An Illustrated Guide to Biology

Second Edition

Science On Illustrations

2018

First Edition 2017, Second Edition 2018

ISBN 978-1-387-64954-9

Science On Illustrations
Batavia, Illinois 60510

www.facebook.com/ScienceOnIllustrations/

DEAR SCIENCE FAN,

I HOPE YOU FIND THIS BOOK BOTH FUN & USEFUL. IT TRULY HAS BEEN CREATED THROUGH A LABOR OF MY LOVE FOR SCIENCE AND EDUCATION. I STARTED THIS PROJECT SO THAT I COULD GIVE MY STUDENTS SUMMARY SHEETS THAT COULD HELP THEM UNDERSTAND & CONNECT TO THE BIG PICTURE OF HOW THIS WORLD OPERATES. ONE HUNDRED PAGES LATER, I FEEL FAIRLY SATISFIED TO SHARE IT WITH YOU. HERE ARE SOME SUGGESTIONS OF HOW YOU CAN USE IT:

1. USE IT AS A PRE READ TO LEARN ABOUT THE MAIN IDEAS.
2. USE IT AS A POST LECTURE TO REVIEW
3. USE IT AS A COLORING BOOK (COLORED PENCILS WORK BEST)
4. USE IT TO MAKE CONNECTIONS TO THE 4 MAIN THEMES
5. USE IT AS A TEMPLATE TO MAKE YOUR OWN DOODLE SUMMARIES.
6. USE IT AS A SLEEP AID.
7. USE IT AS A FIBER SOURCE... THAT IS ROUGH... AGE.

REGARDLESS OF HOW YOU USE IT, I WARN YOU THAT THIS IS HOW MY BRAIN THINKS! WELCOME TO MY INNER CRAZY!

SCIENCE ON!

JEFF GRANT

Nature of Science

Definition of Science

The study of the structure & function of the physical & natural world through experiment & observation

Theory

Scientific theories are testable, able to be charged, and supported by vast amounts of data. They generally explain a wide variety of phenomenon

Ex: Gravitation, Germ, Cell, Evolution

Not the same as common language use.

"I have a theory how he committed the crime;"

This statement is more like a hypothesis

Scientific Method

Make an observation → Think of a scientifc question → Predict an outcome of an experiment (Hypothesis) → Design an experiment → Gather data → Analyze that data → Refine the experiment → Peer review → Theory developed → Make an observation

When cells divide they are multiplying that is just Celly

Notice the method is a circle. This means you can enter anywhere & it goes on & on.

Peer Review

When an author submits her/his research to be published several other scientists review the research for validity before it is published.

↑ Quality ↑ Networking

Scientists are anybody who studies natural or physical science

Pseudo Science

Fake Science

* Can't be proven right or wrong due to a lack of experimentation & data collection

Circles of Knowledge

Science is all about trying to learn about the world we live in. Asking questions and seeking answers to these questions is human nature.

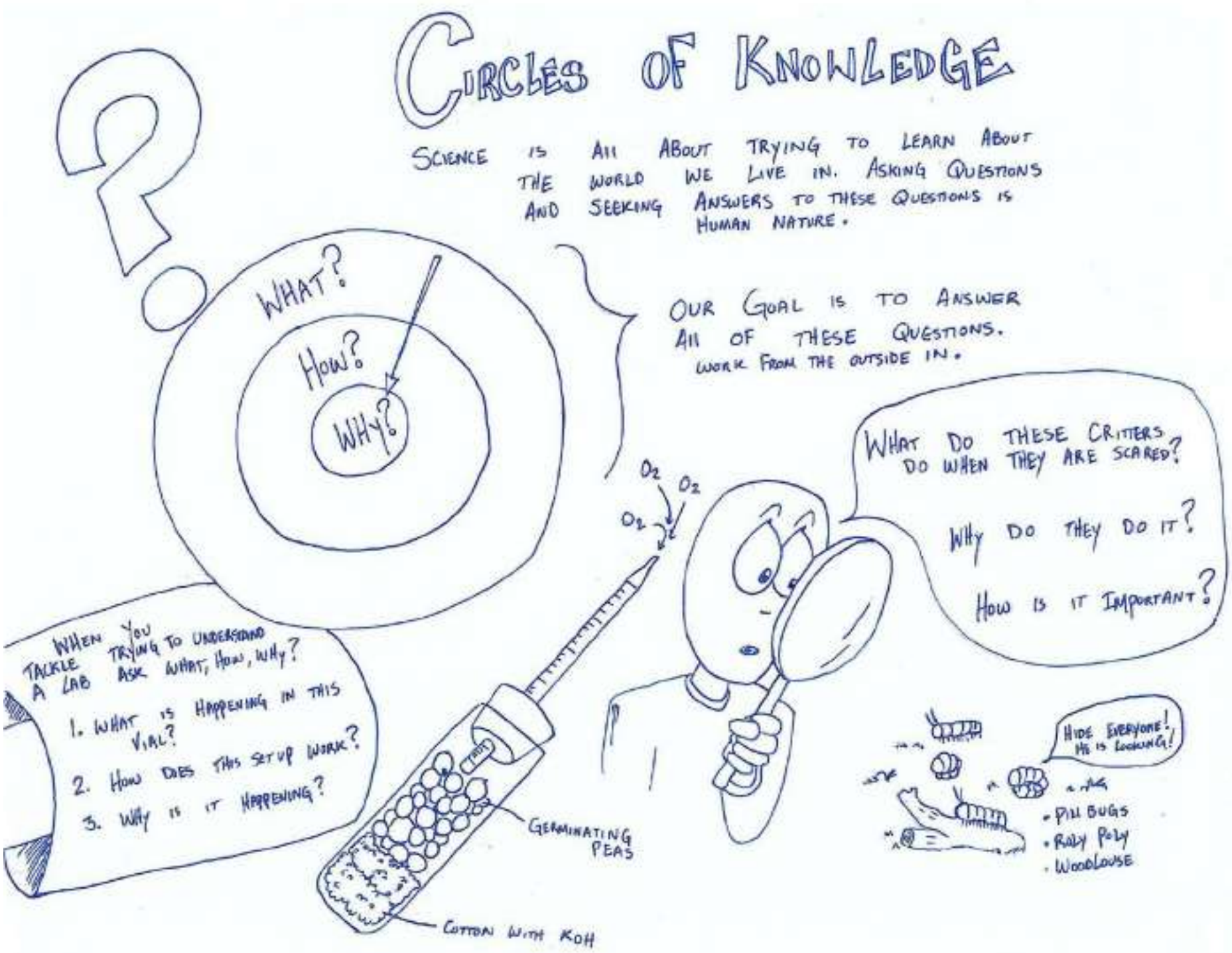


TABLE OF CONTENTS

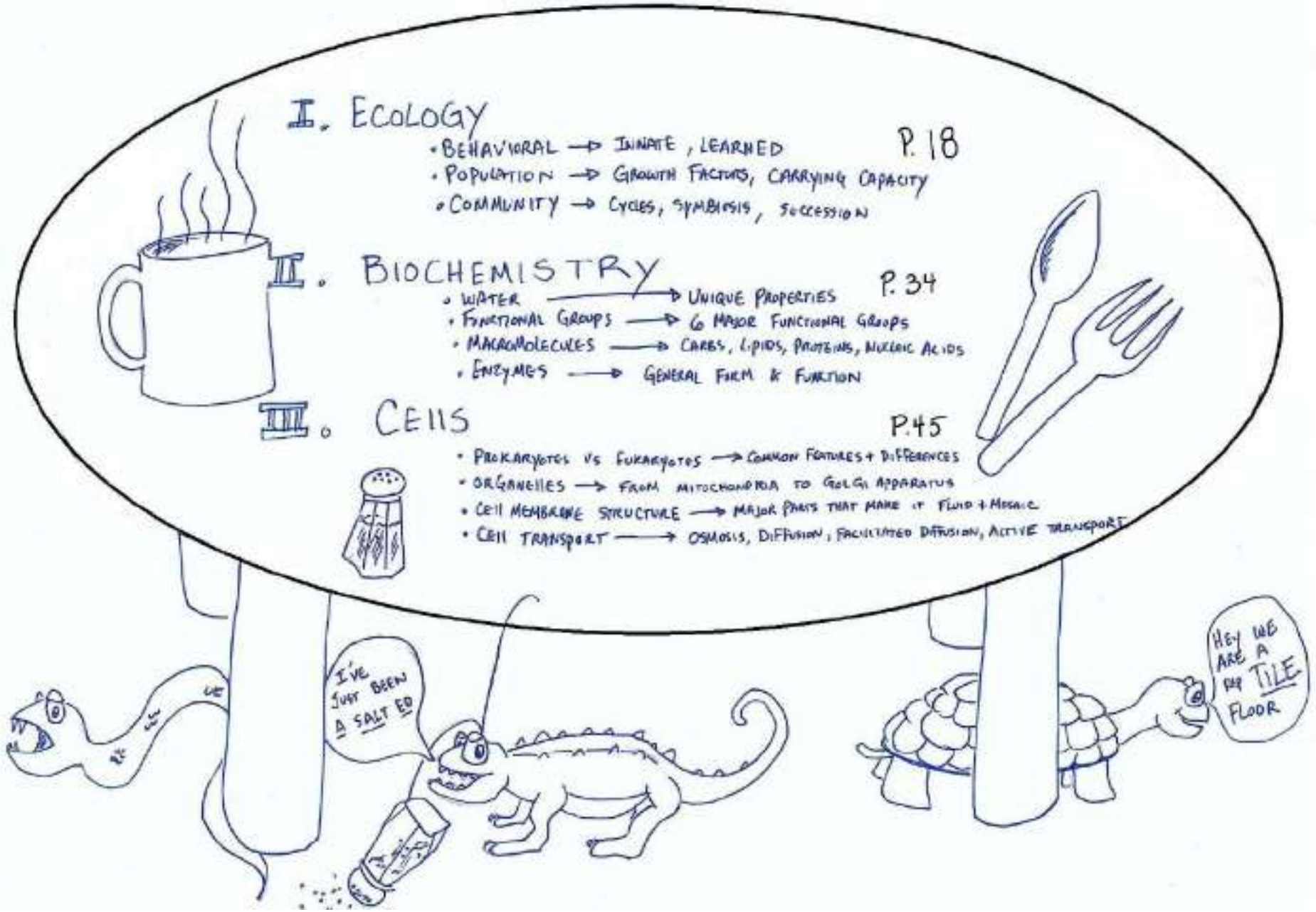


TABLE OF CONTENTS

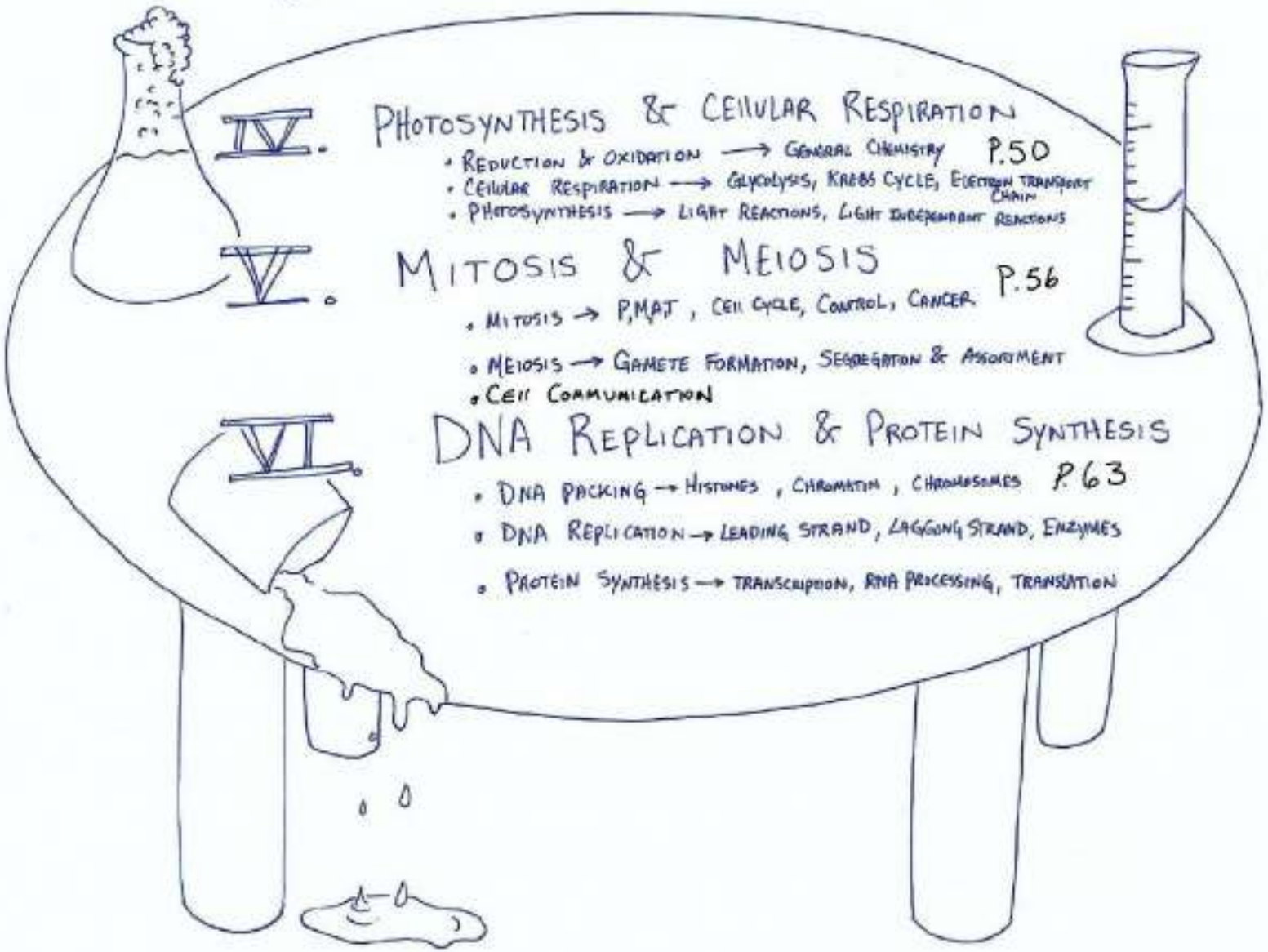


TABLE OF CONTENTS

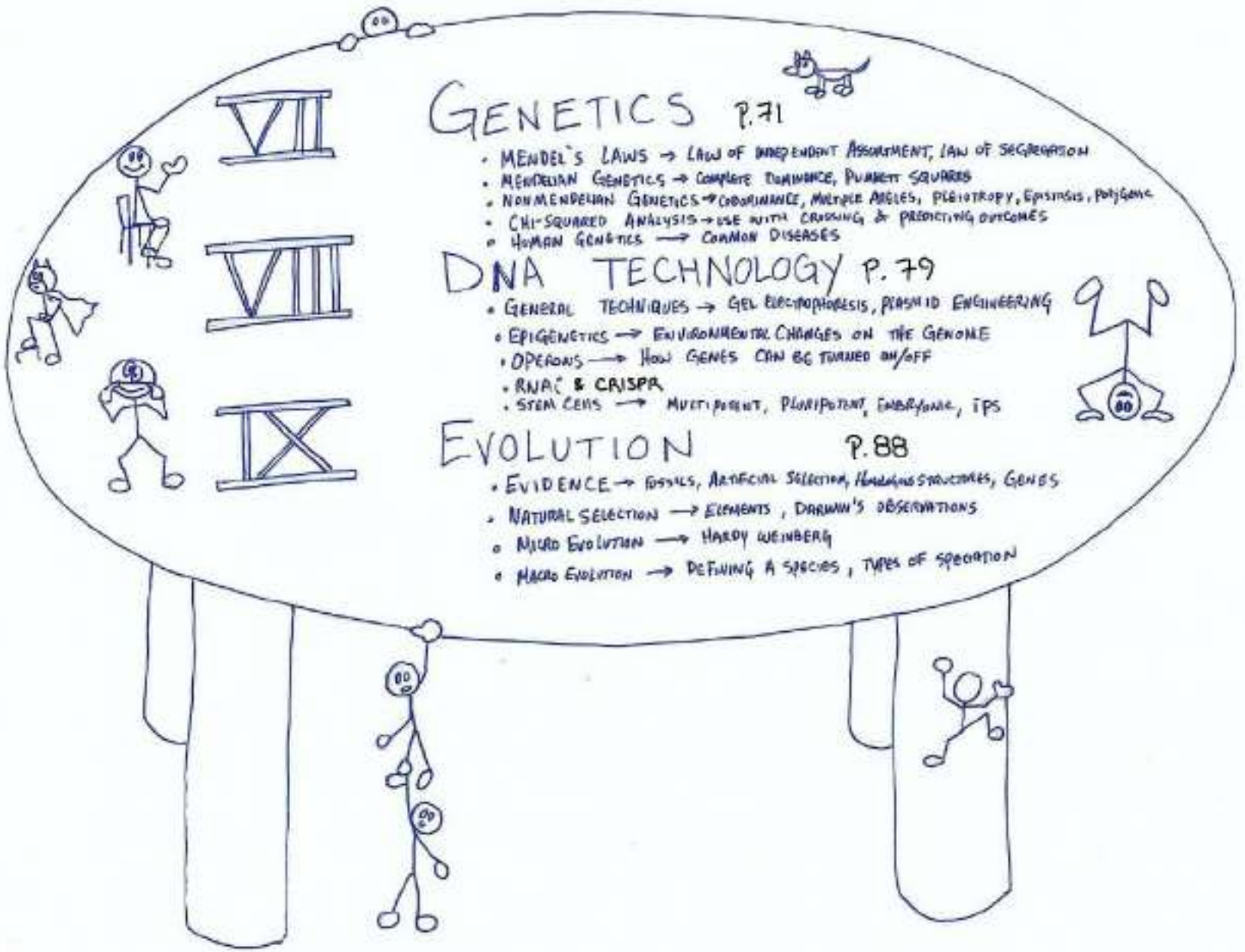


TABLE OF CONTENTS

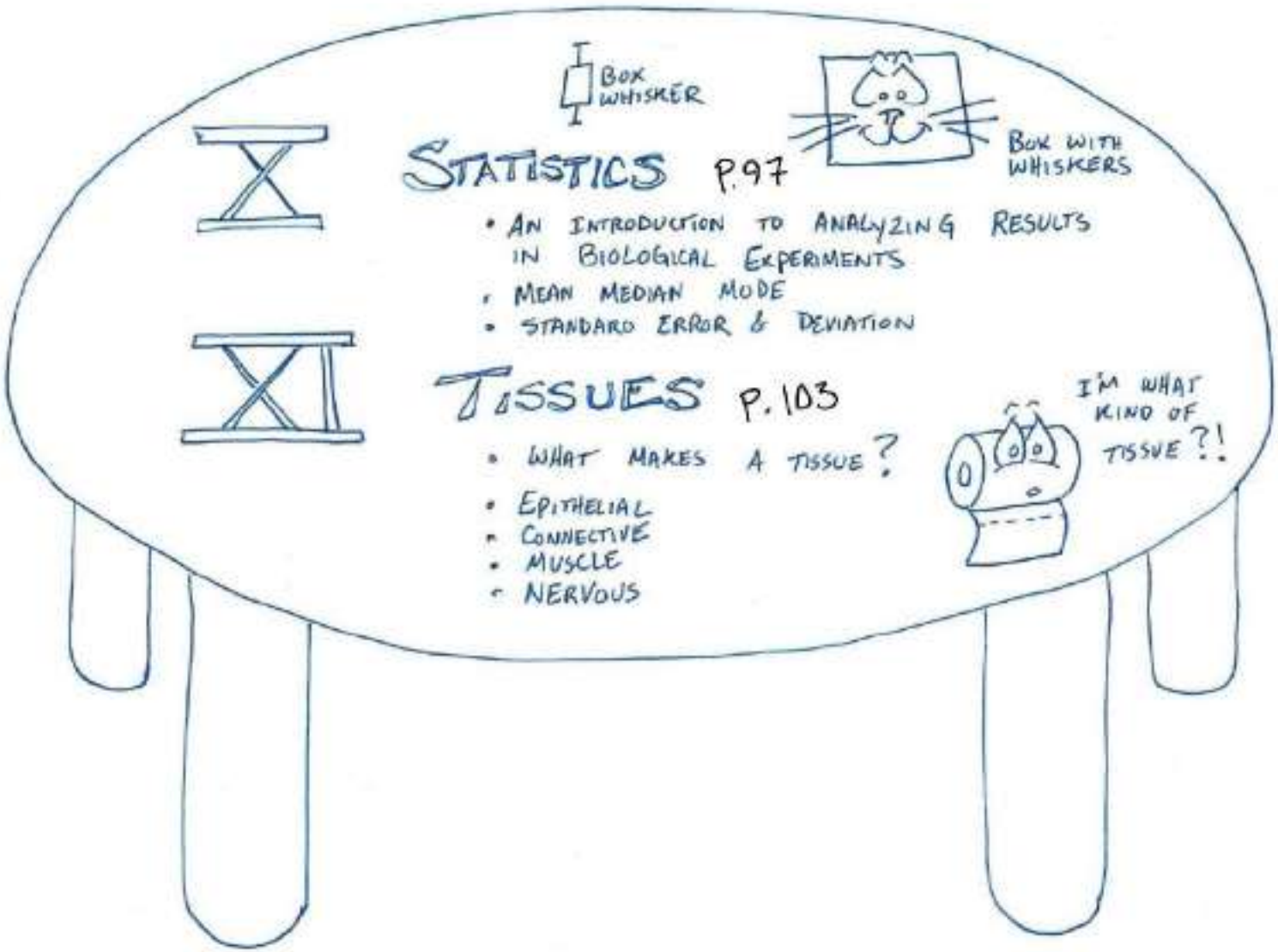
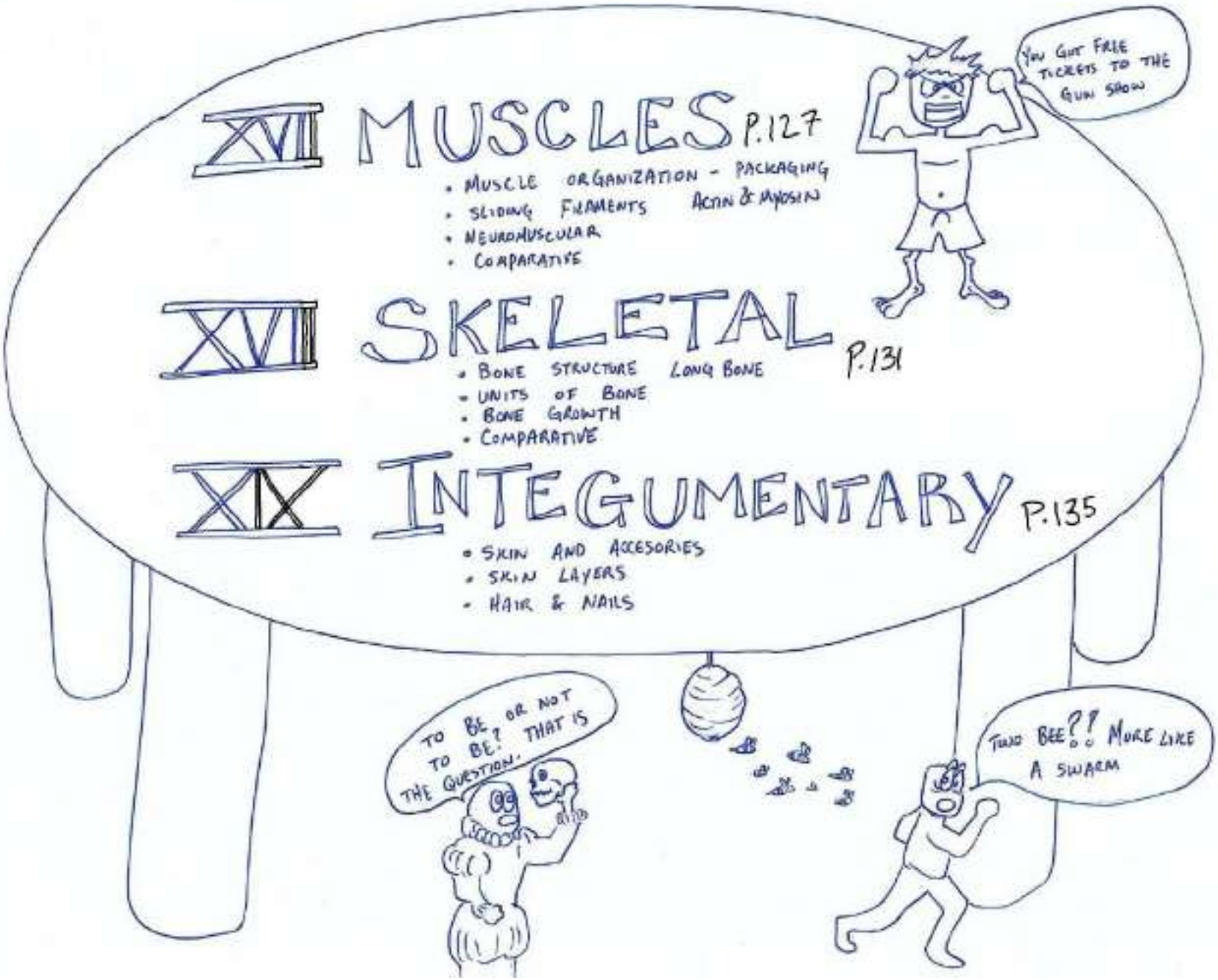
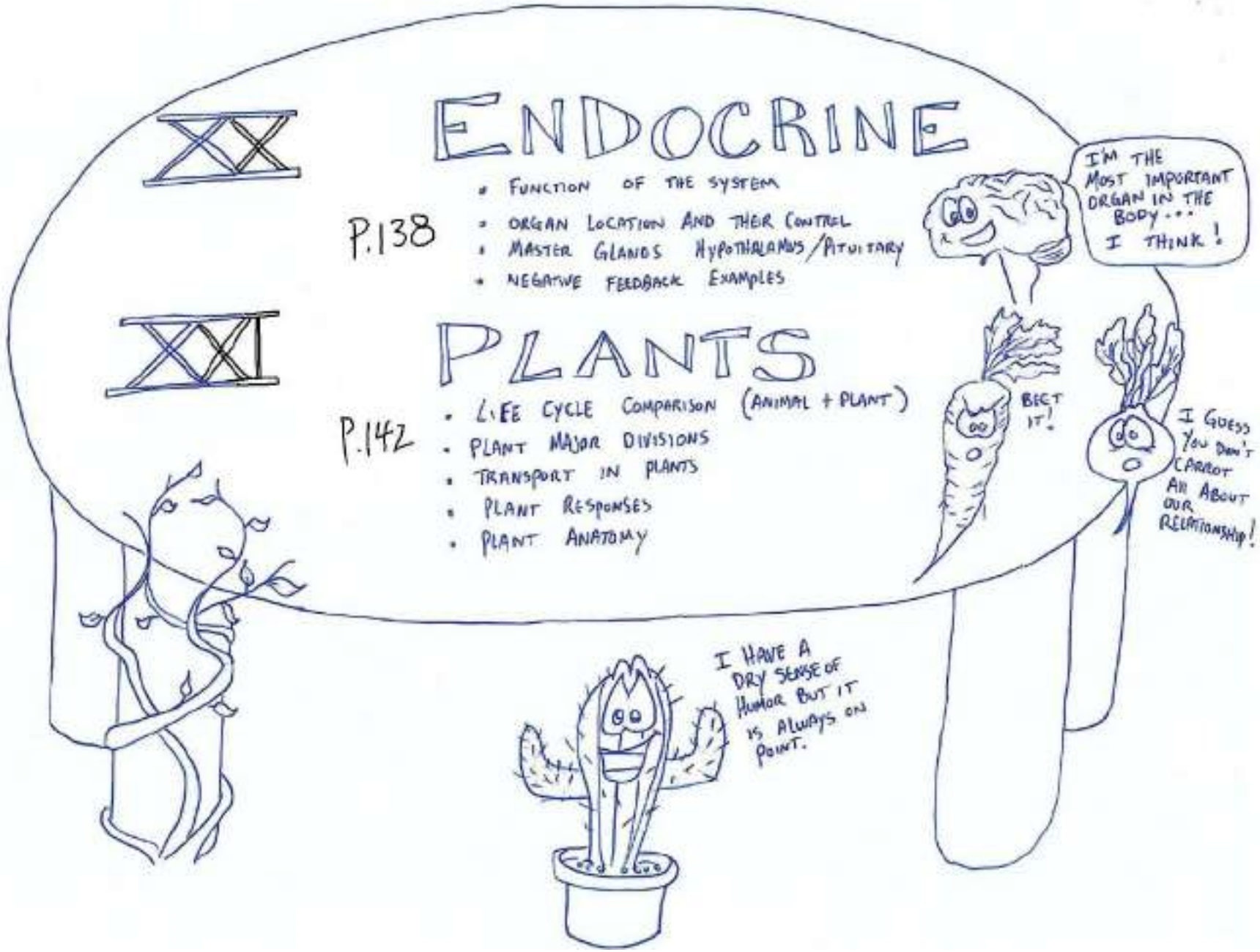


TABLE OF CONTENTS

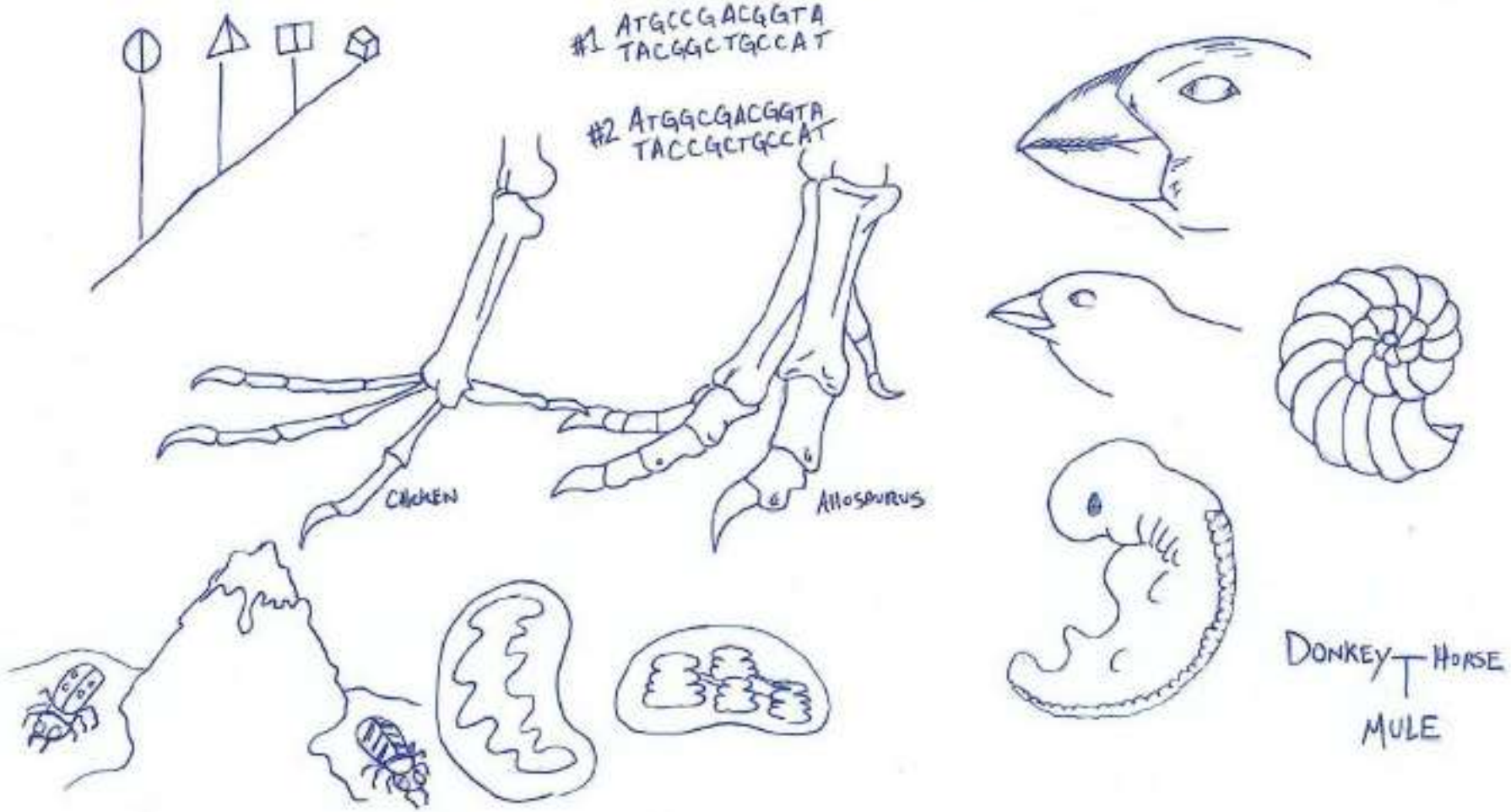
TABLE OF CONTENTS


XVII MUSCLES P.127
• MUSCLE ORGANIZATION - PACKAGING
• SLIDING FILAMENTS ACTIN & MYOSIN
• NEUROMUSCULAR
• COMPARATIVE
XVIII SKELETAL P.131
• BONE STRUCTURE LONG BONE
• UNITS OF BONE
• BONE GROWTH
• COMPARATIVE
XIX INTEGUMENTARY P.135
• SKIN AND ACCESORIES
• SKIN LAYERS
• HAIR & NAILS
YOU GOT FREE TICKETS TO THE GUN SHOW
TO BE, OR NOT TO BE? THAT IS THE QUESTION.
TWO BEE?! MORE LIKE A SWARM


XX
ENDOCRINE
P.138
• FUNCTION OF THE SYSTEM
• ORGAN LOCATION AND THEIR CONTROL
• MASTER GLANDS HYPOTHALAMUS/PITUITARY
• NEGATIVE FEEDBACK EXAMPLES
XXI
PLANTS
P.142
• LIFE CYCLE COMPARISON (ANIMAL + PLANT)
• PLANT MAJOR DIVISIONS
• TRANSPORT IN PLANTS
• PLANT RESPONSES
• PLANT ANATOMY
I'M THE MOST IMPORTANT ORGAN IN THE BODY... I THINK!
BEET IT!
I GUESS YOU DON'T CARROT ALL ABOUT OUR RELATIONSHIP!
I HAVE A DRY SENSE OF HUMOR BUT IT IS ALWAYS ON POINT.

Evolution

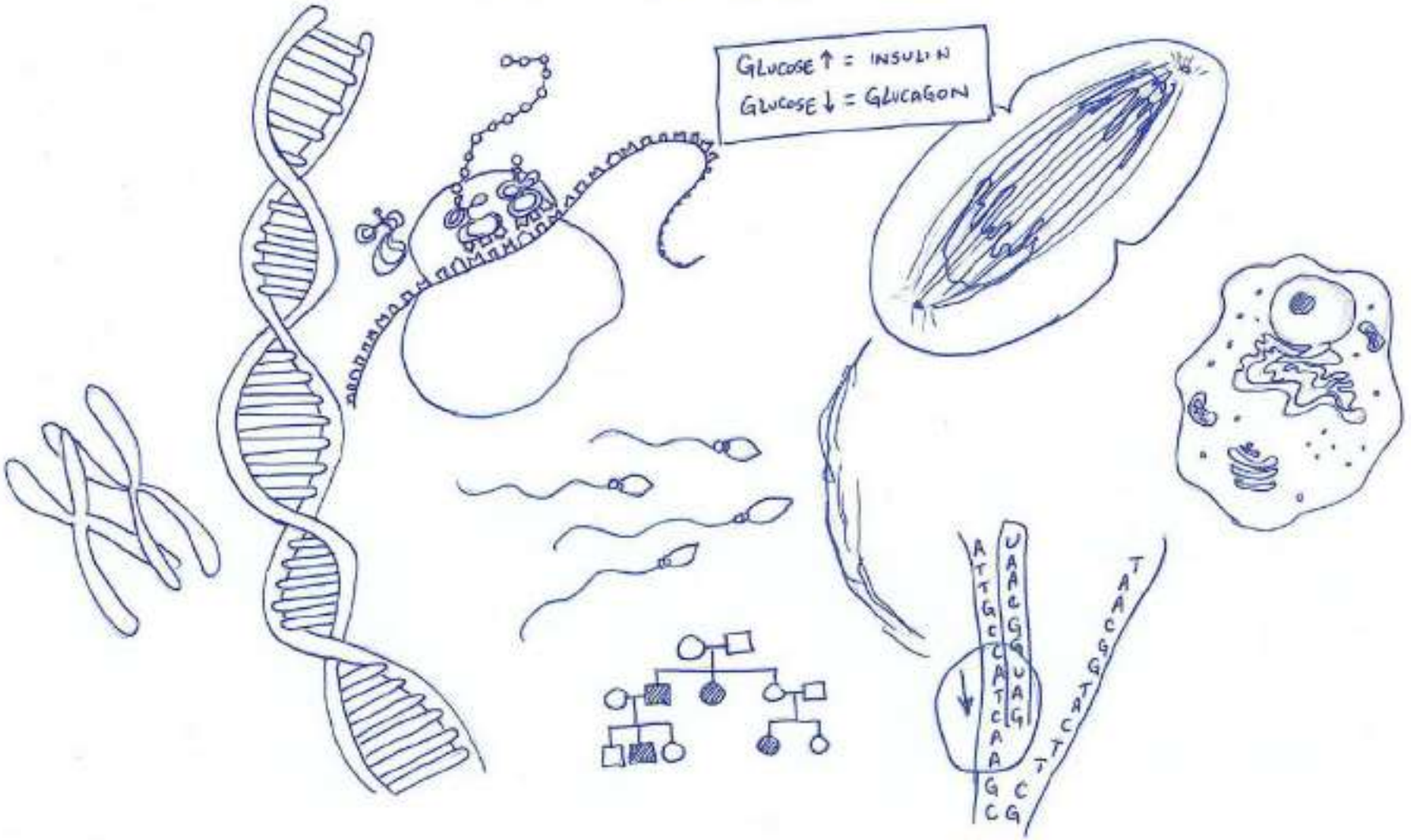
THE PROCESS OF EVOLUTION DRIVES THE DIVERSITY AND UNITY OF LIFE.



14 J.Grant

INFORMATION

LIVING SYSTEMS STORE, RETRIEVE, TRANSMIT AND RESPOND TO INFORMATION ESSENTIAL TO LIFE PROCESSES.

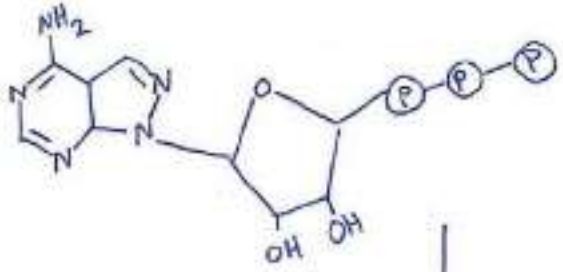


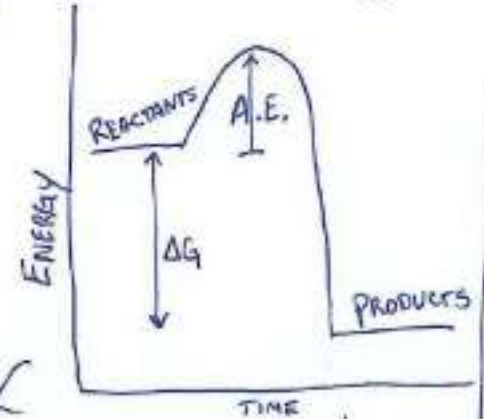
ENERGY

BIOLOGICAL SYSTEMS UTILIZE FREE ENERGY & MOLECULAR BUILDING BLOCKS TO GROW, REPRODUCE, AND TO MAINTAIN DYNAMIC HOMEOSTASIS.

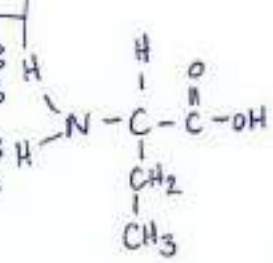
98.6°F
37°C

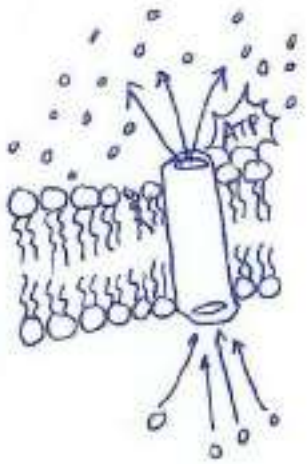
$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

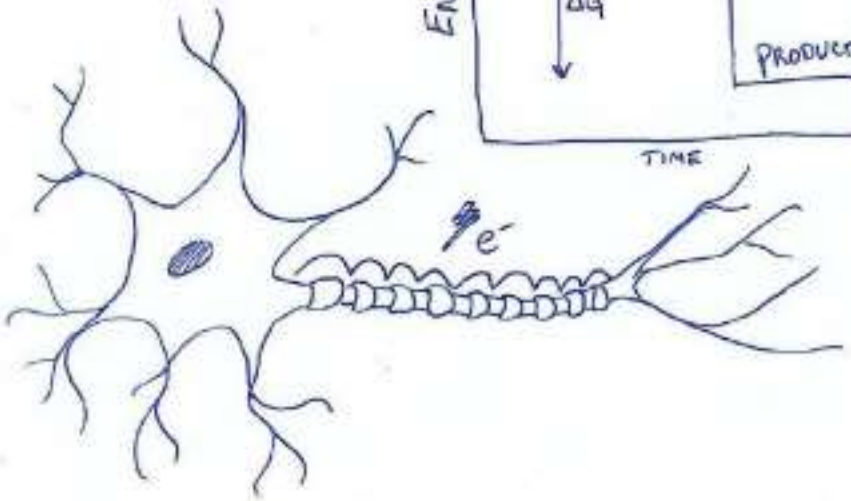




Nutrition Facts	
serving Size 1 cup (236 ml)	
Servings Per Container 1	
Amount per serving	
Calories 120	
Total Fat 5g	8%
Saturated 3g	15%
Cholesterol 20mg	7%
Sodium 120mg	5%
Total Carbohydrates 11g	



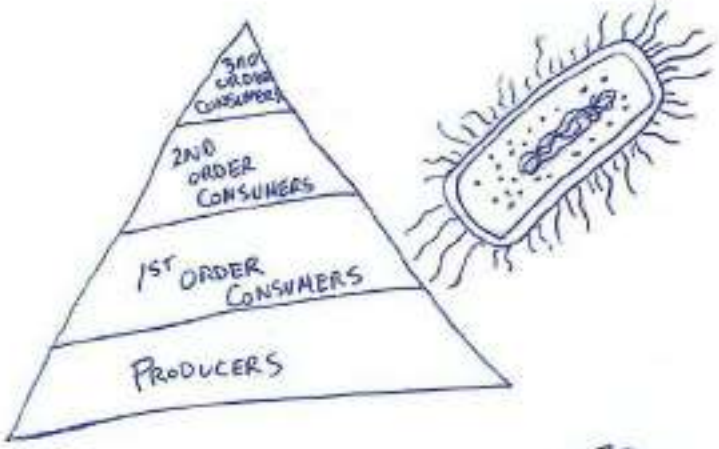


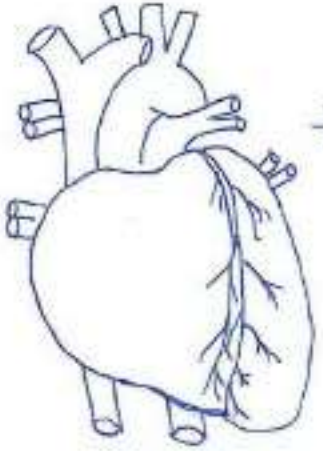


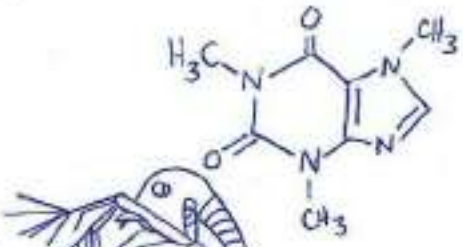
16 J.Grant

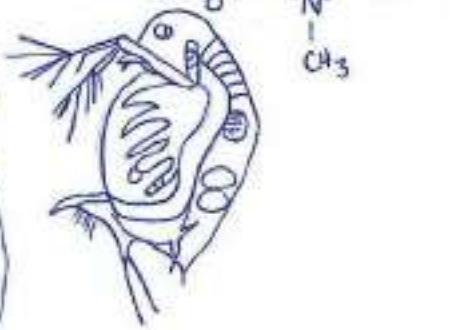
System

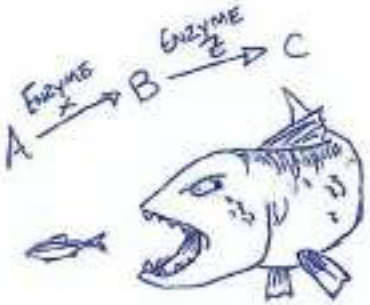
Biological systems interact, and these systems and their interactions possess complex properties.

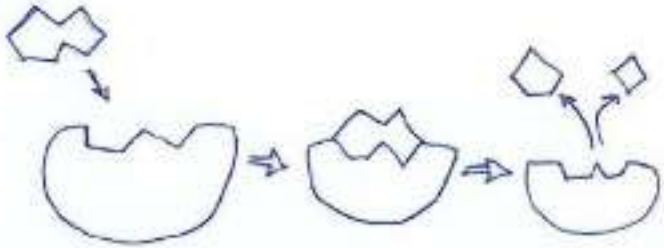












BEHAVIORAL ECOLOGY

- F.A.P.
- KINESIS
- TAXIS
- MIGRATION
- IMPRINTING
- PROBLEM SOLVING
- CLASSICAL
- OPERANT
- SOCIAL LEARNING

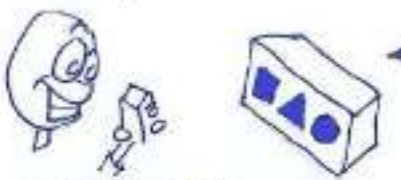
BEHAVIOR SPECTRUM

INNATE — LEARNED

COGNITION — AWARENESS, REASONING, RECALL, AND FINAL CHOICE.

NOT RESERVED TO JUST HUMANS
IT HAS BEEN OBSERVED ALL ACROSS THE ANIMAL KINGDOM

Ex: PROBLEM SOLVING



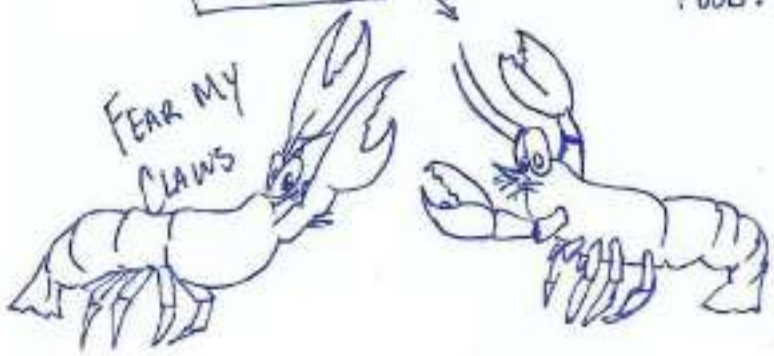
CHILDREN SOLVE SIMPLE TASKS.
CHIMPANZEES, DOGS, AND EVEN RAVENS CAN SOLVE SIMILAR PROBLEMS.

CEPHALOPODS
HEAD FEET ⇨ VERY SMART INVERTEBRATES

Ex: SOCIAL LEARNING

LEARNING BECAUSE YOU ARE PART OF A GROUP

AGONISTIC — FIGHT! FOR MATES, TERRITORY, FOOD.



ALTRUISTIC

I WOULD SACRIFICE MYSELF TO SAVE MY TWO SISTERS OR FOUR COUSINS

KIN SELECTION
HELPING FAMILY BECAUSE YOU SHARE GENES WITH THEM.

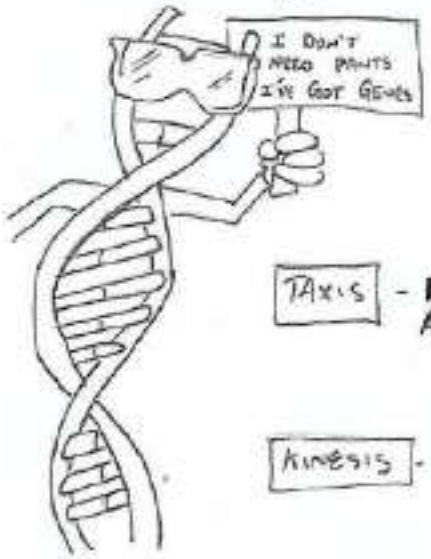
EVOLUTION

BEHAVIORAL ECOLOGY

F.A.P. = FIGHT

FIXED ACTION PATTERNS

A BEHAVIOR SEQUENCE TRIGGERED BY A SIGN STIMULUS. ONCE STARTED IT GOES TO COMPLETION



I LOVE YOU SUN!

INNATE BEHAVIORS

TAXIS - MOVING TOWARDS OR AWAY FROM A STIMULUS

PHOTOTROPISM - GROWING TOWARDS THE LIGHT

KINESIS - CHANGE IN RATE DUE TO CHANGE IN THE SURROUNDINGS

SWIMS FASTER TOWARDS CURRENT

MIGRATION - COMPLEX BEHAVIOR. MOVEMENT FROM ONE LOCATION TO ANOTHER. SOME SPECIES EXHIBIT MIGRATION AS PURELY INNATE BEHAVIOR AND SOME REQUIRE LEARNING FROM OLDER INDIVIDUALS IN THE POPULATION

EX: SHORE BIRDS LIKE THE SANDPIPERS & DARLINGS (INNATE)

BUT WILDEBEEST CALVES REQUIRE ADULTS TO LEARN WHERE TO GO.

IMPRINTING - GENETICALLY PROGRAMMED BUT WHAT IS LEARNED MUST HAPPEN DURING A CRITICAL PERIOD

K. LORENZ

BEHAVIORAL ECOLOGY

PRE PROGRAMMED - INNATE

- GUIDED BY GENES
- SO IF ORGANISMS ARE SIMILAR IN GENES, THAT BEHAVIOR SHOULD BE THE SAME

GENE FOR MOVING TOWARDS THE OCEAN WHEN SEA TURTLES HATCH

(SAME SPECIES = SAME BEHAVIOR)

NATURE VS. NURTURE

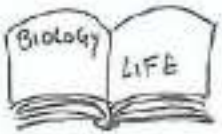
LEARNED

- REQUIRES AN EXPERIENCE AND THEN SUBSEQUENT EXPERIENCES MAY HAVE A MODIFIED RESPONSE IN COMPARISON TO THE FIRST

(LEARNING LANGUAGE)

WHY

SHOULD WE EVEN STUDY BEHAVIOR?



TO UNDERSTAND WHY ORGANISMS DO WHAT THEY DO. CONNECTIONS TO NICHE

BECAUSE IT IS A CONNECTION BETWEEN AN ORGANISM'S GENES AND ITS ENVIRONMENT.

BEHAVIOR IS PART OF AN ORGANISM'S PHENOTYPE

THUS HAS EVOLUTIONARY IMPORTANCE.

LEARNED BEHAVIOR.

OPERANT CONDITIONING TYPE OF LEARNED BEHAVIOR IN WHICH THE ORGANISM LEARNS THROUGH PUNISHMENT OR REWARD OF THE ACTION THAT THEY PARTICIPATED IN.

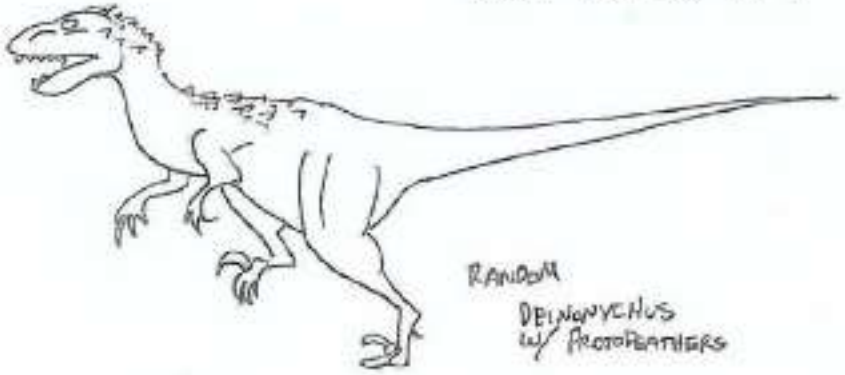
ACTIVITY STRENGTHENS OR WEAKENS DEPENDING ON THE CONSEQUENCE.

CLASSICAL CONDITIONING AN ORGANISM LEARNS TO ASSOCIATE A NEUTRAL STIMULUS TO A SIGNIFICANT EVENT

BOTH OPERANT & CLASSICAL CONDITIONING REQUIRE AN EXPERIENCE & THEN MODIFYING THE BEHAVIOR IN THE FUTURE

Ex: PAVLOV'S DOGS

DR. PAVLOV WOULD RING A BELL THEN GIVE THE DOG FOOD & THIS SEVERAL TIMES OVER OF DAYS THEN HE JUST RANG THE BELL. THE DOG STILL SALIVATES EVEN THOUGH FOOD WAS NOT P



RANDOM DEINONYCHUS W/ PROTOFEATHERS

WHY DID THE DINOSAUR CROSS THE ROAD?

BECAUSE THE CHICKEN HADN'T EVOLVE YET.

POPULATION ECOLOGY

WHAT DEFINES A POPULATION?

ALL THE ORGANISMS OF THE SAME SPECIES THAT LIVE IN A SPECIFIC GEOGRAPHICAL AREA & HAVE THE CAPABILITY OF INTERBREEDING.

Blockheadus stupidous

DISPERSAL MAP

SHOWING A CLUMPED PATTERN OF DISPERSAL

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

DENSITY FOR POPULATIONS IS SIMILAR TYPE OF IDEA. HIGHER DENSITY = $\frac{\text{MORE ORGANISMS}}{\text{AREA}}$

COMPETITIVE EXCLUSION

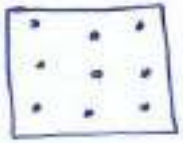
- NO TWO SPECIES CAN OCCUPY THE SAME NICHE.

IF THEY DO ONE WILL BECOME EXTINCT.

ONE OF THE REASONS WHY INVASIVE SPECIES ARE BAD.

THERE IS ALSO

- UNIFORM



AND

- RANDOM

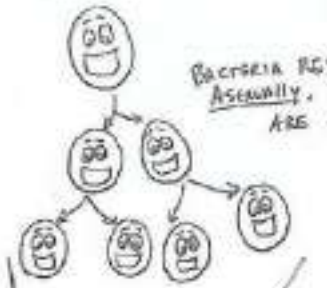
A LOT OF POPULATION DISPERSAL DEPENDS ON RESOURCES AVAILABLE. THESE RESOURCES COULD BE BIOTIC OR ABIOTIC

WHERE IS THE FOOD?

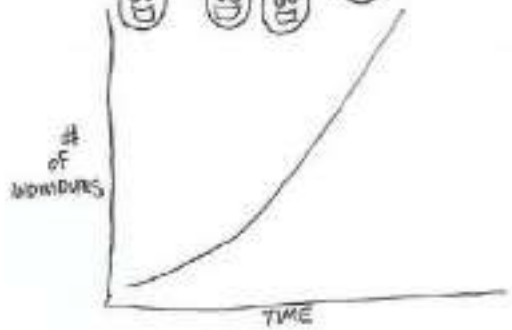
DON'T EAT ME MR. RABBIT!

RAIN, TEMPERATURE, WIND, SOIL, ETC.

How Can We View Population Growth? Graphs



Bacteria reproduce asexually. All offspring are clones.



Exponential

Very few restraints holding back this population

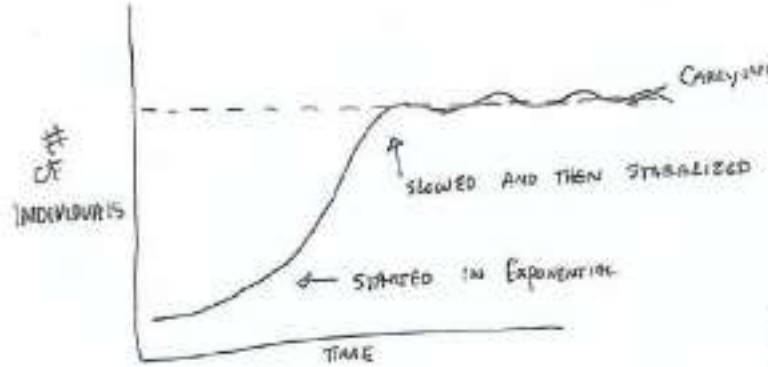
Generally populations newly introduced to an area or rebounding from disaster

Carp Diem

Ex: Asian Carp in the U.S.A.

Why do populations reach a carrying capacity?

