

BASICS OF NEUROBIOLOGY

THE NEURON

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STRUCTURE AND FUNCTION OF THE CELL BODY

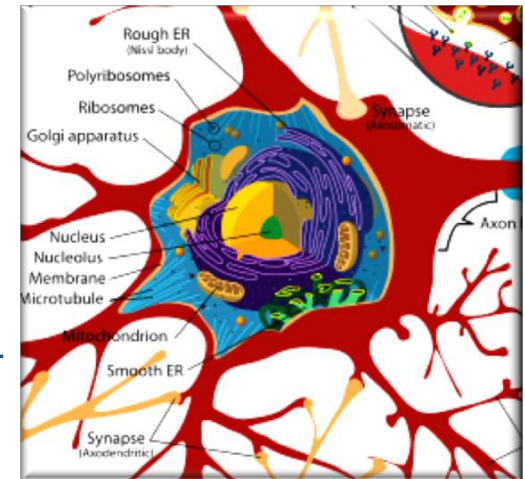
PERIKARYA ARE 10-100 MICROMETER WIDE IN DIAMETER

THE NUCLEUS HAS A CENTRAL LOCATION AND CONTAINS 1-2 PROMINENT NUCLEOLI

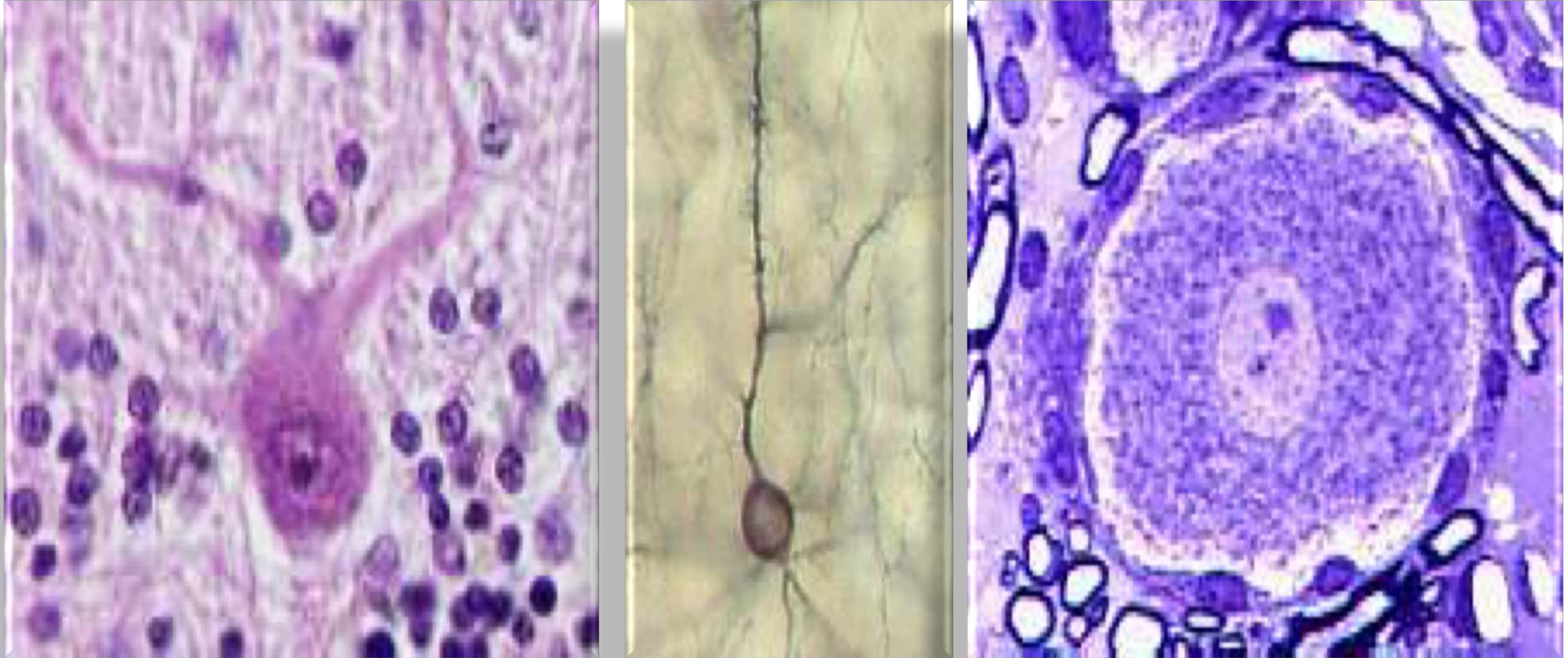
IN LIGHT MICROSCOPIC (LM) PREPARATIONS, THE NUCLEUS HAS A PALE STAINING IN COMPARISON WITH THE CYTOPLASM. THE NUCLEOLUS SHOWS A STRONG BASOPHILIC STAINING

THE CYTOPLASM AROUND THE NUCLEUS CONTAINS WELL-DEVELOPED ROUGH ENDOPLASMIC RETICULUM SYSTEM UNITS CALLED NISSL BODIES. THE STRONG BASOPHILIA OF THE CYTOPLASM IS DUE TO ITS HIGH RIBONUCLEIC ACID CONTENT

FREE RIBOSOMES, RER AND GOLGI COMPLEXES TAKE PART IN THE PRODUCTION AND SORTING OF PROTEINS



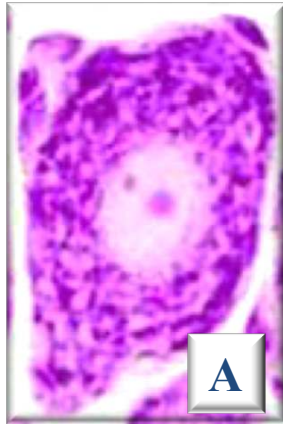
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DIFFERENT PHENOTYPES OF CELL BODIES

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LIGHT MICROSCOPIC FEATURES OF THE PERIKARYON



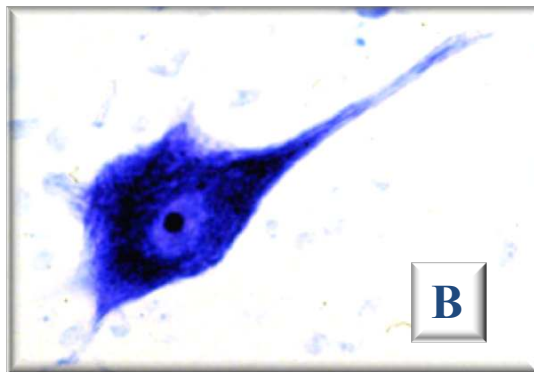
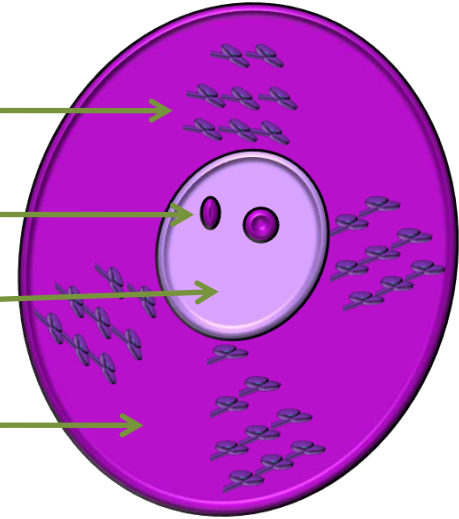
**A. SPINAL GANGLION NEURON,
HEMATOXYLIN-EOSIN STAINING**

NISSL BODY

NUCLEOLUS

NUCLEUS

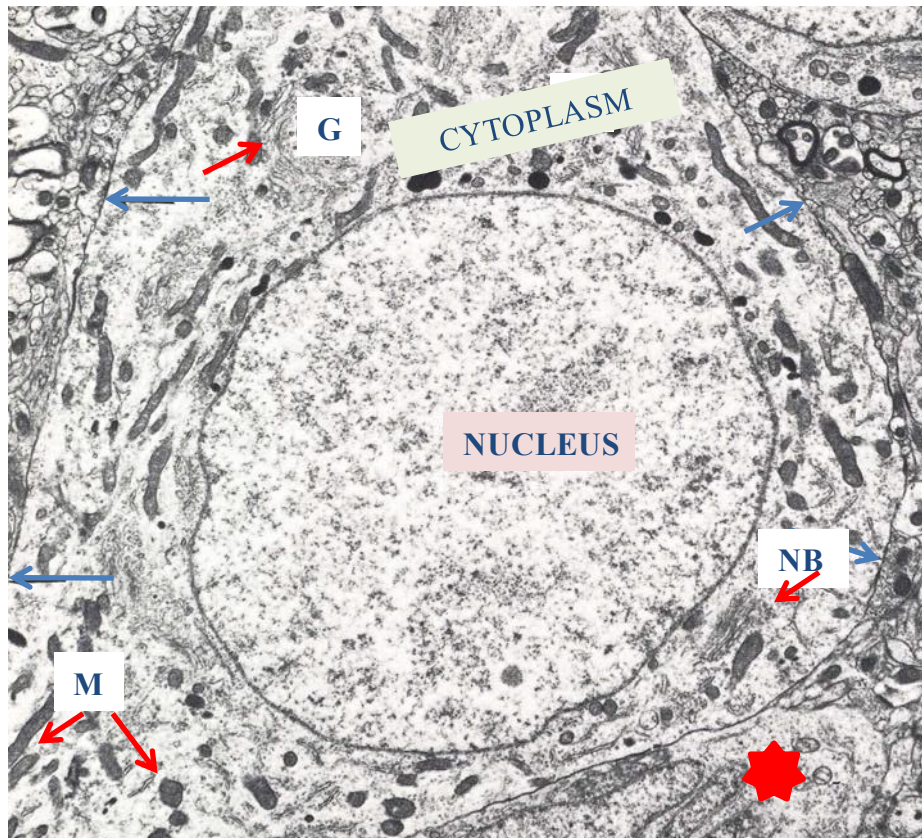
CYTOPLASM



**B. SPINAL MOTONEURON, TOLUIDINE BLUE STAINING.
NOTE, THE PRESENCE OF THE STAIN IN THE PROXIMAL
DENDRITES INDICATING RIBOSOMES AND PROTEIN
SYNTHESIS**

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ULTRASTRUCTURE OF THE NEURONAL CELL BODY



NUCLEUS DISPLAYS HETERO-AND EUCHROMATIN. PROMINENT NUCLEAR MEMBRANE.

CYTOPLASM CONTAINS GOLGI COMPLEX (G), MANY MITOCHONDRIA AND NISSL BODIES (NB).

