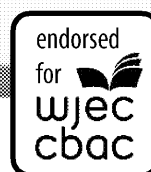


**2016 specification**
first exams in 2018

Course Companion

for WJEC GCSE Food and Nutrition:
The Science of Food: The Effect of
Cooking on Food and Food Provenance

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Contents

Thank You for Choosing ZigZag Education.....	i	Chapter 2: Food spoilage.....	49
Teacher Feedback Opportunity	ii	Microorganisms (food spoilage).....	50
Terms and Conditions of Use	iii	<i>Microorganisms in food (bacteria, mould and yeast) ..</i>	50
Teacher's Introduction.....	1	<i>The role of temperature, moisture, pH and time.....</i>	53
Chapter 1: The effect of cooking on food	2	<i>Signs of food spoilage.....</i>	55
Why and how food is cooked.....	3	<i>Signs of food spoilage (enzymic action)</i>	57
<i>The reasons why food is cooked</i>	3	<i>High-risk foods.....</i>	58
<i>Different methods of heat transfer</i>	6	Buying food.....	60
<i>How cooking affects food.....</i>	11	<i>Deliveries</i>	60
<i>How cooking affect food</i>	12	<i>Date marks</i>	61
The positive use of microorganisms in food		<i>Storage rotation</i>	61
production.....	17	<i>Packaging</i>	62
<i>The role of yeast, mould and bacteria in food</i>		<i>Food labelling</i>	63
<i>production</i>	17	Storing food	65
The working characteristics, and functional and		<i>Temperature control</i>	66
chemical properties of cooking ingredients.....	22	<i>Ambient storage</i>	67
<i>The working characteristics, and functional and</i>		<i>Refrigeration and freezing.....</i>	67
<i>chemical properties of carbohydrates</i>	22	Preparing, cooking and serving food.....	71
<i>Preparing and cooking with carbohydrates</i>	24	<i>Bacterial contamination.....</i>	71
<i>The working characteristics, and functional and</i>		<i>Types of bacterial food poisoning</i>	72
<i>chemical properties of fats and oils</i>	28	<i>The four 'C's'.....</i>	73
<i>Preparing food and cooking with fats and oils.....</i>	28	<i>Food safety.....</i>	74
<i>The working characteristics, and functional and</i>		<i>Reporting sickness.....</i>	74
<i>chemical properties of proteins.....</i>	32	<i>Personal hygiene</i>	74
<i>Preparing food and cooking with proteins.....</i>	34	<i>Food handling area – dos and don'ts</i>	76
<i>Fruit and vegetables.....</i>	37	<i>Cross-contamination</i>	77
The most common faults in cooking and how to prevent		<i>Using correct cooking times</i>	79
them	40	<i>Cleaning.....</i>	79
<i>Cake catastrophes</i>	40	<i>Food waste</i>	81
<i>Pathetic pastries.....</i>	43	Preservation methods used to keep foods for longer	83
<i>Serious sauce problems</i>	45	<i>Chapter 2: Quiz-ine.....</i>	86
<i>Other common mistakes</i>	46	Answers	87
<i>Chapter 1: Quiz-ine.....</i>	48	Chapter 1: The effect of cooking on food.....	87
		Chapter 2: Food spoilage.....	94

Teacher's Introduction

This resource is designed to meet The Science of Food (Area 4) element of the WJEC GCSE Food and Nutrition qualification.

What it covers

The resource comprises two chapters covering the following:

Chapter 1: The effect of cooking on food	Chapter 2: Food spoilage
• Why and how food is cooked • The positive use of microorganisms in food production • The working characteristics, and functional and chemical properties of cooking ingredients	• Food safety principles • Bacterial contamination and how to prevent it • Food wastage

How to use this resource

The resource covers all aspects of The Science of Food and is designed to increase knowledge of the topic and enable learners to test their understanding and skills through a variety of assessment methods.

Learning Outcomes enable the learner to clearly see what they are expected to know at the end of each chapter.

The **Overview** provides a brief summary of what will be covered in the chapter and the **Key Terms** box provides information on key terms within the resource (key terms are emboldened within the chapter text).

Did you know?	These boxes contain handy tips.
Things to think about	These boxes provide learners with a chance to develop cognitive skills, do some research (books, Internet, people) and take part in a discussion.
Apply	These boxes provide the learner with the opportunity to further their skills, either through cognitive or practical application.
Qs	Learners' knowledge and understanding is tested through quick Y/N questions.
Skills	Based on the suggested application of skills section of the WJEC GCSE Food and Nutrition specification, these test learners' skills in food safety through practical application.
Study tip	Useful tips are given to help the learner concentrate on important aspects that may appear in the final assessment.
Check your understanding	Multiple-choice, short-answer and extended-answer questions appear at the end of each section to test knowledge and develop understanding.
Quiz-ine	There is a crossword-style quiz at the end of each chapter to test learners' understanding of key terms used within the resource. The shaded squares spell out a word associated with the chapter text.
Answers	Answers to questions are provided at the end of the resource.

M Golebiowska, March 2018

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* resulting from minor specification changes, suggestions from teachers and peer reviews, or occasional errors reported by customers

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Chapter 1: The effect of cooking

Overview

In this chapter you will learn why we cook food, how heat is transferred to food and how the cooking method can affect the nutritional value and palatability of the dish. You will also discover why and how various ingredients are used in cooking. In this chapter you will also learn how food is made with the use of microorganisms.



Learning Outcomes

After studying this chapter you should be able to do the following:

- ☐ identify the main reasons behind cooking food
- ☐ identify foods that cannot be eaten raw and reasons for that
- ☐ learn how cooking affects foods' features such as appearance
- ☐ learn how preparation affects foods' features and nutritional value
- ☐ define what conduction, convection and radiation are
- ☐ know how conduction, convection and radiation work and why
- ☐ indicate the main processes that take place while cooking different foods
- ☐ identify foods which are produced with the use of microorganisms
- ☐ understand the functional and chemical properties of cooking
- ☐ explain why certain chemical reactions take place
- ☐ indicate how to prevent or trigger certain reactions
- ☐ identify the main reasons why particular results may not be achieved and remedy the situations in such cases

Key Terms

Aeration	The process of incorporating air between fat particles in a food mass lighter
Conduction	The process of exchanging heat between two objects in direct contact; this is a direct way of transferring heat
Convection	A process of exchanging heat between two objects with the help of a fluid (liquid or gas); this is an indirect way of transferring heat
Dextrinisation	The process of breaking down long starch chains into smaller molecules
Radiation	A process in which a wave of heat is sent without the need for a medium; this is an indirect way of transferring heat
Emulsification	The process of combining water and oil together to form a stable mixture
Enzymatic browning	The process of enzymatic breakdown due to plant enzymes leaking out of cells
Foam formation	The process of trapping air bubbles between protein molecules to form a mixture lighter and more susceptible to growth
Food safety	All conditions and actions taken to make food safe for consumption
Gelatinisation	The process of breaking down the chemical bonds in starch molecules in the presence of water and heat
Gluten formation	The process of creating a strong, elastic, netlike structure from wheat flour and water
Infrared	Type of invisible radiation emitted by all living organisms
Microwave	Type of electromagnetic waves with frequencies of 300 GHz, used, for example, in microwave ovens
Oxidation	The process of substances (such as vitamins) decomposing when exposed to oxygen
Plasticity	Elasticity; ability to easily change shape or physical form
Protein coagulation	The process of changing proteins from liquid to gel state
Protein denaturation	The process of damaging proteins' chemical structure
Shortening	The process in which fat particles surround flour particles to make gluten formation impossible



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Why and how food is cooked

Knowing how various cooking ingredients react to different preparation and cooking methods is essential for obtaining a healthy, tasty and appetising dish. The temperature and time of cooking are crucial in selecting the correct cooking method.

The reasons why food is cooked

Food is cooked not just to taste nice, but to make it safe, change the textures, to provide variety in our diets. Let's explore in a bit more depth some of these reasons.

To make food safe to eat

One of the greatest advantages of cooking is that it makes our food **safe to eat** by killing off harmful substances.



Salmonella is a species of bacteria known to cause food poisoning. Symptoms include stomach ache, nausea, vomiting, diarrhoea. It is commonly found in eggs, poultry, meat and milk, and in products like ice creams. For this reason, it is not advisable to eat these products raw. Also, it is better not to freeze the food again once it has been defrosted, because it allows bacteria to grow.

Study tip



Cooking is a way to ensure **food safety**.

Other bacteria found in food include *Escherichia coli* (which usually live in our bowels but are poisonous when in food), *Shigella* (which causes dysentery), *Yersinia enterocolitica* (which causes symptoms similar to *Salmonella*).

One of the most dangerous bacteria found in food is *Clostridium botulinum*, which produces a toxin that paralyses the nerves and may lead to death (if it paralyses the intercostal muscles responsible for breathing). Happily, there is a visible sign of its presence: if the lid of a tuna or meat preserve can is bulging, you definitely should not eat its contents.

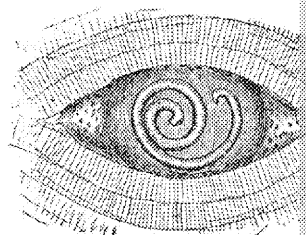
Most bacteria are killed at temperatures over 65 °C. Cooking food at temperature for an appropriate time ensures that all the bacteria and spores are neutralised.

Other poisonous agents in food include toxins, pesticides, enzymes, mycotoxins and

- Solanine is a green-coloured toxin present in badly-stored potatoes (it is produced when they are exposed to sunlight), green tomatoes and other foods. Eating them raw may cause stomach ache, diarrhoea or fever, so it is best to cook them thoroughly to avoid such troubles.
- Aflatoxin is a harmful substance produced by moulds. It is often found in peanuts, grains and other products which have been stored in improper conditions. They are very toxic and can lead to liver inflammation, gastrointestinal problems and cancer.

Did you know?

Wild boars are carriers of the *Trichinella spiralis* parasite and, therefore, their meat cannot be eaten raw!



Trichinella spiralis is a parasite living in muscle cells which causes trichinosis if eaten. Symptoms of infection include very high fever, shivering, muscle pains. To prevent that, all meat is carefully cooked before it can find its way to shops.

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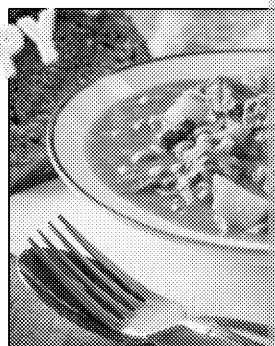
To develop taste and aroma

Cooking allows development of flavours in a number of ways:

- It evaporates water and therefore makes the flavour of its residue more pronounced.
- It causes sugars to caramelise, which is especially advantageous in such products and even certain vegetables, such as onion or carrot.
- During cooking, aromatic molecules evaporate and make the smell more intense. Compounds present in foods are called essential oils (present in large amounts in mint).
- It allows combination of different ingredients, which leads to developing new flavours.



This plum chutney uses both caramelisation and water evaporation to obtain its strong flavour.



Traditional Irish stew is cooked slowly, which allows the fat to melt and gives it its characteristic texture.

Cooking allows us to create the pronounced flavour of stews, jams, sauces or chutneys. Breaking down the structure of cells and freeing the aromatic chemical compounds from ingredients is also helpful in developing the desired flavour and smells, e.g. by adding spices.

To improve texture and aid digestion

You have probably noticed that cooked meat is not only easier to cut, but also to bite and chew. This is because cooking softens and loosens muscle fibres, which makes the meat softer. Also, during cooking, fat melts and penetrates the meat, making it juicy. This is not only important for your taste buds, but also makes it much easier to eat for those who cannot bite or chew, or who experience various digestive issues: babies, the elderly, and people suffering from Crohn's disease or irritable bowel syndrome (IBS), etc.

Cooking (especially frying, grilling and baking) also makes certain foods crunchy/crispy – which is more desirable by some. This includes meat, bread and pastries, and chips and crisps.

During cooking, some foods change their physical state – from liquid to solid (or the other way around). You can obtain the desired texture by simply adjusting cooking time, e.g. four minutes for a soft-boiled egg and 10 minutes for a hard-boiled one, or 10 minutes for a thin sauce and 30 minutes for a thicker one.

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Things to think about

Identify some foods which are difficult to digest and discuss how cooking could aid digestion.

To improve shelf life

Applying high temperatures is a great way of preserving food. This is because most harmful microorganism species die at temperatures above 65 °C. For that reason, cooking kills most of the bacteria or mould normally present in food and prevents **spoilage**. This way, if correctly stored, food can last longer and maintain all of its nutritional values.



Things to think about

for discussion and thought

1. Discuss the 'use by' and/or 'best before' dates of various food items that are stored differently. For example, fresh fish, frozen fish and tinned fish. Note down what the food items are cooked or not and how this impacts on the longevity of the food.
2. Discuss why some cooked foods and raw foods have a 'use by' date, while some have a 'best before' date.

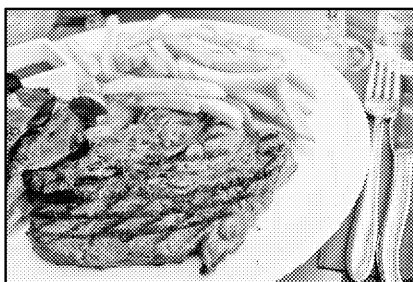
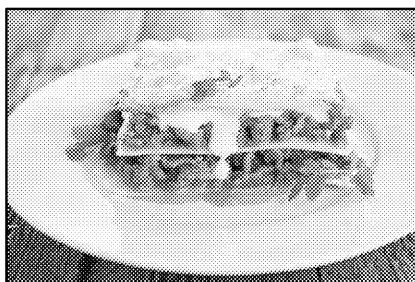


To give food variety

Cooking also allows us to have variety in our diets. This is because of two reasons:

- Different cooking techniques allow us to prepare the same product in a number of ways (e.g. fried, baked, etc.).
- Different combinations of foods, seasoning, herbs and spices make it possible to create a number of different dishes using the same main ingredient.

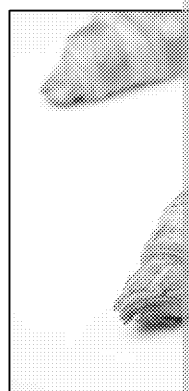
For example, beef can be used to prepare carpaccio, steaks, burgers, stews, soups (e.g. as bolognese sauce), and so on.



Lasagne, steaks and burgers are examples of foods made with beef, but each has a unique flavour because of the way they are prepared and cooked, and through the combinations of other ingredients.

To improve the food's appearance

During cooking, various chemical reactions change the appearance of the food. For example, caramelisation and dextrinisation cause bread to form a golden crust, while fermentation causes it to rise. The Maillard reaction between proteins and sugars, called the browning reaction, is responsible for creating the brown colour of roasted meat, coffee or cocoa beans. The reaction of bicarbonate of soda with water causes muffins to rise and obtain their sponge-like texture. Prolonged cooking can also affect the food's appearance in a negative way, e.g. red cabbage would become blue-green and mushy, while green beans would become dull grey.



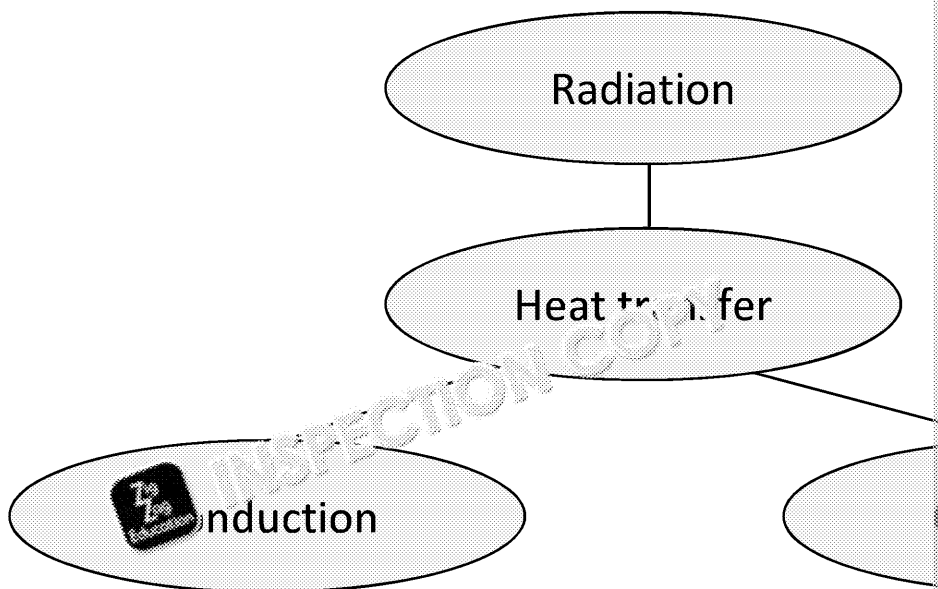
During cooking, the proteins in the meat separate and expose the amino acids. These amino acids then react with the sugars to create a brown crust. This is the Maillard reaction. The Maillard reaction is responsible for the browning of food. It is a chemical reaction between amino acids and sugars that gives browned food its distinctive flavor. At the same time, it can also cause food to become dry and tough. The Maillard reaction is a complex process that involves many different chemical reactions. It is a key part of cooking and food science.

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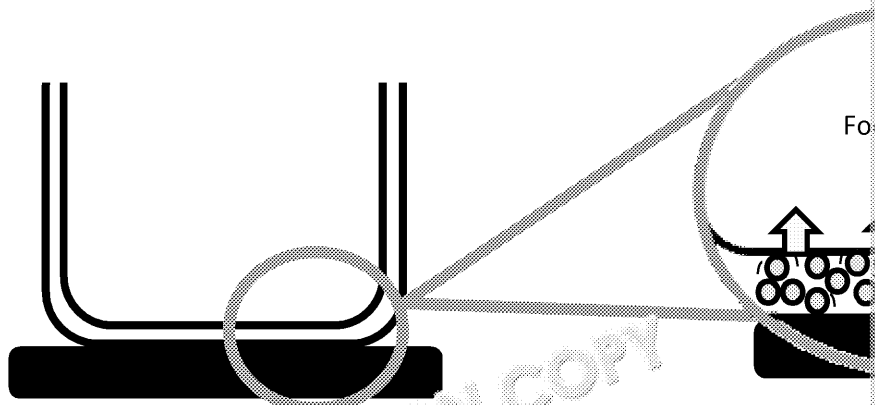
Different methods of heat transfer

There are three ways in which heat is transferred to food. These are conduction,

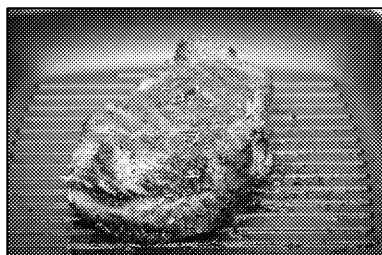


Conduction

The hotter the substance is, the faster its molecules move. That rule is applied in conduction cooking. Heat from the hob is transferred directly to the pan or pot you're cooking in. The molecules of the metal vibrate, and give their energy to surrounding molecules – in this case, molecules of food in the pan. The heat (energy) is transmitted directly, which means that the two objects (the pan and the food) have to touch each other.



Heat causes metal particles to vibrate in the saucepan and causes food molecules to gain kinetic energy and heats the food.



Simmering a stew, frying a steak or cooking a curry in a pan are using conduction.

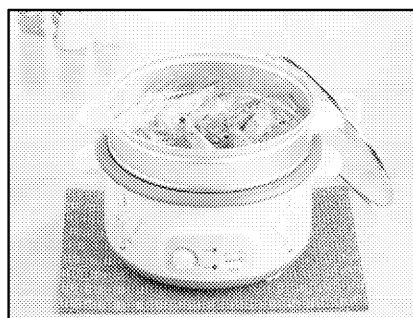
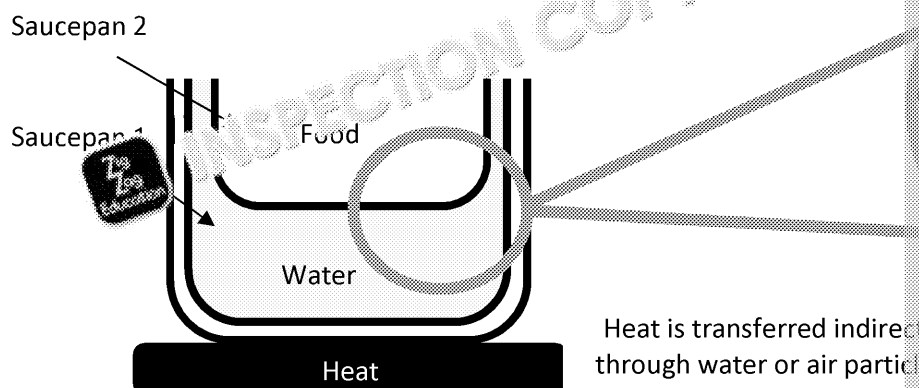
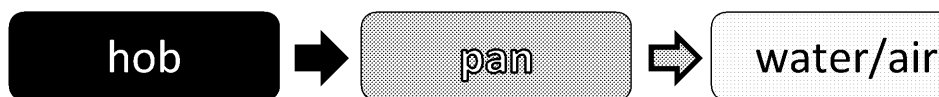
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Convection

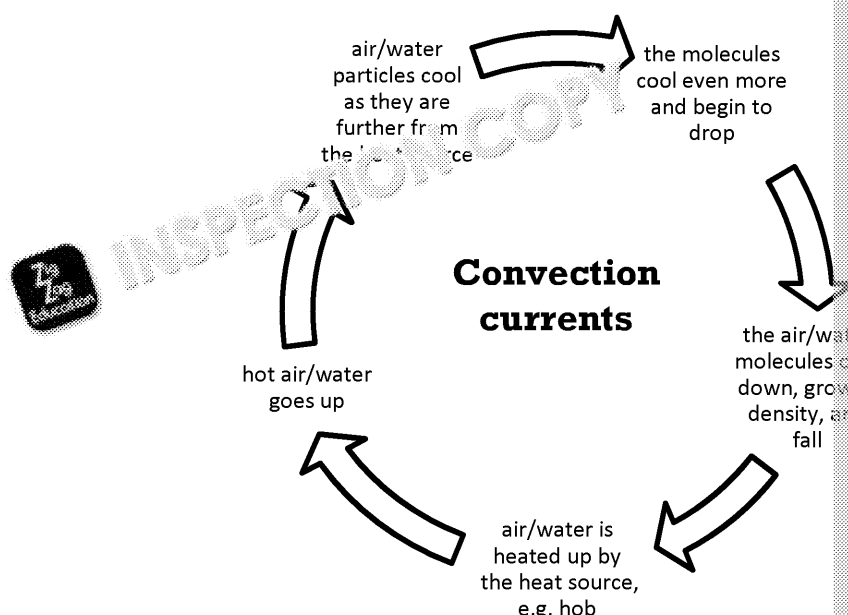
Convection is a way of transferring heat through migration of water or air particles. When heated, water or air particles move up, and when chilled, they move down. These convection currents, are used in cookers, during the baking, boiling, poaching and transferred indirectly through the use of water or air.



Steaming is an example of convective heat transfer, through the use of vapour.

Apply

- 1) Prepare a chosen sauce
- 2) Explain how conduction during the process.
- 3) Explain why it is necessary to stir the mixture.



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Radiation

Radiation is a technique that involves waves of heat being sent to the food – it means that the heater and the food do not need to touch each other.

Radiation involves two kinds of waves – infrared and microwaves.

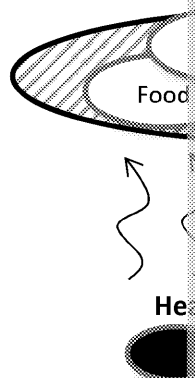
Infrared is a kind of electromagnetic radiation, which involves the use of light waves which are invisible to the eye. In cooking, infrared radiation is used in stoves, ovens and grills, where heat goes from the source to the food.



Grilling/barbecuing is a classic way of using infrared for cooking as the matt black coal is effective in emitting infrared rays.



Infrared radiation is also used in toasters.

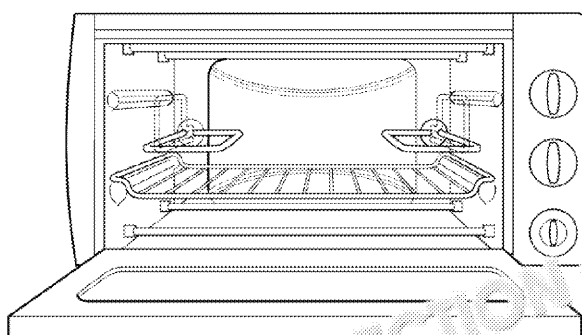


Apply

List cooking methods that use direct infrared radiation.

Microwaves are also a kind of electromagnetic radiation, but they are longer than infrared waves. They are, most obviously, used in microwave ovens. The waves are sent to the food and heat up particles of water, which (as you already know) move faster and faster, transferring the heat to all other surrounding particles. As a result, the meal can be warmed up quite effectively, but the use of microwave ovens is limited to foods which contain a high proportion of water.

It is also important to remember that microwaves can bounce back from shiny surfaces, for example, aluminium foil or plates with metallic decoration into a microwave oven.



How a microwave works

1. Transformer changes high-power electricity to low power.
2. Magnetron creates microwaves.
3. Microwaves are sent to the food by an antenna.
4. Microwaves heat up the food.
5. Water molecules vibrate and heat the food.

Apply

- 1) Prepare a vegetable stew using the recipe at zzed.uk/8257-vegetable-stew
- 2) Discuss what methods of heat transfer are used at each stage of preparation.

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Why are heat transfer methods combined?

Conduction, convection and radiation can often be combined when preparing a dish. Combining different methods allows us to obtain the desired texture, flavour and appearance of the food. We can use various methods of heat transfer when the dish we're preparing consists of many different ingredients, pastry and filling, as each of them often needs to be cooked differently. The table below shows how.

Cooking method	How it works
Baking, roasting	The heat from the heating element in the oven is transferred to the baking tin, which then transfers it to the food inside. The food warms up thanks to conduction and through convection as the hot air inside the oven circulates.
Boiling, simmering, stewing	The heat from the hot plate is transferred from the pan to the water, and as the water creates convection currents, it passes the heat through to the food.
Deep-frying, shallow-frying	The heat is transferred from the pan to the oil, which creates convection currents just as in water. That's why frying in oil uses both conduction and convection.
Grilling, barbequing	As the heat radiates from the heating element (e.g. coal), it heats up both the food and the grill/tin it is placed upon. As the grill/tin warms up, it begins to heat up the food through conduction – that's why grilled foods are 'striped'!

An example of how various methods of heat transfer are used when preparing a dish is shown below.

Making spaghetti bolognese requires three steps:

1. **Cooking pasta**
To cook the pasta, you need to boil the water first, and then add pasta. This process uses conduction (to transfer the heat from the saucepan to the water) and convection (to transfer the heat from the water to the pasta).
2. **Making a sauce**
To make the sauce, you need to fry onion and meat first – this process uses conduction. Then you add tomato and simmer the sauce for a long time to reduce it – during that time, convection occurs as the sauce contains a high percentage of water.
3. **Combining the sauce with pasta and adding cheese**
At the end you can decide to sprinkle the dish with grated cheese. As you know, cheese melts when sprinkled on top of a hot dish – that's because it is heated by radiation from the hot pasta and sauce mixture, not an oven or grill, though!

Things to think about

Think of other dishes which use various methods of heat transfer. Explain how the heat transfer happens.

