

Diseases of Nervous System

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I. Cellular pathology of the central nervous system

- **Cells of the CNS**

- I. Neuron
- II. Glial cells
 - A. Astrocytes
 - B. Oligodendrocytes
 - C. Ependymal cells
- III. Microglial cells
- IV. Meningothelial cells
- V. Choroid plexus cells

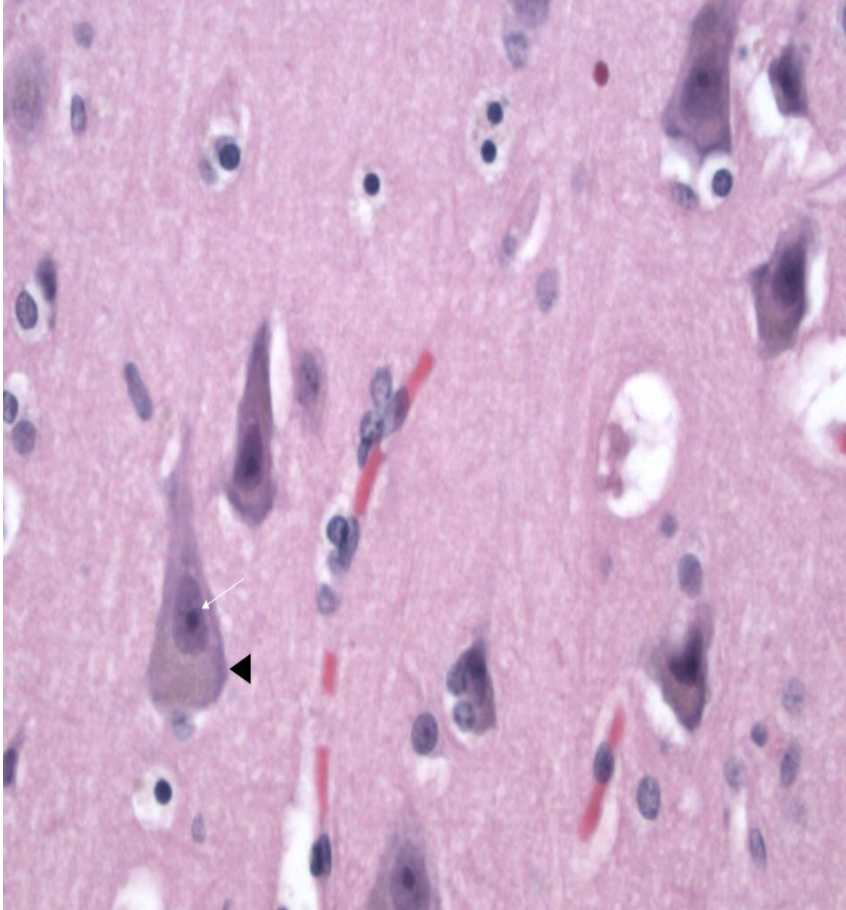
A. Reactions of Neurons to injury

- Neuronal injury may be:
 - a. Acute process:
 - A consequence of oxygen or glucose depletion or trauma
 - b. Slow process
 - Such as in neurodegenerative disorders