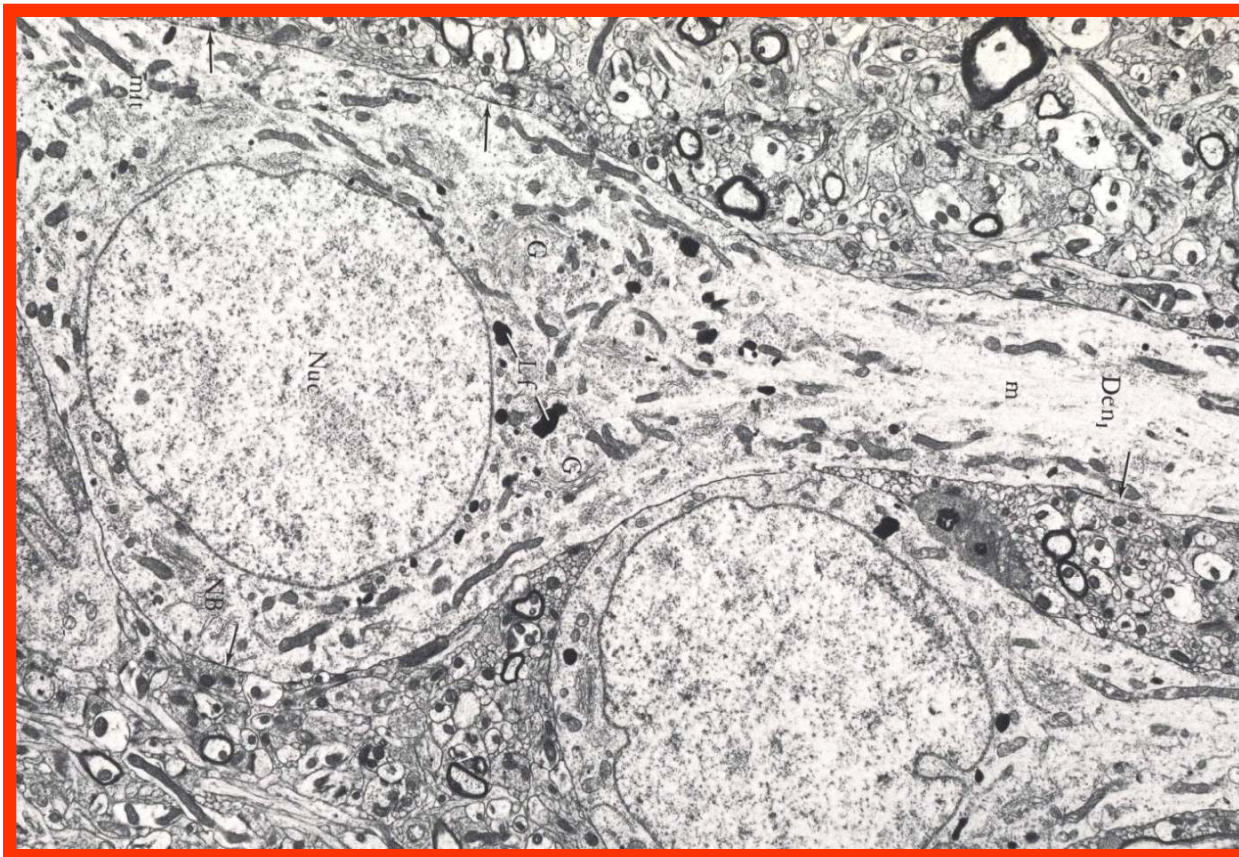
CELL MEMBRANE IS INDICATED BY BLUE ARROWS

A NEIGHBORING CELL IS SHOWN BY A STAR

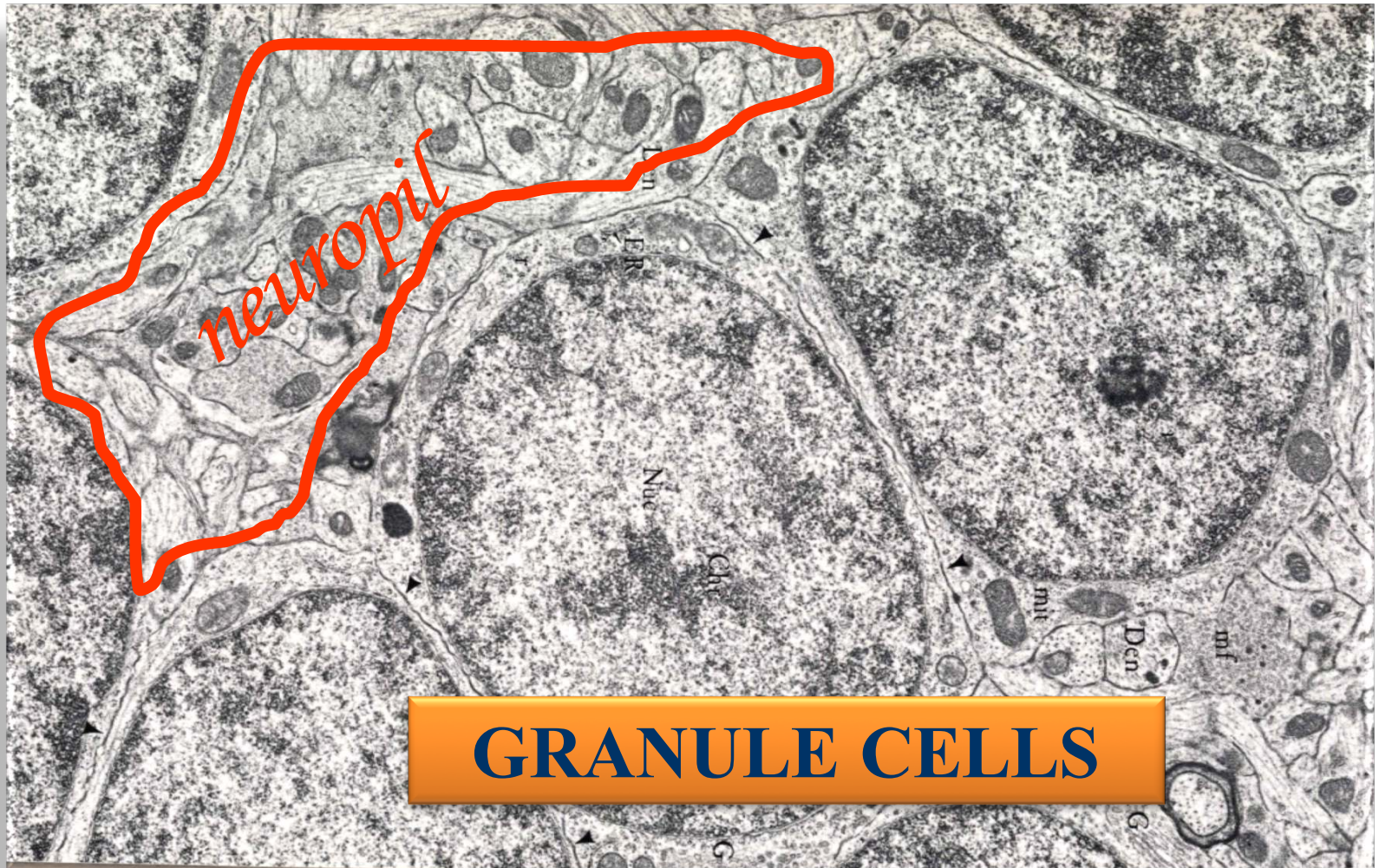
BUNDLES OF DENDRITES, AXONS AND GLIAL PROCESSES ARE PRESENT IN THE VICINITY OF THE CELLS

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PYRAMIDAL CELL

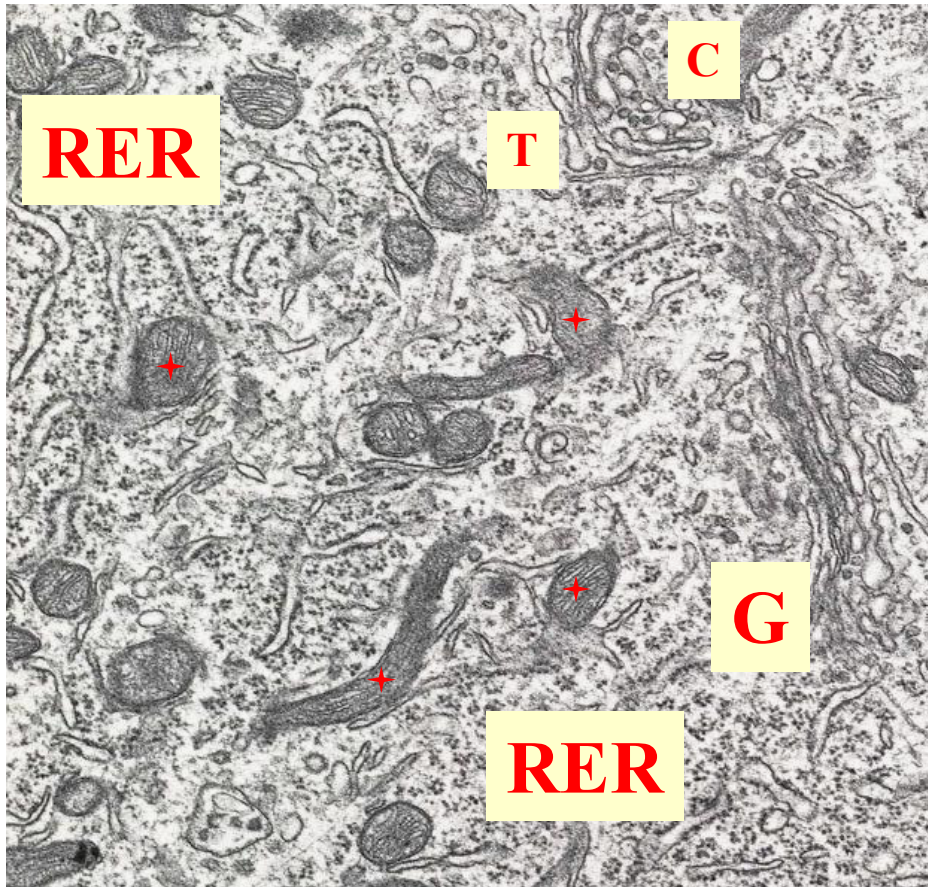


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HIGH POWER DETAIL OF NEURONAL ORGANELLES



