



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Cardiovascular System

Based on Chapters 7 & 8,
Sturgeon (2018)

Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives



www.uwtsd.ac.uk

Cardiovascular System

- Kardia- heart (Greek)
- Vasculum – small vessel (Latin)
- The heart and blood vessels form a closed system that allows blood to transport gases between the lungs and the tissues.
- Split into pulmonary circulation and systemic circulation.

Blood Vessels

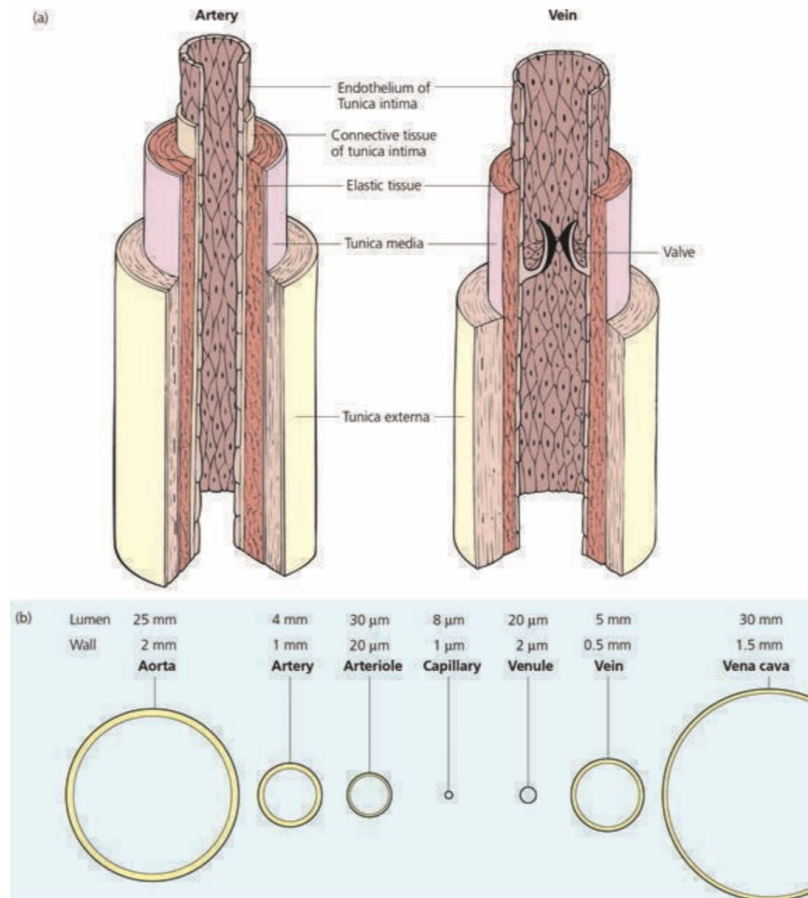


Figure 7.2 (a) Structure of blood vessels. (b) Variations in the thickness of blood vessel walls.