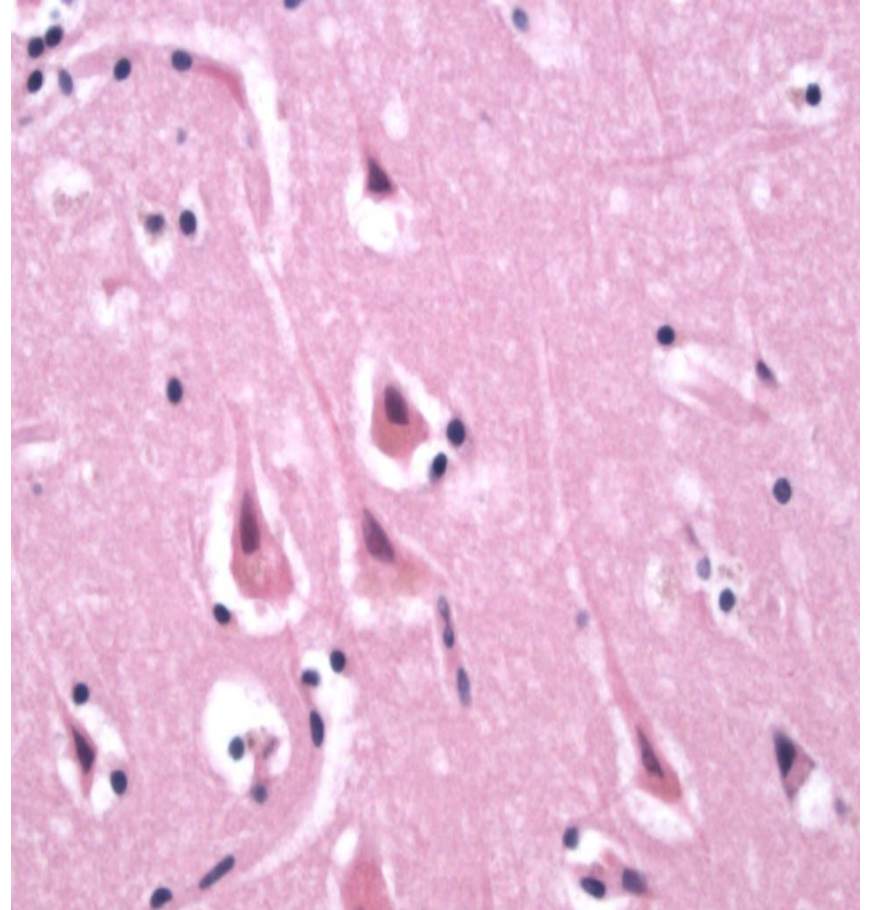
1. Acute neuronal injury (Red neurons):
 - Refers to spectrum of changes that accompany acute CNS hypoxia/ischemia
 - Reflects the earliest morphologic markers of neuronal cell death
 - Red neurons are evident by about 12-24 hours after an irreversible hypoxic /ischemic insults

- The morphologic features by H&E stain are:
 - i. Shrinkage of the cell body
 - ii. Pyknosis of the nucleus
 - iii. Disappearance of the nucleolus
 - iv. Loss of Nissl substance
 - v. Intense eosinophilia of the cytoplasm

Normal pyramidal neuron



Red neuron



2. Specific intranuclear inclusions

a. Inclusions in neurodegenerative diseases
such as

- i. Neurofibrillary tangles in Alzheimer disease
- ii. Lewy bodies in Parkinson disease

