Unit 2.2.5 and 2.2.6 – The Functional Properties of Food

Key Knowledge 2.2.5

The principles of heat transfer in cooking techniques, and the effects on the properties of food of dry and moist heat, electromagnetic radiation, mechanical action, enzymes, and changes to pH

Key Knowledge 2.2.6

The functional properties of fats and oils, protein, starch and sugar in food, and the physical and chemical changes that occur to these components during preparation and cooking, including aeration, caramelisation, coagulation, dextrinisation, emulsification, denaturation, gelatinisation, and the Maillard reaction.

Key Skills 2.2.6

Use accurate food science terminology and techniques to describe and demonstrate, through practical activities, chemical and physical changes to the properties of food.

Key Skills 2.2.8

Design and develop a practical food solution in response to an opportunity or a need in a domestic or small-scale setting.

Key Skills 2.2.9

Undertake practical activities to explore domestic and small-scale commercial food production.

Key Terms and Definitions

Aeration is the process of incorporating air or gas into a mixture or substance, leading to increased volume, lightness, or fluffiness.

Caramelisation is the process by which sugar molecules are heated, undergoing thermal decomposition, and transforming into caramel, resulting in the development of rich flavors and aromas.

Chemical changes, also known as chemical reactions, occur when substances undergo transformations that result in the formation of new substances with different chemical compositions through the breaking and forming of chemical bonds.

Coagulation is the process that transforms a liquid into a solid or semi-solid state, often observed through the clumping together of proteins.

Denaturation is the structural alteration or unfolding of proteins caused by factors such as heat, acids, or mechanical action, leading to changes in texture, appearance, and functionality.

Dextrinisation refers to the breakdown of starch molecules into dextrins, shorter carbohydrate chains, achieved through the application of dry heat.

Emulsification is the process of combining two immiscible substances, such as oil and water, into a stable emulsion with the help of emulsifiers like lecithin or egg yolks.

Gelatinisation is the process in which starch granules absorb water and swell, resulting in the thickening or gel formation of a liquid, commonly observed in cooking when starch is heated in the presence of water.

Physical changes in food refer to alterations that occur in its physical characteristics, such as shape, size, texture, or state, without changing the chemical composition of the food. These changes are typically reversible and do not involve the formation of new substances.

Heat transfer refers to the movement of heat energy from one object or place to another due to a temperature difference. It occurs during cooking when heat is transferred from a heat source to the food, causing changes in the food's temperature and cooking it.

The **Maillard reaction** refers to the chemical reaction between amino acids and reducing sugars, occurring during cooking processes involving high heat, leading to browning of food and the development of distinctive flavors and aromas.

Physical changes refer to alterations in the physical properties of a substance, such as its shape, size, state of matter, or phase transitions, without changing its chemical composition.

The Principles of Heat Transfer

Cooking is both an art and a science. It involves heat transfer principles that cause chemical and sensory changes in food. Understanding why these changes occur will help you achieve the results you want in your cooking and create some amazing dishes.

Chemical and Physical Changes

During cooking, food components undergo physical and chemical changes.

- Chemical changes in food happen when the molecules in the food undergo transformations, leading to new substances being formed. This can affect the sensory properties, and nutritional composition of the food. Examples of chemical changes in food include the browning of bread crust, caramelisation of sugar, or the Maillard reaction in meat.

- Physical changes in food refer to changes that occur in its physical characteristics, such as shape, size, texture, or state, without changing the chemical composition of the food. These changes are typically reversible and/or do not involve the formation of new substances. For example, cutting an orange into slices is an example of a physical change as there has been no change to the chemical composition of the food.

Physical Changes

Frozen Peas

Sliced Orange

Chemical Changes

Fried Egg (coagulated)

Meat marinating (denaturation)

The Effects of Heat Transfer on the Properties of Food

Heat transfer refers to the movement of heat energy from one object or place to another due to a temperature difference. It occurs during cooking when heat is transferred from a heat source to the food, causing changes in the food's temperature and cooking it. Heat can transfer in different ways during cooking.

- Conduction happens when food touches a hot surface like a pan. Induction cooking is an example of conduction. The heat is then transferred through conduction.
- Convection occurs when hot air or liquid circulates around the food. Cooking food in a fan-forced oven or boiling food is an example of convection cooking.
- Radiation is when heat travels through waves, like in grilling and microwaving.

Watch this video about heat transfer: https://youtu.be/MrF8FnhGNoQ

Dry and Wet Cooking Methods

Dry heat cooking methods refer to cooking techniques that use heat without the presence of liquid or steam. These methods involve applying direct heat to the food, which can result in the loss of moisture from the food. Examples of dry heat cooking methods include baking, roasting, grilling, sautéing, and frying.

The table below provides further information regarding dry cooking methods:

Dry Cooking Methods	Description	Advantages	Disadvantages	Examples
Air-frying	A cooking method that uses hot air circulated rapidly around the food to cook. It involves using an air fryer appliance that utilises high heat and a small amount of oil to create a crispy coating.	Healthier options with reduced oil usage, resulting in lower energy intake and a crispy texture.	Healthier option with reduced oil usage, resulting in lower energy intake and a crispy texture.	Chicken wings, sweet potato, fries and crispy tofu..
Baking	Cooking food in an oven using dry heat, typically surrounding the food with hot air.	Retains flavours, allows for even cooking, and creates a desirable texture. Can enhance browning and crust formation.	May lead to moisture loss, particularly in lean or low-fat foods.	Baked chicken, cookies, bread and cakes.
Frying	Frying involves cooking food in hot oil or fat. The food is submerged in the oil, creating a crispy and golden exterior while retaining moisture on the inside.	Frying results in food with a crispy texture and a flavour some crust. It is a quick cooking method that imparts a unique taste and can be used for a wide variety of foods.	Frying can make food high in fat and calories, especially if the oil is not properly maintained or drained. The oil that is heated when frying may catch alight if it becomes too hot.	French fries, chicken wings, doughnuts, tempura, and pakoras.
Grilling	Cooking food directly over an open flame or hot coals. It can also refer to cooking food under direct heat, usually from an overhead source.	Intense heat creates a flavour some, charred exterior while maintaining moisture. For drips off, reducing energy intake. Has a relatively quick cooking time.	Potential formation of harmful compounds due to high heat and smoke. Uneven heat distribution. Potential for food to dry out quickly.	Grilled steak. Hamburgers, vegetables, kebabs, and melted cheese on toast.
Roasting	Cooking food that is lightly coated in fat, often meat or vegetables, in an oven using dry heat, usually at high temperatures.	Enhances flavours, creates a crispy exterior, and allows for caramelization and browning. Can retain moisture in meats.	Longer cooking time compared to other methods, may lead to some nutrient loss.	Roast chicken, roasted vegetables and prime rib.

Wet heat cooking methods, on the other hand, involve cooking food in the presence of liquid or steam. The food is immersed in or cooked with a liquid, which helps to transfer heat to the food and retain moisture. Wet heat cooking methods include boiling, simmering, poaching, steaming, casseroling, and stewing.

