

# Chapter 4 Carbohydrates

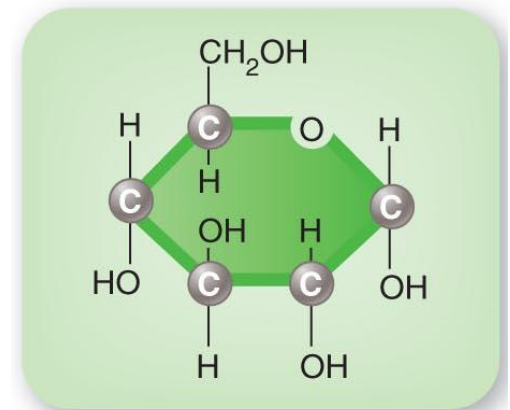
# What Are Carbohydrates?

- **Carbohydrates**

- One of the three macronutrients
- An important energy source, especially for nerve cells
- Composed of the atoms carbon, hydrogen, oxygen
- Good sources include fruits, vegetables, grains

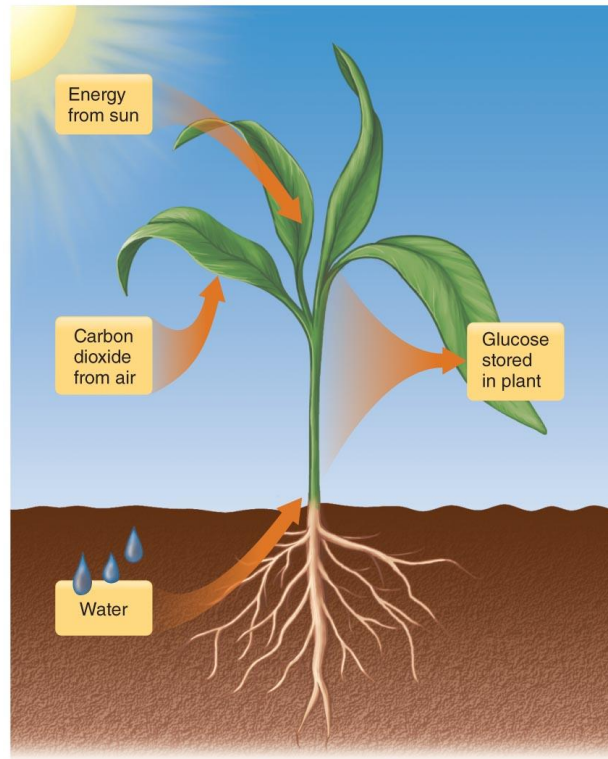
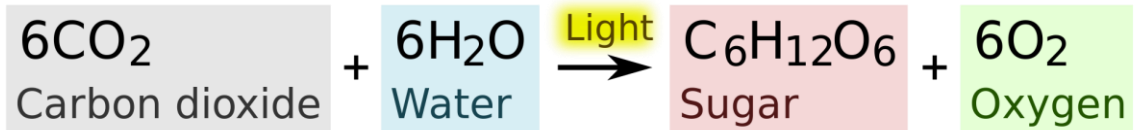
- **Glucose**

- The most abundant carbohydrate (sugar)
- Produced by plants through photosynthesis
- Preferred source of energy for the brain
- An important source of energy for all cells



**Glucose**

# Photosynthesis



# Simple & Complex Carbohydrates

- **Simple carbohydrates** contain one or two sugar molecules

- Monosaccharides
- Disaccharides



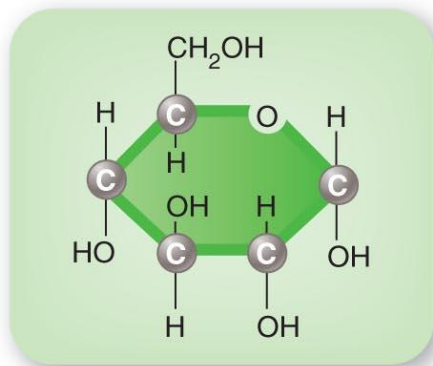
- **Complex carbohydrates** are polysaccharides – these nutrients consist of long chains of glucose molecules.

- Starch
- Glycogen
- Fiber



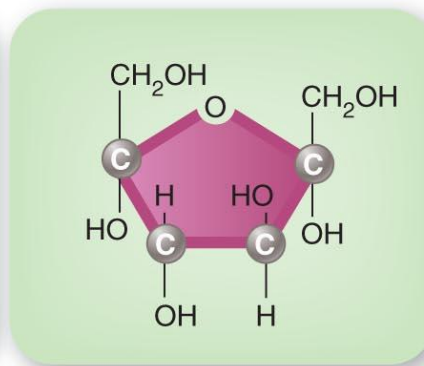
# Simple Carbohydrates

- **Monosaccharides** are the simplest carbs, consisting of only one sugar molecule
  - Glucose, Fructose, Galactose, Ribose



