

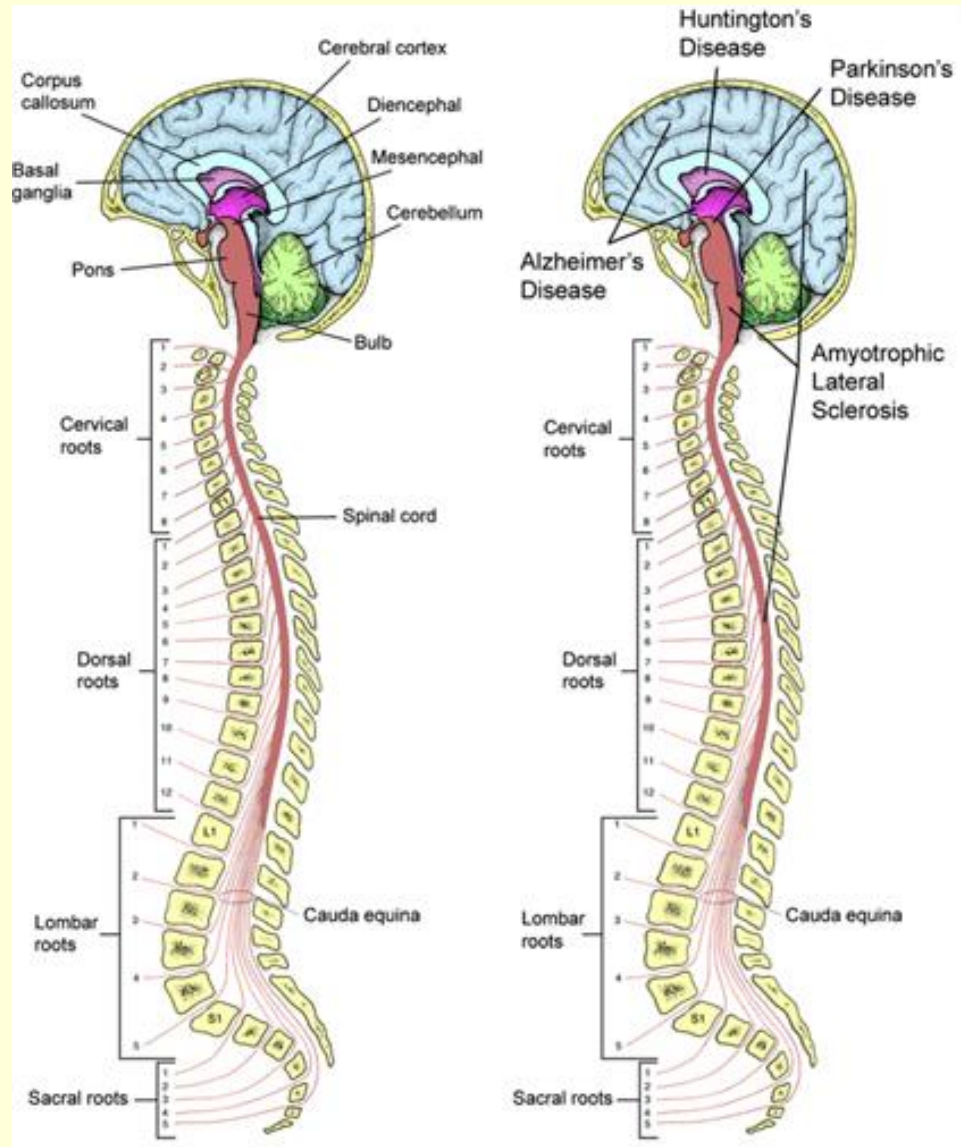
Pathophysiology of the Central Nervous System Pain

lecture from Physiology and Pathophysiology II

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Central Nervous System (CNS)

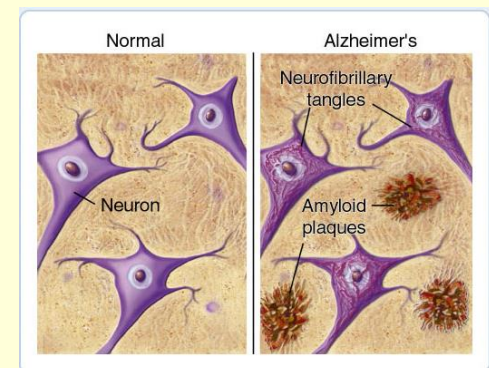


Degenerative Diseases

- heterogeneous group of disorders of **unknown etiology and pathogenesis**
- **slow, progressive loss of function in the absence of an apparent cause** (e.g. no infection, neoplasm, vascular disease, toxicity)
- generally **diseases of middle age and later**
- most of them are **acquired** or **sporadic**, but there are usually subsets of cases which are **inherited** (Huntington's disease)
- pathological changes tend to selectively affect **certain CNS subdivisions**

