BIO 2320 Human Anatomy and Physiology II
Dr. Jeff Simpson, DC, CCSP

LABORATORY OBJECTIVES

Required Text: Human Anatomy and Physiology Laboratory Manual, Current Ed. Elaine N. Marieb, R.N., Ph. D.

BIO 2310 Dissection Kit. Available in the bookstore; includes a scalpel, a blunt probe, dissection scissors and forceps. Also required are disposable latex or nitrile gloves, a lab coat or an old shirt to protect your street clothes and protective eyewear.

Upon completion of lab exercises, you should complete the corresponding review sheets located in the back of your lab manual. Although you will not be required to hand in these exercises, they will help to emphasize key concepts and are a valuable tool in preparing for lab exams.

WEEK 1 Language of Anatomy and Endocrine Physiology

Exercise 1: Use your own body and the human torso models to complete this exercise.

Exercise 27:

a) Obtain a cat and open the ventral body cavity as described in Dissection Ex. 3 near the back of the book, or by your instructor.

b) Observe all endocrine glands illustrated in Ex. 27.

c) Observe the pituitary gland on a sheep brain. See Ex. 19.

d) Observe the pineal gland on a sheep specimen. See Ex. 19.

e) Put your cat away as described in class by your instructor, and clean your work area thoroughly.

f) Observe the microscopic anatomy of the thyroid gland, pancreas, adrenal gland ovary and testis as described in Ex. 27.

WEEK 2 BLOOD

Exercise 29:

a) Observe the color and clarity of plasma after you conduct the hematocrit test (to be done later in this lab).

b) Observe the formed elements of the provided blood sample by making a smear and staining the slide as described in your lab manual in Activity 2.

c) Use your prepared slide to make a differential White Blood Cell Count as described in Activity 3.

d) Conduct a total White Blood Cell Count as described in Activity 2.

e) Conduct a Hematocrit as described in Activity 4, using the microhematocrit reader card. Then, observe the color and clarity of the plasma and record observations in your lab manual.

f) Determine the approximate hemoglobin concentration of the blood sample using the Tallquist Method as described by your instructor.

g) Obtain an unknown blood sample and conduct the blood typing experiment to determine its ABO typing described in Activity 8.

h) Read through all of the omitted sections of this lab.

WEEK 3 ANATOMY OF THE HEART

Exercise 30:

a) Observe the sheep heart as described in Ex. 30. You are responsible for the following structures: Mediastinum, pericardial sac, pericardial cavity, and parietal pericardium are best observed on your cat.

Visceral pericardium (epicardium), myocardium, endocardium, coronary blood vessels, left and right atria, left and right ventricles, auricles, pulmonary trunk, aorta, ligamentum arteriosum, aortic semilunar valve, pulmonary veins, superior and inferior vena cava, right atrioventricular valve (tricuspid), pulmonary semilunar valve, interventricular septum, coronary sinus, papillary muscles, chordae tendinae, and left atrioventricular valve (bicuspid), are best observed on the sheep heart.

b) Observe the microscopic anatomy of cardiac muscle as described in the lab manual in Ex. 30.

WEEK 4 EXAM

WEEK 5-6 BLOOD VESSELS

Exercise 32:

a) Complete at least the arteries of the cat for the first lab. Complete the veins for the second lab.

Dissection Ex. 4

b) Dissect your cat as described in Dissection Ex. 4. You are responsible for the following blood vessels:

Coronary arteries, aorta, pulmonary trunk/arteries, right brachiocephalic artery, left subclavian artery, right subclavian artery, common carotid arteries, lingual arteries, external carotid arteries, vertebral arteries, costocervical trunk, thyrocervical trunk, internal mammary artery, axillary arteries, subscapular arteries, brachial arteries, radial arteries, ulnar arteries,.

Descending aorta, celiac trunk, left gastric artery, hepatic artery, splenic artery, superior mesenteric artery, adrenolumbar artery, renal arteries, testicular or ovarian arteries, inferior mesenteric artery, iliolumbar artery, external iliac arteries, internal iliac arteries, femoral artery, saphenous artery, popliteal arteries, sural arteries, posterior tibial artery, anterior tibial arteries.

Superior vena cava (precava), inferior vena cava (postcava), pulmonary veins, azygos vein, internal mammary (thoracic) veins, vertebral veins, brachiocephalic veins, external jugular veins, subclavian veins, axillary veins, subscapular veins brachial veins, cephalic veins, hepatic veins, adrenolumbar veins, renal veins, testicular or ovarian veins, iliolumbar veins, common iliac veins internal iliac veins, external iliac veins, deep femoral veins, femora vein, great saphenous vein, popliteal vein, hepatic portal vein, superior mesenteric vein, inferior mesenteric vein.

Basilar artery, circle of Willis (see sheep brain and Ex. 32).

WEEK 7 CARDIOVASCULAR PHYSIOLOGY

Exercise 33: Complete all sections of this lab except Act. 3

WEEK 8 EXAM

WEEK 9 ANATOMY OF THE RESPIRATORY AND DIGESTIVE SYSTEMS

Exercise 36: Examine a microscopic section of lung tissue as described in Ex. 36.

Dissect you cat as described in Dissection Ex. 6. You are responsible for: External nares, oral cavity, oropharynx (oral pharynx), trachea, larynx, thyroid cartilage, cricoid cartilage, epiglottis, hyoid bone, vagus nerve, primary bronchi, pleural cavities, parietal pleura, visceral pleura, diaphragm, phrenic nerve, lungs.

Exercise 38: Dissect your cat as described in Dissection Ex. 7. You are responsible for: Parotid salivary gland, submandibular salivary gland, sublingual salivary gland, teeth, hard palate, soft palate, palatine tonsils, tongue papillae, lingual frenulum, esophagus, parietal peritoneum, liver, greater omentum, gallbladder, falciform ligament, stomach (cardia, fundus, body, pylorus), greater and lesser curvature of the stomach, lesser omentum, pancreas, spleen, common bile duct, small intestine

(duodenum, jejunum, ileum), mesentery, cecum, colon (ascending, transverse, descending), mesocolon, rectum, anus, and visceral peritoneum.

Observe the microscopic sections of the small intestines, stomach, liver, colon and taste buds as described in Activities 2 and 3, and in the Histology Atlas in Review Sheet Exercise 46.

WEEK 10 RESPIRATORY PHYSIOLOGY

Exercise 37A:

a) Determine respiratory volumes and capacities (Respiratory Rate, TV, MRV,ERV, VC, IRV) as described under Activity 2, Procedure A, using a spirometer.

b) Complete # 3-9 under "Pneumograph" section by describing rate, depth, and rhythm of respiration rather than using the pneumograph.

c) Listen to respiratory sounds using a stethoscope as described.

d) Read through the sections on acid-base balance and ciliary action.

WEEK 11 ANATOMY OF THE URINARY AND REPRODUCTIVE SYSTEMS

Exercise 40:

a) Observe a nephron on a microscopic kidney section.

b) Observe the following structures on the cat kidney: renal capsule, cortex, medulla, medullary pyramids, and renal pelvis.

c) Dissect your cat as described in Dissection Ex. 8. You are responsible for: kidneys, hilus, ureter, urinary bladder, and urethra.

Exercise 42:

a) You are responsible for the anatomy of both male and female cats. Dissect as described in Dissection Ex. 9, and know the following: penis, scrotum, testes, spermatic cord, ductus deferens, inguinal canal, prostate gland.

Uterus (uterine body and two horns), broad ligament, round ligament, uterine tube (fallopian tube), ovary, ovarian ligament, vagina, cervix, and vulva.

b) Observe the microscopic anatomy of the ovary and the testes as described in the histology atlas in the Review Sheet Ex. 46 near the back of the book.

WEEK 12 URINALYSIS

Exercise 41A:

a) Complete as much of the table in Ex. 41 as possible using information derived from observation, reagent strips and the refractometer. Perform these tests on your own urine specimen, and interpret the results.

b) Complete the sedimentation analysis as described.

WEEK 13 REPRODUCTIVE PHYSIOLOGY

Exercises 42, 43 & 44: Read these exercises. A film on reproduction will be viewed during your laboratory period.

WEEK 14 EXAM

BIO 2320 Anatomy and Physiology II

General Definitions

Anatomy-

Gross Anatomy-

Microscopic Anatomy-

Physiology-

The Six Levels of Structural Organization of the Body

1) Atomic level-

2) Molecular Level-

3) Cell Level-

4) Tissue Level-

5) Organ Level-

5) Organ System Level-

7) Organism Level-

Anatomical References

1) Anatomical Position
   Person standing facing forwards; head looking straight; feet facing straight; palms facing forwards

   Purpose- Standard reference/ Common Starting point to locate body parts in relationship to each other
   Refer to subject's right and left not yours
   If you don't have a picture you can use text to describe the same thing

2) Directional Terms
   Based on the human anatomical position

Medial- Towards the midline of the body
The heart is located medially, toward the lungs

Lateral- Away from the midline of the body

Shoulder is lateral to the sternum

Proximal- Located closer to the attached base
Shoulder located proximal to the elbow

Distal- Located away from the attached base
The wrist is located distal to the

Anterior/ (Ventral)- Toward the front of the body
Ventral- (Belly), Toward the belly
The navel is anterior/ ventrally located toward the spine

Posterior /(Dorsal)- Toward the back of the body
Dorsal: (Back), Toward the back
The spine is posterior/dorsal to the breastbone

Superior- Towards the top of body
Cephalic: (head), Toward the head

Inferior-Towards the bottom of the body/ feet
Caudal: (tail), Toward the tail

External (superficial)- -Located toward the surface of the body

Internal Located toward the inside of the body

Deep- Away from the surface (internal)

Cephalad- Toward the head

Caudal- Toward the tail

Palmar- refer to the palm of the hand

Plantar- refer to the bottom of the feet

Dorsum of the foot: Top of the foot

Sides of the Body

A) Ipsilateral- Same; Located on the same side of the body

B) Contralateral- Against/ Opposite; Located on the opposite side of the body

C) Bilateral- Located on the both side of the body

Planes or Sections of the Body

A) Sagittal-
Mid- Sagittal:
Para- Sagittal:

B) Frontal-

C) Transverse-

Body Cavities

I. Dorsal Body Cavity
Arises from the back surface of the body

A) Cranial- House the
B) Vertebral/ Spinal- Housing

II. Ventral Body Cavity AKA *Coelomic cavity*
The diaphragm divides the Ventral Body Cavity into Thoracic and Abdominopelvic Cavities

A) Thoracic Cavity
1) Pleural: 2 pleural cavities:
2) Mediastinum:

3) Divide the Thoracic cage into right and left halves

What's found in the mediastinum:

B) Abdominopelvic Cavity-
Below the diaphragm
1) Abdominal Cavity-

2) Pelvic Cavity-

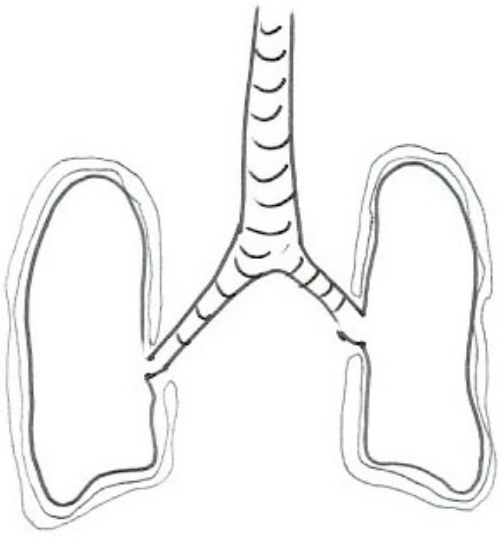
Linings of the Ventral Body Cavities

Each cavity has a double layer sac that holds the viscera in place while preventing _____between the internal organs as they move; these are called serous membranes that attach to the body cavity walls and the organs, each membrane is a mesothelial layer supported by connective tissue.

A) **Pleura**: The lung is surrounded by this thin membrane

The main function is to

friction → heat =



1. Parietal- The outer layer comes in contact with the inside of the thoracic cavity
2. Visceral- The inner layer that touches/ comes in contact with the (lungs) organs tissues
3. Pleural Cavity: The fluid is found within the two layers of the Pleural Cavity. Thin film of fluid in between; very tiny space

The two layers are always in contact with each other; they can be pull part but it makes the lungs inefficient (potential space)

Pleuritis-

Pleural Effusion-

B) **Pericardium**:

Similar to the pleural linings

There layers to the heart:

- *Epicardium (Outer Layer) AKA Visceral Pericardium*
- Myocardium (Muscular layer)
- Endocardium (Inner Layer)

1. Visceral- Outer layer of the heart; very close to the myocardium,

2. Parietal- Pericardial Space/ Cavity

Outer layer of the sac
Serous membranes that produce fluid in the space

1. Parietal Pericardium
2. Fibrous Layer

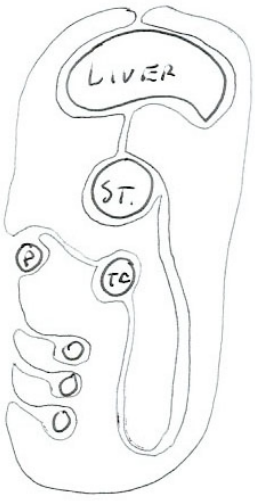
Made of collagen fibers, somewhat restrictive

Pericardial Sac
Due to the fibrous layer, the pericardial sac expand a little, but not much

Cardiac Tamponade:

C) Peritoneum

Serous Lining that covers the visceral of the abdominopevic cavity



1. Visceral-
2. Parietal-

3. Mesentaries-
   - Part of the peritoneum that are drawn forward and that does not come in contact with the abdominal walls and the visceral.
   - Serous peritoneal sheets that suspend the organs in the abdominal cavity.

- Consist of 2 layers of peritoneum fused together, connect the visceral peritoneum of some abdominopelvic organs to the parietal peritoneum on the body wall or to the visceral peritoneum of the abdominopelvic organs
- Functions: Provide supports and provide a pathway for vessel and nerves to supply the visceral/organs

Peritoneal Cavity- Potential space; between the visceral, parietal; mesenteries; serous membrane-lining

Peritonitis-

Peritoneal Effusion-

Ascities-

THE ENDOCRINE SYSTEM

The Overall Function of the Endocrine System: Responsible for homeostatic regulation of the body.

What do we mean by homeostasis?

Negative Feedback Loop- control homeostasis; (example is the thermostats in the room).
A mechanism that opposes variations outside normal limits

Examples:

<u>The Two Main Systems Involved in Maintaining Homeostasis</u>

1) Nervous System

2) Endocrine System

Two Main Types of Glands

1) Exocrine Glands: Ducted glands that release their secretion to a body surface (inner or outer body surface)

2) Endocrine Glands: Ductless glands that release their products to the surrounding space and eventually into the blood stream

Endocrine Glands of the Body

1)
2)
3)
4)
5)
6)
7)
8)
9)

Hormone-Secretions of the endocrine glands made of proteins and/or steroids that travel through the circulation to affect cells in other parts of the body

Hormone Effects-

Target Cells- Specific cells that are sensitive to a hormone's presence; they have receptors to that hormone on their cell surface, cell membrane or within the cell.

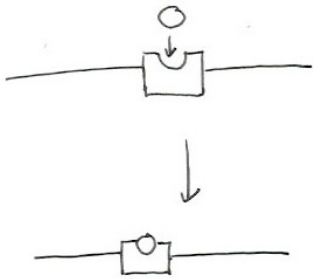
Mechanisms of Hormonal Action (3 Types)

1) Hormones and c-AMP

- Embedded proteins: proteins that are found within the cell membrane
- Peripheral proteins: Proteins that are found _____.

General Pathway-

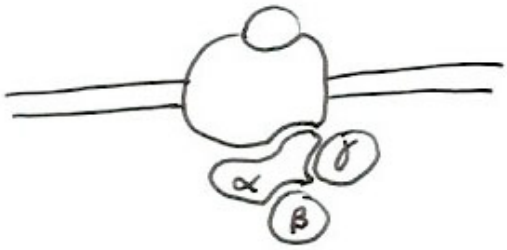
- Adenyl cyclase's (enzyme) job when activated
  Hormone binding causes conformational change in the hormone receptor proteins activate adenyl cyclase



PDE (Phosphodiesterase)- Enzyme that breaks down
You don't want C-AMP to be activate for a long time
Convert:

C-AMP → AMP

2) G Protein [Complex]-



- Hormone binding causes conformational change of receptor proteins leading to the disassociation of the α (alpha) subunit
  - Alpha subunit is sometimes phosphorylated or dephosphorylated; adding or removing phosphate to activate or inactivate pathways
  - Alpha subunits might do a number of things

Overall Functions

1) Release calcium for muscle contractions
2) Open ionopores
3) Activate enzymes → activate adenyl cyclase
4) Activate gene transcription: which cause protein synthesis

Hormones Utilizing this Pathway

The C-AMP pathway was the first to be discovered

a)
b)
c)
d)
e)
f)

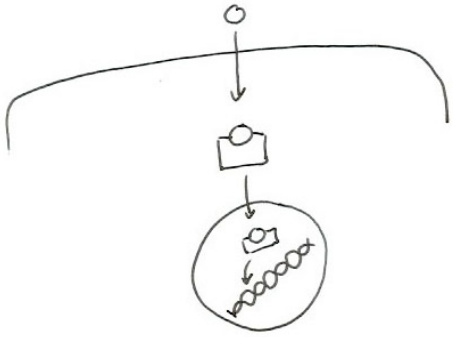
3) Gene Activation

Steroid hormones can pass directly through the cell membrane of the target cell.

Side Notes:

- Steroids arise from cholesterol
- Steroids are lipid soluble but not water soluble
- Cholesterol embeds itself in the cell membrane (make up of 13% of cell membrane). The cholesterol pushes the phospholipid heads apart to allow steroid in.
- Cholesterol assists the movement of steroid molecules through the cell membrane
- Steroid molecules/ hormones [simple] diffuse through cell membrane to bind to intercellular receptors

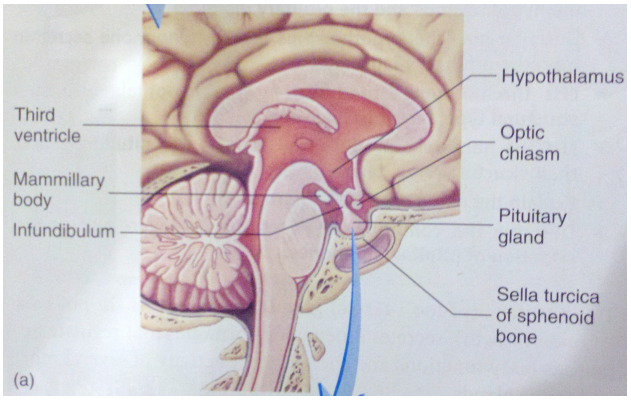
Receptor Protein-Hormone Complex



Glands of the Endocrine System

1) Pituitary Gland (AKA-
Considered the master gland. Pituitary Gland produce a number of hormones that affect the endocrine system

Location- It rests in the sella turcica of the sphenoid bone; inferior to the hypothalamus; Infundibulum is



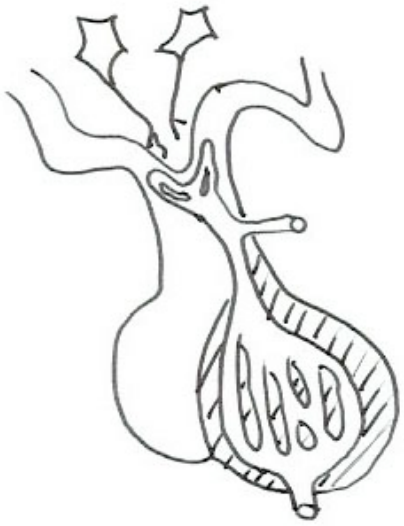
Divided into an Anterior and Posterior Portion (Pituitary Gland)

A) Anterior Pituitary Gland- AKA.

B) Glandular portion of the pituitary gland
Rathke's Pouch-

Hypothalamic-Hypophyseal Portal System

Blood supply- contains a series of blood vessels that connect it to the hypothalamus. The endocrine system, - the hormone is secreted into the blood stream and flows to different parts of the body (superior hypophyseal artery)



Portal Vessel

Portal vein: is a vein that's located between two capillary beds

A blood supply that's carrying oxygen to the tissue. Then the oxygen is diffused out into the tissue, throughout the capillary bed.

3 Cell Types [based on staining]

cells of the anterior pituitary gland

1) Acidophils-

Secrete –
(Cell that picked up that stain)

1) HGH (Human Growth Hormones)
2) Prolactin

2) Basophils-

Secrete/ [produced]–
1) TSH
2) ACTH
3) FSH
4) LH
5) MSH

Side notes: don't think that all basophiles will produce all these hormones. Each specific cell produced their own specific hormones but all the hormones take up the basophil stain.

3) Chromophobes –

Secrete-
1) ACTH

HORMONES OF THE ANTERIOR PITUITARY GLAND

(*7 hormones produced by the Anterior Pituitary Glands)*

1) HGH-AKA

HGH is an anabolic hormone (growth)

- Responsible:
  Cell growth and multiplication by allowing amino acids to enter the cell via cyclic AMP
- Functions-
  1) Tremendous amount of protein synthesis
  2) Increases glycogenolysis- break down of glycogen in glucose, which is used as an energy source, stored in the liver
  3) Lipolysis

Human growth Hormones and Testosterones:

When women takes Testosterone:

HGH - bone length stay the same even when HGH is shut down
Testosterones: Muscle will shrink to the same size it was before taking drugs

Negative Feedback Loop

2) TSH- AKA.
TSH: Thyroid Stimulates Hormones

Function:
To stimulate the production and secretion of thyroid hormones by the thyroid gland.

Control by-

3) ACTH
Function: Stimulates hormones production in the adrenal cortex
Increase blood sugar, called glucocorticoids

Hormones from the hypothalamus called

Major hormone group- corticosteroid => increases blood sugar

If you see and IH or RH it's coming from the hypothalamus

4) FSH

Functions:

Females: stimulates monthly oogenesis or the production of the follicles. Follicles are where the eggs come from. Stimulates oogenesis and follicular development.

Males: Stimulates spermatogenesis

Under the control of the hormones called

Inhibin: produced by the gonads (Ovaries and Testes) to slow down follicular development or spermatogenesis.

5) LH – Luteinizing Hormone

In females: AKA.-

- Involved in initiating the releasing of the egg (Ovulation)
- Help maintaining the corpus luteum

In males: AKA. –

It's called Interstitial Cell Stimulating Hormone b/c of these cells, which are also known as Leydig cells to produces Testosterone, in response to luteinizing hormones.

Under the control of GnRH
Regulated by GnRH- produced by the hypothalamus
Inhibited by increased levels of estrogen, progesterone and androgens

6) PRL- Prolactin

Regulated by:

a) PRH-

b) PIH-

7) MSH -

Regulated by:

a) MRH- Melanocyte Releasing hormones

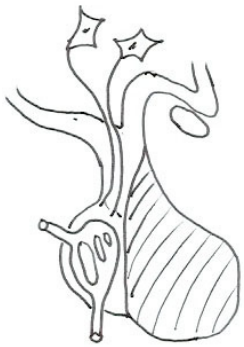
b) MIH- Melanocyte Inhibiting hormones

Posterior Pituitary Gland

AKA.- Neurohypophysis

-The Posterior Pituitary gland is not glandular

It's not hormone secretion, but more like a



Two Cell Types

a) Pituicytes- support cells

Are a type of glial cells

Glial Cells:

b) Axons of neurons located in the hypothalamus.

Functional Properties

1) Neurosecretory cells in the hypothalamus produce hormones.

2) Hormones move down

3) The hormones are stored here and released into the capillaries of the posterior pituitary.

The neuropeptides are release into the

Posterior Pituitary Gland

~ There's only 2 hormones

A) Oxytocin- produced by the paraventricular nuclei of the hypothalamus.
The synthetic version is called:

Functions-

a) Stimulate smooth muscle contractions of the pregnant uterus prior to delivery
b) Stimulate smooth muscle contractions of the

c) In men:
d)

Milk Let-Down Reflex

Oxytocin release and receptor sites (cell of the breast tissue)

a) infant suckles on nipple stimulating the release of oxytocin
b) causes contraction of smooth muscle surrounding the ducts of the glands
c) results in the release of milk within about 20 seconds

d) Causes the milk let-down reflex:

B) Antidiuretic Hormone (ADH)

Functions-

a)

b) If you are already dehydrated it does:
c)

End Result:

a) increase blood pressure, works against urination
   - Retaining fluids, not losing fluid helps to maintain blood pressure
b) Vasopressin: Constriction of the vessel => increased blood pressure

It's the most powerful of all the vasoconstrictors

ADH is produced in response to:

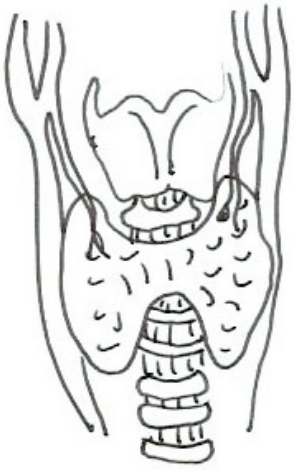
1) A rise in concentration of electrolytes in the blood
   Cells in the body can be hydrated and dehydrated
2) Fall in blood volume or pressure

What will happen if ADH is absent?

C) Endorphins- produced by the pituitary gland in general.
Endorphins are also produced by other areas as well
Naturally occurring peptides isolated in the pituitary gland.

The Thyroid Gland

Located just below the larynx (voice box). Inferior to the cricoid cartilage.



Function:
Regulates

Thyroid Histology

Colloid- a viscous fluid produced by the follicular cells

Colloid contains two major thyroid hormones both of which require iodine.

1. Thyroxin AKA

It's made up of 90% of what travels in the blood stream.
There are 4 iodine molecules associated with it
IT IS THE PRECURSER

2. Triiodothronine

It represents less than 10% of thyroid hormone found in blood, there are other smaller molecules.

The inactive/ precursor is the one that travel in the blood stream and once it reaches the tissue, the tissue removes one of the iodine (but has to be the correct iodine that is removed to become active). The tissue converts T4 to T3.

Thyroid hormone functions (T3 and T4):

They increase metabolism by:

1) Increasing mitochondrial production of ATP
2) Activated genes involves in glycolysis and ATP production

Negative Feedback mechanism:

Regulation of Thyroid Hormone secretion

TRF Hypo Ant Pit TSH Thyroxin TGB Blood

Endemic Goiter-

Goiter due to a deficiency in iodine in the diet
Thyroid gland enlarges
Common in the Midwest where there was low iodine content in the soil.

Negative feedback mechanism

Treatment-give iodine
Cretinism-

Calcitonin

Thyroid gland also produces calcitonin

Produced by:

Calcitonin help maintain the homeostasis of blood calcium level

It [calcium] has to be maintained within a narrow range

Thyroid hormones and calcitonin keep in balance
Calcitonin=>

Functions: lowers blood calcium by:

1) Increase Osteoblastic activity

This occurs in the bones. Osteoblasts and osteoclasts are bone cells

Osteoblasts -job is to make bones. Take calcium from the blood and put it in the bones

2) Decrease Osteoclasts activity

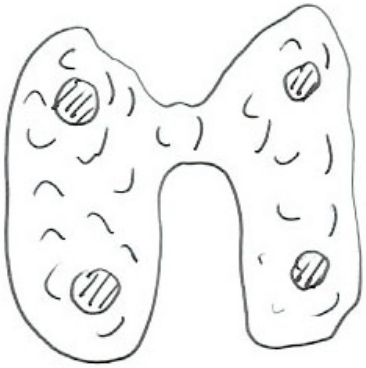
Osteoclasts -job gobble up the bone matrix and release the calcium into the blood stream

Anterior pituitary glands and hypothalamus do not get involved in this process/ pathway.

It's a negative feedback mechanism. However, the receptor is found on the "C" Cells

Parathyroid Glands

Location: 4 small round masses on the posterior surfaces of the thyroid's lateral lobes.



Cell Types

1) Principle or Chief Cells

Produce

Function:

Side Note:
This requires Vitamin D; it a vital player
Vitamin D isn't considered a vitamin (co-factor in an enzymatic pathway) anymore but more as a hormone.

Mechanisms of Action:

a) Decrease Osteoblastic activity
Osteoblasts are precursor. Make boney matrix

b) Increase Osteoclastic activity

c) Retain Ca+ (Calcium) at the kidneys
Why? If blood Ca+ decrease. It decides what to keep, if ca+ needs to be keep, then it is returned back into the body, but if we don't need

Kidney:
Healthy kidney should be able to remove as much calcium as possible. They filter almost everything in the blood. Its job is to separate what we want to keep and what to get rid of.

the Ca+ then it is removed by the urine.