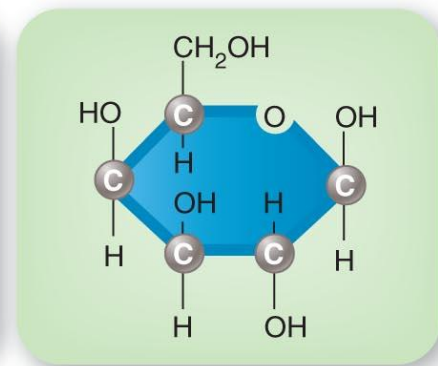
**Glucose**

Most abundant sugar molecule in our diet; good energy source



**Fructose**

Sweetest natural sugar; found in fruit, high-fructose corn syrup

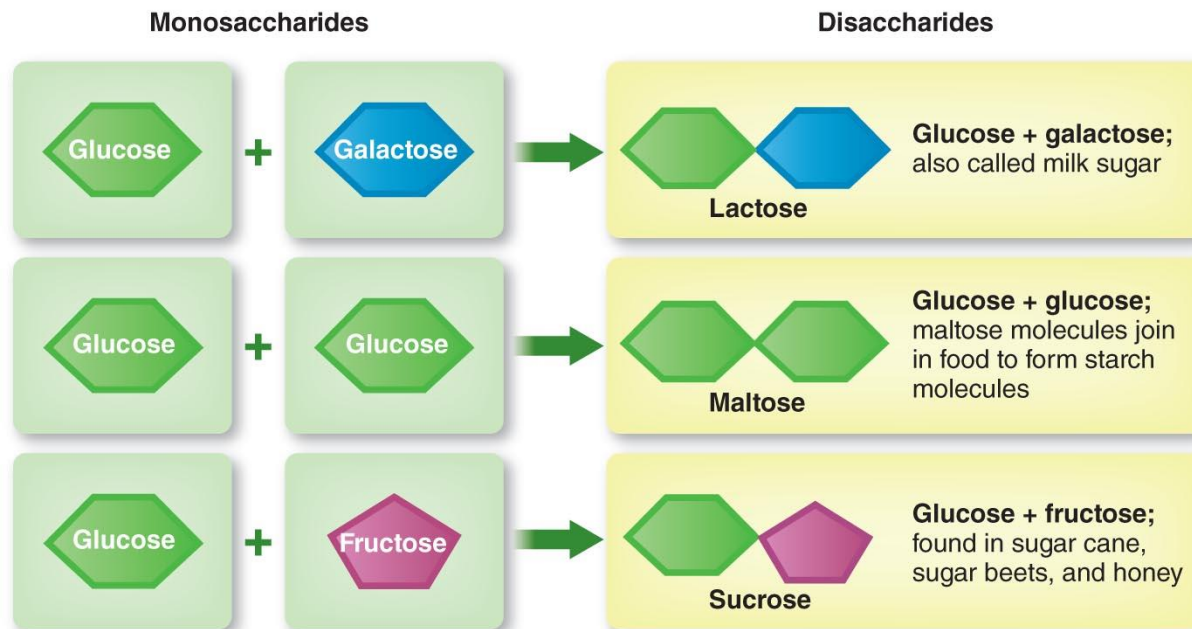


**Galactose**

Does not occur alone in foods; binds with glucose to form lactose

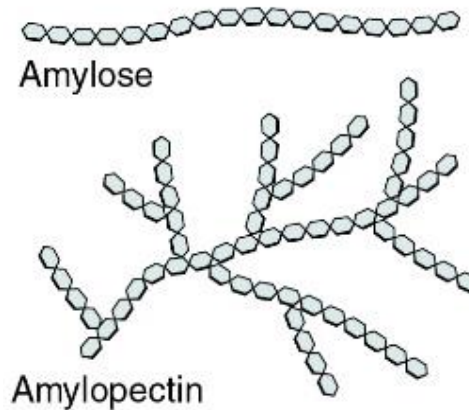
# Simple Carbohydrates

- **Disaccharides** contain two sugar molecules
  - Lactose, maltose, sucrose



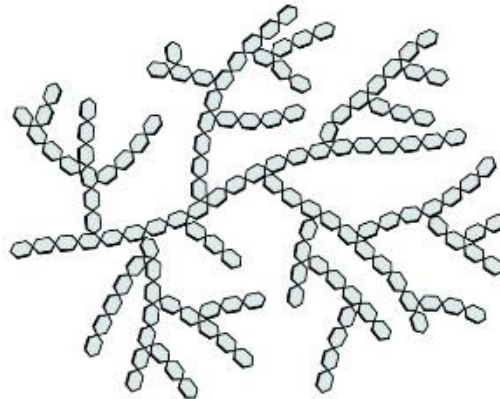
# Complex Carbohydrates

- **Starch** is a polysaccharide stored in plants.
  - This is how plants store glucose
  - Our cells cannot use complex starch molecules exactly as they occur in plants
  - We digest (break down) starch into glucose
  - Grains, legumes, and tubers are good sources of dietary starch



# Complex Carbohydrates

- **Glycogen** is a polysaccharide stored in animals.
  - This is how animals store glucose
  - Stored in our bodies in the liver and muscles
  - Not found in food and therefore not a dietary source of carbohydrate

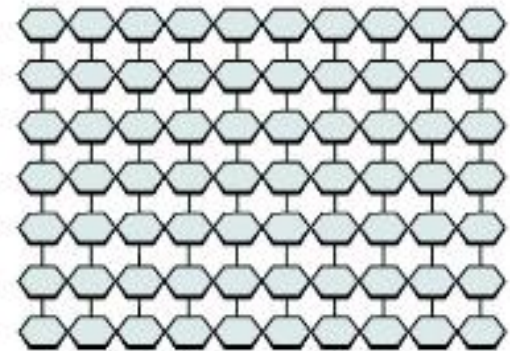


**Glycogen**



# Complex Carbohydrates

- **Dietary fiber** is the non-digestible part of plants that form the support structures of leaves, stems, and seeds.
  - This is like the plant's 'skeleton'
  - Reduces the risk of colon cancer and may enhance weight loss
- Note: Functional fiber is the non-digestible form of carbohydrate with known health benefits, which is extracted from plants and added to foods
  - Cellulose, Guar gum, Pectin, Psyllium
- Total Fiber = Dietary + Functional fiber



