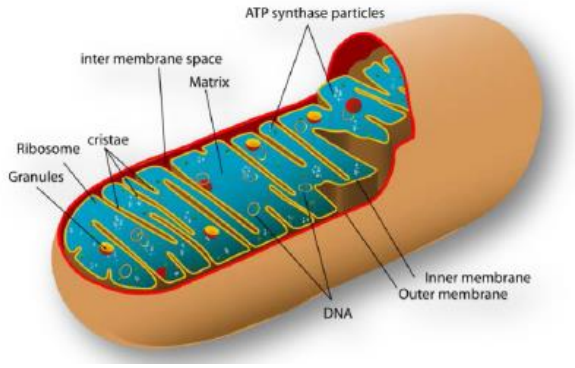
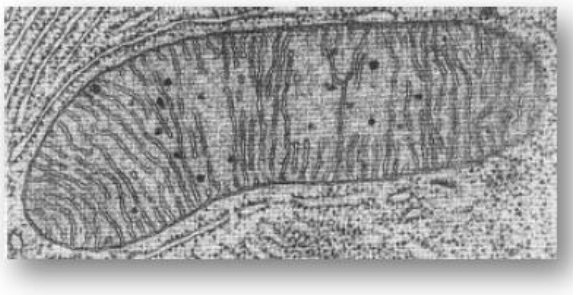
SEMESTER 1

Mitochondria

Oxidation of carbohydrates and lipids. Goes through the processes of the Krebs cycle, respiration and ATP synthesis.

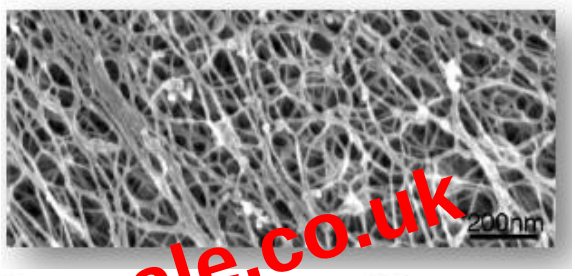




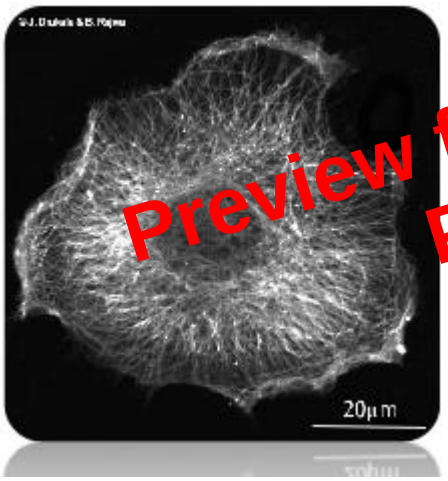
The Cytoskeleton

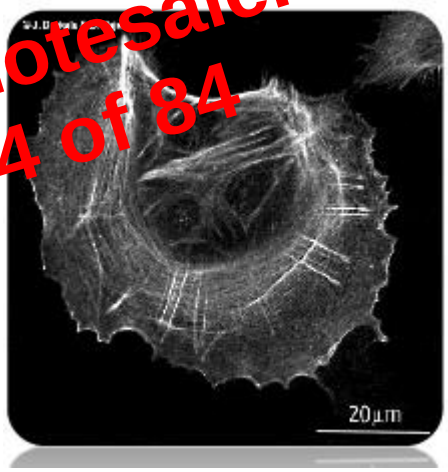
Protein structure that acts as a skeleton:

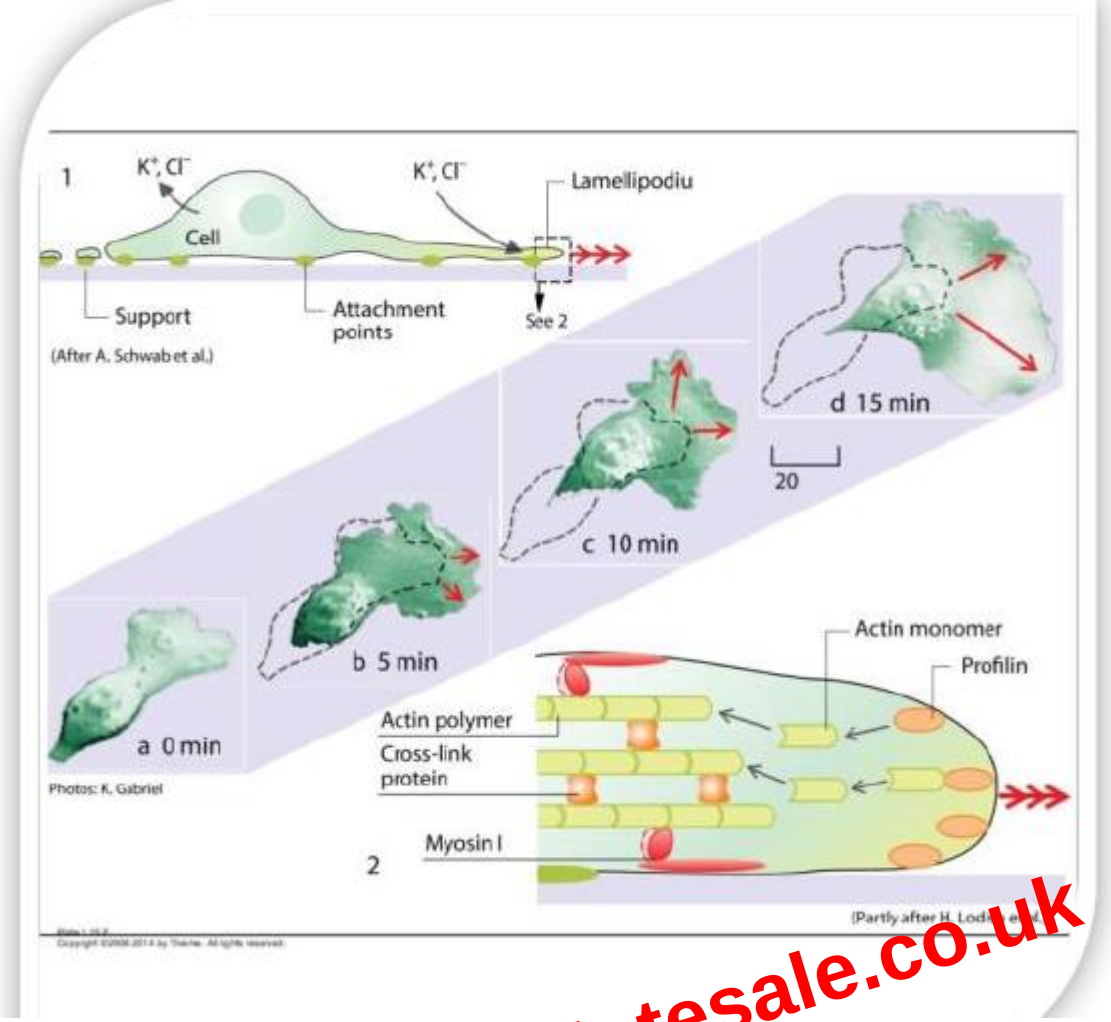
- Determines the shape
- Maintains or changes it
- Motility



Made up of actin filaments.

