Home Economics

Health and Food Technology

Resource Management

[HIGHER]

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SECTION 1

Functions and sources of nutrients

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It is important for good health to eat a balanced diet. A balanced diet provides all the necessary nutrients in the correct proportions and quantities to meet our needs. One way to follow a balanced diet is to make sure we eat a variety of foods which supply a range of nutrients.

Protein

- Proteins are made up of amino acids.
- Proteins that contain all the essential amino acids are called high biological value (HBV) proteins.
- Proteins that lack one or more of the essential amino acids are called low biological value (LBV) proteins.

Functions	Sources
Proteins are essential to life. All living cells are built and replaced by protein molecules. The main value of protein is in: • Growth of new cells • Repair of cells • Maintenance of the body cells. The secondary value of protein: • Excess protein will provide the body with energy, once it has been used for its main purpose of growth, repair and maintenance.	High biological value (HBV) proteins: • These are found mainly in animal sources such as meat, cheese, fish, milk, eggs. • The plant food soya beans contain HBV protein. Low biological value (LBV) proteins: • These are found mainly in plant food such as – cereals, e.g. wheat, rice, oats – pulses, e.g. peas, beans, lentils – some nuts, quorn.

Fats

- The term 'fat' includes both fats (solid at room temperature) and oils (liquid at room temperature).
- Fat is present in food either as 'visible' or 'invisible' fat
  - Visible fat is easy to detect in food, e.g. fat on meat, butter, margarine, lard, cooking oil.
  - Invisible fat is a constituent part of food and is difficult to detect, e.g. fat in pastry, cakes, biscuits.

Functions of fats are to:

- Provide a concentrated source of energy
- Provide essential fatty acids
- Provide a source of fat-soluble vitamins A, D, E and K
- Surround and protect certain vital organs such as the kidneys
- Form an insulating layer underneath the skin and so to help maintain body temperature
- Provide a feeling of fullness (satiety) through consumption of foods containing fat
- Support the structure of all body cells.

Fats can be classified into *saturated* fats and *unsaturated* fats.

Saturated fats

Important points	Sources
• Fats which are solid at room temperature are mostly made of saturated fatty acids. • A diet high in saturated fats tends to raise blood cholesterol levels (particularly the low-density lipoprotein – LDL, the 'bad' cholesterol) in some people, so increasing the risk of heart disease. • The LDL tends to stick to artery walls, increasing the risk of blood clots and blockage of the artery. • Certain cancers such as bowel and breast cancer have been linked with high intakes of saturated fats.	Mainly of animal origin • Meat and its products, e.g. pies, sausages, lard, suet • Fats, e.g. butter, hard margarine, some blended cooking oils • Milk and dairy products, e.g. butter, whole milk, cheese, cream, eggs But also • Coconut oil and palm oil which are used to make biscuits, pastry, cakes

Unsaturated fats

Important points	Sources
Monounsaturated fats • Monounsaturated fats remain liquid at room temperature, but start to solidify when chilled • Monounsaturated fats reduce the bad LDL cholesterol. They also maintain or slightly increase the good high-density lipoprotein (HDL) cholesterol. • HDL cholesterol helps to ferry the cholesterol away from the arteries to the liver where it is broken down into bile.	• Olive oil • Rape seed oil • Avocados • Nuts
Polyunsaturated fats • Polyunsaturated fats usually remain liquid at both room temperature and cold temperatures. • Polyunsaturates help to bring down blood cholesterol levels. • There are specific polyunsaturates which are vital for health and cannot be made in the body. These are called **essential fatty acids** (EFAs) and must be obtained from food.	• Oily fish, e.g. mackerel and sardines • Pure vegetable oils, e.g. sunflower, soya • Nuts and seeds
Essential fatty acids The two main EFAs are • **Omega 3** (or linolenic acid) Omega 3 reduces the risk of blood clots forming, so reducing the risk of a heart attack. It may also reduce the incidence of inflammatory diseases, such as rheumatoid arthritis. • **Omega 6** (or linoleic acid) These tend to decrease bad cholesterol, but too much may also decrease good cholesterol levels. Both Omega 3 and 6 are needed for brain development in babies. Humans make special linolenic and linoleic acids in breast milk. This is one of the reasons why human breast milk is best for babies.	**Omega 3** • Oily fish – mackerel, pilchards, sardines, herrings, trout **Omega 6** • Polyunsaturated margarine • Corn, sunflower and soya bean oils

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• Another type of polyunsaturated fat is called **trans-fatty acids**. **Trans-fatty acids** are polyunsaturated fats artificially hardened by adding extra hydrogen. They cause an increased risk of heart disease and rheumatoid arthritis and may be linked to some cancers. Trans-fatty acids increase blood levels of bad cholesterol and may reduce levels of good cholesterol. Trans-fatty acids are not listed on food ingredients, but hydrogenated or partially hydrogenated oils are listed.	• Hard margarine • Biscuits and cakes • Commercially fried foods, e.g. French fries from fast-food chains • Packaged snacks • Any food label that indicates hydrogenated or partially hydrogenated fats/oils

Carbohydrates

The functions of carbohydrates are:

- To supply energy for all activities
- To supply energy to maintain normal body temperature
- To supply indigestible fibrous material (NSP: Non Starch Polysaccharides) to aid digestion
- Important in the structure of cells.

Carbohydrates can be subdivided into three main groups:

1. *Monosaccharides* (sugars)
2. *Disaccharides* (sugars)
3. *Polysaccharides* (starches)

Sugars can also be classified as:

- *Intrinsic sugars* – those that form part of the cell structure of plants (for example fruits)
- *Extrinsic sugars* – not part of the cell structure of plants. They include non-milk extrinsic sugars (NME sugars), for example refined sugar, sugar added to foods, extracted sugars in honey and fruit juice.

Important points	Sources
1. Monosaccharides Monosaccharides or simple sugars are single-unit carbohydrates.There are three main monosaccharides:	
• *Glucose*	Fruit, vegetables, e.g. onions, beetroot, available in powder, liquid or tablet form honey
• *Fructose* (often called 'fruit sugar')	Fruit and vegetables, honey
• *Galactose*	Milk
2. Disaccharides These are double sugars made up of two monosaccharides joined together. The three main disaccharides are:	
• *Sucrose* Used in cookery and obtained by refining sugar cane or beet. Sucrose is formed from one unit of glucose and one unit of fructose.	Refined sugar cane or beet. Some fruit and vegetables.
• *Lactose* Found in the milk of mammals to supply the infant with a source of energy. It is not as sweet as sucrose. Lactose is formed from one unit of glucose and one unit of galactose	Milk
• *Maltose* Sometimes called 'malt sugar', it is found in cereals where it is formed during germination. Maltose is formed from two units of glucose.	Germinating cereals, e.g. barley
3. Polysaccharides These are called starches or complex carbohydrates. They consist of chains of monosaccharides. The main polysaccharides are:	
• *Starch* Formed from many glucose units joined together like links in a chain.	Bread, flour, potatoes, cakes
• *Non-starch Polysaccharides* (NSP) These are a form of polysaccharides.	Wholegrain cereals – oats, wheat, rice, wholemeal bread. Skins of fruit and vegetables

Starches

It is recommended that we should get most of our energy from starch or complex carbohydrate foods rather than sugar. There are a number of reasons for this.

- *Starch foods are good sources of other nutrients*. Examples include potatoes, which are also a source of vitamin C; and bread, which is also a source of protein, calcium and iron. Sugar is often described as 'empty calories' since it provides energy but no other nutrients.
- *Starch foods provide bulk with few calories*. Most of these foods provide substantial amounts of water and NSP. This means that they are filling, without being a concentrated source of energy.
- *They do not encourage tooth decay*, as bacteria in the mouth do not like starches. On the other hand, sugar provides food for acid-producing bacteria on the surface of the teeth and this acid damages teeth.
- *They are generally inexpensive foods*. For example, bread and breakfast cereals are inexpensive and are fortified with vitamins and minerals.

Vitamins

Although vitamins are only required in small amounts, each is essential to general good health. Vitamins are classified according to whether they are soluble in fat or water.

Vitamin A

This is a fat-soluble vitamin. Carotene (the plant source of vitamin A) is converted to vitamin A in the small intestine.

Functions	Sources
• Required to make visual purple (a red photopigment), which assists with good vision – particularly in dim light • Required to keep the mucous membranes in the eyes, lungs, throat and digestive tract moist and free from infection • One of the antioxidant vitamins that helps to prevent cancer and heart disease • Required for the maintenance and health of the skin • Required for the normal growth of children	**Animal sources (as retinol)** • Milk, cheese, butter, eggs • Oily fish – sardines, herring, pilchards, fish liver oils • Added to margarine by law **Plant sources (as carotene)** • Green vegetables – spinach, watercress, parsley, cabbage • Orange and red-coloured fruit and vegetables – carrots, tomatoes, apricots

Vitamin B complex

This is a water-soluble vitamin. There are many types of vitamin B within this group.

Functions	Sources
Vitamin B1 (thiamin) • Essential for the release of energy from carbohydrates • Needed for growth and normal functioning of the nervous system • Maintains muscle tone • Required for the normal growth of children and for general good health	• White flour is fortified by law • Fortified breakfast cereals • Brown rice, wholemeal pasta • Liver, kidney • Milk and eggs
Vitamin B2 (riboflavin) • Essential for the release of energy from food, especially protein, carbohydrates and fats • Essential for normal growth	• Meat, liver, kidney • Milk and eggs • Green vegetables • Wholemeal bread • Some is also manufactured by bacteria in the intestine
Vitamin B3 (niacin) • Essential for the release of energy from food, especially carbohydrates • Essential for healthy skin and nerves	• Meat and meat products • Poultry and fish • Wholemeal bread and cereals • Fortified breakfast cereals • Pulses, nuts • Some is also manufactured by bacteria in the intestine
Vitamin B12 • Helps prevent certain forms of anaemia (pernicious anaemia) • Needed for the metabolism of amino acids (protein) • Protects the nervous system	• All animal foods – meat, liver, fish, cheese, milk, eggs • Fortified breakfast cereals
Folic acid (folate) • Essential for the formation of blood cells • Helps protect against neural tube defects such as spina bifida in unborn babies. Women are advised to eat folate-rich foods before planning a pregnancy and for the first 12 weeks of pregnancy • Required for the release of energy from food, especially protein • Essential for normal growth	• Green leafy vegetables – brussels sprouts, broccoli • Wholegrain cereals • Fortified breakfast cereals • Dairy products • Peas, beans and lentils • Oranges, bananas and grapefruit

Vitamin C

This is a water-soluble vitamin.

Functions	Sources
• Must be present to help the absorption of iron and so helps prevent anaemia • One of the antioxidant vitamins that helps to prevent cancer and heart disease • Required to make connective tissue which binds body cells together • Helps cuts and wounds to heal quicker • Essential in the manufacture of blood and cell walls of blood vessels	**Rich sources** • Blackcurrants, rosehips, green peppers, kiwi fruits **Good sources** • Citrus fruits – oranges, lemons, grapefruit, limes • Strawberries • Cabbage, spinach, brussels sprouts, broccoli **Reasonable sources** • Bean sprouts, peas, potatoes

Vitamin D

This is a fat-soluble vitamin.

Functions	Sources
• Must be present so that calcium is absorbed • Essential in the intestine so that calcium can be absorbed • Acts with calcium and phosphorous to form strong bones and teeth • Promotes quicker healing of bone fractures	• Main non-food source is the sun's ultra-violet rays reacting on the skin. A substance under the skin is converted to vitamin D which is then stored in the liver. The sun could supply all the body's requirements for vitamin D. • Cod and halibut liver oils, oily fish • Added by law to margarine • Egg yolk • Fortified breakfast cereals • Fortified infant milk

Vitamin E

This is a fat-soluble vitamin.

Functions	Sources
• A very effective antioxidant vitamin that helps to prevent certain cancers and heart disease • Involved in the maintenance of cell membranes – protects polyunsaturated fatty acids from damage by free radicals in the cell membranes in the body	• Vegetable oils, especially sunflower seed oil • Egg yolk • Wheat germ • Oatmeal • Peanuts • Margarine • Milk and milk products • Liver and meat • Leafy green vegetables, such as lettuce, contain a small amount

Antioxidant vitamins

- Antioxidant vitamins, known as the ACE vitamins, have an important effect on health. The ACE vitamins include vitamin A (and in particular beta carotene – the vegetable source of vitamin A), vitamin C and vitamin E.
- Antioxidant vitamins ward off free radicals which are a natural result of the oxygen-using processes in the body, e.g. breathing, digestion.
- Left to their own devices, free radicals can form a chain reaction that can cause serious damage to cells and contribute to heart disease and cancers.
- Antioxidants form a defence system against the free radicals.
- Antioxidants occur naturally in a wide range of foods, including
  - *vitamin A* – red and orange fruit and vegetables, e.g. carrots, tomatoes, apricots and peaches
  - *vitamin C* – citrus fruits, blackcurrants, kiwi fruit, green leafy vegetables, e.g. broccoli, etc.
  - *vitamin E* – vegetable oils, wholegrain cereals, green leafy vegetables.

The health benefits of antioxidants

- They safeguard long-term health
  - by reducing the risk of chronic diseases, e.g. heart disease, a variety of cancers, and disorders of the intestine caused by increased numbers of free radicals
  - by reducing damage to body cells and tissues.

- They maintain a healthy immune system
  - by destroying free radicals which attack the body's natural defence system.

- They reduce the harmful oxidation of fats in the body
  - by preventing free radicals oxidising polyunsaturated fatty acids in foods and in cell membranes to give a substance which causes cell damage
  - by slowing the rate at which LDL cholesterol is deposited on artery walls, thus reducing the risk of heart disease.

Fruit and vegetables are a source of antioxidants and will also provide NSP. This will give additional benefits such as less constipation, bowel cancer, less obesity and over consumption of foods high in sugar and fat.

Minerals

Calcium

Function	Sources
• With phosphorus it combines to make calcium phosphate which is the chief material that gives hardness and strength to bones and teeth • Helps blood to clot after an injury • Required for the correct functioning of muscles and nerves • Required for maintenance of bones and teeth	• Milk, cheese, yoghurt • Fortified white flour and white bread • Green leafy vegetables • Tinned fish with bones that can be eaten, such as salmon, sardines • Dried fruit • Nuts and seeds

Phosphorus

Function	Sources
• Works with calcium in the formation, development and maintenance of bones and teeth • Essential for the production of energy in the body by releasing energy from the cells	Found in most natural foods – present as phosphate in all plant and animal cells • Milk, cheese, eggs • Cereal products • Meat and meat products • Fish • Nuts

Iron

Function	Sources
• Iron is a component of haemoglobin, the substance which gives red blood cells their colour • Haemoglobin is required to transport oxygen around the body to every cell so that we do not feel tired and eventually become anaemic • Needed to form red cells in the blood	• Red meat especially liver, kidney, corned beef • Fortified flour and bread • Green leafy vegetables • Dried fruit • Pulse vegetables • Cocoa, plain chocolate

Sodium

Function	Sources
• Water balance – essential for maintaining the correct fluid balance of the body • Needed by cell walls so that nutrients in the blood can flow into body cells and waste products can flow out • Required for correct muscle and nerve activity – too low an intake can result in muscle cramps.	• Table salt • Bacon • Cheese • Some savoury snacks, e.g. crisps • Canned foods • Found naturally in some foods such as fish and meat

SECTION 2

Water and non-starch polysaccharides (NSP)

Functions of water	Sources of water
• Water is vital to life – 70% of the human body is water • Required for all body fluids, e.g. digestive juices, mucus, saliva, blood, sweat and urine • Assists in the excretion of waste faeces by combining with NSP and so prevents constipation • Required as part of many metabolic reactions, e.g. water is a major constituent of the fluid which carries nutrients to the cells • Keeps linings of mucous membranes, digestive tract and bronchial tubes moist • Some nutrients need to dissolve in water for proper absorption • Helps regulate body temperature by perspiration • Lubricates joints and membranes	• Fruit and vegetables • Milk • Meat • Tap water • Bottled mineral water (still and carbonated)

Functions of NSP	Sources of NSP
• Aids the removal of waste products, which could be harmful or toxic, from the body • Absorbs a lot of water ensuring that the faeces are soft and bulky, enabling them to pass along the intestine by means of peristalsis • Helps prevent various bowel disorders including constipation, diverticular disease, bowel cancer, and haemorrhoids (piles) There are two types of NSP:	
(a) Soluble NSP This type of NSP is thought to slow down the digestion and absorption of carbohydrates and so help to control blood sugar levels – it is useful for diabetics	**Soluble NSP** • Oats • Pulse vegetables – peas, beans and lentils • Most types of fruit and vegetables
(b) Insoluble NSP Insoluble NSP absorbs water and increases in bulk, so helping the gut keep in good working order	**Insoluble NSP** • Wholemeal bread and flour • Wholegrain breakfast cereals, pasta and rice • Fresh fruit and vegetables

SECTION 3

The body's absorption of calcium and iron

Elaboration

Factors which assist calcium absorption:

- Vitamin D
- Lactose
- Protein

Factors which hinder calcium absorption:

- Lack of vitamin D
- Phytic acid
- Fibre (dietary)/NSP
- Fats
- Oxalic acid

Calcium absorption

Factors which **assist** calcium absorption	Factors which **hinder** calcium absorption
Vitamin D • Vitamin D controls absorption of calcium so there must be a good supply in the diet • Without vitamin D we cannot make use of the calcium in food **Lactose** • This is a sugar present in milk and increases calcium absorption during digestion **Protein** • The amino acids formed from protein as a result of digestion combine with calcium to form soluble salts and these salts are very readily absorbed	**Lack of vitamin D** • Without vitamin D less calcium will be absorbed and this deficit may adversely affect the strength of bones and teeth **Phytic acid** • Phytic acid is found in wholegrain cereal foods and combines with calcium in a form that prevents calcium being absorbed **NSP** • NSP cannot be digested in the human digestive system as the NSP and calcium bind together. Much of the calcium in fibrous foods is made unavailable to the body **Fats** • Fats, particularly saturated fatty acids, form insoluble soaps with calcium which cannot be absorbed by the body **Oxalic acid** • Oxalic acid, which is particularly high in rhubarb and spinach, also interferes with calcium absorption

Iron absorption

Elaboration
Factors which assist iron absorption:
- Vitamin C

Factors which hinder iron absorption:
- Lack of vitamin C
- Fibre (dietary)/NSP
- Phytic acid

Factors which **assist** iron absorption	Factors which **hinder** iron absorption
Vitamin C • Vitamin C is needed to change the iron into a form that is more easily absorbed – from its ferric state to a ferrous state • Most of the iron in food is in a ferric state and cannot be absorbed and must be changed to ferrous iron to help absorption.	**Lack of vitamin C** • If vitamin C is lacking in a diet, the iron in food will not be able to be changed from its ferric (non-haem) state into the easily absorbed (haem) ferrous state **NSP** • Too much indigestible NSP in leafy vegetables and fresh fruit can bind with iron and therefore not allow it to be absorbed into the blood stream. • Phytates found in food containing NSP will remove iron from the body • Phytates form insoluble complexes with iron in the small intestine which then inhibits iron absorption **Phytic acid** • Phytic acid in wholegrain cereals binds with iron to prevent absorption

SECTION 4

Interrelationship of dietary food sources

Elaboration

- Calcium, phosphorus and vitamin D
- ACE vitamins
- Iron, vitamin C and folic acid
- Vitamin B complex and carbohydrates
- Iron, fibre (dietary)/NSP and phytic acid
- Water and fibre (dietary)/NSP

Interrelationship of: calcium, phosphorus and vitamin D

- Calcium and phosphorus are both needed together for the formation and maintenance of strong bones and teeth. Together they form calcium phosphate which gives bones and teeth their hardness.
- Absorption of calcium is controlled by vitamin D. A diet lacking in vitamin D results in poor calcium absorption and affects the formation of strong bones and teeth.
- Without vitamin D we cannot make use of the calcium in food.
- If blood levels of calcium and phosphorus fall too low then the hormone produced by the parathyroid gland removes these nutrients from the bones and teeth and sends them back into the blood.

Interrelationship of: ACE vitamins

- The best-known antioxidants, which help to neutralise potentially damaging free radicals in the body, are vitamins A, C and E.
- A diet high in ACE vitamins is thought to reduce the risk of coronary heart disease.
- Vitamin E improves the activity of vitamin A in the body.
- Vitamin C helps the action of vitamin E in the body, e.g. after vitamin E has been used by the body and is finished, vitamin C then works on this vitamin E to recycle it.

Interrelationship of: iron, vitamin C and folic acid

- Depending on the food source of iron, about 10 per cent of the iron which is eaten is actually absorbed by the body. Iron in our food is ferric iron, and cannot be absorbed until it is changed to ferrous iron.

- Vitamin C is required to change iron into its more easily absorbed form – ferrous iron – and thus ensures an adequate supply of red blood cells.
- Folic acid also improves the red blood cell count – if iron is lacking then folic acid can supplement the supply.
- Folic acid can also help prevent megaloblastic anaemia if the iron absorption is poor

Interrelationship of: vitamin B complex and carbohydrate

- Vitamin B complex acts as a link in a complex chain of chemical reactions which release energy from carbohydrates.
- The B-complex vitamins have a role in the release of energy from food so that it can be used by the body.
- The release of energy from carbohydrates requires adequate supplies of B-complex vitamins.
- If more energy is needed by the body, e.g. for a sports person, then more vitamin B complex is required to release the energy.
- Vitamin B1 (thiamine) helps release energy from glucose.
- Vitamin B2 (riboflavin) and vitamin B3 (niacin) help release energy from food.

Interrelationship of: iron, NSP and phytic acid

- Too much indigestible NSP in leafy vegetables and fresh fruit can bind with iron and therefore not allow it to be absorbed into the bloodstream.
- Phytates found in food containing NSP will remove iron from the body in waste materials.
- Phytates form insoluble complexes with iron in the small intestine which then inhibits iron absorption.
- Phytic acid found in wholegrain cereal foods prevents the absorption of iron from foods.

Interrelationship of: water and NSP

- NSP absorbs water in the gut. The bulk and softness of the waste matter is affected by this absorption of the water.
- If there is no NSP in the waste matter, no water is absorbed into it and the waste matter is then difficult to get rid of from the body (constipation).
- If there is plenty of NSP and the waste matter absorbs water, it becomes bulkier, softer and much easier to pass out of the body.
- NSP is of great importance in the diet as it absorbs a lot of water, and binds the other food residues to itself. This ensures that the faeces are soft and bulky and so can pass out of the body easily and quickly.

SECTION 5

Effects of storage of nutrients

Elaboration
- Deterioration and rancidity of fats when exposed to air
- Deterioration and oxidation of vitamins
- Suitable storage methods to reduce loss of nutrients

Nutrient	Effect of storage
Fats	**Deterioration and rancidity of fats when exposed to air** • Exposure to air leads to gradual deterioration of fat due to rancidity • Fat may become rancid due to: *Oxidation* – in oxidation oxygen is absorbed by the fat molecules and reacts with these to produce substances which give the fat an unpleasant flavour and colour – oxidation is accelerated by light, by the impurities in fat, by enzymes and by the presence of many polyunsaturated fatty acids. *The enzyme lipase* – lipase breaks down the fat molecules and 'off' flavours and odours develop because of the fatty acids in the food.

