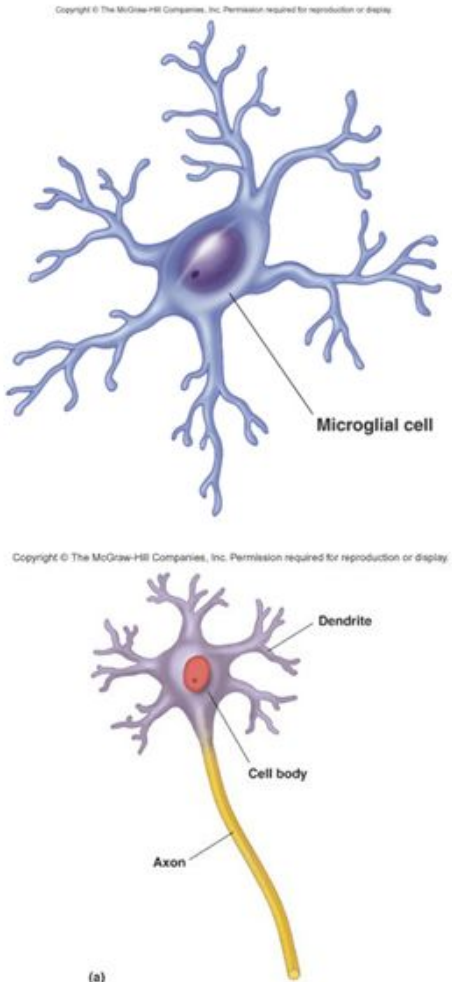
Unit 5

# NERVOUS SYSTEM, IMMUNE SYSTEM AND CELL SIGNALLING

## NERVOUS SYSTEM

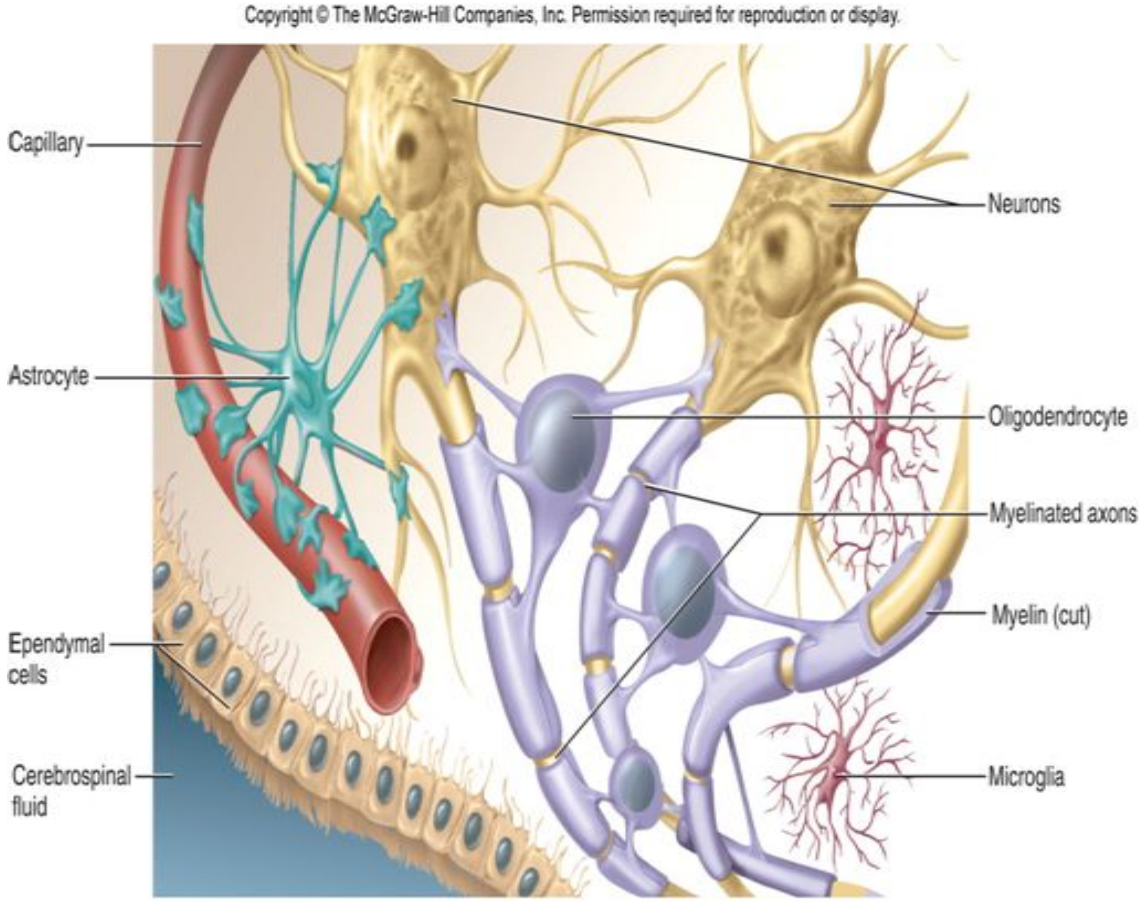
# CELLS OF THE NERVOUS SYSTEM

- The complex nature of the brain and associated nervous system allow the human beings to perform activities superior to other animals.
- The highly sophisticated neural machine, the brain, accomplishes this task by using nerve cells and the connections between them.
- The nervous system has two classes of cell: glial cells and nerve cells.




- **Glial cells** or neuroglia
  - Support and protect neurons
- **Neurons** or nerve cells receive stimuli and transmit action potentials
  - Organization
    - **Cell body** or soma
    - **Dendrites**: input
    - **Axons**: output

# 1. SUPPORTING CELLS :GLIAL CELLS




The supporting cells

- Provide a supportive scaffolding for neurons
- Segregate and insulate neurons
- Guide young neurons to the proper connections
- Promote health and growth

# TYPES OF GLIAL CELLS

## Six Types of Neuroglial Cells

- **Oligodendrocytes** form myelin sheaths in **CNS**
  - each wraps processes around many nerve fibers
- **Astrocytes**
  - contribute to BBB & regulate composition of brain tissue fluid
  - most abundant glial cells - form framework of CNS
  - sclerosis – damaged neurons replace by hardened mass of astrocytes
- **Ependymal cells** line cavities & produce CSF
- **Microglia** (macrophages) formed from monocytes
  - concentrate in areas of infection, trauma or stroke
- **Schwann cells** myelinate fibers of **PNS**
- **Satellite** cells with uncertain function

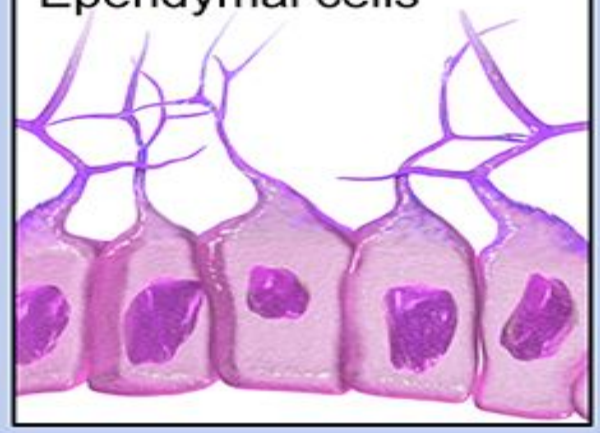
**Glial Cell Types by Location and Basic Function**

| CNS glia | Basic function |
|---|---|
| Astrocyte | Support |
| Oligodendrocyte | Insulation, myelination |
| Microglia | Immune surveillance and phagocytosis |
| Ependymal cell | Creating CSF |