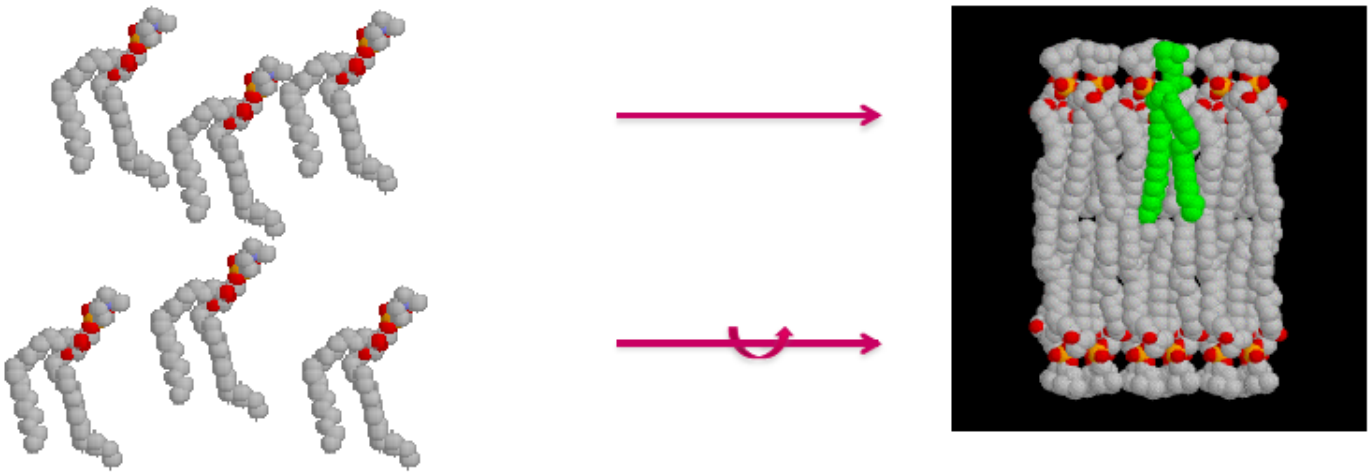






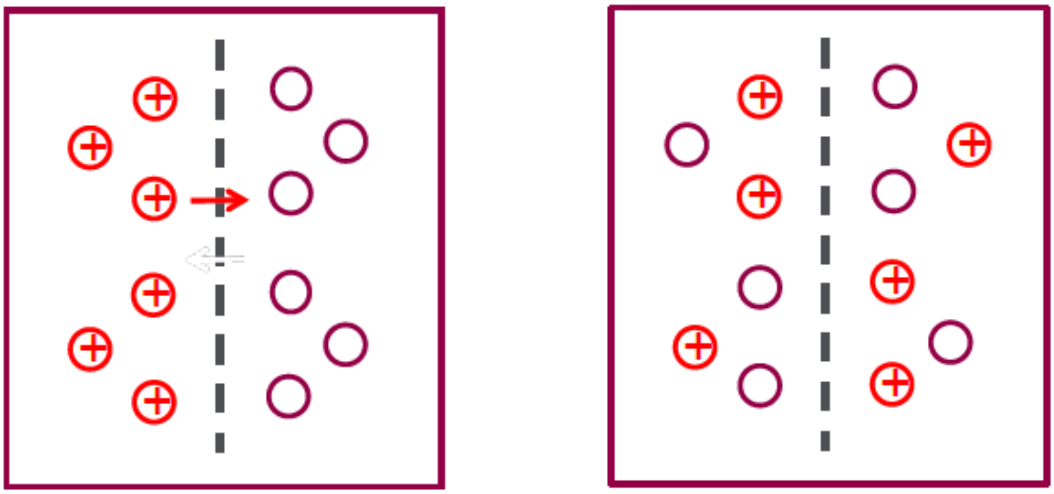
Cell Membrane

- Phospholipids – Hydrophilic head and hydrophobic tail
- Proteins:
- Channels
- Carriers
- Markers
- Receptors



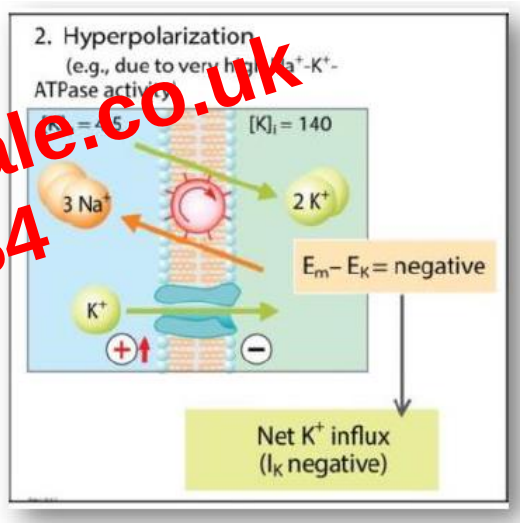
Electrical Gradient

Intracellular and extracellular fluids are also made of ions: Na+, Cl-, Ca2+ and organic ions.



Active Transport

It occurs against concentration or electrical gradients. Requires energy expenditure (ATP) Has Na+ - K+ pump (3Na+ out and 2K+ in).

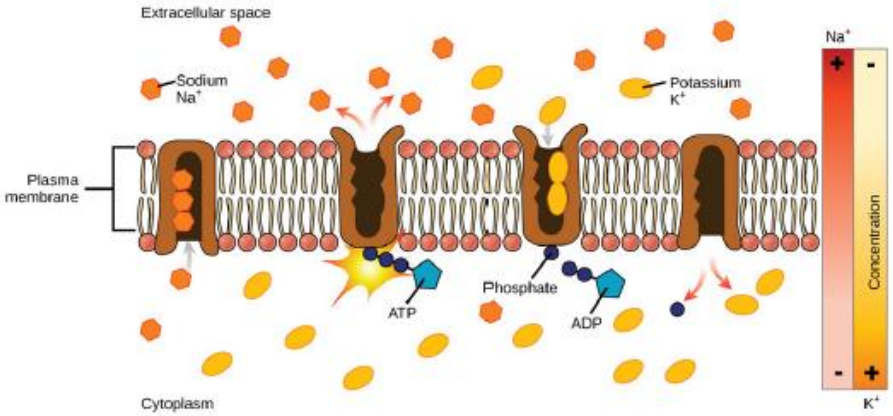


The sodium-potassium pump moves K+ into the cell while moving Na+ at a ratio of three Na+ for every two K+ ions. When the sodium-potassium- ATPase enzyme points into the cell, it has a high affinity for sodium ions and binds three of them, hydrolysing ATP and changing shape.

As the enzyme changes shape it reorients itself towards the outside of the cell, and the three sodium ions are released.

