YOUR MEDICAL CARE AS IT RELATES TO ANATOMY, PHYSIOLOGY AND DISEASE STATES

Richard Wendel MD, MBA Moderator
An 8 week Fall OLLI online course
Thursdays from 11am-12pm starting September 23rd.
Email address: rgwendel4@gmail.com
Each week we will focus on one of the body’s systems:

1. September 23: Nervous System
2. September 30: Endocrine glands
3. October 7: Skeletal, Muscles, Skin
4. October 14: Digestive System
5. October 21: Immune system
6. October 28: Pulmonary system
7. November 4: Cardiovascular system
8. November 18: GenitoUrinary tract
There are approximately 232 PowerPoint slides that I will be using in this course. The file is too large to be emailed. If you want a file containing all the slides, I will be sending the file via the Internet through the OLLI office, but the best way for you to have a complete set is to send me a thumb or flash drive through the mail at my home and I will copy the file and send it back.

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Brain and Central Nervous System

Gross Anatomy

Functional MRI and PET scanning as Research Tool
Arterial Blood Supply to the Brain

- Basilar artery
- Posterior communicating artery
- Middle cerebral artery
- Anterior cerebral artery
- Right vertebral artery
- Right subclavian artery
- Brachiocephalic trunk
- Right carotid artery
- Right common carotid artery
- Middle cerebral artery

Bruit location:
### Neurotransmitters; carry impulses across synapses

- **Dopamine** (reward-motivation) Parkinson’s
- **Serotonin** (SSRIs) Depression
- **Acetylcholine** (alpha adrenergic-parasympathetic)
- **Norepinephrine** (blood pressure) (Beta adrenergic)
- **Epinephrine/adrenalin** (Beta adrenergic)
- **GABA**-(gamma-aminobutyric acid) and **Glutamine** (epilepsy and seizures)
Cranial Nerve Diagram: 12 altogether

- Olfactory I
- Oculomotor III
- Trochlear IV
- Abducens VI
- Facial VII
- Vestibulocochlear VIII
- Glossopharyngeal IX
- Hypoglossal XII
- Accessory XI
- Vagus X
Cursory Neurologic Exam when you go to see your Primary Care Physician

- Sensorium and memory
- Pupils (R&R&RLA)
- Funduscopic exam
- Eyes movements
- Check Reflexes with reflex hammer
- Strength evaluation and proprioception
- Balance
Optic Chiasm
Right Brain versus Left Brain

• Right brain more adept at spatial and nonverbal concepts and being more creative and emotional (a scientist or musician) imagination, holistic thinking

• Left Brain are more analytical and methodical. They are better at things like reading, writing, and computations. (an accountant or author) logic

No proof that one is dominant but the differences do appear to be real between the two sides.
Autonomic Nervous System or Involuntary nervous system

- Sympathetic nervous system: the ‘fight or flight’ response to stress mediated by adrenaline/epinephrine or nor-epinephrine. The response to stress includes pupil dilation, increased sweating, increased heart rate, and increased blood pressure. The adrenal gland and solar plexus secrete adrenaline.

- Parasympathetic nervous system; involuntary functions of the body such as peristalsis, slowing of the heart, constriction of the pupil. Mediated by acetylcholine. The Vagus nerve, the tenth cranial nerve, is a parasympathetic nerve trunk.
# Medical Conditions of the CNS

- Demyelinating Disorders; Multiple Sclerosis, Amyotrophic lateral sclerosis (ALS), Guillain-Barre Syndrome
- Brain Cancer: (meningioma, glioblastomas, gliomas, acoustical neuroma)
- Psychosis and Neurosis
<table>
<thead>
<tr>
<th>Amyotrophic Lateral Sclerosis/Lou Gehrig’s Disease</th>
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<tr>
<td>• Slowly progressive (5-8 years) but uniformly fatal demyelinating disorder (neural sheaths) of both upper and lower motor neurons with about 13,000 deaths per year. <strong>Retain cognitive function</strong></td>
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<tr>
<td>• Onset between age 50 and 70: mean 55 and more common in men and 10 percent familial</td>
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<tr>
<td>• Progressive Respiratory symptoms most devastating</td>
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<tr>
<td>• No known treatment; Riluzole a glutamate inhibitor can be given.</td>
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Multiple Sclerosis; an autoimmune inflammatory demyelinating disease three to four time more common in females than males

• Variable symptoms beginning between the ages of 20 and 40: slurred speech, fatigue, dizziness, tingling, altered sexual, bowel and bladder function, cognitive

• Common disorder about 720,000 cases in US with variable course and no diagnostic lab test (MRI)

• FDA has approved 15 plus drugs for treatment (average cost per year 80,000)-these drugs alter the immune response of lymphocytes.
<table>
<thead>
<tr>
<th>Meningitis, Encephalitis, and Brain Abscess</th>
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<tbody>
<tr>
<td>• Viral meningitis is fairly common due to enteroviruses (85-95% and seasonal)</td>
</tr>
<tr>
<td>Presents with stiff neck or nuchal rigidity</td>
</tr>
<tr>
<td>• Encephalitis can be caused by the Herpes simplex virus and is treated with acyclovir and dexamethasone.</td>
</tr>
<tr>
<td>• Lumbar puncture with examination of cerebrospinal fluid is diagnostic</td>
</tr>
<tr>
<td>• MRI is better than CT scan for diagnostic purposes.</td>
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</table>
### Parkinson’s and Parkinsonism that has a broad range of presentations

- **Cause:** Due to loss of Dopamine producing cells in the basal ganglia at the base of the brain
- **Symptoms:** tremors, **rigidity**, gait, mask face, mood change, hallucinations
- **Early symptoms:** anosmia, sleep disorders, constipation, depression, restlessness, anxiety, orthostatic hypotension (may occur many years before)
- **Treatment:** directed at increasing dopamine. Levodopa the mainstay but a whole array of meds prescribed by neurologists. Deep brains stimulation of basal ganglia can be used and is often effective—do not know why this works.
# Dementias

1. **Alzheimer's disease:** 60% of patients (Beta-amyloid and Tau Protein with tangles)—cause unknown (APOE-e4 genetic link). No effective treatment although there is a new blood test for Tau protein that is 96% accurate in diagnosing Alzheimer’s: anticholinergics and NMDA receptor antagonists may temporarily delay the need for NH placement but no long term benefits.

2. **Arteriosclerotic; multiple mini-strokes, Transient Ischemic Attacks (TIAs)**

3. **Temporal Frontal Lobe Dementia;** usually starts with difficult in speech and behavioral problems. More rapidly progressive.

4. **Lewy Body Dementia;** more behavioral problems and shorter course and hallucinations

5. **TDP- 23 deposition dementia in ¼ over the age of 90**

For all dementias try to avoid too many meds; less is more and antipsychotics are not well tolerated.
Strokes; two types--ischemic and hemorrhagic

- Unlike heart attack do not give aspirin because of possible intracranial bleeding
- Cincinnati Criteria: *Facial droop, Arm drift, Slurred Speech: All three present = 87% chance of stroke.*
- Emergency CT scan to differentiate
- Window of 3-4.5 hours from when symptoms first started (with new angiography techniques can estimate amount of viable brain beyond stroke (flair and penumbra) and possible large vessel disease and in some cases extract the clot to retrain maximal function up to 24 hours.)
- IV anticoagulant and fibrinolytic: plasminogen activator (tPA) and Alteplase. Cannot give after 4.5 hours.
- Carotid bruit
Migraine; 40 million Americans and second most disabling condition worldwide

A disorder with many treatments; none curative

- 1. Tryptans (effect on serotonin) and NSAIDS—moderately effective, mainstay of treatment
- 2. Calcitonin gene-related peptide receptor antagonists (vasodilator)—moderate to high effectiveness.
- 3. Dihydroergotamine (blocks vasospasm)—(traditional treatment) moderate to high effectiveness.
- 4. Acetaminophen—moderate effectiveness
- 5. Remote electric neuromodulation (stimulates upper arm peripheral nerves to modulate pain especially in adolescence)—moderate effectiveness
- 7. Noninvasive vagal nerve stimulation (mainly cluster headaches)—moderate
- 8. Botox (15 or more headaches per month, 31 injections) Costy? And lasts several months.
Benefits of Sleep

• Critical role in immune function, metabolism, memory, learning, (retain information better right before sleep) and other vital functions
• The 5 or 6 sleep cycles each night lasts about 90 minutes
• Dream sleep or rapid eye movement (REM) sleep consumes about 90 minutes on an average night; heart rate and breathing increase and your limbs may even become paralyzed
• Need between 7 and 9 hours of sleep per night and people over 65 should also get 7 to 8 hours per night
• Why do we sleep? No definitive answer; but brain shrinks and may open the blood–cerebrospinal fluid barrier (BCSFB) for excretion of waste products.
BRAIN DEATH IN ORGAN DONATION

1. Comatose and unresponsive
2. EEG for brain wave activity
3. Now have a nuclear scan that reveals total brain blackout. No longer need to rely on clinical findings and expert opinions, but still by law need multiple expert opinions.
<table>
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<tr>
<th>Obstructive Sleep Apnea (OSA) and Central Sleep Apnea (CSA)</th>
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<tr>
<td>• An epidemic due in large part due to increasing BMIs (weight in kilograms divided by height in meters squared with normal range of 18.5 – 24.9 with 30 and above equaling morbid obesity)</td>
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<tr>
<td>• As high as 37% of men and 50% of women being afflicted</td>
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<tr>
<td>• Symptoms of snoring, gaps in breathing with intercostal attempts, HPT, drowsiness and stroke.</td>
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<tr>
<td>• Treatment CPAP (Continuous positive airway pressure)</td>
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<tr>
<td>• Opioids greatly exacerbate the complications of OSA (sudden death)</td>
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Peripheral Segmental Nerves

Cervical 1-7, Thoracic 1-12, Lumbar 1-5

[Diagram of the human spine and brachial plexus with labeled nerves]
Peripheral Nerve Testing

- Tendon Reflexes: ankle, knee, elbow
- Sensory for vibration with a tuning fork
- Pain pin prick
- Hot, Cold and light touch
- Proprioception: finger to nose with eyes closed
- EMG
<table>
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<th>Medical conditions of peripheral nerves</th>
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<tr>
<td>• Peripheral neuritis (age, diabetes, alcohol risk factors)</td>
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<tr>
<td>• Carpal Tunnel syndrome</td>
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<tr>
<td>• Sciatica (most commonly occurs when a herniated disk, bone spur on the spine or narrowing of the spine (spinal stenosis) compresses part of the nerve.</td>
</tr>
<tr>
<td>• Herniated disc disease</td>
</tr>
<tr>
<td>• Paraplegia and Quadriplegia</td>
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<tr>
<td>• Herpes Zoster</td>
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The Endocrine System: Glands that produce chemical messengers called hormones.

