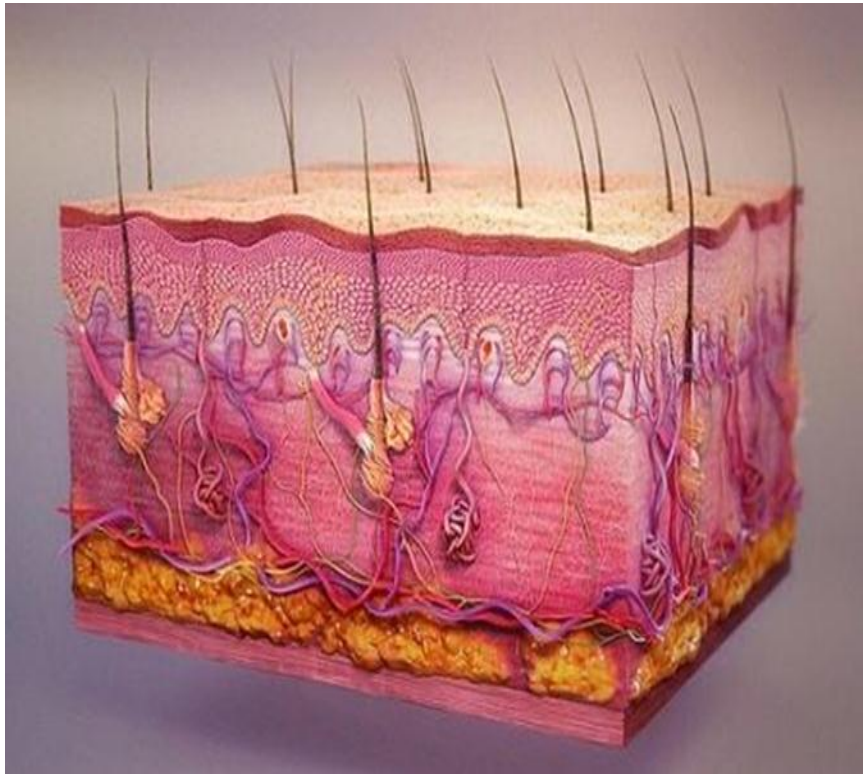
# Chapter:1
# Protection, Support and Movement.

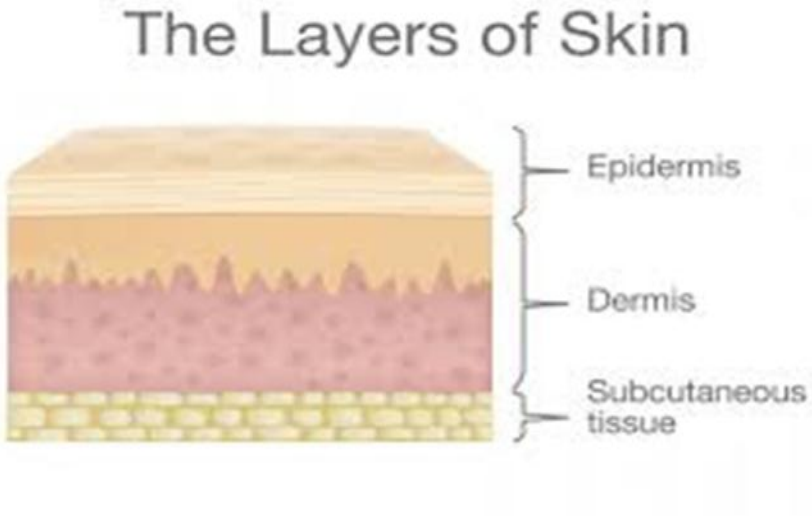
# Introduction to integumentary system

- External covering of an animal
- Includes hairs, follicles, hooves, feathers
- Protect body from damage
- Regulates the body temperature
- Excretion of waste materials
- Conversion of sunlight into vitamin D
- Reception of environmental stimuli
- Locomotion and movement



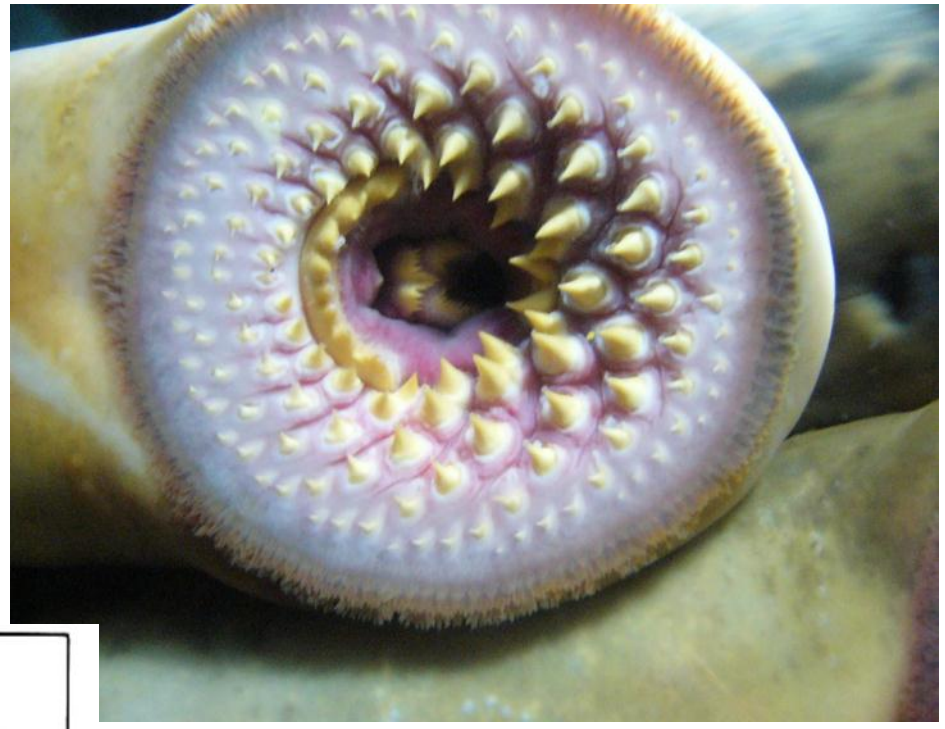
# SKIN

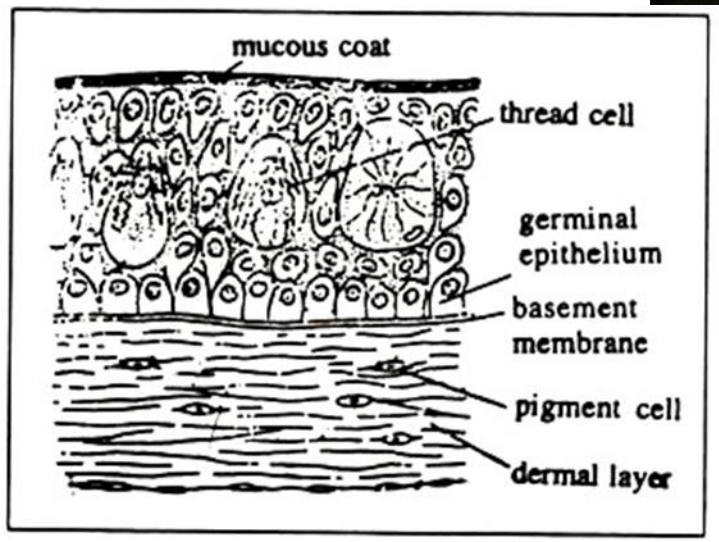
- Vertebrate integument
- Largest organ
- Epidermis(epithelial,1 to several cell thick)
- Dermis(connective tissue, thicker)
- Hypodermis(loose connective, adipose tissue, nerves)
- Protection, regulation, sensation



# Skin of jawless fishes

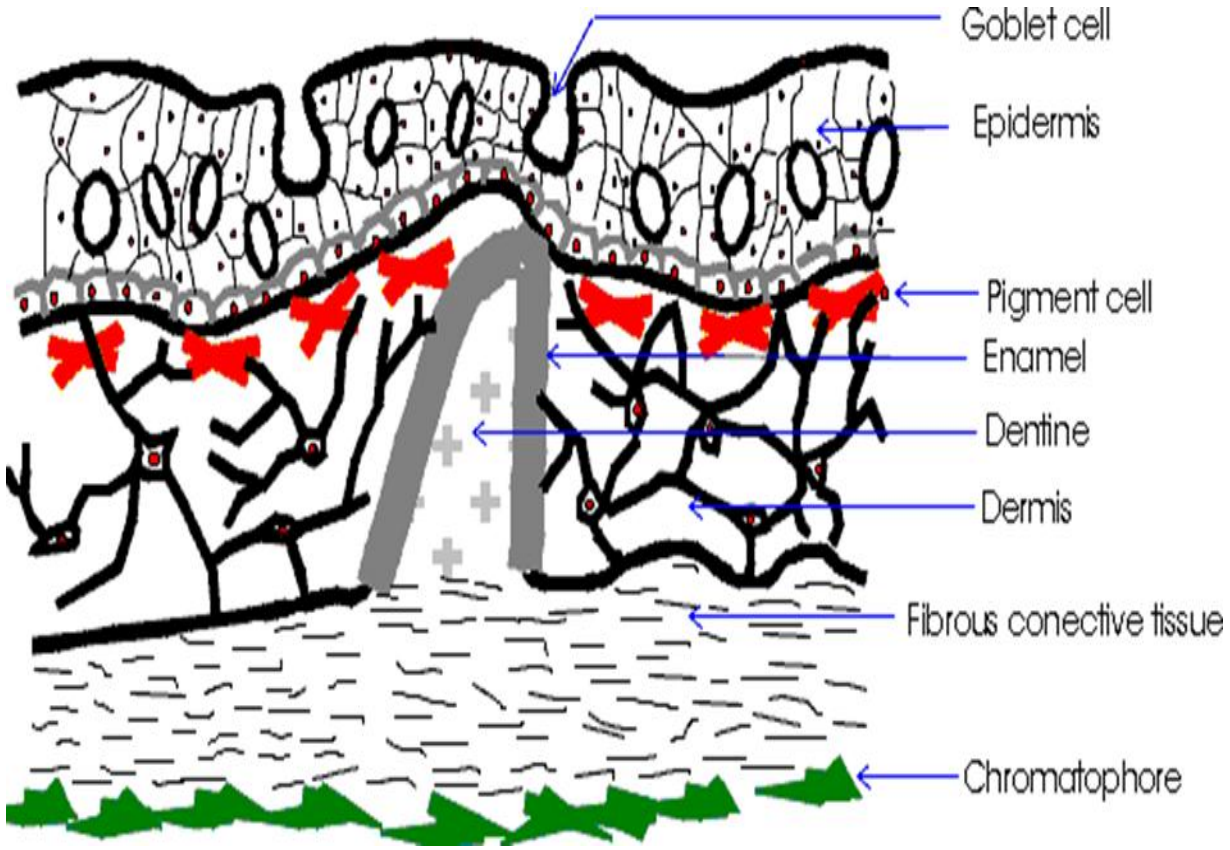
- Thick skin
- Glandular cells
- Protective cuticle
- Slime glands; slime eel
- Slime protects from parasites, clogs enemy gills
- Extinct small mineralized scales/dermal armour
- Examples hagfishes





# Skin of cartilaginous fishes

- Multilayered
- Mucous and sensory cells
- Bony placoid scales in dermis
- Denticles(like teeth)
- Contains blood vessels nerves
- Grow throughout life→mature→lost
- Sandpaper texture, denticles



# Skin of bony fishes

- Covered Scales(dermal bones)
- At margins and lower surface
- Growth  lines
- Gas exchange
- Rich capillaries in dermis
- Mucous glands(epidermis)
- Bacterial, fungal infection preventer, reduces friction
- Granular glands→irritaing, poisonous alkaloid
- photophores→specie  recognition, warning signals (teleost)

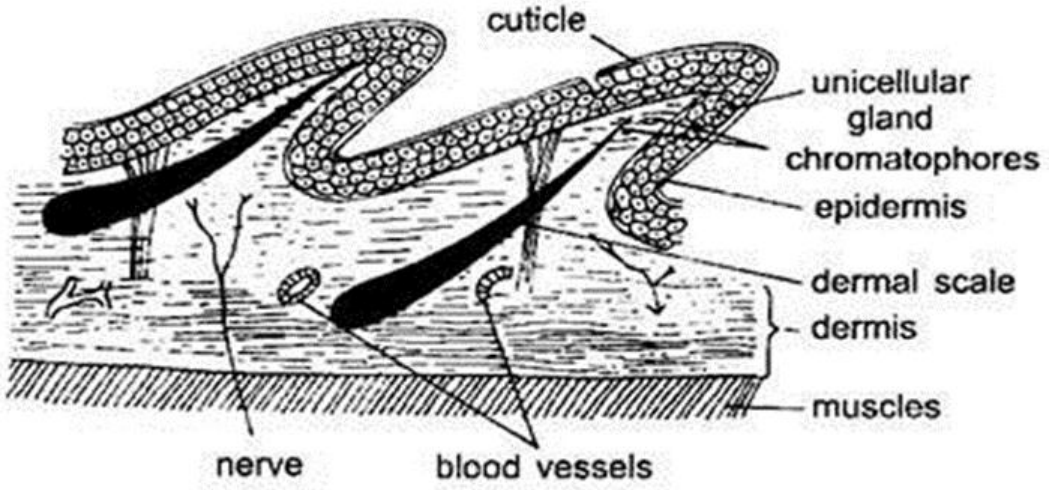
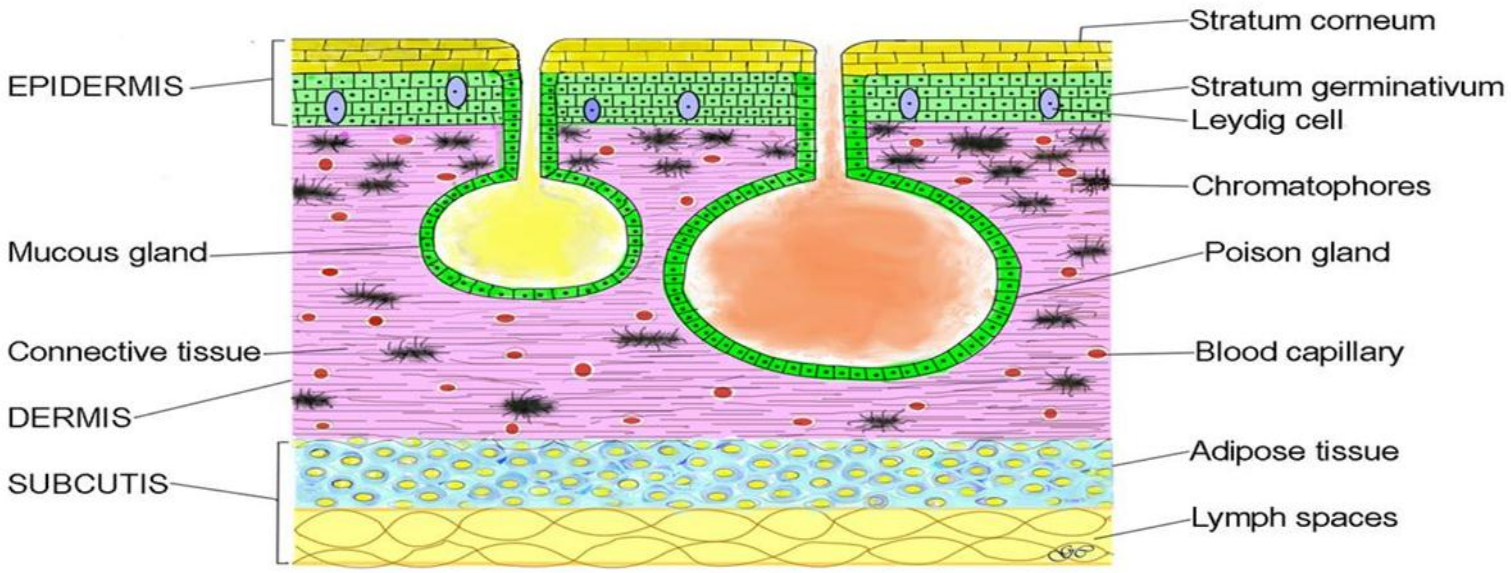



**Fig. 41.13.** V.S. of skin of bony fish.

# Skin of amphibians

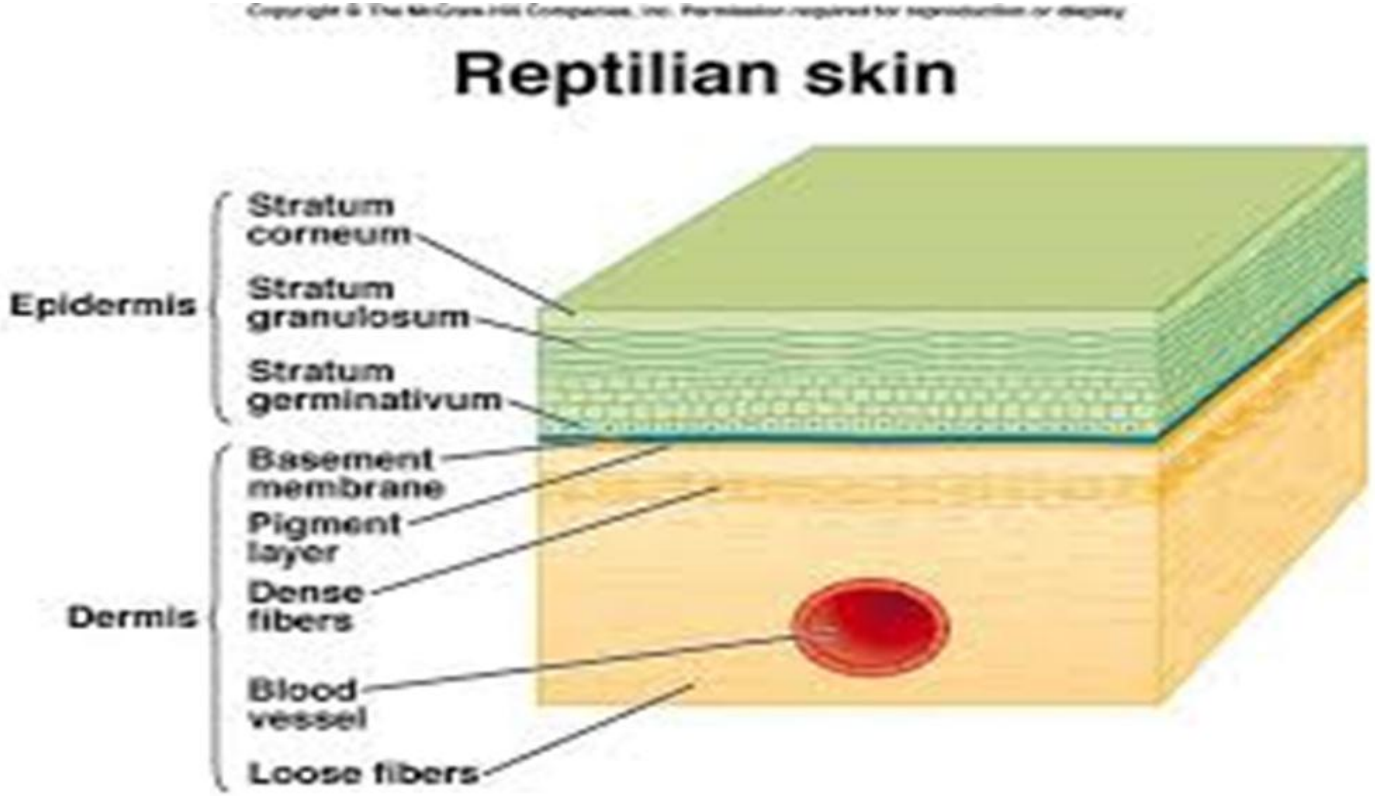
- Stratified epidermis and dermis
- Mucous gland(desiccation, gas exchange, predator ESCAPE)
- serous gland, pigmentation cells
- Earlier had dermal bone scales
- Terrestrial challenges
- Keratin production(tough impermeable, protein),protects from UV rays
- Poison glands, predator deterrent




