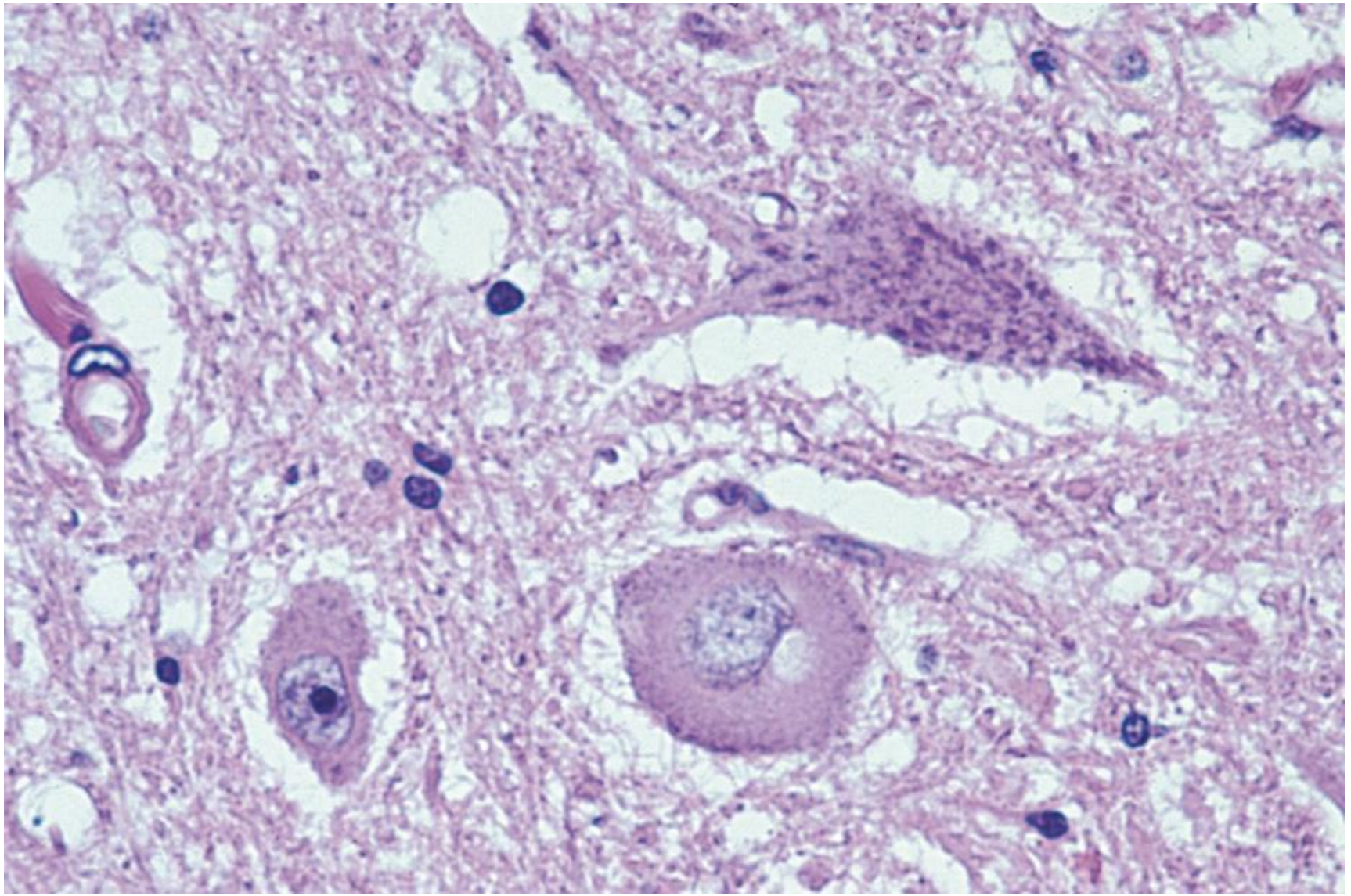
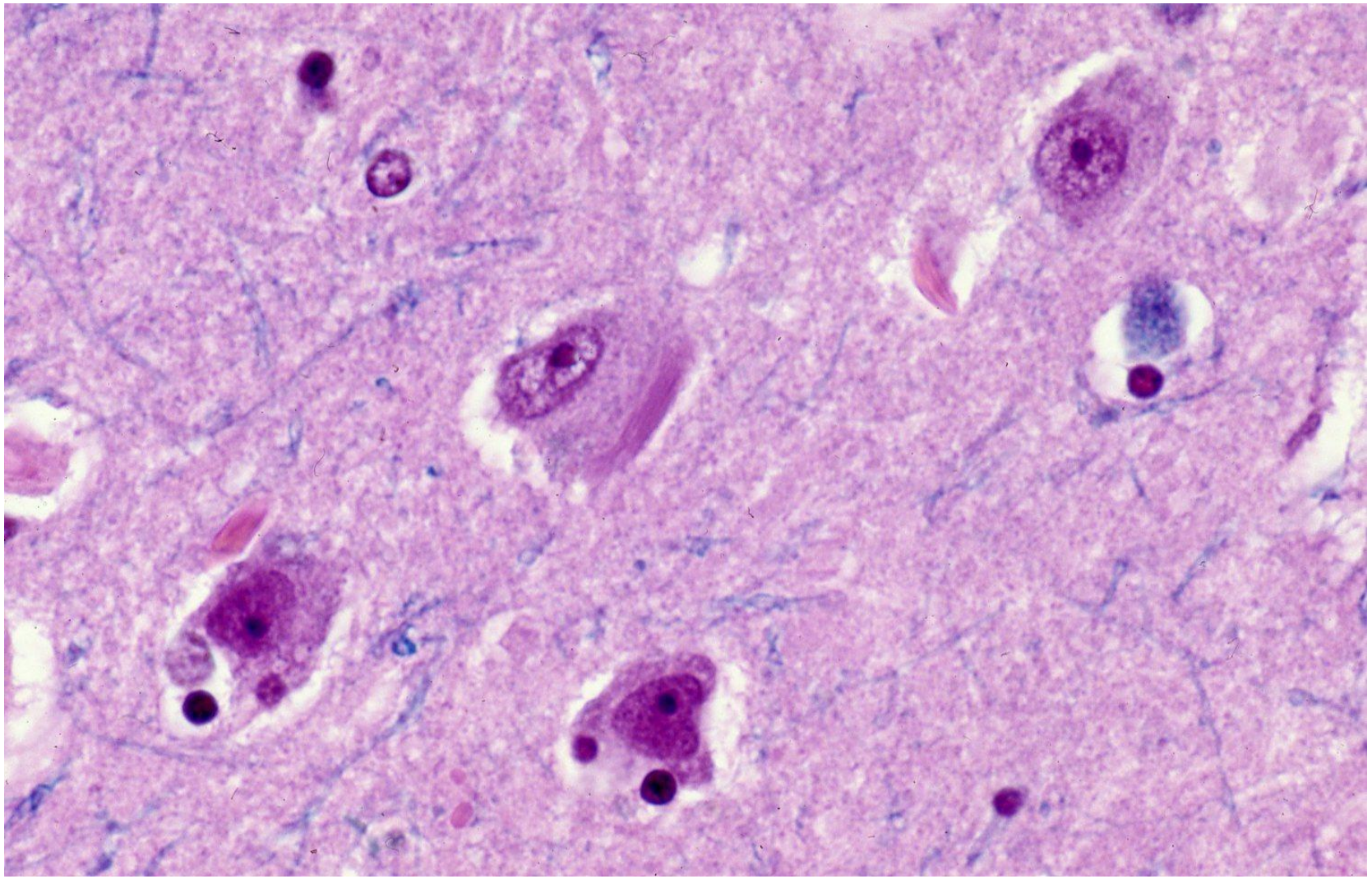
Neuropathology of inclusion bodies and abnormal structures

Neuronal inclusions are valuable histological hallmarks in establishing an accurate neuropathological diagnosis of neurodegenerative disorders. They also provide insight into the underlying molecular pathology of these disorders. Inclusion bodies and abnormal structures seen in the central nervous system are demonstrated herein. Neuronal inclusions are either cytoplasmic or intranuclear, and may be seen in the aging human brain or in a range of neurodegenerative disorders or infectious disorders. Some inclusions are seen in glial cells. Histological methods and immunostaining may help us recognize the inclusion bodies.

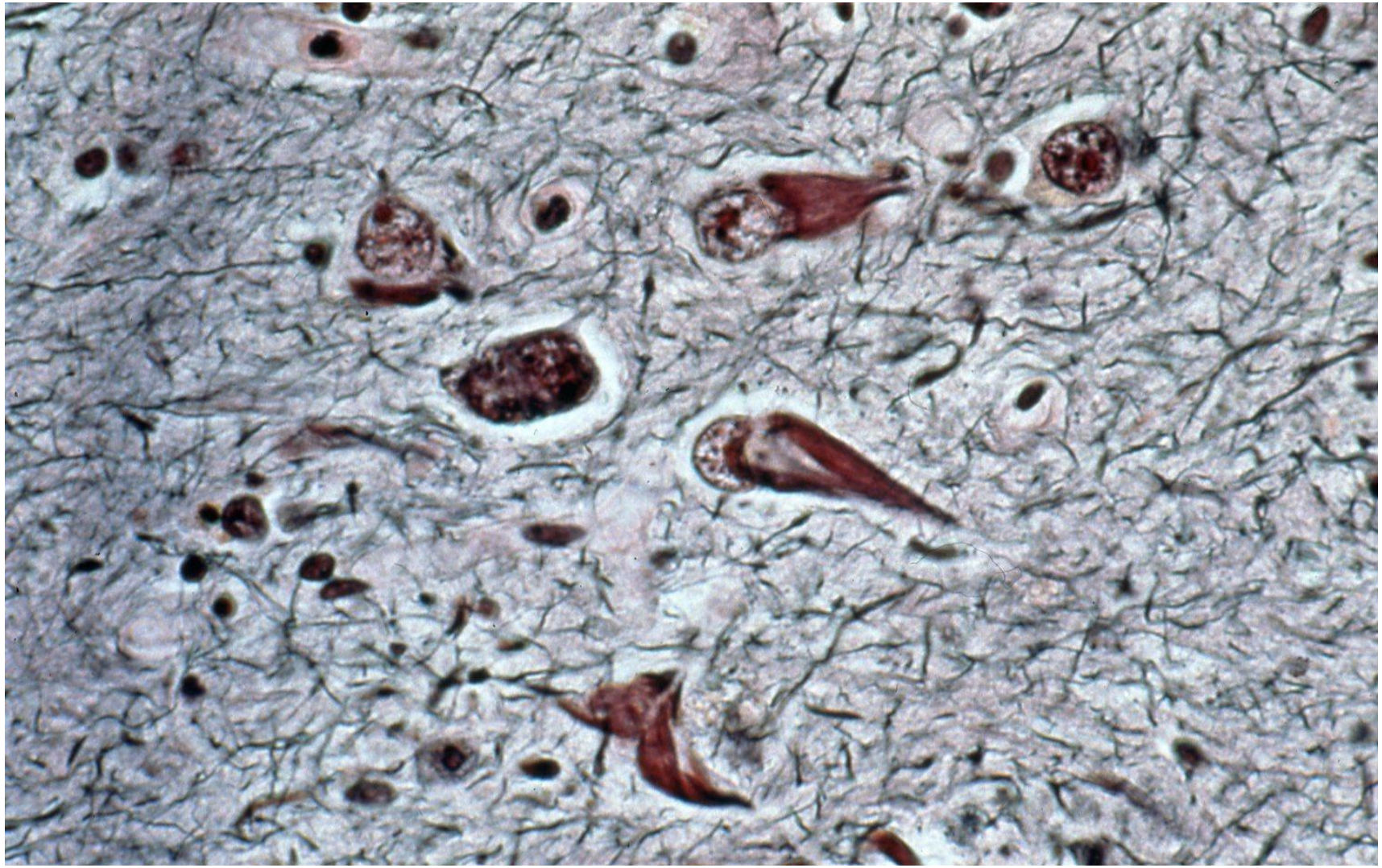
Ref.: Dickson DW, Lin WL. Neuronal inclusions. Neuroscience, Mayo Clinic 2025. https://mayoclinic.elsevierpure.com/en/publications/neuronal-inclusions



