Lungs

Section 1: Respiration

• Why do we need to breathe?

Every cell in the body carries out a process called respiration in order to release the energy it needs to function. Respiration needs oxygen and produces the waste gas carbon dioxide, so we breathe in order to get the oxygen into our blood and the carbon dioxide out.

The air you inhale contains about 21% oxygen, while the exhaled air contains about 16-17% oxygen, demonstrating that oxygen has been absorbed and used by the body.

- **Suggested Films**
  - **The Dark Side of Oxygen**
  - **Big Breathers**

X-ray of the human torso

DIAGRAM 01:

Composition of Air

BIOLOGY • HUMAN BODY • LUNGS

	Oxygen	Carbon Dioxide
Inhaled Air	21%	0.03%
Exhaled Air	17%	4%

Extension Question

Q1. What happens to the composition of exhaled air during exercise?

The amount of oxygen in exhaled air during exercise will fall and the amount of carbon dioxide will rise. This is because the rate of respiration in cells will have risen during exercise, thereby using more oxygen and creating more waste carbon dioxide.

Section 2: The Lungs

• What is the function of the lungs?

The function of the lungs is to provide an ideal exchange surface between the air and the blood, so that gas exchange can occur as efficiently as possible. Oxygen needs to diffuse into the blood and carbon dioxide needs to diffuse out. The lungs have a huge surface area and are in very close contact with the blood, factors which are ideal for rapid diffusion.

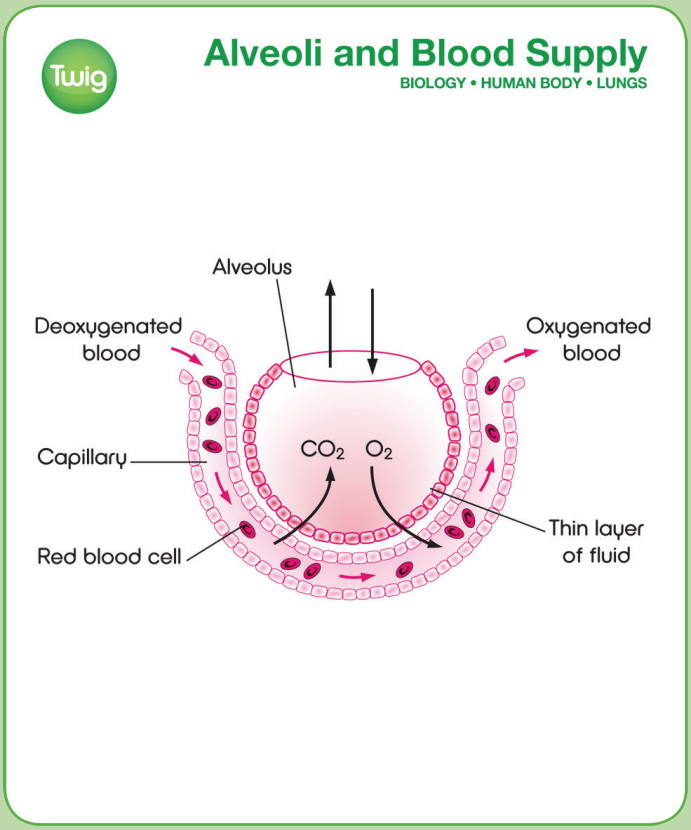
- **Suggested Films**
  - **Lungs**
  - **FactPack: Lungs**

Extension Question

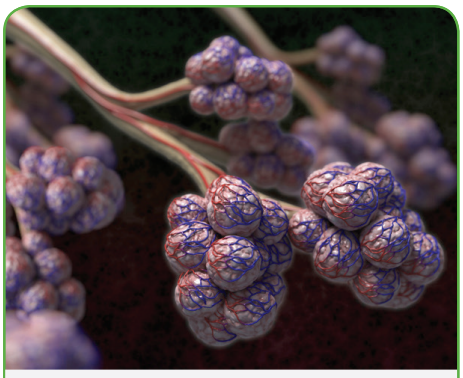
Q2. Why do we keep breathing in and out?

