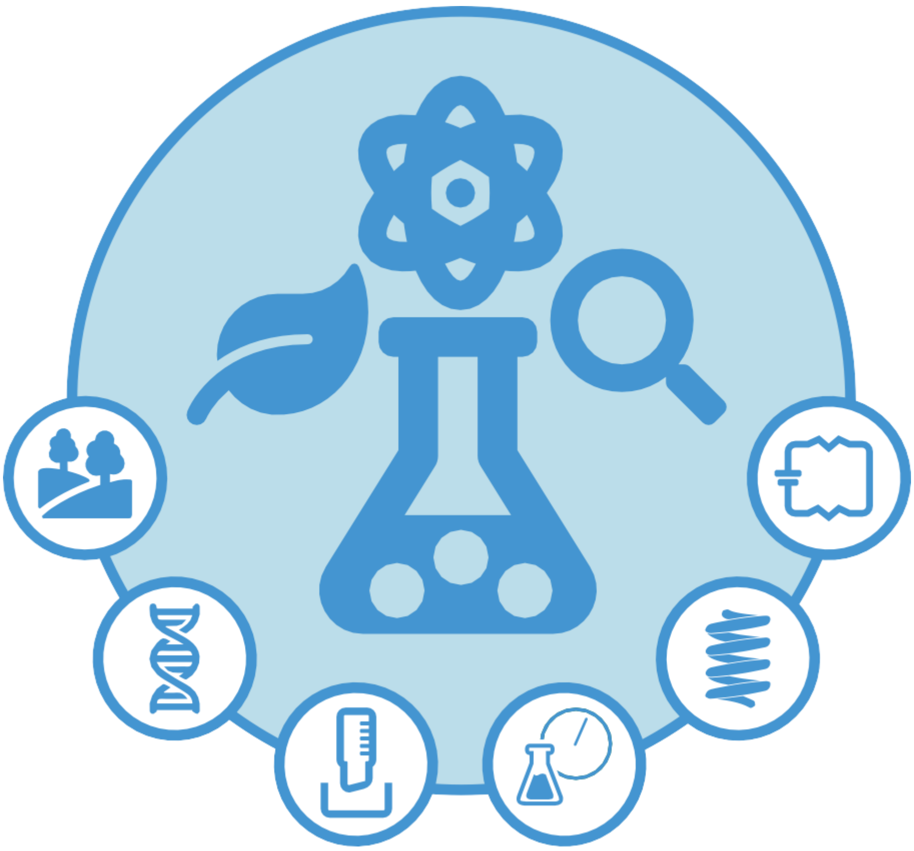
EXEMPLAR LESSON

OpenSTEM Africa

SPIROMETRY AND LUNG FUNCTION



Acknowledgements

Ministry of Education

The Ministry of Education, Ghana, for their oversight, support and guidance which has been essential in ensuring that OpenSTEM Africa aligns with and complements other education initiatives and programmes.

CENDLOS
CENTRE FOR NATIONAL DISTANCE LEARNING AND OPEN SCHOOLING
Nexus of virtual learning

CENDLOS, Ghana, for their collaboration and innovation in providing essential avenues for OpenSTEM Africa to reach learners and teachers.

Ghana Education Service (GES)

Ghana Education Service, and the expert SHS science teachers, for their expertise in producing materials that are rooted in the Ghanaian school context, accessible and useful to learners and teachers.

OpenSTEM Africa

For information on OpenSTEM Africa see: www.open.ac.uk/ido

OPITO

OPITO for their generous support, which has made OpenSTEM Africa and the development of the Virtual Laboratory and these materials possible.

Contents

Exemplar lessons for the OpenSTEM Africa Virtual Laboratory applications

All the exemplar lessons are examples of lessons which could be used both individually and by whole classes of Senior High School (SHS) students in the elective sciences of Biology, Chemistry and Physics. Each of the lessons is linked specifically to one of the applications in the OpenSTEM Africa Virtual Laboratory. The exemplar lesson is created to give, both to SHS students and to SHS teachers, a clear example of the ways in which the applications can be used in the learning and teaching of practical science. There is a focus throughout the lesson on the student's development of the practical and experimental skills which, along with knowledge and understanding, are integral to the profile of learning, teaching and assessment in SHS sciences.

The 'you' in this lesson is 'you', the Senior High School student. Remember that you can repeat the experiments and activities in this lesson as often as you have time for in class. This freedom to repeat experiments and activities is also important if you are accessing the lesson outside the classroom, for example for homework. Every application in the OpenSTEM Africa Virtual Laboratory contains real data – the experiments are real experiments. This means you might make mistakes the first or second or third time you try an experiment or an activity – and that is exactly what often happens in the real world in the sciences. So, it is helpful for you as a student to share in some of the real-world trial and error of science as you develop your skills as a scientist.

The exemplar lesson also contains a set of teaching notes at the end of this document for 'you' the SHS science teacher, to suggest how you might want to set up this particular lesson with one of your classes. Hopefully it will also generate ideas for other lessons on the same topic, or other lessons which use the same OpenSTEM Africa Virtual Laboratory application.