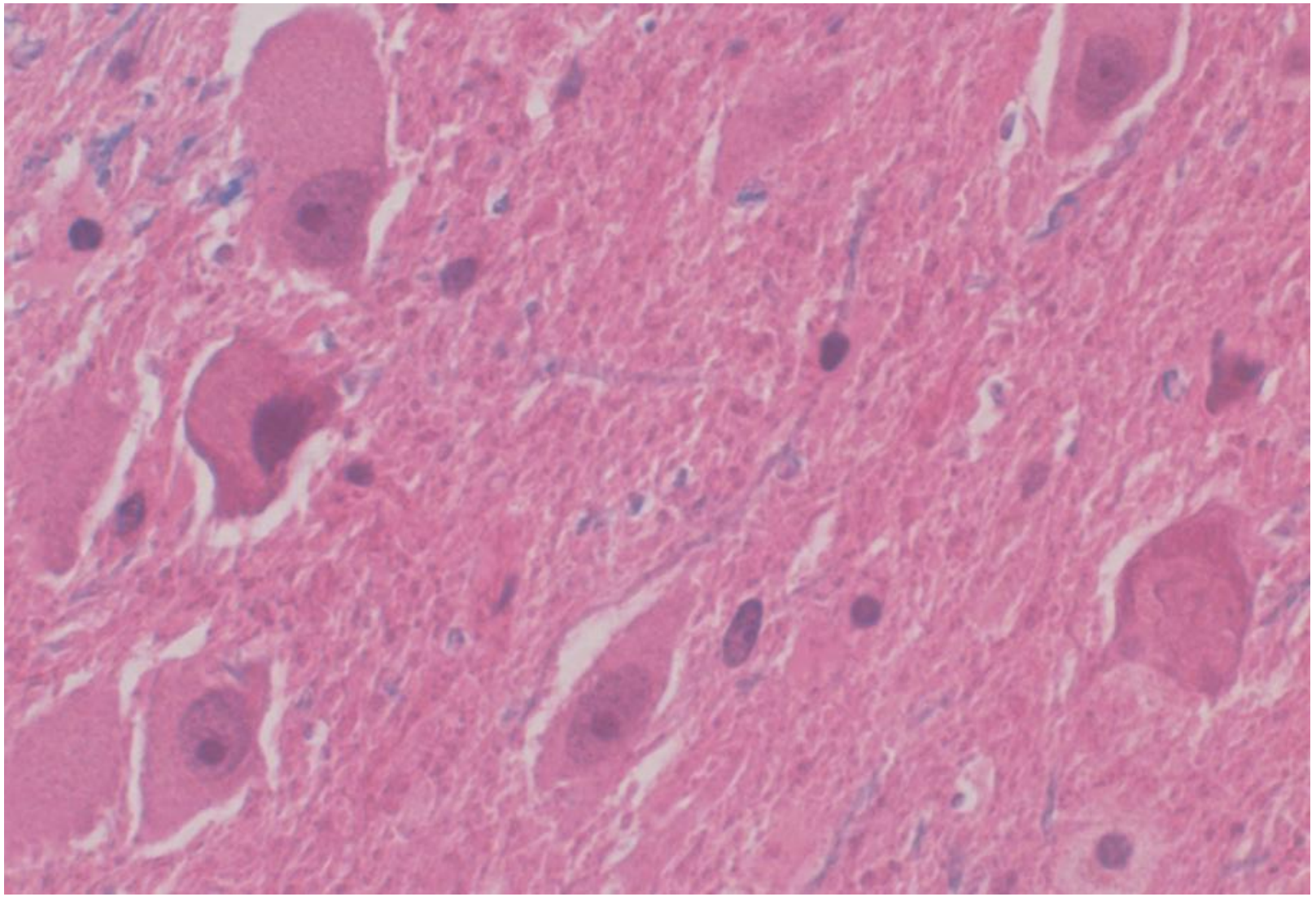
Central chromatolysis seen in the motor neuron of the anterior horn of the spinal cord in a lethal 7 y-o boy with tetanus complicating opisthotonus. Nissle granules are clustered at the periphery of the cytoplasm (H&E).



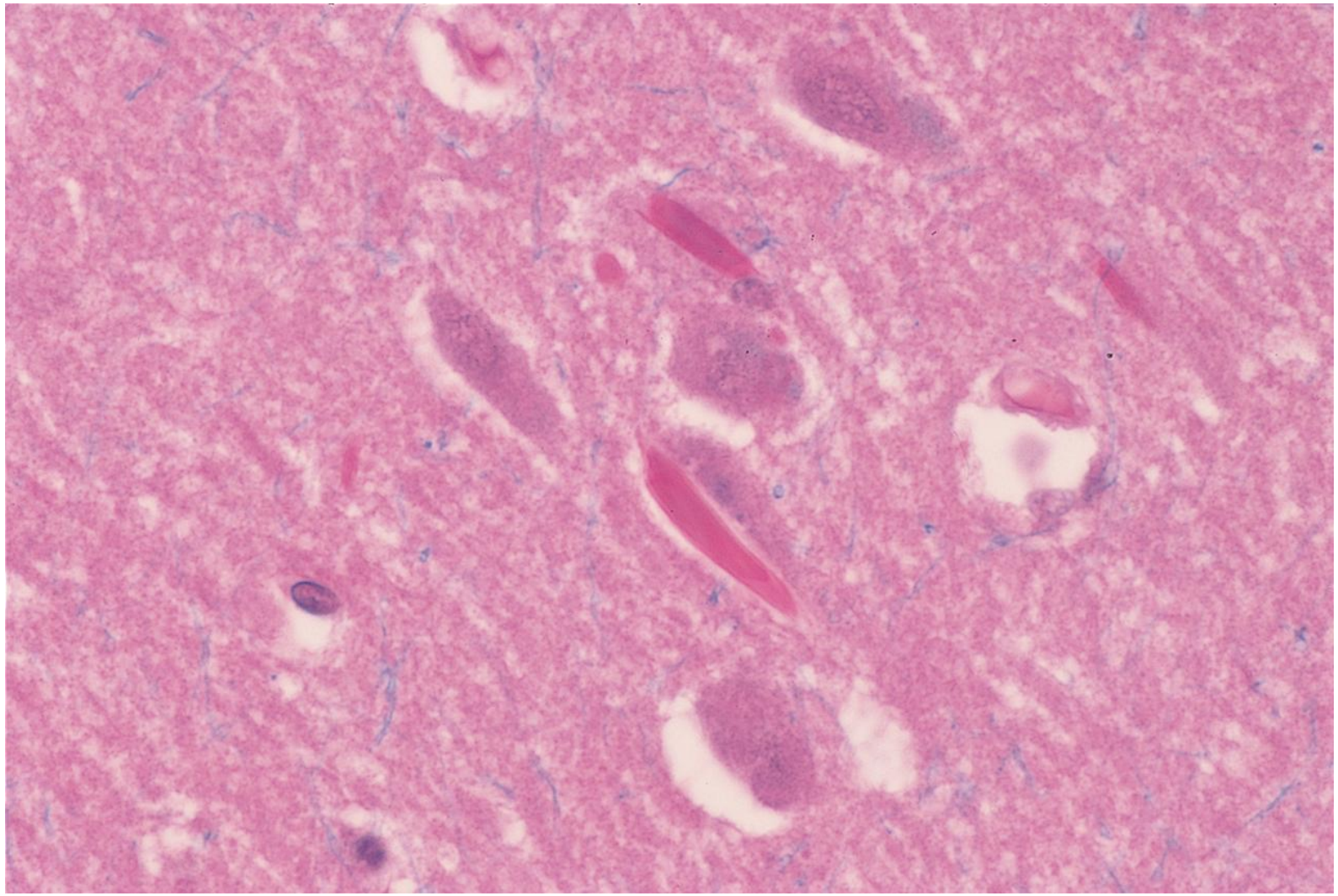
Neurofibrillary tangles seen in cortical neurons of a 79 y-o female patient with Alzheimer's disease. Basophilic fibrils are clustered in the cytoplasm (H&E).



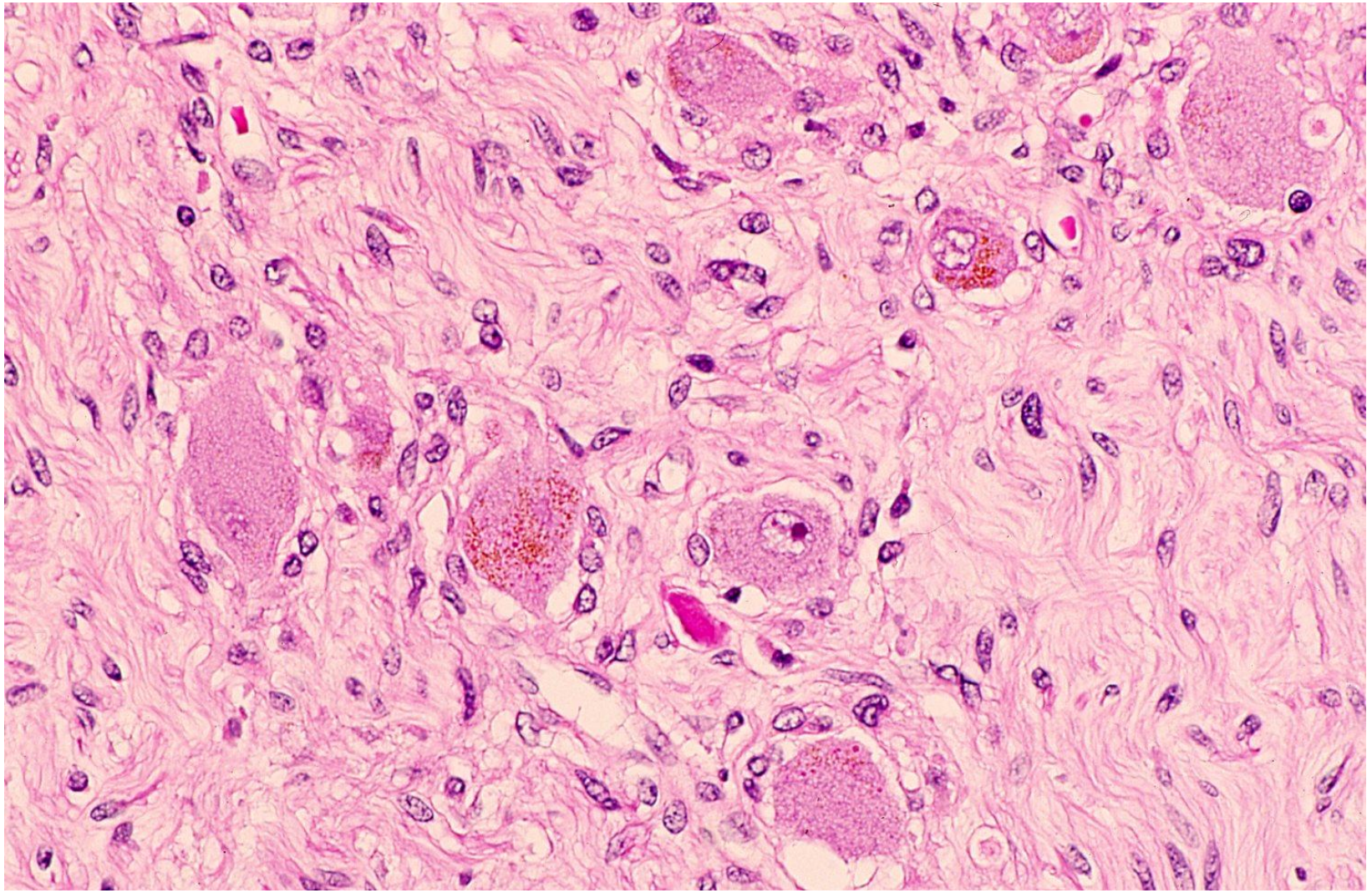
Neurofibrillary tangles seen in cortical neurons of a 79 y-o female patient with Alzheimer's disease. Black-stained fibrils (tangles) are clustered in the cytoplasm (Bodian's silver).



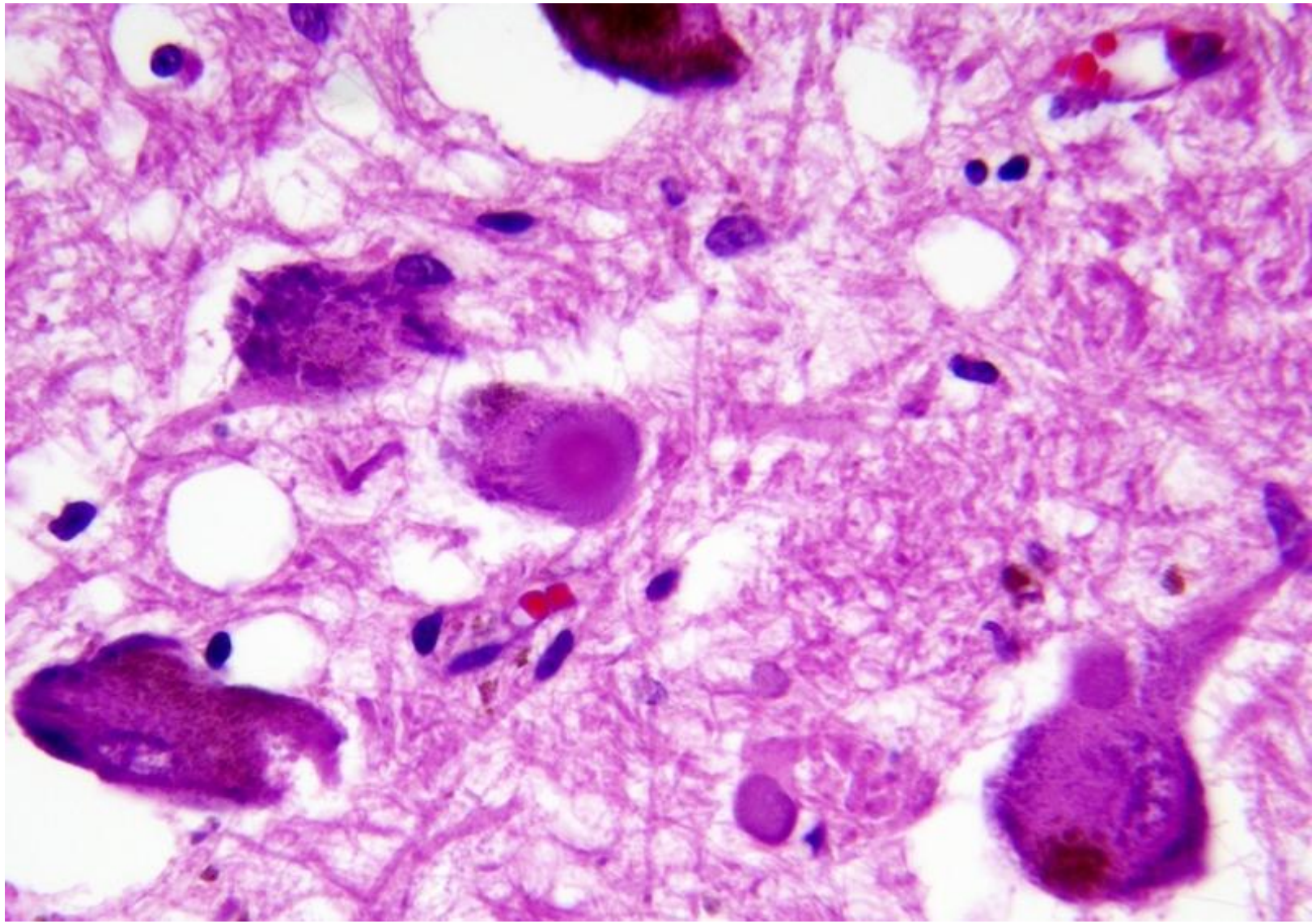
Neurofibrillary tangles seen in neurons of olivary nucleus of the cerebellum seen in a 70 y-o male patient with progressive supranuclear palsy. Finely basophilic fibrils are clustered in the cytoplasm. Subthalamic nucleus also shows a similar change (LFB-H&E).