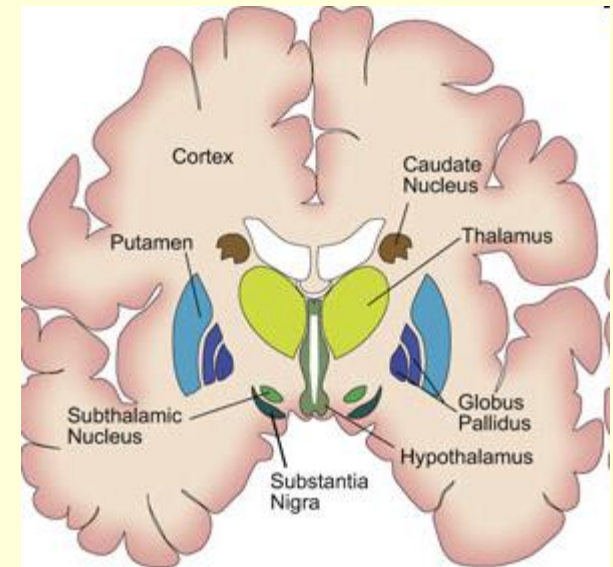
Alzheimer's Disease

- **most common degenerative brain disease** with unknown cause
- incidence rises with age (20% of those over age 80)
- short term memory loss, impairment of executive and mental functions
- wandering, irritability, incontinence, troubles with language
- gross findings are **cerebral atrophy**
- micro shows **senile plaques**, neurofibrillary tangles in neocortex and limbic regions
- senile plaque has **amyloid** core, a halo of distorted neurons
- currently no satisfactory treatment



Diseases of the Basal Ganglia

- **basal ganglia**
 - deep brain structures that help start and control movement
- problems with ability to control speech, movement and posture
- patient with basal ganglia dysfunction may have difficulty starting, stopping or sustaining movement
- depending on which area is affected, there may also be problems with memory and other thought processes



