Organisms
Breathing *and* Digestion

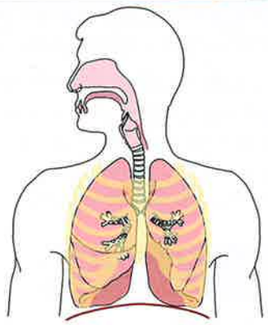
Ideas you have met before

Breathing and gas exchange

Animals, including humans, need air to survive.

Breathing is taking air in and out of our lungs.

The air around us contains oxygen.



Diet and nutrition

Animals cannot make their own food and must eat plants or other animals for energy.

Humans must eat a balanced diet containing the correct types of food to stay healthy.

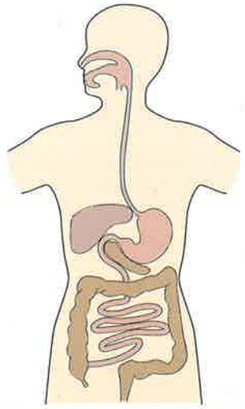
Digestion

We have different types of teeth and each type has a different role in breaking down food.

Several parts of the body help us to digest food – such as teeth, stomach and intestines.

Each part of our digestive system has a different job to do.

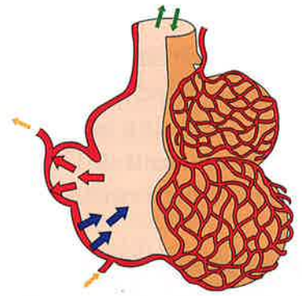
Nutrients from digestion are transported round the body in the blood.



In this chapter you will find out

The breathing system

- Breathing occurs through the action of muscles in the ribcage and diaphragm causing a change in volume of the chest.
- The breathing system is well adapted to get gases in and out of our bodies.
- During gas exchange, oxygen is transported to cells for aerobic respiration and carbon dioxide is removed from the body.
- Disease and lifestyle can affect our breathing system, for example, asthma and smoking.



A healthy diet

- Each component of a healthy diet has a different role. For example, carbohydrates provide energy, fibre supports the large intestine and protein allows growth and repair.
- Different foods provide different amounts of energy and different people have different energy requirements depending on age and lifestyle.
- Both starvation and obesity can cause serious health issues.

The digestive system

- Each part of the digestive system has a specific role. For example, protein digestion begins in the stomach, the small intestine allows absorption of nutrients and the large intestine removes water.
- Each organ of the digestive system is well adapted to do its job.
- Following digestion, food molecules are transported to cells for respiration.
- Enzymes are biological catalysts and they digest specific food molecules to smaller molecules.
- Bacteria live in the gut and some of these help us to digest food.

Understanding how we breathe

We are learning how to:

- Describe the mechanism for breathing in and out.
- Explain how changes in pressure help us to breathe.
- Evaluate a model for breathing.

A breathing system is important because it gets gases that we need into the body and moves waste gases out. Breathing is something that we do without even thinking about it. The brain controls movements in the chest which cause us to breathe in and out.

The mechanism of breathing

The main organ of the **breathing** system is the **lungs**. These are housed in the chest cavity.

Movements of your ribcage and **diaphragm** bring about breathing in and out.

1. Give another name for the windpipe.
2. Describe which way the diaphragm and ribcage move as you breathe in.
3. Describe the changes in the volume of the chest as you breathe in and then out.

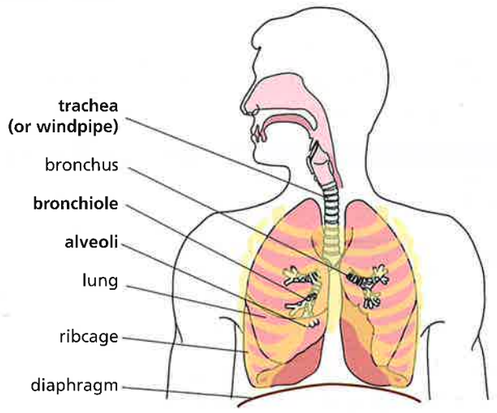
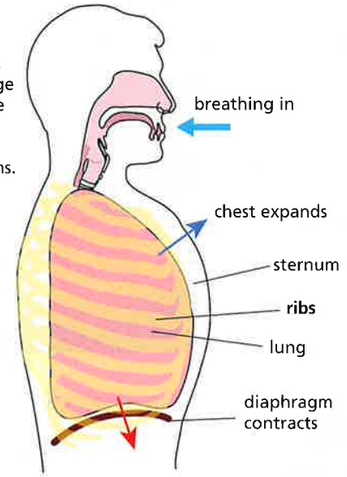


FIGURE 2.8.1a: Trace the journey of air through your nose to the alveoli.

During breathing in, muscles in the ribcage contract, moving the ribcage up and out. The diaphragm contracts and flattens. This increases the volume in the lungs and air rushes into the lungs.



During breathing out, muscles in the ribcage relax and the ribcage moves down and in. The diaphragm relaxes and moves up. This decreases the volume in the lungs and air rushes out of the lungs.

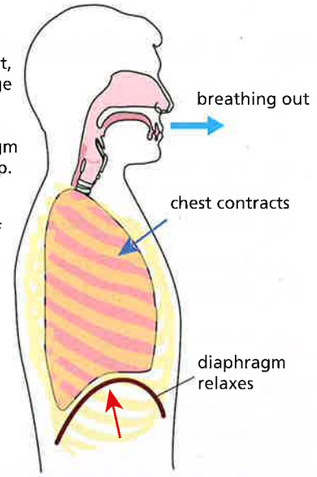


FIGURE 2.8.1b: Movements of the ribcage and diaphragm cause changes in the volume of the chest.

Under pressure

8.1

The change in volume of the chest space during breathing in and breathing out causes a change in pressure in the lungs.

When the chest volume is high, the air can spread out and pressure is low. When the chest volume is low, the air is squashed and pressure is higher. A difference between the **pressure** inside the lungs and the pressure of the air around us (atmospheric pressure) is what causes us to breathe in and out.

