

Electrocardiography

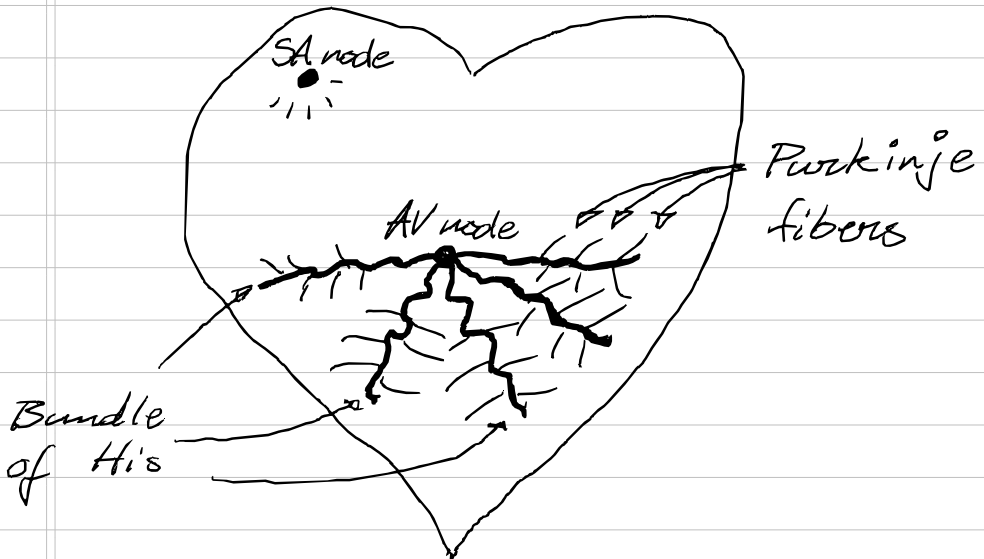
- Graphic representation of the electrical activity of the heart

Heart Attack vs. Cardiac Arrest

- ★ **HA:** is a flow problem. Blockage of a coronary artery supplying blood to the heart, the heart dies & fails.
- ★ **CA:** is an electrical problem interrupting or altering the normal pathway of electrical conduction through the heart

Electrical Pathway of Conduction

- **Depolarization** - Series of electrical events causing contraction (action potential)
- **Repolarization** - Series of electrical events that cause repolarization resulting in a "resting" phase or "relaxation" allowing the heart to refill



Sinoatrial node (sa node)

→ "Pace maker" fires every 0.8 seconds, initiates series of events that cause contraction, causes atria to contract

Atrioventricular node (av node)

→ Dense collection of cells that transmits the electrical impulse from SA node, necessary due to dense fibrous skeleton between atria and ventricles, which is a poor conductor

Bundle of His (AV Bundle)

→ Atria ventricles get thorough innervation and that every cell possible is involved in the contraction for maximum efficiency

Purkinje Fibers

→ Same as Bundle of His

SA node → AV node → Bundle of His → Purkinje Fibers

0.8 seconds (one heartbeat)

Electrocardiogram (ECG, EKG)

- A test designed to give health care professionals information about the electrical activity of the heart
- Quick, non-invasive, painless





P wave : Atrial depolarization

QRS Complex : Ventricular Depolarization

T Wave : Ventricular Repolarization

sinus rhythm : normal electrical heart activity

Atrial Fibrillation :

→ Random scribbles where P wave should be

Atrial Flutter :

→ Not as uncoordinated as Fibrillation

Ventricular Fibrillation :

→ Completely uncoordinated ventricular polarization

Heart block : Delay or complete blockage of the SA node transmission to the rest of the heart

→ **1st degree** : delay in pickup of SA node by AV node, results in larger P-Q interval

→ **2nd degree** : some of the SA node signals are blocked and some make it through, QRST complex doesn't exist half the time

→ **3rd degree** : no SA node transmissions make it through, Purkinje Fiber ectopic heart beat

Blood (General)

Microliter: μL

- One millionth of a liter
- About $50\mu\text{L}$ in a drop of liquid
- 20 drops in a mL
- 1000 mL in a liter
- About 4-6 liters of blood in the body

Hematology → Study of blood

Functions of Blood:

- Transports important molecules (gases, hormones)
- Maintain the pH (electrolytes & CO_2)
- Regulate temperature
- Fight disease
- Hemostasis

Blood Volume

- Males 75mL/kg (5-6 liters)
 - Females 67mL/kg (4-5 liters)
- } Roughly 8-12 pints per person

Why more fat in females?