2) Oxyphil Cells – synthesize a reserve level of PTH

Ultimately: these 2 hormones are involved in maintaining the homeostasis of blood calcium.

Calcitonin:

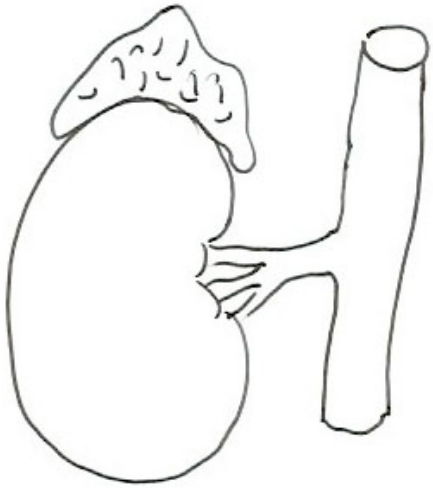
Parathyroid:

Adrenal Glands (Suprarenal Glands)

Location: on top of the Kidneys

A) Adrenal Cortex –

There are 3 layers in the cortex



Subdivisions

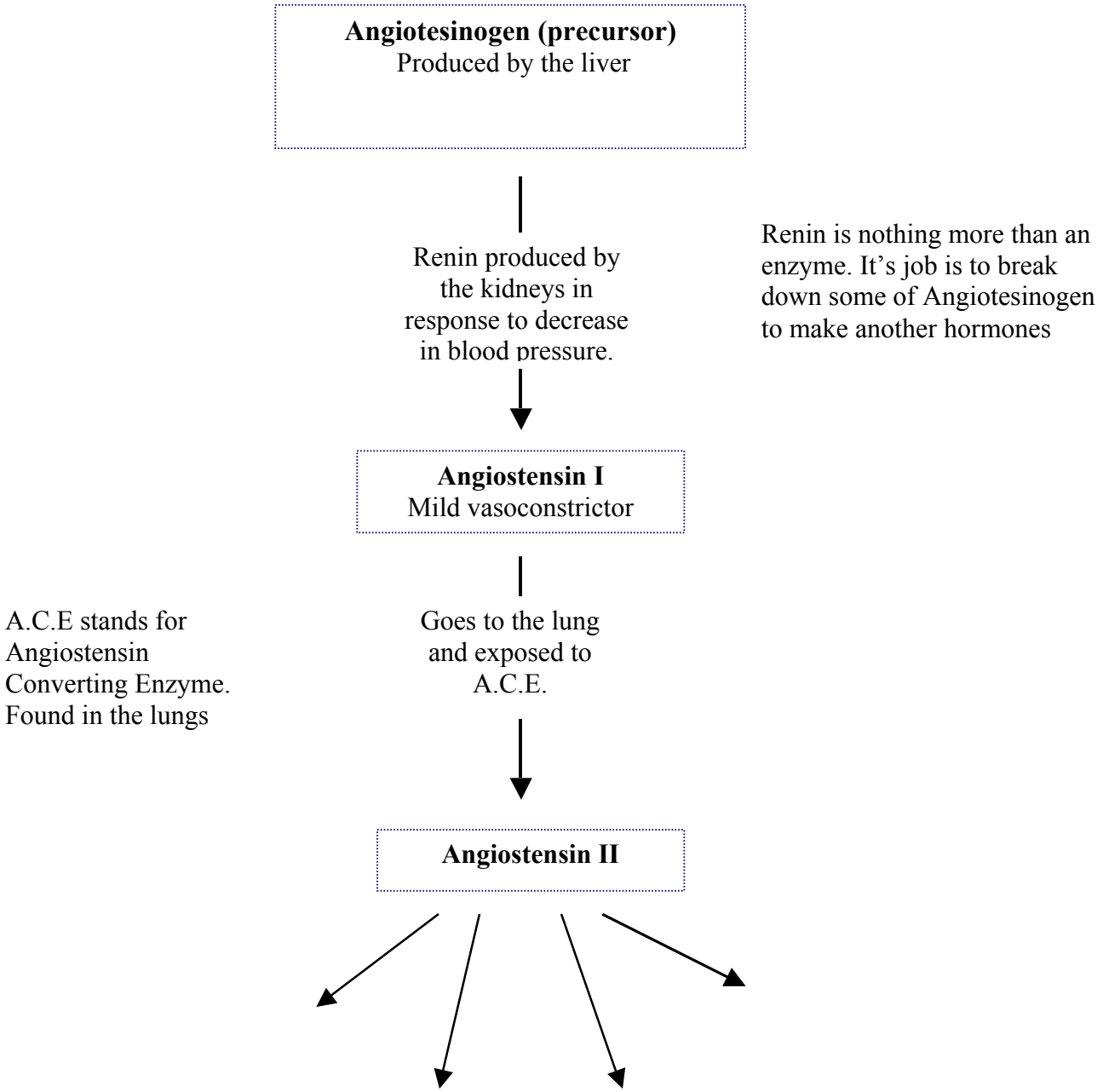
1) Zona glomerulosa –
   Secretes
   1. example: Aldosterone- main mineralocorticoids, steroid hormones that affect electrolyte composition of the bodily fluids

   Specific function:

   General function:
   Maintain blood fluid volume and pressure

   Control of Aldosterone Secretion

The Renin-Angiotensin Pathway



2) Zona Fasciculata -next deepest layer
   (Middle Layer)

   Secretes glucocorticoids

Example: the cortisol (different version of it)

- Cortisol is a steroid because it's derived from cholesterol

- This process occurs in liver when fat and glucose reserves are low.

Main Functions

A. Promotes normal metabolism
   Help promote gluco/neo/genesis

B. Reduces
   Decrease blood vessel diameter, decreases dilation to tissues and decreases edema, it reduces swelling and controls allergic reactions.

There is a trade off

a)

b)

C. Zona Reticularis – deepest layer

Secretes gonadocorticoids

Types of gonadocorticoids

1)
2)

B) Adrenal Medulla – inner region of the adrenal gland

Composed of Chromaffin cells

These cells produce 2 hormones

1)

2)

They are what we call sympathomimetic hormones,

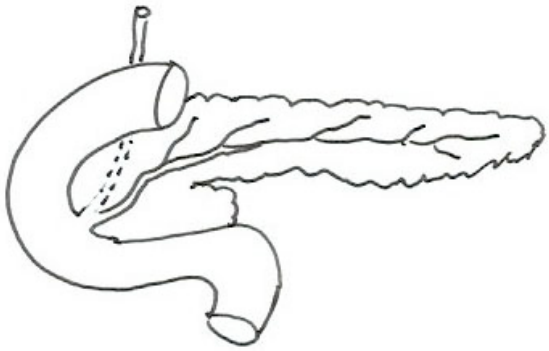
Effects of these hormones

1) Accelerate the breakdown of glycogen into glucose
2) Mobilize fats into the blood stream to be used by the tissue
   Side note: You can see how it works in conjunction to cortisol. High cortisol levels means high level of adrenaline
3) Increase heart rate (H.R.) and force of contraction (F.O.C.)

The Pancreas

Location:

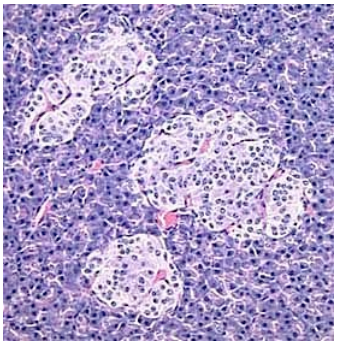
Just below (inferior) to the stomach, with the head residing in the curve of the duodenum



Considered both an endocrine and an exocrine gland

1) Exocrine-

2) Endocrine-



Islets of Langerhans- which are cell clusters with in the pancreas divided into two cell types

1) Alpha Cells

Produce

Function:

Glucagon's job is to increase blood sugar
Example: Let say you're haven't eaten anything for 4-5 hrs; there are small pulses of glucagon to releasing sugar from your liver
into the blood stream to help maintain blood sugar level (3-4 hrs). That's different from eating a meal, because you'll have plenty of sugar in a short amount of time. When you're resting and you haven't eaten, it's the small pulsing of glucagon that help maintain blood sugar level within a narrow range.

Mechanism of Action

Glucagon inhibited by

2) Beta Cells

Make up about

Function:

Accelerate the conversion of glucose back into glycogen. Once it is back into the cell, it'll be stored as glycogen in the cells.

Insulin Facts:

If you don't produce enough insulin, the blood sugar elevates dramatically => diabetics.

Insulin also send/ shuttle amino acids into the cell

So the amino acid can be used as building block for proteins

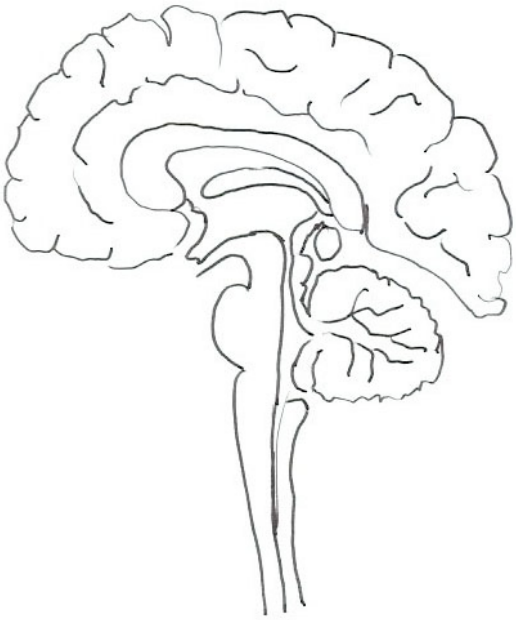
Insulin and glucagon are involved in maintaining blood sugar homeostasis.

Discuss diabetes ***A1c***

Pineal Gland

A pea-sized and shaped (cone shaped) gland located
at the posterior junction of the fornix and the corpus callosum.

Located in the Brain



Pinealocyte – the main cell type

Function – synthesizes: Melatonin

- Help maintain sleep (sleep aid)

- Plays an important role in regulating the sexual endocrine glands and internal biological clocks. (Sexual hormone regulatory cycle)

- Regulation of the Ovarian Cycle (Menstrual Cycle)

  An increase in melatonin causes

  Control of melatonin production: is dependent on the light that enters the eyes

  1) During daylight hours:

  2) During the night

It is believed to control our

Thymus Gland

Location-

Large in infants and progressively gets smaller as we age. It size decrease as we age
It's large initially because when we're first born/ little we are exposed to 1000s of different new antigens. But as we get older, we are exposed to very few newer antigens, so our immune system is pretty much developed. So now, we only get expose to a few antigens therefore we don't need a large thymus. The fats replace the area where the thymus is located.

Produces: Thymosin

The cell of the thymus are called thymocytes

Function:
Involved in the maturation of lymphocytes
It's part of our autoimmune process

Heart

Produces: ANH- Atrial Natriuretic Hormone/ Peptide
Extraction/ eliminate sodium from the body through urine.
Natriuretic: Increase urine production
Secreted by

Secretion occurs when:

Function: (basic inhibits the 4 mechanism that retain fluids)

1) Inhibits the thirst drive

2) Suppresses AHD and aldosterone's function/ production

3) Increase the loss of sodium and water through the kidney

End result:

Prostaglandins

Local tissue hormones that function to alter activities of adjacent cells.

Almost all cells in the body produce them

Mechanism of Action:

They work via Cyclic AMP on smooth muscle contractions, platelet stickiness/ adhesion, and glandular secretion

The Liver

Produce:

IGF'S (Insulin-Like Growth Factors)

They are the pawns for human growth hormone

AKA

Somatomedians

Function:

A peptide synthesized in the liver, capable of stimulating certain anabolic processes in bone and cartilage, and whose secretion and biological activity are dependent on somatotropin

The Cardiovascular System

General Components

1)
2)
3)

General Functions

1) Carry oxygen and nutrients to the tissues from the blood
2) Carry wastes and CO_2 from the tissues to the blood

Blood

Blood is a complex liquid that performs a # of critical functions.

General functions of blood

1. Transports oxygen
2. Transports carbon
3. Transports nutrients

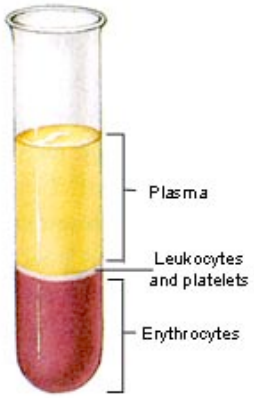
4. Transports

5.

6.

7. Involving helping prevent blood

Two Main Components of Blood



1) Plasma – liquid that remains after cells have been removed from whole blood.
2) Formed elements – (solids) cells and cell-like structures suspended in plasma

Includes: white blood cells, red blood cells, and platelets

*serum-

Hematopoiesis/Hemopoiesis

Process by which all blood cells are formed.
Hematopoiesis arise from a cell known as hemocytoblast/ PHSC

PHSC: Pluripotent Hemopoetic Stem Cells
It is a precursor stem cell

Location:

1) myeloid tissue: made in the bone marrow (continue maturation in the bone marrow)

2) lymphoid tissue: made in the lymphatic system

The Hemocytoblast:

Blood Cell Types

1) Erythrocytes (Red blood cells)

Characteristics:

a)

b)

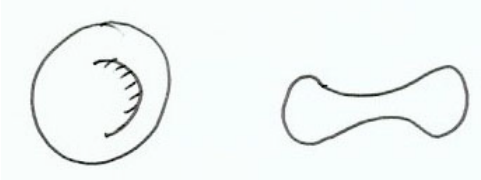
c) 5.4 million/mm^3 – males; 4.8 million/mm^3 – females

Why the difference?

b/c menstruation, which decrease red blood cell number within the volume of blood.

d) Red color – hemoglobin – 33% of RBC volume

Hemoglobin is a red pigment, 280 million hemoglobin molecules per RBC



Function: transport of oxygen and carbon dioxide

- CO_2 and O_2 can reversibly bind to hemoglobin
- Carbon monoxide (CO) can also bind, hemoglobin has a high affinity to bind to CO
- Carry oxygen and nutrients to the tissues from the lung and digestive tracts
- Carry waste and CO2 away from the tissue to the to the lungs and digestive tract

How is oxygen carried in?

Hemoglobin a quaternary protein; it has 4 subcomponents.
4 oxygen combine to 1 hemoglobin

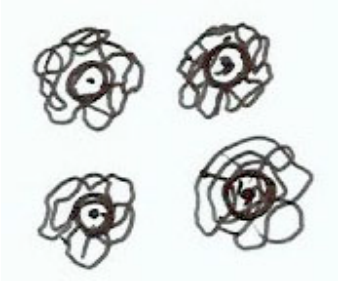
Hemoglobin Structure

2 alpha (α) subunits and 2 beta (β) subunits

Each globular protein chain contains a heme structure made up of :

Heme groups:

Function of the hemoglobin molecule:



Erythrocyte Life Cycle

Life span: around 120 days (after life- they get recycle and reused)

Hemocytoblast
↓
Erythroblast (precursor)
↓
Reticulocyte (precursor to RBC)
↓
Erythrocyte (RBC)

Recycling blood components

After cell death the heme group is converted to

Older red blood cells travel through the liver and spleen and are broken down. They are converted into a molecule known as bilirubin. Most is recycled, some is eliminated.

Stimulation of Erythropoiesis

Oxygen deficiency in kidneys cell
↓
Produces EPO (Erythropoetin)

<u>Erythropoetin (EPO)</u>
A hormone produced by the kidney:

Function:

A hormone that stimulate red blood cell production. Stimulate hemocytoblast to produce more red blood cells.

RBC Pathology

Anemia-

Causes:

Decrease in number of hemoglobin per RBC
Decrease RBC in a given unit of volume of blood
Decrease in iron
Decrease in vitamin B-12
Ultimately:
Decrease in oxygen carrying capacity of blood

Reticulocytosis-

- An increase a number of reticulocytes. Why?

- An elevation in the number of reticulocytes (young red blood cells) in blood, a sign of unusually rapid red blood cell production. The number of reticulocytes is normally less than 1% of the total number of the red blood cells. A higher proportion (above 1%) constitutes reticulocytosis.
- condition where there is an increase in reticulocytes, immature red blood cell
- Common in Anemia

Red Blood Cell Typing

Individual blood types are determined by the presence or absence of antigens located in the cell membrane of the RBC.

Agglutinogens (antigens) – glycoproteins or glycolipids that are genetically predetermined.

Upward to 50 antigens on a cells

The Four Main Types
O –
A –
B –
AB -

The percentages can be different depending on race or ethnicity.

Agglutinins (antibodies) – immunoglobins in blood that attack foreign antigens. (Protein structures)

Type A	Type B	Type AB	Type O
carries agglutinins to	carries agglutinins to	carries agglutinins to	carries agglutinins to

You don't have the agglutinins (antibodies) against your own antigens. If you have an antibodies against your own, you have an Antigen- Antibodies Reaction (cross reaction) leading to destruction of those cells and agglutination.

Agglutination = clumping

Universal Donor-

There are no antigens on the cell surface for the antibodies to be recognized. It won't be recognized and destroyed. This blood is worth Gold in ER.

Universal Recipient-

There are no antibodies, so you can receive anybody blood type and it won't get destroyed.
AB Positive they want your blood, b/c there aren't any antibodies in the plasma and they can give it to all patients.

They take the O Negative red blood cells (b/c no antigens) and plasma from the AB Positive (no antibodies) and give it to critical patients in a pinch.

If incompatible blood is donated to a patient, a cross-reaction occurs causing agglutination.

RH Factor

Named after the rhesus monkeys utilized to find this antigen.
Rhesus monkey is the they used to do the initial research

A.K.A.-

Rh + means: Have the antigens
Rh Negative means:

It's important to know because of **Erythroblastosis Fetalis** AKA

Erythroblastosis Fetalis- hemolytic of the newborn - due to a cross-reaction with mother's blood.

How does this disease occur?
b/c some of moms blood with antibodies to Rh+ went into the baby

Rhogam- Rh+ antibodies (synthetics)
If mom is Rh- she gets this drug, you're giving mom the Rh+ antibodies during the pregnancy. So, if any of the baby's blood (Rh+ antibodies) gets across, it is bound up and destroyed and mom doesn't develop sensitivity to the baby's blood.

Leukocytes
White Blood Cells

Characteristics

- Nucleated, do not contain hemoglobin
- Major component of the immune system
- Diapedesis-

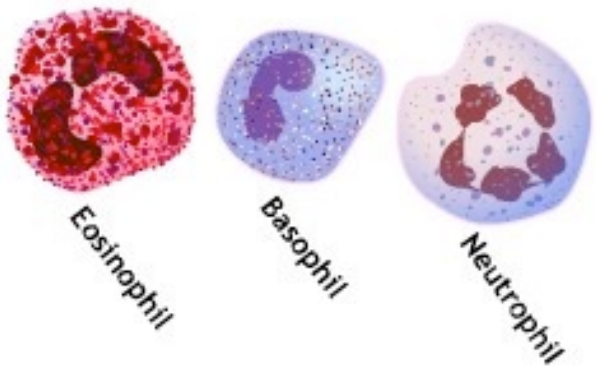
- Chemotaxis-

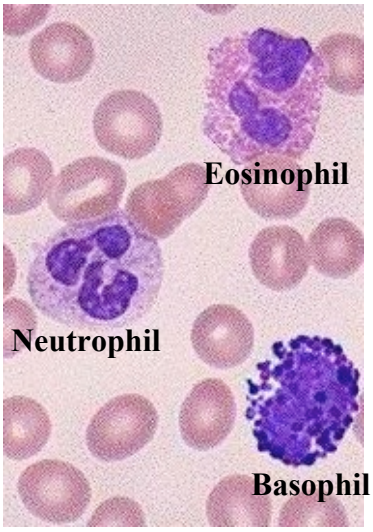
  Any time you have inflamed or damaged tissue, it releases this molecules into the blood stream, which will attract WBC

- Phagocytosis-

Two Major Groups

a) ***Granular Leukocytes*** (Granulocytes) – relatively large, secretory granules (usually purple or bluish-purple) are observed within the cytoplasm after staining procedures. These are usually visible granules in the cytoplasm





1) Neutrophils (Polymorphonuclear Leukocytes) –
    - Neutral Stained (don't pick up the stain as much)
    - The 1st line of defense
    - Life span [in the circulation]
    - Account for
    - Major role- phagocytosis
        - Release lysozyme (break down the bacteria cell wall) from granules (H_2O_2) to destroy bacteria
    - They have multi-lobed nuclei
    - Secrete leukotrienes which
        - Increase capillary cell wall permeability, causes inflammation, increase blood flow in body/area (very powerful)
    - They also secrete prostaglandins to increase inflammation.
    - An increased neutrophil count indicates damage by invading microbes (usually bacteria).

2) Eosinophils
    - granules stain
    -
    - Same size as the Neutrophils
    - Account for
    - Major role- combat irritants caused by allergic reactions and fight parasitic infections.
    - Release histamine, serotonin and bradykinin (but not as much as the basophils)
    - They engulf antibodies that mark various antigenic substances.

3) Basophils-
    - small,
    -
    - The granules obscure the nucleus
    - Look like a lymphocytes, but w/o they cytoplasmic halo
    - Account for
    - Involved in allergic reactions
    - They enter the tissue and release heparin, histamine and seratonin to prevent blood clotting and increase local inflammation
    - Release massive amounts of
        - They increase local inflammation
        - Anaphylactic shock: Large release of histamine, serotonin and bradykinin from the basophils
            - 2 Main concerns

                1.

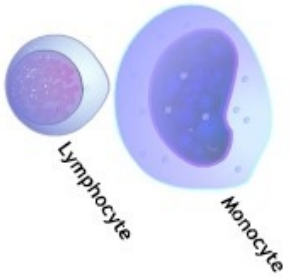
                2.

Granulocyte Development

Hemocytoblast (the stem cells found within the bone marrow) Precursor cells
↓
myeloid stem cell(marrow)
↓
myeloblast
↓
myelocyte
↓
band cell (immature granulocyte)
↓
granulocyte

Band Cell:
What they are referring to are the nuclei, is it a banded or is it segmented?

b) ***Agranular Leukocytes***- cytoplasmic granules here do not stain well.
There are granules in the cells, but they don't stain



1) Lymphocytes-
   - account for
   - Life Span:
   - Have a large nucleus surrounded by a thin halo of cytoplasm
   - Major role- responsible for <u>specific immunity</u>, which is the ability to attack different types of microbes on an individual basis.
     -
     -

Responds to threats two different ways:

They both go to the lymphatic tissue for final maturation (liver, spleen, and etc..)

a) T Lymphocytes- responsible for <u>cellular immunity</u> by attacking the cells directly. Killer T cells.
   -
   - Attach foreign invader directly (specifically)

b) B Lymphocytes- responsible for <u>humoral immunity</u>. Activated B cells will become either:
   -

i) <u>Plasma Cells</u>

ii) Memory Cells which "remember" a specific antigen, and when re-exposed to that antigen divide wildly to make plasma cells that will produce specific antibodies to that antigen.

Lymphocyte Development

Hemocytoblast
↓
lymphoid stem cell (lymphatic tissue)
↓
lymphoblast
↓
prolymphocyte
↓
lymphocyte

c) Monocytes-

-
- The nucleus is oval or kidney-bean shaped
-
- Account for
- Take longer to reach the infection site
- Utilize phagocytic action to engulf the foreign invader
- Prevalent in chronic infections (i.e. tuberculosis).
- If they are sent out to fight the fight, they get destroyed
- Life span:

Monocyte Develpoment

hemocytoblast
↓
myeloid stem cell
↓
monoblast
↓
promonocyte
↓
monocyte

White Blood Cell Percentages

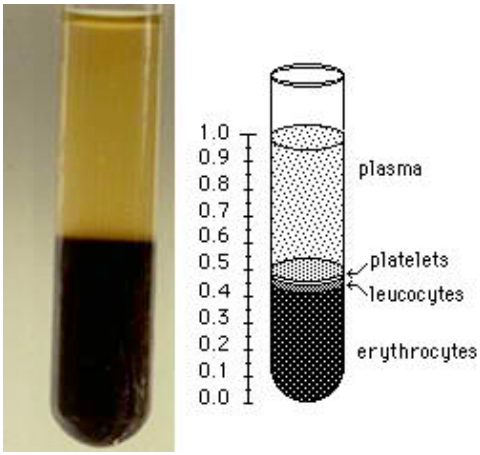
N *Never*	L *Let*	M *Monkey*	E *Eat*	B *Banana*	
60%	30%	8%	3%	0%	(>1%)

Thrombocytes (Platelets)

- Between 250,000-400,000/mm^3.
- Function to initiate and carry out
- Life span- approximately 1 week.
-
- Megakaryocytes are what make the platelets
  - found in the bone marrow
  - very large cell
- They release platelets into the blood stream, which cause stickiness when activated.

Thrombocyte Development

Hemocytoblast
↓
myeloid stem cell
↓
Megakaryocyte (bone marrow)
↓
platelets



Plasma

The liquid-like component of blood remaining when the formed elements are removed.

Plasma without the clotting factor (minus clotting factor) is known as

Made up of water, electrolytes nutrients, waste products and proteins.

Blood Proteins:

1) Albumins:
   - represent approx. 60% of blood proteins
   -
2) Globulins:
   - Represent 35% of blood proteins.
   - Function as blood transporters and immune proteins.

- Immunoglobins- antibodies.
- Thyroxin Binding Globulin.
- Serve to carry/ transport material though the blood

3) Fibrinogens:
   -
   - Long thin fibrous proteins part of the clotting process

Differences between Plasma and Interstitial Fluid

Plasma	Interstitial Fluid
Greater [O2]	greater [CO2]
↑ Dissolved proteins	↓ proteins

The Clotting Process

The process of clotting is known as coagulation or hemostasis (the prevention of blood loss).

The Five Phases of Clotting

Stage I: The Vascular Phase

Stage II: The Platelet Phase
"Platelet Adhesion"
Membranes of injured cells become sticky

Stage III: The Coagulation Phase-

The Two Pathways to Coagulation

Fast Process
Small amounts

Extrinsic Pathway

Release of Tissue Thromboplastin (Tissue factor) from injured tissue

↓

Extrinsic Thromboplastin

Intrinsic Pathway

Slow process
Large amounts

Release of PF-3 (Platelets factors- 3)

Form within platelets after they rupture. The platelets clump together and release Thromboplastin, Factor VIII required

↓

Intrinsic Thromboplastin

↓ ↓

⇓

Common Pathway

↓ Vit. K required

Prothrombin

↓

Thrombin

↓

Fibrinogen → Fibrin

A plasma protein that forms an insoluble network of proteins threads, to catch blood cells

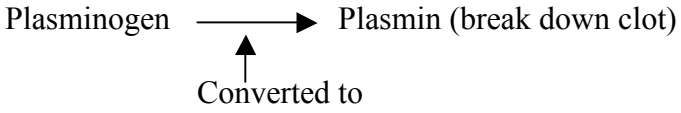
Procoagulants (Clotting Factors)-
Made in liver
Are intermediates in the pathway that lead to clotting

Hemophilia-
"Classic Hemophilia"

Stage IV: Clot Retraction Phase

Stage V: Fibrinolysis

Clot dissolution



Unwanted Clotting

Thrombosis-

Embolus-

Embolism

The Heart

The Heart- (def.)

Hollow muscular organs (b/c it has chambers inside) that pump blood through the circulatory system

Location-

Posterior to the sternum

Located within the mediastinum between the 2 lungs

The largest structure in the mediastinum, lies on top of the diaphragm and in front of the trachea, esophagus and great vessels.

2/3 of mass is on the left hand side.

Side notes:

- HCM
  - Genetic condition
  - Enlarged heart
  - The heart is not as strong as it should be

Apex-

Pointed end faces downward towards the left
Located in the left 5th intercostal space

Good landmarks to know where to place the stethoscope
2nd intercostals space: you can hear the semilunar valve very well.
5th on the left side you can hear the AV (Artrioventricular Valve) valves very well

Apex- pointed end, faces down and toward the left, located at the left fifth intercostal space

Base-

Located more towards the right side
2nd intercostals space

Pericardium: the sac that surrounds the heart; loosely fitting sac that surround the outside of the heart

Functions-

1) Protective covering

2) Produce a fluid to reduce friction as the heart beats.
70 times/ minutes

3)

Pericardial Structure

1) Pericardial Sac- attaches to the base of the heart around the great vessels and to the diaphragm along the inferior border of the heart.

    a) Outer:

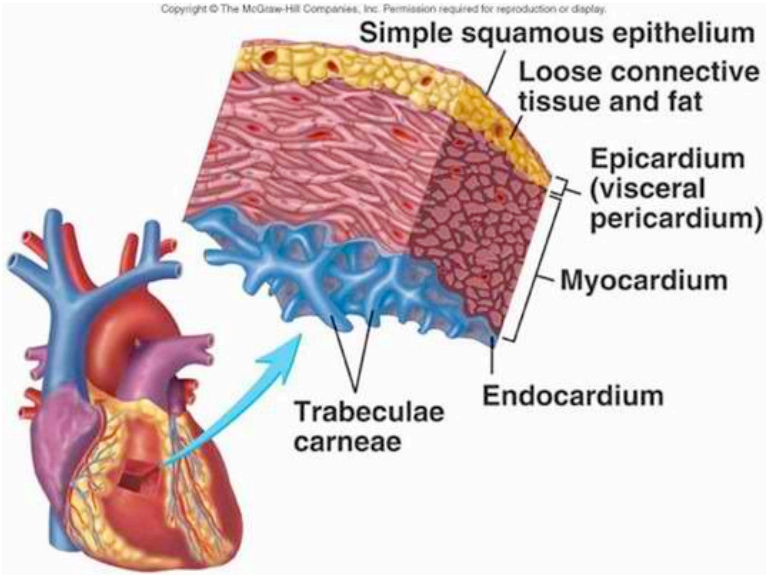
    b) Inner:

2) Serous Layer AKA Visceral Pericardium AKA

The Parietal and Visceral Pericardium layers are where the fluid is produced into the pericardial sac.