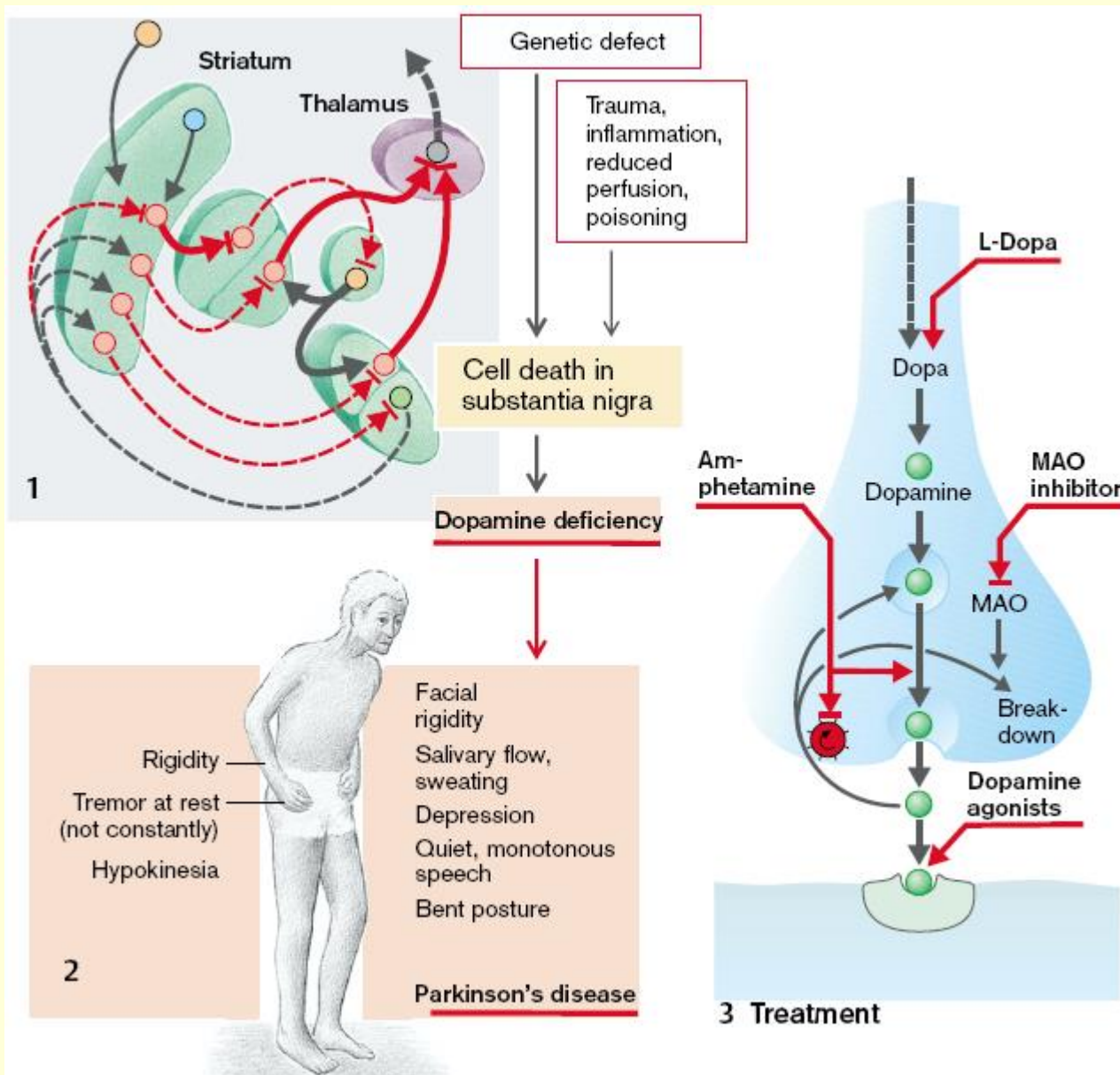
HUNTINGTON'S DISEASE

PARKINSON'S DISEASE

Parkinson's Disease (PD)

- sporadic disease with unknown etiology
- expression of cell loss and degeneration involving the **substantia nigra** with **dopaminergic neurons** that project principally to the striatum (caudate and putamen)
- their death thus leads to a loss of dopaminergic innervation to the striatum
- **imbalance of dopamine and acetylcholine** within the extrapyramidal system is the biochemical basis for the signs and symptoms of PD
- triad of **rigidity, bradykinesia, tremor**
- about one-third develop dementia later

Parkinson's Disease (PD)



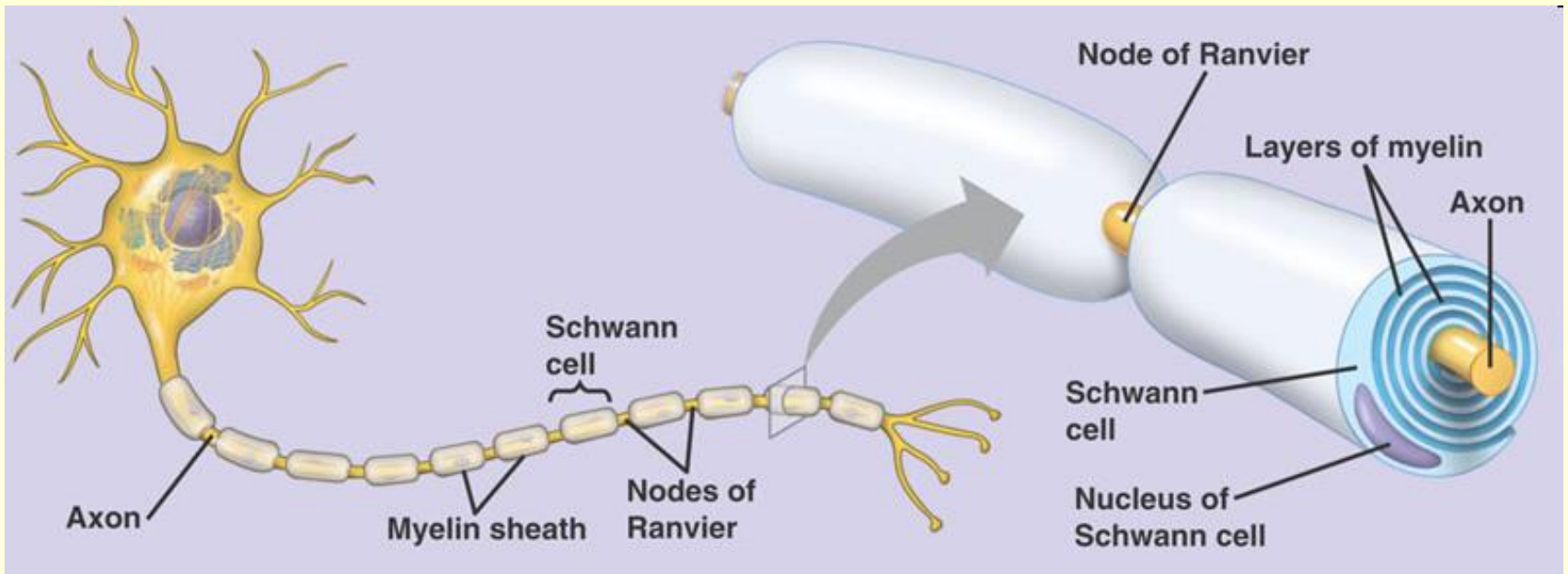
Huntington's Disease (Huntington's Chorea)

