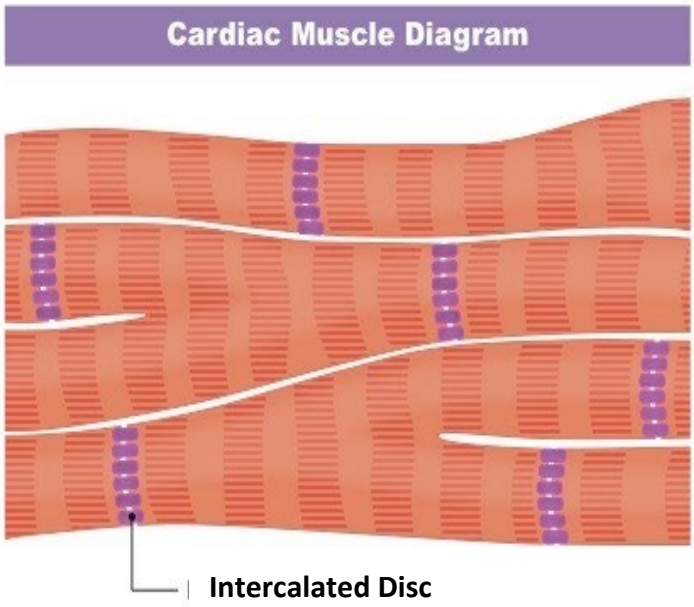
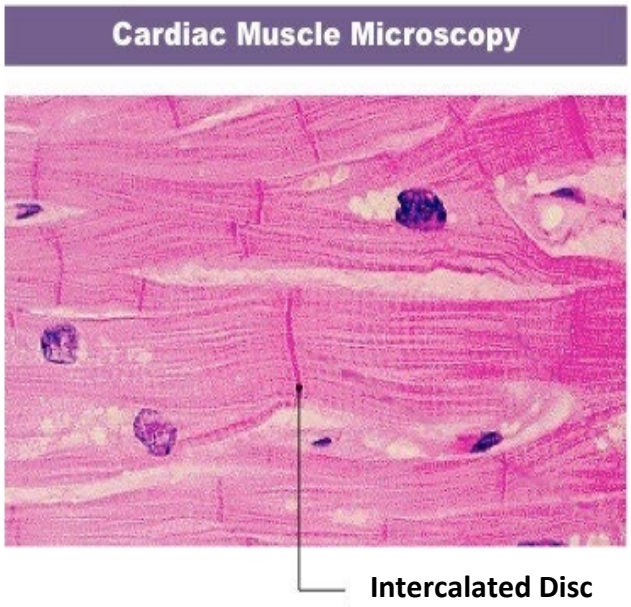
1. CARDIAC MUSCLE

- Is **myogenic** as it can **contract without any stimulation** by the **central nervous system**.
- It has the following structure:

