Carbohydrates

Carbohydrates

- **Digestible carbs** (with fats and proteins) add bulk to foods and provide energy
- **Indigestible carbs** (most fibres in foods) - no energy but have other benefits

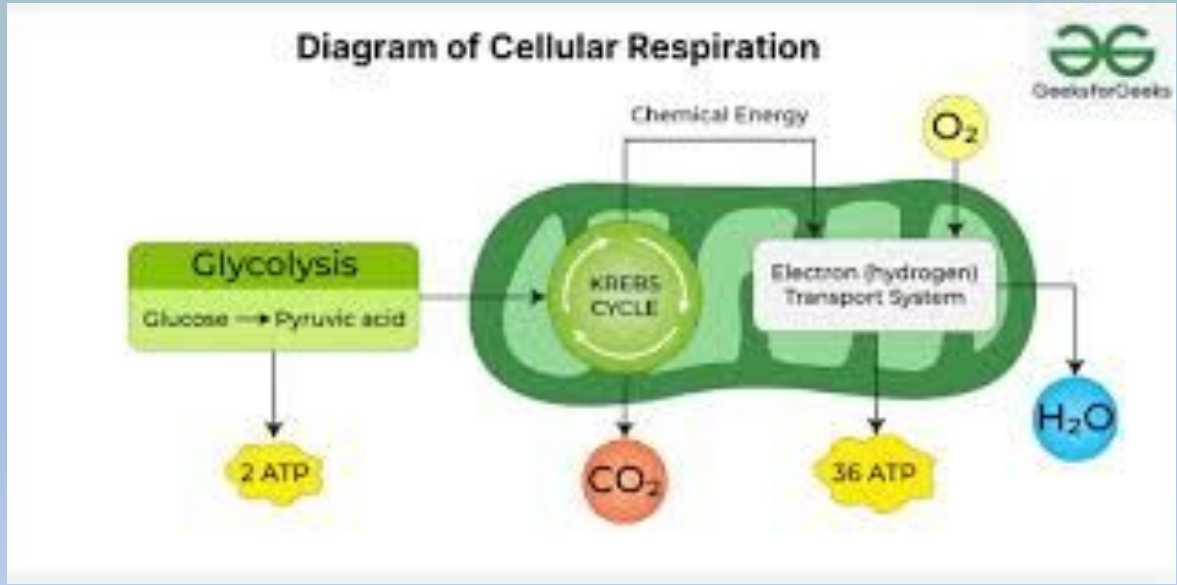
Carbohydrate Biochemistry

Carbohydrates are very important biological molecules.

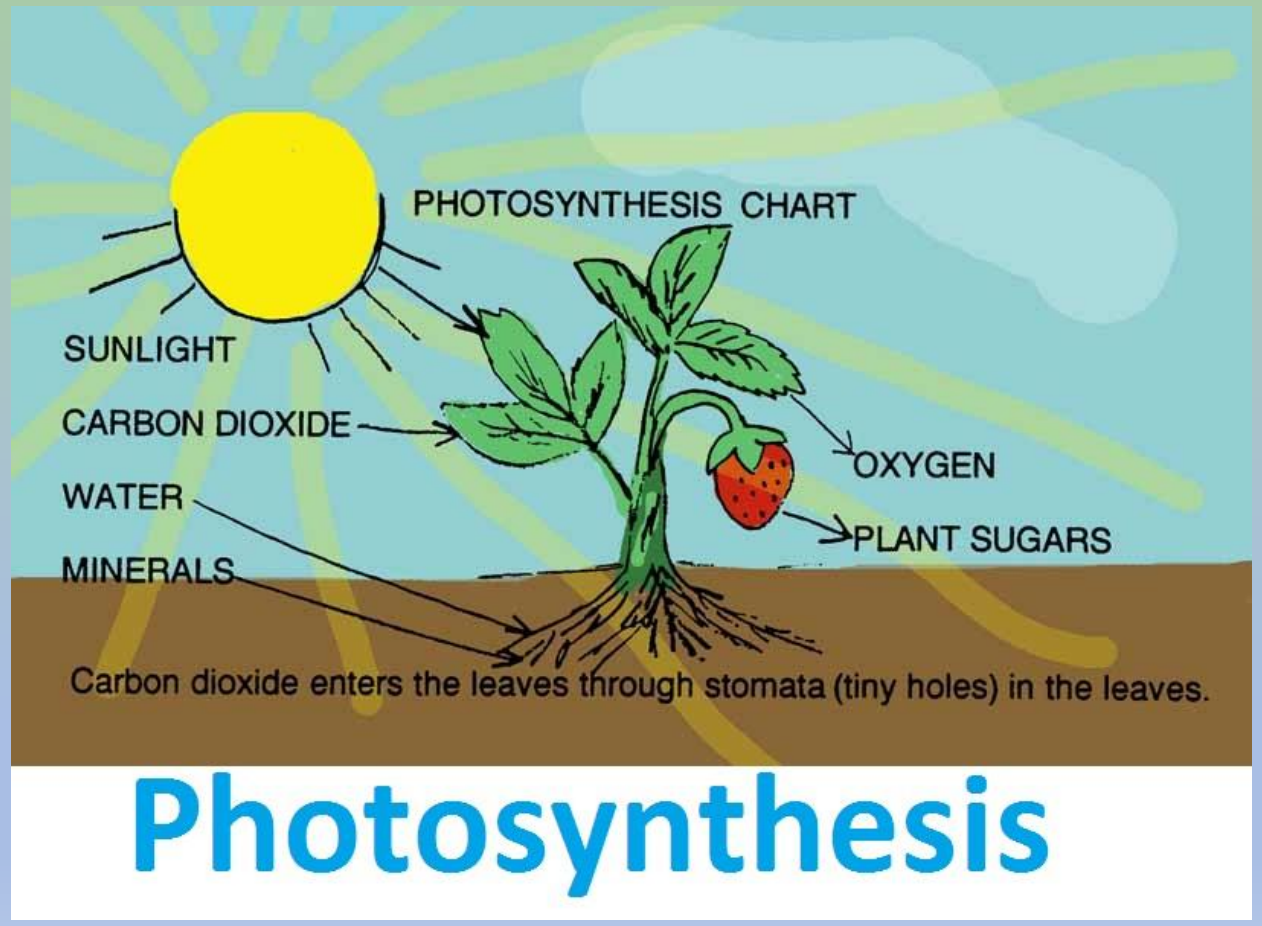
Simple sugars are the primary fuel used for energy.