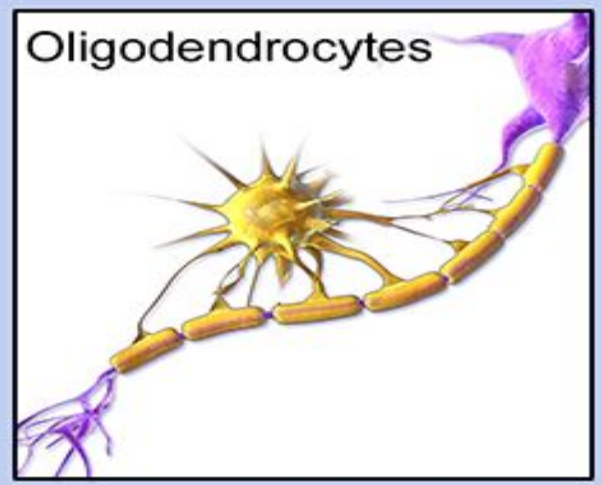
# Types of Neuroglia

## *Central Nervous System*

Ependymal cells

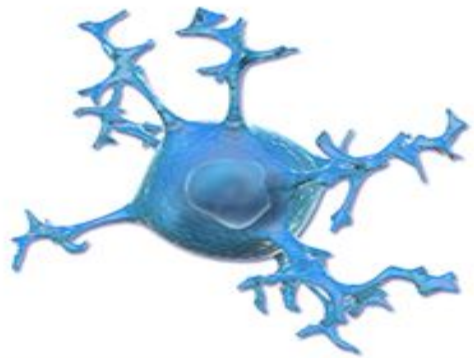


Oligodendrocytes



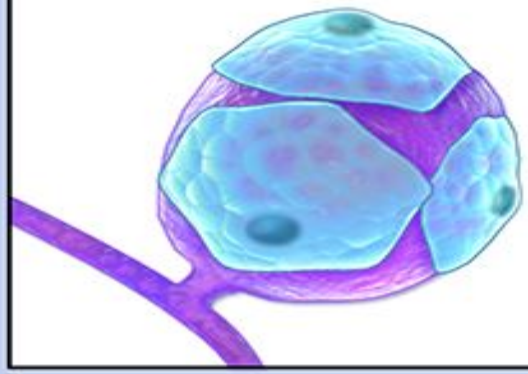
Astrocytes

Microglia



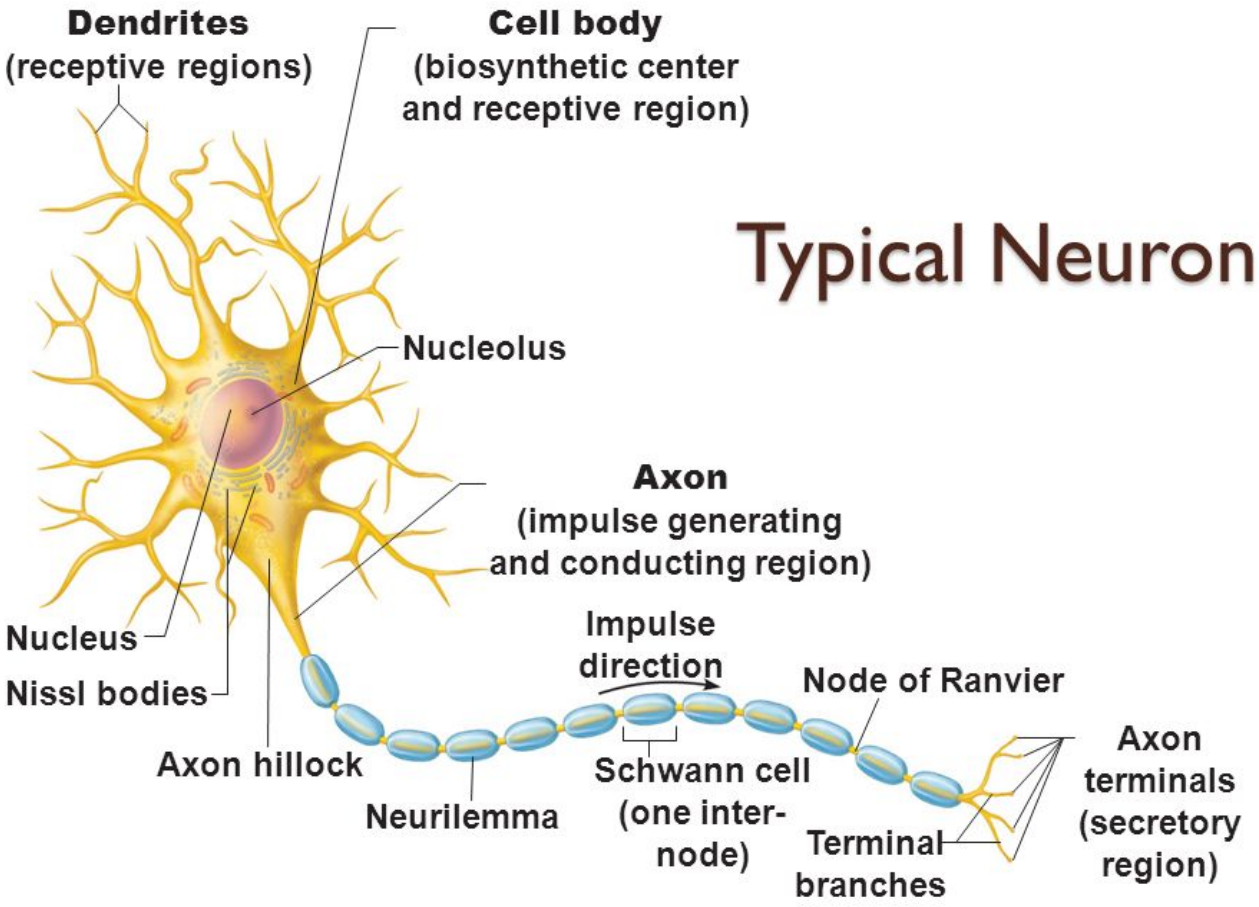
## *Peripheral Nervous System*

Satellite cells



Schwann cells

# 2. NERVE CELLS




## Nodes of Ranvier

-- are bare spots where myelin is ***not*** present

-- allows impulse to "**jump**" from one node to the next & further ***increase*** speed of transmission

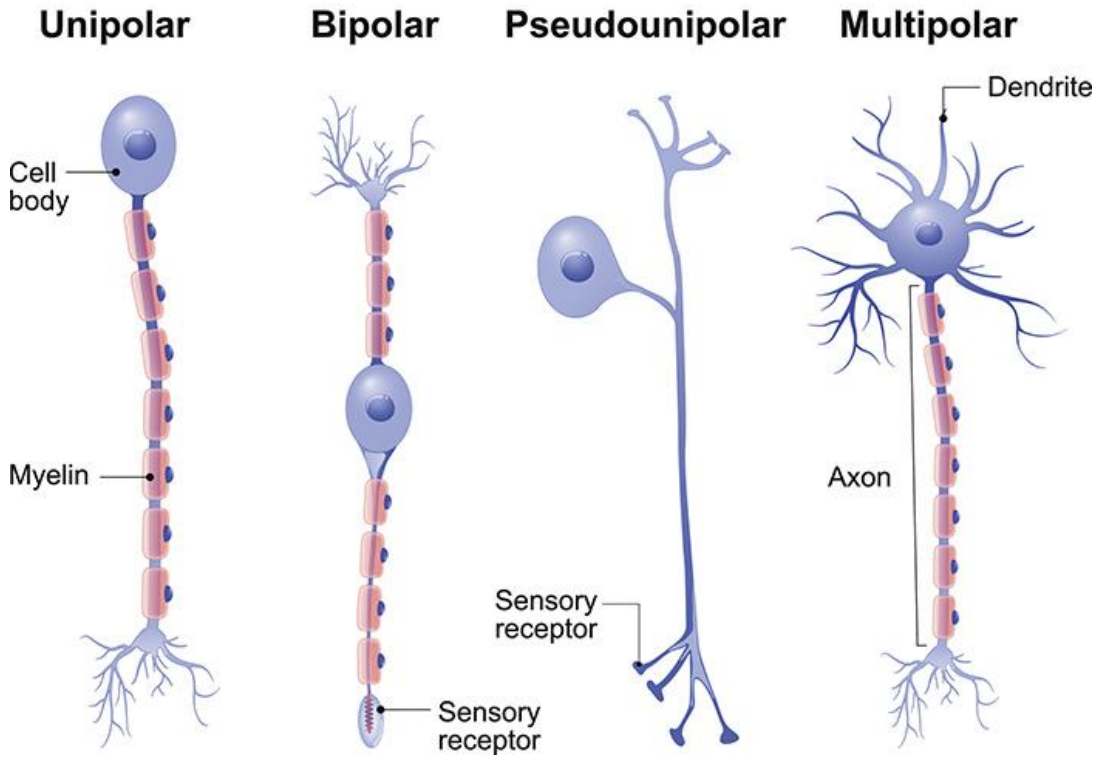
- The Nissl substance is responsible for synthesizing protein, which flows along the dendrites and the axon and replaces the proteins that are broken down during cellular activity.

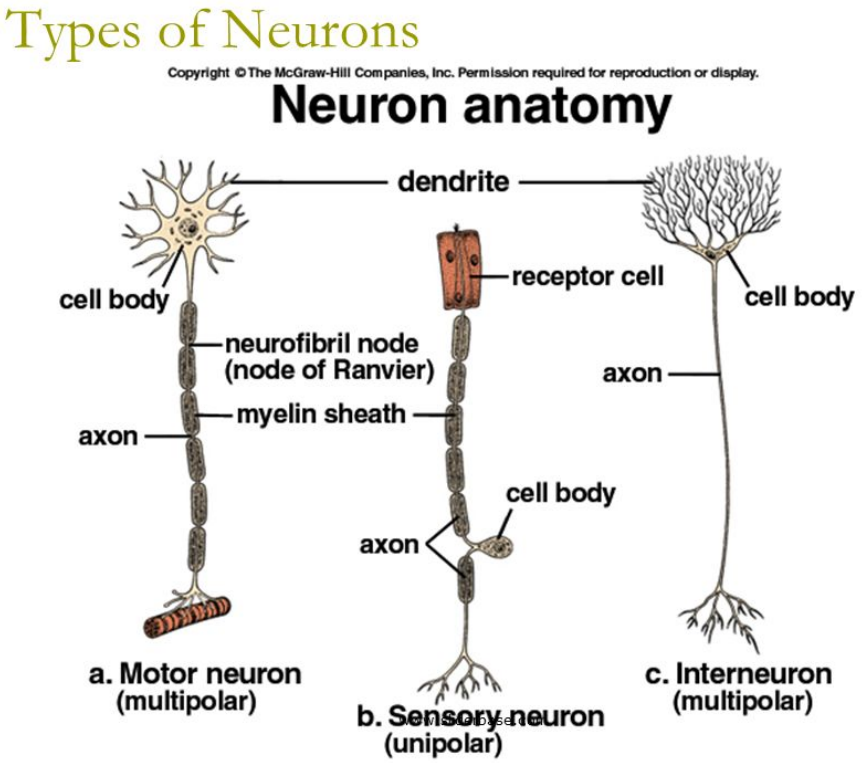
**AXON HILLOCK** is the area on the soma where the action potential of the neuron builds up before it transmits the signal down the axon.

## Schwann cells

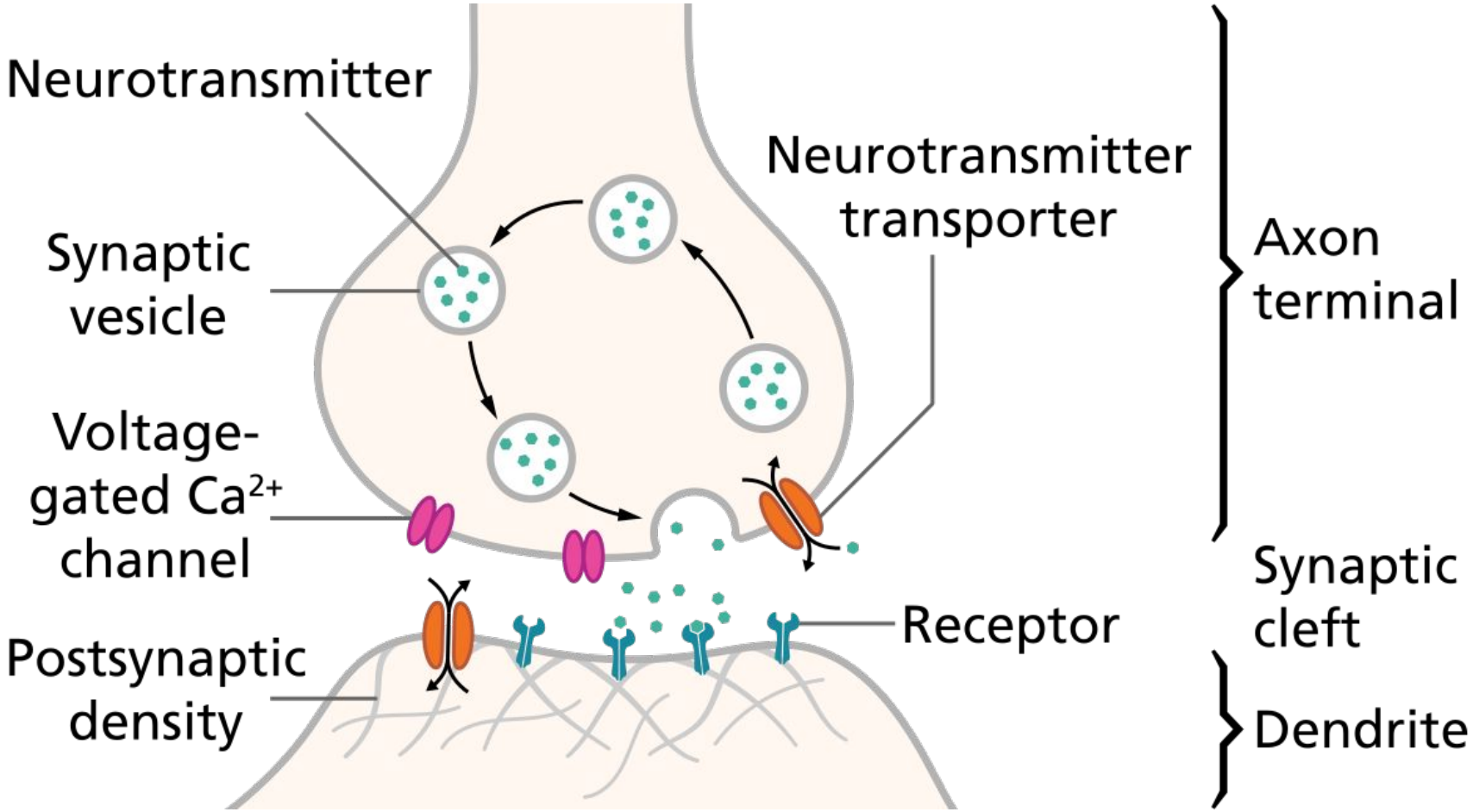
– **Form myelin sheath in the peripheral nervous**