The table below provides further information regarding wet cooking methods:

Wet Cooking Methods	Description	Advantages	Disadvantages	Examples
Boiling	Cooking food in liquid at its boiling point (100°C).	Retains nutrients well, quick and easy cooking method, suitable for pasta, grains, and vegetables.	Can cause nutrient leaching into the cooking liquid, flavors can be diluted.	Boiled eggs, boiled potatoes, pasta.
Casseroling	Casseroling, is similar to stewing, involves cooking food slowly in a covered dish, often in the oven or on the stovetop, with a moderate amount of liquid.	Flavour development and tenderisation of ingredients with the convenience of leftovers and meal preparation.	Longer cooking time and potential nutrient loss due to extended heat exposure.	It typically involves simmering ingredients, such as meats, vegetables, and grains together.
Simmering	Cooking food in liquid just below its boiling point, typically at a temperature around 95°C.	Gentle cooking method that helps retain flavours and nutrients. Ideal for tenderising tough cuts of meat.	Longer cooking time compared to boiling.	Simmered stews, soups, braised meats.
Steaming	Cooking food by exposing it to steam.	Retains nutrients and flavours well, requires no added fats, and preserves the natural colours and textures of the food.	Can lead to a softer texture in some foods.	Steamed fish, steamed vegetables, dumplings.
Stewing	Cooking food slowly in a liquid, often with added ingredients, over low heat.	Tenderises tough cuts of meat, melds flavours together, and creates a rich sauce.	Longer cooking time, potential nutrient loss due to extended heat exposure.	Beef stew, chicken casserole, vegetable stew.
Poaching	Cooking food gently in a liquid, typically at a temperature just below simmering.	Retains moisture, preserves delicate flavours and textures. Minimal fat is needed for cooking.	Less intense flavour development compared to other methods.	Poached eggs, poached chicken, poached fruit.

The Effects of Electromagnetic Radiation on the Properties of Food

In relation to cooking, electromagnetic radiation refers to the use of radiant heat in the form of electromagnetic waves for the purpose of heating and cooking food. Electromagnetic radiation, specifically in the form of microwaves, is used in microwave cooking. Microwaving is a versatile method that can be employed for both dry and wet cooking techniques.

Microwave cooking as a dry method involves placing food in a microwave-safe container and subjecting it to electromagnetic waves. The microwaves cause the water molecules in the food to vibrate rapidly, generating heat and cooking the food from within. This method is ideal for reheating leftovers, cooking vegetables, or preparing microwave popcorn.

When wet cooking methods are used in the microwaves cause the water molecules surrounding the food to vibrate. This vibration generates heat within the food, leading to the cooking process. This allows the food to cook in its own moisture. Examples include steaming vegetables or fish, poaching eggs, or cooking grains like rice or quinoa.

Watch this video about how a microwave works: https://youtu.be/xDM_Gkpplck

The table below provides further information regarding microwave cooking:

Cooking Methods	Description	Advantages	Disadvantages	Examples
Microwaving	Microwave cooking is a method of food preparation that utilises microwave radiation to generate heat within the food, resulting in quick and efficient cooking or reheating.	Microwaves cook food faster than traditional methods, reducing cooking time, while retaining more nutrients due to shorter cooking times and minimal water contact. Microwaves are versatile appliances suitable for reheating, defrosting, steaming, and cooking meals, and they are energy-efficient by directly heating food without the need for preheating or using a large oven.	Microwave cooking may result in uneven heating and softer textures compared to traditional methods. Achieving desired browning or crusts can be challenging, and proper container selection is important for safe cooking.	Dry Cooking: popcorn, bacon, and homemade potato chips. Wet cooking: steamed vegetables, poached eggs, and cooking rice.

The Effects of Mechanical Action on the Properties of Food

Mechanical action in cooking refers to the physical manipulation or force applied to food during the preparation and cooking process. This action can have various effects on the chemical structure and sensory properties of food, resulting in changes in texture, appearance, and flavour.

Examples of mechanical action are provided below:

When ingredients are mixed or beaten, such as in baking, the mechanical action helps combine the ingredients uniformly, creating a homogenous mixture. This action also incorporates air into the mixture, resulting in lighter and fluffier textures, as seen in cakes or whipped cream.

Kneading dough in baking, particularly for bread-making, involves repetitive folding, pressing, and stretching. This mechanical action develops gluten, a protein network that gives bread its structure and elasticity. Kneading also helps distribute ingredients evenly and enhances the texture of the final product.

When cutting or chopping foods containing protein, such as eggs, fish, chicken, and tofu, the mechanical action can help break down muscle fibres and protein bonds, making the food more tender. This denaturation process contributes to improved texture (tenderness).

Grinding or mincing food items, such as spices or meat, applies mechanical action that breaks down the food into smaller particles. This process increases the surface area, promoting better flavour extraction, and can result in smoother textures or desired consistency, as seen in ground spices or minced meat.

The Effects of Enzymes on the Properties of Food

An enzyme is a biological catalyst and protein molecule that increases the rate of a chemical reaction in living organisms. They play a significant role in food science and can have various effects on the properties of food during cooking. In food, enzymes can impact texture, flavour, colour, and nutritional composition. Enzymes can be naturally present in food or added during food processing. In the context of cooking, enzymes be advantageous and disadvantageous, as their activity can lead to desirable or undesirable changes in the properties of food.

It is important that you understand and control enzyme activity during cooking in order to achieve the results you desire in terms of taste, appearance, and nutritional value of the food.

Texture

Enzymes can break down complex molecules in food, affecting the texture. For example, in the ripening of fruits, enzymes such as pectinases can degrade pectin, a component responsible for the firmness of the fruit's cell walls. This enzymatic action leads to the softening of the fruit's texture.

Taste

Enzymes can contribute to the development of flavours in food. For instance, during the aging and fermentation of cheese, enzymes break down proteins and fats, resulting in the release of amino acids and fatty acids. These breakdown products contribute to the flavour and aroma of different cheese varieties.

Appearance

Enzymatic reactions can cause colour changes in food. For example, enzymatic browning occurs when enzymes, with phenolic compounds in fruits and vegetables. This reaction leads to the formation of brown pigments, impacting the colour of the food.

Nutritional Changes

Enzymes can affect the nutritional composition of food. Some enzymes can break down complex nutrients into simpler forms that are more easily absorbed by the body. For instance, enzymes like amylases break down starch into sugars, assisting with their digestion and absorption.

Shelf Life and Food Spoilage

Enzymes can influence the shelf life and spoilage of food. Enzymatic activity can lead to the deterioration of food quality, flavour, and texture over time. Proper cooking techniques, such as blanching or heat treatment, can help inactivate enzymes to extend the shelf life of certain foods.

