

Chapter 18 - History of Life

Dating

- radioactive dating
- using sedimentary rocks (strata)
- palaeomagnetic dating
- dendrochronology
- ice cores

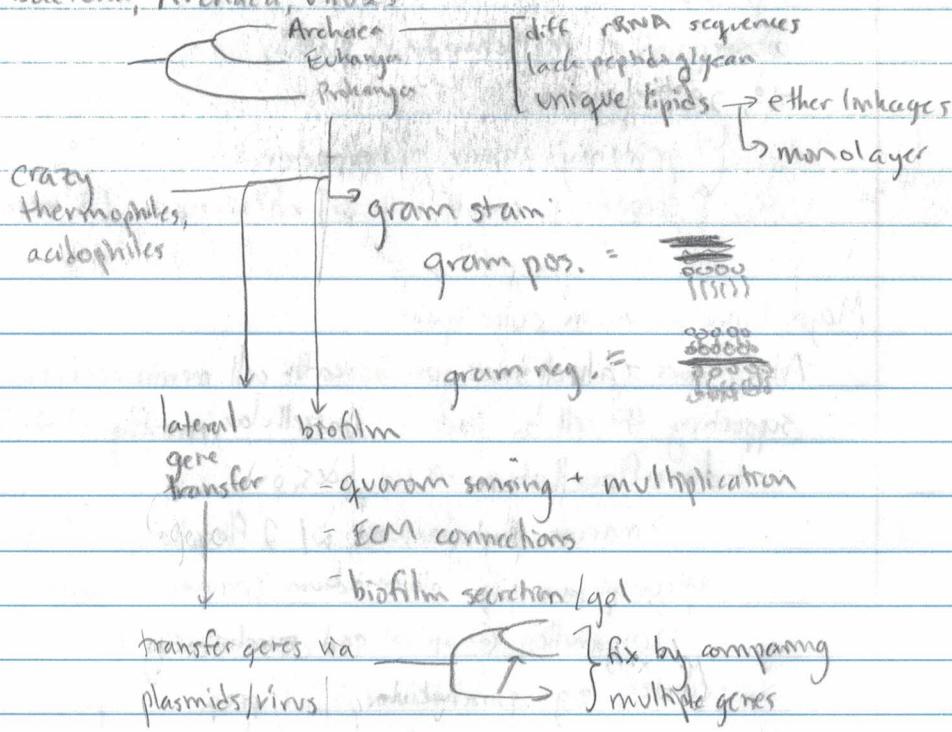
in Earth's physical environment

- continental drift, plate tectonics
- sea levels → hot/cold climate
- atmospheric changes
- general ↑ in O₂, but not always
- glaciation
- simultaneous volcanoes from tectonics

↳ mass extinction

Chapter 19 - Bacteria, Archaea, Viruses

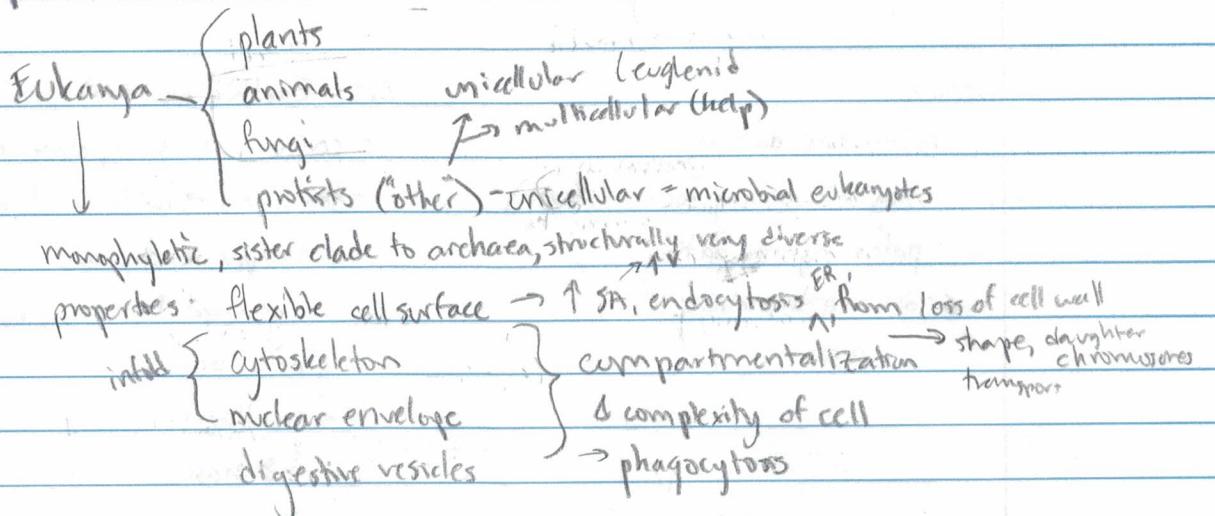
Taxonomy



Viruses

- str (viruses) — { nucleic acid
capsid (protein coat)
optional envelope (lipid membrane) } } not living

Chapter 20



Endosymbiosis

- absorption of mitochondria, plastids

-1^o, 2^o

↳ primary: absorb cyanobacterium

↳ secondary: engulf cell w/ chloroplast (3 membranes) (O)

Major Lineages within eukaryotes

- Alveolates - alveoli sacs just beneath cell membranes, play a role in supporting the cell surface. - unicellular, mostly photosynthetic

- dinoflagellates → red tides, oil

↳ marine phytoplankton w/ 2 flagella (mostly)

- apicomplexan e.g. plasmodium (causes malaria)

↳ organelles @ apical end, exclusively parasitic.

- ciliates e.g. paramecium prop prop act

- stramenophiles e.g. diatoms (silicon, dominate earth, photosynthetic producer)

↳ tubular hairs on longer of 2 flagella

→ conjugation

protists can reproduce sexually or asexually

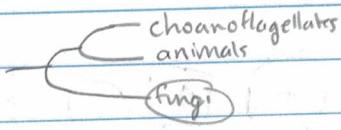
Chapter 22

Fungi

- ## Synapomorphies of fungi

-chitin

"absorptive heterotrophy"



Anatomy

- fruiting structure above ground.
 - mycelium under ground - "roots"
 - ↳ contains hyphae - tube-like filaments that absorb nutrients
 - contains walls (septa) or not

septate coenocytic

- note: most fungi are multicellular, but some are unicellular (yeast)

- yeast refers to a lifestyle, not a clade

- fungi food

- from dead/living material

- 4 types:

-saprobic-molds, from non-living org. matter

- parasitic - from living plants, e.g. invade plant cells

- pathogenic - cause disease, e.g. Athlete's foot

- mutualists - relationship benefits both parties e.g.

