

Chapter 29 - Human Nutrition

Learning objectives

- To understand heterotrophic organisms and define the terms 'omnivore', 'herbivore' and 'carnivore'
- To define the term 'digestion' and explain why digestion and a digestive system are necessary
- To explain 'ingestion', 'digestion', 'absorption' and 'egestion' in relation to the human digestive tract
- To describe the structure and function of the alimentary canal and associated glands in digesting and transporting nutrients
- To describe the mechanical breakdown of food in the human digestive system, to include the teeth, peristalsis and the stomach
- To describe the chemical breakdown of food in the human digestive system, to include bile salts and an amylase, protease and lipase enzyme
- To describe the basic structure and function of the small and large intestines
- To explain the benefits of dietary fibre
- To describe two functions of symbiotic bacteria in the human digestive tract
- To explain the importance of a balanced diet containing a variety of food from the main food groups.

Chapter 29 - Human Nutrition

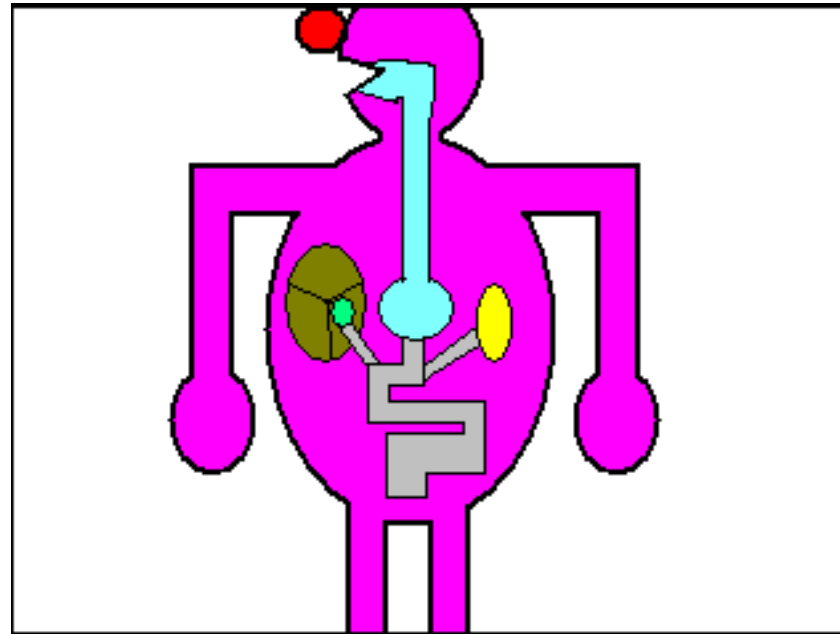
Autotrophic - Organisms that make their own food, e.g. plants and some bacteria.

Heterotrophic - get their food from another source, e.g. animals, fungi and some bacteria.

Heterotrophs can be **herbivores**, **carnivores** or **omnivores**.



Digestion - is the breaking down of food into small particles that can move into cells.



Syllabus



You are required to study three enzymes:

- an **amylase** (which digests starch)
- a **protease** (which digests protein)
- a **lipase** (which digests lipid or fat)