Enzymes used in Food Preparation and Cooking

In cooking, there are certain times when enzymes are added to cause specific reactions and bring about desirable changes in the food. These are just a few examples of how enzymes can be added to cooking processes to achieve specific reactions and desired outcomes.

In meat preparation, enzymes such as papain (derived from papaya) or bromelain (derived from fresh pineapple) can be used as natural meat tenderisers. These enzymes break down the connective tissue in meat, helping to tenderise tough cuts by enzymatically breaking down the collagen and proteins.

In cheese-making, enzymes play a crucial role in curd formation and flavour development. Rennet, derived from the lining of a calf's stomach or produced through microbial fermentation, contains the enzyme chymosin. Chymosin helps coagulate milk proteins, causing them to form curds, which are then pressed and aged to create cheese. Other enzymes, such as lipases, contribute to flavour development in specific cheese varieties.

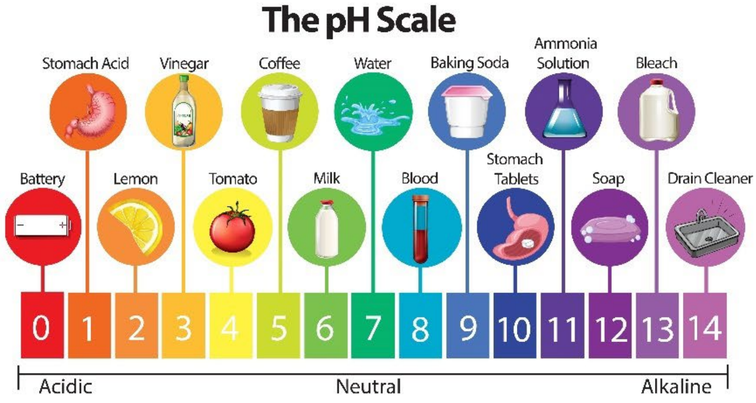
Enzymes are vital in yeast cookery, particularly in baking. They facilitate the fermentation process by breaking down carbohydrates into simpler sugars, which yeast metabolizes to produce carbon dioxide and alcohol. These enzymes improve fermentation and provide yeast with the necessary nutrients. As a result, bakers can achieve well-risen, flavourful, and high-quality baked goods.

Enzymes play a crucial role in beer and wine making processes. They assist in breaking down complex compounds, such as starches, proteins, and pectin, to facilitate fermentation, enhance clarity, and improve flavour. Other enzymes aid in converting starches into fermentable sugars and contribute to clarification by breaking down proteins and pectin. These enzymes are carefully selected and used to perfect the production of beer and wine, resulting in desirable taste, aromas, and appearance.

The Effects of pH on the Properties of Food

pH refers to the measure of acidity or alkalinity of a substance on a scale ranging from 0 to 14. A pH of 7 is considered neutral, below 7 is acidic, and above 7 is alkaline. In cooking, changes to pH can have significant effects on the properties of food, including taste, texture, and colour.

The chart below identifies the pH levels of a range of food and non-food items:



When the pH of a food ingredient or mixture is altered during cooking, it can influence various chemical reactions and interactions within the food.

Taste

pH plays a vital role in determining the taste perception of food. Different taste sensations are more pronounced at specific pH levels. For instance, sourness is associated with acidity, while bitterness can be accentuated in alkaline conditions. Adjusting the pH during cooking can help balance and enhance the desired taste profile of a dish.

Texture and Structure

Changes in pH can affect protein solubility, and denaturation, leading to changes in the texture and structure of food.

The following are some examples of how the altering of pH and how it impacts food.

- In cheese making, adjusting pH levels during curd formation affects the firmness and texture of the final cheese product.
- When poaching an egg in vinegar, the acidic nature of vinegar (pH 2-3) plays a crucial role. The acidic environment created by vinegar speeds up the denaturation and coagulation of proteins in the egg white. The low pH causes the proteins to denature quickly, resulting in a firmer texture and a more compact egg white. Additionally, the tanginess from the vinegar adds a distinct flavour to the poached egg.
- When beating eggs, adding cream of tartar, which is an acidic compound, lowers the pH of the egg whites. The reduced pH affects the protein structure, promoting denaturation and leading to a more stable foam. This acidity contributes to increased volume and stability, allowing the beaten egg whites to hold their shape better. The addition of cream of tartar is particularly beneficial in recipes like meringues and soufflés, where a light and fluffy texture is desired.

Colour

pH can impact the colour stability of certain food components. Acidic conditions can intensify the bright colours of pigments such as anthocyanins, while alkaline conditions can cause pigments to shift towards a more dull or brownish hue. pH adjustments are often employed in cooking to preserve or enhance the desirable colour of ingredients or dishes. For instance, when cooking red cabbage, the natural pigment anthocyanin gives it a vibrant purple colour. By cooking the cabbage in an acidic solution like vinegar or lemon juice, the acidic pH stabilizes the anthocyanin pigments, intensifying the bright purple colour. Conversely, if the cabbage is cooked in an alkaline solution with baking soda, the alkaline pH causes the anthocyanin pigments to become less stable, resulting in a shift towards a more dull or brownish colour.

Preservation and Shelf Life

pH can impact the growth of microorganisms and the stability of food products. Acidic conditions, achieved through processes like pickling or fermentation, can inhibit the growth of spoilage-causing bacteria and increase the shelf life of certain foods.

Functional Properties of Fats and Oils, Proteins, Starch and Sugar

Food preparation and cooking involve more than just combining ingredients and applying heat. It is a complex process that involves understanding the functional properties of various components and the changes they undergo during cooking.

During cooking, fats and oils, proteins, starch, and sugars undergo physical and chemical transformations. Understanding these processes and their effects on food will enable you to create delicious and visually appealing dishes.

The Functional Properties of Fats and Oils

Fats and oils have various functional properties in food. They contribute to flavour, texture, and mouthfeel. During cooking, fats and oils undergo physical and chemical changes. They can melt, solidify, and emulsify.

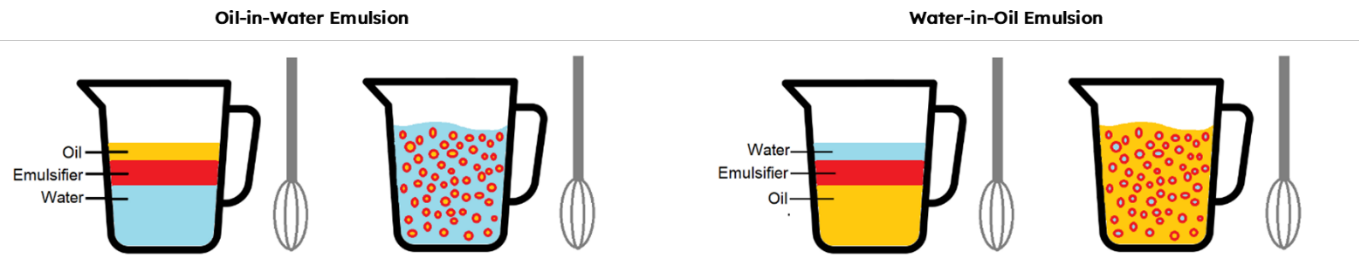
Emulsification

Emulsification is a process where we mix two liquids that don't normally mix, like oil and water, to create a smooth and uniform mixture. In cooking, emulsions are essential for creating creamy textures and combining oil-based and water-based ingredients.