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Heat transfer summary:

Heat transfer method	Conditions	
Conduction	The objects have to touch each other	
Convection	The objects don't have to touch each other	
Radiation	The objects do not touch each other but waves of heat are being sent	

Apply

Identify the processes that take place when:

- 1) grilling tomato
- 2) boiling pasta
- 3) cooking a soup
- 4) roasting chicken
- 5) boiling potatoes
- 6) frying fish
- 7) preparing cottage pie
- 8) preparing a curry
- 9) cooking a béchamel sauce
- 10) poaching eggs

Got time? Give them a go at home or in your class.

Apply

Use a microwave and an oven to prepare frozen pizza. How long does it take?

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How cooking affects food

Cooking affects food both externally (which makes it look different) and internally (which changes its features such as texture). Cooking also affects the nutritional value of foods. That's because certain micronutrients – such as group B vitamins, vitamin C and vitamin A – are very sensitive to temperature and break down during cooking.

Nutritional value

High temperature, pressure, time of cooking, fragmentation, contact with oxygen in the air – all these factors can affect nutritional value of foods. Most vitamins are damaged by high temperatures; for example, 50% of vitamin B6 and 70% of folate will be damaged during cooking. It is also important to remember that some vitamins are water-soluble. This means that they will dissolve in water during boiling and will be lost if the water is drained.

Appearance

The look of food changes depending on the ingredients and cooking methods used. In meat, protein fibres will shrink and push out water (or jus), so the meat becomes smaller. Denaturation and coagulation will cause eggs and pastry to set and become solid. Dough and cake will rise – due to either yeast or chemical leavening agents producing carbon dioxide. Rice, pasta and other starchy foods will absorb water and increase in size.

Colour

The colour of the food usually changes due to the Maillard reaction, caramelisation and dextrinisation, which cause the food to become golden or brown. Some vegetables, such as red cabbage or beetroot, will lose their purple colour and become blue or brown if cooked for too long – the colour may then be restored by adding an acid, such as vinegar. Green vegetables, such as spinach or broccoli, may lose their colour and become dull. To avoid this, they should be cooked for a short time only, and preferably in a lidded pan.

Texture

High temperatures cause food ingredients to change their chemical structure. As a result, some ingredients will become soft (meat, vegetables, fruit, rice or pasta), while others will become crispy and crunchy. Starch gelatinisation and water evaporation will cause sauces to thicken. Coagulation of proteins will cause eggs to set and change from liquid to solid. Dough and cakes will rise due to carbon dioxide, air or steam action. Sugar will caramelise and create a crust.

Smell

The smell of hot foods is usually more pronounced than that of cold foods. That's because volatile compounds in foods are evaporated and filling the air, which makes them easier to smell, especially when baking, roasting or simmering a stew.

Flavour

The flavour of food may change due to changes in chemical structure or due to the addition of other flavourings. During cooking, starch will dextrinise, giving a slightly sweet taste. The caramelisation of sugars leading to a deeper, buttery or nutty taste. A complex chemical reaction called the Maillard reaction will produce numerous chemical compounds which change the flavour of coffee or chocolate.

Appearance

Just as the colour of food changes during cooking, so the texture of food changes.

The colour of food changes during cooking, so the texture of food changes.

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Palatability

Various chemical reactions which take place during cooking affect all food properties. Food that is pleasurable to eat is called palatability. It could be described by such terms as 'crispiness' and will usually make food appetising and desirable to the consumer.



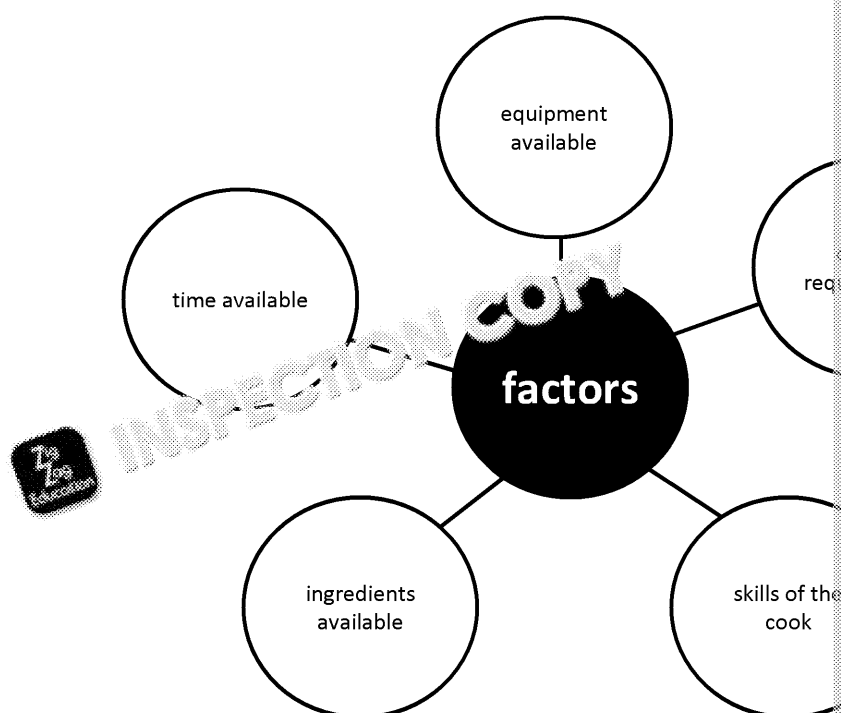
Raw onion which is sharp.

During cooking, sugar in onion caramelises, which causes the onion to change colour and taste (fried onion is sweet). Some of the sulphur-based compounds present in the onion are broken down, so the smell will be sweeter and more gentle. The onion also becomes softer – that's because some of the fibres in its cell walls are broken down. Cooked onion will have less vitamin C than raw onion.

How cooking affect food

There is a wide selection of cooking methods, which involve water-based, fat-based or dry heat. The choice depends on various factors, such as skills of the cook or requirements of the person who doesn't own an oven will not be able to make a lasagne, and a person who doesn't have a stove will not be able to poach an egg. Likewise, it won't be possible to cook a three-course meal without an oven. It won't be possible to cook spaghetti without water (frying isn't a good example, as it is not recommended to offer triple-fried chips to someone suffering from cardiovascular disease).

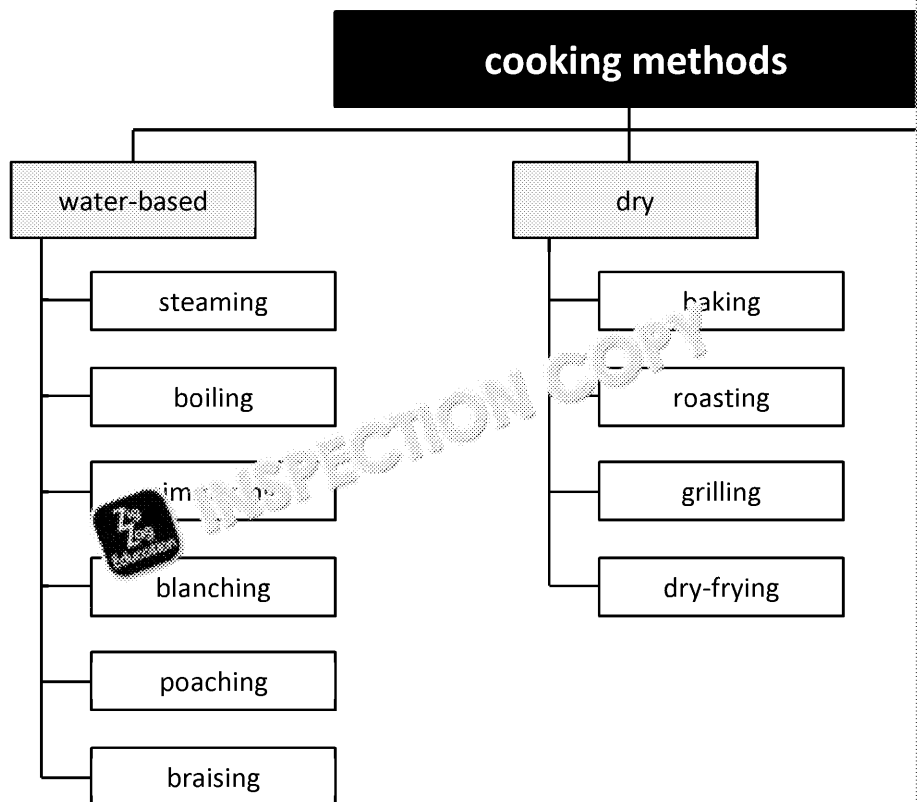
Therefore, the choice of a cooking method depends on such factors as equipment available, time available, ingredients available, skills of the cook, time available for cooking, available ingredients and requirements of the person who is for.



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Different cooking methods are often combined to obtain the desired meal. Cooking methods are divided into water-based, dry and fat-based methods.



Water-based cooking methods

Water-based cooking methods use water and other liquids to transfer heat – either directly (as in boiling) or indirectly (as in steaming). Their use is beneficial for a number of reasons:

- The addition of fat is usually not required, making the dishes low in calories.
- They help to soften proteins, which makes them more digestible.
- They are safe for fat-soluble vitamins as they will not dissolve in water or be lost.
- They help to soften the starch and make it more digestible for people.
- The cooking time may be easily adjusted – it's enough to probe the cooked food to see if it's done.

Steaming is a technique which requires the use of a steamer (or simply a strainer). In a steamer, a small amount of water is placed in the lower pan, and food is placed in the upper pan. As the water evaporates and cooks the food above. This method is advantageous because vitamins do not dissolve in water because they have no contact with it). Foods cooked this way are nutritious and low-fat.

Boiling is one of the most common cooking methods, in which food is cooked in a large amount of water at a rolling boil. An example of this method is boiling potatoes, cabbage or eggs. Boiling makes them easier to digest, although it also leads to loss of water-soluble vitamins.

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Simmering is a technique in which food is cooked with a significant amount of liquid, but on a low heat and for a long time. An example of the use of this method is simmering a stew. The foods cooked this way will become soft and tender, but the long cooking time will decrease their nutritional value.

Poaching is a technique in which small amounts of water (or other liquid, such as wine or milk) and low heat are applied to food to prevent it breaking apart. It is used to cook delicate products such as eggs, poultry or fish, as it seals their surface and prevents them from falling apart. It is a good idea to save the liquid and use it to prepare a sauce to prevent vitamin loss.

Braising is a cooking method which, technically, combines frying and simmering. The surface is seared at high temperatures, and then simmered for a long time. This way, the food remains juicy and tender. The long time necessary at high temperatures applied will, unfortunately, decrease the nutritional value of a food.

Apply



Boil, fry and roast potatoes. Measure the time they need to cook properly. Compare the benefits of different cooking methods versus the time people may have to spend.

Dry methods

Dry methods include those cooking techniques which do not require the use of water. These include roasting, grilling and dry-frying. Since these methods produce high temperatures, a special probe is used to check the readiness of the cooked food (because the surface is usually browned).

Baking and roasting are techniques that require the use of an oven.

Baking is applied to foods that do not have a stable structure but will obtain it after processing. This includes such foods as muffins, sponge cake or fish pie. Before baking, it is advisable to line the baking tin with parchment paper or cover with fat/breadcrumbs, to prevent it from sticking to the pan or baking tray. Baking helps to obtain soft foods with a crispy surface – such as the crust on top of bread. Sugar will caramelize at high temperatures and add flavour to the foods. Starch will break down and become more easily digestible, which may be important for people with digestive tract diseases.

Roasting is applied to foods that are already solid, such as turkey or parsnips. During roasting, it is advisable to sprinkle the surface of the meat with fat or oil and to baste it with juice that's leaking out of it to create a crispy, shiny surface. Roasting softens and tenderizes the food, but the long time required leads to the loss of heat-sensitive vitamins.

Grilling is a technique which uses infrared waves to heat up the food. Grilling allows for the cooking of a large amount of food at once. It is not appropriate for some people, e.g. those on a low-fat diet. Grilling foods, especially at high temperatures, can produce harmful, carcinogenic substances as a result of the charring of the food.

Dry-frying is frying in a dry pan – without the use of fat. It usually requires the use of a non-stick pan (Teflon, stainless steel or ceramic). During dry-frying, fat will melt and leak out of the food. This method is more acceptable for people who cannot consume a lot of fat. The cooking time is longer than for frying in oil. The longer the food is cooked the more vitamins will be lost due to the high temperatures applied.

All dry methods of cooking are recommended for health reasons to people who want to reduce their intake of fats.

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Apply

Research (using books or the Internet) a recipe for a casserole or tagine and of how to prepare. What cooking methods will you use?

Fat-based cooking methods

Fat-based cooking methods include shallow-frying, deep-frying and stir-frying. Frying usually produces high temperatures (around 200 °C and more) and, therefore, damages vitamins in foods. Depending on the quality and quantity of the fat used, fried foods are more or less appropriate for different people. For example, frying in general is inappropriate for an obese person with hypertension but shouldn't be harmful for a healthy individual.

Fat-based cooking methods use different fats, such as vegetable oils, butter, lard and margarines.

Shallow-frying requires only a small amount of fat. The fat in shallow-frying:

- seals the surface and closes juices inside the food (e.g. meat)
- creates a crispy skin/surface
- gives the food the desired taste
- prevents food sticking to the pan

Shallow-frying will damage some of vitamin C and vitamin B2 due to heat, but will add more fat-soluble vitamins to the food.

Deep-frying uses large amounts of fat – this is often used to fry chips or breaded treats such as Scotch eggs. During deep-frying, the whole product is sunk in fat, allowing it to cook evenly. Unfortunately, during deep-frying a lot of fat is absorbed by the food, making it fatty and not suitable for many people. Also, the heat will lower the vitamin content in the food.



These deep-fried...

Study tip



Stir-frying, steaming, grilling, dry-frying and poaching are ways of conserving foods' nutritional value.

Stir-frying is a variation of shallow-frying, in which food is cooked constantly in the pan. The technique is specific to Chinese cuisine. The dish in which food is stir-fried is a method which takes a short time only, so the food retains its nutritional value and colour.

Think about

Discuss the advantages and disadvantages of all of the cooking methods (and fat-based methods). Discuss how the use of each of these methods affects the health of an individual and how this can influence the food choices they make.

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Check your understanding

Why and how food is cooked

1. Water is necessary for... (1 mark)
 - a. baking ☐
 - b. boiling ☐
 - c. frying ☐
 - d. grilling ☐
2. The flavour of food may be changed by... (1 mark)
 - a. coagulation ☐
 - b. caramelisation ☐
 - c. dextrinisation ☐
 - d. both b and c ☐
3. During cooking, rice will... (1 mark)
 - a. increase its size and absorb water ☐
 - b. decrease its size ☐
 - c. reduce its size and lose water ☐
 - d. decrease its size ☐
4. Sauces thicken during cooking because of... (1 mark)
 - a. water evaporation and caramelisation ☐
 - b. water absorption and caramelisation ☐
 - c. water evaporation and starch gelatinisation ☐
 - d. water absorption and starch gelatinisation ☐
5. State three reasons why food is cooked. (3 marks)
 1.
 2.
 3.
6. Explain the scientific changes that take place when baking a lasagne. (4 marks)

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7. Identify two ways in which braising affects the nutritional value and/or...
 1.
 2.

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The positive use of microorganisms in food

Bacteria, yeast and mould can all be used in the production of foods such as bread (bagels, pizza or calzone), soya products (tofu), cheese and yoghurt to name a few. However, only selected species are used in food manufacturing – others may cause more harm than good. Microorganisms in food production are responsible for the distinctive flavour, aroma and texture of the product, and help to improve its shelf life and nutritional value, as well as digestibility.

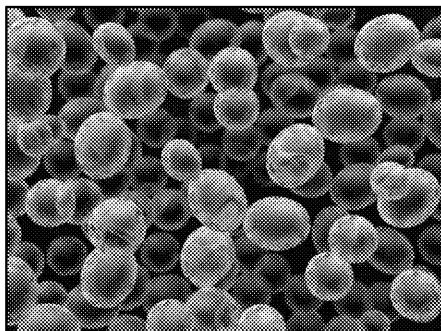
The role of yeast, mould and bacteria in food production

Various microorganisms can be used in food production for different reasons. For example, yeast is used as a raising agent in baked goods and to ferment sugars into alcohol in the production of beer. Different species of bacteria can be used in the manufacturing of dairy products, but also in the production of pickles. Mould is used in the production of cheese and meat products, and sauces. Often, different microorganisms are used in the production of one product, as the combination all have a different effect.

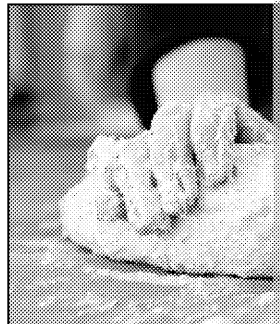
How is yeast used in bread-making?

Yeast is a type of fungus used in bread-making to make bread dough rise. Yeast works by breaking down sugars into alcohol and carbon dioxide, which, in turn, release carbon dioxide. It is the carbon dioxide that makes the dough rise. The yeast used in bread production is referred to as baker's yeast (or brewer's yeast in alcohol production). The scientific name for baker's yeast is *Saccharomyces cerevisiae*. Yeast can be isolated from the skins of fruit. Yeast can also be used for bread-making.

Baker's yeast breaks down sugars and releases carbon dioxide.



Carbon dioxide makes dough rise and is released during baking.



D

Blue mold
on lemon

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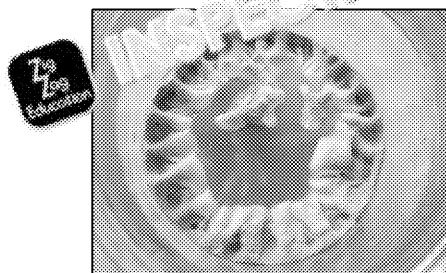
How is mould used in blue cheese?

A culture of the blue mould *Penicillium* is used to create the blue-veined appearance of Roquefort (from sheep's milk), Gorgonzola and Stilton (from cows' milk). The mould enhances flavour and produces a pungent taste and smell. It does this by breaking down (releasing) proteins within the cheese and releasing **enzymes**. This process also raises the pH.

Mould requires oxygen for it to grow. Air holes within the cheese act as pockets for oxygen (sometimes bacterial cultures are added to create the holes).

The *Penicillium* mould culture is found naturally (blue mould grows on lemons) and is also manufactured in laboratories. The *Penicillium* mould is non-toxic, unlike other moulds which can be safely used in food production without the risk of producing mycotoxins. Once the cheese is 'blueing' (from oxygen) once 'blueing' has occurred, the cheese is wrapped in foil and placed in a container.

The blue mould culture *Penicillium* is grown in a laboratory.

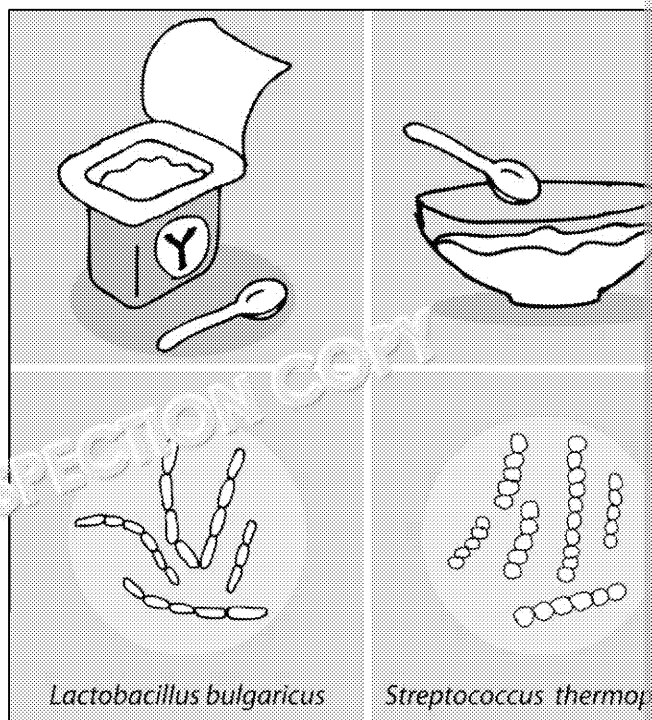


The mould is added to the cheese and it spreads via the air holes.



How is bacteria used in yogurt?

The bacteria used in yogurt are *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. These bacteria break down the sugars in the milk (called lactose) and create lactic acid. This lowers the pH, making the milk more acidic. This process makes milk curdle, thereby producing yogurt (a type of fermented milk). These bacteria are considered 'friendly' bacteria as they aid digestion and help to improve gut flora. These bacteria are referred to as 'probiotic'.



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How microorganisms are used in production of meat products

Some fermented meat products such as Spanish chorizo, Italian salami or French saucisson are made using a mixture of 'good' bacteria and mould. The bacteria are added to raw, minced meat, where they trigger chemical reactions. The different species and varieties of microorganism play different roles in production:

- *Micrococcus* bacteria transform nitrate to nitrite – due to this, the meat made in this way is safe to eat
- *Lactobacillus* bacteria lower the pH of the sausage, making its flavour slightly tangier (through denaturation of the protein in the meat) – the ready sausage is often sold in brine
- *Penicillium* moulds create a white coat on the surface, which is desirable in some products

The 'good' bacteria and moulds also help to protect the sausage from the harmful varieties, increasing its shelf life.

The fermented meat is then mixed with salt and spices, put into natural or artificial casings, and then dried and matured. During the last step, some sausages can be smoked (this is popular, e.g. for German and Hungarian fermented sausages). The various preservation methods used during production of these meats means that they can be safely stored even outside the fridge.

Apply

Read the article at zzed.uk/8257-sausages and list all of the preservation methods used in the production of fermented sausages.

Explain why low temperatures have to be kept during production.



Champagne is made from fermented grapes. It is served in tall, thin glasses called 'flutes' so that the CO₂ bubbles don't escape too quickly!

Use of microorganisms in the drinks

When yeast ferments sugar, it produces not only carbon dioxide (which is very helpful in baking), but also ethanol. The earliest evidence of fermentation dates back to 7000 BC to produce wine from fruit, honey and yeast. Yeast is used in the production of alcoholic beverages such as beer and champagne. During production, the sugar-rich juice is filtered and pumped into large containers. There, yeast is added – they transform the sugar from fruit into ethanol and carbon dioxide. That's why most of these drinks are carbonated.

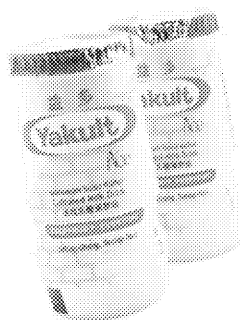
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Other foods made with the use of microorganisms

Fermentation has been used as a popular way of preserving foods around the world, though people didn't understand the mechanisms behind it. Today we know that probiotic bacteria, mould and yeast. The products made with them usually have a unique flavour and texture. These products include the following:

- Soy sauce, Worcestershire sauce, fish sauce, Tabasco
- Pickles (e.g. pickled gherkins)
- Sauerkraut and kimchi (Asian-style sauerkraut)
- Milk beverages, e.g. kefir, ayran, *Actimel*®, *Yakult*® and kombucha (beverage containing probiotic bacteria, drunk instead of fizzy drinks)
- Tempeh and miso paste (made of fermented soybeans)
- Cocoa beans (yes – they also undergo fermentation before being turned into chocolate)
- Pu-erh tea
- Olives
- Fish preserves, e.g. anchovies in the Mediterranean region, surströmming in Sweden



Yakult is made with the use of specially selected bacteria species.



Soy sauce is made from soybeans fermented with mould.

Skills

1. Demonstrate the effect of yeast in making bread rise.
2. Make a bread dough, and finish and shape it for use in pizza, breads, etc.

Think about

Think of other foods that go through a fermentation process.

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Check your understanding: the processing of microorganisms in food products

- Which of the following mould cultures is used in blue cheesemaking? (1 mark)
a. Mycotoxins ☐ b. *Penicillium* ☐ c. Spores ☐
- What is the name for sugars in milk on which bacteria feed? (1 mark)
a. Fructose ☐ b. Lactose ☐ c. Sucrose ☐
- Lactic acid causes which type of process in order to create yoghurt? (1 mark)
a. Boiling ☐ b. Curdling ☐ c. Whipping ☐

- Show two functions of bacteria in cheesemaking. (2 marks)

1.

2.

- Discuss how the processing of salami helps to make it microbiologically safe.

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The working characteristics, and functional and chemical properties of cooking ingredients

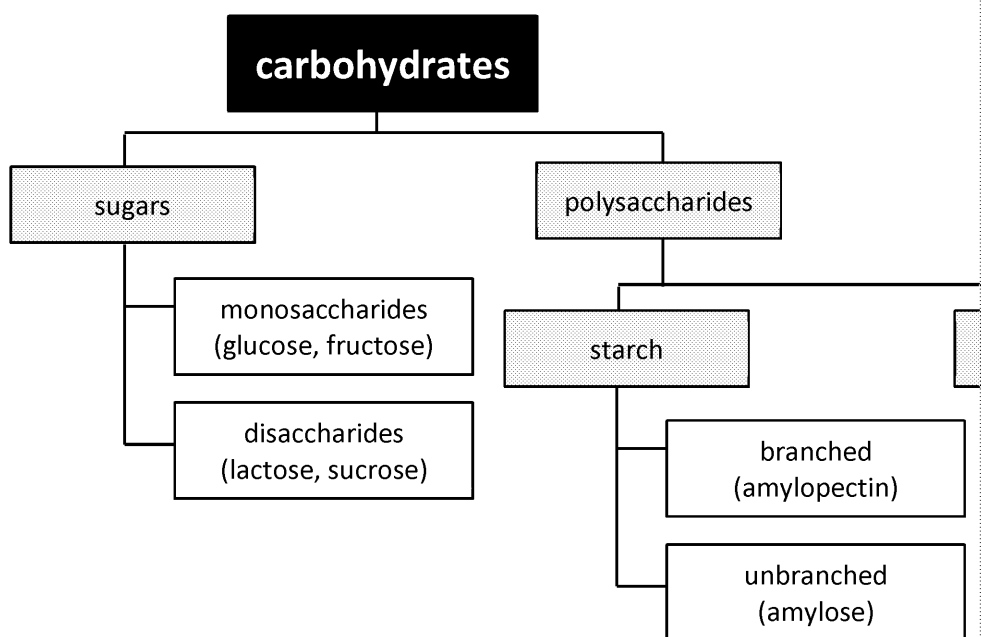
Cooking is mostly based on the sciences of chemistry and physics. Knowing the characteristics of ingredients is very important, as it helps to understand why and how an ingredient functions, its functions are, and how to adjust the proportions, cooking methods and time, and how to prevent the effect of an ingredient from being lost – and how to prevent the effect of an ingredient from being lost.

The working characteristics, and functional and chemical properties of carbohydrates

Carbohydrates include sugars, starches and dietary fibre. They are present in many vegetables and fruit to provide energy. Carbohydrates are the main source of energy necessary to build and maintain the body and conduct all live processes in every living cell.

The chemical structure of carbohydrates

Carbohydrates are all structured differently and can be split into the following groups:



Sugars include monosaccharides (single molecules) and disaccharides (built of two monosaccharides). They are found in table sugar, honey, syrups, etc. They dissolve easily in water.

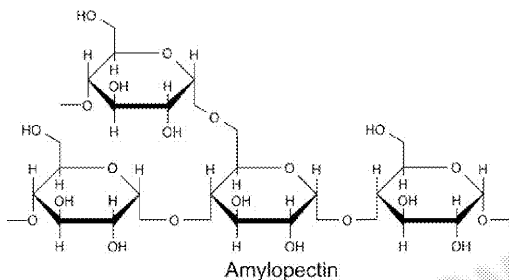
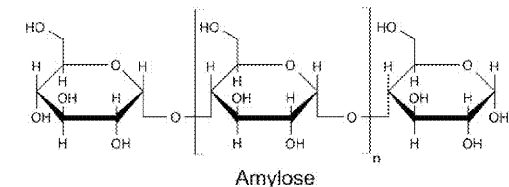
Starches and fibre are long chains of monosaccharides bound together.