- Pituitary gland
- Hypothalamus
- Pineal (melatonin)
- Thyroid glands
- Parathyroid glands
- Adrenal glands
- Pancreas
- Testicles and ovaries
The Pituitary Gland; Master Gland; size of a pea or one-half gram
## Pituitary Hormones

### Anterior Pituitary
- Growth Hormone (GH)
- Thyroid stimulating hormone (TSH)
- Adrenocorticotrophic hormone (ACTH)
- Gonadotropic hormones; Luteinizing hormone (LH), ICSH, Follicle Stimulating hormone (FSH)
- Melanocyte Stimulating Hormone (MSH)

### Posterior Pituitary
- Anti-Diuretic hormone or vasopressin (ADH)
- Oxytocin (love and uterine contractions)
- Prolactin (lactation)
## Pituitary Dysfunction

- Acromegaly, Gigantism, Dwarfism (GH)
- Hyperthyroidism (Graves Disease), Hypothyroidism
- Cushing’s disease or Addison’s disease
- Hypogonadism
- Infertility
Thyroid and Parathyroid Glands
Feedback Regulatory Mechanisms

THYROID STIMULATING HORMONE (TSH) TESTING

WHAT IS TSH?

HYPOTHALAMUS

Hypothalamus

PITUITARY GLAND

Negative feedback inhibition

TRH
Thyroid Releasing Hormone

TSH
Thyroid Stimulating Hormone

T₃
Triiodothyronine hormone

T₄
Thyroxine hormone

THYROID GLAND

T₃

T₄

C
Calcitonin

GET REAL
About Hypothyroidism.

Nature-Thyroid

WP Thyroid

West thyroid Pure
Thyroid and Parathyroid Glands

Parathormone has Opposite effect

Calcitonin:
- Inhibits Ca\(^{2+}\) reabsorption in the kidney (excreted in the urine)
- Promotes deposition of Ca\(^{2+}\) into bones (inhibits osteoclasts and stimulates osteoblasts)
- Lowers Ca\(^{2+}\) levels in blood

Inhibits Ca\(^{2+}\) absorption by the intestine
The Adrenal Glands: total weight combined 10 grams or 1/3rd of an ounce
Adrenal Gland Locations
The Effects of Prednisone
Short courses of Cortisone safe; chronic use has many side effects

Effects of cortisol

- Raise or lower the mood depending on the situation.
- Production of cortisol is controlled via the hypothalamus and the pituitary gland.
- Stimulates gluconeogenesis in the liver.
- Increases blood sugar, blood pressure increase, inhibitory effect on the immune system.
- Digestion is slowed down.
- Reduces allergic reactions, anti-inflammatory, dampens pain sensation, body starts to sweat.
- Permanently increased dosage favors osteoporosis and muscle weakness.

ACTH

Moon Facies Cushionoid
Addison's and Cushing's Disease

- **Adrenal Insufficiency** is usually caused by autoimmune adrenalitis (many other causes as well) and gives symptoms related to the three hormones the adrenal gland secretes—ADH, Cortisone and Sex Hormones. These include weakness, fatigue, low BP, weight loss. Treatment is hormone replacement.

- **Cushing’s Disease** is due to an excess of steroids often due to pituitary adenoma or long term corticosteroid treatment. Symptoms of diabetes, HPT, moon facies, obesity, buffalo hump.
Parathyroid Disease

- Four pea sized glands in the neck behind the thyroid gland that secrete Parathormone, a hormone, that regulates calcium levels through bone resorption, GI absorption and renal excretion.

- Adenomas of the parathyroid glands and paraneoplastic syndromes may cause hypercalcemia and HPT. Extreme elevations of Ca+ can be life threatening (mental and cardiac arrhythmias)
The Pancreas
Functions of the **Pancreas** (Diabetes is cause by a lack of insulin (Juvenile Diabetes) or insulin resistance (Adult onset of Diabetes))

- Secretion of insulin, which acts to lower blood sugar, and glucagon, which acts to raise blood sugar.
- Digestive enzymes Lipase, Amylase, Trypsin
Diabetes Mellitus: Juvenile and Adult Onset Diabetes
(13.8 percent of Cincinnatians have the latter)

• In the Juvenile variety the B cells in the pancreas are unable to produce insulin; possibly an autoimmune response? And no genetic factors have been identified with 90% with no relative with the disorder.
• Adult Onset Diabetes: an epidemic with a number of risk factors; (no identifiable gene seems to predispose to its occurrence but it does seem to occur more frequently in some families). Insulin resistance seems to be a factor.

Risk Factors:
• Obesity
• Age and inactivity
• African-Americans
• Smoking
• Obesity
• Hyperglycemia
• Low socioeconomic status
• Inactivity
Organs effected by Diabetes: sugar is a toxin

- The Kidney with albuminuria (prognosis and diagnosis), decrease GFR. 50 percent of dialysis patients with End Stage Renal Disease have diabetes.
- Strict glucose control has greater benefit for Type 1/Juvenile as opposed to Type 2 diabetes.
- Diabetes is the primary cause of blindness in adults ages 20 to 74.
- Associated with The Metabolic Syndrome with arteriosclerosis disease.
Diagnosing Diabetes

- **FBS**--overnight fasting generally and normal value is up to 100 mg/dl. Values of 100 to 125 mg/dL suggest you are prediabetic, and 126 mg/dL or higher indicates you probably have diabetes.
- **Glucose Tolerance Test**
- **Gestational diabetes**
- **Hgb A1C** the gold standard to diagnose and regulate diabetes; on an annual physical if the FBS is over 100, a Hgb A1C is performed.
Overview of Treatment

Medications to Treat Diabetes

• Metformin (Glucophage). Generally, metformin is the first medication prescribed for type 2 diabetes. (increases sensitivity to insulin, decreases sugar absorption and lowers sugar production). ...survival benefits?
• Sulfonylureas. Least expensive; activate B cells
• Insulin-many forms and ways to control blood sugar levels.
Newer Medications for the Treatment of Diabetes

- **SGLT2 inhibitors**: (Farxiga/Jardiance and many more) prevents reabsorption of glucose in proximal tubule in the kidney, osmotic diuresis; it lowers A1c levels
- **GLP-1 receptor** (Trulicity) (glucagon-like peptide agonists) associated with some weight loss, slows emptying of stomach and by injection.
Skeletal System

206 bones
Joints most commonly involved in disease states
Terminology

• Tendon
• Ligament
• Vertebrae and Inter-Vertebral Discs
• Cartilage
• Synovia and synovial Fluid
• Structure of bones: cortical bone and cancellous bone, bone marrow, periosteum
24 Vertebrae

- Vertebral body
- Intervertebral foramen
- Anulus fibrosus
- Nucleus pulposus

Our height decreases as we age.
Cross Section of a long bone

- Periosteum
- Compact / Cortical Tissue
- Spongy / Cancellous Tissue
- Marrow

B CELLS AND OTHER BLOOD CELLS
Types of Joints

Various types of synovial joints:
1. Hinge joints as in knees, elbows and ankles
2. Ball and socket joints as in the hip and shoulder (which is multiaxial)
3. Pivotal or rotational as in the spine, elbow
“Aging is the process of wearing out gradually”

- Degenerative arthritis/osteoarthritis
- Many causes like RA, psoriasis, inflammatory bowel disease, reactive arthritis
- Falls/hip fractures
- Spinal Stenosis

The Bionic Man comes to the rescue

- Joint replacements from easiest to hardest in terms of rehabilitation and satisfactory outcomes:
  Hips< Knee< Shoulder (others ankle, elbows, finger, vertebrae)
I can't say I'm entirely pleased with my hip replacement.
Conservative Treatments (surgical replacement a final solution after all else fails)

- In the morning you have more stiffness and pain that usually decreases after you are active.
- Neuropathic pain often chronic pain-can have regional pain syndrome
- Physical therapy: range of motion and strengthening exercises
- Pain medication: mainly NSAIDS like Advil or Celebrex
- Ultrasound
- Lidocaine patches
- Injections of joints: lidocaine, steroids, hyaluronic acid derivatives and ?stem cells
- Arthroscopic evaluation and trimming up cartilage.

If in doubt, get a second opinions when surgery is offered is often worthwhile. But joint replacement can be a Lifestyle issue and replacements are very successful; how much functionality do you want?
Most important question; how much and for how long will I have pain?
Athletic Injuries and Cancer

• Anterior Cruciate Ligament (ACL) and PCL tears
• Torn Cartilage in knee (surgery or not?) Quadriceps exercises
• Plantar fasciitis (calf stretching)
• Tendon tears (biceps, quadriceps)
• Dislocated shoulder

Cancers:
• Osteosarcoma, Chondrosarcoma (rare)
• Multiple Myeloma and Leukemia (bone marrow biopsies)
• Metastatic Cancer (Prostate, breast, and lung most common)
Plantar Fasciitis
Rheumatoid Arthritis: A Chronic Disorder with a variable course

- 0.24 to 1 percent incidence with 2 to 1 women
- RA is an autoimmune disorder. It occurs when your body’s immune system attacks the synovium of the joint that produces joint fluid that nourishes the cartilage and lubricates the joints.
- If left untreated it can invade and destroy a joint and surrounding bony tissue.
- The exact cause of the immune system’s attacks is unknown
Joints involved with RA

Rheumatoid arthritis usually affects joints symmetrically (on both sides equally), may initially begin in a couple of joints only, and most frequently attacks the wrists, hands, elbows, shoulders, knees and ankles.
Treatment of Rheumatoid Arthritis (immune suppressants) very effective with good outcomes

- Methotrexate (alone or in combination with hydroxychloroquine and sulfasalazine)
- Many new and expensive drugs such as Leflunomide
Gout; Podagra; the Devils Grip

- 50 percent of 1st episodes in foot but can involve many joints
- Elevated serum uric acid >6 as a marker
- Uric acid kidney stones (low purine diet, allopurinol and alkalization of urine with sodium bicarb.)
- Prevention; lower purine diet, alkalinize the urine
- Acute episodes; NSAIDS, steroids, Colchicine, and titrate uric acid level with Allopurinol (A xanthine oxidase inhibitor) to less than 6
- Acute attacks 5-7 days
- Low purine diet (alcohol)
What is osteopenia and osteoporosis

