



Histology

faculty of medicine - JU2015

Lecture#14

Rama Alashqar

Dr.Hiba Kalbouneh

Skin

Skin appendages: accessory structures of the skin, we can find inside the skin the hair and the hair follicles, the nails (which are keratinized plates of dead cells, sebaceous glands that open into the hair follicle, we also talked about eccrine and apocrine sweat glands.

HAIR

It is an elongated keratinized structure that is found inside the hair follicle (pocket shaped) **The hair itself is divided into two parts:**

1. the part that is embedded inside the skin is called → *root of the hair*
2. the part that is visible (above the level of the skin) is called → *shaft of the hair*

The epidermis of the skin invaginates inside the dermis and form a pocket where you find the hair, this is called hair follicle.

Hair bulb: the most basal swollen area of the hair follicle.

What do we have surrounding the hair follicle? The dermis, we call it dermal sheath

Structure of the hair follicle

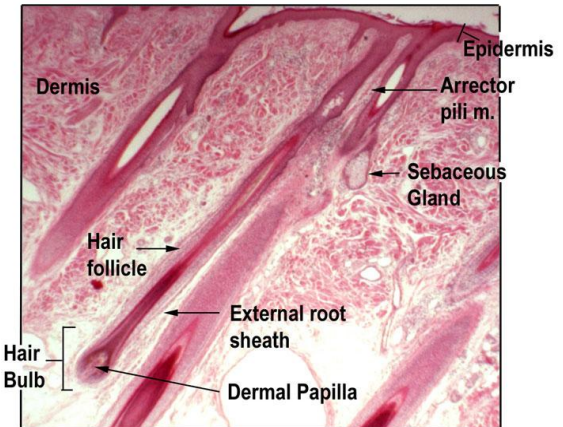
-*Inner root sheath* → most inner part, terminates at the level of the opening of the sebaceous glands because we need space or canal in order for the sebum to be discharged and lubricates the skin and the hair. Inner root sheath is composed of three layers (which we are not obliged to know)

-*Outer root sheath* → is continuous with the skin epidermis, in particular it is continuous with stratum basale and stratum Spinosum of the epidermis.

-*Glassy membrane* (thickened basement membrane) → also it is continuous with the basement membrane of skin epidermis. It is called glassy since it is thick and it appears glassy in color (hyaline)