Capillary Beds

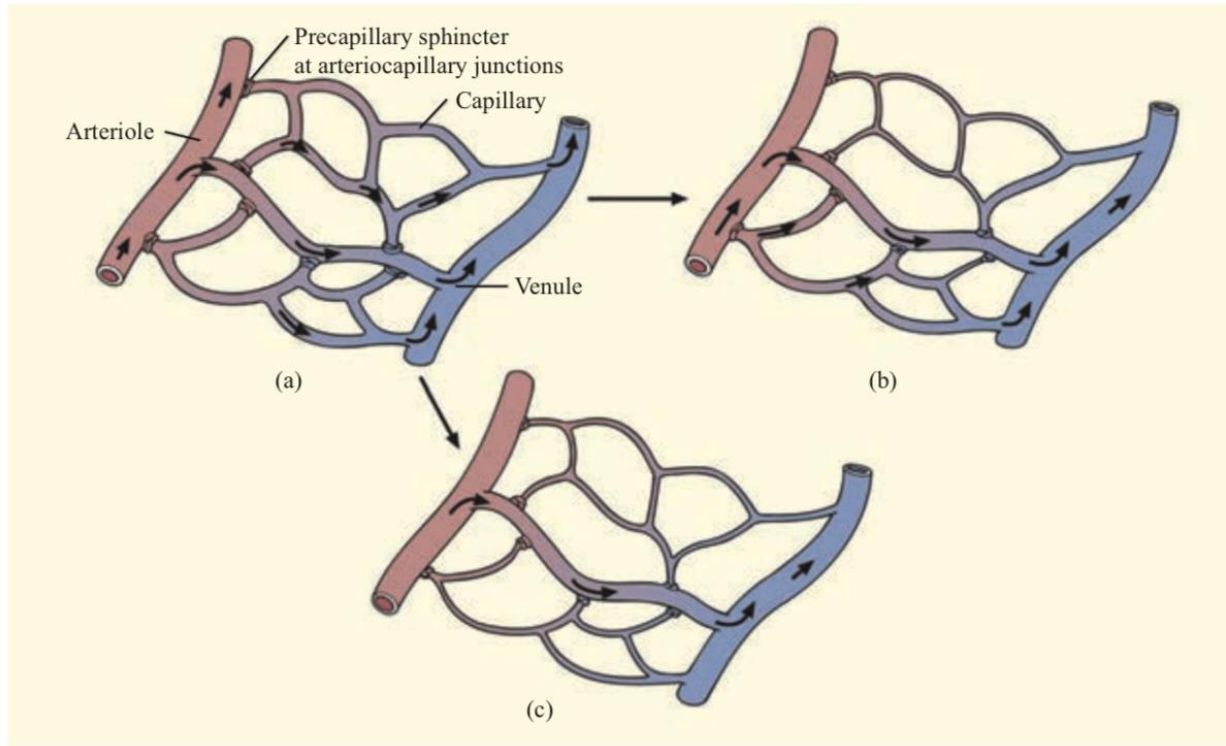


Figure 7.3 (a) Structure of the capillary bed with two possible alterations in the pattern of flow (b) and (c).