Populations have limits or growth factors.



Logistic

$$\frac{dN}{dT} = rN\left(\frac{K-N}{K}\right)$$

K = Carrying Capacity or maximum amount sustainable

r = Rate of Growth

T = Time

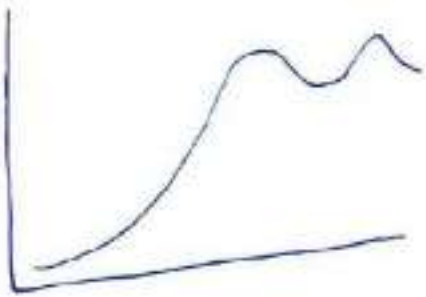
N = Size of Population

dN = Δ in # of individuals

dT = Δ in time

POPULATION ECOLOGY

WHAT CAUSES POPULATION SIZES TO CHANGE?



- BIRTH ↑ = ↑ POPULATION SIZE
- DEATH ↑ = ↓ POPULATION SIZE
- IMMIGRATION ↑ = ↑ POPULATION SIZE
- EMMIGRATION ↑ = ↓ POPULATION SIZE

IN

OUT

OTHER THINGS TO CONSIDER . . .

- AT WHAT AGE DOES THE SPECIES BECOME SEXUALLY MATURE?

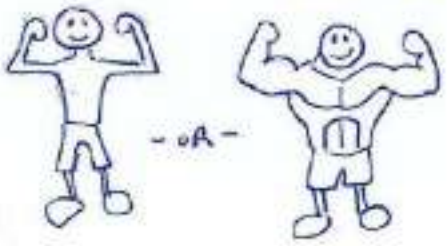
FRUIT FLIES HAVE ONLY 4 CHROMOSOMES PER CELL SO THE SPERM HAS ONLY 2

AND THE EGG ONLY HAS 2. ↓ 2

FRUIT FLY IS READY ≈ 96 hrs AFTER FERTILIZATION.

- IS THERE A SOCIAL DYNAMIC?

- ONLY THE STRONGEST MALE CAN MATE WITH FEMALES.



Population Growth Factors

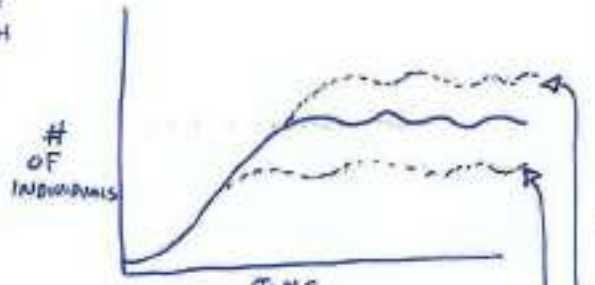
Part 1

Density Dependant Growth Factors

[Elements that will change survivability in large populations.]

- Competition - Only 15 cheeseburgers are hidden in the school per day = will drastically change how many can survive in this environment.
- Predators - We drop two mountain lions into the school. = should have no problem finding some of you and eating you.
- Disease - Bubonic plague erupts in the school. The fact that there is so many of you it is easy to spread the disease and limit how many of you survive.

Nasty bacteria caused the Black Death around 1350.



★ Changing resources can change the carrying capacity

More food

More parasites in the H_2O supply

How does scenario 2 apply?

Let's set the stage.

Imagine a scenario like the Hunger Games where you get locked in your high school.

You need to look for food and avoid predators.

Scenario 1: There are 1,000 other students locked in the school with you = high density population

Scenario 2: There are 10 other students locked in the school with you = low density

★ All you need to do is survive and make it through to the next year.

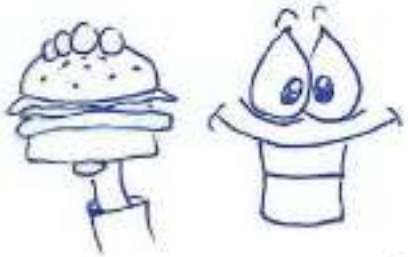
Population Growth Factors

Part 2

Density Dependent Factors

Don't effect small populations

- Competition ? 15 burgers is plenty to sustain all 10 of you.



Eating makes me happy.

- Predation ? Those mountain lions will have a hard time finding you

- Disease ? A big part of diseases ability to spread is reliant on human to human contact. With few people in the population it limits this avenue.

You get sick more during the winter because you are inside near people more often. Spreading the disease.

Some factors hit both large & small populations.

Density Independent Growth Factors

- Natural Disasters - A hurricane whips through the school. Scenario 1 or 2 will be influenced
- Radical changes in Environment - A drought hits the school and the water supply is turned off. Scenario 1 or 2 will be influenced.
- Human Influence - A wrecking ball knocks down half of the school. Regardless of the size of your population your group will change.

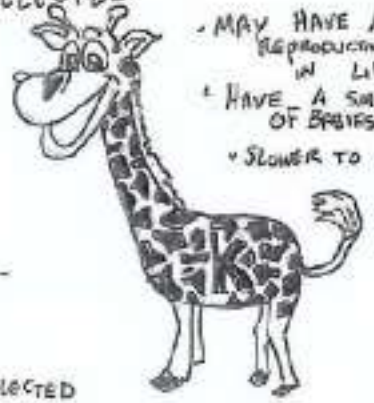
THE DYNAMICS THAT GOVERN POPULATION GROWTH.

POPULATION ECOLOGY

THE SPECIES LIFE STRATEGY

- DO THEY PRODUCE A LOT OF BABIES PER EPISODE?
  - ☐ YES → r-SELECTED
  - ☐ NO → K-SELECTED
- DO THEY INVEST ENERGY INTO THEIR OFFSPRING IN ORDER TO INCREASE THE OFFSPRING'S FITNESS?
  - ☐ YES → K-SELECTED
  - ☐ NO → r-SELECTED

- REPRODUCE ONCE
- LAY ≈ 150 EGGS
- SHORT LIFESPAN
- QUICK TO GET TO REPRODUCTIVE AGE.



- MAY HAVE MULTIPLE REPRODUCTIVE PERIODS IN LIFE
- HAVE A SMALL AMOUNT OF BABIES PER EVENT
- SLOWER TO GET TO REPRODUCTIVE AGE

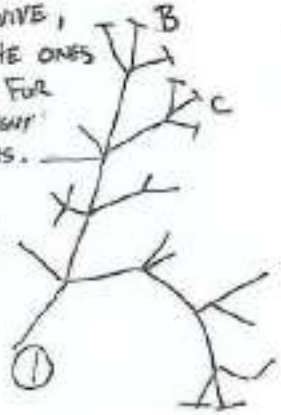
FITNESS

BEING ABLE TO SURVIVE & REPRODUCE

NOT JUST ABOUT BEING STRONG

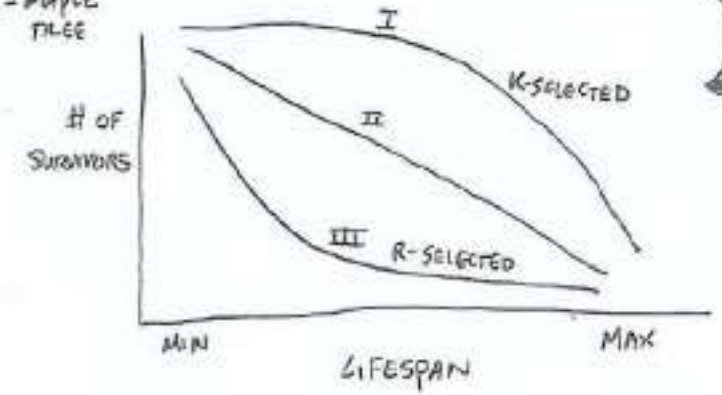
IT'S NOT JUST THE STRONGEST OR THE FASTEST THAT SURVIVE, IT'S JUST THAT THE ONES WITH BETTER GENES FOR THE GIVEN ENVIRONMENT MAKE MORE BABIES.

EVOLUTION



TYPE I EXAMPLE = ELEPHANTS
TYPE II EXAMPLE = SQUIRREL
TYPE III EXAMPLE = MAPLE TREE

SURVIVORSHIP CURVES



SymBiosis

Two different species in close physical contact.
Shipping each other

Mutualism (+/+) Both individuals benefit from the relationship

Commensalism (+/0) One organism benefits but the other is not helped or harmed.

Predation / Parasitism (+/−) One organism benefits and the other is harmed

Coevolution
Two populations that shape each other over time
- Bee & flowers
- Cheetah Gazelle

No animal on the planet can break down cellulose found in plants yet a cow's diet is all plants

Bio Cow →

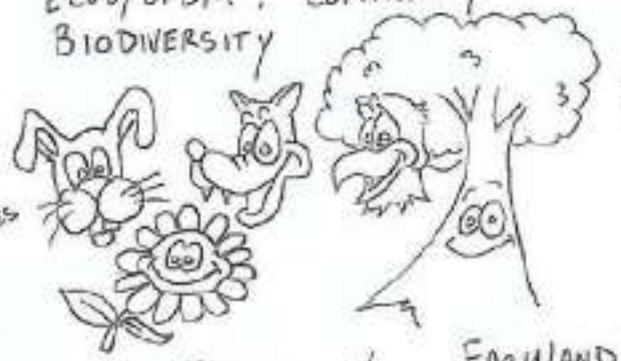
They have a symbiotic relationship with bacteria & protists that can break it down for them → Ruminent stomach

The key is that no species evolves in isolation!!

WHAT IS BIODIVERSITY?

VARIETY OF ORGANISM IN AN ECOSYSTEM, COMMUNITY BIODIVERSITY

FOXES, RABBITS, HAWKS, AND TREES PLAY HAPPILY



DECIDOUS FOREST

↓

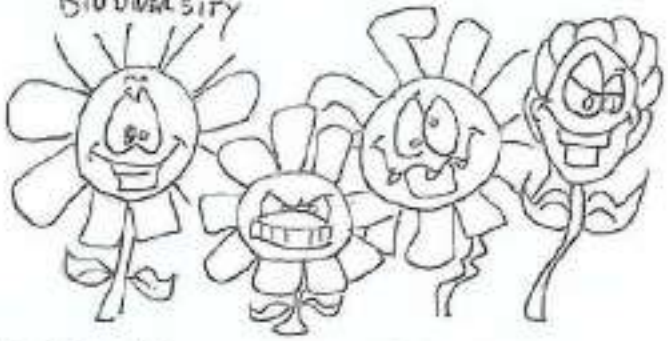
LEAVES FALL FROM THE TREES IN THE FALL

VS.

FARMLAND

REALITY

VARIETY OF PHENOTYPES (TRAITS) IN A POPULATION GENETIC BIODIVERSITY



VARIETY OF FLOWER COLORS

VS.

ALL THE SAME COLOR

WHY IS IT IMPORTANT?

- CONTINUATION OF THE ECOSYSTEM THROUGH ENVIRONMENTAL CHANGE.

AS THE EARTH CHANGES, SO TO DO THE ORGANISMS THAT LIVE ON IT.

WITHOUT BIODIVERSITY POPULATIONS RUN THE RISK OF EXTINCTION

THE KEY IS THAT POPULATIONS MUST HAVE THE GENES IN THE GENE POOL IF THEY, AS A POPULATION ARE TO CONTINUE ON.

EVOLUTION

Succession

Change of an Ecosystem over time.

Edges start eroding

Change in H_2O flow

Example of Secondary Succession Soil was already present in the ecosystem at the start

Events that can "reset" an ecosystem yield 2ndary succession

Primary Succession starts on soiless land

D

One of the coolest science words to say. Just say it. M-A-G-M-A. Awesome!

From cooled Magma new land is born. This land must be invaded by lichens to begin the soil creation process

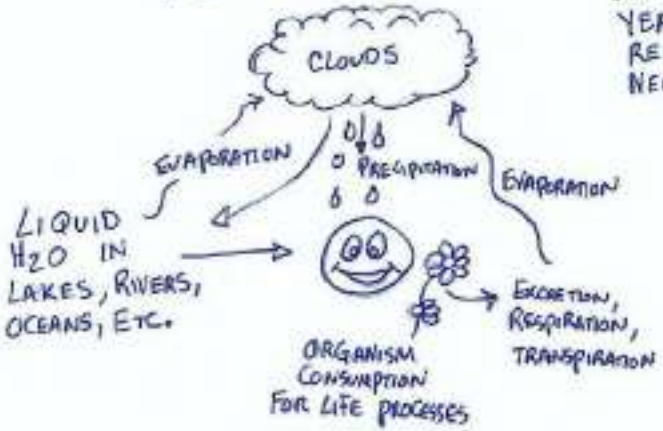
F.Y.I. Magma is molten rock underground. Lava is molten rock above ground.

30 J.Grant

CYCLES

ALL THE ATOMS OF THE ELEMENTS ARE THE SAME ONES WE HAD ON EARTH MILLIONS OF YEARS AGO. THEY JUST GET REARRANGED AND RECYCLED INTO NEW MOLECULES AND/OR LOCATIONS.

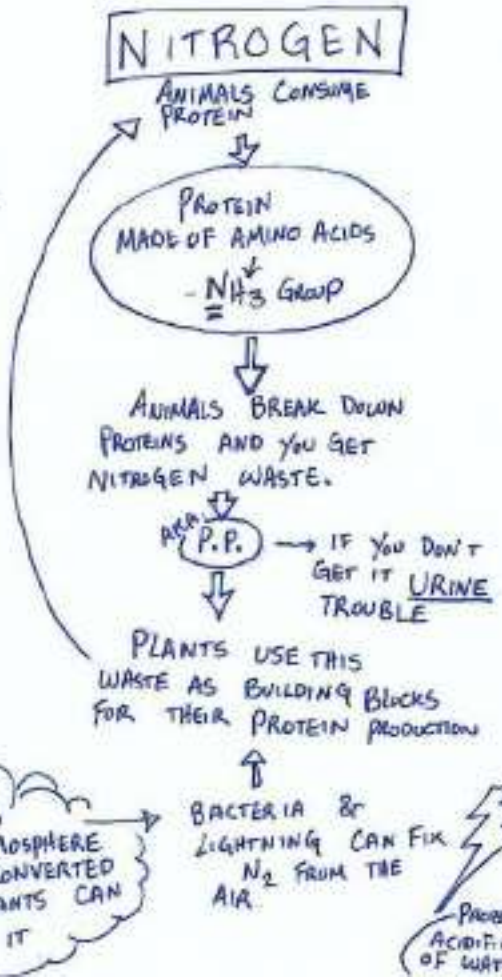
H_2O HYDROLOGICAL



BIOMAGNIFICATION

ACCUMULATION OF TOXINS IN THE FOOD CHAIN

NITROGEN



THE H_2O A DINO PEED OUT 154 MILLION YEARS AGO HAS THE POSSIBILITY TO BE IN YOUR WATER BOTTLE NOW. A WATER MOLECULE IS A WATER MOLECULE!

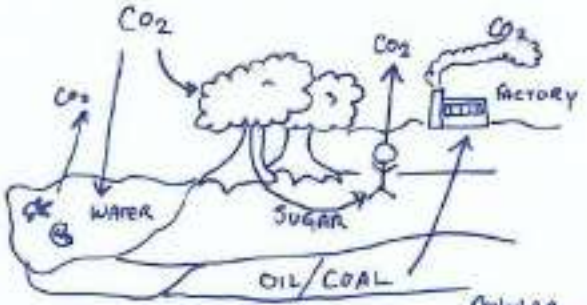
CARBON

PLANTS AND OTHER PRODUCERS ARE THE ONLY ONES THAT CAN REMOVE CO_2 FROM THE AIR AND TURN IT INTO $C_6H_{12}O_6$. (SUGAR)

HETEROTAPHS USE SUGARS FOR ATP PRODUCTION & IN TURN MAKE CO_2

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

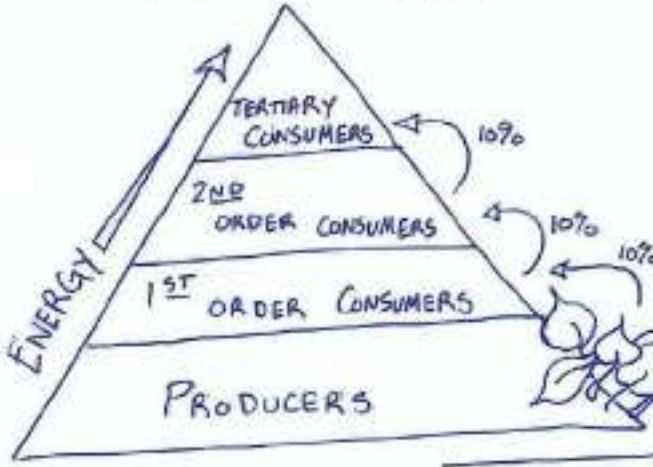


- ANIMALS PRODUCE CO_2 FROM CELLULAR RESPIRATION OF SUGARS AND OTHER ORGANIC MATTER
- BURNING OLD (DEAD) ANIMALS PRODUCES CO_2
- CO_2 CAN DISSOLVE INTO THE WATER ($\downarrow$pH) & AQUATIC PLANTS CAN USE THE CO_2
- PLANTS REMOVE CO_2 & TURN IT INTO ORGANIC MATTER

PROBLEM: ACIDIFICATION OF WATER

ENERGY FLOW & COMMUNITY DYNAMICS

TROPHIC LEVEL = FEEDING LEVEL

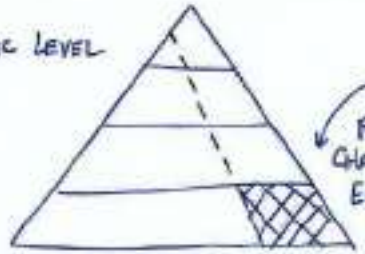


UNLESS SOMEONE LIKE YOU CARES A WHOLE AWFUL LOT, NOTHING IS GOING TO GET BETTER IT'S NOT! — THE LORAX

PRODUCERS ARE THE ONLY ONES WHO CAN TRANSFER THE SUN'S ENERGY INTO THE FOOD CHAIN [PHOTOSYNTHESIS]

RULE OF 10%

ONLY 10% OF THE ENERGY FROM ONE TROPHIC LEVEL MOVES TO THE NEXT TROPHIC LEVEL
- ENERGY IS LOST AS HEAT
- ENERGY IS USED BY THE ORGANISM THAT IS CONSUMED



REMOVING PRODUCERS CHANGES THE AMOUNT OF ENERGY AVAILABLE TO THE REST. THUS THE PYRAMID SHRINKS

SO WHO EATS THOSE AT THE TOP OF THE FOOD CHAIN?

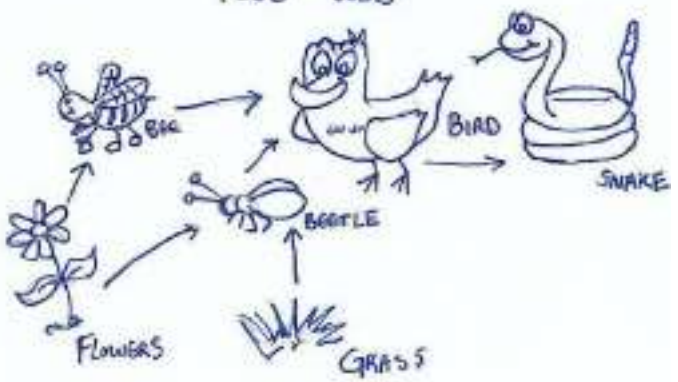
DECOMPOSERS

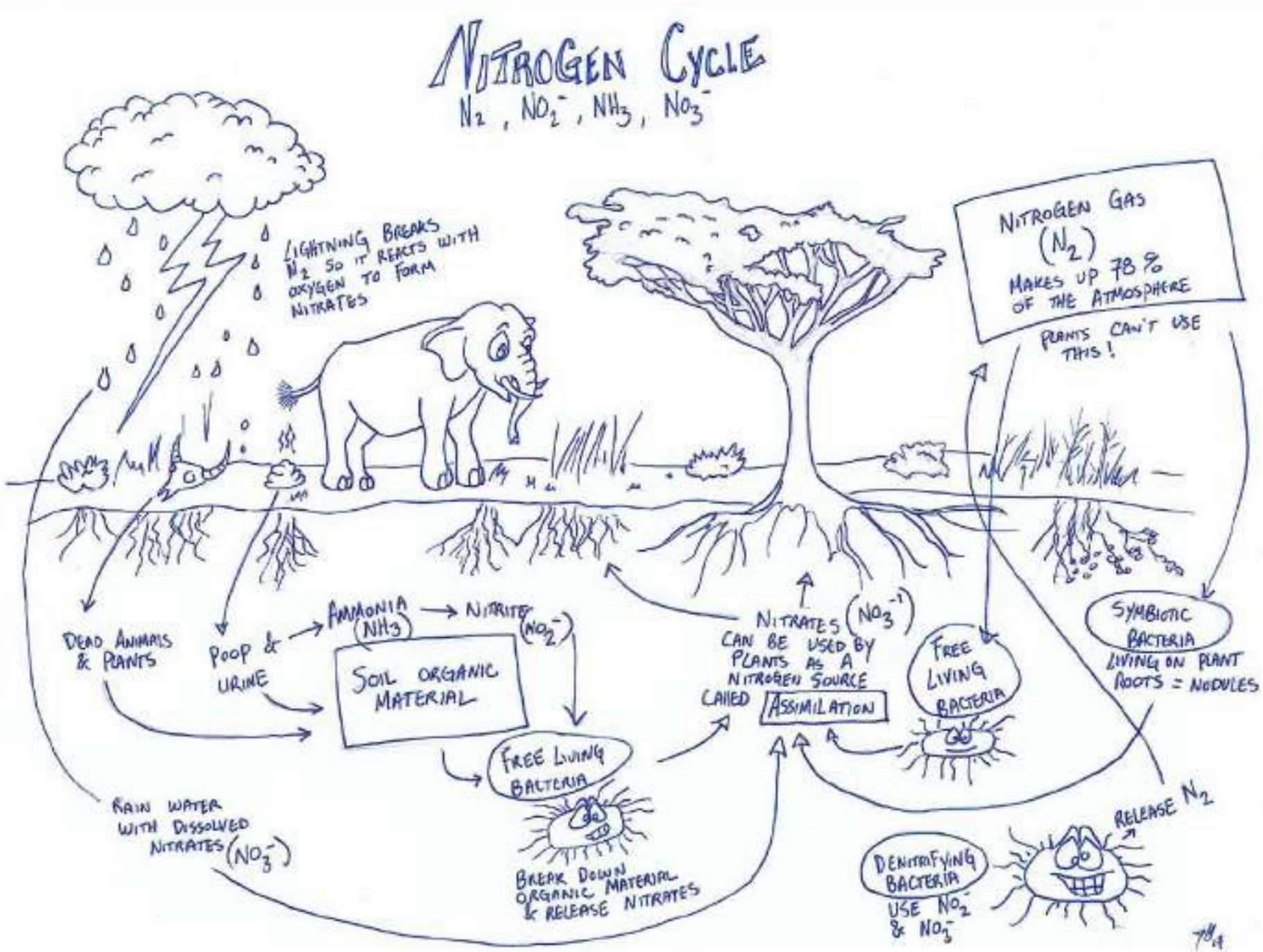
CONSUME THE LEFTOVER ENERGY AND RETURN NUTRIENTS BACK INTO THE SOIL AND WATER.

WHY WON'T ANYONE PLAY WITH ME?! I'M A FUNGI!

NPK
NITROGEN
PHOSPHORUS
POTASSIUM

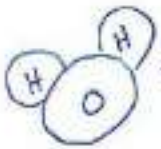
FOOD WEB



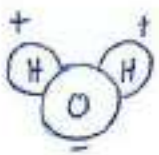

NITROGEN CYCLE
N_2, NO_2^-, NH_3, NO_3^-
LIGHTNING BREAKS N_2 SO IT REACTS WITH OXYGEN TO FORM NITRATES
NITROGEN GAS (N_2) MAKES UP 78% OF THE ATMOSPHERE
PLANTS CAN'T USE THIS!
DEAD ANIMALS & PLANTS
POOP & URINE
AMMONIA (NH_3)
NITRITE (NO_2^-)
SOIL ORGANIC MATERIAL
FREE LIVING BACTERIA
BREAK DOWN ORGANIC MATERIAL & RELEASE NITRATES
RAIN WATER WITH DISSOLVED NITRATES (NO_3^-)
NITRATES (NO_3^-) CAN BE USED BY PLANTS AS A NITROGEN SOURCE CALLED ASSIMILATION
FREE LIVING BACTERIA
SYMBIOTIC BACTERIA LIVING ON PLANT ROOTS = NODULES
DENITRIFYING BACTERIA USE NO_2^- & NO_3^-
RELEASE N_2

WATER
LIFE'S FAVORITE MOLECULE

WATER YOU DOING? STUDYING SCIENCE! DUH!



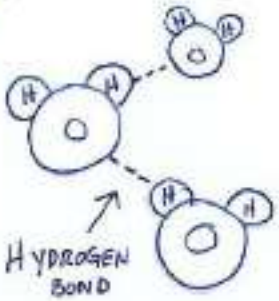
IT IS A POLAR COVALENT BOND BETWEEN OXYGEN AND HYDROGEN → ONE ATOM "LOVES" ELECTRONS MORE THAN ANOTHER SO THAT ATOM BECOMES MORE NEGATIVE



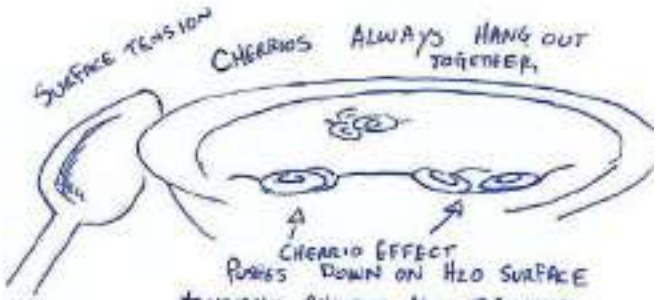
THEY ARE SHARING BUT MORE LIKE A BROTHER & SISTER SHARE.

SWEATING WORKS BECAUSE OF EVAPORATIVE COOLING. WHICH IS A RESULT OF HIGH SPECIFIC HEAT.

THIS POLARITY ALLOWS FOR A WIDE VARIETY OF PROPERTIES MOST OF WHICH ARE LINKED TO THE HYDROGEN BOND!



THE ATTRACTION OF ONE WATER MOLECULE TO ANOTHER



* USUALLY CHEERIOS ARE TOGETHER BECAUSE THEY FALL INTO DIMPLES.

LEADS TO UNIQUE PROPERTIES LIFE REQUIRES

1. HIGH SPECIFIC HEAT (4.18 J/g°C) - IT TAKES A LOT OF ENERGY TO CHANGE ITS TEMPERATURE
2. COHESION - WATER STICKING TO ITSELF
3. ADHESION - WATER STICKING TO OTHER THINGS
4. SOLID IS LESS DENSE THAN ITS LIQUID FORM - ICE FLOATS ON LIQUID WATER
5. HIGH SURFACE TENSION - RESISTS SURFACE BREAKAGE
6. GREAT SOLVENT - IT DISSOLVES MANY THINGS.

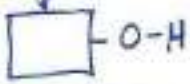
FUNCTIONAL GROUPS

– EQUALS A SINGLE COVALENT BOND

SHOW UP TOGETHER AND GIVE THE MOLECULE SPECIAL PROPERTIES

HYDROXYL

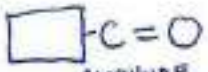
A.K.A. ALCOHOL



FORM H-BONDS = SOLUBLE IN H_2O EASILY

–TONS ARE FOUND IN SUGARS

CARBONYL



ALDEHYDE

OR

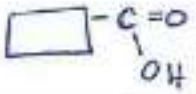
KEYTONE

ALSO HELPS WITH SOLUBILITY IN H_2O

– LOTS IN SUGARS

CARBOXYL

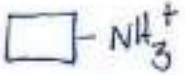
A.K.A. CARBOXYLIC ACID



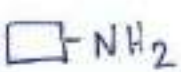
EASILY DONATE H^+ INTO THE SOLUTION } ACID

– FATTY ACIDS → LIPIDS
– AMINO ACIDS → PROTEINS

AMINO



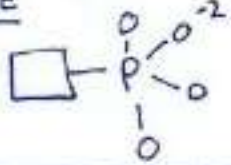
OR



EASILY TAKE UP H^+ FROM SOLUTION } BASE

– AMINO ACID → PROTEIN

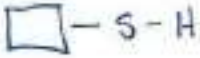
PHOSPHATE



EASILY IONIZES

– DNA, RNA, ATP

SULFHYDRAL



HELP WITH STABALIZATION ESPECIALLY IN PROTEIN STRUCTURE

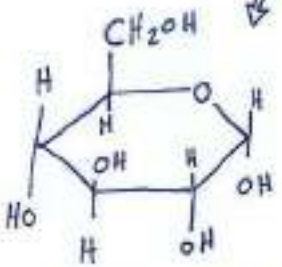
– SOME AMINO ACID R-GROUPS – TERTIARY STRUCTURE

CARBOHYDRATES PART 1

PRIMARY ROLE : ENERGY SOURCE

GENERAL RATIO: CH_2O 1:2:1

$C_6H_{12}O_6$



EVERY CORNER OF THE  IS A CARBON EXCEPT THE ONE OXYGEN

$C_6H_{12}O_6$ GLUCOSE

$C_6H_{12}O_6$ FRUCTOSE

$C_6H_{12}O_6$ GALACTOSE

SAME FORMULA DIFFERENT STRUCTURE

ISOMERS

I. D. NOTES
- C_1H_2O IN THE MOLECULE (1:2:1)
- WHEN IN A POLYMER FORM IT LOOKS LIKE THE RINGS ARE HOLDING HANDS

GLUCOSE → BLOOD SUGAR

A.K.A = MONOSACCHARIDE

FRUIT SUGAR ↓ IS A CONDENSED FORM HARMFUL?

OR IS IT THE OVER CONSUMPTION OF SUGAR BY HUMANS?

LACTOSE = MILK SUGAR
GALACTOSE + GLUCOSE
$C_{12}H_{22}O_{11}$

MALTOSE = MALT OR BEER SUGAR
GLUCOSE + GLUCOSE
$C_{12}H_{22}O_{11}$

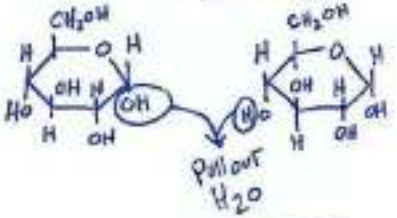
WHEN YOU REMOVE H_2O FROM THE MONOSACCHARIDE YOU FORM A GLYCOSIDIC LINKAGE

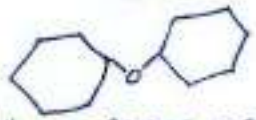
TWO TOGETHER D.I SACCHARIDE
SUCROSE = TABLE SUGAR
$C_{12}H_{22}O_{11}$

AW! THAT IS SWEET!

GET IT? SWEET? SUGAR

DEHYDRATION REACTION
REMOVE H_2O





ADD H_2O TO REVERSE IT = HYDROLYSIS

CARBOHYDRATE
PART 2

SECONDARY ROLL

BECAUSE YOU CAN'T HAVE JUST ONE.

DELICIOUS :P

POLYSACCHARIDE

POLY = MANY

SACCHARIDE = SUGAR

TONS OF MONOMERS LINKED TOGETHER

SECONDARY ROLE

BIOL

CONNECTIONS

- IF YOU CARB LOAD BEFORE A BIG EVENT YOU ARE TRYING TO STORE COMPLEX SUGAR.

COMPLEX SUGAR = POLYSACCHARIDE

THIS CARB LOADING EVENT IS A BALANCE OF HYDROLYSIS AND CONDENSATION REACTIONS.

YOU BREAK THE STARCH INTO GLUCOSE (MONOMER) AND SEND IT TO YOUR MUSCLES AND LIVER. THEN YOUR ENZYMES JOIN THOSE GLUCOSE MOLECULES INTO GLYCOGEN

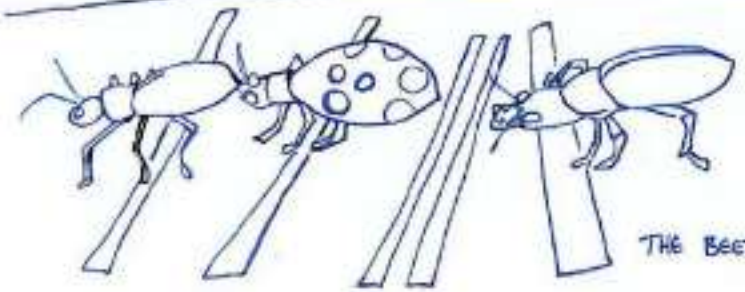
- ENERGY STORAGE
  - STARCH
    - PLANT STORAGE FOR FUTURE USE
  - GLYCOGEN
    - STORAGE IN MUSCLES OR LIVER FOR FUTURE USE

EACH KERNAL IS A BABY. A MAJORITY OF THE KERNAL IS STARCH = BABY FOOD

- STRUCTURAL SUPPORT
  - CELLULOSE
    - CELL WALLS OF PLANTS
      - PAPER, CLOTHES, HOMES, ROPES
  - CHITIN
    - EXOSKELETONS OF ARTHROPODS
    - CELL WALLS OF FUNGUS

STRENGTH IN CELLULOSE

GET IT? :P



THE BEETLES

Proteins

PART 1

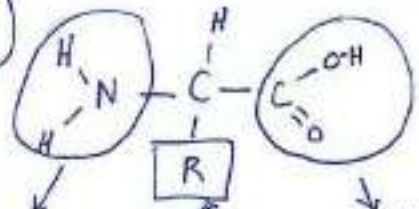
OVER 50% OF THE DRY WEIGHT OF YOUR BODY IS PROTEIN

ROLES OF PROTEINS

1. ENZYMES - BIOLOGICAL CATALYST THAT SPEED UP REACTIONS
2. STRUCTURE - SUPPORT FOR THE BODY COLLAGEN, KERATIN, AND ELASTIN
3. MOVEMENT - MUSCLE'S MOTOR UNITS ARE MADE OF ACTIN & MYOSIN
4. HORMONES - HELP REGULATE OUR BODY FUNCTIONS. INSULIN → CONTROL BLOOD SUGAR
5. TRANSPORT - HELP MOVE MOLECULES AROUND THE BODY. LIKE HEMOGLOBIN → MOVE O_2
6. IMMUNE - ANTIBODIES HELP REMOVE FOREIGN SUBSTANCES AND FIGHT INFECTION.
7. GENE REGULATION - HELP WITH THE EXPRESSION OR SILENCING OF GENES.

A MEAN-O ACID

ALL PROTEINS ARE MADE OF AMINO ACIDS (MONOMER)



AMINO

CARBOXYLIC ACID

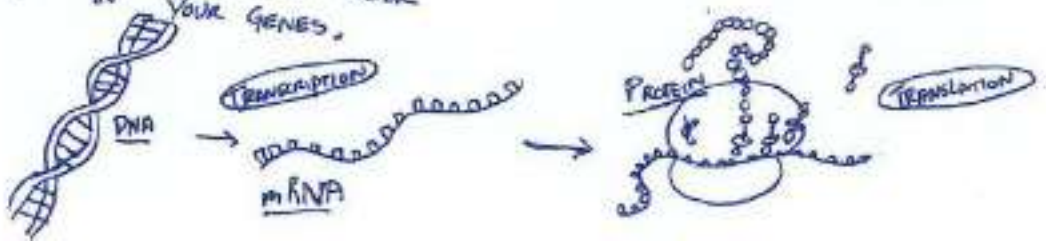
20 DIFFERENT R GROUPS AVAILABLE.

THESE R GROUPS CAN BE ACIDIC, BASIC, POLAR, OR NON POLAR.

ARRANGING THEM IN DIFFERENT ORDERS WILL GIVE THE FINAL PROTEIN ITS PROPERTIES AND THUS FUNCTION.

I.D. NOTES
- C, H, O PRESENT BUT ALSO HAS N
- AMINO GROUP NH_2
- CARBOXYL GROUP COOH

REMEMBER THE CODE FOR IS THE AMINO ACID ORDER IN YOUR GENES.



Proteins Part 2

Like most things in this world proteins are 3-D. This 3-D shape determines its function.

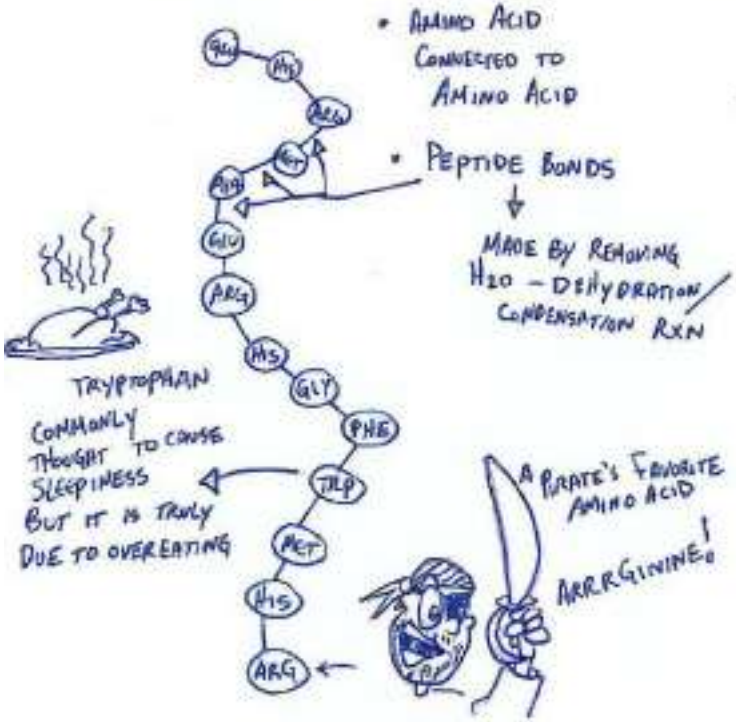
How does it get this 3-D shape?

They Fold!!

When we link the amino acids together by removing water we get a polypeptide

1° Primary Structure

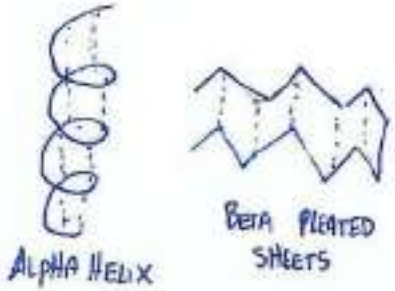
- Amino Acid connected to Amino Acid
- Peptide Bonds
  - Made by removing H_2O – dehydration condensation rxn



2° Secondary Structure

Due to H-bonds between different sections

- The chain develops 2 distinct shapes



3° Tertiary Structure

Interaction of R-Groups strengthening the 3-D structure

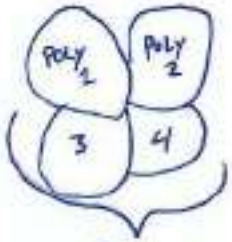
- H-Bonds
- Non Polar Interactions & most notably
- Disulfide Bridges

S–S

Strong Bond

4° Quaternary Structure

- Multiple polypeptides with 3° structure all interacting to make the functional protein



Functional protein similar to Hemoglobin

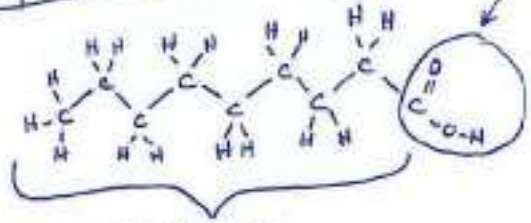
Lipids

WHY DO THEY TASTE SO GOOD?
EVOLUTIONARY SIGNIFICANCE.
THEY PACK MORE ENERGY PER GRAM. 9 CAL/1g VS. CARBS 4 CAL/1g.

FATTY ACID

SATURATED - TYPICALLY FROM ANIMALS

CARBOXYLIC ACID



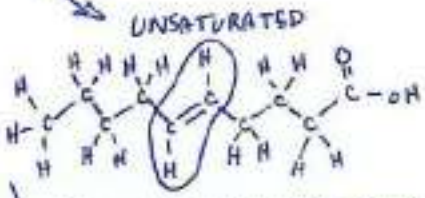
HYDROPHOBIC "WATER-FEARING" THEY DON'T DISSOLVE IN H_2O WELL

NON POLAR HYDRO-CARBON CHAIN

PHOSPHOLIPIDS

I.D. NOTES
- ALMOST ALL C, H VERY LITTLE O
- LOTS OF CHAINS
- NO DISTINCT MONOMER UNITS

UNSATURATED



BECAUSE OF A DOUBLE BOND THE CARBONS CAN'T HOLD THE MAXIMUM HYDROGEN
- TYPICALLY FROM PLANTS

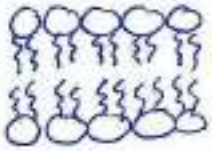
PHOSPHATE HEAD HYDROPHILIC

HYDROPHOBIC FATTY ACID TAILS

AMPHIPATHIC - BOTH HYDROPHILIC & HYDROPHOBIC

USED IN ALL CELL MEMBRANES

OUTSIDE CELL



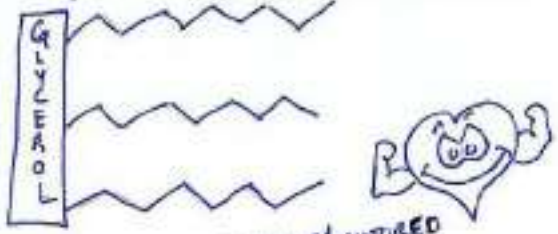
PUT INTO A BILAYER

INSIDE CELL

AMPHIBIAN DUAL LIVES LAND & WATER

WE PULLED OUT H_2O TO JOIN THIS FATTY ACID TO THE GLYCEROL - DEHYDRATION RXN OR CONDENSATION RXN

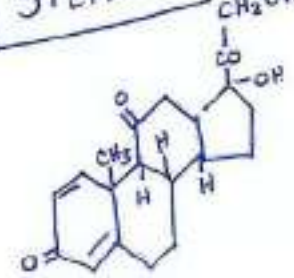
3 FATTY ACIDS + A GLYCEROL = TRIGLYCERIDE



OFTEN MONITORED BY DOCTORS FOR HEART HEALTH

NON POLAR HYDROPHOBIC

STEROIDS



MOSTLY CARBON & HYDROGEN (NONPOLAR)

GENERALLY 4 FUSED RINGS

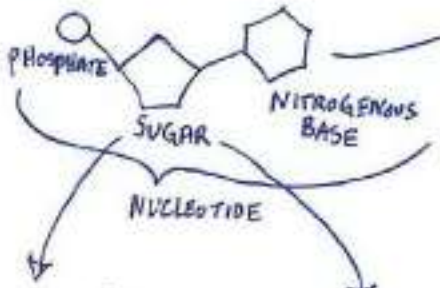
- HORMONES = TESTOSTERONE, ESTROGEN
- CHOLESTEROL - HELPS IN CELL MEMBRANES

NUCLEIC ACIDS

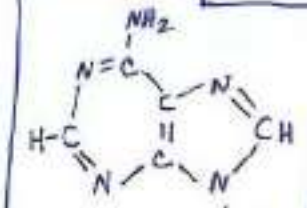
THESE ARE MAINLY YOUR GENETIC STORAGE

I.D. NOTES
- CONTAIN C, H, O, N, P
- NITROGEN BASES LOOK LIKE SUGARS BUT HAVE N IN THE RINGS
- SUGAR, PHOSPHATE, NITROGEN BASE

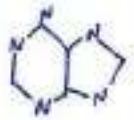
MONOMER



PURINES

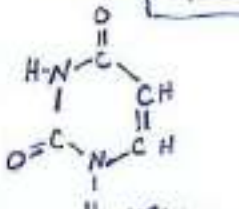


2 RINGS

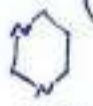


PURE SILVER (Ag)

PYRAMADINES



1 RING



SMALLER THEY HAVE BEEN CUT

POLYMER

DNA

DEOXYRIBONUCLEIC ACID

NAME COMES FROM THE SUGAR

- HAS LESS OXYGEN
- ALL OF YOUR GENES FOR YOUR PHENOTYPE (TRAITS) ARE CODED IN THIS
- DOUBLE STRANDED HELIX
- NITROGENOUS BASES AVAILABLE
  A, T, G, C

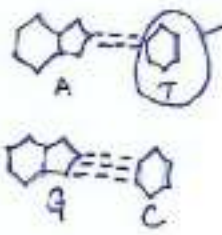
RNA

RIBONUCLEIC ACID

NAME COMES FROM THE SUGAR

- HAS MORE OXYGEN
- ORIGINALLY THOUGHT TO ONLY BE mRNA, rRNA, AND tRNA. NOW WE KNOW THAT THEY HAVE A VAST ARRAY OF USES AND TYPES.
- SINGLE STRANDED MANY SHAPES
- NITROGENOUS BASES AVAILABLE
  A, U, G, C

WHEN NITROGEN BASES JOIN TOGETHER IT IS THROUGH A H-BOND



IN RNA IT IS U

AWESOME - TEACHER
COOL - GUY/GAL

ENZYMES PART 1

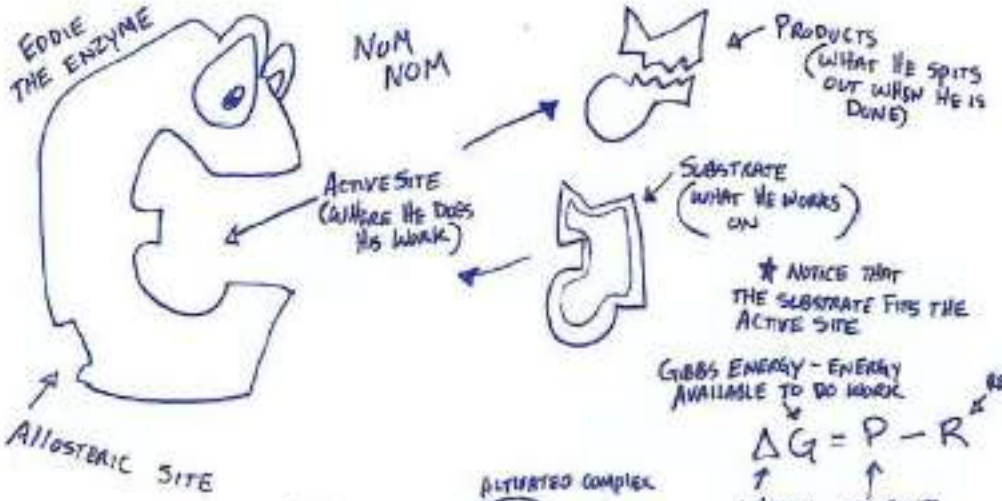
BIOLOGICAL CATALYST SPEED UP CHEMICAL REACTIONS

VERY VERY VERY SPECIFIC SHAPE. 3-D

WHERE DOES IT GET ITS SHAPE? FROM ITS FOLDING 1°, 2°, 3°, 4°

BOVINE
HEIFER
ANGUS
HOLSTEIN
BELGIAN BLUE

CATTLE-LIST



★ NOTICE THAT THE SUBSTRATE FITS THE ACTIVE SITE

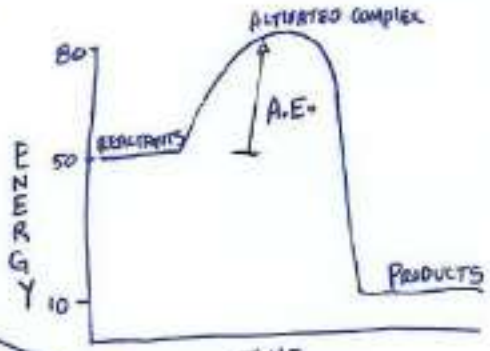
SOME ENZYMES BUILD → ANABOLIC

SOME ENZYMES BREAK → CATABOLIC

GIBBS ENERGY - ENERGY AVAILABLE TO DO WORK

$$\Delta G = P - R$$

CHANGE PRODUCTS REACTANTS

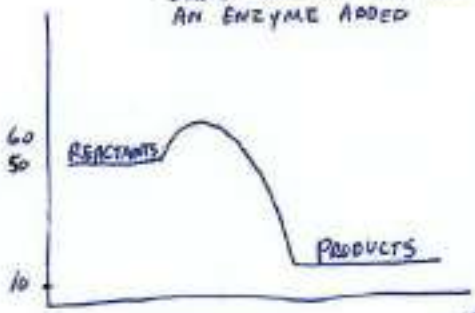


A.E. = ACTIVATION ENERGY IS THE ENERGY REQUIRED TO MOVE THE REACTION FORWARD

- VALUE ΔG = EXERGONIC
+ VALUE ΔG = ENDERGONIC

ΔG = -40
A.E. = 30

SAME REACTION BUT WITH AN ENZYME ADDED



ΔG = -40
A.E. = 10

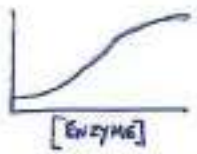
THE ΔG STAYS THE SAME BUT IT DOESN'T TAKE AS MUCH ENERGY TO GET IT GOING

ENZYMES PART 2

FACTORS THAT AFFECT ENZYME RATE ON A REACTION

- [ENZYME] — BRACKETS MEAN CONCENTRATION

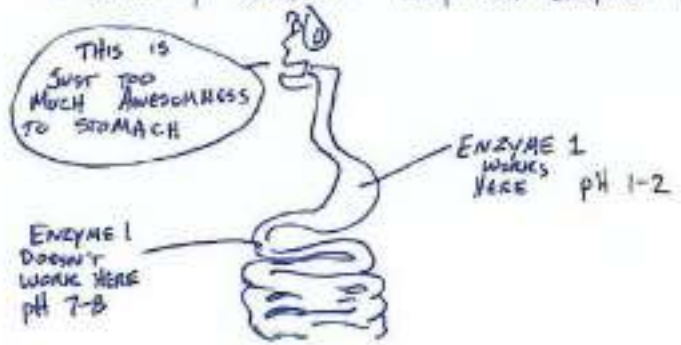
IF YOU INCREASE THE # OF WORKERS SO TO SHOULD THE RATE



- [SUBSTRATE]

INCREASE THE AMOUNT OF THINGS TO WORK ON IT IS EASIER FOR THE ENZYME TO 'FIND'.

- TEMPERATURE — SINCE TEMPERATURE CHANGES BONDS, IT WILL CHANGE THE ENZYME'S 3-D STRUCTURE. EVERY ENZYME HAS ITS OWN 'HAPPY' ZONE.
  - MOST ENZYMES WILL HAVE A LOW RATE AT COLD TEMPERATURES BECAUSE MOLECULES SIMPLY MOVE SLOWER
- pH — SAME AS TEMP. ALL ENZYMES HAVE 'HAPPY' pH ZONES
- SALINITY — SAME AS TEMP. ALL ENZYMES HAVE 'HAPPY' SALT ZONES

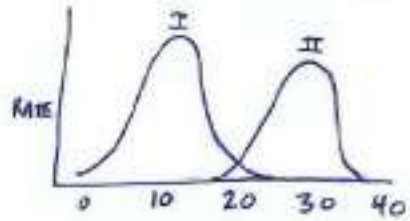


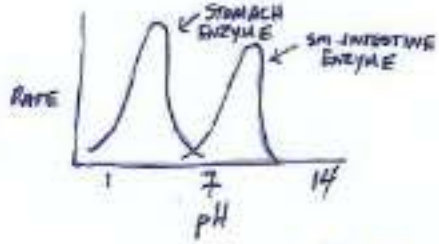
DENATURING

TAKING AN ENZYME OUT OF ITS HAPPY PLACE WILL CAUSE THE ENZYME TO UNFOLD.

REMEMBER FORM = FUNCTION

WITHOUT FORM YOU GET NO FUNCTION



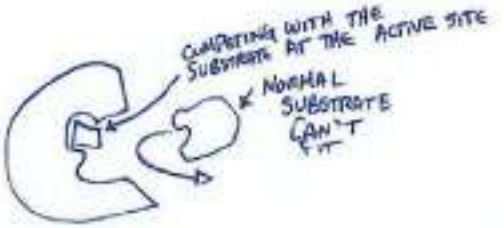


★ THE COOL THING IS THAT SOMETIMES PROTEINS CAN REFOLD BACK INTO THEIR SHAPE IF YOU BRING THEM BACK TO THE HAPPY ZONE

ENZYMES

PART 3

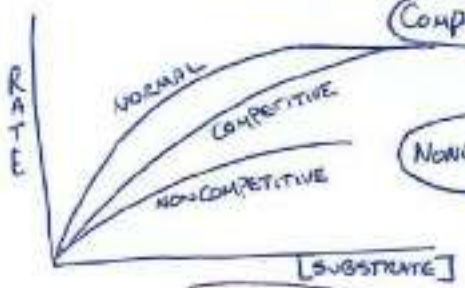
FACTORS THAT AFFECT ENZYME RATE CONTINUED



INHIBITION

COMPETITIVE – WHEN A SUBSTANCE DIRECTLY COMPETES WITH THE SUBSTRATE AT THE ACTIVE SITE.

NONCOMPETITIVE – WHEN A SUBSTANCE BINDS TO AN ALTERNATIVE LOCATION ← ALLOSTERIC SITE AFFECTING THE ENZYME.



↑ BINDS AT ALLOSTERIC CHANGING THE ACTIVE SITE

PROMOTING

CAN BIND INTO THE ACTIVE SITE OR THE ALLOSTERIC SITE

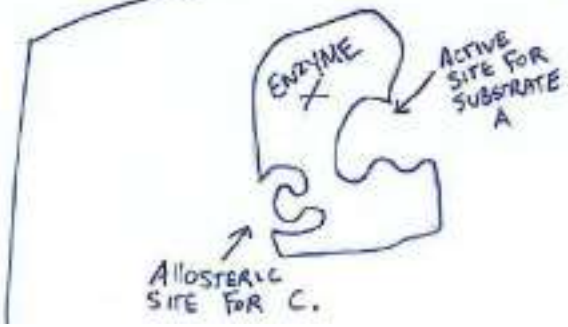
COFACTORS – TEND TO BE INORGANIC OFTEN ARE THE ESSENTIAL MINERALS IN YOUR DIET (Zn^{+}, Mg^{+2}, Ca^{+2}, ETC.)

COENZYMES – ORGANIC VITAMINS (C, B_{12}, D)

NEGATIVE FEEDBACK CONNECTION

$A \xrightarrow{\text{ENZYME X}} B \xrightarrow{\text{ENZYME Y}} C$

THE GOAL IS TO MAKE C BUT WHEN ENOUGH C IS MADE WE WANT THE PROCESS TO TURN OFF.



AS THE [C] ↑ IN THE CELL C STARTS BINDING TO ENZYME X AND IT TURNS OFF X.

CELLS

A CELL IS THE SMALLEST UNIT OF LIFE. THE TERM COMES FROM ROBERT HOOKE WHO THOUGHT THEY LOOKED LIKE LITTLE ROOMS "CELLULA".

ALL CELLS HAVE THE SAME BASIC COMPONENTS

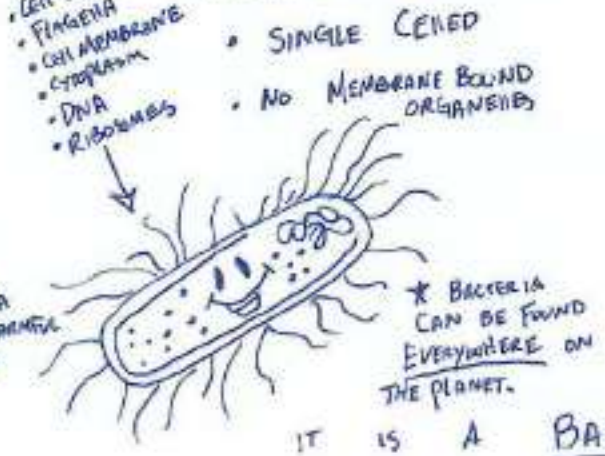
1. CELL MEMBRANE - TO SEPERATE OUTSIDE FROM INSIDE
2. CYTOPLASM / CYTOSOL - MOSTLY H_2O
3. GENETIC INFORMATION - TO REPLICATE & PRODUCE PROTEINS
4. RIBOSOMES - TO PRODUCE PROTEINS

THE FIRST CELL PHONE

PROKARYOTE

BACTERIA & ARCHAEBACTERIA

- SINGLE CELLED
- NO MEMBRANE BOUND ORGANELLES



★ MOST BACTERIA ARE NOT HARMFUL TO HUMANS

★ BACTERIA CAN BE FOUND EVERYWHERE ON THE PLANET.

IT IS A BACTERIA WORLD!

