins

Students should review the posters from the various groups. Draw out, as a class, successful features from different posters and revise the scientific principles behind them. Use this opportunity to reinforce ideas about energy absorption and evaporation (link to zeer pots) and the reduction in moisture content helping to reduce microbial growth.

#### Differentiation

##### All students will:

- be able to explain the principle of solar drying

##### Most students will also:

- be able to explain how the Sun dries food
- design a simple solar dryer

## A few students will make more progress and:

- understand the role played by solar drying in global food preservation

## Resources

### Worksheets

- Solar drying
- It's a good business

### Equipment

- Access to the internet or other information resources to research solar dryers.

## Useful websites

[practicalaction.org/drying-vegetables-practical-action-southern-africa](http://practicalaction.org/drying-vegetables-practical-action-southern-africa)

The source for the video clip mentioned in the first activity, Too dry to rot.

[practicalaction.org/solar-drying-2](http://practicalaction.org/solar-drying-2)

This provides a useful overview of solar dryers and their use in developing countries.

[practicalaction.org/technical-briefs-schools-food](http://practicalaction.org/technical-briefs-schools-food)

A number of technical briefs about food are present here including one on solar dryers.

## Homework suggestions

Students should complete the worksheet *It's a good business*.

## Suggestions for out-of-school activity

Students could build their own solar dryer. There lots of examples of how to do that on the internet, including making one out of a pizza box...let them choose which one they want to try.

## Lesson 2: Osmosis

### Learning objectives

- Demonstrate an understanding of the principle of osmosis.
- Be able to relate science to some common preservation techniques.

### Lesson sequence

#### Introducing osmosis

10 mins

Review the different food preservation techniques used around the world that the students have learnt about so far. Tell them this lesson will focus on salting as a method. Show some food that have been preserved in this way e.g. tuna in brine, salted fish from a Chinese supermarket.

This lesson involves an experiment that looks at how salt can be a preservative because it draws water from foods by osmosis. Sort the class into pairs and hand out the worksheet *Investigating osmosis*. Review the definition of osmosis. Osmosis is the movement of water molecules from an area of high concentration (a weak solution) to an area of low water concentration (strong solution) through a partially permeable membrane. The students need to make a note of this definition on their worksheets and then predict what might happen to the weight of the potato discs in the experiment.

#### Checking our prediction

30 mins

From their understanding of the definition of osmosis, the pupils should predict that potato placed in distilled water will undergo a gain in weight and potato placed in salt solution will lose weight.

It may be necessary to spend a little time discussing this to ensure that the pupils have understood. A common misunderstanding centres on the understanding of concentrated and dilute solutions. They need to understand that a concentrated or strong solution has a low concentration of water molecules and a dilute or weak solution has a high concentration of water molecules and in osmosis water molecules move from where they are in a high concentration, i.e. a dilute solution, to where they are in a low concentration, i.e. a concentrated solution.

If the potato is placed in distilled water, the concentration of water outside of the cells is greater than the concentration of water inside the cells. There will be a net movement of water from the area of high concentration to the area of low concentration and as a result of this the cells will contain more water and weigh more than they did. If the potato is placed in a salt solution the concentration of water will be greater inside the cells than outside. Osmosis will take place and water will move from the area of high concentration (inside the cell) to the area of low concentration (outside the cell). This will cause the potato to lose weight. If the potato is placed in a solution that is the same concentration as its cells there will be no net movement of water and the potato will weigh the same.

#### Salting it away

5 mins

Review the results from the investigation and encourage the students to understand that foods may be too 'dry' for microbes to grow even if they seem 'wet' (e.g. jam or salted fish). Brainstorm the range of foods that depend on osmosis for preservation identifying

what it is that is acting as the osmotic agent. Finally, consider the advantages and disadvantages of salting or high-sugar for food preservation.

## Differentiation

### All students will:

- explain that some food preservation depends on the use of chemicals such as salt and sugar

### Most students will also:

- explain the principle of osmosis
- explain the findings of an investigation on the basis of their understanding of osmosis

### A few students will make more progress and:

- understand and be able to explain the link between osmosis and food preservation

## Resources

### Worksheets

- Investigating osmosis

## Equipment

### For each investigation group:

- 125ml of 1mol sodium chloride solution
- 125ml distilled water
- 15 cylinders of potato each weighing 5.3g
- 15 beakers
- 2 measuring cylinders (150ml)
- potato borers
- set of weighing scales
- 1 small scalpel
- 1 stop watch /stop clock
- Labels for beakers

## Useful websites

[bit.ly/how-osmosis-works](http://bit.ly/how-osmosis-works)

This page provides an animation showing osmosis.

## Homework suggestions

Ask students to identify which foods in their cupboards at home rely on osmotic drying to preserve them. You can review their suggestions at the start of the next lesson.

## Suggestions for out-of-school activity

Design and carry out an investigation to find out what concentration of sugar will act as a preservative.