Illustrated Guide to Biology & Anatomy

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Nature of Science

Definition of Science

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

Scientific Method

Make an observation → Think of a scientific 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 cell-y

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

Peer Review

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

Theory

Scientific theories are testable, able to be changed, 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

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

How Do Biologist Count All The Organisms In An Area?

Quadrat

A square plot that is used to mark off, at random, a location and assess a large area's composition of plant or animal life.

- Complete several quadrat collections across an area. You must be random when you drop your quadrat.

Taking several small samples over the entire area being studied gives you a fairly accurate representation of its composition

Snap shots of a bigger story

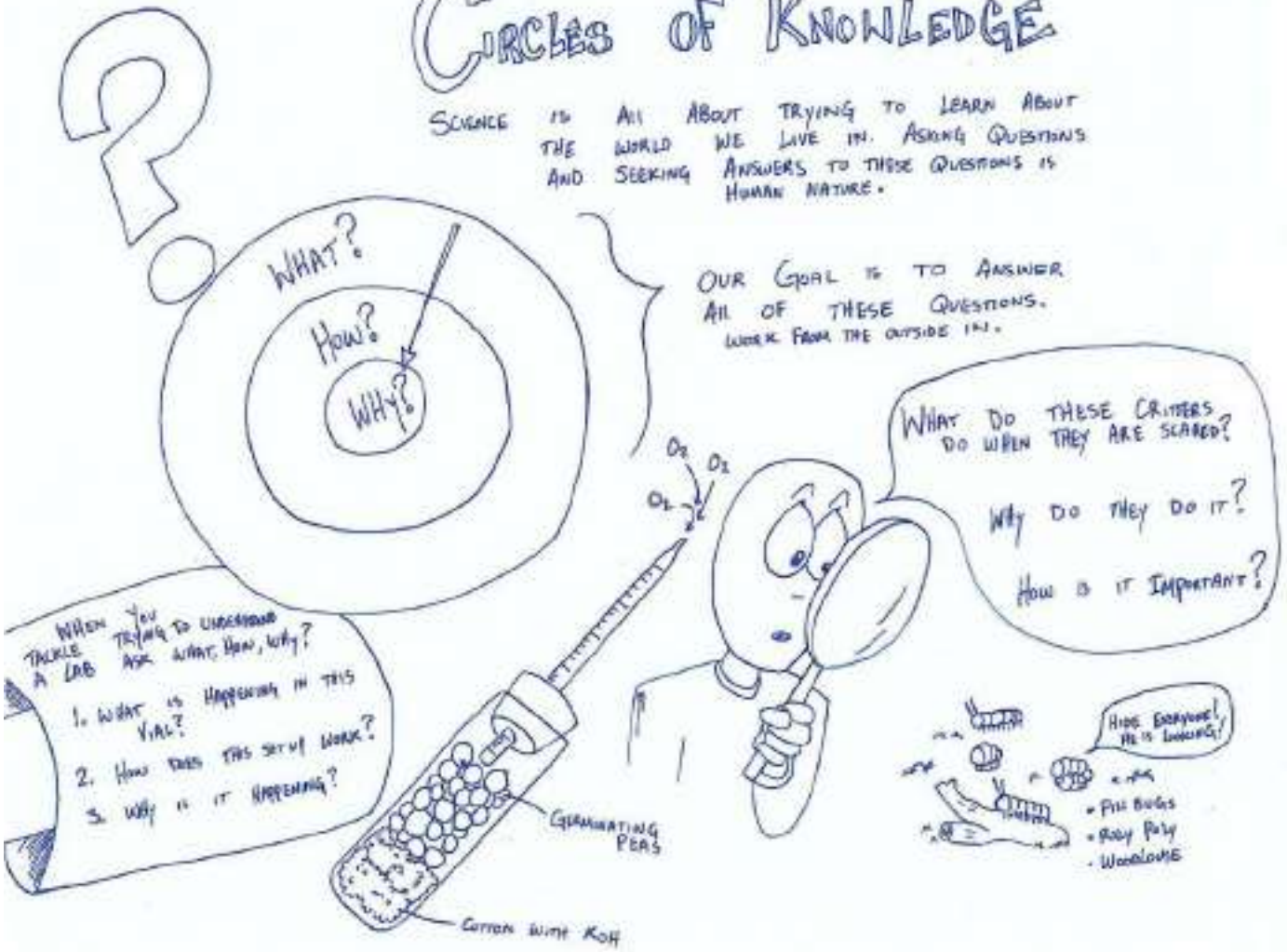
This is just 3 pictures, but you can get an idea of what is happening

Purpose:

1. Determine Plant Density
   How many plants live in an area
2. Determine Plant Frequency
   How often you can expect to find a specific plant
3. Determine Biomass
   Mass of the living organisms
4. Determine Biodiversity
   The amount of different species in a given area

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.



Ecology

Behavioral Ecology

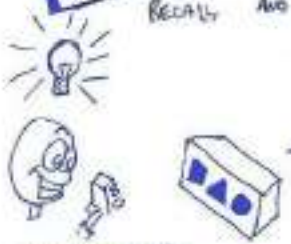
- F.A.P.
- Kinesis
- Taxis
- Migration
- Imprinting
- Problem Solving
- Classical
- Operant
- Social Learning

Innate — Behavior Spectrum — 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.

Ex: Social Learning

Learning because you are part of a group

Cephalopods — Head / Feet ⇒ very smart invertebrates

Agonistic — Fight! For mates, territory, food.