Vitamins	Deterioration and oxidation of vitamins	Suitable storage methods to reduce loss
A	Vitamin A is found in fatty foods and may be lost during storage as a result of oxidation or exposure to light	To reduce loss, store in a fridge, package foods, or store in dark containers away from light
Vitamin B complex		
Vitamin B1 (thiamin)	Exposure to sunlight/ UV light reduces thiamine content	Store away from light
Vitamin B2 (riboflavin)	This vitamin deteriorates quickly with exposure to UV light	Store away from sunlight in dark conditions Avoid foods stored for a length of time in a brightly illuminated supermarket display cabinet
Vitamin B3 (nicotinic acid)	Some loss by oxidation	Avoid storage if possible
Vitamin C	Do not store for a long time as vitamin C is oxidised by exposure to air. The vitamin C content is reduced by oxidation Exposure to air leads to changes to the chemical structure of vitamin C so that it cannot be used by the body. Bruised fruits and vegetables will have lost more vitamin C by enzyme action and oxidation	Buy as fresh as possible, as long-term storage causes deterioration of vitamin C Store in a refrigerator as low temperature slows down oxidation of vitamin C, e.g. put green leafy vegetables in the vegetable or salad drawer in the refrigerator Store in the absence of light to avoid loss of vitamin C, e.g. store root vegetables in a cool dark place, away from heat, daylight and air Avoid bruising or damage prior to storage as this will lead to destruction of vitamin C Avoid buying ready prepared produce as these are more likely to have suffered nutrient loss because of advance preparation and then storage. Frozen vegetables have a higher vitamin C content, because they are frozen quickly so that the vitamin is preserved

SECTION 6

Effects of preparation and cooking on nutrients

Elaboration
- Loss of vitamin B complex in milling process
- Preparation of fats to assist digestion
- Effects of preparation methods on vitamin C

Effects of preparation on nutrients

Nutrient	Effect of preparation
Vitamin B Complex	**Loss of Vitamin B complex in milling process** • The B-complex vitamins are contained in the bran (outer husk) of a cereal grain. When the wheat grain is milled to produce white flour these parts are removed along with the vitamin B complex • White rice is usually 'polished' to free it from bran. Vitamin B1 is removed with the bran. If rice is the staple diet as in Far Eastern countries, then the disease beri-beri may result
Fats	**Preparation of fats to assist digestion** • A high concentration of fat in some food, e.g. cheese, makes it difficult to digest • Exposing more of the surfaces of the food to the digestive juices by dividing finely, e.g. grating, chopping and slicing, enables the fat to be more easily digested • Combining with a starchy food, e.g. cheese with potatoes or macaroni, will help absorb the fat and so make the food more digestible
Vitamin C	**Effects of preparation methods on vitamin C** • Avoid soaking as vitamin C is water soluble and will leach out into the water and will be lost unless the water is used as a gravy • Prepare as needed because vitamin C will be lost through oxidation if the fruit and vegetables are prepared in advance • An enzyme in the vegetables called *oxidase* is activated by chopping and cutting. As this enzyme activity will destroy *cont'd on the next page*

	vitamin C, vegetables should not be prepared too far in advance • Knives should be sharp, as blunt knives cause more cells to be damaged, causing more of the enzyme oxidase to be released which then destroys vitamin C • Avoid peeling if possible, or peel thinly, as most vitamin C is just under the skin. Peeling exposes more surfaces to the air, thus speeding up oxidation and vitamin C loss • Prevent oxidation by chopping into large chunks, resulting in less surface area being exposed to the air • Use acids such as vinegar or lemon juice which can slow down the loss of vitamin C by oxidation

Effects of cooking on nutrients

Elaboration

- Coagulation of protein
- Breakdown of fatty acids and glycerol
- Effect of dry heat on starch – dextrinisation
- Effect of moist heat on starch/solubility
- Effect of heat on sugar – caramelisation
- Effects of heat and water on vitamin B complex and vitamin C
- Effect of alkaline solutions on vitamins B complex and C

Nutrient	Effect of cooking
Protein	**Coagulation of protein** • Protein coagulates or sets when heated, e.g. albumin in egg white sets • Heating wheat protein, called gluten, helps form the structure of bread • Milk proteins form a skin on the surface when heated • Meat proteins shrink when heated • Protein becomes denatured when heated • Protein becomes less soluble when heated • Normal cooking makes protein more digestible • Overheating leads to hardening of the protein • Overheating reduces the digestibility of protein • Overheating reduces the nutritive value of protein
Fats	**Breakdown of fatty acids and glycerol** • Solid fats melt to liquid • Fats are fairly stable to heat at normal cooking temperatures, and break into fatty acids and glycerol at 200°C or just below smoke point • If oil continues to be heated a blue haze is given off, the fat ignites and burns rapidly • Oil which has ignited burns fiercely, gives off carbon smoke and a sheet of flame • If oil is overheated, the breakdown into fatty acids and glycerol reduces the nutritional value and keeping qualities of the fat • Smoking shows the chemical structure of the fat is beginning to break down and the fat will go rancid *cont'd on the next page*

	• If the chemical structure of the fat has broken down, the fat will smell and a substance called acrolein which affects the eyes is produced
Carbohydrates: Starch	**Effect of dry heat – dextrinisation** • Dextrin is formed when foods containing starch are subject to dry heat, e.g. toasting bread • Dextrin is more soluble than starch • The surface of any baked item changes to dextrin during cooking in the dry heat of the oven. Dextrinisation gives the baked item a brown colour • Overheating of starch causes charring and damage to its structure **Effect of moist heat on starch/solubility** • When moist heat is applied to starch, the starch grains first soften and swell, then absorb water, causing some to rupture. The starch is released, which forms a gel. The carbohydrate value is not lost unless the food is burnt and becomes inedible
Carbohydrates: Sugar	**Effect of heat on sugar – caramelisation** **Dry heat** • When dry heat is applied to sugar it melts, then caramelises going a brown colour and then burns • Sugar contributes to the colour of baked items by caramelisation in the dry heat of an oven and forms a golden crust on baked items **Moist heat** • When moist heat is applied to sugar it dissolves, then at high temperatures and prolonged heating it becomes a syrup, which caramelises then chars when the water has evaporated The carbohydrate value is not lost unless the food is burnt and becomes inedible
Vitamin B complex	**Effect of heat and water on vitamin B complex** **Vitamin B1** • Stable to temperatures up to boiling point • Gradually destroyed if heated to above boiling point for a long period • Quick methods of cooking (steaming, stir frying, microwaving, pressure cooking) help to conserve vitamin B1 **Vitamin B2** • More stable than vitamin B1 but is affected by heat *cont'd on the next page*

	Vitamin B3 • The most stable vitamin in the B complex. • Usually little loss in normal cooking processes **Folic acid** • Soluble in water and so should not be soaked, and is destroyed by prolonged cooking • Cook in as little water as possible for as short a time as possible **Effect of alkaline solutions on vitamin B complex** • Avoid alkaline cooking mediums, e.g. bicarbonate of soda, as this destroys vitamin B complex
Vitamin C	**Effect of heat and water on vitamin C** • Destroyed by fairly low temperatures and so should be added to boiling water and cooked for a minimum time • Putting foods rich in vitamin C into boiling water denatures the enzyme called oxidase which destroys vitamin C • As vitamin C is water soluble it will be lost in cooking water so use as little as possible to prevent the vitamin leaching out into the water • Cook for as short a time as possible as the vitamin C will leach into the water • Choose methods which conserve the vitamin, e.g. steaming, microwaving or stir frying • Vitamin C can be oxidised if foods are not served immediately or if they are kept warm **Effect of alkaline solutions on vitamin C** • The presence of an alkaline solution causes vitamin C to be destroyed by oxidation

SECTION 7

Prevention of dietary diseases

Elaboration

- Anaemia
- Coronary heart disease (CHD)
- Dental caries
- Diverticulitis
- Hypertension
- Obesity
- Osteomalacia
- Osteoporosis

Iron deficiency anaemia

- A shortage of iron is one cause of anaemia – a disorder where your body has too little **haemoglobin** in the blood.
- Iron is a vital part of haemoglobin, the pigment in red blood cells that binds with oxygen in the lungs and carries it to all parts of the body.
- If you become too short of iron you start making red blood cells containing less haemoglobin. That means your body has to work harder to supply you with enough oxygen. This extra work can leave you feeling weak, constantly tired and short of breath – all of these things are symptoms of **iron deficiency anaemia.**
- Resistance to infection is reduced and there may be poor regulation of body heat.
- Extra iron which is not needed for haemoglobin is stored in the liver, spleen or bone marrow, ready to be used if there is a shortage in the diet. You only become anaemic if these stores run out, although you can start to suffer some of the symptoms before you reach that stage.

Prevention of iron deficiency anaemia

To prevent anaemia:

- The daily food intake must include sufficient iron to maintain the normal level of haemoglobin in the blood. Eggs, red meat especially liver and kidney, fortified bread and breakfast cereals, dried fruit, beans, lentils and leafy green vegetables all contain iron.
- Eat foods rich in vitamin C alongside these iron-rich foods to help absorption of non-haem iron.

- Iron from food sources not linked with NSP or phytates is more easily absorbed by the body (i.e. haem iron).
- A course of iron tablets may also be taken to make up for a shortage of iron.

Reasons why iron may be lacking in the diet

- Snacking and grazing throughout the day rather than traditional meals could reduce iron intake.
- If people are not aware of nutrition or are lacking in the skills to prepare iron-rich foods then sufficient iron may not be included in their diet.
- Less red meat may be eaten for health, moral or religious reasons – to reduce saturated fats.
- Dark-green vegetables can be unpopular, particularly with the younger age groups.
- If a good supply of fruit and vegetables, supplying vitamin C, is not eaten, then absorption of iron will be affected.

How much iron is needed?

Most people lose about 1 or 2 mg of iron a day from their bodies. But to replace that you need to eat foods containing a greater amount – about 8 to 15 mg – because only a small proportion of the iron in food is absorbed by our bodies.

Certain groups of people may be more likely to suffer from iron deficiency anaemia:

Adolescent girls and **women who are menstruating. I**t is estimated that 30 mg of iron is lost during menstruation and this will be more if periods are heavy and prolonged.

Pregnant women. During pregnancy, a total of about 400 mg of iron is supplied to the unborn child and the actual birth causes the loss of a further 250 mg. However, the increased needs of pregnancy for iron should be met without a further increase, as menstruation has stopped and the mother's store of iron can be used. Dietary supplements may be needed by mothers with low iron stores, e.g. teenage mothers.

Babies are born with an iron store which is needed because milk has a low iron content. This store will only last about four months so it is important to introduce iron-rich foods quite soon (at about four months) to prevent anaemia. This can be done by giving enriched cereals, pureed vegetables, minced meat, etc.

It is particularly important to ensure that babies and young children get enough iron. There seems to be a critical period – between six months and five years – when a shortage of iron in the diet can cause a small but permanent reduction in a child's learning ability.

Teenage boys require plenty of iron because during growth the volume of blood increases. There has been quite an increase in the number of teenage boys suffering from anaemia particularly during the 'growth spurt' period. As their bodies grow so does the volume of blood required. They may also require extra iron for muscle growth and also to supply oxygen to the muscles during sporting activities.

Elderly The main reasons for anaemia in the **elderly** are either that they cannot afford iron-rich foods or because they are often living alone and cannot be bothered or do not have the strength to prepare adequate meals. Also the high consumption of tea can be a factor, as the tannin in tea prevents absorption of iron.

Vegetarians may have difficulty in obtaining enough iron as the main food sources of iron are those not consumed by them, e.g. red meat, liver, kidney, eggs. The other good sources are perhaps those that are slightly less popular, e.g. green leafy vegetables, dried fruits, etc., and more of these are required to give the same quantity of iron, which can make diets bulky.

Vegans may absorb less iron due to the high phytic acid content of NSP foods such as cereals.

People living on low incomes. A low income may mean that this group of people cannot afford iron-rich food; they may not be sufficiently motivated to prepare adequate iron-rich meals, and they may have poor facilities for storage, preparation and cooking of foods.

Athletes. They may have a higher loss of iron from the body due to muscular activity.

Too much iron

Too much iron can be more harmful than too little. Our bodies regulate the amount of iron, so for the great majority of people there is no risk of poisoning from even the largest amounts of iron that you are ever

likely to get from food. But the larger amounts concentrated in iron tablets are not so safe.

Iron tablets could be a common cause of poisoning in young children. The tablets can often look like sweets, and the amount of iron in just a few can be harmful for children. If you are taking an iron supplement it would be wise to treat it as a medicine and lock it away safely.

Coronary heart disease (CHD)

Coronary heart disease is the term used to describe the gradual narrowing of the coronary arteries. These arteries supply blood and oxygen to the heart muscle

The arteries usually narrow because of a build-up of a fatty-type substance (**cholesterol**) within the inner lining of the coronary artery and this slows down blood circulation and the amount of oxygen that reaches the heart. This build-up is usually caused by an increased concentration of cholesterol in the blood.

There are two types of coronary artery disease:

- In one, the blood flow is reduced to the point where the increased demand of hard work cannot be met and this results in **angina**.
- In the other, the coronary artery becomes completely blocked usually by a clot, and this is **coronary thrombosis.**

Angina

The pain is usually linked to exertion and forces the patient to stop; subsequently it passes away within a few minutes. The pain is a result of not enough oxygen and nutrients being supplied to the heart muscle and so the muscle becomes starved.

Coronary thrombosis (heart attack)

Deposits of cholesterol are found in the lining of the arteries. These deposits may be quite thick, roughening the interior of the arteries, and making the risk of blood clots more likely. If the clot formation blocks the coronary artery then part of the heart muscle is deprived of blood and oxygen. This may lead to heart failure and the patient dies. Some heart attacks only cause a small amount of damage to the heart muscle and people can recover quite quickly. A heart attack is usually

accompanied by severe pain. Obstruction of an artery to the brain is one of the causes of a **stroke**, i.e. cerebral thrombosis.

Dietary factors which may contribute to coronary heart disease include:

Obesity caused by over-eating
- Being overweight is a major risk factor
- Being overweight leads to problems such as high blood pressure or diabetes, both of which are risk factors that can lead to heart disease

Too much saturated fat intake
- Mainly from animal origin – increases the level of cholesterol in the blood. Cholesterol is made in the liver in our bodies using the fat we eat, especially saturated fats. High blood cholesterol is thought to be one of the risk factors in the development of heart disease
- Cholesterol is ferried around the bloodstream by proteins called lipoproteins. LDL stands for **low density lipoprotein**. It is often branded **bad** cholesterol, because high levels of LDL increase the risk of heart disease. That is because it tends to form fatty deposits on artery walls, increasing the risk of blood clots and blockage of the artery

Too much trans fatty acids
- These increase blood levels of LDL cholesterol and may reduce levels of good cholesterol and so increase the risk of heart disease

Too much total fat intake
- Eating too much fat in total can cause obesity which is a contributory factor in heart disease

Too few polyunsaturated fats
- Omega 3 is the name given to a type of polyunsaturated fatty acid that is found mainly in oily fish such as mackerel, sardines and pilchards. Omega 3 reduces the risk of blood clots forming, so reducing the chance of a heart attack

Too much salt
- Eating too much salt may cause high blood pressure. If blood pressure is too high for too long, the arteries can be damaged. This can make them brittle and liable to clog with cholesterol. If this happens in one of the arteries that supplies the heart with blood, the result could be a heart attack

Too little NSP

- Soluble NSP found in oats, fruit, lentils and peas has been shown to reduce blood cholesterol levels
- NSP lowers the level of cholesterol in the blood by binding the bile salts, which are made from cholesterol, and thus preventing re-absorption.

Too little fruit and vegetables

- Fruit and vegetables are good sources of antioxidant vitamins – the ACE vitamins. The antioxidant vitamins neutralise the 'free radicals' which may damage cells and tissues within the body and this gives us some protection against heart disease.
- ACE vitamins slow down the rate at which LDL cholesterol is deposited on the artery walls, so helping to prevent heart disease

Too much sugar

- If too much sugar is eaten then this can result in obesity, high blood pressure and heart disease.
- Dietary sucrose can also cause disturbances in the body which are characteristics of type-2 diabetes. CHD is a common cause of death in people with diabetes

Cigarette smoking

- Smoking causes the blood to thicken, so increasing the tendency to clot
- Smoking constricts (narrows) the arteries, so reducing the blood flow to the heart
- The nicotine in tobacco smoke increases the pulse rate and raises the blood pressure. The carbon monoxide content of cigarette smoke cuts down the oxygen in the blood so the heart has to work harder
- Smokers need a high intake of ACE vitamins as smoking increases the number of free radicals in the body. Free radicals damage cells and tissues and so increase the risk of heart disease

Heredity

- Some families may inherit high risk factors such as a liking for fatty foods, and this will increase the risk of heart disease. Poor eating practices developed in childhood often create bad habits which are carried on into adulthood
- Genetic conditions may produce high blood cholesterol levels

High alcohol intake

- This can cause high blood pressure which can contribute to heart disease

Lack of physical exercise

- Regular exercise benefits the heart from increased stamina and strengthens the heart muscle and makes it more efficient
- Regular exercise reduces stress and lowers blood cholesterol levels – both of which can contribute to heart disease
- Exercise helps weight loss and so prevents obesity

Emotional stress

- People who are tense, impatient and anxious may be more likely to suffer from heart disease
- Blood pressure also tends to rise under stress and this could damage the artery walls, particularly if they are clogged with cholesterol. The heart then has to pump harder to force blood round the body

Gender

- More men than women tend to have heart disease, but it is affecting an increasing number of women
- Women under 40 years may be protected from heart disease by their hormone, oestrogen. After the menopause when oestrogen levels are reduced, cholesterol levels rise and the risk of heart disease increases.

Dental caries

Foods that contain a high proportion of sugar are reduced to a very sticky mixture when they are chewed and mixed with saliva. Even after swallowing, sugary particles are left sticking to the teeth. If the teeth are not thoroughly cleaned afterwards, traces of very sticky foods, such as toffees, may be detected, clinging to the teeth as long as twenty-four hours later. Bacteria which are normally present in the mouth, attack the sugary residues, and change them to acids. The acids gradually dissolve small areas of the teeth's protective covering, the enamel. This is the way tooth decay begins.

Theoretically, sugar in any form will cause tooth decay, but in practice, sugars contained naturally in foods, e.g. fruit, have less effect. **Sucrose** is the sugar that contributes most to dental decay. It is the frequency and amount of NME sugars – mainly confectionery, soft drinks and table sugar – that are the main causes.

The most effective means of reducing dental caries that is available to the individual is to control the sugar intake. The most important factor is not the total amount of sugar that is consumed but the **number of**

times that sugar enters the mouth. Sugar eaten at meals is not as damaging as sugar eaten between meals as snacks. The main aim in sugar control for the prevention of decay is to persuade people to limit their consumption of food and drinks containing sugar to meal times.

Prevention of dental caries

Diet

- Foods rich in calcium, phosphorus and vitamin D must be eaten to give teeth their hardness.
- Vitamin C must be included in the diet to keep the gums healthy.
- Crunchy foods, like apples and carrots, should be eaten regularly to exercise the gums and prevent infection.
- Eating too much salt/sodium in the diet could lead to extraction of calcium from the bone, thereby weakening the teeth.
- Saliva plays an important part, in that the flow of it over the teeth not only assists cleaning but helps to neutralise the acid. This is why foods that require a lot of chewing and are not sticky are better because they increase saliva production.
- 'Diet' drinks lower the intake of sugar but are a major cause of tooth erosion (tooth wear) due to the acidity of the drinks. Water should be the preferred drink.
- Reduce NME sugars intake by:
  - limiting consumption of sugar, sugary foods and drinks which cause a build-up of plaque which attack the enamel
  - avoiding sugary and sticky snacks between meals as this prolongs exposure to the acid which causes a build-up of plaque
  - becoming aware of the foods with 'hidden' sugar – read the labels on food products
  - increasing the use of fresh or dried fruit as sweetening agents on breakfast cereals, in baking and also as a snack food. These are intrinsic sugars which do not produce the same amount of acid in the mouth
  - avoiding grazing on biscuits and juice – continual contact with sugar
  - avoiding sweet foods last thing at night
  - not missing breakfast – more sweets may be eaten as snacks to compensate for a missed breakfast
  - choose low sugar option from tuckshop or vending machine
  - eating fresh fruit and vegetables as snacks
  - not being influenced by adverts for sweet foods
  - not giving children sweets when they have been upset or hurt themselves or as a reward. This will encourage a sweet tooth in later life.

Good oral hygiene

- Effective brushing is essential for healthy teeth and gums; brush after each meal when possible, but at least twice a day.
- Use a fluoride toothpaste to strengthen the enamel of teeth.
- Visit the dentist twice a year to have teeth checked.
- Ask the dentist to demonstrate the correct way to brush teeth to prevent a build-up of plaque.
- Toothbrushes should be in good condition and renewed every 3 months.
- Use dental floss to clean between teeth to prevent a build-up of food wedged between the teeth. If not removed, this will infect the gums.

Diverticulitis

- If extra stain is put on the muscular walls of the small intestine because of constipation, then diverticular disease may develop.
- If the faeces are small and hard due to a lack of NSP and water, then the muscular walls of the intestine have to work harder to move the faeces along.
- This results in increased pressure in the intestine. Pouches of the bowel lining are forced through weak spots in the intestinal walls to form small pockets, called diverticula, and where they occur the subject is said to be affected by diverticulitis.
- Diverticula usually occur in the lower part of the large intestine. They may start to harbour bacteria which are usually excreted.
- Symptoms are acute abdominal pain, flatulence, constipation and diarrhoea.
- Diverticulitis usually only appears in people who have a diet low in NSP and are less active.
- An increase in consumption of refined and convenience foods also contributes to this condition.

Hypertension (high blood pressure)

Everyone has blood pressure. The pressure is created by the heart's constant pumping of blood around the body. Exercise, excitement, anger or anxiety all make the heart beat faster and increases blood pressure temporarily.

High blood pressure is often called hypertension. It is usually caused by narrowed or damaged blood arteries – this means that the heart has to

work harder to pump blood around the body. When blood is forced through arteries at high pressure it is more likely to damage artery walls.

There are many factors which contribute to high blood pressure:

- Being overweight
- Poor diet
- Lack of exercise
- Excessive alcohol
- Stress
- Age – as people get older, blood pressure rises a little as the artery walls become less elastic
- Certain drugs and medicines
- Family history – high blood pressure is more likely if it is common within families
- Smoking.

High blood pressure does not usually have any symptoms, but it is important – especially if it goes unnoticed over a long period of time. It is one of several risk factors which increase the chance of having a stroke, heart attack or kidney failure.

To reduce the risk of high blood pressure:

- *Avoid obesity* – keeping weight down helps keep blood pressure down
- *Reduce alcohol intake*, if necessary, to no more than 21 units per week for a man, or no more than 14 units for a woman (1 unit equals a half pint of ordinary beer, a small glass of wine or a single measure of spirits). Alcohol is high in calories and can increase blood pressure.
- *Add less salt to food*, and cut down on salty foods. This will not help everyone with hypertension but those who take a lot of salt may well benefit from cutting down. Research has shown that there is a link between sodium intake and high blood pressure.
- *Regular physical exercise* helps control stress and helps keep blood pressure normal
- *Stop smoking*. Smoking temporarily raises blood pressure. It also adds to the damage that high blood pressure may cause to the heart and blood vessels.
- People who suffer from hypertension should *avoid stressful situations* which are likely to raise the blood pressure because this condition may lead to a heart attack or a stroke.

- It should also be noted that *reducing fat intake*, particularly saturated fat, is recommended, because cholesterol found in saturated fats can narrow arteries and so restrict blood flow.
- Potassium tends to reduce blood pressure, so *a diet which is high in cereals, fruit and vegetables, i.e. is high in potassium*, will have a beneficial effect on blood pressure.

Obesity

A major dietary problem in this country today is *obesity* or *overweight*. Overweight caused by excess body fat is a hazard to health. There are no exact figures to tell us what an individual of a given height, with a certain bone structure, should weigh. Tables which have recommended weights give a good guide, and it is always clear when a person is so grossly overweight that they become obese. Usually, overweight is caused by long-term overeating. Your energy requirement dictates what you can eat and this varies from person to person, and becomes less as you grow older.

Dietary factors that cause obesity

High sugar diet

- Sweets contain high quantities of fat or sugar which can contribute to weight gain, especially if eaten daily between meals or instead of meals.
- Drinks with added sugar, e.g. sweetened fruit drinks or fizzy drinks can contribute to weight gain.

High-fat diet

- Fast foods and snack consumption are both high in fat. These are popular especially with teenagers and have a high fat and energy content.

Reluctance to eat fresh fruit and vegetables

- Some people prefer to snack on high-fat and sugar foods rather than fruit and vegetables.
- There may be limited availability in the home due to cost or lack of knowledge about how to prepare these foods.

A diet too high in energy – fat and/or sugar

- If energy intake from food is more than energy output over a period of time then this leads to obesity.

Increased consumption of pre-prepared convenience meals in the home

- There is an increasing tendency for these meals to be used in the home as an alternative to home-made meals – these foods can be high in fat and sugar.

Huge increase in range of convenience food and fast-food eating outlets

- More take-aways are eaten by families, especially teenagers – and these can have a high energy value.

Diet low in NSP and total complex carbohydrates

- These are both filling and are therefore less likely to lead to snacking on high fat and sugar foods which may cause to obesity.

Lack of sensible eating habits

- Poor eating habits may have developed from childhood.
- Snacks eaten in preference to regular meals, increased 'grazing' between meals.

Social reasons that cause obesity

Lack of exercise and physical activity, due to the following factors:

- Increased use of cars by all members of the family, e.g. teenagers do not walk to school.
- Lack of sports facilities locally or the cost may be too high.
- An increasing number of teenagers just watch TV or play computer games.
- Parents may be inactive and do not encourage teenagers to take part in sports outside school.
- Parents may be concerned about the safety of children outdoors.

Advertising and media

- These promote snack foods and often high-fat and sugar foods which appeal to children and teenagers.

Family income

- Where income is limited, cheaper, poorer-quality foods may be bought in quantity – often high-fat and sugar foods – in preference to more expensive protein foods or fruit and vegetables.
- Higher income may mean more disposable income being given to teenagers which, in turn, may provide them with greater opportunity to buy snacks and fizzy drinks.

- Higher income may lead to more convenience-type foods being bought to accommodate a busy lifestyle. These foods are often high in fat or sugar.