VERTICAL SECTION OF SKIN OF FROG

# Skin of reptiles

- Epidermis thick, no glands
- Modified into keratinized scales, cutes in snakes &turtles ,beaks in turtles→rattles in snake→claws, plaques & spiny crests
- Inhibits dehydration, abrasion& armour
- Molting by diffusion

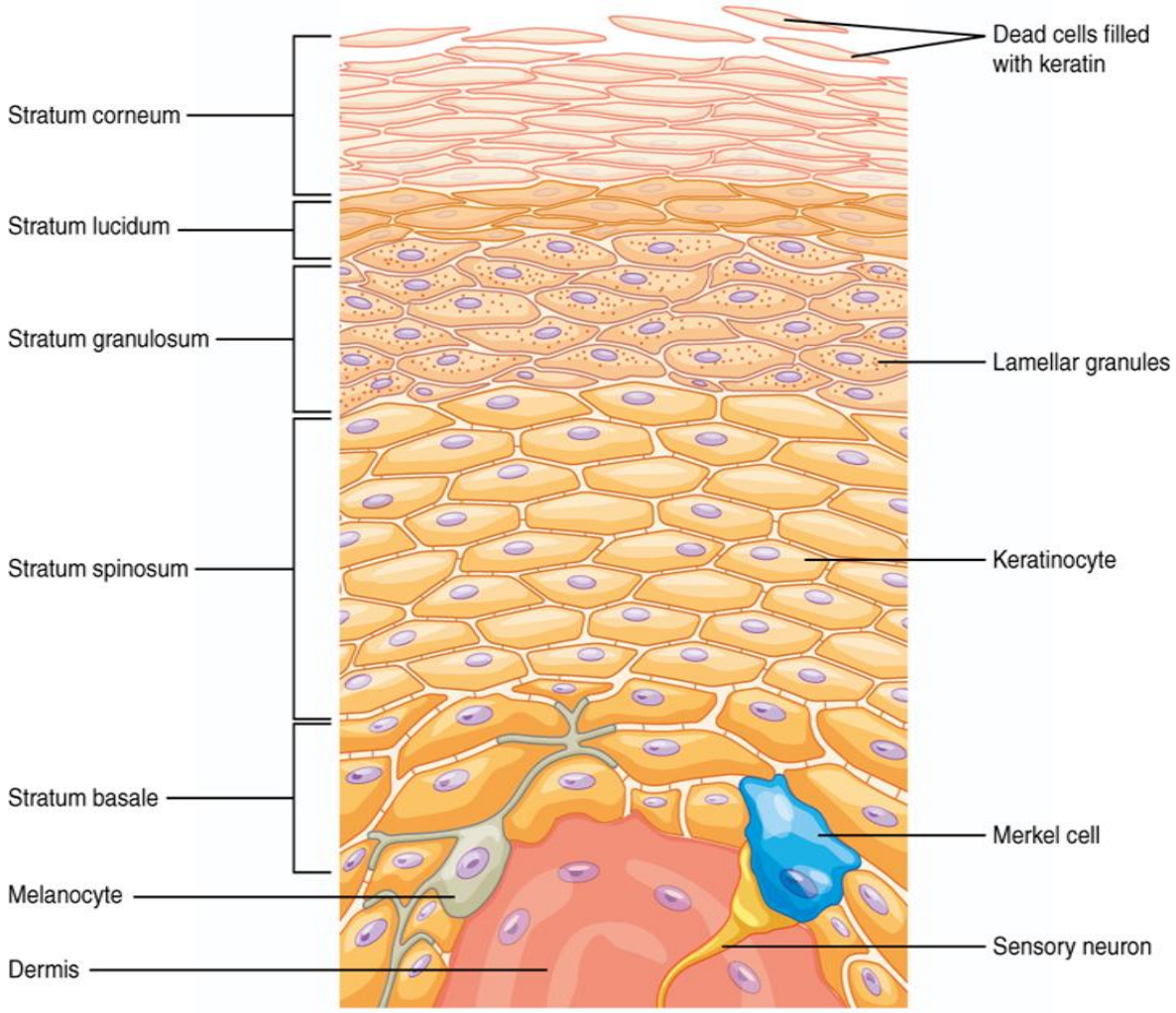


# Skin of birds

- Reptilian features
- Preen gland
- 1 or 2 cell thick epidermis,
- Soft keratinized layer
- Dermis(blood, lymph vessels, nerves & air spaces thermal regulation)
- feathers(reptilian scales derived)
- dermal smooth muscle fibers

(behavior, flying & thermal regulation)

- Fat in epidermis(aquatic)insulation



# Skin of mammals

- Hairs, glands, highly stratified epidermis, thicker dermis

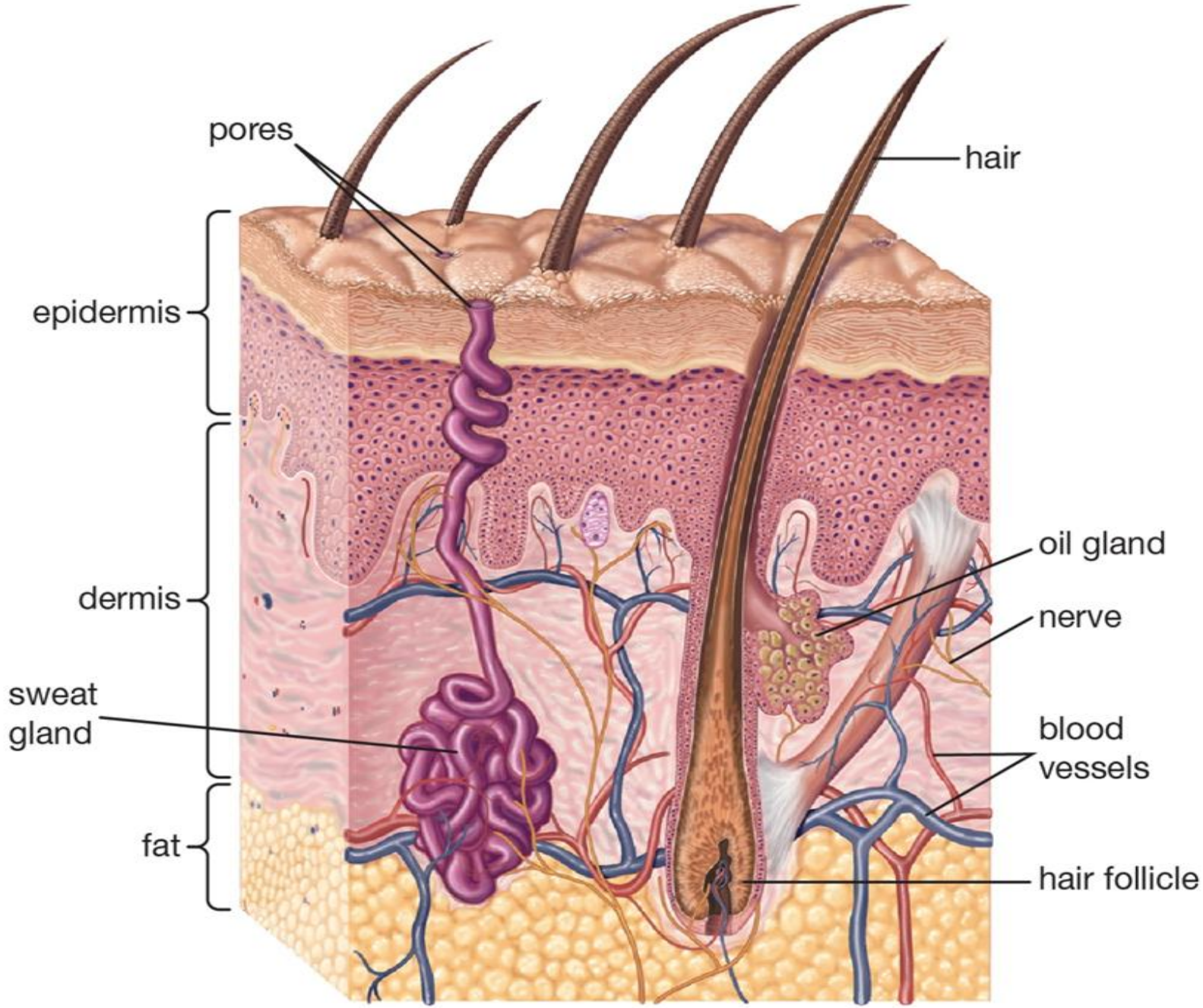
**Epidermis:** epithelial + other
Cell division+ keratinized cells
Stratum corneum(defense)
**Dermis:** (thick, blood, lymph
Vessel, nerve, hair, muscle, gland)
Leather formation

**Hypodermis**:

Adipose : fat, insulation, energy
Skeletal muscles :free skin
Loose connective tissue

- Skin:

rays chemical to V-D
Sense organ: heat cold touch
Pressure, pain(nerve endings)
responsive



- **Sweat pores & glands**: perspiration; cooling effect; homeostasis
- pheromones;(chemical to communicate with specie members)
- **sebaceous glands**: sebum(softening & protective agent)
- pheromone
- **colour**:
- (a)pigments(melanin) in chromatophores(cells),epidermis, hair
- (b)blood
- Camouflage
- Social communication
- **Hair (keratin filled cells)**
- Shaft + root
- Arrector Pilli muscles(goose bump) Behavior signs

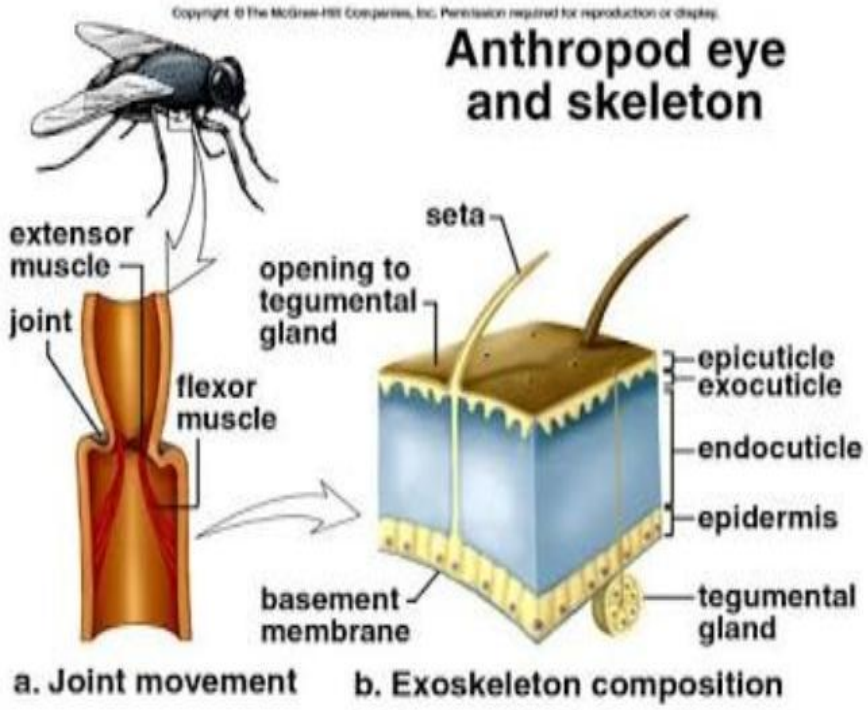
# The skeleton System of Invertebrate:

## Hydrostatic Skeletons

- Core of liquid surrounded by tension resistant sheath of longitudinal and circular muscles
- Movement and form is controlled by using muscles to change the shape of the fluid filled compartment
- Movement done by creating a rhythm in body of longitudinal and circular muscles
- For example: skeleton of hydra and earthworm

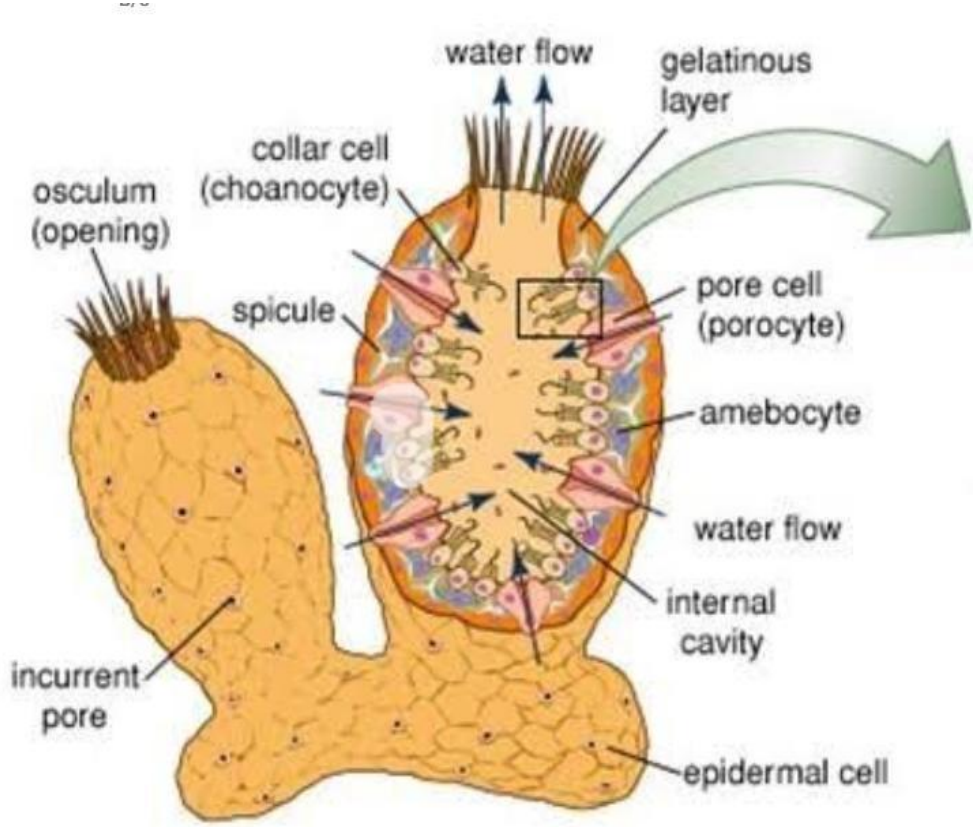
# Exoskeleton Of Invertebrate

- Rigid exoskeletons have locomotor functions
- Also support and protect the body
- In arthropods, the epidermis of body wall secrets a thick, hard cuticle that waterproofs the body also protect the soft internal organs
- In arthropods joints e.g ( wing joints possess a highly elastic protein called resilin
- In crustaceans, exoskeleton contains calcium carbonate that make it hard



# Endoskeletons Of Invertebrate

- Endo means "within"
- Endoskeletons of sponges: It consist of mineral spicules and fibers of spongin that keeps the body from collapsing
- Endoskeletons of echinoderm: consist of small, calcareous plates called ossicles

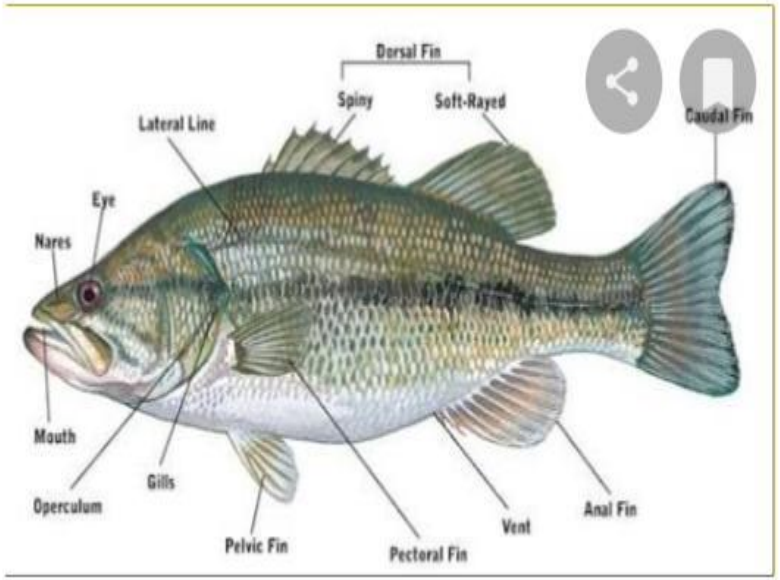


# Skeletal System Of Vertebrates

- Vertebrate skeletal system is an endoskeleton that consist of cartilage and bone
- **Cartilage**: Connective tissue provide muscle attachment, aid in movement and provides support
- Consist of cells, fibers and a cellular matrix
- **Bone**: Connective tissue provide attachment for muscles, support internal organs, store calcium and phosphate and manufacture red blood cells
- Rigid and contain inorganic salts mainly calcium phosphate and calcium carbonate
- Bone cells are osteocytes that communicate other cells passing through small channels

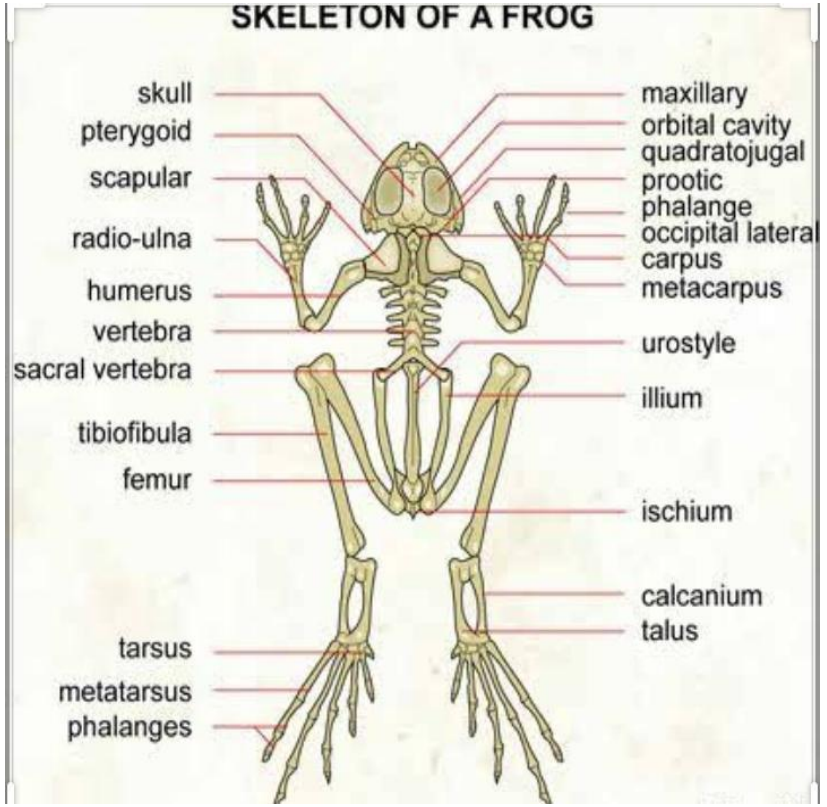
# The Skeleton Of Fishes

- Most fishes have well-defined vertebral column, the jawless  vertebrate do not e.g lampreys only have isolated cartilaginous blocks along the notochord and hagfish don't even have these
- Most jawed fishes have an axial skeleton that includes a notochord, ribs, and cartilaginous or bony vertebrae
- Muscles used in locomotion attach to axial skeleton



