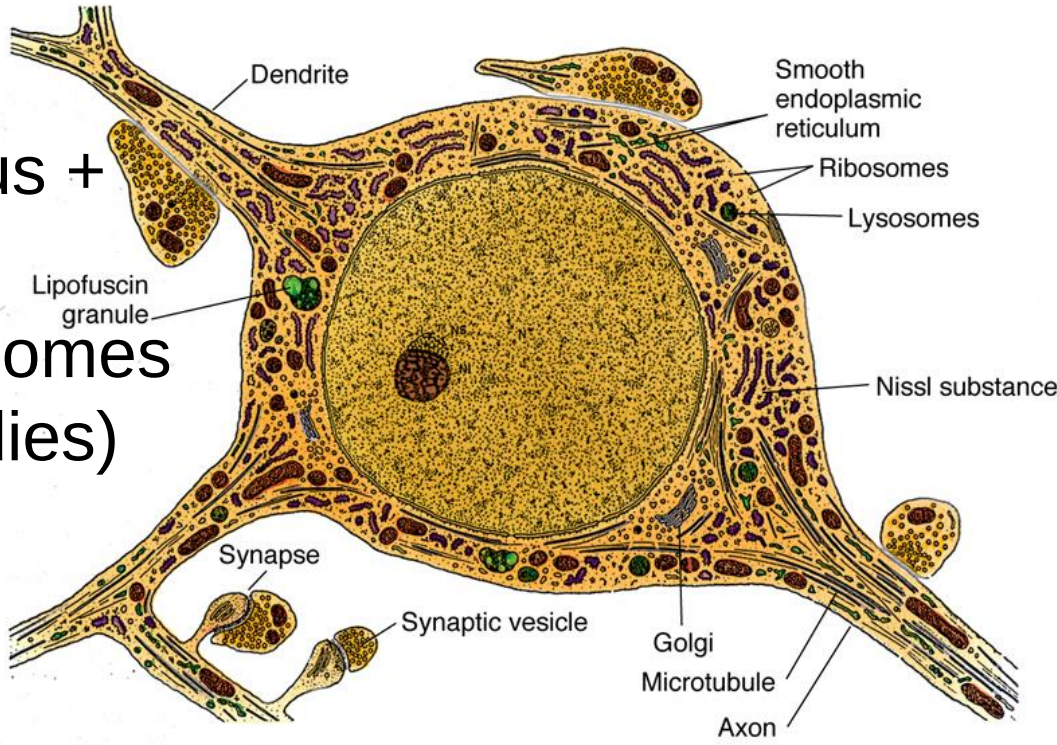
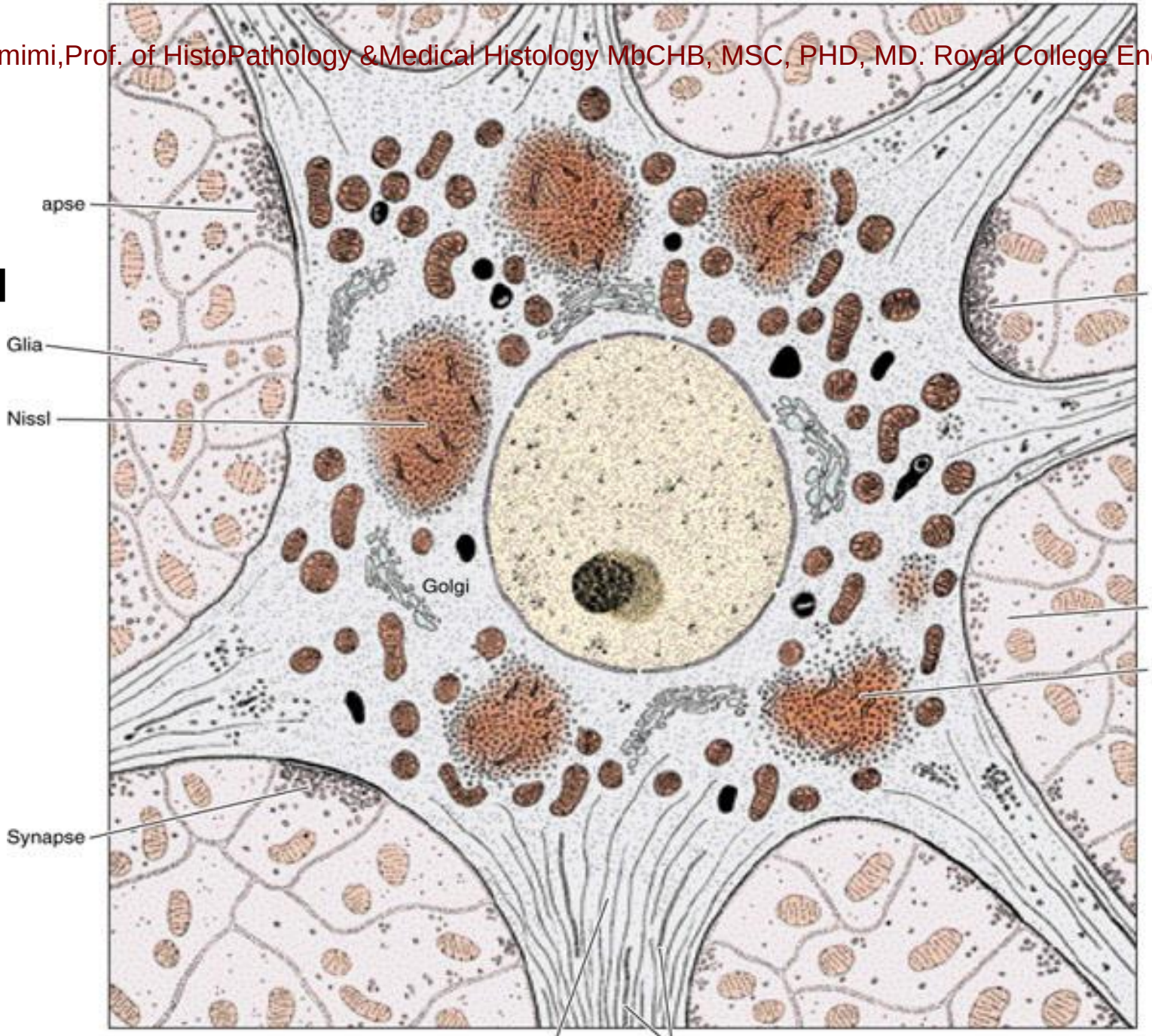
The cell body (perikaryon)