The enzymes new shape allows two potassium to bind and the phosphate group to detach, and the carrier protein repositions itself towards the interior of the cell.

The enzyme changes shape again, releasing the potassium ions into the cell. After potassium released into the cell, the enzyme binds three sodium ions, which starts the process over again.



$$V = RI$$ ← It is a linear relation

$$I = GV \text{ where } G = \frac{1}{R}$$

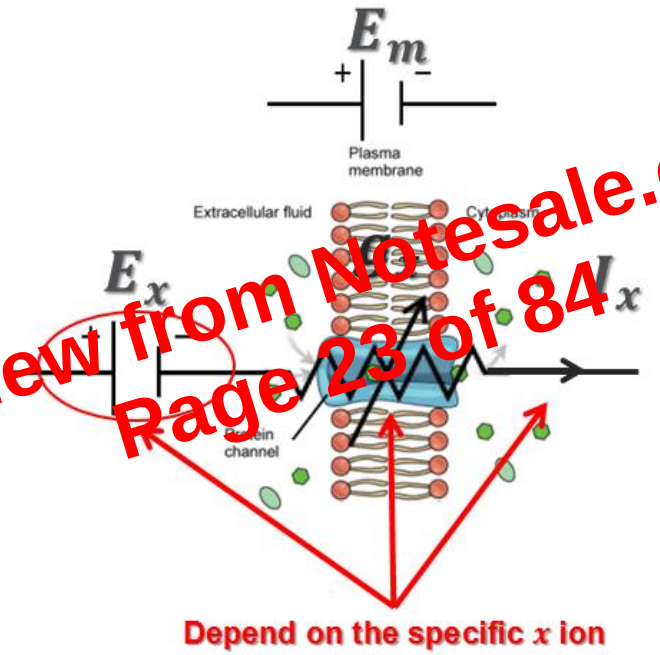
Conductance

The electrochemical driving potential $\Delta E_x = (E_m - E_x)$

Membrane permeability to the x ion g_x

Ions flow I_x

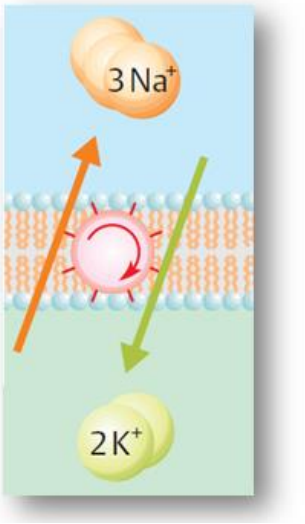
$$I_x = g_x \Delta E_x = g_x (E_m - E_x)$$

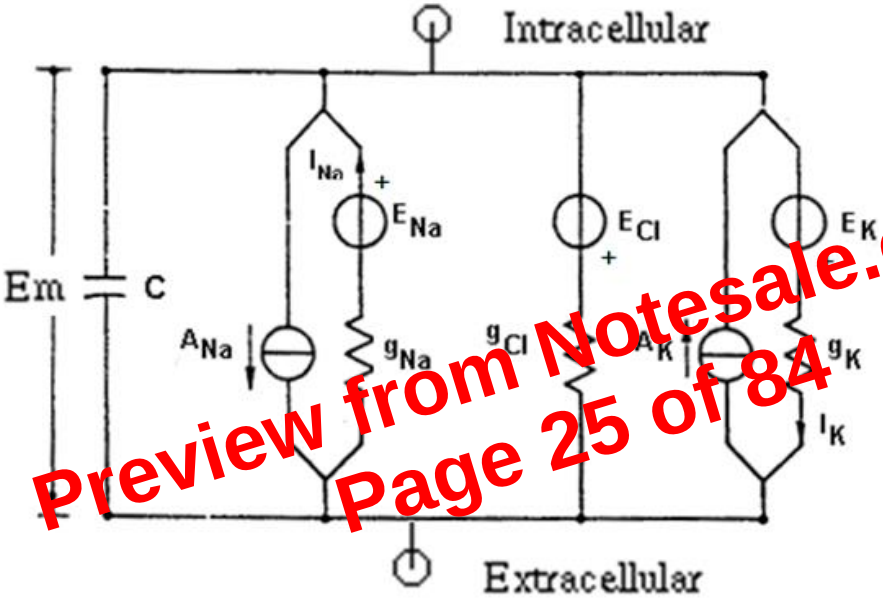


Hodgkin e Huxley model

The same as voltage. The capacitor stores the charge (the plasma membrane)

Active pumps produce the movement of ions. These are current generators. It uses ATP the basis of the signals





Membrane Polarization

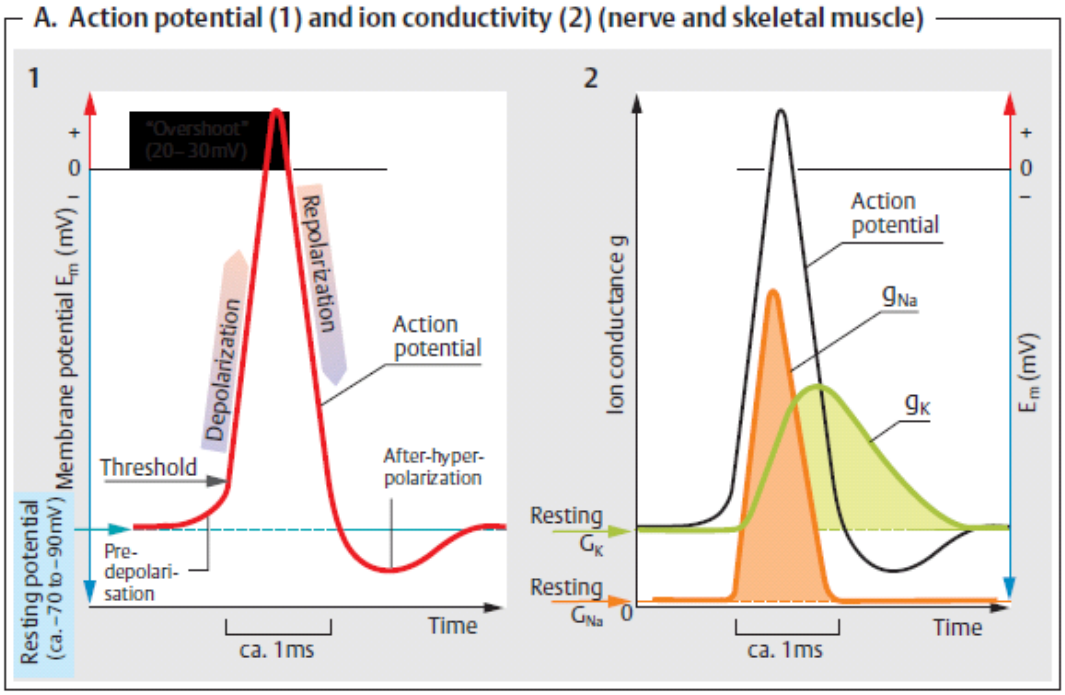
Cell membrane is polarized: A specific difference in charges concentration across the membrane (a voltage) is maintained by active pumps.