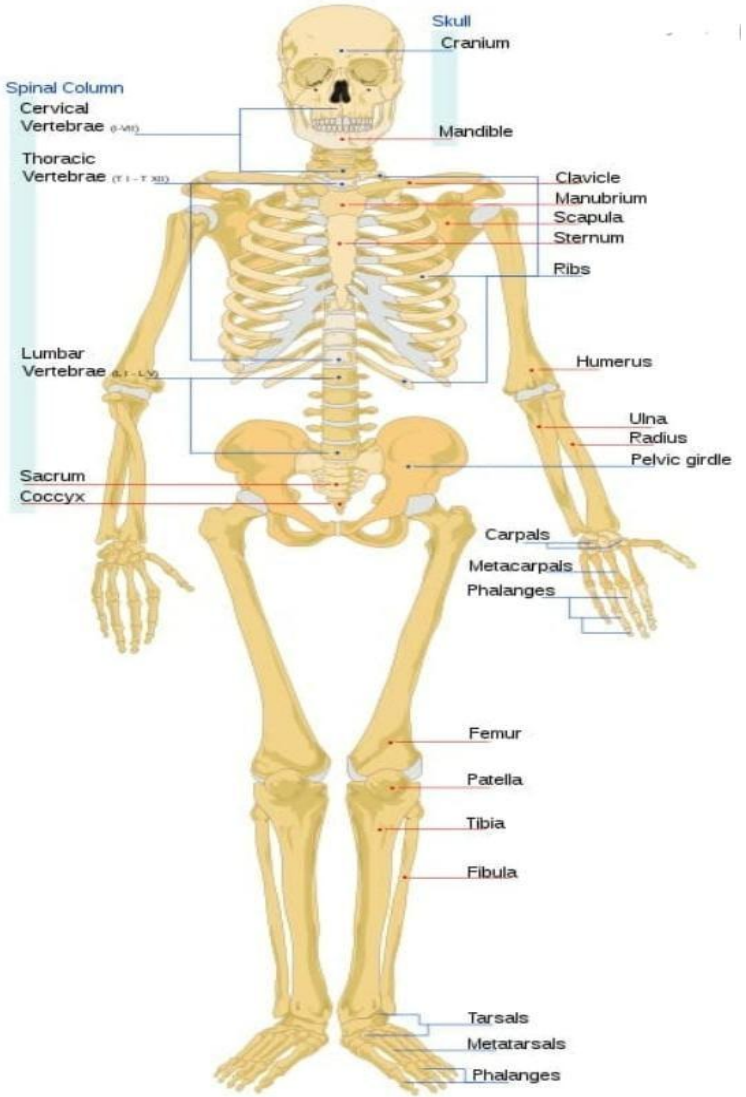
# The skeleton of Tetrapods

- During evolution from water to land endoskeleton of tetrapod became modified for support
- This support resulted from intervertebral disks that hold the vertebral column together
- Also absorb shock and provide mobility
- Bone replaced the cartilage and became more rigid
- Appendages became elongated for support



# The Human Endoskeleton

- It has two major parts
- **Axial skeleton:** Skull, vertebral column, sternum and ribs
- **Appendicular skeleton:** Appendages, pectoral girdle, and pelvic girdles
- These girdles attach upper and lower appendages to axial skeleton



# Movement: Non muscular movement and muscular system

- Movement is one of the things that differentiate a living thing from a nonliving thing.
- All cells have capacity to move and changes shape due to their cytoskeleton

# Non muscular movement

- Protozoan protists move by means of specific non muscular(Pseudopodia, flagella or cilia) that move the contractile proteins actin and myosin.

- **Types:**

1- Amoeboid movement

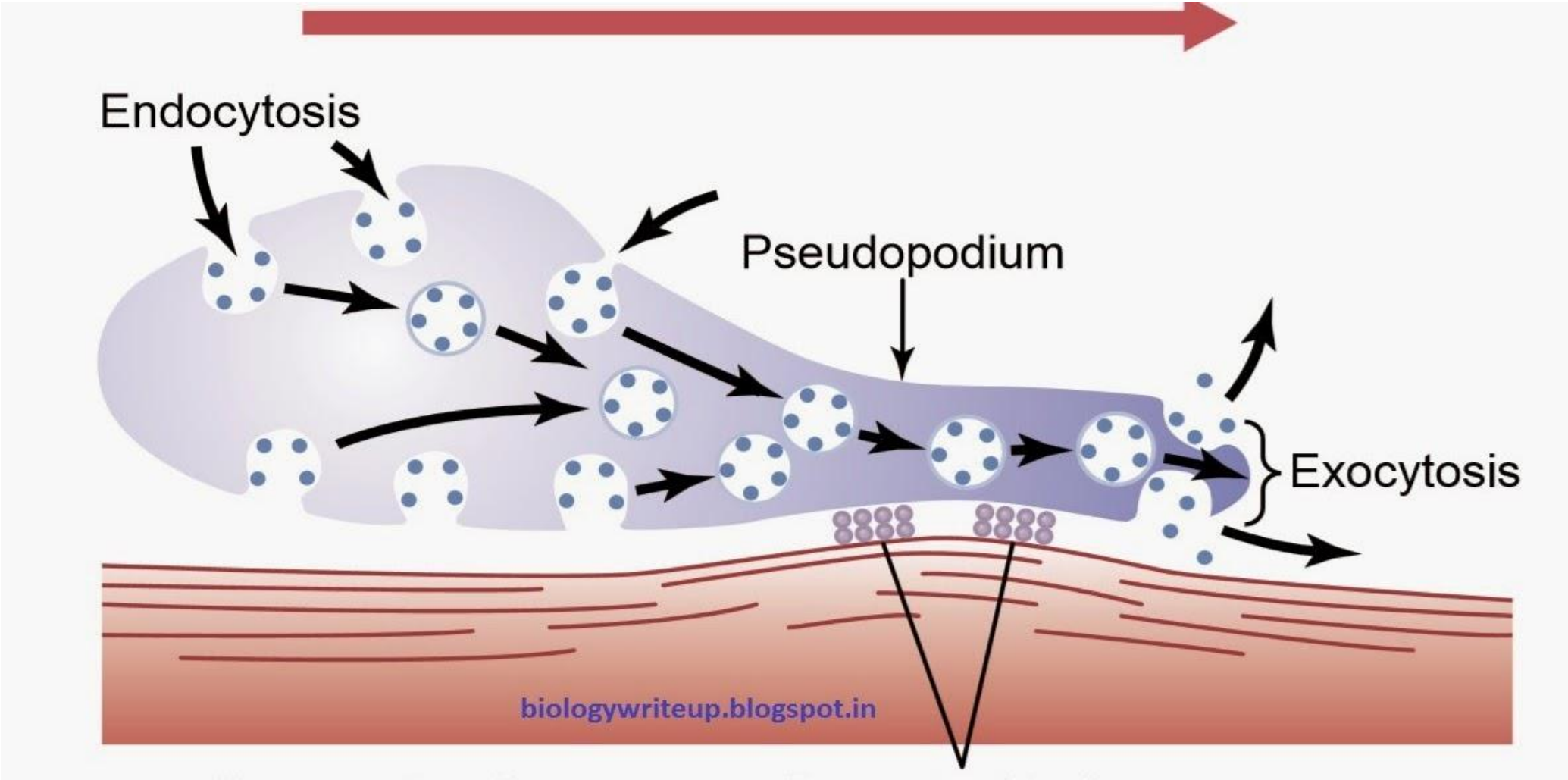
2-Ciliary movement

3-Flagellar movement

# Amoeboid movement

- A crawling-like type of movement in which the cell forms pseudopodia towards the front of the cell.
- PM has adhesive properties since new pseudopodia attach to substrate.
- PM slide over underlying layer of cytoplasm.
- PM rolling in a way analogous to a bulldozer track.

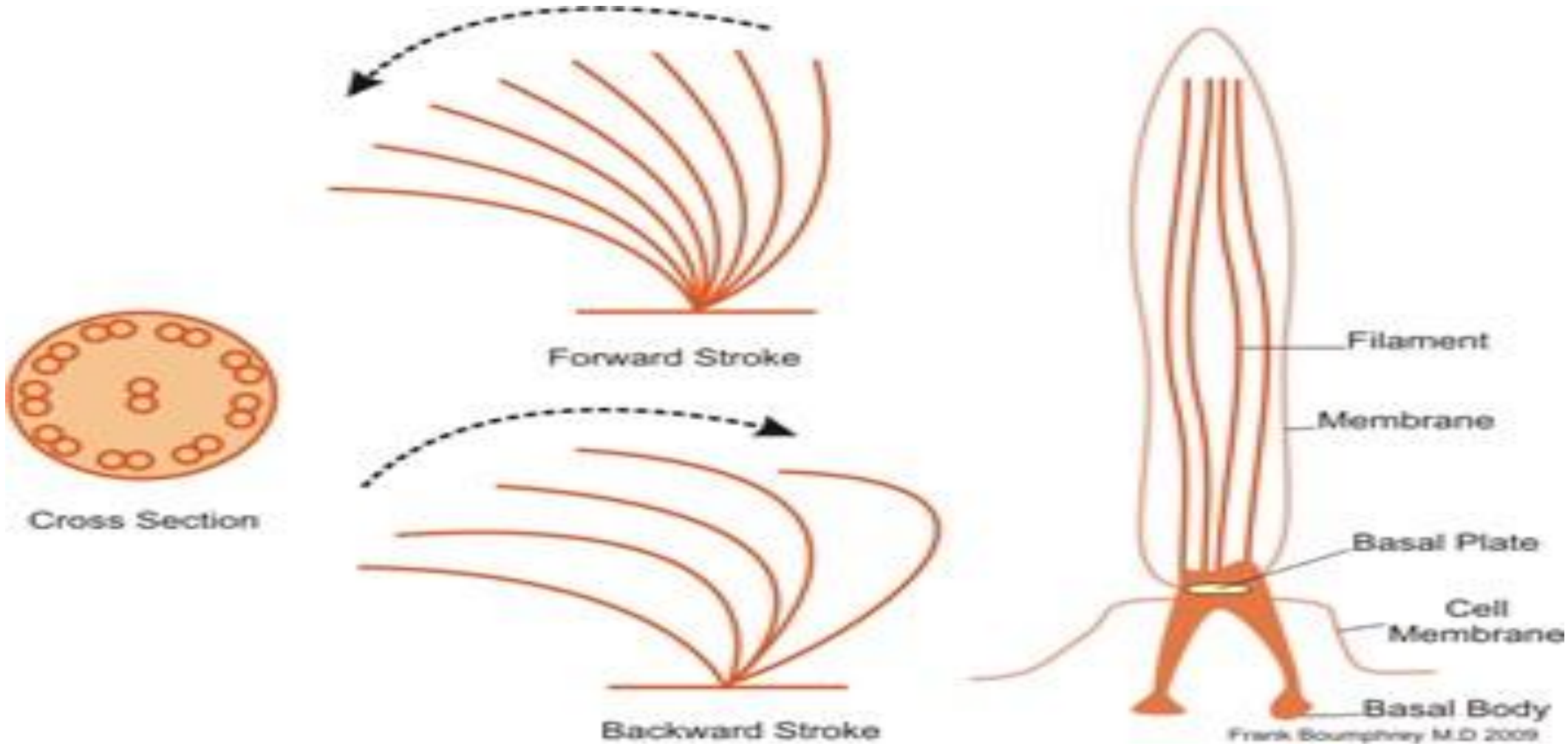
# Amoeboid movement



# Ciliary And Flagella Movement

- It takes place  by the presence of cilia that are hair like structure.
- Cilia are shorter and numerous than flagella and arranged in a longitudinal row.
- Occur throughout the cell surface and beat in co-ordination.
- cilia and flagella help in cell movement.
- Flagella are long and occur singly or in pairs.
- Cilium and flagellum emerge from basal bodies.

# Ciliary Movement



# Animal Muscle

- Properties:

1-Excitability, the capacity to receive and respond to a stimulus.

2-Extensibility, the ability to be stretched.

3-Elasticity, the ability to return to its original shape after being stretched or contracted

# Muscular system of invertebrates

**Locomotion of soft bodied invertebrates:**

- Move over a firm substratum
- Flatworms and gastropod  moluscs  exhibit pedal locomotion
- Peristaltic locomotion is common in earthworm, it involves the alternation of circular and longitudinal muscle contraction waves
- Leeches and some insect larvae exhibit looping movement
- Polychaete  worms move by the alternate movement of multiple limbs(parapodia)
- Water vascular system of echinoderms provides a unique means of locomotion

# Terrestrial locomotion in invertebrates: Walking

- Terrestrial arthropods are much denser than the air
- Require structural support
- That move quickly use joints, tendons and muscles that attach to rigid cuticle
- Walking limbs of crustacea and uniramia are uniform in structure
- Limbs are less massive toward tip
- Joint is articulated to allow movement in one plane
- Limb joints allow extension and flexion of limbs

# Flight

- Insects exhibit a wide range of structural adaptations and mechanisms for flight
- Active flight consists in moving through the air by flapping the wings
- Passive flight involves gliding and soaring

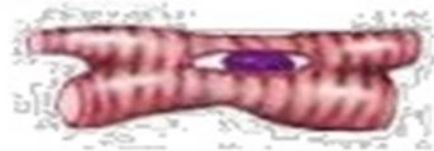
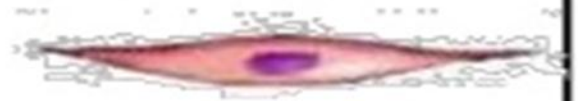
Jumping

# THE MUSCULAR SYSTEM OF VERTEBRATES:

**INTRODUCTION**:

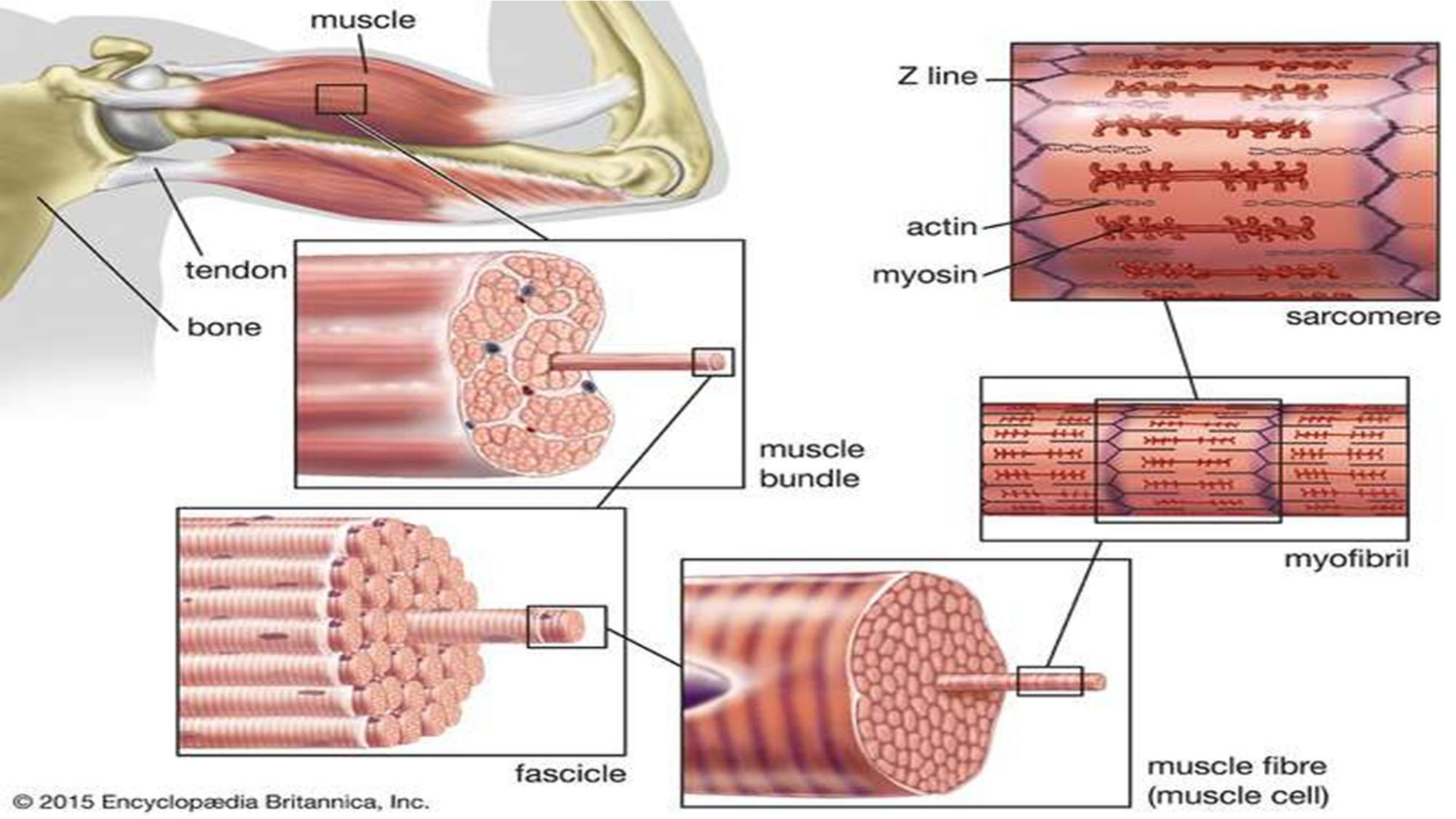
- The **muscular systems** in **vertebrates** are controlled through the nervous **system** although some **muscles** (such as the cardiac **muscle**) can be completely autonomous.
- Together with the skeletal **system**, it forms the **musculoskeletal system**, which is responsible for movement of the human body.
- The two major divisions of the **vertebrate musculature** are the visceral **musculature** and the somatic **musculature** (the striated **muscles** of the body wall).an body.