Remember: glucose produces ATP energy through the process of cellular respiration

[Carbohydrates Bozeman Science]



Carbohydrates contain the sun's energy



- Green plants make carbohydrates through photosynthesis
- CO_2 and H_2O combine to make glucose
- Carbohydrate is made of C, H and O held together by energy- containing bonds

Carbohydrates

Carbohydrates – 3 types

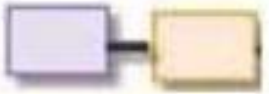
Monosaccharide

Simple sugar

Glucose

Fructose

galactose



Disaccharides

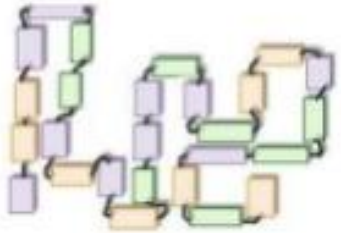
Maltose

Sucrose

lactose

polysaccharides

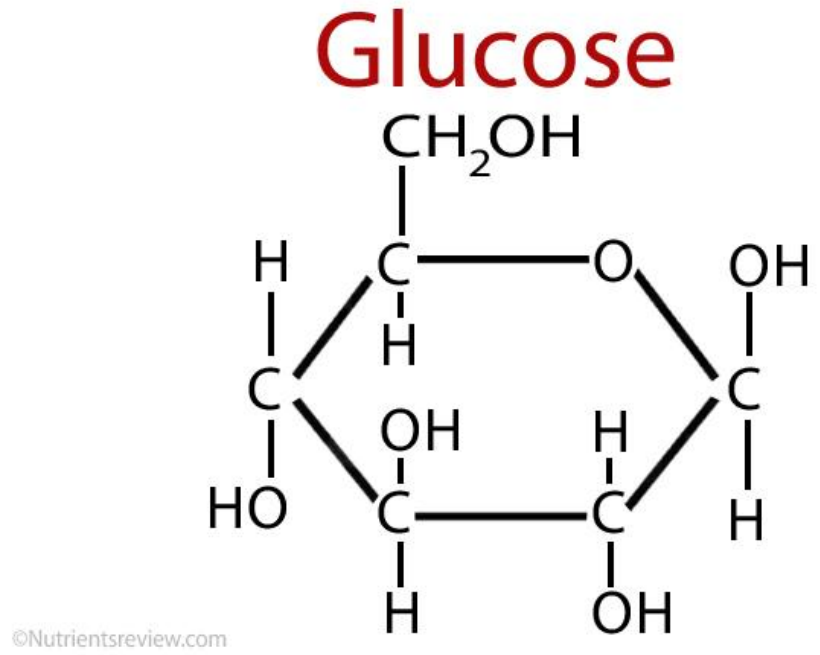
starch cellulose glycogen



Monosaccharides				Dissacharides
Glucose	+	Glucose	→	Maltose
Glucose	+	Fructose	→	Sucrose
Glucose	+	Galactose	→	Lactose