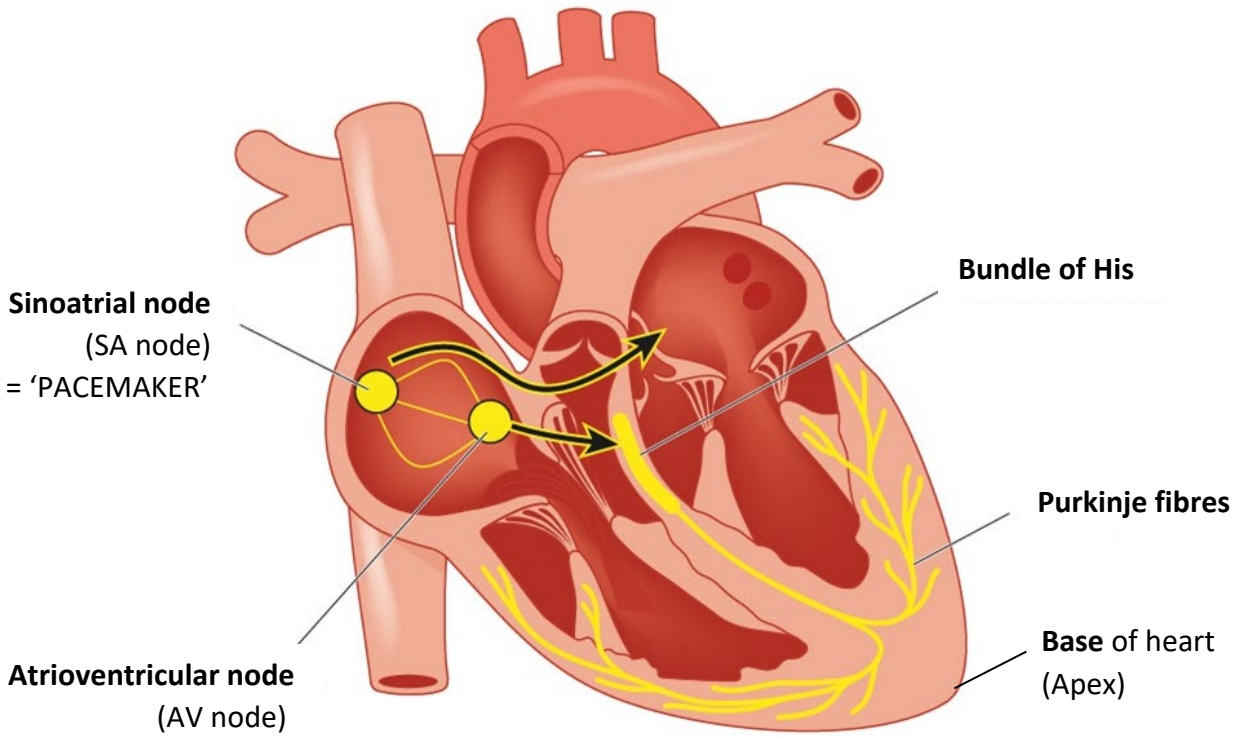




- The junctions have a 'zig-zag' shape and are called **intercalated discs**.
- **Intercalated discs**.are **cross-bands**, which act as **attachment sites** between **adjacent cells**.
- There are **gap junctions** at the **intercalated discs**, between **cell membranes**, **–** the **cells** are **not fused together.**
- Cardiac muscle **cells** also have the following properties:

BRANCHED (Y-SHAPED)	• Allows: - **fast propagation** of **electrical impulses** to the **walls** of the heart = **fast coordinated contraction** - **groups** of **cells** to **work together/synchronise**
INTERCALATED DISCS	• **Hold cells together** so they **do not separate** • Allows **rapid conduction** of **electrical impulses between cells**
GAP JUNCTIONS	• Form **channels** that allow **continuous flow**, **between cells**, of: - **ions** - **electrical impulses** - **cytoplasm**
MANY MITOCHONDRIA	• **More aerobic respiration** to **release more energy** for **continuous contractions**