- Due to hormones (primarily estrogen)
- More fat = less blood/weight

Fun facts:

- If lose 10% of your blood before you have medical issues (drop in blood pressure, heart rate change, shock)
- 25% loss = concern of life
- Donating blood - every 8 weeks, no pay
- Donating plasma - 2 times a week, payed

Blood types

A
B
AB
O

} Each can be positive (Rh factor) or negative

Antigen → (Agglutinin)

• A marker on red blood cells that determines or designates the blood type, A, B and Rh presence

Antibody (Agglutinin)

• Specific protein produced in response to antigen exposure, found in plasma, normal blood antibodies have opposite markers of antigens

Agglutination

• Clumping that occurs when antibodies find their matching antigens

Blood Transfusion Rule

<u>Blood type</u>	<u>Antigen</u>	<u>Antibody</u>
A	A	B
B	B	A
AB	A & B	—
O	—	A & B

★ The donor's antigens cannot match the recipient's antibodies

Rh antigen

→ determines + or -

if present, +, in not, -

"Rh" used to honor the rhesus monkey

Genes

Basic unit of heredity consisting of DNA responsible for passing traits from parent to child

Alleles

Each gene contains 2 alleles, one from mother & father, which are variations of the same gene

Blood type is codominant & recessive

Codominance = if allele is present, it's expressed

Genotype

Literal allele combination responsible for expressing the phenotype

Phenotype

Physical characteristics observable from genotype

Blood genotypes	AA	AO	BB	BO	AB	OO
Blood phenotypes	A	A	B	B	AB	O

Erythroblastosis Fetalis

- When Rh^- mother gives birth to Rh^+ child
- Some of the Rh^+ baby blood introduces Rh antigen to mother and mother makes antibodies in response to Rh antigen exposure
- After 1 child, mother is producing Rh antigens, all subsequent children will be attacked by mother's antibodies and die

Constituents of Blood

① Plasma - liquid portion of blood

* 91% water * make up 55% of blood sample

* Clear, yellow tint * other 9% contains acids, vitamins, proteins

② Formed elements - solid portion of blood

* 45% of blood

Red blood cells - erythrocytes

4.3 - 5.8 million / μ liter, 30 trillion total

White blood cells - leukocytes

5-10 thousand / μ liter, 60 million total

Platelets - thrombocytes

250,000 - 400,000 / μ liter, 2.4 trillion total

Erythrocytes

- most numerous of formed elements
- Carry oxygen, some CO_2
- Small, circular biconcave discs, no nucleus
- 120 day lifespan - accounts for blood viscosity
- Flexible to fit through tiny capillaries
- Shape allows more surface area $\rightarrow$ better gas exchange

Hematocrit

Test to determine the percentage of RBC (erythrocytes) in blood sample

- Should be about 45%
- Sometimes referred to as the "packed cell volume," "PCV"

Hemoglobin

- Molecule found in RBC
- Transport oxygen & some CO_2
- 300 million / RBC

Globin

- Protein binding to oxygen

Heme

- 4 hemes per hemoglobin
- Each heme has iron atom
- Each iron combines reversibly with oxygen (O_2)

Oxyhemoglobin - O_2 attached

Reduced hemoglobin - without O_2 attached

Iron (Fe)

- 4g iron in body
- 65% in hemoglobin
- 15-30% in liver, spleen & bone marrow
- 5-20% in blood $\rightarrow$ (ferritin, hemosiderin)
- Males lose 0.9 mg / day
- Females lose 1.7 mg / day
- $\rightarrow$ women lose more iron due to menstruation

RBC production

- Erythropoietin (EPO) - hormone produced in the kidneys in response to low O_2 to stimulate RBC production

RBC destruction

- Broken down by spleen, also bone marrow & liver
- Globin broken down into amino acids & iron
- RBC broken down & excreted as bilirubin

★

- Spleen overestimated while body infatuated with mono

Leukocytes (WBC)

- 5 different types
- Nucleated
- 5-10 thousand/microliter
- They fight disease

1. Neutrophil

AKA polymorphonuclear leukocytes

- Multi-lobed nucleus, granulocyte
- Most common leukocyte, 60-70%
- General phagocyte, fights infections

2. Eosinophil (ee-o-zin-o-fil)

- Figure 8, bilobed nucleus
- Phagocytic, granulocyte
- Allergies, asthma & hay fever
- 1-4% of all leukocytes

