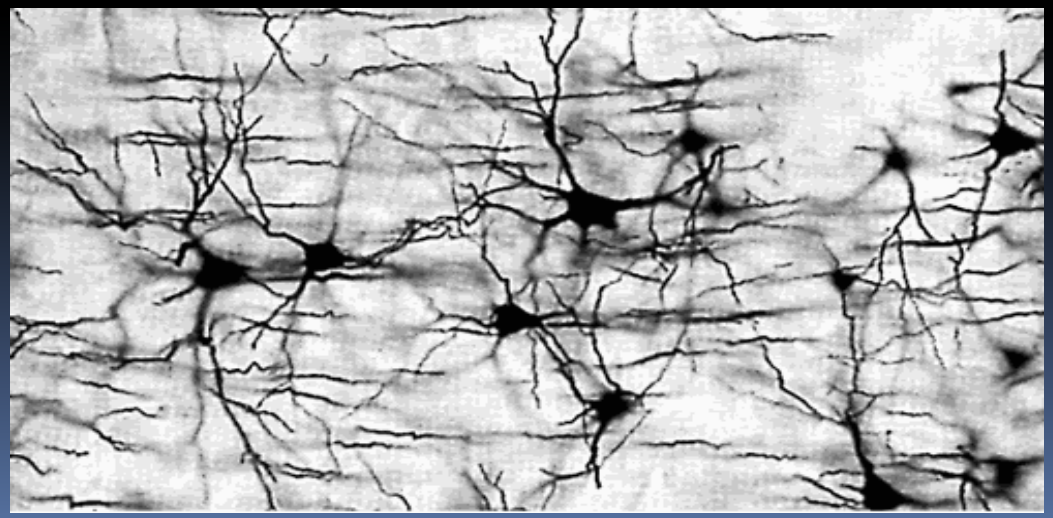
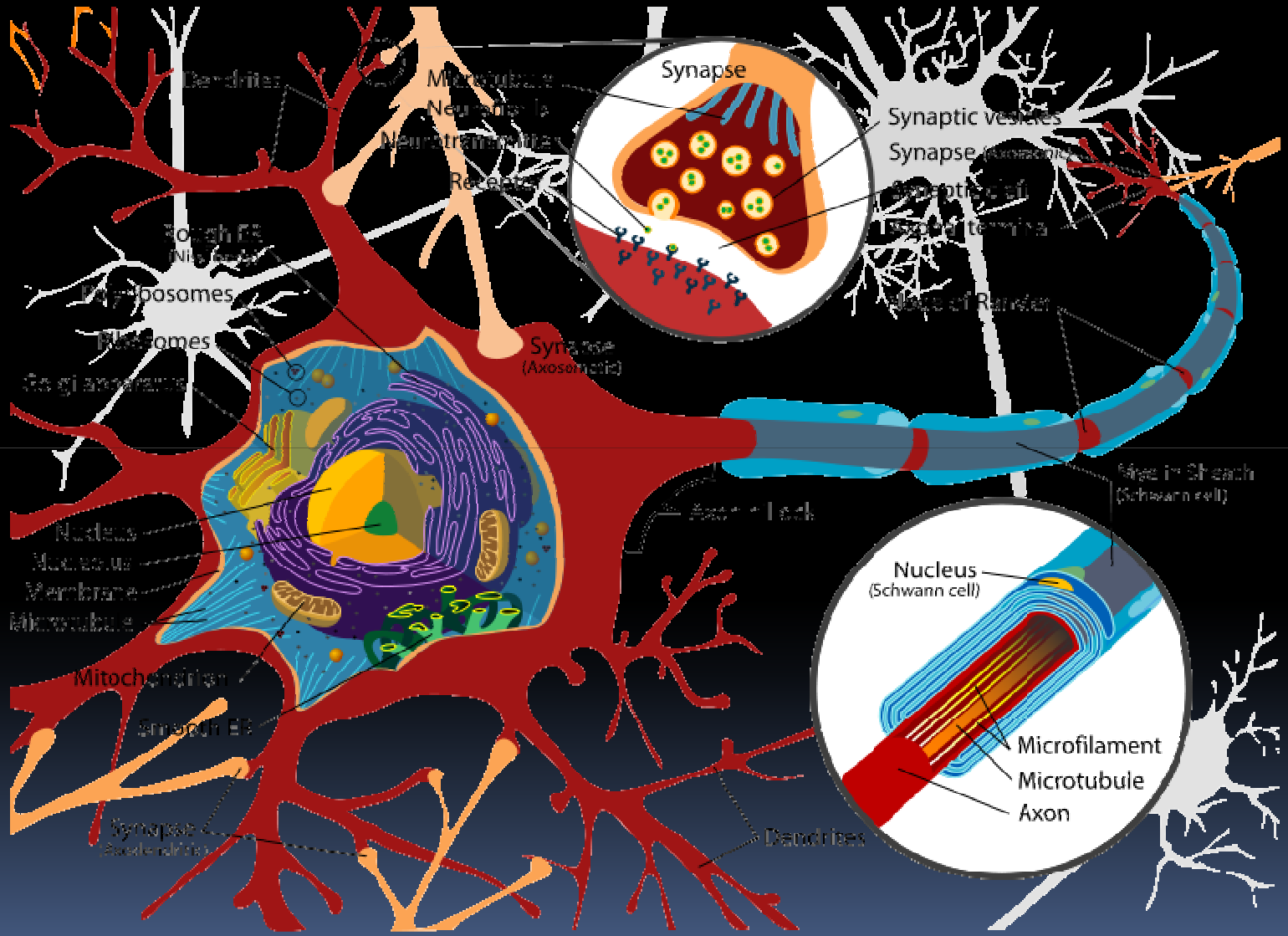
HUMAN NERVOUS SYSTEM – IMPULSE CONDUCTION