- mycorrhizae - fungi + plant roots

- lichen - fungi & photosynthetic microorganisms

photosynth

fungi

-sugars and

water

- 10 -

- minerals (P)

Reproductive cycles

- ascomycota (sac) vs. basidiomycota (club)

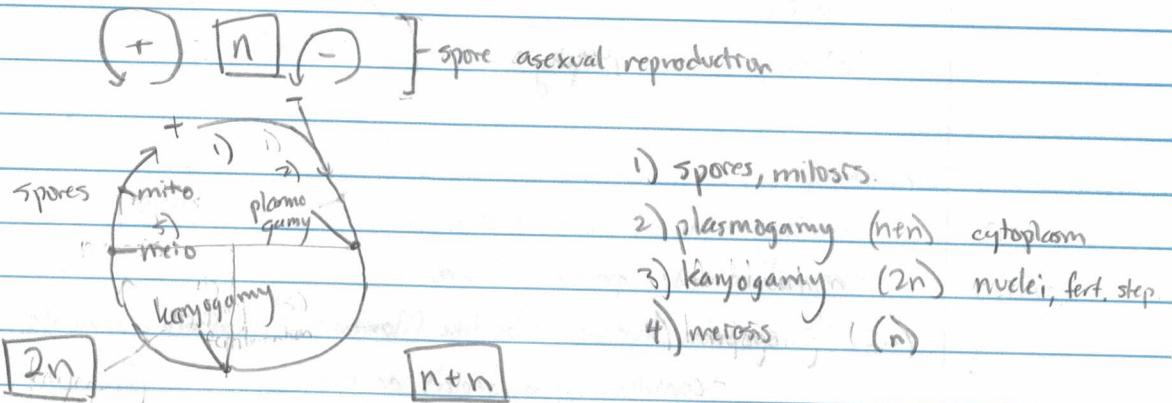
-spores in ascii vs. spores on pedestal

- asexual, not just sexual (+/-)

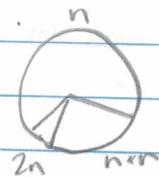
↳ hyphae fuse to form dikaryotic cells

- both have dikaryon stage

general fungus life cycle



- more like



- club fungi:

- develop dikaryotic club fungi
- in club until spores released from gills.

Chapter 23

Animal Diversity

Synapomorphies:

- similar rRNA
- unique junctions in cells
- ECM w/ collagen, proteoglycans
- similar genes that control dev.

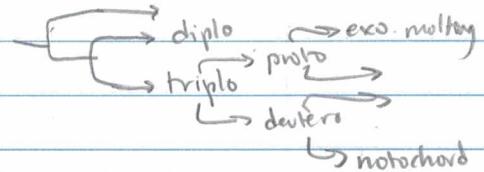
animal origins:

- colonies of choanoflagellates aggregated
- cells specialized
- bim! sponges.



animal groups distinctions

- # germ layers - diploblastic vs. triploblastic
 - endo, ecto
 - endo, meso, ecto
- body plan - symmetry (bilateral, radial), segmentation, external appendages
- blastosphere dev. - protostomes (oral) vs. deuterostomes (anus)
- brain / cephalization



Some interesting animals/groups

- protostomes - ecdysozoan - molting cuticle
 - thin cuticles, restricted to moist env.
 - arthropods - characteristics:
 - muscles attached to inside exoskeleton
 - segmentation
 - jointed appendages (paired, complex, specialized)
 - rigid exoskeleton of protein/chitin for support & protection
 - chordates - following structures at least once in life:
 - dorsal hollow nerve cord
 - tail that goes past anus
 - dorsal supporting rod (notochord)
 - amniotes - eggs, scales to prevent drying, urinary system
 - mammals - sweat glands, milk, hair, 4 chamber heart, 3 bone ear
- | |
|-----------------|
| spinal chord |
| coccyx |
| spine vertebrae |
| Gallows larger |
| animals |

5:00 Dani
6:00 Calvin

Chapter 21

Plant evolution

- trend:

no plumbing → plumbing
gametophyte → sporophyte + gymno } angio } sperms
(hap) (dip)

syn: primary endosymbiosis of cyanobacteria

charophytes (green algae) } closest relatives
land plants

- key adaptations:

- cuticle

- stomata

- gametangia

- embryos

- mutual association w/ fungi

- key organisms:

non vascular - mosses

vascular

↳ no seeds - ferns

seeds

↳ no flowers - pines

flowers - orchard

21 - Plant Evolution

1) chloroplasts via primary endosymbiosis

- 3 genomes (plant, mito, chloro)

- originally water plants

glaucophytes,
algae

2) land plants

- cuticle

- em byo

- stomata

- mutualism w/ fungi

- gametangia

- ... life cycle

3) a)

a) non-vascular

- restricted size, loc.

mosses

(small, moist env., water for sperm movt.)

- G photo., s dependent (G, remains attached)

G 5

b) vascular (tracheophytes)

ferns

- still need water, but xylem/tracheid?

- G photo, g ind. of s.

G 5

c) i. seeds, gymnosperms

- drier env. b/c. pollen (male game.)

- naked seed, but cones

seed pws:

- nutrients

- protects

- animals move

- dry, viable for long

time

- S. photo; g dependent on S

ii. seeds, angiosperms

- double fert.

- phloem

- carpel, stigma

-

- flowers → fruits, endosperm

24 Plant Body

- goals:

- harvest energy (shoots)
- nutrients from soil (roots)

} respond to env.

- eudicots vs. monocots

- net venation

- parallel venation

- tap root

- fibrous root

- pithole

- development

- meristem - embryonic stem cells

- primary growth vs. secondary growth

a apical (basal)

lateral (radial)

extend roots/shoots

girth (vascular ring)

- layers:

- dermal - outer covering

- ground - photosynthesis

- vascular - transport

- xylem - water + minerals, one way, dead tissue

- phloem - water + sugars, both, source to sink

plasmodesmata, companion cell

25 Plant Nutrition, Transport

- Minerals

- N, P, K, identified using aquaponics

- root hair obtain nutrients from soil

- crop harvesting
leaching } → shifting agriculture
 organic, chemical fertilizers legumes

- Contributors

- fungal-mycorrhizal

- water, minerals (P)

- plants actually send signals

- nitrogen fixing bacteria

- $N_2 \rightarrow NH_3$

- insects in carnivorous plants

- Transport

- xylem

- positive potential = good, not wilted

- transpiration-cohesion-tension

(mesophyll xylem xylem)

controlled by stomata

neg. pressure (pull)