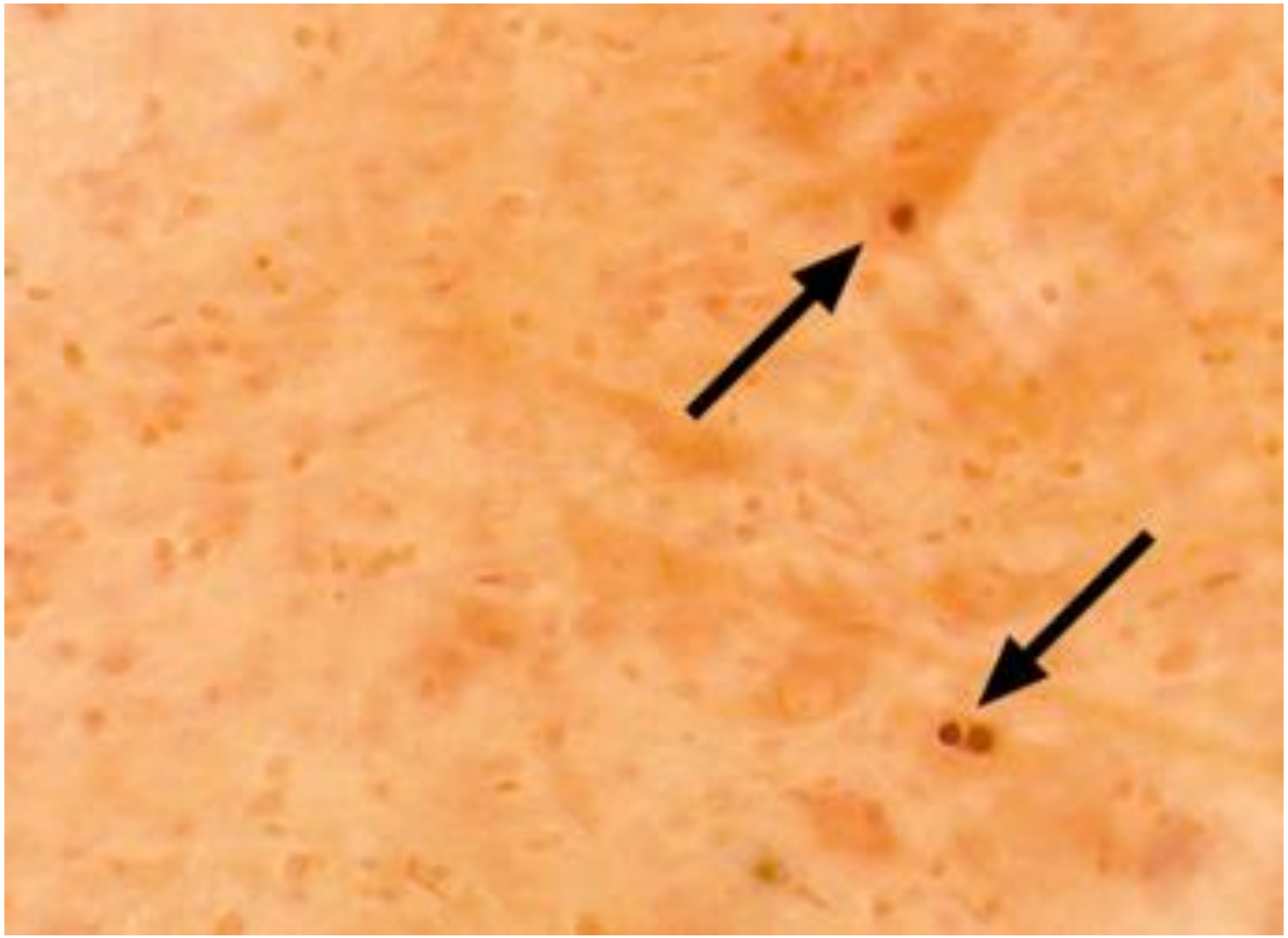
Hirano bodies in hippocampal neurons seen in Alzheimer's disease. Hirano bodies are rod-shaped eosinophilic crystalline inclusions, representing axonal swelling. They may be seen in aged individuals (H&E).



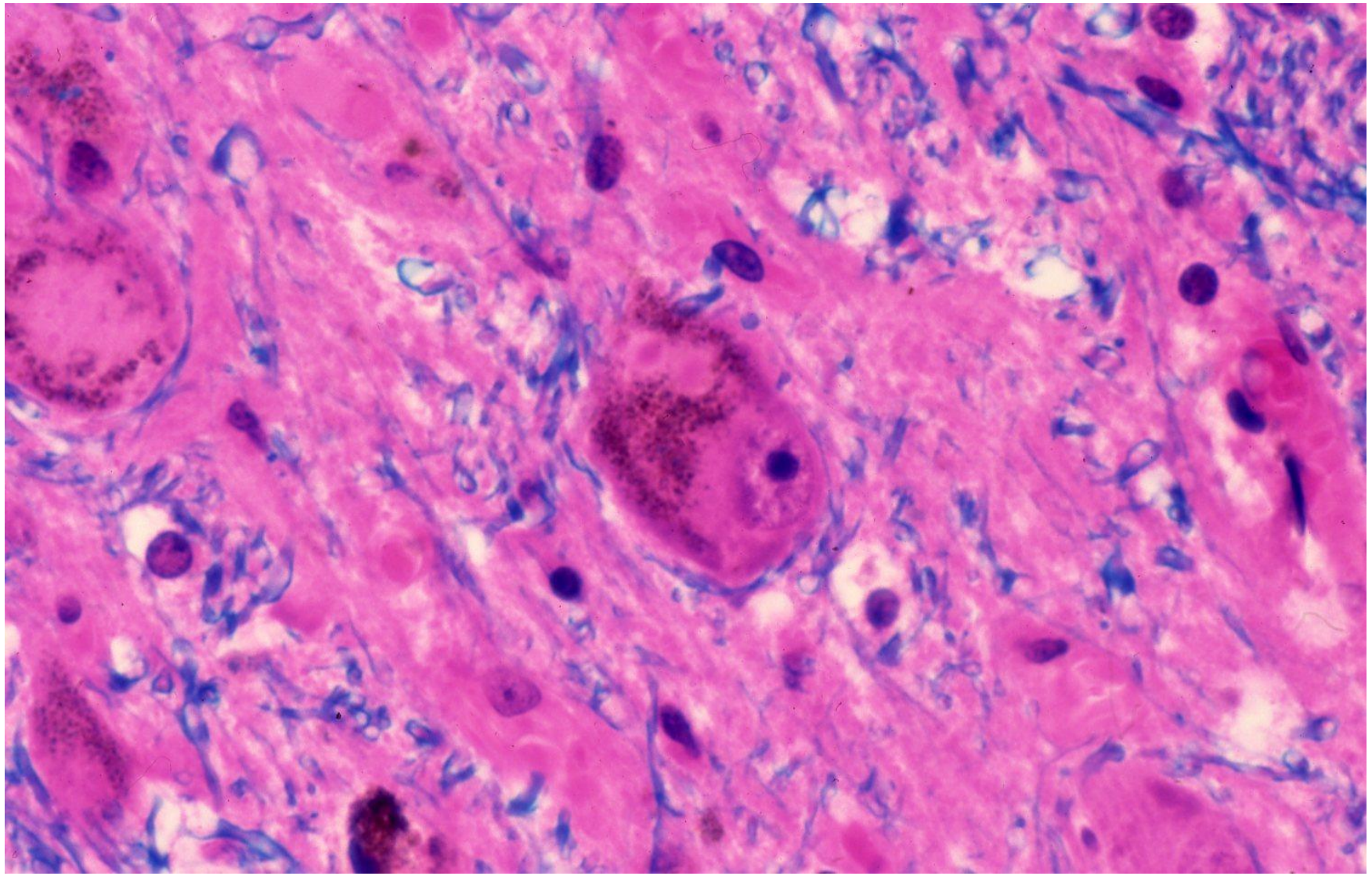
Axonal swelling seen in the inferior sympathetic ganglion of a female patient aged 60's. Eosinophilic ballooned structures are seen in the matrix (H&E).



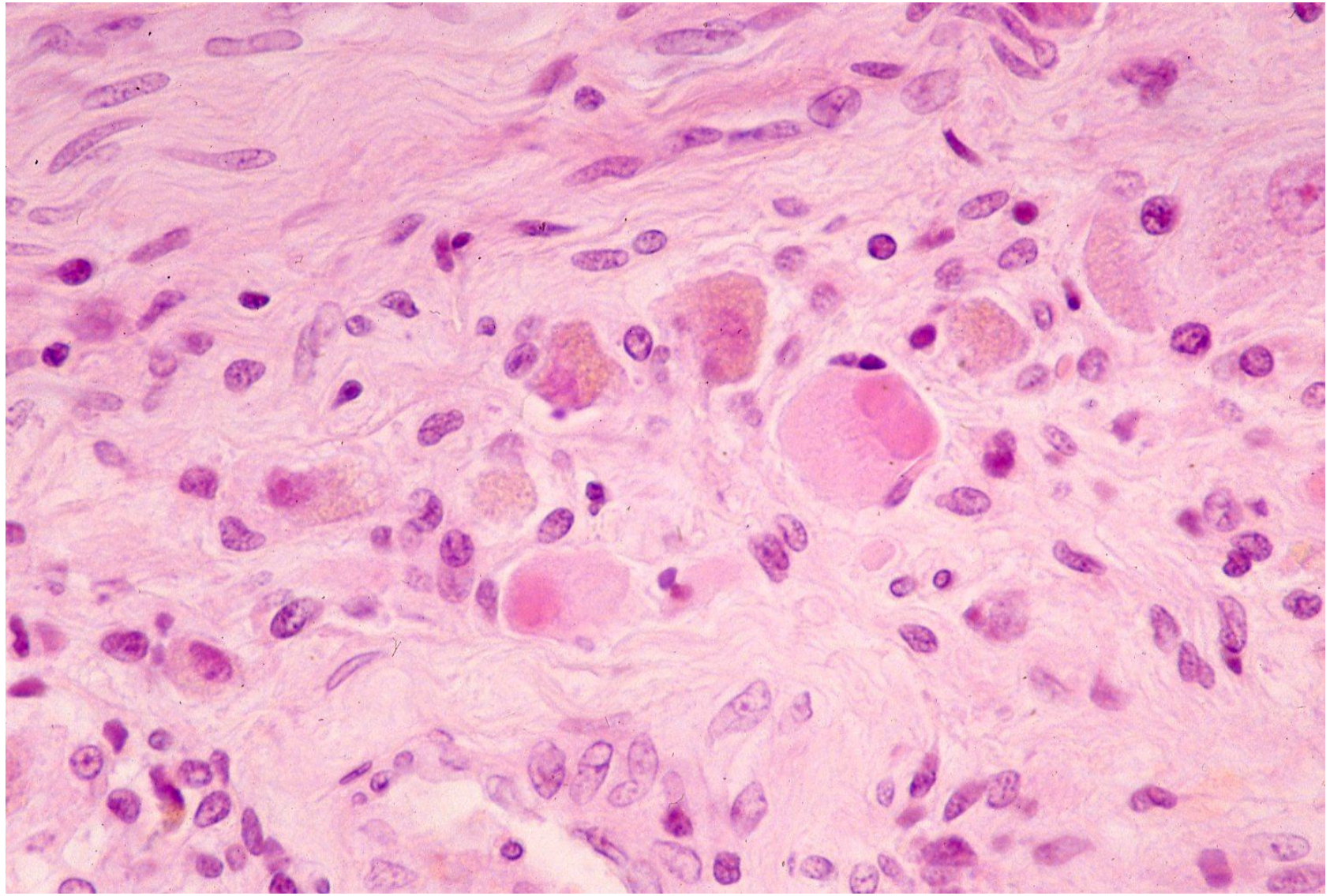
Pick bodies in neurons in the cerebral frontal cortex in Pick's disease (frontotemporal dementia). Eosinophilic globular inclusions are observed in the cytoplasm of the neurons (H&E).



