Cyclic electron flow – flow of photon energized electrons from photosystem I, through an electron transport chain that produces ATP by chemiosmosis but no NADPH.
↳ generates proton gradient for chemiosmotic ATP synthesis

Light independent reactions

Calvin cycle → occurs in stroma of chloroplast
→ CO_2 fixed into sugars.
→ energy put into formation of the bonds of the C atoms.

C3 photosynthesis → 3 carbon intermediate is first formed (PGA)

Calvin cycle

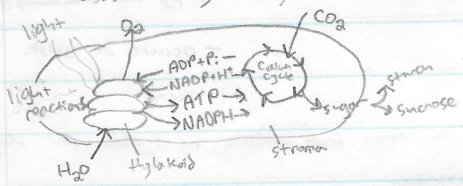
$3\,CO_2$ + $3\,RuBP$ —(rubisco)→ $6\,PGA$ (3-C) —$3H_2O$→ $6\,G3P$ (3-C) → $6\,ATP + 6\,NADPH$ used

$6\,G3P$ → $5\,G3P$ (3-C) + $1\,G3P$ → glucose, starch, sucrose

$5\,G3P$ —$3H_2O$ + $3\,ATP$ used→ $3\,RuBP$ (5-C)

Carbon Fixation | reduction reactions | regeneration of RuBP

* uses $9\,ATP$, $5H_2O$, $6\,NADPH$, $3CO_2$ for $1\,G3P$

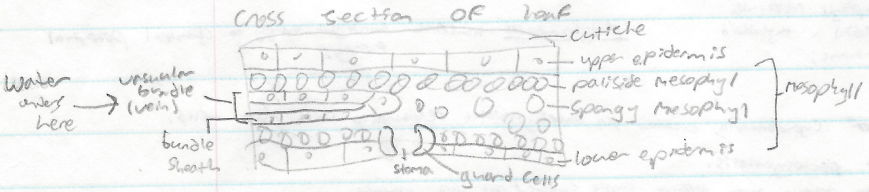


(3) **action spectrum** – effectiveness of wavelengths of lights to promote photosynthesis.
absorption spectrum – different wavelengths of light a pigment absorbs.

$6CO_2 + 12H_2O$ + light energy → $C_6H_{12}O_6 + 6H_2O + 6O_2$

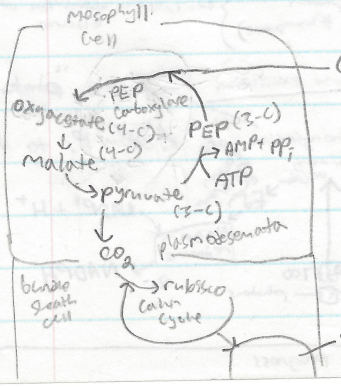
photosynthetically active radiation (PAR) – wavelengths of light between 400–700 nm that support photosynthesis.
↳ combine pigments with accessory pigments to get absorption range to full visible spectrum.
↳ xanthophylls (yellow), carotenoids (orange), anthocyanins (red, blue) + chlorophyll a and b.

Cross section of leaf



CAM plants
- Stomata open at night, usually closed during day. (since photorespiration optimum temp. higher than photosynthesis optimal temp.)
- CO_2 converted to acid and stored during day, at night, released to rubisco for photosynthesis.
- cactuses and orchids.

C4 plants
- photorespiration – oxidation of RuBP by rubisco and oxygen in light to form glycolate, which releases CO_2.
↳ 20% carbon in C3 plants affected by photorespiration
end product: photosynthesis → 2 PGA (3-C)
photorespiration → 1 PGA (3-C), 1 glycolate (2-C)



Chapter 4

① – maintaining internal balance called homeostasis
– positive feedback – reinforce change, not common
– negative feedback – restores steady state, common

thermoregulation – Maintenance of body temperature within a range enabling efficient functionality.

– Animals with large surface area : volume lose heat faster.

ectotherms – ambient temp.
– freeze during winter
↳ produce glucose to prevent ice crystals from forming, loss of cell water (up to 60%)

endotherms – Maintain temp. regardless of surrounding temperature metabolism.

cold stress – blood vessels constrict, decreased blood to skin, reduced loss of heat. Blood warms internal organs.
Heat stress – blood vessels dilate, increased blood flow to skin. heat exhausts from skin via sweating – cools organs blood returns to.

wastes – Ammonia – deamination of amino acids from liver, } kidneys
Urea – NH_4^+ CO_2
uric acid – product of breakdown of DNA.

CO_2 – product of cellular respiration } lungs

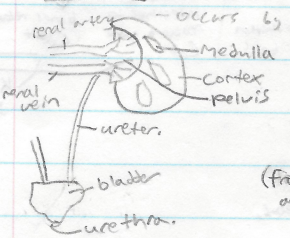
bile pigments – breakdown of hemoglobin } liver
lactic acid product of anaerobic respiration }
solid wastes } large intestines

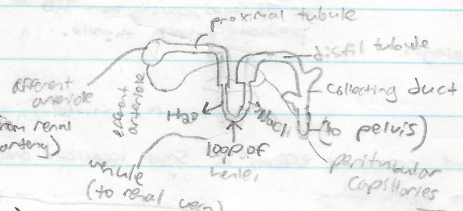
② Formation of urine

1) Filtration – blood moves from afferent arteriole to glomerulus (high pressure filtrate – 65mmHg) Materials move from high pressure to low pressure, except platelets, plasma proteins and blood cells.

2) Reabsorbtion – Selective reabsorbation by active and passive transport.
– Na^+ actively transported, -ve ions follow by charge attraction. Mitochondria fuels this.
– reabsorbtion occurs until threshold level is reached. → after threshold level is reached molecule is excreted with urine.
– glucose and amino acids attach to carrier molecules into blood → also with other molecules.
– osmotic gradient draws water from nephron. – pH controlled by tubular secretions of H^+
– interstitial fluid → fluid surrounding body cells. – descending loop of Henle, permeable to water, ascending, permeable to salt.
– urea and uric acid diffuse back into blood as H_2O is reabsorbed.