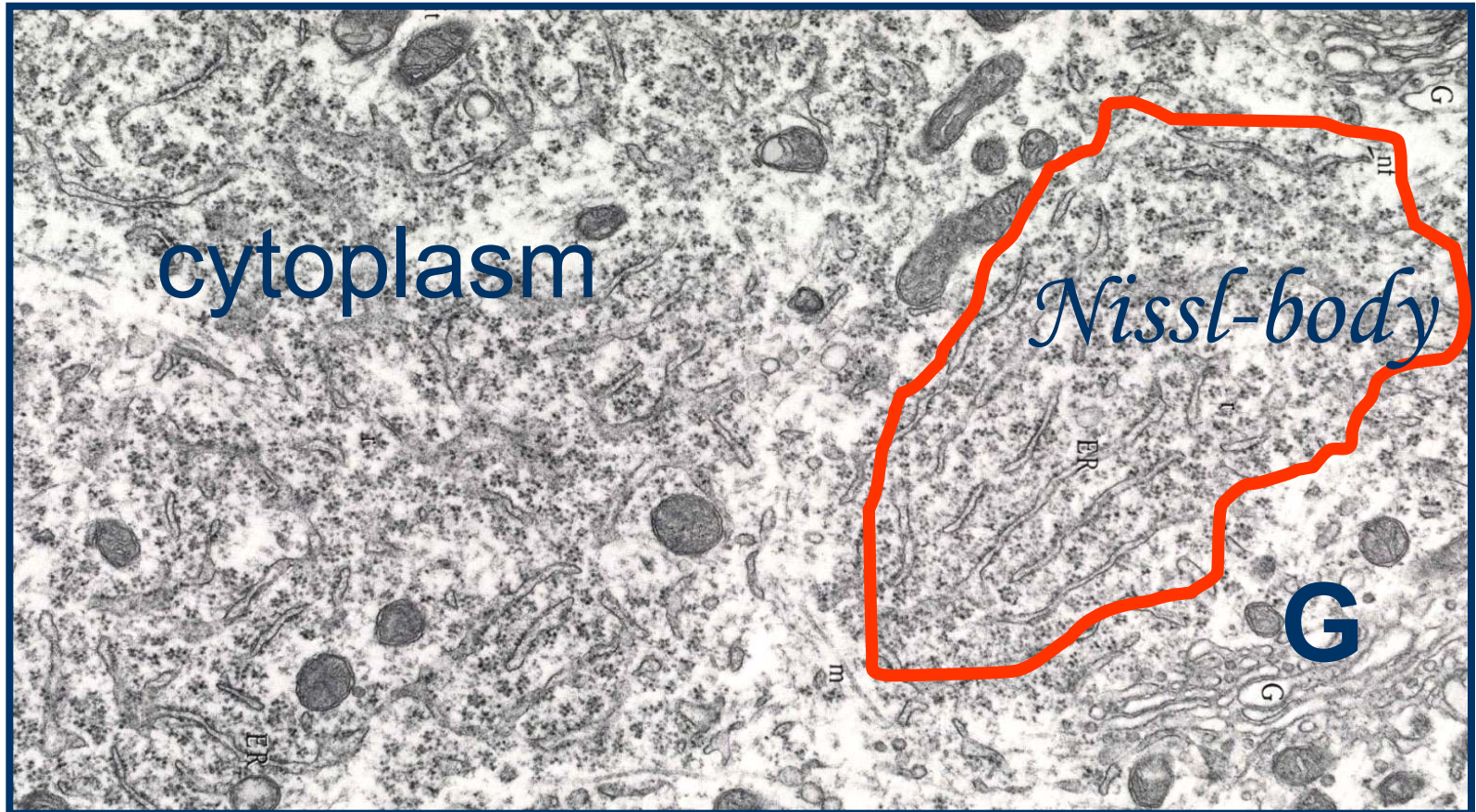
CLUSTERING MITOCHONDRIA (STAR) PROVIDE ENERGY FOR CELLULAR ACTIONS

WITHIN THE ROUGH ENDOPLASMIC RETICULUM (RER), BOTH THE FLATTENED CISTERNAE AND THE RIBOSOMES ARE VISIBLE

THE GOLGI COMPLEX (G) IS ACTIVE. THE TRANS (T) AND CIS (C) FACES ARE DISTINGUISHABLE

THE CRISTAE ARE OBVIOUS IN MOST MITOCHONDRIA

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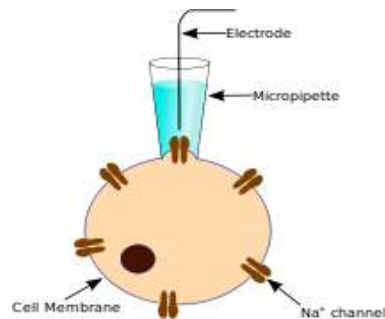
STUDYING THE ION CHANNELS OF THE NEURAL MEMBRANE *IN VITRO* BY PATCH CLAMP ELECTROPHYSIOLOGY

GLASS ELECTRODE WITH A TIP OF 1 MICROMETER IS FILLED WITH SPECIAL ELECTROLYTE SOLUTION

THE SMOOTH ELECTRODE TIP IS PLACED ON THE CELL MEMBRANE UNDER MICROSCOPIC CONTROL AND A SEAL IS MADE

CHLORIDED SILVER ELECTRODE PICKS UP THE CURRENTS AND SENDS THEM TO THE AMPLIFIER

ERWIN NEHER AND BERT SAKMANN DEVELOPED THE TECHNIQUE, THEY RECEIVED NOBEL PRIZE IN 1991.



TYPES OF APPLICATION

CELL ATTACHED
WHOLE-CELL
INSIDE-OUT
OUTSIDE-OUT
PERFORATED
LOOSE

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DENDRITES

MOST NEURONS HAVE MULTIPLE DENDRITES THAT ARE CONTINUOUS WITH THE CYTOPLASM

DENDRITES BRANCH NEAR THE PERIKARYON RESULTING IN PRIMARY, SECONDARY AND TERTIARY UNITS

DENDRITES ESTABLISH THIN CYTOPLASMIC PROTRUSIONS CALLED DENDRITIC SPINES

DENDRITIC SHAFTS AND SPINES RECEIVE MOST OF THE INCOMING INFORMATION, THEREFORE SYNAPSING AXON TERMINALS CAN BE FOUND ON THEIR SURFACES

