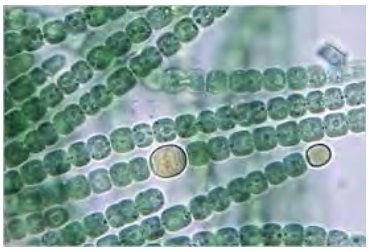
Bio 1A/1AL Images and Charts

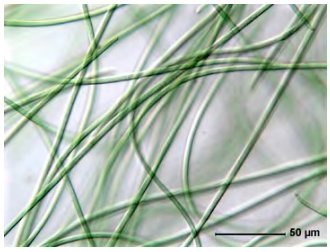
Prokaryotes

Cyanobacteria:



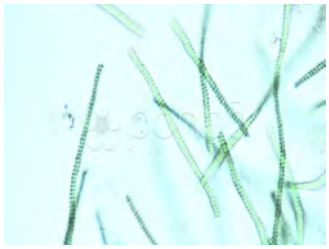
Anabaena sp.

- Perform Nitrogen fixation with heterocysts
- Gram—negative
- photosynthesis



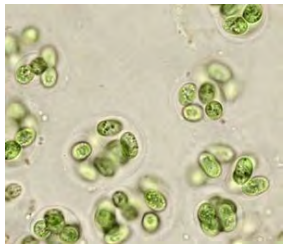
Oscillatoria

- Oscillate by themselves
- Gram—negative
- photosynthesis



Spirulina

- Source of protein
- Gram—negative
- photosynthesis



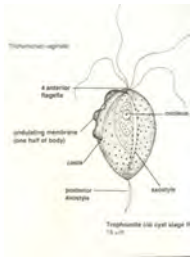
Gloeocapsa

- Form colonies
- Gram—negative
- photosynthesis

Eukaryotes

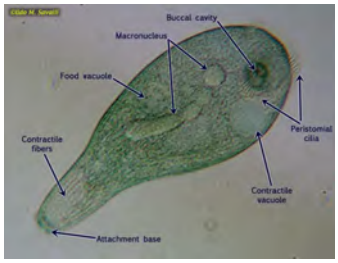
Excavata (flagellates):

Parabasilids:



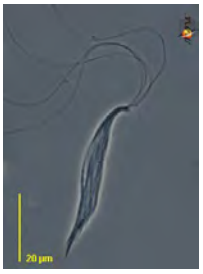
Tricomonas

- Relatively small
- Add methocel
- Found in termite gut (anaerobic environment): digests cellulose
- Lack plastids and oxidative respiration (no mt)



Triconympha

- Very large
- Add methocel
- Found in termite gut (anaerobic environment): digests cellulose
- Lack plastids and oxidative respiration (no mt)



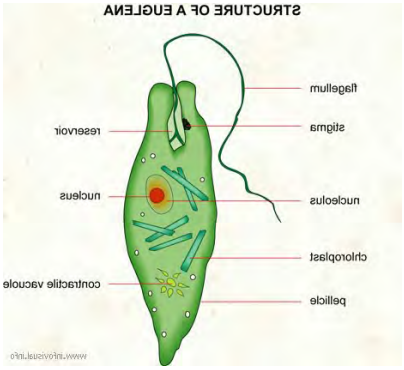
Streblomastix

- Relatively small
- Add methocel
- Found in termite gut (anaerobic environment): digests cellulose
- Lack plastids and oxidative respiration (no mt)

Euglenozoans:

Euglena

- Reddish photoreceptor (eye spot)
- One flagella
- Add methocel

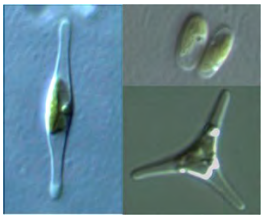


"SAR" / Chromalveolata:

Diatoms:

Phaeodactylum

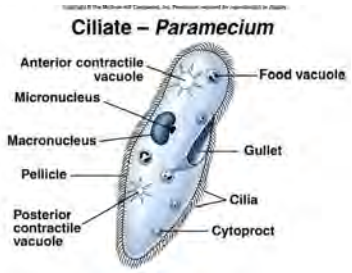
- Algea
- Silca cell walls
- chlorophyl



Ciliates:

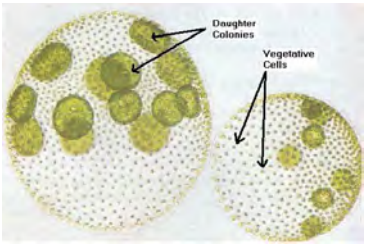
Paramecium

- Eat yeast
- Reproduce through cell division
- Add methocel
- Contain micro and macro nucleus.



Arcgaeoplastida:

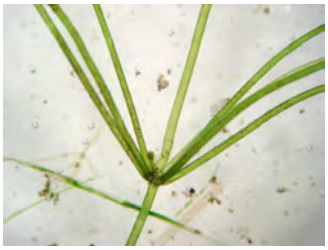
Chlorophye:



Volvox

- Green algea
- Has parent and daughter colony
- Has flagella
- Add sand

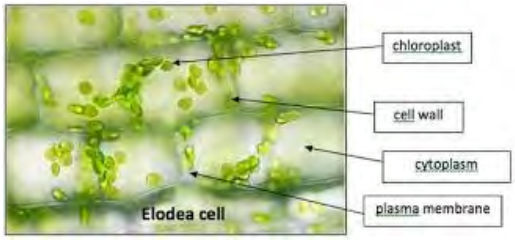
Charophte:



Nitella

- Green algea
- Uses cytoplasmic streaming (bulk mixing of cytoplasm)

Land Plant:



Elodea

- Has central vacuole
- chloroplasts

Unikonta:

Amoebozoans/Tibulinds:

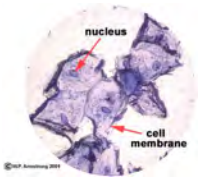
Amoeba

- Bottom dwellers
- Add sand
- Move with pseudopods (through cytoplasmic streaming)
- Use contractile vacuole to regulate water balance

Animals: — Choanoflagellates — Fungi

Human Cheek Cell

- Dye (methylene) binds to DNA
- Saline solution is isotonic
- Type of epithelium



Pro K	1 DS DNA, circle, nucleoid	No membrane bound organelles (nucleus, mts, vacuole, ER, Golgi, cts, lysosomes) but some have periplasmic space and heterocysts	Size 1-10 µm (10x smaller)	Ribosomes: smaller; susceptible to certain antibiotics, bound to PM	Cell wall: Composed of pepti-doglycan	Flagella: Composed of three parts: fila-ment, hook, and basal body, can have pili or cytoskeleton	Have prophag-es and oper-ons, and polycictronic mRNA	Divide by binary fis-sion,	Can simultane-ously script and slate	Genetic diversi-ty through: F plasmids, tranferance (DNA from surroundings, phages	1 origin of replication
EuK	>1 DS DNA, linear molecule, histones, telomeres	Membrane bound organelles (nucleus, mts, vacuole, ER, Golgi, cts, lysosomes)	10-100 µm (10x bigger)	Bigger, bound to RER	Cell wall: Composed of chitin in fungi, cellulose in plants	Flagella: Composed of microtubules: central pair sur-rounded by cylinder of 9 doublets, sur-rounded by mem-brane, centriole at base; can have cilia pili or cytoskeleton	Have post translational modification, TATA box in promoter, and AAUAAA termi-nation seq in scription	Mito-sis/ meio-sis	Compart-mentalize scrip-tion (nuc) and slation (cyt)	Genetic diversi-ty through: sexual reproduc-tion, mutations, transposons, etc	Many origins of replication

Plant	Cell wall (cellulose)	chloro-plasts	Few lyso-somes	Central vacuole	Rarely centrioles	Oils unsat. fats	Sitoserol		Sporophyte -> Spores & game-tophyte ->gametes
Animal			lysosomes		Some centrioles	Solid, saturated fats	Cholesterol	Extracellular matrix	Gametes (sperm/ egg)
Fungi	Cell wall (chitin)						Ergosterol		

Ender (+G) v Exergonic(-G) Rxns:

- Cellular resp
- Photosynthesis
- Motor/transport
- Hyd ATP
- Transfer of e– from food to O2 (CR)
- Sealing backbone
- Injecting DNA
- Binding tRNA

Supramolecular Structures:

- Chaperon Proteins (renaturation)
- Proteome (digestion in cell)
- Ribosomes

Endomembrane System: (responsible for secreatory and membrane proteins)

- Plasma membrane
- ER, Golgi
- Lysosomes
- Nucleus
- Vacuole

Double Membrane:

- Nucleus
- Mitochondrion
- Chloroplasts

Starch	Glucose	α (1-6 for amylopectin branches, 1-4 for amylose)	plant	Storage
Glycogen	Glucose	α (1-6 for branches, 1-4 otherwise?)	animal	Storage
Cellulose	Glucose	β 1-4 linkage	Plant	Structure
Chitin	N-acetylglucamine	β 1-4 linkage	Fungi/ animal exoskeletons	structure

Macro-molecule	Residue/monomers	Active functional groups	Polymers/large molecules	Linkage	Function
Carbohy-drate	Sugar/ monosaccharide. i.e: glucose (aldohexose) fructose (ketohexose) ribose (aldopentose)	Hydroxyl and car-bonyl groups	Disaccharides (maltose: α gluc; lactose: β galact. A gluc; sucrose: α gluc. B fruc., oligosaccharides (3-20) poly saccharides	Glycosidic linkage between OH on carbonyl carbon and other OH (ie 4,6 etc): H2O formed as product	Fuel for cellular respi-ration/biosynthesis (monomers), storage, structure
Protein	Amino acids: sim-plest glycine—R = H	Amine, carboxyl, and R group (polar, non polar, or charged)	Polypeptides: form α helix-es and β pleated sheets as secondary structure held together by H bonds	Peptide bonds: de-hydration between carbonxl OH and amine	Structure, storage, transport, communi-cation, movement, enzymes, protection
Lipid	Glycerol + fatty acids	Carboxyl (fatty ac-id), double bond in unsat. Fatty acids, OH in glycerol	Not polymer: fats (ie triglyc-eride: glycerol + 3 fatty ac-ids), phospholipids (glycerol + phosphate + 2 fatty acids), steroids (hydrocarbon rings)	Ester linkage be-tween carboxyl OH and glycerol OH. 2nd & 3rd held to-gether by H bpnds. Also 4th, (both isol-ogous and hetero)	Fats: Long term stor-age, insulation, cush-ioning. PhLipids: bi-layers. Steroids: hor-mones and structure
Nucleic Acid	Nucleotides: sugar, Ph, & nitrogen base (purine (AG)-double ring). Sug & base connected by N-glyc. link	Phosphate, OH from 5 carbon sugar (ribose/ deoxyribose),	Polynucleotide (2 polyNuc make up DNA)	Phosphodiester between sugar and phosphate	Hereditary material, determine protein structure, energy (ATP, co enzymes), signaling (cAMP)

Membrane fluidity increase	**Increase temp. w/o sterol:** increase KE, PL can move more and become loosely packed	**Decrease temp with sterol:** PL can't pack in as closely together, so membrane is more fluid than with sterol. Overall, sterol reduced **amount of change** in fluidity	**Cis– bonds/ unsat. fats:** kinks push PL apart. Come	**Short FA:** fewer hydrophobic interactions. Strength of h-bond is proportional to dist, however, cannont move around as much at high T	Altering lipid composition to maintain homeostasis
Fluidity decrease	**Increase temp with sterol**: Fluidity decreases when compared to w/o sterol: PL bump into sterols and cant move as much	**Decrease temp w/o sterol:** PL move less and become more tightly packed. Overall, sterol reduced **amount of change** in fluidity	**Trans- bonds/ sat fats:** PL closely packed	**Long FA:** more hydrophobic interactions. Strength of h-bond is proportional to dist.	Altering lipid composition to maintain homeostasis

People:

- Frye—Edin: Fluid Mosaic Model
- Robert Hooke: first to observe cell
- Schleiden & Schwann: wrote cell theory
- Peter Mitchell: proposed oxidative phosphorylation
- Sutton Boveri: 'some theory (genes on somes, assort independantly

Membrane Prot: side that faces cyt always faced cyt

Integral Proteins: Hydrophbic regions embedded in bilayer

Peripheral Prot: found on one side of mem, attached by weak mol. Interactions, removed with salt.

Transmembrane Proteins: completely pass through mem. Often α helix, ie transp. prot

Unilateral Prot: One side of membrane, covalently bonded to PL of glycoplipid

- Nirenberg: described protein synthesis
- Jacob Monad: discovered operon mechanism

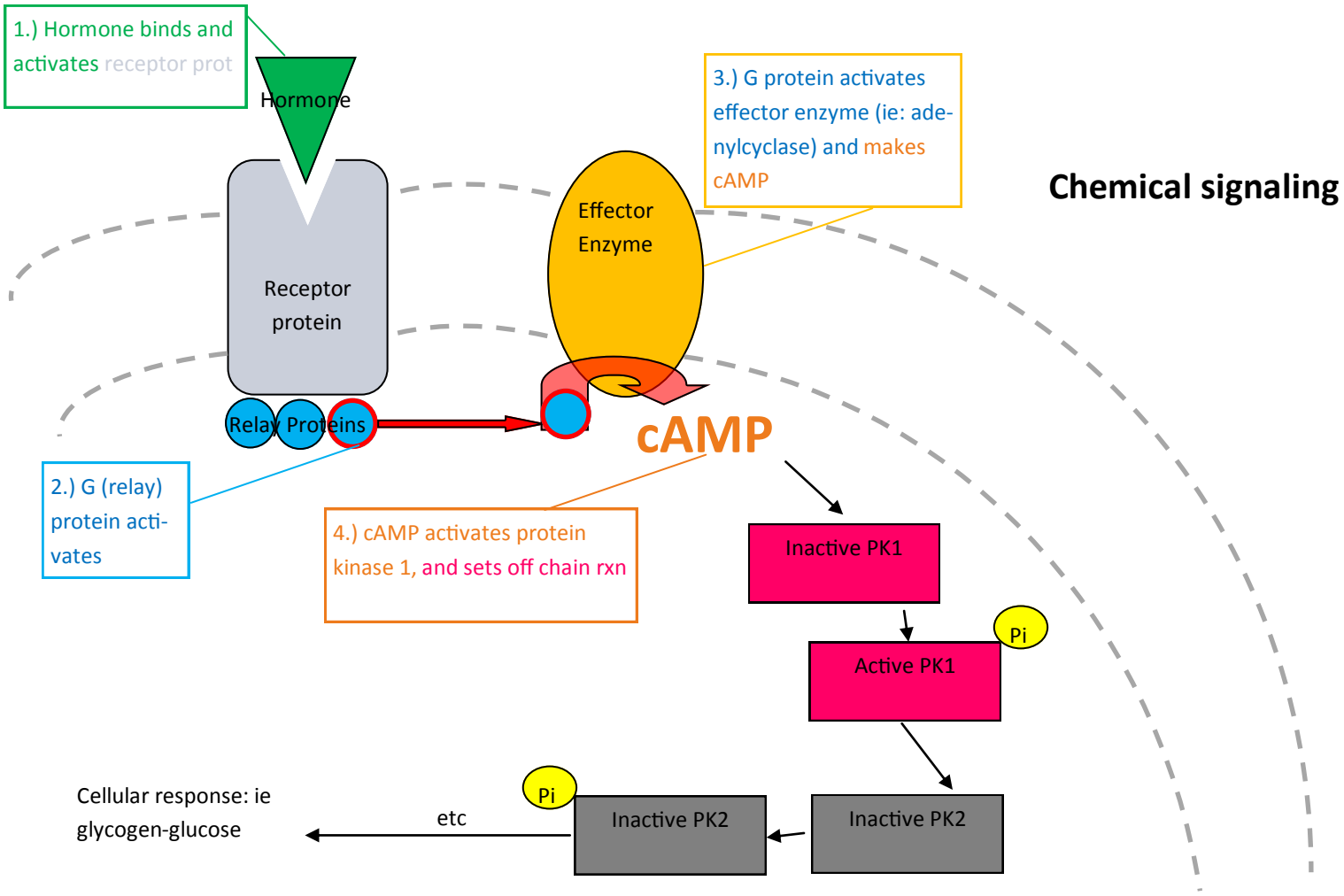
More People:

- Mendel: (1st law:) individuals have 2 alleles per gene (2nd) assort independently into gametes, (3rd) one allele is dominant
- Morgan: drosophilia, pinned eye color gene to X 'some
- Sturtevant:: recombination freq α mu
- Griffiths: DNA = gen mat, Strep. Would uptake & express S virus
- Avery: only DNA was transformed
- Chargaff: A=T, C = G
- Hershey Chase : separated & tagged prot & DNA of virus. DNA was transferred
- Meselson Stahl; used N^{15} to support semi conserved model (not conservative or dispersive
- Tatum Beadle: one gene per polypep/ RNA

Genetics Ratios/Crosses: Dihybrid cross rat– 9:3:3:1; hetero TC: 1:1; homo TC: 3:1; Reciprocal Cross: same on autosome diff on sex 'some; paternal/maternal imprinting 1:1 instead of 3:1

Ribozymes: (consists or rRNA, fn as enzyme) rRNA in RSU and snRNA

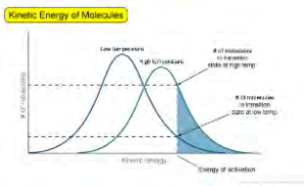
Simple Diffusion (passive)	Requires: conc. Gradient:	Requires no E	Works with small polar molecules	Ex: O2 into mt, CO2 out	things move from low to high conc.
Fascilitated Diffusion (passive)	Requires transport proteins (spec. to certain ions). Either **Channel prot:** gated, hydrophyll. tunnel, or **carrier prot** (permease) w/ binding site	No E, but can become saturated, or inhibited by other molecules	Works w/ large polar molecules	Ex: water channeled w/ aquaporin	Flow from low to high conc.
ATP Pumps (active- primary)	Requires carrier prot. phosphorylation of carrier prot induces conformational change. (Pi added to R grp w/ OH)	Requires ATP for E: creates electrical gradient		Ex: Ca ++ in smooth ER	Can go from low to high
Cotransport (active- primary)	Requires [solute 1] gradient from ATP pump for downhill diffusion of [sol 1] to carry uphill transport of [sol 2]. w/ carrier prot . Carrier prot can be symporter (both molecules in same dir) or antiporter (different dir)	Requires gradient from ATP pump for E. Travels faster with both Che,. And electrical gradient		Ex: sucrse-H+ pump in plants, & glucose w/ Na+ from small intestine into blood. In this ex, fasciliated diffusion also occurs once a favorable gluc gradient is present.	Can go from low to high
Bulk flow (exo/ endocytosis)	Requires movement of cytoskeleton	Requires E	Works for large polar or charged particles (macromolecules)		



Req for ΔG°':

- 298 K
- 1 atm
- pH 7
- [H2o] = 55.5

ΔG = ΔG°' + RTln(prod/rceactants)

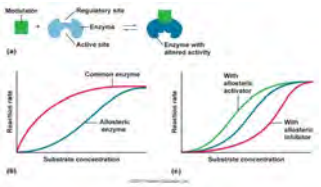


How temp effects Boltzmann dist:

- Increase T increase KE
- More molecules can reach Ea
- Changes ΔG
- However, protein denature with increased T (also occurs with pH-conformational change from R grp interaction)

Emergent Prop. of Life:

- Growth
- E utilization
- Homeostatic
- Reproduce
- Evolve
- High level of org.
- cells



Allosteric Regulation:

- Requires 4° structure
- Inhibitors/activators bind: stabilizing active/inactive conformation
- Sigmoid graph indicates cooperativity
- Ie feedback inhibition

Enzymes:

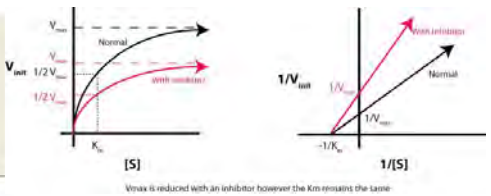
- Kinase: ATP (mg++ cofactor)
- Peroxidase: H2O2
- Isomerase: rearranges atoms
- Oxidase: oxidizes (Fe++ cofactor)
- Reductase: reduces
- Dehydrogenase: NADP

Enzyme Activation E:

- Enzyme creates new pathway, which lowers Ea
- ΔG unchanged

Coenzymes (org. non protein cofactors:

- Riboflavin—FAD
- Niacin—NAD
- Panthothenate—Coenzyme A
- Biotin—used in carboxylases



Km and Vmax:

- Km stays the same even with doubling/halving of Vmax from varying [Enz]
- Km measure affinity, high Km means weak Enz-Subst bonding

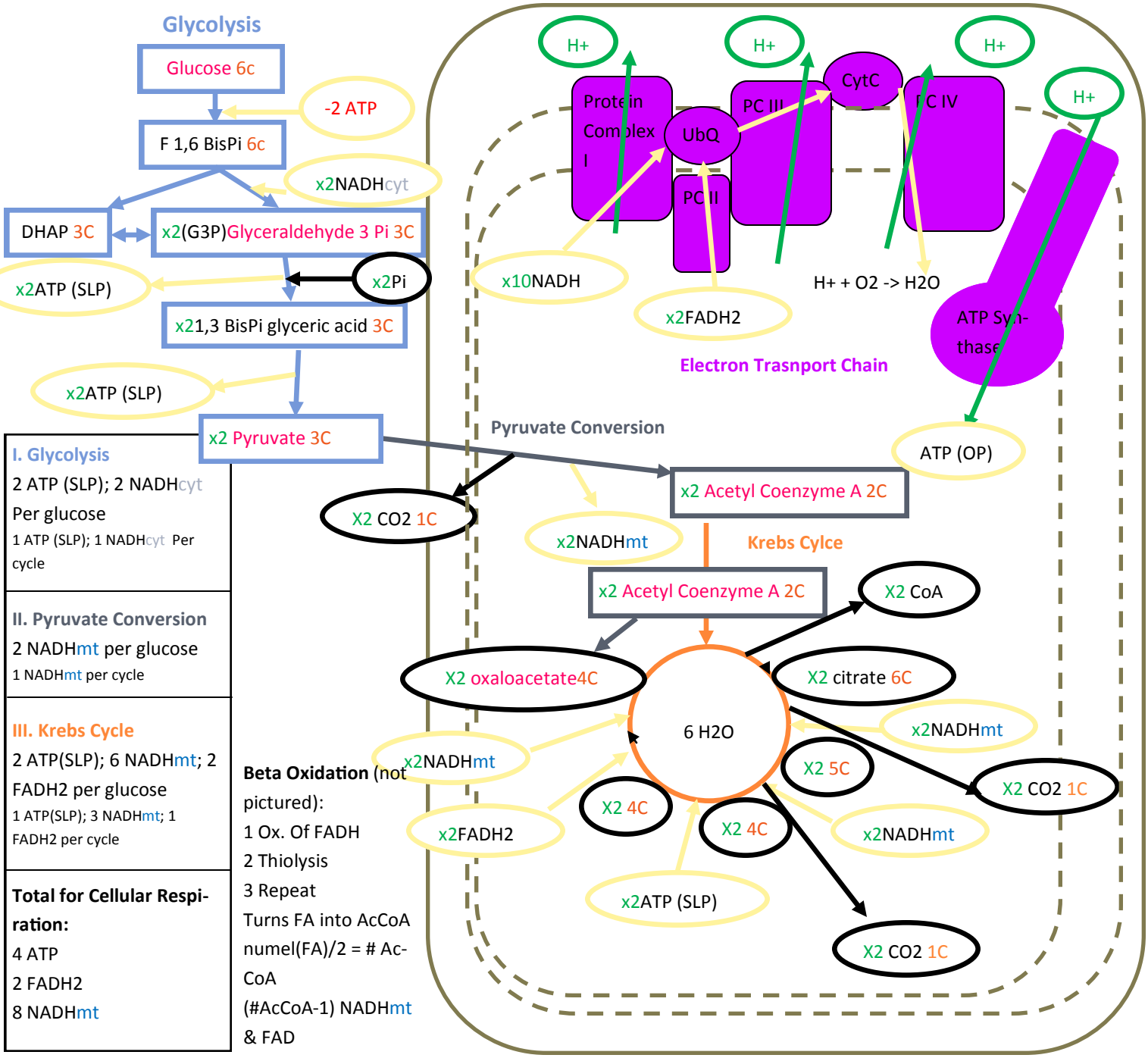
Cofactors (required for prot activity):

