Blood Vessels

There are 3 main blood vessels:

1. Arteries — take blood away from heart
2. Veins — take blood Into heart
3. Capillaries — Site of gas exchange with tissues

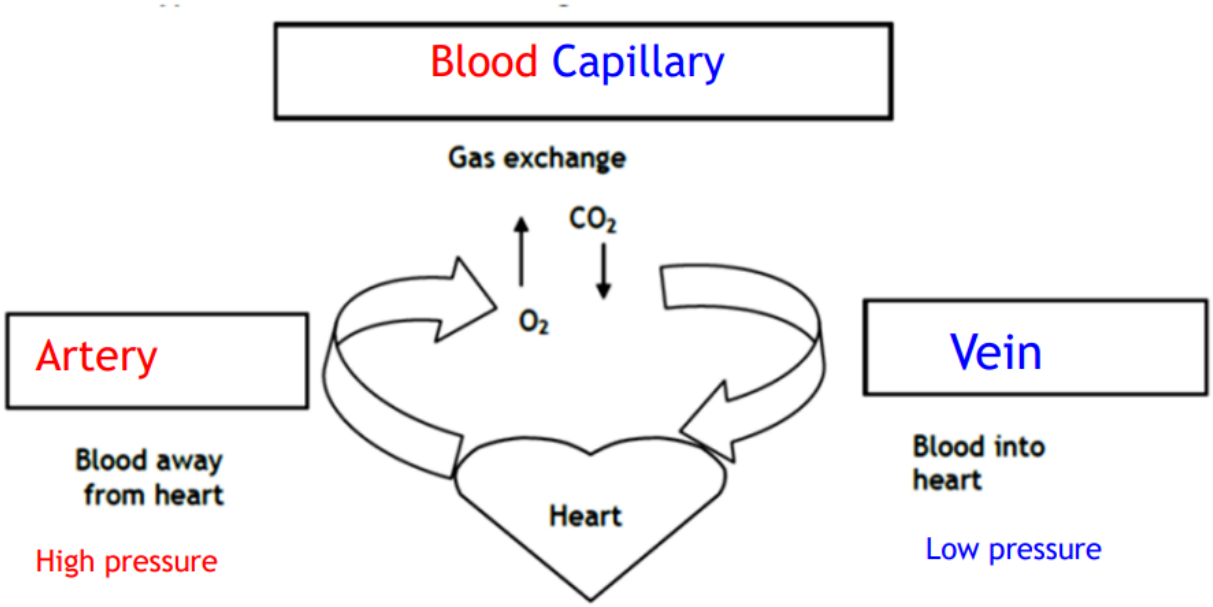
Direction of blood flow

Blood circulates from the heart through the arteries to the capillaries then to the veins and back to the heart.

arteries → capillaries → veins.

High pressure — Low pressure

There is a **decrease in blood pressure** as blood moves away from the heart.



Blood Vessel Structure

Arteries

A) Outer layer of connective tissue containing **elastic fibres**

B) Middle layer containing smooth muscle with **more elastic fibres.**

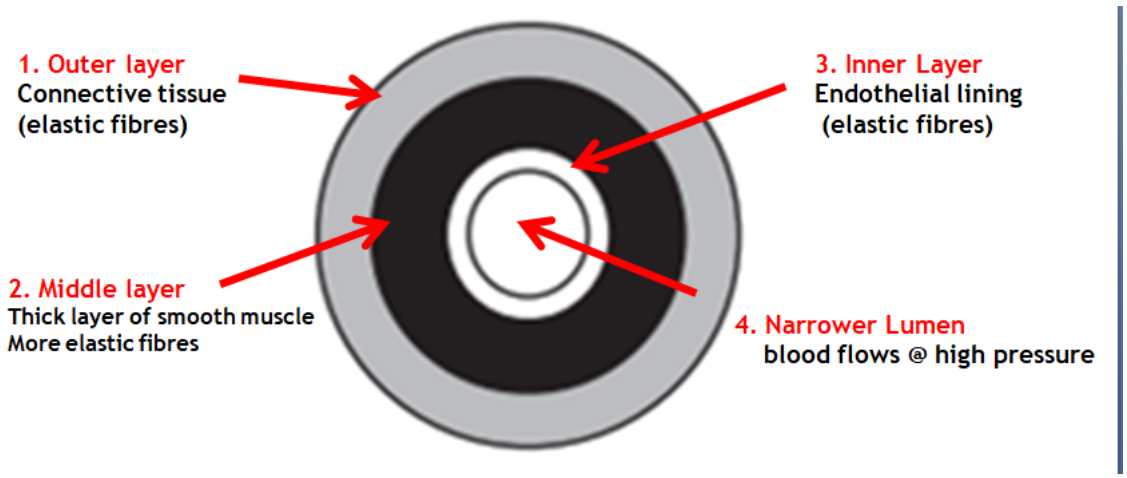
C) Inner endothelial lining

This can become damaged by chronically high blood glucose

high levels of blood cholesterol can cause atheromas to deposit under the lining.