Poor eating habits

- Eating habits and food fads are developed in childhood and are difficult to change.
- High-fat or sugar diet in childhood leads to problems such as obesity in later life.
- Increased 'grazing' between meals.

Lifestyle

- Lack of time for shopping – hence the preference for quick-to-prepare meals which require little food preparation and cooking. Convenience foods are often high in fat and sugar.
- Increased ownership of microwaves and freezers make convenience-type foods very useful for busy families.
- The huge increase of convenience foods and available eating outlets can lead to people eating too many convenience or take-away foods, which again often have a high energy value.

Psychological factors

- If a person is anxious, depressed, bored or lonely she/he may find eating a great comfort and do so to excess.

Parental influence

- Poor eating habits tend to be passed down through families.
- Lack of food-preparation skills leads to a reliance on convenience foods which may be high in fat or sugar and low in fruit, vegetables or NSP.

Health problems associated with obesity

- Problems with hip, knee and back joints and arthritis as extra weight is placed on muscles and skeleton, if overweight.
- Overweight people place a greater strain on their heart and so are more likely to develop high blood pressure, which can lead to coronary heart disease as the heart has to work harder to supply the extra oxygen and nutrients needed by tissues.
- Overweight people are more likely to suffer from varicose veins, high blood pressure, diabetes mellitus, stones in the gall bladder.
- More chance of digestive glands being overworked or ceasing to function.
- Greater risk of having high blood pressure.

- Breathless during exertion as heart and lungs have to work harder to maintain oxygen supply. Likely to tire more easily.
- Psychological problems, such as low-self esteem or lack of confidence can result from obesity. Unwilling to take part in exercise due to body size which then makes the problem of obesity worse.
- Overweight people often suffer from psychological disorders such as depression and anxiety. Obese people may be laughed at by their peer group.
- Dental caries if obesity is caused by eating a high-sugar diet.
- Complications can occur during surgery/operations because of obesity.
- People who are overweight can experience difficulties during pregnancy and childbirth.

Weight reduction

The only way to reduce your weight is to use up excess fat. This means that daily food intake must be reduced so that the excess body fat can be used to meet the body's needs for energy. While on a reducing diet meals must still be 'well balanced'; although the energy intake is reduced the essential nutrients must be provided.

To reduce weight:

- *Decrease kilojoule (Kj) intake*, increase bodily activity.
- *Cut down on fat and carbohydrate intake* – reduce intake of energy foods.
- Do not cut down on essential body-building foods such as protein but *watch that excess protein is not eaten*, as this will contribute to weight gain if not used up as energy.
- *Eat plenty of fresh fruit and vegetable* to provide bulk in diet without providing excessively high Kj intake.
- *Establish a good eating pattern* of 3 to 4 meals per day.
- *Try not to miss a meal*, as hunger may increase the likelihood of unhealthy snacking.
- *Avoid eating between meals* – if hungry, nibble an apple, carrot, etc.
- *Avoid frying as a method of cooking* – choose to grill foods instead.
- *Do not go on a crash diet*, as a steady weight loss is much healthier.
- *Avoid 'gimmick' diets* – these do not establish good eating habits.
- *Adopt a new pattern of sensible eating* and keep to this after weight loss, rather than reverting to bad eating habits.
- *Establish a regular pattern of exercise*.

Osteomalacia

- If absorption of calcium and phosphorus from the small intestine is reduced due to a lack of vitamin D, too much phytic acid or too much NSP, there will be insufficient to maintain the strength of bones. Bones become weak, fragile and may break easily. Strength of teeth is also not maintained.
- This is an adult form of rickets more common in the elderly which can result in serious fractures, after even a minor fall.
- The reasons for osteomalacia in the elderly are not exercising enough, not getting out in the sunshine particularly in winter, not being able to get out or afford some of the required foods, and often being on drugs for a medical condition.

Osteoporosis

Osteoporosis – brittle-bone disease – is on the increase, affecting men as well as women. Osteoporosis develops gradually and unnoticeably over many years; diet and lifestyle now can affect the chances of getting it later on.

What is osteoporosis?

- Osteoporosis means porous bones.
- Bones are made up of collagen for flexibility, and calcium for strength. In osteoporosis bones lose some of their internal collagen and calcium making them weak and liable to break – hence the name of brittle-bone disease.
- Osteoporosis is not a problem of too little calcium but of the way we use and keep that calcium in our bones.
- Most people do not know they have osteoporosis until they have a minor fall or make an awkward movement and end up fracturing a bone.
- Some people with osteoporosis experience chronic backache or notice they are getting shorter and developing a stoop as the bones of their spine become weakened and compacted. Losing 5–10 cm in height is common, and the spinal curve may develop into a 'dowager's hump'.
- This shortening of the body means there is less room for internal organs – the stomach can be forced up into the chest and the abdomen pushed forward. This can cause chest pain and a feeling that food is stuck behind the breast bone.

The bone lifecycle

- Bone tissue is constantly turning over, being broken down and rebuilt.
- Bones stop growing in length around the late teens, early twenties or early thirties.
- At this age bones reach their 'peak bone mass' – their maximum size and density. Potential peak bone mass is determined by heredity, but whether this potential is achieved depends on diet and lifestyle factors. After the early thirties bone density declines.

Guidelines to reduce the risk of osteoporosis

Teenagers with low calcium intakes may not reach their potential peak bone mass. At risk are those who avoid dairy foods, are slimming and/or rely heavily on 'junk food' – foods which contain little calcium.

- *Regular exercise* will increase bone density and stimulate bone formation. In young people exercise may actually raise peak bone mass. In adults it seems to protect against bone loss.
- *Eat a diet rich in calcium, phosphorus and vitamin D* to ensure a strong bone structure is developed.
- Vitamin D helps the absorption of calcium, so *exposure to sunshine* is essential for the syntheses of vitamin D.
- *Stop smoking* – nicotine causes bone loss.
- *Use alcohol in moderation only* – alcohol is a toxin to the bone cells.
- *Be a realistic weight*. Insufficient calories may mean that the calcium target is not being met.
- *Beware of substances which hinder calcium absorption*, e.g. some forms of NSP, phytic acid and certain drugs.
- *Decrease salt in the diet* as it can lead to loss of calcium from the bones.
- Doctors may prescribe *hormone replacement therapy (HRT)* for individuals at risk.
- *Achieving a high peak bone mass in early adulthood* is probably one of the best ways of preventing the development of osteoporosis in later in life. There is a suggestion that high intakes of calcium during younger life may raise peak bone mass. Bones grow very rapidly during adolescence and calcium requirements are higher during teens than at any other time. Teenagers with low calcium intakes may not reach their potential peak bone mass. At risk are those who avoid dairy foods, are slimming, or who rely heavily on junk foods (which usually contain little calcium).

SECTION 8

The use of dietary reference values (DRVs)

Elaboration

- Low reference nutrient intake (LRNI)
- Estimated average requirements (EAR)
- Reference nutrient intake (RNI)
- Safe intake
- Relating to the intake of energy, protein, fats and fatty acids, starches and sugars, fibre (dietary)/NSP, vitamins A, B1, B2, folic acid, C, D, E linking to: age, physical activity (PAL), gender, basal metabolism, special circumstances:
  - pregnancy and lactation
  - convalescents
  - weight reduction
  - vegetarians

  specified groups
  - infants/young children
  - teenagers
  - adults
  - elderly

  (for assessment purposes the reference values will be provided)

Dietary reference values (DRVs)

Dietary reference values were produced in 1991 after a request by the Chief Medical Officer to the Committee on Medical Aspects of Food Policy (COMA) to set up a panel to reach some sort of standard recommendation as to how much of each nutrient is required by each individual. The panel prepared the publication *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. It is likely that these UK nutritional requirements will be reviewed in the near future as they are almost fifteen years old at the time of going to press, and some nutrients such as iron and folate are giving cause for concern.

- People differ from each other in the amounts of energy and nutrients they need. DRVs give figures for nutrients which are enough or more than enough to cover the needs of almost every healthy person in the country.

- All DRVs are intended to apply to healthy people; they do not make any allowance for the different energy and nutrient needs imposed by some diseases.
- The aim of the DRVs is to ensure that everyone in the country gets enough of every nutrient. Therefore, the figures chosen should be high enough to cover the needs of people who have high requirements. Inevitably, this means that if people with average or lower than average needs eat that much, they will be getting far more than they need.
- The quantity of most nutrients that may be consumed by some people in excess of their needs is most unlikely to be harmful, but some people do try to eat larger amounts of nutrients than required. This can prove expensive and wasteful. Some nutrients, if eaten in large amounts, are toxic.
- All of these issues were addressed by the panel in considering the DRVs so it is not surprising that they have produced not one set of figures but up to four for some nutrients.

Dietary Reference Values (DRVs)

This is the general term to cover all the figures produced by the panel. It includes:

- Estimated average requirements (EAR)
- Reference nutrient intake (RNI)
- Lower reference nutrient intake (LRNI)
- Safe intake

Estimated Average Requirements (EAR)

- Energy intake has been treated differently.
- If the standard for energy intake of a group of people was designed to be enough for those individuals with high needs, it would be too much for most people in the group.
- If all the members of the group consumed that much energy, many of them would become obese, which would not be desirable.

Reference Nutrient Intake (RNI)

- An amount of a nutrient that is enough for every individual, even someone who has a high need for the nutrient.
- This level of intake is therefore considerably higher than most people need.
- If individuals are consuming the RNI of a nutrient, they are most unlikely to be deficient in that nutrient.

Lower Reference Nutrient Intake (LRNI)

- An amount of a nutrient that is enough for only a small number of people with low needs.
- Most people will need more than the LRNI if they are to eat enough.
- If individuals are habitually eating less than the LRNI they will almost certainly be deficient.

Safe intake

- A term normally used to indicate the intake of a nutrient for which there is not enough information to estimate requirements.
- A safe intake is one which is judged to be adequate for almost everyone's needs but not so large as to cause an undesirable effect.

How should DRVs be used?

Assessment of an individual's diet

DRVs may help to give an indication of the likely adequacy of an individual person's diet, but great care needs to be taken in using figures for this purpose.

If a person is regularly consuming less than the LRNI, it is likely that the individual will not be getting enough. Someone consuming the RNI or more than that is unlikely to be deficient.

If an individual's consumption of a nutrient is somewhere between the LRNI and the RNI, it is not possible to say whether or not the amount of the nutrient is adequate because it is not known whether the person has a high, average or low requirement. However, the closer the intake is to the LRNI, the more likely deficiency becomes.

Assessment of diets of groups of people

The objective is to ensure that all individuals within the group are eating sufficient nutrients to satisfy their needs. To ensure that the risk of deficiency within the group is small, the average group intake should be at the level of the RNI.

Planning food supplies for large groups

The objective is to ensure that everyone gets enough of every nutrient to satisfy individual needs. The needs of those with high nutrient requirements must be catered for so it would be wise to use the RNI figures.

Nutritional labelling

Nutritional labels are used by individuals, and what is appropriate for groups may not be appropriate for individuals; '4 mg of iron per 100g of food' does not mean much to many people. Knowing that a 125g portion supplies 40% of what they need may mean more, and that is the form which is to be recommended for food labelling in the future. The nutrient content should be expressed as a percentage of EAR, which would be interpreted as an average requirement. This is in preference to using the RNI figure as this would provide more than most people need.

RNI for energy

The amount of energy required by different individuals is related to a wide variety of factors, including:

- Age
- Basal metabolic rate
- Gender/sex
- Weight/height/body size
- Lifestyle/physical activity level (PAL)
- Occupation
- Special circumstances
  - Pregnancy
  - Lactation
  - Convalescents
  - Weight reduction
  - Vegetarians

Estimated average requirements (EAR) for energy

Age	EAR (MJ/day) (kcal/day)			
	Male		Female	
0–3 month	2.28	(545)	2.16	(515)
4–6 months	2.89	(690)	2.69	(645)
7–9 months	3.44	(825)	3.20	(765)
10–12 months	3.85	(920)	3.61	(865)
1–3 years	5.15	(1,230)	4.86	(1,165)
4–6 years	7.16	(1,715)	6.46	(1,545)
7–10 years	8.24	(1,970)	7.28	(1,740)
11–14 years	9.27	(2,220)	7.92	(1,845)
15–18 years	11.51	(2,755)	8.83	(2,110)
19–50 years	10.60	(2,550)	8.10	(1,940)
51–59 years	10.60	(2,550)	8.00	(1,900)
60–64 years	9.93	(2,380)	7.99	(1,900)
65–74 years	9.71	(2,330)	7.96	(1,900)
75+ years	8.77	(2,100)	7.61	(1,810)

Source: *Dietary Reference Values: A Guide*, HMSO

Age (Basal metabolic rate)

Everyone needs energy from their food but as we get older, i.e. after 60/65 years of age, and slow down in movement, the body needs less energy as people become less active, e.g. on retirement from work. Basal metabolic rate is the amount of energy used when the body is resting. The basal metabolic rate, which varies with age, also affects the amount of energy that is required.

Gender/sex (weight, height, body size)

Adult males normally have greater body size than females and adults are taller than younger teenagers. Every single body cell needs to be supplied with energy; therefore, the larger the body size, the more energy is required. Gender (i.e. male or female) usually has an influence on body development and weight in non-obese people.

Lifestyle, physical activity level (PAL) (occupation)

The amount of energy needed by adults, in particular, depends upon the type of work that they do and how much physical energy is required to do it. However, that is not all that needs to be taken into consideration, and given that few jobs now demand high levels of physical effort due to mechanisation and technology, often what is done

in non-work activities is more important when calculating how much energy a person requires. Some people after work have to spend a lot of energy doing household tasks, others who have free time spend it in an active way, e.g. gardening or taking part in sports

EARs for energy take account of this fact, so they are no longer based upon whether an adult has a sedentary, moderately active or very active job. They are based on the current lifestyle in the UK which is fairly sedentary.

Special circumstances

Pregnancy
Although energy is needed during this time to support the growth of the foetus and to enable fat to be laid down in the mother's body for child birth and later breast feeding, considerable reductions occur in physical activity during the last three months of pregnancy. Therefore the amount of energy required is limited to an EAR of 0–8MJ per day for the last three months only.

Lactation
Breast feeding demands energy as the milk has to contain enough energy to supply the needs of the growing infant. Apart from the body fat laid down for this purpose, an additional EAR is calculated for energy, which increases generally with each month of breast feeding up to the time the mother decides to stop breast feeding.

Convalescents, invalids
People who are largely immobile, i.e. confined to bed or to a wheelchair because of disability or illness or not doing a lot in the house or hospital while they recover from an illness (convalescing), do not have the normal requirement for energy. They should cut down on sugar, fat and ensure that large quantities of starchy carbohydrates are not eaten, so preventing obesity.

Weight reduction
People who are attempting to lose weight sensibly will be given a medically approved diet which reduces the EAR of energy. Cutting down on the energy level for these people means their bodies will be forced to use up the stored fat as an energy source, so reducing weight as the fat level in the body falls.

For severely underweight or anorexic people EARs do not provide enough energy for them to gain weight. Special diets have to be made

up which will include more energy foods than the EAR for individuals of the same age, sex and of normal weight

Vegetarians

The same amount of energy would be required by vegans/lacto vegetarians. Energy will come from cereals, grains and potatoes, particularly for vegans. Lacto vegetarians may have to be careful of the amount of saturated fats – eggs, cheese, milk – in their diets which may raise energy levels.

RNI for protein

Reference nutrient intake (RNIs) for protein

Age	Reference nutrient intake(g/day)
0–3 months	12.5
4–6 months	12.7
7–9 months	13.7
10–12 months	14.9
1–3 years	14.5
4–6 years	19.7
7–10 years	28.3
Males	
11–14 years	42.1
15–18 years	55.2
19–50 years	55.5
50+ years	53.3
Females	
11–14 years	42.1
15–18 years	45.4
19–50 years	45.0
50+ years	46.5
Pregnancy	+6
Lactation	
0–4 months	+11
4+ months	+8

Source: *Dietary Reference Values: A Guide*, HMSO.

These figures are valid only if the needs for energy and all other nutrients are met. If energy needs are not met, dietary protein is used as a source of energy rather than the 'raw material' for tissue growth and repair.

The chart includes figures for children, pregnant and lactating women. These figures allow for:

- growth in children
- growth of foetal and maternal tissue in pregnant women
- breast milk production in lactating women.

The amount of protein any group requires is directly related to the following factors:

Weight, height, body size

Males normally have greater body size than females and obviously adults and teenagers have more body volume than infants and young children, i.e. the greater the body size, the more protein is required to repair and maintain body tissue.

Age/growth

This is partly related to the previous factor in that protein is required to make all the new body tissue, e.g. bone, skin, muscle that is associated with growth. A 7-year-old, therefore, needs less protein than a 17-year-old because the 17-year-old has a larger body to repair and maintain as well as needing the protein for growth.

Adults who have stopped growing do not need protein for growth but still need as much as teenagers because they have larger bodies at that age to repair and maintain.

Adequate protein continues to be important to elderly people because body tissue wears out quickly in older age groups but with an adequate amount of protein in the diet, this process will not happen more quickly than it should do.

Special circumstances

Pregnancy

The table shows that for pregnancy the RNI is +6 g. This means that females must add on 6g protein per day to the normal RNI for their age group, e.g. a 23-year-old pregnant woman would need 45 + 6 g protein

per day = 51 g protein. This additional amount (6 g) of protein is required for the growth and development of the foetus while the 45 g is for the normal protein needs of the woman herself.

Lactation

Similarly, women who breast feed their baby for the first 4 months of the baby's life should add on 11 g of protein per day to the normal RNI for their age group. If they continue to breast feed beyond 4 months then they should add on 8 g per day to the RNI for their age group.

Convalescents, invalids

Although no reference is made to invalids, they would normally need additional protein because repair of weakened or damaged tissue caused by illness or an operation would require to take place.

Weight reduction

The most effective and healthy way to reduce weight is to take in slightly less energy from food than the body needs each day.

Vegetarians

The same amount of protein would also be required by vegan/lacto vegetarians but this must be supplied by the type of protein foods which are considered suitable for them

DRVs for fats and fatty acids

The DRVs for fat found in food, which includes saturated, polyunsaturated and monounsaturated fatty acids are given as a percentage of total food energy intake. It is recommended that the following intakes are practised:

- Total fat should provide no more than 35% of total energy intake
- Saturated fats should provide no more than 11% of total energy intake
- Polyunsaturated fatty acids should provide no more than 6% of total energy intake
- Monounsaturated fatty acids should provide no more than 12% of total energy intake
- Trans fatty acids should provide no more than 2% of total energy intake

These figures for fat consumption are related to the importance of the type of fat consumed to prevent coronary heart disease.

DRVs for carbohydrates (starches and sugars)

DRVs for carbohydrates are given as a percentage of daily total energy intake. It is recommended that that:

- approximately 10% of carbohydrates are in the form of sugar
- approximately 37% of carbohydrates are in the form of starches
- total carbohydrate intake should average 47% of total dietary energy for the population.

Fibre (dietary)/NSP

A DRV for fibre (dietary)/NSP is based on an estimated average intake of 18 g per day.

No benefit is thought to occur if excess of 32 g per day is eaten, therefore adults should aim at an intake of between 18 and 32 g per day. Because of their smaller body weight children should eat less.

Special circumstances

- *Pregnancy and convalescents*. Sufficient fibre/NSP in the form of fruit, vegetables and wholegrain products will prevent constipation. Inactivity, due to illness or in the later stages of pregnancy, will contribute to the risk of constipation.

- *Weight reduction*. Foods rich in fibre/NSP will aid weight reduction by providing a feeling of fullness, so reducing the risk of snacking on high fat or sugar foods.

- *Vegetarians*. The extra bulk provided by the fibre/NSP in foods such as plant protein foods, may have to be spread throughout the day to avoid feeling too full after a meal.

RNI for vitamins

Most requirements for vitamins are expressed in three ways as the table below shows.

Age	LRNI		EAR		RNI	
0–12 months	150		250		350	
1–3 years	200		300		400	
4–6 years	200		300		400	
7–10 years	250		350		500	
11–14 years	250		400		600	
	Males	*Females*	*Males*	*Females*	*Males*	*Females*
15 – 50 + years	300	250	500	400	700	600
Additional amounts to be added to pre-pregnancy DRVs						
Pregnant women			+100			
Lactating women			+350			

Source: *Dietary Reference Values: A Guide*, HMSO.

The LRNI is the lowest figure suitable for a small number of people with low needs. It then progresses to the middle figure, the EAR, which is the average requirement. Finally the chart states the RNI, which is considered enough for almost everyone, even someone who has high needs for the nutrient. The RNI is considerably higher than most people need. (*Refer to the RNI for Vitamins table on pages 60–1*.)

For most people, a figure somewhere mid-way between the EAR and the RNI would be sufficient for normal needs.

Note: Needs for most B-group vitamins are related to the EARs for energy. The higher the amount of energy required by a group of people (e.g. athletes), then the higher the need for B-group vitamins will be, as most have an essential role to play in the release of energy from carbohydrates and other nutrients.

Special circumstances

Pregnancy and lactation
Women intending to become pregnant, and for the first 12 weeks of pregnancy, are advised to take supplements or foods rich in folic acid. This will help reduce the risk of their baby developing a neural tube defect.

Additional vitamin B1 (thiamine) is also required during the last three months of pregnancy and if lactating because of increased metabolism in the body.

RNI for minerals

The requirement for minerals are expressed in exactly the same way as for vitamins using the three figures of LRNI, RNI and LRNI.
(*See Reference Nutrient Intake (RNI) for Minerals table on pages 61–2.*)

Special circumstances

Women of child-bearing age
The RNI given for iron would not be sufficient for women who have a high menstrual loss each month. The most practical way for such a person to meet her iron requirement would be to take iron supplements.

Pregnancy
During pregnancy, calcium absorption increases and no additional calcium is generally required. However, an exception would be the pregnant adolescent whose bones are still forming and whose bone density is still being laid down.

The increased needs of pregnancy for iron should be met without a further increase in iron intake because of:

- the cessation of menstrual periods
- the mobilisation of some of the mother's stores. Dietary supplement may be needed by mothers with low iron stores, e.g. teenage mothers and those women who do not eat a well-balanced diet.

Reference Nutrient Intakes for vitamins (per day)

Age	Thiamine (mg)	Riboflavin (mg)	Niacin (nicotinic acid equivalent) (mg)	Vitamin B6 (mg)	Vitamin B12 (µg)	Folate (µg)	Vitamin C (mg)	Vitamin A (µg)	Vitamin D (µg)
0–3 months	0.2	0.4	3	0.2	0.3	50	25	350	8.5
4–8 months	0.2	0.4	3	0.2	0.3	50	25	350	8.5
7–9 months	0.2	0.4	4	0.3	0.4	50	25	350	7
10–12 months	0.3	0.4	5	0.4	0.4	50	25	350	7
1–3 years	0.5	0.6	8	0.7	0.5	70	30	400	7
4–6 years	0.7	0.8	11	0.9	0.8	100	30	500	0
7–10 years	0.7	1.0	12	1.0	1.0	150	30	500	0
Males									
11–14 years	0.9	1.2	15	1.2	1.2	200	35	600	0
15–18 years	1.1	1.3	18	1.5	1.5	200	40	700	0
19–50 years	1.0	1.3	17	1.4	1.5	200	40	700	0
50+ years	0.9	1.3	16	1.4	1.5	200	40	700	10**

** For the population aged 65 or more only.

cont'd on page 61

Reference Nutrient Intakes for vitamins (per day) – cont'd

Females	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin B6 (mg)	Vitamin B12 (µg)	Folate (µg)	Vitamin C (mg)	Vitamin A (µg)	Vitamin D (µg)
11–14 years	0.7	1.1	12	1.0	1.2	200	35	600	0
15–18 years	0.8	1.1	14	1.2	1.5	200	40	600	0
19–50 years	0.8	1.1	13	1.2	1.5	200	40	600	0
50+ years	0.8	1.1	12	1.2	1.5	200	40	600	10**
Pregnancy	+0.1	+0.3	*	*	*	+100	+10	+100	10
Lactation									
0–4 months	+0.2	+0.5	+2	*	+0.5	+60	+30	+350	10
4+ months	+0.2	+0.5	+2	*	+0.5	+60	+30	+350	10

Note: No daily RNI is given for vitamin D as ultra-violet rays from the sun provide sufficient to store for year-long use.

* No increase in requirements.

** For the population aged 65 or more only.

Source: *Dietary Reference Values: A Guide,* HMSO.