Starch is the main component of many foods. It is built from many monosaccharides bound together into long chains, which can be either branched or unbranched (this may be important when dissolving starch – the branched one should dissolve more easily). Starch doesn't dissolve in cold water, but instead forms a suspension. A suspension is a mixture of starch particles floating in water, and eventually, forming a residue at the bottom of the vessel (dish, glass). During cooking, starch can either **gelatinise** or **dextrinise**.

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Amylose is an example of an unbranched starch, while amylopectin is branched. They are both built from thousands of glucose molecules.

Dietary fibre is built of thousands of glucose molecules bound together into long chains. It is usually indigestible for humans but has many benefits. Soluble fibre absorbs water and creates a jelly-like substance when cooked. Insoluble fibre will not absorb water and will not cook, which causes plant cell walls to break down.

The table below shows why cooking is important. Can you think of any other reasons why cooking is important?

	Function in cooking	Example
Sugar	Sweetening	Cakes, creams, beverages
	Bulking agent	Cakes, e.g. sponge
	Aeration	Creams, e.g. buttercream
	Improving flavour	Sauces, e.g. tomato sauce
	Preserving food	Jams
	Improving texture	Cakes, e.g. sponge cake, meringue
	Enhancing fermentation	Baked goods which use yeast, e.g. bread
	Improving colour	Cakes, bread and meat (due to dextrinisation and Maillard reaction)
Flour	Bulking agent	Baked goods, e.g. cakes, bread
	Improving texture	Goods that are high in gluten, e.g. bread
	Thickening agent	Sauces, e.g. custard, white sauce
	Improving nutritional value	Goods made with wholemeal flour, e.g. bread

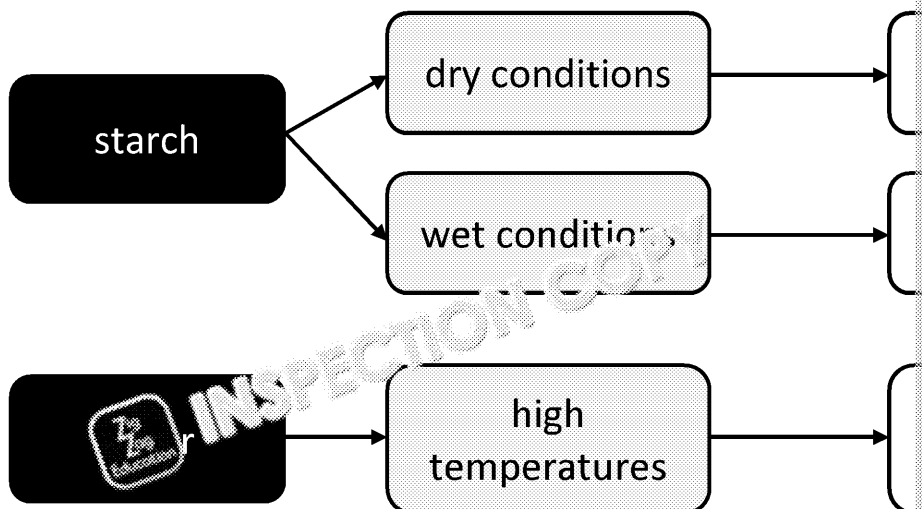
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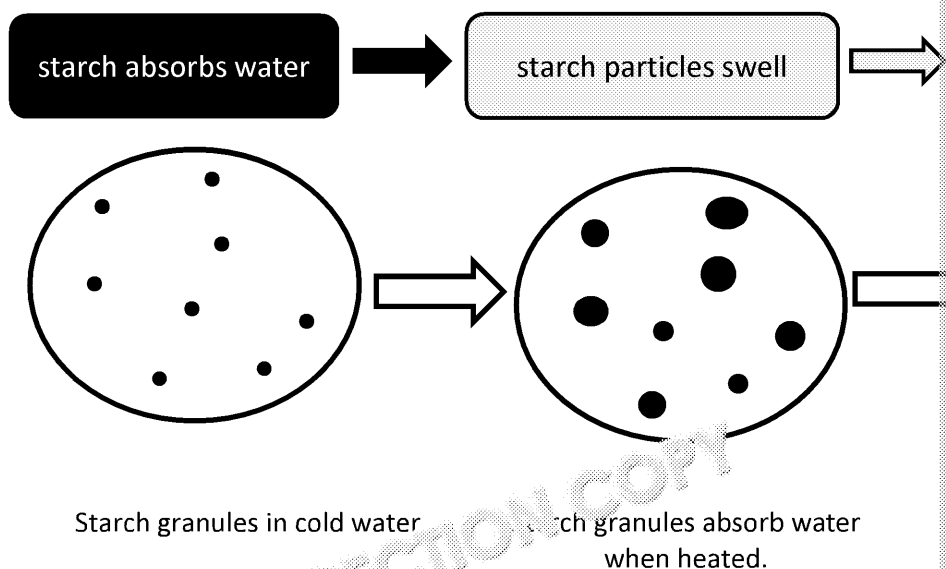
Preparing and cooking with carbohydrates

Food preparation and cooking involve many varied techniques which differently affect the texture and the chemicals it's made of. Various cooking times, temperatures and the pressure will cause visibly different effects on carbohydrate-rich food products.



Gelatinisation of starch

Starch particles do not dissolve in water. Instead, they absorb it and swell, turning into a gel. This process happens when the mixture of water and starch is heated and is called gelatinisation. It is a cooking process since it helps thicken sauces and other mixtures, such as puddings. The mixture must be stirred constantly to prevent the formation of lumps. In cold water, starch granules will settle at the bottom of the vessel.



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Apply

- 1) Prepare three samples of béchamel sauce: use plain flour for sample 1, butter for sample 2 and again plain flour for sample 3 but do not stir the mixture. What do you observe?
- 2) Explain how convection and conduction are applied during sauce-making.



Dextrinisation of starch

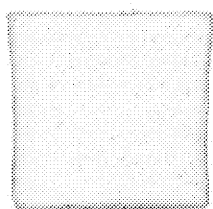
Shorter chains of polysaccharides are also called dextrin. When polysaccharides, under certain conditions, their long chains break down into shorter ones – this is called dextrinisation. This happens while baking bread (and other starchy foods) and is responsible for the sweet-ish crispiness of the crust.



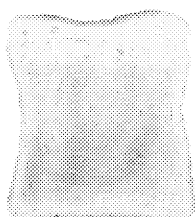
Apply

Place a piece of bread in your mouth and chew for 60 seconds. Notice how the taste changes from savoury to sweet. This is because the long chains of polysaccharides are broken down by the enzymes in your mouth into sweet short chains of dextrin molecules of sugar. This happens when bread is being baked by enzymes, but heat stops the process.

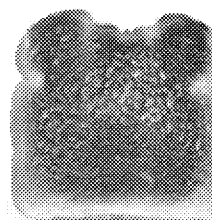
While making roux for a sauce, flour dextrinises. Different stages of dextrinisation lead to a final variation of colour and taste.



Fresh bread has long chains of polysaccharides.



Lightly toasted bread will have some of the polysaccharides broken down into dextrins, so its colour and flavour will change.



Too long a time and too high a temperature of toasting will cause the bread to burn. The starch in it will be dextrinised, but the evaporation of water will cause it to taste bitter.

Apply

Toast bread on different settings in a toaster (1, 2, 3, 4 and 5) or for different times (e.g. 2, 5, 10, 15 and 20 minutes). Compare the colour and taste of the bread slices. Notice how both the appearance and the taste of the bread change.

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Additional reading: caramelisation of sugars

Sugars include molecules of monosaccharides and disaccharides. At high temperatures, sugar crystals break and melt into syrup, and change colour from light yellow through golden to brown. This is because oxygen and hydrogen are being evaporated and only black molecules of carbon are being left. Depending on the temperature and time of cooking, all foods containing sugars will caramelise.

Caramelisation is used in cooking to either change the flavour or affect the colour of the food to make it more appealing. This process is used when making fudge or burning the surface of *crème brûlée* to create the golden, crunchy top. Caramel is also used in manufacturing cola-like beverages and is responsible for their dark brown colour.

Caramel
sweet to st

Apply

- 1) In  prepare roasted carrots and onions.
 - Group A: roast for 30 minutes at 200 °C
 - Group B: roast for 30 minutes at 160 °C
 - Group C: roast for 60 minutes at 160 °C
 - Group D: roast for 60 minutes at 100 °C
- 2) Make notes on how cooking time and temperature affect the colour and

Did you know?

The Maillard reaction takes place when proteins and carbohydrates are cooked by dry methods. Amino acids from proteins and sugar from carbohydrates react with each other, which results in the creation of so-called Amadori compounds. These agents change the smell, flavour and colour of the food (it becomes brown). The Maillard reaction is used to obtain the desired smell and flavour of bread and pastry, beer and coffee beans.



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Check your understanding: carb

1. Tick the box next to each statement to show whether it is true or false

- | |
|--|
| a) sugar helps to extend the shelf life of foods |
| b) the main function of carbohydrates is to sweeten food |
| c) flour can be used as a gelling agent |

2. Dextrinisation takes place when... (1 mark)

- | | |
|--|---|
| a)  mixing a tomato sauce | ☐ b. making a roux |
| c. boiling jelly | ☐ d. boiling pasta |

3. The process of absorbing water and thickening mixtures with the use of

- | | |
|-------------------|--|
| a. dextrinisation | ☐ b. caramelisation |
| c. gelatinisation | ☐ d. gelation |

4. During cooking, pasta... (1 mark)

- | | |
|---------------------------------------|--|
| a. will push out water and dextrinise | ☐ b. will swell and dextrinise |
| c. will absorb water and dextrinise | ☐ d. will absorb water and dextrinise |

5. Describe the function of starch when making sauces and explain how it affects the final product. (4 marks)

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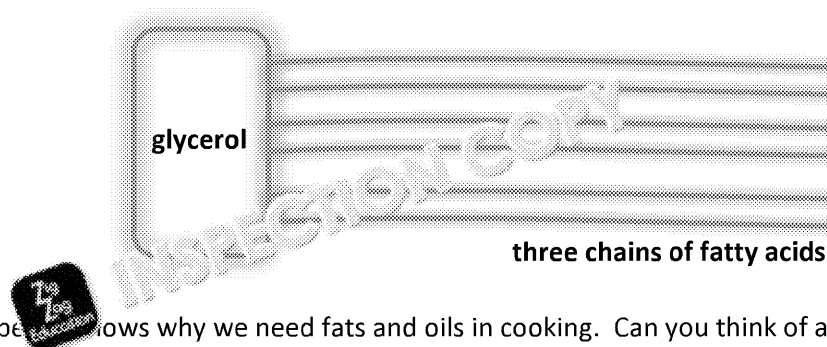
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The working characteristics, and functional and chemical properties of fats and oils

Fats and oils are built of a glycerol 'head' to which three chains of fatty acids are attached. In the fatty acids are bound together by either single or double bonds. This determines whether the fat is solid at room temperature – generally, saturated fats (which have only single bonds) are solid at room temperature and unsaturated fats (in which double bonds are present) are liquid at room temperature. The chemical structure of a fat or an oil is important because it determines its colour, taste, and, therefore, usage in cooking.



The table below shows why we need fats and oils in cooking. Can you think of any other uses for fats and oils in cooking?

	Function in cooking	
Fats and oils	Improve the texture	Butter in buttercream
	Serve as shortening	Biscuits, pie crust, pastry
	Extend the shelf life	Baked goods, e.g. bread
	Improve the flavour	Cream in soup, butter in sauce
	Help to obtain a crispy surface	In fried foods, e.g. chips
	Add flaky texture	Flaky pastry
	Emulsify mixtures	Sauces, e.g. mayonnaise
	Add colour	e.g. butter in shortcrust pastry
	Improve nutritional value	e.g. olive oil in salad dressing
	Carry and improve absorption of fat-soluble vitamins	e.g. dressing in salad

Preparing food and cooking with fats and oils

The structure of fats has an important role when choosing cooking ingredients. So when preparing shortcrust pastry, while oils will be better for frying or preparing a dressing, a fat will help to obtain the desired effect.

Plasticity

The plasticity of fats means their ability to be spread and to melt at different temperatures (they have different melting points). A good example is butter and lard. They are solid while in the fridge, become soft and greasy at room temperature, and melt into oil during cooking.

There are different types of margarine which are spreadable at low temperatures – you can say that they have good plasticity.

Shortening

When mixed with starch (such as flour), fats create a layer around starch particles and therefore, prevent gluten from forming long chains. This is called **shortening** and it helps to obtain crunchy, crumbly textures, as in biscuits. It is noticeable that only solid fats can shorten the mixture – oils will rather turn it into a lump. For this reason, it is best to use cold butter/lard and cold water, and then let the pastry rest in a fridge to obtain a melt-in-the-mouth pastry.

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Apply

Prepare two shortbread doughs, one using butter and the other using half butter and half oil. Bake the biscuits and describe the difference in texture and taste.

Aeration

Similar to foam formation, aeration is the trapping of air bubbles in the fat mixture. This leads to the creation of creams, which can be observed when whisking butter with sugar or when whipping cream. Aeration is also used to obtain the cloud-like texture of soups and creams.

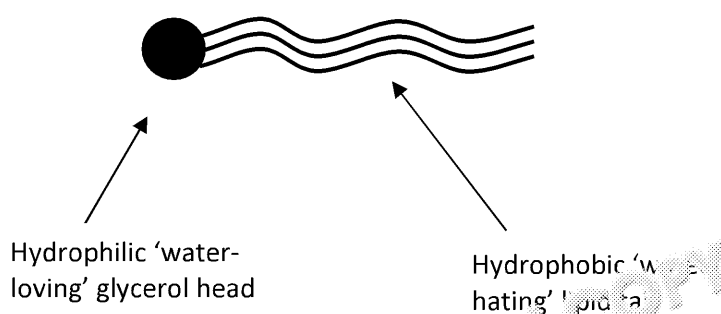
Apply

- 1) Pour three different kinds of cream into three separate bowls: single cream, double cream, and heavy cream.
- 2) In groups, whisk each cream to measure the time needed and observe the texture.
- 3) Compare the results of each of the creams and how this affects the final volume.

Emulsification

An emulsion is a mixture of oil and water. Depending on the proportions of ingredients, we can distinguish water-in-oil emulsions and oil-in-water emulsions. An example of an oil-in-water emulsion is milk: usually, fat molecules are spread evenly in the liquid, but if the milk is boiled, they will form a layer on top. An example of a water-in-oil emulsion is butter (how it 'sweats' when taken out of the fridge).

Since fat is hydrophobic, the particles of fat and water will repel each other, leading to the separation of the emulsion into layers. To prevent this and to make the mixture stable, emulsifiers are used. One of the most popular emulsifiers is lecithin, present in egg yolk. Emulsions are used not only in cooking, but also in the cosmetic industry.



When put in water, fat particles will turn their hydrophilic heads towards it, creating a monolayer. Emulsifiers will attach to oil droplets, keeping them dispersed and making the mixture stable.

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Did you know?

Mayonnaise is also an emulsion, made of vegetable oil, egg yolk, vinegar and flour.

- liquid phase – vinegar (sometimes milk is also used)
- oil phase – vegetable oil, such as sunflower oil; various types of mayonnaise use other kinds of oil, such as olive oil, to improve their nutritional value
- emulsifier – egg yolk; it is a natural source of lecithin, which will suspend the mixture and prevent layering

Large factories may also use homogenisers – special machines which pump the mixture and make oil droplets smaller, making it easier to suspend in the mixture.

Research

Read the label on a jar/bottle of mayonnaise and try to define whether it's an oil-in-water or water-in-oil emulsion. Justify your answer.

Research

Check what substances are used as emulsifiers in foods on <https://www.faia.org.uk/emulsifiers-in-food/>

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Check your understanding: fats

1. Shortening means that... (1 mark)
- | | |
|--------------------------------|--|
| a. fatty acids become shorter | ☐ b. gluten fibres become shorter |
| c. sugar chains become shorter | ☐ d. carbohydrate chains become shorter |

2. Plasticity means that... (1 mark)
- fat is solid at room temperature
 - fat is liquid at room temperature
 - fat is easily spreadable at room temperature
 - different fats melt at the same temperature

3. Which statements about emulsions are TRUE? (1 mark)
- fats dissolve in water
 - fats and water create emulsions
 - fats with acid create emulsions
 - all fats have the same melting temperature

4. Identify two changes to the fat during the production of a sponge cake.

1.
2.

5. Describe how the chemical structure of fats affects their physical state. Give two examples in your answer. (2 marks)

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6. Explain why emulsifiers must be used during the production of mayonnaise.

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7. Explain the chemical changes that help to obtain a shortcrust pastry. (4 marks)

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The working characteristics, and functional and chemical properties of proteins

There is a wide variety of food products that are rich in protein. And although the protein in the diet, they also play a crucial role in creating the desired texture, flavour and appearance of a dish. One of the most versatile protein-rich ingredients is egg. Due to its chemical properties, it is used in a wide variety of various dishes, and for different reasons. Other protein-rich staples include milk and cheese. The functions of each of these products in cooking are described in the table below.

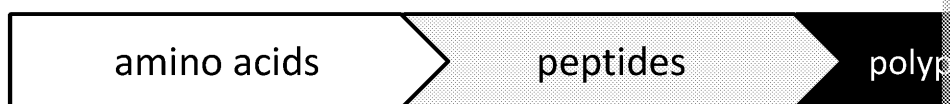
	Function	
Eggs	Binding agent / improve the texture	Cakes, muffins
	Coating (adds shine and lengthens shelf life)	Bread rolls
	Leavening agent	Cakes, soufflés
	Thickening agent	Sauces, e.g. custard
	Stabiliser (e.g. in mayonnaise)	Sauces, e.g. mayonnaise
	Improve the moisture	Cakes, muffins
	Improve the nutritional value (by adding protein, vitamins, minerals, and omega-3 fatty acids)	Sweet and savoury
Milk	Improve the appearance (used as a garnish)	Garnish in salads
	Binding agent	Muffins, pancakes
Cheese	Improves the texture	Yorkshire puddings
	Improves the flavour	Sauces, e.g. cauliflower cheese
	Adds colour	Sauces, fillings, e.g. in lasagne
Yoghurt and buttermilk	Adds texture	e.g. on pizza or in bread
	Improve the texture (used as a marinade)	Meat, fish
	Improve the nutritional value (lowers fat content)	Salads, soups, sauces
Cream	Thickening agent (add creamy texture)	In soups and sauces
	Thickening agent	In soups and sauces
	Improves the appearance (often used instead of garnish)	In salads and soups
	Improves the texture	In creams, and in soups

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The chemical structure of proteins

Proteins are large biomolecules built of hundreds of amino acids. Amino acids bond together to form peptides, and peptides bond together to form longer chains of polypeptides (polymers).



Proteins can adopt different spatial structures, usually to save room and fit more into a cell. Amino acids may react with each other, creating new chemical bonds.

1. **Primary structure** – when the protein has the form of a simple chain of amino acids bound together.
2. **Secondary structure** – when the chain starts to form a spiral (helix) or harmonica (sheet); here, the amino acids come closer together, creating hydrogen bonds between them, which gives them one of these two shapes (shown right).
3. **Tertiary structure** – when the spiral/harmonica clumps more tightly to form a ball or other 3D shape (usually to save room). In the tertiary structure the protein is still built from one chain of amino acids, which now form three different types of chemical bond (peptide bonds, hydrogen bonds and disulphide bridges).
4. **Quaternary structure** – when different chains of proteins form a 'lump' made of different tertiary-structured proteins, to form a fully functioning biological unit such as an enzyme or hormone.

Now you have a better understanding of how proteins are structured, we can begin to look at how different methods of preparation and cooking can change the structure and chemical properties of a protein.

In the quaternary structure, different chains of proteins join together to form a functioning unit, such as an enzyme.



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Preparing food and cooking with proteins

Protein denaturation

Denaturation is a process in which chemical bonds in the proteins are broken, and happens in certain conditions:

1. when heat is applied to a protein, e.g. when baking a soufflé or boiling an egg
2. when acid is applied to a protein, e.g. when lemon juice is added to meringue
3. due to mechanical actions, such as whisking egg white (see foam formation)

Different proteins denature at different temperatures. For most of the proteins in food, denaturation is around 65 °C and more. This is why eggs set, meats and fish become spongy when cooked.

Acid is also capable of damaging bonds in protein. This is used when adding lemon juice to prevent foam from collapsing (e.g. whipped egg white for meringue) or when marinating meat.

Foam formation

Mechanical actions, such as whisking, also lead to the damage of protein structure. This can be partially reversed – you can notice how whipped egg white will turn into liquid again. During whisking, protein molecules stretch and tiny air bubbles are forced into the mixture, forming a foam. Foams are used to lighten the texture of food, to make it more palatable during cooking. Foam formation is used to prepare sponge cakes, soufflés, ice cream and other foods.

Notice that if beaten for too long, the proteins will shrink and push out water – the foam will collapse.

Apply

- 1) Prepare an egg white. Beat it to obtain a white foam.
- 2) Divide the foam into three bowls.
- 3) Add a teaspoon of lemon juice to the second bowl. Continue beating to a stiff foam.
- 4) Write down your observations.

Apply

- 1) Marinate a piece of pork and a piece of fish. Compare the structure of the raw and marinated pieces.
- 2) Roast all of the products. Compare the structure. What do you notice?
- 3) Learn at [zzed.uk/8257-marinades](https://www.zzed.uk/8257-marinades) how to make various marinades.

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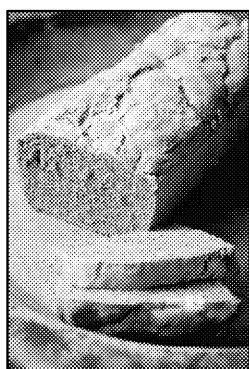
Coagulation

Coagulation is a process in which large particles of proteins aggregate and form lumps. This is because they are being deprived of their electric charge. You can observe it by adding salt to an egg white. This process is usually reversible. Coagulation is used, for example, in salted fish – to undo it, you need to soak the fish in water in order to wash out the salt. Coagulation often takes place simultaneously with denaturation, so it might be difficult to differentiate them; for example, when frying eggs, the proteins both denature and coagulate, leading to the final change of texture. Coagulation may also be caused by enzymes, such as rennin used in cheese production, and heat; for example, when boiling eggs.

In coagulation, proteins are deprived of their electric charge, leading to the aggregation of large particles and the formation of lumps.

Apply

- 1) Prepare five eggs and boil them for different times: 3, 5, 7, 10 and 20 minutes. Use a pen to know when to remove which egg from the water.
- 2) Peel the eggs and cut them in half, and note down the differences you observe.



Gluten gives the dough plasticity and traps air bubbles, allowing it to rise.

Gluten formation

Gluten is the protein found in certain grains (such as wheat, rye, barley and oats). Gluten is formed from two kinds of protein: glutenin and gliadin. When mixed with water, they join together and form a net-like structure. Gluten fibres are elastic and can be easily stretched, which gives the dough a sponge-like structure. This feature is called **plasticity**. This is why wheat bread is soft and elastic, and gluten-free bread is rather fragile and crumbly.

Did you know?

Oats are not gluten-free. Unfortunately, the processing of oats uses the same machinery as wheat, so the process will contaminate the oats with gluten. Oats very often contain small amounts of gluten, which means that they are not suitable for people with coeliac disease. However, some products are certified as gluten-free, which means they contain less than 0.5% gluten. This means they can be eaten by people with coeliac disease in small amounts. However, if you have coeliac disease, you will occur gluten.

During bread-making, yeast produces carbon dioxide (CO_2). The gluten net is useful because it traps the carbon dioxide bubbles and allows the dough to rise.

Apply

- 1) In groups, prepare three kinds of bread dough using different flours, such as whole wheat flour, plain flour and cornmeal. You can use the recipe at zzed.uk/8.
- 2) Write down your observations.

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Check your understanding: p

1. Which process occurs when kneading a bread dough? (1 mark)
 - a. foam formation ☐
 - b. denaturation ☐
 - c. coagulation ☐
 - d. gluten formation ☐
2. Denaturation CANNOT be caused by... (1 mark)
 - a. adding lemon juice ☐
 - b. adding kitchen salt ☐
 - c. adding balsamic vinegar ☐
 - d. adding spirit vinegar ☐
3. A marinade tenderises meat because... (1 mark)
 - a. it contains salt ☐
 - b. it contains oil ☐
 - c. it contains acid ☐
 - d. it contains pepper ☐
4. Gelatinisation takes place when... (1 mark)
 - a. making a shortbread pastry ☐
 - b. baking a quiche ☐
 - c. toasting bread ☐
 - d. cooking pasta ☐

5. Explain three functions of eggs in cooking. (6 marks)

1.
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2.
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3.
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6. Explain how the use of high-gluten flour helps to produce a quality bread. (6 marks)

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7. Identify two changes to protein structure when making a quiche. (2 marks)

1.
2.

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Fruit and vegetables

Various cooking and preparation methods affect the nutritional value of fruit and vegetables, an important source of fibre, vitamins and minerals. Special care should be taken to avoid the damaging influence of external factors, such as oxygen or light. To prevent the loss of nutrients in fruit and vegetables, and to maintain their appearance, texture and taste as much as possible, care should be taken when preparing and cooking, such as:

- not exposing them to air or light unnecessarily to prevent such processes as oxidation from happening
- consuming the liquid in which they were cooked
- microwaving, steaming, roasting or grilling vegetables rather than boiling them
- shortening the time of cooking whenever possible
- scrubbing instead of peeling

Enzymatic browning

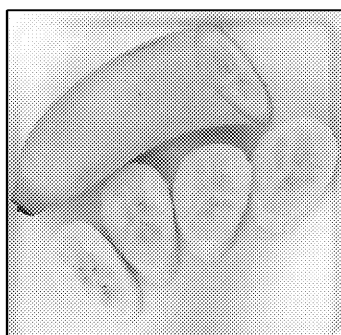
When you're peeling or cutting vegetables, you destroy the structure of plant cell contents to release an enzyme in the cells' juices, called polyphenol oxidase, which damages substances in plant tissues, causing them to brown. This is damaging to food, but on the other hand, helps to obtain the desired flavour of tea, coffee or chocolate in a number of fruit and vegetables, such as:

- avocados, bananas, peaches, pears, apples, mangos, apricots, plums, grapes
- aubergines, mushrooms, potatoes, lettuce

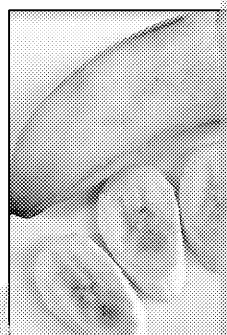
Enzymatic browning can be slowed down or stopped by either:

- lowering the temperature, e.g. putting the cut vegetables into the fridge
- inactivating enzymes by blanching
- adding acid, such as lemon juice or vinegar, to foods
- removing oxygen – this is applied in salad factories, where salads are packed in plastic containers to store the food.

Enzymatic browning will accelerate in the presence of iron or copper – for this reason, avoid using metal plastic containers to store the food.