- Decreased density and mineralization of the bone predisposing to fractures.
- Mainly post-menopausal women (testosterone is protective)
- The meaning of T scores on the DEXA scan: T-0 is the mean or average. Osteoporosis is minus 2.5 or greater, osteopenia is minus 1 to minus 2.5.
- When to treat with bisphosphonates, Vitamin D and Ca supplementation? Ask your PCP
Chewing Muscles

- Temporalis Muscle
- Masseter Muscle
Muscular Disorders

• ALS, Muscular dystrophy and Myasthenia gravis can directly effect the muscles and many illnesses cause secondary muscular weakness but most muscular disorders relate to trauma of one sort or another.
Sarcopenia

Young healthy thigh muscle

Sarcopenic thigh muscle
The Rotator Cuff (external rotation)
Shoulder Replacement

Joint Replacement a lifestyle decision?
Muscle Evaluation

- A physical exam, tendon reflexes,
- Muscle strength tests: muscle atrophy
- Electromyography (EMG)
- A muscle biopsy (muscular dystrophy, dermatomyositis, trichinosis, ALS and a few others)
Skin; largest organ in the body.
Common Disorders of the Skin

• Actinic keratosis/sun exposure related-atrophy, thinning, atypical cells that are precursors to Basal Cell and Squamous Cell cancers (this disorder makes the dermatologists a high income specialist)
• Seborrheic Keratosis and Liver Spots
• Wrinkles (genetic and farmer’s skin)
• Psoriasis is a papulosquamous eruption: extensor surfaces, scalp, T cell malfunction
• Eczema and atopic dermatitis (asthma & hay fever)
• Acne
• Hives
• Furuncle and Carbuncle
Images of Psoriasis

Commonly on extensor surfaces of extremities

On the scalp presents as reddish welts and ridges with excessive ‘dandruff’
More Disorders of the Skin

- Vitiligo
- Alopecia
- Contact Dermatitis and Poison Ivy
- Warts (HPV-venereal warts) Need for vaccination for both women and men!
- Ringworm and Tinea Versicolor (fungi)
- Melanoma (cure rates dependent upon stage and early detection—any change in black mole needs evaluation)
- Sebaceous Cysts
Burns: 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4th Degree

**First-Degree Burns**
Superficial burns that only affect the skin surface

**Second-Degree Burns**
Burns that affect the outermost and second skin layer

**Third-Degree Burns**
Burns that have killed the skin all the way to the fatty tissue
Burn Management

- With a 3rd degree burn about a 2cm defect will close/heal spontaneously over time.
- Split and full thickness grafts
- Skin substitutes; cadaver, pig, synthetic
The Digestive System
Names of the upper GI organs and Terminology

• Salivary Glands (parotids gland largest secrete ptyalin (alpha-amylase) .5-1 liter per day.
• Esophagus (cardiac sphincter) peristalsis
• Stomach (hiatal hernia) hydrochloric acid and pepsin that digest proteins
• Duodenum (4 parts with common bile duct and pancreatic duct connect at the ampulla of vater.
• Ilium and Jejunum (small intestine 22 feet long and need about 5 feet to maintain nutrition)
The Stomach

There are four main regions in the stomach: the cardia, fundus, body, and pylorus.
Old fashion gastro indigestion, heart burn.
Rx:
1. Weight Loss, stop smoking, decrease drinking, overeating, earlier dining
2. Antacids
3. H-2-receptor blockers — to decrease acid production (Tagamet HB)
4. PPI (protein pump inhibitors) that suppress stomach acid. **Frequently prescribed** but chronic use can have long term side effects such as changes in microbiome (c. difficil), osteoporosis, macrocytic anemia, low Mg
(In unconscious patients can cause aspiration pneumonia due to gastric reflux.)
Gastric and Duodenal Ulcers

- A person has a higher risk of developing a peptic ulcer (mainly duodenal) if they have an overgrowth of *Helicobacter pylori* (*H. pylori*) bacteria in the digestive tract. A few are due to malignancy.
- Some medication such as steroids, NSAIDS and aspirin (anticoagulants) can cause (alcohol not associated).
- Treatment of *H. pylori* with two antibiotics is very effective and test for cure with blood, breathe or stool tests.
  - Proton pump inhibitors (PPIs)
  - Histamine H2-receptor antagonists
  - Protectants, such as sucralfate
  - Antacids
Medical Marijuana; effective in treating nausea: not legalized nationally but 50% have tried it by age 20: excellent safety profile for recreational use

- Seventy Cannabinoids but main active ingredient is THC and CBD. (newer plants genetically engineered to increase THC and the product comes in many forms)
- It is both an inhibitor and stimulant.
- Approved medical uses mainly for nausea and vomiting and pain associated with cancer chemotherapy.
- Many other medical uses including epilepsy, mental illness, PTSD, muscle spasms
- Half life 20-30 hours, eliminated 60% in stool, 30% in urine.
- Chronic Use can cause Cannabinoid Hyperemesis Syndrome (CHS)
**The Lower GI Track--Colon and Omentum/mesentery**

- Caecum
- Appendix (vestigial organ with no known function (RLQ pain as opposed to diverticulitis that is usually LLQ))
- Ascending Colon
- Transverse Colon
- Descending Colon
- Sigmoid Colon
- Rectum
- Anus
- Peritoneal and retroperitoneal space
- Greater and lesser omentum: The greater omentum attaches the stomach to the transverse colon. The lesser omentum attaches the stomach and the duodenum to the liver.
- The mesentery attaches your intestines to the wall of your abdomen
Lower GI Tract
The peritoneal cavity

The omentum is a fatty blanket that hangs down in front of all of the intestines.
Acute Appendicitis

Declining incidence for no known reason and just 1 in 20 develop it.

• **Signs and Symptoms**
  RLQ pain and tenderness (rebound if appendix ruptured) If pain is on left it is more commonly related to diverticulitis), nausea, vomiting, low grade fever and elevated white blood cell counts (polys).

• **Rx:** surgical removal usually laparoscopic, if ruptured treat with antibiotics and later removal.
Arterial Blood Supply to upper GI track
The Portal System: carries nutrients from digestion to the liver to store and metabolize, after a meal
Functions of the Liver: a Thousand Metabolic Processes occur in the Liver

- Produces most of the proteins the body needs (albumin/oncotic pressure)
- Prevents shortages of nutrients by storing certain vitamins, minerals, and sugar (glycogen)
- Produces bile, a substance that helps digest fat and absorb fat soluble vitamins A, D, E, and K
- Produces substances that help with the blood clotting cascade (Prothrombin, Fibrinogen, Factors V, VII, VIII, IX, X, XI, XII, XIII)
- Helps your body fight infection by removing bacteria from the blood
- Metabolizes and removes potentially harmful substances from medications and foods
Types of Liver Disease and Terminology

- Hepatitis: Inflammation of the liver, usually caused by viruses like hepatitis A, B, and C. (B&C through blood sharing)
- Cirrhosis: Long-term damage to the liver from any cause can lead to permanent scarring, called cirrhosis. (Alcohol, Hepatitis and Malnutrition)
- Fatty Liver
- Cancer: The most common type of primary liver cancer, Hepatoma, is uncommon and usually occurs in patients with cirrhosis.
- Metastatic Cancer
- Ascites: Increase pressure in the Portal System, some cancers (ovarian), heart failure, peritonitis and anasarca.
Symptoms of Liver Failure: Yellowing of your skin and eyeballs (jaundice); Abdominal swelling (ascites); Nausea & Vomiting; malaise; disorientation and confusion.

Stages of Liver Damage

Healthy Liver  Fatty Liver  Liver Fibrosis  Cirrhosis

Reason to treat Hepatitis C?
Why is pancreatic cancer so difficult to cure? The location of the pancreas and the late onset of symptoms

• 60,000 new cases each year with a 5 year survival rate of 10 percent.
• 50 percent of patient present with metastatic disease, 30 percent with locally invasive disease.
• 10th leading cause of cancer and the 3rd leading cause of cancer related mortality.
• Few are surgical candidates; mainly heavy duty chemo that increases life expectancy by 2-6 months
• Risk factors; smoking, obesity, alcoholism and pancreatitis.
• Host of genetic risk factors.
The Gall Bladder

- Stores bile that digests fats and colors the stool brown
- Gall stone; 6% of men and 9% of women (may predispose to cholecystitis)
- Most asymptomatic; but recurrence of biliary colic common if you have had one attack
- Cholecystitis, Pancreatitis and Common Duct stones more serious
- Laparoscopic removal of gall bladder (minimally invasive)
- Diagnostic tool now used Endoscopic Ultrasound (EUS)
# Factors Influencing Weight

- **Leptin** is a hormone, made by fat cells, that decreases your appetite.
- **Ghrelin** is a hormone released primarily in the stomach that increases appetite, and also plays a role in body weight.
- **Microbiome** (intestinal flora in the gut, mainly large intestine)
- **Hypothalamus** in the Central Nervous System
- Of course: Diet, Mood, Good Food and Exercise play a significant role
Bariatric Surgery for Morbid Obesity (BMI > 40)

- When all else fails:
Disorders of the GI tract

- Celiac disease (gluten in wheat, rye, and barley) genetic immune disorder with one percent incidence with majority undiagnosed. Diagnosis antibody testing and biopsy
- Irritable Bowel syndrome (IBS)
- Ulcerative Colitis-superficial and confined to colon (relapses but 20% go on to colectomy)
- Regional ileitis (Crohn's Disease) penetrating and can involve entire GI tract—fistulae, abscesses, strictures, treatment similar to UC. Follow with fecal calprotectin)
- C difficile bacteria and other ‘super bugs’
- Hemorrhoids
Colon Cancer

- Colon Cancer-3\textsuperscript{rd} or 4th most common cancer with 150,000 new cases each year (1 in 23 (4.4%) for men and 1 in 25 (4.1%) for women) with about 56,000 deaths annually.
- Most often involve the left side of the colon and rectum.
Colonoscopy Screening

• The American College of Surgeons recommends that people at average risk of colorectal cancer start regular screening at age 45 usually with colonoscopy (sedation, anesthesia? And bowel prep) Average cost is $2,750. Routine screening every 10 years without pathology.