By continually breathing in and out, we ensure that the air in the lungs is refreshed, the concentration of oxygen remains high and the concentration of carbon dioxide remains low in the alveoli. This means gases can continue to diffuse in and out of the blood rapidly because we have maintained the diffusion gradients.

DIAGRAM 02:



• How are lungs adapted for their function?



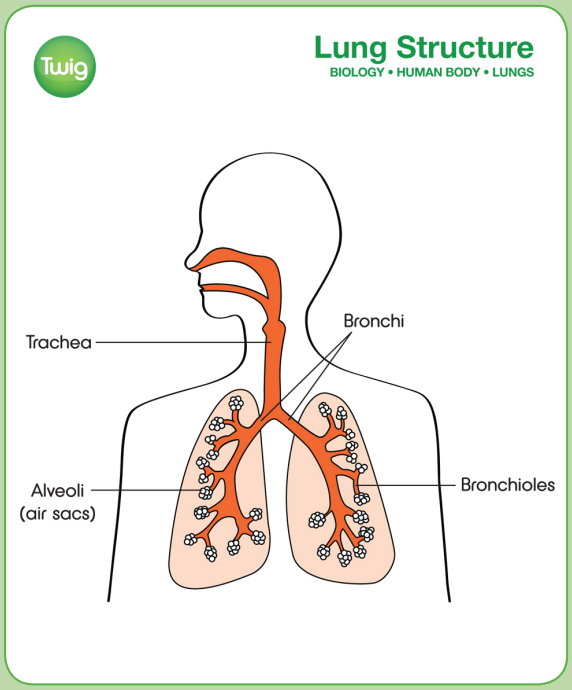
Alveoli within the lungs

The lungs consist of millions of tiny air sacs called alveoli. In total they create a surface area for gas exchange of about 70m^2. These alveoli are in very close contact with the blood capillaries so that oxygen and carbon dioxide can diffuse efficiently.

Air reaches the alveoli via the windpipe (called the trachea), which branches into two bronchi, which branch further into numerous bronchioles. These bronchioles lead to the alveoli.

- **Suggested Film**
  - **Lungs**
- **Suggested Activity**
  - **Examine prepared slides of lung tissue**

DIAGRAM 03:



Extension Questions

Q3. How do the lungs keep themselves clean?

When you breathe in, dust, bacteria and other particles can enter the lungs. This could affect breathing and possibly lead to a lung infection. The nasal passages and the tubes in the lungs are lined with hairs and sticky mucus; together these help trap unwanted particles. In addition, the trachea and bronchi are covered with cilia, which are microscopic hairs capable of wafting dirt back up and out of the lungs, thereby keeping them clean. The dirt they remove is either swallowed or coughed up.

Q4. What is the larynx?

The larynx is your voice box. It is found at the top of the trachea and contains the vocal cords. Its job is to control the pitch and volume of your speech. If it becomes inflamed you are said to have laryngitis.

• How do we move air in and out of the lungs?

The lungs are surrounded by the rib cage and the diaphragm. When muscles in the diaphragm contract, it is pulled down creating a greater volume in the chest and therefore a lower pressure. This causes air to rush in. If muscles between the ribs contract, the rib cage is pulled up and out, creating the same effect, and so allowing us to breathe more deeply. Breathing out simply involves reversing these actions. The diaphragm rises up, the ribs fall and the air is forced out.