INTRODUCTION :

•Neurons/ Nerve cells are the basic structural elements of the nervous system.
•Form part of a communication network.
•Neurons on their own cannot do much, but large networks of neurons produce complex behaviours.
•All human behaviour is based on impulses firing in neurons.



SCHEMATIC REPRESENTATION OF THE NEURON – PG 61



PARTS OF THE NEURON

DENDRITES
•Receive messages from other neurons.

SOMA / CELL BODY
•Receive messages from other neurons.
•Can send it's own messages – nerve impulses.

CELL NUCLEUS
•Control centre.
•Controls all the metabolic activities in the cell.

AXON
•Axons differ in length and thickness.
•Connect parts of the body that may be some distance apart.

➢Bundle of axons in the brain and spinal cord = nerve tract
➢Bundle of axons outside the brain and spinal cord = nerve

MYELIN SHEATHS

•Enclose the axon.
•Instrumental in effectively conducting impulses along the axon.

AXON TERMINALS / TELODENDRIA

•Branches at the end of the axon.

BOUTONS

•Contain tiny vesicles, filled with neurotransmitters.

NEUROTRANSMITTERS

•Chemical substance.
•Play an instrumental role in the conduction of impulses from one neuron to another.

TYPES OF NEURONS

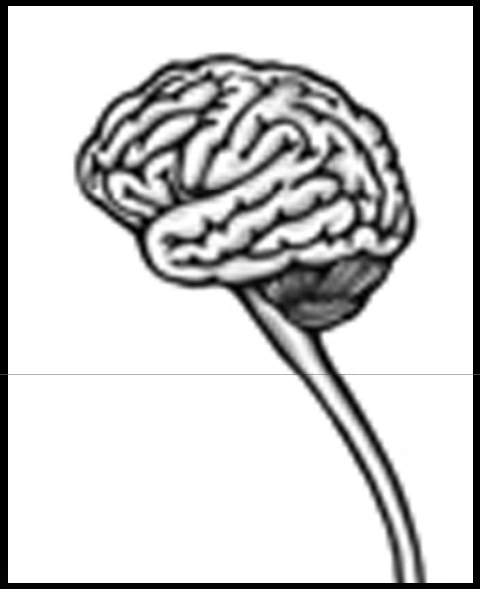
Neurons are classified according to the functions they perform.