3. Basophil

- Large U or S shape nucleus, granulocyte
- Functions in allergic reactions
- Releases histamine (vasodilator & increases vessel permeability)
- Releases heparin (blood thinner)
- 0-1% of all leukocytes, least common

4. Lymphocyte

- Circular nucleus may take up most of cytoplasm
- Agranulocyte, main cell found in lymph
- Function in specific immune response
- 20-30% of all leukocytes, 2nd most common

Granulocytes

5. Monocyte

- Kidney bean shaped nucleus
- large macrophage
- 2-6% of all leukocytes, largest leukocyte

Blood Pressure

→ Pressure exerted by the blood against the walls of the blood vessels, specifically the arteries

High blood pressure causes:

→ Smoking → Weight
→ Salt → Age → Genetics → Stress

Medicine Treatments

→ ACE Inhibitors → Inhibit angiotensin converting enzyme action

→ Beta blockers → Inhibit effect of epinephrine & other stress hormones

→ Diuretics → Remove water from the blood

Systolic pressure

↳ 120/80, diastolic pressure

Below 90/60 → low blood pressure "Hypotension"

↳ No symptoms = No problem

90-120
60-80 = Normal blood pressure

121-139
80-90 = Pre-Hypertension (lifestyle change recommendations)

Above 140/90 = Hypertension → Medication possibly required

High number over low/normal number is indicator of isolated hypertension

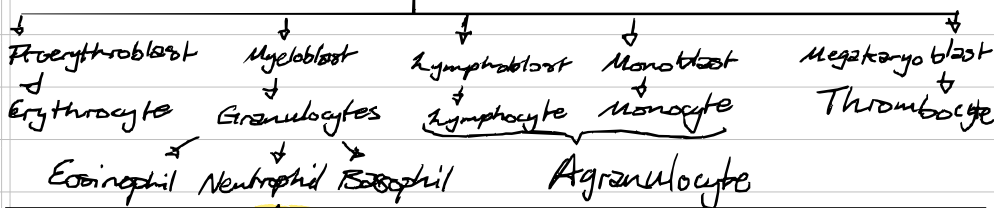
→ cardiovascular risk regardless of age

High diastolic pressure = Indicator of issues for people over 50

Evolution of Blood Cells

Hemocytoblasts

(Generic bone marrow cells, eventually form all blood cells)



Hemostasis

- Closes open circulatory system, stops bleeding

3 steps:

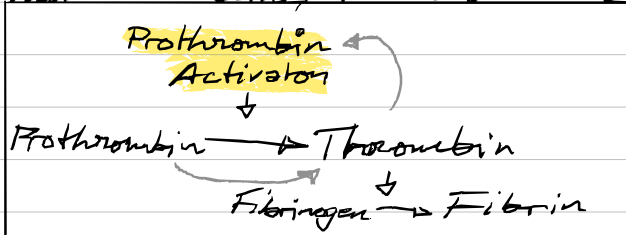
1) Vasoconstriction

2) Platelet Plug

- ADP is a component of vessel tissue
- Vessel injury exposes platelets to ADP
- Platelets become sticky, build up on each other & walls of vessel @ site of injury

3) Clotting

- Creates fibrin, sticky white threads catch red blood cells, makes "mat" (scab) to plug hole



Dissolving Clots

Plasminogen normally in blood, converts to plasmin in order to dissolve clots safely:

Plasminogen → Plasmin

Thrombus/Embolus

Thrombus: blood clot attached to vessel wall

Embolus: free-floating clot through circulatory

→ Concern is occlusion (blocking) of a blood vessel

→ Emboli are more concerning, but both are potentially fatal.

Pulmonary embolism: Blood clot in lungs

Review: Blood types in 1/15 under Electrocardiography

Muscle Physiology & More!