Spirometry and lung function

Lesson objectives

By the end of the lesson, you will be able to:

- Explain the concept of gaseous exchange
- Identify the organs of the respiratory system of humans and describe their functions
- Outline the breathing mechanism in humans
- Enumerate some problems and disorders associated with the respiratory system in humans

The following practical and experimental skills will be developed:

- Observation
- Planning and Designing of Experiments
- Manipulation
- Recording
- Interpretation

Background

In this lesson you will use an online Spirometer to investigate the changes in the amount of air moved into and out of the lungs. Movement of air in and out of the lungs is called **pulmonary ventilation** and it involves the main structures of the respiratory system (Figure 1):

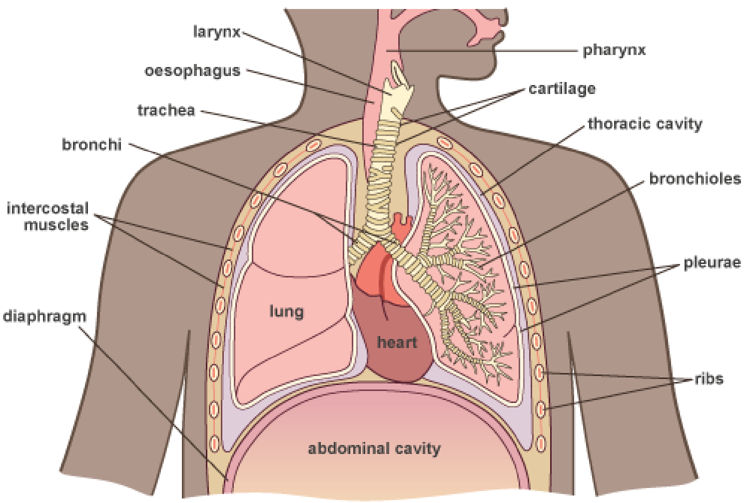


Figure 1. Cross-section through the structures of the respiratory system.

When we breathe in, oxygen rich air enters the body through the nostrils and passes into the nasal cavities.

From the nasal cavities, the air passes to the pharynx (throat) at the back of the mouth where it is joined by air that has entered the system through the mouth.

Air passes into the trachea which is held open by rings of cartilage, and then enters the bronchi and bronchioles.

The trachea then divides into two branches called bronchi (singular: bronchus) (Figure 1). These serve the left and right lungs. Like the trachea, the walls of the bronchi contain cartilage, which prevents their collapse. Each main bronchus divides into smaller and smaller tubes, finally ending in terminal bronchioles. Bronchioles also contain cilia that help to keep the airways clean by moving mucus and particles from the lower respiratory tract up to the pharynx to be expelled.

Finally, the air enters small sack-like structures called alveoli (singular: alveolus). It is here where the oxygen is transferred into the blood and the waste gas, carbon dioxide is transferred out of the blood (Figure 2).

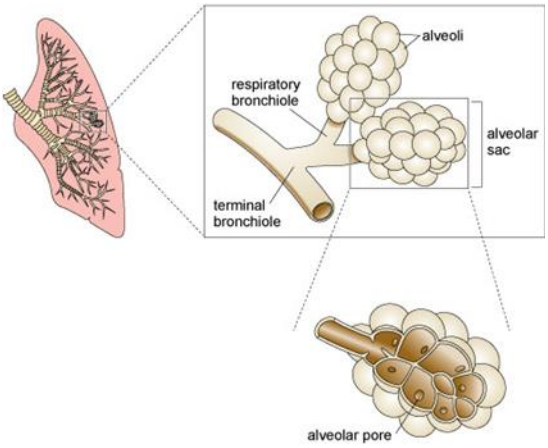


Figure 2. A drawing of a lung (pink) with a bronchus and branching bronchioles within the lung.

Gaseous exchange

Gaseous exchange refers to the transfer of oxygen and carbon dioxide between the air and blood.

The walls of the alveoli are only one cell thick. This is also true of the walls of the tiny capillaries surrounding the alveoli (Figure 3) therefore carbon dioxide and oxygen can move by diffusion.

When oxygen rich air is breathed in, the oxygen diffuses into the red blood cells (erythrocytes) which deliver the oxygen to all the other cells of the body. Carbon dioxide, returning from the body in the blood, diffuses from the red blood cells into the alveolar space and is breathed out.

The capillaries are so tiny that they only allow one blood cell at a time to pass through, slowing the blood flow and allowing time for gaseous exchange.

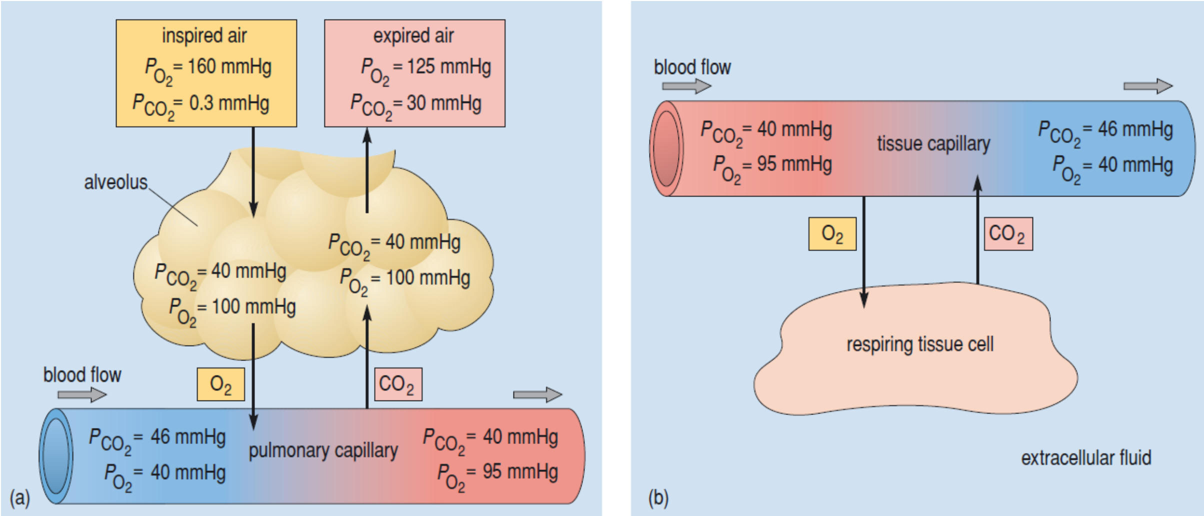


Figure 3. Gas exchange at (a) the lungs and (b) the tissues, showing the partial pressures of the gases, PO_2 and PCO_2.