- degeneration of the striatum (caudate and putamen)
- autosomal dominant inheritance, mutation on chromosome 4
- pathogenesis unknown (defective vs. toxic protein)
- movement disorder (chorea, athetosis)
- personality change characterized as depression progressing to dementia and death
- diagnosis by history, imaging, molecular genetics

Demyelinating Diseases

- myelin sheath, once properly formed and functioning, is destroyed by a disease process

MULTIPLE SCLEROSIS



Multiple Sclerosis

- myelin sheaths around the axons are damaged, leading to **demyelination**
- onset usually occurs in young adults, more common in females
- **etiology unknown** (immune or viral factors suspected), rather multifactorial (genetic and environmental factors)
- **multiple zones of demyelination**, most numerous in the white matter of the cerebrum, brain stem, cerebellum and spinal cord

Multiple Sclerosis

- main clinical feature is the **dissemination of signs and symptoms in time and space**, the lesion can occur anywhere in the white matter of the CNS
- common initial symptoms: diplopia, numbness or weakness of an extremity, and monocular blindness
- clinical course variable, marked by **exacerbations** (attacks followed by **remissions**), each cycle generally leaves further neurologic deficit and may involve motor, sensory or cerebellar functioning
- diagnostic methods: MRI, CT scans and evoked potentials

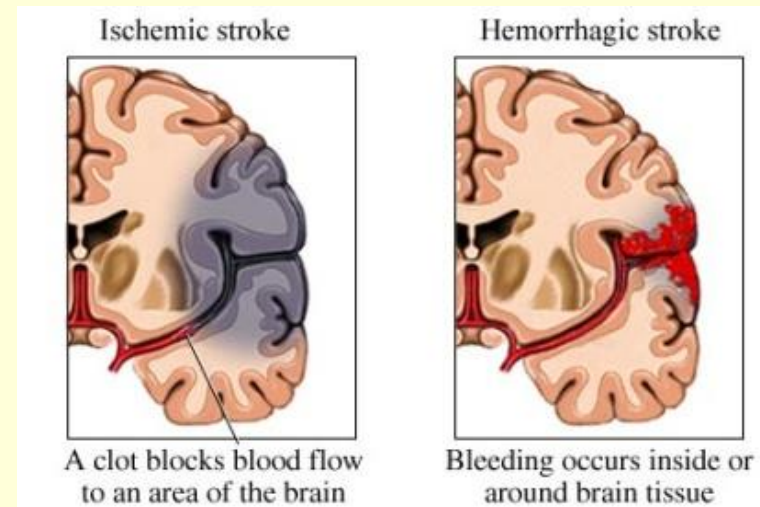
Hypertension Brain Affections

HYPERTENSIVE ENCEPHALOPATHY

- sudden change in blood pressure causes brain vessels spasm, ischemia and edema
- headache, confusion, somnolence to coma, convulsions

BRAIN STROKE (APOPLEXY)

- ischemic
 - thrombosis
- hemorrhagic
 - spontaneous intracerebral hemorrhage
 - subarachnoid hemorrhage

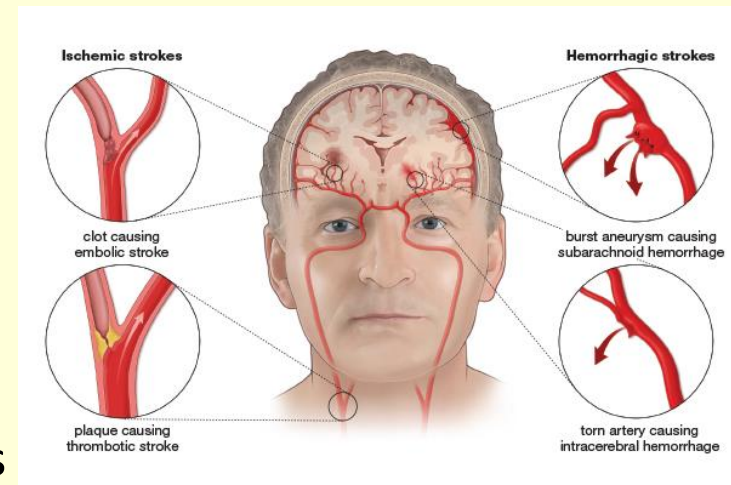


Brain Stroke

- speaking disorder (aphasia, dysarthria)
- confusion
- muscle weakness, especially on one side of the body
- numbness, especially on one side of the body, decreased sensation
- severe headache
- vision changes (in one or both eyes)
- difficulty with swallowing
- facial droop on one side
- hemiplegia, balance problems

FAST Test Signs of possible stroke

- **F** means face -- if one side of the face droops
- **A** means arms -- if the person cannot hold both arms out
- **S** means speech -- slurring words and poor understanding of simple sentences
- **T** means time -- if any of the FAS signs are positive