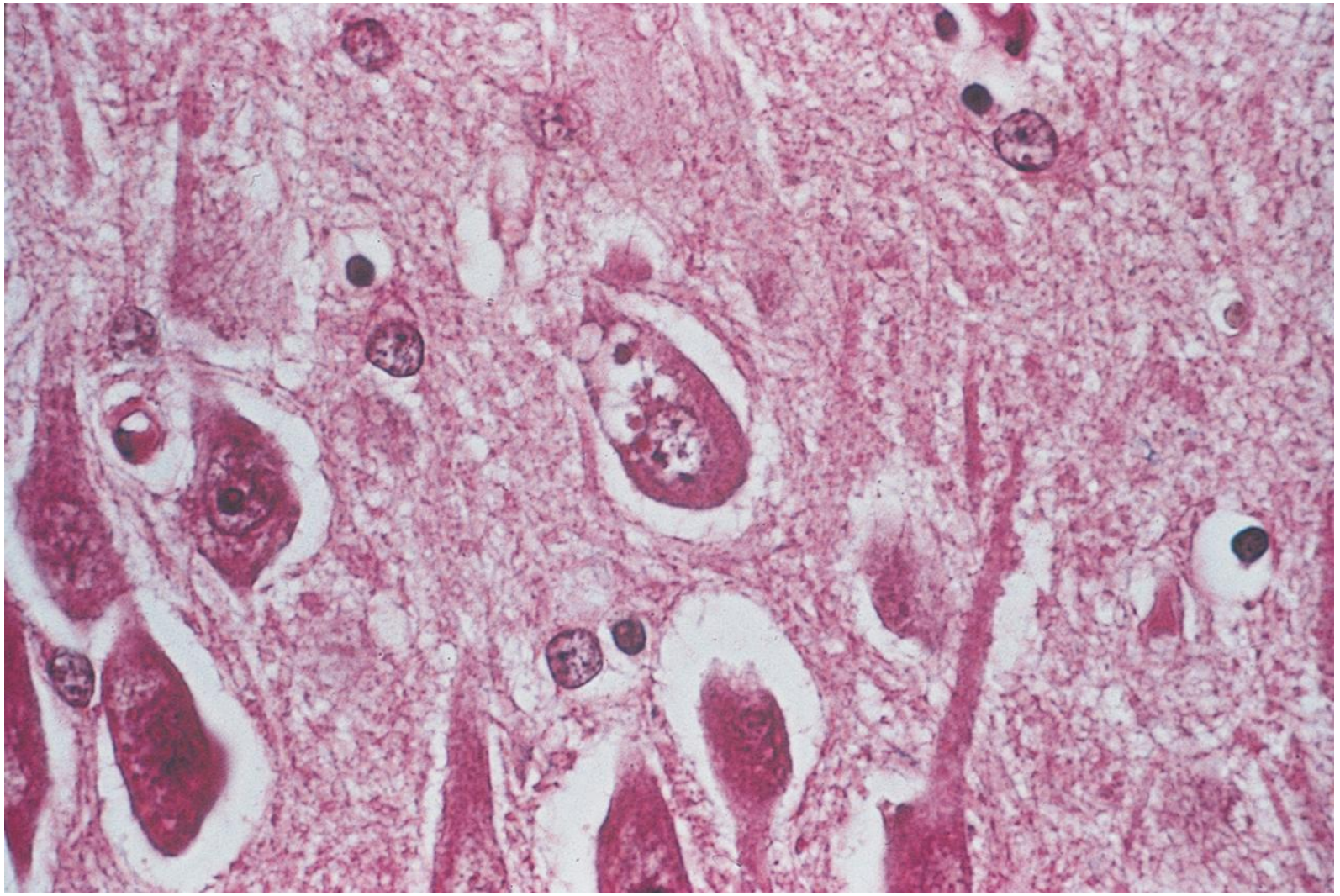
Intranuclear p62-positive inclusion bodies in neurons of the superior olivary nucleus in Huntington's disease. SQSTM1/p62 is a scaffold protein closely involved in the macroautophagy process. p62 functions to anchor the ubiquitinated proteins to the autophagosome membrane, promoting degradation of unwanted molecules. Errors in the regulation of SQSTM1/p62 accelerate the development of Huntington's disease.



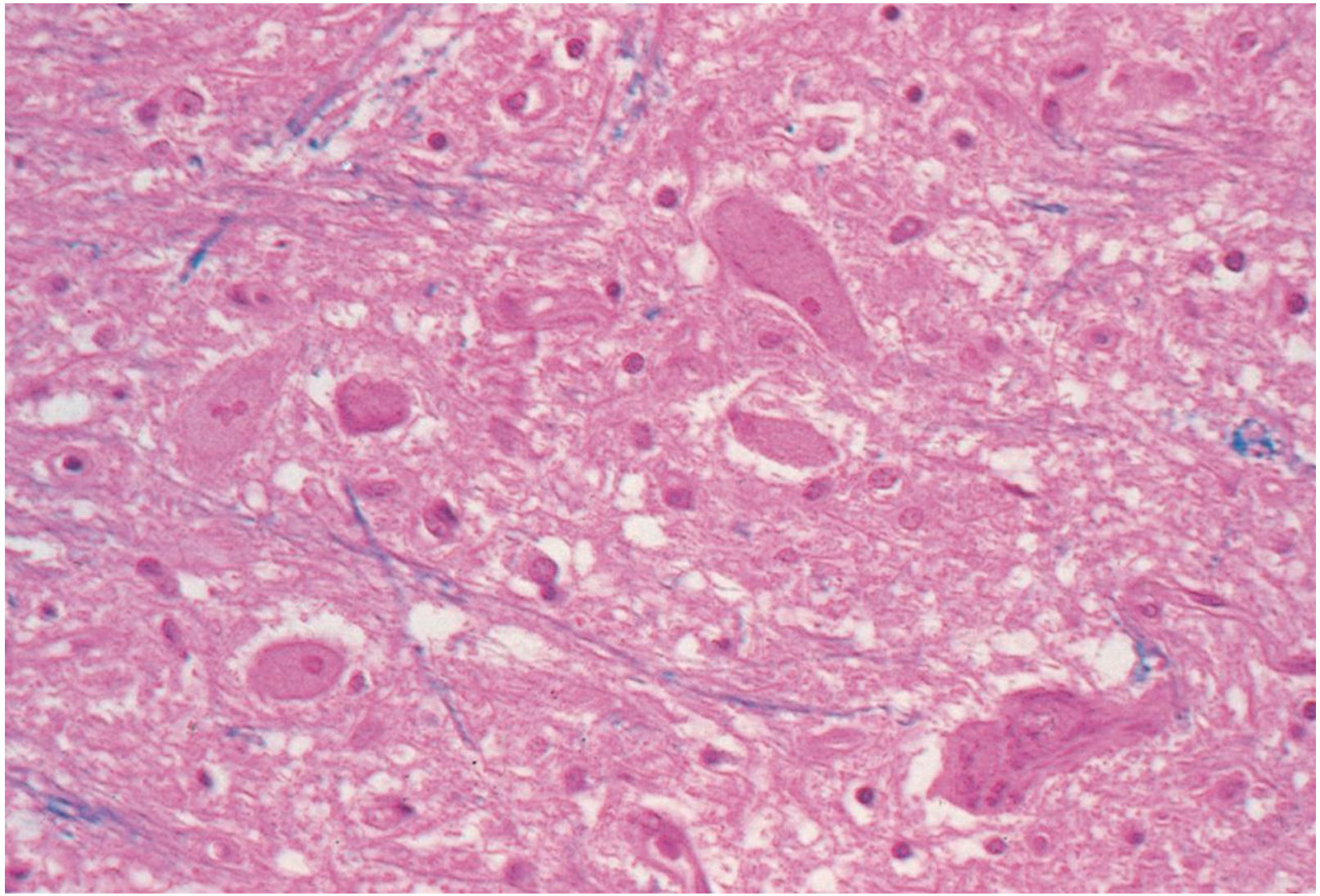
Lewy bodies in neurons of substantia nigra in Parkinson's disease. Lewy bodies, round eosinophilic and targeted structures, represent abnormal accumulation of alpha-synuclein. They are also seen in cortical neurons in dementia with Lewy bodies (LFB-H&E).



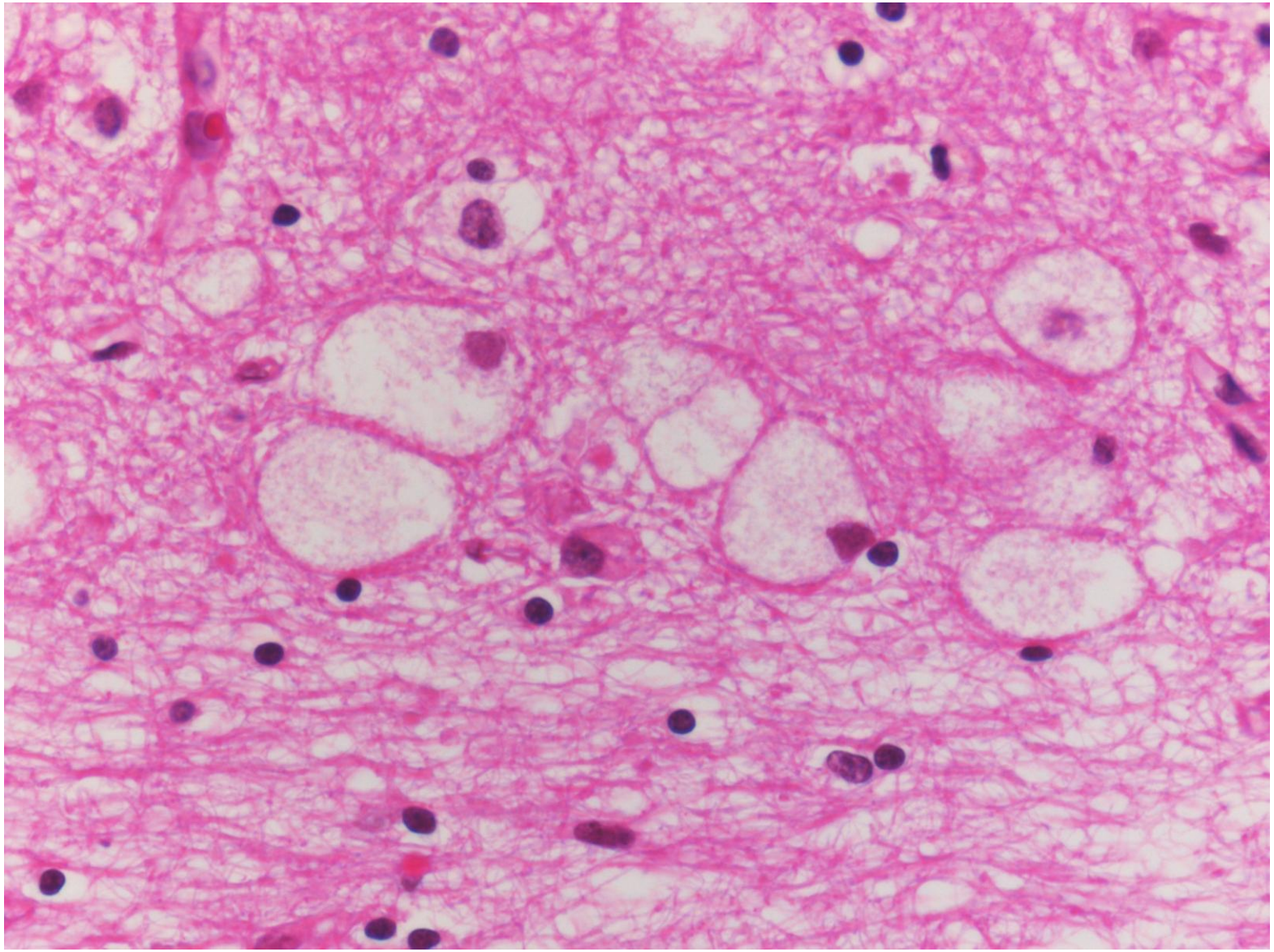
Lewy bodies in ganglion cells of mid-cervical sympathetic ganglion in Shy-Drager's syndrome. Lewy bodies, round eosinophilic structures, represent abnormal accumulation of alpha-synuclein (H&E).