2. CONTROL OF THE CARDIAC CYCLE



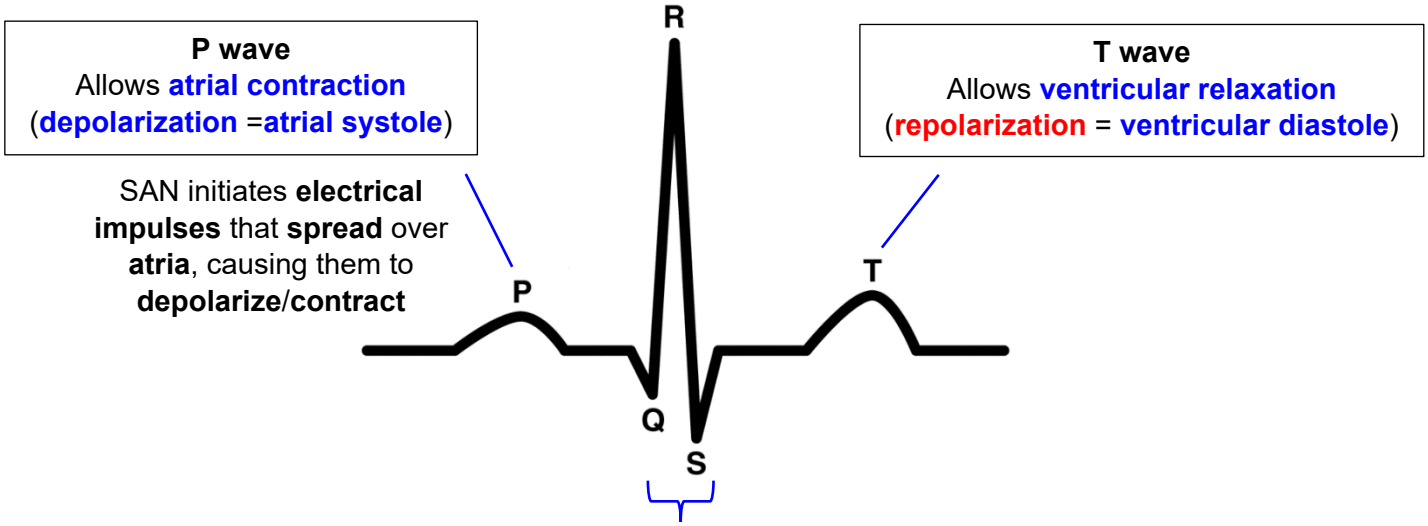
- The **sinoatrial node** (SA node) in the **wall** of the **right atrium** **initiates** electrical **impulses**.
- These **impulses** spread **across** the **walls** of the **atria**, causing them to **contract** (= **atrial systole**)
- The **impulses** are **prevented** from reaching the **walls** of the **ventricles** by a layer of **fibrous tissue**.
- There is a **delay** (of about 0.09 seconds) before **impulses** are **passed** on from the **atrioventricular node** (AVN).
- This **gives time for the ventricles to completely fill with blood** **before** they **contract**.
- **Impulses** pass from the **AV node** along conducting fibres: the **Bundle of His** (in the septum between the ventricles) and then **Purkinje fibres** (in the ventricle walls).
- **Impulses** are carried to **all parts** of the **walls** of the **ventricles** and the **base** of the heart, leading to them **contracting** (= **ventricular systole**).
- A **wave of contraction** then moves **upward** from **base** to **ventricles**.
- This **forces blood** into the **arteries**.

THE ATRIOVENTRICULAR NODE (AVN)

1. **RELAYS IMPULSES BETWEEN THE SAN AND VENTRICLES**
2. **ALLOWS THE VENTRICLES TO CONTRACT**
3. **DELAYS IMPULSES SO THAT THE ATRIA EMPTY FULLY BEFORE THE VENTRICLES CONTRACT**

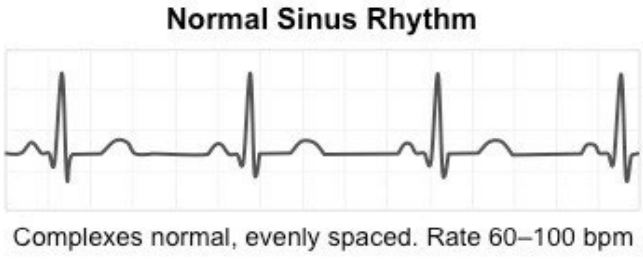
3. ELECTROCARDIOGRAMS (ECGs)

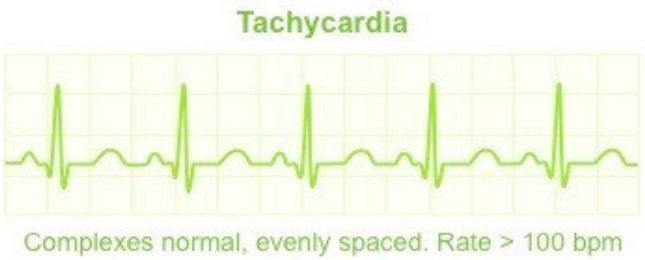
- Electrical activity within the heart can be detected using an **electrocardiogram (ECG)**.

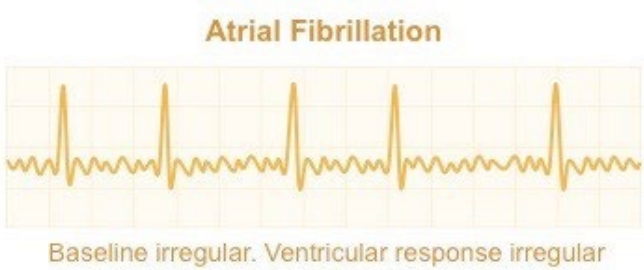


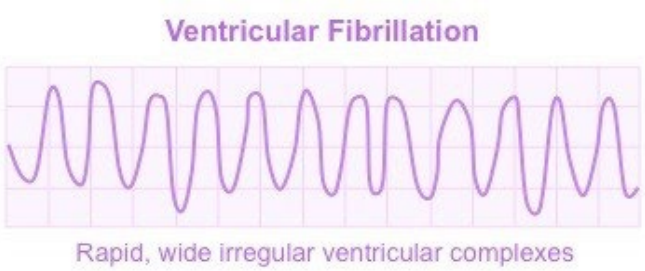
impulses initiated from the **AV node**
spread across the heart and travel along
Purkinje fibres to cause the
ventricles to **depolarize/contract**

