Central nervous system
- Brain is a prisoner
- Basic cellular elements
  - Neurons, location means everything
  - Neuronal reaction to injury, very limited
    - Axonal growth
    - No regeneration of lost cells
    - Accumulation of junk within the cells can be harmful.
  - Glial component, supportive
    - Microglia, the police force of the CNS
    - Astrocytes, structural like fibroblasts elsewhere
      - Gemistocytes are reactive astrocytes
    - Oligodendrocytes, make myelin (the insulation)
- Meninges

Cerebral Edema
- Injury to brain
  - Tumor
  - Rubor......
  - Swelling can't go anywhere
  - Compression of vital structures
- Herniation
  - Sublax
  - Transtentorial
  - Cerebellar tonsils

Brainstem Hemorrhages

CSF Flow
- Made in the ventricles
- Flows down aqueduct
- Into 4th ventricle
- Out into the subarachnoid space
- Up to the arachnoid granulations
- Back into the blood
- Obstructions in movement will lead to hydrocephalus
Hydrocephalus

- Obstruction to flow of CSF
- Over production of CSF
- Inability of arachnoid granulations to restore water of CSF back into circulation

Hydrocephalus

- Noncommunicating: Can’t get out of ventricles
- Communicating: CSF can’t get to arachnoid granulations

Trauma

- Birth trauma
- Hemorrhage
- Permanent loss

Trauma

- Closed head
  - Coup
  - Contra-coup
- Penetrating
- Hemorrhage
- Contusion
- Laceration

Contusions
Subdural Hemorrhage
- Rotational injury tears little veins
- Slow venous bleeding

Epidural Hemorrhage
- Trauma with skull fx
- Middle meningeal a.
- Hemorrhage compresses brain

Subarachnoid Hemorrhage
- Not as commonly due to trauma, but maybe.
- Arterial bleeding
- Typically from Circle of Willis
- Blood in subarachnoid space

Vascular Disease
- Hypoxic
  - TIA
  - Stroke
    - Infarction
- Hemorrhagic
  - Vascular blowout
  - Trauma
Ischemic Infarcts

Hypertensive Hemorrhages
- Berry aneurysm
- Subarachnoid
- Parenchymal

Berry Aneurysm

Subarachnoid Hemorrhage

Lacunar Infarcts
- Hypertensive vascular disease
- ‘Watershed’ infarcts

Chronic Ischemia
- Chronic vascular insufficiency
- Atherosclerosis
- Marked cerebral atrophy
**Infections**

- **Brain proper**
- **Meninges**
- **Bug**
  - Bacteria
  - Virus
  - Spirochetes
  - Parasites
  - Prions

**Bacterial Meningitis**
- Exudate over cerebral hemispheres
- Bacteria grow in CSF
- CSF
  - Cell count
  - Glucose
  - Protein
- Age of patient
- Complications
  - Starring
  - Epilepsy
  - Abscess

**Cerebral Abscess**
- Septic endocarditis
- Blood borne pathogens
- Must surgically drain

**Viral Encephalitis**
- Infection of brain substance
- Herpes
- Absent temporal lobes
- Sporadic
- Immunsuppressed
- HIV
HIV Encephalopathy
- Meningitis
- Neuronal
- Both cognitive motor
- Diffuse cortical atrophy
- Microglia at site of dead neurons
- gp120 protein is directly toxic

Tertiary Syphilis
- Years after initial infection
- Obliterative end arteritis
- Meningitis
- Brain proper
- Tabes dorsalis

Prion Disease
- No nucleic acid
- Sporadic or genetic
- Accumulation of abnormally folded protein
- Variety of conformations of the diseased protein
- Spongiform encephalopathy
- Kuru

Degenerative Diseases
- Not just aging changes
- Neuronal Death
- Gray matter
  - White matter changes are secondary
  - Selective or generalized loss
  - Atrophy (local or global)
- Histological features
  - Neurofibrillary tangles
  - Intracellular or intranuclear inclusions
Alzheimer’s Disease

- True dementia
- Marked atrophy
- Protein alterations
  - Tau protein
  - Amyloid related protein
  - Senile plaques
  - Amyloid angiopathy