**Cellulose (fiber)**

# Complex Carbohydrates

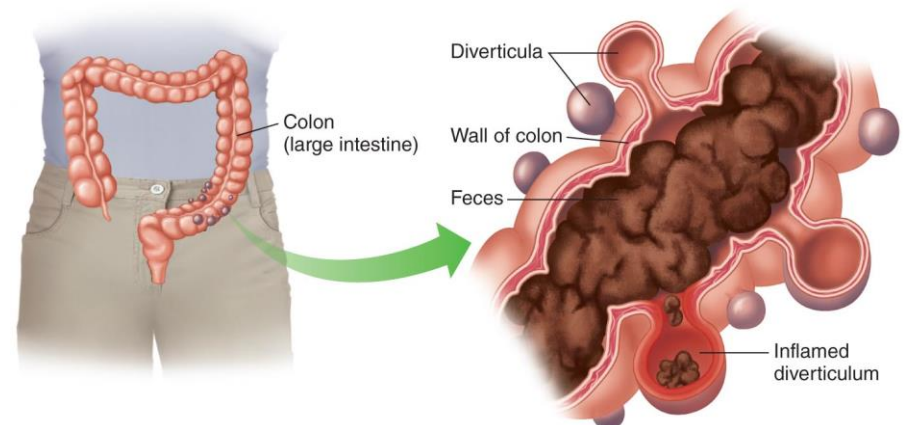
Dietary fiber is also classified by solubility

## Soluble Fiber

- Dissolves in water
- Viscous and fermentable
- Easily digested by bacteria in the colon
- Found in citrus fruits, berries, oats, and beans
- Reduces risk for cardiovascular disease and type 2 diabetes by lowering blood cholesterol and glucose levels

## Insoluble Fibers

- Generally do not dissolve in water
- Found in whole grains (wheat, rye, brown rice) and many vegetables
- Promote regular bowel movements, alleviate constipation, and reduce risk for diverticulosis

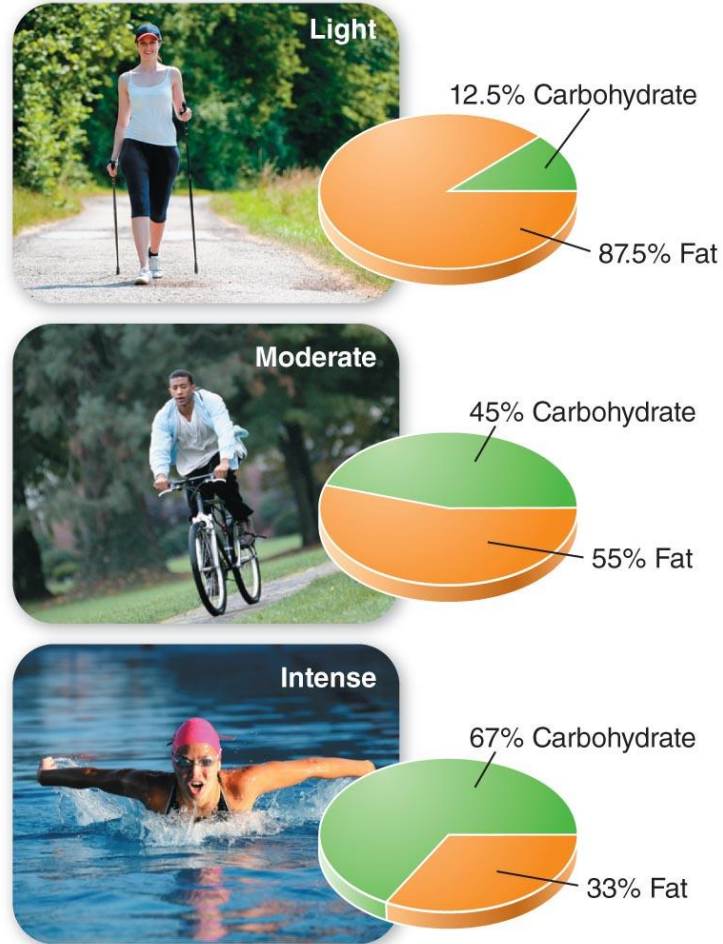


# Energy From Carbohydrates

- One gram of carbohydrates contains 4 calories = **4 kcal/g**
- Energy from carbs are used for:
  - Carbohydrate and fats supply energy to fuel daily activity
  - Glucose is especially important for energy to fuel exercise
  - Red blood cells rely *only* on glucose for their energy supply
  - Help preserve protein for other uses
    - When diet does not provide enough carbohydrate, the process of **gluconeogenesis** converts proteins in blood and tissue into glucose

# Exercise Intensity & Carb Usage

Carbohydrate Use by Exercise Intensity



# Why Do We Need Carbohydrates?

- **Ketosis** is a process caused by an insufficient carb intake, resulting in the **breakdown of fat** and the production of **ketones** as alternate energy source.
  - Insufficient carb intake causes ketosis to occur as our bodies seek an alternative source of fuel
  - Excessive ketones can result in high blood acidity, which damages body tissues
- **Carbohydrate spare protein** is when an insufficient carb intake forces the body to make its own **glucose from protein**
  - **Loss of key functions** when protein is used for energy: Proteins cannot be used to make new cells, repair tissue damage, support the immune system, and properly perform any of their other functions.

