# Biology PAG 6: Physiology, responses, respiration

# Suggested Activity 1: Physiology, responses, respiration

## Instructions and answers for teachers & technicians

This practical activity is composed of two parts; a teacher/technician section and the learner activity which can be found on [page 8](#_Student_Activity). This Practical activity supports OCR GCSE Biology.

**When distributing the activity section to the learners, either as a printed copy or as a Word file, you will need to remove the teacher instructions section.**

|  |
| --- |
| This is a **suggested** practical activity that can be used as part of teaching the GCSE (9-1) Gateway Science (A) and Twenty First Century Science (B) specifications.  These are **not controlled assessment tasks**, and there is **no requirement to use these particular activities**.  You may modify these activities to suit your learners and centre. Alternative activities are available from, for example, [Royal Society of Biology](https://www.rsb.org.uk/education/teaching-resources/secondary-schools), [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry), [Institute of Physics](http://www.iop.org/education/teacher/resources/index.html), [CLEAPSS](http://science.cleapss.org.uk/) and [publishing companies](https://global.oup.com/education/content/secondary/key-issues/gcse_science_2016/?region=uk), or of your own devising.  Further details are available in the [specifications](http://www.ocr.org.uk/science) (Practical Skills Topics), and in these [videos](https://www.youtube.com/playlist?list=PLBD9B84FF4BD54AA4). |

**OCR recommendations:**

**Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.**

**CLEAPSS resources are useful for carrying out risk-assessments: (**<http://science.cleapss.org.uk>**).**

**Centres should trial experiments in advance of giving them to learners. Centres may choose to make adaptations to this practical activity, but should be aware that this may affect the Apparatus and Techniques covered by the learner.**

### Introduction

The topic of physiology covers a vast range of processes. This Practical activity focuses on cellular respiration and the responses to exercise. Learners will participate in an exercise activity and then will measure their pulse, ventilation rate and recovery. There are two methods suggested in this activity for measuring ventilation rate: chest rises and, if available, spirometer traces.

The equipment that is designed to measure ventilation is a spirometer. One of the uses of a spirometer is to measure ventilation rate before and after exercise. It generally consists of a chamber suspended over water and counterbalanced so that gas passed in or drawn out makes the chamber rise or fall.

The spirometer procedure was modified from Nuffield foundation and CLEAPSS practical “Using a spirometer to investigate human lung function.” <http://www.nuffieldfoundation.org/practical-biology/using-spirometer-investigate-human-lung-function>.

### DfE Apparatus and Techniques covered

The codes used below match the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) and Trackers ([**Biology**](http://www.ocr.org.uk/Images/323480-gcse-biology-practical-tracker.zip) / [*Combined Science*](http://www.ocr.org.uk/Images/323483-gcse-combined-science-practical-tracker.zip)) available online. **There is no requirement to use these resources.**

**4** *[4]*: Safe and ethical use of living organisms (plants or animals) to measure: i) physiological functions; ii) responses to the environment

### Aim

To investigate and monitor changes in pulse, ventilation rate and recovery following exercise.

### Intended class time

This activity will take 30 minutes (with a spirometer the experiment can take 60 minutes).

### Links to Specifications:

### Twenty First Century

B4.1.1 Compare the processes of aerobic and anaerobic respiration, including conditions under which they occur, the inputs and outputs, and comparative yields of ATP.

B4.1.2 Explain why cellular respiration occurs continuously in all living cells.

### Gateway

B1.3a Describe cellular respiration as a universal chemical process, continuously occurring that supplies ATP in all living cells.

B1.3c Compare the processes of aerobic respiration and anaerobic respiration.

### Mathematical Skills covered

Understand and use the symbols: =, <, <<, >>, >, ∝, ~

### Twenty First Century IaS references covered

IaS1.8 Use appropriate scientific vocabulary, terminology and definitions to communicate the rationale for an investigation and the methods used using diagrammatic, graphical, numerical and symbolic forms.

IaS2.10 Evaluate an experimental strategy, suggest improvements and explain why they would increase the quality (accuracy, precision, repeatability and reproducibility) of the data collected, and suggest further investigations.

IaS2.11 In a given context interpret observations and other data (presented in diagrammatic, graphical, symbolic or numerical form) to make inferences and to draw reasoned conclusions, using appropriate scientific vocabulary and terminology to communicate the scientific rationale for findings and conclusions.