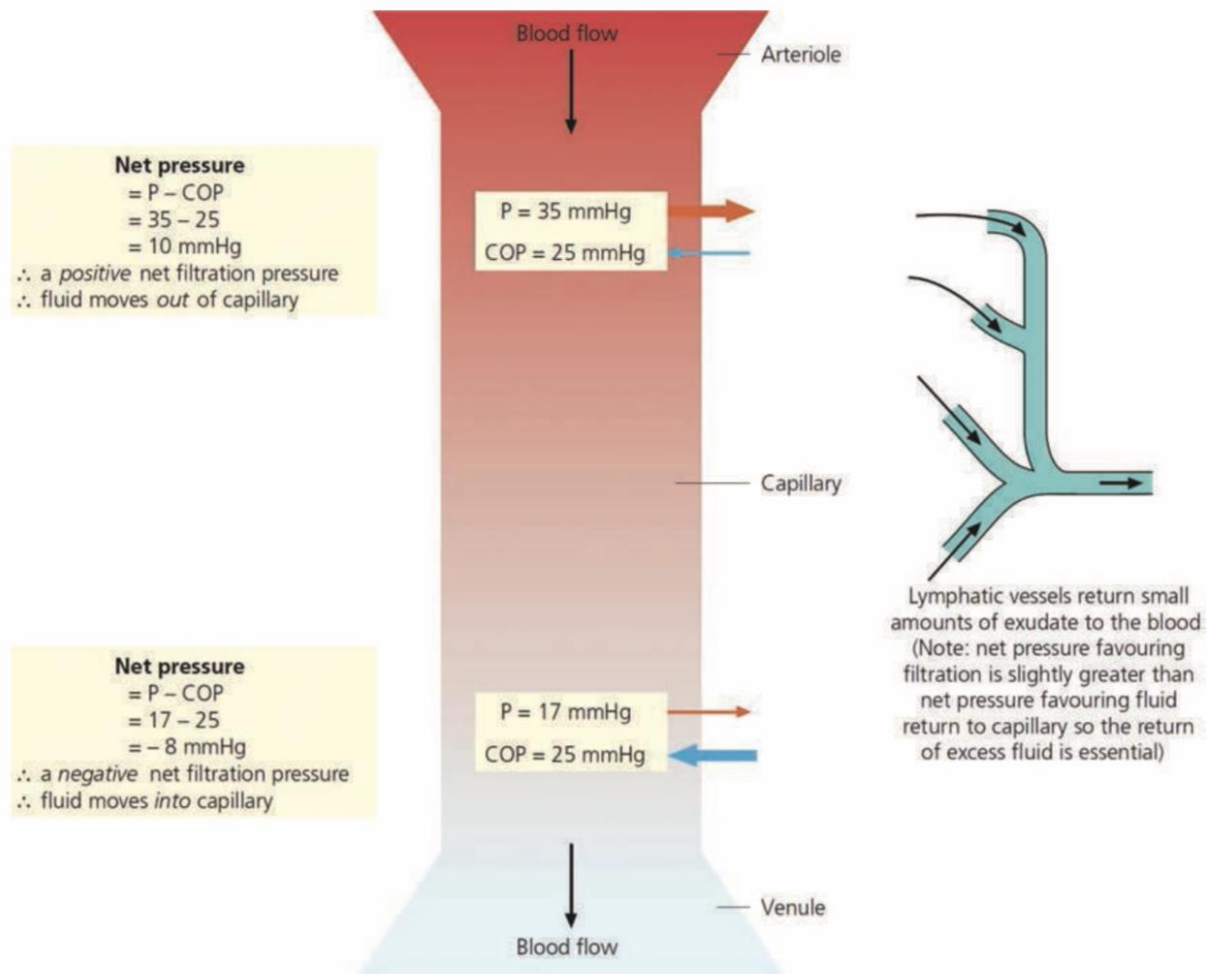


Figure 7.4 Fluid exchange between plasma and interstitial fluid across the capillary wall (P = fluid/hydrostatic pressure, COP = colloid osmotic pressure).

The Heart

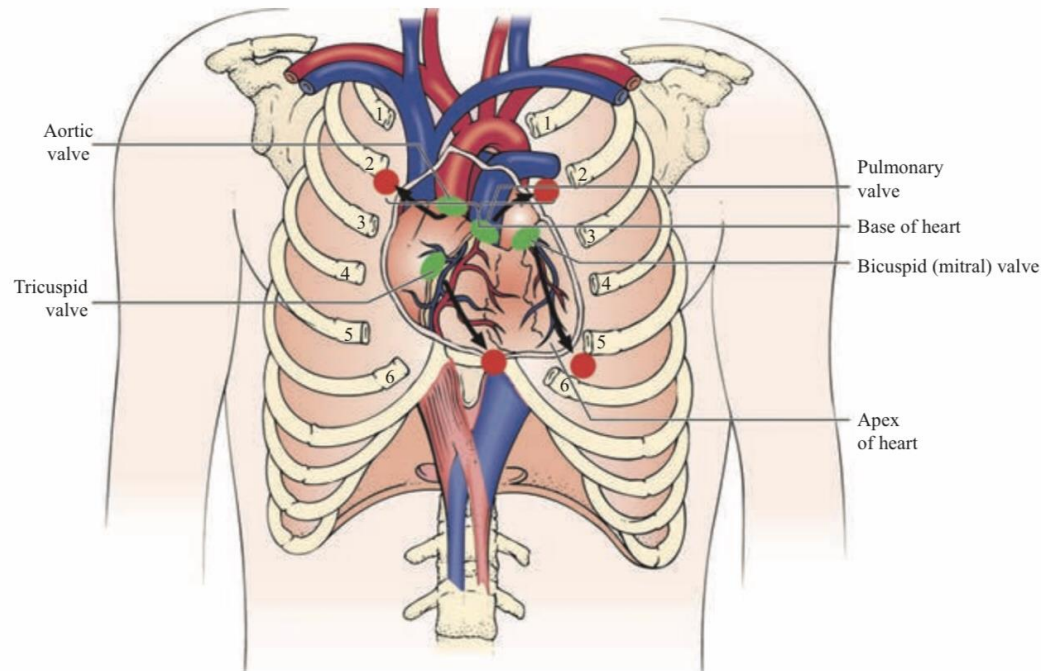


Figure 7.5 Location of the heart, heart valves (green spots) and auscultation sites for heart sounds (red spots) within the mediastinum.