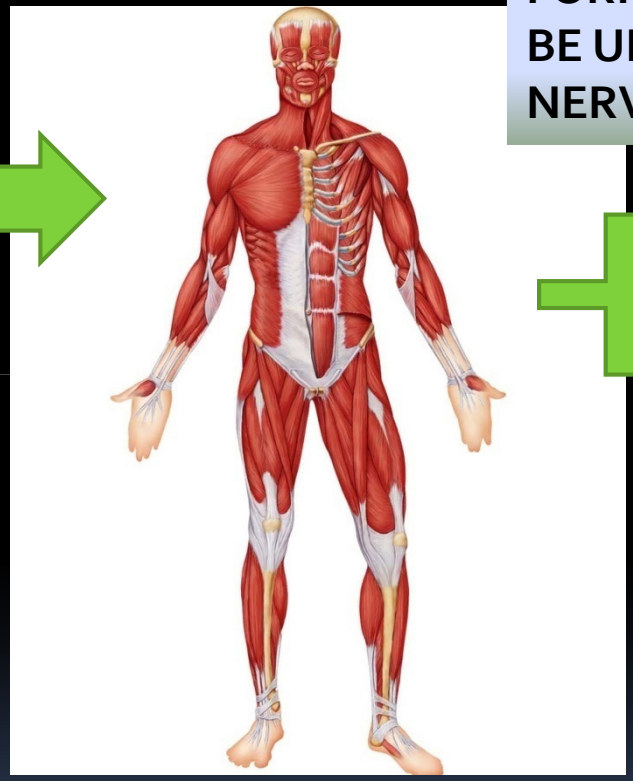
1. SENSORY / AFFERENT NEURONS
(receives information from external + Internal stimuli)

- Information detected by senses and carried to the brain and spinal cord. Information my also come from some of the organs inside the body.

2. MOTOR / EFFERENT NEURONS
(SENDS INTERNAL MESSAGES)

STIMULUS REFERS TO THE FORM OF ENERGY THAT IS RECEIVED BY THE SENSES AND CONVERTED INTO A FORM OF ENERGY THAT CAN BE UNDERSTOOD BY THE NERVOUS SYSTEM.





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GLANDS

•Neurons conduct information from the brain and spinal cord to the muscles and glands.