### Gateway Working scientifically references covered

WS1.1g Make decisions based on the evaluation of evidence and arguments.

WS2a Carry out experiments with due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions.

WS2b Make and record observations and measurements using a range of apparatus and methods keeping appropriate records.

WS2c Presenting observations using appropriate methods to include descriptive, tabular diagrammatic and graphically.

### Equipment

Timer (per group)

Method of recording data (pen/paper) (per group)

If available (per class):

* Spirometer
* Carbosorb/soda lime
* Disinfectant
* Oxygen tank
* Nose-clip
* Kymograph or Motion sensor with data logging software

### Health and Safety

Teachers will need to carry out a suitable risk assessment for each practical. The following may assist you in the preparation of your risk assessment:

Ask if any learners are asthmatic or diabetic before proceeding with any exercise activity or using spirometer.

Learners should use a spirometer only under the direct supervision of a teacher.

Take care handling the Carbosorb/soda lime.

Disinfect the spirometer mouthpiece between users.

### Method

*Pulse rate*

1. Learners hold out one of their hands with the palm facing upwards and the elbow slightly bent.
2. Put the first and middle fingers of the other hand on the inside of the just below the thumb along the radius.
3. Press the skin until the learner can feel the pulse.
4. Count the number of pulses in 1 minute using the timer.
5. After exercise (e.g. star jumps), learners repeat 1 to 4.
6. Learners record their rate in the results table or draw their own.

*Measuring ventilation rate using chest rises*

1. Count the number of chest rises in 1 minute.
2. Learners record the results in the following table or draw their own.

*Measuring ventilation rate using a spirometer*

1. Set up the spirometer as per manufacturer instructions.
2. Check for leaks and calibrate the spirometer.
3. Choose a selection of learners with no medical history of asthma and a good indication of fitness.
4. The learner should be rested and sitting down with a nose-clip in place. With the two-way tap closed and the mouthpiece connected to the outside atmosphere, have the learner breathe normally into the mouthpiece to familiarise the learner to the spirometer.
5. Then, turn the two-way tap to connect the learner to the spirometer chamber at the end of an outward breath.
6. Record for a few normal breaths for 1 minute.
7. After exercise (e.g. star jumps), repeat steps 4 to 6.
8. Dispose or clean the mouthpiece.
9. Repeat for another learner.

### Technician Notes

***Pulse rate***

* Timer (per group)
* Method of recording data (pen/paper) (per group)

***Ventilation rate***

* Timer (1 per group)
* Spirometer (optional, 1 per class)
  + Carbosorb/soda lime
  + Oxygen tank
  + Nose-clip
  + Kymograph or Motion sensor with data logging software

### Quiz - Answers

|  |  |  |
| --- | --- | --- |
| **1.** | Calculate the difference in the pulse and ventilation rate following exercise. Add your results to the table. **[2 marks]** | |
|  |  | |
| **2.** | What effect did exercise have on the number of heartbeats in 1 minute (pulse) and on the number of breaths (ventilation rate)? **[2 marks]** | |
|  | The pulse increased following exercise. ✓  The ventilation rate increased following exercise. ✓ |  | |
|  |  | | |
| **3.** | Compare and explain the measurements for pulse and ventilation rate at the following time points: 10 minutes after, immediately after and before exercise. **[5 marks]** | |
|  | 10 minutes after ~ before exercise < after exercise ✓✓  The exercise increased the demand for energy and oxygen, increasing cellular respiration. ✓ As a result, the ventilation rate and pulse increased immediately following exercise. ✓ After 10 minutes, the ventilation rate and pulse had recovered and returned to a normal level. ✓ |  | |
|  |  | | |
|  |  | |
| **4.** | How do aerobic respiration and anaerobic respiration differ? Which process produces more energy in the form of adenosine triphosphate (ATP)? **[2 marks]** | |
|  | Aerobic respiration occurs in the presence of oxygen, while anaerobic respiration takes place when there is no oxygen available. ✓ Aerobic respiration produces more ATP. ✓ |  | |
|  |  | | |