- phloem

- translocation - source \rightarrow sinks

- pressure flow

pos pressure (push)

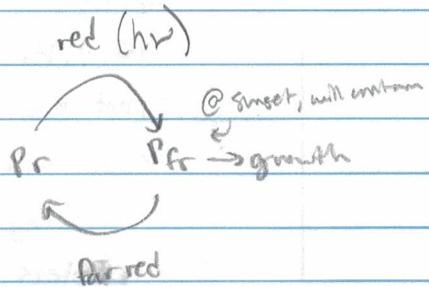
25 slide 25

2b Plant growth, development

- factors

- environmental cues genome red (hr)

receptors
hormones



- seed

- dormancy

- H_2O, O_2 exclusion photo/dormancy

- protect embryo thermo

- chem. inhibition (abscisic acid)

- activates w/ H_2O

- early shoot dev't

- coleoptile in monocots, cotyledons in eudicots

- hormones

- gibberellin - general growth hormone

- stem elongation

- fruit growth

- seed germination (hydrolysis of stored food mol.)

phytohormones

- auxin - stem elongation hormone

- released down shoot (polar transport) by

phototropism $\xrightarrow{\text{from apex}}$ auxin

- auxin in, H^+ out, auxin ionized, auxin out

- concentrated on shaded side

- f(x)

- root initiation

- leaf abscission inhibited (keep leaves)

- maintain apical dominance

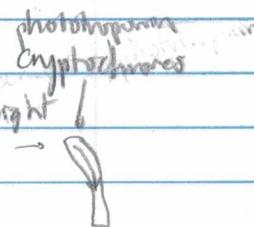
- fruit dev.

- cell elongation

- brassinosteroid = stunts growth

- ethylene ripens fruit
 \hookrightarrow causes leaf abscission

- cytokinins - delay senescence (aging)



21 - Reproduction of angiosperms

- anatomy

- sepal → form fruit 2n polar nuclei ovule becomes endosperm.
- petals → 2 sperm + egg = zygote + sperm = triploid
- carpel → megasporophytes (n) 2 cells some plants
- stamen → microsporophytes self pollinate (sex.)

- hormones, signalling

- environmental } annuals, biennials, perennials
- genetic

- flowers

apical meristem → leaves LEAFY

→ inflorescence meristem → flowers APETALIA

→ floral meristem - limited, determinant growth/flowers

- photoperiods

- short day } length of night phytochrome
- long day
- influenced by single leaf

- vernalization - flower after cold temps.

6-1 Photosynthesis

- pigments such as chlorophyll absorb blue & red light
- action spectrum differs from absorption spectrum, indicating the presence of other pigments (chloro A, B, accessory pigments)

Chapter 29

Fundamentals of Animal f(x) (Introduction to Animal Cell)

- energy

- catabolic rxns release heat from chemical bonds

- metabolic rate depends on physical activity, size (MR)

- rate of energy consumption, measured by O₂ consumption

- ↑ physical activity = ↑ MR (except for birds)

- basal metabolic rate (BMR)

- resting MR

- shows that MR varies w/ body size

Homeostasis - maintenance of stable conditions in an organism's internal environment

Maintaining body temp

- regulators

- homeotherms / endotherms

- physiological mechanisms

- far more costly

- thermogenesis

- shivering

- ↑ MR w/

- thyroid

- BAT -

breaks down

w/ producing

ATP

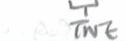
- Constricting
blood vessels



- conformers



- poikilotherm / ectotherms



- behavioural mechanisms

- less expensive

- e.g. basking in sun



- less fur / insulation, ↑ SA

- dissipating heat

- sweating, panting

- dilation of blood

vessels

PF 2020/21

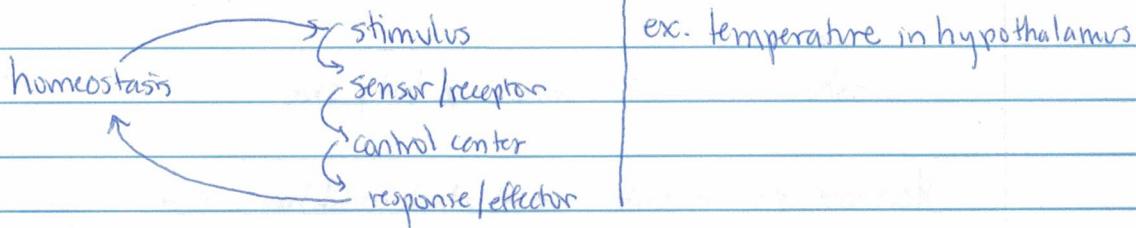
Fundamentals of Animal F(x)

- anatomy organization

- tissues → organs → multi-organ system

↓
epithelial cells stomach

- control mechanisms



- feedback systems

- set point
- negative - reduce/negate diff that exist
 - e.g. mammalian thermostat
 - positive - intensifies stimulus until turned off
 - e.g. childbirth, hunger, orgasms?

Chapter 30

Digestive System

- energy

- food + O₂ → CO₂ + H₂O + energy → basis of calorimetry

- chemical energy from food → stored for future use

- lipids

- glycogen

Animal gut: 1) digest & fi

2) absorb

- essential macromolecules

- essential amino acids - 8

- essential fatty acids - Omega-3/6 from fish, oils, etc.

- essential vitamins D, A, folic acid

- essential minerals Ca, Fe

- gut microbiome

- symbiosis w/ microbes

- gut

- mouth → anus

- tubular

- different animals have different specialized regions

- determines what food an organism can digest (nutritional value)

- e.g. cows can digest cellulose w/ help of symbiotic bact., protists

- moves through...

- swallowing

- a series of reflexes

- peristalsis

- sphincters relax w/ each wave

- mouth carbohydrates - starch → amylase

- stomach proteins - pepsinogen (activated by low pH) ends digestion

- small intestine fat - small int. liver synthesizes bile secreted into duodenum

by gall bladder

- pancreas produces enzymes, bicarbonate to neutralize pH.

