Functions

salivary glands	produce saliva that moistens food and contains carbohydrase enzymes
stomach	produces hydrochloric acid and protease enzymes
pancreas	produces carbohydrase, protease and lipase enzymes
liver	produces bile
gall bladder	stores bile
small intestine	produces carbohydrase, protease and lipase enzymes, and absorbs digested food
large intestine	absorbs water

Positioning

Physical vs Chemical Digestion

Physical digestion breaks food into smaller pieces by:
-chewing in the mouth
-squeezing in the stomach This is done so that:
-food can pass more easily through the digestive system
-a larger surface area is provided for enzymes to work on

Chemical digestion uses digestive enzymes to breakdown large food molecules into smaller ones so they can be absorbed into the blood. The products of chemical digestion are absorbed into the body in the small intestine:
-sugars and amino acids pass into the bloodstream by diffusion
-fatty acids and glycerol pass into the lymph

Enzymes

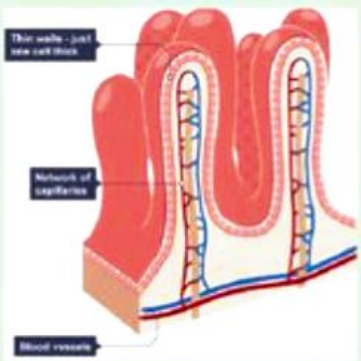
enzyme	breaks down...	into...	in the...
carbohydrase	starch	sugar	mouth + small intestine
protease	protein	amino acids	stomach + small intestine
lipase	fat	fatty acids + glycerol	small intestine

Stomach acid provides the correct pH for stomach protease to function properly.

Breakdown of starch

1. starch --> maltose
2. maltose --> glucose

Small intestine adaptations



-it has a thin lining
-it has a good blood supply
-it is very long and has a large surface area
-villi provide a large surface area for absorption to take place
-villi have a rich supply of blood vessels to carry away absorbed molecules.

pH differences

Why is the pH in the mouth and small intestine alkaline, but the pH in the stomach is at acidic levels?

> The enzymes there work at different optimum pH levels.

Bile purpose

What is the purpose of bile?

> To lower the pH of food as it moves from the stomach to the small intestine.

How does bile (from the gall bladder) improve fat digestion?

> It emulsifies (breaks down) fats in the small intestine. This provides a larger surface area in which the lipases can work.

Terms

zygote	cell that develops into offspring
embryo	unprotected or unhatched off spring
genetic diversity	inherited genetic differences in a species
sustainability	ability of environment to keep supporting its organisms into future
reproduction	ensures life exists beyond its present gen. and species exist in future

DNA

Chromatin	Condensed form of DNA
Nitrogen bases	"steps of DNA"; a with t, c with g
Chromosomes	condensed chromatin for reproduction
Homolog pairs	chromes that are the same shape, size, have same genetic info in same spot; one from ea. parent

DNA replication

During late interphase, Dna unwinds with enzyme and bases are paired with new bases.

Asexual Reproduction

binary fission	mitosis in prokaryotes
budding	buds in multicelluar can detach through repeated mitosis and form separate org.
frag.	part of multicelluar breaks off due to injury and becomes separate org.
vegetative.	stems, leaves, or roots are used to asex. repro.
spore	spores grow into new org.

Cancer (from mutations in cell cycle)

Cancer cells have large nuclei, no use, they attract blood vessels and become tumours, and can metastasize

MITOSIS

prophase	nuclear membrane disappears, fibres attach to centromeres	
metaphase	chromes align on equator	
anaphase	fibers pull sister chromatids to poles	
telophase	fibres disappear and membrane reforms around each set	
(cytokinesis)	cell contents are divided into 2 cells	cleavage furrow or cell plate

Embryo Develop (first 8 wks)

morula	end of week one	ball of cells
blastula	end of week two	hollow ball of cells, cell can develop to any kind
gastrula	3 distinct layers of cells (**DIFFERENTIATION**)	ecto: skin/ nerves, mes: muscles/bones, end: lungs/liver/digestive system lining

Asexual v. Sexual

lots of offspring quickly, large **colonies** can form to out-compete, lots=many may survive if conditions change, less energy	disease/mute=death, compete for food and space, bad condition=wiped out
genetic diversity, ext: little energy to mate, more offspring can exist after disaster, int: more protect and care	int: more energy/risk to mate, fewer produced, ext: gams,embryos, offs are unprotect

Fertilization: Pros and Cons

external	very little energy mate, lots of offspring, spread widely in evrionment (less comp.)	many gametes die, many eggs aren't fertilized, offspring are unprotected
internal	embryo protected, offspring's parents will protect	more energy, fewer zygotes, more energy to raise

Fetal Devlopment

differentiation	formation of organs/tissue from gastrula	
1st tri	0-12 wks	development of all organ systems
2nd tri	12-24	rapid growth (12-16); fetal movements felt
3rd tri	24-38	continued growth (**brain**)

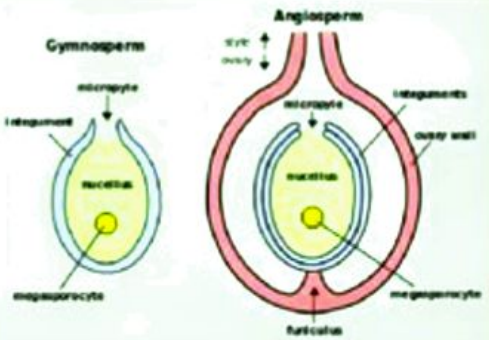
MEIOSIS

prophase	spindle fibres form and push centris. to poles, homolo chromosomes are paired	cross over
metaphase	homolo chromosomes align on 2 sides of equator	
anaphase	homolo chromosome pairs separate to opposite poles	assort
telophase	2 nuclei form, after 2 cells form	

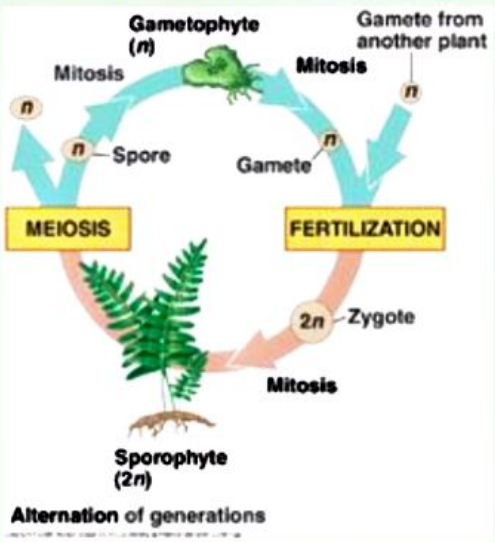
Stages of Sexual Repro.

mating	egg and sperm come together at same time and place
fertilization	gametes fuse to make zygote
development	embryo develops

Gymnosperms vs. Angiosperms

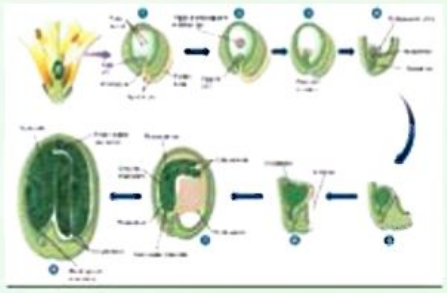


Gametophyte/Sporophyte Cycle



Angiosperm Reproduction

Seed Development



Monocot vs. Dicot

Types of Fruits

Plant Transport

Short-distance

> occurs by osmosis (movement of free water through aquaporins)

Long-distance

> bulk flow using:
> translocation (H^+ gradient) through phloem (sugar)
> transpirational pull (cohesion) through xylem (fluid/minerals)

Plant Hormones

Auxins

> distribution of auxins → phototropism
> enhances apical dominance (vertical)
> promotes fruit growth

Cytokinins

> stimulates cytokinesis & cell division
> delays senescence (aging)

Gibberellins

> cause stem elongation, fruit growth, & seed germination
> auxin+gibberellins=fruit development

Brassinosteroids

> induce cell elongation & division in stem segments, slow leaf abscission

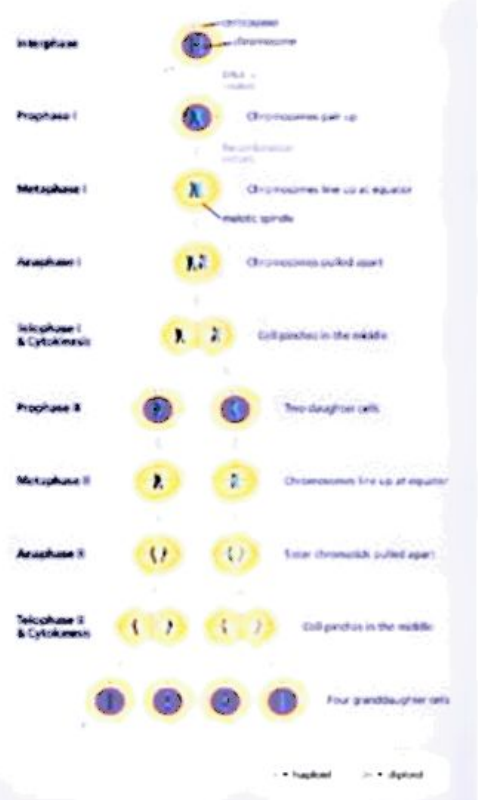
Abscisic Acid (ABA)

> antagonizes growth hormones, inhibits germination, used to withstand drought
> must be washed/exposed to light/cold to deactivate

Ethylene Gas

> produced in response to stress during fruit ripening, apoptosis, & exposure to auxin

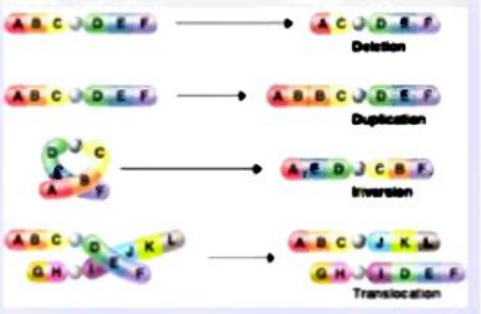
Meiosis



Mutations

mutation	genetic or chromosomal (deletion, inversion, translocation, polyploidy) abnormality
karyotype	diagram that shows size, #, & shape of chromosomes
nondisjunction	failed separation of homologous chromosomes→ aneuploidy(trisomy, polyploidy

Chromosome Mutations



Mendelian Laws

Law of Dominance

> offspring of 2 organisms that are homozygous for 2 opposing traits will be hybrid but will only exhibit the dominant trait and not the recessive trait

Law of Segregation

> during formation of gametes, the 2 traits carried by each parent will separate

Law of Independent Assortment

> alleles of a gene for one trait segregate independently from alleles of a gene for another trait (applies w/dihybrid cross)

Genes

linked	genes on the same chromosome
sex-linked	traits carried on X chromosome
linkage mapping	↑ distance between genes on chromosome= ↑ chance of separation by crossing over
recombination frequency	=total recombinants/total # offspring x100
pedigree	used to determine how traits are inherited
Barr body	inactivated X chromosome in each female mammal's somatic cell→ genetic mosaic

Types of Crosses

monohybrid cross	Tt x Tt; phenotype ratio=3:1; genotype ratio=1:2:1
testcross	B/__ x b/b to determine B/__'s genotype
dihybrid cross	TtYy x TtYy; can produce 4 types of gametes & phenotype ratio=9:3:3:1

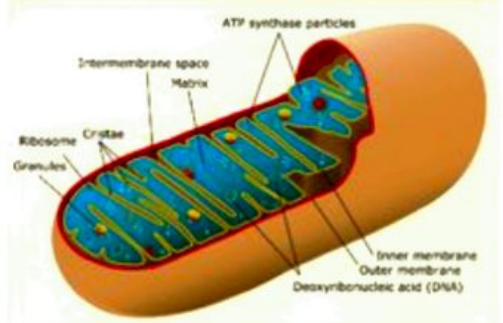
Dihybrid Cross

	AB	***Ab***	***aB***	***ab***
AB	***AABB***	***AABb***	***AaBB***	***AaBb***
Ab	***AABb***	***AAbb***	***AaBb***	***Aabb***
aB	***AaBB***	***AaBb***	***aaBB***	***aaBb***
ab	***AaBb***	***Aabb***	***aaBb***	***aabb***

Types of Inheritance

incomplete dominance	hybrids show blending of traits
codominance	hybrids show both traits
multiple alleles	more than 2 allelic forms
pleiotropy	1 gene affects an organism in several/many ways
epistasis	2 genes, 1 trait; 1 masks expression of the other
polygenic	blending of several genes that vary along a continuum

Mitochondria



Glycolysis

Glycolysis

> 2 ATP + 1 Glucose → 2 pyretic acid + 4 ATP

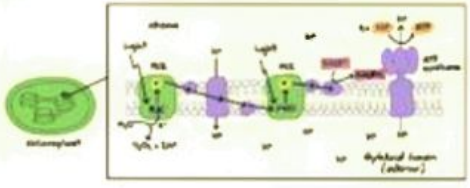
Substrate level phosphorylation→ATP
PFK=allosteric enzyme inhibited by ATP

Chloroplasts

Parts: outer/inner membranes, intermembrane space, thylakoid membrane/space, storm

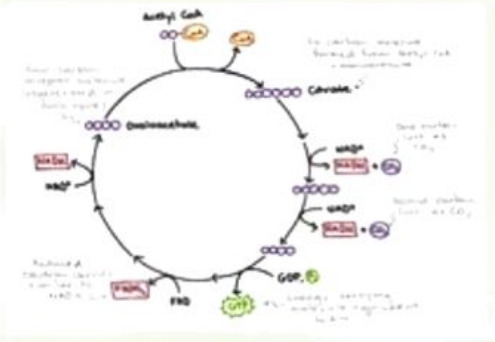
Chlorophyll a/b=absorb red/blue/violet
Carotenoids=absorb blue/green/violet

Noncyclic Photophosphorylation



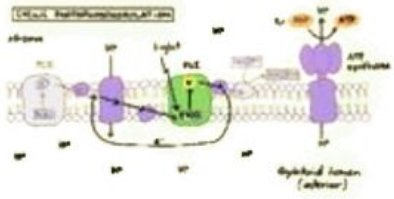
Photosystem II (P680)→Photolysis→ETC→Chemiosmosis→NADP→Photosystem I (P700)

Citric Acid/Krebs Cycle



substrate-level phosphorylation→ATP+pyruvate
pyruvate+coenzyme A→acetyl CoA
products=3 NADH, 1 ATP, 1 FADH, CO_2

Cyclic Photophosphorylation

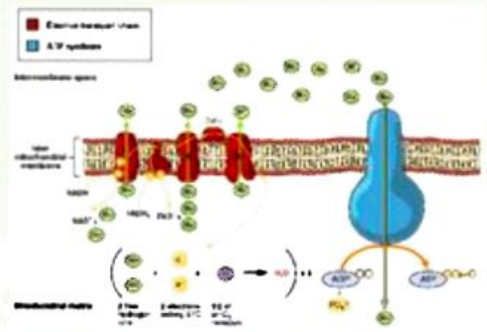


Cycles electrons from P680 ETC→P700→primary electron acceptor→cytochrome complex (ETC)

Photorespiration, C-4, & CAM

Photorespiration	rubisco binds with O_2 instead of CO_2; produces no ATP or sugar
C-4 plants	**use alternate C-fixation (PEP carboxylase) that ends in a 4C compound (occurs in mesophyll & bundle sheath cells)**
CAM plants	carbon fixation to organic acids at night→light reactions release CO_2 in the day

ETC/Oxidative Phosphorylation/Chemiosmosis

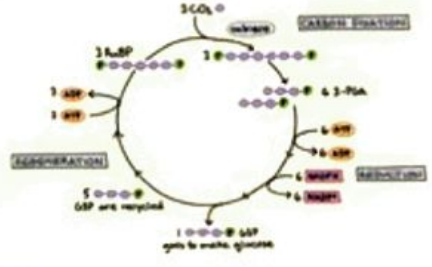


chemiosmosis= energy-coupling mechanism using potential energy in H^+ gradient; phosphorylates ADP→ATP
oxygen=final hydrogen acceptor

Fermentation

facultative anaerobes	tolerate, but do not use, O_2
obligate anaerobes	**cannot live in an environment w/O_2**
alcohol fermentation	converts pyruvate into ethyl alcohol+CO_2 & oxidizes NADH to NAD^+
lactic acid fermentation	**reduces pyruvate into lactic acid (lactate) & oxidizes NADH to NAD^+**

Calvin Cycle



Population Ecology

biotic/abiotic factors→response: acclimate, regulate, conform, migrate, torpor, etc.

fundamental niche=range of factors/resources a species could use

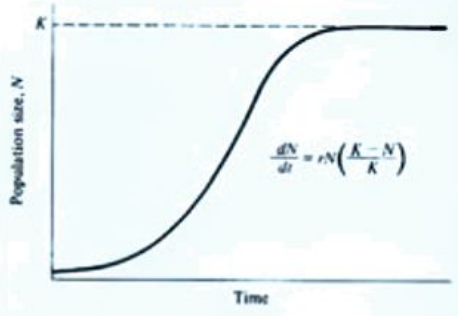
realized niche=actual use of potential environment

uniform dispersion=evenly spaced

random dispersion=unpredictable spacing

clumped dispersion=aggregate in patches

Logistic Growth



K-selection=sensitive to population density
r-selection=maximizes r (reproductive rate)
density independent= pop. density does not affect birth/death rate
density dependent= ↑ pop. density→ ↓ birth rate/ ↑ death rate

Species Richness and Diversity

species richness	# of different species in a community
species diversity	# & size of each population in a community
relative abundance	proportion of different species in a community
dominant species	most abundant species w/ highest biomass
keystone species	has pivotal ecological role/niche

Interspecific Interactions

Competitive Exclusion Principle

> 2 species can't survive in the same ecological niche; fundamental≠realized

Interspecific Interactions (cont)

Predation

> +/-; adaptions: cryptic/aposematic coloration, Batesian/Müllerian mimicry

Symbiosis

> -parasitism: +/-, endo & ecto
> -mutualism: +/+, obligate vs facultative
> -commensalism: +/0 interaction

Community Disturbance

primary succession	colonization by pioneer organisms (bacteria/algae/lichens/moss) in a virtually lifeless area to form soil
secondary succession	colonization of an area where the existing community was cleared but soil is intact

Learning

habituation	loss of responsiveness to stimuli w/no new info
imprinting	formation of permanent long-lasting response to an individual during sensitive period
spatial	**landmarks, cognitive maps**
associative	classical/operant conditioning
cognitive	awareness, reasoning, judgment →problem solving

Social Behavior

cooperation	behavior done as a group
agonistic	aggressive behavior
dominance hierarchies	dictate social position of an animal in a culture
territoriality	behavior to defend an area from others
altruism	↓ individual's reproductive fitness, ↑ fitness of colony

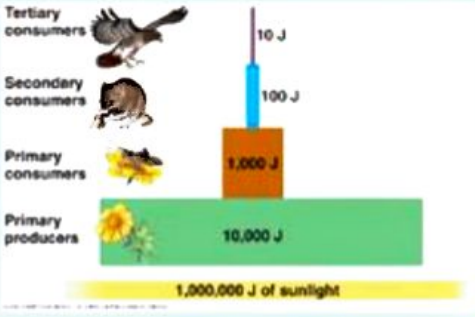
Chemical Cycles

Water	evaporation, condensation, precipitation, runoff/transpiration
Carbon	photosynthesis & respiration, burning fossil fuels
Nitrogen	fixation: free nitrogen→NH_4^+ nitrification: NH_4^+→nitrites/ates denitrification: nitrates→N_2 decomposition: organic matter→ ammonia

Animal Behavior

Proximate Cause	how a behavior occurs/is modified
Ultimate Cause	why behavior occurs in context of natural selection
Fixed Action Pattern	highly stereotypic behavior that is unchangeable and carried to completion
Sign Stimulus	external cue that triggers FAP exchanged within a species=releaser
Communication	visual (waggle dance), chemical (pheromones), tactile, & auditory (birdsong)
Kinesis & Taxis	change in activity in response to stimulus; oriented movement toward/away from stimulus