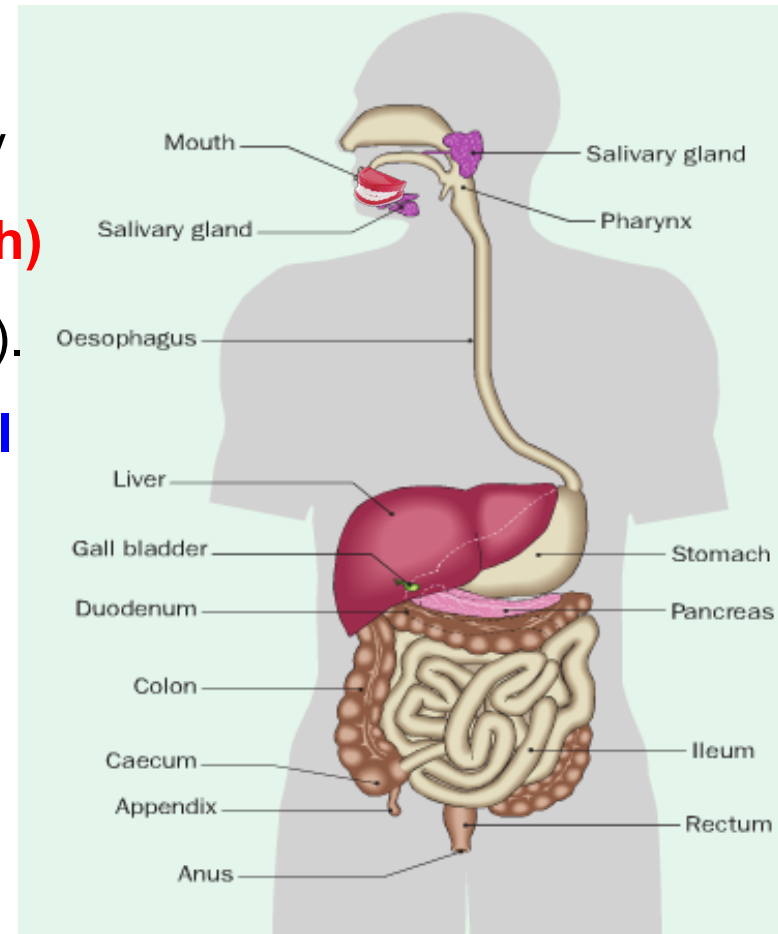
The Digestive System

1. Ingestion - Food is taken into the **Alimentary canal**.

2. Digestion - Food is broken down by **mechanical** means in the mouth (**teeth**) and in the **stomach** (muscles contract). Food is also broken down by **chemical** means by **enzymes** and acid.

3. Absorption - Food is moved across the gut wall into the **blood** and cells.

4. Egestion - Unabsorbed food is removed through the **anus**.







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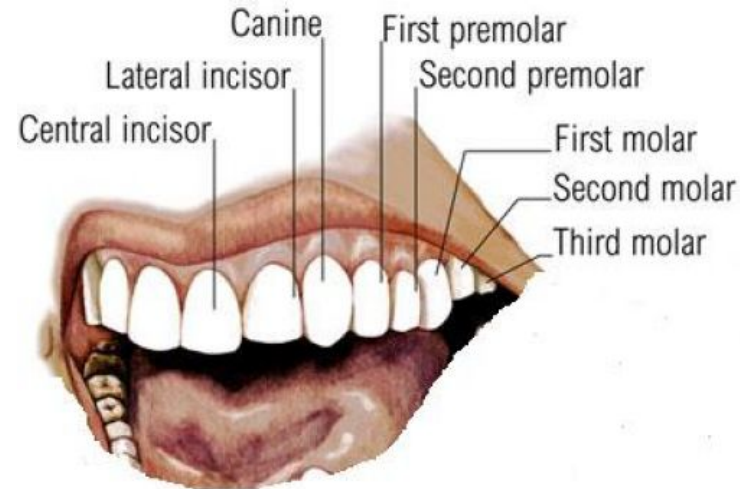
Teeth

The human dental Formula is,

$$2 \left(I \frac{2}{2} \quad C \frac{1}{1} \quad PM \frac{2}{2} \quad M \frac{3}{3} \right)$$

To use this we just need to look at half of your mouth, top or bottom.

TOOTH TYPE	SHAPE OF TOOTH	FUNCTION
Incisor		Cutting and biting food
Canine		Tearing food
Premolar		Crushing and grinding food
Molar		Crushing and grinding food