# TYPES OF NERVE CELLS



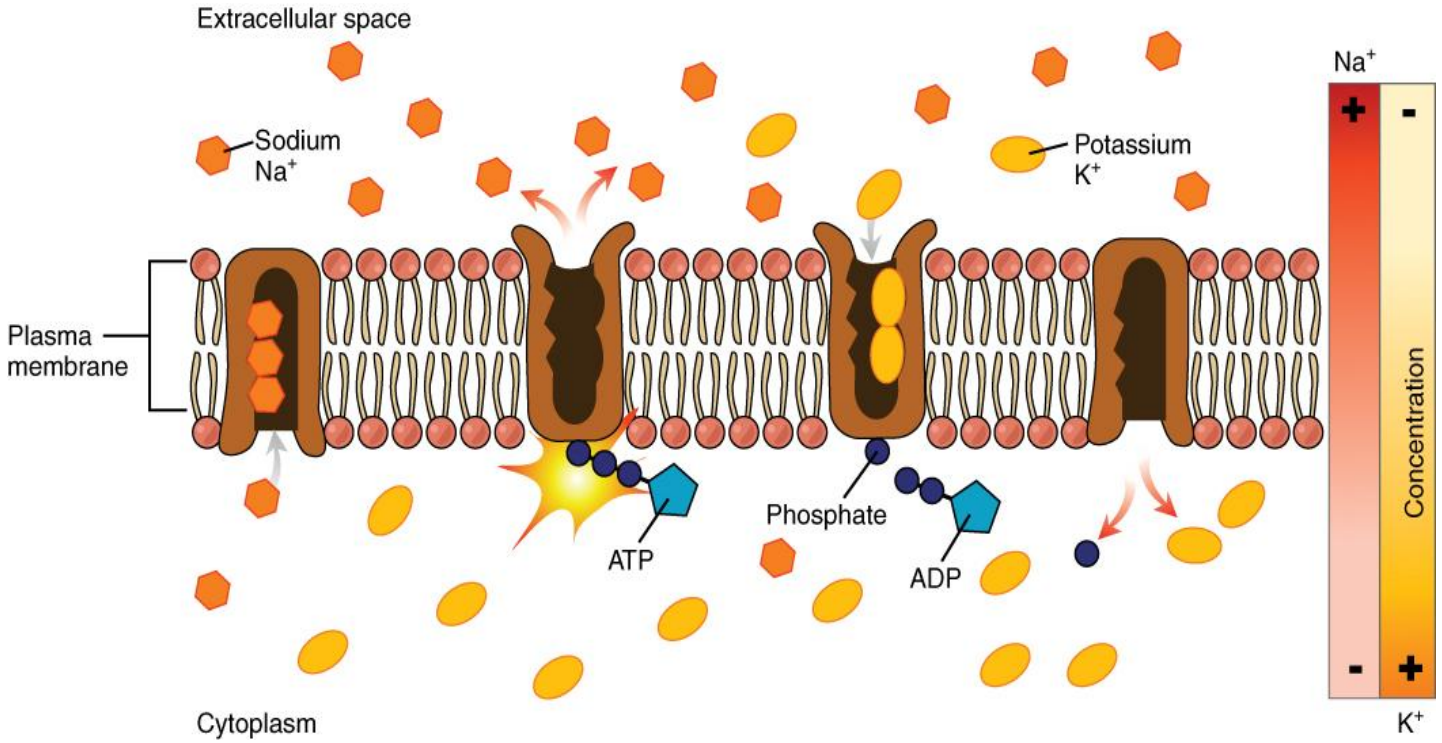



# SYNAPSE

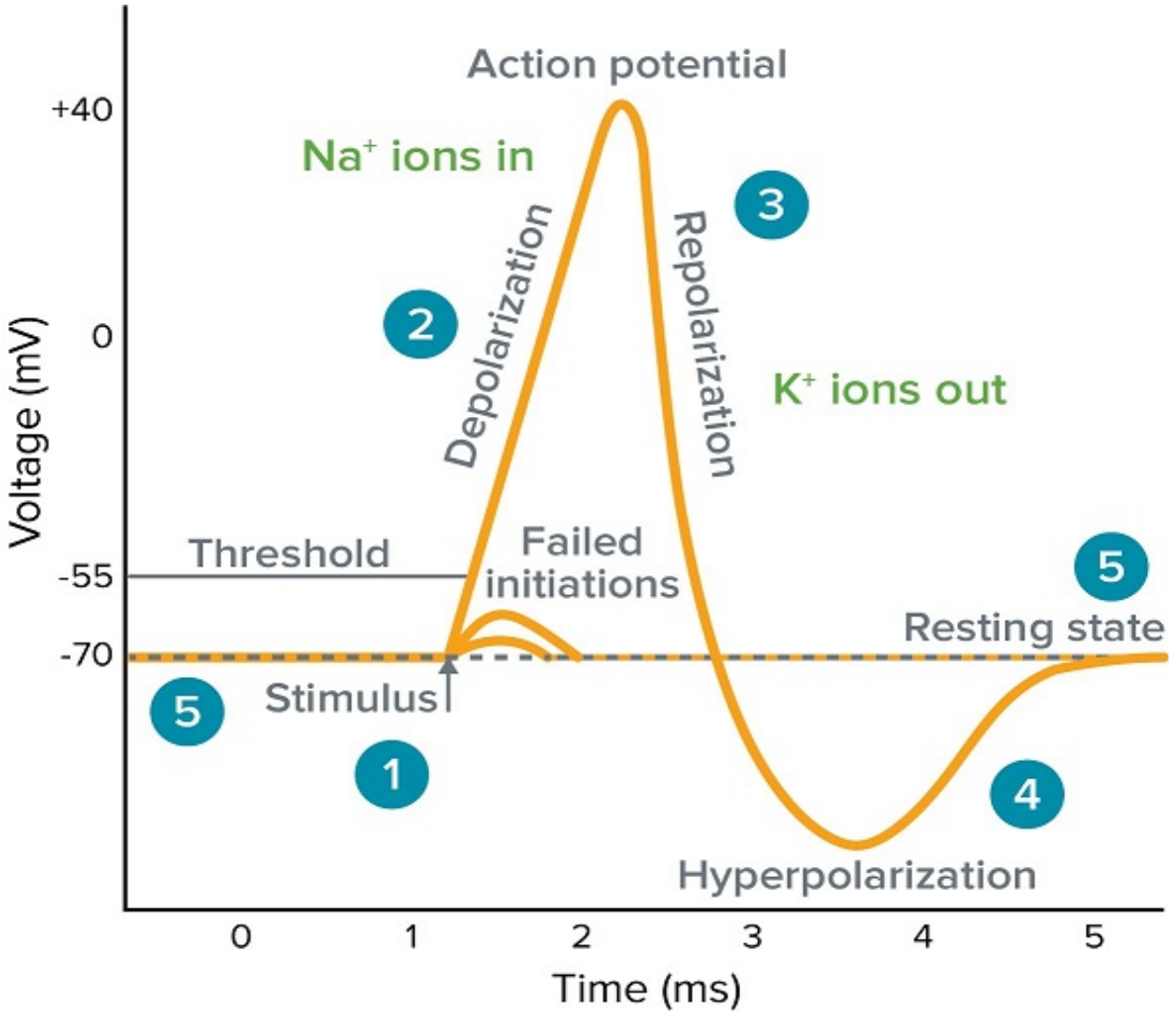

Neurotransmitter
Synaptic vesicle
Voltage-gated $Ca^{2+}$ channel
Postsynaptic density
Neurotransmitter transporter
Receptor
Axon terminal
Synaptic cleft
Dendrite

# ACTION POTENTIAL

- **The unique feature of the neurons to generate an electrical current in response to excitation is called action potential.**
- **After entry of sodium ion from outside, they travel to axon hillock where the summation of all electrical currents occur.**
- **Neural signals which are excitatory open Na+ channels while others which are inhibiotory open Cl- and K+ channels**
- **Depending on the strength of the signals, the axon hillock decides whether to propagate or not propagate the action potential.**