Ecosystem Energy Flow



bottom-up model: influence from low→high
top-down (trophic cascade) model: influence from high→low
biological magnification: ↑ trophic level= ↑ accumulated toxin concentration

Types of Tissues

Epithelial	covers outside of body, lines inner organs & cavities
Connective	binds & supports other tissues (collagenous, reticular, & elastic fibers)
Muscle	body movement; skeletal=voluntary, cardiac+smooth=involuntary
Nervous	senses stimuli & transmits signals as nerve impulses

Maintaining Homeostasis

Thermoregulation

- ectotherms=warmed externally
- endotherms=warmed by metabolism
- poikilotherm=temp varies w/environment
- homeotherm=relatively constant temp
- -insulation, vasodilation, vasoconstriction, sweating, thermogenesis, behavior

Osmoregulation

- manages water/solute concentration
- regulate urine concentration/amount

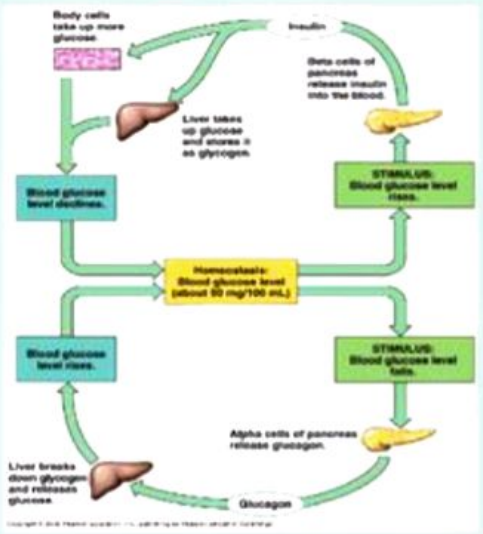
Hormones

hormone	molecule secreted into extracellular fluid that circulates in blood/hemolymph, & communicates regulatory messages
endo/exo-crine glands	ductless/duct-having organs that secrete substances
local regulators	secreted molecules that act over short distances & reach target cells by diffusion (cytokines, growth factors, NO, prostaglandins)
pheromones	chemicals released into external environment for a species to communicate

Endocrine/Nervous System Coordination

hypothalamus	integrates systems, initiates endocrine signaling from nerve info
pituitary gland	stores & secretes hormones from hypothalamus (anterior & posterior)
thyroid gland	thyroid hormone regulates bioenergetics, maintains BP, HR, muscle, digestion

Hormone Pathway: Insulin

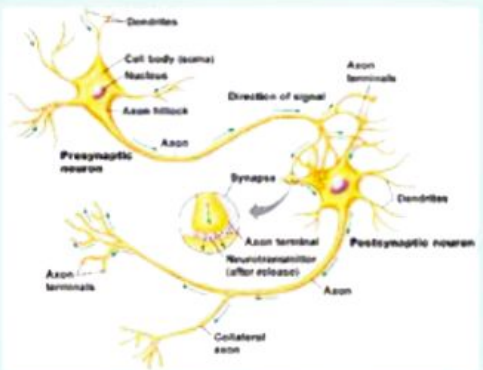


negative feedback= loop in which response reduces initial stimulus

type 1 diabetes= immune system destroys beta cells of pancreas

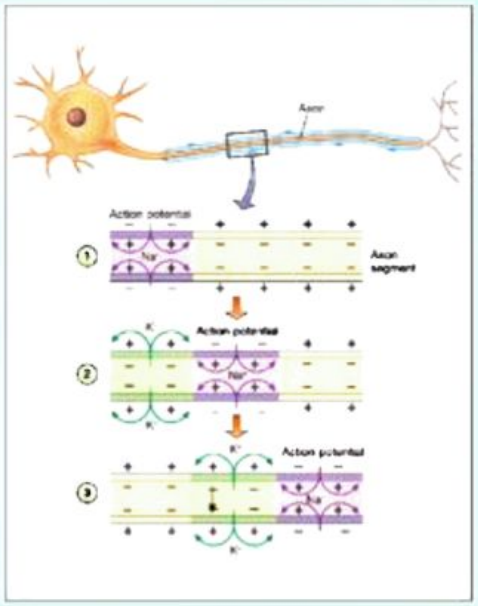
type 2 diabetes= failure of target cells to respond to insulin

Neurons



sensory, inter-, and motor neurons

Action Potentials



purple= depolarized; green= refractory period; yellow= polarized

Nonspecific Immune Defense

Barriers

- skin, mucus, cilia, stomach acid

Systems

- -inflammatory response: histamine ↑ blood flow→ immune cells destroy pathogens
- -interferon: inhibits virus reproduction
- -fever: ↓ bacterial growth, stimulates immune system

Specific Immune Defenses

Humoral Immune Response

- B cells attack pathogens w/antibodies

Cell-Mediated Response

- T cells attack pathogens, cells w/pathogens, & cancer cells by lysing them

TEETH (ECTOMESODERMAL IN ORIGIN)

→ ECTODERM → ENAMEL (SECRETED BY AMLEOBLAST CELLS)

→ MESODERM → DENTINE (SECRETED BY ODONTOBLAST CELLS)

↳ Surrounds the pulp cavity.

→ COMPOSITION — INORGANIC SALT 96%; WATER 3%; PROTEIN 1%.

FOUR TYPES OF TEETH ARE FOUND IN MAMMALS

① INCISORS — Cutting; Long Chisel like

② CANINE — SHARP; POINTED FOR TEARING.

DIASTEMA — SPACE BETWEEN TEETH INABSENCE OF CANINES IN HERVIVORES.

③ PRE MOLARS — TRIANGULAR IN SHAPE (CHEWING AND CRUSHING OF FOOD)

④ MOLARS — CHEWING AND CRUSHING OF FOOD (RECTANGULAR)

DENTAL FORMULA — $\frac{2,1,2,3}{2,1,2,3}$ → ADULT $\frac{2,1,0,2}{2,1,0,2}$ - CHILD

HOMEOSTATIC REGULATION OF TUBULAR REABSORPTION AND TUBULAR SECRETION.

① RENIN - ANGIOTENSINOGEN - ALDOSTERONE SYSTEM

WHEN BLOOD VOLUME AND BLOOD PRESSURE DECREASES.

↓

AFFERENT ARTERIOLES ARE STRETCHED LESS.

↓

JG CELL → RELEASE RENIN

↓

CONVERTS ANGIOTENSINOGEN

↓

ANGIOTENSIN I
(10 AMINO ACID)

↓

ACTIVE ← ANGIOTENSIN II
(8-AMINO ACID)

DECREASE IN GFR BY VASOCONSTRICTION OF AFFERENT ARTERIOLES.

ENHANCES REABSORPTION OF Na^+, Cl^-, AND WATER IN PCT.

STIMULATES ADRENAL CORTEX TO RELEASE ALDOSTERONE.

INCREASES REABSORPTION OF Na^+, Cl^- IN DCT AND COLLECTING DUCT. AND SECRETES MORE K^+

H_2O IS REABSORBED

TONGUE

- ATTACHED TO THE FLOOR OF THE MOUTH BY A FOLD CALLED LINGUAL ~~FRENELUM~~FRENULUM.
- ATTACHED VIA HYOID BONE TO POSTERIOR PART.
- SULCUS TERMINALIS DIVIDES THE UPPER SURFACE OF TONGUE INTO ANTERIOR OVAL PART AND POSTERIOR PHARYNGEAL PART.
- FORAMEN CAECUM – SMALL MEDIAN PIT IN SULCUS TERMINALIS.

PAPILLAE (LITTLE PROJECTIONS)

UPPER SURFACE OF TONGUE HAS FOUR TYPES OF PAPILLAE

i) VALLATE PAPILLAE OR CIRCUMVALATE PAPILLAE :- Largest → 8-12 in number, Contains taste Buds.

ii) Filliform Papillae :- Smallest and Most numerous; conical THEY HAVE TACTILE RECEPTORS BUT LACKS TASTE BUD.

iii) FUNGIFORM PAPILLAE :- ROUND & NUMEROUS; PRESENT IN ANTERIOR PART OF TONGUE. HAS 5 taste Buds.

iv) FOLIATE PAPILLAE :- NOT DEVELOPED IN HUMANS.

HUMAN DENTITION HAS THE FOLLOWING FEATURES

① DIPHYODONT – TEETH APPEAR TWICE IN LIFE → MILK TEETH, → PERMANENT TEETH.

(PRE MOLAR AND 3rd MOLAR ~~AND~~ ARE NOT DIPHYODONT)

② THECODONT – TEETH OCCURS IN SOCKETS

③ HETERODONT – DIFFERENT SETS OF TEETH

SALIVARY GLAND

① PAROTID GLAND (LARGEST) – STENSON DUCT ; 25% of SECRETION;

② SUB MAXILLARY / SUB MANDIBULAR – WARTON DUCT - 75%.
SECRETION ↓ LONGEST SALIVARY DUCT

③ SUB LINGUAL – SMALLEST SALIVARY GLAND ; DUCT OF RHINIVIS
MINIMUM SECRETION (5-10%)

SALIVA – DAILY SECRETION - 1500ml ; PH - 6.8 ; COMPOSITION - H_2O (99%)
LYSOZYME ; MUCUS AND THIOCYNATE ; IGA ANTIBODY AND UREA.

DIGESTION AND ABSORPTION

THE PROCESS OF CONVERSION OF COMPLEX FOOD SUBSTANCES INTO SIMPLE AND ABSORBABLE FORM IS CALLED DIGESTION

↳ CATABOLIC PROCESS.

CARRIED OUT BY OUR DIGESTIVE SYSTEM BY MECHANICAL AND ~~BIOCHE~~- BIOCHEMICAL METHOD.

IT INCLUDES

→ INGESTION
→ SECRETION
→ MIXING AND PROPULSION
→ DIGESTION
→ ABSORPTION
→ DEFECATION

ALIMENTARY CANAL

→ MOUTH TO ANUS
→ 5-7 m in living person
→ 7-9 m in cadaver due to loss of Muscle tone.

ORIGIN

→ ECTODERMAL → ORAL CAVITY, ANAL CANAL AND ANUS

→ ENDODERMAL → PHARYNX, OESOPHAGUS, STOMACH, SMALL INTESTINE AND LARGE INTESTINE.

MOUTH

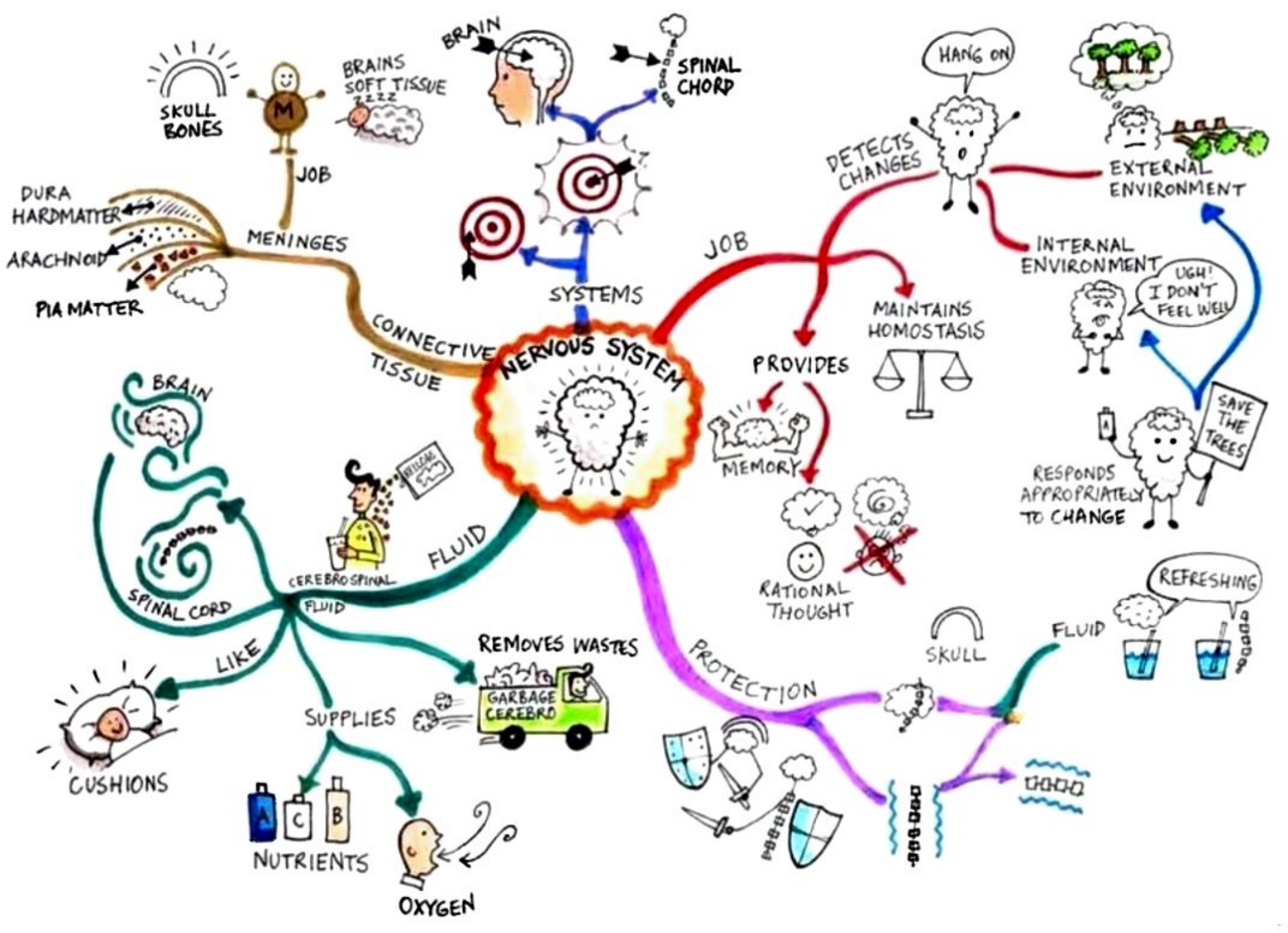
MOUTH OPENS IN THE BUCCO PHARENGIAL CAVITY

IT IS DIVIDED INTO →

- BUCCAL VESTIBULE
  IT IS THE SPACE BETWEEN CHEEKS AND GUMS.
- MAIN ORAL CAVITY
  - INNER AND CENTRAL PART OF MOUTH
  - IT IS SURROUNDED BY UPPER AND LOWER JAW AND IS LINED BY STRATIFIED SQUAMOUS EPITHELIUM.

PALATE → ROOF OF ORAL CAVITY

- HARD PALATE — ANTERIOR PART OF THE PALATE MADE UP OF MAXILLA AND PALENTINE BONE.
  — IT BEARS TRANSUERSE RIDGES CALLED RUGAE.
- SOFT PALATE — SMOOTH POSTERIOR PART OF PALATE. LINED BY STRATIFIED SQUAMOUS EPITHELIUM.
  - FREE PART OF SOFT PALATE HANGS DOWN AS A SMALL FLAP → CALLED UVULA.


NERVOUS SYSTEM
CONNECTIVE TISSUE
MENINGES
DURA HARDMATTER
ARACHNOID
PIA MATTER
JOB
SKULL BONES
BRAINS SOFT TISSUE
SYSTEMS
BRAIN
SPINAL CHORD
JOB
DETECTS CHANGES
HANG ON
EXTERNAL ENVIRONMENT
INTERNAL ENVIRONMENT
UGH! I DON'T FEEL WELL
MAINTAINS HOMOSTASIS
PROVIDES
MEMORY
RATIONAL THOUGHT
RESPONDS APPROPRIATELY TO CHANGE
SAVE THE TREES
FLUID
CEREBROSPINAL FLUID
BRAIN
SPINAL CORD
LIKE
CUSHIONS
SUPPLIES
NUTRIENTS
OXYGEN
REMOVES WASTES
GARBAGE CEREBRO
PROTECTION
SKULL
FLUID
REFRESHING

Organelles

Mitochondria
- crista
- inner membrane
- matrix
- outer membrane
- for enzymes of respiration
- Large surface area
- highly folded inner membrane
- Surround fluid-filled matrix
- two membranes
- latter stages of aerobic respiration

Cilia


- made of microtubules
- Extend from cell surface

Smooth Endoplasmic Reticulum
- phospholipids
- cholesterol
- triglycerides
- production of...

Rough Endoplasmic Reticulum

- enclosing fluid-filled space
- Flat membrane sacs
- protein synthesis
- Ribosomes

Chloroplasts

- site of photosynthesis
- large surface area
- several internal membranes

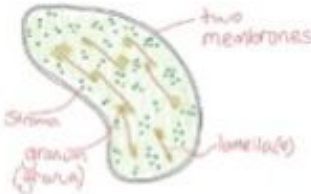
Lysosomes

- contains digestive enzymes
- destroys worn-out parts of cell
- Single membrane

Ribosomes


- attached to RER or free in cytoplasm
- protein synthesis

Plasma Membrane
- retains cell contents

Nuclear Envelope


- Ribosomes on outer surface
- Similar to R.E.R.
- double envelope membrane
- separates nucleus from cytoplasm

Nucleus
- contains genetic information
- as DNA in chromosomes

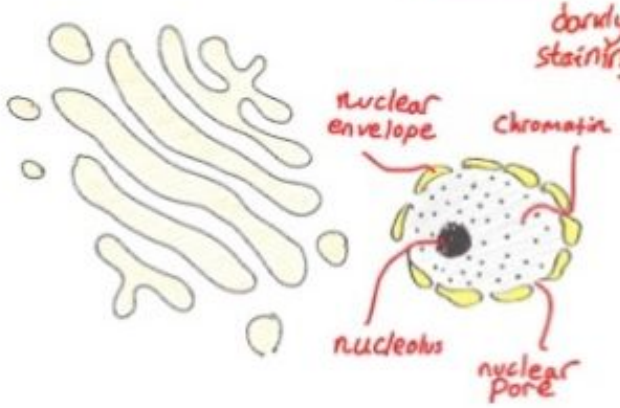
Microtubules
- pathways within cells
- cytoskeleton
- forms spindle fibres
- (mitosis)
- made of tubulin

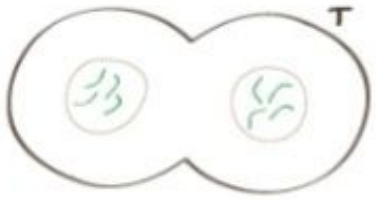
Nucleolus
- densly staining
- produces ribosomes

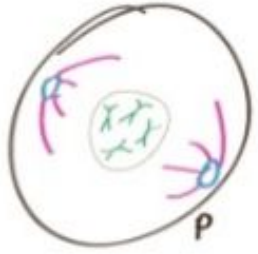
Microfilaments
- made of actin
- part of cytoskeleton

Golgi Apparatus
- modifies proteins
- packages proteins
- produces lysosomes
- Vesicles form around edge
- Pile of flat sacs

Centriole
- made of microtubules







mitosis

Prophase

- become double-stranded structures
- chromosomes reorganise
- spindle fibres start to form
- chromatin condenses to form visible chromosomes
- Nuclear envelope breaks down

Metaphase

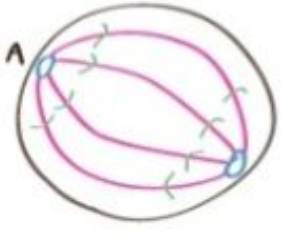
- chromosomes attach to spindle fibres
- by their centromeres

Anaphase

- centromeres divide (split)
- spindle fibres pull chromatids
- to opposite ends of the cell

Telophase

- cytokinesis starts
- Nuclear envelopes reform
- chromosomes unravel
- return to chromatin



DNA Replication

Initiation
(separation of strands)

Step #1

Prok: one origin
Euks: many origins

replication origin

nick in A>T base pairing
(fewer H-bonds [2] so easier to pull apart)

initiator proteins (recruit other proteins and unwind DNA)

5' 3' 3' 5'

Helicase binds to fork: in unwound DNA to recruit DNA Polymerase

Single-stranded binding proteins prevent strands from reannealing
(DNA polymerase can push them aside)