Cell membrane can be hyperpolarized and depolarized.

Hyperpolarization: It is the increase of the polarization

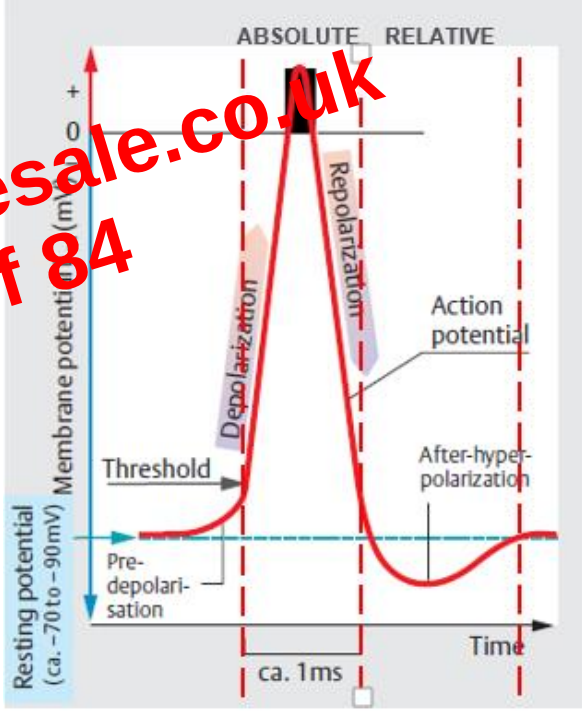
Depolarization: It is the decrease or the removal of the polarization

The membrane potential has external ligands i.e. Acetylcholine (It's able to band and open some more channels. There is a fast influx of sodium ions. The sodium becomes less high as it has reached a potential that is closer).



Refractory periods:

- Absolute – No further AP by any stimulus
  Na+ channels inactivated
  K+ channels open
- Relative – AP if stronger stimulus
  Some Na+ channels still inactivated
  K+ channels open
  Need stronger stimulus to over large g_K (i.e. threshold is higher)



There are two refractory periods when the cell is not signalling i.e. a defibrillator (a resuscitating current).

Sympathetic Division:

- Ganglia are located close to the vertebrae in the so called sympathetic chain are called paravertebral ganglia
- Short axon for preganglionic neurons
- Long axon for postganglionic neurons

Parasympathetic Division:

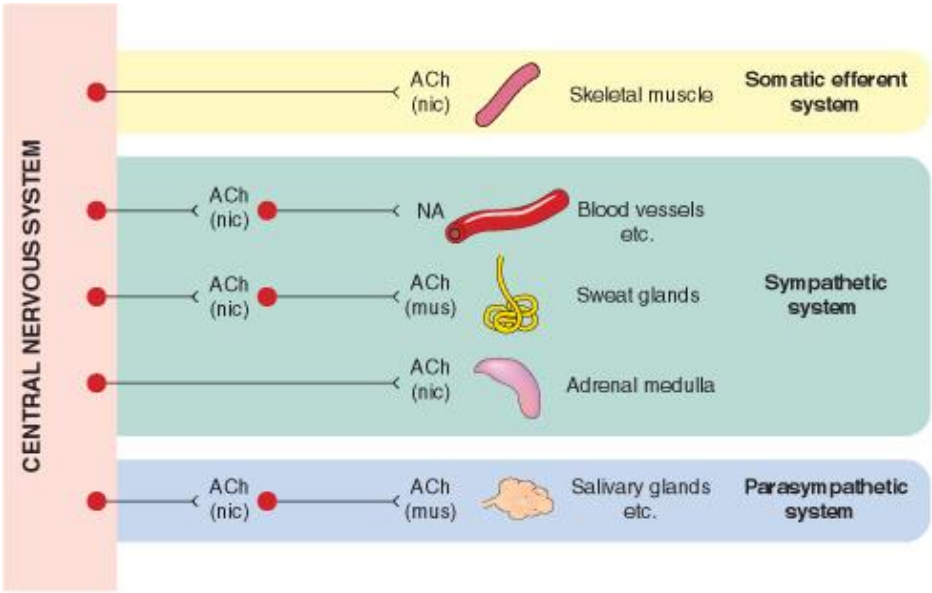
- Ganglia are located either in or near to the target organs
- Long axon for preganglionic neurons
- Short axon for postganglionic neurons

Neurotransmitters:

- Acetylcholine
- Noradrenaline (UK) = Norepinephrine (USA)
- Parasympathetic and sympathetic preganglionic neurons release acetylcholine
- Sympathetic division
  - Postganglionic neurons are Noradrenergic (i.e. release noradrenaline to the target organs)
  - Except those which innervate sweat glands (acetylcholine)
- Parasympathetic Division
  - In the parasympathetic division, the postganglionic neuron release acetylcholine to the target organs (smooth muscle, glands)
- Adrenal Medulla
  - Directly innervated by the preganglionic neuron of the sympathetic system
  - Has the capacity to release adrenaline (epinephrine) or noradrenaline (norepinephrine) directly into the circulation

Functions:

- ANS divisions:
  - Fight or flight for the sympathetic system
  - Rest and digest for the parasympathetic system
- Sympathetic: e.g. increases heart rate, dilates bronchioles, dilates blood vessels in muscle
- Parasympathetic: e.g. decreases heart rate, constricts bronchioles, constricts blood vessels in muscle



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Levels of Organisation

- Behavioural neuroscience
- Systems neuroscience
- Cellular neuroscience
- Molecular neuroscience

Neuroglia Cells

Oligodendrocytes: Secret myelin

Astrocytes: Absorb nutrients from the capillary and pass it to the neuron. Blood-brain barrier