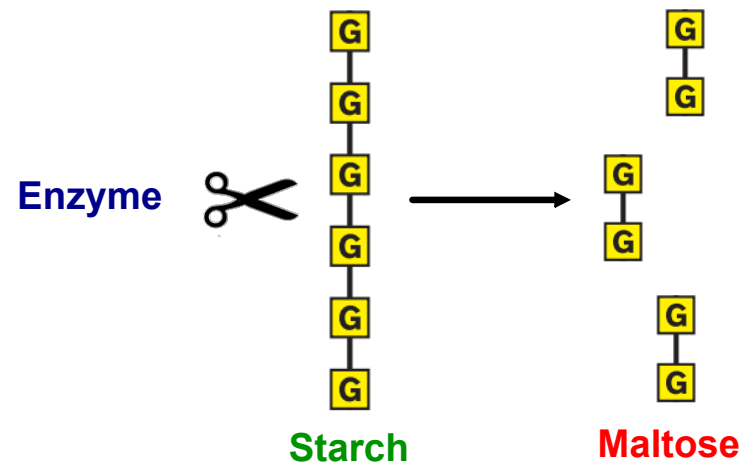
Mouth

Physical/Mechanical Digestion

- Food is broken down by teeth, and by the stomach churning.

Chemical Digestion

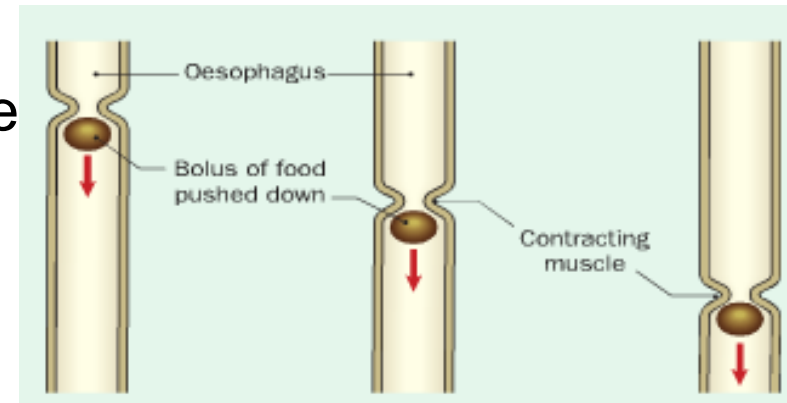
- Starch is broken down into **Maltose** (a disaccharide).
- Starch is broken down in the mouth by an enzyme called **Amylase**.
- Amylase is found in **Saliva**.
- pH of the mouth is 7/8.



Peristalsis

This muscular movement carries food to the stomach and through the whole alimentary canal.

Fibre stimulates peristalsis.



Stomach

This is a muscular bag that holds and churns the food.

Food is added through the **cardiac sphincter** and leaves through the **pyloric sphincter**.

The stomach has a layer of alkaline **mucous** to prevent self-digestion. The cells are **tightly packed** for protection.

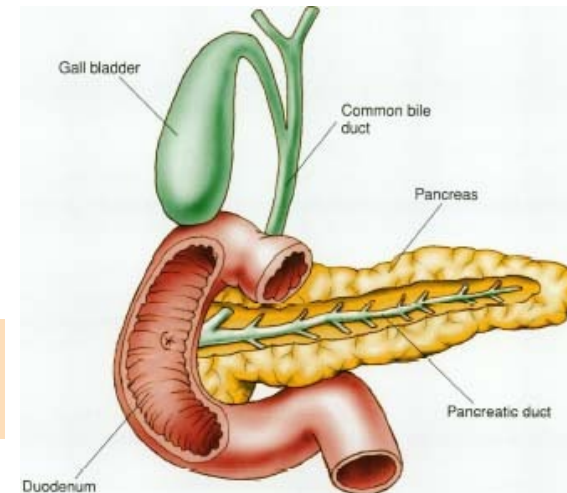
It produces a harmless enzyme called **pepsinogen** which is made active by the **Hydrochloric Acid** and converted to **pepsin**. This pepsin then breaks protein into amino acids.

Pancreas

The pancreas is a gland that secretes **insulin**. This hormone controls blood glucose levels. The pancreas also secretes other enzymes such as pancreatic **Amylase** and **Lipase**.

Starch $\xrightarrow{\text{Amylase}}$ Maltose

Lipids $\xrightarrow{\text{Lipase}}$ Fatty acids and glycerol



Both of these enzymes are active in the **Duodenum**.