- The changes to the **size of peaks** and **lengths of intervals** can be used to detect heart problems.





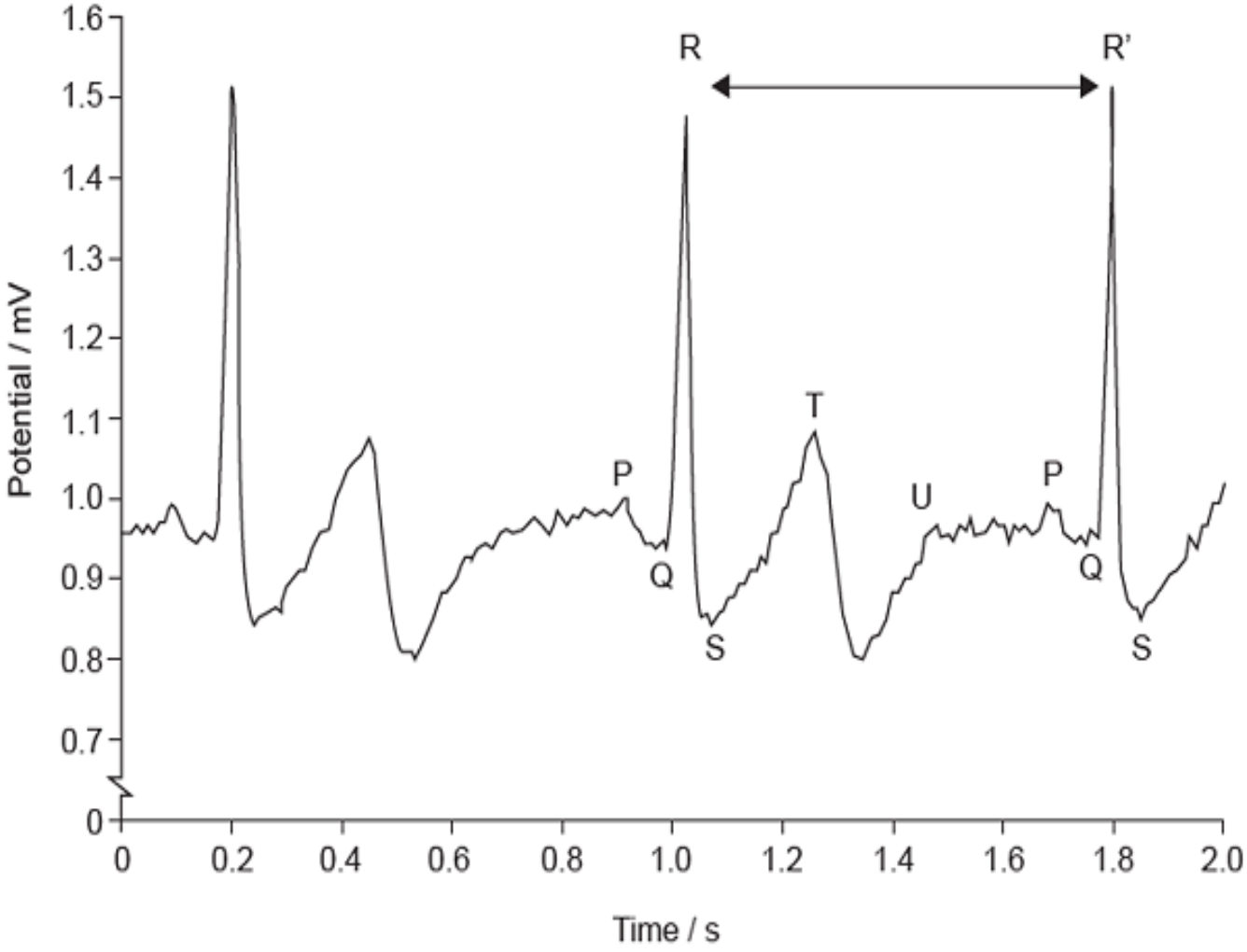




4. HOW TO CALCULATE HEART RATE FROM R-WAVES

Time between **R waves** is used to calculate the **heart rate**.