### Document updates

v1 Published on the qualification pages

v1.1 January 2017 Consolidated labelling and formatting of activities

v1.2 June 2021 Update to meet digital accessibility standards



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# Biology PAG 6: Physiology, responses, respiration

# Suggested Activity 1: Physiology, responses, respiration

## Learner Activity

### Physiology, responses respiration

### Introduction

Exercise requires energy in the form of adenosine triphosphate (ATP). Cellular respiration is the process of ATP production from food in the cell. The oxygen and food involved in cellular respiration are transported throughout the body by the circulatory system. Your pulse is a measure of your heart rate, working to pump blood throughout the body in response to the demands of exercise on food and oxygen. Your breathing also changes in response to these demands. Following exercise, the time required for your breathing and pulse to return to normal is called the recovery time.

In this activity you will have the chance to investigate the effects of exercise on your breathing (ventilation rate), heart rate (pulse) and recovery time.

### Aims

To investigate and monitor changes in pulse, ventilation rate and recovery following exercise.

### Equipment

Timer (per group)

Method of recording data (pen/paper) (per group)

If available (per class):

* Spirometer
* Carbosorb/soda lime
* Disinfectant
* Oxygen tank
* Nose-clip
* Kymograph or Motion sensor with data logging software

### Health and Safety

If you have asthma or diabetes let your teacher know before starting this practical.

### Method

*Pulse rate*

1. Learners hold out one of their hands with the palm facing upwards and the elbow slightly bent.
2. Put the first and middle fingers of the other hand on the inside of the just below the thumb along the radius.
3. Press the skin until the learner can feel the pulse.
4. Count the number of pulses in 1 minute using the timer.
5. After exercise (e.g. star jumps), learners repeat 1 to 4.
6. Learners record their rate in the results table or draw their own.

*Measuring ventilation rate using chest rises*

1. Count the number of chest rises in 1 minute.
2. Learners record the results in the following table or draw their own.

*Measuring ventilation rate using a spirometer*

1. Set up the spirometer as per manufacturer instructions.
2. Check for leaks and calibrate the spirometer.
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4. The learner should be rested and sitting down with a nose-clip in place. With the two-way tap closed and the mouthpiece connected to the outside atmosphere, have the learner breathe normally into the mouthpiece to familiarise the learner to the spirometer.
5. Then, turn the two-way tap to connect the learner to the spirometer chamber at the end of an outward breath.
6. Record for a few normal breaths for 1 minute.
7. After exercise (e.g. star jumps), repeat steps 4 to 6.
8. Dispose or clean the mouthpiece.
9. Repeat for another learner.

### Results

1. Record your results in a suitable table, such as the one below.

| Time point | # of heartbeats in a minute (pulse) | # of chest rises in a minute (ventilation rate) |
| --- | --- | --- |
| Before exercise (t0) |  |  |
| Immediately following exercise (t1) |  |  |
| 10 minutes after exercise (t2) |  |  |
| Difference following exercise (t1 – t0) |  |  |

1. (Optional) Determine the ventilation rate (breaths per minute) on the spirometer.
   1. Using the speed of rotation of the drum (mm\*s-1), calculate the horizontal displacement equal to 60 seconds.
   2. Count the number of normal breaths in 10 seconds.
   3. Calculate the number of breaths in 1 minute.

### Quiz

|  |  |  |
| --- | --- | --- |
| **1.** | Calculate the difference in the pulse and ventilation rate following exercise. Add your results to the table. **[2 marks]** | |
|  |  | |
| **2.** | What effect did exercise have on the number of heartbeats in 1 minute (pulse) and on the number of breaths in 1 minute (ventilation rate)? **[2 marks]** | |
|  |  |  | |
|  |  | | |
|  |  | |
| **3.** | Compare and explain the measurements for pulse and ventilation rate at the following time points: 10 minutes after, immediately after and before exercise. **[5 marks]** | |
|  |  |  | |
|  |  | | |
|  |  | | |
| **4.** | How do aerobic respiration and anaerobic respiration differ? Which process produces more energy in the form of adenosine triphosphate (ATP)? **[2 marks]** | |
|  |  |  | |
|  |  | | |

### DfE Apparatus and Techniques covered

If you are using the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc)) you may be able to tick off the following skills:

|  |  |
| --- | --- |
| **Biology** | |
| 4-i | 4-ii |