Parts of the Nerve Cell and Their Functions

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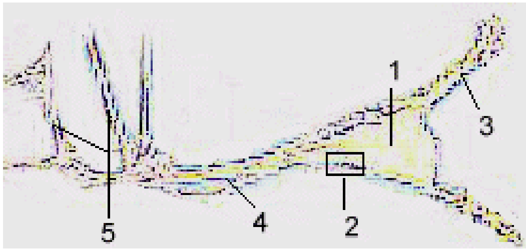
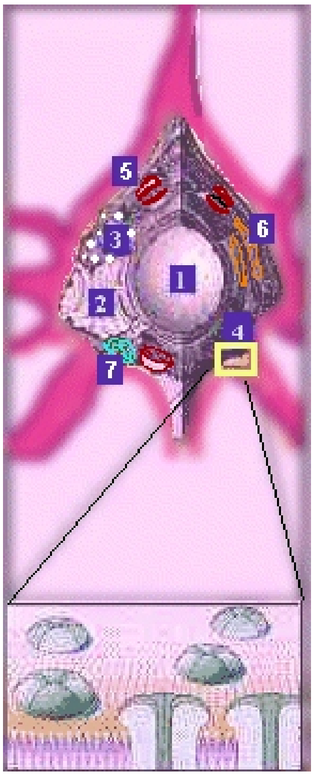


[1. Cell body] [2.Neuronal membrane] [3.Dendrites] [4. Axon] [5. Nerve ending]

1. Cell body



The **cell body** (soma) is the factory of the neuron. It produces all the proteins for the dendrites, axons and synaptic terminals and contains specialized organelles such as the mitochondria, Golgi apparatus, endoplasmic reticulum, secretory granules, ribosomes and polysomes to provide energy and make the parts, as well as a production line to assemble the parts into completed products.

Cytosol - Is the watery and salty fluid with a potassium-rich solution inside the cell containing enzymes responsible for the metabolism of the cell.

1. Nucleus - Derived from the Latin word for "nux", nut, the nucleus is the archivist and the architect of the cell. As archivist it contains the genes, consisting of DNA which contains the cell history, the basic information to manufacture all the proteins characteristic of that cell. As architect, it synthesizes RNA from DNA and ships it through its pores to the cytoplasm for use in protein synthesis.

The.***Nucleolus*** is an organelle within the nucleus which is involved actively in ribosome synthesis and in the transfer of RNA to the cytosol.

2. Golgi Apparatus - membrane-bound structure that plays a role in packaging peptides and proteins (including neurotransmitters) into vesicles.

3. Polyribosomes - there are several free ribosomes attached by a thread. The thread is a single strand of mRNA (messenger RNA, a molecule involved in the synthesis of proteins outside the nucleus). The associated ribosomes work on it to make multiple copies of the same protein.

4. Neuronal membrane (see next box)

5. Mitochondrium - this is the part of the cell responsible for the supply of energy in the form of ATP (adenosine triphosphate). Neurons need an enormous amount of energy. The brain is one of the most metabolically active tissues in the body. In man, for example, the brain uses 40 ml of oxygen per minute. Mitochondria use oxygen and glucose to produce most of the cell's energy.
The brain consumes large amounts of ATP. The chemical energy stored in ATP is used to fuel most of the biochemical reactions of the neuron. For example, special proteins in the neuronal membrane use the energy released by the breakdown of ATP into ADP to pump certain substances across the membrane to establish concentration differences between the inside of the neuron and the outside.

6. Rough Endoplasmic Reticulum and **Smooth Endoplasmic Reticulum (7)** - A system of tubes for the transportation of materials within the cytoplasm. It may have ribosomes (rough ER) or no ribosomes (smooth ER). With ribosomes, the ER is important for protein synthesis.

Nissl Bodies - Groups of ribosomes used for protein synthesis.

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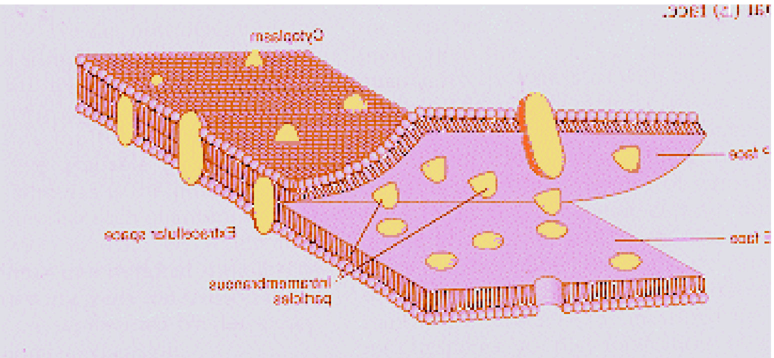
2. Neuronal Membrane



The **neuronal membrane** serves as a barrier to enclose the cytoplasm inside the neuron, and to exclude certain substances that float in the fluid that bathes the neuron.

