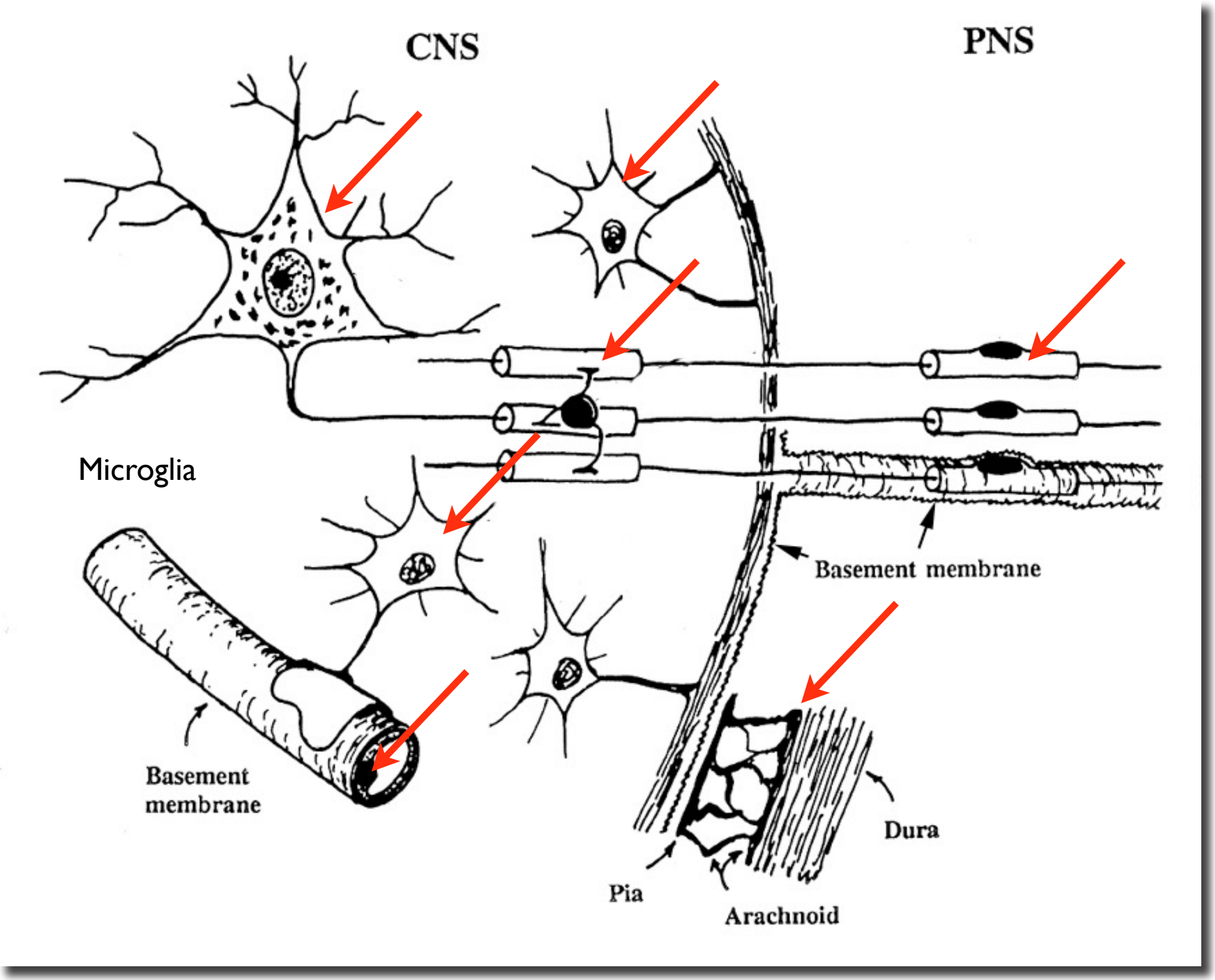
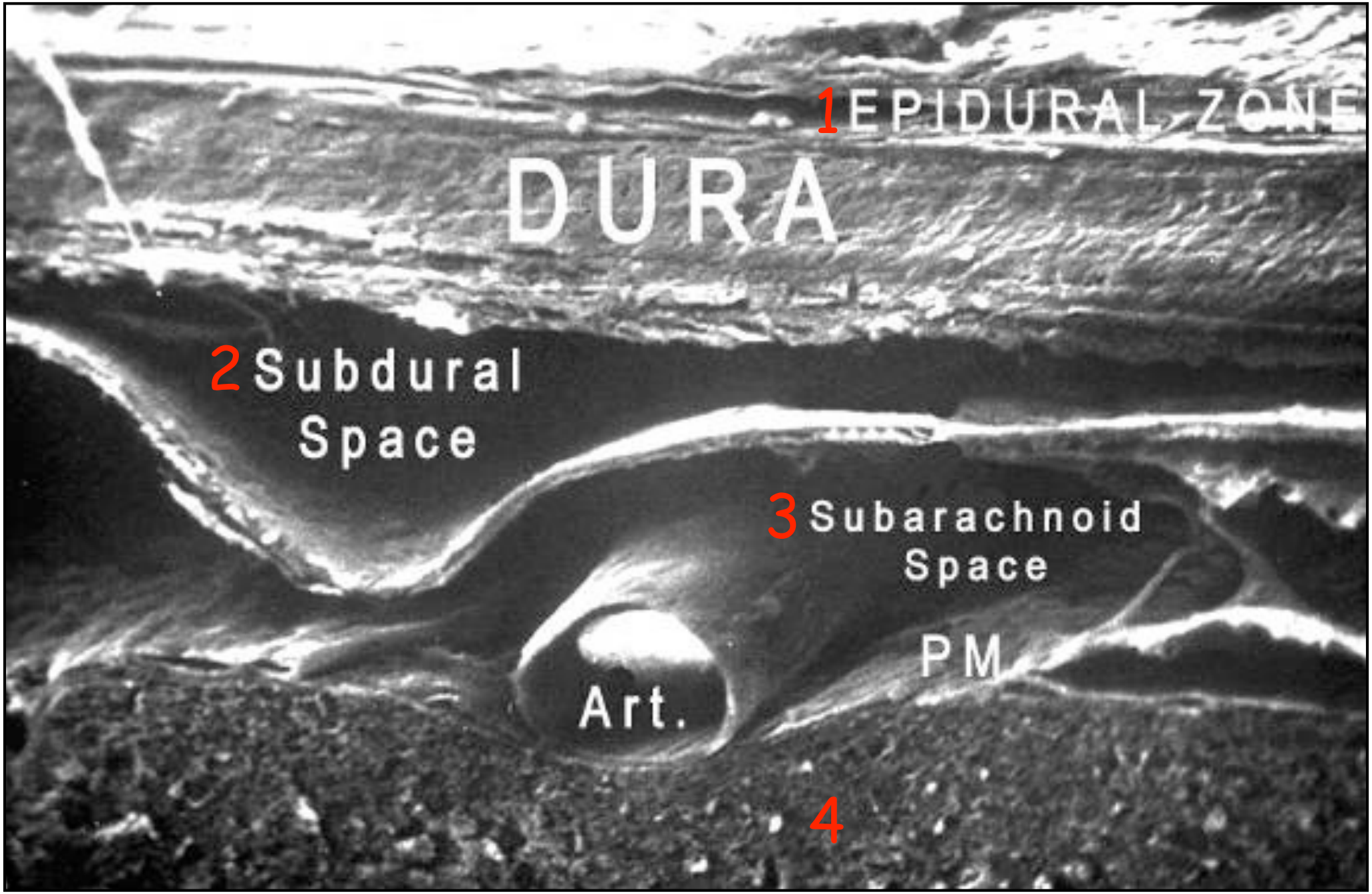
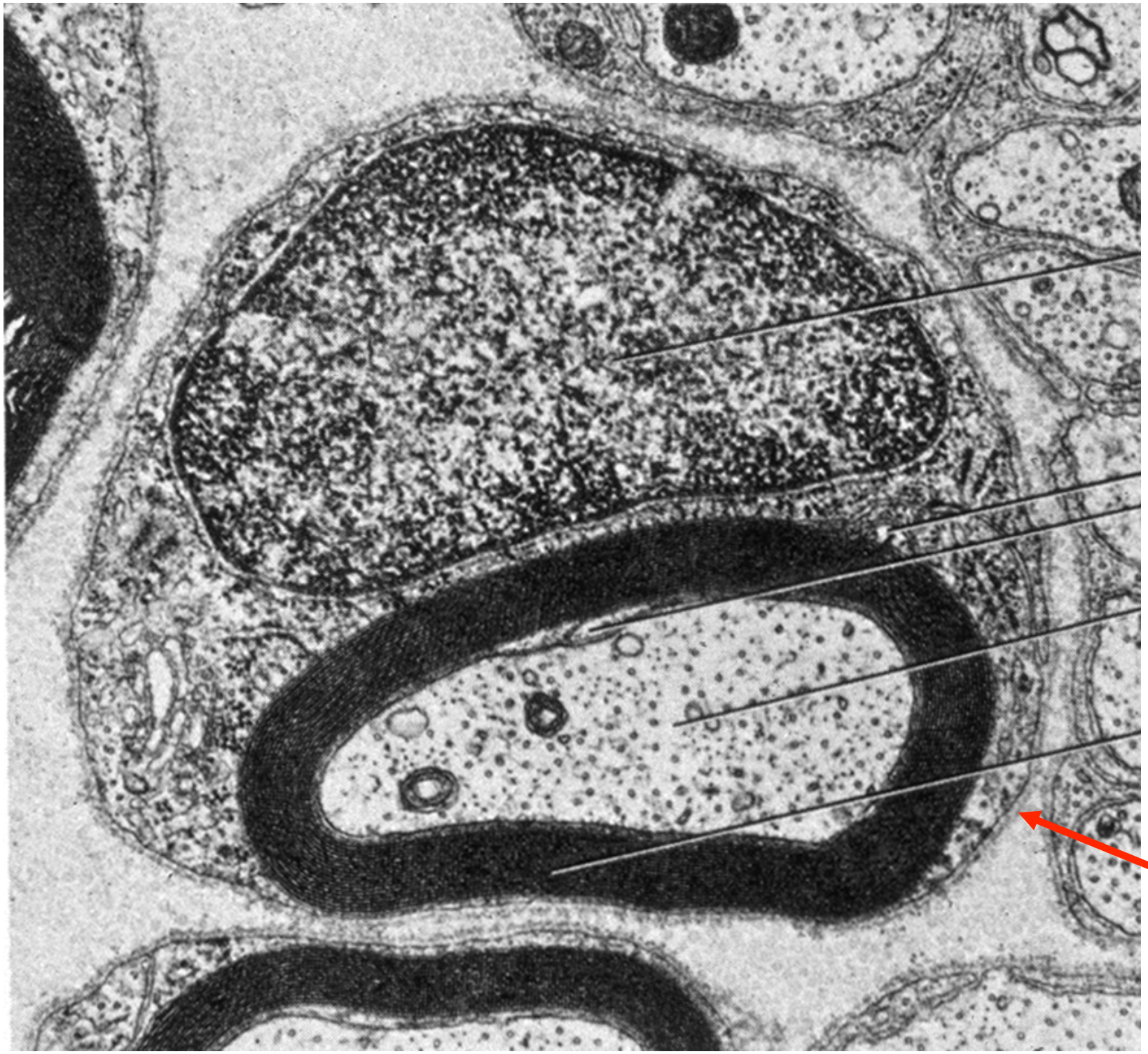
Central Nervous System Pathology

Dr. Henry Sánchez


CNS
PNS
Microglia
Basement membrane
Basement membrane
Dura
Pia
Arachnoid


1 EPIDURAL ZONE
DURA
2 Subdural Space
3 Subarachnoid Space
PM
Art.
4



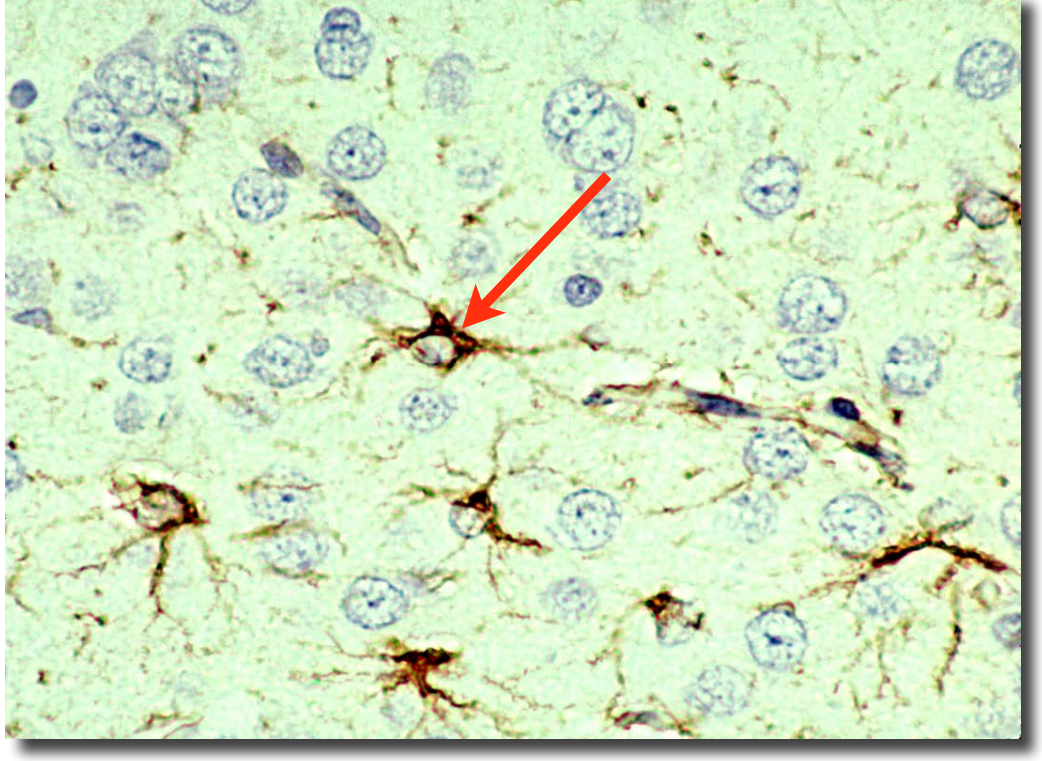
Schwann cell nucleus

Outer and inner membranes

Axon

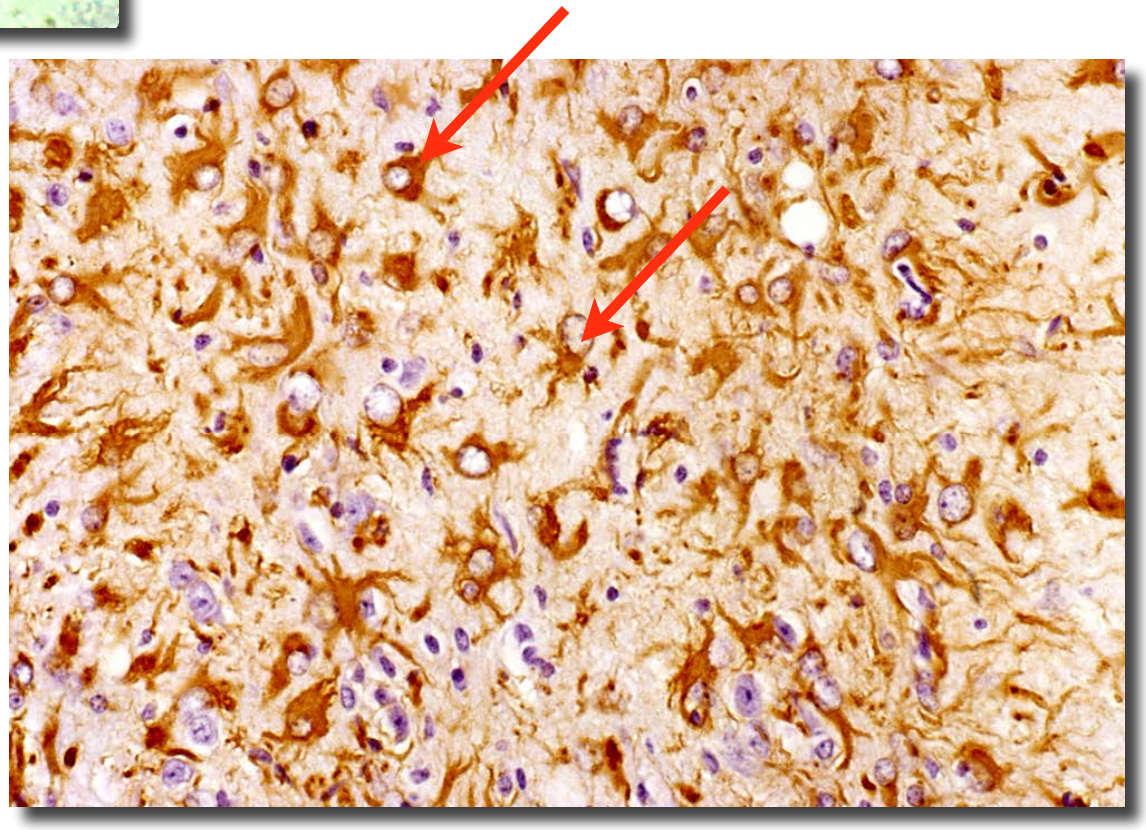
Myelin

Basement membrane

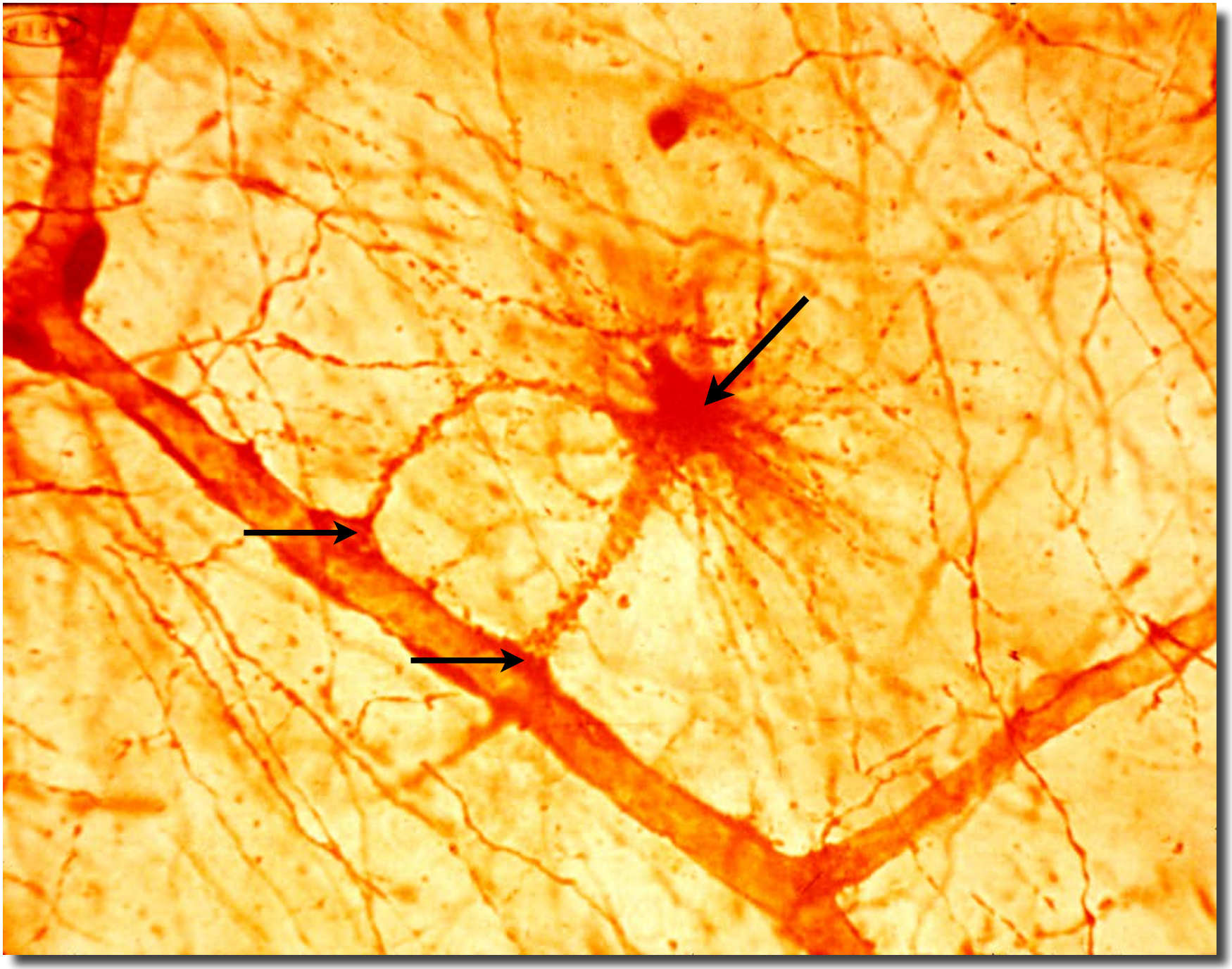


Astrocytes

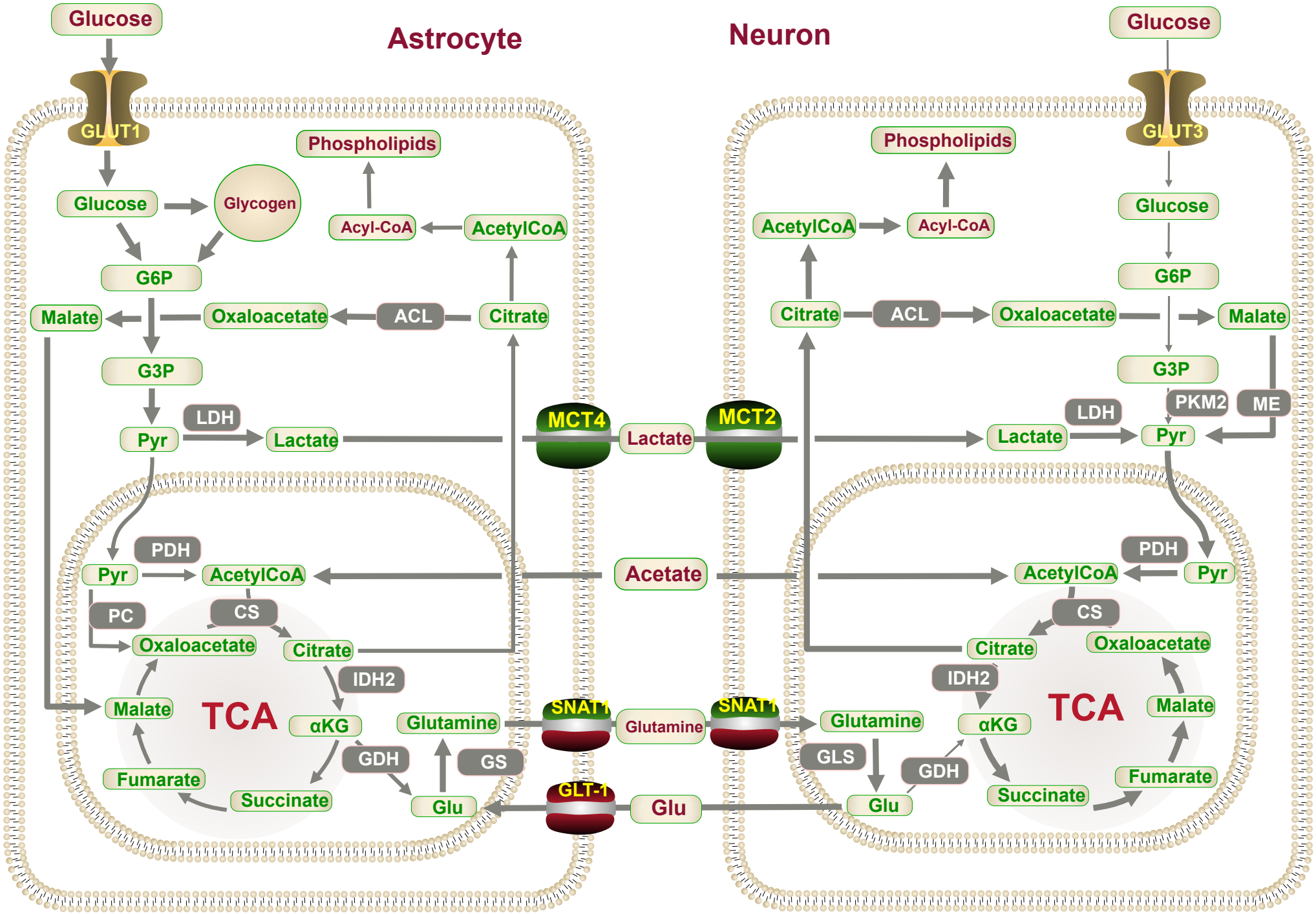
Astrocytic Gliosis



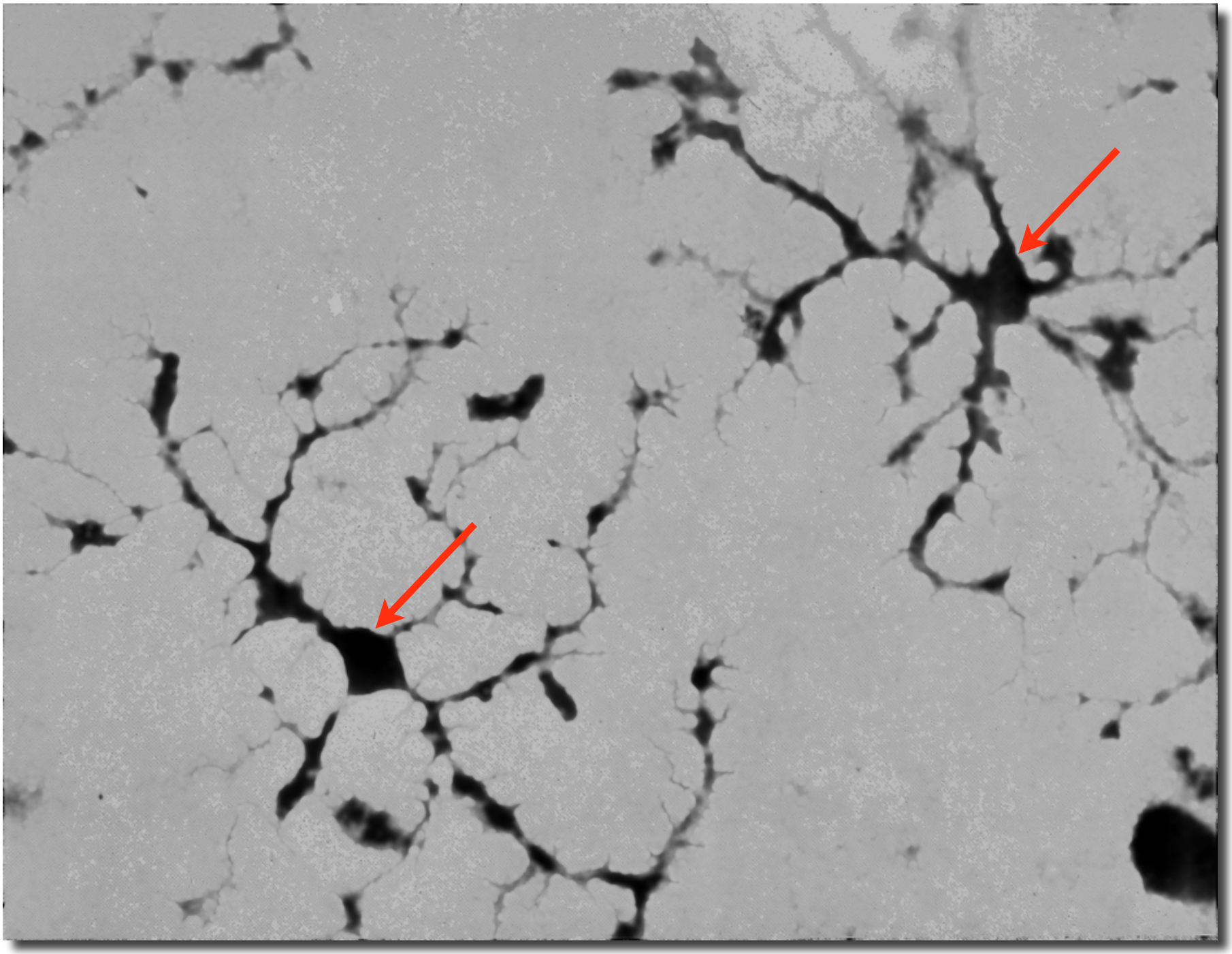
Astrocyte



Metabolic Intercellular Synergy in Brain



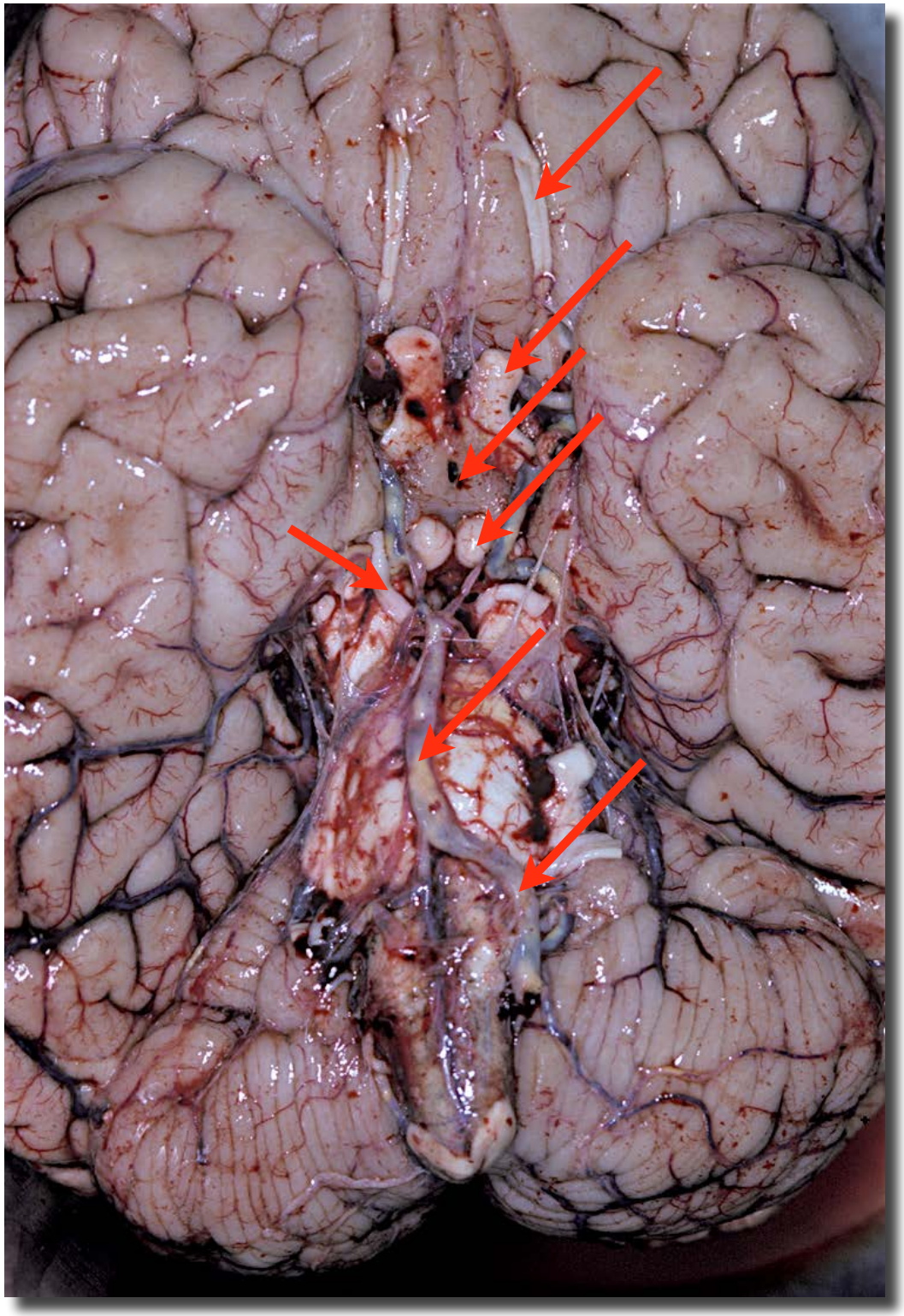
Microglia



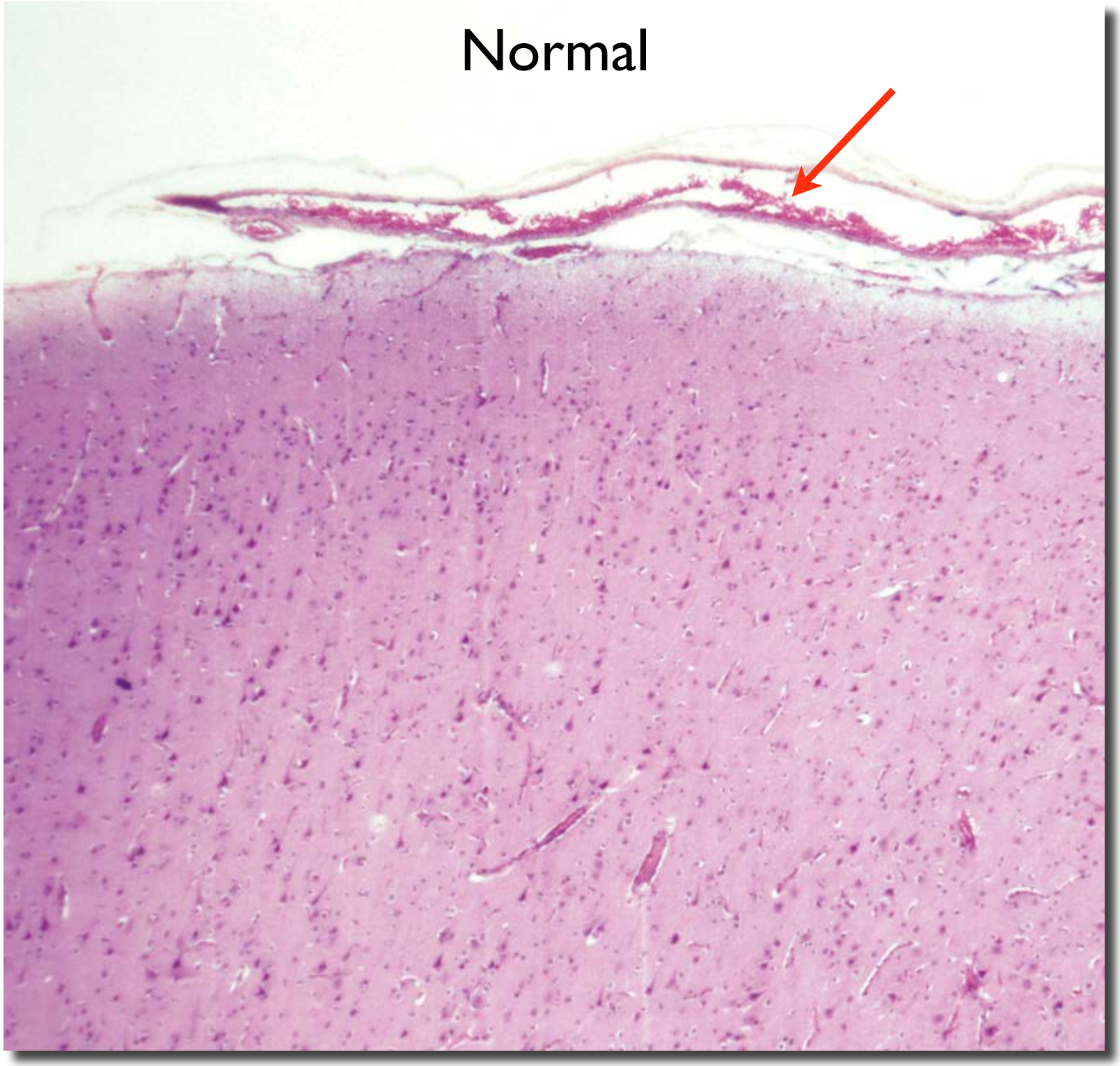
CNS Diseases

- Infectious diseases
- Cerebral vascular diseases
- Congenital diseases
- Neurogenerative/Demyelinating diseases
- Neoplasia