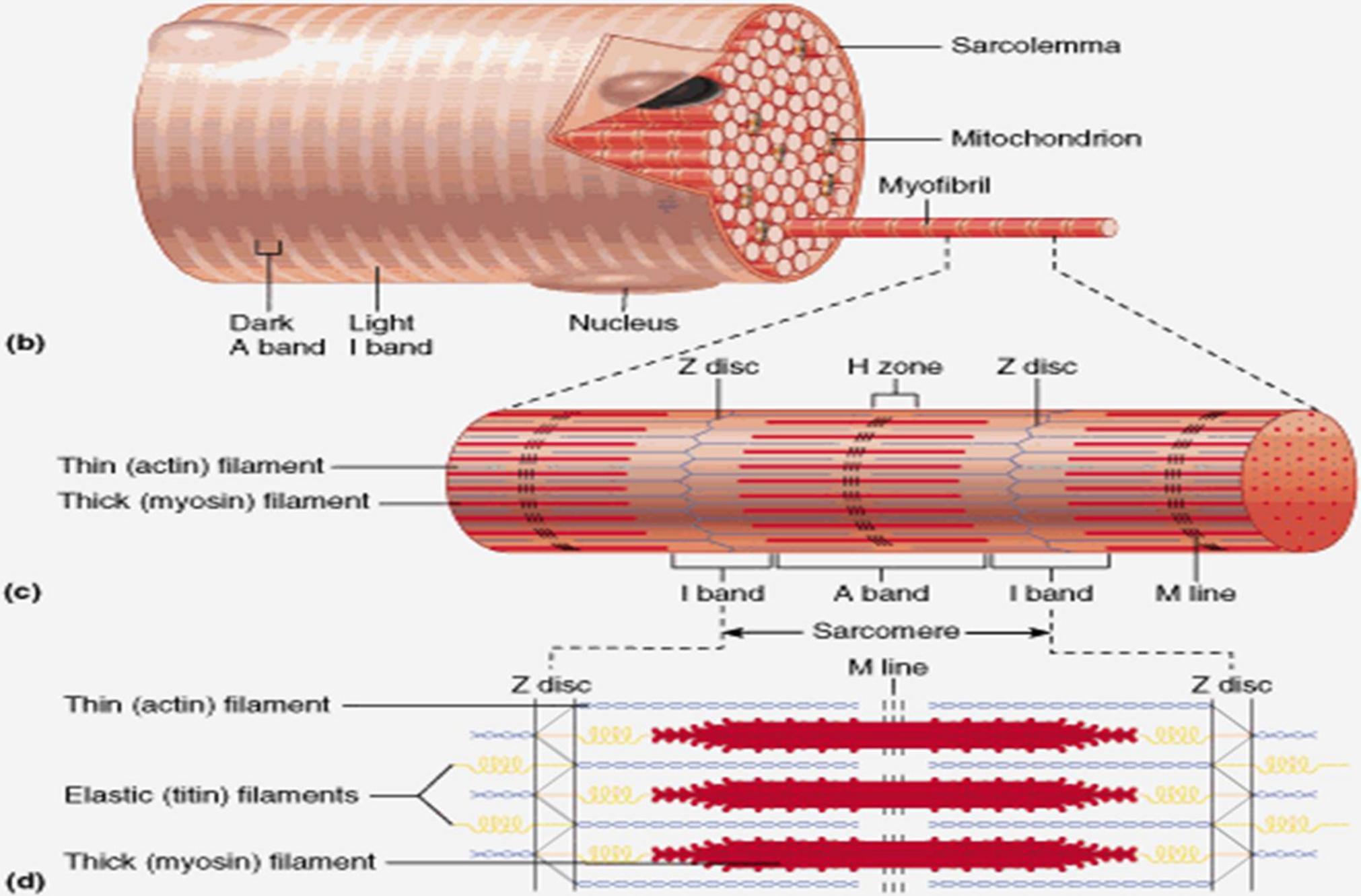
# Comparison of Muscle Types

| Muscle Type | Skeletal | Cardiac | Smooth |
|---|---|---|---|
| Location | Attached to bone | Heart | Walls of internal organs + in skin |
| Function | Movement of bone | Beating of heart | Movement of internal organs |
| Control Mode | Voluntary | Involuntary | Involuntary |
| Shape | Long + slender  | Branching  | Spindle shape  |
| Characteristics | Striated- light and dark bands<br>Many nuclei | Striated<br>One or two nuclei | Non-striated<br>One nucleus (visceral) |

# SKELETAL MUSCLE CONTRACTION

- All skeletal muscles contractions occur as a result of conscious effort originating in the brain.
- The brain sends electrochemical signals through the nervous system to the motor neuron that innervates several muscle fibers.[16]
- In the case of some reflexes, the signal to contract can originate in the spinal cord through a feedback loop with the grey matter.
- Other actions such as locomotion, breathing, and chewing have a reflex aspect to them: the contractions can be initiated both consciously or unconsciously.



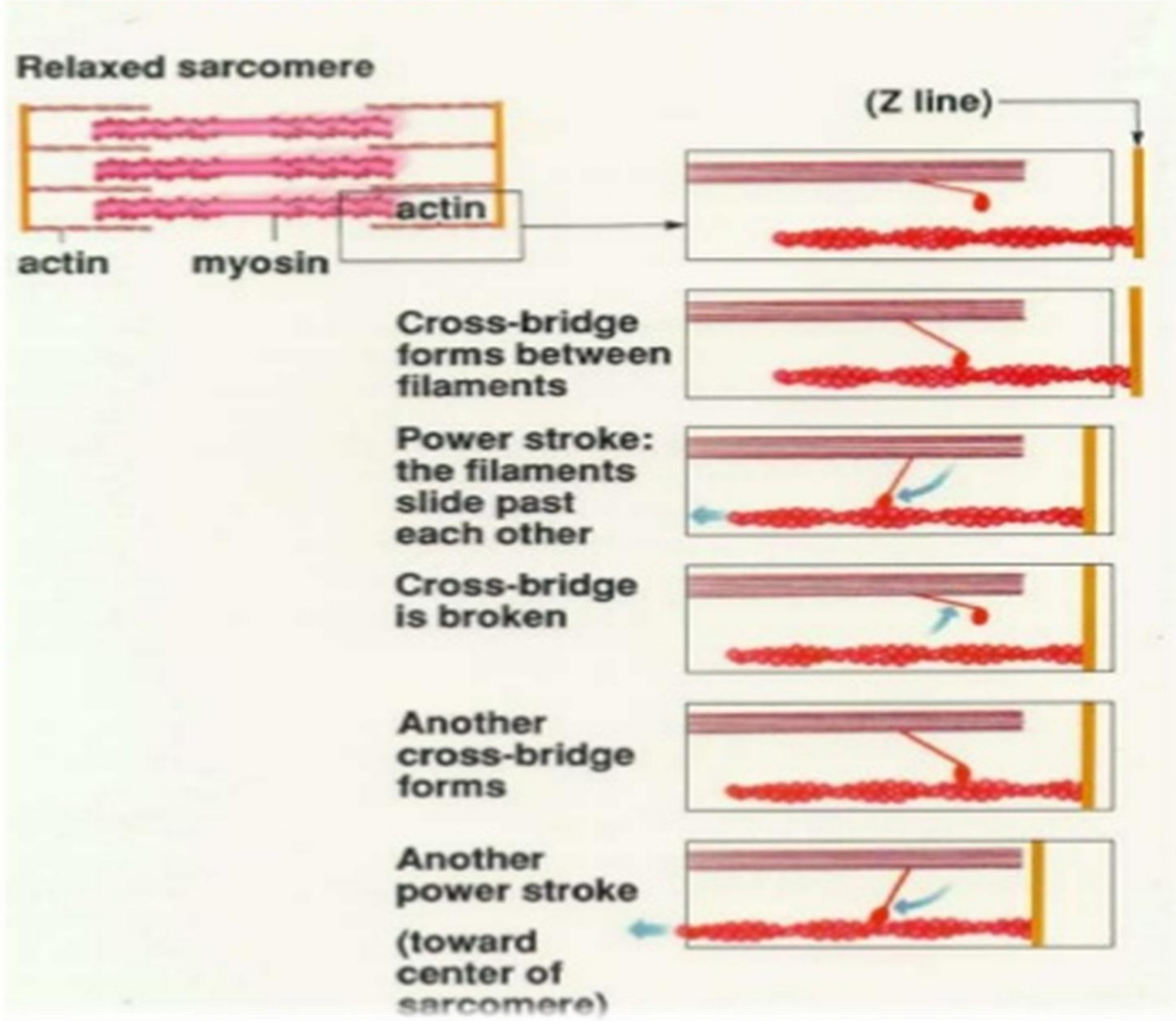


# Control Of Skeletal Muscle Contraction

- Vertebrate striated **muscle contraction** is controlled (**regulated**) by the action of the protein's troponin and tropomyosin on the actin filaments.
- Nervous stimulation causes a depolarization ofthe **muscle** membrane (sarcolemma) which triggers the release of calcium ions from the sarcoplasmic reticulum.
- The acetylcholine molecules then bind to nicotinic ion-channel receptors on the muscle **cell** membrane, causing the ion channels to open.
- Sodium ions then flow into the muscle **cell**, initiating a sequence of steps that finally produce muscle contraction.

# Mechanics of a Muscle Contraction

- What causes actin to slide over myosin?
  - **The head of myosin connects to actin and pivots.**
- What is this connection called?
  - **cross-bridge**
- The binding of the myosin heads throughout the sarcomere occur asynchronously…
  - **some myosin heads are binding while other heads are releasing the actin filaments.**
  - This process must be performed repeatedly during a single muscle contraction so that the muscle is able to generate a smooth force.

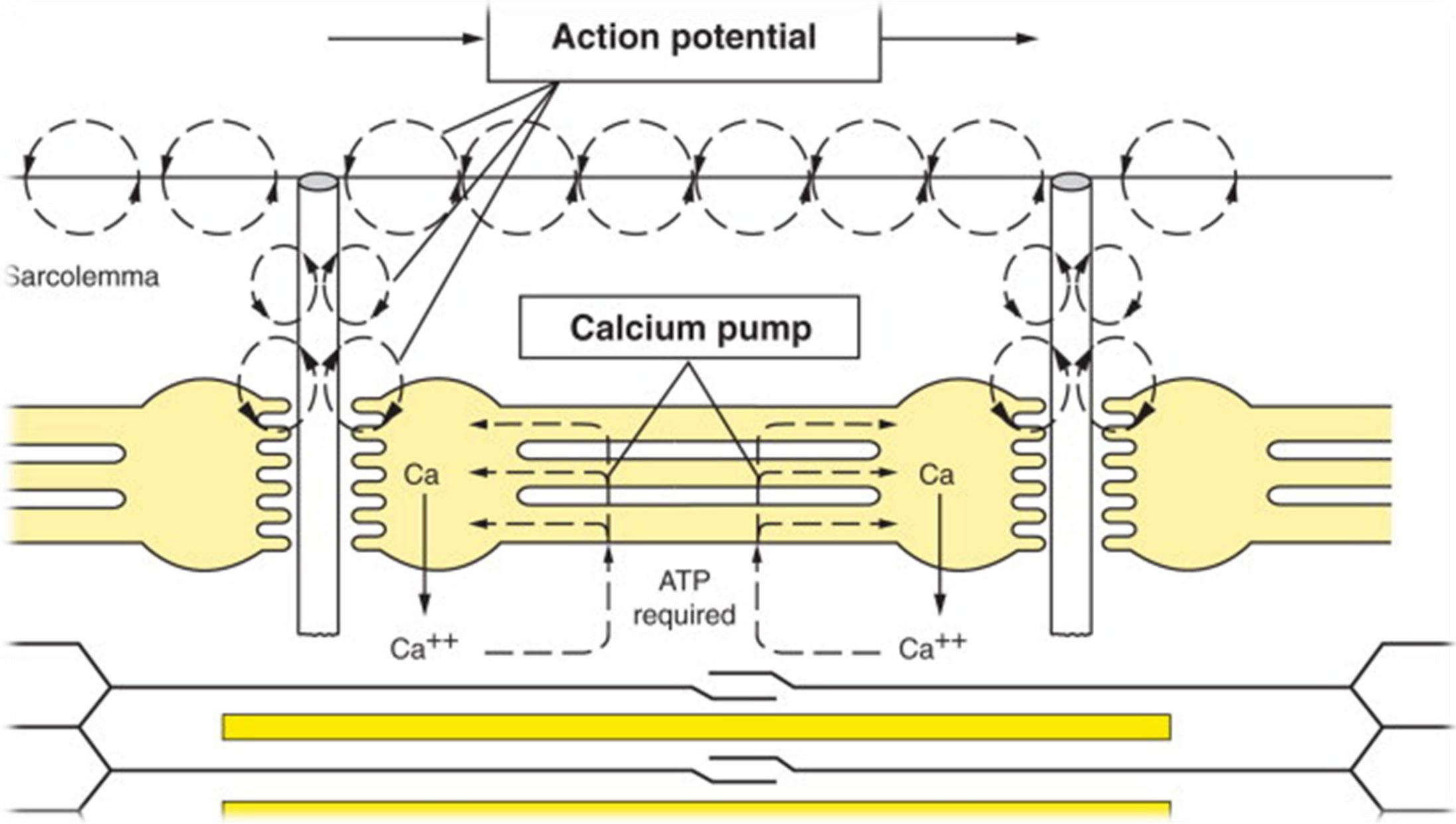


# In order for a skeletal muscle contraction to occur;

- There must be a neural stimulus.
- There must be calcium in the muscle cells.
- ATP must be available for energy.

## Muscle contraction:

- **Calcium** remains in the sarcoplasmic reticulum until released by a stimulus.
- **Calcium** then binds to troponin, causing the troponin to change shape and remove the tropomyosin from the binding sites.
- Cross-bridge cling continues until the **calcium** ions and ATP are no longer available.


Action potential
Sarcolemma
Calcium pump
Ca
Ca
ATP
required
Ca++
Ca++

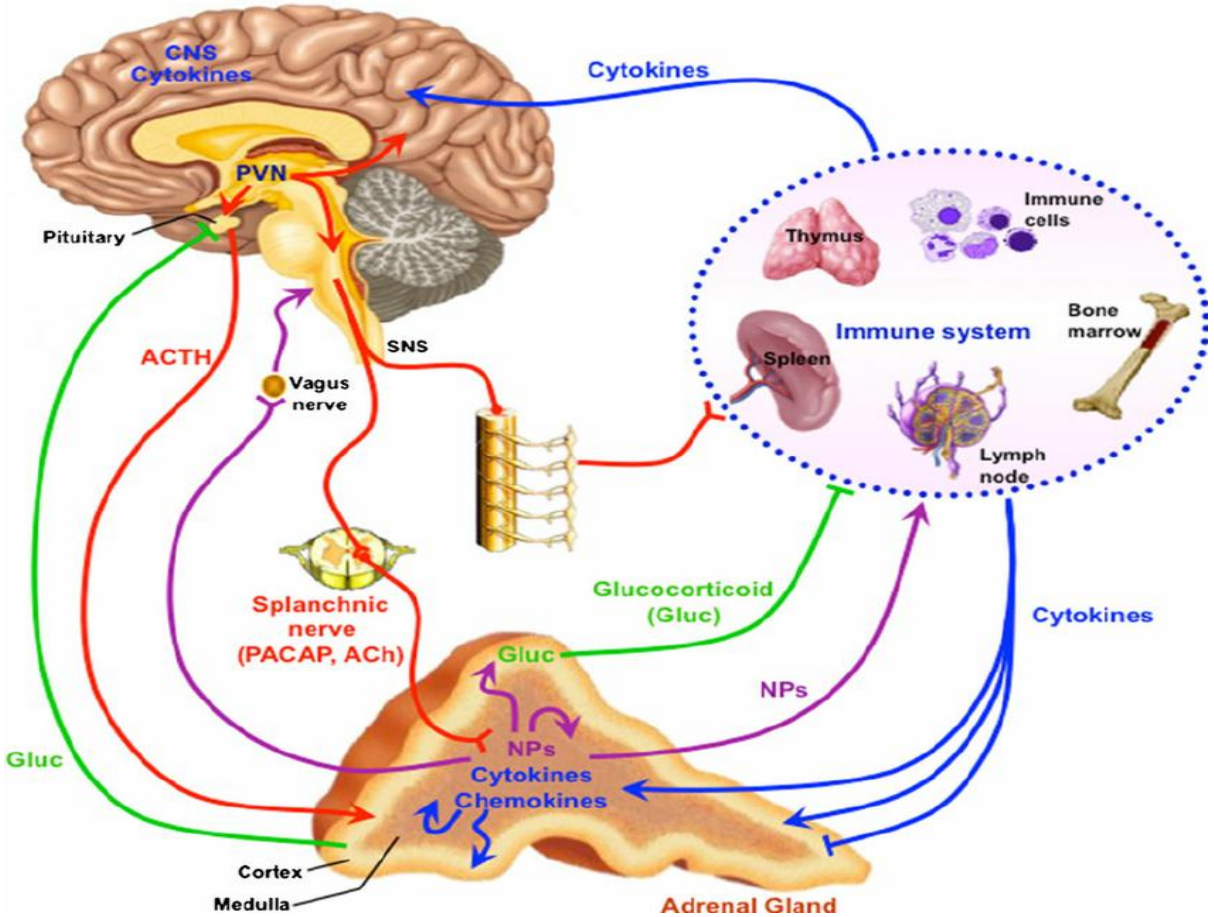
# Chapter: 2
# Communication 1: Nervous System

# Communication In Animal

- Communication: when one animal **transmits information to another** ,causing some kind of change in the animal that gets the information.
- **Biological Communication**
- The Study of Animal Communication is called **Zoosemiotics.**

# Forms Of Communication

- **Neuronal**
  - ➢ Transmit Electrical Signal
- **Hormonal**
  - ➢ Initiate a widespread, prolonged response



# Functional Types Of Neurons:

1. **Sensory Neurons**

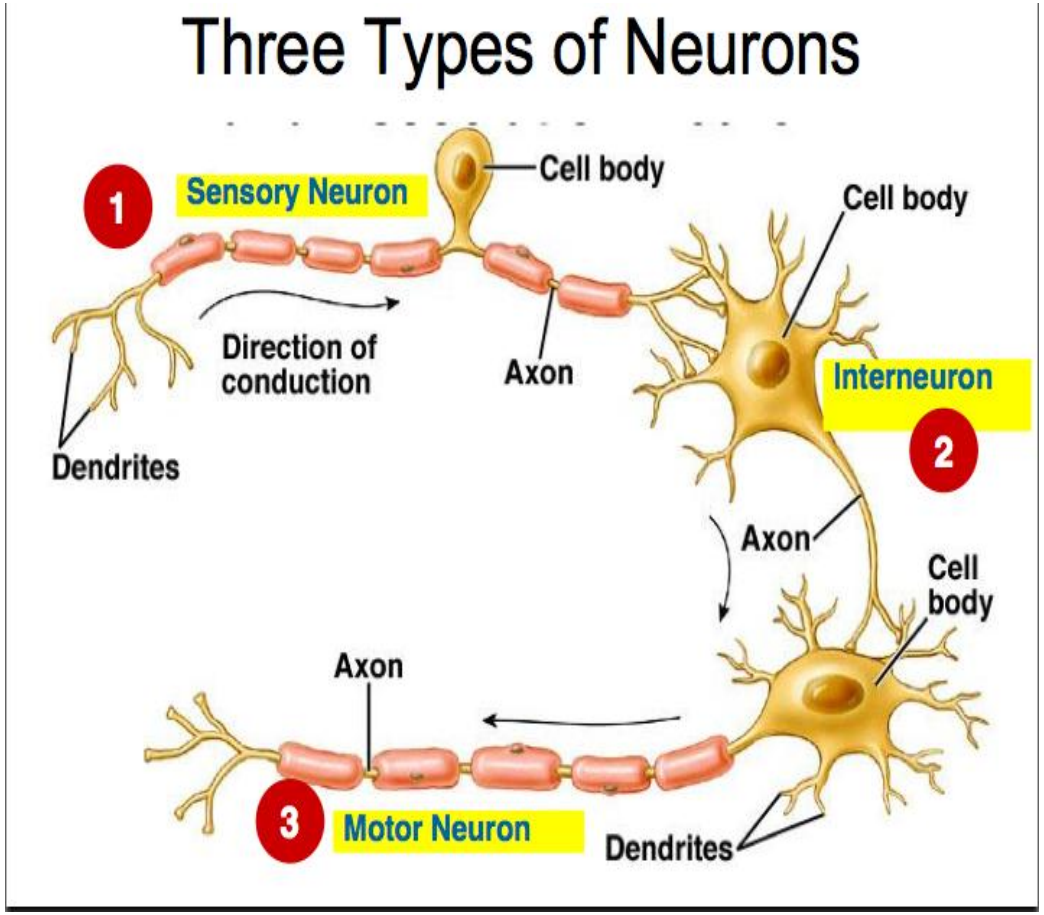
Carry signals from outer parts of body to CNS