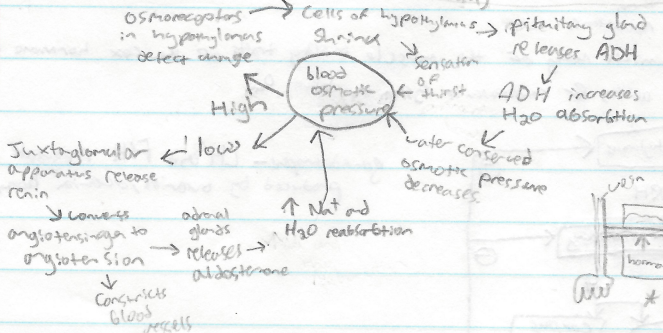
3) Secretion – movement of wastes back into nephron.
– occurs by active transport, Molecules shuttled by blood into nephron.





proximal tubule – controls pH → glucose, amino acids + vitamins.
distal tubule – controls pH, concentration of NaCl and K^+
descending loop → passive secretion H_2O
ascending loop → passive secretion NaCl, then active. at thick segment,
collecting duct → urea, uric acid, Minerals.

③



formed by cellular respiration, leads to ↓ of pH

$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+$

Carbonic acid/bicarbonate buffer
kidneys generate reverse direction, forming H_2CO_3, which becomes HCO_3^- and H^+, HCO_3^- buffer H^+ ions in blood, while H^+ ions are excreted with phosphate from nephron.

* dialysis can't maintain blood pH or osmotic pressure.

④

diabetes Mellitus – lack of insulin production – glucose in urine will cause dehydration – insulin injections (10%) (type I)
diabetes insipidus – destruction of ADH producing cells in hypothalamus – No ADH regulates H_2O reabsorbtion, urine output ↑ – ADH injections (90%) (type II)
brights disease – destruction of blood vessels in glomerulus – proteins pass glomerulus, drawing H_2O to nephron – none
Kidney Stones – precipitation of mineral solutes from blood – lodged in renal pelvis, then ureter, bladder and urethra. – Surgical removal (shockwave treatment)
Kidney transplants – Xenotransplants (from animals) may be attacked by immune system, thinking its a foreign invader.

Chapter 5 – endocrine glands produce endocrine hormones, which are secreted in blood and to various other hormones in body
– exocrine glands secrete substances through ducts or tubes onto a body surface or cavity.

Steroid
- receptors in cytoplasm
- hormone-receptor complex attaches to chromatin, activate a gene
- send message to ribosomes in cytoplasm to produce specific protein
- made of cholesterol
- fat soluble

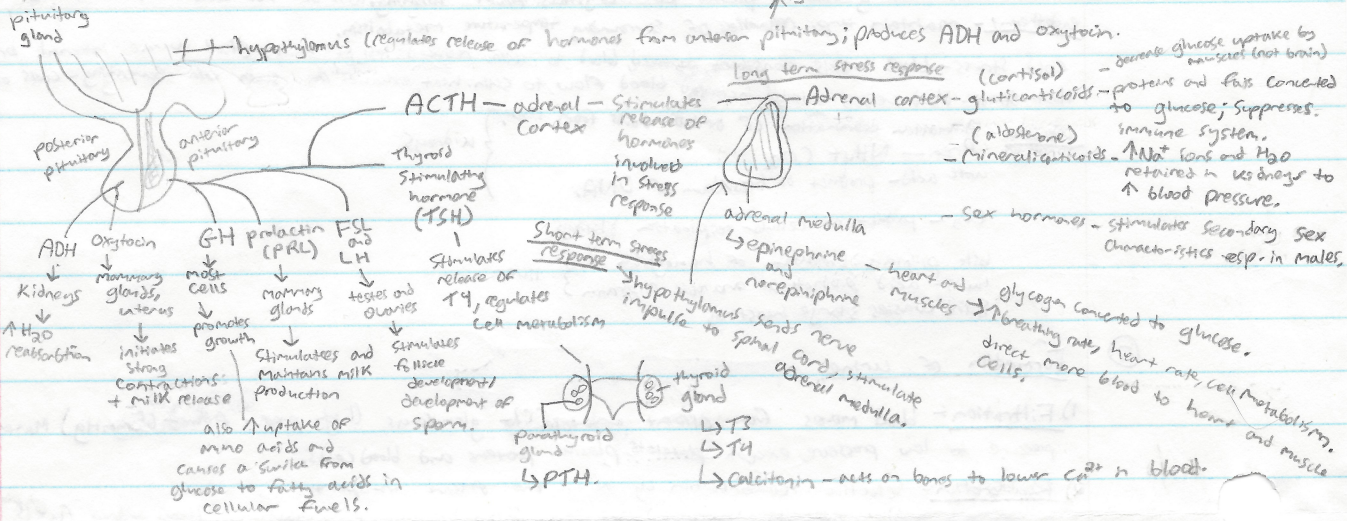
Proteins
- receptor on cell membrane
- Hormone receptor complex activates production of enzyme called adenylyl cyclase. Causes cell to convert ATP to cAMP.
- cAMP functions as messenger, activating enzymes in cytoplasm
- made of amino acids
- includes insulin, GH.
- water soluble.

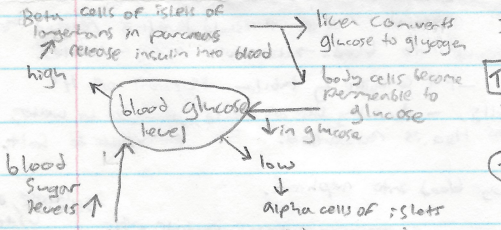
target hormones ↳ affect specific cells, or tissues

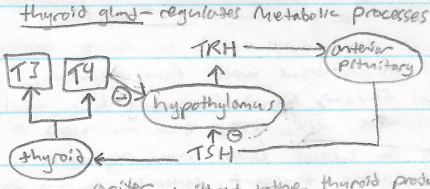
Hormones signal cells by attaching to receptor sites.

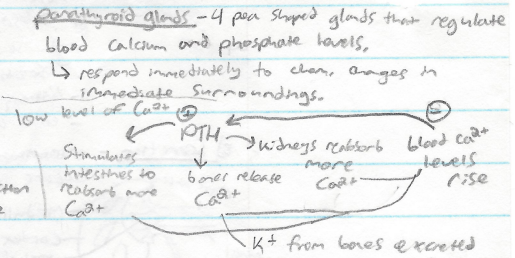
- hyperglycemia – weight loss, nervous
↳ high blood sugar.
- hypoglycemia – muscle weakness, dizziness
↳ low blood sugar

best and fastest isolated hormone insulin, removing symptoms of diabetes.