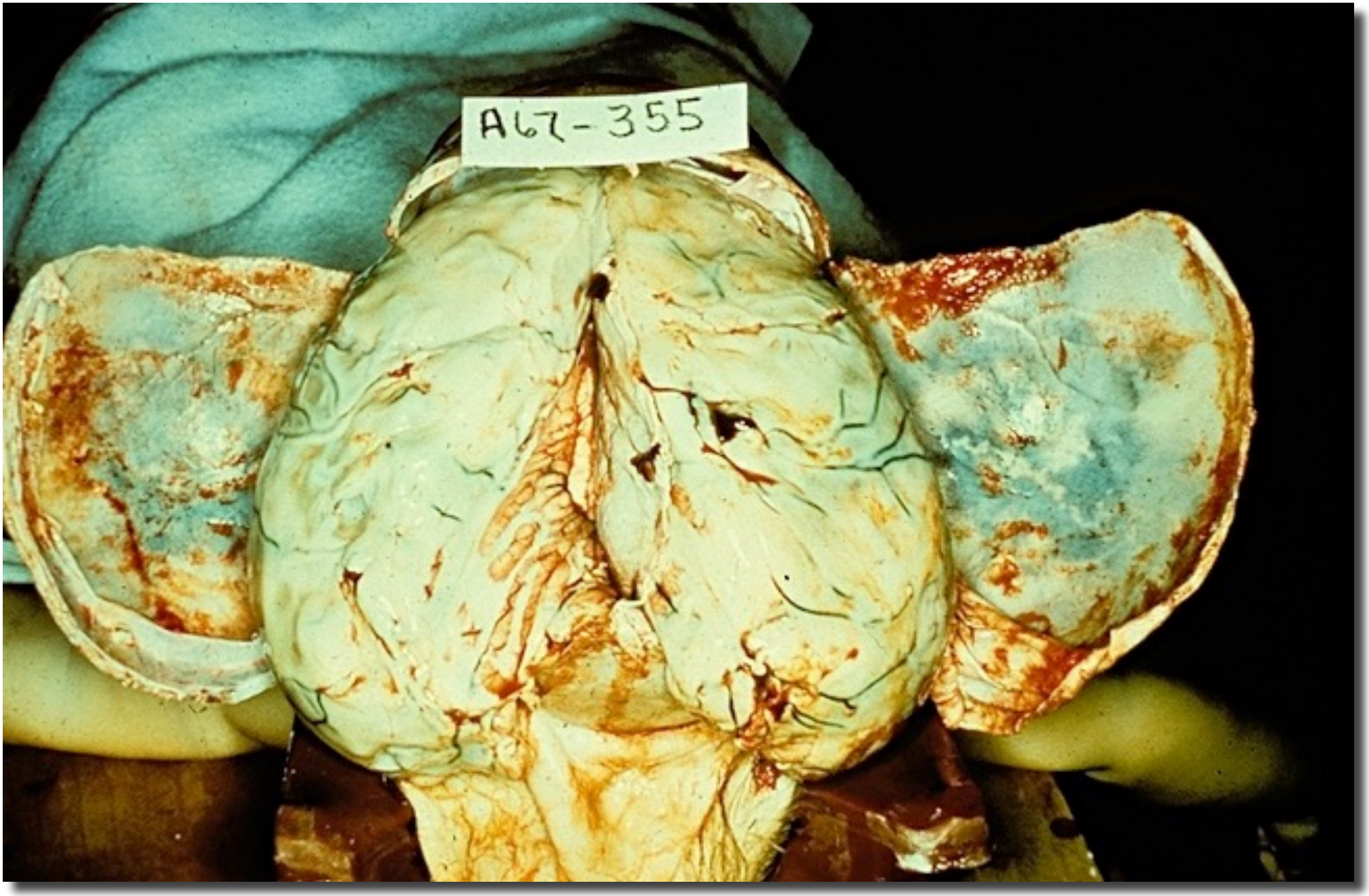
Infectious Diseases



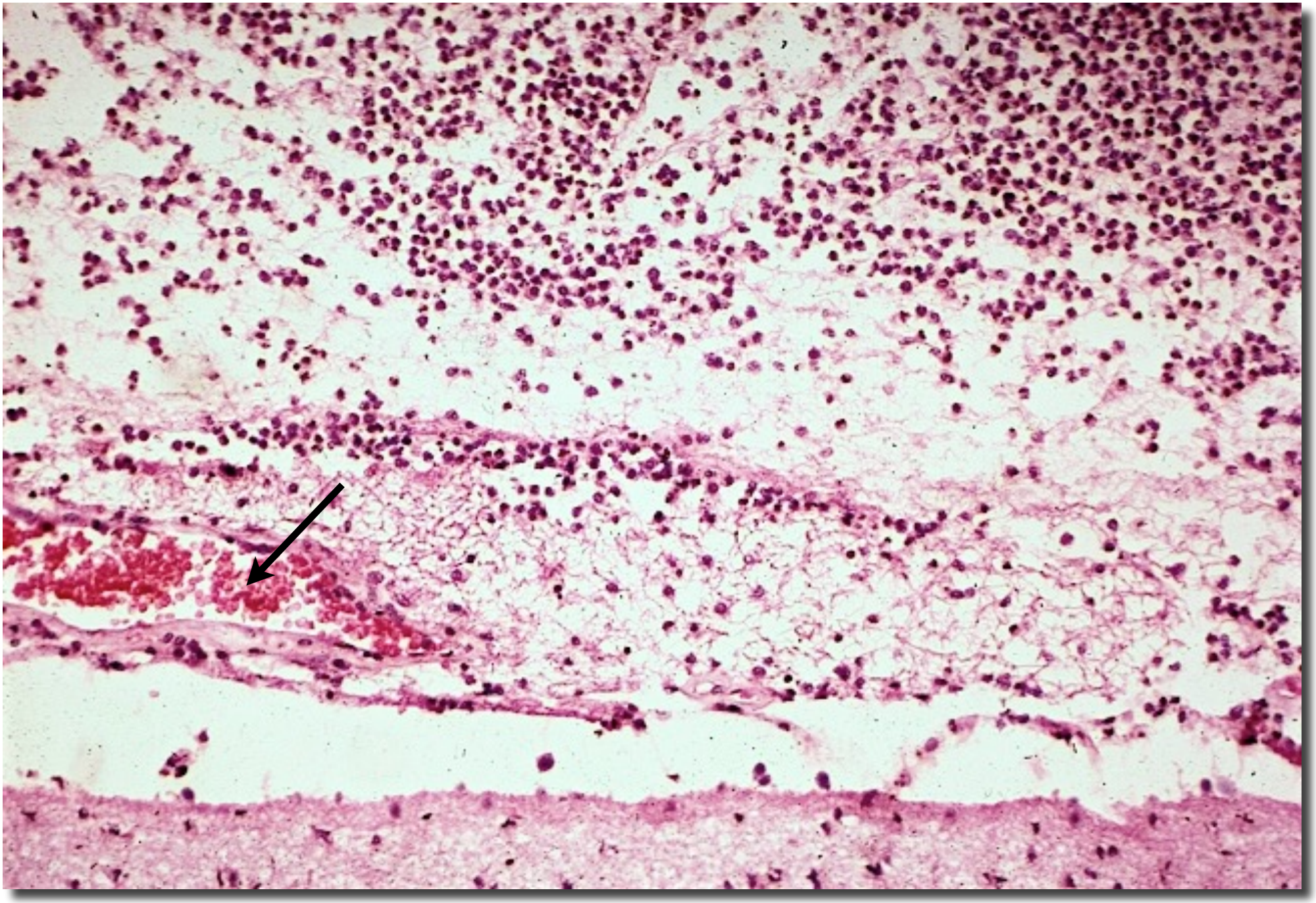
Normal



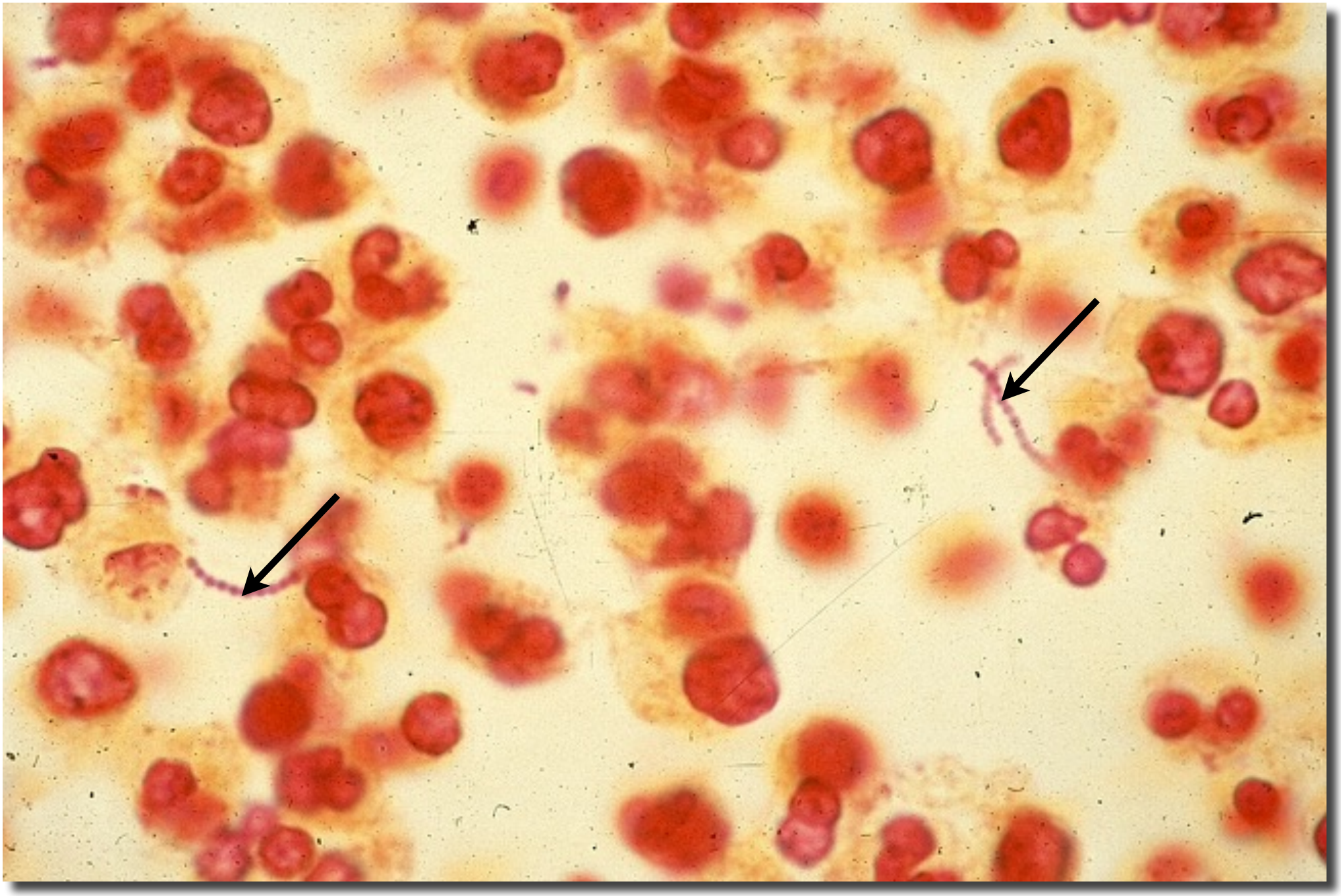
Acute Bacterial Meningitis



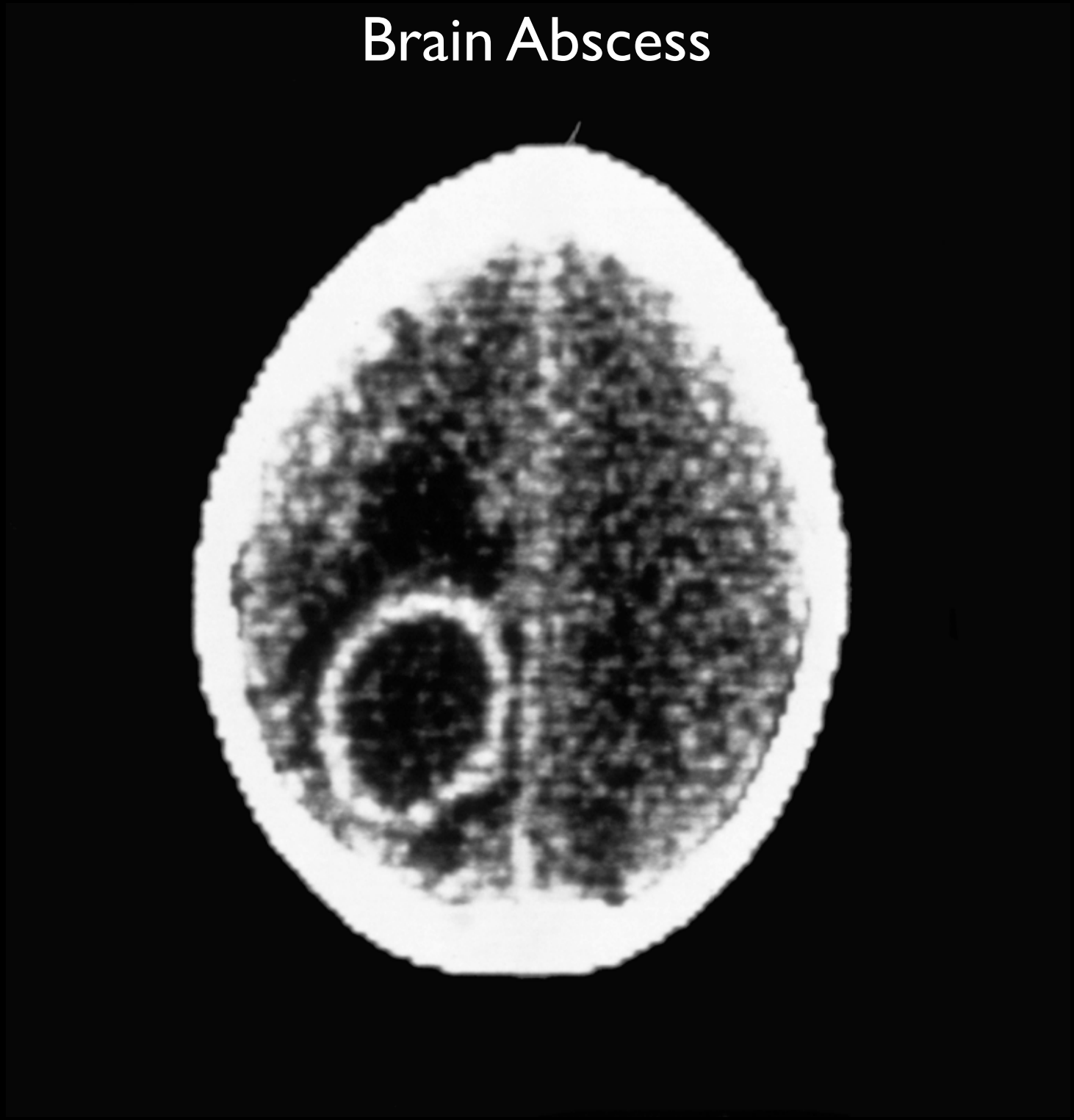
Acute Bacterial Meningitis



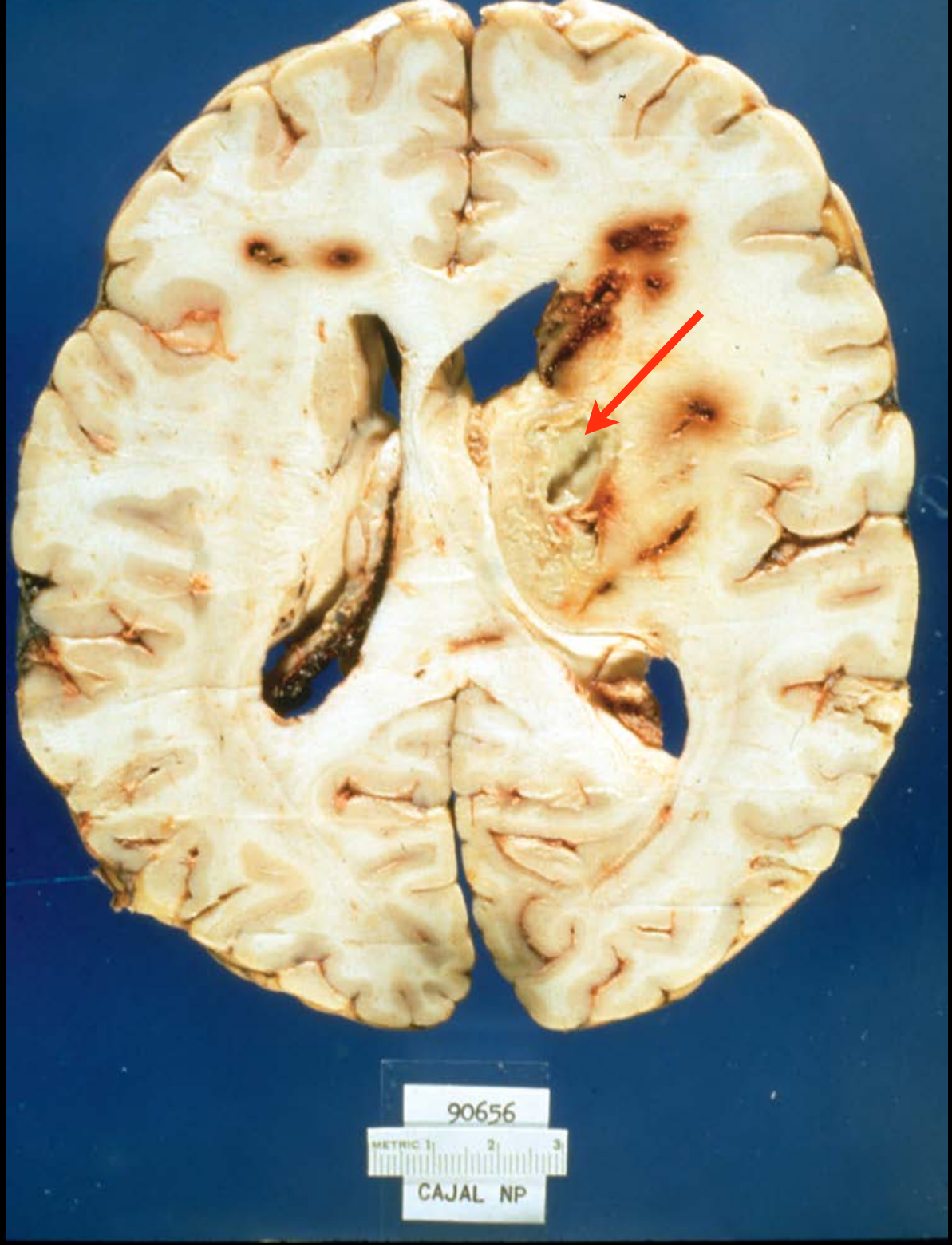
Acute Bacterial Meningitis



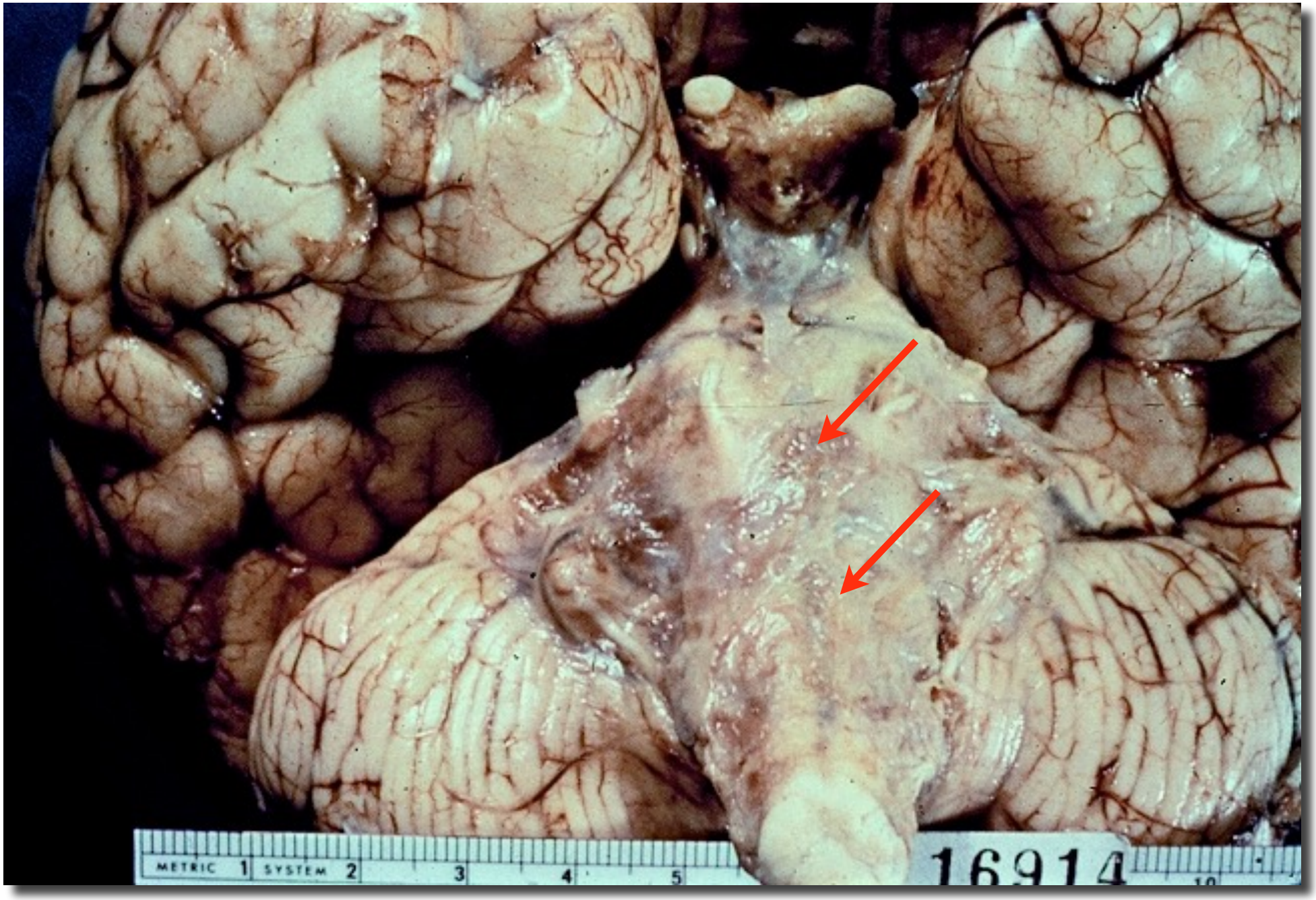
Brain Abscess



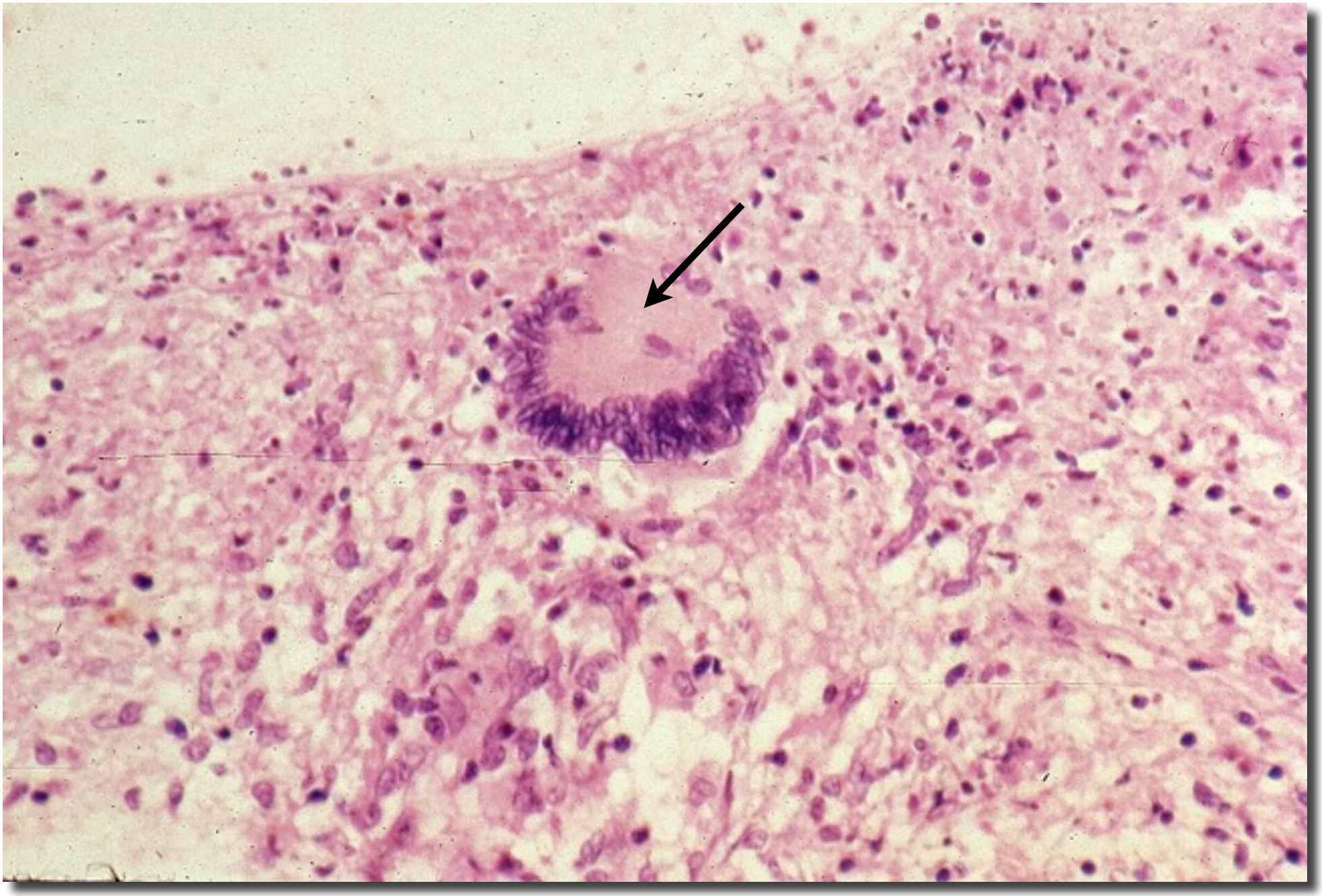
Brain Abscess



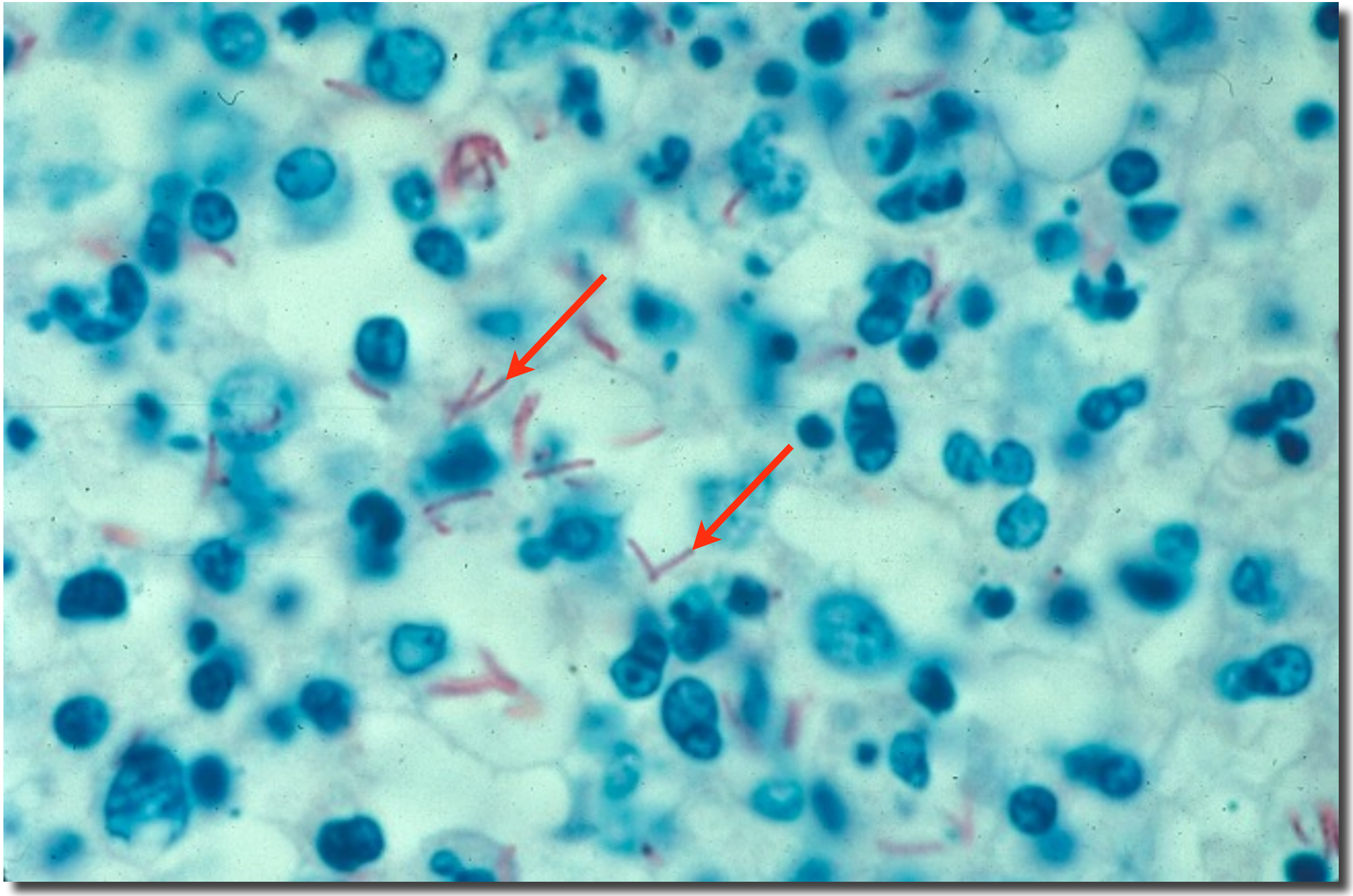
Chronic TB Meningitis



Chronic TB Meningitis



Chronic TB Meningitis (AFB Stain)



Chronic TB Meningitis

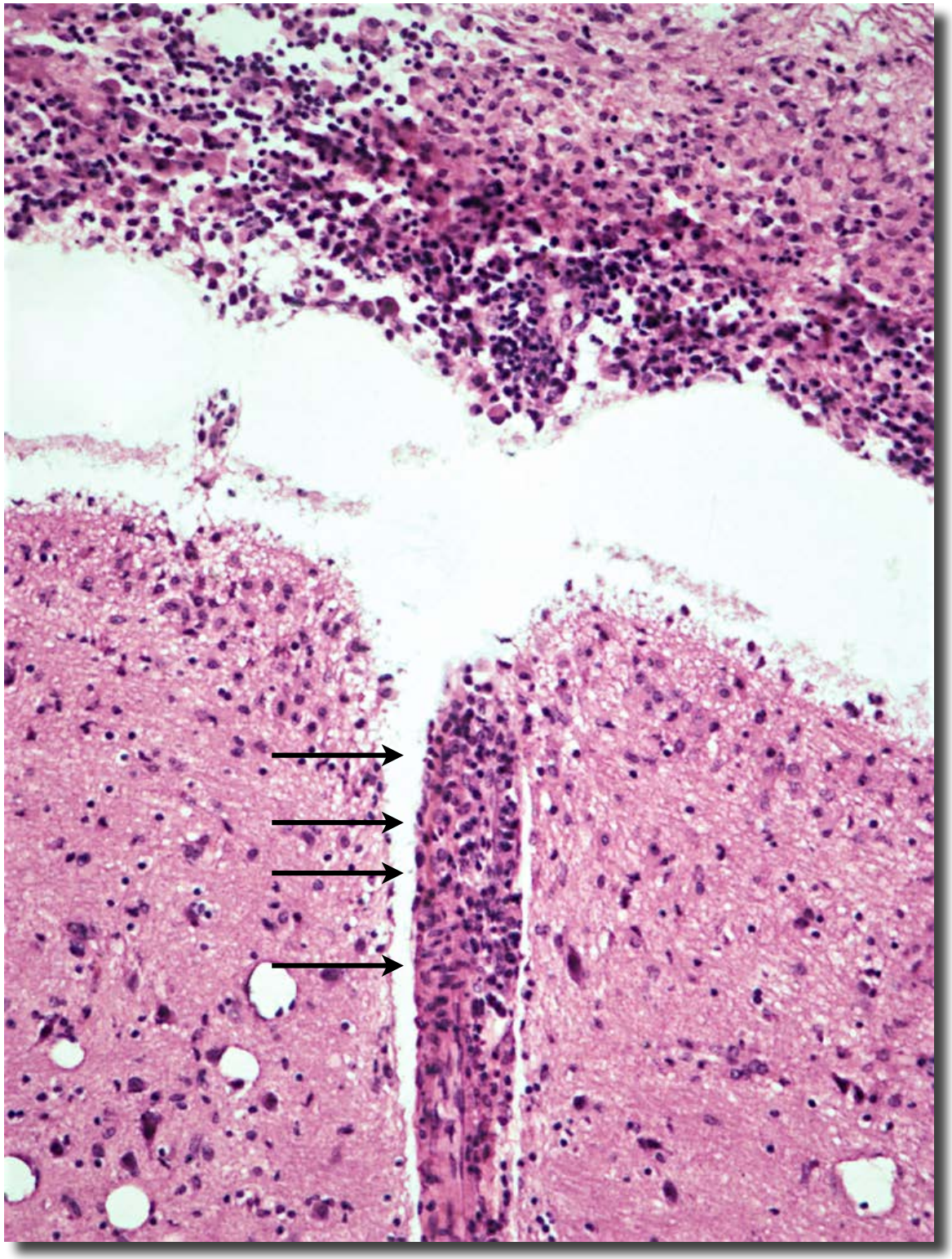
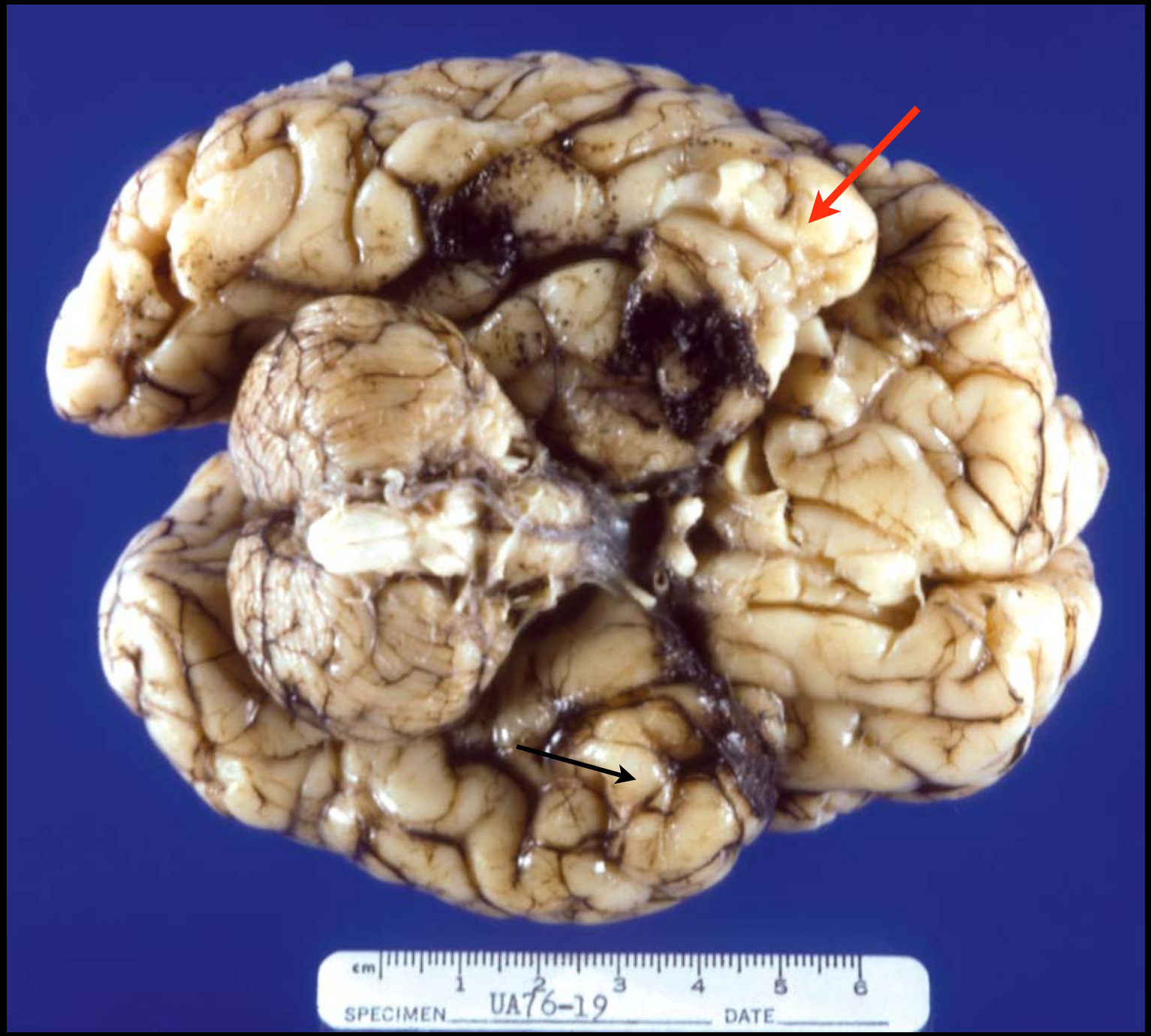


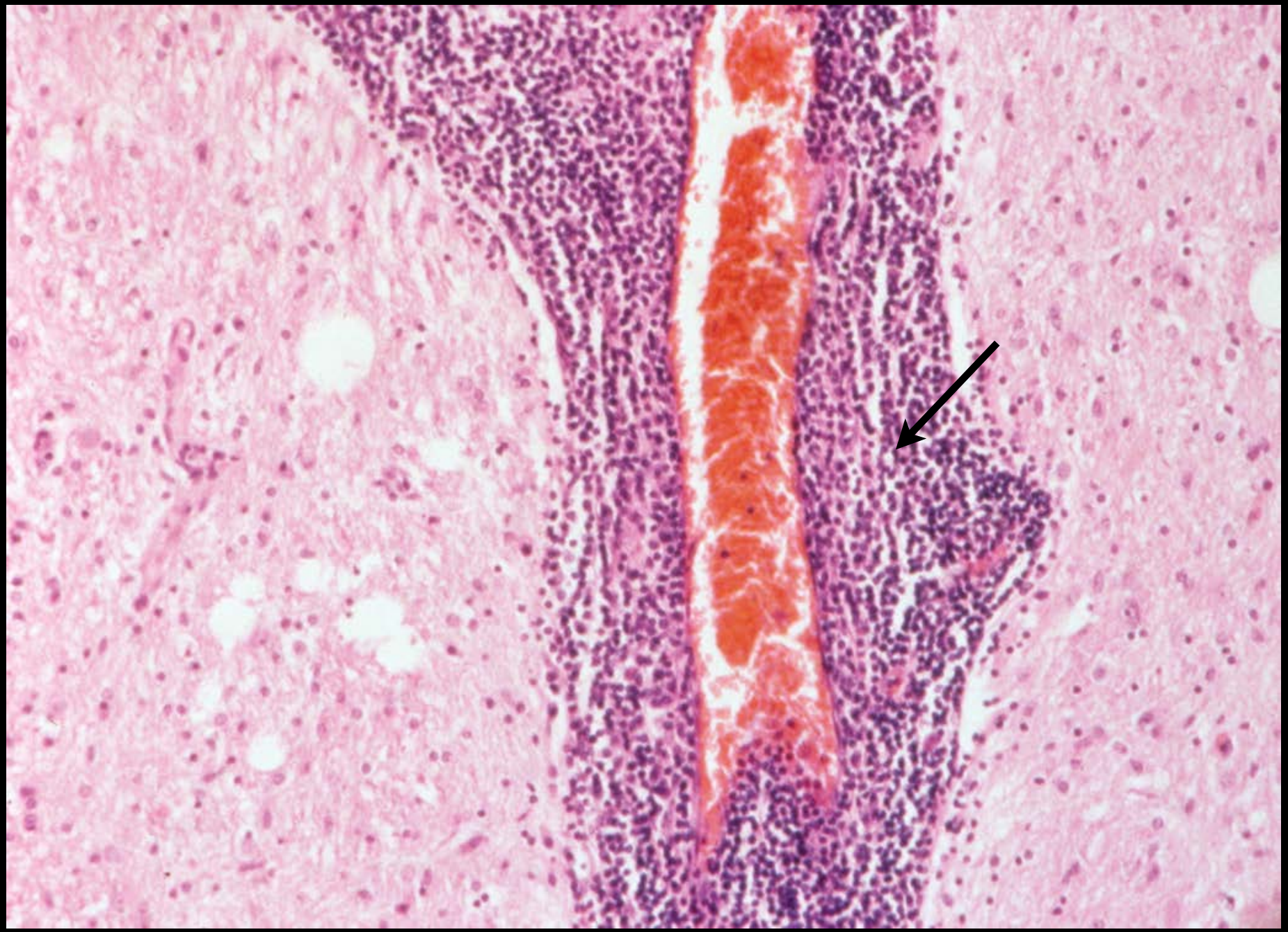
Table 29-1. CSF Parameters in Different Forms of Meningitis

Condition	Cells/μL	Glucose (μg/dL)	Proteins (mg/dL)	Pressure (mm H_2O)
Normal values	<5 lymphocytes	45–85 (50–70% glycemia)	15–45	70–180
Purulent (bacterial)	Up to 90,000 neutrophils	Decreased (<45)	Increased (>50)	Markedly elevated
Aseptic (viral)	100–1,000 most lymphocytes	Normal	Increased (>50)	Slightly elevated
Granulomatous (mycobacterial/ fungal)	100–1,000 most lymphocytes	Decreased (<45)	Increased (>50)	Moderately elevated