EUKARYOTE

ANIMALS, PLANTS, FUNGUS, PROTISTS

- MULTICELLULAR
- MEMBRANE BOUND ORGANELLES

NO CELL WALL - ANIMAL CELLS

CELL WALL PLANTS, FUNGI, AND SOME PROTISTS

SIZE OF CELLS

ALL CELLS ARE RELATIVELY SMALL

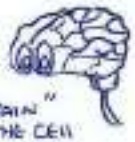
BECAUSE OF SURFACE AREA TO VOLUME RATIO

$SA = \frac{6}{V = 1} = 6$ $\quad SA = \frac{150}{V = 125} = 1.2$

★ THE BIGGER THE CELL THE LONGER IT TAKES FOR SUBSTANCES TO GET TO THE MIDDLE OF THE CELL AND OUT.

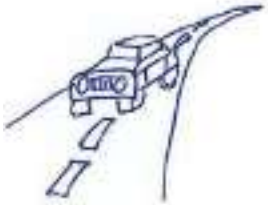
ORGANELLE PARTY

NUCLEUS – DOUBLE MEMBRANE HOLDER OF THE DNA. PROTECTS IT FROM POSSIBLE DANGER THAT CAN EXIST IN THE CYTOPLASM "THE BRAIN" OF THE CELL



RIBOSOME – NOT MEMBRANE BOUND
MADE OF rRNA & PROTEIN
SITE OF PROTEIN SYNTHESIS
- FREE - MAKE PROTEINS FOR THE CELL
- BOUND - MAKE PROTEINS FOR EXOCYTOSIS

ENDOPLASMIC RETICULUM
- HIGHLY FOLDED ORGANELLE THAT ALLOWS SUBSTANCE TO MOVE THROUGH THE CELL
- **SMOOTH** – SYNTHESIS OF LIPIDS & CARBOHYDRATES
- **ROUGH** – HAS RIBOSOMES ATTACHED TO IT. MAKE EXPORTABLE PROTEINS



GOLGI APPARATUS – MODIFIER OF SUBSTANCES. CAN TAG PROTEINS TO ENSURE PROPER DELIVERY

CHLOROPLAST – DOUBLE MEMBRANE ORGANELLE THAT CONVERTS SUNLIGHT INTO CHEMICAL ENERGY
★ HAVE THEIR OWN RIBOSOMES & DNA

LYSOSOMES – GARBAGE DISPOSAL OF THE CELL. BREAKS DOWN OLD ORGANELLES & FOREIGN SUBSTANCES

MITOCHONDRIA – DOUBLE MEMBRANE ORGANELLE THAT CONVERTS CHEMICAL ENERGY INTO USABLE ENERGY
★ ALSO HAVE THEIR OWN RIBOSOMES & DNA

PEROXISOMES – PRODUCE HYDROGEN PEROXIDE (H_2O_2)
GOOD FOR DETOXIFICATION AND VARIOUS METABOLIC ACTIVITIES

HIGHLY REACTIVE & OXIDIZER.

VACUOLES – STORAGE
IN PLANTS IT IS A CENTRAL VACUOLE THAT STORES H_2O

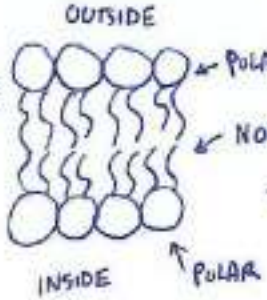
AND THIS IS A TEEPEE

Cell Membranes

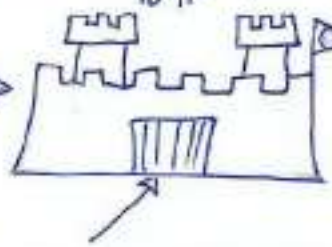
Fluid (moving) Mosaic (lots of parts)

All cells have a phospholipid bilayer, but there is all kinds of other pieces that make up membranes as well.

1. Phospholipids — Barrier

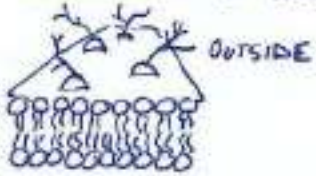


* Most of the content inside & outside of cells is H_2O so the polar heads point to it

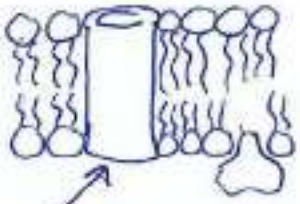


4. Surface Carbohydrates

Help with cell to cell communication & identification



2. Proteins
- Doorways
- Attachment

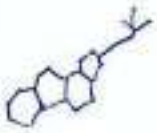


Integral - Allow things to move in & out. Only small nonpolar molecules can move freely

Peripheral - Cytoskeleton can attach to it

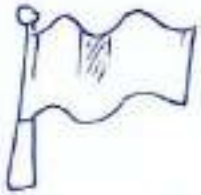
3. Cholesterol

Membrane Fluidity



A nonpolar that helps space out the phospholipids so the membrane flexes & slides more

Membranes are always moving



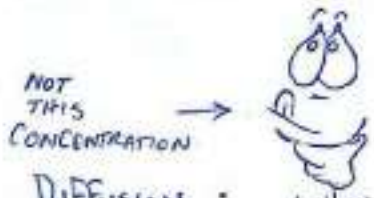
Like a flag in the wind cell membranes flex.

The phospholipids & the other mosaic pieces also shuffle side to side.

Movement Across Membranes

Entropy (S) — Disorder of the system. Everything naturally moves to a disorder

Concentration Gradient – More "stuff" in one area vs. another



The molecules move randomly and spread out

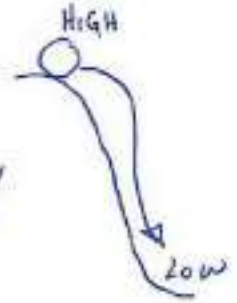
Diffusion: When a substance moves from high concentration to low concentration.

Facilitated Diffusion: Diffusion that requires help. Integral proteins help large or charged particles move down the gradient

Osmosis: Diffusion of H_2O. Water moving down its gradient.

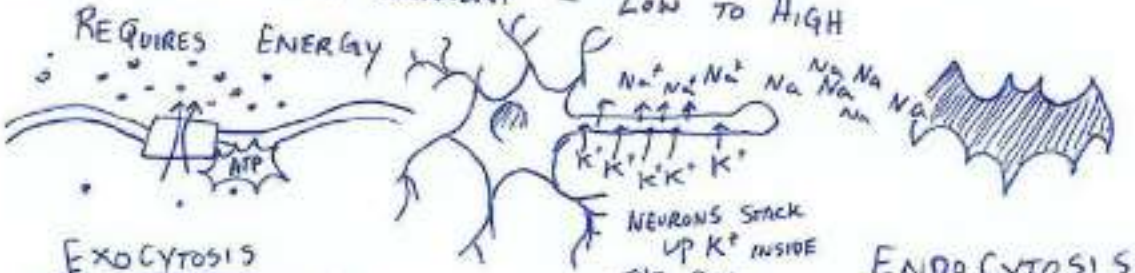
The fart smell diffuses around the room

Passive — No energy required



Active Transport: Against the gradient – Low to High

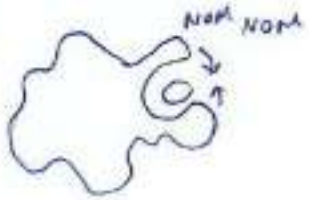
Requires energy



Neurons stock up K^+ inside the cell & Na^+ outside.

Exocytosis — Pushing substances outside of the cell

Endocytosis — Bringing things into the cell

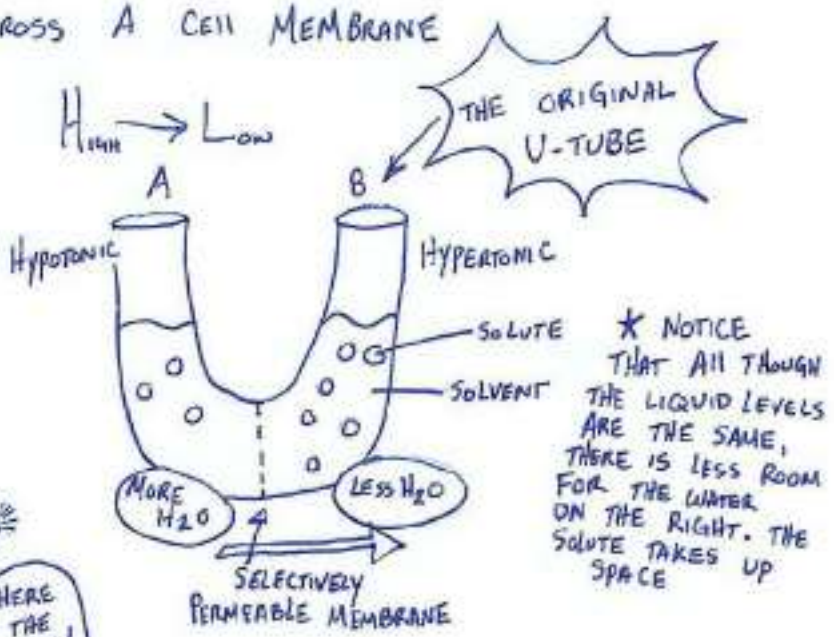


OSMOSIS

THE DIFFUSION OF H_2O ACROSS A CELL MEMBRANE

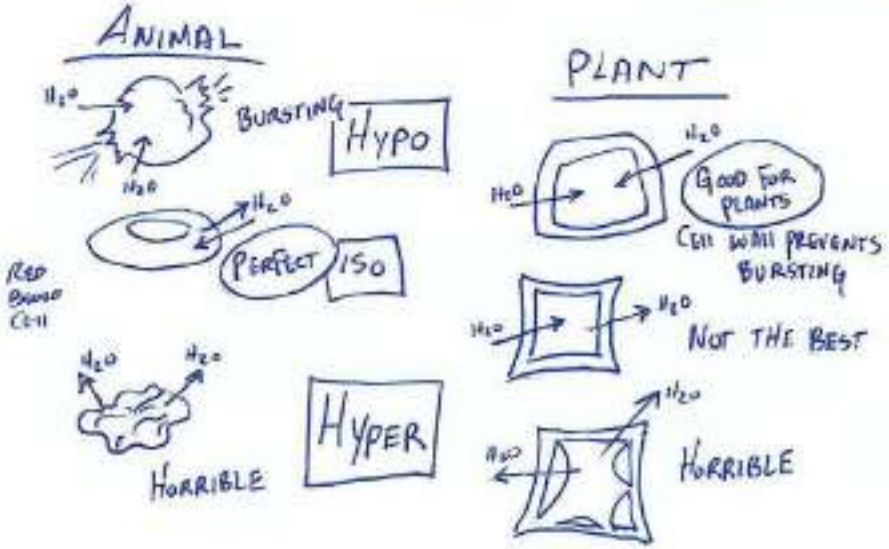
WATER MOVES DOWN ITS GRADIENT

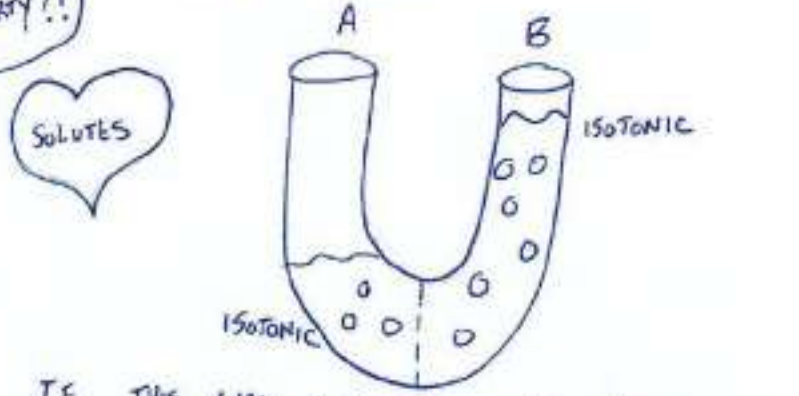
- HYPERTONIC – THERE IS A LOT OF MATERIAL (SOLUTE) DISSOLVED IN THE WATER (SOLVENT)
  LOTS STUFF
- HYPOTONIC – THERE IS A LITTLE AMOUNT OF MATERIAL (SOLUTE) DISSOLVED IN THE WATER (SOLVENT)
- ISOTONIC – THERE IS EQUAL AMOUNT OF MATERIAL DISSOLVED IN BOTH LOCATIONS



★ NOTICE THAT ALL THOUGH THE LIQUID LEVELS ARE THE SAME, THERE IS LESS ROOM FOR THE WATER ON THE RIGHT. THE SOLUTE TAKES UP SPACE

REAL CELLS



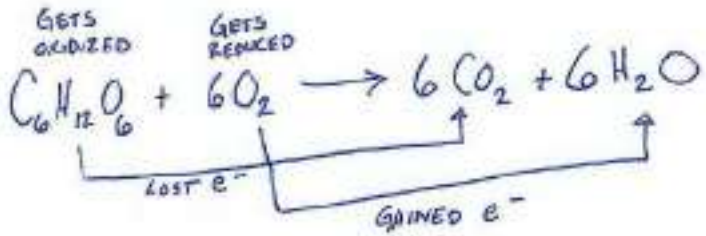


IF THIS WAS KOOL-AID, AT THE BEGINNING SIDE B WOULD BE SWEETER THAN A, BUT AT THE END THEY TASTE THE SAME.

Reduction & Oxidation

It is all about the movement of electrons.

LEO the Lion goes GER



Generally substances that gain e⁻ get bigger

Law of the Conservation of Matter

- Matter cannot be created or destroyed but it can be rearranged

L.E.O. — Lose Electrons — Oxidation

G.E.R. — Gain Electrons — Reduction

↑ Has gained electrons

Lost its electrons

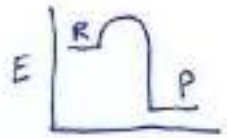
NAD^+ gets its e⁻ from food (glucose)

↑ Reduced — ↑ Oxidized

NADH then needs to get oxidized to allow cellular respiration to continue.

The oxidized @ the E.T.C. or in the cytoplasm if O_2 isn't available

Cellular Respiration Part 1



Exergonic

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \approx 36\ ATP$$

Sugar — Oxygen — Carbon Dioxide — Water — Energy

Glycolysis

No O_2 or organelles required

1 Glucose (6 carbon sugar)

2 ATP

Pyruvate 3 carbon sugar

Pyruvate

NADH x2

Cytoplasm

Main Steps

O_2 required

Krebs Cycle (Citric Acid Cycle)

2 Pyruvates

CO_2 x2

* When CO_2 is released the carbon chain gets smaller

2 Acetyl-CoA

2 carbon sugar

4 carbon sugar

6 carbon

Matrix of the mitochondria

CO_2

5 carbon

CO_2

4 carbon

NADH x2

ATP x2

NADH x6

$FADH_2$ x2

Electron Transport Chain E.T.C.

Mitochondria

H^+

Proton motive force

ATP synthase

O_2

ADP

ATP

H_2O

Pigs drop off e^- to power the pumps. They can now go back to get more e^-

O_2 grabs the e^- and some H^+ and becomes H_2O

For every NADH = 3 ATP

$FADH_2$ = 2 ATP

* As the ATP synthase twirls it grinds out ATP

Cellular Respiration
Part 2

A.T.P.

All cells will do Glycolysis. It requires no organelles or O_2, but it gives very little ATP.

For more ATP energy you need the Mighty Mitochondria

Without O_2 the cells must **Ferment.**

Pyruvate (3-carbon) → Lactate (3-carbon)

NADH → NAD+

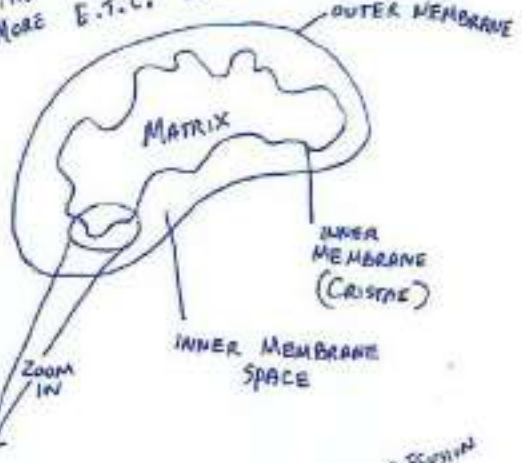
★ Recycle NAD+ Get rid of the electrons so you can do, at least, Glycolysis again.

Pyruvate → CO_2 + Ethanol (2-carbon)

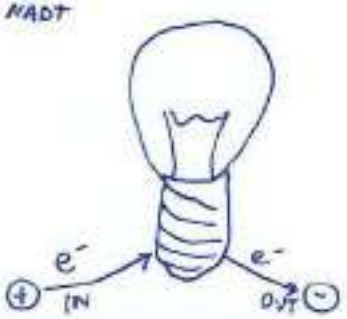
NADH → NAD+

★ And as if mitochondria aren't cool enough, they also have their own DNA & ribosomes

★ The folds ↑ surface area ↑ More E.T.C. ↑ ATP available = More ATP

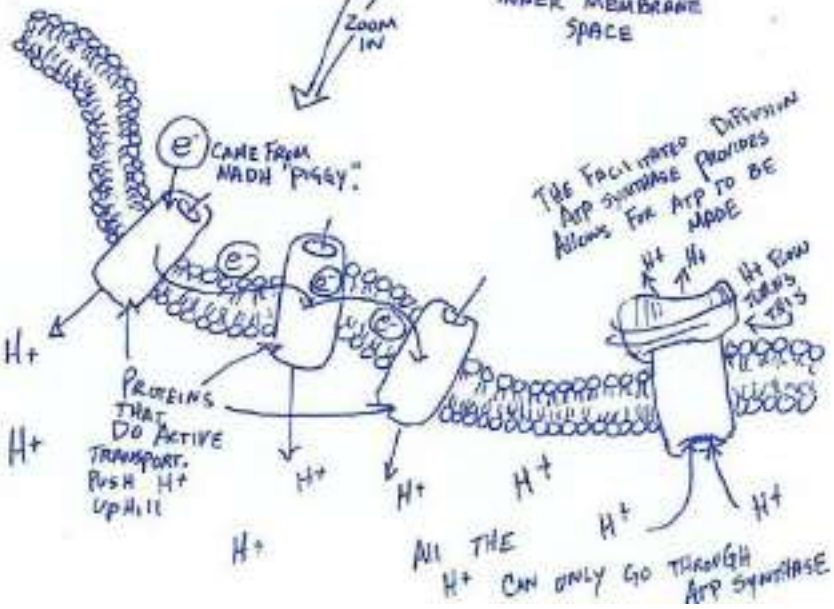


Electrons, no different than what flows through electrical outlets can allow work to be done.



All circuits must have an IN and an OUT.

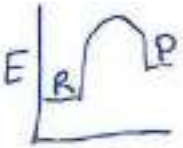
This is why O_2 must be present. To pick up the e^-.



PHOTOSYNTHESIS

PART 1

ENDERGONIC



$$\text{SUN} + 6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

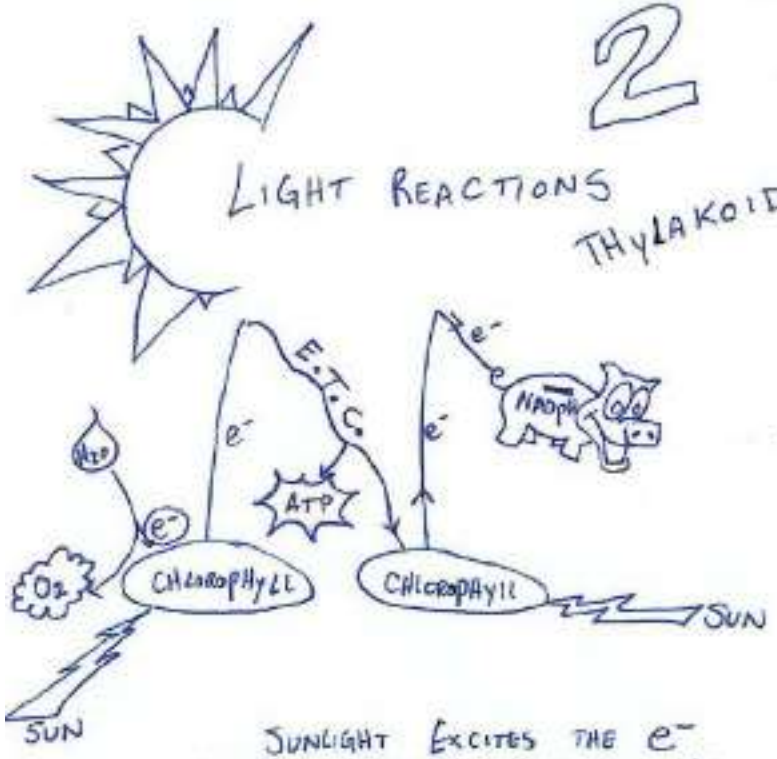
LIGHT ENERGY

MAKING SUGAR FROM AIR!

2 MAJOR STEPS

LIGHT REACTIONS

THYLAKOID



SUNLIGHT EXCITES THE e^- AND THEY JUMP UP. DUE TO THIS CHLOROPHYLL LOSES ITS e^- AND NEEDS NEW e^- THESE e^- COME FROM H_2O.

ADP + NADP+

ATP & NADPH

$3CO_2 = 1$ G3P

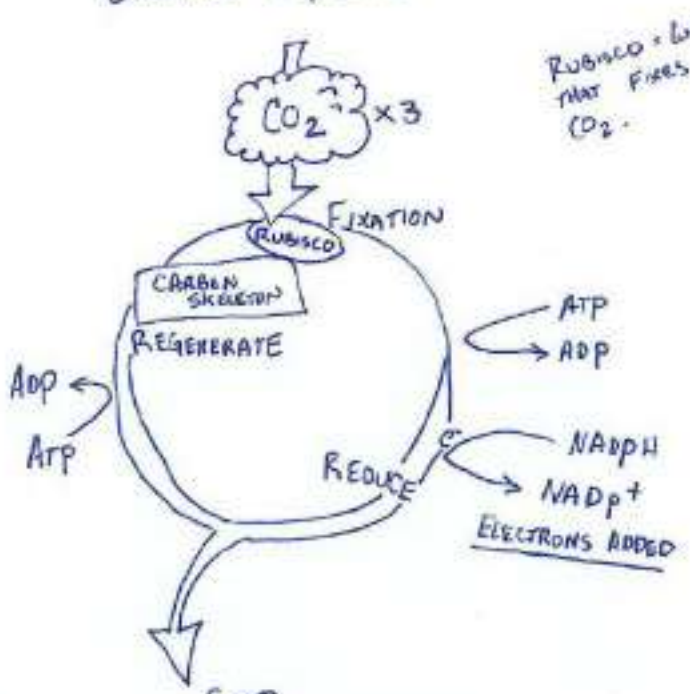
SO

$6CO_2 = 1$ GLUCOSE

LIGHT INDEPENDENT REACTIONS

STROMA

CALVIN CYCLE



RUBISCO = ENZYME THAT FIXES CO_2.

G3P

GLYCERALDEHYDE-3-PHOSPHATE

1/2 OF A GLUCOSE

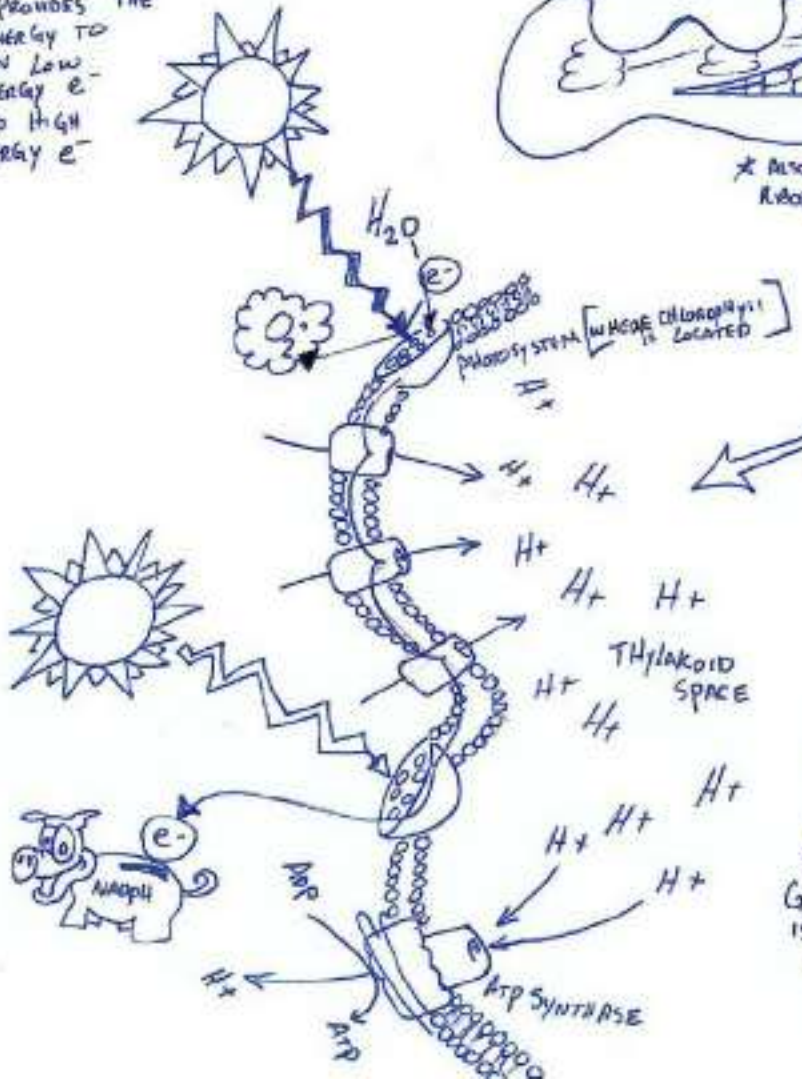
Photosynthesis Part 2

All Done With The Cool Chloroplast

* Also has its own Ribosomes & DNA

In order to be more efficient in absorbing light plants have Accesory Pigments. You usually only see these colors in the Fall but they are always there.

Sunlight provides the energy to turn low energy e^- into high energy e^-



Carotenoids (orange)

Green color is in the 500nm. That is why plants look green. Green wavelength is reflected, not absorbed.

The Problem and the Plants that Found a New Niche

The Problem

is that when things get hot & dry plants tend to photorespire

Plants need H_2O for electrons but if the soil is dry and it is hot out, plants close their stomates.

Guard cells closed to conserve H_2O

CO_2

⇒ If they can't get rid of the O_2 & $[CO_2]\downarrow$ then they essentially start breaking the sugar they are attempting to make.

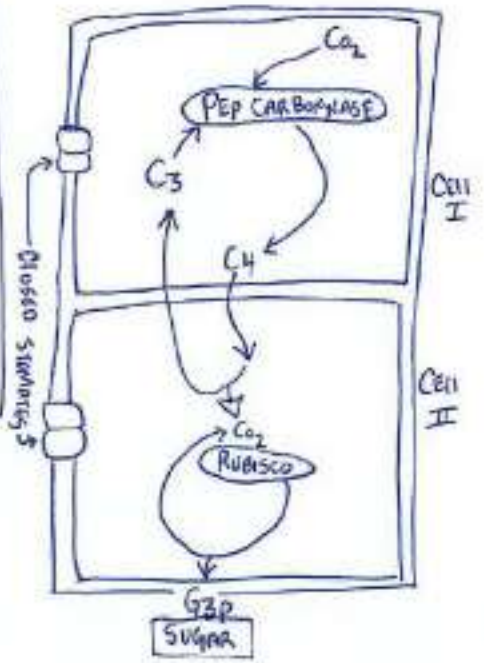
Due to Rubisco's love for O_2 more than CO_2

Photo Respiration

Evolution

→ Opening for Growth & Diversification

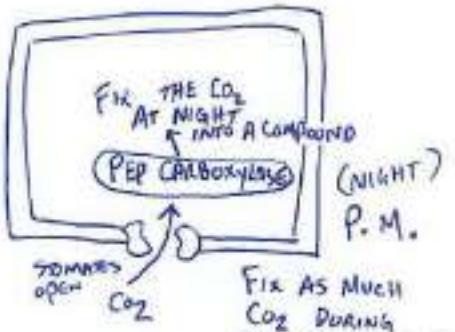
C_4 Plants [Separate Cells]



C_4 plants have an enzyme that only fixes CO_2 into a 4 carbon sugar & then that CO_2 is passed to Rubisco in another cell.

CAM

A.M. & P.M.



Fix as much CO_2 during the night while it is cool. Conserve H_2O loss.

Hot. Close the stomates (M-Day) A.M.

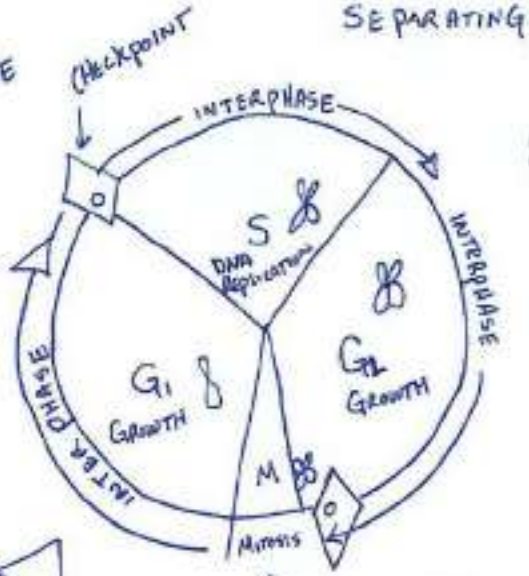
Similar to C_4 plant but the separation is time of day, not cells.

MITOSIS

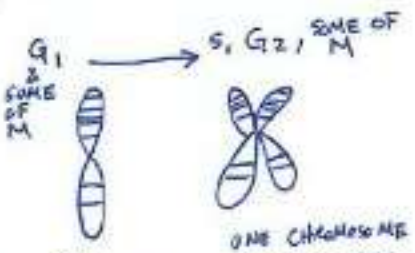
SEPARATING A CELL'S DNA PART 1

WHY?

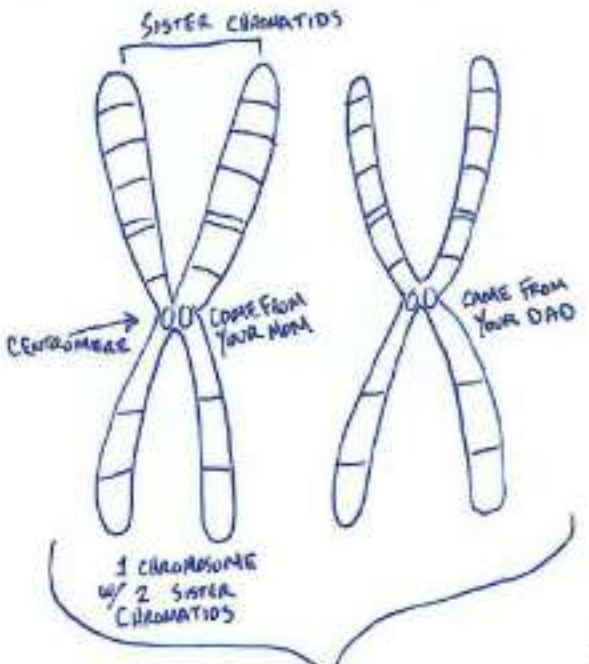
- TO GROW
- TO REPAIR
- TO REPLICATE



WE CAN ONLY SEE CHROMOSOMES WHEN CELLS ARE IN MITOSIS.



THE CHROMATID TERM IS USED TO SHOW THAT THERE ARE 2 IDENTICAL COPIES OF DNA ATTACHED TO EACH OTHER

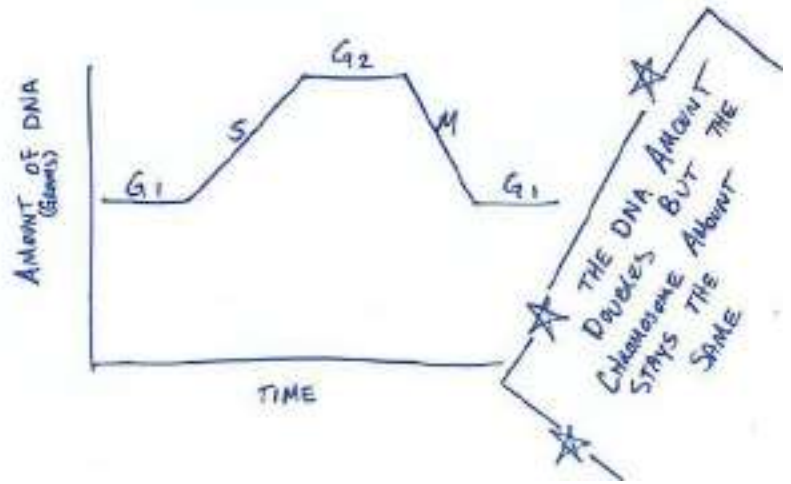


- SAME SIZE, SAME BANDING, BUT MAY HAVE DIFFERENT INFORMATION.

SINCE YOUR CELLS HAVE SETS (ONE FROM MOM & ONE FROM DAD) OF CHROMOSOMES YOUR CELLS ARE **DIPLOID (2N)**

CELLS GROW ORGANELLES AND OTHER CELLULAR COMPONENTS IN PREPARATION FOR DIVISION. IT ALSO DUPLICATES THE DNA SO THAT THE TWO RESULTING CELLS HAVE THE EXACT SAME AMOUNT.

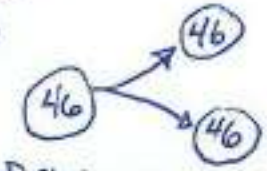
CHECKPOINTS MAKE SURE CELLS DON'T MOVE ON UNTIL THEY ARE READY.



MITOSIS PART 2

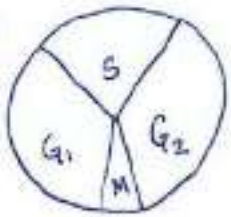
GOAL

TO MAKE TWO CELLS WITH THE SAME AMOUNT OF CHROMOSOMES



DIPLOID TO DIPLOID

MITOSIS IS ONLY A SMALL WEDGE IN THE CELL CYCLE.



4 PHASES

THESE ARE JUST PICTURES TAKEN AS THE CELL MOVES THROUGH THE PROCESS SO THERE IS ALWAYS GREY AREA AS YOU SHIFT FROM ONE PHASE TO ANOTHER.

PROPHASE

- CHROMOSOMES VISABLE
- NUCLEUS IS DISSOLVING
- SPINDLE FIBERS FORM & ARE GROWING

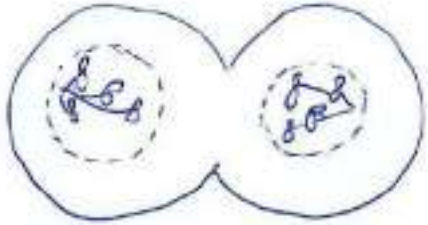
METAPHASE

- CHROMOSOMES ARE AT THE MIDDLE OF THE CELL [SINGLE FILE]
- SOME OF THE SPINDLE FIBERS ATTACH TO THE CENTROMERES
- SOME SPINDLE FIBERS DON'T.

ANAPHASE

- CHROMATIDS ARE PULLED APART AND MOVE TO OPPOSITE POLES.
- OTHER SPINDLE FIBERS PUSH THE CELL INTO AN ELLIPSE.

TELOPHASE



- CHROMOSOME BEGIN TO UNRAVEL
- NUCLEI BEGIN TO FORM
- CYTOKINESIS IS HAPPENING SIMUTANEOUSLY

HOMOLOGOUS PAIRS ARE PRESENT PAIRED UP. BUT NOT

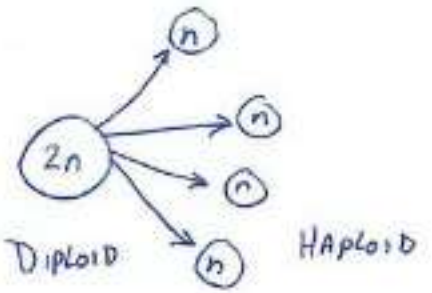
IN PLANTS MITOSIS LOOKS VERY SIMILAR EXCEPT THE CELLS CAN'T PINCH DURING CYTOKINESIS

Meiosis Part 1

Goal

- To reduce chromosome count in half
- Reproduction (Sexual)

PMAT I
PMAT II

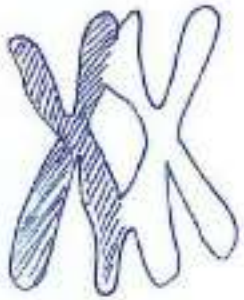


It still follows the same flow as Mitosis

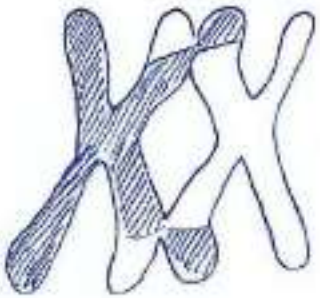
Double the DNA then divide

But there are key differences.

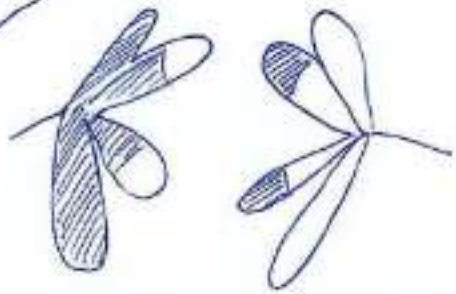
Crossover



Prophase I



Anaphase I

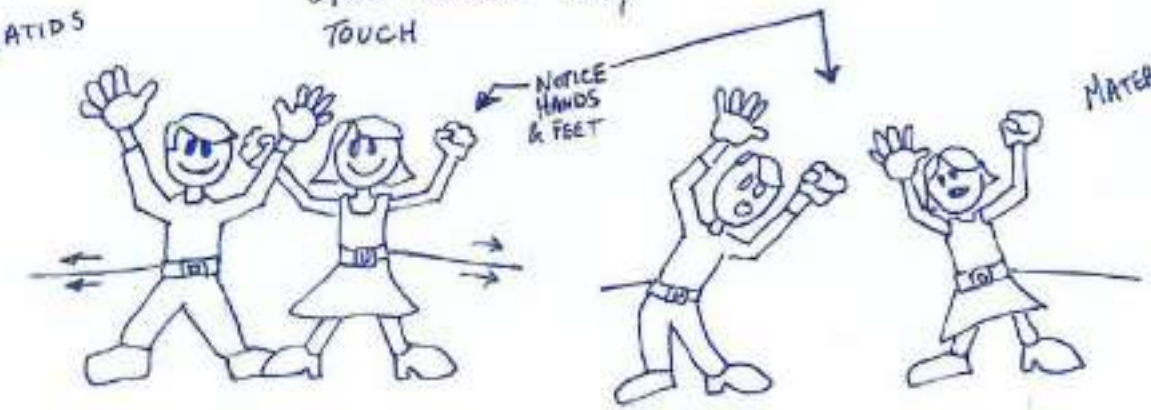


Homologous Chromosomes pair up.

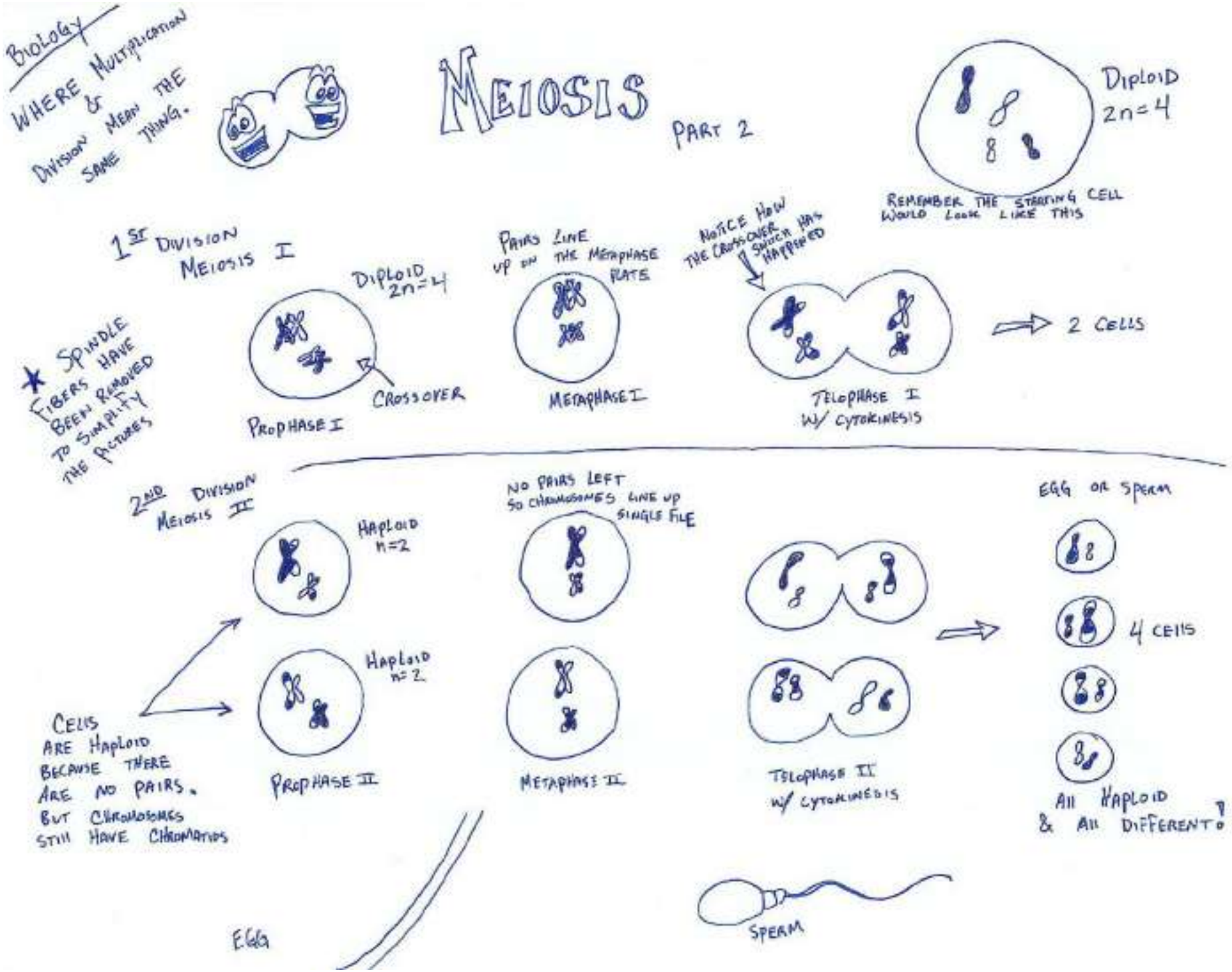
- The inside chromatids touch

The chromosomes switch info at those spots where they touch

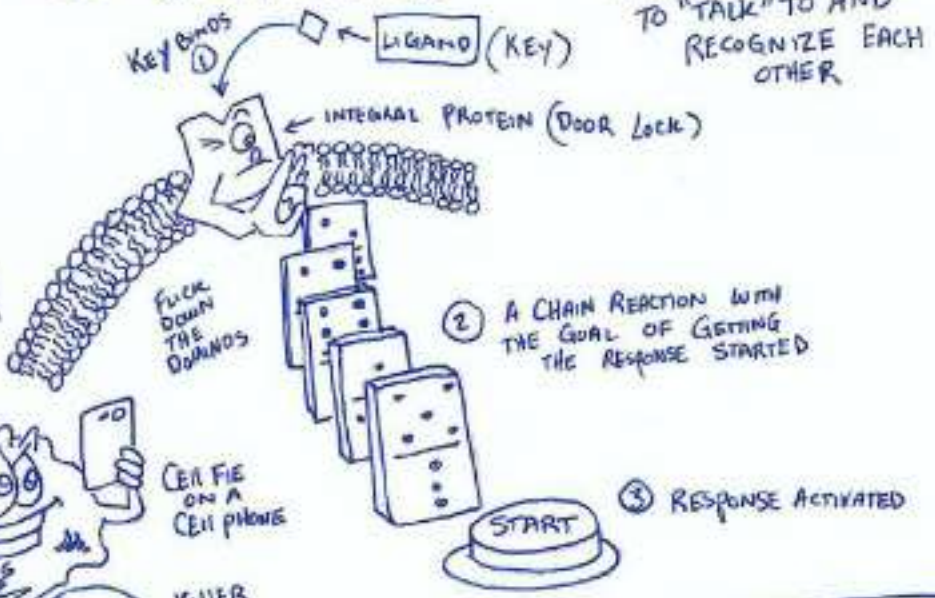
Homologous pairs are pulled apart



Maternal & paternal copies meet up and switch information

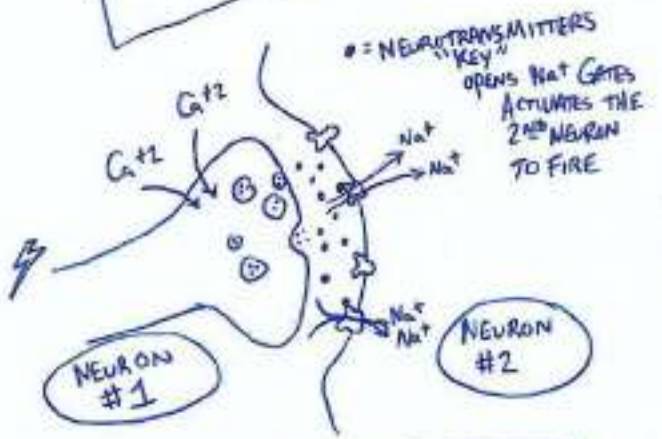

Biology
Where Multiplication & Division Mean the Same Thing.
Meiosis
Part 2
Diploid 2n=4
8
8
Remember the starting cell would look like this
1st Division Meiosis I
Diploid 2n=4
Crossover
Prophase I
Pairs line up on the Metaphase Plate
Metaphase I
Notice how the crossover switch has happened
Telophase I w/ cytokinesis
2 cells
* Spindle fibers have been removed to simplify the pictures
2nd Division Meiosis II
Haploid n=2
Haploid n=2
Cells are Haploid because there are no pairs. But chromosomes still have chromatids
Prophase II
No pairs left so chromosomes line up single file
Metaphase II
Telophase II w/ cytokinesis
Egg or Sperm
4 cells
All Haploid & All Different!
Egg
Sperm

Cell Signaling = Communication that allows cells to "talk" to and recognize each other

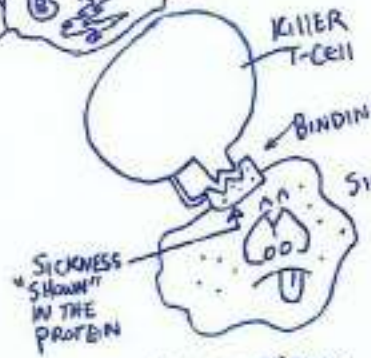


3 Major Steps

1. **Reception** – A molecule / ligand (Key) binds with a cell receptor (like a door's lock)
2. **Transduction** – Because the molecule bound to the receptor a chain reaction happens inside the cell (relay race style)
3. **Response** – The cellular response occurs (Goal)



Nervous System Communication



Killer T-cells destroy cells that are recognized as sick

Immunity Communication

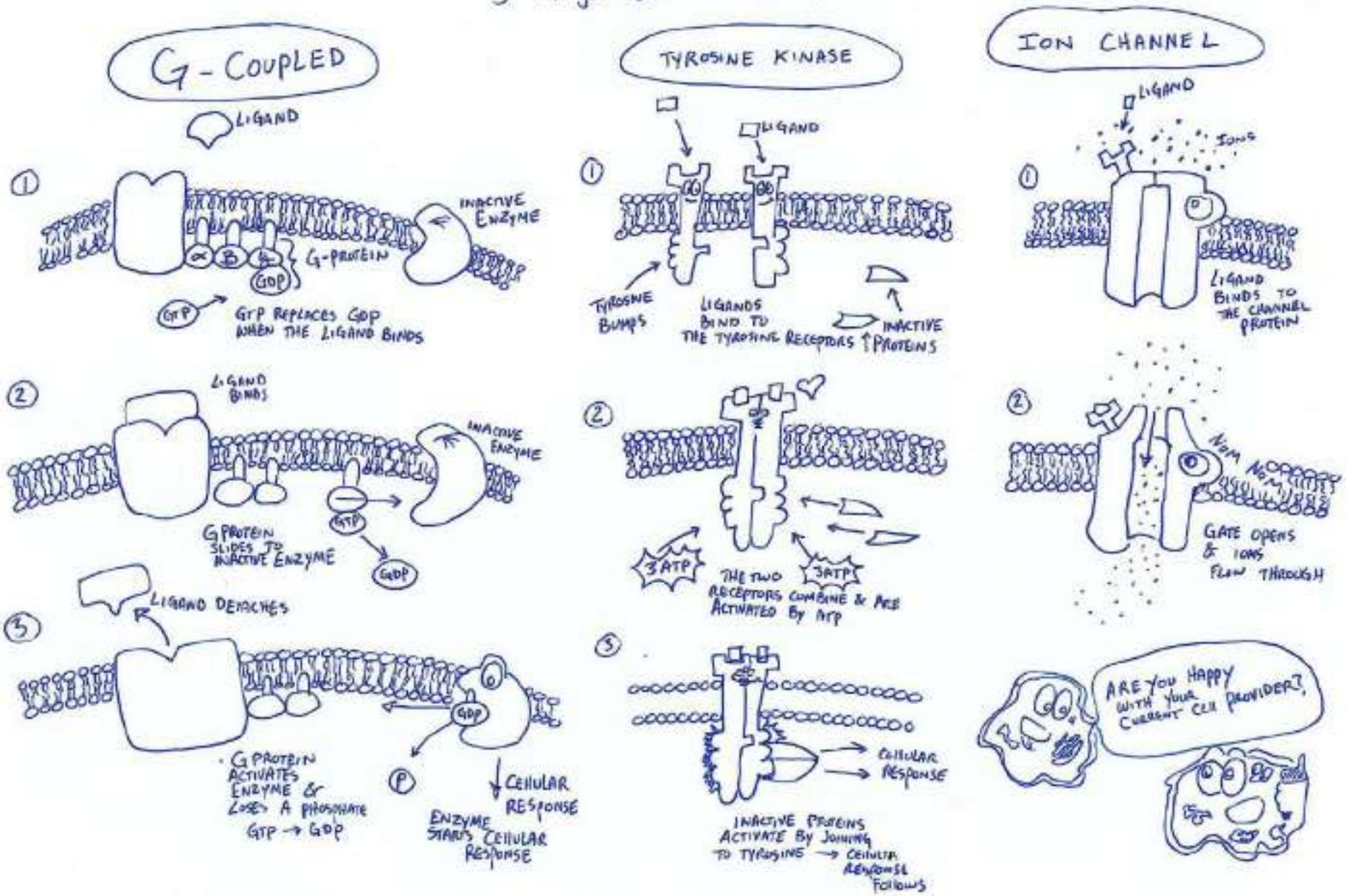
Cancer = failure to respond to death signal

Other Examples

- **Mitosis** – cells that line a cut respond to secreted ligands causing cellular division to fill the void.
- **Blood Sugar Homeostasis**
  - Pancreas releases insulin (ligand) which binds to insulin receptors & lets glucose enter the cell
- **Auto Immune Diseases** often a result of poor cell communication

CELL COMMUNICATION

3 MAJOR LIGAND RECEPTORS

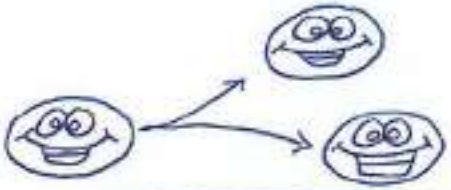


ASEXUAL REPRODUCTION

VERY SIMILAR TO MITOTIC DIVISION

CELL GENETIC CONTENT STAYS THE SAME

BINARY FISSION



★ CLONES
EACH INDIVIDUAL IS THE SAME

1 INDIVIDUAL MAKES TWO

★ EXCEPT WHEN IT DOESN'T

MUTATIONS CAN OCCUR AND THE RESULTING CELLS WILL BE DIFFERENT.

- OVERCOME THE ISSUE OF SMALL VARIATION BY REPRODUCING INCREDIBLY QUICKLY

VARIATION FROM
- MUTATIONS

ORGANISMS THAT DO THIS
- BACTERIA
- PROTISTS
- UNICELLULAR FUNGUS

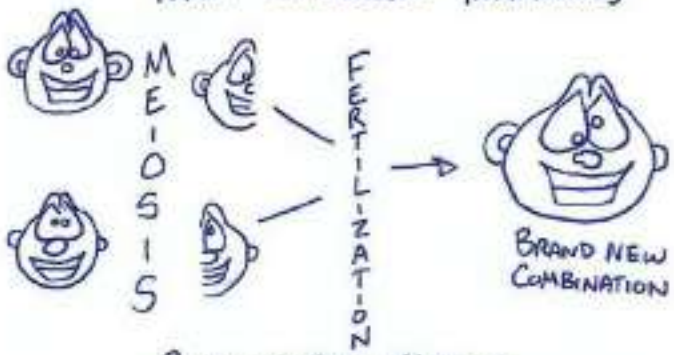
★ SOME CAN DO BOTH
- BUDDING IN JELLYFISH
- RUNNERS IN STRAWBERRIES
- WATER SPROUTS IN TREES

EXCEPTIONS
- SELF POLLINATION
- PARTHENOGENESIS

SEXUAL REPRODUCTION

WHEN TWO CELLS, THAT ARE HAPLOID, JOIN TOGETHER = FERTILIZATION

- OFTEN TIMES THESE CELLS COME FROM DIFFERENT INDIVIDUALS



2 INDIVIDUALS MAKE 1

★ SEXUAL REPRODUCTION = THE NEW INDIVIDUAL IS DIFFERENT.

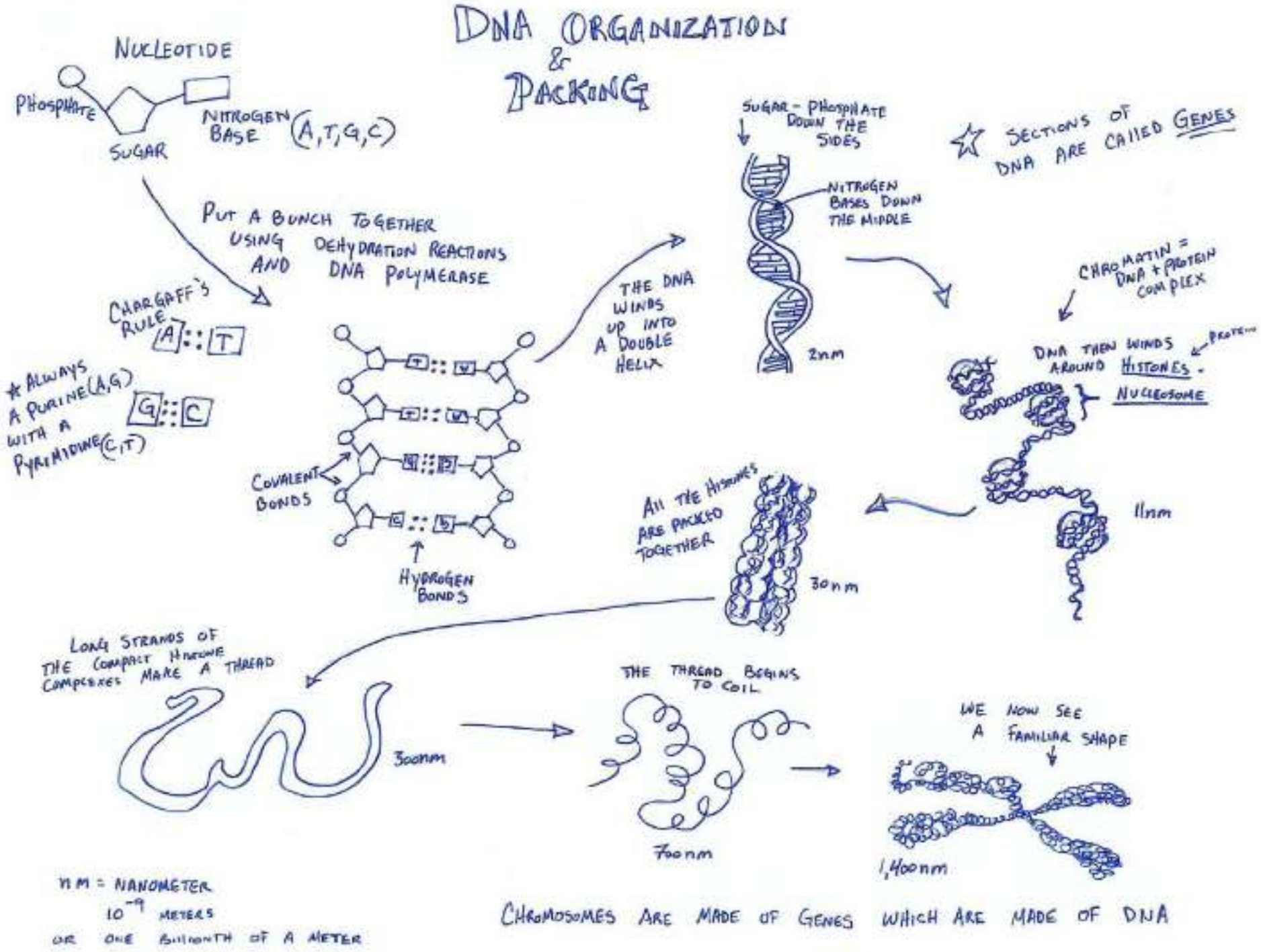
VARIATION FROM
- SEXUAL REPRODUCTION
- CROSSOVER
- RANDOM FERTILIZATION
- MUTATIONS

ORGANISMS THAT DO THIS
- ANIMAL KINGDOM
- PLANT KINGDOM
- FUNGI KINGDOM

DNA VARIATION

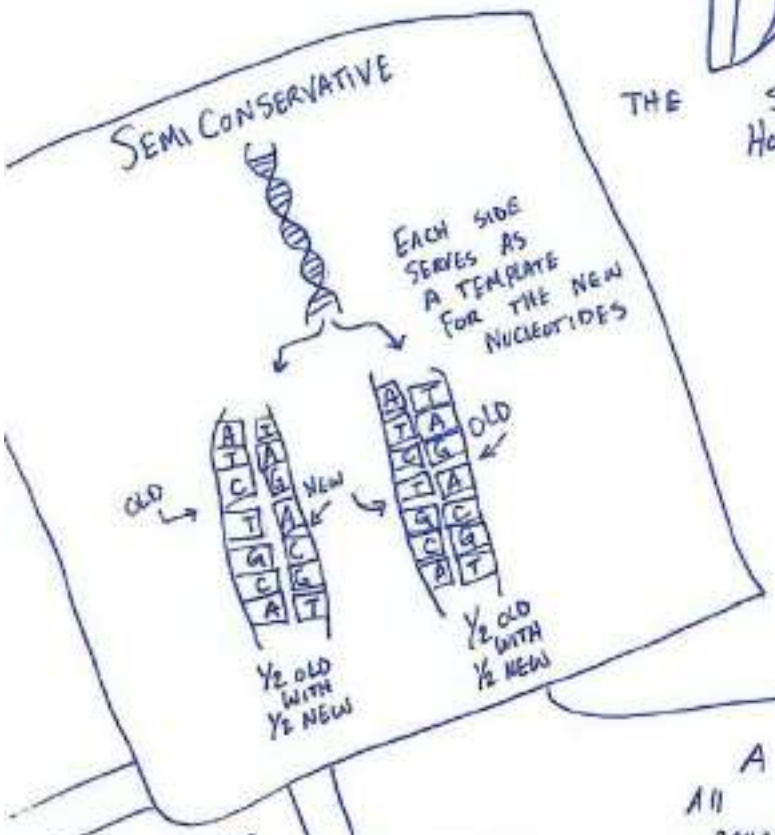
WHY IS VARIATION THE KEY TO THE FUTURE?