Types of Emulsions

There are two main types of emulsions:

- Oil-in-Water: This is when we disperse tiny droplets of oil in water. Examples include vinaigrettes and salad dressings.
- Water-in-Oil: This is when we disperse tiny droplets of water in oil. Examples include butter and some types of mayonnaise.



To make emulsions stable, we use emulsifiers like egg yolks or mustard. These emulsifiers surround the tiny droplets, preventing them from separating. They keep everything well mixed and smooth.

Understanding emulsification helps us create creamy sauces, dressings, and other mixtures where oil and water come together.

Emulsions can also be classified as temporary or permanent.

- Temporary Emulsions: Temporary emulsions can separate over time. They require continuous mixing or agitation to maintain stability. An example of a temporary emulsion is a simple vinaigrette dressing, where oil and vinegar are combined with the help of an emulsifier like mustard or honey. When shaken or whisked, the ingredients temporarily mix together, but they can separate if left for a while. Regular stirring or shaking is needed to keep the emulsion.
- Permanent Emulsions: Permanent emulsions are stable and do not separate easily. They have a longer shelf life and can be stored without continuous agitation. These emulsions rely on stronger emulsifiers and more thorough mixing techniques. An example of a permanent emulsion is mayonnaise, which combines oil and egg yolks using an emulsifying agent like mustard or lemon juice. The emulsifier helps stabilise the mixture, creating a creamy and stable emulsion that doesn't separate.

Aeration

Fats and oils assist with the aeration of mixtures, contributing to the texture, structure, and overall quality of many culinary creations. One important role is fats and oils ability to trap and stabilise air bubbles during the creaming process, resulting in the incorporation of air and the creation of light and airy textures.

When fats or oils are mixed with other ingredients, such as sugar or eggs, and beaten or whipped vigorously, they can create a foam-like structure. This process, known as creaming, helps to incorporate air into the mixture. Fats and oils also then act as emulsifiers because they stabilise and hold the air bubbles within the mixture, preventing them from collapsing. The air bubbles expand during baking, leading to a tender and airy crumb in the final product.

The following are some examples of situations in cookery where aeration occurs:

- The aeration of fats and oils is commonly seen in various baked goods.
- Other examples include the use of whipped cream or whipped butter, where the aeration of fats provides a light and airy consistency.
- Additionally, in the production of mousses, meringues, and certain desserts, fats like egg yolks or cream are whipped to introduce air and create a delicate and smooth texture.

Watch this video about emulsification: https://youtu.be/v28rxrAhP0k

Watch this video about aeration: https://youtu.be/FyW-Zs8F0Tg

The Functional Properties of Proteins

Proteins are components of food that play an important role in cookery. During the process of preparation and cooking, proteins undergo both physical and chemical changes.

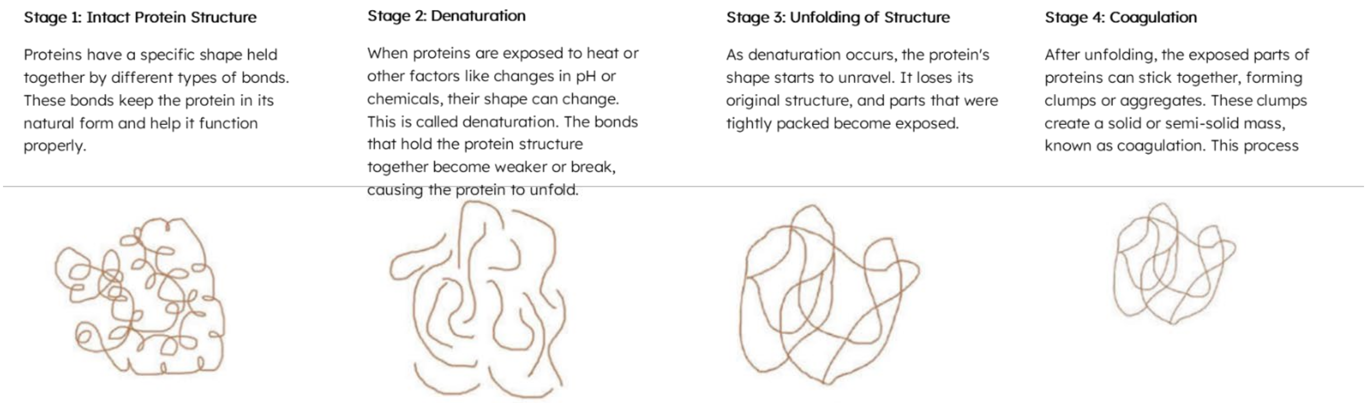
Denaturation and Coagulation

During denaturation, proteins undergo a change where they unfold and lose their original shape. This process leads to changes in the texture of food, making it more tender, and also affects its appearance. It occurs when acids, enzymes, heat, mechanical action, and salt are added to a food that contains protein.

Coagulation occurs after proteins have been denatured. During this process, the denatured proteins come together, forming a network or solid mass.

The following are some examples of situations in cookery where denaturation and coagulation occur:

- When eggs are exposed to heat, the proteins in the egg whites undergo denaturation, causing them to unfold and coagulate. This results in the transformation of liquid egg whites into a solid form, as seen in dishes like scrambled eggs, omelettes, and frittatas.
- In custard-based desserts like crème brûlée or a flan, the proteins in the eggs denature when heated. The denatured proteins then coagulate, giving the custard its smooth and creamy texture. This coagulation allows the custard to set and hold its shape.
- When meat is cooked, the heat causes the proteins in the muscle fibres to denature and coagulate. This leads to the formation of a browned crust on the surface of the meat, as well as the desired texture changes. The coagulation of proteins helps retain moisture and contributes to the tenderness and structure of cooked meat.
- In cheese production, rennet or other coagulating agents are added to milk. These agents cause denaturation and coagulation of milk proteins, resulting in the formation of curds. The curds are then further processed and pressed to create various types of cheese.
- Gelatin is a protein derived from collagen and is widely used in desserts like panna cotta or jelly. When gelatine is moistened and heated, its proteins denature and then coagulate as they cool. This process leads to the setting of the dessert and the creation of a firm, yet delicate, texture.



The Maillard Reaction

The Maillard reaction is a chemical reaction that occurs between amino acids (found in proteins) and sugar when exposed to a high heat. It is responsible for the browning, aroma, and complex flavours observed in various cooked foods, such as seared meat, baked cakes, or roasted vegetables.