- Just before you breathe in, the pressure in your lungs falls below atmospheric pressure and air automatically rushes into the lungs.
- Just before you breathe out, the pressure in your lungs rises above atmospheric pressure and air automatically rushes out of the lungs.

4. Draw a table to compare volume, pressure and movement of air for each of breathing in and breathing out.
5. Suggest what would happen if the pressure in the lungs stayed the same as atmospheric pressure.

Did you know...?

Hiccups are caused by an involuntary contraction of the diaphragm. Hiccups are harmless and usually last only a few minutes. However, there are conditions under which hiccups persist for longer than a month.

Evaluating a breathing model

We use models in science to help us to visualise what we cannot actually see. When using models, we should always consider how well they represent real life.

A group of students have been shown a model (Figure 2.8.1c) to help them understand how we breathe in and out.

6. In the model shown in Figure 2.8.1c, what represents each of the following?
   - **a)** the alveoli
   - **b)** the ribcage
   - **c)** the diaphragm
   - **d)** the trachea.
7. Describe what happens to the 'alveolus' as the 'diaphragm' in this model moves down.
8. Evaluate the model by listing ways in which the model matches a real breathing system and ways in which it doesn't.

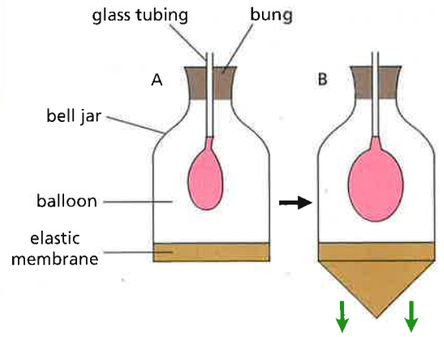


FIGURE 2.8.1c: You can make a model of the breathing system using a glass bell-jar and balloons.

Know this vocabulary

breathing
trachea (windpipe)
bronchi
bronchioles
diaphragm
alveoli
ribs

Measuring breathing

We are learning how to:

- Describe what is meant by lung volume and identify some simple methods to measure it.
- Identify independent, dependent and control variables in a lung-volume investigation.
- Interpret and evaluate data linked to lung volume.

Do bigger people have bigger lungs? How can we investigate that question scientifically? Lung volume can be measured quite easily and then be compared for different people.

Measuring lung volume

The amount of air that you can breathe out following a big breath in is known as your **vital capacity** or your **lung volume**.

There are several ways of measuring lung volume, for example by displacing water.

The average lung volume of an adult male is 6 litres (*l*).

1. Describe what is meant by lung volume.
2. A boy used the apparatus in Figure 2.8.2a to measure his lung volume. At the start, the bottle was full. Use the diagram to estimate the lung volume of the boy.
3. Suggest why the boy's lung volume is less than that of an adult male.

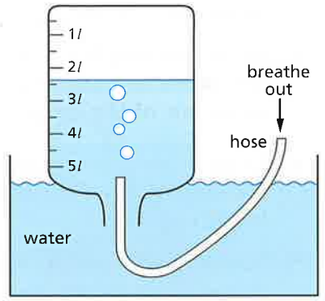


FIGURE 2.8.2a: As you breathe out strongly through the tube, water is displaced. The volume of water displaced is equal to the lung volume.

Investigating a claim

A group of students wanted to investigate the **claim** that taller people have bigger lung volumes. They tried to explain why this idea may be correct. This type of explanation is called a **hypothesis**.

Their teacher then gave them some definitions:

- **Independent variable** – the variable that we change in an investigation.
- **Dependent variable** – the variable that we measure in an investigation.
- **Control variables** – other factors that we need to control during the investigation.

They measured their own lung volumes by blowing into lung-volume bags. They also measured their heights.

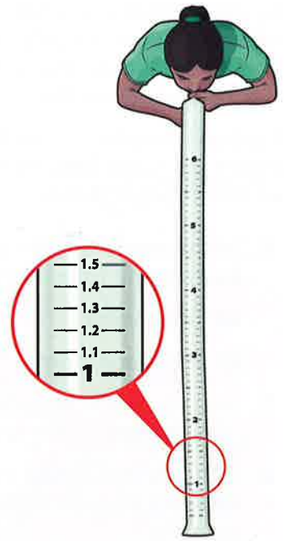


FIGURE 2.8.2b: Blowing into a lung-volume bag.

4. In this investigation, identify:
   a) The dependent variable. What units would it be measured in?
   b) The independent variable. What units would it be measured in?
   c) Two control variables.
5. Suggest a hypothesis for the claim that taller people have bigger lungs

Unravelling the data

It is important when investigating that we use a big enough sample size. Data was collected from a large group of adult male students at a university to investigate the link between height and lung volume – the results are shown in Figure 2.8.2c. We can then use data to comment on whether a claim is true.

6. From further investigation, the scientists found out that one of the men is an outstanding athlete. How tall is this man?
7. Suggest why this data may be more reliable than the data collected by the school students.
8. Using the data as evidence, comment on the claim that taller people have larger lung volume.

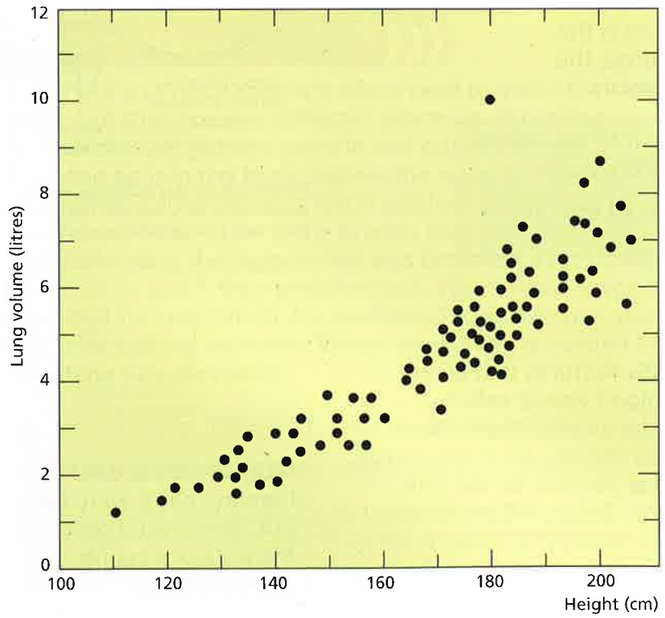


FIGURE 2.8.2c: Lung volume and height investigation.

