Section 2—Food Science learn sheet

Cooking of Food & Heat Transfer

Why is food cooked? Food is cooked in order to:

⇒ Make it safe to eat (cooking destroys micro-organisms)
⇒ Change raw food to cooked food
⇒ Make it palatable: develop flavours; improve mouthfeel; improve texture
⇒ Help keep quality (extend shelf life)
⇒ Make it easier to digest
⇒ Give variety to diet.

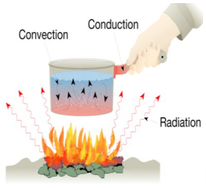
How is food cooked?

- Cooking use heat to change texture, flavour and colour of food.
- Cooking methods are wet (moist), dry or fat-based
- Pre-cooking methods can improve tenderness and flavour e.g. marinating meat or fish
- The selection of a cooking method depends on: the type of food being cooked, time available, the skill of the cook and the facilities available, the desire to improve palatability.

Method	Method of heat transfer	Characteristics	Examples
Water-based			
Boiling	Conduction ➔Convection	Softens	Vegetables, rice, pasta
Simmering	Conduction ➔Convection	Tenderises, evaporates	Stews, sauces, curry
Poaching	Conduction ➔Convection	Tenderises	Fish, chicken, eggs
Braising	Conduction ➔Convection	Tenderises, softens	Meat, fish, vegetables
Steaming	Conduction ➔Convection	Tenderises	vegetables
Oven			
Moist or fat	Conduction	Tenderises	Vegetables, joints of meat, potatoes
Dry			
Grilling	Radiation	Chars, browns, crisps	Bacon, toast, cheese
Baking	Conduction ➔Convection	Browns, crisps	Cakes, pasties
Dry Frying	Conduction	Browns, crisps	Bacon, chorizo, potatoes
Roasting	Conduction ➔Convection	Browns, crisps	Joints of meat, potatoes
Fat-based			
Deep frying	Conduction ➔Convection	Browns, crisps	Battered fish
Shallow frying	Conduction	Sets, browns	Eggs, onion
Stir fry	Conduction	Softens, reduces bulk	Bean sprouts, mushrooms

Heat Transfer

Conduction	Convection	Radiation
• Food molecules vibrate to transfer heat via **conduction**. • Heat is transferred by contact of heat source to pan to food, e.g. frying .	• **Convection** takes place in air (in ovens) or liquids. • Currents occur as heated air or water rises and cooler air or water falls, e.g. boiling water.	• Heat energy passing in direct lines to the food, e.g. grill to food. • Energy from microwaves penetrate food to transfer energy.



Key Words: Palatability, Microwave, Radiation, Conduction, Convection

Functional & Chemical properties of food

Key Words:
Denaturation
pH level
Marinade
Enzymic browning
Oxidation

Proteins

Denaturation: occurs when the structure of amino acids found in protein are altered. They change shape or unfold because chemical bonds are broken.
Protein in food can be denatured by heat, reduction of **pH level**.

Protein coagulation:
Protein coagulation is a type of protein denaturation, it changes in texture, for example, runny eggs become coagulated (set). It usually starts at 60°C and is completed by 70°C. it is irreversible and causes loss of solubility.

Gluten Formation:
Gluten formation occurs when water is added to wheat flour to form a dough. Wheat contains two proteins (glutenin and gliadin which combine to form gluten).

Enzymic Browning:

Bread	Pastry	Pasta
Makes dough stretchy and elastic. Salt and kneading help strength the dough. Gluten forms the structure of the baked loaf of bread.	Rubbing fat into flour makes short gluten strands (shortening). Gluten forms the structure in baked pastry.	Gluten in wheat four helps pasta hold its shape. Gluten makes the pasta dough flexible and increases its ability to hold various shapes.

Enzymic browning occurs on the surface of cut fruits/ vegetables, such as apples/ potatoes. It happens due to cell enzymes reacting with air (oxidation). It can be prevented by; blanching, blanching then freezing, dipping in acid (lemon juice), removal of air, cooking.

Oxidation:
Oxidation causes discolouration e.g. cut lettuce leaves turn pink/brown. Oxidation also causes vitamins to be lost, especially vitamin C. It also enables enzyme activity (browning, discolouration). It can be reduced during preparation and cooking by: cooking vegetables in small amounts of water, using a quicker, shorter method of cooking e.g. steaming, serving vegetables immediately after cooking, using the cooking water for gravy.

Key Words:
Shortening
Plasticity
Aeration
Creaming
Foam
Emulsification

Fats and Oils

Types of fat:

Fat from animal sources include butter and lard (these are saturated fats). Fat from vegetable sources include margarine and vegetable shortening (these are unsaturated fats and are suitable for vegetarians, vegans and certain religions).

Shortening:

Is a process using fat that creates a characteristic short, crumbly texture. Shortening is seen in shortcrust pastry, shortbread biscuits, cookies etc. the process in food preparation most likely to bring about shortening is the rubbing-in method. Fats with plasticity are good shortening agents because they rub-in easily. Fat coats the flour grains, preventing gluten development. During cooking the flour grains absorb the fat, the pastry changed from pliable to rigid (the gluten sets) and the pastry turns golden brown.