Watch this video about the Maillard reaction and caramelisation: https://youtu.be/NtwwjRYNw9c

Aeration

Aeration plays an important role in cooking, particularly when relation to proteins. Aeration refers to the process of incorporating air into food mixtures, resulting in the creation of light and airy textures. This process can significantly impact the structure, texture, and overall quality of various food products.

Ingredients such as egg whites and cream, contain proteins that have the ability to trap air bubbles. Whisking or beating these proteins introduces air and creates a foam-like structure. This foam traps the air bubbles, leading to the expansion of the mixture and the development of a light and fluffy texture.

One of the key proteins responsible for this aeration effect is albumin found in egg whites. When egg whites are beaten, the proteins denature and unfold, this allows them to form a network that can hold air. The incorporation of air into the egg whites results in the formation of a foam.

Aeration is essential in various culinary preparations, such as making meringues, soufflés, mousses, and cakes. However, it's important to note the foam created is temporary. Over time, the air bubbles may release, causing the mixture to deflate. Sugar or cream of tartar is often added to an egg foam to help it maintain its structure.

The Functional Properties of Starch

Starch is a complex carbohydrate found in various plant-based foods, such as grains (like rice, wheat, and corn), potatoes, and legumes. Starch also plays a role in providing structure and stability to baked goods like bread and pastries, contributing to their texture and shape. It also acts as a thickening agent, contributing to the desired texture and consistency of sauces, gravies, and fillings.

Gelatinisation

When starch is exposed to heat and moisture during cooking, it undergoes a process called gelatinisation. Gelatinisation is the process that makes sauces thicken. It is also important in baking, where it contributes to the structure and texture of bread, cakes, and other baked goods.

The gelatinisation process involves both physical and chemical changes. Physically, the starch granules rupture and release starch molecules, which then form a network and trap liquid, creating a thickened mixture. Chemically, the bonds in the starch rearranges, resulting in the transformation to a more gel-like state.

By understanding the process of gelatinisation, you will be able to control the texture and thickness of sauces. The cooking time and temperature, as well as the presence of other ingredients like acids or sugars, can influence the degree of gelatinisation and the resulting texture of the cooked food.

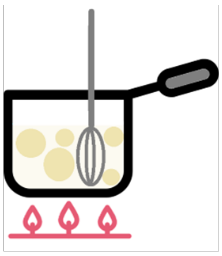
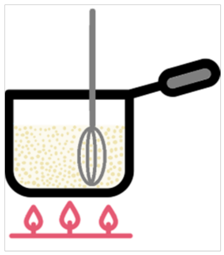
The following are some examples of situations in cookery where gelatinisation occurs:

- When making sauces and gravies, gelatinisation is often used to thicken the liquid and create a smooth texture.

- Puddings and custards, such as rice pudding or crème caramel, rely on gelatinisation to achieve their creamy and thickened consistency. Starches or other thickeners like cornflour are sometimes added to the mixture, and as they are heated, gelatinisation takes place, resulting in the desired texture.
- In pie fillings, gelatinisation helps to thicken the fruit juices.
- Starch gelatinises when baked goods like muffins, cakes and pastries are heated in the oven.
- When cooking pasta or noodles made from wheat flour or other grains, gelatinisation occurs as the starches in the dough are exposed to heat and water. This results in the cooked pasta or noodles having a soft and tender texture.

Watch this video about gelatinisation: https://youtu.be/zjyhMzjDaVI

The diagram below demonstrates how gelatinisation occurs when making a sauce:

Stage 1	Stage 2	Stage 3	Stage 4
Starch is mixed with a liquid, such as water or broth. No heat is applied at this stage.	The starch and liquid mixture is then heated and stirred. As the temperature rises, the starch granules start to absorb the liquid and swell.	As the heating and stirring continue, the starch granules absorb more liquid and continue to swell. This process causes the granules to reach their maximum capacity.	The bursting of starch granules releases the starch molecules, creating a smooth and thick texture. The starch molecules become dispersed and suspended throughout the mixture, contributing to the thickening and gel-like consistency.
			

Dextrinisation

Another important property of starch is dextrinisation. Dextrinisation occurs when starch is exposed to dry heat, such as baking or toasting. In this process, the starch molecules break down into smaller, simpler carbohydrates called dextrins. Dextrinisation contributes to the browning, crispiness, and development of a nutty flavour in foods like bread crusts, cookies, and roasted grains.

The following are some examples of situations in cookery where dextrinisation occurs:

- When bread is toasted, the heat causes dextrinisation, resulting in a brown, crispy crust.
- High-temperature roasting leads to dextrinisation on the surface of potatoes, giving them a golden-brown colour and a crispy texture.
- Dextrinisation occurs during the roasting process of coffee beans, contributing to the aroma, flavour, and browning of the roasted coffee.
- Baked items like cookies, biscuits, and cakes turn a golden-brown colour and become crispy as a result of dextrinisation. The application of heat causes the breakdown of starches into dextrins, creating a toasty and crunchy quality in roasted nuts.

The Functional Properties of Sugar

Sugar plays an important role in cookery by providing sweetness, contributing to texture and moisture retention, enabling browning and caramelisation, supporting fermentation, acting as a preservative, and enhancing flavours. Its versatility and wide range of applications make it an essential ingredient in cooking.

Caramelisation

Caramelisation refers to the chemical process in which sugar molecules are heated to high temperatures, beyond their melting points, causing them to break down and undergo a series of complex reactions. This process leads to the development of a characteristic brown colour, rich flavours, and aromas associated with caramel.

Caramelisation can occur in various cooking applications, such as when making caramel sauces, candies, or caramelising the surface of crème brûlée. It adds depth, complexity, and a sweet taste to a wide array of dishes.

Watch this video about caramelisation and dextrinization: https://youtu.be/8OonKbQo3Z4

Written Activity One

10+ Questions!

Read the content at this link: https://foodstudies.com.au/courses/unit-2-2-5-2-2-6/

Answer the questions below.

1. What is the difference between chemical changes and physical changes in food during cooking?

2. What are the different methods of heat transfer used when cooking?

3. List one dry and one wet cooking method.

   Identify one advantage and one disadvantage of each method.

   Provide an example of a food cooked using this method.

4. How does electromagnetic radiation, during microwave cookery, affect the properties of food during cooking?

5. Provide three examples of how enzymes can affect texture, taste, appearance, nutritional changes, and shelf life of food.

6. When altering the pH of a food ingredient or mixture during cooking, what is one change that can occur to the sensory properties of the food?

7. What is an emulsion and why is it useful in cooking?

8. What kind of product might you make when using the aerating a mixture using beaten egg white? What are the physical properties of beaten egg whites?

9. What is the difference between the term's denaturation and coagulation?

10. How do the physical properties of food change after undergoing the Maillard reaction?

11. What is the term used to describe the thickening of a white sauce? How does this occur?

12. How does dextrinisation differ to caramelisation?

Practical Activity One

Bus Stop Activity: Exploring Food Science

In this task you will conduct various food preparation and cooking techniques that showcase different scientific processes such as aeration, caramelisation, coagulation, dextrinisation, emulsification, denaturation, gelatinisation, and the Maillard reaction.