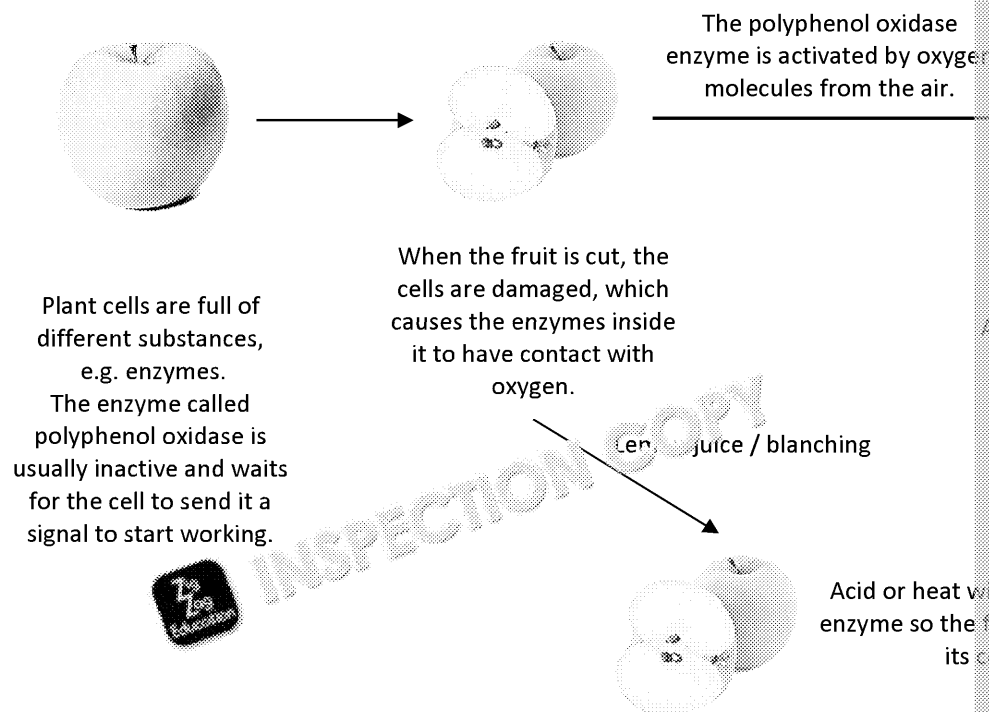
Freshly cut banana



*The same banana
after 15 minutes*

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Research

Explore in more detail why enzymatic browning takes place at zzed.uk/8257-apple-varieties

Oxidation

Oxygen is necessary to live – it is produced by plants from carbon dioxide and used by animals for breathing. However, oxygen has a destructive effect on most foods, causing substances in them to oxidise. During oxidation, food particles lose electrons, which are caught (or, more often, stolen) by oxygen molecules. This leads to food spoilage and loss of nutritional value, leading to the development of an unpleasant flavour and smell.

Natural antioxidants are present in foods (such as vitamins A, C and E), but it is best not to expose the food to air if possible. Oxidation may be stopped or slowed down by:

- protecting food from oxygen, e.g. by covering it or packing in oxygen-free conditions
- using antioxidants, either natural or artificial, such as lemon juice, lime juice
- using barrier substances such as salad dressing which covers the surface of food

Apply

- Take three apples of different kinds (e.g. Golden Delicious, Gala and Jonagold).
- Cut or grate the apples and leave for 30 minutes.
- During this time, you should observe different stages of oxidation – this is due to different amounts of vitamins protecting them from the process.
- Repeat the experiment, but add lemon juice to each sample. What do you observe?

Research

Explore the variety of English apples and pears on zzed.uk/8257-apple-varieties and assess which apple varieties are less prone to enzymatic browning.

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Check your understanding: fruit and vegetables

1. Oxidation is undesirable because... (1 mark)
 - a. it increases the amount of vitamins to dangerous levels
 - b. it leads to vitamin loss
 - c. it prevents food spoilage
2. Antioxidants include... (1 mark)
 - a. vitamins A, C and K
 - b. vitamins A, C and E
 - c. vitamins C, E and K
 - d. vitamins A, E and K
3. Enzymatic browning affects most... (1 mark)
 - a. dairy products
 - b. nuts
 - c. meat
 - d. fruit and vegetables
4. Oxidation leads to... (1 mark)
 - a. development of a bad smell and flavour
 - b. loss of nutritional value
 - c. unappetising appearance of the food
 - d. all of the above
5. Enzymatic browning will happen more quickly in... (1 mark)
 - a. fruit which is high in vitamin C
 - b. grated potatoes kept in a metal bowl at room temperature
 - c. vegetables which are cooked whole
 - d. fruit kept in a covered bowl in a fridge

6. Explain the difference between enzymatic browning and oxidation in fruit.

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7. Explain three ways of preventing enzymatic browning in food. (6 marks)

1.
2.
3.

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The most common faults in cooking and

There are many factors which can affect the final effect which is your dish. Knowing why common cooking faults happen can help you prevent them in the future. The most common causes of error include:

- lack of skills in the cook – but don't worry, you will learn everything you need during this course!
- lack of care when measuring ingredients
- improper time and temperature of cooking
- improper preparation technique, including not preheating the oven and underdoing or overdoing the batter
- improper choice of ingredients

Cake cakes

The most common faults in cake-making include flour, eggs, sugar and fat, sometimes with too much or too little of one or more ingredients. The following table describes the most common problems encountered during cake-making, and explains how to prevent them.

What happened	Why it happened	How to prevent it
The cake is tough and dry	Too much flour (or other powder, e.g. cocoa) was used	• Measure the flour carefully next time • Use the same amount of cocoa powder as the recipe calls for • Cut the cake in half horizontally to make a layered dessert, such as tiramisu
The cake has sunk in the middle	The cake is under-baked You didn't use enough sugar and/or baking powder, so the cake wasn't able to support the cake! You opened the door during cooking	• Use the cooking time according to the recipe and check the readiness of the cake by inserting a skewer into the oven! • If the top of the cake is already browned but the bottom is not, bake for a longer time. • Measure the ingredients properly • Cut the cake into pieces and use it as a dessert • We know it is tempting, but cook the cake for the proper amount of time • Try not to open the oven door during cooking

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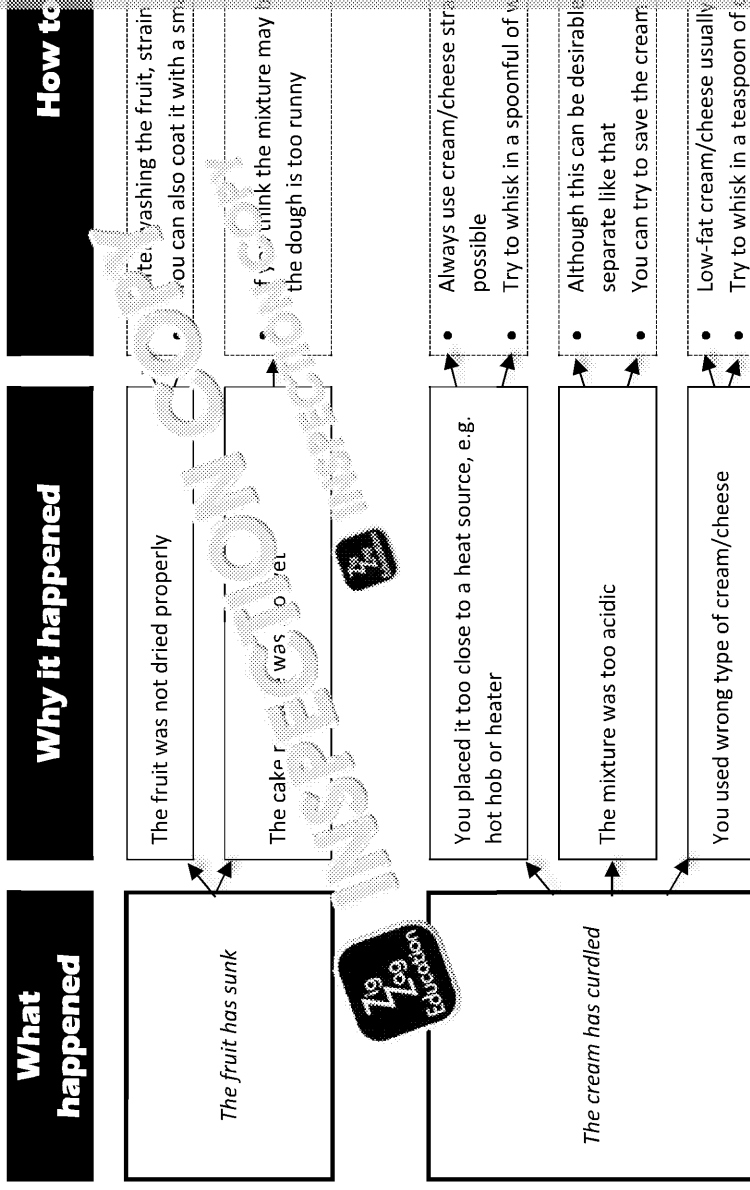
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What happened	Why it happened	How to
The top of the cake has cracked	You poured too much dough into the tin The temperature was too high and the cake cooked before it had risen properly	• Good practice to only fill the tin 2/3 full, which need to be fully risen • Put the cake in the middle shelf • To serve the cake, cut off the top or another dessert
The cake has not risen at all	You didn't use the proper raising method, e.g. you folded whipped egg whites in too quickly or did not cream the sponge for long enough You didn't add enough raising agent You folded the flour in too vigorously	• Next time, spend more time on creaming the butter, sifting the flour • Measure bicarbonate of soda carefully • Next time, fold in the flour gently
The cake has a hard crust	Too much sugar was used You used granulated sugar instead of caster sugar You didn't cream the dough properly	• Next time, carefully measure out the sugar into grams and weigh with kitchen scales • It is always best to use a type of softening sugar – so that the cake is moist • The mixture of sugar and butter should be creamed for 2 minutes

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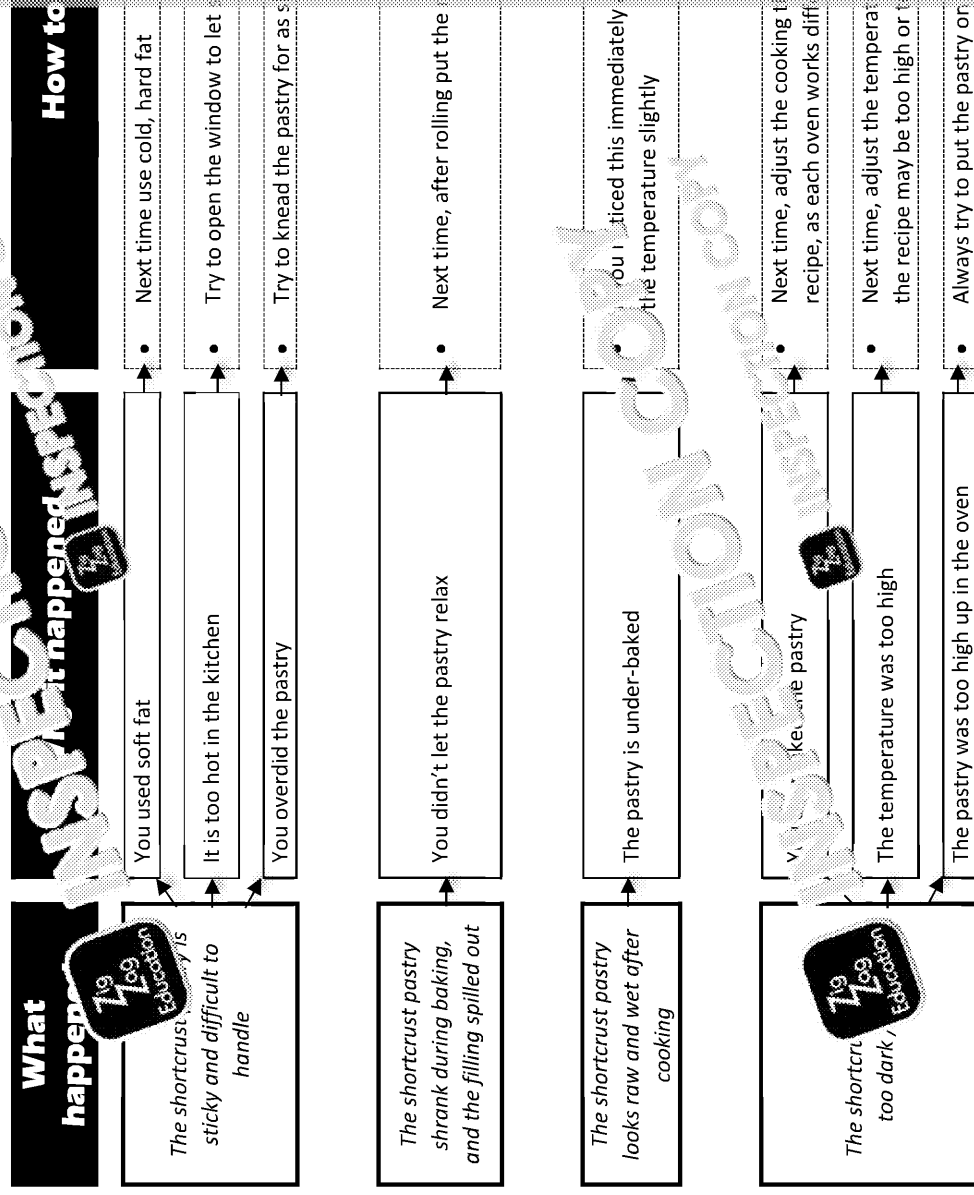


Other baked goods, such as bread and other yeast-based products, may also fail to rise properly due to:

- **lack of sugar** in the dough – the yeast needs sugar to multiply and produce carbon dioxide
- **lack of water** in the dough – the yeast needs water to multiply
- **improper temperature** – it is best to let these foods rise in a warm place and protect them from drafts. A temperature that is too hot or too cold can kill the yeast, and a temperature that is too hot can cause the dough to rise too quickly and not rise at all
- **too much salt** – salt inhibits the growth of yeast, so it cannot grow as fast as it could in proper conditions
- **too little yeast** – if you have too little yeast, it will take too long to rise, and it may not rise at all
- **overdone** – if you over-kneaded the dough, the chances are that you knocked out the carbon dioxide that was produced. It is best to knead the dough lightly and let it prove for a proper amount of time in the baking tin.

Pathetic pastries

Although shortcrust pastry may seem easy, sometimes it may not turn out as expected. It is crucial to the temperature of the ingredients, the pastry and your own hands, as they all play a role in creating a pastry.



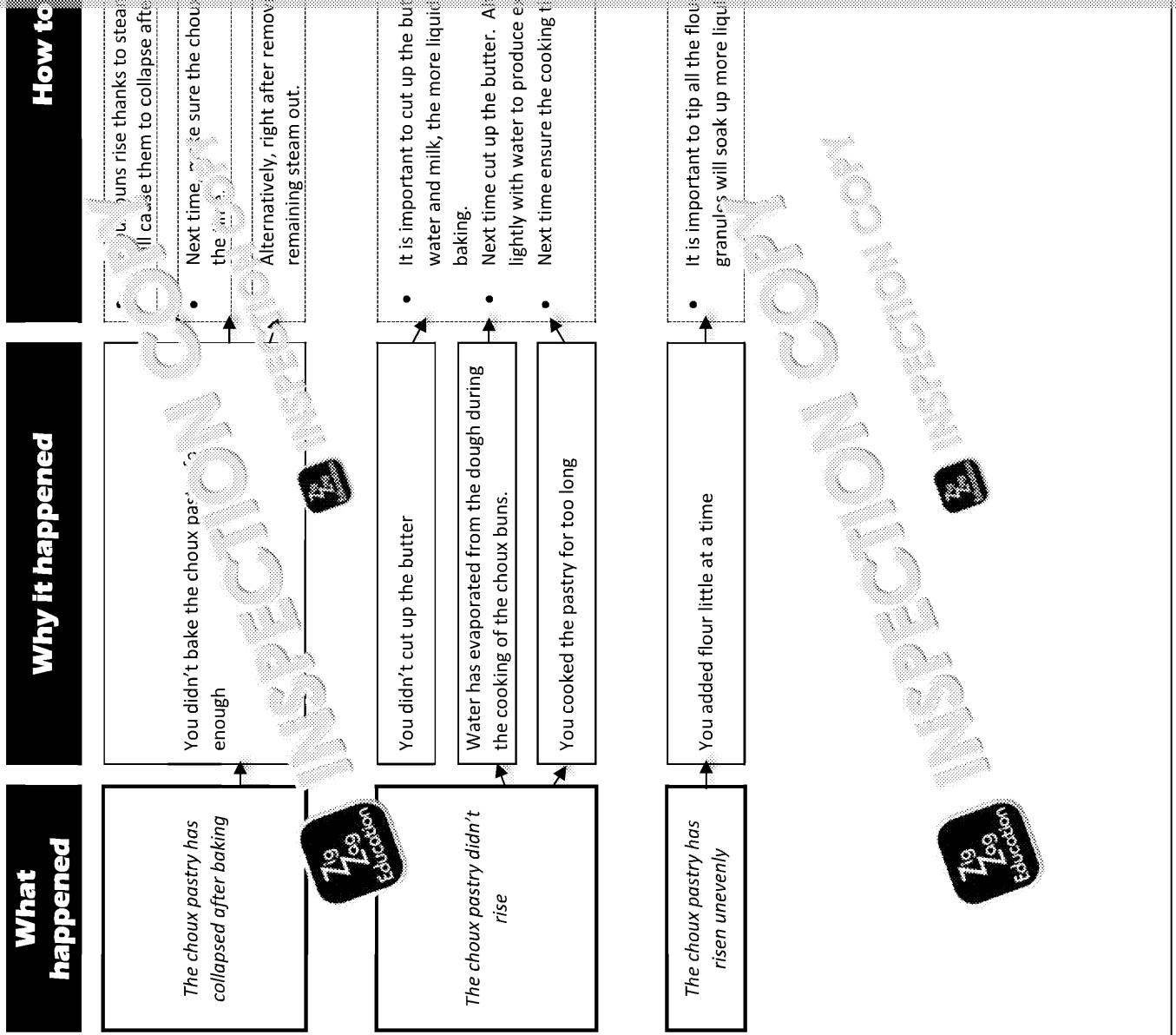
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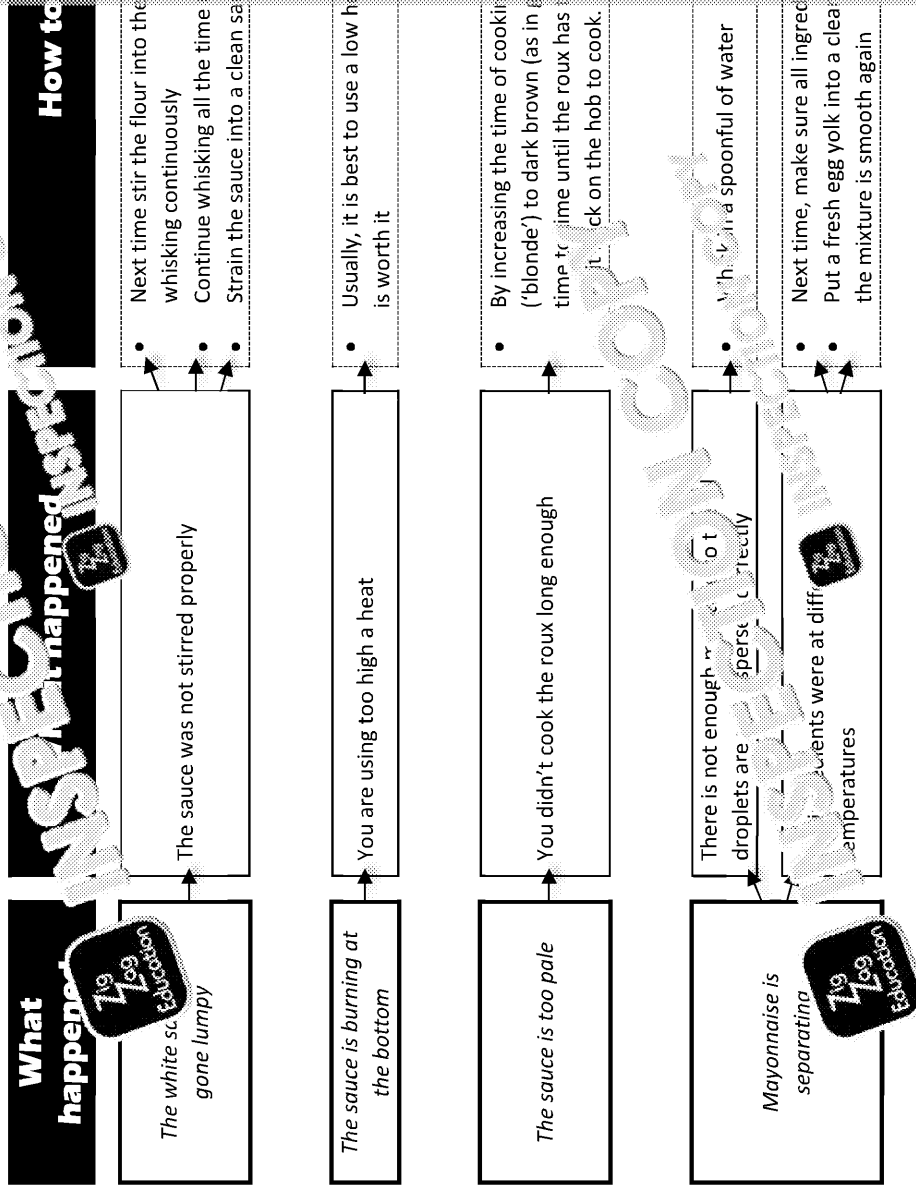
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Serious sauce problems

There are many various techniques of sauce-making. Some sauces are based on starch, some require reduction of liquid and concentration of flavour, and others require the use of emulsifiers. Sauce is of worth knowing how to make it well.



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Other common mistakes

Both new and experienced cooks can make mistakes – due to lack of either skill, knowledge or haste is not your friend when in the kitchen, so it is best to always spend your time reading recipes thoroughly, so that you know what to do step by step, how to schedule your ingredients and utensils to make the cooking easier – and succeed at it! The table below lists some common cooking mistakes which many of us make.

Mistake	Effect
Overcrowding the pan	Instead of frying, your meat and fish begin to steam and you cannot obtain that lovely, crunchy crust
Adding garlic too early	A dish which is slightly burnt and bitter
Flipping the food too often	Fish is likely to overcook and fall apart, and you cannot get a lovely crust
Adding wet greens to a pan full of hot oil	The oil splatters around may possibly burn you, the greens will boil instead of frying, and you end up with a soggy dish
Breading the food improperly	The breading falls off. Next time, dip the food in egg first and then in breadcrumbs – this way, it will stick



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Check your understanding: the faults in cooking and how to prevent them

- Why should garlic be added to a dish at the end of cooking? (1 mark)
 - to make the aroma less intense ☐
 - to improve the taste ☐
 - to improve the appearance of the dish ☐
 - to make sure it doesn't burn ☐
- Which method can prevent fruit from sinking to the bottom of a cake?
 - coating it with breadcrumbs ☐
 - washing it thoroughly ☐
 - coating it with flour ☐
 - cutting it very fine ☐
- What can cause a sauce to become lumpy? (1 mark)
 - overcooking ☐
 - lack of agitation ☐
 - adding too much salt ☐
 - adding too much liquid ☐
- Tick the box next to each statement to show whether it is true or false.

The longer the roux is cooked, the darker the sauce will be.

Using a high-gluten flour causes cakes to sink in the middle.

Low-fat cream is less likely to curdle than full-fat cream.

- State three issues which may occur when making a cake, and which are due to the quality of ingredients. (3 marks)
 -
 -
 -
- Explain three cooking mistakes which can cause bread to fail. (6 marks)

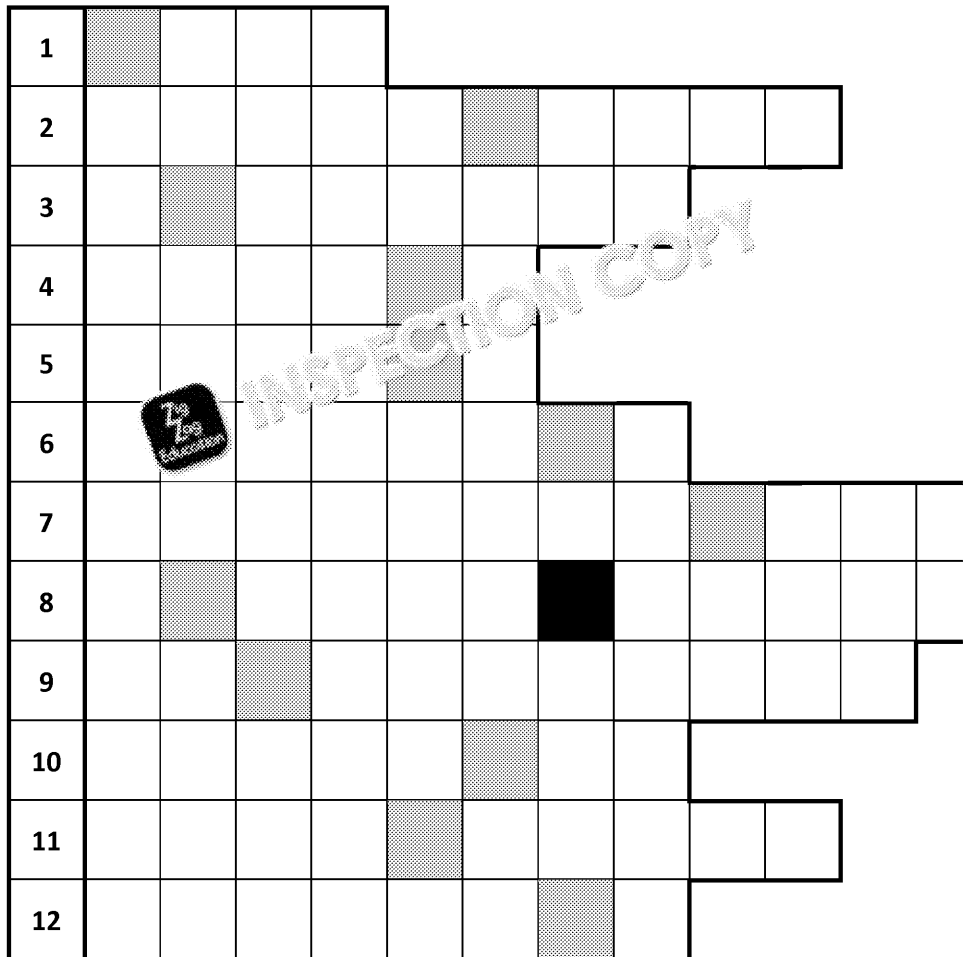


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Chapter 1: Quiz-ine

Fill in the answers to the questions below to reveal a phrase relevant to food science (a black square is a space).



1. A mixture in which gas bubbles are suspended in a liquid phase (4)
2. Type of fat used for making pastry (10)
3. Discolouration of fruit and vegetables caused by enzymes (8)
4. Traditional Italian sausage made with the use of bacteria and mould (6)
5. Complex protein formed when flour is mixed with water (6)
6. Green-coloured toxin which accumulates in badly-stored potatoes (8)
7. Term used to describe the damage to the chemical structure of protein caused by heat (6)
8. Lack of this gas can cause bread to fail (6, 7)
9. Vitamin or agent which prevents the negative effects of oxygen on food (11)
10. Action which prevents lumps in a sauce (6)
11. Type of radiation used for cooking (10)
12. Cooking method which uses convection currents and water vapour (8)

The shaded squares reveal this word:

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Chapter 2: Food spoilage

Overview

In this chapter we will look at the effects of microorganisms and enzymes and their role in food spoilage. We will also explore different sources of bacterial contamination and food poisoning, and learn how to recognise and prevent them. Issues with high-risk foods and the danger zone temperatures of cooling foods will be addressed, along with using temperature probes to check that food is cooked thoroughly.

