Cambridge Assessment International Education

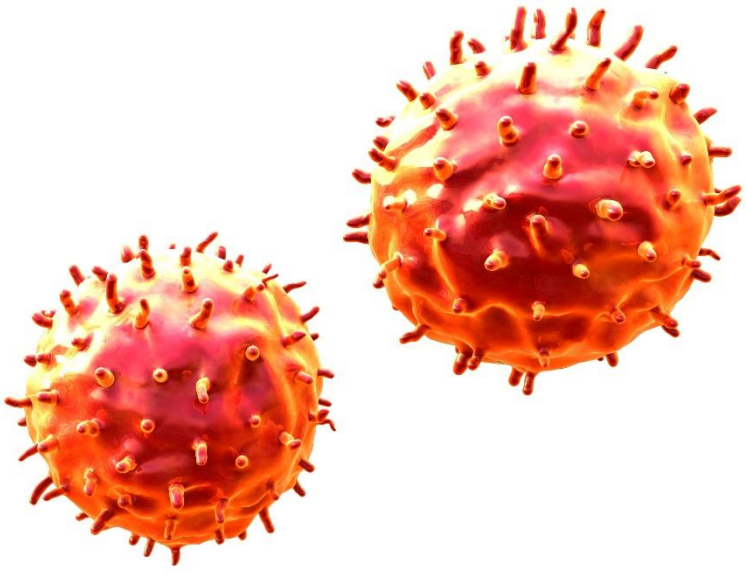
Teaching Pack

Heart dissection

Cambridge IGCSE™

Biology 0610

This *Teaching Pack* can also be used with the following syllabuses:
- Cambridge IGCSE™ (9–1) Biology **0970**
- Cambridge IGCSE™ Biology (US) **0438**
- Cambridge IGCSE™ Combined Science **0653**
- Cambridge IGCSE™ Co-ordinated Sciences (Double Award) **0654**
- Cambridge IGCSE™ (9-1) Co-ordinated Sciences (Double Award) **0973**
- Cambridge O Level Biology **5090**
- Cambridge O Level Combined Science **5129**



Version 2.0

Cambridge Pathway

Contents

Icons used in this pack:

Briefing lesson

Lab lesson: Option 1 – run the experiment

Lab lesson: Option 2 – virtual experiment

Debriefing lesson

Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and / or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

↓

Lab lesson (1 hour*)	
Option 1 – run the experiment	**Option 2 – virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experimental skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experimental skills introduced in the *Briefing lesson*.

↓

Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases, it will also provide the opportunity to practise extended writing skills.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this *Teaching Pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: Heart dissection

This *Teaching Pack* focuses on a heart dissection.

In the experiment, learners will make observations and measurements to identify the anatomy of the heart.

This experiment has links to the following syllabus content (see syllabus for detail):

- 9.2 Heart

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations** (see syllabus for assessment objectives):

- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- evaluate methods and suggest possible improvements.

Prior knowledge

Knowledge from the following syllabus topic is useful for this experiment.

- 9.2 Heart

Going forward

The knowledge and skills gained from this experiment will be useful for when you teach learners about the heart.

Briefing lesson: Making and interpreting measurements

Resources	• Worksheets A and B • A timer
Learning objectives	By the end of the lesson: • ***all*** learners should be able to measure and compare heart rate at rest and during activity. • ***most*** learners should be able to record data on heart rate in a table and a graph. • ***some*** learners should be able to interpret data to review the link between heart rate and exercise.

Timings	Activity
10 min	**Starter/introduction** Set learners the question of how they could investigate cardiac fitness; you might need to explain that this is the ability of the heart to supply oxygen to the muscles and that the heart of a very athletic person who exercises a lot is able to pump more blood around the body with each contraction of the heart (and therefore has a lower resting heart rate). This should lead to a discussion of what they could measure. Most learners should be able to suggest measuring their resting heart rate. Ask learners how this could be measured and what equipment they would need. Discuss different suggestions and agree that in the classroom, without specialist equipment, they can just use a timer and count the number of beats per minute by using touch. Show learners how to measure heart rate, then ask them to record their heart rate for one minute. Learners work in pairs and compare their resting heart rates. Ask what variables should be controlled during the measurement (e.g. both learners are sat down, pulse is taken on the same-side wrist, in the same position and recorded for the same amount of time). They should record their heart rates on paper.
10 min 10 min 10 min	**Main lesson** Ask learners to share their resting heart rate. Discuss why there may be variations between them. Link this to their fitness levels, height and gender. Ask learners whether there could be any other explanations for the variations in regards to their method of collecting the data. Discuss the accuracy of recording the resting heart rate and whether there would be a more accurate way of recording this. This could be a class discussion. Create a mind map for the whole class to see with the centre reading '*How to increase accuracy*'; learners add their ideas to this. Suggestions might include recording the resting heart rate three times to calculate a mean; comparing with others of similar height, same sex and age; using more accurate equipment; or performing the test lying down so as to more accurately reflect a resting heart rate. Give learners either Worksheet A or Worksheet B. Worksheet B is for abler learners. Challenge learners to record more accurate readings for their resting heart rate by taking multiple readings to calculate a mean. The abler learners will be asked to design a table to record this information (Worksheet B); learners needing support will be given a table to complete (Worksheet A). Circulate the room and challenge learners with Worksheet B to think what the unit of measurement would be for this task. *Continues on next page …*

Timings	Activity
20 min	**Main lesson continued …** Review learners' resting heart rates from a more accurate calculation and ask how this compares to their initial reading in the starter, is it the same? Is this data more reliable? Now set learners the challenge of investigating how physical activity affects their heart rate. Ask them to hypothesise what will happen to their heart rates during exercise. Learners should be able to explain that heart rate increases due to increased metabolic activity and also suggest that heart rate will be higher than resting heart rate after stopping exercise. As a class, learners to decide and agree upon up to three activities to do in order to compare their heart rate immediately after exercise to their resting heart rate. The amount of activities that you do will depend upon class size, room layout, time constraints and learner abilities. It might be that you only have time to do one activity to compare with heart rate from the initial task. Worksheet A is designed as if there will be time for three activities. This will need to be amended before the lesson for the amount or type of activities you want to run. You might want to specify the activities rather than letting learners suggest their own. Suggestions include: star jumps, running on the spot, jogging on the spot, running a set distance, or press-ups (if risk-assessment and space allow). Agree on a set time to carry out the activity, to minimise risk of learners overworking; do not exceed 1 minute. Medical notes will need to be read prior to the activity. It is your responsibility to carry out a risk assessment before allowing learners to engage in physical activity. **Safety** Learners record their heart rate immediately after exercising for one minute for up to three activities on either Worksheet A or B. Learners review their results and compare them to their resting heart rate. Ask learners to interpret their data by reviewing their hypothesis, and considering if their data supports it. What does their data suggest about the impact of exercise on heart rate? Can they explain why this is using their knowledge of cardiac fitness discussed in the starter? This can be done verbally as a class before asking learners to do this independently using the prompts on their worksheets.
10 min	**Plenary** Review the class' results and discuss their conclusions. Make sure that learners' conclusions use their data to support their statements. Discuss again why there are variations between individuals. This could have been due to differences such as age, gender and fitness. Ask how accurate their results were. Could they have improved them? Were they sufficiently accurate for the purpose of their experiment? They suggest an improvement would be to repeat their measurements three times in order to calculate a mean, and that this would make their results more meaningful. Discuss how the mean eliminates anomalous data points. Explain that there are variations within individuals that can occur, as well as measurement errors, so calculating a mean balances out / reduces the effect of these variations.

Hazard	Risk	Prevention
Learners trip over bags, coats or chairs during activity	Could injure themselves.	Chairs, bags and coats should be tucked / cleared away.
Learners could over-exert themselves.	Learners could become faint.	Limit exercise time to 1 minute maximum.

Lab lesson: Option 1 – run the experiment

Resources	• Worksheets C, D, and E • *Teacher walkthrough video, Teacher notes, Teacher method* • Equipment as outlined in the *Teacher notes*
Learning objectives	By the end of the lesson: • ***all*** learners should be able to conduct a heart dissection following a method and record observations in anatomical drawings. • ***most*** learners should be able to use their observations to identify and compare the anatomy of the heart. • ***some*** learners should be able to infer the role of the left and right side of the heart from observations and measurements.

Timings	Activity
5 min	**Starter/introduction** Give learners Worksheet C, which is an image of the heart. Draw a mind map for the whole class to see, with the central question: '*What observations or measurements could you record from a dissection of a heart?*'. Give learners two minutes to discuss in small groups (2–4). Review their suggestions as a class. Suggestions might include: the thickness of the walls; size of the chambers; colour of the tissue; size of the heart as a whole; number of blood vessels. Ask learners if these observations and measurements are qualitative or quantitative data. Does that affect how they will make the observations or measurements? Explain that they need to be making these observations and measurements during a dissection. Leave the mind map on the board for learners to refer to during the experiment and when completing Worksheet E.
10 min	**Main lesson** Give learners the method (Worksheet D). Briefly outline the safety precautions of the experiment. Draw a risk assessment on the board and discuss possible hazards and how to avoid these with learners.

Hazard	Risk	Prevention
Handling raw meat	Possible infection	Wear gloves; do not put hands in mouth; do not touch surfaces, books, pens or paper with dirty gloves; wash hands thoroughly at the end of the experiment.
Scalpel	Cuts	Make incisions away from the body in a downwards motion on a white tile; keep fingers away from the blade; return scalpels to the front when not in use; carry them safely, away from the body but not pointing outward towards others.

