THE INSTITUTE OF EDUCATION

Home Economics

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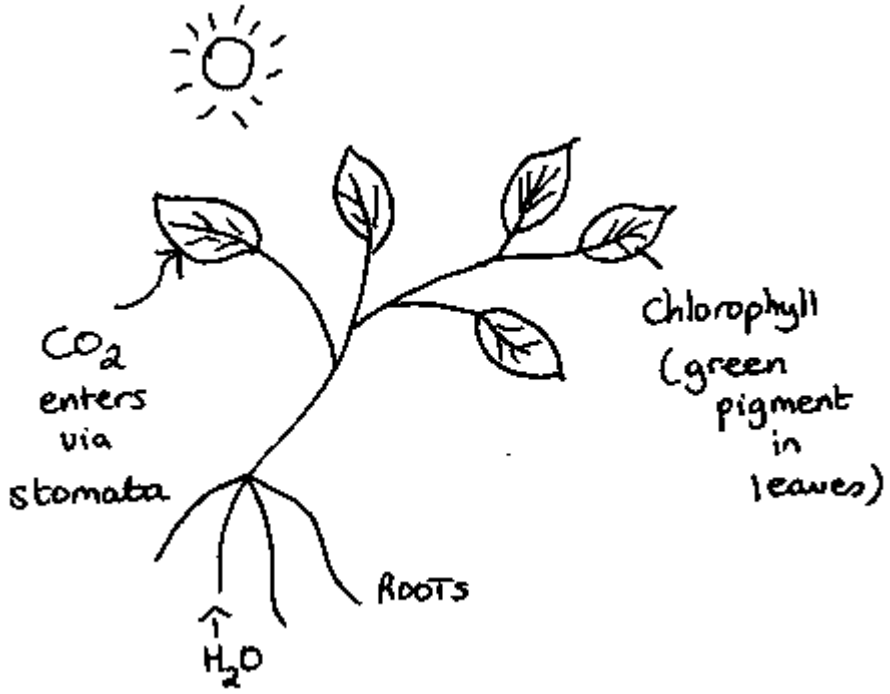
Higher Level

2020-21

Carbohydrates

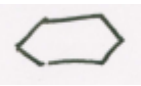
Carbohydrates 2005, 2007, 2012 Q1.B

- Plants have the ability to make their own food by a process called Photosynthesis.



- H_2O is absorbed via the roots.
- CO_2 (from air) is absorbed visa stomata in the leaves.
- Sunlight (energy) is absorbed by chlorophyll in the leaves.

RESULT

- The plant produces food ($C_6H_{12}O_6$)
- The plant food is also known as simple sugars called monosaccharides.
- They are hexose sugars 

Chemical Equation for Photosynthesis

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + CO_2$$

Elemental Composition of Carbohydrates

Carbo hydrates

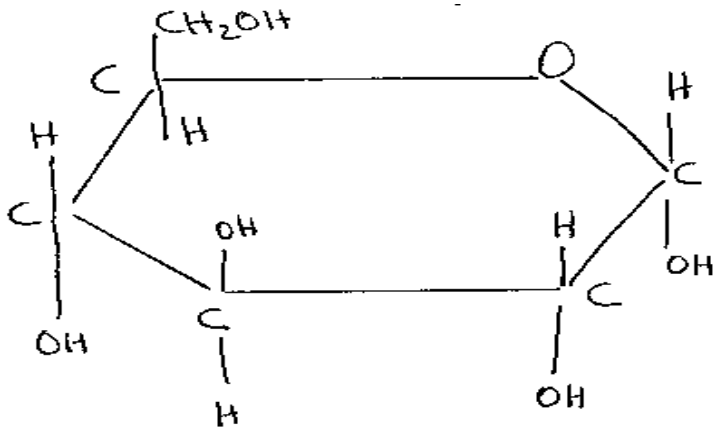
↓ ↓

Water

C H O

H:O = 2;1 EG. $C_6H_{12}O_6$

- The most common monosaccharide is Glucose
- It has the following structure



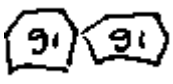
Note: The only difference between monosaccharides is their molecular arrangement (ie. The position of Carbon, Hydrogen and Oxygen differs with each hexose sugar.)