- 3 single sugars (**monosaccharides**): fructose, glucose, galactose
- 3 double sugars (**disaccharides**): sucrose (table sugar), maltose, lactose

Six sugar molecules important in nutrition

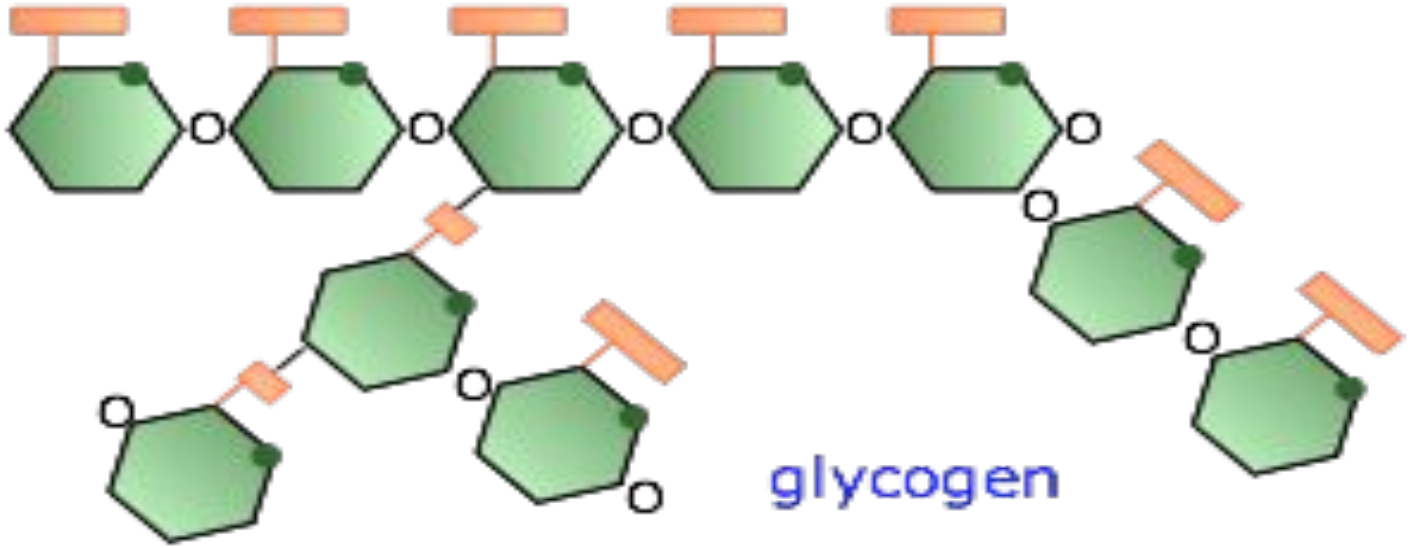


- The most important monosaccharide in body
- Most other monosaccharides and disaccharides become glucose in the body

Glucose

- Long strands of hundreds to thousands of glucose units: starch, glycogen, fibre

Polysaccharides



- **Starch** – storage of glucose in plants, humans can break them down to provide energy
- **Glycogen** – storage form of glucose in animals and humans
- **Fibre (i.e., Cellulose)** – Glucose chains that are linked in such a way that human enzymes cannot digest them.

Polysaccharides

Fibres

- **Soluble fibres:** dissolve in water, form gels (viscous), easily digested by bacteria in human colon. Present in oats, barley, legumes, fruits, vegetables
- **Insoluble fibres:** do not dissolve in water, less readily fermented (cellulose, outer layers of whole grains aka bran), strings of celery, hulls of seeds, skins of corn kernels. They aid digestive system by easing elimination

Soluble Fibre

- Soluble, viscous, fermentable fibres
- Add thickness to food
- Readily dissolve in water
- Cannot be digested by enzymes to produce energy **but** may be broken down to absorbable products by bacteria in the digestive tract
- **Beta-glucan** – a type of soluble fiber that has been extensively studied for its health benefits including heart health, healthy cholesterol levels, stabilizing blood sugar and boosting immunity. Highest food sources include: oats, barley, mushrooms & nutritional yeast

Insoluble Fibre

- Tough, fibrous structures of fruits, vegetables, and grains
- Do not dissolve in water
- Indigestible
- Aid in elimination through the bowels

Why do nutrition experts recommend fibre-rich foods?