2. **Motor Neurons**

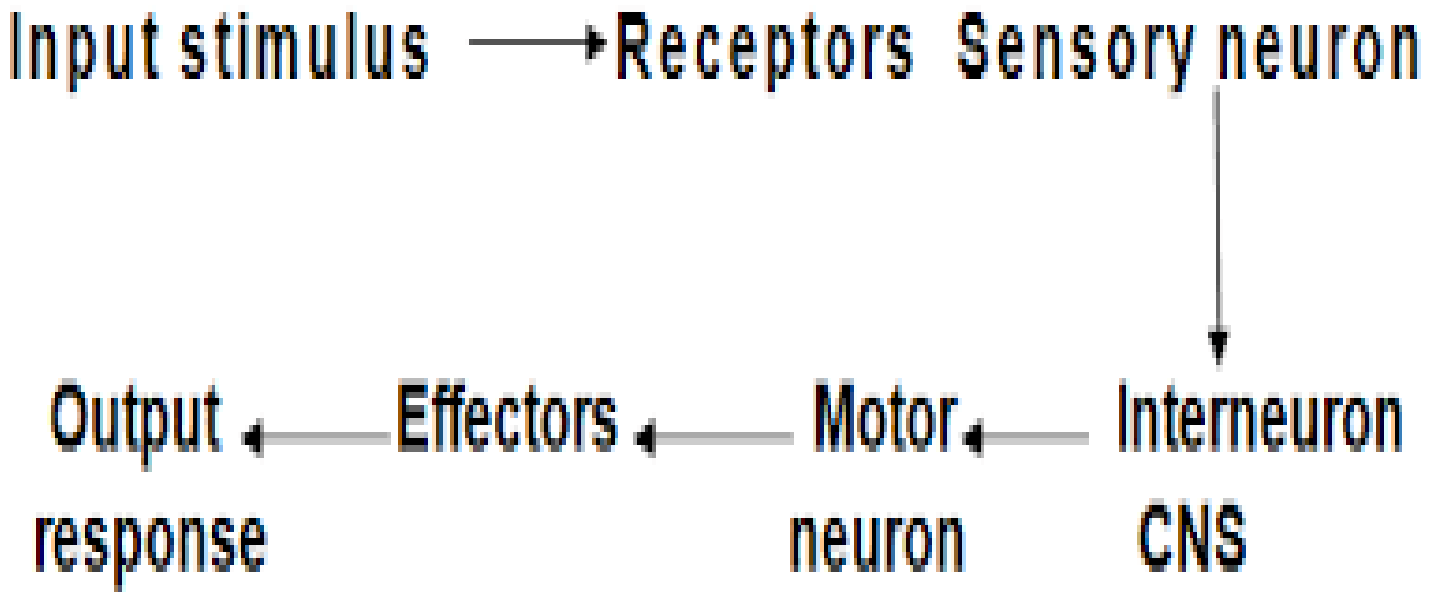
Carry signals from CNS to outer parts of body

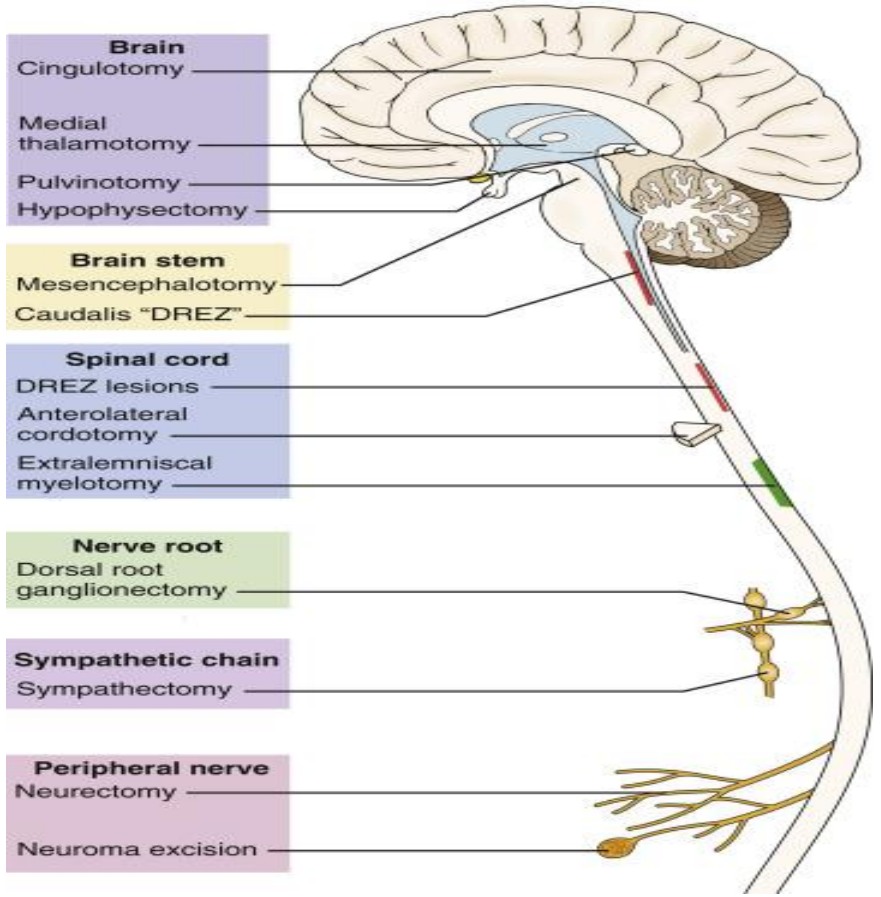
3. **Inter Neurons**

connect various neurons within the brain and spinal cord



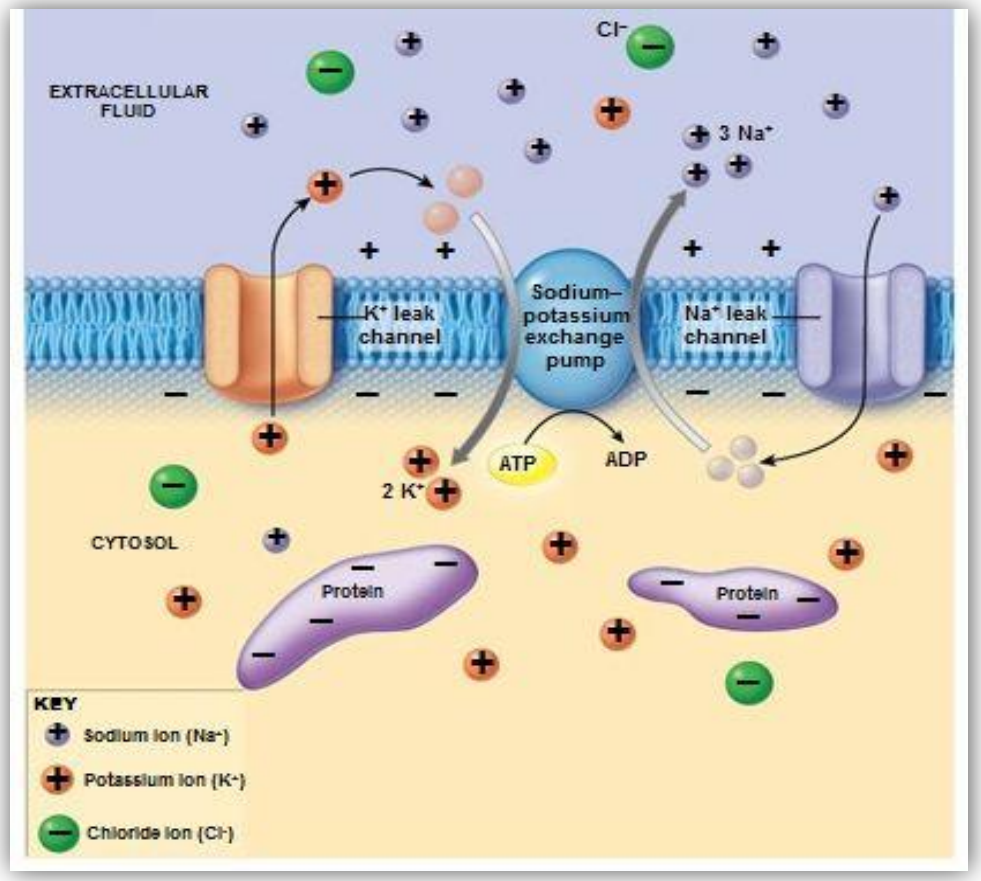
# Generalized Pathway For Flow Of Info. In CNS



# Resting Membrane Potential

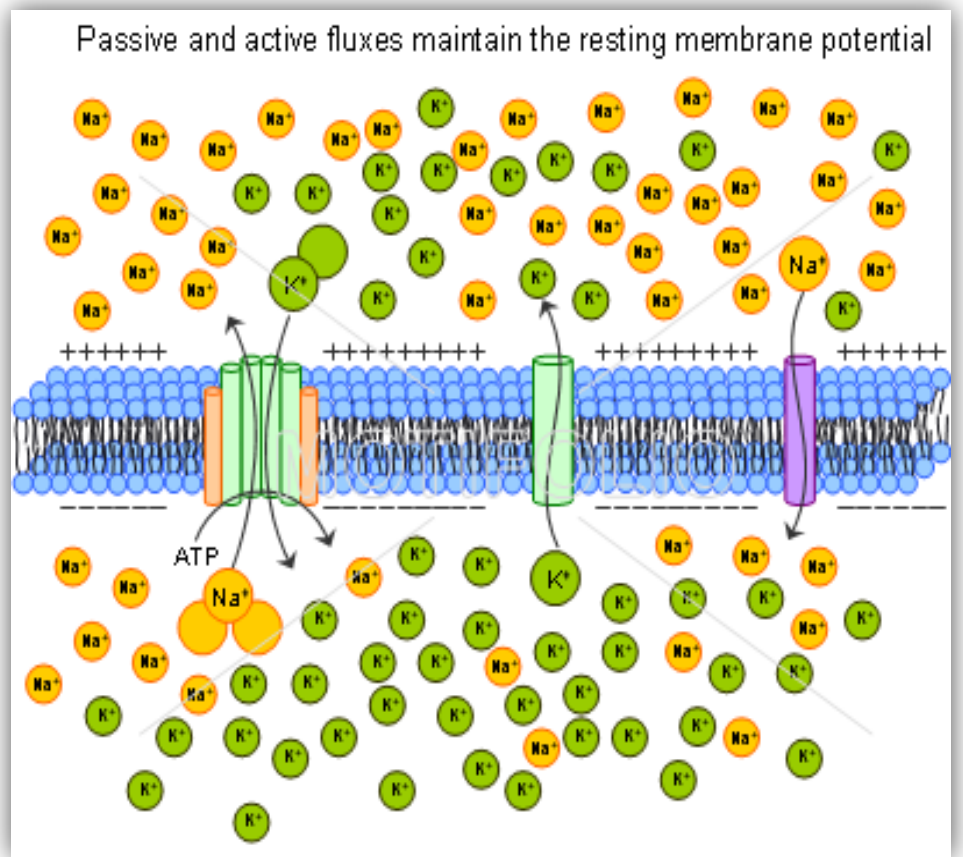
- Neuron is polarized.
- Difference in electric charge is due +ve and -ve ions in fluids on either side.
- Permeability of plasma membrane of these ions.
- All cells have resting membrane potential
- Measured in milivolts(-70mV).




https://www.google.com.pk/restingmembranepotential

# Mechanism of Resting Membrane Potential

- Na+ are concentrated outside and potassium(K+) are concentrated inside.
- Diffusion of ions takes place.
- Membrane remain constant due to **sodium potassium ATPase pump.**
- 3Na+ moves out and 2K+ moves in.
- The pump work to establish resting potential across membrane.
- Membrane regain potential of -70mV.




https://www.google.com.pk/url/restingmembranepotential

# Action Potential

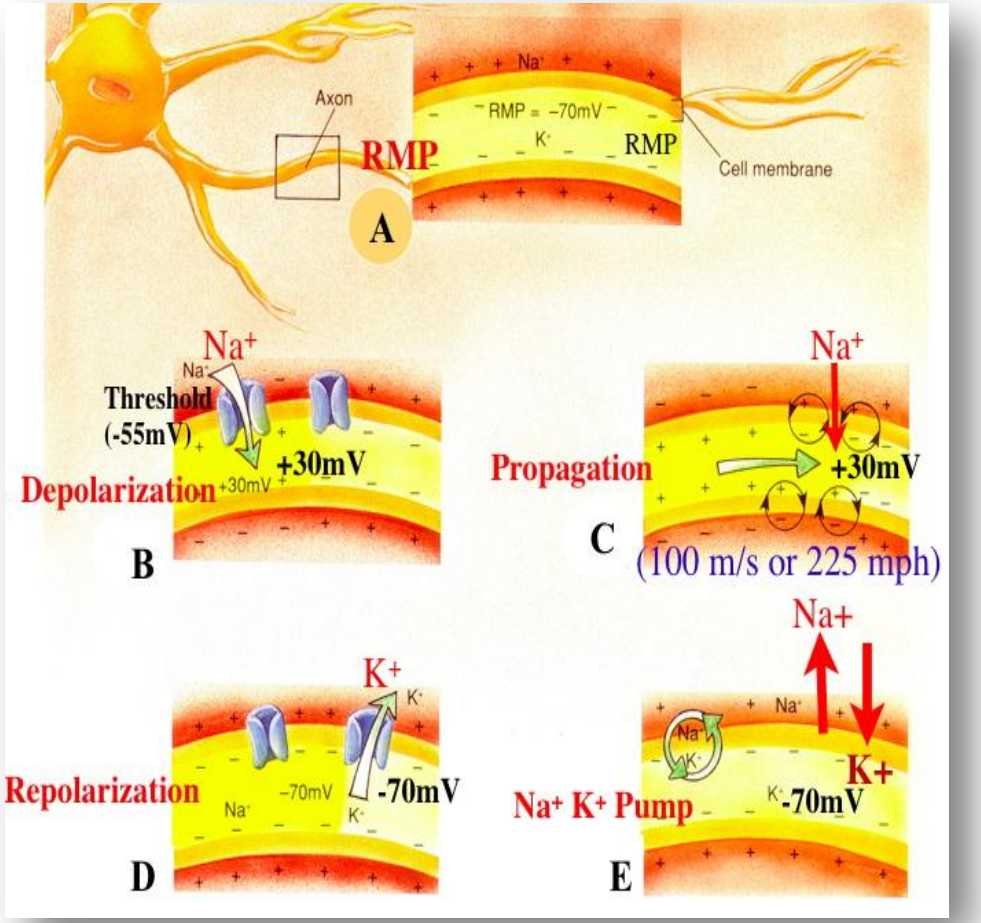
- Series of events occurs in RMP when cell is stimulated with adequate stimulus.
- Threshold stimulus is needed to initiate an impulse.

❑ **Events:** The events are as follows;

➢ Depolarization

➢ Repolarization

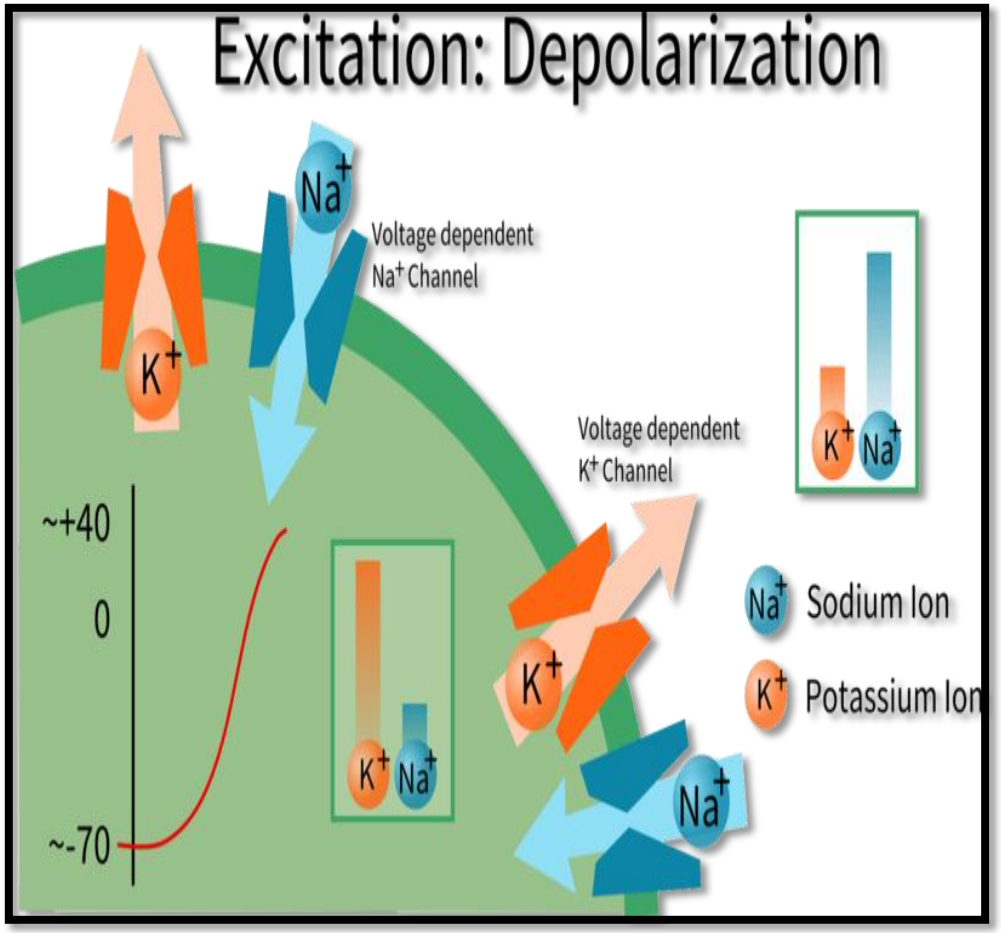
➢ Hyperpolarization




https://www.google.com.pk/url/action potential

# Depolarization

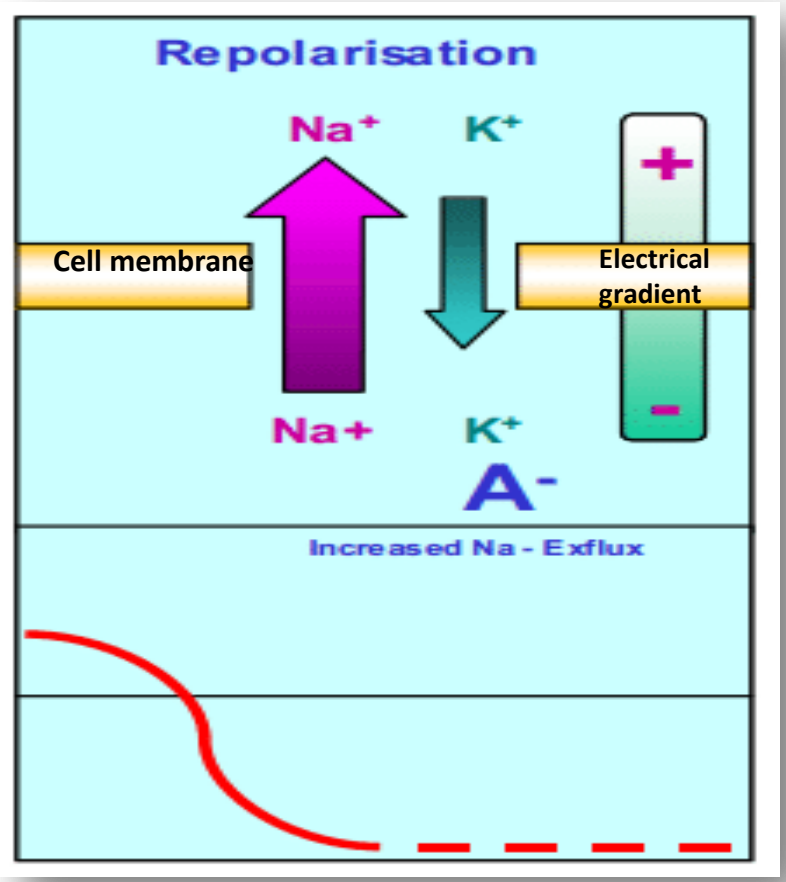
- Threshold increases the permeability of Na+.
- Na+ move inside causes membrane potential fall from -70mV to 0.
- Inside_ **+vely** charged
- Outside_ **-vely** charged
- Na+ gate open and it rush inside.
- Decrease the membrane potential.
- After that, K+ gate open and it rush outside.




https://www.google.com.pk/url/depolarization

# Repolarization

- Na+ gated channels closes, K+ gates channels open.
- Lead to efflux of K+ ions.
- Inside _ **-vely** charged.
- Outside _ **+vely** charged.
- Then K+ gate close.
- This lead to repolarization.