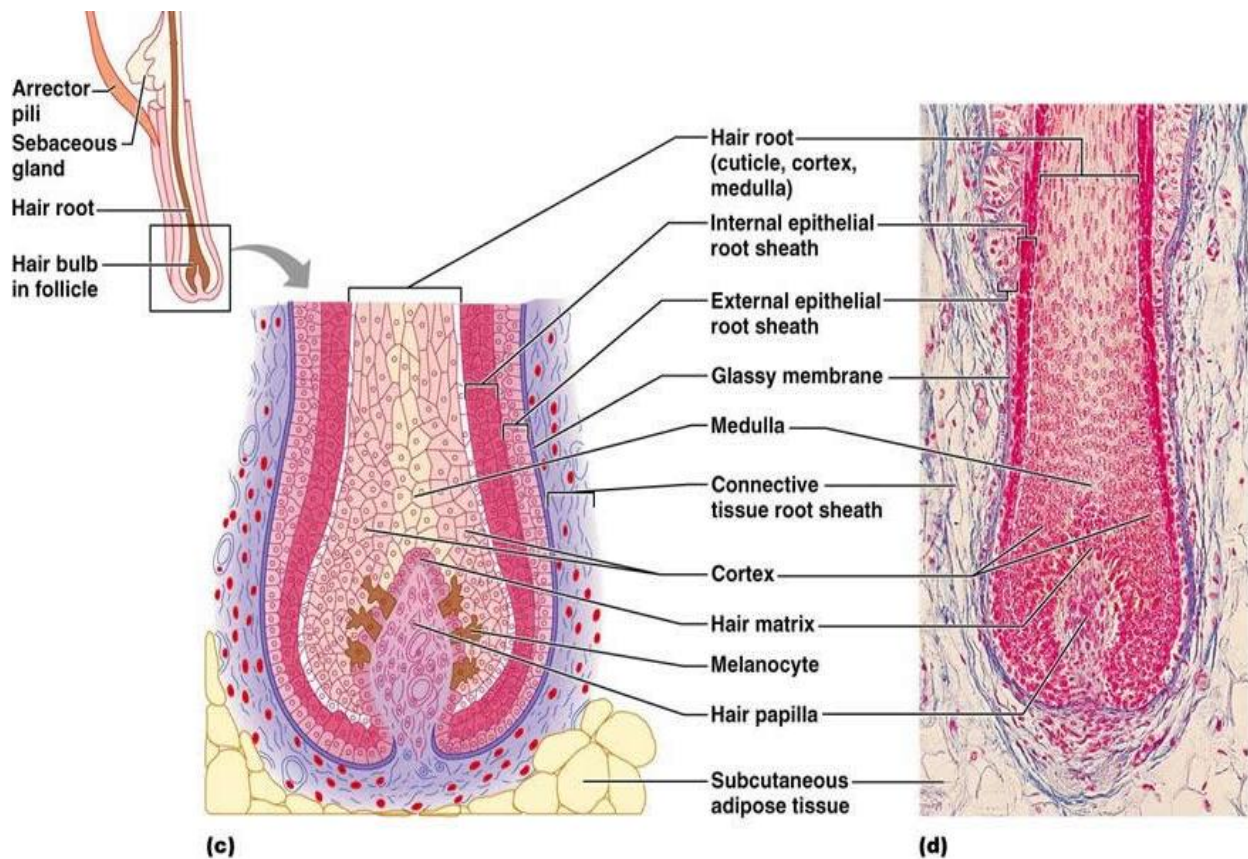
-*Surrounding dermal sheath*

At the base of the hair bulb, the dermis invaginates inside the hair bulb and forms a dermal papilla (hair papilla), since it's similar to the dermal papilla of the skin epidermis). The dermal hair papilla contains tiny blood vessels to nourish the hair cells.

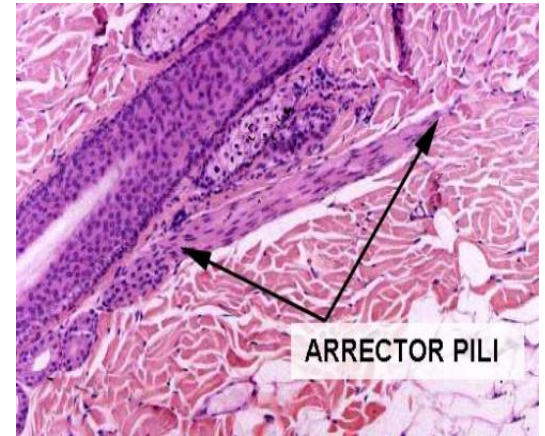


Stratum basale: if we follow the stratum basale layer, it goes inside the dermal papilla and lines it, it forms a layer of cells called the matrix, we previously mentioned that we have mitotic activity inside the stratum basale so these matrix cells undergo mitosis and give up cells that become keratinized as we go up to form the hair shaft. The hair shaft formation process is similar to the keratinization of the skin, but not all the cells here undergo mitosis only the matrix cells. They divide and form something similar to Spinosum layer and granulosum and they accumulate more and more keratin. The difference between the keratin of the hair and the keratin of the stratum corneum is that the keratin of the stratum is soft while the keratin of the hair is hard and it is highly compacted to form the hair shaft.

These matrix cells divide and form the hair shaft and the inner root sheath.



Arrector pili muscle: arrector because it causes erection to the hair, pili: hairs. It is a smooth muscle which means it's involuntary, it is connected to the hair follicle from one side and to the papillary layer of the dermis from the other side. It is supplied by sympathetic nervous system-autonomic nervous system. The contraction of this muscle will cause hair to stand up (perpendicularly to the skin) and this will close the pore which will reduce the heat loss, we call this condition goose bumps (which is when you are cold or when you are frightened) under the stimulation of the sympathetic nervous system. It is more prominent in animals it reduces the heat loss, in animals covered with fur or hair, the erect hairs trap air to create a layer of insulation. The erect hairs also make the animal appear larger in response to fear.