Continues on next page …

Timings	Activity
5 min 30 min 5 min	**Main lesson continued …** Arrange learners into pairs or small groups (2–4) and ask them to read through the method to make sure that they understand what they are doing. They will have to use the images on Worksheet D and the structure of the heart on Worksheet C to help them identify certain regions; knowledge of the heart will also help. Learners follow the instructions on Worksheet D and use Worksheet E to record their results, which will take the form of anatomical drawings and measurements. Learners will need spare pairs of gloves in order to move between doing the dissection and making drawings. Reiterate the importance of washing their hands and not touching other surfaces with dirty gloves. **Safety** Circulate the classroom at all times during the experiment so that you can make sure that your learners are safe and that the data they are collecting is accurate. You will need to check learners are drawing the correct side of the heart in anatomical terms (left = right and right=left). Some learners might need support with this. They are directed to use sticky labels on their dissection tray to reiterate the correct sides. Some hearts may have more fatty deposits than others and appear yellow and hardened on the surface. Challenge learners to suggest what impact this could have on the heart. Learners can be challenged to track the passage of blood through the heart using red straws to represent oxygenated blood and blue straws to represent deoxygenated blood. This is not included in the method as it would guide learners through the steps when they should be challenged to do so. You can ask learners which side would have blue straws and which would have red. Review their layout and ask learners to explain this to you in their groups. Dispel the misconception that blood flows in the right side and then the left side. Reiterate that this occurs at the same time.
5 min	**Plenary** Collate the learners' measurements of the thickness of the left ventricle wall and the right ventricle wall for the whole class to see. Calculate the average thickness of the heart tissue of the left and right side. Ask learners as a class what conclusions could be drawn from the data. This can then be linked to the anatomy of the heart and why the left side is thicker. Abler learners could be challenged to discuss the accuracy of the measurements leading to errors / variation; but also how the thickness of the heart may vary between individuals, linking this back to the ideas explored in the briefing lesson. Ask learners to suggest what they could do to improve accuracy. Learners should be able to suggest that they should take multiple measurements and observations to eliminate any anomalies, calculate a mean and collect reliable data. Learners' thoughts could be shared as a group with hands up.

Teacher notes

Watch the *Teacher walkthrough* video and read these notes.

Each group will require:

- a lamb / sheep / goat heart (be aware of religious and cultural sensitivities when choosing)
- a dissection board / tray
- sticky labels
- scalpels
- 15 cm rulers (should be made of material that is easily cleaned)
- gloves (latex and / or non-latex in case of any allergies)
- red and blue straws (optional)
- disinfectant spray and cloths

Safety

The information in the table overleaf is a summary of the key points you should consider before undertaking this experiment with your learners.

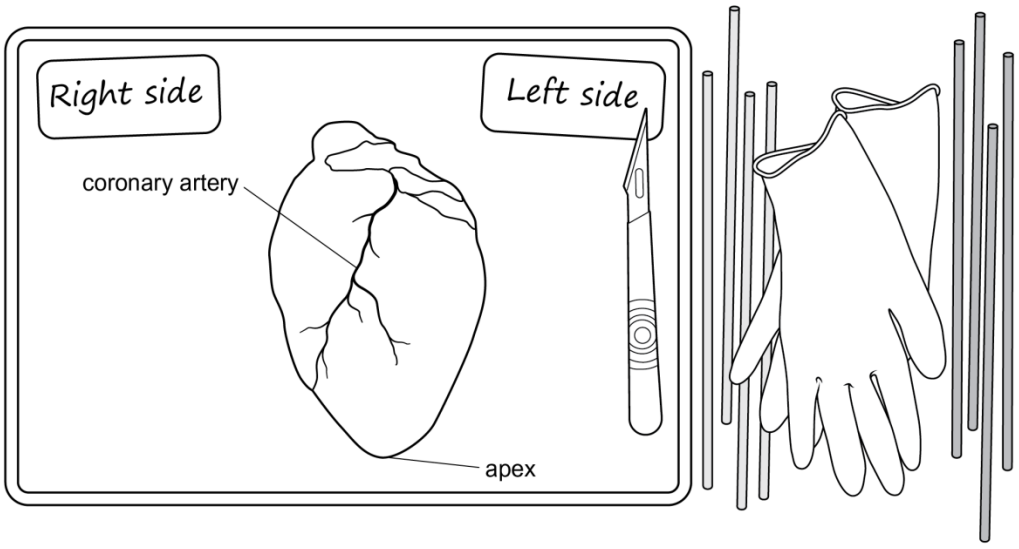
Some associated safety precautions include:

1. All learners should wear lab coats or plastic / disposable aprons.
2. Raw meat should not come into contact with the skin; gloves should be worn and hands washed after the dissection.
3. Learners should wear eye protection to prevent material getting into the eye in cases where blood or juices accidentally spray.
4. Although gloves will be worn, learners should still cover any existing cuts on their hands with plasters.
5. Learners should not put their hands in their mouth.
6. Learners should not touch their pens, notepads or other surfaces with contaminated gloves; gloves must be removed when making the anatomical drawings or writing down measurements or answers to questions.
7. Make sure that the scalpels are sharp so less force is needed and there is less risk of learners slipping and causing injury.
8. Make sure learners are aware of the safe method of using the scalpel: cutting in a downwards motion away from the body; fingers should be kept clear of the blade; and cutting should be done on a dissection tray.
9. Learners carrying scalpels could present a hazard to other people in the classroom; so make sure they are aware of the safe way to carry them.
10. There should be a clear disposal box for learners to put used scalpels into; you or the technician, are responsible for sterilising these after use.
11. The scalpels should be counted out and in.
12. Check for latex allergies before carrying out the experiment; signs of allergy include itchiness and rashes. Look out for severe allergic reactions such as difficulty breathing and / or swelling of the face, body or tongue.
13. Learners must not use their own rulers to make measurements.

It is **your** responsibility to carry out an appropriate risk assessment for this practical.

Substance	Hazard	First aid
Animal parts	BIOHAZARD	**In the eyes:** Flood the eye with gently-running tap water for 10 minutes. If discomfort persists, see a doctor. **Swallowed:** do no more than wash out the mouth with water. Do not induce vomiting. See a doctor if necessary. **Spilt on the skin or clothing:** Remove contaminated clothing; wash skin thoroughly with (antibacterial) hand soap and running water. **Spilt on the floor, bench, etc.:** clean the area thoroughly using an appropriate disinfectant (**you must do a risk assessment for any disinfectant used**).
Sharps (e.g. scalpels, knives, mounted needles)	Risk of cuts or puncture wounds due to sharps. Wounds can lead to infection, especially if the blade or point is contaminated.	**Minor cuts:** Rinse the wound with water. Get the casualty to apply a small, sterile dressing. **Severe cuts**: Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.
Latex gloves	Allergic reaction	Remove the gloves and wash hands under water. Look out for severe allergic reactions such as difficulty breathing and/or swelling of the face, body or tongue. Seek emergency medical attention immediately.

Experiment set-up



Teacher method

This is your version of the method that accompanies the *Teacher walkthrough video.*
Do not share this method with learners. Give them Worksheet D.

Before you begin
Plan how you will arrange your learners during the experiment session; consider if learners should work in pairs or small groups (2–4). The method requires learners to make observational drawings, so learners will need to remove their gloves, wash their hands, make their drawings and then put on fresh gloves again for each drawing and measurement they make; so, consider if all learners should do the dissection or if learners can take it in turns to dissect and draw.

Think about:
- cultural or religious beliefs / sensitivity of the learners: some learners might be unable to, or find it uncomfortable to, handle raw meat.
- an appropriate source of the hearts: how easily can you obtain them? Do you have a trustworthy source?
- the condition of the hearts: some butchers or suppliers will remove the atriums; or the hearts will be cut to check for disease; and sometimes some of the blood vessels will also be removed.
- if learners are mature enough to handle the scalpels and the raw meat.

Experiment
Circulate during the experiment in case learners encounter any difficulties.

Step	Notes
1. Run through the safety instructions. Ask if any learners have a latex allergy. Make it clear that learners must be wearing gloves when handling the heart to avoid the risk of infection or contamination from raw meat. Eye protection and lab coats (or plastic aprons) should be worn and care should be taken when using and carrying the scalpels around the classroom.	*Count the number of scalpels out and in, to make sure that they are all returned. You might wish to demonstrate how to carry the scalpels around the room: with the blade pointing downwards and away from the body.*
2. Demonstrate to learners how to use the scalpel effectively and safely.	*Use the scalpel to make clear cuts in a downward motion away from the body. Keep the heart a good distance from the body. Do not use a sawing action.*
3. Distribute the hearts and ask learners to place their hearts on their dissection trays.	*Check each heart to determine if any structures are missing and amend the instructions accordingly. For example, the atria and vessels are often removed. Also note that different hearts might have slightly different anatomies, so learners might need support in identifying the structures on their hearts*

Step	Notes
4. Check that learners have the heart in the front-facing position.	*The apex of their heart should be facing towards them and the left and right side properly identified using sticky labels. The heart should be placed down on the dissection tray so that the coronary arteries are facing upwards. See Worksheet D.*
5. Learners might need assistance in identifying the coronary artery and measuring about 25 mm from this to make the incision.	
6. Learners will be asked to make observations on the front appearance of the heart. They will also be asked to measure the widest part of the heart.	
7. Learners will be asked to make an incision about 25 mm to the left of coronary artery to open up the right side of the heart.	*You might have to show learners where this is.*
8. Learners will be asked to put their fingers or the straws into and through the main blood vessels of the heart to identify which region of the heart it is. Some learners will need support with this and so demonstrating this can be helpful.	*Learners' previous work on anatomy will help to support them in this task, as will the diagram on Worksheet C.*
9. The valves often are difficult to see and are damaged. Learners should be able to see the tendons around the area where the valves should be.	*The atrioventricular valves tend to be more commonly seen than the semilunar valves.*
10. The dissection could be paused at the point where learners make the incision from the blood vessels to the earlier incision.	*This would be a good place to demonstrate it first; talk through the process; or discuss what learners have observed.*
11. Learners will repeat these incisions for the left side of the heart. They will first open the ventricle by making an incision about 25 mm from the coronary artery. Then they will identify the aorta and make an incision from this to the initial cut.	

Step	Notes
12. Learners will be asked to make measurements throughout the experiment.	
13. Some learners could then be challenged to use red and blue straws to identify the passage of blood.	*Ask learners which colour straw would be used on which side of the heart.*
14. Learners should gather all of the equipment that they have used into their dissection tray and return this to the front of the class.	
15. Learners should remove their gloves and put these into the bin. Learners should sanitise their desks using antibacterial spray and then wash their hands thoroughly.	*The heart can be disposed of in the technician's general waste.*

Clean-up

After the experiment learners should:

- tidy up the work space
- return their dissected hearts to the teacher to be disposed of
- return all equipment
- wipe down their work space using disinfectant spray
- remove their gloves and throw these into the bin
- wash their hands thoroughly under running water using soap.

The heart material should be wrapped in newspaper or other suitable medium and thrown into the bin at the end of the dissection. Double-bag the waste bag for disposal in an industrial bin.

Lab lesson: Option 1 – demonstrate the experiment

In this lesson only you perform the dissection, however you still need to do a risk assessment.

Resources	• Worksheets C, D and E • *Teacher walkthrough* video, *Teacher notes* and *Teacher method* from *Lab lesson: Option 1 – run the experiment* • Equipment as outlined in the *Teacher notes* • Clipboards or similar

Learning objectives	By the end of the lesson: • ***all*** learners should be able to record observations from a heart dissection. • ***most*** learners should be able to use their observations to identify and compare the anatomy of the heart. • ***some*** learners will be able to infer the role of the left and right side of the heart from observations and measurements.