Did you know...?

Spanish cyclist (and five times Tour de France winner) Miguel Indurain had lungs so big that they displaced his stomach, leading to a trademark paunch. His lung capacity was 8 litres when he was at his fittest.

FIGURE 2.8.2d: Miguel Indurain.

Know this vocabulary

lung volume (vital capacity)
claim
hypothesis
independent variable
dependent variable
control variable

Explaining gas exchange in humans

We are learning how to:

- Describe the features of the human gas exchange system.
- Explain how the features enable gases to be exchanged.
- Distinguish between breathing and respiration.

Gases pass from the lungs to the blood and vice versa across the alveoli. These must have adaptations to enable this to happen efficiently. Without well-adapted alveoli we would be deprived of oxygen.

Our gas exchange system

Once in the lungs, air travels through the bronchioles to the **alveoli**. Gas exchange then takes place across the walls of the alveoli.

- Oxygen passes from the alveoli into the blood, which carries it to all the body cells where it is used in **respiration**.
- Carbon dioxide is a waste product of respiration in cells. It is carried by blood back to the lungs. Carbon dioxide passes from the blood into the alveoli. The carbon dioxide is breathed out.

These gases move across the alveoli and **capillary** walls by **diffusion**. Diffusion is the spreading out of particles. In the lungs, the particles are oxygen and carbon dioxide.

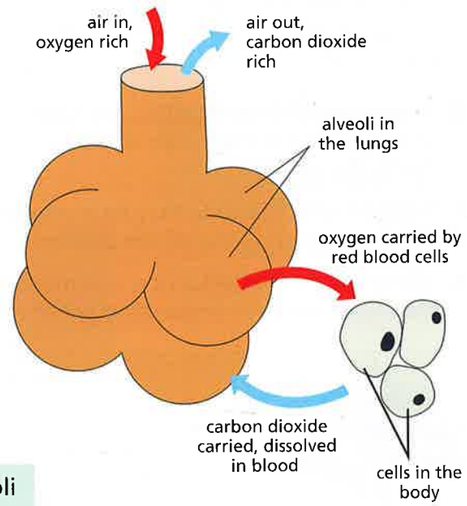


FIGURE 2.8.3a: Gas exchange across alveoli. Why do you think the alveoli have such a large surface area?

1. Name the gas that passes back into the alveoli after respiration in the cells of the body.
2. Explain why oxygen is taken to all the cells in the body.

Perfectly adapted

Our gas exchange system has specific features that allow diffusion to work efficiently. Tiny blood vessels called **capillaries** run over the surface of the alveoli. Gases travel between the blood in the capillaries and the air in the alveoli. This exchange is made as effective as possible by the thin lining of the alveoli and the very thin lining of the capillary walls. The surfaces of the alveoli are 'bumpy' (similar to cauliflower florets) to increase their surface area and the walls are moist to dissolve the gases.

Did you know...?

If the alveoli in one human's lungs were laid out, they would cover the area of a tennis court (100 m^2).

3. Describe what the surface of the alveoli is like.
4. Explain how each of these features of the alveoli supports gas exchange:
   - **a)** moist surface
   - **b)** surrounded by many blood capillaries
   - **c)** large surface area
   - **d)** thin alveoli walls.

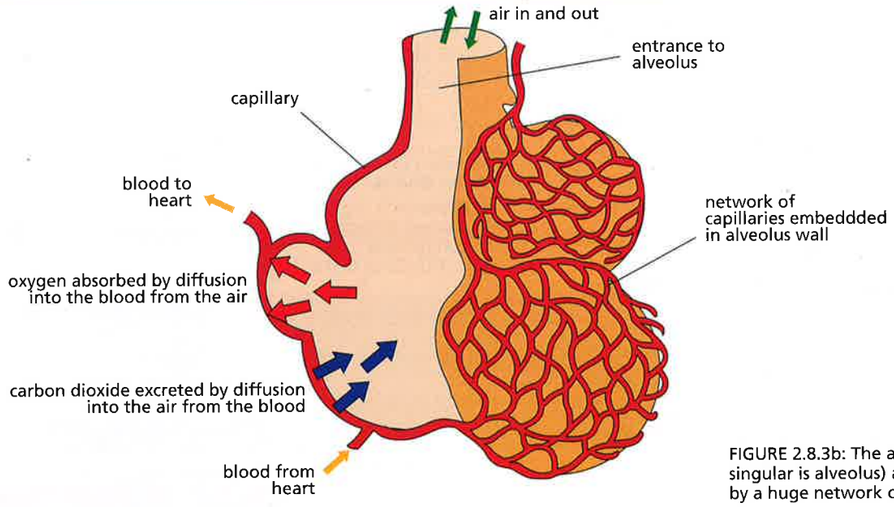


FIGURE 2.8.3b: The alveoli (the singular is alveolus) are surrounded by a huge network of capillaries.

Respiration or breathing?

Breathing and respiration are often used to mean the same thing, but they are very different processes. Breathing is the process of getting gases in and out of the body. Once the air is in the body, we use the oxygen in cells in respiration. Carbon dioxide gas is produced in cells by respiration. Respiration is the process that takes place in body cells using the oxygen that was breathed in. It travels to the lungs and is then breathed out. When more oxygen is needed for respiration, for example during exercise, the rate of breathing increases. When less oxygen is needed the breathing rate decreases.