Non viscous, insoluble, less fermentable fibre (from brown rice, fruit, legumes, seeds, vegetable, wheat bran, whole grains):

- Alleviate constipation
- Lower risks of diverticulosis, hemorrhoids, appendicitis
- Weight management
- Beneficial prebiotic (support growth of beneficial bacteria)

Soluble, viscous, more fermentable fibre (pectins, psyllium, etc. from barley, oats, bran, rye, fruit, legumes, seeds):

- normalize blood cholesterol
- Viscous fibre: normalize blood glucose (lower risk of diabetes)
- Lower risk of heart disease & diabetes
- Lower bad cholesterol
- Help with weight management

DRI for fibre -

Men 19 - 50 38g/day

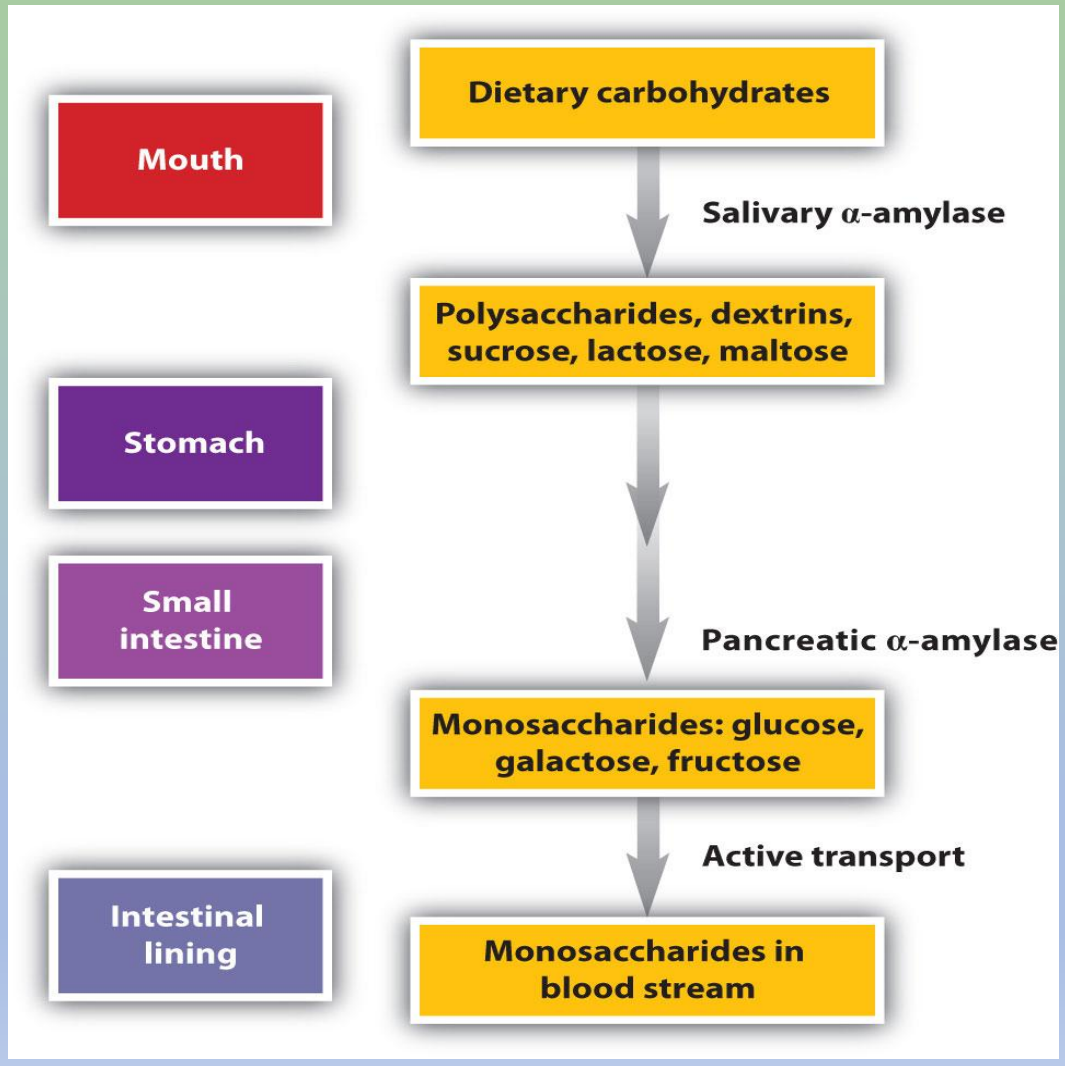
Men 50+ 30g/day

Women 19 - 50 25g/day

Women 50+ 21g/day

OR 14g/1000 kcal/day (USDA)

Digestion of Carbohydrates



Carbohydrate and Nutrition

- **-4 calories per gram**
- USDA recommends 45-65% of your total calorie intake come from carbohydrates

HOW MANY CARBS SHOULD YOU EAT?