Timings	Activity
5 min	**Starter/introduction** Give learners Worksheet C, which is an image of the heart. Draw a mind map for the whole class to see, with the central question: '*What observations or measurements could you record from a dissection of a heart?*' Give learners two minutes to discuss in small groups (2–4). Review their suggestions as a class. Suggestions might include: the thickness of the walls; size of the chambers; colour of the tissue; size of the heart as a whole; number of blood vessels. Ask learners if these observations and measurements are qualitative or quantitative data. Does that affect how they will make the observations or measurements? Explain that they need to be making these observations and measurements during a dissection. Leave the mind map on the board for learners to refer to during the experiment and when completing Worksheet E.
10 min	**Main lesson** Give learners the method (Worksheet D).Explain that you are going to demonstrate a dissection of a [sheep's] heart. Explain that it looks and works like a human heart but is a bit smaller. Briefly outline the safety precautions of the experiment. Draw a risk assessment on the board and discuss possible hazards and how to avoid these with learners.

Hazard	Risk	Prevention
Handling raw meat	Possible infection	Wear gloves; do not put hands in mouth; do not touch surfaces, books, pens or paper with dirty gloves; wash hands thoroughly at the end of the experiment.
Scalpel	Cuts	Make incisions away from the body in a downwards motion on a white tile; keep fingers away from the blade; return scalpels to the front when not in use; carry them safely, away from the body but not pointing outward towards others.

Continues on next page …

Timings Activity

Main lesson continued …

30 min

Give learners Worksheet E and ask them to make observations during the dissection. Learners should make very rough sketches in light pencil strokes, which they can draw properly later in the lesson. If clipboards are available for learners to write on that would be helpful whilst making their observations.

You should follow the instructions on Worksheet D. Show learners the outside of the heart and refer to the measurements and observations that can be made. Use questioning to aid learners in making written descriptions, for example – how many blood vessels can they see, how big are they, what diameter is the large one? Ask them to request measurements from you based on Worksheet E. You can make the measurements and they record the result.

It may be that the atria are not present due to the butchery process. Compare the size of the atria (if present) with the ventricles.

Follow the teacher method, *Teacher walkthrough* video and Worksheet D to dissect the right side of the heart. Learners often confuse the left / right side of the heart, so remind them which side is which. Some hearts may have more fatty deposits than others and appear yellow and hardened on the surface. Challenge learners to suggest what impact this could have on the heart. You could challenge learners to identify which area is which to make the dissection more interactive and support learners by placing cocktail sticks with labels into the heart to make their observations clear. Be sure to pause to show the learners areas of interest such as the ventricles and any valves that may be present so that they can complete the internal observation description on Worksheet E.

Make incisions to dissect the left side of the heart and ask learners to make their observations. Ask learners to draw a table to record the difference between the thickness of the left and right ventricle walls; they can do this on the back of their worksheet. Give learners a minute to draw this and then ask for their ideas. This will challenge abler learners. A volunteer could then sketch the suggested table onto the board.

A table is suggested below:

Right side thickness (mm)	Left side thickness (mm)

Hold the ruler against the right side of the heart and ask for volunteers to read off the ruler and record a measurement. Learners should not touch the ruler or the heart material. You could ask multiple learners to take a reading and ask why this would make the data more reliable.

Use red and blue straws (or something similar) to track the passage of blood through the heart starting with the entry of deoxygenated blood to the right atrium through the vena cava. Use questioning to get the learners to describe the passage of the blood. Use red straws to show oxygenated blood.

Continues on next page …

Timings	Activity
	**Main lesson continued …** Make sure to explain that the heart is a pump and so deoxygenated blood and oxygenated blood will flow through simultaneously. Learners often have the misconception that blood flows through the right side first and then the left. Leave the straws in the heart and hold it upright to demonstrate a pumping action to show that this happens at the same time. (This will work better with a complete heart; so if you have a second one that hasn't been dissected, use that.) Now ask learners to return to their tables and make anatomical drawings of the heart from their rough sketches. You could ask learners to take photos of the relevant sections (front of heart, right side, left side) during the dissection and then display these for the whole class to see. Or you could display stills from the *Virtual experiment* video onto a whiteboard. The heart could be left on the side for learners to refer back to.
	**Plenary** Ask learners as a class what conclusions could be drawn from the data. This can then be linked to the anatomy of the heart and why the left side is thicker. Remind learners to refer to numerical data to support their explanations. This can be written in their books or on the reverse side of Worksheet E. Abler learners could be challenged to discuss the accuracy of the measurements leading to errors / variation; but also how the thickness of the heart may vary between individuals, linking this back to the ideas explored in the briefing lesson. Ask learners to suggest what they could do to improve accuracy. Learners should be able to suggest that they should take multiple measurements and observations to eliminate any anomalies, calculate a mean and collect reliable data. Learners' thoughts could be shared as a group with hands up.

Lab lesson: Option 2 – virtual experiment

Resources	• *Virtual experiment* video • Worksheets C, F and G • Ruler
Learning objectives	By the end of the lesson: • ***all*** learners should be able to record observations from a heart dissection and make measurements from images. • ***most*** learners should be able to use their observations to identify and compare the anatomy of the heart. • ***some*** learners will be able to infer the role of the left and right side of the heart from observations and measurements.

Timings	Activity
5 min	**Starter/introduction** Give learners Worksheet C, which is an image of the heart. Draw a mind map for the whole class to see, with the central question: '*What observations or measurements could you record from a dissection of a heart?'* Give learners two minutes to discuss in small groups (2–4). Review their suggestions as a class. Suggestions might include: the thickness of the walls; size of the chambers; colour of the tissue; size of the heart as a whole; number of blood vessels. Ask learners if these observations and measurements are qualitative or quantitative data. Does that affect how they will make the observations or measurements? Explain that they need to be making these observations and measurements during a dissection. Leave the mind map on the board for learners to refer to during the experiment and when completing Worksheet F.
25 min	**Main lesson** Explain to learners that they will watch a video that shows them how to dissect a sheep's heart. Give them Worksheet F and ask them to make observations as they watch; thinking in particular about the ideas that they collated from the starter. Play the video; it will automatically pause on the shot of the front-facing side of the heart. Learners make their observations and drawings on Worksheet F. Use questioning to help learners in making written descriptions, for example: what colour is the heart? What do they think the white / yellow regions are? Learners may not be aware that there could be fatty deposits on the heart that appear yellow and hardened on the surface. Challenge learners to suggest what impact this could have on the heart. How many coronary arteries can you see? How many blood vessels can you see? How big are they compared to each other? Give 10 minutes for learners to complete their first observations, then resume play of the video. They will see a section discussing the vessels of the heart and then the dissection will start. The video will automatically pause after the left side of the heart has been opened out. Give learners 5 minutes to make their observations and drawings as before. Resume play of the video. The video will pause after the right side of the heart has been opened out. Give learners 5 minutes to make their observations and drawings as before. *Continues on next page …*

Timings	Activity
20 min	**Main lesson continued …** Give learners Worksheet G and ask them to measure the structures in the two images. Ask learners to interpret their findings to suggest which wall is the left ventricle and which wall is the right ventricle based upon these measurements (they should have observed from the video that the left ventricle is thicker than the right ventricle). Discuss their answers as a class and refer back to content-based knowledge to reinforce this if required. Resume play of the video, which will play until the end. It will show learners the one-way valves; discuss the thickness of the ventricle walls; and discuss the flow of blood through the heart. Ask learners to discuss the passage of blood and identify the areas they see the straws being passed through. Learners could be challenged to create a flow chart to track the passage of blood using these observations.
10 min	**Plenary** Ask learners as a class what conclusions could be drawn from the data. This can then be linked to the anatomy of the heart and why the left side is thicker. Remind learners to refer to numerical data to support their explanations. This can be written in their books or on the reverse side of Worksheet F. Abler learners could be challenged to discuss the accuracy of the measurements leading to errors / variation; but also how the thickness of the heart may vary between individuals, linking this back to the ideas explored in the briefing lesson. Ask learners to suggest what they could do to improve accuracy. Learners should be able to suggest that they should take multiple measurements and observations to eliminate any anomalies, calculate a mean and collect reliable data. Learners' thoughts could be shared as a group with hands up.

Debriefing lesson: Evaluation

Resources	• Learners' completed Worksheets F or G • Worksheets D, H, I, J and K
Learning objectives	By the end of the lesson: • ***all*** learners should be able to use observations to identify blood vessels. • ***most*** learners should be able to interpret information to match function with observational drawings. ***some*** learners will be able to evaluate the effectiveness of the heart dissection method and suggest improvements.

Timings	Activity
15 min	**Starter/introduction** Arrange learners into groups (2–4) and hand out Worksheet H. Ask learners to use their observations from the heart dissection lesson (virtual or practical) to answer the questions.
25 min	**Main lesson** Still in their groups, give learners Worksheet I and explain that the image is a cross-section through the top of the heart, cutting through the four vessels. Challenge them to annotate as much of the diagram as possible using the descriptions provided and by making measurements. Give learners Worksheet J and ask them to work in pairs to identify the regions in each image. Learners use their observations and the descriptions, and make measurements. Learners will be asked to provide a reason for their identification and should be challenged to describe this in detail when explaining why they think it is that part of the heart based on what they see. For example; '*I think this is the left ventricle because the tissue wall looks thick and the measurement is similar to that of mine in the heart dissection*'. They can use their results from the *Lab lesson* to help them (Worksheet E or F).
15 min	Ask learners what makes an effective method; discuss ideas as a class. Suggestions should include a method that allows accurate and valid results to be gathered that tests the hypothesis. Remind them that evaluating a method involves considering the appropriateness (strengths and weaknesses) of the method in terms of the purpose of the method; they should think in terms of the required degree of accuracy, the time it takes, and how easy it would be to do (for example, is it easily repeated?). Ask them to think about the *Lab lesson* and then discuss in groups of 2–4 what they think an effective method would include in the context of the heart dissection and to evaluate the method they followed / watched. Allow time for discussion and then share feedback with the class. Gather learners' ideas onto a central board. Discuss with learners their evaluations of the method, reflecting back on what they have done and suggesting possible improvements. This scaffold will provide some ideas for the next task. *Continues on next page …*

Timings	Activity
	Main lesson continued … Give each group Worksheet K and Worksheet D; if learners watched the *Virtual experiment* video, explain that Worksheet D is a written version of the method used in the video. Set learners the task of improving the method. Ask them to work through each step on Worksheet D and tick the ones that are strengths and cross the ones that contain potential weaknesses; they should note down what those weaknesses are. They then use these notes to think of ways to improve the method. Suggestions should include ideas to make the heart dissection clearer so that structures could be more easily identified; making more measurements; making the steps easier to follow; ways to reduce error; ways to reduce complications in the method. Some learners could be challenged to suggest what else they could investigate and how they would go about adapting the method to allow for this. For example, some learners might wish to investigate the septum or structure of the blood vessels, so could suggest adaptations to their method to include this. Learners should complete Worksheet K with their suggestions for improvements and / or ideas for further investigation.
	**Plenary** Learners feedback to the group on answers to Worksheet K. Ideas can be added to a central whiteboard. Discuss learners' ideas and how they improve the method; discuss if the improvement is necessary in terms of the purpose of the experiment: did the data collection methods they used allow them to sufficiently identify the structures of the heart?