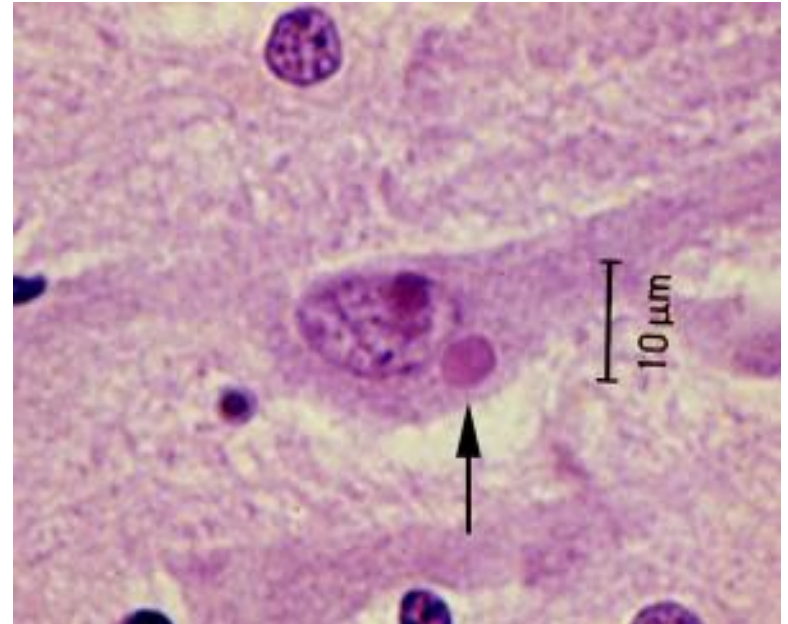
c. Inclusions in viral infections

C. Inclusions in viral infections of The CNS

1. Cowdry body in herpetic encephalitis



2. Nigri bodies in Rabies



B. Reactions of astrocytes to injury

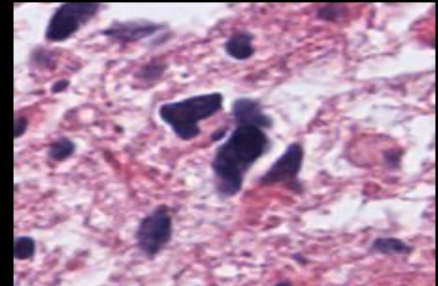
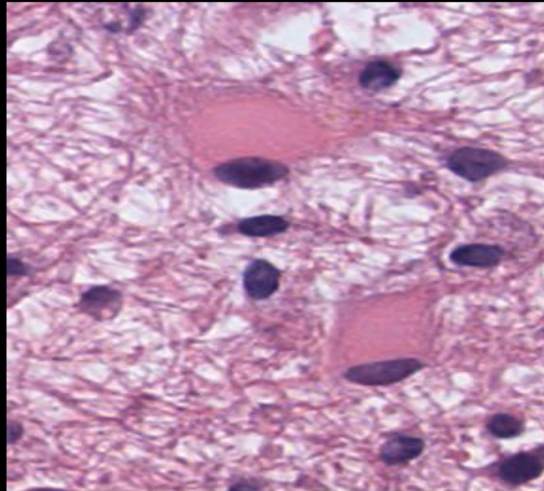
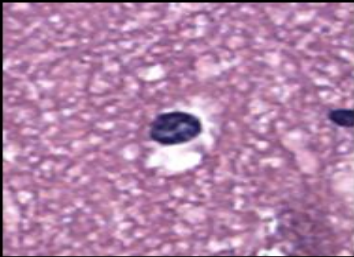
The astrocyte derives its name from its star-shaped appearance

- Astrocytes have multipolar branching cytoplasmic processes
 - These processes have intermediate filament called glial fibrillary acidic protein (GFAP)
 - **Morphologic patterns of injury include:**
- I. **Gliosis:** is the most important histologic indicator of CNS injury and characterized by:

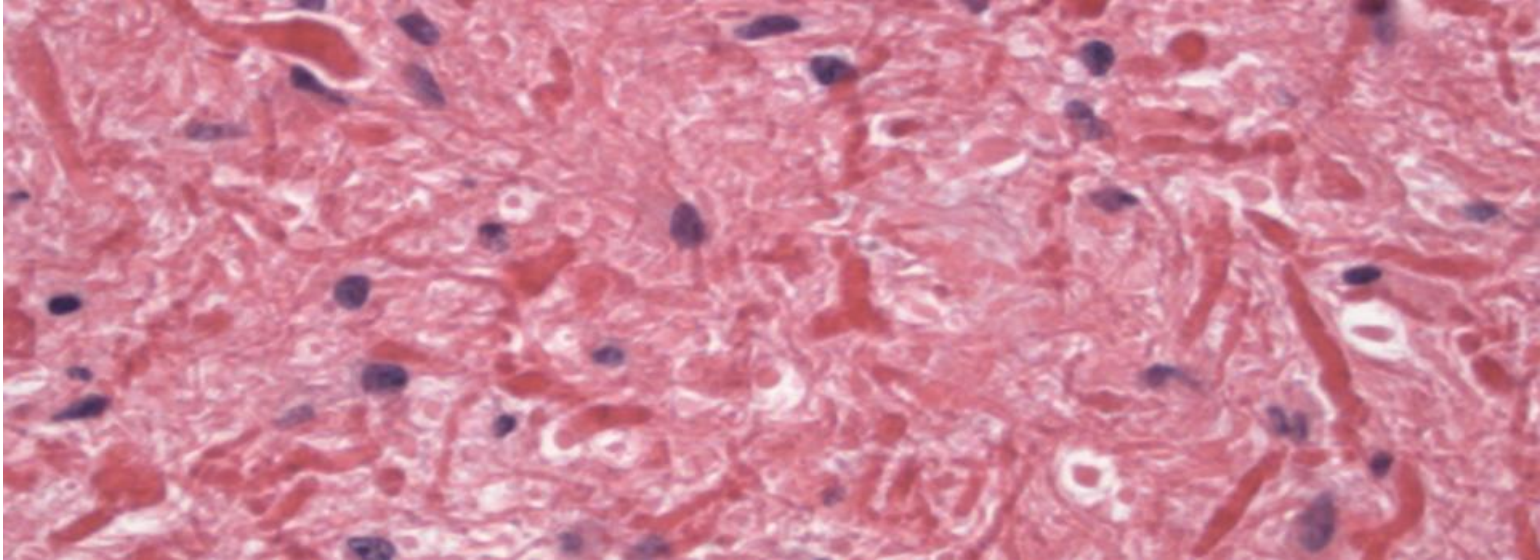
both hyperplasia and hypertrophy of astrocytes

- The astrocytes nuclei enlarge and become round and eccentric with prominent nucleolus
- The cytoplasm expand to bright pink
- These astrocytes are called **gemistocytes**