TYPE OF ACTIVITY	RECOMMENDED CARBOHYDRATE
Very light training program	3-5 GRAMS / KG
Moderate-intensity training programs, 60 min/day	5-7 GRAMS / KG
Moderate- to high-intensity endourance exercises, 1-3 hours/day	6-10 GRAMS / KG
Moderate- to high-intensity exercises, 4-5 hours/day	8-12 GRAMS / KG

myfitnesspal

- Question: If an individual is consuming a 2000 kcal/day diet and they want 65% of their diet to be carbohydrate, how many grams of carbohydrates will that person need to consume?

- The Math:
- 2000 cal/day * 0.65 = 1300 kcal of carbs
- 1300 cal / 4 cal per gram = **325 g**
- Health Canada does not recommend a certain percentage of carbs but does use 300g as their Daily Value for food labeling

- Consider: Keto diets generally recommend less than 30g carbohydrate per day, low carb can mean under 50, 75 or 100g/day
- When would it be appropriate to follow a low carb – keto dietary plan?

- *Recall that Inuit & other Northern traditional peoples survived on a very low carbohydrate diet*
- *The controversy over carbohydrate recommendations continues & is a major topic of interest in nutritional science*

If I want to lose weight and stay healthy, should I avoid carbohydrates?

- Better to consume balanced diet based on foods high in complex carbs
- Avoid refined sugars – Why?

- 400 calories of refined sugars (sucrose, fructose) contain no other nutrients (protein, vitamins, minerals, fibre) **VS**
- 400 calories of vegetables or whole grains: proteins, vitamins, minerals, ***phytochemicals***, fibre
- OK to choose the refined sugar IF you have met all of your nutrient needs for the day and still have calories to spend

Blood Glucose Regulation

Glucose fuels the work of most of our body's cells. Glucose generates energy through the processes of **glycolysis, Krebs cycle** and the **Electron Transport chain**.

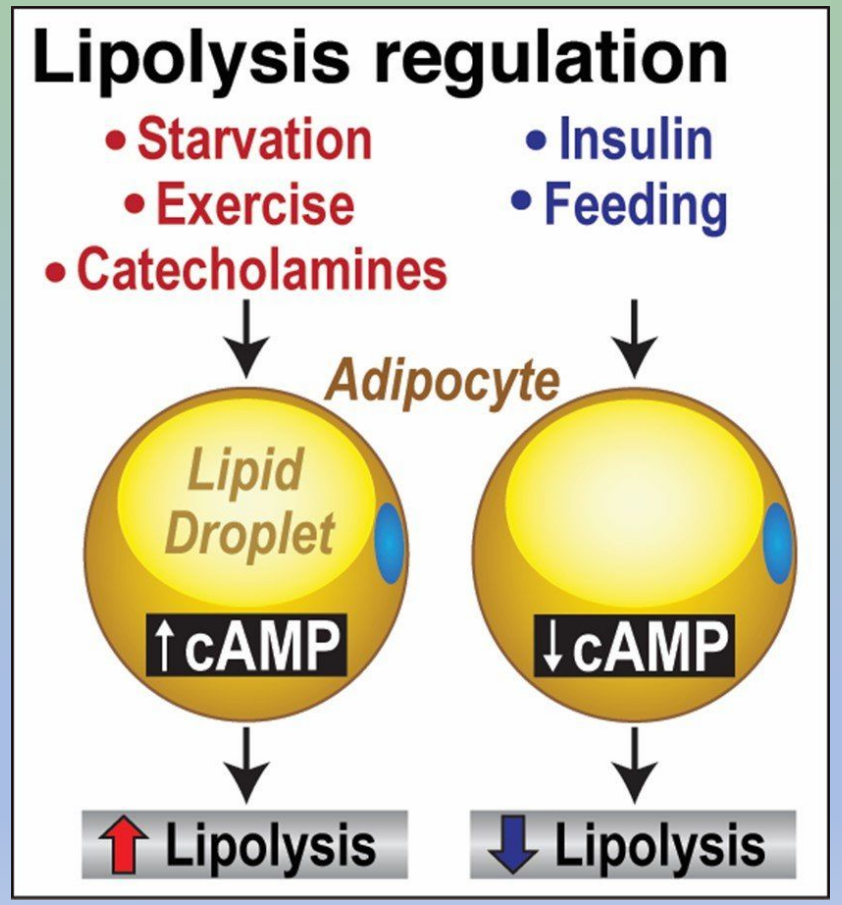
When blood glucose rises, the pancreatic hormone **insulin** stimulates the body cells take take in more glucose. Cells of the **muscles** and **liver** will turn this excess glucose into the highly branched polysaccharide, **glycogen**.