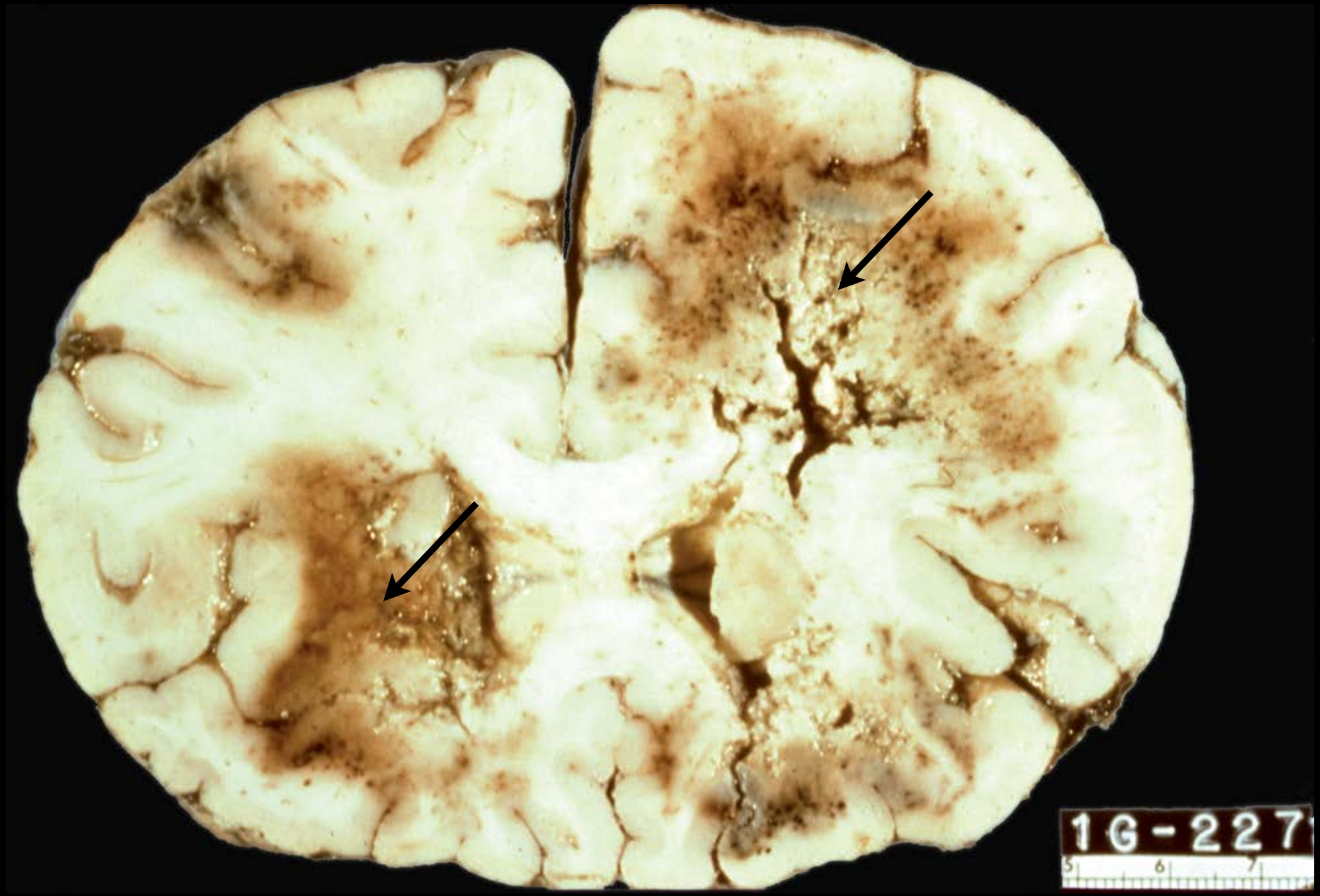
Herpes Simplex Encephalitis



Herpes Simplex Encephalitis



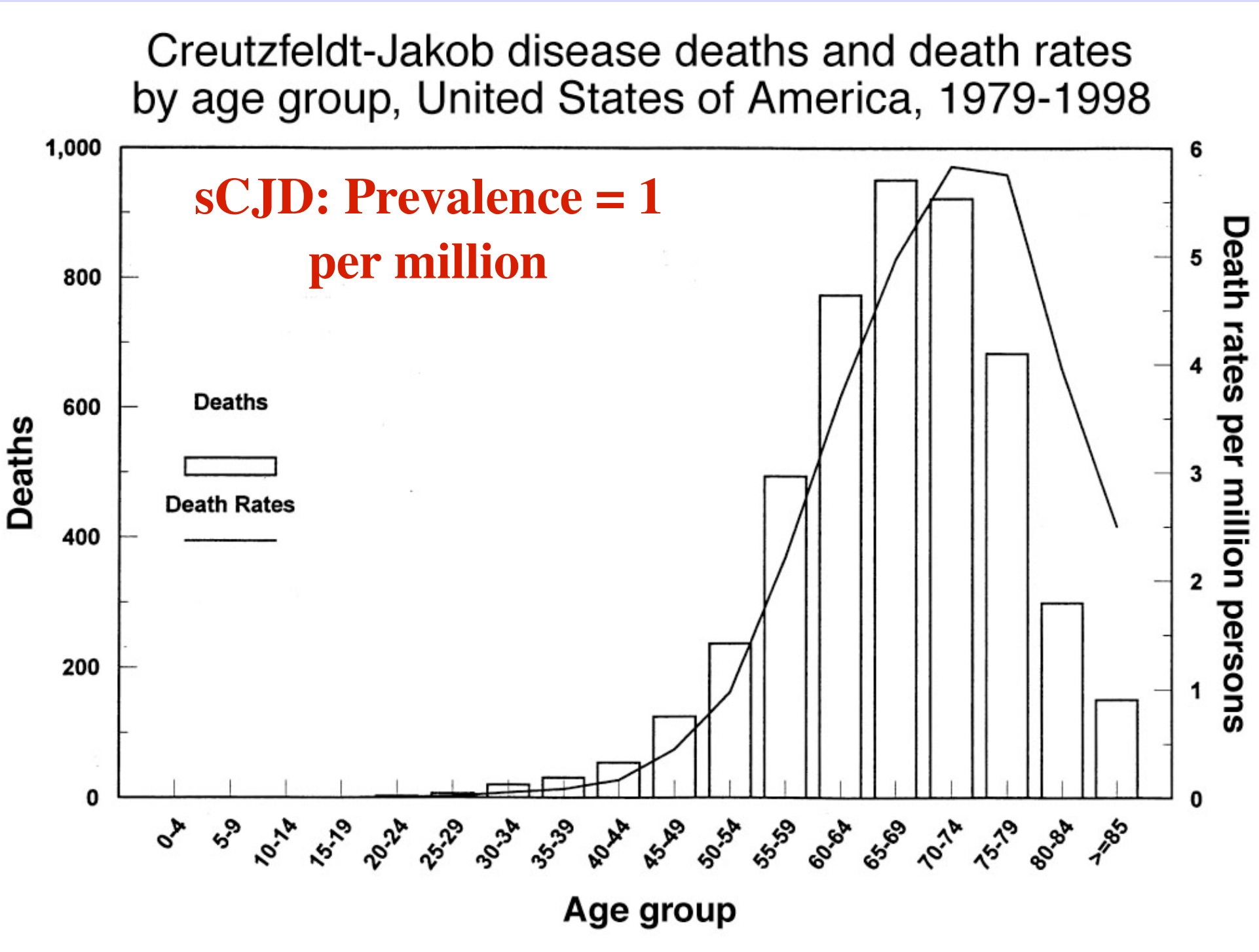
Aspergillus Encephalitis



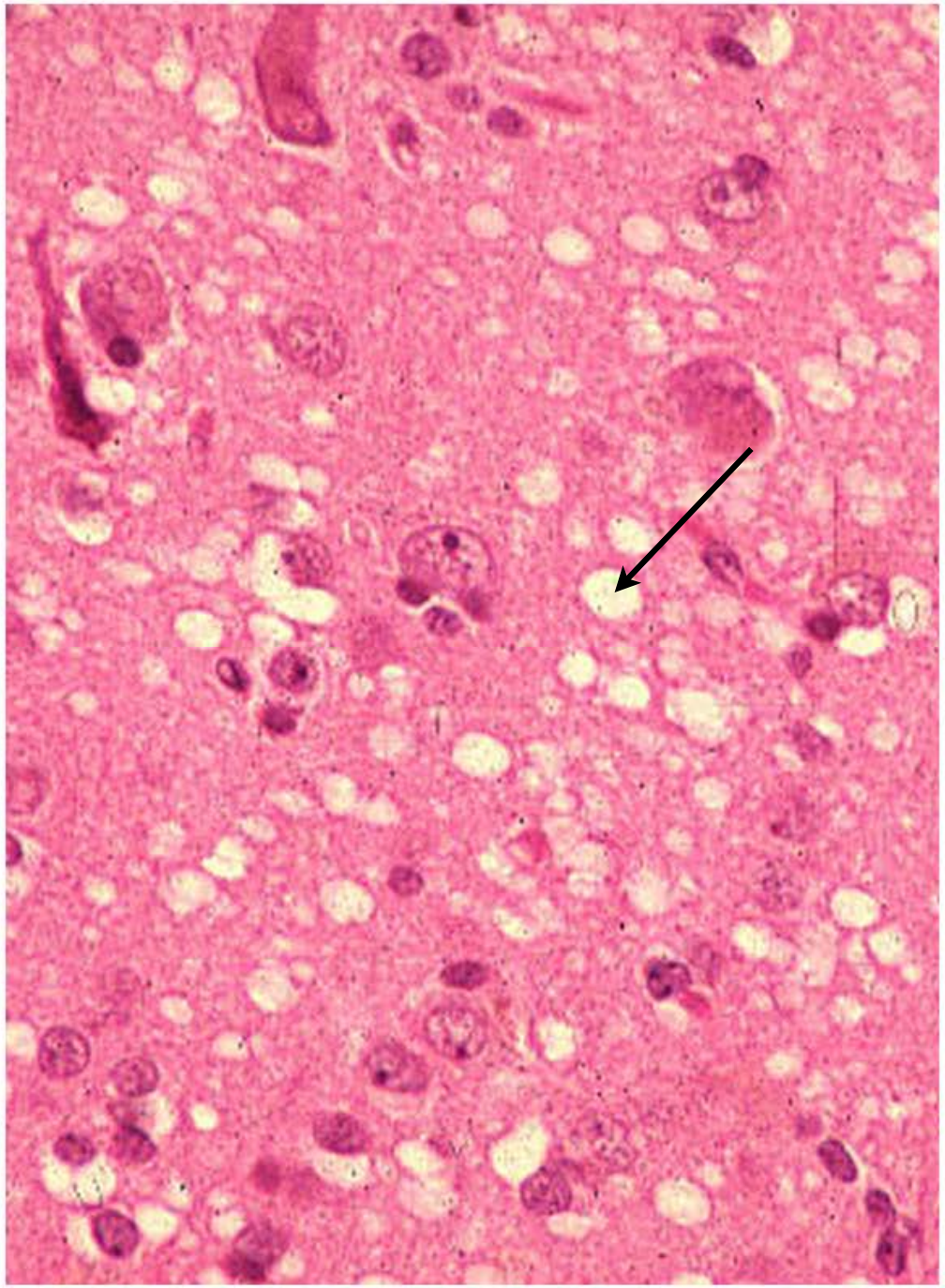
Prion Diseases

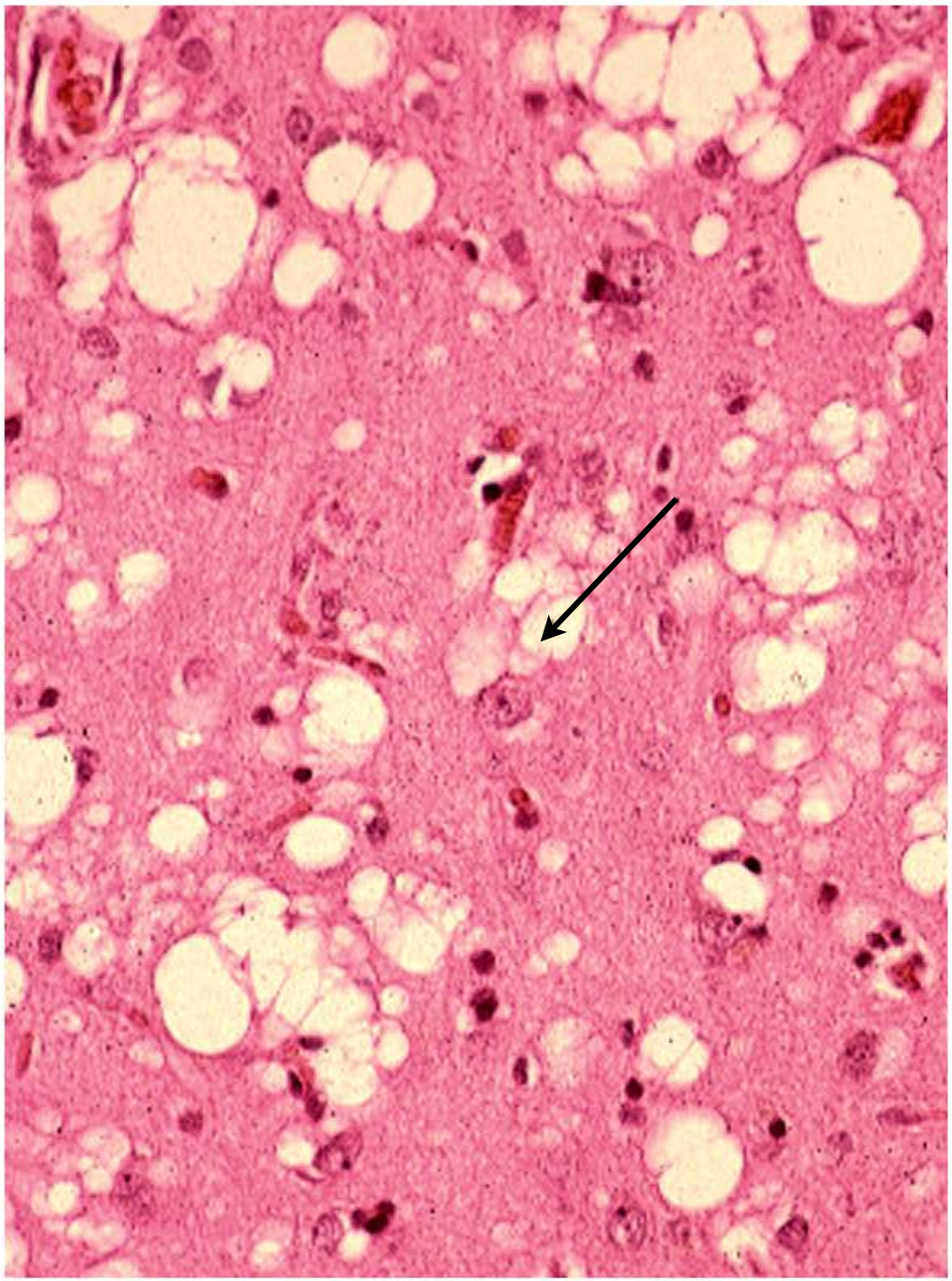
Table 29-2. Prion Diseases

Disease	Infectious Agent	Host	Comments
Kuru	Prion	Human	Subacute Spongiform Encephalopathy (SSE); Fore Tribe - New Guinea; consuming infected brains
Creutzfeldt-Jakob Disease	Prion	Human	SSE Genetic predisposition
Gerstmann-Straussler	Prion	Human	SSE
Fatal Familial Insomnia	Prion	Human	SSE
Scrapie	Prion	Sheep	SSE—scraping their wool off on fences

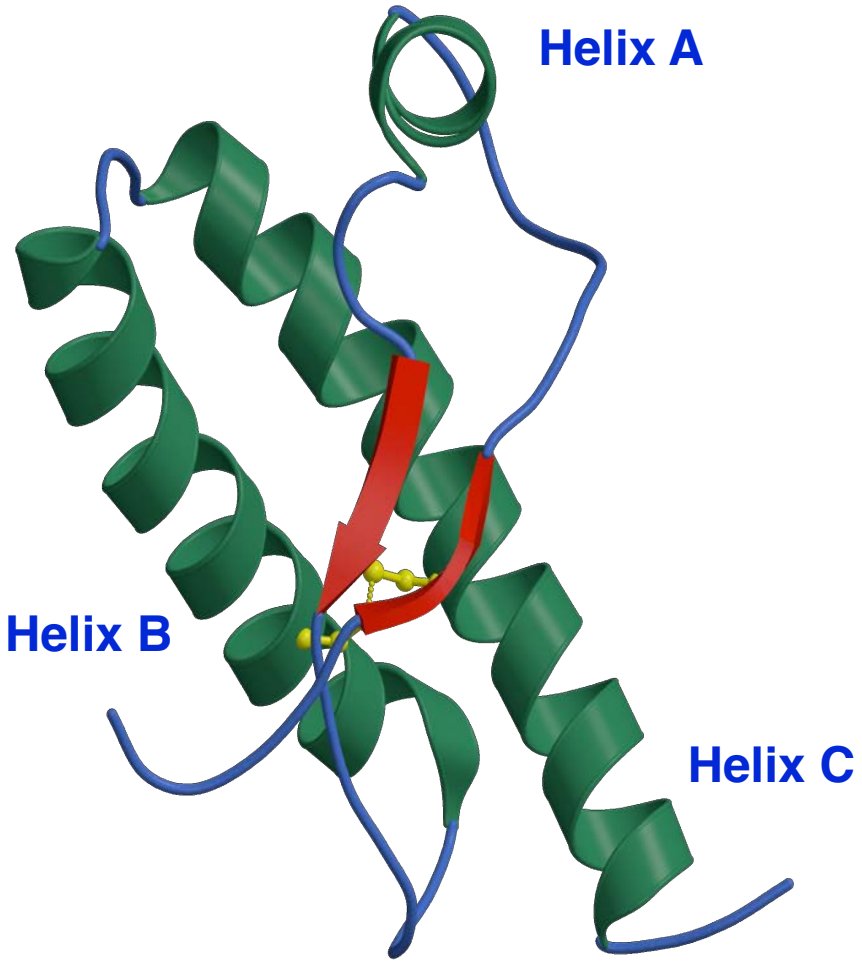

Creutzfeldt-Jakob disease deaths and death rates by age group, United States of America, 1979-1998
sCJD: Prevalence = 1 per million
Deaths
Death Rates
Deaths
Death rates per million persons
Age group
1,000
800
600
400
200
0
6
5
4
3
2
1
0
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
>=85

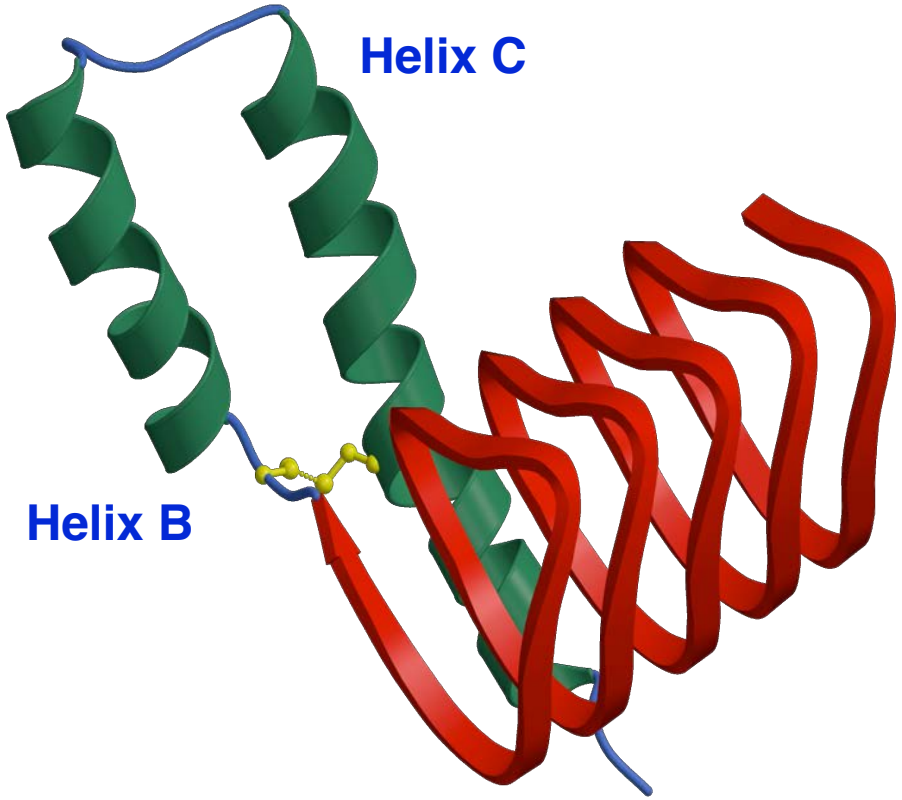
Spongiform Vacuolar Degeneration





Current Models of PrP^{C} and PrP^{Sc}

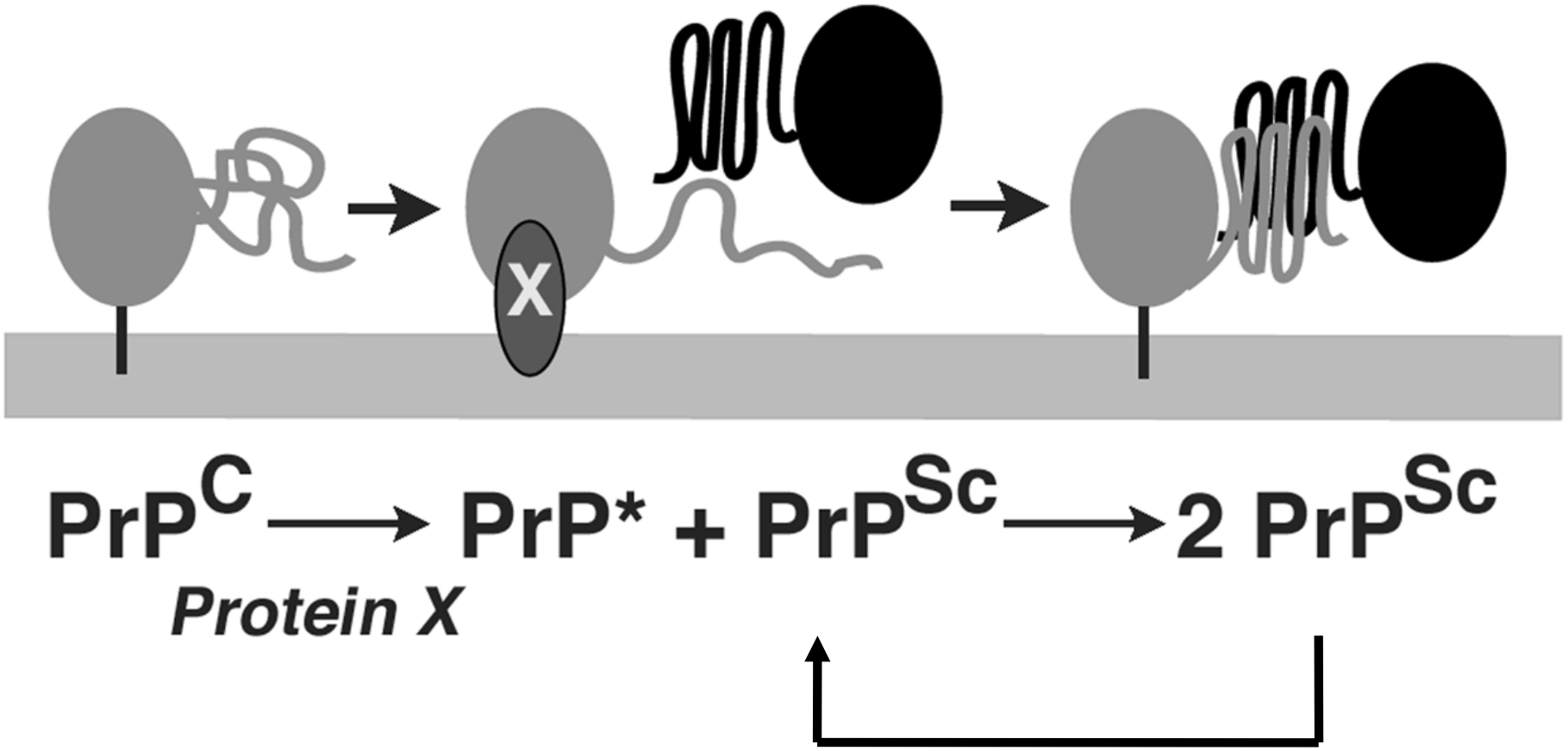




PrP^{C}

PrP^{Sc}

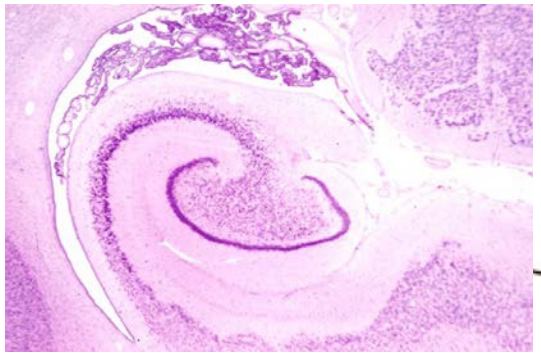
PrP^{Sc} acts as a template for the conversion of PrP^{C} to nascent PrP^{Sc}



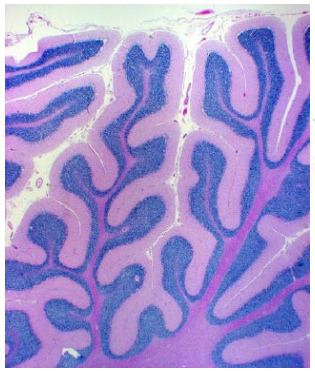
Cerebral Vascular Disease

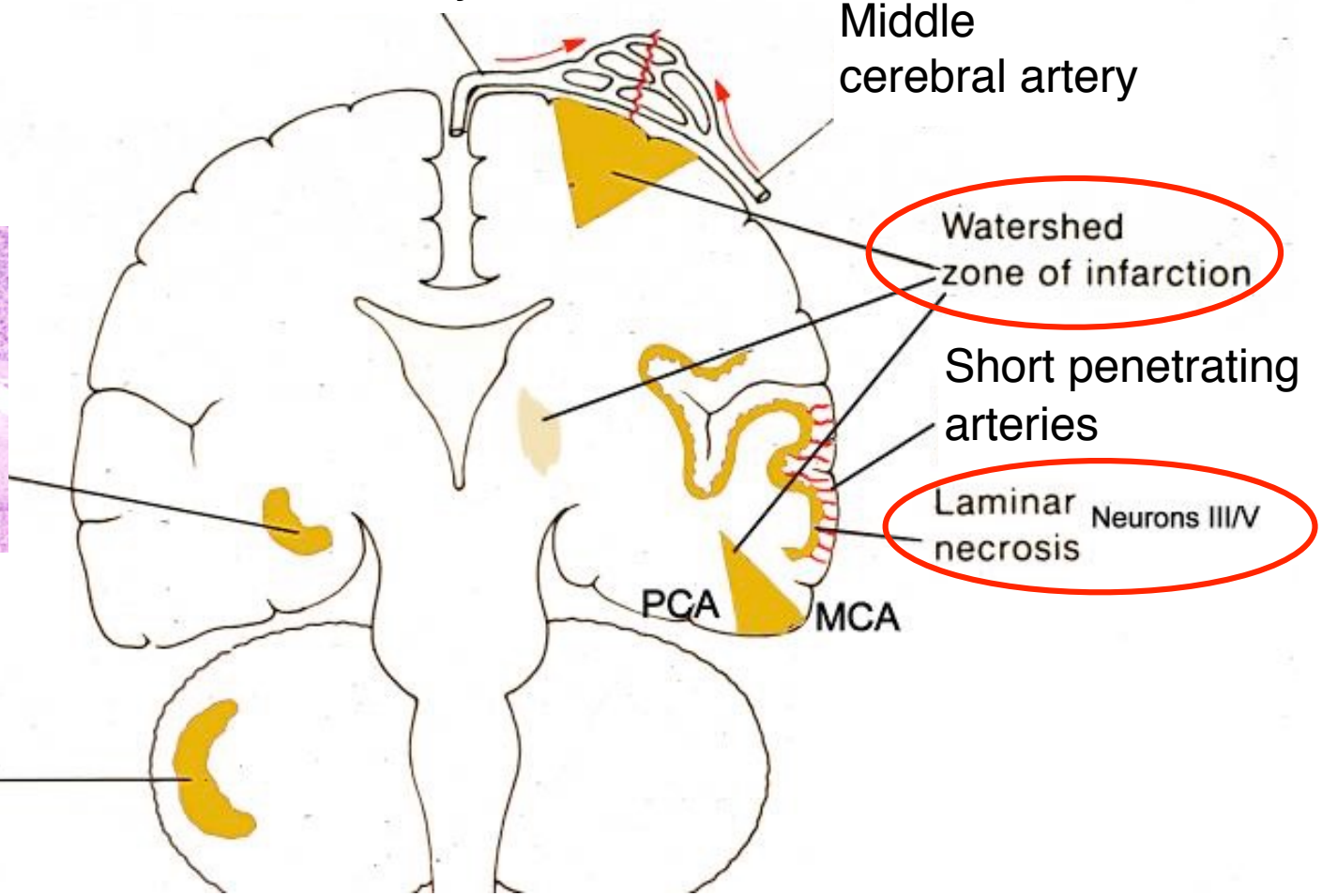
Patterns of Selective Vulnerability with Global Ischemia/Hypoxia

Hippocampus

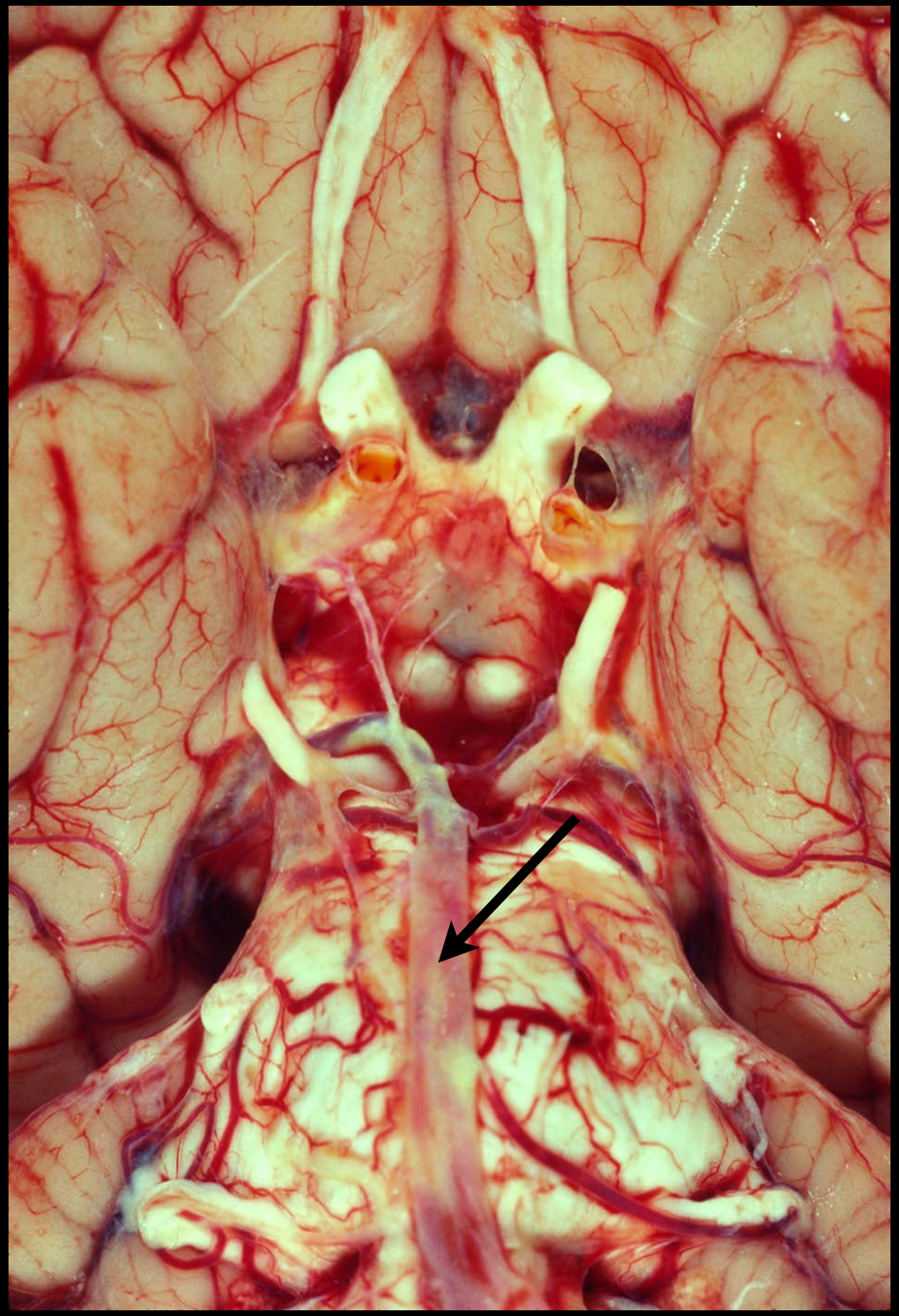


Cerebellum

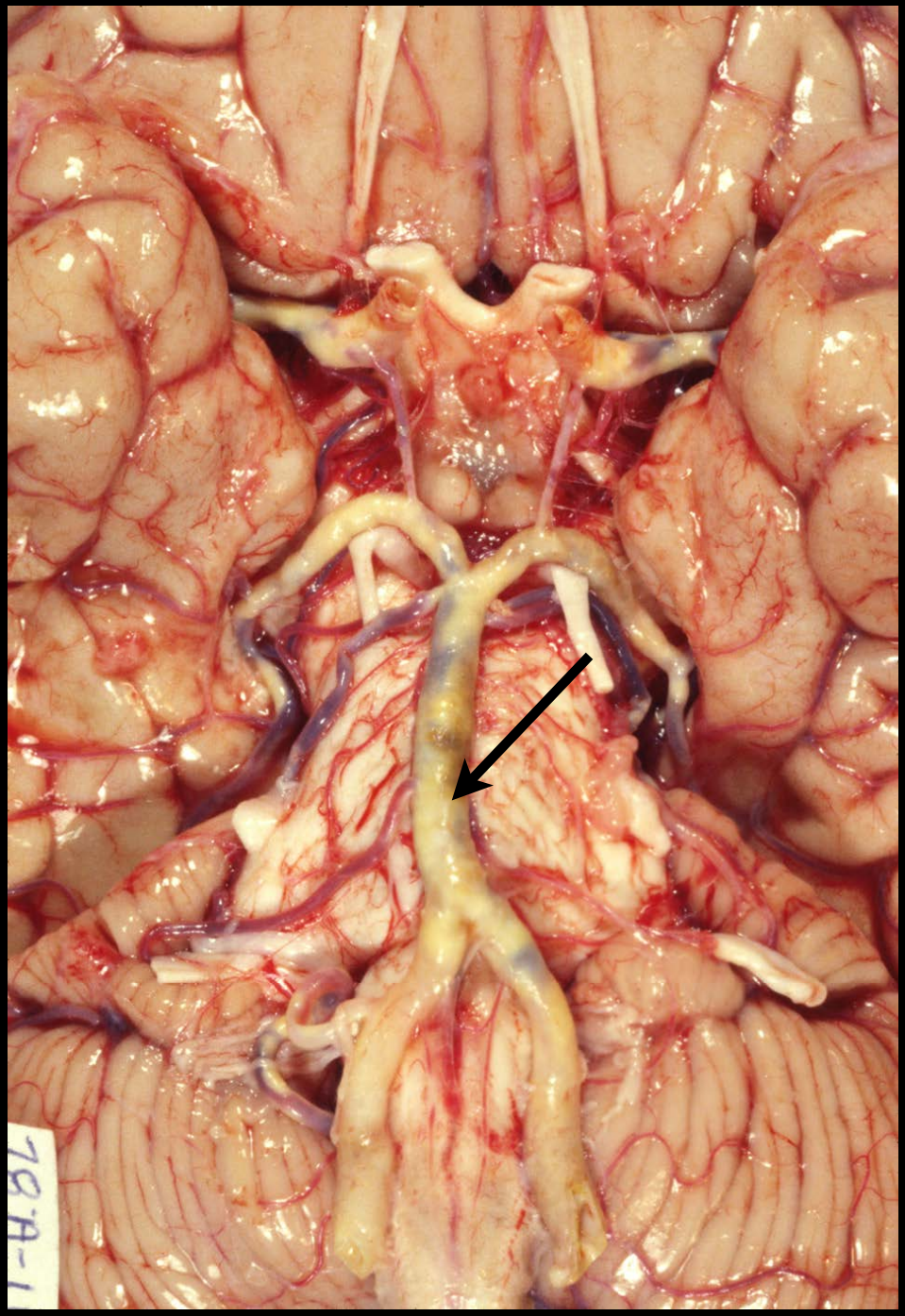




Normal



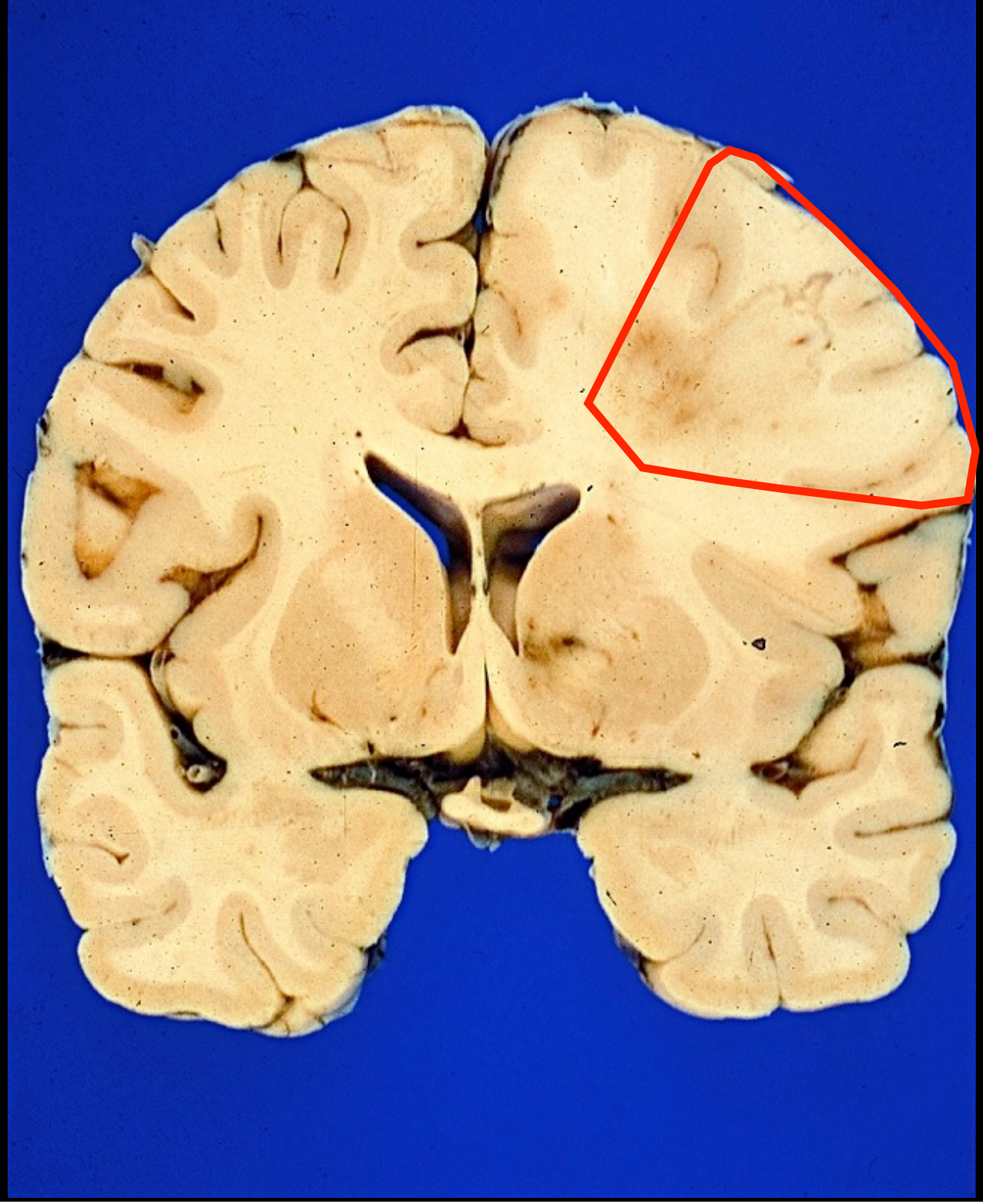
Atherosclerosis



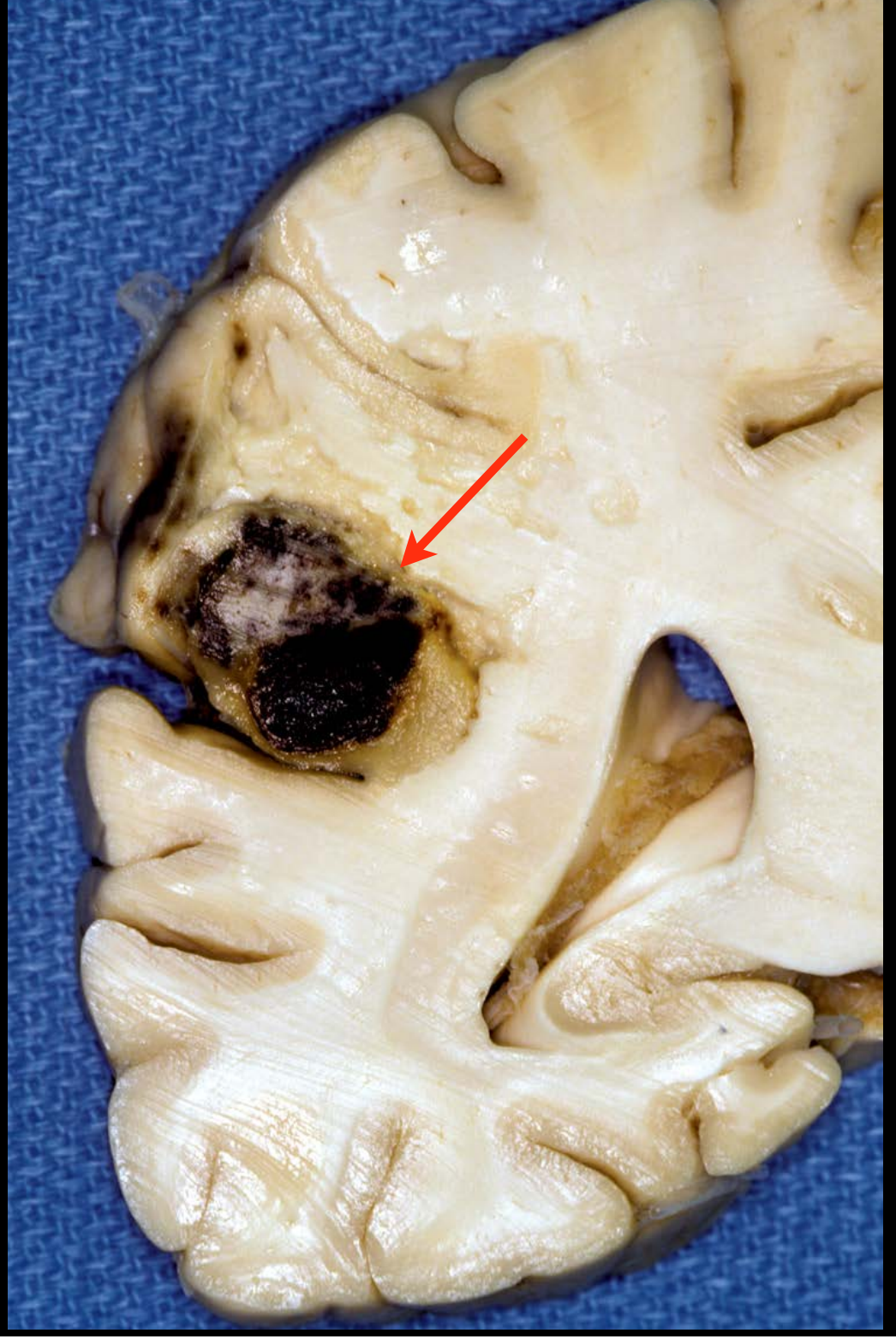
Morphologic Evolution of an Infarct

Infarct stage	Gross features	Microscopic features
Acute infarct (0-2 days)	Normal or mild edema Mild blurring of grey-white interface	Eosinophilic neuronal necrosis ("dead red" neurons) (>6-12 hr) Variable neutrophilic infiltrate (>24 hr)
Subacute / evolving infarct (3 days-1 month)	Softening/edema Blurring of grey-white interface Gradual tissue liquefaction	Macrophage infiltrate (> 3 days) Vascular proliferation (> 1 week) Reactive astrocytosis (> 1 week)
Remote infarct (> 1 month)	CSF-filled cavity with firm tissue at the periphery	Cystic necrosis Residual macrophages Well-developed reactive astrocytosis (glial scar)