- Size from 5 to 150 micrometers
- Large and pale nucleus + prominent nucleolus
- Rough ER + polyribosomes (Nissl substance / bodies)
- Mitochondria
- Golgi, lysosomes
- Pigments

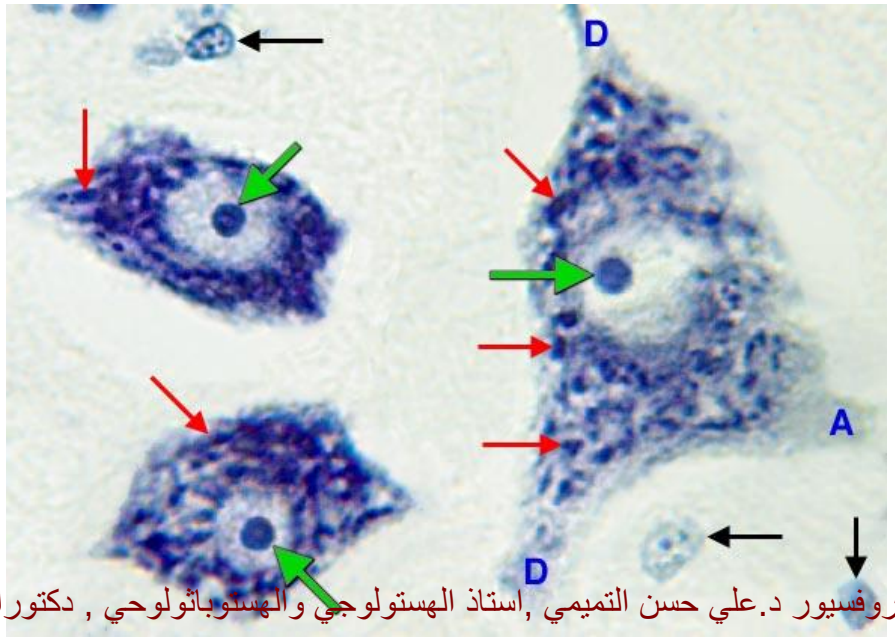


CELL BODY of NEURON



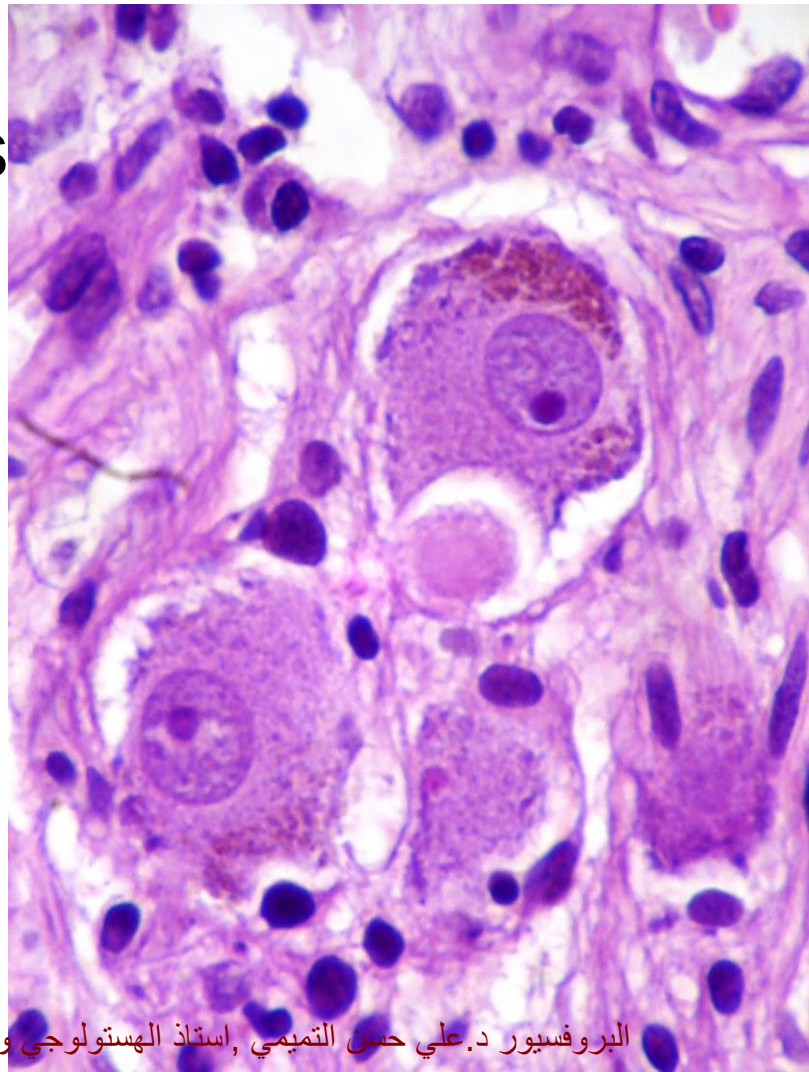
Nissl substance (bodies)

- Responsible for synthesizing proteins
- Composed of rough endoplasmic reticulum