Altruistic

I would sacrifice myself to save my two sisters or four cousins

Kin Selection

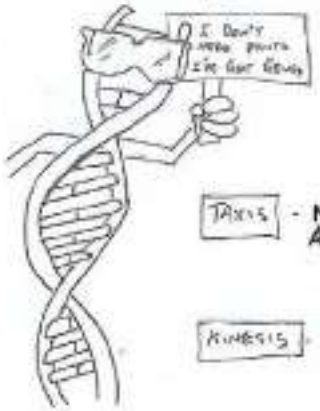
Helping family because you share genes with them.

Evolution

BEHAVIORAL ECOLOGY

INNATE BEHAVIORS

FIXED ACTION PATTERNS — A BEHAVIOR SEQUENCE TRIGGERED BY A SIGN STIMULUS. ONCE STARTED IT GOES TO COMPLETION



TAXIS - MOVING TOWARDS OR AWAY FROM A STIMULUS

PHOTOTROPISM - GROWING TOWARDS THE LIGHT

KINESIS - CHANGE IN RATE DUE TO CHANGE IN THE SURROUNDINGS

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: SOME BIRDS LIKE THE SANDPIPERS & PLOVERS (SHOREBIRDS)

BUT WHOOPING CRANE REQUIRE ADULTS TO TEACH YOUNG TO GO.

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

BEHAVIORAL ECOLOGY

PRE PROGRAMMED

INNATE

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

GENE FOR HOMING TOWARDS THE OCEAN WHEN SEA TURTLES HATCH

(SAME SPECIES = SAME BEHAVIOR)

NATURE VS. NURTURE

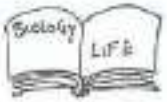
LEARNED

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

(LEARNING ENCOUNTERS)

WHY

SHOULD WE EVEN STUDY BEHAVIOR?



→ 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.

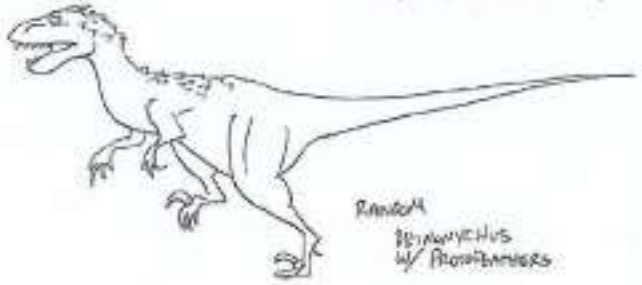
ACTIVITY STRENGTHENS OR WEAKENS DEPENDING ON THE CONSEQUENCE.

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

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

EX: PAVLOV'S DOGS

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



RANDOM BRONTOSAURUS W/ PROGRAMMERS

WHY DID THE DINOSAUR CROSS THE ROAD?

BECAUSE THE CHICKEN HADN'T EVOLVED 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.

Blackheads stupidus

DISPERSAL MAP

SHOWING A CLUMPED PATTERN OF DISPERSAL

DENSITY = MASS / VOLUME

DENSITY FOR POPULATIONS IS SIMILAR TYPE OF IDEA. HIGHER DENSITY = MORE ORGANISMS / AREA

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.

COMPETITIVE EXCLUSION

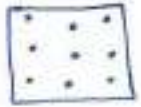
- NO TWO SPECIES CAN OCCUPY THE SAME NICHE.

IF THEY DO ONE WILL BECOME EXTINCT.

ONE OF THE REASONS WHY INVASIVE SPECIES ARE BAD.

THERE IS ALSO

- UNIFORM

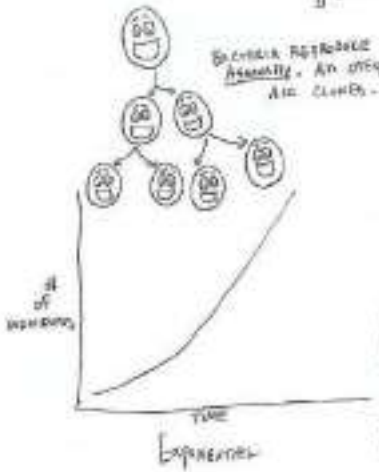


AND

- RANDOM

How Can We View Population Growth?

Graphs

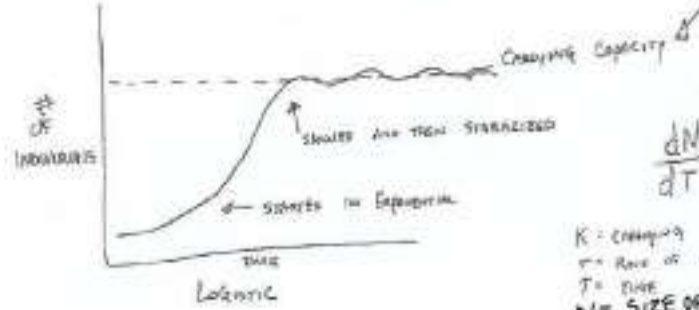


Very few resources Adding back the population

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

Generally populations newly introduced to an area or rebounding from disaster

Why do populations reach a carrying capacity?



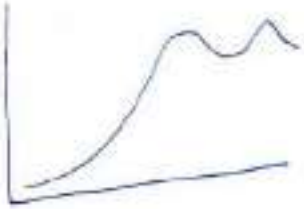
Populations have limits as growth factors.

