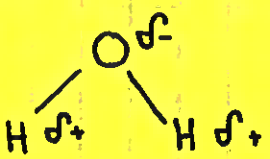
WATER

polar molecule
↳ unequal sharing of e^-



considered the universal solvent
↳ dissolves everything

Cohesion
↳ water molecules stick to eachother due to H^+ bonds

Adhesion
↳ water molecule attatched to some other molecule

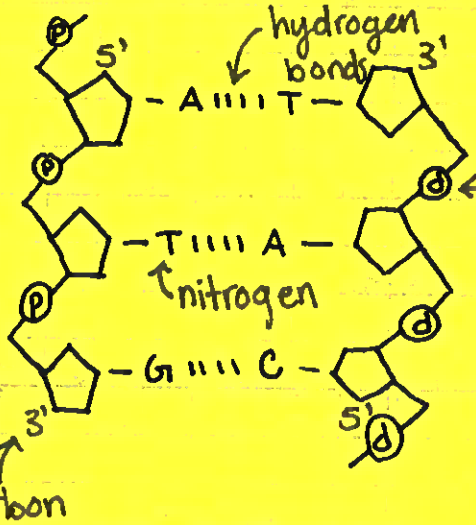
Temperature buffer
↳ H-bonds take a lot of energy to break
ie) energy doesn't translate to temp change

Lubricant
↳ H_2O forms a barrier around food via adhesion/cohesion

DNA

Structure

DNA is double helixed, has a backbone made of sugar phosphate components & rungs made of pairs of nitrogeneous bases
nucleotide made of sugar attatched to a phosphate & nitrogen base
bases are Adenine, Thymine (A-T) Guanine & cytosine (G-C)



The strands are antiparallel: left runs 5'→3' while right runs 3'→5'

Function of DNA: code for the correct order of AA in polypeptide

DNA Replication

making of DNA from existing DNA
semiconservative → each strand acts as template, each daughter molecule has one old & one new strand.

Replication begins at sites called origins of replications
Initiation proteins bind to origin of replication
Helicase unwinds double helix
Topoisomerase prevents DNA from getting too tightly bounced
Single Strand Binding Proteins prevent DNA strands from combining back together into a double helix
Primase makes RNA primer that provides 3'end for DNA poly to attatch to
DNA polymerase III adds complimentary nucleotides 5'→3'
DNA polymerase I removes primer & replaces it with nucleotides
Ligase seals nicks that remain after primers are replaced.

Leading & Lagging strands
↳ replication occurs continuously along 5'→3' strand called leading strand
strand that runs 3'→5' copied in segments called okazaki fragments
↳ needs multiple primers
→ slower = lagging strand

Telomeres
↳ chromosomes of eukaryotes have ends
→ DNA at very end cannot be fully copied, resulting in slow shortening of chromosome → DNA poly has no way to complete 5' end
→ Tips of chromos have "caps" called telomeres
→ telomeres consist of repeats of 5'- TTAGGG -3'

~~Telomeres~~
Telomerase
↳ some cells have ability to reverse telomere shortening by expressing telomerase
enzyme that extends telomeres of chromos.

Transcription

synthesis of RNA using DNA template, takes place in nucleus
RNA polymerase → enzyme that seperates the 2 DNA strands & connects RNA ~~to~~ nucleotides ~~to DNA~~
5'→3' direction + uracil replaces thymine
promoter → DNA sequence ~~that~~ where RNA poly attatches
terminator → DNA sequence that signals end of transcription
transcription unit → entire sequence that is transcribed

1. Initiation
↳ in bacteria RNA poly binds to promoter
in eukaryotes transcription factors assist the binding of RNA poly to promoter
whole thing called transcription initiation complex

2. Elongation
↳ RNA poly moves along DNA adding RNA nucleotides to 3' end
→ as it moves along, double helix reforms & new RNA moves away from template

3. Termination
↳ when RNA poly transcribes termination sequence, RNA transcript is released and polymerase detatches

- Transcription results in pre-mRNA in eukaryotes which undergo processing to become mRNA (messenger RNA)
- mRNA carries genetic message of DNA to ribosome

Processing

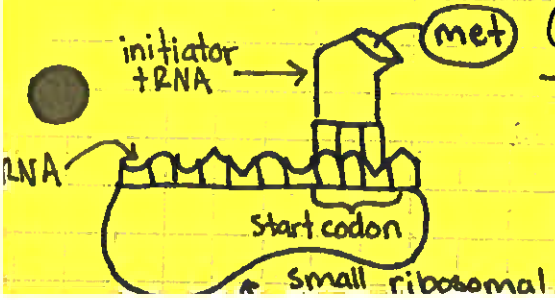
the addition of 5' cap + poly-A tail protect mRNA from degration of enzymes + facilitate attatchment of mRNA to ribosome

RNA Splicing
↳ large portions of RNA are removed
→ introns removed
→ exons remain → spliced together by spliceosome
→ because of RNA splicing one gene can often make more than one polypeptide → alternative gene splicing

Translation

- occurs at ribosome
- tRNA → transfers AA from cytoplasm to ribosome
- anticodon → specific nucleotide triplet that has complimentary codon of mRNA
- 64 different codons including 3 stop codons (UAG, UAA, UGA) and 61 codons for 20 AA
- ribosome composed of rRNA + proteins and has 2 subunits
- large subunit has 3 binding sites for tRNA
  ↳ P-site → holds tRNA that carries growing polypeptide chain
  → A-site → holds tRNA that carries AA that will be added to chain next
  → E-site → exit site for each tRNA