- Is basopphilic, can be well demonstrated by staining with basic dyes (as toluidine blue or hematoxylin)



Pigments in nerve cells

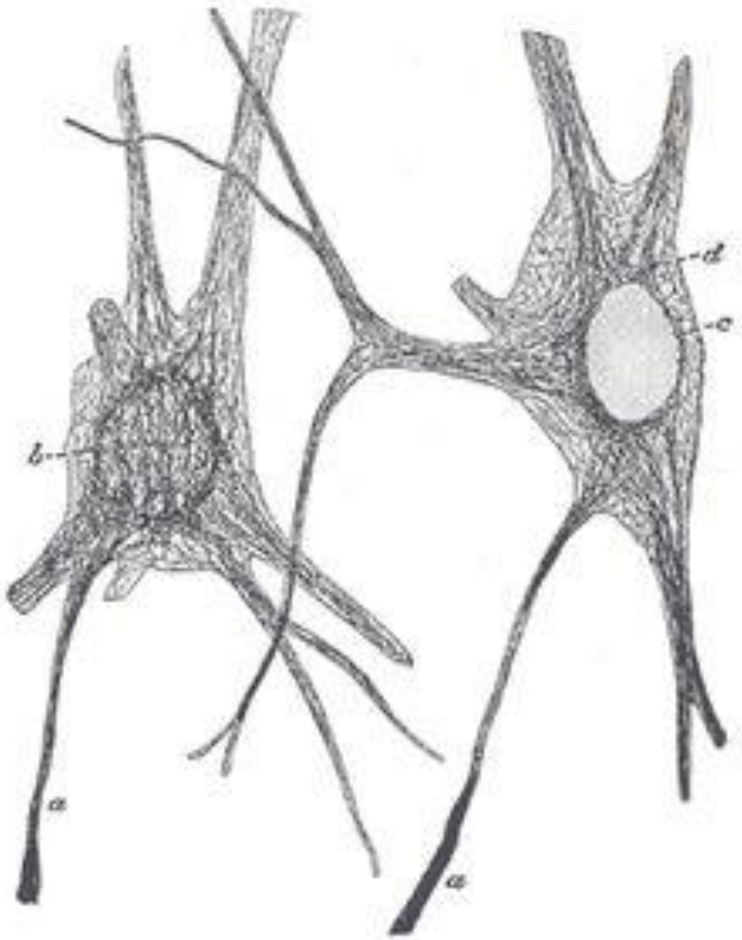
- **Lipofuscin granules** – pigmented residual bodies deribed from lysosomal degradation that accumulate with age
- **Melanin** – black cytoplasmic pigment found in the substantia nigra (in midbrain)