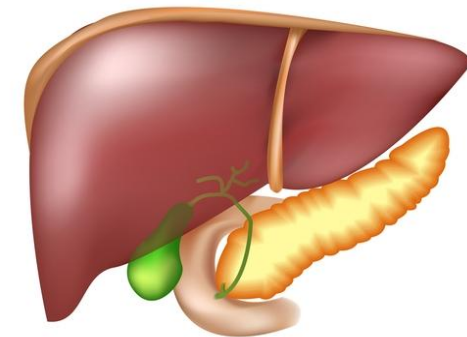
They both have an **optimum** pH of around **pH 7/8** and so the acidic pH of the food from the stomach is first neutralised by **Sodium Hydrogen Carbonate - Bile Salts** (made in Pancreas and liver).

Liver

The liver is a complex organ with many functions.

Among the most important functions of the liver are:

- making bile
- detoxifying the body, i.e. breaking down poisons such as alcohol and drugs
- breaking down excess amino acids to form urea
- converting glucose to glycogen for storage
- converting excess carbohydrates to fat
- storing vitamins such as vitamin D
- storing minerals such as iron (Fe), copper (Cu) and zinc (Zn)
- making plasma proteins such as fibrinogen (used in blood clotting)
- making cholesterol, which is needed to form many hormones
- producing heat to warm the blood (and the body)



Bile

Is formed from dead **red blood cells**.
It is a yellow/**green** viscous liquid.
Bile is made in the **liver** and stored in the **gall bladder**. It holds the bile and releases it into the **bile duct**, which leads to the duodenum. Gall stones can block the bile duct and cause pain and damage.



What it does

It **emulsifies** fats by breaking them down into small droplets.
It contains **Sodium Hydrogen Carbonate** to change the pH.
This helps Lipase break down the lipids more easily.



Small Intestine

Consists of 2 main parts,

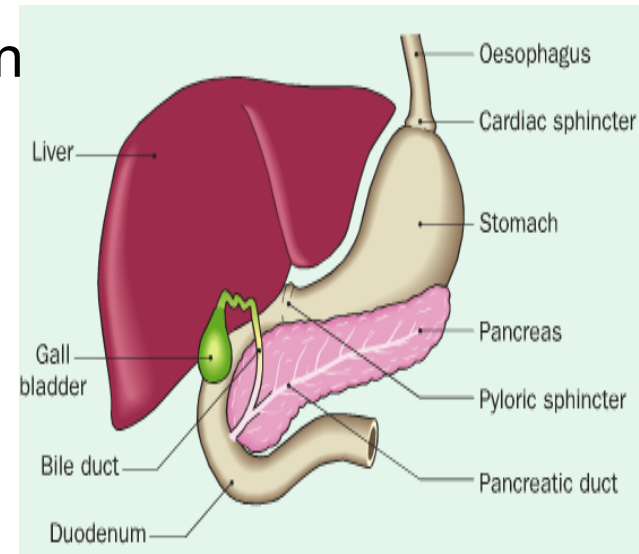
Duodenum - 25 cm long - **Digestion** happens here.

Ileum - 5.5 metres - most **absorption** happens here.

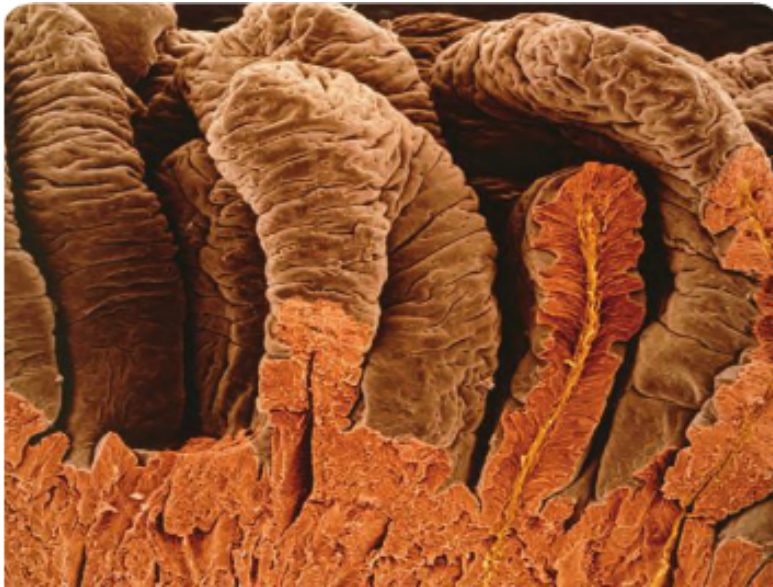
The small intestine is adapted for digestion and absorption by having lots of small infoldings called **villi** (villus for one).