Normal astrocyte gemistocyte



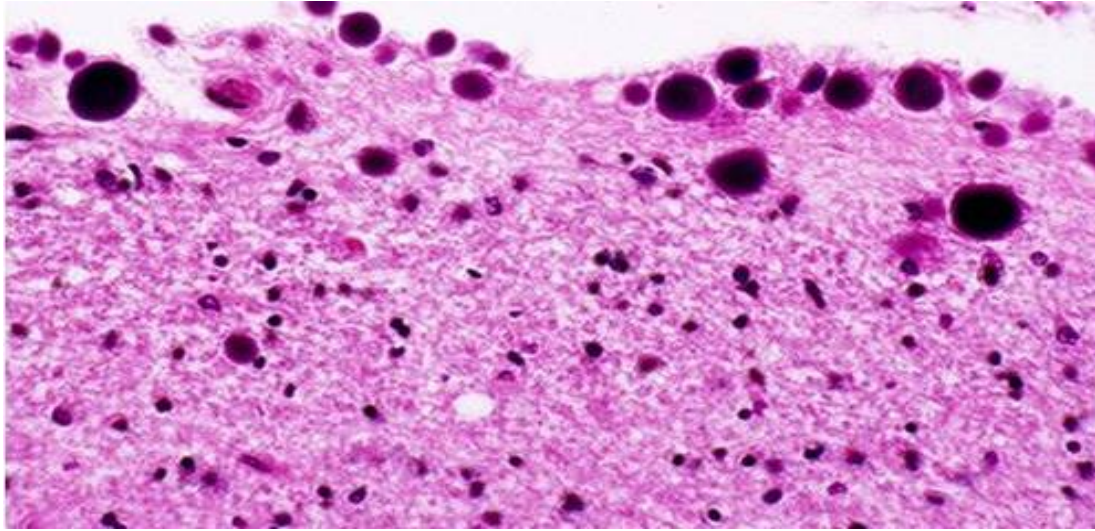
- **Note:**
 - Unlike else in the body fibroblasts participate to a limited extent in healing in brain and in the following situations:
 1. Brain abscess
 2. Penetrating trauma



2. Rosenthal fibers

- Some forms of injury lead to formation of Rosenthal fibers which are thick elongated , eosinophilic aggregates found in processes of astrocytes
- Contain two heat shock proteins and ubiquitin

- Rosenthal fibers are seen in:
 - i. Chronic gliosis
 - ii. Pilocytic astrocytoma(inside the tumor)
 - iii. In the tissues surrounding certain tumors such as Craniopharyngioma
 - iv. Alexander disease: A disease caused by activating mutation in GFAP gene



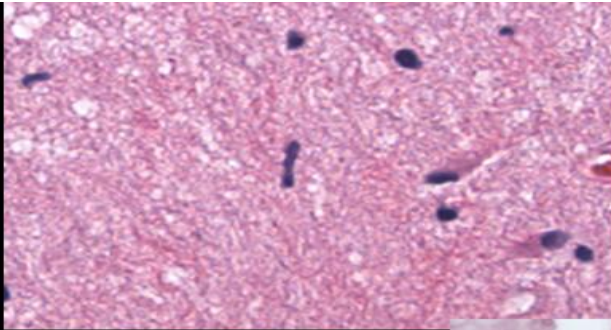
3. Corpora amylacea:

- Are spherical laminated bodies composed of polyglucosan
- Their accumulation is associated with aging and in response to neuronal loss
- Stain positive with PAS

