# ACTIVITY 2: LUNGS

# TEACHERS' GUIDE

This is the basis of a plan for one lesson to cover the second learning cycle for this sequence. It links with a specially made TV programme featuring the work of Ceri Harrop, a researcher in respiratory medicine. The video can be downloaded from Weblink: TTV.

## THE STORY SO FAR

In the first activity, Breathless, the trainees analysed data from tests on 400m runner Wayne Ashall (19). Wayne is hoping to compete at the 2012 Olympics. They learned that his asthma need not limit his chances if properly treated. In this activity they look more closely at what happens inside lungs. In the process they learn how their lung tissues are specialised to pass oxygen into the bloodstream quickly and how their delicate structure is protected from dirt and disease.

## LEARNING OBJECTIVES

**Big Scientific Idea**

Cells – Life processes are supported by the organisation of cells into tissues, organs and systems (Strategy Framework 2.1).

**What we want students to understand**

- Your respiratory and circulatory systems are specialised to deliver oxygen to cells.
- Small molecules, like oxygen, diffuse into your blood quickly because your lungs have a large surface area and a good blood supply.

**The questions they will explore**

- What makes our lungs so good at getting oxygen into our blood?

**What students need to remember**

- Lungs are made from thousands of tiny air sacs.
- The cells that line your airways are protected by a thin layer of mucus.

**What they need to know how to do**

- Handle irritant chemicals safely.

**Language**

Gas exchange, respiration, alveoli, cilia

## LEARNING CYCLE

| Stage | Time | Running notes | Opportunities |
|---|---|---|---|
| **Engage**<br>Just how much extra oxygen can you take in when you run? | 5 min | Slides 3 and 4 of L&K Academy 2 Lungs remind the trainees about the extra oxygen an athlete's lungs need to be able to take in when they run. Invite students to feel their rib movement during breathing at rest and maximum volume breathing. Air flow through the lungs during severe exercise rises from about 60dm$^3$ to about 1,200 dm$^3$ per minute. Students could get a better feel for the volumes involved by holding metre rules in a cube to approximate the volume of air passing thorough Wayne's lungs per minute at exercise (1 metre x 1 metre x 1 metre = 1,000 dm$^3$). | |
| **Elicit**<br>Students suggest ideas about what makes our lungs so good at getting oxygen into our blood. | 5 min<br><br>(10 min) | For slide 5, divide students into groups to discuss ideas and come up with three features of lungs. They can look back at the end of the lesson and see if their ideas have changed.<br><br>Ideally trainees should be given the opportunity to see a pair of lungs from a sheep or pig. If they are not too badly damaged, and there is enough tubing left to create a seal, a bicycle pump can be used to inflate them. This must should be done inside a large plastic bag to avoid releasing a fine spray of fluid aerosols possibly contaminated with pathogens from any cuts. Show the reinforced windpipe and display the branching tubes leading air into both lungs. If the lungs are not needed by another class, the tissue could be sliced to show some of the smaller airways in cross section and let students feel the soft, elastic quality of the tissue.<br><br>Red centicubes could be distributed with the information that a piece of lung tissue this size is divided into more than 150,000 air spaces.<br><br>  <br><br>• Keep the lungs refrigerated until they are needed, but not in a fridge used for storing food.<br>• The lungs must NOT be blown up by mouth. A bicycle pump can be used to inflate the lungs if they are not too badly slashed and there is enough tubing left to create a seal around the pump. They should be covered with plastic while any attempt is made to inflate them to avoid spraying aerosols into the air.<br>• Cover all open cuts with a waterproof plaster. If a student or member of staff receives a small cut as a consequence of dissecting the organ, wash the wound in cold running water, allow minor wounds to bleed freely and refer the casualty to a first-aider.<br>• The work surface, dissecting tray and any dissecting instruments used to display the organs should be thoroughly cleaned with hot water and detergent after the lesson.<br><br>Refer to CLEAPSS Handbook section 14.7.2/4. | Where the class includes Muslim students who might object to handling pork, sheep's organs should be used.<br><br>It is not necessary for students to wear gloves to feel the texture of the lung tissue.<br><br>Have soap, warm water and towels available and ensure that students who have handled the tissues wash their hands before leaving the room. |