Cardiac Tamponade:

Three Layer of the Heart Muscle Tissue



1) Epicardium- outermost
   AKA

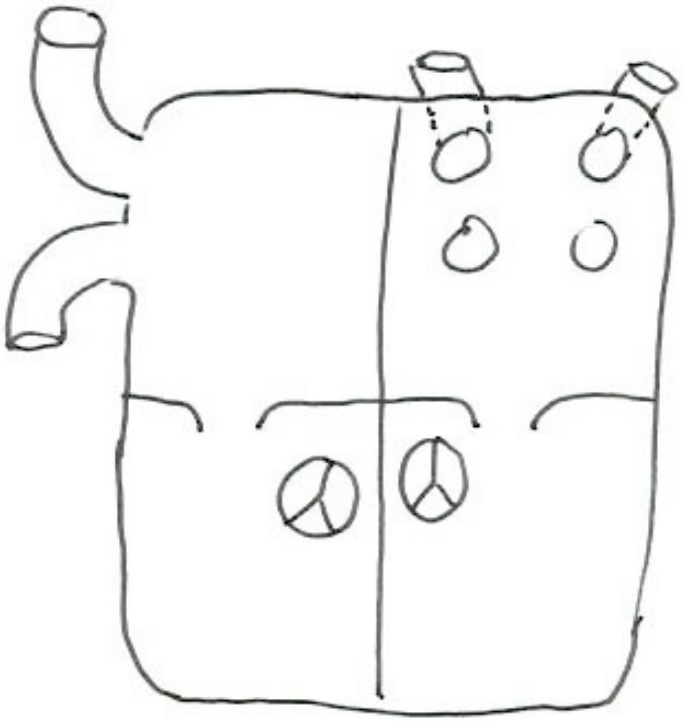
2) Myocardium- middle, thickest, muscular layer
   - Striated
   - Similar to the skeletal muscle b/c it's striated
   - Involuntary
   - Intercalated disks

Ability to conduct electrical activity from one cell to the next
Functional Syncytium: Interconnected, functions as a unit; group of muscles cells work as one due to the interconnectiveness of cardiac tissue.
The intercalated disks contribute to the interconnectiveness

Allows heart tissue to contract as one big muscle fiber known as a functional syncytium.

3) Endocardium-
   - Inner layer of the heart
   - It lines the chamber
   - Continues with the endothelium of the vessels
   - one cell layer thick
   - Serve as a non-sticky surface for blood

Cardiac Circulation



<u>Atrioventricular Valves (AV Valve)</u>

1) Tricuspid Valve
   Right Atrioventricular Valve)
2) Bicuspid Valve
   Left Atrioventricular Valve
   Mitral Valve
      Commonly affected valve when it comes to valvular disease

<u>Semilunar Valves</u>

3) Pulmonary Semilunar Valve
   (Pulmonic)

Goes to the lung via pulmonary trunk

4) Aortic Semilunar Valve

Coronary Sulcus-

Deep groove on the exterior surface of the heart between the atria and ventricles

Interventricular Sulcus-

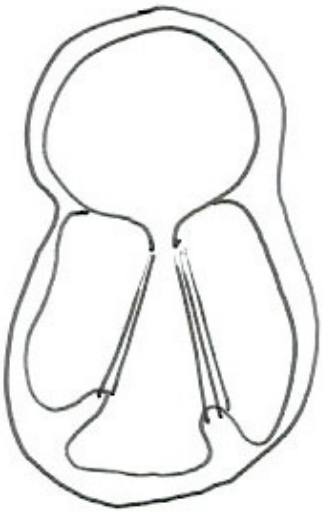
Groove between the 2 ventricles on the front and back surface of the heart.

Chordae Tendinae-

- Thin, strong connective tissue string
- Associated with the AV valves
- Prevent the cusp valve from going back in the opposite direction-prolapse
- Tendinous cord that attach the valve cusp to the papillary muscle

Papillary Muscles-

- Attach to the chordae tendinae
- Muscular columns of the ventricular wall that attaches to the chordae tendinae
- Contracts with the ventricular wall to help hold the chordae tendinae in place

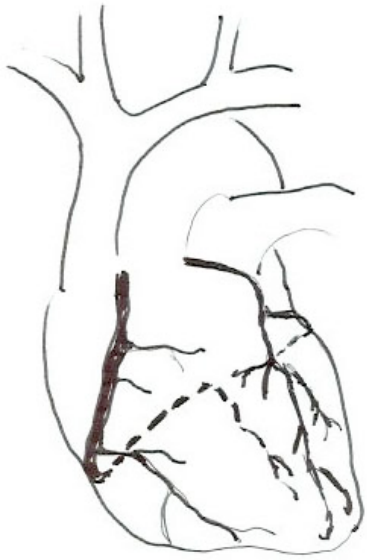


Trabecula Carnae- (Meat Strut)

Irregular services of ridges and folds in the myocardium

Coronary Artery Circulation- the heart's blood supply

- First arteries of the aorta
- Send blood out to the heart muscle tissue



A) Left Coronary Artery
   - Comes off of the aorta between the left atrium and the pulmonary trunk

1) Circumflex branch-
   - Goes around between the atria and the ventricles on the left hand side following the coronary sulcus
   - Supply left atrium and left ventricle

2) Anterior Interventricular branch-
   Follows the anterior interventricular sulcus
   - Lies between left and right ventricles on the anterior surface
   - Supply the anterior aspect of the two (left and right) ventricles

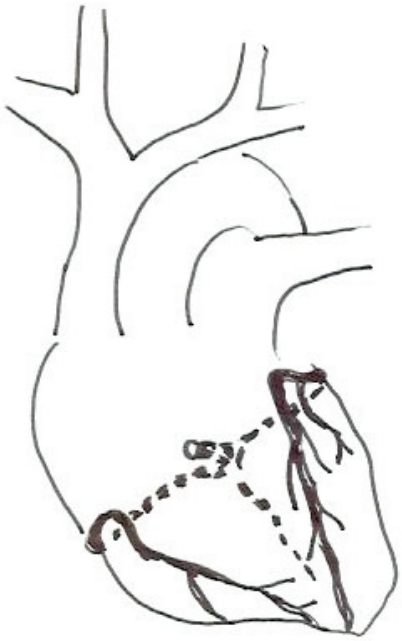
B) Right Coronary Artery
   Comes off the aorta between the right atrium and the pulmonary trunk

1) Posterior Interventricular branch
   - Comes around the back side between the atria and ventricle and descends (comes down the posterior side of the heart) along the posterior interventricular sulcus

- Supply the posterior left and right ventricles

2) Marginal Branch
   - Comes along the anterior aspect of the right ventricle
   - To supply the right ventricular [wall] and right atrium

Cardiac Veins

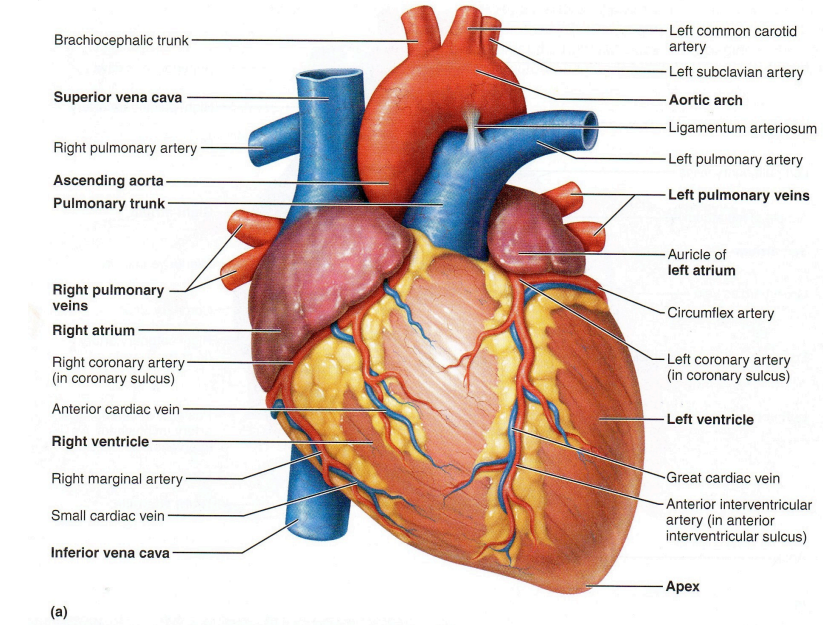


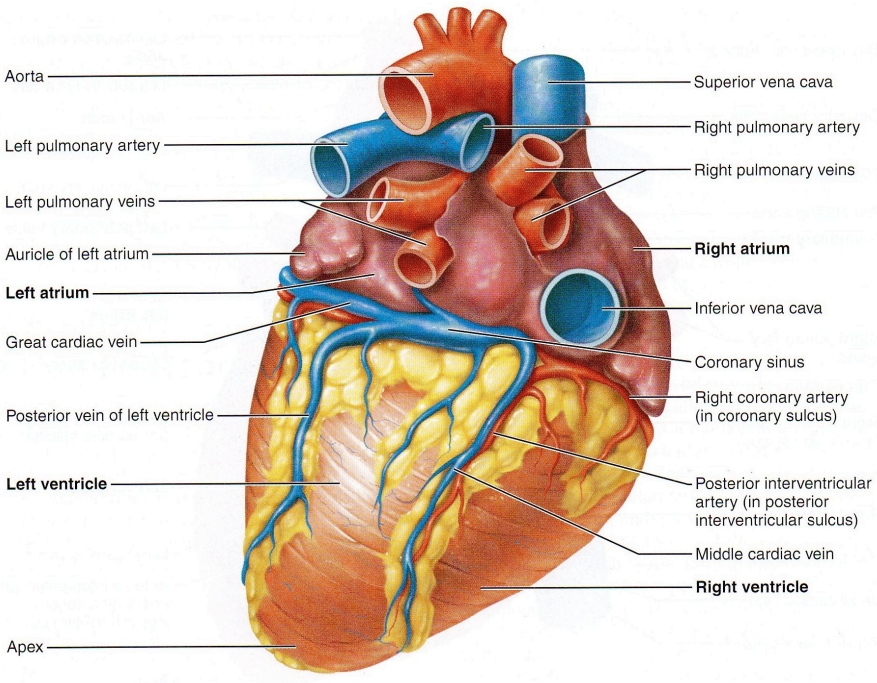
A) Great Cardiac Vein
   - Coronary sinus (found within the right atrium) is the opening of the Great Cardiac vein into the right atrium
   - Lies in the anterior interventricular sulcus, wraps around the back of the heart between the left atrium and ventricle drained into the coronary sinus
   - Goes around the front, draining the anterior heart tissue

B) Middle Cardiac Vein

- Lies in the posterior interventricular sulcus and drains the posterior heart tissue

Both come together to drain into the coronary sinus





The Cardiac Conduction System

Cardiac Muscle will contract [beat] on it's own.

- If you remove all the nerves, it'll still beats on it's own
- Auto-rhythmicity: fact that heart muscle will beat on it's own outside normal neural stimulation
    - Beat on it's own at a much slower rate
- Typical heart rate 70-72 beats/ minutes

- If you let the atria and ventricles beat on their own, the atria beat at a different rate than the ventricles beat
- Ventricles beat at 15-40 beats/ minutes
-

The Refractory Period of cardiac muscle is much longer than in skeletal muscle tissue.

Depolarization: represents the influx of sodium ions (Na+ enter/ flow into the cell)
Repolarization: Potassium to go out
Can't depolarization during repolarization

Repolarization is called the refractory period, can't not re-stimulate that nerve/ muscle
Refractory period: period during repolarization that we cannot re-stimulate that muscle

This represents the electrical wave, but doesn't represent the contraction of muscle, there is a lag time

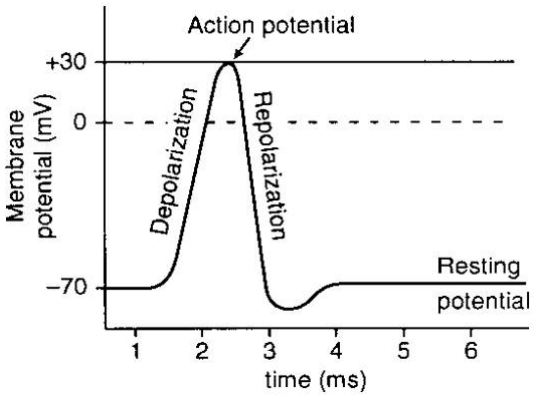
Skeletal muscles contract quickly:

- But there is a lag time between when the electrical wave passes on the surface on the muscle until we get contraction inside the skeletal muscle
- Muscle contraction, single muscle twitches which allow tetany to occur
  - Tetany: contracts muscles and keep them contracted for a long period of time, until your run out of either or both Ca+ or ATP

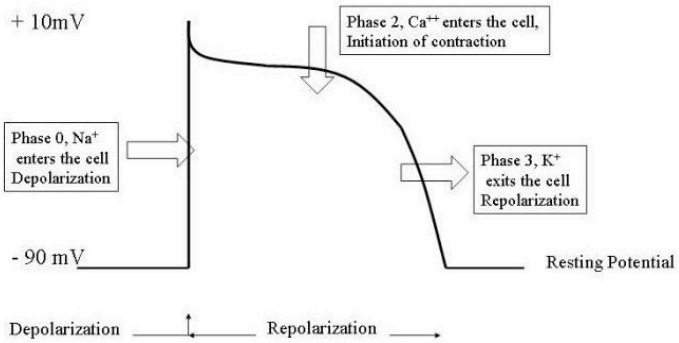
Don't want to see complete tetany in cardiac muscle tissue, b/c there is not time for the ventricles to filled with the blood b/c it's constantly contracted

- So not ventricle filling with blood, no movement of blood through the body.
- Cardiac muscle tissue has a special mechanism to prevent tetany, which is part of the refractory period
- Long refractory period

Skeletal Muscle



Cardiac Muscle



Function of the longer [absolute] refractory period in cardiac muscle tissue-

- Prevents complete tetany, which ensures that the ventricles can be filled with blood between each heart muscle contraction
  - b/c complete tetany causes death (no blood movement through the heart muscle tissue)

Cardiac Muscle Energy Source

1) ↑# of mitochondria
2) Abundant myoglobin
   - Myoglobin: carry/ bind oxygen
3) Glycogen/lipid energy stores
   - Cardiac muscle tissue is aerobic tissue, CANNOT be anaerobic

The Cardiac Conduction Pathway

It is not nerves that travel thought the heart muscle tissue
Modified cardiac muscle tissue through which the electrical wave travel
Not going to see the electrical conduction tissue

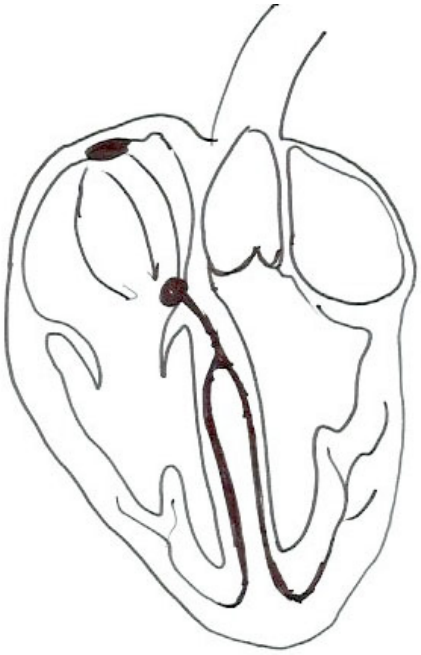
A) The SA Node (Sinoatrial Node) AKA.
   - Pacemaker: b/c help generate/ maintain heart rhythm

- Sinoatrial Node:

Location - junction of the superior vena cava and the right atrium.
Top of the right atrium near the superior vena cava

Characteristics- comprised of specialized cardiac muscle cells. It initiates each cardiac cycle.
It's speed can be altered by the autonomic nerve system

Vagus N. -Cardioaccelerator N. as well as epinephrine and thyroid hormone.



B) Internodal Pathways-

C) AV Node (Atrioventricular Node)

Location- in the junction between the atria and ventricles, it now depolarizes after both atria contract

D) AV Bundle (Bundle of His)

Location- lies within interventricular septum, and divide to form the 2 left and right bundle branches

E) Right and Left Bundle Branches
Located with in the interventricular septum and travel down to the apex

F) Purkinje Fibers
Left and right bundle branches terminate as purkinje fibers that are found within the wall of the left and right ventricles

Order of the Cardiac Conduction Pathway

1.
2.
3.
4.
5.
6.

Order of Heart Muscle Contraction

1) Atria contract (push blood down the ventricles to top them off)
2) Interventricular Septum Contract
3) Ventricular Apex
4) Ventricular wall contract from the Apex upward (push blood up and out)

Electrocardiogram AKA

Electrocardiogram is the electrical wave that travel through the heart muscle tissue, does NOT represent directly (indirectly it does) heart muscle contractions

Records the electrical changes that accompany the cardiac conduction cycle.

Electrodes are placed on various places on the chest wall and extremities to monitor the electrical depolarization of the cardiac muscle.

Basic EKG (Place electrode)
- Left Arm
- Right Arm
- Left leg

Provides a 2 Dimensional picture that only look at the electrical wave traveling vertically throughout the body

1) P wave-

2) QRS Complex-

3) T wave-

The Cardiac Cycle

Period between the start of one heartbeat to the beginning of the next

Systole-

Represents heart muscle contraction

You have both atrial and ventricular contraction

Diastole-

Represent heart muscle relaxation

One Normal Cardiac Cycle

1. The two atria contract first, while the ventricles are relax
2. Then the two ventricles contract, while the atria are resting/relax
3. Both [Atria and Ventricles] are relaxed
    a. 8/10 of second no contraction occur

Normal Cardiac Cycle refers to the systole and the diastole of both atria and ventricles.

A) Atrial Diastole

1) The atria are relaxed, passively filling with blood, the ventricles are also

2) The Atrioventricular (AV) valves are open (to let the blood flow down the ventricles); the Semilunar (SL) valves are closed

B) Atrial Systole

1) The SA (Sinoatrial Node) fire causing atrial contraction

2) The atrial contraction

3) Atrioventricular valves are still open (pushing blood down into the ventricles), Semilunar valves are still closed

C) Ventricular Systole

1) AV node (Atrioventricular Node) fires, creating a QRS complex
   - The ventricles contract, ejecting their blood to either the body or lungs

2) AV valves are closed and SL valves are open
   SL valves have to be open so blood can travel to lungs and body
   Papillary muscles are contracting to prevent the atrioventricular valves from opening

D) Ventricular Diastole

1) [Beginning] Semilunar valves are closed, the Atrioventricular valves are closed
   - Right after Ventricular Systole the SL and AV are closed
   - The reason is b/c there is still more pressure in the ventricles than in the atria
     - Doesn't last long (fraction of second)
     - Called isovolumic relaxation => same volume relaxation
     - Very brief period of time both SL and AV valves are closed
2) [End] Atrioventricular valves are open; the Semilunar valves stay closed

Heart Sounds

Actually have 4 heart sounds
With a regular stethoscope, you only hear S1 and S2 not S4 or S4

1st Heart Sound (Lubb)-
The first heart sounds

2nd Heart Sound (Dupp)-

Why do we hear the valves close?

Pressure Changes within the Heart Chambers

Pressure develops within the chambers related to:

1) Chambers size

2) Volume of blood it contains

Intraatrial Pressures

a) Atrial Diastole

Pressure steadily increases as the atria fill up

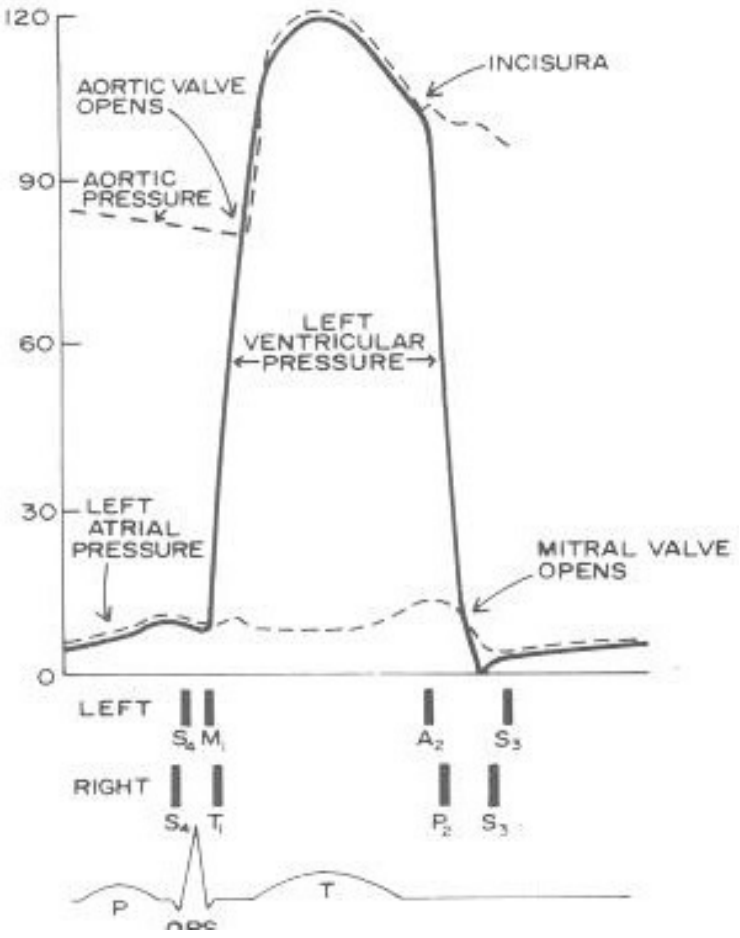
Remember:

Atria fill first, then blood flows into ventricles

Fluid will always flow from area of high to low pressure

b) Atrial Systole

Atria contraction causes a momentary increase in atrial pressure as the blood is ejected from the atria down to the ventricles



Intraventricular Pressures

- Ventricular pressure is going to be much greater than the atrial pressure because the ventricular pressure has to push blood further than the atria.
  - The atria just has to top off the ventricles

- While the ventricles have to push blood out of the heart (to the lung, head, neck and etc…)
  - Not only do we send it out but we need enough pressure to push it back to the heart
- Pressure 120/80 mmHg
  - Pressure in the lung 25/8 mmHg

a) Ventricular diastole

a. Pressure continues to increase as the blood from the atria fills the ventricles

b. Mild increase in atrial pressure occurs as the atria contracts to top off ventricular volume

b) Ventricular Systole

a. huge increase in ventricular pressure during ventricular contraction
b. There is also an increase in pulmonary and aortic pressure
   i. When the ventricles contract they push blood out into the aorta and pulmonary trunk, so we'll see an increase in pressure as the blood is injected out

The Cardiovascular System (cont.)

Stroke Volume- the amount of blood ejected from ventricle during each ventricular systole.

-

- Better representation =>
  - Typical talk in a hospital setting to determining the effectiveness of someone's heart
  - Percentage of blood ejected from the ventricles during ventricular systole

Cardiac Output- The amount of blood ejected from the left ventricle into the aorta per minute

***Cardiac Output*=**

Different for each individual depending on: body mass, exercise, body need, resting and etc…

Cardiac Reserve- maximum % that the cardiac output can increase above resting amounts. It is the difference between normal and maximal cardiac output.

Cardiac Output Variations- differences can be seen in certain pathological conditions.

What would happen in shock?

- Leads to a decrease in blood volume
- Decreased perfusion of oxygen to the body tissue
- Increase heart rate due to decrease in stroke volume from a loss in blood volume b/c ultimately we want to maintain cardiac output (5 L/min)

End Diastolic Volume (EDV) – the amount of blood in the ventricle prior to systole.

- Volume of blood in the end of diastole
- Largest volume of blood in the ventricles
-

End Systolic Volume (ESV) - the amount of blood left in the ventricle after ventricular systole.

- Still some remaining, we don't ejected all of it
-

Stroke volume = End Diastolic Volume – End Systolic Volume

Starling's Law- the greater amount of blood dumped into the ventricles the greater the force of contraction.

-
- What comes in the heart on the right side has to be what exits the heart on the left side
- What is going to the lungs per given unit of measurement of time is also the same for what's going to the rest of the body
- Pulmonary edema: build up of fluid in the lungs (due to what comes in does not equal what goes out)

Reason for Starling's Law?

The more the sarcomeres stretch, the harder the heart muscle contracts

The Vessels

Blood Vessels – a network of tubes that carry blood to and from the tissues.

A) Arteries-

Three Types- from the largest to the smallest.

1) Elastic Arteries- largest vessels, walls not very thick, but very resilient.

i. A lot of elastic fibers
ii. They aren't elastic b/c the force would be weak [pressure is low]
iii. Relatively thick muscle layer
iv. Doesn't change much in diameter
v. Low number of smooth muscle fibers
vi. Example:

2) Medium Sized Artery- AKA
Distribute blood to peripheral organs, large amount of smooth muscle fibers in middle layer
    - Relativity thick muscular wall
    - Can constrict and dilated to a large extent
    - They will dramatically vasoconstrict to prevent excessive amount of blood loss.
    - Example:

3) Arterioles- much smaller than medium sized arteries.
Have an incomplete layer of smooth muscle fibers, these fibers allow for constriction and dilation of arterioles.
    - Function:

The reason why:

We don't have enough to go to all of the capillary beds, if we don't need it, we'll shut it down

4) Capillaries- the smallest and thinnest vessels. Flow is slow here. Most areas are one cell thick, and only allow one RBC through at a time.
    i.
    ii.
    iii.

5) Venules – small vessels continuing from the capillaries that collect unoxygenated blood
    -
    -

6) Veins- larger vessels carrying unoxygenated blood from the venules to the heart. Veins walls contain smooth muscle, but also a lot of elastic and collagen fibers.
    - If you drink a gallon of cold water: the blood pressure will not go up b/c your veins help maintain hemostasis. The vein will expand to compensate for the increase in blood volume, serve as a blood reservoir.

Vein valves-

The Three layers to the Vessel Walls

1) Tunica Externa-AKA
   Made off loose areolar connective tissue
   Predominately elastic and collagen fibers

2) Tunica Media-
   Elastic Fiber and smooth muscle
   Allow the vessels to constrict and dilate, helps to regulate blood flow

3) Tunica Interna-
   AKA
   AKA
   Simple squamous epithelium (b/c it doesn't come in contact with the outside environment)
   Blood product should not stick to it unless it's damage,
      If damaged this is where platelets stick
   It lines arteries, veins, venules, arterioles; a continuous layer that become the capillary
   Capillary wall is nothing more than a continuation of the Tunica Interna

Arteriole walls are thicker then the Venules b/c of pressure

Cardiovascular System (Flow Dynamics)

Blood Flow –

Two factors affecting Flow Rates

A) Pressure –

Rules Regarding Pressure

1. Pressure is directly proportional to flow rate
   (Increase flow rate, increase pressure)
2. Fluid always flow from areas of higher pressure to areas of lower pressure
3. The greater pressure the difference/ gradient between two areas the faster the flow rate

Pressures within the Vessels

Base on MAP

The average pressure

Aorta- 100 mmHg
Arteries – 100-40 mmHg
Arterioles – 40-25 mm Hg
Capillaries – 25-12 mm Hg
Venules – 12-8 mm Hg
Veins – 10-5 mm Hg
Vena Cava – 2 mm Hg
Rt. Atrium – 1-0 mm Hg

The aortic pressure (blood coming out the aorta)- average is 100mmHg. Coming back to the right side of the heart the pressure should be somewhere around 0 mmHg pressure.

