Chemical Structures

Atom: The smallest components of an element that have all of the properties of an element (Whitney and Rolfes)

Element: A type of atom, has unique properties (for ex. iron, oxygen)

Molecule: Two or more atoms of the same or different elements joined by chemical bonds

Simple Carbohydrates

Monosaccharides

- Glucose: Form of energy used in body
- Fructose: From fruits and honey
- Galactose: Part of lactose

Disaccharides

- Maltose = glucose + glucose
- Sucrose = glucose + fructose
- Lactose = glucose + galactose

Carbohydrates

"Hydrated carbons"

Molecules that are made up of water (hydrogen and oxygen) and carbon
Complex Carbohydrates
“Polysaccharides”

- Chains made of hundreds to thousands of glucose molecules
- **Glycogen** - made in the body of animals to store glucose
- **Starch** – digestable, from plants
- **Fiber** – undigestable, from plants

**Glucose:**
The body’s energy currency

- All cells in the body use glucose for energy
- Brain and nervous system use glucose almost exclusively
- Red blood cells use only glucose

(Fat is also used as an energy source)

**Enzymes for Carbohydrate Digestion**

- **Amylase**: Facilitates the break down of starch to small polysaccharides and disaccharides; in saliva and pancreatic juices
- **Maltase**: Facilitates the break down of maltose; on wall of small intestine
- **Sucrase**: Facilitates the break down of sucrose; on wall of small intestine
- **Lactase**: Facilitates the break down of lactose; on wall of small intestine
Carbohydrate Absorption

- Glucose and Galactose: active transport (fast)
- Fructose: facilitated diffusion (slower)
- Starches: must be broken into monosaccharides before absorption (slow)

Consequences of fast or slow absorption of monosaccharides...How to maintain constant blood glucose levels?

Liver and Carbohydrates

- Converts fructose and galactose to glucose
- Stores glucose as glycogen (70g or 280kcal)
- Converts excess glucose to fat and sends it to fat stores in the body

Muscles and Carbohydrates

- Muscles use glucose for energy
- Can store glucose as glycogen (120g or 480 kcal of energy)
- Uses glycogen stores when necessary

Fate of Absorbed Glucose
Review of Actions of Insulin and Glucagon

When a person eats, blood glucose rises. High blood glucose stimulates the pancreas to release insulin. Insulin stimulates the uptake of glucose into cells and storage as glycogen in the liver and muscles. Insulin also stimulates the conversion of excess glucose into fat for storage. As the body's cells use glucose, blood levels decline. Low blood glucose stimulates the pancreas to release glucagon into the bloodstream. Glucagon stimulates liver cells to break down glycogen and release glucose into the bloodstream.

Run out of Carbohydrates?

- When the body runs out of glucose and glycogen store, it creates its own glucose!
- Converts amino acids (proteins) into glucose (gluconeogenesis)

Carbohydrate Deficit in Diet

- Fat is converted into ketone bodies as an alternative energy source for the brain
- Lots of ketone bodies in the blood causes ketoacidosis, which makes the blood acidic
- Ketoacidosis alters body's basic functions and damages organs

Carb Intake

- Recommended Dietary Allowance (RDA) is 130 grams/day just to supply the brain with glucose.
- 45-65% of daily calorie intake should be in the form of carbohydrates.
- Focus on foods high in fiber and low in added sugars.
Names of Foods that are Carbohydrates?

Added Sugar

• Sugar that is added to food which already has natural sugars in it (for ex, candied fruit)
• DRI suggests intake should be less than 25% of total energy intake
• WHO and FAO suggests that should be less than 10% of total energy intake
• Why?

Diets high in simple sugars

Can cause dental problems such as cavities, tooth decay, and gum disease

• Associated with increased levels of “bad cholesterol”
• Associated with decreased levels of “good cholesterol”
• Can lead to poor nutrition, due to failure to obtain necessary vitamins, minerals, fiber, etc. (empty calories)
Fiber Intake

• The Adequate Intake (AI) of fiber is 14 grams for every 1,000 kcal in the diet
• Most Americans eat only half the recommended amounts of fiber
• Too much fiber (VERY RARE) can lead to malnourishment, GI distress, limited nutrient absorption

2 Types of Fiber

1) Viscous: Soluble, more fermentable
2) Nonviscous: Insoluble, less fermentable

Viscous Fiber

• Gums, mucilages, pectins, psyllium
• Found in: whole grain products (barley, oats, rye), fruits, legumes, seeds, vegetables,
• Also extracted and used as food additives

• Lowers blood cholesterol by binding bile and blocking absorption of cholesterol
• Slows glucose absorption
• Slows transit of food in upper GI tract
• Holds moisture in stools (softening them)
• Digested by bacteria and yield fatty acids the colon uses for energy

→ Lowers risk of both heart disease and diabetes
**Insoluble Fiber**

- Cellulose, Lignins, Resistant starches, psyllium, many hemicelluloses
- Brown rice, fruits, legumes, seeds, vegetables, wheat bran, whole grains
- Also extracted and used as food additives

**Diverticulosis**

**Insoluble Fiber**

- Increase fecal weight and speed of fecal passage through colon
- Provides bulk and feeling of fullness
- Alleviates constipation
- Lowers risk of diverticulosis, hemorrhoids, and appendicitis
- May help with weight management

**Health Problems and Carbs**

Three health disorders related to carbohydrate metabolism are
- Lactose intolerance
- Diabetes
- Hypoglycemia
Lactose intolerance

• Insufficient lactase production causes an inability to digest lactose found in dairy products
• Symptoms include intestinal gas, bloating, nausea, cramping, diarrhea
• Lactose intolerant people may need to find alternate sources of calcium

Diabetes

• Inability to regulate blood glucose levels
• Untreated diabetes can cause ketoacidosis, nerve damage, kidney damage, blindness, and can be fatal
• Three types:
  - Type 1 diabetes
  - Type 2 diabetes
  - Gestational diabetes

Hypoglycemia

• Low blood sugar (glucose)
• Fasting hypoglycemia results when too much insulin is produced even when the patient has not eaten
• Reactive hypoglycemia results when too much insulin is produced after a meal
• Causes shakiness, sweating, anxiety

Graph Blood Sugar after Meals

1) Healthy Individual
2) Diabetic
3) Individual with Hypoglycemia