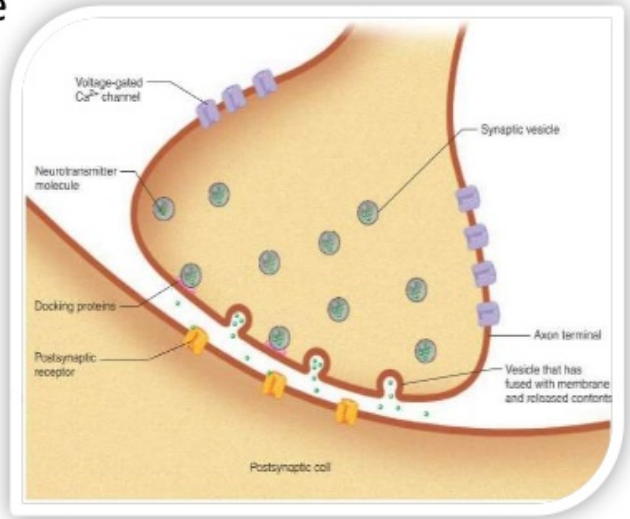


# ACTION POTENTIAL

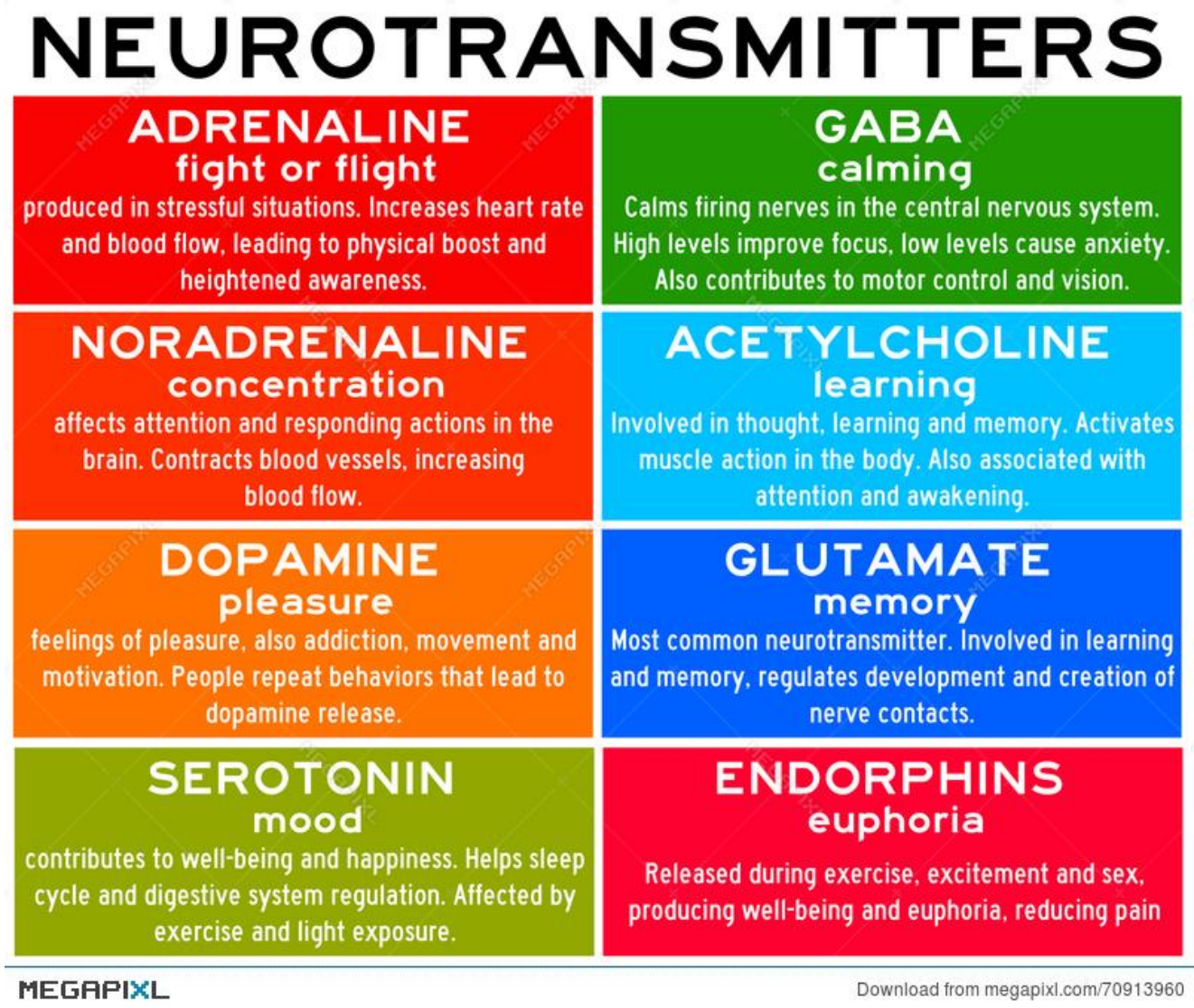


# NEUROTRANSMITTORS

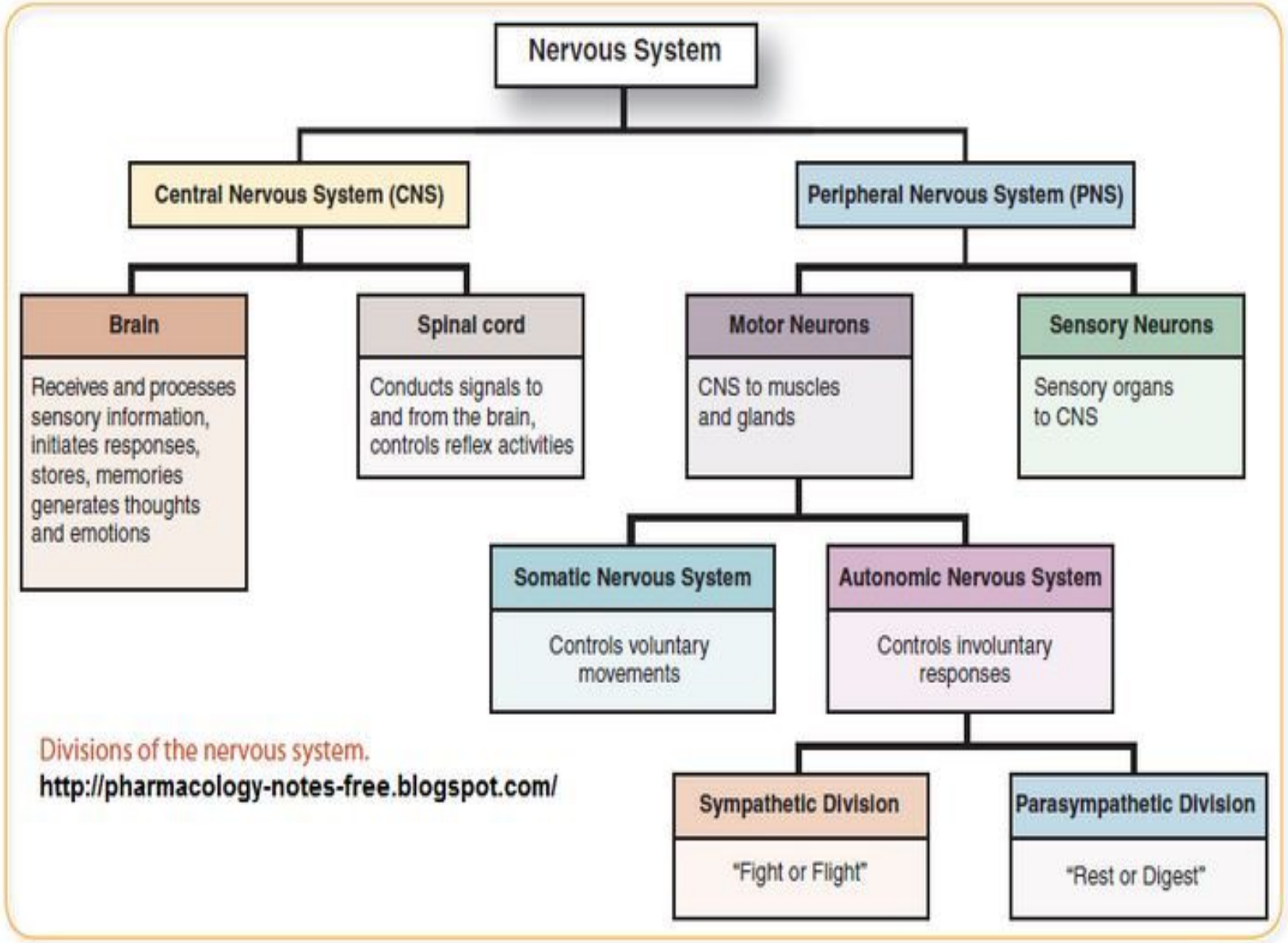
Neurotransmitters are the chemical substances which are responsible for transmission of an impulse through a synapse.




Schematic diagram of synapse

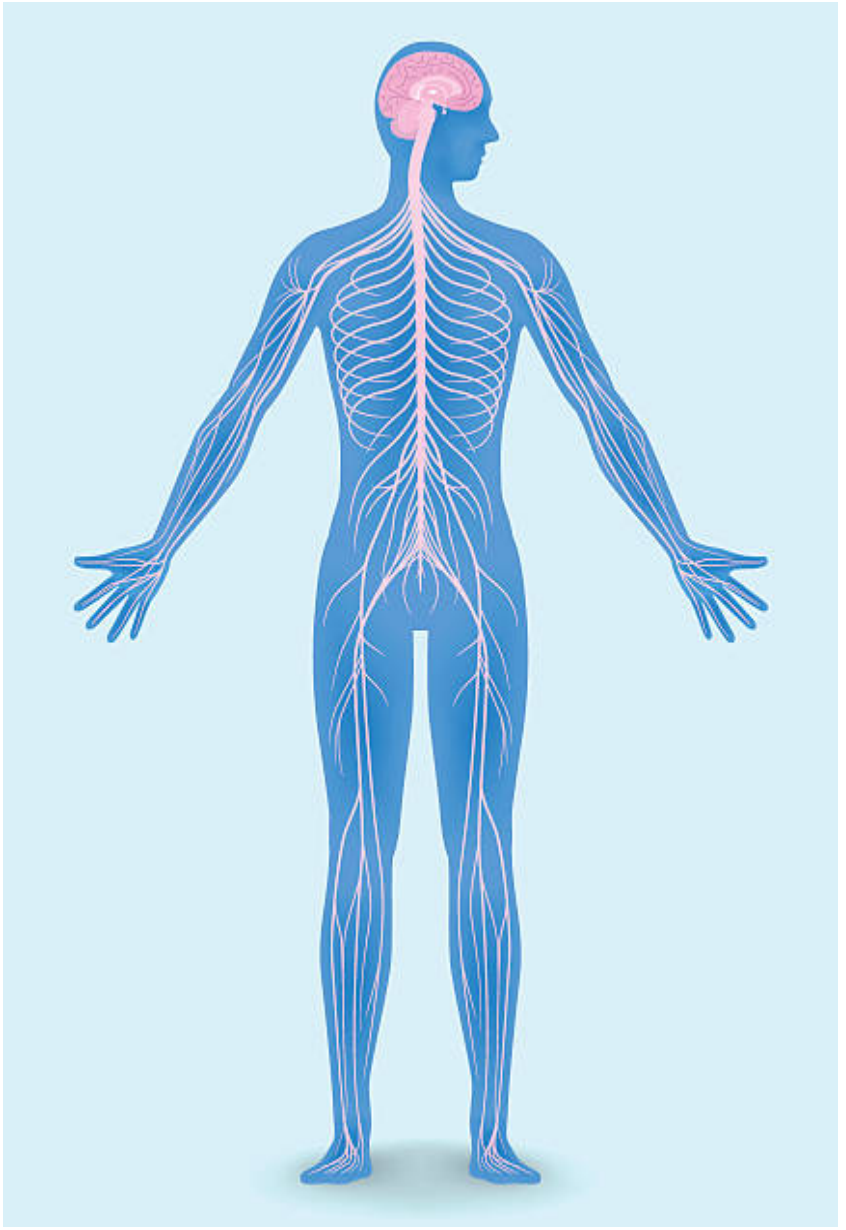


# ORGANIZATION OF NERVOUS SYSTEM




Divisions of the nervous system.