D) Narrower central lumen due to thicker smooth muscle (increased pressure)

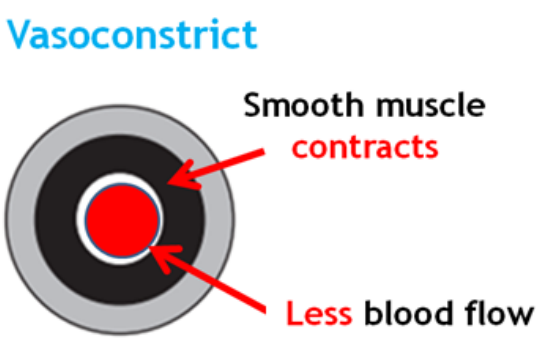
Elastic nature of artery walls
Accommodates the **stretching** r& recoil required when blood surges through from the heart.

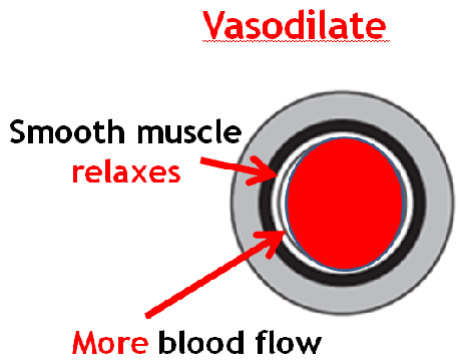


Smooth muscle of arteries cause

1. **Vasoconstriction**
   Smooth muscle contracts
   Lumen narrower
   Decreasedblood flow

2. **Vasodilation**
   Smooth muscle relaxes
   Lumen wider
   Increased blood flow





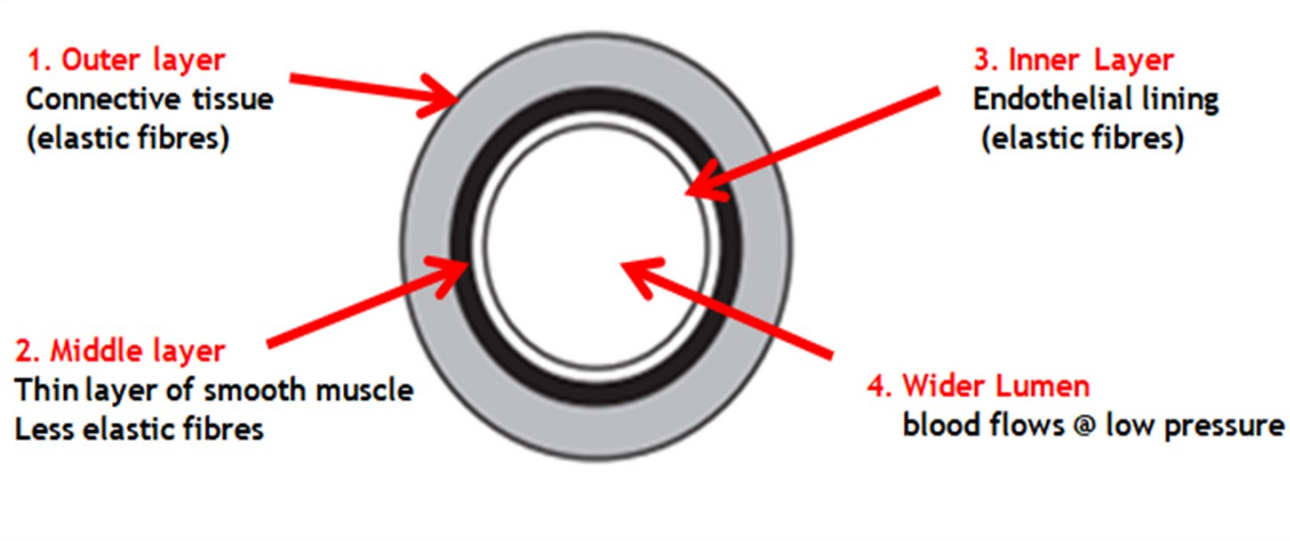
Blood Vessel Structure

2.Veins

Outer layer of connective tissue containing elastic fibres'.

Much **thinner smooth muscle** wall than arteries as blood flows at much lower pressure.