- Monosaccharides are also known as simple sugars (they cannot be broken down any further and they are absorbed easily by the villi in the small intestine)

- Disaccharides
- In some plants the products of photosynthesis (ie. Monosaccharides) are arranged in pairs.
- Two monosaccharides link together.
- As the chemical link is formed one molecule of water is eliminated in a condensation reaction (H from one monosaccharide and OH – hydroxyl group from the other monosaccharide.
- Chemical formula for disaccharides $C_{12}H_{22}O_{11}$ (Note: H : O 2 : 1)

$$C_6H_{12}O_6 + C_6H_{12}O_6 - H_2O$$

$$C_{12}H_{24}O_{12}$$

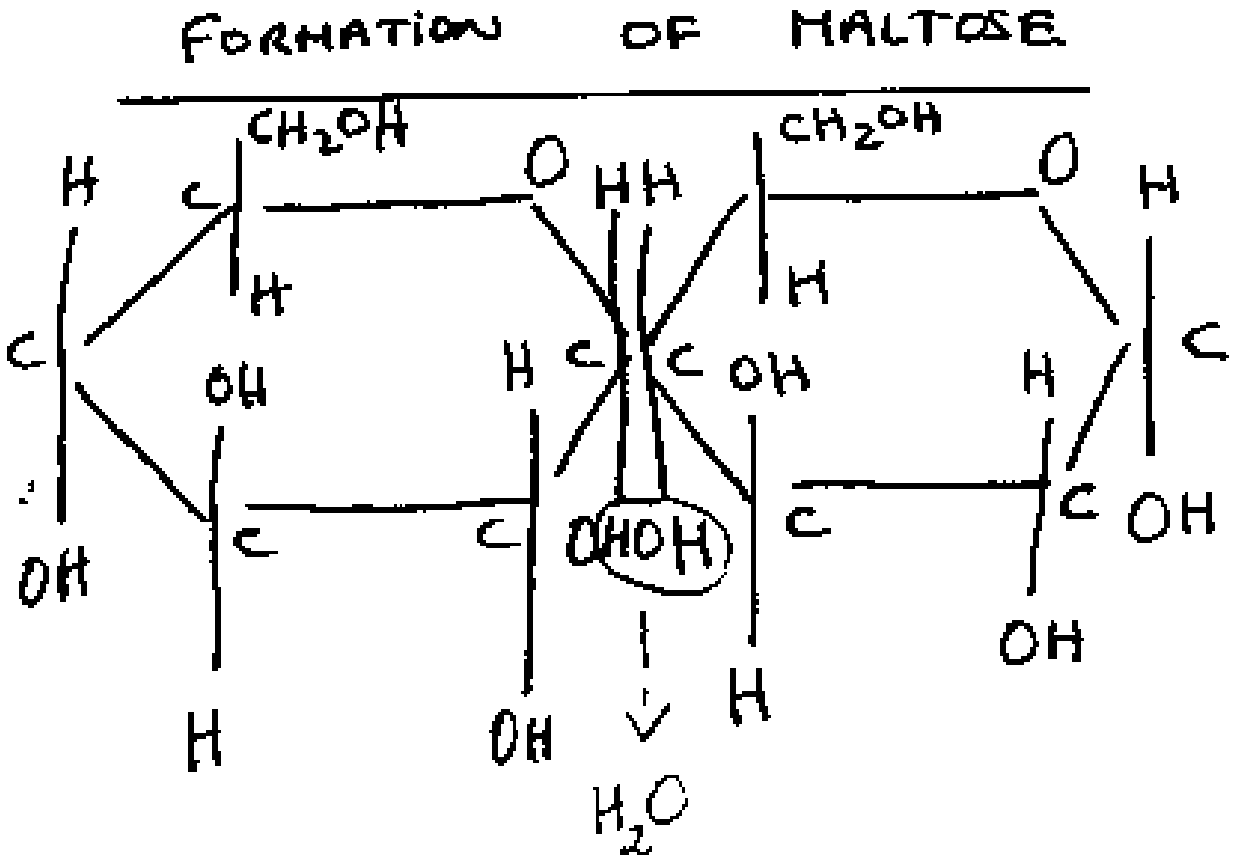
Example of Disaccharide	Formation	Source
Sucrose		Table Sugar
Lactose		Milk
Maltose		Germinating barley

 = Glucose

 = Galactose

 = Fructose

Formation of Maltose



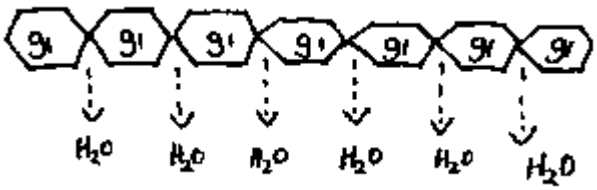
- Two glucose units (monosaccharides) link together.
- H_2O (one molecule of water) is eliminated as H from one glucose joins with OH from the second glucose ie. Condensation reaction.