| | | | |
|---|---|---|---|
| **Explore**<br>Groups model diffusion. | 15 min | Jack uses slides 6 and 7 to set the next task. L&K Academy 2 Lungs SS 2 (or the more structured SS 3) gives detailed guidance. The 'air spaces' are holes in phenolphthalein-stained agar and the 'oxygen' is 0.1M sodium hydroxide solution.<br><br>At the same time, a demonstration of diffusion through different thicknesses of agar could be set up in test tubes.<br><br>  <br><br>• The sodium hydroxide (Hazcard 91) needs to be labelled irritant. Students must wear eye protection and rinse splashes off their skin.<br><br>Slide 8 prompts the trainees to explain their observations<br><br>They should discover that more of the agar is stained around the smaller holes where the agar has a greater total surface area in contact with the alkali. The demonstration apparatus shows diffusion from a different angle to emphasise that molecules take longer to diffuse through thicker tissues. | |
| **Explain**<br>Jack explains why lungs are so good at taking in oxygen. | 10 min | Use slides 9 and 10 to emphasise how thin the alveoli walls are compared to the sizes of the alveoli, the large surface area their walls provide, and how close the blood vessels are.<br><br>The effect of dividing the lungs into sections could be demonstrated using two wine boxes. Open out an empty box to show the wall area. Then show one with the bottle dividers in place to model a lung filled with alveoli. The dividers can be removed and spread out to show how much extra surface area you get if you have 12 air spaces.<br><br>An adult's lungs have about 300 million air spaces and between them their walls could cover most of a tennis court. | Weblink: Anatomy of Breathing Flash Animation could be use to remind students of basic lung structure before revealing slide 9. |
| **Elaborate**<br>Carbon dioxide diffuses out as oxygen diffuses into your blood. | 10 min | A clip from Weblink: Science in Focus: Circulation and respiration (9.30–16.30 min) could be shown at this point. It shows a model of the alveoli to emphasise the thinness of their walls and the network of capillaries that surround them.<br><br>Emphasise that carbon dioxide is mainly carried in the plasma and oxygen in red blood cells. | |
| **Evaluate**<br>Students apply their knowledge and understanding | 10 min | Wayne's gran has come to the Academy for a visit. She knows that Wayne has some problems with his lungs but doesn't really understand how they work.<br><br>Students could draw a set of labelled diagrams that Wayne could use to explain why his lungs wouldn't work as well if they were hollow. | This could be set as homework. |

| | | | |
|---|---|---|---|
| **Extend**<br>**TV clip**<br>Ceri explains her research. | 5 min | Slide 11 emphasises that lung tissue is very delicate and needs protection. Weblink: Into the Mucus River has animations showing how cilia co-ordinate their movement to move the mucus layer along.<br><br>Slide 12 and 13 introduce the final TV clip. Wayne is considering whether to get more involved in Ceri's research. Ceri explains what her research is about. | Work-related learning – what does Ceri's research into the properties of mucus involve? |

| | |
|---|---|
| **Formative assessment**<br><br>The 'Elicit' activities find out what existing knowledge students already have and the 'Evaluate' tasks get them to explain or apply what they know in context. | **Differentiation**<br><br>Student sheet SS 2 allows more able students to consider the validity of the model they are using whilst SS 3 provides a more structured approach to the exploration. |
| **Health and safety**<br>The activities have been checked for health and safety, and advice provided where appropriate. The teacher should check this risk assessment advice and modify it if necessary to meet local circumstances.<br>Please refer to the Safety Information document. | |
| **Additional resources**<br>Visit the activity's web page to access the web resources, share ideas and improvements and check for corrections. | |

# ACTIVITY 2: LUNGS

# RESOURCE GUIDE

## EQUIPMENT REQUIRED

**Equipment needed for the Elicit section**

For each student:

- Red centicube

**Optional equipment**

For demo:

- Dissecting tray
- Sharp scissors
- Disposable gloves
- Access to soap and disposable hand towels
- Bicycle pump
- Large transparent dry cleaning bag
- Animal lungs – preferably as part of a pluck

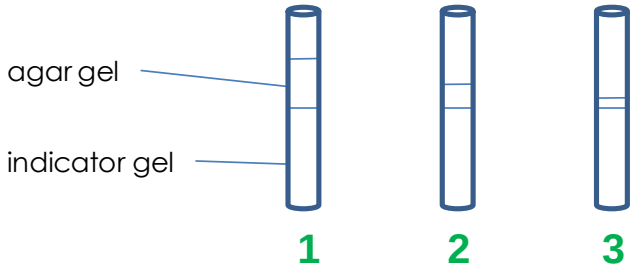
- Keep the lungs refrigerated until they are needed, but not in a fridge used for storing food.
- The lungs must NOT be blown up by mouth. A bicycle pump can be used to inflate the lungs if they are not too badly slashed and there is enough tubing left to create a seal around the pump. They should be covered with plastic while any attempt is made to inflate them to avoid spraying aerosols into the air.
- Cover all open cuts with a waterproof plaster. If a student or member of staff receives a small cut as a consequence of dissecting the organ, wash the wound in cold running water, allow minor wounds to bleed freely and refer the casualty to a first-aider.
- The work surface, dissecting tray and any dissecting instruments used to display the organs should be thoroughly cleaned with hot water and detergent after the lesson.
- It is not necessary for students to wear gloves to feel the texture of the lung tissue, but they may feel uncomfortable about touching meat with ungloved hands. Have soap, warm water and towels available and ensure that students who have handled the tissues wash their hands before leaving the room.
- Refer to CLEAPSS Handbook sections 14.7.2 and 14.7.4.