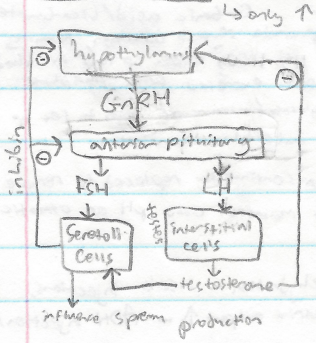


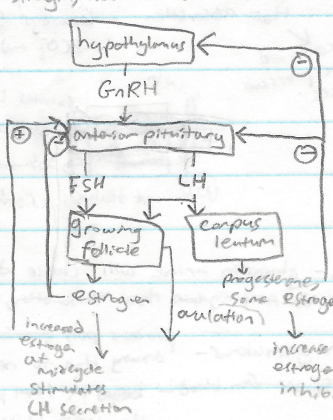




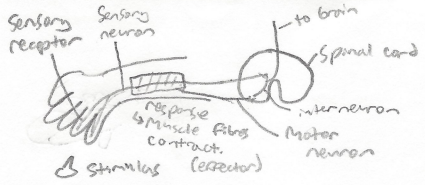
prostaglandins – hormones that have pronounced effects in small localized areas.
- over 16 kinds.
- alters cell activity to oppose change.
- mediator cells secrete them
- released during allergic reactions.

anabolic steroids – substances that mimick many of the muscle building traits of the sex hormone testosterone.
↳ only ↑ strength, not ability for cardiovascular system to deliver O_2.





gonadotropins – LH and FSH regulate control of hormones produced by ovaries; ovarian hormones regulate gonadotropins.



reflex arc: occurs within a second, without brain coordination
- receptor
- sensory neuron
- inter neuron (in spinal cord)
- motor neuron
- effector

Chapter 6

① - Contains over 100 billion nerve cells.

- Nerve cells and glial cells found in nervous system.
- glial cells - non-conducting cells important for structural support and Metabolism of nerve cells.
- Neurons - Functional units of nervous system. Conduct nerve impulses.
  - ↳ sensory neurons - carry impulses from sensory receptors to CNS.
    - located in clusters called ganglia outside of spinal cord.
  - ↳ interneurons - interpret sensory info. and connect neurons to outgoing motor neurons.
    - located mainly in brain and spinal cord.
  - ↳ motor neuron - relay info from CNS to effectors.
    - ↳ muscles, etc. are effectors because they produce responses.

Nervous System
- (CNS) Central nervous System
  - ↳ brain and spinal cord
  - ↳ body coordinating centre for mechanical and chemical actions
- Peripheral Nervous System
  - ↳ Consists of nerves that carry info. between organs of the body and the Central nervous System.
  - (voluntary) Somatic nerves
    - ↳ Controls the skeletal muscles, bones and skin
    - Sensory
      - ↳ relay information about the environment to the central nervous system.
    - Motor
      - ↳ initiate an appropriate response.
  - (involuntary) Autonomic nervous System
    - Sympathetic
      - ↳ prepares body for stress.
      - ↳ nerve, long postganglionic
    - parasympathetic
      - ↳ returns body to normal resting levels.

Nodes of Ranvier - gaps in myelin sheath. Nerve impulses jump between nodes, makes impulses move faster.

Cell body - nerve cells contain cell body + nucleus

Dendrites
↳ Carries impulses toward body

Axon - carries nerve impulses away from body. (smaller = faster impulse)

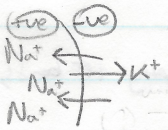
Myelin Sheath
↳ white coat of fatty protein covering axon. insulating neurons, preventing loss of charged ions. made by Schwann cells.

Neurilemma - Surrounds axon, promotes regeneration of axons.
- found in peripheral nervous system.

in CNS
- Myelinated fibres — white matter
- Non myelinated — gray matter

② action potential - when nerve is excited (40mV)
resting potential - more K^+ ions move out than Na^+ ions move in (Membrane 50x more permeable)
- ion gates control movement of ions across cell membrane.
- excess +ve ions accumulate outside of membrane, while -ve ions accumulate inside; → polarized membrane.
- has potential to do work, expressed in millivolts (mV)

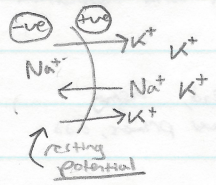
Nerve becomes excited, cell membrane more permeable to Na^+ than K^+



- Na^+ rushes in by diffusion and charge attraction.
- cause depolarization until voltage becomes +40mV, then Na^+-K^+ pump actively transports $3Na^+$ out and $2K^+$ in membrane, against concentration gradient using ATP. → repolarization.

refractory period - time it takes for neuron to be able to produce another action potential.

- depolarized ions attracted to adjacent -ve ions aligned on inside of nerve membrane.
- electrical disturbances cause adjacent area to depolarize.
- wave of depolarization followed by wave of repolarization.



threshold level - minimum level of stimulus required to produce response.

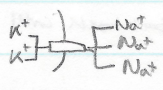
all or none response - nerve responds completely or not at all to a stimulus.
↳ each neuron has different threshold levels, more impulses mean more intense stimulus.

Synaptic transmission - Synapses - small spaces between neurons and effectors, rarely involve 2 neurons, usually more.

end plates of axons have small vesicles containing neurotransmitters, impulses make along axon and release neurotransmitters from end plate to presynaptic neuron to synaptic cleft to post synaptic neuron. (20nm space)

Nerve transmission slows down across synapse.

acetylcholine - neurotransmitter that makes post synaptic membranes more permeable to Na^+ ions.
↳ cholinesterase - enzyme which breaks down acetylcholine.
↳ both excitatory and inhibitory transmitter
- ↳ open Na^+ gates
- ↳ open K^+ gates



repolarization (refractory period)

hyperpolarized - rush of K^+ ions becomes more +ve than resting potential.

Summation - effect produced by 2 or more neurotransmitters accumulated, alone do not have sufficient neurotransmitter for action potential.