• Stool Guaiac

• Cologuard, a stool test that shows altered DNA and/or blood in stool. Cologuard can detect 92% of cancers but only 42% of large precancerous polyp with 12% false-positive rates. Average cost $500.
GI Diagnostic Studies

- EGD (Esophago-gastro-duodenoscopy)
- Colonoscopy
- Cologard
- CT and MRI
- PET scan
- Stool guaiac
- Serum Direct and Indirect Bilirubin, ALP (alkaline phosphatase) ALT, AST, GGT
Immune System
Lymphatic and Hematopoietic Systems related to the Immune Response
Lymphatic System/lymphoid tissue

- Tonsils
- Lymph nodes
- Thymus
- Bone marrow
- Spleen

- T-cells
- B-cells
Peripheral Blood Smear
<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Value</th>
<th>Reference Range</th>
<th>Function/Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrophils Relative</td>
<td>37.0 %</td>
<td></td>
<td>bacterial infections</td>
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<tr>
<td>Lymphocytes Relative</td>
<td>53.0 %</td>
<td></td>
<td>immune system, leukemia</td>
</tr>
<tr>
<td>Monocytes Relative</td>
<td>7.0 %</td>
<td></td>
<td>immune system, globulins, mature into macrophages</td>
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<tr>
<td>Eosinophils Relative</td>
<td>2.0 %</td>
<td></td>
<td>Allergic reactions, parasitic diseases</td>
</tr>
<tr>
<td>Basophils Relative</td>
<td>1.0 %</td>
<td></td>
<td>inflammation</td>
</tr>
<tr>
<td>Neutrophils Absolute</td>
<td>3.3 $10^3$/uL</td>
<td>1.5 - 7.8 $10^3$/uL</td>
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</tr>
<tr>
<td>Lymphocytes Absolute</td>
<td>4.7 $10^3$/uL</td>
<td>0.8 - 3.9 $10^3$/uL</td>
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</tr>
<tr>
<td>Monocytes Absolute</td>
<td>0.6 $10^3$/uL</td>
<td>0.2 - 0.9 $10^3$/uL</td>
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<tr>
<td>Eosinophils Absolute</td>
<td>0.2 $10^3$/uL</td>
<td>0.0 - 0.5 $10^3$/uL</td>
<td></td>
</tr>
<tr>
<td>Basophils Absolute</td>
<td>0.1 $10^3$/uL</td>
<td>0.0 - 0.2 $10^3$/uL</td>
<td></td>
</tr>
</tbody>
</table>
The immune response to antigens and injury

- Cytokines are secreted by immune cells and act as signaling proteins. They include Interferons (some 20 or so), Interleukins (30 or more), Growth factor, Tumor Necrosis factor.

- Prostaglandins (response to injury) and leukotrienes (response to allergy) are involved in numerous homeostatic biological functions and inflammation.
Blood Cell Formation
NK cells are best known for killing virally infected cells, and detecting and controlling early signs of cancer.
The Immune System; Lymphoid System

**B cells**

**Humoral immunity**
- Antigen on bacterium
- Lymphocyte receptor
- B cell
- Helper T cell
- Cytokines
- Antibodies
- Memory B cells
- Plasma cells

**Adaptive immunity**

**T cells**

**Cell-mediated immunity**
- Antigen-presenting immune cell
- Activated Helper T cell
- Cytokines
- CD8+ T cell
- Cytotoxic T cell
- Infected cell
**Cytotoxic T Cells (CD8 T Cells)**
Cytotoxic T cells kill their target cells, primarily by releasing cytotoxic granules into the cell to be killed. These cells recognize their specific antigen (such as fragments of viruses) when presented by **MHC (Hyman leukocyte antigens (HLA) Class I)** molecules that are present on the surface of all nucleated cells.

MHC Class I molecules interact with a protein called CD8 on the cytotoxic T cells, which helps to identify this cell type. **Cytotoxic** T cells require several signals from other cells to be activated, such as from dendritic cells and T helper cells.

Their main function is to kill virally infected cells, but they also kill cells with intracellular bacteria or tumorous cells.

**T-Helper Cells (Th) (CD4 T Cells)**
T helper cells have a wider range of effector functions than CD8 T cells and can differentiate into many different subtypes, such as **Th1, Th2, Th17** and regulatory T cells.

They become activated when they are presented with peptide antigens by MHC Class II molecules, which are expressed on the surface of APCs. **MHC Class II** molecules interact with a protein called CD4 on the T helper cells, which helps to identify this cell type.

The roles of a CD4 T cell may include activating other immune cells, releasing **cytokines**, and helping B cells to produce antibodies. They help to shape, activate and regulate the adaptive immune response.

**Memory T Cells**
Following an infection, antigen-specific, long-lived memory T cells are formed. **Memory T cells** are important because they can quickly expand to large numbers of effector T cells upon re-exposure to the antigen and have a low threshold for activation. They provide the immune system with memory against previously encountered antigens. Memory T cells may either be CD4+ or CD8+. 
Immunoglobulins

Immunoglobulins, also known as antibodies, are glycoprotein molecules produced mainly by plasma cells and initiate the immune response by specifically recognizing and binding to particular antigens, such as bacteria or viruses, and aiding in their destruction.
The five major antibody classes are:

- **Immunoglobulin G (IgG)**, 80%, is found in all body fluids and protects against bacterial and viral infections.
- **Immunoglobulin M (IgM)**, is the first antibody to be released by B cells during primary response
- Immunoglobulin D (IgD, important in B cell activation
- **Immunoglobulin A (IgA)**, which is found in high concentrations in the mucous membranes, particularly those lining the respiratory passages and gastrointestinal tract, and prevent attachment of pathogens to epithelial surfaces.
- **Immunoglobulin E (IgE)**, found on mast cells and basophils and triggers release of histamine which is associated mainly with allergic reactions (when the immune system overreacts to environmental antigens such as pollen or pet dander). It is found in the lungs, skin, and mucous membranes.
These recommendations must be read with the footnotes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars in Figure 1. To determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry and adolescent vaccine age groups are in bold.

<table>
<thead>
<tr>
<th>Vaccines</th>
<th>Birth</th>
<th>1 mo</th>
<th>2 mos</th>
<th>4 mos</th>
<th>6 mos</th>
<th>9 mos</th>
<th>12 mos</th>
<th>15 mos</th>
<th>18 mos</th>
<th>19-23 mos</th>
<th>2-3 yrs</th>
<th>4-6 yrs</th>
<th>7-10 yrs</th>
<th>11-12 yrs</th>
<th>13-15 yrs</th>
<th>16-18 yrs</th>
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</thead>
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<tr>
<td>Hepatitis B (HepB)</td>
<td>1st dose</td>
<td></td>
<td></td>
<td></td>
<td>2nd dose</td>
<td>3rd dose</td>
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<tr>
<td>Rotavirus (RV) (RV1: 2-dose series); RV5 (3-dose series)</td>
<td>1st dose</td>
<td>2nd dose</td>
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<tr>
<td>Diphtheria, tetanus, &amp; acellular pertussis (DTaP; &lt;7 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
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<td>3rd dose</td>
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<tr>
<td>Tetanus, diphtheria, &amp; acellular pertussis (Td; 2 doses)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Haemophilus influenza type b (Hib)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
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<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Pneumococcal conjugate (PCV13)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
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<td>3rd dose</td>
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<tr>
<td>Pneumococcal polysaccharide (PPSV23)</td>
<td>1st dose</td>
<td>2nd dose</td>
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<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Inactivated Poliovirus (IPV) (&lt;18 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
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<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Inactivated Poliovirus (IPV) (&gt;18 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Inactivated Poliovirus (IPV) (IPV)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Measles, mumps, rubella (MMR)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
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<td>3rd dose</td>
<td>4th dose</td>
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<tr>
<td>Varicella (VAR)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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</tr>
<tr>
<td>Human papillomavirus (HPV2: females only; HPV4: males and females)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
<td></td>
<td></td>
<td>3rd dose</td>
<td>4th dose</td>
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</tr>
<tr>
<td>Meningococcal (Hib-MCV; &gt;6 weeks; MenACWY-D; &gt;9 mos; MenACWY-CRM ≥ 2 mos)</td>
<td>1st dose</td>
<td></td>
<td></td>
<td></td>
<td>2nd dose</td>
<td>3rd dose</td>
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</tbody>
</table>

**NOTE:** The above recommendations must be read along with the footnotes of this schedule.
## Adult Immunizations

Almost 1 out of every 3 people in the US will develop shingles in their lifetime

- **Shingles vaccine**, which protects against shingles and the complications from the disease (recommended for healthy adults 50 years and older) Two Shots/Expensive!
- **Pneumococcal polysaccharide vaccine (PPSV23)**, which protects against serious pneumococcal disease, including meningitis and bloodstream infections (recommended for all adults 65 years or older, and for adults younger than 65 years who have certain health conditions)
Leukemias and Lymphomas

- Acute Lymphocytic Leukemia (ALL)
- Acute Myeloid Leukemia (AML)
- Chronic Lymphocytic Leukemia (CLL)
- Chronic Myeloid Leukemia (CML) translocation of chromosome 9 & 22 (Philadelphia chromosome) diagnosed with Karyotype, FISH, and PCR. New Rx. With tyrosine kinase inhibitors, good outcomes
- Chronic Myelomonocytic Leukemia (CMML)
- Polycythemia Vera-too many RBCS; JAK2 pathway, Dx. PCR and increase EPO. Thrombosis main issue. Phlebotomy, and Hydroxyurea.
- Essential thrombocytosis: JAK2, CALR and MPL mutations, too many platelets, usually asymptomatic
- Myelofibrosis; nasty disease, burned out bone marrow, allogenic stem cell transplant with 18 month survival or less.
- Multiple Myeloma
Autoimmune Diseases

- Rheumatoid Arthritis
- Psoriasis
- Multiple Sclerosis
- Crohn’s Disease
- Ulcerative Colitis
- Type I diabetes/juvenile
- Addison’s Disease
- Graves Disease
- Scleroderma
- Lupus Erythematosus
- Pernicious Anemia
- Polyarthritis Nodosa
- Myasthenia Gravis
SLE-SYSTEMIC LUPUS ERYTHEMATOSIS