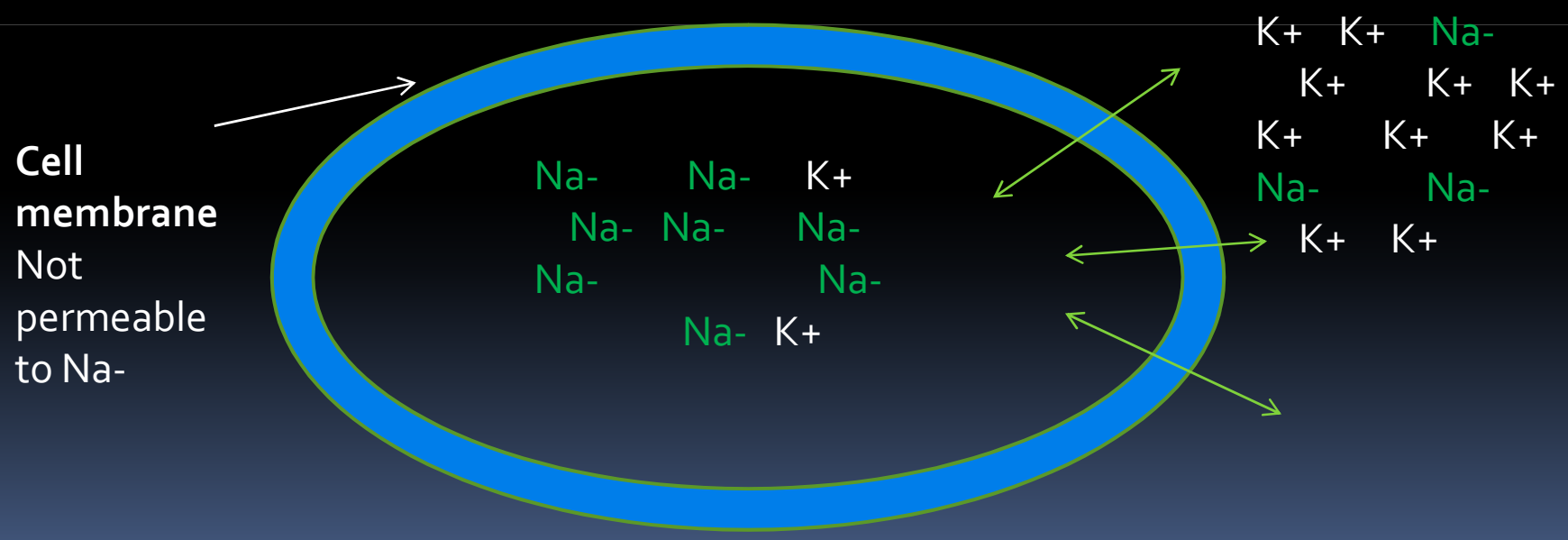
THE PROCESS OF IMPULSE CONDUCTION

Impulse conduction the basic form of sending information in the nervous system

1. **Electrical process :**

A nerve impulse begins in the first segment of the axon and travels down the axon to the terminals, this is because of electrical events in the cell membrane.