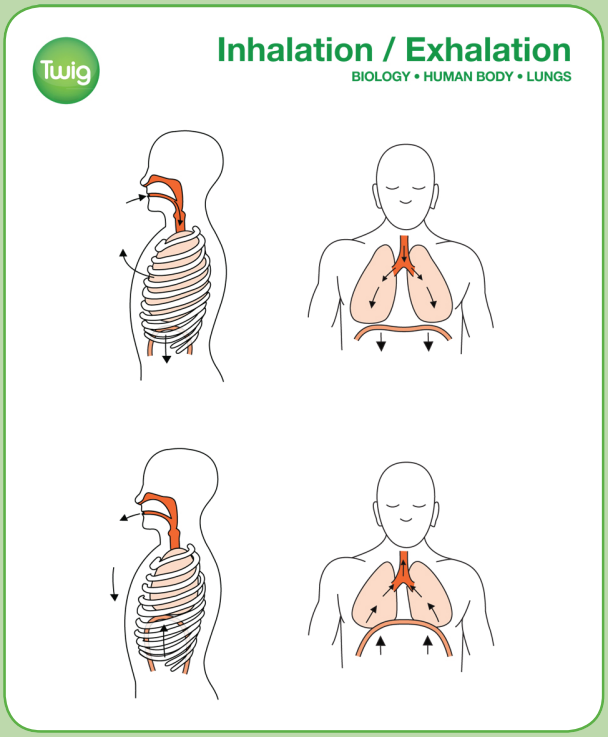
- **Suggested Activities**
  - **Demonstrate the Bell Jar model**
  - **Use vital capacity bags to demonstrate lung volumes**

Extension Question

Q5. Why are there rings of cartilage in the walls of the trachea and bronchi?

When you breathe in, you briefly create sub-atmospheric pressures in your lungs. This is why air rushes in. To stop the airways collapsing in on themselves, they are reinforced with tough rings of cartilage.

DIAGRAM 04:



Section 3: Strains On the Respiratory System

• What happens to our breathing when we exercise?

When we exercise our cells respire more rapidly, which means they require more oxygen. They also produce more carbon dioxide. This is detected by a region of the brain stem called the medulla. In response to rising carbon dioxide concentrations, the medulla instructs the breathing muscles of the diaphragm and between the ribs to contract more frequently and forcefully. As a result, breathing rate and depth increase, and more air is moved in and out of the lung.

• Suggested Activity

– Ask students to plan and carry out an investigation into the effect of exercise on ventilation rate

Extension Question

Q6. What makes someone fitter than another?

There are lots of reasons why someone is fitter than another, but lung capacity and red blood cell count are two important ones. As someone trains they can increase their lung capacity and the number of red blood cells they have. This means that they can deliver greater quantities of oxygen to their cells for respiration.

• Suggested Film

– Little Breathers

• What is asthma?

Asthma is a common lung disorder in which the airways become constricted and inflamed. This leads to coughing, wheezing and difficulty drawing breath. It is triggered in sensitive people by allergens, such as dust and smoke, as well as sudden changes in temperature.

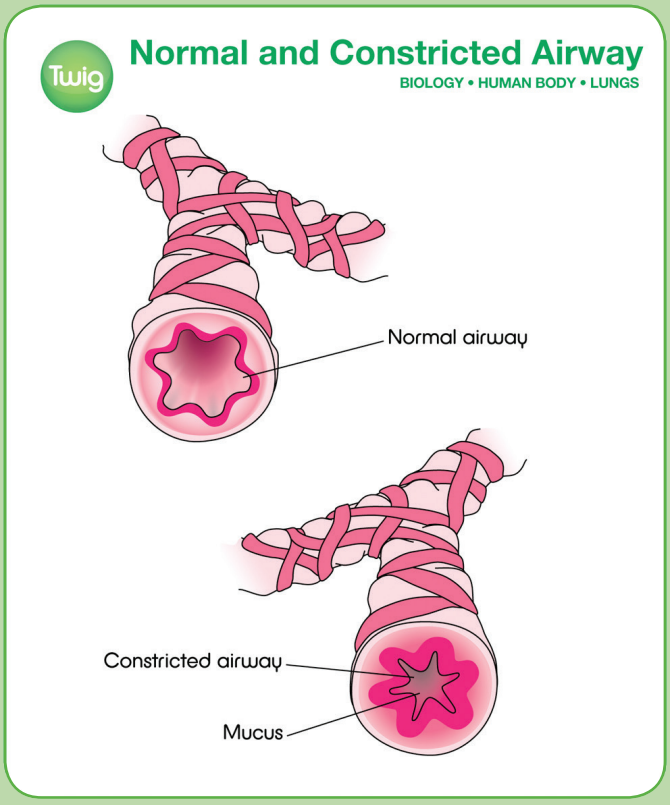
Inhalers can be used to treat asthma

Extension Question

Q7. How is asthma treated?