Cytoskeleton - neurofibrils

- Bundles of intermediate filaments („neurofilaments“) and microtubules („neurotubules“)
- After staining with silver are visible with light microscope and are called neurofibrils
- Run through the cell body to processes, they are responsible for cell transport (thanks to molecular motors – dynein and kinesin)

Neurofibrils after impregnation with silver salts (e.g., Holmes´ method)





Dendrites

- Are receptor processes that receive stimuli from other neurons or from the external environment
- Carry informations to the cell body
- Form extensive arborizations (branches) called dendritic trees

Why do dendrites have so many branches???

- Dendrites provide an enlarged surface area to receive signals from the terminal buttons of other axons allowing for a chemical signal to pass simultaneously to many target cells



Axons

- Effector processes that transmit stimuli to other neurons or effector cells
- Each neuron has only one axon, and it may be extremely long (more than 1 meter)
- Originates from the axon hillock
- Initial segment – the site which an action potential (nerve impuls) is generated

Axon vs. Dendrite - differences

AXON

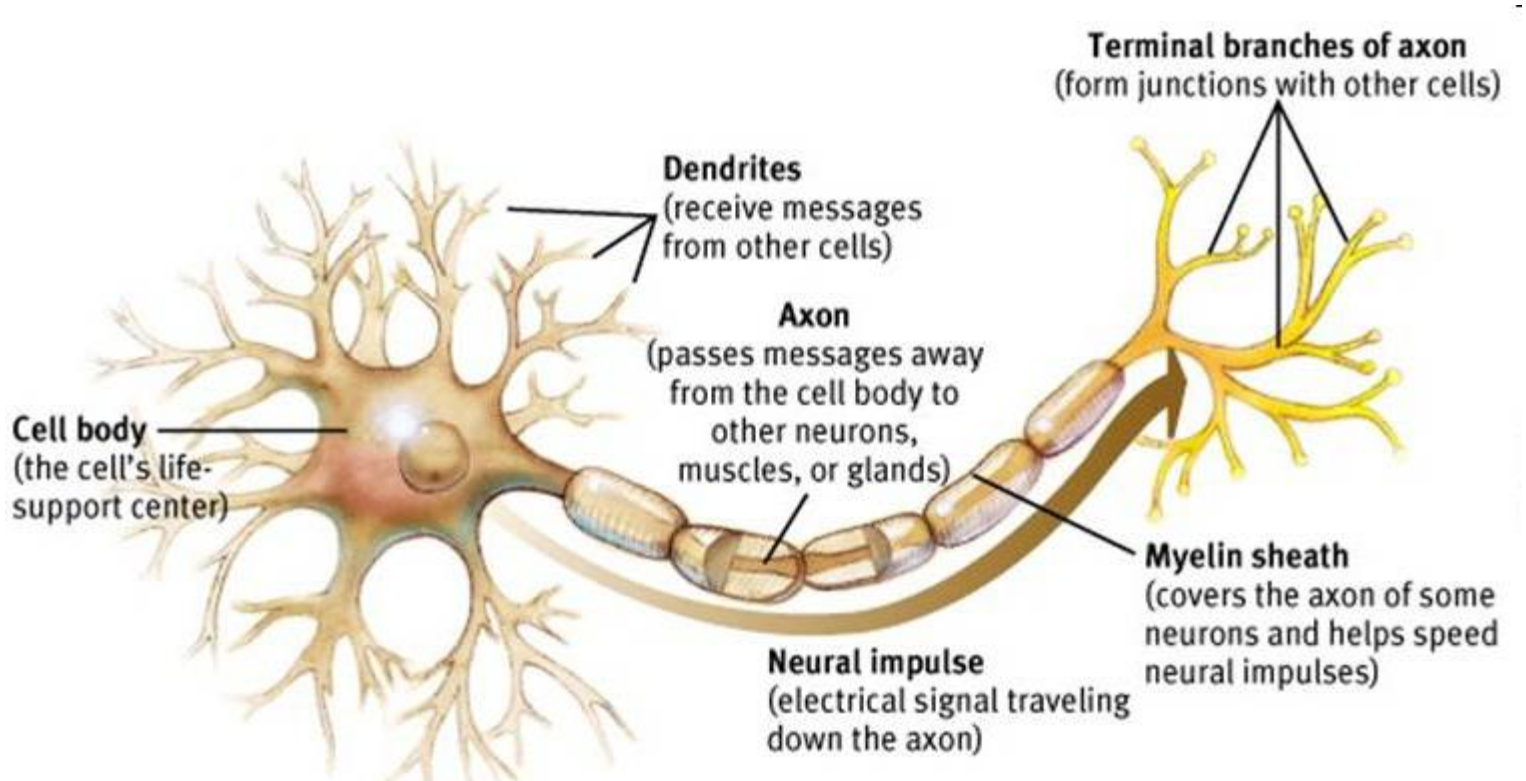
- Only one axon is present in a neuron.
- It is a thin long process of uniform thickness and smooth surface.
- The branches of axon are fewer and at right angles to the axon.
- Axon contains neurofibrils and no Nissl's granules.
- It forms the efferent component of the impulse.

