1) **What two elements are present in all organic molecules? Which organic molecules have polar covalent bonds so that they are readily water soluble? Which are hydrophobic and why? (question)**
    - **a.** Carbon
        - **i.** Unique because they readily share electrons via covalent bonds
        - **ii.** Sugar: soluble: will readily travel in our bloodstream
    - **b.** Hydrogen
    - **c.** Anything with an OH group is polar
2) **What is unique about the ratio of Carbon, Hydrogen, and Oxygen in a carbohydrate? Name one monosaccharide and one disaccharide. Compare the 3-dimensional structures of glycogen, cellulose and starch. Which complex carbohydrate is most rapidly catabolized? Explain why.**
    - **a.** Carbs: most common source of energy to fuel the body
        - **i.** Composed of carbon, hydrogen, and oxygen: hydrogen and oxygen are usually found in the same two-to-one relative proportions they have in water
            - **1.** CH_2O –all carbs have this (including glucose)
            - **2.** Polar
        - **ii.** Complex carbs
        - **iii.** Polysaccharides
            - **1.** Starch: can digest
                - **a.** Used for energy storage in plants
            - **2.** Glycogen: digest most rapidly (most surface area)
                - **a.** Energy storage in humans
            - **3.** Cellulose: not digestible
        - **iv.** Simple sugars (monosaccharides)
            - **1.** Glucose and fructose
            - **2.** Glucose: most common fuel
        - **v.** Disaccharides
            - **1.** Sucrose (table sugar)
3) **Describe the 3-dimnesnional structural differences between saturated, monosaturated, and polyunsaturated fatty acids. Compare their number of double C-C bonds. What are the subunits of a triglyceride?**
    - **a.** Lipid: all are hydrophobic
    - **b.** Triglyceride: most common (fat)
        - **i.** Storage and fat
        - **ii.** Three carbon atoms
        - **iii.** Three fatty acids
    - **c.** Saturated: fatty acid chains that have no double carbon bonds and contain the maximum number of hydrogen atoms
        - **i.** Straight, rigid
        - **ii.** Pack tightly together
        - **iii.** Animal fats: high in both saturated fat and cholesterol
    - **d.** Mono-unsaturated: C-C bonds cause bending of fatty acid chain (one)
        - **i.** Unable to pack together as tightly
        - **ii.** **Liquid** at room temperature → oil
    - **e.** Polyunsaturated: two or more double bonds
        - **i.** Look at pictures
        - **ii.** Light weight, low density
        - **iii.** Pack more loosely together, making cell membranes more flexible
    - **f.** Trans fatty acids: unsaturated fatty acids that are chemically treated to produce partially hydrogenated fats (by breaking a double bond→ kinds → worse for you)
4) **Given examples of dietary lipids that are liquid vs. solid at room temp. How does hydrogenation alter a fatty acid? Which types of fatty acids are "unhealthy"? List some foods that contain those types of bad fatty acids. What is the key feature of a ketone?**
    - **a.** Side effect of partial hydrogenation: trans-fat
        - **i.** Animal fat (red meat): naturally produces trans fat
    - **b.** Complete hydrogenation: flattened out
    - **c.** Cholesterol
        - **i.** Metabolized in the liver
            - **1.** Hydrocarbons make it hydrophobic: has a polar hydroxyl head that makes it hydrophilic

1) **Name the extracellular vs. intracellular fluid compartments in the body**
    a. Extracellular: outside
        i. Fluid environment outside the enclosure
    b. Intracellular: *cytoplasm*
        i. Fluid interior of the cell
2) **Explain why a cell membrane is both a bilayer and a fluid mosaic. What are some of the general functions of a cell membrane?**
    a. Cell membrane: extremely pliable structure composed primarily of back-to-back phospholipids
    b. Phospholipid bilayer
    c. Flexible
    d. Unique
    e. Fluid mosaic: free floating molecules, not rigidly locked in place
3) **What is the structure of a phospholipid molecule? Which region of this molecule is hydroliphic and which is hydrophobic? How are phospholipids arranged in a membrane? How does the membrane flexibility change if the phospholipids contain more saturated fatty acids than normal?**
    a. Hydrophilic heads interact with water of both extra and inter cellular
    b. Hydrophobic tails interact with each other
    c. Have to be very small or hydrophobic to go through
        i. Lipids can cross the cell membrane easily
    d. Phospholipids: two fatty acid chains (charged region → polar head)
    e. More saturated → stiffer and more solid (think that saturated fats are solid at room temperature)
    f. Phospholipid bilayer blocks ions
    g. Selective permeability: only certain substances can pass through
        i. Only small, non-polar molecules can move through
        ii. Water-soluble need assistance
4) **Compare the general differences between active and passive transport. Which transport methods use ATP, which use kinetic energy of the molecule? Which goes up or down a concentration gradient? Compare the differences in the actions of channel and carrier proteins?**
    a. Passive
        i. Movement of substances across the membrane without the expenditure of cellular energy
        ii. Kinetic energy
            1. Eventually will reach a point where there is an equilibrium
            2. The steeper the gradient, the faster the change
        iii. Down a concentration gradient (high to low)
            1. Concentration gradient: the difference in concentration of a substance across a space
        iv. Types of diffusion: simple, facilitated, osmosis
        v. Insulin resistance
    b. Active
        i. Movement of substances across the membrane using energy from ATP: cellular energy
        ii. "Up" a concentration gradient (low to high)
        iii. Carrier mediated vs. vesicles
5) **Describe simple diffusion. How does each of these variables affect the rate of diffusion: temperature (kinetic energy), concentration gradient, molecular / ion mass?**
    a. Simple diffusion: fat soluble molecules directly through the phospholipid bilayer
        i. NO ATP
    b. Temperature: warmer, speeds up diffusion as molecules move faster
    c. Concentration gradient:
    d. Molecular / ion mass: higher masses → slower diffusion
        i. Smaller → faster diffusion
6) **Describe the carrier-mediated transport of glucose. Describe the role of insulin in regulating the number of glucose transporters. Define insulin resistance**
    a. Facilitated diffusion: the diffusion process used for those substances that cannot cross the lipid bilayer due to their size or polarity (using carrier proteins)
        i. NO ATP
        ii. Both facilitated diffusion and active transport are carrier-mediated
    b. Via protein carrier specific for one chemical; binding of substrate causes transport protein to change shape