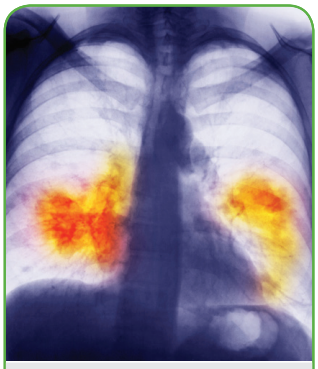
Asthma is treated both by using drugs and by avoiding those factors which seem to trigger it, such as allergens like dust and animal hair. Drugs used include those which act to relax the muscle walls of the bronchioles, causing them to dilate and make breathing less restricted.

DIAGRAM 05:



• How does smoking affect the lungs?

Tobacco smoke contains a cocktail of chemicals which are damaging to the lungs. These chemicals can irritate the lining of the lungs, damaging the tiny cilia and causing increased mucus production. This can lead to increased coughing – called smokers cough – and an increased likelihood of infection and inflammation of the airways – known as bronchitis. Long-term smoking can lead to a condition called emphysema (in which the alveoli break down and fuse together) and possibly lung cancer. To make matters worse, the carbon monoxide in the smoke can reduce the oxygen carrying capacity of the blood, by binding to the haemoglobin inside red blood cells, preventing it from carrying oxygen.



Chest X-ray showing lung cancer

- **Suggested Films**
  - **Smoking: The Damage**
- **Suggested Activity**
  - **Ask students to design a poster to show the effect of smoking on the lungs**

Extension Questions

Q8. What are the the symptoms of emphysema?

Because the alveoli break down and fuse together in emphysema, the total surface area of the lungs is dramatically reduced. This slows the rate of gas exchange in the lungs causing the patient to become breathless easily. In fact, some people with emphysema can hardly walk without gasping for breath.

Q9. How does smoking cause lung cancer?

There are several chemicals in tobacco smoke which cause cancer. These chemicals cause the DNA inside lung cells to mutate. Sometimes these mutations will cause cells to start dividing out of control to form a tumour. If the tumour continues to grow and spread, it can cause the lungs to fail. Sometimes the tumour can also spread to other parts of the body where it continues to grow.

• Quizzes

Lungs

Basic

• Why do we need oxygen?

A – to breathe in

B – to breathe out

C – to respire

D – for energy

• What is the scientific name for the windpipe?

A – trachea

B – oesophagus

C – bronchus

D – alveolus

• What are the smallest tubes in the lungs called?

A – trachea

B – bronchioles

C – bronchi

D – capillaries

• What gases are exchanged in the alveoli?

A – carbon dioxide and oxygen

B – carbon dioxide and nitrogen

C – oxygen and nitrogen

D – carbon dioxide and water vapour

Advanced

• Which of the following is the best definition of breathing?

A – the chemical process which releases energy inside every living cell

B – the exchange of oxygen and carbon dioxide in the lungs

C – the movement of air into and out of the lungs

D – the contraction of the intercostal and diaphragm muscles

• What is the scientific name for the windpipe?

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• What is the scientific name for the air sacs in the lungs?

A – trachea

B – oesophagus

C – bronchi

D – alveoli

• How are the air sacs adapted for gas exchange?

A – they have thin walls and a rich blood supply

B – they are spherical

C – they are near the rib cage

D – they are rich in haemoglobin

• Answers

Lungs

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