DENDRITE

- Dendrites are usually multiple in number in a neuron.
- These are short multiple processes. Their thickness diminishes as these divide repeatedly. The branches are studded with spiny projections.
- The dendrites branch profusely and are given off at acute angles.
- Dendrites contain both neurofibrils and Nissl's granules.
- Dendrites form the afferent component of the impulse

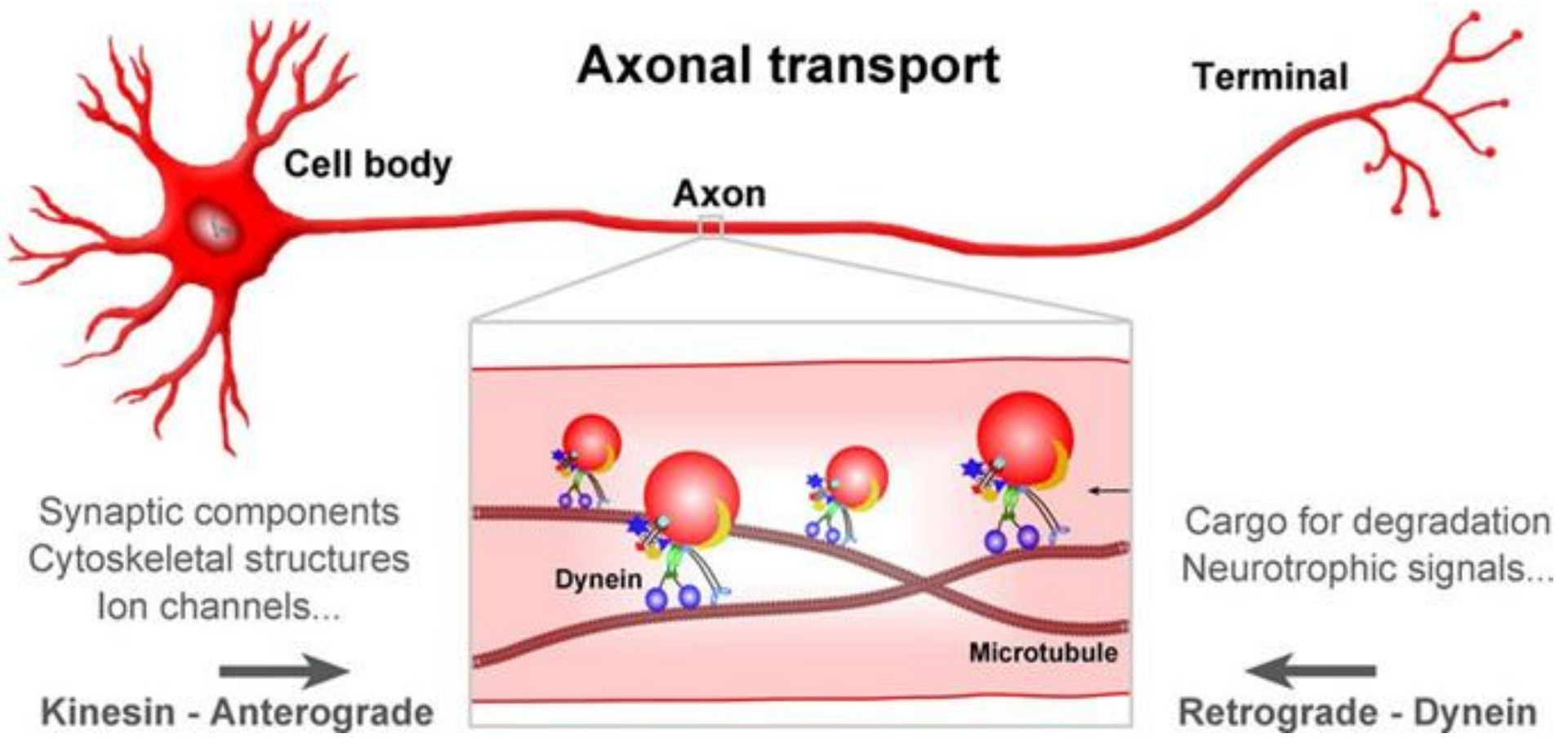
Microscopic difference between axon and dendrite