Valves prevents backflow of blood

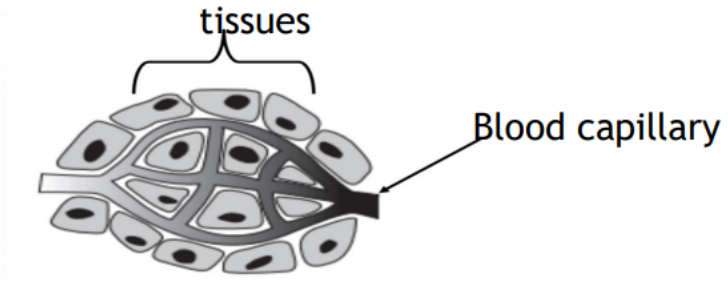


Blood Vessel Structure

Capillaries

Capillaries allow exchange of materials with tissues.

They are composed of epithelial cells that are one cell thick to allow easy diffusion of substances.



Tissue Fluid

Blood plasma enters the blood capillary from an artery containing **glucose, oxygen and plasma proteins.**

Pressure filtration

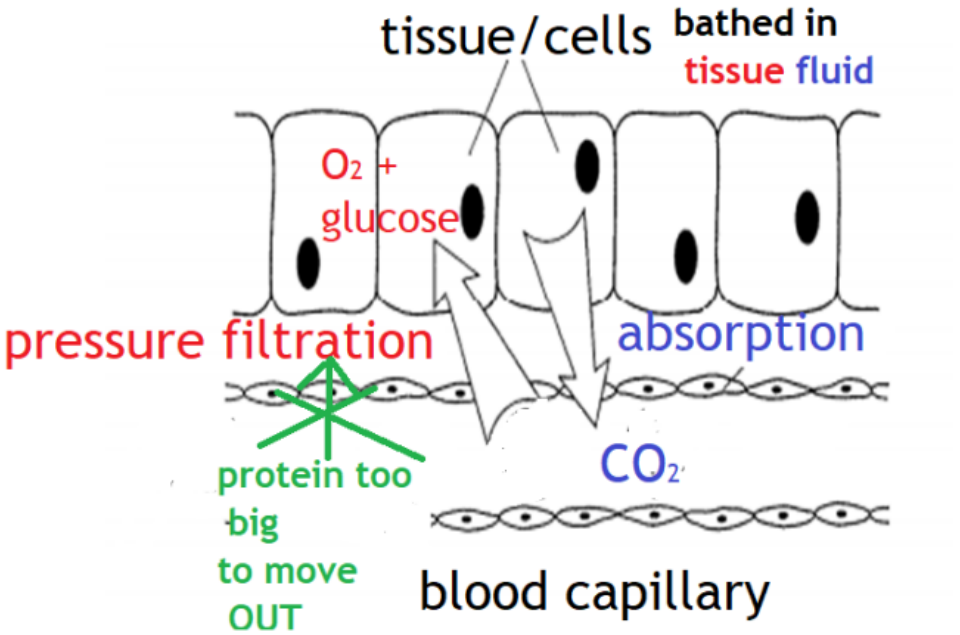
Blood plasma is **forced out** the blood capillary through the permeable walls of the blood capillary forming **tissue fluid**

All substances move out to bathe the tissues in tissue fluid **except plasma proteins** which are **too large** to fit through the gaps and are retained in the blood capillary

O_2 and glucose move from tissue fluid into tissues/cells for respiration

CO_2 the waste product of respiration is

1. Absorbed via the tissue fluid into blood capillary
2. **Excess tissue fluid** is absorbed into the **lymph**



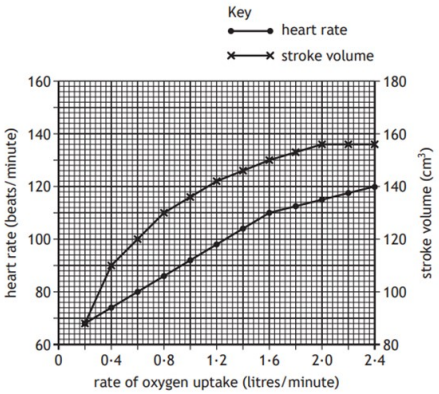
Cardiac Output & Heart Structure

Cardiac Output

The volume of blood pumped through each ventricle per minute

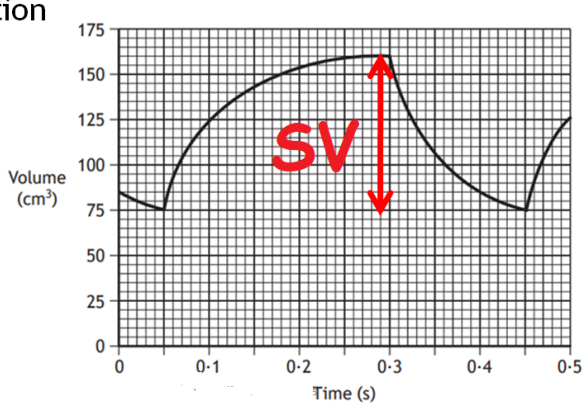
CO= HR x SV

HR= number of heart beats per minute (pulse)
SV= volume of blood expelled by each ventricle contraction