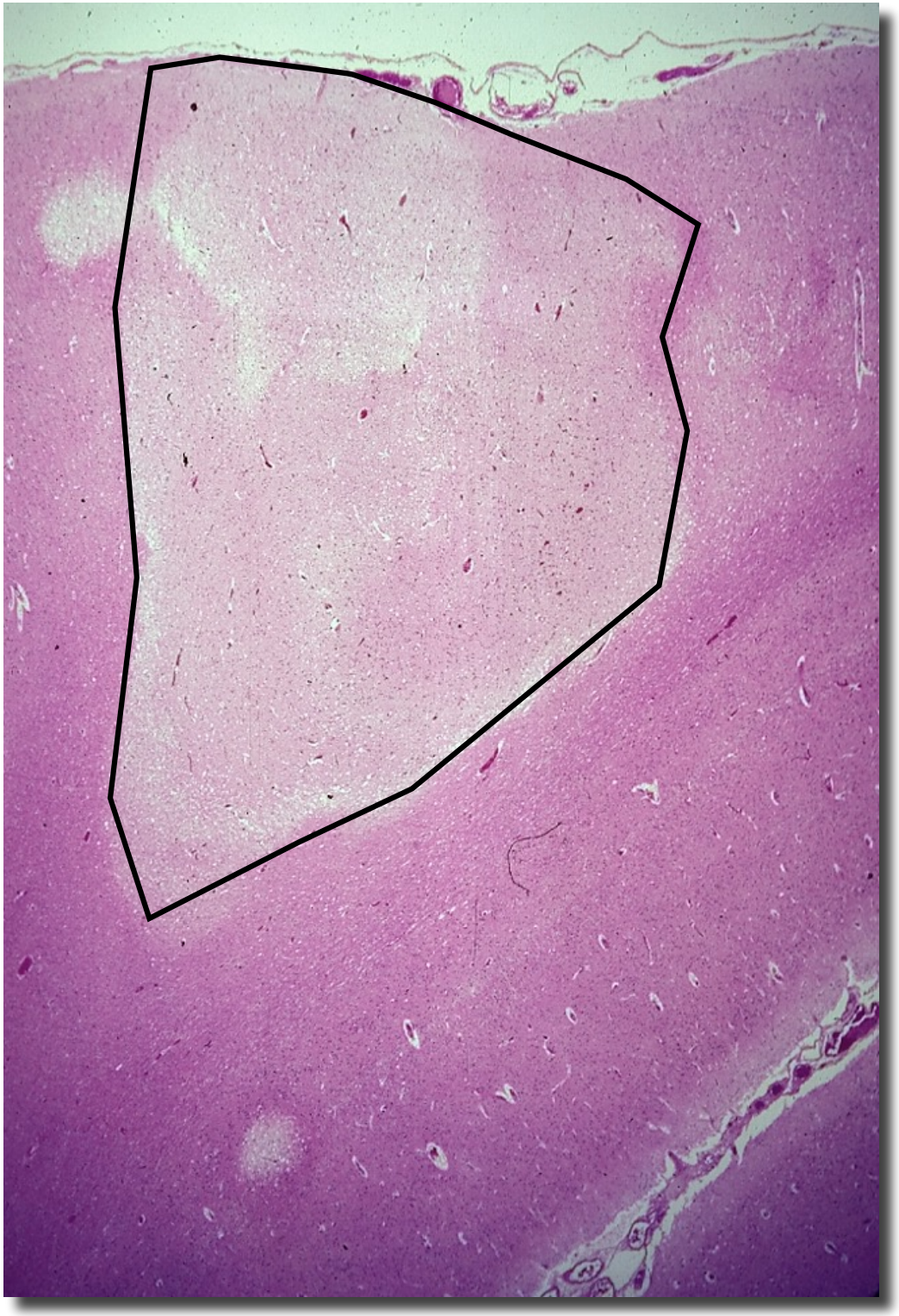
Acute Pale Infarct



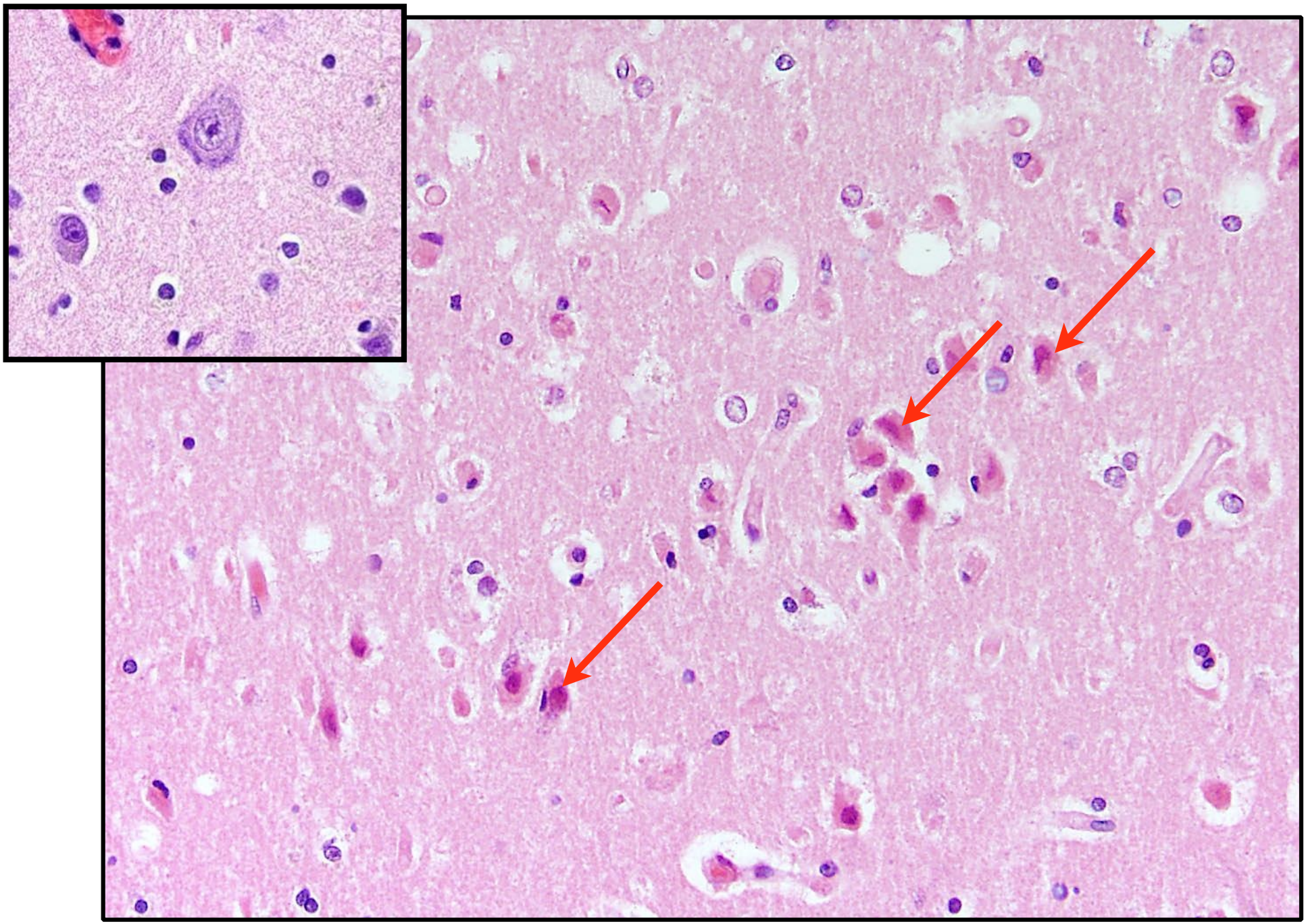
Acute Hemorrhagic Infarct with Hemorrhagic Transformation



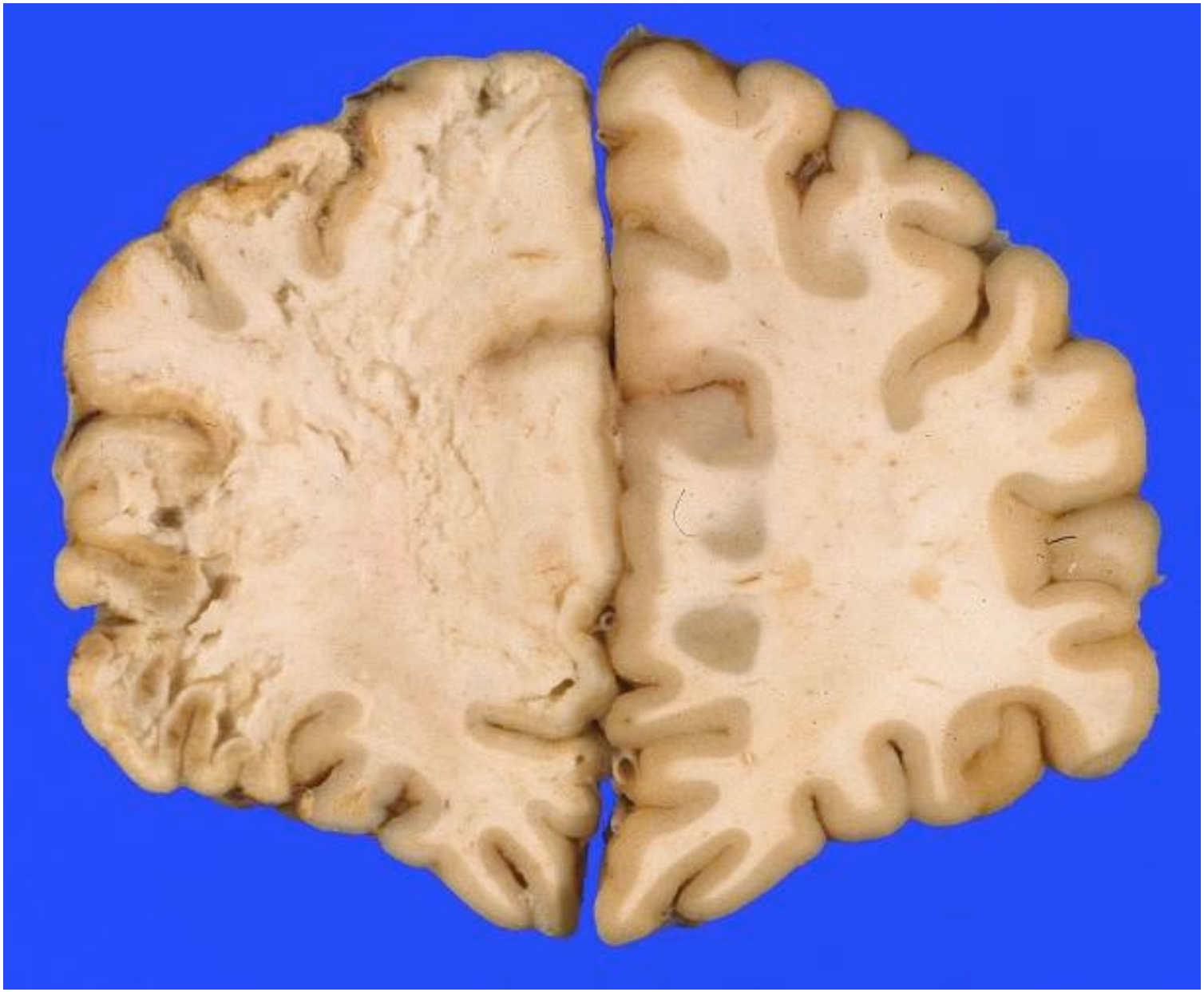
Acute Pale Infarct



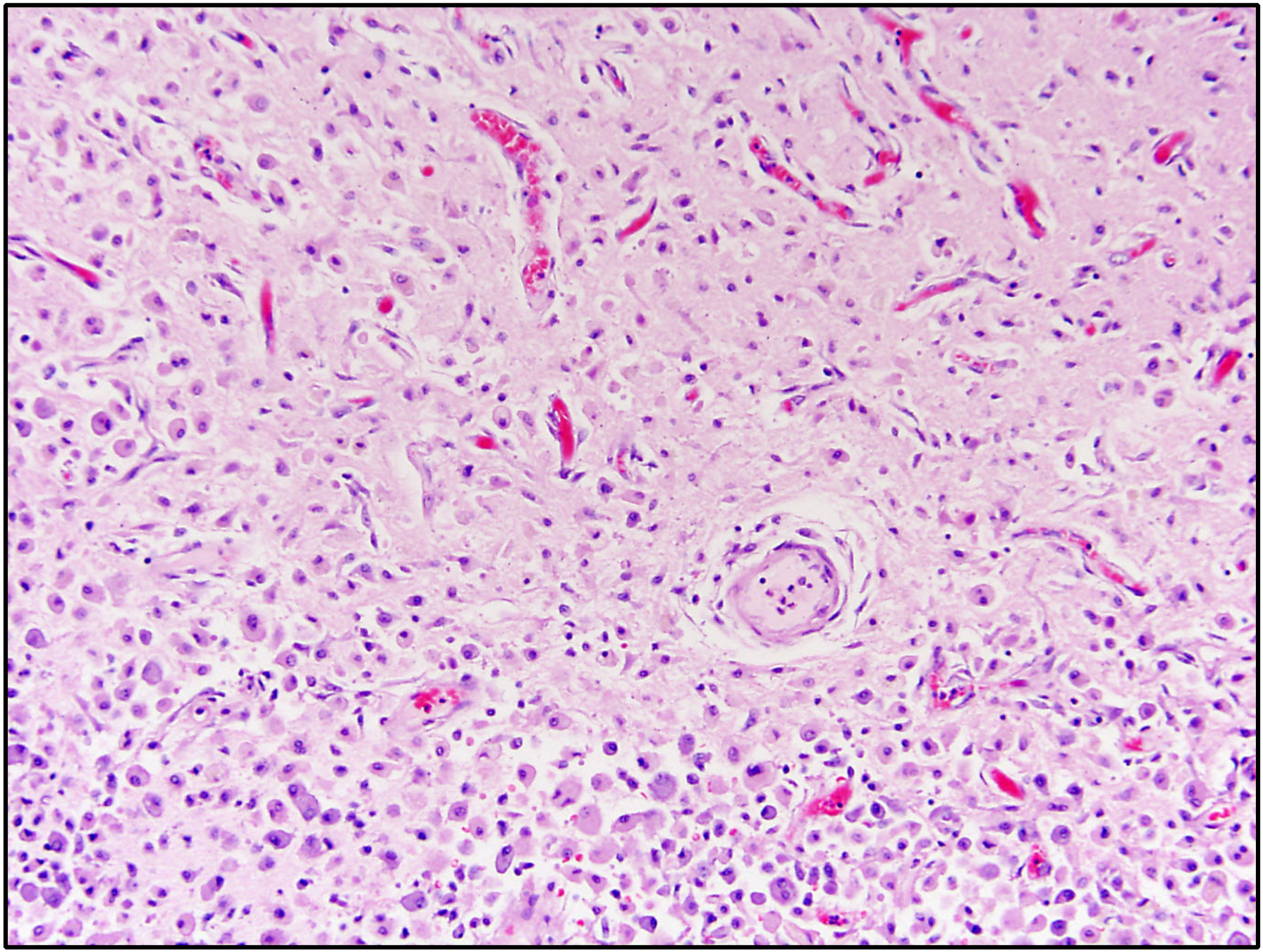
Acute Pale Infarct (1-2 Days)



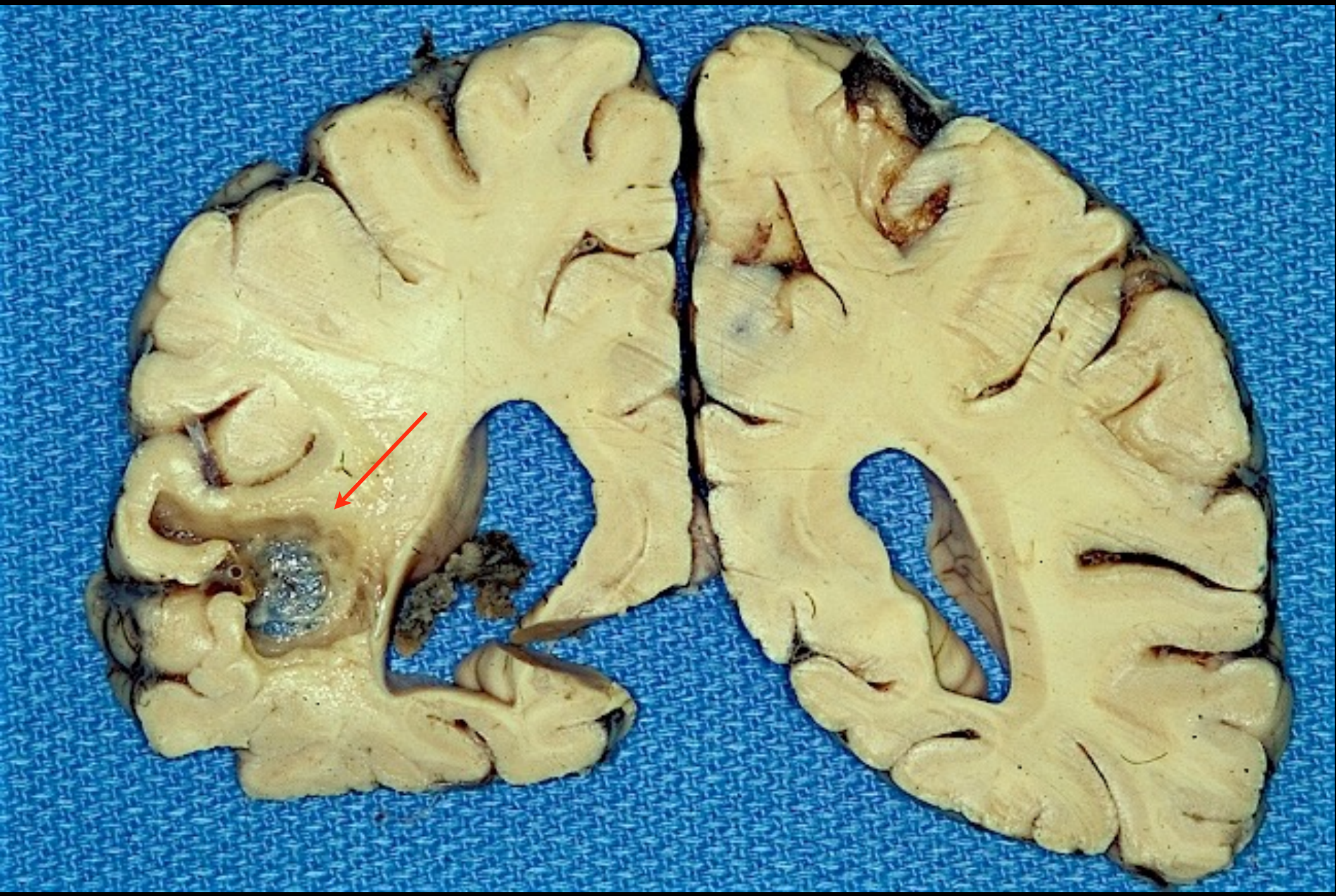
Left Subacute Infarct of the Frontal Lobe



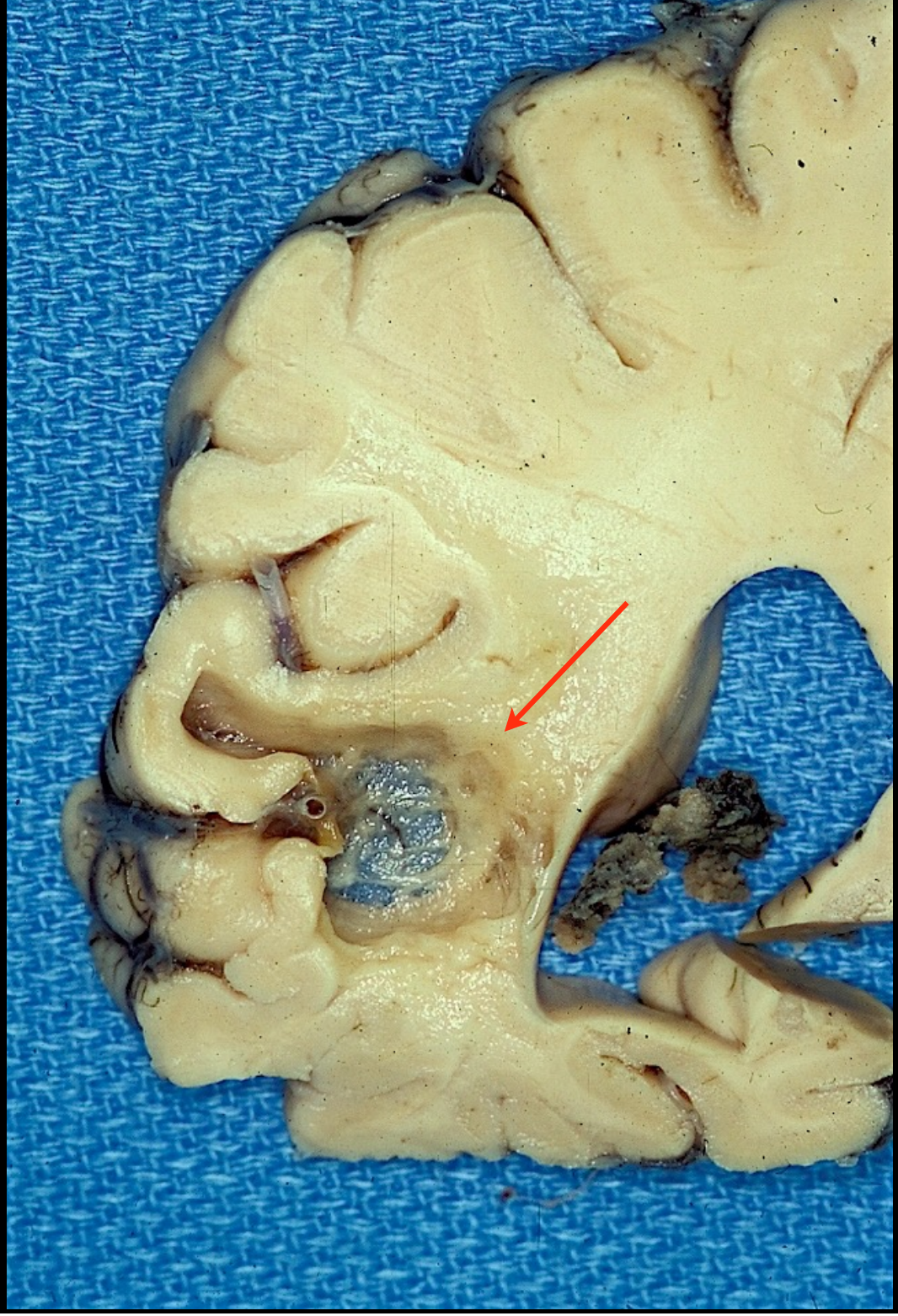
Subacute Infarct (1-3 weeks)



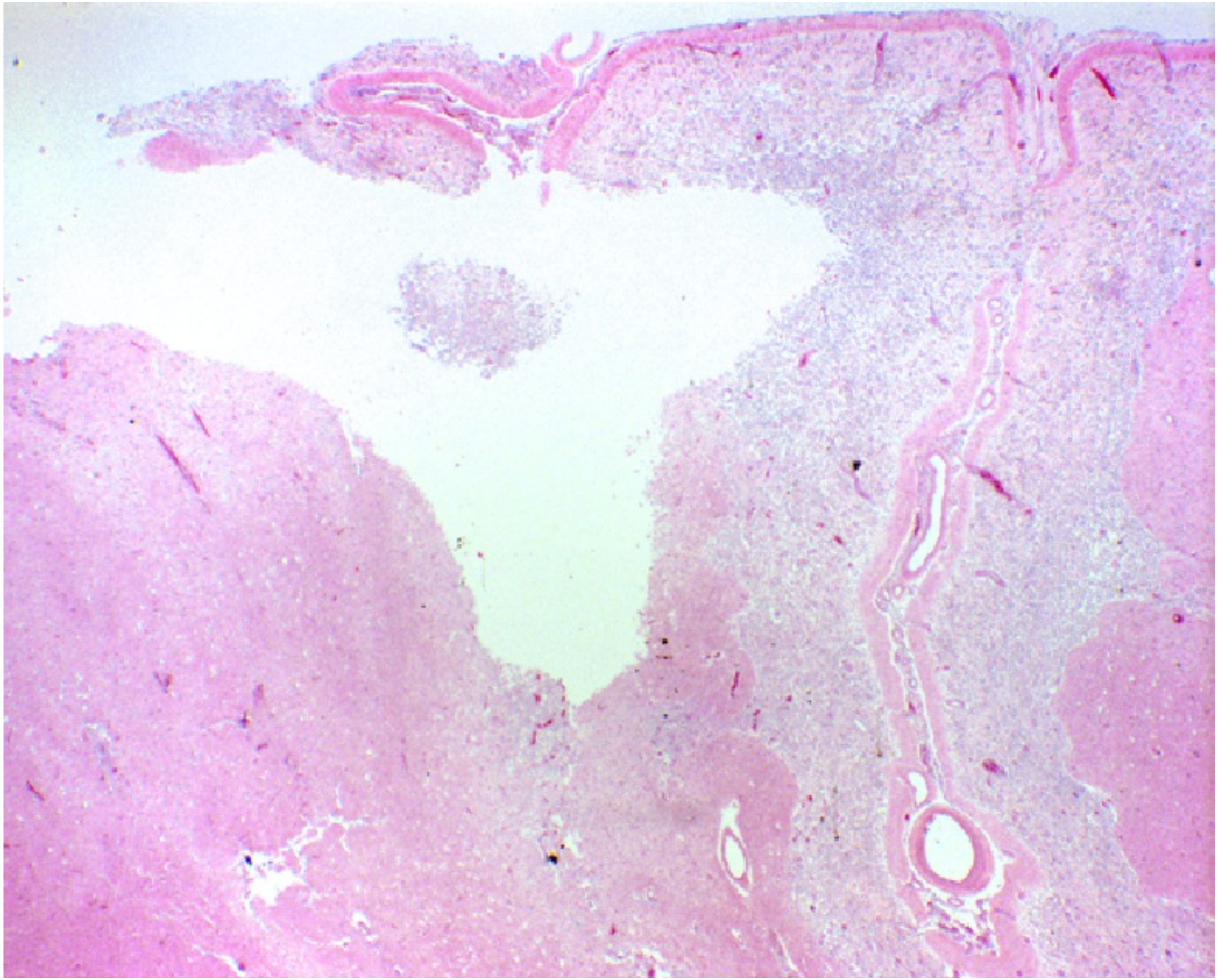
Remote Infarct



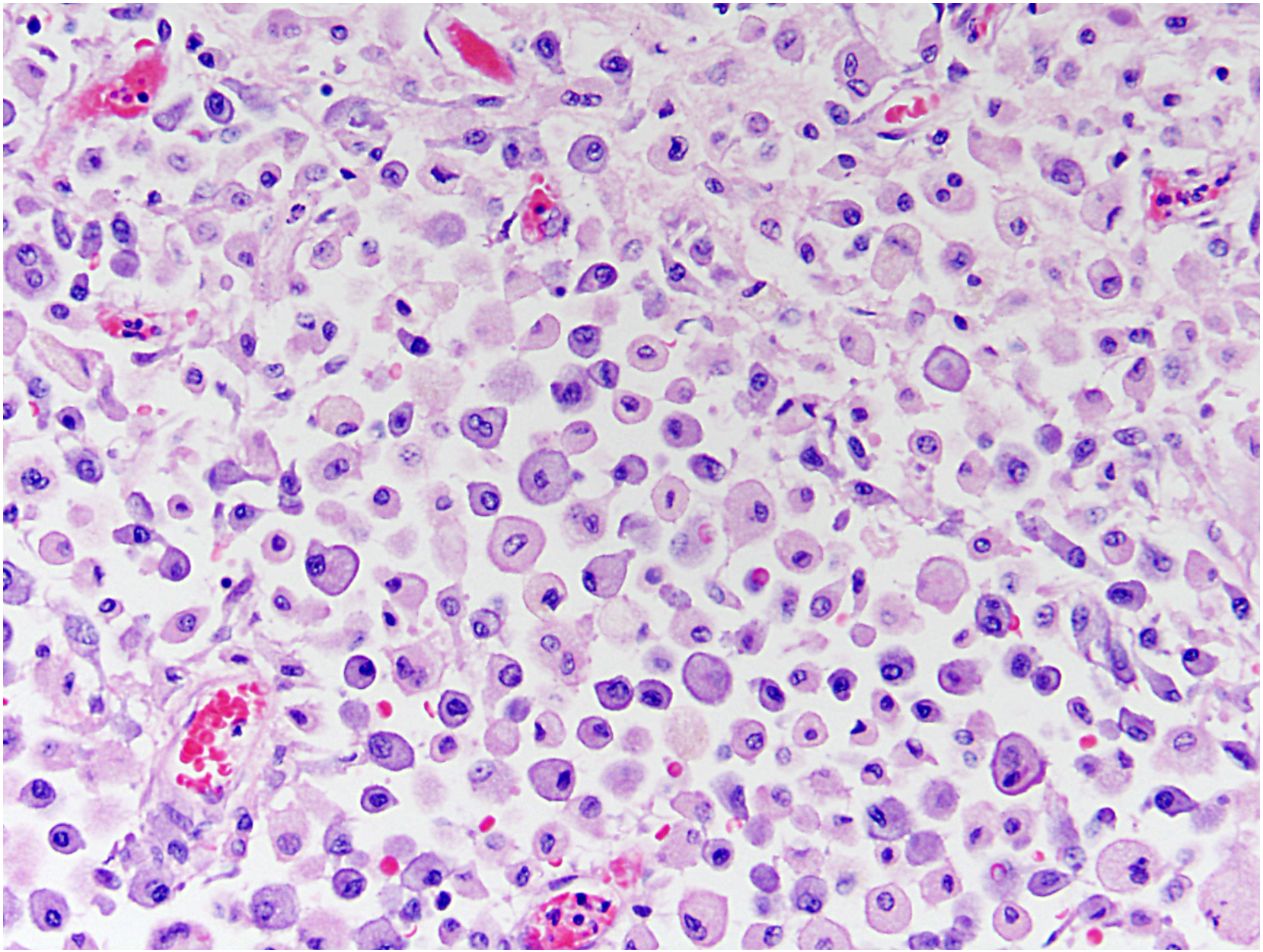
Remote Infarct



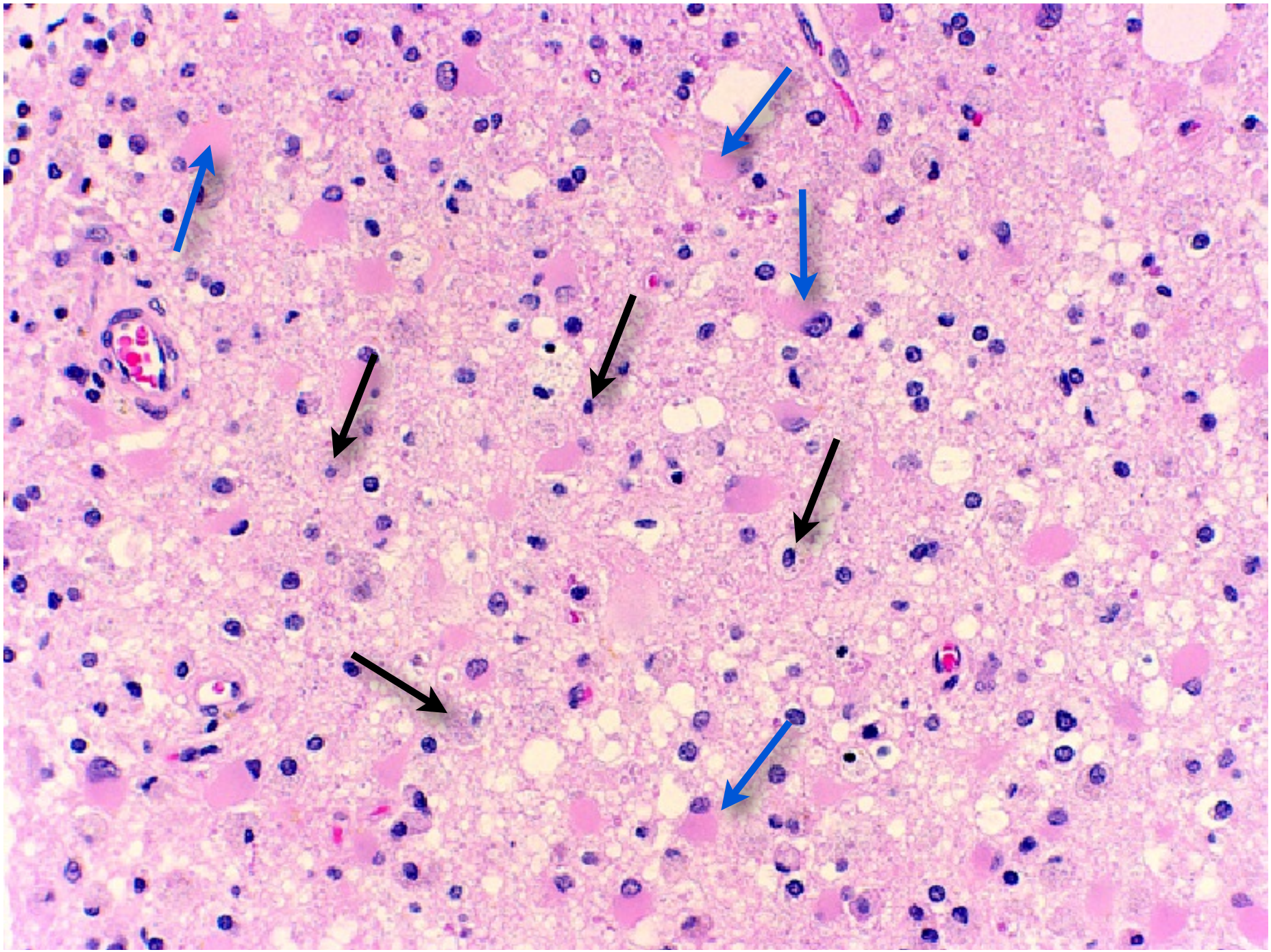
Remote Infarct



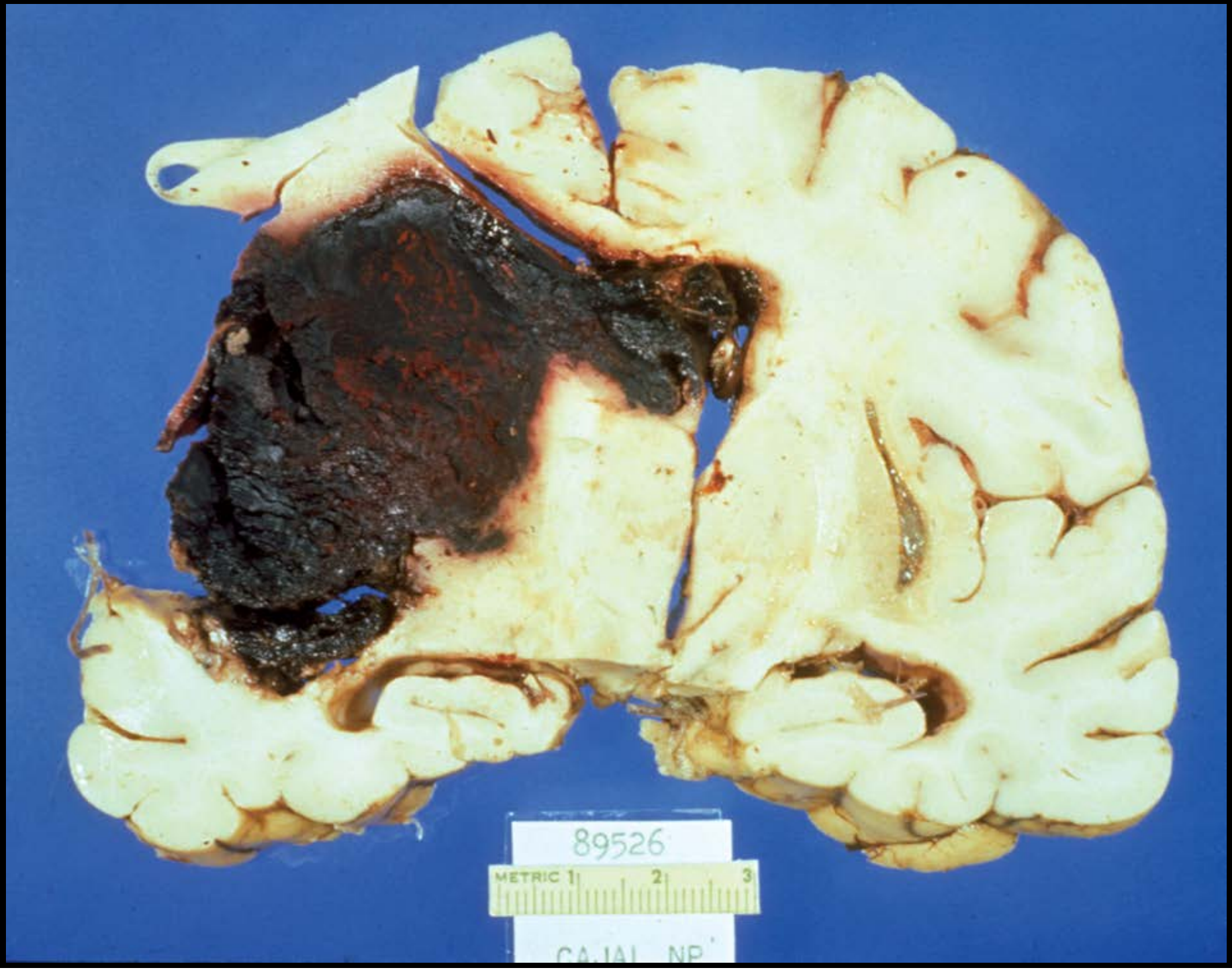
Remote Infarct: Adjacent to Cavity



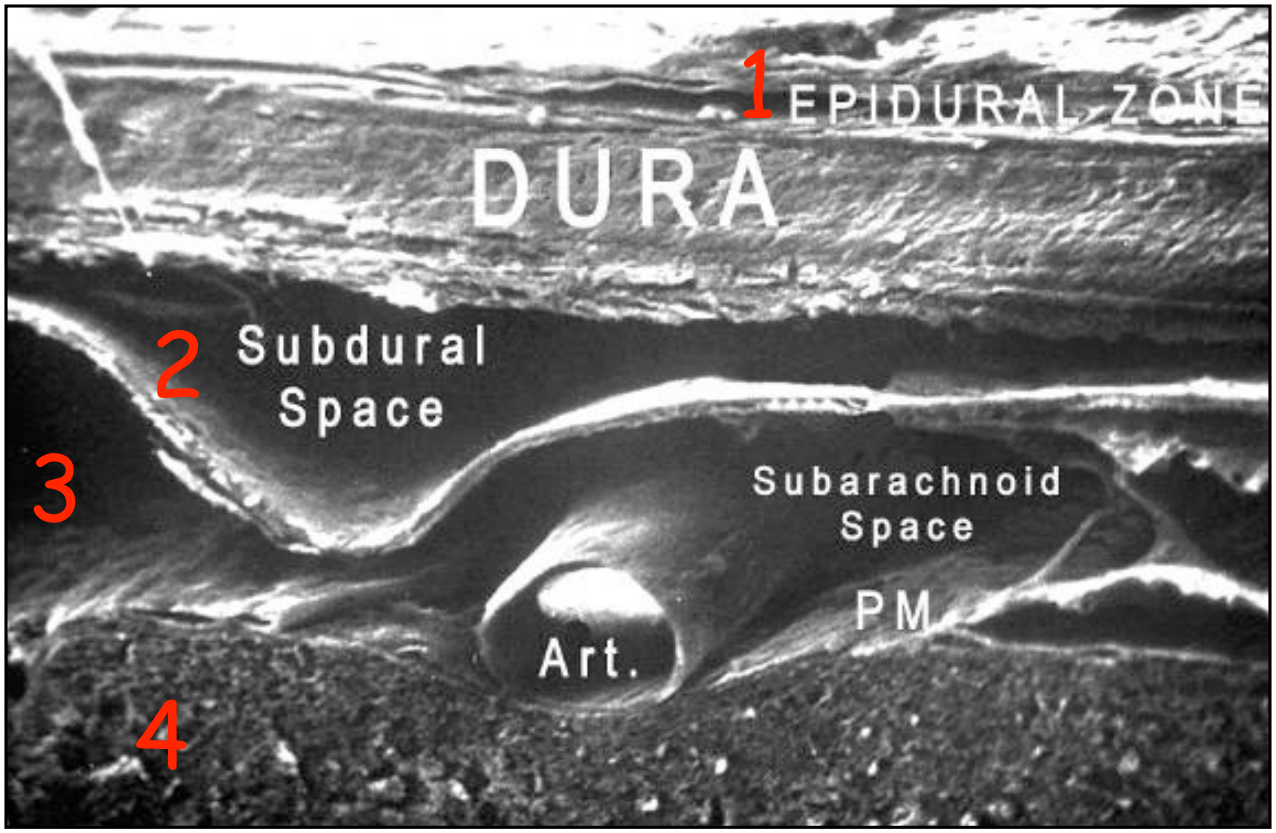
Remote Infarct: Glial Scar Adjacent to Intact Brain Tissue