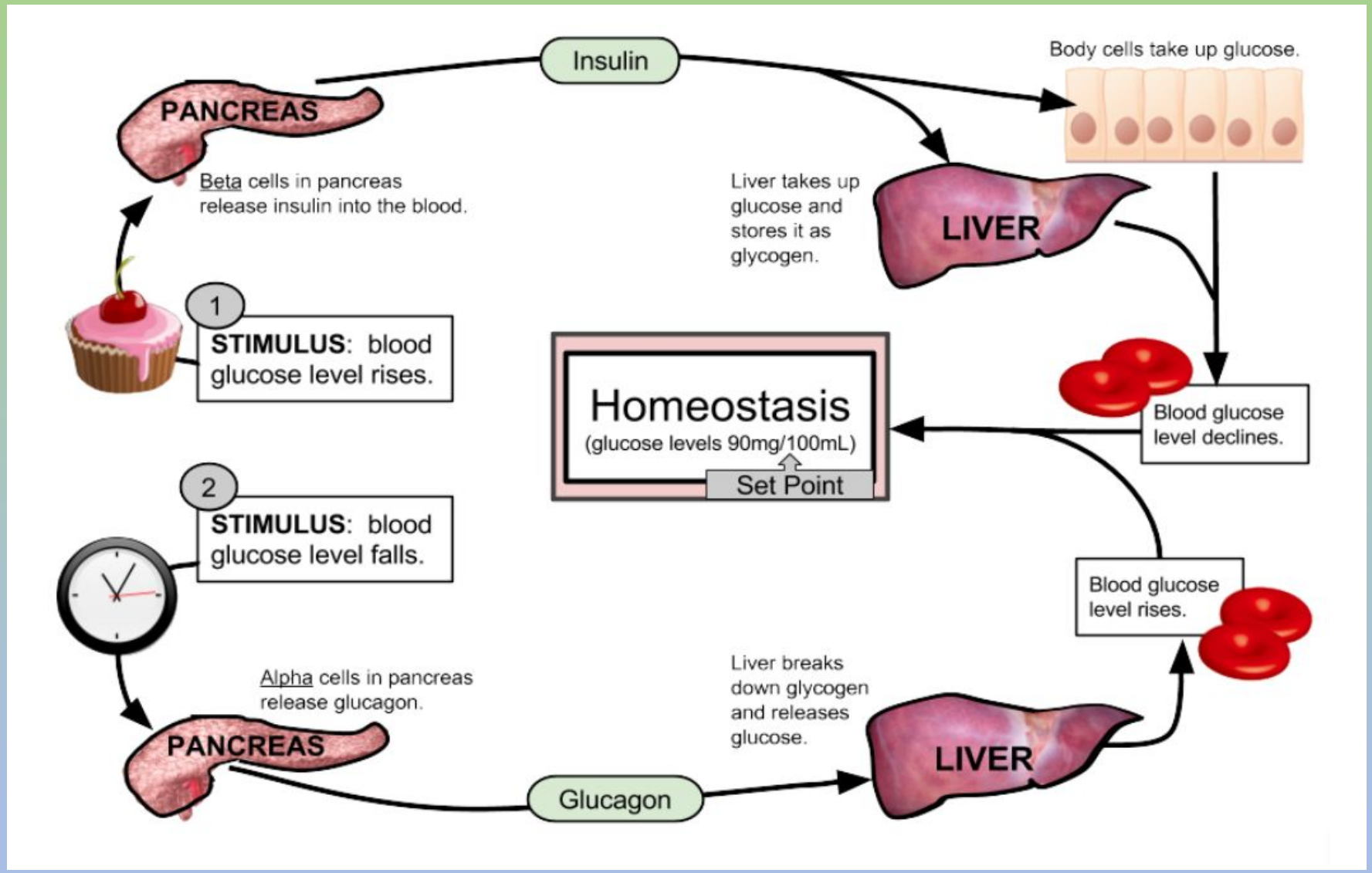
Glucose that exceeds the amount required for energy and glycogen formation will be converted into **fatty acids,** which will be stored as **triglycerides** in the adipose tissue**.**