H=Hydrogen

OH= Hydroxyl group.

Polysaccharides

- In other plants the monosaccharides are arranged in chains eg. Potato plant.



- Many monosaccharides link together and water is lost each time two monosaccharides link.

- Formula → $(C_6H_{10}O_5)_n$

Note: n = number of monosaccharides in the polysaccharide chain.

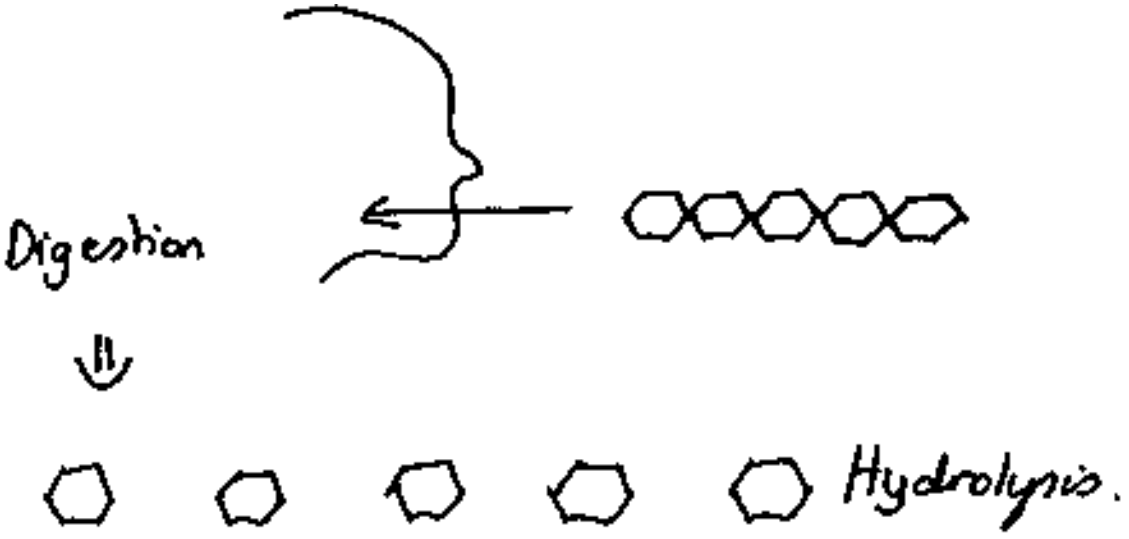
Examples of Polysaccharides

Starch – Present in potatoes, cereals, rice, pasta, vegetable, bread.

Pectin – Gelling agent found in the walls of fruit (ripe fruit) eg. Apples, blackcurrants.

Glycogen – Store of glucose in humans and animals (found in liver).

Dextrins – When bread is toasted, the starch molecules near the surface brown = dextrins.



- Classification of carbohydrates

Carbohydrates may be classified according to (a) Food source.

(b) Chemical Structure.

(a) Food source

Sugar	Jam, honey, sweets, cakes, biscuits
Starch	Rice, bread, potatoes, cereals, pasta.
Cellulose	Fruit, vegetables, bran, whole cereals.

Note:

- Cellulose may also be called fibre or roughage.
- It is an example of a non starch polysaccharide (NSP)
  (ie . cannot be digested by humans) See page _____

(b) Chemical Structure

Monosaccharides	-Glucose -Fructose -Galactose
Disaccharides	- Lactose - Maltose - Sucrose
Polysaccharides	- Starch - Pectin - Glycogen

- **Do not draw diagrams for classification of carbohydrate.**

- Energy Value
  1 gramme of carbohydrate when oxidised releases 4kcals (16.8 Kj) of energy

- RDA of carbohydrate
- None instead the RDA varies on the energy needs of different people.
- The prominence of carbohydrate rich foods varies widely in different parts of the world. Consumption depends on availability and cost of protein + lipid foods and the amount of money that can be spent on food.
- In poor countries 80% of total energy intake is from carbohydrates (mainly starch).
- In wealthier countries eg. Ireland 50% of total energy intake is from carbohydrates.
- There is however an RDA for cellulose/fibre. Current nutritional guidelines suggest a daily intake of 25g of fibre . On average Irish people only consume 18g of fibre per day.