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

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

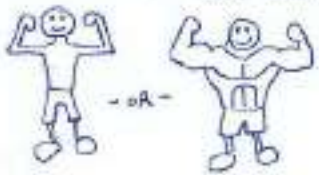
OTHER THINGS TO CONSIDER . . .

- AT WHAT AGE DOES THE SPECIES BECOME SEXUALLY MATURE?

FRUIT FLY IS READY ≈ 96 HRS AFTER FERTILIZATION.

- IS THERE A SOCIAL DYNAMIC?

- ONLY THE STRONGEST MALE CAN MATE WITH FEMALES.



Population Growth Factors

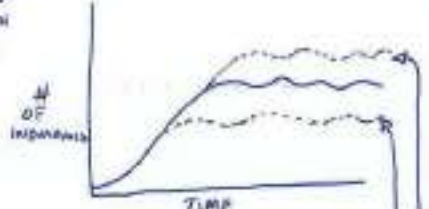
Part 1

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.

Many Europeans 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 1

Density Dependent Factors

Don't effect small populations

- Competition? 16 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 disease's 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
  - ☐ NO
- DO THEY INVEST ENERGY INTO THEIR OFFSPRING IN ORDER TO INCREASE THE OFFSPRING'S FITNESS?
  - ☐ YES
  - ☐ NO

r-SELECTED

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

K-SELECTED

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

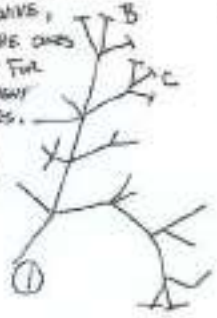
FITNESS

BEING ABLE TO SURVIVE & REPRODUCE

NOT JUST ABOUT BEING STRONG

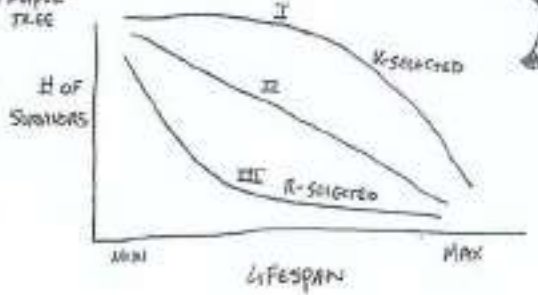
IT'S NOT JUST THE STRONGEST OR THE FASTEST THAT SURVIVE; IT'S JUST THAT THE ONES WITH BETTER GENES FOR THE GIVEN ENVIRONMENT MAKE MORE BABIES.

EVOLUTION



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

SURVIVORSHIP CURVES



SYMBIOSIS

TWO DIFFERENT SPECIES IN CLOSE PHYSICAL CONTACT.
SHAPING 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

HUMANS ARE NOT AN EXCEPTION

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 TREE 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 flows

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

Events that can "reset" an ecosystem after 2° succession

Primary Succession starts on soiless land

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.

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

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

NITROGEN

ANIMALS CONSUME PROTEIN

PROTEIN MADE OF AMINO ACIDS

NH_2 GROUP

ANIMALS BREAK DOWN PROTEINS AND YOU GET NITROGEN WASTE.

P.P. → IF YOU DON'T GET IT URINE TROUBLE

PLANTS USE THIS WASTE AS BUILDING BLOCKS FOR THEIR PROTEIN PRODUCTION

BACTERIA & LIGHTNING CAN FIX N_2 FROM THE AIR

N_2 GAS IN THE ATMOSPHERE MUST BE CONVERTED BEFORE PLANTS CAN USE IT

BIOMAGNIFICATION

ACCUMULATION OF TOXINS IN THE FOOD CHAIN

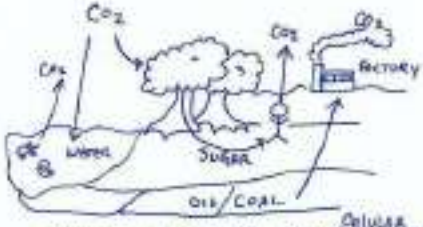
CARBON

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)

HETEROTROPHS USE SUGARS FOR ATP PRODUCTION & IN TURN MAKE CO_2

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

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

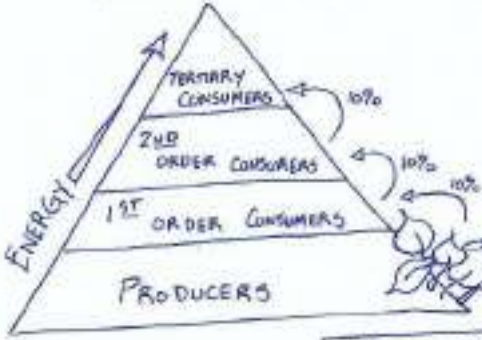


- ANIMALS PRODUCE CO_2 FROM CELLULAR RESPIRATION OF SUGARS AND OTHER ORGANIC MATTER
- BURNING OLD (ORGANIC) ANIMALS PRODUCES CO_2
- CO_2 CAN DISSOLVE INTO THE WATER
- PLANTS REMOVE CO_2 & TURN IT INTO ORGANIC MATTER