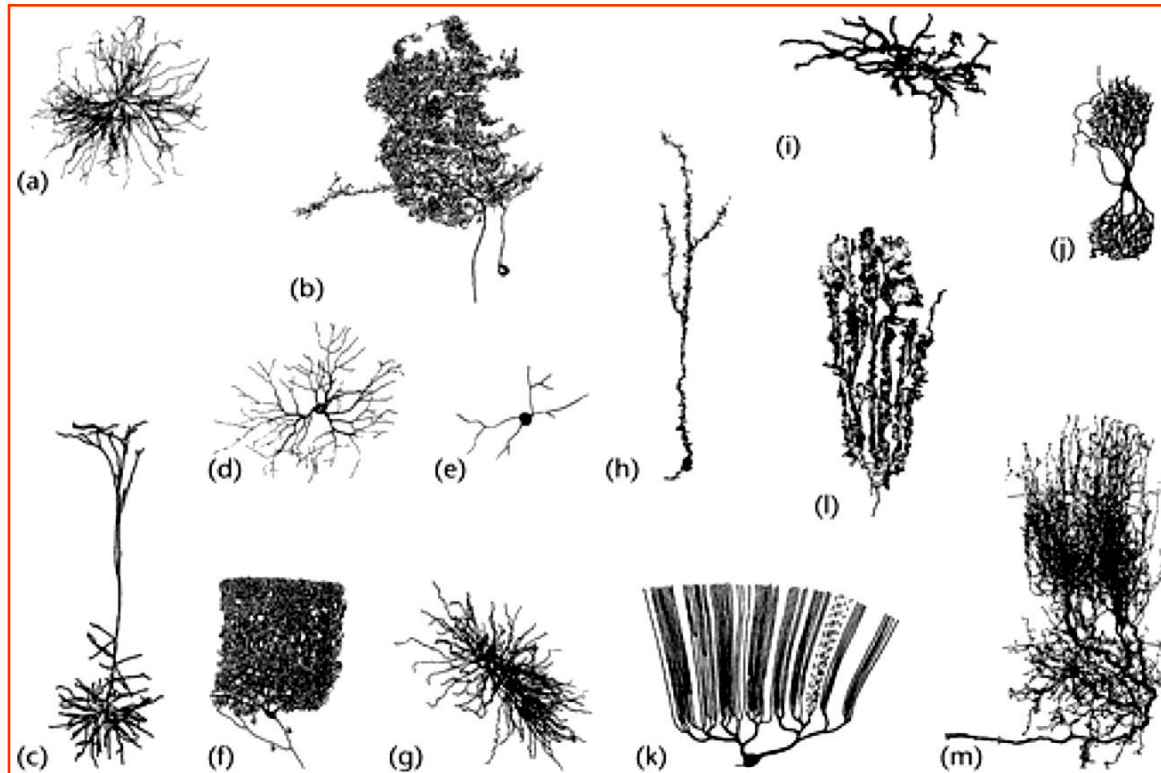
THE DENDRITIC TREE TAKES PART IN NEURONAL PLASTICITY AND REMODELING

THEY CONTAIN MICROTUBULES, RER, POLYSOMES AND SPECIFIC mRNAs

THEY ARE ENRICHED IN SPECIFIC PEPTIDE AND TRANSMITTER RECEPTORS

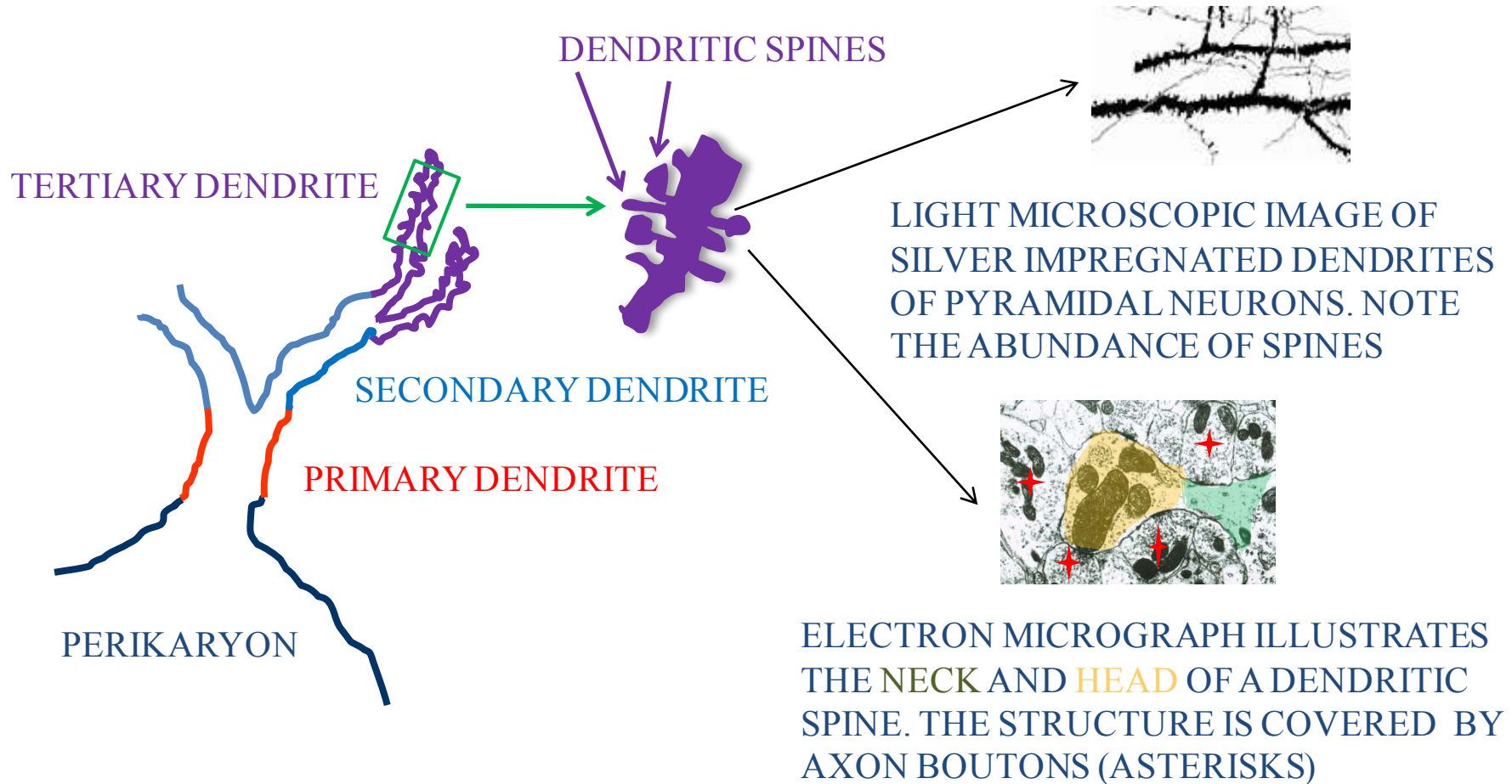
THEIR PRIMARY ROLE IS TO INTEGRATE THE INCOMING INFORMATION FROM THOUSANDS OF AXONS

Dendritic trees



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BRANCHING OF DENDRITES, DENDRITIC SPINES



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ULTRASTRUCTURE OF DENDRITIES



THE PICTURE DEPICTS A CELL BODY-FREE REGION OF THE NEURAL TISSUE CALLED NEUROPIL

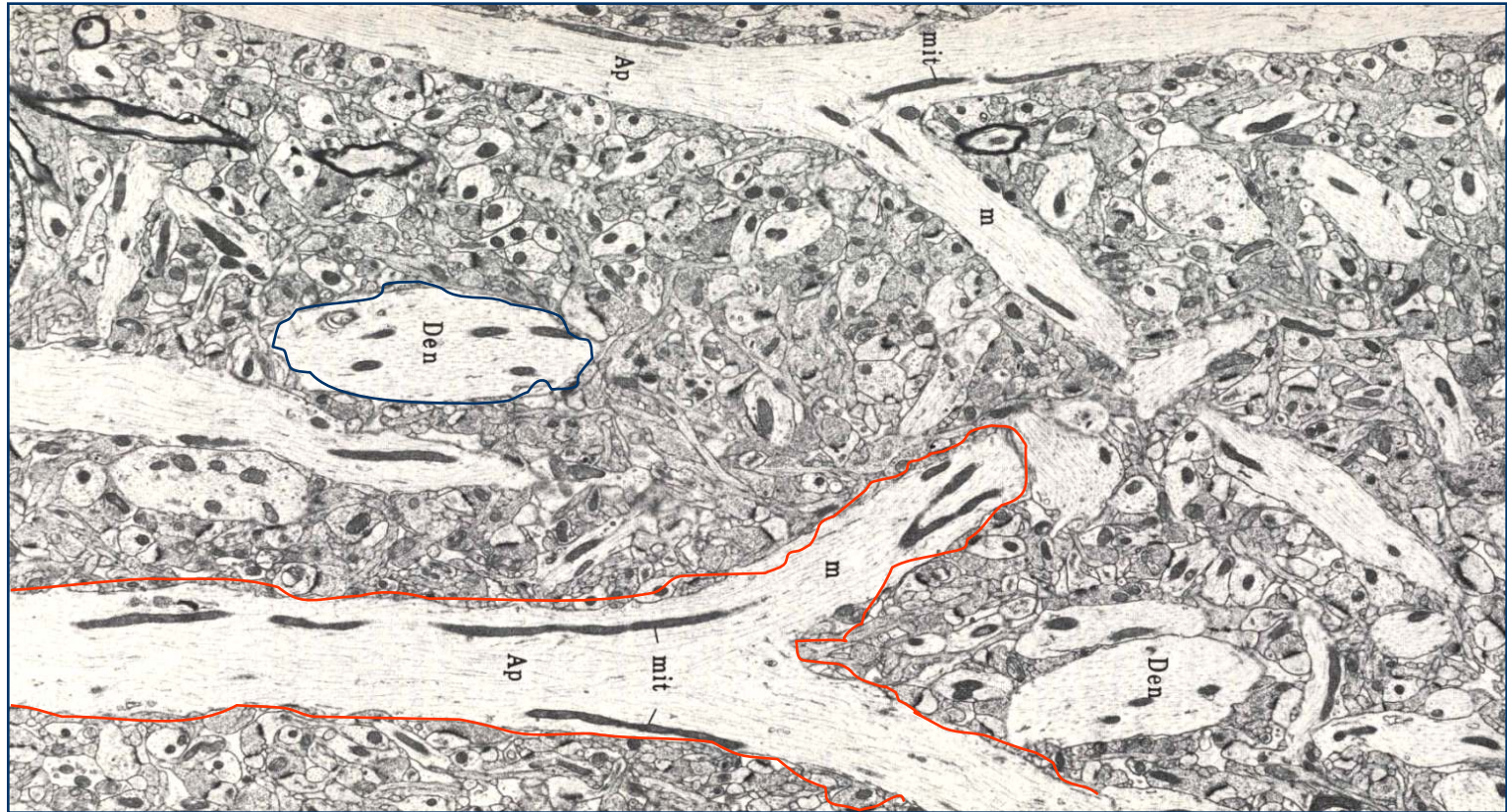
IN THE NEUROPIL, LONGITUDINALLY- AND CROSS-SECTIONED DENDRITES OF DIFFERENT CALIBERS CAN BE REVEALED

AT THIS POWER, MICROTUBULES AND MITOCHONDRIA ARE RECOGNIZABLE

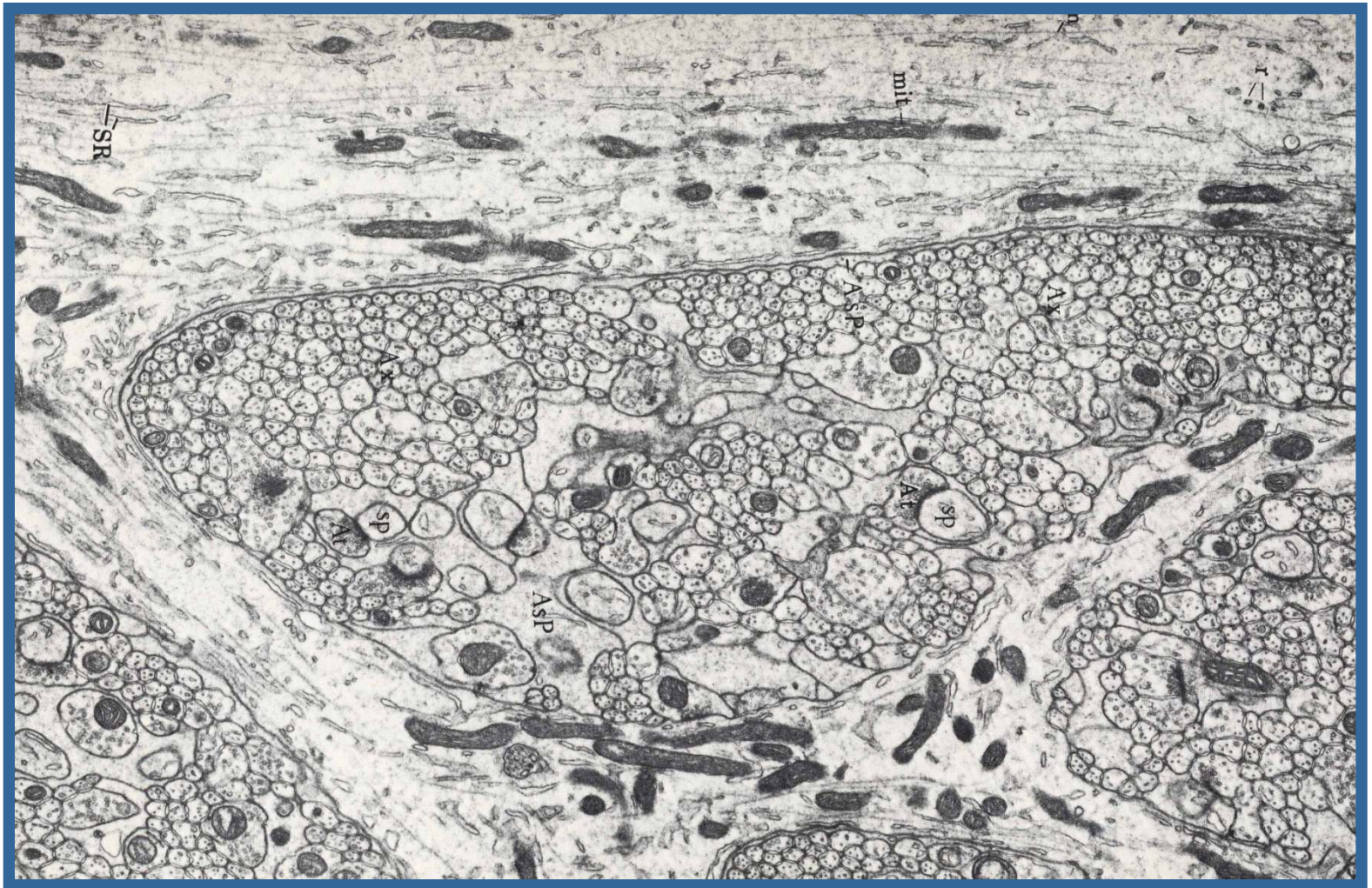
DENDRITIC PROCESSES ARE LESS ELECTRON DENSE THAN AXONS (ARROWHEADS)