5. Which parts of the body does breathing involve?
6. Which parts of the body does respiration involve?
7. A student has labelled a diagram of the breathing system (like Figure 2.8.1a) as the 'respiration system'. Explain why this is incorrect.

Know this vocabulary

alveoli
respiration
capillary
diffusion

Exploring the effects of disease and lifestyle

We are learning how to:

- Describe the physical effects of disease and lifestyle on the breathing system.
- Explain the physical effects of disease and lifestyle on the breathing system.
- Describe how our understanding about the effects of smoking has changed over time.

The breathing system can be affected by both lifestyle choices and disease. We can't choose about inheriting a disease, but we do have a choice about whether or not we exercise or smoke.

Lifestyle choices and disease

Regular exercise improves breathing. It increases the strength of intercostal muscles (between the ribs) so the chest can expand more when you breathe in, so your lung volume increases. It also increases the number and size of the blood capillaries surrounding the alveoli, so more oxygen can reach cells for respiration.

Diseases such as **asthma** affect the breathing system negatively. Asthma is thought to be influenced by inheritance, being born prematurely and being exposed to smoking in the womb or as a young child.

1. Give examples of a lifestyle choice and a disease that affect the breathing system.
2. Describe two ways in which the bronchioles change during an asthma attack, making it hard to breathe.
3. Describe two ways in which exercise affects the breathing system.

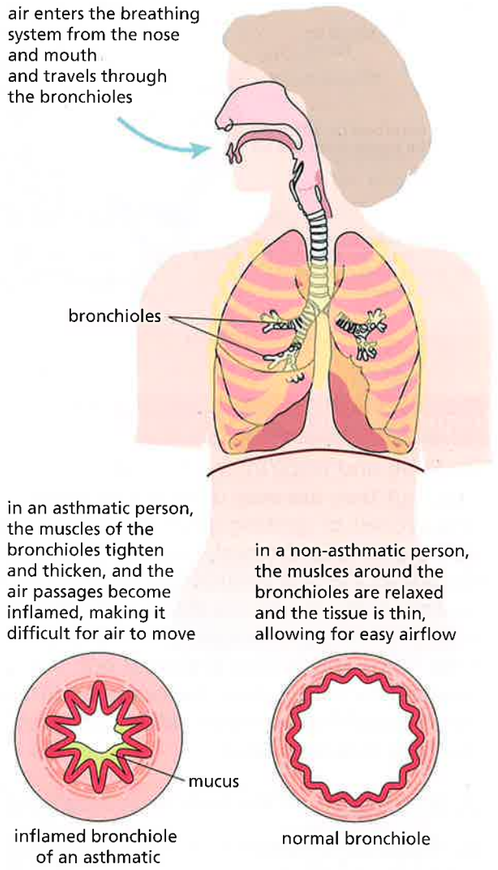


FIGURE 2.8.4a: Asthma makes it hard to breathe.

Why is smoking a problem?

8.4

Cigarettes release chemicals such as **nicotine**, **tar** and carbon monoxide.

- Nicotine is addictive.
- Carbon monoxide reduces the amount of oxygen the blood can carry.
- Tar can cause cancer.

In normal bronchioles, there are cells with tiny hairs called **cilia**. These sweep out any dirt particles that could damage the lungs.

In a smoker, the cilia are stuck together by tar and so dirt and smoke particles enter the lungs, which become irritated, leading to a smoker's cough. Persistent coughing can damage the alveoli. In cases of severe lung damage, a patient may be added to a waiting list for a lung transplant from a suitable donor.

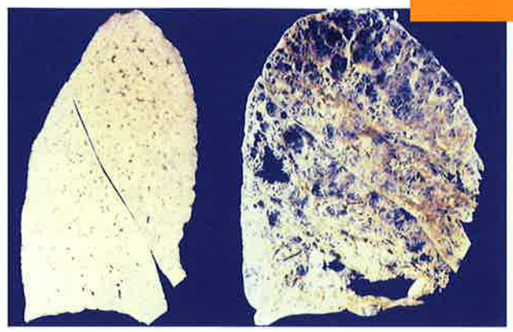


FIGURE 2.8.4b: Sticky brown tar coats the lungs of smokers. Tar can lead to lung cancer – the tobacco smoker's lung is on the right.

4. Name three dangerous chemicals in cigarettes.
5. Describe two effects of tar on the lungs.
6. How may smoking cause damage to people around the smoker?

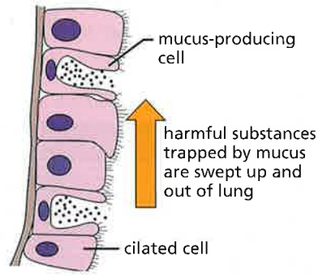


FIGURE 2.8.4c: What would happen without cilia?

Evidence and bias

We take it for granted now that smoking is bad for us, but it wasn't always like that. Before the 1950s, there were no health warnings with cigarettes and many believed they did no harm. There are claims that tobacco companies may have influenced research and the messages that were given to the public about the effects of cigarettes. Promoting a certain viewpoint is known as **bias**.

In the 1950s, scientists recognised the link between smoking and lung cancer. But it still took some time before their theories were generally accepted. Cigarette adverts were later banned on TV, radio and in cinemas. Only in the 1970s was it proven and accepted that smoking can harm the people around a smoker as well as the smoker. Being around a smoker during pregnancy can also affect a mother and her developing foetus.

7. Suggest the role that research took in cigarette advertising being banned.
8. It is suggested that there was bias in the reporting on the effects on people around a smoker before 1970s. Suggest who may have caused the bias and why.

Did you know...?

Research estimates that, on average, each cigarette shortens a smoker's life by 11 minutes.

Know this vocabulary

asthma
nicotine
tar
cilia
bias

Exploring a healthy diet

We are learning how to:

- Describe the components of a healthy diet and explain the importance of each.
- Compare the energy requirements of different healthy diets.
- Calculate energy content within different diets.

Some adverts try to promote food products as being part of a healthy diet. What is a healthy diet and how can different people get the energy and nutrients they need?