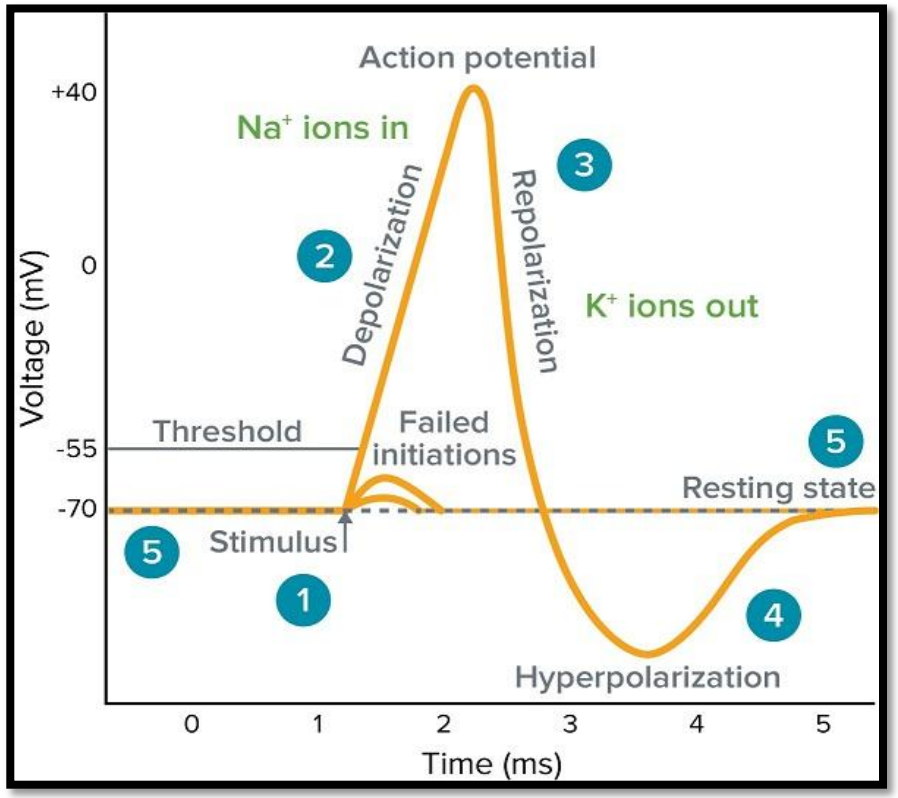

https://www.google.com.pk/url/repolarization

# Hyperpolarization

- Action potential stops for an interval of time.
- K+ rushed out.
- Increase in membrane potential.
- This brief period is **refractory period**.
- Resting potential is stored in membrane.

➢ **All-or-none law**

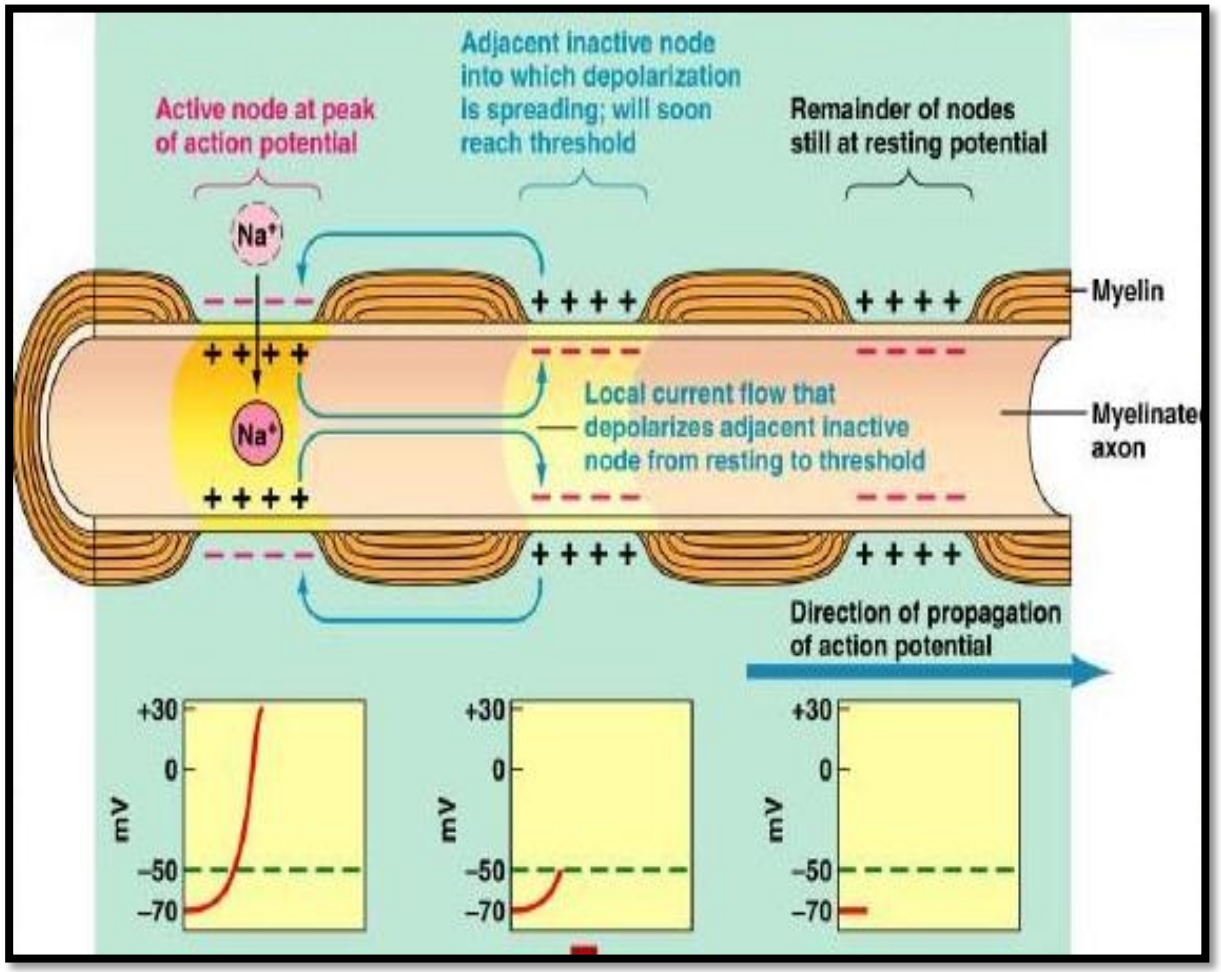
“Axon will fire at full power or not at all’’




https://www.google.com.pk/url/hyperpolarization

# Role of Myelin

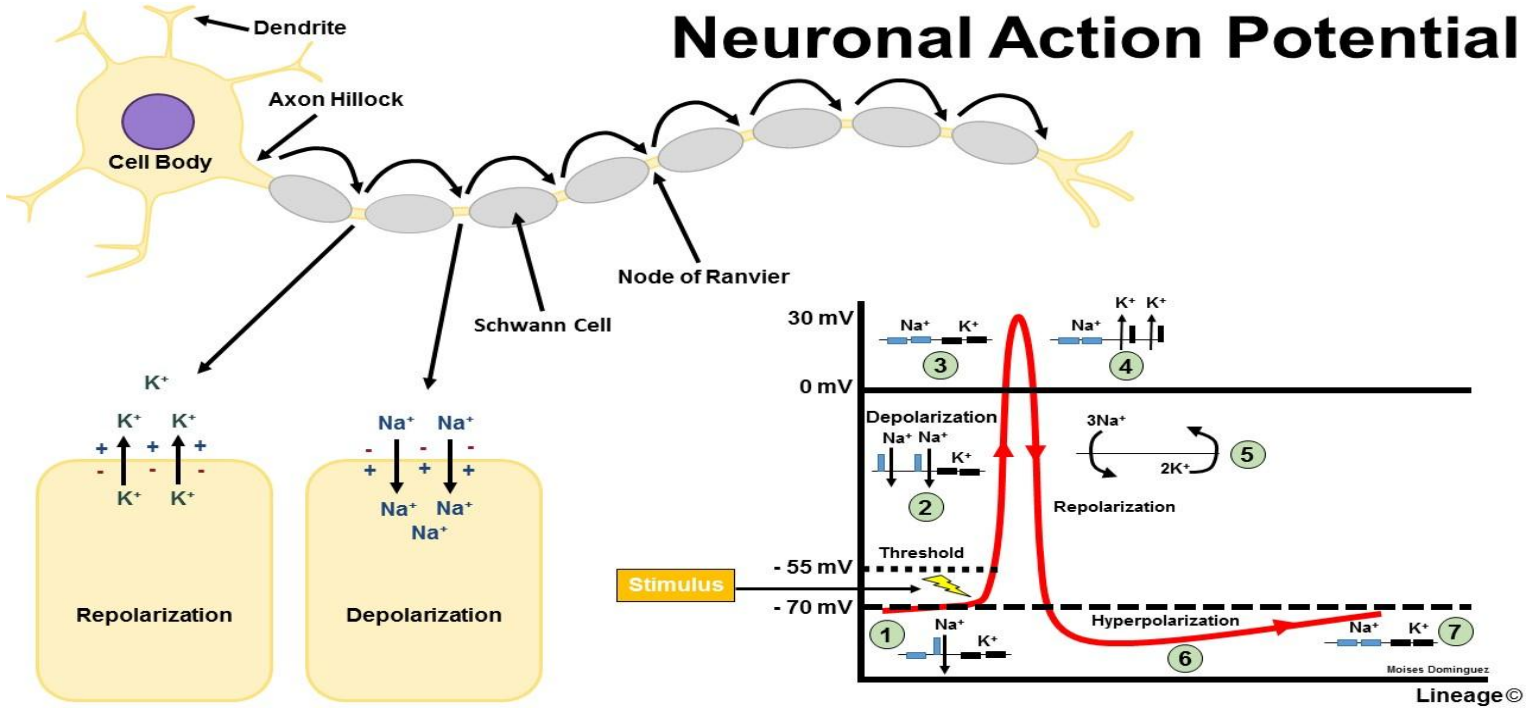
- Action potential jumps from node to node (Saltatory Conduction).
- **Myelination** allow rapid conduction in small neurons.
- Cause increase in conduction velocity.
- Axon diameter is large in invertebrates.




https://www.google.com.pk/url/saltatoryconduction

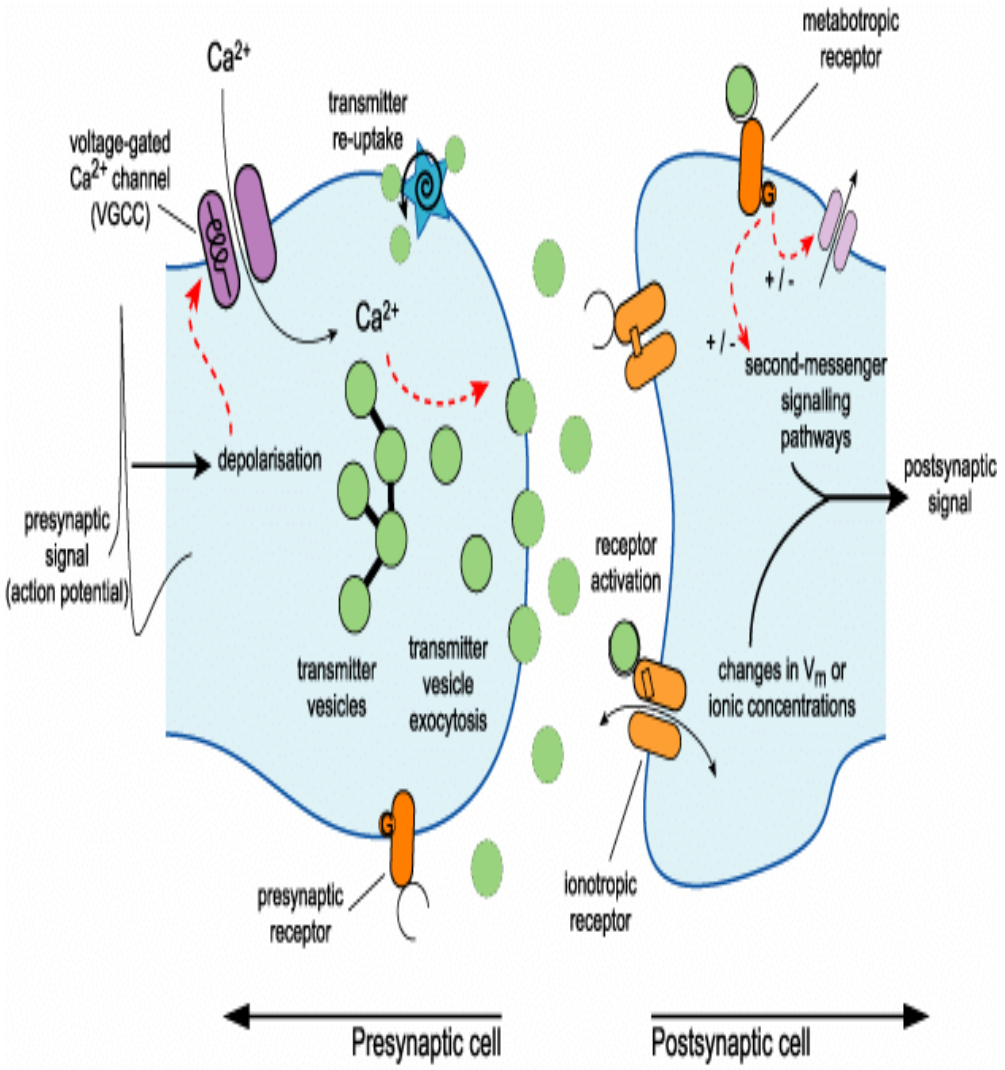
# Action potential

- Neuron receive input.
- Neurotransmitter.
- **Action potential** ( the polarity change).
- Signal (stimulates other neurons).
- Generate **nerve impulse** .

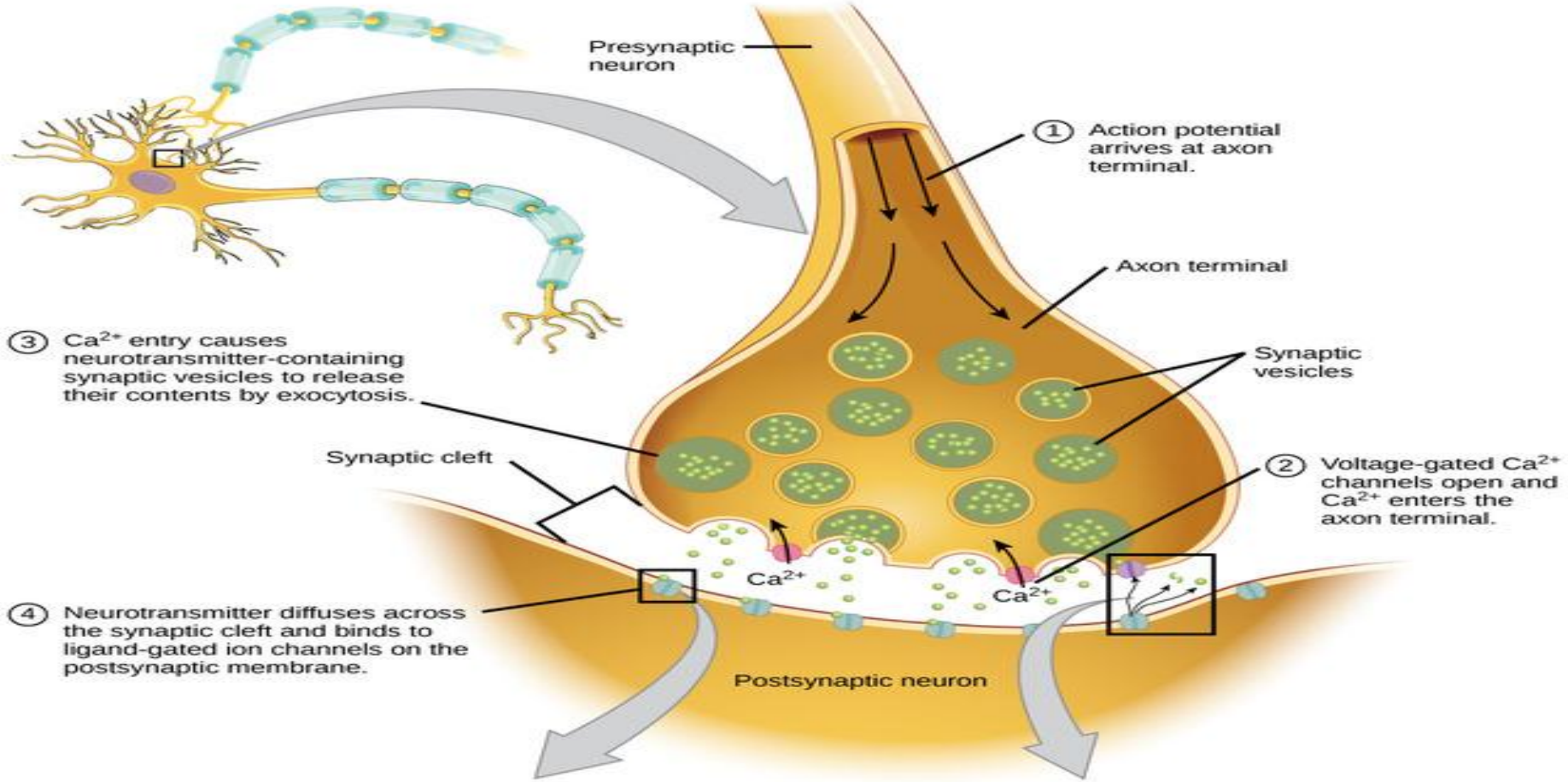


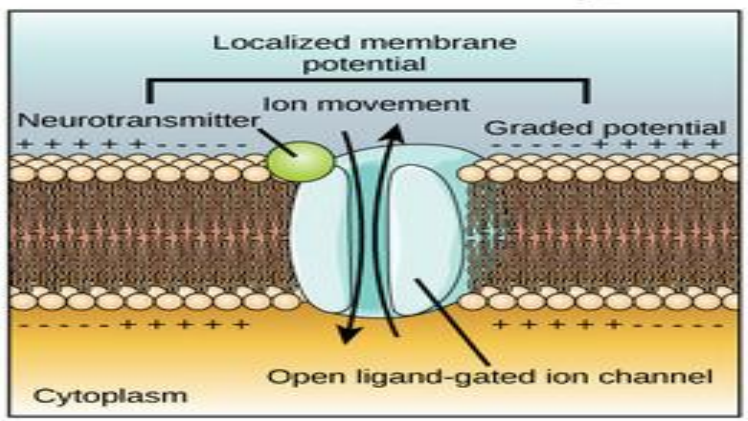

hhtpp.action.potential.hjk

- **Synapses** :
- Junction (axon of one and dendrite of other neuron).
- **End Bulb** :
- End of the branching axon .
- **Synaptic cleft :**
- Space between end bulb and dendrite of next neuron.
- **Presynaptic neuron(before synapse):**
- Neuron carry the action potential toward synapse.
- **Postsynaptic neuron(after synapse):**
- Neuron carry impulse /action potential away from synapse.