Structure of the hair shaft; it consists of 3 layers of hard protein (keratin):

The inner most layer → medulla

Intermediate layer → cortex

Outer layer → flat squamous cells filled with very hard keratin, called the cuticle (when the hair is damaged with split ends مقصف those cells are desquamated from their place)

Hair Growth Cycle

Are all your hair growing at the same time? For example, the hair follicles on your scalp are they growing at the same rate? No.

The first phase is called **anagen**: in this phase the matrix cells of the dermal papilla undergo mitosis and give new cells to form the hair root and the hair shaft which gets longer and longer, we call this the growth state, it **lasts from 3-6 years**. Some people have difficulty growing their hair beyond a certain length because they have a short active phase of growth. On the other hand, people with very long hair have a long active phase of growth. The hair on the arms, legs, eyelashes, and eyebrows have a very short active growth phase, explaining why they are so much shorter than scalp hair

The second phase is called **catagen**: it is a transitional state, **lasts for 10 days**, disintegrations of the dermal papilla; it separates from the hair bulb and once you

separate the blood vessels from the hair bulb what will happen? The hair follicle shrinks

After this period the dermal papilla is completely detached from the hair bulb and we call this phase the **telogen phase** it is a resting phase; nothing happens. In this case shedding of hair is possible because it is no longer attached to the dermal papilla it **lasts from 5 to 6 weeks**.

If hairs enter the resting phase too early, excess shedding and noticeable thinning of the hair can occur

After 6 weeks we go back to anagen; formation of new dermal papilla within the hair bulb and new formation of hair takes place.

85% of hair follicles are in anagen phase, 15% at telogen phase which means if we have around 150,000 hair follicles in our scalp then it is normal to shed up to 100 hairs per day.

Note: we do not generate new hair follicles anytime during our lives. We have about 5 million hair follicles on the body, all have been formed during intrauterine life

Sweat glands

We have about 3 million sweat glands distributed on our skin. There are two types and it is very important to differentiate between them. Eccrine are distributed all over our body and the ducts of these glands open into the surface, they produce true sweat and are the most numerous of the sweat glands, and are particularly abundant on the palms of the hands, soles of the feet, and forehead; their secretion is clear watery secretion with electrolytes and it is filtration from the blood plasma also it's Hypotonic (lesser salt concentration)

What is the main function of sweating? To cool the body temperature by evaporation

Apocrine: they are in restricted places like the axilla or the genitalia. In human, their role is not really understood well .. but they are important in sexual attraction between animals

The secretion of apocrine sweat glands is rich in proteins and lipids and this is called pheromones

The secretion of apocrine sweat glands is associated with the presence of the hair follicle. Can we find apocrine sweat glands in thick skin? No, but we can find the eccrine in the palms and the sole of the foot and that is why we have smelly feet sometimes, not because sweat has odor but because it is exposed to bacterial decomposition.

Your feet sweat into your shoes all day so they get wet and bacteria start to grow. The bacteria continue to breed once you've taken your shoes off, especially if you put them in a dark cupboard. Then, when you put your shoes back on the next day, even if you've just had a shower, putting your feet into still wet shoes creates the perfect conditions for the bacteria to thrive – warm, dark and moist ☺

The structure of the sweat gland: *simple coiled tubular gland*, the secretory part is lightly stained while the duct is darkly stained.

The duct morphology concerning the eccrine and the apocrine is the same: stratified cuboidal epithelium. The difference of the two types lies in the secretory portion; in the apocrine they are very large (lumen is very wide) and the lining epithelium is simple cuboidal while in eccrine they have small lumen.

The lining epithelium of eccrine secretory portion is pseudostratified or special type of stratified cuboidal epithelium. And its composed of three cell types:

Lightly stained cells under the microscope are clear cells they filtrate the blood plasma into the lumen, darkly stained cells produce glycoproteins (dark cells).

myoepithelial cells are important to squeeze the product into the lumen and the duct. Duct is responsible of reabsorption of salt in order to preserve the salt. In the beginning, the secretory cells filtrate the blood plasma with high concentration of Na, once this secretory product passes through the duct system it will be reabsorbed.