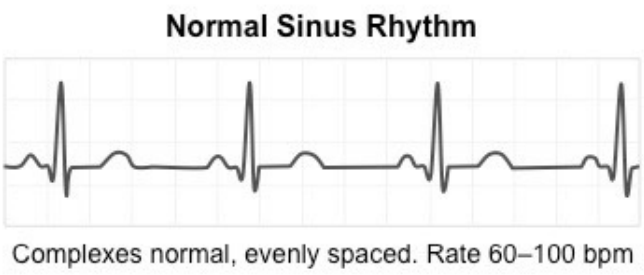
This distance spans **one heartbeat**

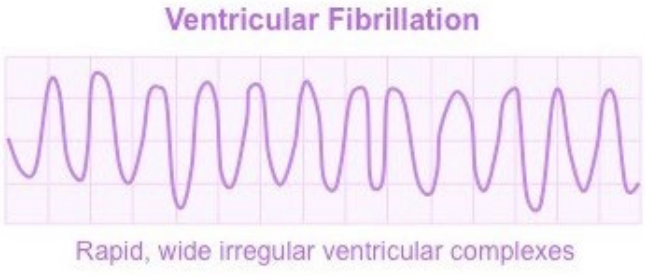


- **Heart rate = $\frac{60\ s}{0.8\ s}$ = 75 beats per minute**

5. DEFIBRILLATORS

- A feature of a **heart attack** is **ventricular fibrillation**.
- This is when **ventricles twitch** due to **fast** and **chaotic contraction** of **individual** muscle cells.
- This makes the **ventricles ineffective** in **pumping blood** into the **arteries**.





- The **two metal paddles** of a **defibrillator (electrodes)** are applied to the patient's **chest** in a **diagonal line**, with the **heart** in the **middle**.
- The **defibrillator** first **detects** if the ventricles are **fibrillating**.
- If they are, it **delivers** an **electrical discharge/shock** to the **heart.**
- This **depolarizes** the **cardiac muscle**.
- (And) enables the **SAN** to **regain control**.
- (So) **fibrillation** is **stopped** and a **normal heart rhythm** is **restored**.

6. ARTIFICIAL PACEMAKERS

- For patients who have a:
  - **malfunctioning SA node**
  - **heartbeat** that is **too slow/ fast/ irregular /fibrillations**
  - **block** in the **impulse conduction pathway** generated by the **SAN**