Food groups

There are seven **food groups**, shown in Table 2.8.5. These provide the **nutrients** you need to live, grow and use in processes in the body.

TABLE 2.8.5: The seven food groups.

Food group	Uses in the body
carbohydrates	Two types: starches and sugars. They provide energy – an excess causes weight increase.
protein	Important for growth and repair of cells and tissue.
lipids (fats and oils)	Stored as a reserve energy supply. A layer under the skin provides insulation against cold. An excess causes weight gain and can lead to other health issues.
minerals	Tiny amounts are needed – e.g. iron for red blood cells and calcium for teeth and bones.
vitamins	Small amounts are needed – e.g. vitamin C for repair of the skin and vitamin D for taking up calcium.
dietary fibre	Needed to keep the large intestine working well.
water	Needed to stop a person becoming dehydrated.

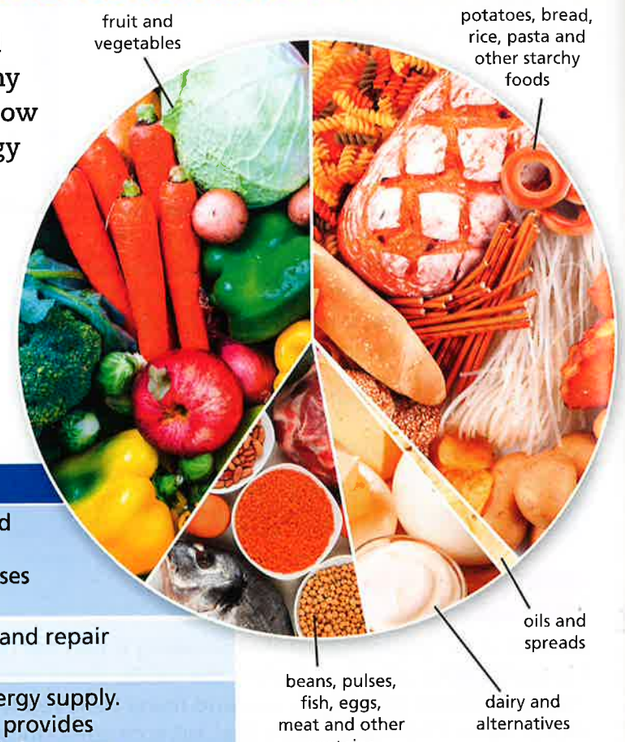


FIGURE 2.8.5a: You can help to ensure that you have some of each food group in your diet by varying the foods that you eat.

1. Name the main food group we get from fish.
2. Give two foods that contain carbohydrates.

Did you know...?

Several foods such as blueberries, goji berries and kale have been marketed as 'superfoods' in the past. However, this term is now debated and the 'superfood' label can only be used if backed up by an authorised health claim.

A balanced diet

Each of the food groups has a different role to play in the **balanced diet** that our bodies need.

In a typical Western diet, there is often too much sugar and fat and not enough dietary fibre. We do not digest dietary fibre. Instead, it adds bulk to food and helps to move it through the intestines. A lack of dietary fibre can cause constipation, where faeces become difficult to pass.

We need different amounts of each of the food groups in our diet. An 'eatwell plate' like that shown in Figure 2.8.5a can help us make sure that we are eating the food groups in the correct proportions.

3. List the food types in order of the relative proportions we should include in our diet, as recommended by the 'eatwell' plate in Figure 2.8.5a.

FIGURE 2.8.5b: Why do these people need different daily amounts of energy?

Considering energy requirements

Food provides us with energy. We need energy to grow, repair, move and keep warm.

The amount of energy in foods is measured in **kilojoules (kJ)**. The amount of energy we need per day varies, depending on age, gender and level of activity.

Most food labels tell us how much energy food contains. This can help us to monitor how much energy we are taking in. However, we should also take into account other factors when choosing foods, such as the nutrients and amount of fat they contain.

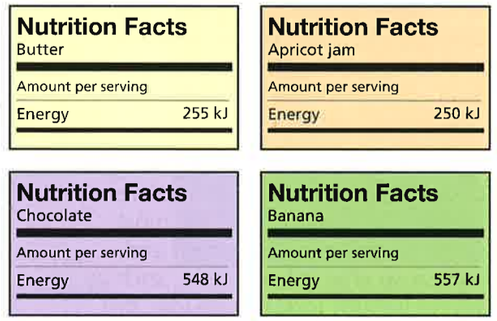


FIGURE 2.8.5c: Some food labels tell us how much energy is in each portion of food.

4. Suggest why there might be a difference between the daily energy requirements of an average adult woman and a pregnant woman.
5. Looking at just the energy counts shown in Figure 2.8.5c, suggest why some people would find it difficult to choose between having butter or jam for breakfast, or between having chocolate or a banana for a snack.
6. Which of the choices in question 5 would be the healthier? Explain why.

Know this vocabulary

food group
nutrient
carbohydrates
protein
lipids
vitamin
dietary fibre
balanced diet
kilojoules (kJ)

Understanding the effects of an unbalanced diet

We are learning how to:

- Describe the physical effects of eating too much or eating too little.
- Identify the causes and effects of some deficiencies in the diet.

When over-eating or under-eating is prolonged, it can cause serious damage to our health. However, even when we eat food to provide us with energy, we can still be deficient in some nutrients if our diet is not balanced. Deficiency diseases can cause severe illness and even death.

FIGURE 2.8.6a An obese person is at greater risk of health problems.

The effects of eating too much or too little

Body mass index (BMI) is a measure of body fat based on the height and weight of an individual. People with **obesity** have a very high BMI. Obesity can cause serious physical problems such as pain in the joints, heart disease, high blood pressure and difficulties with breathing.

Starvation is caused by not taking in enough energy and nutrients over a prolonged period. It is the most serious form of **malnutrition** and can cause physical problems, such as severe weight loss, muscle loss, dry skin and hair, infertility and fatigue. Both obesity and starvation can cause death.