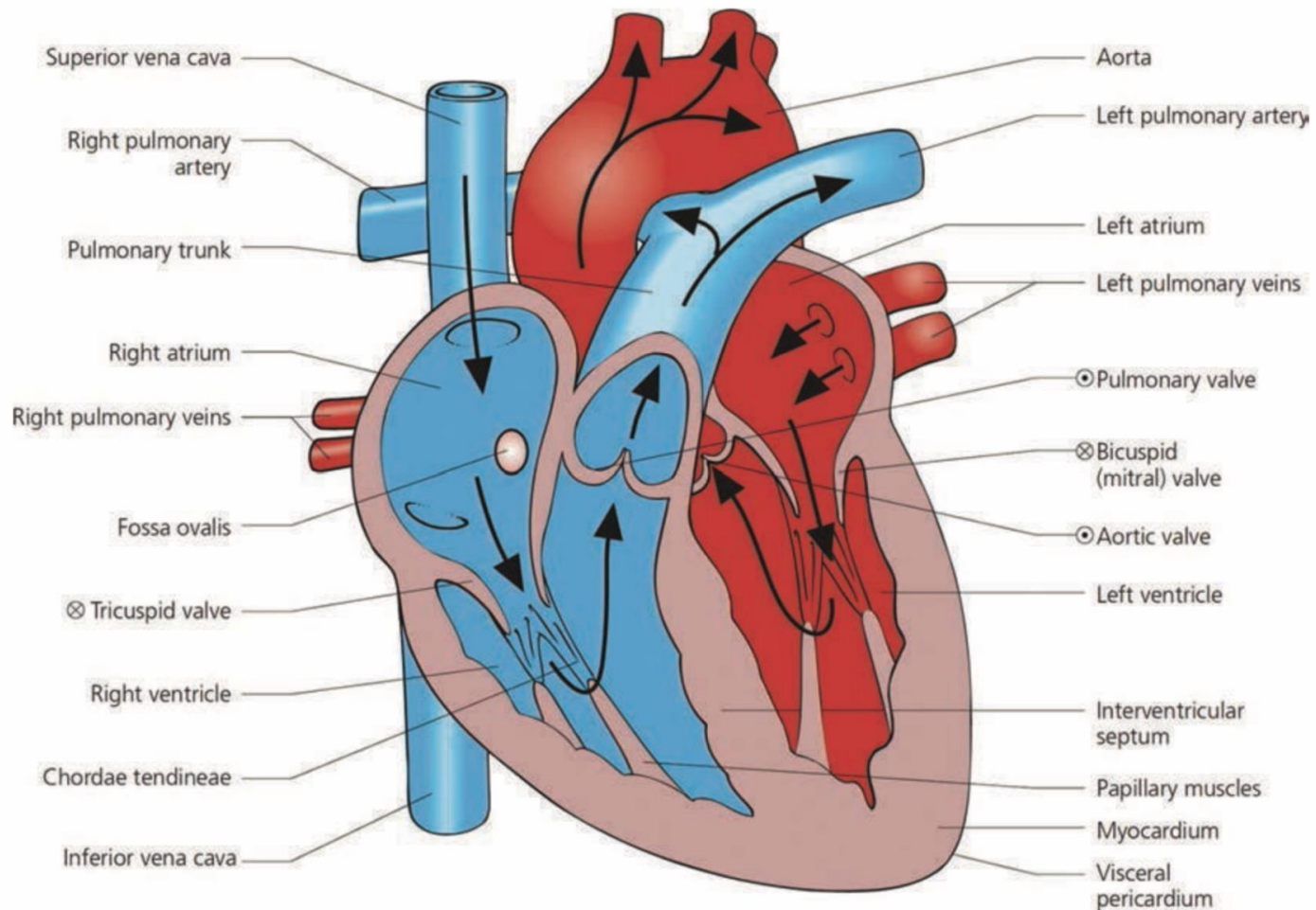
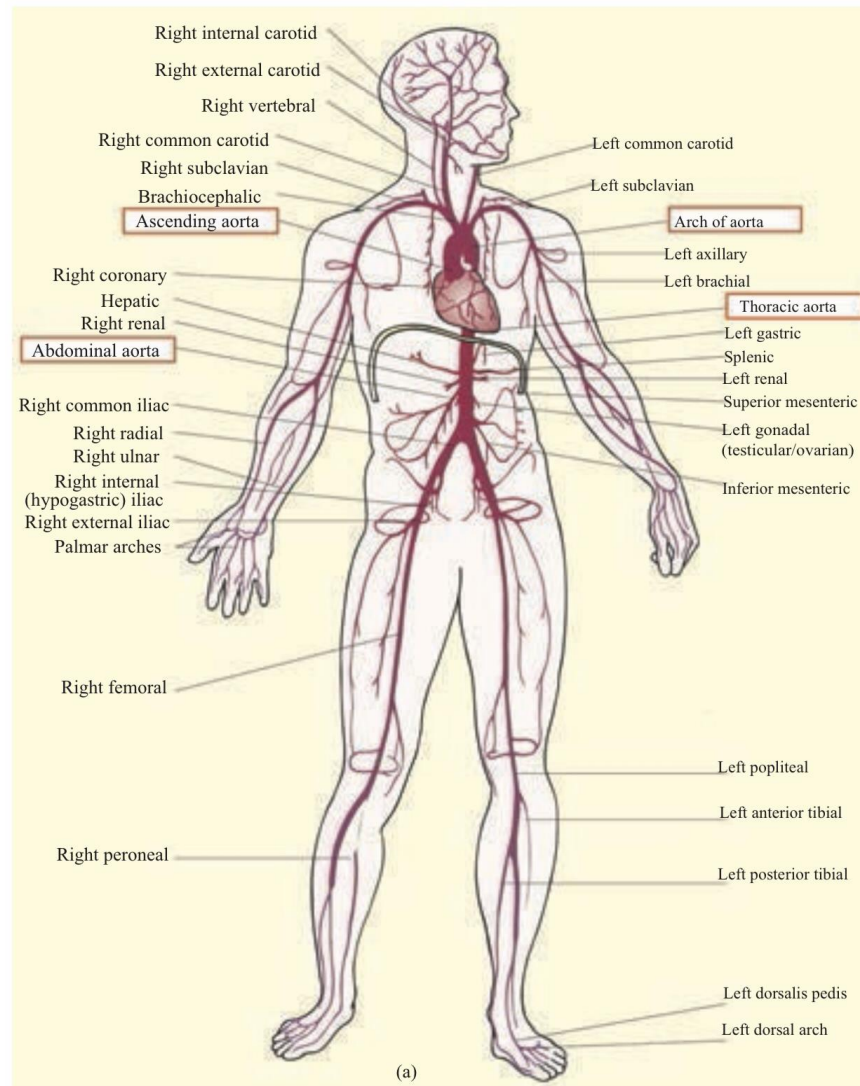