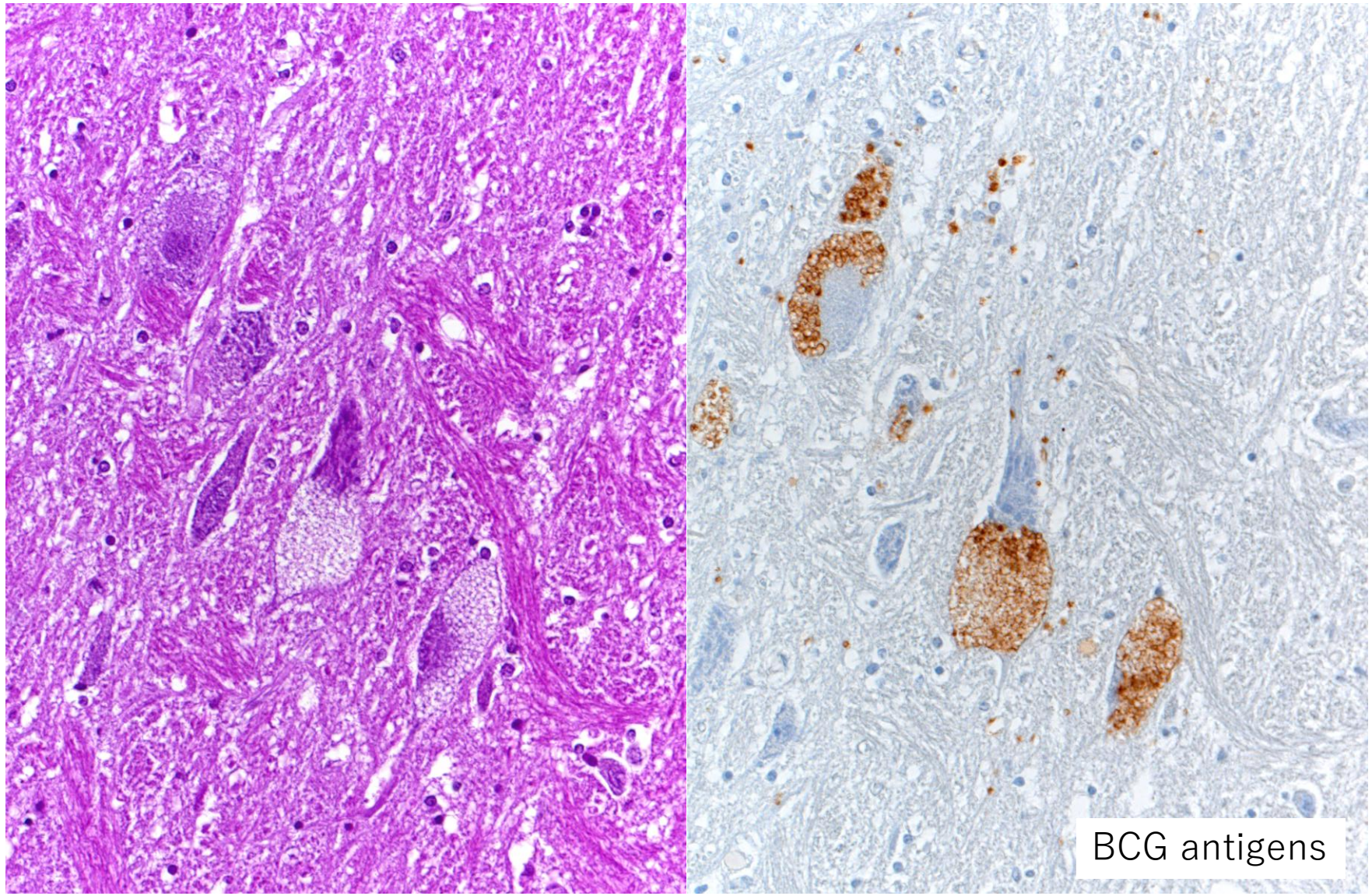
Granulovacuolar change of the neuron of hippocampus in Alzheimer's disease. Senile brain may also contain the same change. The cytoplasmic vacuoles measuring 3-4 μm contain basophilic fine granules (H&E).



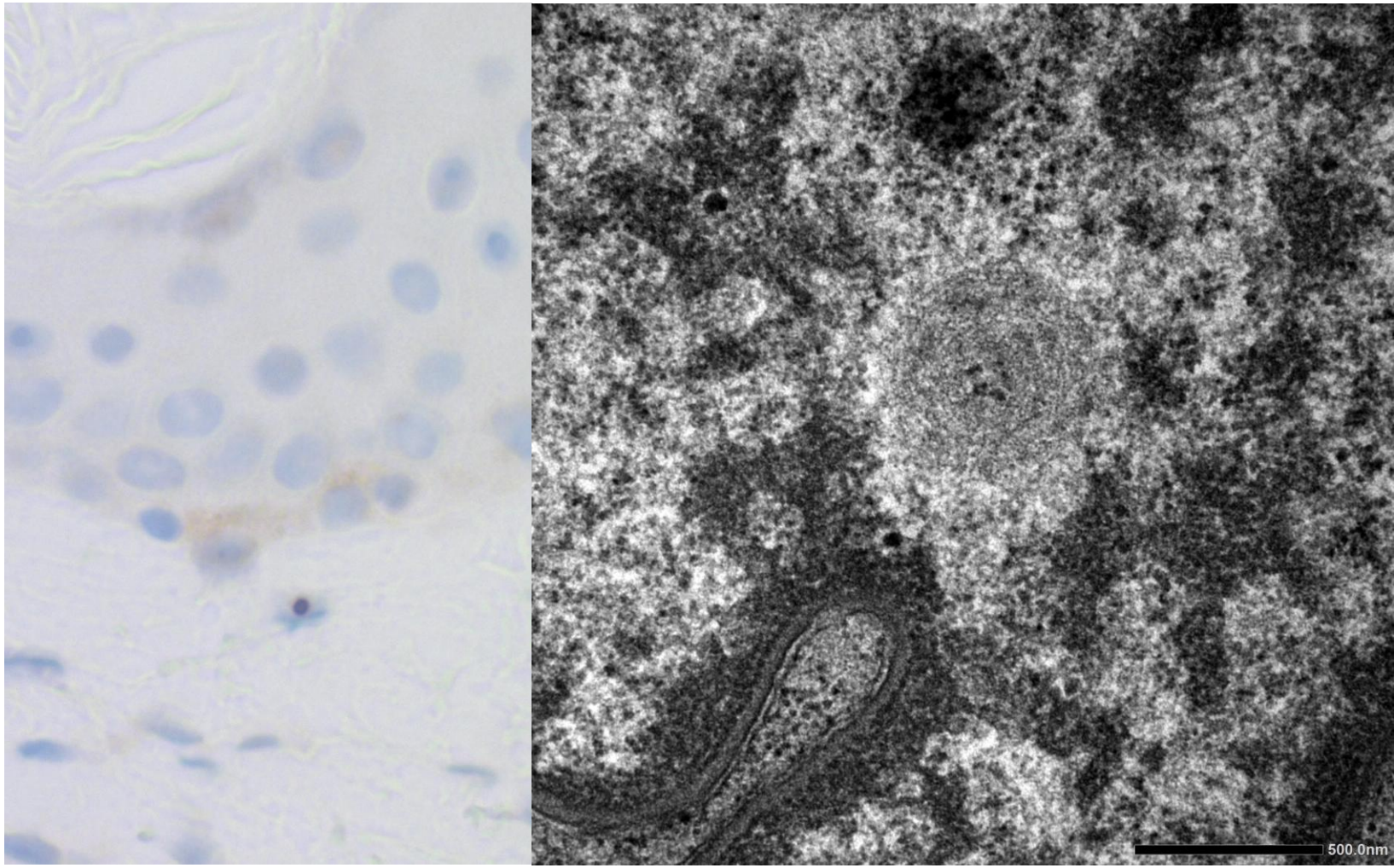
Bunina bodies seen in motor neurons of the anterior horn of the spinal cord in amyotrophic lateral sclerosis (ALS). Round or oval eosinophilic cytoplasmic inclusion bodies, measuring around 5 μm, contain a central area with faint staining (H&E).



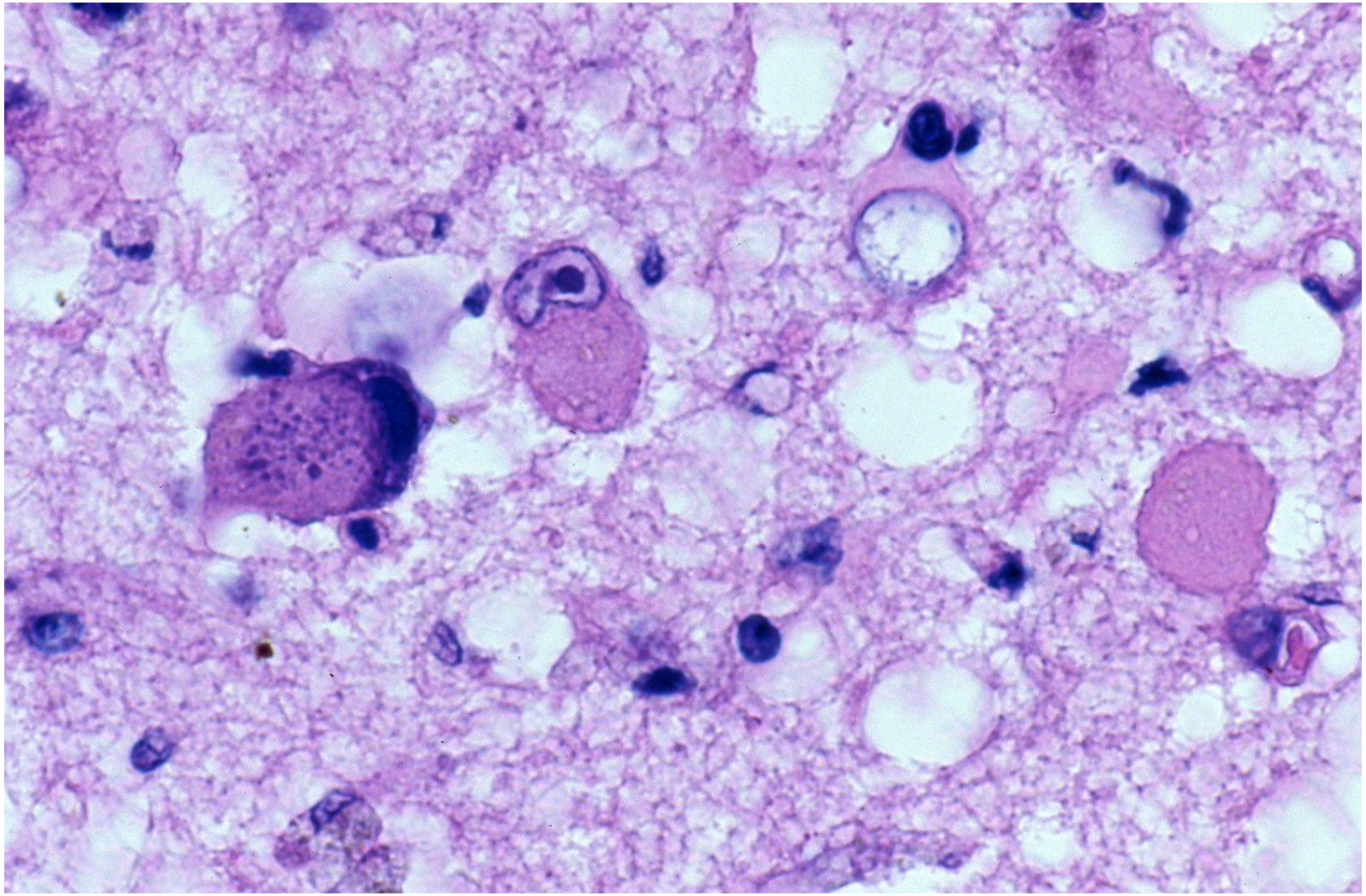
Tay-Sachs disease. An autopsied brain microscopically shows lipid accumulation in the cytoplasm of neurons in the pons. Cytoplasmic ballooning is evident (H&E).