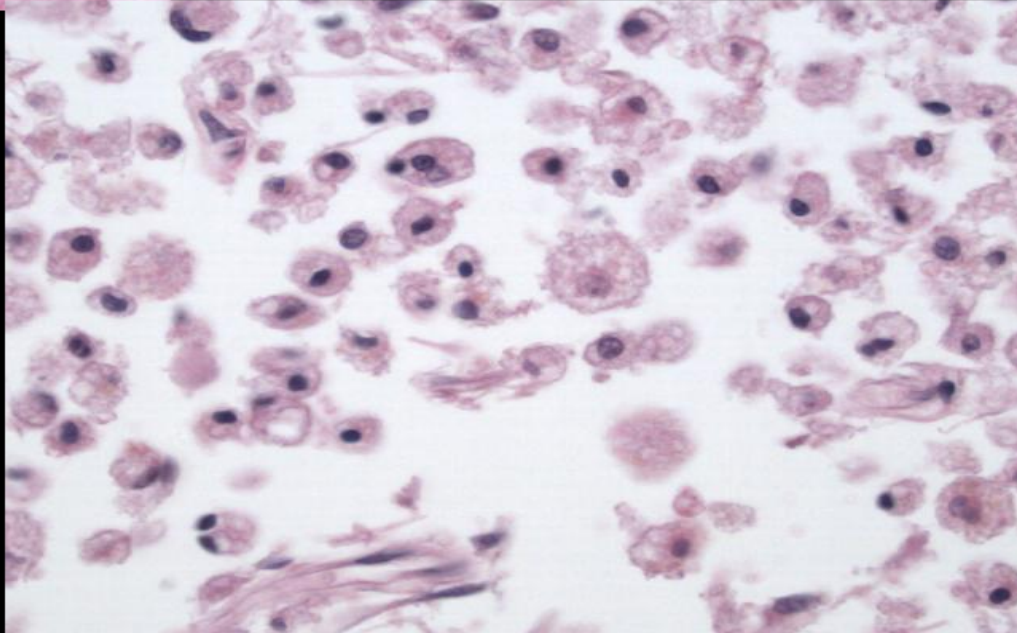
3. Microglial cells

- Are mesoderm derived phagocytic cells
- Serve as resident macrophages of the CNS
- They respond to injury by
 - i. Proliferation
 - ii. Develop elongated nuclei and called Rod cells in neurosyphilis

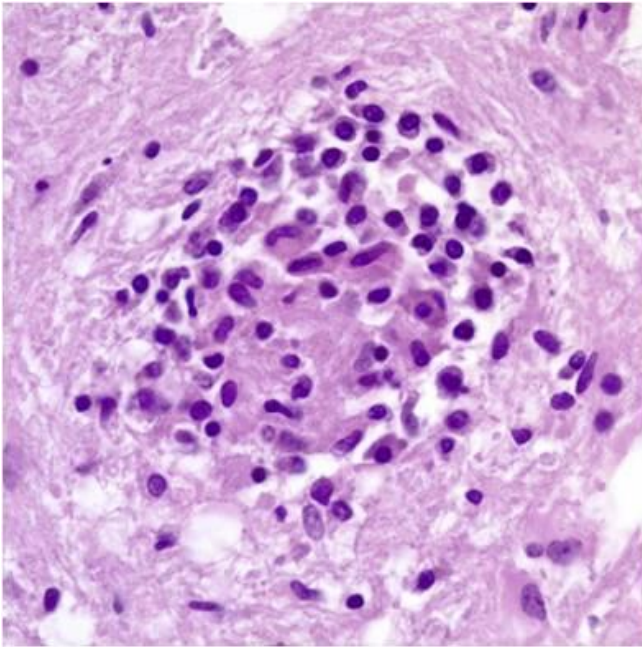
Microglia



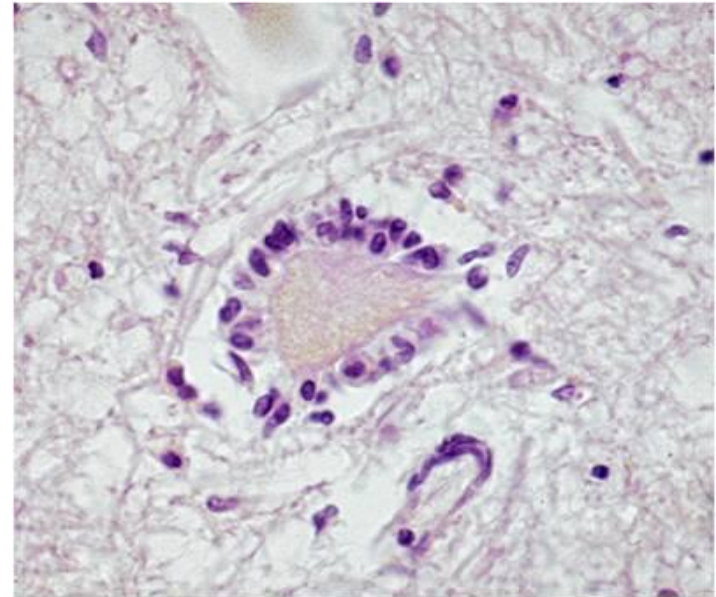
Macrophages



iii. Form aggregates around areas of tissue necrosis called microglial nodules such as HIV encephalitis



iv. Congregate around cell bodies of dying neurons called neuronophagia such as poliomyelitis