N.S.P.

- Non Starch Polysaccharides cannot be digested or broken down by the body.

Examples

→ Fibre (cellulose)

→ Pectin

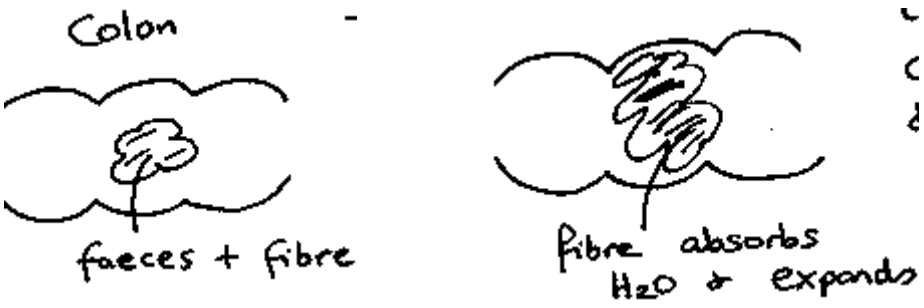
→Gums (guar gum, carob bean gum).

NB. Fibre

What is it?

- NSP
- Also called cellulose or roughage.
- Forms the structural part of plants, outer skins and seed coverings, found in fruit, vegetables, nuts, cereals.
- Cannot be digested.
- Hydroscopic (absorbs six times its own weight in water)
- RDA Fibre = 25-30g.

Functions of Fibre



A. Stimulates Peristalsis

- Fibre passes through the digestive tract undigested.
- However it does have a key role ie. Removal of waste (faeces) from the body.
- Fibre is mixed through faeces. Fibre absorbs water in the colon, as a result the fibre swells and therefore the faeces expand. This soft mass of waste pushes against the muscular walls of the colon/large intestine causing the muscles to contract/relax. This wave like movement is called Peristalsis, it causes waste to move along the colon and eventually leave the body via the back passage.

B. Fibre helps lower cholesterol

Soluble fibre in oats, rye contains plant sterols, these plant sterols can block the absorption of cholesterol in the intestine so the cholesterol passes out of the body.

Eg. Porridge is a good source of plant sterols.

C. Fibre adds bulk to the diet.

By including foods high in fibre in the diet, they can create a feeling of fullness without adding extra kilocalories to a meal eg. Homemade vegetable soup with lots of chunky vegetables, adding peppers, mushrooms, tomatoes to casseroles and Bolognese sauce. Good for people on low Kcal diets.