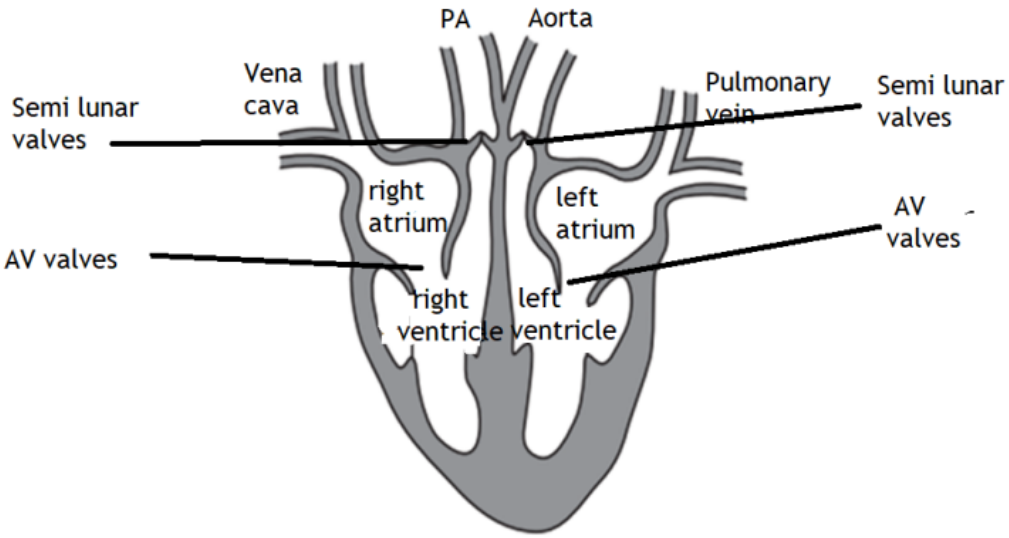


Stroke Volume

Volume of blood expelled by each ventricle's contraction

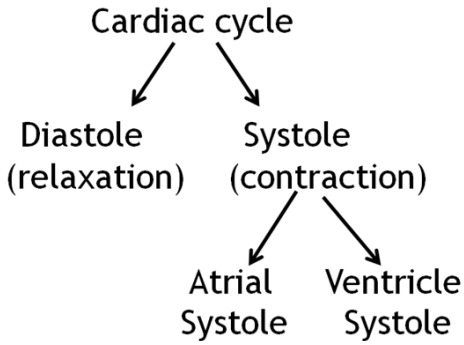


Flow of Blood Through the Heart



1. Vena cava bring deoxygenated blood
2. Deoxygenated blood enters the right atrium
3. Deoxygenates blood enters the right ventricle
4. Pulmonary artery takes blood to the lungs
5. Pulmonary veins returns blood to the left atrium
6. Oxygenated blood enters the left ventricle
7. Oxygenated blood exits heart through the aorta (artery)

Cardiac Cycle

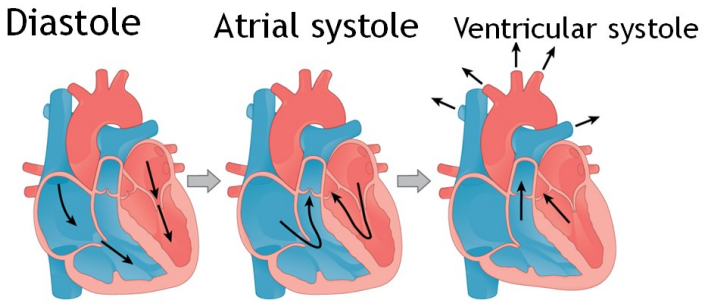


Cardiac cycle.

This consists of a pattern of relaxation (diastole) and contraction (systole) during one heart beat

Systole: contraction of the heart (Atrial first, then ventricular), blood forced out of chambers.

Diastole: relaxation of the heart, chambers fill with blood.