DENSE, BAR LIKE THICKENINGS (ARROWS) INDICATE SYNAPTIC COMMUNICATION SITES

Dendrites in cross and longitudinal sections



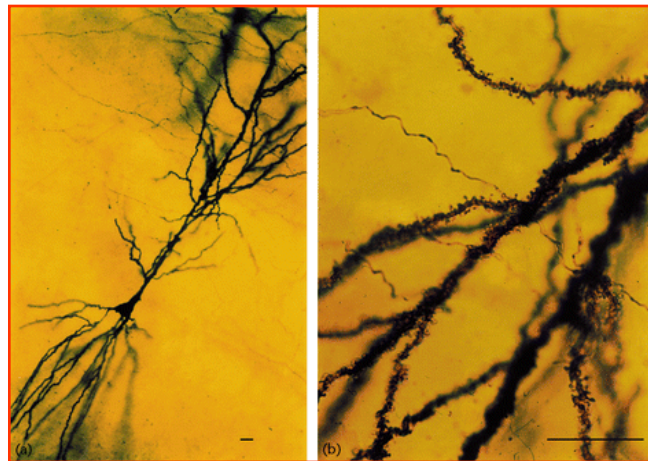
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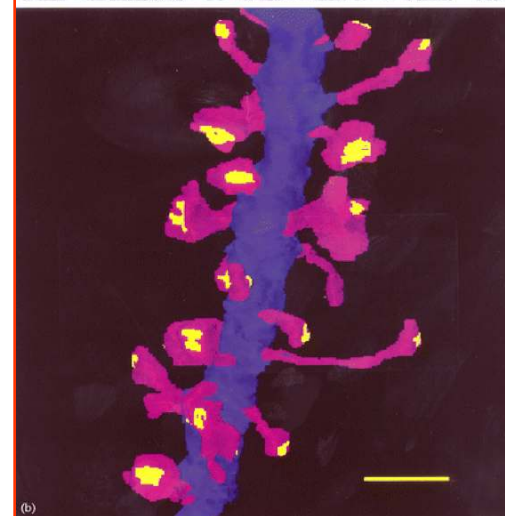
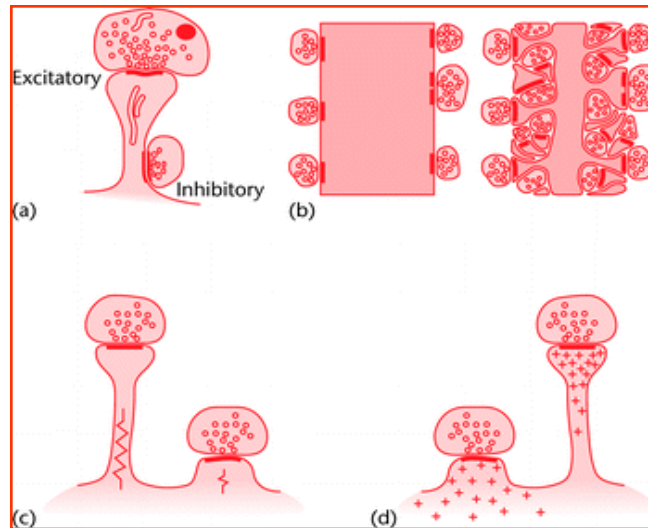
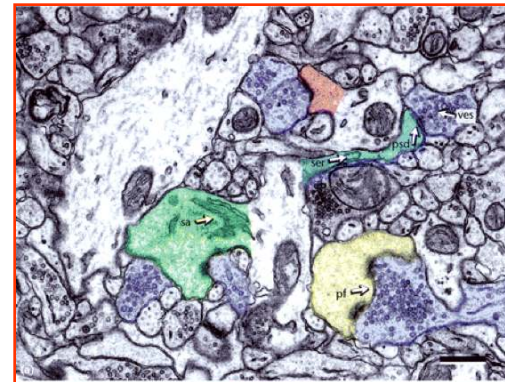
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DENDRITIC SPINES