Priming
(DNA Polymerase needs a primer to start DNA synthesis)
Requires free 3' OH group

Step #2

Primase
5' RNA 3'
primer 10-20 nt in length

5' 3'
DNA Polymerase III

Synthesis
DNA polymerase adds to 3' end according to Watson-Crick base pairing rules [but 1 mistake every 10^6 bases]

Step #3

Cleavage of triphosphate provides energy

5' HO Base O OH 3' NTP
nucleoside triphosphate

Okazaki fragments
5' 3' 3' 5'

replication bubble

leading strand synthesizes continuously
lagging strand has to reinitiate synthesis as replication fork moves along
lagging
leading
replication fork

$5 \cdot 10^4$ nucleotides synthesized continuously on leading strand

Step #4

semiconservative

Proofreading
(DNA polymerase sometimes adds the wrong nucleotide)
→ proofreading catches 99% of mistakes (makes 1 mistake per 10^9 bases)

Adds wrong nucleotide

Mispaired nucleotide removed by 3'-5' exonuclease

"exo": cuts from ends
"endo": cuts in middle

Correct base added, synthesis continues

Antivirals
: block DNA replication b/c viral polymerase takes up these "bases" and has no 3' end to extend

Guanine
HOCH2 O CH2
H2C
acyclovir

Thymine
HOCH2 O
H H H H
N3 H
AZT
azide group

phosphorylated in own cells but our DNA polymerase doesn't use

Step #5

sliding clamp protein (attaches DNA polymerase tightly to DNA)
helicase
primase
single-stranded binding proteins
RNA primer
DNA Polymerase III associates with helicase to be closer to the start of the next fragment

Ligation

DNA Pol I degrades primer (5'-3' exonuclease) and synthesizes new DNA (nick moves along) (nick translation)

DNA Pol III
DNA Pol I
DNA ligase
DNA Pol I

DNA ligase joins free 3' hydroxyl and 5' phosphate

DNA synthesis continues until primer reached
nick translation
ligation
nick sealed

Telomeres
(protein-DNA structures at end of chromosomes: indicate chromosomes intact, protect coding DNA from chromosome shortening)

Protein-DNA structure
5' 3'
3' overhang displaces strand (complementary) section

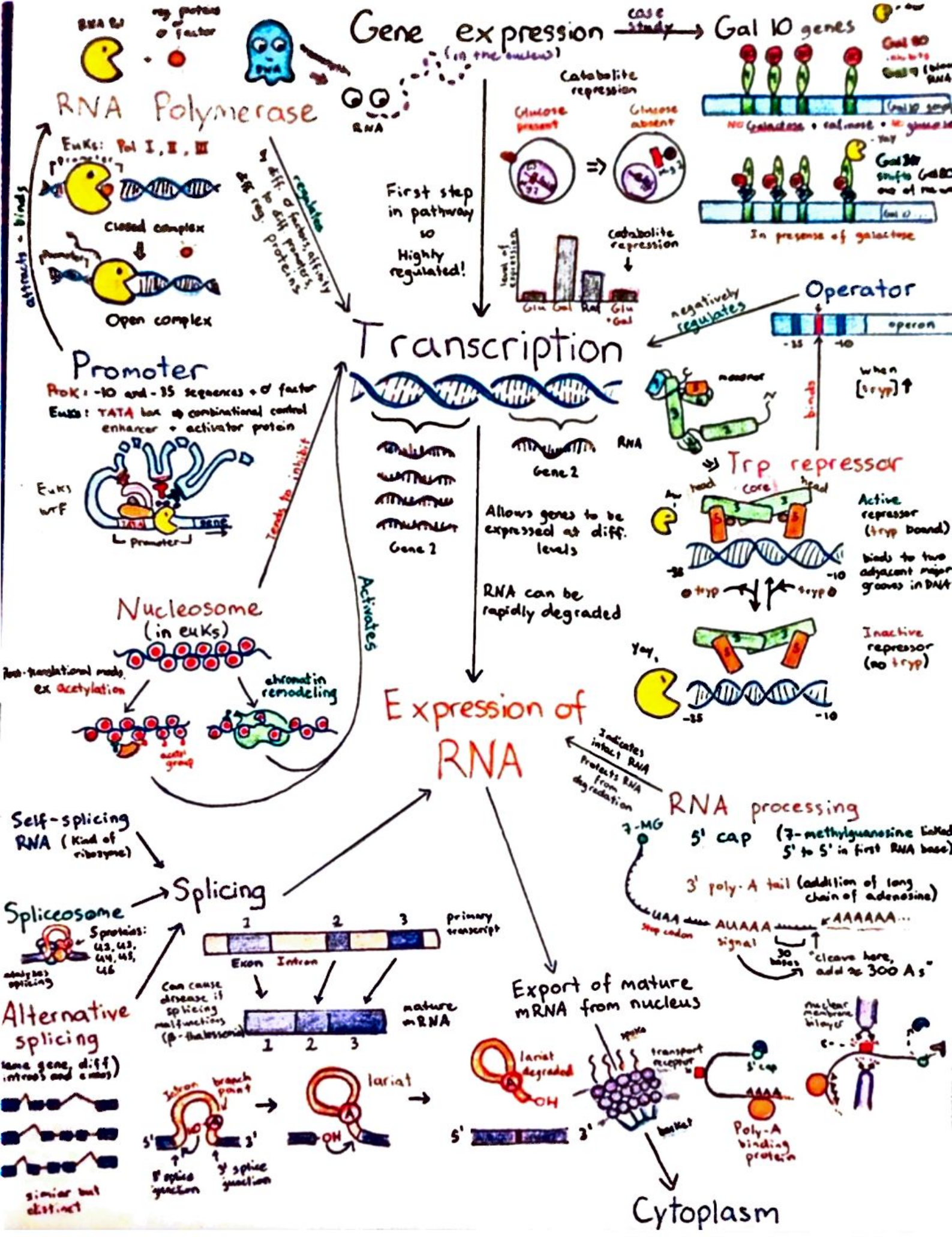
leading strand ∴ shortens each time
3' 5'
primer removed
strand incomplete!

Telomerase expressed in germ line cells
ex. gametes, stem cells

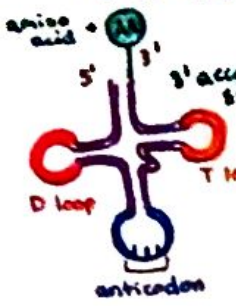
synthesis
telomerase
RNA template
new synthesis

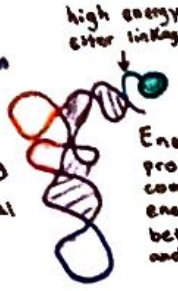
No telomerase in somatic cells so cancer cells abnormally express telomerase

Without telomerase chromosomes shorten after each replication
Mutations in DNA accumulate so length of telomeres tell cells when to stop dividing


Gene expression
case study
Gal 10 genes
(in the nucleus)
RNA
RNA Polymerase
Euks: Pol I, II, III
Closed complex
Open complex
attracts + binds
regulates
First step in pathway so Highly regulated!
Catabolite repression
Glucose present
Glucose absent
Catabolite repression
In presence of galactose
Transcription
Promoter
Euks: TATA box + combinational control
enhancer + activator protein
Nucleosome (in euks)
post-translational mods ex acetylation
acetyl group
chromatin remodeling
Activates
Tends to inhibit
Gene 1
Gene 2
RNA
Allows genes to be expressed at diff. levels
RNA can be rapidly degraded
Operator
negatively regulates
operon
when [tryp] ↑
Trp repressor
Active repressor (tryp bound)
binds to two adjacent major grooves in DNA
Inactive repressor (no tryp)
Expression of RNA
Indicates intact RNA
Protects RNA from degradation
RNA processing
5' cap (7-methylguanosine linked 5' to 5' in first RNA base)
3' poly-A tail (addition of long chain of adenosine)
AUAAA signal
"cleave here, add ≈ 300 As"
Self-splicing RNA (kind of ribozyme)
Splicing
Spliceosome
Proteins: U1, U2, U4, U5, U6
primary transcript
Exon
Intron
Alternative splicing
Can cause disease if splicing malfunctions (β-thalassemia)
mature mRNA
lariat
Export of mature mRNA from nucleus
lariat degraded
Poly-A binding protein
Cytoplasm

tRNA





internal base pairing + unconventional bases

Energy for protein synthesis comes from high energy ester link between tRNA and amino acid

base pairing codon-anticodon crucial to specificity

Wobble

Some tRNA only require accurate base pairing at first two positions of the codon

determines protein product

Genetic code

A group of three bases (a codon) specifies one amino acid

Features

- Universal (evolved only once)
- Redundant
  - 64 possible codons for 20 amino acids
  - Frequently used amino acids have more codons
  - Ser → 6 codons
  - Trp → 1 codon
  - Functionally related amino acids have similar codons
  - Redundancy occurs at wobble position

Asp	Glu	Gln
GAC	GAG	CAG
GAU	GAA	CAA

- Nonoverlapping
- No gaps

Translation

crucial to specificity

can harm

Polyribosome

Mutations

Missense: one base change results in amino acid change

Ala → Gly
GCC → GGC
Can be ok if change conservative

Frameshift: insertion/deletion of base changes reading frame from point of mutation onwards

GCC	GAG	UAU
Ala	Glu	Tyr
Ala	Arg	Val

GCCAGAUUAU

Usually extremely detrimental

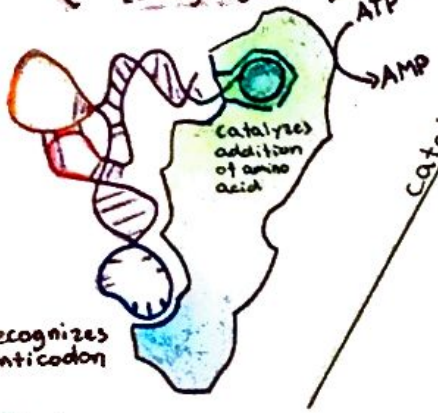
Nonsense: change of amino acid codon into premature stop codon

Tyr
... UAU ...
... UAA ...
Stop

Results in truncated protein

Aminoacyl tRNA synthetases

(attach amino acids to tRNAs [charging])



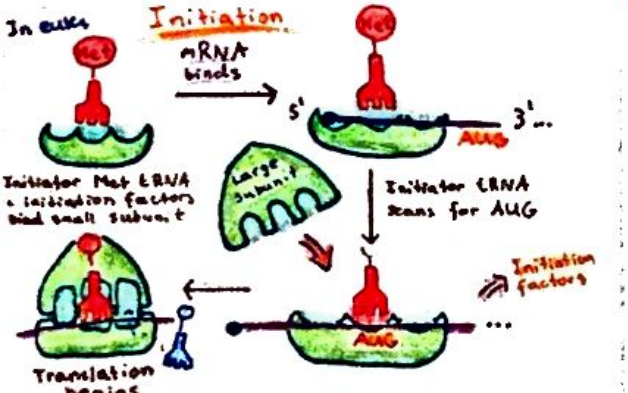
catalyzes

A - aminoacyl - tRNA
P - peptidyl - tRNA
E - exit

Ribosome

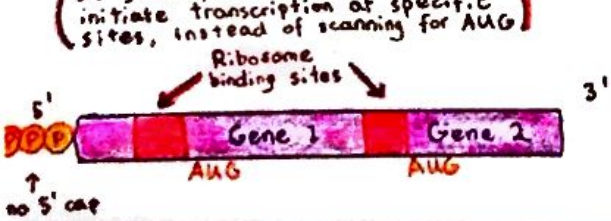
Initiation

In eukes



In procaryotes

(No genes polycistronic, ribosomes initiate transcription at specific sites, instead of scanning for AUG)



Step 1

tRNA to codon base pairing

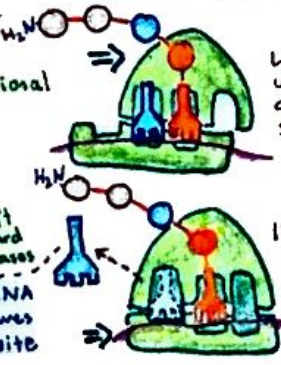
A t RNA carrying an amino acid binds to the vacant A-site

Step 2

Peptidyl transferase activity

The carboxyl end of the polypeptide chain is uncoupled from the t RNA in the P-site and joined to the amino acid in the A-site

Step 3



Conformational change

Large subunit undergoes conformational shift

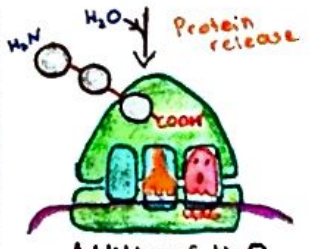
small subunit moves forward exactly 3 bases

tRNA leaves E-site

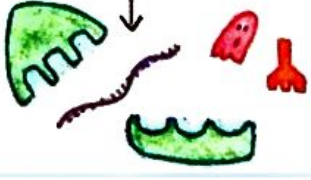
1st tRNA leaves (back to step 1)

Termination

Stop codon binds release ghost



Addition of H_2O catalyzed instead of new amino acid



DNA Packaging in Chromatin

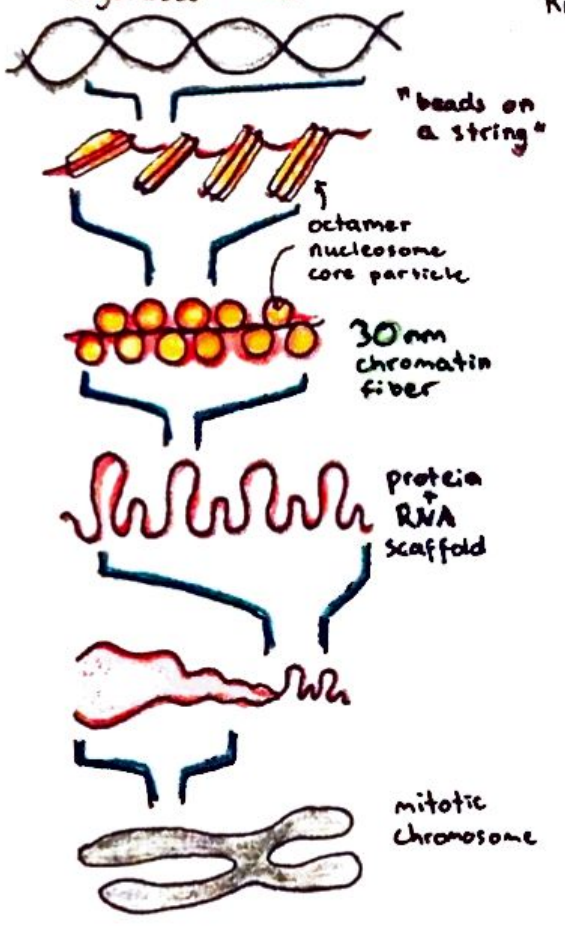
Purpose

Human genome is about $3 \cdot 10^9$ bp long

↳ 102 cm at 0.34 nm per base pair

∴ Must be condensed 10,000 fold

Chromatin: complex of DNA/protein that condenses DNA in highly organized manner



Histones

(Eukaryotic proteins involved in condensing DNA. Very highly conserved)

First level (the protein)

5 types: H1, H2A, H2B, H3, H4

High conservation means entire protein important in function

Rich in positively charged basic lysine and arginine residues

Octamer of 2x (H2A, H2B, H3, H4) → Nucleosome core particle

First level (proteins + DNA)

Nucleosome

(Nucleosome core particle plus Adjacent linker region)

"beads on a string"

200 bp DNA in nucleosome

Second level

30 nm Chromatin Fibers

(Second level of DNA packaging: 30 nm in width)

Requires histone H1

Structure still controversial [one start helix or two start helix]

H1 creates regular angle of adjacent linker region

∴ forms regular repeating pattern

Higher levels

Higher Levels of DNA Packaging

30 nm fibers → Loops of 30-200 Kbp

Loops anchored to nuclear matrix, made of RNA and non-histone proteins

Chromatin Remodeling

(Chromatin remodeling complexes change nucleosome structure to allow access to DNA)

methylation, acetylation, phosphorylation

↓

Covalent modification of histone H3 tail influences nucleosome structure

Cancer → Metastasis + Angiogenesis

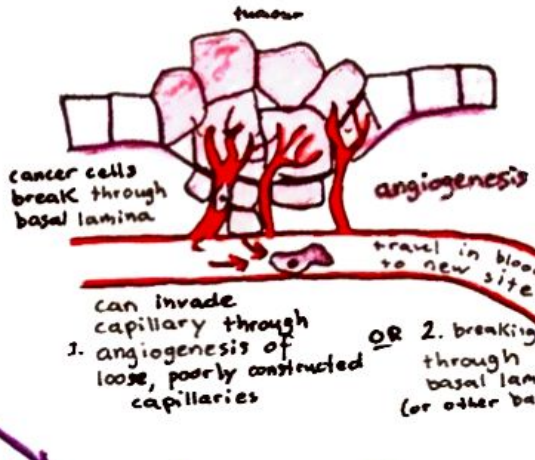
- leading cause of death in North America
- 25% of all deaths
- characterized by genetic and biochemical defects (disease of biomolecules)

Benign tumours

Encapsulated, do not spread

Malignant tumours

Invasive, tend to spread



Cancer cells attract capillaries to them (get own nutrient supply, grow and spread)

Causes of Cancer

Genetic - cancer susceptibility inherited
- ↳ retinoblastoma, xeroderma pigmentosum, etc.