• Rare (140/100,000) but more common in minorities and young women with a strong genetic predisposition.
• Treatment with Hydroxychloroquine
• Symptoms; butterfly rash, Reynaud's phenomena, alopecia and depression
• Delay in diagnosis due to wide range of symptoms than mimic other disorders.
### DRESS-Drug Reaction with Eosinophilia and Systemic Symptoms (take drugs sparingly with definite indications)

| • Rare but anti-seizure drugs, allopurinol, sulfa, vancomycin, minocycline |
| • HLA (haplotype) cause CD4 AND CD8 lymphocytes to upregulate to make TNF and Interferon plus activate Herpes and CMV viruses. |
| • Rashes of all kinds, fever, adenopathy, liver, heart and kidney impairment. (2-10% mortality) |
| • Patch testing |
HIV-the virus; Aids-the syndrome

- A retro virus that infects CD4-T cells causing a decline in their numbers. Less than 200 is critical level. (susceptible to opportunistic infection)
- 1.1 million infected in US, more men than women and 1/7th are unaware they are infected.
- No longer considered a death warrant but a chronic disease with no complete cure and need for lifelong medication. ($3000 cost per month. Undetectable viral counts=untransmissable)
- Screening of high risk individuals (after 45 days from inoculation this detects 99% of cases).
- Three classes of new drugs for treatment; mainstay Truvada and Descovy (15,000/yr ). Problems with compliance.
- In high risk individuals move toward prophylaxis (PrEP) with one pill a week with Truvada or Descovy.
## Tests

- Antinuclear antibody (ANA)
- Rheumatoid factor
- CBC
- C-reactive protein (CRP)
- Erythrocyte sedimentation rate (ESR)
- Urinalysis
- Complement (part of immune system)
Genetics and Cellular Anatomy

Amino Acids

- Adenine (A)
- Thymine (T)
- Cytosine (C)
- Guanine (G)
What is a chromosome?

- **Chromosomes** are the things that make organisms what they are. They carry all of the information used to help a cell grow, thrive, and reproduce. **Chromosomes** are made up of DNA. Segments of DNA in specific patterns are called genes. ... You will find the **chromosomes** and genetic material in the nucleus of a cell and mitochondria. A **chromosome** contains hundreds to thousands of **genes**.
**Definitions**

This image shows a pair of homologous chromosomes. Name and annotate the labeled features.

- **Genotype**
  - The combination of alleles of a gene carried by an organism

- **Phenotype**
  - The expression of alleles of a gene carried by an organism

- **Centromere**
  - Joins chromatids in cell division

- **Alleles**
  - Different versions of a gene
  - Dominant alleles = capital letter
  - Recessive alleles = lower-case letter

- **Carrier**
  - Heterozygous carrier of a recessive disease-causing allele

- **Homozygous dominant**
  - Having two copies of the same dominant allele

- **Homozygous recessive**
  - Having two copies of the same recessive allele. Recessive alleles are only expressed when homozygous.

- **Codominant**
  - Pairs of alleles which are both expressed when present.

- **Heterozygous**
  - Having two different alleles. The dominant allele is expressed.

- **Gene loci**
  - Specific positions of genes on a chromosome
Difference between DNA & RNA

- **DNA** is a long polymer with deoxyribose (a sugar) and phosphate backbone. Having **four** different nitrogenous bases: adenine, guanine, cytosine and thymine.

- **RNA** is a polymer with a ribose (a sugar) and phosphate backbone. **Four** different nitrogenous bases: adenine, guanine, cytosine, and uracil.

Differences between DNA & RNA: Thymine is the pyrimidine base of the DNA, whereas Uracil is the pyrimidine base of the RNA. The occurrence of thymine and uracil is a crucial difference as thymine is only found in DNA and uracil is only found in RNA. Methyl group is absent in uracil whereas present in thymine at the C-5 position.
What is the chemistry of cytosine, adenine, thymine and guanine made

- As a nitrogenous base, **cytosine** is full of nitrogen atoms (it has three). It also has one ring of carbon, which makes it a pyrimidine. A purine, on the other hand, has two rings of carbon. There are two pyrimidines, **cytosine** and thymine, and two purines, adenine and guanine, in DNA.
Basic structure of DNA

Nitrogenous Bases

Pyrimidines

- Cytosine (C)
- Thymine (in DNA) (T)
- Uracil (in RNA) (U)

Purines

- Adenine (A)
- Guanine (G)
What is an amino acid?

- An amino acid is an organic molecule that is made up of a basic **amino group** (−NH$_2$), an acidic **carboxyl group** (−COOH), and an organic R group (or side chain) that is unique to each amino acid. The term amino acid is short for $\alpha$-amino [alpha-amino] carboxylic acid.
Amino acids

• ESSENTIAL AMINO ACIDS
• Essential amino acids cannot be made by the body. As a result, they must come from food.
• The 9 essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.
• Nonessential amino acids include: alanine, arginine, asparagine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, and tyrosine.
In **humans**, each cell normally contains 23 pairs of **chromosomes**, for a total of 46. Twenty-two of these pairs, called autosomes, look the same in both males and females. The 23rd pair, the sex **chromosomes**, differ between males and females. The **X** and **Y** chromosomes are sex chromosomes.
Karyotyping

1. 5 mL venous blood
2. Add phytohemagglutinin and culture medium
3. Culture at 37°C for 3 days
4. Add colchicine and hypotonic saline
5. Cells fixed
6. Spread cells onto slide by dropping
7. Digest with trypsin and stain with Giemsa
8. Analyze “metaphase spread”
Difference between Meiosis and Mitosis

- Sperm and ova; they fuse to form a zygote

In mature organs cell division is infrequent
When Should Someone have a Genetic test?

- At birth? Pregnancy?
- When they come down with a disease/cancer for precision medical care?
- Wait for genetics to advance more?

Arguments to get it in the newborn period
- 1. Uncover repairable genetic defects (CRISPR-cas9 or gene replacement therapy.
- 2. Predict predisposition for various illnesses
- Social, emotional and societal consequences
## Common Genetic Disorders that relate to an identifiable gene

- Cystic Fibrosis
- Hemophilia
- Huntington’s Chorea
- Neurofibromatosis
- Thalassemia
- Tourette syndrome
- Von Willenbrand’s
- Sickle Cell
- Down’s
Designer Babies and Curative Technique for genetic disorders?

- Gene Splicing techniques/problems (Crispr-Cas9)
- Eugenics/ethical considerations
- Role inheritance plays; nature vs. nurture
- Crack babies, smoking, need for prenatal care
The Cell; basic unit of you body with some 60 trillion individual cells
The Cell Structure
The basic cell ingredients; organelles

- The nucleus contains the hereditary DNA of the cell
- Ribosomes are granules that are the site of protein synthesis (contained in the rough endoplasmic reticulum)
- The mitochondrion is the power plant that form ATP and converts glucose, fats and protein to energy
- The rough endoplasmic reticulum manufactures proteins
- Smooth endoplasmic reticulum chemically modifies proteins, lipid and other molecules
- The Golgi apparatus processes and packages proteins and targets them
- The centrioles are associated with cell division
- A cytoskeleton composed of microtubules and microfilaments support the cell and is involved in cell movement and organelle movement.
- The plasma membrane regulates traffic of materials into and out of the cell
- The nucleolus begins the assembly of ribosomes from proteins and RNA
- Lysosome digests particles like food taken into the cell by phagocytosis.
- Peroxisome collect toxic materials
• Telomeres are repeated DNA sequences at the end of chromosomes. **Telomeres get** shorter each time a cell copies itself, but the important DNA stays intact. Eventually, **telomeres get** too short to **do** their job, causing our cells to **age** and stop functioning properly. Therefore, **telomeres** act as the **aging** clock in every cell.

• Messenger RNA (mRNA) is a single-stranded RNA molecule that is complementary to one of the DNA strands of a gene. The mRNA is an RNA version of the gene that leaves the cell nucleus and moves to the cytoplasm where proteins are made. During protein synthesis, an organelle called a ribosome moves along the mRNA, reads its base sequence, and uses the genetic code to translate each three-base triplet, or codon, into its corresponding amino acid.
Apoptosis; programmed cell death or injury (necrosis)

**Apoptosis** is programmed cell death

- **Faulty enzymes** must be digested or they can be incorporated in other cells
- **Scavenger cells** digest the apoptotic bodies
A Neuron; are new brain cells created in the adult and what is neuroplasticity (growth and reorganization)

The Importance of stem cells as mature neurons and cardiac muscle cells probably do not exhibit mitosis.
Types of Viruses/phage particles: Lytic/virulent and lysogenic

- DNA: single stranded (Covid-19) or double stranded
- RNA: single stranded or double stranded

More than two-thirds of human viruses can also infect non-human hosts, mainly mammals, and sometimes birds.

There are 219 virus species that are known to be able to infect humans.
Only a small part of the total diversity of viruses has been studied. As of 2019, 4 realms, 9 kingdoms, 16 phyla, 2 subphyla, 36 classes, 55 orders, 8 suborders, 168 families, 103 subfamilies, 1,422 genera, 68 subgenera, and 6,589 species of viruses have been defined by the ICTV.
Coronaviruses are a large family of viruses found in both animals and humans, and are known to cause the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS), Severe Acute Respiratory Syndrome (SARS), and Novel Coronavirus (COVID-19). The COVID-19 virus attacks angiotensin 2 receptors present in virtually all human cells and thus attacks multiple organ systems as well as the lungs.
The Pandemic

- Novel Corona or Covid-19 is a single stranded RNA virus that mutates at a high rate, which results in the emergence of new variants such as the Delta strain that is now prevalent in the U.S. The current vaccines are still effective against the Delta strain which is more easily transmitted than the initial strains.
Viruses are entirely dependent on the host for replication and they are roughly one-hundredth the size of a bacteria. They consist of two or three distinct parts:
1. genetic material, either DNA or RNA
2. a protein coat, or capsid, which protects the genetic information
3. a lipid envelope is sometimes present around the protein coat when the virus is outside of the cell
M, E, N proteins are envelope proteins

Hemagglutinin-esterase destroys receptors
Covid-19 and the Pandemic

A multisystem disease since every blood vessel in the body has **Angiotension 2 receptors**. It is more lethal than the flu with ‘long haul’ symptoms lingering in more than 30 percent of patients with shortness of breath, chronic fatigue, renal failure, brain fogginess to name a few. These may last months/years and be irreversible. At this time over 700,000 Americans have died and a sizable proportion could have been saved with high vaccination rates and government policy that dealt with it as a medical issue and not a political one. Misinformation and anti-vaxxer push back remains a serious problem. Age and compromised immune systems are major risk factors. If you recover from Covid within 2 weeks your outlook of have any long-haul consequences decreases dramatically.
Covid-19; therapy; still no magic bullets or even curative remedies in the pipeline