   i. Can be triggered to open up and release their digestive enzymes into the cytoplasm of a damaged or unhealthy cell, killing the cell
   ii. May decrease after a cortisone injection

4) **Describe the structure and internal environment of a mitochondrion. What organic molecules can mitochondria use to supply the energy needed to build ATP? Are oxygen molecules required? Can ATP be built anywhere else in the cell? What effect does a high fat diet have on mitochondrial function and autophagy by lysosomes? What effect do these changes have on beta cells of the pancreas (where insulin is produced)?**
   a. Outer / inner lipid bilayer
   b. Inner: surface area, folds called cristae
   c. Convert energy stores in nutrient molecules (like glucose, fatty acids, and polypetides) into ATP
   d. Oxygen is required (catabolized)
      i. Proves of breaking down complex molecules into smaller units
   e. Excess fatty acid intake → damage mitochondria and impair autophagy → beta cell failure in pancreas → cell death → Type 2 diabetes
5) **What are the subunit molecules that are present in ATP? Compare the structure of ATP and ADP that breaks off in ATP to release energy for cellular work?**
   a. Composed of a ribose sugar, an adenine base, and three phosphate groups
   b. Supplies energy to cells when covalent phosphate bonds are broken, supplying energy to cells
   c. More ATP is produced in the presence of O2 than not
   d. When a phosphate group is cleaved off, the products are ADP and P (phosphate)
6) **Describe the overall function of the cytoskeleton. Describe two of the major components in the cytoskeleton: microfilaments and microtubules. Describe the structure and function of cilia and flagella. How do they work? Do they use ATP?**
   a. Quaternary: multiple proteins linked together end to end (fibrous proteins provide structural support)
   b. **Microfilaments:** thinner type of cytoskeletal filament
      i. Actin: protein that forms chains: primary component of these microfilaments
      ii. Resists stretching
      iii. Responsible for muscle contraction
      iv. Helps split cells
   c. **Microtubules:** tubular filament composed of subunits of a protein called tubulin
      i. Maintain cell shape and structure, help resist compression of the cell, and play a role in positioning the organelles within a cell
      ii. Quaternary structure
      iii. Cilia and flagella
      iv. Set the paths along which the genetic material called be pulled during cell division (*requiring ATP*)
         1. Move chromosomes and organelles

Lecture 8

1) **How does the phospholipid bilayer of the nucleus help protect DNA from chemical damage? Describe the function of the nucleolus within the nucleus. List the three types of molecules in a nucleotide. What other molecule, besides DNA or RNA is derived from a nucleotide design? How are nucleotides arranged within DNA and RNA?**
   a. Nuclear envelope
      i. Two adjacent lipid bilayers with a thin fluid space between them (double)
      ii. Bigger barrier
   b. Nucleolus: manufactures RNA necessary for construction of ribosomes
   c. Nucleotide
      i. One or more phosphate groups
      ii. Pentose sugar: deoxyribose or ribose
      iii. Nitrogen containing base: admen, cytosine, guanine, thymine, or uracil
      iv. Can be assembled into DNA, RNA, or triphosphate (ATP)
   d. DNA:
      i. Deoxyribose, phosphate group,
      ii. Nitrogen base: adenine, cytosine, guanine, or thymine (varies as a code)
      iii. Double helix
      iv. Hydrogen bonds: weak, holding the two sides together

- **e.** RNA
  - **i.** Ribose, one phosphate group, adenine, cytosine, guanine, and uracil
  - **ii.** Single strand

2) **Summarize the two major events in protein synthesis: transcription and translation. Which event occurs within the nucleus and which even occurs in the cytoplasm?**
   - **a.** Transcription (within the nucleus to make mRNA)
     - **i.** the synthesis of a strand of mRNA that is complementary to the gene of interest
     - **ii.** initiation: a promoter triggers that start of transcription
     - **iii.** elongation:
       1. RNA polymerase unwinds the DNA segment
       2. Coding strand becomes template
       3. Polymerase aligns that correct nucleic acids (A, C, G, or U) with its complementary base on the coding strand (inverse)
     - **iv.** Termination: when the polymerase reaches the end of the gene, one of the three specific triplets codes a stop signal
   - **b.** Translation (translating to amino acid sequences)
     - **i.** Using RNA: can make multiple copies (speeds up efficiency)
     - **ii.** Limits risk of damage to DNA
     - **iii.** Broken RNA can be recycled
     - ***iv.*** *Process of synthesizing a chain of amino acids called a polypeptide*
     - **v.** Initiation: binding of a ribosome to an mRNA transcript
     - **vi.** Elongation: recognition of a tRNA anticodon with the next mRNA codon in the sequence (triplet → codon → anticodon)
       1. Each type of tRNA carries only one type of amino acid indicated by its anticodon
       2. Stringing together specific amino acids
       3. Building primary structure (bonding amino acids together with covalent bonds)
     - **vii.** Termination: when the final codon of the mRNA is reached
   - **c.** Overview
     - **i.** Copy DNA to from MRNA
     - **ii.** Ribosome forms bonds between amino acids
     - **iii.** Rough ER folds proteins
     - **iv.** Golgi apparatus modifies
     - **v.** Vesicle pinches off and forms a lysosome