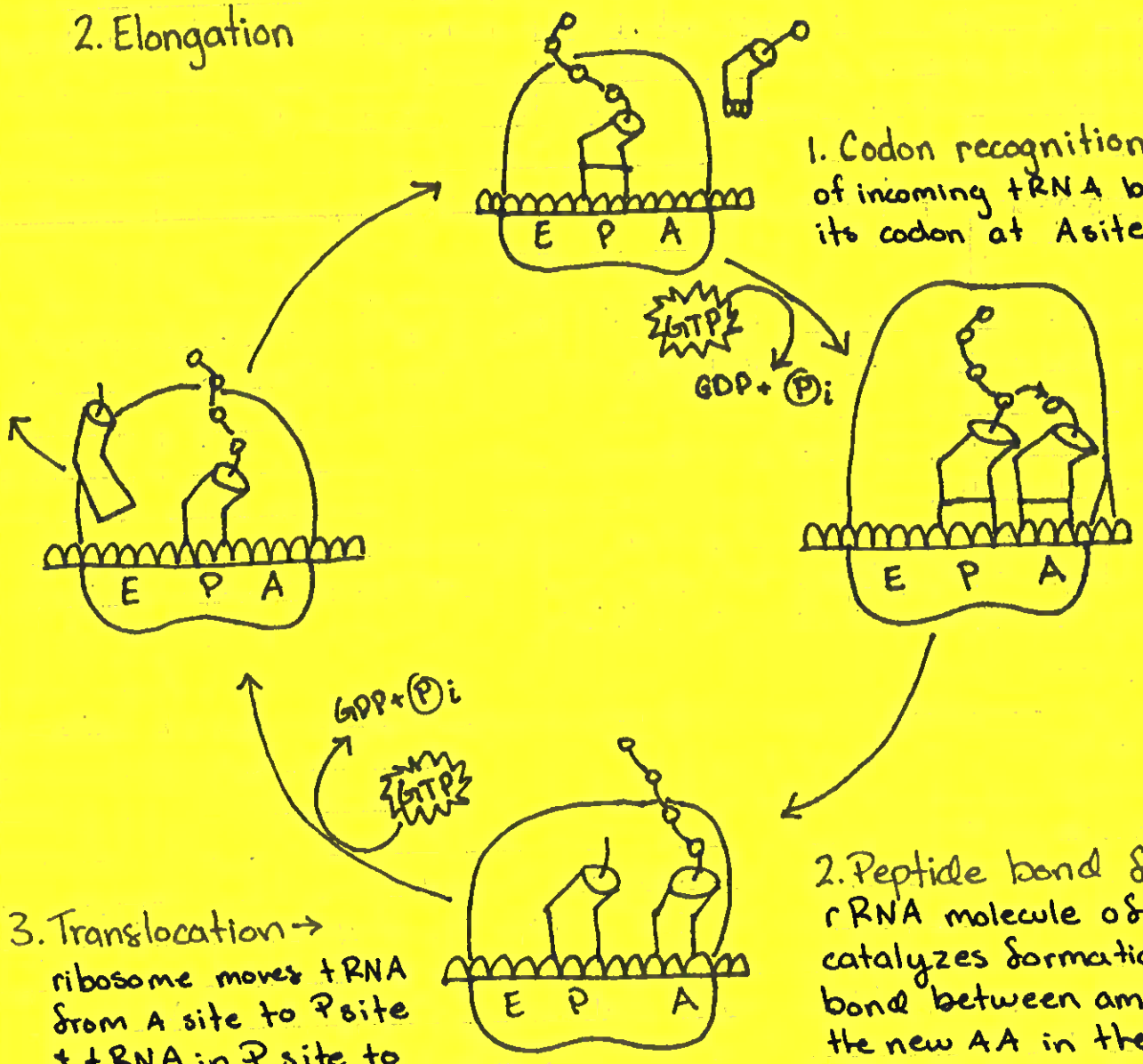
1. Initiation



- small unit binds to mRNA so the first codon (AUG) is in the right spot
- tRNA w anticodon UAG and pp Methionine, hydrogen bonds to the first codon (initiation factors are proteins that assist in holding all this together

large subunit attatches, allowing tRNA with methionine to attatch to P site
A site is available to tRNA that will bring the second AA

2. Elongation



1. Codon recognition → anticodon of incoming tRNA base pairs with its codon at A site

2. Peptide bond formation → rRNA molecule of large subunit catalyzes formation of peptide bond between amino group of the new AA in the A site & carboxyl strand of pp in P site & ~~attatches~~ pp is removed from tRNA in P site & attatches to AA on tRNA in A site

3. Translocation →
ribosome moves tRNA from A site to P site & tRNA in P site to E site where it is released. mRNA moves along with tRNA bringing next codon to A site.

3 Termination

↳ stop codon in mRNA is reached and translation stops
→ protein called release factor binds to stop codon & pp is released from ribosome

→ pp then fold to assume their specific conformation.

Mutations

alteration in genetic material of cell
altered genes can have, +, - or no effect on organism

Frameshift Mutations

↳ Deletion: ~~substitution that change~~ loss of nucleotide pair
→ Insertion: addition of nucleotide pair
→ can cause the mRNA to be read incorrectly on each remaining codon

Point Mutations

↳ Nonsense: substitution that changes regular AA codon to stop codon terminating translation too early = 0 function of pp
→ Missense: sub that changes codon of AA to a codon for a different AA = function of pp changes
→ Neutral: sub that changes AA made. Different pp made but same function
→ Silent: sub that doesn't change AA made = same pp + function (multiple codons for 1 AA)

Mutagens → substances or forces that interact with DNA and cause mutations ex) X-rays, other radiation, certain chemicals.

THE CELL

3 key details about prokaryotes:
1. The single circular chromo is found in a region called the nucleoid, but there is no nuclear membrane = no nucleus
2. No membrane-bound organelles in cytosol
3. much smaller than eukaryotes

3 key details about eukaryotes:
1. membrane-bound nucleus contains cell's linear chromos
2. many membrane bound organelles in cytosol
3. larger than prokaryotes

Organelles

Nucleus
↳ contains DNA
→ surrounded by nuclear envelope (double membrane)
  ↳ nuclear pores on envelope control what leaves & enters
→ chromatin is complex of DNA & protein
  ↳ during cell replication it condenses into chromos
→ nucleolus is region of nucleus where rRNA complexes w protein to form ribosomal subunits

Ribosomes
↳ Free ribosomes float in cytosol and produce proteins used in cell
→ Bound ribosomes are attatched to ER and make proteins for outside of cell

Endoplasmic Reticulum (ER)
↳ smooth ER: synthesis of lipids, metabolism of carbs, & detox of drugs & poisons
→ ~~Protein~~ Rough ER: synthesize proteins

Golgi Apparatus
↳ modifies, stores & ships protsins

Lysosome
↳ membrane bound sacs of hydrolytic enzymes that can digest large molecules (proteins, fats & nucleic acids)
→ digestive enzymes that break down macro molecules & monomers are re-used in cell

Vacuole
↳ stores stuff (lipid membrane)

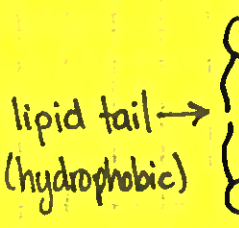
Vesicle
↳ used for transport (lipid membrane)

Peroxisome
↳ metabolizes fatty acids. turns it to hydrogen peroxide then to water (lipid membrane)

Cell Structure

Cytoskeleton → network of fibres in cytoplasm that are responsible for support motility & regulating some chem rxn
↳ microtubules
  ↳ made of tubulin
  → largest fibres
  → shape & support cell
  → tracks along which organelles w motor proteins can move
→ microfilaments
  ↳ made of actin
  → smaller scale support
  → smallest
→ intermediate filaments
  medium size
  maintains shape of cell & fixing position of certain organelles

Perimeter of cell is surrounded by phospholipid bilayer



- lipid based molecules can pass through easily
- small, uncharged molecules pass easily

plasma membrane = selectively permeable = allows substances to cross more easily than others

Selective Permeability

↳ non-polar molecules (CO_2, O_2) can cross membrane easily
→ ions + polar molecules cannot cross easily
→ H_2O moves through aquaporins (transport proteins)

Passive Transport

↳ diffusion of substance across membrane with 0 energy used
→ substance travels from high → low [] (concentration gradient)
→ H_2O crossing = osmosis
↳ Isotonic solution
↳ no net movement of H_2O
→ same rate in both directions
→ Hypertonic solution → ↑ [] of solute outside cell
↳ cell loses water to surroundings
→ cell shrivils + dies
→ Hypotonic solution → ↑ [] solute in cell
↳ water enters faster than it leaves
→ cell will swell + may burst

~~Active Transport~~

ions + polar molecules diffuse through facilitated diffusion
↳ transport proteins either provide channel or bind + carry them across.

Active Transport

↳ substances moved against conc. gradient
↳ requires ATP
ex) sodium potassium pump
↳ pumps Na^+ out of cell + k^+ into cell

→ large molecules are moved across cell membrane through endo + exocytosis
↳ Exocytosis: vesicles from cells interior fuse with cell membrane, expelling their contents
→ Endocytosis: cell forms vesicle from plasma membrane and surrounds macromolecule allowing it to enter cell

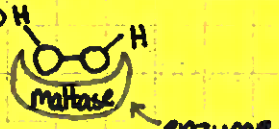
DIGESTIVE SYSTEM

Oral Cavity

Goal: take food and turn it into bolus
↳ sphere of food that is easier to digest

*2ways to break down food:
Physical/Mechanical: increases surface area for max chemical digestion
Chemical: using enzymes to speed up chemical reactions (hydrolytic enzymes)

Hydrolysis (using water to break things apart)



- starch (multiple glucose) → Maltose (salivary amylase)
- no protein, lipid or nucleic acid breakdown at this point

Esophagus

food is pushed down using peristalsis
Cardiac sphincter → prevent food/acid from backtrakking
Pyloric sphincter → prevents food entering small intestine

Stomach

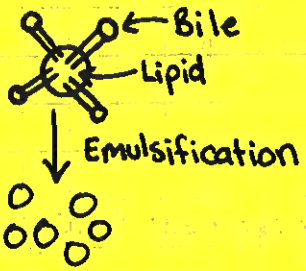
Protein $\xrightarrow[HCl]{}$ polypeptide $\longrightarrow$ peptide
pepsinogen $\xrightarrow[HCl]{}$ pepsin (enzyme)