**Therapy**

- Ventilation with PO2 of greater than 60% not SOB, CPAP, Intubation and other assisted ventilation as late as possible.
- The prone position improves breathing
- Antiviral treatment Remdesivir, Baricitinib, Tocilizumab when given early and usually with steroids may be beneficial.
- Steroids (hydroxydexamethasone) 10% reduction in mortality (no standardization of dose)
- Convalescent Serum is no longer recommended
- Anticoagulation with LMWH (Low Molecular Weight Heparin) to prevent DVT and strokes due to clotting.
Pulmonary System
Pulmonary System

The Respiratory System

Adenoids
Tonsils
Pharynx
Epiglottis
Esophagus
Sinus
Nasal Cavity
Oral Cavity
Tongue
Larynx
Trachea
Right Bronchus
Right Lung
Left Bronchus
Ribs
Pleura
Pleural Space
Diaphragm
Bronchiole
Alveolus (Air Sac)
Pulmonary Vein
Capillaries
Mucus
Cilia
Cells
Lungs in Detail
The Pleural Space

PNEUMOTHORAX

Trachea

Collapsed lung

Normal lung

Air or fluid in the pleural space

Diaphragm

Pleural space
Functions of the Lungs

- Exchange of CO2 (hypercapnia) and O2 (hypoxia)
  Use pulse oximeter to gage blood oxygen levels
- Acid and Base Balance (Respiratory Acidosis) with hyperventilation you can produce respiratory alkalosis and dizziness.
- Pulmonary arteries (deoxygenated blood) come from the right ventricle of the heart and pulmonary veins (oxygenated blood) returned blood to the left atrium of the heart.
- Filtering and removal of bacteria and small particles in the air (tracheal elevator)
**Pulmonary Studies**

- Chest x-ray (not a screening test)
- Pulse Oximetry (will become part of the fitbit?)
- Serum CO2 and arterial blood gases (acidosis or alkalosis) Low CO2 suggests acidosis or ketoacidosis, a complication of diabetes; high CO2 may indicate pulmonary alkalosis.
- Spiral CT with Calcium index
- Sputum Culture
- Lung Biopsy
## Electrolytes

Normal Blood Ph. is 7.4: below is acidosis, above alkalosis

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Value</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>138 mmol/L</td>
<td>135 - 146 mmol/L</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.5 mmol/L</td>
<td>3.5 - 5.1 mmol/L</td>
</tr>
<tr>
<td>Chloride</td>
<td>102 mmol/L</td>
<td>98 - 110 mmol/L</td>
</tr>
<tr>
<td>CO2</td>
<td>25 mmol/L</td>
<td>22 - 29 mmol/L</td>
</tr>
<tr>
<td>Anion Gap (high equals acidosis)</td>
<td>11 mmol/L</td>
<td>5 - 13 mmol/L</td>
</tr>
</tbody>
</table>
Obstructive Sleep Apnea; with periods of hypoxia (low oxygen levels) mainly during REM sleep

Signs & Symptoms: Snoring, daytime drowsiness, hypertension, heart disease, stroke, diabetes,

Evaluation in Sleep Lab

Treatment of OSA:
Lose weight
Sleep on your side
CPAP
Dental Prosthesis
Surgery (controversial)
The mechanics of Intubation and being on the ventilator
Pulmonary Function Tests; spirometry
Normal Pulmonary Function

• The **normal** one second value for the (Forced Expiratory Volume) FEV1/FVC (Forced Volume Capacity) ratio is 70% (and 65% in persons older than age 65).
# Pneumonia

- **Bacterial** (community acquired and hospital acquired) Just like MRSA
- **Viral**
- **Aspiration**
- **Pneumocystis Pneumonia** and unusual bacterial in Immune compromised patients of any sort. HIV especially
- **Procalcitonin** responds to tissue injury: New lab test to differentiate between bacterial and viral pneumonia and meningitis.
Idiopathic Pulmonary Fibrosis.

- Most have no known cause; 3-5 year course. Newer treatments with nintedanib and pirfenidone, ground glass appearance on x-ray, pulmonary hypertension.
- 40,000 deaths per year and often goes undiagnosed because of non-specific symptoms.
- Life expectancy after diagnosis 8-12 years.
- Anything that damages the lung like irradiation, certain drugs, pneumonia, pneumoconiosis,
- Rare diseases like connective tissue disease, Systemic lupus erythematosus, Rheumatoid arthritis, Sarcoidosis, Scleroderma
Medical Conditions

- Tuberculosis (declining incidence in US)
- Histoplasmosis (high incidence in Ohio valley, but rarely causes serious disease)
- Pulmonary embolus
- CHF
- Atelectasis
1% with COPD have genetic Alpha-1-antitrypsin deficiency,

- **Cigarette smoking** (*1/3**RD** nonsmokers*), asthma, chronic bronchitis, fumes and industrial irritants.

Acute-or-chronic respiratory failure that predispose to pulmonary infection, pulmonary embolism, cardiac arrhythmia and lung cancer

**Treatment:**

1. Stop smoking and avoid air pollutants
2. Rx active infections/ sputum liquefiers
3. LAMA (long acting muscarinic antagonists/anti-parasympathetic drugs like atropine
4. LABA (long acting beta2 agonists) like adrenalin
5. Long acting steroids—effective if eosinophil count elevate
6. O2 if needed based on pulse oximeter (<88-90%)
7. Some new anti-inflammatory drugs (Monoclonal antibodies-Triple Rx.)
More on COPD/ slowly progressive; no predictive tests

- FEV peaks at age 20.
- Asthmatics have better prognosis
- CT diagnostic insight (multistage loss of tissue leads to increase cancer risk)
- O2 bronchitis phenotype leads to metabolic syndrome
- 6 minute walk -- <350 meters
- Stress test
<table>
<thead>
<tr>
<th>Leading causes of death in US</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Heart disease</strong>: 647,457.</td>
</tr>
<tr>
<td>• <strong>Cancer</strong>: 599,108.</td>
</tr>
<tr>
<td>• Accidents (unintentional injuries): 169,936.</td>
</tr>
<tr>
<td>• Chronic lower respiratory <strong>diseases</strong>: 160,201.</td>
</tr>
<tr>
<td>• Stroke (cerebrovascular diseases): 146,383.</td>
</tr>
<tr>
<td>• Alzheimer's disease: 121,404. (5.5 million people are affected)</td>
</tr>
<tr>
<td>• Diabetes: 83,564.</td>
</tr>
<tr>
<td>• Influenza and pneumonia: 55,672</td>
</tr>
<tr>
<td>• Where will Covid 19 Fit?</td>
</tr>
</tbody>
</table>
The Pleural Spaces

- Asbestosis and Mesothelioma (of the pleura)
- Pleural Effusions; Transudate or Exudate
- Congestive Heart Failure most common cause but many others such as Cirrhosis, Cancer, Pneumonia, Nephrotic syndrome, Drugs
- Empyema
- Hemothorax mainly due to trauma
- Chest Tubes
Occupational Exposures

- Silicosis
- Black lung disease
- Asbestosis
- Talcosis
- Hyperimmune pulmonitis
- All of these conditions you can multiply by 10 in heavy smokers.
Lung Cancer: Number one Killer (116,000 cases with 72,000 deaths in 2019 Americans). Five year survival rate 20.5%

- Tobacco responsible for about 90 percent and with 40 pack year history have 20 times the incidence; currently sixty percent are diagnosed with advanced disease.
- Therapy Improving with detection at earlier stages: Surgery; X-ray, Targeted therapy—sequencing and mutations and Immunotherapy.
- Low dose CT for screening (1 preventable death for every 150 persons screened)

Criteria for screening with LDCT: Smokers age 55-80, 30 pk year history, quite just within past 15 years.
Pulmonary Emboli and DVT

- Hypercoagulable states and genetic predisposition
- Vascular damage or trauma
- Circulatory stasis and dependency
Emergencies in Oncology

- Hypercalcemia—in 30% Multiple Myeloma—bisphophonates, hydration, QT on EKG
- Cord compression—lung, breast, prostate
- Tumor lysis syndrome—increase K and Uric Acid
- Hyponatremia—120-135 mEq—CNS symptoms
- Hyper-viscosity syndrome—increase Igm
- Leukostasis—WBC greater than 100,000
- Febrile neutropenia—WBC 1500-500
- Superior vena cava syndrome
- Related to therapy be it Monoclonal antibodies, Immunotherapy or Chemotherapy
Vaping; Electronic Nicotine Device System (ENDS)

• 25 percent of high school students are experimenting with vaping
• JUUL
• Addicting and can cause lung damage due to ingredients such as propylene glycol, THC, Flavorants, Vitamine E acetate, and heavy metals such as zinc and manganese.
• Some deaths and permanent pulmonary fibrosis.
Global Health Disorders

A grim reaper
Global top ten causes of death, m, 2017

1. Ischaemic heart disease
2. Strokes
3. Chronic obstructive pulmonary disease
4. Lower respiratory infections
5. Alzheimer's and other dementias
6. Trachea, bronchus, lung cancers
7. Tuberculosis
8. Diabetes
9. Road injury
10. Diarrhoeal diseases

Source: WHO

Tuberculosis deaths among people with HIV
Cardiovascular System
CARDIOVASCULAR SYSTEM

THE HUMAN HEART
Human Heart with four chambers
Overview of Circulation
The Arch of the Aorta

- Right common carotid artery
- Right subclavian artery
- Brachiocephalic artery
- Arch of aorta
- Left common carotid artery
- Left subclavian artery
- Right coronary artery
- Left coronary artery
Cardiac Electrical System

Electrocardio physiologist
Abdominal Aorta and Vena Cava
Heart Conditions

- Arrhythmias (atrial fib, atrial flutter, heart blocks, ventricular tachycardia, and fibrillation)
- CHF (two types)
- HPT
- Congenital defects, atrial septal defects common (patent fossa ovalus)
### Myocardial Infarction/Acute Coronary Syndromes and Angina