- Dendrite – similar to the perikaryon
- Axon – absent rough ER (Nissl substance)



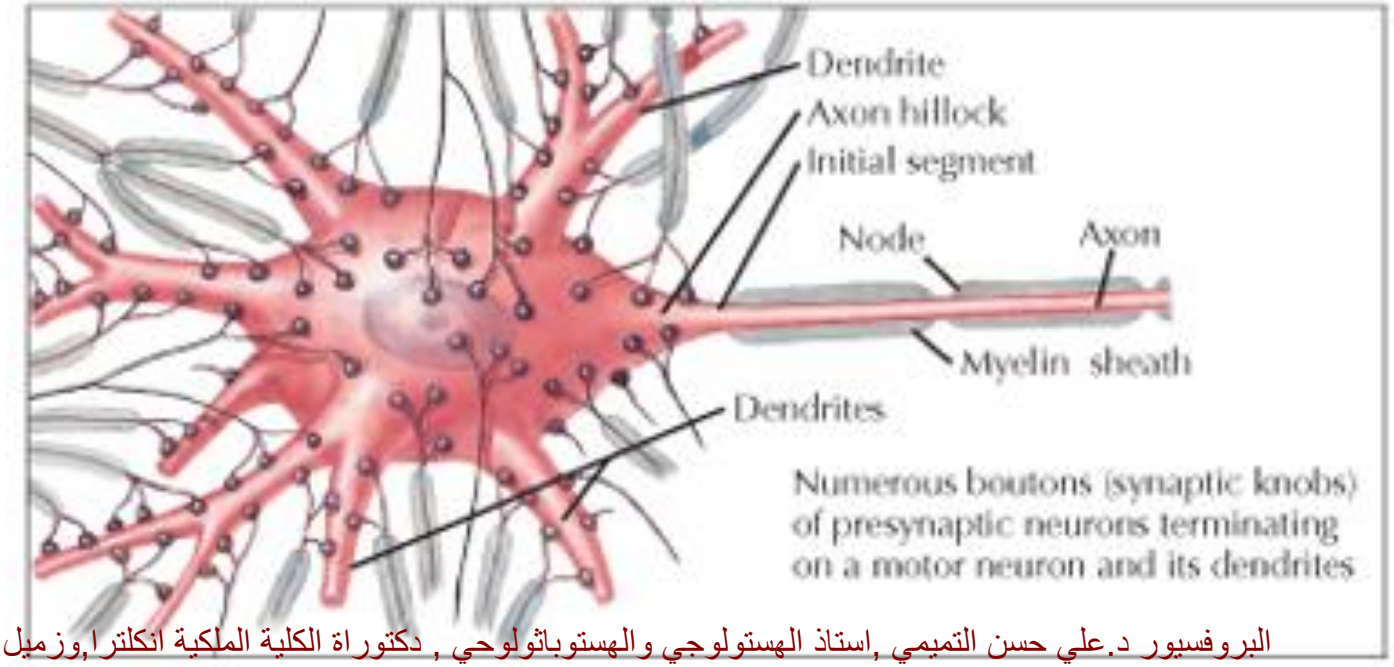
Axonal transport

- All of the structural and functional protein molecules (important for neurotransmission) are synthesized in the nerve cell body
- These molecules are distributed to the axons via axonal transport – in both directions
- Anterograde transport – transport vesicles
- Retrograde transport – from terminal parts to the perikaryon (tetanus toxin, rabies virus, ...)


Axonal transport
Terminal
Cell body
Axon
Synaptic components
Cytoskeletal structures
Ion channels...
Dynein
Microtubule
Cargo for degradation
Neurotrophic signals...
Kinesin - Anterograde
Retrograde - Dynein

Synapses

- Specialized junctions between neurons that facilitate transmission of impulses from one neuron to another neuron
- Also occur between axons and effector cells (muscle cells, gland cells)



Classification of synapses

- Depends on mechanism of conduction of the nerve impulses
  - Chemical synapses – conduction of impulses is achieved by the release of chemical substances (neurotransmitters) from the presynaptic neuron
  - Electrical synapses – are common in invertebrates, contain gap junctions that permit movement of ions between cells