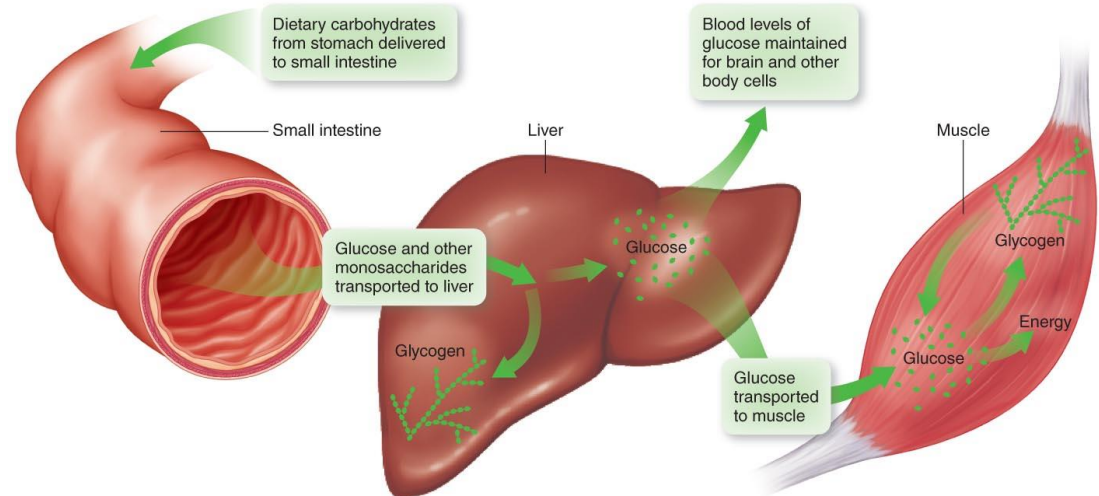
# Effects of a Low Carb Diet

What could potentially develop if a person was eating an **extremely low carbohydrate diet** for a prolonged period of time and was therefore in or near ketosis for a long period of time?

- Our body takes amino acids for energy from the blood, then other tissues such as muscle, heart, liver, and kidney tissues
- Can cause irreversibly damaged to these organs

# Digestion of Carbohydrates

- Most chemical digestion of carbohydrates occurs in the **small intestine**
- Most monosaccharides are **converted to glucose** by the liver. There are two paths that it can follow:
  - Glucose is released into the bloodstream to provide immediate energy
  - Glycogenesis occurs when excess glucose is converted to glycogen and stored in the liver and muscles



# Blood Glucose Regulation: Insulin

- **Insulin** is a hormone secreted by the pancreas that helps **transport glucose** from the blood **into the cells**
  - Stimulates the liver and muscles to take up glucose and convert it to glycogen when blood glucose is high

<b>HIGH Blood Sugar</b>	<b>Step 1</b>	<b>Step 2</b>	<b>Step 3</b>
<b>Action</b>	Insulin secretion	Cellular uptake	Glucose storage
<b>Description</b>	The pancreas secretes insulin	Insulin travels to tissue and stimulates glucose transporters, allowing glucose to enter cells	Insulin stimulates glucose storage.



# Blood Glucose Regulation: Insulin

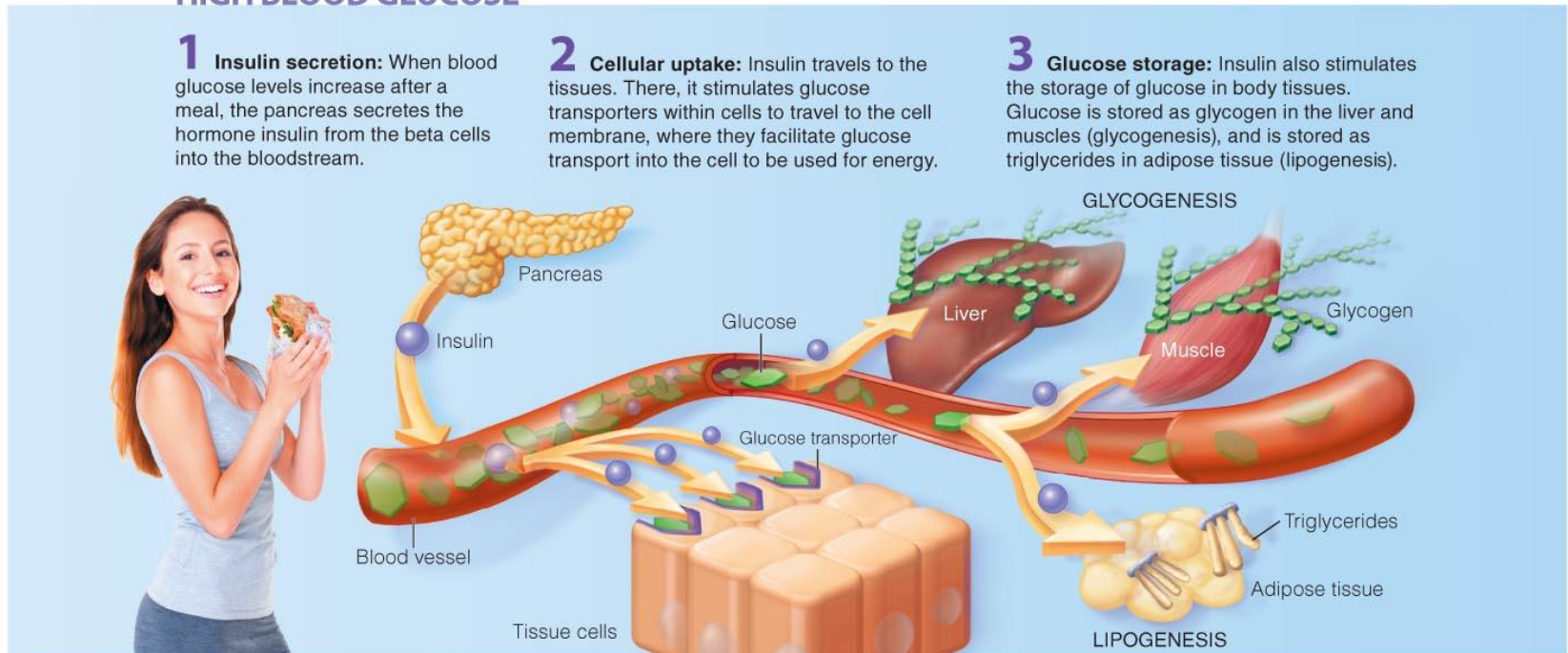
Our bodies regulate blood glucose levels within a fairly narrow range to provide adequate glucose to the brain and other cells. Insulin and glucagon are two hormones that play a key role in regulating blood glucose.