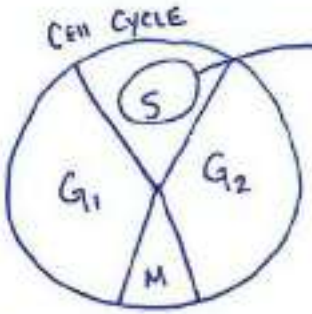
THE EARTH IS CONSTANTLY CHANGING. IF A POPULATION HAS DIVERSITY IN THEIR GENOME AS A GROUP THEY MAY HAVE SOME INDIVIDUALS THAT COULD SURVIVE WHAT THE FUTURE BRINGS.


DNA ORGANIZATION & PACKING
NUCLEOTIDE
PHOSPHATE
SUGAR
NITROGEN BASE (A,T,G,C)
PUT A BUNCH TOGETHER USING DEHYDRATION REACTIONS AND DNA POLYMERASE
CHARGAFF'S RULE
A :: T
ALWAYS A PURINE(A,G) WITH A PYRIMIDINE(C,T)
G :: C
COVALENT BONDS
HYDROGEN BONDS
THE DNA WINDS UP INTO A DOUBLE HELIX
SUGAR - PHOSPHATE DOWN THE SIDES
NITROGEN BASES DOWN THE MIDDLE
2nm
SECTIONS OF DNA ARE CALLED GENES
CHROMATIN = DNA + PROTEIN COMPLEX
DNA THEN WINDS AROUND HISTONES - PROTEIN
NUCLEOSOME
11nm
ALL THE HISTONES ARE PACKED TOGETHER
30nm
LONG STRANDS OF THE COMPACT HISTONE COMPLEXES MAKE A THREAD
300nm
THE THREAD BEGINS TO COIL
700nm
WE NOW SEE A FAMILIAR SHAPE
1,400nm
NM = NANOMETER
10^{-9} METERS
OR ONE BILLIONTH OF A METER
CHROMOSOMES ARE MADE OF GENES WHICH ARE MADE OF DNA

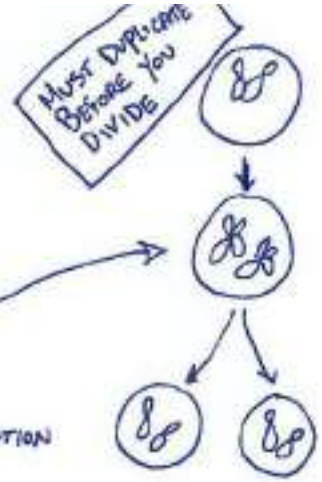
DNA Replication Part 1

THE STRUCTURE OF DNA LEADS TO HOW IT IS DUPLICATED





SYNTHESIS OF DNA AKA DNA REPLICATION



CELLS HAVE TO DUPLICATE THEIR DNA BEFORE THEY DIVIDE.

A COMPLICATED PROCESS BUT IS ALL RUN BY SPECIAL PROTEINS CALLED ENZYMES.

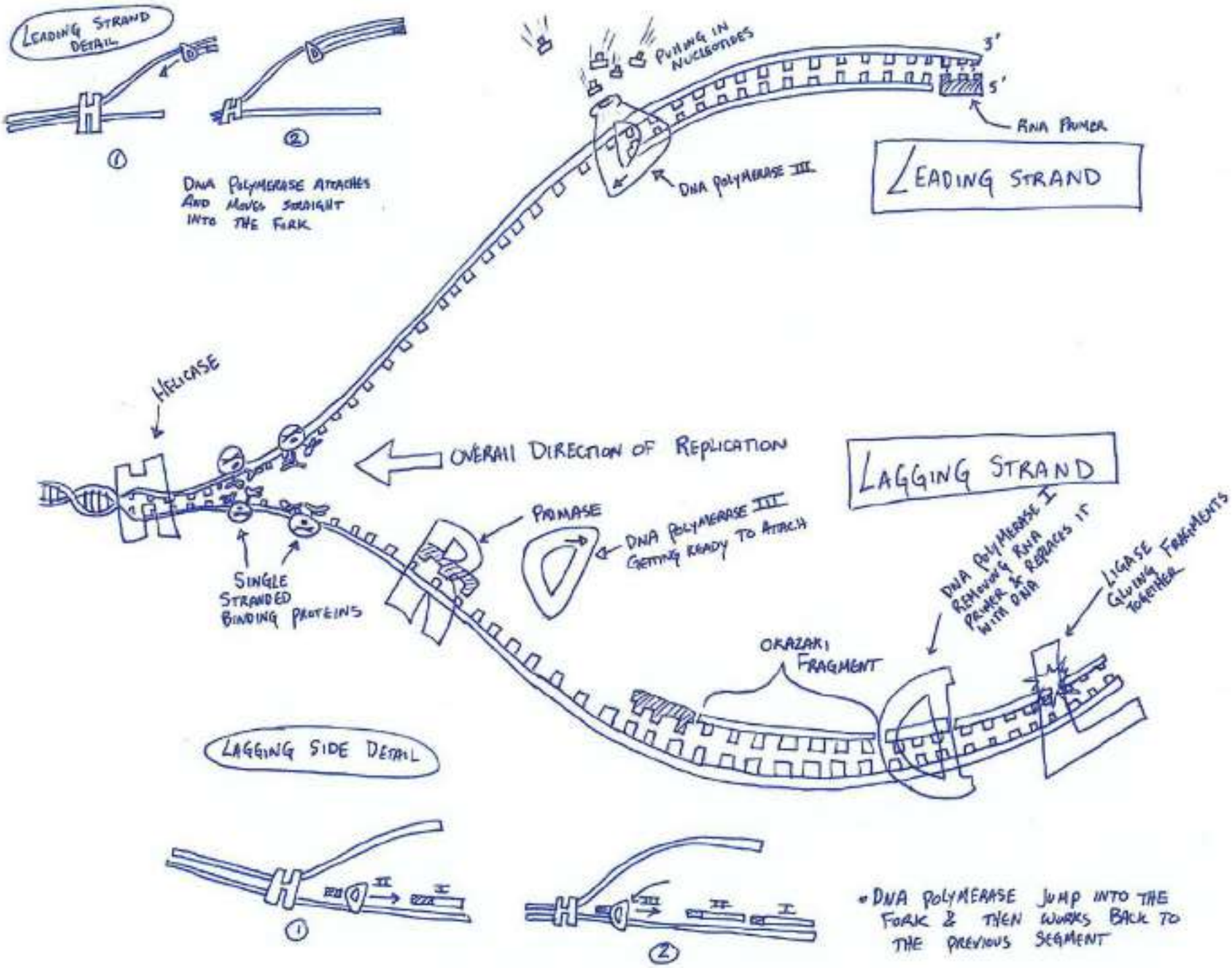
MEET YOUR WORKERS FOR THE PROCESS

1. HELICASE – UNZIPS THE DNA EXPOSING THE NITROGEN BASES
2. ★ DNA POLYMERASE - ADDS NEW COMPLIMENTARY NUCLEOTIDES ★
3. PRIMASE – ADDS RNA PRIMERS
4. LIGASE - GLUES NUCLEOTIDES TOGETHER
5. SINGLE STRANDED BINDING PROTEINS - HOLD THE REPLICATION FORK OPEN

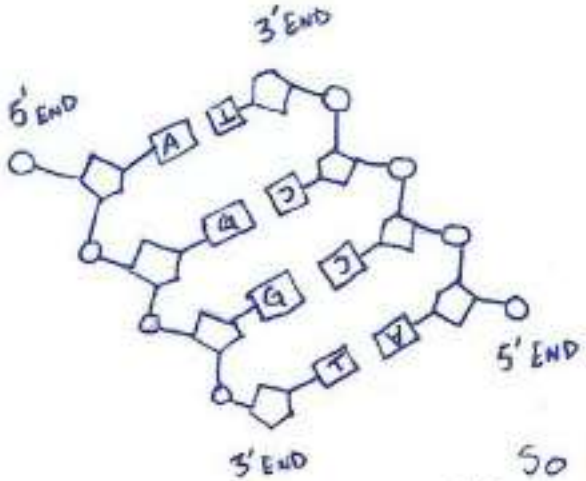
DNA POLYMERASE ★ RULES

- CAN ONLY GO 5' → 3'
- MUST HAVE NUCLEOTIDES PRESENT TO ATTACH

64 J.Grant

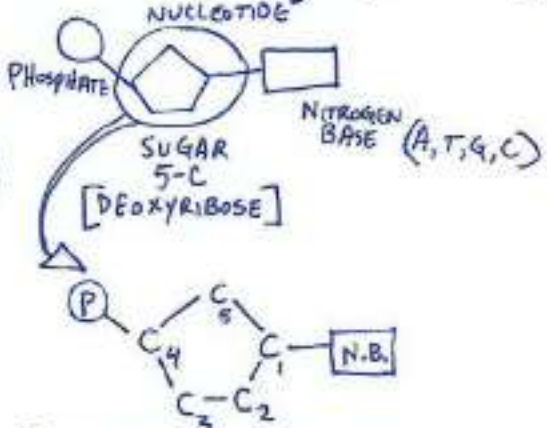

LEADING STRAND DETAIL
1
2
DNA POLYMERASE ATTACHES AND MOVES STRAIGHT INTO THE FORK
PUTTING IN NUCLEOTIDES
3'
5'
RNA PRIMER
DNA POLYMERASE III
LEADING STRAND
HELICASE
OVERALL DIRECTION OF REPLICATION
LAGGING STRAND
PRIMASE
DNA POLYMERASE III GETTING READY TO ATTACH
SINGLE STRANDED BINDING PROTEINS
DNA POLYMERASE I REMOVING RNA PRIMER & REPLACES IT WITH DNA
LIGASE GLUING FRAGMENTS TOGETHER
OKAZAKI FRAGMENT
LAGGING SIDE DETAIL
1
2
• DNA POLYMERASE JUMP INTO THE FORK & THEN WORKS BACK TO THE PREVIOUS SEGMENT

DNA STRUCTURE AND REPAIR



ANTI PARRAILEL STRANDS THAT ARE COMPLIMENTARY

DNA IS A POLYMER MADE OF UNITS (MONOMERS)



EACH CARBON IN THE SUGAR GETS NUMBERED. C_1 GETS A 1 BECAUSE IT IS CONNECTED TO THE NITROGEN BASE. THE NUMBERING OF THE OTHER CARBONS IS CLOCKWISE FROM THE C_1.

SO DNA POLYMERASE CAN ONLY GO ONE DIRECTION

MISTAKES

MAKING A MILLION+ COPIES OF YOUR DNA DAILY IT IS BOUND TO BE PRONE TO ERROR.

① ATATGCA / TATTAGA

NUCLEASE I.D.'S THE MISTAKE AND CUTS IT OUT

② ATAATCT / TATTAGA

DNA POLYMERASE ADD THE NEW NUCLEOTIDES

★ NO ISSUES WITH 5'→3' OR PRE EXISTING NUCLEOTIDES

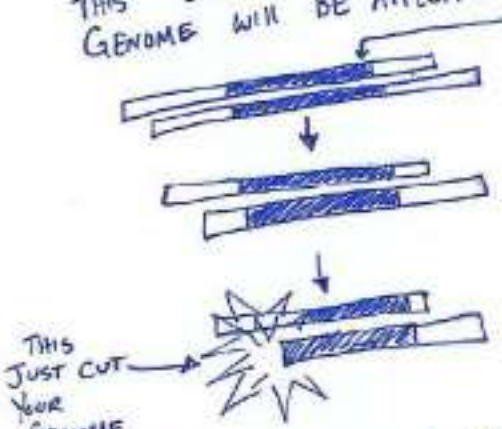
③ ATAATCT / TATTAGA

LIGASE GLUES THE PIECES TOGETHER

EVERY TIME DNA GETS REPLICATED THE ENDS GET SHORTER. THIS IS DOE TO DNA POLYMERASE'S RULES. IT MUST HAVE NUCLEOTIDES IN PLACE TO ADD. SO EACH COPY THE JAGGED PIECE MOVES INWARD

Cancer & Telomeres
Immortal Cells

So Everytime Your Cells Replicate Your DNA The DNA Will Get Shorter. If This Continues, Eventually Your Genome Will Be Affected



Those Ends of a Chromosome are Called Telomeres. They are A Lot Like The Plastic Protector of Your Shoe Lace.

They Protect The Chromosome From Damage. Only One Enzyme Makes This Protective Non Sense DNA Code

Telomerase is only Active in Two Types of Cells

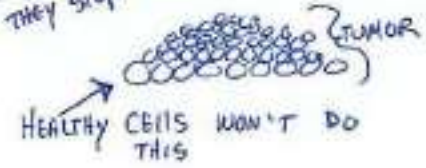
Immortal

Cancer Cells

Cancer Cells Don't Follow Normal Cell Rules [Checkpoints]

They Also Don't Follow

1) Anchorage Dependancy - Cells Must Stay Attached to Others or They Die
2) Density Dependancy - Once They Touch Enough Cells They Stop Dividing.



Stem Cells

Immortal

They are Called Stem Cells Because They Have the Potential to Branch Out And Turn Into Many Types of Cells

Multipotent - Have Flexibility But it is Limited. Blood Stem Cells Can Turn Into Red, All The White, Etc.

Pluripotent - Can Turn Into Any Kind of Cell. Brain, Skin, Muscle, Etc.

Protein Synthesis

From DNA → Protein

OR

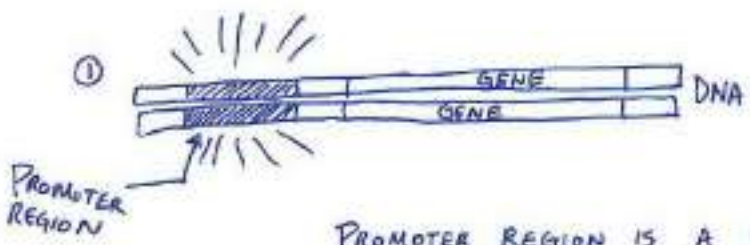
Genotype → Phenotype

DNA inside its home where it is safe

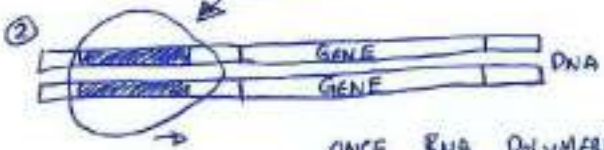
Step 1. Transcription

Turn DNA into RNA. But why? → DNA is super important so we don't want it damaged

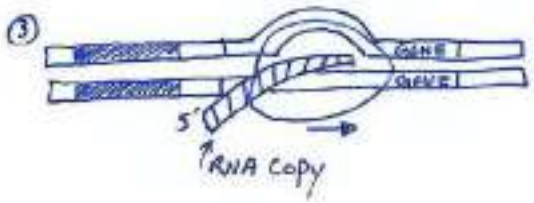
If we make a copy it is ok if it accidentally gets damaged. We can make another copy

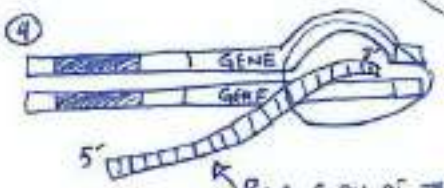


Promoter region is a section of the chromosome before the gene that "calls" RNA polymerase

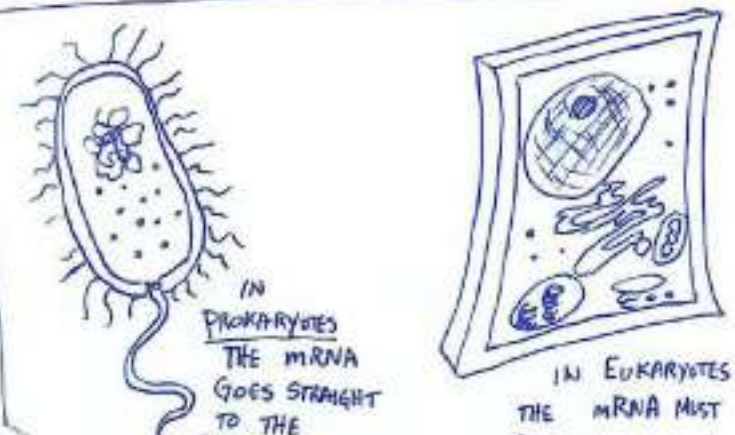


Once RNA polymerase attaches it simultaneously unzips and copies the DNA into RNA 5′ → 3′ direction





RNA copy of the gene } A.K.A mRNA (messenger)



In prokaryotes the mRNA goes straight to the ribosome to be translated

In eukaryotes the mRNA must be processed

RNA Processing

Eukaryotic Cells

When RNA comes out of RNA polymerase it needs to be twerked.

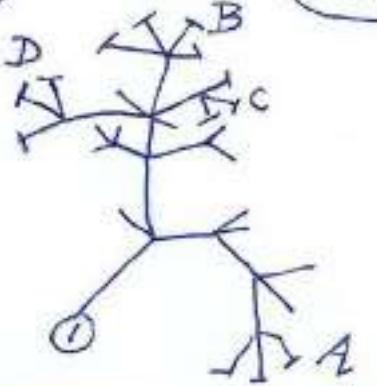
Cap + tail on a mRNA will protect the transcript from endonucleases (restriction enzymes) that may damage the RNA before it is translated

E = Exons
I = Introns

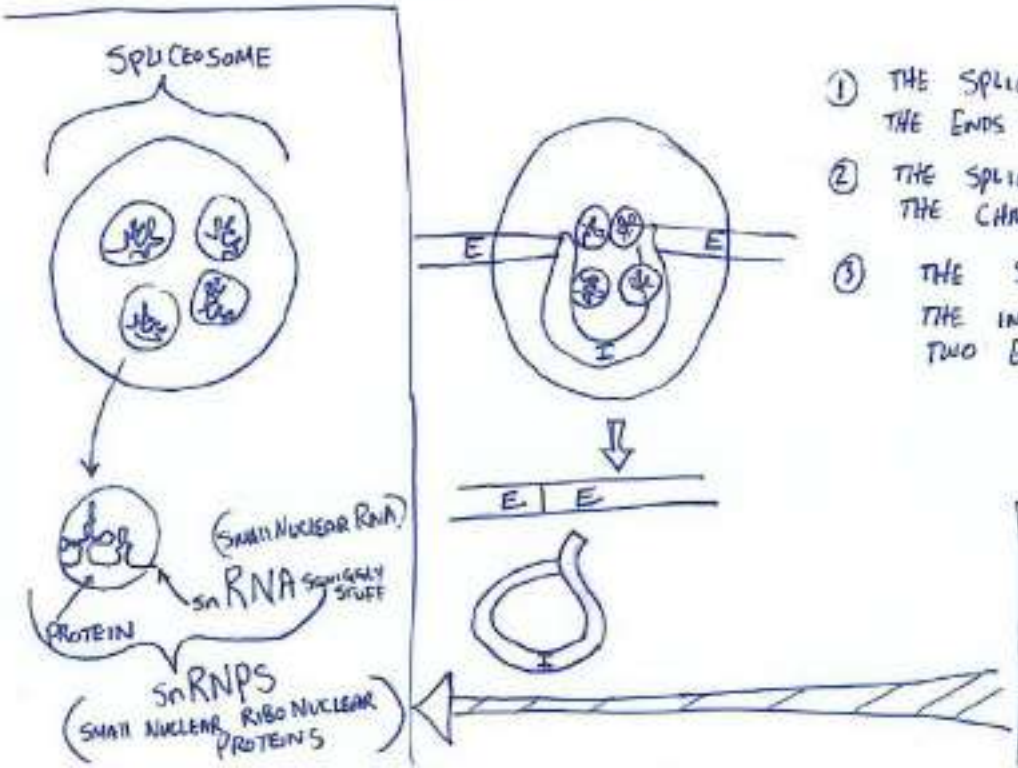
- Exons are transcribed & translated sections of a Eukaryotic chromosome
- Introns must be removed

Evolutionary Benefit of Introns

- Spacing between coding genes allows for more possibilities for crossover to (↑ diversity)
- Alternate splicing can yeild new protein varieties = (↑ diversity)



Darwin's tree



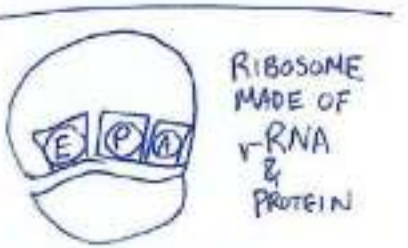
1. The spliceosome identifies the ends of an intron
2. The spliceosome folds the chromosome
3. The spliceosome cuts out the intron & binds the two exons together

- snRNA = RNA that has catalytic activity (ribozyme)
- snRNA + protein = snRNPs
- Several snRNPs together make a spliceosome

Protein Synthesis

Step 2.

Translation = turning the mRNA into a polypeptide



Ribosome made of r-RNA & protein

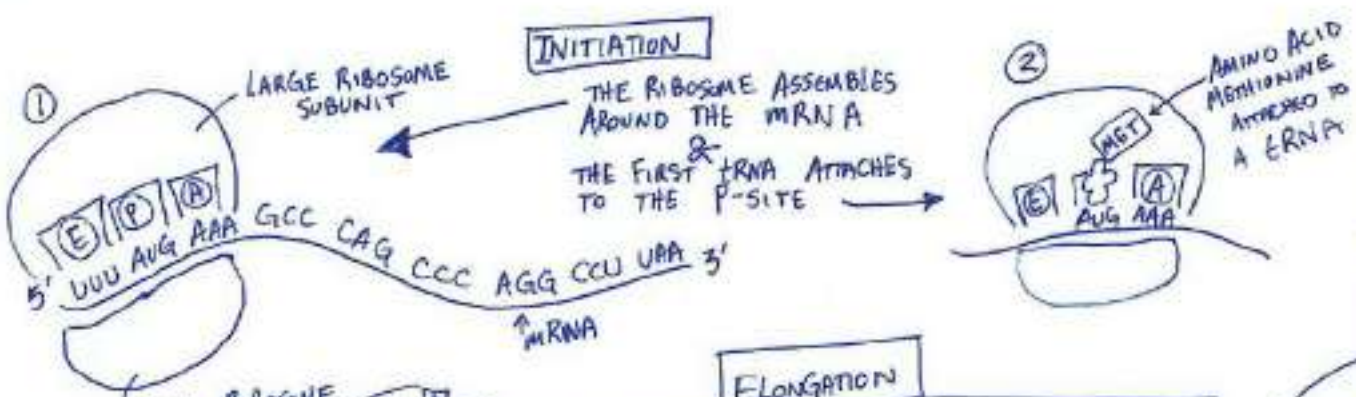
A = tRNA Attach

P = polypeptide chain grows

E = tRNA w/o amino acid leaves

Initiation

1. Large ribosome subunit
2. The ribosome assembles around the mRNA & the first tRNA attaches to the P-site
3. Amino acid methionine attached to a tRNA



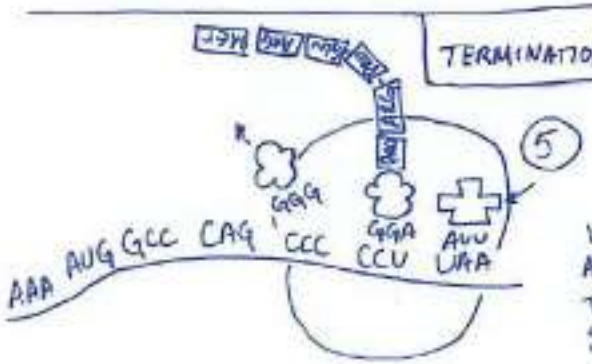
Small ribosome subunit

Elongation

Ribosome slids 5'→3'

4. New tRNA bind at the A-site. Amino acids form a peptide bond and the polypeptide grows at the P-site. tRNAs leave at the E-site to go find a new amino acid

Termination



5

When the stop codon is at the A-site it cause the whole complex to separate & the polypeptide to float away.

All organisms use the **same** code to make their proteins.

So codon UUU codes for phenylalanine in a bacteria, human, lion & even a lionfish!

Lionfish

RAW MATERIAL FOR EVOLUTION → MUTATIONS – CHANGE IN DNA

NUCLEOTIDE – CHANGE IN ONE NITROGEN BASE OR NUCLEOTIDE

– SUBSTITUTION – A SINGLE BASE SWITCHES EX: ATTGCA SWITCHES TO ATCGCA
MAY CODE FOR ONE DIFFERENT AMINO ACID

• INSERTION/DELETION – ADDING A NEW NUCLEOTIDE OR REMOVE A WHOLE NUCLEOTIDE EX: ATTGCA SWITCHES TO ATTAGCA..
OR
SWITCHES TO ATGCA
FRAMESHIFT

THE ENTIRE READING FRAME MOVES
THE CODE IS READ IN CONSECUTIVE 3 NUCLEOTIDE FRAMES.

GENE CHANGES IN FULL GENE SECTIONS

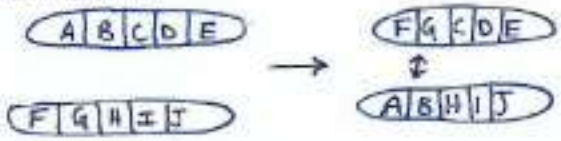
• DUPLICATION

FULL CHROMOSOME WITH MULTIPLE GENES

o DELETION

• INVERSION

• TRANSLOCATION



FULL CHROMOSOME – GETTING AN ADDITIONAL CHROMOSOME OR LOSING AN ENTIRE CHROMOSOME.

ANEUPLOIDY = WRONG # OF CHROMOSOMES

★ NONDISJUNCTION IN MEIOSIS

HUMANS

ANEUPLOIDY	NORMAL	ANEUPLOIDY
45 (TURNERS 45X) ←	46	→ 47 •KLEINFELTERS OR •DOWNS

Basic Genetic Laws

Often referred to as Mendel's Laws

Law of Independent Assortment

- When homologous pairs line up on the metaphase plate in Meiosis I, pairs don't influence each other.

Option 1 or Option 2

Random Assortment

Pair ① does Not influence pair ②

n+1 = Haploid amount + 1 extra chromosomes

Ex: Human $(n = 23) + 1 = 24$ in a sperm or egg

Meiosis I

Gamete results

All 4 gametes are wrong

Law of Segregation

- Homologous pairs, and chromatids, should seperate during Anaphase, Anaphase I, and Anaphase II

Gregor Mendel

Father of Genetics

Mutation

Non Disjunction – Failure of chromosomes to seperate properly. → Can be visable on a Karyotype

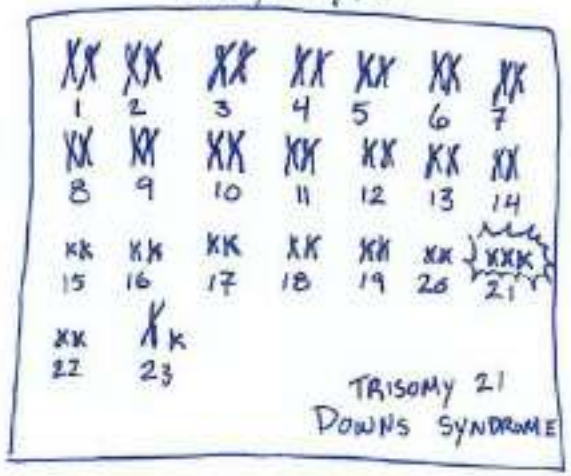
This side has too many

This side has too few

Meiosis II

2 are normal

2 are wrong



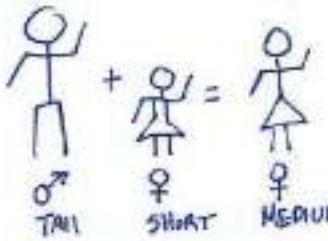
Trisomy 21

Downs Syndrome

GENETICS
PART 1

THE STUDY OF HEREDITY AND GENES.

BEFORE GREGOR MENDEL'S WORK WITH PEA PLANTS MOST PEOPLE BELIEVED INHERITANCE OF TRAITS WAS STRICTLY BLENDING



MENDEL EXPERIMENT EXAMPLE

P GENERATION

RED FLOWER POLLEN × WHITE FLOWER EGG

F1 GENERATION

ALL THE FLOWERS WERE RED

• SO THEN HE CROSSED THE CHILDREN TOGETHER

F2 GENERATION

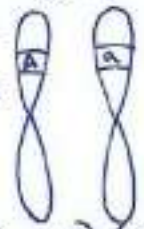
ABOUT 3/4 OF THE OFFSPRING WERE RED & 1/4 WERE WHITE

CAPTAIN OBVIOUS

HEY PHENOTYPE & PHYSICAL BOTH START WITH 'PH'

VARIATION IN A GENE

ALLELE ALTERNATIVE FORMS OF A GENE



(AWESOME) (NOT AWESOME)

A = CAPITAL LETTER DENOTES THAT IT IS DOMINANT

COMPLETE DOMINANCE

• IN A DIPLOID (2n) ORGANISM THE DOMINANT ALLELE CAN MASK THE EFFECTS OF THE RECESSIVE ALLELE

Aa

EVEN THOUGH THERE IS A 'NOT AWESOME' GENE THE 'AWESOME' GENE TAKES OVER.

PHENOTYPE - PHYSICAL CHARACTERISTIC

IN THIS CASE IT IS BEING AWESOME.

GENOTYPE

REPRESENTATION OF THE DNA COMPOSITION FOR A TRAIT

[AA - Aa - aa]

SAME ALLELES AA OR aa HOMOZYGOUS

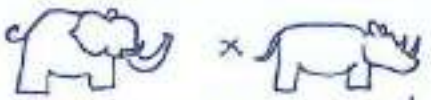
DIFFERENT ALLELES Aa HETEROZYGOUS

GENETICS PART 2.

PUNNETT SQUARES

★ CAN BE USED TO FIGURE OUT THE POSSIBILITY OF FUTURE OFFSPRING.

WHAT DO YOU GET WHEN YOU CROSS AN ELEPHANT WITH A RHINO?



ELE-IF-IHNO!

SEX DETERMINATION

♂ XY ♀ XX

	X	X
X	XX	XX
Y	XY	XY

50/50 CHANCE OF GETTING A BOY OR A GIRL. MALE GAMETES DETERMINE THE BABY'S SEX

ANOTHER BABY GIRL? IT'S THE QUEEN'S FAULT. OFF WITH HER HEAD!

HENRY VIII

IF THE FIRST 3 BABIES COME OUT RED, WHAT IS THE POSSIBILITY OF THE NEXT CHILD BEING RED?

STILL 3/4!

PAST EVENTS HAVE NO BEARING ON FUTURE EVENTS.

♂ RED FLOWERS Aa → POLLEN GRAIN POSSIBILITIES A OR a

♀ RED FLOWERS Aa → EGG POSSIBILITIES A OR a

GAMETES

MALE GAMETES \ FEMALE GAMETES	A	a
A	AA RED	Aa RED
a	Aa RED	aa WHITE

★ EACH SQUARE REPRESENTS A POSSIBILITY OF THESE TWO PARENTS CHILDREN FOR THIS ONE TRAIT

GENOTYPE

1/4 POSSIBILITY OF THE CHILD BEING AA

2/4 = 1/2 POSSIBILITY OF THE CHILD BEING Aa

1/4 POSSIBILITY OF THE CHILD BEING aa

PHENOTYPE

3/4 POSSIBILITY OF THE CHILD BEING RED

1/4 POSSIBILITY OF THE CHILD BEING WHITE

WHAT ABOUT PREDICTING A TWO TRAIT CROSS?

AaBb x AaBb = ? Aabb

4x4 SQUARE

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

OR

TRY MULTIPLING 2 SMALL PUNNETT SQUARES TOGETHER

	A	a
A	AA	Aa
a	Aa	aa

x

	B	b
B	BB	Bb
b	Bb	bb

1/2 x 1/4 = 1/8

1/8 POSSIBILITY OF GETTING A CHILD WITH A Aabb GENOTYPE.

NON MENDELIAN GENETICS

MOST TRAITS ARE NOT A ONE GENE ONE TRAIT INHERITANCE OR A COMPLETE DOMINANCE INHERITANCE

INCOMPLETE DOMINANCE – THE HETEROZYGOUS GENOTYPE IS A BLEND BETWEEN THE TWO HOMOZYGOUS GENOTYPES

RED × WHITE = PINK

CODOMINANCE – THE HETEROZYGOUS GENOTYPE SHOWS BOTH HOMOZYGOUS GENOTYPES IN ITS PHENOTYPE

BLUE × YELLOW = BLUE WITH YELLOW SPOTS

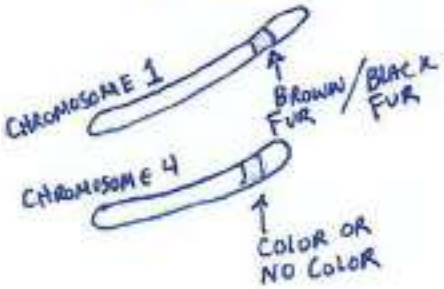
PLEIOTROPY – ONE GENE HAS MULTIPLE PHENOTYPIC RESULTS.

COAT COLOR GENE = WHITE FUR, CROSSED EYES, AND BRAIN DEVELOPMENT

POLYGENIC INHERITANCE – MULTIPLE GENES COMBINE TO MAKE ONE PHENOTYPE

TEND TO SEE A WIDE RANGE OF PHENOTYPES } HAIR COLOR, EYE COLOR

EPISTASIS – ONE GENE ALTERS ANOTHER GENE'S PHENOTYPIC EFFECT.



MULTIPLE ALLELES

- SOMETIMES A SPECIFIC GENE HAS MORE THAN TWO VARIETIES.

Ex: HUMAN BLOOD I^A, I^B, i

BUT IN A DIPLOID ORGANISM YOU CAN ONLY HAVE TWO AT ONE GIVEN TIME

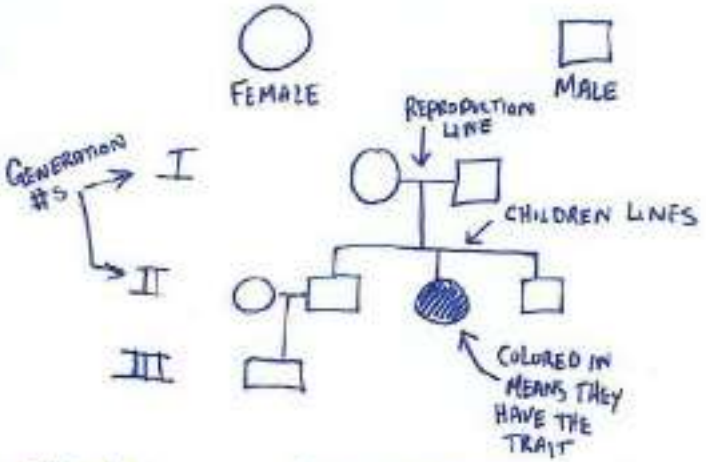
I^AI^B I^Ai I^AI^A ETC.

PEDIGREE DOGS ARE COME FROM THE SAME "FAMILY"... SO YEAH, THEY ARE INBRED!

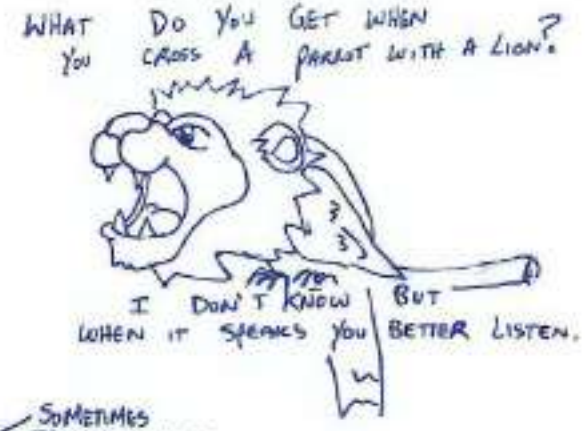
OUTLAWED IN HUMANS BECAUSE MUTATIONS HAVE A HIGHER LIKELIHOOD OF MEETING UP & CAUSING A DISEASE.

GENETICS

PEDIGREES TO TRACK TRAITS



SOMETIMES THEY ARE HALF COLORED IN. THEY ARE CARRIERS HAVE THE ALLELE BUT SHOW 'NORMAL' PHENOTYPE



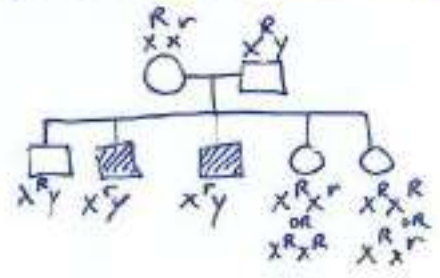
AUTOSOMES - IN HUMANS THEY ARE CHROMOSOMES 1-22

SEX CHROMOSOMES - IN HUMANS IT IS THE 23RD

FEMALES CAN BE CARRIER BUT MALES ONLY GET ONE COPY

THE Y CHROMOSOME DOESN'T HAVE AS MUCH INFORMATION ON IT

SEX-LINKED OR X-LINKED RECESSIVE



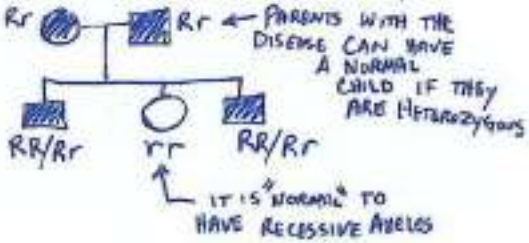
AUTOSOME RECESSIVE PATTERN

BOTH PARENTS DON'T SHOW IT BUT THEY HAVE A DAUGHTER THAT DOES

WE DON'T KNOW ENOUGH SO IT IS EQUALLY POSSIBLE TO BE RR OR Rr

HAS THE TRAIT SO MUST HAVE 2 COPIES OF THE ALLELE

AUTOSOMAL DOMINANT PATTERN



PARENTS WITH THE DISEASE CAN HAVE A NORMAL CHILD IF THEY ARE HETEROZYGOUS

IT IS "NORMAL" TO HAVE RECESSIVE ALLELES

GENETICS

HUMAN DISEASE & TRAITS

AUTOSOMAL RECESSIVE [ON A NON-SEX CHROMOSOME]

MUST BE aa OR GET THE DISEASE

- SICKLE CELL ANEMIA - A SINGLE NUCLEOTIDE CHANGES AND THE RED BLOOD CELL'S SHAPE CHANGES
- TAY SACHS - CANNOT PROCESS LIPIDS - DEFICIENCY IN AN ENZYME FAT BUILDS UP IN THE BRAIN & NERVOUS SYSTEM
- CYSTIC FIBROSIS - A DEFICIENCY IN A SODIUM CHANNEL IN THE LUNGS. FLUID GETS THICK & ALLOWS BACTERIA TO BUILD UP
- PKU - PHENYLKETONURIA - CANNOT PROCESS PHENYLALANINE AND IN TURN IT BUILDS UP IN TISSUES.

AUTOSOMAL DOMINANT [ON A NON-SEX CHROMOSOME]

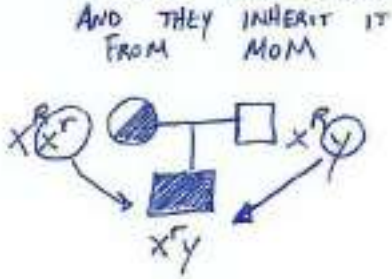
MUST BE Aa OR AA TO GET THE TRAIT

- POLY DACTYL - PRODUCING AN EXTRA DIGIT (FINGER) ON EACH HAND
- HUNTINGTON'S DISEASE - A BUILD UP OF A BAD PROTEIN RESULTING IN DEATH. - LATE ONSET (35-40 YRS OLD)
- ACHONDROPLASTIC DWARFISM - SHORT STATUE CHANGE IN BONE & MUSCLE DEVELOPMENT

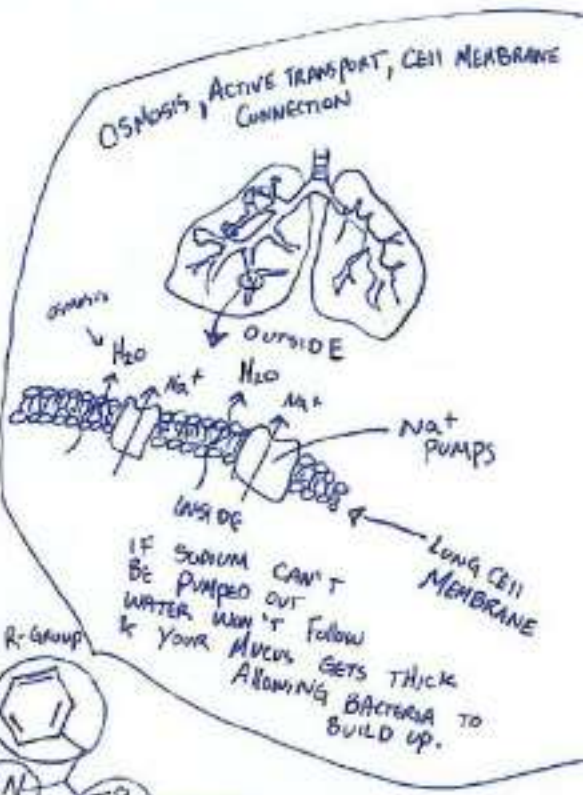
SEX LINKED OR X-LINKED RECESSIVE [ON THE X CHROMOSOME]

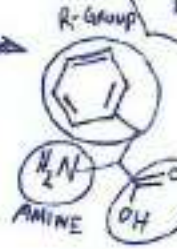
- RED/GREEN COLORBLINDNESS - CANNOT DIFFERENTIATE BETWEEN RED & GREEN WAVELENGTHS OF LIGHT.
- HEMOPHILIA - HAVE TROUBLE CLOTTING BLOOD

BOYS GET THE DISEASE MORE OFTEN AND THEY INHERIT IT FROM MOM



OSMOSIS, ACTIVE TRANSPORT, CELL MEMBRANE CONNECTION





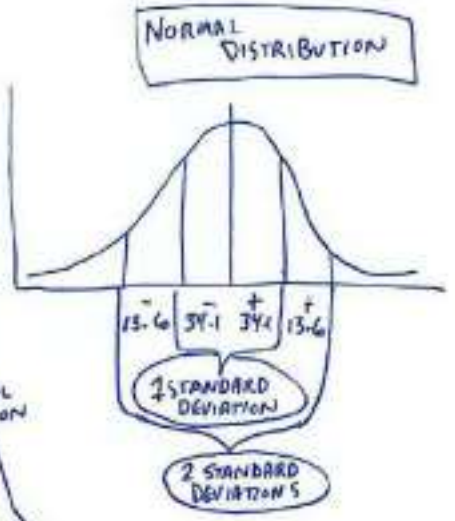
JUST ONE OF 20 AMINO ACIDS

Chi Squared & Genetics

The Formula

$$\chi^2 = \sum \frac{(O-e)^2}{e}$$

- χ^2 — Chi Squared
- $\sum$ — Sum
- O — Observed
- e — Expected



The purpose of using the statistical test Chi Squared is to see if what you think the inheritance pattern is matches up with what the experiment shows

Ex:

P: Two red eyed parents are crossed and their offspring are listed below.

F1: Red eyed: 741 — Sepia eyed: 259

So based on the results you may think complete dominance inheritance.

Make a Punnett square

	R	r
R	RR	Rr
r	Rr	rr

3/4 Red
1/4 Sepia

This looks close

So now we need to try the formula

Convert your Punnett square ratios into numbers relevant to your experiment.

3/4 × 1000 total flies = 750 Expected

1/4 × 1000 = 250 Expected

Now apply χ^2

$$\chi^2 = \frac{(741-750)^2}{750} + \frac{(259-250)^2}{250}$$

$$\chi^2 = 0.432$$

df = Degrees of Freedom

$df = n - 1$

n = # of events

In this case you have 2 events red or sepia so our $df = 1$

df	Probability			
	0.20	0.10	0.05	0.01
1			3.84	
2			5.99	
3			7.82	

Scientists focus on this row

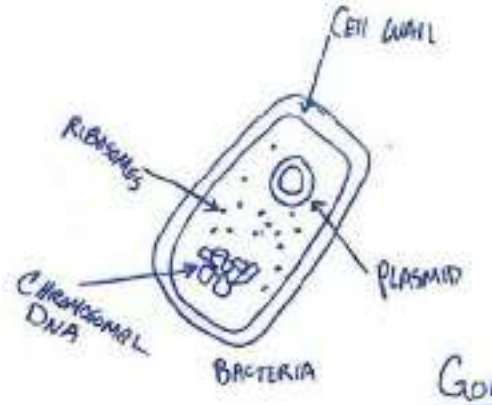
Compare these two

Final

Our χ^2 is smaller than the critical value we found, so we accept that our prediction of inheritance is supported & that the O & E are only off because of randomness

DNA TECHNOLOGY

PART 1



PLASMID IS A SMALL RING OF DNA FOUND IN BACTERIA THAT IS REPLICATED SEPERATELY FROM THE CHROMOSOMAL DNA. [OFTEN THEY CONTAIN ANTIBIOTIC RESISTANCE]

GOAL: TO MAKE A BACTERIA PRODUCE INSULIN SO THAT THE INSULIN CAN BE GIVEN TO SOMEONE IN NEED.

STEP 1:

EXTRACT THE PLASMID

STEP 2:

ADD A RESTRICTION ENZYME THAT WILL CUT THE RING OPEN

STEP 3:

CUT A PIECE OF HUMAN DNA THAT CONTAINS THE INSULIN GENE WITH THE SAME TYPE OF RESTRICTION ENZYME

STEP 4:

MIX THE CUT PLASMIDS WITH THE CUT HUMAN DNA. SOME WILL STICK TOGETHER CORRECTLY

STEP 5:

ALLOW BACTERIA TO TAKE THE PLASMID [TRANSFORMATION]

GMO = GENETICALLY MODIFIED ORGANISM

STEP 6:

THAT BACTERIA WILL REPRODUCE ASEXUALLY PRODUCING CLONES OF ITSELF WITH THE NEW PLASMID INSIDE.

PETRI DISH WITH CLONED BACTERIA THAT ARE NOW MAKING → HUMAN INSULIN

RESTRICTION ENZYMES

- (MOLECULAR SCISSORS) THAT CUT DNA AT VERY SPECIFIC NUCLEOTIDE SEQUENCES

EX: EcoR1 ← 1ST RESTRICTION ENZYME FOUND IN E. Coli

- CUTS AT THE PALINDROME

G|AATTC
CTTAA|G

- THIS LEAVES STICKY ENDS.

G . . . .
CTTAA

- ANY DNA THAT HAS THE COMPLIMENTARY SEQUENCE CAN HYDROGEN BOND TO THESE JAGGED PIECES

AATT
G . . . .
CTTAA

DNA Technology

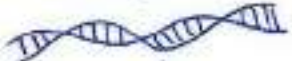
Part 2

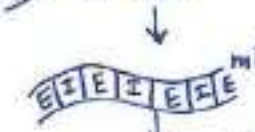
The Issue with Inserting Human DNA into a Bacteria

Prokaryotes don't have introns & exons so they translate the entire gene unlike eukaryotes who complete RNA processing.

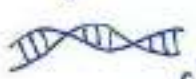
Solution:

Eukaryote DNA





Add Reverse Transcriptase



cDNA

Complimentary DNA (lacks introns)

H.I.V. = Human Immunodeficiency Virus

is a retrovirus because it contains an enzyme that is able to turn its RNA into DNA. The enzyme is called Reverse Transcriptase.

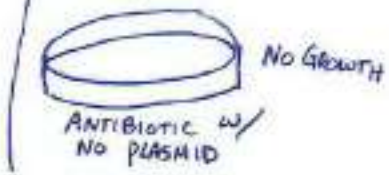
It does this before it hijacks your cells.

Screening

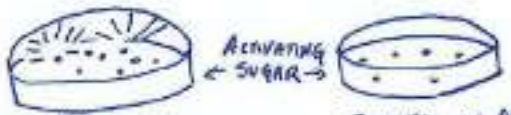
How do we figure out which bacteria got the correct plasmid?

Good plasmid → Put the bacteria on an antibiotic

Wrong plasmid or no plasmid → Put the bacteria on an antibiotic



Wrong plasmid



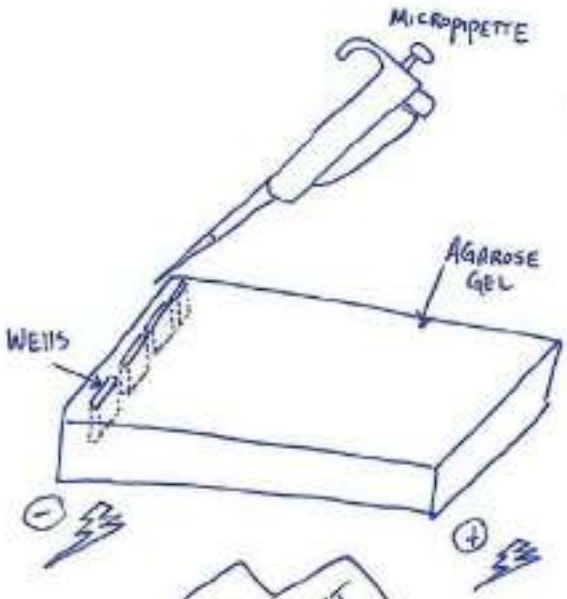
Survives on antibiotic and changes color due to Operons

Survives on antibiotic but doesn't change color with activating sugar

Gel Electrophoresis

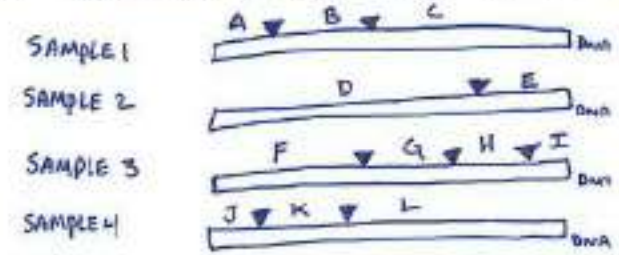
By using an agarose gel and electric current you can separate DNA fragments by size

CAN BE USED FOR:
1) CRIME SCENE A
2) PATERNATITY TESTS
3) DISEASE DETECTION
4) SPECIES COMPARISONS
→ EVOLUTION



① THE DNA YOU ARE GOING TO ANALYZE MUST FIRST BE CUT BY RESTRICTION ENZYMES. IF YOU ARE ANALYZING 4 DIFFERENT PIECES OF DNA (CRIME SCENE) USE THE SAME RESTRICTION ENZYME FOR THE 4 SAMPLES

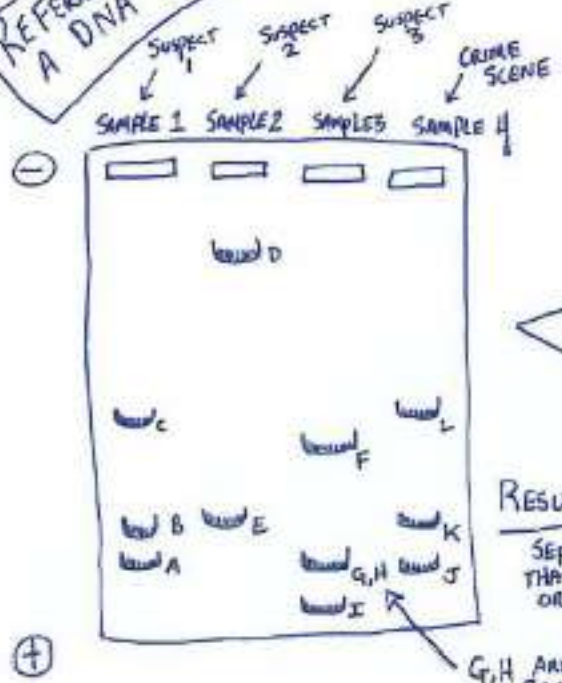
② SINCE EVERYONE'S DNA IS DIFFERENT (EXCEPT IDENTICAL TWINS) THE RESTRICTION ENZYMES WILL CUT AT DIFFERENT SPOTS.



▼ = RESTRICTION SITE FOUND & DNA IS CUT

RESULTING SEGMENTS HAVE BEEN LETTERED

REFERRED TO AS A DNA FINGERPRINT



③ INJECT EACH SAMPLE INTO THE WELLS AND ENSURE THAT THE WELLS ARE AT THE (−) POLE. DNA IS NEGATIVELY CHARGED SO IT MIGRATES TO THE (+) POLE (OPPOSITES ATTRACT)

RESULTS: THE FRAGMENTS SEPARATE BY SIZE. NOTICE THAT THEY MAY BE OUT OF ORDER.

G,H ARE IN THE SAME BAND BECAUSE THEY ARE THE SAME SIZE

ANALYSIS

- SAMPLE 1 & 4 HAVE THE SAME FINGERPRINT (DNA BANDS OF THE SAME SIZE)
- VERY HIGH PROBABILITY THAT SUSPECT 1 WAS AT THE CRIME SCENE

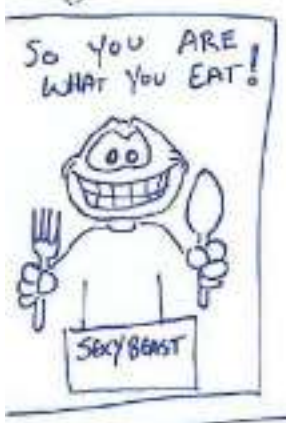
EPIGENETICS

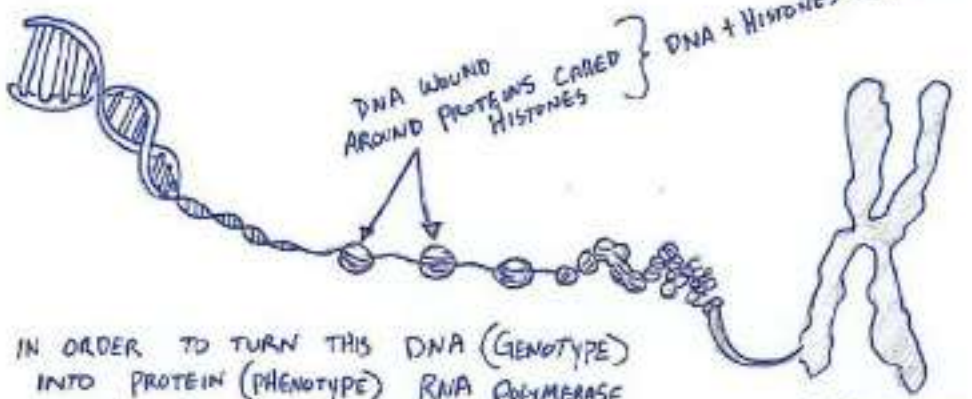
THIS IS WHY IDENTICAL TWINS LOOK DIFFERENT!

