TEACHING WITH MODELS OF THE LUNG

The 13+ Biology specification includes:

Topic	Learning Outcomes	Recommended Practical Activities	Links to prior learning at 11+
Breathing in humans	Know how the movements of the diaphragm and ribcage lead to breathing in humans. Understand how changes in pressure lead to breathing in and out in humans. Recognise that medical conditions such as emphysema and asthma reduce the movement of oxygen into lungs.	Demonstrate, using the bell jar and parallelogram models, the role of the diaphragm and ribs in breathing. Measure vital capacity in humans, using peak flow metres.	Y5: 2a, 2b Y6: 2c

There is a number of different models of the human lungs that could be used, but here we will think about three, a bell jar model, the parallelogram model and an animal model (pluck).

When teaching with lung models, it is good practice to ask pupils to consider the ways in which the model accurately represents features of the lungs and in what ways does the model not represent the lungs. When doing this, pupils are developing their experimental skills of observation. In the terms of Thinking and Working as a Scientist (TWAS) they are being given opportunities to:

- use scientific theories, models and explanations to develop hypotheses.

THE BELL JAR METHOD

These are available from science practical stockists (eg Philip Harris, B8R06015), but they can also be made, inexpensively, from a plastic water cooler bottle, a rubber sheet, tubing, balloons and a drilled bung.

The two balloons represent the lungs and the rubber sheet represents the diaphragm. When the rubber sheet (diagram) is pulled downwards, the balloons inflate. This is because, the volume inside the jar (which represents the thorax) increases and the air pressure falls below that of the air. As a result, air enters the tubes (representing the trachea and bronchii) and the lungs inflate.

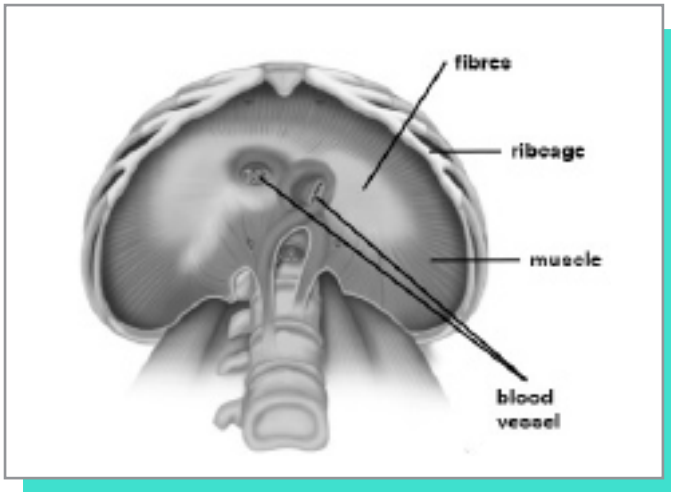
[Image from Philip Harris catalogue]

Likewise, when the rubber sheet (diagram) is pulled upwards, the balloons deflate. This is because, the volume inside the jar (which represents the thorax) decreases and the air pressure rises above that of the air. As a result, air leaves the and the balloons deflate.

The model illustrates the importance of the diaphragm in breathing.

There are three main ways that the model differs from the human thorax:

- in the human thorax, the lungs fill the space, whilst in the model, they do not fill the jar.
- in the human thorax, the ribcage moves: upwards and outwards (when breathing in) and downwards and inwards (when breathing out). The jar is unable to move in the model.
- the whole of the rubber sheet diaphragm can contract in the model. In the human diaphragm, the muscle forms a ring around the outside of the diaphragm. The centre consists of fibres. Blood vessels and the gut (alimentary canal) pass through the diaphragm, which does not happen in the model.

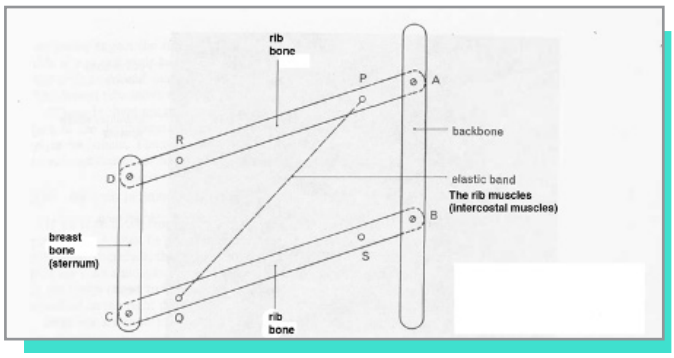


[A diagram of the diaphragm, showing the location of the muscles and fibres]

Pupils are not expected to have to have a detailed recall of these differences. They might, in an examination, be asked to describe some differences between a model and a biological structure, but all necessary contextual information would be given within the question.

THE PARALLELOGRAM MODEL

The parallelogram model was a feature of Nuffield biology teaching schemes, and some schools may still have them. They are easily made, otherwise.



The model consists of wooden pieces, arranged as shown above. The horizontal pieces, representing the rib bones should be the same size. Two pieces represent the breast bone and the sternum are of different sizes. The pieces are loosely connected by screws and nuts, so that the pieces can all move upwards and downwards.

Small hooks are present on both sides of the ribs at identical positions: P and Q on one side and R and S on the other. These are attachment points for elastic bands. The two bands need to be of the same size.

Attaching the elastic band to P and Q causes the ribs to move upwards. At this point, the elastic band cannot move back to its original position, without being stretched.

Attaching an identical band at R and S will allow this to happen and the ribs move downwards.

The elastic bands represent the (intercostal) muscles that are found on either side of the rib bone (think Chinese spare ribs)

Chinese spare ribs are intercostal muscles

The movement of the ribs up and down requires two sets of muscles. [This is because muscles can only get shorter. They cannot (on their own) return to their original lengths.]

The muscles around the ribs act together. They are called 'antagonistic' pairs* because they act in opposition to each other.

*This term was introduced in Year 6 of CE.

AN ANIMAL MODEL (PLUCK)

Some butchers can be asked to supply a 'pluck' consisting of trachea, lungs, heart, diaphragm. Usually this is from sheep. Pig plucks should be avoided for cultural reasons.

This should be carried out as a teacher demonstration, with due regard to the sensitivities of the pupils, hygiene and safety. CLEAPSS has appropriate guidance for dissections. Schools are strongly recommended to use the CLEAPSS website as the basis of all their risk assessments.

The value of this model is that it shows the relative sizes of the organs and allows their arrangement to be studied. It can be directly compared with plastic torso models that the school might possess.

The differences between the animal model and the human breathing system are slight. Sheep and humans are both mammals and have similar breathing systems. The sheep lungs may be larger than human lungs.