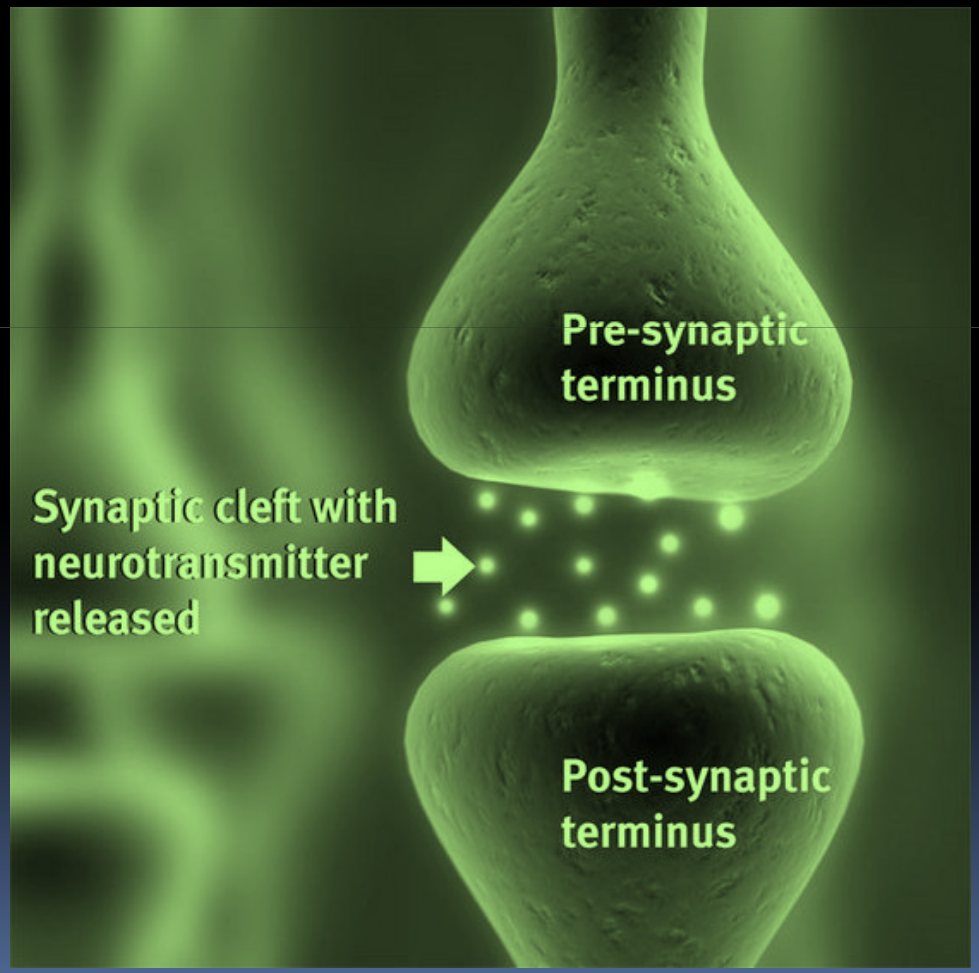
Movement of ions



Na - = sodium/negatively charged K+ = Protein/positively charged

2. CHEMICAL PROCESS :

The passage of the nerve impulse from one neuron to another.



ELECTRICAL

ELECTRICAL

RMP – RESTING MEMBRANE POTENTIAL :

•Condition of readiness.
•An electrical charge brought about by the difference between the positive and negative ions.
•At this stage the neuron is ready to receive information in the form of electrical impulses.

AP – ACTION POTENTIAL :

•If the **RMP** changes enough the cell will reach a threshold or critical point.
•Different neurons have different thresholds.
•When the electrical charge is strong enough to exceed the threshold, the **RMP** is changed into **AP**.
•Now the stimulus (electrical impulse) is conducted along the axon.
•The structure of the axon changes: tiny openings/channels in he membrane allow ions to outside the cell membrane to move inside.
•Channels open near the soma and **AP** sweeps along the axon.
•The inside of the cell is now more positively charged.

ELECTRICAL

RP – REFRACTORY PERIOD :

•**RP** is the period when the neuron is not ready to fire.
•The movement of ions, changes the electrical charge in the cell so that immediately after the impulse has been conducted the neuron is not ready to send another impulse until the **RP** has been restored.
• 2 types of refractory period :

1. ABSOLUTE REFRACTORY PERIOD –
No impulse can be generated.

2. RELATIVE REFRACTORY PERIOD –
An impulse can be generate, but only with a very intense stimulus.

•The **RMP** prevents the nervous system from over-stimulation, by regulating the relationship between stimulus intensity and impulse frequency.

CHARACTERISTICS OF IMPULSE CONDUCTION

ELECTRICAL

ALL-OR-NOTHING EVENT:

The cell provides the energy, the energy does not come from the stimulus.

STRENGTH AND SPEED:

•The strength and speed of impulse conduction is constant in a particular neuron.
•Strength and speed impulse conduction may however vary with nerve fibres of different sizes.
•The greater the diameter of a nerve fibre the stronger the impulse and faster the conduction.

large fires : 100m per second **small fibres : 100 cm per second**

FREQUENCY:

The more intense the stimulus the more frequently the impulse will be conducted. Because the shorter the space is before firing.