## HIGH BLOOD GLUCOSE

**1 Insulin secretion:** When blood glucose levels increase after a meal, the pancreas secretes the hormone insulin from the beta cells into the bloodstream.

**2 Cellular uptake:** Insulin travels to the tissues. There, it stimulates glucose transporters within cells to travel to the cell membrane, where they facilitate glucose transport into the cell to be used for energy.

**3 Glucose storage:** Insulin also stimulates the storage of glucose in body tissues. Glucose is stored as glycogen in the liver and muscles (glycogenesis), and is stored as triglycerides in adipose tissue (lipogenesis).



# Blood Glucose Regulation: Glucagon

- **Glucagon** is a hormone secreted by the pancreas that stimulates the breakdown of **glycogen to glucose**.
  - Stimulates the liver to break apart glycogen and convert it to glucose when blood glucose is low

<b>LOW Blood Sugar</b>	<b>Step 1</b>	<b>Step 2</b>	<b>Step 3</b>
<b>Action</b>	Glucagon secretion	Glycogenolysis (Glycogen splitting)	Gluconeogenesis (Glucose making)
<b>Description</b>	The pancreas secretes glucagon	Glucagon stimulates liver to convert glycogen to glucose	Glucagon stimulates liver to breakdown protein into amino acids and then into glucose

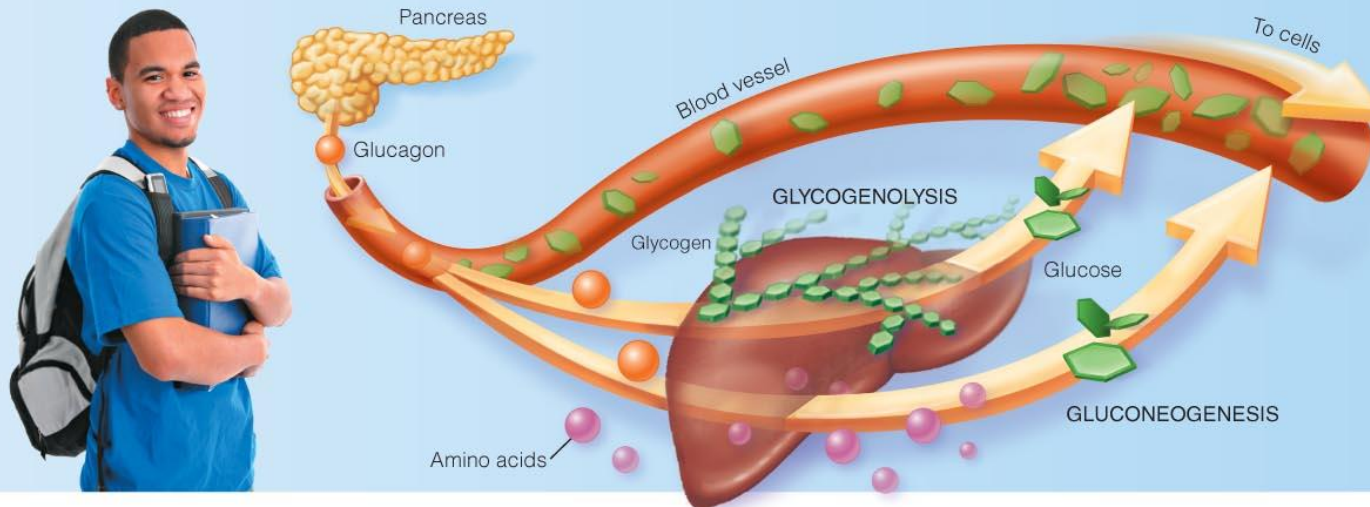
# Blood Glucose Regulation: Glucagon

## LOW BLOOD GLUCOSE

**1 Glucagon secretion:** When blood glucose levels are low, the pancreas secretes the hormone glucagon from the alpha cells into the bloodstream.