3) **Compare the design and function of these types of RNA:**
   - **a.** **Messenger (mRNA):** single stranded nucleic acid that carries a copy of the genetic code for a single gene out of the nucleus and into the cytoplasm where it is used to produce proteins
   - **b.** **Transfer (tRNA):** ferries the appropriate corresponding amino acids to the ribosome, and attaches each new amino acid to the last, building the polypeptide chain one by one
     - **i.** Transfers specific amino acids from the cytoplasm to a growing polypeptide
     - **ii.** within the nucleus
   - **c.** **And RNA in a ribosome (rRNA):** a type of RNA that, together with proteins, composes the structure of the ribosome
     - **i.** Positions so that everyone goes in order
   - **d.** **How many nitrogen bases from one codon. Each codon identifies one type of amino acid. How can codons identify 20 types of amino acids?**
     - **i.** Codon: three base sequence of MRNA
       1. Three nucleotides
     - **ii.** Triplets: minimum required to give an individual sequence of info
       1. Also gives redundancy
       2. Matches one codon
     - **iii.** Codon: on messenger RNA
       1. Matches amino acid

4) **The primary structure of a protein is defined by the sequence of amino acids. After translation, some proteins orient properly into their final secondary and tertiary shapes. Where are these proteins found?**
   - **a.** In the cytoplasm

5) **Some proteins are packaged and folded as they travel through which 2 organelles? What are the final destinations of the proteins processed by these organelles? What happens if a protein is folded incorrectly? Can it**

v. Ca initiates contraction, *sustained by ATP*
vi. As long as CA remains in the sarcoplasm to keep the actin-binding sites unshielded, and as long as ATP is available, muscle will continue to shorten
vii. Stops when:
1. Signaling from the motor neuron ends, repolarizes and closes voltage gated calcium channels
2. Ca ions pumped back into the SR
3. Also run out of ATP and becomes fatigued
viii. Myosin heads pull on the actin filaments
1. Power stroke: myosin pulls actin
2. *ATP: supplies the energy for muscle contraction, active-transport Ca pumps in the SR*

b. Myosin heads hydrolyze ATP and become reoriented and energized
c. Myosin heads bind to actin, forming cross bridges
d. Myosin cross bridges rotate towards center of the sarcomere
e. As myosin heads bind ATP, the cross bridges detach from actin

Lecture 13

1) Compare these aspects of Type I red and Type IIB white muscle fibers:
a. Color
i. Red: much darker (more myoglobin → more oxygen)
ii. White: less myoglobin
b. Diameter (number of myofibrils)
i. Red: smaller diameter
1. Aerobic → much longer duration (high endurance)
2. Better at biking, marathons, etc.
3. EVERYTHING uses red fibers
4. While white gets smaller with age, red has continual maintenance
ii. White: bigger diameter → stronger per single electrical event but fatigue much quicker
1. Anaerobic
2. Sprinters!!
3. But add them together to do high intensity work
4. Body building, wrestling, etc.
c. Glycogen and fat storage
i. Red: more fatty acids
ii. White: more glycogen
d. Blood supply (number of capillaries)
i. Red: more capillaries, more mitochondria
1. Aerobic exercise can increase the capillaries around red myofibers
a. More mitochondria and myoglobin
2. Weight training → white fibers
ii. White: less

2) Compare the fatigue resistance, relative strength, anaerobic or aerobic ATP metabolism of Type I and Type IIB fibers. How may a high percent of red of white fibers affect your athletic skills?
a. See above

3) Define a motor unit. Why does each motor unit have an all-or-non response? Describe the major differences between asynchronous and synchronous motor unit recruitment. Describe how motor units are recruited, in relationship to motor unit size
a. Motor unit: single motor neuron innervating a group of muscle fibers
b. Synchronous recruitment: working in motor units
i. One motor neuron (one controller) controls a group of similar cells
1. Either all red or all white
ii. "stair" : a different signal will kick in each motor unit, but the previous ones will keep firing
1. Depends on how much energy you need
2. Red first (small), then white
3. Summed up based on size
iii. Doesn't become synchronous until you have a lot working together
iv. Asynchronous: not a bigger effort, same effort over longer period of time (work shifts)

iii. Leads to acidosis
iv. Exercise level high: big oxygen debt
1. As in peak work (sprinting)
v. Recovery in minutes
vi. A lot of aerobic exercise: reduces oxygen debt because you can do more work before lactic acid begins building up
vii. Building up of lactate and having to recreate glucose: costs energy

c. Fatigue in anaerobic working: buildup of lactic acid
d. Fatigue in long aerobic workout: depletion of glucose