The Nail

Hard plate of keratin, it is not colored because there is no activity for the melanocytes.

Between the matrix cells of hair follicle there is melanocytes that produce the color (same concept as the epidermis)

Nail is divided to 3 parts

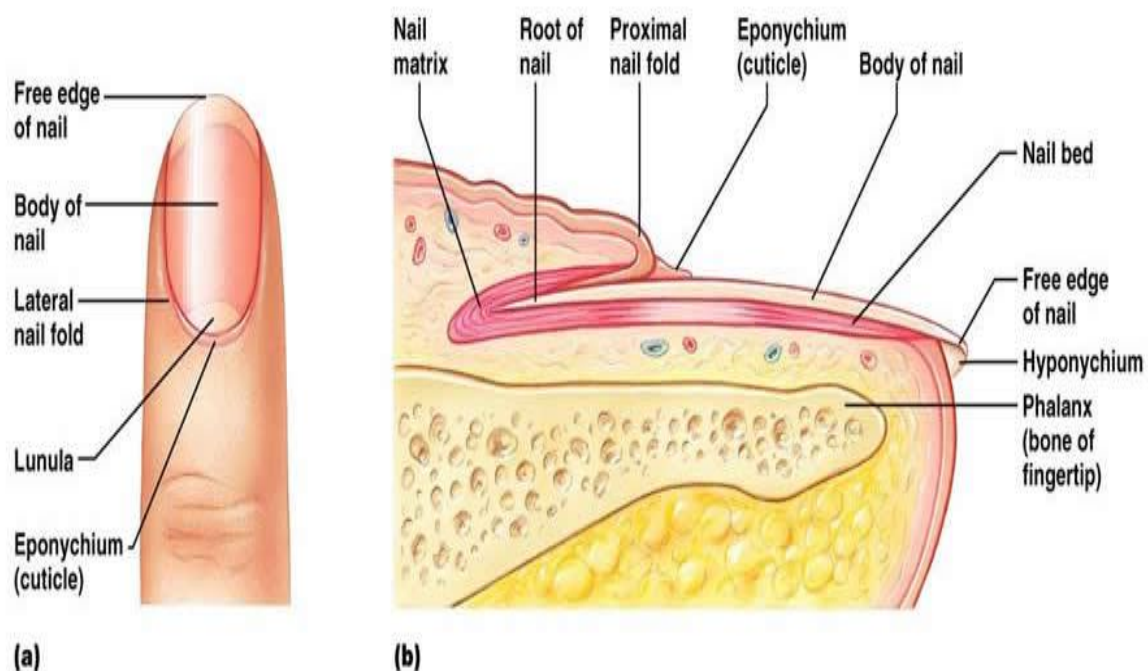
1-free edge; which is the part we cut.

2-body of the nail; it appears pinkish under the nail and this is very important clinically as an indicator of distal tissue vascularization of the patient. When you press on the nail you can see the vascularization through the nail.

3-root of the nail; embedded deep inside the skin and covered by a fold called eponychium or cuticle. Another fold is the hyponychium (under the free edge) and it is where the dirt accumulates.

Nail bed: under the body of the nail, layer of the epidermis (stratum basale and stratum Spinosum)

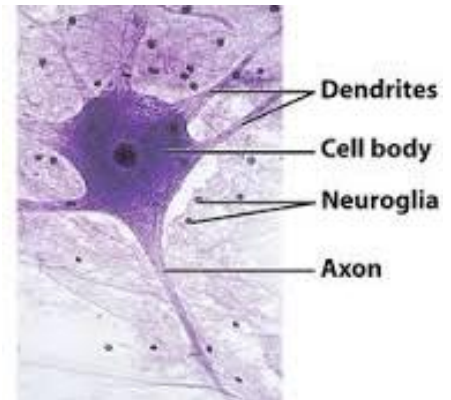
The **nail matrix** is the layer of cells at the base of the nail. It consists of rapidly dividing skin cells that soon fill with the protein keratin. When matrix cells undergo mitosis they push the nail plates over the nail beds and that's how they grow.