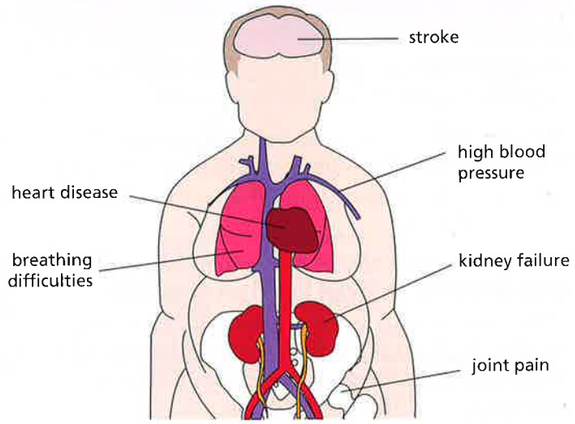


FIGURE 2.8.6b: Obesity can affect many parts of the body.

1. What is meant by 'BMI'?
2. What causes starvation?
3. Draw a table to summarise the physical effects of obesity and starvation.

Did you know...?

Three iced ring doughnuts contain approximately the amount of energy an 8-year-old boy needs during one day. It would take over 90 minutes of cycling to use up this energy.

Diseases caused by deficiencies

Many **deficiency diseases** are caused by a lack of certain vitamins or minerals. However, a person can also suffer from a lack of other food groups such as protein.

The symptoms of scurvy are fatigue, bleeding gums, loss of teeth, fever and death. It is caused by a deficiency of vitamin C. In the past it caused the death of sailors whose diet consisted of dried meat and grains, but little fresh fruit.

Rickets causes muscles and bones to become soft. This can lead to permanent deformities in children. Rickets is caused by a lack of vitamin D, which is needed to absorb calcium into bones to strengthen them and allow growth. Sunlight is needed to allow your body to use vitamin D.

Anaemia is a condition that makes the sufferer feel extremely tired due to a lack of oxygen being transported around the body. It is caused by a lack of iron. Iron is used to make red blood cells that carry oxygen.

4. In the past, why did a lot of sailors suffer from scurvy?
5. Suggest why children need more calcium than adults.
6. In recent years, children living in developed countries have spent more time indoors. Why there has been a rise in rickets in recent years?

FIGURE 2.8.6c: Scurvy is caused by a lack of vitamin C.

FIGURE 2.8.6d: Rickets is caused by a lack of vitamin D.

Preventing and treating deficiency diseases

Deficiency diseases are usually easily treated by re-introducing the missing nutrient into the diet. The problem in the past has been identifying the cause.

Scurvy is treated by eating foods containing vitamin C (or taking supplements). Some foods, such as milk formula and cereals, have vitamin D added to them to prevent rickets.

TABLE 2.8.6: Deficiency diseases.

Disease	Deficiency causing the disease	Food to treat or prevent the disease
scurvy	vitamin C	limes
rickets	vitamin D	eggs
anaemia	iron	beans and pulses

7. Explain how sunlight can help to prevent rickets.
8. Explain why scurvy in sailors was treated with limes.

Know this vocabulary

obesity
starvation
malnutrition
deficiency disease

Understanding the human digestive system

We are learning how to:

- Identify the organs of the human digestive system.
- Describe the process of digestion.
- Evaluate a model of the digestive system.

The food we eat has chemical energy stored in it. To make use of this energy, we must digest the food. **Digestion** starts at the mouth and finishes at the anus. Many organs of the body are involved in digesting our food along the way.

FIGURE 2.8.7a: Digestion of your food starts in your mouth.

The human digestive system

Food is broken down and passes through each of the organs in the **digestive system**.

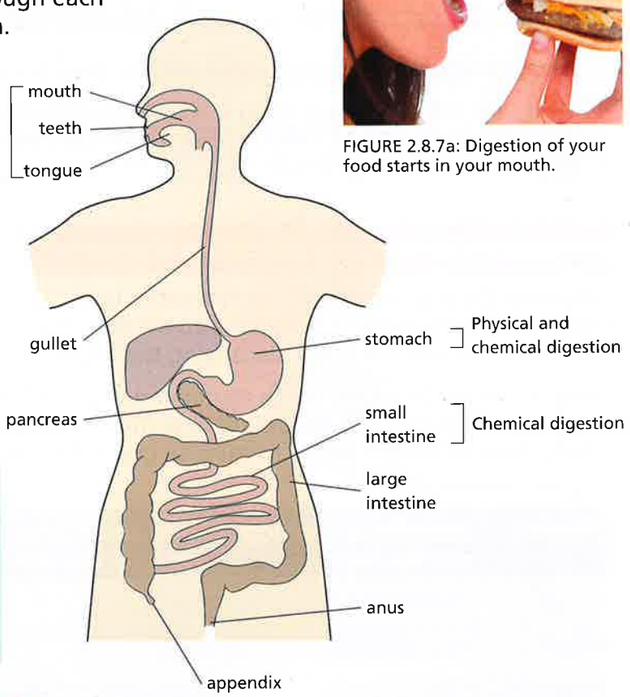


FIGURE 2.8.7b: Food enters the mouth, passes down the gullet to the **stomach**, then into the **small intestine** and **large intestine** before the waste is passed through the anus. The pancreas is needed for digestion, but food does not pass through it.

1. List the organs of the digestive system in the order that food passes through.
2. Suggest what would happen if there were a blockage in the large intestine.

Why do we need digestion?

Food contains chemical energy. You must break down the large molecules in the food (such as starch) you eat into smaller molecules (such as glucose) so that you can use the energy in your body. This process is called digestion.

The small food molecules are then absorbed into the blood through the walls of the small intestine by diffusion. The blood then carries the food molecules to the cells of the body where they can be used to release energy. This process of releasing energy from food molecules (and oxygen) is called respiration.

3. Name the type of energy that food contains.
4. Explain why we need to break food into smaller molecules during digestion.
5. Describe what faeces are and explain what happens to faecal waste.