Lecture 14

1) **Describe the parts of the CNS and PNS. Compare the terms: nerve and neuron. What type of neurons can be present in a nerve? Why are nerves and neurons surrounded by connective tissues in the PNS?**
   a. CNS: brain and spinal cord
      i. Very protected
      ii. Spinal cord faster than brain → shorter distance, fewer synapses
   b. PNS: nerves
   c. Neuron
      i. Nervous system
      ii. Electrical signals that communication information
      iii. Soma: cell body
   d. Nerve: a bundle of axons in the PNS
      i. Sensory and motor
      ii. NOT interneurons
2) **Describe the structure and function of dendrites, axons, synaptic terminals. Where is the nucleus of a neuron? What are the functions of microtubules in a neuron?**
   a. Cell body: cell's life support center (soma)
      i. Nucleus and most of the major organelles
      ii. CNS: located collection of neuron cell bodies
      iii. PNS: ganglion
   b. Dendrites: receive messages from other cells (extend from the cell body)
      i. High SA / V → lots of branches to pick up signal
      ii. More space for more NT to find a receptor
   c. Axons: passage message away from the cell body to other neurons, muscles, or glands
      i. Axon hillock
      ii. Voltage gated channels happen only after the axon hillock
      iii. Why both synaptic and action?
         1. Synaptic doesn't travel very far: would have to have a lot of really short neurons
         2. Action: does travel far
   d. Myelin sheath: covers the axon and helps speed neural impulses
      i. Node of Ranvier: gaps
   e. Terminal branches: form junctions with other cells
      i. Synaptic terminals: releasing NT
   f. Microtubules: cytoskeleton / moving organelles
3) **Describe these parts of a reflex arc and put them in correct order:**
   a. **Stimulus**
   b. **Receptor:** arrival of stimulus and activation of receptor
   c. **Sensory / afferent**
      i. Generator potentials → starts reflex arc
      ii. Basically same thing as graded
         1. Sensory!!
         2. **All receptors are graded signals**
      iii. **Action potential**
   d. **Interneuron:** only in the CNS
      i. **Synaptic**
   e. **Efferent / motor**

6) **What NT's are used by the parasympathetic and sympathetic divisions at their target organs? Compare the design of nicotinic and muscarinic receptors for acetylcholine. How can NE have a longer lasting effect on a target organ than Ach?**
   - **a.** Sympathetic: uses Ach and releases NE
     - **i.** Ach used only in preganglionic, NE used in target organs
     - **ii.** Ach: nicotinic
     - **iii.** NE: adrenergic
       1. Alpha and beta
       2. Slowest (secondary messengers)
   - **b.** Parasympathetic: Ach (cholinergic system)
     - **i.** Ach: nicotinic (nicotine)
     - **ii.** Ach: muscarinic
     - **iii.** Ach used at target organs
   - **c.** What determines action is specific kind of receptor
   - **d.** Nicotinic
     - **i.** Quickest on and off
     - **ii.** Ligand gated cation channel
     - **iii.** Postsynaptic membrane:
       1. All autonomic ganglia
       2. All neuromuscular junctions
       3. Some CNS pathways
       4. Depolarization → excitation
       5. Ligand gated channels
   - **e.** Muscarinic Ach receptors
     - **i.** G-protein coupled receptor
     - **ii.** Ach is always excitatory
     - **iii.** Binds to nicotinic receptors in both motor divisions
     - **iv.** Slower (secondary messengers)
     - **v.** Produces parasympathetic nerve effects in heart, smooth muscle, and glands
     - **vi.** Hyperpolarized (K channels opened) → inhibition slower heart rate
     - **vii.** Depolarized (K channels closed) → excitation smooth muscle of gut
   - **f.** More from review
     - **i.** Autonomic
       1. **Sympathetic (NE) and Para (Ach)**
       2. Ach or NE: smooth muscle contraction or relaxation
       3. Cardiac muscle: increased or decreased rate and force of contraction
       4. Glands: increased or decreased secretions
       5. Myelinated preganglionic neuron and unmyelinated postganglionic
     - **ii.** Somatic
       1. **Ach**: skeletal muscle contraction
       2. Myelinated
       3. Always excitatory

Lecture 17

1) **Special senses**
   - **a.** Hear, smell, sight, taste
   - **b.** Shorter pathways to the brain
2) **Where are the taste buds located on the tongue papillae? Compare supertasters and non-tasters; who has more taste buds, what are the benefits of each?**
   - **a.** In the pits
   - **b.** Saliva is important to get it there
   - **c.** Microvilli can be replaced
   - **d.** Each taste bud contains all types of cells
   - **e.** Super-tasters
     - **i.** 25 %
     - **ii.** 10 x more taste buds than non-taster
     - **iii.** Very sensitive to bitter, sugar; dislike generally (because they can detect tiny amounts)

i. Bulk flow: high pressure → low pressure
   1. Down a pressure gradient
   2. Not diffusion
   3. Moving things great distances
   4. Compression stocking: pressure highest on the bottom of the foot
   5. Blood vessels: high pressure zone
ii. Overlapping epithelial cells

k. Smooth muscle along the lymph vessel can squeeze and move fluid forward
l. Lymphatic capillaries: vessels where interstitial fluid enters the lymphatic system to become lymph fluid
   i. None in CNS or bone marrow
   ii. One cell layer thick layer of endothelial cells
   iii. Pressure is low: endothelial flaps close to prevent backflow
   iv. Collagen filaments: pull on endothelial cell flaps
m. Also makes it easy for pathogens to get into a lymph vessel
   i. E.g. more permeable than blood capillaries
   ii. Wants pathogens to choose this pathway → better than a blood vessel
   iii. Helps infections stay local → moves much slower
   iv. Lead into a lymph node full of white blood cells
n. Empty into larger lymphatic vessels
o. Summary
   i. Blood → interstitial → lymph
   ii. Towards the heart with one way valves that use bulk flow (high pressure → low pressure)
   iii. Very permeable and slow because you want pathogens in here and kept here
   iv. Go to lymph nodes with WBC's

