Lesson One

Biology: Food and Digestion

Aims

By the end of this lesson you should be able to:

- list the nutrients contained in a balanced diet
- give the function of each nutrient and examples of foods it is found in
- explain what is meant by digestion
- label a diagram of the digestive system and give the function of each part
- say why figures on health and diet are difficult to interpret

Context

This lesson studies nutrition, one of the key characteristics of living things listed in Lesson One of the Year 7 course.

Oxford Home Schooling

Introduction

Along with all other animals, human beings need **food** to survive. This food is needed for two reasons:

- to supply the *energy* needed for all the activities of life, like moving and growing, and
- to supply the *materials* needed to build new cells during growth and repair.

In this lesson we look first at the types of food needed for health, and then at how the body's digestive system deals with this food to extract the nutrients from it.

A Balanced Diet

In everyday life, being on a "diet" means eating less to get thin. But not in Biology. In Biology, your **diet** is simply what you eat and drink. So if you eat mountains of cream cakes each day, you are on a diet!

However, not all diets are healthy. To be healthy you must eat a **balanced diet**. A balanced diet is one that contains the right amount of each of seven key types of chemical called **nutrients**.

Most **foods** contain several of these nutrients. In Biology, a "food" is an object on your plate, like a banana, or a steak pie, whereas a "nutrient" is a type of chemical contained in those foods.

A balanced diet contains the right amount of each of the following nutrients:

1. carbohydrates
2. fats
3. proteins
4. vitamins
5. minerals
6. dietary fibre
7. water

If you are lacking any of these, you get ill with a **deficiency disease**. You can also eat too much of some of the nutrients,

like fats. If you are ill through not eating a balanced diet you have **malnutrition**.

Activity 1	The best way to find out what you actually eat and drink is to write it down as you go along. For the next seven days, write down everything you consume in the grid below. You may be surprised at what you find!
	

Day	*Item 1*	*Item 2*	*Item 3*	*Item 4*	*Item 5*
Sunday					
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					

Carbohydrates

Carbohydrates include **starch** and **sugars**, and their job is to supply us with energy.

Starch is not sweet, and is contained in foods like bread, potatoes, pasta and rice.

You can test for the presence of starch using **iodine solution**. Iodine solution is brown or yellow in the bottle, but turns **blue/black** when exposed to starch.

Sugars are sweet, and are contained in sweets, cakes, biscuits, and in bags of sugar which we add to other foods. The

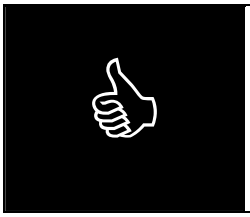
most important sugar is **glucose**, which we will learn a lot about later on.

Fats

Fats (often called **lipids**) also supply us with energy. You need some to make the cell membranes of cells as well, so you cannot replace them completely with carbohydrates. Butter, margarine, cooking oil, cheese and red meat are rich in fats.

Fats are a more concentrated form of energy than carbohydrates, and a gram of fat contains more than twice as much energy as a gram of carbohydrate. This is why we store our spare energy as a layer of fat under the skin. This fat layer also keeps us warm, and provides padding against knocks.

Eating too much fat in the diet (especially fat from animal sources) can cause **heart disease**, because it encourages layers of fat to clog up our arteries.



Get it right! Eating too much fat does not make you fat (obese). You get fat if you regularly eat more energy in your diet than you use up. This energy can come from fats or carbohydrates or both.

Proteins

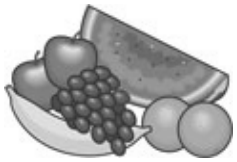
Quiet a lot of each cell is made of protein. So if you want to grow new cells, you need a supply of protein in the diet to do it. This means protein is needed for:

- **growth** (getting bigger by growing new cells), and
- **repair** (replacing damaged or worn out cells).

Meat, fish, milk, eggs and beans are all good sources of protein.

Vitamins

A vitamin is a chemical which we need in *small amounts* for some particular chemical reaction in the body. There are several of these.



One of the most important is called **Vitamin C**. Vitamin C is found in fresh fruit and vegetables, for example lemons and oranges. Without it we get a deficiency disease called **scurvy**, which involves bleeding gums, loose teeth, slow healing of cuts and lots of colds.