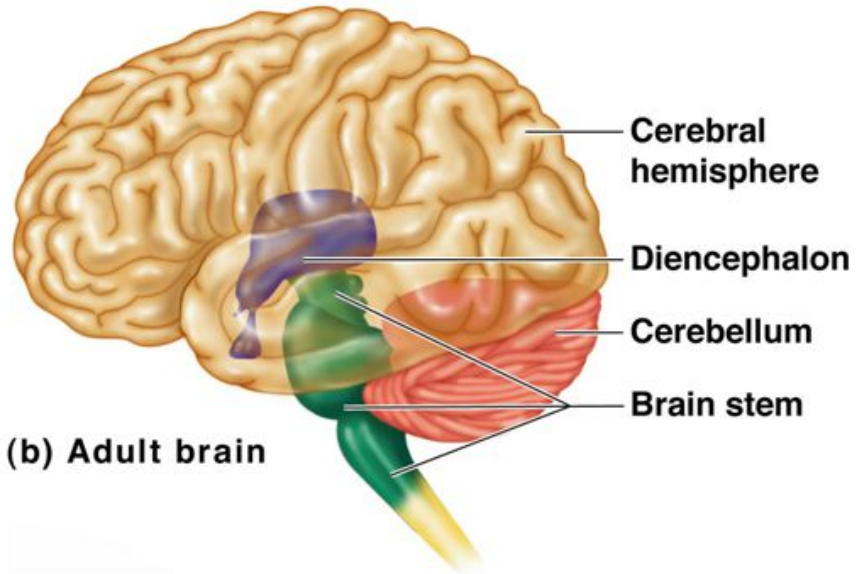
http://pharmacology-notes-free.blogspot.com/



# CENTRAL NERVOUS SYSTEM

## Regions of the Brain

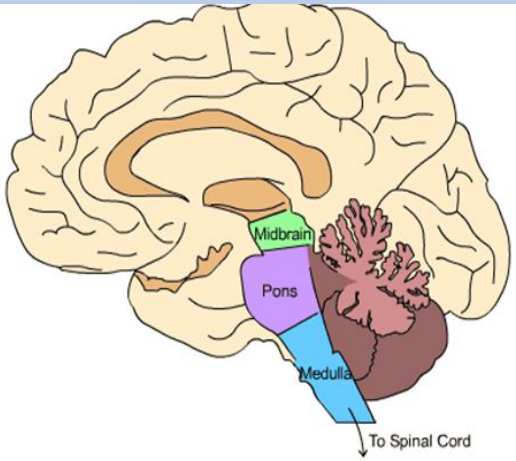
1. Cerebral hemispheres (cerebrum)
2. Diencephalon
3. Brain stem
4. Cerebellum



# CENTRAL NERVOUS SYSTEM

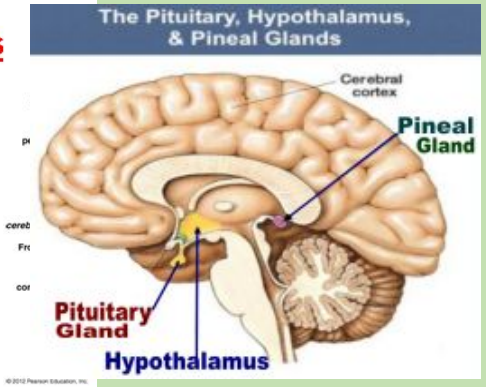
- Largest part of the brain (specifically the forebrain
- Cerebral cortex is thrown into folds (gyri) and fissures (sulci).
- Cerebral cortex divided into lobes i.e temporal, frontal, parietal and occipital by theses grooves .
- Control functions like thinking speech, emotions, vision, pain, hearing etc.

- **Pons**
  - Relay station for cortex
- **Medulla oblongata**
  - **Controls vital functions**
    - Heart rate
    - Breathing
    - Blood pressure
    - Swallowing
    - vomiting

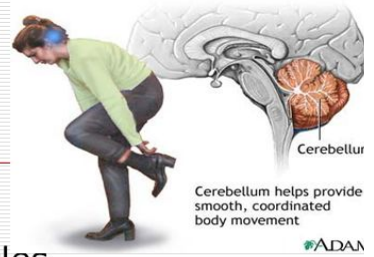



Diencephalon has two parts: Thalamus and Hypothalamus

- Thalamus
  - Relays and processes **sensory** information
- Hypothalamus
  - Hormone production
  - Emotion
  - Autonomic function
- Pituitary gland
  - Major endocrine gland
  - Connected to hypothalamus
  - Via **infundibulum** (stalk)
  - Interfaces nervous and endocrine systems

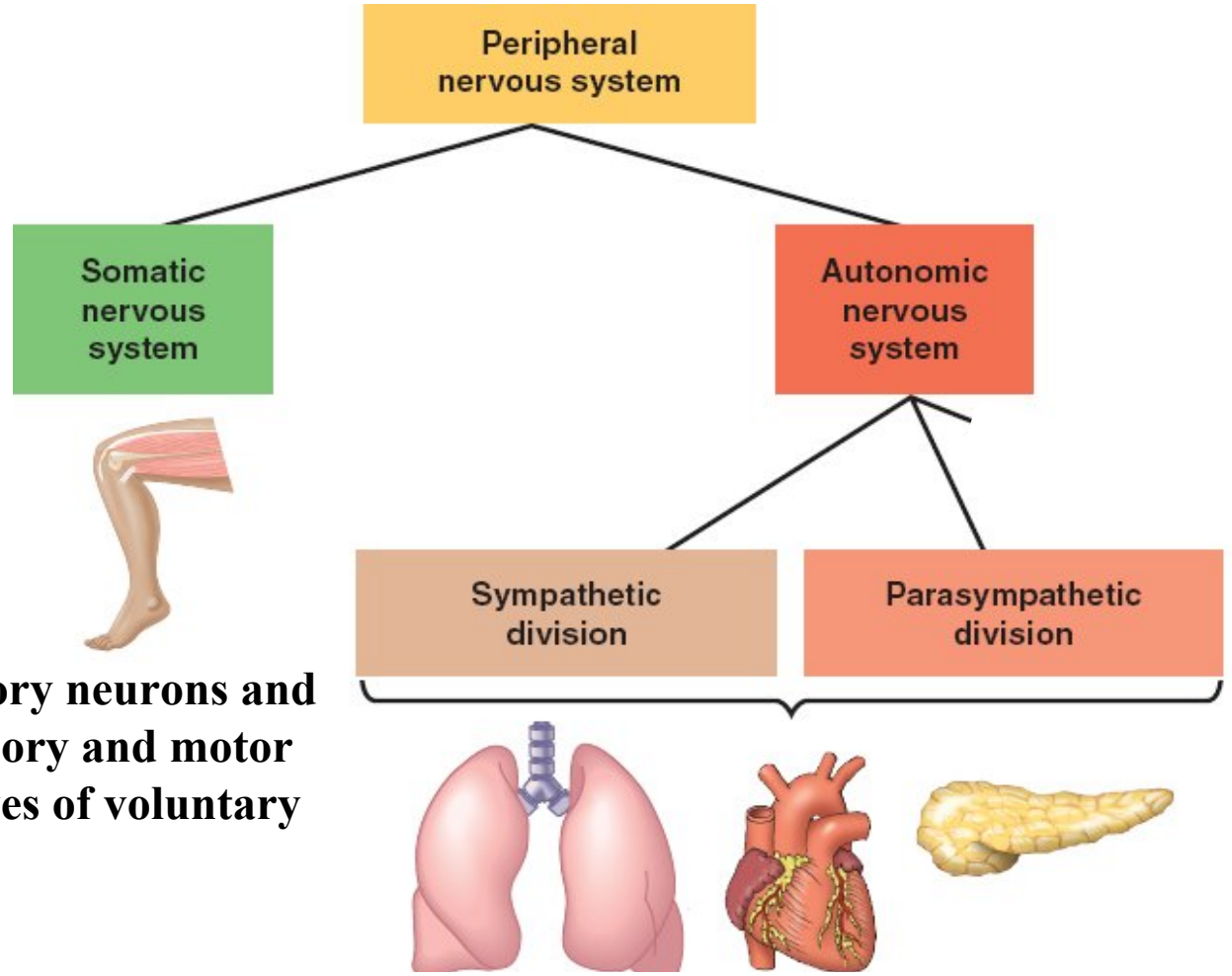



## Cerebellum




- Functions
  - Coordination of voluntary muscles
  - Maintenance of balance
  - Maintenance of muscle tone
- Effects of alcohol
  - Cerebellum function is temporarily affected by alcohol and other drugs.
  - Field sobriety tests are test of cerebellar function
  - Cerebellum function may be permenantly affected by long term alcoholism, stroke or trauma