DNA damaging agents
- ↳ carcinogens (cause cells to divide)
  - ↳ division mutagenic
  - ↳ ex. asbestos (tumour promoter)
- ↳ mutagens (damage DNA)
  - ↳ ex. UV light, radiation

Viruses - hepatitis, HIV, HPV

Smoking - 30% of all cancers, 90% of lung cancers
- rise in lung cancers 20 years after rise in smoking
- cigarettes contain 69 chemicals known to cause cancer

Ageing - cancer risk increases with age as mutations accumulate

Properties of Cancer cells

1. Divide in absence of growth factors (do not need signals to divide)
   - ↳ do not respond to control of cell division
2. Do not respond to cell death signals ("immortal")
   - ↳ do not undergo apoptosis
   - ↳ express telomerase so chromosomes don't shorten
3. Lost cell cycle control
   - ↳ cancer cells don't look at checkpoints
     - ↳ more DNA damage

4. Genetically unstable
   - ↳ constantly acquire new mutations
     - ↳ point mutations, copy number variation, chromosomal abnormal
5. Multiply in abnormal places
   - ↳ grow independent of environment (ex. lung cancer can grow in liver)
   - ↳ cancer cells multiply in culture indefinitely
     - ↳ normal cells cannot grow in culture

Cancer Treatments

Surgery - #1 option

Radiation, Chemotherapy - stop cells from replicating by damaging DNA (cisplatin), interfering w/ mitosis (taxol), reducing replication substrates (methotrexate → dNTPs)

Problems → specificity of treatment
- ↳ affect normal cells as well

→ different cancers have different causes
- ↳ diff genes, tissues, locations
- ↳ different diseases

→ heterogeneity of tumour
- ↳ not all cells the same (diff mutations)
- ↳ tumour evolving, dynamic, unstable

→ cancer cells develop resistance to drugs
- ↳ target evolves or is lost
- ↳ overexpress transporters to pump out drug

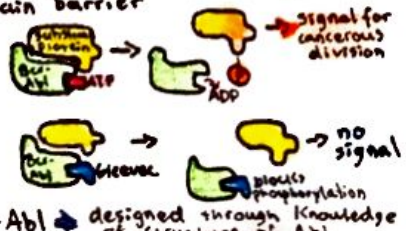
→ inaccessibility of the tumour to drug
- ↳ blood-brain barrier

→ Gleevec

treats chronic myeloid leukemia

used by fusion of Bcr w/ Abl

Gleevec blocks Bcr-Abl → designed through knowledge of structure of Abl

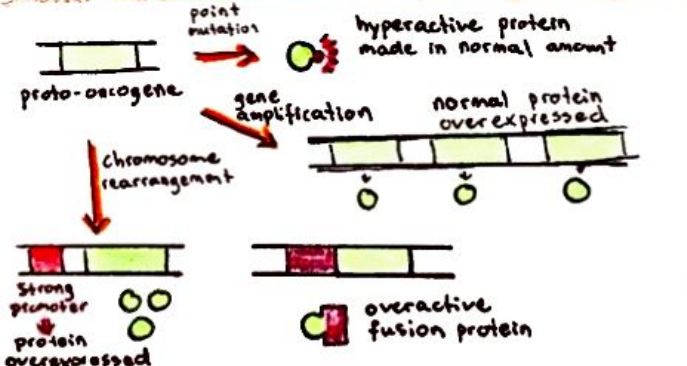


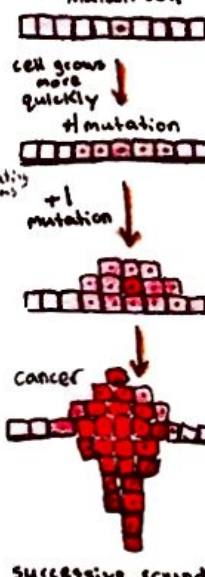
Cancer causing Genes

88 1 activating mutation

Oncogenes	Tumour Supressors
Presence causes cancer	Absence causes cancer
Dominant	Recessive
Gain of function	Loss of function
Overactivity mutation	Underactivity mutation

88 2 inactivating mutations





Functions of cancer causing genes

- cell division
- cell differentiation
- growth factors
- growth factor receptors

- molecules involved in cell-cell interactions
  - ↳ contact inhibition
- regulators of normal or programmed cell death
- transcription factors → over or underexpress key proteins
- DNA repair proteins
  - ↳ more damage

How to clone Your Favourite Gene (YFG) Part 1

Source:
mRNA or (genomic) DNA (but cannot have introns)

To find tissues that express YFG

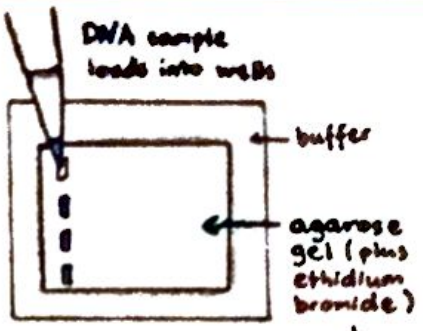
First convert to cDNA
1. Hybridize mRNA w/ Poly-T primer
2. Make DNA copy w/ reverse transcriptase using mRNA as template
3. Degrade RNA w/ alkaline/alkali solution

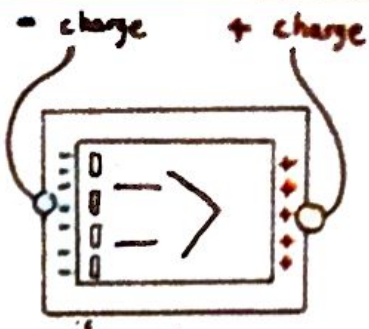
if no introns

Northern Blot

PCR
(exponentially amplifies amount of any DNA)
↳ 1 copy to 2n copies after n cycles
↳ After 30 cycles 2^{30} (~1 billion) copies

Gel purify PCR product
(cut resulting band on gel with a scalpel and extract purified DNA)

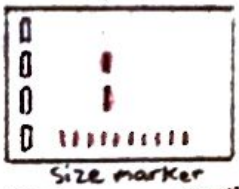




negatively charged pulled to agarose positive
↳ smaller molecules move so get in ge

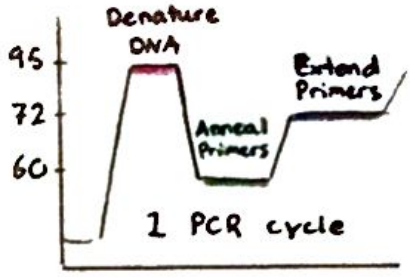
Or can radioactively label 5' ends and X-ray

if ethidium bromide present

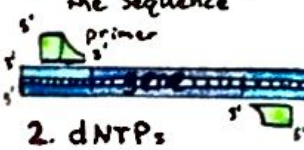


UV

when stained ethidium bro DNA fluores under UV



PCR requires:
1. Primers that flank the sequence



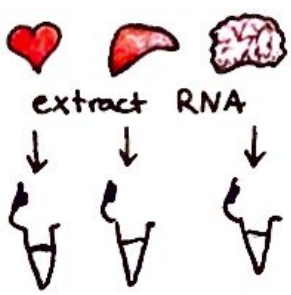
2. dNTPs
3. Heat stable DNA polymerase (Taq poly
4. Template DNA

Denature

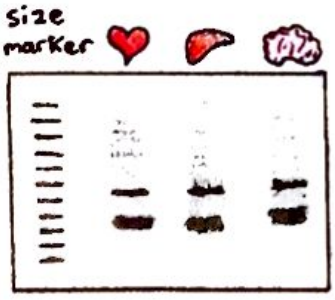
Anneal

Extend

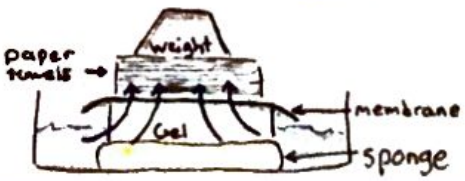
Step 1: Extract total RNA from tissues of interest



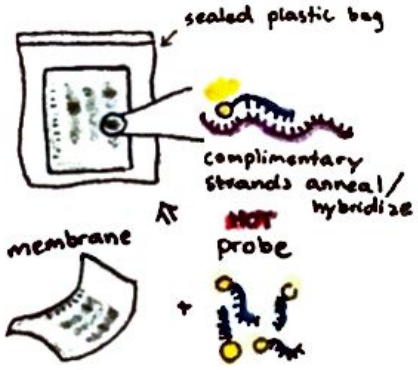
Step 2: Separate by size through gel electrophoresis



Step 3: Transfer RNA to nitrocellulose membrane
↳ RNA will move from gel to membrane by capillary action



Step 4: Probe membrane
↳ with radioactively labelled DNA



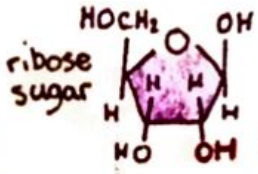
Step 5: Wash away non-specifically bound probe and X-ray
↳ bound probe = RNA shows up as a band

Intro to DNA and RNA

RNA

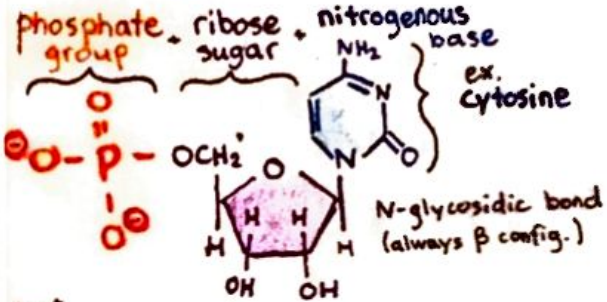
Functions as mRNA, rRNA, tRNA, and more

Uracil instead of Thymine in RNA



Ribonucleotides
(building blocks of RNA)

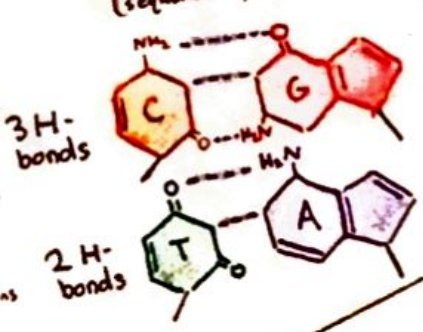
phosphate group + ribose sugar + nitrogenous base



just Sugar + base = nucleoside
(in DNA too. ex. cytidine, adenosine etc)

RNA Structure

- single stranded
- base pairs with itself
- bases more often modified + more modifications
- structure sequence dependent
- base-base pairing
  - hydrophobic interactions like in DNA

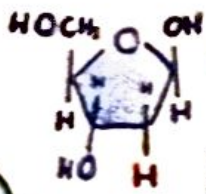


Major/Minor Grooves

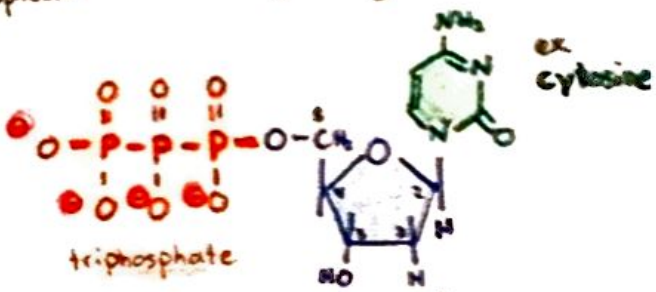
(Results because H-bonding between bases is not symmetric)

DNA

Functions to carry genetic material



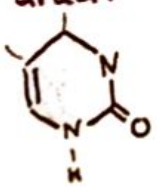
Nucleotides
(building blocks of DNA)



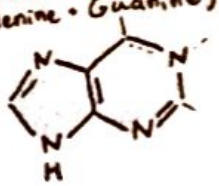
Deoxycytidine triphosphate, a deoxynucleotide

Nitrogenous bases
(planar, hydrogen bond with each other, somewhat hydrophobic)

Pyrimidines
(Cytosine, Thymine, Uracil)



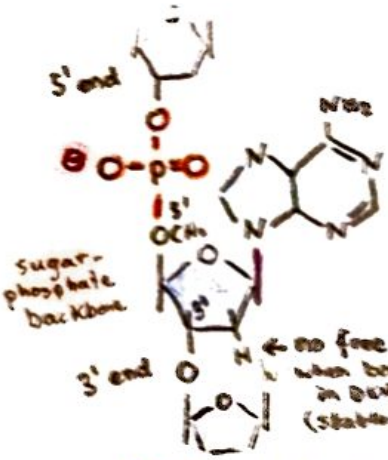
Purines
(Adenine + Guanine)



Polynucleotides

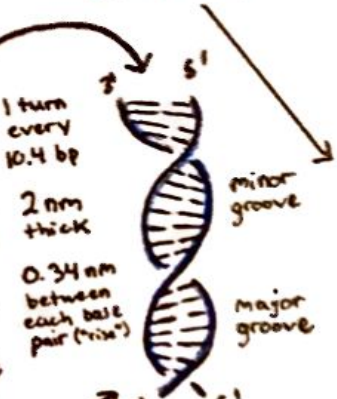
5' G A T C 3'

Sugar residues joined via phosphodiester linkage
C3 – C5
∴ sequences conventionally written 5'-3'



Double Helix of B-DNA
(2 DNA strands associate to form a double helix)

Right-handed, antiparallel

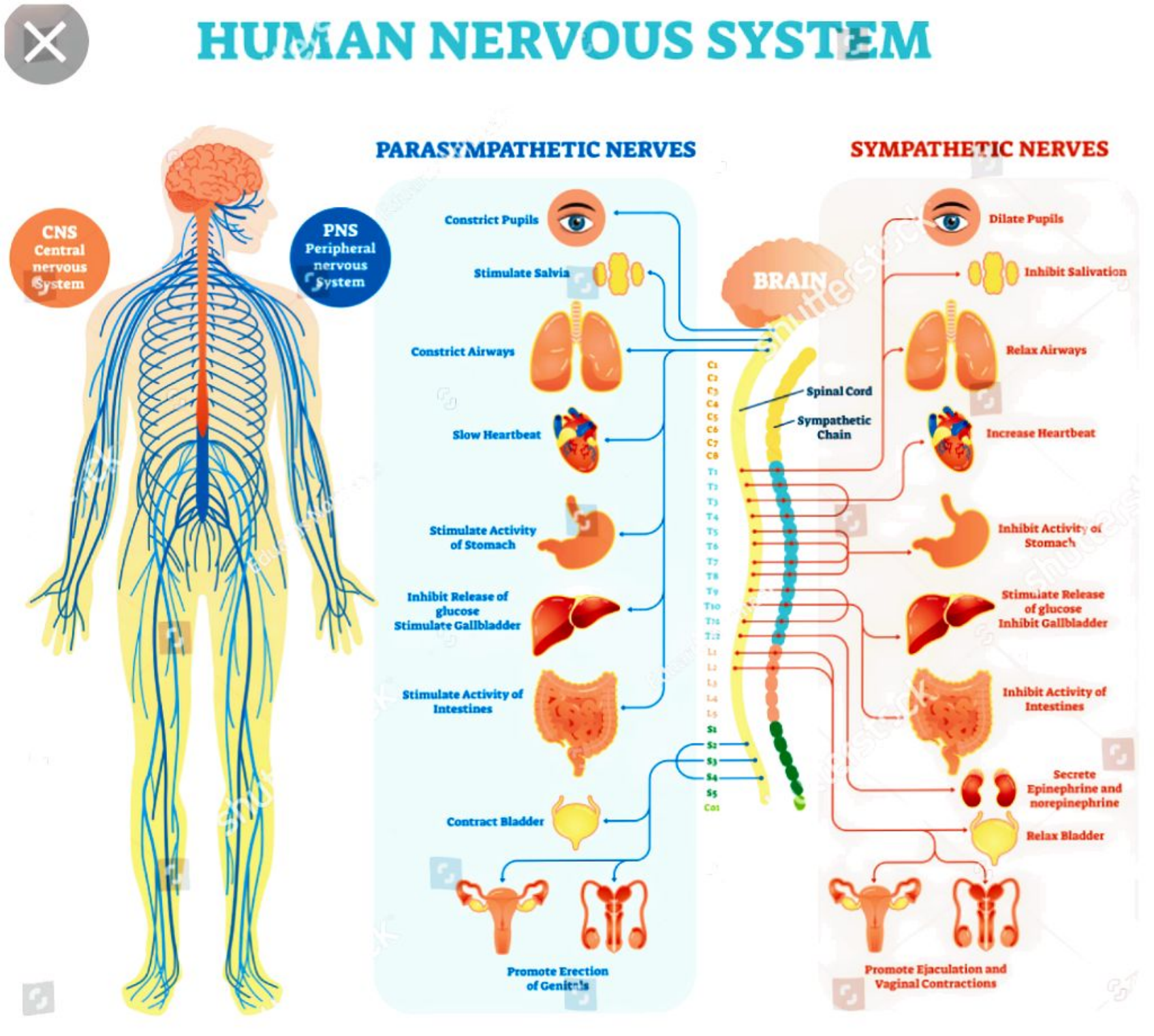


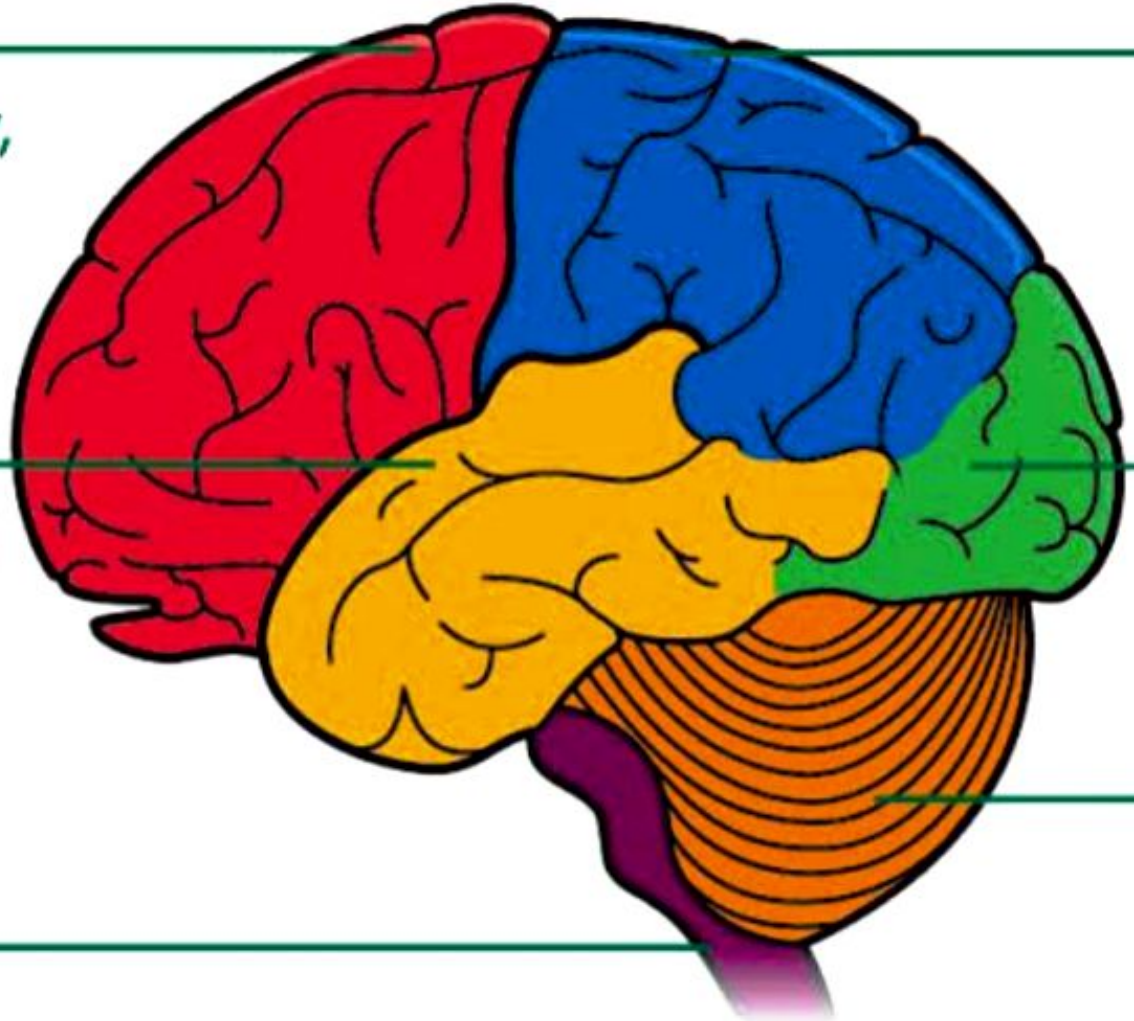
Discovery

- **Chargaff's rules**
  within a species: %A = %T and %G = %C
- **Diffraction pattern**
  Suggested double helix w/ periodicity of 3.4 nm and 10 repeating units
- **Correct tautomeric forms of bases**
  Revealed H-bonding pattern for bases

Hydrophobic Interactions

HUMAN NERVOUS SYSTEM




Frontal lobe (thinking, memory, behaviour and movement)
Parietal lobe (language and touch)
Temporal lobe (hearing, learning and feelings)
Occipital lobe (sight)
Cerebellum (balance and coordination)
Brain stem (breathing, heart rate and temperature)

Nervous system

Central nervous system (brain and spinal cord)

Peripheral nervous system

Autonomic nervous system (communicates with internal organs and glands)

Somatic nervous system (communicates with sense organs and voluntary muscles)

Sympathetic division (arousing)

Parasympathetic division (calming)

Sensory (afferent) nervous system (sensory input)

Motor (efferent) nervous system (motor output)

NERVOUS System Vs ENDOCRINE System

Rapid Control

Regulates long term changes

CHEMICAL TRANSMITTERS

NEUROTRANSMITTERS
produced by neurons

Travel Short distances to effect muscles and glands

=

QUICK, BRIEF RESULTS

HORMONES
produced by endocrine glandular cells

Travel long distances in the blood stream to affect nearly all tissues and organs.