1. One and a half million cases in US yearly (STEMI vs Non STEMI) Often the cause of SCD (sudden cardiac death) (ECD)
2. Usually presents with crushing central chest pain that can radiate into the neck and down the arm with profuse sweating, dizziness, hypotension. Some atypical presentations.
3. A true emergency; 1. Call 911-and EMS squads have monitoring equipment, medications, means to treat cardiac arrest, arrhythmias, hypotension, and can alert ER to prepare for PCI in the cardiac cath lab (85 percent of cases) 2. Give aspirin.
4. PCI (window of several hours) and TPA very effective in reversing coronary artery occlusion.
5. Need to go to hospital with 24/7 cardiac lab for PCI
6. Acute MI due to unstable plaque disruption that causes inflammation and clot formation. (control of cholesterol may reverse)
Atrial Fibrillation

- Irregular irregularity of the pulse; often intermittent but if persists needs to be treated.
- Fast heart rate generally in the range from 100 to 175 beats a minute
- Why is it serious; less efficiency of the heart, clots in atrial appendage can migrate causing strokes and emboli to other organs.
- Risk Factors: age (about ¼ will develop—an epidemic), hypertension, European ancestry, Diabetes, heart failure, Ischemic heart disease, Hyperthyroidism, open heart surgery, moderate to heavy alcohol use
Treatment of Atrial Fibrillation

- Cardioversion if sustained (within 48 hours) (AED)
- Anticoagulation
- Antiarrhythmic drugs (several classifications)
  Main objective is to slow the heart rate and make the myocardium less irritable.
- Atrial ablations (destroys aberrant pacemakers in the pulmonary veins)
  The Watchman device or tying off the left atrial appendage where most emboli originate.
Heart Failure

- **An Epidemic due to an aging population;**
- Two types of Left Ventricular Heart Failure: Normal and Low Ejection Fraction Failure: One is a large heart with ventricular hypertrophy and low EF, the other is normal EF with normal heart size and wall rigidity.
- Symptoms of SOB, Dyspnea on exertion, orthopnea, peripheral edema. Possibly coronary syndrome pain.

- Pulmonary Hypertension: (>25 mm Hg/cor pulmonale) due to hereditary, COPD and other pulmonary diseases, Left sided heart failure, multiple pulmonary emboli, Obstructive Sleep Apnea.
Improvements in Treatment of CHF

• Beta Blockers
• ACE inhibitors
• ARB
• ARNI
• SGLT2
• Diuretics relieve symptoms but no survival benefit
• Digoxin—no long term benefit
• Better fluid regulation through device tele-monitoring; Jugular vein pressure, orthopnea and bendopnea (SOB within 30 seconds bending over. (decreases hospitalizations)
<table>
<thead>
<tr>
<th>Anti-coagulants: Some Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVT, atrial fib, heart valves, prevent stroke, emboli, massive obesity, cancer and renal failure</td>
</tr>
</tbody>
</table>

- Warfarin or Coumadin with INR to regulate with 2-3 range effective in patients taking warfarin ($39 per month) Monthly blood test to regulate
- Factor Xa inhibitors or DOAC (direct oral anticoagulants such as Eliquis, Pradaxa and Xarelto (average cost per month $235)
  - Aspirin
  - Plavix
  - NSAIDS
  - Heparin
  - Low Molecular Weight Heparin (lovenox)
### Tests and Interventions for Acute Myocardial Infarction, Angina and CHF

- PCI (Percutaneous Cardiac Interventions) and Atrial Ablations
- Chest X-ray
- Echocardiogram (TEE)
- Stress Test
- Blood Tests for Myocardial Damage
  - Troponin (now High Sensitivity)
  - CPK
  - Natriuretic peptide (BNP)
CT angiography (CTA) of the Heart

- With advanced equipment (64 t 128 detectors) can visualize coronary vessels 1.5 mm and above.
- If normal, there is 99% negative predictive value and 10 year warranty that you will not die of a cardiac event.
- Indications: Chest pain, Equivocal Stress test, screening before valvular surgery, new onset of CHF and cardiomyopathy, coronary anomalies, bypass surgery, stint patency.
**Subacute and Acute Bacterial Endocarditis** (infections/vegetations on the valve leaflets) commonly due to staph aureus and enterococcus in acute and strep viridans and enterococcus in SBE

- Risk Factors: Mitral value prolapse (20 % of young women), congenital defects, enlarged hearts, rheumatic fever, prosthetic heart valves, bicuspid aortic valves and stenosis in older men, HIV and most common today IV Drug use.

  These predisposing conditions are one of the reasons for prophylactic antibiotics prior to some surgeries such as dental procedures and bowel surgery.

- Diagnosis via blood cultures and ECHO cardiogram (Transesophageal ECHO 85-90 percent diagnostic)

- SBE is generally slow in onset whereas Acute progresses quickly.

- Treatment; need high doses of bactericidal antibiotics such as Ceftriaxone and Vancomycin

- One very concerning complication is mycotic emboli to the brain causing stroke.
Cardiac Valvular Disease

- **Mitral regurgitation** common (10 percent over the age of 75) Rx if EF is less than 50% and even between 50 and 50%. Can cause pulmonary hypertension.
  
  Two types; valvular abnormalities (Mitral Valve Prolapse), and secondary to LVH or ventricular abn. The former treat with replacements or mitral clips

- **Aortic stenosis** due to arteriosclerosis. Bicuspid aortic valve present serious problem and symptomatic individuals have low survival rates. Open permanent surgical replacement in young and percutaneous dilatation and prosthesis in poorer surgical risk patients.

- Need for anticoagulation and prophylactic antibiotics with dental procedures.
Giant Cell Arteritis/Temporal Arteritis

- Headache and fever of unknown origin in older folks
- Jaw claudication, tenderness over temporal region and visual loss
- Can involve all large arteries and .5 to 1 percent of population.
- Effective treatment with steroids and new monoclonal antibodies.
The Metabolic Syndrome

The Epidemic Complex of

• a. Obesity
• b. Hypertension
• c. Hypercholesterolemia
• d. Hyperlipidemia
• e. Adult Onset of Diabetes Mellitus (Hgb A1C >6 or 6.5.)
### Major Classifications of Antihypertensive Medications

- **ACE (angiotensin converting enzyme inhibitors)**
- **ARBs (Angiotensin II receptor blockers)**
- **Calcium Channel Blockers**
- **Beta-blockers**
- **Diuretics (Thiazides, Loop Diuretics, K+ sparing)**
Genitourinary System
Renal Collecting System

![Diagram of the renal collecting system](image)
20 Percent of Cardiac output goes to the Kidney
Diagram of Renal Tubule/Nephron

Creatinine and Bun Values

Lasix
Functions of the Kidney

- Water and electrolyte balance (Na & K)
- Acid-base balance (Hydronium ion)
- Elimination of metabolic waste like urea, creatinine, drugs and toxins
- Blood pressure regulation with angiotensin
- Erythropoietin hormone that stimulates RBC production
Affliction of Genitourinary System

- Pyelonephritis and Cystitis
- Kidney Stones
- Urinary Incontinence
- Renal Cell Carcinoma and Transitional cell bladder cancer
- Uremia due to ESRD
- Glomerulonephritis
- Congenital disorders
The Nephrotic Syndrome; a disorder effecting the glomeruli of the Kidney

- Massive proteinuria; greater than 3.5 gms
- Hypoalbuminemia less than 2.5 grams per dl
- Hyperlipidemia
- Edema-osmotic pressure

- Many Causes but some idiopathic due to an unknown factor circulating in the blood.
Male Problems

- BPH
- Cancer of the prostate
- Prostatitis (acute and chronic)
- Epididymitis
- STD (sexually transmitted disease)
- ED (erectile dysfunction) (Viagra, Cialis, Levitra)
- Peronei's Disease
Cancer of the Prostate; most common cancer in men;

- 11 percent of men develop with 33,000 deaths annually
- Usually diagnosed with PSA (and DRE) followed by trans rectal biopsy and Gleason Score and staging with bone scan and CT.
- High risk with family history, African-Americans, BRAC-2 gene.
- Rx: Radical prostatectomy, x-ray therapy, Brachytherapy, and LHRH and anti androgens like Flutaminde, and in hormonal resistant disease Docetaxel or androgen receptor inhibitors like Enzalutamide
Female Reproductive System

Diagram of Female Reproductive System

- Ampulla
- Peritubal
- Isthmus
- Fundus of uterus
- Body of uterus
- Uterine tube
- Ovarian ligament
- Primordial follicle
- Corpus albicans
- Corpus luteum
- Ovulation
- Ovulated oocyte
- Myometrium
- Uterine cavity
- Endometrium
- Internal orifice
- Isthmus of uterus
- Cervical canal
- Fimbriae
- Ovary
- Cervix
- Cervical os (external orifice)
- Vaginal rugae
- Vagina
- Sperm cell
- Fertilization
- Infundibulum
- Primary follicle
- Secondary follicle
- Mature follicle
Overactive Bladder Disorder (OBD) and Urinary Stress Incontinence (Pelvic Relaxation)

OBD treatments:
- Timed Voiding
- Anticholinergics
- Sacral and tibial nerve stimulation
- Botox injections

Urinary Stress Incontinence:
- Pessary and perineal exercises
- Estrogen vaginal cream
- Sling procedures
More Female Conditions

• Cancer of the Cervix (HPV)
• STD
• Uterine fibroids
• Infertility
• Need for C section?
Cervical Cancer—13,000 cases a year

- HPV (types 16 & 18) responsible for 70 percent of cases.
- HPV vaccination (females and males?) with Gardasil 9 at age 11 or 12.
- Pap smears and HPV Testing on cervical smears
- Colposcopy
- Why don’t PCPs do pelvic examinations?
Spring Quarter Class

- Sight/ The Eye
- Hearing/The Ear
- Skin/Dermatology
- The Cell and Immunity
- Genetics
- Palliative Pain Management
- Managing Healthcare Costs
- Changes in Medicine in past 50 years.
Palliative Pain Management

- Overriding issues and goals
- Quality of life
- The emotions of dying as a normal process
- Relief of pain
- Integrate the psychological and spiritual
- Live as active as possible

- Pain as distress: physical, psyche, social, emotional spiritual
Nociceptive versus Neuropathic Pain

- Nociceptive pain is the body’s response to actual damage or stretching like physical trauma that is divided into two categories:
  - **Somatic pain** usually related to trauma that is localized to the injury or stimulus and often is aching, sharp, increases with movement
  - **Visceral pain** that relates to body organs (usually obstruction of a viscera) that is often poorly localized, colicky and frequently radiates.
Neuropathic Pain

Pain originating with the nerve that represents an abnormal processing of sensory imputes.