- Stomach is lined with mucus cells that release mucin
  ↳ mucin coats the stomach and prevents it from eating itself
- turns food into chyme → semi fluid mass of partially digested food

Small intestine

Starch $\xrightarrow[\text{amylase}]{\text{pancreatic}}$ maltose $\xrightarrow[\text{maltase}]{}$ Glucose → absorbed into blood via active transport

- Peptides —Trypsin→ smaller peptides —peptidase→ amino acids
- Lipids —Bile→ smaller lipids —Lipase→ Glycerol + Fatty Acids
  ↳ go into lymphatic system



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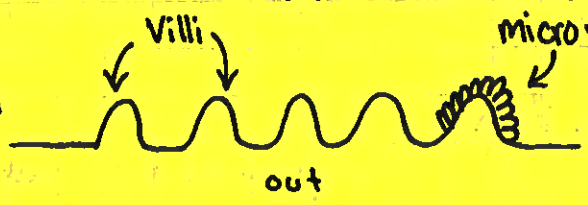


- Villi & microvilli increase surface area

Large intestine

Diarrhea → too much water leaving body / not enough water being absorbed
↳ rapid contraction of smooth muscle
→ caused by food intolerance, illness, or stress

Constipation → lack of fibre
↳ too much water is absorbed into body and everything backs up

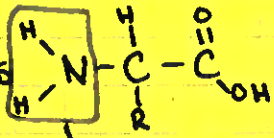
Pancreas

Exocrine (duct) → Pancreatic juice
↳ lipase, trypsin, pancreatic amylase, sodium bicarbonate

Endocrine (blood) → high blood sugar
↳ Pancreas detects high glucose
→ releases insulin into blood
→ insulin binds to a receptor protein on liver
→ glucose channel opens
→ glucose stored as glycogen

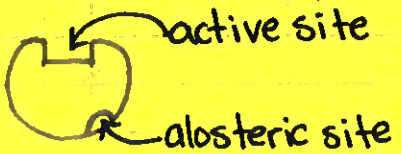
→ low blood sugar
↳ pancreas detects low glucose
→ releases glucagon into blood
→ glucagon binds to liver receptor protein
→ glucose channel opens
→ glycogen → glucose that enters blood

Liver

Bile production → breaks down lipids into smaller lipids
Red blood cell breakdown → build up = jontis , uv accelerates process
Sugar regulation
Protein production (blood clotting)
Urea
Detox → toxin break down
→ Protein → Amino Acids 
→ NH_3 → $NH_3 + CO_2$
→ urea → save water

Enzymes

- Catalyzes a chemical reaction by decreasing Ea
- Catabolism → breakdown ex) maltose $\xrightarrow{\text{maltase}}$ glucose + glucose
- Anabolism → build up ex) amino acid + amino acid = dipeptide



substrate = reactant
product = product

Factors that affect enzymatic activity:

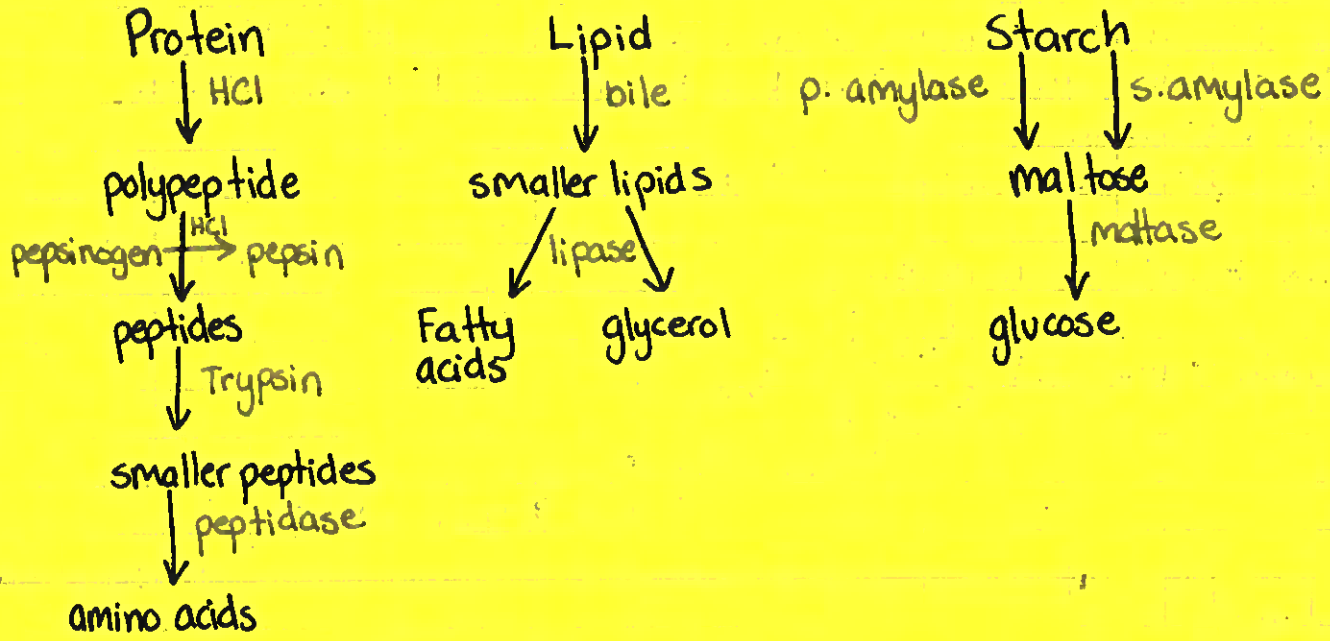
1. Amount of substrate or enzyme
2. Temperature
   → ↑ temp = active site stretches } affect lock & key + induced fit → lowers enzymatic activity
   ↓ temp = active site shrinks }
3. PH → ↑ pH = OH interacts w/ active site }
   ↓ pH = H^+ interacts w/ active site }

4a) Competitive inhibitor
   → inhibitor binds to active site + blocks substrate from joining
   → lowers enzymatic activity

b) Non-competitive inhibitor
   → binds to alosteric site + changes active site ~~to better~~ so the substrate no longer fits
   → lowers enzymatic activity

5. Co factor
   → binds to alosteric site + changes active site to better fit substrate
   → increases enzymatic activity

Summary



Enzyme	Produced by	target
trypsin	pancreas	sm. int
lipase	pancreas	sm. int
matase	sm. int	sm. int
peptidase	sm. int	sm. int
pepsinogen	stomach	stomach
s. amylase	mouth	mouth
p. amylase	pancreas	sm. int.

CIRCULATION + RESPIRATION

* The circulatory system has 3 components : Blood, vessels + a heart *

Heart Parts

Arteries → carry blood away from the heart and branch into smaller atrioles. Their walls are thich and have lots of smooth muscle. The puls is felt in an artery.
Capillaries → microscopic ~~cells~~ vessels composed of only a single layer of cells. All diffusion occurs here.
Veins → carry blood back to the heart. They have valves to prevent backflow.
Atria → heart chambers that recieve blood and convey it to ventricles, whic pump blood.