=

SLOW, LONG LASTING RESULTS

pituitary GLAND hormones

adrenocorticotropic hormones
- stimulates secretion of glucocorticoids by the adrenal gland

human growth hormone
- stimulates liver, muscle, cartilage, bone, and other tissue to secrete IGFs

melanocyte stimulating hormone
- may have influence on the brain
- in excess, can cause darkening of the skin

thyroid stimulating hormone
- stimulates the synthesis and secretion of thyroid hormones which regulate metabolism

antidiuretic hormone (ADH)
- conserves body water by decreasing urine volume and decreasing perspiration
- raises blood pressure

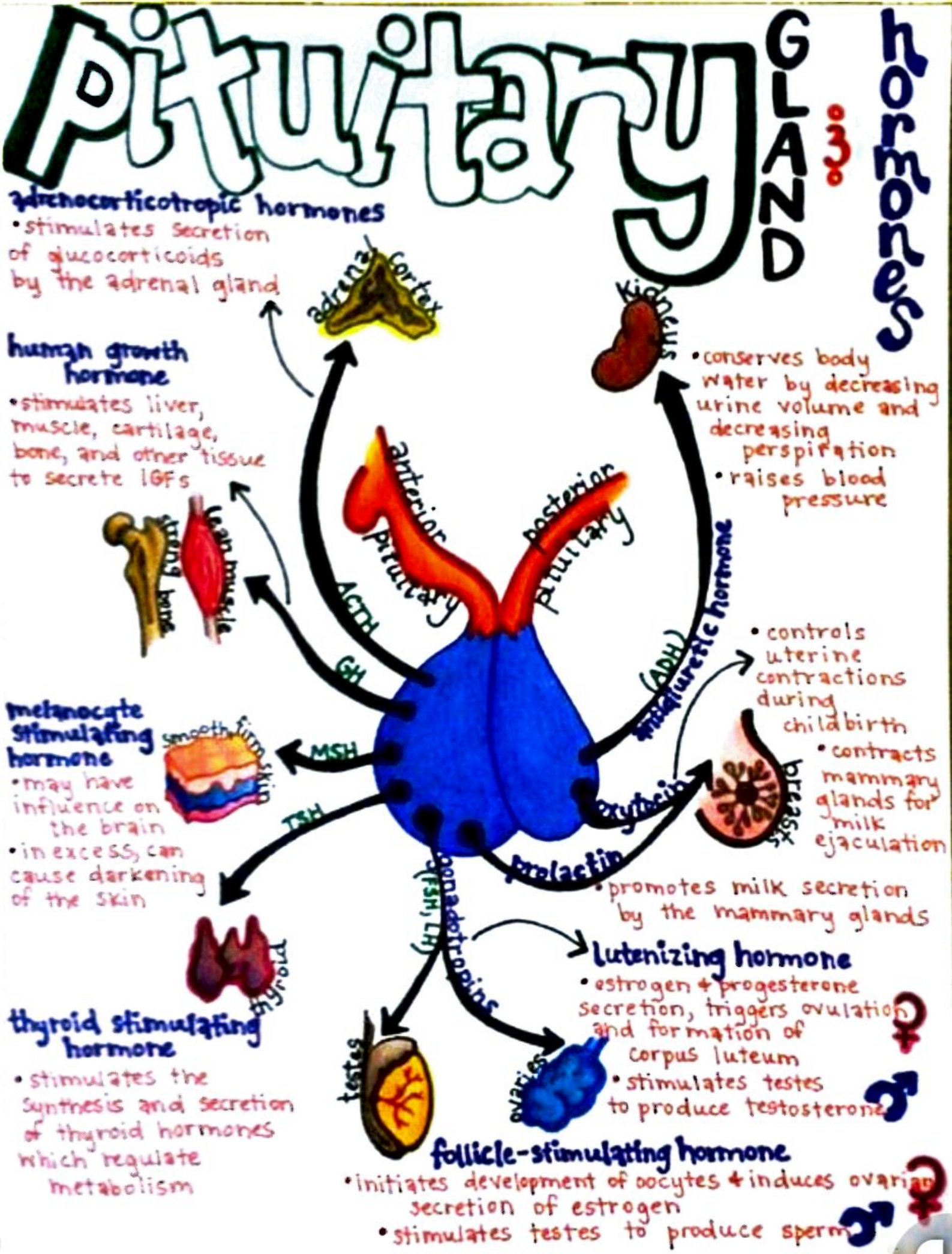
oxytocin
- controls uterine contractions during childbirth
- contracts mammary glands for milk ejaculation

prolactin
- promotes milk secretion by the mammary glands

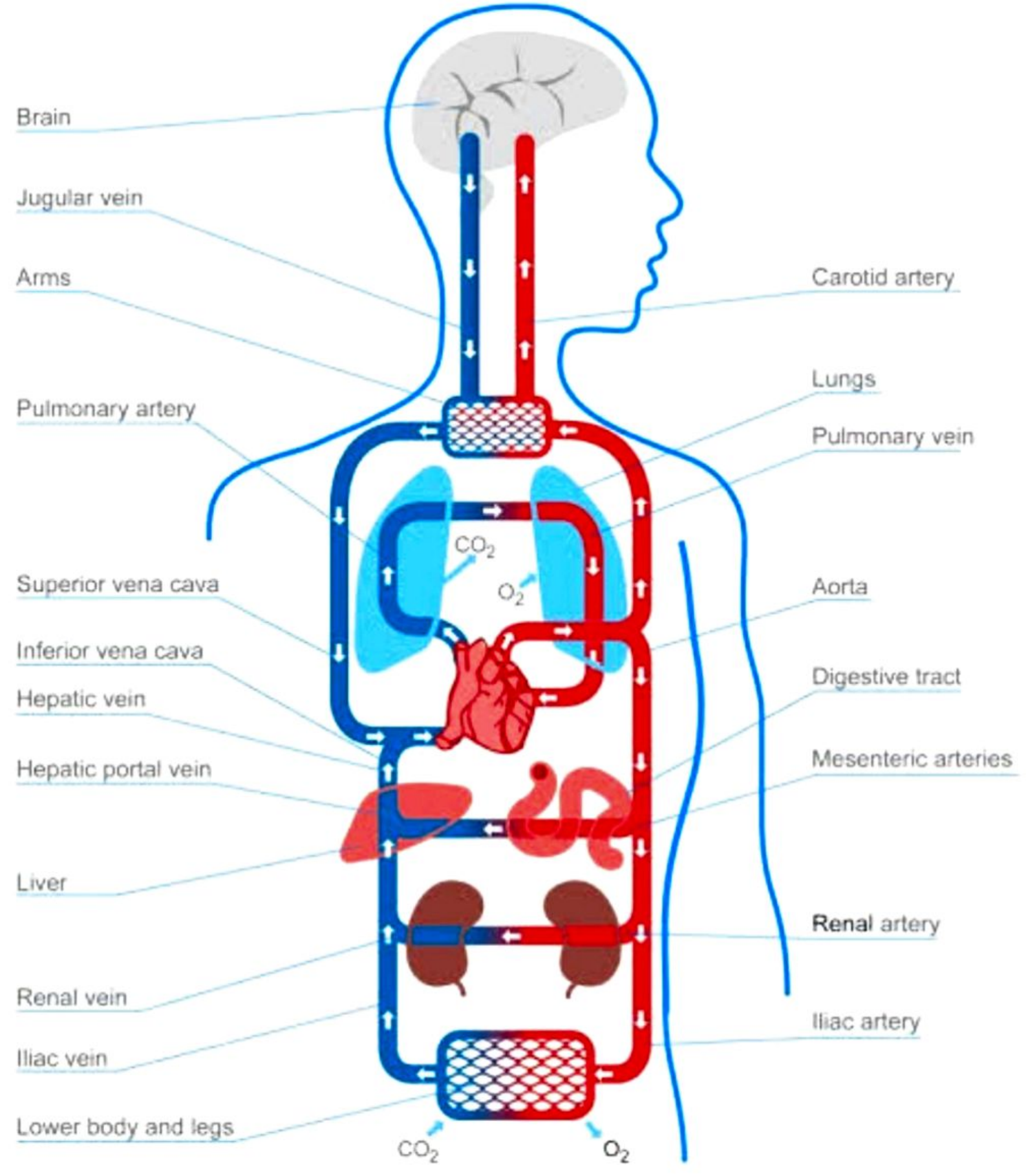
gonadotropins (FSH, LH)

lutenizing hormone
- estrogen & progesterone secretion, triggers ovulation and formation of corpus luteum
- stimulates testes to produce testosterone

follicle-stimulating hormone
- initiates development of oocytes & induces ovarian secretion of estrogen
- stimulates testes to produce sperm



THE CIRCULATORY SYSTEM



The Circulatory System

Aorta
(pumps oxygenated blood to the head **and** body)

Superior Vena Cava
(Sends deoxygenated blood to the right lung)

Pulmonary Artery
(**sends** deoxygenated blood to the left lung)

Pulmonary Vein
(receives oxygenated blood from **the lungs**)

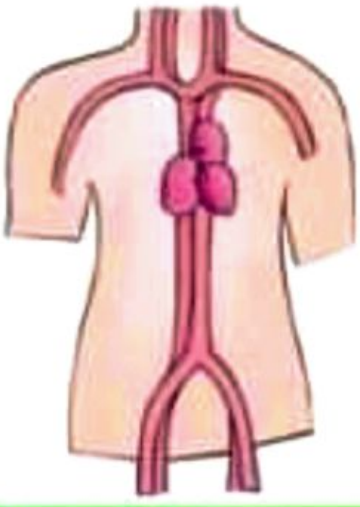
Left Atrium

Pulmonary Artery
(deoxygenated blood from head and **arms**)

Right Atrium

Left Ventricle
Pumps blood to **the aorta**

Inferior Vena Cava
(receives deoxygenated blood from the torso and **legs**)



Right Ventricle
Pumps blood to the lungs

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Artery	Organ	Vein
Carotid artery (Internal carotid)	Brain	Jugular Vein
Brachial artery	forearm	Brachial Vein
Hepatic "	liver	Hepatic Vein
Phrenic "	diaphragm	Phrenic Vein
Gastric "	stomach	Gastric Vein
Mesentric "	Intestine	Mesentric "
Splenic "	spleen	Splenic "
Renal "	Kidney	Renal "
Gonadial "	gonads	Gonadial "
External Iliac "	Leg	Ext. Iliac "
Int Iliac /Hypogastric/ Vesicular artery	Urinary Bladder	Int Iliac "

Opening	**Valve**
Right Atrio-ventricular	**Tricuspid [RAT]**
Left Atrio-ventricular	**Mitral/Bicuspid [LAMB]**
Pulmonary trunk & Aorta	Semilunar valves **[PAS]**
Coronary Sinus	Thebasian valve **[CST]**
Inferior vena cava	Eustachian valve **[*i.e.*]**

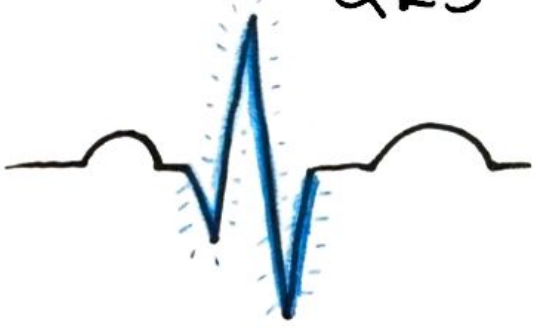
P WAVE

- SA node contracts
- both atria contract

PR

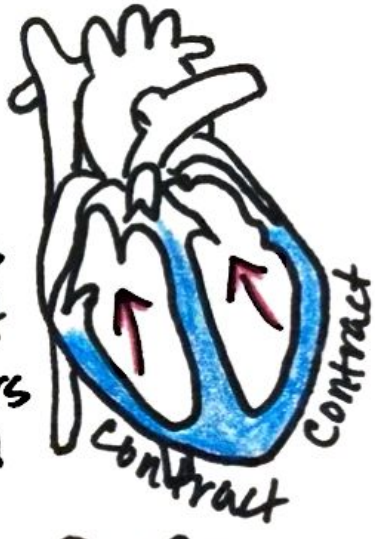
impulses reach AV node 0.10 delay allows atria to contract & empty into ventricles

QRS

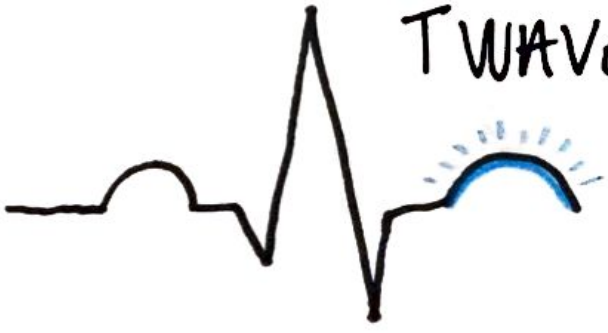


impulses hit AV bundle branch off into two bundles down front of heart into purkinje fibers causing contraction

- L. ventricle goes to aorta → body
- R. Ventricle sends blood to lungs

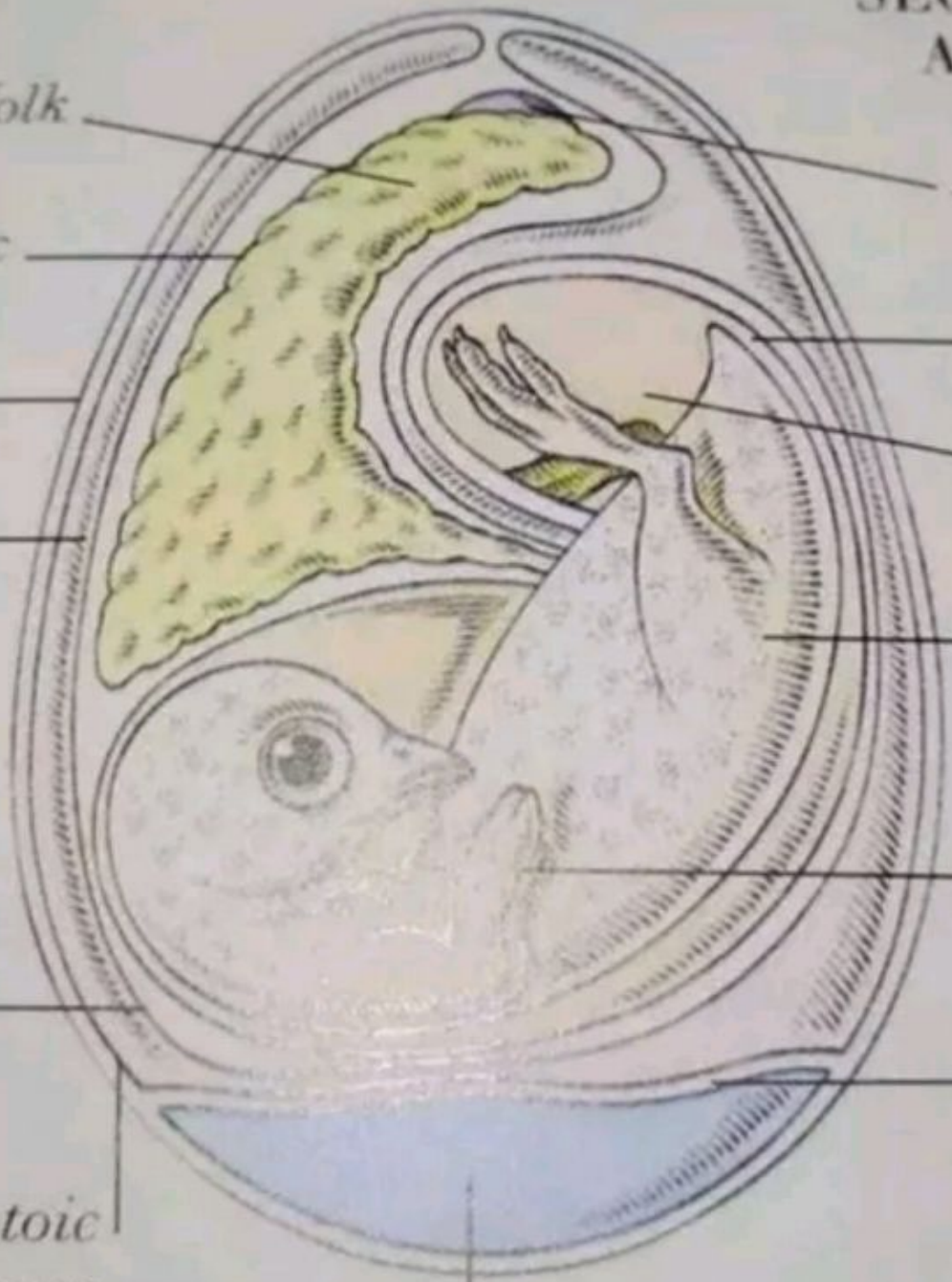


T WAVE



repolarization or recovery of the ventricles

SECTION THROUGH A CHICKEN'S EGG



Yolk

Albumen (egg white)