Working in small groups, rotate to different stations to explore and engage in various food science activities.

Activity Stations

Aeration:	**Whipped Cream**
Ingredients:	50 ml thickened cream
Method:	Whip the cream with a whisk or electric mixer until it forms stiff peaks.
Whipping incorporates air into the cream, creating tiny air bubbles that give it a light and fluffy texture.	
Discussion Questions: What happened to the cream when it was whipped? What changes did you observe in its texture and volume? Why do you think incorporating air into the cream makes it light and fluffy? Can you think of other examples in cooking or baking where aeration is important?	

Coagulation:	**Curdling Milk**
Ingredients:	2 eggs, 1 tablespoon milk, pinch of salt and pepper (optional)
Method:	Heat the milk in a small saucepan until it reaches a temperature just below boiling point. Remove the saucepan from the heat . Slowly add vinegar or lemon juice to the hot milk, stirring gently. The acid will cause the milk to curdle and coagulate. Allow the mixture to sit undisturbed for a few minutes, allowing further coagulation to occur. Not the clumps of coagulation in the milk.
This quick demonstration showcases the coagulation process involved in cheese-making. While the resulting cheese curds may not be fully aged or flavorful, it provides a simple and tangible example of coagulation in cookery.	
Discussion Questions: What happened to the milk when vinegar or lemon juice was added? Describe the changes in its appearance. What is coagulation, and why is it important in cheese-making? Can you think of other examples where coagulation is used in cooking or food preparation?	

Caramelisation:	**Caramelised Onions**
Ingredients:	½ sliced onion, 2 teaspoons butter, pinch salt, ¼ teaspoon sugar (optional)
Method:	Cook onions in butter over low heat until they turn golden brown and develop a sweet flavour.
Caramelisation occurs when heat breaks down the sugars in the onions, creating a complex flavor and brown color.	
Discussion Questions: Describe the changes that occurred to the onions during caramelisation. What happened to their color and flavor? How does the heat break down the sugars in the onions to create a complex flavor and brown color? What other foods can you think of that undergo caramelisation when cooked?	

Emulsification:	**Salad Dressing**
Ingredients:	50ml Olive oil, 1 tablespoon white wine vinegar, 2 teaspoons Dijon mustard, pinch of salt and pepper, honey (optional)
Method:	Combine ingredients in a bowl and whisk vigorously until the oil and vinegar form a stable emulsion.
Emulsification occurs when two immiscible substances, such as oil and vinegar, are blended together with the help of an emulsifier (in this case, mustard), creating a stable mixture.	
Discussion Questions: What did you observe when you combined the oil, vinegar, mustard, and other ingredients? How did they mix together? Why is it challenging to blend oil and vinegar without an emulsifier? Can you think of other examples of emulsions in cooking or food products?	

Dextrinisation:	**Toasted Bread**
Ingredients:	Slices of bread
Method:	Toast bread slices until they turn golden brown.
Toasting bread dextrinises the starch molecules, creating a crispy texture and enhancing the flavour.	
Discussion Questions: What changes did you notice in the bread slices after toasting? How did their color and texture change? How does toasting bread dextrinize the starch molecules and enhance the flavor? Are there other foods you can think of where dextrinization is important?	

Denaturation:	**Egg foam**
Ingredients:	1 egg
Method:	Separate the egg white from the yolk, ensuring no traces of yolk are mixed in with the egg white. Place the egg white in a clean and dry bowl. Begin whisking the egg white vigorously using a whisk or an electric mixer on medium-high speed. Continue whisking until the egg white becomes foamy and increases in volume.
During the whisking process, denaturation of the proteins in the egg white occurs. The mechanical agitation unfolds the proteins. These denatured proteins then bond together, forming a network that traps air bubbles and stabilises the foam structure. The denatured proteins coagulate and create the desired texture, resulting in a foamy and airy mixture.	
Discussion Questions: What happened to the egg white when it was whisked? How did it change in texture and volume? What is denaturation, and how does it contribute to the foam structure in the egg whites? Can you think of other recipes or dishes that use whipped egg whites as a key component?	

Gelatinisation:	**Cornflour Sauce**
Ingredients:	2 teaspoons cornflour, 2 tablespoons water and 100 ml stock
Method:	In a small bowl, mix cornflour with a small amount of cold water to create a smooth paste. In a saucepan, heat water or broth over medium heat until it simmers. Gradually whisk the cornflour paste into the simmering liquid, stirring constantly to prevent lumps. Continue cooking and stirring until the sauce thickens to the desired consistency. Remove the sauce from heat and let it cool slightly before serving.
This activity demonstrates gelatinization, as the cornflour thickens the liquid when heated. By adding the cornflour paste to the simmering liquid and stirring continuously, the starch molecules absorb water and swell, resulting in a thickened sauce.	
Discussion Questions: What happened to the sauce when the cornflour was added and heated? How did its consistency change? How does gelatinisation occur, and why does the sauce thicken as a result? Can you think of other dishes or sauces that rely on gelatinisation for their texture?	

Maillard Reaction	**Browning Meat**
Ingredients:	Thin slices of meat (such as steak, chicken, or pork), 2 teaspoons oil, pinch of salt and pepper,
Method:	Season the thin slices of meat with salt, pepper, or any desired seasonings. Heat a frypan over medium-high heat and add a small amount of cooking oil. Place the seasoned meat slices in the frypan. Cook the meat slices for a few minutes on each side until they develop a golden-brown crust. Remove the cooked meat slices from the heat and let them rest for a minute. Serve the browned meat slices.
The Maillard reaction occurs during the browning of the meat. The Maillard reaction is a complex chemical reaction between amino acids and reducing sugars present in the meat. When heat is applied, a series of reactions take place, resulting in the development of flavours, aromas, and the characteristic brown color on the surface of the meat.	
Discussion Questions: What changes did you observe in the meat slices as they browned? How did their color and aroma change? What is the Maillard reaction, and how does it contribute to the development of flavors and aromas? Can you think of other foods or cooking techniques where the Maillard reaction plays a significant role?	

Practical Activity Two

Roasted Vegetable Salad, Poached Chicken with Garlic Mustard

In this task you will work in a pair to prepare a roasted vegetable salad with garlic mustard dressing and poached chicken.