Alzheimer’s Disease

- Progressive loss
  - Memory
  - Cognitive
- 5-15 years
- Eventually loss of language
- Higher functions
- Parkinson’s in a few
- Pneumonia is often cause of death

Alzheimer’s Disease

- Senile plaques
- Vascular amyloid changes

Parkinson’s Disease

- Parkinsonism, collection of symptoms
  - Rigidity, stooped posture, gait disturbances, pill rolling, face
  - Drug induced
  - Parkinson’s Disease

Huntington Disease

- Hereditary
- Progressive
- Extrapyramidal motor
- Choreaform movements
- Huntington gene
  - Trinucleotide repeats
  - CAG
  - Normal 6-34 copies
  - HD has 50-70 repeats
- Caudate nucleus atrophy
- Suicide and infections
Amyotrophic Lateral Sclerosis (ALS)

- Sporadic loss of motor neurons
- Spinal
- Bulbar
- Poor swallowing
- Pneumonia

Demyelinating Disorders

- White matter
- Disease of oligodendrocytes
- Autoimmune most times

Multiple Sclerosis

- Lesions dispersed in space and time
- Come and go
- Symptoms
  - Optic nerve
  - Urination
  - Heat makes worse
  - Weakness
- Degeneration of white matter
- Plaques

Multiple Sclerosis

- Areas of demyelination
  - Plaques
  - Active repair
  - Quiescent
Toxic and Vitamin Deficiencies

Thiamine Deficiency
- Beriberi
- Alcohol abuse
- Abrupt psychotic changes
- Wernicke's encephalopathy
  - Hemorrhages in mamillary bodies
  - Confusion
  - Paralysis of extraocular muscles
  - Ataxia
- Korsakoff's
  - Inability to form new memories
  - Confabulation

B12 Deficiency
- Inability to maintain myelin
- Posterior column degeneration

Ethanol
- Acutely, neural depressant
  - Inhibitions go first
  - Loss of depth perception
- Chronic
  - Degeneration of granular cell layer of cerebellum
  - Loss of Purkinje cells
  - Bergman's gliosis
- Fetal alcohol syndrome
  - Microcephaly
  - Growth retardation
  - Facial abnormalities
  - Mental retardation
  - Abnormal migration of neurons during development
**CNS Tumors**

- Primary vs. metastatic
- Benign vs. malignant
- Focal vs. diffuse
- Above or below tentorium
- Not too common in adults
- About 20% of childhood malignancies
- Location is critical
- Cell type
  - None are of neuronal origin
  - Astrocytoma, most
  - Oligodendroglioma
  - Microgliomatosis
  - Ependymoma

**Astrocytoma**

- Astrocytic origin
- Above-tentorium most times in adults
- Multiple grades
- Compresses surrounding tissue
- Hemorrhage and necrosis
- With higher grade malignant tumors,
  - Look for vascular growth

**Ependymoma**

- Children
- Medulloblastoma
- Midline cerebellum
- Subarachnoid spread
Meduloblastoma

- Arise from meninges
- Benign in a biological sense
- Consider where it is
- Fibroblast looking
- Cells in whirls and clusters
- Psammoma bodies

Meningioma

- Psammoma bodies
  - Little calcifications
  - Microscopic
  - Within the tumor
  - Can spot on X-ray
  - Concentric layers

Peripheral Nerves

- Axon vs. Schwann cells
  - Motor
  - Sensory
- Inflammatory, autoimmune
- Toxic
- Trauma
- Vascular, especially diabetes
- Tumors

Guillian-Barré Syndrome

- Autoimmune?
- Follows
  - Infection
    - Oral
    - Mycoplastema
  - Allergic reaction
  - Demylinization
  - Ascending paralysis
  - Phrenic nerve involvement is life threatening
Peripheral Nerve Tumors
- Actually nerve sheath tumors
  - Schwann cells
- Cranial nerves too
  - V & VIII

Neurofibromatosis
- Two types
- No capsule
- Type 1
  - Genetic
  - All over the body
  - Glioma of optic n. (rare)
  - Meningioma
  - Café-au-lait spots
  - Pigmented nodules of iris

Neurofibromatosis
- Lisch Nodules
- Café Au Lait Spots

Neurofibromatosis
- Plexiform Neurofibromas