B) Resistance – A force that opposes or resists movement

Three Factors Affecting Resistance

1) Vessel Diameter-
   Increase Vessel Diameter, Decrease resistance
   Makes it easier for fluid flow

2) Fluid Viscosity
   Viscosity: thickness of fluid
   Increase Viscosity, harder to pump
   Viscosity is inversely proportional to flow
   Increase Viscosity- increase resistance, decrease flow

3) Turbulence
   Creation of eddies or swirls from irregular surfaces within vessels.
      Disruption in laminar (layers) flow
      Causes sounds
      A smooth walled, straight vessel would create little or no turbulence, but a vessel with irregular surfaces increases resistance-turbulence.

Other Definitions

Systolic Pressure – the peak pressure during ventricular systole.
The pressure in the vessels,

Diastolic Pressure – the minimum pressure during ventricular diastole

The pressure in the vessels,

Average Blood Pressure = 120 ← Systolic
80 ← Diastolic

Pulse-

You can feel pulse waves
An expansion wave as it travels though the arteries from the systolic pressure, so as the ventricles contract it causes the arteries to expand, which travels like the wave through the vessels

Mean Arterial Pressure (MAP)

Simply reported when we use a single value for blood pressure

$$MAP = Diastolic + \frac{(Systolic - Diastolic)}{3}$$

Example:

Why we use it?

- It gives the average blood pressure found in the vessels
- To get an idea of the average pressure that the vessels are exposed to during one cardiac cycle
- How much of the vessel will be expose to the 120 mmHg?
  - On average 20% of the time the vessels are exposed to the higher pressure
  - 80% of time the vessels are expose to the lower pressure
- Basically give us an overall pressure that the vessels are expose to during a given period of time

Total Peripheral Resistance –

Resistance of the entire circulatory system, including the veins and arteries

Peripheral Resistance –

Resistance in the arterial system

Blood Volume Effects on Blood Pressure

1) Blood Volume Increase => Blood Pressure Increase

2) Blood Volume Decrease => Blood Pressure Decrease

Realistically

Not going to see a significant change in Blood pressure b/c of homeostasis.

Homeostasis: going to try and maintain blood pressure, when blood volume change

Veins [arteries]:

- Vasoconstriction: Help increase blood pressure when we are dehydrated
- Vasodilates: Help decrease blood pressure when we are hydrated

Neural Regulation of Arterial Pressure (4 Factors)

All in the brain stem

A) Vasomotor Center – clusters of neurons in the medulla that control vessel diameter.

1) Stimulatory VMC –

Function: causes vasoconstriction

Global vasoconstriction if we need to increase blood pressure

When we need to dramatically increase blood pressure, this system will fire very quickly

2) Inhibitory VMC –

Cause Vasodilatation => Decrease Blood Pressure

B) Baroreceptors

Involve in monitoring blood pressure

1) Aortic Baroreceptor-

Located in the arch of the aorta

2) Carotid Sinus Baroreceptor –

Pressure has to be monitored in the internal carotid arteries b/c it can cause damage, not found in the external carotid.

Second Impact syndromes:

3) Atrial Baroreceptor –

Monitors pressure within the vena cava and right atrium

C) Chemoreceptors – sensitive to chemicals in the blood.
Detect:

*Affects the vasomotor center and respiratory centers within the brain stem

1) Aortic Body-
Arch of the aorta

2) Carotid Body-
Located at the junction/ split of the External and External Carotid Arteries
Purpose: is to protect the brain from chemical imbalances[CO_2, O_2 and PH] to tell the brain what's going on

D) Autonomic NS Control

1) Sympathetic Stimulation- release of Epi. and Norepi.
Epi. and Norepi acts on centers of the brain to increase cardiac output. Causing vasoconstriction of the GI vessels, vasodilatation of the Skeletal Muscle Vessels

2) Parasympathetic Stimulation – release of ACH
Involved in decreasing cardiac output. Shunting blood from the Skeletal Muscle to the GI tract
Maintaining overall autonomic tone
Sending blood to the GI tract and higher centers of the Brain

Hormonal Regulation of Blood Pressure (4 parts)

1) ADH – Antidiuretic Hormone AKA Arginine Vasopressin

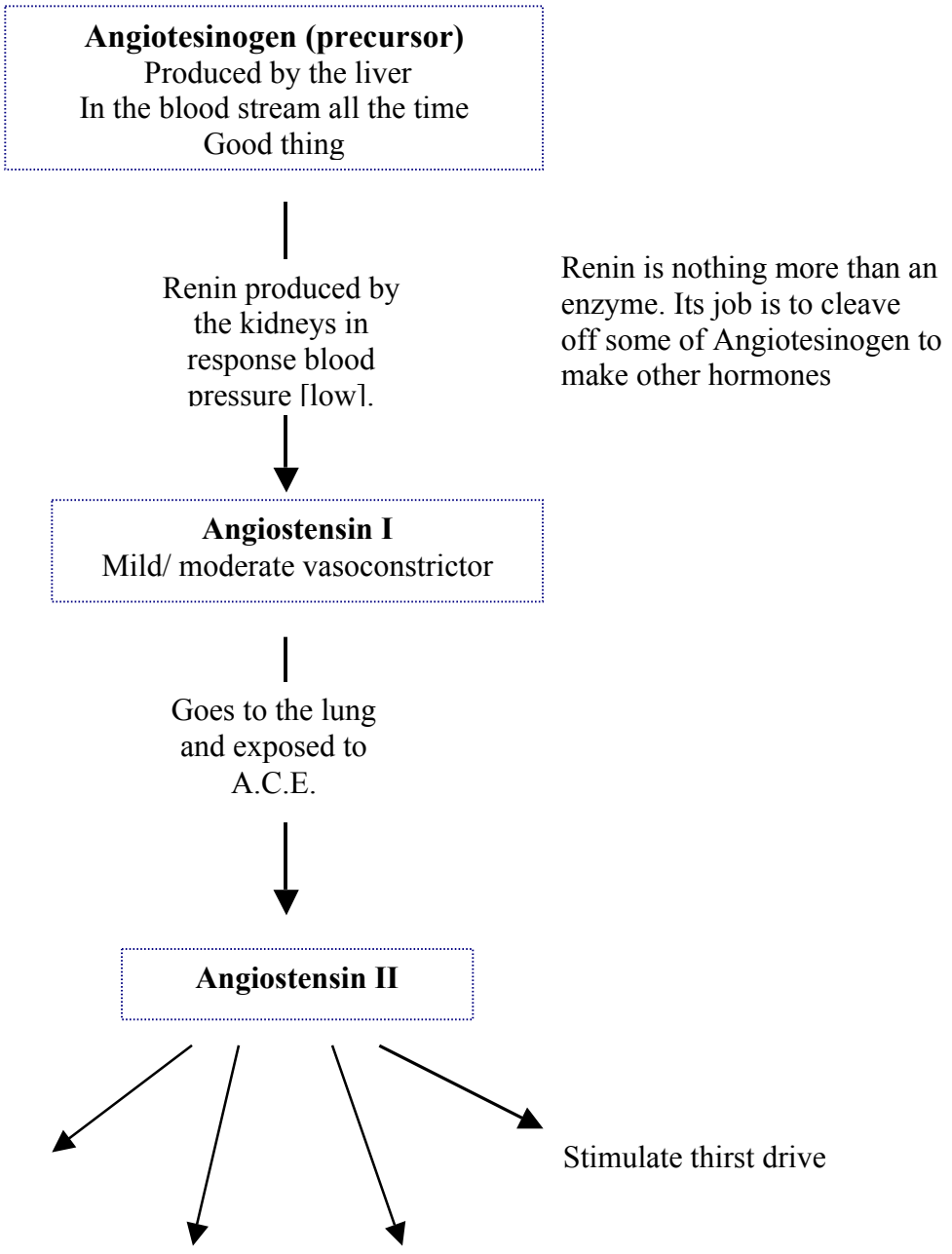
ADH Functions Two Ways
a. Prevents the

b. Causing

The overall function of the hormone is to increase blood pressure

2) The Renin-Angiotensin- Aldosterone System

The Renin-Angiotensin Pathway



3) EPO (Erythropoetin) – released from the kidneys.

Increase production of RBC/ hematocrit

4) ANH (Atrial Natriuretic Hormone/Peptide)
Released when Blood Pressure Increase
-produced by specialized atrial cardiac cells

The only hormone that counteracts the other ones
Decrease Blood pressure → increase fluid lost by kidneys
Increases H2O loss at kidney
Decreases thirst
Blocks ADH and Aldosterone
Stimulates vasodilation

The Two Major Circulatory Pathways

A) Pulmonary Circulation – functions to oxygenate blood

Pathway – oxygenated blood leaves pulmonary artery from right ventricle and travels to the lungs to be oxygenated. Oxygenated blood returns to the left atrium.

B) Systemic Circulation

Pathway - The circulation that carries oxygenated blood to the tissues and returns unoxygenated blood to the heart.

Arteries of the Systemic Circulation

Ascending Aorta- largest art., first to exit heart, first branches- coronary arts.
↓
Aortic arch- 3 main branches coming off the aortic arch
a) brachiocephalic – first branch supplies right arm and head

Only right side
Branch into two:
1. right common carotid – right head and neck

2. right subclavian- right upper ext. and right upper thorax.
   Subclavian because it lies under the clavicle

Brachiocephalic become subclavian until after the first rib, it then becomes axillary

Axillary to brachial when it leaves the armpit and goes into the arm

b) left common carotid- 2nd branch- supplies left side of head
c) left subclavian- 3rd main branch –supplies left upper extremity and left thorax

You have 4 main arteries that supply the head:

2 Vertebral Arteries

Both right and left vertebral arteries arise off of the subclavian from their respective sides and

travel up through the transverse cervical foramen of the cervical vertebrae to enter the skull through foramen magnum. They come together to form the basilar art.

Goes up in the back of the head

2 Common Carotids

Travel up just lateral to trachea and deep to the sternocleidomastoid m., and split into an internal and external carotid art. At the level of the hyoid bone.

They travel up in the front

A) external carotid – supplies the head outside the skull. 9 branches come off

4 Main Branches

1) Lingual- 1st branch supplies floor of mandible
   Goes to the tongue

2) Facial- 2nd, supplies face, travels under the mandible just anterior to the angle of jaw. Continues up medially toward the medial angle of the eye. Tortuous- for jaw movement.
   Not considered a pulse point, but you can palpate it
   Looks a lot like vein

3) Maxillary-3rd, supplies maxillary region.
   Goes toward the maxillary area

4) [Superficial] Temporal- 4th, terminal branch, supplies scalp and external jaw muscles. Pulse can be taken here
   You can palpate anterior to the tragus.

B) Internal Carotid- supplies brain and tissues inside skull. Enters skull through carotid canal.

Circle of Willis

- A circular blood supply within the skull that allows for collateral blood supply to brain.
- Fed by internal carotids and basilar artery
- Considered an anastomosis (a connection between blood vessels that acts as a safety mechanism to ensure a continuous blood supply should a vessel become blocked.)
- Anastomosis blood supply for the brain
    - Collateral blood supply
    - Insure that blood supply get to the brain
    - Anytime you cut off a arteries it'll still supply blood
- 4 vessel (2 main blood supply)
    - Front Carotid arteries
        External carotid become cerebral
    - Back vertebral arteries
        The two vertebral comes from the back and become the basilar artery

2 diseases:
Stroke and berry aneurysm

Arteries of the Upper Extremity

Subclavian (bilateral)
↓
Axillary- travels through axilla
↓
brachial- travels through arm on medial side, pulse point-brachial pulse
↓
splits into the

1) radial- travels down lateral forearm- radial pulse
2) ulnar – travels down medial forearm

Arteries of the Thorax and Abdominal Cavity

Aortic arch – bends down to travel posterior to the heart and lateral to the vertebral column on left side.

↓

Thoracic aorta – no major branches (small intercostals arteries)

Part of the descending aorta

Descending thoracic aorta has small intercostals arteries coming off of it

↓

Abdominal Aorta (branches)

1) Celiac Trunk, 1st Main branch, unilateral
   a) left gastric- to stomach
   b) hepatic- to liver
   c) splenic- to spleen

2) Superior Mesenteric- unilateral
   Supplies pancreas, small intestines and first 2/3 of upper large intestine

   The Celiac Trunk and the Superior Mesenteric A. coming off together
   There isn't a significant distance to separate them

3) Suprarenals- bilateral, supply adrenal glands
   They are above the renals glands to the adrenal glands

4) Renals-bilateral to kidneys

5) Gonadal – testicular/ovarian- bilateral, small, lie just below renal, just above inferior mesenteric.

6) Inferior Mesenteric- unilateral, supplies last 1/3 of large intestine, sig. Colon and rectum.

7) Common Iliacs- bilateral, the abdominal aorta **splits** into these two main branches at the level of the pelvis.

Main Branches

a) Int. Iliacs- bilateral, supplies pelvic floor, urinary tract and repro. System.
b) Ext. Iliacs- bilateral, travels into leg and branches into:
   1) Deep Femoral- lateral to femur, wraps around leg to supply posterior lateral thigh.
   2) Femoral – a continuation of the Ext. iliac, travels down medial thigh to supply post., ant., and medial thigh.

Arteries of the lower limbs

Popliteal Art. – ***femoral artery becomes the popliteal artery as it passes behind the knee***. *This artery has an anastomosis with the deep femoral art. It has three branches:*

1. Anterior Tibial- supplies ant. Foreleg compartment, and dorsal foot to dorsalis pedis pulse.
2. Posterior Tibial – supplies posterior foreleg, and plantar surface of foot
3. Peroneal – supplies blood to the lateral foreleg compartment.

You have 3 compartments in the foreleg: Anterior, Posterior, and Lateral compartments, each has it own blood and nerves supply

Fetal Blood Circulation

Ductus Arteriosus

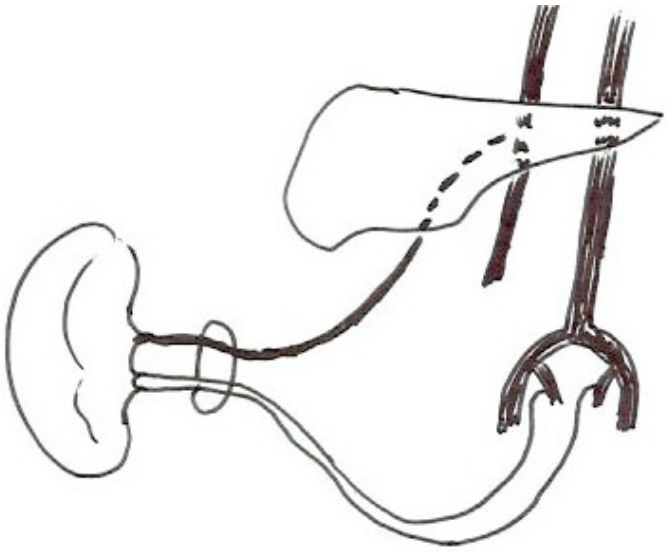
↓

(Ligamentum Arteriosum)

Foramen Ovale

↓

(Fossa Ovalis)



Ductus Venosus *Inf. Vena Cava*

↓

(Ligamentum Teres) *Abd. Aorta*

Umbilical Vein(1)

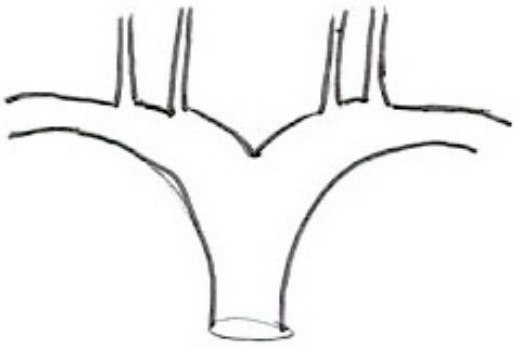
↓

Umbilcal Arteries(2) *Flow*

Placenta

Veins

1) Superior Vena Cava- drains superior portion of body into right atrium
   Branches into:
   A) Right Brachiocephalic Vein-
   B) Left Brachiocephalic Vein-



*Brachiocephalics continue on as:

the right and left subclavian veins at the junction of the internal and external jugular veins.

1) Ext. Jugular- bilateral, lie on top of the SCM, readily seen just below the skin surface, drain head, neck, face, scalp and salivary glands
   On top of the SCM
   Can see on the neck

2) Int. Jugular- bilateral, lies inside the carotid sheath with the carotid art. and the vagus n., lies deep to the SCM. Drains cranium (dural sinuses) face and neck.
   Common carotids arteries travel with the internal jugular below the SCM
   Deep to SCM

SCM= Sternocleidomastoid muscle

C) Right and Left Subclavian Veins- continue on as the Axillary Veins bilaterally

D) Right and Left Axillary Veins- continue on as the Brachial Veins

- Cephalic Veins- bilateral, lie superficially on anterolateral brachium, observed just under skin.
  Lateral side

- *Basilic Veins- bilateral, lies just superficial on the medial brachium, drains medial arm*
  More Superficial
  Medial side

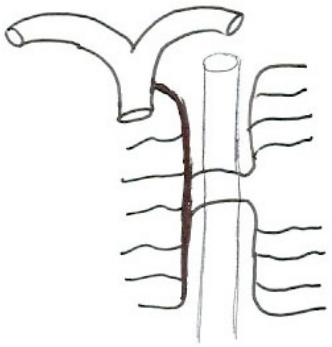
Cephalic and Basilic all come down the cubitial fossa (front of the elbow)

E) Brachial Veins- bilateral, deep, travels upward behind humerus

- *Median Cubital Vein – a superficial vein that connects the cephalic vein with the basilic vein within the cubital fossa(anterior elbow). Serves as a common location for blood draws.*

Azygos and Hemiazygos Veins

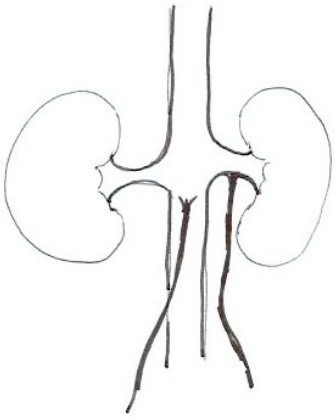
Drain intercostals veins into the superior vena cava.
Azygos sits to the right of the vertebral column
Relatively large



Inferior Vena Cava

Below are the branches traveling inferiorly.
Inferior vena cava goes thought the liver
The liver wraps around the Inferior Vena Cava

1) Right and Left Hepatic Veins- drain unoxygenated blood from the liver into the Inf. Vena Cava
2) Right and Left Suprareanl Veins -drain adrenal glands
3) Right and Left Renal Veins- drain kidneys
4) Genital Veins- bilateral, drain testicular and ovarian tissue
    a. Left – drains into renal vein
    b. Right – drains into inferior vena cava.



5) Left and Right Common Iliac Veins- come together to drain into inferior vena cava
6) Internal Iliac Veins- drain blood from pelvic muscles, skin urinary and reproductive organs.

7) External Iliac Veins- continue on as femoral veins bilaterally as they exit the abdominal wall

7) Femoral Veins- travel through medial, posterior aspect of deep thigh.
8) Popliteal Veins- travel through popliteal fossa to drain into femoral vein.

Two Branches:
Anterior Tibial V.- drains anterior foreleg
Posterior Tibial V.- drains posterior foreleg

**Great Saphenous Vein- bilateral, branches off of the ext. iliac veins to travel along medial thigh and foreleg. Drains medial leg and foreleg (bypass surgery)*

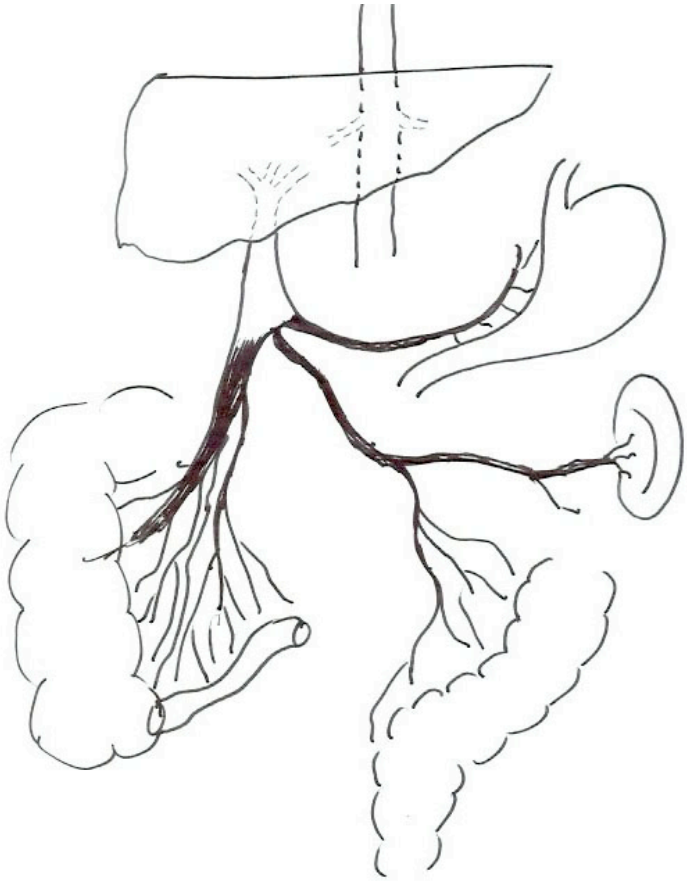
Hepatic Portal System

Receives unoxygenated, nutrient rich blood from digestive organs and dumps this blood into liver to store the nutrients, detoxify harmful substances, and clean the blood from pathogens.

Portal system is defined as a vessel that lies between two capillary beds.

Veins that drain into the Hepatic Portal Vein [system] (not the inferior vena cava):

- Inferior Mesenteric
- Superior Mesenteric
- Splenic
- Gastroepiploeic



Lymphatic System

A system that drains protein containing fluid from tissue spaces that initially has drained from capillaries.

works with the immune system

Lymphatic System Includes:

1) Lymphatic Vessels-
   Drains into larger lymphatic vessels, and eventually drain back into the subclavian veins
   This is how we return the lymphatic fluids back into the cardiovascular system

2) Lymph-
   The fluid from/leave the interstitial tissue space that enter/drain the lymphatic vessels
   If it is in the lymphatic vessels it is called lymph.
   Resembles plasma with smaller protein concentration. Why is that important?

3) Lymphatic Organs-
   Contains a large number of lymphocytes
   Example: Tonsil, thymus, spleen, liver (to some extent), lymph nodes

4) Lymph Nodes-
   Bean-shape structure located along the lymphatic vessels that monitor the contents of the lymph passing through it.

Lymphatic Flow

Components of the plasma from blood capillaries entering into the interstitial spaces. The fluid is now called interstitial tissue fluid.

↓

This fluid now enters small lymphatic channels and is called lymph

↓

travels to lymph nodes

↓

to larger lymphatic vessels

↓

Lower Body Drainage

Into Cisterna Chyli

Bottom of the thoracic duct

Expanded lymph chamber that is located in front of the 2nd lumber vertebra

↓

Thoracic Duct

Collects lymph from the:

1)

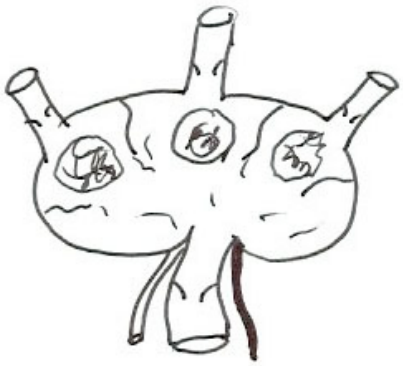
2)

The Thoracic Duct drains lymph back into the venous system at the left subclavian vein.

Right Lymphatic Duct

<u>Lymph Node Structure</u>

Cortical Sinus- outer region containing germinal centers



Afferent Lymphatic Vessels

Efferent Vessels

Lymph from Interstitial Fluid

Valves- one way flow

Trabecula- inner framework

Germinal Center- where lymphocytes are produced and reside

Medulary Sinus- inner region

Lymphatic Organs

A) Spleen- largest mass of lymphatic tissue in the body

1) White Pulp-
Lymphoid tissue surrounded by arteries
These clusters of lymphocytes are called

2) Red Pulp-
Venus sinus filled with blood and cords of splenic tissue

Spleen Function-
Phagocytizes bacteria and worn out RBC (and platelets)
Involved in producing plasma cells and the maturation of lymphocytes
Low blood volume-

B) Thymus Gland- involved in the maturation of immature T cells from the bone marrow

C) Tonsils- masses of lymphoid tissue embedded in mucous membrane.
Contain macrophages that clean up bacteria, foreign material and cellular debris

1) pharyngeal- AKA
Found in the nasopharynx

2) palatine-
Located between the palatine arches
commonly removed

3) lingual-
At the base of the tongue
Never removed
If removed, you can damage the nerve supply

Immunity

Active- occurs after exposure to an antigen
When you are exposed to a brand new antigen your body will develop a response to the antigens
Develop your own antibodies

Passive- transferred antibodies to another person
Acquired immunity
Example- breast feeding, shots

Nonspecific Defenses

1) Physical Barriers-
Prevent microorganisms and chemicals from entering the body
Example: skin and mucus membrane
First line of defense
Prevent the approach and denies access to pathogen

2) Phagocytic Cells – remove cellular debris
Remove debris and pathogens

a) Microphages- neutrophils, eosinophils

b) Macrophages- monocytes

1) Fixed-
Monocytes residing in tissue
They reach out, grab it and destroy it
They do not roam around, but stay in the same place for the rest of your life
Example:
Microglia- Antigenic Presenting Cells, T-helper cells

2) Free-
Are monocytes
Larger cells
Move through the cardiovascular system
The nucleus is washed out
Roaming through the blood, shark
Example:

Characteristics of Macrophages

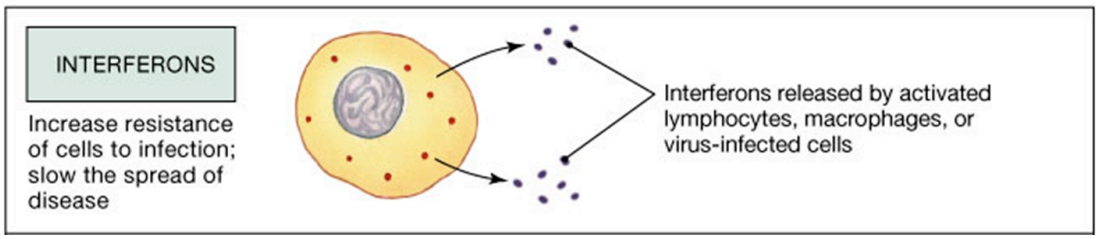
Characteristics are similar for many white blood cells

a) Diapedesis-

b) Chemotaxis-

3) NK Cells (Natural Killer Cells) –bind to abnormal cells/bacteria and release _____.
Larger granular lymphocyte

4) Interferon- proteins released by cells infected with viruses.



Glycoproteins release by activated lymphocytes and macrophages and by virally infected cells

5) Compliment System- a chain reaction with 11 proteins that help attack and destroy invading microbes (antigenic substances).