Inflammatory Diseases of CNS

ENCEPHALITIS

- acute inflammation of the brain usually caused by a viral infection
- symptoms: headache, neck pain, drowsiness, nausea and fever

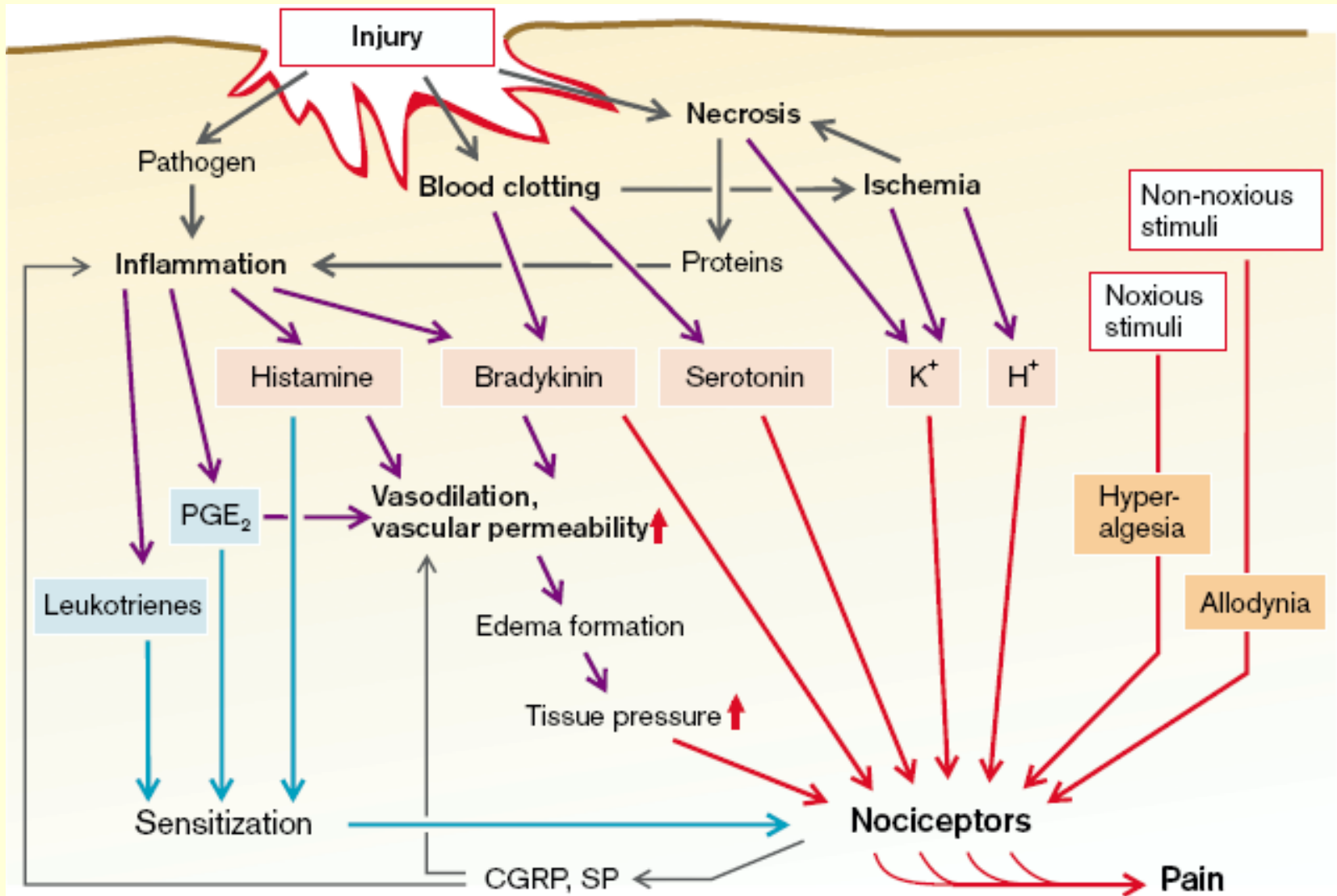
MENINGITIS

- inflammation of the meninges of the brain and spinal cord
- most often caused by a bacterial or viral infection
- symptoms: fever, vomiting or stiff neck