Minerals

All of the nutrients listed so far are **organic** compounds – that is, compounds containing the element carbon. But we also need a supply of several chemical elements that can be eaten in a more simple form. These are called **minerals** or **mineral ions**. For example:

calcium is needed to make strong bones and teeth. Milk and cheese are especially good sources.

iron is needed to produce the red compound **haemoglobin** in red blood cells which carries oxygen around the body. Liver and spinach are especially good sources.

Dietary Fibre

Dietary fibre (also called "fibre", or "roughage") comes mainly from the **cell walls** of plants (see Lesson 1 of year 7), which are made of the compound **cellulose**. We are unable to digest dietary fibre, so it comes out unchanged in the **faeces**.

Fibre is bulky, and it stretches the walls of the **large intestine** (see later) encouraging it to push back and move the food through quickly. This stops us getting **constipation** (inability to produce faeces), which may be a cause of **bowel cancer**.

Leafy vegetables (e.g. cabbage), high-fibre cereals and whole-grain bread contain a lot of dietary fibre.

Water

We don't normally think of water as a nutrient, but it is certainly something essential that we put in our mouths and swallow! About 70% of the body is water, and we are continually losing it through breathing, urination, and sweating. This water must be replaced, because all the

chemical reactions of life go on in solution in water. So if there is no water they stop and we die!

We get water from drinks (any liquid you can drink is mainly made of water), and many foods e.g. lettuce.

A Glass of Water

Activity 2

Go to BBC Bitesize at

www.bbc.co.uk/schools/ks3bitesize/science/.

Click on "Organisms, behaviour and health" and then "Food detective – Activity". The interactive presentation will quiz you on the nutrient content of foods, and also show you simple tests to detect the presence of sugars, proteins and fats.

Activity 3 Extension

The following government website contains lots of information and advice on eating healthily and the nutritional content of foods;

www.eatwell.gov.uk/

The Digestive System

There is a problem with food: some of the nutrients we need consist of large, insoluble molecules which the body is unable to take in as they are. Before we can take them in (= **absorb** them), they have to be broken down into small soluble molecules first. This breakdown of molecules is called

digestion. It is the job of **the digestive system** to achieve this and then to absorb the small molecules that the body needs.

Get it right!

Digestion is the breakdown of large **insoluble molecules** into small **soluble molecules**.

The tube running from the mouth to the anus is called the **gut** or the **alimentary canal**. The **digestive system** is this plus the attached organs, e.g. the pancreas.

Enzymes and Digestion

The large nutrient molecules that need breaking down are:

- proteins
- fats
- starch (one of the carbohydrates)

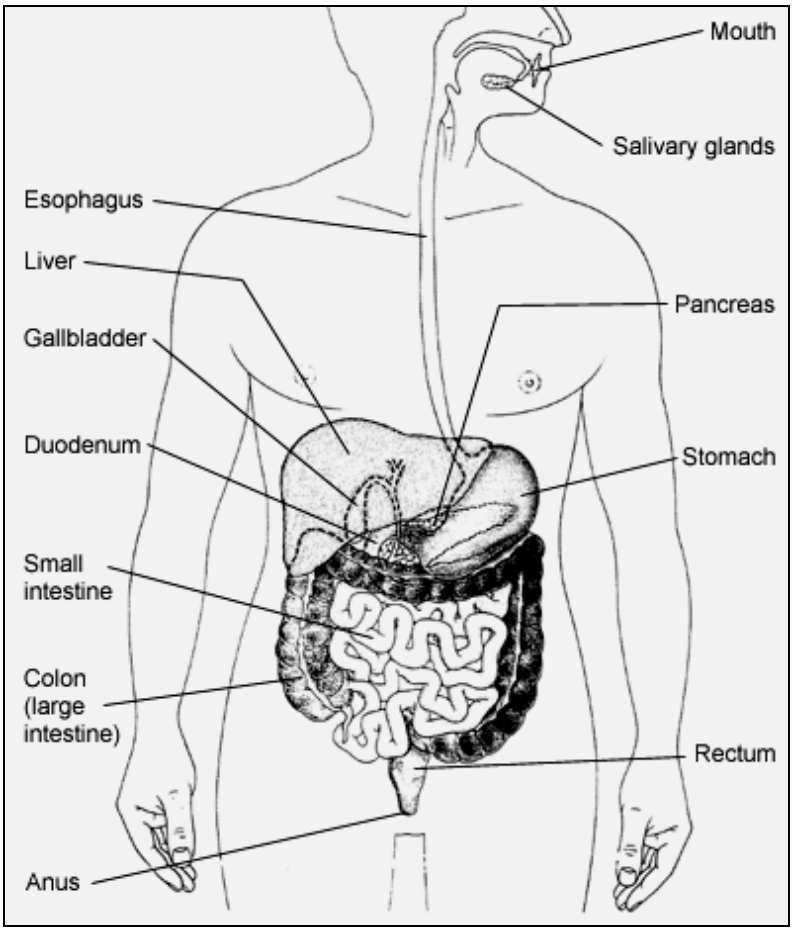
They are broken down in the digestive system by special molecules called **enzymes**. A different group of enzymes is needed for each sort of large molecule, as shown below:

Large molecule	Enzymes	Small molecules produced
starch	carbohydrases	glucose (a sugar)
proteins	proteases	amino acids
fats	lipases	glycerol + fatty acids

The small molecules on the right are called the **products of digestion** that the body absorbs. Most sugars, vitamins, minerals and water already have particles small enough to be absorbed, so they do not need to be digested first. Dietary fibre also consists of large molecules. However we don't make enzymes able to break it down, so it is not absorbed and escapes in the faeces.

Parts of the Digestive System

A "map" of the digestive system is shown below.



Each part has a different job to do connected with food:

- **Mouth**: The food is broken into small pieces by the **teeth**. This is *not* the same as digestion, because the molecules are not affected. It is mixed with saliva, which contains a **carbohydrase** called **amylase** which starts the breakdown of starch.

- **Stomach**: Here a **protease** starts the breakdown of proteins. The stomach also makes **hydrochloric acid**, which kills most of the bacteria in food that would otherwise cause food poisoning.

- **Small intestine**: This does two different jobs:

1. Completes the digestion of all the large molecules (starch, proteins and fats) to small molecules.
2. Absorbs the nutrients into the bloodstream. To make this quicker, its surface is covered with finger-shaped projections called **villi** (singular villus) which give it a large **surface area**.

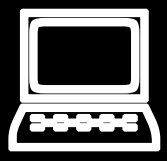
- **Pancreas**: This makes many of the enzymes which digest the food in the small intestine.

- **Liver**: This makes liquid called **bile**. Bile **emulsifies** fats – i.e. breaks them up into smaller droplets with a larger surface area so the lipase enzymes can digest them faster.

  Once the products of digestion have been absorbed into the blood, they are carried to the liver before being released to the rest of the body.

- **Large intestine**: Also called the **colon**, his absorbs most of the water so the faeces become solid. The last part, called the **rectum**, stores the faeces before they leave through the **anus**.

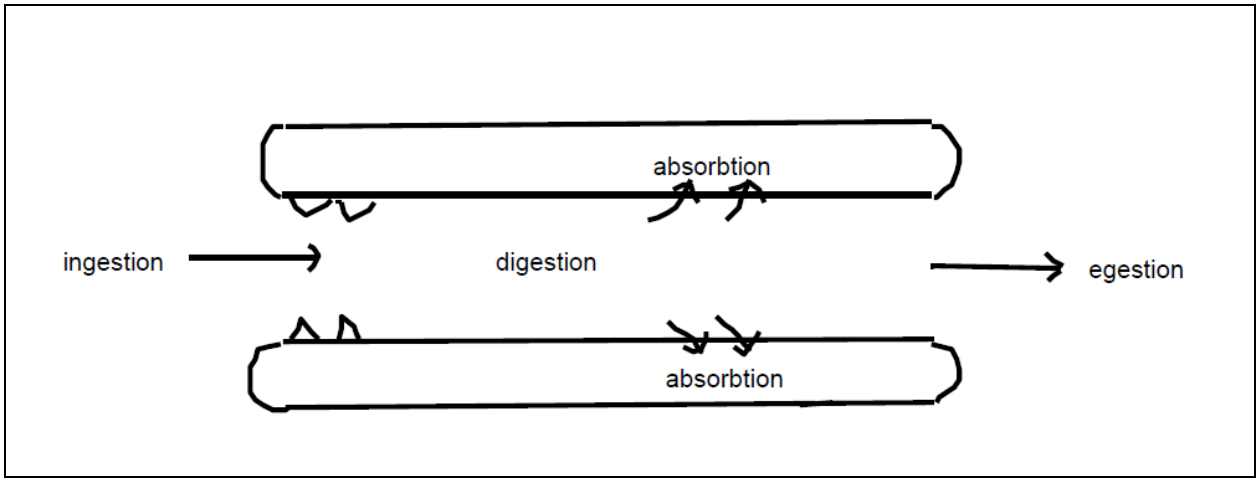
Activity 4



Go to the Google home page at www.google.co.uk/ and press on the link "Images" to access the website Google Images. Now enter "villi" in the search box to view some good photos of villi in the small intestine.