Roasted Vegetable Salad

Ingredient:

1 baby beetroot

⅛ butternut pumpkin, peeled and chopped

½ small, sweet potato, peeled and quartered lengthways

1 small carrot

¼ red onion, peeled and sliced into two

3 teaspoons extra virgin olive oil

4 cherry tomatoes

¼ cup baby spinach leaves

25 grams fetta cheese

2 sprigs flat-leaf parsley

Method:

1. **Preheat** oven to 220°C (200°C fan-forced).
2. **Line** two large oven trays with baking paper.
3. **Trim** stalk and tail from beetroot. **Wash** well. **Cut** in half beetroot. **Wrap** beetroot in foil. **Place** on an oven tray; **roast** for 10 minutes.
4. **Divide** pumpkin, sweet potato, carrot, and onion between trays.
5. **Toss** in oil and **sprinkle** with sea salt.
6. **Roast** for 30 minutes or until all vegetables are tender and beginning to brown.
7. **Add** tomatoes to tray; roast for about 10 minutes.
8. **Remove** vegetables from tray when golden and tender.
9. **Remove** beetroot from foil and gently **rub** to remove the skin.
10. **Scatter** fetta over the vegetable salad.

Garlic Mustard Dressing

Ingredient:

1 clove garlic, crushed

1 teaspoon horseradish cream

1 teaspoon Dijon mustard

1 tablespoon red wine vinegar

¼ cup (60ml) extra virgin olive oil

Method:

1. **Whisk** garlic, horseradish cream, mustard, and vinegar in a small bowl.
2. Gradually **whisk** in oil.
3. **Season** with salt and pepper.

Marinated and Poached Chicken

Ingredient:

1 chicken breast

1 tablespoon olive oil

1 teaspoon lemon zest

1 teaspoon fresh rosemary or thyme, chopped

2 garlic cloves, minced

2 teaspoons pomegranate seeds

salt and pepper to taste

Method

1. **Combine** the olive oil, lemon zest, chopped fresh herbs (rosemary or thyme), minced garlic, salt, and pepper in a bowl. **Mix** well to make the marinade.
2. **Place** the chicken breast in a resealable plastic bag or a shallow dish.
3. **Pour** the marinade over the chicken breast, making sure it is evenly coated on all sides.
4. **Massage** the marinade into the chicken.
5. **Seal** the bag or **cover** the dish and **refrigerate** for at least 30 minutes, allowing the flavours to infuse the chicken. For maximum flavour and tenderness, you can marinate the chicken overnight.
6. **Fill** a saucepan with enough water to **cover** the chicken breast.
7. **Bring** the water to a gentle **simmer** over medium heat.
8. Carefully **add** the marinated chicken breast to the simmering water. Ensure the chicken is fully submerged.
9. **Poach** the chicken for approximately 15-20 minutes or until it reaches an internal temperature of 74°C and is no longer pink in the centre. Cooking times will vary depending on the thickness of the chicken breast.
10. Once cooked, **remove** the chicken from the poaching liquid and let it **rest** on a cutting board for a few minutes.
11. **Slice** or **shred** the poached chicken breast and arrange neatly over the roasted vegetable salad.
12. **Garnish** the salad with fresh pomegranate seeds.

Evaluation Questions:

1. Which vegetables in the recipe are most likely to undergo caramelisation during roasting?
2. How does the caramelisation process affect the sensory properties of roasted vegetables?
3. Are there any steps in the recipe that specifically encourage or enhance caramelisation?
4. Which ingredient in the recipe is most likely to undergo denaturation? What factors can contribute to the denaturation of this ingredient?
5. What happens to the chemical structure of this ingredient during denaturation?
6. When does coagulation occur in the recipe?
7. How does coagulation affect the texture and consistency of the dish?
8. What happens to the chemical structure of this ingredient during coagulation?
9. When does emulsification occur in the recipe? What is the emulsifier in the recipe?
10. Can you suggest any alternative ingredients or methods that could enhance emulsification in the dressing?
11. What are the physical and sensory properties of the chicken that was poached like?
12. How would the physical and sensory properties of the chicken have changed if a dry cooking method was used?

Practical Activity Three

Cheese Souffle

In this task you will work individually to prepare a souffle.

Cheesy Souffle

Preparation Time: 20 minutes

Cooking Method: Baking

Cooking Time: 20 minutes

Makes: 1 ramekin (250 to 300 ml capacity)

Ingredients:

- ☐ Butter, for greasing the ramekin
- ☐ 1 tablespoon fresh breadcrumbs
- ☐ 2 teaspoons butter
- ☐ 2 teaspoons plain flour
- ☐ 80 ml low fat milk
- ☐ 1 egg yolk, at room temperature
- ☐ 2 egg whites, at room temperature
- ☐ 30 grams cheese, grated
- ☐ ¼ to ½ teaspoon Dijon mustard

To make prepare the ingredients and equipment:

1. **Preheat** oven to 180°C and **place** a tray inside the oven.
2. **Collect** and **measure** the ingredients.
3. **Grate** the cheese.
4. Using a pastry brush, **grease** ramekin with butter.
5. **Place** fresh breadcrumbs in ramekin and **turn** to coat.
6. **Run** your finger around the inside rim of the ramekin, to remove the breadcrumbs at the top only.
7. **Turn** the ramekin upside down to remove the excess breadcrumbs.

To make the cheese sauce:

1. **Melt** the butter on a low temperature in a small saucepan and **add** the flour.
2. **Stir** until the mixture bubbles, then **remove** from the heat immediately.
3. Slowly **stir or whisk** in half the milk and then **add** the remainder. **Stir** until blended and smooth.
4. **Return** to the heat, **stir** constantly, until the mixture has thickened.
5. **Bring** to the boil and then **remove** from the heat immediately.
6. **Whisk** in the egg yolk, mustard, and cheese.

To make the souffle:

1. **Beat** the egg white in a clean bowl until soft peaks form.
2. **Use** a metal spoon to **add** one spoonful of the egg white to the cheese sauce mixture until just combined. **Repeat** until all the egg white is used.
3. **Pour** the cheese mixture into the ramekin and **smooth** the top.
4. **Run** your finger around the inside rim of each ramekin.
5. **Place** the souffle on the preheated oven tray.
6. **Bake** for 20-25 minutes or until golden brown and puffed. **Serve** immediately.

Evaluation Questions:

1. When does the Maillard reaction occur in the recipe?
2. What are the physical and sensory properties of the souffle like due to the Maillard reaction?
3. When does aeration happen in the recipe?
4. What chemical changes occur as a result of aeration?
5. What physical changes occur as a result of aeration?
6. You might like to draw a diagram to assist your explanation.
7. What is the relationship between denaturation and coagulation in the context of this recipe?

Practical Activity Four

Testing pH

In this task you will work individually to discover the impact of changing pH can have on food.

Title	The physical and chemical impact of pH and enzymes on green vegetables during cooking
Aim	To determine if pH and enzymes impact the physical properties of green vegetables during cooking.
Hypothesis	pH and enzymes impact the physical properties of green vegetables during cooking.
Materials	9 pieces of broccoli or 9 green beans Three medium-sized saucepans filled halfway with water Three litmus pH paper measuring strips or a digital pH thermometer Less than 1 tsp of bicarbonate of soda (alkaline) Less than 1 tsp of citric acid (acid) 9 white plates – plastic or cardboard is recommended so that you can write on them 1 sharpie pen Range of green-coloured pencils or textas

Safety Precautions
1. This experiment can take place in the Food Technology room. 2. Wear lab safety gloves, goggles, and an apron or lab coat. 3. Turn the handles of saucepans towards the back of the stove. 4. Keep hot liquids away from the edge of the table or bench. 5. Use the back hotplates plates and ensure that the saucepan's size matches the size of the hotplate so that the flame does not come over the edge of the saucepan, heating the handle. 6. Wait until hot water has cooled to walk to a sink with it and use an oven mitt to carry it with both hands.