Classic Pathway of Compliment Activation

The first compliment protein attaches to an antigen-antibody complex to initiate a process that causes four things.

a)

b)

Cause mast cells and basophils to release bradykin, serotonin, and histamine

Histamine increase capillary permeability, fluid gets out, causes inflammation

Inflammation: swelling, heat, redness, pain

c)

Punches holes in the Target cell to cause them to lysed

d)

Makes proteins to stick to bacteria, creating nubbins
Makes it easier for the macrophages to grab a hold and engulf the bacteria

6) Fever – high body temps. Inhibit some bacterial and viral replication
Increases body temp high enough to kill bacteria without causing harm to us

7) Inflammation- caused by the release of histamine, serotonin and heparin from Mast cells and basophils
Theory:
Increase inflammation making it easier for the white blood cells to come in and do their job

Increase inflammation → increase blood flow → increase WBC → speed up healing process

Specific Immunity

Controlled by lymphocytes (account for 25-30% of WBC population)

Specific Immunity Function
Destruction or inactivation of pathogens, abnormal cells, and foreign molecules.
We are producing cancer cells (abnormal cells) every day, in a healthy immune system the cells are being destroyed

A) Cellular Immunity-

- T lymphocytes spend much of their time maturing in the thymus
[Killer] T-Cell- punch holes in bacterial cell walls

B) Humoral Immunity-

- B-Cell> Activated B-cells will either become plasma cells or memory cells

A. <u>Cellular Immunity</u> -T Cell
T cells mature in the thymus
↓
T Cells in Lymphoid Tissue
↓

Sensitized T Cell

Been exposed to antigens

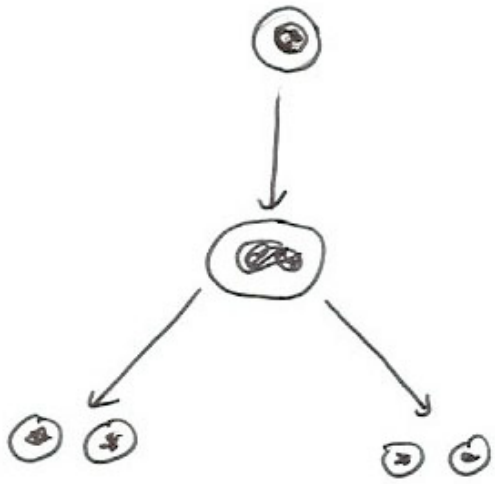
Memory T Cell

- Part of vaccination
- Lives in the thymus or lymph tissue for many months or years
- Ready to divide wildly and rapidly when exposed to the specific antigens

Cytotoxic (Killer) T Cell

<u>3 Functions</u>

1) Secrete Macrophage Chemotaxic Factor
2) Secrete Sensitization Factor (more T-Cells to wildly divide)



3) Attach to Antigen and destroy them, which will produce lymphotoxin> responsible for destroying antigenic cells

<u>T Helper Cell</u>

Secret cytokine

Function:

i. Accelerate Killed T cell Maturation
ii. Activate NK Cells
iii. Promote antibody production and B cell division

Doesn't destroy anything directly, assists in the intercommunication of immune system cells
This is the cell that's affected in HIV

B. Humoral Immunity – B Cells

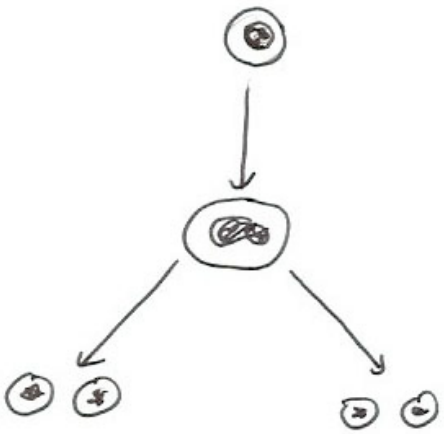
B Cell in Lymphoid Tissue

Sensitized B Cell
Been exposed to antigens

Memory Cells

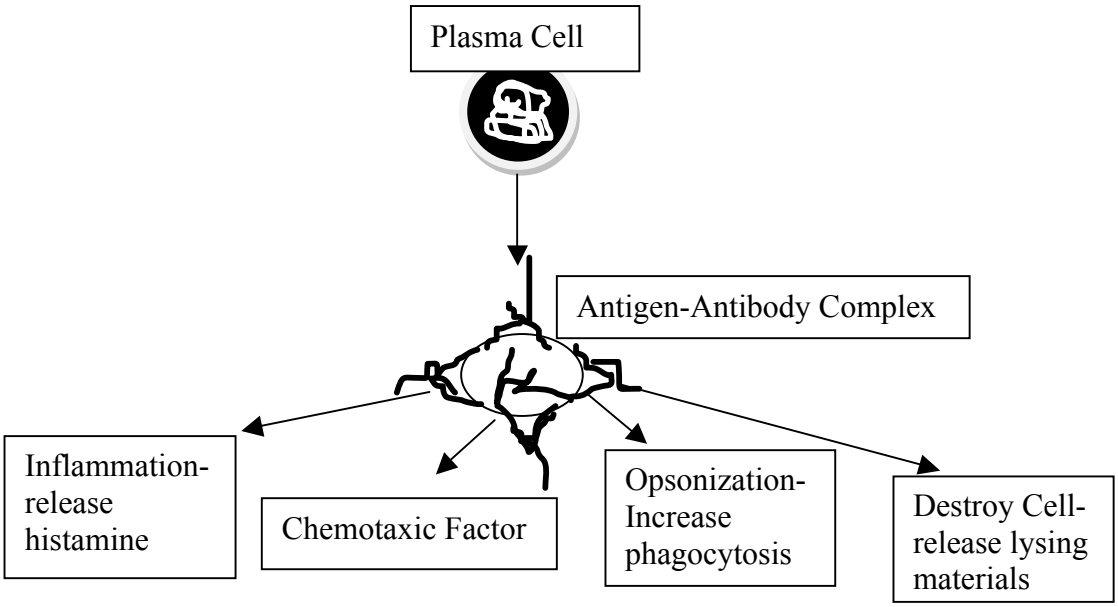
- The same thing happens as in the T memory cell
- Reside in the immune system waiting for the 2nd exposure

Plasma Cells



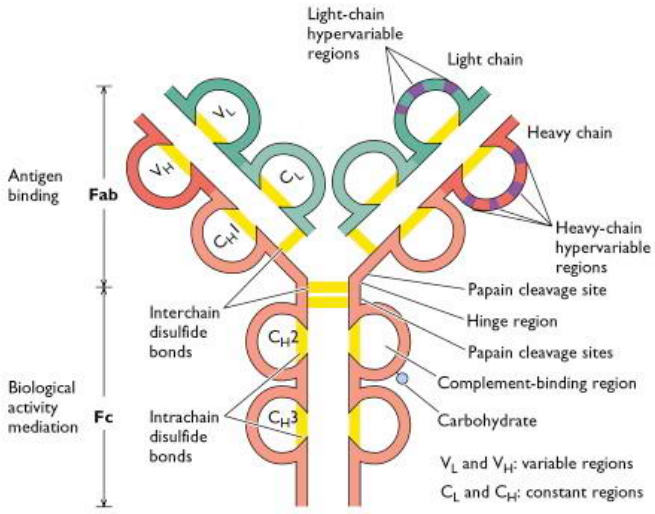
Antigen- Antibody Complex

- Activated complement system
- Binds to the antigens increasing antigens weight
- Render the antigen ineffective
- Precipitate out the blood making it easier for phagocytosis
- Neutralized antigens
- Inflammation: the whole process promotes inflammation from basophils and mast cells activation
- Chemotaxic Factor
- Opsonization
  Nubbins to enhance phagocytosis
- Destroy Cell
  Allow or enhance the release of lyse materials


Plasma Cell
Antigen-Antibody Complex
Inflammation-release histamine
Chemotaxic Factor
Opsonization-Increase phagocytosis
Destroy Cell-release lysing materials

Antibodies- (AKA- Immunoglobins) proteins produced by the plasma cells in the presence of specific antigens.

They are Y shaped
Produced by the Plasma cell
Antigen specific



a) IgG-
The most common

b) IgE-
Work in response to

c) IgD-
Helps B cells binds to

d) IgM-
Involved in agglutination

e) IgA-
Attach to pathogens before entering the body
Found:

Mast Cell:
Closely related to the basophils
Only found in tissue not in blood
Generally function like basophils

Basophils founds in blood

The Respiratory System

Organs involved in the function of exchanging gases between the atmosphere and blood.

Include the nose, pharynx, larynx, trachea, bronchi and the lungs.

Components of the Respiratory System

1. Nose – a supportive framework of bone and cartilage covered with skin externally and mucus membranes internally.

Nostrils
The two [external] holes on the bottom of the cartilage like materials

Internal Nares:
Transition between the back of the nasal cavity and the nasal pharynx

Nasal conchae: when covered with mucus membrane called turbinates

Cranial Sinuses- generally adjacent to the walls of the nasal cavity
4 found within the skull

a) frontal-

b) sphenoid-

c) Ethmoid-

d) Maxillary-
Largest
Filled with mucus and inflamed during sinus infection
2nd bacterial infection occurs from a primary viral infection
Functions-
1) Speech resonance
Provides specific vocal quality to your voice/ sounds
2) Decrease weight of skull
3) Help to warm the air

Nasal Cavity Floor is formed by the:

1) Hard Palate (front)

make up of bones, palatine and maxillary (anterior is maxillary)

2) Soft Palate (back)

Nothing more then mucus membranes with some muscles

*Uvula-

Lateral Walls of the Nasal Cavity:

Conchae-

Comes off the ethmoid bones and the inferior nasal conchae bones
Scroll - like projections coming off the lateral aspect of nasal cavity

Superior- part of the ethmoid bone
Middle- part of the ethmoid bone
Inferior-

Its own bone; made up by the inferior nasal conchae bones

Function-

1.

2.

Meatuses-

Grooves between the concha on the lateral nasal wall or the turbinates
The meatuses are inferior to each of the conchae
Superior
Middle
Inferior

Function-

Nasal Septum- splits the nasal cavity in half.

Consists of the:

1. Perpendicular plate (upper)
2. Vomer (lower)
3. Nasal cartilages (anterior)

Internal Nares- opening at the back of the nasal cavity.

Opening that separated the nasal cavity from the nasal pharynx

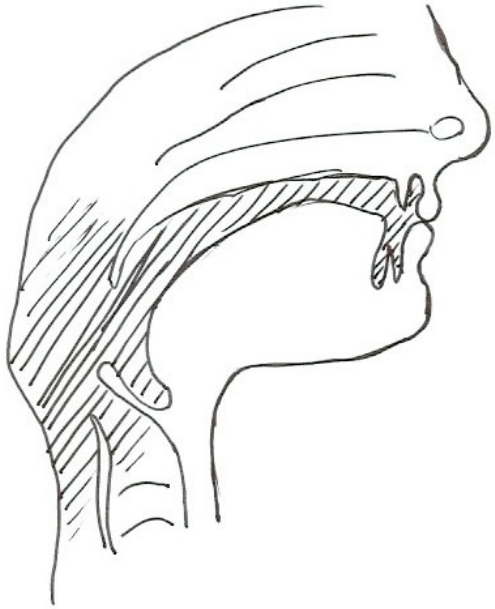
2) Pharynx (3 parts)

A) Nasopharynx- upper part of the pharynx, just below the nasal cavity
Located at the back of the nasal cavity

Houses the:
1) pharygeotympanic tube AKA
Connect air with the middle ears
Function: equalizes pressure between the outside air and the middle ear
2) pharyngeal tonsils AKA
Help defend the body against infection
Posterior surface of the nasopharynx
Can impede flow of air if inflamed

B) Oropharynx – middle portion, from soft palate to base of the tongue
The visible portion of the back of the mouth when the mouth is open

C) Laryngeopharynx- inferior to oropharynx
Part of the pharynx between the hyoid bone to the esophagus
the base of the tongue
Where vocal production occurs
Transition into the larynx



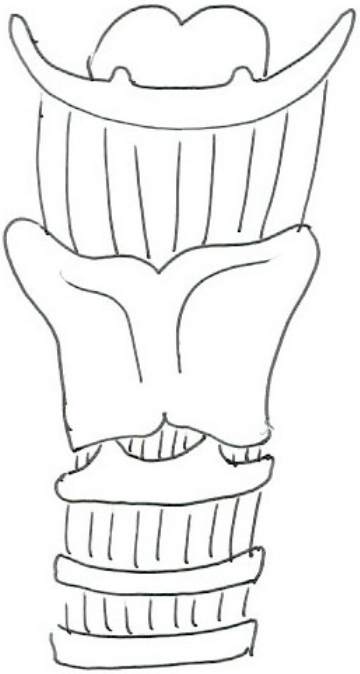
3) Larynx- region below the pharynx and above the trachea
Also where vocal production occurs
Further down from the laryngeopharynx

Contains:

a) Voice box

b) Epiglottis-

Anatomy of the Larynx



Larynx (Superior to Inferior View)

Sound Production-

High Frequency-

Low Frequency-

Epiglottis-
Cartilage flap that covers the glottis during swallowing or drinking

4) Trachea- windpipe, lies between the levels of the C6-T5 vertebrae> C6-T5 branch off to become the left and right [main] bronchi (bifurcation starts at T5)
C-shaped rings
Doesn't goes around the back
Right side of bronchi is @ more of an angle than the left side

Lined with: a)
Cilia beat upward
Carry mucus out of the respiratory system
Protection
Trap pollution and dust

Understand there is tremendous number of macrophages in the lung tissue

b)
Mucus cells

Tracheal rings- trachea is lined with approx. 20 ringed cartilages

Trachealis: helps push the esophagus out of the way during forceful inspiration to bring air in and out the lung. The trachealis tightens (contract) during forceful inspiration to maximally open the trachea

Bottom of the trachea, you'll see branching (much like a tree), there is no need for cartilage at the bottom b/c the air movement is slower here

5) Right and Left Main Bronchi- the bifurcation is located at the T5 vertebral level.
Ciliated pseudostratified columnar epithelium located within these passageways as well

Like the tracheal rings, the primary bronchi contain incomplete rings lined by ciliated columnar epithelium.

6) The 6 Levels of the Bronchial Tree (road map)

a) R and L Main Bronchi

b) Secondary or Lobar Bronchi –
3 branches on the right and 2 on the left, the reason is because we have three lobes on the right and 2 on the left

Right main bronchi hang lower [steeper angles] than the left

If you have foreign object lodge in trachea, usually goes down the right side

c) Tertiary or Segmental Bronchi –

d) Bronchioles

e) Terminal Bronchioles

f) Respiratory Bronchioles
Start to see transition from cartilage to smooth muscle

We have cartilage that surround the trachea and large passageways, we create a negative pressure (when we breathe in)

All the tracheal rings (that surround the trachea and large passage way) prevent the wall from collapsing

When we travel down the passageways, we don't have strong pressure observed in the upper regions

g) Alveolar Ducts

h) Alveoli
Termination of the air passageways
Grape-like cluster/structures (300 million)
Gas exchange occurs here between air and blood

Cell Types-

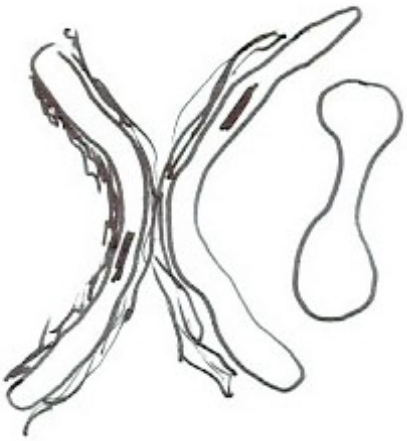
1)
For easy exchange of gases/ material across the cell

2)
Lines the septum of the alveoli

Produce surfactant → Reduce surface tension at the alveoli (make it easier to breathe) and prevent alveolar walls from collapsing

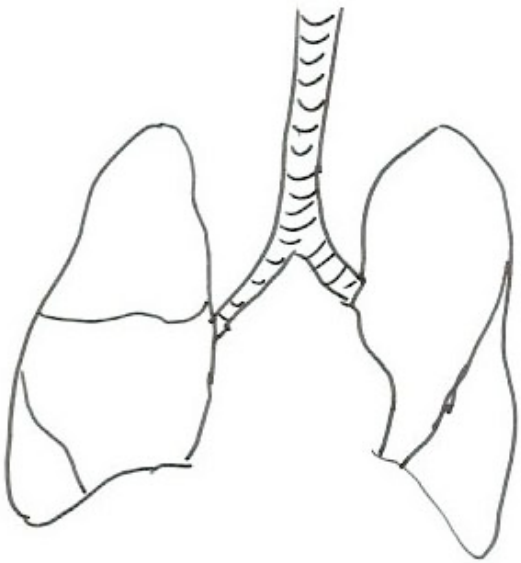
Respiratory System (cont.)

Alveolar –Capillary Membrane



Lungs- main organ of respiration

Lungs- Surface Anatomy



Pleural Membranes

Surround the lungs

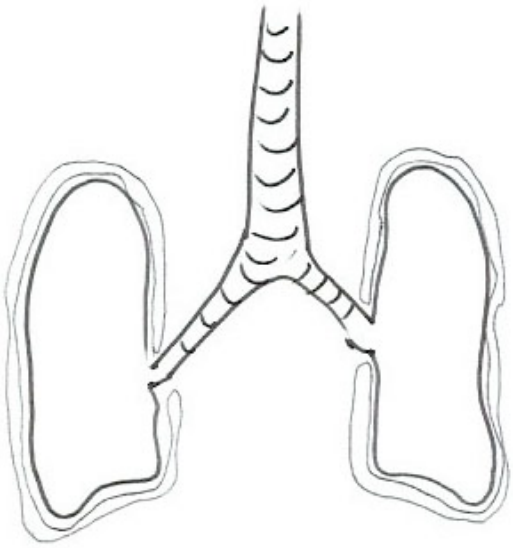
Reduce friction and prevent inflammation

1) Parietal Pleura-

The outer membrane that adheres to the inside of the thoracic cage

2) Visceral Pleura-

Membrane that adheres to the outside of the lungs



Definitions and Laws Assoc. with Respiration

1) Respiration-

A) External Respiration-

Representation of gas exchange between the outside air and blood

B) Internal Respiration-

Representation of gas exchange between blood and tissue

2) Ventilation- AKA Breathing

Process by which atmospheric gases travel up into the blood from the lungs and waste gases travel out the blood and into the air

*Alveolar Ventilation- movement of air in and out of the alveoli> Process is more diffusion than an active process

3) Inspiration- AKA

Contraction of respiratory muscle, creating a negative pressure (vacuum), which brings air into the lungs

Negative pressure = pulls air in

Positive pressure = pushes air out

When we breathe in we create a negative pressure, outside air rushes into the lung

Air flow:
Higher → lower pressure

Normal atmospheric pressure
1 Atm = 760 mmHg (at sea level)

It takes a change of only 2 mmHg to bring the 500 mmHg of air into the lungs

Muscles Involved

1)

Runs from ribs to ribs (upper ribs to the lower ribs)
Increase thoracic cage diameter
The upper fibers contract first, and then we move downward to pull the lower ribs to the upper ribs

Function: pulls ribs upward to increase thoracic cage diameter

2)

Contract, causing an increase in thoracic cage volume

*Intrapulmonic Pressure-

Represent: pressure at the alveoli
Pressure measured across the lungs and into the alveoli
Inspire- decreased intrapulmonic pressure
Creates a vacuum, causes air to rush into the lung
Expire: positive pressure
the air travels back out

Negative pressure created when we suck air in, positive pressure when we push air back out

*Intrapleural Pressure –

Pressure measured between the pleural membranes
Different from interpulmonic pressure
Greater of the two pressures because it must pull on the outside of the lungs (expand the alveoli) and cause them to expand

When we inspire, the 2 pleural membranes stick together so the lungs can get larger. The pleural membranes stick together, we need a negative pressure to get them to stick together.

The two membranes must to stick together, for the lungs to function correctly

Surface tension:

Each alveoli is surrounded by elastic fibers,

Expiration is a passive process:

Why are there two different pressures?

i. If there are elastic fibers around the alveoli, look at the pleura membrane: more force to expand them
ii. The forces at the perimeter are greater than the forces at the center of the lung
iii. The elastic fibers disipate the forces from the outer perimeter towards the center of the lungs
iv. You take a breath and the alveoli expand greater toward the perimeter than toward the center

4) Expiration- AKA

Normal expiration [resting] is a passive process
If pressure in the lung is greater than outside → air will leave the lungs

Muscles Involved-

1)

2)

Forced Expiration- occurs quickly
(Muscles involves)

1)

2)

Oblique (contract- pull ribs down)
Rectus Abdominus

Boyle's Law

V=1/P

The reason why expiration and inspiration occur
Volume is disproportionate/ inversely related to pressure
Increase pressure, decrease volume (visa versa)
If we decrease the pressure within the thoracic cage, it causes a negative pressure, increase thoracic cage volume

Respiratory Emergencies

1) Pneumothorax-

Condition:

Example: Gun Shot to the lung/ Puncture the lung
In normal air flow there is a lot of resistance and turbulence
During each breath, air goes into the pleura cavity, not going to lung tissue.
Mediastinal shift, everything left to the left side.

*Atelectasis-
Collapsed lungs [in babies]> often referred to as "collapse lung"
Will fill up to move things over laterally and lead to a tension pneumothorax

2) Decreased Surfactant Production-

Type II Surfactant Cells- AKA
a. **Surfactant** is

b. Make it easier for the lungs to expand
c. Surface tension:
d. Causes the water molecules along the alveoli to attract to each, which causes the alveoli to shrink (along with the fact there is elastic fiber along the alveoli)
e. 2 factors: elastic fibers and surface tension within the alveoli cause them to shrink
f. The cell that produce surfactant (The phospholipids that are produced by Type II surfactant cells)

Immature Baby has immature type II surfactant cells, which makes it harder for them to breathe

Respiratory Volumes and Capacities

Capacity is the summation of multiple volumes (multiple volume added together)

Tidal Volume-

Amount of air inhaled or exhaled with each breath under resting conditions
Represent about:

Expiratory Reserve Volume-
Amount of air that can be exhaled after normal tidal volume, exhalation
The bottom of expiration, we breathe out as much as we can ~

Residual Volume-

Volume of air still remaining in the respiratory passage and the lungs, after the most forceful expiration
What's left over at the bottom of Expiratory Reserve Volume
What's left over in the lung after we breathe out as much air as we can
This is the air we dip into when we get the wind knock out of us

Inspiratory Reserve Volume-

Amount of air that can be forcefully inhaled after a normal tidal volume inhalation
Breathe in as much as we can

Vital Capacity=

Max volume of air that can be exhaled after max inspiration (apx. 4600 mL)
Everything we have control over

Inspiratory Capacity=

Amount of air that can be forcefully inhaled after a normal tidal volume, inhalation (apx. 3500 mL at rest)

Functional Residual Capacity=

Amount of air remaining in the lungs at the end of a normal expiration (apx. 2300 mL)

Total Lung Capacity=

Vital capacity + Residual volume

~ 5800 mL

<u>Respiratory System</u> (cont.)

Minute Volume of Respiration

MVR=

Example:

Typical respiration (resting) lasts about 5 seconds (2 sec inspiration and 3 sec of expiration)
About the same amount of blood pumped per minutes (about 6000 mL/min)

Dead Air Volume (Anatomical Dead Air Space)-

- Represent the amount of air inhaled where no gas exchange takes place
- It's at the bronchi. Bronchus, trachea (Gas change ONLY occurs at the alveoli)
- 150 mL of the 500 mL that we inspire
- The last part that we breathe doesn't get down into the alveoli. Most air from a specific breath doesn't make it to the alveoli, it stays at the Bronchiole
- Diffusion causes the air to go to the alveoli (oxygen diffuses down to the alveoli)
- If all the air goes into the alveoli, the blood will be heavy with oxygen and it will lead to hypo- oxygenated and hyper-oxygenated blood
- As long as we are breathing, we are maintaining constant oxygen concentration

Dalton's Law- each gas, in a mixture of gases, exerts its own pressure independent of the other gases (as if the other gas isn't present)

partial pressures

According to Dalton's Law we can add up all gases

$pN_2 + pO_2 + pCO_2 + pH_2O = 1$ Atm

Atmospheric air is a mixture of several gases including:

1) N_2 → makes up about 78% of the air
2) O_2 → 21%
3) CO_2→ 4%
4) H_2O → 5%

Atmospheric pressure at sea level: 760 mmHg

How do we determine the partial pressure of each gas?

$pN_2 + pO_2 + pCO_2 + pH_2O = 1$ Atm

1) N_2 → 0.78 x 760= 592 mmHg
2) O_2 → 0.21 x 760 = 159 mmHg
3) CO_2→ 0.04 x 760 x 760 =3 mmHg
4) H_2O → 0.05 x 760 = 3.8 mmHg

Why does gas exchange occur between the lungs and the blood?

Because it deals with diffusion and partial pressure

We move from higher to lower pressure, (this is why oxygen moves from one area to the next)

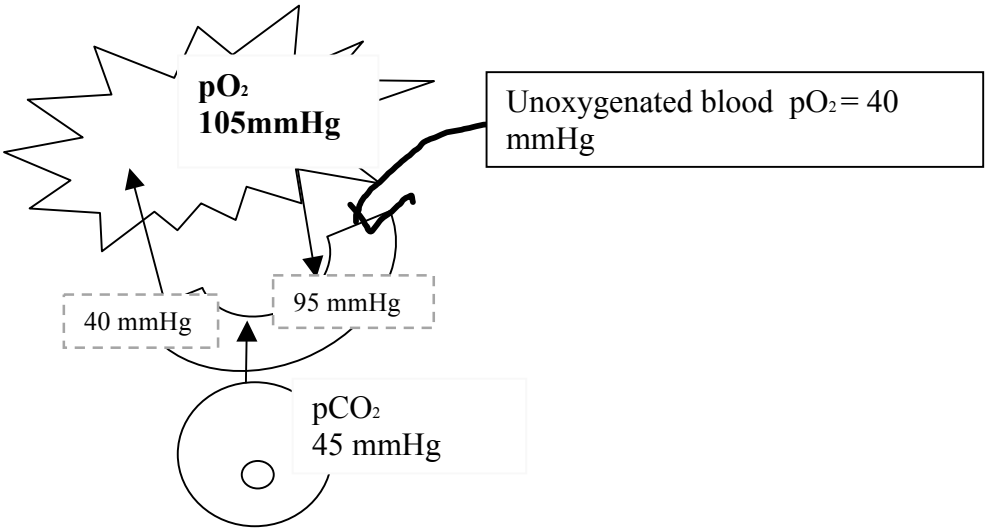
pO_2 = 159 mmHg Atm Air

Alveolar pO_2: 104 mmHg Alveoli

Pul. Blood pO_2: 40 mmHg pul Blood

Pul. Blood pCO_2: 45 mmHg

Alveolar pCO_2: 40 mmHg



Oxygen Transport and Internal Respiration

How O2 and CO2 are carried in the blood

% O_2 bound to hemoglobin:

% O_2 dissolved in plasma:

Now we do not need to perform rescue breaths during CPR b/c oxygen is still bound to hemoglobin. (The hemoglobin serves as O2 reservoir)

Hemoglobin as an O_2 reservoir –

Large amount of O2 still bound to the hemoglobin

The faster and higher the metabolism

Oxyhemoglobin:

The brain needs oxygen and glucose to survive

Factors Affecting the Release of O2 from the Hemoglobin Molecule

A) The Bohr Effect

For any given oxygen hemoglobin saturation, oxygen will be kicked off the hemoglobin at a faster rate, if any of these conditions are present:

1) lower pH:

The more acidic the blood the faster we kick the oxygen off the hemoglobin
A decrease in pH means an increase in the partial pressure of oxygen in the plasma
A decrease in pH means more H ion concentration in the blood
A decrease in pH means your increasing metabolism → we make more oxygen available to the tissue

pO_2 (partial pressure of O2 in plasma)
Represent the 3%

2) increased temperature:

Increase temperature, kick oxygen off at a faster rate for hemoglobin saturation
Does the same thing as pH

3) increased levels of 2,3- DPG:

B) Lower pO_2 in tissues

Simple diffusion (higher to lower)
Lower oxygen in the tissue cause oxygen to _____.

<u>Carbon Dioxide Transport</u>

CO_2 generated as a by product of metabolism

Three Modes of CO_2 Transport: (3 ways CO_2 is carry in the blood)

1) Dissolved in plasma

2) Bound to hemoglobin

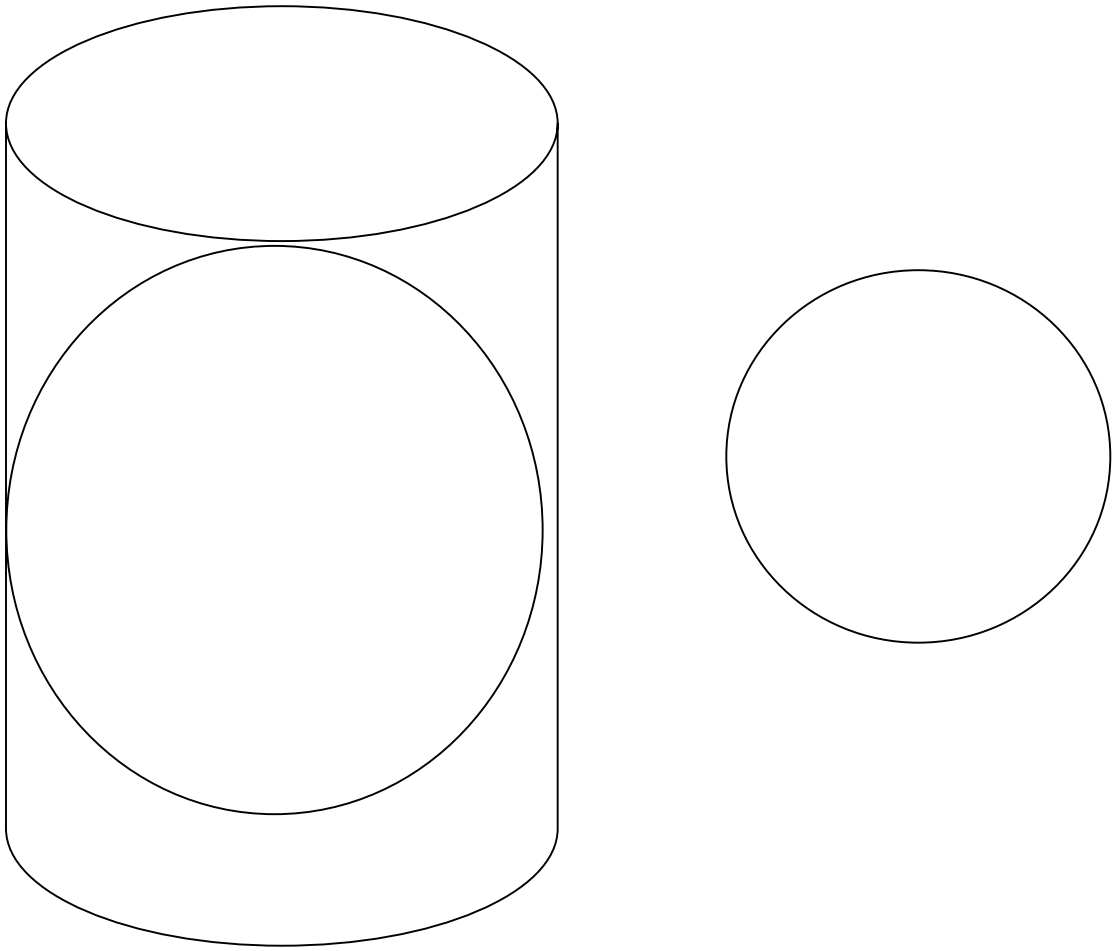
Hemoglobin that carries CO_2

3) As a component of the blood buffer system

Carbonic Acid Buffer System

We blow out CO_2

The drawing below shows how CO_2 is carried in the blood



*The Chloride Shift-
For every bicarbonate ion that goes outside the cell, chloride goes in the cell to maintain a net electrical neutrality

Respiratory System (cont.)