- Flavoprots: flavin
- Cytochromes: heme
- Iron sulfur clusters

* Uq: ubiquinone

*CytC: Cytochrome C oxidase

Mitochondria: Cellular Respiration



I. Glycolysis
2 ATP (SLP); 2 NADHcyt Per glucose
1 ATP (SLP); 1 NADHcyt Per cycle

II. Pyruvate Conversion
2 NADHmt per glucose
1 NADHmt per cycle

III. Krebs Cycle
2 ATP(SLP); 6 NADHmt; 2 FADH2 per glucose
1 ATP(SLP); 3 NADHmt; 1 FADH2 per cycle

Total for Cellular Respiration:
4 ATP
2 FADH2
8 NADHmt

Beta Oxidation (not pictured):
1 Ox. Of FADH
2 Thiolysis
3 Repeat
Turns FA into AcCoA
numel(FA)/2 = # Ac-CoA
(#AcCoA-1) NADHmt & FAD
-2 ATP per FA

Energy Carrier	**# After Krebs**	**ATP yield per E carrier** (H+ per pair of e-/ 4 for ATP synth)	**Cost for G3P transfer thru β barrel** (opposed to malate in heart and kidney)	**Total ATP Yield**
NADHcyt	2	10/4 = 2.5	-2	(2.5)(2) - 2*[1,0] = [3,5]
NADHmt	8	10/4 = 2.5	0	(8)(2.5) = 20
FADH2	2	6/4 = 1.5	0	(2)(1.5) = 3
ATP	4	-	-	4
				ATP per glucose: 30—32

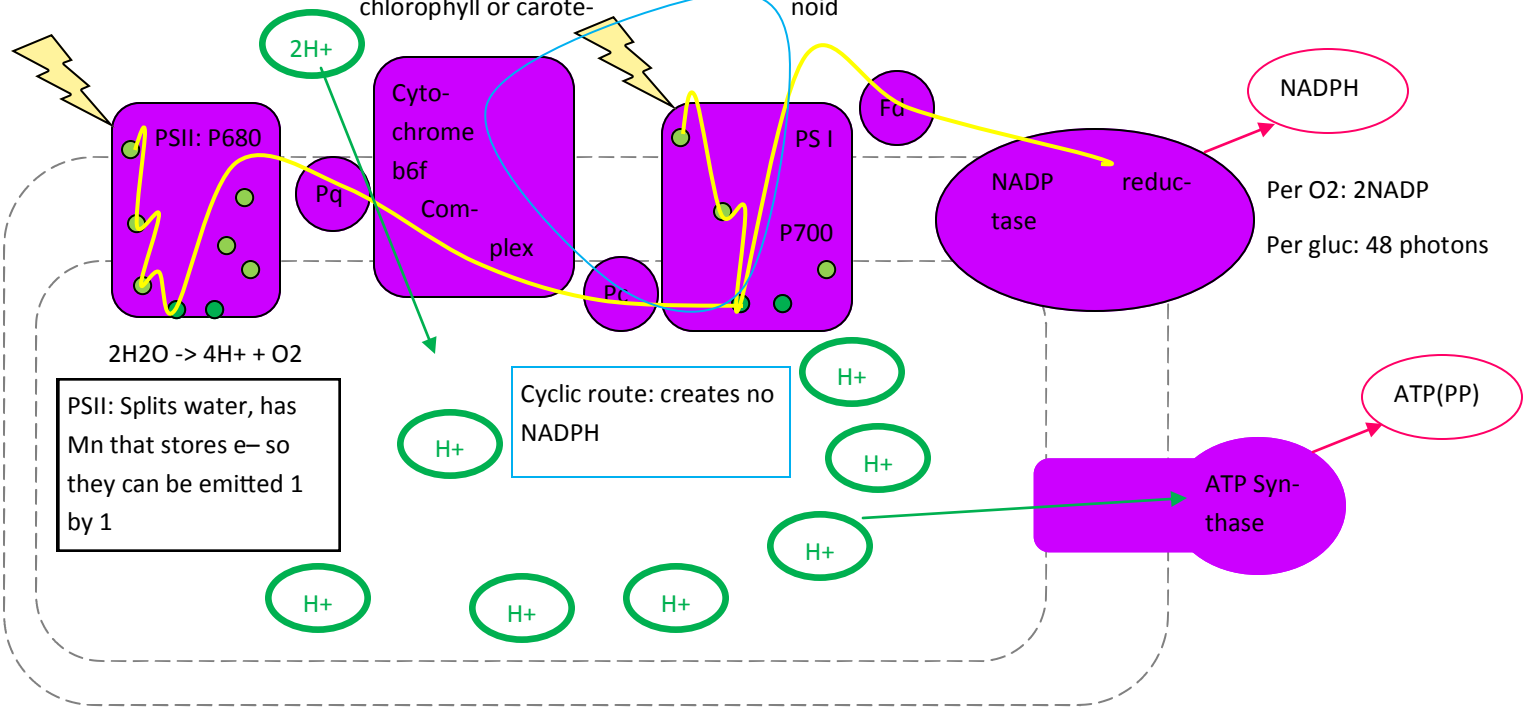
Types of Phosphorylation:

- Substrate Level:
- Oxidative:
- Photo:

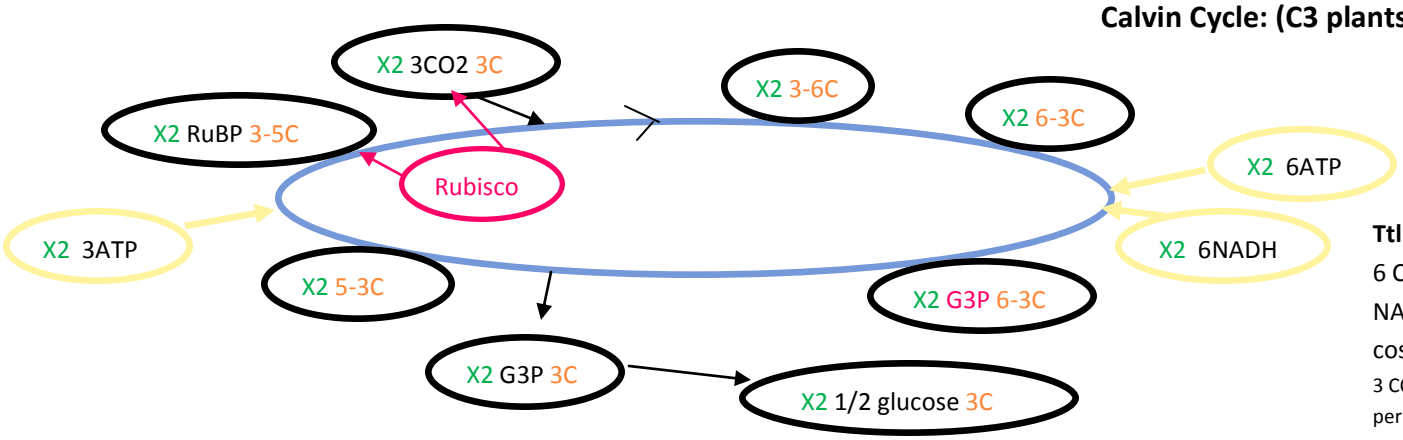
Starting pt in CR:	Starting mat:	Extra Req.	NADH per cycle	FADH2 per cycle	ATP per cycle	Ttl ATP
Glycolysis	Sugars		1cyt + 4mt	1	1glyc+2krebs	C(12.5)+C(1.5) + C(3) - C(cyt) - 2gly
G3P	Glycerol, Carbs		1cyt + 4mt	1	1glyc+2krebs	C(12.5)+C(1.5)+ C(3) - C(cyt)
Pyruvate	Proteins		4mt	1	2krebs	C*10 + C*1.5 + C*2
AcCoA	Proteins & FA	FA +24C: Beta Oxidation_ numelFA)/2 AcCoA. Add appropriate NADPmt & FAD)	C-1 + 3mt	C-1 + 1	2krebs	NADH*2.5 + 7.5*C + FAD*1.5 + 1.5*C + 2*C - (2*FAs)
Krebs	Proteins		3mt	1	2krebs	7.5*C + 1.5*C + 2*C

Photosynthesis

*Pq = Plastiquinone *Fd = ferredoxin *Pc = Plasmocynin = Chlorophyll a (methyl grp) = chlorophyll or carote-noid

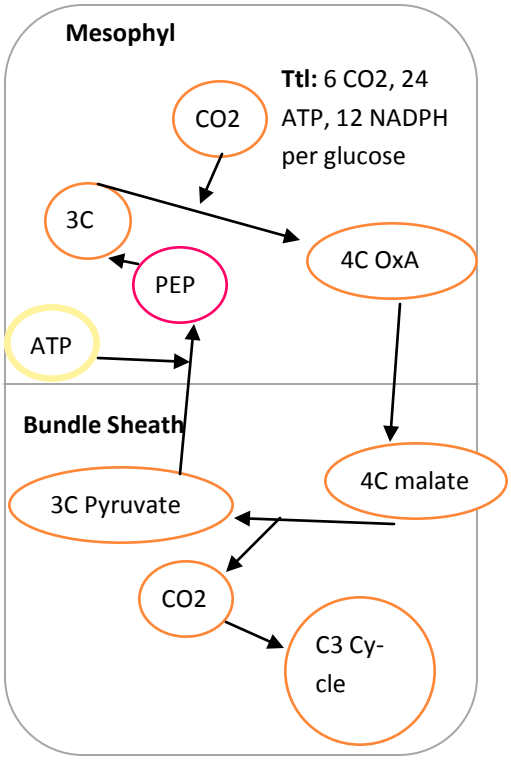


Calvin Cycle: (C3 plants)

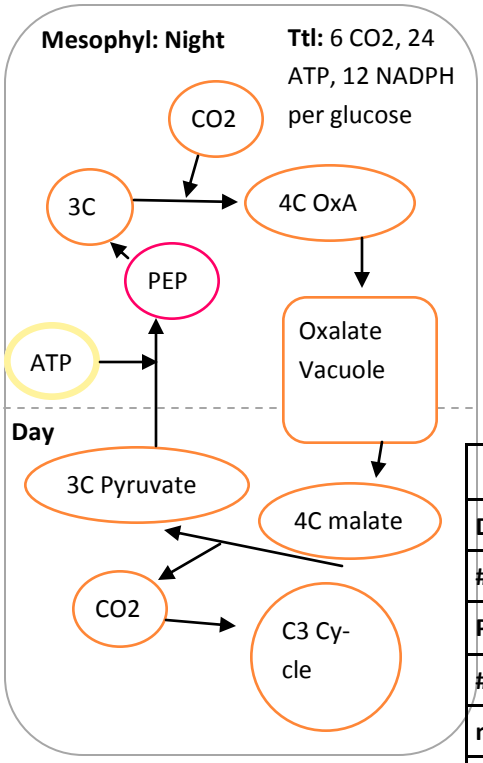


Ttl:
6 CO2, 18 ATP, 12 NADPH per glucose
3 CO2, 9 ATP, 6 NADPH per cycle

C4: sugarcane



CAM: pineapple



Alternate forms of respiration (no Krebs or ETC in anaerobic conditions:

- Lactate from liver -> pyruvate. Occurs in the cytoplasm
- Alcohol fermentation: Pyruvate—CO2 -> Ethanol
- Both still include glycolysis

Heteropolysacchs:
Hyaluronic acid, D-glucuronic acid (skin/cartilage)

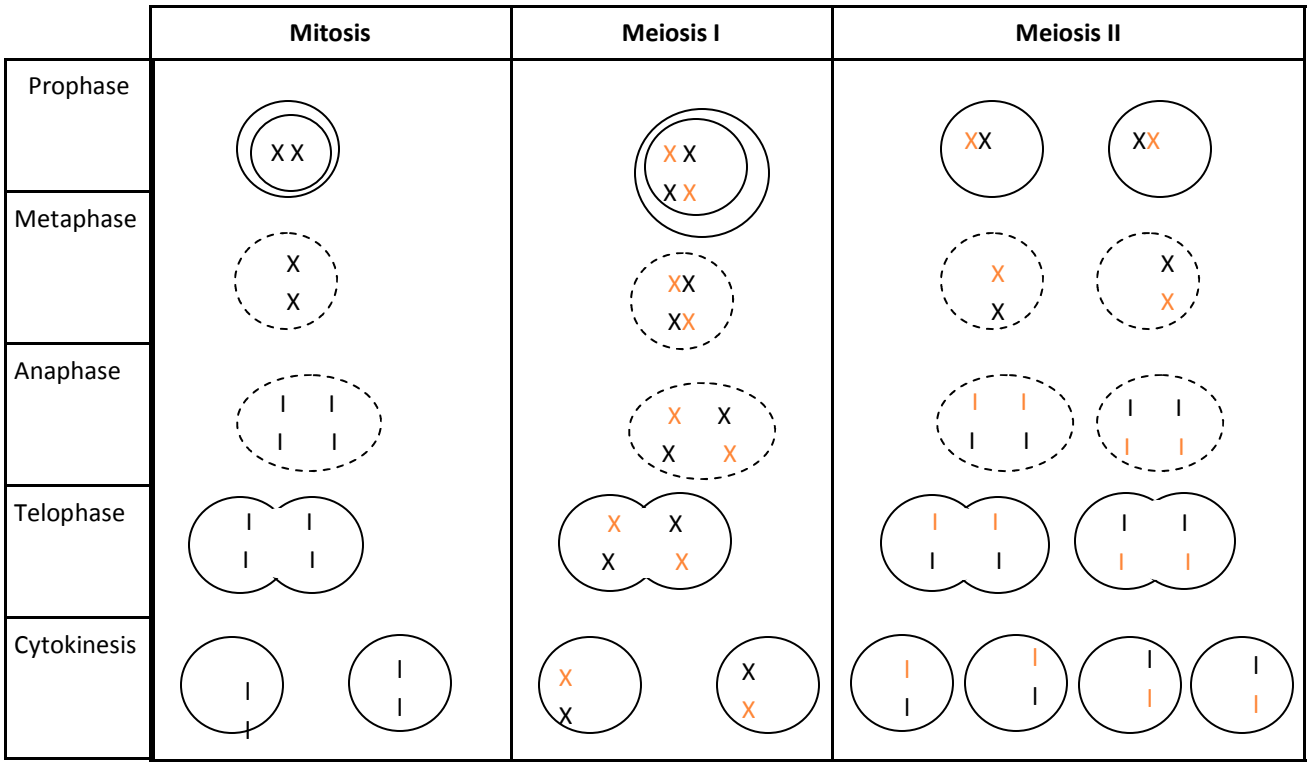
	Mitosis	Meiosis
DNA replicated	S	S1
# Divisions	1	2
Ploidy	NA	n,n/2
# daughters	2	4
metaphase	Somes	Tetrads, somes
Daughters	identical	different

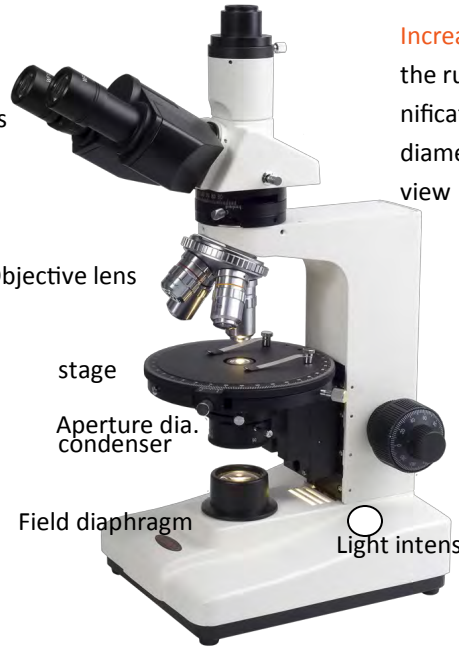
2N = 6	**N**	**C**	**Chromosomes**	**Chromatids**
G1	2N	2C	6	0
G2	2N	4C	6	12
End Mei I	N	2C	3	6
End Mei 2	N	C	3	0

Plant: Diploid sporophyte –Meisosis-> haploid spore –mitosis-> gametophytes –mitosis-> gametes –fertilization-> zygote
Animal: germ cells –meiosis-> gametes (egg/sperm) -fertilization-> zygote

Naming HydroC

- Count C staring from carbonyl
- D,L based on farthest asym. C from carbonyl (d= right)
- OH on ring form of carbonyl carbon used to be double bonded O
- Ketose aldose
- Pentose, hexose, etc





Increase size of subdivision in the ruler, decrease total magnification, and increase field diameter, increase depth of view

Microscope steps:

- Turn switch off, plug in scope
- Raise condenser, lower stage
- Clean lenses
- Mount slide
- Turn on the light, position slide so it passes through cloth
- Focus image with coarse adj, fine adj, and diopter
- Set interpupilary distance
- Close field diaphragm
- Adj. condenser until edges are sharp
- Open field diaphragm until edges are out of the field of view
- Adjust contrast with aperture diaphragm

Numbers/ Fromulas:

- ΔG°' cell resp = -686 kcal/mol
- ΔG°' hyd. ATP = -7.3 kcal/mol
- ΔG = ΔG°' + RTln(prod/rceactants)
- Vmax/[Enz] = turnover (mol. Subst/s)
- 2^n = possible isomers/gametes
- Efficiency= # moles ATP X 7.3 /# kcal released/mol subst (e.g., glucose)
- -log(I/Io) = clz
- pH = pKa + log([A-]/[HA])
- 2.4/(V2-2.4) = Vx/5
- 1/4^5 = 1/10^3
- Number of gametes: (#perm parents)^(# somes in a set)
- Unitl length DNA = Num templates * ((2^num cycles)—2n)
- # bases^# in codon = # AA

Undefined media	Contains nutrients for growth, but in unknown quantities
Defined media	Contains nutrients for growth in known quantities
Selective media	Contains nutrients that favor the growth of one species over another
Differential media	Allow organisms to show phenotypes like colony shape or color

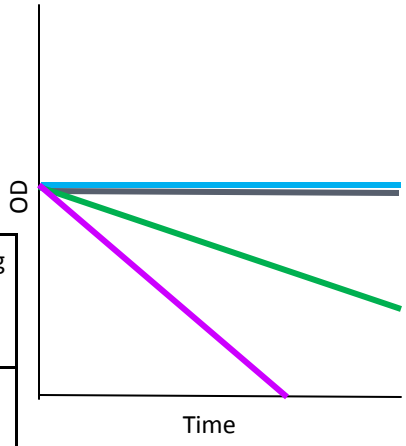
Enzyme Rxn order:

- Add enzyme, starch, wait 5 minutes (for enzyme to catalyze rxn)
- Add DNS (to stop rxn– interacts with aldehyde in linear form)
- Heat (to make DNS maltose precipitate appear.
- Order for blank = starch, DNS, everything else

Hill Rxns:

- Dark control: to make sure procedure is correct
- Light control: compare to normal behavior
- Meth: acts as a pH buffer to minimize changes in proton concentration of the lumen
- DCMU: block electron transport between PSII and PSI

PCR	Fluorescent ddNTP Seq	Radioactive primer Seq	DNA ladder
2 primers (F R)	1 primer	1 radioactive primer	0 primers
2 rxn tubes	1 rxn tube	4 rxn tubes	1 tube
Taq, buffer, 4	Taq, buffer, 4 dNTPs, 4 fluor.	Buffer, Taq, 4 dNTPs, 1 ddNTP per tube	Loading dye



PCR temp: denature > extension > annealing

Paralog	are homologs in the same species that came about from a mistake in meiosis, unequal crossing over and recombination so that you end up with more than one copy of a gene on a chromosome. Results from gene duplication. Genes specialize overtime (divergence)
Ortholog	are homologs and due to a speciation event, you end up with the same gene in different species
Homolog	are genes that came from one original gene, share common ancestor.

Fluorescent or radioactive dNTP	4 rxn tubes	Problem: first base won't show up on gel, end strand for short template will show up
Fluorescent or radioactive primer	4 rxn tubes	All bases that terminate and are long enough will show up (including end strand in short template)
Fluorescent ddNTP	1 rxn tube	Final strand, even in short template, will only show up for the last base

DNA	Non-coding template strand and coding non-template strand. Contains promoter for binding RNA	Introns,No poly A tail or cap, no UTR	
pre-mRNA	Same as non-template, but with U's	Introns,No poly A tail No UTR or cap,	
Mature mRNA		No introns,Ploy A tail and 5' cap,5' and 3' UTR	Shorter than ''
rRNA	Ribosomal, sometimes makes ribzyme		
tRNA	(transfer) Special adapter between mRNA and AA seq. Transfers AA from cyt to ribosome	Has anti codons complementary to codons (not unique to AA, allows for wobble, and sometimes addition of inosine)	80 bp long
SRP RNA	Takes free ribosomes to RER, component of signal rec. particle		
snRNA	(small nuclear), fn as ribozyme, processes RNA so it can pass through pores	part of snRNP along with protein	
siRNA	Small interfereing RNA	Helps degrade/ block viral DNA	
miRNA	Micro RNA	Helps degrade/ block mRNA that we don't want to be translated	22 bp
Xist RNA	X inactivation specific transcript	Coats 'some and recruits methylases for X inactivation	

Complete Dominance	P/p = purple, p/p = white	Mendelian peas	One phenotype or other, doesn't apply to commonality or survivability
Incomplete Dominance	R/R = red, R/R' = pink, R'/R' = white	Snap dragons	Blending of phenotypes
Codominance	I^A/I^A= A, I^B/I^A = both, $I^{B/}I^B$ = B	Blood type	Both phenotypes equally
Epistasis	C/C;P/P	complimentation	Expresses whatever whatever enzymes it makes in the pathway
Epigenetic	Maternal: a^{+meth}/a; will express a even though a+ is dominant. Methylation will be removed in both male, and conserved in both female gam-	Calico cats	Change in phenotype, no change in seq.