An important feature of gaseous exchange is that gases diffuse from a region of high concentration to a region of lower concentration, or in other words, they move down their concentration gradient. The convention is to use partial pressures when describing the concentration of respiratory gases and the units shown in Figure 3 are millimetres of mercury (mmHg).

What is a partial pressure? The partial pressure of a gas is the proportion that gas contributes to atmospheric pressure. At sea level, the average atmospheric pressure is 760 mmHg – so, if the partial pressure for oxygen at sea level in inspired air is 160 mmHg, then the percentage of oxygen in inspired air can be calculated by dividing 160 mmHg by the atmospheric pressure and multiplying the result by 100:

(partial pressure of the respiratory gas/atmospheric pressure) x 100 = percentage of the gas

(160 mmHg/760 mmHg) x 100 = 21%

The percentage of oxygen in inspired air is 21%

What is the percentage of carbon dioxide gas in <u>inspired</u> air?
Go to Appendix 3 for the answer.

What is the percentage of carbon dioxide gas in <u>expired</u> air?
Go to Appendix 3 for the answer.

The role of the diaphragm

The expansion and contraction of the lungs is controlled mechanically by the diaphragm and the intercostal muscles (Figure 4). The intercostal muscles are located in the ribcage (see Figure 1). The diaphragm is a large dome-shaped muscle that sits underneath the lungs.

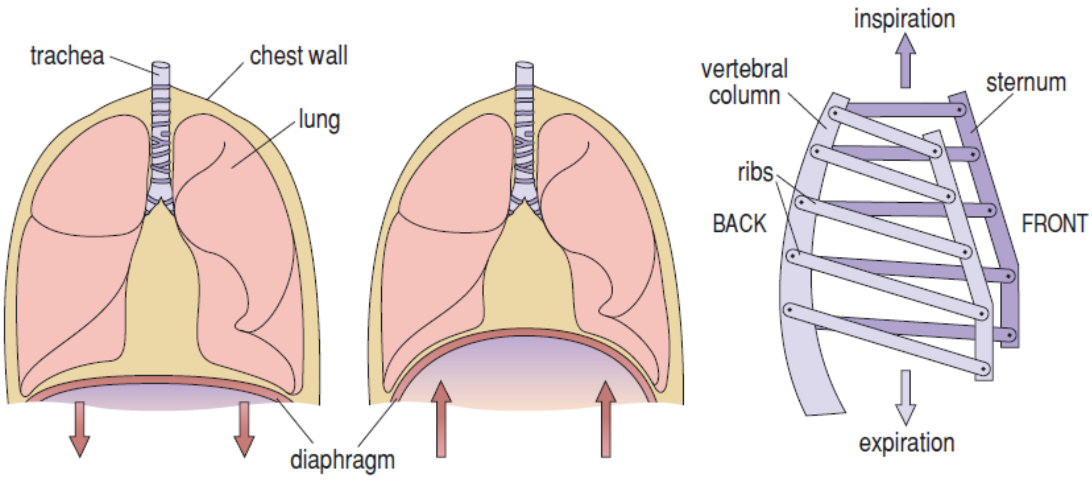


Figure 4. The mechanics of inspiration and expiration. (a) The diaphragm flattens and moves downwards, so increasing the thoracic capacity and allowing air to enter the lungs. (b) During expiration, the diaphragm curves upwards and the thoracic capacity is reduced. (c) A model of the ribcage as a side view. During inspiration, the ribs and sternum move upwards and outwards; during expiration, the ribs and sternum move downwards and inwards.

Activity

Part 1

Place your hands onto your ribcage. Now, take a deep breath in. What happens to your ribcage?

> You should find that your ribcage moves upwards and expands outwards as the air enters your lungs.

Movement of the diaphragm and intercostal muscles acts to expand the size of the thoracic cavity drawing air into the lungs.

Part 2

Now blow the air out of your lungs. What happens to your ribcage?

> You should find that your ribcage moves downwards and retracts inwards as the air leaves your lungs.

Relaxation of the intercostal muscles and diaphragm reduces the size of the thoracic cavity. The ribcage, diaphragm and lung tissue itself return by elastic recoil to their original pre-inspiratory positions. The consequent retraction of the chest wall forces air out of the lungs.

Lung function

Changes in lung tissue caused by age, disease or smoking can affect the capacity of the lungs to hold and exchange air. Lung capacity is calculated from the volume of air that is exchanged during normal and forceful breathing. The volumes that are used to calculate total lung capacity are shown in Figure 5.