NERVOUS TISSUE

Quick review:

We said previously we have two types of neurons; sensory (afferent) and motor (efferent) neurons. Sensory neurons carry information from the periphery towards the CNS while the motor neurons carry information from the CNS towards the muscle; if it is a skeletal muscle we call it somatic nervous system and if it is an involuntary muscle (smooth or cardiac muscle/gland) we call it autonomic nervous system. (VIP) the difference in shape between the sensory and motor neuron. We also mentioned that the propagation of action potential is unidirectional (from dendrites to cell body to axon).



(**question about it in the final) the difference between the axon and the dendrites.

Autonomic nervous system carries information from viscera (heart, lungs..) and sends motor impulses to the smooth muscles, cardiac muscles and glands. This division which is the motor division of the autonomic nervous system is the sympathetic and parasympathetic controlling the internal environment of our body.

Structure of the neuron: a highly specialized nerve cell that is composed of cell body and has many processes (two types):

1. *dendrites* because they look like a tree. If you notice when u go away from the cell body the dendrites keep branching and become thinner in diameter (smaller).

2. *Axon*, it is a long process, it could reach up to one meter especially axons reaching the muscles of the big toe. The axon does not branch profusely, only at the terminals (axonal terminal branches). The terminal parts of these branches are swollen areas called synaptic boutons/knobs or terminal boutons. Terminal boutons contain synaptic vesicles (the neurotransmitters) for communication with other neurons or with muscle cells (neuromuscular junction).

We took previously that dendrites are typically never myelinated, while axons can be myelinated or unmyelinated. So what is myelin? It is a lipoprotein that forms segments around the axon, its main function is to provide protection and to increase the

propagation of action potential. Myelin is not a product of the axon (neuron itself) there is another type of cells that we will be talking about called neuroglial cells and they form these myelin segments and in between these segments we have areas that are not covered in myelin→nodes of Ranvier. The myelin segments are called internodal segments

Structure of the cell body (soma): inside it we find nucleus and very prominent nucleolus which looks like an owl eye or fried-egg appearance under the microscope, we find the cytoplasm of the cell body full of dots which they first called Nissl bodies but with the invention of electron microscope they discovered that they are ribosomes (RER) which means that these cells have high protein synthetic activity.

Do we have organelles inside the dendrites? Yes, only the proximal part, the distal part have no organelles only cytoskeleton (microtubules, microfilaments and intermediate filaments (neurofilaments)). Axon also has no organelles, only neurofilaments and microtubules except the terminal part in the synaptic (terminal) boutons, you find mitochondria and smooth ER. exocytosis of the neurotransmitter needs Ca and ATP which is the reason why we can find smooth endoplasmic reticulum and mitochondria in the terminal boutons, but it is impossible to find rough endoplasmic reticulum, that's why we have something called axonal transport because the main factory for the proteins and organelles synthesis is the cell body.

Synapse is the area of contact between two neurons or a neuron and a muscle.

Nervous tissue as a tissue; we see supporting cells called neuroglial (glue) cells important to support the neuronal cells and nourish them. Inside the CNS, we don't have connective tissue so the supporting tissue is considered the neuroglial cells.

It is very important to differentiate between neurons and neuroglial cells:

	NEURONS	NEUROGLIAL CELLS
Excitation(ability to transform any stimulus into action potential)	Electrically excitable (like muscle cells)	Not excitable, they are only supporting cells
Mitotic activity	Don't have centrioles→don't undergo mitosis	Have centrioles→undergo mitosis
Size	larger	Small
Number	less	More
Function	Sensation, dreaming, thinking, motor activities, controlling gland functions...	Supporting a microenvironment suitable for the action of these