Superior Vena Cava → vessel that recieves blood from head, neck, upper extremities and thorax + delivers it to right atrium
Inferior Vena Cava → vessel that receives deoxyginated blood from the lower and middle body + delivers it to right atrium
Pulmonary Veins → transfer oxygenated blood from lungs to left atrium
Pulmonary Arteries → carries deoxygenated blood from right ventricle to left atrium
Aorta → supplies blood to almost all of the major organs through the smaller arteries that arise from it. The largest artery + starts at the left ventricle, arches upwards towards the neck, then curves back downwards extending into abdomen
Pulmonic Semi lunar Valve → allows blood to be pumped into arteries, but prevent backflow of blood from arteries into ventricle
Aortic Semilunar Valve →
Bicuspid Atrioventricular Valve → permits blood to only flow from left atrium into left ventricle
Tricuspid Atrioventricular Valve → permits blood to only flow from right atriu to right ventricle
Right Atrium → receives deoxygenated blood from right vena Cava and pumps it to the right ventricle
Right Ventricle → receives deox. blood from right blood and pumps it into lungs vid the pulmonary artery

Left Atrium → receives ox. blood from lungs + pumps it to left ventricle
Left Ventricle → receives ox. blood from left atrium + pumps it through the aorta

Sinoatrial (SA) Node → located in the upper wall of right atrium + generates electrical impulses that set the rate at which cardiac muscle cells contracts (pacemaker of the heart)
Atrioventricular (AV) Node → located in the lower wall of right atrium + delays impulses from SA node to allow the atria to completely empty before ventricles contract.
Purkinje Fibres → receive conductive signals from AV node + activate the left + right ventricles by directly stimulating the ventricular myocardium

Cardiac Cycle

- blood enters right atrium
- blood pressure stimulates SA node
- SA node sends signal to atria to contract
- blood is pushed through AV ~~node~~ valve into ventricles
- SA node sends signal to AV node
- AV node sends signal to ventricles to contract using purkinje fibres
- blood pushed through semilunar valves + out pulmonary/aortic arteries

Blood

Composition

Plasma
↳ 90% water
→ contains ions, electrolytes + plasma proteins
→ transports nutrients, metabolic wastes, gases + hormones and blood cells
Cells
↳ Red Blood Cells (RBC) → transport O_2 via hemoglobin
→ White Blood Cells (WBC) → part of the immune system
→ Platelets → clotting

Clotting

Platelets damaged + release...
Thromboplastin + calcium.
Prothrombin (made by liver) is converted into...
Thrombin by thromboplastin + Ca^{+2}
Fibrinogen is converted into
Fibrin (insoluble via thrombin + Ca^{+2}

Blood clotting occurs when a blood vessel is injured.

Blood Types

Type	Genotype	Antigen	Antibody
A	I^AI^A / I^Ai	A	B
B	I^BI^B / I^Bi	B	A
AB	I^AI^B	A, B	none
O	ii	none	A, B

Donation:
recipients antibodies
Rh compatability

	Antigen	Antibody
Rh^+	Rh	no Rh antibody
Rh^-	no Rh	no Rh antibody

Rh^+ can't donate to Rh^-
↳ recipient would develop Rh antibody → Agglutination

Agglutination
↳ clumping of red blood cells so a macrophage can engulf it

Donor — Recipient

\+ — +
\- — -
\- — +
\+ — -

O — A
B — AB
B — O
A — O

Blood Pressure:
↳ systolic → pressure your heart exerts while beating
→ diastolic → pressure in arteries between beats

S/d

Fetal Circulation

Umbilical cord attatched to baby + placenta
Umbilical vein provides ox. blood for baby + nutrients
Umbilical arteries get rid of baby's deox. blood

Rh Compatability:
if baby = Rh^+ and mom = Rh^- mom will develop Rh antibody
mom needs an amino-suppressant

Neural Signaling

Aortic + Carotid Bodies are chemoreceptors that detect $\uparrow H^+$, $\uparrow CO_2$ & $\downarrow O_2$

Aortic Bodies ← aortic arch
Carotid Bodies ← carotid artery
vagus nerves + glossopharyngeal nerves → Medulla
Medulla → phrenic nerve → Diaphram
Medulla → Thoracic nerve → Intercostals
= ↑vol = ↓pressure = Θpress = air in

Respiratory system

Nasal Cavity → mucus - trap
→ cilia - sweep
→ capilla - warm → ↑ gas exchange diffusion

Pharynx → air/food mix, back of mouth
Larynx → voice box
Trachea, Bronchi, Bronchioles → - cartilage, - mucus, - cilia

Alveoli → moist
→ thin
→ grape clusters
→ dense w/ capillaries
} ↑ diffusion rates
→ stretch receptor → prevent overfilling
→ pulmonary surfactant → ↓ surface tension

Haldane Effect

- Hemoglobin will join w/ O_2 if $[O_2]$ is high (Hb has an afinity for O_2 when $[O_2]$ is high) $Hb + O_2 \rightleftharpoons Hb_{O_2}$ (oxyhemoglobin)
- at cells if cellular respiration is occuring
  - ↳ Hb kicks off O_2 because:
    - ↑ CO_2
    - ↑ H^+
    - ↑ temp

CO_2 Transport:
- CO_2 + H_2O exit cell
- CO_2 can travel in plasma (1-3%)
- CO_2 can join w Hb : $Hb + CO_2 \rightleftharpoons Hb_{CO_2}$ (carbahemoglobin) (3-8%)
- CO_2 can react w H_2O in RBC
  - ↳ $CO_2 + H_2O \rightleftharpoons H^+ + HCO_3^+$
    - ↑ carbonic anhydrase
    - ↑ bicarbonate

$Hb + H^+ \rightleftharpoons HHb$
(reduced hemoglobin)

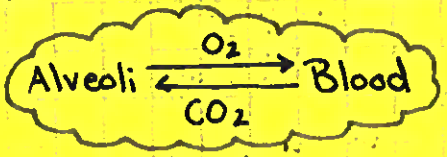
At Lungs:
- CO_2 → diffuses out of blood + into lungs
- $HbCO_2$ → Hb kicks off CO_2 because $[O_2]$↑ at lungs
- HHb → Hb kicks off H^+ because $[O_2]$↑ at lungs
- HCO_3^- → join w/ H^+ $H^+ + HCO_3 \rightarrow H_2CO_3 \rightarrow H_2O + CO_2$

Factors that affect Hb affinity for O_2 at cells (↓):
- ↑ temp → weakens bond w O_2
- ↑ H^+ → bind to Hb + changes O_2 binding site
- ↑ CO_2 → changes shape of O_2 binding site AND changes to bicarbonate + releases H^+

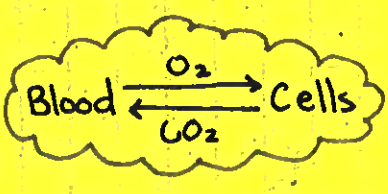
Respiration

Diffusion → movement of solute (gas) from high - low [ ]
P_{O_2} + P_{CO_2} (partial pressure) refer to amo

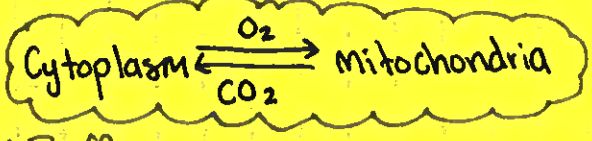
External Respiration
↳ movement of gas from alveoli of lungs to capillaries of circulatory system
→ blood in capillaries have higher P_{CO_2} than alveoli
  ↳ CO_2 diffuses out of blood and into lungs
→ alveoli have higher P_{O_2} than capillaries
  ↳ O_2 diffuses out of lungs + into blood



Internal Respiration
↳ movement of gas from capillaries to all cells of body
→ cells have higher P_{CO_2} than capillaries
  ↳ CO_2 diffuses out of cells into blood
→ blood in capillaries have higher P_{O_2} than cells
  ↳ O_2 diffuses out of blood and into cells



Cellular Respiration
↳ in/out mitochondra



H^+ Buffer
↳ the blood needs to be at contsant pH of ~7.4
→ Alkalosis - result of hyperventilation
  ↳ decrease in H^+
  → dizziness + twitching
→ Acidosis - Hyperventilation
  ↳ increase in H^+
  → coma + die

Breathing Mechanism
↳ signal from medulla
↓
diaphram + intercostals
↑ volume of chamber → ↓ pressure → ⊖ pressure = air rushes in

URINARY SYSTEM

Functions:
1. excretion of metabolic wastes
   ↳ urea, creatine, uric acid
2. water/salt balance
   ↳ NaCl, K^+, HCO_3^-, Ca^{+2}
3. pH balance
   ↳ excretion of H^+, reabsorption of HCO_3^-
4. regulation of blood pressure