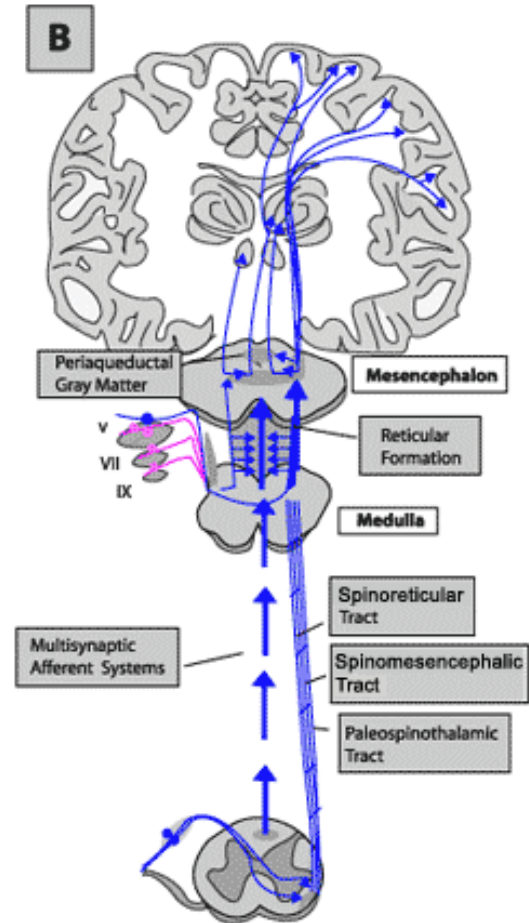
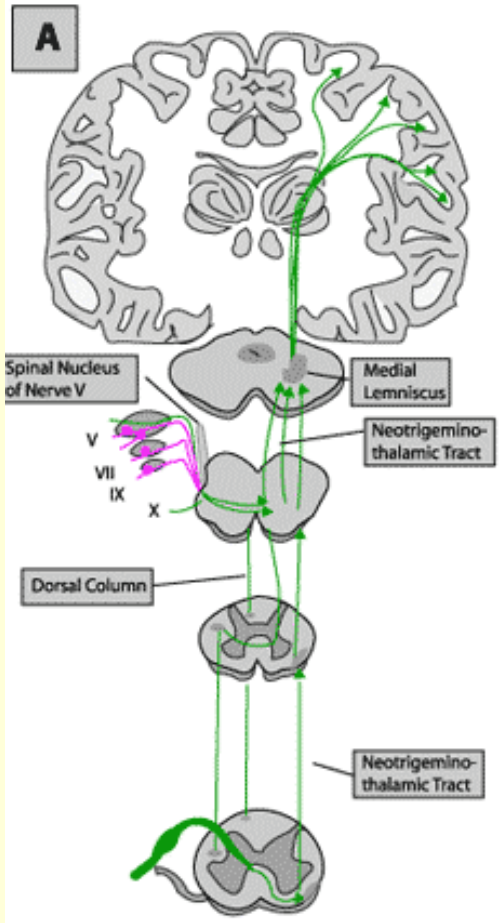
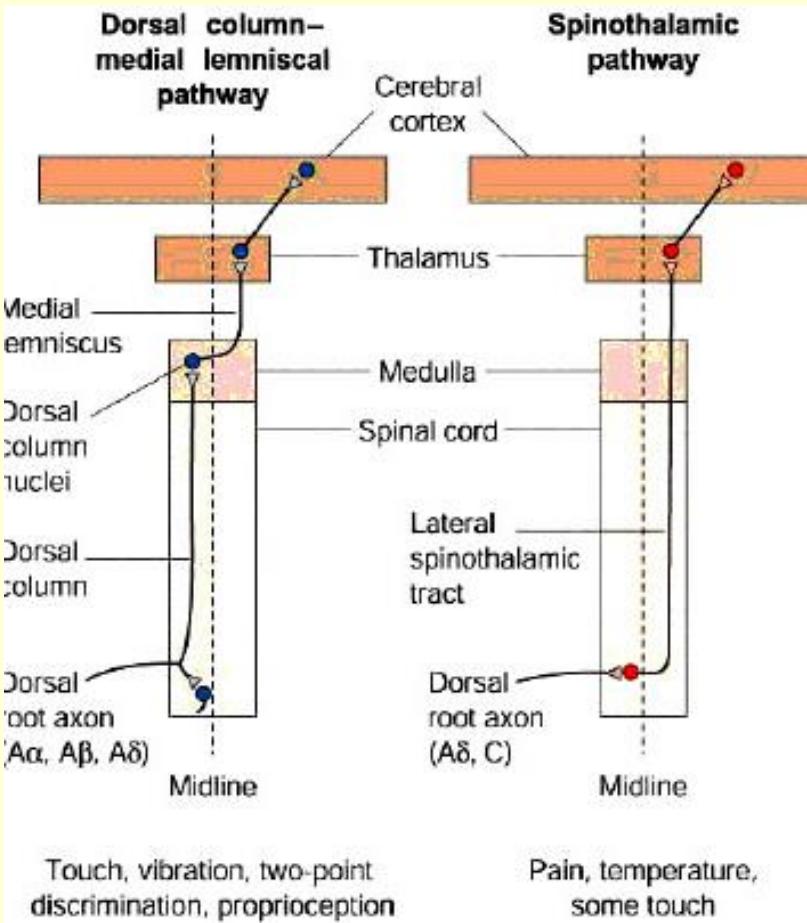
Pain