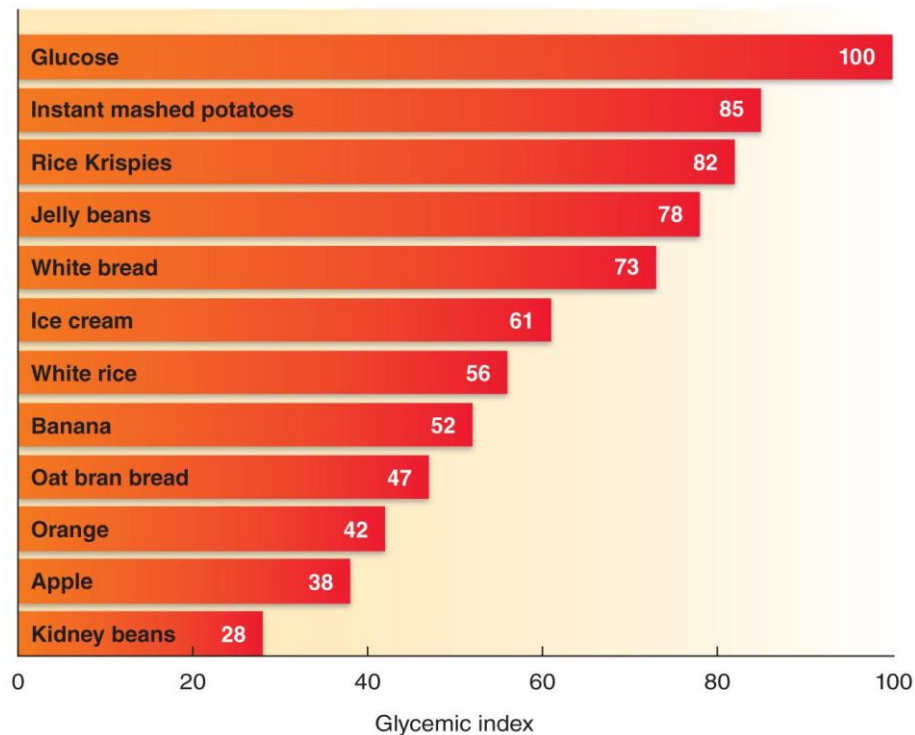
**2 Glycogenolysis:** Glucagon stimulates the liver to convert stored glycogen into glucose, which is released into the blood and transported to the cells for energy.

**3 Gluconeogenesis:** Glucagon also assists in the breakdown of proteins and the uptake of amino acids by the liver, which creates glucose from amino acids.



# Blood Glucose Regulation

- **Glycemic index** is a measure of a food's ability to raise blood glucose levels
  - Foods with a low glycemic index cause low to moderate fluctuations in blood glucose



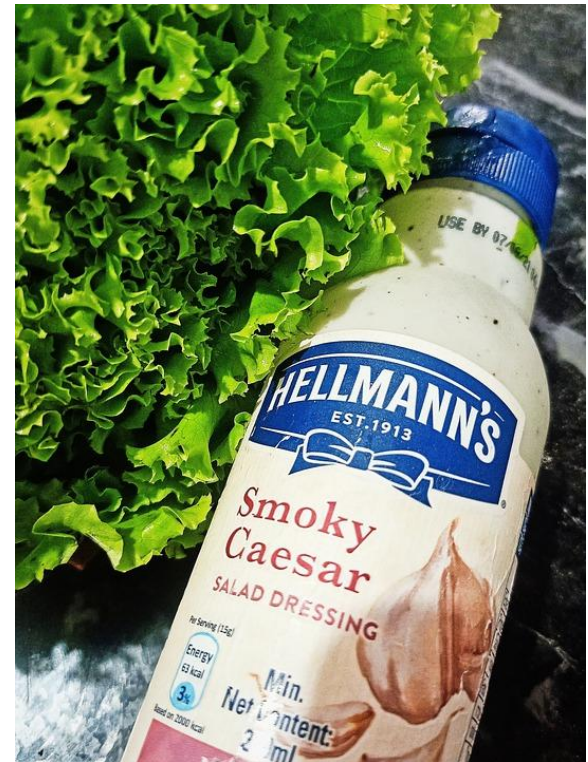
# How Many Carbs Should We Eat?

- The Recommended Dietary Allowance (RDA) for carbohydrate is 130 g per day just to supply the brain with glucose
- **45–65% of daily calorie intake** should be in the form of carbohydrates
  - Women = 225 g/day
  - Men = 325 g/day

Focus on food high in fiber and low in added sugar

# Unhealthy Carbs: Sugar

- Most people eat too much added sugar
  - Sugars are added to foods during processing or preparation
  - Most common source is soft drinks
  - Typical sources are cookies, candy, fruit drinks
  - Unexpected sources include peanut butter, flavored rice mixes, salad dressing
  - Added sugars are not chemically different from naturally occurring sugars, but have fewer vitamins



# Unhealthy Carbs: Sugar

- High sugar diets put people at **much higher risk for the following:**
  - Dental problems and tooth decay
  - Heart disease
  - Diabetes
  - Obesity
  - Unhealthy blood lipid levels

# Diabetes

- **Diabetes** is a chronic disease in which the body cannot regulate glucose within normal limits.
- This metabolic disease is caused when the body cannot produce any or enough insulin, which causes elevated levels of glucose in the blood.