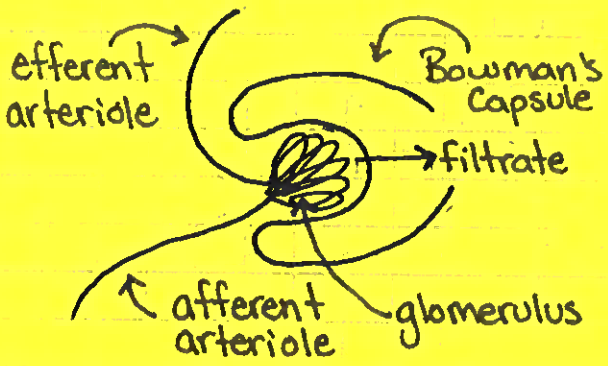
The Kidney & Nephron

Renal Cortex

Renal Medulla → cone shaped masses of tissue that secrete urine into tiny sac-like tubules

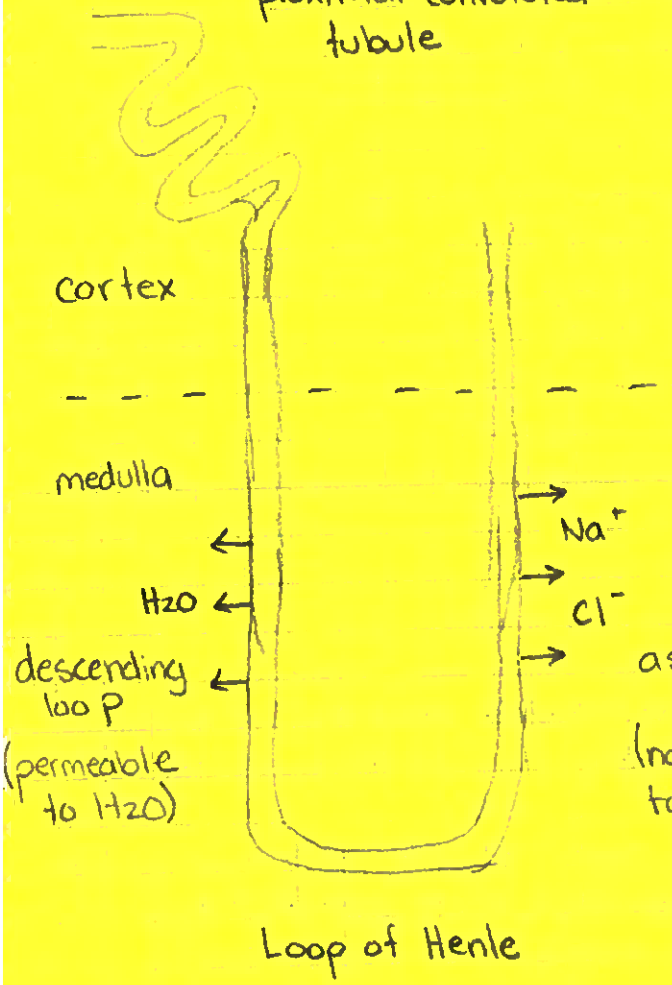
Renal Pelvis → funnel shaped tube surrounded by smooth muscle that uses peristalsis to move urin out of kidney, into ureter and to the bladder

1. Glomerular Filtration → bowman's capsule + glomerulus



- blood enters the afferent arteriole + glomerulus
- blood pressure forces H_2O + small particles (glucose, AA, salt, urea) into bowmans capsule
- large molecules + blood cells can't leave capillaries
- the fluid that enters nephron is called filtrate

2. Tubular Reabsorption → proximal convoluted tube, loop of Henle + some DCT



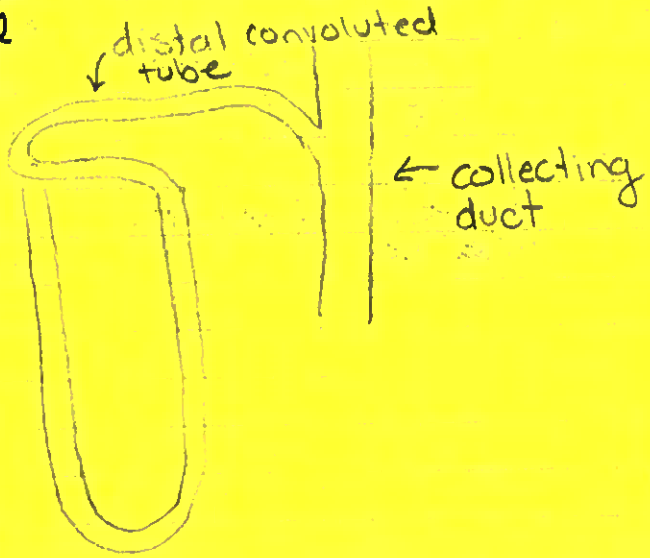
Proximal Convoluted Tubule
↳ villi + carrier proteins allow molecules to be reabsorbed into blood actively + passively
ex) glucose

Descending Loop of Henle
↳ medulla is very high in salt so water leaves through aquaporin protein channels by osmosis
↳ water goes from low to high salt [ ]

Ascending Loop of Henle
↳ NaCl diffuses passively out the lower end (lower salt [ ] there)
→ Na Cl actively transported out upper end
↳ NaCl causes salty medulla which causes osmosis in descending limb

Collecting Tubule / Duct
↳ H_2O leaves through aquapourins by osmosis again bc the collecting duct crosses into the salty medulla
→ urea leaves through channel proteins by diffusion
↳ creates an even higher concentration gradient + allows more water to leave

3. Tubular Secretion → DCT
↳ no microvilli
→ K^+, creatine + many other drugs sent from blood are secreted into the tube by active transported
→ H^+ / HCO_3^- absorbed into blood
↳ pH regulator



Blood Pressure Regulation

If low blood pressure

↳ juxtaglomerular apparatus secretes renin
→ renin is an enzyme that changes angiotensinogen → angiotensin
→ aldosterone promotes excretion of K^+ + reabsorption of Na^+ at the DCT. The reabsorption of Na^+ is followed by the reabsorptio of H_2O into blood
↳ blood volume ↑ = bp ↑

If high blood pressure

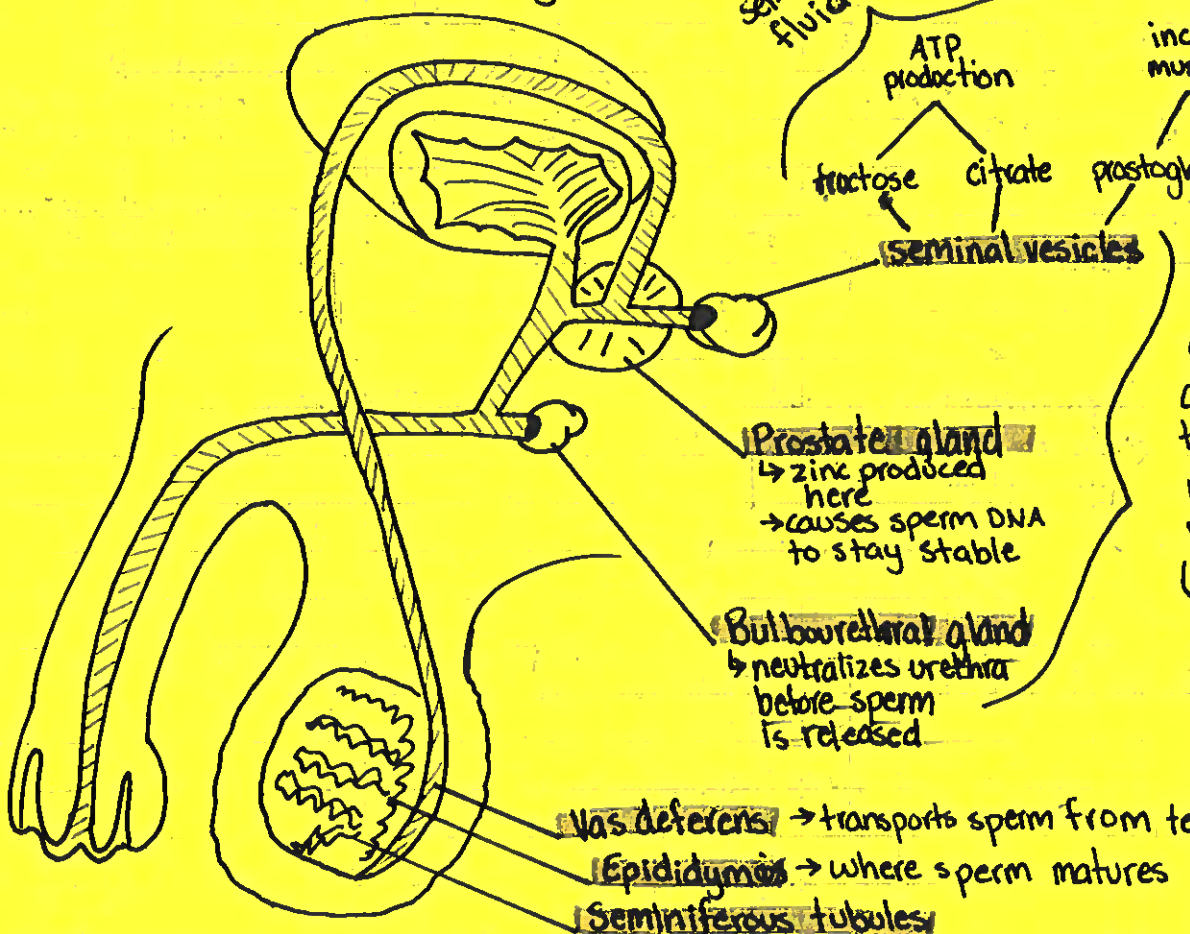
↳ atrial naturietic hormone (ANH) secreted by right atrium of heart ir response to stretching due to higher BP
→ inhibits renin secretion by juxtaglomerular apparatus
↳ ie) inhibits aldosterone release