Yolk sac

Amnion

Shell

Amniotic fluid

Allantoic fluid

Developing chick

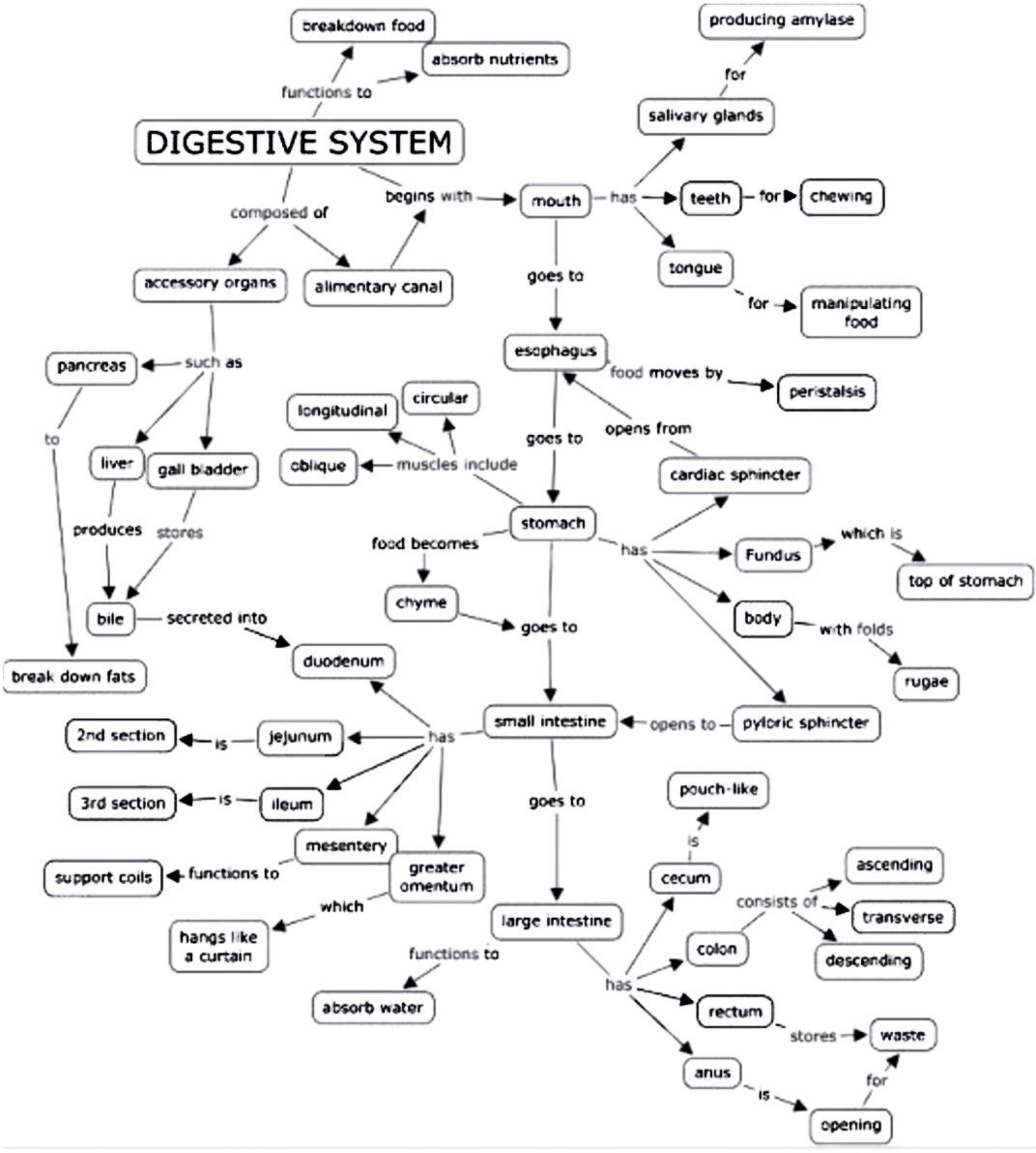
Developing wing

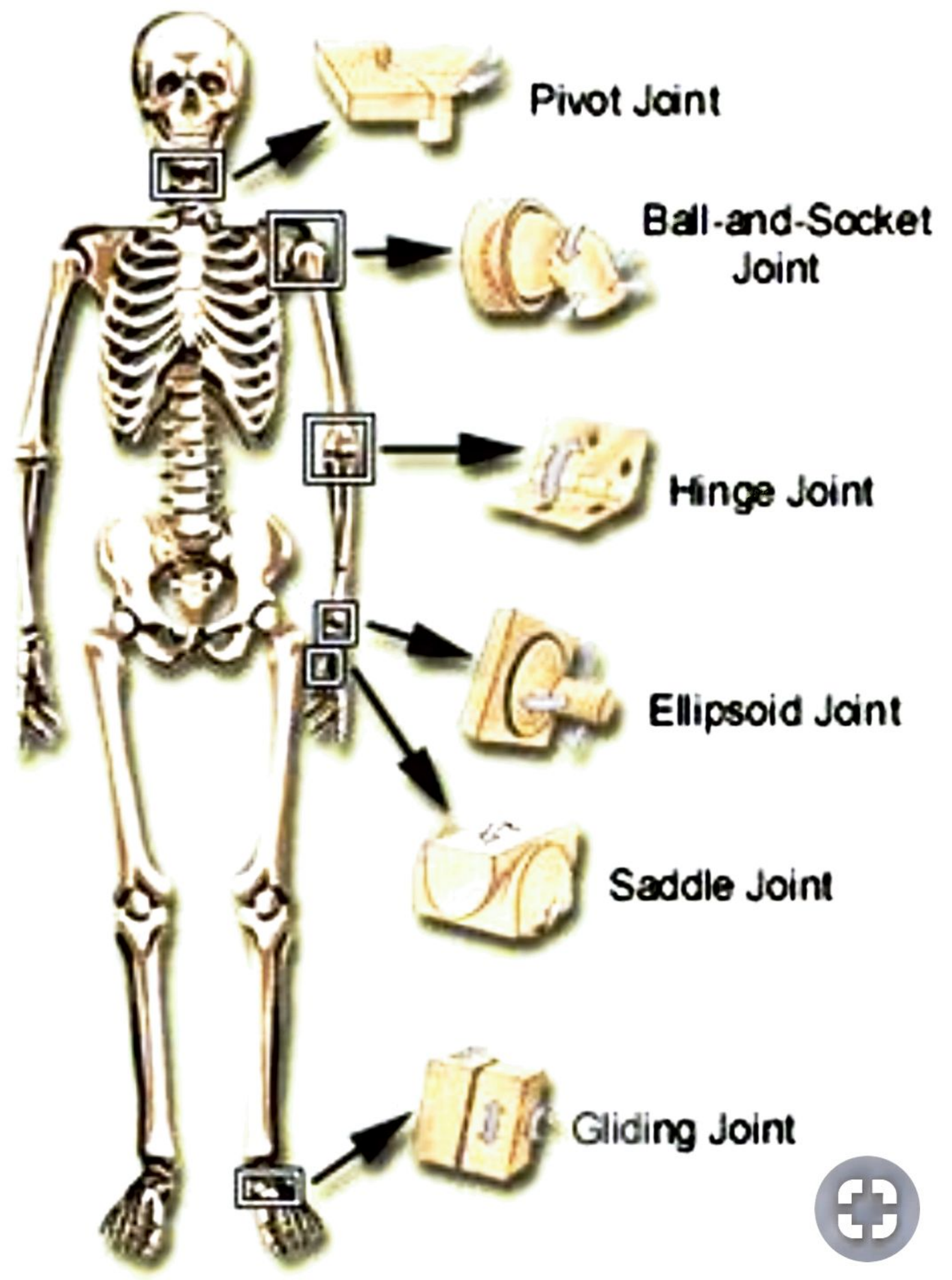
Allantois

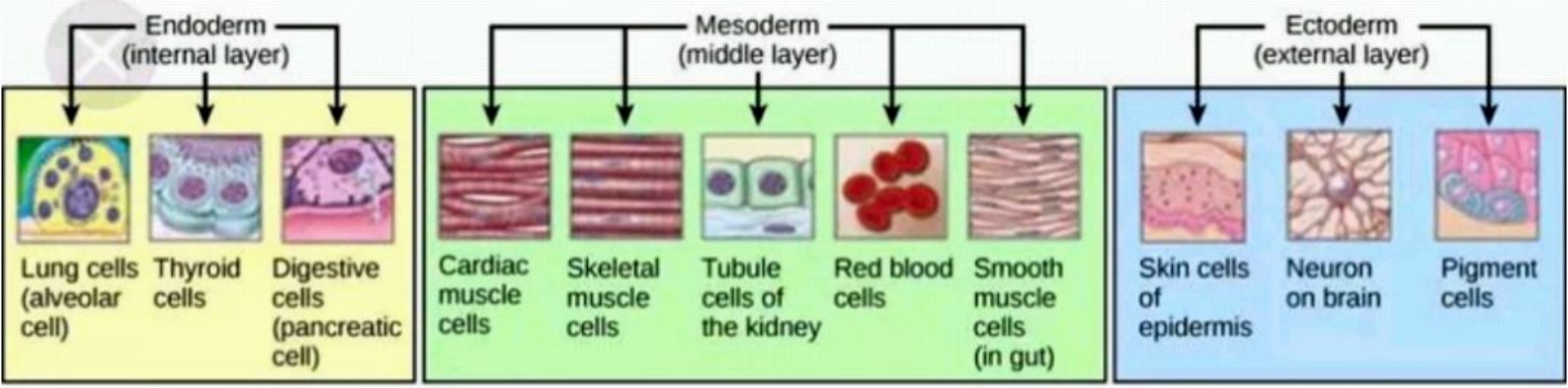
Shell membrane

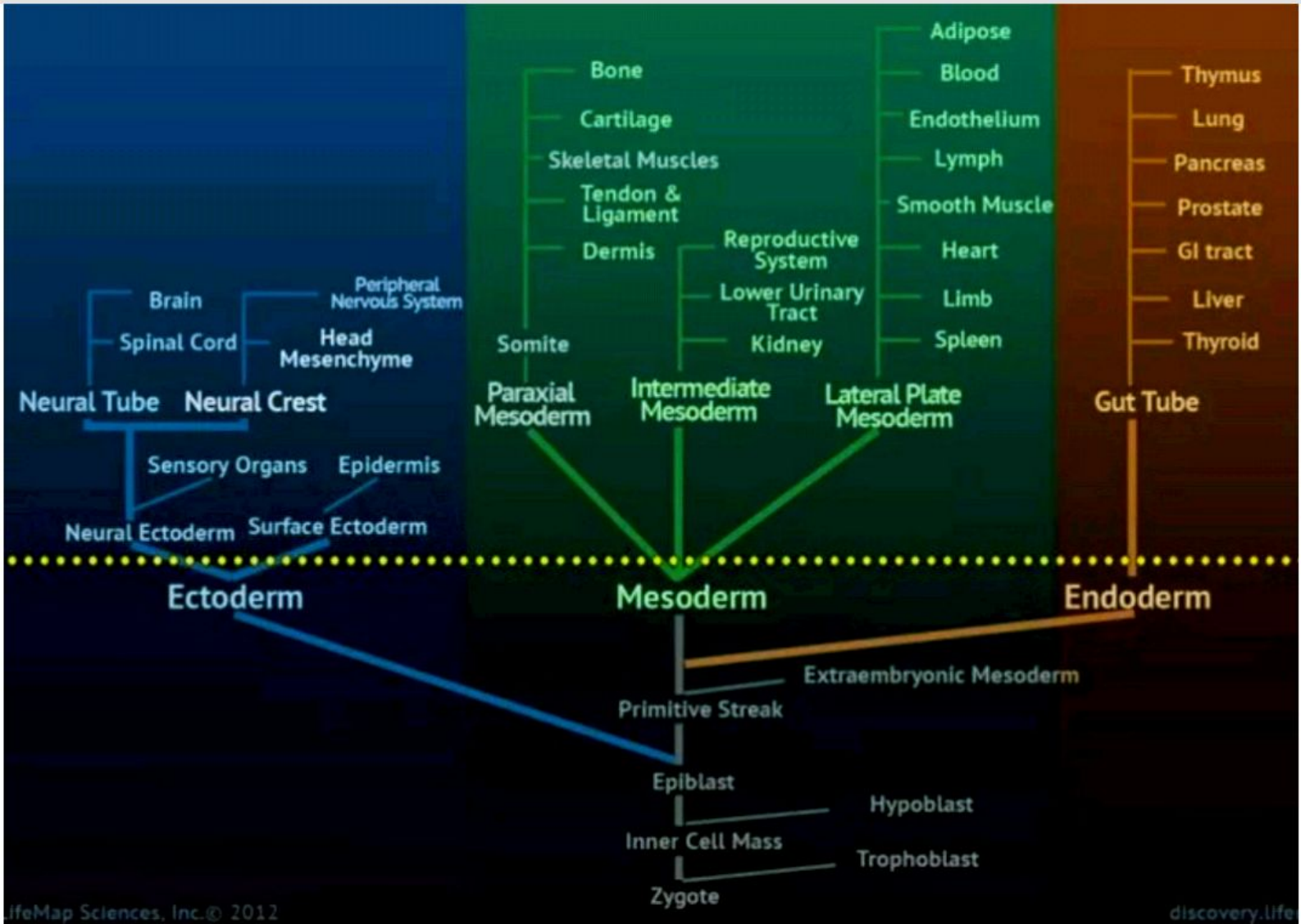
Chorioallantoic membrane

Air sac


DIGESTIVE SYSTEM
functions to
breakdown food
absorb nutrients
composed of
accessory organs
alimentary canal
begins with
mouth
has
salivary glands
for
producing amylase
teeth
for
chewing
tongue
for
manipulating food
goes to
esophagus
food moves by
peristalsis
opens from
cardiac sphincter
stomach
food becomes
chyme
goes to
has
Fundus
which is
top of stomach
body
with folds
rugae
pyloric sphincter
opens to
small intestine
goes to
duodenum
jejunum
is
2nd section
ileum
is
3rd section
mesentery
functions to
support coils
greater omentum
which
hangs like a curtain
large intestine
functions to
absorb water
pouch-like
is
cecum
consists of
ascending
transverse
descending
colon
rectum
stores
waste
anus
is
opening
for
pancreas
such as
liver
gall bladder
produces
stores
bile
secreted into
break down fats
longitudinal
circular
oblique
muscles include


Pivot Joint
Ball-and-Socket Joint
Hinge Joint
Ellipsoid Joint
Saddle Joint
Gliding Joint


Endoderm
(internal layer)
Mesoderm
(middle layer)
Ectoderm
(external layer)
Lung cells (alveolar cell)
Thyroid cells
Digestive cells (pancreatic cell)
Cardiac muscle cells
Skeletal muscle cells
Tubule cells of the kidney
Red blood cells
Smooth muscle cells (in gut)
Skin cells of epidermis
Neuron on brain
Pigment cells


Brain
Spinal Cord
Peripheral Nervous System
Head Mesenchyme
Neural Tube
Neural Crest
Sensory Organs
Epidermis
Neural Ectoderm
Surface Ectoderm
Ectoderm
Bone
Cartilage
Skeletal Muscles
Tendon & Ligament
Dermis
Somite
Paraxial Mesoderm
Reproductive System
Lower Urinary Tract
Kidney
Intermediate Mesoderm
Adipose
Blood
Endothelium
Lymph
Smooth Muscle
Heart
Limb
Spleen
Lateral Plate Mesoderm
Mesoderm
Thymus
Lung
Pancreas
Prostate
GI tract
Liver
Thyroid
Gut Tube
Endoderm
Extraembryonic Mesoderm
Primitive Streak
Epiblast
Hypoblast
Inner Cell Mass
Trophoblast
Zygote
ifeMap Sciences, Inc.© 2012
discovery.life

Immunoglobulins

IgG

mother → fetus

G
mother
"big G"

g
fetus
"little g"

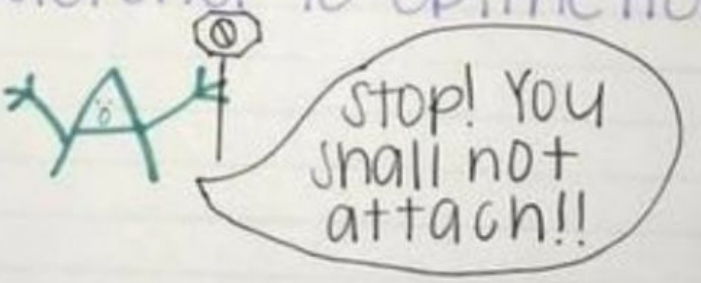
IgM

antibody type made by a newborn

IgM → made by baby

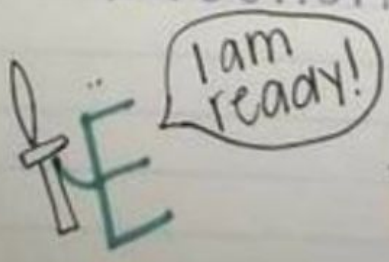
IgA

prevents attachment of viruses & bacteria to epithelial cells



IgE

involved in inflammation, allergic responses & combating parasitic infections



INFLAMMATION

ALLERGIES

PARASITES

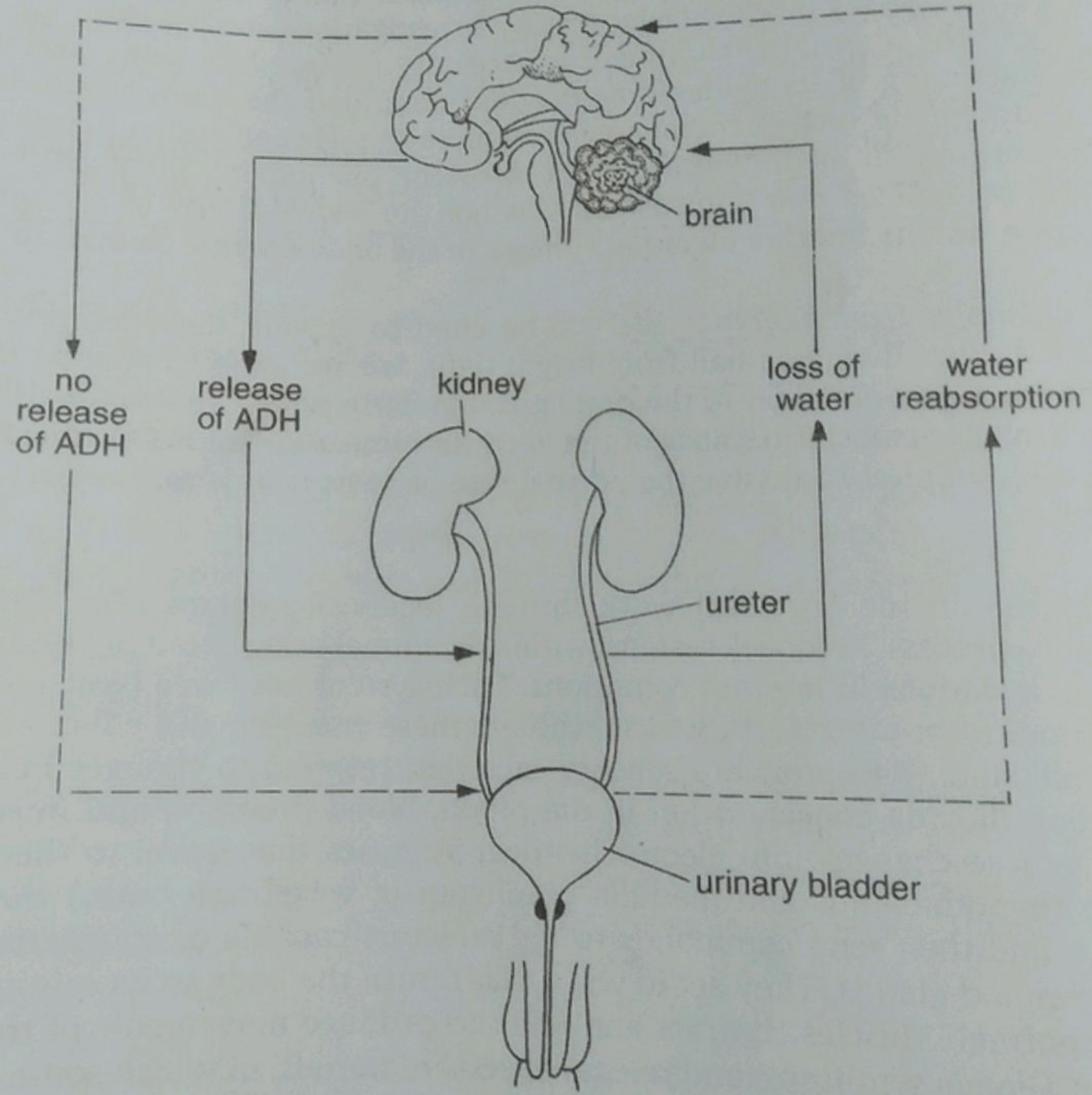


Fig. 12. Feedback mechanism which checks the loss of water from kidneys.

Enzymes

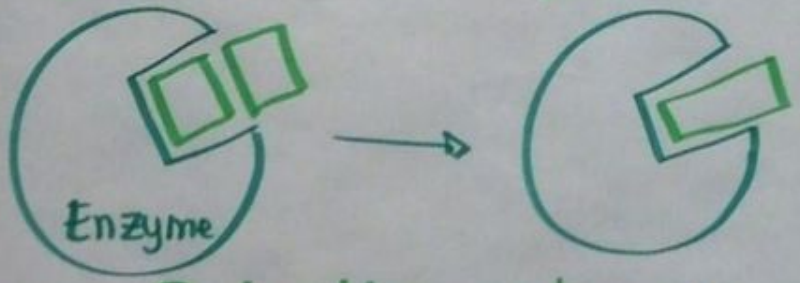
10/13/15 ⑦

enzyme: a protein that regulates and speeds up biological reactions by building or breaking molecules.