EFFECT OF MYELINNATION :

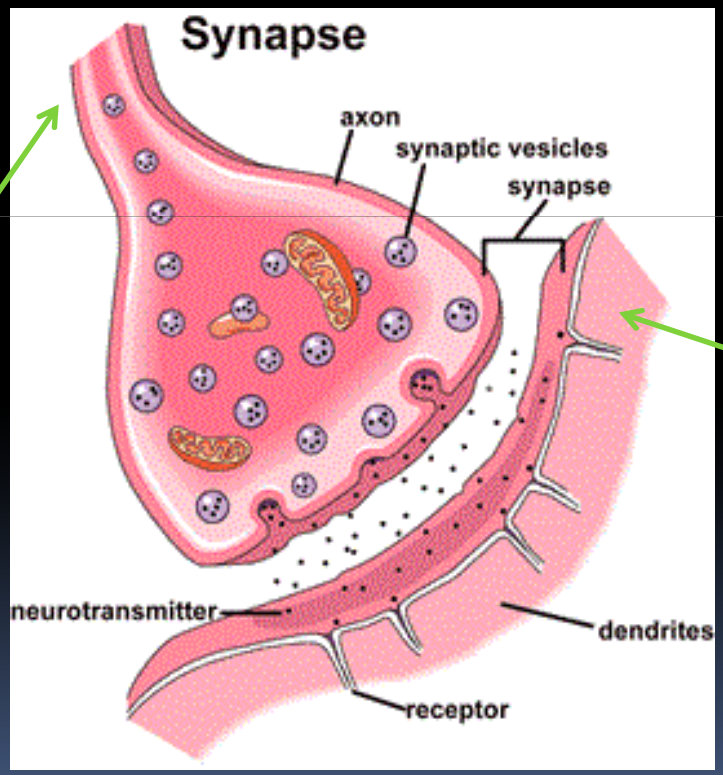
AP travels much faster along a myelinated axon than an un-myelinated axon. Myelin sheaths insulate the axon, there are tiny gaps/nodes between the sheaths and the impulse jumps from node to node. I this way conduction is faster and uses less energy.

SYNAPTIC TRANSMISSION OF IMPULSES

CHEMICAL

- The point where information moves from one neuron to another.
- The microscopically small gap between the neurons = synapse.
- When **AP** reaches the axon terminals it causes chemicals to be released into the synaptic cleft.