Reference Nutrient Intakes for minerals (per day)

Age	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Sodium (mg)	Potassium (mg)	Chloride (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Selenium (µg)	Iodine (µg)
0–3 months	525	400	55	210	800	320	1.7	4.0	0.2	10	50
4–6 months	525	400	60	280	850	400	4.3	4.0	0.3	13	60
7–9 months	525	400	75	320	700	500	7.8	5.0	0.3	10	60
10–12 months	525	400	80	350	700	500	7.8	5.0	0.3	10	60
1–3 years	350	270	85	500	800	800	6.9	5.0	0.4	15	70
4–6 years	450	350	120	700	1100	1100	6.1	6.5	0.6	20	100
7-10 years	550	450	200	1200	2000	1800	8.7	7.0	0.7	30	110

cont'd on page 62

Reference Nutrient Intakes for minerals (per day)

Males	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Sodium (mg)	Potassium (mg)	Chloride (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Selenium (µg)	Iodine (µg)
11–14 years	1000	775	280	1600	3100	2500	11.3	9.0	0.8	45	130
15–18 years	1000	775	300	1600	3500	2500	11.3	9.5	1.0	70	140
19–50 years	700	550	300	1600	3500	2500	8.7	9.5	1.2	75	140
50+ years	700	550	300	1600	3500	2500	8.7	9.5	1.2	75	140
Females											
11–14 years	800	625	280	1600	3100	2500	14.8**	9.0	0.8	45	130
15–18 years	800	625	300	1600	3500	2500	14.8**	7.0	1.0	60	140
19–50 years	700	550	270	1600	3500	2500	14.8**	7.0	1.2	60	140
50+ years	700	550	270	1600	3500	2500	8.7	7.0	1.2	60	140
Pregnancy	*	*	*	*	*	*	*	*	*	*	*
Lactation											
0–4 months	+550	+440	+50	*	*	*	*	+6.0	+0.3	+15	*
4+ months	+550	+440	+50	*	*	*	*	+2.5	+0.3	+15	*

* No increase in requirements.
** Insufficient for women with high menstrual losses where the most practical way of meeting iron requirements is to take iron supplements.

Note: During pregnancy, calcium absorption increases and no additional is generally needed. An exception is the pregnant adolescent. The increased needs of pregnancy for iron should be met without a further increase in iron intake because of cessation of menstrual losses and the mobilisation of some of the mother's stores. Dietary supplements may be needed by mothers with low iron stores.

Source: *Dietary Reference Values: A Guide,* HMSO.

Dietary needs

Pregnancy

General points

- Pregnant women should have a nutritionally sound diet so that they produce a healthy baby and are able to sustain their own health throughout the pregnancy.
- Poor eating habits of mothers affect foetal growth and development which in turn affects the well-being and growth of the child into adulthood.
- Smoking in pregnancy will reduce the flow of nutrients to the foetus.
- Any alcohol taken taken during pregnancy will interfere with the nutrient absorption of the mother and also passes into the unborn baby's bloodstream.
- Pregnant women will get dietary advice from the community midwife, doctor and health visitor, who all keep a careful check on the health of mother and baby.

Dietary guidelines

All nutrients are important in pregnancy but particularly the following:

Nutrient	Reason
Protein	• A little additional protein will be required for the development of the foetus's body cells. • Too much, however, could contribute to weight gain.
Carbohydrate	• In the last 3 months of pregnancy, the body has a greater requirement for energy. This is a time of rapid growth and development for the growing baby. • It is important at this stage not to eat too many energy foods as weight gain may occur because of reduced activity at this stage in pregnancy. • Constipation can be a problem in pregnancy. If it is, more NSP should be taken along with increased fluid intake and gentle exercise such as walking or swimming.
Iron	• The mother must have enough iron during pregnancy to supply her own body and to provide the growing baby with a store of iron for the first 4 months after birth. • Breast milk and cow's milk are both poor sources of iron, so a store of iron is essential. A mother's haemoglobin count is checked regularly during pregnancy.

Vitamin C	• To enable iron to be absorbed, foods rich in iron and vitamin C are required. • Vitamin C is also required for the baby's tissue formation.
Folic acid	• Women have been advised to ensure that their diet contains adequate supplies of folic acid before becoming pregnant and during pregnancy, especially the first 3 months of pregnancy. • Folic acid reduces the risk of babies being born with neural tube defects such as spina bifida. It is required for the development of the brain and nervous system of the foetus.
Calcium, vitamin D and phosphorus	• The baby's bones are supplied with calcium provided by the mother's diet. • It is important that calcium intake is maintained to ensure that calcium deposits from the mother's bones and teeth are not used for this purpose.

Foods to avoid during pregnancy

1. *Too many sugary and fatty foods*, especially during the later stages of pregnancy. Women generally are less active then and this could lead to excess body fat which can then be difficult to loose.
2. *Soft, ripened cheeses*, such as brie and camembert, and also paté should be avoided, as they may contain listeria bacteria which can be harmful to the unborn child. Cook-chill meals should be thoroughly reheated as they may also contain listeria bacteria.
3. *Eggs should be thoroughly cooked* as they may contain salmonella bacteria which can cause food poisoning. Raw egg dishes should also be avoided for the same reason.
4. *Avoid eating liver and its products* as they may contain large amounts of vitamin A which can be harmful to the developing baby.

Breast-feeding (lactation)

Scotland does not have a good rate of breast-feeding although there has been a slight improvement. Evidence has confirmed that breast milk has more advantages than milk formulae. Scottish dietary targets recommend that mothers breast-feed their babies for at least the first six weeks of life.

Advantages of breast-feeding

1. *Pyschological benefits*
   - Mother bonds with child and establishes a close emotional attachment to the child.

2. *Health benefits*
   - Breast milk contains antibodies and other protective substances which provide specific protection for the child and encourages growth and development of infant tissues and organs.
   - Baby is less likely to become overweight because baby decides when full.
   - No likelihood of allergies to breast milk.
   - Greater resistance to infection, especially gastro-intestinal infection and diarrhoea.
   - Medical evidence suggests that babies who are breast feed have a lower risk of developing asthma.
   - Breast-feeding may help the mother to lose excess fat stores gained during pregnancy.
   - Medical evidence suggests that women who breast-feed have a lower risk of developing breast cancer.

3. *Hygiene benefits*
   - Human milk is germ free.
   - Less chance of stomach upsets through unhygienic preparation of feeds.

4. *More convenient and labour saving*
   - No preparation time is needed and there is less hassle.
   - No equipment to sterilise.
   - Possible to feed baby on demand and quickly if necessary.
   - Cannot be prepared incorrectly.

5. *Easier to digest and suitable for all babies*
   - Easier to digest therefore less chance of nappy rash and stomach upsets.
   - Milk contains all the energy and essential nutrients needed by babies and in the correct proportion.

6. *More economical*
   - No extra equipment is needed, no milk formulae to buy – breast feeding is free.
   - Breast milk is always at the correct temperature so no heating is needed.

Experts recommend that babies are breast-fed for at least 4 months as there are real health benefits. Babies should not be given solid food until they are 4 months old – this is called weaning. By this time, babies have developed sufficiently to cope with a more varied diet.

Weaning

Practical guidelines

- Introduce new foods gradually.
- Introduce different textures, flavours in food.
- Establish regular eating times.
- Aim for five small meals a day.
- Foods should be sieved or pureed.
- By six months, baby should have a diet which is a mixture of solid and liquid food.
- Choose foods with no additives.
- Choose foods that are low in sugar and salt.
- Restrict the intake of sweets.
- Encourage the drinking of milk.

Infants and young children

General points

- Poor diet in childhood can lead to health problems in later life.
- Good eating habits start in childhood and poor eating habits may be difficult to change in later life.
- A healthy diet will help children avoid becoming overweight or obese.
- Regular meals, consisting of small attractive servings and a pleasant atmosphere, are important in encouraging young children to eat.
- Include the use of naturally brightly coloured foods in meals and snacks.
- Introduce new tastes and textures gradually.
- Use food products which are additive free.

Dietary guidelines

- A variety of foods should be introduced so that a range of nutrients is obtained.
- Some complex carbohydrate foods such as wholemeal bread and potatoes should be included to supply energy.
- Do not include too much NSP-rich foods as this will be very filling and children would be unable to eat enough food to supply all the other nutrients they need.
- Avoid giving children too many foods high in fat or fried foods. As children approach school age their fat intakes should be in line with the Scottish dietary recommendations.

- Choose low-fat versions of dairy produce. After the age of two semi-skimmed milk may be given, provided adequate energy intake is ensured from the rest of the diet. Skimmed milk should not be given before five years of age.
- Avoid too many sugary foods, as this will contribute to obesity and tooth decay. Avoid giving sweets as a reward and avoid sugar-coated breakfast cereals.
- Encourage the eating of fruit and vegetables as a low-fat and sugar snack. Serve vegetable sticks as snacks and give fresh and dried fruits as snacks in order to supply vitamin C.
- Protein is required for growth of new body cells and tissues as well as repair of damaged tissues. Children will be going through a growth spurt at this age.
- Calcium, phosphorus and vitamin D are required to form and maintain strong bones and teeth. Serve milk instead of sugary drinks.
- Supply iron rich foods to prevent anaemia, e.g. add dried fruits to breakfast cereals.
- Avoid salty foods as this encourages a liking for salt in the diet. Avoid salty snacks and a lot of processed foods in the diet.

Teenagers

General points

- Adolescence is a period of rapid growth and body development and nutrient requirements increase at this stage.
- Many teenagers have a tendency to 'graze' on snack or fast foods so it is essential to encourage a healthy diet.
- Food habits during teenage years will affect health in later life.
- Smoking is extremely detrimental to bone health and alcohol should only be drunk in moderation, as it is a toxin to bone cells. Teenagers should establish a regular exercise programme as exercise can increase and stimulate bone density.

Dietary guidelines

Teenagers have increased requirements for *energy* – especially if taking part in sports.

Males need more energy than females because:

1. They tend to have a larger body size than females and so require more energy
2. They may be more active than females and so will need a greater amount of energy to supply their body cells

3. Males tend to be more muscular than females and so will have a greater need for supplying energy sources to the muscles.

Energy should be provided in the form of complex carbohydrates. Vitamin B complex is required to release energy from carbohydrate foods.

- *Calcium*. About 45% of the adult-sized skeleton forms during adolescence, so plenty calcium and phosphorus foods should be eaten to ensure the proper formation of bones and teeth. Vitamin D will promote the absorption of calcium.

- *Iron*. Iron requirements increase as blood volume expands throughout growth. Iron is particularly important, especially in early adolescence for girls, to prevent anaemia developing when menstruation starts.

- *Protein*. Teenagers require protein for their rapid growth spurt and to repair damaged tissues especially if many sports are played.

- *Vitamin C.* Vitamin C is required to assist the absorption of iron. Plenty of fruit and vegetables should be eaten to provide this antioxidant vitamin.

Adults

General points

- The nutritional requirements of an adult will vary greatly depending on age, gender, lifestyle and occupation.
- Body growth declines in adulthood.
- Adults require a good diet to maintain and repair the body and to keep it healthy.
- Activity levels along with body size will determine the energy and nutrient requirements.
- Women will need less food than men but will need more iron because of menstruation.
- For women, their nutrient requirements will change during pregnancy and after the birth of a baby.

Dietary guidelines

- Adults who are not very active need to pay careful attention to their energy intake, because if energy intake exceeds energy output then the result will be weight gain.

- The requirements for protein and most of the vitamins and minerals remain virtually unchanged in the adult years.
- In comparison to adolescents, energy requirements are lower for both men and women, as are requirements for calcium and phosphorous.
- Reducing the intake of saturated fats, while increasing the total complex carbohydrate (TCC) foods will provide sufficient energy for active adults.

Elderly

General points

- As people grow older, they need less energy.
- Usually they are less active.
- Basal metabolic rate (BMR) falls because there is a loss of lean tissue mass in the body.
- More elderly people are overweight than underweight due to lack of exercise.
- Obesity can be a problem – increased risk of heart disease and high blood pressure, or extra weight puts undue strain on joints.
- Deteriorating teeth can cause difficulty with chewing.
- Arthritis may cause problems with food shopping and preparation.
- A limited budget may influence food choice.
- An elderly person living alone may lack the motivation to prepare a balanced diet (e.g. a complete meal for only one person) and may snack on prepared high-fat and sugar foods.

Dietary guidelines

- A range of nutrients need to be eaten.
- The elderly should be encouraged to eat foods rich in iron to prevent anaemia, e.g. meat, eggs, breakfast cereals, bread, beans.
- Eating several sources of calcium will keep bones healthy and prevent osteoporosis, e.g. milk, cheese, bread, breakfast cereals.
- If the elderly are housebound, then they may lack exposure to sunlight and be at risk from a deficiency of vitamin D. This will lead to poor absorption of calcium and may cause osteomalacia. Vitamin D should be included in the diet.
- There is an increased demand for foods rich in NSP as the decline in activity could lead to constipation. NSP-rich foods should be included in the diet.
- Elderly people who have difficulty in chewing would benefit from fruit and vegetables being pureed to meet dietary needs for fruit and vegetables.

Convalescents

General points

- Anyone recovering from an illness, accident or operation is a convalescent.
- It may be necessary to adjust the normal diet of convalescents to compensate for body weaknesses, poor appetite or poor digestion.
- Medical advice on diet must be carefully followed.
- Food must compensate for the loss of nutrients when recovering, e.g. loss of calcium from a bone fracture or reduced iron as a result of losing blood in an operation.
- Highly seasoned, spicy foods should also be avoided.
- Small portions should be served as the appetite is likely to be poor.
- Food should be served attractively, and have a variety of colours and textures to encourage appetite.
- Food should be thoroughly cooked to prevent food poisoning.

Dietary guidelines

- *Patients may require plenty of liquids* – liquids should provide energy, vitamins and protein. Suggested liquid includes – soups and broths, fruit juice, milk.
- *Avoid foods which contain a lot of fat or sugar* as the convalescent will not be as active as usual to use up all the energy. The energy value of foods should be lower than normal.
- *Foods that contain a good supply of calcium should be eaten by convalescents* with a broken limb, so that the bone heals strongly.
- *Protein intake should be sufficient* to allow damaged cells and tissues to be repaired.
- If the patient is recovering from an accident or operation they should have *sufficient protein for body repair* and iron to replace any that was lost.
- *Plenty of NSP* in the form of fruit, vegetables and some wholegrain cereals will prevent constipation.
- *Greasy foods should be avoided* as they may be difficult to digest.

Weight reduction diets

See also notes on 'Obesity' (pp. 41–44).

Many people in the UK are overweight although average energy intakes of the population have decreased over the past few years, activity levels have also dropped. People are taking less exercise, there are now more labour-saving devices and these factors may contribute to the increase in the number of people who are overweight or obese.

Why do people put on weight?

If we eat food which provides more energy than we need for our normal activities and lifestyle, this extra energy is stored as body fat. For body weight to remain constant, energy intake must equal energy output.

Dietary guidelines

The most effective and healthy way to reduce weight is to take in slightly less energy from food than the body needs each day. The body then makes up the difference by releasing energy it has stored as fat. Gradually the stores of fat are reduced. Usually a diet promoting 1000–1,500 Kcals per day is recommended, depending on the individual. In particular:

- Cut down on total intake of food eaten each day.
- Cut down on sugary and fatty foods.
- Eat more total complex carbohydrate, NSP rich foods and fruit and vegetables which are low in calories and are good sources of NSP , vitamins and minerals. These foods are filling and will help prevent snacking on sugary, fatty foods.
- Use cooking methods which do not involve adding fat.

Very low-calorie diets, 'crash' diets and meal-replacement drinks are advertised as a quick and easy way to lose weight. These types of diet can cause problems because:

- They do not encourage the dieters to change their eating habits in the long term.
- Once normal eating resumes, weight may be put back on quickly.
- They often lead to loss of muscle instead of fat.
- They may not be nutritionally balanced.
- They can be expensive.

Vegetarians

General points

- Vegetarian diets are followed by people who, for various reasons (religious, ethical, moral, health or personal taste) do not eat animal flesh.
- Lacto-ovo vegetarians do not eat meat, meat products or fish. They will eat animal products such as eggs, milk, cheese and dairy products, as well as plant foods.
- Vegans do not eat any animal-derived products including eggs, milk, cheese and other dairy products. They only eat plant products.
- Provided a vegetarian diet is well balanced, it should supply all the nutrients needed by the body throughout life.

Dietary guidelines

Lacto-ovo vegetarians should have few problems achieving a balanced diet as most nutrients are easy to obtain, including the essential amino acids from the protein found in those animal products which they will eat.

- They should limit their consumption of dairy foods such as cheese, butter, whole milk to avoid too large an intake of saturated fats. Reduced-fat versions of these foods should be used.
- Iron may be unavailable to the body from certain plant foods due to the presence of phytic acid, so limit phytic acid in the diet, e.g. wheat bran.
- Vitamin C foods should be eaten to help with the maximum absorption of iron from foods.
- They need to use complex carbohydrate as a source of energy.
- Vitamin B12 may have to be supplemented by fortified foods.

Vegans

- Protein is found in relatively small amounts in plant foods, so a large bulk may have to be eaten. The richest sources are – soya beans, beans, pulses, cereals, nuts. A mixture of plant-protein foods should be eaten to make up for the deficiencies of essential amino acids in each.
- The bulk in the diet may lead to indigestion and fullness after a meal, so it would be advisable to spread the intake of foods throughout the day.
- Vitamin D is seldom found in plant foods so the action of sunlight on the skin is an important source. Fortified foods further ensure adequate amounts, e.g. vegetable margarines, soya milks.

- Vegans can obtain adequate calcium from plant foods. Good sources are tofu, green leafy vegetables, watercress, dried fruit, seeds and nuts. White bread is fortified with calcium, as are soya milks. (The presence of phytic acid in wholegrain cereals may make calcium unavailable to the body.)
- A high intake of NSP in vegans will have a positive effect on health, as more pulses, nuts, fruits and vegetables are consumed.
- As vitamin B12 is only found in animal foods, vegans may be at risk of developing a type of anaemia and may need to take it in tablet form to prevent this happening.

SECTION 9

Current dietary advice: the Scottish dietary targets

Elaboration

- Practical ways of meeting the dietary targets
- The use of dietary targets to influence the proportions of ingredients
- Adaptations of products to meet dietary targets
- The contribution of dietary targets to good health
- Acknowledgement of the contribution food manufacturers make to dietary targets by producing pre-packed foods which help consumers to meet these targets
- Cooking methods to promote the dietary targets

This section presents an awareness of the main issues from the Scottish diet action plan: *Hungry for Success*.

The Scottish dietary targets

The dietary targets form a framework for tackling the long-standing deficiencies in the Scottish diet.

Dietary targets

Fruit and vegetables	Average intake to double to 400 grams per day
Bread	Intake to increase by 45% from present daily intake of 106 g, mainly by using wholemeal and brown breads
Breakfast cereals	Average intake to double from the present intake of 17 g per day
Fat	Average intake of total fat to reduce from 40.7% to no more than 35% of food energy Average intake of saturated fatty acids to reduce from 16.6% to no more than 11% of food energy
Salt	Average sodium intake to reduce from 163 mmol per day to 100 mmol per day
Sugar	Average intake of NME sugars in adults not to increase Average intake of NME sugars in children to reduce by half to less than 10% of total energy
Total complex carbohydrates	Increase non-sugar carbohydrates intake by 25% from 124 g per day through increased consumption of fruit and vegetables, bread, breakfast cereals, rice and pasta and an increase in potato consumption of 25%
Fish	White fish consumption to be maintained at current levels Oil-rich fish to be doubled from 44 g per week to 88 g per week
Breast-feeding	The proportion of mothers breast-feeding their babies for the first six weeks of life to increase to more than 50% from the present level of around 30%

Target: fruit and vegetables

- Double intake to 400 grams per day.

Contribution of the dietary target to good health

- Adds NSP to the diet to prevent constipation, bowel disorders, bowel cancer.

- Very low or no fat, which will not cause weight gain that may then result in high blood pressure (HBP) and link to coronary heart disease (CHD) or a stroke.

- Supplies ACE or antioxidants which destroy free radicals that can damage tissues and cause cancer.

- Supplies ACE or antioxidants which destroy free radicals that can damage tissues and may cause CHD.

- Supplies vitamin C for healthy connective tissue and to help the absorption of iron to prevent anaemia. Vitamin C is also an antioxidant.

- Supplies vitamin A which is an antioxidant needed to prevent cancer and CHD. Vitamin A is also needed to form visual purple in the eye to help vision in dim light and prevent night blindness.

- Supplies iron which helps form haemoglobin, the red colouring in the blood. Haemoglobin helps transport oxygen round the body, and prevents tiredness and anaemia.

Practical ways of meeting the dietary target

- Portion of fruit, e.g. banana, added to breakfast cereal.
- Fruit snack in lunch boxes.
- Fresh fruit pureed into drinks.
- Desserts, e.g. fresh fruit salad.
- A variety of vegetables in soup which could be pureed.
- Extra veg on pizzas, in stews, etc.
- Main dishes, e.g. vegetables curry.
- Served with main dishes or in salads.
- Salad used to fill sandwiches or served as an accompaniment.

Target: bread

- Intake to increase by 45% from present daily intake of 106 g mainly by using wholemeal and brown breads (154 g daily).

Contribution of the dietary target to good health

- Provides protein for growth and repair and maintenance of body tissues.
- Bread is fortified with calcium which is needed for development and maintenance of bones and teeth.
- Wholemeal bread is a good source of NSP, which helps prevent constipation and bowel disorders.
- Contributes to folic acid which is needed to prevent spina bifida in babies (or neural tube defects) and to ensure pregnant women do not become anaemic.
- Contributes to iron intake helping to prevent anaemia.
- Low in fat and sugar so should not cause excess weight gain or obesity → HBP → CHD.
- Helps to fill you up so less likely to snack on high-fat or sugar foods and so reduces risk of obesity → HBP → CHD. Less likely to eat salty snacks which could lead to HBP.

Practical ways of meeting the dietary target

- Many wholemeal bakery products are available, e.g. shops' own brand of bread, pitta bread, garlic bread, naan bread, scones, hot cross buns. Some of these could be used for sandwiches, toasted sandwiches, etc.
- Used in desserts, e.g. bread pudding, summer pudding.
- Serve sandwiches as a snack or packed lunches.
- Make use of new continental or foreign breads to increase variety in the diet or add interest to snacks and lunches.

Target: breakfast cereals

- Average intake to double from the present intake of 17 g per day.

Contribution of the dietary target to good health

- Provides protein for growth, repair and maintenance of body tissues.
- Provides calcium needed for development and maintenance of teeth and bones.
- Helps to fill you up, so less likely to snack on high-fat or sugar foods and so reduces risk of obesity → HBP → CHD. Less likely to eat salty snacks which could lead to HBP.
- Breakfast cereals are a good source of NSP which helps prevent constipation and bowel disorders.
- Contributes to folic acid which is needed to prevent spina bifida in babies (or neural tube defects) and to ensure pregnant women do not become anaemic.
- Contributes to iron intake, helping to form haemoglobin and prevent anaemia.
- Low in fat or sugar versions, so should not cause excess weight gain or CHD in later life.

Practical ways of meeting the dietary target

- Choose wholegrain, high-fibre versions of cereal which are low in sugar, salt and fat for breakfast. Breakfast cereals are also fortified with many vitamins and minerals.
- Breakfast cereals can also be eaten as a snack and the addition of milk will improve the nutritional value.
- Breakfast cereals can also be used in baking, e.g. biscuits, topping for fruit crumble or yoghurts.

Target: fats

- Average intake of total fat to reduce from 40.7% to no more than 35% of food energy.
- Average intake of saturated fatty acids to reduce from 16.6% to no more than 11% of food energy.

Contribution of the dietary target to good health

- Saturated fat will raise cholesterol levels in the blood – the cholesterol will stick to the walls of the arteries and so narrow or clog the arteries. This will result in the heart straining to pump the blood round the body and cause HBP which in turn may cause heart disease.

- A high-fat diet can cause obesity – obesity may cause HBP which may cause CHD.

- A high fat intake is linked to a higher risk of cancer, obesity, HBP, CHD, gallstones.

- A high fat intake that leads to obesity and/or may cause low self-esteem and psychological problems.

Practical ways of meeting the dietary target

- Choose lean meat – cut off any extra fat.
- Choose fish or white meat instead of red meat sometimes.
- Choose low-fat versions of dairy produce. After the age of 2, semi-skimmed milk may be given provided adequate energy intake is ensured from the rest of the diet. Skimmed milk should not be given before 5 years of age.
- Choose cottage or edam cheese instead of cheddar.
- Use semi-skimmed or skimmed milk for cooking, instant desserts, etc.
- Check labels for fat content before buying prepared or convenience foods.
- Avoid eating too many cakes, biscuits, chocolate, crisps and savoury snacks, which all contain hidden fats.
- Avoid processed meats which are often used in a range of ready-made meals.
- Choose a healthy method of cooking, e.g. grilling, where the fat runs off, or steaming or microwaving where there is no added fat.
- Use a little olive oil for stir-frying as this is a mono-unsaturated fat and will help keep cholesterol levels down. Or use a spray-on fat for frying as this will cut down on the amount of fat used.

Target: salt

- Average sodium intake to reduce from 163 mmol per day to 100 mmol per day.

Contribution of the dietary target to good health

- High intake of salt is linked to high blood pressure with an increased risk of coronary heart disease.

- May contribute to stomach cancer.