A model gut

In science we use models to help us to visualise what we cannot see. Models can help us to understand the science of a process.

When we use a model, we must remember there may be some differences to the real thing. We should always assess how good a model is. This means we evaluate it. For example, when we look at a model car, we can say it is a good model because it shows the proportion of the parts, but is unlike real life because the parts do not move as they would in the real thing.

We can use a model to help us to understand what happens in the small intestine. Figure 2.8.7c shows a model of food in the intestine. In this model, the Visking tubing represents the intestine, the water represents the blood surrounding the intestine and the starch and glucose represent food that we have eaten.

Students mixed starch and glucose inside Visking tubing. After 10 minutes, they tested the water outside the tubing and showed that glucose had passed through the tubing but starch had not.

This model represents how small molecules such as glucose can move from the small intestine to the blood, but the large starch molecules cannot.

6. What are the benefits of using models?
7. Evaluate this model. (What is a good representation in this model and what is not like the real digestive system?)
8. What does this model tell us about the importance of digestion?

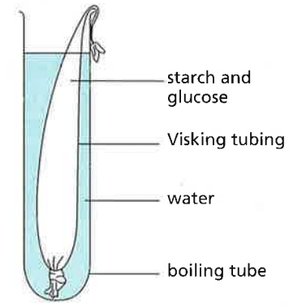


FIGURE 2.8.7c: What does each part of the digestive system model represent?

Did you know...?

Each day about 11.5 litres of digested foods, liquids and digestive juices flow through your digestive system.

Know this vocabulary

digestion
digestive system
stomach
small intestine
large intestine

Understanding the roles of the digestive organs

We are learning how to:

- Describe the roles of the organs of the digestive system.
- Describe the importance of enzymes and gut bacteria in digestion
- Explain how the structure of each of the organs is adapted to its function.

Several organs in the body work together to digest food and dispose of waste. Food is churned, mixed, digested with chemicals and squeezed along the digestive system. Each organ has developed to carry out its specific role.

What do the organs of the digestive system do?

Digestion takes place along the digestive system from the mouth to the small intestine. Once digestion by **enzymes** is complete in the small intestine, the small molecule nutrients pass into the bloodstream and are carried to cells. Figure 2.8.8a shows where both **physical digestion** and **chemical digestion** take place.

1. Name the organ in which digestion by enzymes is completed.
2. List two parts of the digestive system where physical *and* chemical digestion take place.

0 hours
Food enters the mouth where it is chewed up, rolled into a ball by the tongue and moistened by saliva ready for swallowing.

1 hours
Food is swallowed and passes into the oesophagus which carries the food to the stomach.

2 hours
The stomach breaks down food physically by muscle contraction and chemically by enzymes. The acid conditions kill bacteria and help the enzymes to work.

6 hours
The small intestine digests the food further using different enzymes and absorbs it into the blood.

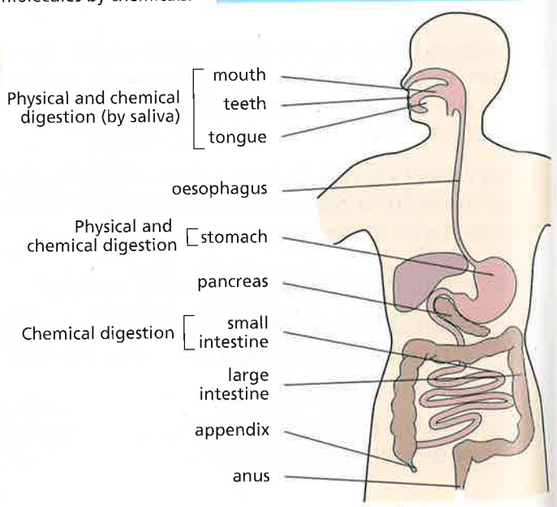
10 hours
In the large intestine water is absorbed to make the waste (faeces) more solid.

16–24hrs
The faeces are then passed out through the anus.

FIGURE 2.8.8a: Physical digestion is the mechanical breakdown of food. Chemical digestion is the breakdown of food molecules by chemicals.

The role of enzymes and bacteria

Enzymes are catalysts; they speed up reactions in our bodies. We have enzymes in our body that help with digestion. This type of digestion is chemical digestion. Enzymes are specific; they can only break down one type of molecule. Specific enzymes break down each food type. Bacteria naturally live in our gut (**gut bacteria**) and many of these bacteria help with digestion. These 'good bacteria' can release energy from some foods, make some enzymes that we need and may protect us from disease-causing bacteria.



Food group	Product of digestion	Enzyme involved	Where the enzyme is found
Carbohydrate (starch)	glucose	amylase	mouth and small intestine
Protein	amino acids	protease	stomach and small intestine
Fats	fatty acids + glycerol	lipase	small intestine

TABLE 2.8.8a

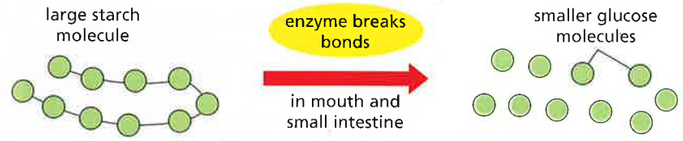


FIGURE 2.8.8b: Amylase enzyme breaks down starch to glucose molecules.

3. Explain why we need enzymes to act as 'chemical scissors' during digestion.
4. Sufferers of cystic fibrosis release very few enzymes into the small intestine. What are the consequences of this?
5. Describe three ways in which some bacteria can help in digestion.

Adaptations of the organs

Each of the organs involved in digestion is specialised for the job it does. This is known as an adaptation. For example, the mouth is well developed to chemically digest starch because it produces saliva.

TABLE 2.8.8b: Adaptations of some of the digestive organs.