5) Describe the 2 major functions of the lymphatic circulations. What is the benefit of having slow fluid flow? Define edema and 2 common causes of it. How are tissues damaged?

a. Edema
   i. High blood pressure → excess fluid leaks into interstitial spaces
   ii. Blockage or loss of lymphatic vessels (increased lymphatic pressure)
   iii. Damages tissues
      1. Diffusion: epidermis has no blood vessels
         a. Blood vessels are further away from epithelial cells because of fluid
         b. Waste removal / nutrient delivery is all impeded
      2. Breast cancer surgery → edema in the arm
b. Compression stockings: lower compressing force at the knees than at the feet

6) What are the advantages of having lymph nodes filtering lymph? Describe the afferent and efferent vessels of a lymph node. Why do lymph nodes swell up during an infection?

a. Afferent lymph vessels enter and efferent lymph vessels exit each node
b. Chain reaction → swell up
c. Any bacteria that infects the interstitial fluid are taken up by the lymphatic capillaries and transported to a regional lymph node
   i. Bacteria that enter through a cut in your skin are more likely to get into a lymph capillary due to open 1 way doors
d. Dendritic cells and macrophages within this organ internalize and kill the pathogens (high WBC count)
e. Slow traveling through the pathway: more time to kill something
f. Adaptive immune responses mediated by T and B cells
g. Surrounded by a tough capsule of connective tissue

7) **Where is the thymus located? What are two of its major functions? Graph the size of the thymus from birth to old age. Explain why the thymus is large when we are young. What happens to the disease fighting potential of our T cells as we get old?**

a. Found in the space between the sternum and the aorta of the heart
b. Thymus: Controls early development of T cell lymphocytes
   i. Produces hormone thymosin (metabolic regulator of the T cells)
c. Newborn: very big, while very small in adults
   i. Peak size 10 -12
   ii. Gland gets smaller and fills up with fat
   iii. Because most active in promoting specific immunity at that age

   ii. Antigenic fragments are displayed
g. Adaptive immune response
   i. Specificity
   ii. Antigens: small chemical groups
   iii. Distinguish between self-antigens and foreign antigens

2) **Describe the development of B and T lymphocytes. What stem cell differentiates into lymphocytes? Where does differentiation take place for T and B lymphocytes? Which lymphocytes provide cell-mediated immunity and which provide humoral (antibody-mediated) immunity?**
   a. Lymphocytes: primary cells of adaptive immune response
      i. Large central nucleus surrounded by a thin layer of cytoplasm
   b. Hemocytoblast → lymphoblast's (fetal liver or bone marrow)
      i. Cell mediated immunity T cells (thymus)
      ii. Humoral immunity B cells (red bone marrow or adults)
   c. Both migrate to lymphoid organs
      i. B cells tend to stay put and out of the bloodstream

3) **What phagocytic cells can display an antigen to a T lymphocyte clone to activate that clone? Describe the action of each of these T cells: helper T, killer T, and memory T lymphocytes. How do the chemicals perforin and cytotoxin work? What cells make them?**
   a. T cell receptor binds to peptide on MCH protein, becomes activated
      i. MCH: cluster of genes that encode these antigen-presenting molecules
      ii. Associated of antigen fragments with an MCH molecules: antigen presentation
   b. Activated T cells multiply, differentiate, and enter blood
   c. Multiply into… → continue to do cell division (rare, can keep multiplying)
   d. Cell-mediated
      i. Intracellular antigens expressed on the surface of a cell infected by a virus, bacterium, or parasite → T cell binds to MHC antigen complexes on the surface of the infected cell → a helper T cell produces cytokines that cause the T cell to become a cytotoxic T cell → infected target cell is lysed
   e. Helper T cells
      i. Helper T cell activates B cells and helps T cells do their job (positive)
      ii. Presentation of antigen starts it, but chemicals of helper T cells (interleukin, between WBC's) tells the killers to do more work, B cells to divide
      iii. Secreting cytokines (like macrophages)
      iv. Positive feedback!
      v. Can produce more helper T cells
      vi. Does not target ALL B and T clones
         1. Programmed rearrangement: millions of unique B and T clones
         2. Never want to turn on everything in your body → keep it specific
         3. B cells → humoral immunity (secretion of antibodies by plasma cells)
         4. Killer cells → cell mediated immunity (attack on infected cells)
         5. Why vaccines will only have a couple antigens packaged
   f. Cytotoxic (killer) T cells
      i. Binds to infected cell
      ii. Perforin makes holes in infected cells membrane and enzyme enters
      iii. Promotes apoptosis like NK
      iv. Different weapons! (more powerful)
      v. Disrupt infected cell's metabolism
   g. Memory cell
      i. Forms after exposure to a pathogen and mounts rapid responses upon subsequent exposures
      ii. Live for many years!!!!!
      iii. Only used the second time!
      iv. T only to T