③ PET → radioisotope inserted to brain via blood and radiation tracked (find brain disorder/cancer)
MRI → magnets knock nuclei out of place, realign nuclei, create image from radio signals (detect hidden areas)
CT → produce X-ray images rearranged to a 3D structure (find blood vessels in brain) - expensive,

vagus nerve
↳ major cranial nerve

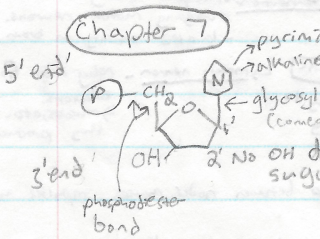
④ Sympathetic nervous System - short preganglionic nerve, long postganglionic nerve, releasing norepinephrine and acetylcholine.

parasympathetic nervous system - long preganglionic nerve, short postganglionic nerve, releasing acetylcholine.

pain interpreted by SG - gray matter in spinal cord, produces neurotransmitter inducing pain. Endorphins attach to receptor cells of SG cell preventing transmitter from being created.
↳ opiates work same way. Must continue using opiates or SG receptors become vacant and pain receptor produced in abundance.
depressants enhance action of inhibitory synapses
alcohol ↑ threshold levels of plasma membrane.

Chapter 7

(1)



nucleotide - 5' carbon sugar + nitrogeneous base + phosphate group.
complimentary base pairing - A-T; C-G

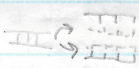
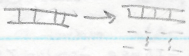
physical properties - helix shaped; 2nm in diameter; clockwise turn every 3.4nm, (10 nucleotides); 0.34nm distance between each base pair.

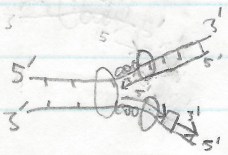
chemical properties - slightly acidic.

(2)

Fredrick Miescher - isolated nuclein from nucleus of cells.
Joachim Hammerling - grafted mushrooms to find phenotypical info come from nucleus (stalk or mushroom)
Alfred Hershey + Martha chase - used radioactively labelled virus' to determine bacteria infected nucleic acids into person, not proteins.
Frederick Griffith - used 2 strains of pneumonia, harmless living strain got info from harmful dead strain.
Erwin Chargaff - Adenine = Thymine, Cytosine = Guanine.
Avery, Mcarty, Mcleod - Extracted DNA from pneumococcus.
Rosalind Franklin - X-ray diffraction suggested DNA was in shape of helix
James watson / Francis Crick - deduced structure of DNA using info from chargoraff, Franklin and Maurice Wilkins.

(3)

- Mitosis followed by cytokinesis.
- DNA replication → Semiconservative  not conservative 



→ DNA helicase binds to replication origin (multiple in Eucaryotes, 1 in prokaryotes), unwinds DNA by disrupting H+ bonds, exposing template strand.
→ SSB proteins bind to template strand to prevent it from annealing.
→ DNA gyrase relieves tension by cutting DNA and letting it swirl around each other. (found mostly in prokaryotes)
→ DNA cannot be fully unwound since 1cm + 5mm diameter, replication forks when close enough form replication bubble.
→ direction of replication is toward replication fork, in the 5'-3' direction
↗ remove phosphorous atoms for energy
→ DNA polymerase III builds complementary strand, using deoxyribonucleoside diphosphates to 3' end, using RNA primer as start point. (10-60 RNA bases) - synthesized by primase. RNA polymerase I removes primers, add deoxyribonucleosides in their place.
→ DNA ligase joins DNA fragments together by catalyzing phosphodiester bonds.
→ DNA polymerase I and III act as exonuclease → cut of nucleotides at end of DNA strand, to backtracks until incorrect sequence is removed.
→ leading strand - uses 3'-5' strand, going towards replication fork.
→ lagging strand - built away from fork in Okazaki Fragments (1000-2000 nucleotides in length for prokaryotes, 100-200 Eucaryotes)

Chapter 8

① **Gregor Mendel** – Certain factors responsible for patterns of inheritance observed in pea plants.

Garrods hypothesis – enzymes under control of the hereditary material ; error in hereditary material → error in an enzyme
↳ from Archibald Garrod, who studied alkaptonuria.

Beadle and Tatum – using garrods hypothesis, produced style gene mutations to molds.
↳ led them to **1 gene, 1 enzyme hypothesis** – 1 gene codes for 1 enzyme.

Vernon Ingram – observed a single amino acid abnormality can create complex disorder (Sickle cell anemia)

* Each gene responsible for coding a single enzyme and protein → 1 gene, 1 polypeptide hypothesis.

② **Central Dogma** – DNA replicates → replication
– DNA codes for production of mRNA → transcription
– mRNA goes from nucleus to cytoplasm
– mRNA goes to ribosomes, used for protein synthesis → translation

DNA vs RNA → double vs. single strand
→ nucleus vs. nucleus and cytoplasm
deoxyribose vs ribose sugar.

Codon – Sequence of 3 bases that serves as a code for an amino acid
↳ start – tells ribosome to start translation → AUG
↳ Stop codon → UAG, UAA, UGA.

③ **transcription** – RNA polymerase binds to DNA upstream → opens double helix } initiation
– starts transcribing at promoter (high in A and T), only recognizes promoter
– RNA builds mRNA upstream in direction 5'–3' until termination sequence } elongation
– DNA is rewound.
– at terminator sequence, mRNA dissociates with template strand } termination.

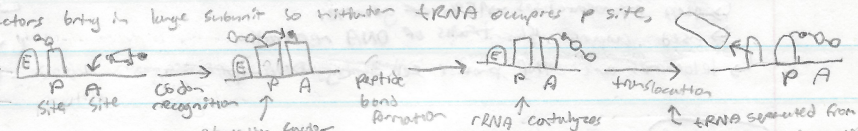
post-transcriptional modifications
– primary transcript modified with 5' cap – protects mRNA from digestion in cytoplasm and binds to ribosome in translation
– poly-A tail added to 3' end. by enzyme poly-A polymerase. → 200–300 adenine bases that protect mRNA from degradation.
– Spliceosomes remove introns, join exons together. Nucleotides of introns recycled.

primary transcript → mRNA transcript. more errors in transcription than replication since no quality control enzyme.

translation – small ribosomal subunit binds with mRNA and initiator tRNA, carrying methionine attaches to start codon (AUG)

initiation – initiation factors bring in large subunit so initiator tRNA occupies P site,

– Elongation –

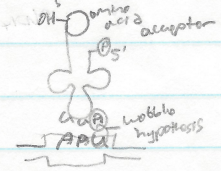


proteomics → large scale study of proteins.