ABOVE THE GENETICS OR GENOME. YOUR ENVIRONMENT CAN CHANGE HOW DNA IS TURNED INTO PROTEIN.

THINGS IN YOUR ENVIRONMENT HAVE THE POSSIBILITY OF CHANGING YOUR GENE EXPRESSION

★ WHAT YOUR MOM CONSUMED WHEN YOU WERE IN HER WOMB ALSO COULD HAVE CHANGED YOUR GENE EXPRESSION.





WHEN THE CHROMATIN IS CONDENSED YOU CAN SEE A CHROMOSOME

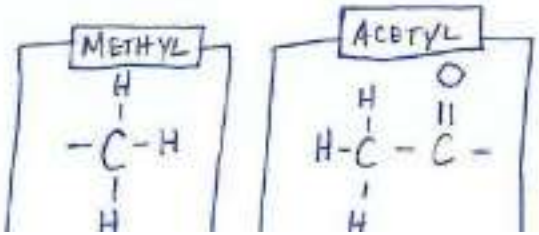
IN ORDER TO TURN THIS DNA (GENOTYPE) INTO PROTEIN (PHENOTYPE) RNA POLYMERASE MUST BE ABLE TO GET TO THE DNA.

EXPOSE DNA OR ACTIVATE A GENE

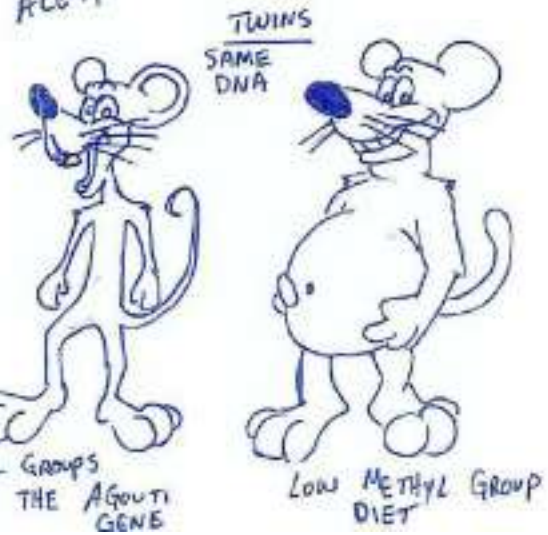
- ACETYL GROUPS WILL INCREASE THE SPACING BETWEEN HISTONES AND ALLOW FOR TRANSCRIPTION
- REMOVE METHYL GROUPS WILL LOSEN THE DNA AS WELL

CONDENSE THE DNA OR INACTIVATE A GENE

- REMOVE ACETYL GROUPS
- ADDING METHYL GROUPS WILL PULL THE HISTONES TOGETHER

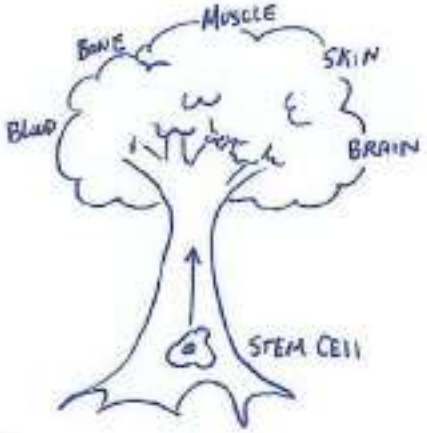


YOUR ENVIRONMENT WILL ADD OR REMOVE THE ACETYL & METHYL GROUPS



Stem Cells & Cloning

A Stem Cell is a cell that has flexibility to turn into different types of cells



Multipotent

- Have flexibility to turn into different types of cells, but it is limited

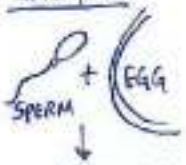
Ex: Bone marrow contains adult stem cells which can turn into any kind of blood cell (red, white, platelet)

Pluripotent

- Have flexibility to turn into <u>any</u> type of cell

Ex: Embryonic stem cells can turn into skin cells, nerve cells, heart cells, etc.

Embryonic



Mitosis

Mitosis

Cells at the base of the tree

Stem cells

Embryo

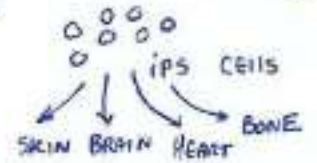
Can turn into any type of cell

iPS (Induced pluripotent stem cells)

Cells at the top of the tree are brought back down to the base

Skin cell (not a stem cell) it is already determined

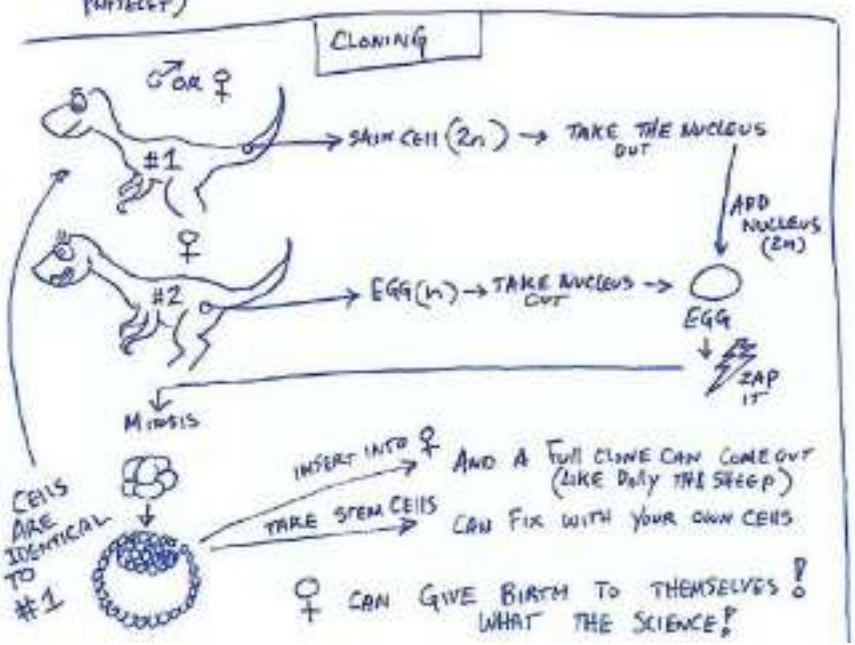
Add iPS reprogramming components [protein based transcription factors]



These cells can fix people's cells (especially with genetic disorders) who have gotten damaged.

Ex: Spinal Injury → Add nerve stem cells
Diabetes type I → Add new insulin producing cells
Cystic Fibrosis → Add new lung cells

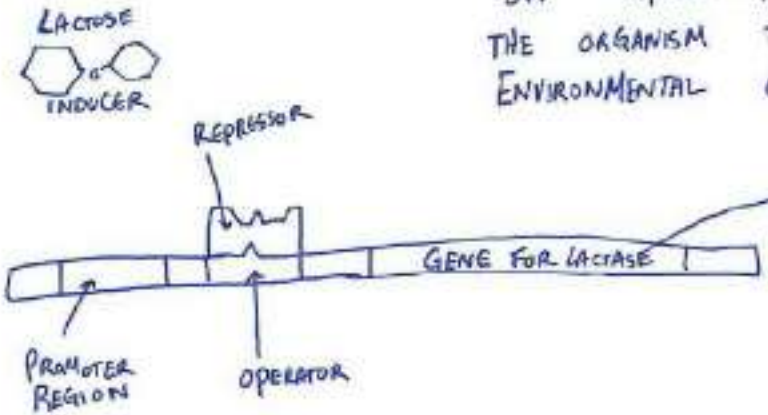
Cloning



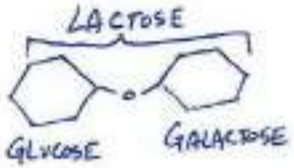
OPERONS

SOME GENES ARE CONTAINED WITHIN OPERONS, OR OPERATING SWITCHES. THIS ALLOWS THE ORGANISM TO CONTROL TRANSCRIPTION WITH ENVIRONMENTAL CUES.

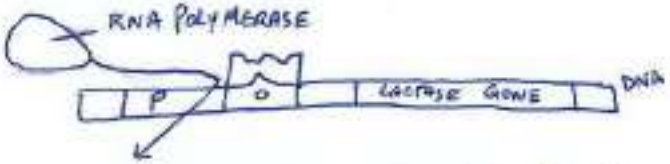
REMEMBER
DNA (GENE) → PROTEIN
GENOTYPE → PHENOTYPE
TO GET FROM GENOTYPE TO PHENOTYPE YOU NEED TO DO TRANSCRIPTION & TRANSLATION



YOU ONLY WANT TO MAKE LACTASE WHEN YOU WANT TO BREAK LACTOSE



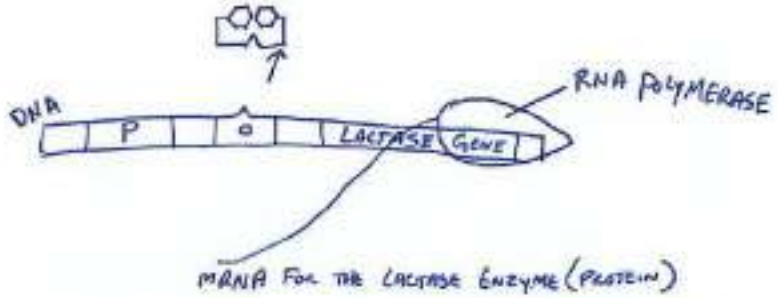
① THE PROMOTER "CALLS" IN RNA POLYMERASE TO MAKE A mRNA TRANSCRIPT OF THE LACTASE GENE BUT THE REPRESSOR BLOCKS IT FROM GETTING TO THE LACTASE GENE



★ ADVANTAGE IS THAT YOU DON'T WASTE ENERGY MAKING LACTASE UNLESS YOU NEED IT.

NEGATIVE FEED BACK CONTROL EXAMPLE

② IF LACTOSE IS AROUND IT WILL PULL THE REPRESSOR OFF THE OPERATOR AND ALLOW RNA POLYMERASE TO GET TO THE LACTASE GENE.



THAT mRNA CAN THEN BE TRANSLATED BY A RIBOSOME INTO LACTASE ENZYME. THE LACTASE BREAKS DOWN THE LACTOSE AND WHEN THE [LACTOSE] ↓ THEN THE REPRESSOR GOES BACK ONTO THE OPERATOR.

RNAi

RNA INTERFERENCE.

STOPPING mRNA BEFORE IT IS TRANSLATED INTO A PROTEIN (PHENOTYPE)

★ POTENTIAL TO STOP ANY CONDITION WHERE BAD PROTEINS ARE MADE ★

Ex: VARIOUS CANCERS, LIVER DISEASE, AND VIRAL INFECTIONS LIKE HEPATITIS

DNA → mRNA → PROTEIN

IF THERE IS A MUTATION IN THE DNA IT MAY YIELD A BAD PROTEIN

★ EXAMPLE HUNTINGTON'S DISEASE (AUTOSOMAL DOMINANT GENETIC DISEASE).

THE BAD PROTEIN BUILDS (THE PROTEIN IS CALLED HUNTINGTIN). THE BAD VARIETY INCREASES IN THE BRAIN CAUSING NERVOUS SYSTEM COMPLICATIONS AND EVENTUALLY DEATH.

SINCE WE KNOW THE DNA SEQUENCE FOR THE BAD FORM OF HUNTINGTIN WE CAN INSERT dsRNA-LIKE COPIES OR siRNA COPIES INTO THE CELL & RISC WILL CHOP UP THE BAD mRNA SEQUENCES BEFORE THEY TURN INTO DEADLY PROTEIN

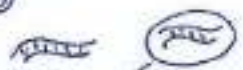
AWESOME!

HOW IT WORKS

①  dsRNA → DOUBLE STRANDED RNA (OFTEN FOUND IN VIRUSES ATTEMPTING TO INVADE CELLS)

② 

→ A PROTECTIVE ENZYME THAT CHOPS UP dsRNA

③  siRNA → SHORT INTERFERING RNA IS THE RESULT OF dsRNA CUT UP

④ 

→ RNA INDUCED SILENCING COMPLEX USES THE siRNA TO "HUNT" FOR mRNA COMPLEMENTS TO DESTROY.

⑤ 

RISC DESTROYS THE mRNA BEFORE IT CAN BE TRANSLATED

★ PREVENTS THE VIRUS FROM SPREADING ★

CRISPR

Allows Scientists to Edit Genomes with Precision

Clustered Regularly Interspaced Short Palindromic Repeats

★ Found naturally in Bacteria and the Bacteria-like Archea

- Virus attempts to inject its DNA into the Bacteria's DNA with the intent of turning Bacteria into factories for new viruses

Immune Response By The Bacteria

- Creates two pieces of RNA, one of which is a compliment to the viral DNA.
- The RNA works with an Enzyme called Cas9.
- The RNA works with the Cas9 & RNA precisely find the viral DNA & chop it up.

Similar to RNAi

★ In the CRISPR sequence all the viruses' DNA that have been encountered are kept... like wanted posters

Waiting to be used for the next viral encounter the bacteria may have.

Humans & Medicine

- Use to precisely find, efficiently treat genes with a high amount of flexibility.
- Use Cas 9 to snip the sequences exactly where you want [bigger sequences] after you feed it guide RNA that compliments your DNA target.
  - Cut out a faulty gene & replace it with a normal one.
  - Fix mutated diseases in humans
  - Fix ecological problems — mosquitos that carry malaria

86 J.Grant

IT IS ALSO A NEW LINE OF CHICKEN WINGS

CRISPR

CAS 9

CLUSTER REGULARLY INTERSPACED SHORT PALIDROMIC REPEATS

DNA SEQUENCE OF A PERSON WITH PKU.

GUIDE RNA

CAS 9 [RNA GUIDED ENDONUCLEASE]
AN ENZYME THAT "LOOKS" FOR A SPECIFIC SEQUENCE TO CUT SHOULD MATCH THE RNA GUIDE

DNA

PAM SEQUENCE
PROTOSPACER ADJACENT MOTIF
3-5 NUCLEOTIDE SECTION THAT IS THE BINDING LOCATION FOR CAS 9

GENOMIC SEQUENCE OF INTEREST

POTENTIAL IMPACT

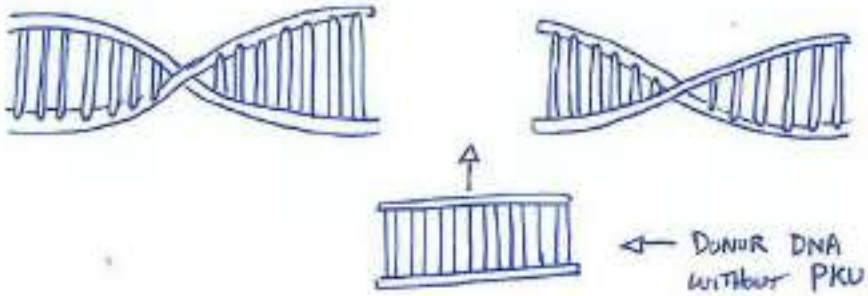
- FIX GENETIC MUTATIONS
- TREAT CANCER
- ALTER HOW PATHOGENIC DISEASES ARE SPREAD
  - CHANGE VECTOR DNA (MOSQUITOS)
- ALTER FOOD
  - PRODUCTION & NUTRITION

① ONCE CAS 9 HAS ATTACHED TO THE DNA @ THE PAM SEQUENCE IT CUTS BOTH SIDES OF THE DNA

WARNINGS

COULD WE FURTHER AND DESIGN FUTURE GENERATIONS?!

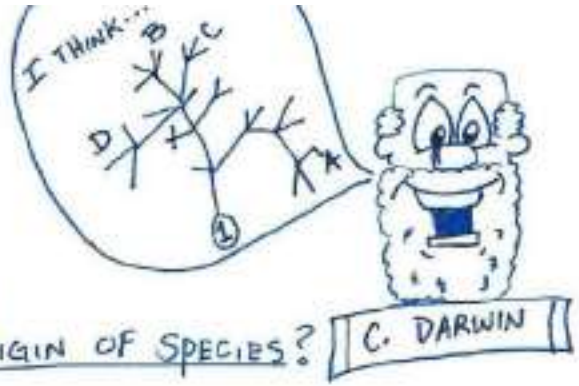
② ONCE THE DNA IS CUT DONOR DNA CAN BE PUT IN AT THE SITE. THIS DNA CAN CONTAIN A MUTATION-FREE SEQUENCE OR WHATEVER YOU WOULD LIKE.



← DONOR DNA WITHOUT PKU MUTATION

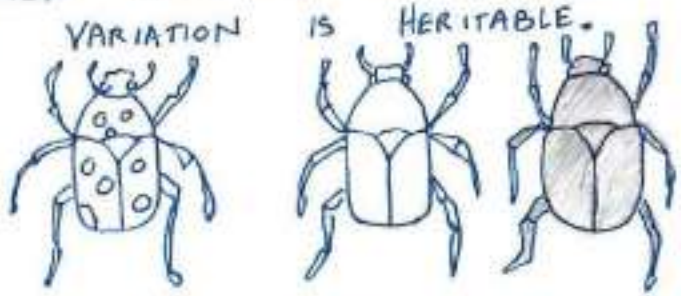
EVOLUTION

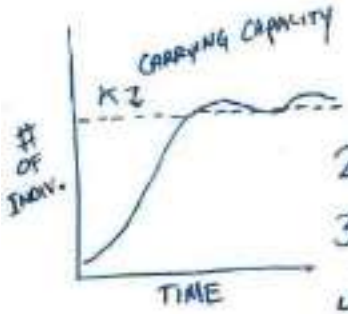
CHANGE IN A POPULATION / TIME =



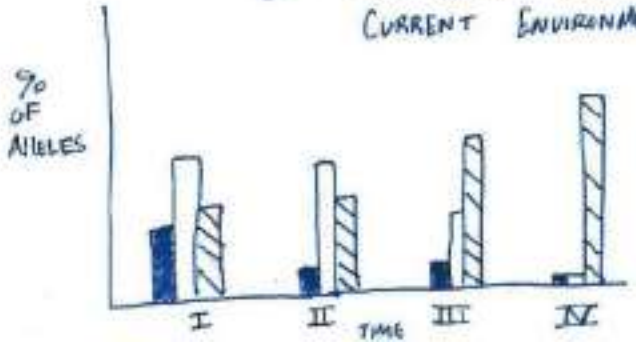
WHAT DID DARWIN OBSERVE AND WRITE ABOUT IN THE ORIGIN OF SPECIES?

1. VARIATION EXISTS IN THE POPULATION & SOME OF THIS VARIATION IS HERITABLE.





2. POPULATIONS TEND TO MAKE LOTS OF OFFSPRING.
3. RESOURCES ARE LIMITED, THUS A STRUGGLE ENSUES.
4. THOSE WITH BETTER TRAITS (PHENOTYPES) WILL DO A BETTER JOB GETTING THOSE RESOURCES AND REPRODUCE MORE.
5. THE GENES THAT CODE FOR "BETTER" TRAITS IN THE CURRENT ENVIRONMENT START INCREASING IN THE POPULATION.



THE EARTH IS ALWAYS CHANGING THUS WHAT MAY BE A "BETTER" TRAIT NOW MAY NOT BE BETTER IN THE FUTURE.

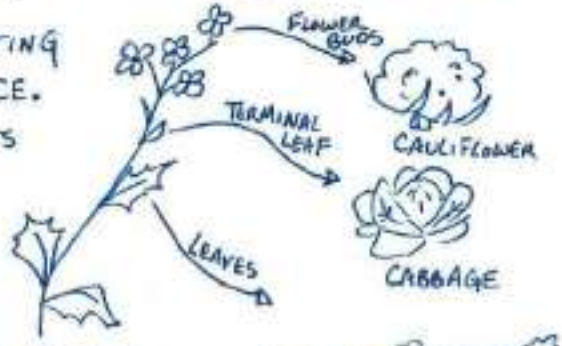
Evidence For Evolutionary Theory Part I

Scientific Theory
A well explained aspect of the natural world that was gained through the scientific method. It is also tested & confirmed repeatedly
Ex: Gravitational, Germ, Plate Tectonics, Cell, Relativity

1. Fossils - Preserved remains of extinct organisms. Tend to form in sedimentary rock.


T. Rex

2. Artificial Selection - Humans selecting which organisms survive & reproduce. So the future population have traits that human's have selected

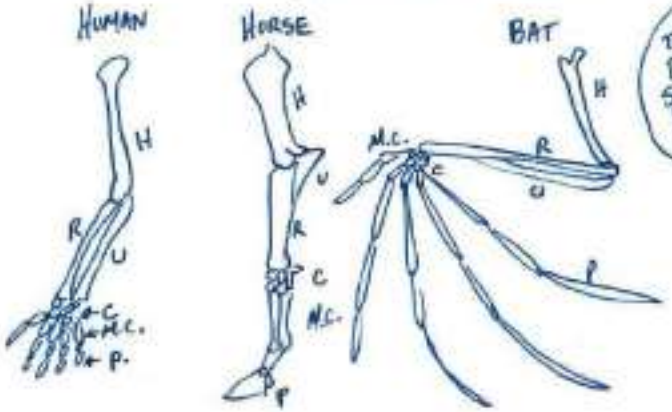


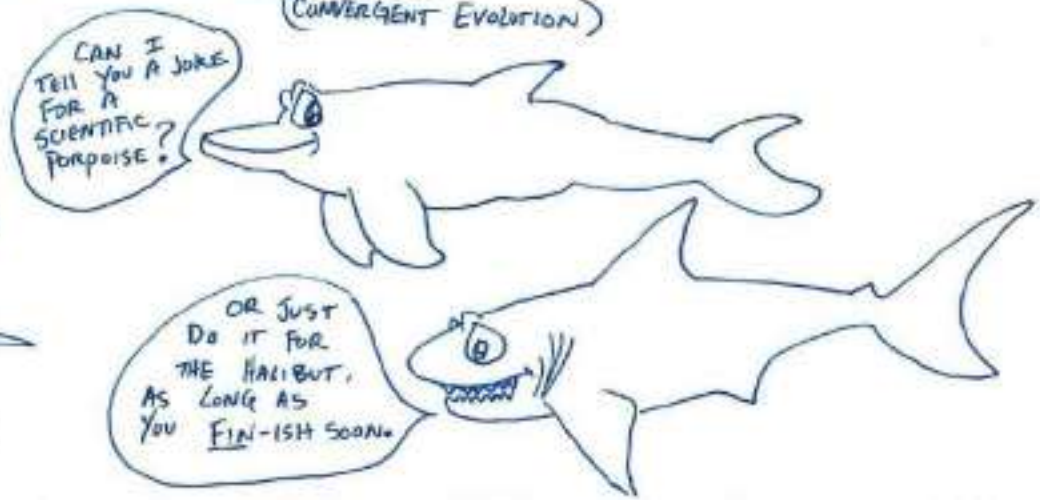
No! You have a Hypothesis!

3. Comparative Structures

Homologous Structures
Common makeup due to shared ancestory, but different function
(Divergent Evolution)

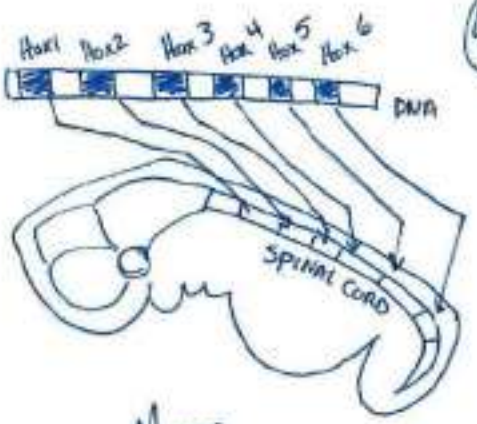
Analogous Structures
Similar function due to similar niche
(Convergent Evolution)





EVIDENCE OF EVOLUTION
CONTINUED PART 2

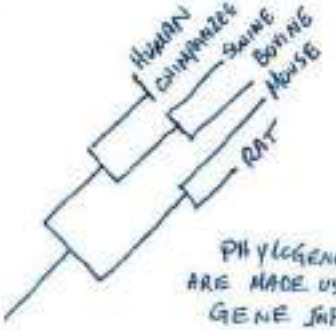
HOX GENES = BODY PLAN CONTROLLER GENES



MOUSE EMBRYO

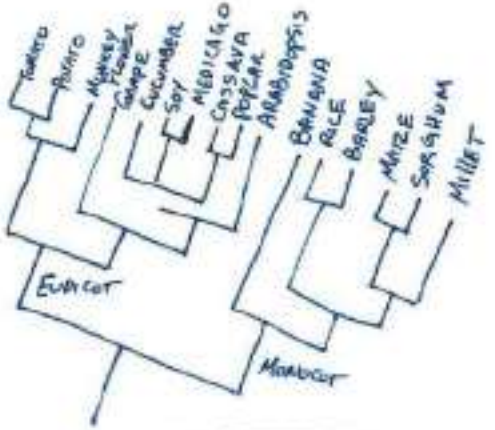
4. COMMON GENES & PROTEINS

SHARED SEQUENCES HELP US TO UNDERSTAND NOT ONLY HOW STRUCTURES DEVELOP BUT ALSO SUPPORTS SHARED ANCESTORY.



PHYLOGENETIC TREES ARE MADE USING COMMON GENE INFORMATION.

VESTIGIAL STRUCTURE - REMNANT STRUCTURES THAT SERVE LITTLE OR NO PURPOSE IN AN ORGANISM BUT DID IN THE ANCESTORS OF THE SPECIES.



5. BIO GEOGRAPHY

DISTRIBUTION OF SPECIES OVER TIME DUE TO GEOGRAPHICAL CHANGE

CHICKEN EMBRYO

PANGEA
PALEOZOIC ERA

FOSSILS OF TETRAPODS CAN BE FOUND ON THE EAST COAST OF SOUTH AMERICA & THE WEST COAST OF AFRICA

APPROX 3m LONG

CYNOGNATHUS

CAVEFISH - STILL HAS AN EYESOCKET BUT NO EYEBALLS.

MICRO EVOLUTION

A FOCUS ON ALLELE FREQUENCIES

- IF THE ALLELE FREQUENCY CHANGES OVER TIME = MICRO EVOLUTION

HARDY WEINBERG EQUILIBRIUM

IF ALL THE FOLLOWING ARE IN PLACE THERE WILL BE NO ALLELE FREQUENCY CHANGE = NO EVOLUTION

1. NO NET MUTATIONS - SO NO NEW ALLELES

2. NO NATURAL SELECTION - EVERYONE HAS EQUAL CHANCE OF SURVIVAL.

PHENOTYPE DOESN'T MATTER ON WHETHER YOU SURVIVE OR NOT

BOTTLENECK EFFECT
CATASTROPHIC EVENT WIPES OUT A MAJORITY OF POPULATION = SMALL POPULATION

FOUNDER EFFECT
SMALL GROUP SPLINTERS FROM THE MAIN POPULATION = SMALL POPULATION

3. POPULATION IS LARGE - SMALL POPULATIONS ARE SUBJECTED TO RANDOM SHIFTS IN ALLELE FREQUENCY - GENETIC DRIFT

4. MATING IS RANDOM - NO ONE CHOOSES THEIR MATE

YOU ARE ASSIGNED A # WHEN YOU ARE BORN. WHEN YOU ARE GOING TO HAVE A CHILD YOU MEET YOUR MATCH. NO CHOICE

5. NO GENE FLOW - NO ONE LEAVES THE POPULATION
NO ONE ENTERS THE POPULATION

ALL POPULATIONS VIOLATE AT LEAST ONE OF THESE FIVE. WHICH MEANS ALL POPULATIONS ARE EVOLVING.

ALLELE FREQUENCIES ARE CHANGING

HARDY WEINBERG EQUATION

TO SOLVE ALLELE FREQUENCIES

$$p^2 + 2pq + q^2 = 1$$

- p^2 ↑ AA GENOTYPE
- $2pq$ ↑ Aa GENOTYPE
- q^2 ↑ aa GENOTYPE

$$p + q = 1$$

- p ↑ A
- q ↑ a

* ALWAYS GO AFTER THE RECESSIVE PHENOTYPE

WHAT DO YOU CALL A CYLINDER WHO PASSED HIGH SCHOOL?

A GRADUATED CYLINDER.

Ex:

FAT BILL IS DOMINANT

CURVED BILL IS RECESSIVE

IF YOU HAVE A POPULATION WHERE 723 ARE FAT BILLED AND 250 ARE CURVED BILL, HOW MANY FAT BILLS ARE CARRIERS OF THE CURVED BILL ALLELE?

① $\frac{250 \text{ CURVED}}{973 \text{ TOTAL}} = aa$ OR q^2

② $0.257 = q^2$

③ $\sqrt{0.257} = q = 0.507$

④ $p + 0.507 = 1$
$p = 0.493$

⑤ $2pq = Aa$
$2(0.493)(0.507) = 0.50$

⑥ $0.50 \times 973 = 486.5$ INDIVIDUALS ARE CARRIERS

Ex: PKU PHENYLKETONURIA IS A RECESSIVE DISORDER WHERE THE INDIVIDUAL CANNOT MAKE PHENYLALANINE HYDROXYLASE AND THUS CAN'T PROCESS PHENYLALANINE (ONE OF THE 20 AMINO ACIDS)

1 IN 10,000 PEOPLE HAVE THE DISEASE, WHAT % OF THE POPULATION ARE CARRIERS?

① $\frac{1}{10,000} = aa = q^2 = 0.0001$

② $\sqrt{0.0001} = q = 0.01$

③ $p + 0.01 = 1$
$p = 0.99$

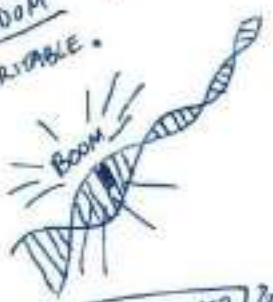
④ $2pq = Aa$
$2(0.01)(0.99) = 1.98\%$

IF TWO CARRIERS HAVE A CHILD PROBABILITY SAYS THAT THERE IS A 25% CHANCE THE CHILD WILL HAVE PKU

	A	a
A	AA	Aa
a	Aa	aa

NATURAL SELECTION IS NOT RANDOM!

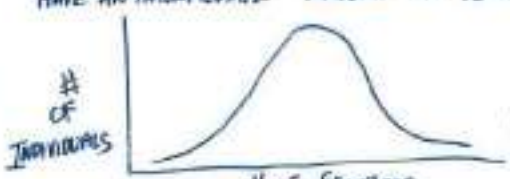
* **MUTATIONS** ARE RANDOM AND CAN BE HERITABLE.



* **CROSSING OVER** & **FERTILIZATION** ARE RANDOM.

INCREASE DIVERSITY

SUPPOSE THERE IS A POPULATION OF BIRISH THAT HAVE DIVERSITY IN THE TRAIT FOR FEATHER QUANTITY. MOST IN THE POPULATION HAVE AN INTERMEDIATE AMOUNT OF FEATHERS



BIRISH

THE ENVIRONMENT CHANGES IN THE BIRISH'S BIOME & IT GETS COLDER. THOSE WITH GENES THAT CODE FOR MORE FEATHERS STAY WARMER (HIGHER FITNESS) & ARE ABLE TO REPRODUCE EASIER. ↑ THE NUMBER OF INDIVIDUALS WITH MORE FEATHERS IN FUTURE GENERATIONS

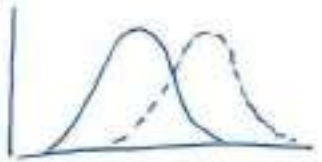
BIOME
A MAJOR ECOLOGICAL COMMUNITY EXTENDING OVER A LARGE AREA AND USUALLY IS DEFINED BY ITS ABIOTIC FACTORS
EX: TUNDRA, RAINFOREST

DIVERSITY IS VITAL FOR A POPULATION'S LONGEVITY.

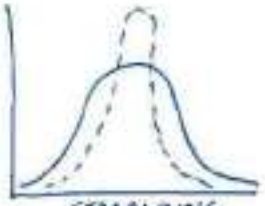
IF THERE ISN'T GENETIC STOCK AVAILABLE TO SURVIVE A CHANGE THE POPULATION WILL GO EXTINCT

MODES OF SELECTION

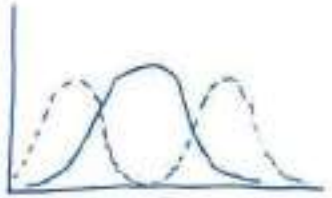
— OLD
--- = NEW



DIRECTIONAL
- ONE EXTREME IS FAVORED



STABALIZING
- THE AVERAGE IS SELECTED FOR



DIVERSIFYING OR DISRUPTIVE
- THE TWO EXTREME PHENOTYPES ARE SELECTED FOR

How Can A New Species Form?

Asexual Reproduction

Staphylococcus aureus Bacteria

Have diversity due to Mutations

You being sick is similar to this Petri dish!

Colonies of Bacteria (clusters of clone bacteria)

+

1st Round

Antibiotic [kills bacteria]

=

Due to diversity some survive the 1st round

+

This Antibiotic disables the bacteria's ability to make cell walls & in turn the cell can't resist osmosis

The cell membrane swells & pops out of the hole in the cell wall.

A couple colonies are left after 2nd round

Doctor prescribes 3 rounds which would kill the remaining bacteria, but you feel healthy and don't take the 3rd round

=

- The ones that survive reproduce (asexually)
- Mutations will happen & some will get mutations for more resistance some will get less resistance

Now there is a new Staphylococcus aureus that is resistant to Methicillin = MRSA

Methicillin Resistant Staphylococcus aureus

New species of Staphylococcus

The Environmental Pressure has changed & S. aureus has evolved.

* This bacteria causes problems for at least 90,000 people world wide

Types of Speciation

All speciation requires separation of a population

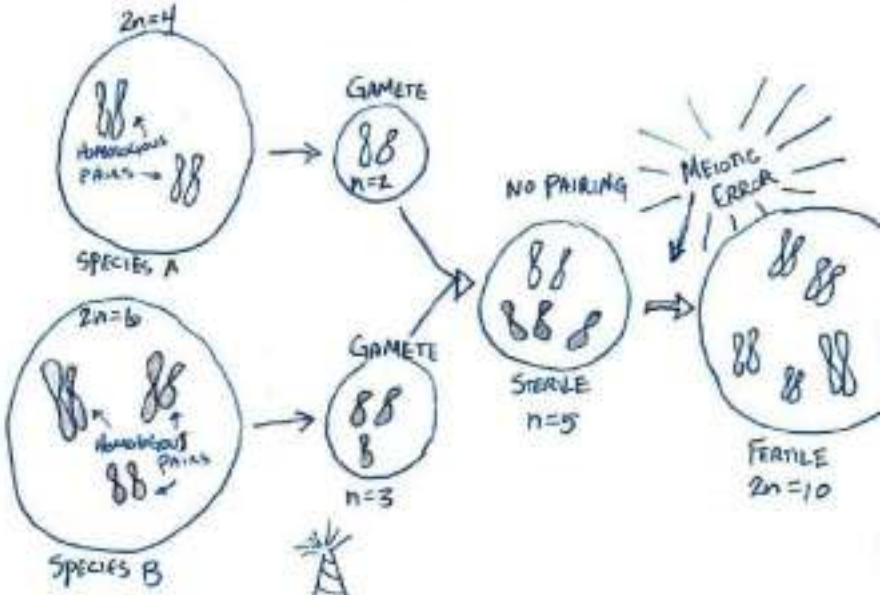
Allopatric Speciation

Speciation due to geographic separation

If the populations come back together & cannot produce offspring they are separate species

Sympatric Speciation

Speciation due to genetic separation



T. Rex's favorite birthday gift

DETERMINING IF INDIVIDUALS ARE SEPARATE SPECIES

COMPETITIVE EXCLUSION PRINCIPLE
NO TWO SPECIES CAN OCCUPY THE SAME NICHE

IF WHEN ANALYZING THE TWO ORGANISMS THEY FAIL TO PASS ANY OF THE FOLLOWING THEY ARE SEPARATE SPECIES.

PREZYGOTIC

TEMPORAL
TIME OF DAY OR SEASON OF ACTIVITY PREVENT MEETING

HABITAT
PHYSICAL HABITAT IS A DIFFERENT LOCATION

BEHAVIOR
THEY DON'T RECOGNIZE EACH OTHER AS THE SAME SPECIES

MECHANICAL
THEIR REPRODUCTIVE PARTS DON'T GO TOGETHER

- TRIANGLE PEG
- ROUND HOLE

GAMETIC
THE SPERM CANNOT FERTILIZE THE EGG

POSTZYGOTIC

REDUCED HYBRID VIABILITY
THE HYBRID OFFSPRING DON'T HAVE GOOD TRAITS TO SURVIVE.

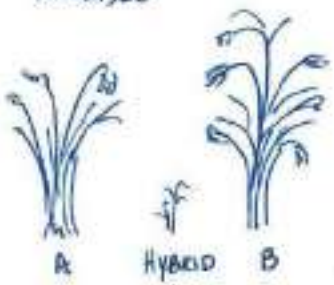
HYBRID CAN'T HIDE OR CONVEY A POISON SIGNAL

REDUCED HYBRID FERTILITY
THE HYBRID OFFSPRING IS STERILE

HORSE 2n = 64 × DONKEY 2n = 62 = MULE 63

WHY THE LONG FACE?
- GENETICS... DUH!

HYBRID BREAKDOWN
CONTINUAL MATINGS OF HYBRID = YIELD DECREASED



STATISTICS

GENERAL PART 1

PURPOSE
TO ANALYZE DATA SETS IN ORDER TO SUPPORT OR REFUTE HYPOTHESES

COLLECTING DATA

QUANTITATIVE COMES IN TWO TYPES

QUALATATIVE - QUALITY OF A POTATO CHIP DESCRIPTIONS LACKING #S Ex: YELLOW, CRUNCHY, SALTY

QUANTITATIVE
QUANTITY OF POTATO CHIPS DESCRIPTION CONTAINING #S
Ex: 30 IS A SERVING, 150 IS MY SERVING

DISCRETE DATA – SEPARATE OR DISTINCT
USUALLY THIS DATA HAS ONLY A COUPLE CHOICES
Ex: HOW MANY TIMES DO YOU GET A CERTAIN # ON A DICE?

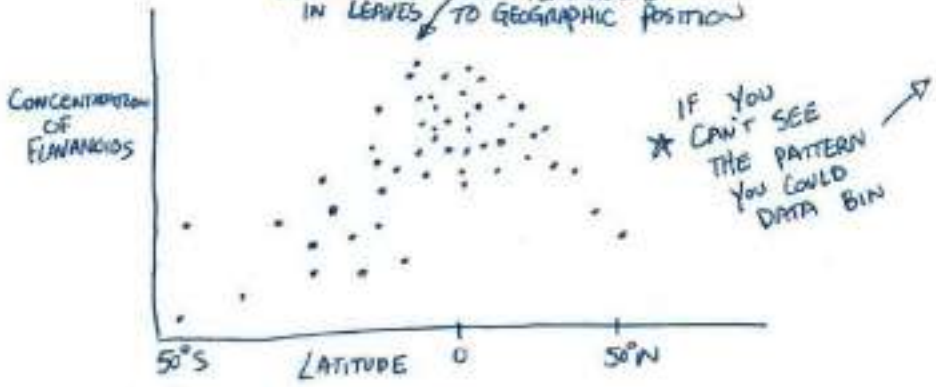
CAN USE A FREQUENCY TABLE

DICE #	FREQUENCY
1	16
2	12
3	13
4	12
5	11
6	15

CONTINUOUS DATA - ON A CONTINUUM OR SCALE
OFTEN GETTING A LOT OF VARIATION. CAN BE A ∞ NUMBER OF VALUES WITHIN A RANGE.
Ex: HEIGHT OF SUNFLOWERS IN JULY

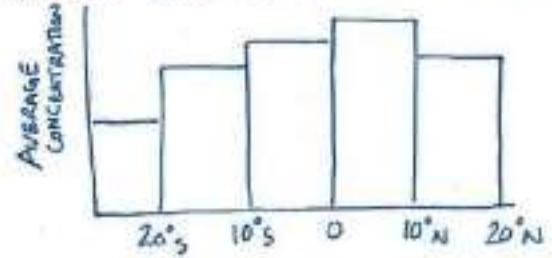
BECAUSE OF THIS IT MAY BE HARDER TO SEE A PATTERN

RELATIONSHIP OF FLAVANOIDS IN LEAVES TO GEOGRAPHIC POSITION



★ IF YOU CAN'T SEE THE PATTERN YOU COULD DATA BIN

DATA BINNING
A WAY TO GROUP NUMBERS IN A CONTINOUS DATA SET. MAYBE INSTEAD OF PLOTTING CONCENTRATIONS OF PLANTS USING LATITUDES DOWN TO A HUNDRETH OF A DEGREE GROUP YOUR LATITUDES IN 10° INTERVALS



STATISTICS

GENERAL PART 2

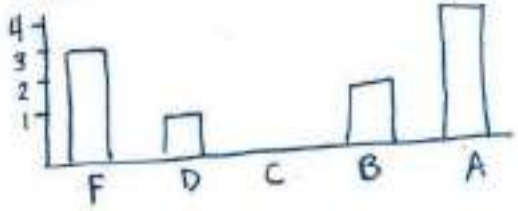
- MEAN = AVERAGE
- MEDIAN = MIDDLE VALUE IN A DATA SET THAT HAS BEEN ORDERED
- MODE = THE MOST FREQUENT #

ONLY USING AN (AVERAGE (MEAN)) AS A WAY TO ANALYZE A DATA SET WILL LEAD YOU AWRY.

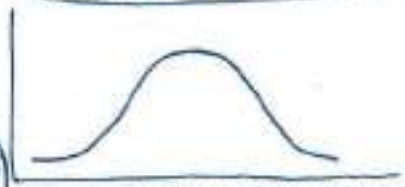
Ex: TEST SCORES IN A CLASS:
91%, 96%, 63%, 36%, 87%, 45%, 29%, 86%, 98%, 92%

MEAN = 72.3%

THE AVERAGE CLASS DOESN'T LOOK BAD BUT THE HAS 3 FAILURES, 1D, 2B, 4A. KIDS EITHER GET IT OR DON'T.



DISTRIBUTION TYPES



NORMAL DISTRIBUTION SYMMETRIC

PARANORMAL DISTRIBUTION

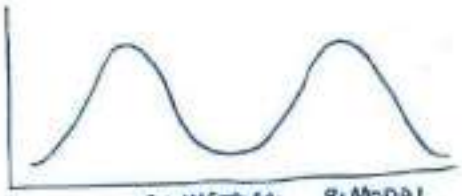
SKEWED RIGHT

SKEWING

SKEWED RIGHT? IT LOOKS LEFT. THIS IS WHY = YOUR DATA IS BEING PULLED RIGHT BY A COUPLE POINTS THAT ARE AWAY FROM THE MAJORITY

THESE POINTS ARE PULLING YOUR CURVE RIGHT

SKEWED LEFT



SYMMETRICAL BIMODAL

NONSYMMETRICAL BIMODAL

TAKING INTO ACCOUNT MEDIAN & MODE OF YOUR DATA SET WILL GIVE YOU A BETTER VIEW OF YOUR DATA SET BUT YOU MUST LOOK @ HOW DISTRIBUTED YOUR DATA IS.

STATISTICS

GENERAL PART 3

DISTRIBUTION OF YOUR DATA

HOW MUCH YOUR DATA DEVIATES FROM YOUR AVERAGE WILL HELP YOU UNDERSTAND YOUR SPREAD.

CONSIDER THESE NORMAL DISTRIBUTIONS

#1 LOW SPREAD

#2

#3 HIGH SPREAD

STANDARD DEVIATION

$$s = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$$

n = HOW MANY DATA POINTS YOU HAVE IN YOUR DATA SET

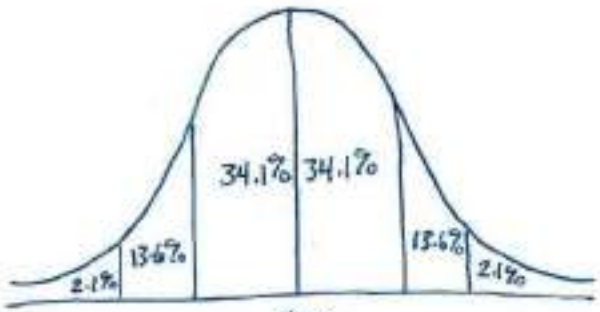
x_i = MEASUREMENT IN YOUR DATA

$\bar{x}$ = AVERAGE OF ALL OF DATA

SO YOU ARE CALCULATING HOW MUCH EACH # IN YOUR DATA SET IS FROM THE AVERAGE

Σ = SUM → ADD ALL OF THESE DIFFERENCES UP & SQUARE IT

SO OF THESE 3 DISTRIBUTIONS #1 WOULD HAVE A LOW STANDARD DEVIATION & #3 WOULD HAVE A HIGHER STANDARD DEVIATION



68% TOTAL

IN A NORMAL DISTRIBUTION 34% OF YOUR DATA WILL FALL WITHIN 1 S.D. OF YOUR MEAN IN THE POSITIVE DIRECTION & 34% OF YOUR DATA WILL FALL WITHIN 1 S.D. OF YOUR MEAN IN THE NEGATIVE DIRECTION

ERROR BARS

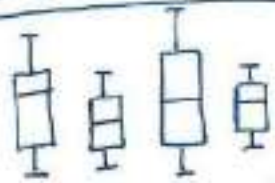
THESE ARE LINES SHOWN ON A GRAPH THAT REPRESENT HOW VARIABLE THE DATA IS. THE MORE VARIABLE THE MORE ERROR A DATA SET CAN BE

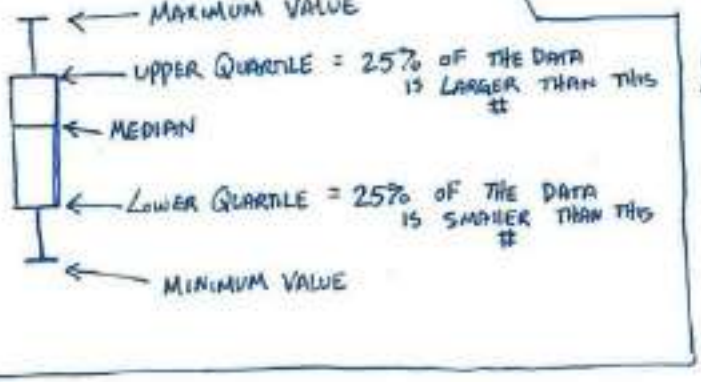
THE ENDS OF THE BARS ARE 1 S.D. FROM THE DOT. THE DOT IS THE MEAN

STATISTICS

GENERAL PART 4

BOX & WHISKER PLOT





P VALUE

PROBABILITY VALUE
HAVING A HIGH P VALUE (OVER 0.05) ACCEPT THE NULL. BELOW 0.05 WE REJECT THE NULL

WHAT IS STATISTICALLY SIGNIFICANT?

WHEN WE CAN JUSTIFY THAT ANY #S FALLING OUTSIDE OF WHAT WE PREDICTED ARE ONLY DUE TO RANDOMNESS

USUALLY WE SAY THAT THE DATA HAS TO FALL WITHIN 95% OF YOUR DISTRIBUTION OR ±2 S.D. FROM THE MEAN SO 5% CAN FALL OUTSIDE & WE CAN ACCEPT THAT AS RANDOM

WHAT IS GOODNESS OF FIT?

TESTS ARE USED TO SEE HOW WELL THE DATA FITS TOGETHER = MAKES A PATTERN

Null Hypothesis = A HYPOTHESIS THAT STATES THAT THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN SPECIFIED POPULATIONS. IF THERE IS A DIFFERENCE IT IS DUE TO RANDOMNESS OR EXPERIMENTAL ERROR

EX: WHEN ANALYZING TEST SCORES IN A POPULATION OF STUDENTS WE WOULD EXPECT ♂ & ♀ TO BE EQUAL

$$H_0 = \mu_1 = \mu_2$$

H_0 = NULL HYPOTHESIS

μ_1 = MEAN OF TEST SCORES FOR ♂

μ_2 = MEAN OF TEST SCORES FOR ♀

EX: TYPES OF TESTS

- **REGRESSION ANALYSIS** RELATIONSHIP BETWEEN DEPENDENT & INDEPENDENT

$r^2 = 0 - 1.0$

COEFFICIENT OF DETERMINATION

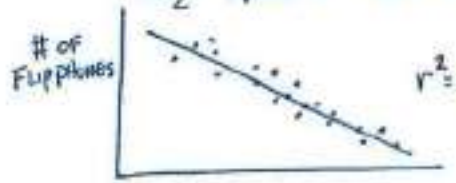
$r^2 = 1.0$ = PERFECT MATCH

$r^2 = 0.0$ = DEPENDENT & INDEPENDENT DON'T CORRELATE

- **CHI-SQUARED TEST**

$$\chi^2 = \sum \frac{(o-e)^2}{e}$$

ANALYZE TWO POPULATIONS WHERE YOU KNOW WHAT ONE OF THE POPULATIONS WILL LOOK LIKE.



$r^2 = 0.89$ AWESOME FIT!

CLIMATE CHANGE IS LEADING TO THE EXTINCTION OF FLIP PHONES!! NOT A GOOD CONCLUSION

JUST REMEMBER

CORRELATION DOES NOT = CAUSATION

YOU MUST HAVE A SOLID PLAUSIBLE EXPLANATION & MULTIPLE DATA SETS TO HAVE A STRONG ARGUMENT

STATISTICS

GENERAL PART 5

THE LOWER YOU GET YOUR S.E.M. & YOUR S.D. THE MORE RELIABLE YOUR EXPERIMENT WILL BE.

REPLICATION IS
- MULTIPLE TRIALS
- MULTIPLE ANGLES
- CONTROL YOUR VARIABLES
- REMOVE HUMAN ERROR

STANDARD ERROR OF THE MEAN (S.E.M.)

ESTIMATES THE VARIABILITY BETWEEN SAMPLE MEANS THAT YOU WOULD GET IF YOU TOOK SEVERAL SAMPLES FROM THE SAME DATA SET.

$$S.E.M. = \frac{\text{STANDARD DEVIATION}}{\sqrt{\#\text{ SAMPLES FROM YOUR DATA SET}}}$$

BETTER PICTURE OF ERROR

☆ HELPS US UNDERSTAND HOW THE MEAN VARIES IN DIFFERENT EXPERIMENTS USING THE SAME QUANTITY

THE MORE YOU SAMPLE, THE SMALLER YOUR S.E.M.

EX: CALCULATING THE AREA OF AN OAK LEAF TO FIND TRANSPIRATION RATE.

USE 10 LEAVES n=10

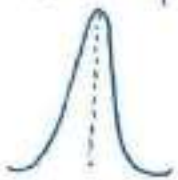
USE 100 LEAVES n=100

MORE POINTS WILL COLLECT NEAR THE MEAN

VS.

STANDARD DEVIATION (S.D.)

IS THE VARIATION/DISPERSION THAT YOU MAY SEE IN A DATA SET



LOW S.D.
A LOT OF YOUR DATA IS AROUND YOUR MEAN ($\bar{x}$)

HIGH S.D.
A LOT OF YOUR DATA IS SPREAD OUT COMPARED TO YOUR MEAN ($\bar{x}$)

$$S.D. = \sqrt{\frac{\Sigma (x-\bar{x})^2}{n-1}}$$

EX: ♂ 72, 70, 62, 61, 69, 68, 62, 59, 68, 59 } # HOT DOGS EATEN BY WINNER OF CONEY ISLAND HOTDOG CONTEST / 10 MIN.

S.D. = 5.74

$\bar{x}$ = 64.5

- THE LARGER THE STANDARD DEVIATION THE MORE SPREAD OUT YOUR DATA SET IS COMPARED TO YOUR MEAN.
- THE MORE DATA YOU COLLECT THE CLOSER YOUR DEVIATION WILL BE TO YOUR MEAN

YOU DON'T GET IT? YOU CAN LEAF

STATISTICS TESTS
WHAT DO I CHOOSE?

- CORRELATION BETWEEN VARIABLES
  - CORRELATIONS → SPEARMAN'S RANK CORRELATION
  - REGRESSION → REGRESSIONAL ANALYSIS
- DIFFERENCES
  - BETWEEN DISTRIBUTION
    - OBSERVED & THEORETICAL → χ^2 FOR GOODNESS OF FIT
    - TWO OR MORE SAMPLES → χ^2 FOR INDEPENDENCE
  - BETWEEN MEANS
    - MORE THAN TWO SAMPLES
      - PARAMETRIC → ANOVA
      - NONPARAMETRIC
        - RELATED SAMPLES → FRIEDMAN TEST
        - INDEPENDENT SAMPLES → KRUSKAL-WALLIS TEST
    - TWO SAMPLES
      - PARAMETRIC → INDEPENDENT SAMPLES → t-TEST
      - NONPARAMETRIC
        - RELATED OR INDEPENDENT SAMPLES → SIGN TEST
        - INDEPENDENT SAMPLES → RANK SUM TEST
  - BETWEEN VARIANCES → F TEST

PARAMETRIC - ASSUMES PARAMETERS OR BOUNDARIES ABOUT THE DATA SET

NON PARAMETRIC - HAS LESS ASSUMPTIONS ABOUT THE DATA SET

REMEMBER THAT ALL OF THESE TESTS JUST HELP SUPPORT THE CONCLUSIONS THAT YOU COME TO. SOMETIMES THE RESULTS WILL SAY THEY AREN'T SIGNIFICANT.

IT COULD BE DUE TO, BUT NOT LIMITED TO

- POOR EXPERIMENTAL SET UP
- NOT ENOUGH DATA
- THERE ACTUALLY ISN'T A DIFFERENCE IN THE DATA SETS

→ P VALUE < 0.05 IS SIGNIFICANT & REFUTES THE NULL HYPOTHESIS

HISTOLOGY
- THE STUDY OF TISSUES

TISSUES

A COLLECTION OF CELLS THAT HAVE THE SAME GENERAL PURPOSE

5TH TISSUE TYPE

4 TYPES OF TISSUES
1. EPITHELIAL
2. CONNECTIVE
3. MUSCLE
4. NERVOUS

EPITHELIAL TISSUE
SURFACE

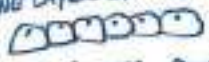
★ CATEGORIZED BY CELL SHAPE & # OF LAYERS

1. CELL LAYERS
   - SINGLE = SIMPLE
   - MULTIPLE = STRATIFIED
2. CELL SHAPES
   - FLAT = SQUAMOUS
   - SQUARE = CUBOIDAL
   - RECTANGLE = COLUMNAR

SIMPLE SQUAMOUS
ONE LAYER OF FLAT CELLS

★ FOUND LINING CAPILLARIES & ALVEOLI = KEY FOR EXCHANGE OF GASES & NUTRIENTS

SIMPLE CUBOIDAL
ONE LAYER OF SQUARES



NOT ALWAYS PERFECT SQUARES

★ FOUND LINING DUCTS
- SWEAT GLANDS
- OIL GLANDS

SECRETION & ABSORBTION

SIMPLE COLUMNAR
ONE LAYER OF RECTANGLES

★ FOUND LINING THE DIGESTIVE TRACT
- STOMACH & SM. INTESTINES

GOBLET CELLS = MUCUS

ABSORPTION & SECRETION

TRANSITIONAL

★ CELLS CAN BE ALL KINDS OF SHAPES

STRETCHES ALLOWS EXPANSION

★ LOCATED IN URINARY BLADDER

PSEUDOSTRATIFIED COLUMNAR
FAKE LAYERS
- LOOKS LIKE THEY ARE STRATIFIED

CAN HAVE GOBLET CELLS & CILIA

★ LOCATED IN THE TRACHEA

SECRETE MUCUS & 4 PROPULSION

STRATIFIED SQUAMOUS
MULTILAYER FLAT CELLS

PROTECTION

★ FOUND @ SKIN SURFACE
- EPIDERMIS
- LINING OF MOUTH

STRATIFIED CUBOIDAL
MULTILAYER SQUARES

★ FOUND IN THE LARGER DUCTS OF
- SWEAT
- SALIVARY GLANDS

PROTECTION

STRATIFIED COLUMNAR
MULTILAYER RECTANGLES

★ RARE. FOUND IN SOME DUCTS OF LARGE GLANDS

PROTECTION

TISSUES

MATRIX

AREA SURROUNDING A CELL THAT CAN CONTAIN MATERIAL BOTH ORGANIC & INORGANIC.

CONNECTIVE TISSUES

TISSUE THAT CONNECTS, BINDS OR SEPARATES TISSUES. OFTEN THESE TISSUES HAVE CELLS THAT MAKE A MATRIX.