Muscles:

- 1) Move the skeleton
- 2) Are connected to bones via tendons and aponeurosis
- 3) Ligaments connect bone to bone

Anatomy
of Muscle

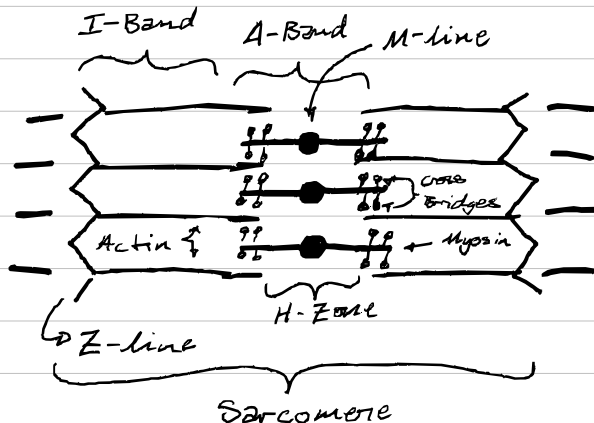
{ Muscle $\rightarrow$ Fascicle $\rightarrow$ Muscle fibers (cells) $\rightarrow$ Myofibrils
 $\rightarrow$ Filaments (Actin/Myosin)

Myosin/Actin

- $\rightarrow$ Proteins known as filaments
- $\rightarrow$ Responsible for striations
 - $\rightarrow$ Myosin is thick & actin is thin
- $\rightarrow$ Responsible for muscle contraction (sliding filament theory)
- $\rightarrow$ Cross bridges from myosin to actin
- $\rightarrow$ Myofibrils are surrounded by sarcoplasmic reticulum

Sarcomere

- $\rightarrow$ Structural & functional unit of muscles
- $\rightarrow$ Basic building block of muscles



The Nervous System

- Detection → Conduct signal

Neuron

- Nerve cell, functional unit of nervous system
- Heal poorly & inconsistently
- Do not undergo mitosis

Nerve fiber

- Axion of a neuron

Fascicle

- Collection of nerve fibers

Nerve

- Collection of fascicles, essentially collection of neurons

Ganglia

- Collection of nerve cell bodies

Somatic

- "Body" cells
- Everything that is not a reproductive cell

Stimulus - A change causing a response

Response - An action called for in response

Afferent → Signals to the brain, sensory

Efferent → Signals from brain to effectors

Sensory → Perception of the environment

Motor → motion

Nervous system

Central nervous system (CNS)

(brain, spinal cord, receives sensory input, formulates responses)

Peripheral nervous system

(nerves, 8 pairs of spinal or 12 cranial)

Afferent division

(Somatic sensory neurons carry impulses to CNS)

Efferent division

(carry responses to sensory info away from CNS to effectors)

Autonomic

Nervous system

(involuntary motor neurons transmit impulses to smooth muscle)

Somatic nervous system

(voluntary)

Parasympathetic nervous system

(counteracts

sympathetic system, restores balance)

Sympathetic Nervous System

(prepares body for energy expending emergency situations, "fight or flight")

Divisions of the nervous system

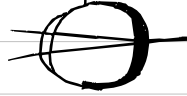
Vision Conditions

1) Presbyopia

- Natural spring of lens in eye, loses flexibility
- Hard to see up close for old people

2) Hypermetropia

"Far sighted"



- Can't see close due to focusing behind retina

3) Myopia

"Near sighted"



- Image focused in front of retina

4) Astigmatism

- Uneven corneal surface

5) Cataracts

- Cloudy lens

6) Glaucoma

- Build up of pressure in eye due to excess fluid
- Puts pressure on blood vessels & optic nerve

7) Color blindness

- Can't see various colors well
- Sex-linked recessive trait
- Red/Green is most common, blue/yellow next

8) LASIK (Laser assisted in situ keratomileusis)

- Laser assisted reshaping of the cornea

9) PRK

↳ flap peeled back from cornea

No-flap LASIK

Respiratory System

Terminology:

Breathing: ventilation, respiration; the exchange of gases between body & environment

Inspiration:

Synonymous with inhalation, breathing in, intrapulmonary pressure is less than atmospheric pressure

Expiration:

Synonymous with exhalation, breathing out, intrapulmonary pressure exceeds atmospheric pressure

