BUILD YOUR OWN HEART AND CIRCULATION SIMULATOR

YOUR TASK
You will be given a set of components and asked to build a working heart and circulation simulator. You will then use the simulator to help deliver a 10 minute presentation to the rest of your group on the working of the human circulatory system, things that can go wrong with it and how these conditions might be treated.

YOUR COMPONENTS
The components you will be given are:

- 2 diesel priming tools
- Approximately 3 metres of 8mm bore PVC tubing
- Approximately 3 centimetres of red rubber Bunsen burner tubing
- 1 long modelling balloon
- 1 solid rubber bung with bottom diameter 8 mm
- A selection of tubing connectors to comprise minimum 3 straight, 6 ‘T’ shape, 3 ‘Y’ shape
- 1 Hoffman clip
- 10 or more 12 mm tool clips or slightly smaller if you can find them
- Small screws for use with tool clips
- 1 thin MDF backing board to measure approximately 1 m by 0.5 m with a hole cut in it
- 1 or more large sheets of paper – enough to cover the MDF board

You will also require the following:

- A plastic washing up bowl
- Gloves
- Plastic jug and funnel
- A few drops of red food colouring and a plastic pipette
- A screw driver to fit the tool clip screws
- A bradawl to help fit the screws
- 2 retort stands with clamps and bosses
- A roll of electrical tape
WHAT YOU NEED TO DO

You should have everything you need to construct a basic model of the human circulatory system. The steps below will help you to put it all together.

1. The idea is that you will create a backing picture for your heart and circulation simulator on the large sheets of paper you have been given. This picture will then be fixed to the MDF backing board. The hole in the backing board is there so that someone can stand behind the simulator and work the ‘heart’ with their hands. You will therefore need to make sure that there is a hole in your paper in the correct place.

2. Take a look at the diagram of the circulatory system on Resource Sheet 8.1 – The Human Heart and Circulatory System. This will help you to lay out the tubing that will simulate the arteries and veins. It is suggested that you lightly sketch out where the tubes will go before you cut them to size.

3. The simulated heart is built from two diesel priming tools, which are simple pumps. One of these will represent the left atrium and left ventricle, the other will represent the right atrium and right ventricle. Remember that humans have a double circulation, so make sure that you connect the priming tools correctly. A photograph of a completed simulator is given at the end of this resource sheet for reference.

4. You can add a simple device to your simulator which will demonstrate a pulse. To do this, cut one of the arteries and insert the device shown in diagram 1. The section of modelling balloon provides a thin, flexible wall through which you can feel the pressure wave produced during systole. The sections of Bunsen tubing should be pushed over the ends of the modelling balloon to make sure that it is fixed on tight to the straight connectors.

5. You can also add a blood pressure demonstrator to your simulator. This is just a length of clear tubing (about 40 cm should do) attached to your simulator and held upright so that the top of tubing reaches at least 20 cm above the top of the highest blood vessel in your simulator. When you fill your simulator with ‘blood’ you will need to make sure that the level of blood reaches no higher than about 20 cm from the top of this tube. The tube needs to be plugged very securely at the end with either a rubber bung or a tight fitting plastic rod. The level of ‘blood’ in this tube should rise and fall as the ‘heart’ contracts and relaxes.
6. The basic simulator does not directly simulate the presence of capillaries, arterioles, venules or the organs themselves. If you have time you might want to think about how you could do this and perhaps try some of your ideas.

7. Create a backing picture to create a good visualisation of the heart and circulation system. When this is complete, fix it to the backing board and then screw the tool clips into position, ready to hold your simulator. It is possible that tool clips may be slightly large for the tubing you have used. If this is the case, wrap a couple of turns of electrical tape around the tubing at the point where it is to be held by tool clip to increase its diameter.

8. You can fill your simulator with blood in two ways. Firstly, you can use a small funnel and jug to fill it with water through the blood pressure demonstrator. This should be done a little at a time and the ‘heart’ should be pumped intermittently to get rid of air bubbles. The other method involves totally submerging the assembled tubing in a washing up bowl of water, again, pumping the ‘heart’ to get rid of air bubbles. Once you have filled your simulator with water, add a few drops of red food colouring and then make sure that the top of the blood pressure demonstrator is securely closed. Wipe everything down so that it is dry and then fix it to the backing board with the tool clips.

**SOME THINGS TO TRY WITH YOUR SIMULATOR**

- Try to make the ‘heart’ beat at about 70 beats per minute and see how long you can keep this up for.
- Feel the pulse on the pulse demonstrator. The balloon section will allow you to feel the pressure wave moving through the simulated artery, but is this a truly accurate representation of what a pulse really is?
- Cause a blockage in one of your arteries by tightening a Hoffman clamp onto it. What effect does this have on blood pressure and the work you have to do to pump the heart?
- Remove the pulse demonstrator and top up the blood pressure demonstrator so there is no air space left. Make sure that all air bubbles are removed from your simulator. Now try to work the heart. Try to explain what happens and why this does not happen in a real circulatory system.

A heart and circulation kit under construction. Note that the pulse demonstrator is fitted on an artery. Also note that, in this model, the lungs have been placed above the heart and the right ventricle and right atrium have been inverted to make the pipe work less complicated.
YOUR PRESENTATION

Your presentation should last no more than 10 minutes and should clearly explain the following:

- The mammalian double circulation system
- Why heart muscle is able to work without fatigue
- The names of the major blood vessels and the organs or parts of the body that they serve
- The passage of oxygenated and deoxygenated blood
- Diastolic and systolic pressure
- The effect of atherosclerosis and other diseases of the heart and circulatory system
- The role of healthcare professionals in caring for patients with diseases of the heart and circulatory system

You may also want to comment on your findings from the ‘things to try’ section above.