Respiratory Centers of the Brain

Located in the reticular formation of the pons and medulla
Each center does different things

A) Respiratory Rhythmicity Center
Sets the basic rhythm for respiration

Two Parts

Dorsal Center-
Controls what you do from a respiratory perspective (whether you're thinking about it or not)
We don't have to think about it 99% of time

Ventral Center-

B) Apneustic Center
Adjusts_____
Example: if you think about it, you will _____

C) Pneumotaxic Center

Respiratory Center performance can be altered by input from 3 areas. Receptors from these areas send info back to the brain to alter respiration.

1) Mechanoreceptors
Respond to lung volume

a) mechanoreceptors proper
Lungs stretch receptor
Like a Golgi tendon for the lungs

Inflation Reflex-
Prevent over expansion of the lungs

Deflation Reflex-
Stimulate inspiration when the lungs begin to collapse
As soon as you breathe out, the lungs say, "ok it's time to breathe in again" (it's just a reflex)

b) Baroreceptors

Monitor blood pressure within the lungs
It's working all the time

2) Chemoreceptors

Chemoreceptor in the carotid and aortic body

Monitor (detect): H^+, CO_2, O_2, and pH levels

The reason why we detect these factors is b/c they are direct indicators of metabolism

get rid of CO_2 and H^+ ion
And increase O_2 level

One of its main functions is to maintain proper pH
CO_2 =

3) Higher Centers in the Brain

- The cerebrum-is controlled by voluntary respiration
- We can override normal respiration: simply by thinking about it
- We can hold our breath, breathe deeper, yawn

The Digestive System

Digestion- the process of converting food to chemical substances that can be absorbed and assimilated by the body's tissues.

<u>The Five Activities of the Digestive System</u>

1) Ingestion-
To eat or take in food

2) Peristalsis
Movement of food along the digestive tract via smooth muscle contraction (involuntary wave)
Mechanical and Chemical Digestion

a) Mechanical-
One aspect is chewing,
Chopping and churning of the stomach and intestine to mix the food with digestive enzymes

b) Chemical-
Digestive enzymatic reactions breakdown carbohydrates, lipids, and proteins into visible molecules

We want to make sure these molecule are completely broken down, b/c if we digest large molecules, these molecule can become antigenic to our immune system/ body

3) Absorption-
   The passage of digestive materials into the circulatory and lymphatic system
   Fat is absorbed into the lymphatic channel/system

4) Defecation-
   The elimination of digestive waste products

Gastrointestinal Tract (AKA- Alimentary Canal)

GI tract: continuous muscular tube running through the ventral body cavity, extending from the mouth to the anus

Approx. 30 feet long

Realistically: closer to 10ft, shorter in a live individual b/c there is muscle tone, shortens the length of the entire tube

Closer to 20-21 ft. long in a living individual

Organs of the Digestive Tract

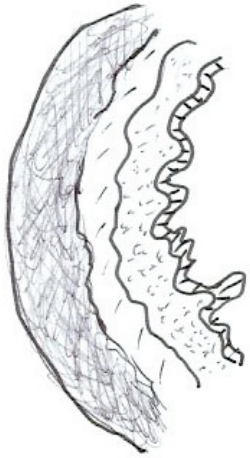
1.
2.
3.
4.
5.
6.
7.
8.
9.

Accessory Organs

1) teeth
2) tongue –help to move food around in the mouth so we can chew
3) salivary glands
4) gastric and intestinal glands
5) liver
6) gall bladder
7) Bruner's glands
8) pancreas
9) spleen

The Four Layers of the GI Tract

From innermost to outermost



1) Tunica Mucosa (three layers)
   Tunica: Coat/ covering
   Mucus coating

   a) Epithelium-
      i. Innermost layer (lines lumen of GI tract)
      ii. It's called epithelium b/c it comes in contact with the outside environment
      iii. One cell layer thick =>
         - Absorption
         - Found in the remainder of the digestive tract
      iv. Stratified squamous epithelium

   b) Lamina propria-
      - Deep to the epithelium
      - Made of loose [areolar] connective tissue
         - Areolar -space in-between
         - Loose and airy

   c) Muscularis mucosa
      i. Deep to the Lamina propria

ii.
iii.
iv. Regulates blood vessel flow through lamina, Meissner's plexus

2) Tunica Submucosa
- 2nd main layer
- Made of loose connective tissue that binds the tunica mucosa to the next deepest layer
- Contains many blood vessels and an autonomic plexus called the Meissner's plexus

Meissner's plexus: (controlled 2 things)
1. Control the Muscularis Mucosa
2.

3) Tunica Muscularis
- Involuntary smooth muscle (loose areolar connective tissue)
- Run throughout most of the GI tract

Two layers (most parts 2 layers but some instance there are 3)

1)
Cause constriction along the tube

2)
Involve in peristaltic motion (under autonomic control)
If it contracts on one side, relaxes on other side

This is why we see chopping and churning motion in this group of muscles

Involved in mechanical digestion, mixture of food and enzyme

You have 2 muscular layers, nerve supply:

Function:
- In between the two layers
- Control the two layers
- Control the mobility of the intestinal tract

Some of the digestive tract is not controlled by the autonomic nervous system, some by conscious control

- Conscious control: begin and end
- Autonomic control: stomach, small and large intestine

4) Tunica Serosa
   - ***AKA Visceral Peritoneal***
   - Outer most layer
   - Serous membrane of connective tissue and epithelium

Peritoneal Membranes

Largest serous membranes in the body.

Function-

1. Prevents friction in the abdominal cavity
2. Help suspend organs in their proper position in the abdominal cavity
3. We know:
   - Some the organs are suspend within the serous membrane
   - Some organs are shrink-wrapped against the back of the abdominal wall (example kidney), can cause trauma if suspended

Two Layers

1) parietal-

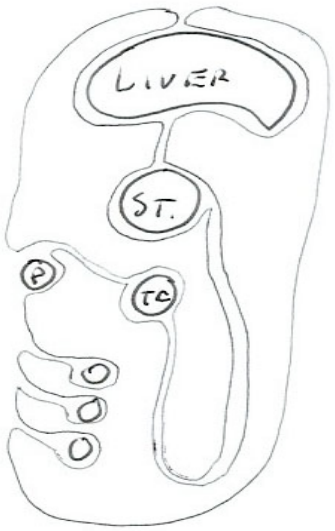
2) visceral-

Embryological Development-

- Organs will grow in peritoneal sacks during embryological
- fist in the balloon theory
  - Start out as small organs that comes off the posterior wall, that drops into and is supported by the mesenteries

Diagram of the Peritoneal Membranes of the Abdominal Cavity

- Greater Omentum: connects the stomach to the transverse colon
- Lesser Omentum: connects the liver to the stomach
- Falciform Ligament: connects the diaphragm to the liver
- Transverse Mesocolon: connects the transverse colon to the posterior abdominal wall via the pancreas (continuous of the greater omentum)
- Mesenteries: surround/ support the small and large intestine



4. Mesenteries-
    - Double layer of peritoneum that suspends organs within the abdominal cavity
    - Part of the peritoneum that is drawn forward and doesn't come in contact with the abdominal wall and the visceral.
    - Serous peritoneum sheets that suspend the organs in the abdominal cavity. Do not adhere to or come in contact to the abdominal walls or organs

<u>Digestive System</u>
<u>Oral Cavity</u>

A) Boundaries

1) Lateral walls-
    Made up by the cheek mucosa membrane and muscle
    Lined with stratified squamous epithelium
    Muscle:
        Buccinator muscle

2) Anterior wall-
    Lips
        - Outside the lips is made of skin, dry mucus membrane
        - Inside is made up of moist mucus membrane

    Vermillion-
        Transition zone of the inner and outer part of the lip

3) Superior-
    Made of palate:

Palate:

- Anterior 2/3 is hard palate (bony)
- Posterior 1/3 is soft palate made of mucus membrane and muscle
    - Consist of skeletal muscle and connective tissue

4) Inferior-
   Tongue and the associated muscle of the floor of the mouth

5) Posterior (Fauces)-
   The divider between the posterior mouth and the oral pharynx

   Palatine Arches

   a) palatoglossal arch-

   -
   -
   - Uvula:
       - the fleshy pendulous structure posteriorly projecting from the soft palate

   - gossal

   b) palatopharyngeal arch-

The palatine tonsil is located between the palatopharyngeal arch and palatoglossal arch

B) Tongue- comprised of skeletal muscle covered with mucous membrane. Dexterity, involved in digestive process.

1) Muscle types-

   a) extrinsic-

   b) intrinsic-

2) Lingual frenulum-
   - Is a fold of mucus membrane/ tissue along the midline under surface of the tongue

- When it is too short and tight, it will have to be cut in surgery and sutured

Submandibular ducts-

Openings on the underside of the tongue
on either side of the lingual frenulum

Taste buds

- not the bump on the surface of the tongue
- sensory receptors on the side of the tongue
- Innervated by glossopharyngeal nerves, the vagus nerve and cranial (facial) nerves
- The reasons why they are on the side:

3) Papillae-

Three types of papillae

1) Circumvallate-
   i. Form an inverted V
   ii. Series of about 20
   iii. Base of tongue
   iv. Contain bitter taste receptors
   v. Larger >seen with naked eye
   vi. These pick up the bitter taste
   vii. Conical shaped
   viii. There is moat or valley that wraps around the base

2) Fungiform-
   - Mushroom shaped
   - Red dots
   - More numerous at the tip of the tongue

3) Filiform-
   - Slender projection found at the anterior surface 2/3 of the tongue

4) Salivary glands- glandular tissue that secretes saliva

Saliva-

Keep mouth moist
Lubricates food
Breaks down starches
Has antibacterial properties

3 Pairs of Salivary Glands

a) parotid-

- located: side/ lateral to the masseter muscle

- Largest
- Anterior and inferior to the ear
- Big gun b/c most of the time it doesn't secret saliva
- Release saliva when your eating

b) submandibular-

- Produce most of the saliva while resting

c) sublingual-

- on either side of the tongue
- Run in a line
- Produce saliva constantly
- Keeps mouth moist

Saliva function

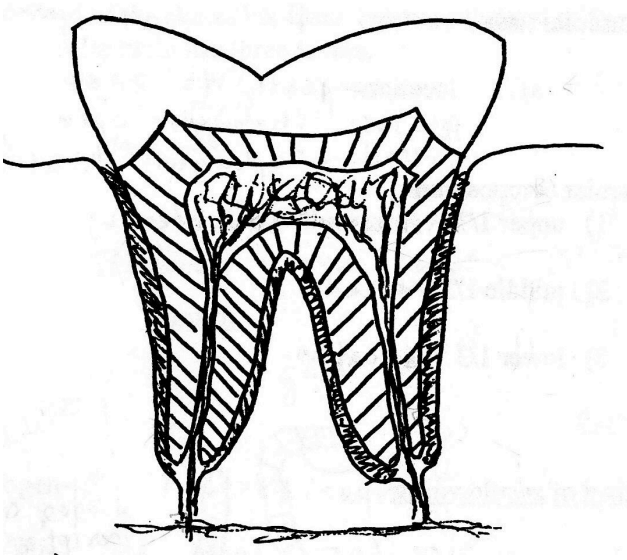
a) Initial carbohydrate break down
b) Destroy bacteria
c) Lubricate food for swallowing

Composition of Saliva-

1. Salivary amylase: breakdown carbs/ glucose
2. mucin: mucus-like secretion
3. lysozyme: (break down material and viruses)

5) Teeth- adults have 32 teeth, function - aid in mechanical digestion

Anatomy of a Tooth



- Crown
- neck : joins crown to root
- root: consists of 1-3 projections embedded in bone

- Enamel: Hardest substance in body
- Dentin: resemble bone, living cellular, calcified tissue
- Pulp cavity: filled with vessel, nerves, lymphatics
- Cementum: bone-like attaches dentin to periodontal ligament, anchor the tooth in the jaw, bonding agents
- Periodontal ligament: dense fibrous connective tissue attaches cementum to surrounding bone
- Root canal
- Apical foramen: where blood vessel and nerve exits

<u>Adult teeth</u> (permanent)
32 teeth, 4 quadrants (8 in each quadrant)
3rd molar AKA wisdom tooth

Teeth (deciduous)

Baby's have only 20 teeth, 5 per quadrant

Definitions

Ingestion: eating food, taking food into the body

Mastication:

Deglutition:

II. Esophagus

1 ft. long muscular tube
Made of stratified squamous epithelium
Folds to allow expanding
You can see a sharp separation from one set of tissue to the next (esophagus to stomach)
Runs from pharynx to stomach

a) location-

- Posterior to trachea

- passes through opening in diaphragm called esophageal hiatus

There are 2 sphincters:

- upper:
- lower:
  - separate esophagus from stomach
  - located close to the heart

Both regulate the movement of food in and out of esophagus

Muscular composition-

1) Upper 1/3:
2) middle 1/3:
3) lower 1/3:

Mechanism of swallowing (Peristalsis)

Peristalsis-

A muscular wave of the digestive tube that pushes food forward

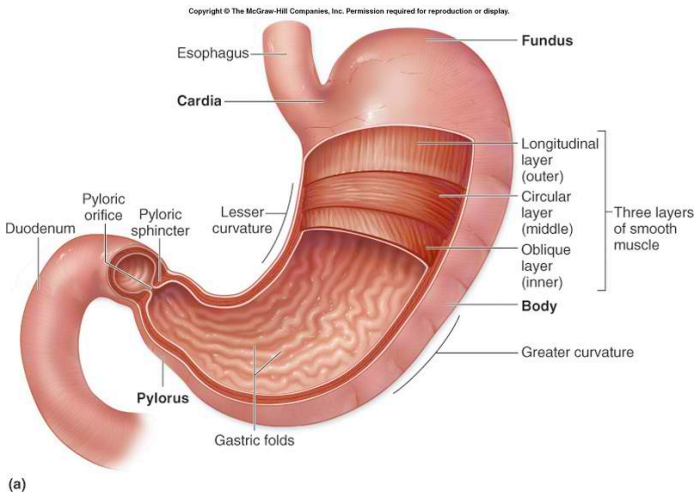
III. Stomach

Functions-

1. store food
2. break down food mechanically
3. break down food chemically
   a. chemical digestion
   b. release enzyme to break down proteins
   c. produce HCL

Chyme- mixture of gastric juices and food material

Anatomy of the Stomach



Digestive System (cont.)

Stomach Wall composed of the same four basic layers as the rest of the digestive tract.
Only difference – muscular tunic has three layers.

1) Outer-
2) Middle-
3) Inner-

Rugae-

- ridges found within the lining of the stomach
- muscular folds that line the lumen of the stomach when empty

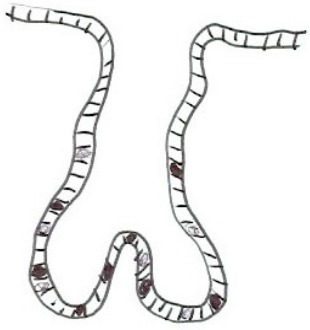
- Little absorption

Microscopic Anatomy of the Stomach

Chief Cells
(Left side)

1. Inactive Pepsinogen-
   Convert to pepsin in the presence of HCL

2. Gastric Lipase-
   Fat break down



Parietal Cell
(Right side)

1. HCL
   pH 1.5 -2.0 activated pepsinogen
   Enzyme that break proteins, etc. down
   Break down bacteria and virus
   Pepsinogen → Pepsin

. 2 Intrinsic Factor-
   Help absorb vitamin B12
   B12 is important in RBC formation

Pepsinogen → Pepsin
Pepsin is important in protein digestion

Mucus neck cell:

Little absorption occurs here.

Chief and Parietal Cells secrete approximately 150ml of gastric juice per day.

There are cells called enteroendorine cells
Many hormones produced in gastric pits (and other parts of digest tract) that speed up or slow down digestion

Enteroendocrine Cells-

Reside within the gastric pits, secrete 6 different known substances.

Gastrin (a main regulatory hormone)-

Polypeptide hormones released when food enters stomach
Function to initially speed digestive process

Regulation of Gastric Function
(Three Phases)

A) Cephalic Phase-
- Sight, smell, taste causes CNS to stimulate Vagus nerve
- This PNS stimulation increases gastric motility and secretion of juices
- Before food enters stomach, prepare for eating
- Example:

B) Gastric Phase-
- Arrival of food to the stomach (food enters stomach)
- Ramp up digestion
- Increase muscle contraction, gastric secretion causes increased motility
- End Result

C) Intestinal Phase-
- Begins as chyme enters duodenum
  - Chime: mixture of food material and stomach acid
  - Chyme is highly acidic
  - When the chyme enters the duodenum it slow down digestion
  - Enters though the pyloric sphincter
- Propose: controls rate of gastric empting
- Mostly inhibitory

Enterogastric Reflexes

If duodenum is full then these reflexes suppress motility and gastric activity.

Arrival of chyme also causes enteroendocrine cells of the small intestine to inhibit gastric secretions.

Basically tries to slow down what's going on in the stomach, so we can keep up with the stomach

We can't dump everything into the duodenum

If too fast causes diarrhea

Released in small amount

They are:

1) Cholecystokinin-

Peptide hormone causing:

1.

2. constrict gall bladder- release bile

3. inhibit gastric activity

2) Secretin-

Tell pancreas to secret

3) Gastric Inhibitory Peptide-

(Glucose-dependent insulinotropic peptide)

Inhibits release of insulin from pancreas

Want the insulin there to take sugar to put in the cell, decrease sugar level

Prepare pancreas for an increase in sugar, so pancreas needs to release sugar

Pancreas

Soft, approximately six inches long.

Set in the curve of the duodenum

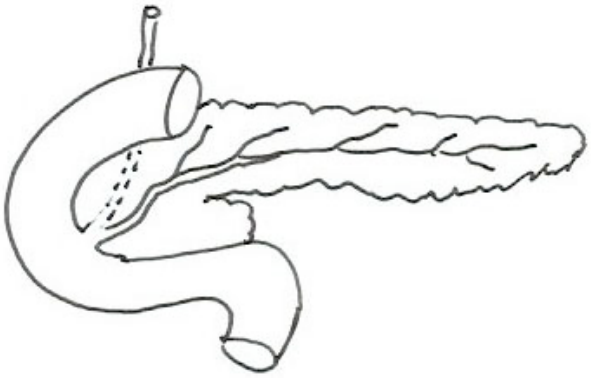
Pancreas has two main duct

Lower/main:

Above/ accessory:

Location-

Posterior and inferior to stomach. Glandular tissue



Made up of 2 types of glandular epithelial Cells

1) Acinar Cells- make up the majority of the pancreatic tissue

   Form the exocrine portion of the pancreas. ***Ducted***
   Secrete pancreatic juice, which is a mixture of digestive enzymes.

   a) alpha-amylase- digesting carbohydrates
   b) pancreatic lipase- digesting fats
   c) Nucleases- breaking down RNA
   d) Proteases (trypsin, chymotrypsin, carboxypeptidase)-

      - Different types to break down different sized proteins/ different bonds within the proteins
      - Carboxypeptidase:

   All these digestive enzymes are released in specific location in the duodenum

   Secretin-
      When chyme enters the duodenum, secretion is released which is an alkaline solution, released to neutralize stomach acid entering small intestine
         Neutralized the acidity of the chyme

   Pancreatic Juice is alkaline with a pH of 7.5-8.8
   Gastric: pH 1.5-2.0

2) Islets of Langerhans- clusters of cells residing within the acinar cells.

Ductless- endocrine

a) alpha cells-

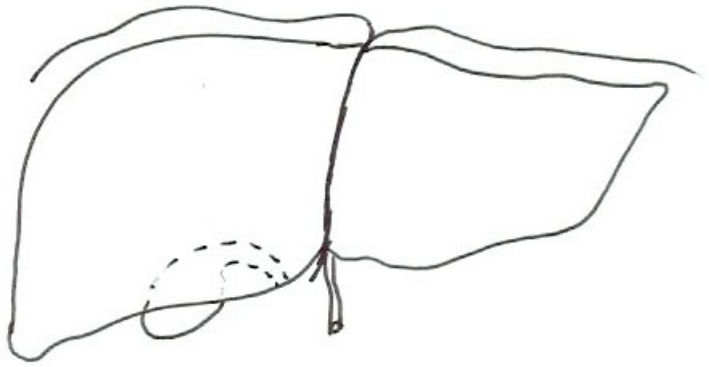
b) beta cells-

Liver

Largest visceral organ within the human body.
Approx. wt.- 4 lbs.
divided into a right and left main lobe
which is separated by the falciform ligament.
Located predominantly within the upper right quadrant of the abdomen under the diaphragm.

Anatomy of the Liver

Anterior View



Inferior View

Everything enters and exits the liver on the under side through the ***Porta Hepatis***:
1.

2.

3.

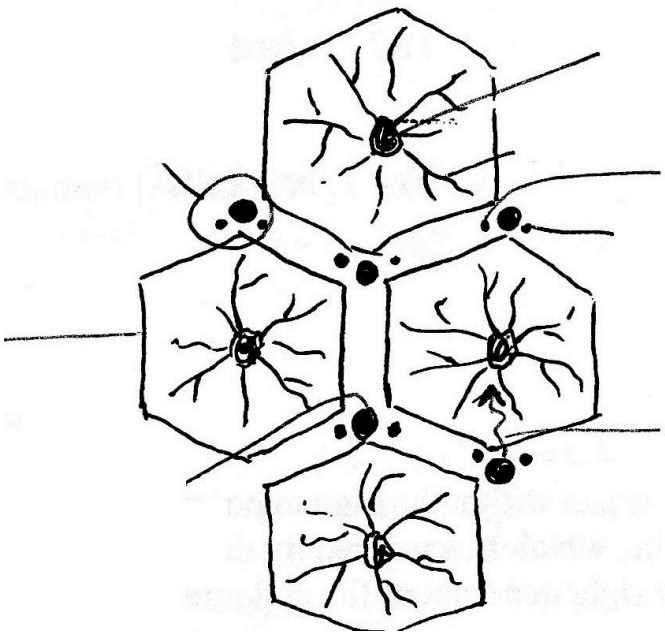
2 main pseudo-lobes to in the liver:
Caudate: between inferior vena cava and left the left lobe (face more towards the tail)
Quadrate: b/c it has four sides

<u>Microscopic Anatomy of the Liver</u>

Lobules- the liver is divided into microscopic units called lobules. They consist of cords of liver cells called hepatocytes, which are arranged in a radial pattern around a central vein.

Sinusoids-

Kupffer Cells-



The blood flow from the central veins to the hepatic vein, then goes into the inferior vena cava
The central veins become the hepatic veins

2 blood supply for the liver:
Double Blood Supply of the Liver

1) Hepatic Artery-
   O2, (nutrient rich- relatively) from celiac trunk

2) Hepatic Portal Vein-
   O2 deficient, nutrient rich from digestion
   Unoxygenated: take nutrient rich, unoxygenated blood from the digestive system, sending it up via the hepatic portal veins to the liver to process the blood. The blood runs through the lobule

Blood Flow

Hepatic Portal vein → Sinusoids→Central Vein→Hepatic Vein→Vena Cava

Liver Functions

A) Metabolic Regulation
   - Monitor circulatory level of metabolites and adjusts them
   - Toxins and other metabolic wastes are also removed
   - Fat soluble vitamins are stored
     - Reason why fat soluble vitamins are toxic when consumed a large amount

B) Hematological Regulation
   - The Liver is the largest blood reservoir in the body
   - Stores blood
   - Removes aged and damage RBC
   - The spleen does the same thing

C) Synthesis and Secretion of Bile
   Bile is composed of bilrubin, cholesterol, ions lipids and water. It is created from the recycling of the heme from RBCs, and is required for the normal digestion of fats.

Function of Bile:

Enterohepatic Circulation-

Secretion of Bile-
Stimulated by cholecystokinin in response to fat in intestine

Cholecystokinin:

The Gall Bladder

A small sac located on the underside of the liver.
Cholecystokinin causes contraction of gallbladder and relaxation of sphincter

Function-
Stores and concentrates bile

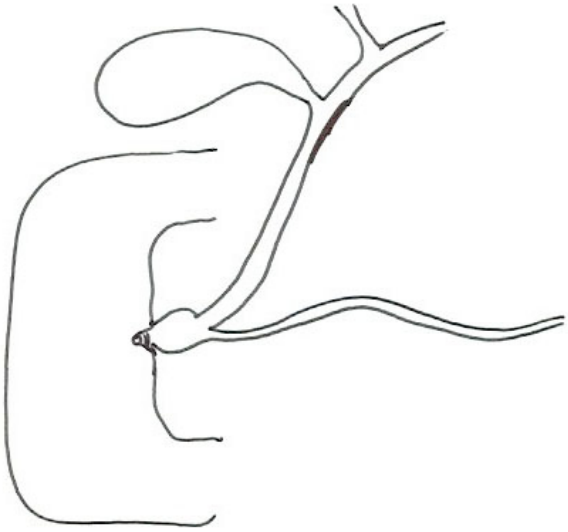
When gallbladder is removed Bile isn't stored or concentrated in the body

Gall bladder removal-
Condition: Steatorrhea

Also an indicator for liver problems
Certain Demographic: 4 Fs

Anatomy of the Region

See diagram of the bile flow



Small Intestine

Approx. 20 ft. long, begins at pyloric valve and ends at the cecum, majority of the absorption occurs here.

It's going to receive a liquid like substance known as chyme from the stomach. The pyloric sphincters only opens up a little bit to allow liquid like substance.
Need to be liquid so it can be absorbed

Three Divisions

A) Duodenum -

Receive chyme from stomach and exocrine secretion from pancreas and liver

Functions: Neutralize the chyme and release contents from the liver and pancreas for digestion to continue

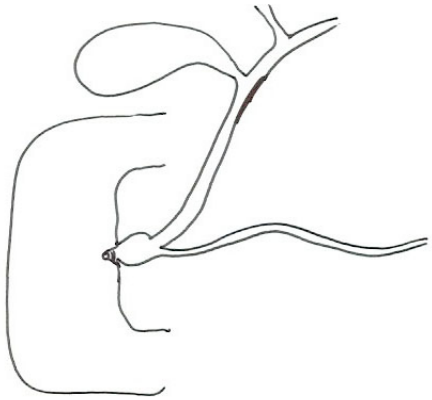
Secretin is used to neutralize

Brunner's glands-

buffers elevate pH of acidic chyme.
pH goes from 1-2 to 7-8

Duodenal papilla-also located here

Pancreatic and bile juices mixed with chyme in duodenum



B) Jejunum- next region of small intestine, approx. 8 ft. long, most of the absorption occurs here

C) Ileum- last region of the small intestine, approx. 12 ft. long.

Peyer's patches-
20-30 of them
A collection of lymph nodules that prevent proliferation of bacteria in small intestine
Immnocompetent tissue
Function:

Only when we arrive in the large intestine the fluid become semisolid
Bacteria in large intestine: coliform bacteria
Bacteria in the small intestine: probiotic

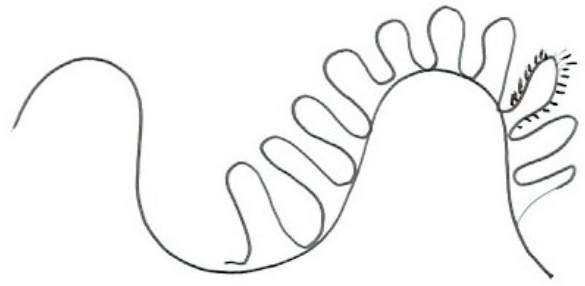
Microscopic Anatomy of the Small Intestines
There are four layers of the small intestine as noted previously.