Type 1: Anabolic Enzymes

- work by building molecules

Before → After

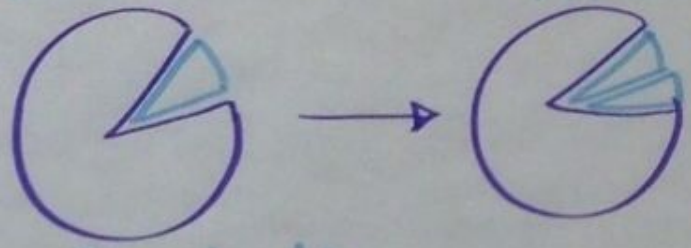


Puts things together

Type 2: Catabolic Enzymes

- work by breaking molecules

Before → After



Break things apart

Conditions

HOT (100°C) ↑ enzyme DENATURES: changes shape, no longer works

↑ enzymes work better

COLD ↓ enzymes slowdown, cannot work well

Temperature

0- Acid ↑ enzyme denatures

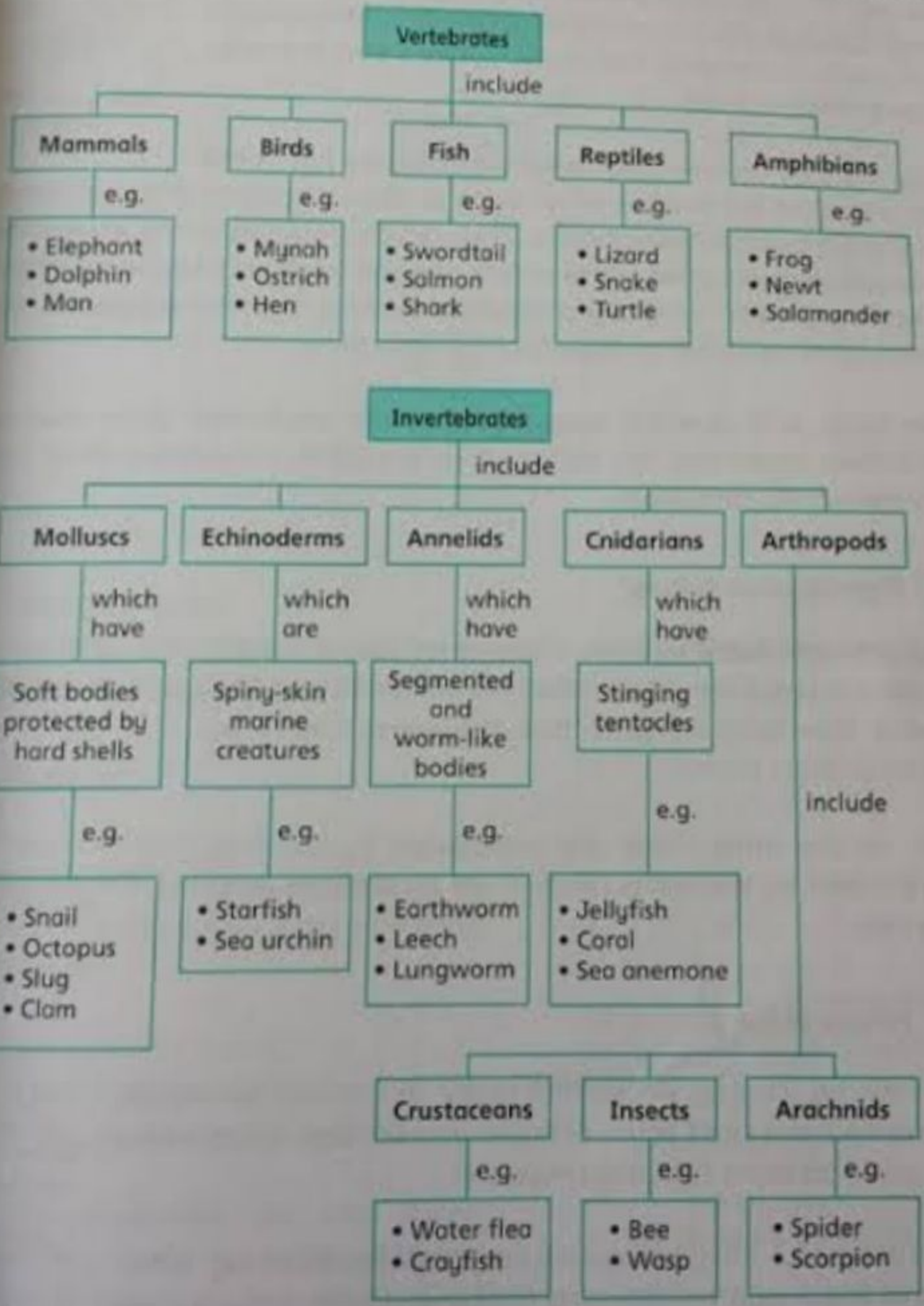
↓ enzymes work better

7- Neutral (like water)

↑ enzyme denatures

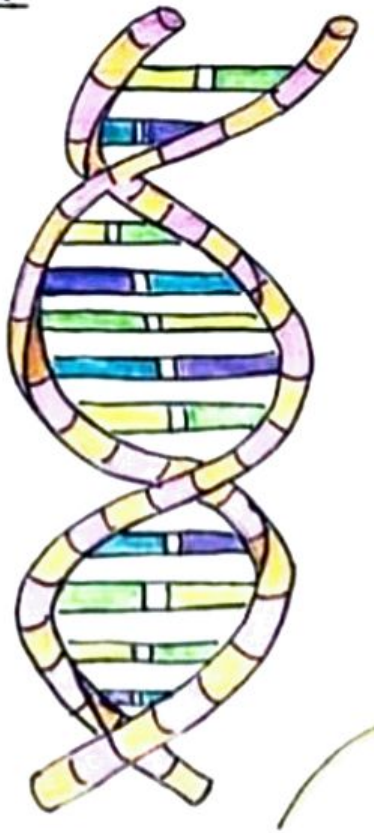
14- Base ↓

pH


Vertebrates
include
Mammals
Birds
Fish
Reptiles
Amphibians
e.g.
• Elephant
• Dolphin
• Man
• Mynah
• Ostrich
• Hen
• Swordtail
• Salmon
• Shark
• Lizard
• Snake
• Turtle
• Frog
• Newt
• Salamander
Invertebrates
include
Molluscs
Echinoderms
Annelids
Cnidarians
Arthropods
which have
which are
which have
which have
Soft bodies protected by hard shells
Spiny-skin marine creatures
Segmented and worm-like bodies
Stinging tentacles
e.g.
• Snail
• Octopus
• Slug
• Clam
• Starfish
• Sea urchin
• Earthworm
• Leech
• Lungworm
• Jellyfish
• Coral
• Sea anemone
include
Crustaceans
Insects
Arachnids
e.g.
• Water flea
• Crayfish
• Bee
• Wasp
• Spider
• Scorpion

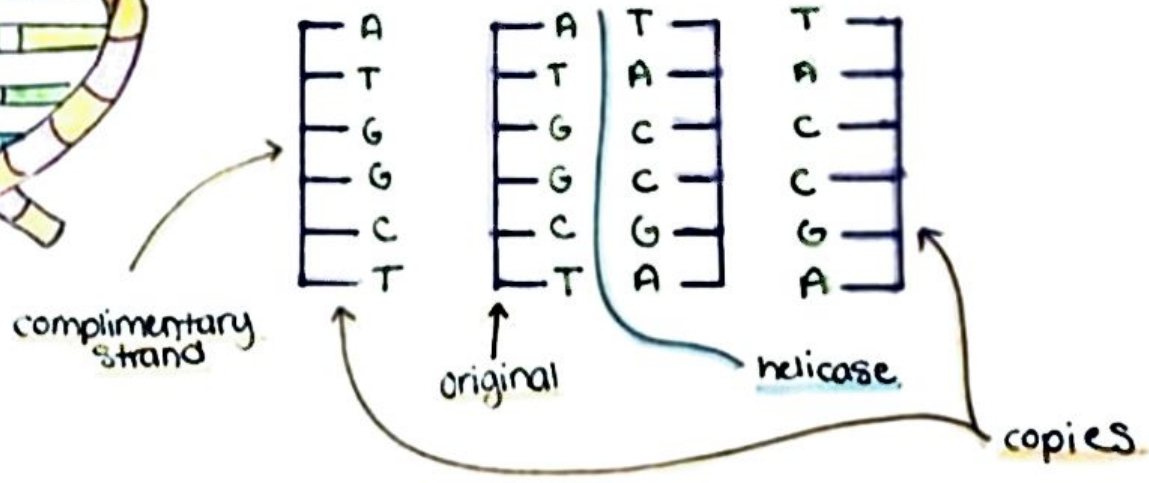
DNA Reflection

The Double Helix



- Deoxyribose sugar
- Phosphate
- Adenine
- Thymine
- Guanine
- cytosine
- Hydrogen bonds

DNA Replication



Mutations

Point mutation ATA → AGA

Deletion. ATAGCTATAGT → ATAGTATAGT

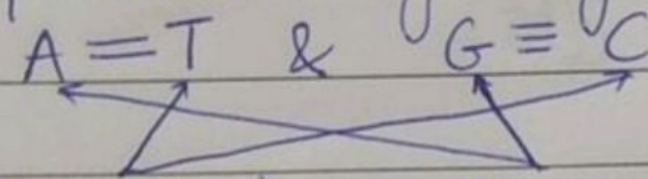
Insertion. ATAGCT → ATAGCAT

Inversion ATGCTA → ATTCGA

1. DNA is unzipped by the enzyme helicase. It's place is two different areas, both sides need a nitrogenous base pair
2. Nitrogenous bases float around the cytoplasm links up w/ DNA
3. The final step is having 2 identical strands of DNA

THE DNA

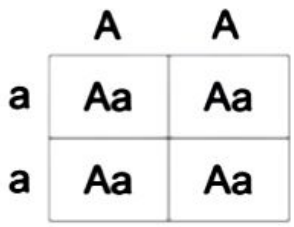
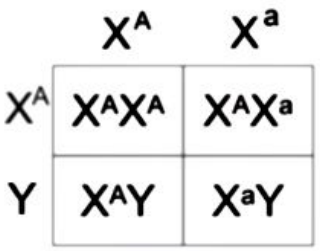
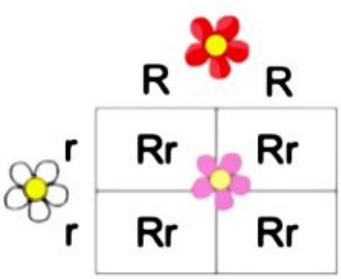
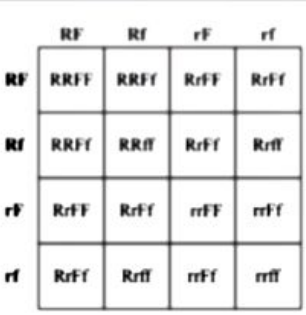
→ Long polymer of deoxyribonucleotides
→ 2 polynucleotide chains.
→ Sugar phosphate backbone
→ 2 chains have antiparallel property
→ Bases are paired through hydrogen bonds



→ 2 chains coiled in right handed fashion.
→ Pitch of helix : 3.4 nm or 3.4×10^{-9} m
→ No. of bp in each turn : 10 (roughly)
→ Distance between a bp in a helix : 0.34nm (approx)

→ Plane of 1 bp stacks over other and confers stability.

Punnett Square CHEAT Sheet

Form of Inheritance	Things to look for:	Sample Punnett Square	Example
Normal (Mendelian)	• One trait is listed with two alleles (Ex: Hairline- widow's peak vs. straight) • Affects males and females equally • Use the same letter on the Punnett square (Ex: Aa)		Dimples dominant over no dimples
Sex-Linked	• Males are affected more than females because they only have 1 X chromosome • Use X^AX^A for females • Use X^AY for males • Use the same letter for the trait (Yes: X^AX^A , NO: $X^AX^{B)}$		Colorblindness in boys
Incomplete Dominance	• One dominant allele is not strong enough to overpower the recessive allele. • Use the same letter on the Punnett square, with heterozygous phenotypes being a blend.		Red flower + white flower = Pink flowers
Co-Dominance	• Both alleles are dominant so they both show up in the phenotype • Use two capital letters in the Punnett square • Use different capital letters on the Punnett square (Ex: AB)		White chicken + black chicken = Black and white speckled chicken
Dihybrid	• Two different traits are given, so the genotypes include 4 letters • Distribute the genotypes to get 4 gametes for each parent • Keep the same letters paired together (YES: AaBb, NO: Abab)		Round yellow peas vs. wrinkled green peas

Cellular Respiration

begins with

glucose

which is broken down during

glycolysis

produces a net gain of

2 ATP

which occurs in the

cytoplasm

which produces

Krebs Cycle

can be used in

ANAEROBIC processes

such as

FERMENTATION

which produces

LACTIC ACID

that is used in

AEROBIC RESPIRATION

starting with

PYRUVATE

which occurs in the

MITOCHONDRIAN

has a net yield of

6 NADH 2 ATP 2 FADH

which occurs in the

ELECTRON TRANSPORT CHAIN

used in the

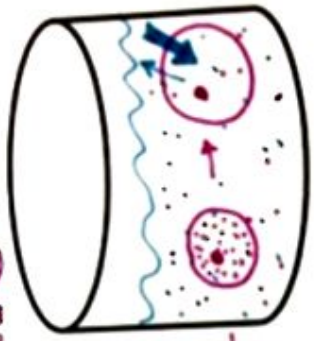
to make

36 ATP

Differences between glycolysis and Krebs'cycle

Glycolysis	Krebs' Cycle
It takes place in the cytoplasm.	It takes place in the matrix of mitochondria.
It is a linear pathway.	It is a cyclic pathway.
It occurs in aerobic as well as anaerobic respiration.	It occurs in aerobic respiration only.
It consumes 2 ATP molecules.	It does not consume ATP.
It yields 2 NADH per glucose molecule.	It yields 6 NADH molecules and 2 $FADH_2$ molecules from 2 acetyl coenzyme-A molecules.
It generates 2 ATP molecules net from 1 glucose molecule.	It generates 2 GTP/ATP molecules from 2 acetyl coenzyme-A molecules.
It oxidises glucose partly, producing pyruvate.	It oxidises acetyl coenzyme-A fully.
It does not produce CO_2.	It produces CO_2.
All enzymes catalysing glycolytic reactions are dissolved in cytosol.	Two enzymes of Krebs' cycle reactions are located in the inner mitochondrial membrane, all others are dissolved in matrix.

Tonicity

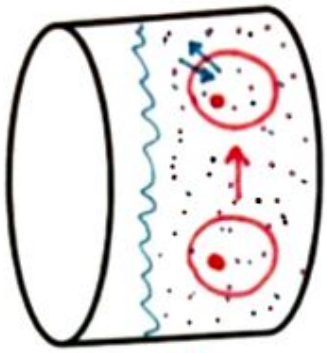


HYPOTONIC

[solutes in solution] < [solutes in cell]

Water moves **into** cell

Animal cells will swell & burst

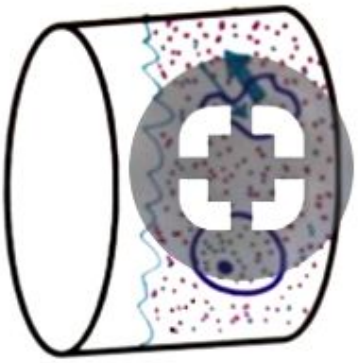


ISOTONIC

[solutes in solution] = [solutes in cell]

Water moves **equally**

Animal cells will stay same



HYPERTONIC

[solutes in solution] > [solutes in cell]

Water moves **out** of cell

Animal cells will shrivel

(plant cells → plasmolysis)

Concentration Gradient

unequal distribution of particles ≠

Transport of Molecules

Factors that affect diffusion:

- Concentration
- Temperature
- Pressure

↑ is ER faster

with concentration gradient

Passive Transport

NO ENERGY REQUIRED

Diffusion

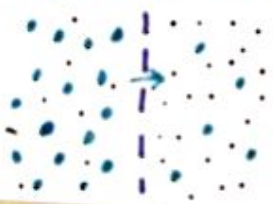
movement of mol from [↑] to [↓].

Results due to RANDOM MOVEMENT OF PARTICLES.

Osmosis

Diffusion of WATER across a selectively permeable membrane

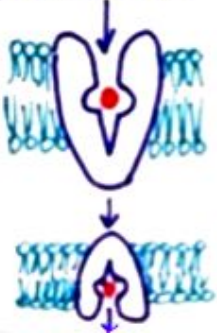
[↑ water] → [↓ water]



Facilitated Diffusion

Requires a HELPER PROTEIN

= NO ENERGY =



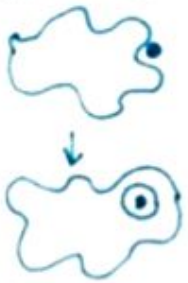
Active Transport

REQUIRES ENERGY

against conc. grad. (↓ → ↑)

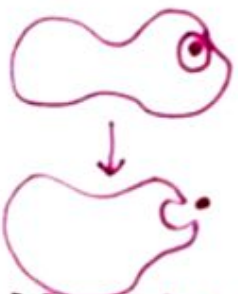
Endocytosis

cell surrounds & engulfs materials



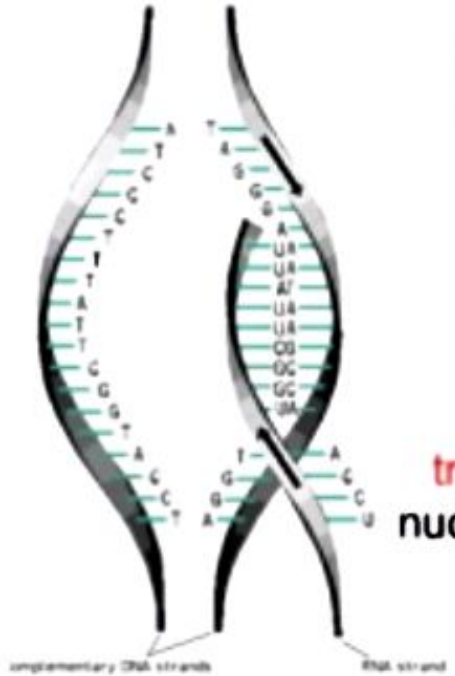
Exocytosis

expulsion of material from cell



Na^+/K^+ Pump & Proton Pumps

mRNA vs tRNA



Both use A, U, G and C bases

m = messenger

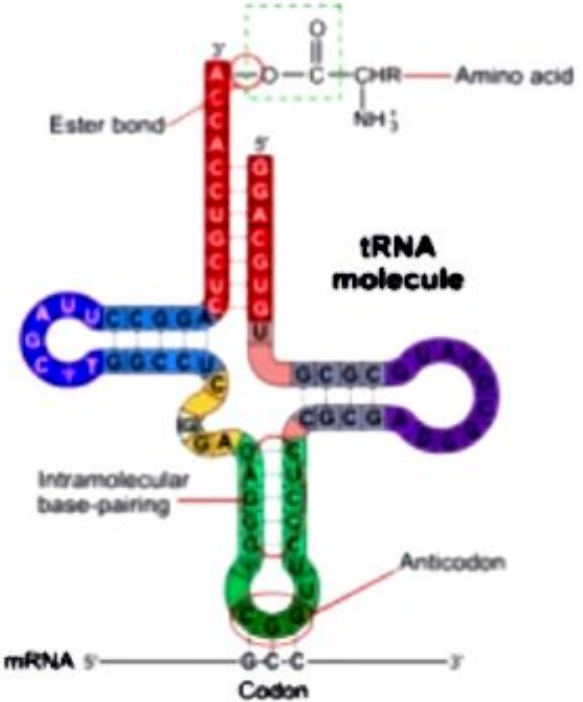
transcribed from DNA in the nucleus and posted out to the ribosomes for translation

codons are complementary to DNA triplets

t = transfer

used to translate mRNA by the ribosomes, making a new polypeptide

anticodons are complementary to mRNA codons and correspond to specific amino acids



mRNA is a simple strand

broken down after translation

tRNA has a clover-shaped loop structure

reactivated with a new amino acid after translation

Aerobic

Oxygen

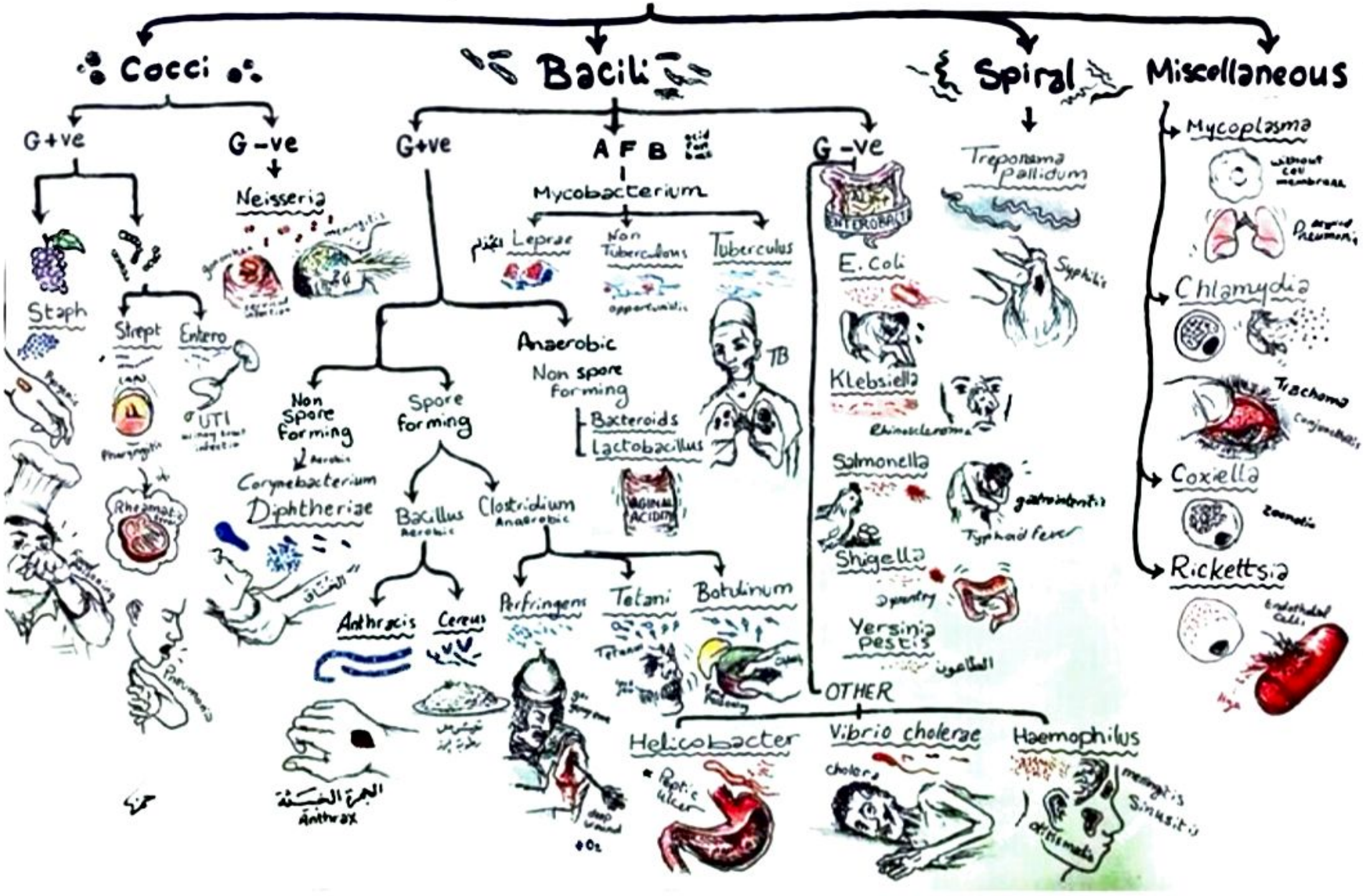
- Oxygen present
- Release more energy (38 molecules of ATP) or 2898kJ
- Produces carbon dioxide, water & energy
- Glucose completely broken down
- Occurs in mitochondria