Acute Intracerebral Hemorrhage



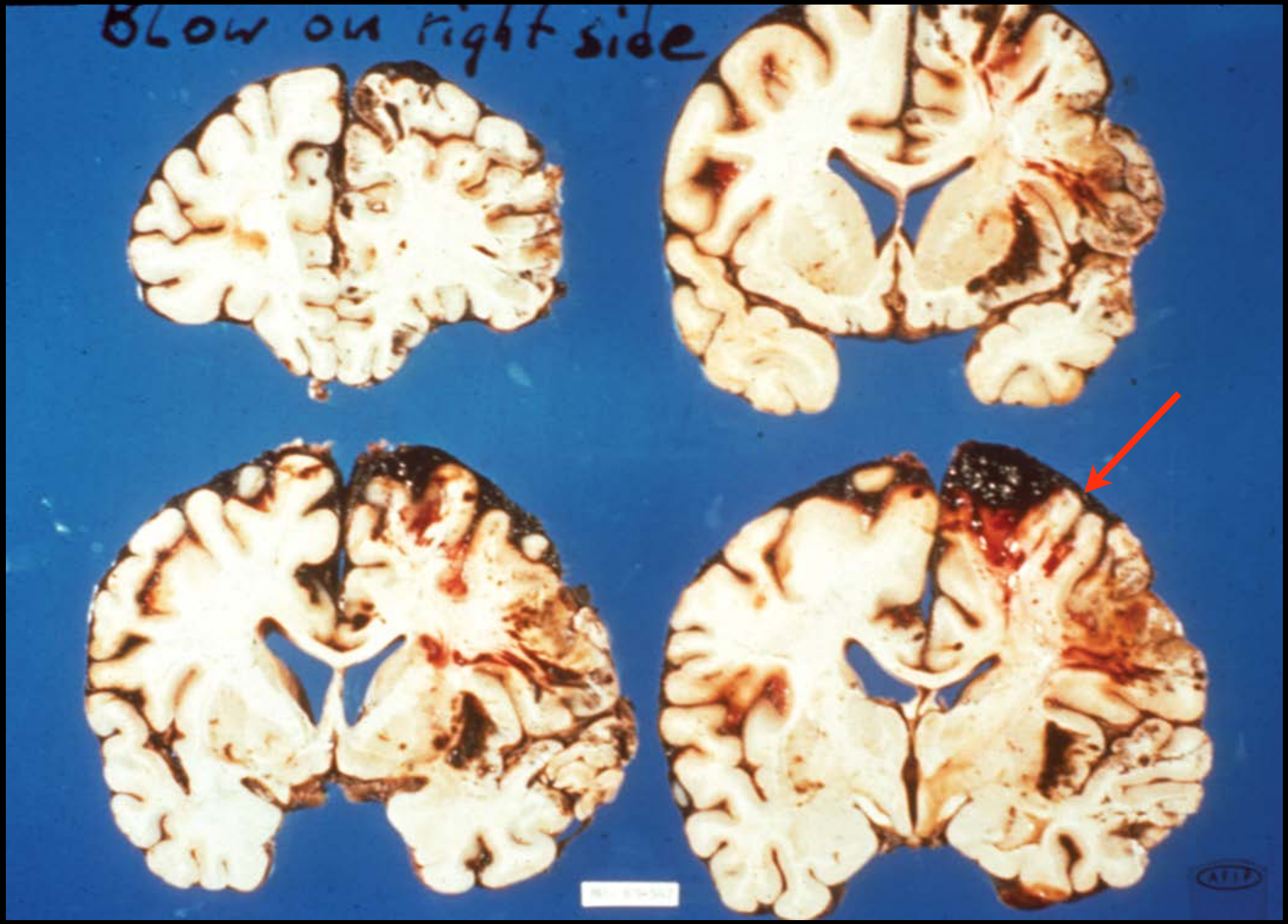
Anatomic Location of a Hemorrhage



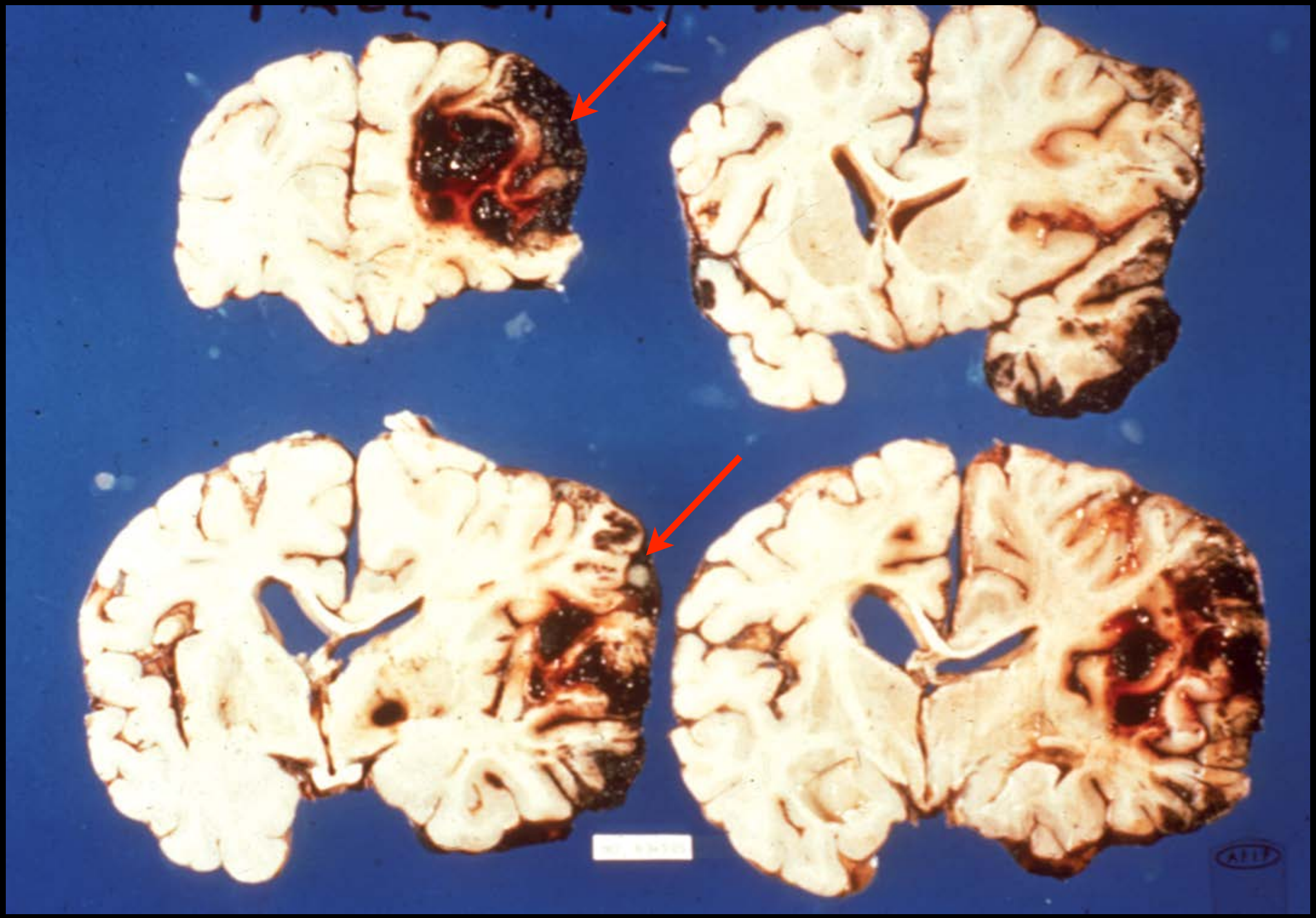
Hemorrhages:

1) Epidural - trauma to middle meningeal artery
2) Subdural - trauma to bridging vein
3) Subarachnoid - ruptured aneurysm
4) Intraparenchymal - hypertension