Permeability of collecting duct is under hormonal control

↳ Antidiuretic Hormone (ADH)
↳ released by posterior pituitary gland (made by the hypothalamus) to regulate BP
→ <u>ADH present</u> = collecting duct becomes more permeable to H_2O
↳ causes ↑ in aquaporin production
→ H_2O leaves kidney + enter blood (↑BP) + a concentrated urine is produced
→ <u>ADH absent</u> = collecting duct less permeable to H_2O
↳ alcohol inhibits aquaporin production
→ H_2O will not leave kidney + dilute urine is produced

REPRODUCTIVE SYSTEM

Male reproductive system



seminal fluid
- ATP production
  - fructose
  - citrate
- increase smooth muscle retraction
  - prostoglandins

seminal vesicles

all 3 have alkaline fluid to neutralize urethra and vaginal cavity (sperm like a basic environment)

Prostate gland
↳ zinc produced here
→ causes sperm DNA to stay stable

Bulbourethral gland
↳ neutralizes urethra before sperm is released

Vas deferens → transports sperm from testicles to ureth

Epididymis → where sperm matures

Seminiferous tubules
↳ sperm production

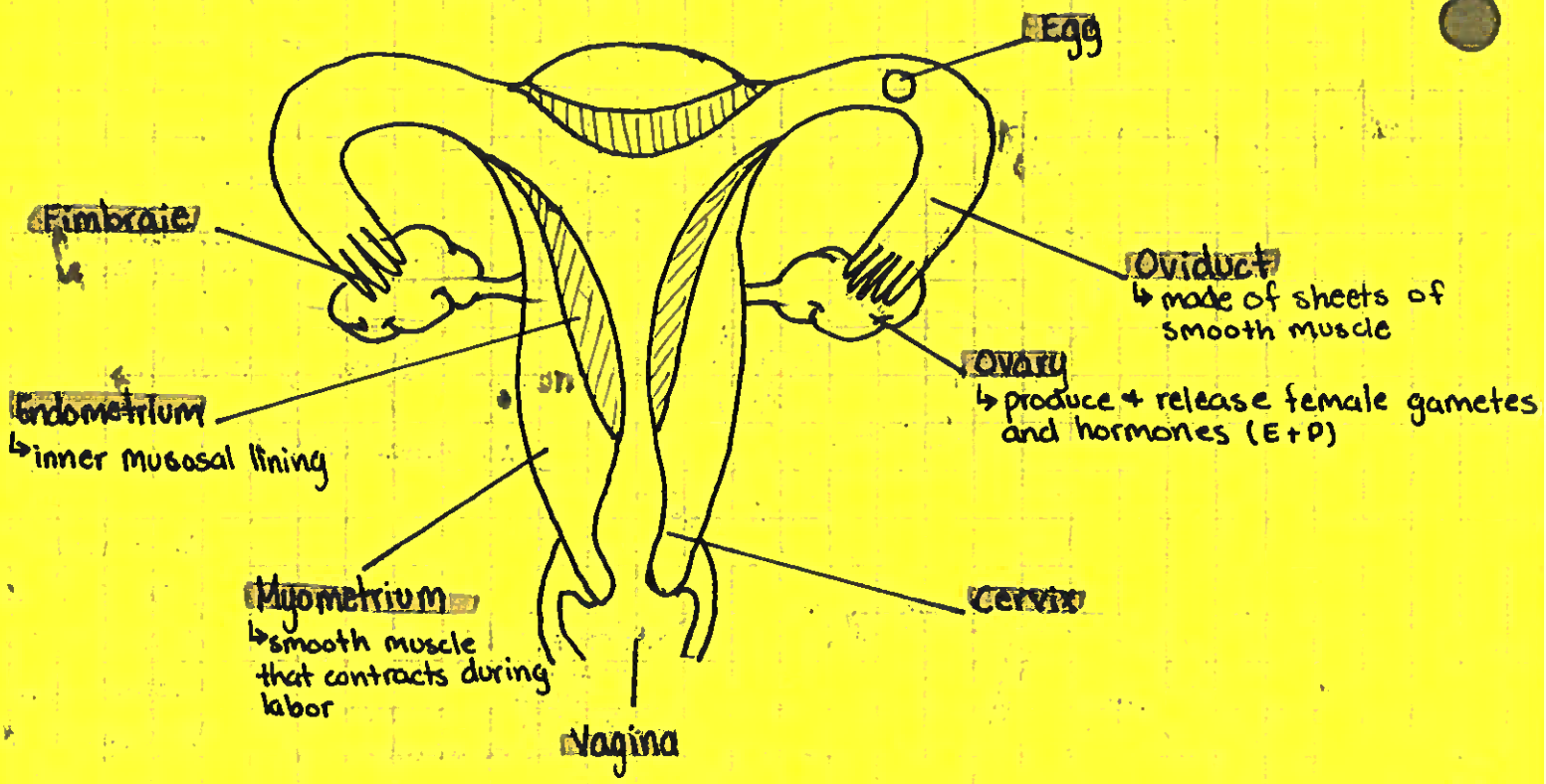
Male hormone regulation

Hypothalamus
↓ gonadotropin releasing hormone (GNRH)
Anterior Pituitary
- Follicle stimulating Hormone (FSH)
  - ↓ seminiferous tubules
  - ↳ sperm production
- Lutenizing Hormone (LH)
  - ↓ interstitial cells
  - → testosterone production
  - ↳ lipid based steroid

* Leads to inhibitor that prevents transcription of GNRH
↳ negative feed back

* steroids have a ⊖ effect on fertility → inhibits GNRH from being made → no sperm

Female Reproductive System



Female Hormone Regulation

Hypothalamus
↓
GNRH
↓
Anterior Pituitary

LH → Stimulates follicle cells (corpus luteum after ovulation specifically) to produce progesterone + estrogen

- Progesterone → Controls the secretory phase
  ↳ ↑ Blood vessels + mucus cells in endometrium
- Estrogen → Controls proliferative phase
  ↳ thicken endometrium
  Day 14 = follicle matures + is released → ↑ E = ↓ in LH

FSH → Stimulates follicle ~~cells~~ growth of follicle surrounding the ovum in ovary

Corpus Luteum
↓
Secretes E+P after ovulation for 14 days
no E+P = triggers menstruation