- Can lead to kidney problems in children.

Practical ways of meeting the dietary target

- Limit intake of processed foods, including ham and bacon.
- Choose low-salt alternatives.
- Limit intake of salty snacks, e.g. crisps and peanuts
- Check food labels on products before buying.
- Use herbs and spices for flavouring instead of salt.
- Taste food before adding salt.
- Gradually cut down the amount of salt added to food during cooking.

Target: sugar

- Average intake of NME sugars in adults not to increase.
- Average intake of NME sugars in children to reduce by half to less than 10% of total energy.

Contribution of the dietary target to good health

- High sugar intake is linked to obesity – obesity can be linked to HBP, CHD and psychological problems.

- High sugar intake is linked to dental decay.

- High sugar intake is linked to a greater risk of diabetes.

Practical ways of meeting the dietary target

- Check food labels before buying.
- Eat fewer cakes, biscuits, sweets – hidden sugars.
- Eat wholegrain, high-fibre breakfast cereals that are low in sugar.
- Eat fresh fruit and vegetables as snacks.
- Do not give sweets as a reward to children.
- Do not add sugar to tea, coffee or cereals.

Target: total complex carbohydrates

- Increase non-sugar carbohydrates intake by 25% from 124 grams per day through increased consumption of fruit and vegetables, bread, breakfast cereals, rice and pasta and an increase of 25% in potato consumption.

Contribution of the dietary target to good health

- Low in fat and sugar so will not cause excess weight gain or CHD in later life.
- Provides protein needed for growth, repair and maintenance of body tissues.
- Provides calcium needed for development and maintenance of teeth and bones.
- Helps to fill you up so less likely to snack on high-fat or sugar foods and so reduces risk of obesity → HBP → CHD. Less likely to eat salty snacks which could lead to HBP.
- Complex carbohydrates are a good source of NSP which helps prevent constipation and bowel disorders.
- Contributes to folic acid which is needed to prevent spina bifida in babies (or neural tube defects) and to ensure pregnant women do not become anaemic.
- Contributes to iron intake, helping to form haemoglobin and prevents anaemia.

Practical ways of meeting the dietary target

- Increase consumption of fruit and vegetables, bread, breakfast cereals, rice and pasta (especially wholegrain).
- Increase consumption of potatoes by 25% – baked or boiled and pulse vegetables.
- Many wholemeal bakery products are available, e.g. shops own brand of bread, pitta bread, garlic bread, naan bread, scones, hot cross buns.
- Some of these could be used for sandwiches, toasted sandwiches, etc.
- Use in desserts, e.g. bread pudding, summer pudding.
- Serve sandwiches as a snack or packed lunches.

- Make use of new continental or foreign breads to increase variety in the diet or add interest to snacks and lunches.
- Choose wholegrain, high-fibre versions of cereal which are low in sugar, salt and fat for breakfast. Breakfast cereals are also fortified with many vitamins and minerals.
- Breakfast cereals can also be eaten as a snack and the addition of milk will improve the nutritional value.
- Breakfast cereals can also be used in baking, e.g. biscuits, topping for fruit crumble or yoghurts.

Target: fish

- White fish consumption to be maintained at current levels. Oil-rich fish to be doubled from 44 g per week to 88 g per week.

Contribution of the dietary target to good health

- Oily fish supplies essential fatty acids – Omega 3 may help to decrease the risk of blood clots and so help prevent heart disease.

- Contributes to vitamin D intake, helping absorption of calcium in the diet and so helps to prevent rickets in children.

- Fish is a good source of protein needed for growth and repair of body tissues.

- White fish is low in fat and so will prevent obesity which can lead to HBP and link to CHD.

Practical ways of meeting the dietary target

Oily fish such as tuna, sardines, herring, mackerel and salmon should be included in a variety of ways, e.g.

- In sandwiches, patés and fillings for baked potatoes.
- In pies, potato-topped pies.
- As fish cakes – shaped to appeal to children.

Target: breast-feeding

- The proportion of mothers breast-feeding their babies for the first six weeks of life to increase to more than 50% from the present level of around 30%.

Contribution of the dietary target to good health

- Breast milk contains antibodies which help fight infection and prevent allergies.

- Breast milk contains the correct proportion of nutrients to meet the needs of the growing baby – baby less likely to become overweight.

- Medical evidence suggests that women who breast-feed have a lower risk of developing breast cancer.

- Breast-feeding helps mothers to lose weight gained during pregnancy.

Practical ways of meeting the dietary target

- Ask midwife for advice/support on breast-feeding.
- Use of breast pumps can help mum's partner take over at times.
- If baby refuses, stay calm and persevere.
- Public buildings should be encouraged to be more supportive of breast-feeding.
- Free breast-guards should be provided for new mums to reduce risk of infection.

Hungry for Success

(*A Whole School Approach to School Meals in Scotland*)

This is a publication in which the Scottish Executive has set out to revitalise school meal services in Scotland – linking school meal services with the curriculum, health education and health promotion. For the first time in the UK, national nutrient-based standards for school lunches are stated. The monitoring of these will be in place, with local authorities, catering professionals and schools working together.

The *Hungry for Success* publication is intended to improve the diet of Scottish school children which is causing concern due to high intakes of fat, sugar and salt.

The reasons for implementing this initiative are to ensure:

- The very best of health, education and social justice for all Scottish school children.
- The provision of providing attractive and nutritionally balanced meals for all school children.
- The provision of providing an eating environment for school children that is welcoming, comfortable and fun.

The recommendations of the publication are linked to the Scottish diet action plan and dietary reference values. The nutrient standards for school lunches for pupils in secondary schools are outlined on the next page.

	Recommendation		Quantity for secondary pupils aged 11–18 years
Energy	30% of EAR (estimated average requirements) mean of boy and girl		2.70 MJ/ 646 Kcal
Fat	Not more than 35% of food energy	Max	25.1 g
Saturated fatty acids	Not more than 11% of food energy	Max	7.9 g
Carbohydrates	Not less than 50% of food energy	Min	86.1 g
NME (non-milk extrinsic) sugars	Not more than 11% of food energy	Max	18.0 g
Fibre/NSP (non-starch polysaccharides)	Not less than 30% of calculated reference value	Min	5.2 g
Protein	Not less than 30% of RNI	Min	13.3 g
Iron	Not less than 40% of RNI	Min	5.9 mg
Calcium	Not less than 35% of RNI	Min	350 mg
Vitamin A (retinol equivalents)	Not less than 30% of RNI	Min	185 μg
Folate	Not less than 40% of RNI	Min	80 μg
Vitamin C	Not less than 35% of RNI	Min	13 mg
Sodium	Not less than 30% of RNI	Max	510 mg
Fruit and vegetables	1/3 of 5 portions		2 portions

Source: *Hungry for Success: A Whole School Approach to School Meals in Scotland.*

The use of dietary targets to influence the proportions of ingredients

With consumers becoming increasingly interested in the nutritional content of foods, manufacturers are becoming more aware that they have a responsibility to provide consumers with a range of products from which they can select a healthy diet. Many consumers take the nutritional content of food products into account when buying food. Nutritional content is therefore an important consideration when drawing up the specification for a product.

The nutritional content of a product may be considered by the food manufacturers for the following reasons:

- To meet the needs of consumers with specific dietary requirements.
- In response to current dietary advice and to assist consumers to make healthier choices – many 'healthy option' ranges are purchased to provide an alternative for consumers.

Whilst altering nutritional content, the manufacturer also has to consider the effect that changing the type or amount of ingredient may have on the final quality. Factors such as flavour, texture, shelf-life and the product's manufacturing process will also have to be taken into account.

Adaptation of products to meet dietary targets

Manufacturers have the opportunity to improve the nutritional content of their products and at least try to contribute in some way to helping consumers improve their diets. When food technologists substitute ingredients in recipes and alter the proportions of ingredients to alter the nutritional balance of a dish, the colour, flavour and texture will change. Great care has to be taken to ensure that the product does not reach the stage where it is unacceptable to consumers.

Dietary targets for Scotland include the following:

Total reduction in fat from 40.7% to no more than 35% of food energy with saturated fatty acids to be no more than 11% of food energy.

- The low-fat sector of the market is a rapidly expanding area. Manufacturers are becoming increasingly aware that this is very profitable. Many consumers search for products labelled 'low fat' or

'reduced fat' and a wide variety is available. It is, however, important to check the label to see how 'healthy' the product actually is – the sugar level may have been increased to improve flavour.
- Low-fat spreads usually contain a high proportion of water. This makes them unsuitable for frying or baking.

Manufacturers have tried to reduce fat in foods in the following ways:

- Use of oils/fats which have a lower quantity/percentage of saturated fats and a proportionately higher amount of unsaturated fats.
- Reduction in the amounts of fats/oils found in ready-made foods, e.g. reduced-fat meals.
- Use of lower-fat ingredients in products and reduced fat versions such as low-fat dairy products.
- Use of fat substitutes in products to reduce the quantity of fat present, but maintain flavour.
- Use of labelling information about the amount and type of fat content.

Average intake of NME sugars in adults not to increase whilst children should reduce intake by half, i.e. to less than 10% of total energy.

Manufacturers may reduce the proportion of sugar depending on the product, in the following ways:

- Breakfast cereals, biscuits and desserts have reduced sugar claims.
- Reduced-sugar products, e.g. fruit can be tinned in natural juice or in apple juice, reduced-sugar jam.
- Use of artificial sweeteners to reduce sugar content.
- Natural sweeteners, such as dried fruit, can be added to some baked products to increase acceptability and assist in reducing NME sugars.
- More on label information regarding sugar content is stated by manufacturers.
- With products such as biscuits, consumer sweetness acceptability levels vary and to suit these tastes manufacturers produce plainer biscuits.

In baked foods, which require air to be trapped, a reduction in volume may result if sugar is reduced – this may not be acceptable to consumers.

Average intake of fruit/vegetables to double to 400 grams.

Manufacturers have tried to increase fruit and vegetables in food consumption in the following ways:

- Prepared vegetables available in chilled conditions on supermarket shelves therefore saving the consumer time and effort in peeling and preparation.
- Wide range of mixed salad leaves available, which makes it easier for the consumer to purchase only the quantity required, and therefore save waste.
- A wide range of prepared salads now available at salad counters to encourage their use.
- A wide range of vegetarian dishes available which contain a good proportion of vegetables.
- Using fruit and vegetables may give bulk to healthy-option dishes.
- Dried fruit now added to many breakfast cereals.

Total complex carbohydrates (TCC) to be increased by 25% through increased consumption of fruit and vegetables, bread, breakfast cereals, rice and pasta, and through an increase of 25% in potato consumption.

Manufacturers have tried to increase TCC in foods in the following ways:

- Manufacturers have increased the amount of NSP in foods, e.g. white bread with added NSP, using both white and wholemeal flours together and adding oatflakes to bread, in an effort to encourage consumers to eat more bread.
- Breakfast cereals have added-NSP and reduced-sugar claims in order to increase consumption.
- They have increased the range of non-processed foods in products to improve NSP content.
- A range of prepared rice and pasta products with vegetables is on offer not only for vegetarians but for those who wish to go part way to meeting this dietary target. These products are a convenient and easy way for consumers to increase their consumption, especially if they are unsure of how to cook these foods from scratch.

Salt to be reduced from 163 mmol per day to 100 mmol per day.

A high percentage of the salt in our food comes from ready-prepared food. The ingredients of food labels should always be read carefully to see if salt has been added.

Manufacturers have tried to reduce salt intake in the following ways:

- By using less salt in the processing of foods, e.g. bread, baked beans.
- By using a salt alternative such as 'lo salt' products for flavouring.
- Use of additional natural flavourings, e.g. herbs, to reduce the amount of salt required.
- Packing of some foods in substances other than brine, e.g. tuna fish in mineral water or sunflower oil.
- Use of information on the food label to identify such low-salt foods.
- Increased range of ready meals with salt reduction.

Bread intake to double from the present level of 106 grams mainly by using wholemeal and brown breads.

Manufacturers have tried to improve bread consumption in the following ways:

- Manufacturers now produce a wide range of speciality bread that encourages consumers to eat more bread.
- Bread has been produced with added grains and NSP. These will still appeal to children because they are white and therefore encourage consumption.
- Manufacturers produce part-baked breads which can be baked and served hot in the home. This may encourage consumption.

Average intake of breakfast cereals to double from the present intake of 17grams per day.

Manufacturers have tried to improve breakfast cereal consumption in the following ways:

- There is an increasing range of breakfast cereal products such as breakfast bars, cereal bars, yoghurts with breakfast cereals and individual servings in packets.
- Breakfast and cereal bars may have a high sugar component which could contribute to obesity and tooth decay if eaten frequently.
- Breakfast and cereal bars may have a high salt component which could contribute to high blood pressure if eaten frequently.

White fish consumption to be maintained at current levels. Oil-rich fish to be doubled from 44g per week to 88g per week.

Manufacturers have recognised the health benefits of eating fish, both white and oil-rich, and have been pro-active in developing products which would support this dietary target. They have tried to improve fish consumption in the following ways:

- White fish, which contains very little fat, is often used in 'low-fat' ranges of prepared dishes.
- White fish which is easily digested and easy to eat, is often made into a variety of convenience products to appeal to a wide market including children, e.g. fish fingers, fish cakes, frozen fish in white sauce, etc.
- Oily fish, such as tuna, is made into ready meals such as tuna and pasta bake, tuna paté, tuna canned in brine or tinned in savoury sauces for snacks.
- Oily fish is available that is already mixed with other ingredients so that it can be used with baked potatoes and sandwiches.
- Because fish is easily and quickly cooked many manufacturers include fish dishes in their microwaveable, 'steam cuisine' and chilled ranges. These require little additional preparation; therefore, making it easier for the consumer.

The contribution food manufacturers make to dietary targets by producing pre-packed foods which will help consumers to meet the targets

The dietary targets are set for Scotland in order to try to improve the poor health record of the nation. If people prepared their meals from scratch then there might be a better chance of achieving the dietary targets. However, since consumers now eat a large amount of prepared foods, it can mean that the fat, sugar and salt content of their foods is controlled by manufacturers.

Manufacturers are under increasing pressure to respond to the dietary targets by producing prepared foods that will help meet the targets. There is now an increasing demand for 'healthy options'.

Manufacturers have made attempts to meet the dietary targets and the demands of health-conscious consumers through a number of developments. They are trying to:

Reduce fat	• In response to consumer demands for 'slimming' products, manufacturers have developed products (fat replacers) which act as substitutes for the fat content to reduce the energy value of ready meals. • Manufacturers can reduce the saturated fat content of ready meals to suit consumers wishing to lower blood cholesterol levels or to reduce concerns about coronary heart disease. • Manufacturers have increased the range of products using quorn, tofu and soya which supply consumers with a low-fat source of protein.
Reduce salt	• Manufacturers are reducing salt, by the use of spices and herbs in ready meals, in response to consumer concerns about the link between hypertension (HBP) and salt intake.
Increase in total complex carbohydrates	• Manufacturers are incorporating more wholegrain ingredients into ready meals to satisfy consumer demand for products high in NSP to help reduce the risk of bowel diseases. • Manufacturers are incorporating more fruit and vegetables into ready meals to satisfy consumer demand to increase fruit and vegetables intake.
Reduce sugar	• Sugar substitutes or artificial sweeteners are being used by manufacturers in ready meals in response to consumer demand for low-sugar/energy products, particularly for those consumers on weight reduction diet or concerned about dental decay.

Improve labelling	• Manufacturers are responding to consumer demands by incorporating nutritional information on ready meals – particularly useful for consumers on a weight-reduction diet. • Labelling schemes make it easier to meet the needs of the individual, for example, free from additives, low in energy, etc.

Cooking methods which promote the dietary targets

The choice of cooking method used can help to promote the dietary targets, especially if suitable foods are chosen. The following methods of cooking will help to promote the dietary targets.

Cooking method: baking

Explanation of cooking method
Baking is the cooking of food by dry heat in an oven, where the hot air circulates and cooks the food by direct heat.

Foods suitable for baking which would contribute to the dietary targets	**How the cookery process contributes to the dietary targets**
• Chicken (chicken wings) • Vegetables (potatoes, peppers, onions) • Fruit (apples, pears) • Flour products (breads) • Milk puddings (baked egg custard, rice pudding) • Ready-made meals – healthy option ranges	• Can be a healthier method of cooking, e.g. baked potatoes, where no additional fat is added or semi-skimmed milk is used for puddings • Fruit can be baked with dried fruit fillings, e.g. sultanas, which will increase fruit consumption • Some baked food, e.g. bread, looks, smells and tastes good, which can contribute to the dietary target for complex carbohydrates

Cooking method: grilling

Explanation of cooking method

Grilling is a fast method of cooking food using intense heat which can be radiated over the food.

Foods suitable for grilling which would contribute to the dietary targets	How the cookery process contributes to the dietary targets
• Fish (haddock, trout) • Meat/poultry (good-quality cuts must be used – steak, mixed grill, grilled chicken) • Vegetables (mushrooms, tomatoes) • Offal and bacon (kidney, gammon steaks) • Bread, rolls, etc.	• Little or no fat is used. Some foods may be lightly brushed with oil before cooking • Fat in food melts and drips out, is usually collected in the grill pan, and is not served with the food • A variety of foods can be used – fish, lean meat and poultry, which can help reduce fat in the diet • Lean or trimmed meat can be used, therefore less fat content • A variety of vegetables can be grilled, so increasing fruit and vegetable consumption • Bread will contribute to the total complex carbohydrate (TCC) target and could be served with a variety of toppings

Cooking method: microwave cooking

Explanation of cooking method

Microwave cooking causes water molecules in the food to vibrate due to the microwaves. This causes cooking through friction heat.

Foods suitable for microwaving which would contribute to the dietary targets	How the cookery process contributes to the dietary targets
• Meats and poultry are best if cooked in sauces • Vegetables (most types) • Fish (all types) • Fruit (baked or stewed fruit, e.g. apple)	• No additional fat is added during cooking • Fruit and vegetables contain water-soluble vitamin C and this is retained due to the small amount of water used and the rapid cooking time • A variety of fruit and vegetables can be microwaved, so increasing fruit and vegetable consumption • A variety of meats and poultry can be used – which can help reduce fat in the diet • As fish cooks quickly and easily in the microwave, this could contribute to the dietary target for fish

Cooking method: poaching

Explanation of cooking method
Poaching is the gentle cooking of food in the required amount of liquid, at just below boiling point.

Foods suitable for poaching which would contribute to the dietary targets	How the cookery process contributes to the dietary targets
• Eggs • Fish (smoked haddock, salmon) • Fruit (fresh pears, dried apricots) • Poultry (chicken)	• Minimum amount of liquid should be used to ensure minimum loss of vitamin C from fruit. The fruit could be served with a coulis (a fruit sauce), so encouraging fruit consumption • No fat is used in this method of cooking • Poultry is low in fat so fat intake could be reduced

Cooking method: pressure cooker

Explanation of cooking method
Pressure cooking is done in a special pan which cooks food under pressure. The water boils at a higher temperature as the pressure is increased. This forces steam through the food so that it cooks more quickly.

Foods suitable for pressure cooking which would contribute to the dietary targets	How the cookery process contributes to the dietary targets
• Lean meat and poultry cooked as stews or casseroles • Whole meat joints and poultry • Vegetables • Milk puddings	• A variety of meats and poultry can be used – which can help reduce fat in the diet • Vegetable consumption could increase if stews and soups were made more quickly using lots of vegetables • Semi-skimmed or skimmed milk could be used for puddings and could lower fat intake

Cooking method: steaming

Explanation of cooking method

Steaming is the cooking of food by steam from boiling water. The steam cooks the food either by heating it directly or by heating the container which holds the food.

Foods suitable for steaming which would contribute to the dietary targets	**How the cookery process contributes to the dietary targets**
• Fish (salmon, smoked haddock) • Meat (chicken, bacon) • Vegetables (almost all vegetables are suitable)	• No fat is added to meats, fish and vegetables • Fewer nutrients (e.g. vitamin C and B group) are lost, as food does not come in contact with water • No salt is required to cook vegetables, flavour is retained, so vegetable consumption could be encouraged

Cooking method: stir frying

Explanation of cooking method
Stir frying is the fast cooking of small pieces of food in a very small quantity of oil at a high temperature.

Foods suitable for stir frying which would contribute to the dietary targets	How the cookery process contributes to the dietary targets
• Fish (prawns, shrimps) • Meat • Poultry • Vegetables (almost all types)	• Less loss of soluble nutrients (Vitamin B complex and C) as food is cooked quickly. • Vegetables are crisp and well flavoured and so may encourage consumption • A variety of vegetables can be stir fried so increasing vegetable consumption • Very little oil is used making this method of cooking almost fat free. • Good-quality, trimmed and lean meats and poultry may be used which will contain very little fat • If noodles are added this will contribute to the target for total complex carbohydrates.

SECTION 10

Causes of food poisoning

Elaboration

- Bacterial food poisoning, spores, toxins
- Conditions for growth of bacteria:
  - Warmth, food, moisture, time, oxygen (aerobic and anaerobic), pH levels.
- Sources, symptoms and control measures for the following:
  - Food poisoning: salmonella, staphylococcus aureus, clostridium perfringens, bacillus cereus
  - Food-borne disease: campylobacter enteritis, listeria, e-coli 0157
- Viral food poisoning
- Chemical food poisoning
- Vegetable food poisoning
- Reasons for food poisoning

Food poisoning is an unpleasant illness which usually happens within 1 to 36 hours of eating contaminated or poisonous food. Symptoms, which include abdominal pain, diarrhoea, vomiting and nausea, can last from 1 to 7 days. Vulnerable groups of people include babies and very young children, the elderly or people with lower immune systems through illness.

Food poisoning can be caused by **bacteria** or their **spores** and **toxins**.

Bacterial food poisoning is the most common type of food poisoning and takes place when food is contaminated by **pathogenic bacteria.**

Spores

- Some bacteria are able to produce spores.
- Spores are bacteria in a resting state and they do not multiply.
- When the spores return to favourable conditions, the spore releases the bacterium which will then grow and multiply.
- Spores can be very resistant to heat. High temperatures of above 100°C for long periods of time are often needed to destroy spores.
- Spores can also resist a high concentration of chemicals.

Toxins

- Some pathogenic bacteria produce a toxin or poison in the food which is difficult to destroy by normal cooking processes.

Conditions required for the growth of bacteria

Warmth

- The best temperature for the growth of bacteria is 37°C, which is body temperature.
- The temperature range of 5°C–63°C is often referred to as 'the danger zone'. Foods should be kept below or above these temperatures whenever possible.
- Ensure that food is thoroughly cooked to core temperatures of 75°C or above.
- Reheat food to 82°C. Small numbers of bacteria may have survived the original cooking and continue to multiply. By increasing the temperature, these bacteria will be destroyed.
- At room temperatures of 20°C–50°C bacteria will multiply rapidly.
- Most bacteria will multiply very slowly in a refrigerator (1°C–4°C).
- No bacteria will multiply in frozen food (–18°C) but many will survive and reproduce on thawing.

Food

- Like all living cells bacteria need food to grow.
- Some foods are **high-risk foods** because:
  - bacteria grow easily on them – these foods are usually high in protein and moisture
  - they can be eaten without further cooking which would normally destroy the bacteria
  - they require refrigerated storage.
- *Examples of high-risk foods are:*
  - all cooked meats and poultry
  - cooked meat products, e.g. stew, gravies, sauces, stock and soups
  - shellfish and other sea food
  - milk cream, artificial cream, custards and dairy produce
  - cooked eggs and products made from egg, e.g. raw eggs in mayonnaise
  - cooked rice.
- Other food which do not normally support the growth of bacteria are known as **low-risk foods**.
- *Examples of low-risk foods are those which are high in:*
  - salt
  - sugar
  - acid.

- This is why food preservation methods such as salting, jam making, pickling or keeping food in syrup are successful.

Moisture

- Like all living cells, bacteria need moisture to grow.
- Bacteria prefer a high water content; many foods contain sufficient moisture for growth.
- Once dried, foods such as milk powder or dried egg have water or milk added; any bacteria present will start to multiply when the food is reconstituted.
- It is essential to use this food as soon as possible after adding the water.

Time

- Given the correct conditions of food, moisture and warmth, some bacteria can divide into 2 every 10 minutes. This process is called binary fission.
- A few bacteria, given sufficient time, can multiply quickly to produce enough to cause food poisoning.
- It is essential that high-risk foods are left in the danger zone (5°C–63°C) for as short a time as possible.

Oxygen (aerobes and anaerobes)

- Most bacteria require oxygen to grow. These are called aerobic bacteria.
- Some bacteria do not require oxygen to grow. These are called anaerobic bacteria.

pH levels

- Acidity is measured using the pH scale, which has 14 points.
- pH 7 is neutral, that is to say neither acid or alkaline.
- Most pathogenic bacteria cannot grow in an acid environment of pH 4.7 or less, for example in the pickling method of preservation.