P-Site ↳ holds tRNA carrying polypeptide chain

A-Site ↳ carries tRNA with the next amino acid

– termination – release factor binds to stop codon and hydrolyzes bond between polypeptide and its tRNA in the P site. (cytosol)



tRNA – transfers amino acids from cytoplasm to ribosome
at 3' end → has amino acid at (end) nucleotide triplet (anticodon) on other.
↳ complimentary to codon on mRNA.
– 80 nucleotides – recognized by aminoacetyl-tRNA synthase (adds amino acid to it)

Ribosome – large 60S
– small 40S
– intact 80S

wobble hypothesis – tRNA can recognize more than 1 codon by unusual pairing btw 1st base on anticodon and 3rd on codon.

④ **Control mechanisms** – housekeeping genes always turned on.
– transcription factors turn genes on/off as necessary.

4 levels of control
– transcriptional → genes transcribed (DNA to mRNA)
– posttranscriptional → mRNA molecules are modified before translation.
– translational → mRNA transcripts get translated
– post translational → protein passing cell membrane

lac operon – negative control system → enzyme stimulation
– lacI protein blocks operator site
– lactose binds to lacI protein, changing its shape allowing β galactosidase to be produced to break down lactose.

trp operon – enzyme repression
– tryptophan acts as a corepressor, binds to trp repressor to activate it,
– repressor blocks tryptophan operator
– cuts tryptophan operator continues to produce tryptophan.

⑤ Mutations - positive, negative or neutral.
- Silent mutation → no change in amino acid.

Substitution
↳ missence - wrong base pair changes amino acid + protein
↳ nonsence - wrong base pair creates early stop codon.

Frameshift
↳ deletion
↳ Insertion
add or remove a nucleotide in DNA sequence.

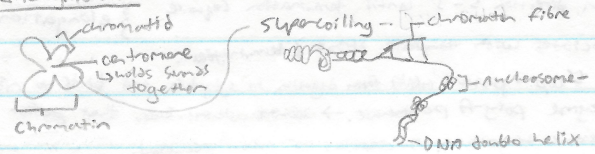
translocations - relocation of groups of base pairs from 1 part of genome to another,
↳ a non homologous pairs usually.

Mutations can be - Spontaneous
- Arise from Mutagenic agents
↳ induced mutations (AKA)

⑤
- Prokaryotes undergo coupled transcription-translation - ribosomes translate mRNA while its still being transcribed.
- prokaryotic genes do not contain introns.
- Shine-Dalgarno sequence recognizes start of mRNA transcript instead of 5' cap.
- Eukaryotic ribosomes larger than prokaryotes.
- Prokaryotic methionine is tagged with formyl group.
- Eukaryotes do not posses operons.
- prokaryotes - circular genome.

Mitochondria
- circular DNA
- genome similar to bacteria cells.
- divide by fission
- contain own system of DNA synthesis, transcription and translation.

Endosymbiotic - Content between species beneficial to at least 1 of the species. (1 species inside of other)

⑥


↳ +ively charged proteins binding to -ively charged DNA. every 200 nucleotides.

UTNR - repetitive sequence of DNA varies among people.
↳ AKA microsatellites → 95% of genome.
↳ used against shortfalls of DNA replication.
↳ telomeres are UTNR, present cell during DNA replication.

Psendogenes - Never transcribed though homologous
↳ LINES - 5000-7000 base pairs long
↳ SINES 300 base pairs short
- Function not clear.

Chapter 9

① GMOs - cotton seed
↳ removed gossypol so humans can eat it.
↳ unhealthy but cheap.
- genetically modified strawberries
↳ gene for cold resistace from cod added to strawberries
↳ vegans wont eat it.
- belgian blue cow
↳ 3x longer due to mutation in myostatin (halts muscle growth)

② PCR - makes copies of host DNA, tests for genetic diseases, biological relationships.
→ Denaturing - Strands separated by 95°C heat (45 seconds)
→ Annealing - temp lowered to 56°C to allow primes to anneal.
- length between primers vary between people
- 30 seconds to anneal.
→ Synthesizing - temp increased to 72°C
- DNA polymerase called TAQ polymerase synthesizes complimentary strand.
- # OF DNA fragments double. (takes 5 minutes.)

palindrome
GAATTC
CTTAAG

③ plasmid → lacen protein coat, 1000-200,000 base pairs length.
→ using enzymes and ribosomes can be expressed/replicated.
→ bacteria gains benefits like resistance to antibiotics.

copy # → more copy # means more phenotypical expression of gene.
→ restriction endonucleases used to splice foreign gene into plasmid at recognition site
↳ recognition sites close together called Multiple cloning site.
→ recognition sites appear once on DNA, ∴ 1 cut to DNA.
→ foreign gene excised by same restriction enzyme ∴ Same complimentary ends causing annealing.

# of copies of plasmid found in bacteria cell.

recombinant DNA

Cloned → recombinant DNA gets duplicated when foreign cell replicates.

- bacterial cell that takes plasmid called "transformed"
- vectors, vehicles DNA are introduced to competent host cells.
  ↳ plasmids are vectors.
  ↳ CaCl makes cell membrane pores, making bacteria become competent.

Gel electrophoresis → tracking dyes added → Nylon membrane added → DNA stained blue → DNA photographed, results are in standard curve.
↳ molecules moved with electric current, slightly -ve DNA fragments move to +ve end.
↳ agarose gel allows smaller pieces of DNA to go through more easily than larger pieces.
genes pattern = banding.

Selective plating
- isolates cells with recombinant DNA.
- ones without have no immunity to antibiotics, so they die. If no antibiotics, lawn colony grows.

④ Restriction Endonucleases → bind to complimentary palindromic sequence
→ recognize 4-8 base pairs on DNA
→ disrupts phosphodiester bonds by hydrolysis
→ form sticky ends or blunt ends.

methylases add methyl group to modify recognition site of endonuclease, so it cannot get cleaved.
Ligases - Join strands of DNA together forming phosphodiester linkages (condensation rxn)
↳ used to join blunt ends together (specifically T4 ligase)

⑤ genetic testing - DNA tested for genetic mutations.