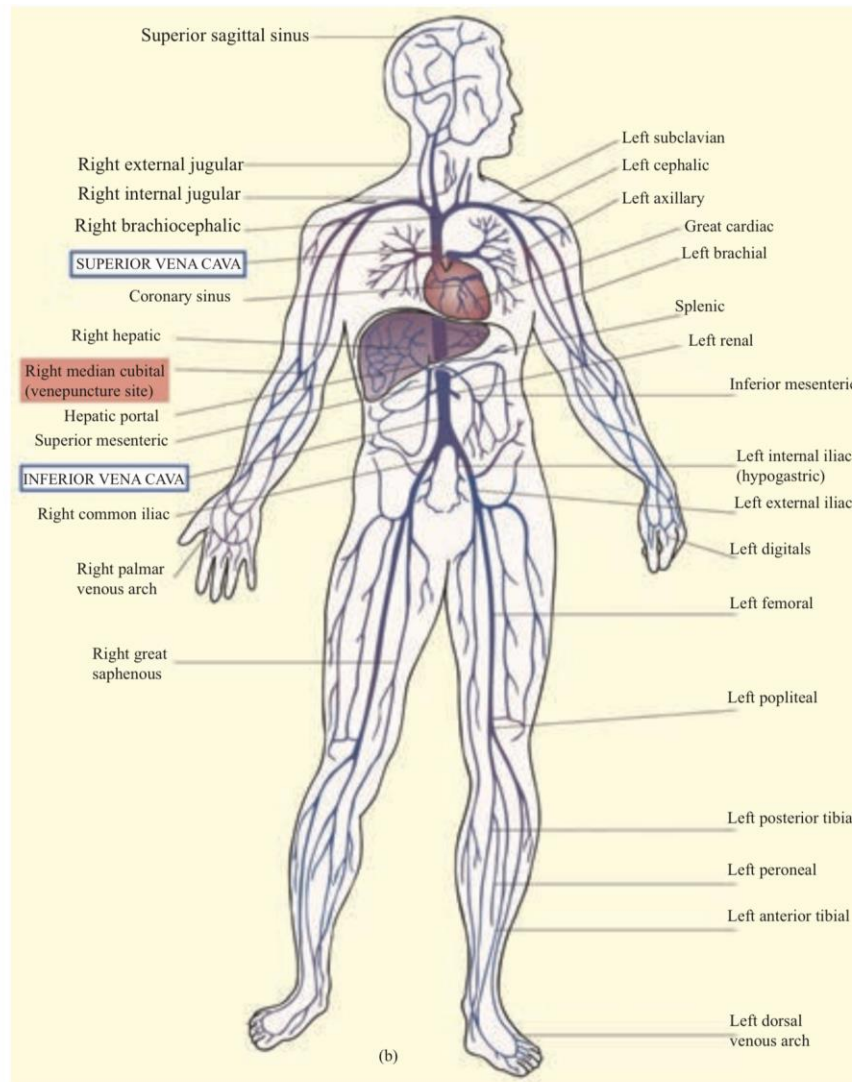