These villi increase the **surface area**.

Each villus has about 600 **microvilli** that increase the surface area even more.



Structure of a Villus



How they are adapted.

Microvilli are only **1 cell** thick.

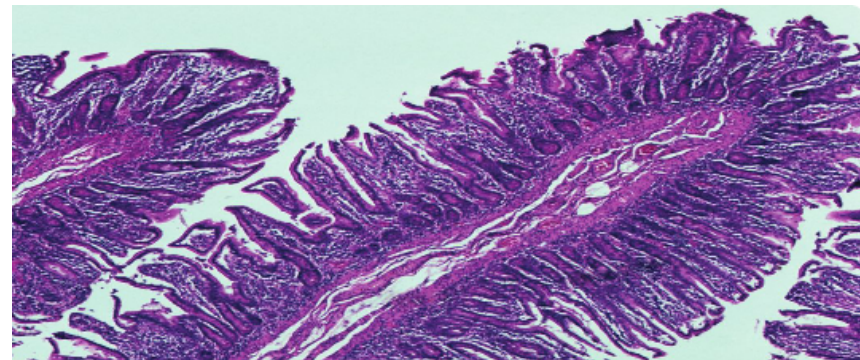
They can **absorb** food easily.

They have a rich **blood** supply to carry away food.

There are many of them to increase **surface area**.

They absorb water, glucose, amino acids and vitamins and lipids.

Amino acids are poisonous and are sent to the liver via the **Hepatic Portal Vein** to be broken down into **Urea**. This is called **deamination**.

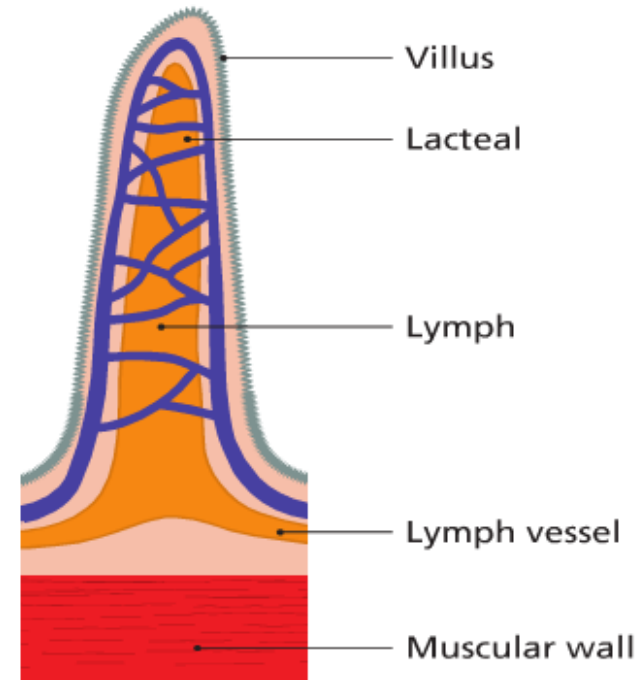


Lacteal

Inside a villus is a **lacteal**. Each lacteal contains lymph fluid. **Fatty acids** and **glycerol** are absorbed into the lacteal from the intestine. They reform into lipids in the lacteal.

ADAPTATIONS OF THE SMALL INTESTINE FOR ABSORPTION

- It is very long.
- It has numerous villi and microvilli.
- The walls of the villi are very thin.
- There is a rich blood supply to carry away water-soluble products.
- Each villus has a lymph supply (lacteal) to carry away the fats.