Gene therapy - alteration of genetic sequence in organism to prevent or treat genetic disorder.

antinociceptive transmitter - reduces pain via neurological pathway.
↳ gene added to cells with transmitter to make more transmitter.
↳ pronociceptive transmitters amplify pain.
↳ antisense oligonucleotides - prevent ribosomes from translating mRNA to protein by deactivating mRNA molecules.
↳ are short strands of DNA+ RNA.

TI plasmid - bacteria attracted by chemicals; infect wounded plant
- results in bulbus growth called crown gall, takes nutrients from plants.
- T region of TI plasmid is incorporated with DNA of plant cell → foreign gene in T region will be expressed in tree
- Can only infect potatoes, peas, beans.

Bt toxin - poisonous substance produced by bacteria as natural herbicide.

DNA fingerprinting - takes advantage of non-coding region of the exon. (Introns)
↳ use PCR and RFLP.

chapter 10

① Evolution - process significant changes in inheritable trait of a species over time.
↳ theory of evolution → concerned with mechanism by which evolution takes place.

both Fossilization
Fossils - preserved remains or traces of an organism, or its activity
↳ Formed when bodies are trapped in sediments which become strata, then sedimentary rock.
Permineralized fossil - dissolved minerals precipitate from solution surrounding body.
- organisms with hard shells/bones and aquatic best chance of fossilization.
- Microfossils - microscopic remains - most common.

Palaeontology - study of fossils
- radioisotopes undergo radioactive decay from parent isotope to daughter isotope. - can change element.
- decay at constant rate → half-life → unaffected by external environment.
- radiometric dating - measure using decay of radioisotopes in rocks. → AKA absolute dating

transitional fossils - show intermediate links between groups of common organisms.

② cuviers - found fossils of different species in different layers.
- more complex forms in shallower deposits.
- catastrophism - global catastrophes caused extinction of species, replaced by newly created forms.
- used relative age, no absolute age tests available.

Kelvin - Calculated Earths age to be 20 mil years old, based off fact earth is cooling from once molten state.
↳ Pierre Curie determined radioactive decay produces heat.
↳ Earth 4.6 billion years old - oldest rock 3.9 billion - Canadian shield.

Hutton - Actualism - some geological processes occured in past as in present.

Lyle - uniformitism - Earths surface always changed and always will slowly.

Erasmus Darwin - all life come from single source (common ancestor)

George Buffon - proposed species can change over time and become new ones.
↳ occur through interaction with environment over species lifetime.

Lamarck - species become more complex by acquired traits passed to offspring.
- New simple species created through spontaneous generation.
↳ organisms come from nonliving matter.

Biogeography - observation and analysis of geographic distribution of organisms.

- Continents had different species despite similar ecological niches.
- birds were 25 different species + Mockingbirds rather than 1 species. → (on Galapagos Islands)

homologous - structures that share common origin but different function.
analogous - structures similar in function but different origin.

vestigial features - non functioning rudimentary features homologous to functioning features in other species.

vestigial genes - do not function but bear a resemblance to functional genes.

- Darwin inspired by Thomas Malthus postulation that in nature, plants and animals produce more offspring than can survive,
↳ competition allows for favorable variations to survive, non favorable to die.

- Darwin took 20 years to amass evidence - natural selection mechanism for evolution (not new concept.)
- Wallace arrived at same conclusion + more eager
- Co published theory then wrote "origin of species by means of natural selection"
↳ preservation of favorable traits, rejection of injurious ones.

observation:
1) individuals within species vary
2) variability is inherited
3) Every generation produces more offspring than can survive
4) population stable in size.

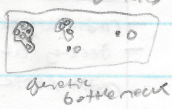
inferences:
1) members of same species compete
2) survival not random - favorable traits survive
3) these individuals survive and procreate → traits become more common

Controversy - Earth of recent origin → species need time to change.
- No transitional species found. (fossils)
- Complex structures like eye could not form.

chapter 11

① gene located on loci - positions on DNA molecule.
Eukaryotic organisms - diploid (2 sets of chromosomes) except sex chromosomes, which are homologous pair.
↳ 1 from each parent.
genes have 2 or more alleles → Homozygous - paired alleles same
→ Heterozygous - paired alleles differ
- genome - complete set of chromosomes of an organism → genotype - set of alleles possessed by an individual.
- large genomes / large # of different alleles → greater the diversity.
population - members of same species living in same population,
↳ genetic diversity ↑ with sexual reproduction.

gene pool - total # of all genes of all individuals in population
gene/allele frequency - proportion of gene copies in population (evolution occurs as frequencies increase/decrease)
adaptations - trait increasing organisms fitness level.
Fixed - when there's a single allele for a gene, allele frequency is 100%.


genetic bottleneck

② Hardy Weinberg principle - allele frequencies do not change so long as:
- large population → genetic drift = genetic bottleneck, founder effect (small population isolates itself reproductively)
- random mating → Non random mating = bias for breeding with individuals, ex inbreeding. ↑ ↑ homozygosity = ↑ genetic disorders ↓ allele frequency 50%.
- no mutations → Mutations = source of new alleles, randomly acting evolutionary force. 10,000 generations
- no migration → gene flow = reduce differences
- no natural selection → natural selection = some genotypes more successful than others.

↳ IF so, then genotype frequency of offspring same as those of parent generation. ↑ Forces of random change

H-W equation
$p^2 + 2pq + q^2 = 1$
p = frequency of dominant allele
q = frequency of recessive allele.

gene duplication - mutation leading to extra gene formed. → formed from uneven crossing over in meiosis
↳ no effect - but can mutate and get new function.

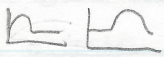
pseudogenes - Similar to homologous genes but not transcribed.

↳ 1/10,000 cell divisions produce mutations → Species with small genome → 1 or more each gamete in large genome.
↳ only affect phenotypes
↳ usually results in death before birth.

③ patterns of Selection

- Harmful mutations occur often but selected against so mutant alleles rare.
- Beneficial mutations occur rarely but selected naturally so mutant alleles common.