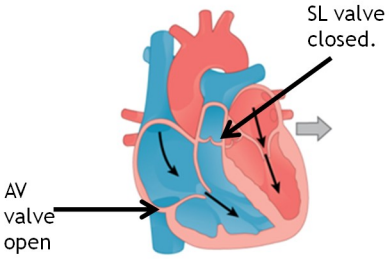
Stage	Duration (s)
Diastole	0·4
Atrial systole	0·1
Ventricular systole	0·3

Stages of Cardiac Cycle

1. Diastole

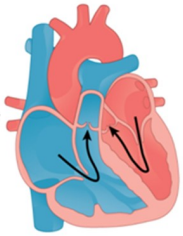
Blood returns to the atria & flows into the ventricles.

The higher pressure in the arteries closes the SL valve.



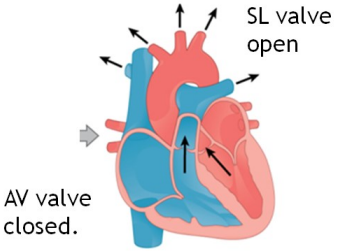
2. Atrial Systole

Transfers the remainder of the blood through the AV valves to the ventricles.



3. Ventricular Systole

Pumps blood out through the SL valves to the aorta & pulmonary artery at very high pressure.



Cardiac Cycle

Diastole blood returning to the atria flows in to the ventricles.
AV valve open **SL valve shut**

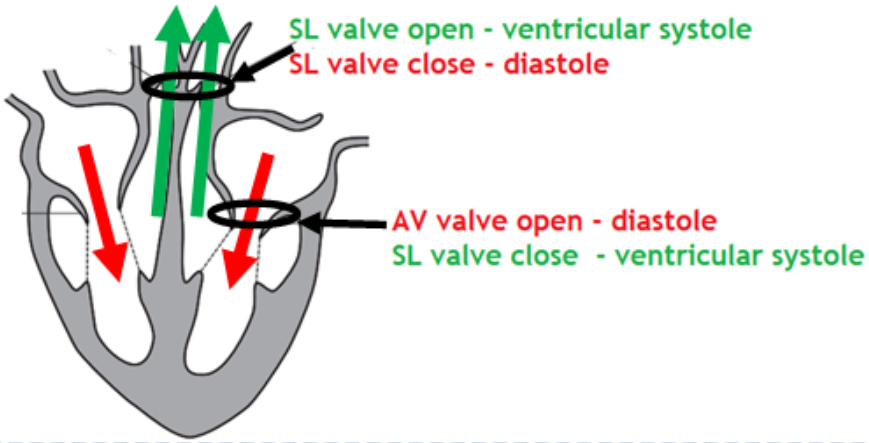
↓

Atrial systole transfers blood through the atrio-ventricular AV valves to the ventricles.

↓

Ventricular systole pumps blood out the ventricle through the aorta and pulmonary artery.

AV valve shut **SL valve open**



The average duration of diastole and systole in a hospital patient over a period of time were measured and are shown below.

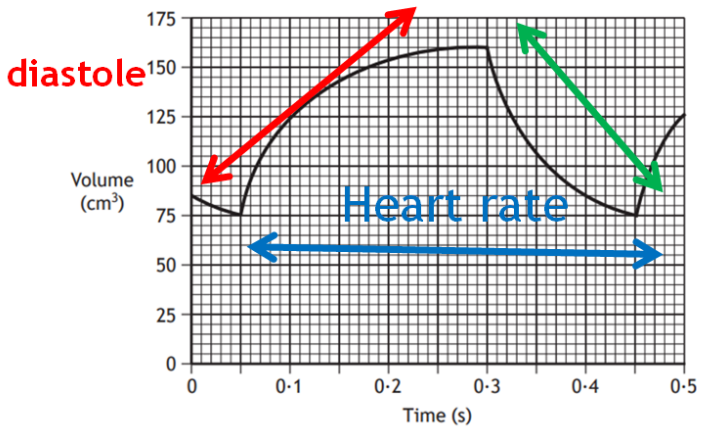
diastole = 0.3 seconds
atrial systole = 0.1s
ventricular systole = 0.2 seconds

What was the average heart rate of this individual over the period of time?

