

# Neural tissue

**Neural tissue** integrates signals regarding all body activities and maintains them within physiologically acceptable limits. It accomplishes this by

- sensing changes in the environment via sensory receptors
- interpreting, integrating and storing those changes in memory
- responding to environmental changes via effectors

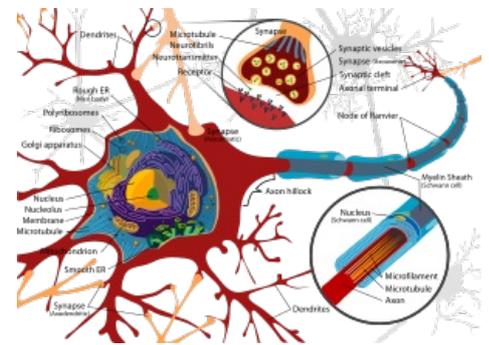
The two primary cell types are neurons and neuroglia.

Anatomically, neural tissue is divided into the **central nervous system** (brain and spinal cord) and the **peripheral nervous system** (nerves and ganglia).

## Neuronal structure

The nerve cell consists of the body (soma, perikaryon) and two types of protrusions, afferent dendrites and efferent neurites ( axons ).

- **Soma** (aka **perikaryon**)
  - body of the neuron bounded by plasma membrane
  - determines origin and spread of excitement
  - contents:
    - nucleus
      - large
      - much protein synthesis necessary, so DNA is in euchromatin form
      - nucleolus often visible
    - Nissl substance (accumulations of RER) - schematic of position ([https://neupsykey.com/wp-content/uploads/2016/06/m\\_waxm27\\_c002f003.png](https://neupsykey.com/wp-content/uploads/2016/06/m_waxm27_c002f003.png))
    - mitochondria
    - lipofuscin pigment aggregations
    - cytoskeleton
      - actin, neurotubules (eq. of microtubules), and neurofilaments (eq. of intermediate filaments)
      - functions in axonal transport (repair axolemma, transport proteins such as gated ion channels, enzymes, neurotransmitters)
        - Slow transport: 1-5 mm/day
        - Fast transport: 200-400 mm/day
- **Neuronal processes**
  - **Dendrites**
    - receive afferent signals
    - typically short and richly branched
    - terminally branch as dendritic spines, where presynaptic axons synapse
  - **Axon** (aka neurite)
    - only one per perikaryon
    - up to 1 m long and 15  $\mu\text{m}$  thick
    - originate at the axon hillock
    - axolemma (equivalent of plasma membrane) encloses axoplasm
    - transmits the action potential from the body of a neuron to another neuron or effector
    - contents:
      - ribosomes
      - small amounts of mitochondria
    - **myelinated axons:** myelin sheath covers the entire length of the axon except at the start, at the terminal branches, and at nodes of Ranvier. Faster conduction.
    - **unmyelinated axons:**
- **Neuropil:** material that fills the space between the perikarya and glial cells, together with the ECM



Neuron

## Types of neurons

There are several ways by which neurons may be classified:

1. **Morphological** (number of processes):
  - multipolar
    - most common
  - bipolar
    - sensory neurons: retina, vestibular and cochlear ganglia
  - unipolar

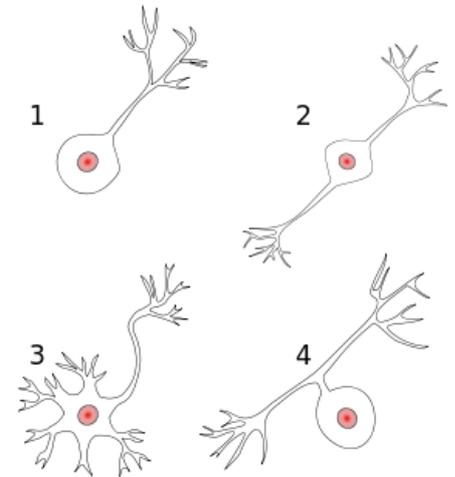
- unipolar brush cell in cerebellum
  - pseudounipolar
    - sensory ganglia of cranial nerves, spinal ganglia
2. By **axon length**:
    - Golgi type I - neurons with long neurite;
    - Golgi type II - neurons with short neurite.
  3. **Position and Functional** in the Neuronal Network:
    - Motor (efferent): stimulate muscles, glands, and other neurons
    - Sensory (afferent): receive stimuli
    - Interneurons: local circuit neurons
  4. Type of **neurotransmitter**
    1. Excitatory: Amino acids, monoamines, catecholamines
    2. Inhibitory: GABA, Serotonin
    3. Both: Dopamine

## Synapses

Synapses are specialized cell junctions that link neurons in a pathway. A single neuron may have 1-10 thousand synapses.

The signal can be transmitted via axodendritic, axosomatic or axoaxonic connections.

- **electrical synapses:** transmit signal via gap junctions
- **chemical synapses:**
  - synaptic vesicles (30-60 nm) from the presynaptic axon terminal merge with the presynaptic membrane and release contents into the synaptic cleft (20-30 nm)
  - postsynaptic membrane contains receptors for neurotransmitters
  - **asymmetric synapses**
    - excitatory
    - thick post-synaptic membrane
    - 30 nm synaptic cleft
    - depolarize membrane of postsynaptic neuron via  $\text{Na}^+$
  - **symmetric synapses**
    - inhibitory
    - thin post-synaptic membrane
    - 20 nm synaptic cleft
    - hyperpolarize membrane of postsynaptic neuron via  $\text{Cl}^-$



Morphological classification of neurons: 1. Unipolar 2. Bipolar 3. Multipolar 4. Pseudounipolar

## Central and peripheral nerve endings

In the CNS, neurons synapse with other neurons.

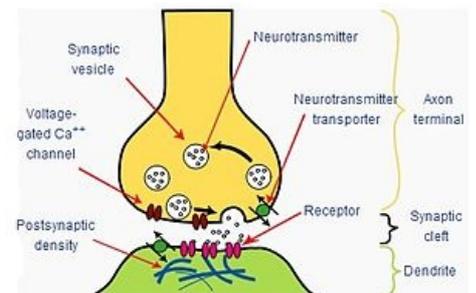
In the PNS, they can synapse and neuromuscular or neuroglandular junctions.

See schematic. (<https://i.pinimg.com/originals/c3/65/9f/c3659ff9e0a8402d8c3b836683c026ac.jpg>)

## References

Mescher, A. and Junqueira, L., 2018. *Junqueira's basic histology*. New York: McGraw-Hill, pp. 161-191.

Vaňhara, Petr et al. *Guide To General Histology And Microscopic Anatomy*. 1st ed., Masaryk University Press, 2020, pp. 6.



Chemical synapse