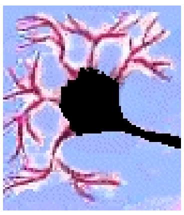
The membrane with its mosaic of proteins is responsible for many important functions:

- keeping certain ions and small molecules out of the cell and letting others in,
- accumulating nutrients, and rejecting harmful substances,
- catalyzing enzymatic reactions,
- establishing an electrical potential inside the cell,
- conducting an impulse
- being sensitive to particular neurotransmitters and modulators .

The membrane is made of lipids and proteins - fats and chains of aminoacids. The basic structure of this membrane is a bilayer or sandwich of phospholipids, organized in such a way that the polar (charged) regions face outward and the non polar regions face inward.

The external face of the membrane contains the receptors, small specialized molecular regions which provide a kind of "attachment port" for other external molecules, in a scheme analogous to a a key and a keyhole. For each external molecule there is a corresponding receptor. Whenever receptors become attached to a molecule, some alterations of the membrane and in the interior of the cell ensue, such as the modification of permeability to some ions.

3. Dendrites



These structures branch out in treelike fashion and serve as the main apparatus for receiving signals from other nerve cells. They function as an "antennae" of the neuron and are covered by thousands of synapses. The dendritic membrane under the synapse (the post-synaptic membrane) has many specialized protein molecules called receptors that detect the neurotransmitters in the synaptic cleft. A nerve cell can have many dendrites which branch many times, their surface is irregular and covered in dendritic spines which are where the synaptic input connections are made.

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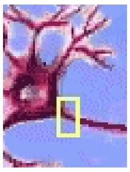
4. Axon


Axon

Usually a long process which often projects to distant regions of the nervous system. The axon is the main conducting unit of the neuron, capable of conveying electrical signals along distances that range from as short as 0.1 mm to as long as 2 m. Many axon split into several branches, thereby conveying information to different targets. Many neurons do not have axons. In these so-called amacrine neurons, all the neuronal processess are dendrites. Neurons with very short axons are also found.

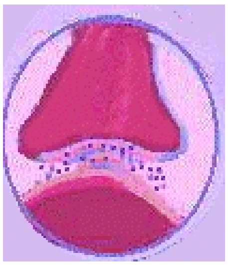
The axons of many neurons are wrapped in a myelin sheat, which is composed of the membranes of intersticial cells and is wrapped around the axons to form several concentric layers. The myelin sheath is broken at various points by the nodes of Ranvier, so that in cross section it looks like a string of sausages. The myelin protects the axon, and prevents interference between axons as they pass along in bundles, sometimes thousands at time.

The cells that wrap around peripheral nerve fibers - that is, nerve fibers outside of the brain and spinal cord - are called Schwann cells (because they were first described by Theodor Schwann). The cells that wrap around axons within the central nervous system (brain and spinal cord) are called oligodendrocytes. The axon, with its surrounded sheath, is called a nerve fiber. Between each pair of sucessive Schwann cells is a gap of a node of Ranvier.


The **Axon Hillock**

The axon hillock is where the axon is joined to the cell. It is from here that the electrical firing known as an action potential usually occurs.

5. Nerve Ending (Presynaptic Terminals)



Synapses are the junctions formed with other nerve cells where the presynaptic terminal of one cell comes into '**contact**' with the postsynaptic membrane of another. It is at these junctions that neurons are excited, inhibited, or modulated. There are two types of synapse, electrical and chemical.

Electrical synapses occur where the presynaptic terminal is in electrical continuity with the postsynaptic. Ions and small molecules passing through, thus connecting channels from one cell to the next, so that electrical changes in one cell are transmitted almost instantaneously to the next. Ions can generally flow both ways at these junctions i.e. they tend to be bi-directional, although there are electrical junctions where the ions can only flow one way, these are know as rectifying junctions. Rectifying junctions are used to synchronise the firing of nerve cells.

Chemical synaptic junction is more complicated. The gap between the post- and presynaptic terminals is larger, and the mode of transmission is not electrical, but carried by neurotransmitters, neuroactive substances released at the presynaptic side of the junction. There are two types of chemical junctions. Type I is an excitatory synapse, generally found on dendrites, type II is an inhibitory synapse, generally found on cell bodies. Different substances are released at these two types of synapse. The direction of flow of information is usually one way at these junctions.

Each terminal button is connected to other neurons across a small gap called a synapse. The physical and neurochemical characteristics of each synapse determines the strength and polarity of the new input signal. This is where the brain is the most flexible, and the most vulnerable. Changing the constitution of various neurotransmitter chemicals can increase or decrease the amount of stimulation that the firing axon imparts on the neighbouring dendrite. Altering the neurotransmitters can also change whether the stimulation is excitatory or inhibitory.

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