Plicae- transverse folds

Larger fold
Increase surface area

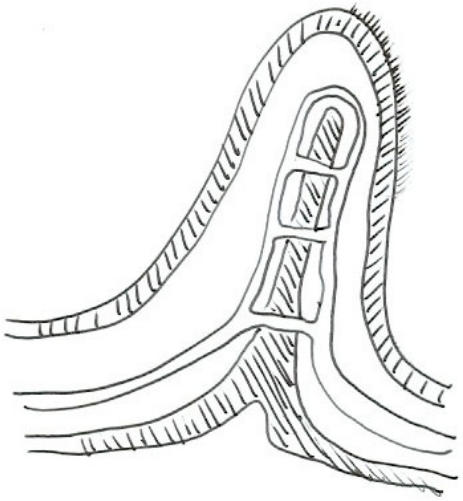
Villi- finger-like projections
Smaller fold on top the plicae
Increase surface area

Microvilli- (brush border)
Each villum is covered by
simple columnar epithelium
Located at the top of the cell
Each cell has microvilli on it's surface
Observe at high magnification



Serve to increase surface area for greater absorption

Microscopic Anatomy of the Villi



Lacteal-
Terminal lymphatics that transport materials that do not enter capillaries because of their large size. I.e Fatty Acid

Large fat molecules are absorbed here

Chylomicrons- protein-lipid packages that transport fatty acids through the lymphatic system.
When fat enters the blood stream: can't be just fat b/c fat is non-polar (doesn't dissolve in water)

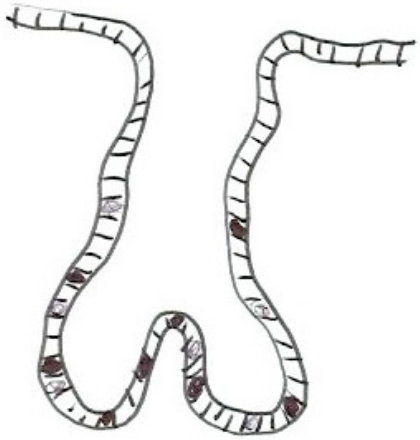
- HDL/LDL cholesterol: to dissolve, it's surrounding by a protein layers
- Low Density Lipid proteins: lots of fat to protein ratio
  - Take fat from food and store it
- High Density Lipid proteins: denser b/c more proteins
  - Use all fat, smaller fat globule with more protein to fat ratio
  - Want more: b/c you take fat from storage to use as an energy storage

Crypts of Lieberkuhn- AKA
Pits in the intestinal wall that perform three functions.

1) reproduce and replace the columnar and goblet cell epithelium that is shed from abrasion during the digestive process.
   Process called exfoliation

2) Produce Enterokinase- hormones that activate pancreatic enzymes

3) Contain Enteroendocrine Cells- produces various hormones including cholecystokinin and secretin.



Mechanical Digestion
Movements of the Muscular Tunic

1) Rhythmical Segmentation- contraction of the circular fibers in various locations on and off to divide small intestine into fragments. Occurs 12-16 times per minute to move chyme back and forth.
   Cause food to slosh and move around
   Cause food to move around and be mixed

2) Pendulous Movements- contraction and relaxation of the longitudinal fibers causing the movement of chyme.
   Close/ contract one side of the tube longitudinal and relax the other side

3) Propulsive Peristalsis- a peristaltic wave that propels chyme forward through the intestines.
   Pushes food forward

Chemical Digestion

1) Carbohydrates
   a. Mouth – salivary amylase begins sugar breakdown
   b. Duodenum – pancreatic amylase continues sugar breakdown
      Absorbed in small intestine

2) Proteins
   a. Stomach- pepsin breakdown of proteins into short chain amino acids
   b. Small Intestine- chymotrypsin, trypsin, carboxypeptidase continue protein breakdown

3) Lipids- covered earlier

4) Vitamins
   a. Water soluble vitamins are easily absorbed through the intestinal epithelium
   b. Fat soluble vitamins are absorbed with lipids
      Most vitamins and minerals are absorbed in the large intestine
      Vitamin A, D. E

Large Intestine
Approx. 5 ft. long

1) Cecum- first portion of the large intestine. Separated from the ileum by the ileocecal valve, which regulates digestive flow from small intestine into the large intestine.
   Receives everything from the small intestine

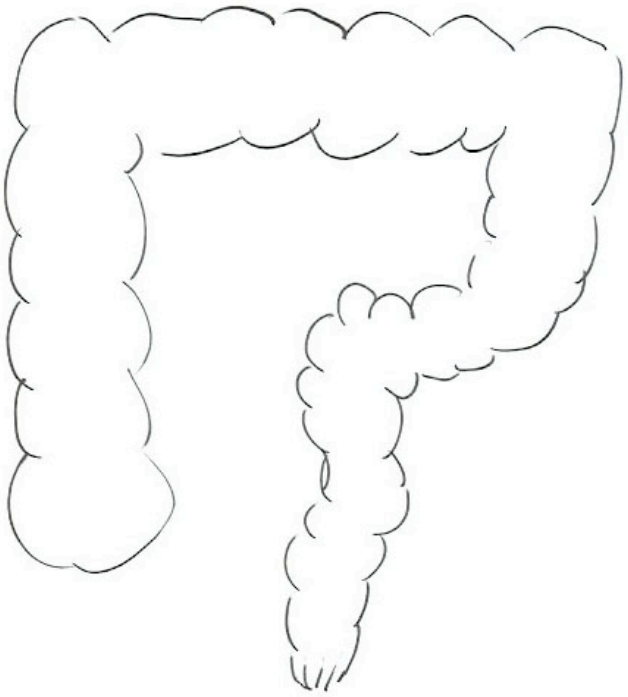
*Vermiform Appendix- extends from the bottom of the cecum. Approx 3-4 inches long, a blind end, hollow tube made of lymphatic tissue

Appendicitis:

.

2.
3.
4.
5.
6.
7.

Anatomy of the Large Intestine



Teniae coli:

Haustra:

Flexure: a little twist/ angle

Microscopic Anatomy of the Large Intestine

Contain fewer plicae and villi, but is lined with columnar epithelium, and many goblet cells to secrete mucus for movement of fecal material.

Mucus main function:

Make it easier for defecation to occur as we go form semisolid to solid.
Protective

Functions of the Large Intestine

1) Movement of Colon Contents

Haustral churning- the haustra distend and relax as they squeeze their contents to the next haustral segment.

2) Peristalsis

Peristaltic movements occurs here as occurs in the small intestine, but mass peristalsis is also observed. This is a strong wave that drives fecal contents into the rectum.

3) Absorption and Fecal Formation

Bacteria aid in the final decomposition of remaining proteins and breakdown bilirubin into a brown pigment. Bacteria also aid in the synthesis of various vitamins. The large intestine is vital in maintaining the body's water balance. The majority of water absorption occurs here. This also converts the fecal material into a semisolid waste ready for elimination.

4) Defecation

Mass peristaltic waves push fecal material into the rectum. This stimulates pressure sensitive receptors to initiate the defecation reflex. Fecal pressure in the rectum causes relaxation of the internal anal sphincter (smooth muscle), and contracting of the external anal sphincter (skeletal muscle). Conscious release of the external anal sphincter allows defecation to occur.

External sphincter you have conscious control over to go to bathroom.
Internal sphincter is subconscious control over by the autonomic nerve system

The Urinary System

Function – maintain homeostasis by controlling the volume and composition of blood.

Maintain pH though buffer system and breathing
Happens secondarily
Blood Buffer -H ions (happen fast)
More important thing the kidney does is maintain the pH of the blood

Major Components

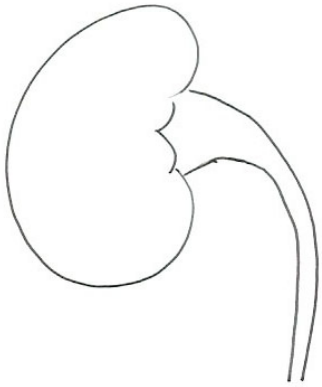
2 kidneys
2 ureters
1 bladder
1 urethra

I. Kidneys

- Bean-shaped organs about 4 inches long and about 2-3 inches wide.

- Maintain homeostasis within minutes to hours

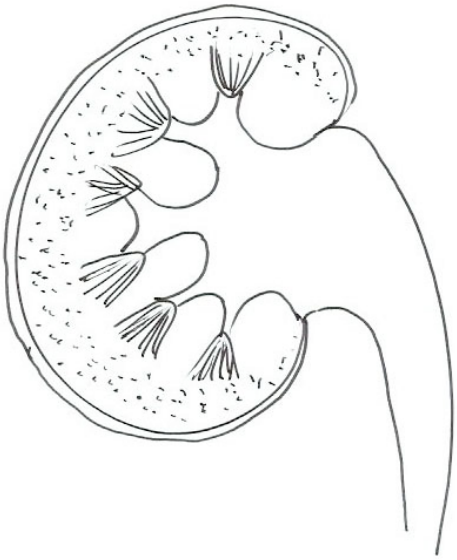
- Get rid of Bicarbonate (HCO_3) and H ions



The Three Layers Surrounding the Kidney

1) Renal Fascia – outermost layer of thin fibrous connective tissue that anchors the kidneys to the surrounding structures.
2) Adipose Capsule – 2nd layer, a mass of fatty tissue surrounding the capsule, which serves to protect the kidney. Layer of Fat. Last areas to lose abdominal fat. Outside
3) Renal Capsule – the innermost layer made of a transparent thick fibrous membrane. The layer:
   Peritoneal → Layer of fat → Renal capsule

Cover the Gross Anatomy of the Kidney



The major calyces is where the 2 minor calix meet

Renal Pelvis: narrow down to the ureter

Pyramids

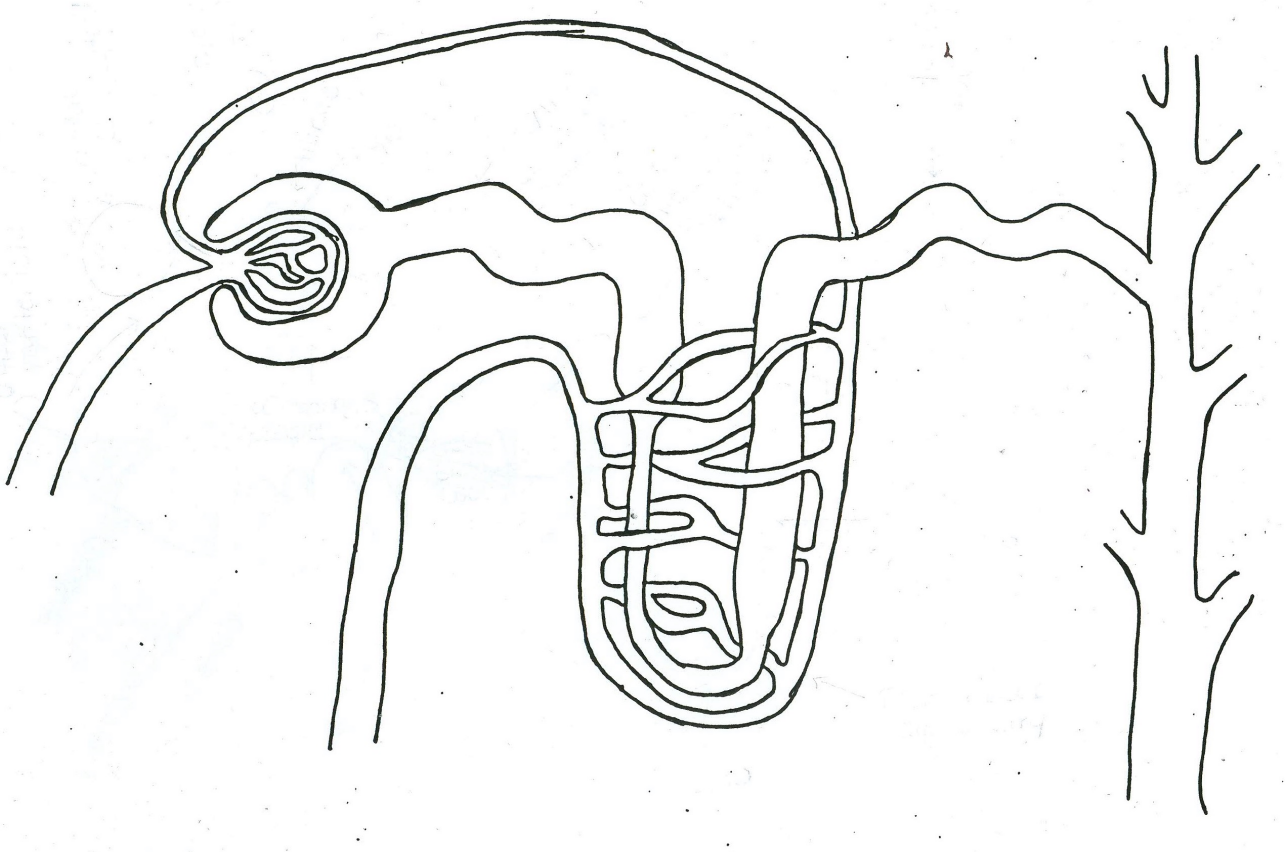
Medulla: Is the inner area where pyramids

Microscopic Anatomy of the Kidney

Nephron-

- The main functional unit of the kidney. (filtration unit of the kidney)
- Approx. 1 million per kidney.
- The nephron consists of a microscopic renal tubule and it's vascular component.

The anatomy of the nephron



Facts:

Some of the blood is pushed through the membrane, it enters the space in the Bowman 's capsule. Once it enters the Bowman's space it's called filtrate, not blood. The filtrate flows down through the whole system.

Two Types of Nephrons

1. Cortical Nephron – it's glomerulus is located in the cortical region of the kidney.
   Makes up the majority
   Does the vast majority of urine concentrating,
   Larger quantity/ larger amount of urine
   Blood supply is the

2. Juxtamedullary Nephron – located at the junction of the medulla and cortex of the kidney.
    - Lies next to the medulla
    - The loop of henle is longer
    - The longer the loop = the greater the concentrating of the urine
        - The urine is more highly concentrated/ not high quantity

    - Blood supply:

The urine is highly concentrated

Blood Supply to the Kidneys

Approx. 1200 ml of blood pass through the kidneys each minute

Cover the anatomy of the blood supply through the kidneys

List the vessels for blood flow:

Blood in:

- Renal artery
    - Branches into the segmental arteries
- Segmental arteries:
- Interlobar arteries:
    - Travel through the renal column
- Arcuate arteries:
    - It arches over the pyramids
- Interlobular arteries:
    - Branches of the arcuate arteries
- Afferent Arteriole
- Glomerulus/Nephron
- Efferent Arteriole
- Venules
- Interlobular veins
- Arcuate vein
- Interlobar vein
- Segmental veins
- Renin vein

Blood out:

Vasa Recta – loops of thin walled vessels that dip along with the loop of henle into the deeper regions of the cortex and into the medulla. Found predominantly with the juxtamedullary nephrons

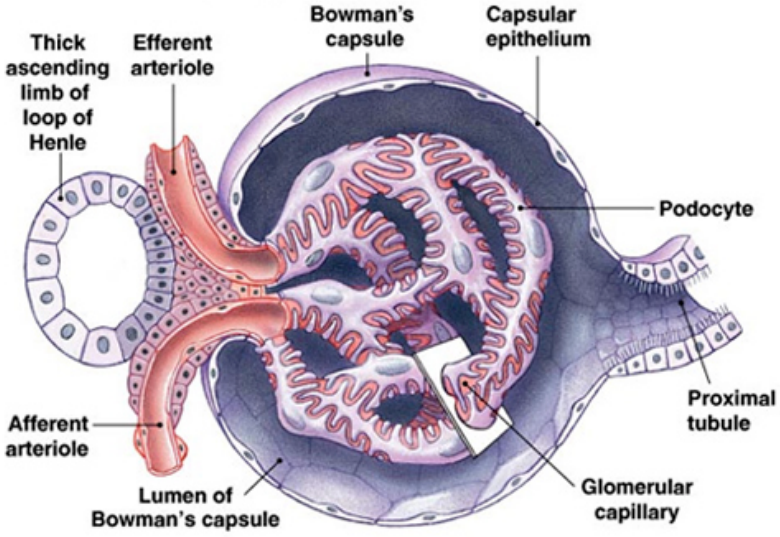
The Bowman's Capsule – The initial portion of the nephron that surrounds the glomerulus. Functions to filter water and solutes in the blood.

Very delicate structure (outer)

Cover the anatomy of the Bowman's Capule, glomerulus, podocytes

Pedicles: Podocyte projection

Distal Convoluted Tubule



Glomerulus:

The capillary bed

1 cell layer thick

They have cells that surround the capillary bed called: Podocyte

Podocyte:

Pedicles:

The Juxtaglomerular Apparatus

Region where the distal convoluted tubule contacts the afferent arteriole.

1. Juxtaglomerular cells
   Sandwich between the afferent and efferent arterioles
2. Macula Densa:

The macula densa and the juxtaglomerular cells (The Juxtaglomerular Apparatus) together account for the secretion of

Renin:

Erythropoietin (EPO):

The anatomy of the apparatus of the macula densa and the juxtaglomerular cells.

Side notes:

In real life the afferent is larger in diameter than the efferent, producing a pressure gradient, which means a lot of blood flow coming in and if we have a larger efferent _____.

If exposed to high level of blood pressure for a long time, the kidney can't handle it,

Urine Production

Step 1 - Glomerular Filtration

Forcing components of the plasma through the endothelial-capsular membrane of the Bowman's capsule and into the proximal convoluted tubule.

Due to pressure difference between the efferent and afferent arterioles

You have to push some of the blood into the Bowman's capsule, which allow fluid in the tubule

Factors involved in filtration

a) Blood pressure forces water and other small solutes into the Bowman's capsule. This fluid is now called filtrate.
b) The efferent arteriole leaving the capsule is smaller than the afferent arteriole, so there is a resistance to outflow of blood from the capsule, thus forcing H2O, etc. to flow into the tubules.

Factors opposing the production of filtrate

a) capsular hydrostatic pressure –

b) blood osmotic pressure –

GFR (Glomerular Filtration Rate) – the amount of filtrate flowing into the capsule per unit time.

Step 2 – Tubular Reabsorption

The movement of filtrate from the tubules back into the blood of the vasa recta and peritubular capillaries.

Proximal Convoluted Tubule

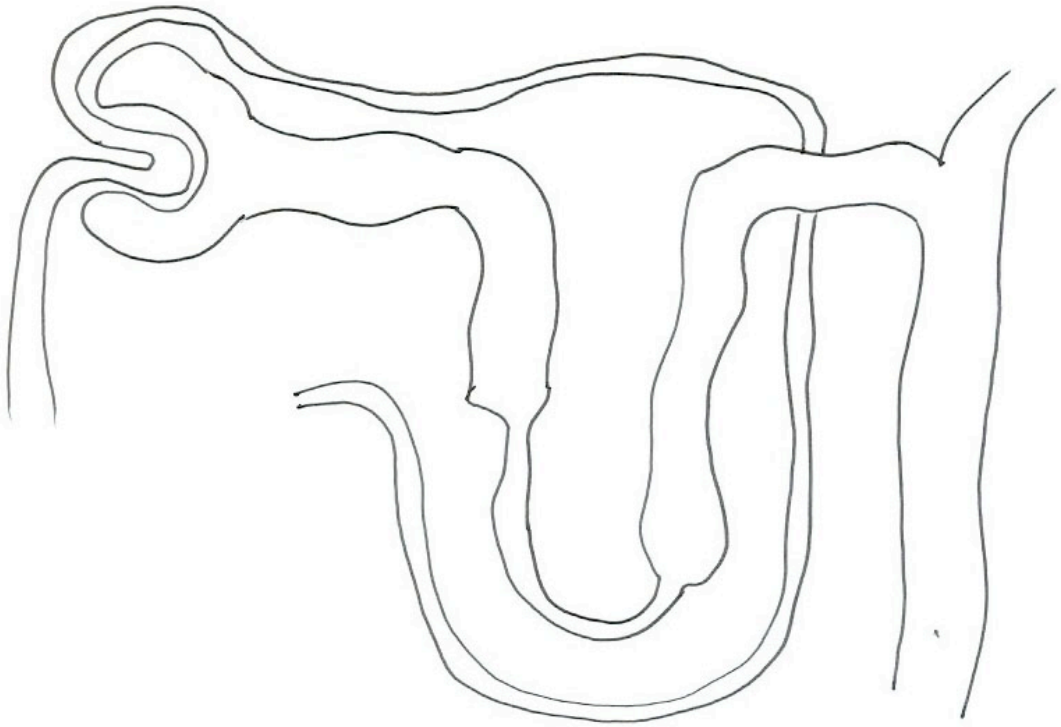
- 60-70% of the volume of filtrate is reabsorbed here.
- Almost 100% of the glucose and amino acids are reabsorbed back into the blood at this location.
- Sodium, potassium, magnesium and bicarbonate ion are actively transported out of the filtrate here.

    A larger amount of NaCl is reabsorbed

Active transport allows this occur

The microvilli increase surface tension = increase absorbing and extremely metabolically active

Osmotic pressure from the increased solute concentration outside the PCT draws H2O out of the PCT and into the peritubular region.



Descending limb of the loop of Henle

The very thin descending limb of the loop of Henle is permeable to H2O, but relatively impermeable to solutes. As the limb descends further into the medulla where the solute concentration is greater, more H2O is pulled out of the descending limb.

Permeable to water but impermeable to the solutes,
We see an increase in osmotic pressure as we go down

Ascending limb of the loop of Henle

The thick ascending limb of the loop of Henle is impermeable to H2O, but actively transports NaCl out of the tubule and into the peritubular space, so as the filtrate continues to rise toward the cortex of the kidney on it's way to the DCT the mOsm/l concentration continues to decrease. However, because NaCl is actively transported out of the ascending limb the mOsm/l concentration in this region (medulla) is very high (1200mOsm/l)

Active transporter for NaCl, pulling salt from the ascending but water can't be pulled out.
The osmotic concentration decreases as we go up, significantly less at the top

The function of the loop of Henle:

To keep what we want and get rid of what we don't want
Fluid flow from the descending to ascending limb

The reason sea mammals can drink salt water and not us, b/c they have a longer loop of henle so they can further concentrated the filtrate

Countercurrent Multiplier Mechanism

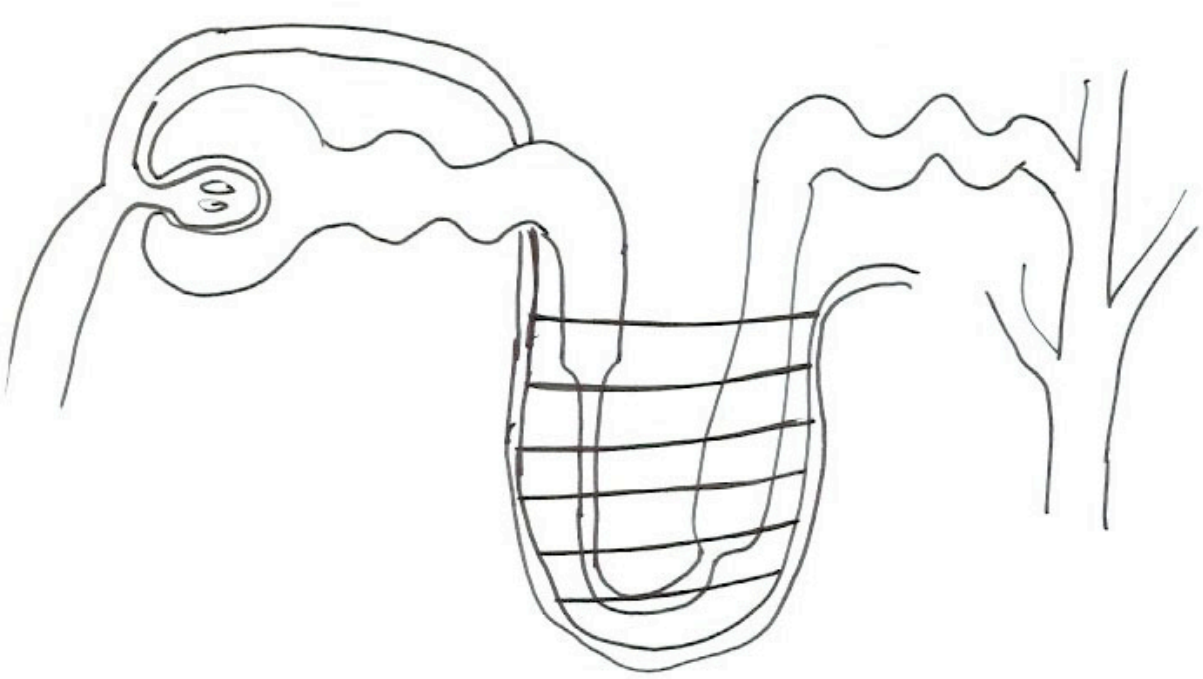
Is a system that allows the kidneys to concentrate solutes within the medulla.

How does this work?

1) NaCl is pumped out of the filtrate in the ascending limb of the loop of Henle.
2) Because the ascending limb and the descending limb are in close proximity to each other the increase in solute concentration from the NaCl is felt at both of the limbs and the loop of Henle.
3) This results in an increase osmotic gradient outside the descending limb, which pulls water out of the descending limb and into the peritubular space.
4) As water leaves the descending limb the osmotic concentration (concentration of solute) within the limb increases, which provides an ample amount of NaCl to be actively transported as this filtrate reaches the ascending limb.

This cycle continues, which means that the medullary region will always be hyperosmotic in order to pull water out of the kidney tubule.

The actively transported NaCl make the interstitial tissues space hyperosmotic, which pull the water out.



The Vasa Recta

A group of arterioles and capillaries that surround the juxtamedullary nephron.
Function: return reabsorbed filtrate back to the blood.

70-80% : Cortical Nephron
20-30%: Juxtamedullary Nephron

Blood flow of the vasa recta flow in the

The further we get down into the medulla, the greater the concentration

In the collecting duct the concentration of solute and solution is really constant the whole way down, b/c the wall is impermeable to everything going outside expect when ADH is present. When ADH is present -

The peritubular capsule surrounding the tubule/ henle

The capillary bed is permeable, as the capillary travels down the osmotic pressure will be low

The capillary blood flow will be much faster then the movement of filtrate b/c of that there is concentration gradient between the interstitial tissue space and capillary

The blood flow is fast relatively compared to the filtrate through these area, so there is a concentration difference between the capillary and interstitial tissue space. b/c blood flood is fast solute is pulled in quickly b/c it's hypo-osmotic, so solute are pulled in and wisked away (as well as water)

Hormonal Interactions

ADH (Antidiuretic Hormone) AKA vasopressin

Diabetes Insipidus – decrease levels of ADH.

Aldosterone (produced in adrenal cortex)

Increases the number and activity of Na-K pumps in the walls of the DCT. Function to return Na to the peritubular space from the filtrate and excrete K in the urine. H2O will follow the Na.