PROBLEM: ACIDIFICATION OF WATER (pH) & AQUATIC PLANTS CAN USE THE CO_2

ENERGY FLOW & COMMUNITY DYNAMICS

TROPHIC LEVEL = FEEDING LEVEL

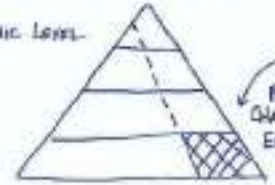


UNLESS SOMEONE LIKE YOU CARES A WHOLE AWFUL LOT, NOTHING IS GOING TO GET BETTER IT'S NOT! – THE LORAX

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. THIS THE PYRAMID SHRINKS

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

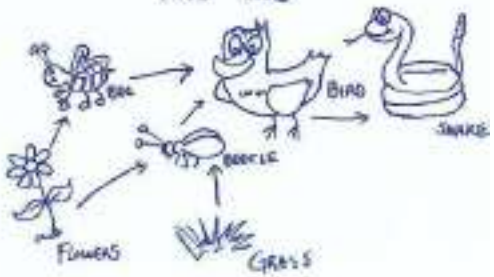
DECOMPOSERS

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

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

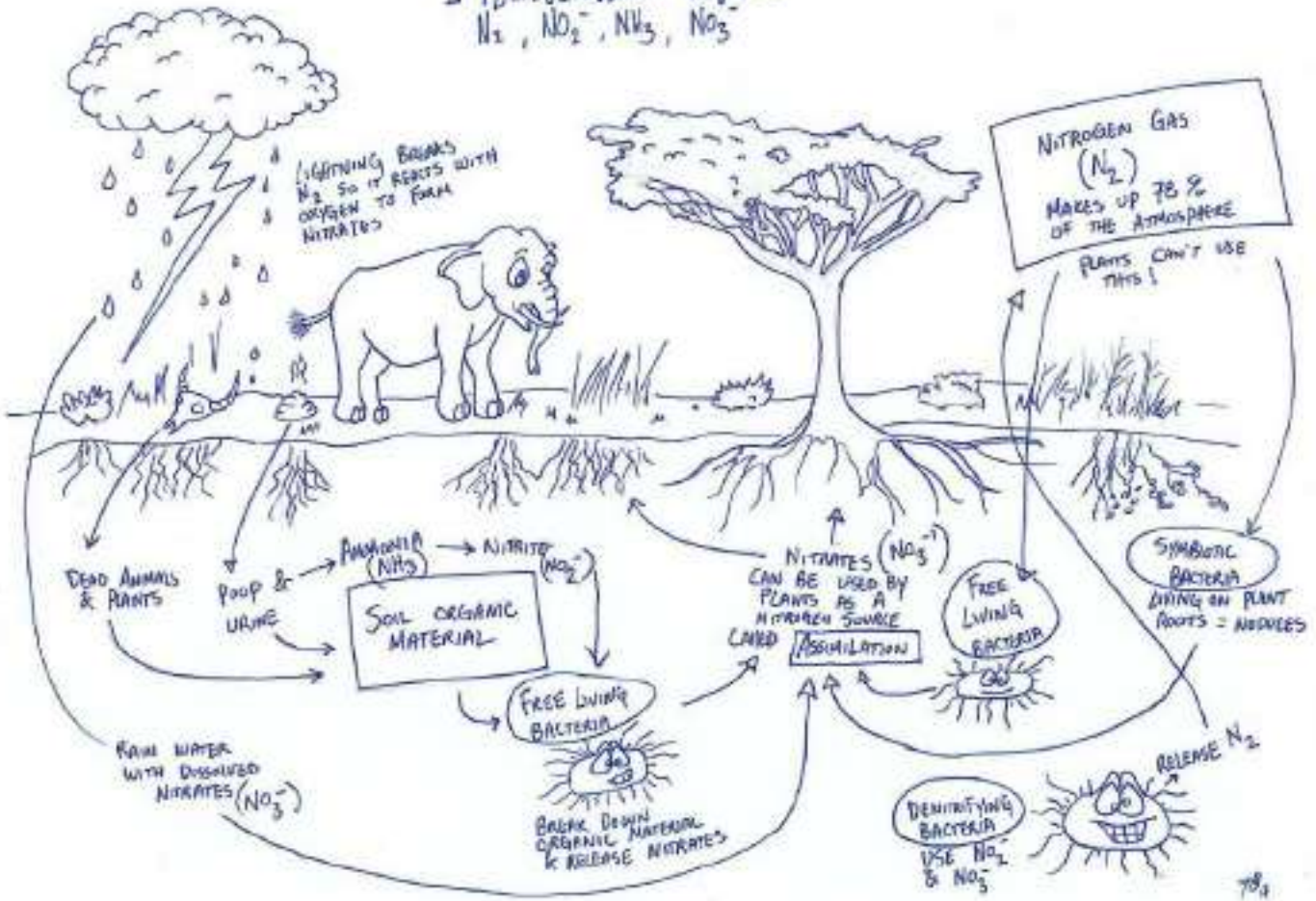
NPK
NITROGEN
PHOSPHORUS
POTASSIUM

FOOD WEB



Nitrogen Cycle

N_2, NO_2^-, NH_3, NO_3^-



Human Impact

We have changed the environment more than any other species

Pollution

Adding heavy metals & pesticides can dramatically alter the food chain.