- hormones + the digestive system

- regulate... → control the process of eating + digesting food

1) appetite

2) digestion

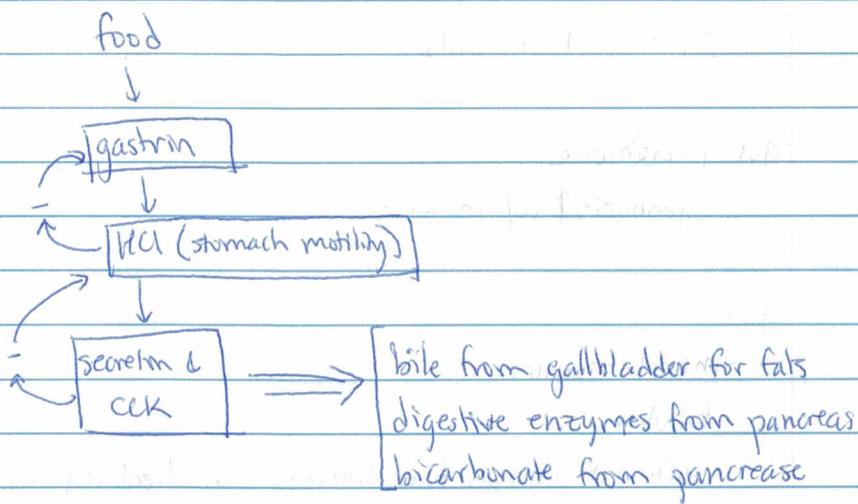
3) storage & release of nutrients

1) appetite:

- ghrelin - appetite stimulator - "grrr..." → stimulates eating

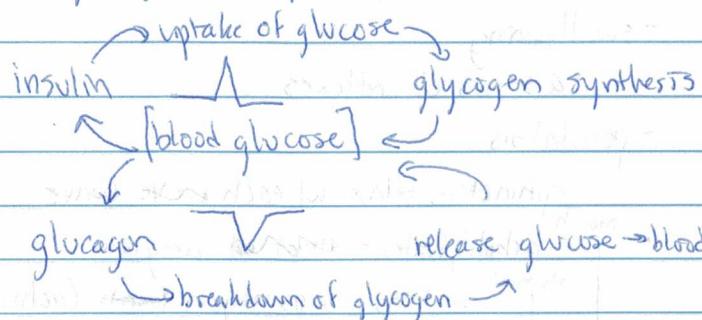
- leptin - appetite suppressor → slows down eating

2) digestion:



3) release of nutrients:

- e.g. insulin / glucagon from pancreas



Chapter 31

Breathing (Respiratory System)

- function:

- gas exchange
- intake of O_2
- removal of CO_2

- review:

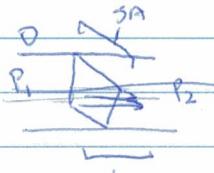
- cellular respiration
- partial pressures
- diffusion ($hi \rightarrow lo$)
- ↳ new: bulk flow

- efficiency:

- some (birds) better than others (humans)
- $\downarrow O_2$ availability w/ \uparrow altitude
- measure rate w/ Fick's law

$$Q = D \times SA \times \frac{\Delta P}{L}$$

\uparrow \uparrow \uparrow
 medium, surface path
 temp. area length



(thinner membrane)

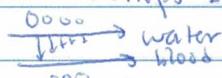
- breathing organs

fish - many gills

- two types:
 - gills - outward
 - lungs - inward
- tidal ventilation
- (in & out in same path)
- all vert.

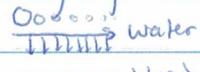
- two types of flow for gills

- concurrent - dumps but eventually evens out



- countercurrent - highs & lows are matched up,

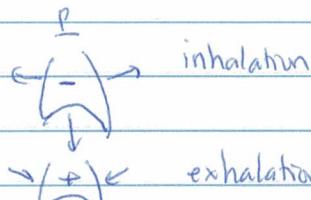
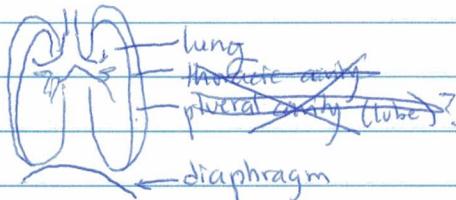
so always greater P in water



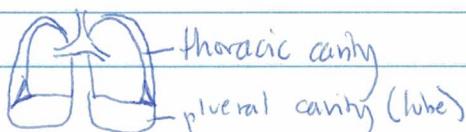
water

minus birds

- anatomy:



when lungs are full, most air exchanged



- high SA
- short L
- bulk flow by hemoglobin

(E) exercise

- exercise

- intercostal muscles help w/ inhalation

Inhalation exhalation



- control

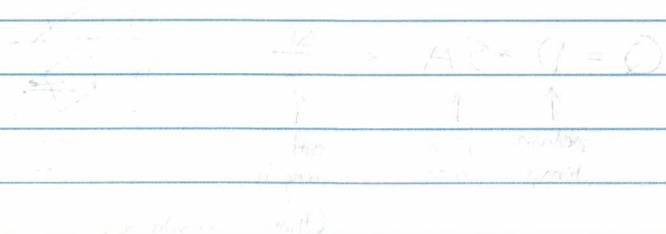
- medulla - breathing

- pons - regularity of breathing

Control with regulation (3rd)

WAVES → regulation (2nd)

→ control of the rhythm



→ regulation (1st)

Regulation of the rhythm of breathing by the brain

↓ Hypothalamus → Pons → Brain stem

↓ Brain stem → Spinal cord → Nervous system

↓ Spinal cord → Diaphragm

↓ Diaphragm → Contraction of diaphragm

↓ Contraction of diaphragm → Inhalation

↓ Inhalation → Inhalation

Chapter 32

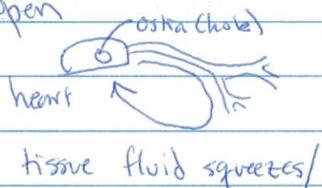
Circulatory System

- components

- pump
- fluid
- conduits (pipes/open spaces)

Variations

- open



tissue fluid squeezes/

moves back to heart

- closed

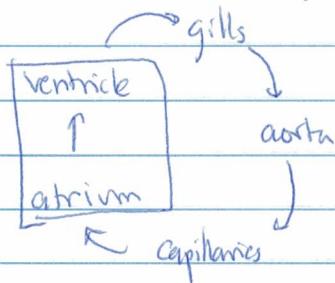


- blood independent of tissue fluid

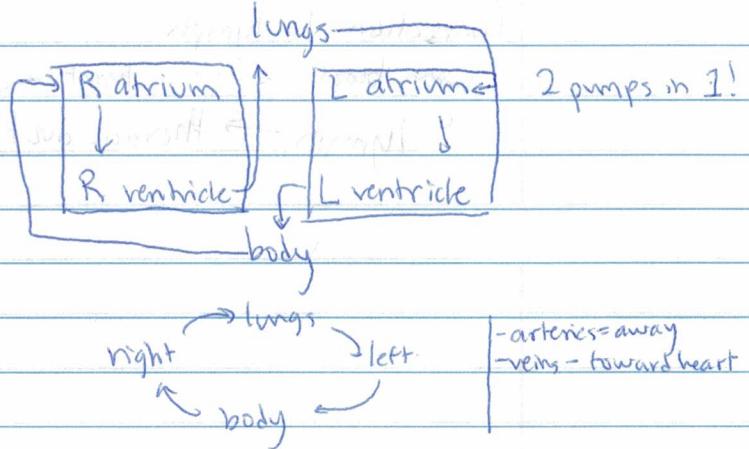
- more rapid flow

- direct blood to specific tissues

- 2 chambered (fish)