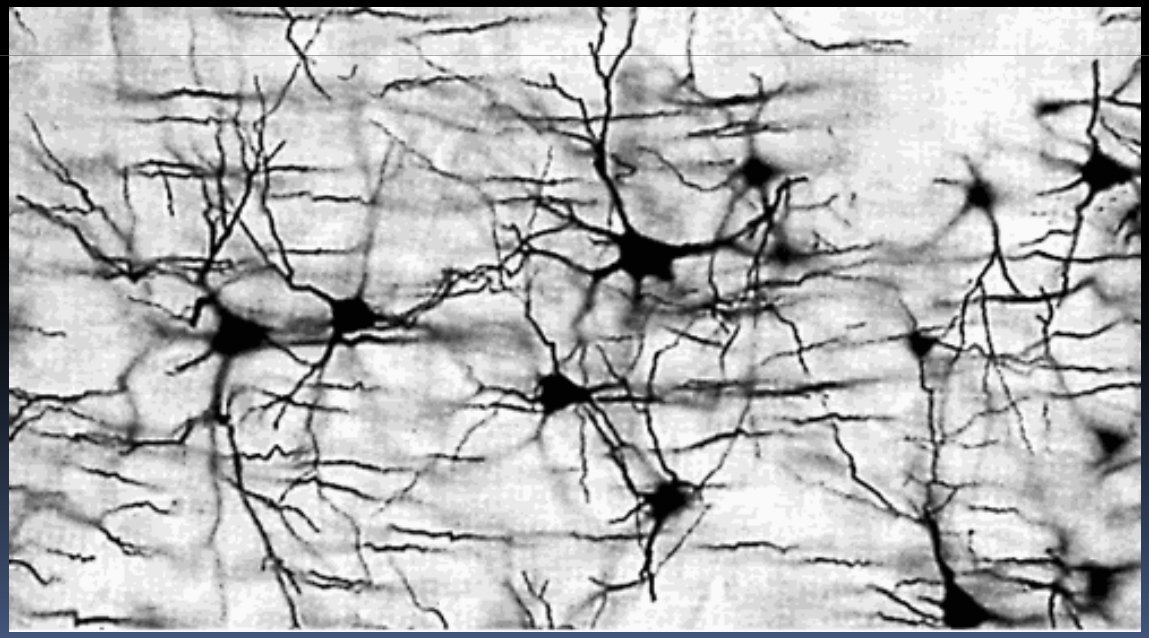
Presynaptic membrane



Postsynaptic membrane

NUROTRANSMITTERS

- These are chemical that allows contact between the neurons.
- Vesicles containing the **NTMR** attaches themselves to the presynaptic membrane. The membrane opens and the **NTMR** mix with the fluid outside the cell and combine with receptors of the postsynaptic membrane.
- Neurons use different **NTMR**, but one kind per neuron.



POSTSYNAPTIC POTENTIALS

•Some **NTMR** excite and some inhibit.
•Excitory **NTMR** : The **NTMR** are more likely to produce an **AP** in the next neuron.
•Inhibitory **NTMR** : The **NTMR** inhibits the production of an **AP** in the next neuron (stops the impulse from firing).
•The **NTMR** is now either undergo a process of:

- re-uptake
- Diffuse away
- Be broken up by enzymes
- Bounce around

Weak impulses can be strengthened by additional **NTMR**

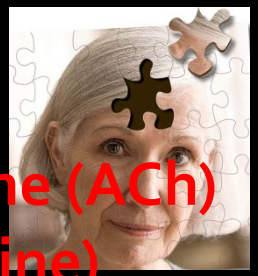
Spatial summation: reinforcement from several axons.
Temporal summation: frequent **AP** along the same axon.

NATURE OF NEUTRANSMITTERS

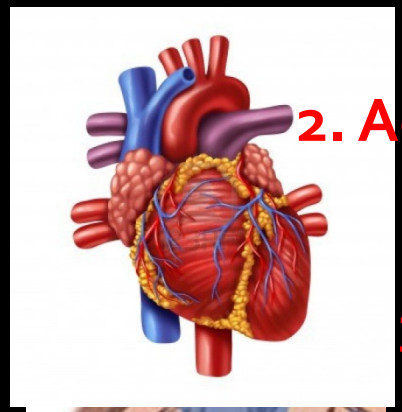
NTMR can be either excitory or inhibitory, but many times can have both effects.
Whether the **NTMR** has an excitory or inhibitory effect will depend on:

- The nature of the **NTMR**.
- The place where it acts.
- The quantity of **NTMR** in relation to the enzymes that destroy it.
- The amount of one or the other **NTMR** at a particular synapse.

CLASSIC NEUROTRANSMITTERS



1.Acetylchline (ACh)
(epinephrine)



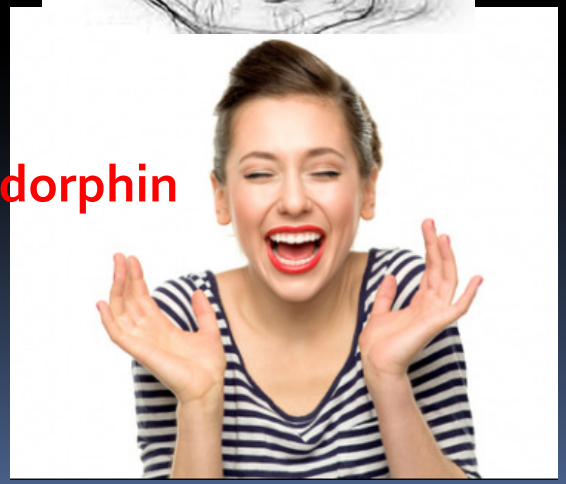
2. Adrenalin

3.Noradrenalin (NA)

4.Dopamine (DA)

5. Serotonin

6.Gamma-aminobutyric acid (GABA)



7. Endorphin