Learning outcomes

After studying this chapter you should be able to do the following:

- ☐ understand and describe the conditions that cause food spoilage
- ☐ list the conditions needed for microorganisms to grow
- ☐ identify high-risk food items and understand what makes them high-risk
- ☐ describe the measures for control of enzymatic action
- ☐ recognise the signs of food spoilage such as mould growth
- ☐ identify the different sources of bacterial contamination
- ☐ list the main sources of bacterial food poisoning
- ☐ recognise the main symptoms of food poisoning
- ☐ explain different ways of preventing cross-contamination

Key Terms

Aerobic bacteria	Bacteria that require oxygen to live and multiply
Allergen	A substance – e.g. an ingredient in food, such as nuts, dairy or sugar – that can cause an allergic reaction in susceptible individuals
Anaerobic bacteria	Bacteria that do not require oxygen to live and multiply
Blanching	The process of quickly dropping food (usually vegetables and fruit) into boiling water and refreshing them in cold water immediately after in order to preserve colour and texture
Blast chiller	An appliance that reduces temperature of food quicker than a refrigerator to prevent bacteria to reproduce
Cold store	A room or large cupboard area where stored food can be kept cool
Colour-coded	Using different coloured utensils and equipment for different foodstuffs to prevent cross-contamination
Danger zone	The temperature range in which most food poisoning bacteria are able to grow
Date marks	'Best before' dates refer to the date at which the quality of food is guaranteed. 'Use by' dates are used for perishable foods and refer to the safety of food.
Dry food area	A dry, dark, ventilated room in which food can be kept stored
Enzyme	A biological catalyst usually made from protein which makes fruit ripen
Fermentation	The breakdown of sugar to form alcohol and carbon dioxide peroxide
Friendly bacteria	Used in probiotic products designed to improve gut flora
High-risk food	Food which has ideal conditions for bacterial growth. It can be reheated or eaten without heat treatment or cooking.
Microbial spoilage	See spoilage bacteria
Microorganism	An organism (e.g. bacterium) that is too small to see with the naked eye and requires a microscope
Pathogenic bacteria	Bad bacteria that can cause illness. A pathogen is a microorganism that causes disease
Perishable	Food that has a limited 'use by' date that will not 'keep'
Personal hygiene	Following personal cleanliness to prevent bacterial contamination
pH / pH level	Measures acidity/alkalinity: 7 = neutral, <7 = acidic, >7 = alkaline
Spoilage bacteria	Bacteria that make food 'go off'
Spore	A reproductive cell capable of developing into another reproductive cell. Spores by which mould (and other fungi) reproduce
Stock rotation	Items where items are prioritised subject to a principle of 'first in, first out' so that items already in stock are used before freshly delivered items
Temperature gauge	A gauge positioned on the outside of appliances that enables the user to check the internal temperature
Temperature probe	A handheld device that is used to check that the temperature in different parts of food sources to check its internal temperature
Thawing temperature	The recommended temperature at which food is thawed: 0 °C – 5 °C
Work surface	A surface such as a table or counter top on which food is prepared

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Microorganisms (food spoilage)

The knowledge and ability to apply food safety principles when buying, storing, cooking and preparing food is essential to ensure that the food is nutritious and safe to eat. Correctly handling food products helps to prevent food spoilage and cross-contamination. Let's have a look at what causes food spoilage and how to prevent it.

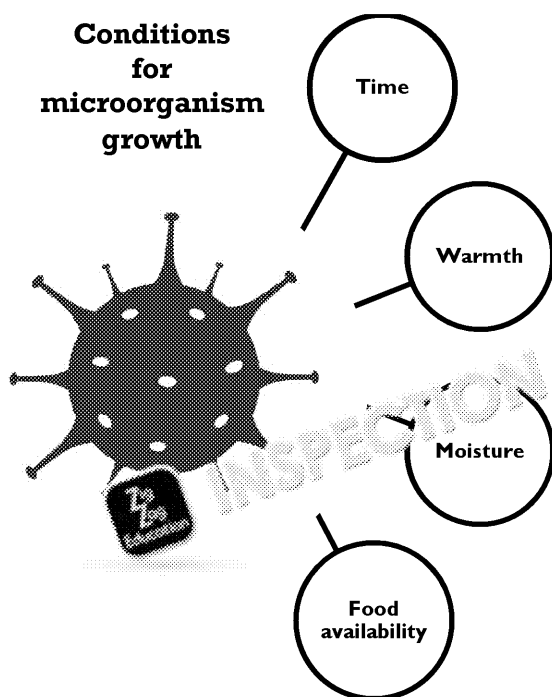
Microorganisms in food (bacteria, mould and yeast)

An organism is an individual animal, plant, fungus, bacterium or single-celled life form. A **microorganism** is an organism that is too small to see with the naked eye and needs to be viewed under a microscope. Microorganisms can be carried on food or in water and can cause food poisoning. Some microorganisms can also be used in food production; for example, bacteria in bio-yoghurt, yeast in bread and moulds in blue cheese.

The role of microorganisms in food production

Microorganism	Good	Bad
Bacteria	'Friendly' bacteria are used in probiotic products designed to improve gut flora.	Microbial bacteria can cause food spoilage (spoilage bacteria) and foodborne disease (pathogens).
Yeast	This is used in bread-making. Yeast produces carbon dioxide to make dough rise. Yeast is also used to make fruit ferment and to create alcohol.	A single-celled fungus, part of the Ascomycota family which can cause food spoilage through fermentation.
Mould	Mould is used in cheesemaking to improve flavour (blue cheese).	Mould can grow on food and make it unsafe to eat, making them a major cause of food spoilage.

Microorganisms need certain conditions in order to grow and multiply. These conditions are:



Where are microorganisms found?

Microorganisms are found everywhere:

- rubbish / food
- clothing
- soil
- food packaging
- water
- air
- dust
- saliva
- animal and human waste
- dandruff
- tears
- phlegm
- pus
- blood
- urine and excrement
- skin cells

These will be discussed in greater detail later on in this chapter.

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Bacteria

There are 'good' and 'bad' bacteria – good bacteria are also referred to as '**friendly**' bacteria, and they help to maintain good gut flora (complex microorganisms that live in the digestive system). **Good bacteria** are needed to help digest food and also to make yoghurt and probiotic products. The positive use of microorganisms in food production was discussed in Chapter 1.

Spoilage bacteria make food 'go off', rot or spoil. This is referred to as **microbial** spoilage. Sometimes we can see or smell spoilage bacteria. Microbial spoilage is caused by bacteria, yeasts and moulds.

Bad bacteria which can cause illness (food poisoning) are referred to as **pathogenic** bacteria. They can lead to bacterial infections such as *E. coli*, *Staphylococcus aureus* and *Campylobacter*. These are bad bacteria which can cause illness and can be seen or smelled in food.

Pathogenic bacteria can come from the following sources:

- raw foods
- pests and dirty pets
- people (from their hands, hair, nose, throat, infected cuts)
- air and dust
- dirt and soil (unwashed vegetables and salads)
- food waste

Research

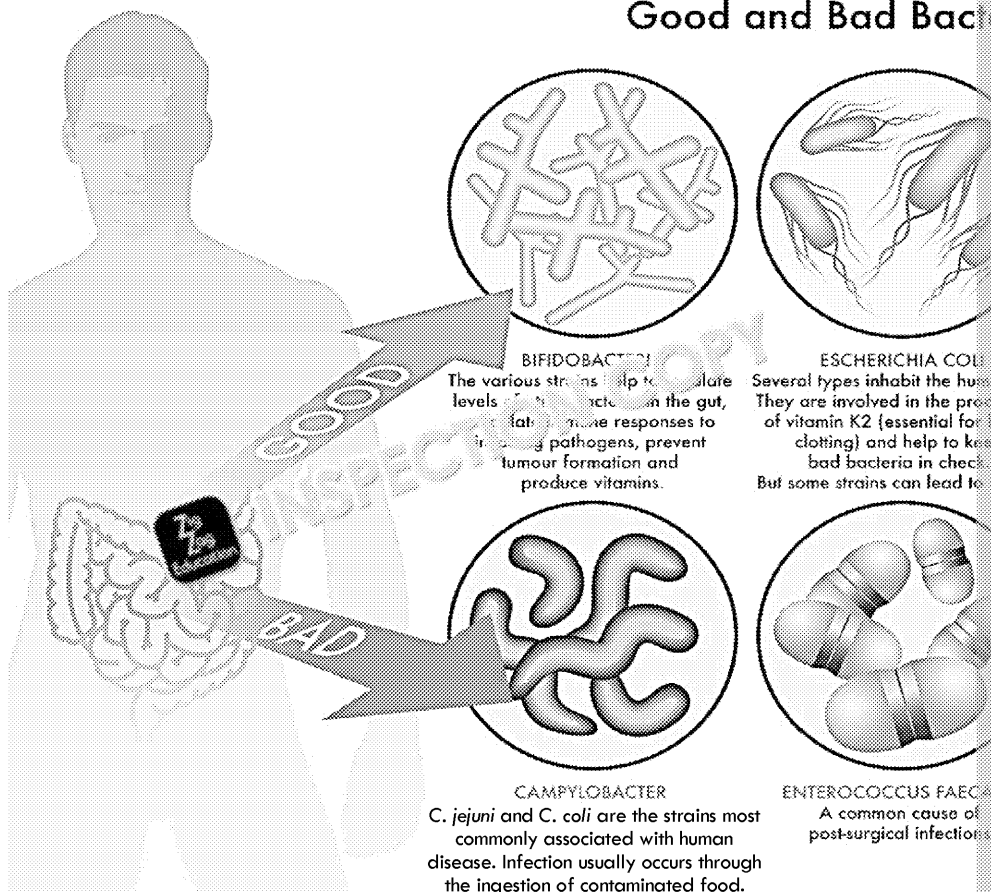
Research food poisoning symptoms and causes on the NHS website using the link: <https://www.nhs.uk/8257-food-poisoning>



Things to think about

Think about who is most at risk from food poisoning, and why.

Good and Bad Bacteria



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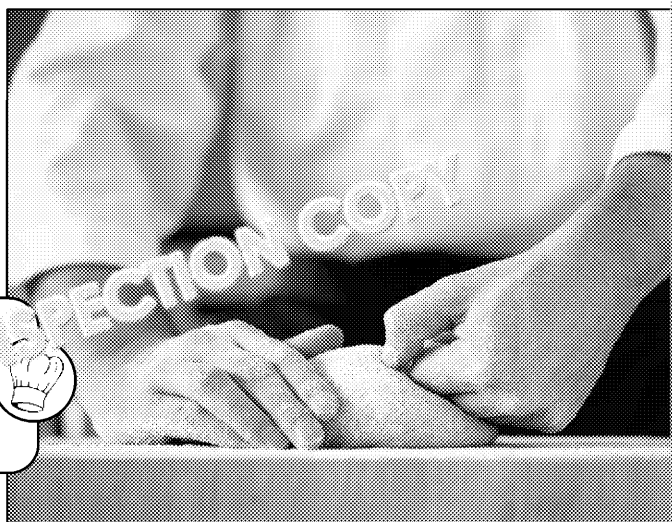


Yeast

Yeast is a microscopic fungus used in the **fermentation** of food products such as bread. Fermentation is a process caused by combining yeast and sugar. Yeast turns sugar into alcohol and 'rise' by producing carbon dioxide (CO₂) gas. Yeast can cause digestive problems and can cause **food spoilage** through fermentation (as yeast uses up sugar and produces carbon dioxide, which makes food become sour and slightly fizzy, which is not necessarily desired in most foods).

Apply

List three food items that contain yeast.

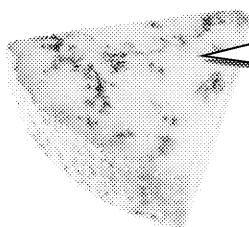


Yeast has an important role in bread-making – it makes dough rise, strengthens the bread dough and its fermentation develops flavour.

Mould

A mould is a fungus that reproduces via **spores**, which grow on organic matter, such as food, when the conditions are present, i.e. warmth and moisture. Mould is used in the production of Stilton, Gorgonzola and Roquefort, and produces a blue-veined appearance. Blue cheese has a strong, pungent taste. Mould in food produces enzymes, which break down the food and cause food to spoil. Mould can also cause allergic reactions and produce harmful toxins called mycotoxins.

Mould in Food Production



Mould in blue cheese gives a blue-veined appearance and a pungent taste.

Mould in bread is visible with initially a white or greenish colour.



Did you know?

The mould used in cheesemaking is Penicillium.



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The role of temperature, moisture, pH and time

To survive and multiply, bacteria need certain conditions such as *time*, *food* (preferably *protein*), *warmth* and *moisture*.

Imagine a frozen chicken (high in protein, moist) left to thaw on a sunny windowsill (time, warmth). Freezing the chicken has slowed down bacterial growth, but as soon as it starts to thaw, the conditions become right for bacteria to grow. The optimum temperature for bacteria to grow is the human body temperature of 37 °C. The combination of time and warmth helps the bacteria to start growing. They start to divide every 10–20 minutes (binary fission process) and bacteria will start to multiply and the food will be in the **DANGER ZONE**.

Control of microorganisms – temperature

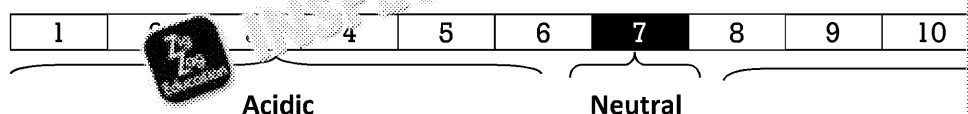
Bacteria can multiply at temperatures between five degrees centigrade (5 °C) and 63 degrees centigrade (63 °C), with the optimum temperature being 37 degrees centigrade (human body temperature). Even if cooked at high temperatures, **high risk** food (i.e. any food that has been cooked and will not go through any other process to kill bacteria, such as a chicken or an egg mayonnaise sandwich) passes through the **DANGER ZONE** as it cools down. *Between the temperatures of 5 °C and 63 °C is where bacteria can grow and multiply.* Bacteria can be killed off at temperatures of at least 75 °C. If reheated, the centre must be at least 82 °C.

Although bacteria can be killed at temperatures of 75 °C or above, at temperatures below 75 °C they slow down ready to grow and multiply once conditions are right, i.e. the food passes through the **DANGER ZONE**. Freezing food at the recommended temperature of -18 °C does not guarantee that it will slow it down. Bacteria may still be present and given time, warmth, moisture and these elements, bacteria start to grow and multiply.

Control of microorganisms – pH

pH refers to neutrality, acidity and alkalinity with pH playing a part in controlling microorganisms. It has been used for centuries (such as in pickling) to control microorganisms in food. Salads and pickled foods have a pH of 4.8 and below (acidic) on the pH scale, 7 is neutral and above 7 is alkaline. Lemon juice and vinegar are acidic.

pH Scale



Litmus test

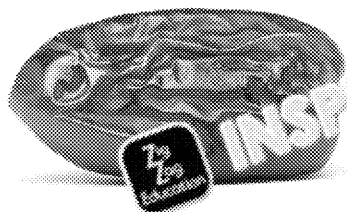
Litmus paper allows you to test the acidity of food yourself. A pH test kit contains litmus paper and a colour chart. The litmus paper is dipped into the food and then compared to the colour on the pH chart to determine its acidity or alkalinity. Litmus paper changes colour depending on the pH. It is red when acidic and blue when alkaline. If you dip blue litmus in an acid such as lemon juice it will turn red. If you dip red litmus paper in an alkali such as baking soda dissolved in water, it will turn blue.

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Control of microorganisms – water availability

Bacteria, mould and yeast need moisture in order to survive, and the availability of water within a food item determines whether these microorganisms can exist or multiply. Dehydrating or desiccating foods helps to inhibit moulds, yeast and bacteria. This is why drying foods can be an effective preservation technique that helps prevent spoilage and increases shelf life. Preparation for drying may include washing and blanching fruit and vegetables before they are dried. Some nutrients, such as vitamins C and A, can be lost during the drying process. The food preservative sulphur dioxide is sometimes added to dried foods to prevent spoilage (e.g. in apricots) and to prevent loss of vitamins. Sulphur dioxide is listed as an allergen on food labels because it can cause a reaction in some people.



Preserving foods, such as fruit, through dehydration has been used for centuries. Examples of dehydrated foods include raisins, sultanas, nuts, apricots and tomatoes. The methods used include:

- Sun-drying
- Oven-drying or microwave-drying
- Dehydrators or air-dryers

Research

Look up house rules on temperatures and bacterial contamination on the Government Food Standards Agency website using the redirect URL [zzed.uk/8257-food.gov](https://www.food.gov.uk/8257-food.gov)



Things to think about

Why is the optimum temperature for human pathogens 37 °C?



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Signs of food spoilage

Spoilage refers to decay and decomposition of food items. Food that has decayed or is in the process of decaying may lose some or all of its nutritional value and may not be fit to eat. Correct storage of food can help to prevent spoilage. Enzymatic action causes ripening (e.g. of fruit such as bananas) and browning of some fruits and vegetables. Yeast reacts with sugars to cause **fermentation**.

This process can occur with fruit such as grapes which contain naturally occurring Yeast and mould growth are signs of age and spoilage. Other fruits that can be affected are blueberries, strawberries, blackberries, tomatoes, raspberries and also citrus fruit.

Spoilage can be slowed down by:

- preserving food
- handling food correctly
- storing food at correct temperatures

Although you cannot see **pathogenic bacteria** with the naked eye, **spoilage bacteria** can cause a process of decay that can be recognised from:

- by the colour of food – e.g. browning
- by the smell
- by the texture – e.g. wrinkling or shrivelling
- by the taste
- by mould growth



A banana with a brown spot

Bacterial growth can be prevented by using preservatives such as salt and sugar or lemon juice. Preservatives may also be used in food, such as sulphur dioxide for preventing browning – sulphur compounds may appear in the ingredients list as sulphites (E220-E228) – metabisulphite, potassium bisulphite, sodium metabisulphite or sodium sulphite. These may cause an allergic reaction in some people. To prevent spoilage food preservatives are used as the following:

- Curing, salting and pickling
- Smoking
- Vacuum sealing
- Heat treatment (e.g. UHT) and pasteurisation
- Low temperatures
- Drying
- Irradiation

Research

Look up the general food regulations regarding food law at the Government's Food Agency website using the redirect URL **zzed.uk/8257-food-law**

Did you know?

It is illegal to sell food if it is not fit for consumption or has lost its nutritional value.

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Prepare fruit and vegetables to prevent yeast and mould growth

Some fruit and vegetables sustain yeast and mould more readily than others (e.g. apples and bananas) and need to be prepared carefully in order to prevent their growth. Preparation includes washing, peeling, skinning fruits and vegetables (yeast and mould growth is contained on the skin) and drying to deter the growth of **microorganisms**.

Skills

Skin a tomato

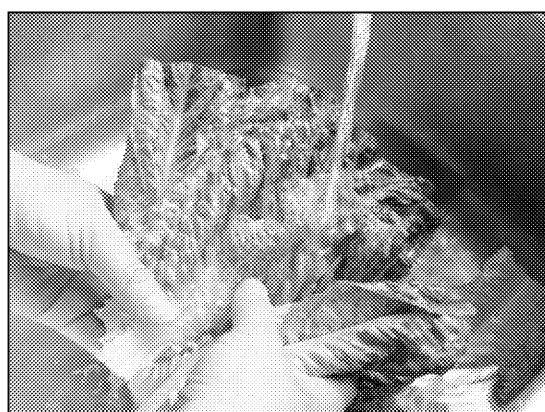
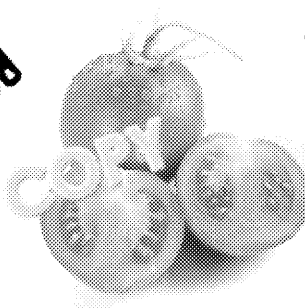
(take care with hot water and sharp implements)

Using a knife, slice an X on the base of the tomato. Place tomato in a bowl of boiling water to loosen the skin and leave until it starts to curl around the X. Pop the tomato into cold water to stop the cooking process (use a spoon) and then peel.

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Skills

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Soil contains **pathogens** present on unwashed grains, such as rice and vegetables helps to reduce their growth.

After washing fruit and vegetables, chilling to deter **microorganisms** (some exceptions below).

Did you know?

Some fruit has to be ripe before placing in a refrigerator as chilling stops the fruit from ripening (e.g. melons, oranges and tomatoes).



Refrigeration stops the growth of microorganisms.

Apply

List three food items that quickly show signs of decay with age.

Skills

1. Demonstrate washing and chilling of fruit/vegetables.
2. Demonstrate different ways of preparing food to control enzymatic browning.

Things to think about

Why do some foods show signs of spoilage before others?

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Signs of food spoilage (enzymic action)

We have looked at how the growth of bacteria, yeast and mould can cause micro spoilage. We have also looked at how **enzymes** can cause cell destruction (called **autolysis**) in some foods. Autolysis is the self-digestion of cells by their own enzymes.

An enzyme is a biological catalyst usually made from protein. Enzymes can do the following:

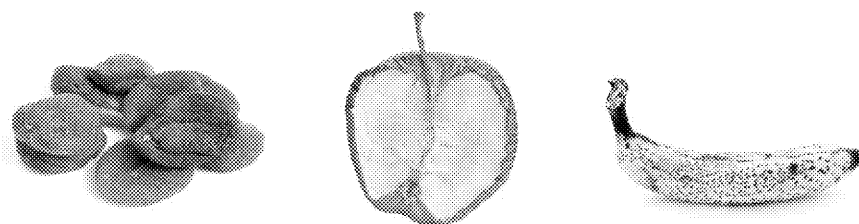
- Help fruit to ripen
- Cause discolouration of fruit and vegetables
- Cause **oxidation**. When chemicals in food are exposed to oxygen, this can change the molecular structure (such as the way in which an apple browns as soon as it is cut and exposed to oxygen). The **oxidation** process can cause the loss of nutrients, such as water-soluble vitamins (A, B and C) from food. Antioxidant molecules can help to prevent oxidation.

Enzymatic action in food can also be beneficial. For example, developing flavour and retaining colour and flavour in dried fruit.

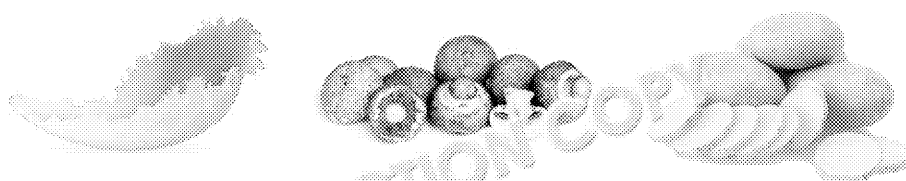
Destructive enzymes in food

Blanching fruit and vegetables helps to stop the enzymatic action within food which causes discolouration and other changes such as loss of flavour, colour, texture and nutrients. Blanching is recommended before freezing or drying fruit and vegetables. Although blanching can protect fat-soluble vitamins from breaking down, it can also cause the loss of water-soluble vitamins. However, this process is less destructive than overboiling. Certain acids, such as citric acid or ascorbic acid, can also be used to prevent browning in fruit and vegetables. For example, lemon juice can be used to lower the **pH** and

Fruits which exhibit enzymatic browning: apricots, apples, bananas, pears, grapes



Vegetables which exhibit enzymatic browning: lettuce, mushrooms, potatoes



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Things to think about

Think about why some foods exhibit oxidation and enzymatic browning.

High-risk foods

Bacteria prefer moist foods that are high in protein and as they exist where there is time. Given one or more of these conditions, they can start growing. Foods in this category include fish, shellfish, eggs, milk and dairy products. High-risk foods are foods that have to be served cold later. High-risk foods will not go through any other process. They should be kept hot and cold foods should be kept cold. Bacteria numbers can be reduced by thawing or reheating.

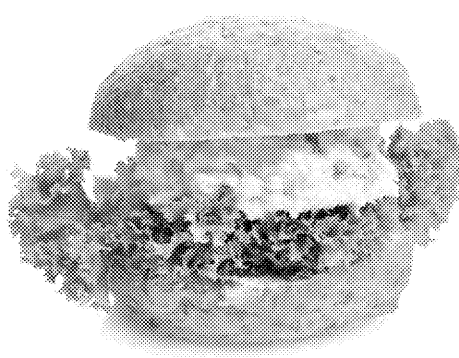
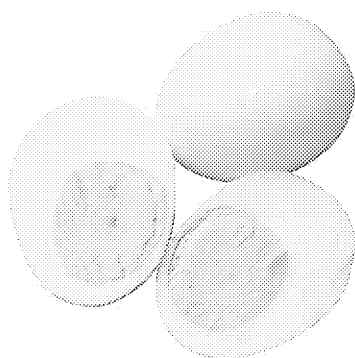
When dealing with high-risk foods, you should ensure that:

- your hands are clean throughout the day and handling is kept to a minimum
 - stored food is kept covered
 - temperature is NOT within the danger zone – between 5 °C and 63 °C for more than 2 hours
 - raw food and high-risk food are kept separate – *clean utensils after chopping raw food to avoid bacteria transferring from raw food to the board, work surface or utensils*
- contamination with raw meat foods. Store raw meat on the bottom shelf of the fridge, not dripping on to other foods.

Be extra vigilant when dealing with the following high-risk foods:

- cooked meat and poultry – e.g. chicken drumsticks, burgers, sausage rolls
- milk and other dairy products – e.g. ice cream or products containing cooked eggs
- shellfish and seafood – e.g. prawn cocktail, fish pâté, scampi
- cooked rice (never leave to cool and then reheat)

Chicken and poultry should never be washed before cooking as water droplets from the washing can transfer bacteria onto work surfaces, utensils or food.



Danger zone

Food is in the **danger zone** when it starts to cool and the temperature is between 5 °C and 63 °C.

Ready-to-eat foods

Ready-to-eat foods such as a chicken sandwich, boiled egg or sausage roll are referred to as **HIGH-RISK** foods because they have not been through temperatures that are between 5 °C and 63 °C and will not be subject to any other processes that will slow down or kill bacteria.

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Check your understanding microorganisms (food spoilage)

- Which of the following statements about **autolysis** is INCORRECT? (1 mark)
 - It causes ripening of fruit ☐
 - It causes discolouration of food ☐
 - It causes oxidation ☐
 - It causes the pH to become more acidic ☐
- Which of the following methods would NOT help to deter microorganisms? (1 mark)
 - Skinning and chilling ☐
 - Seeding and washing ☐
 - Storing at room temperature ☐
 - Washing and chilling ☐
- What temperature is referred to as the DANGER ZONE? (1 mark)
 - Between 5 °C and 63 °C ☐
 - Less than 5 °C ☐
 - More than 63 °C ☐
 - Between 5 °C and 63 °C ☐
- Which of the following statements about preserving food is FALSE? (1 mark)

Bacterial growth can be prevented by using:

 - vinegar ☐
 - salt ☐
 - pepper ☐
- Describe three ways in which temperature control helps to prevent food spoilage and/or enzymes. (3 marks)

-
.....
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- Assess how microorganisms, such as pathogenic bacteria, can cause food spoilage.

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Buying food

Buying food seems an easy job. You go to the shop, choose what you need, pay and take it home. But there are many things to think about it again. How many questions do you ask yourself before deciding whether to buy a product? You need to know what product you need, in what quantity, whether it is fresh and of good quality, and whether it is safe for consumption. In this chapter you will learn what to pay attention to when buying food for consumption.

The food we eat comes from both plants (grown in fields, orchards and polytunnels) and animals (from farms and fish tanks or caught in the wild). The farmers, growers and hunters then sell their produce to food factories, who process it to make food. The food is then transported to supermarkets, where we are able to buy food to cook the dinner. It is important to pay attention to how food is processed, transported and stored, as this can affect its safety and quality.