Natural Selection affects allele frequency in 4 ways:

① Stabilizing selection - most common phenotype doesn't change since well adapted. 
② directional selection - Frequency of allele shifts in constant direction. 
③ disruptive selection - extreme phenotypes favored over intermediate (promotes homozygosity) 
④ Sexual selection - variations helping increase ability to obtain mates → Sexual dimorphism - differences in gender appearance.
↳ selective traits detrimental to survival. → esp runaway traits. → courting and mating behaviors.

Selections are compromise btw 1, 2, 3 and 4.

④ Species - group of individuals capable of interbreeding to produce fertile offspring.
Species arise through isolation (reproductive isolation)

allopatric Speciation - geographic barrier (extrinsic)
Sympatric Speciation - non geographic barrier (intrinsic)

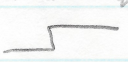
reproductive isolating mechanisms ← intrinsic mech.

prezygotic mech.
- prevention of mating
  - Ecological isolation - no contact
  - Temporal isolation - different breeding time
  - Behavioral isolation - not attracted to each other.
- prevention of fertilization
  - Mechanical isolation - not physically compatable
  - gametic isolation - egg and sperm do not fuse properly.

post zygotic mech. { hybrid inviability + infertility - offspring may not survive or reproduce.

Slow rate of Speciation → Stable Species
Fast rate of Speciation → unstable species

Speciation dynamics

gradualism  punctuated equilibria 

- punctuated equilibria more accurate view of speciation dynamics.
- 99% of species extinct, lifetime of species - 100,000 years.
- Speciation ↑ when new niches become available.
- mass extinctions affect speciation.

⑤ Cumulative Selection - accumulation of small adaptations to significant adaptations. → how complex structures formed.

blind watchmaker - complex structure leads to intellegent Creator

↳ creation of eye result of accumulated beneficial mutations
1) Small mutation leads to patch of cells with chemical sensitivity to light
2) pit formed → provides directional info.
3) pit deepened, opening narrowed - visual ability enhanced / image formed.
4) Accumulated epidermal excretion forms first crude lens.

Altruism - decrease fitness of individual to assist fitness of another, to increase its own fitness indirectly.

Kin Selection - natural selection of behavior enhancing fitness of kin, increasing first individuals fitness indirectly.

Chapter 18

- life existed for 3.6 billion years
- Multicellular eukaryotes arose about 1 billion years ago.

- Hominans have common ancestor with chimpanzees
- only species of hominans extant are humans.
- Africa birthplace of hominans.
- Genetic evidence indicates humans arose Africa 150,000 years ago, left Africa 60,000 years ago. ← out of Africa hypothesis

divergent evolution – 2 or more species evolve increasingly different traits → genetic drift

Convergent evolution – 2 or more species become increasingly similar.

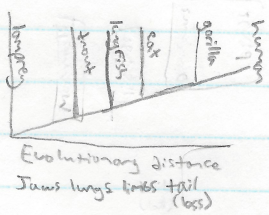
homoplasies – Similar traits found in 2 or more different species resulting from convergent evolution. Not from common descent.
AKA analogous features.

Adaptive radiation – process in which divergent evolution occurs in rapid succession, or simultaneously, to produce 3 or 4 species of higher taxa.

Coevolution – process, in which one species evolves in response to the evolution of another one.

phylogenetic relationships.

Cladistics – grouping organisms based on similarities derived from common ancestory. → clades – monophyletic group.
↳ "relative" relationships – not "who came from who"
↳ organisms closer together simply share more recent common ancestor.
↳ the higher up the chart, the more derived the traits shared.



* human more related to gorilla than cat
* lungfish more closely related to human than trout. (More shared features)

- hominoids have larger brains than monkeys, and no tails.
- DNA differs only by 1.6%.

Unlike other hominoids:
- bipedal
- greatly enlarged brain
- complex language
- complex tools

Macroevolution – large scale evolutionary change, significant enough to warrant classification of groups.

Lucy → 3.2 million year old prehuman hominoid.

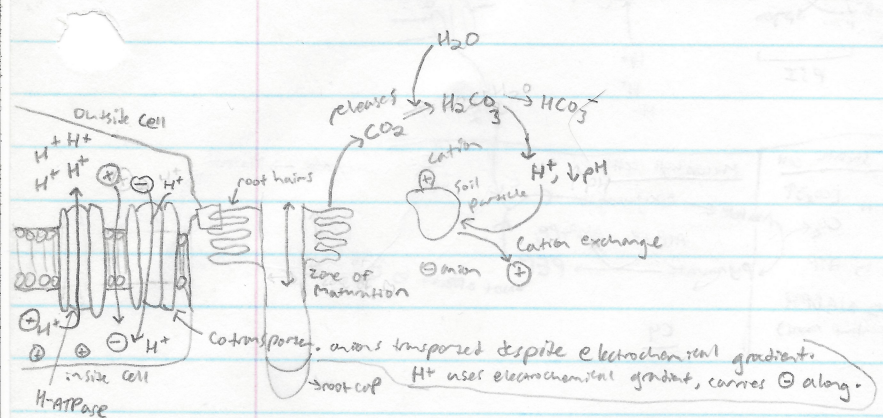
Homo habilis → Homo Erectus → Homo Sapiens
Homo Neanderthanesis.

Xylem pressure ↑ as pressure in roots ↑
↓ as light intensity ↑

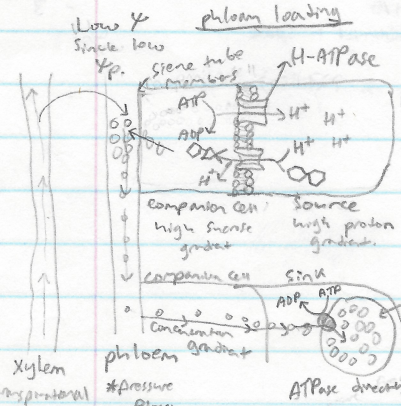
trichomes
↑ ↗ Stomata
epidermal cells → cuticle
↑