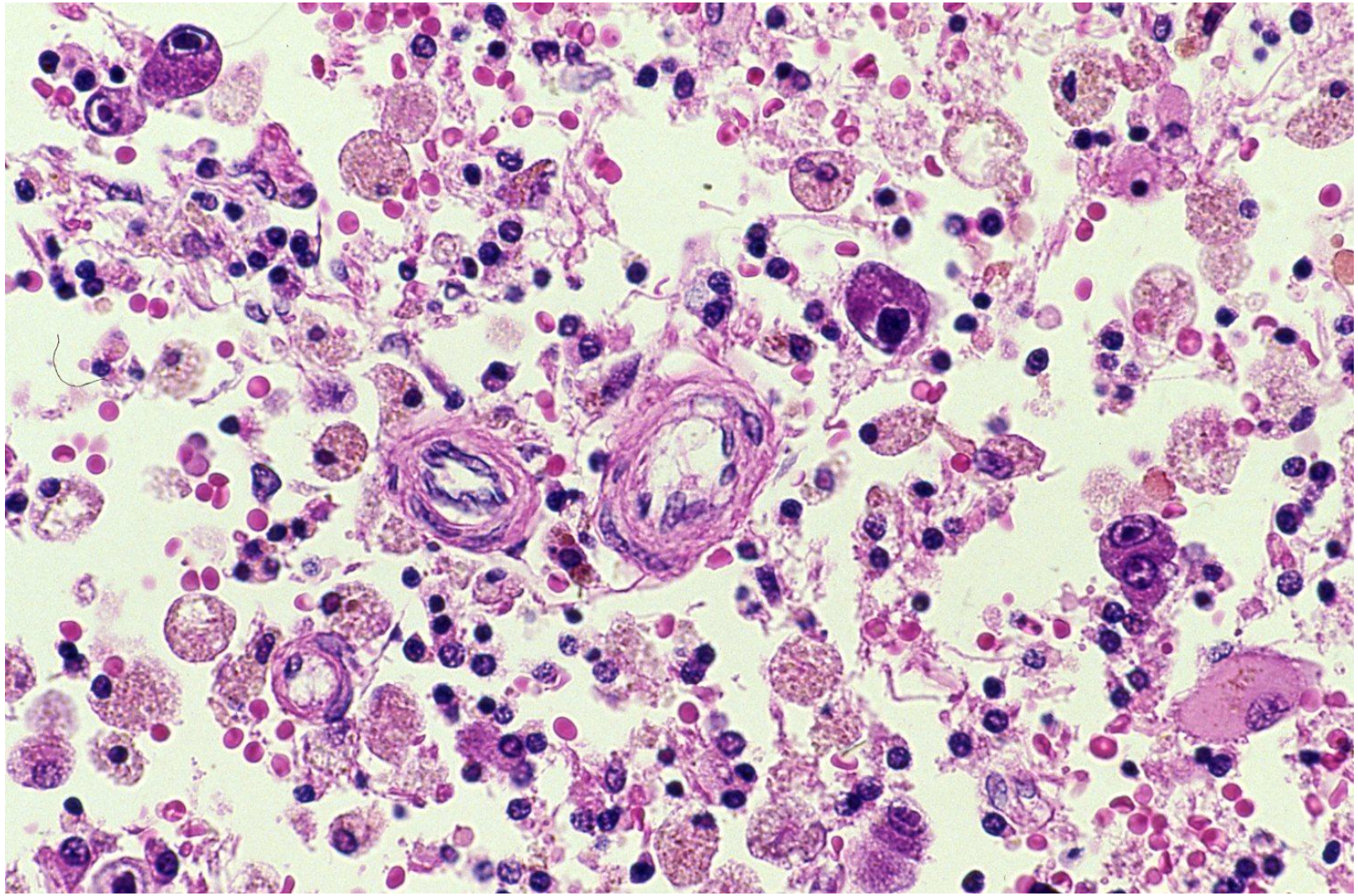
Foamy swelling of neurons of nucleus ambiguous of the medulla oblongata in an autopsy case of lepromatous leprosy after Promin treatment. Motor neurons are swollen with foamy cytoplasm (left: H&E), and immunoreactive for BCG antigens (right), indicating the persistence of *M. leprae*. See neuro-45-brain.



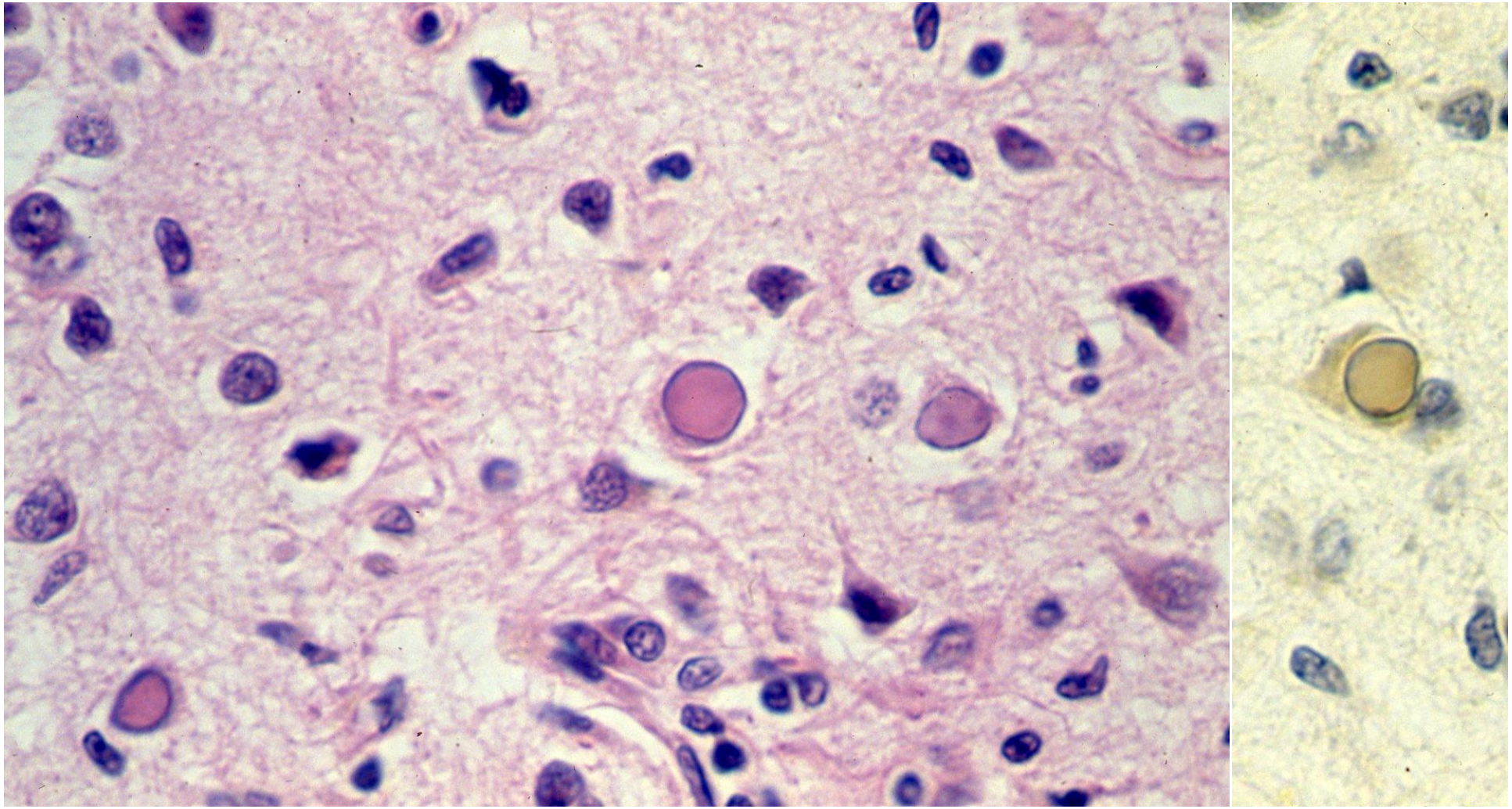
Ubiquitin-positive intranuclear inclusion body is seen in a fibroblastic cell (left: ubiquitin immunostaining). Skin biopsy from a 68 y-o female patient with neuronal intranuclear hyaline inclusion disease (NIHID). Ultrastructurally, small intranuclear inclusion bodies are observed in the capillary endothelial cell. The size of the filamentous intranuclear inclusion body ranges from 300 to 700 nm (right: TEM). Refer to neuro-21-1-brain.



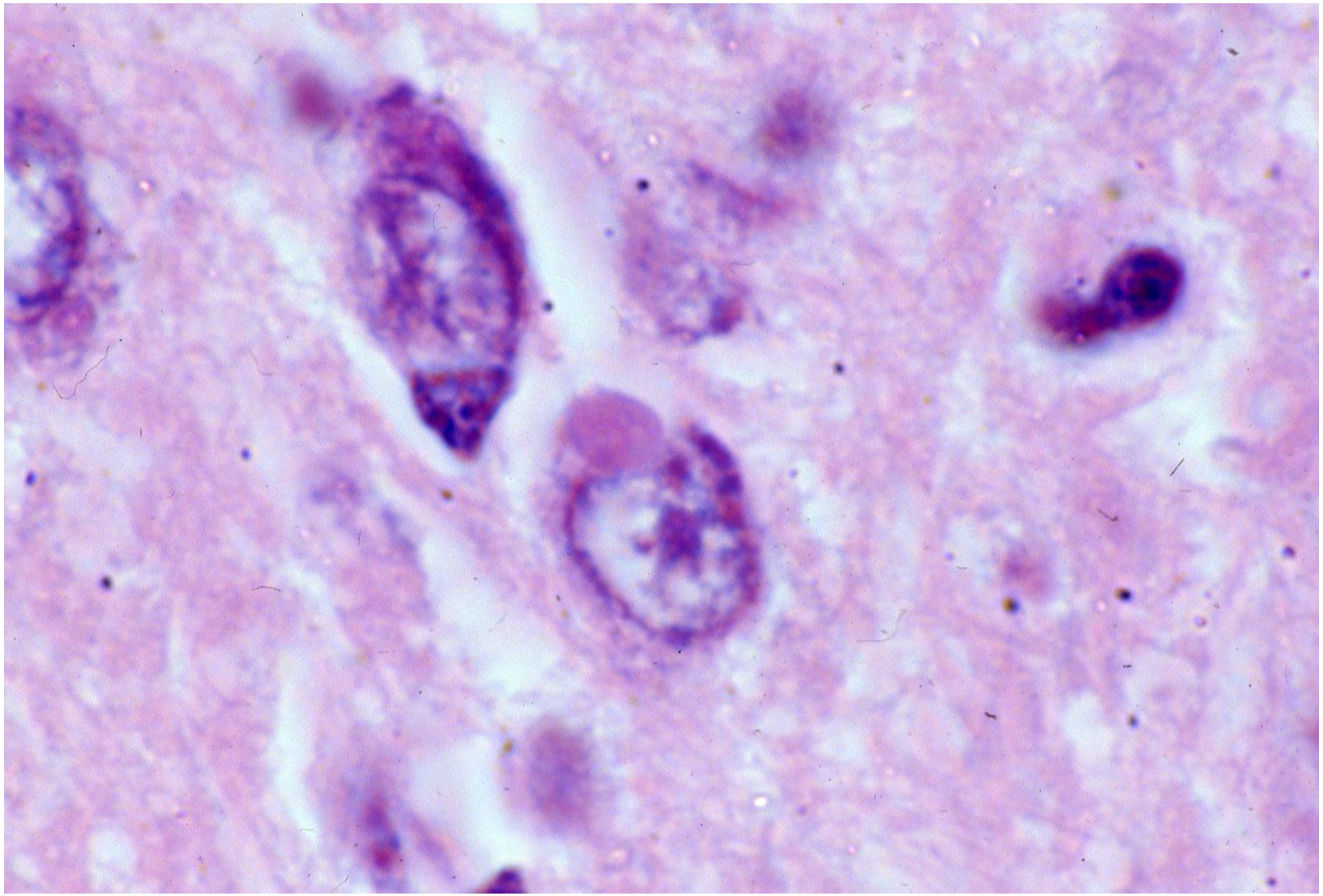
Intranuclear viral inclusions (1). Herpes simplex virus (HSV) encephalitis seen in a male patient aged 30's. The neuron in the temporal lobe contains an intranuclear viral inclusion (H&E).



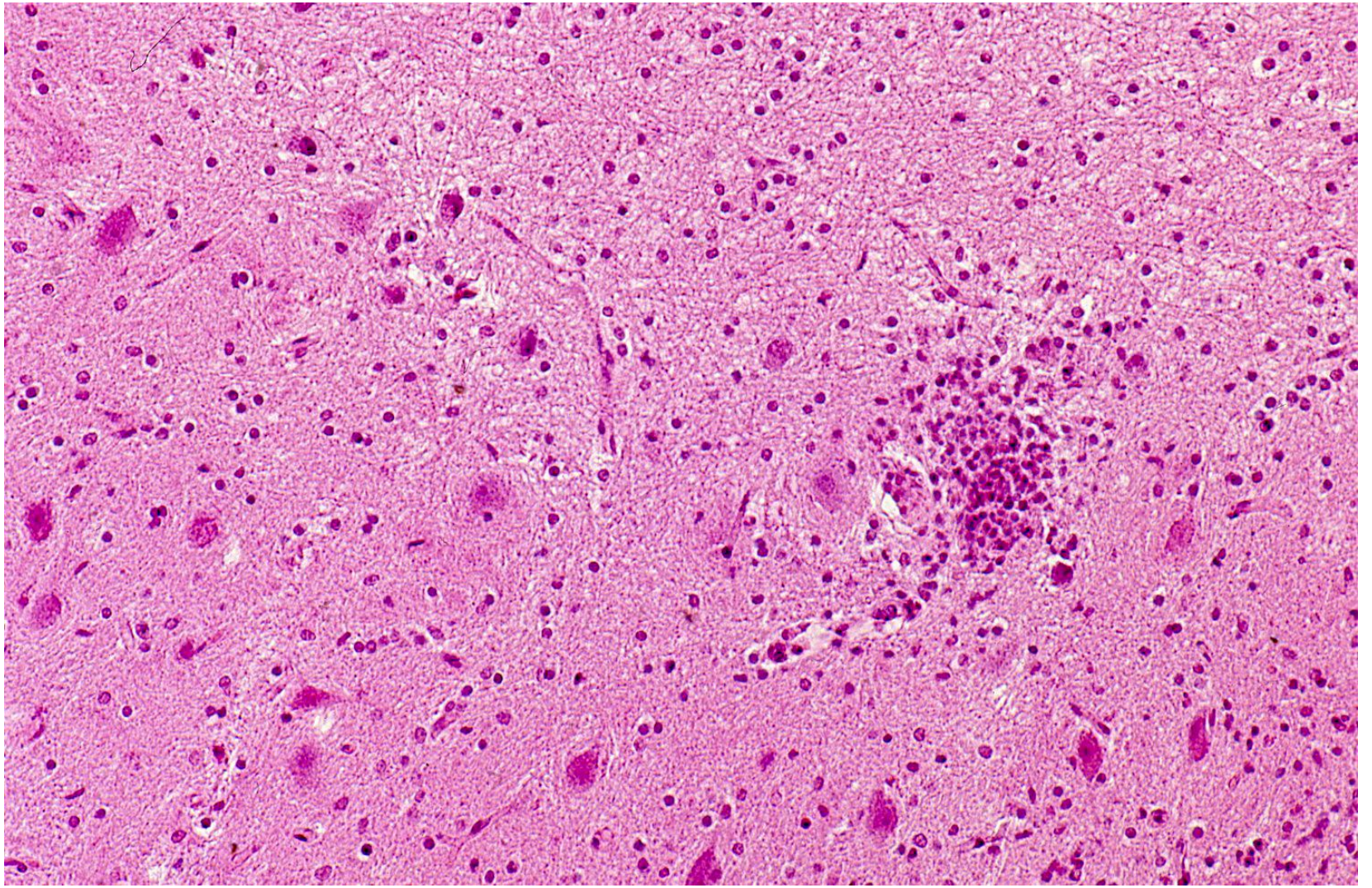
Intranuclear viral inclusions (2). Cytomegalovirus (CMV) encephalitis seen in a male AIDS patient aged 30's. The neurons in putamen contain distinct intranuclear viral inclusions. Infiltration of lymphocytes and macrophages is associated (H&E).