- unpleasant sensory and emotional experience associated with actual or potential tissue damage
- pain stimuli from the skin and the viscera
- distension, temperature, tissue lesions, inflammation
- pain-producing mediators: leukotrienes, prostaglandin E_2 , bradykinin, histamine

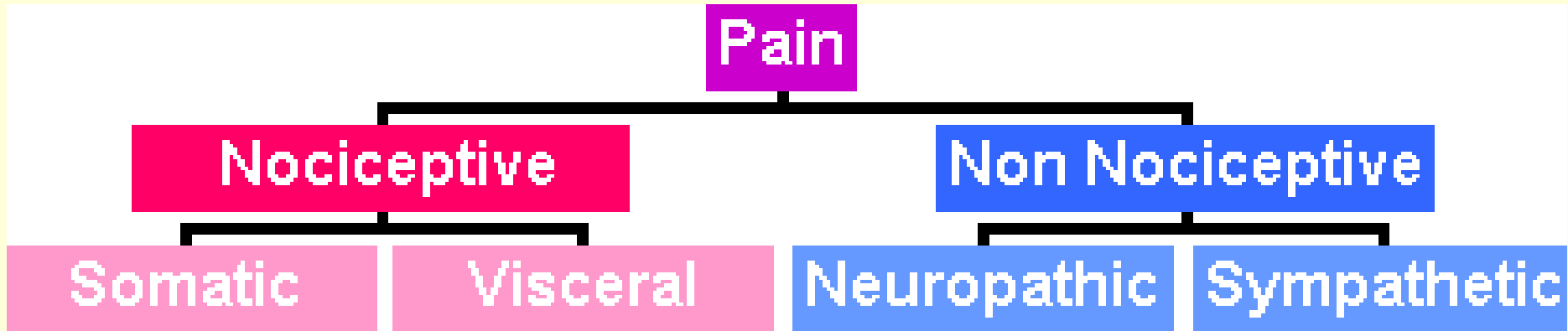
Pain



Pain Pathways



Pain Classification



- **nociceptive pain** arises from the stimulation of specific pain receptors that can respond to heat, cold, vibration, stretch and chemical stimuli released from damaged cells
- **non nociceptive pain** arises from the peripheral and central nervous system with no specific receptors, pain is being generated by nerve cell dysfunction

Pain Duration

ACUTE PAIN

- the normal, predicted physiological response to an adverse chemical, thermal, or mechanical stimulus associated with surgery, trauma, and acute illness
- generally time-limited and is responsive to analgotherapy

CHRONIC PAIN

- pain state which is persistent and in which the cause of the pain cannot always be removed or is difficult to treat
- may be associated with a long term incurable or intractable medical condition or disease

Somatic Pain

- source – skin, muscle, joints, bones and ligaments, known as **musculo-skeletal pain**
- **specific receptors (nociceptors)** for heat, cold, vibration, stretch (muscles), inflammation (e.g. cuts and sprains which cause tissue disruption) and oxygen starvation (ischemic muscle cramps)
- often sharp and well localized and can often be reproduced by touching or moving the area or tissue involved

Visceral Pain

- source are internal organs of the thorax (heart and lungs), abdomen (liver, kidneys, spleen and intestines) and pelvis (bladder, uterus and ovaries)
- **specific receptors (nociceptors)** for stretch, inflammation, and oxygen starvation (ischemia)
- often poorly localized and may feel like a vague deep ache, sometimes being cramping or colicky in nature
- frequently produces **referred pain** to the back, with pelvic pain referring pain to the lower back, abdominal pain referring pain to the mid-back, and thoracic pain referring pain to the upper back