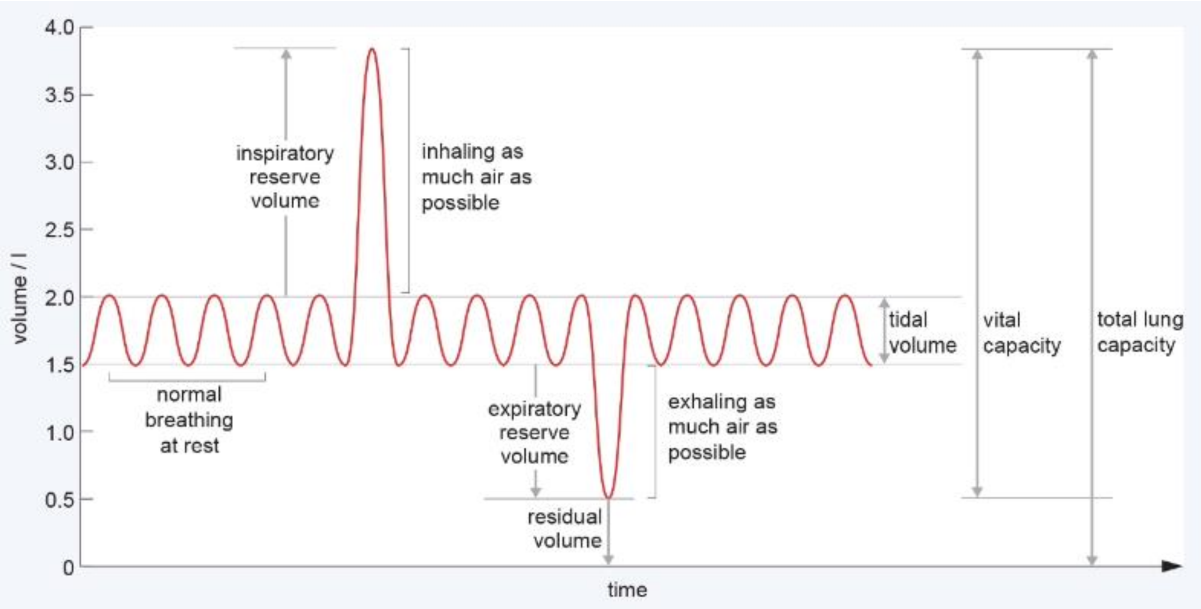


Figure 5. Graph showing the volume of air moving in and out of the lungs during normal and forceful respiration.

- **Tidal volume** is the amount of air moved by your lungs when you are breathing normally at rest.
- **Inspiratory reserve volume** is the extra volume breathed in during forceful inhalation.
- **Expiratory reserve volume** is the extra volume of air breathed out during forceful exhalation.
- **Residual volume** is the amount of air left in the lungs after a forceful exhalation.
- **Vital capacity** is the total amount of air you can breathe in after you have forcefully exhaled.
- **Total lung capacity** is the total lung volume.

Using the information in the spirogram shown in Figure 5 what volume is the vital capacity?
Go to Appendix 3 for the answer.

Compliance of lung function

The ease with which the lungs and pleura expand and contract, based on changes in pressure is called compliance. Low lung compliance means that the lungs and alveoli are 'stiff', so a higher-than-normal pressure is needed to get the lungs to expand and contract. It can result from fibrosis of the lungs due to prolonged inhalation of small particles such as asbestos, tobacco smoke, indoor cooking smoke, car exhaust fumes or coal smoke.

Prolonged exposure to tobacco smoke and indoor cooking smoke can cause inflammation of the lungs (chronic bronchitis) and damage to the alveoli (emphysema) – a condition called Chronic Obstructive Pulmonary Disease (COPD). This makes it more difficult to breathe, reduces the elastic recoil properties of lung tissue and reduces the lung respiratory surface area available for gaseous exchange.

Measuring lung function using spirometry

Lung function can be measured using a spirometer – a simple and inexpensive device that measures the flow and volume of expired air. A typical test involves blowing out into a spirometer as hard as possible until the lungs are empty (this is explained further in the introductory video located on the Spirometer application homepage).

The forced vital capacity (FVC) is calculated as the total volume of air that can be forcefully blown out of the lungs in one expiration (one breath).

Peak expiratory flow (PEF) measures the maximum speed at which air is forcefully expired (litres per second).

The forced expiratory volume 1 (FEV_1) is the amount of air that is forcibly blown out within the first second of a forced expiration.

Plotting the FVC and PEF values generates a spirograph, which you will produce when you use the spirometry application.

The FEV_1/FVC ratio (normally expressed as a percentage) is used to evaluate lung function. In healthy individuals, the FEV_1/FVC ratio is approximately 0.8, meaning that 80% of total volume of air is blown out within the first second. A value of less than 70% indicates that lung function is impaired.

Normal lung function is dependent on an individual's age, height, sex, ethnicity and general fitness. For example, Figure 6 shows how lung efficiency (FEV_1/FVC ratios) decrease with age for both men and women.