- 4 chambered (birds & mammals)



- cardiac cycle

systole

- ventricles contract (lub)
- ↓ blood volume
- ↑ pressure in aorta; ventricle

diastole

- ventricles relax (dub)
- ↑ blood volume
- ↓ pressure in aorta, ventricle

blood pressure - first sound = systole
blood flowing through

last sound = diastole
blood flows back & forth

25.2.2020

- conditions

- hypertension
- pacemakers
- arteriosclerosis

- autonomic nervous system

- norepinephrine +
- acetyl choline -

Blood:

- components of blood

- RBC - O₂
- WBC - immune
- plasma - tissue fluid
- & some proteins, cells are too big to leave the blood

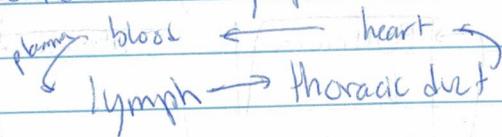
hemoglobin - carries O₂

- releases when [O₂] is low

- Starling's forces

- blood pressure, osmotic pressure oppose each other

- Connection to lymph



Chapter 33

Muscular System

- muscle

- designed for contraction

- 3 types:

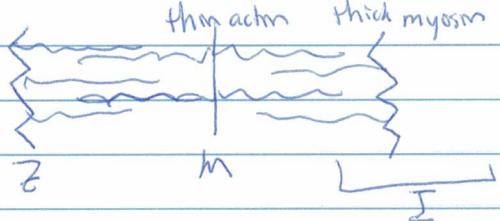
- cardiac - heart - branched w/ intercalated disks, stripes (actin + myosin)

- pacemaker cells - generate heartbeat

- smooth - internal organs - branched w/ intercalated disks, stripes (actin, myosin)

- no stripes, action potential when stretched, gap junctions

- skeletal - movement - muscles > fibers > myofibers > myofibrils



Chapter 34

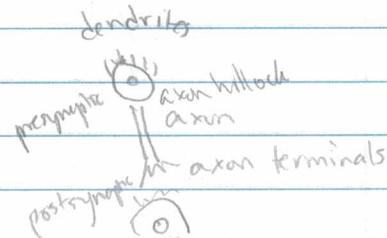
Nervous System

- two types of cells:

- neurons
 - glial cells
- } both produced during development, glial cells can divide.
} sometimes after development, neurons can divide, but rarely

- neurons:

- electrical excitability
- synaptic connections between cells
- neurites - axons & dendrites



- glial cells - support, maintain extracellular environment, affect synaptic transmission

- lots of them

- produces blood-brain barrier

- 4 types:

- astrocytes - between neurons ↗ relatively closed system

- microglia - in brain, immune defenses for nervous system

- oligodendrocytes - myelin insulation (like electrical tape) - CNS

- Schwann cells - also insulate w/ myelin - PNS

04/07/17

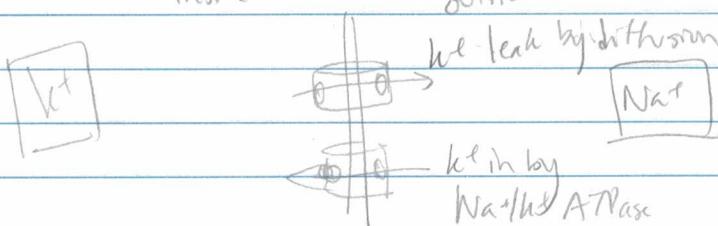
- Membrane potential

- relative to inside - if more - on inside, $-V_m$

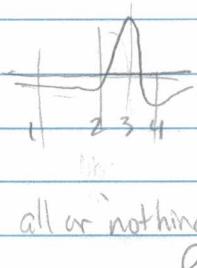
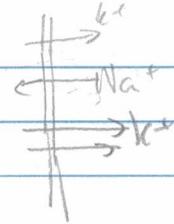
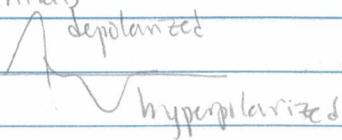
- if more + on inside, $+V_m$

- relative concentrations

	intra	extra	Na^+/K^+ ATPase	~ -65 mV
Na^+	✓	✗	2 Na^+ out	- maintains potential
K^+	✗	✓	3 K^+ in	- more pos. going out than in
Cl^-	✓	✗		- potassium leak channels to outside
Ca^{2+}	✓	✗		



Action Potentials



1) K^+ leak, resting potential

2) Na^+ open, going in, influx } voltage-gated

3) K^+ open, going out, efflux } ion channels

4) K^+ passive transport

Myelin

- ↑ myelin = ↑ speed of action potential

- skips myelin, only goes @ nodes of Ranvier

- Action potential frequency

- ↑ frequency can indicate pain

- postsynaptic neuron can sum excitatory & inhibitory input

→ spatial summation - signals from diff synaptic sites } axon hillock

- temporal summation - same site, over time

Synapses

- process of neuromuscular junction

1) Ca^{2+} into presynaptic via voltage gated ion channel post-action potential

2) release ACh

3) ACh binds to receptors on motor end plate

↳ quickly broken down

- visual - receptor potential

- sound - eardrum → hair cells

- fMRI

- PET

CNS PNS

afferent
(away)

autonomic
symp. parasymp. → enteric

voluntary

Chapter 35

Endocrine + Nervous Systems

Neurons vs. endocrine cells

cell → axon → target cell @ synapse (nerv)

cell → blood vessel → target cell (hormone)

- two types of endocrine cells

- neurosecretory cell

- CNS neuron → capillary → blood → capillary → target cell

- nonneuronal secretory endocrine cell

- cell → capillary → blood → capillary → target cell

- hormone - chemical, secreted in low concentrations into the blood by endocrine cells, that regulate the f(x) of other cells

- secreted by endocrine cells

- which are aggregated as secretory glands

- example:

- epinephrine/norepinephrine | adrenal glands

- fight or flight

- bind to adrenergic receptors

- receptor abundance controlled by neg. feedback

- down regulation - continuous high level of hormone \Rightarrow ↓ # receptors

- upregulation - when hormone secretion is suppressed \Rightarrow ↑ # receptors

- anatomy

- nervous + endocrine:

- pineal

- hypothalamus

- thyroid

- thyroid

- parathyroid

- excretory

- adrenal gland

- pancreas

- anterior } pituitary gland

- posterior

- thymus

- sex:

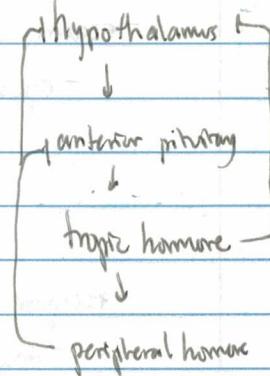
- gonads

Pituitary & nervous system:

- posterior	- ADH - oxytocin	- water absorption by kidney - ↑ blood pressure by vasopressin - milk ejection - uterine contractions	control other glands
- anterior	- follicle stimulating H	- growth of follicles in F, sperm production in M	
	- luteinizing H	- causes ovulation	
	- thyroid stimulating H	- releases T ₃ & T ₄ in thyroid	
	- adrenocorticotropin H	- stimulates adrenal cortex	
	- prolactin	- promotes milk production	
	- endorphin	- natural pain killers	
	- growth hormone	- growth of nearly all cells - take up amino acids	

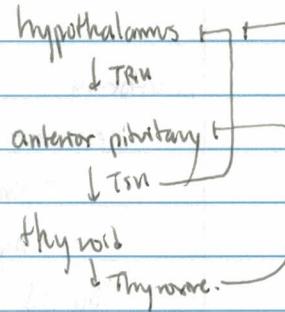
Hypothalamic neurosecretory cells

↓
blood
pituitary



Thyroid:

- thyroid	- T ₃ , T ₄ - calcitonin	thyroxine → - ↑ BMR - ↓ blood Ca ²⁺
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Adrenal Cortex (right above kidneys)

- adrenal cortex
 - aldosterone
 - cortisol

controlled by ACTH

- ↓ Na^+ excretion, ↑ blood pressure

- ↑ CO_2 , fat, protein in blood

- glucocorticoid

- glucocorticoid - affect [blood glucose] & other

aspects of fuel molecule metabolism

- mineralo corticoids - affect extracellular ion balance

- sex steroids - stimulate sexual development
reproductive ability

Adrenal Medulla

- epinephrine & norepinephrine

Sex hormones

- ovaries

- estrogens

- growth of female sex organs

- causes LH surge

- progesterone

- prepare & maintain uterus.

- testosterone

- sex characteristics

- testes

- HCG

- stimulates corpus luteum to grow &
release estrogen & progesterone

- placenta

Chapter 3b

Water and Salt Balance

tonic

-hypertonic

-isotonic

-hypotonic

Q: :

O : :

O :

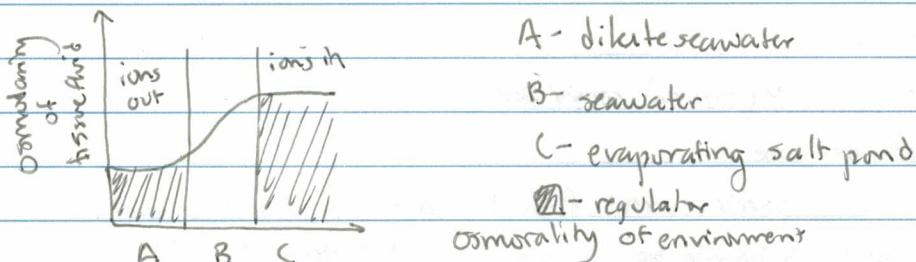
shrink

✓

burst

adaptations

- osmoconformers - tissue fluid similar to seawater - e.g. marine invertebrates
- Osmoregulators - tissue fluid different from environment - e.g. vertebrates



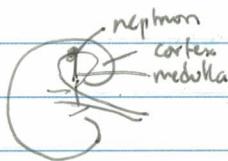
Nitrogen excretion

- nitrogenous wastes from metabolism of proteins & nucleic acids are toxic to the body if not excreted
- different animals secrete different things
 - ammonia - fish
 - urea - mammals, amphibians, cartilaginous fishes
 - uric acid - birds, insects, reptiles

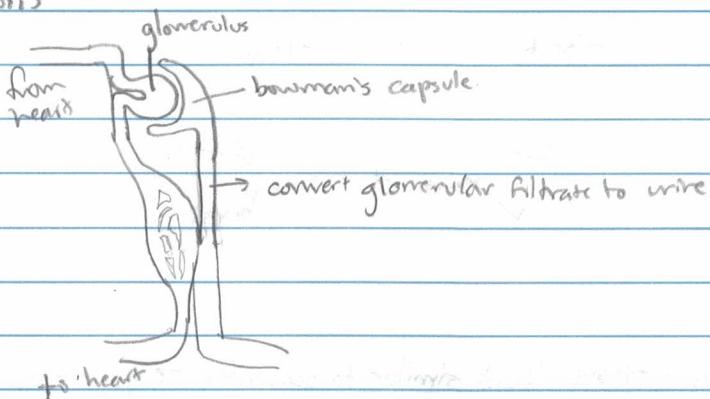
Urinary system anatomy

- kidneys produce urine

- bladder stores urine



Nephrons



Renal tubule

- glomerulus → proximal convoluted tubule → loop of henle → distal convoluted tube
- utilizes countercurrent flow to make urine more concentrated
- resorbs carbonate ions to act as a pH buffer

↑GFR = dilation of afferent renal arterioles = ↑ glomerular blood pressure

↑renin enzyme = ↑ angiotensin = ↑ blood pressure

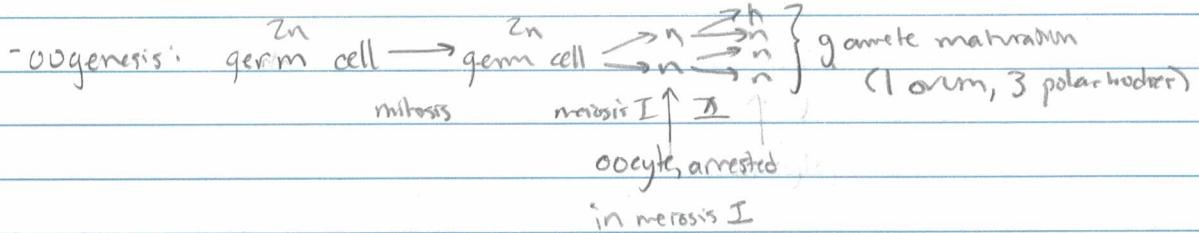
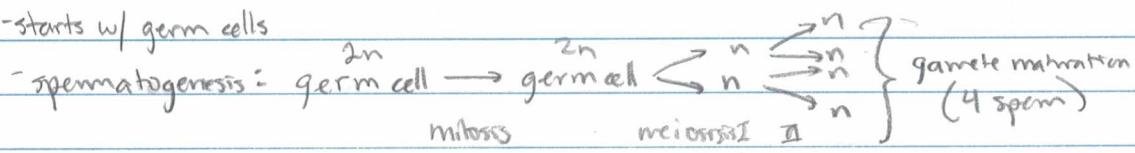
↑ADM = ↑ blood osmolarity, water permeability = ↑ reabsorption = ↓ urine output