A 60 beats per minute
B 72 beats per minute
C 100 beats per minute
D 120 beats per minute

Answer—one cardiac cycle is 0.3+0.1+0.2 = 0.6.
60secs/0.6 = 100 beats per mins

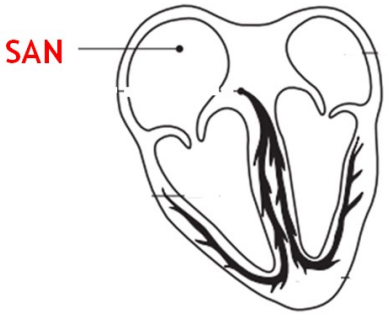
Interpretating Graphs



Control of cardiac system

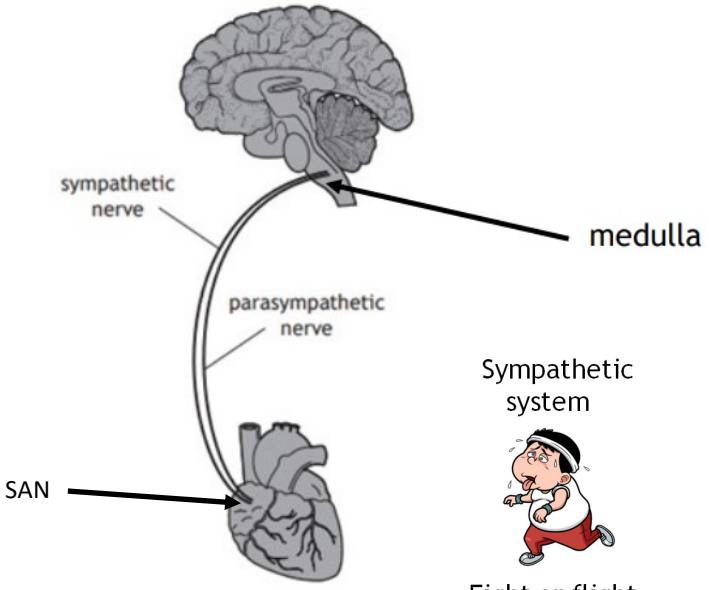
Nervous Control of heart rate

The **medulla (brain)** regulates the rate of auto rhythmic **SAN** through the **antagonistic action** of the two branches of the autonomic nervous system (ANS).



- Sympathetic nerves (fight or flight response)
  Releases noradrenaline and increases heart rate
- Parasympathetic nerves (rest or digest)
  Releases acetylcholine and decrease heart rate

Heat rate at any one point in time is determined by which of the above nerves exerts the greatest control at that point.



Sympathetic system

Fight or flight

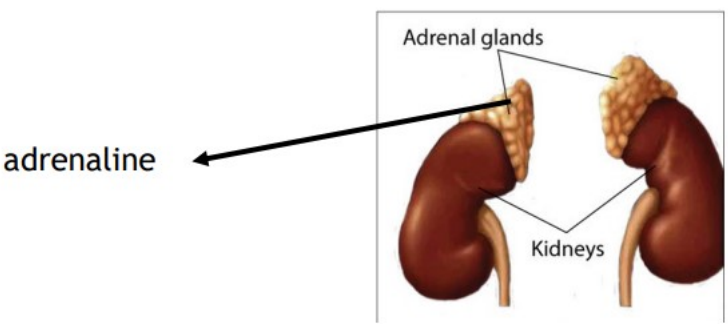
Parasympathetic systems.

Rest or digest

Hormonal Control of Heart rate

Hormones released during **fight or flight** response during **stress /physical activity** can act on the **adrenal glands** to cause **adrenaline** to be released into blood.