4) **Describe how a particular B lymphocyte clone is selected for activation. Describe the function of plasma B cells and memory B cells during a primary immune response.**
   a. B cells encounter and bind to antigen
   b. B cell c responds to antigen by proliferating (diamond shape → unique)
   c. Some B cells differentiated into long-lived memory cells
      i. Get very large

Helper T		Release **cytokines**, activate B, help T (+)
Killer T		Perforin to drill holes and promote **apoptosis**
Plasma B cells		Secrete antibodies
Antibodies		Gamma globulin proteins. T → Y. Turn on complement system, enhance macrophages and mast cells, inactivate antigen by neutralization and agglutination
Tumor Necrosis Factor	Adipose tissue	Sustained inflammatory signaling
High levels of IGF	Adipose tissue	Insulin resistance, associated with cancer
Hypoxia (low in blood vessels)	Adipose tissue	Leads to angiogenesis: blood vessel growth
Hallmarks		Grow without go, avoid immune destruction
Enabling		Cell immortality / unstoppable growth, tumor-promoting inflammation

Unit 4

Lecture 29

1) **Compare the pathways of blood in the pulmonary vs systemic circuit. Trace the flow of blood from any starting point through these: R atrium, R ventricle, pulmonary artery, lungs, pulmonary vein, L atrium, L ventricle, aorta, systemic tissue, vena cava. Which vessels and heart chambers contains oxygenated blood?**
    - **a.** Four chambers
        - **i.** Left side and right side: one atrium and one ventricle
        - **ii.** Upper chambers: right and left atrium
            1. Smaller
            2. Act as a receiving chamber and contracts to pump into ventricles
        - **iii.** Low chambers: right and left ventricles
            1. Larger
            2. Primary pumping chambers of the heart
            3. Pump into arteries
                - **a. Arteries: vessels that exist the heart**
    - **b.** Pulmonary circuit: blood to and from the lungs, where it picks up oxygen and delivers carbon dioxide for exhalation

i. In order to overcome the high resistance required to pump blood into the long systemic circuit, the left ventricle must generate a great amount of pressure
ii. Major pumping chamber for the systemic circuit: ejects blood into the aorta through the aortic semilunar valve
iii. Right ventricle: pulmonary circuit is much shorter and provides less resistance

3) **Describe the tissue of the heart valves. Where are the semilunar vales and AV vales located? How do differences in blood pressure on either side of a valve cause it to open or close? Which valves are open during ventricular systole? Which valves are open during ventricular diastole?**
   a. Fibrous skeleton blocks atrial cells from contact with ventricular cells
      i. *Fibrous skeleton* holds hearts valves in place
      ii. We do not want atrial to ventricular connection
      iii. Structural support: collagen
   b. Heart valves: thin, flexible, smooth
      i. Have smooth surfaces
      ii. Strings: hold the valve closed
      iii. *Made of collagen*
      iv. *Smooth endothelium*
      v. During ventricular contraction, these papillary muscles also contract, preventing backflow into the atria
      vi. Valve: specialized structure that ensures one-way flow of blood
         1. AV valves: valves between the atria and ventricles
            a. Right AV valve: right atrium and right ventricle
            b. Left AV valve: left atrium and left ventricle
         2. Semilunar valves: valves that lead to the pulmonary trunk and aorta
            a. Pulmonary (right) semilunar valve: emerging from the right ventricle
               i. No muscles / cords
            b. Aortic semilunar valve: base of the aorta
               i. Prevents backflow from the aorta
   c. Ventricular diastole
      i. AV vales open
      ii. Semilunar valves closed
   d. Ventricular systole
      i. AV valves closed
         1. Due to backflow
      ii. Semilunar valves open

4) **Compare cardiac vs skeletal muscle cells: cell length, cell branching, number of nuclei, amount of myoglobin, amount of mitochondria, size of SR, presence of intercalated discs and gap junctions. Are cardiac muscle cells red or white fibers in design?**
   a. Auto rhythmicity: ability to initiate an electrical potential at a fixed rate that spreads rapidly from cell to cell to trigger the contractile mechanism
   b. Twitch type contractions: long refractory periods followed by brief relaxation periods
   c. *Aerobic*: blood delivery, capillary beds, myoglobin (huge amounts of O_2 storage)
   d. Every skeletal muscle is sheathed with collagen to stop spread of signal: not needed here
   e. Aerobic: can become more aerobic with exercise: grow capillaries, strengthening heart and improving blood flow
   f. Heart contains rich supply of elastic fibers
   g. *Cells: short and branched*
   h. *Intercalated discs: high SA*
      i. Very tight grip
      ii. More gap junctions per contact: folding
      iii. Special tight junctions
      iv. Helps support the synchronized contraction of the muscle
      v. Tremendous force of stretch: tight junctions holds them together
   i. *SR: small*
      i. Much smaller than skeletal muscle
         1. Shorter with small diameters
      ii. Store and release calcium, pump calcium back in
         1. *Less calcium* → slower onset of contraction

ii. Pressure rises in the atria and blood is pumped into the ventricles through the open AV valves
iii. AV valves are pushed open when the BP in the atria is greater than BP in the ventricles
iv. Weak, small event with the smallest effect (atrial contraction: weak)
v. Semilunar valves are closed