Fibre Deficiency

A. Constipation

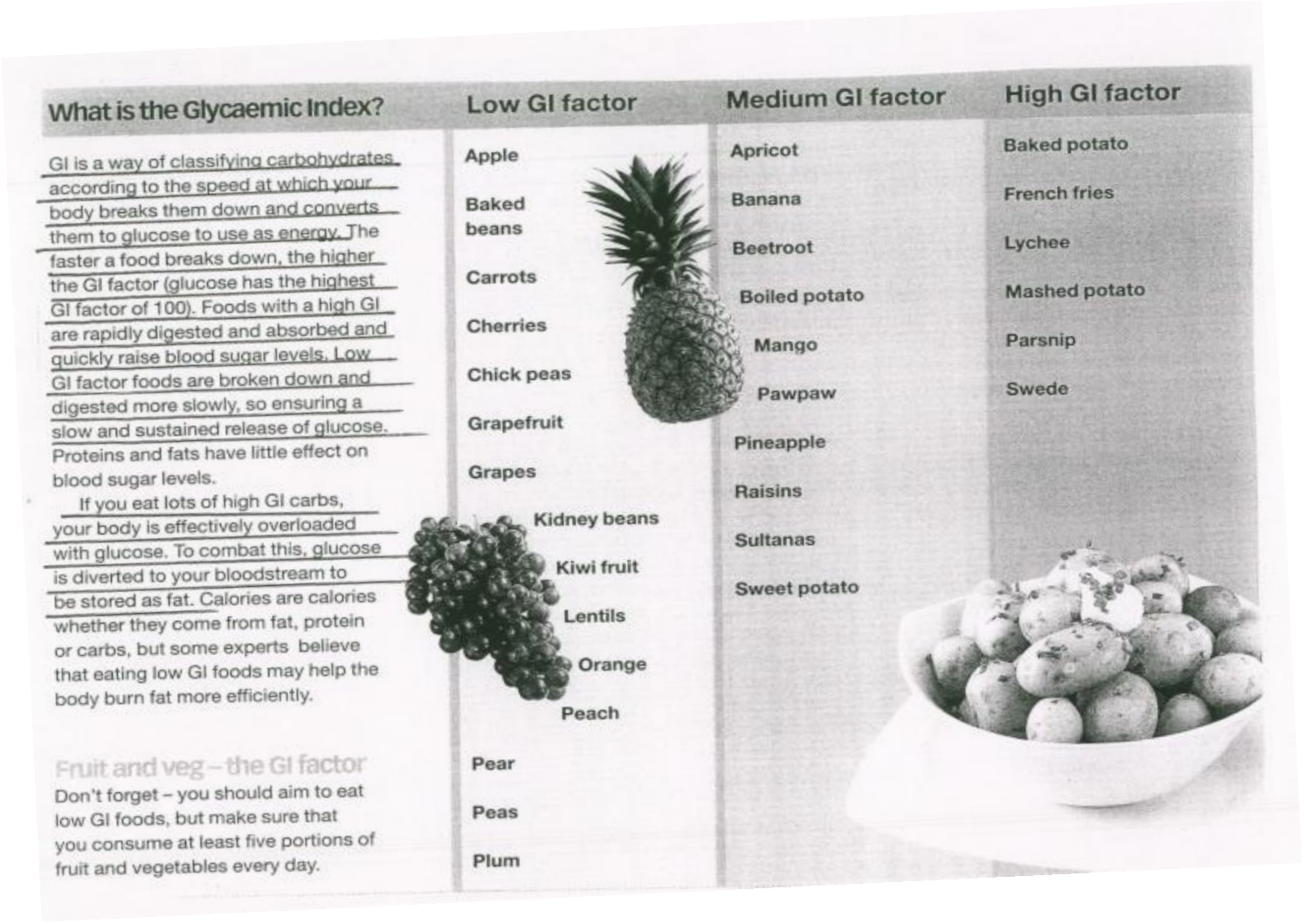
If there is a lack of fibre in the diet, the faeces remain hard in the colon as they cannot expand and stimulate peristalsis. As a result faeces can 'sit' for long periods of time in the colon → called constipation.

B. Diverticulitis

If constipation continues regularly over a number of years pockets or distortions may form in the walls of the colon called 'diverticula' (The condition is called diverticulitis). Waste/faeces may lodge in these diverticula, accompanied by pain/discomfort.

C. Colon Cancer

If waste lodges in the diverticula it can 'go off' and produce toxins. The toxins can in turn act as carcinogens causing normal healthy cells to divide abnormally and produce a tumour.



What is the Glycaemic Index?

GI is a way of classifying carbohydrates according to the speed at which your body breaks them down and converts them to glucose to use as energy. The faster a food breaks down, the higher the GI factor (glucose has the highest GI factor of 100). Foods with a high GI are rapidly digested and absorbed and quickly raise blood sugar levels. Low GI factor foods are broken down and digested more slowly, so ensuring a slow and sustained release of glucose. Proteins and fats have little effect on blood sugar levels.

If you eat lots of high GI carbs, your body is effectively overloaded with glucose. To combat this, glucose is diverted to your bloodstream to be stored as fat. Calories are calories whether they come from fat, protein or carbs, but some experts believe that eating low GI foods may help the body burn fat more efficiently.

Fruit and veg – the GI factor

Don't forget – you should aim to eat low GI foods, but make sure that you consume at least five portions of fruit and vegetables every day.