# Type 1 Diabetes

- **Body does not produce enough insulin**
- Accounts for about **5% of all cases**
- Creates high blood sugar (glucose) levels
- Key warning sign is frequent urination
- May lead to ketosis, coma, death
- Classified as an autoimmune disease
- Most frequently diagnosed in adolescents
- Has a genetic link
- **Requires insulin injections daily**



# Type 2 Diabetes

- Body cells become insensitive or unresponsive to insulin – as a result, glucose remains in the blood
- Accounts for 90–95% of cases
- Develops progressively over time
- Obesity is most common trigger
- Eventually the pancreas may become unable to produce any insulin
- Drugs are prescribed that improve cell sensitivity to insulin

# Diabetes

Diabetes is a chronic disease in which the body can no longer regulate glucose within normal limits, and blood glucose becomes dangerously high.

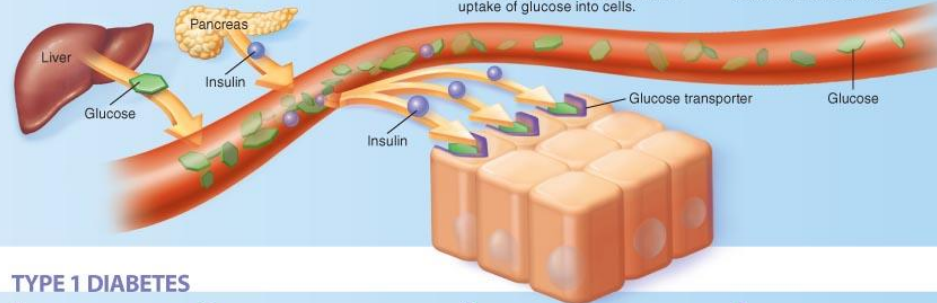
## NORMAL

1 Liver releases glucose into bloodstream.

2 Beta cells of pancreas release insulin into bloodstream.

3 Insulin stimulates glucose transporters within cells to travel to the cell membrane and prompt the uptake of glucose into cells.

4 As glucose is taken into interior of cells, less glucose remains in bloodstream.



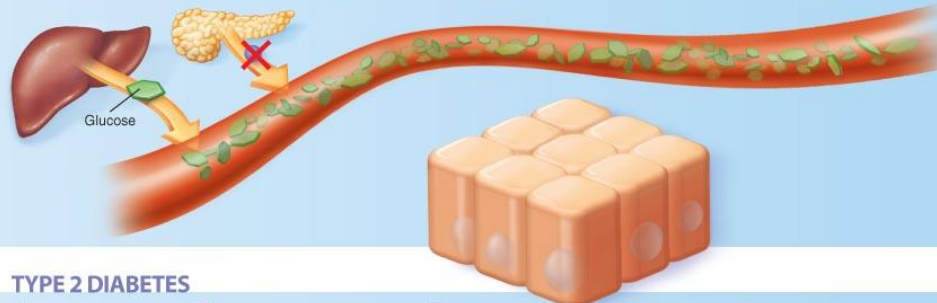
## TYPE 1 DIABETES

1 Liver releases glucose into bloodstream.

2 Beta cells of pancreas are damaged or destroyed. Little or no insulin is released into bloodstream.

3 In the absence of insulin, glucose is not taken up by cells.

4 High levels of glucose remain in the bloodstream.



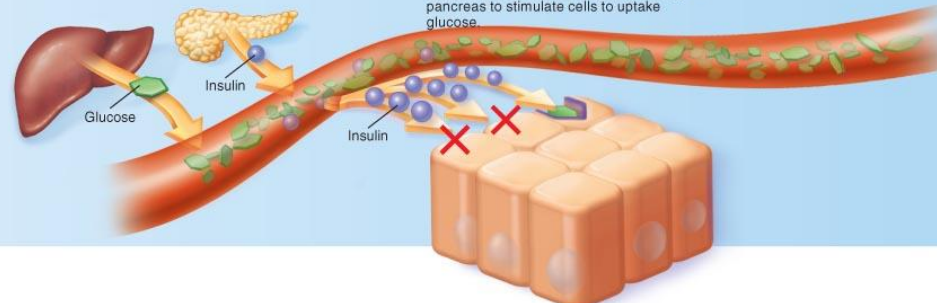
## TYPE 2 DIABETES

1 Liver releases glucose into bloodstream.

2 Beta cells of pancreas release insulin into bloodstream.

3 Insulin is present, but cells fail to respond adequately. Progressively higher amounts of insulin must be produced by the pancreas to stimulate cells to uptake glucose.