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PROPERTIES OF AXONS

THE AXONIC PROCESS APPEARS FIRST DURING DIFFERENTIATION OF NEURONS

ITS INITIAL SEGMENT, THE AXON HILLOCK, HAS A HIGH DENSITY OF ION CHANNELS

THE GENERATION OF ACTION POTENTIAL BEGINS AT THE AXON HILLOCK

MICROTUBULES DISPLAY A UNIFORM POLARITY, THE PLUS ENDS OCCUR DISTALLY

AXON COLLATERALS ARISE IN AN OBTUSE ANGEL, SIMILAR THICKNESS

AXONS CARRY SPECIALIZED PRE-SYNAPTIC MACHINERIES FOR COMMUNICATION

THEIR LENGTH DEPENDS ON THE SPECIES AND THE DISTANCE OF THE SERVICE SITE

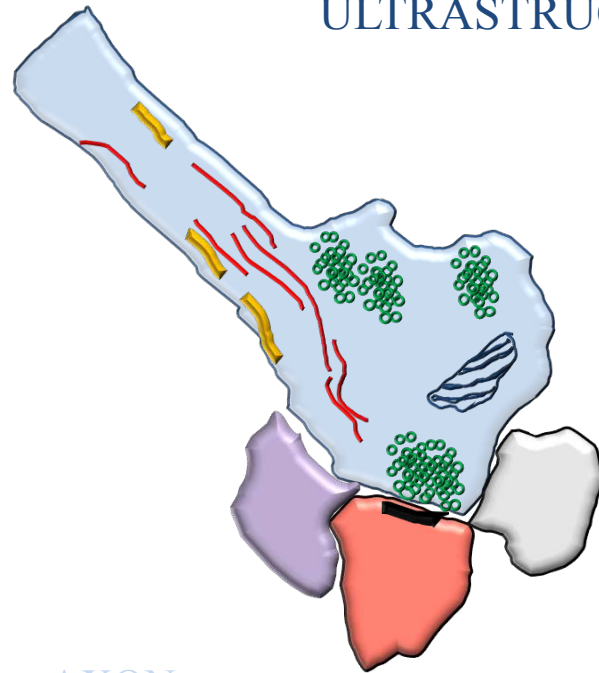
NEUROFILAMENT CONTENT ALLOWS THEIR DETECTION BY SILVER IMPREGNATION

SEVERAL AXONS SHOW VARICOSITIES ALONG THEIR COURSE

THEY BRANCH AT THEIR FINAL DESTINATION, PRE-TERMINAL ARBORIZATION

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ULTRASTRUCTURAL FEATURES OF THE AXON TERMINAL



AXON

MICROTUBULE

NEUROFILAMENT

MITOCHONDRION

SYNAPTIC VESICLE

POST-SYNAPTIC DENSITY

DENDRITE

THE AXON TERMINAL CONTAINS MICROTUBULES, NEUROFILAMENT BUNDLES, MITOCHONDRIA AND POOLS OF SYNAPTIC VESICLES

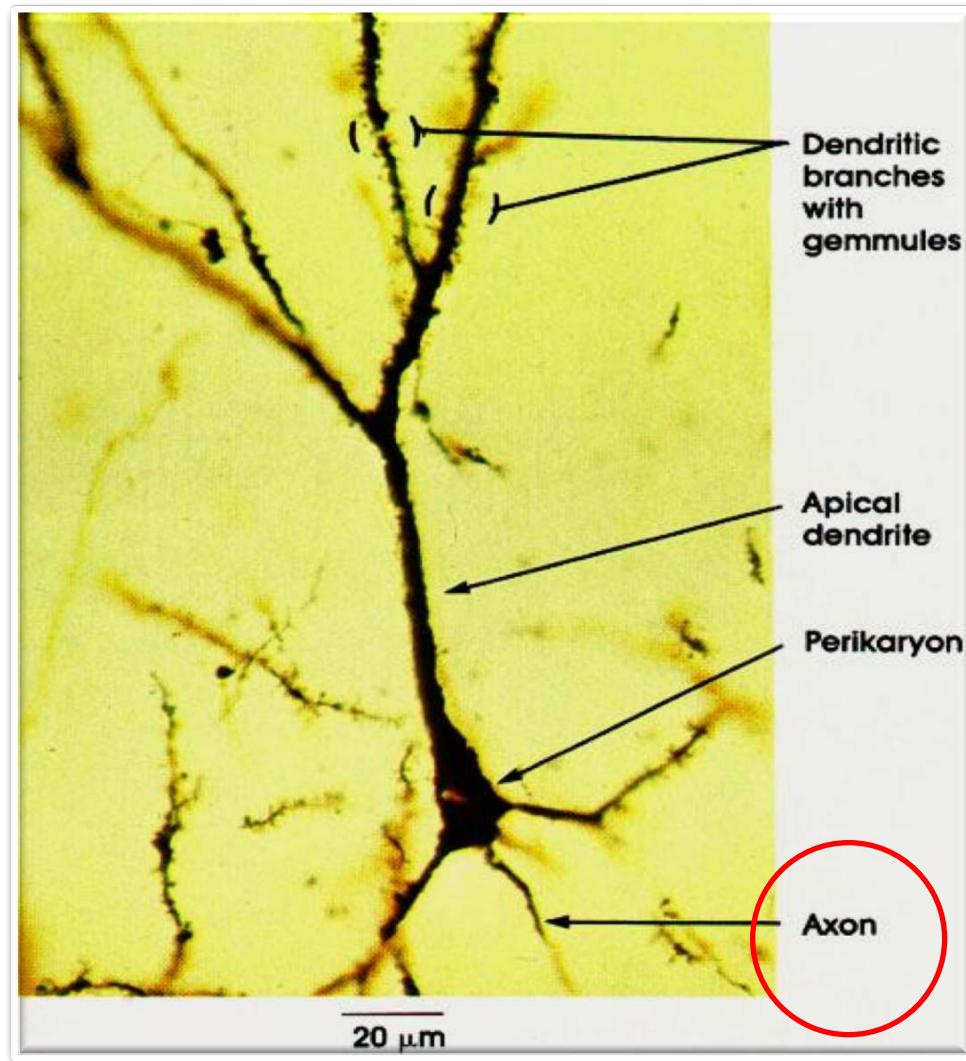
ITS TERMINAL ENLARGEMENT IS CALLED BOUTON

AGGREGATION OF SYNAPTIC VESICLES AT THE PRE-SYNAPTIC MEMBRANE IS INDICATIVE OF COMMUNICATION

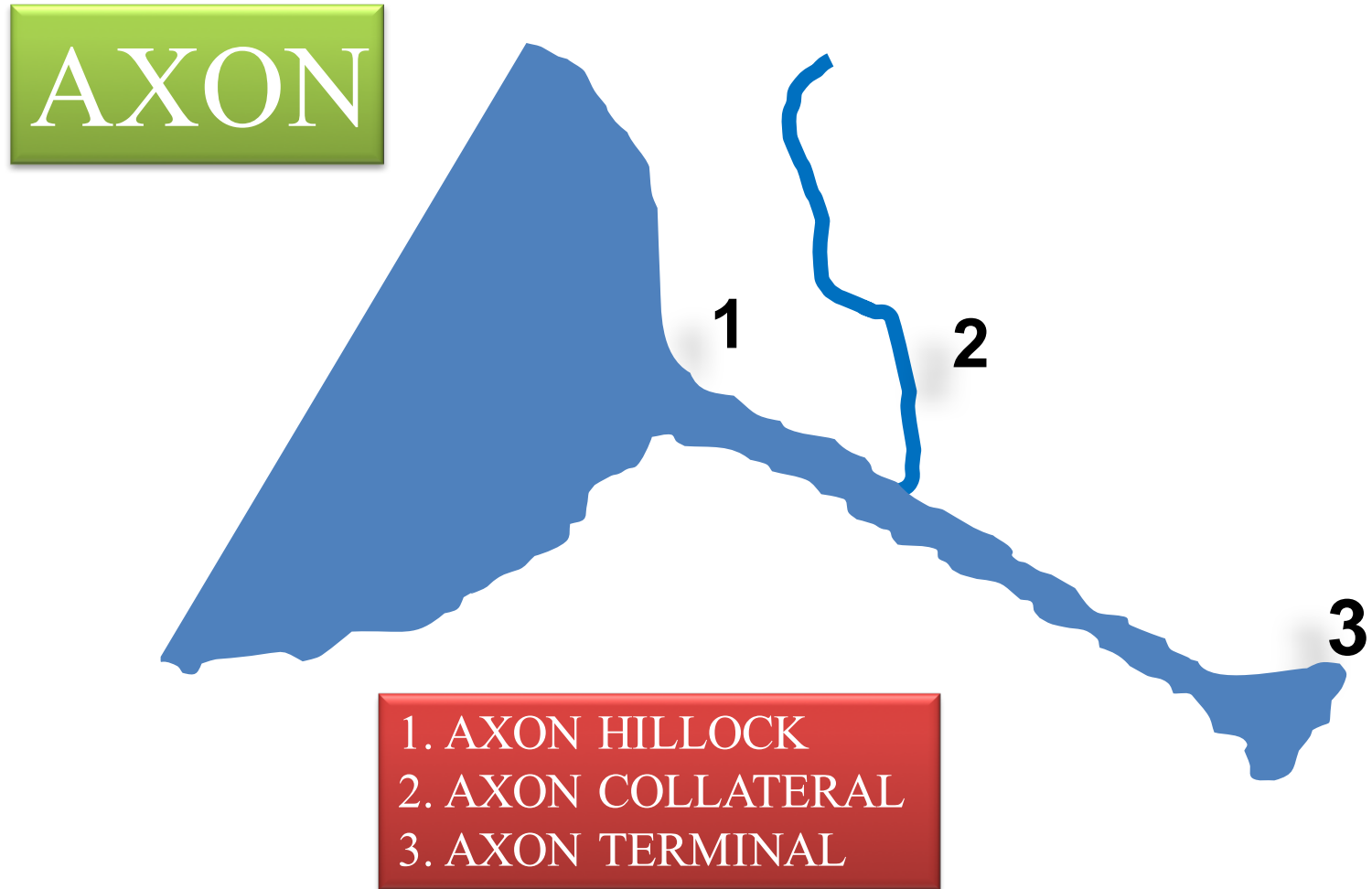
THE SYNAPTIC ENGAGEMENTS CAN BE REVEALED BY ELECTRON MICROSCOPY

GROWING AXONS EXHIBIT CHARACTERISTIC GROWTH CONES

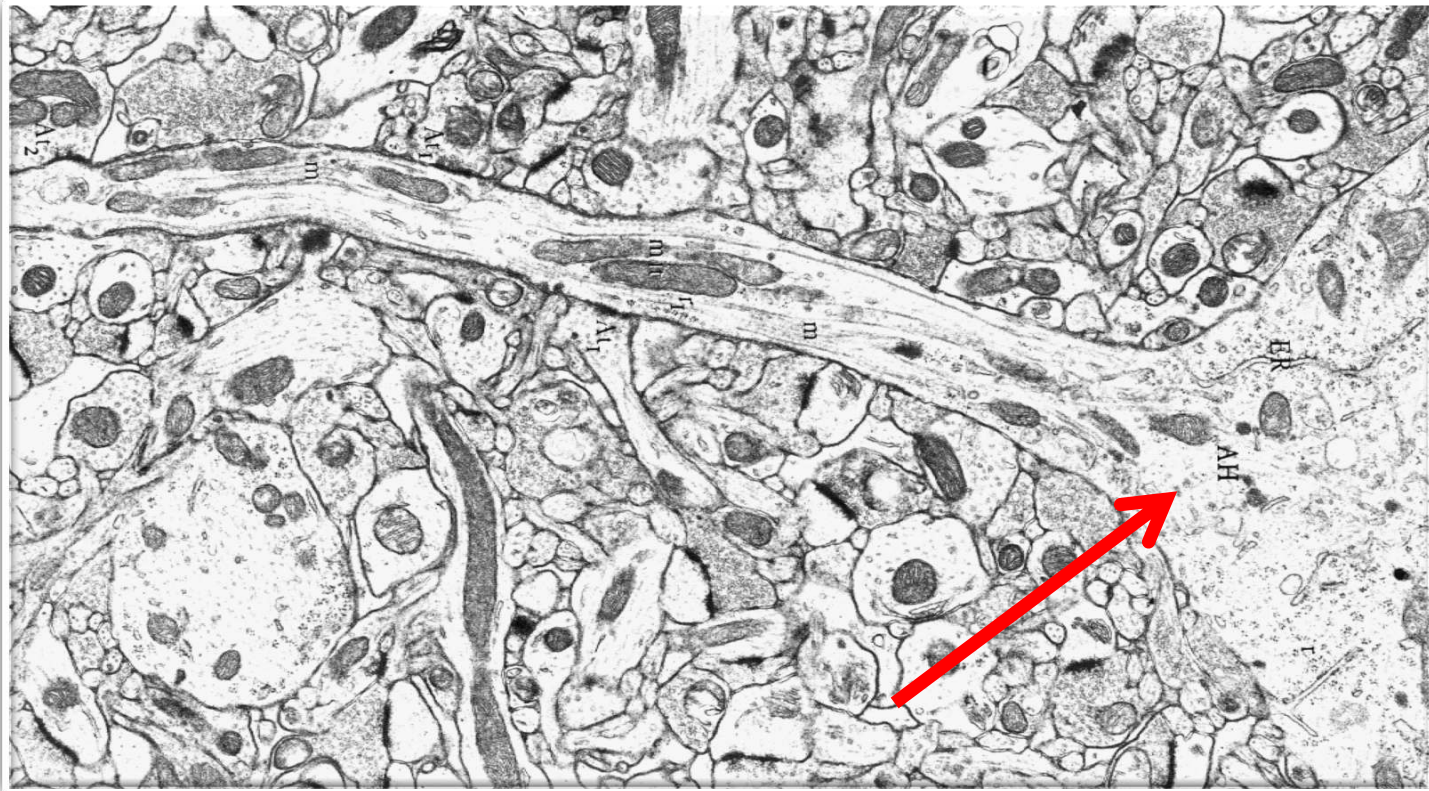
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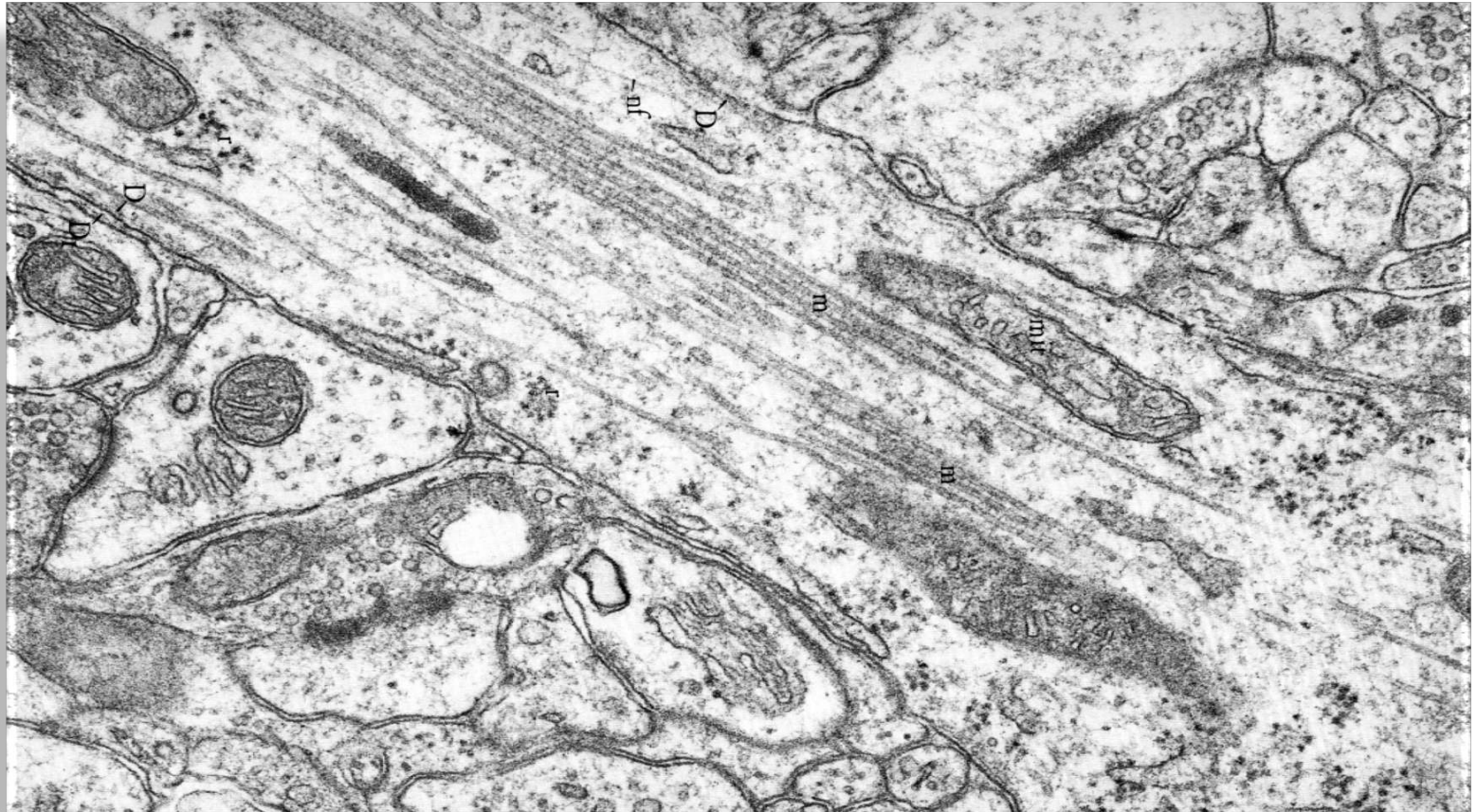


