Disorders

- Tumors: growth of non-functional cells
  - **Benign**: cells grow within their own membrane - clear boundaries
    - Can usually be removed surgically
  - **Malignant**: no "border" between cell and tissue
    - Infiltrating tumor, cancerous - among healthy cells
  - **Metastatic** tumor: cells coming from malignant tumors in other organs that reach the brain and develop
    - i.e. lungs
  - Damage is caused by compression or infiltration
    - Compression takes space and compresses brain
    - Infiltration is cancerous tissue going into healthy brain - occupies space and takes other nutrients from organ area

Tumors
Because neurons cannot divide, they are not responsible for tumors.

**Gliomas:** malignant - can be removed surgically and with radiation (originate in the brain)
  - Glial cells are actually responsible for tumors
  - Can have tumors wherever there are glial cells

**Meningiomas:** from dura mater; benign
- Malignant, benign → compression
- Malignant → take-up space, use-up oxygen/glucose, destroy cells

**Neurological Disorders**

**Seizure disorders:** uncontrollable spread of neural activity (excitatory) - sometimes leads to convulsions
  - Recurring seizures = **epilepsy**

**2 types of seizures**
  - **Partial** (focal + remain local)
    - Partial seizures can be simple (no loss of consciousness) or complex
    - Usually occur in the same spot for many patients
  - **Generalized seizures**
    - Activity everywhere in the brain

**Main Seizure Types**

- **Grand mal:** generalized seizure with convulsions
- Different stages of seizures
  - **Aura** (perceptual phenomenon); few seconds → tonic phase (rigidity, loss of consciousness)
    - ~15 sec → **Clonic** phase (convulsion fast → slow; stop breathing; increase in inhibition) → Sleep/coma
- **Petit mal:** absence seizures (generalized, complex)
  - Stop of activity (~secs), unconscious
• Treatment includes neurotransmitter GABA
  ○ Inhibitory

Seizures
• Epilepsy = repeated seizures
• Primary damage in the temporal lobes
  ○ Hippocampus, amygdala
• Status epilepticus = repeated complex seizures without regaining consciousness
  ○ State of permanent seizures without coming back for a long while
• Neural substrate: hippocampus, among others
  ○ Hippocampus is one of the most interconnect areas in the brain
    ▪ High density - high density brain areas at more risk than others
  ○ Excitotoxicity: neuron death because of too much excitation through NMDA channels

• Treatments:
  ○ Anticonvulsants (benzodiazepines, barbituates)
  ○ Surgery (side effects: remember H.M)
  ○ Vagus nerve stimulation (partial seizures)
    ▪ Designed to prevent seizures by sending regular, mild pulses of electrical energy in the brain via the Vagus nerve
    ▪ VNS device

Disorders: Cerebrovascular Accidents
• Issues with blood vessels in the brain
  ○ Figure 14.5
• Stroke:
  ○ .5 million strokes per year - age related
  ○ Hemorrhagic: bleeding in the brain
  ○ Obstructive: blood clot --> ischemia (loss of blood flow) --> hypoxia (loss of oxygen) --> shortage of oxygen
    ▪ Prevented with aspirin (dilates blood vessels - increase blood vessel size)
  ○ 2 types of obstructive strokes:
    ▪ Thrombus --> blood clot that grows on the vessel wall and can get bacterial infections
    ▪ Embolus --> grows somewhere else and tries to go through blood vessel, blocks it (clump of dead cells) - risk of bacterial infection

Stroke
• Strokes produce permanent brain damage

• Can be prevented:
  - Medications to reduce blood pressure
    - If have vessels that are susceptible to breaking
  - Brain surgery (on vasculature)
  - Antibiotics (embolus and bacterial infections)
  - Anticoagulants (prevent blood clot up to 9 hours after stroke)
    - i.e DSPA (Desmoteplase - prevents blood clot after several hours)

Causes of Stroke

• Plaques - Atherosclerosis: buildup of material on walls of blood vessels
  - Cholesterol, calcium deposits
  - Detected by angiography
    - i.e x-ray of blood circulation
  - Treated by surgery
- Plaque removal (cleaning of blood vessel)
- Stent
- **Stent**: use for obstructive stroke
- Refer to figure 14.7 above
- Rehabilitation after stroke: therapies depend on the type of brain damage (speech, motor impairments, ...)
  - Case of limb movement impairment
    - **Constraint-Induced Therapy**: inducing brain plasticity by artificially "amputating"/restricting movement of good limb - forces use of impaired limb
  - **Brain-Machine Interface**: linking neural activity to an external device
    - Perception: artificial device
    - Motor: artificial hand/arm

**Developmental Disorders**
- Generally induced by viruses or drugs
- Result in nonviability or mental retardation

**Fetal alcohol syndrome**: affects axonal growth and synaptic plasticity (i.e LTP/LTD)
- Low doses of alcohol during pregnancy are sufficient
- Inherited metabolic disorders: deficiency in the production of an enzyme - genetic bases
  - PKU (Phenylketonuria): deficit in phenylalanine --> tyrosine conversion
    - Lack of myelination
    - Mental retardation if untreated
    - Detectable at birth
    - Preventable by appropriate diet (low protein diet)
  - Lack of vitamin B6: damage to thalamus and cerebellum
  - Lack of (milk) glucose metabolism (Galactosemia): damage to cerebellum
  - Tay-Sachs disease: inability to breakdown cellular waste products
    - Accumulation of waste, brain swelling, death
    - Eastern European Jewish population
    - There is a retinal diagnosis
- **Down syndrome**: congenital (born with)
  - 1/700 children >350,000 people in U.S
  - Extra chromosome 21 in mother's ovum
  - Over expression of genes
  - Can be detected before birth
  - 10% less brain - less neurons in frontal lobe and Sup Temp Gyrus (Wernicke's area)
  - Mild to severe mental retardation
  - Can learn to have almost normal lives
  - No cure
  - Research: focused on avoiding associated diseases (heart condition, epilepsy, hearing/vision deficits
    - Study gene over-expression pattern