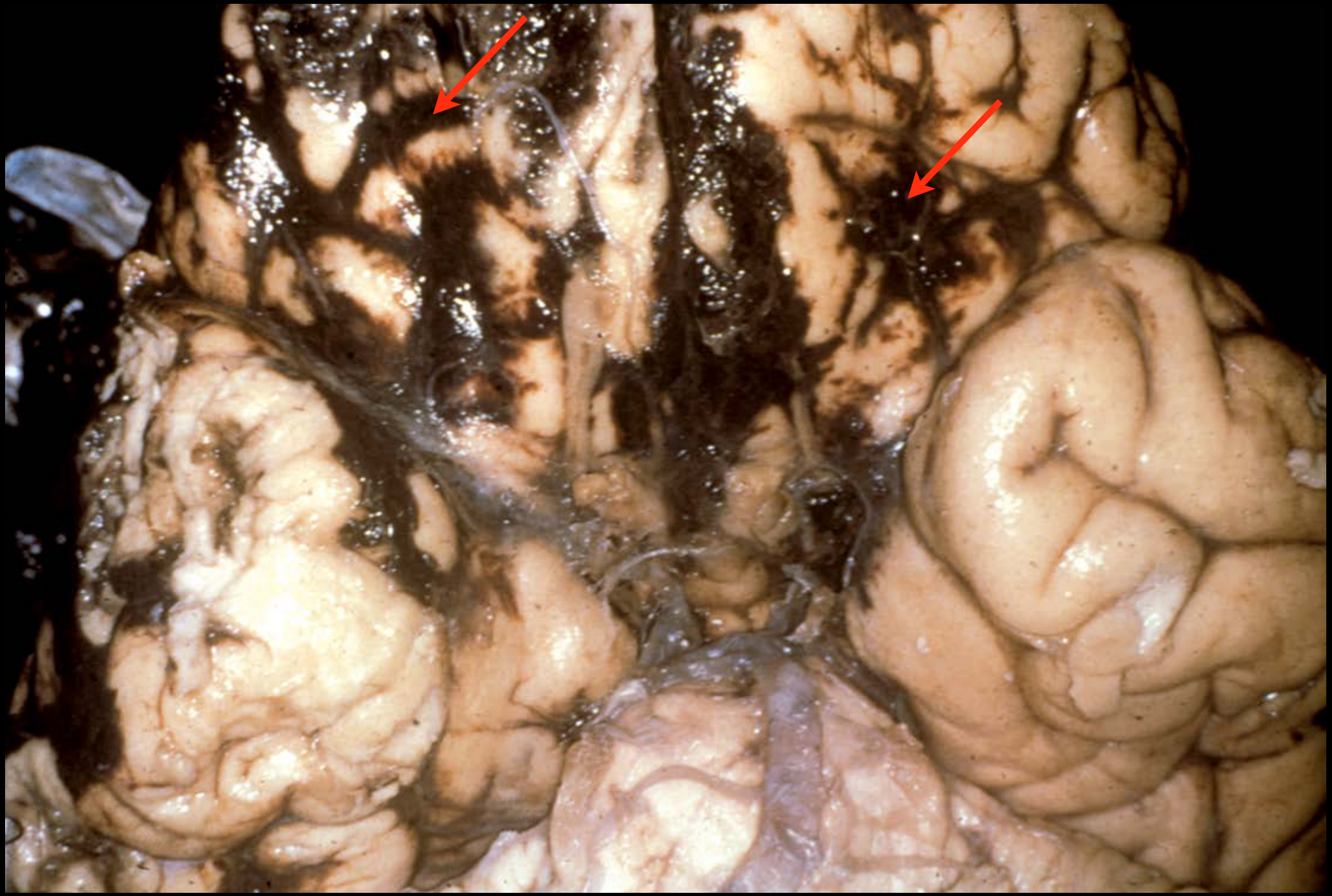
Coup



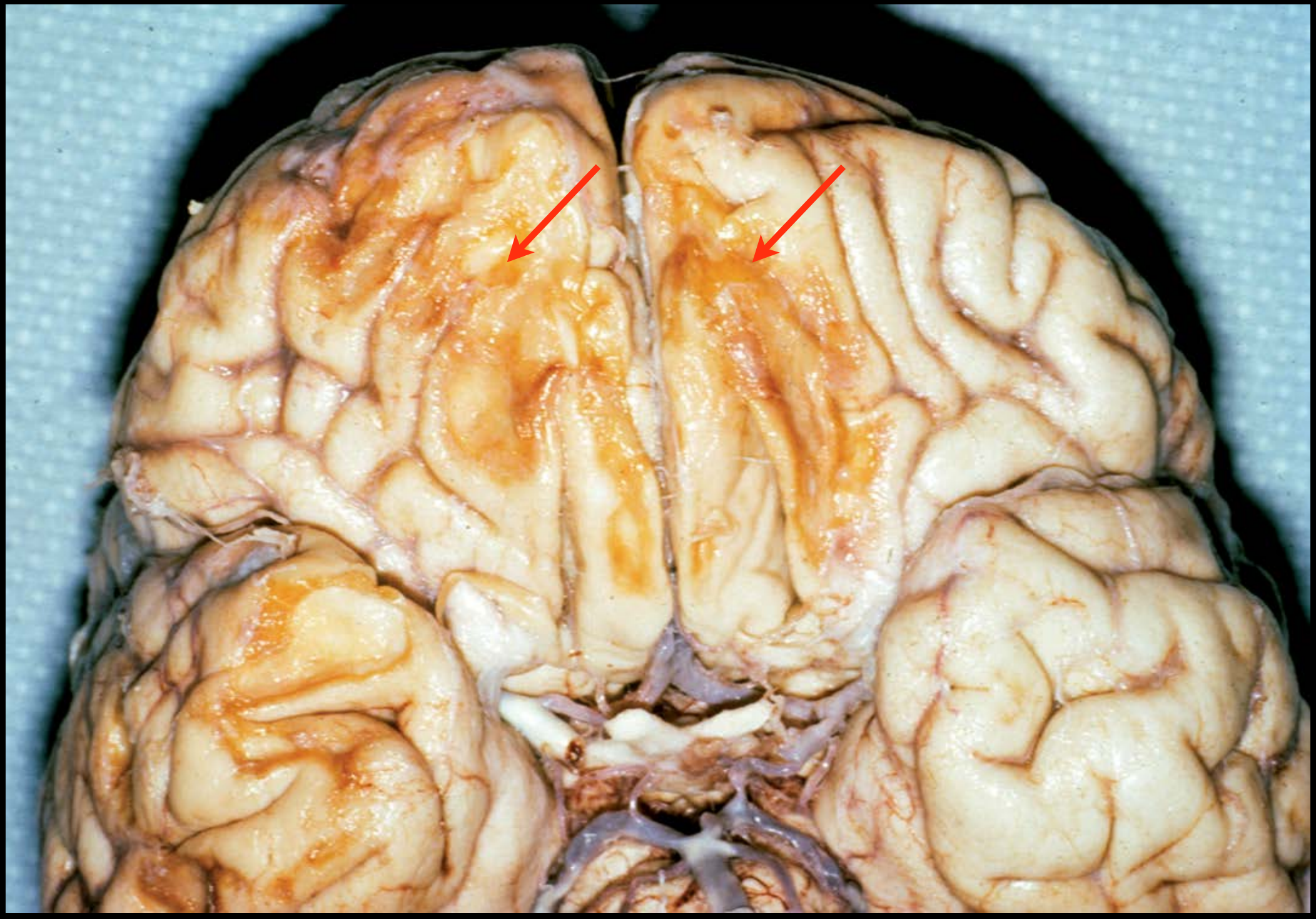
Contrecoup

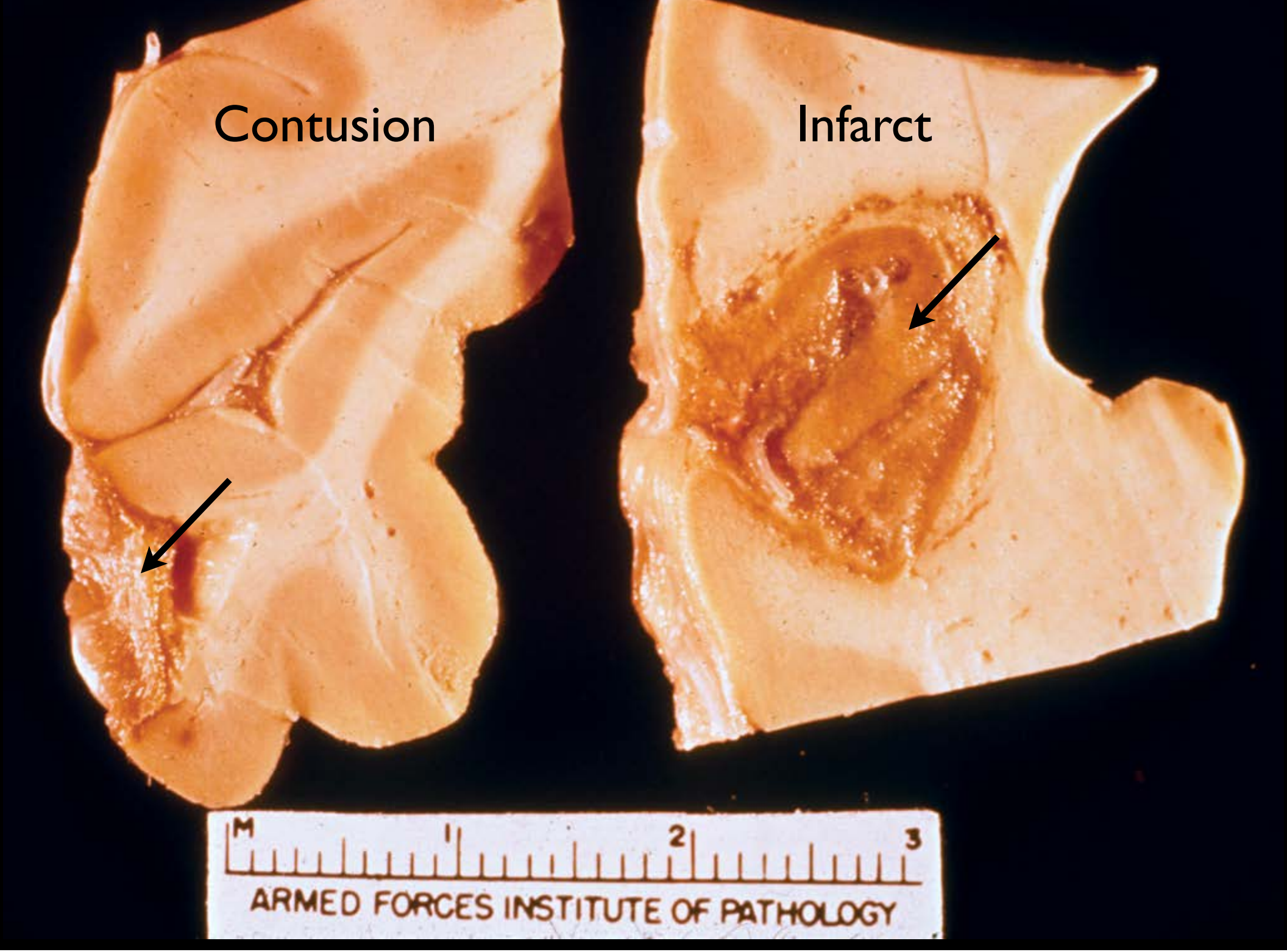


Contrecoup

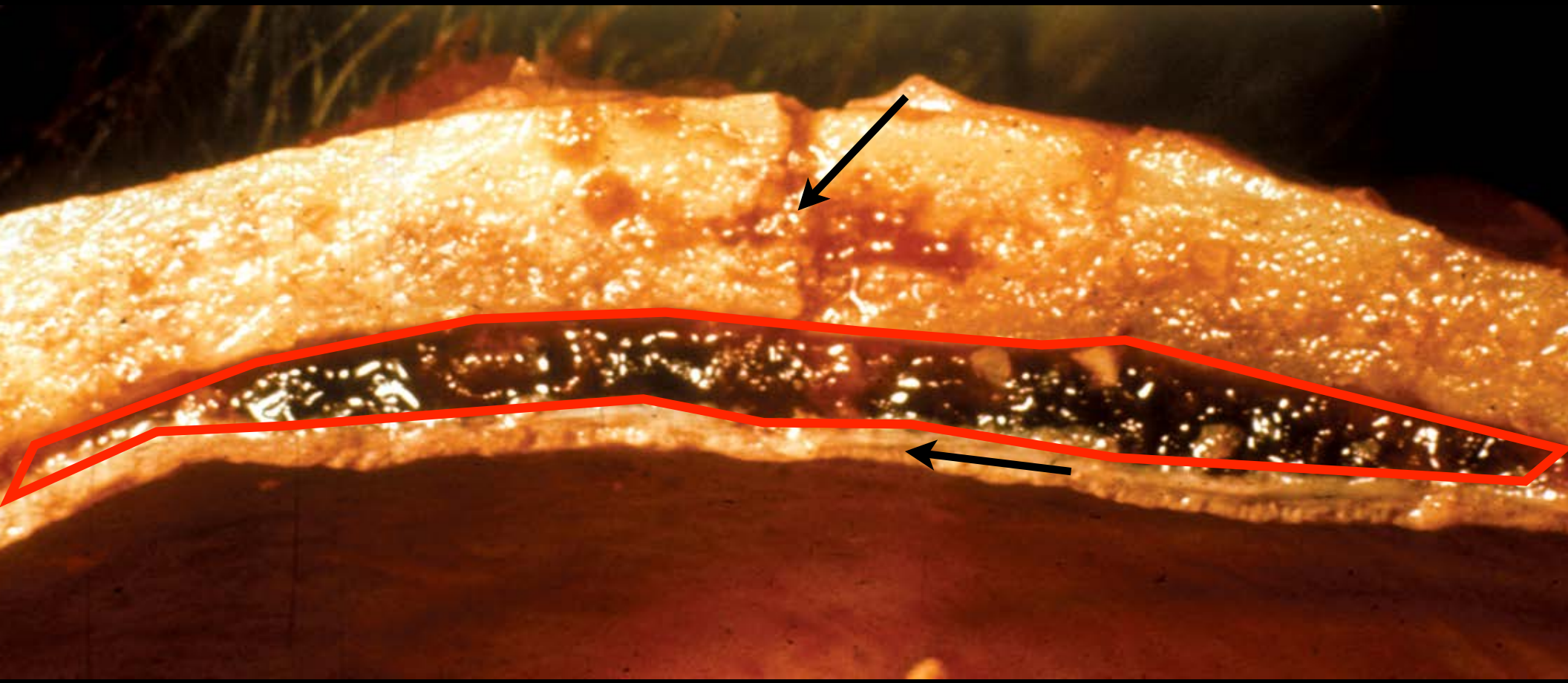


Organizing Contrecoup

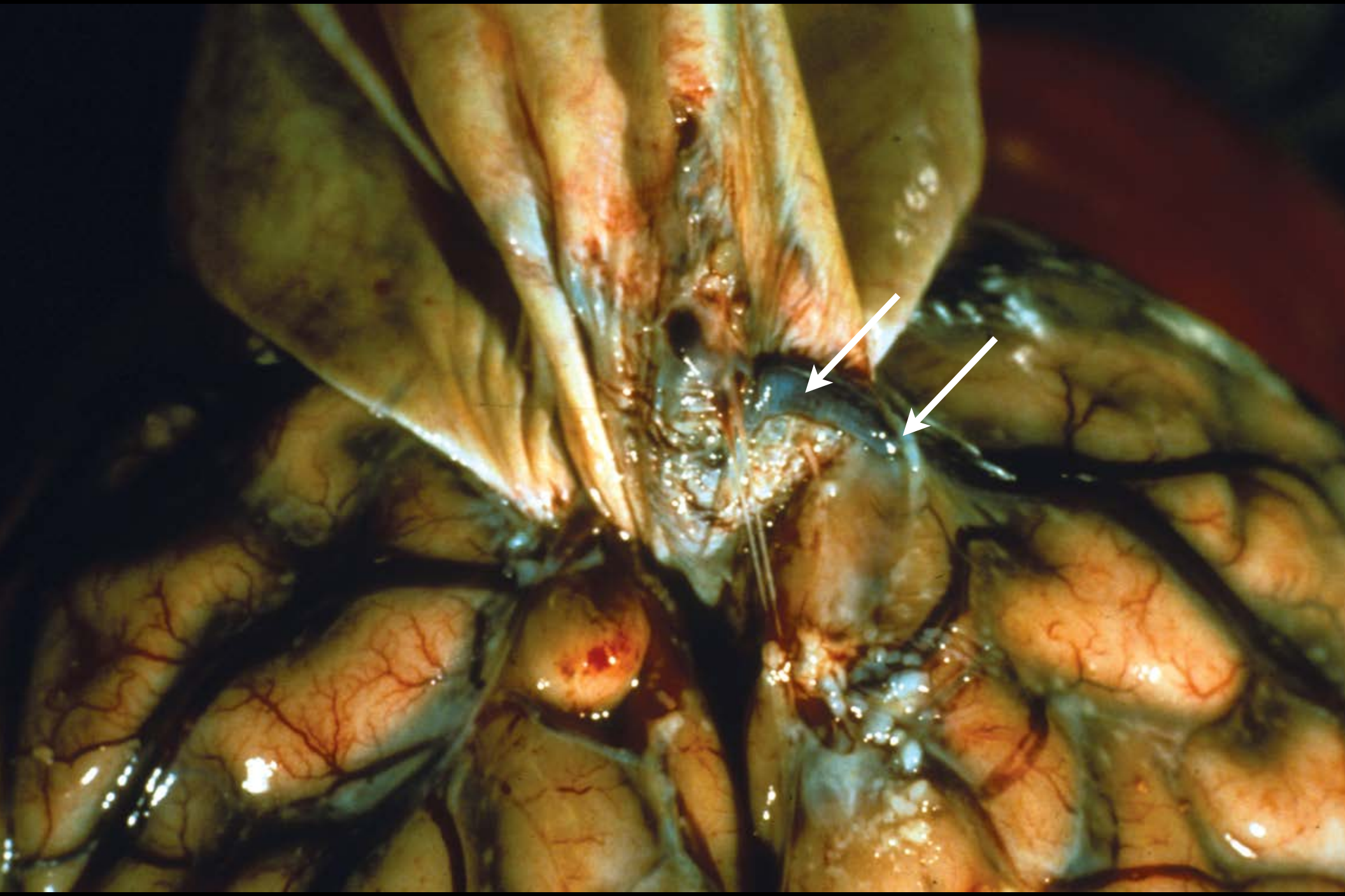



Contusion
Infarct
M
1
2
3
ARMED FORCES INSTITUTE OF PATHOLOGY

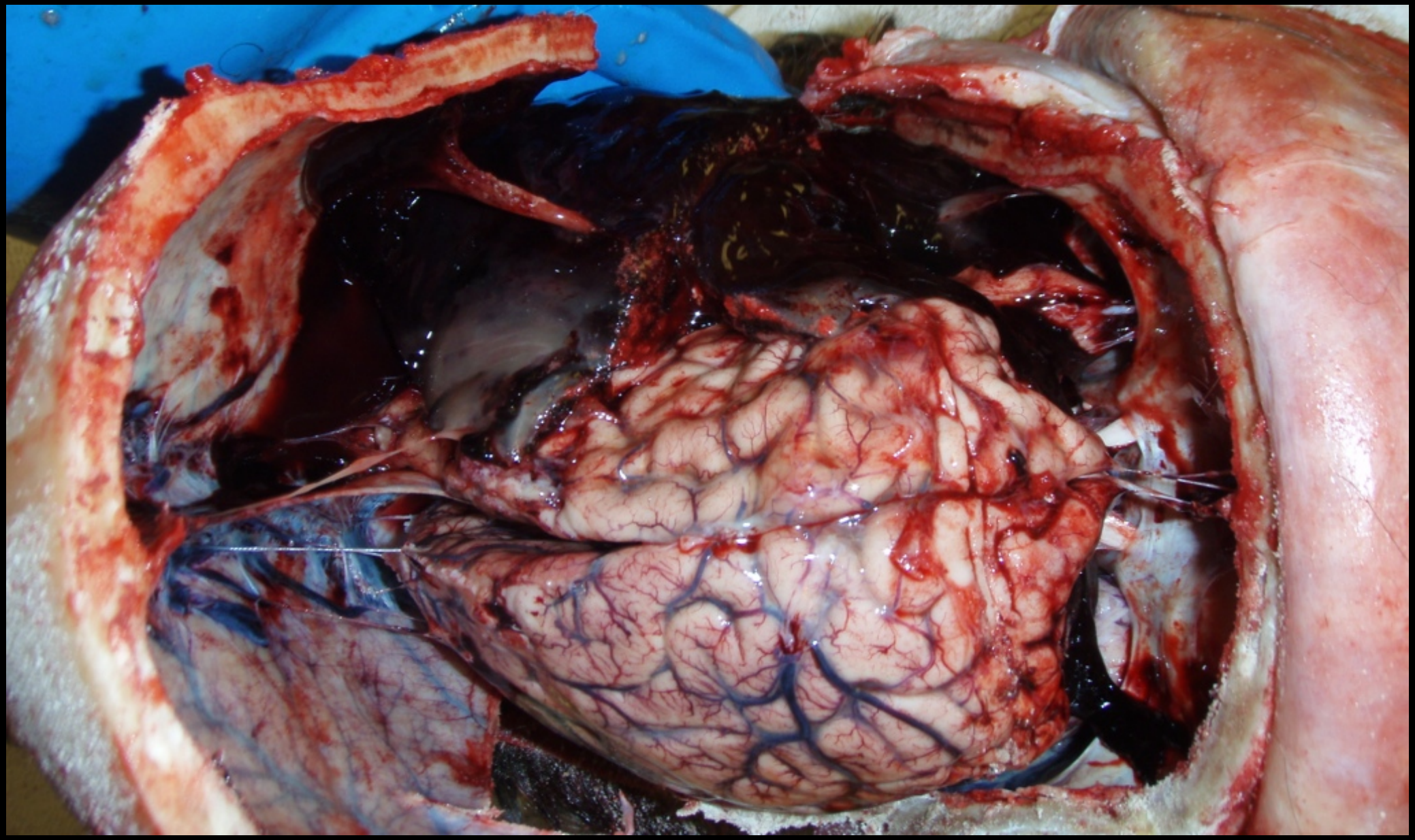
Epidural Hematoma



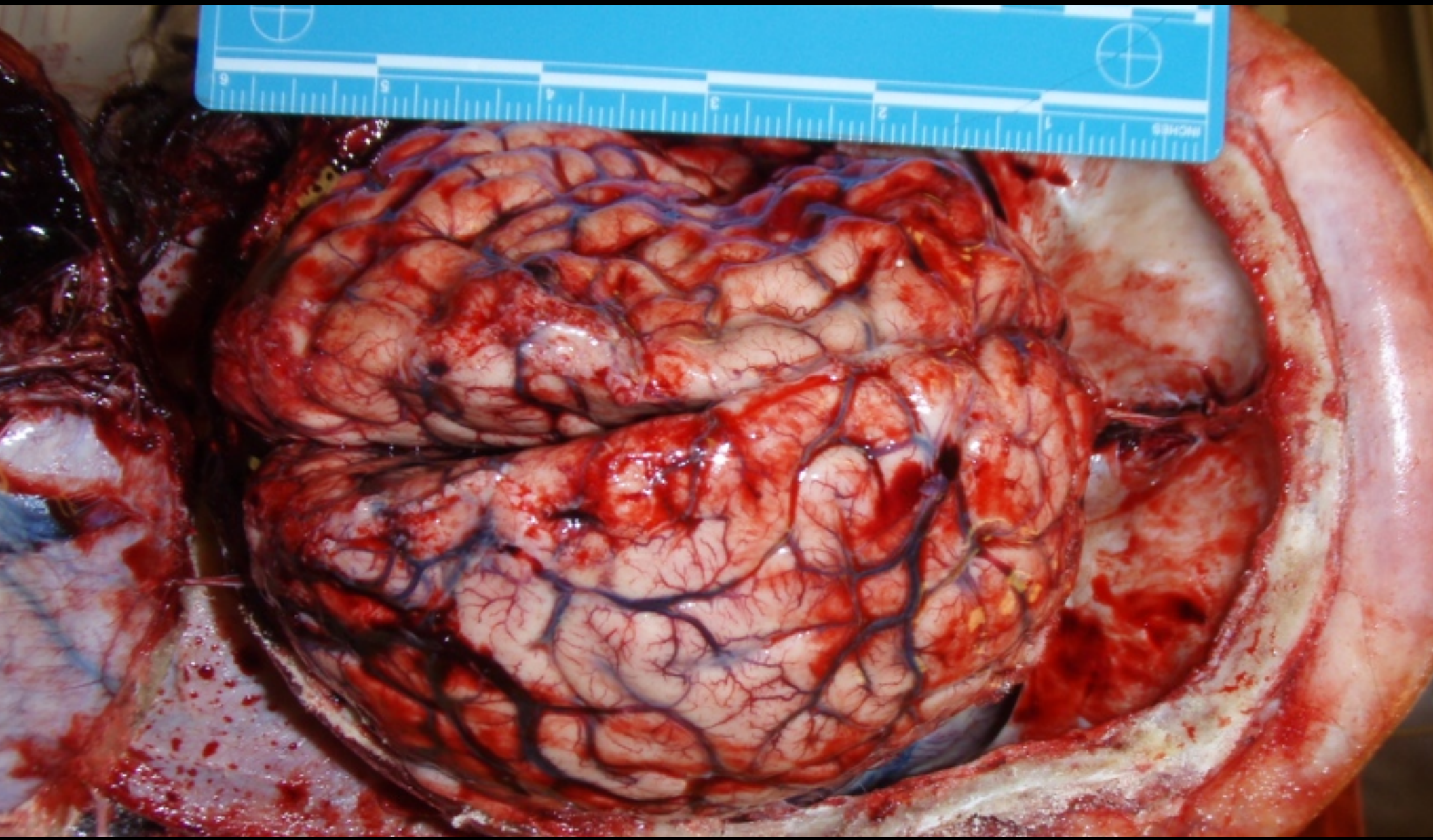
Bridging Vein



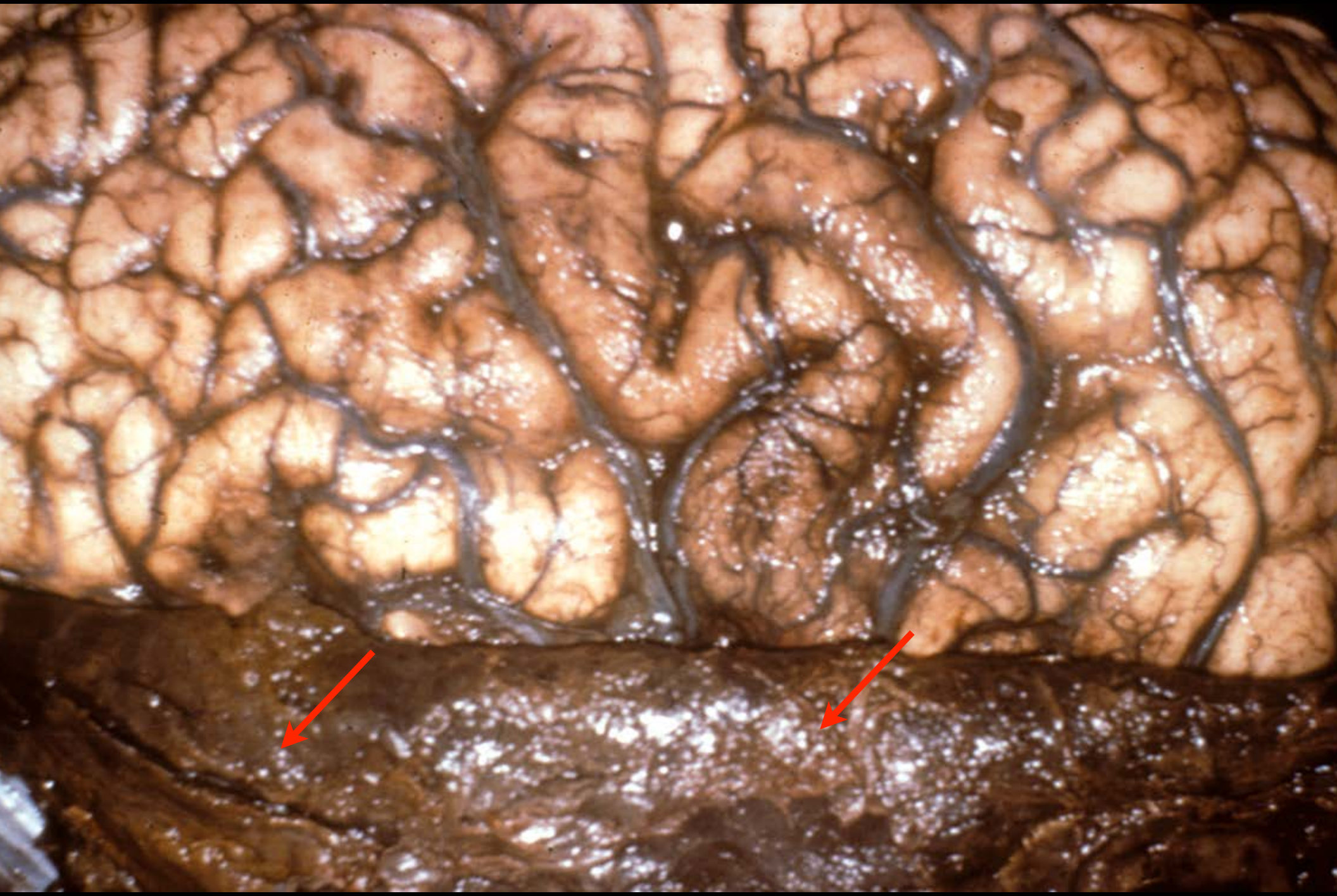
Subdural Hematoma



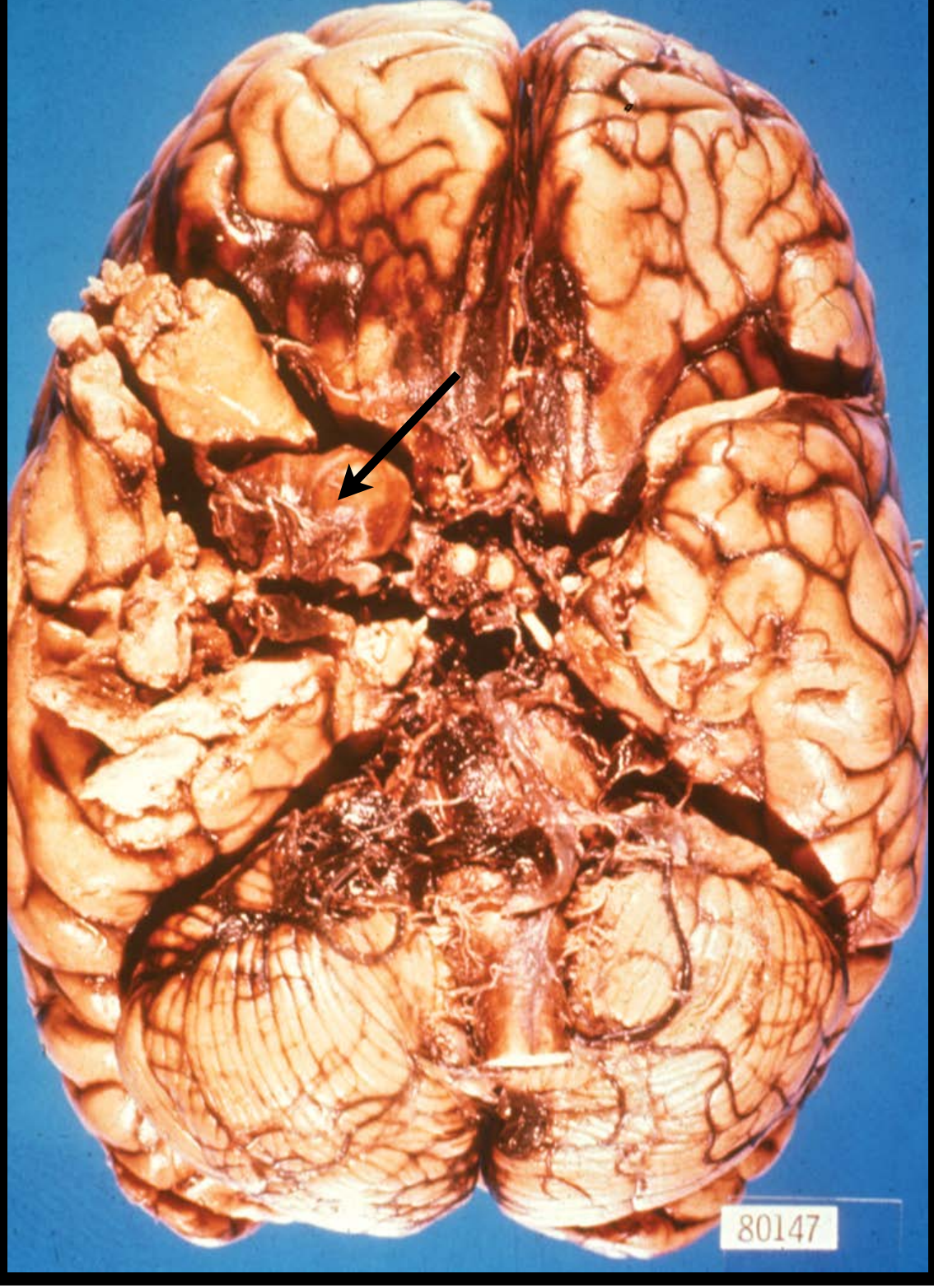
Subdural Hematoma



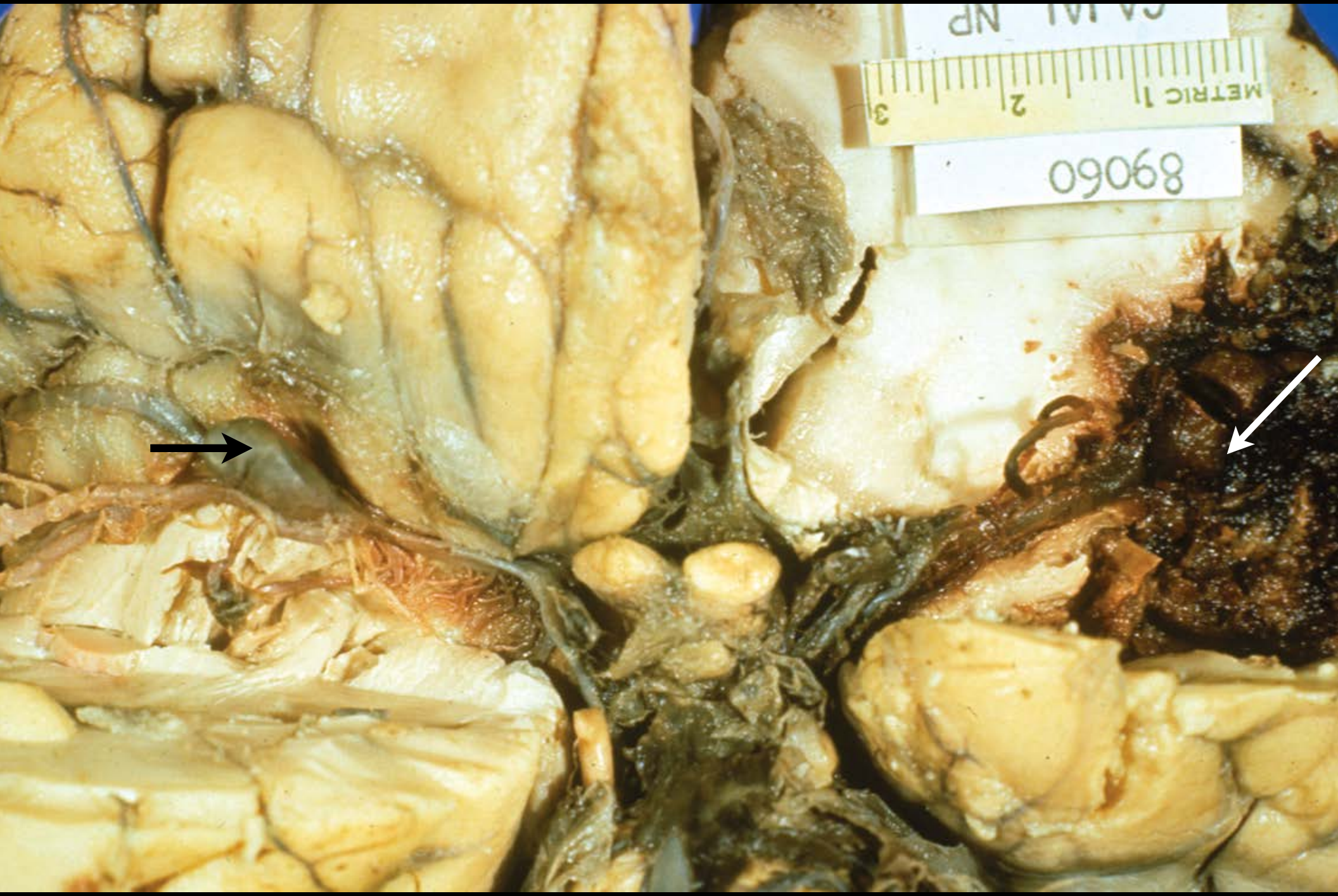
Subdural Hematoma



Subarachnoid Hemorrhage



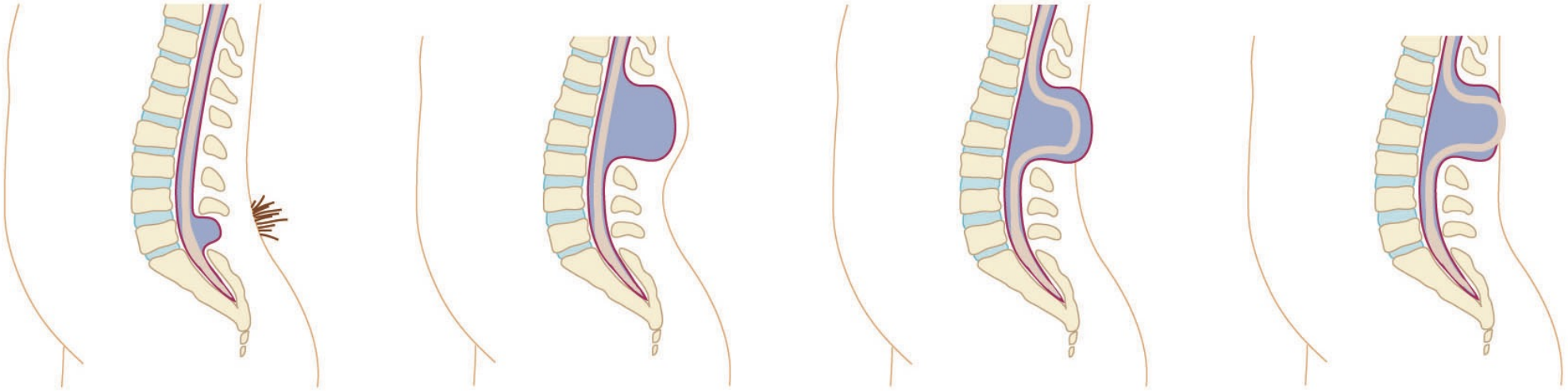
Subarachnoid Hemorrhage



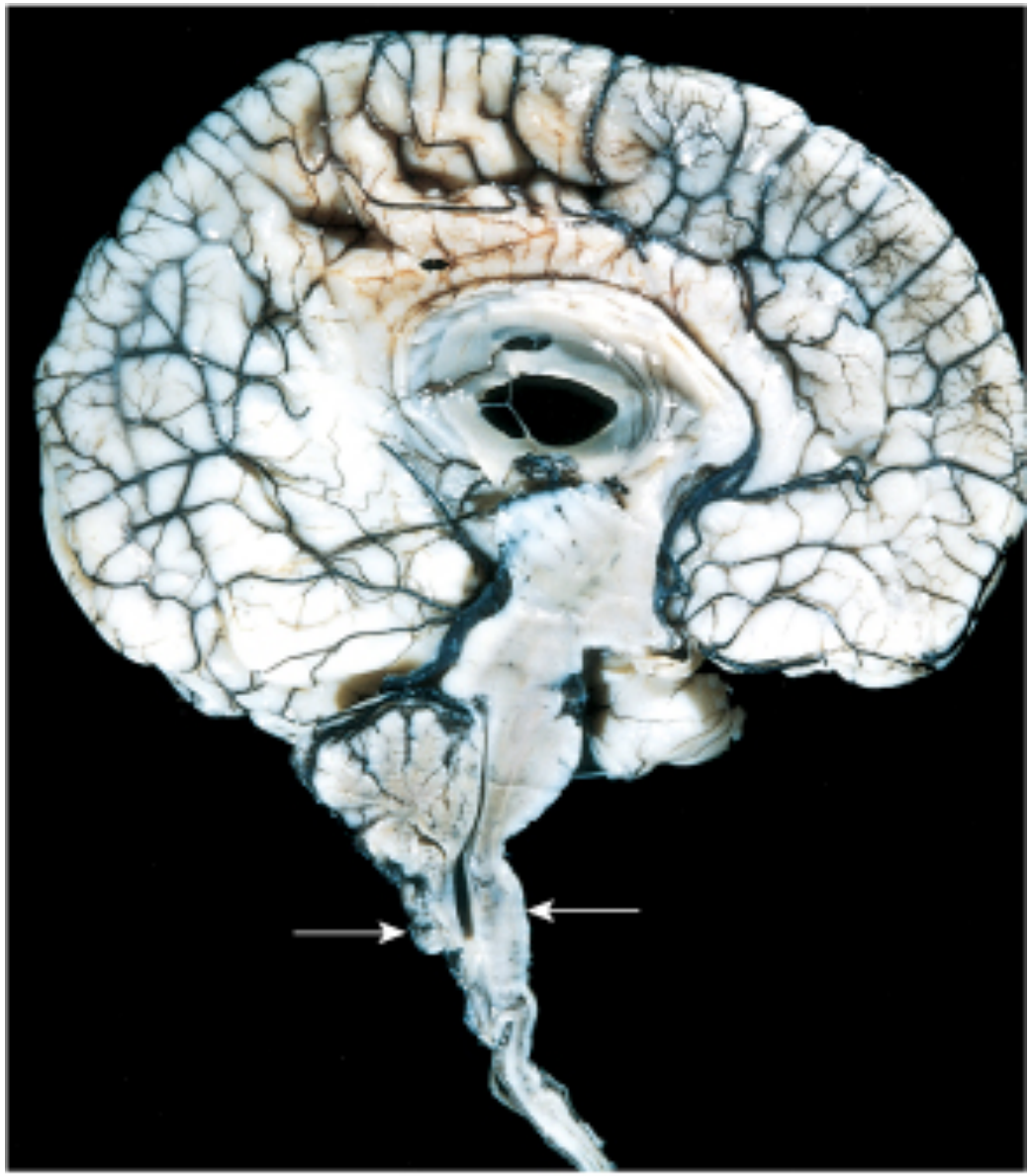
Developmental Anomalies

- Neural tube defects
- Arnold-Chiari malformation
  - Type I - downward displacement of cerebellar tonsils
  - Type II - small posterior fossa
- Syringomyelia (cyst/cavity within the spinal cord)
- Perinatal brain injury - cerebral palsy

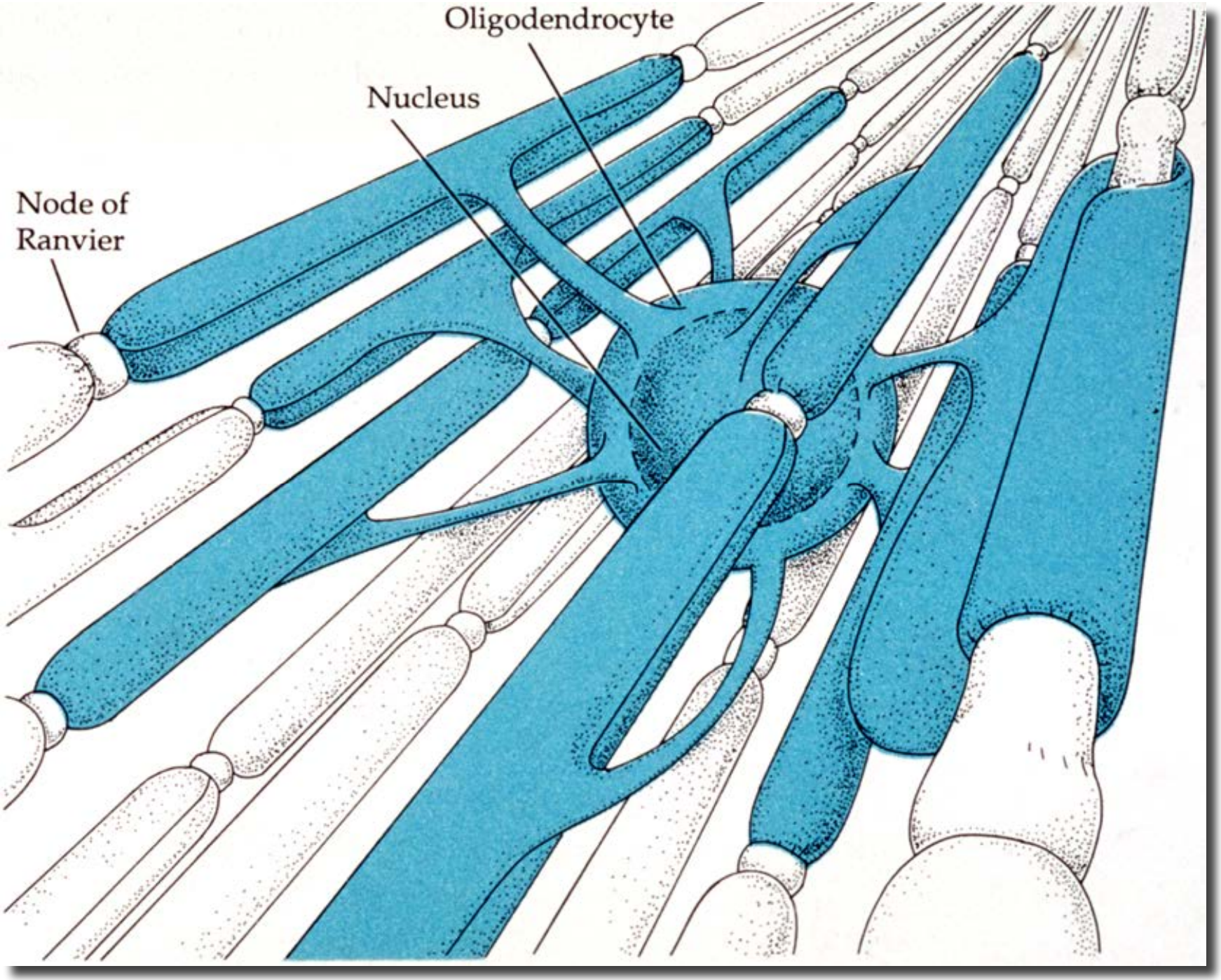
Neural Tube Defects of the Spinal Cord



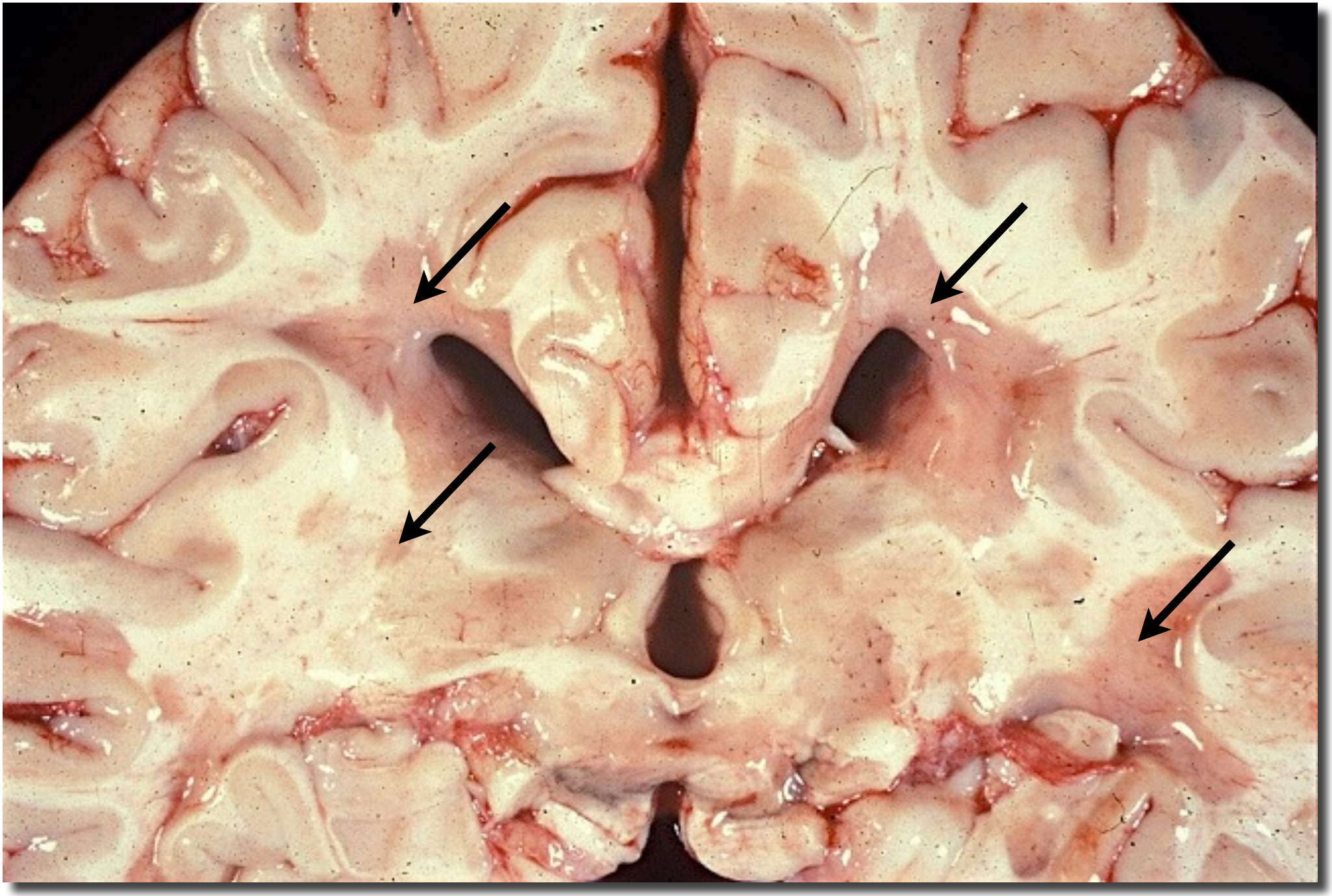
Arnold-Chiari Malformation, Type II



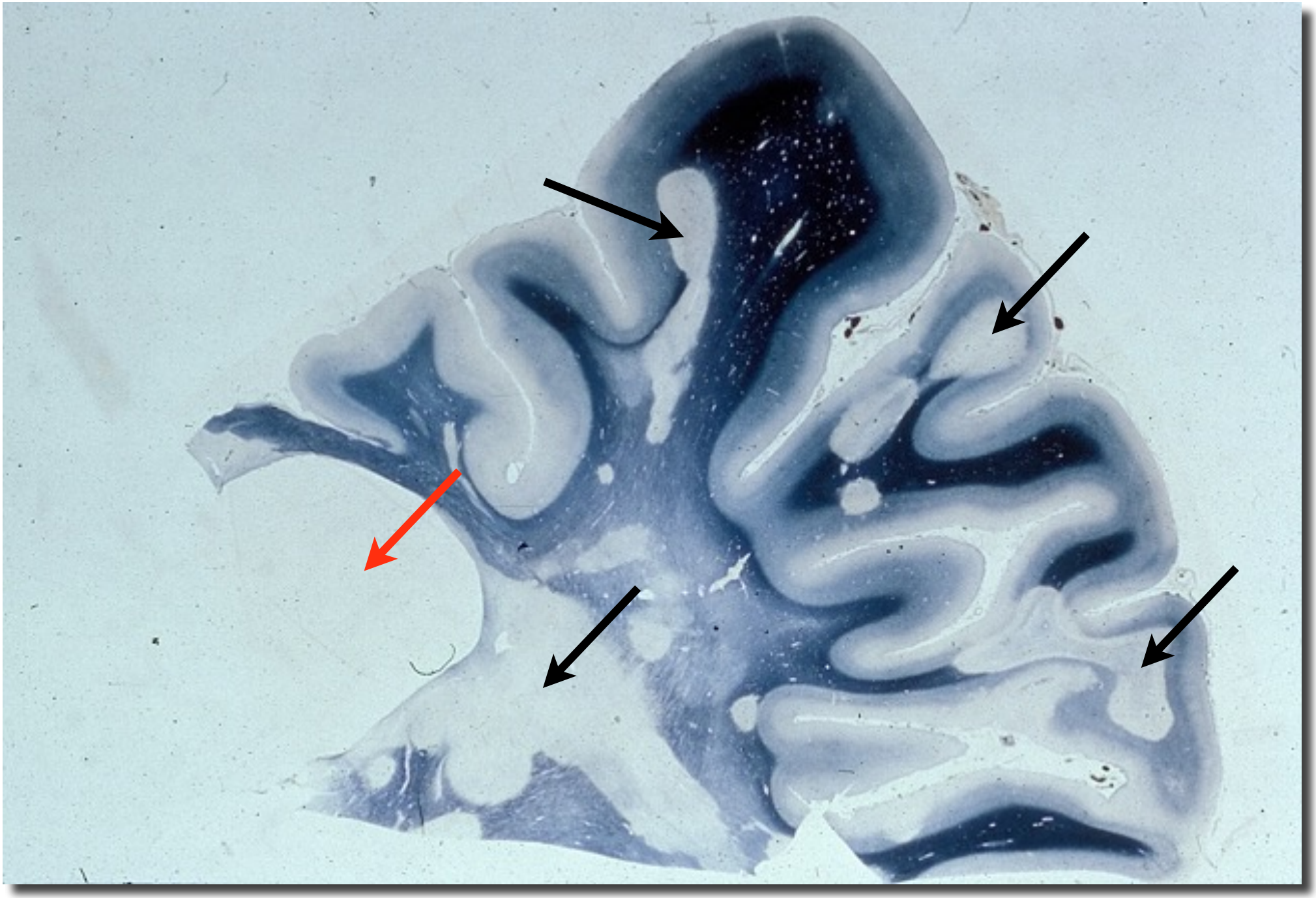
Demyelinating/ Neurodegenerative Diseases


Oligodendrocyte
Nucleus
Node of
Ranvier

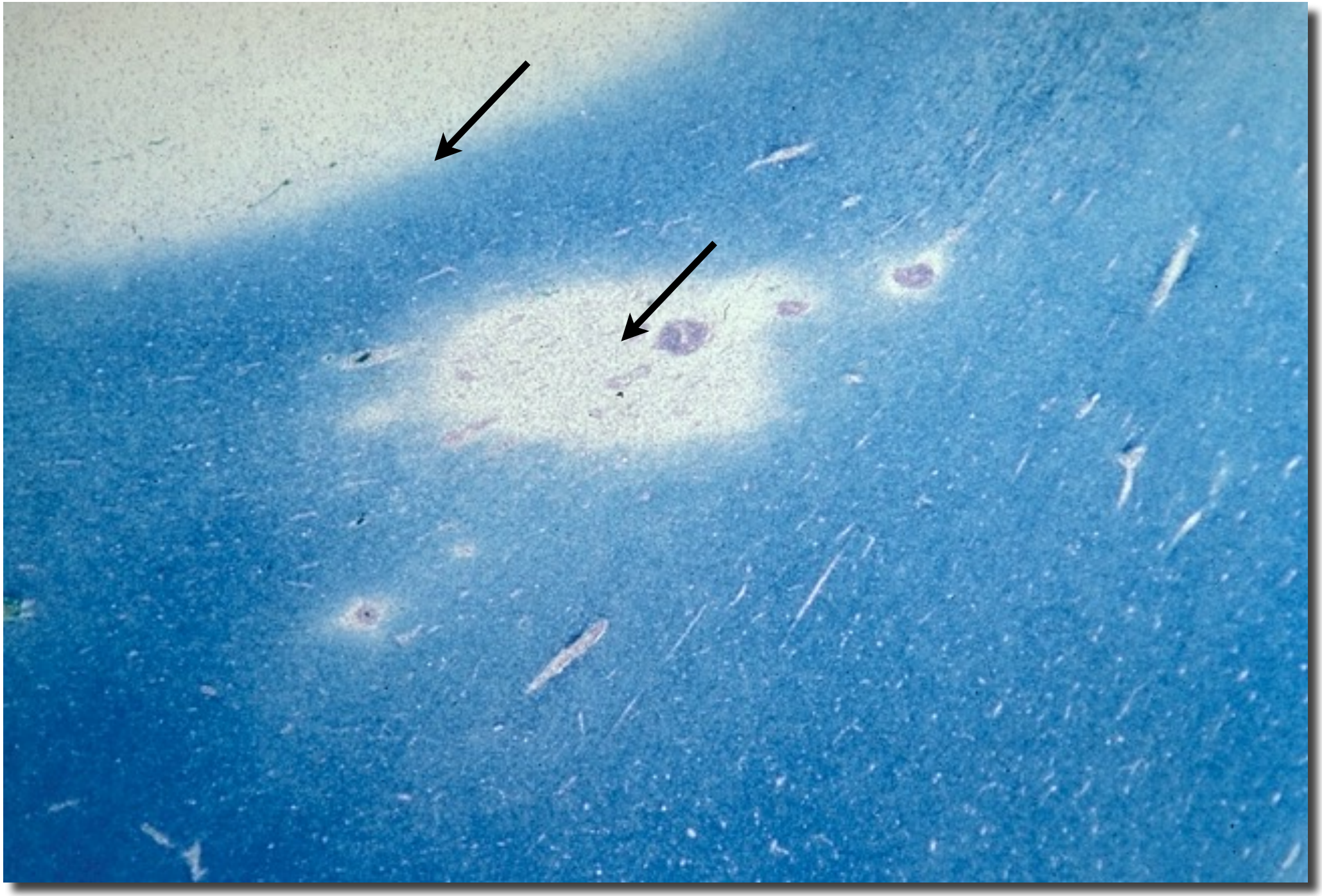
Multiple Sclerosis



Multiple Sclerosis



Multiple Sclerosis



Multiple Sclerosis

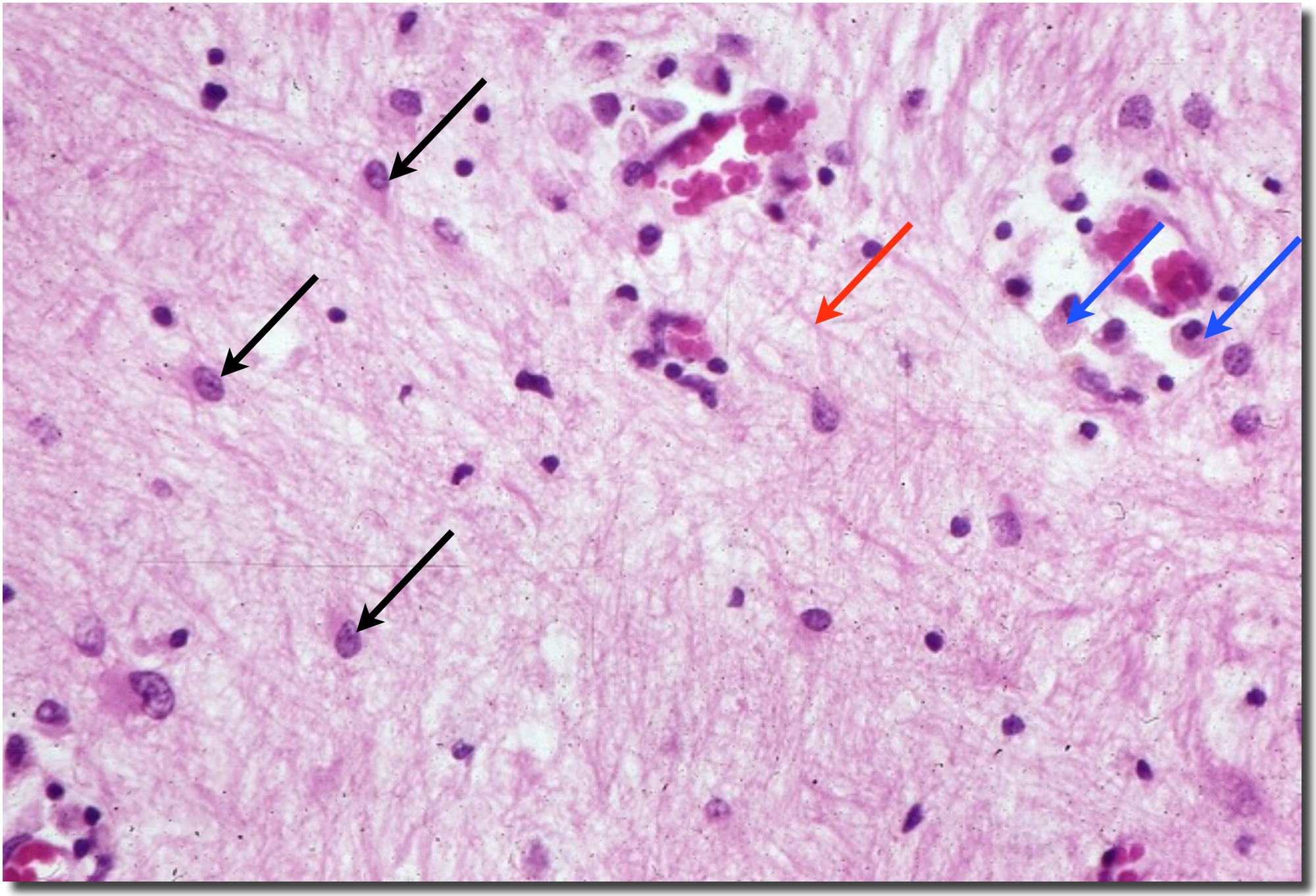
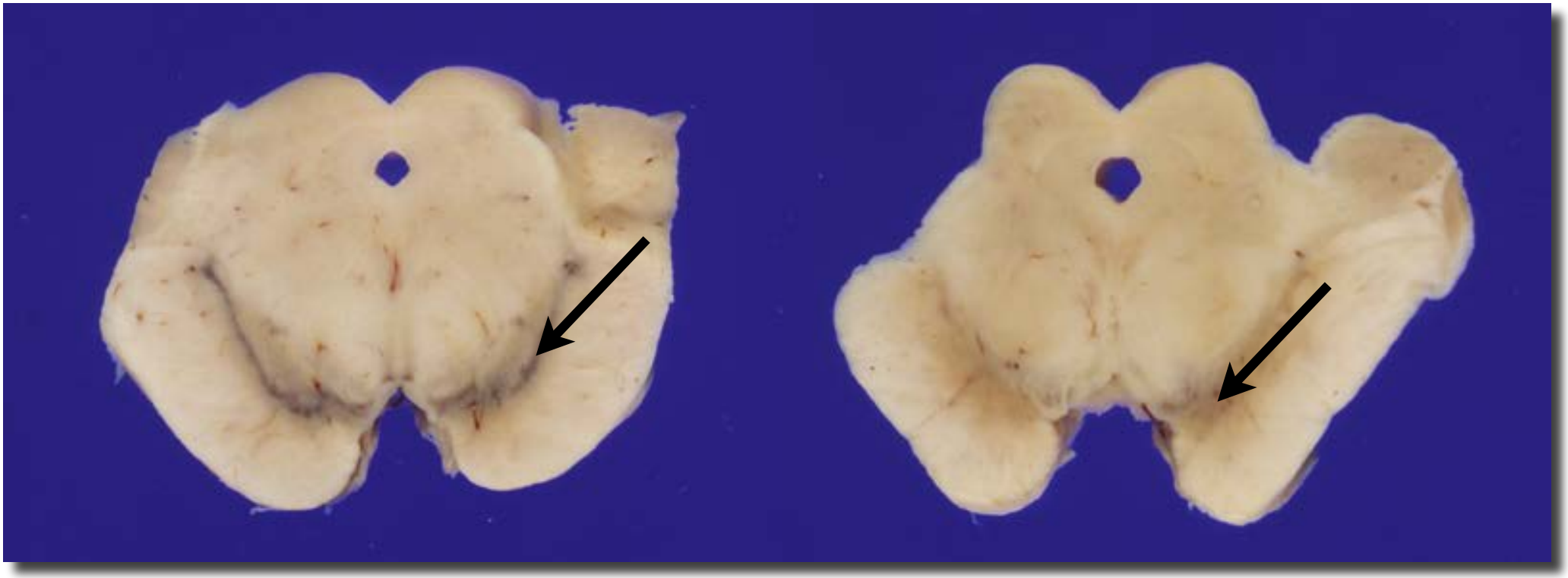


Table 29-4. The Dementias

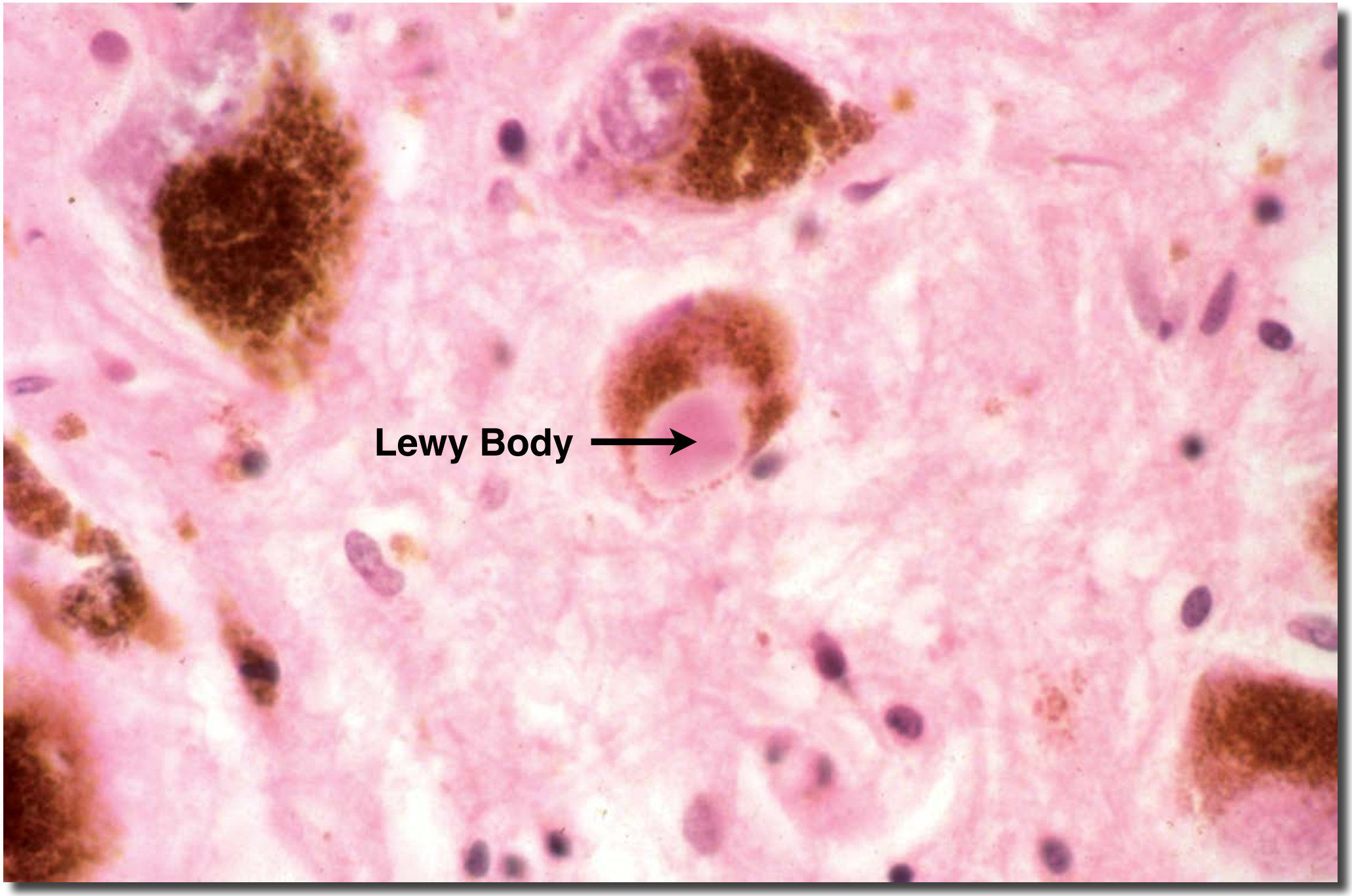
Frequent Causes	Less Frequent Causes
Alzheimer disease	Pick disease
Dementia with Lewy bodies	Primary subcortical degenerations: Parkinson disease, multiple system atrophy, Huntington disease, progressive supranuclear palsy
Vascular dementia	Prion diseases (Creutzfeldt-Jacob)
Mixed Alzheimer and vascular	Normal pressure hydrocephalus dementia