The toxins increase up the food chain = changes to top predators

Fossil Fuel Combustion

Adding extra CO_2 can alter the ecosystem

- Ocean acidification
- Increasing global temp
- Altering weather patterns
- Altering oceanic currents

Over Fishing

- Destruction of habitat
- Changing the life span & age dynamic

Clearcutting

Removing massive amounts of trees from rainforests

- ↓ Habitat
- ↑ Erosion
- ↑ Extinction

Invasive Species

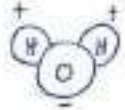
Adding organisms to a new ecosystem that do not have their normal density dependent growth factors change the natural flora & fauna

Biochemistry

WATER
LIFE'S FAVORITE MOLECULE

WHER YOU DOING?
STUDYING SCIENCE!
DUH!

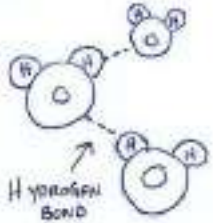
IT IS A POLAR COVALENT BOND BETWEEN OXYGEN AND HYDROGEN → ONE ATOM "LOVES" ELECTRONS MORE THAN ANOTHER SO THAT ATOM BECOMES MORE NEGATIVE



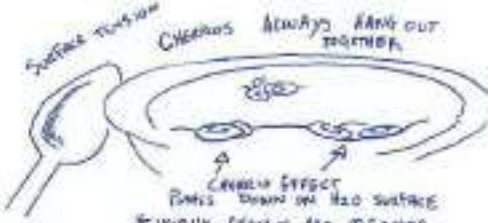
THEY ARE SHARING BUT MORE LIKE A BROTHER & SISTER SHARE.

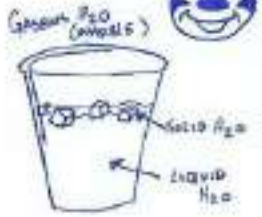
THIS POLARITY ALLOWS FOR A WIDE VARIETY OF PROPERTIES MOST OF WHICH ARE LINKED TO THE HYDROGEN BOND!

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



THE ATTRACTION OF ONE WATER MOLECULE TO ANOTHER





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.

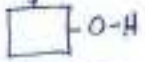
FUNCTIONAL GROUPS

– EQUALS A SINGLE COVALENT BOND

SHOW UP TOGETHER AND GIVE THE MOLECULE SPECIAL PROPERTIES

HYDROXYL

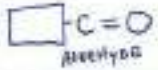
AKA. ALCOHOL



FORM H-BONDS = SOLUBLE EASILY

– FOUND IN SUGARS

CARBONYL



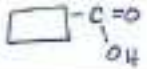
OR

ALSO HELPS WITH SOLUBILITY IN H_2O

– FOUND IN SUGARS

CARBOXYL

AKA. CARBOXYLIC ACID



EASILY DONATE H^+ INTO THE SOLUTION } ACID

– FATTY ACIDS → LIPIDS
– AMINO ACIDS → PROTEINS

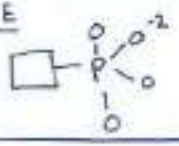
AMINO

OR

EASILY TAKE UP H^+ FROM SOLUTION } BASE

– AMINO ACID → PROTEIN

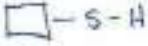
PHOSPHATE



EASILY IONIZES

– DNA, RNA, ATP

SULFHYDRAL



HELP WITH STABILIZATION ESPECIALLY IN PROTEIN STRUCTURE

– SOME AMINO ACID R-GROUPS – TERTIARY STRUCTURE

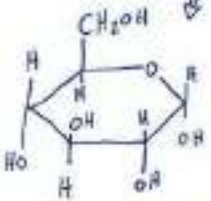
CARBOHYDRATES

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
- $C_nH_{2n}O_n$ ON THE MOLECULE (1:2:1)
- WHEN IN A POLYMER FORM IT LOOKS LIKE THE RUNGS AND HANDRAIL BARS

GLUCOSE → BLOOD SUGAR

A.K.A = MONOSACCHARIDE

FRUIT SUGAR ↓ IS A CONDENSED FORM HARMFUL?

OR IS IT THE OVER CONSUMPTION OF SUGAR BY HUMANS?

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

TWO TOGETHER = DISACCHARIDE

SUCROSE = TABLE SUGAR

$C_{12}H_{22}O_{11}$

AW! THAT IS SWEET!

GET IT? SWEET? SUGAR

LACTOSE = MILK SUGAR

GALACTOSE + GLUCOSE

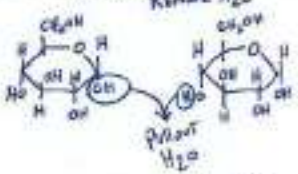
$C_{12}H_{22}O_{11}$

MALTOSE = MALT OR BEER SUGAR

GLUCOSE + GLUCOSE

$C_{12}H_{22}O_{11}$

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!

POLYSACCHARIDE

POLY = MANY

SACCHARIDE = SUGAR

TONS OF MONOMERS LINKED TOGETHER

SECONDARY ROLE

BICEP

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

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

PLANT STORAGE FOR FUTURE USE

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

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

STRENGTH IN CELLULOSE

GET IT?!

FRAYED KNOT

THE BEETLES

Proteins

Part 1

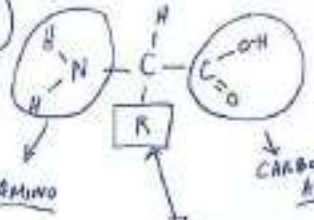
OVER 50% OF THE DRY WEIGHT OF YOUR BODY IS PROTEIN

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)

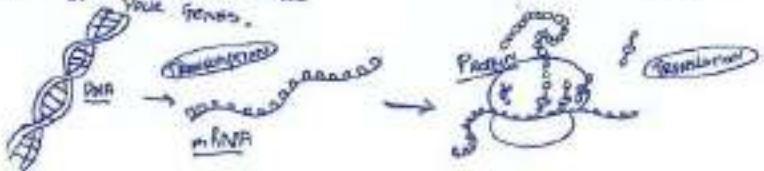


20 different R groups available.