This stimulates the SAN to **increase heart rate.**



Cardiac Conducting System

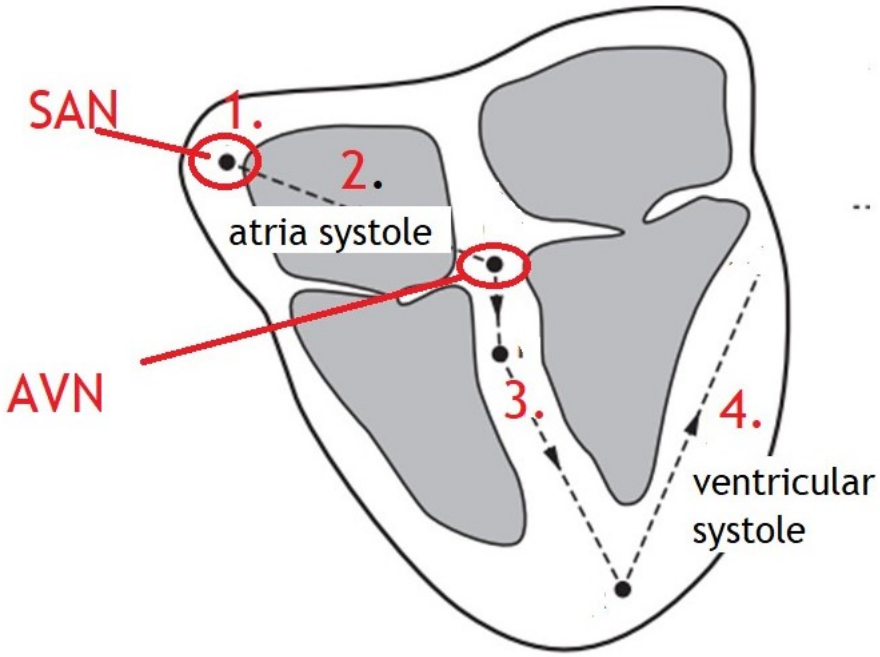
Heart beat

1. Originates in the heart itself via the **auto-rhythmic SAN (pacemaker) & the conducting system.**
2. Heart rate also controlled by ANS & hormones (adrenaline)

Cardiac Conducting System

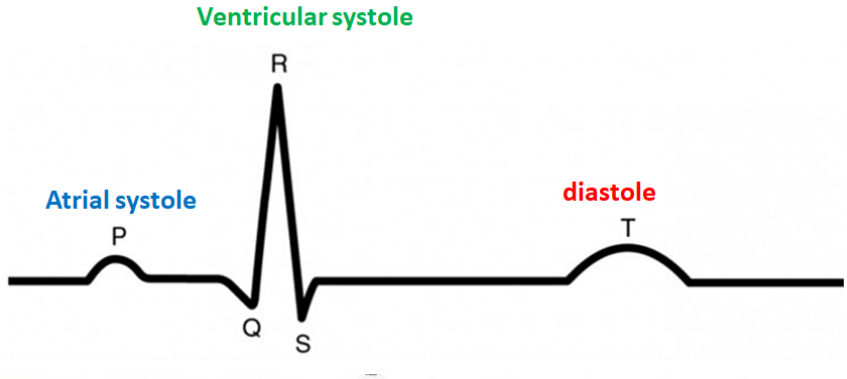
The SAN is located in the wall of the **right atruim.**

1. SAN **initiates the electrical impulse** which makes the **atria contract** at a certain rate (**atrial systole**).
2. This wave of excitement spreads to the **AVN** at the base of the atria.
3. Electrical impulses **pass down the bundle of conducting fibres** in the central wall of the heart.
4. The fibres then divide into the right and left ventricles to make the ventricles contract from bottom up (ventricular systole).



ECG

The electrical impulses generated by SAN/AVN are seen as electrical cur▫rents using an ECG.
Normal ECG pattern. Consists of 3 distinct waves referred to as P,Q,R,S and T.



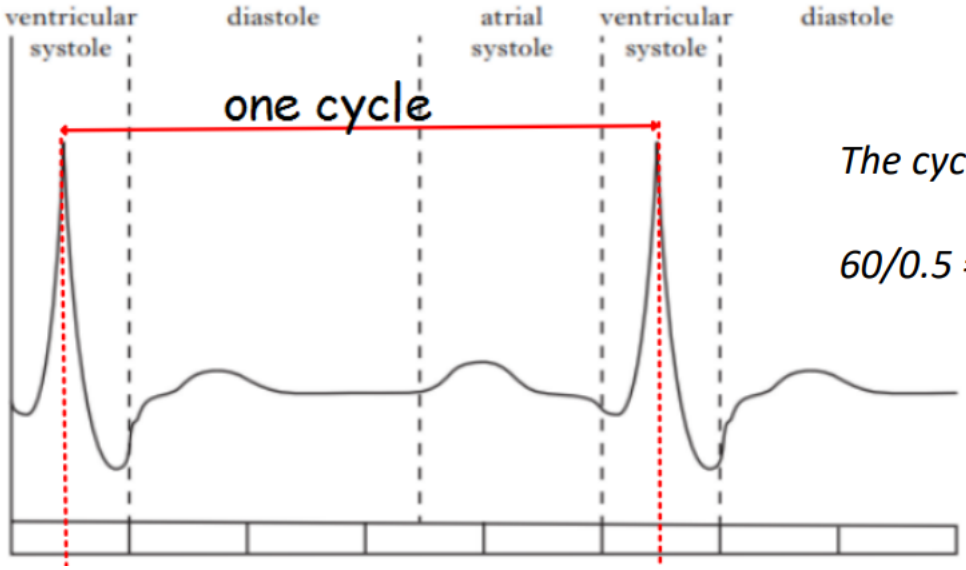
P - Atrial systole **QRS** - Ventricular systole **T** - **Diastole**

Calculating the Heart Rate

A person's heart rate can be calculated by counting the time between two separate peaks of ventricle systole then applying formula

60 seconds/ time for 1 cycle (time between peaks)

The diagram below shows an electrocardiogram (ECG) trace of an individual's heartbeat.