Bacteria can cause food poisoning in two ways:

1. In the first type of food poisoning a large number of bacteria are usually involved, and this normally requires them to multiply within the food. Bacteria which cause **food poisoning** include:

    - salmonella
    - staphylococcus aureus
    - clostridium perfringens
    - bacillus cereus

2. In the second type of food poisoning, only small numbers of these bacteria are required to cause the illness and they do not need to multiply within the food. The bacteria responsible are usually found in the intestines of man or animals.

   Bacteria causing **food-borne diseases** include:

   - campylobacter (causing enteritis)
   - listeria
   - e-coli 0157

Bacteria which cause food poisoning through multiplication in food include the following.

Salmonella

- This bacteria can grow aerobically or anaerobically (with O_2 or without O_2).
- Best temperature for growth is 37°C.
- Readily killed by heat.
- This type of food poisoning can be quite severe in the elderly, very young or in sick people, and can be fatal.

Sources	Control measures
• Foods of animal origin such as meat, poultry, milk and eggs • Meat products • Rats, mice, domestic pets or birds may carry the bacteria in their intestines, on their fur, feathers and feet • Food handlers may carry this bacteria in their intestines, and so could contaminate the food if they have not washed their hands properly after visiting the toilet	**Personal hygiene** Wash hands thoroughly before and after handling food, especially raw meat, poultry and eggs **Kitchen hygiene** Use different surfaces and equipment for preparing raw and cooked food, to prevent cross-contamination Clean all surfaces, equipment and tools thoroughly before and after use, to prevent cross-contamination **Correct storage of foods** Foods should be stored under refrigeration, with cooked and uncooked foods stored separately **Thawing food** Thaw frozen meat and poultry thoroughly before cooking, preferably thawing in the refrigerator **Cooking thoroughly** Cook food thoroughly so that the temperature at the centre of the food is high enough to kill bacteria
Symptoms Fever, headache, abdominal pain, diarrhoea and vomiting. Symptoms may last from 1 to 7 days.	

Staphylococcus aureus

- Multiplies in food stored between 10°C and 40°C, producing a toxin. When food is swallowed this toxin irritates the stomach lining and causes vomiting.
- Does not multiply below 5°C.
- This bacteria is killed by heat (1–2 minutes in boiling water) but the toxin it produces is more resistant to heat and can withstand up to 30 minutes in boiling water.
- Therefore, lightly cooked food will contain no living bacteria but may contain active toxin, which will cause food poisoning.

Sources	Control measures
• Humans in the warm, damp conditions of the nose, throat, pores and hair follicles of the skin • In boils, styes, septic cuts and can be transferred to food via the hands • Food which can be contaminated after cooking when eaten cold or only mildly reheated such as sliced cold meat, cooked poultry, cream dishes, custards, stuffed rolled joints of meat not cooked in the centre • Can grow in a higher salt concentration than other food-poisoning bacteria and so could be found in ham	**Personal hygiene** Wash hands thoroughly before and after handling food No coughing or sneezing over food Cover cuts and sores with a waterproof dressing Handle food as little as possible and use tongs for lifting **Kitchen hygiene** A high standard of kitchen hygiene should be implemented, e.g. chopping boards, cutting and mincing machines and cloths must be cleaned thoroughly after use **Correct storage of foods** Store high-risk food in a refrigerator below 5°C
Symptoms Vomiting, abdominal pain, diarrhoea, exhaustion and sub-normal temperatures. Symptoms last no more than 24 hours.	

Clostridium perfringens

- This is an anaerobic bacteria which grows best in the absence of oxygen.
- Best temperature for growth is between 43°C and 47°C.
- Spores of this bacteria will pass out with the faeces of animals and humans and into the soil and sewage systems. Water and vegetation carry the infection back into the animal kingdom and so into food-production systems.
- Can survive cooking by forming spores.
- Reheating should be carefully done because of the spores which may be formed.
- The anaerobic nature of this bacteria allows it to multiply in the internal cavities of meat and poultry where oxygen has been driven by the heat of cooking, so care must be taken when cooking food in bulk.

Sources	**Control measures**
• Present in animal and human intestines, and so will be present in animal and human excreta • Soil and vegetables covered in soil or dust • Raw meat and poultry • Flies, cockroaches and bluebottles	**Personal hygiene** Wash hands thoroughly after handling raw meat and unwashed vegetables Wash hands thoroughly after visiting the toilet **Kitchen hygiene** Use different surfaces, boards and equipment for raw and cooked foods Remove soil regularly from vegetable stores and preparation areas Scrub vegetables before peeling **Correct storage of food** Separate raw and high-risk foods. Cooling cooked foods quickly and refrigerating immediately – large volumes of meat should be divided into smaller portions to cool more quickly **Reheating thoroughly** Reheating quickly and thoroughly and serving immediately Never reheat meat products more than once
Symptoms Abdominal pains and diarrhoea. Rarely vomiting. Symptoms last 1–2 days.	

Bacillus cereus

- This is an aerobic bacteria which grows best with oxygen.
- Best temperatures for growth is between 35°C–38°C.
- Forms spores when conditions are unfavourable for growth
- Spores will survive most cooking processes.
- If food is left in a warm place or not cooked quickly then spores germinate, producing vegetative bacteria which in turn multiply and produce a very heat-resistant toxin.
- If food is then reheated quickly or insufficiently the heat is unlikely to destroy the toxin. When the food is eaten, the toxin irritates the stomach lining and causes vomiting.

Sources	Control measures
• Soil and dust • Spices • Vegetables • Dairy products • Eggs • Cereals, particularly rice and cornflour • Cornflour sauces • Milk puddings • Cooked rice dishes	**Kitchen hygiene** High standards of kitchen hygiene must be maintained, e.g. clean surfaces and equipment Check cereal dust is removed from storage and preparation areas to avoid contamination **Soil and dust** Ensure vegetables are washed before using Ensure soil from vegetables left lying around in storage areas does not contaminate surfaces **Pre-cooked rice** Avoid preparing rice in advance because if the rice is left in a warm kitchen, bacteria can multiply. Reheating during flash-frying as in fried rice must be thorough or else bacteria will not be destroyed. Cool rice immediately after cooking, then refrigerate. Cook smaller amounts of rice to avoid the need to store it. Avoid reheating rice, but if necessary reheat thoroughly and serve at once. Throw out cooked rice after 24 hours.

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Symptoms
There are two types of illness.

Vomiting type
This begins 1–6 hours after eating contaminated food and does not last more than 24 hours. It is thought that an enzyme in saliva starts the digestion of starch in the mouth and so releases the toxins which are vomited out before reaching the intestines.

Diarrhoea type
This begins 8–16 hours after eating contaminated food. Symptoms include diarrhoea, abdominal pain but rarely vomiting. This type is less common and lasts less than 24 hours.

Bacteria causing food-borne disease

Campylobacter enteritis

- This bacteria grows under partial anaerobic conditions.
- Best temperature for growth is 43°C.

Sources	Control measures
• Farm animals such as cows, sheep and chickens • Domestic animals such as cats and dogs • Infection can be spread from animal to person and from person to person. • Undercooked chicken • Raw, unpasteurised milk • Untreated natural water • Cross-contamination from raw to cooked foods, e.g. meat and poultry	**Personal hygiene** Wash hands thoroughly before and after handling food, especially raw meat and poultry **Kitchen hygiene** Clean all surfaces, equipment and tools thoroughly before and after use to prevent cross-contamination Do not allow domestic pets into areas where food is prepared **Correct storage of food** High-risk foods should be stored in a refrigerator at temperatures below 5°C as bacteria then find it difficult to multiply **Cooking thoroughly** All chicken must be cooked thoroughly as campylobacter is destroyed by heat **Separation of raw and cooked foods** Display, store, prepare raw and cooked foods separately to prevent contamination between raw and cooked foods, e.g. meat and poultry
Symptoms Headaches, dizziness, backache, abdominal pain, diarrhoea. The illness can last 2 to 3 days.	

Listeria

- Vacuum-packing and modified atmosphere packing, in which the level of oxygen is decreased and the level of carbon dioxide is increased, help to prevent the growth of listeria.
- Strict temperature control must be enforced during the distribution and storage of ready-to-eat products.
- At-risk groups should avoid high-risk foods. Pregnant women should avoid patés and soft cheese as they may contain listeria which can damage the foetus, cause a miscarriage, still birth or illness in the new-born baby. Elderly people and those with reduced immunity due to illness are also at-risk groups.

Sources	Control measures
• Soft ripened cheeses such as brie and camembert • Paté, salami and continental sausages • Cook-chill meals • Raw and cooked meats, ready-to-eat chicken • Fish and sea food • Coleslaw and pre-packed salads	**Personal hygiene** Listeria is found in human excreta and soil. Therefore, food handlers should follow strict personal hygiene rules when handling and preparing high-risk foods **Correct storage of food** Refrigerate below 3°C. Although listeria can still multiply at this temperature or lower, the growth should be slower. Listeria may even grow very slowly at 0°C. Observe use-by dates. Bacteria need time to multiply, therefore high-risk foods should be thrown out after the use-by date **Wash salads, fruit and vegetables** Listeria is found in soil, therefore traces may occur in plant foods. If these foods are eaten raw listeria will still be present **Cooking thoroughly** Cook above the core temperature of 75°C for at least 2 minutes. Most listeria will be destroyed at this temperature. Ensure that food cooked in the microwave is not unevenly

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	heated as listeria could survive in cooler parts of the food. **Reheating thoroughly** Reheat to 82°C. Small numbers of bacteria may have survived the original cooking and continue to multiply. By increasing the temperature, these bacteria will be destroyed
Symptoms Infection with listeria causes **listeriosis**. Bacteria get into the bloodstream and multiply. In mild cases the person will feel shivery and feverish. In high-risk groups listeria can cause meningitis, severe aches and pains, fever, confusion, septicaemia and pneumonia. Pregnant women may suffer a flu-like illness or no symptoms at all, but listeria can damage the foetus, cause a miscarriage, still birth or illness in the new-born baby.	

E-coli 0157

- This bacteria grows aerobically and anaerobically.
- Best temperature for growth is 37°C but it is readily killed at temperatures above 55°C.

Sources	Control measures
• Raw foods of animal origin, e.g. meat and poultry. • This bacteria can then be passed to cooked food by cross-contamination from hands, surfaces and equipment • Mincing meat can spread bacteria throughout the meat • Undercooked meats, especially hamburgers • Incorrectly pasteurised milk and milk products • Water in foreign countries	**Personal hygiene** Wash hands thoroughly before and after handling food, especially raw meat and poultry **Kitchen hygiene** Clean all surfaces, equipment and tools thoroughly before and after use to eliminate all bacteria present **Good food-hygiene practices** Any business dealing with food should rigorously apply the HACCP system **Correct storage of food** Meat should be stored in a refrigerator at temperatures below 5°C so that bacteria find it difficult to multiply **Separation of raw and cooked foods** Display, store, prepare raw and cooked meats and foods separately to prevent contamination between raw and cooked foods **Cooking thoroughly** All meat and meat products must be cooked thoroughly as e-coli is destroyed by heat Use a metal temperature probe to ensure joints are cooked thoroughly **Serve food very hot** Above 82°C most bacteria die, so if food is served at that temperature the bacteria will not have time to multiply

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Symptoms

Illness can last 1 to 5 days or can be life threatening. Abdominal pain, fever and diarrhoea, and sometimes vomiting may be present. In babies, acute diarrhoea and dehydration can be fatal. E-coli 0157 can cause life-threatening kidney failure and particularly in children can lead to temporary or permanent kidney damage and anaemia. Toxins can be released that destroy gut and kidney cells, which can be fatal.

Other causes of food poisoning

In addition to bacteria, food poisoning can also be caused by:

- ***Viruses***. Viral food poisoning takes place when viruses are transmitted by water or food. Viruses require living tissue for growth, and therefore do not multiply in food.

- ***Chemicals***. Chemical food poisoning takes place when food is contaminated by chemicals during growth, storage, preparation or cooking, e.g. pesticides or cleaning chemicals may be the cause of the problem. Food should never be stored near poisonous chemicals, and chemicals should not be stored in empty food or drink containers such as a lemonade bottle.

- ***Vegetables***. Vegetable poisoning may be caused by the natural toxins found in some vegetable foods that are poisonous to humans such as deadly nightshade, death cap (which can be mistaken for mushrooms) and toadstools. Red kidney beans which are eaten raw or undercooked, occasionally result in food poisoning. The temperatures of the canning process will destroy the toxin.

Reasons for the increase in food poisoning

Farming/food production

- Intensive methods of food production where large numbers of animals (e.g. battery hens) are in a small space increases the risk of contamination and cross-contamination when infection occurs.
- The increasing length of the food-production chain increases the hazards as more people and processes are involved in treating, transporting or storing food.

Eating outside the home

- More people buy food ready to eat, or eat out more, and so there are more people handling food which therefore increases the risk of food poisoning.
- Less food is prepared and cooked at home; this too results in more people handling food, which could result in an increased risk of food poisoning.
- Infected food handlers or those with poor hygiene habits increase the hazard as bacteria have a much greater chance to multiply.

Shopping for food

- Food which is not kept cold and is purchased at outdoor markets could become contaminated with bacteria, which could lead to food poisoning.
- Chilled or frozen food, which has been purchased but has not been stored or transported home in a cool box, can cause food poisoning. If the food has remained in a car boot for some length of time on a hot day then bacteria will multiply in the warmth.

Rising standard of living means more money available

- This allows the purchase of more meat and dairy products, which are the main carriers of bacteria.

Preparing food in the home

- The greater number of meals which are served for celebrations and anniversaries increases the hazards, as preparation is sometimes done too far in advance and the food may not be stored at the correct temperature.
- Inadequate cooling in a warm kitchen, especially during summer, increases the hazards, as food is not cooled rapidly and bacteria have a much greater chance to multiply.
- Inadequate cooking, micro-waving or reheating increases the hazard as the centre of the food does not reach the core temperatures of 75°C, or 82°C if reheated. The temperature is not high enough to destroy bacteria.
- The popularity of barbecued food increases the hazards if it is burnt on the outside due to the high temperature, but high-risk food such as poultry and sausages do not reach the core temperature in the centre. Thus pathogenic bacteria are not killed.
- Inadequate thawing of poultry increases the hazards as the centre of the food does not reach the core temperature, therefore, pathogenic bacteria are not killed.
- Cross-contamination of raw food to cooked food so that the bacteria are present on the cooked food, leads to food poisoning.
- Raw food contaminating equipment or not being properly cleaned leads to food poisoning.
- Raw food contaminated with bacteria coming into the home and not being cooked properly in the home to destroy bacteria, can lead to food poisoning.
- Damaged utensils, for example cracks in cups, can harbour bacteria which could lead to food poisoning.
- Uncovered food contaminated by animals or flies. The contaminated food is then consumed and could lead to food poisoning.

- Infected food handlers or those with poor hygiene habits increase the hazard by giving the bacteria a much greater chance to multiply.

Increased public awareness

- The general public is more aware of the problem due to media interest and, therefore, more seek medical assistance and more cases are reported.
- Better statistical evidence being kept means there is greater evidence of cases of food poisoning.

SECTION 11

Causes of contamination and cross-contamination

Elaboration
Definition, causes and preventative measures in terms of:
- Physical contamination
- Personal hygiene
- Kitchen hygiene
- Preparation of food
- Correct temperature for heating and re-heating of food
- Storage of food

Main causes of cross-contamination

- Physical contamination by foreign bodies.
- Poor standards of personal hygiene by food handlers.
- Poor standards of kitchen hygiene.
- Poor temperature control when cooking and reheating food.
- Poor storage of foods, especially high-risk foods.

Cross-contamination results when bacteria from contaminated foods (usually raw) are transferred to other foods. This may be:

- By direct contact, for example if raw and cooked foods are stored next to each other and touch.
- By drip, e.g. blood or juices, if raw food is stored above cooked foods.
- By food handlers who may transfer bacteria from raw to cooked foods as they may not have washed their hands thoroughly after handling the raw food.
- By equipment, such as knives, or by work surfaces which may not have been thoroughly washed after being used for contaminated or raw foods.

Prevention of cross-contamination

Physical contamination by foreign bodies

Foreign bodies found in food may be brought into food premises in the following ways:

- With the raw materials
- During storage, preparation, service or display.

Contamination of food by foreign bodies will cause customer dissatisfaction, and could result in bad publicity for the food business which, in turn, could affect its sales and profit.

Sources of foreign bodies found in food include:

1. Raw ingredients containing stones, glass, metal, bones in chicken meat, vegetable stalks, cigarette ends, dirt.
2. Buildings/equipment such as wood, flaking paint, screws, grease.
3. Packaging materials such as cardboard, paper, string, staples.
4. Pests such as rodent droppings, caterpillars, flies.
5. Food handlers may leave jewellery, fingernails, sticking plasters, hair or buttons in the food, particularly during production.

Physical contamination may make food unsafe or unfit to eat, and indicates a breakdown in hygiene procedures. Some foreign bodies, such as glass and stones, may be very dangerous and could result in cut mouths or choking.

Poor standards of personal hygiene by food handlers

All food handlers have a moral and legal responsibility under the Food Safety Act of 1990 to observe high standards of personal cleanliness to ensure they do not contaminate food. Food handlers must have received hygiene training and be appropriately supervised.

Preventative measures

Hands and skin

- Hands must be kept clean at all times as they are in direct contact with food, and so are the main route of transferring bacteria.
- Food handlers should follow a thorough hand-washing procedure and dry hands on disposable paper towels especially

- after visiting the toilet
- on entering the food room and before handling any food or equipment
- in between handling raw and cooked foods
- after touching the hair
- after eating coughing or blowing the nose
- after handling waste food, refuse or cleaning chemicals.

Nose, mouth and ears

- People with bad colds should not handle food as droplet infection from coughs and sneezes can land on food.
- Paper tissues should be used only once and disposed of – hands should then be washed.
- Food must be tasted hygienically with a clean spoon – tasting with the fingers and eating in the food preparation area is not allowed.

Cuts, boils, septic spots and skin infections

- All of these should be covered by blue waterproof dressings to prevent bacteria from being transferred to food.

Jewellery and perfume

- Jewellery should not be worn by food handlers as it may trap dirt and bacteria.
- Stones may also fall out of jewellery and end up in the food being prepared.
- Strong-smelling perfume should not be worn by food handlers as the smell may be transferred to the food.

Hair

- Hair should be completely enclosed so that loose hair and dandruff do not contaminate the food.
- Hair must not be combed where food is being prepared as it may end up in the food.

Smoking

- Smoking is not allowed whilst handling food because:
  - cigarette ends and ash may contaminate the food
  - handlers may touch their lips whilst smoking and then transfer harmful bacteria to food
  - smoking encourages coughing which produces droplets of infection
  - cigarettes ends, placed on worktops, will be contaminated with saliva which is then passed to foodstuffs.

Protective clothing

- Protective clothing should be clean and washable, and it should completely cover the food handler's ordinary clothes.
- Protective clothing should not be worn outside the food-preparation area or whilst travelling to work. Dust, pet hairs or bacteria can be picked up which could then be transferred to food.

General health and reporting of illness

- Food handlers suffering from diarrhoea, vomiting or a food-borne illness should not handle food as it could become contaminated. The supervisor must exclude them from work.
- Food handlers with skin infections, sores, heavy colds, eye or ear discharge should also be excluded until medical approval to work has been obtained.

Poor standards of kitchen hygiene

A high standard of hygiene must be maintained to prevent food becoming contaminated.

Preventative measures

- All equipment, fixtures and fittings must be clean before food preparation begins.
- Separate equipment, working surfaces and working areas should be used for raw and high-risk foods.
- Kitchen cloths should preferably be disposable or should be bleached, disinfected or changed frequently.
- Spillages must be wiped up immediately.
- Waste should be placed in covered bins which should be well away from food-preparation areas.
- Pets should not be allowed in food-preparation areas.

Poor temperature control when cooking and reheating food

Thorough cooking is important to destroy harmful bacteria.

Preventative measures

- Frozen poultry and large joints of meat must be completely defrosted before cooking.
- A minimum centre temperature of 75°C within food should be reached and checked with a food probe thermometer.
- After cooking, the food should be served and eaten as soon as possible so that bacteria have not had the time to multiply as the temperature of the food drops.

- If food is to be kept hot before serving, then a 'holding temperature' of above 63°C must be maintained.
- Food should only be reheated once.
- Food being reheated must be heated to at least 82°C and eaten at once.
- In a microwave food should be heated throughout to a temperature of 75°C – the food should be checked in several different places using a food probe thermometer to ensure there are no 'cold spots' remaining.

Poor storage of foods especially high risk foods

Raw food should always be kept separate from high-risk food at all stages of storage and preparation to avoid cross-contamination.

Preventative measures

- High-risk and perishable foods must be kept in the refrigerator, which should be at a temperature of 1–4°C. The temperature of the refrigerator should be checked using a thermometer several times a day.
- Ideally, there should be a separate refrigerator for raw food. If the same refrigerator is used then raw food should be stored below cooked foods at the bottom of the refrigerator.
- The liquid from defrosting poultry and meats must not come in contact with other foods as this will result in cross-contamination.
- Refrigerators should not be overloaded as this does not allow the cold temperatures to circulate.
- Hot foods should not be placed directly into the refrigerator as this will raise the temperature in the refrigerator and so encourage bacteria to multiply.
- Food should be covered to prevent drying out, cross-contamination or absorption of other odours.
- Refrigerators should be cleaned weekly and spillages wiped up immediately.
- Out-of-date food, or food in damaged cans or packaging, should not be used.
- Dried and canned foods should be stored in dry, cool, clean conditions and should be rotated to prevent spoilage.

SECTION 12

Product development strategy

Elaboration
- Concept generation
- Concept screening
- Prototype production
- Product testing
- Information and advertising materials designed for packaging
- First production run
- Marketing plan
- Launch
- Investigation of existing products by disassembly

This section discusses the task of identifying needs and developing concepts for products.

Manufacturers continually develop and update their products. There has been a large increase in the variety of food products available to the consumer. This increase has occurred due to a number of changes that have taken place in society:

- Changes in consumers' lifestyles and needs, such as healthy eating ranges, ethnic foods, children's products, snacking.
- Technological developments in food production.
- Changes in type of retail food outlets.
- The changing buying power of the consumer.

When a food manufacturer decides to produce a new product, it is a very costly process to research, develop and market. A product development strategy may be based on the following steps:

Step 1: concept generation

- This stage is important as it involves developing ideas for new products.
- Thinking stage – thinking up new ideas, perhaps even looking for a gap in the market.

- Development of ideas from market analysis, perhaps even trialling of popular existing products, looking at, for example, why a certain flavour is popular, looking for something similar yet new and different.
- Manufacturers do not want to replicate existing products in the market.
- Developers will consider cost, portion size, methods of reheating and cooking, flavour, texture and appearance.
- Without this stage the development process cannot take place.

Step 2: concept screening

- Consider all ideas, keep some and discard others.
- This stage is important, as it allows the production process to move away from initial ideas to actual development issues.
- Allows the manufacturer to develop a specification against which to develop ideas.
- Specification allows manufacturer to eliminate ideas that might be costly, difficult to process/not meet other constraints.
- The best ideas are taken forward and a specification is written
- Allow product ideas to be generated so that a prototype can be developed.

Step 3: prototype production

- A prototype is an example or specimen of what the product will be like.
- The prototype is developed and measured against the specification.
- The prototype is tested for appeal and may be further modified or rejected.

Step 4: product testing

- This is an important stage as it allows the products to be tested on consumers, so opinion can be obtained, e.g. trial by workforces, social groups, various ages, tasting panels, etc.
- Allows the product to be further refined or eliminated as a result of consumer opinions.
- Allows the range of possible solutions to be further refined – the most suitable and popular product will be kept.

Step 5: information and advertising materials designed for packaging

- This stage allows the legal and advertising teams to begin to develop the important work in relation to selling the product.
- Allows the advertising team to cost the advertising programme and packaging which will affect the selling price of product.
- Legal labels will be designed and produced.
- The type of packaging will be investigated and tested.

Step 6: first production run

- Allows for the production of an actual item for the first time as a full production run so the item can be assessed.
- Allows the quality-assurance team to test the product to ensure quality and uniformity of standards during the manufacturing process.
- This is an important stage in the development of the product as it affects many of the other stages – e.g. if ingredients are changed then the labelling would require to be changed.

Step 7: marketing plan

- Allows for the development of a range of activities to promote the product, e.g. where the product will be sold – supermarket, corner shop, position in the shop, promotion of product within the shop, e.g. through offers or free recipes, etc.
- This is an important stage as the initial price of the product can be determined by the potential marketing mix, e.g. low cost to attract interest (e.g. shop's own brand), medium/high cost to denote quality (e.g. luxury ranges).
- Packaging can be finalised to take into account marketing plans.