4. oligodendrocytes

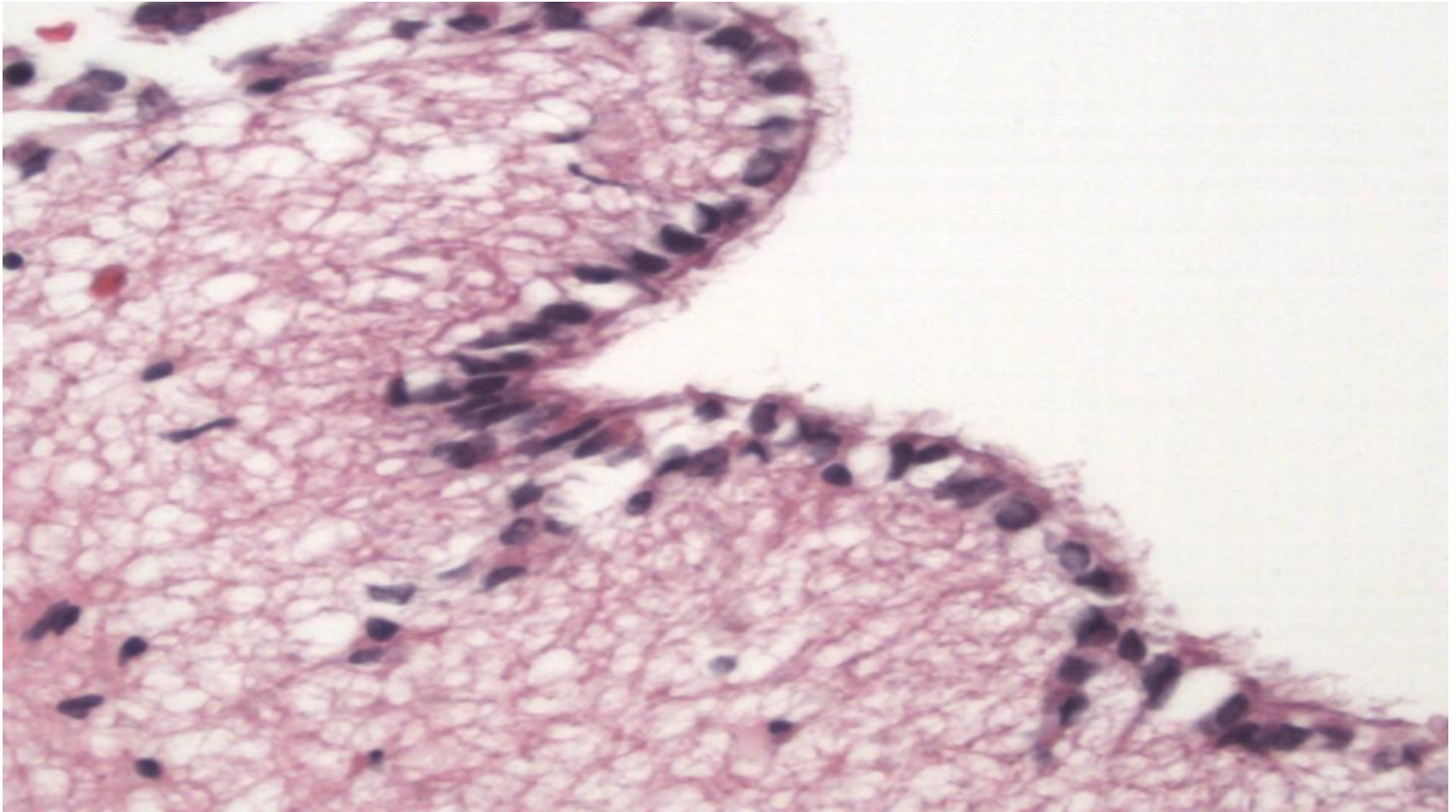
- Are cells that wrap their cytoplasmic processes around axons and form myelin

- Morphologic pattern of injury
 - i. Apoptosis or necrosis such as demyelinating diseases
 - ii. Oligodendrocytes may harbor viral inclusions in progressive multifocal leukoencephalopathy