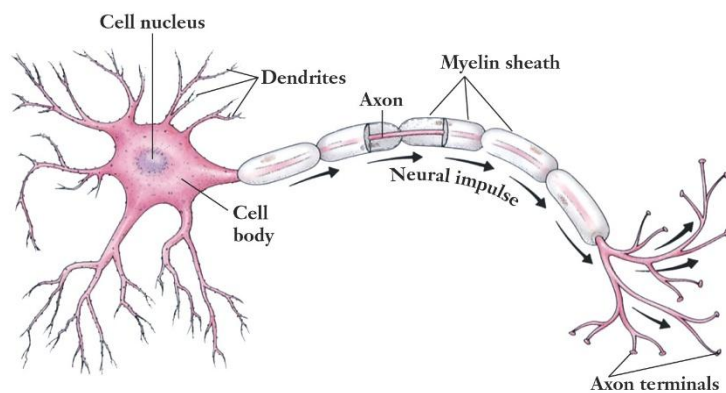
		neurons.
--	--	----------

Let's take a look at the network structure surrounding the neuron, these are not collagen fibers nor elastic, they are the processes of other neuroglial cells; microfilaments and microtubules.

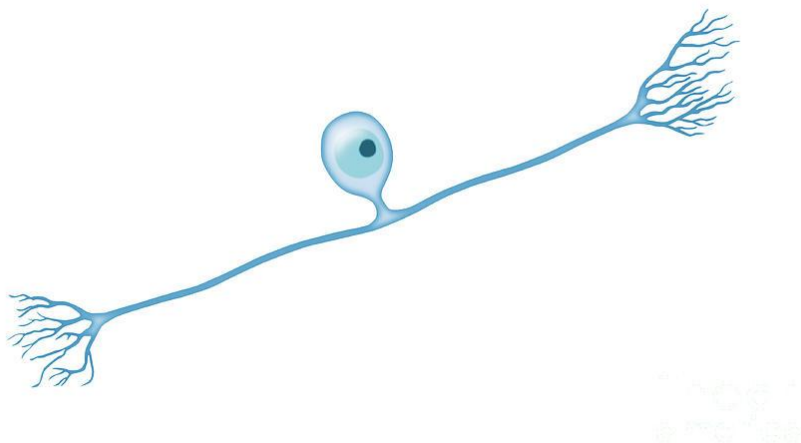
Typical shape of the neuron: cell body, long process (axon) and many processes (dendrites)

-Classification of the neurons according to morphology: (According to the number of processes extending from the cell body) 1-4

1-Multipolar neuron: that has many processes→ex: motor (efferent) neurons



2- Pseudo unipolar neuron: →ex: sensory (afferent) neuron:

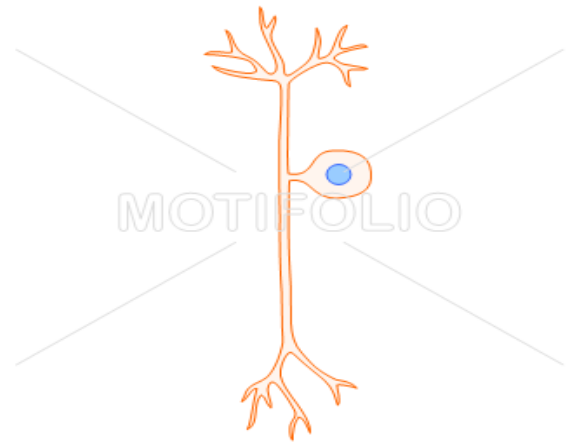


We call this sensory neuron: pseudo unipolar;