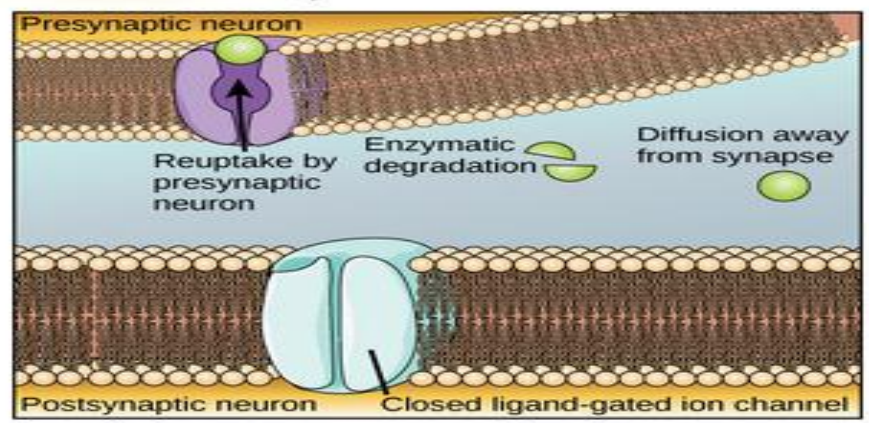



http.synapses.qerd.hghjgdewuh.pk



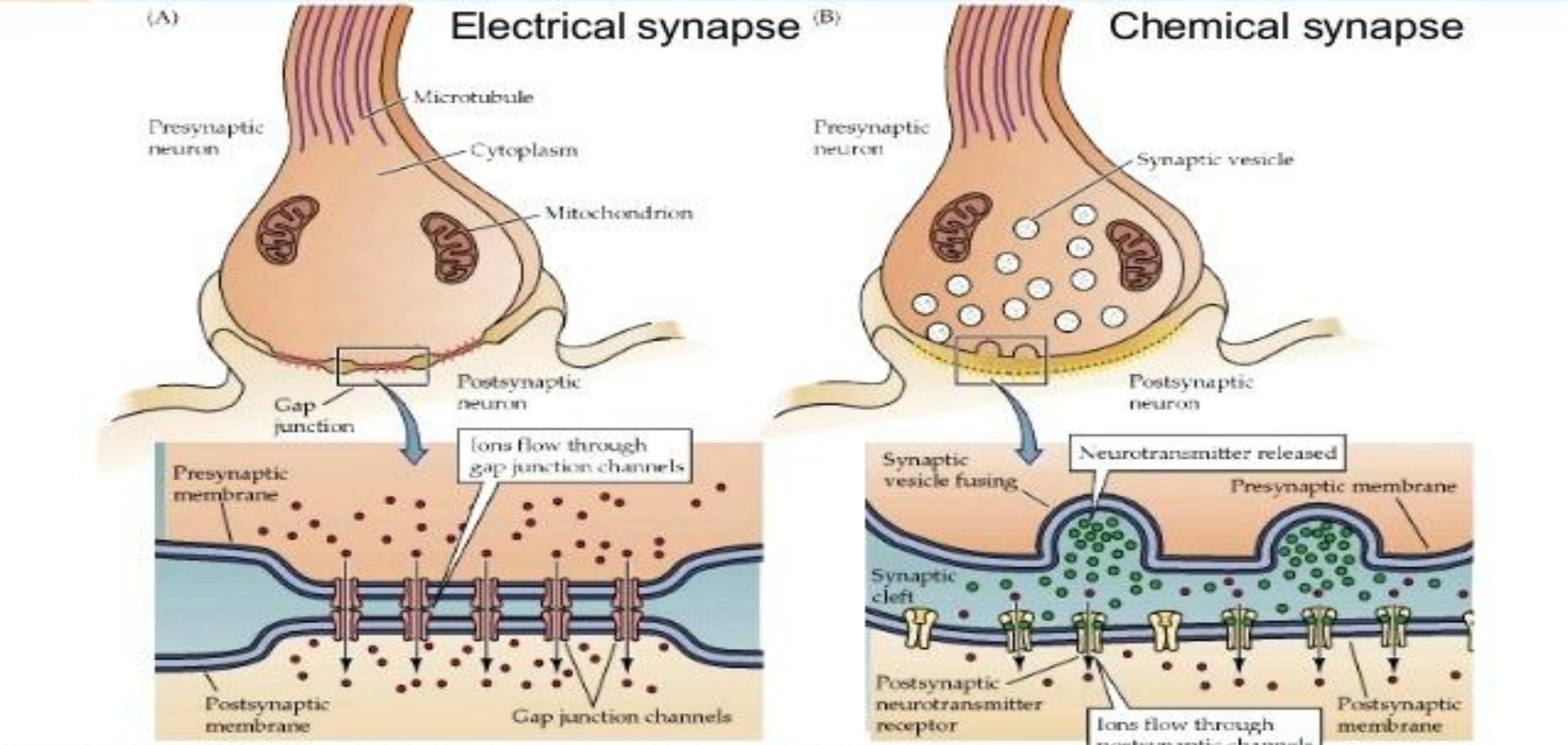




5 Binding of neurotransmitter opens ligand-gated ion channels, resulting in graded potentials.



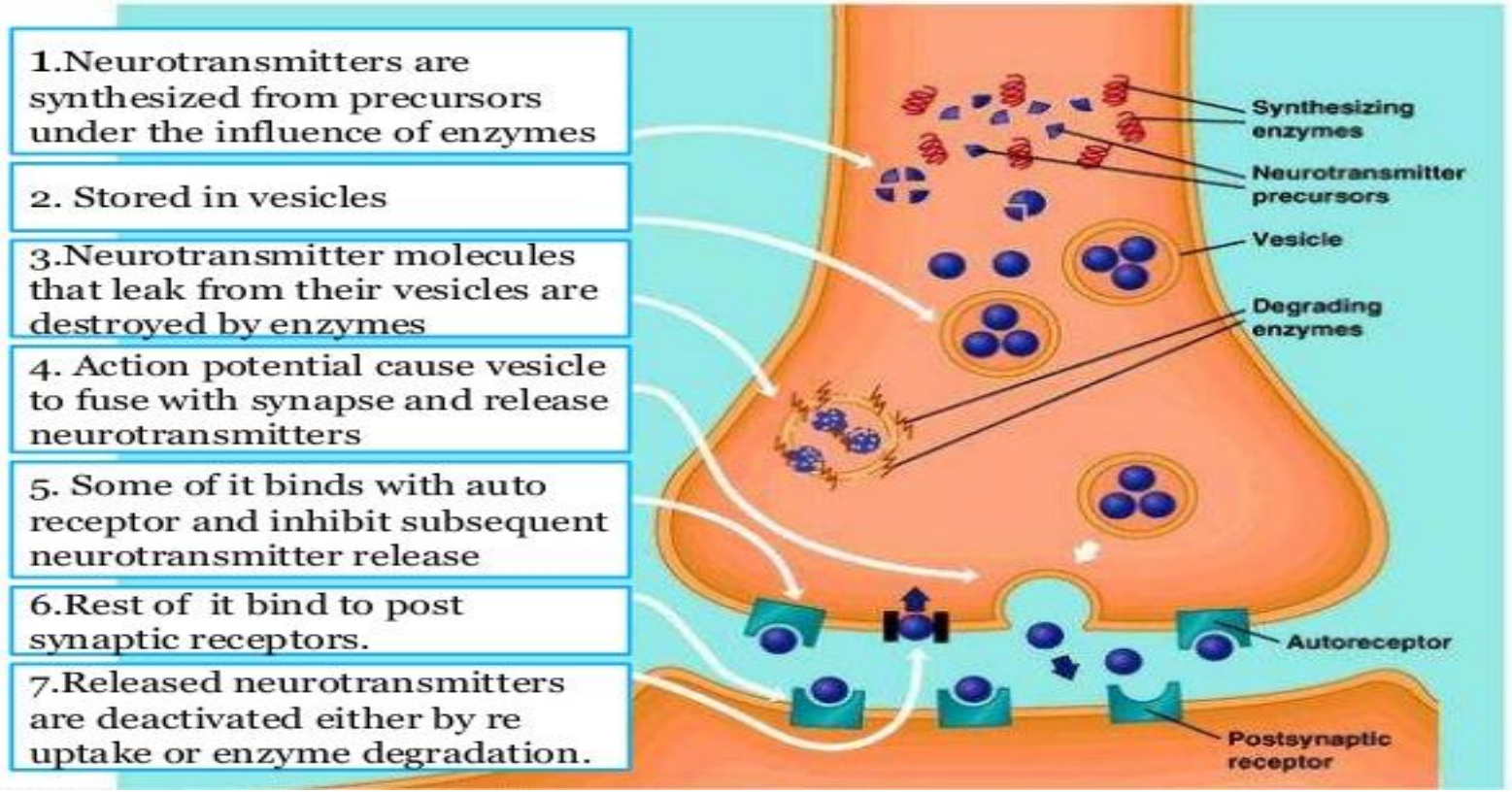

6 Reuptake by the presynapic neuron, enzymatic degradation, and diffusion reduce neurotransmitter levels, terminating the signal.

# Types of synapses




http://kin450-neurophysiology.wikispaces.com/Synaptic+Transmission

# Role of neurotransmitters :



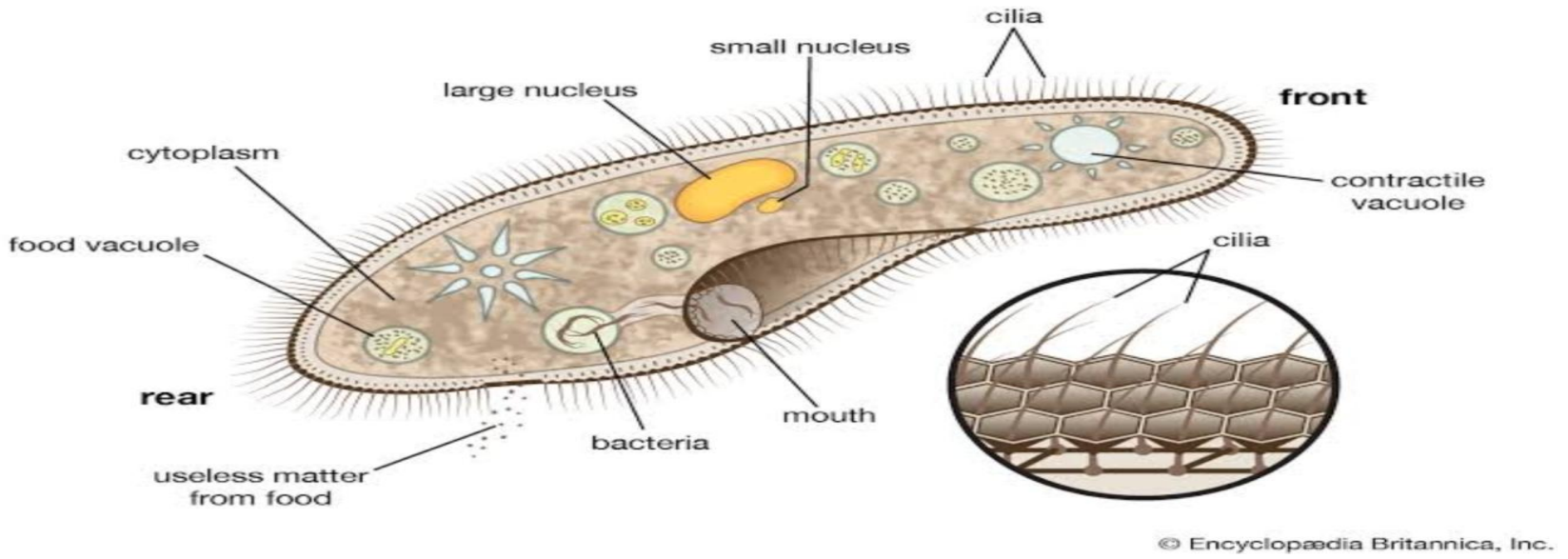

## Types of neurotransmitters:

http.neurotransmitters.phtykcgs

1. Glutamate
2. Oxytocin
3. Epinephrine, Norepinephrine
4. Adenosine triphosphate (ATP)
5. Acetylcholine

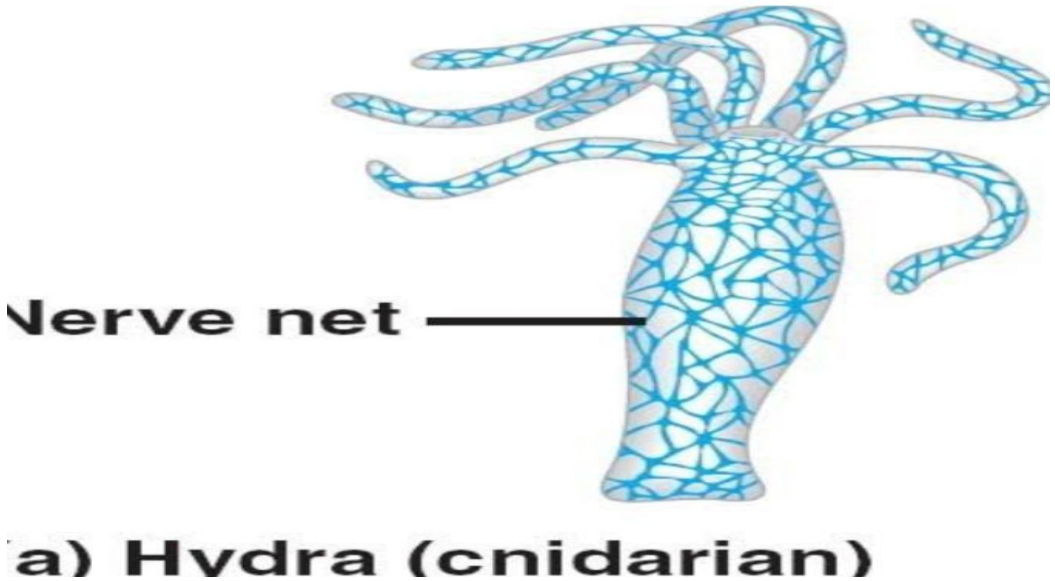
# Invertebrate Nervous Systems

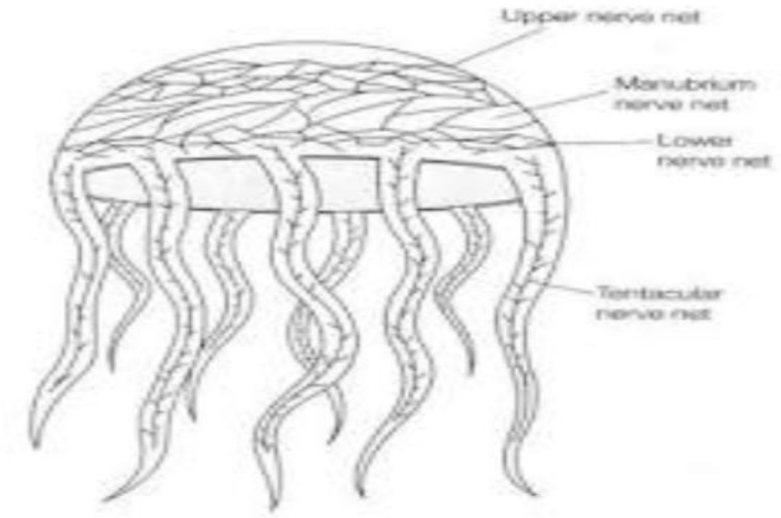
- No real nervous system.
- Coordination due to ciliary movements.
- Coordination to external and internal stimuli.



# Simplest form of nervous organization

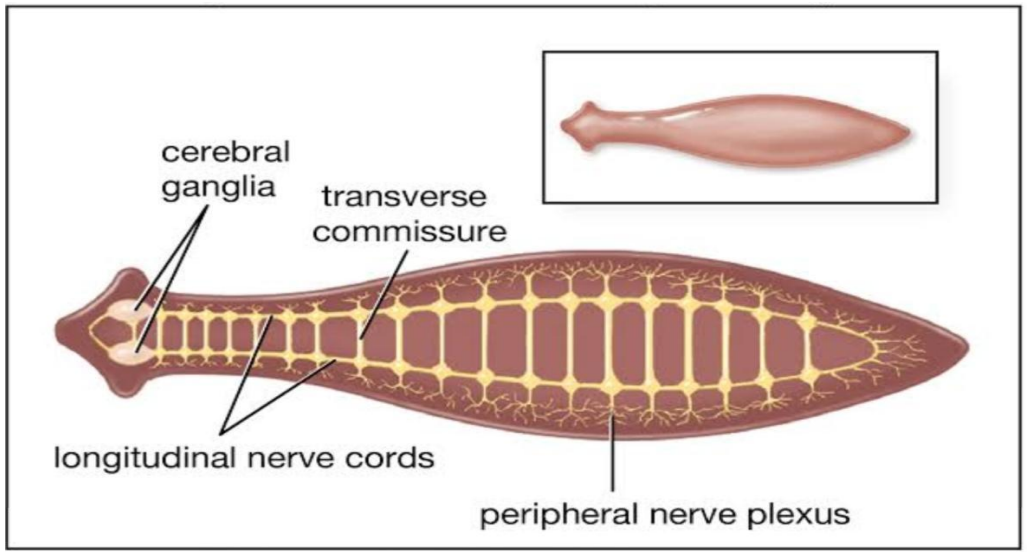
- These animals have a nerve net.
- Latticework that conduct impulse from one area to another.
- Impulse conduction by neuron is bidirectional.
- Involved in slow swimming movements.