Worksheets and suggested answers

	Worksheets	Suggested answers
For use in the *Briefing lesson:*		
A: Measuring heart rate	**23–24**	**50**
B: Measuring heart rate more accurately	**25–26**	**51**
For use in *Lab lesson: Option 1:*		
C: Structure of the heart	**27**	**—**
D: Method	**28–33**	**—**
E: Recording your data	**34–36**	**—**
For use in *Lab lesson: Option 2:*		
C: Structure of the heart	**27**	**—**
F: Making observations	**37–39**	**—**
G: Making measurements	**40–42**	**52**
For use in the *Debriefing lesson:*		
H: Interpreting data	**43–44**	**53**
I: Identifying blood vessels	**45**	**54**
J: Interpreting images	**46–47**	**55**
K: Evaluating the heart dissection	**48–49**	**56**

Worksheet A: Measuring heart rate

Record your resting heart rate for one minute. Conduct this test three times to calculate a mean.

Beats per minute (bpm)			
Test 1	**Test 2**	**Test 3**	**Mean**

1. Why is it a good idea to calculate a mean?

……

……

2. Hypothesise what will happen to your resting heart rate if you started to exercise.

……

……

……

3. Explain your answer to question 2 using your knowledge of the heart.

……

……

……

……

4. Decide upon your chosen activity and record your heart rate for 1 minute.

Activity	**Heart rate after 1 minute of exercise (bpm)**			
	Test 1	**Test 2**	**Test 3**	**Mean**

5. Review your data and decide whether your hypothesis was correct. Use your data to explain how you have come to this conclusion.

……

……

……

……

……

……

……

……

6. Compare your results with other people in the group. Describe any similarities or differences in the data.

……

……

……

……

……

……

……

……

7. Why do you think that there might be these differences in data between individuals?

……

……

……

……

Worksheet B: Measuring heart rate more accurately

1. Design a table in the space below to record your average resting heart rate. Conduct your test three times in order to calculate a mean.

2. Why is it beneficial to calculate a mean?

……

……

……

3. Use your knowledge of the heart to hypothesise what will happen to your resting heart rate if you started to exercise.

……

……

……

……

4. Design a method to record your average heart rate after 1 minute of strenuous exercise.

……

……

……

……

……

……

……

5. Create a table to record the data from your method. Make sure that you make this data as accurate as possible.

6. Review your data and decide whether your hypothesis was correct. Use your data to explain how you have come to this conclusion.

……

……

……

……

……

……

……

7. Compare your results with other people in the group. Describe any similarities or differences in the data.

……

……

……

……

8. Why do you think that there might be these differences in data between individuals?

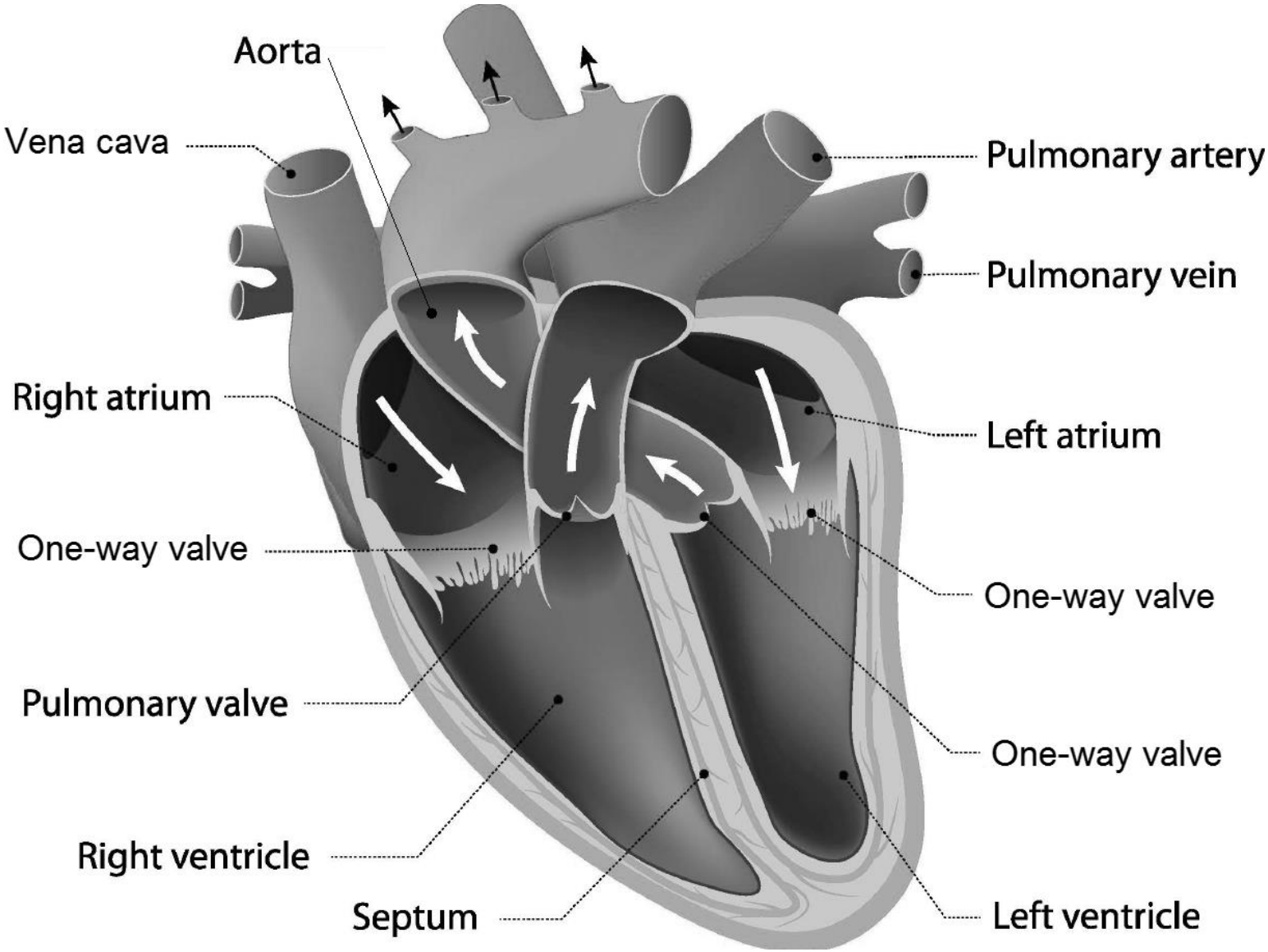
……

……

……

……

Worksheet C: Structure of the heart



Worksheet D: Method

IMPORTANT NOTES:

- Make sure you have a good supply of gloves on your table.
- You must **remove** your gloves and wash your hands before writing down measurements, or making drawings.
- Do **not** use your own ruler to make measurements, use the one provided.
- If you are working in pairs, take it in turns to do the dissecting and measurements, and the drawing and recording, to minimise the number of times you need to change gloves and wash your hands during the dissection.
- Make sure you know how to use the scalpel safely. Ask your teacher if you are unsure.

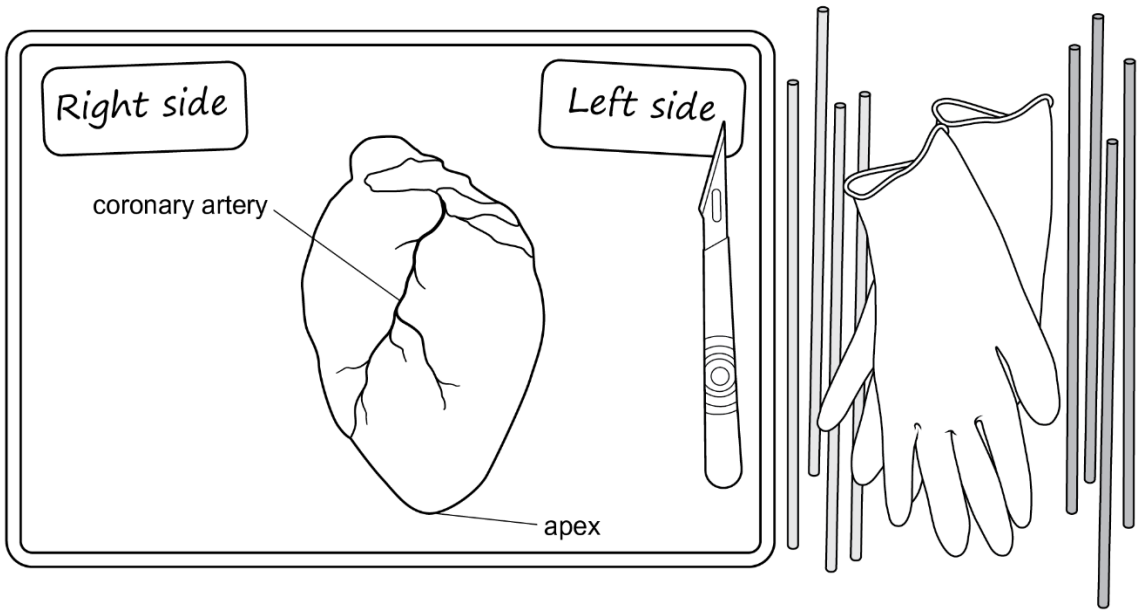
Follow these instructions carefully to dissect the heart.

The instructions are written as if you are working in a pair, one wearing gloves to do the dissection and the other making the drawings and writing down the measurements. When an instruction requires something to be written or drawn, you will see **[Gloves off]**. This reminds you that the person not doing the dissection should be doing the drawing and writing; or if you are doing both, it reminds you to take off your gloves and wash your hands before you draw or write.