The Cycle

OVARIAN

Follicular Phase Day 1-13
- → FSH stimulates follicle (causes it to grow)
- → Follicle releases estrogen
- → Estrogen causes more estrogen to be made (+ feed back)
- → Estrogen causes endometrium to thicken

Ovulation Day 14
- → ↑ in E causes a spike in LH
- → causes graafian follicle to burst and release ovum into oviduct

Luteal Phase Day 15-28
- → remaining follicle (corpus luteum) releases progesterone (some estrogen) which causes the endometrium to become blood vessel rich + secretory

UTERINE

Menstrual Phase Day 1-5
- → LH reduction causes corpus luteum to degenerate (stop producing E + P) and the endometrium sheds

Proliferative Phase Day 6-14
- → Estrogen secreated by follicle causes the endometrium to shed

Secretory Phase Day 15-28
- → Progesterone secreted by follicle causes the endometrium to become blood vessel rich + secretory

Every women's cycle will vary in length, but the luteal phase is always 14 days

Fertilization

sperm(n) + egg(n) = zygote(2n) → embryo → fetus

Time line
- ↳ Ovulation (day 14)
- → Fertilization (day 15)
  - ↳ 2-3 days to reach uterus
  - → 2-3 days to implant in endometrium
  - → 2-3 days to develop placenta
    - ↳ placenta produces HCG
      - ↳ HCG tells corpus luteum to produce E + P
  - → 2-3 months for placenta to produce own E + P

* Placenta is a large organ attatched to wall of uterus that provides fetus with nutrients + oxygen through the umbilical cord

Pregnancy tests detect high levels of HCG in urine

Delivery

↳ Fetus puts pressure on cervix

⊕ feed back

→ Cervix sends a neural message to posterior pituitary → stores hormones

→ Pos pit releases oxytocin into the blood

→ Oxytocin causes prostaglandins to be released in the myometrium causing it to contract (smooth muscle)

→ puts more pressure on cervix

Contraception

→ condom effectiveness: 97% (85% real world)

→ not all contraceptions are equally effective

→ IUD: made of copper, stops sperm's activity

→ Breastfeeding acts as a contraception for the first 6 months of a baby's life

→ High P/Low E Pill: progesterone causes negative feedback which shuts down FSH. Estrogen keeps maintenance level thickness for endometrium so it doesn't shed

STI's

Chlamydia & Gonorrhea → bacterial

Women:

↳ 50-70% are asymptomatic

→ develop into pelvic inflammatory disease (PID)

→ damage to reproductive system... infertility

→ possible symptoms: vaginal bleeding, abdominal pain, fever, painful urination

Men

↳ symptomatic most of the time

→ painful urination, swollen testicles, penile discharge

*Treatment

↳ antibiotics

→ some strains of gonorrhea are antibiotic resistant

Syphilis → bacterial

→ presents w/ skin irritation to nervous/cardiac symptoms

→ *Treatment: antibiotics

Human Papilloma Virus (HPV) → viral

→ various strains cause warts or cervical (and other) cancer
→ most common STI, 3/4 have encountered it
→ there are vaccines
* Treatment: most often infection will clear on its own (virus just stays dormant)

Herpes → viral
→ sores, pain, itching, burning
* no cure

Hepatitis B → viral

→ liver infection
* no cure

Human Immunodeficiency Virus → Viral

→ infects Helper-T cells (immune system)
→ when the helper-T cell count drops below 200 cells per mL^3 blood (normal = 500-1800) a patient has AIDS (aquired immunodeficiency syndrom
→ deaths from bad immune system
* no cure

Key Terms & Ideas

- Hormones are chemical signals that cause a response in a target cell
- neg. feedback = creation of substance causes less of it to be created
  ex) testosterone
- pos. feedback = creation of substance causes more of it to be created
  ex) oxytocin
- hypothalymus: recieves info from nerves + initiates endocrine signals in response
- posterior pituitary: extension of hypo that stores oxytocin
- anterior pituitary: endocrine cells that synthesize + secrete several hormones
- FSH: dev. of ovarian follicles and promotes spematogenesis (sperm production
  ↳ follicle releases E to thicke endometrium
- LH: triggers ovulation and stimulates production of testosterone
  also causes corpus luteum to produce P + some E

Nervous system

- The brain serves as a master neurological center for processing information & directing responses
- Different regions of the brain have different functions
- Structures & associated functions for animal brains are products of evolution, and increasing complexity follows evolutionary lines

Parts of the Brain

Skull → a layer of bone designed to protect the brain from injuries
→ bones that are fused together

Arteries → the brain needs a constant supply of O_2
→ lack of O_2 for a few min results in irreversable damage = stroke

The Meninges → membranes covering brain & spinal cords
→ layers of tissues seperating bone & nervous tissue

The Cerebrum = largest part of the brain
↳ higher brain function such as thought & action
→ cerebral cortex divided into 4 sections called lobes

1. **Frontal Lobe**: reasoning planning, parts of speech, movement, emotions & problem solving (consious thought)
2. **Parietal Lobe**: movement, orientation, recognition, perception of stimuli ~ touch (hot/cold)
3. **Occipital Lobe**: visual processing
4. **Temporal Lobe**: perception & recognition of auditory stimuli, memory & speech (memory)

Retrograde vs Anterograde amnesia
↳ R = can't remember before a certain point
→ A = Hippocamps can't convert short term → long term

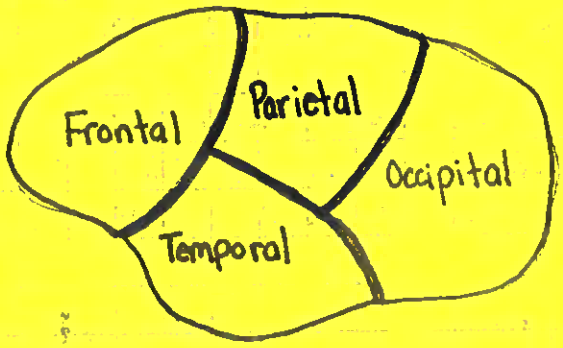
Cerebellum → connected to the brainstem & is the center for body movement & balance

Thalamus → at top of the brain system, called gateway to cerebrum
→ all sensory inputs pass through it to higher levels of brain

Hypothalamus → center for homeostasis
↳ regulates body temp, water balance & B.P.
→ controls endocrine system

Medulla Oblongata → reflex center → swallowing, vomiting, sneezing, coughing & regulation of cardiovascular & respiratory activity

Spinal Cord → nerves branch out from vertebrae to the body



Branches of Nervous System

nervous system
- central nervous system (CNS)
  - brain
  - spinal cord
- Peripheral nervous system (PNS)
  - somatic (motor) system
  - automic nervous system
    - parasympathetic division — rest + digest
    - sympathetic division — fight or flight

CNS → brain or spinal cord
PNS → paired cranial + spinal nerves
Somatic System → voluntary system
→ carries signals to muscles
Automic System → involuntary control over organs
→ controls smooth + cardiac muscle
Sympathetic Division → when activated, causes heart to beat faster + adrenaline to be secreted
Parasympathetic Division → when activated, causes digestion + slows heart beat

acetylcholine = messenger
↳ acetylcholinesterase

norepinephrine = messenger
↳ monoamine oxidase breaks it down

What is acetylcholine+ norepinephrine?
CRF? Cortisol?