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.

For is Remember the code is the amino acid order in your genes.



Proteins

LIKE MOST THINGS IN THIS WORLD PROTEINS ARE 3-D. THE 3-D SHAPE DETERMINES ITS FUNCTION.

HOW DOES IT GET THIS 3-D SHAPE?

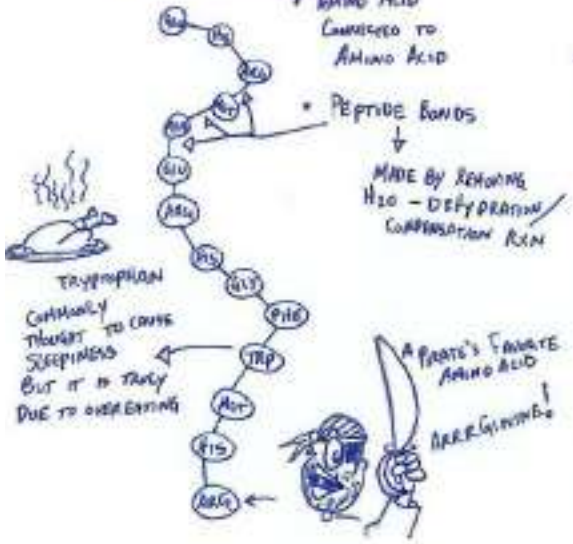
THEY FOLD!!

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

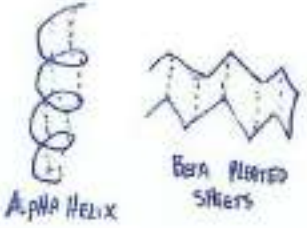
MADE BY REMOVING H_2O – DEHYDRATION CONDENSATION RXN



2° SECONDARY STRUCTURE

DUE TO H-BONDS BETWEEN DIFFERENT SECTIONS

- THE CHAIN DEVELOPS 2 DISTINCT SHAPES



3° TERTIARY STRUCTURE

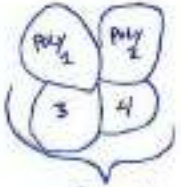
INTERACTION OF R-GROUPS STRENGTHENING THE 3-D STRUCTURE

- H-BONDS
- NON POLAR INTERACTIONS & MOST NUMEROUS
- 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

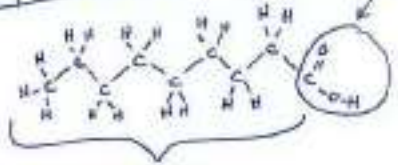
Lipids

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 → NON POLAR Hydro-CARBON CHAIN

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

UNSATURATED

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

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

PHOSPHOLIPIDS

PHOSPHATE HEAD HYDROPHILIC

HYDROPHOBIC FATTY ACID TAILS

AMPHIPATHIC - BOTH HYDROPHILIC & HYDROPHOBIC

USED IN ALL CELL MEMBRANES

OUTSIDE CELL

PUT INTO A BILAYER

INSIDE CELL

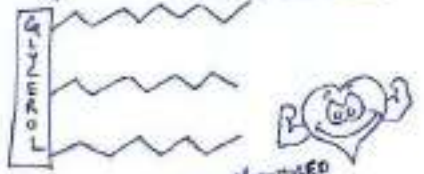
AMPHIBIAN
DUAL LIVES LAND & WATER

WE PUMP OUT H_2O TO JOIN THE FATTY ACID TO THE GLYCEROL - DEHYDRATION RXN or CONDENSATION RXN

3 FATTY ACIDS + A GLYCEROL =

TRIGLYCERIDE

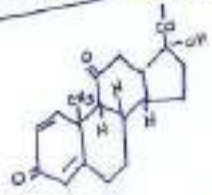
GLYCEROL



OFTEN MONITORED BY DOCTORS FOR HEART HEALTH

NON POLAR HYDROPHOBIC

STEROIDS



MOSTLY CARBON & HYDROGEN (NONPOLAR)

GENERALLY 4 FUSED RINGS

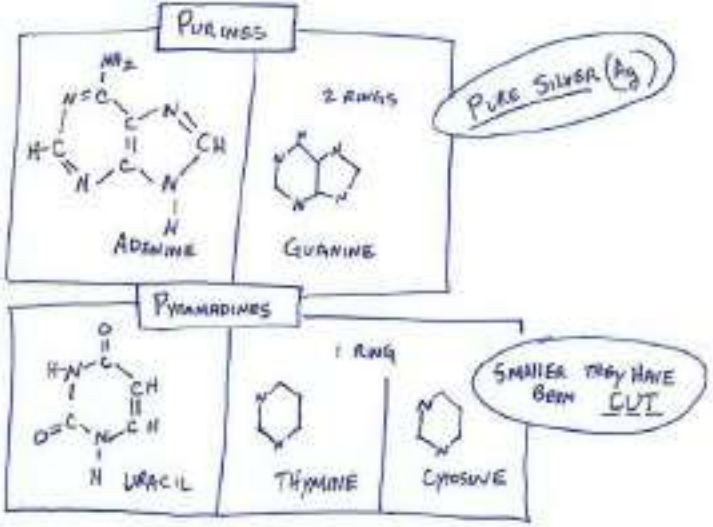
- HORMONES = TESTOSTERONE, ESTROGEN
- CHOLESTEROL - HELPS IN CELL MEMBRANES

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

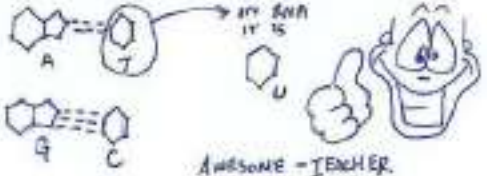


POLYMER

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 VERY 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