Prediction
What do you predict will happen in this experiment?

Procedure

1. Fill each saucepan halfway with tap water.
2. Identify each saucepan as alkaline, acid, and neutral.
3. Add a little bicarbonate of soda to the alkaline pot and measure the pH; you will need to reach a pH of 8. Dilute the water or add more bicarbonate of soda until the Ph reaches 8.
4. Add a little citric acid to the acid pot and measure the pH; you will need to reach a pH of 3. Dilute the water or add citric acid until the Ph reaches 3.
5. Measure the water's pH level in the neutral pot; it should measure a neutral pH of 7.
6. Place the three saucepans of water on the stove and heat it until it is boiling.
7. Once boiling, add the vegetables.
8. Remove one vegetable sample from each pot after being boiled for 5 minutes and place on white plates labelled acid, alkaline, and neutral. Write 5 minutes under the vegetable sample.
9. Remove one vegetable sample from each pot after being boiled for 10 minutes and place on white plates labelled acid, alkaline, and neutral. Write 10 minutes under the vegetable sample.
10. Remove one vegetable sample from each pot after being boiled for 15 minutes and place on white plates labelled acid, alkaline, and neutral. Write 15 minutes under the vegetable sample.
11. Allow vegetables to cool.
12. Wash the saucepans with hot soapy water and dry them thoroughly while waiting for the vegetables to cool.

Results

Observe your results and complete the following table.

You might like to present your results in a graph.

Vegetable Samples	**Colour in each box the colour of the vegetable sample**	**Describe the sensory properties of the vegetables**				
		Appearance	**Texture**	**Aroma**	**Sound**	**Taste**
Alkaline 5 mins						
Acid 5 mins						
Neutral 5 mins						
Alkaline 10 mins						
Acid 10 mins						
Neutral 10 mins						
Alkaline 15 mins						
Acid 15 mins						
Neutral 15 mins						

Discussion of results
Based on the results, which sample of vegetables had the most appealing physical properties? Explain the chemical changes that took place during cooking that caused these physical changes.
Based on the results, which sample of vegetables had the least appealing physical properties? Explain the chemical changes that took place during cooking that caused these physical changes.
What do you think are the ideal pH conditions to cook vegetables in?
What happens to green vegetables when you cook them in an alkaline and acid environment? Why does this happen?
Conclusion
State whether the hypothesis was proven or not. Justify your response.

Summary Activity

Complete the following tasks.

What is the main idea about this key knowledge and key skills?
Write two or three sentences in your own words.

Use as many of the words provided below as you can to define each of the terms listed.

Brown, dextrin, dry, sweet, reaction. sugars, simple, break down.	Dextrinisation
Brown, water, vegetables, sugar, fruit, simple, break down, natural, caramel, steam, nutty.	Caramelisation
Starch, burst, swell, moist, liquid, irreversible, granules, heat, soften, absorb, walls, thick.	Gelatinisation
Water, blend, mustard, mix, oil, egg yolk, emulsifier, combines.	Emulsification
Coils, heat, protein, uncoil,	Denaturation

bonds, tight, unfold, amino acids, weaken, acid, mechanical action.	
Denatured, re-join, protein, liquid, heat, solid, irreversible, amino acids, un-coiled, thicken.	Coagulation
Air, foam, volume, mechanical action, protein.	Aeration
Protein, sugar, brown, breaking down, starch, flavour some, amino acids, complex.	Maillard Reaction
Describe each of the dry cooking methods listed below.	
Air-Frying	
Baking	
Frying	

Grilling	
Roasting	
Describe each of the wet cooking methods listed below.	
Boiling	
Casseroling	
Simmering	
Steaming	
Stewing	
Poaching	
How is heat transferred via each of the methods listed below?	
Conduction	

Convection	
Radiation	
Provide an example of how each of the following factors can impact food.	
Electromagnetic radiation	
Mechanical Actions	
Enzymes	
pH	

Exam Preparation Activity

Multiple-Choice Questions (5 marks)

Choose the response that is correct or that **best answers** the question.

1. The process in which starch granules in flour absorb liquid and swell, resulting in the thickening of a sauce is referred to as:
    a. Coagulation.
    b. Dextrinisation.
    c. Denaturation.
    d. Gelatinisation.

2. Identify the dry cooking method from the list below:
    a. Poaching
    b. Frying
    c. Steaming
    d. Stewing

3. Carrots, corn and pumpkin turn a golden-brown colour when roasting. This is known as
    a. Dextrinisation
    b. Caramelisation
    c. The Maillard Reaction
    d. Radiation

4. Which method of heat transfer occurs when a spoon left in a cup of tea becomes warm?
    a. Conduction
    b. Convection
    c. Radiation
    d. Induction

5. Which addition below assists with the ripening of food?
    a. Mechanical action
    b. Acids
    c. pH
    d. Enzymes

Short Answer Questions (15 marks)

Question 1 (6 marks)

Study the recipe below and answer the questions:

Scrambled Eggs and Toast

Ingredients:

2 large eggs

2 slices of bread

Butter or cooking oil

Salt and pepper to taste

Method:

1. Crack the eggs into a bowl and whisk them until the yolks and whites are well combined. Add a pinch of salt and pepper and mix.
2. Heat a non-stick frying pan or skillet over medium-low heat. Add a small amount of butter or cooking oil to the pan, allowing it to melt and coat the surface.
3. Pour the whisked eggs into the pan and cook briefly without stirring. As the edges begin to set, gently push them toward the center of the pan with a spatula. Repeat this process until the eggs are mostly cooked but still slightly runny.
4. Remove the pan from the heat while the eggs are still slightly moist. The residual heat will finish cooking them to perfection.
5. Serve with toasted bread.

a. Identify the method of heat transfer used when making scrambled eggs. 1 mark

b. Explain how the method identified transfers heat to the eggs during the cooking process. 2 marks

c. Identify the chemical process that bread undergoes when it is toasted. 1 mark

Describe the chemical change that the toast undergoes. 2 marks

Question 2 (9 marks)

Read the scenario below and answer the questions:

Taylor and Kelly are planning a special dinner, and one of the foods they want to include are golden brown and crunchy potatoes. However, they cannot decide whether to steam or roast the potatoes. Both methods have their merits, but they want to choose the best one to achieve the perfect texture and flavour.

a. Compare the two methods of cooking, steaming and roasting. 4 marks

b. Identify the cookery method that would be the best choice and justify your choice by explaining how each method affects the texture and flavor of the potatoes. 5 marks