Has an effect on the distal convoluted tubule and a little on the collecting duct
Job: in a period of time when we have low blood pressure, retain more salt
Salt is pulled and water follows, which decreases urine production,
Question:

Step 3: Tubular secretion:

Harmful substance are actively transported out of the blood into the tubule bypassing the Bowman's capsule all together

II. Ureter

10-12 in. long depending on the height of the individual
Retroperitoneal/ shrink wrapped to the abdominal wall
Peristaltic wave that moves the urine from the kidneys to the bladder
Muscular wave that moves the urine down the bladder
Function-
Tube that transported urine from the kidneys to the bladder
<u>3 coats</u>
Inner- Mucosa: transitional epithelium
Transition epithelium:
Circular shape
Transition one shape to another as bladder wills with fluid
Middle- muscular layer (longitudinal and circular fibers)

Outer- Fibrous coat that is continuous with the renal capsule and peritoneal

III. Urinary Bladder

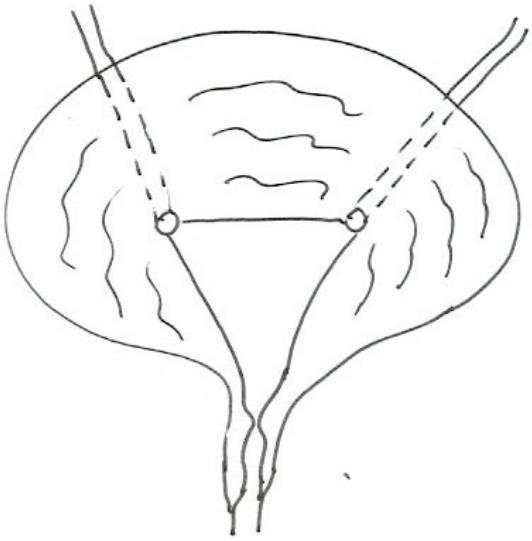
Hollow muscular organ

Posterior to symphysis pubis

Protects bladder when full

Anatomy

- ureter openings
  - Smooth area
- rugae of mucosa
  - Allow for expansion for the filling of the bladder
- trigone
  - No rugae present



- internal sphincter
  - Autonomic nerve system
- external sphincter
  - Controlled by skeletal muscle; you have control over. Main function is to completely eliminate urine from bladder

4 coats

1. mucosa-
   - Innermost
   - Mucus membrane
   - Transitional epithelium-

2. submucosa- dense connective tissue layer
    Connect the mucosa layer to the next deeper layer
    Binding layer

3. Detrusor muscle (under parasympathetic control)
    Inner-
    Middle-
    Outer-

4. Serosa- peritoneum
    Outer layer
    Peritoneum that surrounds and covers the top of the bladder

Micturition- Micturition Reflex- urination reflex

The bladder fills to 200-400 mL, which send signal to cord level S2,3,4 (sacral 2,3,4) parasympathetic causing contractions of the detrusor muscle and relaxation of the internal sphincter

As it fills with urine we feel the sensation, but if we don't immediately urinate, it fills with more urine

The parasympathetic nerves system gets used to the volume and stop firing

The bladder can hold up to 1000 mL or more

IV. Urethra

Small tube that extend from the bladder to the body exterior; start at the internal urethral sphincter

Females-

An inch and ½ long

<u>3 coats</u>

Inner-
Middle-
Outer-

Males-

Typical 8 inches long

<u>2 coats</u>

Inner-
Outer-

REPRODUCTIVE SYSTEM

Reproduction-

Single cell replication of the genetic material allowing growth and duplication of organism

Gonads-

Testes/ ovaries-

Male Reproductive System (simpler compared to females)

I. Scrotum-

- An out pouching of abdominal wall, lose skin, muscle and fascia.
- Houses/ contains testes
- Two testes are separated by scrotal septum
- Women don't have it because the ovary is within the body, but for male the testes descend during the last trimesters of the development
-
-
-
-
-
-
-
- Function: Maintain cooler temperature for sperm development

- The scrotal sac can lower or raise
  - Hot:
  - Cool:

Median raphe-

External seam along mid-sagittal line
You can see along the mid-sagittal line of the scrotum (outside)
Central line (where the scrotum sac comes together initially)

Dartos muscle- smooth muscle

Fibers in septum and below skin of scrotum
Shrink scrotal size
Lies deep to the skin
Autonomic nervous innervation that can cause shrinkage of scrotal sac if decrease in temperature

Function:

It's going to retract or relax to maintain temperature

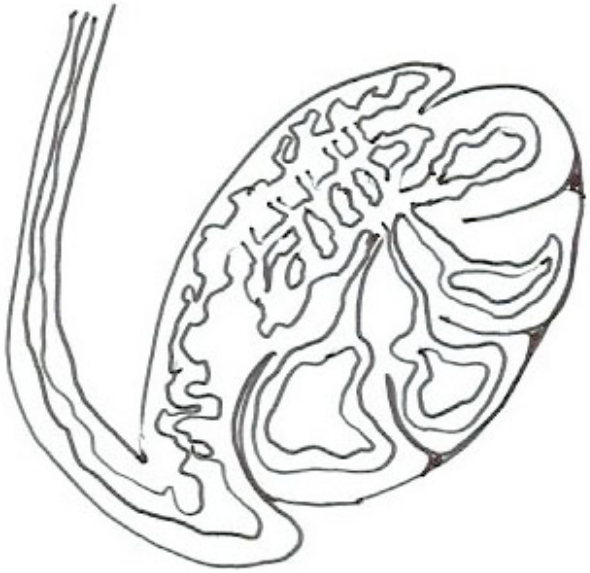
II. Testes

- Paired oval glands inside scrotum
- Sperm production

Tunica albuginea-

Dense fibrous connective tissue covering outside of testes that divide testes into lobules
The outer white layers
The septum in between each lobule

Anatomy of the Testes



Head of epididymis
Tunica albuginea
Lobule-holds seminiferous tubule
Septum
Rete tubules/ testes
    Network like structure
Seminiferous tubule
    Sperm production occur
    Long very thin tube that coils together
Straight tubule
    Sperm drains into this
Tail of epididymis
Ductus epididymis-sperm matures here
Efferent ducts
Ductus deferens

The sperm continues to mature and migrate through this pathway; received at the area called the ampulla.

Sperm production-

Occur in the seminiferous tubules → move to the straight tubule → to rete tubule → efferent ducts → ductus epididymis where sperm begins maturation

III. Ductus epididymis (AKA- epididymis)

20 ft. long

Tightly coiled tubule where the sperm travel slowly to vas efferent

Vas efferent:

Lined with pseudostratified columnar epithelium-

IV. Ductus deferens (AKA- vas deferens)

Portion of the tube connecting epididymis with the ampulla (tube that transports sperm to spermatic chord)

15-18 in. long

Ductus deferens pathway-

Ascend out of the scrotum, through inguinal ligament (inguinal canal) enters pelvic cavity

Loops over side of bladder to enter the back of the prostate gland via the ejaculatory duct

Spermatic cord-

Lymphatics

Wrap over the ureter

Made of: of cremaster muscle, Venus plexus, arteries, vas efferent,

Ductus deferens

Autonomic nerves

Veins & arteries(panpinaform plexus)

Cremasteric muscle-

Surrounds outside of testes and spermatic cords

Elevate testes (and lowers) to maintain constant temperature (skeletal muscle)

Side Note:
Vasectomy

V. Urethra

2 Parts

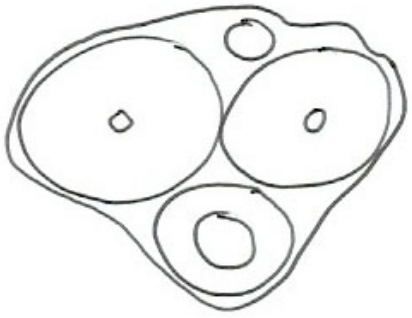
1. Prostatic urethra-
   Approx. 1 in. long
   Travels through prostate glands
   Upper portion
   Walnut size and donut shape
   hold in the middle where the sperm normal travel

2. Penile urethra-
   Approx. 6 in. long
   Lower portion (membrane component)

Penis-
   Function-
   Urination and introduction of spermatozoa into vagina

Cross-section of the penis

Underneath the skin and fascia are three main compartments



Dorsal vein (1)
Corpora cavernosum (2)

Engorged with blood when sexually arousal
Corpora spongiosum (1)
   Never gets as firm as the Corpora cavernosum and the urethra travels through here
Deep artery of the penis (2)

Urethra

Via sexual stimulation; all 3 compartments fill with blood Causing an erection

Glans penis- distal end of penis (enlarged tip)

Corpora spongiosum-
Enlarged to form the glans penis (head of the penis)

Prepuce or foreskin-

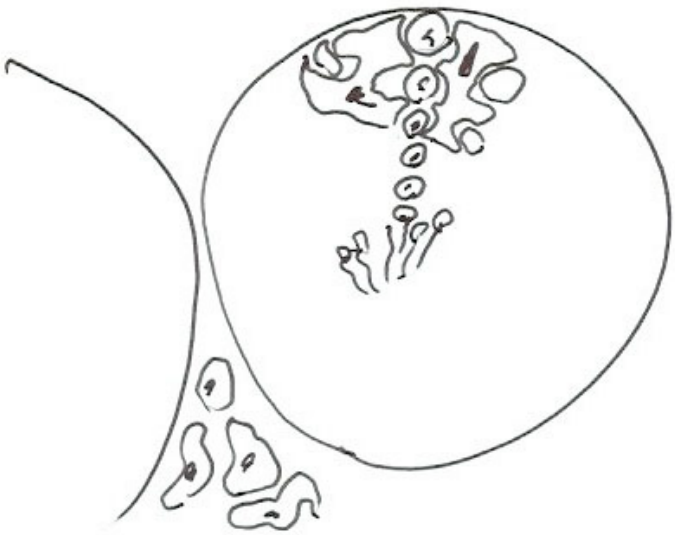
Microscopic Anatomy of the Male Reproductive System

Spermatogenesis-
Sperm production occurs in seminiferous tubules

Cross-section of the Seminiferous Tubule

Interstitial cells of Leydig- testosterone production

Spermatozoa-
Under constant division,
along the outer perimeter



Spermatids- 23 chromosomes; 2nd to last stage in meiosis; develop sperm w/flagella

Secondary spermatocytes- meiosis I

Primary spermatocytes-

Spermatogonia-

- Most immature
- Lies along basement membrane of seminiferous tubule
- Constantly dividing (highly mitotic)

Sertoli cells (sustentacular cells)-

- "Nurse Cell" or Sustentacular cell
- Support development of sperm and protect from (autoimmunity) "self" antibodies
- Surround developing sperm. Separate sperm from rest of body (autoimmune response if we come in contact w/other parts of body)

Spermatogonia → Primary spermatocytes → secondary spermatocytes → spermatids → spermatozoa

Spermatozoa- mature sperm cells, 300 million made/day, survive in female reproductive tract about 48 hours

<u>Anatomy of Spermatozoa</u>

Acrosome-

- Has hyaluronic acid
- Enzyme that break down hyaluronic acid that help move up towards the eggs

head section- contains genetic material

Nucleus-

Neck-

Mid piece-

- has a lot of mitochondria
- very organized tubules
- the microtubule becomes the tails

Tail-

Accessory Glands of the Male Reproductive System

Function-
Secrete liquid portion of semen

1. Seminal Vesicles (2)
2 in. long
Secretes-

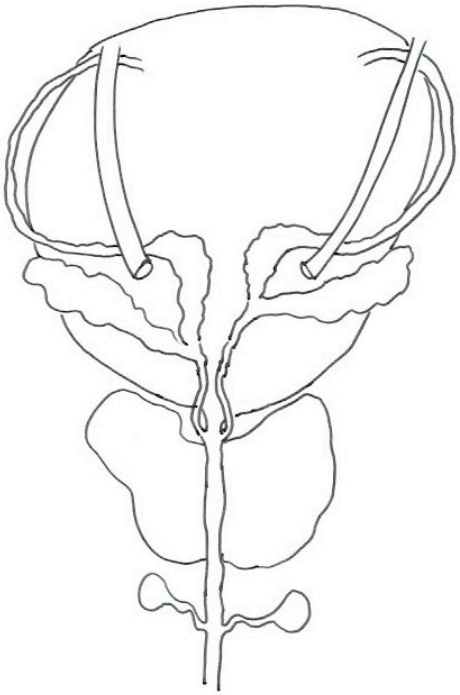
2. Prostate Gland (1)
Chestnut sized, doughnut shaped gland at the base at the urinary bladder through which the prostatic urethra passes
Secretes-

The ejaculatory duct is where the terminal end of the vas ends up which is located in the prostatic urethra

3. Bulbourethral (Cowper's) Gland (2)
Pea-sized gland located beneath prostate gland
Pre-ejaculatory glands
Provide lubrication for urethra
Usually clear, thin viscous material

Secretes-
Mucous

Posterior View of the Urinary Bladder



Ureters
Ductus Deferens
Seminal Vesicles
Ejaculatory Ducts
1. Ductus deferens
2. Seminal vesicle ducts
Prostate Gland
Prostatic Urethra
Bulbourethral Glands
Penile Urethra

<u>Semen</u>

def. - mixture of sperm and other secretions
Ave. volume- 2.5 – 6 mL
pH range- 7.35-7.50 (relativity basic)

Functions-

1. Transport medium-

2. Capacitation-

3. Seminalplasmin- kills bacteria

<u>Hormones</u>

Ant. Pituitary

FSH- Follicle stimulating hormones-

Initiates spermatogenesis during and after puberty
Name b/c the initial work was done in female not in male
Function: Initial sperm cells production and maturation sperm

ICSH-Interstitial Cells Stimulating Hormone (aka LH in women)-

Function: Stimulate leydig cells to produce testosterone
Cause testosterone increase

Testes

Testosterone- male androgenic hormones

Functions-

1. control growth development and maintenance of sex organs
2. stimulate bone growth, protein anabolism
3. involved in sexual behaviors and maturation of sperm
4. secondary sex characteristics:
    - increase body hair
    - increase muscularity

- enlarged thyroid cartilage

Side notes:

Steroid:

Decreases the size or causes shrinkage of testicles, b/c testosterone is produced in the testes, so when you take steroid the brain tells the testes to not produce testosterone

- Anabolic Hormone> increases muscular mass and bone density
- Androgen binding hormone- helps w/proper sperm development

FEMALE REPRODUCTIVE SYSTEM

Major Organs of the Female Reproductive System

Ovaries (2):

Produces eggs

Uterine or Fallopian tubes (2)

Line with ciliated like the vas-efferent

Egg- large cells

Uterus or Womb (1)

Vagina (1)

Vulva (1):

External genitalia

Mammary Glands (2)

I. Ovaries: The female gonad

def. - paired glands. Slightly larger than almonds

Location- upper pelvic cavity on each side of the uterus

Function- produce eggs and female hormones

Anchored by two ligaments

1) Ovarian Ligament:

Attaches ovary to uterus

2) Suspensory Ligament

Attaches lateral surface of ovary to lateral pelvic wall

Suspends the ovary superiorly and laterally

It travels upward

II. Uterine or Fallopian Tube:

Muscular tube by which eggs travel to uterus

5 in. long

Infundibulum-

Expanded distal end

Closest to ovary

Fimbria-

Side note:

Peritoneum wraps on top, there is an opening

Fertilization occurs in the

Cilia-

Line the inside of the tube

Along with smooth muscle both propel ovum to uterus

Peristalsis

Journey takes 3-4 days

III. Uterus

def. - small, pear- shaped organ lying in the pelvic cavity

Normal position-

Antiflexed- bends anterior over the bladder

Flexes forward on top the bladder

Anchored by-

1. Broad Ligament

Extensive mesentery that covers both uterus and ovaries

Example: sheet

Double layer of peritoneum

Equivalent to a mesentery

2. Round Ligament

Arises off of the lateral uterus behind and below the uterine tube.

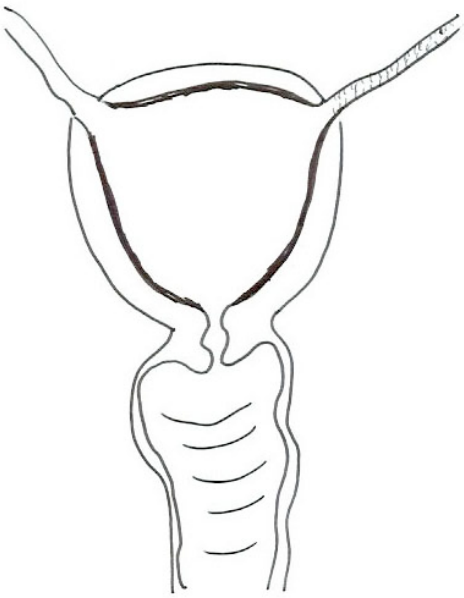
They connect inferiorly to a part of the external genitalia

travels more laterally

3. Lateral Ligament

Connect the uterus to the lateral pelvic wall

Anatomy of the Uterus



Fundus: dome-
    Shaped region above tubes
    Stick up above the body
Fallopian Tubes
Endometrium:
    Mucosa, lamina propia
Myometrium:
    Thick, smooth muscle
Serosa- visceral peritoneum V. SC. peritoneum
Body
    Pear shaped and size
Internal Os
    Narrow region
Isthmus
Cervical Canal
External Os
Fornix
Cervix
Vagina

IV. Vagina:
    def. - Muscular tube extending from cervix to the genitalia, pH 3.5-4.5 [up to pH 6]
    Approx. 3-4 in. long,
    Fornix- shallow recess around periphery of cervix
    Vaginal walls-
        Contain a network of blood vessels, layers of smooth muscle and moistened by secretion of the cervix and other glands
        What happens during sexual arousal?

    Hymen-

V. External Genitalia

Collective term for the female genitalia

1) Mons Pubis
Elevations of adipose tissue covered by pubic hair over the pubic symphysis
Thicker, fatty area over the top of the symphysis pubis
Has fat and hair

2) Labia Majora (homologous to the male scrotum)
Outer
Two longitudinal folds of skin that extend inferiorly from mons pubis.

4) Labia Minora

Medial to majora
Two folds of skin, devoid of adipose tissue and hair

Secrete-
Sebum from sebaceous glands

4) Clitoris (homologous to the male penis)
Small mass of erectile tissue located at the anterior junction of the labia minora

Prepuce- or foreskin
part of minora covering the clitoris

5) Vestibule
Cleft or space between the 2 labia minora
Space between the inner thinner folds

6) Urethral Orifice
Inferior & posterior to the clitoris between minora

7) Vaginal Orifice
Located posterior to urethra orifice

8) Skene's Glands

9) Bartholin's Glands

Menstrual and Ovarian Cycles

-both are occurring simultaneously

I. Ovarian Cycle- a series of events that occur over a period of 28 days that relate to the maturation and release of the ovum (egg).

Oogenesis- the process of formation of the female ovum

Normally 28 day cycle
It's usually irregular in the earlier teens
But it become constant during late teen and early 20's

Menarche:

Date when menstruation first starts
Not just one day,
Early now than years previously b/c of:

Side note:

Female Athlete Triad Syndrome

Menopause

Occur in the late 40's, early 50's and (45-55 years old)
Lasts about 5-10 years
Menstruation stops

Ovarian Cycle

Day 1-5

Primary Follicle Development

From the production of FHS

The follicles have been with the women before she was born

approx. 25 primary follicles begin to develop

The reason is twofold: the follicle will house egg and the outside produces estrogen

-they begin to produce low levels of estrogen

-a clear membrane begins to develop around these ova

Called the zona pellucida

Before day 6:

Secondary Follicle Development

- Only a few of the primary follicles make it to this next step, the rest Degenerate

Larger follicle that start to develop, out of the 25 only one that increases in size

-Zona Pellucida- thickness continues to increase along with secretions of follicular fluid which begins to fill a central cavity known as the antrum

-estrogen production continues to increase from secondary follicl production

*during days 1-5 FSHRF (Follicle Stimulating Hormone Releasing Factor) from the hypothalamus stimulates the Ant. pituitary to produce FSH causing the follicles to grow

Day 6-**13**

Graafian Follicle Development (Follicular Phase)

Antrum: large open space in the center that filled with fluid called liquor folliculi

-only one of the original follicles continue to mature in this stage. It is known as the Graafian follicle. The rest degenerate (atresia).

-this follicle migrates to the surface of the ovary for expulsion at midcycle

-FSH is the dominant hormone at this stage, but as ovulation (expulsion of egg) nears, LH amounts drastically increase due to LHRF secretions from the hypothalamus.

Day 13-**14**

Day 14 the day of ovulation

Ovulation

-the huge spike of LH just prior to Day 14 of the cycle causes the ovum to be released from the ovary. This is known as ovulation, and typically occurs on Day 14.

-only one ovary ovulates each month

Day 15-28

Post Ovulatory Phase

-after ovulation a blood clot forms within the empty follicle and is now called the

Fairly large
Can become an ovarian cyst
Gets really large like an almond
Blood in the center

- The clot is eventually reabsorbed and the follicular cells enlarge and change to form the

Name because it's yellow
Produce progesterone

-this body begins to produce large amounts of progesterone and some estrogen. The progesterone prepares the endometrium for the fertilized egg.

-if implantation of the egg does not occur then the corpus luteum degenerates and is now known as

-if implantation does occur, the hormones produced by the corpus luteum maintain the developing embryo for approx. 3 months, secreting estrogen and progesterone. These hormone secretions also support maternal breast development

-the corpus luteum is maintained by HCG (Human Chorionic Gonadotropin) which is being produced by the developing placenta

II. Menstrual Cycle

Menstrual cycle def. - a series of events that occur over a period of 28 days that relate to the growth and degeneration of the female endometrium.

Menarche-

Menopause-

Occur during the same time of the ovarian cycle
Estrogen and progesterone levels decrease causing the endometrium to slough off b/c no there is hormone to maintain the thickness

When does menstruation (menstrual cycle) occur?

When does ovulation occur in relation to the cycle?

Estrogen increases the thickness of endometrium, to prepare for implantation
½ half of the cycle:

Progesterone- maintains thickness and increases vascularity of the endometrium, increase secretory glands (glucose, glycogens,)
First 1/2 follicular phase
2nd half: Luteinizing Hormone phase

Menstrual Cycle

Day 1-5
Menstrual Phase
-associated with the degeneration and shedding of the superficial portion of the endometrium

-this shedding represents the menstrual flow or period, and is comprised of blood, tissue fluid, mucous and epithelial cells

Day 6-13
Proliferative Phase
-estrogen from the developing follicles stimulates the repair and

thickening of the endothelium
-this readies the ovum for implantation if fertilized

Day 15-28

Secretory Phase

-progesterone production from the corpus luteum continues to thicken the endometrium for egg implantation

-during this time the endometrial glands enlarge, producing mucous-rich glycogen and the vessels elongate and become tortuous. All of this is occurring to provide nutrition for the implanted egg.

- If the egg does not implant, decrease in secretions of estrogen and progesterone from the degenerating corpus luteum, initiating another menstruation to occur and the cycle starts all over again

Mammary Glands- the female breast and its associated tissue

Suspensory Ligaments of Cooper-

Tubuloalveolar ducts-

Glandular tissue- produce milk

Lactation- Milk production

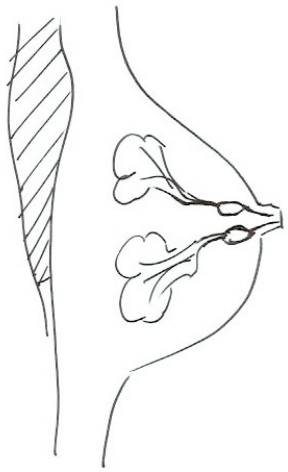
15-20 lobes- contain fat and glandular tissue

Lobules- each lobe is divided into smaller lobules

Alveoli- contain the secretary cells of the breast

Alveoli > secondary tubules > mammary ducts > ampulla > lactiferous ducts > Nipple

Cross-section of the Breast



Pectoralis Major
Adipose tissue
Alveolar ducts
Outer brown rings
Secondary tubules
Mammary ducts
Ampulla
Nipple
Inner ring
Lactiferous ducts
Montgomery glands
Little bumps on the alveolar that produce sebum
To condition Areola
Tubular alveolar cells are the ones that produce milk

Let-Down Reflex-

- Suckling receptors in nipple and areola stimulate posterior pituitary to release oxytocin
- Milk stored in ampulla, lined with myoepithelium (muscle cells) when exposed to oxytocin; muscle constricts and releases milk

PREGNANCY & DEVELOPMENT

Development-

A sequence of events starting with fertilization of the egg and ending with parturition (delivery)

Gametes-

Meiosis-

Specialized cell division producing sibling cell that receives ½ or the haploid number of chromosomes

Fertilization-

Joining of the two gametes to form zygote

Zygote

Have 46 chromosomes

Monozygotic-

Dizygotic-

Cleavage-
A sequence of division that end at contact with the uterine wall

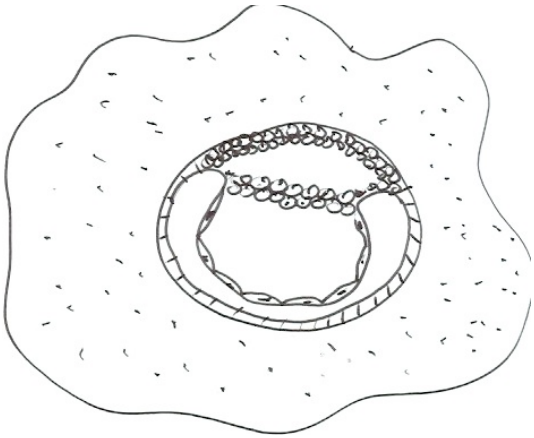
Steps occurring after fertilization

Implantation-
Adhesion of the blastocyst of the uterine cell wall

Fertilization occurs about

Blastodisc

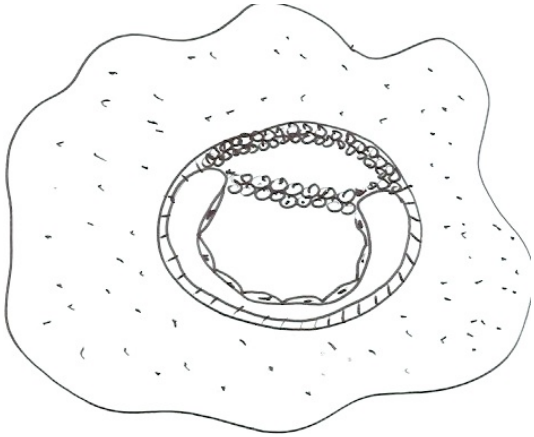
Cellular trophoblast
Amniotic cavity
Epiblast



Bloastoceole
Blastodisc
Hypoblast
Yolk sac
Syncytial trophoblast

The outer membrane doesn't develop until we have contact with the endometrium
The baby doesn't just attach to the endometrium, it burrows into the endometrium and is surrounded by it (syncytial trophoblast)

Syncytial trophoblast



Produces hyaluronic acid- enzyme that breaks down membranes that burrow in the endometrium, once it burrows in, it's covered by the syncytial trophoblast and continue to enlarge in the endometrium

Gastrulation-

The formation of the 3 layers of the blastodic.
Specific cells of the epiblast move toward the center of the blastodisc toward a line called

These cells migrate to a space between the epiblast and hypoblast to form the 3rd layer

3 Germ Layers:

1. ectoderm- (like skin)
    - integumentary system,
    - digestive system
    - respiratory system
    - nerve system

2. mesoderm-
    - muscular
    - skeletal
    - lymphatic
    - cardiovascular
    - urinary
    - reproductive
    - endocrine

3. endoderm- (inner lining)
    - part of the digestive
    - respiratory
    - urinary bladder
    - reproductive- gametes

Neurulation-

The embryologic process responsible for central nerve system (C.N.S) development

Organogenesis-

Organ formation
Week 4
Embryo 5 mm long
Arm and leg bud forms

Embryo vs. fetus-

0-3rd months => embryo
3rd-9th months => fetus

The corpus luteum produces progesterone for the

Extra embryonic Membranes-

Yolk sac-

1st to appear
1st site of blood cell formation
Yellow

The liver actually develops blood cells, production then migrates to the bone marrow (rest of life)

Amnion-

Made of mesoderm and ectoderm, produces and contains the amniotic fluid → cushions and hydrates

Allantois-

An out pocketing of endoderm from the yolk sac- form urinary bladder

Chorion-

A sac surrounding or lying outside the amniotic sac
Transports nutrient and O2 between embryo and trophoblast
One of the first of the extra-embryonic membranes

Placental formation-

By the end of 3rd week the chorion sends out villi that invaginate into the endometrium. Blood vessels of the chorion pass close to endometrial blood vessels for exchange of gases and nutrients.

Decidua basalis:

The portion of the endometrium

Decidua capsularis-

The endometrium surrounding the free floating

Chorion (placental portion)-

Has a projection running to a central stalk for the umbilicus

Conditions:

Placenta previa:

Umbilicus-

Umbilical arteries (2)

Coming from the baby going into the placenta (unoxygenated)

Umbilical vein (1)

Function of Placenta

Supply fetus with O_2 and nutrient

Carry away CO_2 and waste

Human Chorionic Gonadotropin (HCG)-

Produced by placenta→ maintain corpus luteum for 1st 3 months of pregnancy, then the placenta produces estrogens and progesterone to maintain endometrium

HCG is produce by the

If not pregnancy then the

To find out if pregnant:

End of cycle for HCG detection

Afterbirth-

<u>Three Stages of Labor</u>

A) Dilation-

Onset of true labor, cervix dilates, fetus travels down cervical canal

8 hours-12-14 hours

"She is 100% effaced and 10% dilated"

Mean the dilation needs to be 10 cm so the baby head can pass through the opening

The effaced: thinning of the uterus lining pulling away from the baby's head as it migrate early

Don't push early b/c causes inflammation (swelling and opening close)

B) Expulsion-

Parturition – expulsion of the fetus

C) Placental

Uterine contraction eject placenta
Usually happen about 20-40 minutes after the birth of the baby

Hormones involved in Labor

Oxytocin-

From posterior pituitary, hypothalamic stimulation from upper estrogen production and uterine stretch

Prostaglandins-

Cause smooth muscle contraction

Relaxin-

Softens ligaments for pelvic relaxation during fetal development and delivery
Soften all the ligaments in the women