

E Electrocardiograms (ECGs)

It is relatively easy to detect and record the waves of excitation flowing through heart muscle. Electrodes can be placed on the skin over opposite sides of the heart, and the electrical potentials generated recorded with time. The result, which is essentially a graph of voltage against time, is an **electrocardiogram (ECG)** (Figure 9.10).

The part labelled P represents the wave of excitation sweeping over the atrial walls. The parts labelled Q, R and S represent the wave of excitation in the ventricle walls. The T section indicates the recovery of the ventricle walls.

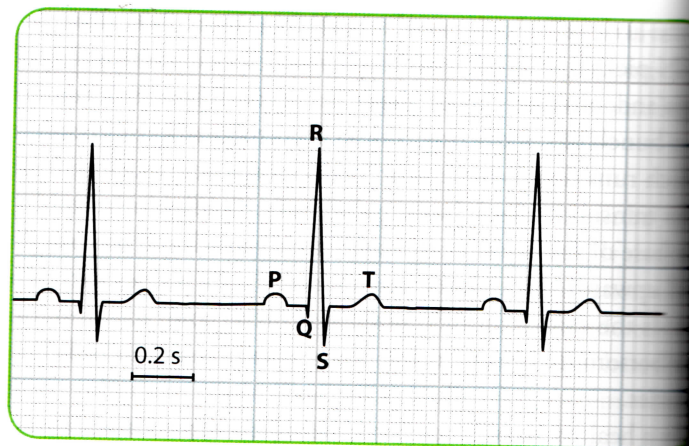


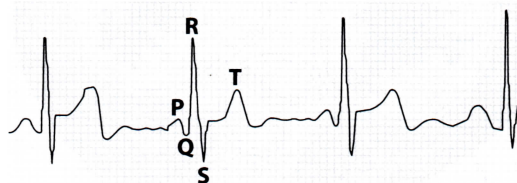
Figure 9.10 A normal ECG.

End-of-chapter questions

- Where is the mammalian heart beat initiated?
 - atrioventricular node
 - left atrium
 - Purkyne tissue
 - sinoatrial node
- What causes the bicuspid valve to close during ventricular systole?
 - a greater blood pressure in the left atrium than in the left ventricle
 - a greater blood pressure in the left ventricle than in the left atrium
 - contraction of muscles in the septum
 - contraction of muscles in the valve
- Figure 9.8 on page 168 shows the pressure changes in the left atrium, left ventricle and aorta throughout two cardiac cycles. Make a copy of this diagram.
 - How long does one heart beat (one cardiac cycle) last?
 - What is the heart rate represented on this graph, in beats per minute?
 - The contraction of muscles in the ventricle wall causes the pressure inside the ventricle to rise. When the muscles relax, the pressure drops again. On your copy of the diagram, mark the following periods:
 - the time when the ventricle is contracting (ventricular systole)
 - the time when the ventricle is relaxing (ventricular diastole).
 - The contraction of muscles in the wall of the atrium raises the pressure inside it. This pressure is also raised when blood flows into the atrium from the veins, while the atrial walls are relaxed. On your copy of the diagram, mark the following periods:
 - the time when the atrium is contracting (atrial systole)
 - the time when the atrium is relaxing (atrial diastole).

- d The atrioventricular valves open when the pressure of the blood in the atria is greater than that in the ventricles. They snap shut when the pressure of the blood in the ventricles is greater than that in the atria. On your diagram, mark the point at which these valves will open and close.
- e The opening and closing of the semilunar valves in the aorta depends in a similar way on the relative pressures in the aorta and ventricles. On your diagram, mark the point at which these valves will open and close.
- f The right ventricle has much less muscle in its walls than the left ventricle, and only develops about one-quarter of the pressure developed on the left side of the heart. On your diagram, draw a line to represent the probable pressure inside the right ventricle over the 1.3 seconds shown.

4 The diagram shows a normal ECG. The paper on which the ECG was recorded was running at a speed of 25 mm s^{-1} .

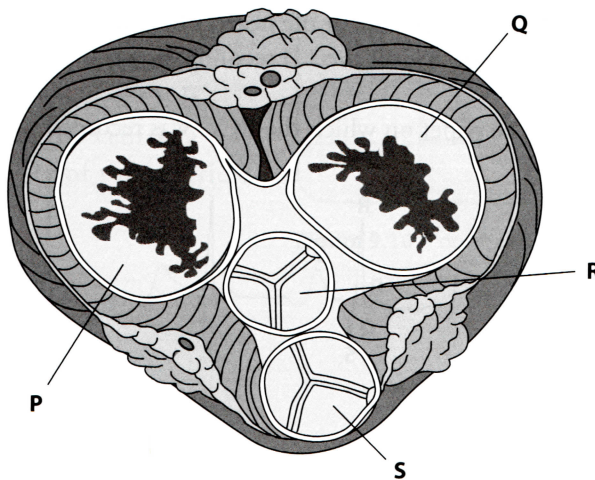


- a Calculate the heart rate in beats per minute.
- b The time interval between Q and T is called the **contraction time**.
 - i Suggest why it is given this name.
 - ii Calculate the contraction time from this ECG.
- c The time interval between T and Q is called the **filling time**.
 - i Suggest why it is given this name.
 - ii Calculate the filling time from this ECG.
- d An adult male recorded his ECG at different heart rates. The contraction time and filling time were calculated from the ECGs. The results are shown in the table.