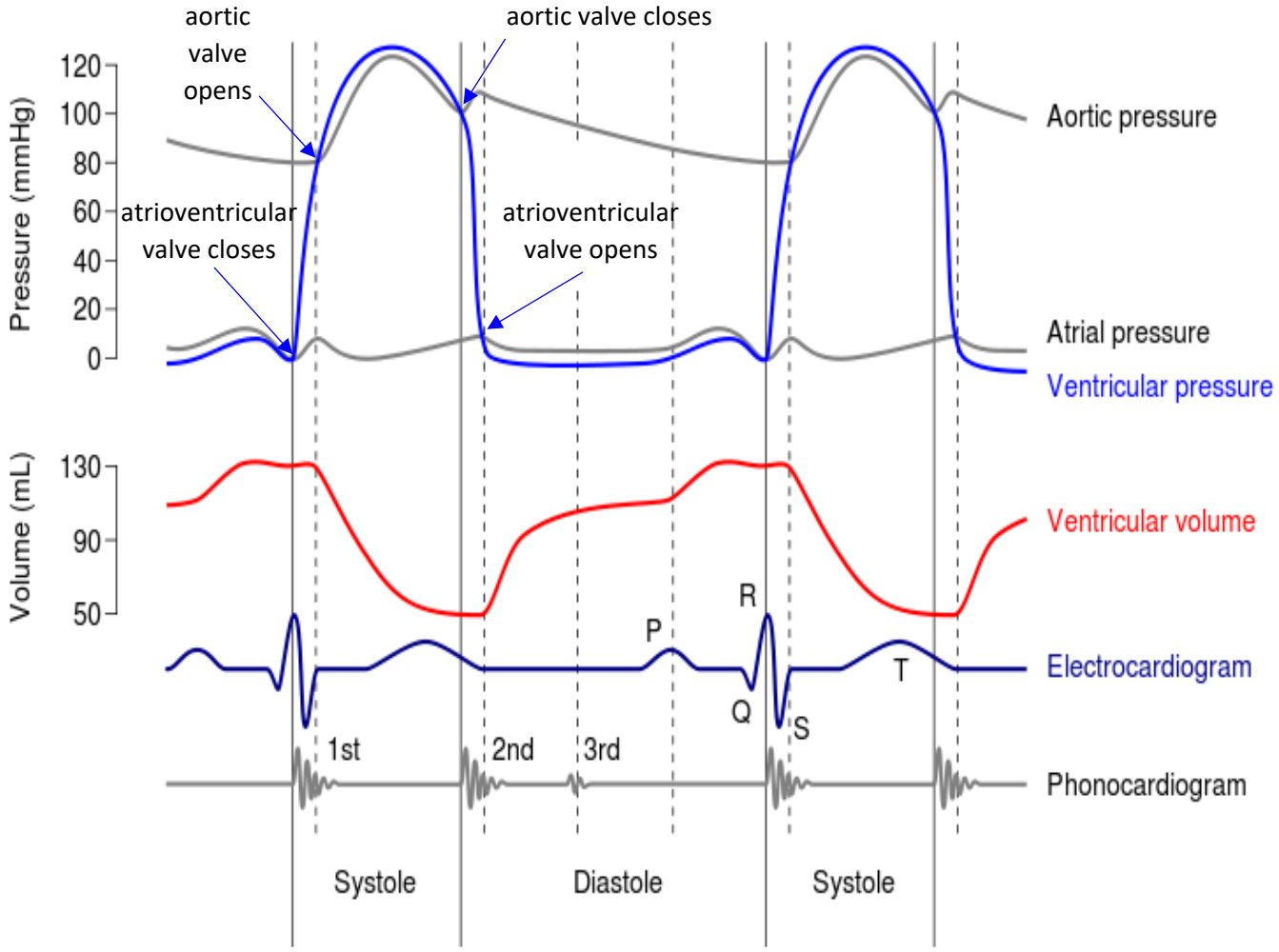
- Artificial pacemakers contain a **battery** and **pulse generator**.
- It is placed **under** the **skin** below the **collar bone.**
- **Wires** are threaded through **veins** to deliver **electrical impulses** to the **heart**.
- It **detects** that the heart's **natural rhythm** is **incorrect**.
- It then **sends electrical impulses** to **correct** the **heartbeat**.
- It provides a **regular impulse/constant rhythm**.

7. HEART VALVES & HEART SOUNDS

- You have met this before in **Topic 6**.

DIFFERENCES in **PRESSURE** cause **VALVES** to **OPEN** or **CLOSE**

Look at what is **EITHER SIDE** of a **VALVE** and work out where the **PRESSURE** must **BE GREATER** to **OPEN** or **CLOSE** it

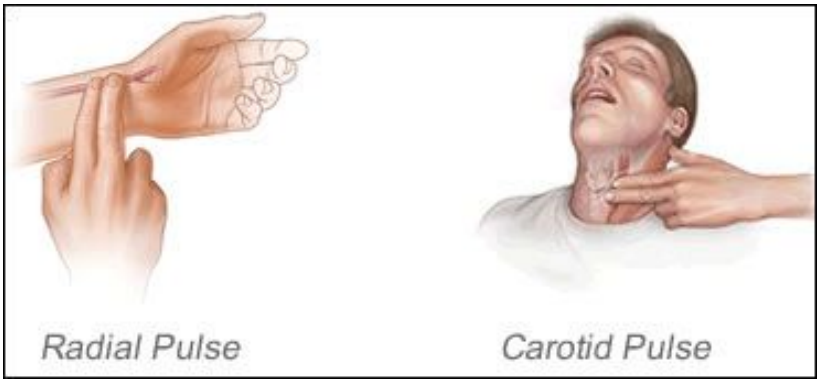


- The **1st** heart sound ('lub') is made when the **atrioventricular valves close**.
- The **2nd** heart sound ('dub') is made when the **semilunar valves close**.
- **Murmurs** (other sounds) can show problems such as **leaking valves**.
- **Heart sounds** can be detected using a **stethoscope**.