Enzymes and Digestion

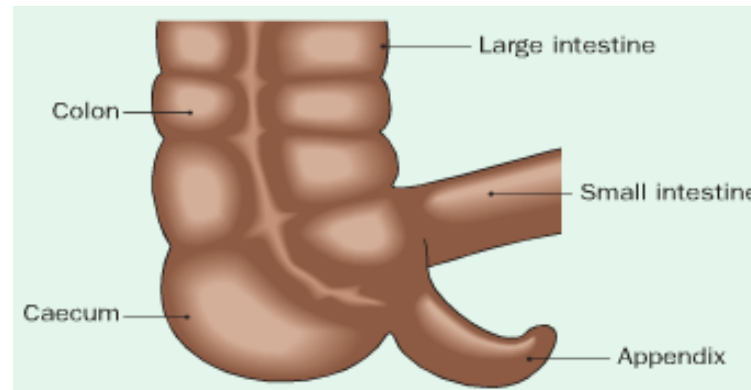
Summary of digestion (enzymes are in bold)					
Substance	Made in	Active in	Substrate	Product	Preferred pH
Amylase	Salivary glands	Mouth	Starch	Maltose	7 to 9
Pepsin	Stomach lining	Stomach	Protein	Peptides	2
Hydrochloric acid	Stomach lining	Stomach	Bacteria and fibrous foods	Dead bacteria and softened food	–
Sodium hydrogen carbonate	Pancreas	Duodenum	Acid	Neutralises acid	–
Amylase	Pancreas	Duodenum	Starch	Maltose	7 to 9
Lipase	Pancreas	Duodenum	Lipids	Fatty acids and glycerol	7 to 9
Bile salts	Liver	Duodenum	Lipids	Lipid droplets	–
Sodium hydrogen carbonate	Liver	Duodenum	Acid	Neutralises acid	–

End products of digestion	
Food	Digested to
Carbohydrates	Monosaccharides (e.g. glucose)
Proteins	Amino acids
Lipids	Fatty acids and glycerol

Large Intestine

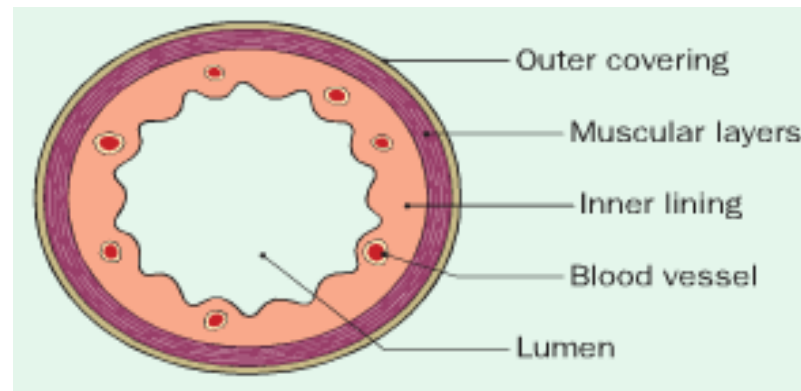
The large intestine is **wide** compared to the small intestine. It is only 1.5 metres long but is 6cm wide. Food stays in here for 10 hours to a few days.

The **appendix** and **caecum** are found in the large intestine. The appendix is believed to be a **vestigial** organ. It was once used to digest cellulose but is now only used to make white blood cells and store bacteria.



Colon

The colon is part of the large intestine that **absorbs water** from the undigested food.



Faeces is stored in the **rectum** till it is **egested** through the anus.

Diarrhoea is when too much water is left in the faeces. This is usually caused by the food moving too quickly through the colon.

Constipation is when too much water is removed from the faeces. This is usually when food moves too slowly through the colon.