Figure 7.6 Chambers, blood vessels and valves of the heart.

TABLE 7.1 Twelve main structures of the heart

	Blood vessel	Chamber	Valve
1	vena cava (into)	R atrium	tricuspid
2	pulmonary artery (out of)	R ventricle	pulmonary semilunar valve
3	pulmonary vein (into)	L atrium	bicuspid
4	aorta (out of)	L ventricle	aortic semilunar valve





Cardiac Output

- $\dot{Q} = SV \times HR$
- $\dot{Q}$ - Cardiac Output – total amount of blood ejected from LV in one minute
- SV – Stroke Volume – amount of blood ejected from LV in one heartbeat
- HR – Heart Rate – number of heartbeats per minute

Does exercising mean your heart does more work in a day??

- Resting HR 75 bpm, no daily exercise :
 - $75 \times 60 \times 24 = 108,000$
- Endurance trained – Resting HR 45 bpm, 1 hour exercise at 140 bpm:
 - $140 \times 60 = 8,400$
 - $45 \times 60 \times 24 = 64,800$
 - Total = 73,200

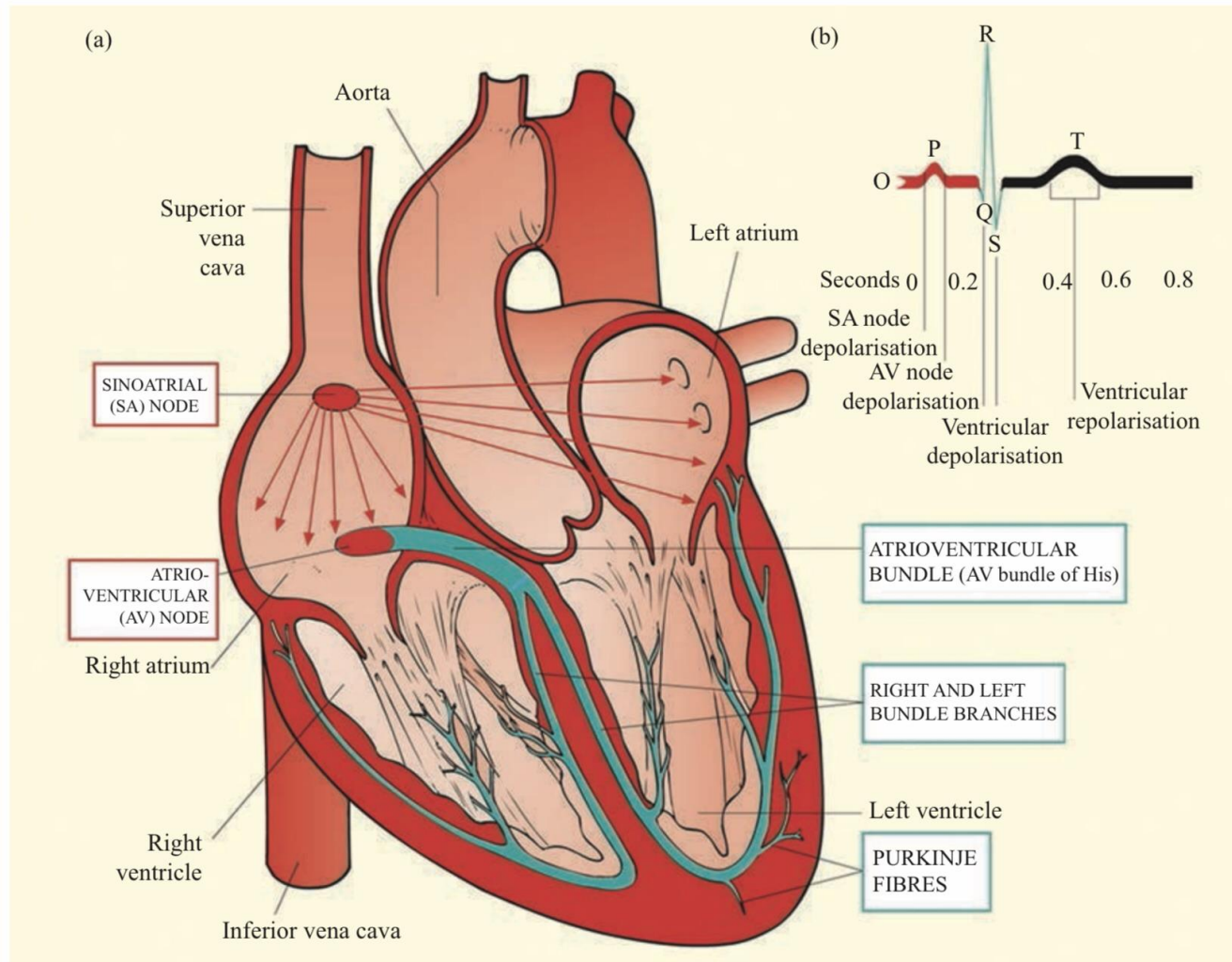


Figure 7.8 (a) Conduction system of the heart. (b) Normal electrocardiogram (ECG) of a single heartbeat.