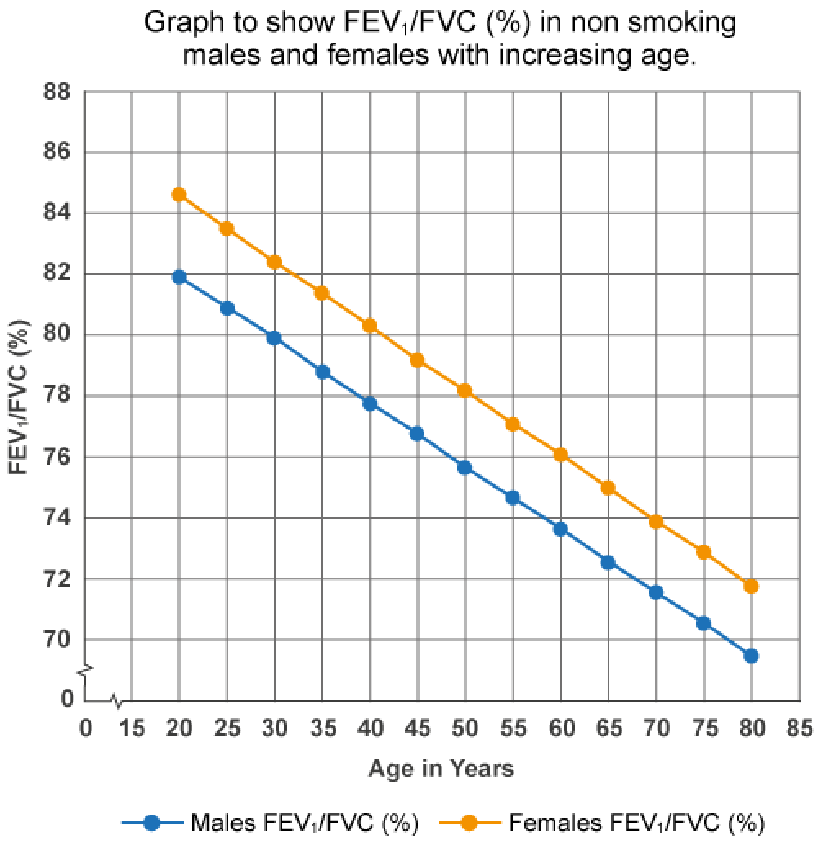


Figure 6. A graph showing the FEV_1/FVC ratios expressed as percentages for healthy non-smoking men and women against age.

Look at Figure 6. Which two statements are correct about lung function with age in both men and women?

- **a) Lung function stays the same across all ages in males and females**
- **b) Lung function increases with age in males and females**
- **c) Lung function decreases with age in males and females**
- **d) Lung function is slightly lower in males than females across all ages**
- **e) Lung function is slightly higher in males than females across all ages**

Go to Appendix 3 for the answer.

When lung function is impaired, the PEF, FEV_1, FVC and FEV_1/FVC values can be used to help determine the cause of the dysfunction; for example, decreased lung volume due to lung cancer, asthma, pneumonia and COPD.

Practical activity

In this activity, you will use the OpenSTEM Africa Virtual Laboratory Spirometer application to measure changes in FEV_1/FVC (%) over time between males and females, and between smokers and non-smokers.

Read the following instructions before accessing the Spirometer application homepage. When you do access the homepage, first watch the introductory video before entering the application.

Task 1

Your first task is to measure the differences between healthy young males and females with a height of 180 cm.

The purpose of this task is to familiarise yourself with the operation of the Spirometer application and to corroborate the sex difference in lung function suggested in Figure 6.

When you enter the spirometry application, set the following parameters:

- age: 20
- male
- height: 180 cm
- non-smoker

Start the measurement and record the output of the FEV_1, FVC and FEV_1/FVC (%) using the ‘Record data’ button. Repeat this measurement a further two times (i.e., three readings per condition), remembering to record the data each time. Once you have collected the data, collate your observations in your laboratory notebook in the form of a table, such as the one shown below.

Data for a non-smoking male aged 20 years old			
	FEV_1	FVC	FEV_1/FVC (%)
Test 1			
Test 2			
Test 3			
Mean (average) values			

Now set the following parameters and take three more measurements.

- age: 20
- female
- height: 180 cm
- non-smoker

Record your data in another table.

Data for a non-smoking female aged 20 years old			
	FEV_1	FVC	FEV_1/FVC (%)
Test 1			
Test 2			
Test 3			

Mean (average) values			

Plot a bar chart showing the mean FEV_1/FVC (%) values for healthy men and women (aged 20 and 180 cm tall) and compare the difference in lung function. Do your observations support the information presented in Figure 6?

Task 2

Your second task is to investigate the effect of height on lung function.

Set the following parameters:

- age: choose any age between 20 and 60 (but use the same age for all recordings)
- sex: choose either male or female (but use the same sex for all recordings)
- non-smoker
- height: choose several heights between 125 and 190 cm

Record your data (FEV_1, FVC and FEV_1/FVC (%) values) in a table – you will use this to answer one of the quiz questions at the end of this lesson.

Task 3

Your third task is to investigate the effect of smoking on lung function.

First, you will collect data for a healthy non-smoking population.

Set the following parameters:

- age: collect data for 20, 40, 60 and 80 years of age.
- sex: choose either male or female (but use the chosen sex for all readings)
- height: choose a height of your choice (but use the same height for all readings)
- non-smoker

Record your data (FEV_1, FVC and FEV_1/FVC (%) values) in a table.

Second, select the smoker status and repeat your data collection with the same settings used in the first part of this task.

Record your data (FEV_1, FVC and FEV_1/FVC (%) values) in a table.

Once you have collected your data, on the same graph plot (using a x–y scatter plot) the change in FEV1/FVC (%) as a function of age for both non-smokers and smokers – you will use this graph to answer one of the quiz questions at the end of this lesson.

Spirometer
Go to the OpenSTEM Africa Virtual Laboratory. Click on on the icon to access the Spirometer application homepage. Watch the introductory video before entering the experiment.

Summary

A spirometer is a simple and inexpensive device that can be used easily, in both urban and rural settings, to monitor lung function. You will have discovered that lung function, such as FVC for example, can change because of height, sex and age. You also investigated the impact of life-long smoking on lung efficient (FEV_1/FVC (%)).

Quiz

Answer the questions, then search for the correct answers in Appendix 4.

Question 1

Put the steps involved in the flow of air from the conduction zone through to the respiration zone in order.
Label the steps from 1–5; 1 being the first, 5 being the last.