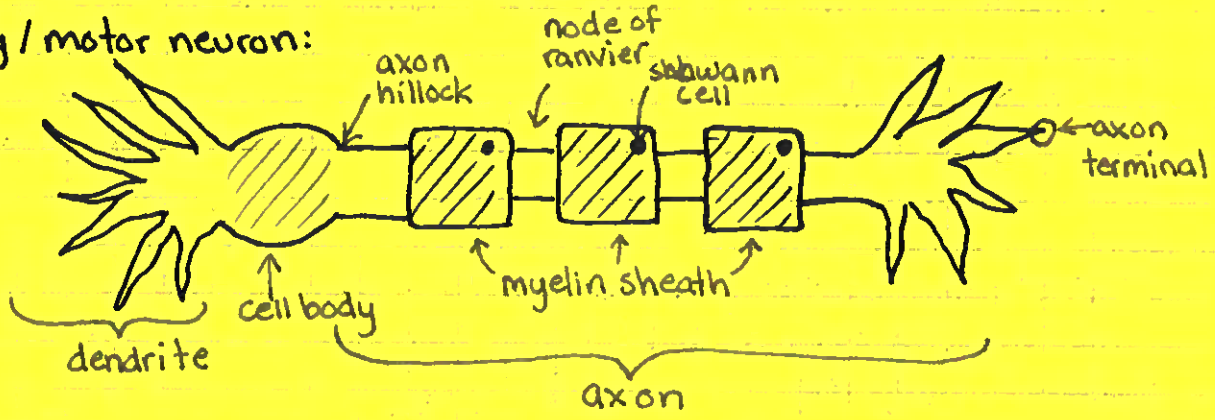
Fight or Flight

Optic Nerve
↓
Thalamus
↓
Amygdala
↓
Hypothalamus

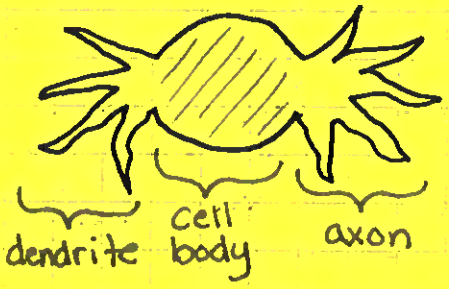
- nerves → Adrenal Medulla (middle of adrenal gland)
  - ↓ release epinephrine
    - ↳ ↑ HR
    - → glycogen → glucose ↑ ATP
- CRF → Anterior Pituitary
  - ↓ release ACTH
  - ↓ Adrenal Cortex
  - ↓ Cortisol
    - ↳ ↑ BP
    - → Fat → glucose ↑ ATP

The Neuron

sensory / motor neuron:



inter neuron:



* inter neurons are not myelinated

neuron → functional unit of the nervous system
cell body → contains nucleus + organelles
dendrites → cell extensions that recieve incoming messages from other cells
axons → transmit messages to other cells
myelin sheath → coil of fat that surrounds axon. speeds up impulse transmission
node of Ranvier → gap in myelin sheath
schwann cell → produces myelin sheath

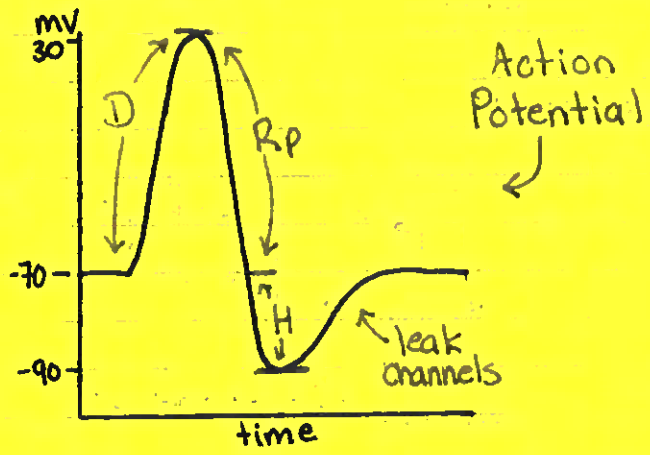
Nerve Impulses

Action Potential

1. Resting Potential → ~ -70 mV
2. Depolarization
   ↳ voltage regulated sodium channels open allowing Na^+ to enter
   shifts voltage to 30 mV
   → once the voltage gets to 30 mV, the Na^+ channel will
   → close in that area
3. Repolarization (reset to resting potential)
   ↳ voltage regulated K^+ channel opens at 30 mV
   K^+ leaves cell and at -70 mV the channel starts to close
   Hyperpolarization
   ↳ voltage falls to -90 mV
   → leak channels allow voltage to reach -70 mV (resting potential)
   ↳ ions will be attracted or repelled
4. Recovery
   ↳ Na^+/K^+ pump (carrier protien) will re-establish the concentratient gradient (Na^+ out / K^+ in) → uses ATP
   → always happening

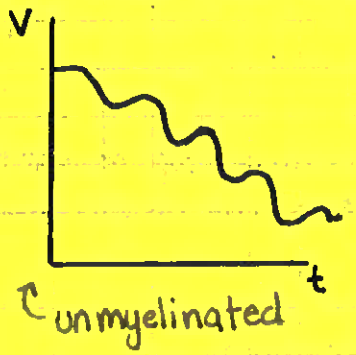
Threshold
↳ minimum stimuli needed for a neuron to fire (~ 55 mV)

Summation
↳ multiple stimuli can add to meet thresh hold
→ All or None
↳ it either fires or it doesn't

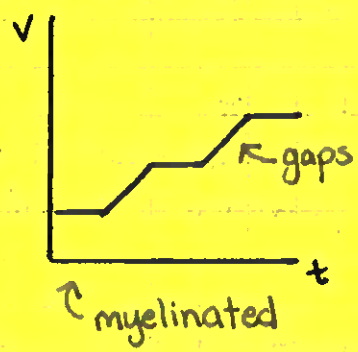


*signal gets weaker as Na^+ moves along neuron b/c of leak channels

Continous Conduction

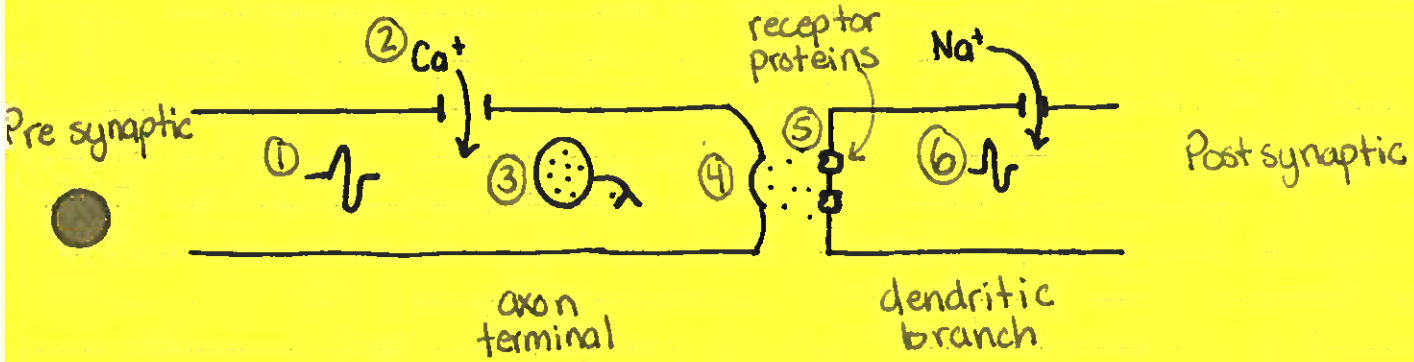


Saltatory Conduction



The Synapse

- The meeting between two neurons
- using neurotransmitters to carry message from one neuron to another or to a muscle gland



1. Action potential (nerve impulse) reaches axon terminal
2. Causes voltage regulated Ca^+ channel to open + Ca^+ enters
3. Motor protein pulls vesicle (w/ neurotransmitters) towards pre-synaptic membrane
4. Vesicle fuses w/ membrane (lipid based) + releases neuro transmitters via exocytosis
5. Neurotransmitters diffuse across synapse + bind to post-synaptic membrane receptor proteins
6. Causes Na^+ to enter dendrite + action potential

Pleasure Pathway

based on time + effort
dopamine (neurotransmitter) → related to endorphins (type of neurotransmitter)
if an event is pleasurable, dopamine is released into the nucleus accumbens

Drugs:
→ increase ~~nucleus~~ dopamine into the nucleus accumbens
shortcut that bypasses time + effort
→ Brain / body adapts → increase smooth ER (liver)
*Pleasurable experiences build condition responses
amygdala → temporal = memory

*dopamine promotes desire
*nucleus accumbens mediates positive reinforcement or pleasure