ADIPOSE

* CELLS APPEAR EMPTY - FAT DOESN'T STAIN WELL
* FAT CELLS - ENERGY STORAGE INSULATION

BLOOD

- RED BLOOD CELLS (NO NUCLEUS)
- WHITE BLOOD CELL (NUCLEUS)

· TRANSPORT GASES
· IMMUNITY

* BLOOD CELLS

BONE

RINGS OF COMPACT BONE

STRUCTURAL SUPPORT

* BONE

RETICULAR

SOFT INTERNAL SKELETON

- DERMIS OF SKIN

DENSE FIBROUS

TIGHTLY PACKED COLLAGEN FIBERS

STRONG

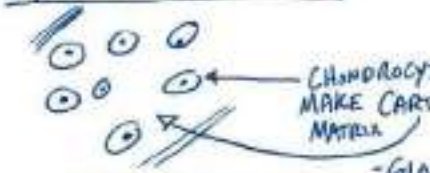
· TENDONS, LIGAMENTS

AREOLAR

FIBERS SCATTERED
- THICK = COLLAGEN
- THIN = ELASTIC

CONNECT ORGANS TOGETHER

HYALINE CARTILAGE



CHONDROCYTES MAKE CARTILAGE MATRIX

- GLASSY APPEARANCE
- MOST ABUNDANT CARTILAGE
- JOINTS - TRACHEA

MAINTAINS SHAPE

ELASTIC CARTILAGE

CHONDROCYTES

ELASTIC FIBERS

· OUTER EAR
· LARYNX

MAINTAINS FLEXABILITY & SHAPE

FIBROCARTILAGE

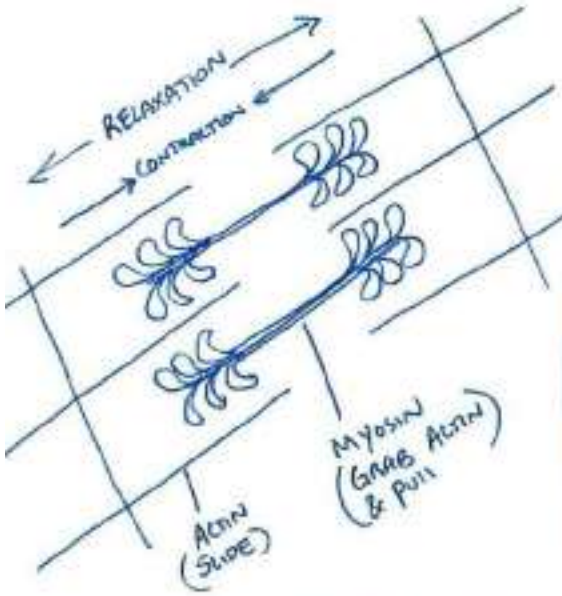
CHONDROCYTES

COLLAGEN FIBERS

· INTERVERTEBRAL DISCS

STRENGTH SHOCK ABSORPTION

TISSUES



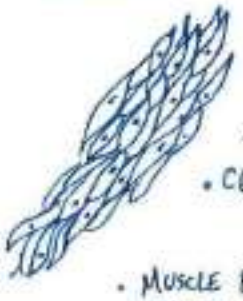
MUSCLE TISSUE

TISSUE THAT'S MAIN PURPOSE IS MOVEMENT. TWO MAIN MOLECULES SLIDE OVER EACH OTHER TO CREATE THIS MOVEMENT

BICEPS BRACHII MOVES THE FOREARM ATTACHED TO SHOULDER & FOREARM

SMOOTH

MOVES ORGANS



- FLOWING APPEARANCE
- CELLS ARE POINTY OVALS
- MUSCLE FOUND IN HOLLOW ORGANS - STOMACH, ESOPHAGUS

★ INVOLUNTARY - NO CONTROL

CARDIAC

MOVES HEART

- BRANCHING
- STRIATIONS (STRIPES)
- INTERCALATED DISCS (DARKER LINES)
- FOUND IN THE HEART

★ INVOLUNTARY - NO CONTROL

SKELETAL

MOVES THE SKELETON

- FIBERS LAYING ON EACH OTHER
- STRIPES
- NO BRANCHING OR INTERCALATED DISCS
- FOUND IN SKELETAL MUSCLES BICEPS BRACHII, PECTORALIS MAJOR ETC.

★ VOLUNTARY CONTROL

Tissues

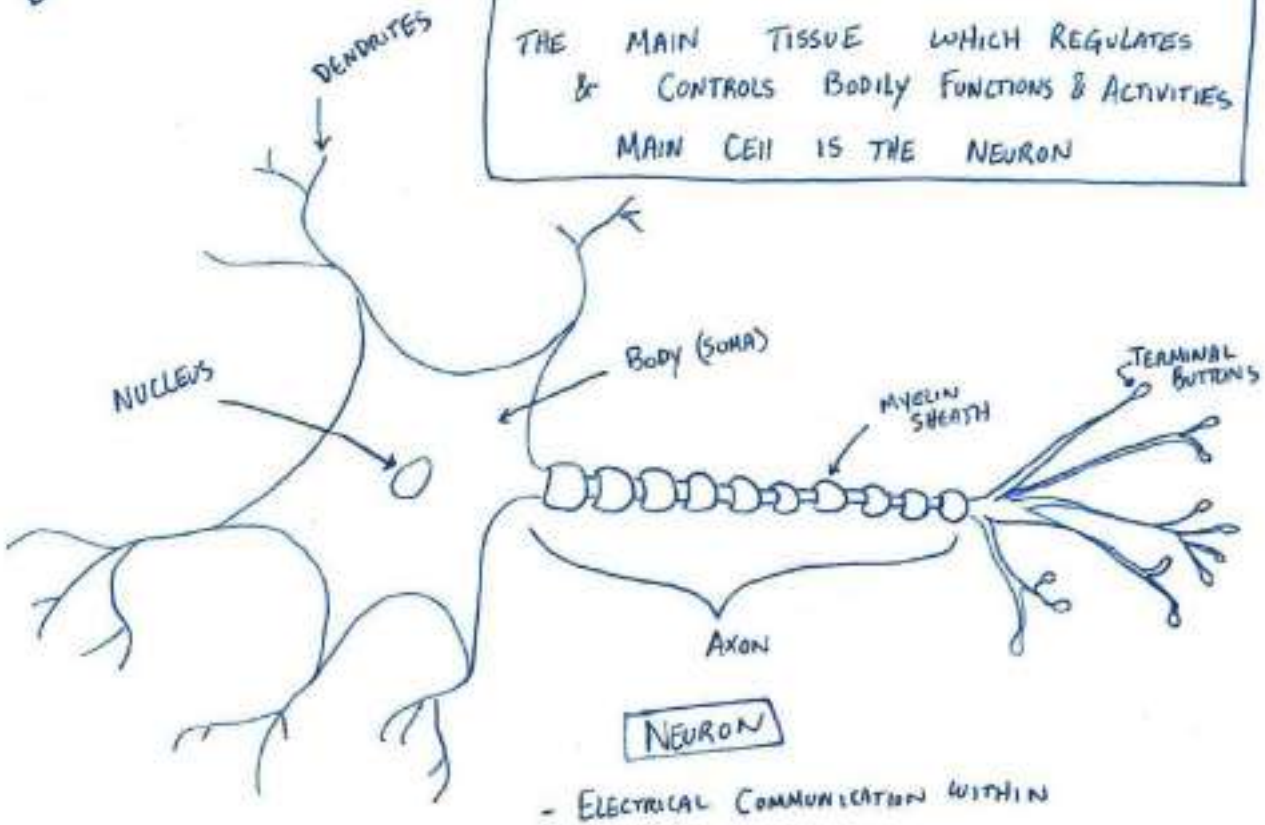
Central Nervous — Brain & Spinal (CNS)

Peripheral Nervous — Branches off CNS (PNS)

Nervous Tissue

The main tissue which regulates & controls bodily functions & activities

Main cell is the neuron



Neuron

- Electrical communication within
- Chemical communication between

Glial means glue = hold system together

Support Cells

Known as glial cells

- Ependymal - Line spinal cord make cerebral spinal fluid
- Oligodendrocytes - Coat the axon of neurons in the CNS
- Schwann cells - Coat the axon of neurons in the PNS
- Microglial - Serves as an immune worker
- Astrocytes - Link neurons to their blood supply

Mood

The feel good movie of the year

Written by Sarah Tonin

106 J.Grant

Circulatory System

Purpose: To transport materials throughout a multicellular organism.

Main Components of the System

Heart - The pump a muscular organ that's sole purpose is to push the nutrient fluid, blood, around.

Artery - Muscular tube that carries blood away from the heart
- Lots of flex
- High pressure

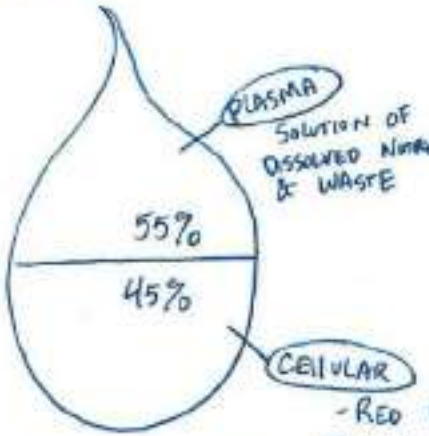
Arteriole - A smaller diameter artery - highly branched connected to capillary beds.

Vein - A tube carrying blood towards the heart contain valves to help move blood

Venule - Smaller diameter vein connected to the capillary beds & veins

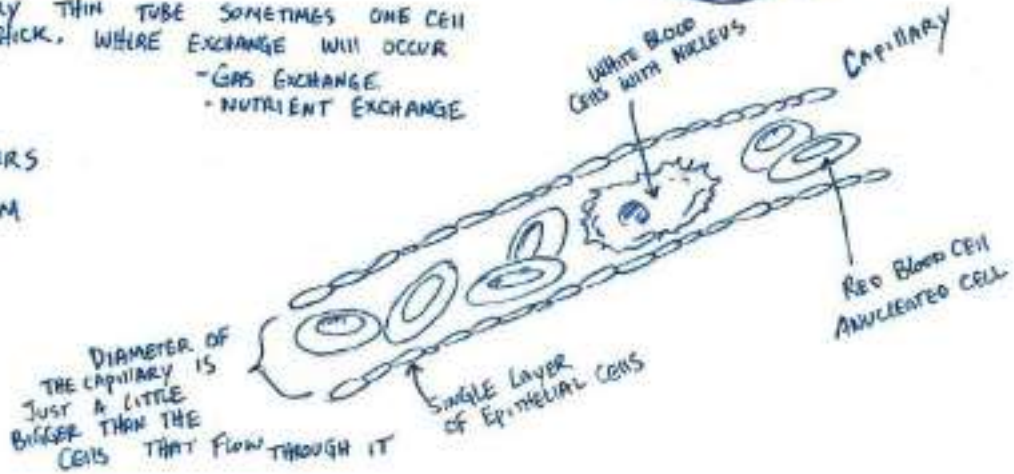
Capillary - Very thin tube sometimes one cell thick. Where exchange will occur
- Gas exchange
- Nutrient exchange

Blood Components



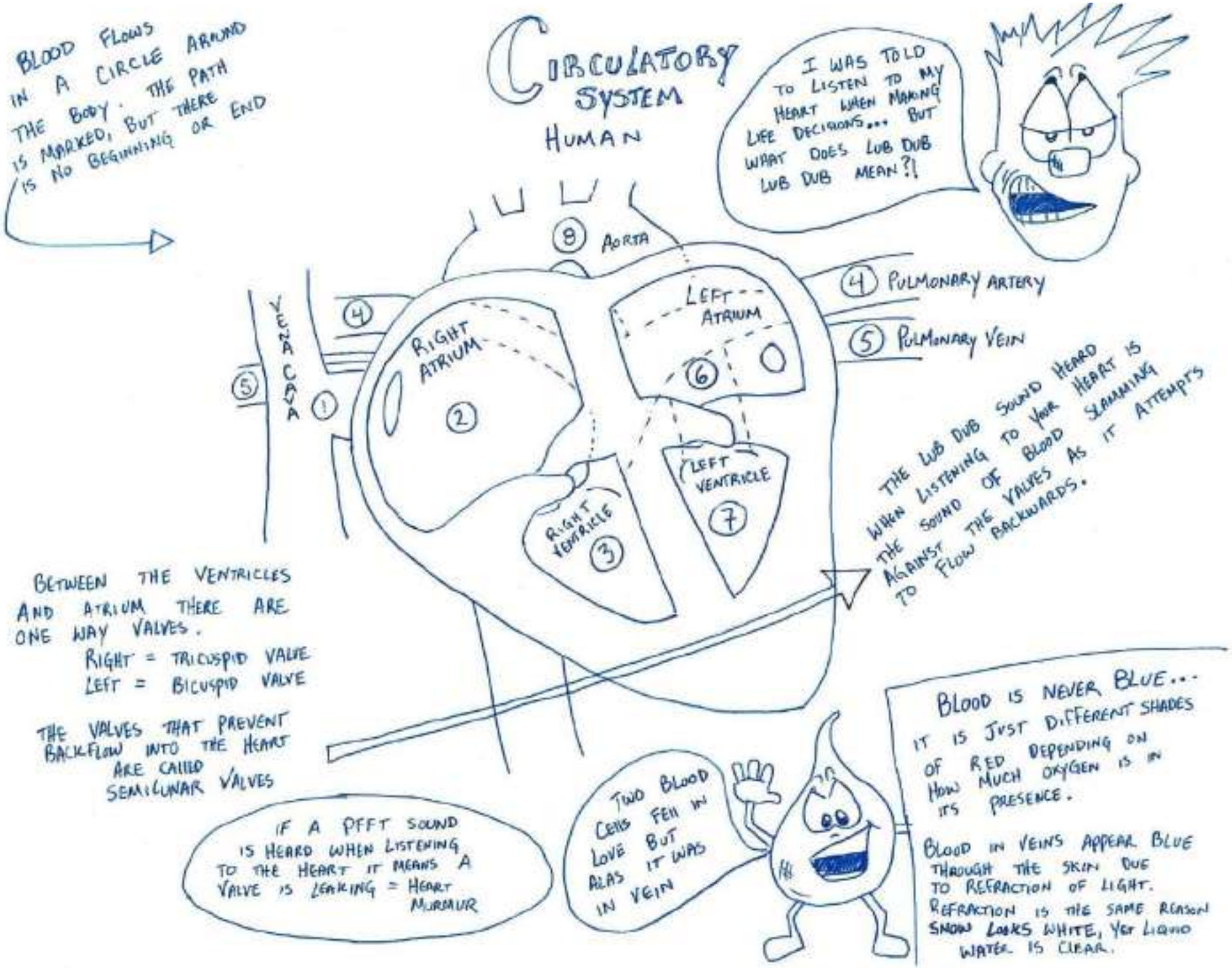
- Red Blood Cells - oxygen carriers

21% {
- White Blood Cells - Immune System
- Platelets - Blood Clotting



Circulatory System

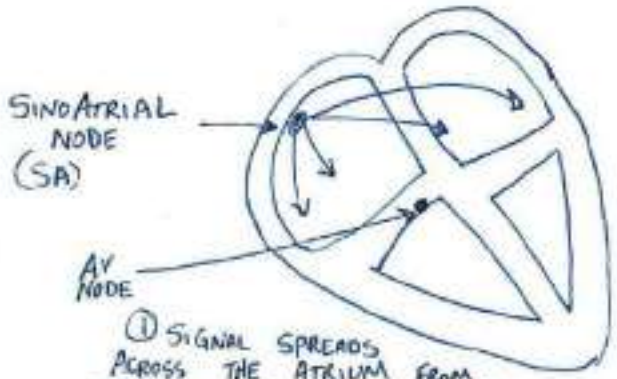
Human



108 J.Grant

Circulatory System

Electrical Control



① Signal spreads across the atrium from the SA node down and across to the AV node

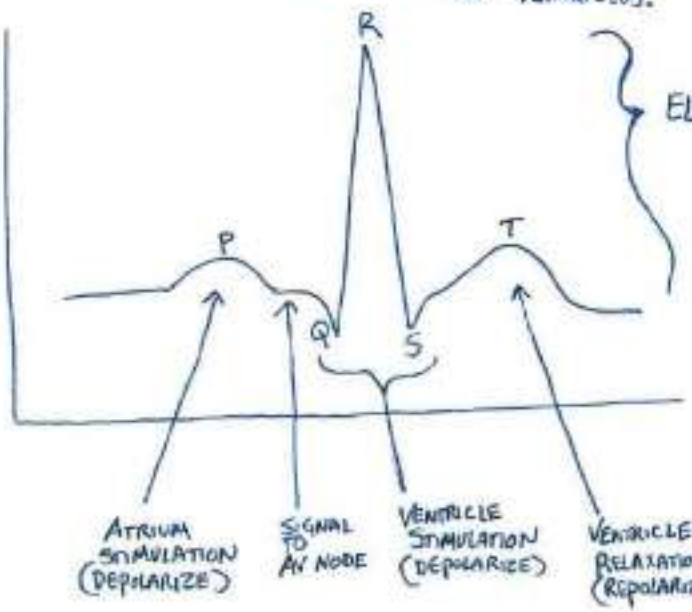
②a. The Atrium Contract (top-down)

b. Signal is pass from the AV node down the septum to the apex of the heart. The signal then spreads up across the ventricles.

③ The atrium relaxes and the ventricles contract (bottom-up)

If your life isn't full of ups & downs ....

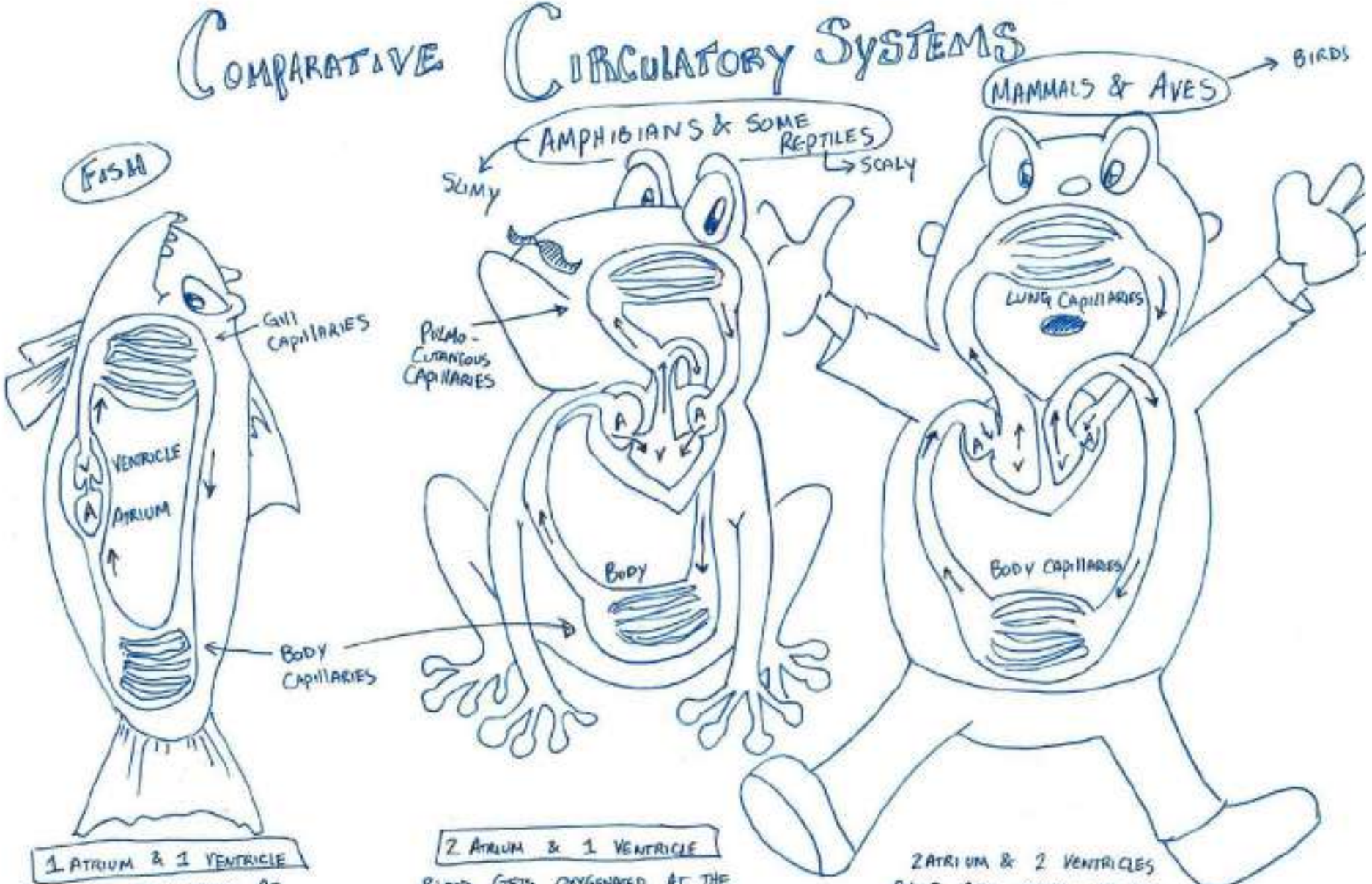
You are probably dead



Where is the Atrium Relaxation on the graph?

Because the ventricle stimulation is so strong and happening at the same time as the Atrium relaxation, it isn't visable.

Comparative Circulatory Systems



1 Atrium & 1 Ventricle

Blood gets oxygenated at the gills then goes straight to the tissues. It gets used & then moves back to the heart

★ The heart always has deoxygenated blood

2 Atrium & 1 Ventricle

Blood gets oxygenated at the lungs (pulmo) and skin (cutaneous)

It then goes to the heart to be pumped out to the body.

★ Oxygenated & deoxygenated blood mix in the ventricle

2 Atrium & 2 Ventricles

Blood gets oxygenated at the lungs. It then returns to the heart to be pumped to the body. Then it returns to the heart again to be pumped to the lungs

★ Oxygenated & deoxygenated blood is separated

DIGESTIVE SYSTEM
PART 1

GOAL
- TURN BIG MOLECULES INTO SMALL MOLECULES AND GET IT TO THE LOCATION THAT NEEDS IT.

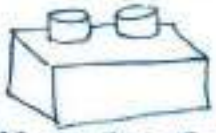
4 MAJOR STEPS [EXTRA CELLULAR]
1. INGEST → GET THE FOOD INTO THE ORGANISM → NOT TRULY INSIDE. MORE IN A CAVITY OR TUBE
2. DIGEST → LARGE MOLECULES INTO SMALL [MECHANICAL & ENZYMATIC]
3. ABSORB → MOVE THE SMALL MOLECULES TO THE INSIDE (BLOOD).
4. ELIMINATE → GET RID OF FOOD THAT CAN'T BE DIGESTED.

INTRACELLULAR
NOM NOM-
SURROUND, ENGULF, AND BREAKDOWN INSIDE THE CELL
EX: AMOEBA, PARAMECIUM, WHITE BLOOD CELL

YOU ARE A FANCY DONUT!

- YOU HAVE 2 OPENING (MOUTH & ANUS) AND A TUBE THAT CONNECTS TO THOSE OPENINGS. (GASTRO INTESTINAL TRACT)

THINK OF ALL LIVING THINGS MADE UP OF LEGOS. THEY MAY HAVE DIFFERENT OVERALL SHAPES BUT THEY



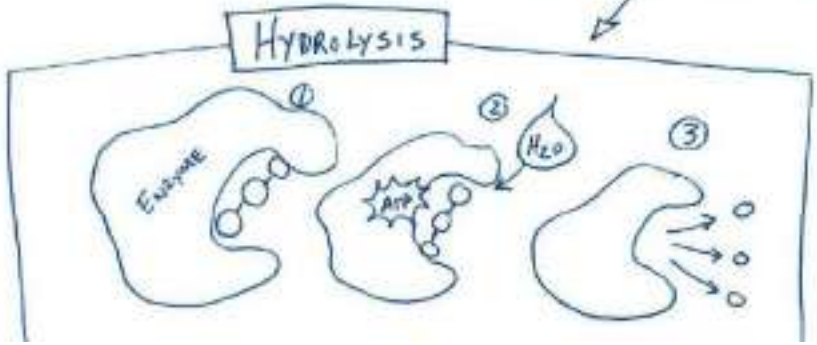
ARE ALL MADE OF THE SAME AVAILABLE PIECES (MONOMERS)
DIGESTION JUST BREAKS APART BIG STRUCTURES INTO THEIR INDIVIDUAL PARTS. THEN YOU ASSEMBLE THOSE PARTS INTO YOU. THE DIRECTIONS = DNA.
- SO YOU TRULY ARE WHAT YOU EAT!

EVERY MORNING START YOUR DAY WITH A BOWL OF SEXY BEAST.

SURFACE AREA

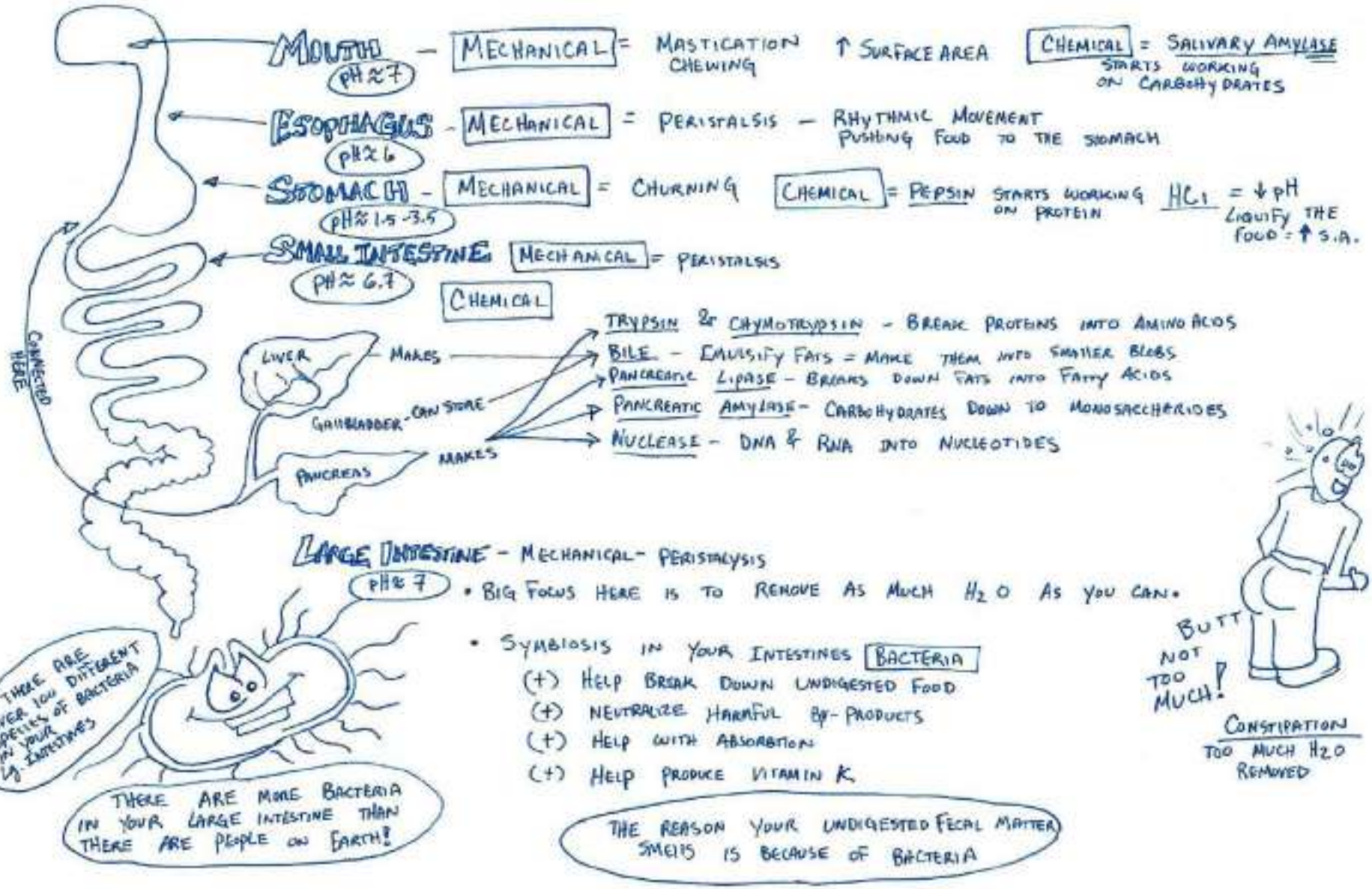
MECHANICAL - USING MUSCLES AND BONE, MANIPULATE THE FOOD INTO A BETTER CONSISTANCY.

ENZYMATIC - USING ENZYMES, TURN POLYMERS INTO MONOMERS.



DIGESTIVE SYSTEM PART 2

WORKS BASED ON COMPARTMENTILIZATION



DIGESTIVE SYSTEM

PART 3

WHY IS COMPARTMENTILIZATION SO IMPORTANT?
- ENZYME FUNCTION

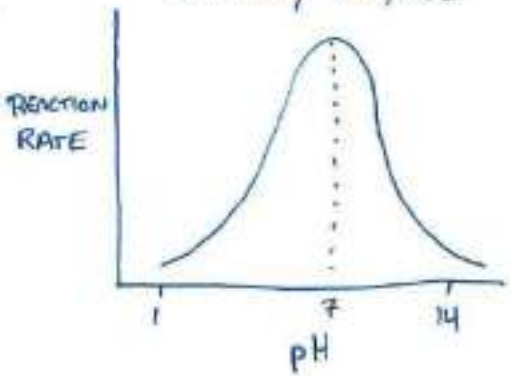
YOU WILL SEE SIMILAR OPTIMAL CURVES FOR TEMPERATURE & SALINITY

EACH SECTION OF THE SYSTEM HAS ITS OWN ROLE THUS OWN ENVIRONMENT IT MUST MAINTAINED

HOMEOSTASIS

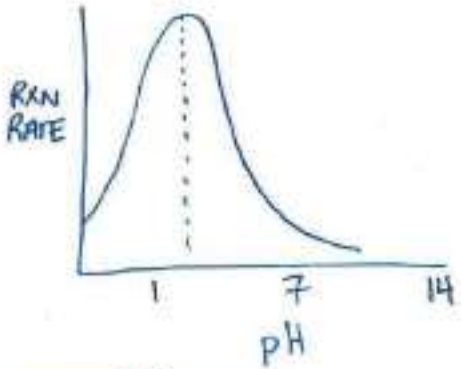
MOUTH

SALIVARY AMYLASE



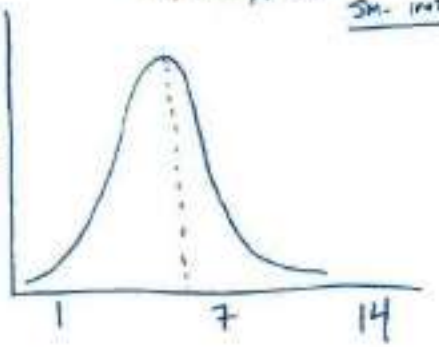
STOMACH

PEPSIN



SM. INTESTINE

CHYMOTRYPSIN



SALIVARY AMYLASE MADE IN THE SALIVARY GLANDS (MOUTH) → DENATURED

PEPSIN (MADE IN THE STOMACH) → DENATURED

CHYMOTRYPSIN (MADE IN THE PANCREAS, DUMPED INTO THE SM. INTESTINE) →

HAPPY ENZYME

* PERFECT TEMPERATURE
PERFECT pH
PERFECT SALINITY

3-D SHAPE THAT ALLOWS FOR MAXIMUM EFFICIENCY ON ITS SUBSTRATE

UNHAPPY ENZYME

DENATURED

- CANNOT WORK ON ITS SUBSTRATE
- MIGHT BE ABLE TO BE RENATURED IF CONDITIONS IMPROVE.

DIGESTIVE SYSTEM PART 4

COMPARATIVE

DENTITION

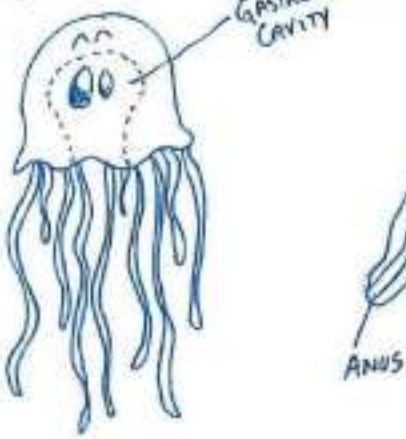
VARIETY OF TEETH EVIDENCE OF DIET.

HERBIVORES = MOSTLY MOLARS

CARNIVORES = SABER TEETH

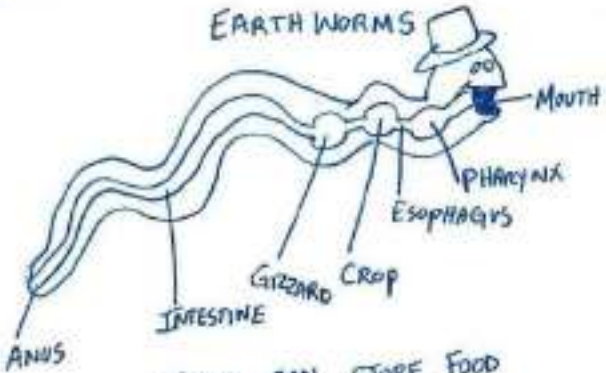
OMNIVORES = MIXTURE → LIKE HUMANS, CHIMPS, APES

JELLIES



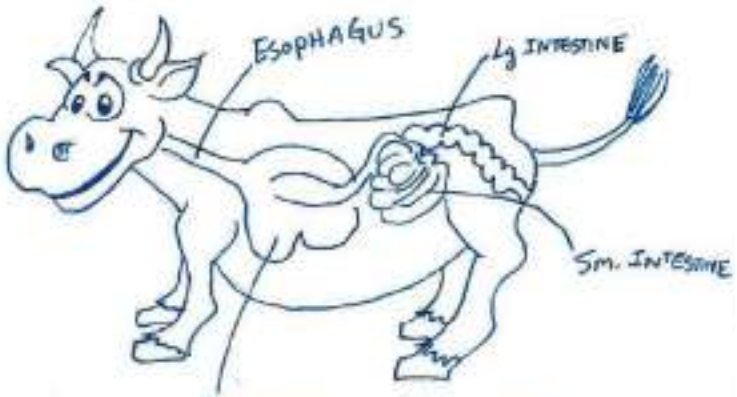
- THEY ONLY HAVE ONE HOLE TO THEIR DIGESTIVE SYSTEM.
- BRING FOOD INTO MOUTH/ANUS
- SECRETE DIGESTIVE ENZYMES INTO THE GASTROVASCULAR CAVITY
- WHATEVER DOESN'T GET BROKEN DOWN & ABSORBED IS PUSHED BACK OUT THE MOUTH/ANUS

EARTH WORMS



- CROP CAN STORE FOOD
- GIZZARD STORES STONES THAT CAN GRIND THE SOIL ↑ SURFACE AREA
- INTESTINE SECRETES ENZYMES & ABSORBS NUTRIENTS

COWS



RUMINANT STOMACH — ADAPTATION

HOUSE SYMBIOTIC BACTERIA, PROTOZOA, AND FUNGI

ALL HERBIVORES HAVE SOME SORT OF CHAMBER THAT HOUSES THESE MICROORGANISMS. THESE ORGANISMS CAN BREAK B GLYCOSIDIC LINKAGES OF CELLULOSE ⇒ ALLOWING THE HERBIVORE TO ACCESS THE ENERGY

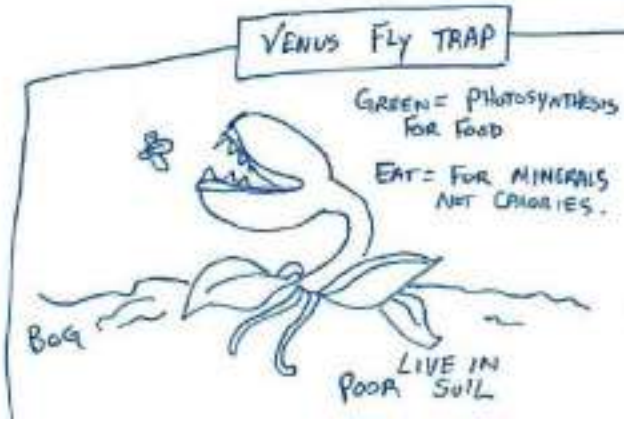
ALLIGATOR

BULK FEEDER

- DON'T CHEW THEIR FOOD
- TEETH ARE TO SUBDUE & KILL
- DIGESTIVE ADAPTATIONS TO DIGEST BIG CHUNKS OF MEAT

- LOTS OF ACID IN STOMACH
- BIG STOMACH
- CAN DIVERT MORE BLOOD TO DIGESTIVE SYSTEM

VENUS FLY TRAP



GREEN = PHOTOSYNTHESIS FOR FOOD

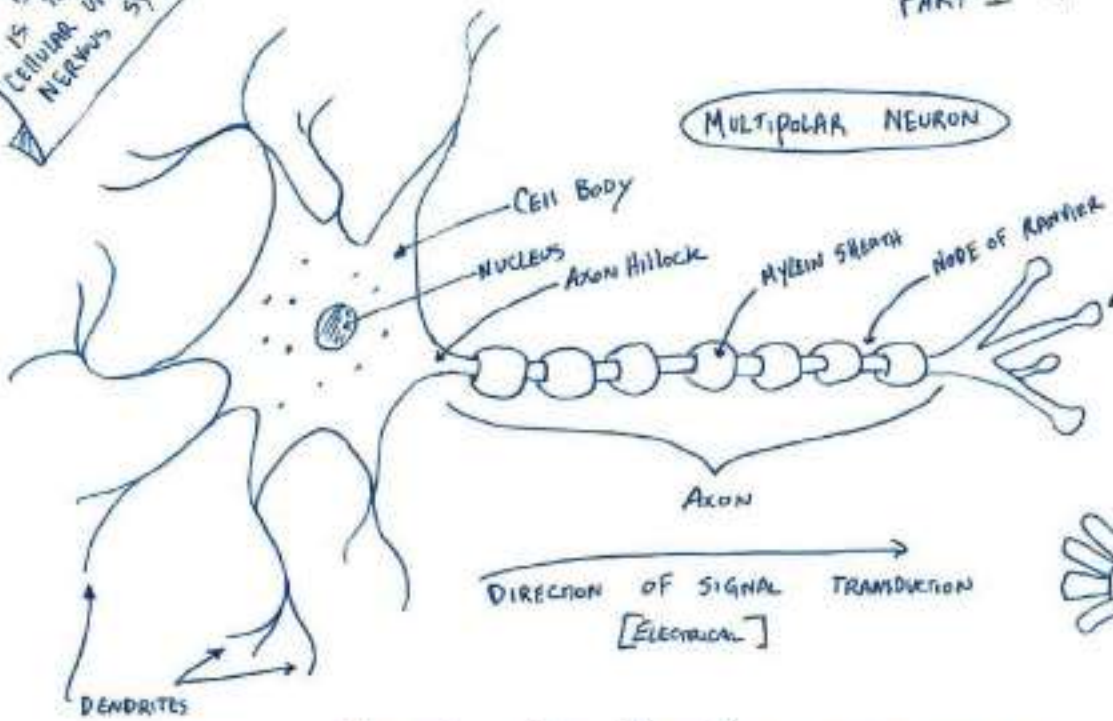
EAT = FOR MINERALS NOT CALORIES.

LIVE IN POOR SOIL

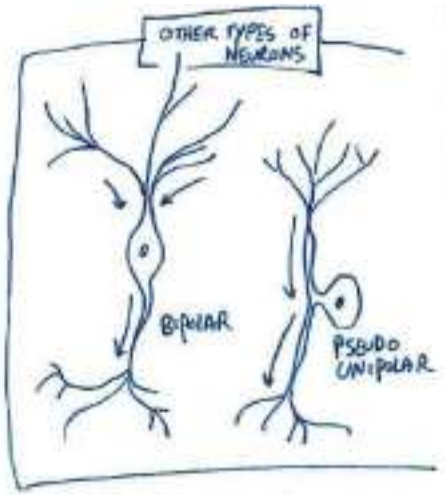
NERVOUS SYSTEM
PART 1

NEURON THE BASIC IS CELLULAR UNIT OF THE NERVOUS SYSTEM

MULTIPOLAR NEURON



DIRECTION OF SIGNAL TRANSDUCTION
[ELECTRICAL]



NEURONS CAN "TALK" TO
- OTHER NEURONS
- MUSCLES
- GLANDS
- AND VARIOUS OTHER TISSUES

THE NEURON PASSES ITS SIGNAL WITHIN ITSELF BY MOVEMENT OF IONS = ELECTRICAL

ONE DIRECTION

DENDRITE → CELL BODY → AXON HILLOCK → AXON → TERMINAL BUTTON

★ SOMETIMES IT CAN START WITH THE CELL BODY IF ANOTHER NEURON CONNECTS THERE INSTEAD OF THE DENDRITE

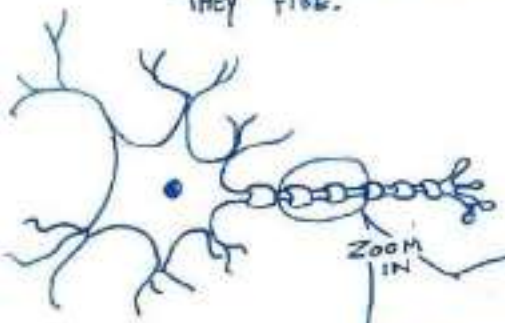
ONE NEURON TALKS TO ANOTHER NEURON (OR OTHER CELL) THROUGH CHEMICAL MEANS

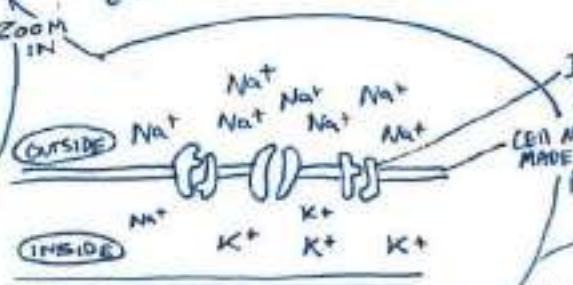
GENERALLY NEUROTRANSMITTERS ARE RELEASED INTO THE GAP JUNCTION BETWEEN NEURONS CAUSING AN EFFECT.

NEURONS

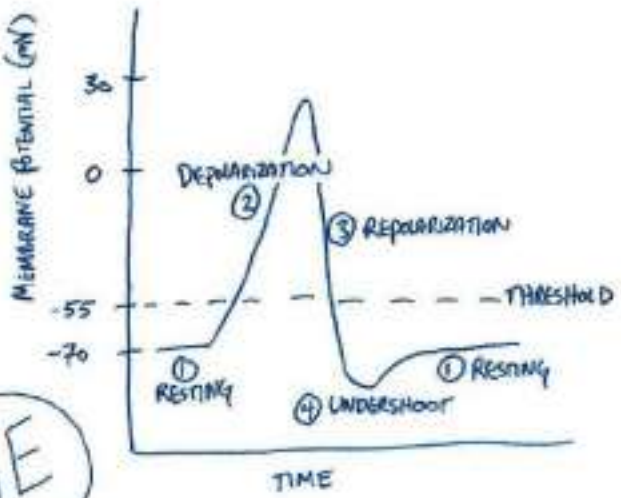
THE DIFFERENCE IN PERCEPTION OF A SIGNAL IS BASED ON HOW MANY NEURONS PARTICIPATE & HOW FREQUENTLY THEY FIRE.

THE ELECTRICAL SIGNAL



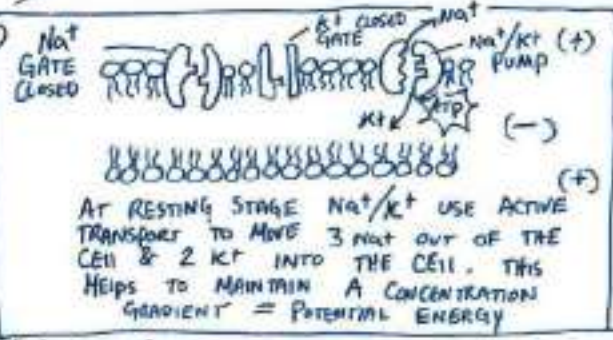


AT REST THE NEURON IS MORE (−) INSIDE COMPARED TO OUTSIDE



ALL OR NONE

IT REACHES THE THRESHOLD AND FIRE OR IT DOESN'T



AT RESTING STAGE Na^+/K^+ USE ACTIVE TRANSPORT TO MOVE 3 Na^+ OUT OF THE CELL & 2 K^+ INTO THE CELL. THIS HELPS TO MAINTAIN A CONCENTRATION GRADIENT = POTENTIAL ENERGY

SALTATORY CONDUCTION

SECTION ① WILL DEPOLARIZE SECTION ② ENOUGH TO GET THE SECTION TO REACH THE THRESHOLD TO OPEN & THAT WILL CAUSE IT TO FIRE

VERY QUICK

IT ONLY GOES ONE WAY BECAUSE THE PREVIOUS SECTION IS IN UNDERSHOOT & CANNOT REACH THE THRESHOLD

Na^+ GATES CLOSE & THE K^+ GATES OPEN CAUSING THE INSIDE TO BECOME MORE (−) AGAIN.

SOMETHING STIMULATES THE CELL TO DEPOLARIZE ENOUGH TO REACH THE THRESHOLD & THE Na^+ GATES OPEN. Na^+ STREAMS IN VIA FACILITATED DIFFUSION CAUSING THE INSIDE TO GET (+).

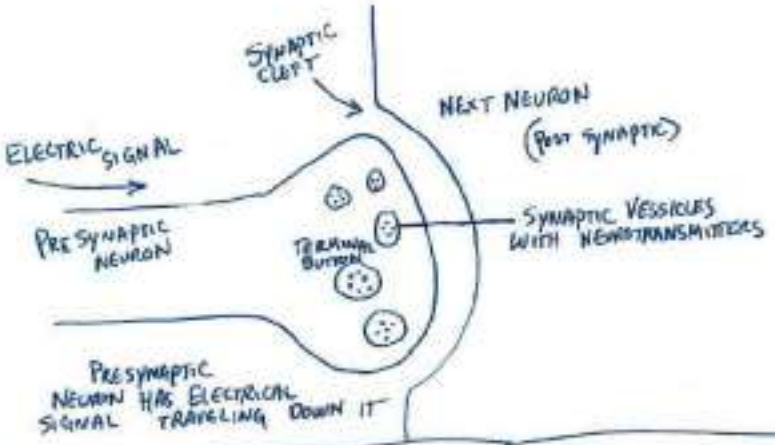
UNDERSHOOT ④

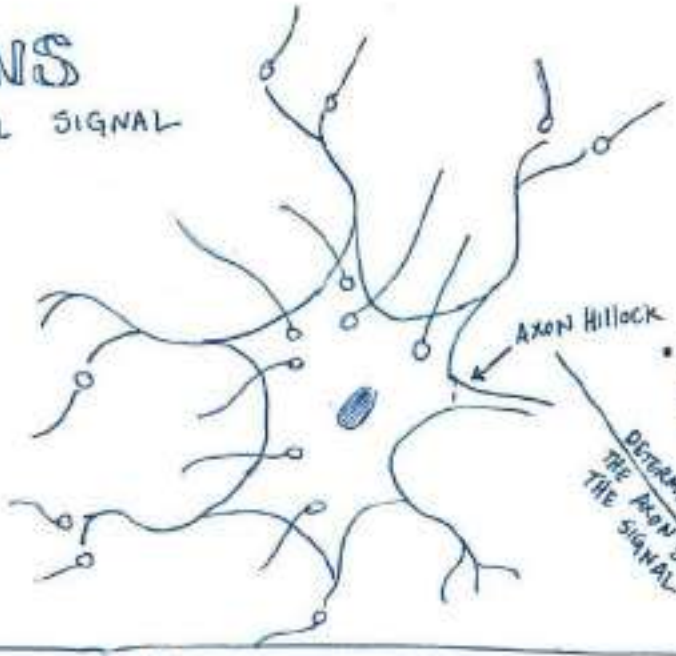
THE K^+ PUMPS STAY OPEN LONGER & THE CELL BECOMES HYPERPOLARIZED (EVEN MORE NEGATIVE THAN ITS NORMAL RESTING −70mV.) THIS PREVENTS THE NEURON FROM BACKFIRING & KEEPS THE SIGNAL MOVING IN ONE DIRECTION.

CELL BODY → TERMINAL BUTTON

NEURONS

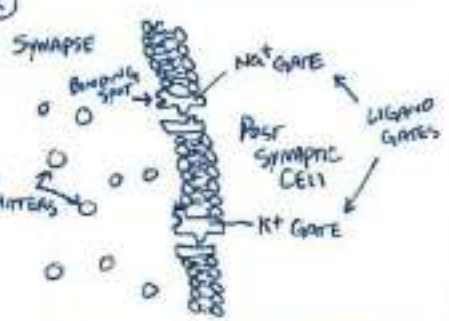
THE CHEMICAL SIGNAL





- IS A CONNECTION FROM ANOTHER NEURON
- NEURONS CAN CONNECT TERMINAL BUTTON TO DENDRITE OR TO THE CELL BODY

① THE ELECTRICAL SIGNAL GOES TO THE TERMINAL BUTTON & CAUSES EXOCYTOSIS OF THE NEUROTRANSMITTER INTO THE SYNAPTIC CLEFT

② 

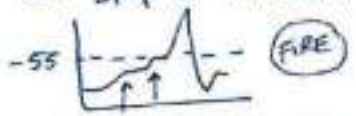
THE NEUROTRANSMITTER WILL BIND TO A LIGAND GATE & LET Na^+ IN OR K^+ IN.

③ THE NEURON DOES NOT FIRE UNLESS THE THRESHOLD IS MET.

BASED ON HOW FREQUENTLY & WHAT KIND OF SIGNAL IS BEING SENT TO THE NEURON THE AXON HILLOCK DETERMINES IF IT WILL FIRE

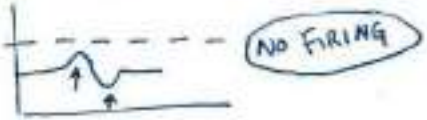
Ex: EPSP BUT NOT FREQUENT

Ex: EPSP & FREQUENT



★ THIS COULD BE MULTIPLE NEURONS CONNECTING AND THEY ARE ALL EPSP

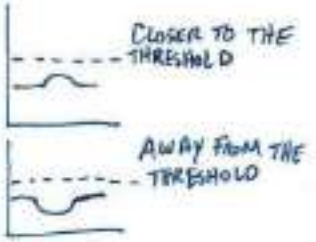
Ex: IPSP & EPSP COUNTERACT EACH OTHER.



SUMMATION
THE ADDED EFFECT OF EPSP & IPSP

EPSP = EXCITATORY POST SYNAPTIC POTENTIAL
IPSP = INHIBITORY POST SYNAPTIC POTENTIAL

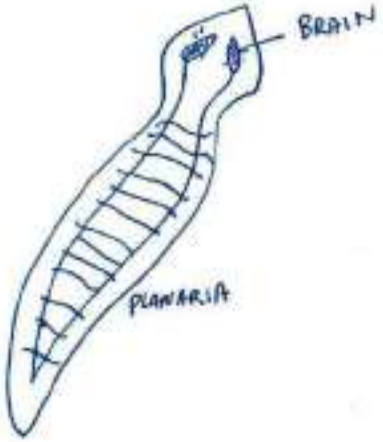
- IF THE NEUROTRANSMITTER CAUSES A Na^+ GATE TO OPEN IT IS CALLED AN EPSP.
- IF THE NEUROTRANSMITTER CAUSES A K^+ GATE TO OPEN IT IS CALLED AN IPSP



NERVOUS SYSTEMS
COMPARATIVE

CNIDARIA (JELLIES)

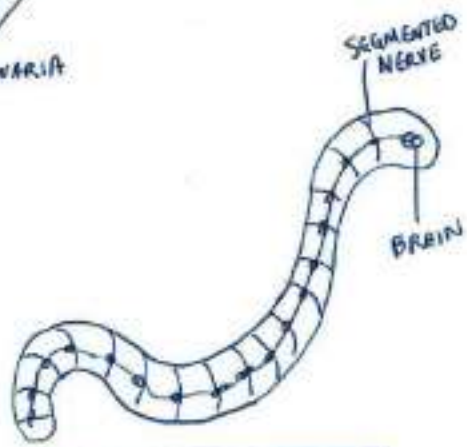
HAVE A VERY BASIC NERVE NET. THIS NETWORK ALLOWS THEM TO SENSE & RESPOND TO THEIR ENVIRONMENT



PLATY HELMINTHES (FLAT WORMS)

- HAVE TWO "BRAINS" WHERE EYESPOTS ARE FOUND. THESE EYESPOTS DETECT LIGHT AND THE INFORMATION CAN BE SENT DOWN THE LENGTH OF THE WORM AND ACROSS IN A COORDINATED FASHION

BRAINS COME IN ALL SHAPES AND SIZES - SOMETIMES A BRAIN IS JUST A CLUSTER OF NEURONS THAT INTERACT, OFTEN CALLED A GANGLION.

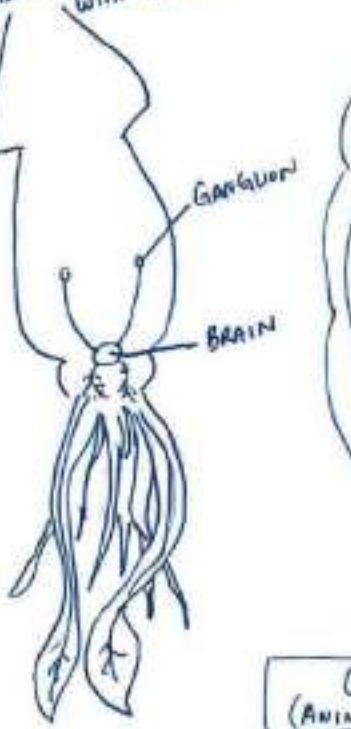


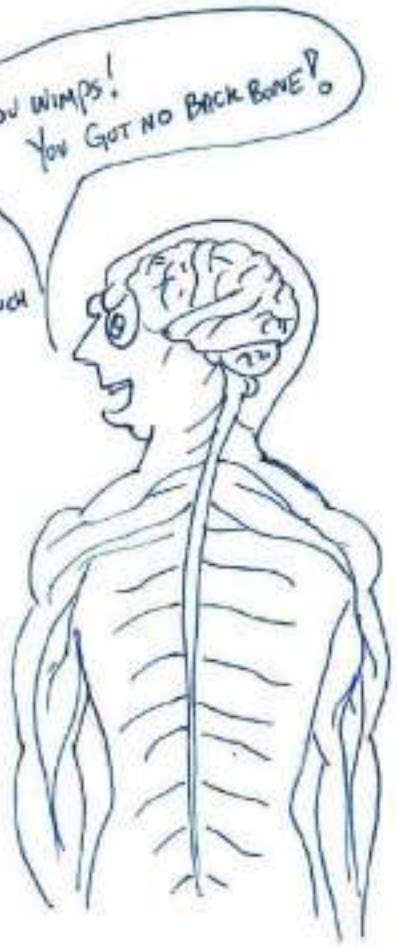
ANNELIDA (ROUND SEGMENTED WORMS)

HAVE A BRAIN THAT CONNECTS TO A VENTRAL NERVE CORD. THE CORD IS CONNECTED TO NERVES ASSOCIATED WITH EACH SEGMENT. THEY OFTEN HAVE ORGANS FOR SENSING LIGHT, CHEMICALS, TOUCH, & EQUILIBRIUM

MOLLUSCA (SOFT BODIES WITH SHELLS)

- OFTEN HAVE A WIDE VARIETY OF GANGLIA FOR PROCESSING VISUAL, TASTE, MOVEMENT, AND TOUCH INFORMATION - MANY MORE CONNECTIONS FOR COMPLEX MOVEMENT & COMMUNICATION WITH OTHERS





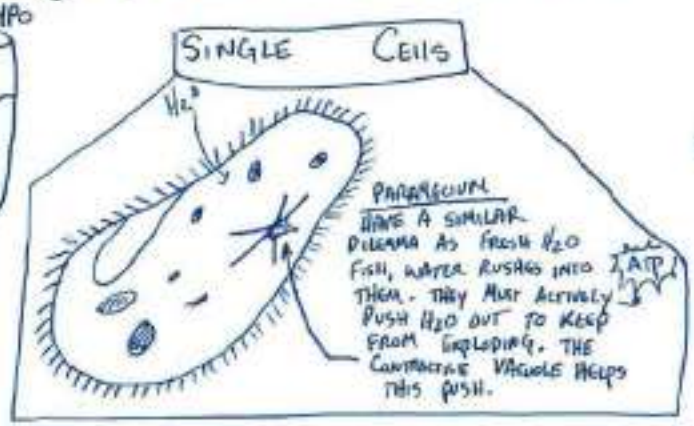
CHORDATA (ANIMALS WITH A NOTOCORD) — VERTEBRATES MAJOR GROUP

HAVE A BRAIN AND DORSAL NERVE CORD THAT IS CONNECTED TO AN EXTENSIVE PERIPHERAL NERVOUS SYSTEM. ABILITY TO SENSE LIGHT, TOUCH, CHEMICAL, EQUILIBRIUM AND OTHER CHANGES IN THE ENVIRONMENT.