Processes in the Digestive System

Note that there are four different processes going on in the digestive system, as illustrated in the following diagram:



1. **Ingestion**: taking in food at the mouth

2. **Digestion**: breaking down large insoluble molecules into small soluble molecules

3. **Absorbtion**: taking the products of digestion across the gut wall into the bloodstream.

4. **Egestion**: removing the faeces at the anus.

The later use of the absorbed nutrients by the body's cells is sometimes called **assimilation**.

Interpreting Data about Diet and Health

It was suggested above that:

- eating lots of dietary fibre reduces the risk of colon cancer, and
- eating too much animal fat causes heart disease.

You will also come across other claims about diet and health on the news and in the papers from time to time.

In fact it is difficult to be sure about the effects of diet upon health, because so many other factors may be involved as well. For example, let's say you study 100 people who have had heart attacks and find that a lot of them ate a lot of fatty food. The fatty food *may* have given them their heart attacks. But perhaps people who eat a lot of fatty food are also more likely to smoke, or less likely to take exercise? If so, how can you

tease out the effect of their diets and separate it from the effect of other aspects of their lifestyles?

This is a general problem with studies of human health and disease. It is not always possible to keep the **control variables** constant to make the study a **fair test**.

Activity 5 Extension

Go to www.heartstats.org to view the latest figures about heart disease in the UK. These are from the British Heart Foundation, the leading UK charity in the area.

Investigating the Activity of Enzymes

Amylase is an enzyme, found in the mouth and the small intestine, which breaks down starch. It is often used to investigate the effect of temperature on how fast enzymes work.

To do this investigation, starch and amylase solutions are mixed together in a boiling tube. Every few seconds a sample of the mixture is removed with a dropping pipette and tested to see whether it still contains starch. This is continued until all of the starch has been broken down by the amylase. The procedure is then repeated at a range of different temperatures to see what effect temperature has on the rate of breakdown.

Activity 6

In the above investigation:

1. What is the independent variable?
2. What is the dependent variable?
3. How could you test whether the starch had all been broken down in the samples?
4. List the main control variables which would need to be kept the same at all temperatures to make the investigation a fair test.

Activity 7

Many of the topics in this Lesson are revised at the website skoool.co.uk.

Go to http://lgfl.skoool.co.uk/keystage3.aspx?id=63 and click on sections 11-17.

Keywords

Food
Nutrient
Diet
Balanced diet
Obese
Haemoglobin
Digestion
Gut
Enzyme
Absorption
Assimilation
Deficiency disease
Malnutrition
Carbohydrates
Iodine solution
Organic
Constipation
Villi
Emulsify
Ingestion
Egestion
Amylase

Self-Assessment Activities

1. There are mistakes in the following. Write it out with the mistakes corrected:

   Beef is a nutrient which is rich in protein and carbohydrates. The digestion of the protein starts in the mouth and is finished in the pancreas. Molecules called lipases break down the protein lumps into amino acids. The amino acids are absorbed in the large intestine, before the faeces leave the body at the rectum.

2. Are the following statements true or false? If they are false, explain why:

   (a) A balanced diet does not need to contain fats.
   (b) Eating too much fat makes you fat (obese).
   (c) Most digestion happens in the stomach.
   (d) Vitamins are elements like calcium and iron.
   (e) Dietary fibre is digested in the large intestine.

Suggested Answers to Activities

Activity 6

(a) Temperature.

(b) Time (or the time taken to break down all the starch), or rate of breakdown.

(c) Add the sample to some iodine solution. If the iodine solution remains brown or yellow, all the starch has been broken down. If it turns black or blue, there is still some starch left.

(d) Concentrations of the starch solution and amylase solution; relative amount of each solution in the mixture; amount of stirring.