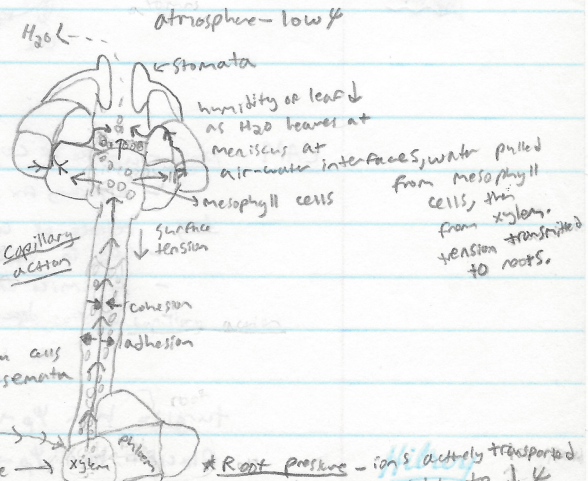
primary growth → Apical meristems → protoderm → dermal tissue system
→ Ground Meristem → ground tissue system → collenchyma → support growing regions
→ Sclerenchyma → support mature regions
→ parenchyma
→ procambium → vascular tissue system
primary xylem → tracheids
→ vessel elements (angiosperms)
→ (conduct H_2O)
→ Some parenchyma cells that transport materials laterally
primary phloem → (conduct sugar)
→ sieve tube members
→ companion cells.

secondary growth → lateral meristems
→ cork cambium (mostly grows to outside)
→ cork (grow to outside of tree)
→ phellogen (grow to inside of tree)
→ vascular cambium (mostly grows to inside)
→ secondary phloem – wood
→ secondary xylem – bark



*electrochemical gradient = Cations able to enter despite concentration gradient.



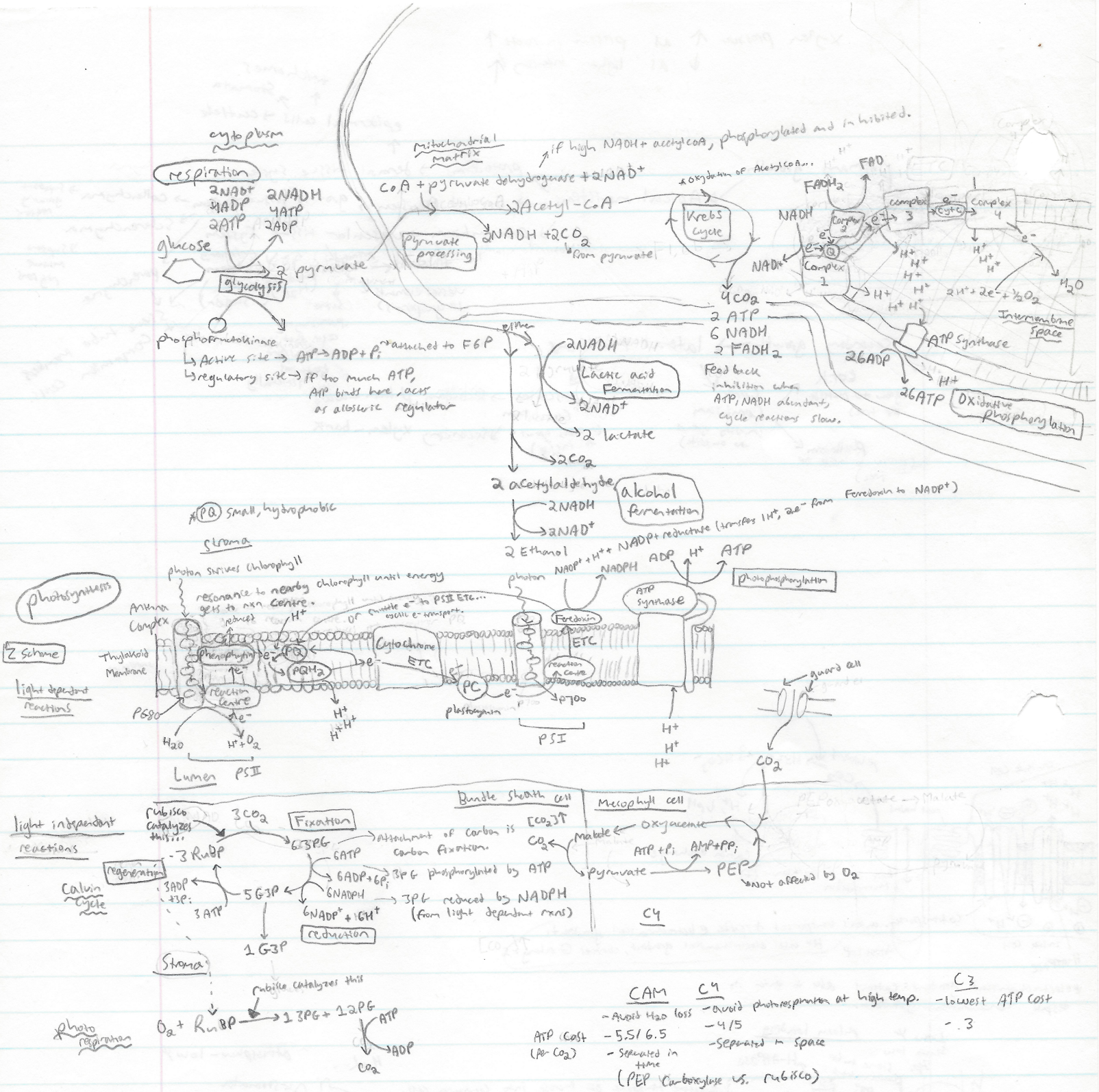


Water in soil H_2O High Ψ → root hair → Epidermis → Cortex → endodermis → pericycle → xylem

Symplastic pathway – connection thru cells via plasmodesmata

Casparian strip – suberin wax in endodermis blocks cell walls of apoplastic pathway.

apoplastic pathways – spaces between cells.



	CAM	C4	C3
	- Avoid H2O loss	- Avoid photorespiration at high temp.	- lowest ATP cost
ATP Cost (per CO_2)	- 5.5/6.5	- 4/5	- 3
	- Separated in time	- Separated in space	

(PEP Carboxylase vs. rubisco)

CAM – Night – uptake of CO_2
- temporary fix to organic acids (CO_2 + PEP → OAA → Malate)

day – release of CO_2 from stored organic acids
- CO_2 in calvin cycle
- minimize effects of photorespiration
- light dependent reactions occur here...

turgid = high Ψ_p → water flows out

flacid = low Ψ_p → water flows in