4 High levels of glucose remain in the bloodstream.

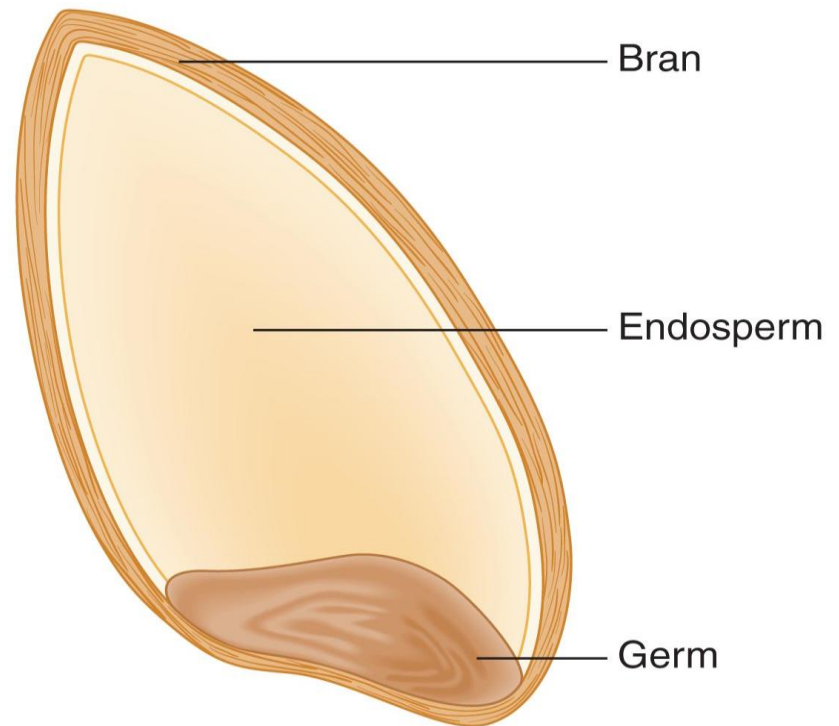


# Symptoms of Diabetes

<b>Type 1 Diabetes</b>	<b>Type 2 Diabetes</b>
Increased or frequent urination	Any of the type 1 signs and symptoms
Excessive thirst	Greater frequency of infections
Constant hunger	Sudden vision changes
Unexplained weight loss	Slow healing of wounds or sores
Extreme fatigue	Tingling or numbness in the hands or feet
Blurred vision	Very dry skin

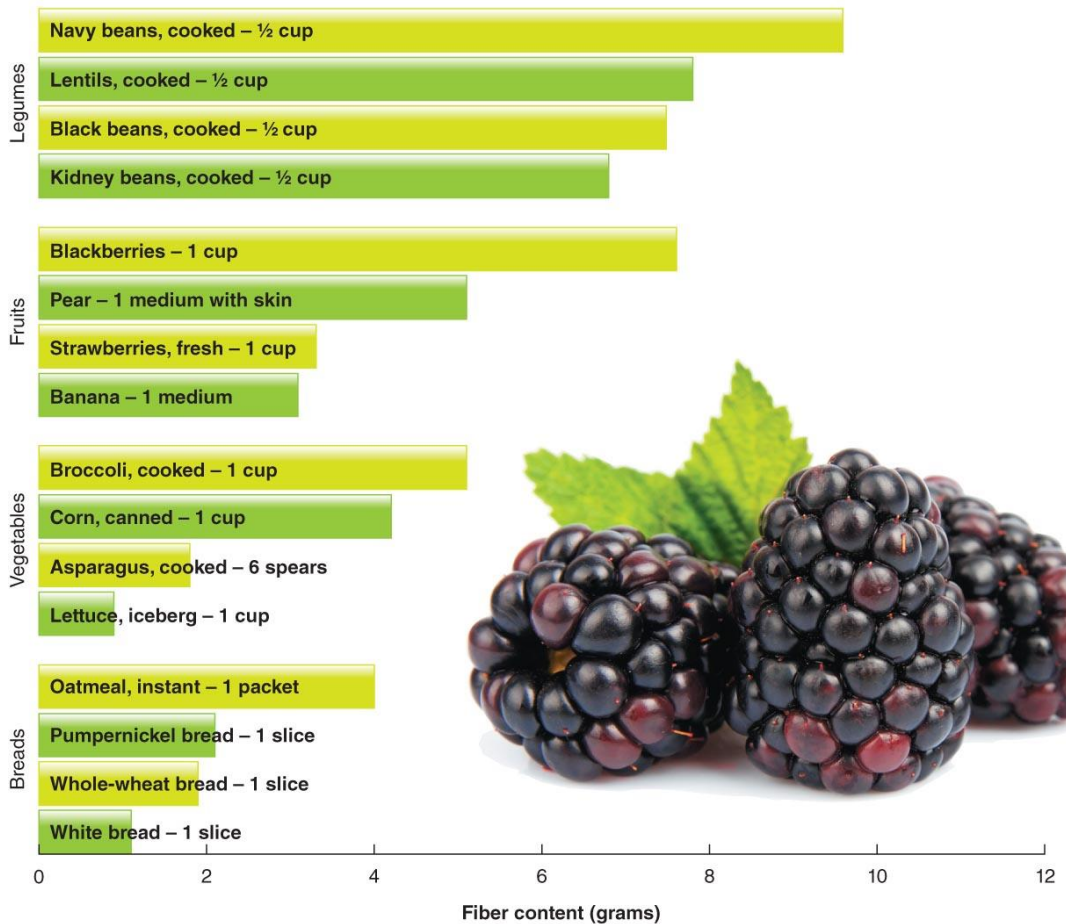
# Healthy Carbs: Whole Grain

- **Whole-grain foods** are kernels that retain the bran, endosperm, and germ
- **White flour** is made from the endosperm only
- **Bran:** Outer covering
- **Endosperm:** Contains carbs and protein
- **Germ:** Contains fats



# Healthy Carbs: Notice the Fiber

- Whole-grains
- Vegetables
- Fruits
- Nuts
- Legumes



# Alternative Sweeteners

- These are food additives that provide a sweet taste like that of sugar, while containing **significantly less kcal**.
- Current research concludes that (if consumed in **moderation**) artificial sweeteners are not harmful.
- Consumption of sweeteners → increased insulin → decreased blood sugar → hunger → increased food consumption → more calories per day → **weight gain**



# How many grams of sugar are in:

- 7-11 Super Size Slurpee

29g

- 7-11 Mega Size Slurpee

39g

- 12 oz can Coke

39g

- 12 oz Mountain Dew

46g

- 2L bottle Coke

220g