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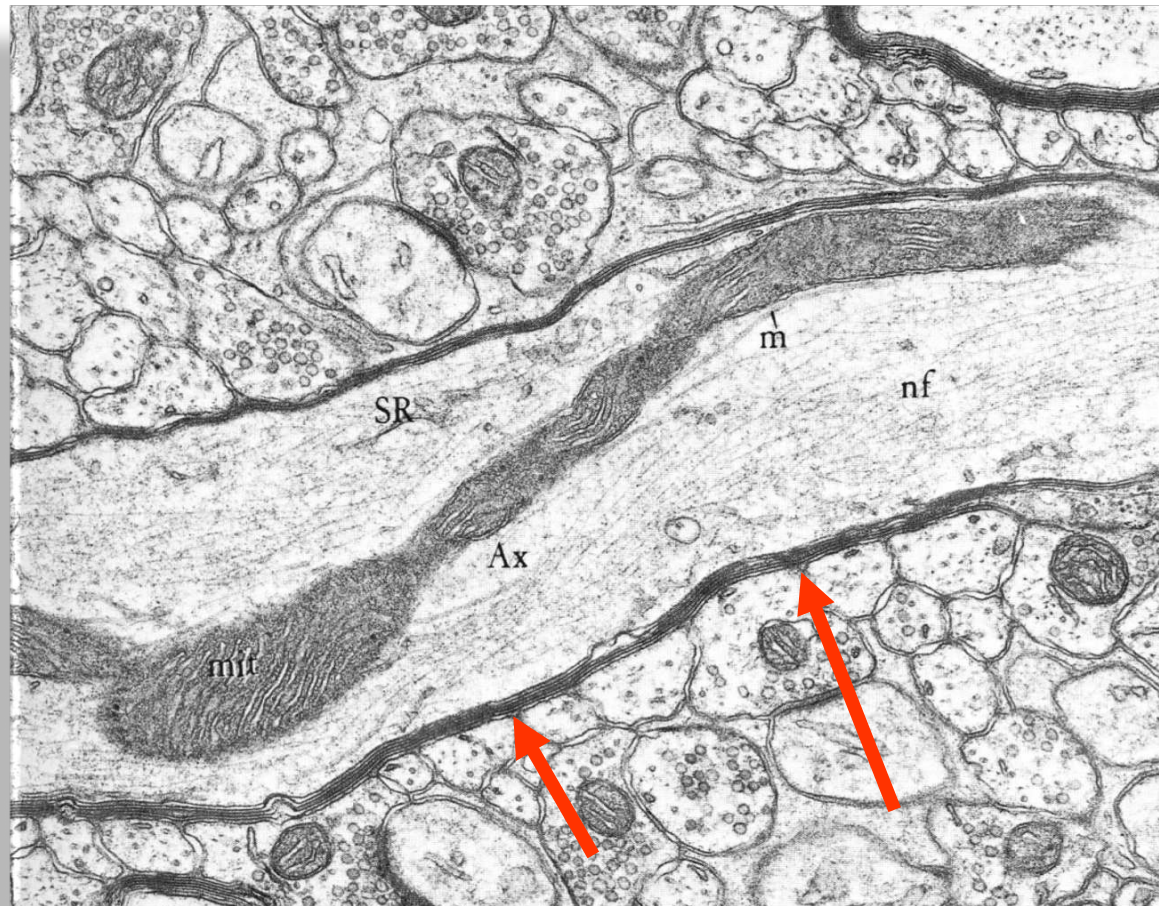
AXON HILLOCK

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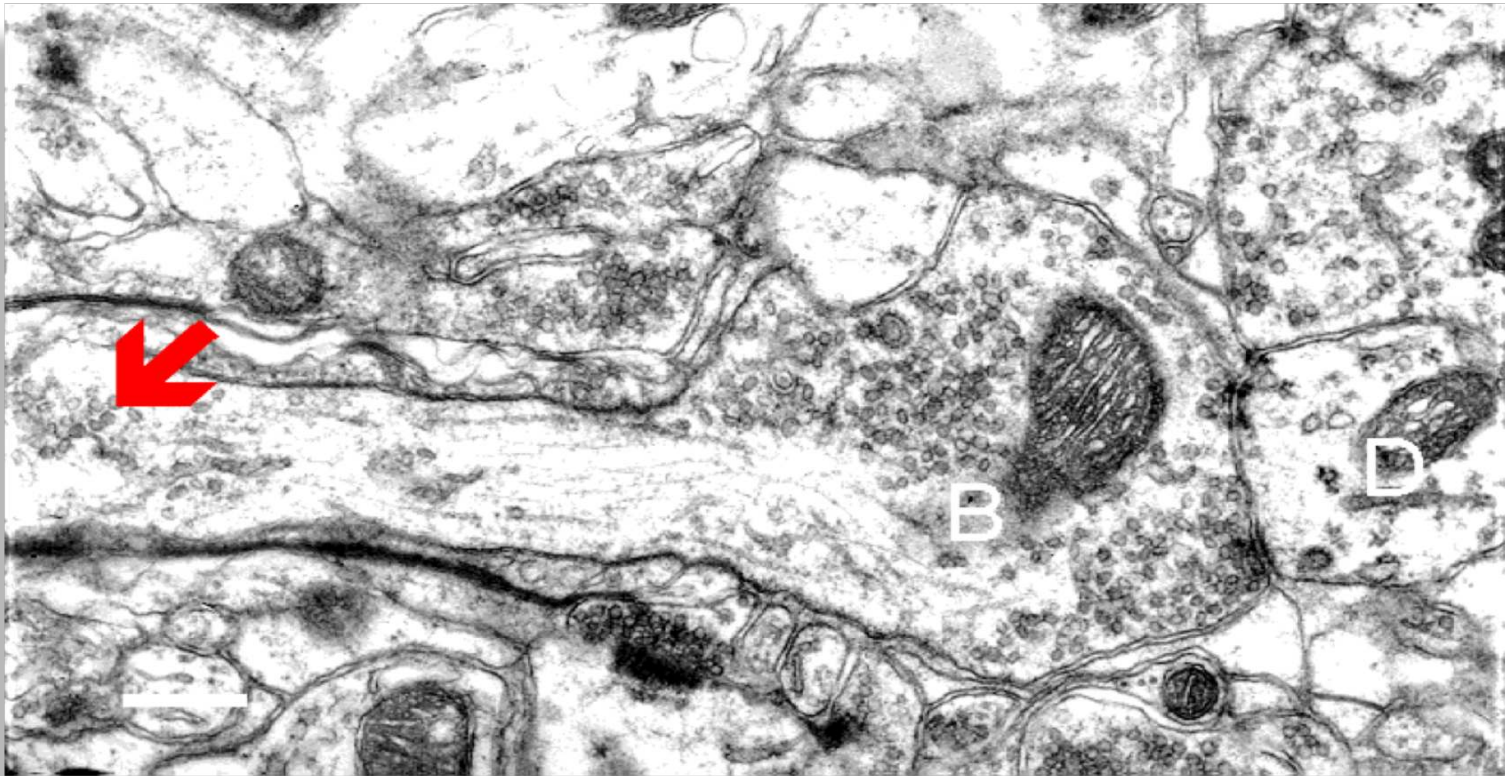
AXON INITIAL SEGMENT

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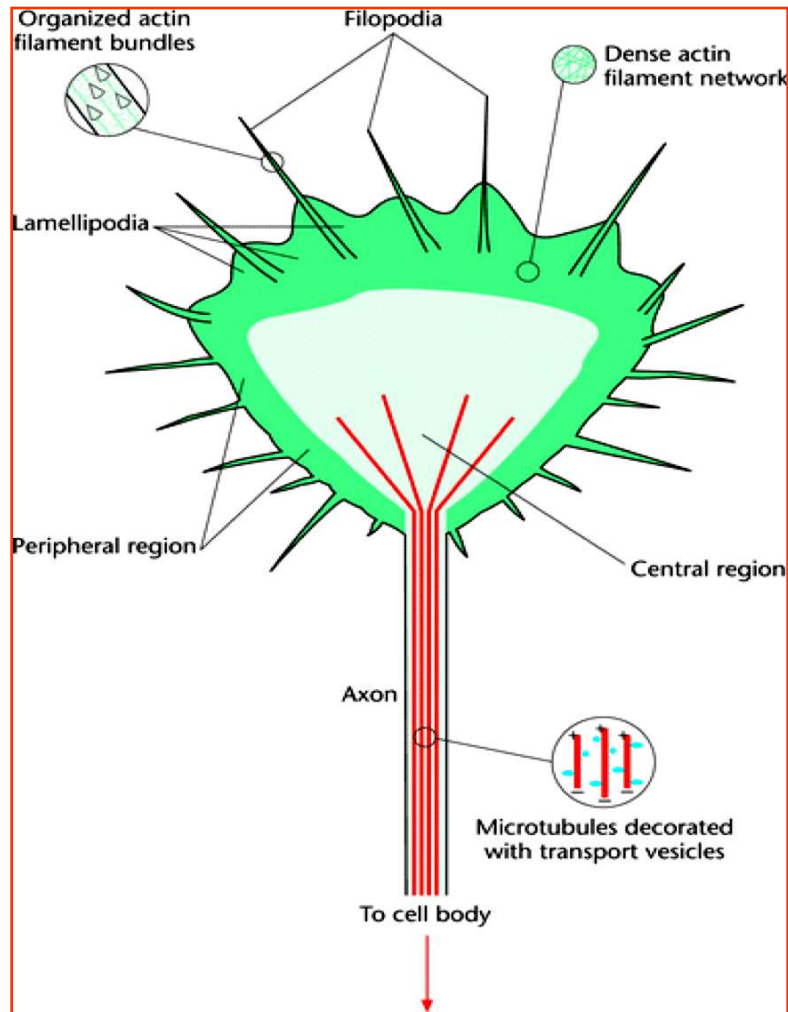
MYELINATED AXON