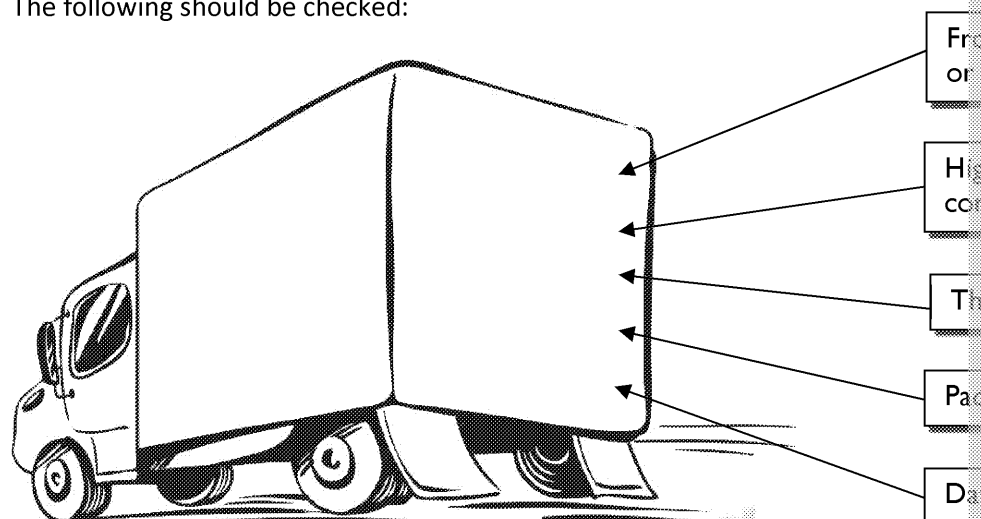
Deliveries

When raw or **perishable** food is delivered, it should be at a safe temperature (i.e. less than 8 °C for refrigerated foods and less than -12 °C for frozen foods).

When taking deliveries the following should be checked:

- Date marks
- Packaging
- Temperature

Deliveries should be rejected if food is out of date, if packaging is damaged or if the temperature is not correct. The following should be checked:



When storing food after a delivery, the following should be performed:

- Handle food with care – do not drop or damage packaging
- Store **perishable** food in the fridge
- Store food at correct temperatures
- Do not store food on the floor
- Keep food away from pests and be aware of the signs of pests
- Keep storage area clean

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Date marks

When checking **date marks**, ensure that you know the difference between 'best before' and 'use by' dates.

Best before	Use by
'Best before' dates refer to the date at which the quality of food will be affected. Food may still be safe to eat after this date. So 'best before' dates refer to QUALITY .	'Use by' dates are used for perishable food, such as fish or dairy products. Food after this date should NOT be eaten. So 'use by' dates refer to SAFETY of the food.
It is illegal to serve or sell food past its 'use by' date.	

Storage rotation

When storing food, it is important to use the correct **storage rotation** methods. Food with a short shelf life should be used before food with a longer shelf life and items should be stored accordingly, with items with a short shelf life stored in front of items with a longer shelf life. Always check the date mark on food before using it.



Things to think about

Why is storage rotation important?

Additional reading: What to look for when buying food: visual checks

Visually checking the food is probably the simplest way of ensuring that it is fresh. The first point is to make sure that the food looks as it should. The table below will help you decide if the food going to buy is OK to use.

	What to look for
Packaging (see more on the next page)	Clean, whole, undamaged; no unintended holes; any damage or marks are clearly visible
Fruit and vegetables	Not wrinkled ¹ ; firm, no brown or black stains ² ; not bruised
Fish	Clear, bright eyes; eyes not sunken; bright red gills; skin is shiny; the flesh is firm and shiny; tail is stiff
Meat	Bright colour (not dull) – the shade will depend on the type of meat; fibres are tightly packed and firm; cuts are smooth; fat is white and firm (not yellow)
Milk and dairy	Lid is not bulging; the milk is not curdled or separated; no signs of mould ⁴

¹ Passion fruit is an exception!

² Occasional soil is OK, as long as the vegetables keep longer when unwashed

³ It is OK in yoghurt to see whey (yoghurt separates because during fermentation the fat and protein in the milk separate. The whey is the liquid part and the curd is the solid part. The whey is not water; it is natural and the yoghurt is still safe for consumption. The whey can be separated from the curd by opening the yoghurt with a spoon; the cream separates into two layers – fat and water. The fat and water repel each other so the process is totally natural – simply shake the yoghurt.

⁴ This doesn't apply to cheeses such as blue cheese, Camembert or Brie, where mould is part of the cheese.

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Packaging

The packaging of food is important as it has many different functions. Food manufacturers have to ensure that the type of packaging used for a chosen product is safe (doesn't interact with the food inside), cheap, light and easy to transport. There are four main functions of packaging:

1. it protects the food from external factors, such as light, oxygen, dirt or microorganisms (protection)
2. it informs the consumer about the product (information)
3. it attracts consumers and tempts them to buy it (marketing)
4. it increases the shelf life of a given product

When buying and storing food, you have to pay extra attention to the following aspects of food packaging:

- whether the packaging is whole and intact – any holes, tears and other unintended openings could allow microorganisms penetrating through to the food, and contaminating it; they also mean that the food is no longer protected from oxygen (and oxidation)
- whether the date marks are clear and easy to read (e.g. not covered by a price tag) so you know the food is out of date
- whether the ingredients of the product are safe, e.g. if it is allergen-free for a particular food, or whether it is gluten-free for coeliacs
- whether it requires any special storage conditions – usually the producers state 'store refrigerated' or 'store frozen', 'store in a dark place', etc. Typical information you may see is 'refrigerate after opening' or 'store in a cool, dry place'.
- whether the food is stored correctly in the shop – e.g. yoghurt is in a fridge / freezer
- whether the lid or packaging is 'bulging' – this can mean that harmful bacteria, such as *botulinum*, have developed in the food, and it is best to throw it away, even if it looks fine



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This carton is designed to prevent eggs from bumping into each other and breaking. On the package you can often find advice to store it in a fridge after purchase.

Storage Instructions

Store in a cool, dry place. To retain freshness.

Additional Information

Suitable for Vegetarians and Vegans. Packaged in a protective atmosphere. Pack by weight, not by volume. Contains 100g. Although every care has been taken, some small pieces may remain. Choke on nuts. **Dispose** Recyclable. Please check website for further recycling information.

A food package may also have other information on it that can tell you whether the product is suitable for vegans, how to store it, etc.

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Food labelling

The information included on a food label and the way a product is displayed in a shop can influence people's food choices. Food labelling is subject to EU law, and all countries belonging to the EU are required to apply these rules. This is to ensure that all European citizens have the possibility of making informed choices when buying food. Various marketing techniques are used to make products appear more appealing.

Paying attention to food labelling when shopping is important. It provides useful information about the nutritional value, fat, and sugar and/or salt content, and lists potential allergens that should be avoided by some people. Some information is mandatory, such as ingredients, and serving suggestions are non-mandatory.

When buying food, people should closely inspect the label to ensure the safety and quality of the food. For example:

- people suffering from diabetes should pay attention to sugar content in the food, particularly added sugar
- people who want to lose weight should pay attention to the amount of fat and calories in the food, and choose foods rich in dietary fibre
- sportsmen should pay attention to the protein content of the food, etc.

One of the most important elements of a food label is the date mark. There are two types of date mark used on a food packaging: *use by date* and *best before date*. You learnt about them earlier on in this chapter.

Date marks help you to make food choices in the shop as they help you to assess the freshness of the food. They can also support you in deciding whether you'll be able to consume the food before it goes off (to prevent food waste) and whether you can store it in correct conditions (e.g. you may need to keep it in the fridge).

You will learn more about nutritional labelling requirements later on in this course.



Things to think about

Discuss what elements of a food label may be important for different groups of people.



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Check your understanding: buy

1. Which of the following statements is correct about mandatory information?
 - a. It is compulsory and required by EU food legislation
 - b. It is at the manufacturer's discretion whether to display it or not
 - c. It refers to marketing and advertising and is used to tempt consumers
 - d. It refers to serving suggestions displayed on food products
2. Which of the following statements serves as a reminder about storage?
 - a. First out, First in
 - b. First in, First out
 - c. First in, First on
 - d. First is best
3. Which of the following statements is TRUE? (1 mark)
 - a. 'Best before' dates refer to dates at which the quality of food is at its peak
 - b. 'Use by' dates refer to the safety of food, rather than the quality
 - c. 'Best before' dates refer to the quality of food, rather than the safety
 - d. Food is still safe to eat after the 'use by' date
4. Describe two ways in which appropriate packaging helps to ensure food safety when buying food. (4 marks)
 - 1
 - 2
5. State what kind of date mark would appear on the packaging of each of the following:
 - a. a chicken and mayonnaise salad
 - b. breakfast cereals
 - c. UHT milk.....
 - d. unpasteurised orange juice

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Storing food

Correct storage of food can help to prevent spoilage, bacterial contamination and **non-allergens** and **allergens**. Spoilage refers to decay and decomposition of food or is in the process of decaying may lose some or all of its nutritional value and no

Did you know?

An allergen is a substance – e.g. an ingredient in food such as nuts, dairy or sulphites – which can cause an allergic reaction in susceptible individuals.



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The points to remember for storage are:

Keep storage areas clean	☐
Keep food covered	☐
Keep food stored at the correct temperatures (dry goods stored between 10 °C and 25 °C)	☐
Keep food stored off the floor	☐
Keep storage areas dry and free from mould	☐
Ensure drainage channels run away from food	☐
Ensure the storage is lit sufficiently so that damage, and signs or spoilage can be seen on food	☐

Food premises should have the following types of storage areas:

- **Dry food areas**
- Refrigerator and **cold store**
- Freezers – check fridge and freezer **temperatures** regularly

When storing food, you must follow the following:

- Air **circulate** between items stored on shelves
- Correct **containers** are used
- Stock is rotated (**stock rotation**) properly (**First in, First out**)
- Raw food is kept on the bottom shelves
- Warm food is not put in the refrigerator or **cold store**
- Food is not stored in open tin cans
- Soily vegetables, such as potatoes, are stored away from other food in a dark, dry area of the store room

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Temperature control

Temperature control is necessary for cooked foods such as ready-to-eat foods (H) through the **DANGER ZONE** temperatures of between 5 °C and 63 °C and will not be that will slow down or kill bacteria.

Cooked food should be eaten within:

- two hours – hot food
- four hours – cold food

After this time, the food should be disposed of and not eaten. Food can only be in the danger zone.

Acidic conditions, i.e. a pH of below 4.5, help to inhibit the growth of **pathogenic** bacteria. UHT products, do not need temperature control due to their acidic nature or to the fact they are sterilised.

- However, some foods with a higher pH are subject to temperature control accordingly.
- It is important to remember that some types of pathogenic bacteria can survive in the form of spores which act as a protective barrier.
- Some pathogenic bacteria also produce toxins which cannot be destroyed by cooking.

During the ripening process, cheese exhibits a low pH (acidic) and this helps to prevent bacteria from growing. However, once cheese has ripened, it should be kept in chilled storage. If the acidity drops, allowing the growth of bacteria. Bacteria cannot grow in temperatures below 5 °C or stop at temperatures below 5 °C. This is why it is important to check the temperature of food when it is served.

- ✓ Cooked meat should be at least 75 °C in the centre or the thickest part of the meat.
- ✓ Beef steaks and other cuts of whole beef and lamb (only whole cuts and not mince) can be served rare and bloody IF the outside has been properly cooked or sealed to kill bacteria.
- ✗ Sausages, burgers, pork and poultry should **NOT** be served or eaten rare or pink in the way through the meat and not just on the outside.

Gravy, sauces and soups should be **simmering** to ensure they are cooked. Cooked food should be kept at 63 °C or above when it cools down below 63 °C and chilled food is in the **danger zone** when the temperature is between 5 °C and 63 °C.

Combining hot and cold food, such as pouring a hot sauce over cold food, can create a danger zone, either warming it up or cooling it down.

Remember that some of the foods are not only high-risk foods due to the risk of food poisoning but also may contain potential **allergens** for some people. Remember – allergens can be found in many foods.

Temperatures to remember:

Hot food	min 63 °C but preferably at least 75 °C in the middle
Cold food	should be kept at 5 °C or less (chilled food preferably at 2 °C or below)
Reheating food	min 75 °C but preferably at least 82 °C
Cooling food	10 °C or lower within 90 minutes
Freezing	-18 °C
Thawing temperature	between 0 °C and 8 °C
Delivered chilled food	should be at a temperature of 8 °C or below, and for long-term storage should be at -12 °C or below

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Microorganisms multiply the fastest at temperatures between five degrees centigrade (63 °C). This is important as ensuring correct temperatures during storage can extend the shelf life of foods.

Danger zone	Human body temperature	Cooking	
5 °C – 63 °C	37 °C	at least 75 °C	at least 75 °C recommended

If reheating food at 82 °C will adversely affect the food, then cooking at temperature for two minutes should be sufficient to kill bacteria.

Temperature control is important for most high protein food, such as chicken. Most high-risk food is high in protein and high in moisture.



Did you know?

Food can only be reheated once.



Did you know?

Cooked hot food prior to storage should be held at temperatures of at least 63 °C.

Ambient storage

Ambient storage refers to food stored in sealed containers at room temperature. Ambient temperature is referred to as *shelf-stable food* and this usually has a long shelf life (due to various preservation processes and packaging used). To make food shelf-stable and able to withstand **ambient temperatures**, it must undergo various processes, such as dehydration or dessication (or chemical preservatives), or be subjected to very high temperatures (pasteurisation).

Refrigeration and freezing

Some foods should be stored at very low temperatures in order to maintain their quality. They may be quickly cooled down with the use of blast chillers, and then stored either in a refrigerator (for short time only) or in a freezer.

Refrigeration

It is important that the temperature of a fridge does not rise above 5 °C. The refrigerator temperature should be checked regularly and, if it exceeds the required temperature, your supervisor must be informed, as the food may need to be disposed of and not eaten. To maintain the temperature of a refrigerator, ensure that:

- it is not overstocked
- the refrigerator door is not opened too frequently or for too long
- warm food is not stored in the refrigerator

Also ensure that the refrigerator is not too full and that the door is closed properly.

According to legal regulations, chilled food must be stored below 5 °C.

Research

To find out more on food safety, temperatures and storage visit the Government website using the redirect URL [zzed.uk/8257-food.gov](https://www.zzed.uk/8257-food.gov)

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Cooling food

To prevent the temperature from rising above 5 °C, hot or warm food should never be placed in a refrigerator but should instead be cooled as quickly as possible through placing it in a large shallow dish (or several smaller dishes) and stirring to distribute heat.

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Because hot food goes through the **danger zone** when it cools down, ensure that cooked food takes no longer than 90 minutes to cool down.

To help the cooling process:

- transfer the food to a larger dish
- stir frequently
- use a **blast chiller**
- divide it into smaller pieces
- place the container with the food in cold water
- store it in a cold store or fridge

Defrosting

Frozen food should be defrosted in a chilled area, refrigerator or **cold room** before chicken defrosts and thaws, liquid/juices will be released. It is important that defrosted food is placed on the **BOTTOM** shelf to avoid juices dripping onto other food items. Some food items should be defrosted in another container to contain the juices. Most microwaves have a defrost function but only defrost food items that will be cooked immediately; otherwise, defrost slowly in a cold room. Meat should be eaten within 24 hours of thawing.

Although you should never refreeze raw meat, fish or poultry that has been defrosted, you can refreeze defrosted items if cooked first.

Freezing

Frozen food must be kept at -18 °C or lower and thawed using manufacturer's instructions. Once thawed, **HIGH-RISK** food should be cooked at the required temperatures. **Freezing** at these temperatures slows down the growth of **pathogenic bacteria** and helps to prevent spoilage bacteria from causing decay.

Frozen food goes through the **danger zone** when it thaws, so it is important that it does not remain frozen while the outside of the food thaws. Some large items of frozen food should be thawed slowly at room temperature.

Appliance	Temperature
Refrigerators	5 °C or below; most caterers set their fridge to lower than 5 °C in case of power failure, leaving the fridge door open
Freezers	-18 °C or below

Note: The temperature of appliances should be checked regularly. If temperatures have risen above the required figures, then your supervisor must be informed. Food may have to be disposed of and not refrozen.

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Packaging and covering food

Storing food correctly is key to ensuring its safety. If raw or cooked food is not packaged in a lidded box or cover it, e.g. with cling film. Covering food is important as it:

- protects the food in question and prevents foods from contacting each other (prevents cross contamination)
- prevents any leaking juice from dripping onto other foods – this applies especially to raw meat
- protects the food from oxygen and prevents oxidation
- prevents the food from taking the smell of other products stored in the same area – and vice versa.

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Did you know?

Freezing food at the recommended temperature of -18°C does not guarantee that bacteria will go dormant. Bacteria may still be present and moisture or oxygen, or a combination of these elements, bacteria start to grow and

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Check your understanding: sto

1. Which of the following statements about ambient storage is TRUE? (1 mark)
 - a. It is at freezing temperature ☐
 - b. It is at boiling temperature ☐
 - c. It is at room temperature ☐
 - d. It is at human body temperature ☐
2. To which of the following temperatures should a freezer be set? (1 mark)
 - a. -10°C ☐
 - b. 5°C ☐
 - c. -12°C ☐
3. HOT cooked food (if not refrigerated) should be eaten within: (1 mark)
 - a. 2 hours ☐
 - b. 1 hour ☐
 - c. 4 hours ☐
4. Describe two ways in which appropriate packaging supports food safety.

1

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5. Explain why temperature control is important for food such as chicken.

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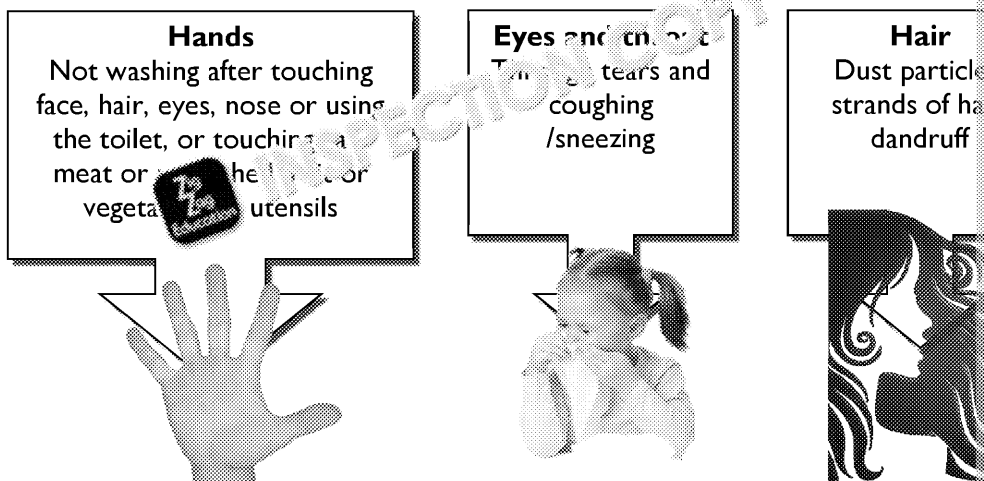


Preparing, cooking and serving

Pathogenic bacteria which find their way into foods can cause food spoilage (increased risk of food poisoning (in direct and indirect ways)). It is very important to distinguish the high microorganisms they can contain, and take appropriate steps when preparing, serving and storing to prevent their negative effect on food and human health.

Bacterial contamination

Bacteria can be transferred from people to food in the following ways:



Other ways in which bacteria can be transferred are shown in the table below:

Animals	Dust	Water	Soil
Animals can carry bacteria in their saliva, their urine and in their hair/fur. This includes domestic pets as well as mice, rats, cockroaches and other pests. Animals can transfer bacteria to food in the following ways – mice leave traces of urine after running across food; flies vomit into food; and insects alight on food after visiting bins, food waste and excrement. 	Bacteria can exist within tiny particles of dust which fall off humans or animals as dead skin cells or from hair or clothes. Dust contains food, moisture and dirt which we may not be able to see when it settles on food.	Untreated water can also contain pathogenic bacteria, and some foods, such as shellfish, which feed by filtering water, can become contaminated by dirty water.	Soil also contains pathogenic bacteria which can be present in unwashed vegetables, grains, such as pulses and pulses.

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Sources of contamination

Contamination may occur in the following ways:

- From unwashed fruit or vegetables – soil and dirt
- From raw food – cross-contamination occurs when raw food is stored with high-risk food or when juices or fluids from raw foods drop onto high-risk food. Cross-contamination also occurs via hands or utensils if they touch raw food.

Bacteria can live on hands, work surfaces, containers, cutlery, utensils and equipment, and towels and cleaning cloths.

When food spoils, it is decaying or decomposing, and this can occur through natural ageing or through microbial contamination with bacteria, mould or yeast. Spoilage can be slowed down by refrigerating food, handling food properly and storing it at the correct temperatures. Any member of staff who handles food, cleans work surfaces, equipment, etc. must practise good personal hygiene and keep their hands clean.

Types of bacterial food poisoning

Food poisoning is caused by contamination of food or water with various species of bacteria under different living conditions, and for that reason we can usually guess what type of bacteria caused it if we know what a person has eaten. Types of food poisoning bacteria are listed below.

Type	Cause
<i>Salmonella</i>	Raw or undercooked poultry, eggs, dairy products, raw beansprouts
<i>Staphylococcus aureus</i>	Undercooked or badly stored meat, not chilling sufficiently, eating foods handled by someone infected with <i>Staphylococcus aureus</i>
<i>Campylobacter</i>	Raw or undercooked meat (particularly chicken), unpasteurised milk, untreated water
<i>E. coli</i>	Undercooked meat (beef), unpasteurised milk, raw beansprouts
<i>Listeria</i> *	Ready-to-eat foods and also soft cheeses
<i>Clostridium perfringens</i> *	Undercooked beef and poultry
<i>Bacillus cereus</i> *	Rice and other leftover food left to cool at room temperature

*these are not required by the specification

Food poisoning is most likely to be caused by bacterial contamination from untreated water and the following raw or insufficiently cooked foods:

- Meat (particularly *E. coli* – beef)
- Poultry (particularly *Campylobacter*)
- Eggs (particularly *Salmonella*)
- Seafood
- Vegetables
- Unpasteurised milk (particularly *E. coli* and *Campylobacter*)
- Ready-to-eat foods (particularly *Listeria*)
- Raw sprouted seeds (e.g. beansprouts)
- Cooked rice left to stand at room temperature

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Bacterial contamination can occur through the following:

- not storing, cooking or chilling properly
- allowing cooked food to cool down gradually and go through the **danger zone**
- not reheating at correct temperatures to kill bacteria
- being touched or handled by someone who is unwell or does not practise good hygiene
- allowing food to go past its 'use by' dates
- cross-contamination between cooked food and raw food (e.g. fluid from raw meat on cooked food)

Rice and reheating

Spores containing the bacterium *Bacillus cereus* exist on rice, which can cause food poisoning. When left to cool at room temperature, the spores multiply and produce toxins. Ideally, leftover cooked rice should not be allowed to cool or be reheated but, if necessary, it should be cooled rapidly and then reheated until piping hot.

Symptoms of food poisoning

Food poisoning can be caused when bacteria grow in large numbers in food, or by viruses transferred from people or animals, or by toxic moulds. Food poisoning can also be caused by poisonous plants and fish or from contamination from chemical or heavy metals. The symptoms of food poisoning are:

- vomiting
- diarrhoea
- stomach ache and stomach cramps
- high temperature and fever
- aching muscles, chills and weakness

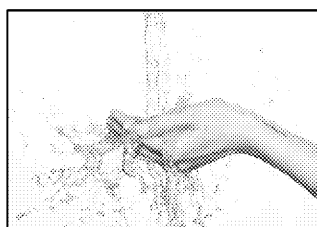


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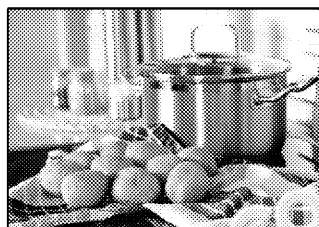
The four 'C's

The Food Standards Agency advise that food-borne illness / food poisoning can be prevented by following the four 'C's of food hygiene: Cleaning, Cooking, Chilling and avoiding Cross-contamination. We will discuss these later on in this section.

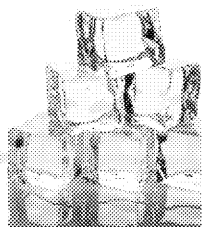
The Four Cs



Cleaning hands properly



Cooking food properly



Chilling food properly

Research

Look up food poisoning on the Government's Food Standards Agency website and use the redirect URL [zzed.uk/8257-food-poisoning-2](https://www.food.gov.uk/8257-food-poisoning-2)

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Things to think about

What is the cause of food poisoning (*E. coli* and *Salmonella*) from raw meat and how can it be prevented?

Food safety

Food safety is about making sure that food is safe to eat. This means making sure that food is clean, that food handlers follow effective **personal hygiene** procedures, that food is eaten within its 'use by' date, that it is cooked or reheated using the correct method, that it is chilled, thawed or frozen correctly.

To make sure that food is safe to eat, we must make sure that we use the correct procedures and understand the importance of **personal hygiene**.

Unsafe food handling can result in illness or death caused by the following:

- food poisoning
- chemical and physical contamination
- food spoilage
- allergic responses and/or anaphylactic shock

The consequences of poor food hygiene could be:

- compensation claims from customers
- pests – rats, mice, insects, birds, etc.
- food poisoning / fatalities
- food contamination and wastage
- legal action and closure
- bad publicity on review sites and social media
- loss of profits, leading to redundancies

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Environmental Health Officers (EHOs) have the right of entry and the power to prosecute if necessary. An EHO can sample and examine food, examine records and serve notices.

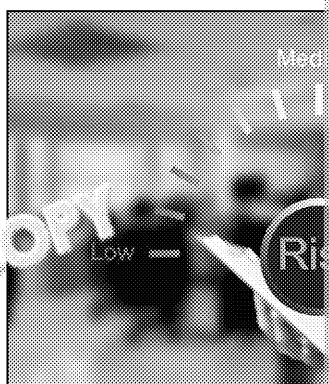
Reporting sickness

To prevent food poisoning or bacterial contamination of food, it is important that your supervisor. It is a legal requirement to report certain illnesses to the health authorities. Your staff and management need to be kept informed by their staff.

You must report the following to your supervisor:

- diarrhoea
- vomiting
- sickness and nausea
- ear, eye, nose discharge
- a septic cut, wound or other skin condition
- any other skin condition or infection

You must also tell your supervisor if anyone who lives with you has any of the above symptoms, as you may be a carrier.



*You have a responsibility to
maintain food safety*

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Things to think about

Why are pregnant women at higher risk from food poisoning?

Personal hygiene

Bacteria can live on hands, **work surfaces**, containers, cutlery, utensils and equipment cloths.

Any member of staff who handles food, utensils, **work surfaces**, equipment, etc. must practice **hygiene** and keep their hands clean. This means washing your hands:

- before you start work
- before you touch **high-risk** food
- between handling raw food and cooked food, e.g. peeling potatoes and toasting bread
- after handling raw food
- after going to the toilet
- after touching any part of your face, body or hair
- after coughing, sneezing, blowing your nose or wiping your eyes
- before and after eating and drinking
- after handling raw meat or fish
- after completing cleaning jobs or handling containers or chemicals
- after dealing with food waste or rubbish

The hand-washing basin should be used exclusively for hand washing and not be used for anything else. There should be liquid soap, hot water and paper (disposable) towels available.