Chemical synapse

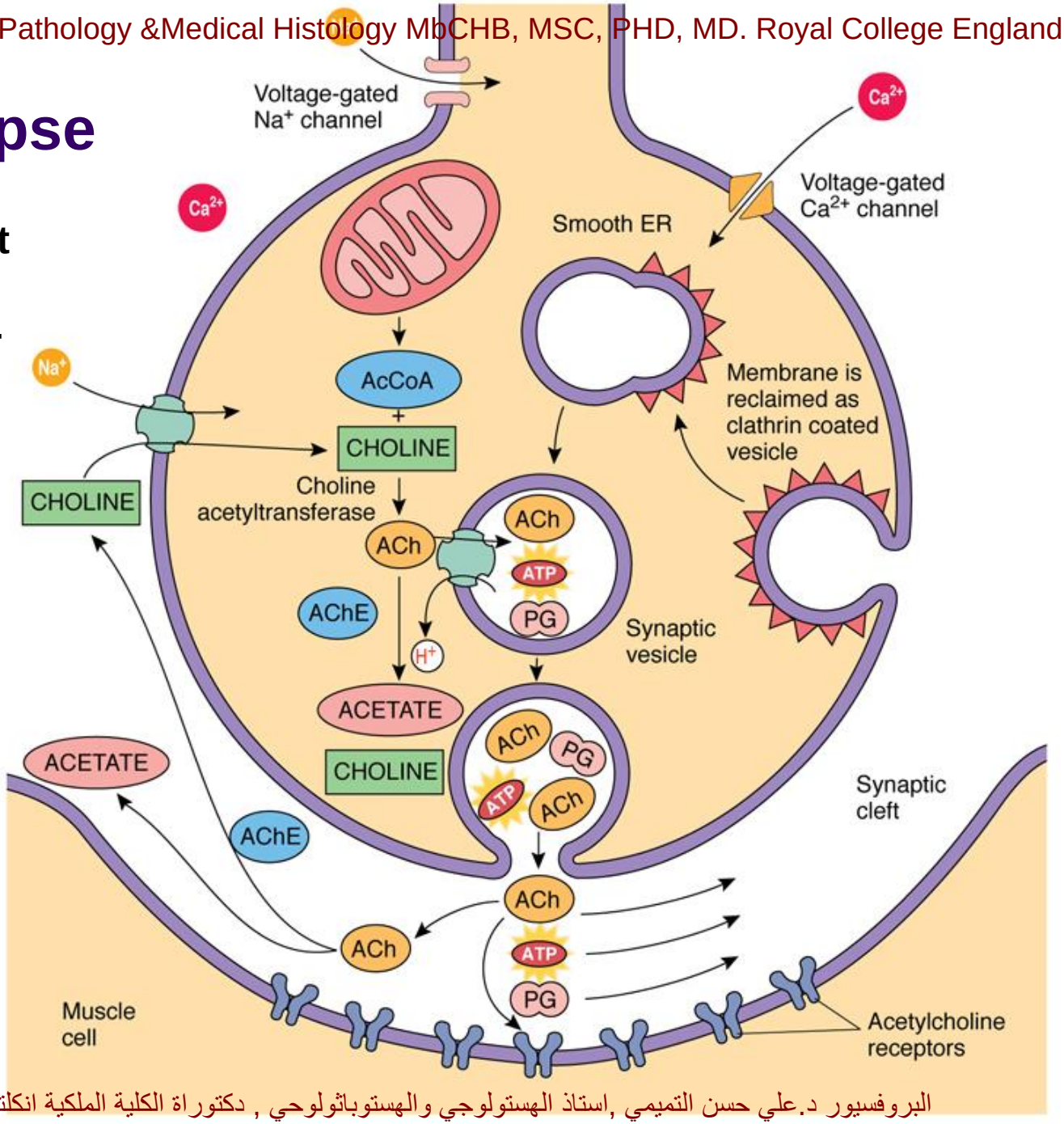
- It is the site of interneuronal communication
- There is a physical gap between pre- and post-synaptic membranes.
- Presynaptic membrane is typically an axon and it contains
  - Mitochondria that provide energy for axon functions
  - Vesicles (round objects) that contain neurotransmitter
  - Cisternae that are a part of the Golgi apparatus: recycle vesicles
- Postsynaptic membrane can be
  - A dendrite (axodendritic synapse)
  - A cell body (axosomatic synapse)
  - Another axon (axoaxonic synapse)

Chemical synapse

Presynaptic component (the end of the axon from which neurotrans-mitters are released, so-called terminal bouton)