Blood Glucose Regulation

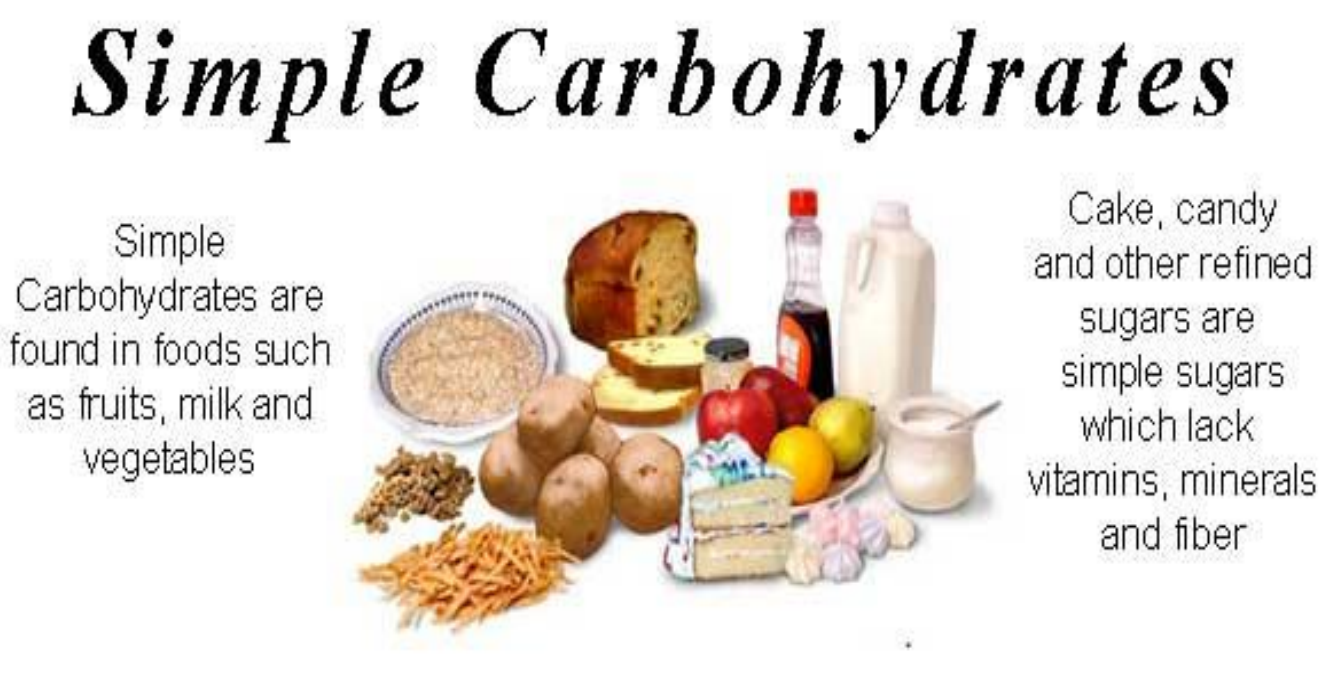
When Blood glucose is low, the pancreatic hormone **glucagon** triggers the breakdown of liver glycogen to free glucose, through the process of **glycolysis.**

Glucagon (and other hormones like epinephrine and norepinephrine and catecholamines) will also stimulate **lipolysis,** which breaks down triglycerides to obtain energy from the fatty acids.