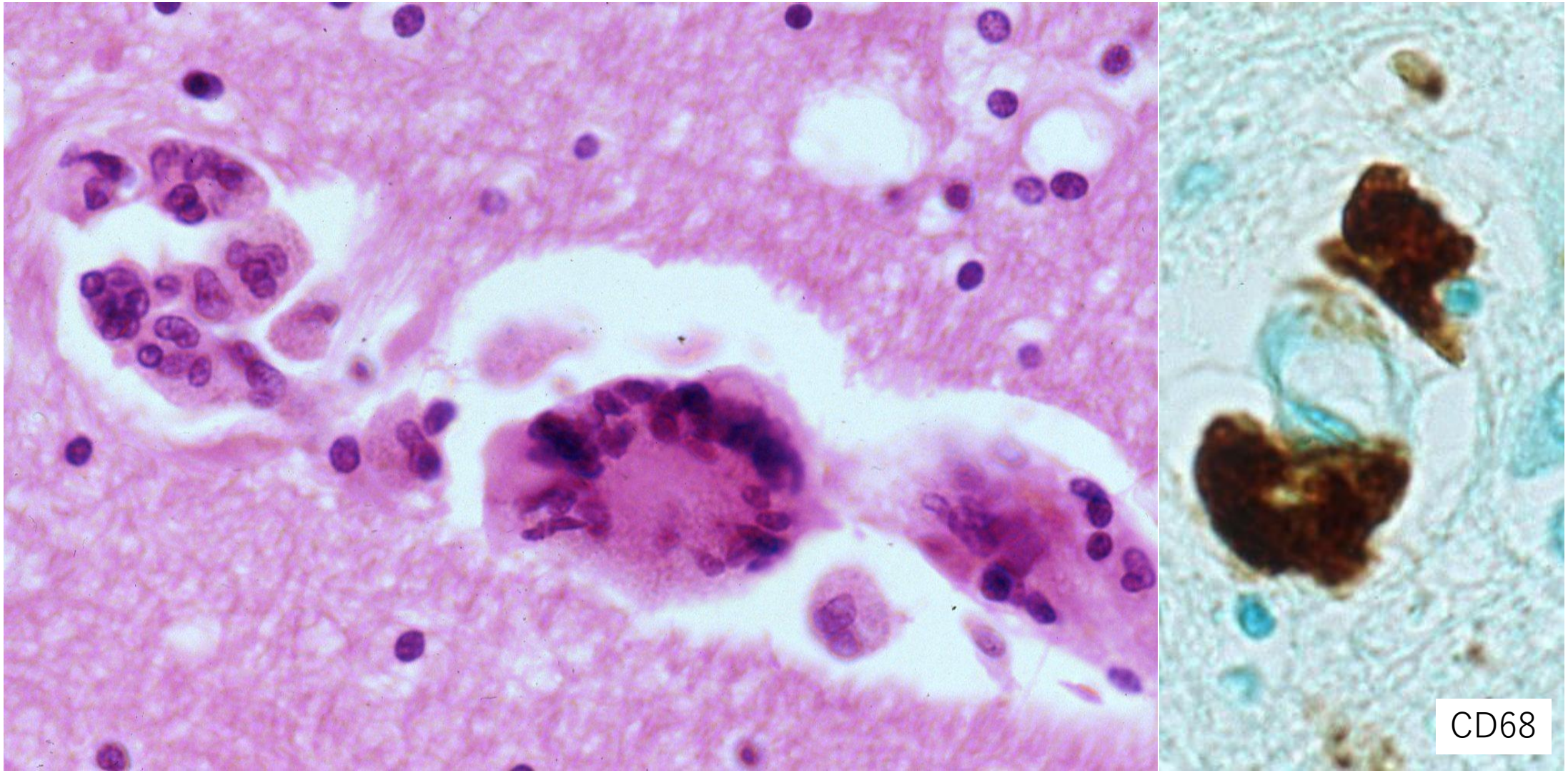
Intranuclear viral inclusions (3). Intranuclear viral inclusions of measles virus seen in oligodendroglia of the white matter in subacute sclerosing pan-encephalitis (SSPE) (an 8 y-o boy, left: H&E). Gliosis is associated. Measles viral antigen is positive in the inclusion (right).



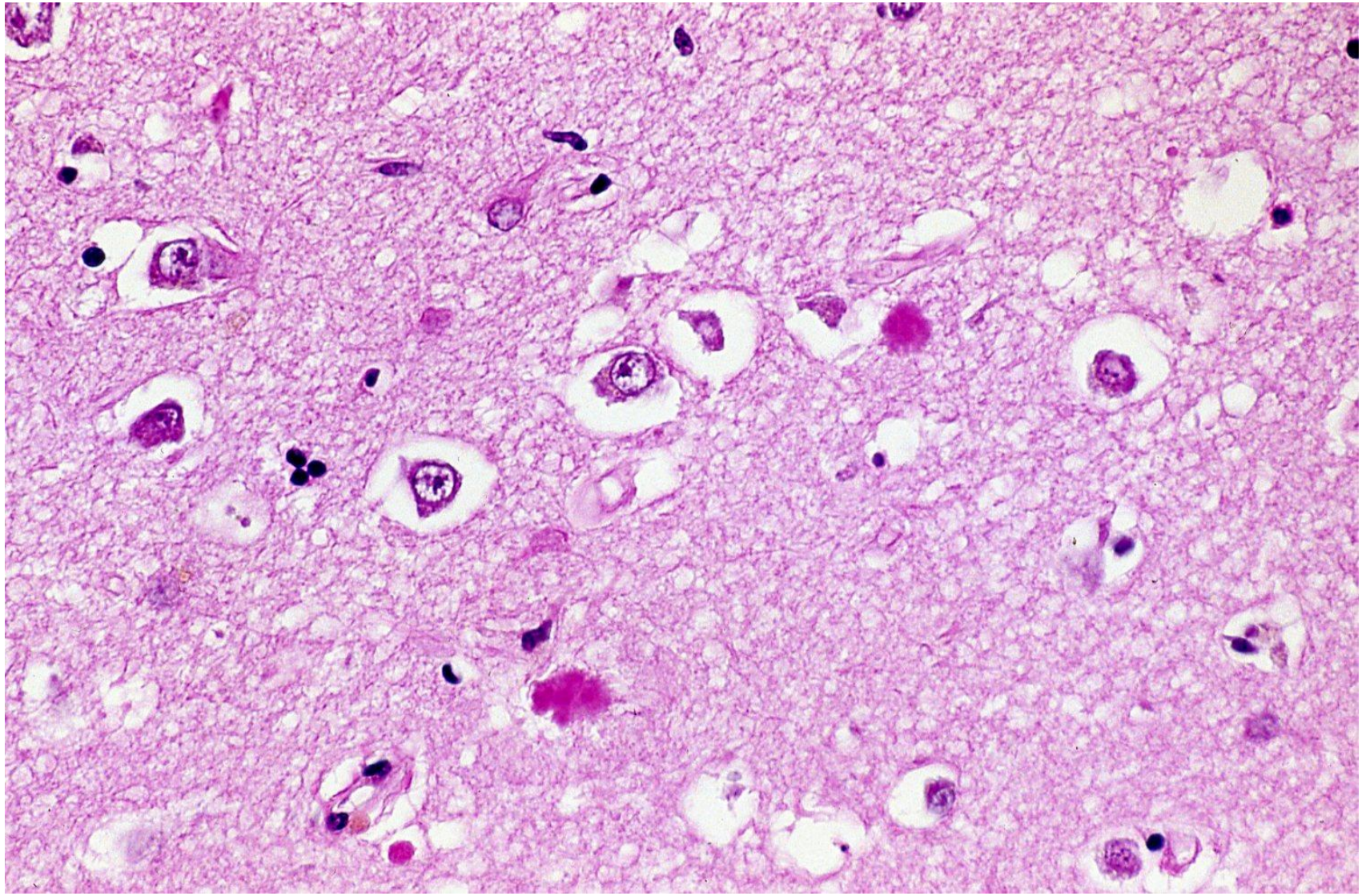
Negri body in rabies. A dog in Thailand suffered from lethal rabies.
An eosinophilic cytoplasmic inclusions is observed in the neuron (H&E).



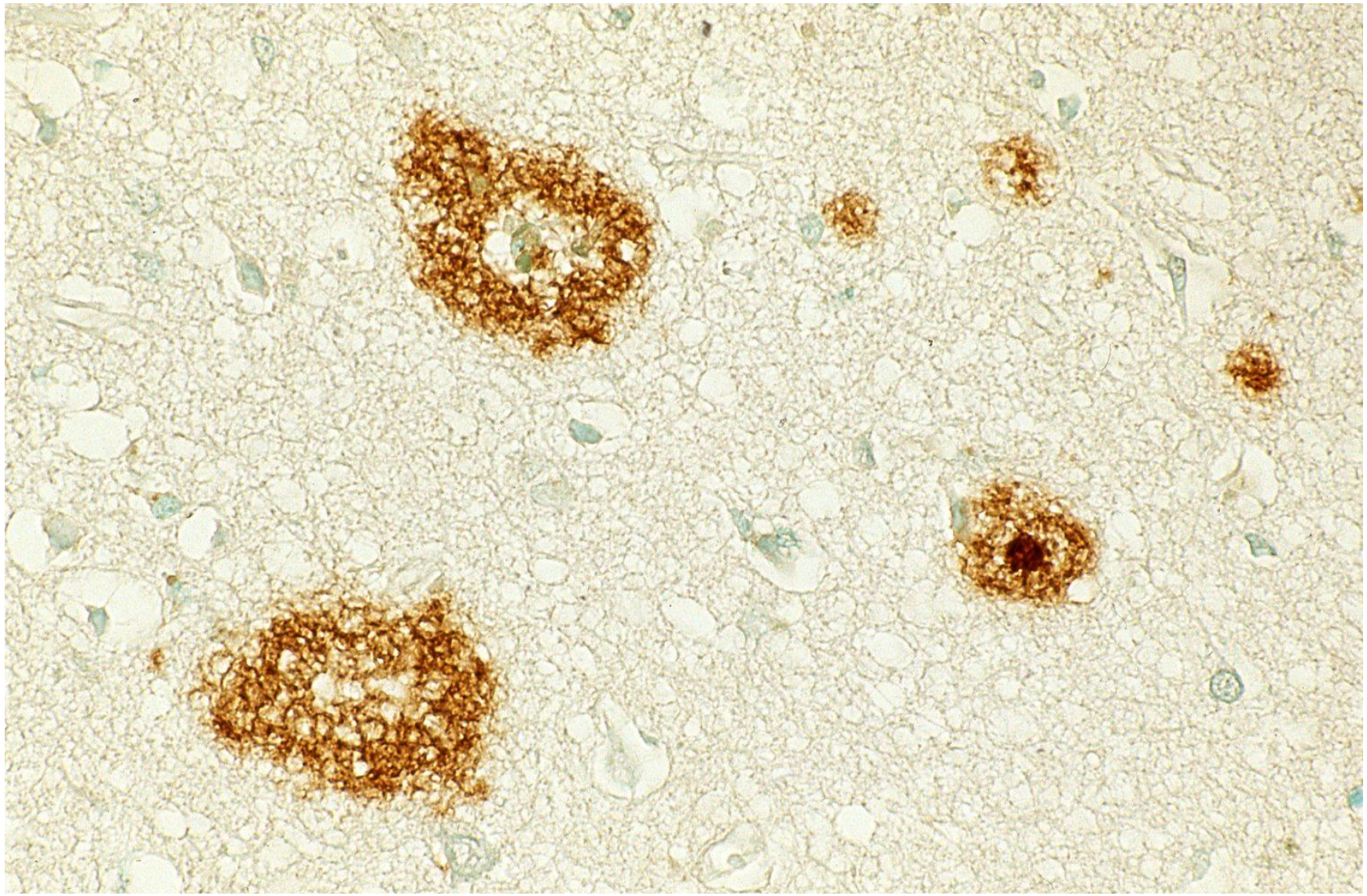
Neuronophagia in enterovirus 71 encephalitis seen in a Japanese boy. The dentate nucleus shows a loss of neuron with localized accumulation of inflammatory cells. Neuronophagia represents an acute stage of viral encephalitis (H&E).