If you are working on your own, make sure you remove your gloves and wash your hands each time you make a drawing or write down a measurement. Then put a fresh pair of gloves on to continue the dissection.

Observing the outside of the heart

1. Collect all your equipment.
2. Use the diagram below to arrange your equipment.



3. You should be looking at the front-facing view of the heart, as shown above. The apex of the heart should be pointing towards you.

4. Put sticky labels onto the dissecting board to identify the left and right side of the heart so you do not get confused during the dissection.

5. Observe the outside of the heart; lift the heart and rotate it to observe it from all sides. Both you and your partner discuss what you can see.

   [Gloves off] Your partner writes down the observations on Worksheet E.

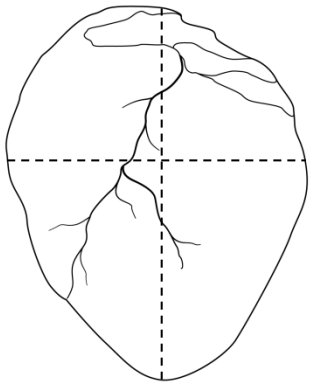
   Make sure your observations include:
   - the colour of the heart
   - how many coronary arteries you can see
   - how many blood vessels you can see
   - any other observations.

   Consider what each of the blood vessels might be based on the diagram on Worksheet C.

6. **[Gloves off]** Use Worksheet E to make the first anatomical drawing of the outside of the heart. Draw only what can be seen.

   The drawing should:
   - be made using a sharp pencil
   - clearly show any blood vessels, tissue or colour differences (shading can be used)
   - be labelled using the information available and your thoughts from step 5.

7. Use a ruler to measure the width of the heart (widest point from left to right). Measure the length of the heart from the top to the apex. **[Gloves off]** Ask your partner to record the measurements in mm on Worksheet E.



8. Measure the longest coronary artery and give the measurement in mm to your partner. **[Gloves off]** Your partner writes this on Worksheet E.

9. Measure the thickness of each of the vessels. **[Gloves off]** Record these on the worksheet.

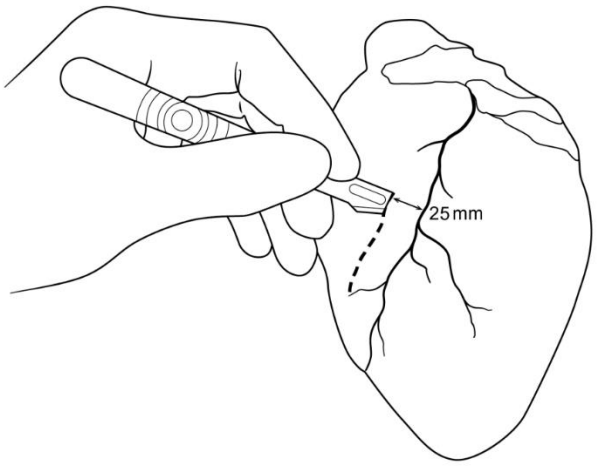
You have now completed your observations and measurements of the outside of the heart. The first box on Worksheet E should be completed.

Dissecting the right side of the heart:

10. Locate the longest coronary artery, the one that splits the heart into the left and right side. Use your finger to follow this down to the middle region of the heart.

11. Measure approximately 25 mm to the **left** of this artery.

12. Use your scalpel to make a cut: cut down into the heart tissue and follow a path along the coronary artery until you are about 25 mm from the apex. Try to keep about 25 mm to the left of the coronary artery all along this path.

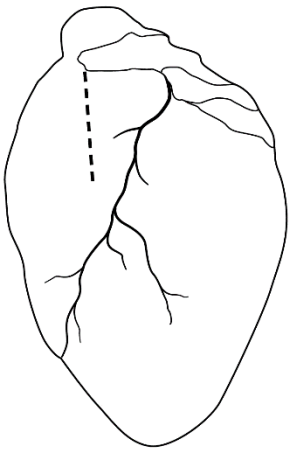


13. You might need to hold open the cut so that you can continue cutting from the inside to open out this side of the heart.

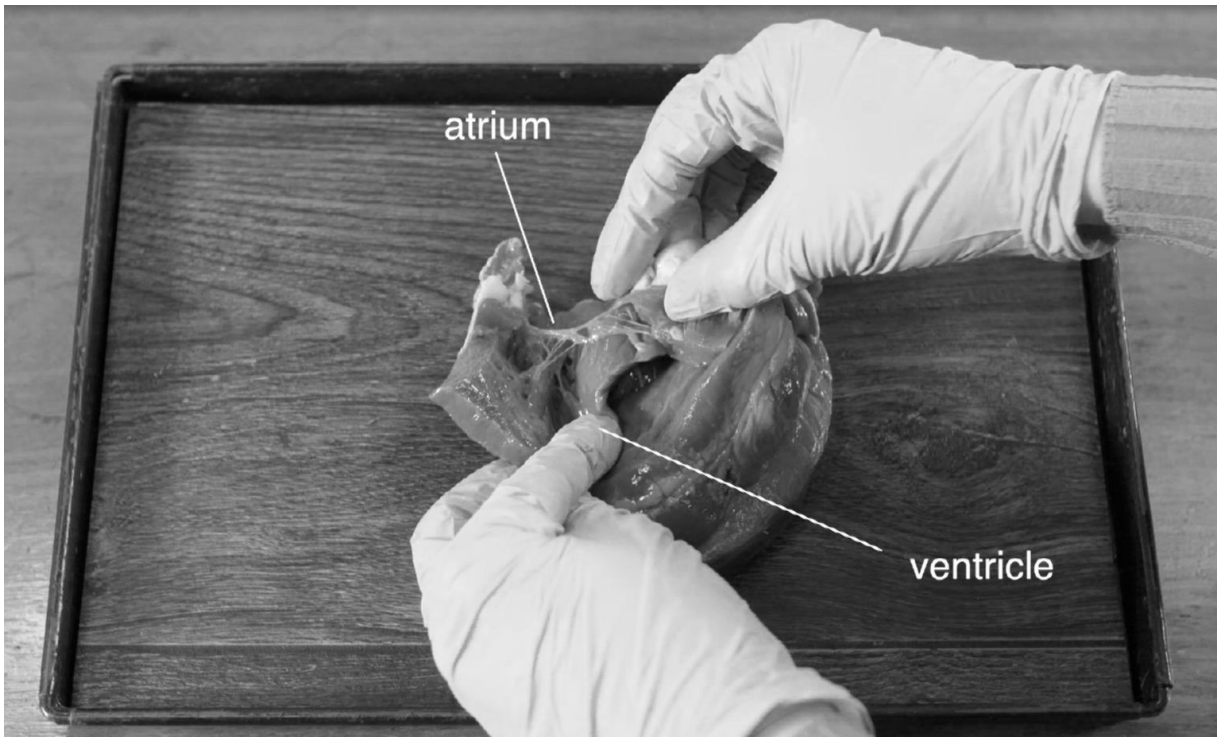
14. When you can see the inside of the right ventricle, put the scalpel down and open up this side of the heart; it will not open fully as the top part is not cut open yet. You should now be able to see into the right ventricle.

15. Work with your partner to identify the pulmonary artery. You can use Worksheet C to help. You might need to put your finger into each of the blood vessels to see where they lead to in order to identify which vessel each one is. Ask your teacher if you are unsure.

16. Make an incision from the pulmonary artery down to the top of the incision that you made earlier along the coronary artery. Open the cut to get inside and cut more if needed.



17. Open out this side of the heart like a book; you should now be able to see inside the right side of the heart.



18. Measure the following structures of the right side of the heart; read the measurements out. **[Gloves off]** Your partner records the data on Worksheet E.

    Measure the:
    i. thickness of the ventricle wall
    ii. the diameter of the blood vessel entering the right atrium
    iii. the width of the atrium
    iv. the width of the ventricle.

19. Observe the inside of the right side of the heart; touch and prod various parts to help you see what is there. Both you and your partner discuss what you can see. **[Gloves off]** Your partner writes down the observations on Worksheet E.

    Make sure your observations include:
    - the colour of the tissue
    - where you can see valves or tendons
    - where you can see vessels connected.

    Decide if it is easier to draw your observations or write them down, or use a combination of both. Use Worksheet C to help you to identify the features you can see.

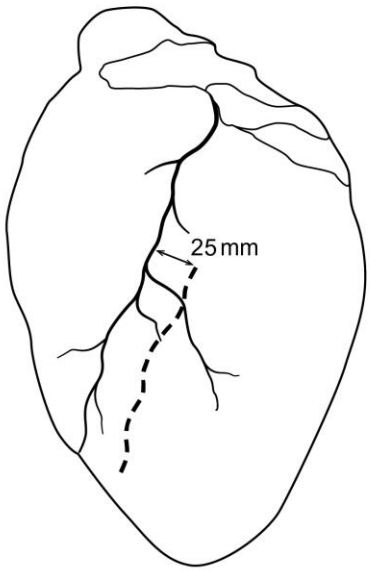
You have now finished dissecting the right side of the heart.

Swap roles with your partner so that someone different is doing the dissecting and someone else is doing the drawing and writing. If you were doing the dissecting before, make sure you remove your gloves and wash your hands thoroughly before you change roles. If you were the one drawing and writing before, make sure you put on gloves.

Dissecting the left side of the heart:

20. Identify the longest coronary artery, as you did earlier. Measure approximately 25 mm to the **right** of this.

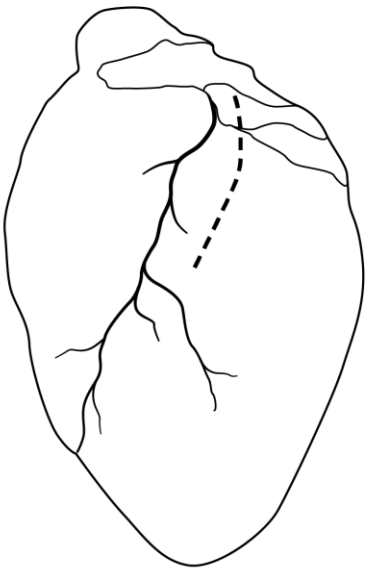
21. Using your scalpel, make a cut along the path of this artery until you are almost 25 mm from the apex of the heart. Try to keep about 25 mm to the right of the coronary artery throughout the cut. You might need to pinch open the cut you have made in order to cut deeper inside the heart.