DNA/RNA Regions:

- Origin of Replication: where bubble forms in replication
- Promoter: in DNA, control region for gene switch, contains site where RNA attaches, and init site where scription begins. In EuK, TATA box for TATA TF
- EuK: 5' cap: increases t1/2 of RNA and prevents degredation, aids in binding 5' UTR in slation
- Intron: noncoding region of RNA removed by spliceosome in RNA splicing
- Prok: control region consists of operator and promoter
- Prok: operon is control region and structural genes
- 3' UTR, binds proteins for degradation
- 5' UTR: ribosomes bind here

Signal Amp:

- Many RNA poly work simultaneously
- Many ribo translate same mRNA to form polyribo

Bacterial Protection:

- Mutate receptor site used by virus to enter cell
- Restriction enzymes: cut up DNA, and create palindromic sticky ends
- Methylate own DNA binding site to protect against RE

Things that happen in nuc vs cyt

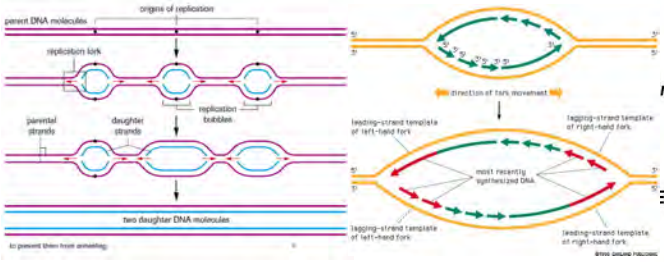
- tRNA made
- euK, ribosomal subunits assembled.
- Everything in a proK
- Slation
- Scription
- Splicing
- miRNA (pri -> pre)
- siRNA

Types of Mutation:

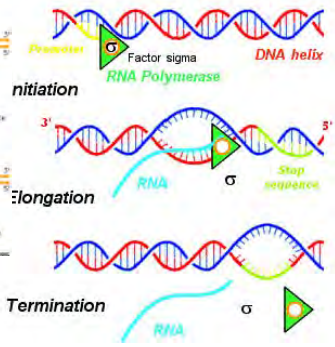
- Aneuploidy: too many copies of a some
- Subst: replace base, pt, can be silent, or missense (diff AA), nonsense (stop), or sense (not stop), exon -> intron or intron inclusion
- Deletion/insertion: pt, CAN result in frameshift -> dead prot, immediate nonsense, massive missense, or +-AA
- Less meaningful in RNA

	Initiation	Elongation	Termination	Fun Facts
DNA—DNA (replication)	Helicase unzips, topoisomerase relieves tension, RNA primer attach to complementary seq at origins (100's) of replication by DNA primase. In both directions for both strands	DNA poly 3 anneals to 3' end & forms replication fork (leading strand). Lagging strand annealed with multiple primers and Okazaki fragments (100-200 bp). DNA poly 1 removes RNA primer and fills with DNA(attaching to OF in back) , DNA ligase seals backbone (costs 2 pi)	Bubbles meet.	One mistake in 1 billion bases. Very accurate. If DNA primase were used, accuracy would decrease due to use of non permanent RNA
DNA—RNA (transcription)	General TF bind to promoter, RNA poly (many at once) 2 binds and anneals on one strand in one direction	RNA polymerase seperates strands and links NT, RNA peels from template	RNA continues until it reaches a terminator sequence. In EuK, often AAUAAA	Since this process is self starting, it has low accuracy
RNA—Protein (translation)	Small RSU binds 5' end of mRNA, tRNA binds to start codon (AUG) with GTP cost and initiator factors, large RSU binds, initiation factors released, tRNA in P site, initiator complex complete	Codon on tRNA recognized and binds (GTP cost required), pep bond formed between A sire and P site (catalyzed by peptidyl transferase), as ribo move 5' to 3', t&mRNA in A move to P, tRNA in P to E, GTP hydrolysis	Termination codon (3) enters A site, release factor binds stop codon and hydrolyzes bond between polypep and tRNA in P. polypep & tRNA leave ribo, RSU dissociate	Ribo binds to RER with Signal Recognition Particle and feeds proteins into membrane bubble (first AA zip-code). EPA order of sites. 3 different stop codons

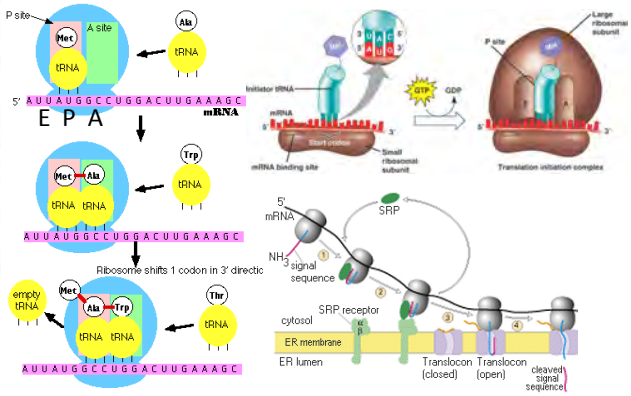
Replication



Transcription

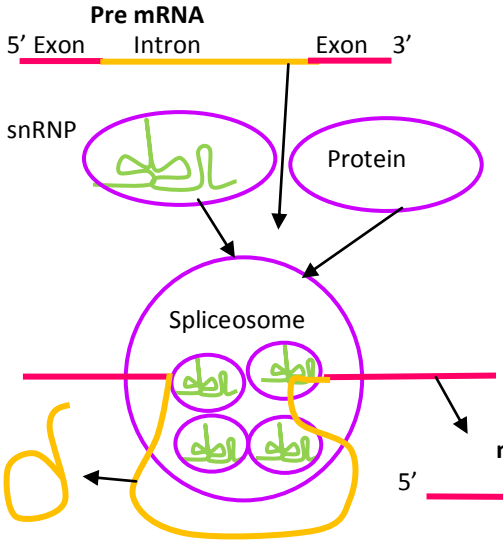


Translation

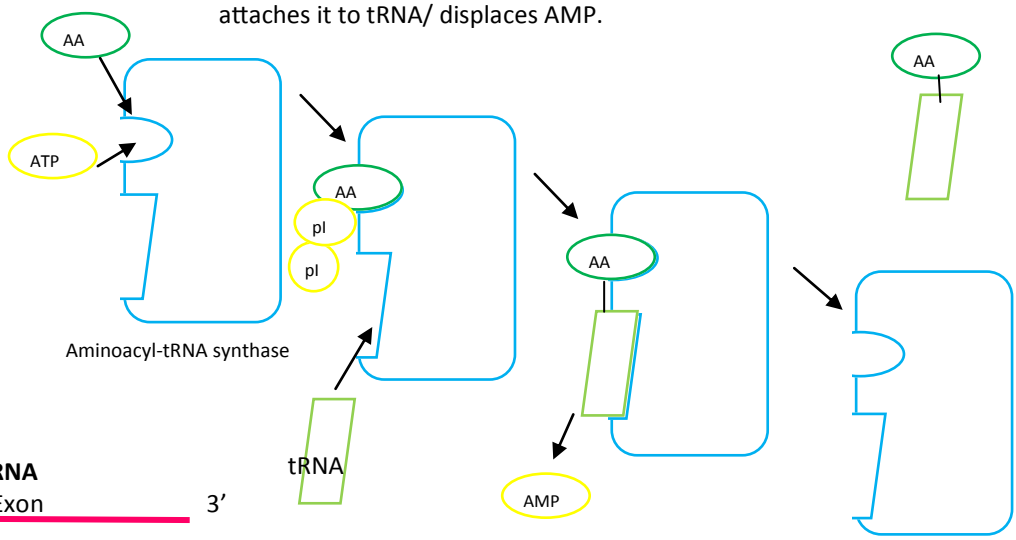


Supplementary Proccesses:

RNA Splicing (scription): snRNP and proteins combine to form spliceosome, which attaches exons and expels looped introns to be degraded

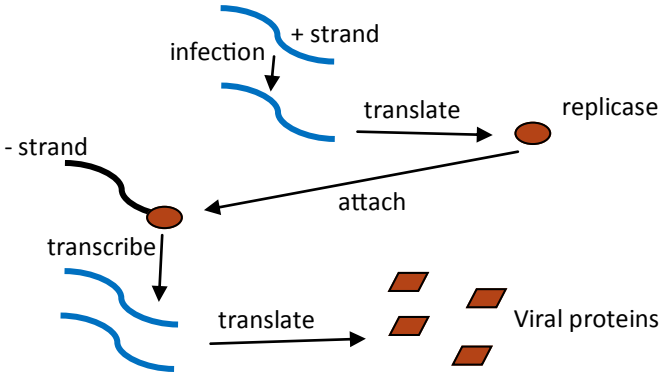


tRNA/AA attachment (slation): Aminoacyl-tRNA synthase (specific to AA and tRNA) activates AA w/ ATP hydrolysis, and attaches it to tRNA/ displaces AMP.



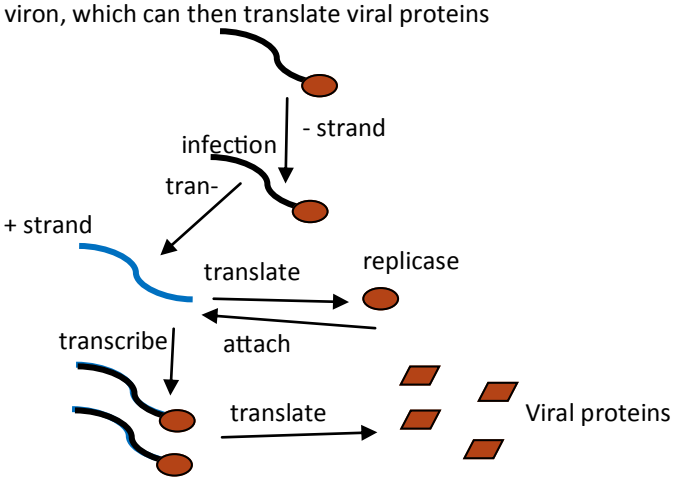
RNA Viruses

Positive strand: one gene encodes for DNA-dependent poly (replicase), transcribe to— strand, transcribe + stand, translate to viral proteins



Retrovirus: type of positive strand DNA that reverse transcriptase as its replicase, which works for either RNA or DNA, which can be inserted into the host (HIV)

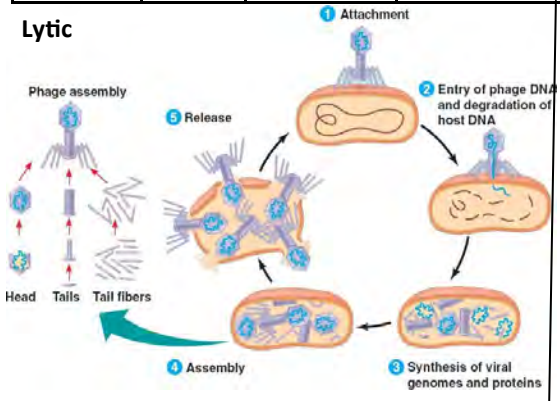
Negative strand: replicase(initially from host cell) is packages in viron, which can then translate viral proteins



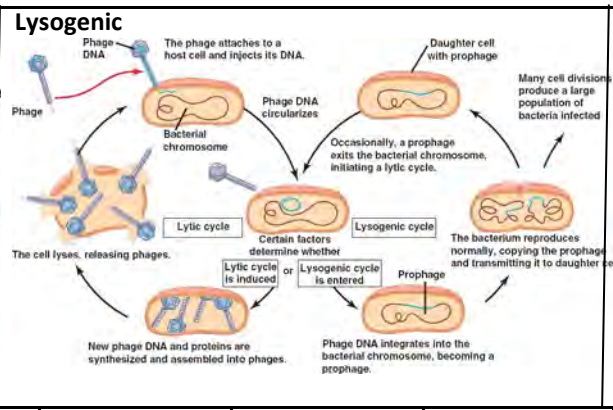
Virus Reproduction

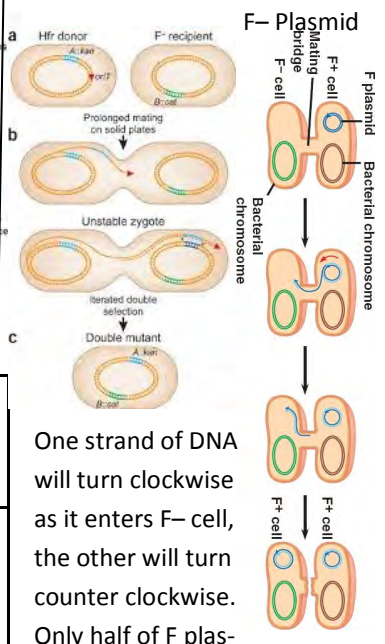
Lytic	T4 phage	Causes the death of the host cell	Phage attaches, injects DNA (ATP cost), host transcribes and translates DNA, one of the first proteins destroys the host DNA, cell makes pahges, phages assemble, lysoszymes break down cell wall	20-30 minutes to complete
Lysogenic	Lamb-da phage	Not deadly in itself, but can start lytic phase	Binds to surface, injects DNA, forms circle, inserts itself (prophage) into host chromosome prophage makes prepressor protein which turns off other prophage genes, prophage passed on ti daughter cells, under proper conditions, genes activated and cell goes lytic.	longer

Lytic



Lysogenic





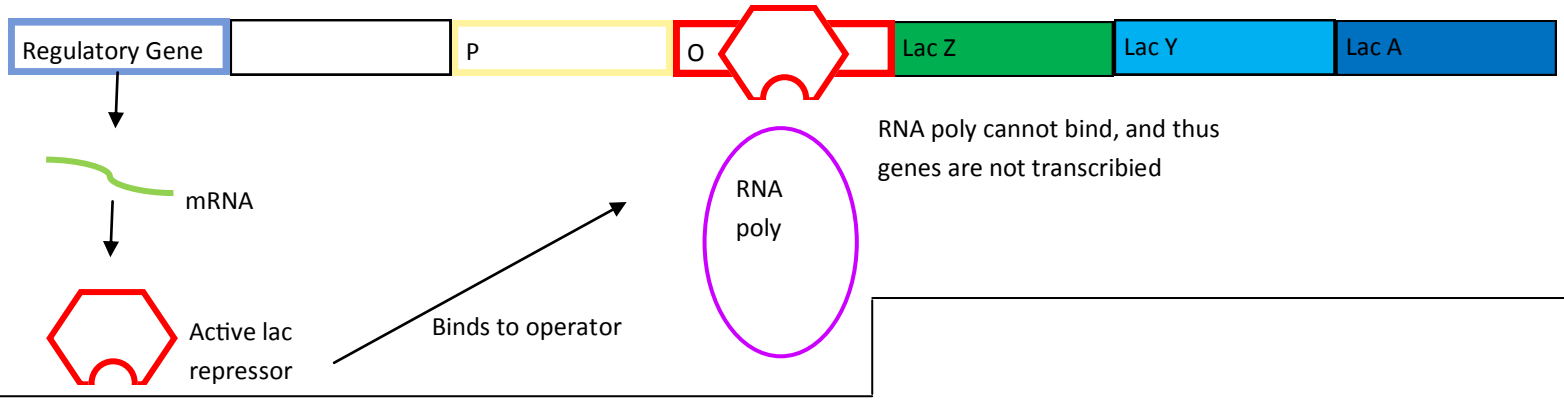
One strand of DNA will turn clockwise as it enters F– cell, the other will turn counter clockwise. Only half of F plasmid transferred from HFR cell, 3' end always enters first.

Transformation	Takes up DNA from surroundings via surface receptor	Ex: Giffiths S and R strains of Streptococcus	Only works for closely related species	Combined via crossing over
Transduction	Transfer of DNA via bacteriophage that accidentally got bact DNA instead of viral DNA			"
Conjugation	Direct transfer of DNA through sex pilus (formed by gene on F plasmid, cytoplasmic bridge)	F (or R resistance) plasmid	Only works between F- and F+ varieties	Recombination between recipient F– cell and HFR fragment

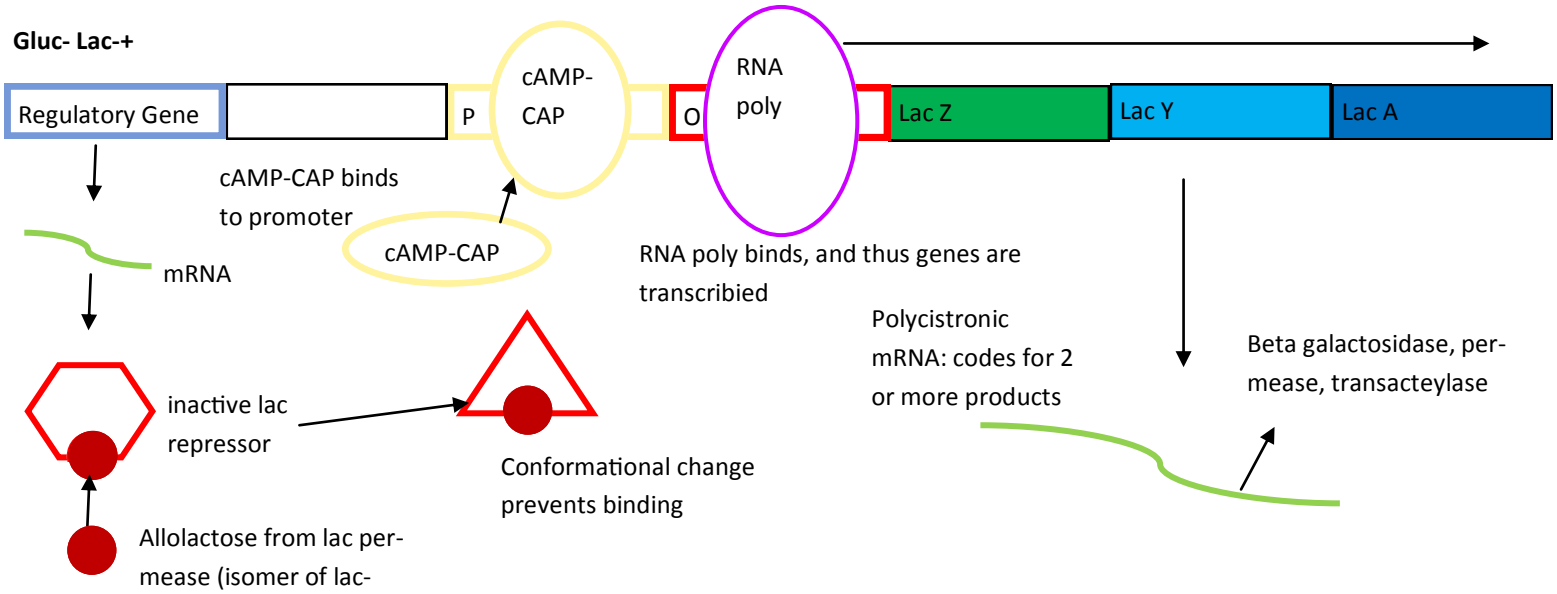
Increase in lac	Beta galactosidase up	Lactose permease up	No effect on cAMP	w/ increase in cAMP-CAP turns on gene	w/ cAMP conf. change in LAC repressor
Increase in gluc	Low beta galacto-sidase	Low lactose per-mease	Decrease in cAMP and cAMP-CAP (no expres-sion)	w/o cAMP-CAP Lac re-pressor binds and turns off	

Lac operon (inducible)

Gluc+ Lac-

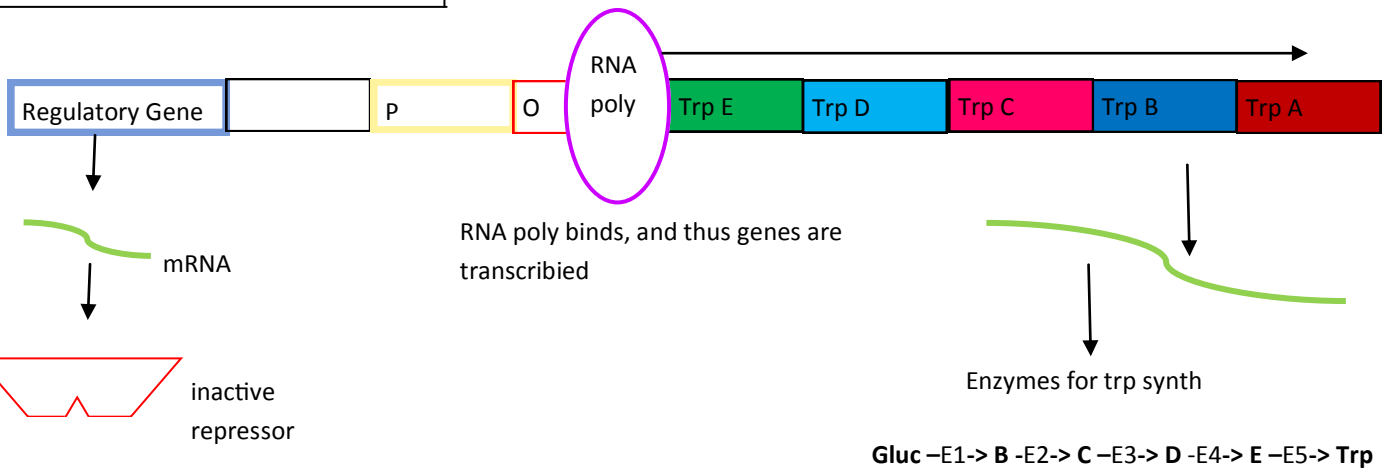


Gluc- Lac-+

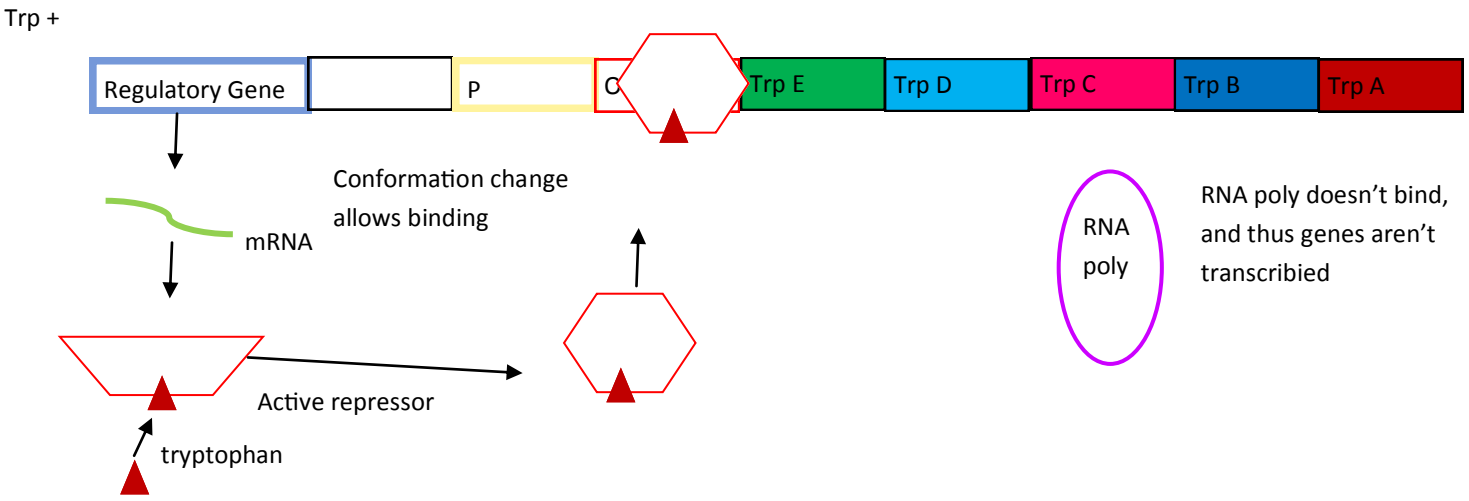


Trp operon (repressible):