Organ	How it is adapted to its function
oesophagus	Contains rings of muscle that contract behind the bolus (rounded mass of food and saliva) to move the food along.
stomach	Contains muscles to squeeze the food. Secretes acid to kill bacteria. Contains an enzyme to digest protein.
pancreas	Releases enzymes that digest carbohydrates, protein and fats.
small intestine	Contains muscles to move the food along the tube and enzymes to complete digestion. Has thin walls and a good blood supply to help absorption of nutrients into blood.

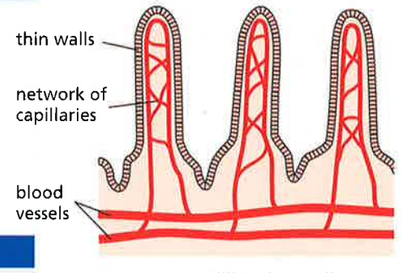


FIGURE 2.8.8c: Villi in the small intestine allow nutrients to be absorbed into the bloodstream.

6. Food does not pass through the pancreas. Explain why it is shown as part of the digestive system.
7. How is the digestive system adapted to digest fats?
8. Figure 2.8.8c shows how the small intestine is folded to increase its surface area. Suggest how this increased surface area helps the role of absorbing nutrients into the blood.

Did you know...?

In humans the small intestine is between 6 and 8 metres in length. That is more than the width of a typical swimming pool.

Know this vocabulary

enzymes
physical digestion
chemical digestion
gut bacteria

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

- ☐ Recall that the ribs and diaphragm bring about breathing.
- ☐ Describe how movement of the ribs and diaphragm bring about breathing and describe the changes in volume of the chest.
- ☐ Explain how changes in pressure in the chest bring about breathing.

- ☐ Define gas exchange and describe why it is needed in the lungs.
- ☐ Identify features of the gas exchange system in humans.
- ☐ Explain how parts of the gas exchange system are adapted to their function and distinguish between breathing and respiration.

- ☐ Describe the physical effects of disease and lifestyle on the breathing system, such as the effects of asthma and smoking.
- ☐ Explain the physical effects of disease and lifestyle on the breathing system, such as the effects of asthma and smoking.
- ☐ Describe how our understanding of the effects of smoking have changed over time and explain the role of bias in the process.

- ☐ Recall the components of a healthy diet and know that it is unhealthy to eat too much or too little.
- ☐ Describe the role of some of the components of a healthy diet and name examples of deficiency diseases.
- ☐ Describe the causes and effects of some deficiency diseases and suggest possible treatments and preventions. Describe the components of a healthy diet.

- ☐ List different groups of people who need different amounts of energy.
- ☐ Compare the energy requirements of different people such as men and women, the elderly and pregnant women.
- ☐ Explain why different people have different energy requirements and suggest how they could meet these.

- ☐ Define digestion and name and locate the organs of the digestive system.
- ☐ Describe the importance of digestion and describe the role of the organs of the digestive system, including the role of bacteria and enzymes.
- ☐ Describe adaptations of parts of the digestive system, such as the small intestine and oesophagus and describe what happens to the small molecules following digestion.

Questions

KNOW. Questions 1–9

See how well you have understood the ideas in this chapter.

1. What is the main food group found in fish? [1]

a) carbohydrate **b)** fibre **c)** protein **d)** fat.

2. Which food group adds bulk to our food and helps to move it through the digestive system? [1]

a) fibre **b)** fats **c)** vitamins **d)** protein.

3. Which organ in the digestive system contains hydrochloric acid? [1]

a) mouth **b)** small intestine **c)** large intestine **d)** stomach.

4. Describe *two* ways in which we use energy when we are sleeping. [2]

5. Which gas is there more of in exhaled (breathed out) air than inhaled (breathed in) air? [1]

a) oxygen **b)** carbon dioxide **c)** nitrogen **d)** sulfur dioxide.

6. Gas exchange in the lungs takes place through the: [1]

a) bronchi **b)** bronchioles **c)** alveoli **d)** ribs.

7. Describe the changes in the volume and pressure inside the chest just before breathing in. [2]

8. Oxygen is carried to cells from the lungs for: [1]

a) respiration **b)** photosynthesis **c)** breathing **d)** digestion.

9. Using the letters on the diagram, identify: [2]

a) the trachea **b)** bronchioles.

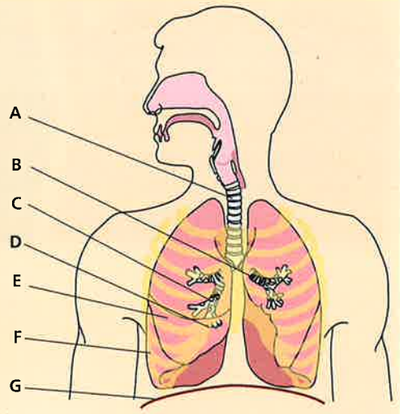


FIGURE 2.8.10a

APPLY. Questions 10–15

See how well you can apply the ideas in this chapter to new situations.

10. Explain the differences between chemical digestion and physical digestion. [2]

11. Why is it difficult to estimate the number of people dying from obesity? [1]

a) The number is increasing.
b) The number is decreasing.
c) People with obesity often die from other conditions.
d) Obesity doesn't kill people.

12. Which of the following foods would the pancreas help most in digestion? [1]

a) turkey breast **b)** lettuce **c)** apple **d)** butter.

13. Explain why lemons can help to treat a person with scurvy. [2]

14. Suggest why smoking is even more harmful to an asthma sufferer than to someone without asthma. [2]

15. The villi in the digestive system are adapted to allow small food molecules to pass through their walls. Suggest how the alveoli in the lungs may be similar to villi. [4]

EXTEND. Questions 16–17

See how well you can understand and explain new ideas and evidence.

16. A diet company claims that it has produced a medicine that blocks lipase (fat-digesting) enzymes. Explain how such a medicine may support weight loss. [4]

17. The pressure in the lungs just before breathing in has been calculated as –0.4 kilopascals (kPa). The pressure in the lungs just before breathing out has been calculated as 0.4 kPa. Calculate the pressure difference in the lungs between breathing in and breathing out. (Remember to use units.) [2]