About Sandra:
Sandra graduated with a B. Ed. (Hon.) in Home Economics from St Catherine’s College of Education for Home Economics. She has been teaching in the Institute since 1991. Sandra also spent two years teaching in the Dublin College of Catering and was assistant to Mairín Uí Chomáin on the R.T.E. cookery series “Cuisine le Mairín”.

She has contributed articles in the print media since 1993. Sandra is the author of the Leaving Certificate revision book, Rapid Revision Home Economics, part of the Rapid Revision series by Folens.
- Plants have the ability to make their own food by a process called **Photosynthesis**.

- H₂O is absorbed via the roots.
- CO₂ (from air) is absorbed via stomata in the leaves.
- Sunlight (energy) is absorbed by chlorophyll in the leaves.

**RESULT**
- The plant produces food (C₆H₁₂O₆)
- The plant food is also known as simple sugars called **monosaccharides**.
- They are **hexose sugars**

**Chemical Equation for Photosynthesis**

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{sunlight}} \text{chlorophyll} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{CO}_2 \]

**Elemental Composition of Carbohydrates**

<table>
<thead>
<tr>
<th>Carbohydrates</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>C H O</td>
<td>2:1</td>
</tr>
</tbody>
</table>

- 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 )

\[
\begin{align*}
\text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6 \cdot \text{H}_2\text{O} \\
\text{C}_{12}\text{H}_{24}\text{O}_{12}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Example of Disaccharide</th>
<th>Formation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>![Sucrose Diagram]</td>
<td>Table Sugar</td>
</tr>
<tr>
<td>Lactose</td>
<td>![Lactose Diagram]</td>
<td>Milk</td>
</tr>
<tr>
<td>Maltose</td>
<td>![Maltose Diagram]</td>
<td>Germinating barley</td>
</tr>
</tbody>
</table>
Formation of Maltose

- Two glucose units (monosaccharides) link together.
- $\text{H}_2\text{O}$ (one molecule of water) is eliminated as H from one glucose joins with OH from the second glucose i.e. Condensation reaction.

$\text{H}=$ Hydrogen

$\text{OH}=$ 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 $\rightarrow \quad (C_6H_{10}O_5)_n$

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

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>Jam, honey, sweets, cakes, biscuits</td>
</tr>
<tr>
<td>Starch</td>
<td>Rice, bread, potatoes, cereals, pasta.</td>
</tr>
<tr>
<td>Cellulose</td>
<td>Fruit, vegetables, bran, whole cereals.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Carbohydrate Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monosaccharides</td>
<td>Glucose, Fructose, Galactose</td>
</tr>
<tr>
<td>Disaccharides</td>
<td>Lactose, Maltose, Sucrose</td>
</tr>
<tr>
<td>Polysaccharides</td>
<td>Starch, Pectin, Glycogen</td>
</tr>
</tbody>
</table>

• Do not draw diagrams for classification of carbohydrate.

• Energy Value
  1 gramme of carbohydrate when oxidised releases 4kcal (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.
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

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Starch</th>
<th>Non Starch Polysaccharides</th>
</tr>
</thead>
</table>
| • Sugar provides energy for the body.  
  • Excess is converted to glycogen (energy store) ↓ | • Starch provides energy for the body.  
  • → same  
  • Saves protein from being used as an energy source. | • Cellulose stimulates peristalsis in the colon. |

Extra is converted into adipose tissue.
Culinary Functions ie. Functions in cooking.

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

(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 brûlée) but sugar solutions (syrups) will caramelise if heated strongly enough.
- There are ten changes between melting of sugar and caramelisation (first stage @ 104°C, last stage @ 177°C)
- Avoid too much heat → bitter caramel.

Uses in cookery:
- Crème brûlée
- Caramel squares
- Crème caramel.

(2) Sweetness

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Relative Sweetness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>170</td>
</tr>
<tr>
<td>Sucrose</td>
<td>100</td>
</tr>
<tr>
<td>Lactose</td>
<td>15</td>
</tr>
</tbody>
</table>

- 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 @ 55°C – 70°C (the liquid begins to thicken)
- Complete gelatinisation @100°C 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