Step 8: launch

- This is an important stage of the plan as the item is now on sale.
- Piloting of the product could be carried out to monitor the sales in a small area initially. From experience gained here the manufacturer can adjust the marketing approach before using it more widely. (Piloting to gauge success of product.)
- Market monitoring: finally the product is launched into the national marketplace. Sales figures will be checked very carefully initially and again the key role of market research will provide regular feedback so

that the manufacturer can continually rethink and readapt the marketing approach as quickly, economically and effectively as possible.
- Market research will provide regular feedback. This allows the product to continue to be refined and improved.

Marketing of a new product is an important step in the product development strategy and there are four main factors to consider.

Factors which should be considered when marketing a product

Factor	Importance to the final success of the product
1. Product and how it will be packaged	• Packaging will be designed, labelled and costed to suit the product developed and to encourage sales • Type of packaging must be suitable for the product and ensure that it will be protected from damage, contamination (linked to food safety) and tampering • Packaging will be designed to appeal to the target group (visual image/recyclable/easy to open or use) to encourage purchase • Packaging will be designed to suit the portion size, may be available in various sizes/multi-packs to suit consumers' needs • Legal labelling designed to meet requirements of the law (e.g. Food Safety Act 1990)
2. Price	• Initial price of product will be decided by the potential market or target group • Product could be marketed initially at a low cost (introductory price) to attract interest and the price increased at a later date • Product could be marketed at mid/high cost to denote quality in order to attract a particular target group
3. Place to be sold	• It will have to be decided where to sell the product, e.g. supermarket or corner shop, etc. to a ensure high profile during launch • Product may be sold in particular branches of a supermarket to see how well it sells and who it appeals to, before launching it throughout stores nationwide • Shops have to decide where the product will be situated to attract most attention/customers, which aisle/shelf, checkout (point of sale)
4. Promotion of the product	It is important to promote the product to ensure maximum sales. This could include the following methods of promotion • **Demonstrations and taste sessions** to allow customers to taste before buying, and so encourage sales • **Free recipe leaflets** may be given with the product to give further ideas for use. Leaflet would have to be colourful

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- **Special offers and money-off coupons** might be given to customers to encourage people to try the product. This is good for consumers on a budget, as people feel they are getting a bargain
- **Free toys**. This will encourage families with small children to purchase products, for example, fast foods. Collectible toys would attract children who might then pester their parents to continue purchasing the product. Toys might not be of good quality, could be easily broken and could cause arguments between the children in the family. Free toys should always be certified as safe before being issued to children
- **Television adverts.** This is an effective method as a large number of people watch television. Adverts are timed during the day to suit certain target groups, for example children's television on a Saturday morning for this target market. Adverts with a jingle or which feature a famous personality appeal to the public
- **On-pack coupons** may be on initial packs to encourage a second pack to be bought
- **Adverts, coupons, recipe ideas** may be offered in **supermarkets' own magazines** to promote the product
- **Charity sponsorship**, e.g. cancer appeals – an amount of the profit will go to charity
- **Point-of-sale display**. Customers often have to queue at point-of-sale checkouts so may be tempted by attractive displays
- **Posters** if colourful have a huge visual impact, e.g. if a celebrity is used and the poster attracts attention then this technique can be effective. However, if the poster is unimaginative or displayed in an area where it will have little visual impact it will not be effective
- **Leaflets or fact sheets** will only be effective if they are attractively presented and do not contain too much text
- **Interactive website**. An interactive website would be available only to those consumers

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	who have access to a computer, and therefore may not be so effective. Up-to-date information will be given which allows the consumer to make an informed choice. Special discounts and offers may be promoted which encourage consumers to purchase Due to the costs involved in developing a website, this is an expensive way for consumers to market their food products.

Disassembly of products

Disassembly of existing products may be used to stimulate ideas for design. Disassembling may also be used to investigate ingredients in existing products.

To disassemble means to take something apart. A food product can be disassembled to find out more information about it, e.g. how it was designed and the function of the ingredients.

By carefully taking a product apart and weighing each separate ingredient, more information will be gained about the composition and proportions of a food product. This will give an idea of why the product is successful or how it could be improved.

Who uses disassembly?

A manufacturer may disassemble products:

- To get ideas for the design of a new range of food products, i.e. examine the label and packaging to help develop a new style of packaging and discover the most effective way of informing the consumer.
- To assess an existing product, food manufacturers constantly review their own products. Their food technologists may disassemble products if there has been a drop in sales or if they wish to produce a 'new and improved' version.
- To produce a specification for the new product.
- To discover the functions of ingredients in existing food products, such as the weight of different sections, e.g. breads, spreads and fillings in a sandwich.
- To understand how foods react when mixed with other ingredients.
- To correct faults that might occur at any point in the manufacturing process.

- To ensure products are of the correct quality – so that the food product remains at its best during storage, until purchase and until consumption.
- To ensure consumers will be satisfied with the newly developed food product and will continue to buy it.
- To get ideas from competitors' products and obtain some idea of the competition. The results are analysed and evaluated before the company launches its own product. Disassembly allows the manufacturer to investigate how the proportion and variety of ingredients will affect the cost and nutritional value of the product.

Trading standards officers may disassemble products:

- To check that manufacturers are meeting legal requirements and packaging claims.

Stages involved in disassembly

1. Before disassembling, a chart or proforma should be designed on which to record results. This should list the procedures that will be carried out and the questions that have to be answered. Using a proforma ensures that the same method of analysis is used for each sample and like can be compared with like in the evaluation. The proforma will vary depending on what has to be found out but may include the following points:

    - evaluation of how well the product meets the original specification
    - the sensory characteristics of the product, e.g. taste, texture, appearance, aroma
    - choice and suitability of ingredients
    - proportions of ingredients
    - preparation and cooking process
    - quality of product
    - storage and shelf-life
    - value for money.

2. Disassemble the product. Start with the information on the label and package.

3. Take the food product apart. Weigh and measure the different parts of the product. For example, if a sandwich is disassembled the bread, spread and fillings each have to be weighed separately.

4. Compare the results of all the products being disassembled.

SECTION 13

Market research

Elaboration
- Reasons why manufacturers use market research
- Benefits of market research to manufacturers and retailers
- Types of market research
  - Direct and indirect
  - Qualitative and quantitative

Market research may be carried out by a manufacturer

- Before the development of a new product.
- Throughout the development of a new product.
- After the launch of a new product.
- For existing product evaluation – for example, if the product has been available for some time and sales have dropped.

Manufacturers use market research to find out:

- *What consumers want to buy or to gain consumers' opinions* – if there is need for a certain product and will it be marketable and sell, e.g.
  - whether it is cheap, attractive, convenient
  - snack-type foods
  - for a special group, e.g. consumers on a weight-reduction diet.
- *If there is a gap in the market* – this helps find out if there is a real need for a product or service.
- *About the competition* from other manufacturers.
- *The market trends* – which foods are popular at a particular time.

Market research for product evaluation will look at aspects of the product. The public may be asked to judge or comment on sensory properties:

- *Appearance* – how the food looks (does it look fresh, healthy, appetising?) and its colour; for instance blue custard might be rejected because it is not what we expect; combinations of colours are more attractive than an all-white meal, and garnishes can help here

- *Texture/consistency* – how the food tastes in the mouth, e.g. crunchy, smooth, rough, dry.
- *Smell* – this matters because if something smells burnt or bad, then people will not want to eat it.
- *Taste/flavour* – detected by the taste buds in the mouth, i.e. fruit, sharp, sweet, sour, saltiness, bitterness; the flavour of food is a combination of taste and smell.

Other aspects of product evaluation may be concerned with gaining public opinion on:

- *Acceptability of price* – i.e. will the consumer pay a certain price for the product? (We all like value for money.)
- *Packaging* – what shape and size of packaging will the consumer prefer for the product?
- *Method of cooking or reheating* the product – microwave, oven, grill, etc. (Container/packaging may have to suit all of these.)

The benefits of market research to manufacturers and retailers are:

- It helps food businesses plan how they will promote and advertise a product.
- Market research will help the food industry find out if a new product is a good idea before they spend too much money on product development.
- Market research should ensure that the development of the product is profitable. Manufacturers should not make a loss and retailers should have a good turnover of goods.
- Manufacturers will keep track of market trends, i.e. what the consumer wants, what meets their needs and how much they are willing to spend. Manufacturers will then be able to provide a product that will sell well and give them good profit margins.
- Competition from other manufacturers will be identified.

There are different types of market research:

- **Direct and indirect**
  - *direct research* from the public using the telephone, personal and group interviews, tasting and testing sessions, questionnaires.
  - *indirect research* where existing information is used, including reports such as *Social Trends* (HMSO publication), computer databases, CD-ROMs, collecting sales information.

- **Qualitative and quantitative**
  - *quantitative* – surveying large numbers of people by questionnaires and interviews.
  - *qualitative* – asking small groups of people for their opinions on products. In this context, a group is usually made up of ten people or less who are then asked about their likes and dislikes for certain products and how to make that product more appealing.

SECTION 14

Sensory testing

Elaboration

- Reasons for manufacturers carrying out sensory testing
- Sensory tests
- Preference tests
- Rating/ranking test
  Discrimination tests:
  - Paired comparison test
  - Duo–trio test
  - Triangle test
  - Taste threshold test
  - Profiling test or star diagrams
- Conducting sensory tests to determine the effects of range and proportion of ingredients on appearance, texture, flavour, aroma, overall acceptability, quality and preference

Tasting is essential to judge the success of a food product. Sensory evaluation involves using one or more tests to assess different characteristics of food such as appearance, texture, flavour, aroma, as manufacturers want to determine the effects of different ingredients or the proportion of ingredients on their products.

The overall acceptability of a product is extremely important to food manufacturers. They rely on tasting panels to judge the quality of their product through identifying their preference about a product during sensory testing.

Food manufacturers train people to work on tasting panels and they are able to detect minor differences between products and then record their opinions. All tasting is carried out under controlled conditions, but the same conditions could be easily applied to the classroom.

Reasons for manufacturers carrying out sensory testing

A very important part of food product development is sensory analysis and testing. Manufacturers rely on the sensory testing of food for a number of reasons:

- *To decide about its acceptability to consumers* when developing a new product.
- *To compare a product against that of a competitor*, to establish whether or not the sensory qualities affect sales figures; and the effect of other factors, such as image, advertising or packaging.
- *To assess the shelf-life* by testing the product at various lengths of time after production to see how the eating quality is affected.
- *To carry out quality control*, so ensuring a consistent standard across different batches of the product and to compare against the original specification.
- *To monitor prototypes*, checking that the specifications or improvements have been met.
- *To find out if changes to existing products*, e.g. reducing salt content in line with current dietary advice, *are noticeably affecting the eating quality*.
- *To investigate why one product is more popular* than another.
- *To reduce cost, to try to change the price* of the product without affecting the taste.

Procedures which should be followed when carrying out sensory testing to ensure valid results

Controlled condition		Reason
• Always check that everyone is able to taste the product	→	Some people may have allergies or special dietary needs, e.g. diabetics or vegetarians, that may prevent them from tasting
• Always practise good hygiene when tasting. Everyone uses clean spoons and separate dishes	→	This prevents infection being spread from person to person
• Do not allow people who are unwell (colds, upset stomachs) to taste	→	They could spread their infection to others or their illness could alter the true flavour of the food for them
• Serve all food samples in the same way (same size portions, similar plates, same temperature)	→	This ensures the food is **fairly** compared
• Label the foods with random letters or numbers	→	So people cannot identify the samples
• Only allow tasters to test up to six samples at a time	→	The taste buds will become less effective after more than this
• Have water available to sip between tastings, or a dry biscuit	→	This will help clear the palate and make tastings more effective on a number of samples
• Complete the tasting charts after each person tastes the food	→	If this is not done, the taster may forget his/her opinion.
• Use separate booths for each taster	→	To ensure no influence from other tasters

Sensory tests

Different tests are used in sensory evaluation and analysis to obtain different kinds of information. There is a set of standard tests which can be used by industry.

Preference tests

These supply information about peoples' likes and dislikes for a food product. They are not intended to evaluate specific characteristics such as crunchiness or smoothness. They are subjective tests about preference.
For example:

Ranking

- In ranking tests, the tasters are asked to rank in order of preference a range of similar food products.
- Tasters rank samples in order for a specific characteristic. An example is given below.

Ranking test

Please taste the samples and rank them in the order you like best.
1 = the one you like best, 5 = the one you like least

Products	Order	Any comments
A		
B		
C		
D		
E		

Rating

- Products are scored on a 5- or 9-point scale according to the degree of liking of a product's palatability appeal.
- Samples can be scored to evaluate specific characteristics, e.g. colour, flavour, aroma, overall acceptability and quality
- Comments should also be recorded.

An example is given below.

Rating test

In this test, foods may be given a score of 1 to 5 as follows:

1. Dislike a lot
2. Dislike a little
3. Neither like nor dislike
4. Like a little
5. Like a lot

Samplers complete a chart similar to the one below and circle the number which describes the product.

Rating test	Product A	Product B	Product C
1. Dislike a lot	1	1	1
2. Dislike a little	2	2	2
3. Neither like nor dislike	3	3	3
4. Like a little	4	4	4
5. Like a lot	5	5	5

Pictures can be used for children – tick the box under the face which best describes how you feel about the product.

Rating score	1 ☹	2 ☹	3 😐	4 ☺	5 ☺
Product A					
Product B					
Product C					

Discrimination tests

Discrimination tests can be used to:
- evaluate the difference between similar products
- evaluate specific attributes, e.g. smoothness
- gauge consumer response to new products
- check that a food product meets its original specification

They are objective tests to determine whether or not there is a difference.

Paired comparison test

Tasters are asked to compare two samples for a specific characteristic, e.g. flavour or seasoning of the dish, e.g.

Paired comparison test

1. Prepare two samples
2. Compare one attribute – e.g. which one is smoother

Duo–trio test

Out of three samples, tasters are told which is the control and are then asked which of the other two samples differs from the control, e.g.

Duo–trio test

1. Prepare three samples, two of which are the same
2. Using one of the two identical samples as a control, decide which of the other samples is the same as the control.

Triangle test

Tasters are presented with three samples, two of which are the same, and are asked to identify the odd one out, e.g.

Triangle test

1. Prepare three samples, two of which are the same.
2. Arrange the samples in a triangle; decide which sample is the odd one out.

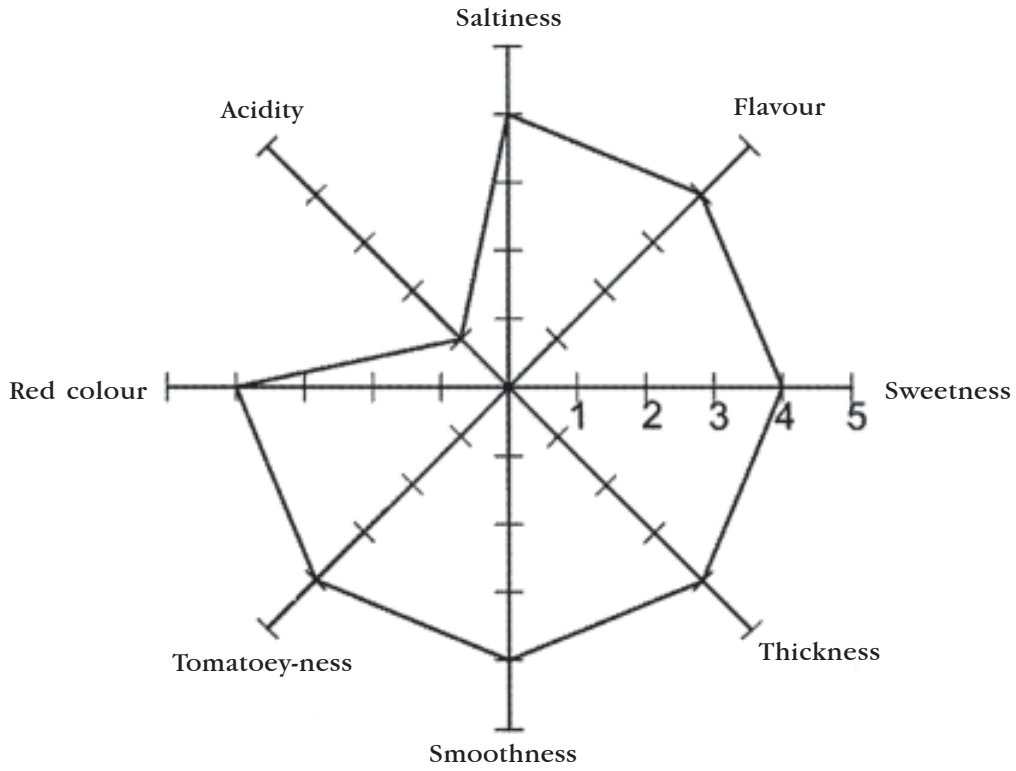
Taste-threshold test

Essentially, the taste threshold test determines the sensitivity of the taster to a particular taste. For example, the taster might be asked how much water can be added to squash before the flavour is too weak.

Profiling test or star diagrams

Characteristics of a product can be profiled and then compared with other samples of a competitor's products.

The diagram shown is called a star diagram because it is drawn in the shape of a star. Each line of the star is marked on a scale of 1 to 5 (where 1 is the least and 5 is the most), and each line is labelled with a descriptor – a word which describes the food product. The star can have as many or as few lines as required; it depends on how many words there are to describe the product.



Star diagram for tomato sauce

These results show that this tomato sauce has a good colour, flavour, thickness and average acidity and sweetness. Other examples may also be used.

Manufacturers use this method to compare their own products with one which is popular with consumers, in order to see where they need to improve their own product.

Words to describe food products

It is useful to have a vocabulary of words to describe food products. Some suggestions are given below.

Characteristics	Word bank
Appearance	Greyish, pale, dark, separating, off-colour, lumpy, glutinous, bright, firm, dull, runny, light
Texture	Soft, smooth, crunchy, crisp, creamy, chewy, hard, sticky, crumbly, tough, tender, lumpy, gritty, watery, thick, dry, moist, oily, greasy, light, heavy, spongy, firm
Flavour	Sour, sweet, bitter, salty, acidic, spicy, mild, weak, strong, savoury, sharp, fruity, bland, tangy, peppery, juicy
Aroma	Sour, spicy, fruity, yeasty, burnt, sweet, floral, roasted, rancid
Overall acceptability and quality	Appetising, appealing, attractive, enjoyable, tasty, acceptable, pleasant, unattractive, good, bad, awful, delicious, lacks flavour, golden brown, good colour, pale, bright, dull, unacceptable, poor quality, quite good, horrible

SECTION 15

Functional properties of food

Elaboration

- Aeration
  - Mechanical
- Binding
- Coagulation
- Crystallisation
- Emulsifying
- Fermentation
- Gelatinisation
- Hydrogenation
- Preserving
  - salt
  - sugar
  - pH
  - dehydrating
  - use of temperature
- Shortening
- Sweetening
  - fresh and dried fruits (intrinsic sugars)
  - sugar (non-milk extrinsic sugars (or NME sugars)
  - sugar substitutes

To produce variety in products, both in industrial and domestic food processing, knowledge of the qualities or properties a food possesses is essential. To create a successful product, food technologists need to apply their knowledge of the properties of food used as ingredients in a product.

The qualities a food possesses depend on the physical and chemical nature of the product. These qualities are called **properties.**

What happens to food during processing depends on these properties. To make successful products, food technologists use these properties and they are described as **functional properties.**

Aeration

To ensure that flour mixtures rise, gases must be introduced before baking. Gases expand when heated, the proteins in the mixture set, and the mixture holds the risen shape.

Mechanical methods of introducing air

1. ***Sieving***
   - Air becomes trapped between the particles of flour when it is sieved.

2. ***Creaming***
   - Air is trapped in the mixture.
   - Fat and caster sugar are beaten together to form an air-in-fat foam.
   - Air is trapped in the mixture in tiny bubbles which makes the mixture lighter.

3. ***Rubbing in***
   - Fat is rubbed into the flour and coats the flour particles.
   - This forms a waterproof barrier but also traps air as the mixture is lifted and rubbed in with the fingertips.

4. ***Whisking***
   - When egg white is whisked it increases the mixture in volume. This is due to the protein in egg, called albumin, stretching and trapping air bubbles in the foam.
   - When egg is whisked with sugar, a large volume of air is trapped in a honeycomb-like mesh.

Binding

- When whole eggs are used for binding, the property of coagulation is used. Eggs will start to coagulate or set from 63–70°C.
- The egg proteins coagulate when heated, and they bind or hold together combinations of ingredients.
- This should result in an unbroken final product such as fishcakes, hamburgers, rissoles.

Coagulation

The texture of foods that contain protein can be altered by heat. The structure of protein is permanently altered when heated due to the property called coagulation.

Coagulation is the change from a liquid to a solid. Proteins may be coagulated or set by the following methods:

- *Heat*, e.g. the properties in meat become firmer in texture when heated; protein in milk forms a skin on the surface when heated.
- *Acid*, e.g. when milk becomes sour, lactic acid is formed and this may cause coagulation of the milk protein.
- *Enzymes* – rennet is used to coagulate milk to produce curds in cheese making.
- *Salt* – increases the firmness of the curd in cheese making.
- *Mechanical action* – partial coagulation of protein occurs when egg white is whisked.

However, it is the first method, heat, that is particularly important in food-product development and accounts for the difference between raw and cooked foods.

Eggs

Eggs are commonly used in cookery due to their property of coagulation.

Coagulation of eggs is affected by:
- The temperature used
- The cooking time
- The other ingredients used.

The temperature and time used:
- When eggs are heated they change from a fluid state to a more solid state.
- Egg white thickens or sets between 60 and 65°C.
- Egg yolk thickens at 65°C and eventually sets at 70°C. This thickening is called coagulation.
- When eggs are mixed into a liquid, e.g. milk, and then heated, coagulation makes the mixture thicken. This is what happens when an egg custard, bread-and-butter pudding or the filling for a flan are baked.

- When heated beyond coagulation temperatures, the protein structure is denatured, i.e. it becomes hard, tough and rubbery.
- This is easily seen when eggs are overcooked, e.g. scrambled eggs become tough and liquid appears because the proteins within the egg shrink and the liquid is squeezed out.

Other ingredients used

In food products, eggs are used in varying concentrations and along with other ingredients. These factors affect coagulation.

A firmer set is achieved and the temperature of coagulation is raised by:
- the addition of an extra egg to the mixture
- the addition of salt
- the addition of acid.

A looser set is achieved and the temperature of coagulation is raised by the addition of sugar.

The following functions are also associated with coagulation:
- Supplementary thickening, e.g. to thicken the lemon sauce base for a lemon meringue pie, thickening custards, sauces.
- Binding, e.g. egg is used to bind ingredients for rissoles or burgers. The egg coagulates on heating and holds the ingredients together.
- Coating, e.g. on potato croquettes. The coating of egg coagulates and prevents the food from falling apart.
- Glazing, e.g. whole egg or egg yolk is used to glaze pastry.

Crystallisation

Sugar is very soluble in water and many manufacturers will make use of this property during food processing. When sugar (sucrose) and water are boiled, the water is driven off, the concentration becomes greater and eventually a thick sticky syrup is formed. This sets or solidifies on cooling. During boiling a chemical change takes place. The sucrose changes into glucose and fructose – these are known as invert sugars.

Crystallisation happens when crystals form after a saturated sugar solution cools after boiling.

Ways in which manufacturers can use the property of crystallisation:

- Food technologists use this information when making jams and sweets. In boiled sugar mixtures only very small crystals are required to obtain the right texture.
- Having sufficient invert sugar in the product will prevent large sugar crystals forming – giving small crystals and smoother texture.
- If there is too little invert sugar in the product then the sugar will crystallise out during storage, e.g. if the sugar in the jam crystallised, the jam would be gritty and consumers would not buy the product.
- Acid is often used in jam making (e.g. lemon juice) to prevent large crystals forming.

Crystallisation in sugar mixtures can be prevented by:

- adding glucose and fructose – manufacturers may use commercially prepared glucose and fructose in the production of some jams, marmalades and sweets if they do not crystallise easily.
- adding acid, for example:
  - naturally occurring acid in fruit used in jam making
  - lemon juice, cream of tartar or vinegar
  - the effect of an acid on sucrose when heated is to change some of the sucrose to glucose or fructose.
- the amount of sugar added must be correct – too much will cause crystallisation.
- the mixture should not be stirred whilst the sugar is dissolving or boiling – if the stability of the mixture is disturbed by stirring, then crystals will start to accumulate on the surface of the spoon.
- some sugar mixtures, such as fudge, are beaten as they cool – this creates very small crystals and a smooth texture results.
- manufacturers will add other ingredients such as milk, butter, chocolate, starch and gelatine products – these ingredients help to prevent or delay crystallisation and therefore ensure that the product will not crystallise before the expiry of the storage time claimed for that product.

Emulsifying

- Egg yolk contains a substance called lecithin which acts as an emulsifier.
- When egg yolk is added to the mixture of oil and another liquid, it is the lecithin in the yolk which enables the oil and liquid to be mixed to an emulsion without separating.