f. Ventricular systoles: pumping, contraction (and atrial diastole)
i. Follow depolarization of the ventricles
ii. Pressure is greater than atria (now in diastole) → backflow closes the AV valves
iii. Pressure rises in ventricles → blood into pulmonary trunk and aorta
iv. Pressure higher in the ventricle
v. Ventricles contract to eject blood into the pulmonary trunk and aorta
vi. *Ventricle pressure > atrial pressure*
vii. *Ventricle pressure > arterial pressure*
viii. *High blood pressure: heart is working way hard too pump stuff out*
ix. *In other words, when BP in the ventricles is greater than BP in the atria, the AV valves will began to close*
x. AV valves closed
1. Due to backflow → pushing to close AV and open semilunar
2. When pressure in the ventricles is greater than pressure in the atria
xi. Semilunar valves open

g. Atrial and ventricular diastole
i. Repolarization
ii. Long: (*slow heart rate)* plenty of fill time
iii. In exercise: improved venous return
iv. AV open as blood flows from atria into ventricles
v. Semilunar valves closed to prevent backflow into the heart
vi. *Heart murmurs: valves are not closing properly*

h. Timing
i. Atrial systole: short
ii. Ventricular systole: long
iii. Both in diastole: long
iv. Ventricles: stronger than atria
v. Left is much stronger
vi. Aria: thin and weaker

i. Systole: contraction, pushing blood out
j. Diastole: relaxed, filling with blood

2) Describe the 2 differences between conduction cells and normal cardiac muscle cells

a. Contractile cells: 99 %
b. Conductingcells:1 %
i. Generally much smaller
ii. Larger diameter cells → faster electrical signal
iii. Myofibrils absent
iv. Lost their contractile ability and only go through electrical signaling
c. SA node
d. AV node
e. Purkinje fibers

3) Know the pathway: SA node → atrial muscle → AV node → AV bundle → Purkinje fibers → ventricular muscle. Why is the SA node the primary pacemaker? What does that AV node do if the SA node is damaged? What is the benefit of the long delay of the electrical signal at the SA node?

a. SA: automatic depolarization
i. Beating without neural input
ii. SA node generates 70 -80 per minute, atria contracts
iii. *Fastest*
iv. *Located in the RA*

b. →50 milliseconds
c. AV node
i. The impulse pauses at the AV node so ventricles have time to fill
ii. Due to smaller diameter

		Expiration: out down pressure gradient
Vital capacity = TV + ERV + IRV	ERV = amount you can forcefully exhale IRV = deep inhalation TV= volume of air expired or inspired in a single breath	
Total lung capacity = TV + ERV + IRV + RV	RV = residual volume, air left in the lungs after you exhale as much as possible	Will never be exhaled
RMV = RR x TV	RMV = respiratory minute volume RR = respiration rate TV = tidal volume	Same as cardiac output Deep breath: more fresh air, less CO2

	Artery	Arteriole	Capillary	Venule	Vein
Inside diameter	Big	Smaller	Smallest	Bigger	Big
Smooth muscle (sympathetic only in blood vessels, airway both)	Yes	A little	None	Some	Some
Elastic fibers	Yes	Barely	No	No	No
Endothelium	Yes (thin)	Yes	Yes	Yes	Yes

Final Unit

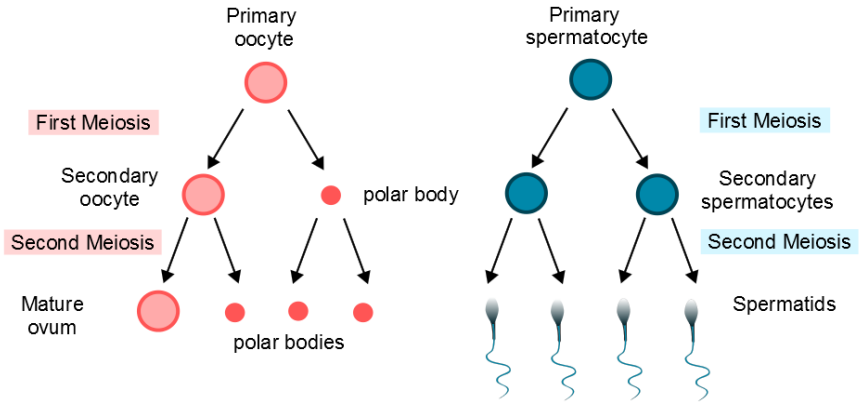
Lecture 37

1) **Where are your kidneys? What keeps the kidneys in place and helps protect them from mechanical injury? Why are the kidneys of starving individuals at risk of moving lower in the visceral cavity? List the parts of the urinary system in order.**
    a. Behind the rib cage
    b. Retroperitoneal: behind abdominal cavity membranes
    c. Fat around them as a cushion
    d. Nothing holding them in place except wall and fat: would drop if you lose all fat
        i. Kidneys still work
        ii. Ureter: if it kinks, cut off urine flow out of the kidney
        iii. That will shut down the kidney
            1. Fill up with urine
    e. Bladder
2) **List 5 major functions of the kidneys. Compare the 3 types of nitrogenous waste (ammonia, urea and uric acid) for: size toxicity and water solubility**
    a. Removing toxic nitrogenous wastes
    b. Regulate blood pressures and water balance
    c. Regulate plasma pH
    d. Regulate numerous minerals, Na, K, CA
    e. Produced EPO and TPO to regulate blood cell production
    f. Wastes
        i. Ammonia
            1. Water soluble
            2. Protein catabolism
            3. Most toxic
            4. Smallest
        ii. Urea
            1. Water soluble
            2. Made in liver
            3. Most common
        iii. Uric acid
            1. Largest, not water soluble