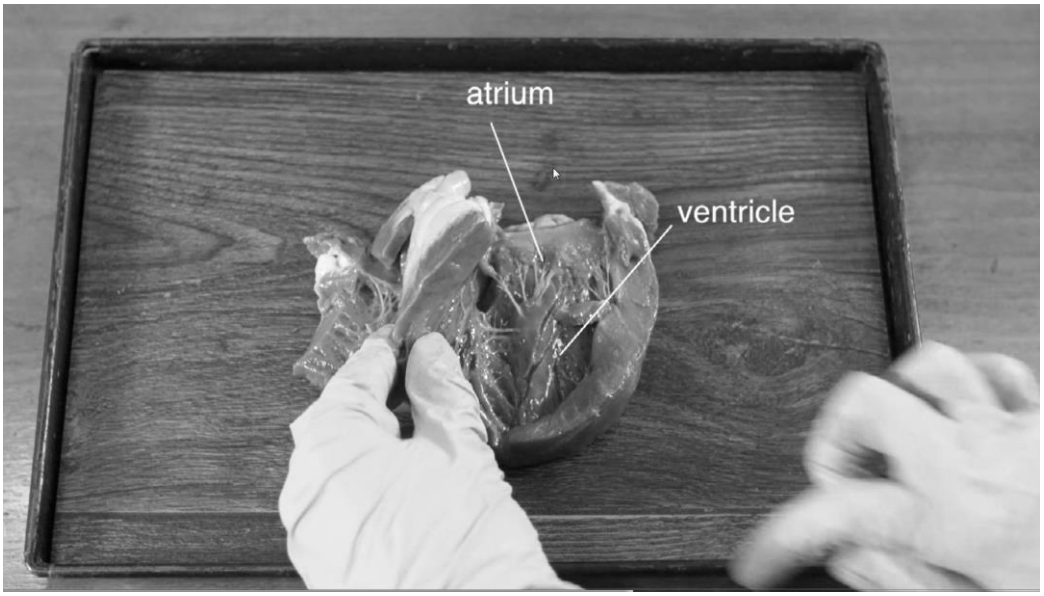
22. When you have cut through the tissue and can see the inside of the left ventricle, open the heart wider to better see inside (it will not open the all the way).

23. Look at the top of the heart and identify the blood vessel that would be the aorta; put your finger through the vessels to help you identify which one is the aorta (use Worksheet C to help). Ask your teacher if you are unsure.

24. Use the scalpel to make an incision from the aorta down to the incision in the left ventricle.



25. Yc a book.



26. Measure the following structures of the left side of the heart; read the measurements out. **[Gloves off]** Your partner records the data on Worksheet E.

Measure the:

i. thickness of the ventricle wall

ii. the diameter of the blood vessel entering the left atrium

iii. the width of the atrium

the width of the ventricle. 27. Observe the inside of the left side of the heart; touch and prod various parts to help you see what is there. Both you and your partner discuss what you can see.

[Gloves off] Your partner writes down the observations on Worksheet E.

Make sure your observations include:

- the colour of the tissue
- where you can see valves or tendons
- where you can see vessels connected.

Decide if it is easier to draw your observations or write them down, or use a combination of both. Use Worksheet C to help you to identify the features you can see.

You have now finished dissecting the left side of the heart and Worksheet E should now be complete.

IMPORTANT NOTES:

- Put the dirty scalpel and ruler into your dissection tray, with the heart.
- Give the dissection tray and dirty equipment back to your teacher.
- Use antiseptic spray to clean your tables.
- Remove your gloves and wash your hands thoroughly using soap under a running tap.

Worksheet E: Recording your data

Write your observations of the outside of the heart below.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Make an anatomical drawing of the outside of the heart below.

Width of heart (left to right) = …… Length of heart (top to apex) =…….

Length of longest coronary artery = ……..……..……..…..

Width of vessels = ……..……..……..……..

Write your observations of the right side of the heart below.

……

……

……

……

……

……

……

……

……

……

……

Thickness of ventricle wall = ……

Diameter of blood vessel entering atrium = ……

Width of the atrium = ……

Width of ventricle = ……

Make an anatomical drawing of the right side of the heart below.

Other measurements:

Write your observations of the left side of the heart below.

……

……

……

……

……

……

……

……

……

……

……

Thickness of ventricle wall = ……..

Diameter of blood vessel entering atrium = ……..

Width of the atrium = ……..…

Width of ventricle = ……..……..……

Make an anatomical drawing of the left side of the heart below.

Other measurements:

Worksheet F: Making observations

Write your observations of the outside of the heart below.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Make an anatomical drawing of the outside of the heart below.

Write your observations of the left side of the heart below.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Make an anatomical drawing of the left side of the heart below.

Write your observations of the right side of the heart below.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

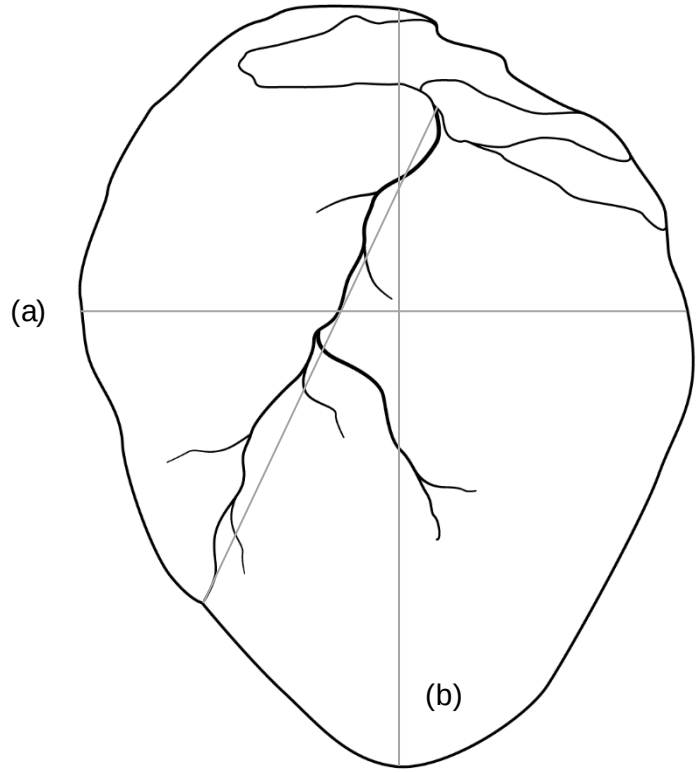
……

……

Make an anatomical drawing of the right side of the heart below.

Worksheet G: Making measurements

Front-facing view of the heart



1. Measure the image above to fill in the data below. Grey lines have been added as a guide for where to measure.

   (a) Length of widest part of heart = ……

   (b) Length of longest part of heart =……

   Length of longest coronary artery = ……

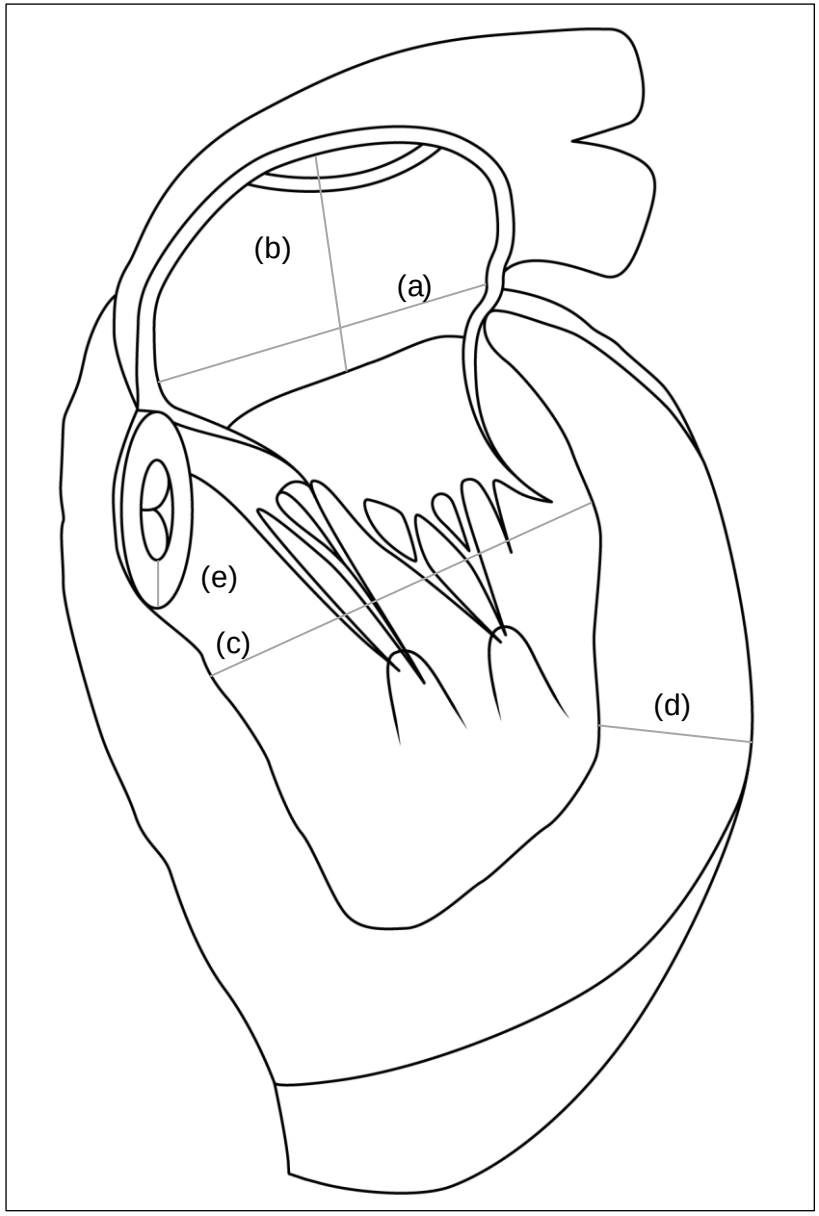
   Why is the length of the longest artery only an estimate and not an exact measurement?

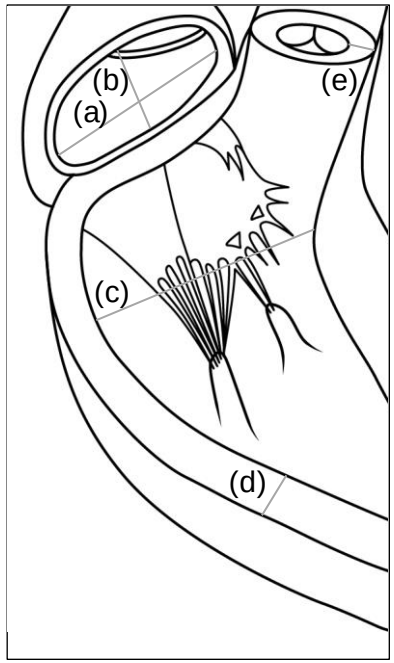
   ……

   ……

   ……

The images show the heart after dissection. The left and right sides have been opened out.