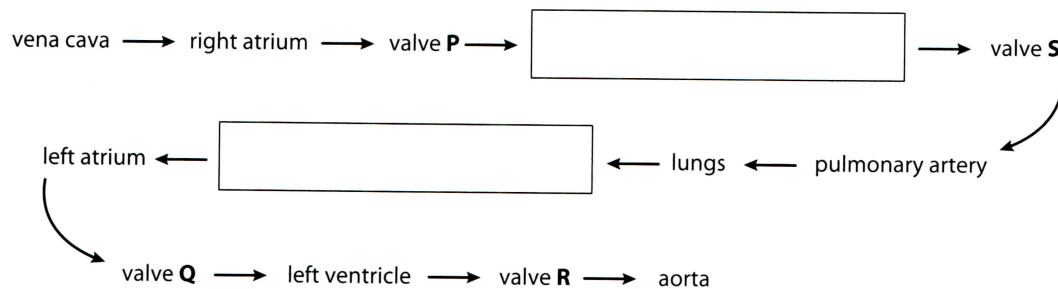
Heart rate/ beats per minute	Contraction time/s	Filling time/s
39.5	0.37	1.14
48.4	0.39	0.82
56.6	0.39	0.66
58.0	0.38	0.60
60.0	0.38	0.57
63.8	0.40	0.54
68.2	0.42	0.45
69.8	0.38	0.46
73.2	0.38	0.44
75.0	0.38	0.39
78.9	0.38	0.36
81.1	0.39	0.33
85.7	0.37	0.32
88.2	0.39	0.30

- i Suggest how the man could have increased his heart rate for the purposes of the experiment.
- ii Present these results as a line graph, drawing both curves on the same pair of axes.
- iii Comment on these results.

5 The figure below shows a cross-section of the heart at the level of the valves.

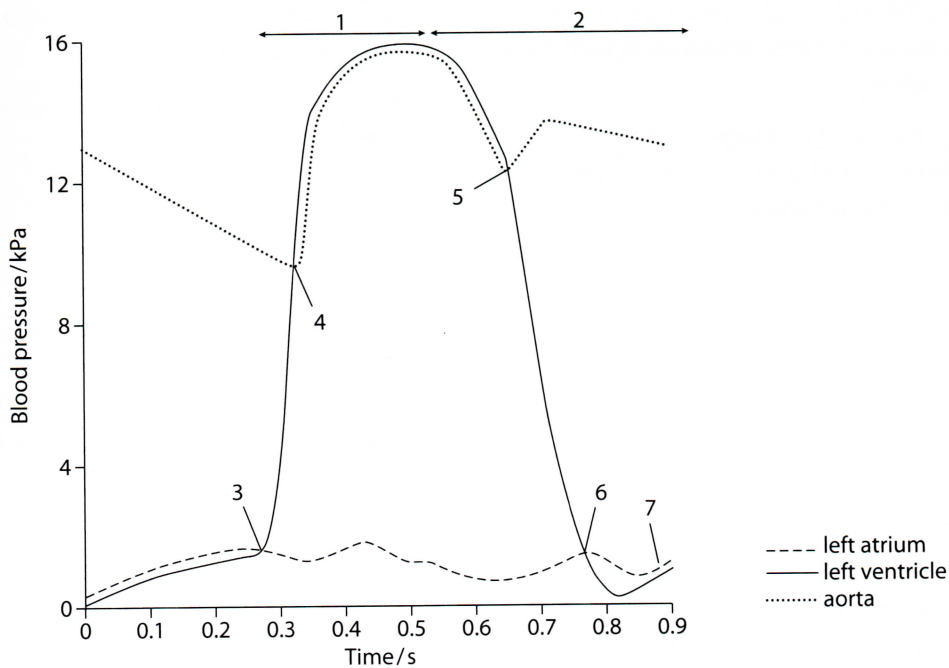


a i Copy and complete the following flow chart to show the pathway of blood through the heart.



ii Explain how the valves P and Q ensure one-way flow of blood through the heart.

The cardiac cycle describes the events that occur during one heart beat. The following figure shows the changes in blood pressure that occur within the left atrium, left ventricle and aorta during one heart beat.



- b Copy and complete the table below. Match up each event during the cardiac cycle with an appropriate number from 1 to 7 on the figure. You should put only one number in each box. You may use each number once, more than once or not at all.

The first answer has been completed for you.

Event during the cardiac cycle	Number
atrioventricular (bicuspid) valve opens	6
ventricular systole	
semilunar (aortic) valve closes	
left ventricle and left atrium both relaxing	
semilunar (aortic) valve opens	

[4]

- c Explain the roles of the sinoatrial node (SAN), atrioventricular node (AVN) and the Purkyne tissue during one heart beat.

[5]

[Total: 13]

[Cambridge International AS and A Level Biology 9700 Paper 21, Question 3, May/June 2010]