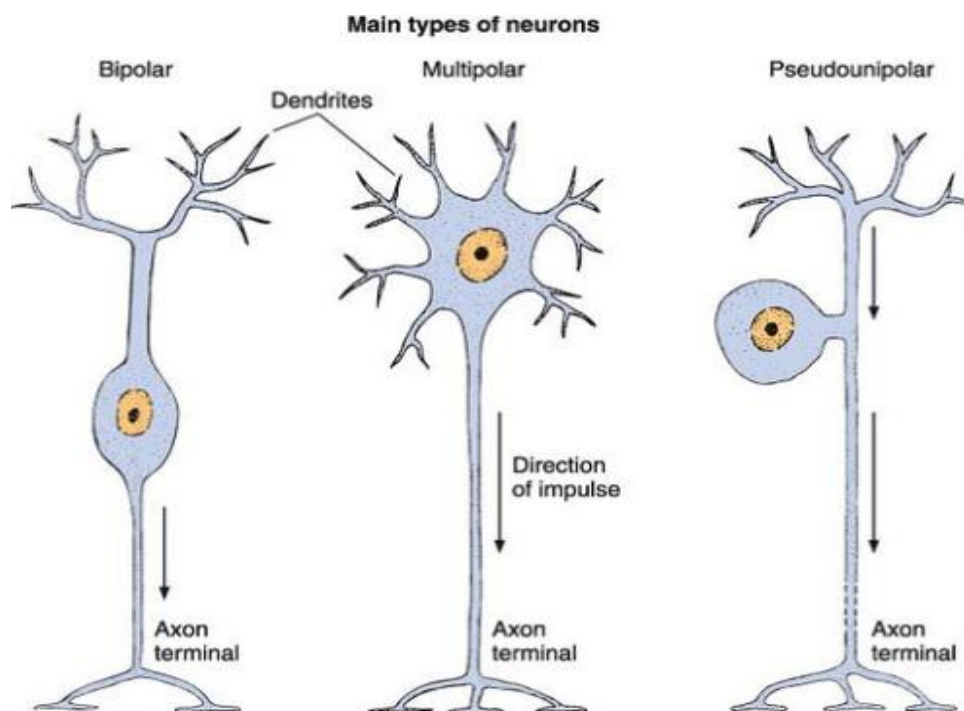
because originally it was bipolar, it had one dendrite and one axon but during the development those two processes fuse together to form the short stem that divides into two processes; peripheral and central. The stem has two processes, one is analogous to the dendrite and we call it peripheral and one is analogous to the axon and we call it central.

3-Bipolar neurons → have two processes, one axon and one dendrite. Example: sensory receptors; in retina, olfactory mucosa, inner ear.

neuron pseudounipolar



Copyright © mol



The last type is **4-anaxonic neuron** (an: means without) more precisely they have axons but it is not easily differentiated but in general let us stick to the book and consider that it has no axons and that its only composed of dendrites. These cells do not produce action potential, they have a regulatory function and are only found in the CNS.

What is the importance of myelin? We mentioned earlier that axons can be myelinated or un-myelinated. In order for the axon to generate the action potential, there must be something called influx of Na ions (from outside to inside) in order to change the membrane potential into more positive inside. If there is no myelin, sodium ions need to go across the whole length of the axon in order to reach the axon terminals. This is what we call continuous propagation of action potential. Myelin itself which is a lipoprotein decreases the flow of ions by thousand times, in this case Na will enter the cell only through Nodes of Ranvier, it will jump from one node to the next, and this is what we call saltatory conduction of action potential, *salta* means jump. What is its clinical importance? Local anesthesia is low molecular weight molecules that bind to the voltage gated Na channels which will prevent Na influx so no generation of action potential will take place and no sensation will reach the CNS which will result in temporary loss of sensation.

Types of synapses (junction between two neurons)

1-Axodendric: typical synapse, between the axon and the dendrite of the next neuron

2-Axosomatic: between the axon and the cell body (soma)

3-Axoaxonal: between two axons. For example you have presynaptic neuron and post synaptic neuron. The synapse with post synaptic neuron could be with a cell body (Axosomatic) or a dendrite (Axodendric). We could have a third neuron that synapses with the axon of the presynaptic neuron (axoaxonic) in order to regulate the activity of this neuron.

Nerve is a group of axons together, imagine you are holding a group of balloons the balloons are the cell bodies and the ropes are the axons. The collection of the cell bodies could be seen inside the CNS → and we will call it nucleus, or outside it → in the peripheral nervous system (PNS) → we call it ganglion.

Examples of peripheral nerves (like a radial or a spinal nerve), these nerves are collections of axons (without cell bodies!!!!)

The peripheral nerve is surrounded by a dense type of connective tissue; epineurium that sends septa to divide the interior of the nerve into fascicles, each fascicle is surrounded by thick type of connective tissue called perineurium and inside each fascicle we have axons (dots) with myelin sheath around it. Each axon and its myelin is surrounded by a thin layer of connective tissue called endoneurium.