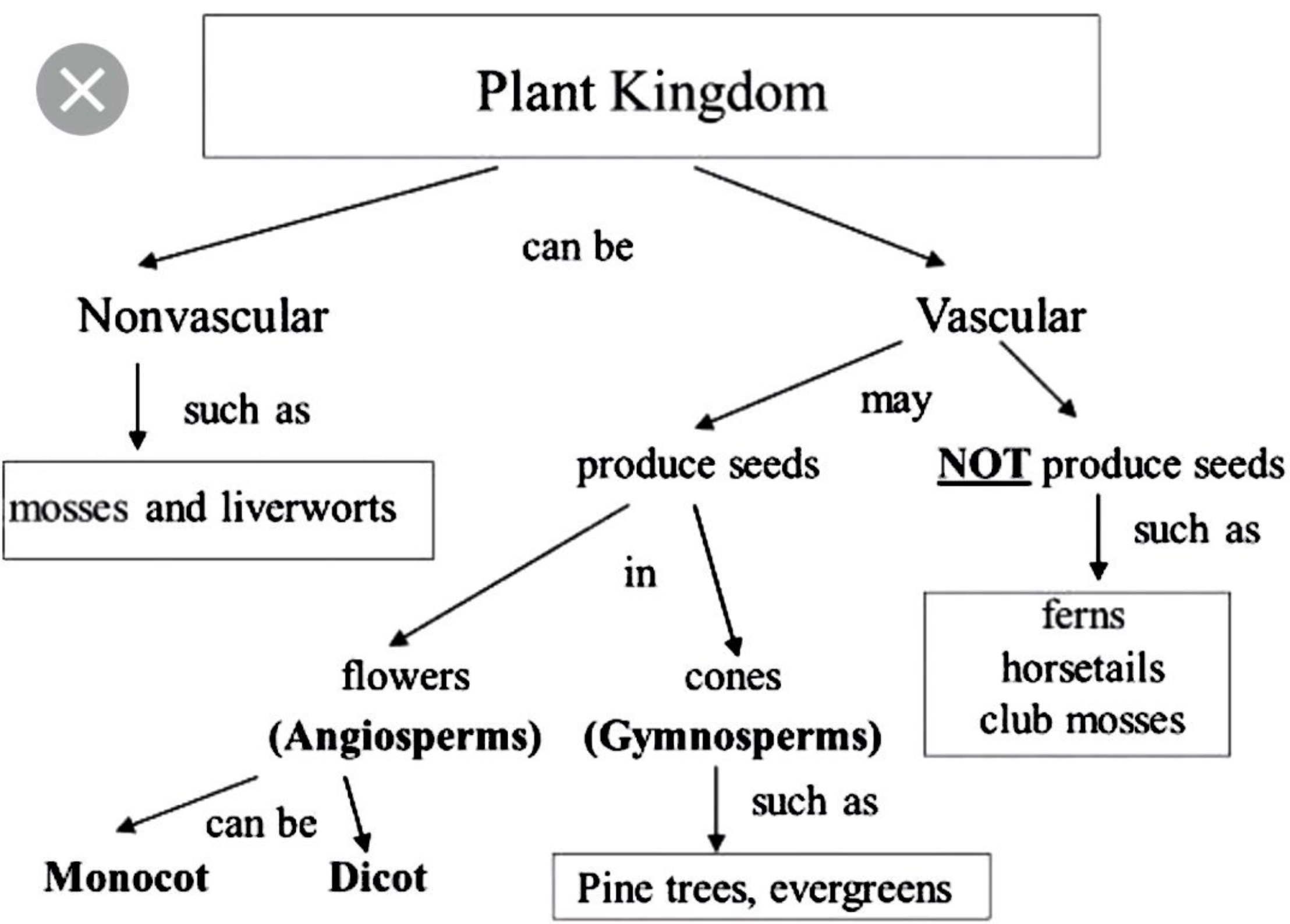
Anaerobic

Anti oxygen

- Oxygen absent
- Release less energy (2 molecules of ATP or 150kJ (muscle cells) 210kJ (yeast))
- Produces lactic acid & energy (muscle cells) or ethanol, carbon dioxide & energy (yeast)
- Glucose NOT completely broken down
- Occurs in cytoplasm

BACTERIOLOGY




Plant Kingdom
can be
Nonvascular
such as
mosses and liverworts
Vascular
may
produce seeds
NOT produce seeds
such as
ferns
horsetails
club mosses
in
flowers
(Angiosperms)
cones
(Gymnosperms)
such as
Pine trees, evergreens
can be
Monocot
Dicot

Br	–	Bracteate	$\underline{\overline{G}}$	–	Inferior ovary
Ebr	–	Ebracteate	♂	–	Male
K	–	Calyx	♀	–	Female
C	–	Corolla	⚥	–	Bisexual
P	–	Parianth	⊕	–	Actinomorphic symmetry of flower
A	–	Androecium	%	–	Zygomorphic Symmetry of flower
G	–	Gynoecium			
G	–	Superior ovary			

ALGAE

Haplontic → eg Volvox, Spirogyra & some species of Chlamydomonas
Haplo-diplontic – Echocarpus, Polysiphonia, kelps
Diplontic – Fucus

* Various forms :-
  - Unicellular → Chlamydomonas, Chlorella, Spirullina
  - Colonial → Volvox
  - Filamentous → Ulothrix, Spirogyra
  - massive body → Kelps

* Chlorophyll bearing, simple, thalloid – Plant body

* Habitat → Aquatic (mostly)
  - moist stone, soil, wood
  - Algae + Fungi => lichen
  - on animals (sloth bear)

* Reproduction:
  - Sexual by Gametes → Isogamous → Flagellated eg - Chlamydomonas; Non Flagellated eg - Spirogyra
  - Anisogamous eg - species of Chlamydomonas
  - Oogamous eg - Volvox, Fucus
  - Asexual by Spores → Zoospores (mostly) → germi → Thallus
  - Vegitative → Fragment → grow → Thallus (new plant)

Uses: 1) 50% CO_2 fixation on earth
2) Prim. producer & basis of aquatic food cycle
3) 70 species of Marine algae used as food. eg - Porphyra, Laminaria, Sargassu
4) Produce - Hydrocolloids → Brown algae : Algin; Red algae = Carrageen
5) Gelidium & Gracilaria → Agar → used to grow microbes; prep of ice-cream & jellies
6) Chlorella & Spirullina → unicellular algae used as food supplement; rich in protein

	Red light	Far-red light
1.	P_{660} changes to P_{730}.	P_{730} changes to P_{660}.
2.	Stimulates germination.	Inhibits germination.
3.	Induces formation of anthocyanins (plant pigments).	Inhibits formation of anthocyanins.
4.	Stimulates flowering in long-day plants.	Inhibits flowering in long-day plants.
5.	Inhibits flowering in short-day plants.	Stimulates flowering in short-day plants.
6.	Inhibits elongation of internodes.	Stimulates elongation of internodes.
7.	Induces increase in leaf area.	Prevents increase in leaf area.
8.	Causes epicotyl (plumule) hook to unbend.	Maintains epicotyl (plumule) hook bent.
9.	Inhibits growth of lateral roots.	Stimulates the growth of lateral roots.

Table 2. The chemicals that control plant growth.

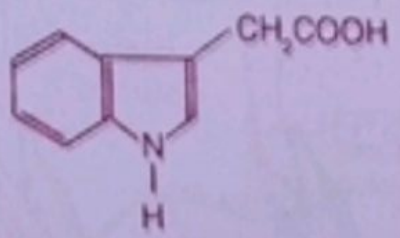
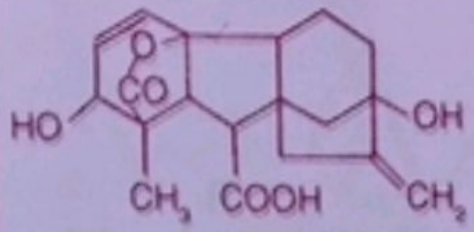
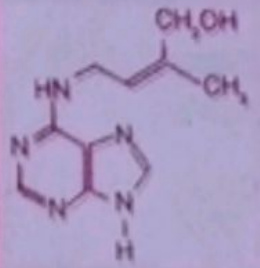
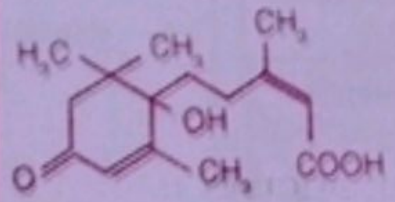
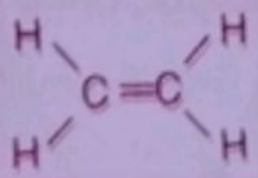
Regulator	Chemical structure	Main functions
Auxins (indole compounds)		Promote stem growth by cell elongation; stimulate root growth at very low concentrations; involved in apical dominance and tropisms.
Gibberellins (terpenes)		Promote growth of the internodes by cell elongation; promote fruit growth; break seed dormancy and involved in germination.
Cytokinins (adenine derivatives)		Promote cell division in apical meristems and cambium; interact with auxins in these areas, but promote lateral bud growth, helping overcome apical dominance.
Abscisic acid (carotenoid derivatives)		Inhibits cell division and growth in stem and root; promotes dormancy in both buds and seeds.
Ethylene (gas)		Inhibits growth of stem and root; promotes fruit ripening and fruit and leaf fall.

Table 3. Major physiological roles of growth regulators in plant growth and development.

Process affected	Auxins	Gibberellins	Cytokinins	Abscisic acid (ABA)	Ethylene
1. Stem growth	Promotes cell enlargement and cell division	Promotes cell enlargement and cell division and 'bolting' of some rosette plants	Promotes cell division	Inhibitory, notably during physiological stress.	Inhibitory, notably during physiological stress
2. Apical dominance	Promotes by inhibiting lateral bud growth	No effect	Antagonistic to auxins, i.e. promotes lateral bud growth	—	—
3. Bud dormancy	No effect	Breaks	Breaks	Promotes	Breaks
4. Bud (shoot) initiation	Promotes callus in some but sometimes antagonistic to cytokinins and inhibitory	Promotes callus in chrysanthemum	Promotes	—	—
5. Root initiation	Promotes root initiation in cuttings and calluses	No effect	No effect or promotes lateral root growth	—	—
6. Root growth	Promotes at very low concentration	Inactive	No effect or inhibits primary root growth	Inhibitory	Inhibitory
7. Leaf growth	No effect	Promotes	Promotes	—	—
8. Leaf senescence	—	—	Delay	Sometimes promotes	—
9. Abscission	Inhibits	No effect	No effect	Promotes	—
10. Stomatal mechanism	No effect	No effect	Promotes stomatal opening	Promotes closing of stomata under conditions of water stress	No effect
11. Flowering	No effect; promotes in pineapple	Promotes in long-day plants and inhibits in short-day plants	Usually no effect	Antagonistic to gibberellins; promotes in short-day plants and inhibits in long-day plants	Promotes in pineapple
12. Fruit ripening	—	—	—	—	Promotes
13. Seed dormancy	No effect	Breaks	Breaks	Promotes	Promotes in pineapple
14. Fruit growth	Promotes; induce parthenocarpy	Promotes; induce parthenocarpy	Promotes; induce parthenocarpy	—	—

Table 7. Differences between C_3 and C_4 plants.

	C_3 plants	C_4 plants
1.	The leaves of C_3 plants do not show Kranz anatomy.	The leaves of C_4 plants show Kranz anatomy.
2.	The bundle sheath cells do not contain chloroplasts.	The bundle sheath cells contain large chloroplasts.
3.	The chloroplasts of mesophyll cells store starch.	The chloroplasts of bundle sheath cells store starch.
4.	Photorespiration takes place in C_3 plants.	There is no measurable photorespiration in C_4 plants.
5.	Energy (ATP) required for fixation of CO_2 is low.	Energy required for fixation of CO_2 is comparatively high.
6.	The rate of photosynthesis is sensitive to change in atmospheric concentration of oxygen.	The rate of photosynthesis is insensitive to change in atmospheric concentration of oxygen.
7.	CO_2 compensation point is high (40-60 ppm CO_2).	CO_2 compensation point is low (around zero).
8.	Photosynthesis is saturated at 1/4 to 1/3 of full sunlight.	Net photosynthesis increases with the increase in light intensity and saturate only at full sunlight.
9.	There is only one CO_2 acceptor Rubisco, which occurs in all green cells of the plant.	There are two CO_2 acceptors, PEP carboxylase in the mesophyll cells and RuBiSco in bundle sheath cells.
10.	Chlorophyll *a* to *b* ratio is 2.8.	Chlorophyll *a* to *b* ratio is 3.9.
11.	They operate only Calvin cycle.	They also operate Hatch and Slack cycle in addition to Calvin cycle.
12.	They can perform photosynthesis only when stomata are open.	They can perform photosynthesis even when stomata are almost closed.
13.	They are usually adapted to cool and moist climate.	They are well adapted to tropical climate.
14.	Negligible or no change in net rate of photosynthesis at warmer temperature.	Net rate of photosynthesis 50 per cent higher at the warmer temperature.

Study of Blood → haematology
Study of Liver → Hepatology
Study of fungi → Mycology
Study of Algae → Phycology
Study of Virus → Virology
Study of Kidney → Nephrology
Study of Cancers → Oncology
Study of Universe → Cosmology
Study of Fruits → Pomology
Study of Birds → Ornithology
Study of Bones → Osteology
Study of Egg → Oology
Study of Dream → Oneirology
Study of Hair → Trichology
Study of Eyes → Opthalmology
Study of Soil → Pedology
Study of Languages → Philology
Study of Brain → Encephlology
Study of Nails → Cosmetology
Study of Air → Aerology

Gene taxi~Plasmid

Workhouse for gene cloning~pBR322(an artificial plasmid)

Molecular Scissor and Chemical scalpel/knives~ Restriction endonucleases

Molecular glue~Ligases

Natural genetic engineer~Agrobacterium tumefaciens

Mobile genetic element~Transposon

Passenger DNA~Foreign DNA

Practical File – 5 Marks

The Visiting Examiner is required to assess students on the basis of the Biology Practical file maintained by them during the academic year.

Each practical done during the year, needs to be recorded by the student in the Practical file and the same must be checked, signed and dated by the teacher.

SCIENTISTS AND THEIR CONTRIBUTIONS:

1. Oparin: Coacervates, Conditions on primitive earth were favourable for chemical evolution
2. Stanley Miller & Harold Urey: Recreated probable conditions on primitive earth
3. Ernst Haeckel: Proposed the recapitulation theory
4. Charles Darwin: Natural Selection
5. Lamarck: Inheritance of acquired characters
6. Hugo de Vries: Mutation
7. T. R. Malthus: Theory of Human Population Growth/ Essays on population
8. Alec Jeffrey: DNA finger printing
9. Temin and Baltimore: Reverse transcription.
10. Jacob, Monad and Lwoff: proposed Lac operon.
11. Watson & Crick: Structure of DNA
12. Nirenberg and Khorana: Genetic code
13. Benzer: Cistron, recon, muton
14. Gregor Mendel: Father of genetics
15. Sutton and Boveri: Chromosomal theory of inheritance
16. Hugo de Vries, Correns and Tschermack: Rediscovered Mendelism
17. T H Morgan: Linkage
18. P Maheshwari: Plant tissue culture
19. A Sturtevant: Chromosomal mapping
20. Henking: Discovered X-chromosome
21. F. Meischer: Isolated nucleic acid from pus cells, called Nuclein
22. Chargaff: Rule of equivalence in DNA structure
23. F. Griffith: Transformation in bacteria
24. Avery, MacLeod and McCarty: DNA is the genetic material
25. Hershey and Chase: DNA is the genetic material
26. Meselson and Stahl: Semi-conservative replication of DNA
27. G. Gamow: Triplet nature of codons
28. S Ochoa: discovered polynucleotide phosphorylase
29. Wallace: divided the Earth into biogeographical regions
30. M S Swaminathan: Green revolution in India
31. H Boyer: discovered Restriction Enzyme
32. S Cohen: method to transfer plasmid DNA in host cells
33. R Mishra: Father of Indian Ecology
34. E Wilson: coined the term Biodiversity
35. P Ehrlich: Rivet Popper Hypothesis
36. Sanger: DNA/Protein sequencing

LIST OF ABBREVIATIONS TO BE STUDIED

1. DDT – Dichloro diphenyl trichloro ethane
2. ECG – Electrocardiogram
3. C. T. Scan – Computed Tomographic Scanning
4. IUCD/IUD – Intra uterine contraceptive device
5. SCID – Severe Combined Immuno Deficiency
6. MRI – Magnetic Resonance Imaging
7. SSBP–Single Strand Binding Protein
8. PKU- Phenyl ketonuria
9. ADA- Adenosine Deaminase
10. RCH- Reproductive and Child Health Care Programmes
11. MMR- Maternal Mortality Rate
12. IMR- Infant Mortality Rate
13. LAB- Lactic Acid Bacteria
14. PID- Pelvic Inflammatory Diseases
15. ET- Embryo Transfer
16. IUT- Intra Uterine Transfer

17. ISCI- Intra Cytoplasmic Sperm Injection
18. IUI- Intra Uterine Insemination
19. snRNA- Small Nuclear Ribo Nucleic Acid
20. hnRNA- Heterogeneous Nuclear Ribo Nucleic Acid
21. sRNA- Soluble Ribo Nucleic Acid
22. UTR- Untranslated Region
23. EST- Expressed Sequence Tags
24. SNPs-Single Nucleotide Polymorphisms
25. VNTRs- Variable Number of Tandem Repeats
26. CMI- Cell Mediated Immunity
27. MALT- Mucosal Associated Lymphoid Tissue
28. NACO- National AIDS Control Organisation
29. MOET- Multiple Ovulation Embryo Transfer Technology
30. LSD- Lysergic Acid Diethylamide
31. IRRI- International Rice Research Institute
32. IARI- Indian Agricultural Research Institute
33. EFB- European Federation of Biotechnology
34. GMO- Genetically Modified Organism
35. GPP- Gross Primary Productivity
36. NPP- Net Primary Productivity
37. GFC- Grazing Food Chain
38. DFC- Detritus Food Chain
39. IUCN- International Union for Conservation of Nature and Natural Resources
40. CPCB- Central Pollution Control Board
41. CNG- Compressed Natural Gas
42. JFM- Joint Forest Management