Nerve (Neuropathic) Pain

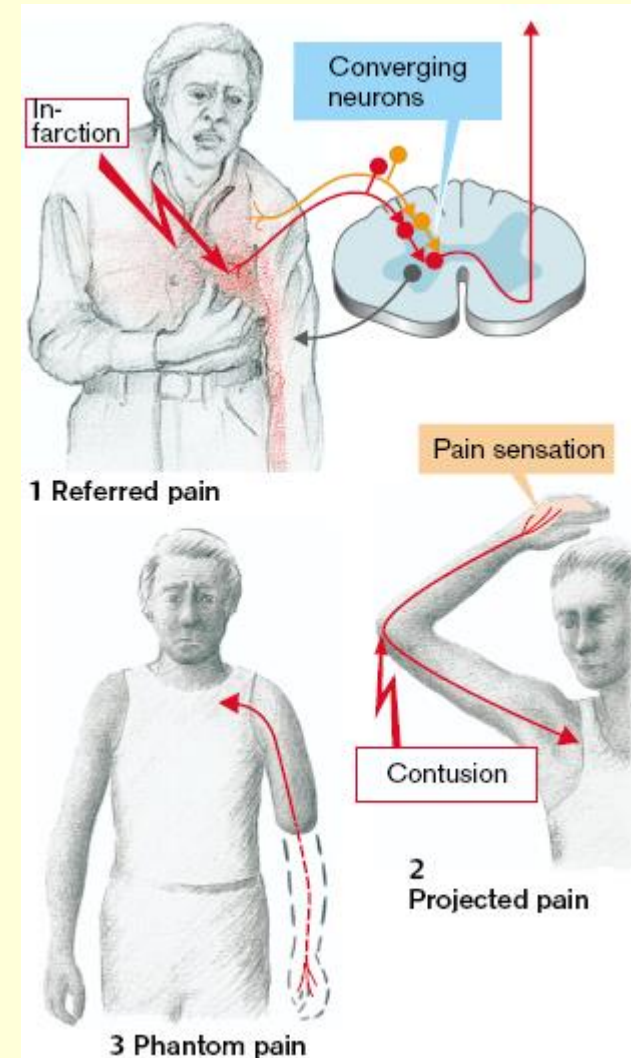
- source is from the nervous system itself (PNS and CNS)
 - **nerve degeneration** – MS, stroke, brain hemorrhage
 - **nerve pressure** – trapped nerve
 - **nerve inflammation** – torn or slipped disc
 - **nerve infection** – viral infections
- no specific receptors for pain, instead of when a nerve becomes injured, it becomes electrically unstable, firing off signals in a completely inappropriate, and disordered fashion
- signals are interpreted by the brain as pain, and can be associated with signs of nerve malfunction such as hypersensitivity (touch, vibration, hot and cold), tingling, numbness and weakness
- often referred pain to an area where that nerve would normally supply
- spinal nerve root pain often associated with intense itching in the distribution of a particular dermatome, described as lancinating, shooting or burning
- partially sensitive to paracetamol, NSAIDs, opioids, more sensitive to anti-depressants and anti-convulsants

Sympathetic Pain

- arises due to possible over-activity of the sympathetic nervous system
- the sympathetic NS controls blood flow and sweating
- occurs more commonly after fractures and soft tissue injuries of the arms and legs and injuries may lead to **Complex Regional Pain Syndrome (CRPS)**
- no specific pain receptors (non-nociceptive)
- extreme hypersensitivity in the skin around the injury and peripherally in the limb (**allodynia**) with abnormalities of sweating and temperature control
- the limb is painful, patient refuses to use it, causing secondary problems of muscle wasting, joint contractures, and osteoporosis
- initiated by trauma to small peripheral nerves close to the injury

Referred Pain

- pain perceived at a site adjacent to or at a distance from the site of an injury's origin
- ischemia brought on by a **myocardial infarction** (heart attack) where pain is often felt in the neck, shoulders and back rather than in the chest
- **phantom pain** (amputees, quadriplegics)



Pain Regions

HEADACHE

MYOFASCIAL

RHEUMATIC

PELVIC PAIN

NEUROPATHIC

Headaches (Cephalgia)

PRIMARY

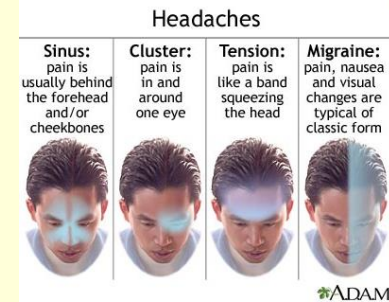
- Tension headaches
- Migraine
- Cluster headaches

SECONDARY

- due to an underlying structural problem in the head or neck
- bleeding in the brain, tumor or inflammatory processes (meningitis, encephalitis)

CRANIAL NEURALGIAS

Headache (Cephalgia)



TENSION HEADACHES

- the most common type of primary headache (up to 90 % of adults, more commonly women)
- the pain begins in the back of the head and upper neck and is described as a band-like tightness or pressure
- the pain usually is mild (not disabling) and bilateral (affecting both sides of the head)

CLUSTER HEADACHES

- headaches that come in groups (clusters) lasting weeks or months, separated by pain-free periods of months or years
- pain typically is excruciating and located around or behind one eye

Migraine

- unilateral pain (affecting one half of the head) and pulsating in nature, lasting from 4 to 72 hours
- caused by vasodilatation with releasing of chemicals from nerve fibers that coil around the large arteries of the brain, this stretches the nerves and causes releasing of the mediators causing inflammation, pain and other vasodilatation that magnifies the pain
- nausea, vomiting, photophobia (increased sensitivity to light), phonophobia (increased sensitivity to sound)
- **aura** – unusual visual, olfactory or other sensory experiences that are a sign that the migraine will soon occur
- migraine triggers – stress, sleeping disturbances, odors, cigarette smoke, hormonal dysbalance