1. Yellow body
2. After ovulation

vii. Start of window: more than one egg allowed to develop
viii. Menstruation

3) **What is PCOS?**
   a. Most common endocrine disorder in women
   b. Strong genetic component
   c. Ovary produces excess androgens → facial hair, acne
   d. Ovulation fails, cysts form in ovary → infertility
   e. No cure
4) **How does PCOS affect the health of young women?**
   a. Young age
      i. Menstrual disorders
      ii. Hirsutism
      iii. Contraception
      iv. Sexual health
      v. Infertility
   b. Older age
      i. Pregnancy complications
      ii. Quality of life
      iii. Type 2 diabetes
      iv. Cardiovascular disease
      v. Cancer risk
5) **Compare meiosis of egg and sperm**
   a. 2 cell division: four tiny cells for sperm (four spermatids → four sperm cells)
      i. Creates four equally sized haploid cells
   b. Homologs pair and cross-over occurs
      i. Synapsis
      ii. Haploid: 23 chromosomes
      iii. Diploid: 46 chromosomes
   c. Females: uneven distribution of cytoplasm
      i. **Creating polar bodies:** Got enough cytoplasm, a little bit of DNA
      ii. One egg instead of multiple (big egg): higher probability of survival
         1. Egg has to get from fallopian tube to uterus
         2. All organelles come from this
      iii. Meiotic spindle: protein pulls apart chromosomes
         1. Centrosomes: produced microfilaments, made of microtubules



   d.
6) **How does age affect a women's fertility?**
   a. eggs: formed before you were born
      i. millions
      ii. begin to die off or disappear rapidly before birth
   b. successful metabolic activity of eggs: reduced

2. Positive feedback → more prostaglandins and oxytocin
3. Bigger contractions → more babies head pushes on cervix
4. Uterine contractions are the positive feedback!

v. Relaxin: softens the cervix
vi. Helps the baby be born faster

9) Compare milk production vs milk ejection pathways

a. Stimulation of mechanoreceptors in nipples by suckling infant sends afferent impulses to the hypothalamus
   i. Hypothalamus release prolactin releasing factors to portal circulation
      1. Anterior pituitary secrets prolactin to blood
      2. Prolactin targets glands of breasts
      3. Increased milk production
      4. Really kicks in when the breast is empty
   ii. Hypothalamus sends efferent impulses to the posterior pituitary where oxytocin is stored
      1. Oxytocin is released from the posterior pituitary and stimulated myoepithelial cells of breasts to contract
      2. Kicks in during actual nursing
      3. Let down reflect
         a. Milk is ejected through ducts of nipples

10) Benefits of breast feeding

a. Short term
   i. Immunoglobulins: antibodies
   ii. ***Colostrum:*** first few days
      1. Lactose, lipids, protein, immunoglobulin
   iii. Benefits to mom
      1. Lower risk of breast cancer
      2. Bonding

Lecture 45

1) Explain the pathology of the bacteria, chlamydia

a. Infection can lack symptoms → undetected
b. Trigger endocytosis, feed on cytoplasm
c. Evade lysosome defense: cells coated with lipids from host organelles
d. Invade new cell → apoptosis
e. Fibroblast → scar tissue
f. Intracellular: hard to treat
g. 15-24 year old females: highest infection rate
h. Pelvic inflammatory disease
   i. Can lose fertility: damage to uterus, might have to remove reproductive system

2) Why is incidence increasing

a. Most common bacterial STI in the world
b. Decline, now growing again
   i. Everybody used condoms because of risk of HIV
   ii. Use of birth control pill by teenagers has been stable, while use of condoms has increased
c. 12 – 20, male, most likely to have an STI

3) How does chlamydia infection vary with socioeconomics?

a. Education
b. Employment
c. Income (parents)
d. Area deprivation

4) HPV

a. Usually clears itself before you know you had it
b. Genital warts
c. Infects epithelial cells
d. HPV integrates into cell DNA
e. Turns on oncogenes
f. Can cause cancer long term

Vas Deferens		Smooth muscle → thick wall gives propulsive force
Glands	Bulbourethral	Mucus: lubrication, neutralize vaginal acids
Vestibular Glands		Secrete lubrication for females
PCOS	Most common endocrine disorder	Ovary produces excess androgen → infertility
Meiotic Spindle	Pulls apart chromosomes	Made of centrosomes → made of microtubules
Fallopian Tubes	Cilla move egg Microvilli provide nutrients	Chemosensors to catch egg WHERE FERTILIZAITON HAPPENS
Cervix		Keeps embryo in
Endometrium	Smooth muscle in uterus (in addition to myometrium) Changes in monthly cycle	Stratum functionalis: comes off during menstruation / maintained by estrogen / progesterone Stratum basalis
Endometriosis		Tissue outside the uterus → decreased fertility
Trophoblast		Attaches and eats the uterine endometrium → nutrients to inner cell mass / embryo / protection against immune system / makes placenta
Ectopic pregnancy	Most common cause of maternal morality	Egg is fertilized and stuck somewhere besides the uterus (fallopian tubes)
Chlamydia	Bacteria Intracellular	Feeds on cytoplasm → evades lysosome → apoptosis
Pelvic Inflammatory Disease		Damage to uterus → can lose fertility
HPV	Virus	Genital warts → integrates into cell DNA → can cause cancer long term