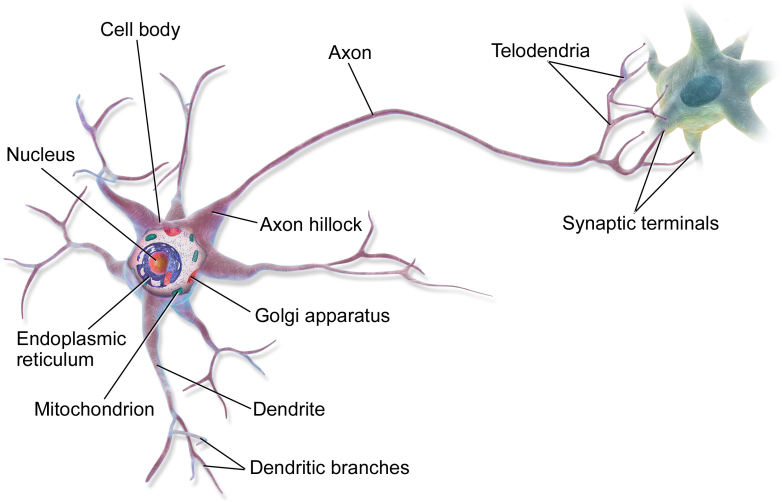
Neuron

A neuron (also known as a neurone or nerve cell) is an electrically excitable cell that processes and transmits information through electrical and chemical signals.



These signals between neurons occur via synapses, specialized connections with other cells.

The brain is composed of billions of neurons, which are specialized cells that transmit information through electrical and chemical signals. When neurons communicate with each other, they generate patterns of activity that can be detected and measured.

Neurons can connect to each other to form neural networks. Neurons are the core components of the nervous system, which includes the brain, and spinal cord of the central nervous system (CNS), and the ganglia of the peripheral nervous system (PNS).

Each neuron may be connected to up to 10,000 other neurons, passing signals to each other via as many as 1,000 trillion synaptic connections, equivalent by some estimates to a computer with a 1 trillion bit per second processor. Estimates of the human brain’s memory capacity vary wildly from 1 to 1,000 terabytes (for comparison, the 19 million volumes in the US Library of Congress represents about 10 terabytes of data).

Classification

1. By Structure (Morphology) This classification is based on the number of processes (axons and dendrites) extending from the cell body:

Unipolar neurons: One single extension that branches into axon and dendrite (common in invertebrates).

Bipolar neurons: One axon and one dendrite (e.g., retina, olfactory epithelium).

Multipolar neurons: One axon and multiple dendrites (most common in CNS).

Pseudounipolar neurons: A single process that splits into two branches (sensory neurons in dorsal root ganglia).

2. By Function Based on the role they play in the nervous system:

Sensory (afferent) neurons: Transmit signals from sensory receptors to the CNS.

Motor (efferent) neurons: Transmit signals from CNS to muscles/glands.

Interneurons (association neurons): Found entirely within the CNS; they connect neurons to other neurons (very abundant in the brain and spinal cord).

3. By Neurotransmitter Type

Excitatory neurons (e.g., glutamatergic neurons)

Inhibitory neurons (e.g., GABAergic neurons)

Modulatory neurons: Use neuromodulators like dopamine, serotonin, acetylcholine.

4. By Electrophysiological Properties Fast-spiking interneurons

Regular-spiking pyramidal neurons

Burst-firing neurons

Used in research on cortical circuits and neural dynamics.

5. By Location and Connectivity Cortical pyramidal cells

Purkinje cells (cerebellum)

Granule cells (cerebellum, hippocampus)

Betz cells (primary motor cortex)

Spinal motor neurons

6. By Developmental Lineage Neurons can also be classified based on their embryonic origin, especially in developmental neurobiology.

Central neurons.

Cortical neurons.

Dopaminergic neuron.

Pyramidal neurons.

Retinal ganglion cell

Sensory neuron…

The neurons fulfill three main functions: afferent neurons are used to transmit messages from sensory organs to the brain and Central Nervous System (CNS), while efferent neurons send information and commands from the CNS to the muscles and glands.

An interneuron (also called relay neuron, association neuron, connector neuron or local circuit neuron) is one of the three classifications of neurons found in the human body.

The third type, interneurons, are used for communication between the other two types.

Recording extracellulary from neurons in the brains of animals in vivo is among the most established experimental techniques in neuroscience, and has recently become feasible in humans. Many interesting scientific questions can be addressed only when extracellular recordings last several hours, and when individual neurons are tracked throughout the entire recording. Such questions regard, for example, neuronal mechanisms of learning and memory consolidation, and the generation of epileptic seizures. Several difficulties have so far limited the use of extracellular multi-hour recordings in neuroscience: Datasets become huge, and data are necessarily noisy in clinical recording environments. No methods for spike sorting of such recordings have been available. Spike sorting refers to the process of identifying the contributions of several neurons to the signal recorded in one electrode. To overcome these difficulties, we developed Combinato: a complete data-analysis framework for spike sorting in noisy recordings lasting twelve hours or more. Our framework includes software for artifact rejection, automatic spike sorting, manual optimization, and efficient visualization of results. Our completely automatic framework excels at two tasks: It outperforms existing methods when tested on simulated and real data, and it enables researchers to analyze multi-hour recordings. We evaluated our methods on both short and multi-hour simulated datasets. To evaluate the performance of our methods in an actual neuroscientific experiment, we used data from from neurosurgical patients, recorded in order to identify visually responsive neurons in the medial temporal lobe. These neurons responded to the semantic content, rather than to visual features, of a given stimulus. To test our methods with multi-hour recordings, we made use of neurons in the human medial temporal lobe that respond selectively to the same stimulus in the evening and next morning [1)].

Neuromodulation is the physiological process by which a given neuron uses one or more neurotransmitters to regulate diverse populations of neurons.

Journal

see Neuron Journal.

1)

Niediek J, Boström J, Elger CE, Mormann F. Reliable Analysis of Single-Unit Recordings from the Human

Brain under Noisy Conditions: Tracking Neurons over Hours. PLoS One. 2016 Dec 8;11(12):e0166598. doi: 10.1371/journal.pone.0166598. PubMed PMID: 27930664.