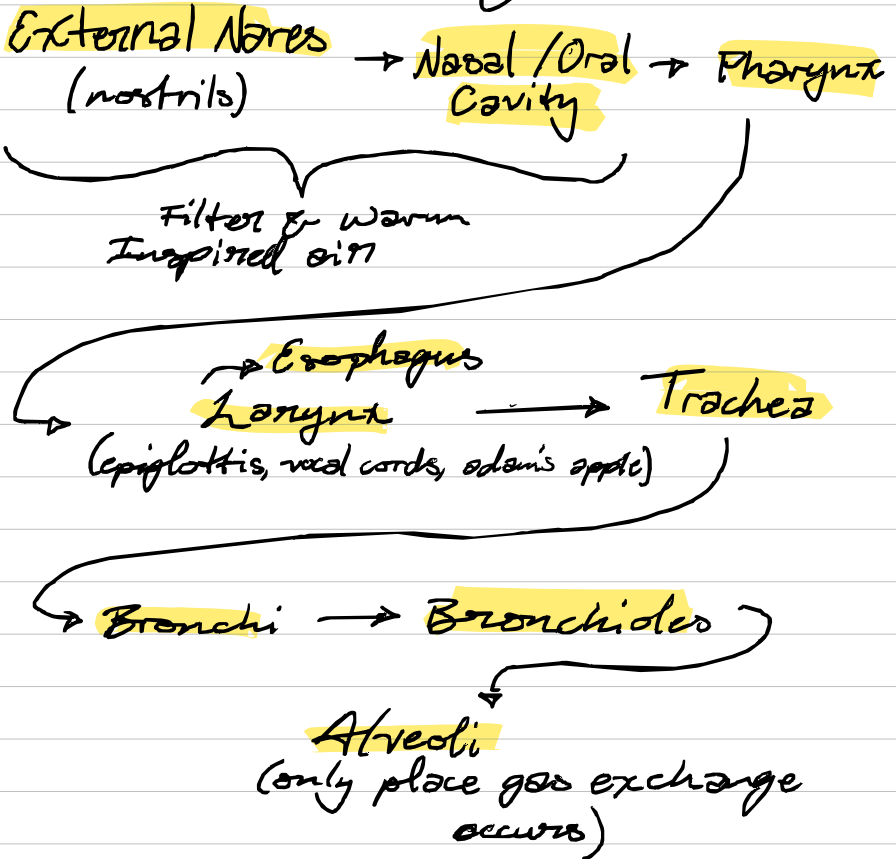
1 inspiration + 1 expiration = 1 respiratory cycle, 12 cycles per minute @ rest

Atmospheric pressure:

Pressure exerted by all gases that make up our environment, 760 mmHg

Pathway of Air through Respiratory System

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Pressure Gradients

- Gas flows from high to low pressure

Mechanics of Breathing

- Intrapulmonary pressure — inside pushing out, Atmospheric press. = 760 mmHg
- Intrapleural pressure — from pleural cavity pushing in, 756 mmHg
- Natural collapsing force of lung tissue, 4 mmHg

ADS $\rightarrow$ Anatomical dead space

- * MRV (Minute Respiratory Volume)
 $= RR(\text{Respiratory rate}) \times TV(\text{tidal volume})$
- * AV (Alveolar ventilation)
 $= RR(TV - PDS) \rightarrow \text{Physiological dead space}$

Ex 1: 218 lbs, 22 lbs overweight. 53 ml

Alveolar volume unavailable from illness

- A) Anatomical dead space: 196 ml
- B) Physiologic dead space: 249 ml
- C) Respiratory volume: 8,500 ml
- Alveolar ventilation: 4,267 ml

- * Physiologic dead space = Alveolar volume unavailable for gas exchange + ADS
- * Tidal volume averages 500 ml for resting breath

Ex 2:

$$240 - 21 \rightarrow 219 = \text{ADS}$$

$$+ 32 = 251 \text{ PDS}$$

$$5,000 \div 500 = \textcircled{10} = \text{RR}$$

$\hookrightarrow$ TV

$$\textcircled{D} 10(500 - 251) \rightarrow 10(249) \rightarrow 2,490$$

AV

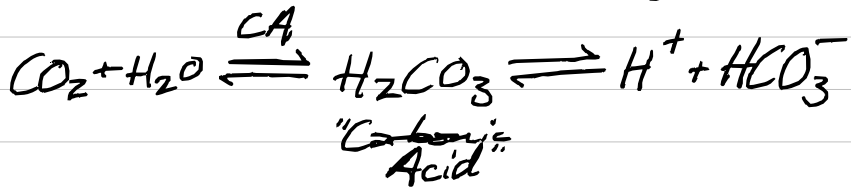
Partial Pressures

- The amount of pressure each individual gas contributes to the whole
- Symbolized by "P" in front of gas formula
- PCO_2 is symbol of partial pressure of carbon dioxide
- Our atmosphere is 21% O_2

Carbon dioxide transport

- 8% dissolved in plasma
- 20% carried in carbamino compounds
↳ "Globin", which carries CO_2
- 72% carried by bicarbonate ions:

How is CO_2 converted to HCO_3^- ?



CA = Carbonic Anhydrase