AWESOME - TEACHER
COOL - GUY/GAL

ENZYMES part 1

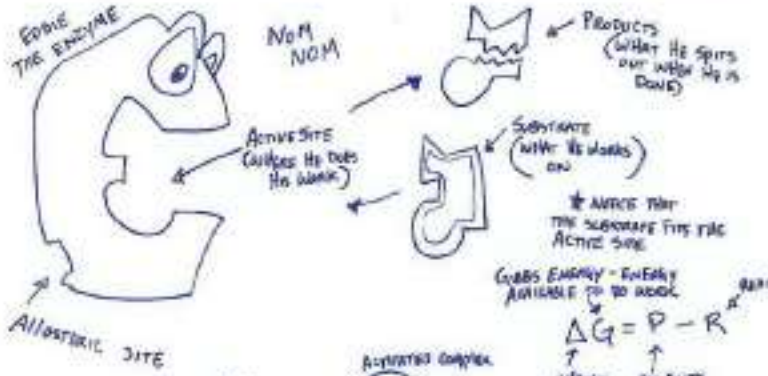
BIOLOGICAL CATALYST SPEED UP CHEMICAL REACTIONS

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

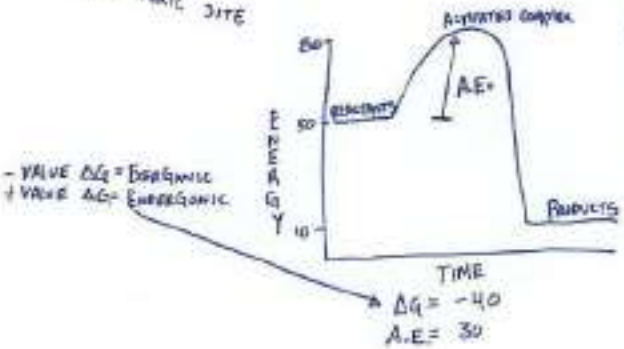
SOME ENZYMES BUILD → ANABOLIC

SOME ENZYMES BREAK → CATABOLIC

GIBBS ENERGY - ENERGY AVAILABLE TO DO WORK

$\Delta G = P - R$ (R = REACTANTS)

↑ CHANGE ↑ PRODUCTS

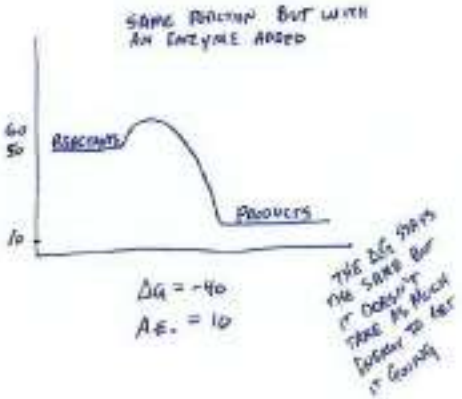


- VALUE ΔG = EXERGONIC
+ VALUE ΔG = ENDERGONIC

$\Delta G = -40$

A.E. = 30

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



$\Delta G = -40$

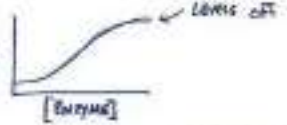
A.E. = 10

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

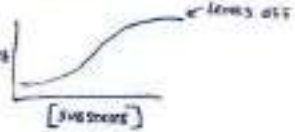
ENZYMES PART 2

FACTORS THAT AFFECT ENZYME RATE ON A REACTION

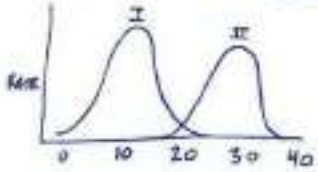
- [ENZYME] — BECAUSE HIGH CONCENTRATION
  IF YOU INCREASE THE # OF WORKERS SO IT SHOULD THE RATE



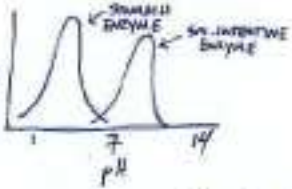
- [SUBSTRATE]
  INCREASE THE AMOUNT OF THINGS TO WORK ON IT IS EASIER FOR THE ENZYME TO "FIND".