Trp -



Gluc –E1-> **B** -E2-> **C** –E3-> **D** -E4-> **E** –E5-> **Trp**



Proteins common to all euk cells:

- Structural prot of chormosomes (histones)
- RNA poly
- Cytoskeleton
- Cell Resp. enzymes
- DNA repair enzymes

EuK gene reg before scription:

- Hist acetylation
- Hist methylation
- DNA methylation

Genomic Breakdown

- 20-30% expressed
- 44% repetitive elements (like transposons)
- 1.5% exons
- 5% introns
- 20% regulatory seq
- 15% unique noncoding DNA
- 14% repetitive DNA unrelated to transposons
- 10% Alu elements: similar to srpRNA, likely added to genome by retrotransposon

Stages of DNA folding

- 10nm
- 30nm
- 300nm
- 700nm
- 1400nm

EuK gene reg after scription:

- Processing (splicing)
- Delay export (nuc to cyt)
- Delay localizatio once in cyt (3' UTR)
- T1/2: remover/ shorten poly A tail and 5' cap, proteins bind to 3' UTR to remove cap, or degrade mRNA

Regulation at level of slation:

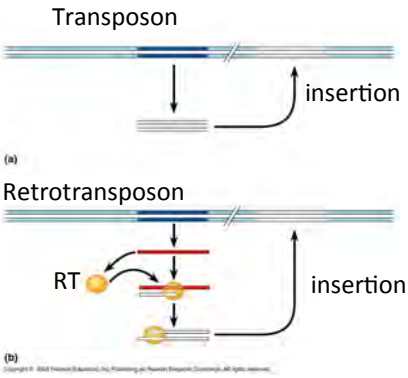
- Prevent ribosome from binding to 5' UTR
- Add Pi to inactivate init factors and prevent init complex from forming

Histone acetylation	reversible	Loosens histones	Any AA
Histone methylation	Can be passed on to progeny	Mostly represses transcription, can activate it	H3K27, some arg & H3K4 (activation)
DNA methylation	Permanent, always inherited	Always repressive	

Area in DNA seq	**TF**	**Fun Facts**	**Location**
Promoter	Gen TF	Steroid receptor complexes can act as TF, phosphorylation cas-	Right before gene seq
Enhancer	Specific activators/ repressors	Sim to operons, made of control elements, can help assemble init. Complex, can cover binding site for sctivator, can mask activation surface of activator, can bind to TF to push enhancer away, can recruit acetylases	Far away
Silencer	repressors	Sim to operons, made of control elements,	Far away

Transposon	Cut paste	Codes for integrase and transposase	No change in copy #	After it's been replicated, transposase cuts out transposon, integrase inserts it somewhere else in the transposon elsewhere
Retrotransposon/ Long inverted terminal repeats (viral)	Copy paste	Codes for reverse transcriptase	Increase in copy #	Reverse transcriptase enzyme made in the cytosol, RT goes into nuc, transcribes RT mRNA into ds DNA retrotransposon, integrase (made by cell) inserts

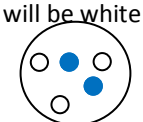
miRNA	**siRNA**
Pri-miRNA —Droasha—> pre-miRNA **In Nuc**	
In cyt Pre-miRNA —Dicer—> ds miRNA —binds Argonaute—> RISC RISC = RNA Inducing Silencing Complex (ss miRNA+ Argonaute), RNA binds to 3' UTR, Argonaute degraades	In cyt Ds RNA —Dicer—> ds siRNA —binds Argonaute—> RISC RISC = RNA Inducing Silencing Complex (ss siRNA+ Argonaute) RNA binds to 3' UTR, Argonaute degraades



Post-slational controls:

- Phosphorylation
- Change quarternary struct
- Enzymatic cleavage (zymogen)
- Change cofactors
- Tag w/ ubiquitin
- Cleave peptide bonds

cDNA Library	**Genomic Library**
1. **Starting Mats:** plasmid with Lac Z gene containing multiple coupling site, and AmpR gene (resistance to ampicillin), and human RNA from tissue specific cell (ie for insulin, need pancreatic cell) 2. **Process for Obtaining tissue specific DNA:** obtain RNA w/ poly A tail from cell 3. Add poly G/C string to the 5' end of RNA with T4 ligase 4. Create poly T DNA primer, and use reverse transcriptase to create complementary DNA 5. Increase PH to destroy RNA (not DNA) and increase heat to denature RT 6. Treat gene with EcoR1 methylase to methylate EcoR1 (or other enzyme) binding site within gene 7. Add linkers (ds DNA w/ blunt end) containing binding site for enzyme to poly A/T side and to poly C/G side. Now EcoR1 will selectively cut out gene 8. Treat with EcoR1 to cut out gene 9. Start with step 2 for genomic libraries. cDNA libraries can be used to actually produce protiens for human use from bacteria. Genomic libraries cannot, because the DNA used has introns, which the bacteria cannot remove.	1. **Starting Materials:** plasmid with Lac Z gene containing multiple coupling site, and AmpR gene (resistance to ampicillin), and human DNA from any cell 2. **Process:** Cut both with same restriction enzyme so sticky ends will be complementary (ie, EcoR1) 3. Mix two together 4. DNA ligase will seal sticky ends. This includes sticky ends of plasmid to itself (no insert) and sticky ends of insert to plasmid (what you want) creating two classes of plasmid. Source DNA can also anneal to itself, but these pieces won't have an effect 5. Mix solution with culture of E. coli (don't have ampR gene initially), and let transformation occur 6. 3 classes of bacteria created: bacteria with out any recombinant plasmid (no transformation, majority in this class), bacteria with recombinant DNA but no insert, and bacteria with recombinant DNA and insert. 7. Plate on selective media with ampicillin and x-gal (sim to lactose, turns blue when processed by beta galactosidase 8. Amp kills non transformed bacteria, bacteria without insert (with intact Lac Z gene) will be blue, and those with intert (what we want, interucpted lac Z gene) will be white 9. Every white colony has different human gene 10. Replica plate white colonies, lyse cell, bake, Wash with radio active probe complementary to gene you want. The spots that develop on the film can be mass produced



	Cnidarians	Platyhelminthes	Annelid	Mollusca
How eat	GVC	GVC	Complete GI tract	Complete GI tract
Nitrogenous waste	NH3	NH3, osmoconformers, polynephridia filter interstitial fluid	Urea/uric acid on land, Meta-nephridia , osmoconformer	NH3/uric acid, nephridia
Reproduction	Asexual & Sexual, monoecious or dioescious	Asexual & Sexual, monoescious	Asexual & Sexual, monoescious (polychaete dioescious)	Mostly Sexual, dioecious (gastropada monoescous)
Respiration	Body surface	Body surface	Body surface (earthworm) , polychaete (featherduster) breath through feathery structures	Ctenidia, (land snail uses mantle cavatiy)
Circulation	N/A	N/A	Closed, respiratory pigment hemoglobin	Open, Cephalopods closed, respiratory pigment hemocyanin
Digestion	Gastrovascular Cavity	GVC	complete GI	Complete GI
Cephalization	N/A	Select species	yes	Yes
Nervous system	Nerve net	Nerve ladder	Ganglia and ventral nerve cord	Cephalopods have highly developed nervous system (axon 1 mm thick)
Skeletal	GVC fluid hydrolic	hydrolic	hydrolic	Exoskeleton
How move	Medusa form move	muscles	Muscles in body wall	Scallops move with adductor muscle, others move with foot

	Gastropod	Bivalve	Cephalopod	Polyplacophore
Mantle	yes	yes	Yes	yes
Radula	yes	no	yes	yes
Foot	yes	yes	Foot —> head	Yes
Ctenidia	Not land snail	yes	yes	Yes
Shell	0/1	2	0/1	8

	Germ Layers	Tissues	Ceolom	Digestive opening
Cnideria	2 (ecto/ endoderm)	2 (gastric and epithelial)	N/A	1
Platyhelminthes	3 (+mesoderm)	4	Aceolmate	1
Annelids	3	4	Ceolomate	2
Mollusca	3	4	Ceolomate	2

Chordata:

- Pharyngeal gill clefts
- Notochord (underlies nerve cord)
- Single, hollow dorsal nerve cord
- Presence of a post anal tail

Blood flow:

- Right atrium
- Right ventricle
- Pulmonary arteries
- Pulmonary capillaries
- Pulmonary veins
- Left Atrium
- Left Ventricle
- Systemic arteries
- Systemic capillaries
- Systemic veins
- Right atrium

Firsts in development

- First true tissues: **Eumetazoa** (porifera doesnt have them)
- 3 germ layer: **Bilateria** (radiate has 2)
- Cephalization: platyhelminthes
- Acoelomate: Platyhelminthes (turbellaria)
- Ceolom (first studied): annelida
- First (studied) GI tract: annelid
- First (studied) close circulatory system: annelida

Populations:

- Porifera: 6,000
- Cnidarian: 10,000
- Platyhelminthes: 20,000
- Annelida: 15,000
- Mollusca: 100,000
- Echinodermata: 7,000
- Arthropoda: millions

Mesoderm:

- Notochord
- Skeletal system
- Muscular system
- Excretory system
- Circulatory system
- Lymphatic system
- Reproductive system

Ectoderm:

- Skin
- Nervous system
- Sensory receptors

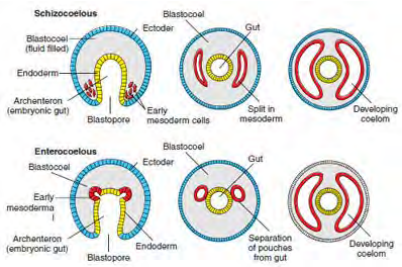
Endoderm:

- Epithelial lining of digestive and respiratory tract
- Liver pancreas and thymus
- Lining of excretory and reproductive system

Meroblastic: chicken
Holoblastic: urchins, frogs, sand dollars

	Cnidaria	Platyhelminthes	Annelid	Mollusca	Chordata	Echinodermata	Arthropoda	Arthropoda
	Hydra	Planaria	Earthworm (Oligochaeta)	Clam (Bivalvia)	Rat (rattus)	Starfish (asteroidean)	Cockroach (hexapoda)	Crayfish (crustacea)
Skeleton	hydrolicl	hydrolic	hydrolic	Shell created by mantle	Endoskeleton (CaPi)	Endoskeleton: protein and Ca salts	Chitin exoskeleton	Chitin and CaCO3 salt
Kidney/ Fluid		Protonephridia, Filters interstitial fluid	Metapnephridia/ hemoglobin	Nephridia, hemocyanin	Kidney, hemoglobin	Osmoconformer, hepatic caeca, release NH3 through skin	Malpighian tubes (uric acid) hemolymph	Green gland (NH3), hemocyanin
Storage			Glycogen & fat		Fat, glycogen in liver	Hepatic caeca (fat/ glycogen)	fat	Gastrolith for Ca
Crop	GVC	GVC	crop	stomach	stomach	Cardiac/pyloric stomach	crop	Cardiac/ pyloric stomach
Gizzard	GVC	GVC	gizzard	Radula/ stomach	Teeth/ stomach	Sea urchins have teeth	Gizzard	Gastric mill
Digestive Gland	Gland and nutritive muscle cell	Gastrodermis	intestine	Digestive gland	Pancreas/ salivary gland	Hepatic caeca/ cardiac stomach	Digestive caeca	Digestive gland
Main Absorbtion	Gastrodermis "	gastrodermis	intestine	Digestive gland	Small intestine	"	midgut	Digestive gland
Lungs	Body surface	Body surface	Body surface	ctenidia	lungs	Dermal papillae	tracheoles	gills
Circulation	GVC	GVC	Pseudoheart, closed	Heart, open (except ceph)	Heart, closed	Water vascular system, open	Dorsal vessel, open	Heart & Ostia, open
Nervous	Nerve net	Nerve ladder	Ganglia & ventral nerve cord	Cephalopods developed nervous system	Brain	Ventral nerve cord	Ventral nerve cord	Starburst shaped

	Protostome	Deuterostome
Cleavage	Spiral (diagonal division)	Radial (half division)
	Determinate (no twins)	Indeterminate (twins)
Ceolom Formation	Schizocoelus: Coelom formed by splitting the mesodermal tissue	Enterocoelus: ceolome is pinched off the mesoderm



Dates:

- 14 bill ya: universe formed
- 5 bill ya: formation of earth
- 4 bya: first life
- 1 bya: split with fungi
- 800 mya: first animals
- 550 mya: chordates
- 530 mya: Cambrian explosion
- 200 mya: mammals

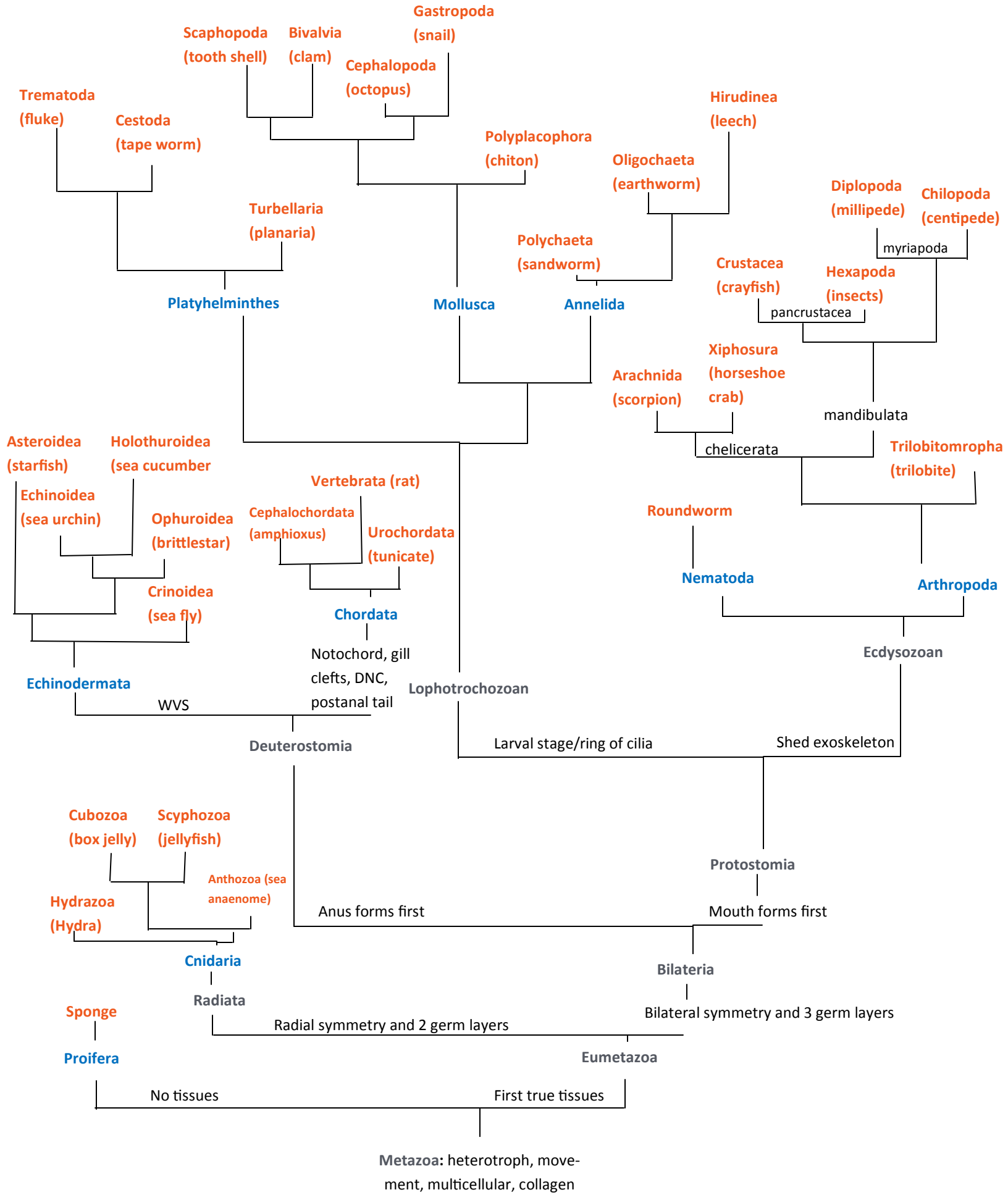
Extraembryonic Membranes

- Chorion membrane: surrounds everything
- Yolk sac: surrounds yolk, helps uptake nutrients
- Allantoic membrane: buds off midgut, stores nitrogenous waste, eventually fuses with chorion
- Amniotic membrane: immediately surrounds embryo, cushions and prevents dessication

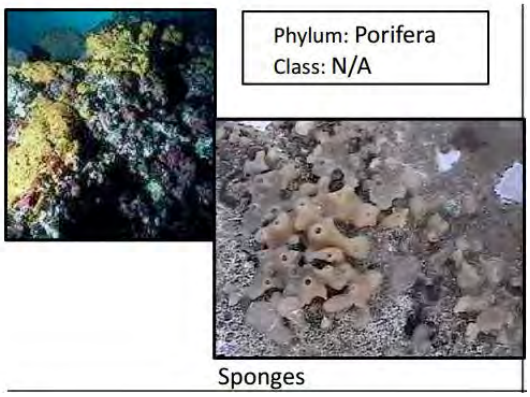
Orientation:

- Ew: **Ventral** nerve cord
- Clam: **anterior** short end/foot
- Chick: notochord **dorsal**
- Fly tracheoles: **dorsal**

Monoescious	Cnidarian (lab hydra)	Annelida (ew)	Platyhelminthes	Gastropod			
Dioescious		Ploychaeta		Mollusca clam	Urchin, starfish	crayfish	roach
Asexual	Cnidarian (hydra)	Annelida	platyhelminthes				


Gastropoda (snail)
Scaphopoda (tooth shell)
Bivalvia (clam)
Cephalopoda (octopus)
Trematoda (fluke)
Cestoda (tape worm)
Hirudinea (leech)
Polyplacophora (chiton)
Oligochaeta (earthworm)
Diplopoda (millipede)
Chilopoda (centipede)
myriapoda
Turbellaria (planaria)
Polychaeta (sandworm)
Crustacea (crayfish)
Hexapoda (insects)
pancrustacea
Platyhelminthes
Mollusca
Annelida
Xiphosura (horseshoe crab)
Arachnida (scorpion)
mandibulata
chelicerata
Asteroidea (starfish)
Holothuroidea (sea cucumber
Trilobitomropha (trilobite)
Vertebrata (rat)
Echinoidea (sea urchin)
Cephalochordata (amphioxus)
Ophuroidea (brittlestar)
Urochordata (tunicate)
Roundworm
Crinoidea (sea fly)
Nematoda
Arthropoda
Chordata
Notochord, gill clefts, DNC, postanal tail
Ecdysozoan
Echinodermata
Lophotrochozoan
WVS
Deuterostomia
Larval stage/ring of cilia
Shed exoskeleton
Cubozoa (box jelly)
Scyphozoa (jellyfish)
Protostomia
Anthozoa (sea anaenome)
Hydrazoa (Hydra)
Anus forms first
Mouth forms first
Cnidaria
Bilateria
Radiata
Sponge
Bilateral symmetry and 3 germ layers
Radial symmetry and 2 germ layers
Proifera
Eumetazoa
No tissues
First true tissues
Metazoa: heterotroph, move-ment, multicellular, collagen

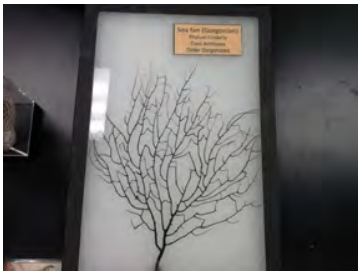
Porifera

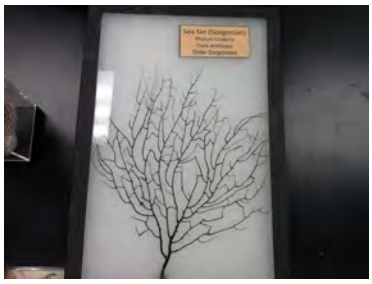


Fun facts:

- Suspension feeders
- Choanocytes contain flagella that beat water into the cavity, and out another opening
- Food ingested by phago-cytosis
- Ameobocytes move food and produce skeleton

Cnidaria

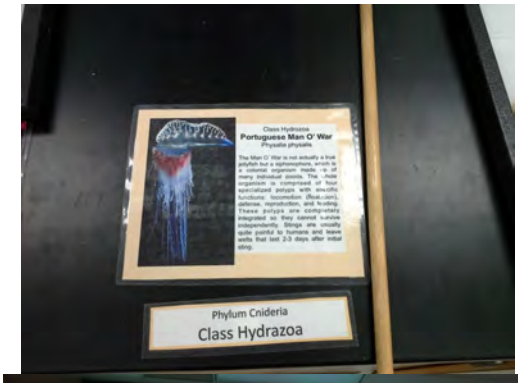


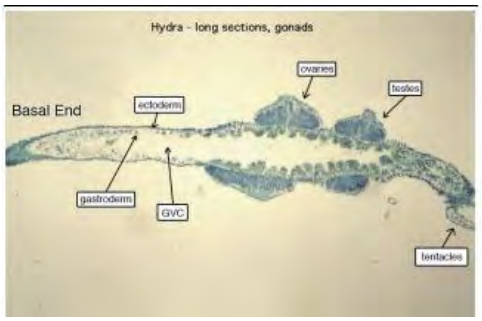


Cnidarian: Anthozoa: Corals and anenomes.