Outdoor clothes are a contamination risk as they can transfer dust, soil and dirt. Remember: hair, dust and soil can carry bacteria.

Ideally, to prevent contamination from outdoor clothes, light-coloured protective clothing should be worn in the food handling area (light coloured so any spillages or marks can be seen). A change room should be available for changing from outdoor clothes into protective clothes. Hair should be covered with a hat.

What you wear:

To ensure that you do not drop fibres, hair or other foreign objects into food, wear protective clothing or an apron and tie your hair back (if your hair is too short to be tied back, use an Alice band) or use a hairnet or cap to keep your hair in place. Remove jewellery – gemstones from earrings could fall out and land in food, and rings harbour bacteria. Do not wear nail varnish or false nails, and keep nails short and clean.

Cuts, boils and rashes:

If you cut yourself, place a brightly coloured waterproof sticking plaster over the cut. Do not work with cuts, spots, rashes or boils.

Hand washing:

Wash your hands before and after handling food. There should be washing facilities provided with hot and cold water, liquid soap and paper towels. This sink should be used exclusively for hand washing and not be used for washing dishes or vegetables.

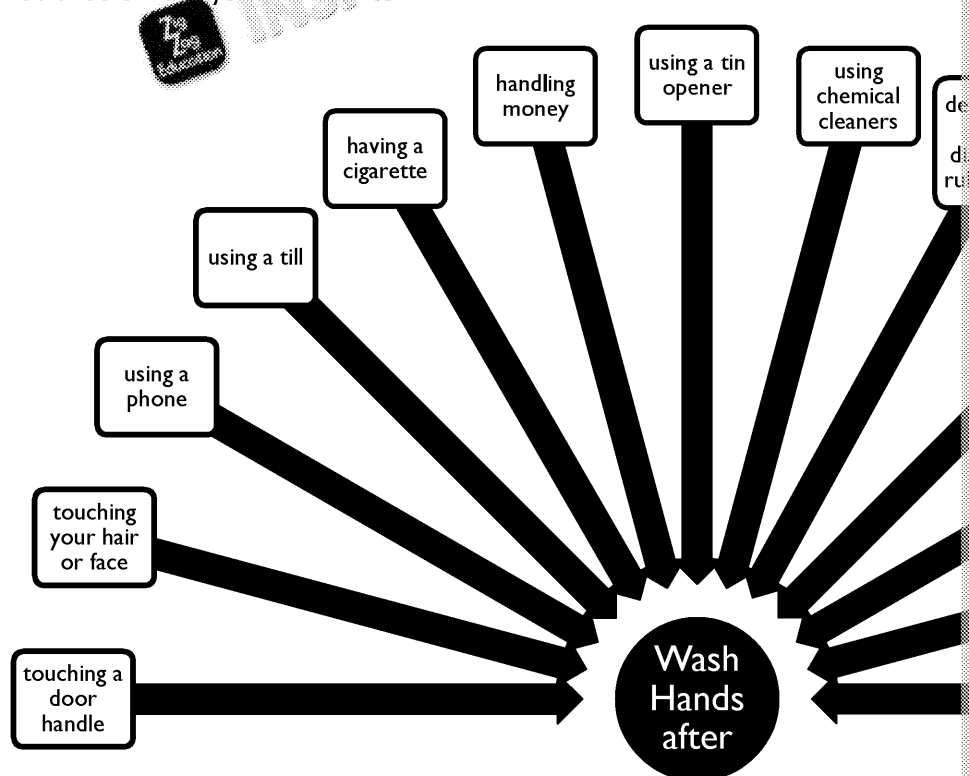
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Food handling area – dos and don'ts

Do			
✓	go outside the food handling area to blow your nose	✗	blow your nose in the food handling area
✓	wash your hands after blowing your nose	✗	touch any part of your face
✓	take your breaks away from the food handling area		your nose or mouth
✓	wash your hands before handling food	✗	use your fingers to clean spoons or knives
✓	wash hands after touching hair or any part of body	✗	use a tissue in a food handling area
		✗	use a tissue to wipe your nose on your sleeve
		✗	breathe on glassware

You should wash your hands after:



Smokers should remove their protective clothing/apron when smoking and also be transferred to food.

Hands should also be washed after doing the following:

- touching work surfaces which have not been cleaned properly
- eating or drinking
- handling raw eggs in their shells

Remember: Wash your hands thoroughly when you start work and before touching food. You must wash your hands between touching high-risk food and raw food.

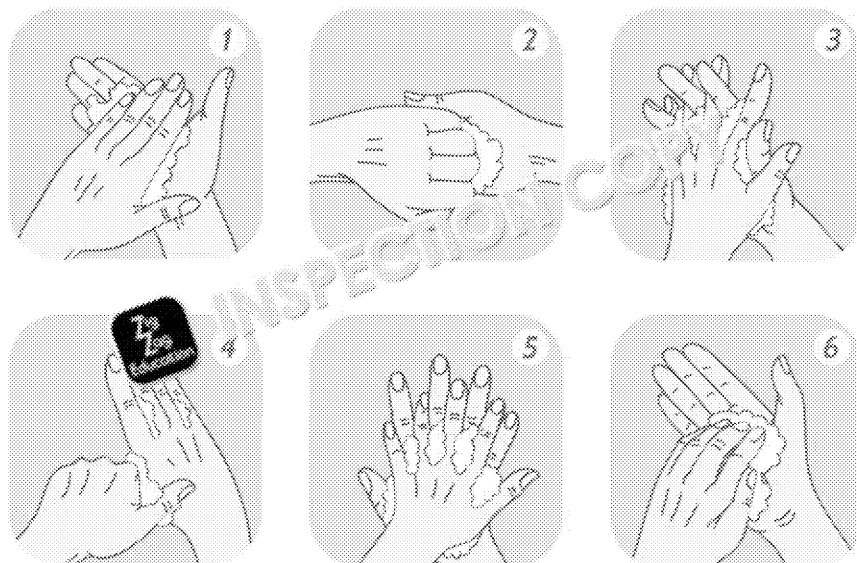
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Correct hand-washing technique

Wet hands thoroughly and add a blob of liquid soap (more hygienic than a bar of soap). Rub over backs of hands, rub between fingers and thumb, rub across your nails. Rinse and dry with a disposable paper towel (ensure your hands are totally dry – a moist environment on which to grow). Turn off the tap using the paper towel, and then



Cross-contamination

Using separate utensils

Equipment and utensils such as knives and chopping boards should be colour-coded to prevent cross-contamination. For example, only use a chopping board and knives that are colour-coded green for salads and fruit. This helps to prevent bacteria being transferred from raw

Colour code for chopping boards and utensils		
RAW MEAT	→	Red
RAW FISH	→	Blue
COOKED MEAT	→	Yellow
SALADS/FRUIT	→	Green
VEGETABLES	→	Brown
DAIRY	→	White

Colour-coding chopping boards and utensils helps to prevent cross-contamination

Ensuring that equipment and surfaces are kept clean and free from damage will help to prevent cross-contamination.

Clean utensils. Do not use a chopping board or work surface and utensils that have been used for chopping raw meat to prevent bacteria transferring from the meat to the board or work surface and utensils. This helps to prevent cross-contamination of foods.

It is important that raw foods and high-risk foods are stored separately so that cross-contamination is prevented. For example, do not place raw meat on a shelf above other food, especially high-risk foods, as they could drip onto the items stored on shelves below.

Keep stored food covered.

Chicken and poultry should never be washed before cooking as water droplets from the water can spread bacteria onto work surfaces, utensils or food.

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Skills

1. Demonstrate knife skills to prevent cross-contamination.
2. Demonstrate washing and drying fruit and vegetables to prevent food contamination.
3. Prepare, combine and shape wet mixtures (e.g. falafel, fish cakes, meatballs) to prevent cross-contamination and correct handling of high-risk foods.

Separating raw and cooked foods

To prevent **cross-contamination**, raw foods such as uncooked meat (e.g. chicken) should not be prepared or stored with cooked foods (e.g. **high-risk** foods such as cooked meat rolls).

Other ways to prevent cross-contamination:

- Keep surfaces covered
- Keep surfaces covered, and empty them when required
- Store food safely
- Check for damaged packaging on deliveries
- Keep doors and window screens closed to prevent **pests**
- Clean work surfaces regularly
- Clean up spillages and dispose of food waste promptly

Did you know?

It is easy to check if the probe is working by checking the boiling water. The boiling water should be 100 °C.

Checking temperatures

It is important that temperatures of freezers and fridges are checked daily. **Temperature probes** should be positioned on the outside casing of appliances, such as ovens, refrigerators, so that temperatures can be seen and recorded easily.

It is also important that **temperature probes** are used to record the temperature **centre (or thickest part)** of meat to at least 75 °C or 82 °C if reheated. Temperature should be recorded. You can also check the temperatures of food on the oven gauge while the food is being cooked.

Temperature probes should be calibrated on a regular basis and cleaned after each use.

Other ways to test food for readiness and/or to ensure it is safe to eat:

- With a knife/skewer
- Finger or poke test
- Taking a bite
- Visual checking

Things to think about

Discuss how cross-contamination can occur between different food items.

Skills

1. Use a temperature probe (to ensure food is safe to eat).

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Skills

1. Use a knife/skewer, bite, squeeze or poke test to test the readiness of food (to ensure food is safe to eat).

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Using correct cooking times

We have looked at the correct temperatures at which to cook and reheat food, but time is also vitally important to food safety, especially when cooking red meat and poultry. Meat and poultry should reach at least 70 °C for a minimum of two minutes.

Although some foods are safe to be blanched briefly, most foods must be cooked for the recommended cooking times to ensure safety.

Lower cooking temperatures can be used so long as the food is cooked for the recommended duration at the temperature. The core temperature of food should be kept at the following levels:

Temperature	Duration
90 °C	At least 45 minutes
65 °C	At least 10 minutes
70 °C	At least 2 minutes

Leave food to stand for a minute after cooking as the temperature will either stay at or rise above the recommended temperature, thereby killing bacteria.

Cleaning

It is important that food handling areas are kept clean to ensure that **cross-contamination** is avoided. Surfaces should be cleaned frequently by removing food debris and then disinfected.

Work surfaces and equipment include:

- chopping boards
- preparation areas
- tables
- machinery
- utensils
- containers

Skills

1. Use a brush to clean surfaces (ensuring cleanlines)

Worktops should be smooth and non-porous, and wood should be avoided unless fully washable.

Disinfection should be performed after cleaning (remove debris, dirt and grease first) and for the correct contact time (as stated on the manufacturers' instructions).

- Detergents dissolve grease and loosen debris – detergents do NOT kill bacteria.
- Hot water at 82 °C or above, such as high temperatures in dishwashers, may kill some bacteria by contact.
- Steam can also be used to kill some bacteria.
- Sanitising is a combination of disinfectant and detergent *but should only be used on lightly soiled areas*.
- Chemical disinfectant (e.g. bleach) is required to KILL bacteria.

In order to disinfect correctly, the surface must be clean.

Did you know?

Cleaning cloths should be changed after wiping a surface that has been used for meat and also after wiping up spills (e.g. raw egg or soil from root vegetables).

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Cleaning schedules

Food premises should have a cleaning schedule in place which will detail the following:

- What to clean
- How often it should be cleaned
- Type of cleaning required
- Who is responsible for cleaning

Clean, clean, clean...

- ✓ All areas in a food handling area should be cleaned regularly throughout the day. Special care should be taken on surfaces where raw food or high risk foods are placed. Work surfaces must be cleaned between using for raw food and high risk food.
- ✓ Temperature probes should be cleaned after each use.
- ✓ Items that are regularly touched should be cleaned, such as handles and switches, cleaned after each use for different food types.
- ✓ Mops and cloths need to be kept separate to prevent multiplication of bacteria. They should be stored away from food.
- ✓ Bins should be emptied regularly and kept covered, away from food. Outside bins should be kept covered with tightly fitting lids so as not to attract flies.

The correct way to clean

Some food premises use a two-sink method when washing dishes. This enables the removal of food debris and to clean dirt, and then rinse in a second sink with hot water at 82 °C. The procedure below:

- Remove food debris from soiled areas or from pots, pans and crockery
- Wipe the area or wash with hot water and detergent to remove dirt and grease
- Rinse the area or rinse items with hot water to remove traces of detergent
- Disinfect the area or items using a chemical cleaner for the prescribed contact time
- Use a final rinse of clean hot water
- Avoid using cloths to dry dishes as they may harbour bacteria. If hot water is used for the final rinse, then the moisture will evaporate if left to dry in the air.

Taking care

Take care when cleaning, and take the following precautions:

- Keep food covered or well away from areas that are being cleaned to prevent contamination
- Wear protective clothing, gloves, masks and goggles if necessary
- Do not mix cleaning agents together – this is **DANGEROUS**
- Store chemical cleaners, cloths and mops away from food
- Always wash your hands after cleaning and before you touch food



Breathing vapours from some detergents can irritate the respiratory system

Chemical cleaners can be a source of skin irritation

Chemical cleaners or vapours can irritate the eyes

Chemical cleaners (such as bleach) can ruin clothes

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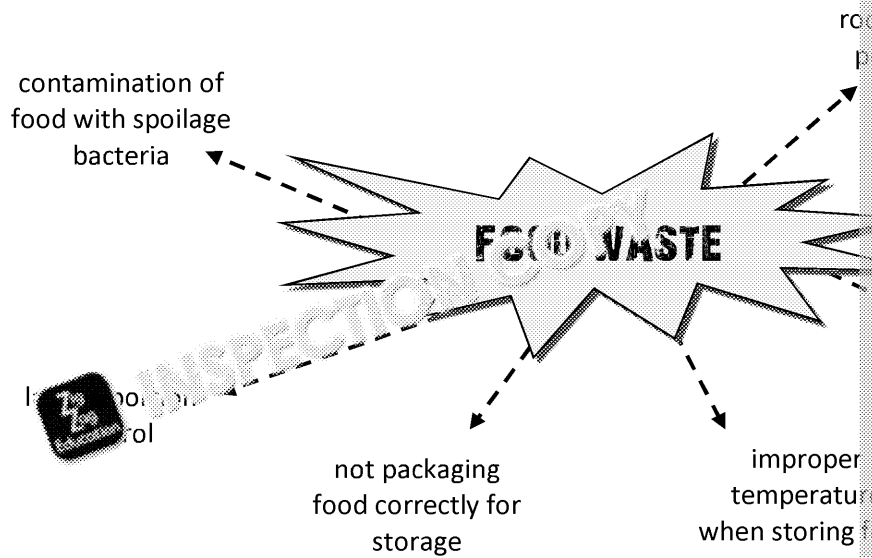


Research

To find out more about cleaning schedules go to the Government's Food Standards Agency website using the redirect URL [zzed.uk/8257-food.gov](https://www.zzed.uk/8257-food.gov)

Food waste

You already know that mishandling food may cause food poisoning or an allergic reaction. Handling food correctly may also lead to food waste. Some of the reasons for waste are shown in the diagram below.



It is important for food outlets to prevent food waste, as it may cause serious financial loss to the business, increase recycling costs and reduce clients' trust. Food waste also poses a risk to the environment. This will be covered in more depth in 'Where Food Comes From'.

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Check your understanding preparing, cooking and serving

1. Which of the following statements about bacterial transference is FALSE?
 - a. Mice and rats can transfer bacteria to food ☐
 - b. Domestic pets can transfer bacteria to food ☐
 - c. Bacteria can exist in dust particles ☐
 - d. Bacteria can exist in water ☐
2. Which of the following DON'T you need to tell your supervisor about?
 - a. Vomiting ☐
 - b. Diarrhoea ☐
 - c. Sickness ☐
 - d. Toothache ☐
3. Why should light-coloured clothes be worn in the kitchen? (1 mark)
 - a. They look nice ☐
 - b. So that the public can tell if they are clean ☐
 - c. To see stains and marks ☐
 - d. So that the restaurant's larder is clean ☐
4. Which COULDN'T you need to use separate utensils? (1 mark)
 - a. Between preparing fruit and salad ☐
 - b. Between preparing raw and cooked meat ☐
 - c. Between handling raw fish and eggs ☐
 - d. Between handling dairy products ☐
5. The four Cs represent which of the following? (1 mark)
 - a. Cleaning, Cooking, Chilling, Cross-contamination
 - b. Cleaning, Cooking, Containing, Cross-contamination
 - c. Cleaning, Cooking, Cold-storing, Cross-contamination
 - d. Cleaning, Cooking, Chilling, Cross-transferring
6. Explain why correct cooking times are important when preparing, cooking and serving food.
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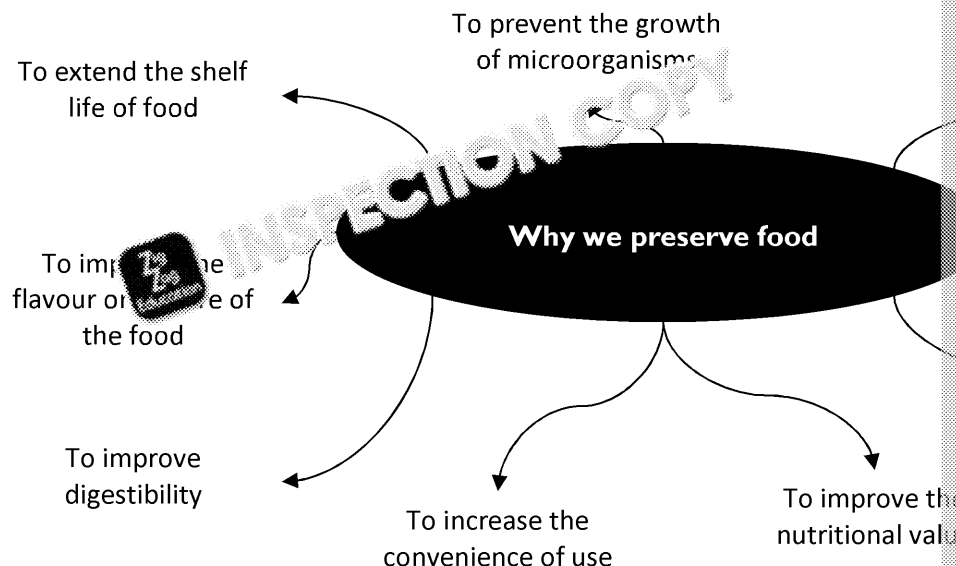
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Preservation methods used to keep food

Personal hygiene, correct cooking times and care when handling high-risk foods are essential for ensuring food safety. As applying food hygiene rules prevents cross-contamination, food remains edible for longer. For centuries, people have been using various preservation methods to ensure they know no fresh food will be available for the forthcoming months. Thanks to global transportation, we can enjoy fresh foods all year long. However, many people still prefer to make them at home). The diagram below shows different reasons why people preserve food.



Freezing

Freezing means that a food is stored at temperatures below 0°C (home freezers usually are set to -18°C; industrial freezers can use lower temperatures or liquid nitrogen). At such low temperatures, the water turns solid, and so-called water activity decreases. This means that bacteria and other microorganisms lack the basic nutrient (water) and cannot multiply. This method has been used since ancient times (before the agricultural revolution) during cold winter months.

Drying

In the past, drying was performed during the summer months, as the hot rays of the sun dried food quickly and efficiently. The development of technology allows us today to dry food while retaining its nutritional value. Drying means that water is removed from the food, so it is not suitable for microorganisms – and that stops them from multiplying. Today, dried foods such as herbs are preserved with the use of preservatives to extend their shelf life even more. These include dried milk, beef jerky and raisins.

Pickling

Food can be pickled in brine (solution of water and salt) or in vinegar. Pickling significantly changes the texture, appearance and flavour of the food. The pickling solution often contains flavourings, such as garlic, horseradish, bay leaf, black peppercorn or cloves to improve the flavour of the final product. It is worth mentioning that foods pickled in brine undergo bacterial fermentation. As a result, lactic acid is produced. This has many health benefits, as it promotes the growth of probiotic bacteria in the large intestine and improves digestion.

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Bottling

Bottling is used to preserve liquids, such as fruit juices, milk or beer. During bottling, glass or plastic bottles are washed, and then the liquid is poured into them on a bottling line. Often, the bottle is then closed with a seal (usually made of aluminium foil) and only after that is the lid put on the bottle. The seal and lid close the bottle tightly, so that no air can get inside. This is important as it prevents oxidation. You can often notice that bottles are darker in colour (e.g. vanilla extract, syrups, medicine) – this is to protect the liquid in them from the sunlight. Once the bottles are filled and closed, they are often additionally pasteurised to ensure harmful bacteria are killed and cannot spoil the food.

Vacuum packing



In vacuum packing, all air is removed from the container. Afterward, the package is sealed. Vacuum packing extends the life of food by removing oxygen and limiting oxidation and microorganisms. Unfortunately, it does not prevent microorganisms. To additionally protect the food in the container, it is filled with nitrogen – consequently, they don't get oxidised during transportation.

Jam making

Jam is a thick mixture made of fruit and sugar. To prepare a jam, you need to wash and crush the fruit, and then simmer it with sugar. During cooking the fruit releases pectin, which is a natural gelling agent. Release of pectin can be improved by adding a little lemon juice. As some fruit is low in pectin, food factories may decide to use powdered pectin, agar-agar or other gelling agents to thicken the mixture. To make sure that the jam keeps for a long time, you need to ensure the following:

- high content of sugar – it is a natural preservative and keeps moulds and bacteria at bay; this is because sugar binds water, which then becomes unavailable for microorganisms to grow (remember they cannot grow without it!)
- thorough cooking – high temperatures help to kill microorganisms which may be present
- clean jars and lids – ideally, they should be sterilised before pouring the jam into them

You can also choose to pasteurise the jam after it has been closed in the jars – to do this, place the jars in a large saucepan, pour some water in so that it reaches two-thirds the height of the jars, and simmer for around 30 minutes.

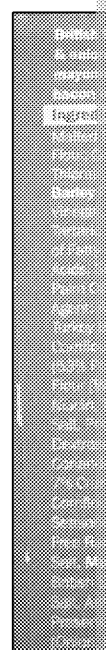
Preservatives

Preservatives are natural or artificial agents which are not an ingredient of a recipe, but are added to food to enhance its shelf life, e.g. by preventing bacterial growth or oxidation. Preservatives can be divided into antimicrobial preservatives (they prevent the growth of microorganisms, e.g. by lowering the pH of the food) and antioxidants (which prevent oxidation). The most popular preservatives include sulphur dioxide, which is also considered a major food allergen, and is found in dried fruit and wine; nitrates and nitrites are used in cured meats; and sodium benzoate is added to a wide range of foods (such as salad dressings and sauces). Antioxidants include ascorbic acid (vitamin C, added to fruit juices), and tocopherols (vitamin E, added to baked goods).

Apply



Inspect packages of various food products to see what kinds of preservatives are added to them.



Food labels showing preservatives

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Check your understanding: preservation

1. Which statement is FALSE about vacuum packing? (1 mark)
 - a. It removes all air from the package ☐
 - b. The package must be sealed ☐
 - c. It prevents growth of aerobic bacteria ☐
 - d. It prevents growth of anaerobic bacteria ☐
2. Pickling food in brine increases the amount of which nutrient in food? (1 mark)
 - a. Sodium ☐
 - b. Glucose ☐
 - c. Protein ☐
 - d. Fat ☐
3. Which of the following foods CANNOT be preserved by drying? (1 mark)
 - a. Milk ☐
 - b. Grapes ☐
 - c. Eggs ☐
 - d. Vegetable oil ☐
4. Which of the following is the preservative in jams? (1 mark)
 - a. Sugar ☐
 - b. Pectin ☐
 - c. Water ☐
 - d. Apple juice ☐

5. Describe how three preservation methods help to prevent bacterial contamination. (6 marks)

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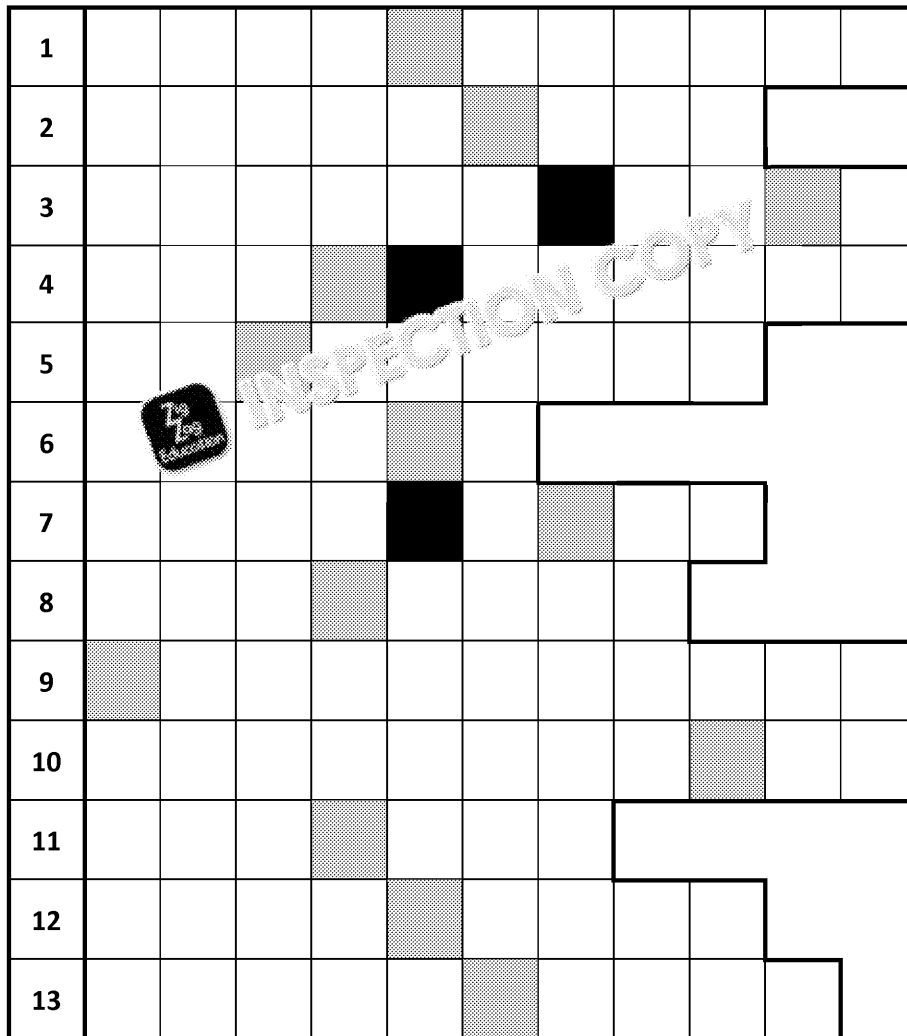
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Chapter 2: Quiz-ine

Fill in the answers to the questions below to reveal a phrase relevant to food science (black squares are spaces).



1. Type of mould used in production of blue cheese (11)
2. Dangerous toxin produced by certain mould types (9)
3. A term used to describe the range of temperatures in which microorganisms grow (4, 6)
4. Date mark which applies to food quality (4, 6)
5. One of the digestive symptoms of food poisoning (9)
6. Protein-based catalyst which speeds up chemical reactions (6)
7. Ready-to-eat foods are referred to as _____ (4, 4)
8. When a food takes on the smell of another food product (8)
9. _____ wipes or sprays can inhibit or kill bacteria (13)
10. Something added to foods to extend the shelf life (12)
11. Room temperature is also referred to as this (7)
12. The 'bad' bacteria which cause food spoilage and poisoning (9)
13. The type of bacteria commonly associated with eggs (10)

The shaded squares reveal this word:

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Answers – The effect of cooking

Why and how food is cooked

Things to think about (p. 4):

- Examples could include deep-fried foods, such as chips, which are high in fats. The bile has to be produced in the gall bladder, and that puts extra strain on the liver, so boiling before frying so that the surface of the food is sealed and the food doesn't absorb as much fat.
- Also, raw vegetables might be difficult to digest for some people due to high insoluble fibre. It might be best to steam or boil them to break down some fibre and improve digestion.