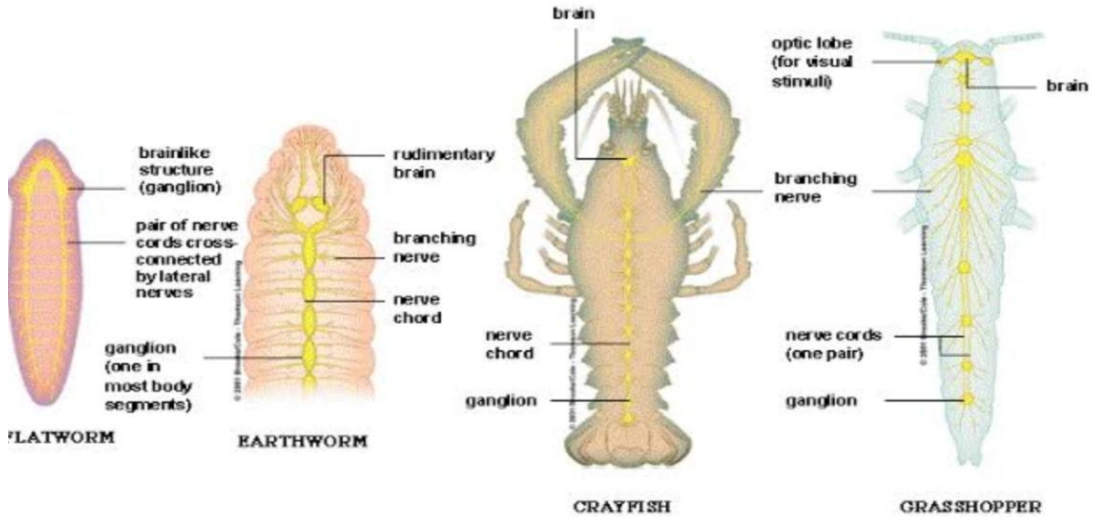
# Second trend in nervous organization

- Have sense organs concentrated in the body region.
- Nervous system evolution involves cephalization.
- Concentration of receptors and nervous tissues in animals anterior region.
- Ganglia functions as primitive brain.
- Distinct lateral nerve cords.
- Example:flateworms and roundworms.



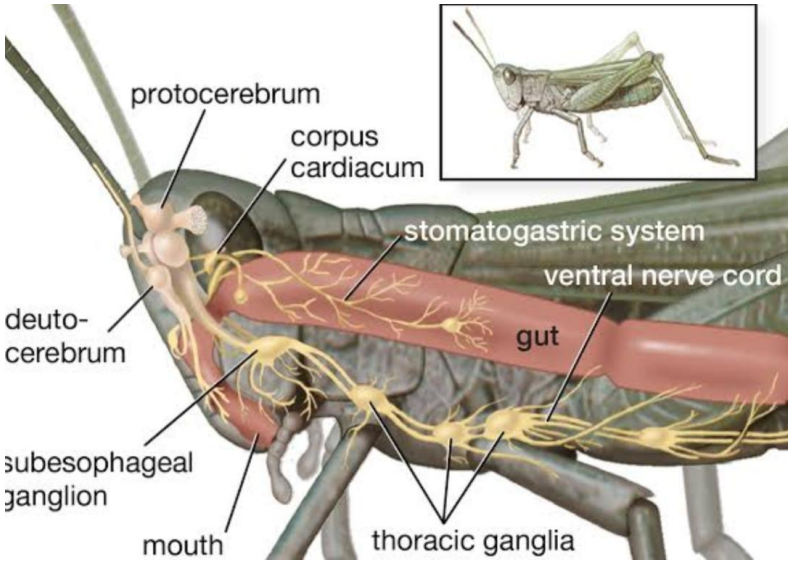
# Third trend in nervous organization

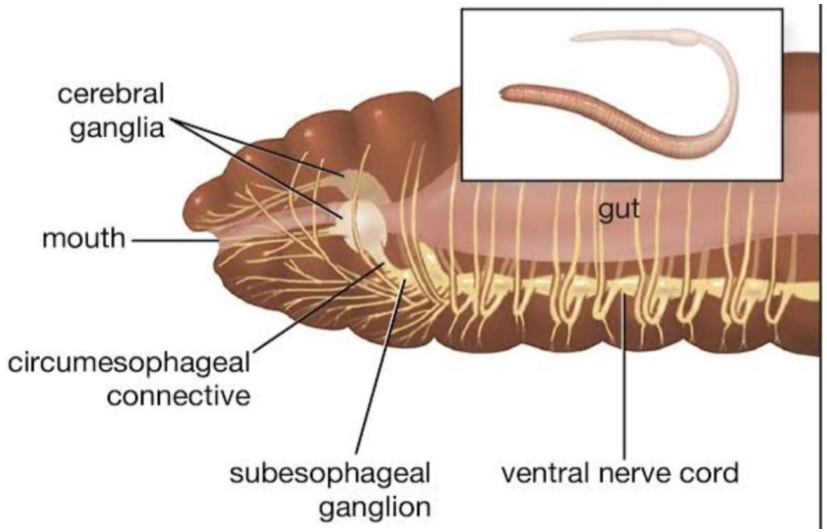
- Lateral nerve cords are present.
- Bilateral symmetry have led to paired neurons, sensory structures and brain centers.
- Pairing facilitates ambulatory movements such as climbing, crawling or walking.
- Examples:flatworms



# Fourth trend in nervous organization

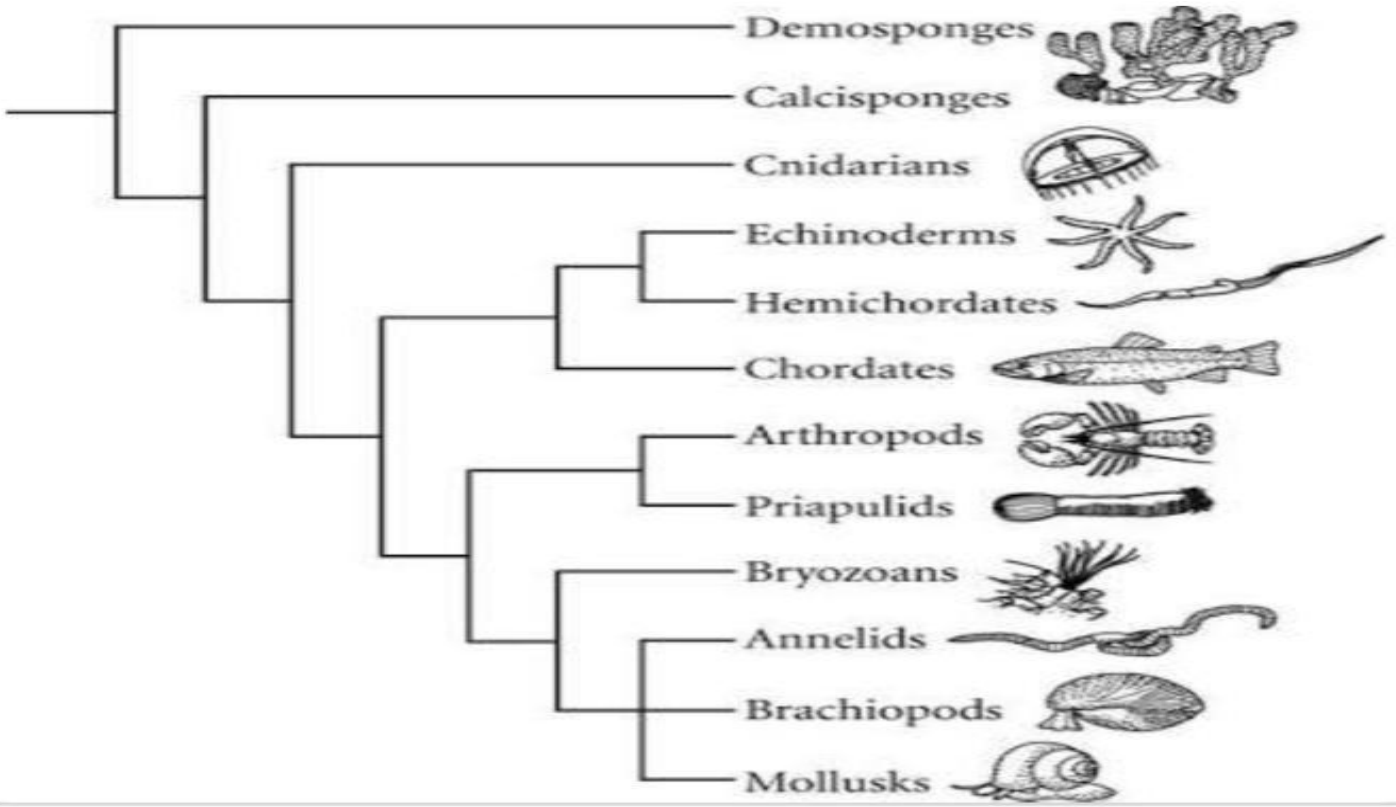
- Axons join into nerve cords.
- Centralized brain.
- Ganglia can occur in each body segment.
- Ganglia can be scattered throughout the body.
- Example:crustaceans segmented worms and arthropods.



# Fifth trend in nervous organization

- It is a consequence of the increasing number of interneurons.
- More complex the animals the more complicated its behaviour.
- More neurons are concentrated in an anterior brain.
- Bilaterally organized ganglia.

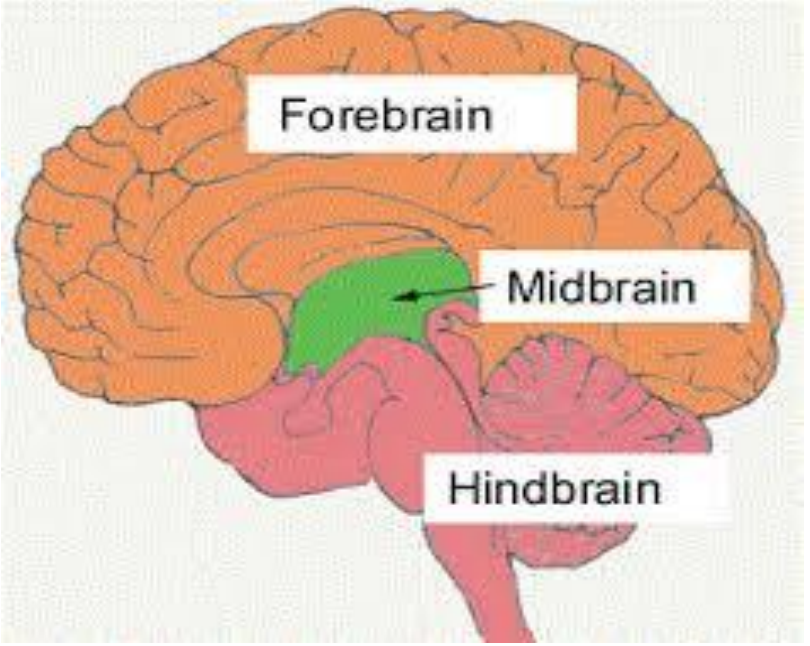


# Human brain

- Brain is organ of soft nervous tissue contained in the skull of vertebrates functioning as the coordinating center of the body.

Human brain is divided into 3 main parts.

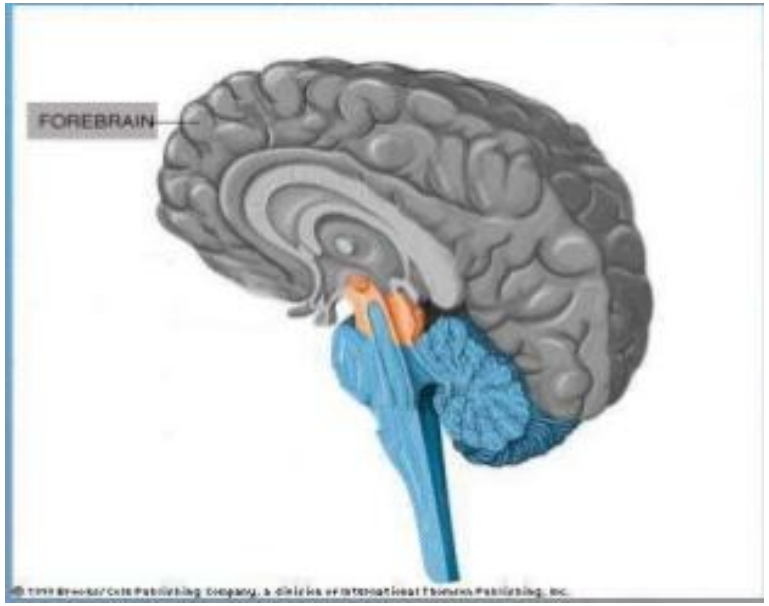
- Fore brain
- Mid brain
- Hind brain



# Fore Brain

- It is the anterior part of the brain.
- It has 3 parts

1. Thalamus
2. Hypothalamus
3. Cerebrum
4. Pineal and pituitary gland



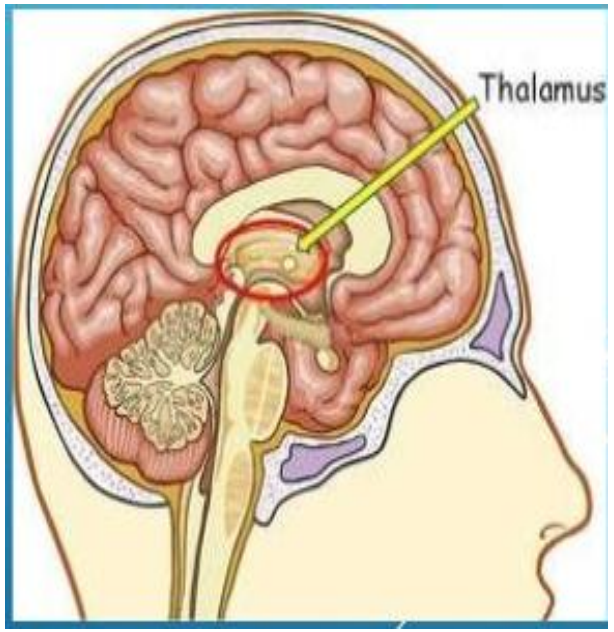
**1.Thalamus:**

It relays all sensory information to higher brain center

**2.Hyphothalamus:**

lies below the thalamus and regulate many functions such as

- Body temperature
- Sexual drive Carbohydrate metabolism
- Hunger
- Thirst




**3. Pineal glands:**

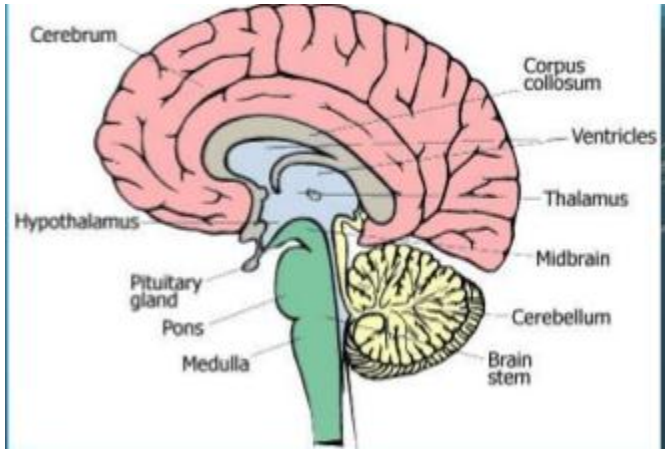
Control body rhythms

**4. Pituitary gland**

major endocrine gland

# Cerebrum

- The cerebrum is the biggest part of the brain.
- This part we associate with higher brain functions such as thinking and action.
- It contains the cerebral cortex and other subcortical structures.

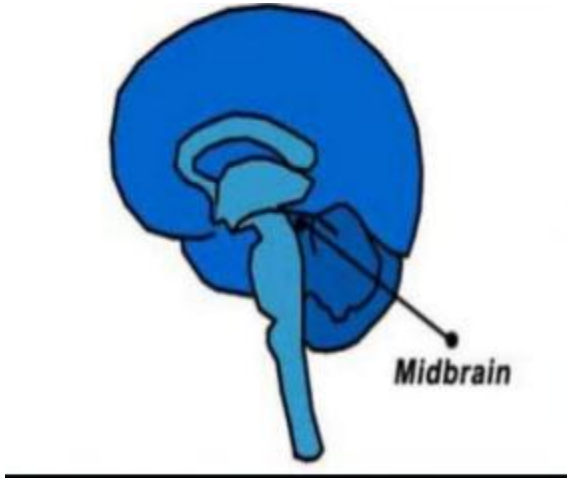



# Mid Brain

- It is located below the cerebral cortex and above hindbrain

It controls:

- Reflex movement of body
- Hearing reflexes

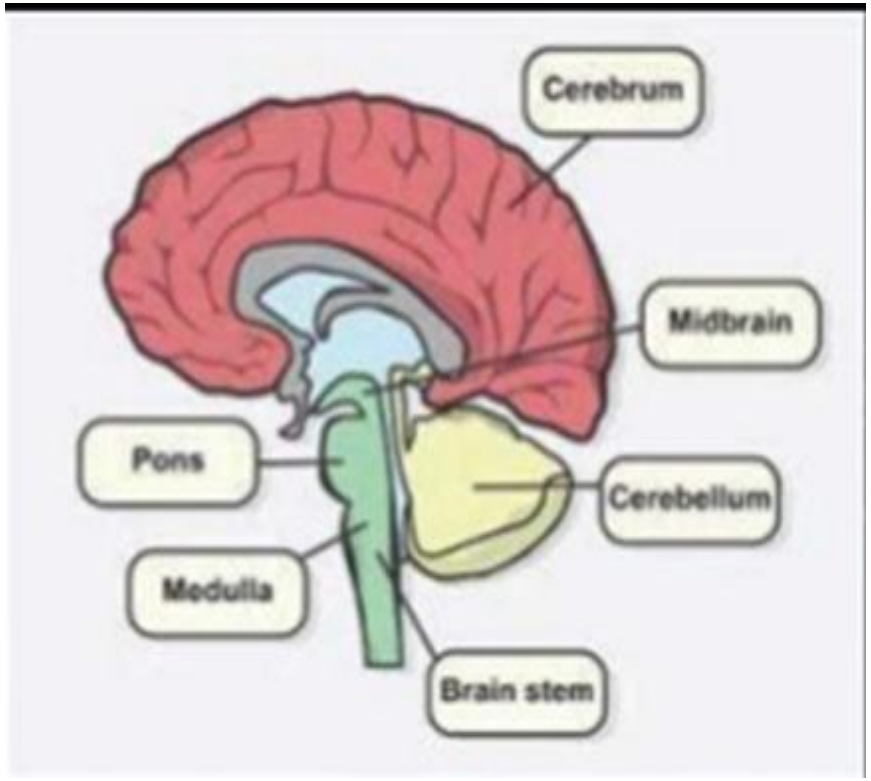


# Hind brain

- Located  at the backside of brain

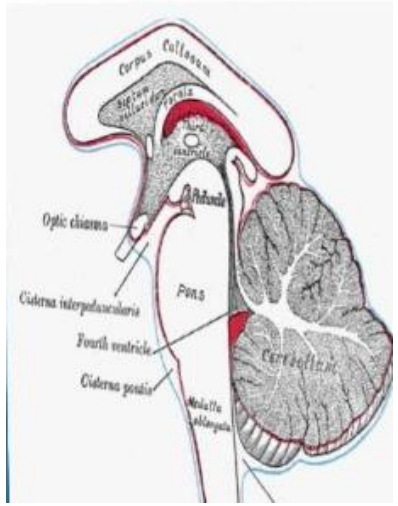
**Parts:**

- Cerebellum
- Pons
- Medulla oblongata
- **Cerebellum:**
- Located at back side of head
- Controls balance of body
- Voluntary movement of body



**Pons:**

- Located above medulla
- Controls sleep
- Pattern of breathing




- **Medulla oblongata:**
- Posterior part of brain

Controls:

- Breathing
- Heart rate
- Swallowing
- Blood circulation