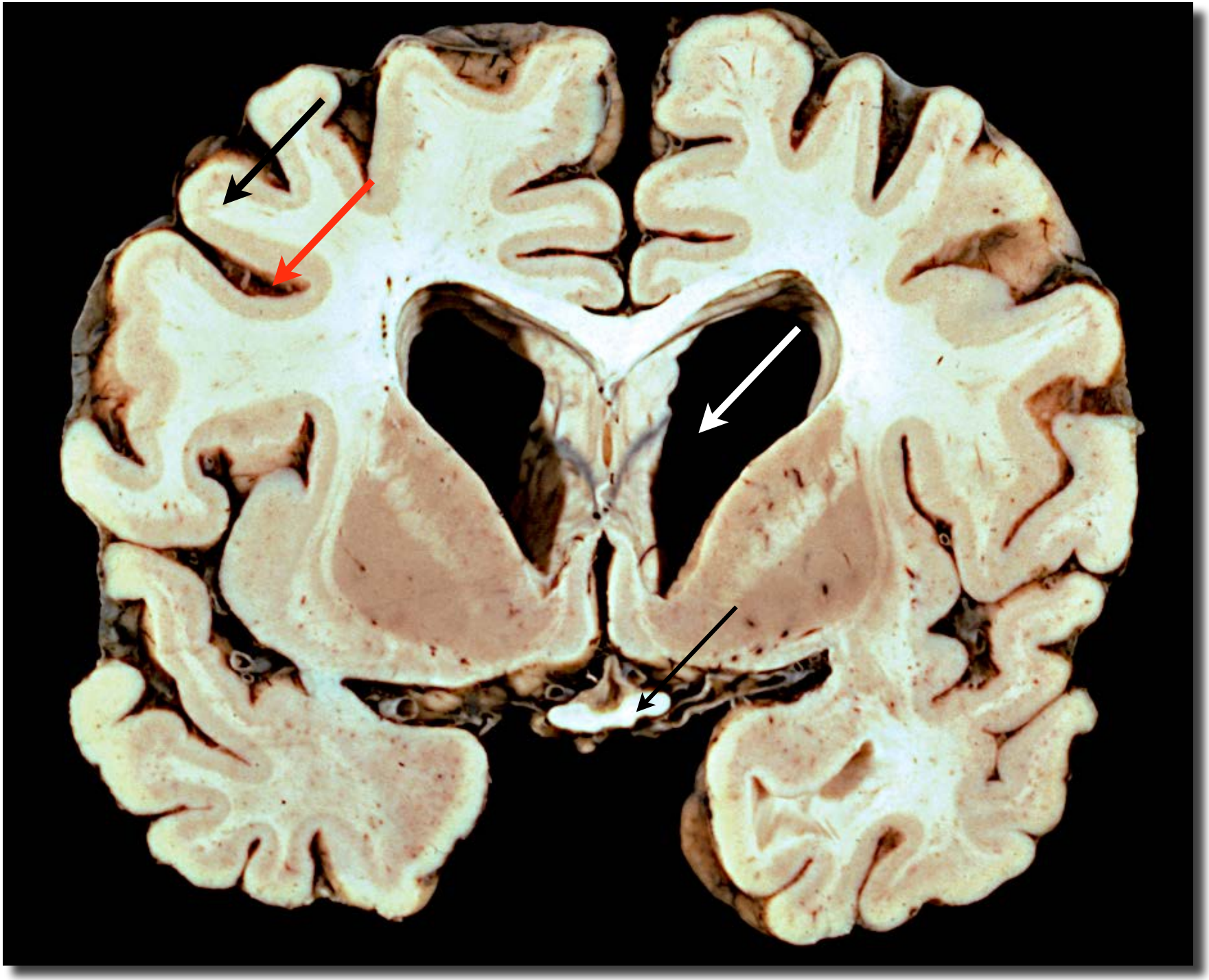
Normal

Parkinson Disease

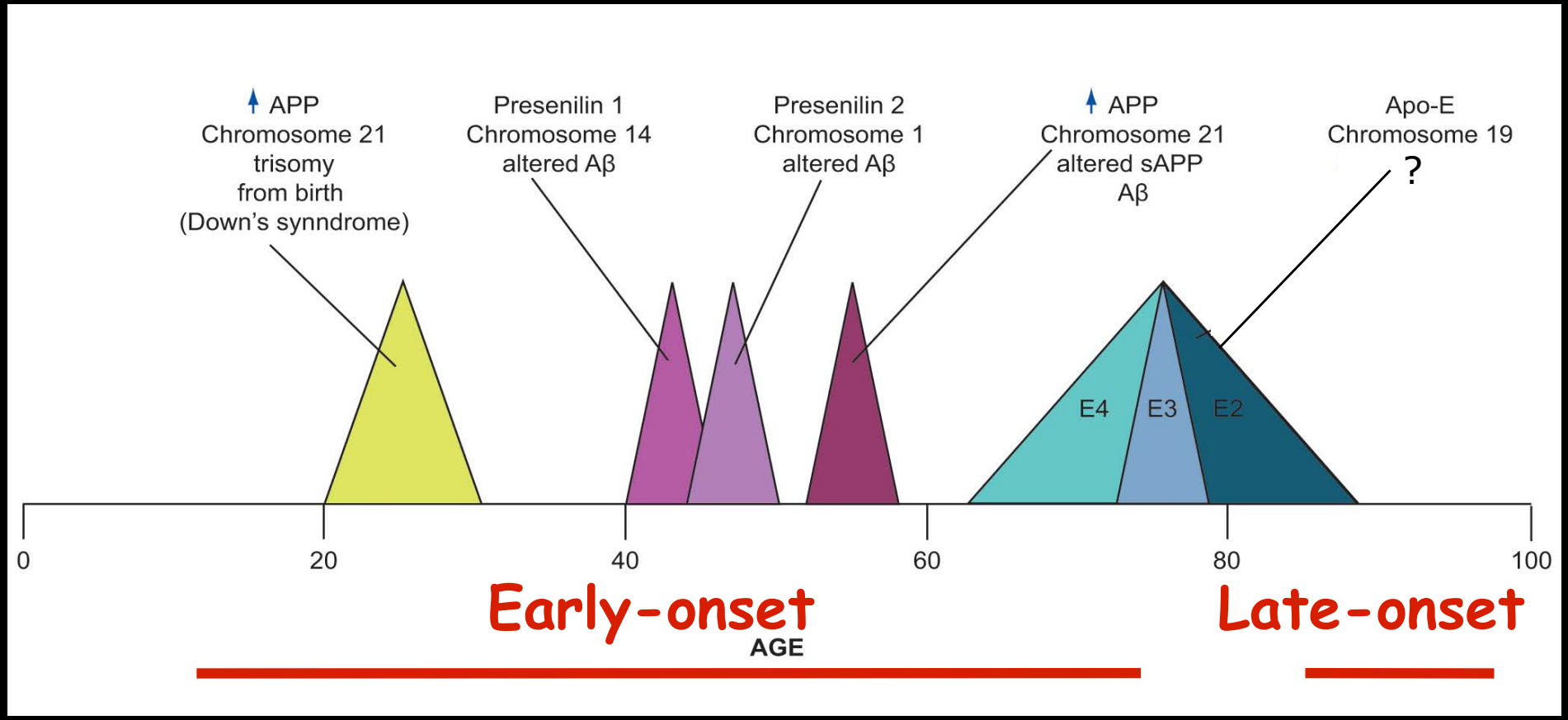
Parkinson Disease



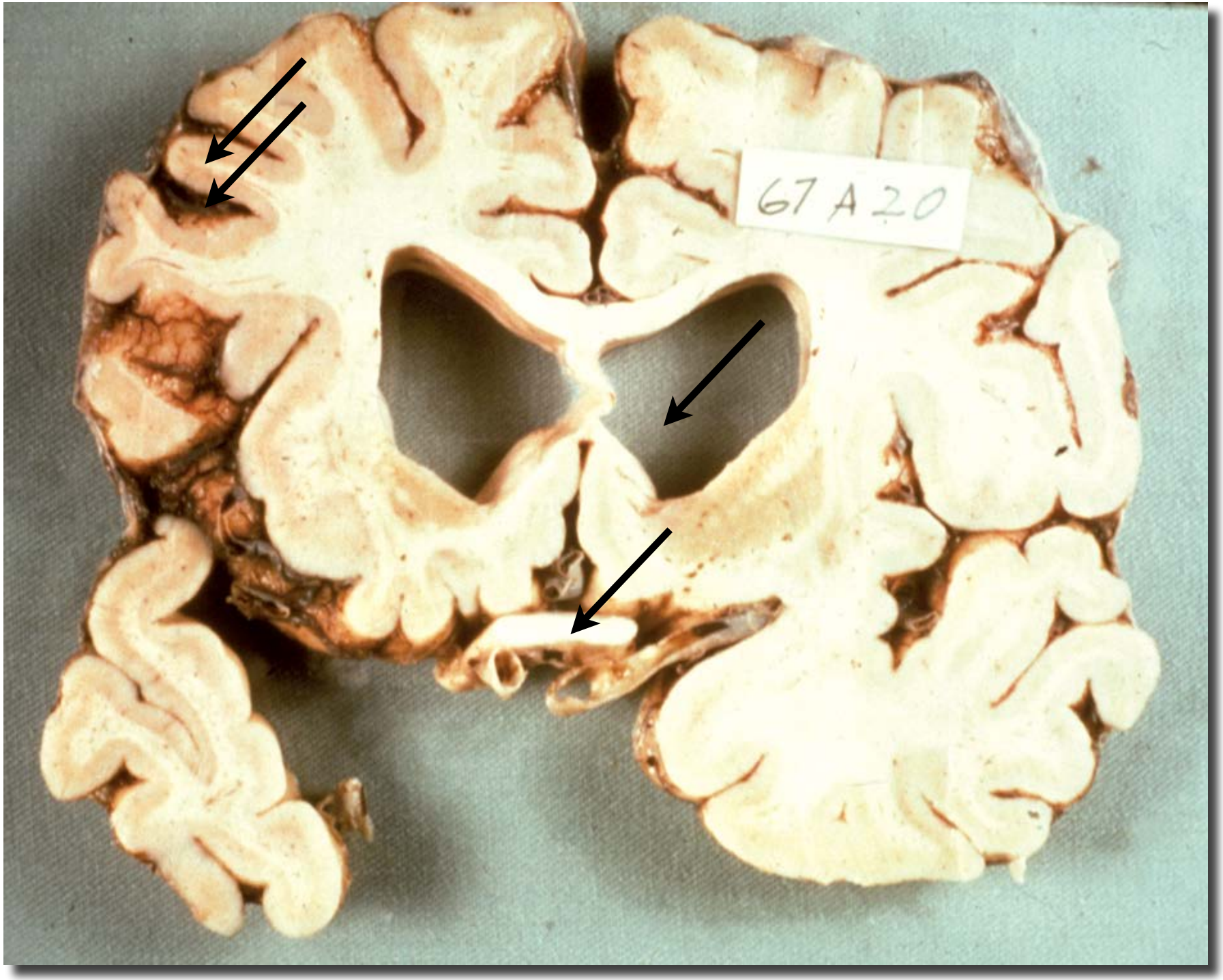
Huntington Disease



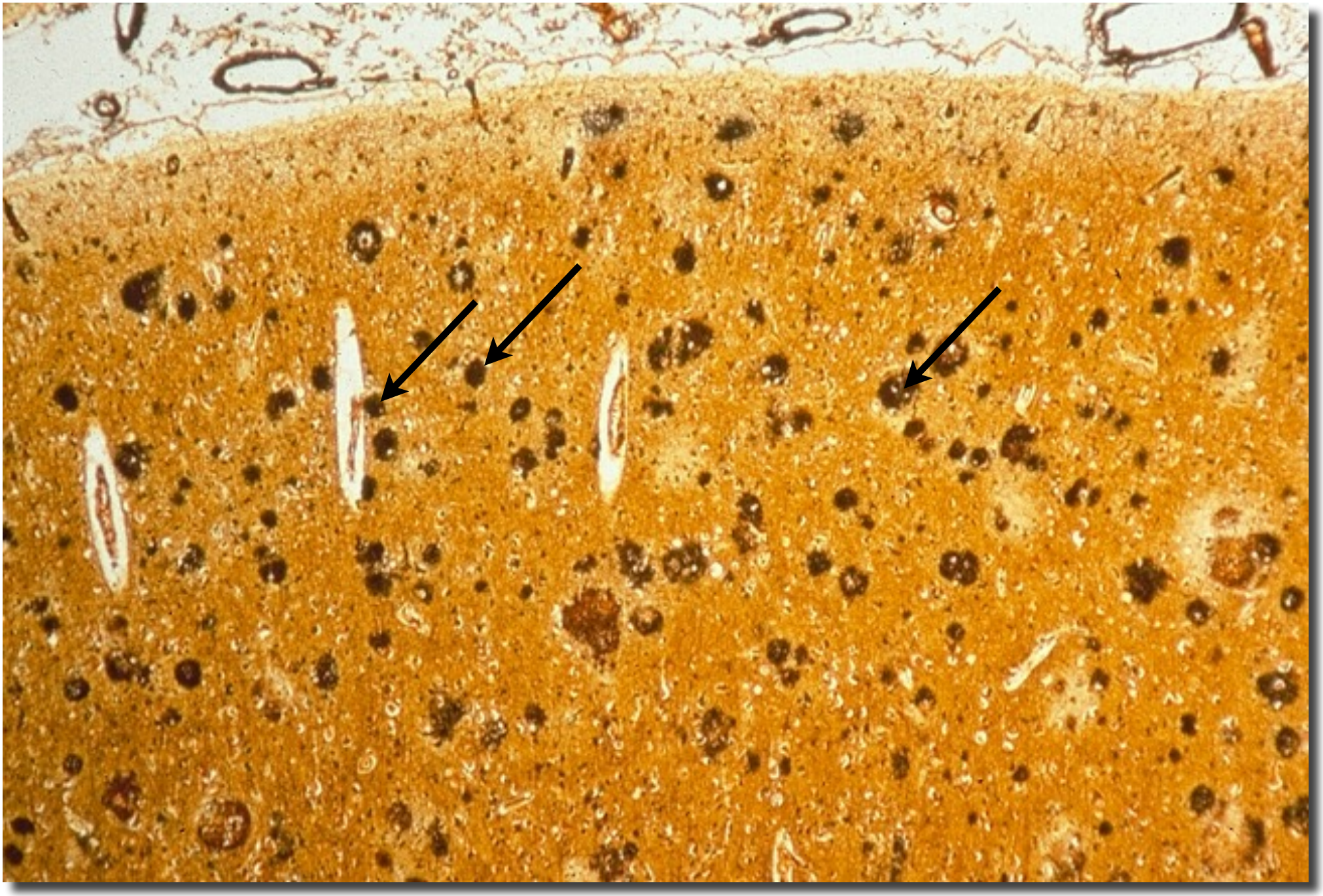
Genes associated with Alzheimer disease



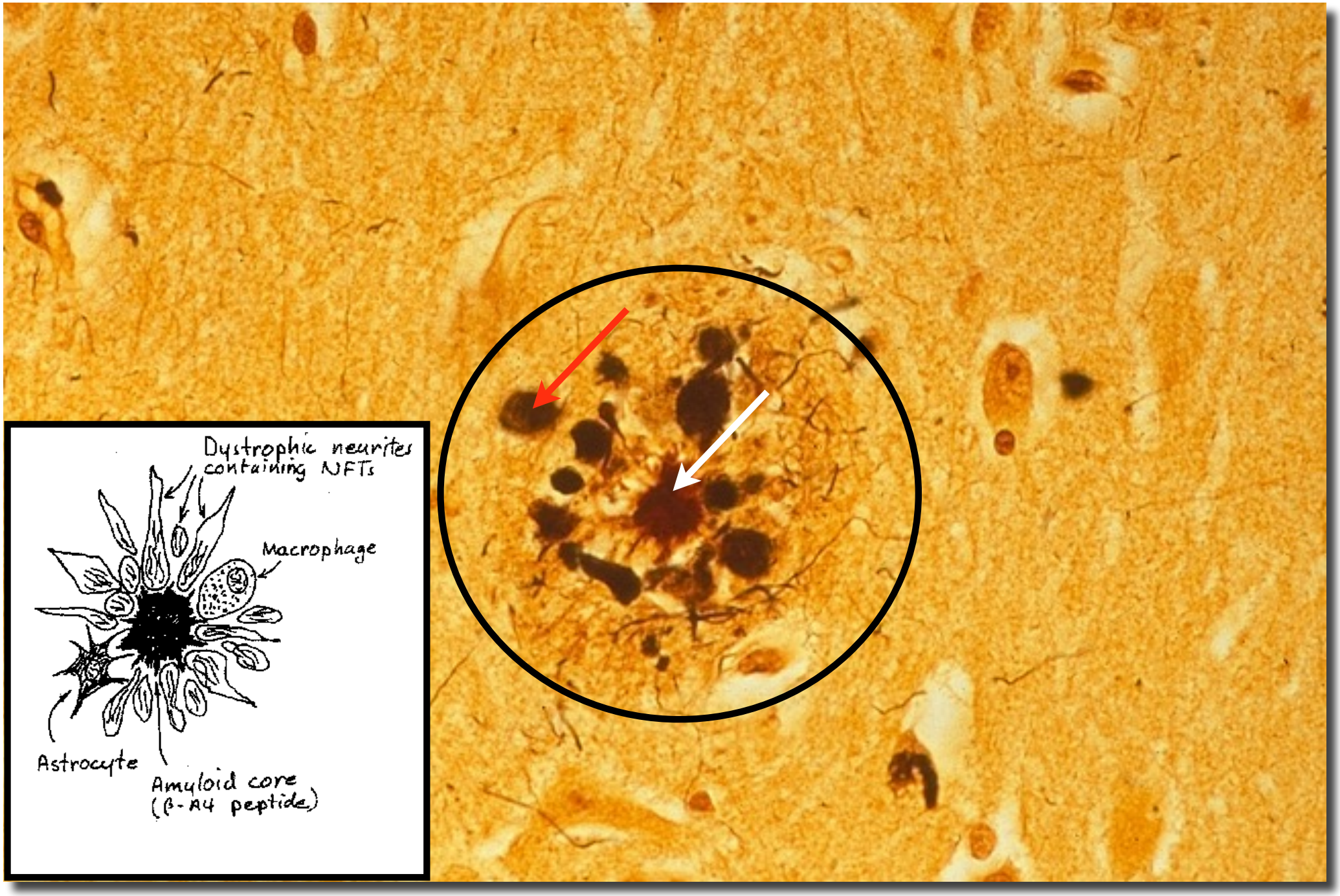
Alzheimer Disease



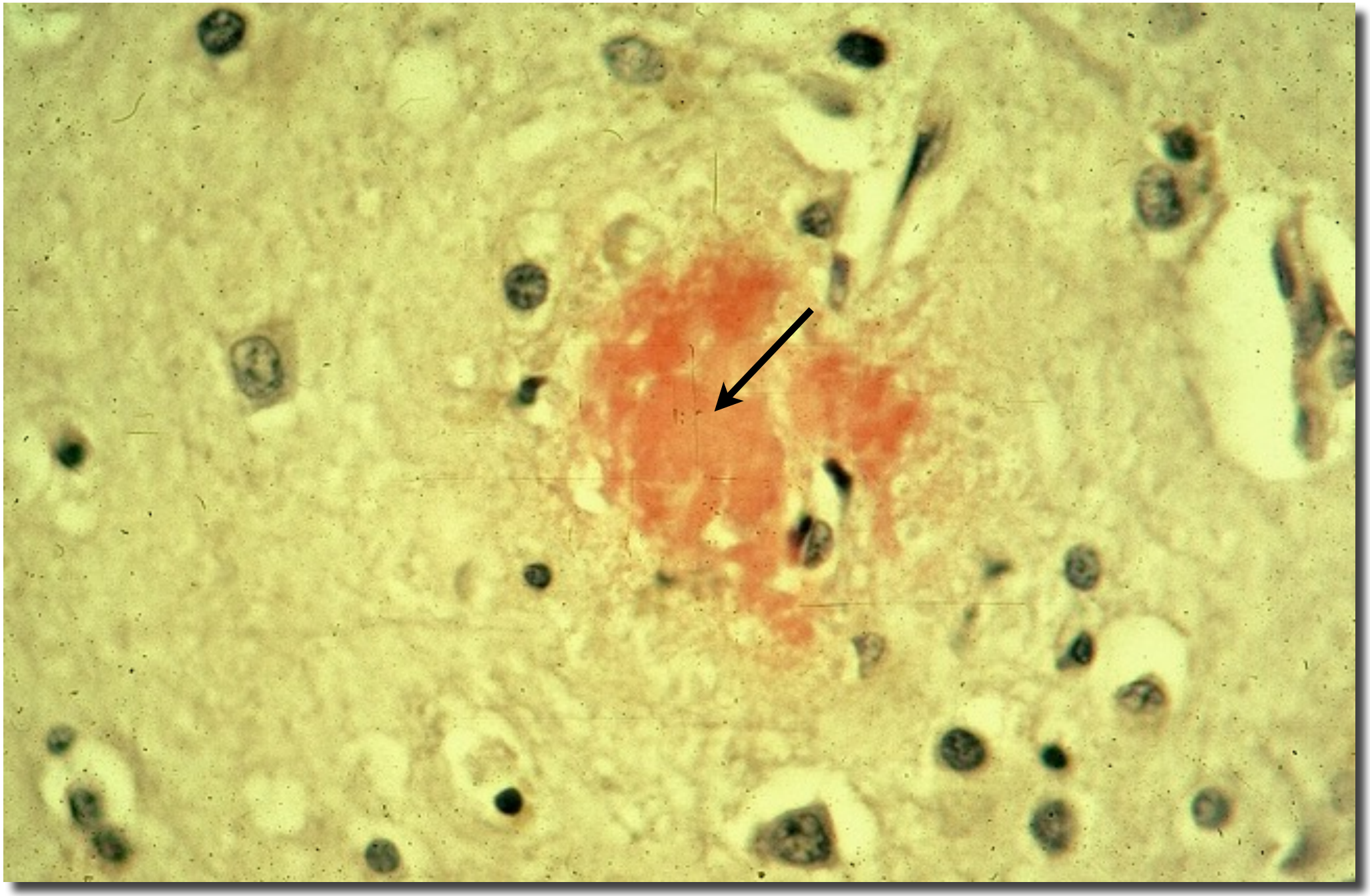
Alzheimer Disease: Neuritic Plaques



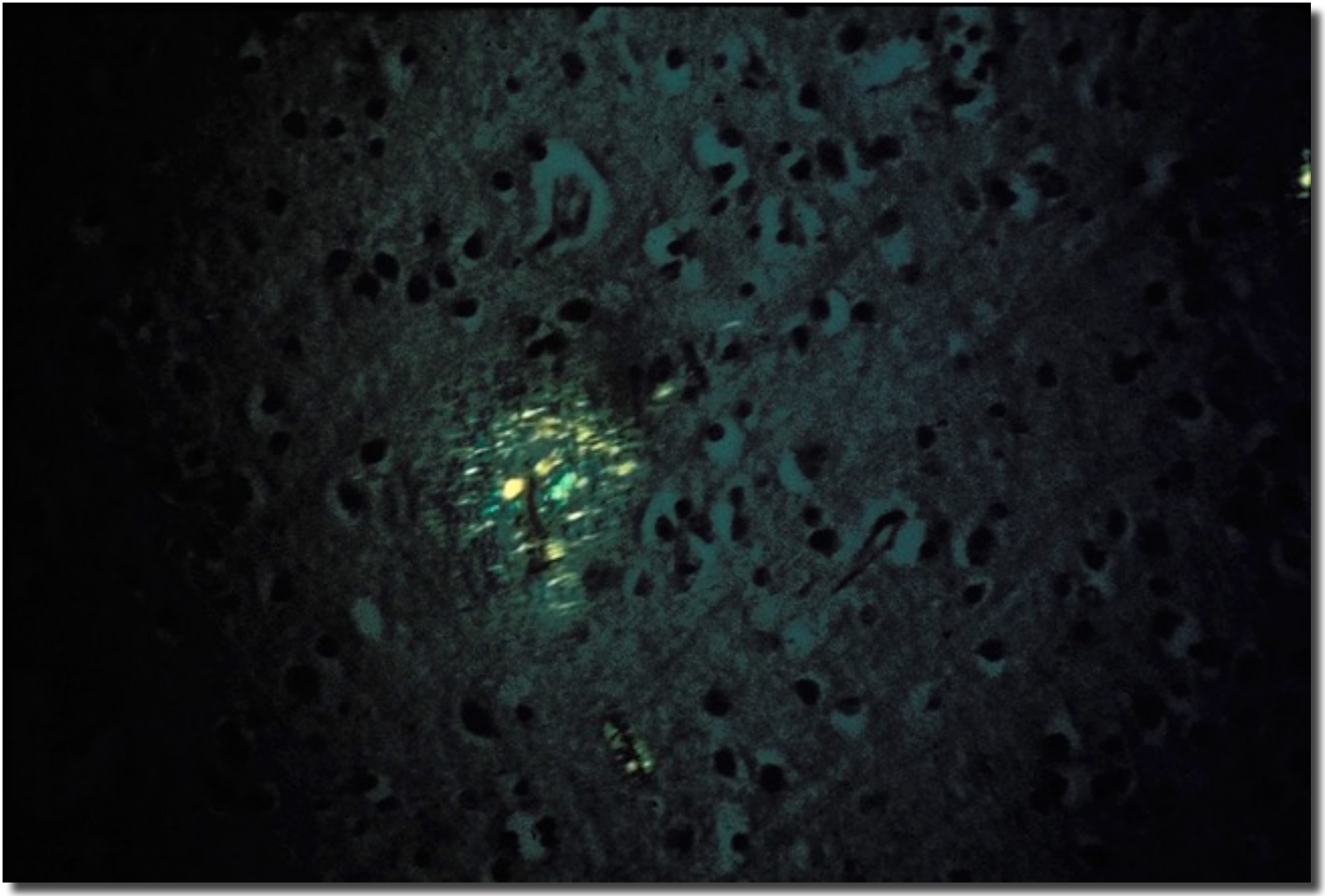
Alzheimer Disease: Neuritic Plaque



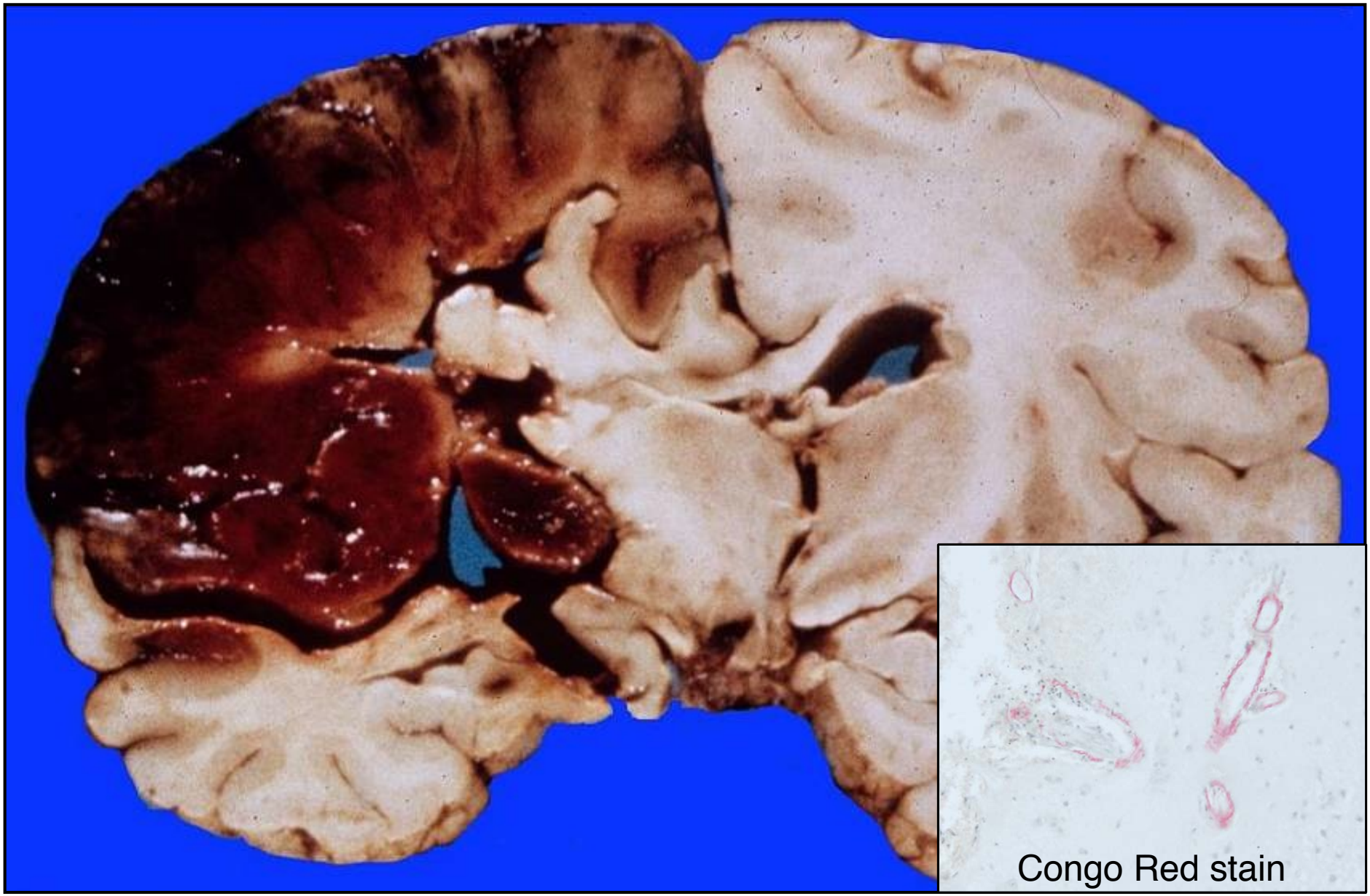
Alzheimer Disease: Neuritic Plaque (Congo Red)



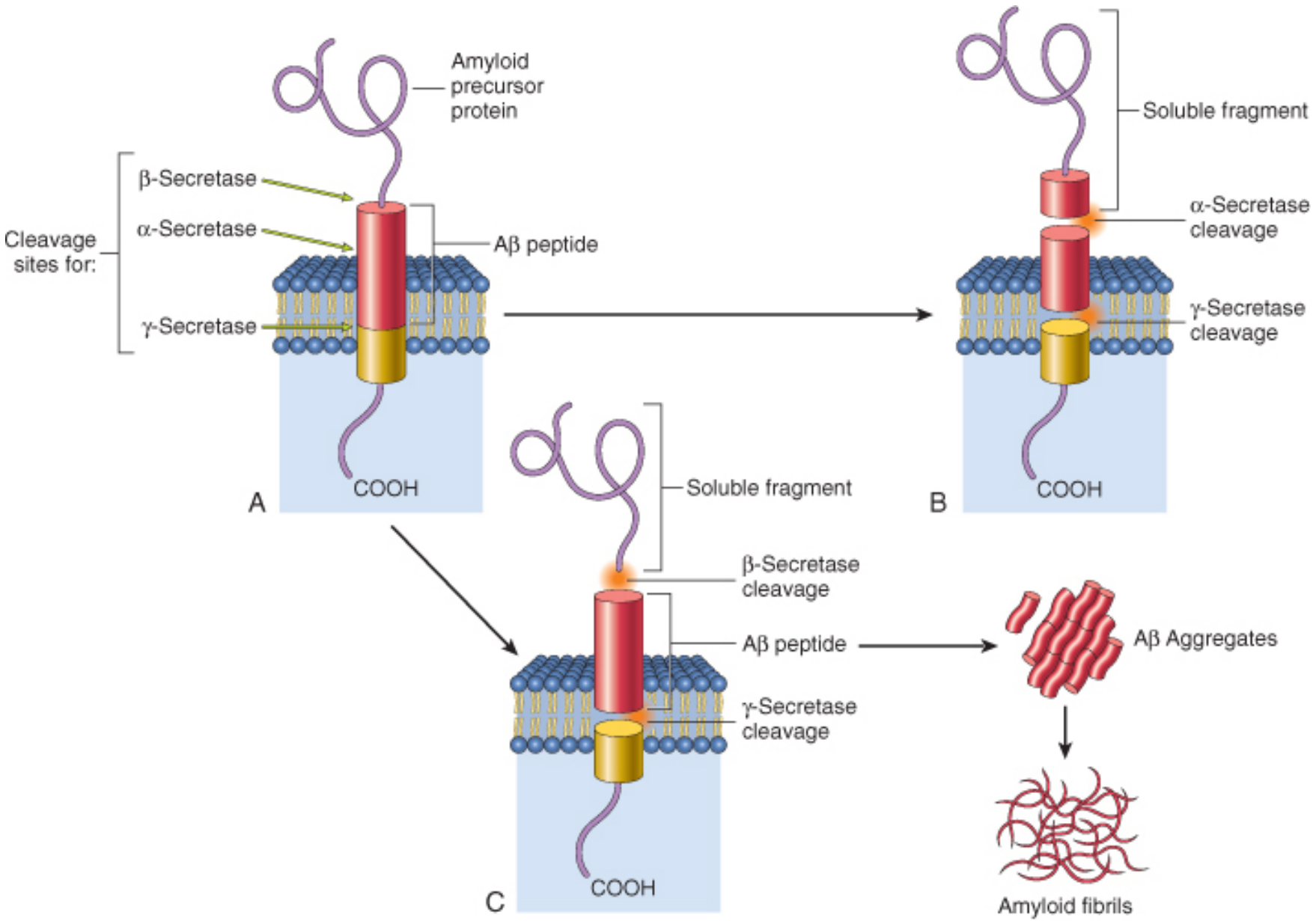
Alzheimer Disease: Neuritic Plaque (Polarized Light)



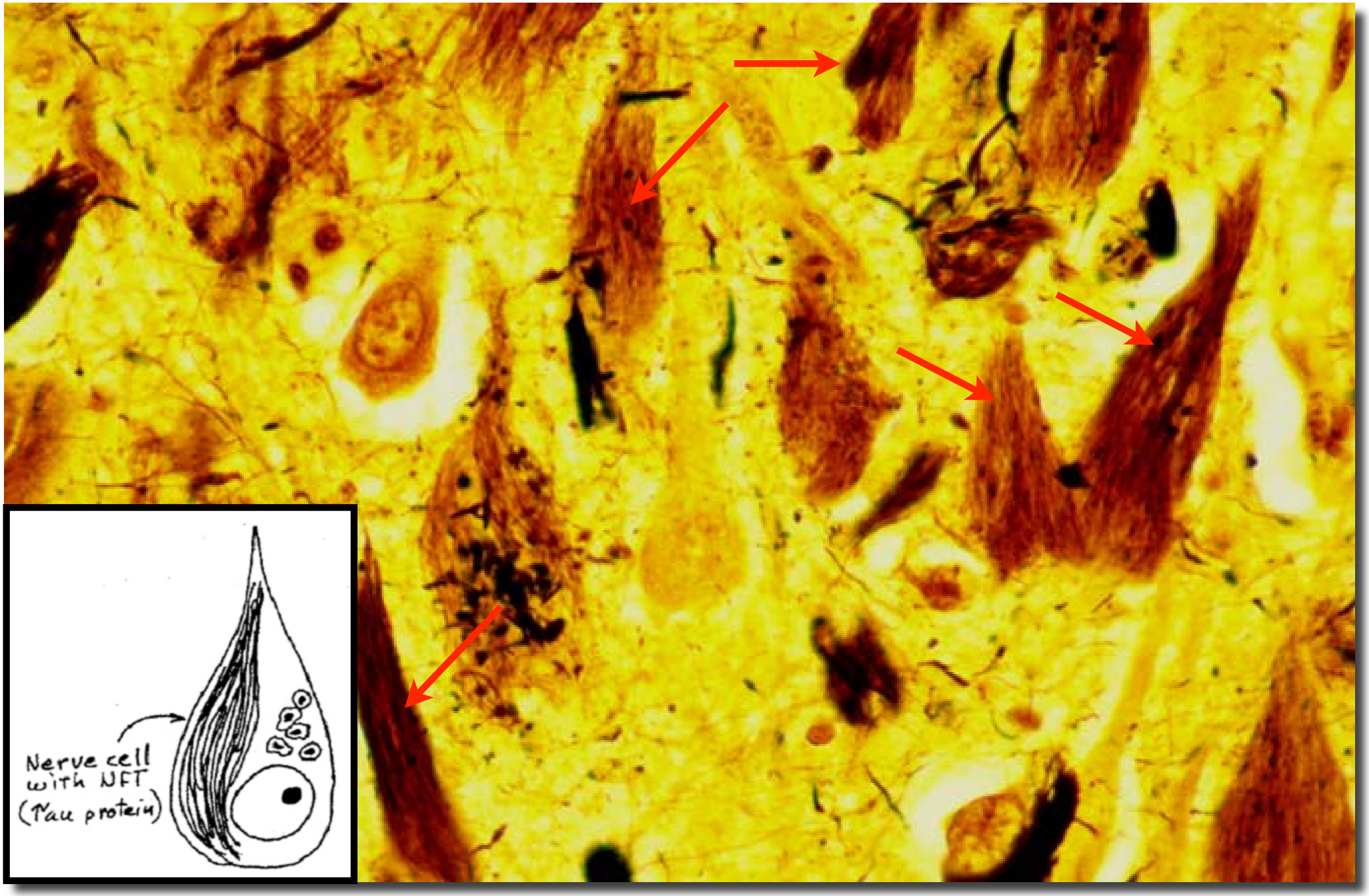
Alzheimer Disease: Lobar Hemorrhage due to Cerebral Amyloid Angiopathy

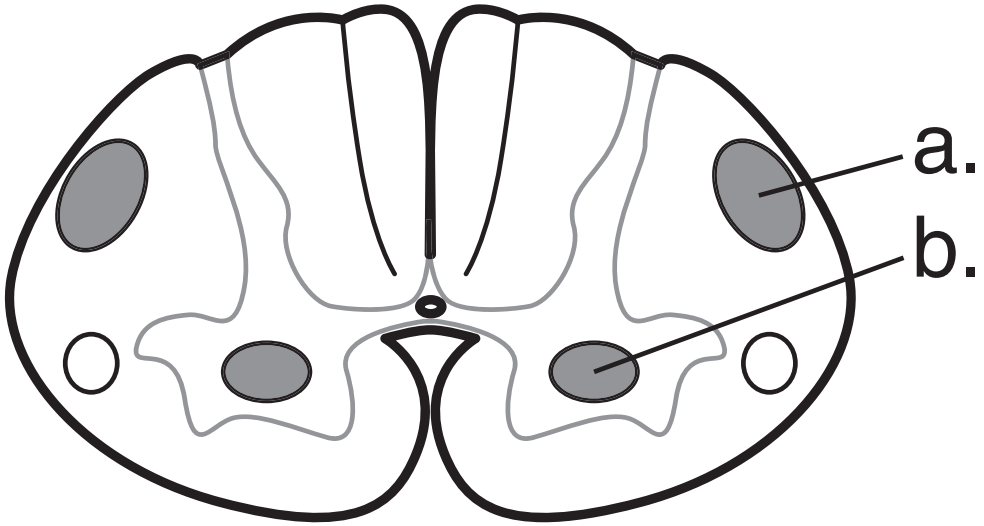


Pathogenesis of Alzheimer Disease



Alzheimer Disease: Neurofibrillary Tangles





Amyotrophic lateral sclerosis (ALS)

a. Primary lateral sclerosis (corticospinal tract)

b. Progressive spinal muscular atrophy (ventral horn)

Friedreich Ataxia

- Autosomal recessive
  - Expansion of an unstable triplet nucletide repeat in the frataxin gene
- Degeneration of neurons:
  - Dorsal root ganglia
  - Clarke's column (origin of spinocerebellar tract)
  - Neurons of the posterior column of spinal cord
  - Cranial nerve nuclei of VII, X, and XII
  - Dentate nucleus and Purkinje cells of cerebellum
  - Neurons of primary motor cortex
- Clinical manifestations: gait ataxia, dysarthria, hand clumsiness, loss of sense of position, impaired vibratory sensation, and loss of tendon reflexes