5. Ependymal cells

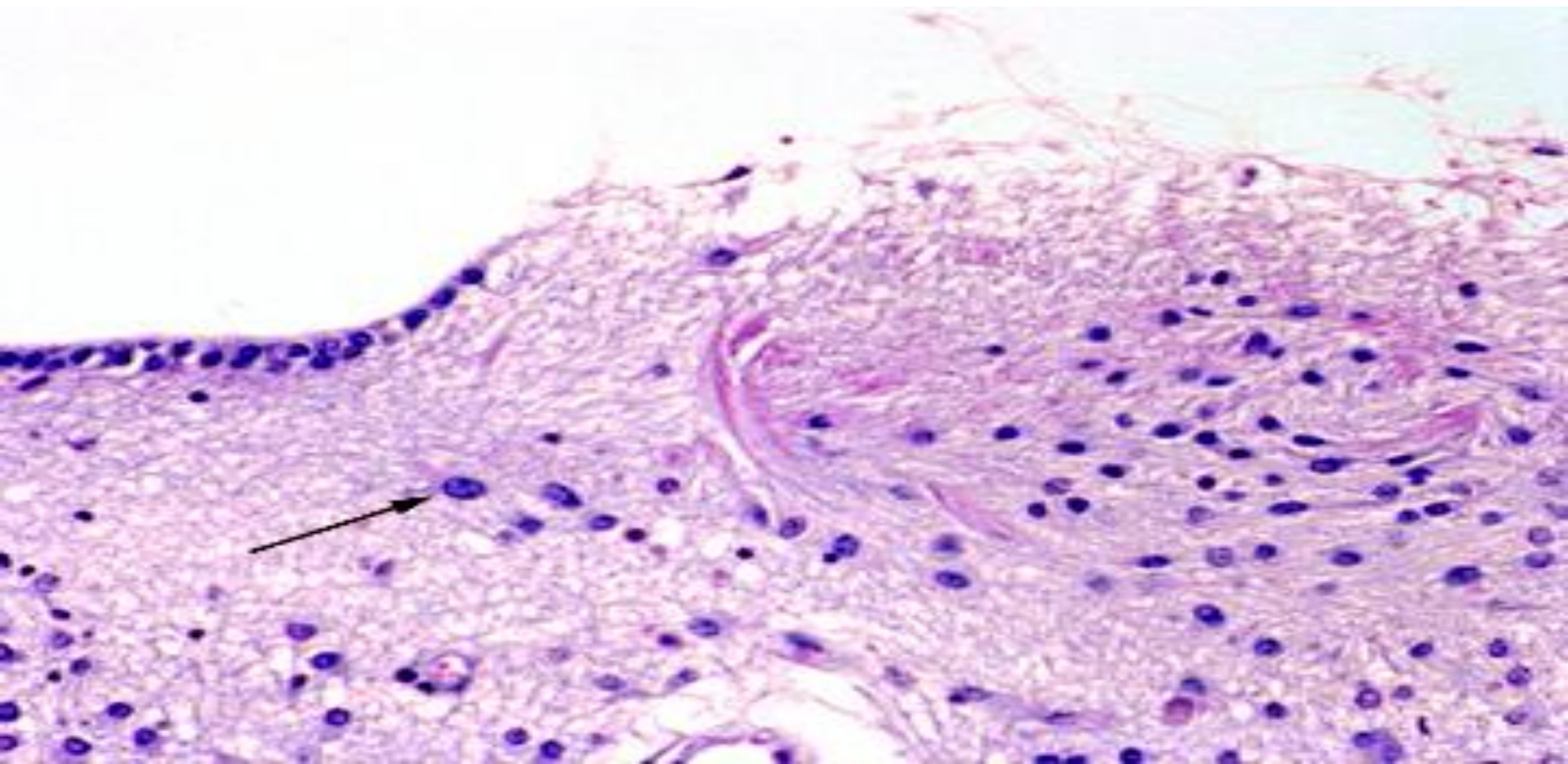
- The ciliated columnar cells that line the ventricles
- Have limited capacity to regenerate

Ependymal cells



- Typical ependymal reactions to injury include:
 - a. Atrophy and reactive cell loss
 - b. Formation of ependymal discontinuities
 - c. Ependymal granulations: proliferation of glial cells in the zone beneath the ependymal lining

- Which appear as tiny clear granules (granular ependymitis) and best seen in the floor of the fourth ventricle.



II. Edema Hydrocephalus and Herniation

1. Brain Edema

- Is the accumulation of excess fluid within the brain parenchyma either in the cells or extracellular space

- There are two main types that may occur together mainly after generalized injury

I. Vasogenic edema

- Is the most common type
- Affects mainly the white matter
- Occurs when the integrity of the blood brain barrier
- Is disrupted allowing fluid to shift from the blood vessels in to the extracellular spaces of the brain