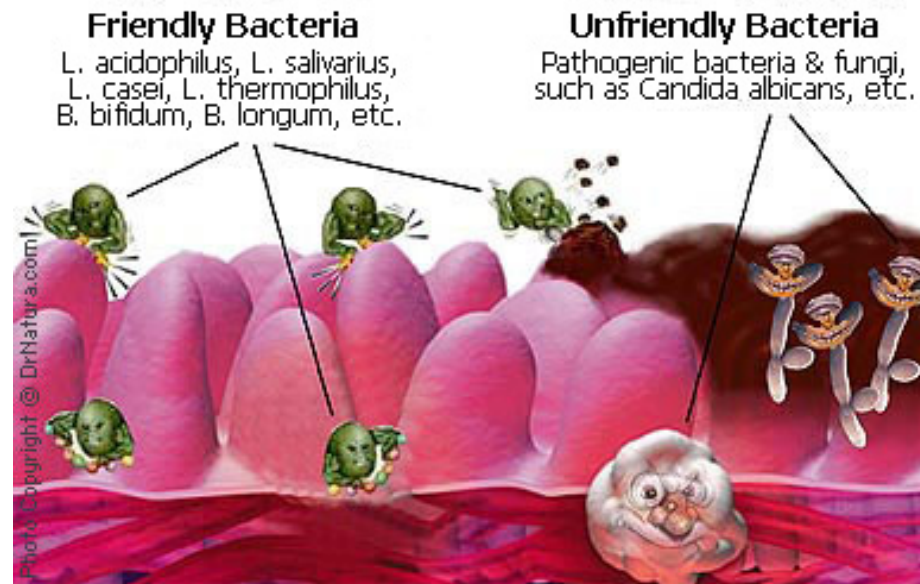
Symbiotic Bacteria in the Digestive System.

Symbiosis is when two organisms live near each other and at least one benefits from the relationship.

Bacteria in the colon produce group B vitamins and also **vitamin K**. We absorb these vitamins and they get food from us.

They also break down **cellulose** for us.

Having beneficial bacteria in our colon stops disease-causing (**pathogenic**) bacteria from growing.

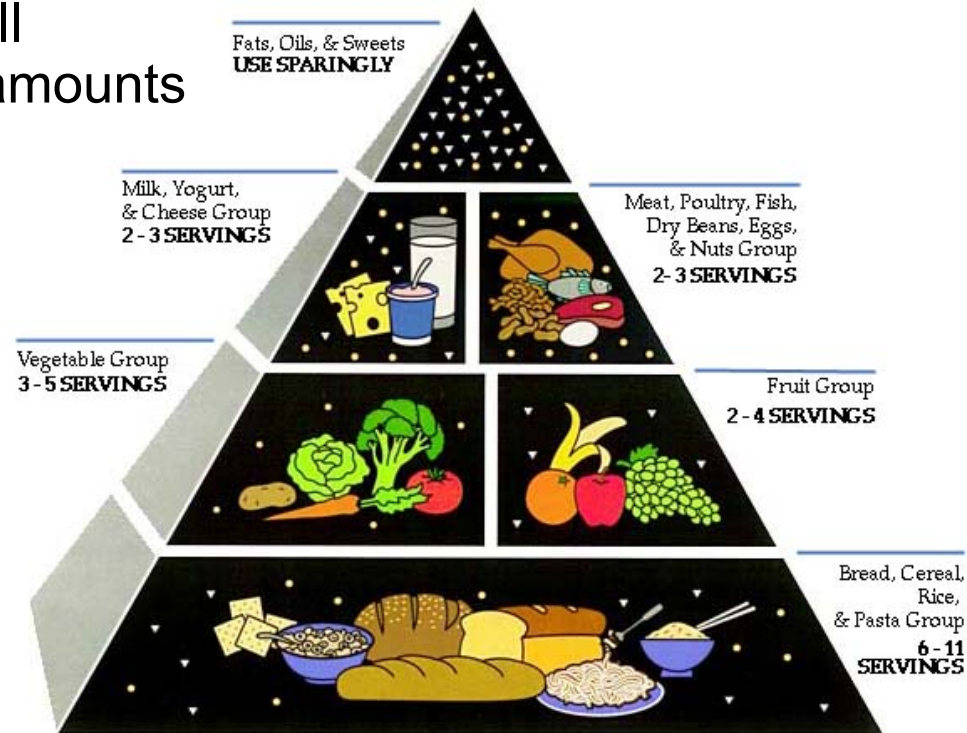


Balanced Human Diet

A **balanced diet** consists of all the biomolecules in the right amounts needed to stay healthy.

The amount of food you need depends on your gender, age, activity level and health.

- cereals, bread and potatoes (6+)
- fruit and vegetables (4+)
- milk, cheese and yogurt (4)
- meat, fish and poultry (2)



Why do we overeat?

Attachments

The Science of Appetite - Beating Overeating (High).flv