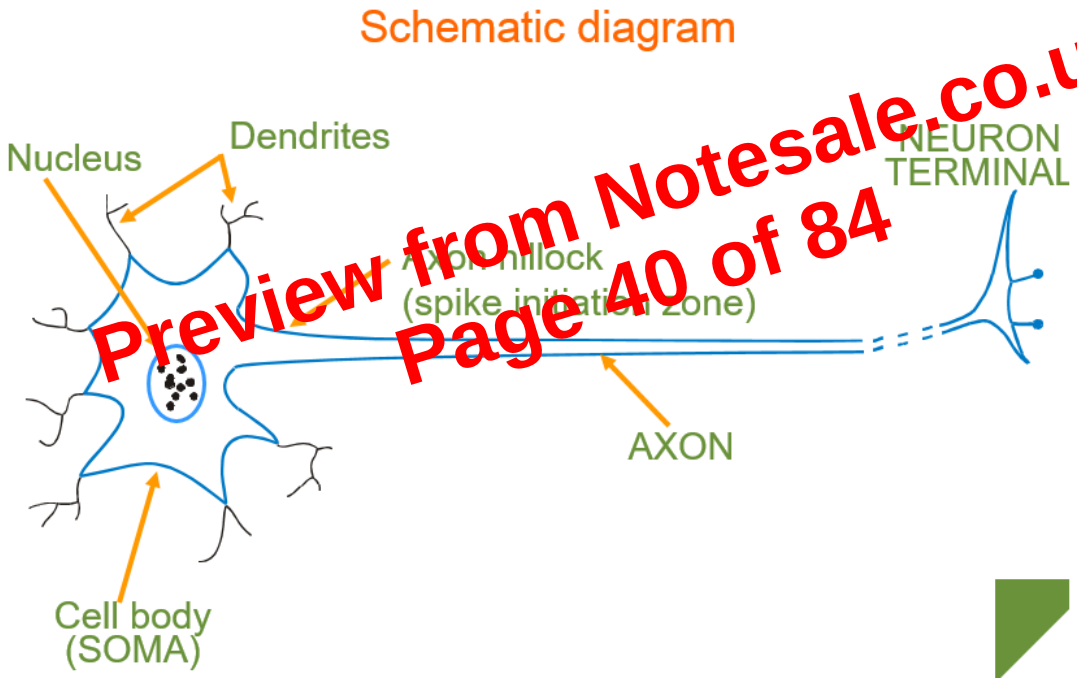
Microglial Cells: Engulf harmful substances

Ependymal Cells: Filter blood making the cerebrospinal spinal fluids

Satellite cell (PNS and ANS): Similar in function to Astrocytes

Schwann cell (PNS): Similar function to Oligodendrocytes

Neurons: The basic unit of the nervous system



Neuron Schematic Structure: Definitions

Soma:

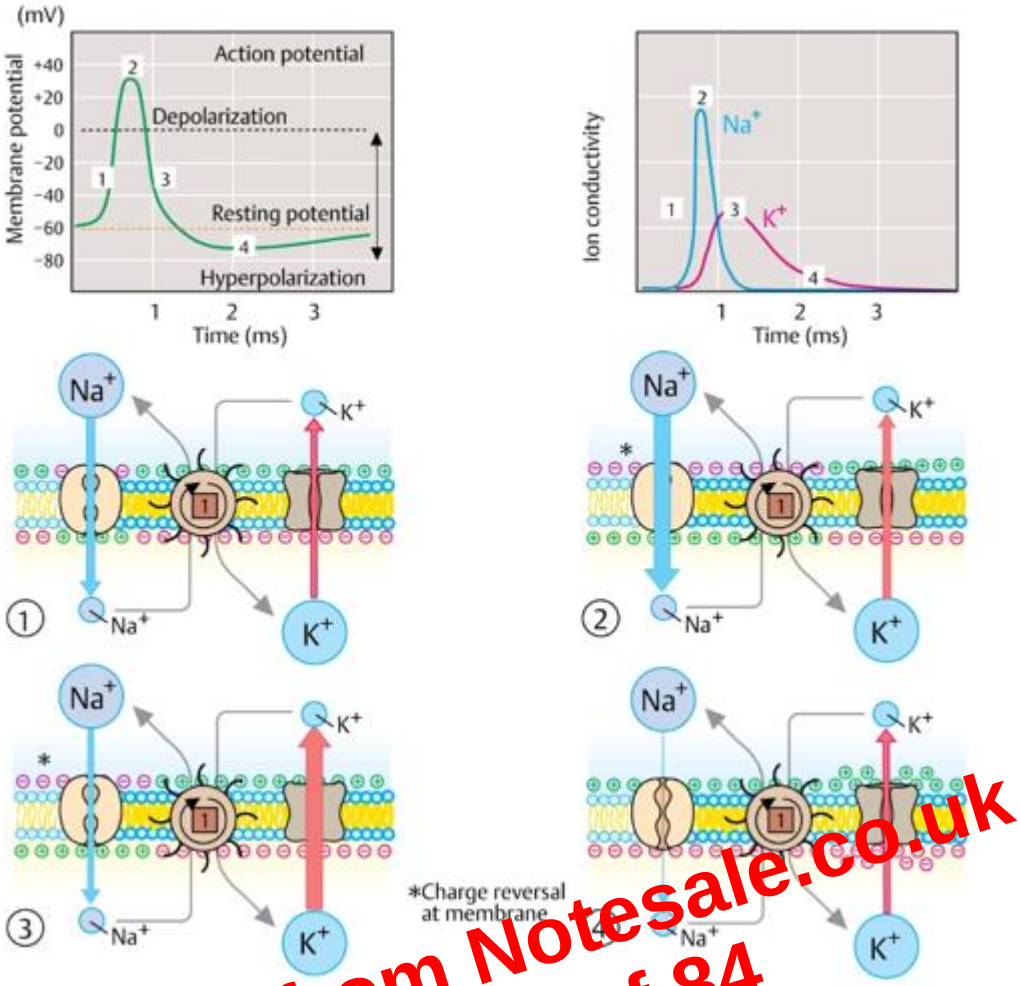
- The central region of the neuron containing the nucleus
- Also called the cell body

Dendrite:

- Extend from the cell body to receive synaptic contacts from the other neurons

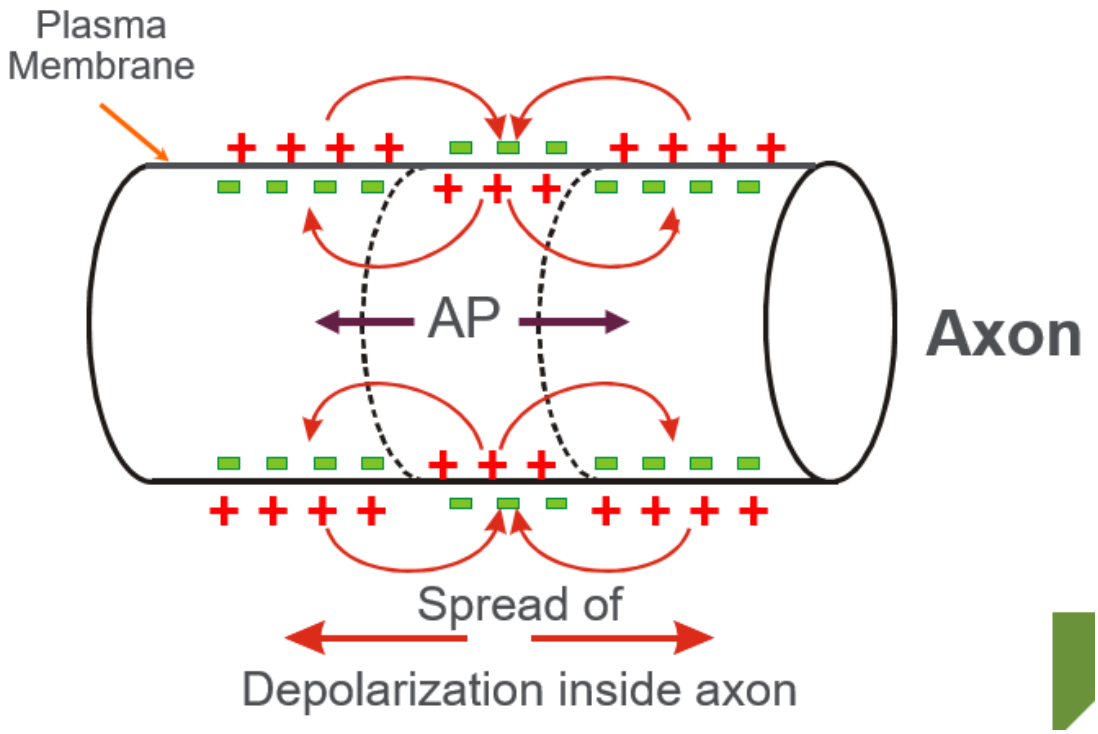
Axon:

Firing Threshold

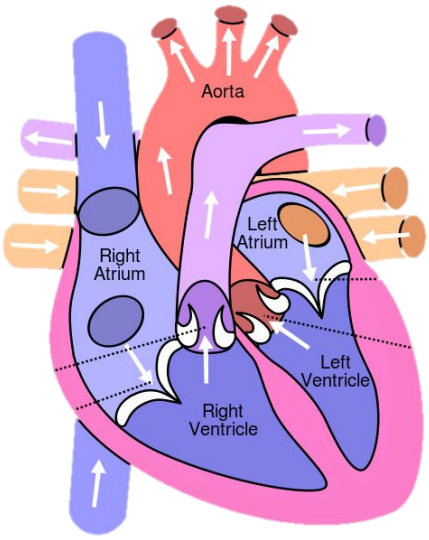


Action potential propagation

- Electro-tonic spread: due to local current flow



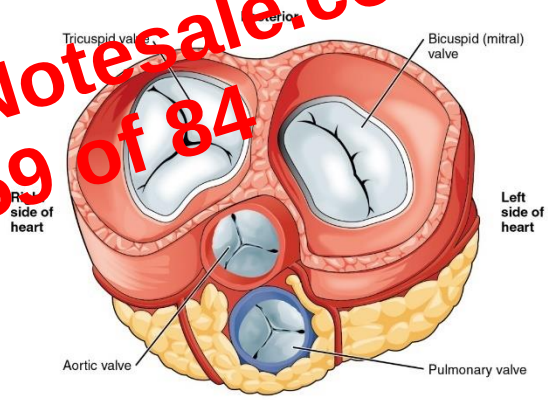
- Four chambers
  - 2 atria
  - 2 ventricles
- Separated by septum
  - Interatrial
  - Interventricular
- Right side veins
  - Inferior and superior
- Left side arteries
  - Aorta and pulmonary trunk



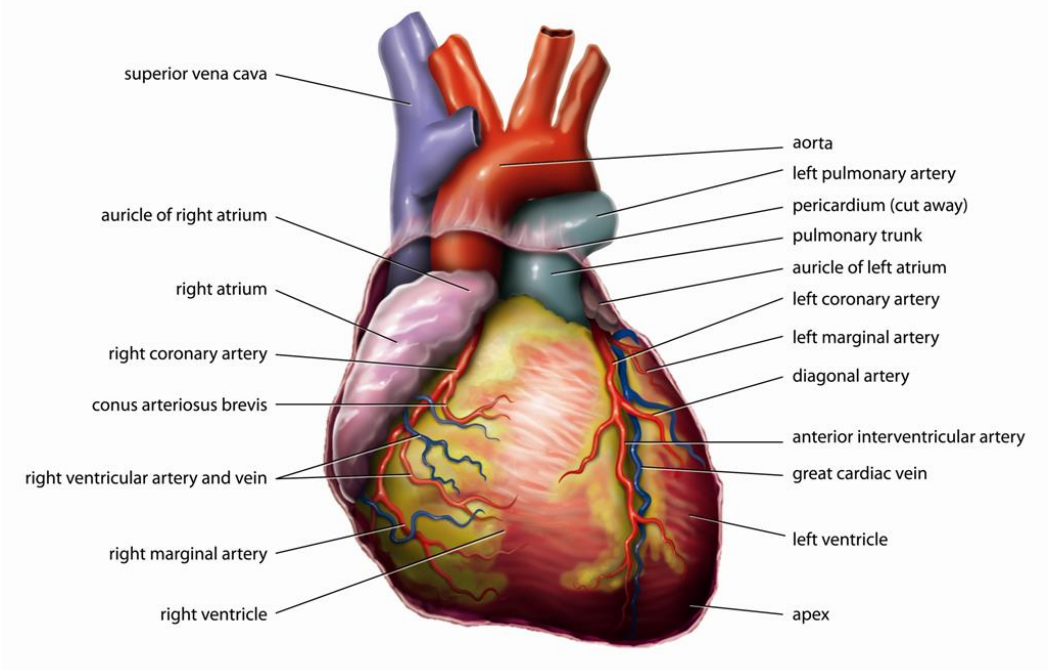
- Muscular tissue arrangement
  - Different for atria and ventricles
  - Reflects mechanical functions
- Different pressure regimes
- Four valves
  - Two regulate internal blood flow
  - Two regulate in → out blood flow

Thin on atria and thick tight on ventricles

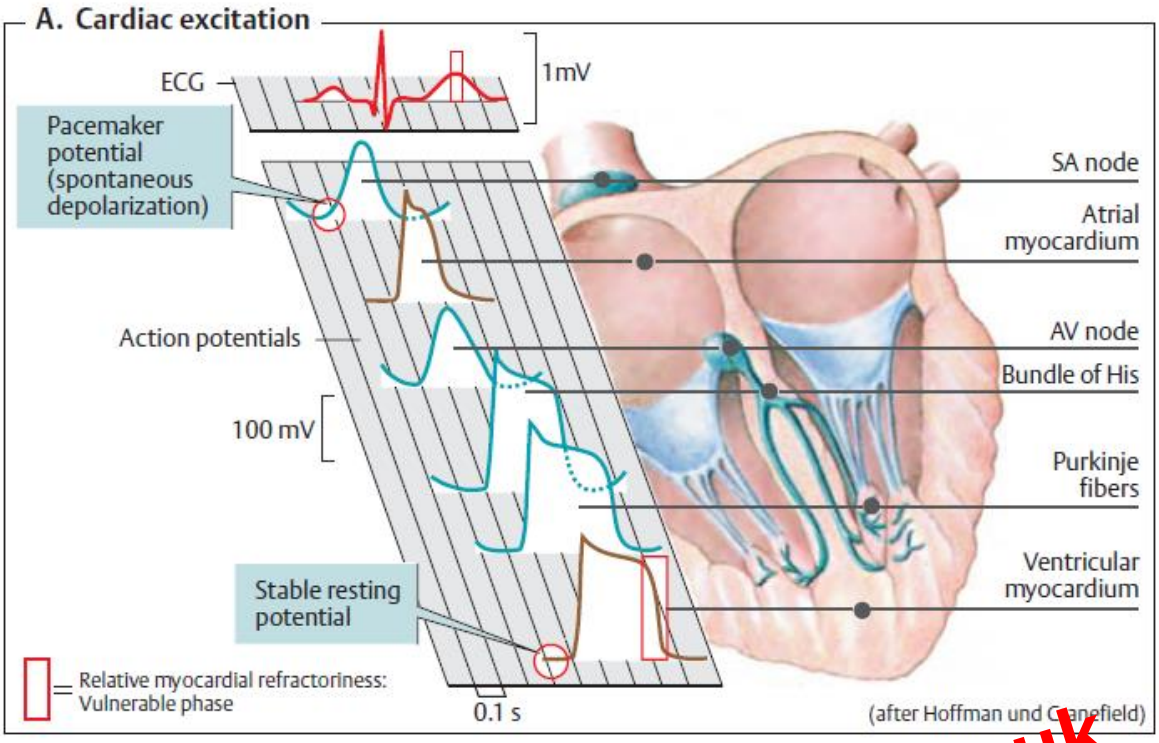
- Internal Valves
  - Tricuspid
  - Bicuspid (Mitral)
- In too out valves
  - Semilunar valves