Air passes down the back of the pharynx, past the epiglottis and into the larynx.	
Air is taken in through the nasal cavities.	
From the larynx, air travels into the trachea, and into the bronchi.	
Air moves through the terminal bronchioles and into the respiratory bronchioles.	
Air passes into the alveolar ducts and into the alveolar sacs.	

Question 2

Which one of the following statements is true?

- An individual with a FEV_1/FVC (%) reading of 65% has impaired lung function
- An individual with a FEV_1/FVC (%) reading of 71% has impaired lung function.

Question 3

Based on the data you collected, and the bar chart produced in Task 1, complete the following statements. For each of the statements decide if it is smaller or larger.

1. FEV_1/FVC (%) is __________ for males than females
2. FVC is __________ in males than females.

Question 4

Based on the tables you produced in Task 2, complete the following statements. For each of the statements decide it increases or decreases.

1. FEV_1 __________ with increasing height.
2. FVC __________ with increasing height.
3. The FEV_1/FVC (%) value __________ with increasing height.

Question 5

Figure 6 shows that FEV1/FVC (%) values decrease with age for both men and women. Which of the following statements best describes the effect of life-long smoking on lung function?

1. Lung function efficiency shows a modest impairment for smokers compared with sex-matched, age-matched and height-matched non-smokers but does not fall below the 70% that suggests obstructed lung function.
2. Lung function efficiency shows a marked decline for smokers compared with sex-matched, age-matched and height-matched non-smokers and starts to fall below the 70% threshold from about the age of 50 indicating obstructed lung function.

Question 6

Which of the following structures are part of the respiratory zones of the lungs? Select all that apply.

a. trachea
b. alveolar ducts
c. pharynx
d. respiratory bronchioles
e. alveoli

Glossary

Alveolar sacs – Part of the respiratory zone structures, located at the end of the alveolar duct

Bronchi – The two main branches of the windpipe or trachea, leading to the lungs (singular, bronchus).

Cartilage – Strong, flexible material of which bones are first made and which provides the articulating surface of bones at the joints.

Conduction zone – The parts of the lungs that conduct gas to and from the external environment.

Diaphragm – A muscular wall involved in lung ventilation, separating the chest (thoracic) cavity from the abdominal cavity.

Elastic recoil – The ability for lung tissue to return it its relaxed state after an inhalation.

Expiratory reserve volume – Extra volume breathed out during forceful exhalation.

External respiration – Exchange of gases in the lung between the blood and the external environment.

Forced expiratory volume 1, (FEV_1) – The amount of air that is forcibly blown out of the lungs within the first second of a spirometry test.

Forced vital capacity (FVC) – Total volume of air that can be forcefully blown out of the lungs.

Inspiratory reserve volume – Extra volume breathed in during forceful inhalation.

Intercostal muscles – External and internal muscles between the ribs that are involved in the movement of the rib cage during breathing.

Lungs – The respiratory organs that are located in the chest cavity; consisting of two elastic sacs with branching airways that allow air to be drawn into the body and expelled by a combination of muscular action and elastic recoil. They provide a large surface area where gaseous exchange occurs between the blood and the air.

Nasal cavities – Part of the upper respiratory tract by which air enters and leaves the body

Pharynx – The opening at the back of the throat that serves as a common passageway for the digestive and respiratory systems.

Residual volume – Amount of air left in the lungs in addition to the expiratory reserve volume.

Respiratory zones – Composed of the bronchioles, alveolar ducts and alveoli in which gas exchange takes place during respiration.

Spirometry – A test used to measure lung function.

Thoracic cavity – The part of the chest enclosed by the ribcage and diaphragm containing the lungs and heart.

Tidal volume – Amount of air entering or leaving the lungs in a single resting breath.

Total lung capacity – The total volume of air contained in the lungs after a full inspiration (it is equal to the vital capacity plus the residual volume).

Trachea – A tube that connects the throat (pharynx) and voice box (larynx) to the lungs, allowing the passage of air. Also known as the windpipe.

Vital capacity – The sum of the tidal volume, inspiratory reserve volume and expiratory reserve volume.

Appendix 1: Teacher notes – organisation of the lesson

This lesson links directly to SHS and the teaching and learning activities associated with it.

Ideas for organising this exemplar lesson link directly to activities and teaching examples in the OpenSTEM Africa CPD units *Using ICT to support learning* and *Approaches to active notetaking*.

A full list of the OpenSTEM Africa CPD units can be found at: https://www.open.edu/openlearncreate/CPD_units

Overview

If possible, this lesson should take place in the ICT Lab in your school if this can be arranged through your Head of Science and the Head of ICT. If the lesson takes place in the ICT Lab, it may be possible for each student to work individually at a computer; otherwise divide the class so that students are in small groups at a computer.

If it isnot possible to use the ICT Lab for this lesson, then try to set up this lesson in your classroom. You may be lucky enough in your school to have a set of 'empty' tablets or mobile phones which students can use. Or you may be able to bring into the classroom a laptop connected to the internet or to your school intranet – and perhaps connected to a projector to make it possible for the whole class to view at once. If access to ICT is a real challenge in your school but you want your students to view an experiment, you might be able demonstrate it to small groups of your students at a time, using your own mobile phone

Whatever way(s) you set up the class, it would still be helpful to the students to be able to work in pairs or small groups for at least some of the lesson. Do remember as well that students need desk space to be able to write in their notebooks and to draw diagrams.

Steps in organising the lesson

Step 1: This takes place in the lesson before the one where you and your class access the OpenSTEM Africa Virtual Laboratory spirometer. Have students work in pairs to pre-read the Background section of the exemplar lesson and ask each other the questions in the Background section. While they are doing so, you may want to walk round the class and check their laboratory notebooks, as accurate note-taking and filling in the tables is important for this exemplar lesson.