# PERIPHERAL NERVOUS SYSTEM



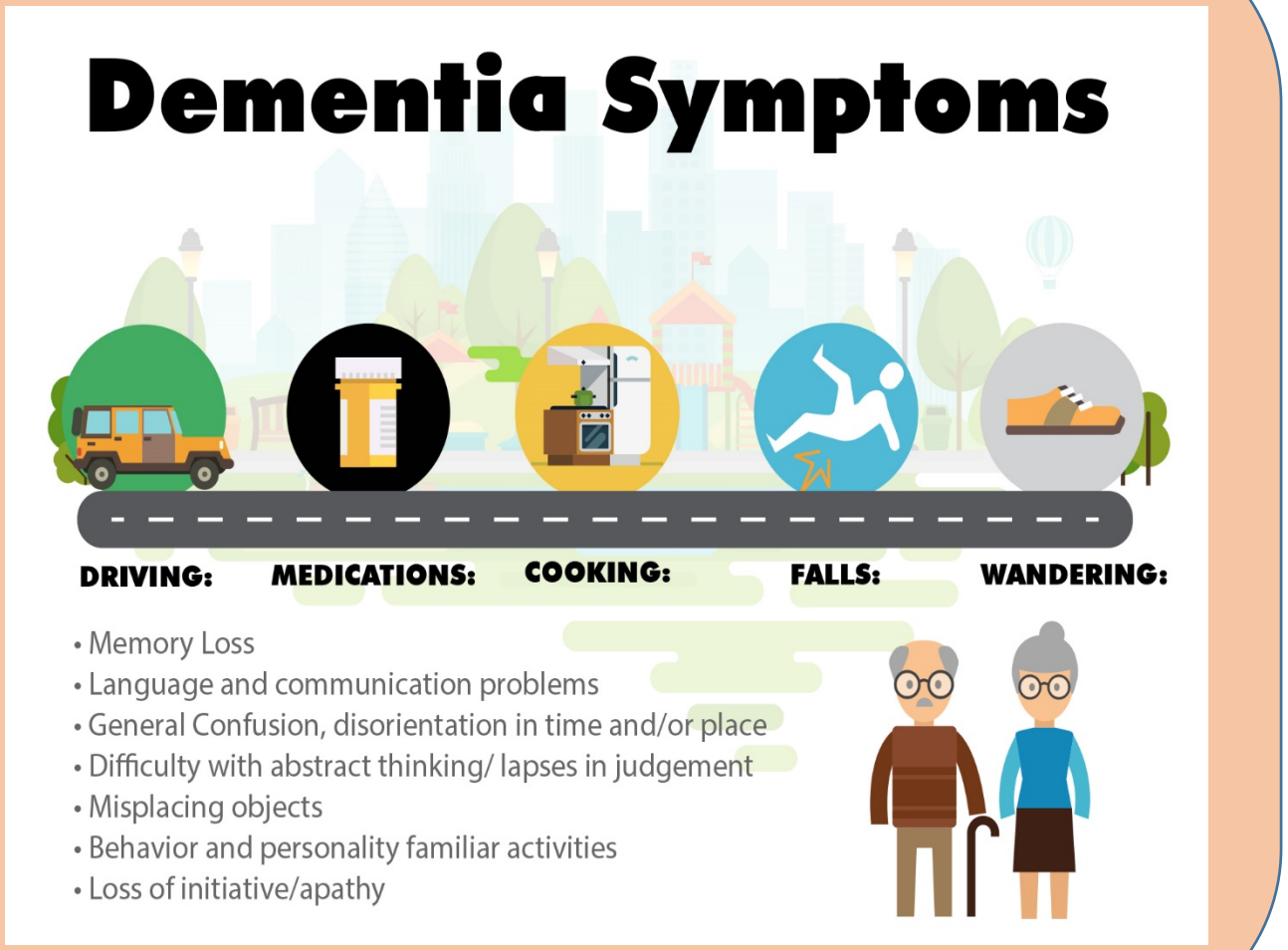

**Sensory neurons and sensory and motor nerves of voluntary**

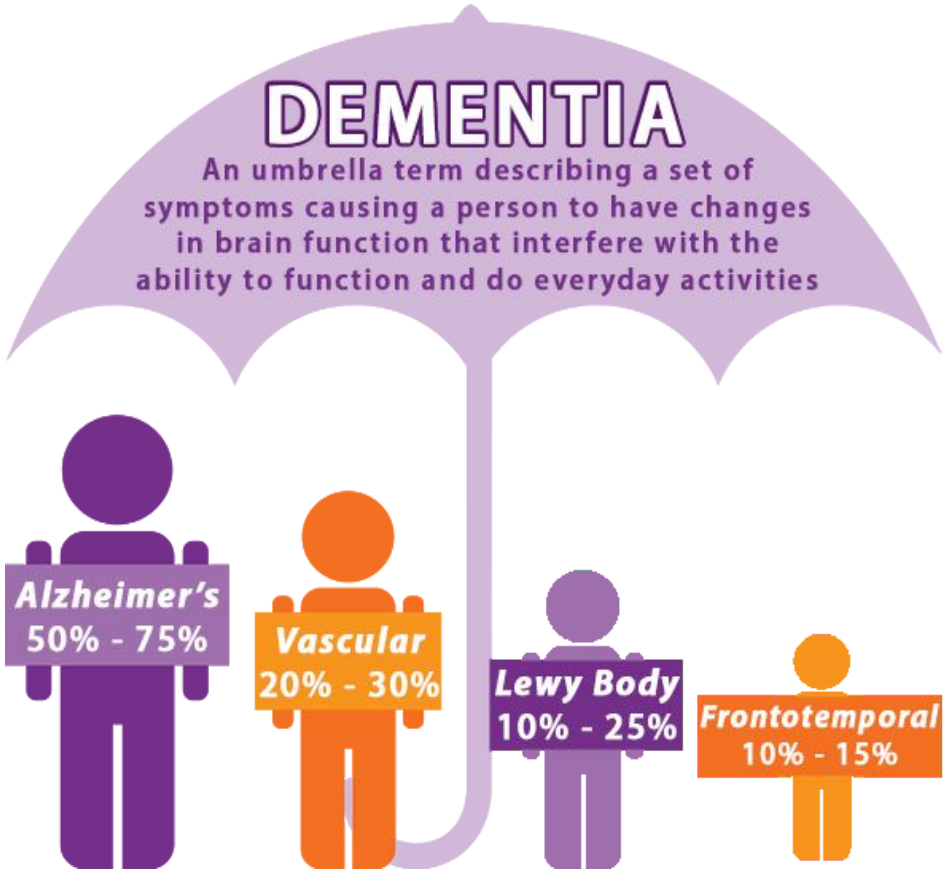
**Exerts a maintenance control following a sympathetic nervous response**

**Fight or flight response during which the body is prepared to run away or resist danger**

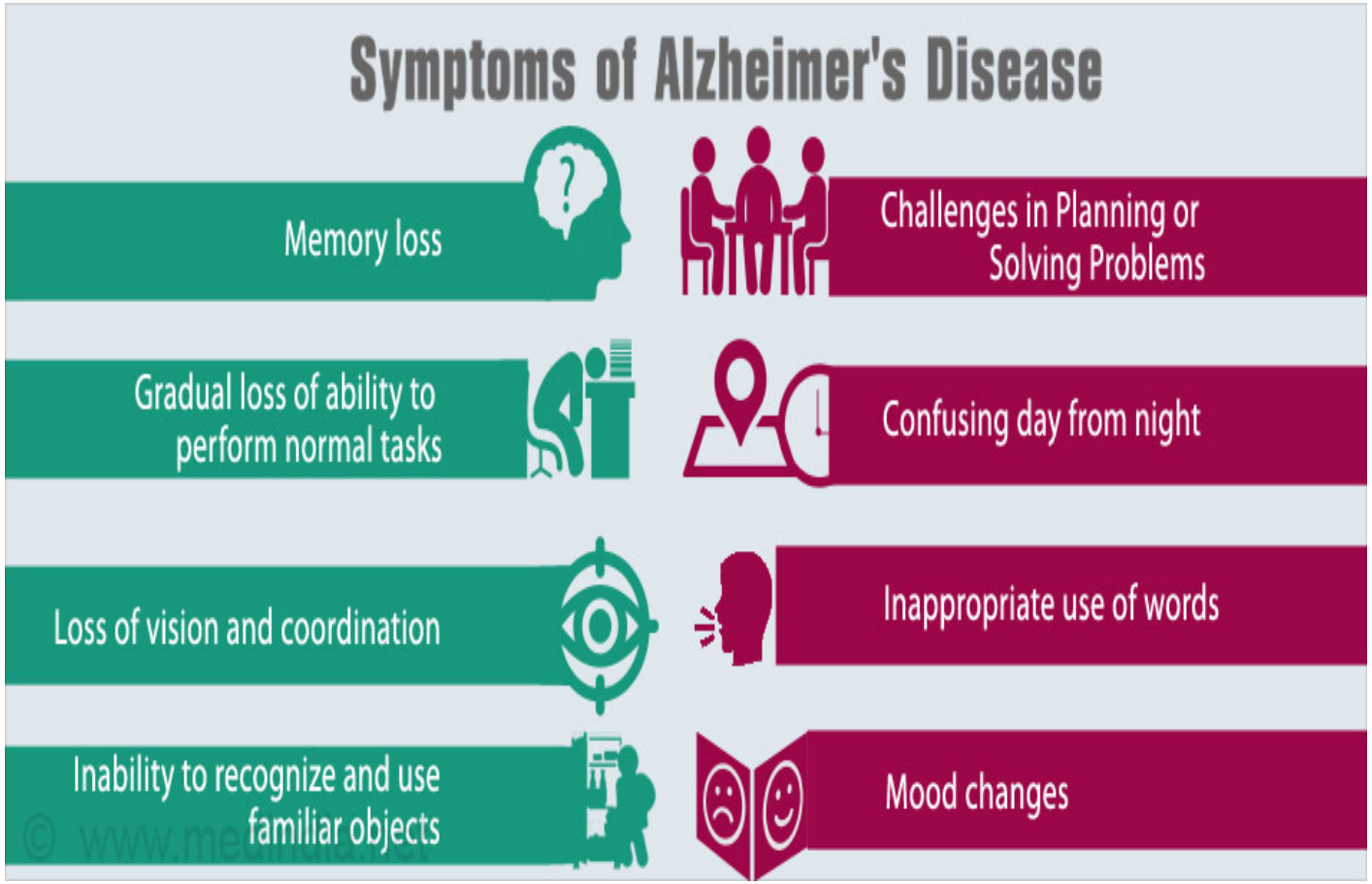
# DISEASES OF THE NERVOUS SYSTEM

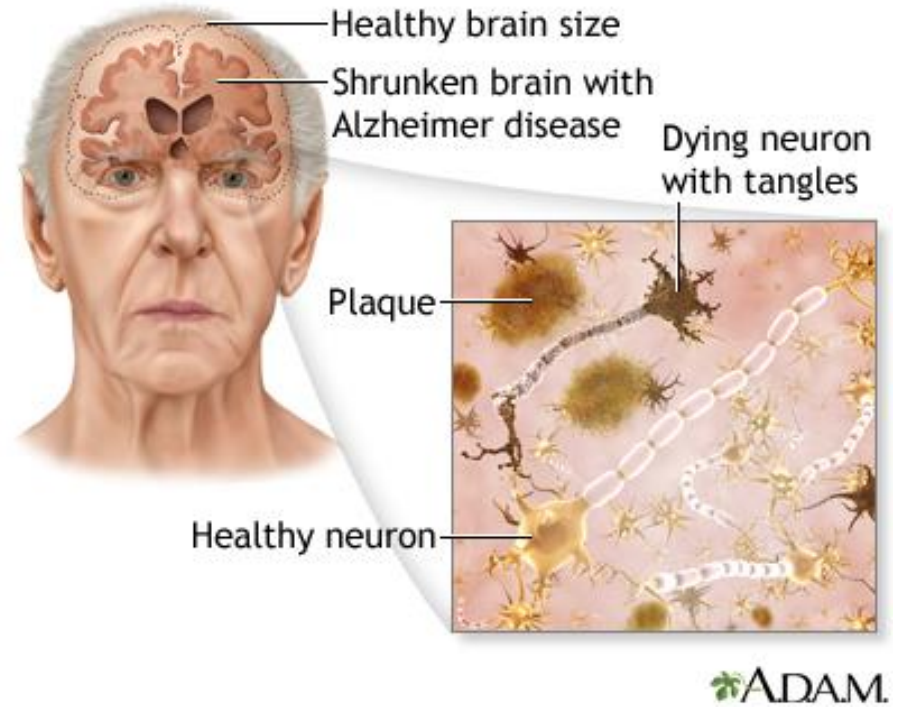
**1. Dementia is another disorder associated with aging seen in patients over 60.**