Synaptic cleft – 20- to 30- nanometer space

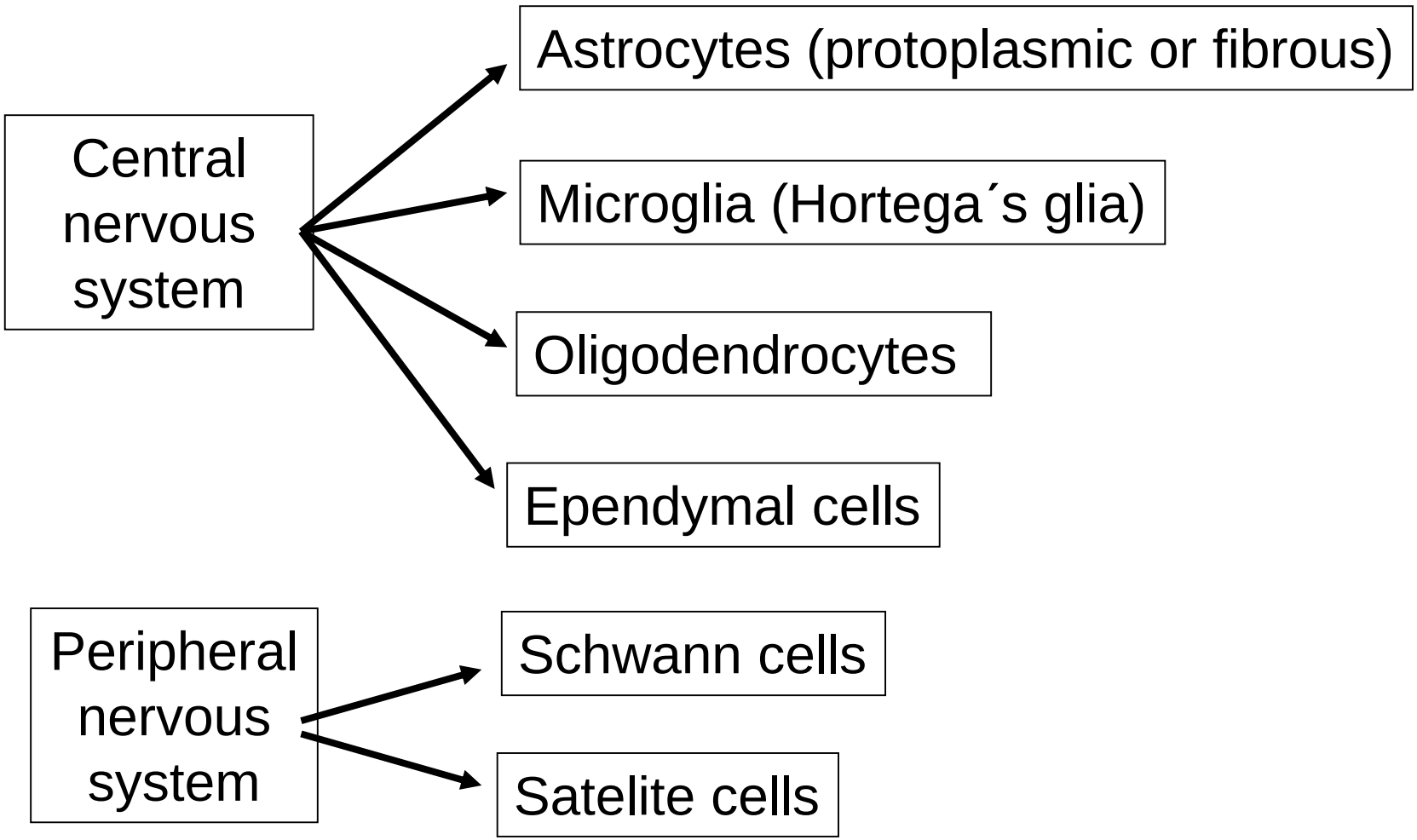
Postsynaptic membrane which contains receptor sites with which the neurotrasmitters interact



Functions of neuroglial cells

- **supporting role in the nervous tissue**
- **occupy interneuronal spaces**
- **creation of myelin sheaths around nerve fibers**
- **nutrition of the nervous tissue**
- **phagocytosis**
- **healing of defects (glial scars)**
- **regulation of stable chemical constitution of cerebrospinal fluid**
- **creation of blood-brain barrier (together with the endothelium of capillaries)**

Neuroglia – supporting cells



Astrocytes

- Star-shaped branched cells
- Physical and mechanical support for neurons
- The largest neuroglial cells
- Prominent bundles of intermediate filaments (glial fibrillary acidic protein)
- project foot processes to capillaries → **blood-brain barrier**
- participation in controling the ionic and chemical enviroment of neurons