- Allodynia—pain due to a stimulus that does not normally provoke pain
- Hyperalgesia-- increased pain from a stimulus that usually provokes pain
- Hyperesthesia-- is an increase in the sensitivity of any of your senses, such as sight, sound, touch, and smell
- Neuralgia--extreme shooting or stabbing pain that follows the path of a damaged or irritated nerve unrelated to the stimulus.
Assess Pain

- Perception - what makes it worse or better; get the story from the patient.
- Quality - what it feels like
- Radiation
- Site - severity and relation to movement or static
- Temporary and timing
- What is impact of pain in your life
Goals; comfort and functionality

Mild Pain

- Non Pharmacological: massage, PT/OT, ice/heat, ultrasound, meditation, cognitive, prayer
- Non-Opioid: NSAIDS (Selective COX 2 like Celebrex), Acetaminophen, Steroids, Capsaicin creams, Lidocaine patches
Moderate Pain

- Codeine - usually in cough medicine
- Tramadol - opioid effect, muscle relaxant.
- Hydromorphone - long acting opioid
- Methadone - less addicting, cheap
- Morphine, oxycodone
- Fentanyl patch - long acting
- Buprenorphine patches (in combo with naloxone used to treat addiction)
Other Modalities

- Variety of nerve blocks (agents--glycerin, hypertonic saline, phenol, thermal)
- PCA pump that patient controls
- Pain point injections with lidocaine, steroids
- Epidurals with steroids
- Intrathecal ad epidural pumps
- Vertebralplasty (bone cement), Kyphoplasty to restore height.
medial lemniscus, also known as Reil's band or Reil's ribbon, is a large ascending bundle of heavily myelinated axons that decussate in the brainstem, specifically in the medulla oblongata.
Vision/The Eye

Uvea-choroid, ciliary body and iris
The Sixth Cranial nerve, the Abducens, the Third, Oculomotor nerve, and the Fourth, the Trochlear supply the movements of the eye.
Diseases of the Eye

• Age-Related Macular Degeneration (wet and dry).
• Cataract.
• Diabetic Retinopathy.
• Glaucoma.
• Amblyopia/strabismus: lazy eye is an imbalance in the muscles, common and can result in loss of vision in weak eye. Good treatment.
Glasses and

• A nearsighted/myopic person sees near objects clearly, while objects in the distance are blurred.

• A farsighted/hyperopia person sees faraway objects clearly, while objects that are near are blurred.

• Still another defect of vision is known as presbyopia or farsightedness due to old age.
Tests for sight

• Routine exam; eye movements, pupils round and regular and react to light and accommodation, nystagmus

• A refraction assessment determines if you have vision problems such as nearsightedness or farsightedness, astigmatism (evenly), or presbyopia

• **Tonometry**: A standard eye test that is done to determine the fluid pressure inside the eye. **Normal pressure range** is 12 to 22 mm Hg

• Visual fields

• Funduscopic examination
The External, Middle and Internal Ear
The Internal Ear

- Bony labyrinth (contains perilymph)
- Membranous labyrinth (contains endolymph)
- Ampulla of semicircular canal
- Utricle
- Vestibule
- Oval window
- Saccule
- Cochlea
- Cochlear duct
- Lateral window
- Round window

(a) Components of the right internal ear

Figure 17.20 Tortora - PAP 12/e
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The **vestibulocochlear nerve** (auditory vestibular nerve), known as the eighth cranial nerve transmits sound and equilibrium (balance) information.

- **There are four types of hearing loss:**
  - Auditory Processing Disorders.
  - Conductive.
  - Sensorineural.
  - Mixed.
Types of hearing loss

Sensorineural:
- Aging
- Noise damage
- Drug side effects
- Auditory tumors
- Blast/explosion

Mixed:
- Genetic disorders
- Infections
- Head trauma

Conductive:
- Fluid
- Foreign objects
- Allergies
- Ruptured eardrum
- Impacted earwax
The aging ear

- **Presbycusis** (a type of hearing loss known as sensorineural) is the loss of hearing that gradually occurs in most individuals as they grow older. Hearing loss is a common disorder associated with aging. About 30-35 percent of adults age 65 and older have a hearing loss. It is estimated that 40-50 percent of people 75 and older have a hearing loss.
Tests for Hearing Loss

• Physical exam; otoscope
• Tuning fork to differentiate between bone and air conduction.
• Audiometry
Audiometer Testing

- There are a few tests involved in audiometry. A pure tone test measures the quietest sound you can hear at different pitches. It involves using an audiometer, which is a machine that plays sounds via headphones. Your audiologist or an assistant will play a variety of sounds, such as tones and speech, at different intervals into one ear at a time, to determine your range of hearing. The audiologist will give you instructions for each sound. Most likely, they’ll ask you to raise your hand when a sound becomes audible.
Every increase of 10 dB on the decibel scale is equal to a 10-fold increase in sound pressure level (SPL).

<table>
<thead>
<tr>
<th>Sound</th>
<th>Decibel Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal conversation</td>
<td>60 dB</td>
</tr>
<tr>
<td>Heavy city traffic</td>
<td>85 dB</td>
</tr>
<tr>
<td>Lawn mower</td>
<td>90 dB</td>
</tr>
<tr>
<td>MP3 player at maximum volume</td>
<td>105 dB</td>
</tr>
<tr>
<td>Sirens</td>
<td>120 dB</td>
</tr>
<tr>
<td>Concerts</td>
<td>120 dB</td>
</tr>
<tr>
<td>Sporting events (depending upon the stadium)</td>
<td>105 to 130 dB</td>
</tr>
<tr>
<td>Firearms</td>
<td>150 dB</td>
</tr>
</tbody>
</table>
Quantification of hearing loss

![Graph showing quantification of hearing loss](www.healthyhearing.com)
Before you buy
When looking for a hearing aid, explore your options to understand what type of hearing aid will work best for you. Also:

Get a checkup. See your doctor to rule out correctable causes of hearing loss, such as earwax or an infection. And have your hearing tested by a hearing specialist (audiologist).

Seek a referral to a reputable audiologist. If you don't know a good audiologist, ask your doctor for a referral. An audiologist will assess your hearing, help you choose the most appropriate hearing aid and adjust the device to meet your needs. If you have hearing loss in both ears, you will get best results with two hearing aids.

Ask about a trial period. You can usually get a hearing aid with a trial period. It may take you a while to get used to the device and decide if it's right for you. Have the dispenser put in writing the cost of a trial, whether this amount is credited toward the final cost of the hearing aid and how much is refundable if you return the hearing aid during the trial period.

Think about future needs. Ask whether the hearing aid you've chosen is capable of increased power so that it will still be useful if your hearing loss gets worse. Hearing aids do not function indefinitely, but they should last about five years.

Check for a warranty. Make sure the hearing aid includes a warranty that covers parts and labor for a specified period. Some dispensers may include office visits or professional services in the warranty.

Beware of misleading claims. Hearing aids can't restore normal hearing or eliminate all background noise. Beware of advertisements or dispensers who claim otherwise.

Plan for the expense. The cost of hearing aids varies widely — from about $1,500 to more than a few thousand dollars each. Professional fees, remote controls, hearing aid accessories and other hearing aid options may cost extra. Talk to your audiologist about your needs and expectations.
Types of Hearing Aids

• In-the-ear (ITE) hearing aids (custom fit) *half-shell* designs that fill half the bowl of the outer ear to *full-shell* designs that fill almost the entire outer ear bowl, directional microphones and manual controls

• Invisible in the canal (IIC) small, manual dexterity, invisible, with string
  Completely in the canal (CIC) larger, longer battery life,

• Behind-the-ear (BTE) hearing aids (does not occlude entire canal) **Receiver in the ear (RITE)** rechargeable *battery* option, **telecoi**l options fits all degrees of hearing loss, including **profound hearing los**
Things to Consider

**What is the best hearing aid style for me?**

- **Do you currently wear hearing aids?**
  - **Yes:**
    - Do you like the style?
      - **Yes:**
        - Has your hearing changed?
          - **Yes:**
            - Keep your current style; consider new technology options
          - **No:**
            - Do you have any dexterity issues?
              - **Yes:**
                - A low profile ITE or BTE with earmold; automated features
              - **No:**
                - Are you home-bound or restricted?
                  - **Yes:**
                    - BTE with earmold; basic technology and ALDs
                  - **No:**
                    - What is your hearing loss?
                      - **MILD OR MODERATE LOSS:**
                        - CIC, ITC or open fit RIC; advanced technology
                      - **SEVERE OR PROFOUND LOSS:**
                        - ITC, low profile ITE or BTE with earmold; advanced technology and ALDs
    - **No:**
      - **Do you currently wear hearing aids?**

[www.healthyhearing.com](http://www.healthyhearing.com) - Healthy Hearing
• Analog and digital hearing aids

• **Directional microphone**

• **T-coil (Telephone switch)** allows you to switch from the normal microphone setting to a "T-coil" setting in order to hear better on the telephone. The voice of the speaker, who can be some distance away, is amplified significantly more than any background noise.

• **Direct audio input**

• **Feedback suppression** helps suppress squeals when a hearing aid gets too close to the phone or has a loose-fitting earmold.
• **What is a cochlear implant?**
  • Cochlear implants are complex medical devices that work differently than hearing aids. Rather than amplifying sound—which helps a person with residual hearing ability—a cochlear implant provides the sense of sound by stimulating the auditory nerve directly.

• Adult candidates are generally eligible for an implant if they:
  • Have severe or profound hearing loss in both ears.
  • Get little or no benefit from hearing aids.
  • Have no medical problems that could put them at risk during surgery.
  • Have a strong desire to be part of the hearing world and communicate through listening, speaking and speechreading.
Cost

- The average cost of a hearing aid is $1,000 to $4,000.
- The average price of a single hearing aid is $2,300, according to a 2015 report from the President's Council of Advisors on Science and Technology. And most people need two.
- The average price of a single hearing aid is $2,300, according to a 2015 report from the President's Council of Advisors on Science and Technology. And most people need two. (Six global manufacturers control 90 percent of the market.)
- According to the website Exposing Hearing Aids, a provider information portal that also connects patients with providers, a typical hearing aid pricing model breaks down as follows:
  
  Total patient price: $4,600  
  Manufacturer costs (materials and research): $1,400  
  Retailer costs (operating costs, salaries, marketing, continuing education): $2,236  
  Service costs for the life of the hearing aids (adjustments, cleaning, repairs, batteries): $574  
  Potential pretax profit: $350