- and can be

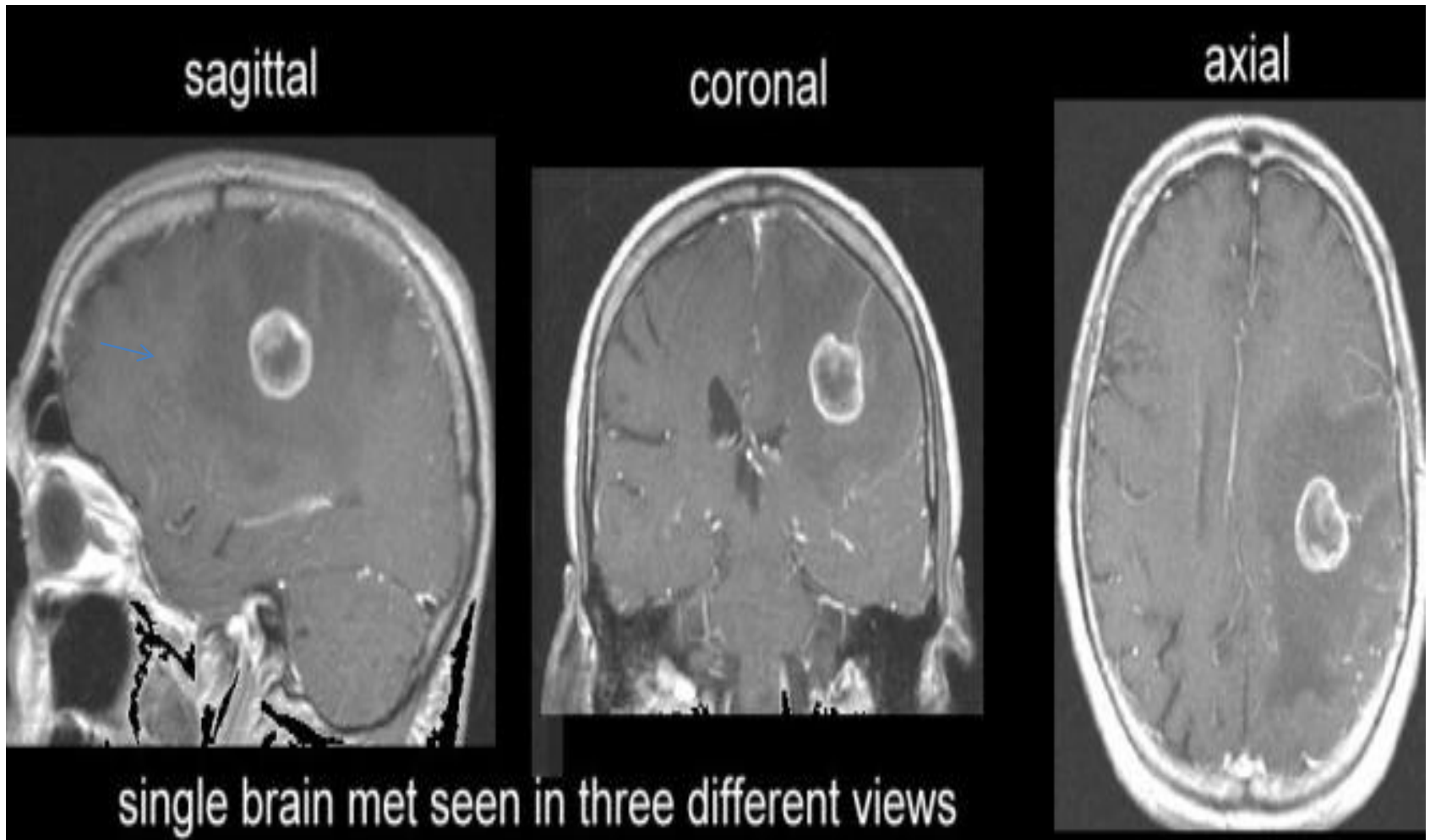
A. Localized in

a. Brain tumors

- Either primary or metastatic (it is more severe in metastatic brain tumors)
- In brain tumors, the blood vessels may be abnormal with fenestrations in the capillary wall

b. Cerebral abscess

Vasogenic edema surrounding glioblastoma (primary malignant brain tumor)



B.. Generalized

- In late stages of ischemic encephalopathy due to damage of endothelial cells by ischemia

II. Cytotoxic edema :

- An increase in intracellular fluid secondary to neuronal or glial membrane injury
- The extracellular space is reduced
- The blood brain barrier is intact
- Caused by ischemia to the brain

- it occurs because energy failure disables the Na/K pump system allowing large amounts of sodium accompanied by water to enter the cells
- Mainly affects the gray matter

III. Interstitial Edema:

- It occurs in Patients with acute obstructive high pressure hydrocephalus
- Due to damage to the ependymal lining by stretching
- Which leads to an increase in the water content in the periventricular white matter
- It is most pronounced around the frontal and occipital horns of the lateral ventricles

2. Hydrocephalus

Means accumulation of excessive CSF within the ventricular system as a result of disturbance in its secretion, circulation or absorption

- a. Most commonly due to impaired flow or resorption of CSF
- b. Overproduction of CSF, seen in choroid plexus papilloma is only rarely causes hydrocephalus.