Step 2: At the beginning of this exemplar lesson, check understanding by asking the class the questions in the Background section. If possible, organise the class to work in the same pairs as in the previous lesson. Have each person in the pair create the tables in their own laboratory notebook in preparation for their data collection.

Step 3: Once the students have seen an experiment in the spirometer application one time, give the class a set time to discuss it with their partner. Within each pair, have them check each other's work.

Step 4 Make sure that each pair has access to/can see the computer screen to begin the actual experiments. Ensure that each pair knows how to carry out the experiments and record the data gathering – or if you are using a laptop/projector, that you draw on the expertise of the class as you go through each step of the application – i.e., ask them what the next step is

Step 5: Have the class follow the instructions. Make sure, if working in a pair on a PC, that each student in the pair gets to follow all the steps in each of the spirometer scenarios; if working in a group on a PC, have the group leader ensure that everyone in the group is involved.

Step 5: What they write in their tables will be agreed between the pair or within the group but allow enough time for everyone in the class to fill in their own set of tables. Have them check each other's writing.

Step 6: Ten minutes before the end of the lesson, tell the students to complete thequiz.

Appendix 2: Teacher's notes – output of lesson

The spirometer has been designed to produce small differences in output due to natural human variation and instrumental error. The outputs for task 2 and task 3 will differ depending on the parameters selected by your students, however, the changes will be similar to those reported below.

Task 1

To compare the difference in lung efficiency (FEV_1/FVC (%)) between male and females of the same age (20 years) and height (180 cm).

Male data collected using the spirometer:

age	height	gender	smoker	FEV_1	FVC	FEV_1/FVC (%)	
20	180	male	N	4.85	5.81	83.48	×
20	180	male	N	4.79	5.75	83.30	×
20	180	male	N	4.82	5.78	83.39	×

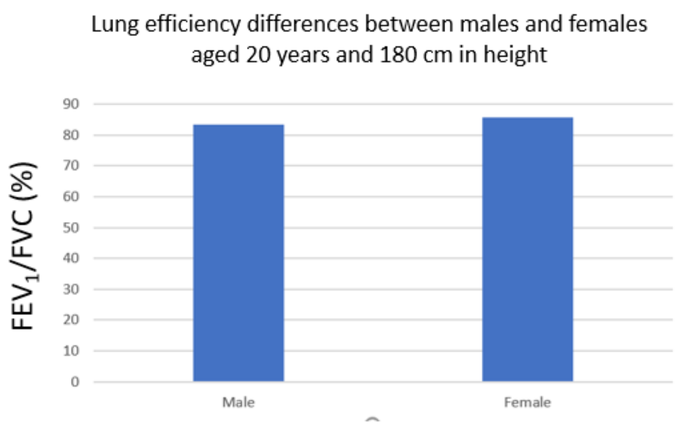
Averages	4.82 litres	5.78 litres	83.39%

Female data collected using the spirometer:

age	height	gender	smoker	FEV_1	FVC	FEV_1/FVC (%)	
20	180	female	N	3.94	4.60	85.65	×
20	180	female	N	4.01	4.67	85.87	×
20	180	female	N	3.92	4.58	85.59	×

Averages	3.96 litres	4.62 litres	85.70%

The observations confirm that females have a slighter higher FEV_1/FVC (%) than their male counterparts. However, males have a larger FVC.



Task 2

How does increasing height affect lung function?

Below is a data table copied from the spirometer record output for males aged 20 years.

Both FEV_1 and FVC show a marked increase in volume with increasing height, however the FEV_1/FVC (%) values show a modest decline.

Ask your students to think about this in terms of the deliver of oxygen to the lungs and the removal of the waste gas carbon dioxide. Are taller people really disadvantaged?

age	height	gender	smoker	FEV_1	FVC	FEV_1/FVC (%)	
20	130	male	N	2.59	2.84	91.20	×
20	145	male	N	3.22	3.66	87.98	×
20	160	male	N	3.84	4.49	85.52	×
20	175	male	N	4.46	5.34	83.52	×
20	190	male	N	5.33	6.46	82.51	×

Task 3

The effect of tobacco smoking on lung function.

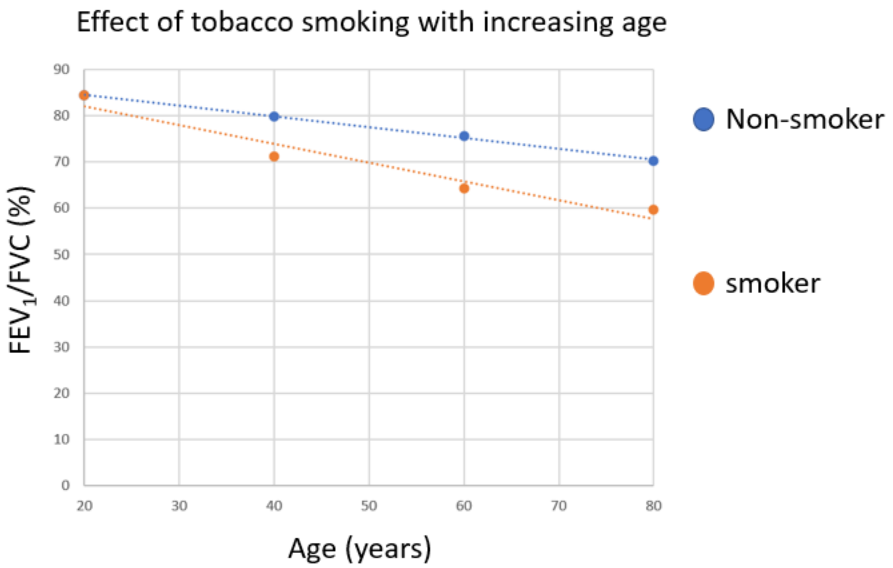
The data set for smokers assumes that they started smoking at the age of 20 and smoked one pack of cigarettes each day throughout their lifetime.