Things to think about (p. 5):

1. Students should note that foods which are frozen and sealed have longer date marks than raw fish and fish salad. Students should also note that highly processed, sterilised foods are labelled with a 'best before' date rather than a 'use by' mark.
2. Students should draw a diagram showing that a 'use by' date mark is used on fresh, easily perishable (e.g. fresh meat, fish, dairy products), while a 'best before' date mark is used on foods which are less perishable. The 'use by' date mark is used to indicate the time when the food is no longer safe to eat, while the 'best before' date mark is used to indicate the time when the food is no longer at its best, but it is still safe to eat.

Things to think about (p. 9)

Examples could include the following:

- Fish pie – preparation of this dish includes several steps, such as poaching fish (conduction), boiling potatoes (conduction, convection) and making cheese sauce (conduction, convection). Pre-boiling the potatoes prior to assembling the dish helps to shorten the baking time (radiation, convection). The pre-boiling also helps to obtain the desired texture of the dish (potatoes are soft, fish is not 'leaking' juices).
- Braised pork – in braising, food is first lightly fried, which helps to 'seal' the surface of the food, making the dish moister; then, the food is roasted or simmered for a long time at a low temperature to achieve the desired soft, melt-in-the-mouth texture.

Things to think about (p. 15):

Examples could include:

	Advantages	
Boiling	• Low-calorie • No added fat • Quick	• Vitamins destroyed when draining • Loss of vitamins • Loss of colour
Steaming	• Preserves the nutritional value of food • Low-fat • Food becomes tender • Hard to overcook	• Can't be used for tough cuts of meat, as it will take a long time to cook
Simmering	• Develops the flavours • Helps to obtain a desirable texture • Helps to cook the food evenly throughout • Helps to obtain the desired texture by evaporating water the food becomes tender	• Time-consuming • Can cause vitamins to be lost
Blanching	• Helps to preserve the nutritional value and colour of the food • Quick	• The food does not remain hot for long
Poaching	• Good for preparing delicate ingredients • Helps to preserve the texture of the food • Food remains juicy	• Can't be used for tough meat, as the meat will be tough • Vitamins can be lost when draining
Braising	• Seals the surface so the food remains juicy • Improves the texture of the food	• Time-consuming • Causes vitamins to be lost at high temperatures
Baking	• Creates an attractive crust • Develops flavours through dextrinisation and caramelisation • Improves palatability of food	• Time-consuming • Food may be cooked too high or too low • The long cooking time can cause vitamins to be lost

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	Advantages	
Roasting	- Creates an appetising crust/surface - Helps to lower the calorific value of food as fat melts and leaks out of it	- Causes vitamin loss at high temperatures - Time-consuming - Can increase extra fat in food
Grilling	- Usually quick - Usually low-fat - Helps to preserve the nutritional value of food	May create a charred crust to the very surface
Dry-frying	- Very quick - Helps to preserve the nutritional value of food - Helps to lower the calorific value of food	Very high temperatures to burn very quickly
Shallow-frying	- Creates a crunchy crust - Helps to create an appetising colour - Seals the surface so the food remains juicy	- Increases calorie content - High temperatures
Stir-frying	- Very quick - Helps to prevent the nutritional value of food from being lost - Low-fat - The food remains crunchy - The colour of food (e.g. broccoli) is usually preserved	Can't be used for large pieces of food, e.g. pork, as they will not cook through

Check your understanding

1) B 2) D 3) A 4) C (1 mark for each correct, max. 4 marks)

5) 1 mark for each correct, max. 3 marks

Any three from (1 mark for each, max. 3 marks):

- To make food safe to eat
- To prevent bacterial contamination of food
- To improve/aid digestion of food
- To improve the texture of food
- To improve the taste of food
- To improve the appearance of food

Other suitable answers may be accepted.

6) 1 mark for each correct statement, max. 4 marks:

- During baking, heat is transferred to food through radiation (from the oven)
- Also, the heat is transferred through conduction directly from the baking tray
- When baking a lasagne, the water from sauce is absorbed by starch in the pasta
- Thanks to contact with water, the starch in the pasta begins to gelatinise.
- The pasta changes its texture from hard and dry to soft and moist.
- The cheese on top melts.
- The cheese also changes its colour to golden/brown thanks to the Maillard reaction
- The meat in the sauce tenderises and softens
- The aroma of the lasagne becomes more intense
- Since tomato sauce usually contains some sugar, the sugar may begin to caramelize
- Cooking allows the moisture from the sauce to be absorbed by the pasta, allowing it to reach its final texture (soft but not runny).

Other suitable answers may be accepted.

7) Any two from (1 mark each, max. 2 marks):

- Frying helps to seal the surface of the meat, thanks to which it stays moist/juicy
- Frying helps to create an attractive, brown colour / improves the appearance
- Stewing helps to soften and tenderise the meat, as the protein in it will denature
- The long time and high temperature of cooking will cause vitamin loss (generally heat-sensitive to heat)
- Addition of fat during the first step of braising means that the calorific value of the dish and the amount of fat in the dish will increase.

Other suitable answers may be accepted.

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The positive use of microorganisms in food products

Things to think about (p. 20)

Examples could include:

- baked goods (bread, bread rolls, buns, croissants)
- alcoholic beverages (beer, cider, wine and champagne)
- yoghurts and cheeses

Check your understanding

1) B 2) B 3) B (1 mark for each correct, max. 3 marks)

4) 1 mark for each correct, max. 2 marks

Any two from:

- transforming lactose
- producing lactic acid
- lowering the pH
- coagulation of protein
- denaturation of protein
- separation of curd
- altering the colour
- altering the aroma
- altering the texture

Other suitable answers may be accepted.

5) Production of salami includes a number of steps and procedures, each of them the answer should include reference to at least three from: (1 mark for each correct)

- Before mincing, the meat is partially frozen to kill potential parasites (*Trichinella*)
- Before mincing, the mincing machine and all utensils used are sterilised to kill bacteria
- Mincing takes place at a low temperature to slow down the growth of microorganisms
- Starter cultures of bacteria and moulds are added.
- Bacteria produce lactic acid, which lowers the pH of the sausage and slows down bacterial growth
- Mould creates a coat on the outside of the sausage and shields it from the air
- Drying reduces the amount of water in the sausage, so bacterial growth is slowed

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The working characteristics, and functional and chemical properties of cooking ingredients

Carbohydrates

Check your understanding

1) a = true b = false c = true (1 mark for each correct, max. 3 marks)

2) B 3) C 4) D (1 mark for each correct, max. 3 marks)

5) 1 mark for indicating the function of starch (max. 1 mark)

- Function of starch: thickening / improving the texture / setting agent
- Up to 3 marks for the correct description/explanation (max. 3 marks)

Indicative content:

- Starch undergoes gelatinisation in the presence of water and heat.
- Starch molecules absorb water and swell.
- Absorption of water leads to thickening of a given mixture, e.g. a soup or sauce.
- The more starch there is in the mixture, the thicker it will become.
- If the mixture is overcooked, it will become thin again.
- During gelatinisation, the starch forms a net-like structure in which water is held.
- If the mixture is overcooked, that structure is damaged and the water is released.
- The stages of gelatinisation include:
 - at 60°C the starch granules begin to swell (due to absorption of water)
 - at 80°C the starch granules begin to burst open and release starch into the mixture
 - at 100°C all starch is released into the mixture, and the sauce is cooked
 - cooking the sauce for longer may lead to its separation, as the starch granules release the water they previously absorbed

Other suitable answers may be accepted.

Fats and oils

Check your understanding

1) B 2) C 3) B (1 mark for each correct, max. 3 marks)

4) 1 mark for each correct, max. 2 marks

Any two from:

- Creaming/aeration (during beating)
- Melting of fat (during baking)
- Beating (fat with sugar)

5) Up to 2 marks for a detailed description. Must supply examples with explanation

- If a fat only contains single chemical bonds, it will be solid both at room temperature and when cooled. Examples include butter, lard and coconut oil.
- The presence of double chemical bonds in fatty acid chains changes the physical properties. Monounsaturated fats will be liquid at room temperature, but will solidify when cooled (example: sunflower oil); polyunsaturated fats are always liquid (example: sunflower oil).

6) 2 marks for a detailed explanation, 1 mark for a basic explanation (max. 2 marks)

Indicative content:

- Mayonnaise is a mixture of oil and vinegar (water based liquid).
- Fats are hydrophobic and repel water molecules, leading to separation of the two.
- Emulsifiers bond to both types of molecule.
- Consequently, emulsifiers prevent the mayonnaise from separating.
- Emulsifiers help to ensure the proper texture of mayonnaise.

7) 1 mark for each correct statement (max. 4 marks):

- In creaming, fat molecules coat flour granules.
- Fat molecules create a hydrophobic layer around starch molecules.
- This prevents gluten in starch from accessing the water.
- Gluten cannot form long fibres without water.
- Only short fibres of gluten can be developed. This helps to keep the dough crumbly.
- Therefore, the pastry is crumbly/crunchy, rather than spongy and elastic.

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Proteins

Check your understanding

- 1) D 2) B 3) C 4) B (1 mark for each correct, max. 4 marks)
- 5) Any three from (1 mark for each function and 1 mark for a relevant explanation)
- Glazing – egg wash helps to create a shiny finish to bread rolls and other baked goods
 - Binding – egg acts as a glue in sweet and savoury dishes, such as muffins or cakes
 - Coating – egg helps the breadcrumbs stick to the food, meaning they do not fall off
 - Raising agent – whisked egg white traps a lot of air, which is used in many cakes and soufflé
 - Improving the texture – whisked whole eggs create a foam, which can be used in cakes
 - Emulsifier – eggs contain lecithin, which is a natural emulsifier; as a result, they are used in emulsion sauces, such as mayonnaise
 - Thickener – eggs coagulate in the presence of heat, and therefore, are used in custards
 - Colourant – egg yolks add a yellow shade to butter and other mixtures
- Other suitable answers may be accepted.
- 6) 2 marks for a detailed description, 1 mark for a basic description (max. 2 marks)
- Indicative content:
- Gluten is formed when flour is mixed with water.
 - In the presence of water, gliadin and glutenin proteins bind together, forming a gluten network.
 - The gluten net has the ability to stretch and trap air bubbles inside.
 - During baking, the air expands and stretches out the gluten fibres.
 - This makes it possible to obtain the open texture of bread.
 - Gluten-free flours cannot trap air, and, therefore, their texture is close and dense.
- Other suitable answers may be accepted.
- 7) 1 mark for each correct (max. 2 marks)
- coagulation (of the egg)
 - denaturation (of the egg and gluten)

Fruit and vegetables

Check your understanding

- 1) B 2) B 3) D 4) D 5) B (1 mark for each correct, max. 5 marks)
- 6) 2 marks for a detailed description, 1 mark for a basic description (max. 2 marks)
- Enzymatic browning is primarily caused by an enzyme called polyphenol oxidase reacting with oxygen. Enzymatic browning cannot take place if either the enzyme or oxygen is lacking. Enzymatic browning can be stopped or prevented by removing oxygen or stopping the reaction (e.g. blanching the food). Enzymatic browning affects some fruits and vegetables, such as apples, bananas and lettuce.
 - Oxidation is primarily caused by oxygen, which reacts with various chemicals in food. Oxidation cannot take place if oxygen is lacking. Oxidation may be stopped by removing oxygen / oxygen or by the use of antioxidants (e.g. vitamin C). Oxidation may affect the taste and texture of food (causes it to go rancid).
- 7) 1 mark for each method of prevention, max. 3 marks
1 mark for each explanation, max. 3 marks
- Indicative content:
- covering with cling film or putting in an airtight box to shield from air/oxygen – because it bonds with the polyphenol oxidase enzyme
 - packing in a modified atmosphere to reduce the amount of oxygen – as above
 - using proper packaging which do not contain copper or iron – both of these metals can catalyse the reaction
 - blanching the food to deactivate enzymes – enzymes are built from proteins and are denatured by heat
 - using acids such as lemon juice or vinegar – enzymes are built from proteins and are denatured by acids
 - lowering temperature by putting food in the fridge – enzymes are built from proteins and are denatured by heat
 - blanching the food to deactivate enzymes – enzymes are built from proteins and are denatured by heat
- Other suitable answers may be accepted.

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The most common faults in cooking and how to prevent them

Check your understanding

- 1) D 2) C 3) B (1 mark for each correct, max. 3 marks)
- 4) a = true b = false c = false (1 mark for each correct, max. 3 marks)
- 5) 1 mark for each correct statement, max. 3 marks
Any three from:
- Adding too much sugar can cause the cake to sink in the middle.
 - Adding too much flour or cocoa can cause the cake to be tough and dry.
 - Adding too much baking powder / bicarbonate of soda can cause the cake to rise too much.
 - Adding too little baking powder / bicarbonate of soda can cause the cake to be flat.
 - Adding too much sugar can cause the cake to develop a hard, sugary crust.
- Other suitable answers may be accepted.
- 6) Any three from (1 mark for identifying the mistake, 1 mark for explaining why it is a mistake)
- **Mistake:** not adding sugar to the dough
Explanation: this means that the yeast has no food, so cannot multiply, and the dough will not rise
 - **Mistake:** using the wrong type of flour (e.g. low-gluten)
Explanation: this means that the carbon dioxide produced by yeast will not be trapped, and the bread will be tough
 - **Mistake:** lack of water in the dough
Explanation: this means that gluten will not develop, and the dough will be tough
 - **Mistake:** using the wrong type of flour (e.g. gluten-free)
Explanation: this means that gluten will not develop in the dough, and the bread will not develop the open, sponge-like texture
 - **Mistake:** using old yeast
Explanation: can mean that it is not alive any more, so the dough will not rise
 - **Mistake:** using water that is too hot
Explanation: it can kill the yeast in the dough, so it will not rise at all
 - **Mistake:** using water that is too cold
Explanation: it will lower the temperature of the dough, and that can slow down the yeast, so the dough will rise very slowly (or not at all)
 - **Mistake:** adding too much salt to the dough
Explanation: this means that it will compete with sugar for water, and that there will be no more sugar to caramelise
 - **Mistake:** adding too much salt
Explanation: it can slow down yeast growth, and that can cause the dough to be tough
 - **Mistake:** kneading the dough too vigorously
Explanation: it can cause the carbon dioxide to escape from the dough, and the bread will be tough
 - **Mistake:** proving the dough for too short a time (or not proving at all)
Explanation: it means that the yeast will have not enough time to multiply and produce carbon dioxide, and that will make the bread tough
 - **Mistake:** baking the bread for too short a time
Explanation: this can cause it to sink and become tough and moist
 - **Mistake:** baking the bread too high up in the oven
Explanation: it can cause it to burn on top and crack, while the middle can be undercooked
- Or any other suitable answer

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Chaper 1: Quiz-ine

1. Foam
2. Shortening
3. Browning
4. Salami
5. Gluten
6. Solanine
7. Denaturation
8. Carbon dioxide
9. Antioxidant
10. Stirring
11. Microwaves
12. Steaming

The shaded fields reveal this word: **fermentation**



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Answers – Food spoilage

Microorganisms (food spoilage)

Things to think about: (p. 52)

Most at risk are the very young or elderly, people who are already ill or recovering, and Any individual whose immune system is weaker is more susceptible to the effects of pass from a pregnant woman to an unborn foetus.

Things to think about: (p. 55)

This is human body temperature which creates ideal conditions for bacteria to grow

Things to think about: (p. 57)

Some foods, such as grapes and tomatoes, show signs of spoilage before others as they can This is because they provide all the conditions necessary for the growth of microorganisms food (protein and sugar) and temperature (as they are often stored in room temperature)

Things to think about: (p. 58)

Some fruits have yeasts on their skins which react with sugars, causing fermentation action through ripening process. Grapes, apples and bananas are examples of this

Check your understanding

1) D 2) C 3) A 4) C (1 mark for each, max. 4 marks)

5) 1 mark for each correct statement, max. 3 marks

Any three from:

- Very low temperatures, such as in freezing, deactivate enzymes, so that enzyme activity is not conducted.
- Very low temperatures, such as in freezing, make bacteria dormant and cause them to be inactive and do not multiply.
- Low temperatures, such as in a fridge, slow down the action caused by enzymes so that spoilage is delayed.
- Low temperatures, such as in a fridge, slow down the growth of bacteria and fungi, but in temperatures above 5°C.
- High temperatures, such as in cooking (above 63°C) and blanching, deactivate enzymes and denature protein and denature due to high temperatures).
- High temperatures, such as in cooking (above 63°C), kill most bacteria.
- Very high temperatures, such as in sterilisation (above 100°C), kill all bacteria, making food safe at least until it cools down and goes through danger zone again, or until it is consumed as contaminated food.

6) Any 8 from (1 mark for each correct statement, max. 8 marks):

- Microorganisms such as *E. coli* and *Campylobacter jejuni* cause food poisoning.
- Toxic mould present in food or water.
- Pathogenic bacteria can come from raw foods, pests, people, air, dust, dirt and moisture, food, moisture, protein and warmth, bacteria can multiply using a process called binary fission.
- Because pathogenic bacteria cannot be seen or smelled in food it is possible to get food poisoning without realising the potential danger.
- Pathogenic bacteria which cause food poisoning are present in humans and can be passed on to other humans through handling of food.
- Dust, dirt and soil can carry pathogenic bacteria. This is why it is important to keep food covered.
- Raw food, such as undercooked chicken, contains pathogenic bacteria which can be killed at correct temperatures will kill bacteria making the food safe to eat.
- Bacteria are not killed when raw food is frozen but remain dormant until it is thawed. If chicken isn't thawed and then cooked quickly at the correct temperatures, it can become a potential food poisoning risk.
- The danger zone for food is between the temperatures of 5°C and 63°C. If food is kept in the danger zone (the danger zone) then bacteria can start to grow and divide every 10–20 minutes, increasing the risk of food poisoning.
- The optimum conditions for bacteria to grow are warmth, time, moisture and food. If food is kept for long enough at room temperature, it will develop bacteria which can cause food poisoning.
- Cooking food at correct temperatures can kill pathogenic bacteria. Food that is not cooked properly can start growing bacteria. In some people this may only cause a slight gastric upset, but in others it can be fatal. The elderly, the very young or those who are ill or recovering from an illness are more at risk.

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food poisoning due to compromised immune systems. Unborn babies can be born with health problems if pregnant women should take care.

- Food poisoning can be caused by storing food incorrectly. Raw food and high-risk foods should be stored separately to ensure that cross-contamination does not occur, e.g. raw chicken should be stored in the fridge to prevent juices dripping onto other food items.
- Food poisoning can be caused by pathogenic bacteria from raw food being transferred to other foods via surfaces or chopping boards.
- Food poisoning can be caused by eating cooked rice which has been left to stand at room temperature.
- Food poisoning can be caused by pathogenic bacteria present in milk and dairy products, shellfish, seafood, and cooked meat and poultry, with the biggest risk being when raw and cooked foods are combined.
- Food poisoning can be caused by harmful toxins called mycotoxins which are naturally occurring in some crops and some can be used in food production.

Buying food

Things to think about (p. 64)

Storage rotation is important so that food with a short shelf life is used before food with a longer shelf life. Food should be stored according to the 'first in, first out' principle, with items with a short shelf life stored in front of items with a longer shelf life.

Things to think about (p. 64)

Examples could include:

- allergy sufferers – should pay attention to the list of ingredients and special warnings to ensure the food is safe from allergens and safe for consumption for them (allergens are usually printed in bold on the label)
- lactose intolerant people – should pay attention to milk content in the food so they can avoid it
- people with high blood pressure – should pay attention to salt/sodium level in the food
- people with coronary heart disease / a high blood cholesterol level – should check for saturated fat or enriched with phytosterols, which help to lower blood cholesterol (usually indicated by a health or nutrition claim)
- people with a vitamin deficiency – can check whether the food contains a given vitamin or added during fortification
- people for whom animal welfare is important – can see whether the food was produced to high welfare standards, e.g. organic or free-range
- people who cannot cook – may find preparation instructions useful
- date marks – can be useful for people concerned about food waste issues, as they can see the date by which the food should be eaten with a short date if they know they won't be able to eat it by that time, etc.

Check your understanding

1) A 2) B 3) A (1 mark for each, max. 3 marks)

4) 1 mark for identifying, 1 mark for explaining why it is efficient (max. 4 marks)

Any two from:

- it includes information about food allergens, so foods which contain them can be avoided by people allergic to specific foods
- it includes date marks, which help to identify whether the food is still fresh
- it includes storage conditions, which help to advise whether the buyer/consumer should store the food in the correct conditions at home
- it provides an ingredient list, which helps to decide whether a food is high in fat/sugar/salt and whether it will require any special preparation skills
- it should be understood that the consumer knows that the food couldn't have been produced from the food manufacture to the shop

Other suitable answers may be accepted.

5) 1 mark for each correct, max. 4 marks

- use by
- best before
- best before
- use by

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Storing food

1) C 2) D 3) A (1 mark for each correct, max. 3 marks)

4) 1 mark for identifying, 1 mark for explaining why it is efficient (max. 4 marks)

Any two from:

- Sealed bags and containers protect the food inside from the air – as a result, oxidation cannot happen.
- Closed boxes and bags protect the food inside from pests and microorganisms, so the food cannot be spoilt.
- Packaging protects the food inside from sunlight – so that the vitamins do not lose their value and the value of the food is maintained.
- Packaging contains information about the food – so that the consumer can choose what they want, e.g. free from allergens or free from gluten.
- Packaging contains a date mark, which says how long the food is fresh and when it is best to eat it.
- Packaging protects from leakage, such as the leaking juice, e.g. from meat, dairy products in the shopping bags, e.g. in the fridge.
- Packaging can be used to maintain cool temperatures, so that the food does not spoil and bacteria cannot multiply.

Other sensible answers may be accepted.

5) Any four from (1 mark for each correct statement, max. 4 marks):

- Chicken is a high-risk food which is high in protein and high in moisture. The warmth, provides ideal conditions for bacteria to thrive.
- The correct temperature to cook chicken is at 75 °C or higher. If reheating, it should be at 82 °C. Cooking or reheating below these temperatures allows bacteria to grow.
- For storage, chicken should be frozen at -18 °C (this will slow down bacterial growth during the thawing process).
- Frozen food such as chicken goes through the danger zone when thawing so ensure that the inside thaws while the outside of the chicken thaws. This means need thawing slowly at room temperature, which can necessitate the food being in the danger zone for a period of time. Cooking at the correct temperature will kill the bacteria.
- Temperature control is important when dealing with thawed chicken. Although it can be refrozen once thawed, poultry that has been defrosted can be refrozen if cooked at the correct temperatures.
- Temperature control is important when storing or defrosting raw chicken in the fridge so that the temperature of the appliances is at 5 °C or lower and that warm food is not put in the fridge to prevent the temperature from rising. Temperatures above 5 °C put the chicken in the danger zone and bacteria can start to grow and multiply.
- Cooked chicken which is served cold should be kept cool and eaten within 4 hours. If it is not eaten, it can start to grow and multiply and the chicken should be disposed of.
- Hot food, such as cooked chicken, must be held at temperatures of at least 60 °C.
- Combining hot and cold foods can affect the temperature of food, either warming or cooling it. This can affect the temperature of cooked chicken, such as cooling it down to room temperature and then putting it in the fridge. This can affect the temperature of cooked chicken, such as cooling it down to room temperature and then putting it in the fridge.
- Chicken is a high-risk food containing the risk of bacterial food poisoning and should be handled with care.

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Preparing, cooking and serving food

Things to think about: (p. 74)

Food poisoning can be caused when bacteria grow in large numbers in food or by viruses, animals, or by toxic moulds. Food poisoning from bacterial contamination of untreated raw or insufficiently cooked can be the cause of *E. coli* and *Salmonella*. Beansprouts and other legumes, when stored with temperature conditions (i.e. between 5 °C and 63 °C), this can enable bacteria to grow (these are the ideal conditions). Because of the danger from food poisoning, beansprouts should only be served if they have been cooked or otherwise should be steamed or cooked until piping hot. Raw beansprouts should not be served.

Things to think about: (p. 75)

Pregnant women can transfer food poisoning to their unborn babies. This can have serious consequences and sometimes lead to miscarriage.

Things to think about: (p. 79)

Cross-contamination between salad items and cooked chicken can occur from soil on unwashed hands. Utensils, such as chopping boards and knives, can transfer bacteria from raw to cooked food. It is important to use separate utensils when preparing raw and cooked food.

Check your understanding

1) B 2) A 3) C 4) A 5) A (1 mark for each, max. 5 marks)

6) Any four from (1 mark for each correct statement, max. 4 marks):

- The core temperature of food should be kept at the correct level for the required time.
- Although some foods are safe to be blanched briefly, most foods must be cooked for the recommended cooking times to ensure safety. Lower cooking temperatures can be used if the food is cooked for the recommended duration for that temperature.
- Food should be reheated at the correct temperature to kill bacteria. In some cases, reheating at lower temperatures may adversely affect the texture or taste of food, it can be reheated at a higher temperature for the required duration (e.g. red meat should reach at least 70 °C for at least 10 minutes).
- Cooking food at the correct temperatures is important for prevention of bacterial growth. Standing food for a minute after cooking can also help to kill bacteria as temperature continues to rise within this time.
- Cooking at the correct temperatures can help to kill bacteria, but some foods require higher temperatures of at least 75 °C. The following duration must be maintained at these temperatures: at least 45 minutes at 60 °C, at least 10 minutes at 65 °C and at least 5 minutes at 70 °C.
- Gravy, sauces and soups should be simmering to ensure that they are cooked through. This means that, after boiling, the heat should be reduced so that cooking continues at a lower temperature for the prescribed amount of time.
- Some foods should be cooled very rapidly to prevent bacterial growth with them. This can be done using a blast chiller to cool food rapidly by circulating very cold air.

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Preservation methods used to keep food for longer

Check your understanding

1) D 2) A 3) D 4) A (1 mark for each correct, max. 4 marks)

5) 1 mark for each method identified, 1 mark for a relevant explanation (max. 6 marks)
The answers could include a reference to:

- **Method:** jam making
Why/how it works: in jam, sugar binds water and makes it unavailable for microorganisms to multiply and cause food spoilage
- **Method:** pickling
Why/how it works: when pickling food in brine, salt increases the osmotic pressure, which draws water from the bacterial cells, which then cannot multiply; when pickled in vinegar, the solution is highly acidic, which disables growth of most microorganisms
- **Method:** freezing
Why/how it works: in freezing, water changes its physical state from liquid to solid, making it unavailable for microorganisms; also, at low temperatures enzymes (proteins) are denatured and cannot be used by bacteria for multiplying
- **Method:** bottling
Why/how it works: in bottling, microorganisms are killed by high temperatures, then sealed in sterilised containers (e.g. jars) which help to prevent contamination and, therefore, prevent food spoilage
- **Method:** vacuum packing
Why/how it works: in vacuum packing, all air is removed from the packaging, which helps to prevent growth of aerobic bacteria, which require oxygen for growth; however, it is not as effective in preventing growth of anaerobic bacteria

Accept other suitable answers.

Chapter 2: Quiz-ine

1. *Penicillium*
2. Mycotoxin
3. Danger zone
4. Best before
5. Diarrhoea
6. Enzyme
7. High risk
8. Tainting
9. Antibacterial
10. Preservative
11. Ambient
12. Pathogens
13. *Salmonella*

The shaded fields reveal this word: **contamination**

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