Chapter 37

Reproductive Systems

- gamete overview

- starts w/ germ cells



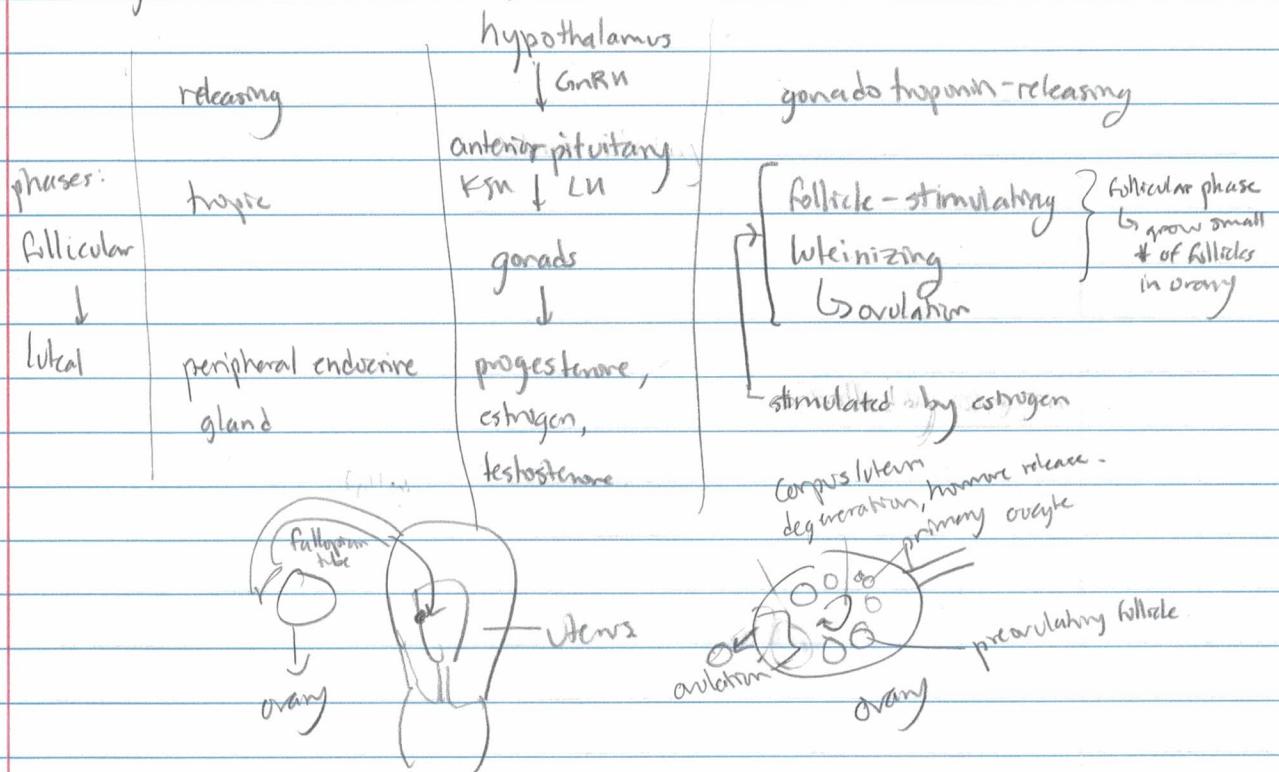
- two cycles

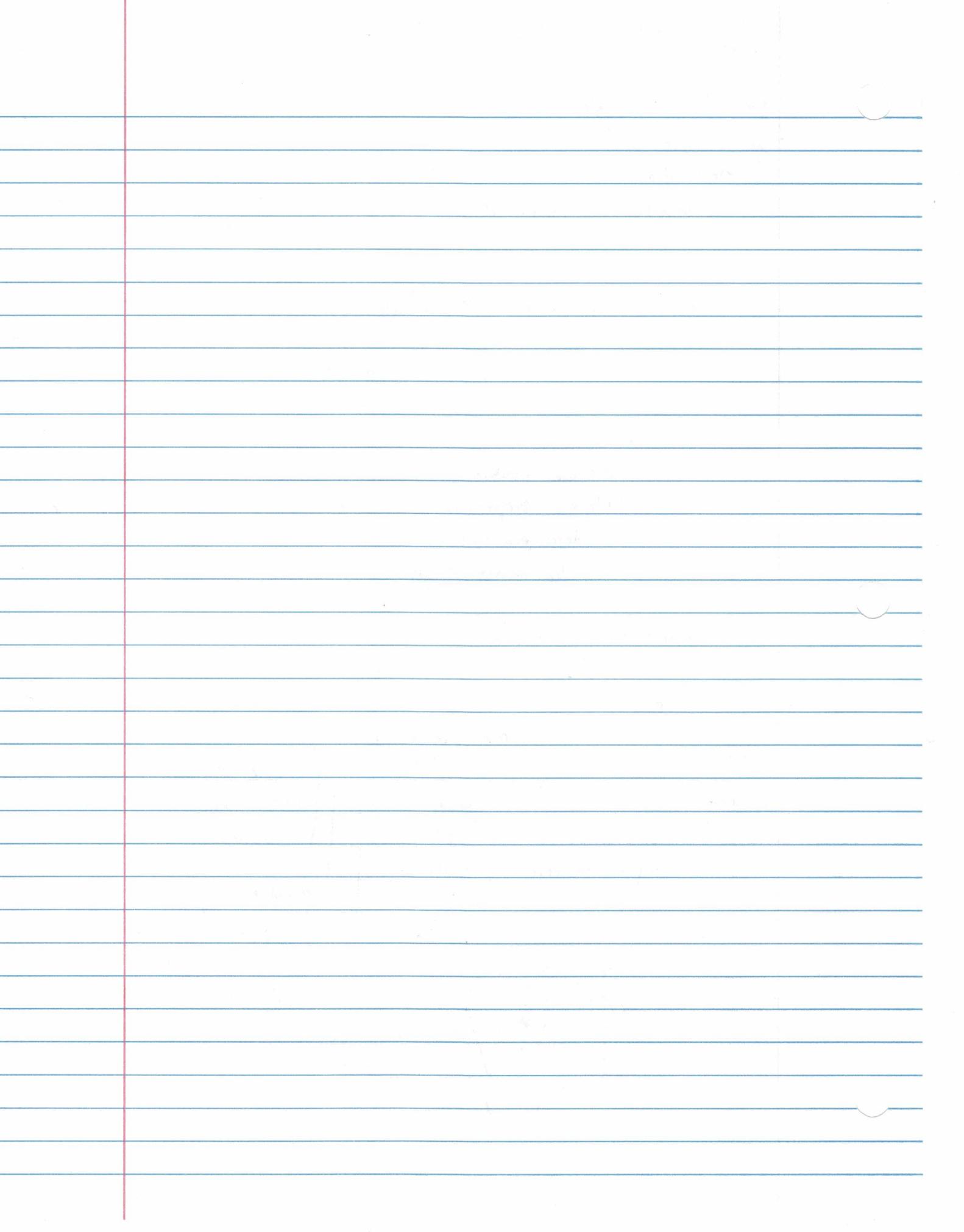
- ovarian - produces one matured haploid egg + releases - 28 days