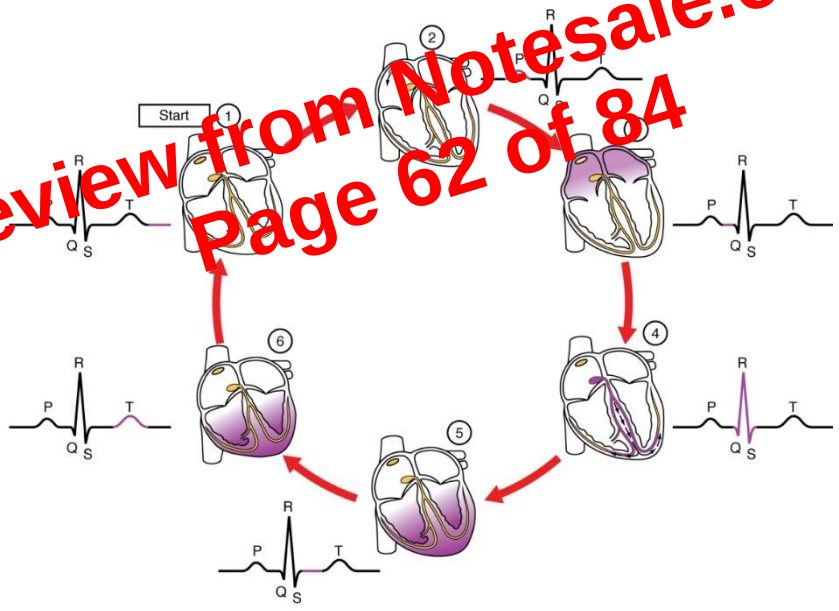


The Coronary Circulation:



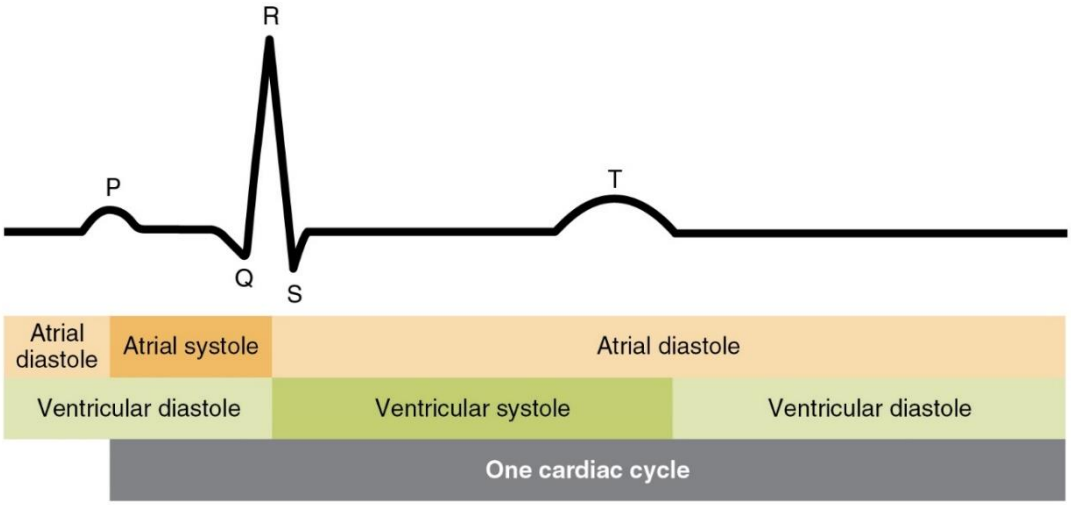
All components of the conduction system can depolarize spontaneously, but the SA node is the natural or nomotopic pacemaker in cardiac excitation. The intrinsic rhythms of the other pacemakers are slower than the sinus rhythm.





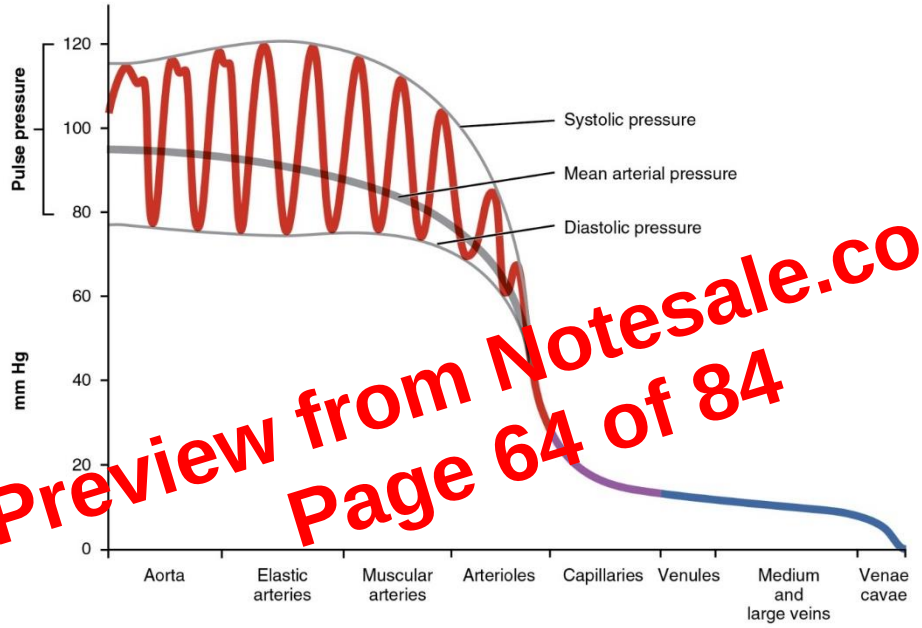
- Pacemaker system consists of cells that do not have a resting potential
- They slowly depolarize until the threshold potential is reached and an action potential is generated

The Aps spontaneous depolarization normally does not occur in the myocardium.