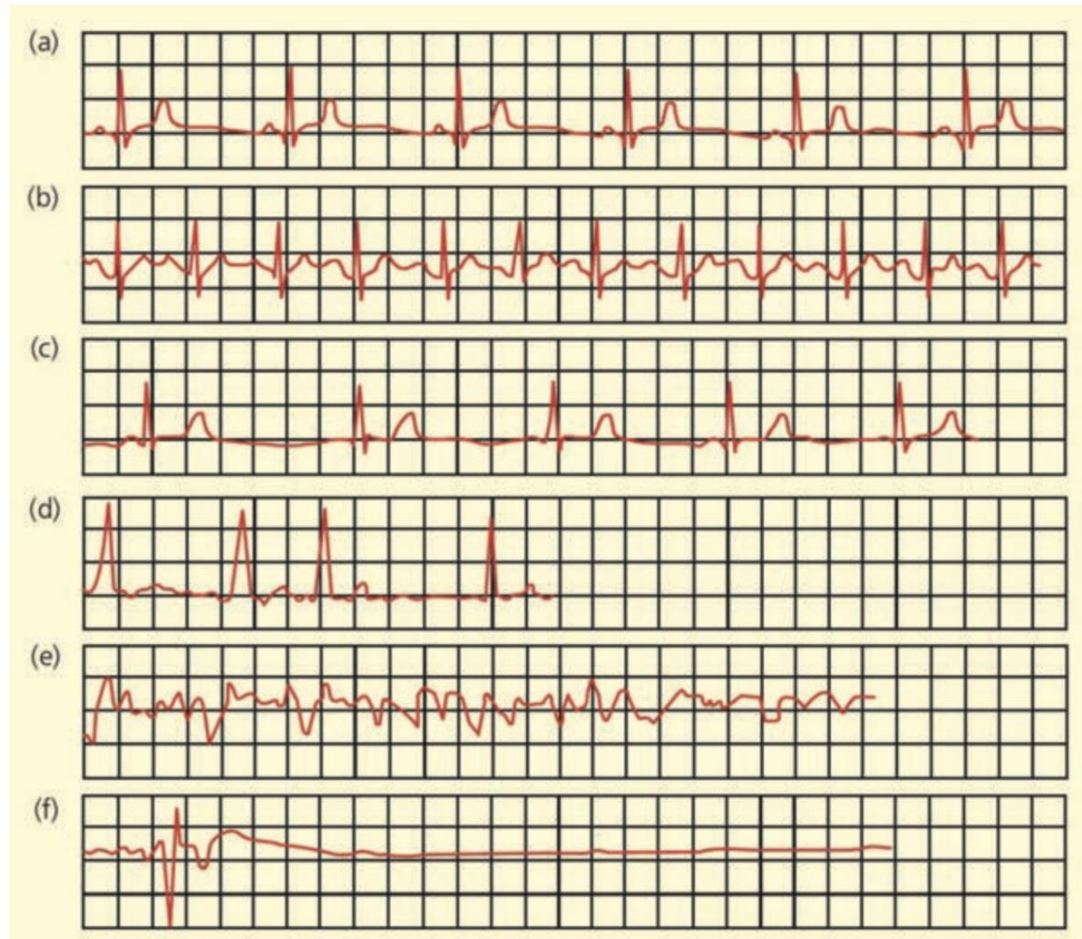


Figure 7.10 Cardiac arrhythmias. (a) Sinus rhythm. (b) Sinus tachycardia. (c) Sinus bradycardia. (d) Atrial fibrillation (AF). (e) Ventricular fibrillation (VF). (f) Asystole.

Autonomic Nervous System Control

- Sympathetic Nervous System – fight or flight – adrenaline is secreted by sympathetic nerves, increasing heart rate
- Parasympathetic Nervous System – rest and digest – vagus nerve secretes acetylcholine, decreasing heart rate.