Neoplasias of the CNS

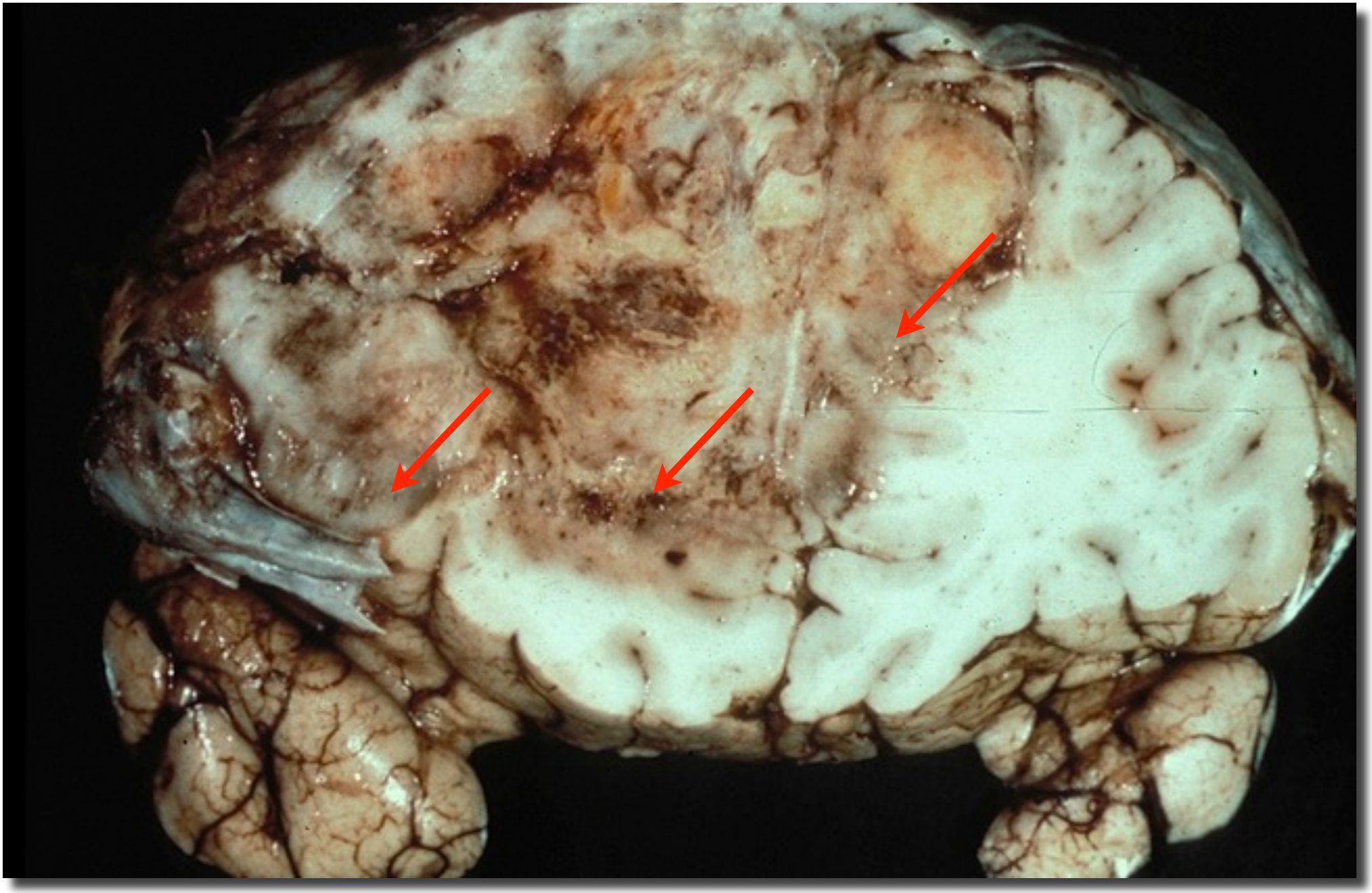
CNS Tumors

- Epidemiology
  - Half of all brain and spinal cord tumors of metastatic
  - Most frequent primary CNS tumors - meningiomas and glioblastoma multiforme
  - Primary malignant CNS tumors account for 2-3% of all cancer deaths in the United States
- Clinical manifestations
  - Headache, often worse at night, or early morning
  - Seizures - tumors involving the cerebral cortex
  - Mental changes - memory deficits, concentration, reasoning
  - Focal neurological symptoms
  - Increased intracranial pressure

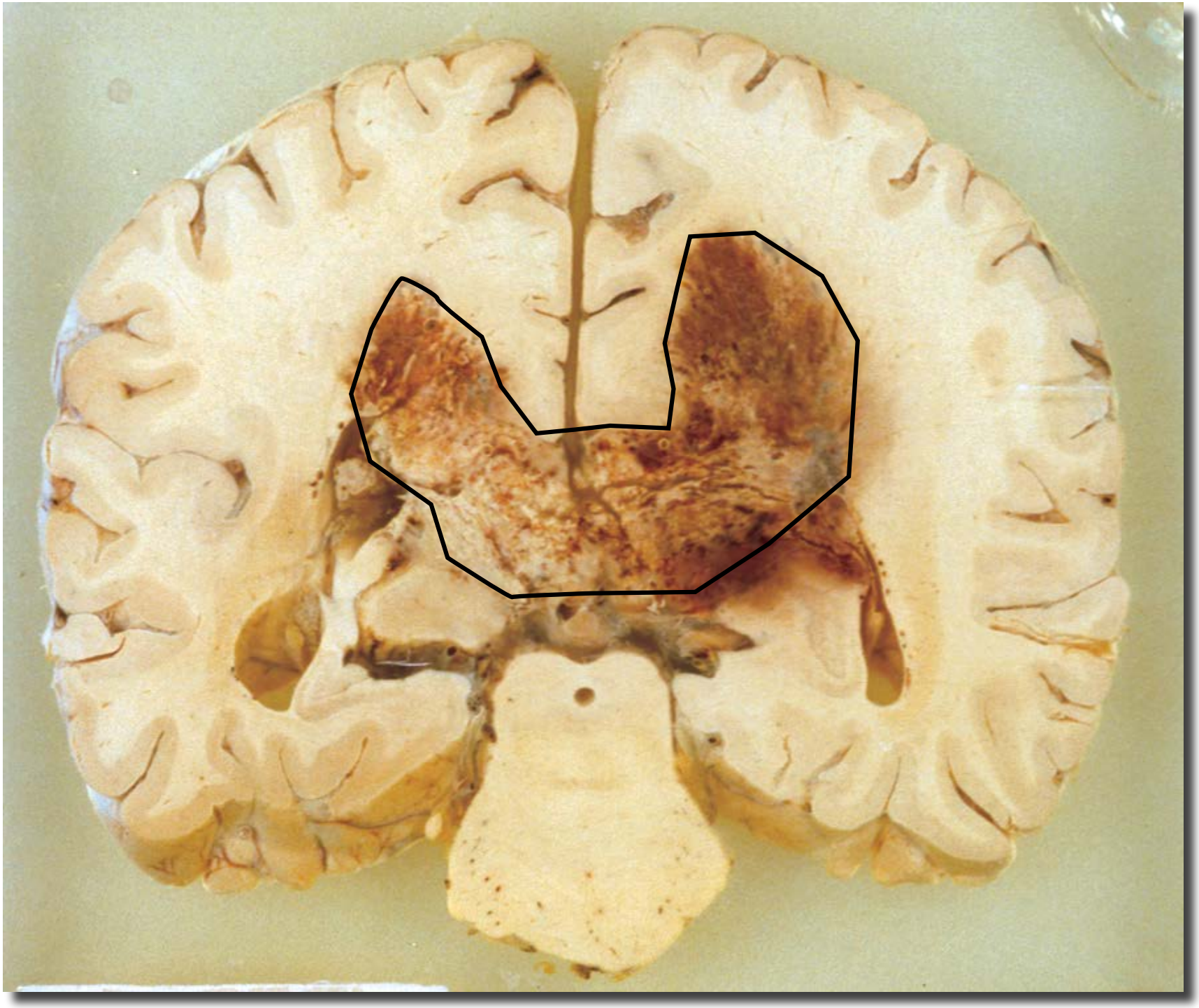
CNS Tumors

- Astrocytoma
  - Fibrillary astrocytoma
    - Glioblastoma multiforme
  - Pilocytic astrocytoma
- Oligodendroglioma
- Ependymoma
- Meningioma
- Primitive neuroectodermal tumors (PNET) - medulloblastoma and retinoblastoma
- Schwannoma
- Craniopharyngioma

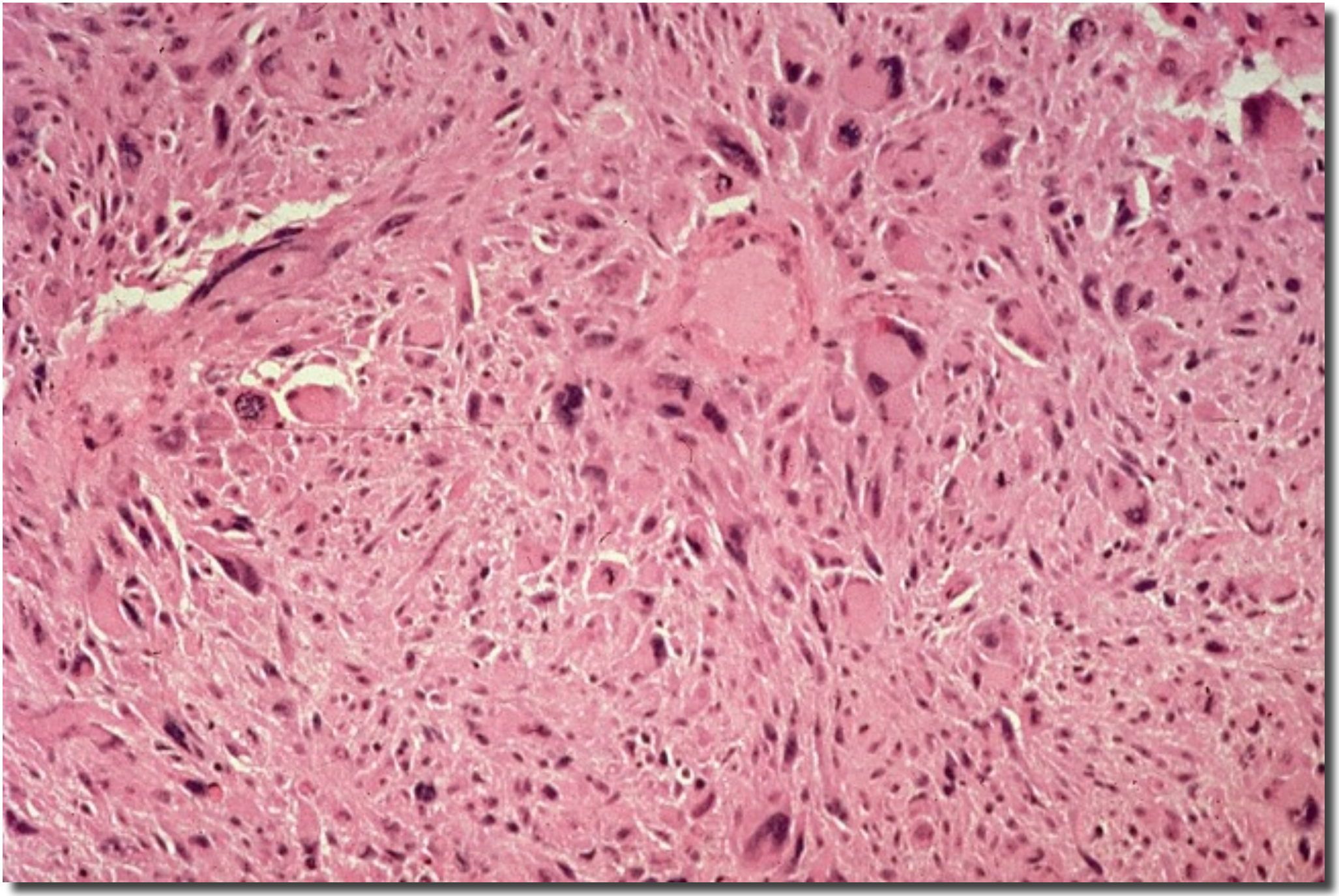
Glioblastoma Multiforme



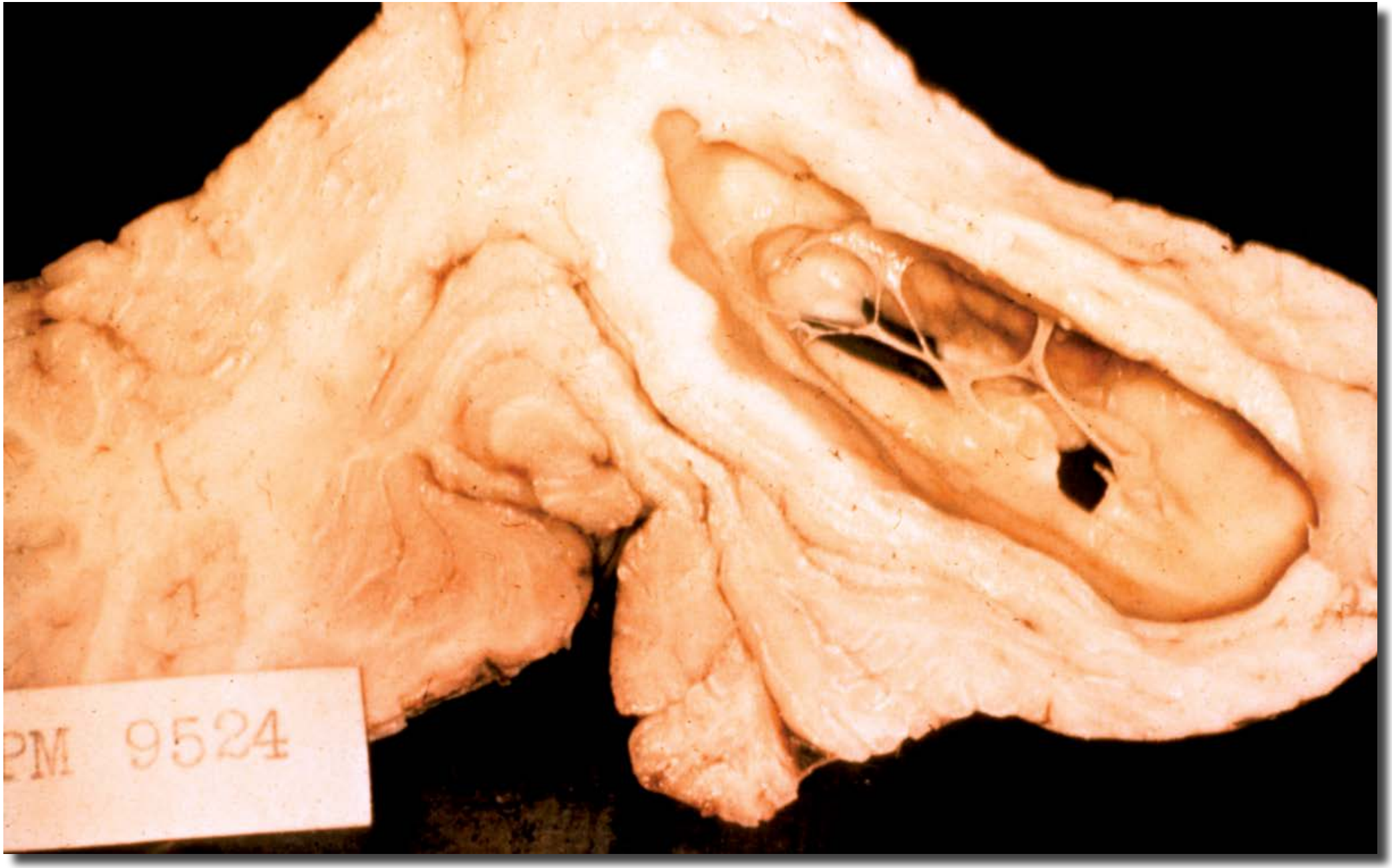
Glioblastoma Multiforme



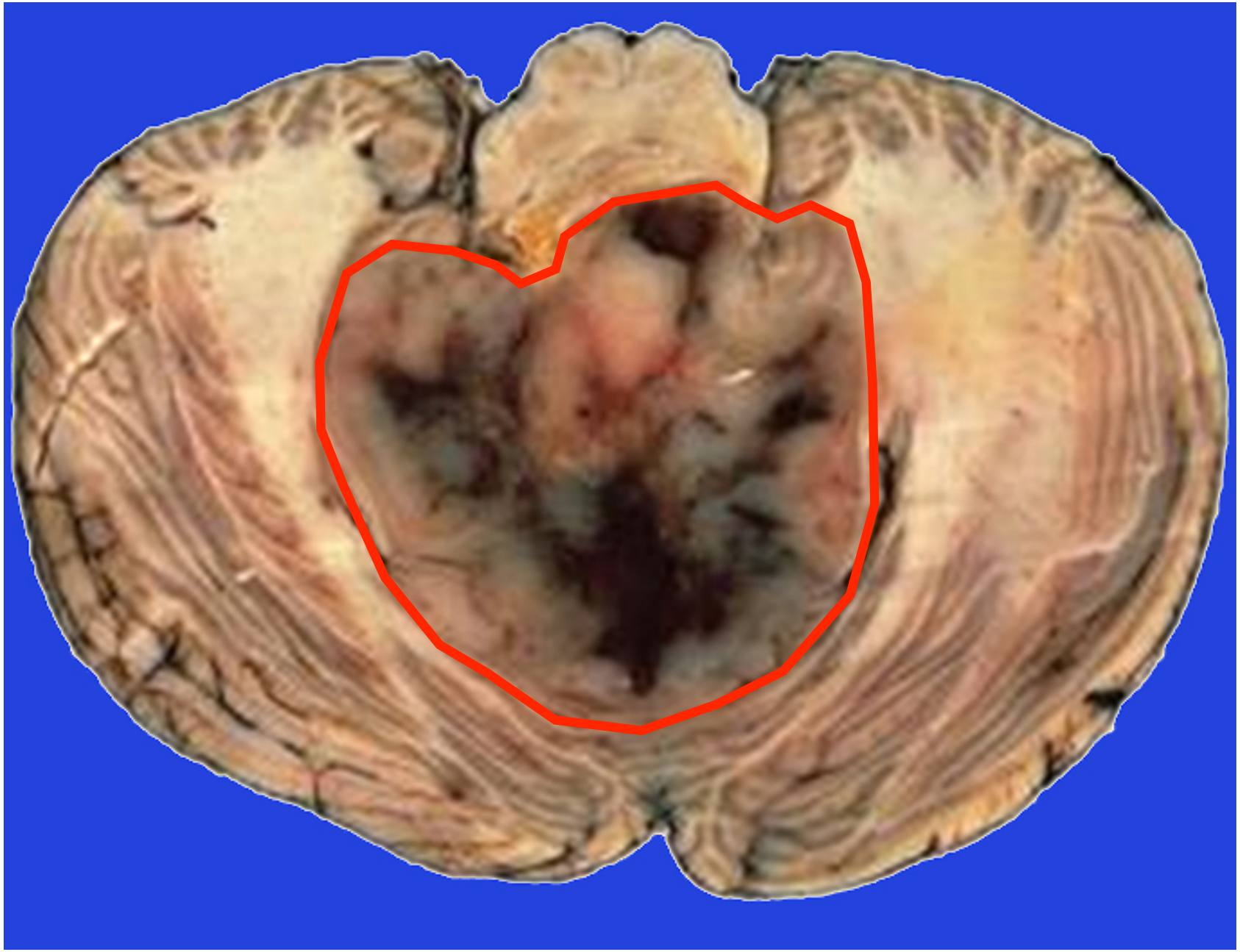
Glioblastoma Multiforme



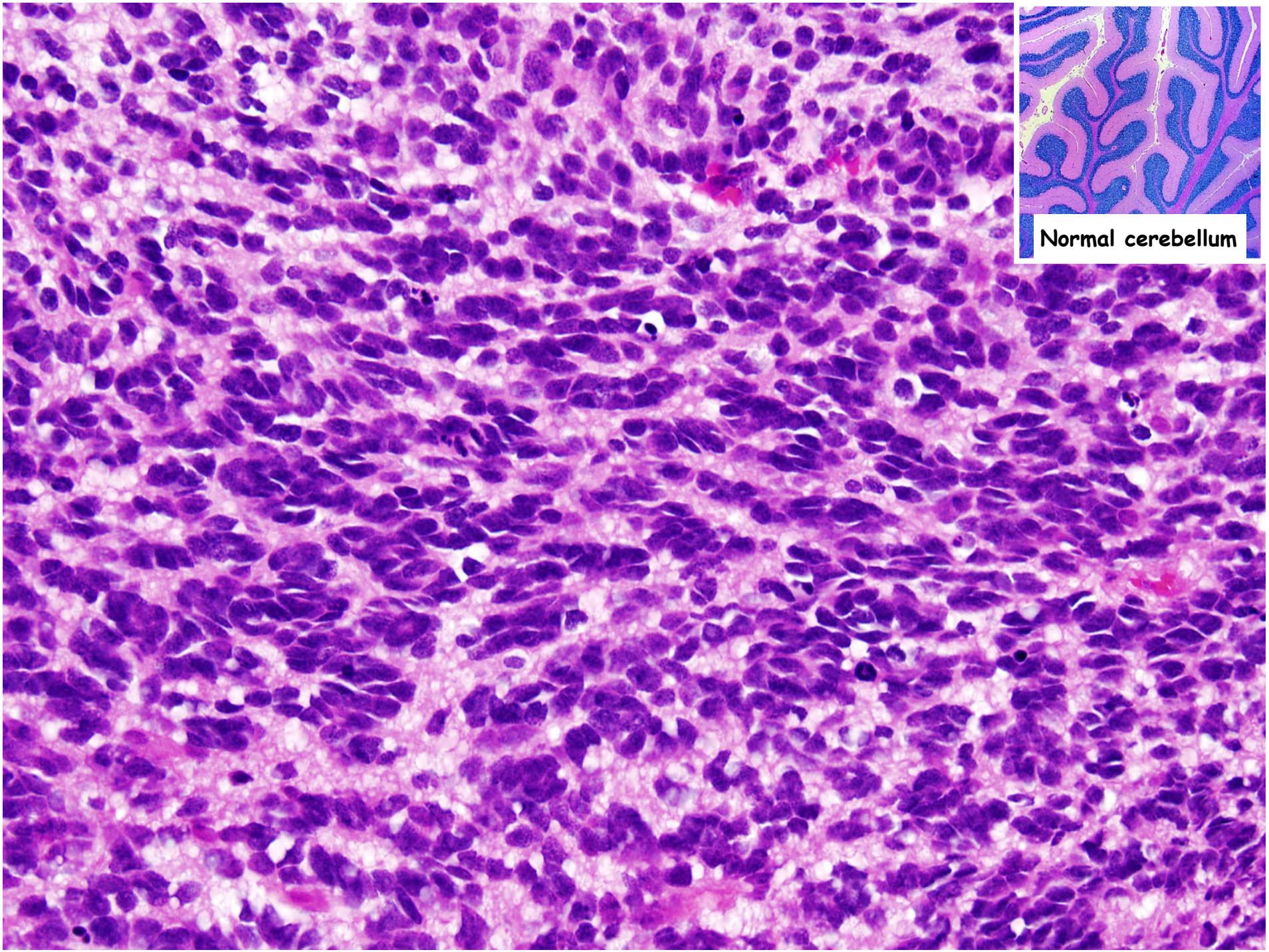
Juvenile Pilocytic Astrocytoma



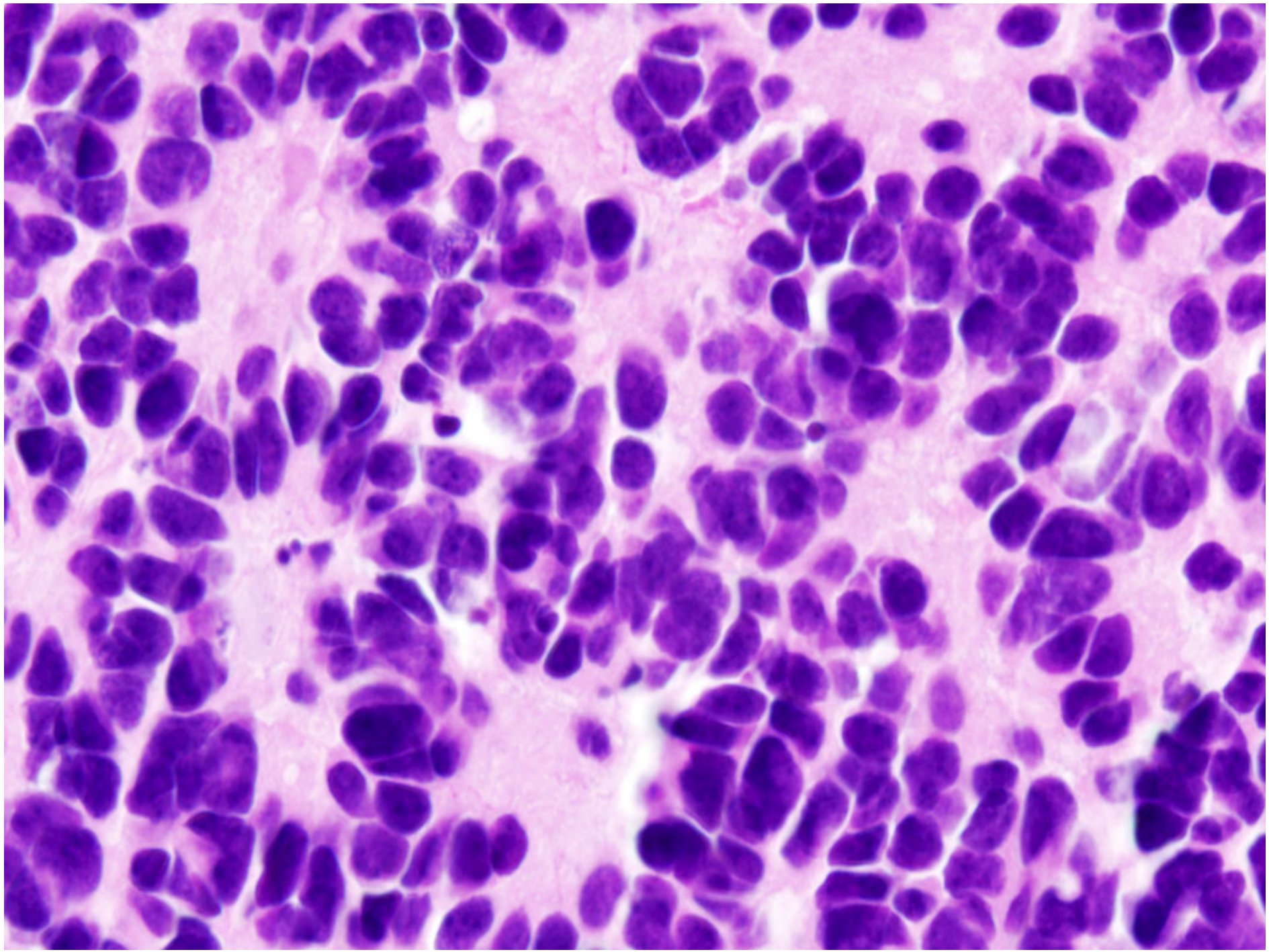
Medulloblastoma



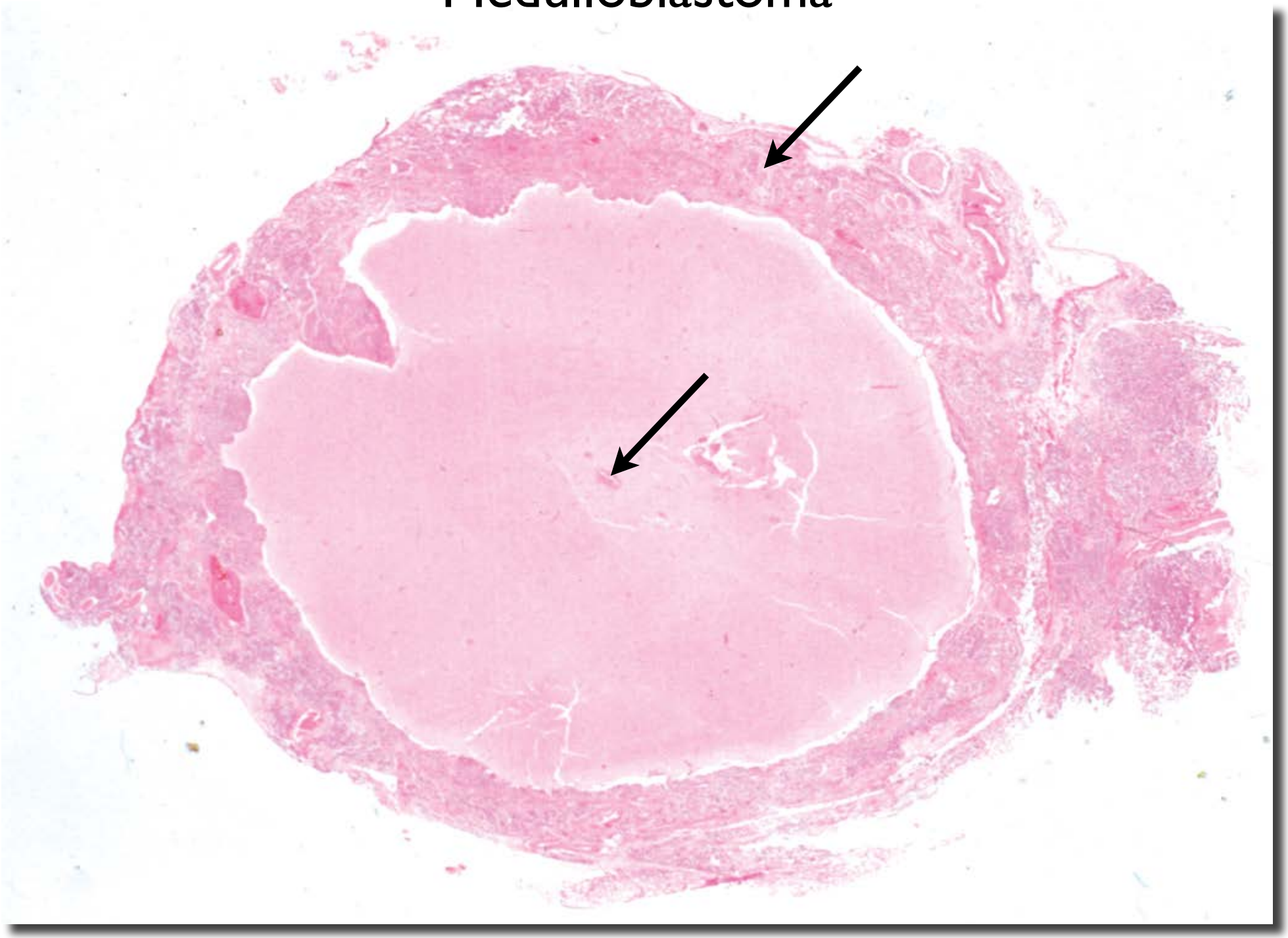
Medulloblastoma



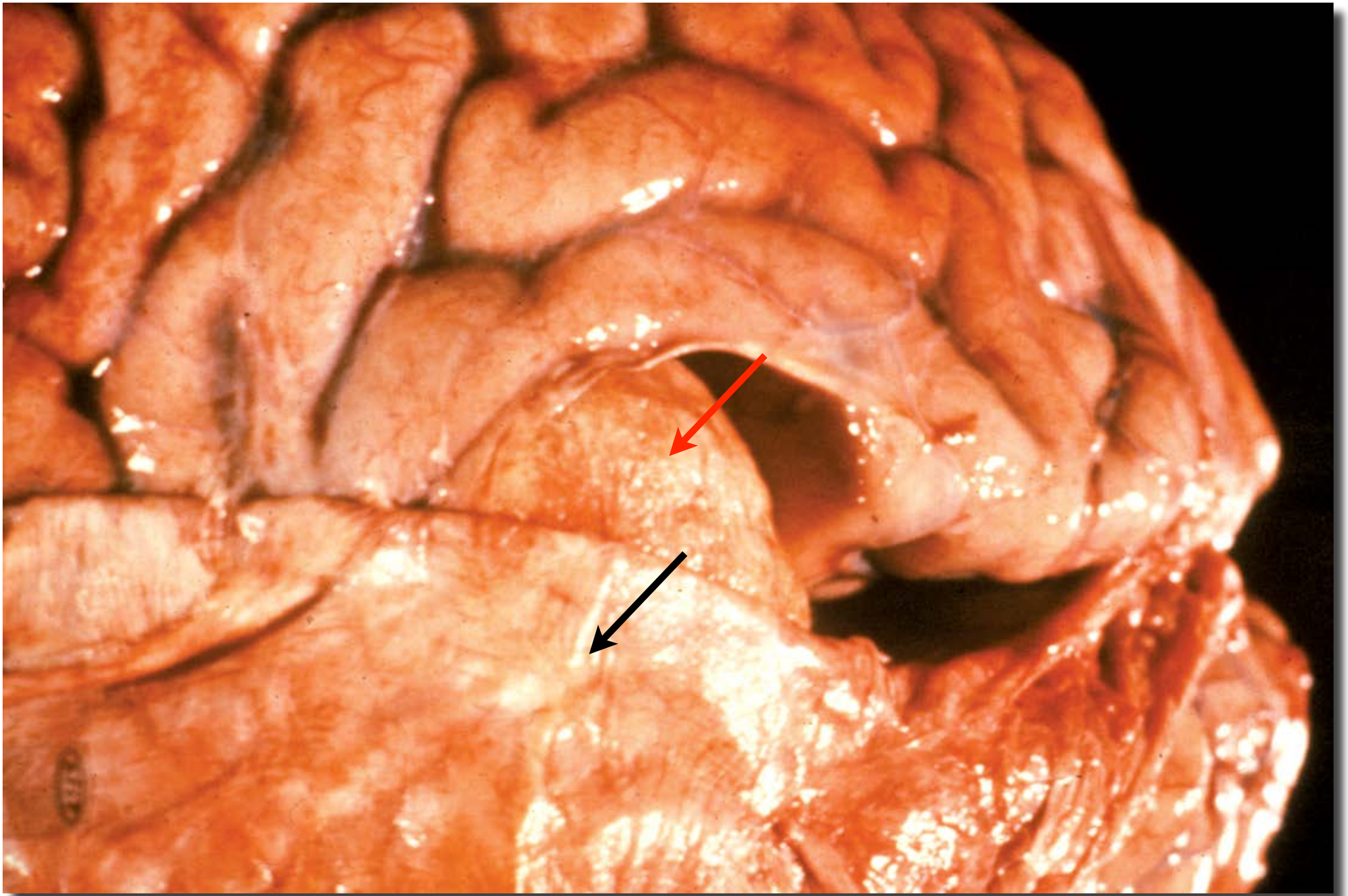
Medulloblastoma: Rosettes



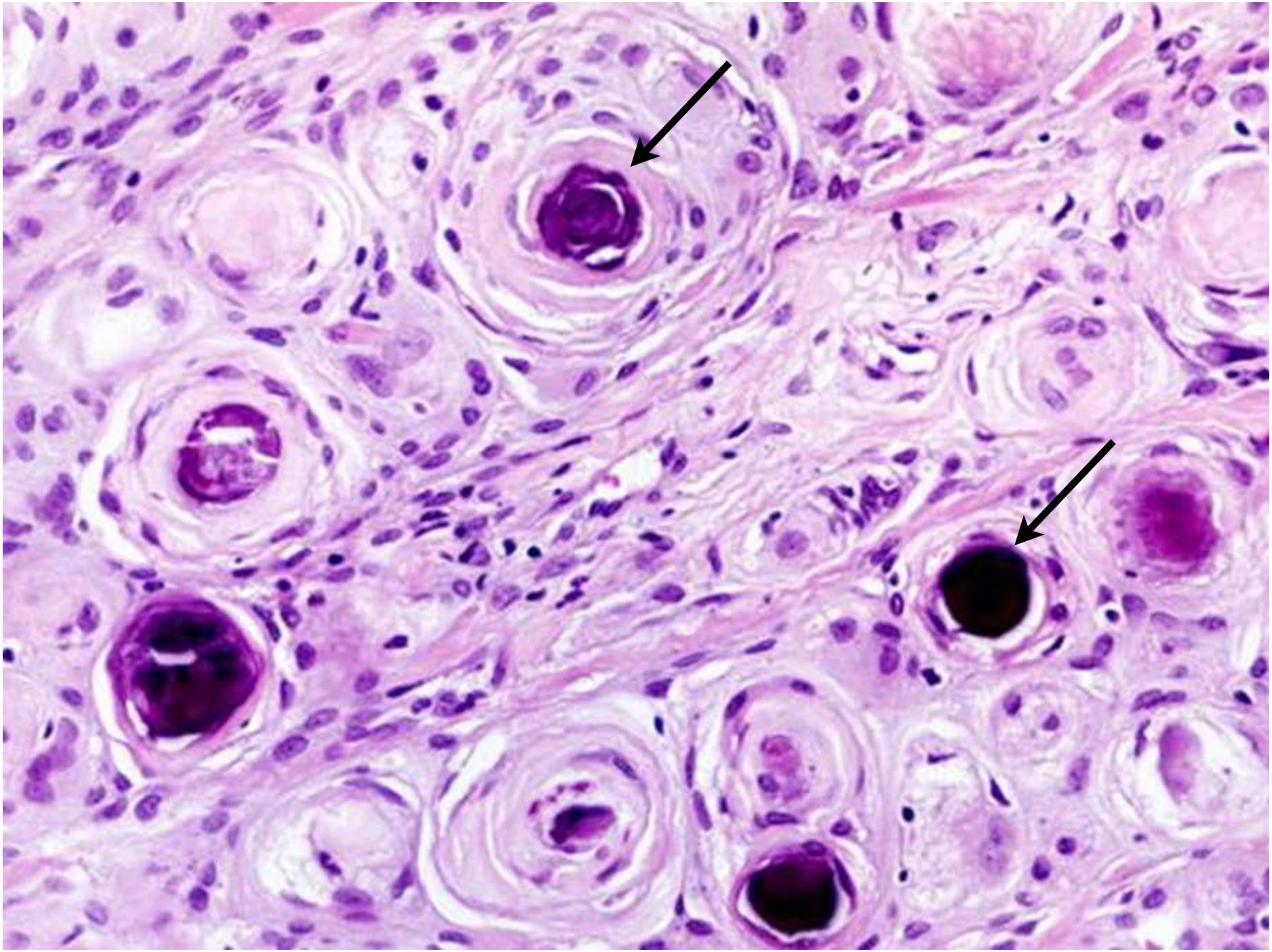
Medulloblastoma



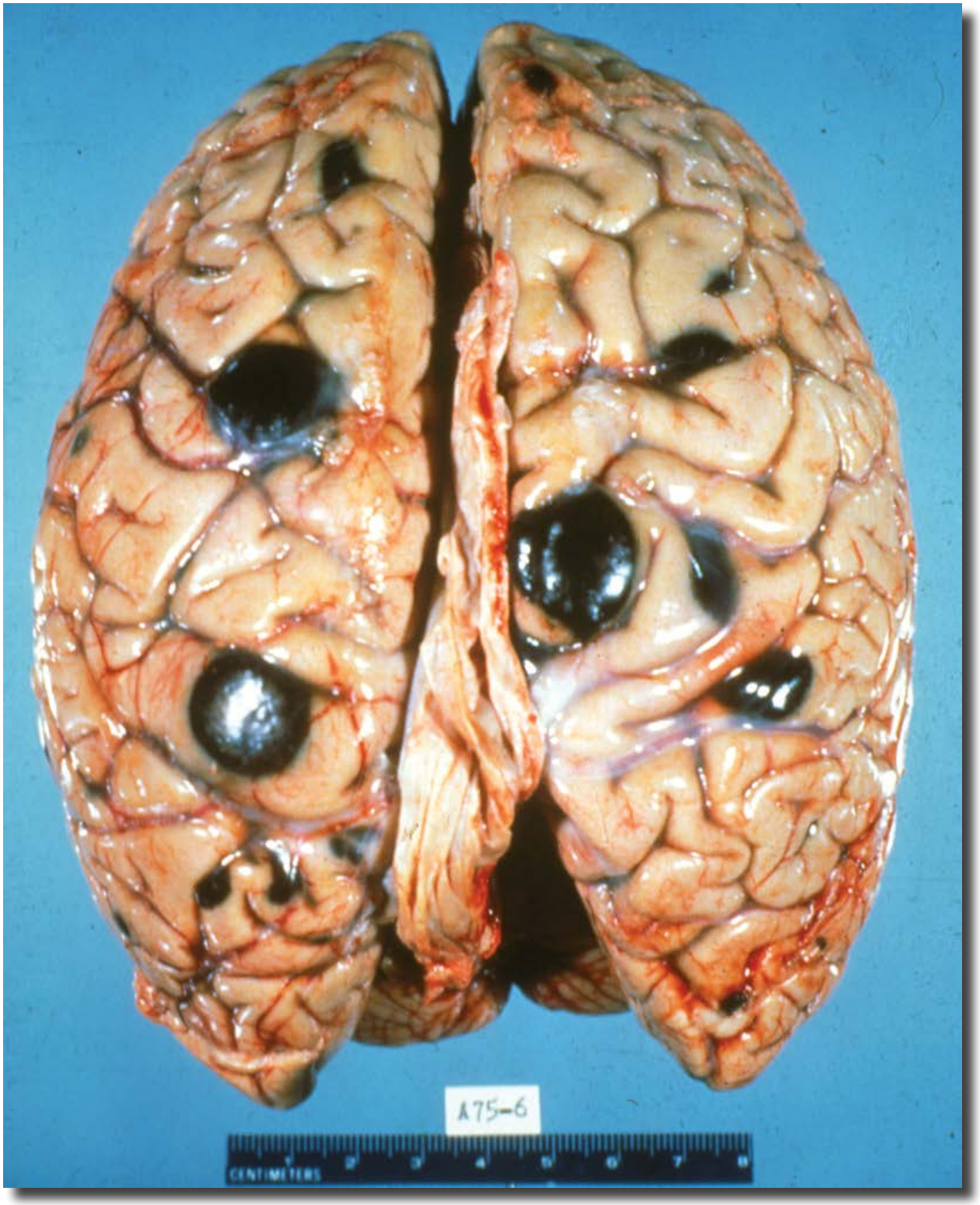
Meningioma



Meningioma



Metastatic Melanoma



Types of Brain Herniations