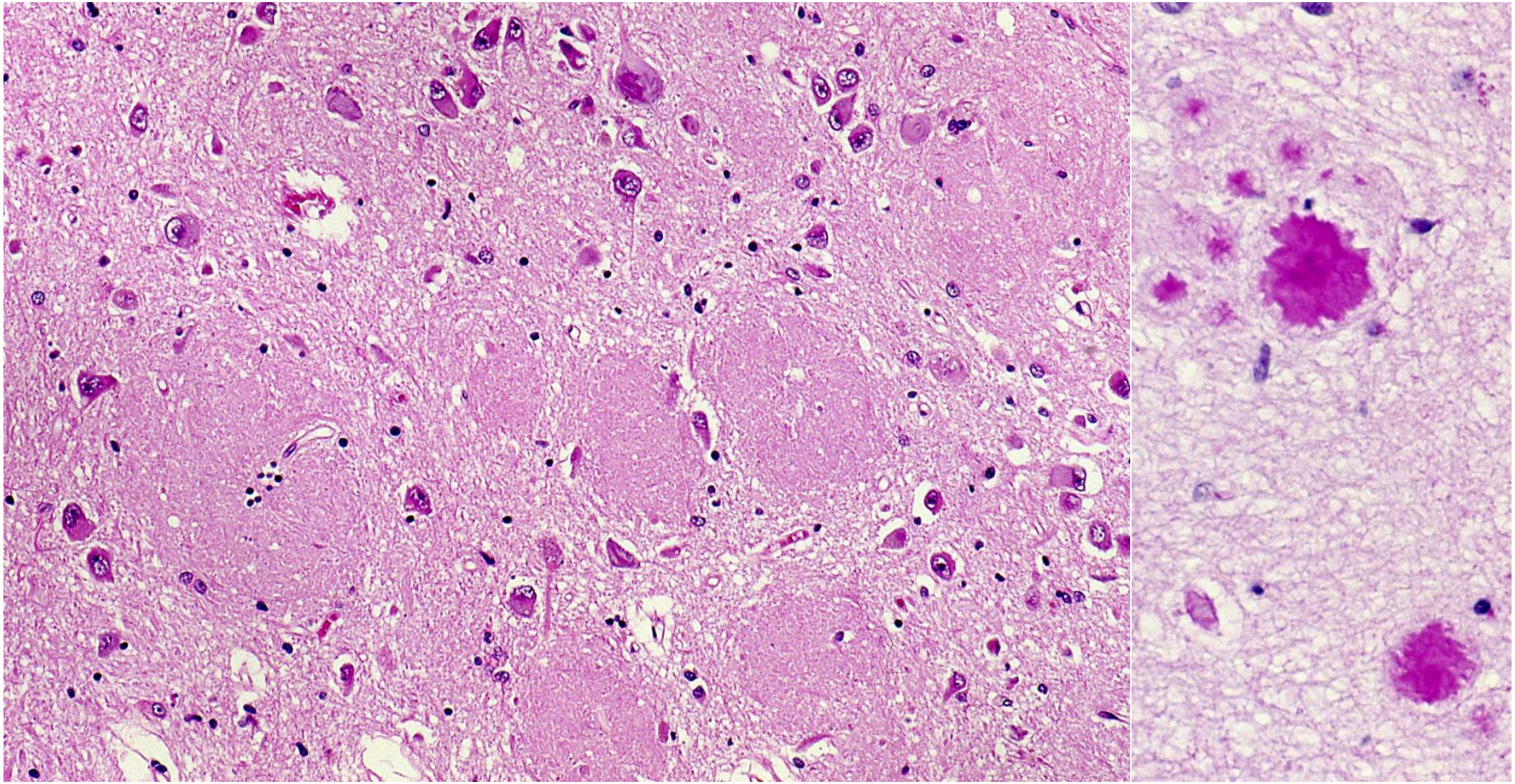
Multinucleated giant cell reaction in AIDS encephalopathy (left: H&E). The patient manifested dementia and blindness. Macrophage origin of the multinucleated giant cells is demonstrated by immunostaining for CD68 (right).



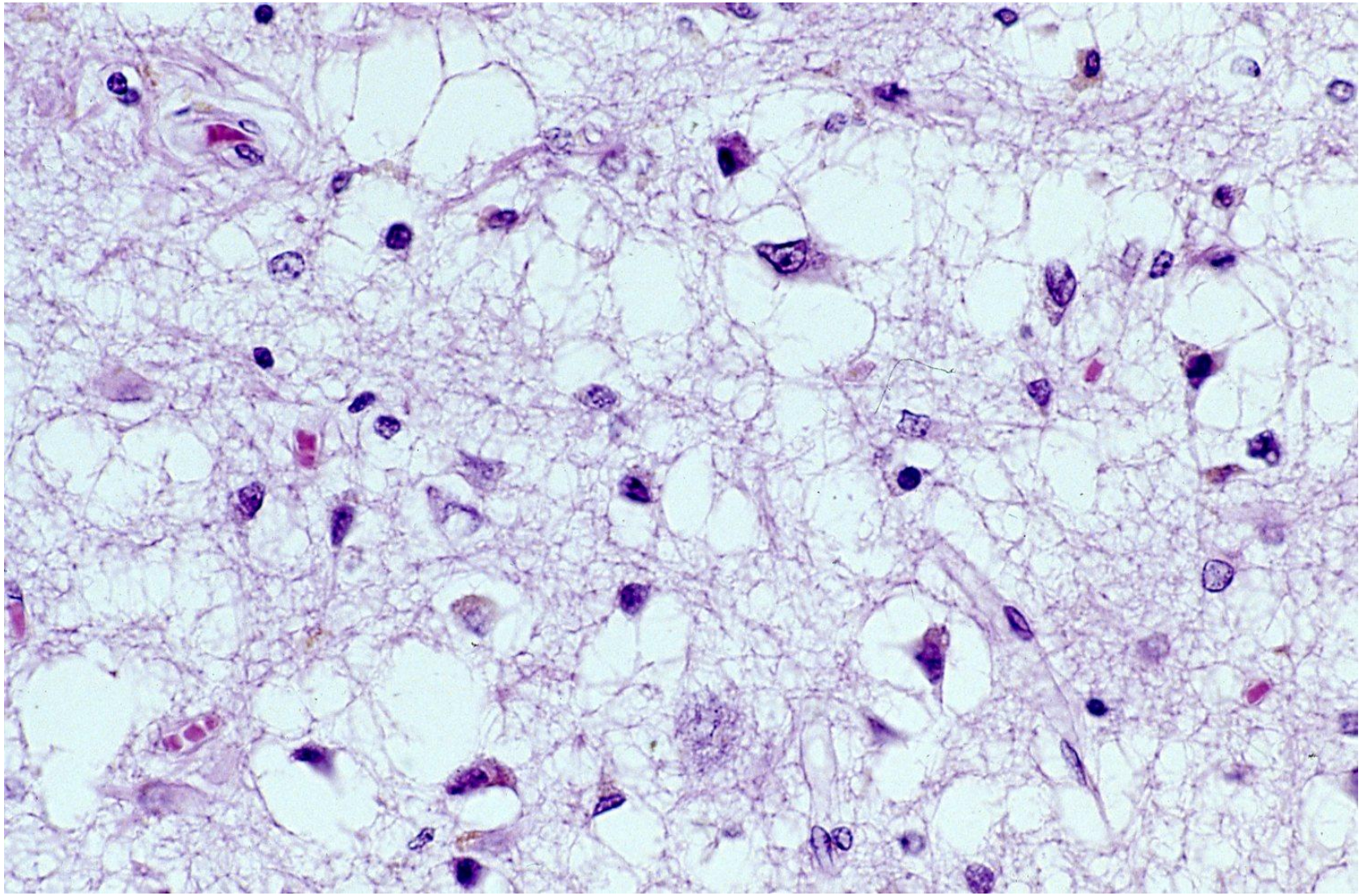
Senile plaques in the cerebral cortex of Alzheimer's disease. Senile plaques are significant neuropathological hallmarks of Alzheimer disease. They have a central amyloid core surrounded by degenerating neurons (dystrophic neurites) (H&E).



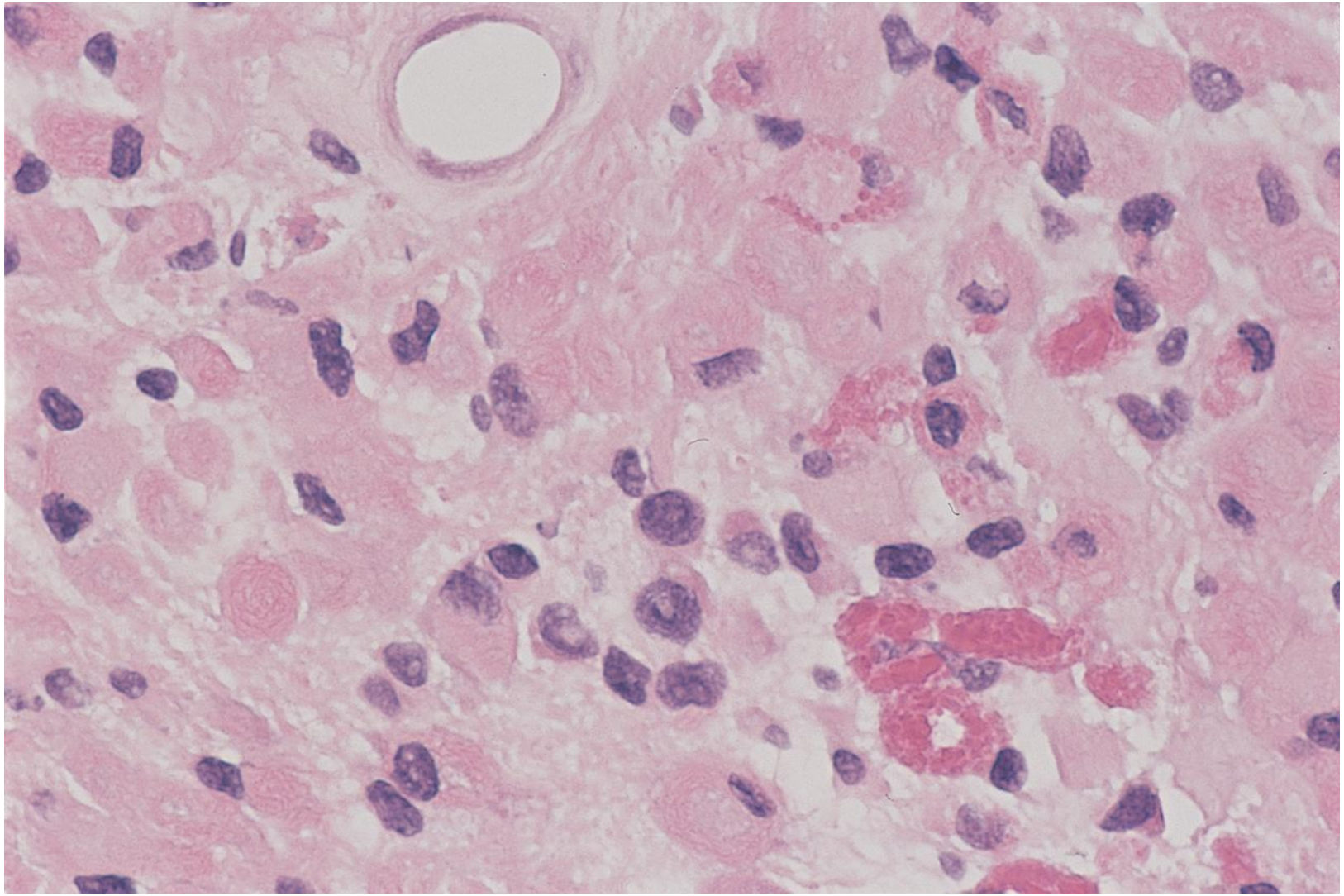
Senile plaques in the cerebral cortex of Alzheimer's disease. Senile plaques are extracellular deposits primarily composed of amyloid beta protein found in the gray matter of the brain. Immunostaining for amyloid beta protein clearly demonstrates the senile plaques.



Senile plaques in Gerstmann–Sträussler–Scheinker syndrome, a prion disorder. Numbers of senile plaques are seen in neuropil (left: H&E). The senile plaques are PAS-reactive (right), and are immunoreactive for amyloid beta protein.



Spongy state in the cerebral cortex in Creutzfeldt-Jakob's disease, a representative prion disorder. The cerebral cortex reveals a prion-induced loose spongy state with reactive gliosis (H&E).



Rosenthal fibers seen in astrocytoma of the cerebral hemisphere of a 45 y-o female patient. Rosenthal fibers are amorphous (rods or oval-shaped) eosinophilic inclusions consisting of ubiquitinated glial fibrillary acidic protein (GFAP) (H&E). They are also seen in Alexander's disease, an autosomal dominant disorder with GFAP gene mutations.