**Most common type of dementia observed in Western countries is <u>Alzheimer's disease.</u>**

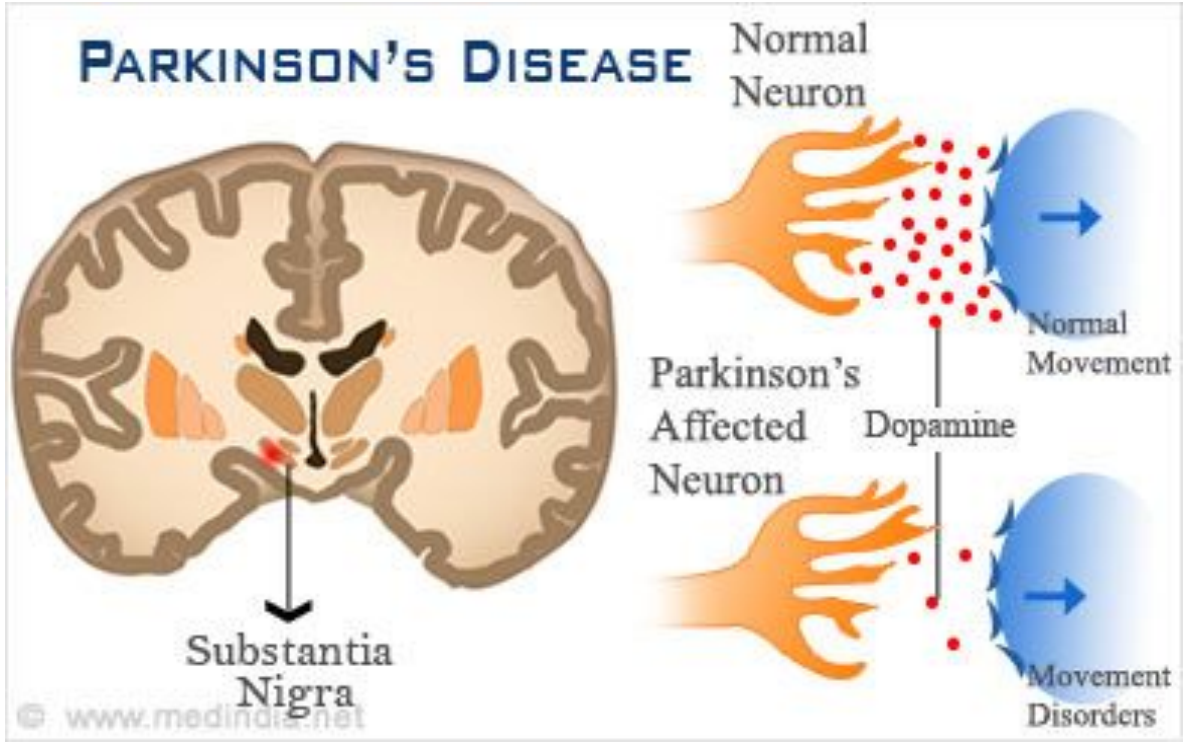


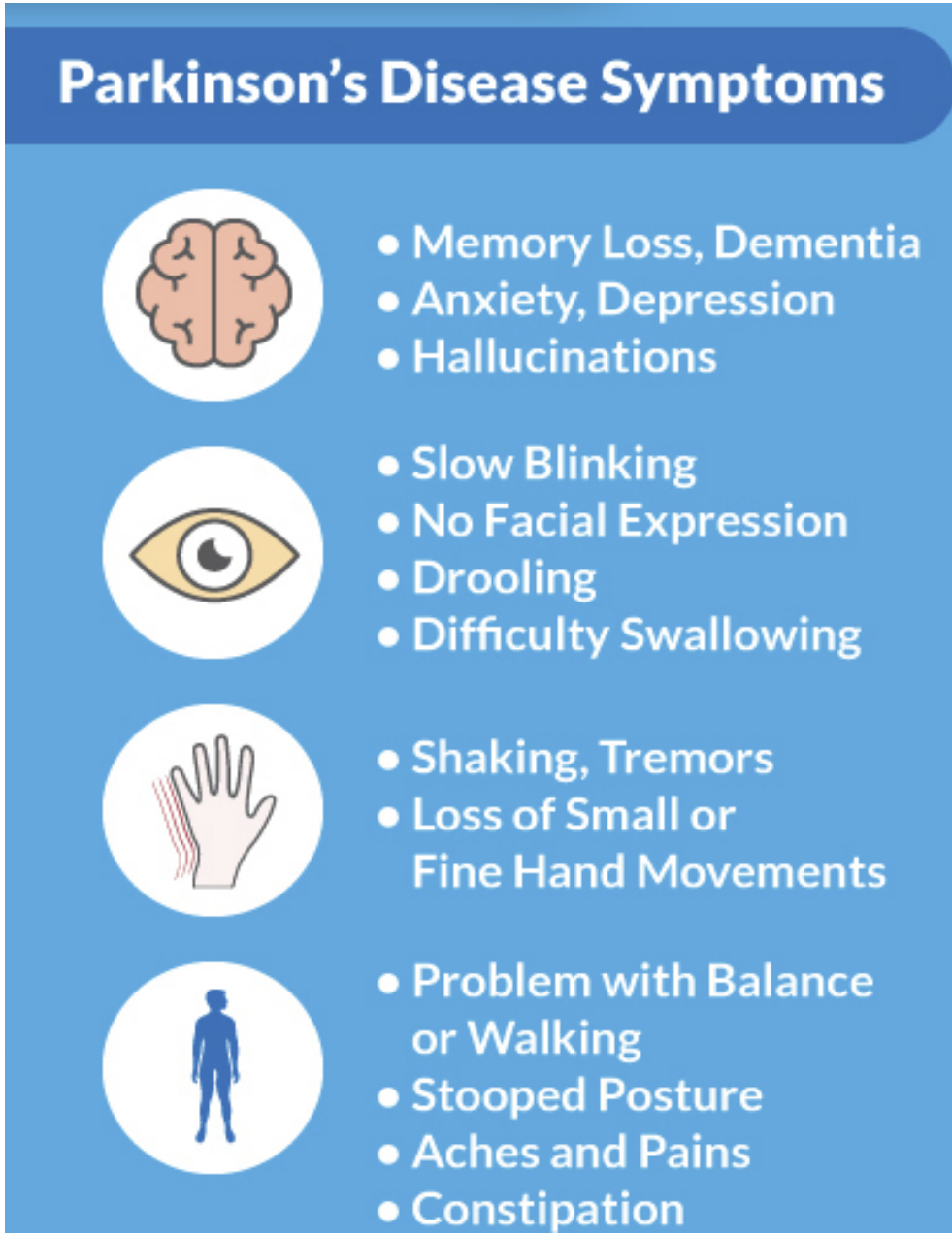




- **Loss of neurons in the cortex, hippocampus regions.**
- **Deposition of amyloid plaques containing beta amyloid protein.**