- This property is used in mayonnaise, which is an emulsion of oil and vinegar stabilised by egg yolk.
- In cake making, lecithin in the egg yolk stabilises the mixture by forming an emulsion with the fat and oil in the margarine and the liquid in the egg. This prevents the fat from separating from the liquid (the sugar and eggs), which would cause the mixture to curdle.

Fermentation

Fermentation is a process used by the baking, brewing and wine-making industries. Fermentation results when yeast, under the right conditions, produces carbon dioxide and alcohol – this allows flavour, texture and volume to develop, e.g. in bread making, brewing, etc. To obtain successful results the conditions for fermentation must be correct. These are:

- the correct amount of yeast
- a source of food (sugar or flour)
- moisture
- the correct temperature – fermentation works best at 25–29°C and the process stops at 55°C, when the yeast is killed.

In bread making, fermentation takes place during the time that the dough is set aside to rise or 'prove'. Bread is made from 'strong' flour – one with a high gluten content which will produce an elastic dough. The elasticity of the gluten enables the yeast dough to stretch and hold carbon dioxide gas, produced during fermentation, in small pockets. During fermentation, sugars present naturally in flour are converted to glucose and this is fermented by the yeast to carbon dioxide gas and alcohol. This raises the dough.

Bread made by the traditional method involves leaving the dough to rise at least twice. This is very time consuming. A quicker method of bread making was developed to speed up the process and allow bakers to mass-produce loaves in a shorter time. This method is known as the Chorleywood process. In this method the dough is thoroughly mixed for about five minutes, then the yeast, fat, water and ascorbic acid (vitamin C) are added. All these factors cause the dough structure of become elastic enough to allow it to ferment and rise in less time than the traditional method of bread making. Almost any type of flour can be mixed and even 'weak' flour (one with a low gluten content) can give good results. Controlling the temperature is also less important, as the quick fermentation reactions cause the dough temperature to rise.

The fermentation process has to be carefully monitored during manufacture to avoid the following problems:

- **Over-fermentation** – the gluten becomes overstretched and loses elasticity. The dough is not able to efficiently hold onto the CO_2 gas produced by the yeast. Too much pressure from the CO_2 gas causes the gas pockets to break down, leaving large, uneven holes in the bread. The food product is heavy, of poor volume and may have 'off' flavours.
- **Insufficient fermentation** – not enough CO_2 gas forms and the gluten does not stretch enough. The finished bread has a heavy, close texture and the volume is poor.

Gelatinisation

The way starch behaves when it is processed plays an important part in the final texture and consistency of food products. Most types of flours mainly contain the carbohydrate starch, including wheat flour, corn flour, rice flour and arrowroot.

- Starch consists of tiny granules that do not dissolve when added to cold water. When stirred, the granules are suspended in the liquid.
- When the mixture is heated, the liquid passes through the walls of the starch granule and the granules swell to about five times their normal size and burst.
- By this process the starch absorbs water and thickens the liquid. This usually takes place at 79–93°C.
- This process is called gelatinisation, i.e. starch on heating absorbs water and thickens liquids such as sauces.
- Gelatinisation allows a mixture to form a gel. As a cooked starch mixture cools, there is an increase in the stiffness of the gel as gelling setting takes place, e.g. custard powder made from cornflour thickens when heated with milk and when cool it sets and can be used for trifles.

Food technologists use the property of gelatinisation to ensure products meet the specification for consistency and texture. For example, a sauce that is used to coat vegetables must be thick enough to provide an even coating. If it is too thin, it will run off the vegetables; if it is too thick it will not spread over the vegetables smoothly. In food technology how thick the mixture becomes is called its **viscosity.**

Viscosity is the thickness/thinness of sauce and its ability to 'flow' correctly.

If the gelatinisation process does not take place properly it could result in:

- An unpalatable mixture with loss of flavour due to the taste of raw uncooked starch
- The sauce being the wrong consistency
- The sauce being lumpy.

Lumps will form in a starch-thickened mixture if:

- Dry starch is mixed with warm or hot liquid. The hot water will gelatinise the outer edge of the starch granules, forming a barrier. The liquid is unable to penetrate through to the remaining uncooked starch granules in the lump. This is the reason why starch used for thickening is usually blended with a little cold water before the hot liquid is added.
- The mixture is not stirred whilst being heated. The starch grains will not remain in suspension unless the mixture is stirred. The grains settle at the bottom of the pan in groups. The starch granules in contact with the liquid gelatinise and prevent the liquid from penetrating the remaining starch.

The degree of gelatinisation is affected by:

- *The proportion and type of starch*. The more starch there is in proportion to the liquid in the mixture the thicker the mixture becomes. Each type of starch has granules of a particular size and shape and this affects the finished mixture. Arrowroot gives a clear, transparent gel when thickened, and is used for sweet and savoury sauces. Wheat flour gives a cloudy, creamy sauce and is used for white sauces and to thicken soups.
- *The temperature of the liquid*. The temperature of gelatinisation varies with the type of starch. Most starch mixtures start to thicken somewhere between 75 and 87°C but complete gelatinisation does not happen until the mixture is nearly at boiling point. It is important to boil mixtures containing starch to ensure all starch grains are fully gelatinised.
- *The effect of other ingredients*.
  - ***Acid***: if an acid, such as lemon juice, tomato or vinegar is cooked together with starch and a liquid, the thickening quality of the starch is reduced. This is because some of the starch granules are

broken down into smaller particles by the acid. To avoid this happening, the acid ingredients should be added after the starch mixture has been cooked and thickened, e.g. in a lemon meringue pie, the lemon juice should be added after the cornflour and water mixture has been thickened.

– ***Sugar***: if too much sugar is added to a starch-and-liquid mixture, gelling will not take place and the mixture will then be runny. It is recommended that if a lot of sugar is to be added it is done after the starch has gelatinised.

Hydrogenating

- This is the process by which liquid oils are converted to solid fats.
- Unsaturated fatty acids have the ability to hold more hydrogen atoms which makes them more solid.
- During hydrogenisation hydrogen is bubbled through oils under controlled conditions.
- The process can be stopped when required hardness has been reached.
- The process of hydrogenisation is used in the manufacture of margarine.
- Hydrogenisation causes some polyunsaturated fatty acids to change to trans fatty acids.
- Trans fatty acids may raise blood cholesterol levels and manufacturers are trying to reduce the level of trans fatty acids in their products.

Preserving

Food is preserved to:

- Reduce the number of spoilage organisms present.
- Destroy any bacteria which could cause food poisoning.
- Prevent further contamination during storage.
- Prevent multiplication of any organisms still present during storage.

Preservation also aims to retain as many qualities (such as colour, flavour, texture and nutritional value) of the fresh food as possible.

Salt

- The use of salt as a preservative is not new and has been used for centuries as an effective method of preventing food decay.
- Salt not only preserves the food but also adds flavour.
- Most foods have salt added or are preserved in salt, including cheese,

sausages, dried fish, bacon/ham, tinned vegetables and fish (in brine), processed foods; and salt is present naturally in many foods.
- Salt is also found in monosodium glutamate (MSG), which is a flavour enhancer used in Chinese dishes and savoury foods.

Sugar
- Sugar is added to food for a variety of reasons. It is:
  - a preservative
  - a sweetener
  - an energy provider.
- Sugar must be used in large quantities to act as a preservative, e.g. in jam making.
- Micro-organisms cannot grow in strong sugar solutions – a concentration of 60% sugar is therefore recommended.
- Sugar is also used to preserve certain fruits and fruit peels by crystallisation.
- The large amount of water present in the fruit is exchanged for the strong sugar syrup when the fruit is allowed to soak in a concentrated sugar solution.
- Sugar can also be a preservative when used in cakes and biscuits. It helps these products to stay moist, which keeps them in good condition for longer and gives them a longer shelf-life.

pH
- Some acids are used as a preservative – for example vinegar, citric acid, lactic acid and tartaric acid.
- The acidity of a substance is measured by its pH value on a scale of 1 to 14. Substances that have a pH of 1 to 6 are acidic – 1 being the most acidic.
- A pH of 7 is neutral, e.g. water. Most bacteria only grow well at pH 7.
- A pH of 8 to 14 is alkaline – 8 being the weakest alkali.
- The acids that are used for preserving, such as vinegar for pickling, are usually fairly strong. They usually have a pH of 2–3 and so are suitable for preserving less acid foods, e.g. pickled onions.
- Most bacteria cannot survive below pH 4.5.
- Other preserves may use a mixture of acid, sugar and salt in their product, e.g. chutneys.
- The strength of an acid used to preserve food has to be adjusted according to the type of micro-organism that would normally contaminate the food, e.g. some moulds grow at pH 2 and yeasts grow at pH 4–4.5.
- If the pH is low or acid, a sour taste will be noticeable and will affect the taste and sales of a product.
- A bitter taste will be noticeable if the pH is high or alkaline, which can also affect sales.

pH table

1	Strong acid	Kills	
2		most	Lemon juice
3		bacteria	Vinegar, pickles
4			Pineapples
5	Weak acid		Black coffee
6			Bananas
7	Neutral	Water	Milk chocolate
8			Egg white
9	Weak alkali		Baking soda
10			
11			
12			
13			
14	Strong alkali		

The pH (acidic level) of a food affects not only the taste of a product but also the ability to create a smooth texture. Foods which have a high acidic level (like fruits) can cause mixtures to curdle, while foods with a low acidic level (like milk) may need to have their acidic level raised to ensure a smooth texture, e.g. yoghurt.

Dehydrating

This is the oldest and simplest method of preserving food. Micro-organisms and enzymes, like all living things, cannot grow and multiply without moisture. In dehydration water is drawn out from the cells and this concentrates natural salts or sugars and preserves the food.

Removing water from food also reduces the bulk and weight of the product. The food will stay dehydrated until the water is put back into it (rehydrated). Once water is added back into the food, micro-organisms will start to grow and reproduce again. Dried food must therefore be stored in a cool, dry place.

The effects of dehydration

- *Colour*. The colour of the food may change completely, darkening when it becomes concentrated as the food dries, e.g. green grapes turn to brown sultanas or currants.

- *Texture*. Food will become brittle (herbs) or hard (dried pulses) or it may crumble (coffee granules).

- *Appearance*. Food may wrinkle, shrink in size and become lighter in weight, e.g. dried plums become prunes, vegetables in dried soups.

- *Flavour*. Food becomes sweeter or more salty as a result.

- *Nutritional value*. Some vitamin C and vitamin B1 (thiamin) may be lost.

Use of temperature

Heat

Heat treatment is the most effective method of preserving foods. Most bacteria, yeasts, moulds and enzymes are destroyed by heating at 100°C. The main methods of heat treatment are:

- *Pasteurisation*. This process is commonly used for milk. In pasteurisation the milk is heated to at least 72°C for 15 seconds to kill harmful bacteria. After this it is rapidly cooled to less than 10°C. This process does not affect the appearance or flavour of the product. Pasteurisation is used for other food items such as milk products, fruit juices, vegetable juices and liquid egg for bakery products.

- *UHT*. This method uses a very high temperature of 132°C for 1–3 seconds for milk and cream. This type of milk is affected by processing and its flavour is very different from pasteurised milk. It can be stored unopened for 6 months, but once opened should be treated as pasteurised milk.

- *Canning*. Canning is used for preserving a wide variety of foods. Cans are made from steel and then coated with a thin layer of tin to prevent them going rusty. Canning preserves foods by preventing air coming into contact with the food. Some micro-organisms can survive without air, so cans have to be heat treated to destroy these.

Cold

When the temperature is reduced, the activities of most micro-organisms are slowed down until they become dormant, inactive and growth stops. Once the temperature is raised, growth of these micro-organisms will start again. The main method of preservation involving cold temperature is freezing.

- *Freezing*. Freezing is the reduction of temperature in a food to the point where not only does microbial activity stop, but the natural decay and deterioration of the food is halted for a period of time.

The domestic freezer will store frozen food products at –18°C and a commercial freezer at between –18°C and –29°C.

When a food is frozen, ice crystals are formed in it. The speed at which food is frozen is important. If food is frozen quickly, small ice crystals will form reducing the damage to the structure of the food. When food is frozen slowly, large uneven ice crystals are formed and these break through the cells on thawing to affect the flavour, texture and nutritive value. Frozen foods are kept in good condition for a longer period of time as micro-organisms are dormant at these very low temperatures.

Shortening

In order to make baked products such as shortcrust pastry and shortbread soft and crumbly, fat is added as a **shortening.**

- One of the functions of the fat is to 'shorten' a mixture and give it a crumbly texture. This texture is created by the fat coating the flour particles to form a waterproof barrier. A fat that coats the flour particles easily will give the best results.
- Some flour particles remain uncoated. When water is added to shortcrust pastry, the uncoated flour particles absorb the water and for this type of pastry the less water added, the 'shorter' the pastry.
- The protective coating of fat around the flour particles means that less water can mix with the protein of the flour, so less gluten is formed and a shorter, more tender, 'melt-in-the-mouth' pastry is produced.

Ingredients to use

- The best shortening ingredients are pure fats such as lard and pure vegetable fats. For health reasons, lard is not advised and the most common fats used in shortening are margarine and butter.
- Liquid oils can also be successfully used to shorten mixtures because they coat the flour particles thoroughly and the end product is very crumbly.

Proportions

- The proportion of fat used is a critical factor as there needs to be enough to coat the flour particles thoroughly and reduce gluten development
- Too much fat will make the product unpalatable and difficult to handle.

Sweetening

Fresh/dried fruits (intrinsic sugars)

- Intrinsic sugars are formed naturally in foods, mostly in the cell structure, and they will usually taste sweet.
- The inclusion of dried fruits (e.g. sultanas, dates, prunes, apricots) and fresh fruits is a useful way of sweetening products so that their sugar content can be reduced. The addition of some fruit juices can achieve the same result.

Sugar (non-milk extrinsic or NME sugars)

- Extrinsic sugars are not found in cell structures. They include non-milk extrinsic sugars (NME sugars), such as refined sugar, extracted sugars in honey and fruit juices, sugars added to foods like baked products, soft drinks and processed foods.
- It is recommended that we reduce the amount of NME sugars in the diet as they contribute to dental decay and also help develop a liking for sweetness.
- NME sugars are sometimes hidden in products such as canned vegetables, soups, sauces where you would not normally think that sugar would be present. Look out for the following names on a list of ingredients – sucrose, dextrose, malto-dextrin and glucose.

Sugar substitutes

- These are used in food manufacturing to give sweetness to products and at the same time reduce the intake of calories. They are used quite a lot by manufacturers of soft drinks.
- Consumers using sugar substitutes in food preparation in the home will have to adapt recipes, as sugar substitutes have different functional properties from sugar.
- There are two types of artificial sweeteners – bulk and intense sweeteners.
- *Bulk sweeteners* such as sorbitol, may not be as sweet as sucrose, can withstand high temperatures and are used in confectionery and jam making.
- *Intense sweeteners* include saccharin, aspartame and acesulfame. Saccharin is 300 times sweeter than sucrose and aspartame is 2000 times sweeter. As a result only small amounts are added to products by food manufactures.

For more detail on sugar substitutes refer to the Consumer Studies Unit: 'The impact of technological developments on consumer choice of food'.

SECTION 16

Factors affecting finished products

Elaboration
- Ingredients
- Proportion of ingredients
- Processing of ingredients
- Cooking time and temperature
- Effect of:
  - light
  - heat
  - pH

Throughout food production consideration is given to the finished product for aesthetic and functional reasons.

The type of ingredients

The type of ingredients used in food preparation will perform important physical functions. The choice of ingredients is influenced by:

- type of end product, e.g. cereal, bread
- selling sector the product will be in, e.g. frozen
- selling price range, e.g. luxury costs more
- method of processing
- how the food behaves after processing/cooking if it is not to be eaten immediately.

Ingredient used	Effect on finished product
Fat	• traps air when creamed with sugar and so helps a cake to rise • adds flavour and colour • provides 'shortness' to cakes and biscuits • improves the keeping qualities • contributes to the flavour, smoothness and glossy appearance of a sauce.

Flour	• the gluten (protein) stretches and forms the structure of baked goods • adds flavour, depending on the type of flour, colour and texture • wholemeal flour adds nutty flavour/crunchy texture • provides the bulk in bread, cakes, etc.
Sugar	• used as a sweetening, for example in breakfast cereals and drinks • prevents food spoilage in jams because it acts as a preservative • helps the yeast to rise in bread making • gives lightness to cakes by dissolving into a syrup and softening the gluten (protein) in flour during baking • helps the colour of cakes by caramelising on the top crust because of the dry heat of the oven • decreases the thickness of starch-based sauces and puddings because sugar increases the temperature at which the sauce thickens.
Eggs	• used to glaze pastries and produce golden brown results • set and thicken fillings and flans when protein coagulates • bind ingredients together, e.g. biscuits • hold air and acts as a raising agent.
Liquid	• helps to raise cake mixtures by producing steam • works with raising agents to help cakes to rise • needed in bread making so that the yeasts can grow and multiply • mixes with the gluten of the flour • during baking and sauce making water is needed for gelatinisation with the starch.

The proportion of ingredients

Manufacturers combine foods in different combinations to obtain a successful product.

The constant need to develop products that meet dietary targets encourages food manufacturers to change the standard proportions of ingredients.

Fat

Reducing fat in a product	*Increasing fat in a product*
• gives a less moist result • affects the keeping qualities • the product will become stale more quickly • gives less flavour • gives a paler colour	• gives a greasy result • improves the flavour • gives a darker colour

Examples of finished products where the proportion of fat has been changed

Cakes	The higher the proportion of fat to flour, the more fragile and softer will be the cake. The cake will also be richer in taste.	
	Too little fat to flour	***Too much fat to flour***
Scones	Scones will not be as tender and soft as desired.	Scones will turn out similar to a cake mixture.
Pastry	Pastry will be hard and tough.	Pastry will be fragile and crumbly. Excess fat results in greasy pastry.
Sauce	Sauce may be lumpy and dull in appearance.	Sauce will be fatty.

Sugar

Reducing sugar in a product	*Increasing sugar in a product*
• gives less flavour • gives poorer keeping qualities • gives a paler colour • results in the product not rising so well	• results in a longer cooking time • gives a darker colour • gives some foods a sugary texture • produces very soft mixtures during baking, which will then become hard when cool • gives a sweeter result

Examples of finished products where the proportion of sugar has been changed.

	Too much sugar	*Too little sugar*
Cakes	Hard sugary crust Coarse-grained product Fruit will sink in a fruit cake as the structure will collapse Cake will sink in the middle as the gluten has been over-softened so that it collapses	Cakes will not rise so well
Scones	Scones will have a 'speckled' appearance	Scones will lack flavour
Pastry	Pastry will to too sweet and may be a darker colour	Pastry will not be sweet enough
Sauce	Gelling will not take place and a thin runny mixture will be produced	Sauce will lack flavour

Examples of finished products where the proportion of liquid has been changed.

	Too much liquid	*Too little liquid*
Cakes	Cake has a heavy, doughy texture and the top may be cracked Fruit will sink in a fruit cake if the mixture is too wet The heavy fruit cannot be held evenly throughout	Cake is dry
Scones	Dough is too soft and as a result it spreads and loses shape when cooking	Dough is stiff Scones are heavy and poorly risen
Pastry	Hard and tough shortcrust pastry	Shortcrust pastry will be fragile and crumbly Flaky pastry will be hard and tough as layers of flakes will not form
Bread	The dough is sticky and the bread has a coarse and open texture	The dough is stiff to handle and does not rise well. The bread has heavy texture

Processing of ingredients

The mechanical forces used in the mixing of ingredients allows changes to happen to the ingredients and may alter the quality of the finished product.

Process	Food(s)	What happens	Reason
Whisking	Egg white	Increases in size.	The protein albumin stretches to hold up to seven times its own value of air, trapping small air bubbles in stable foam.
	Eggs and sugar	Thick, pale yellow stable foam is formed.	The egg proteins stretch, incorporating air into the mixture. Large bubbles become very small bubbles and are trapped inside a very fine honeycomb mesh.
Whipping	Cream	Thickens.	Fat globules start to coalesce (stick together) until cream becomes thick.
Rubbing in	Scones Pastry	Air is trapped during mixing.	Fat rubbed into flour particles will form a waterproof barrier and will also trap air.
Creaming	Cakes	Air is trapped into mixture.	Fat and sugar form an air-in-fat foam. The small needle-shaped crystals present in the fat are separated by the abrasive action of gritty sugar. Individual fat crystals surround the tiny air bubbles and trap the air in the mixture.
Kneading	Bread/rolls	Air is trapped in the dough. Gluten is developed in the dough. Chains of yeast cells are broken up.	Produces a light product. Produces good volume. Produces an even texture.

Cooking time and temperature

Many foods have properties that allow them to be changed into other forms and this has a major effect on the finished product. It is important that the time taken and the temperature used to cook the product will enhance the texture, consistency, colour and appearance – all of which will appeal to consumers.

The **colour** of the finished product can be controlled by the temperature it is cooked at and the length of cooking time, e.g. a cake baked at a low temperature or for a short time will be paler than one baked at a higher temperature or for a longer time. Manufacturers must give consumers accurate cooking times and temperatures to ensure good results.

Other examples include:

- When a carbohydrate, such as a simple sugar, is heated with protein, a series of reactions can occur, resulting in browning. This type of browning is sometimes called Maillard browning and it occurs during the cooking of meat, and the baking and toasting of breakfast cereals and toasted nuts. The products are more appetising as a result.

- Boiled green vegetables are bright green at the beginning of cooking. They then become dark olive green then brown as they are overcooked. Manufacturers who produce prepared vegetables dishes have to consider this fact when advising consumers on reheating their products.

- Caramelisation happens when sugar is heated to a temperature above its melting point for some time. The result is a brown caramel-type substance which has a pleasant toffee-like flavour. If heated for too long a black, bitter-tasting charcoal-like substance is produced. Sugar contributes to the colour of baked items by caramelisation on exposure to the dry heat of the oven, forming a golden brown crust.

- Sugar toppings in cakes, pastries and crème brûlées can be caramelised by flashing at a high temperature under the grill, to give an attractive brown appearance and good flavour.

- The surface starch of any baked items such as scones, pastry or cakes changes to dextrin during cooking time in the dry heat of the oven. This contributes to the brown colour. The process is called dextrinisation.

- The cooking method used will affect colour. When food is grilled or baked it turns brown due to dextrinisation, caramelisation or Maillard browning. The colour changes very little when food is microwaved or steamed.

- When hard-boiled eggs are to be sliced and used in salads, they must be carefully cooked to the required time. The egg white changes from an opaque colour to white but a green/black ring may form around the yolk. This is due to the reaction of sulphur in the egg white with iron in the egg yolk. This reaction can be partly prevented by cooling the egg quickly after cooking. This discoloration looks unattractive to consumers in such food items as Scotch eggs, egg salads, etc.

Other factors that may affect finished products include light, heat and pH level.

- **Light**
  - exposure to UV light may influence the nutritive value of the finished product, particularly of vegetables.

  - if products are left lying around, exposure to light can cause oxidation, e.g. fats may go rancid and vitamin A will be lost.

- **Heat/temperature**
  - if applied to a finished product heat/temperature could change the colour, flavour, texture, appearance and nutritive value of the product.

  - heat would bring about a change in a product. When working with food it is important to know the melting point, freezing point and boiling points of a material.

Melting point

When working with food the melting point of a material, i.e. when it changes from a solid to a liquid, is important. For example, when creaming fat and sugar for cake making, the fat should be soft but not liquid.

Freezing point

The point at which a material changes from a liquid to a solid, i.e. the freezing point, is also important. For example:

- the freezing point of a salt solution is lower than that of water
- a sugar solution freezes at a higher temperature than a salt solution.

This is important when freezing vegetables and making ice-cream.

Boiling point

The boiling point of a liquid can be affected by atmospheric pressure and what is in the solution:

- standard atmospheric pressure is 14.7 lb per square inch; at this pressure pure water boils at 100°C
- when the atmospheric pressure is lower than standard atmospheric pressure, water boils at a temperature lower than 100°C
- when the atmospheric pressure is higher than standard atmospheric pressure, water boils at a higher temperature than 100°C
- a sugar syrup solution boils at a higher temperature than 100°C
- the higher the proportion of sugar to water in the solution, the higher the temperature at which the solution boils.

Product	**Concentration of sugar %**	**Boiling point (°C)**
Marmalade	68	105
Fudge	82	115

When a sugar solution boils, water vapour is driven off. The concentration of the solution increases. This is important when developing jams and jellies.

pH level

- pH value will influence the taste of a product and could make it more acidic or alkaline.
- pH value may affect the ability of a product to be well risen.
- If pH level is low, a sour taste will be noticeable.
- If pH level is high, a bitter taste will be noticeable.
- Lemon juice would prevent cut fruit from becoming brown, e.g. French apple tart.
- Meat can be tenderised by marinating in an acid (such as orange juice or vinegar).
- Addition of ascorbic acid can prevent fat going off or becoming rancid in a product.