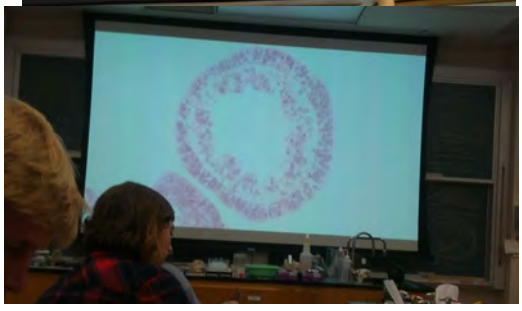
Cnidaria facts

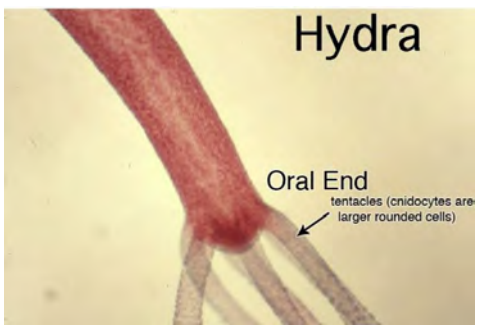
- all have radial symmetry.
- Two body plans: polyp (sessile) and medusa (mobile).
- Flagella beat food into GVC, where proteases di-gestepidermis (ectoderm), mesoglea, gastrodermis (endoderm)
- Cnidocytes sting with nematocysts
- Nerve net, but no cephalization
- Coral have symbiotic relationship with zooxanthellae

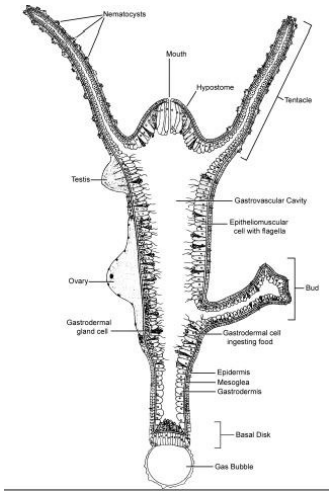




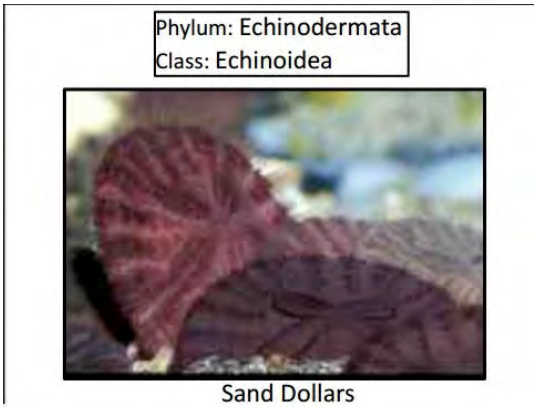
Cnidarian: Hydrozoa: hydras and Portuguese Man o' War. Reproduce asexually by budding.





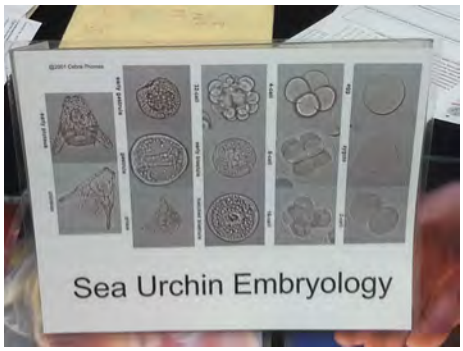


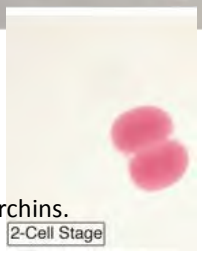
Echinodermata



Sand Dollars

Sea Urchins



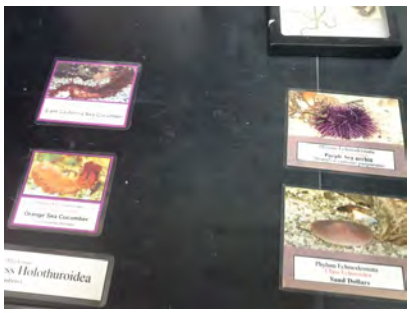


Echinodermata: Echinoidea: sand sollars and sea urchins.

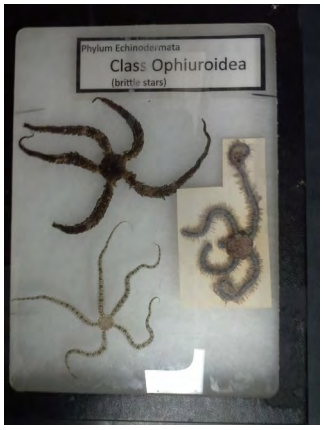
Fast/Slow block formation:

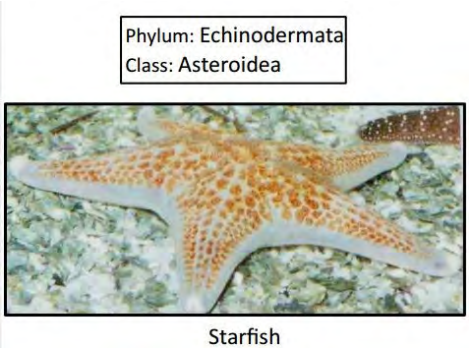
- Fast addition of Na+ -> rapid depolarization. This is the fast block. It only lasts a couple of minutes
- Sperm hydrolyze jelly coat. Calcium increase triggers the slow block. Vesicular contents are released into the perivitelline space, which creates space between the egg cell membrane and the vitelline membrane. Enzymes harden the vitelline membrane and it becomes the fertillization membrane

Sea Cucumbers

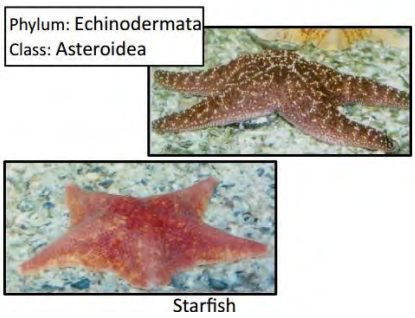


Echinodermata: Crinoidea —> Holothuroidea & Echinoidea <—



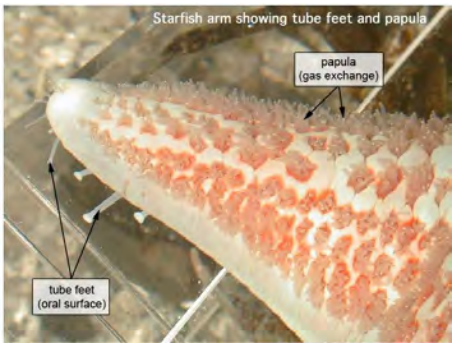


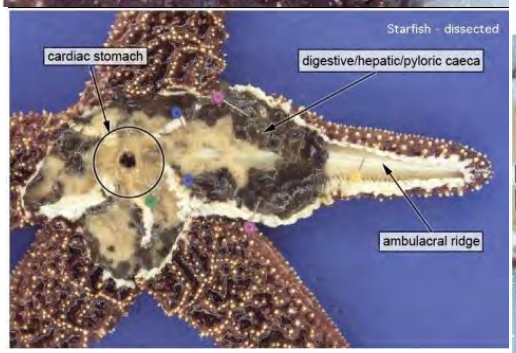
Starfish

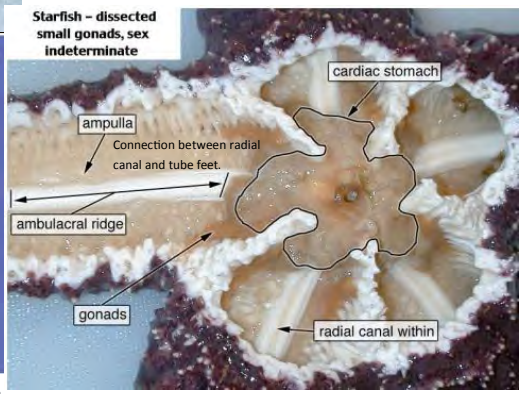


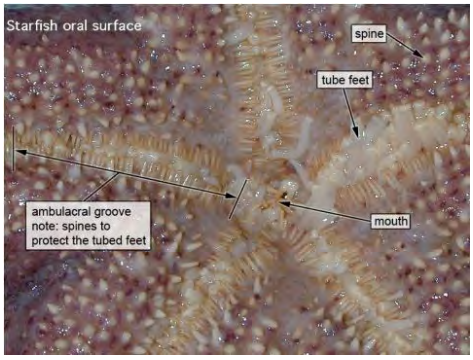
Echinodermata Fun Facts:

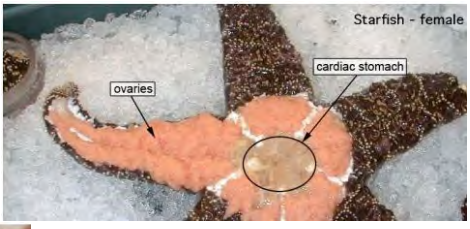
- bilateral symmetry in larva,
- Asexual reproduction via regeneration
- Water vascular system unique to phylum, ampullae contract as water is brought to them, which causes the stretching of tube feet

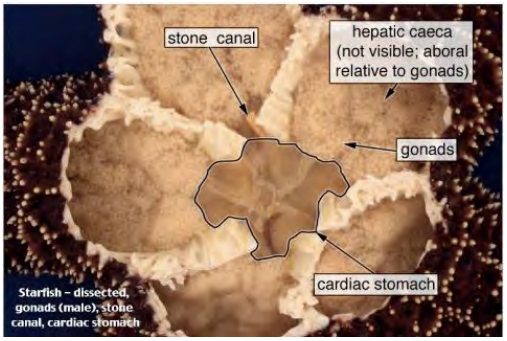


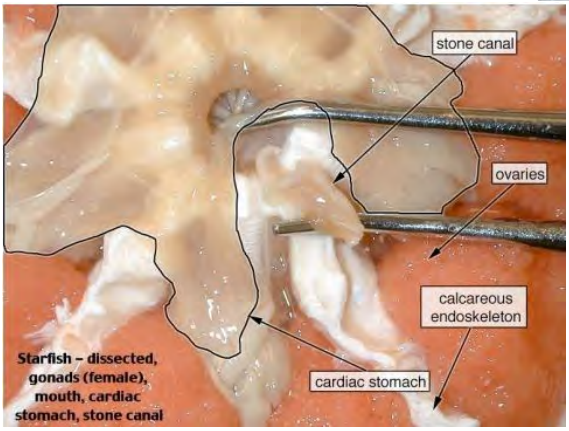


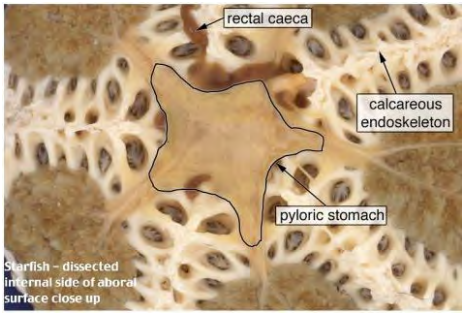


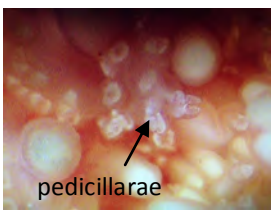


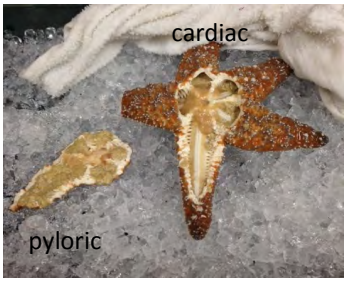


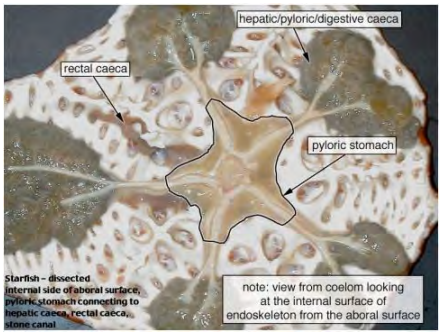


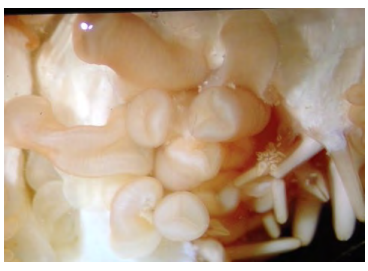








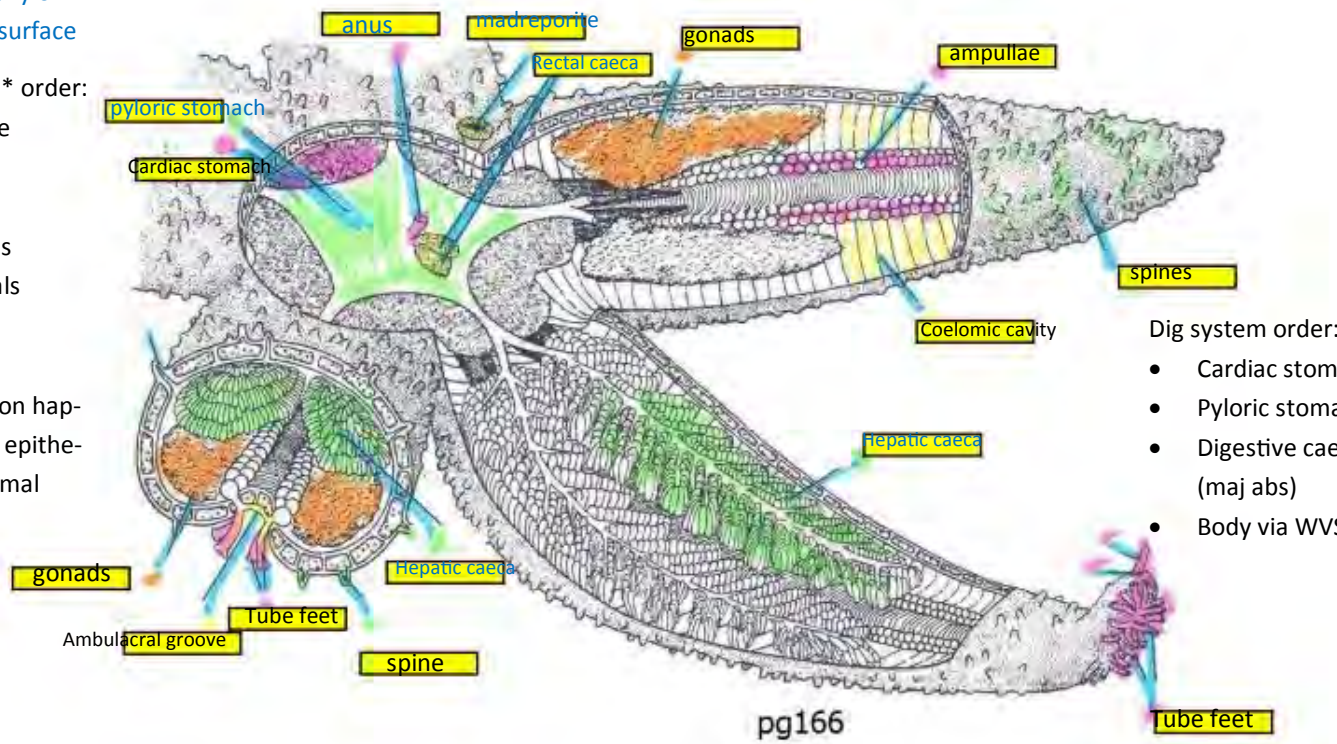




*normally on aboral surface

WVS (Circ/Resp)* order:

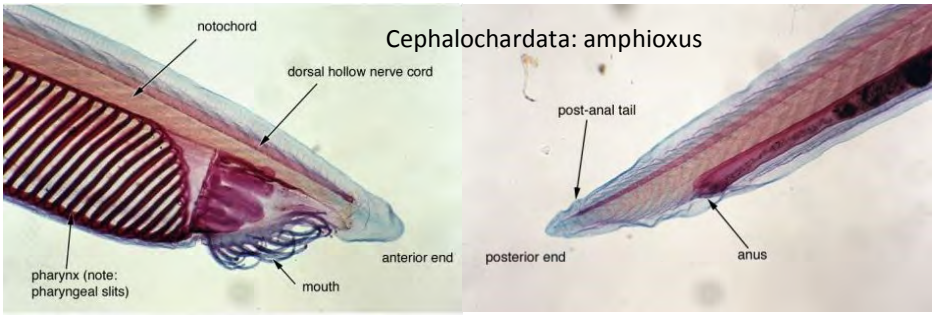
- Madreporite
- Stone canal
- Ring canal
- Radial canals
- Lateral canals
- Ampulla
- Tube feet
- *Gas diffusion happens across epithelium via dermal brachiae



Dig system order:

- Cardiac stomach
- Pyloric stomach
- Digestive caeca (maj abs)
- Body via WVS

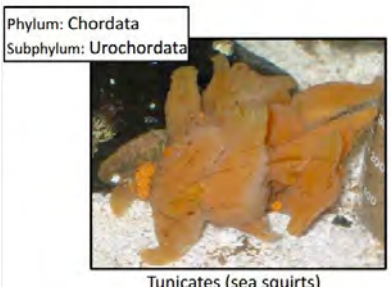
Chordata



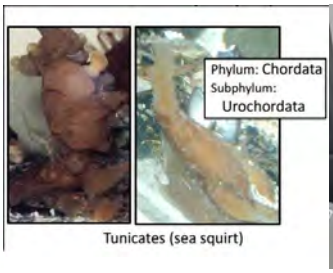
Chordata: cephalochatdata: amphioxus

Chordate features:

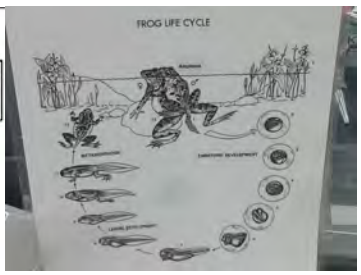
- Notochord
- Gill clefts
- Post anal tail
- Dorsal nerve cord



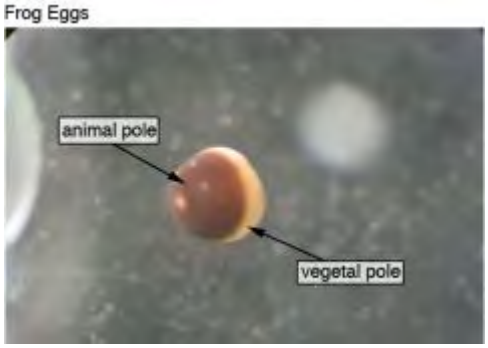
Tunicates (sea squirts)



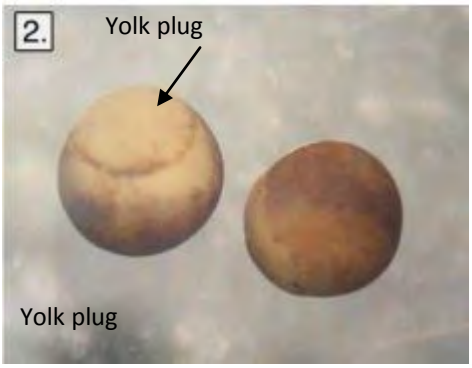
Tunicates (sea squirt)

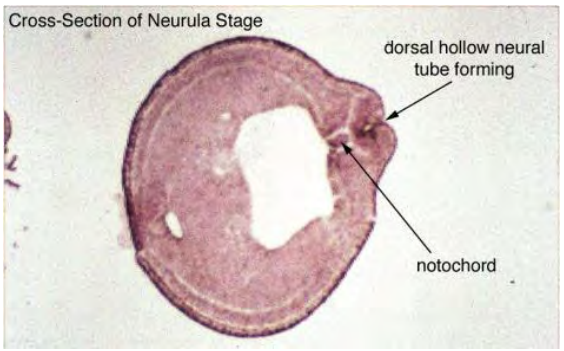


Frog Eggs



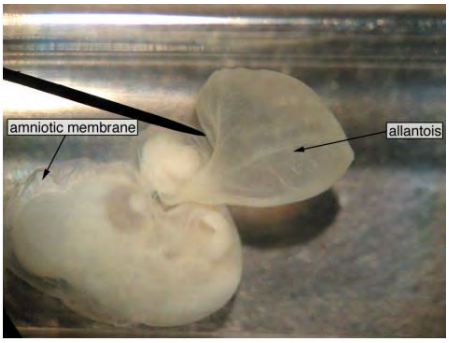

(8 cell) note: unequal cell sizes, holoblastic cleavage

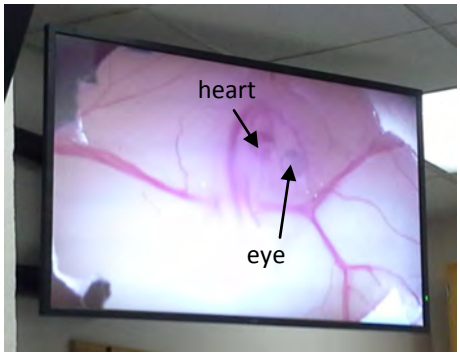


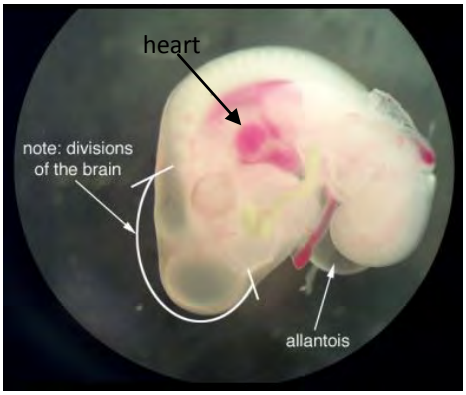


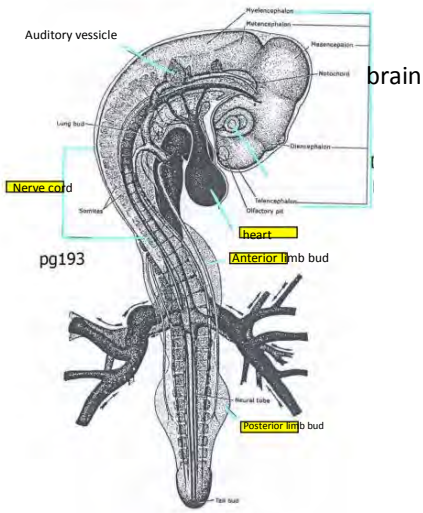
Frog, xenopus laevis, Facts:

- Ovum –. 2 cell -> 4 cell -> 8 cell -> merula -> blastula (blastocoel inside) -> gastrula (formation of yolk plug, blastopore and archenteron) -> nerula (form neural plate and notochord)
- Vegetal pole lighter in color, with bigger cells



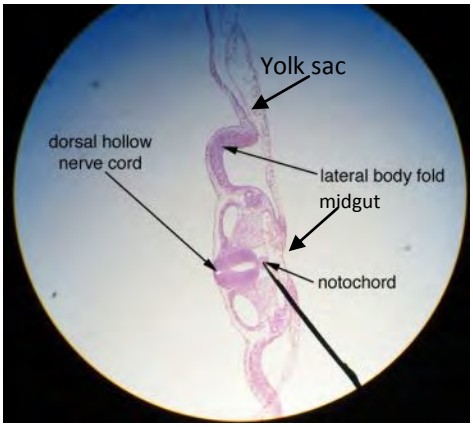


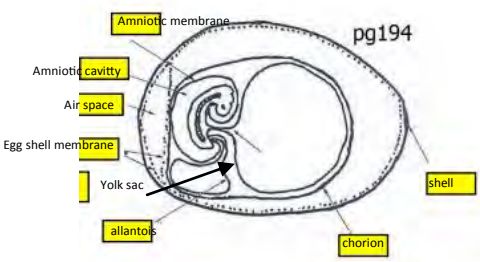


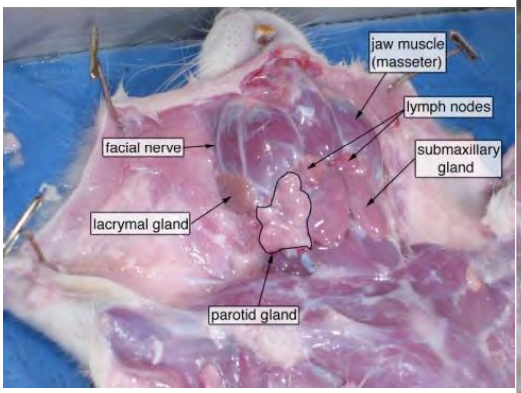


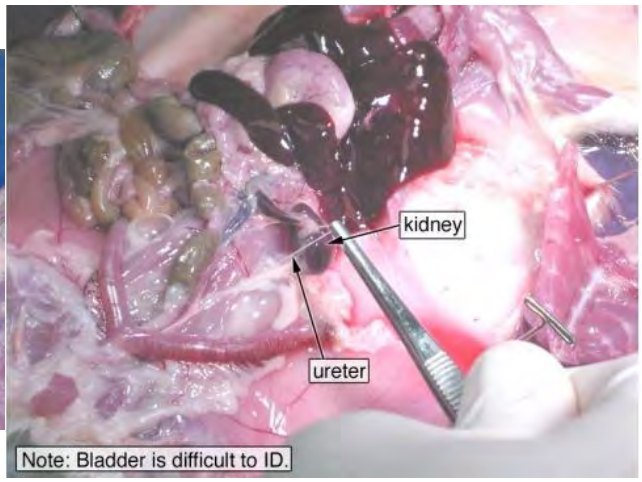
Chicken Fun Facts:

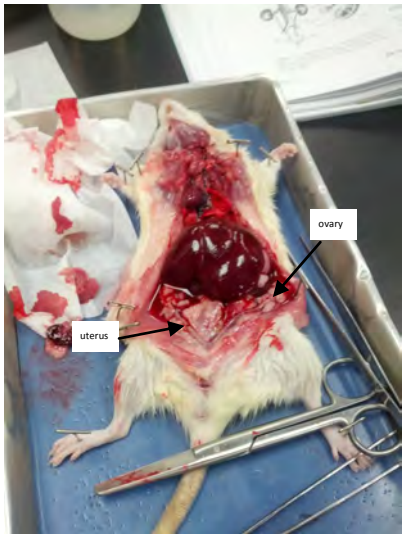
- Meroblastic cleavage (large yolk)
- Allantois stores uric acid

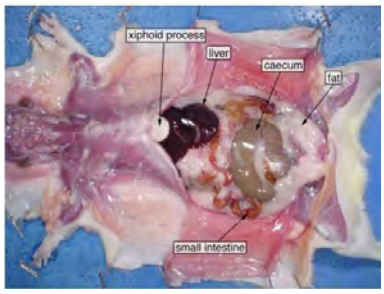


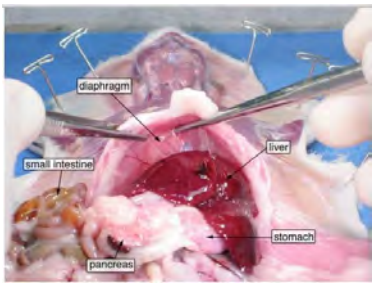


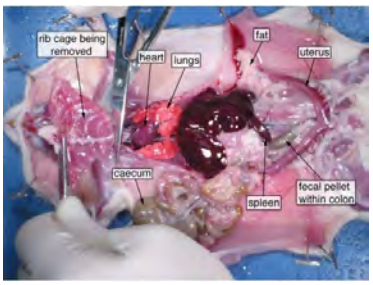


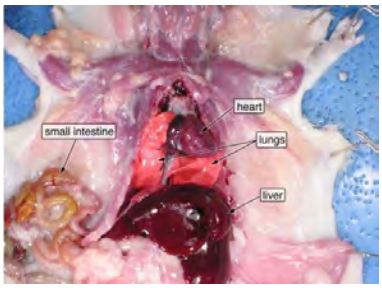


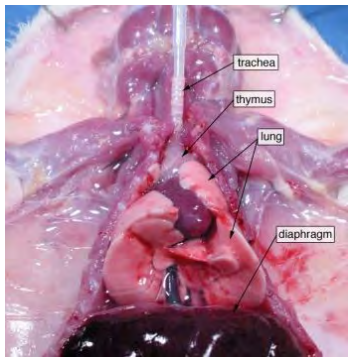


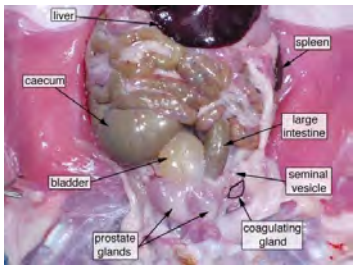


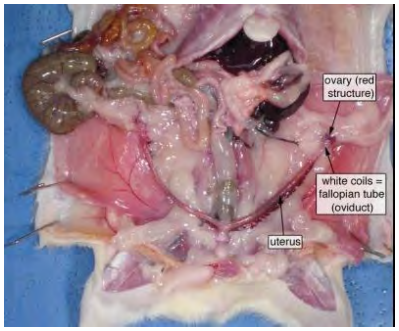


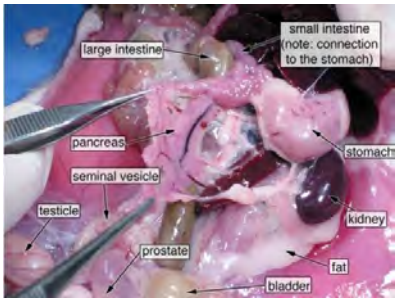


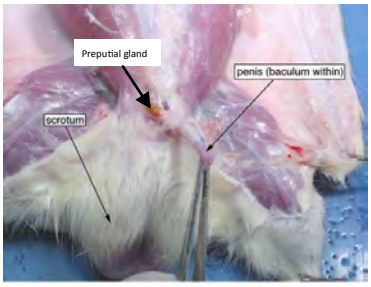


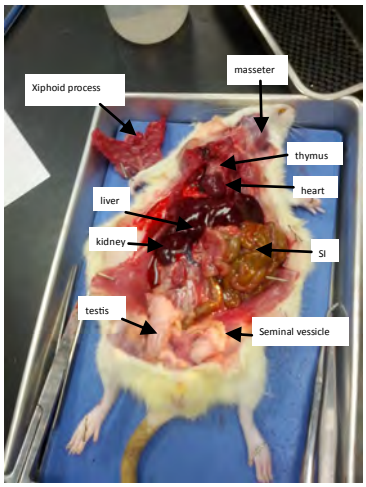


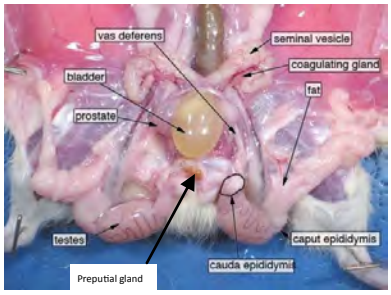


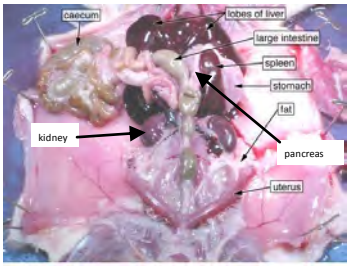


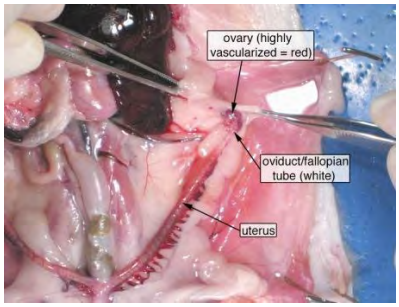


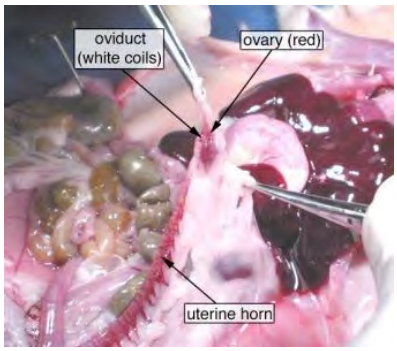












Lymphatic Order:

- Lymph vessels return interstitial fluid to circ system
- Spleen filters blood (w/ lympho and phago cytes), destroys/ stress RBC

Excretory Order:

- Blood enters via renal artery at medial de-pression
- Nephrons (form urine)
- Ureter
- Bladder
- urethra

Resp Order:

- Larynx,
- laryngopharynx,
- Trachea
- lungs

Dig Order:

- Pharynx (liquid from parotid ducts)
- Esophagus
- Stomch (HCl)
- Pyloric sphincter
- Duodenum (liver/ pan-creas-dig enzymes and bicarbonate)
- Jejenum
- Ileum
- Caecum (breakdown cellulose)
- Large intestine
- Rectum
- anus

Rep Order M:

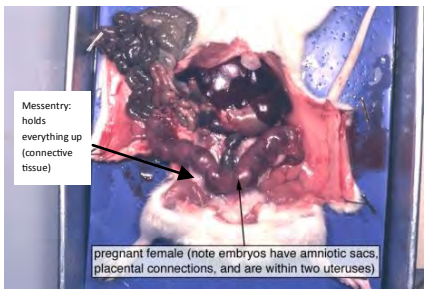
- Spermatagonia (2N 2C)
- Primary spermatocyte (2N 4C)
- Secondary " (1N 2C)
- Spermatid (1N 1C)
- Spermatazoa (1N 1C)
- Caput epididymis
- Cauda epididymis
- Vas deferens
- Ejaculatory duct
- Urethra
- Through follicular cells to ovum, or stopped by zona polusida

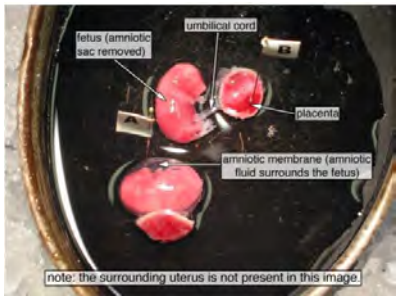
Glands

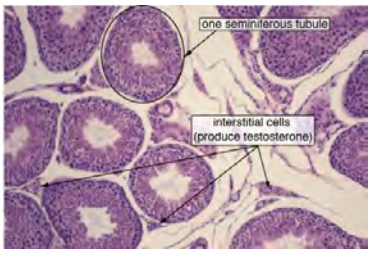
- Coagulating: copulatory plug
- Seminal vesicle: fructose to in-crease motility and viability
- Prostate: most of the fluid in semen
- Preputial gland: lubrication

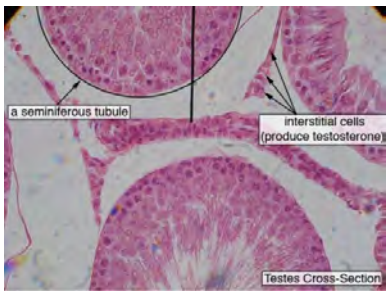
Rep Order F:

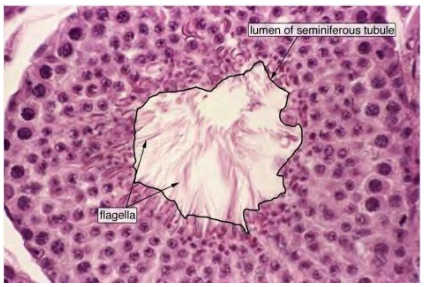
- Oogonium (2N 2C)
- Primary oocyte + polar body (2N 4C), growing follicle
- Secondary oocyte + polar body (1N 2C- released during human ovulation), mature follicle
- Ootid (in rats) 1N 1C
- Ovum (1N 1C), corpus lutenum
- Ovary
- Fallopian tube/ oviduct
- Uterus

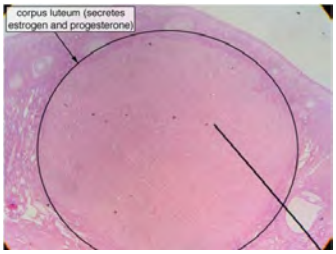


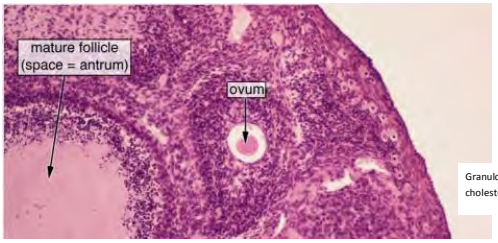










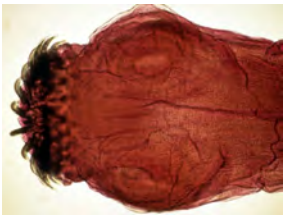


Fun Facts:

- Growing follicle is a couple cell layers think, immature is only one
- Sertoli cells: make barrier between blood and sperm, and convert testosterone -> DHT
- rats have esterous (as opposed to menstral) cycle, females are only receptive to mating at certain times
- F: thecal cells: testosterone -> estrogen

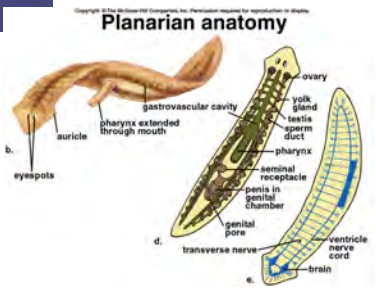
Platyhelminthes:

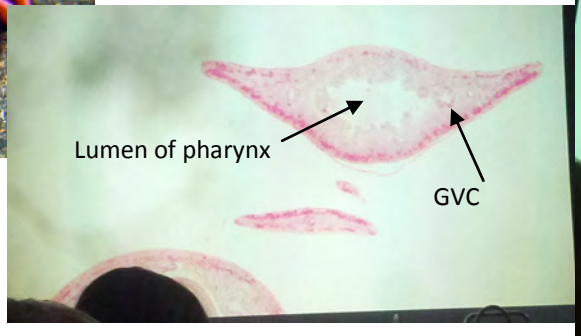
Trematoda (fluke) parasidic ->

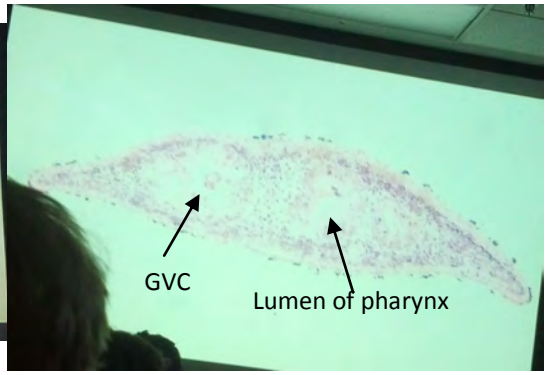


Tapeworms consist of proglittis and scolex (head), no GVC

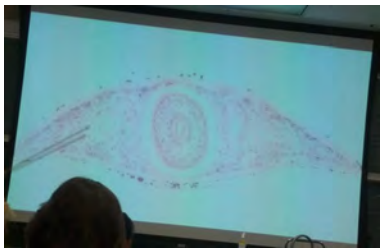
cestoda (tapeworm) parasidic

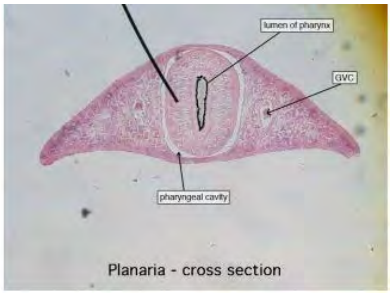


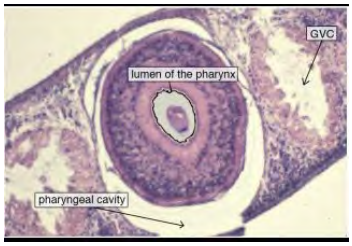




Tubellaria: free living scavengers, imitated by nudibranchs, brightly colored but not poisonous. Asexual reproduction via regeneration





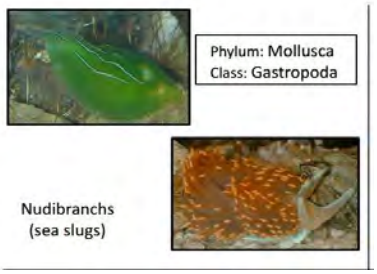


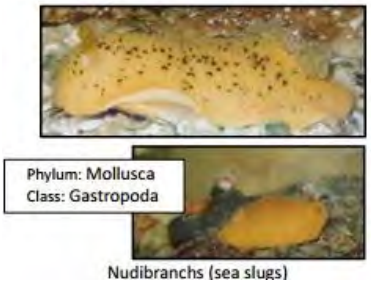
Platyhelminthes fun facts:

- Acoelomate
- Cephalized
- Contain protonephrdia with flame cells for gas exchange

Mollusca

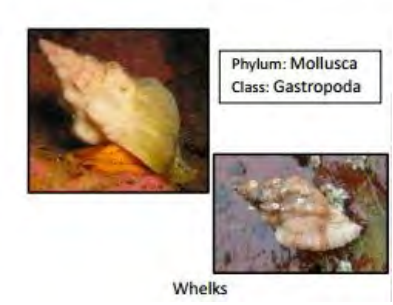
Scaphopoda: tooth shell

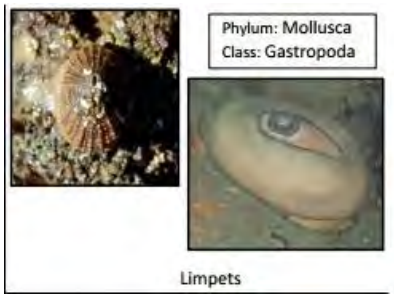


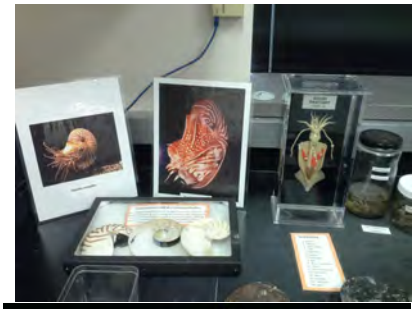


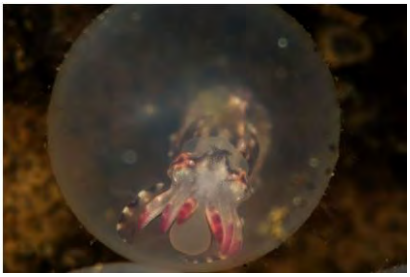
Gastropoda Fun Facts:

- Limpets, snails, nudi-branchs, abalone
- Some are shell-less
- Land snails produce uric acid and don't have ctenidia







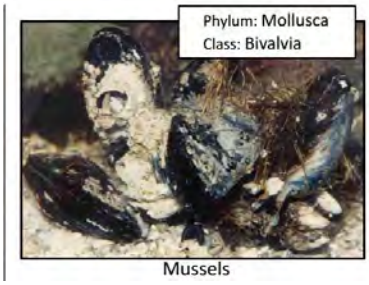


Cephalopod Fun Facts:

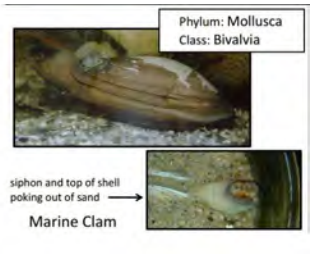
- Foot in head region
- Nautili have shells and don't ink
- Some don't have shells

Chiton (Polyplacophora) Fun Facts:

- 8 shells, but some-times hidden
- Eat algae

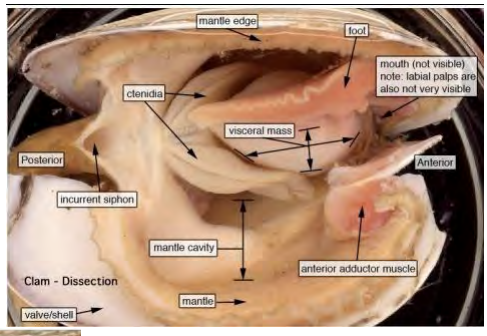


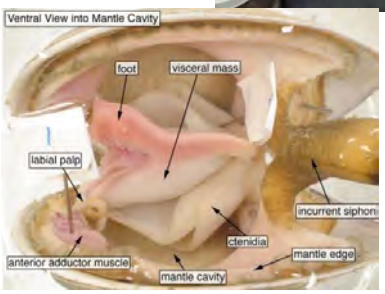
Mussels



Marine Clam

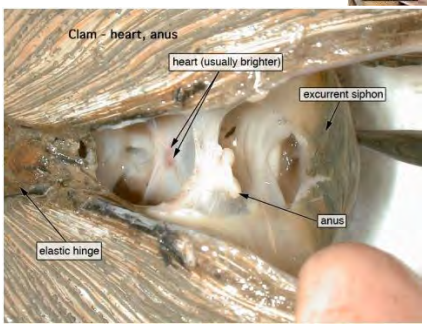
Scallop

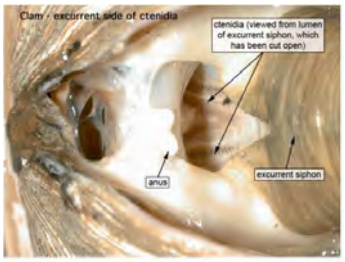


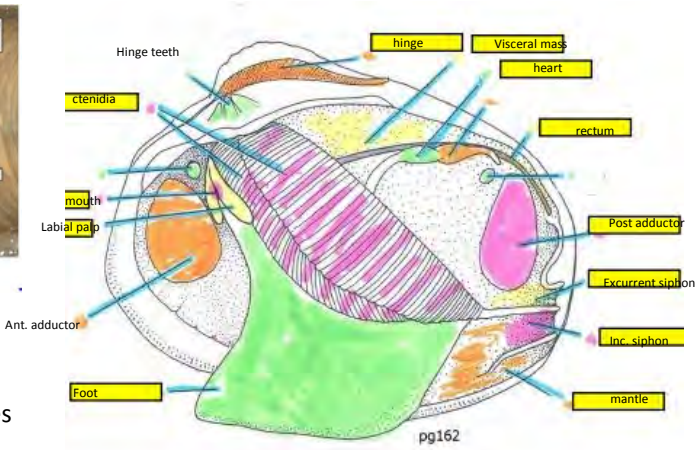


Bivalve Fun Facts:

- Have no radula
- 2 shells
- Filter feeders
- Most hemocyanin,, some hemoglobin







Digestive Order:

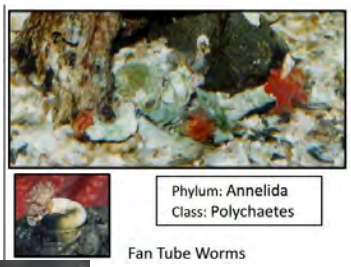
- Ctenidia pull in water/ food through incurrent siphon
- (water goes out excurrent sipho-ne) Food goes through mouth and labial palps
- Esophagus stomach, dig glands
- Intestine, anus, excurrent siphon
- Visceral mass houses nephridia for excretion

Circulatory Order:

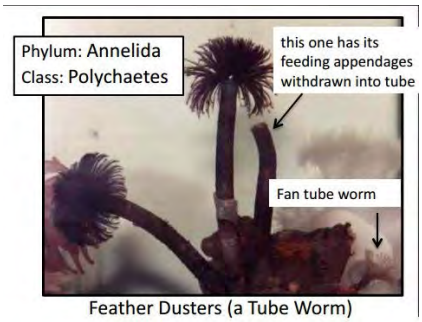
- Open, w/ lymphocytes
- Aorta, into various sinuses
- Ctenidia (gas exchange)
- Sinuses again

Repro: dioescious, gametes exit excurrent siphon

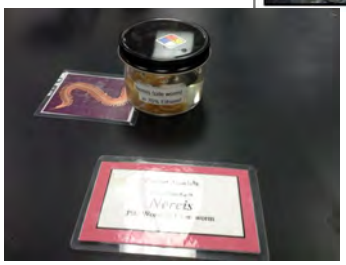
Annelida



Fan Tube Worms



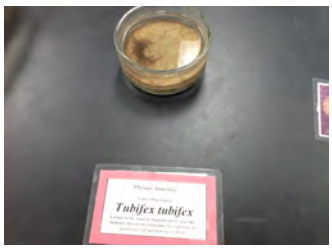
Feather Dusters (a Tube Worm)



Polychaeta:

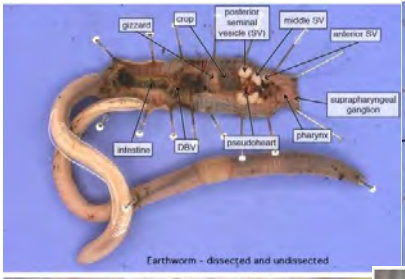
- Marine
- Feather dusters breath through feathers

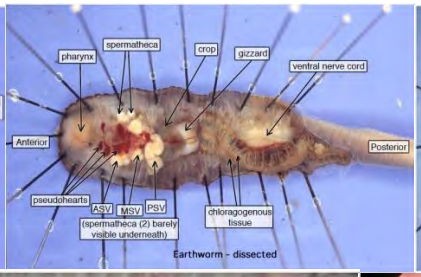

Hirudinea: leeches

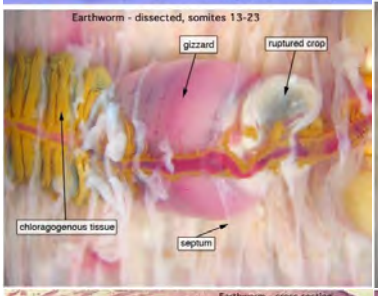


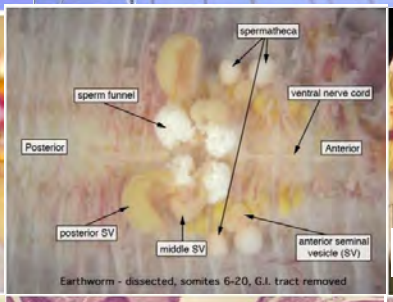
Annelida:

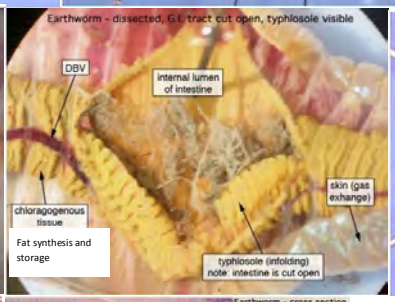
- Segmented worms (obvious metamerism)
- GI SA increased with typhlosole
- Metanephridia, hemoglobin
- Asexual budding, sexual monoescious

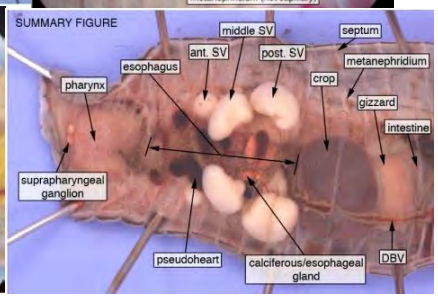


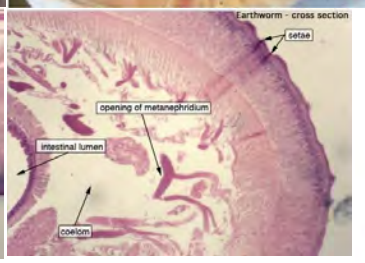


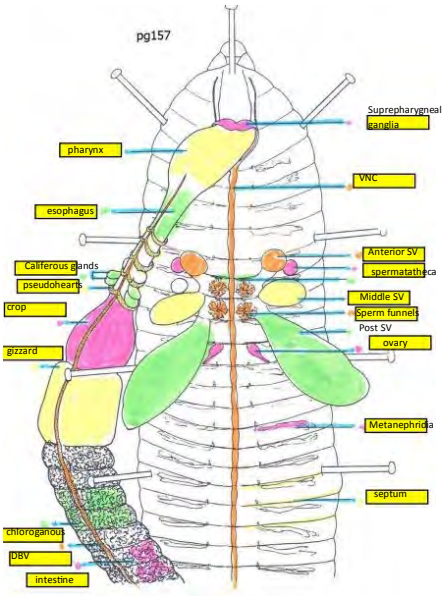


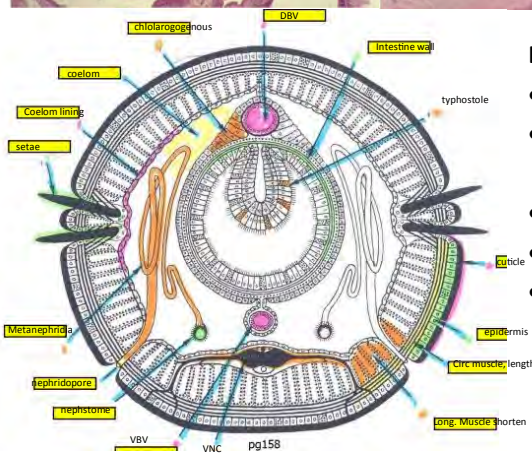












Dig Order:

- Pharynx
- Esophagus (Ca glands)
- Crop
- Gizzard
- Intestine (chol. Tissue)

Circulation:

- Closed
- hemoglobin

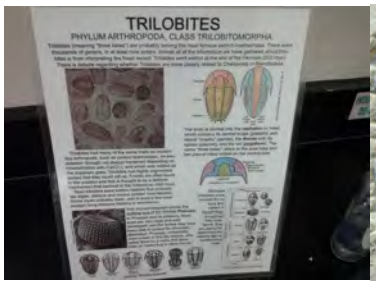
Excretory Order

- Nepherstome (ciliated)
- Post. Metanephridia
- metanephridipore

Repro: sperm exit SV or one worm, stored in spermatatheca of other, later eggs released

Nematoda: pseudoceolomate

Arthropda:

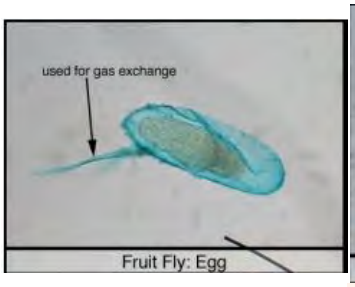


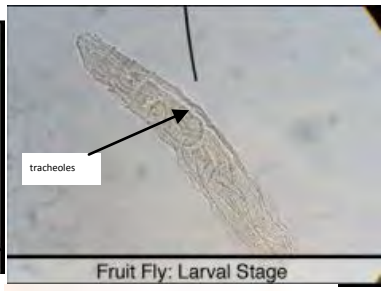
Chelicerata:

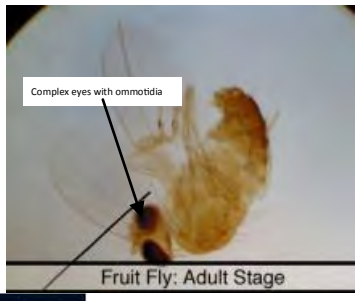
- Xiphsura & arachnida
- Chelicerae
- Book lungs in spiders

Mandibularia: myriapoda

Pancrustacea: hexapoda





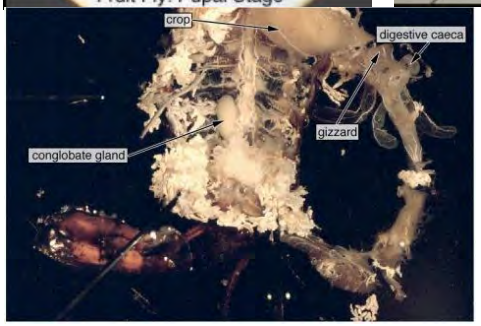


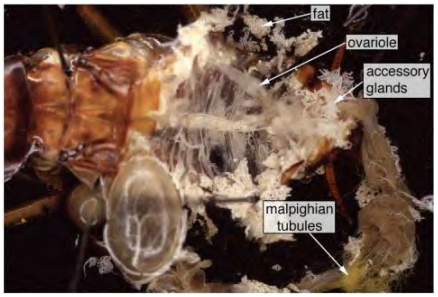
Hemimetabolous:

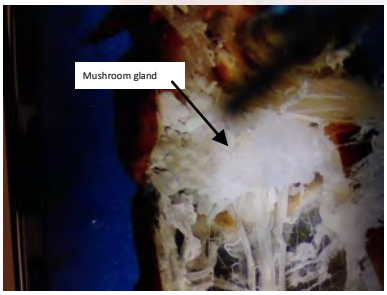
- Egg to nymph
- Grasshopper
- Mini version of adult

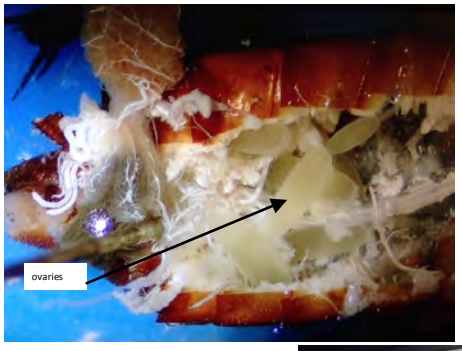
Holometabolous:

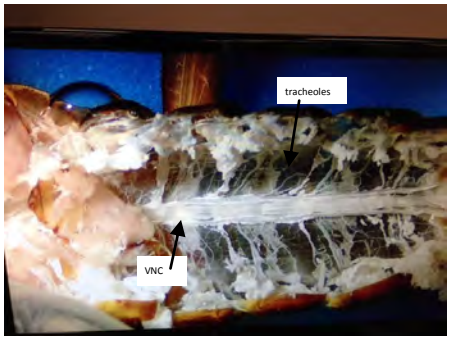
- Egg to larva
- fly
- Larva look different











Dig. Order:

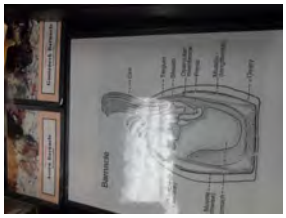
- Esophagus
- Crop
- Gizzard (salivary glands)
- Dig. Caeca
- Malpighian tubes
- Ileum
- Colon
- anus

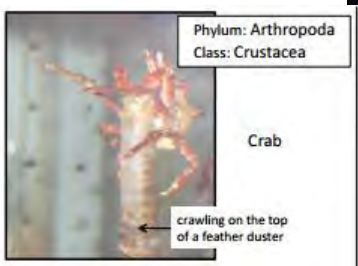
Resp Order:

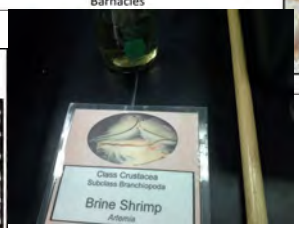
- Spiracles
- Trachea
- body

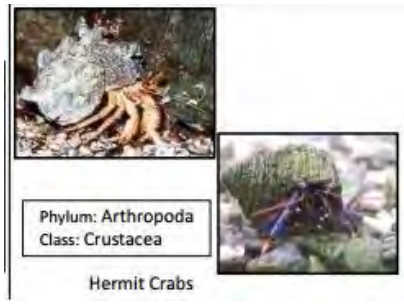
Circ/ Exc: open, hemolymph and amoebocytes, no pigment. Filtered in malpighian tubes and emptied into hindgut

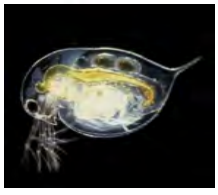
Pancrustacea: crustacea

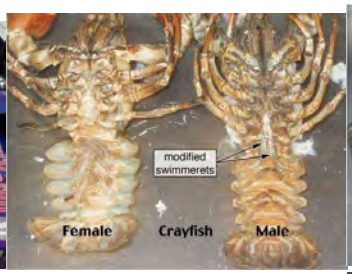


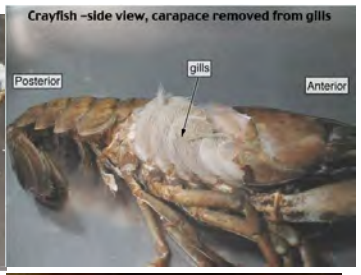


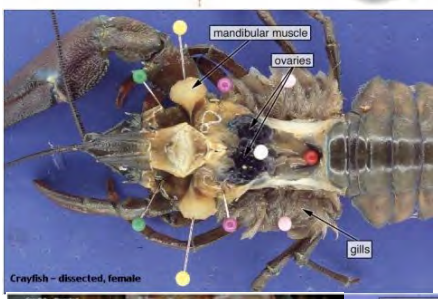


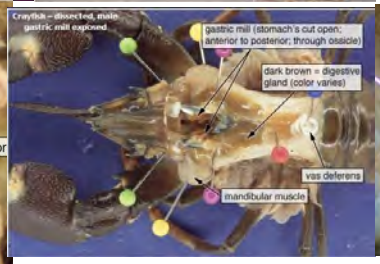


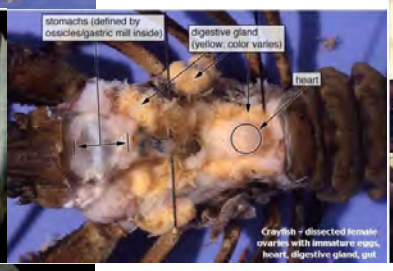


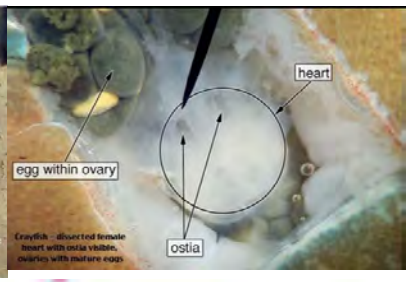


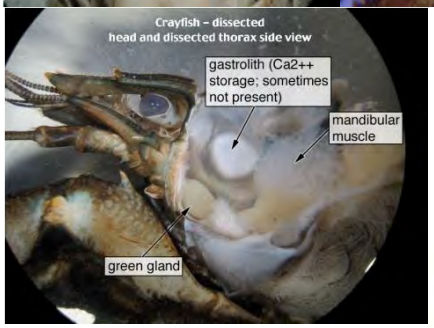












Dig Order:

- Mouth
- Cardiac w/ gastric mill/ pyloric stomach
- Midgut (dig glands)
- Intestine
- anus

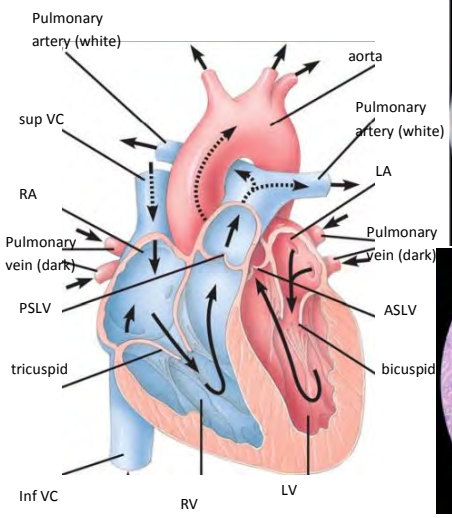
Circ Order:

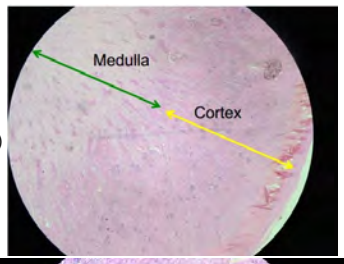
- Open, hemocyanin
- Heart
- Arteries
- Tissues (-O2)
- Central sinus
- Gills (+O2)
- Pericardial sinus

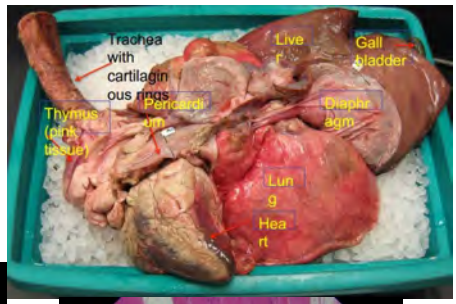
Exc: N waste filtered in green gland and exctred

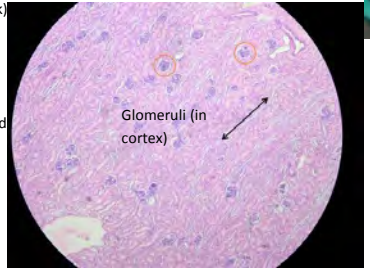
Repro: sperm exit at base of 4th walking legs, swimmerettes help move them. Sperm stored swimmerettes or in seminal recepticals. Eggs released from genital pore at the base of 2nd walking legs. Zygotes stored on swimmerettes hatch later

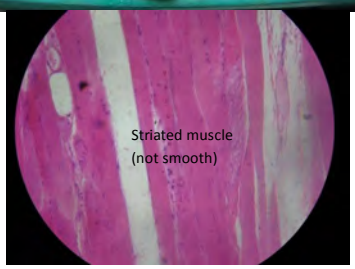
Organs:











Epithelial	Form skin/ line body cavities and organs (covering), makes glands (glandular)	Basal lamina binds to underlying CT. No vessels travel through epithelium. Tight junctions prevent passage of mats	Seal surfaces, perform selective transport, protect, secrete
Connective	CT proper, cartilage, bone, blood	Mostly extracellular matrix (protein for struct, and prot-carb complexes for nutrient diffusion), contain nerves and blood vessels	Mechanical support, lubrication, defense, and storage
Nervous	Brain, spinal cord, neurons	Neurons and glial cells	Conduct electrical signals for communication, sense stimuli, conceptual thought
Muscular	Skeletal, cardiac (heart) and smooth (SI)	Bound with CT	Movement, contraction/ dialations (visceral movements)

Squamous	**Simple**	Flat sheet	Lungs/ heart
	Stratified	Top layer flat sheet	Trachea
Cuboidal	**Simple**	Square	
	Stratified	Top layer square	
Columnar	**Simple**	Tall	SI
	Stratified	Top layer tall	

Endocrine:
- No ducts, directly to blood
- Adrenal
- Hypothalamus'
- Thyroid/ parathyroid
- gonad

Exocrine:
- Has duct
- Liver
- Kidney
- Lachrymal
- testis

Homeostatic Things:
- Oxy tension
- pH
- Osmotic pressure
- Temp
- Metabolic subst conc
- Waste conc

CT Proper	Fluid matrix	Tendon, ligaments (bone to bone), packing materials	Dense irregular (dermis), dense regular (tendons/lig) adipose (fat), loose
Cartilage	Gel matrix	Tubular organs and articular surfaces	chondrocytes secrete matirx
Bone	Hard calcified matrix	In skeleton. Matrix + lacunae + BV and nerves = Haversian system (osteon)	Mostly CaPi crystals, also collagen and prot-carb complexes (osteocyte -> osteoblast maintain, osteoclast breaks down)
Blood	Fluid matrix (plasma)	Circ	Plasma, erythrocytes (RBC), leucocytes (WBC), thrombocyte (platelet)

Homeostatic Temp Control:
1. **Control Center:** Thermalregulation at hypothalamus
2. **Receptor**: thermal receptor
3. **Effector**: heat regeneration through vasoconstriction and shivering/ brown fat, or heat loss through vasodilation

Radiation	Q loss or gain
Conduction	Q loss or gain, Proportional to thickness of surface
Evaporation	Q loss only
Convection	ΔQ from conduction and evaporation enhanced