A pig's heart and lungs are most suitable as they are approximately the same size as the corresponding human organs. Where the class includes Muslim students who might object to handling pork, sheep's organs should be used. Fresh lungs from a butcher are best but frozen specimens can be ordered from www.blades-bio.co.uk/, Blades Biological Ltd, Edenbridge, Kent, TN8 7DX. Tel: (01342) 850 242, sheep's lungs, trachea and heart (PZL 065) – price £13.75.

**Equipment needed for the Explore section**

For demo:

- 0.1M sodium hydroxide
- Teat pipette
- Three test tubes filled to a depth of 2cm with agar containing phenolphthalein (see below) and then topped with standard agar. One with a few mm depth, one with about ½cm and one with 1cm depth




For each group of 2–3 students:

- 0.1M sodium hydroxide
- Teat pipette
- Petri dish (90mm diameter) filled with solid agar containing phenolphthalein.
- L&K Academy 2 Lungs SS1 and either SS2 (extension) or SS3 (core) according to ability

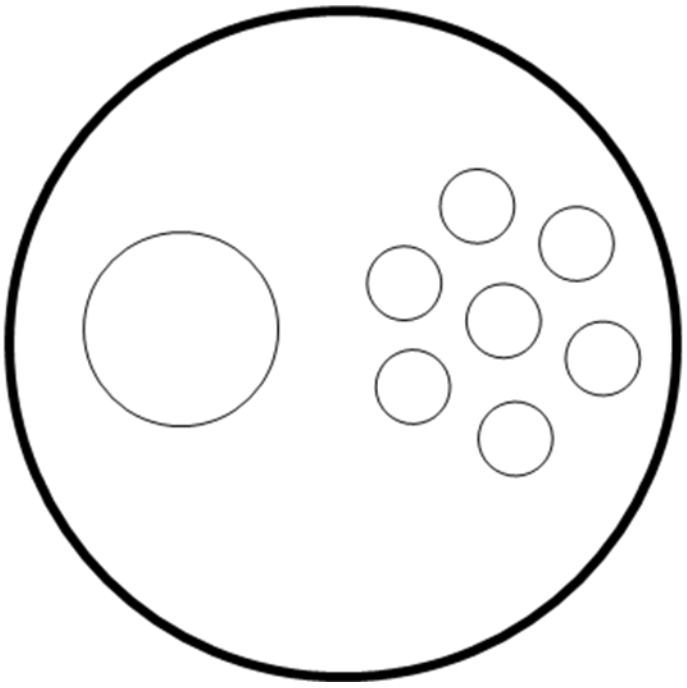
To make the agar more solid than normal, stir 8g of plain (technical) agar powder into 400cm$^3$ of water.
Heat and stir the mixture in a boiling water bath until the solution clears, allow it to cool slightly and add 4cm$^3$ of 1% phenolphthalein solution (1g phenolphthalein in 100cm$^3$ 95% ethyl alcohol) and stir.
If the mixture is very pink, add a few drops of 0.1M hydrochloric acid until the pink colour disappears.
Then pour a layer of agar into each petri dish and allow it to set overnight.

- The sodium hydroxide (Hazcard 91) needs to be labelled irritant. Students must wear eye protection and rinse splashes off their skin.
- The phenolphthalein (Hazcard 32) is low hazard but the stock solution is dissolved in ethanol which is highly flammable.

Before the lesson, cut holes in the agar using the template on the next page. The small circles of agar are easily removed with a 10mm diameter cork borer and the larger one can be cut out with thin-bladed knife or scalpel.

For each student:

- L&K Academy 2 Lungs SS 4 to record their results on



**Equipment needed for the Explain section**

For the demo:

- Two wine boxes. One should be emptied, opened up and held back together with masking tape so that it can be quickly flattened to show the total surface area of the walls. The other should have all the bottle dividers in place.