8. MEASURING HEART RATE (= NUMBER OF BEATS PER MINUTE)

Can use:

- **radial** pulse at the **wrist**
- **carotid** pulse in the **neck**
- **stethoscope**
- **digital heart rate monitor**



There is a **positive correlation** between **exercise intensity** and **heart rate** as:

Muscles require more energy

(So) more oxygen and glucose delivered to cells

(So) more aerobic respiration

(And) more (toxic) carbon dioxide is removed

(And) more lactic acid is taken to the liver and broken down/oxidised

9. INCIDENCE OF CORONARY HEART DISEASE (CHD)

Coronary heart disease is damage to the heart muscle

due to blockage of the coronary arteries, typically by a blood clot

- Investigating **CHD** by **experiment** is **unethical**, so we **analyse epidemiological data** instead.

10. BLOOD PRESSURE

- Is the **pressure** of **blood** on the **artery wall**.
- Measured in **mm Hg** (mercury).
- By a **sphygmomanometer** or a **digital blood pressure monitor**

Systolic blood pressure

The **pressure** in your **arteries** during the **contraction** of the **ventricles**

120

80

Diastolic blood pressure

The **pressure** in your **arteries** when your **heart muscle** is **between beats/relaxed**

Sphygmomanometer

A **cuff** is placed around the **upper** arm and it is **inflated** to **constrict** the upper arm.

This **prevents blood** in the **arteries** from **entering** the **lower** arm.

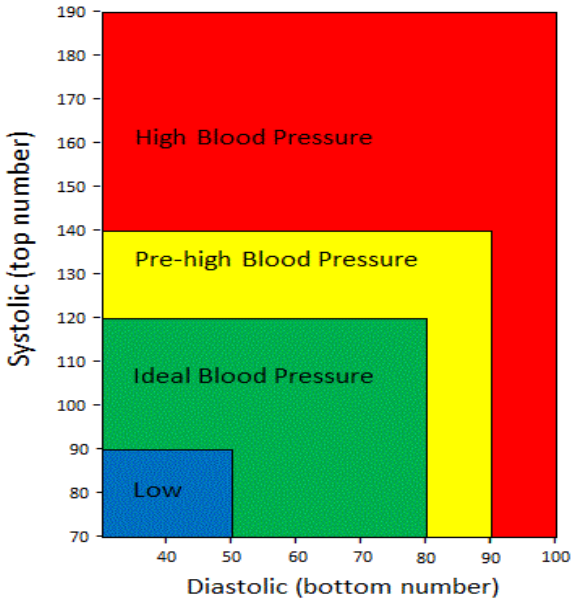
The **cuff** is then **slowly deflated** and the doctor uses a **stethoscope** to listen for **sounds** of **blood flow** in the **artery** below the cuff.

When the **cuff pressure** < **systolic** pressure:
First sound is heard = systolic blood pressure.

The cuff is **deflated further** and the doctor keeps listening.

When the **cuff pressure** < **diastolic** pressure.
No sound is heard = diastolic blood pressure.

The chart shows how blood pressures are interpreted:



11. HYPERTENSION & THROMBOSIS

	HYPERTENSION	THROMBOSIS
What it is	**High** blood pressure	**Blood clots** forming inside **blood vessels**
Risk factors	• **Obesity** • **Lack** of **exercise** • Eating **too much salt** • Drinking **too much alcohol** • Drinking **too much coffee** • Genetics	• High **LDL** levels in blood • High levels of **saturated** fat and **trans-fat** in blood • **Inactivity** on **air flights** • Smoking **tobacco** • **Hypertension** • **Genetics**
Can Cause	If left untreated, it can cause **kidney damage**, **heart attack** and **stroke**.	If blood clots block **coronary arteries**, a **heart attack** can occur. If blood clots block **carotid arteries**, a **stroke** can occur.