2. Complete the table by measuring the images above. Grey lines have been added as a guide for where to measure.

Measurement / mm	Image A	Image B
Width of atrium (a)		
Length of atrium (b)		
Width of ventricle (c)		
Thickness of ventricle wall (d)		
Thickness of vessel wall in ventricle (e)		

3. Based on your measurements of the thickness of the ventricle wall (d) and the vessel walls (e), identify which image is the left side of the heart and which is the right side of the heart.

   Left side of the heart is image ……

   Right side of the heart is image ……

Explain your answer using your knowledge of the heart and the data you gathered above.

……

……

……

……

……

……

……

……

……

……

……

……

……

Worksheet H: Interpreting data

1. Why was the widest part of the outside of the heart measured?

……

……

……

2. Suggest the function of the coronary arteries. What would happen if they got blocked?

……

……

……

3. Use your observations to explain how it is possible to identify:

aorta ……

……

……

pulmonary artery ……

……

……

pulmonary vein ……

……

……

vena cava ……

……

……

4. Write down the thickness of the muscular wall of the right and left ventricle in the table below.

Thickness of the right ventricle (mm)	Thickness of the left ventricle (mm)

(a) What do you notice about the thickness of each wall? Can you explain this?

……

……

……

……

……

……

(b) Suggest why there might be differences in the measurements from other individuals.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

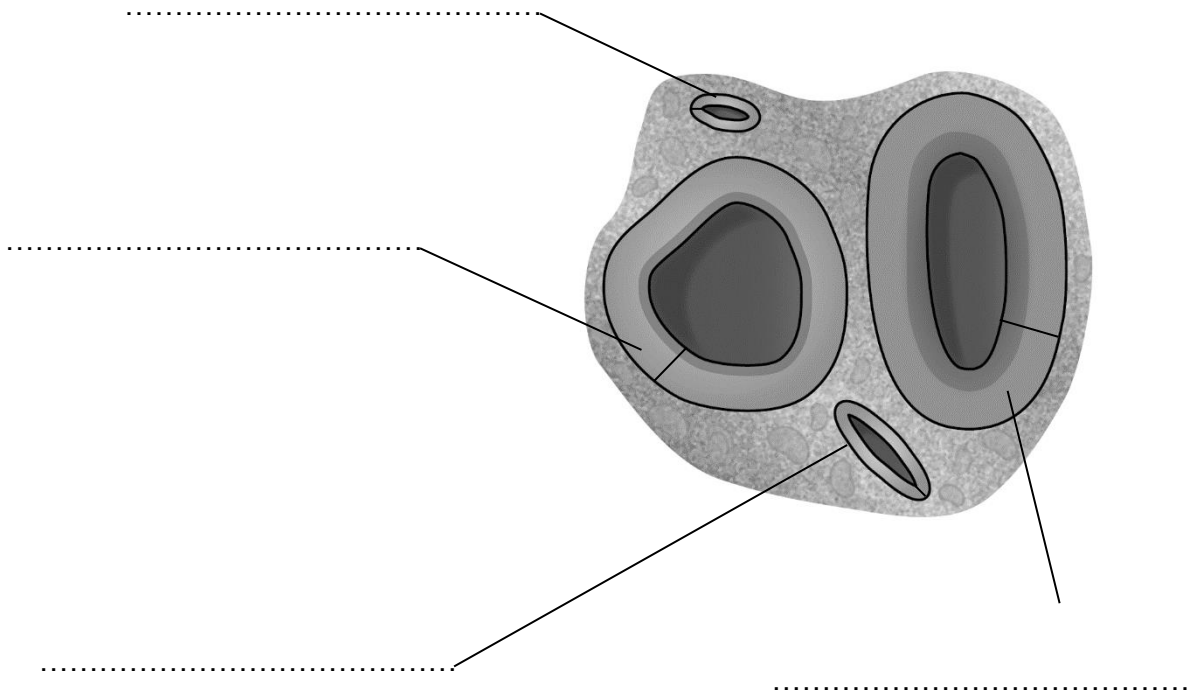
……

Worksheet I: Identifying blood vessels

Label each vessel in the diagram below.

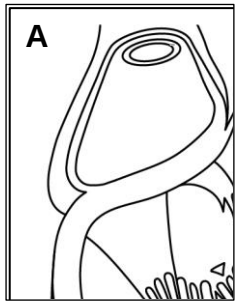
Write a description of each vessel using your observations and measurements.

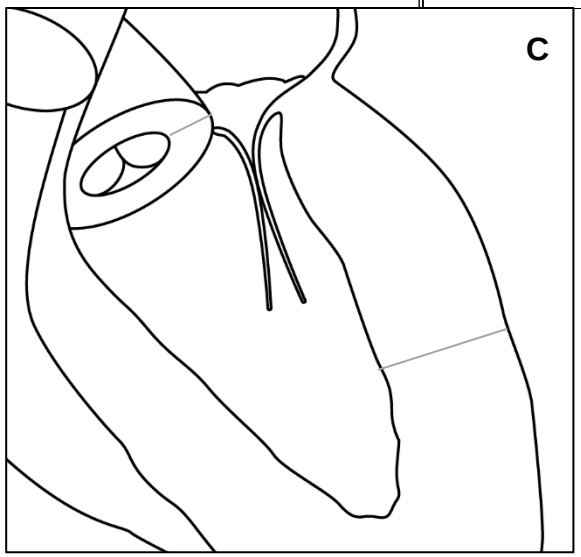
Black lines have been added across the vessel walls as a guide for where to measure.

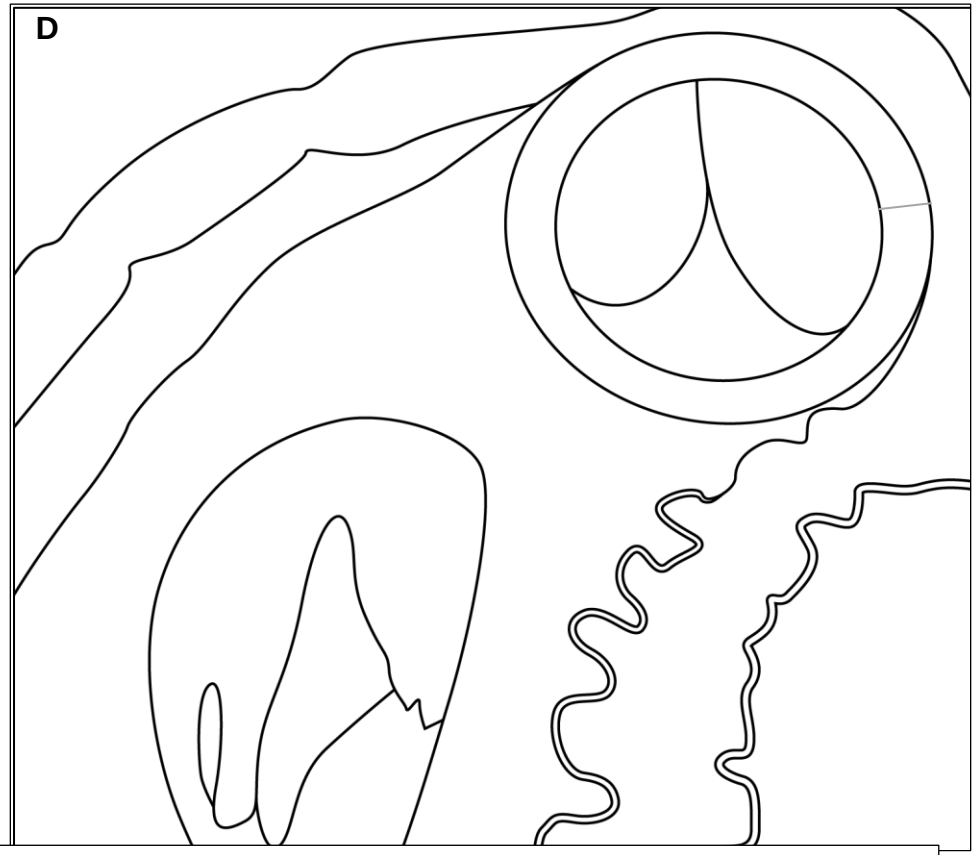


Aorta:
Pulmonary vein:
Pulmonary artery:
Vena cava:

Worksheet J: Interpreting images







By measuring some of the key features of each image, and using your observations, you should be able to identify the part of the heart shown. Grey lines have been added as a guide for where to measure.

Image of the heart to identify	What does the image show? (Remember to include data and observations)	Challenge: What is the function of this part of the heart and how is it adapted to do this?
A		
B		
C		
D		

Worksheet K: Evaluating the heart dissection

The aim of the heart dissection was to make anatomical observations and measurements to identify regions of the heart.

1. Describe what went well in this experiment to help you achieve this aim.

……

……

……

……

……

……

2. Describe what didn't go well in this experiment in relation to the aim.

……

……

……

……

……

……

3. Make three suggestions of how you could improve the method so that you could complete the aim more effectively or more accurately.

……

……

……

……

……

……

……

……

……

4. In the heart dissection, the main focus was observing the left and right sides of the heart. Make a suggestion of two other parts of the heart you would like to investigate further:

……

……

……

……

5. Using Worksheet D to help you, adapt the method so that you could include the other parts of the heart that you would wish to investigate. Remember, your focus is on observations and measurements.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Worksheet A: Suggested answers

1. Why is it a good idea to calculate the mean?
   By calculating a mean, you can eliminate any large or small numbers that could distort the results.

2. Hypothesise what will happen to your resting heart rate if you started to exercise.
   Resting heart rate will increase.

3. Explain your answer to question 2 using your knowledge of the heart.
   Heart rate will increase to supply blood to the tissues / cells that will be respiring at an increased rate.

4. Decide upon your chosen activity and record your heart rate for 1 minute.
   Learners' own results.

5. Review your data and decide whether your hypothesis was correct. Use your data to explain how you have come to this conclusion.
   Learners' own results. (Heart rate increases.)

6. Compare your results with other people in the group. Describe any similarities or differences in the data.
   Learners' own results. There might be a slight difference in the resting heart rate. Most people will have a resting heart rate of between 60 and 80 bpm.