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AXON TERMINAL

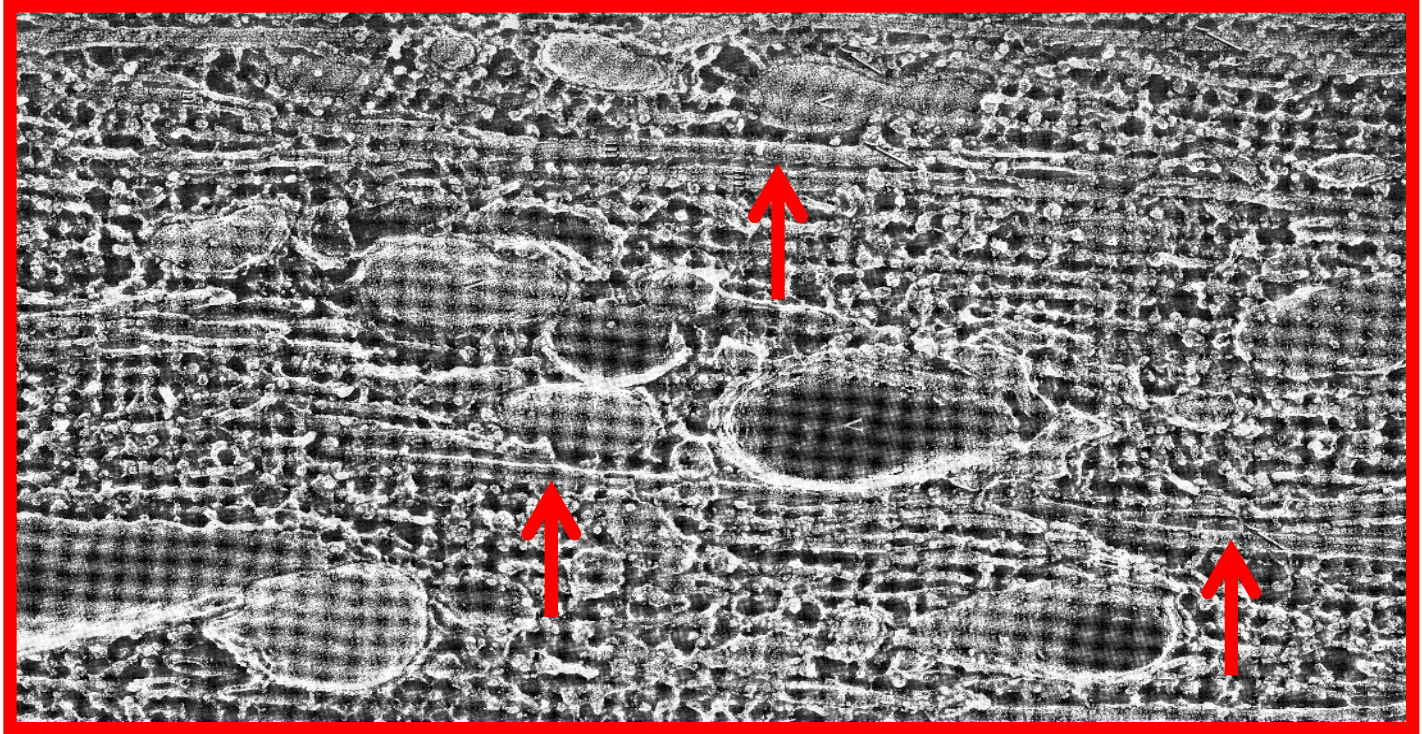
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AXON GROWTH

GROWTH CONE

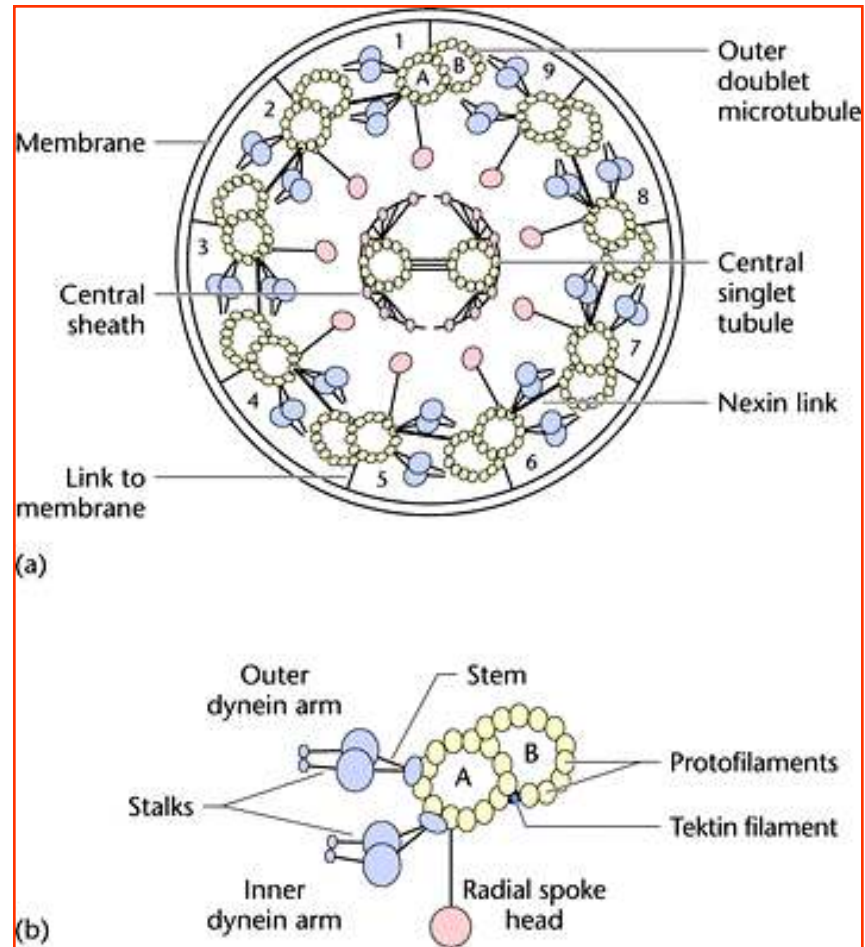
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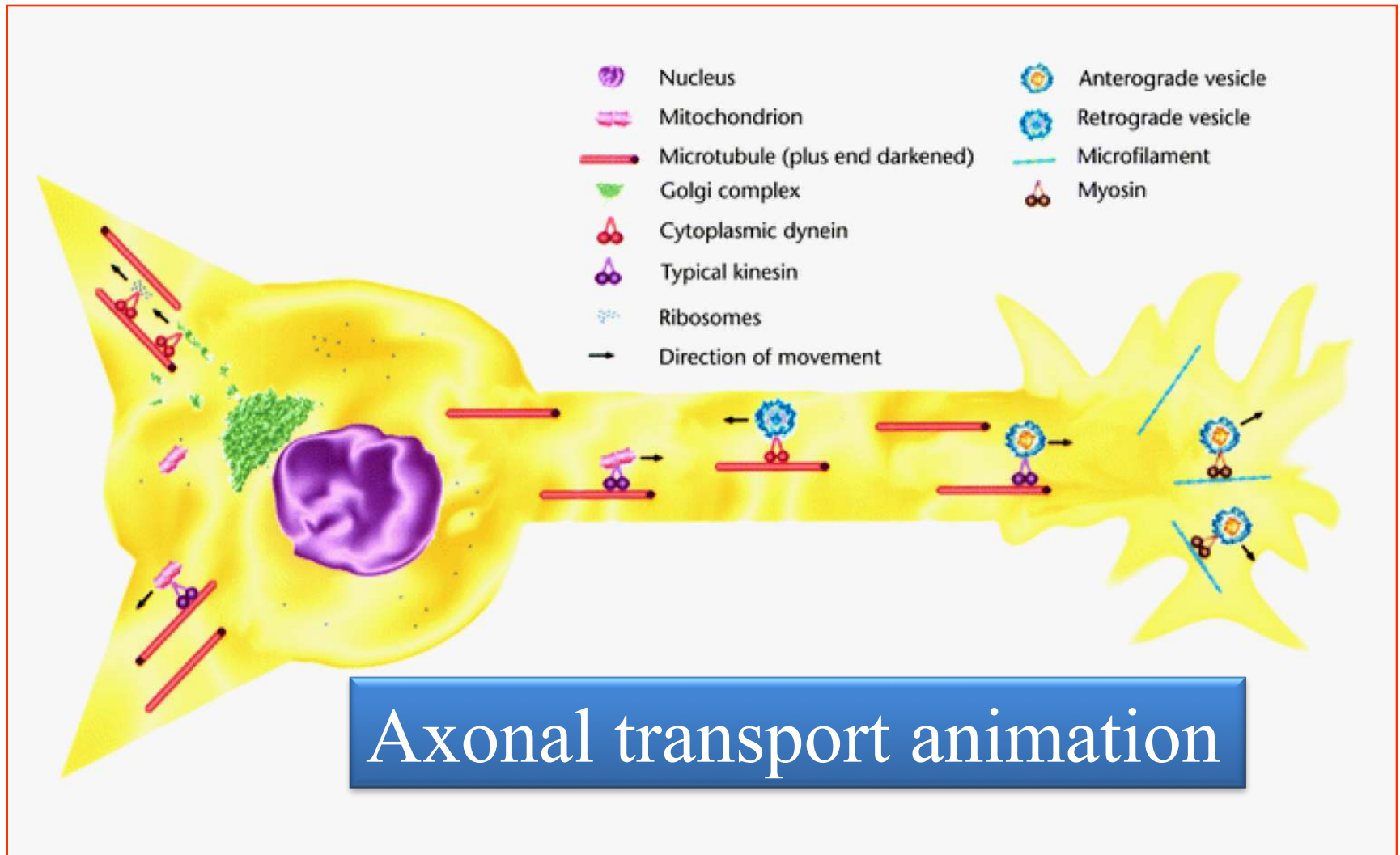
AXONIC MICROTUBULES

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MICROTUBULE



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Light and electron microscopy of
neurons

<http://synapses.clm.utexas.edu/>

synapseweb