Blood Pressure

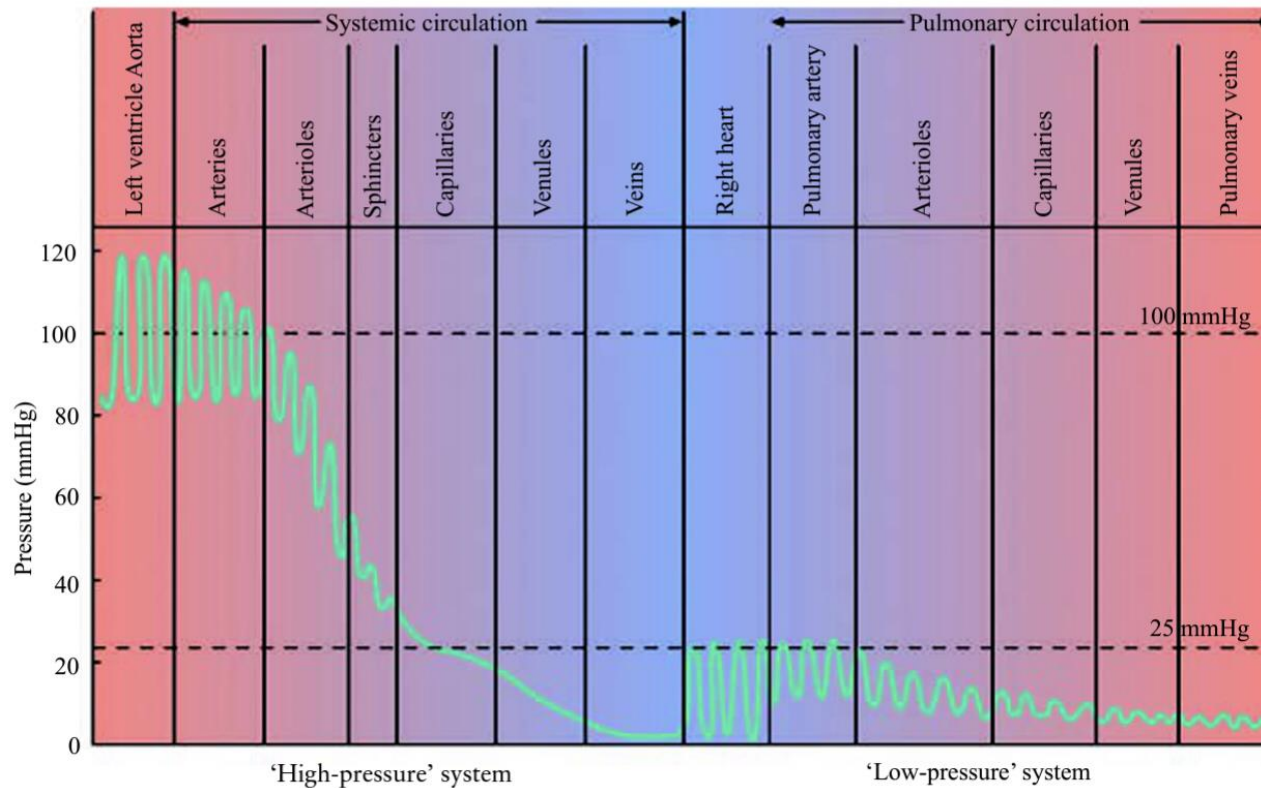


Figure 8.1 Blood pressure changes within the circulatory system.

Terms

- Systolic Pressure – highest pressure exerted on artery walls during systole (normally 120 mmHg)
- Diastolic Pressure – lowest pressure exerted on artery walls between pulses (normally 80 mmHg)
- Pulse Pressure – difference between systolic and diastolic – force of one heart beat (normally 40 mmHg (120-80))

Mean Arterial Pressure (MAP)

- Diastole lasts twice as long as systole, therefore:
 - $\text{MAP} = [(2 \times \text{diastolic}) + \text{systolic}] / 3$
 - E.G. for someone with 120/80
 - $\text{MAP} = [(2 \times 80) + 120] / 3$
 - $\text{MAP} = 93.3 \text{ mmHg}$
- Normal range is 70-110 mmHg

Venous Return

- Veins contain valves that prevent back-flow
- Muscle Pump squeezes veins, pushing blood back to heart
- Respiratory Pump – changes in intra-thoracic pressure by breathing 'pulls' blood back to heart.

Preload

- Starling's Law – the strength of the heart's systolic contraction is proportional to the diastolic expansion.
- i.e. the more blood that returns to the heart, the more the ventricles fill, and therefore the greater the Stroke Volume.
- Decrease in venous return = decrease in stroke volume.

Afterload

- Pressure that ventricle must produce in order to open the aortic semilunar valve
- Higher Diastolic BP = higher afterload = greater EDV = lower stroke volume

Ejection Fraction

- Proportion of blood in Ventricle that is ejected during a beat.
- 55%-70% is normal.

Regulation of Blood Pressure

- Blood Pressure is determined by Cardiac Output and Total Peripheral Resistance
- Change in Cardiac Output ($HR \times SV$) can change BP
- Change in TPR (e.g. vasoconstriction/vasodilation) can change BP
- Blockages (e.g. plaque) can increase BP.

- https://www.youtube.com/watch?v=X9ZZ6tcxArl&list=PL8dPuuaLjXtOAKed_MxxWBNaPno5h3Zs8&t=0s