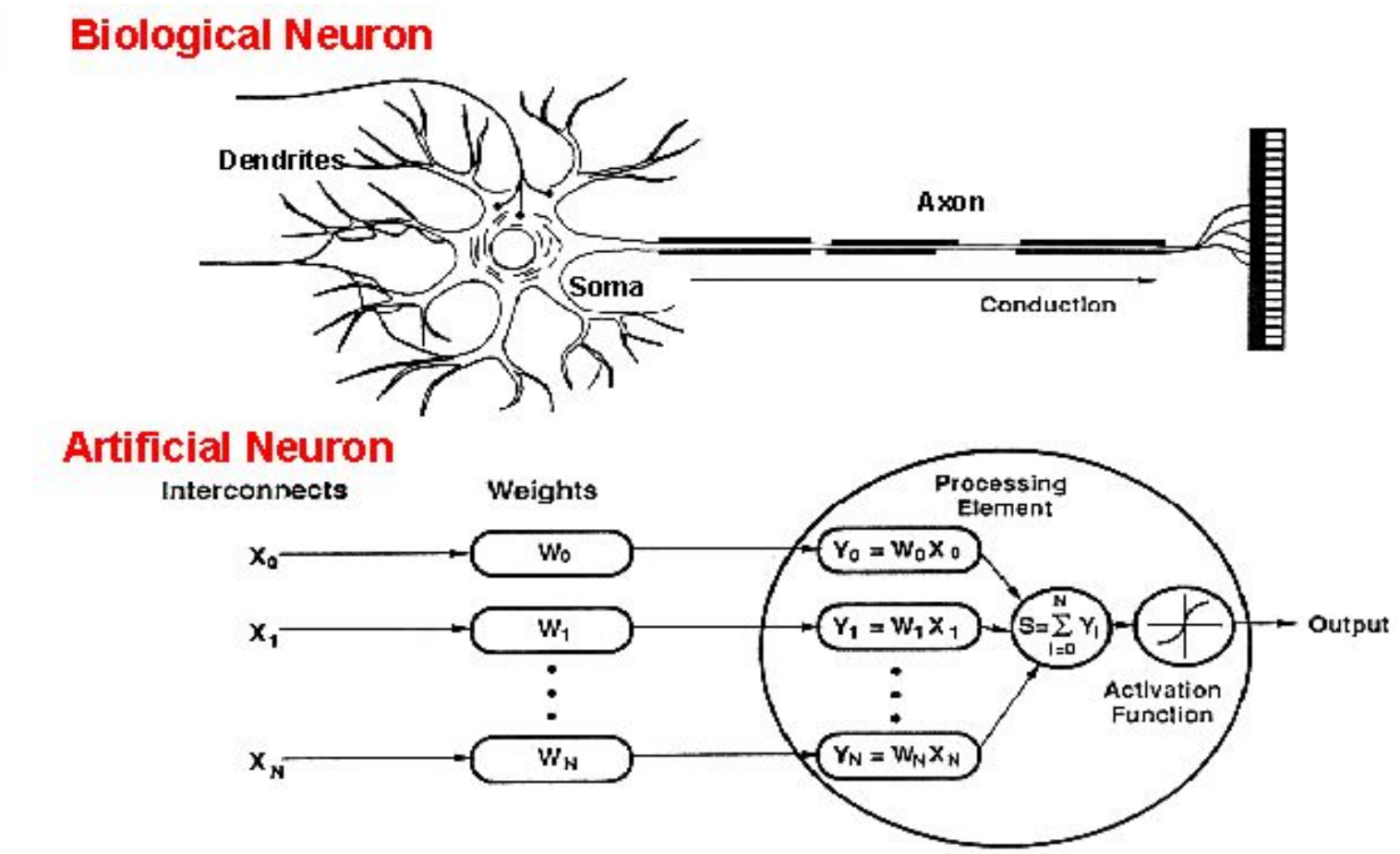
## 2. Parkinson disease

- **Parkinson is usually observed between the ages of 50-60.**
- **Environmental toxins may be responsible for onset of the disease.**
- **Destruction of cell bodies and neurons that produce dopamine.**



# Artificial Neural Network



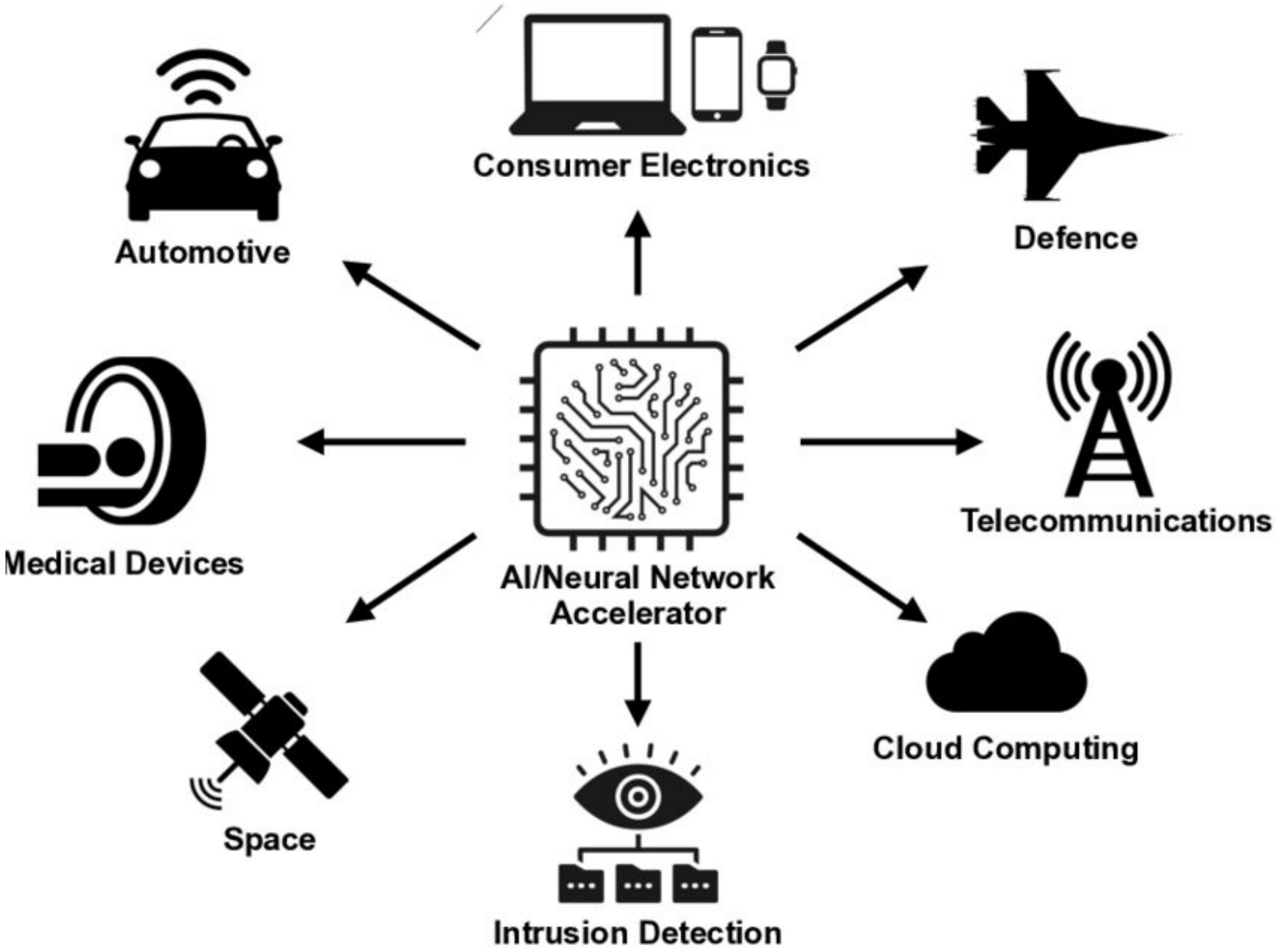

An artificial neuron is an imitation of a human neuron

# COMPUTER BASED NEURAL NETWORKS

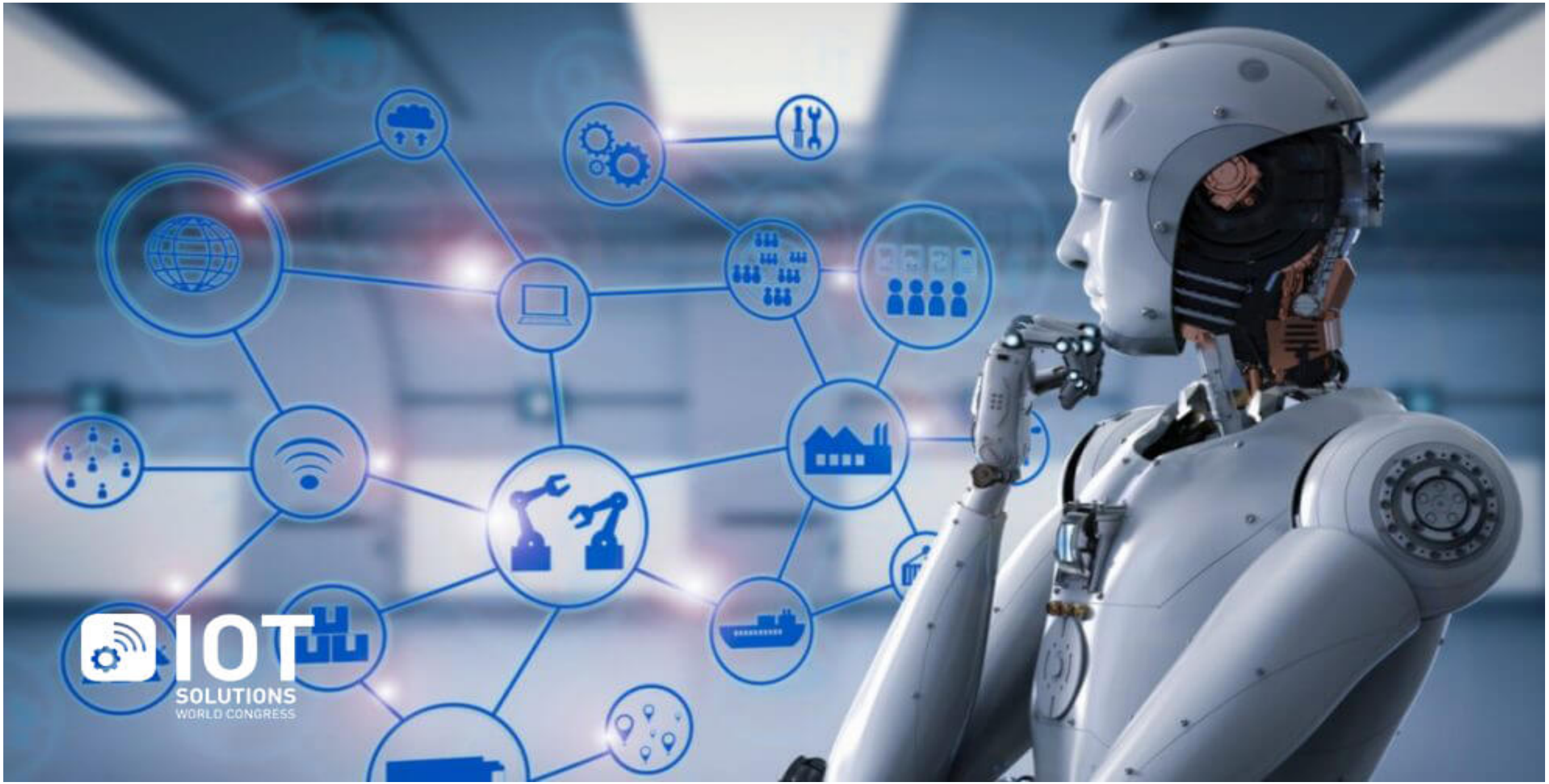
- **Brain has certain remarkable qualities which makes it at par with any computers like**
    1. **Its performance tends to degrade gracefully under partial damage and partial recovery from damage is possible.**
    2. **It performs massively parallel computations extremely efficiently.**
    3. **It supports our intelligence and self awareness through yet to be determined mechanism.**

- **Neural Networks attempt to bring computers a little closer to the brains' capabilities by imitating certain aspects of the brain in a simplified way.**
- **Neural networks are not biological rather only elements of a program or silicon circuits.**
- **Although these networks are not as powerful as human brain, they can be trained to perform useful functions.**
- **Two concepts were responsible for emergence of neural networks (i) Statistical mechanics (ii) back propagation algorithm.**
- **Neural networks have been applied to different applications like aerospace, automotive, banking, defence, electronics, mathematics etc.**

# COMPUTER BASED NEURAL NETWORKS



# THANK YOU



# PRACTICE THESE DIAGRAMS