Water Balance

All organisms require H_2O for life. Systems. If you live in H_2O this isn't as big of an issue. If you live on land it is a bigger problem.

Single Cells



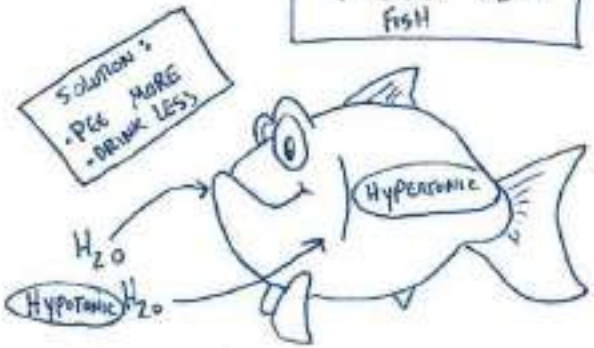
Osmosis

Diffusion of H_2O across a membrane.

Passive

★ Remember: from hypotonic to hypertonic.

Fresh H_2O Fish



The amount of ions in the water is less than in the fish flesh. This means H_2O moves into the fish due to osmosis.

Salt H_2O Fish

• The amount of ions outside the fish is greater than inside. This means water is lost easily

Gills are a common area for the H_2O exchange

Osmoconformers

• Tissue content matches their environment

• If the salinity of the H_2O environment changes their tissue changes as well.

WATER BALANCE

THE NEPHRON

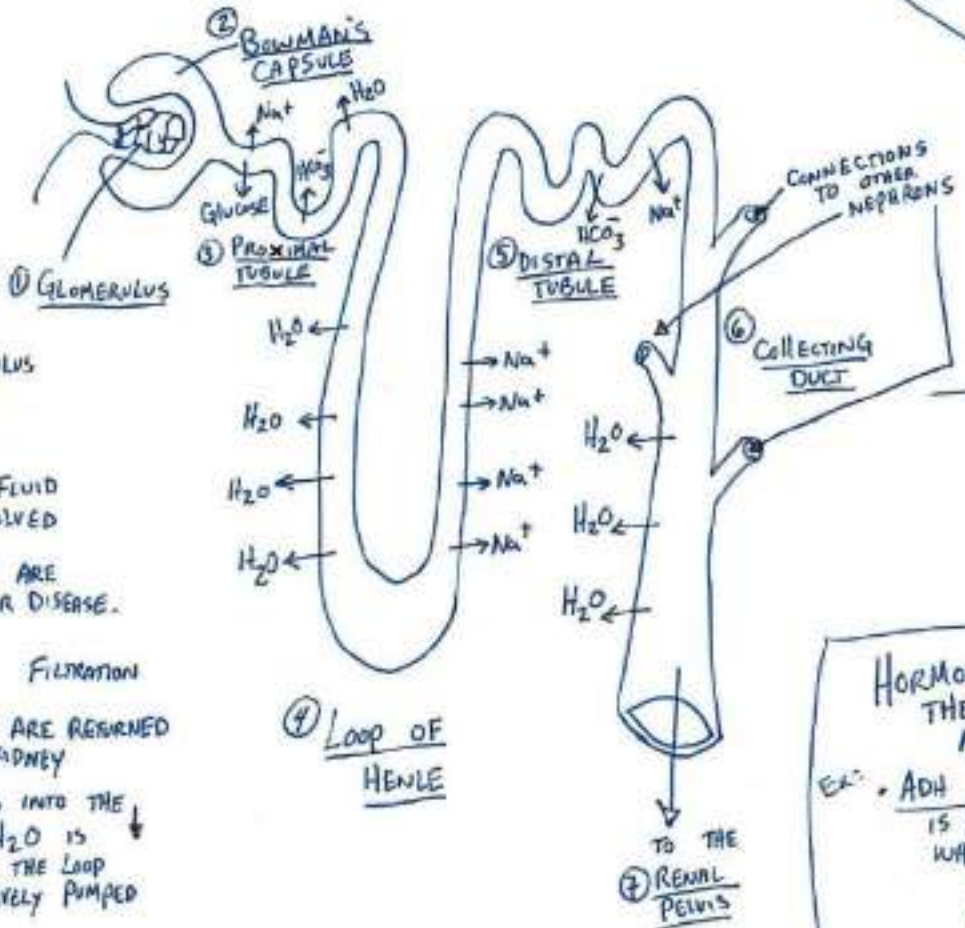
THE FUNCTIONAL UNIT OF THE KIDNEY

WHY FILTER?

- IT SEEMS LIKE ALL WE DO IS PULL THINGS OUT OF THE FLUID. WHAT STAYS IN THE URINE? NITROGENOUS WASTE AND EXCESS. THE EXCESS CAN BE Na^+, K^+, HCO_3^-, ETC.

NITROGENOUS WASTE

- BY PRODUCTS OF METABOLIC BREAK DOWN OF PROTEINS & NUCLEIC ACIDS
  - AMMONIA – VERY TOXIC AQUATIC ANIMALS ONLY
  - URIC ACID – LESS TOXIC
  - UREA – LOW TOXICITY



CORTEX
"LESS SALTY"

MEDULLA
"MORE SALTY"

① BLOOD COMES IN FROM AN ARTERY TO THE GLOMERULUS BLOOD PRESSURE FORCES THE FLUID INTO THE...

② BOWMAN'S CAPSULE. THIS FLUID IS MOSTLY WATER & DISSOLVED IONS.
- ★ CELLS IN THIS FLUID ARE SIGNS OF TRAUMA OR DISEASE.

③ THE FLUID GETS ITS FIRST FILTRATION AT THE PROXIMAL TUBULE. Na^+, H_2O, GLUCOSE, HCO_3^- ARE RETURNED TO THE TISSUE OF THE KIDNEY

④ THE LOOP OF HENLE DIVES INTO THE KIDNEY (SALTIER TISSUE) & H_2O IS ↓ REMOVED VIA OSMOSIS. AS THE LOOP ↑ GOES BACK UP Na^+ IS ACTIVELY PUMPED OUT.

⑤ THE DISTAL TUBULE REMOVES ANY LAST IONS THAT MAY BE NEEDED.

⑥ THE COLLECTING DUCT PULLS THE LAST H_2O OUT THAT MAY BE NEEDED. THIS REMAINING FLUID IS SENT OUT.

HORMONES CAN HELP THE NEPHRON REABSORB MORE H_2O.

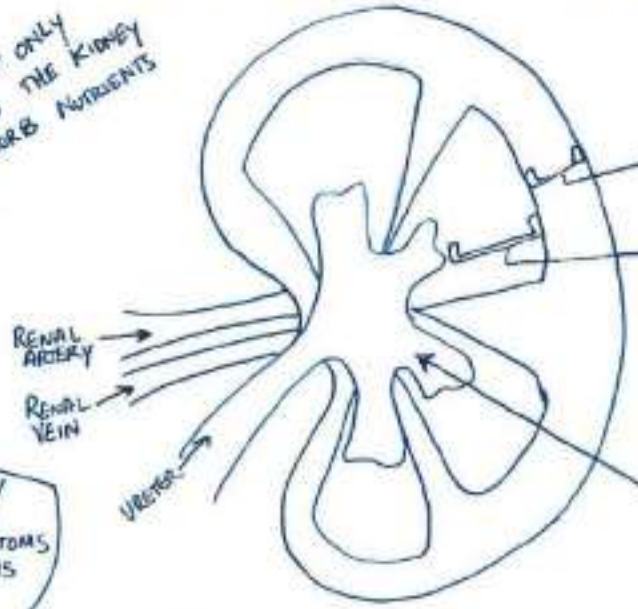
EX. • ADH (ANTIDIURETIC HORMONE)
IS RELEASED BY THE BRAIN WHEN BLOOD OSMOLARITY IS ABOVE 300 mOsm/L. ADH TARGETS THE COLLECTING DUCT, MAKING IT REABSORB MORE H_2O BACK INTO THE TISSUES OF THE KIDNEY

WATER BALANCE

IF YOU ARE A TERRESTRIAL ORGANISM YOU MUST CONSERVE THE WATER YOU GET.

THE KIDNEY IS THE ORGAN OF WATER BALANCE
THIS IS DONE BY FILTERING THE BLOOD

CAPILLARY BEDS ARE USED TO NOT ONLY GET THE FLUID INTO THE KIDNEY BUT ALSO TO REABSORB NUTRIENTS



KIDNEY STONES

- CRYSTALS OF SOME TYPE OF COMPOUND. EXAMPLES
  - CALCIUM STONES
    CAN FORM FROM DIET OR METABOLIC DISORDERS
  - URIC ACID STONES
    UREA CRYSTALS FORM FROM TOO LITTLE H_2O OR TOO MUCH PROTEIN
  - STRUVITE STONES
    DUE TO AN INFECTION

BLOOD COMES INTO THE KIDNEY WITH DISSOLVED NUTRIENTS & WASTE THROUGH THE RENAL ARTERY. THE KIDNEY FILTERS THIS LIQUID KEEPING THE NUTRIENTS & IONS IT NEEDS TO MAINTAIN OSMOTIC BALANCE (HOMEOSTASIS). EXTRA IONS AND WASTE (NITROGENOUS) IS EXPELLED TO THE RENAL PELVIS → URETER → URINARY BLADDER → URETHRA.

DRINK PLENTY OF H_2O!

TOO MUCH WATER IS A BAD THING AS WELL!

KIDNEY COMPARATIVE

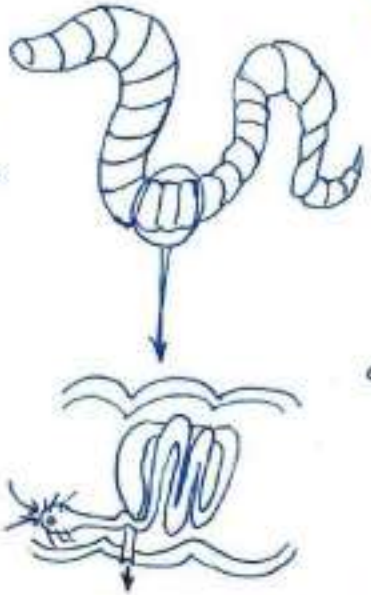
KANGAROO RATS GET ALL THEIR LIQUID H_2O FROM FOOD } VERY EFFICIENT KIDNEYS

PLATYHELMINTHES
FLATWORMS

PROTONEPHRIDIA

BODY FLUID IS PUSHED THROUGH THE BULB END, THE CILIA RECAPTURES NUTRIENTS BEFORE WASTE IS PUSHED OUT

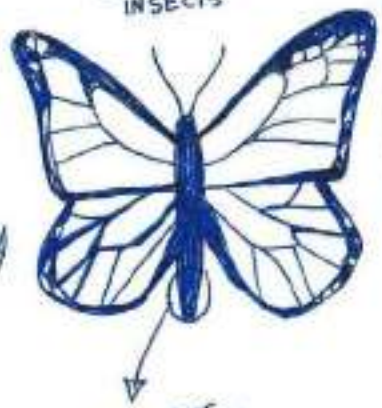
ANNELIDA
EARTHWORM



MESANEPHRIDIA

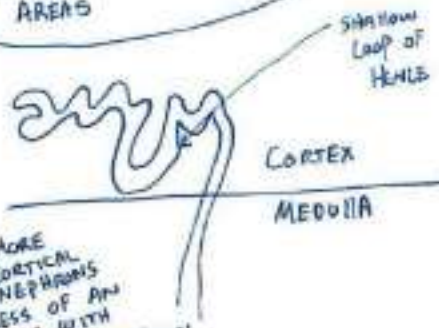
FLUID IS PUSHED INTO THE MESANEPHRIDIA & IMPORTANT NUTRIENTS ARE REABSORBED BEFORE WASTE IS PUSHED OUT OF THE BODY.

ARTHROPODA
INSECTS



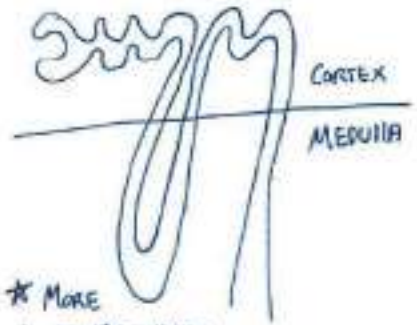
MALPIGHIAN TUBULES ARE EXTENSIONS OF THE DIGESTIVE TRACT THAT EXCESS SALT, H_2O, AND WASTE CAN BE EXPELLED INTO

MAMMALS IN WET AREAS



* MORE CORTICAL NEPHRONS LESS OF AN ISSUE WITH H_2O REABSORBTION

MAMMALS IN DRY AREAS



* MORE JUXTA MEDULLARY NEPHRONS. LOOP OF HENLE GOES DEEP INTO MEDULLA FOR MAXIMUM H_2O REABSORBTION

IMMUNITY

DEFENSE AGAINST THINGS THAT ARE "NOT YOU".

MOST MULTICELLULAR ORGANISMS HAVE SEVERAL LINES OF DEFENSE

NON-SPECIFIC DEFENSE

IT DOESN'T MATTER "WHO" THE INVADER IS THE WAY YOU FIGHT IS THE SAME

1ST LINE OF DEFENSE

- SKIN - A WATER-PROOF LAYER OF CELLS FULL OF COMPETITIVE BACTERIA & ACIDIC pH.
- MUCUS - LIQUID SECRETIONS THAT TRAP POSSIBLE INVADERS NOSE, LUNGS, THROAT.
- TEARS - LIQUID SECRETIONS THAT PREVENT INVASION

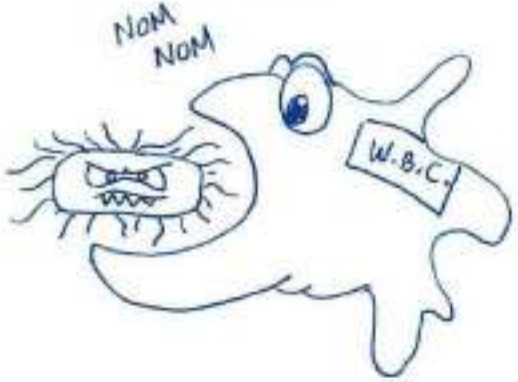
LYSOZYME - ENZYME SECRETION THAT DESTROYS INVADERS

YOU CRY WHEN YOU ARE SAD... YET YOUR TEARS CAN KILL MILLIONS OF BACTERIA & VIRUSES. SO DO BACTERIA CRY BECAUSE YOU CRY?

2ND LINE OF DEFENSE

IF YOUR SKIN (OUTER LAYER) IS BREACHED THEN YOUR WHITE BLOOD CELLS GO TO WORK.

MACROPHAGES WORK TO "EAT" ANYTHING THAT IS FOREIGN



INFLAMMATION

- HISTAMINES ARE RELEASED CAUSING VASODILATION. = MORE BLOOD TO THE AREA OF THE WOUND.

FEVER

TEMPERATURE INCREASE = FEVER

GOOD FOR IMMUNE SYSTEM

- DECREASE MICROBE REPLICATION
- CHANGES FOOD SUPPLY FOR MICROBES

PROLONGED FEVER OR EXTREMELY HIGH FEVER IS BAD

IMMUNITY

CELL COMMUNICATION
SELF VS. NONSELF

BLOOD TYPES CONNECTION

TYPE A ← ANTIGEN

MAKE ANTIBODIES AGAINST B

OTHERWORDS NONSELF (A) CAUSES B BLOOD TO CLUMP

MEMORY

★ WHEN YOUR BODY ACTIVATES HELPER T-CELLS, CYTOTOXIC T-CELLS, & B CELLS THE BODY ALSO MAKES MEMORY CELLS OF EACH OF THEM IN ORDER TO FIGHT THE INVADER FASTER ON SECOND EXPOSURE

FOREIGN INVADER (ANTIGEN)

↓ EATEN BY MACROPHAGE

MACROPHAGE PRESENTING SOME OF THE FOREIGN ANTIGENS

CHEMICAL CALL INTERLUKIN 1

"CALLS" HELPER T-CELLS → NO! IT DOESN'T CALL ON A CELL PHONE

HELPER T-CELL READS THE ANTIGEN & MOUNTS THE SPECIFIC DEFENSE

INTERLUKIN-2 CALLS

INTERLUKIN-2 CALLS

HUMORAL IMMUNITY

MAKE

★ HAVE VARIABLE BINDING SPECIFIC TO THE INVADER ANTIBODIES

B-CELLS
WHITE BLOOD CELLS THAT MATURE IN THE BONE MARROW

CELL MEDIATED

KILLER T CELLS (CYTOTOXIC) MATURES IN THE THYMUS

CYTOTOXIC T CELLS "KILL" BODY CELLS THAT ARE INFECTED OR NOT FUNCTIONING WELL.

SICK BODY CELL

ADULT STEM CELLS BLOOD (RED MARROW)
- RED BLOOD CELLS
- PLATELETS
- WHITE BLOOD CELLS

MACROPHAGES BIG EATERS

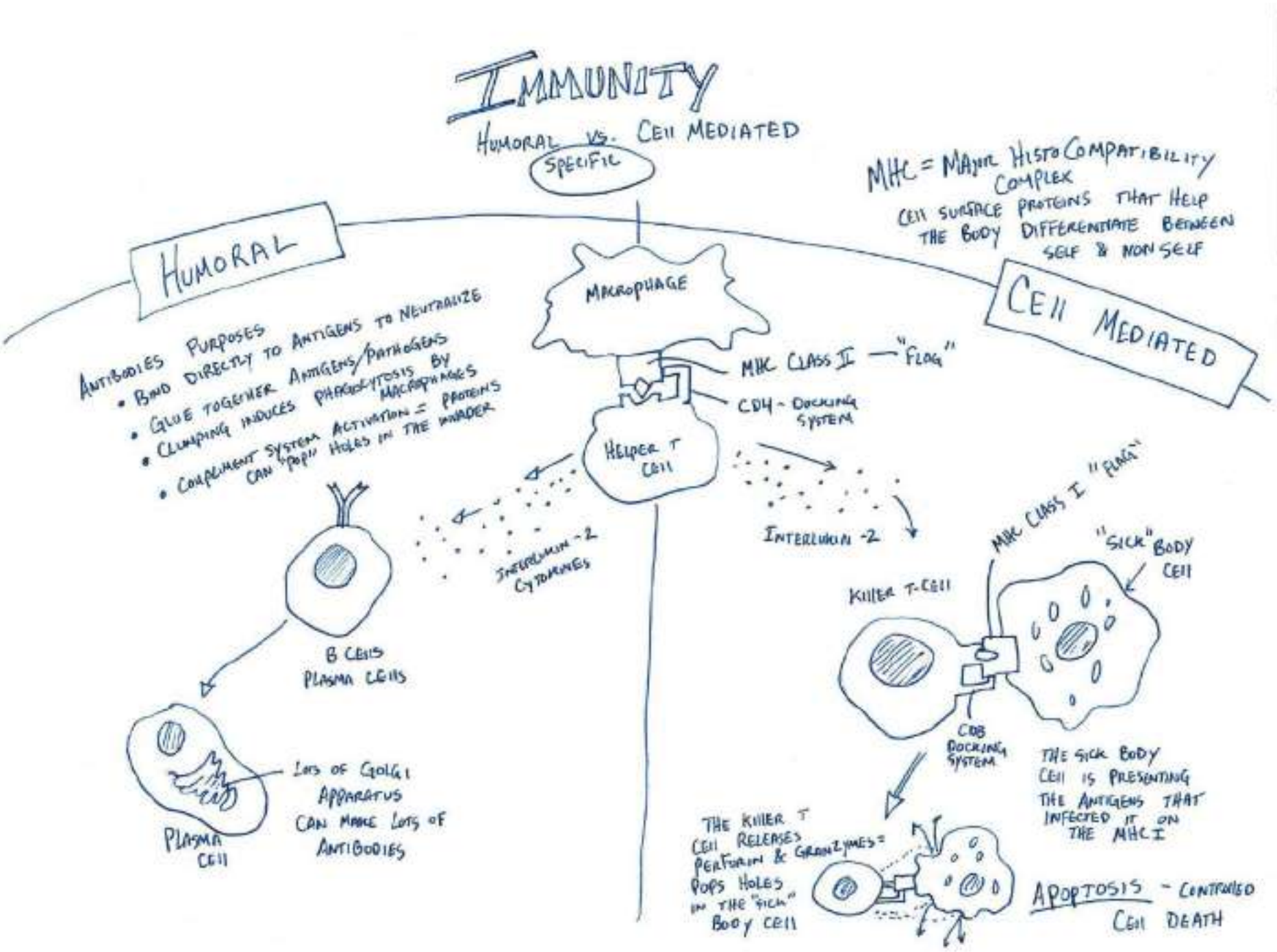
B-CELLS ANTIBODY FACTORIES

T-CELLS

NEUTROPHILS

EOSINOPHILS

124 J.Grant


IMMUNITY
HUMORAL VS. CELL MEDIATED
SPECIFIC
MHC = MAJOR HISTOCOMPATIBILITY COMPLEX
CELL SURFACE PROTEINS THAT HELP THE BODY DIFFERENTIATE BETWEEN SELF & NON SELF
HUMORAL
CELL MEDIATED
ANTIBODIES PURPOSES
• BIND DIRECTLY TO ANTIGENS TO NEUTRALIZE
• GLUE TOGETHER ANTIGENS/PATHOGENS
• CLUMPING INDUCES PHAGOCYTOSIS BY MACROPHAGES
• COMPLEMENT SYSTEM ACTIVATION = PROTEINS CAN "POP" HOLES IN THE INVADER
MACROPHAGE
MHC CLASS II — "FLAG"
CD4 - DOCKING SYSTEM
HELPER T CELL
INTERLEUKIN-2 CYTOKINES
INTERLEUKIN -2
MHC CLASS I "FLAG"
"SICK" BODY CELL
KILLER T-CELL
B CELLS
PLASMA CELLS
LOTS OF GOLGI APPARATUS CAN MAKE LOTS OF ANTIBODIES
PLASMA CELL
CD8 DOCKING SYSTEM
THE SICK BODY CELL IS PRESENTING THE ANTIGENS THAT INFECTED IT ON THE MHC I
THE KILLER T CELL RELEASES PERFORIN & GRANZYMES = POPS HOLES IN THE "SICK" BODY CELL
APOPTOSIS - CONTROLLED CELL DEATH

IMMUNITY

FIRST EXPOSURE VS SECOND EXPOSURE

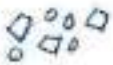
VACCINES

- PRODUCE AN ACTIVE IMMUNE RESPONSE
- BUT YOU DON'T HAVE TO "FIGHT" THE DISEASE. YOU GET THE MEMORY CELLS TO FIGHT THE VIRUS 2ND TIME YOUR SYSTEM SEES IT.

VACCINE COMES FROM THE WORD VACCA = COW

WHAT IS IN A VACCINE?

"DEAD" OR WEAKENED VIRUSES



VIRUS FRAGMENTS

TOXINS FROM A VIRUS OR BACTERIA

ACTIVE IMMUNITY

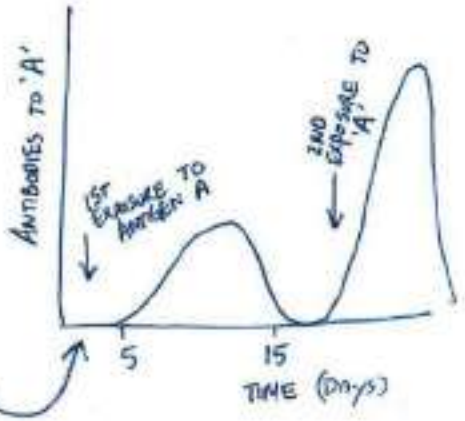
WHEN YOUR BODY FIRST COMES INTO CONTACT WITH A PATHOGEN (CONTAINING ANTIGENS) IT GOES THROUGH THE LONG PROCESS OF MACROPHAGE → HELPER T CELL → B-CELLS → ANTIBODIES

→ KILLER T CELLS

OFTEN TIMES THE PATHOGEN IS ABLE TO SPREAD AND YOU → DEVELOP SYMPTOMS OF THE ILLNESS.

LAG

BUT... DURING THIS 1ST EXPOSURE YOUR BODY DEVELOPS MEMORY CELLS



MEMORY CELLS ALLOW YOU TO MOUNT AN ATTACK FASTER

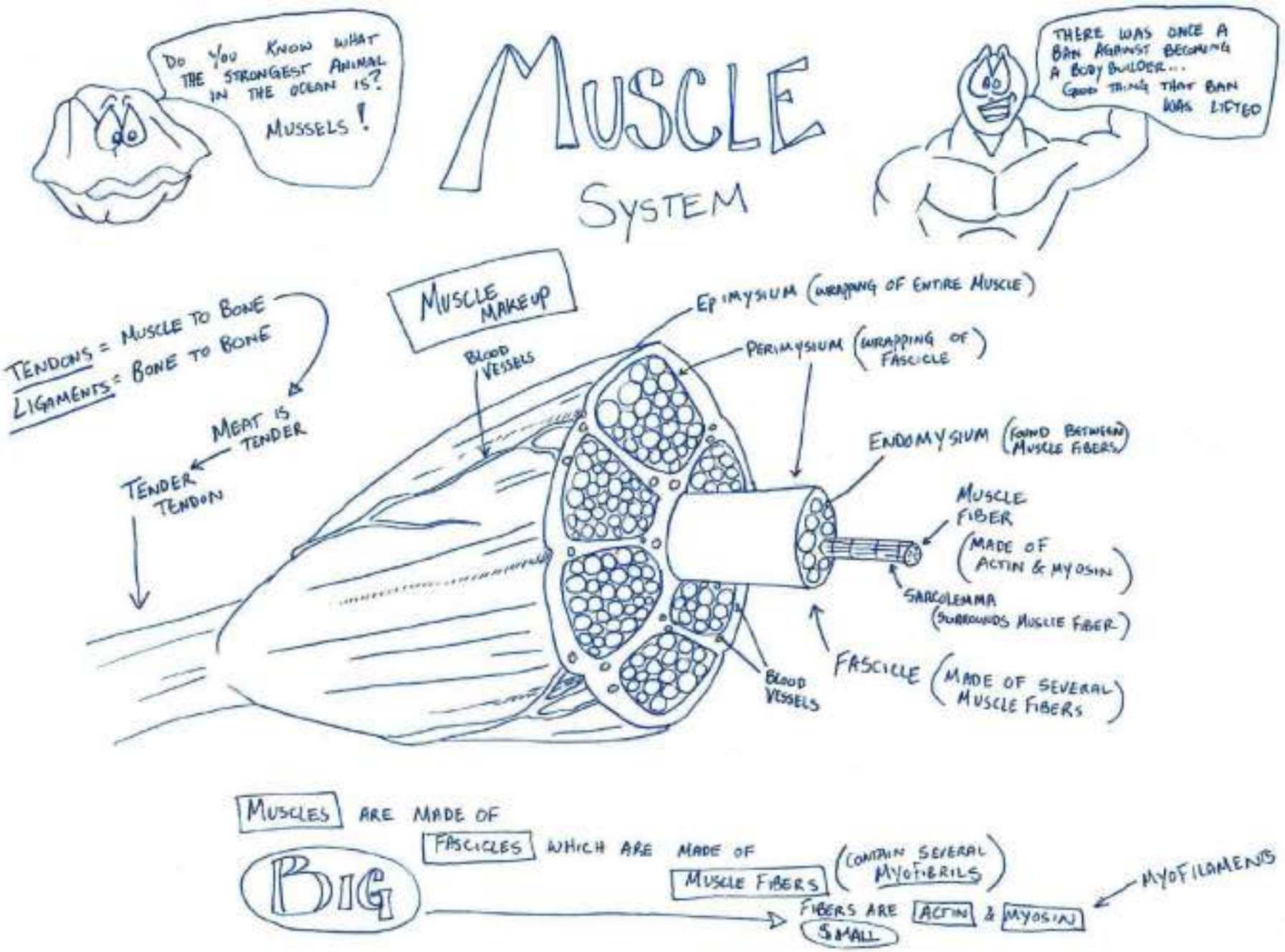
I REMEMBER THIS ONE! GET EM'!

JONAS SALK

DEVELOPED THE POLIO VACCINE & DIDN'T PATENT IT. WANTED TO SAVE LIVES

"THERE IS NO PATENT, COULD YOU PATENT THE SUN?"

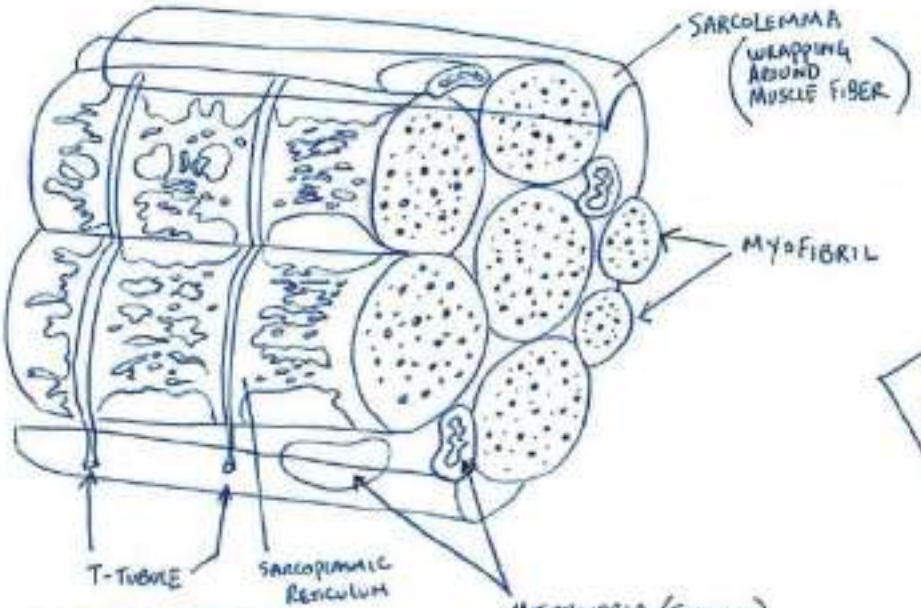
126 J.Grant

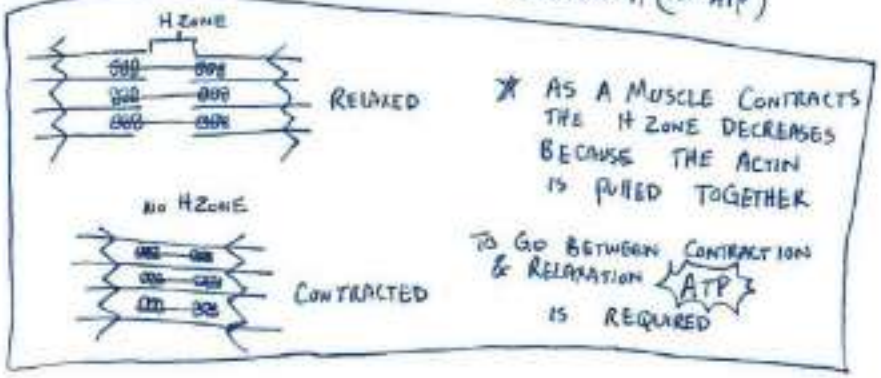

DO YOU KNOW WHAT THE STRONGEST ANIMAL IN THE OCEAN IS?
MUSSELS!
MUSCLE
SYSTEM
THERE WAS ONCE A BAN AGAINST BECOMING A BODY BUILDER... GOOD THING THAT BAN WAS LIFTED
TENDONS = MUSCLE TO BONE
LIGAMENTS = BONE TO BONE
MEAT IS TENDER
TENDER TENDON
MUSCLE MAKEUP
BLOOD VESSELS
EPIMYSIUM (WRAPPING OF ENTIRE MUSCLE)
PERIMYSIUM (WRAPPING OF FASCICLE)
ENDOMYSIUM (FOUND BETWEEN MUSCLE FIBERS)
MUSCLE FIBER
(MADE OF ACTIN & MYOSIN)
SARCOLEMMA (SURROUNDS MUSCLE FIBER)
FASCICLE (MADE OF SEVERAL MUSCLE FIBERS)
BLOOD VESSELS
MUSCLES ARE MADE OF
FASCICLES WHICH ARE MADE OF
MUSCLE FIBERS (CONTAIN SEVERAL MYOFIBRILS)
MYOFILAMENTS
BIG
FIBERS ARE SMALL
ACTIN & MYOSIN

Muscle Fiber

From Muscle Fiber to the Working Unit of Muscle

The Sarcomere



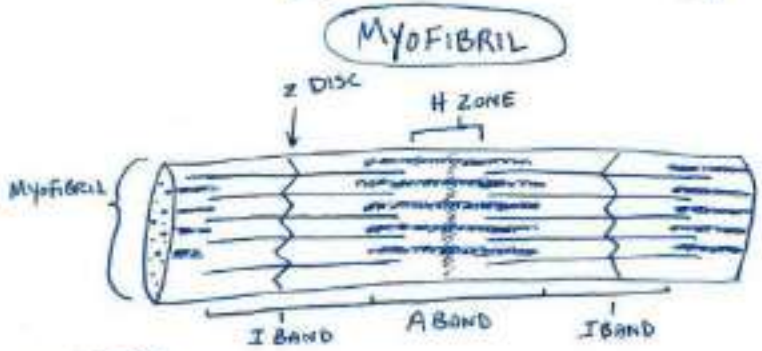


* As a muscle contracts the H zone decreases because the actin is pulled together

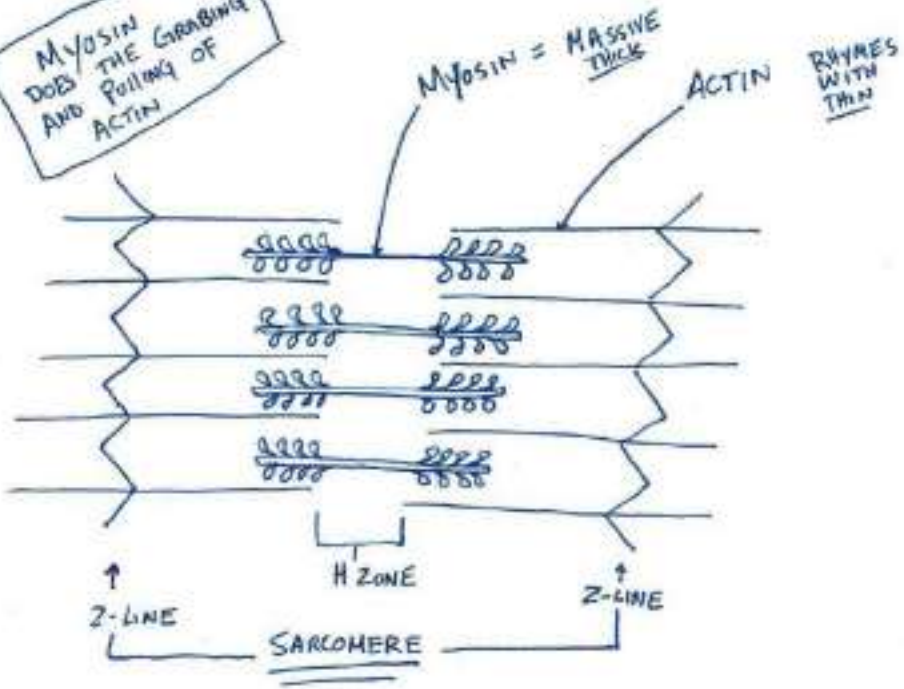
To go between contraction & relaxation ATP is required

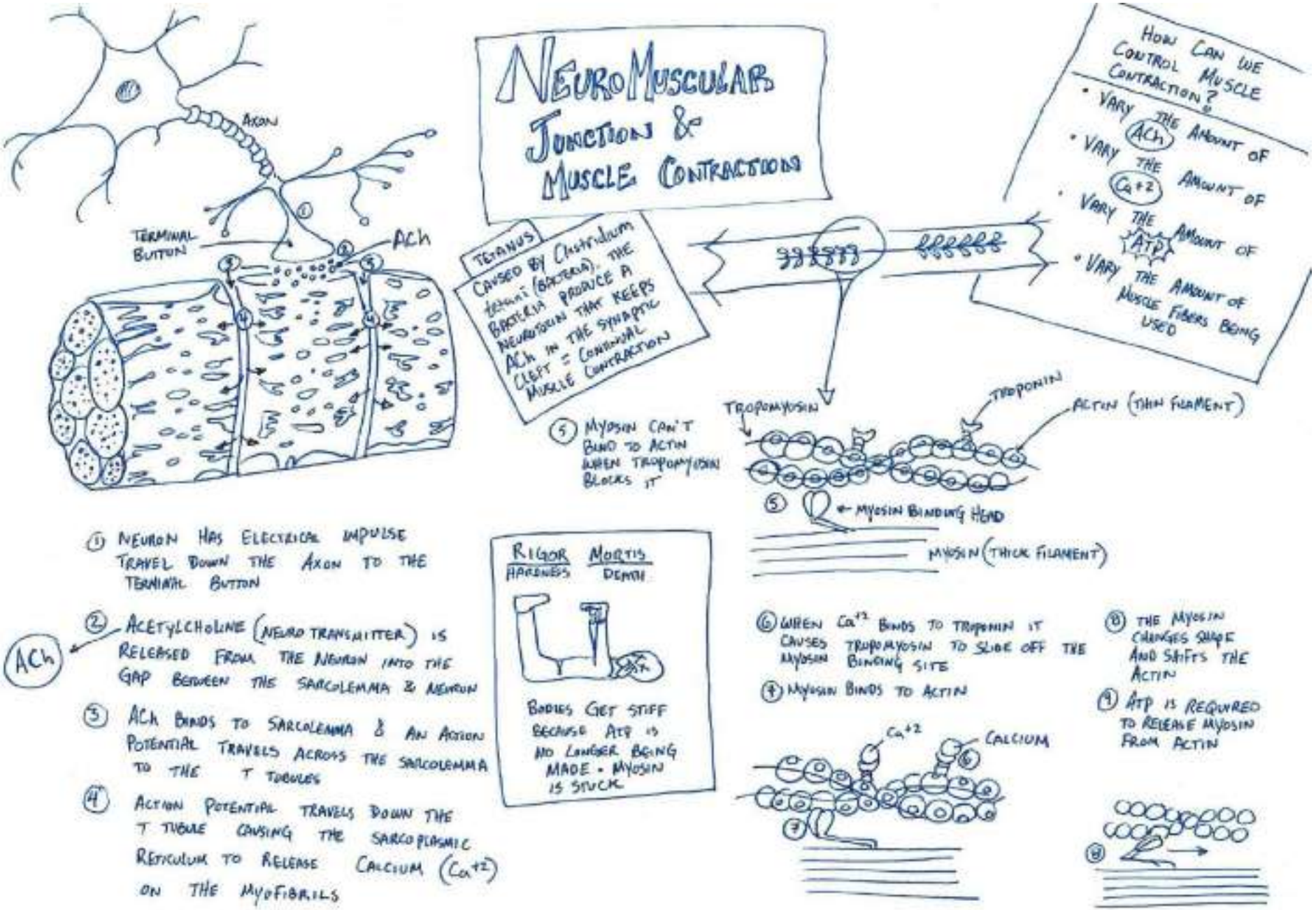
Actin + Myosin

[Sliding Filament Model]



Myosin does the grabbing and pulling of actin




NEUROMUSCULAR JUNCTION & MUSCLE CONTRACTIONS
AXON
TERMINAL BUTTON
ACh
TETANUS
CAUSED BY Clostridium tetani (BACTERIA). THE BACTERIA PRODUCE A NEUROTOXIN THAT KEEPS ACh IN THE SYNAPTIC CLEFT = CONTINUAL MUSCLE CONTRACTION
HOW CAN WE CONTROL MUSCLE CONTRACTION?
• VARY THE AMOUNT OF ACh
• VARY THE AMOUNT OF Ca+2
• VARY THE AMOUNT OF ATP
• VARY THE AMOUNT OF MUSCLE FIBERS BEING USED
(5) MYOSIN CAN'T BIND TO ACTIN WHEN TROPOMYOSIN BLOCKS IT
TROPOMYOSIN
TROPONIN
ACTIN (THIN FILAMENT)
(5) ← MYOSIN BINDING HEAD
MYOSIN (THICK FILAMENT)
(1) NEURON HAS ELECTRICAL IMPULSE TRAVEL DOWN THE AXON TO THE TERMINAL BUTTON
(2) ACETYLCHOLINE (NEUROTRANSMITTER) IS RELEASED FROM THE NEURON INTO THE GAP BETWEEN THE SARCOLEMMA & NEURON
ACh
(3) ACh BINDS TO SARCOLEMMA & AN ACTION POTENTIAL TRAVELS ACROSS THE SARCOLEMMA TO THE T TUBULES
(4) ACTION POTENTIAL TRAVELS DOWN THE T TUBULE CAUSING THE SARCOPLASMIC RETICULUM TO RELEASE CALCIUM (Ca^{+2}) ON THE MYOFIBRILS
RIGOR MORTIS
HARDNESS DEATH
BODIES GET STIFF BECAUSE ATP IS NO LONGER BEING MADE - MYOSIN IS STUCK
(6) WHEN Ca^{+2} BINDS TO TROPONIN IT CAUSES TROPOMYOSIN TO SLIDE OFF THE MYOSIN BINDING SITE
(7) MYOSIN BINDS TO ACTIN
Ca^{+2}
CALCIUM
(8) THE MYOSIN CHANGES SHAPE AND SHIFTS THE ACTIN
(9) ATP IS REQUIRED TO RELEASE MYOSIN FROM ACTIN

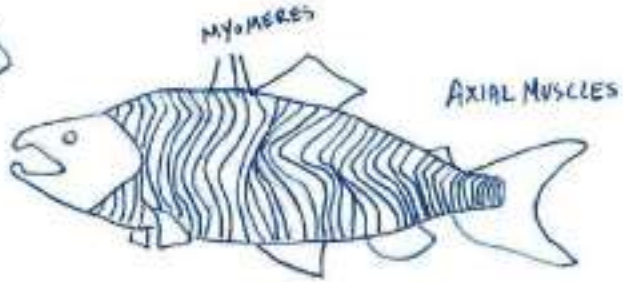
COMPARATIVE MUSCLE

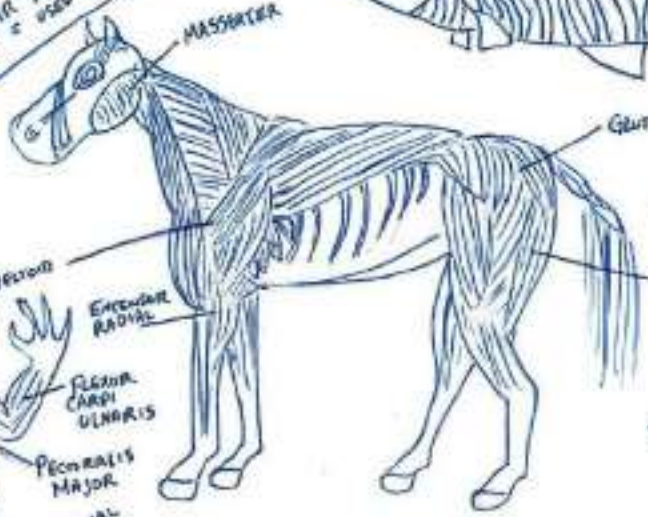
ORIGIN & INSERTION RELATIONSHIP TO FUNCTION

ORIGIN = FIXED ATTACHMENT
INSERTION = MOVES WITH THE ACTION

SIMILAR MUSCLES TO HUMANS BUT DIFFERENT & USED FOR DIFFERENT FUNCTION

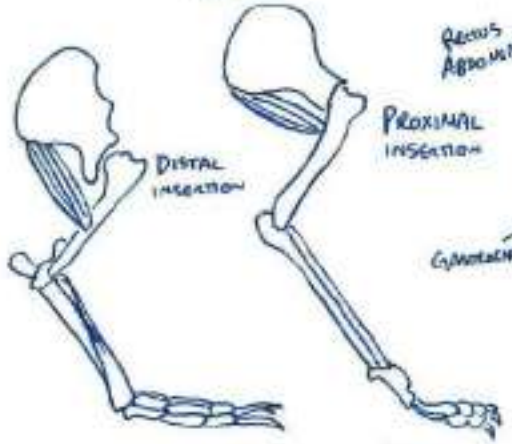
A PROXIMAL INSERTION (I_1) WILL HELP THE ANIMAL WITH SPEED
A DISTAL INSERTION (I_2) WILL HELP THE ANIMAL WITH STRENGTH





AXIAL & APPENDICULAR MUSCLES

* STRIATIONS ON MUSCLES POINT TO THE ORIGIN & THE INSERTION



BADGER CHEETAH

SKELETAL MUSCLE

RED MUSCLE VS WHITE MUSCLE

DARKER MUSCLE TISSUE IS DUE TO THE AMOUNT OF MYOGLOBIN

RED MUSCLE (SLOW TWITCH)

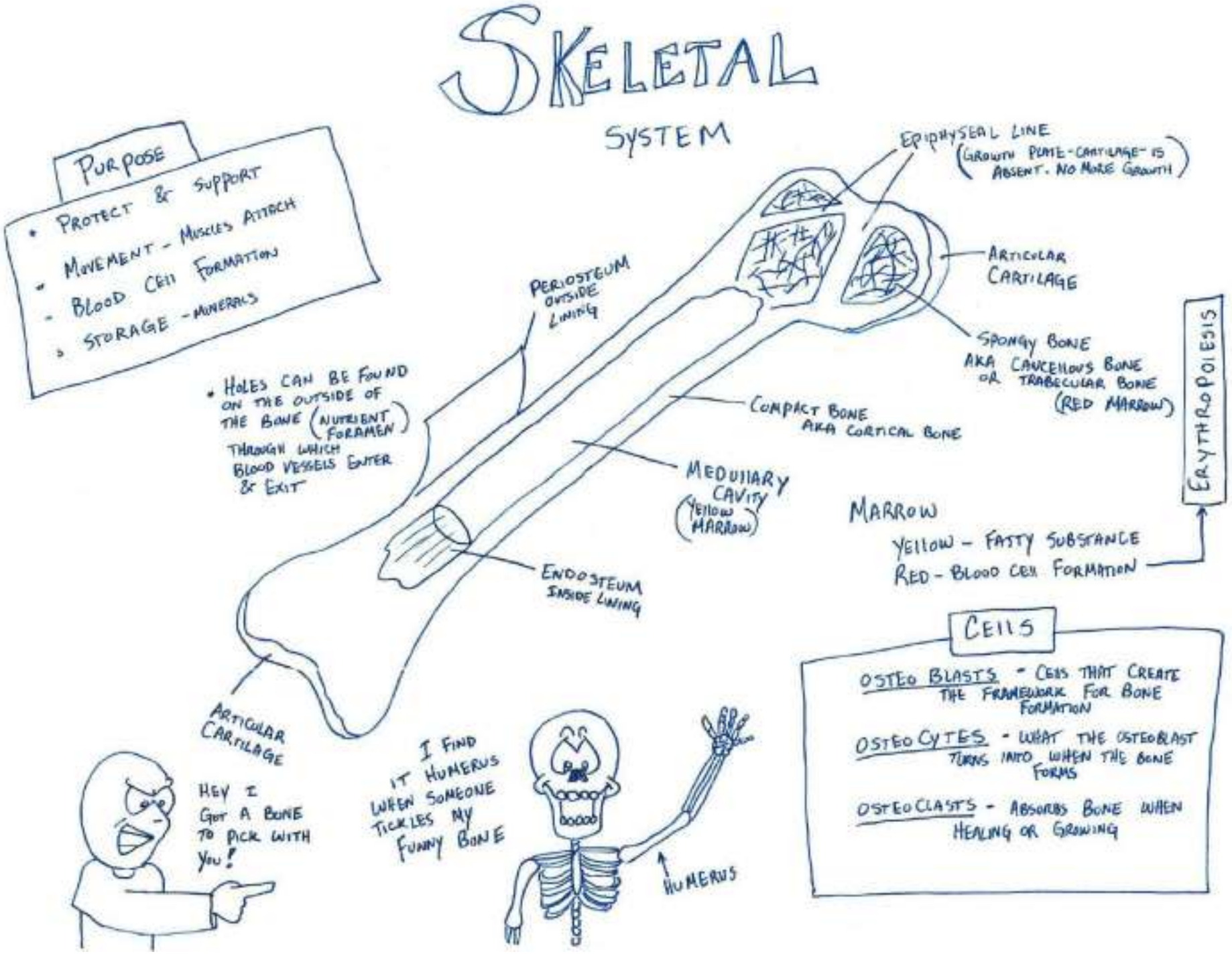
- DENSE WITH BLOOD VESSELS
- RICH IN MITOCHONDRIA
- HIGH LEVELS OF MYOGLOBIN & MAKES IT APPEAR RED OR DARK

* GOOD FOR LONG SUSTAINED ACTIVITY

WHITE MUSCLE (FAST TWITCH)

- THICK MUSCLE FIBERS
- VERY FAST CONTRACTION
- LOTS OF FORCE
- DUE TO LOWER AMOUNTS OF MITOCHONDRIA AND MYOGLOBIN, THE MUSCLE FATIGUES FASTER

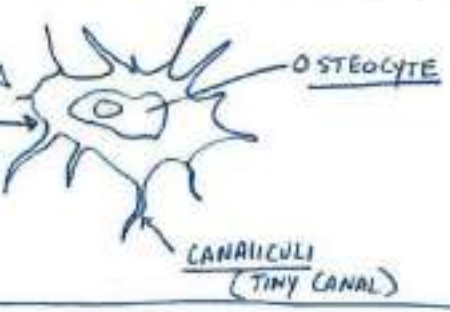
SKELETAL SYSTEM



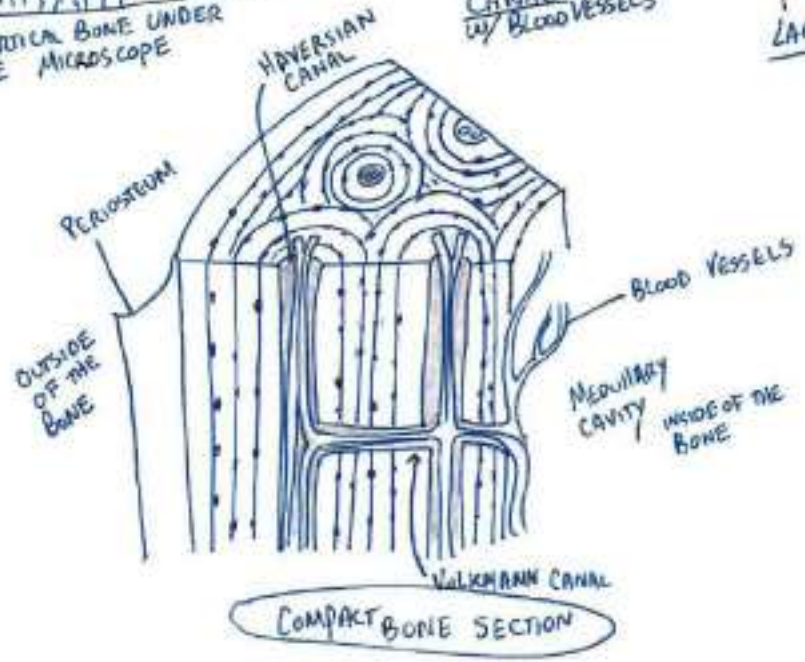
UNITS OF BONE

THE COMPACT BONE GROWS IN DISTINCT RINGS
THESE RING UNITS ARE CALLED OSTEONS

CORTICAL BONE UNDER THE MICROSCOPE



OSTEOCYTES MAINTAIN THE CALCIFIED BONE MATRIX MATERIALS (NUTRIENTS AND WASTE) ARE PASSED BETWEEN LACUNAE VIA THE CANALICULI. MATERIALS & WASTE ARE ALSO TRANSPORTED IN & OUT OF THE BONE VIA THE BLOOD VESSELS FOUND IN THE HAVERSIAN & VOLKMANN CANALS



COMPACT BONE SECTION

Bone Growth & Repair

Fracture

From a simple oblique to complex compound fracture, bones heal using both endochondral & intramembranous growth

Hormones

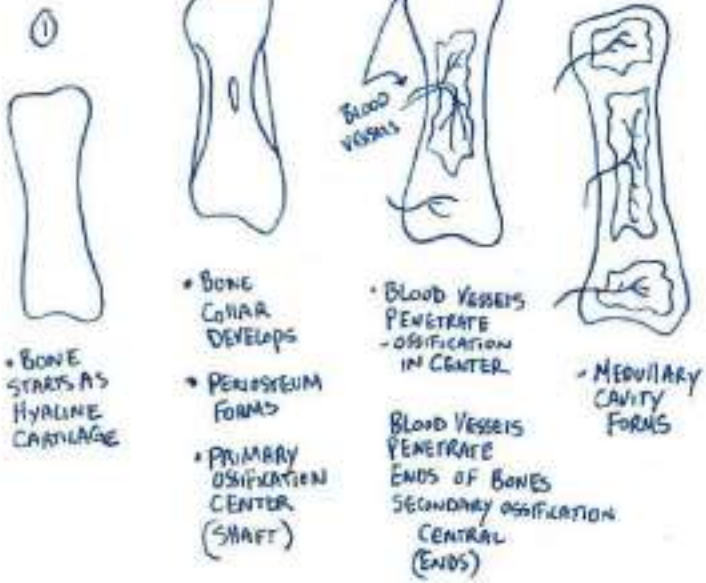
Parathyroid – releases calcium from bones - bone remodeling

Calcitonin – helps bones absorb calcium – strengthen

Endochondral ossification

Most bones

- Inside
- Cartilage
- Bone formation



1. Bone starts as hyaline cartilage
2. • Bone collar develops
   • Periosteum forms
   • Primary ossification center (shaft)
3. • Blood vessels penetrate – ossification in center
   Blood vessels penetrate ends of bones secondary ossification central (ends)
4. • Medullary cavity forms
5. • Compact bone in diaphysis
   • Spongy bone in epiphysis

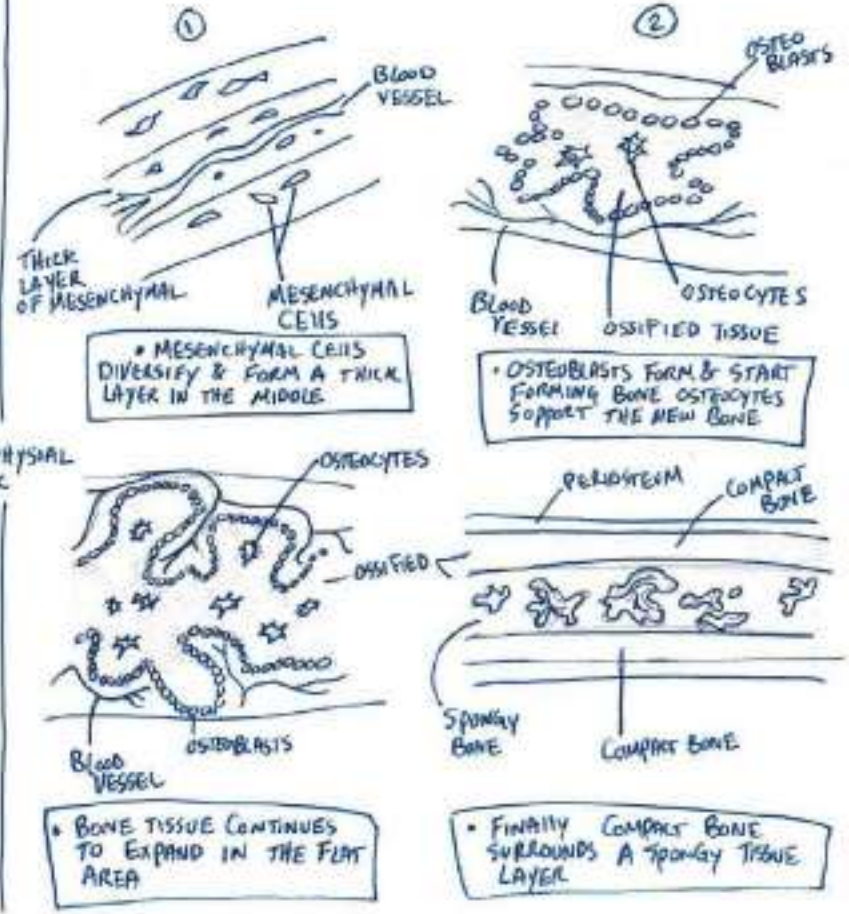
This type of learning can really grow on you!