Low GI factor	Medium GI factor	High GI factor
Apple	Apricot	Baked potato
Baked beans	Banana	French fries
Carrots	Beetroot	Lychee
Cherries	Boiled potato	Mashed potato
Chick peas	Mango	Parsnip
Grapefruit	Pawpaw	Swede
Grapes	Pineapple	
Kidney beans	Raisins	
Kiwi fruit	Sultanas	
Lentils	Sweet potato	
Orange		
Peach		
Pear		
Peas		
Plum		

Note

Carbohydrate foods with a low GI are sometimes called complex carbohydrates as they release glucose slowly into the blood stream. As long as glucose is 'trickling' into the blood stream hunger pangs stay away!

'Brown foods' are complex carbohydrates eg. Brown bread, brown rice, wholegrain pasta, whole cereals.

Biological Functions

Sugar	Starch	Non Starch Polysaccharides
• Sugar provides energy for the body. • Excess is converted to glycogen (energy store) ↓ Extra is converted into adipose tissue.	• Starch provides energy for the body. • → same • Saves protein from being used as an energy source.	• Cellulose stimulates peristalsis in the colon.

Culinary Functions ie. Functions in cooking.

Sugar	Starch	NSP
• Sweetener in drinks, desserts, cereals. • Activates yeast during fermentation. • Jam making. • Icings and sweets. • Syrups in fruit salad. • Aeration of creamed cakes.	• Used to thicken sauces, soups and gravies. • Dextrins (browning food). • Food source for yeast →baking. • Choux pastry → starch gelatinises.	• Pectin is a gelling agent in jam making. • Bulks out food eg. Vegetables in a soup.

(2007 Q1) GENERAL PROPERTIES OF CARBOHYDRATE (part 2)

- Section A on the Home Economics paper has 12 short questions.
- Students must answer 10 questions @ 6 marks each.
- If the following terms appear re: Carbohydrates, answer as follows:

Explain the following terms

(i) Caramelisation#

- Form of non-enzymic browning
- When sugars are heated above their melting points, they produce a range of brown substances known as caramel.
- Caramelisation occurs most readily in the absence of water (eg. Crème brûlee) but sugar solutions (syrups) will caramelise if heated strongly enough.
- There are ten changes between melting of sugar and caramelisation (first stage @ 104ºC, last stage @ 177ºC)
- Avoid too much heat → bitter caramel.

Uses in cookery:

- Crème brûlee
- Caramel squares
- Crème caramel.

(2) Sweetness

Sugar	Relative Sweetness
Fructose	170
Sucrose	100
Lactose	15

- All sugars are sweet (but do not have the same degree of sweetness)
- Using the tasting method the sweetness of different sugars can be compared using a point scale in which sucrose is 100.
- Starch and other polysaccharides do not have a sweet taste.

Uses of sweetness in cookery.

- Pavlova or meringues
- Sprinkling sugar over fresh strawberries
- To sweeten custards/cream.

(3) Solubility

- This is the degree to which a substance will dissolve in a given solvent.
- Sugars (monosaccharides and disaccharides) are very soluble in cold water.
- Solubility is increased by heating water.
- Sugars form supersaturated syrups (eg.Ice cream made based on syrup)

Note Starches and other polysaccharides are insoluble in water.

Uses of Solubility in cooking

- Fruit syrup in fruit salad.

- Making Ice cream using a syrup.

(4) Gelatinisation (2007)

- If a mixture of starch and liquid is heated, the water penetrates the outer layers of the granules (starch) and the starch granules begin to swell.
- As the size of the granules increase, liquid is absorbed and the mixture becomes more viscous ie. Thick and gluey.
- Initial gelatinisation @ 55ºC – 70ºC (the liquid begins to thicken)
- Complete gelatinisation @100ºC the mixture becomes more viscous as more liquid is absorbed forming what is called a sol.
- On cooling a sol forms a gel.

Uses in cookery

- White sauce (Lasagne)

- Choux Pastry (eclairs)

- Fruit Glaze

(5) Dextrinisation (2007)

- Effect of Dry heat on starch
- Non-enzymic browning
- Most foods that contain starch (long polysaccharides of glucose also contain small amounts of dextrins (short polysaccharides of glucose)
- On heating, dextrins polymerise to form longer chains and become brown coloured substances called pyrodextrins.
- Pyrodextrins give a brown colour to many foods

Uses in cooking

- Toast

- Bread crust