7. Why do you think that there might be these differences in data between individuals?
   Learners' own results. Ideas should include different size, sex, age, fitness.

Worksheet B: Suggested answers

1. Learners' own tables. An example might be:

	Test 1	Test 2	Test 3	Mean
Number of beats per minute (bpm)				

2. Why is it beneficial to calculate a mean?
To eliminate anomalies.

3. Use your knowledge of the heart to hypothesise what will happen to your resting heart rate if you started to exercise.
Increase in heart rate. During exercise the tissues / cells respire more and so an increased supply of oxygen via the blood is required.

4. Design a method to record your average heart rate after 1 minute of strenuous exercise.
Learners' own suggestions. Suggestions might include: Record the beats per minute. Rest until heart rate has returned to normal. Then repeat exercise and record heart rate. Do this 3 times so that a mean can be calculated.

5. Learners' own tables. An example might be:

	Heart rate / bpm			
	Test 1	Test 2	Test 3	Mean
Type of exercise				

6. Review your data and decide whether your hypothesis was correct. Use your data to explain how you have come to this conclusion.
Learners' own results. (Heart rate increases.)

7. Compare your results with other people in the group. Describe any similarities or differences in the data.
Learners' own results. There might be a slight difference in the resting heart rate. Most people will have a resting heart rate of between 60 and 80 bpm.

8. Why do you think that there might be these differences in data between individuals?
Learners' own results. Different size, sex, age, fitness.

Worksheet G: Suggested answers

1. Length of widest part = 85 mm; length of longest part of heart = 100 mm; length of longest coronary artery: ~72 mm. This is an estimate as the artery is not a straight line.

Measurement / mm	Image A	Image B
Width of atrium (a)	45	25
Length of atrium (b)	29	11
Width of ventricle (c)	55	31
Thickness of ventricle wall (d)	20	6
Thickness of vessel wall in ventricle (e)	6	3

2. Image B is the right side of the heart. Image A is the left side of the heart. The left side has a thicker ventricle wall as it has to pump oxygenated blood around the whole body whereas the right side pumps deoxygenated blood to the lungs. The left side must be thicker to generate enough force to be pumped from the head to the toes. The vessel in Image A has a much thicker wall than the vessel in Image B, suggesting this might be the aorta.

Worksheet H: Suggested answers

1. Why was the widest part of the outside of the heart measured?

   The widest part was measured so that it could be accurately compared with other hearts that are also measured at the widest part. Helps to give an idea of overall size of the heart.

2. Suggest the function of the coronary arteries. What would happen if they got blocked?

   The coronary arteries supply the cardiac muscle of the heart with oxygen; the heart needs its own supply of oxygen because it works very hard continuously. If a coronary artery gets blocked, then the part of the heart it leads to will not get oxygen and the heart won't be able to function properly, causing a heart attack.

3. Use your observations to explain how it is possible to identify:

   Aorta: This is the largest blood vessel with the thickest walls. It leads out from the left atrium.

   Pulmonary artery: This is the second largest blood vessel of the heart and also has thick walls. It is not as thick or large as the aorta. It leads out from the right atrium.

   Pulmonary vein: This is a thin-walled vessel that leads into the left atrium.

   Vena cava: This is a thin-walled vessel that leads into the right atrium.

4. Possible measurements might be:

Thickness of the right ventricle / mm	Thickness of the left ventricle / mm
Approx. 4 mm	Approx.13 mm

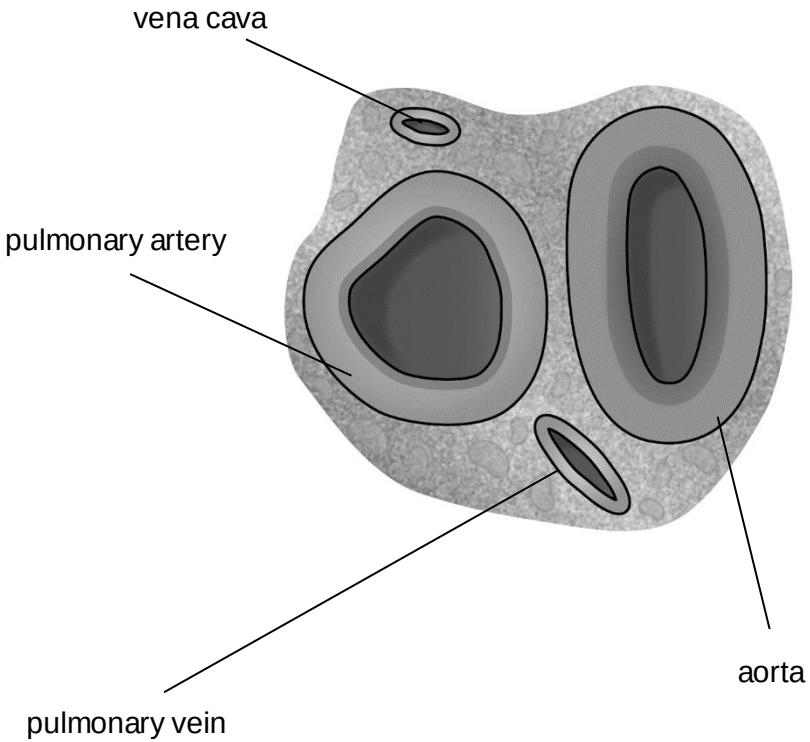
(a) The thickness of the left ventricle is much greater than the right, about 3 times thicker. The right side of the heart fills with deoxygenated blood before pumping this to the lungs to be oxygenated. The left side has to pump oxygenated blood around the whole body. The left side therefore has to be thicker to generate enough force to do this.

(b) There might be slight differences in the thickness of the ventricle wall from heart to heart due to differences in sex, age and fitness of the animal the heart was taken from.

Worksheet I: Suggested answers

Label each vessel in the diagram below.

Write a description of each vessel using your observations and measurements.



Aorta: wall thickness is 8 mm; the largest blood vessel with a large lumen. It has thick vessel walls which contain darker areas.
Pulmonary vein: wall thickness is 2 mm; the diameter of the vessel is much smaller than the arteries. The lumen is also relatively small.
Pulmonary artery: wall thickness is 6 mm; a thicker walled vessel than the veins but not as thick as the aorta. The walls also contain darker areas.
Vena cava: thickness is 1.5 mm; in comparison with the other blood vessels this is the smallest. It has thinner walls than the arteries and has a narrow lumen.

Worksheet J: Suggested answers

Image	What does the image show? Remember to include data and observations.	Challenge: What is the function of this part of the heart and how is it adapted to do this?
A	This is the right atrium, observations and measurements might include: Chamber is small, which suggests it's an atrium. Blood vessel leading in has a thinner wall (1 mm) compared to other diagram. Thinner vessel suggests it's a vein. The edge of the heart is on the left and the blood vessels go in towards the right, so this must be the right atrium.	The right ventricle collects blood from the vena cava. When the right atria contract, this causes blood to flow through the one-way valves into the ventricle. The valves have tendons / heartstrings to prevent the backflow of blood into the atria. The pulmonary artery is thicker than the vena cava to carry the blood to the lungs to be oxygenated. This is thicker to cope with the higher pressure in the ventricle.
B	This is the right ventricle, observations and measurements might include: It's large, suggesting it's a ventricle. Wall thickness = 5 mm, suggesting it is the right ventricle. Thickness of vessel wall is 1 mm, suggesting it's a vein and confirming it's the right ventricle.	The right ventricle collects the deoxygenated blood. It has a relatively large diameter size to collect blood. The septum separates the left and right side of the heart so that the oxygenated and deoxygenated blood is kept apart. The valves prevent the backflow of blood into the atria.
C	This is the left ventricle, observations and measurements might include: Large chamber, which suggests it's a ventricle. Thickness of ventricle wall: 17.9 mm Vessel has the thick wall (6 mm). This suggests it's the aorta. Presence of aorta and thick ventricle wall means that this is the left ventricle.	The ventricle is large and has a thick muscular wall to generate high pressures so that oxygenated blood can be transported around the body.
D	This is the aorta, observations and measurements might include: The vessel has a very thick wall (6.5 mm) and one-way valves; it's on the left side of a ventricle, so it must be the aorta.	The aorta must be thick to withstand the high pressure generated by the ventricle. The valves can shut to prevent the backflow of oxygenated blood into the ventricles.

Worksheet K: Suggested answers

1. Describe what went well in this experiment to help you achieve this aim.

   Possible suggestions include:
   - the method was followed closely;
   - the different components of the heart (atria / ventricles / coronary artery) were successfully identified; the aorta was successfully identified;
   - anatomical drawings were accurate and observations were detailed.

2. Describe what didn't go so well in this experiment in relation to the aim.

   Possible suggestions include:
   - it might have been difficult to identify the blood vessels or the atria as they were removed by the butcher / supplier;
   - the heart might have been damaged making identification of the coronary artery difficult;
   - the valves may have been removed making identification of the atria / ventricle difficult.

3. Make three suggestions of how you could improve the method so that you could complete the aim more effectively or more accurately.

   Possible suggestions include:
   - could collect results from multiple people in order to calculate a mean of the thickness of the heart walls and arteries to ensure the results are accurate;
   - drawings could be clearer or more detailed;
   - could also use magnifying glasses to investigate the detail of the heart to make observations more accurate.

4. In the heart dissection, the main focus was observing the left and right sides of the heart. Make a suggestion of two other parts of the heart you would like to investigate further.

   Possible suggestions include:
   - could investigate the blood vessels, such as aorta and pulmonary artery, in more detail to see if size of the aperture (hold) varies;
   - could investigate the septum and record the size in multiple samples; could also record the mass or size of the heart and compare this;
   - the front of the heart might be covered in lots of fatty tissue, so could investigate whether the fatty hearts are generally larger or smaller to investigate the effectiveness of the heart.

5. Using Worksheet D to help you, adapt the method so that you could include the other parts of the heart that you would wish to investigate. Remember, your focus is on observations and measurements.

   Possible suggestions that could be added into the method are:
   - recording the diameter of the blood vessels; the thickness of the blood vessel walls; and recording in a table to compare the size and thickness of the walls.
   - dissecting the heart to expose the septum and measure its thickness; this could be compared in different hearts to compare mass / fat deposits and the thickness of the heart to see if there is a relationship.
   - measuring the mass of the heart before dissecting and compare with others.
   - before dissecting the heart, recording the percentage coverage of the heart with fatty deposits.

Cambridge Assessment International Education
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
t: +44 1223 553554 f: +44 1223 553558
e: info@cambridgeinternational.org www.cambridgeinternational.org