Intramembranous ossification

Flat bones

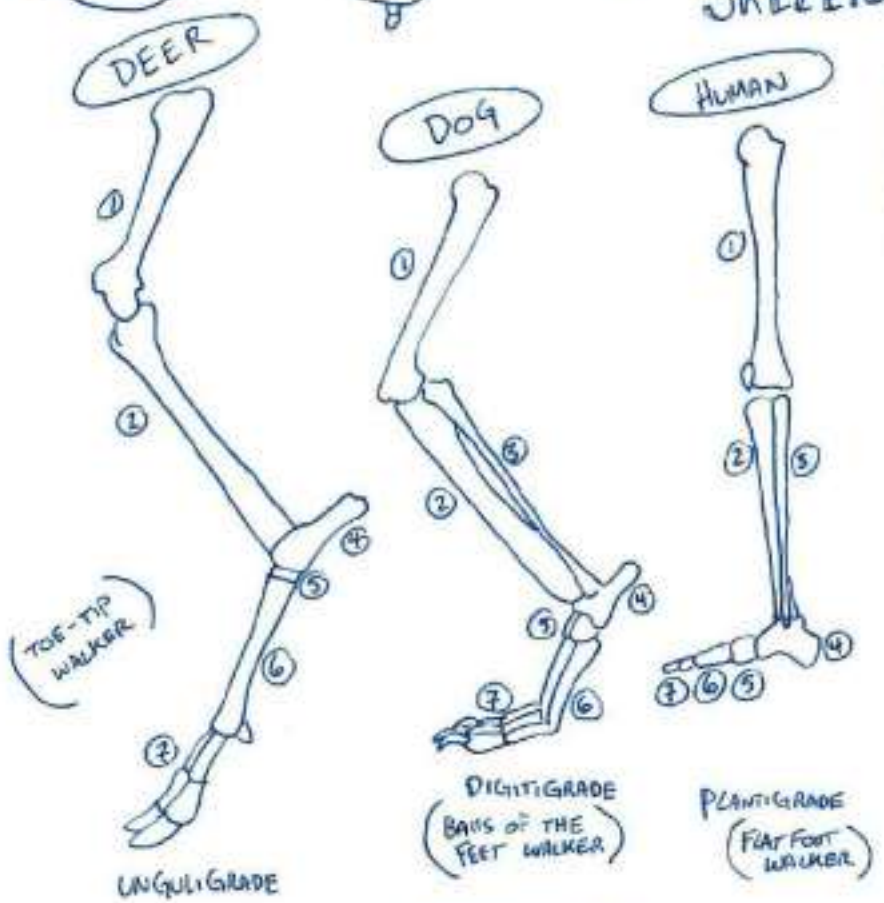
Scapula, ribs, skull

- Within
- Membrane
- Bone formation

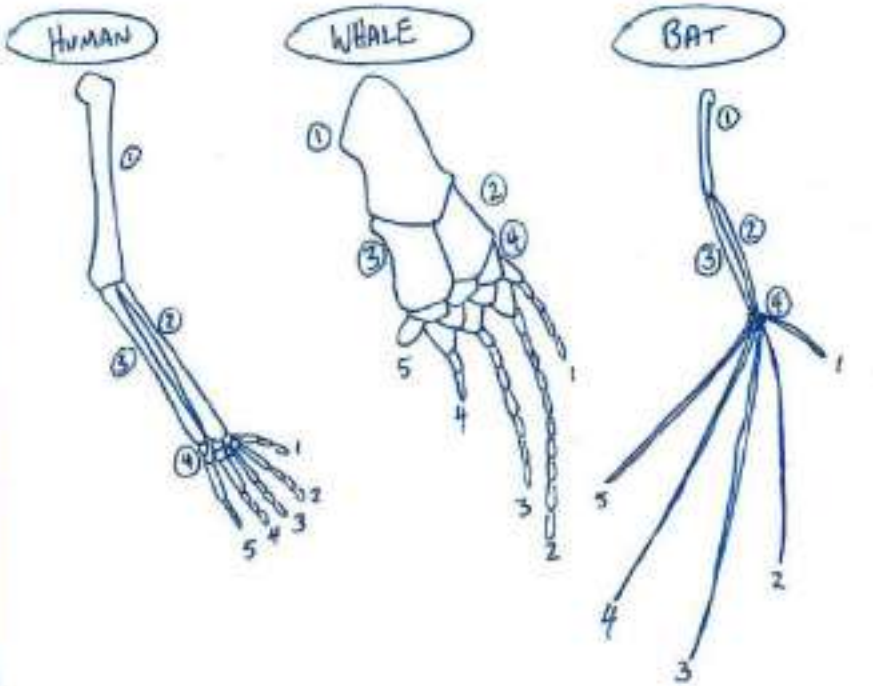


1. • Mesenchymal cells diversify & form a thick layer in the middle
2. • Osteoblasts form & start forming bone osteocytes support the new bone
3. • Bone tissue continues to expand in the flat area
4. • Finally compact bone surrounds a spongy tissue layer

COMPARATIVE SKELETONS



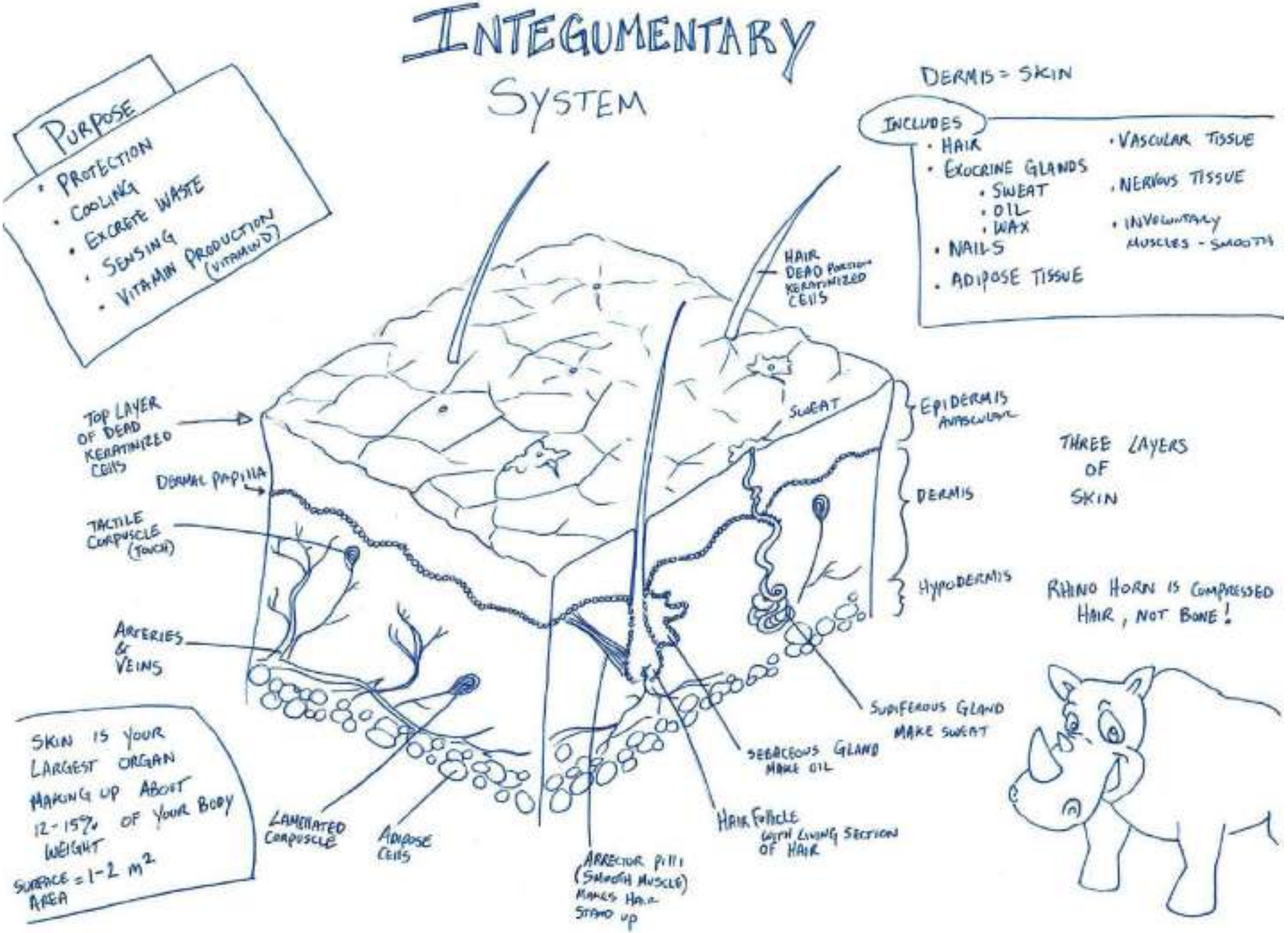
① FEMUR ② TIBIA ③ FIBULA ④ CALCANEUS ⑤ TARSALS
⑥ META TARSALS ⑦ PHALANGES



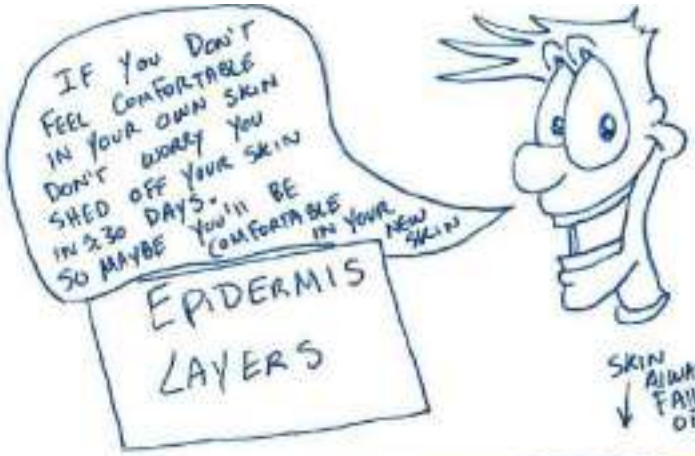
① HUMERUS ② RADIUS ③ ULNA ④ CARPALS

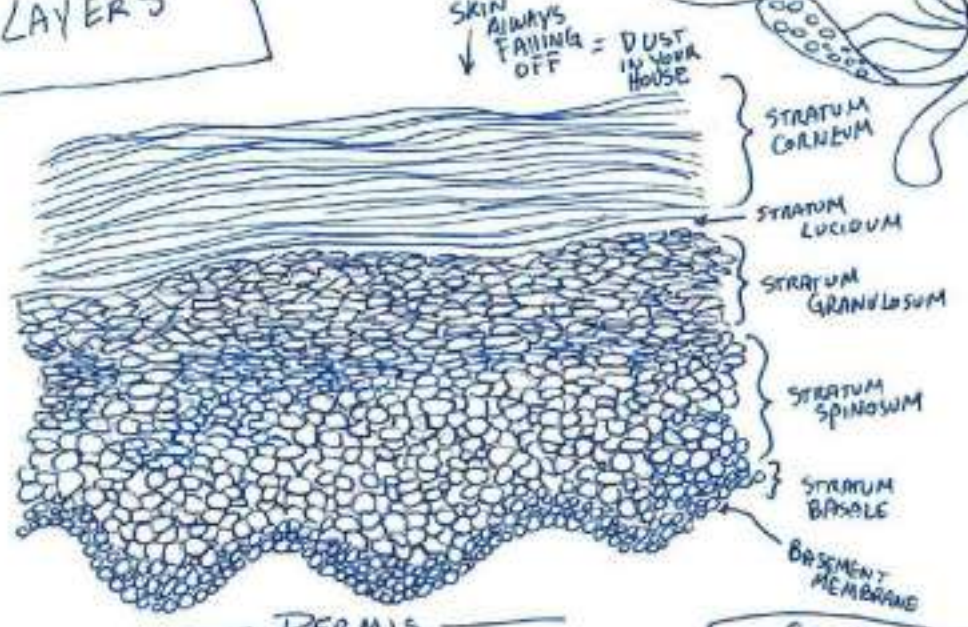
FINGERS
1 = THUMB 5 = PINKIE

INTEGUMENTARY SYSTEM



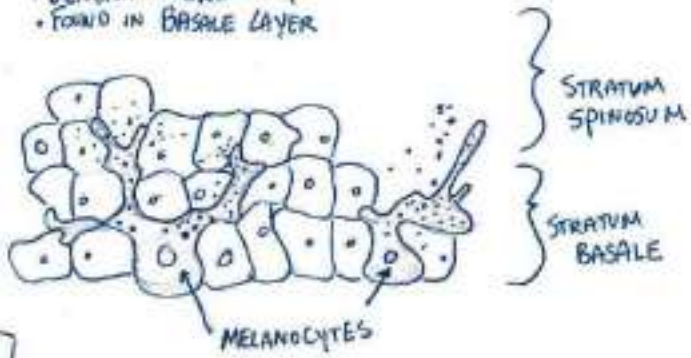
INTEGUMENTARY SYSTEM





COLOR CELLS

- MELANIN PRODUCING CELLS
- DENDRITIC - BRANCHING
- FOUND IN BASALE LAYER



DIVERSE ROLE OF MELANIN

- FOUND IN CEPHALOPOD INK
- COLORATION OF IRIS IN AN EYE
- BIRD FEATHER COLORATION
- BACTERIA & FUNGUS USE IT FOR PROTECTION
- FOUND IN EXOSKELETONS OF ARTHROPODS

CANCERS

1. BASAL CELL - STARTS @ STRATUM BASALE
2. MELANOMA - FOUND IN MELANOCYTES
3. SQUAMOUS - TOP LAYER CELLS

2 TYPES OF MELANIN

- EUMELANIN - BROWN OR BLACK PIGMENT
- PHEOMELANIN - PINK TO RED HUE

PURPOSE

PROTECT AGAINST U.V. RADIATION WHICH CAN DAMAGE DNA LEADING TO CANCER & PREVENT FOLIC ACID BREAKDOWN

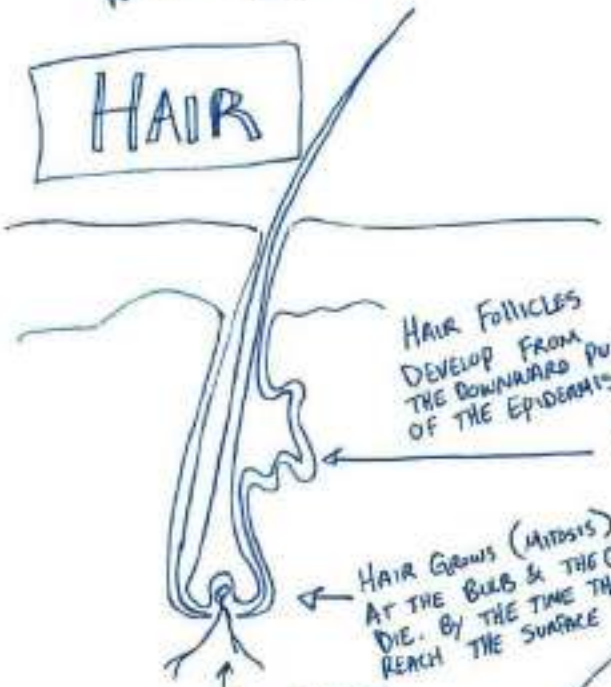
1. BASEMENT MEMBRANE ATTACHES EPIDERMIS TO THE DERMIS
2. STRATUM BASALE - MITOSIS LAYER. CLOSEST TO BLOODSUPPLY FOUND IN THE DERMIS. AS THE CELLS AGE THEY MIGRATE UP TO THE NEXT LAYER
3. STRATUM SPINOSUM - KERATIN (PROTEIN) FIBERS ACCUMULATE
4. STRATUM GRANULOSUM - KERATIN IS DENSE. CELLS RELEASE LIPIDS (WATERPROOFING) & CELLS BEGIN TO DIE
5. STRATUM LUCIDUM - CLEAR LAYER (ONLY PRESENT IN THICK SKIN)
6. STRATUM CORNEUM - PROTECTIVE LAYER OF DEAD CELLS. CELLS SLOUGH OFF FROM THIS LAYER'S SURFACE.

INTEGUMENTARY SYSTEM

TYPES OF HAIR

TERMINAL - COARSE HAIR - COLOR
LANUGO - BABY HAIR
VELLUS - COLORLESS HAIR ON BODY - "PEACH FUZZ"

HAIR



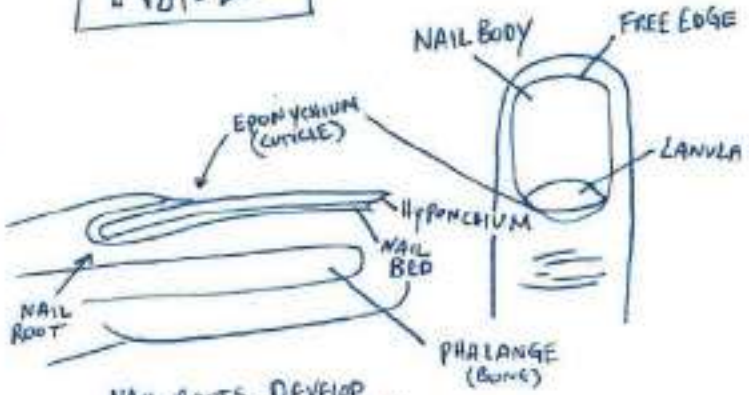
HAIR FOLLICLES DEVELOP FROM THE DOWNWARD PUSH OF THE EPIDERMIS

SEBACEOUS (OIL) GLANDS CAN BE ASSOCIATED WITH A HAIR FOLLICLE

HAIR GROWS (MITOSIS) AT THE BULB & THE CELLS DIE. BY THE TIME THEY REACH THE SURFACE

BLOOD VESSELS BRING NUTRIENTS TO THE DIVIDING CELLS

NAIL



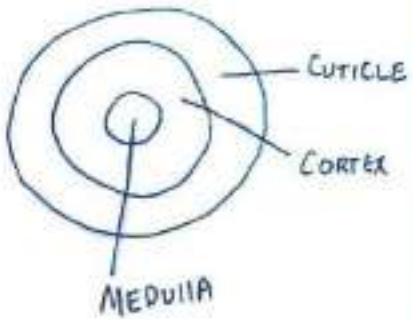
NAIL ROOTS DEVELOP FROM THE DOWNWARD PUSH OF THE EPIDERMIS

NAILS ARE MADE OF DEAD KERATINIZED CELLS MUCH LIKE HAIR

MYTH

- SHAVING INCREASES HAIR GROWTH
  - ★ DARKENING OF HAIR = PUBERTY & ↑ GROWTH
  - DARKER HAIR = MORE NOTICABLE

HAIR CROSS SECTION



STAGES OF HAIR GROWTH

ANAGEN

ACTIVE GROWTH OF HAIR. LOTS OF MITOSIS & RUSH OF NEW CELLS UPWARD

≈ 2-6 YEARS - SCALP
30-45 DAYS ON ARMS LEGS

CATAGEN

TRANSITIONAL PHASE WHERE GROWTH STOPS AND PREPS FOR TELOGEN

≈ 2-3 WEEKS

TELOGEN

RESTING PHASE USUALLY WHEN THE HAIR FALLS OUT

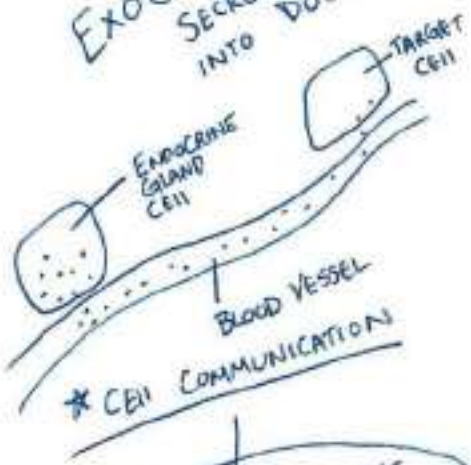
≈ 100 DAYS SCALP
LONGER ON ARMS, LEGS EYEBROWS

YOU KNOW WHAT THEY SAY HAIR TODAY GONE TOMORROW

ENDOCRINE SYSTEM

ENDOCRINE - SECRETE CONTENTS INTO THE BLOOD STREAM DUCTLESS

EXOCRINE - SECRETE CONTENTS INTO DUCTS



* CELL COMMUNICATION

FEEDBACK GUIDANCE

TWO PATHS COMMUNICATION IN ANIMALS
- NERVOUS SYSTEM & ENDOCRINE

BOTH RESPOND & "TALK" TO EACH OTHER

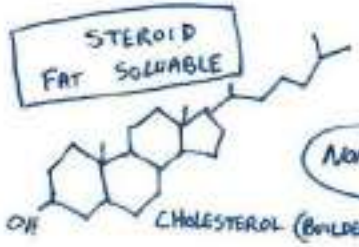
- ENDOCRINE SYSTEM HELPS MAINTAIN HOMEOSTASIS

DIFFERENT TYPES OF HORMONES

HORMONES FOLLOW THE CELL COMMUNICATION PATHWAY

- LIGAND BINDING (RECEPTION)
  - HORMONE TO SURFACE CARBOHYDRATE
- ENZYME CHAIN REACTION INSIDE CELL (TRANSDUCTION)
  - A —Enz X→ B —Enz Y→ C —Enz Z→ D
- RESPONSE

STEROID
FAT SOLUBLE
NONPOLAR

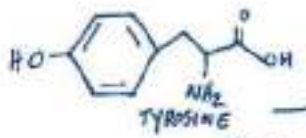


CHOLESTEROL (BUILDER)
- TESTOSTERONE
- ESTRADIOL

PEPTIDE
PROTEIN BASED

SHORT POLYPEPTIDES (AMINO ACID CHAINS)
- OXYTOCIN
- GROWTH HORMONE
- INSULIN
- FSH

AMINO ACID-DERIVED
POLAR

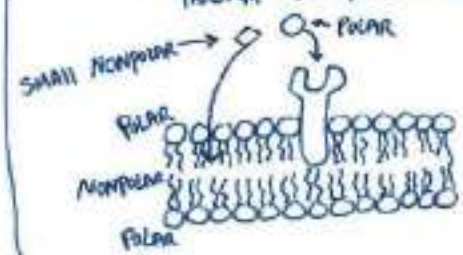


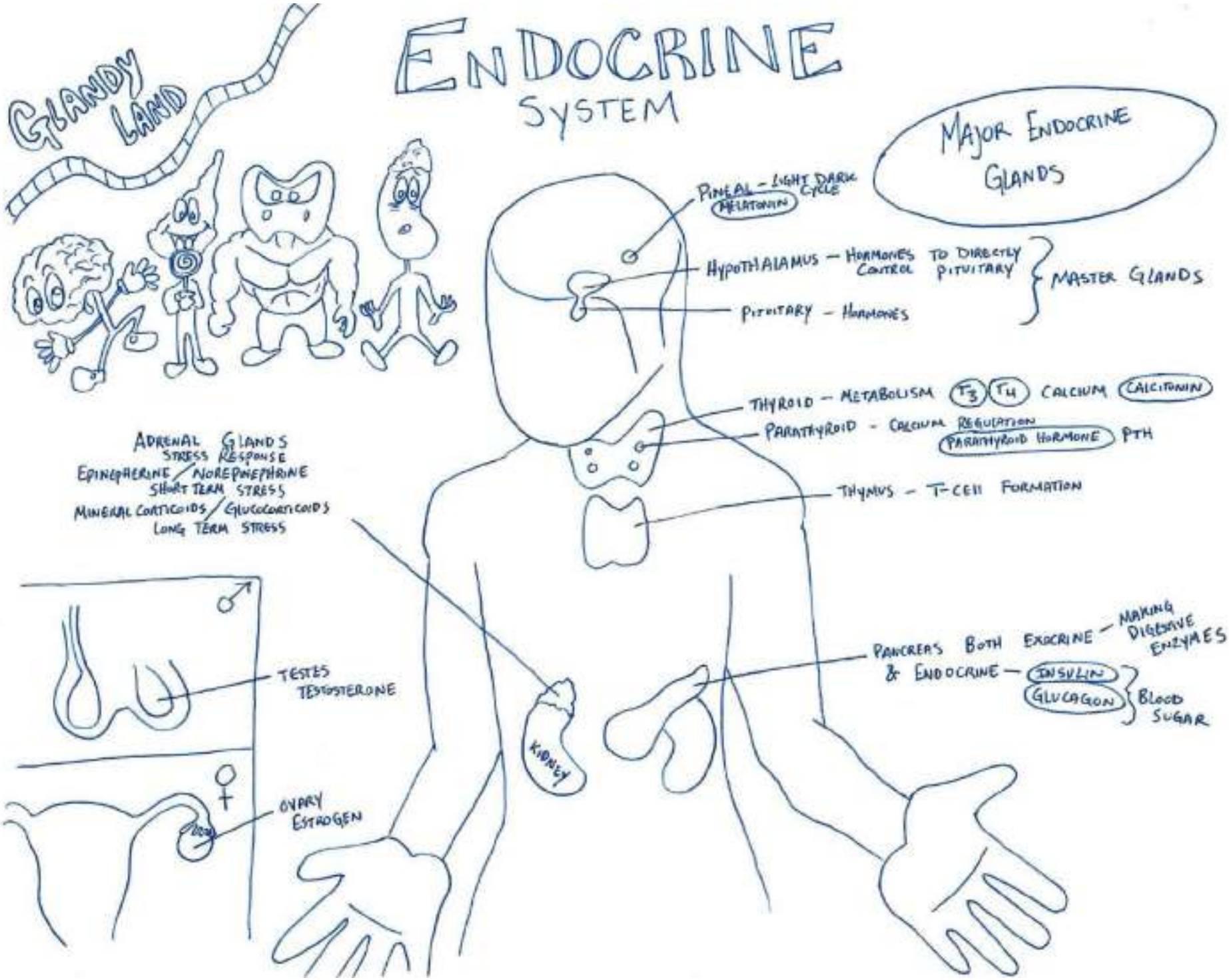
TYROSINE →
- EPINEPHRINE
- MELATONIN
- THYROXINE

POLAR VS. NONPOLAR

POLAR
POLAR - DISSOLVE WELL IN THE BLOOD STREAM BUT MUST BIND TO A LIGAND RECEPTOR TO WORK

NONPOLAR - CAN MOVE THROUGH CELL MEMBRANE

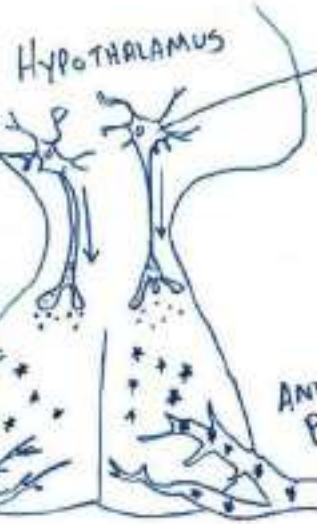



GLANDY LAND
ENDOCRINE SYSTEM
MAJOR ENDOCRINE GLANDS
PINEAL – LIGHT DARK CYCLE
MELATONIN
HYPOTHALAMUS – HORMONES TO DIRECTLY CONTROL PITUITARY
PITUITARY – HORMONES
MASTER GLANDS
THYROID – METABOLISM
T3
T4
CALCIUM
CALCITONIN
PARATHYROID – CALCIUM REGULATION
PARATHYROID HORMONE
PTH
THYMUS – T-CELL FORMATION
ADRENAL GLANDS
STRESS RESPONSE
EPINEPHERINE / NOREPINEPHRINE
SHORT TERM STRESS
MINERAL CORTICOIDS / GLUCOCORTICOIDS
LONG TERM STRESS
TESTES
TESTOSTERONE
OVARY
ESTROGEN
KIDNEY
PANCREAS BOTH EXOCRINE – MAKING DIGESTIVE ENZYMES
& ENDOCRINE –
INSULIN
GLUCAGON
BLOOD SUGAR

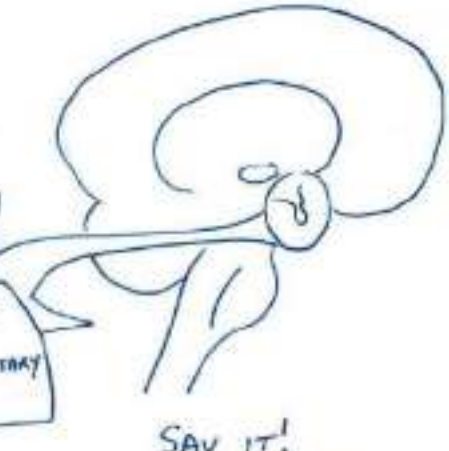
ENDOCRINE SYSTEM

HYPOTHALAMUS & PITUITARY

TROPIC HORMONES
ARE HORMONES THAT TARGET OTHER GLANDS.
PITUITARY TROPIC HORMONES
- THYROID STIMULATING HORMONE [TSH]
- ADRENOCORTICOTROPIC HORMONE [ACTH]
- FOLLICLE STIMULATING HORMONE [FSH]
- LUTEINIZING HORMONE [LH]



★ = HORMONE



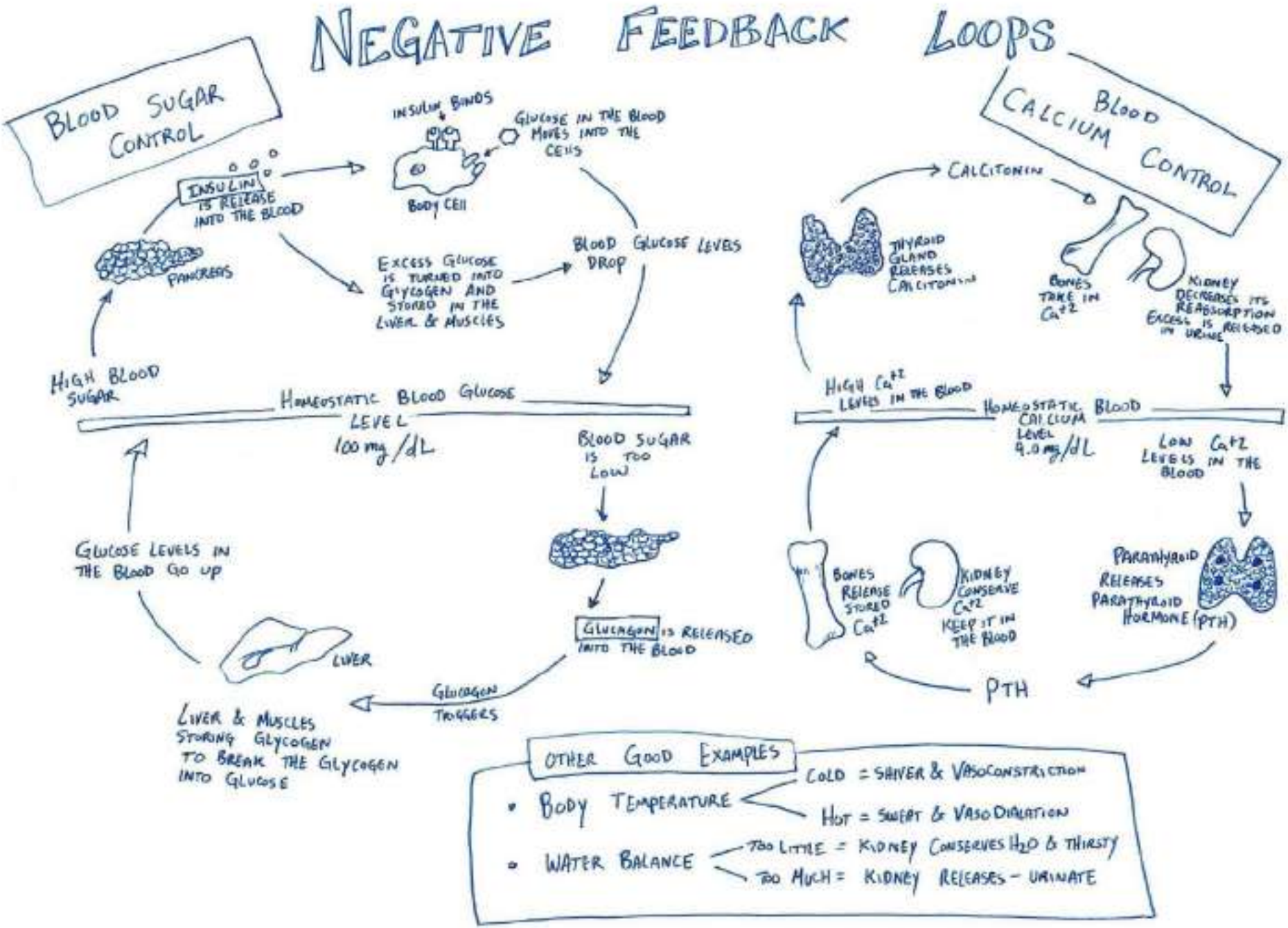
SAY IT!

PIT-UI-TARY
YOU SPIT AS YOU SAY IT. JUST LIKE THE GLAND SPITS OUT TONS OF HORMONES

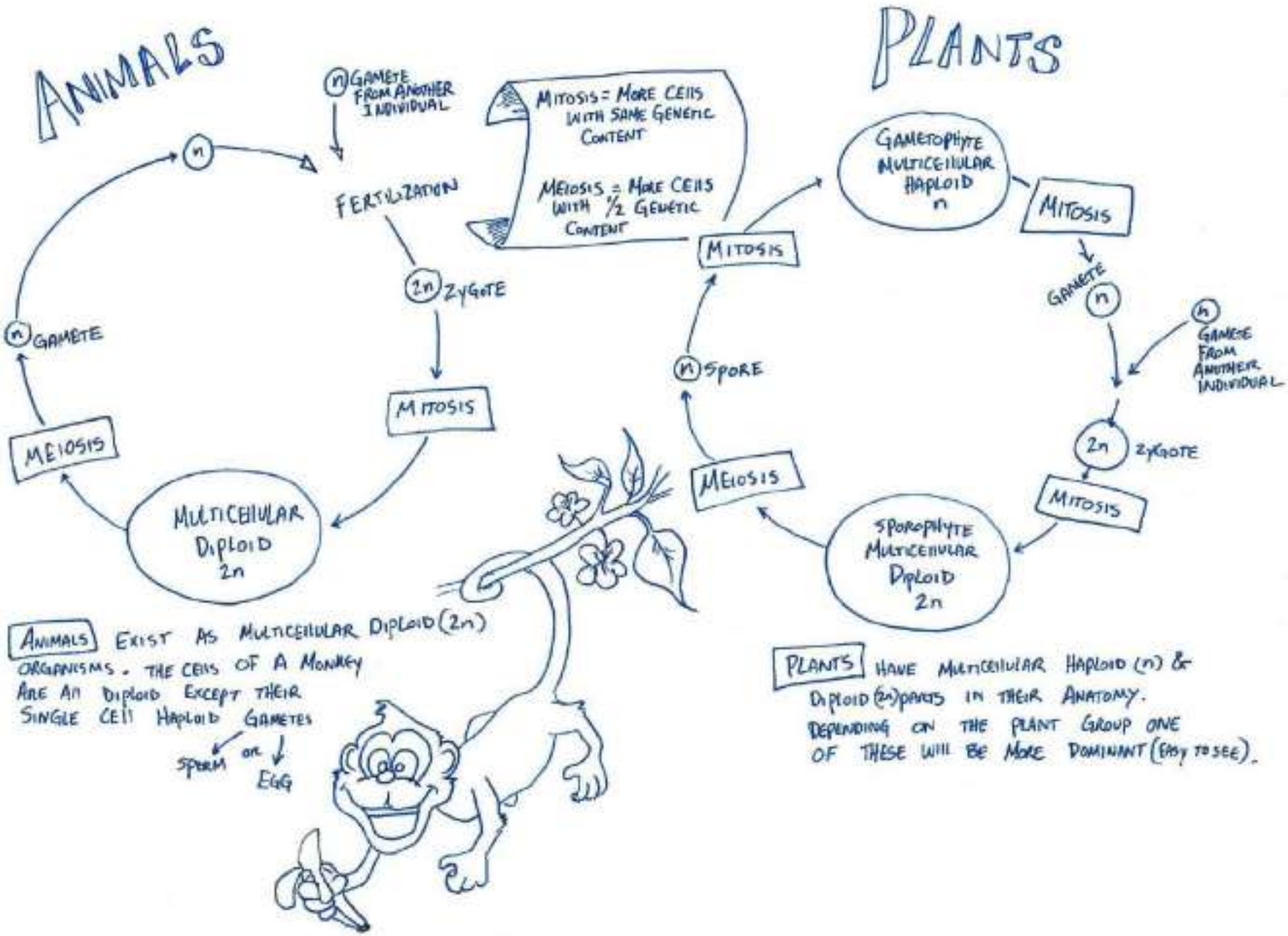
- ANTIDIURETIC HORMONE [ADH]
  KIDNEY = KEEP MORE H_2O IN THE BODY LESS IN THE URINE
- OXYTOCIN
  MAMMARY GLANDS = MILK EJECTION } BABIES
  UTERINE MUSCLES = CONTRACTION

"CUDDLE HORMONE" = LINKED TO BONDING IN COUPLES
- EVEN DOGS TO OWNERS

- GROWTH HORMONE [GH]
  BONES
- PROLACTIN [PRL]
  MAMMARY GLANDS
- FOLLICLE STIMULATING HORMONE [FSH]
- LUTEINIZING HORMONE [LH]
  BOTH EFFECT THE GONADS
  TESTES = SPERM FORMATION
  OVARIES = EGG
- THYROID STIMULATING HORMONE [TSH]
  ACTIVATES THYROID
- ADRENOCORTICOTROPIC HORMONE [ACTH]
  ACTIVATES ADRENAL GLANDS
- MELANOCYTE STIMULATING HORMONE [MSH]
  MELANOCYTES = MAKE PIGMENT
- ENDORPHINS
  INHIBIT PAIN TRANSMISSION


NEGATIVE FEEDBACK LOOPS
BLOOD SUGAR CONTROL
INSULIN BINDS
GLUCOSE IN THE BLOOD MOVES INTO THE CELLS
INSULIN IS RELEASE INTO THE BLOOD
BODY CELL
PANCREAS
EXCESS GLUCOSE IS TURNED INTO GLYCOGEN AND STORED IN THE LIVER & MUSCLES
BLOOD GLUCOSE LEVELS DROP
HIGH BLOOD SUGAR
HOMEOSTATIC BLOOD GLUCOSE LEVEL 100 mg/dL
BLOOD SUGAR IS TOO LOW
GLUCOSE LEVELS IN THE BLOOD GO UP
GLUCAGON IS RELEASED INTO THE BLOOD
LIVER
GLUCAGON TRIGGERS
LIVER & MUSCLES STORING GLYCOGEN TO BREAK THE GLYCOGEN INTO GLUCOSE
BLOOD CALCIUM CONTROL
CALCITONIN
THYROID GLAND RELEASES CALCITONIN
BONES TAKE IN Ca+2
KIDNEY DECREASES ITS REABSORPTION EXCESS IS RELEASED IN URINE
HIGH Ca+2 LEVELS IN THE BLOOD
HOMEOSTATIC BLOOD CALCIUM LEVEL 9.0 mg/dL
LOW Ca+2 LEVELS IN THE BLOOD
BONES RELEASE STORED Ca+2
KIDNEY CONSERVE Ca+2 KEEP IT IN THE BLOOD
PARATHYROID RELEASES PARATHYROID HORMONE (PTH)
PTH
OTHER GOOD EXAMPLES
BODY TEMPERATURE
COLD = SHIVER & VASOCONSTRICTION
HOT = SWEAT & VASODILATION
WATER BALANCE
TOO LITTLE = KIDNEY CONSERVES H_2O & THIRSTY
TOO MUCH = KIDNEY RELEASES - URINATE

LIFE CYCLES



ANIMALS EXIST AS MULTICELLULAR DIPLOID (2n) ORGANISMS. THE CELLS OF A MONKEY ARE ALL DIPLOID EXCEPT THEIR SINGLE CELL HAPLOID GAMETES → SPERM OR EGG

PLANTS HAVE MULTICELLULAR HAPLOID (n) & DIPLOID (2n) PARTS IN THEIR ANATOMY. DEPENDING ON THE PLANT GROUP ONE OF THESE WILL BE MORE DOMINANT (EASY TO SEE).

142 J.Grant

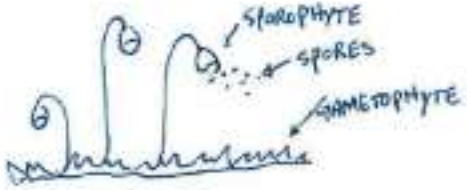
ANTHERIDIA - ♂ GAMETOPHYTE MAKES SPERM

ARCHEGONIUM - ♀ GAMETOPHYTE MAKES EGG

PLANTS

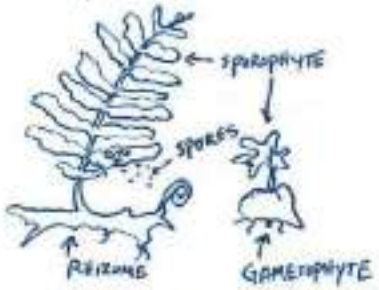
4 MAJOR DIVISIONS

MOSSES
BRYOPHYTES



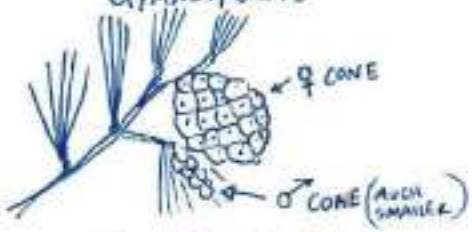
- DOMINANT GAMETOPHYTE GENERATION THE GREEN MATERIAL ON ROCKS & TREE TRUNKS
- NO ROOTS
- NON VASCULAR PLANT (NO XYLEM OR PHLOEM) THUS IS SHORT
- WATER REQUIRED FOR FERTILIZATION SPERM SWIMS TO EGG ANTHERIDIA ♂ ARCHEGONIA ♀
- SPOROPHYTE GROWS OUT OF THE ARCHEGONIA
- SPORES SPREAD THROUGH THE AIR ★ HOW THE POPULATION INHABITS NEW LOCATIONS

FERNS
PTEROPHYTES



- DOMINANT SPOROPHYTE WITH A REDUCED GAMETOPHYTE
- RHIZOME ROOTS
- VASCULAR PLANT TUBES (XYLEM & PHLOEM) GAIN HEIGHT
- WATER REQUIRED FOR FERTILIZATION SPERM SWIMS TO EGG ANTHERIDIA ♂ ARCHEGONIA ON SAME HEART SHAPED STRUCTURE ♀
- SPOROPHYTE GROWS OUT OF THE ARCHEGONIA - TIP OF HEART
- SPORES SPREAD THROUGH AIR ★ HOW THE POPULATION INHABITS NEW LOCATIONS

CONIFERS
GYMNOSPERMS



CONE BEARING TREES

- VERY DOMINANT SPOROPHYTE WITH SMALL (MICROSCOPIC) GAMETOPHYTE
- WIDESPREAD ROOTS
- VASCULAR PLANT XYLEM & PHLOEM LIGNIFIED (HARD) TISSUE
- SPERM IN POLLEN GRAIN (GAMETOPHYTE) ★WIND BLOWN TO EGG IN MEGASPORE (GAMETOPHYTE)
- SEED DEVELOPS - CONTAINS ENDOSPERM (FOOD) FOR EMBRYO
- SEEDS SPREAD THROUGH WIND ★ HOW SPECIES SPREADS

FLOWERING PLANTS
ANGIOSPERMS

FLOWERING PLANTS

- VERY DOMINANT SPOROPHYTE SMALL (MICROSCOPIC) GAMETOPHYTE
- WIDESPREAD ROOTS
- VASCULAR PLANT XYLEM & PHLOEM LIGNIFIED TISSUE
- SPERM IN POLLEN GRAIN (GAMETOPHYTE)

★ COEVOLUTION - POLLINATORS

TO EGG IN MEGASPORE (GAMETOPHYTE)

- SEED DEVELOPS - CONTAINS ENDOSPERM (FOOD) FOR EMBRYO
- SEED HOUSE IN A FRUIT ★

FRUIT AIDS IN DISPERSION

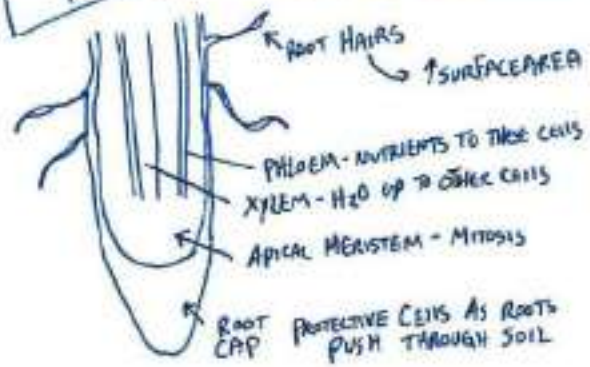
↓

VERY DIVERSE

PLANT ANATOMY

Angiosperm perspective

ROOTS - optimize uptake of H_2O & minerals



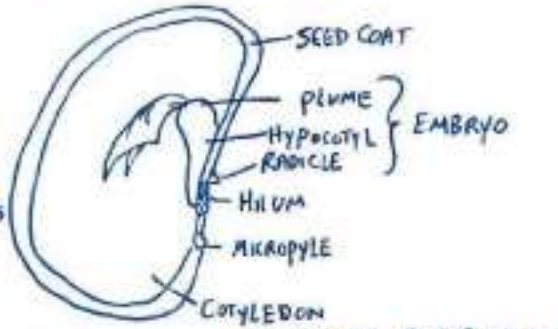
Roots of Plants

- Symbiosis with bacteria - help to pull nitrogen out of the air

Types

Fibrous	Tap
Spread to optimize H_2O uptake	- Thick & can store nutrients
[Grasses]	[Carrot]

SEED



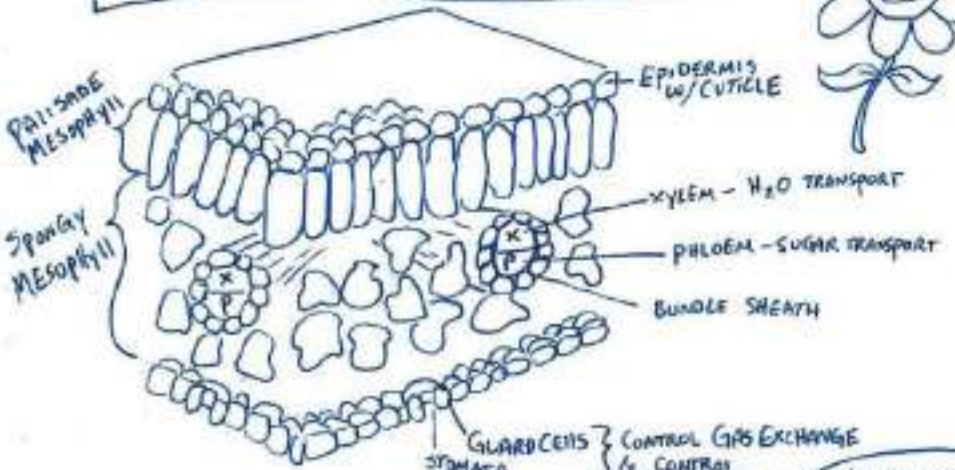
Endosperm is the food for the embryo before it can get above ground to do photosynthesis

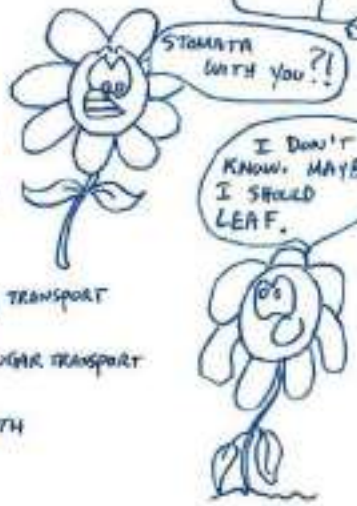
↓

To humans it is delicious calories

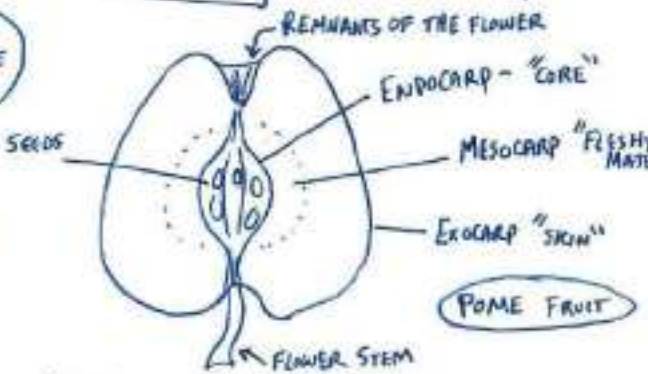
Bread - Grain - Seed

LEAVES - optimize photosynthesis





FRUIT - enlarged ovary



Diversity of fruits - some examples -

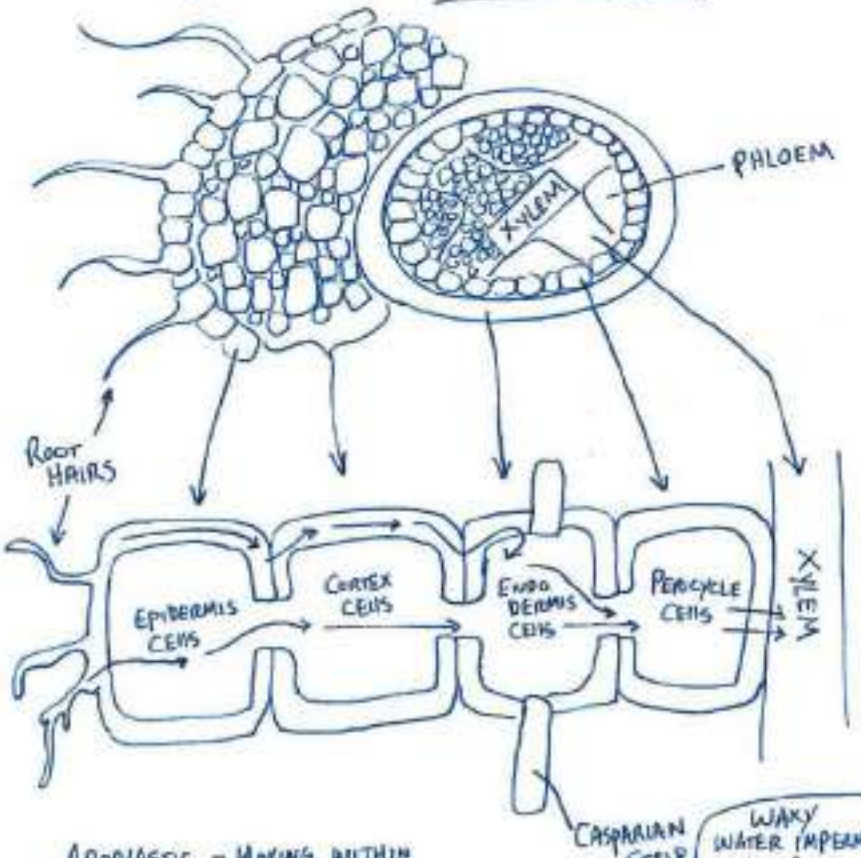
144 J.Grant

TRANSPORT IN PLANTS

GARDEN PARTIES ARE ALWAYS TOO LOUD EVERYONE IS SAYING "TURNIP THE BEET!" EVEN IF ITS THE WRONG THYME.

WATER & MINERAL TRANSPORT

ROOT CROSS SECTION



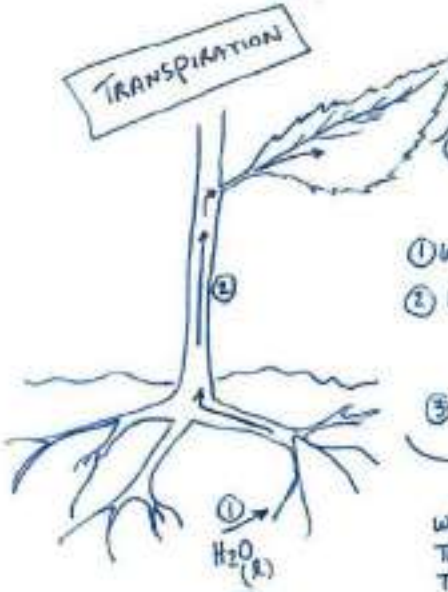
WAXY WATER IMPERMEABLE STRIP THAT PREVENTS MOVEMENT THROUGH CELL WALLS

APOPLASTIC – MOVING WITHIN THE CELL WALLS

SYMPLASTIC – MOVING BETWEEN CELLS THROUGH THE PLASMODESMATA

TRANSMEMBRANE – MOVE STRAIGHT THROUGH WALLS & MEMBRANES VIA WATER CHANNELS

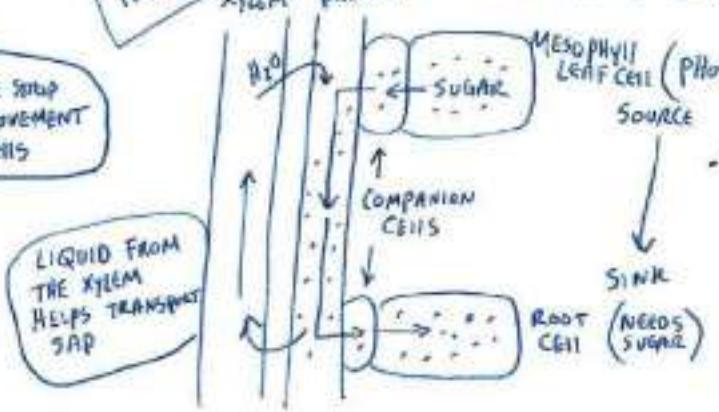
TRANSPIRATION



1. WATER ENTERS ROOTS VIA OSMOSIS
2. WATER MOVES UP XYLEM CELLS
   - ADHESION TO CELL WALLS
   - COHESION WATER TO WATER
3. WATER IS LOST TO THE ENVIRONMENT DUE TO OPEN STOMATA

WHEN ONE H_2O MOLECULE LEAVES THROUGH THE STOMATA IT PULLS THE NEXT ONE UP. EACH H_2O MOLECULE PULLS ON THE ONE BELOW IT ALL THE WAY DOWN TO THE ROOTS. = TRANSPIRATION

TRANSLOCATION



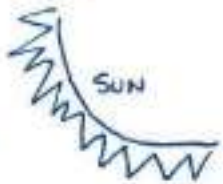
- TRANSPORT OF SUGAR FROM SOURCE TO SINK

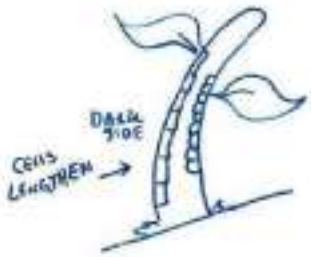
LIQUID FROM THE XYLEM HELPS TRANSPORT SAP

PLANT RESPONSES

PHOTOTROPISM

GROWTH/ MOVEMENT TOWARDS LIGHT





HORMONE : AUXIN CAUSES CELLS ON THE DARK SIDE TO LENGTHEN = LEAN TOWARDS LIGHT SOURCE

GEOTROPISM

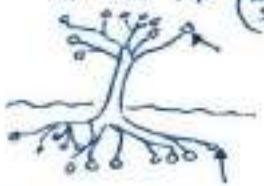
GROWTH/ MOVEMENT TOWARDS GRAVITY

MERISTEMS

GROWTH CENTERS

APICAL MERISTEM

PLANTS GROW LENGTH ONLY AT THE TIPS (ROOT & SHOOT)

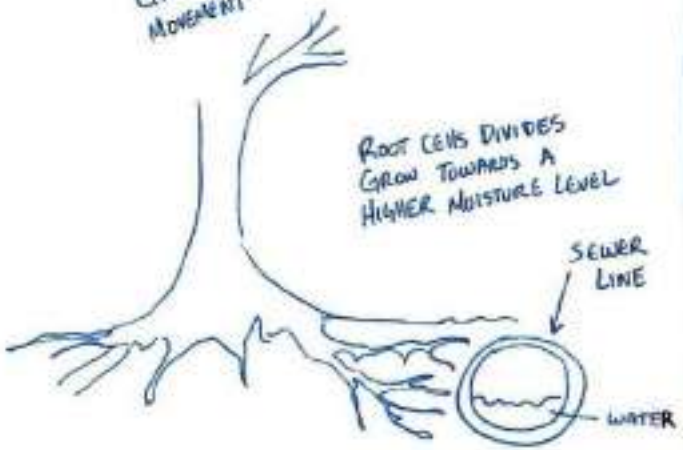


VASCULAR CAMBIUM

PLANTS GAIN THICKNESS BY ADDING XYLEM & PHLOEM

HYDROTROPISM

GROWTH/ MOVEMENT TOWARDS WATER



THIGMOTROPISM

GROWTH/ MOVEMENT IN RESPONSE TO TOUCH

TENDRIL = MODIFIED STEM. GROWS IN ALL DIRECTIONS UNTIL IT TOUCHES ANOTHER STRUCTURE. IT THEN WRAPS AROUND THAT STRUCTURE