The cycle takes 0.5 secs.

60/0.5 = 120beats/min.

Blood Pressure

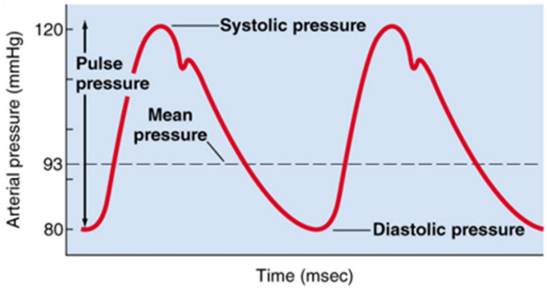
A healthy young adult should have a typical reading of **120/80mmHg.**

Sphygmomanometer.

An inflatable cuff **stops the flow of blood** and deflates gradually.

Systolic Pressure (120mmHg)

The blood pressure starts to flow (pulse)



Diastolic Pressure (80 mmHg)

The blood flows freely through the artery

(pulse not detected)

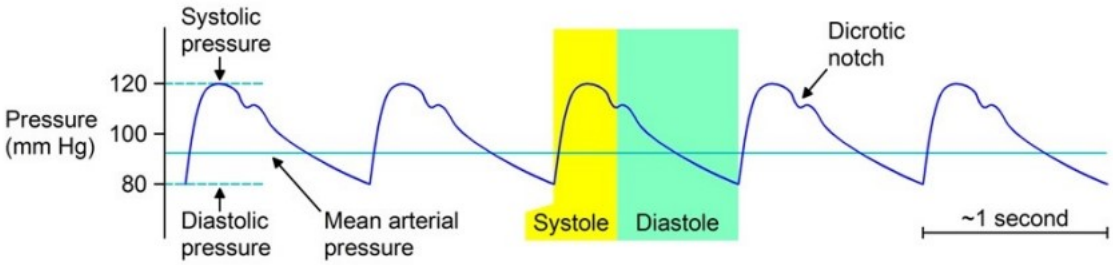
Hypertension

Hypertension is high BP.

This is any value over **140/90mm Hg.**

This is a major risk factor in many diseases such as stroke and coronary heart disease

Blood Pressure Graph.

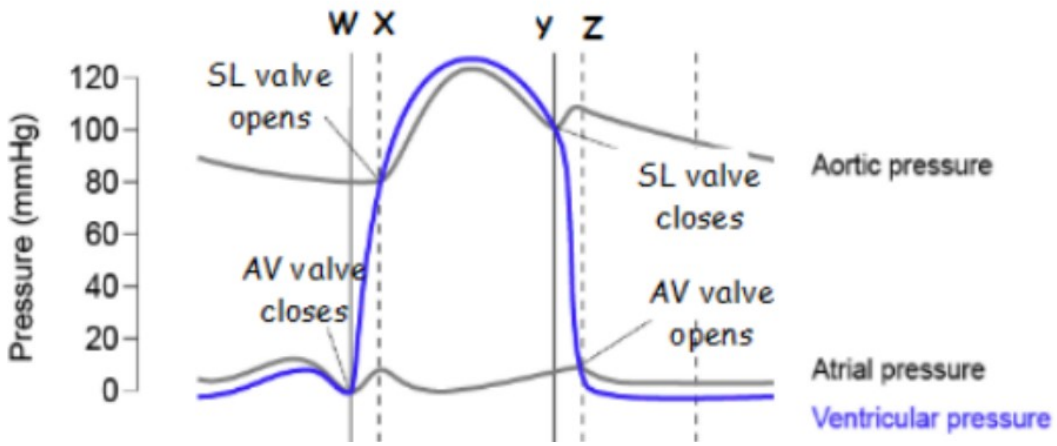


Cardiac Cycle

Valves

The opening and closing of the valves give the heart its familiar beating noise 'lub dub'with a stethoscope.

The higher blood pressure in arteries during diastole of heart (120mmHg vs 80mmHg) closes SL valve



W - AV valve closes as ventricular pressure is greater than atrial pressure. This creates the 'LUBB' noise. This is the beginning of atrial diastole and ventricular systole.

X - SL valve is forced open as ventricular pressure is greater than atrial pressure forcing the blood through the artery.

Y - As the pressure falls the SL valve closes. Results in the 'DUPP' noise. Ventricle diastole begins.

Z - Ventricular pressure falls below the atrial pressure and the AV valve opens.