Normal blood glucose: 6 - 10 mmol/L

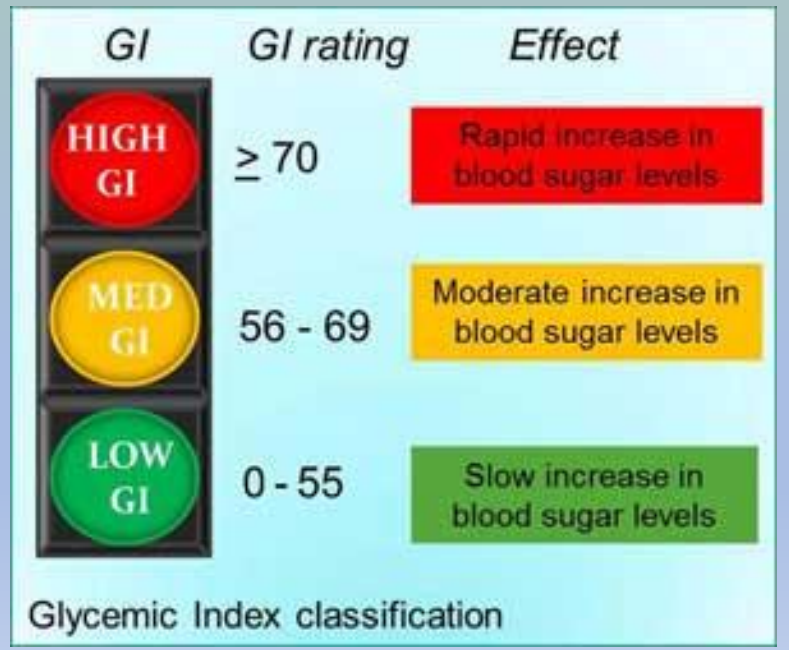


Not all Carbohydrates are equal in terms of nutrition

The Glycemic response

Glycemic index (GI): food potential to raise blood glucose relative to a standard (glucose or white bread)

https://youtu.be/wxzc_2c6GMg

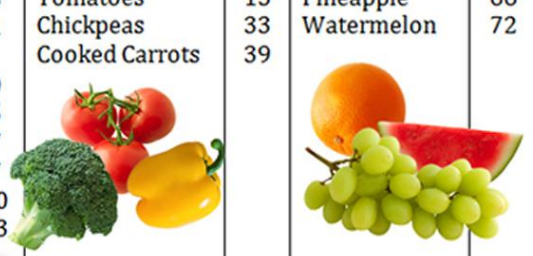


Glycemic Index of Foods

Glycemic Index

Low GI (<55), Medium GI (56-69) and High GI (70>)

Grains / Starchs		Vegetables		Fruits		Dairy		Proteins	
Rice Bran	27	Asparagus	15	Grapefruit	25	Low-Fat Yogurt	14	Peanuts	21
Bran Cereal	42	Broccoli	15	Apple	38	Plain Yogurt	14	Beans, Dried	40
Spaghetti	42	Celery	15	Peach	42	Whole Milk	27	Lentils	41
Corn, sweet	54	Cucumber	15	Orange	44	Soy Milk	30	Kidney Beans	41
Wild Rice	57	Lettuce	15	Grape	46	Fat-Free Milk	32	Split Peas	45
Sweet Potatoes	61	Peppers	15	Banana	54	Skim Milk	32	Lima Beans	46
White Rice	64	Spinach	15	Mango	56	Chocolate Milk	35	Chickpeas	47
Cous Cous	65	Tomatoes	15	Pineapple	66	Fruit Yogurt	36	Pinto Beans	55
Whole Wheat Bread	71	Chickpeas	33	Watermelon	72	Ice Cream	61	Black-Eyed Beans	59
Muesli	80	Cooked Carrots	39						
Baked Potatoes	85								
Oatmeal	87								
Taco Shells	97								
White Bread	100								
Bagel, White	103								



Net Carbohydrates

Besides memorizing the Glycemic Index, and long lists of foods, how can I know if I'm making healthy Carbohydrate choices?

1) Choose more carbohydrates found in nature & consume their recommended serving size
2) Read food labels & calculate "net carbs" - a good estimate of how quickly the food will affect your blood sugar.

total carbohydrates (g) - fiber (g) = net carbohydrates

Carbs Ted Ed

The dietary monosaccharides include

1. Sucrose, glucose, and lactose
2. Fructose, glucose, and galactose
3. Galactose, maltose, and glucose
4. Glycogen, starch and fibre

The polysaccharide that helps form the supporting structures of plants is

1. Cellulose
2. Maltose
3. Glycogen
4. Sucrose

Digestible carbohydrates are absorbed as _____through the small intestinal wall and are delivered to the liver, where they are converted to _____

1. disaccharides; sucrose
2. glucose; glycogen
3. monosaccharides; glucose
4. galactose; cellulose

When blood glucose concentration rises, the pancreas secretes ____, and when blood glucose levels fall, the pancreas secretes _____

1. glycogen; insulin
2. insulin; glucagon
3. glucagon; glycogen
4. insulin; fructose

Foods rich in fibre can lower blood cholesterol

1.T
2.F

Key Points

- Body tissues use carbohydrates for energy
- The brain and nerve tissues prefer carbohydrate as fuel
- Fibres can reduce blood sugars and cholesterol levels
- Fibres are a critical fuel source for the bacteria in our guts
- Recommendation is that a diet based on foods rich in complex carbohydrates and fibre is good general dietary advice.
- But the best dietary advice is very individual! Research is ongoing *https://youtu.be/0z03xkwFbw4*