Ectotherm	Conform to Q	BMR (basal metabolic rate)
endotherm	Generate Q internally	Higher SMR (standard metabolic rate)

MR increase	Body mass down	Heart rate up	Breathing rate up	Blood volume up
MR decrease	BM up	HR down	BR down	BV down

Essential amino acids:
- Tryptophan (corn)
- Methionine
- Valine
- Theonine
- Phynlalanine
- Lecine
- Isoleucine (beans)
- Lysine

- 8000000 to 500 oogonia between gestation and ovulation

More Numbers and Formulas:
- Met rate = energy used/T
- 1L O2 = 4.83 kcal liberated
- Cardiac Output = Stroke Volume X Heart rate
- BP = systolic/diastolic
- MAP = 93mmHg
- Flow = CO = ΔP/Resistance
- CO = MAP/Tot Peripheral Resistance
- RBC: 45% volume, 5trill/L
- Tidal volume (normal) 500ml
- Vital capacity: 4500ml

+ vs — feedback:
- CO2
- Child birth
- Ovulation
- Ant pit
- Low est levels
- High est levels
- Progesterone on LH/ FSH. Cont. if implant through hCG

	Fun Facts	Carbs	Proteins	Lipids (2x the E)	Nucleic acids
Mouth, Pharynx, and Esopha-gus	Food forms bolus when mixed with mucus and saliva; protects mouth from damage and makes swallowing easier	Carb/ chemical digestion starts in the mouth. Salivary glands secrete salivary α– amylase			
Stomach	Bolus mixes with acid to form chyme. Stomach made of 3 layers of smooth muscle: inner oblique, mid-dle circular, and outer longitudinal	Chemical diges-tion stops when enzymes are denatured by the low pH	Protein digestion starts here. Gastric glands: parietal cell secretes HCl, which denatures proteins and activates pepsin (cleaves peptide bonds, and makes more pepsin from pep-sinogen); chief cells make pep-sinogen; mucous cells protect against HCl.		
SI		Pancreas se-cretes pancre-atic amylase	Pancreas secretes trypsinogen (activated to trypsin by en-teropeptidase, tryp activates everything else), chymotropsin (ogen), (pro)carboxpeptidase	Liver + gall bladder secrete bile salts, which emulsify fat and keep it from coalescing. Pancreas secretes pancreatic lipase. Fats are broken down into lipase, and then mono-glycerol and fatty acids	Pancreas secretes pancre-atic nuclease. DNA and RNA are broken down into nucleotides
SI brush border	Microvilli of SI, looks like hairbrush	Disaccharides -> monsaccha-rides	Makes enteropeptidase. Di-peptides -> amino acids		Nucleotidase (nucleotides to nucleosides); nucleo-sidase + Pi (into Pi, sugars, N bases)

What	Monosaccharide	Amino Acids	MG, fatty acids, glycerol	N base, sugar, Pi
How (lumen side)	Gluc/ galactose: cotran-sport w/ Na+. Fructose: facilitated diffusion	Cotransport w/ Na+	Simple diffusiom. Turned to TG in SER, coated with protein (chylomicron) in Golgi.	N bases and Pi: active transport. Sugars (5C): simple diffusion.
Basal (blood) side	Facilitated diffusion	Facilitated diffusion	exocytosis	Facilitated diffusion
Blood or lymph?	Blood: Capillary in villus -> portal vein -> liver	Blood: Capillary in villus -> portal vein -> liver	Lymph: lacteal capillary: lacteal vessel/duct: veins that go to heart	Blood: Capillary in villus -> portal vein -> liver

Cephalic (prep)	Think of food	Nerves or hormone: brain -> auto-nomic NS -> enteric NS -> stomach	Stomach: increases secretion and motility
Gastric (start**)**	Food enters stomach (distension, in-crease pH and peptides)	G-cells -> gastrin	Stomach: increases secretion and motility
Intestinal (slow)	Food enters SI (fatty acids and MG)	CCK-PZ cells -> CCK-PZ (cholecystokinin-pancreoenzyme)	Pancreas: exocrine gland cells -> dig enzymes. Gall bladder -> bile
Intestinal (slow)	Food enters SI (decrease pH)	S-cells -> secretin	Pancreas -> bicarbonate. Stomach: decreases secretion and motility

Gluc increase	β cells in pancreas make insulin	All cells (except brain, kidney, and SI) increase gluc uptake, dec appetite	Muscles and liver: excess gluc converted to fat in liver, and stored in adipose cells.
Gluc decrease	α cells in panc make glucagon	Liver breaks down glycogen and releases it into blood. Adipose breaks down TG to FA and glycerol an d releases into blood.	Glucagon start glucogenesis, which makes glucose from aa, glycerol, other stuff. As concentration of FA increases, more FA and less gluc get used.

Stimulus	**Source**	**Hormone**	**Target**	**Increase hormone**	**Decrease hormone**
High calorie food	L-cells in SI (ileum) and colon	PYY	Decrease appetite/feel full	Inc appetite dec food intake	dec appetite inc food intake
Increase fat in adipose	Adipose release leptin	Leptin	Decrease appetite	Decrease appetite	Uncontrolled eating
dec food in stomach	stomach	Gherlin	Inc hunger (number of times, not amount)	Ie after diet: want to eat more	Appetite decrease

2 chambers	1A 1V, fish	+O2 in gill capillaries, -O2 in systematic capillaries	Limits O2 delivery and metabolic rate
3	2A 1V, amphibians and reptiles	Pumocutaneos circuit: (LA) +O2 in lungs and skin. Systematic ciruit: (RA) -O2 in organs. Septum separates ventricle, diverts blood away from lungs underwater.	Vigorous blood flow to brain. Increases O2 and metabolic rate
4	2A 2V, Birds, mammals, crocodiles	Separates oxy poor and rich blood	Enhances O2 delivery and helps restore pressure after lungs

Stroke Volume/HR Reg:

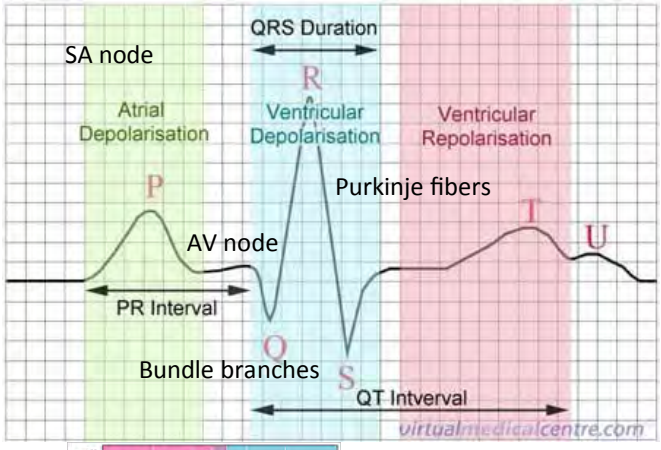
- Brain or hormone
- Control SA/ AV node (HR)
- Strength of contraction (SV)

LV systole:

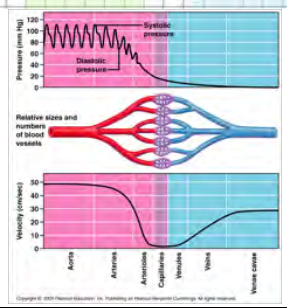
- V contracts
- Vp > Ap
- AV valve closes (lub)
- Vp > Aorticp
- ASLV opens
- Blood goes into aorta

LV diastole:

- V relaxes
- Vp < Aorticp
- ASLV closed (dub)
- Vp < Ap
- AVV opens



Heart	SS Ep & CT	Myocardium: Striations w/ intercalated discs, separated by gap junct.	SS ep & CT
BV	SS ep & CT	Smooth muscle (smooth muscle) & elastic sheets (esp. large arteries). Med arteries regulate distribution. Arterioles have lage SA and reg BP	CT
Veins	" more CT	" More smooth muscle, thinner larger lumen. Blood moved by muscle & resp pumps	"



BP increase:

- Sensed by barroreceptors
- Inc HR
- In SV
- Inc TPR
- Inc MAP
- Means constricted arterioles

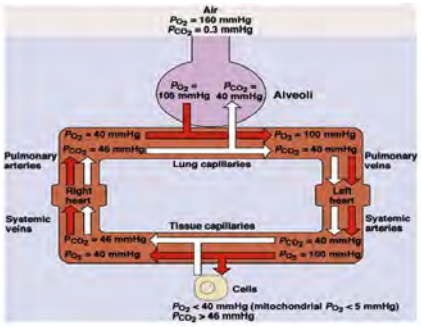
Conc gradient	O2. CO2, Na+, K+, etc	Flow through leaks/holes in capillaries at anastomosing networks.	Low V helps
Hydro p grad.	water	Decreases, still favors filtration. Net (osmo + hydro) out of cap	Due to actual pressure (BP). Raise MAP, raise filt, lower MAP
Osmo p grad	Water	Stays constant, favors reabsorbtion	Due to conc. Gradient. Lower Osmop, raises filt, lower MAP

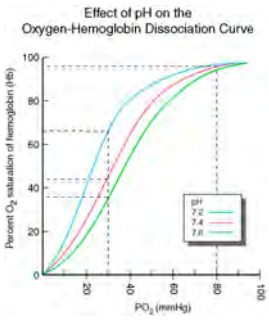
Water		Easy to keep surfaces moist	Gills/skin	
Terrestrial	Higher concentration of O2	Resp surface must be inside	Lungs/ trachea/ skin	CO2 and O2 diffuse faster, less E

Resp Surface	Either GVC or skin capillaries	Cnidarians, annelids, frogs	Must be dmp and have high SA:V ratio
Gills	Total SA large	Starfish, mollusk, crayfish, parapodia	Bony fish: continuous flow of water ventilates gills.
Trach	Air sacs near important organs	insects	Large insects ventilate w/ body movements
Lungs	Conducting and resp passages. Surfactant prevents collapse of alveolus	Vertebrates, snails, spiders	Circ system req. Frog: positive pressure, push air into lungs, Birds: linear lungs, that utilize all of air

Conducting vs Resp passages

- Trap and eliminate debris, have mucus and cilia
- Nose
- Pharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles
- Where gas ex occurs + capilaries
- Resp bronchiole
- Alveoli

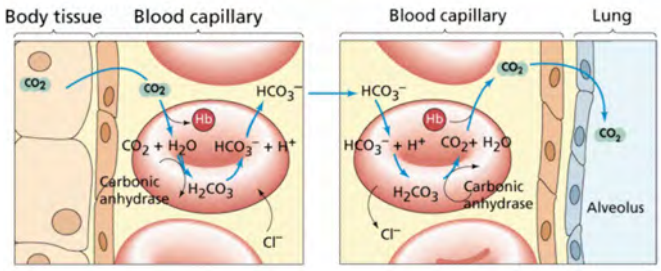




Low pH = high T of CO2

	Arteriol	Venus
pO2	100	40
PCO2	40	46

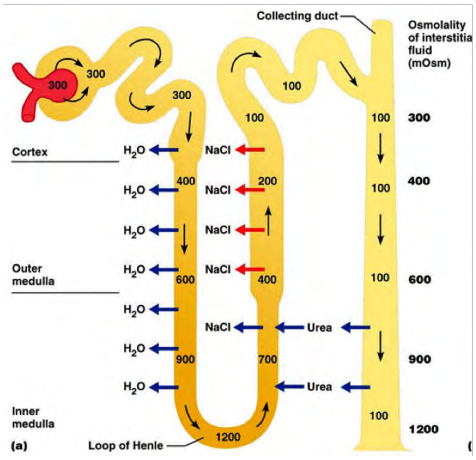
Hemoglobin	Annelids/ vertebrates	Iron (red)	Packaged in cells (98%)
Hemocyanin	Arth. molluscs	Copper (blue)	Dissolves in plasma

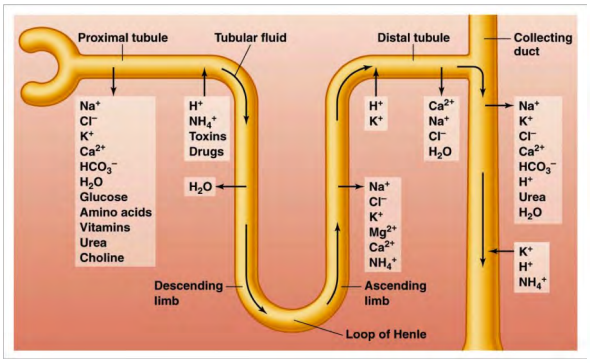


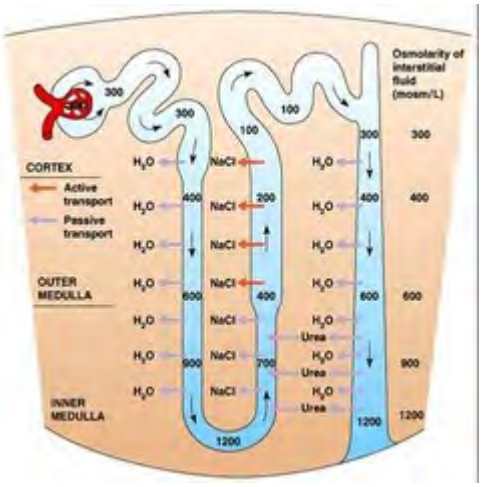
In Venus blood, %60 and arterial blood 90% of CO2 transported as bicarbonate (HCO3-). Carbonic anhydrase in HB breaks down CO2 very quickly

Inc PCO2	Drastic ventilation inc	Peripheral (& central in medulla) chemoreceptors in large arteries	Maintain O2 CO2 balance
Dec aterial pH	Vent inc	Peripheral chemoreptors	Regulates plasma pH
Dec aterial PO2	Vent inc	Peripheral CR	rare(<60mmHg)

Renin	Released from juxtaglomerular apparatus (macula densa cells) during drop in BP or Na	Promotes angio II and aldost.
Angiogensin II	Inc Na+ and water reabs.	Stimulates aldosterone from adrenal gland
Aldosterone	Inc Na+ and water reabs.	
ANF	Atrial nutritive factor: inhibits renin, aldost, and NaCl	
ADH	Antidiuretic hormone: increases water permeability in DCT/CD, decreases osmolarity	increased ECF osmo releases ADH from pituitary (hypothalamus controls)

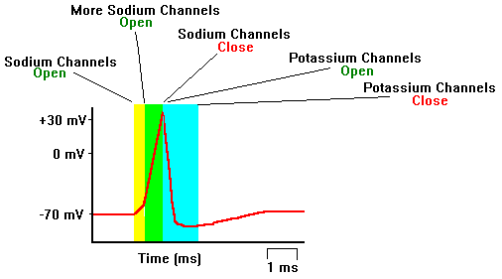






Freshwater fish	Water lass conc. Than body, fish gains water and loses salt	Does not drink water, salt in (AT), salt out, H2O in	Large amount of unconcentrated urine
Boney fish	Water more concentrated than body, fish loses water and gains salt	Drinks in salt, salt out through gills (AT), H2O out	Small amount of slightly diluted urine
Terrestrial	Loses water	Water and salt in (drink), water and salt out	Moderate volume of concentrated urine

	Na		**K**
	Fast	Slow	
Rest	closed	open	Closed
Thresh	open	Start closed, still open	Start open, still close
Depol	open	open	"
Peak	open	inactive	Open
Refract		Can open	Start close, still open



Sarcomere	Makes up myofibrils, make up muscle cells called fibers, and are made of myofilaments, made of Z line, 1/2 I band (thin) A band (thick) 1/2 I band, Z line.	Ca enters, and bind to troponin, troponin and tropomyesin move and exposes actin-myosin binding site. Myosin pushes think and thin bands together during contraction (requires ATP)	Plasma membrane called a sarcolemma. Has T tubules (folds) with Na/K pumps and channels. AP travels down T tube to SER, where Ca is released	SER called sarcoplasmic reticulum. Has Ca pumps to maintain gradient (pumps Ca into SER) and Ca channels opened by AP.

Ig: all determine binding properties of Fc

- IgG: gamma
- IgA: amylase
- IgM: milk
- IgE: allergies w/ mast cell
- IgD: receptor on B cell

Autoimmune Diseases:

- Lupus: histones
- Rheumatoid Arthritis: cartilage
- Diabetes I: pancreas
- Rheumatic fever: heart

Immune Timeline:

- Macrophage w/ MHC2
- T4 binds
- B cell makes MHC2
- B cell makes plasma cells
- T helper binds makes interleukins (starts activation and clonal expansion)
- Plasma cells make Ab in blood and lymph
- T8 cell on MHC1 uses interleukin for activation
- Cytoxic T lyses cell (porferin/ granzymes)
- Ab destroy antigen

Neutrophil	60-70% WBC	Phagocytic, secrete anti bacterials (innate) stimulate repair	Release chemicals to kill bact. Fast response, short lived	
Eosinophil	2-4% WBC	Allergies		
Basophil	0-1%	Initiate inflammation (like mast)		
Monocytes/ Macrophage	3-8%	Become macrophage (innate), stimulate repair	Antigen presenting cell, starts specific immunity, slow response long lived.	Present part of pathogen w/ MHC 2
Lymphocyte (B)	20-30%	Specific immunity, become plasma cells	Display MHC2. Plasma cells make Ab which inactivate pathogen	Develop in bone marrow. Activates mostly by prot
Lymph T4	20-30%	Specific immunity. Make helper T	Need major histocompatibility complex (MHC)	Develop in thymus. Activates mostly by prot
Lymph T8	"	Specific immunity. Make cytoxic T	Need MHC 1 (cytotoxic). Kill viral infected and cancer cells w/ perforin and granzymes	Develop in thymus. Activates mostly by prot
Lymph T help	"	Specific immunity. Active T cells, B cells, NKC, & MO w/ interleukins	Need MHC 2. only come from Ag presenting cells.	Come from T 4. Activates mostly by prot
Mast Cell		Release histamine: initiates inflammation	Releases histamine, which causes vasodilation	Activated by injury, Ag-Ab complex, or complement

General **Infected body actions**	**Cell:** Release interferons to make adjacent cells resistant, and to activate macrophages/ natural killer cells.			Increase clotting factors so bact don't move
Specific **Infected call actions (humoral:** inactivation w/ Ab, **cell mediated:** lyse/ phagocytosis	Epitopes bind to antigens, bind to immunoglobulins (made of light and heavy region, Fc, same in all cells). Fab region determines antigen	Clonal expansion: excess T and B cells serve as memory cells (as opposed to effector cells) which are not activated. Increase rate and duration of 2nd immune response	Ab activate complement on bact, lyses bact, enhances inflamm, etc	Cytoxic and Helper T cells activate more lymphocytes, and secrete cytokines (interleukins: activate T and B cells; Perforin/ Granzymes: from cytoxin T, and lyse cell)

Neutralization	Ag-Ab complex surrounds and neutralizes virus
Precipitation/ Aggultination	Ag-Ab complex binds a lot of Ag determinants together, so they ppt out
Opsonization	Ag-Ab surrounds and protects bacteria
Complementation	Ag-Ab complex assembles complement

Hormones:

- Oxytocin: for labor
- ADH: kidney
- Thyroid Stimulating (TSH):
- Adrinocorticotropic (ACTH): controls cortocoids
- Growth (GH): counters insulin, non-tropic effect on metabolism
- Lutenizing (LH): stimulates interstitial cells in men, and corpus luteum in women
- Follicle stimulating (FSH): spermatogenesis in males
- Prolactin: Lactation
- Epin/norepinephrin: increase HR, BP, BS, vasoconstriction, less digestion/ release fat
- Cortisol: glucocorticoid, reg by ACTH, anti-insulin effects/ release fat
- Aldosterone: mineralocorticoid, effects NaK pumps to reg BP
- Calcitonin: decreases plasma Ca by dec bone reabsorbtion
- ParaTH: opposite of calcitonin
- Thyroid Hormone: T3 (triodothyonine) & T4 (thyroxine) . Inc met rate and mental acuity/ growth

Lymph Organs:

- Thymus: produce T
- Spleen: expose blood born antigens to T/B, phagocyte particulate matter and damaged blood cells
- Tonsils: expose B/T to antigens in injested material
- Lymphnodes: expose lymph born antigens to B & T cells
- Bone Marrow: produce B
- Nonhuman: hemocytes/ ameobocytes

Amino Acid (Tyrosine) & **Peptide/ Protein** water soluble	Secreted through exocytosis,	dissolve in plasma, dissolved part—free fraction, active	Break peptide bonds in blood or target cells	Short half life (s-m)	Receptors on cell membrane (ion channel/ signal transduction
Steroids (Cholesterol)/ Thyroid hormones fat soluble	Secreted through membrane,	bind to proteins (globulins), active when not bound	Hydroxylated and conjugated in liver	Long half life (hours)	Receptors inside the cell (transcription factor)

Hypothalamus	In brain	Controls post. Pituitary directly, ant pituitary through hormones, ie dopamine	Negative feedback from ant pit.
Pituitary	Anterior (adenohypophysis) of epithelial, and posterior (neurohypophyis)	Post. Produces oxytocin and ADH. Ant: TSH, ACTH, GH, LH, FSH, PRL	Negative feedback regulation for ant. GH: too much, tall. Too little, short
Thyroid	follicular cells surround a colloid. C cells (parafollicular) in between	Colloid makes thyroid hormone, Thyroglogin made by foll. Cells, along with iodinated tyrosines. TH released during phagocytosis of colloid. C calls make calcitonin	Not enough TH: enlarged thyroid (goiter). Too much, exophthalmos
Parathyroid	4 on dorsal part of thyroid	Parathyroid hormone & calcitonin	Rickets: vitamin D def
Adrenal	On top of kidneys, consist of cortex (zona glomerulosa, fasciculata reticularis) and medulla	Medulla: epinephrine and norepinephrine. Cortex makes aldosterone and cortisol	Too much glucocort: Cushings (fat, hyper). Too little (cortisol or aldosterone): Addisons (weight loss, hypo)
Pancreas	Alpha and beta cells	beta cells make insulin, alpha cells make glucagon	
Gonad	Growing follicles secrete estrogen		

Hormones Cont:

- Insulin: decreases plasma glucose by increasing its utilization
- Glucagon: increases plasma gluc by increasing its synthesis

Random Repro Notes:

- Bulbourethral glands: clear urethra and nutrilize urine
- Top of sperm called acrosome
- Cumulus oophorus: layer around oocyte that triggers enzyme release
- Secondary oocyte released for Graaian follicle, turns into corpus luteum
- Atresia: process of killing remaining follicles
- Fimbria: fingers on fallopian tube

Ovulation occurs just after peak in LH, FSH, and estrogen. Progesterone peak occurs during corpus luteum degredation