Plasticity:

Plasticity means the ability of a fat to change properties over a range of temperatures. Cold fats are solid and firm. Fats a room temperature become soft and spreadable. Plastic fats such as butter and margarine can be used for spreading, rubbing-in, creaming. Warm fats melt and become runny.

Aeration:

Aeration helps products have a light and open texture. Fats aerate mixtures during beating or creaming with sugar. Aeration increases the volume of a product by incorporating air.

Emulsions:

Emulsions are mixtures of liquids that do not normally mix (immiscible liquids). Emulsifiers have a hydrophilic end, which is water loving and forms chemical bonds with water, and a hydrophobic end, which is water-hating and forms chemical bonds with oil. Fats and oils add texture, flavour and colour to emulsified sauces (hollandaise, mayonnaise). Stabilisers keep emulsions mixed, preventing them separating. The process of emulsification requires agitation by whisking, by mixer or food processor. It requires sow addition of oil to prevent the emulsion splitting. **Emulsification** is helped by a natural emulsifier called lecithin, this is present in egg yolks.

Carbohydrates

Key Words:
Gelatinisation
Viscosity
Consistency
Dextrinisation
Caramelisation

Gelatinisation:

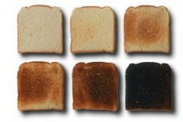
Occurs when starches (wheat flor, cornflour, arrowroot) thicken liquids. The process needs heat and agitation. It occurs during the cocking of starchy food such as potatoes, rice or pasta. Starch grains start to absorb liquid at 65°C, burst at 80°C and finally thicken the sauce. At 100°C gelatinisation is complete so it is important to boil a sauce to when using starch to thicken. The ratio of starch to liquid affects the thickness of the sauce, the higher the ratio of starch to liquid the thicker the sauce will be. Retrogradation is the deterioration of a starch-based sauce on keeping—this results in shrinkage, drying and cracking.

Synerisis is the loss of fluid from a foam or set mixture.

Modified starches are used to help gelatinisation occur in different ways. Quick-cook pasta or rice are modified by pre-gelatinisation. Milk shakes use starch modified to allow cold liquid thickening. Instant thickening granules are modified starch that can be sprinkled into boiling liquids. Modified starches thicken cold desserts without the application of heat, and are used to thicken and stabilise salad dressings.

Dextrinisation:

Occurs when starch is toasted or cooked by dry heat. It is a result of starch breakdown by dry heat to form dextrin's. It changes the properties of starch as a result of heat application, it is also known as non-enzymic browning. Dextrins taste sweeter than starch and add flavour to toasted, charred or baked good. Dextrins are hygroscopic, absorbing moisture from the air. Characteristic of dextrinization are golden colours, browning, sweeter taste and crispness.



Caramelisation:

Causes sugar to change colour and flavour due to dry or moist heat. It causes surface browning on bakes goods containing sugar. It changes the properties of sugar; solutions become syrups, it is also known as non-enzymic browning. Characteristics of caramelisation are a golden colour, browning, gloss, sweetness and stickiness.

Raising Agents

Raising and Aerating

Key Words:
Physical raising methods
Chemical raising agents
Yeast

Physical Methods	Mechanical methods
• **Physical raising agents** such as air, water vapour or steam help products to have a light, open texture. • Recipes that need to be light have ingredients that function as raising agents such as water, milk, egg whites.	• Food preparation methods such as sieving, whisking or beating can be used to trap air. • Combinations of physical and mechanical methods work well in food preparation to make mixtures light, e.g. batters for Yorkshire puddings.

Air, Steam and Foam as Raising Agents.

Air is a very effective raising agent because it expands when it is heated. Air pockets swell and volume increases. Food preparation techniques help prevent loss of air, e.g. folding in flour when making a whisked sponge cake. Steam is produced from water in a mixture; this is a physical change. It produces light, open and uneven textures adding volume during cooking. Moist mixtures produce steam during cooking.

Foams—whisking helps to trap air. Ingredients containing protein form foams, e.g. milk froth, egg whites. Egg whites stretch and unravel to trap air form a gas-in-liquid foam.

Chemical Raising Agents

Chemical raising agents produce carbon dioxide when heated with a liquid. They cause effervescent fizzing and bubbles of gas. Chemical raising agents must be carefully measures. **Bicarbonate of soda** is an alkaline powder, it can leave a soapy aftertaste. It works more effectively with an acid ingredient. **Baking powder** is a ready-to-use mixture of cream of tarter plus bicarbonate of soda and rice flour. **Self-raising flour** is plain flour and baking powder added together to create rise. It contains a pre-sieved precise measured amount of baking powder for ease and speed of use.

Biological Raising Agents

Yeast is a biological raising agent. It ferments to give off carbon dioxide gas. Fermentation in yeast is a biological raising agent. The conditions for yeast fermentation are warm temperature 25°C-35°C; moisture; food; time.