Below is the output from the spirometer for non-smoking males with a height of 170 cm.

age	height	gender	smoker	FEV_1	FVC	FEV_1/FVC (%)	
20	170	male	N	4.35	5.15	84.47	×
40	170	male	N	3.82	4.78	79.92	×
60	170	male	N	3.20	4.23	75.65	×
80	170	male	N	2.45	3.49	70.20	×

Below is the output from the spirometer for life-long smoking males with a height of 170 cm.

age	height	gender	smoker	FEV_1	FVC	FEV_1/FVC (%)	
20	170	male	Y	4.35	5.15	84.47	×
40	170	male	Y	3.45	4.84	71.28	×
60	170	male	Y	2.71	4.22	64.22	×
80	170	male	Y	2.08	3.48	59.77	×



Life-long smoking dramatically reduces lung efficiency. Life-long smokers over the age of 50 are likely to have impaired lung function, FEV_1/FVC (%) is less than 70%.

Ask your students how they could improve on the precision of the data set? For example, the fitted trend line suggests that the 70% threshold is breached at the age of 50 in the smoking population – perhaps collecting data with an age interval of 5 and/or 10 years may have been a better approach than the 20-year interval used here?

Appendix 3: In-text question answers

What is the percentage of carbon dioxide gas in inspired air?
Answer: (0.3 mmHg/760 mmHg) x 100 = 0.04%

What is the percentage of carbon dioxide gas in <u>expired</u> air?
Answer: (30 mmHg/760 mmHg) x 100 = 3.9%

Using the information in the spirogram shown in Figure 5, what volume is the vital capacity?
Answer: The vital capacity shown in Figure 5 is approximately 3.5 litres. This is the sum of the expiratory reserve volume, the tidal volume and the inspiratory reserve volume.

Look at Figure 5. Which two statements are correct about lung function with age in both men and women? a) Lung function stays the same across all ages in males and females b) Lung function increases with age in males and females c) Lung function decreases with age in males and females d) Lung function is slightly lower in males than females across all ages e) Lung function is slightly higher in males than females across all ages
Answer: c) Lung function decreases with age in males and females d) Lung function is slightly lower in males than females across all ages

Appendix 4: Quiz answers

Correct answers are highlighted in green.

Question 1

Put the steps involved in the flow of air from the conduction zone through to the respiration zone in order.
Label the steps from 1–5; 1 being the first, 5 being the last.

Air passes down the back of the pharynx, past the epiglottis and into the larynx.	2
Air is taken in through the nasal cavities.	1
From the larynx, air travels into the trachea, and into the bronchi.	3
Air moves through the terminal bronchioles and into the respiratory bronchioles.	4
Air passes into the alveolar ducts and into the alveolar sacs.	5

Feedback

The conduction zone includes the airway structures involved in the conduction of air to and from the respiratory zone, where gaseous exchange takes place.

Question 2

Which one of the following statements is true?

- An individual with a FEV_1/FVC (%) reading of 65% has impaired lung function.
- An individual with a FEV_1/FVC (%) reading of 71% has impaired lung function.

Feedback

If you are still uncertain, watch the introductory video which explains how spirometry is used to measure impaired lung function.

Question 3

Based on the data you collected, and the bar chart produced in Task 1, complete the following statements using the dropdown menus.

1. FEV_1/FVC (%) is smaller for males than females
2. FVC is larger in males than females.

Feedback

Whilst FEV_1/FVC (%) is slightly smaller in males compared with females, FVC is slightly larger, meaning that the volumes of air reaching the respiratory surfaces in both males and females is more than sufficient to maintain healthy respiratory function.

Question 4

Based on the tables you produced in Task 2, complete the following statements.

1. FEV_1 increases with increasing height.
2. FVC increases with increasing height.
3. The FEV_1/FVC (%) value decreases with increasing height.

Feedback

There is a positive association between a person's height and lung capacity. Whilst FEV_1/FVC (%) shows a modest decrease with increasing height, the important factor here is that the volumes of air reaching the respiratory surfaces in a healthy person are more than sufficient to maintain healthy respiratory function.

Question 5

Figure 6 shows that FEV_1/FVC (%) values decrease with age for both men and women. Which of the following statements best describes the effect of life-long smoking on lung function?

1. Lung function efficiency shows a modest impairment for smokers compared with sex-matched, age-matched and height-matched non-smokers but does not fall below the 70% that suggests obstructed lung function.
2. Lung function efficiency shows a marked decline for smokers compared with sex-matched, age-matched and height-matched non-smokers and starts to fall below the 70% threshold from about the age of 50 indicating obstructed lung function.

Feedback

If you are uncertain, revisit the Spirometer application to collect more data, but instead of using 20-year intervals, use 10- or 5-year intervals to improve the resolution of the trend over time.

Question 6

Which of the following structures are part of the respiratory zones of the lungs? Select all that apply.

a. trachea
b. alveolar ducts
c. pharynx
d. respiratory bronchioles
e. alveoli

Feedback

The respiratory zones are composed of the bronchioles, alveolar ducts and alveoli in which gas exchange takes place during respiration.

ACKNOWLEDGEMENTS

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