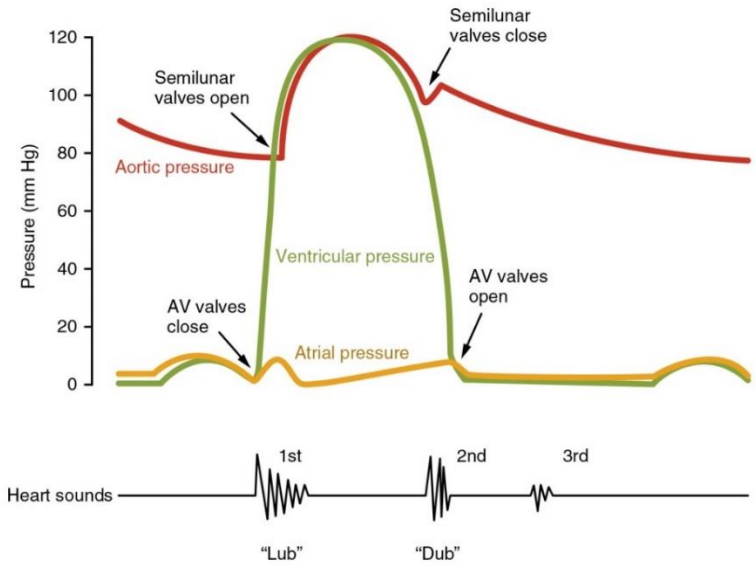


Circulatory System:

- Blood pressure changes continuously

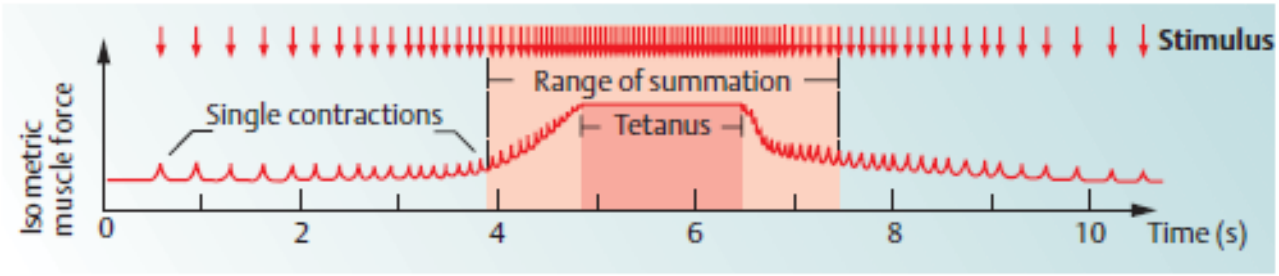


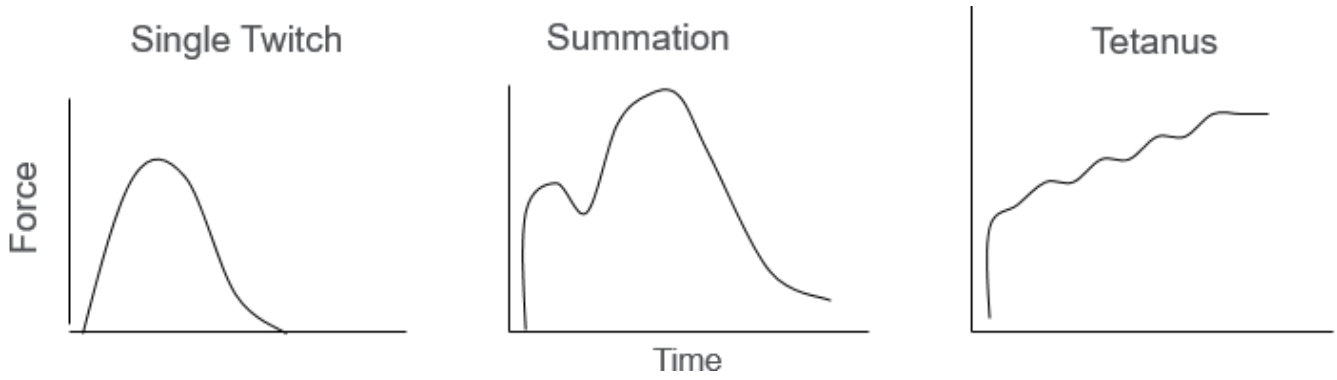
Pressure variations in Cardiac Cycle:



Twitch vs. Tetanus:

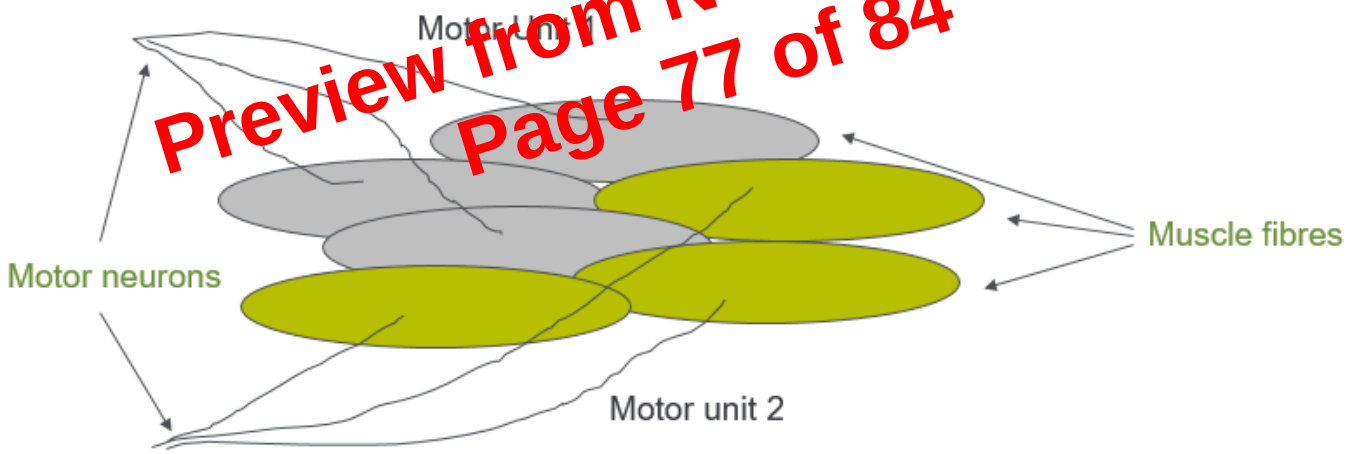
- Action potential is much shorter than the contraction, so it is possible to re-excite the muscle fibre before the previous contraction has finished





Motor Units:

- Recruitment of multiple motor units:
  - At different times
  - In different amount



Types of Contraction:

- Isometric contraction: muscle remains at the same length but produces tension (pushing, supporting)
- Isotonic contraction: muscle remains at the same tension but shortens (movement)