- uterine - prepares lining of uterus for possible arrival of a developing embryo

- aka menstrual cycle

- gamete formation hormones





Chapter 40

Animal Behaviour

- Ethology - study of animal behaviour from an evolutionary perspective

- instinctive behaviours genetically determined by fixed action patterns. e.g. spatial learning of digger wasps

- performed w/out learning

- stereotyped - performed same way each time.
↳ as opposed to species-specific.

trigged by releasers
(specific stimuli)
↳ grey patch on bill

e.g. duck courtship

- deprivation experiments - used to determine whether a behaviour was inherited.

- behaviours affected by environmental (climate) change

- Behaviors

- rapid learning → mimicry

- behavioral imprinting - during critical period, animal learns a complex set of stimuli that later act as releasers

- helps animals recognize each other.

- e.g. song learning

- Biological rhythms

(free running:
→ can't be entrained)

- circadian rhythms - ≈ 24 hours, independent of light & dark.

- entrainment - reset circadian rhythm by exposure to environmental cues.

- photoperiod - indicator of upcoming seasonal changes

- day length.

- circannual rhythms.

- Environmental variation

- Territorial animals

- Foraging theory

- cost-benefit analysis

- Moving

- navigation - moving towards a destination/ along a course
- orientation - adopting a position/ path relative to an environmental cue. e.g. the sun

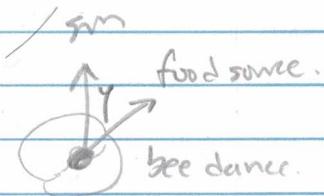
- communication -

- displays/signals

- chemical
- visual
- acoustic

- mechanosensory

- electrical



- Societies

- social behaviour - can be cooperative

- ↑ competition, but...

- flocking / aggregating together provides protection

- eusocial - nonreproductive members aid reproductive

- altruism → e.g. parental care

- e.g. ants, bees, wasps

Chapter 41

Earth's Ecological Systems

Ecology - scientific study of interactions btwn organisms & env. e.g. bees

- physical geography

- biogeography

- environment

- abiotic factors (physical & chemical)

- biotic factors (living)

- used to manage ecosystems to maintain the services they provide.

- biosphere - planet

- ↳ ecosystem - abiotic env. → human-dominated

- ↳ community - biotic, collection of pops.

- ↳ population - species in an area

- ↳ croplands,
pasturelands
urban settlements

- Climate & topography

- uneven heating of Earth → global atmospheric circulation

- rain shadows

- glacial advance, storms, temp. change

- Biome - distinct physical env. inhabited by ecologically similar

- organisms w/ similar adaptations

- endemic - describes org. found only in a certain region

- biogeography - tectonic shift

Human problems

- damming & channelization of rivers

- pollution, habitat fragmentation

- overexploitation of wild species

- new species

Chapter 42

Populations

- Population - all indiv. of a species in a given area.

- pop. structure - age distribution, how they're spread in env.

- pop. density - # indiv. / (unit area / vol)

- spatial terminology:

- geographic range - region in which a species is found.



- habitats - species's specific env.

- habitat patches - "islands" of suitable habitat surrounded by unsuitable

- dynamic, densities change over time

(↳ related to density of other species)

- birth-death model :

$$N_{t+1} = N_t + B - D$$

b = per capita birth rate

$$\frac{\Delta N}{\Delta t} = rN \text{ where } r = (b - d)$$

d = per capita death rate

r = per capita growth rate

- life table - shows ages at which indiv. make life cycle

transitions, how many do so successfully

- survivorship - fraction of indiv. that survive from birth to diff life stages/stages - survivorship curves



- fecundity - avg. # of offspring

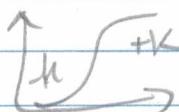
- life history trade-offs - can only invest in growth, reproduction, or survival

w/ resources, pops grow multiplicatively

- but eventually slows & reaches a steady size.

$$\frac{\Delta N}{\Delta t} = r \left(\frac{K-N}{K} \right) N \quad N = \text{pop. size}$$

K = carrying capacity



- pops. that depend on limited resources fluctuate more than those that depend on many.

- predator-prey - predator lags behind prey

- BIDE model of pop. growth

$$N_{t+1} = N_t + B + I - D - E$$

- habitat corridors

↳ not one if work
or not though

- duh - growth rate (# births) highest when pop. is well below its carrying capacity → hunters

- pops. w/ high reproductive capacities easier to harvest

↳ any species can be overharvested, regardless

Chapter 43

Inter/intra-specific Interactions

- Interactions

- (-/-) - competition → intraspecific - within a species
interspecific - 2+ species
- (+/-) - consumer-resource
 - predation
 - herbivory
 - parasitism↳ results in niches (physical/biological cond.)
get nutrients from other organisms → lead to evolution (morphological/chemical defense)
aposematism
↳ color = poison
- (+/+) - mutualism - e.g. gut bacteria, frugivores (fruit for seed dispersal)
- (+/0) - commensalism - e.g. mites on nematodes hitching a ride.
- (-/0) - amensalism - e.g. elephants trampling on plants, bugs.

- reciprocal adaptation/coevolution - adaptation of one species → evolution of an adaptation in a species it interacts w/
- invasive species - introducing species to region w/ no nat. enemies

- Trophic levels

- primary producer → primary consumer → secondary consumer
- food webs - webbed, so single change affects whole web
↳ e.g. Yellowstone: elk & wolves (trophic cascade)
↳ aspen & willows