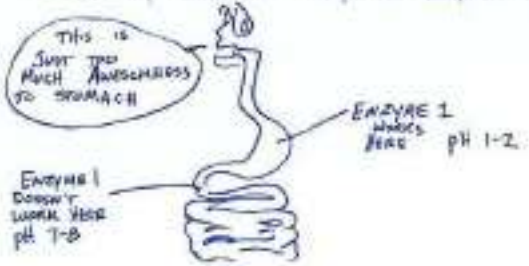


- TEMPERATURE — SINCE TEMPERATURE CHANGES BONDS, IT WILL CHANGE THE ENZYME'S 3-D STRUCTURE. EVERY ENZYME HAS ITS OWN "HAPPY" ZONE.
  - MOST ENZYMES WILL HAVE A LOW RATE AT COLD TEMPERATURES BECAUSE MOLECULES SIMPLY MOVE SLOWER



- pH — SAME AS TEMP. ALL ENZYMES HAVE "HAPPY" pH ZONES
- SALINITY — SAME AS TEMP. ALL ENZYMES HAVE "HAPPY" SALT ZONES





DENATURING

BRINGS AN ENZYME OUT OF ITS HAPPY PLACE AND CAUSE THE ENZYME TO UNFOLD.

REMEMBER SHAPE = FUNCTION

WITHOUT SHAPE 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 5

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}, Cu^{+2}, ETC.)

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

NEGATIVE FEEDBACK CONNECTION

A —ENZYME X→ B —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 and Membranes

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

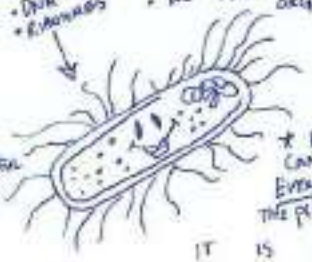
THE FIRST CELL PHONE

PROKARYOTE

BACTERIA & ARCHAEBACTERIA

- SINGLE CELLED
- NO MEMBRANE BOUND ORGANELLES

- CELL WALL
- FLAGELLA
- CELL MEMBRANE
- CYTOPLASM
- DNA
- RIBOSOMES



★ 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

$SA = 6$ $V = 1$ $\frac{SA}{V} = 6$

$SA = 150$ $V = 125$ $\frac{SA}{V} = 1.2$

★ 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 DAMAGE 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 EXPORTS

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

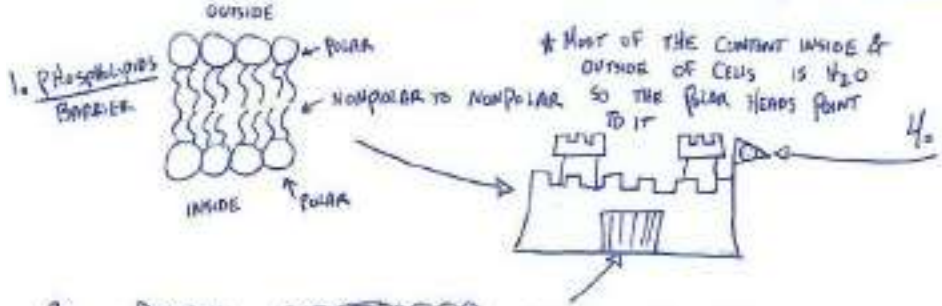
VACUOLES - STORAGE
IN PLANTS IT IS A CENTRAL VACUOLE THAT STORES H_2O

AND THIS IS A TEEPEE

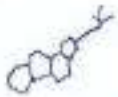
Cell Membranes

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.



3. Cholesterol-
Membrane fluidity



Antifreeze

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

Even at cold temp

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 disorder

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

The molecules move randomly and spread out

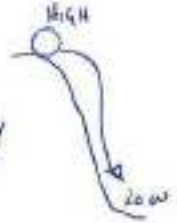
Diffusion: When a substance moves from high concentration to low concentration.

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.

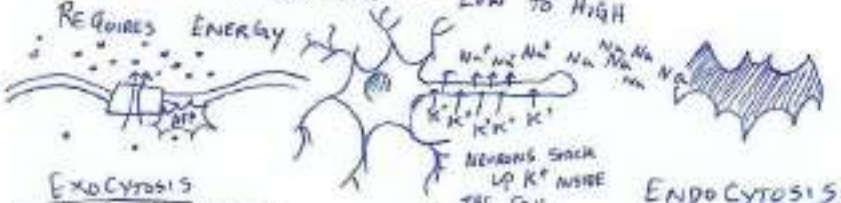
The fart smell diffuses around the room

Passive — No energy required



Active Transport: Against the gradient – Low to High

Requires Energy



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

Exocytosis — Pushing substances outside of the cell

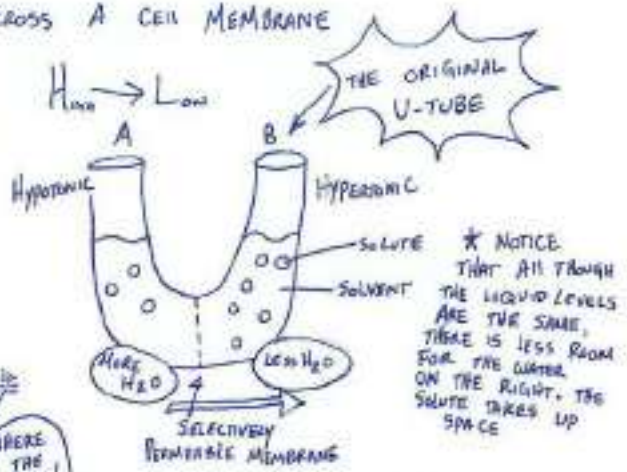
Endocytosis — Bringing things into the cell

OSMOSIS

THE DIFFUSION OF H_2O ACROSS A CELL MEMBRANE

WATER MOVES DOWN ITS GRADIENT

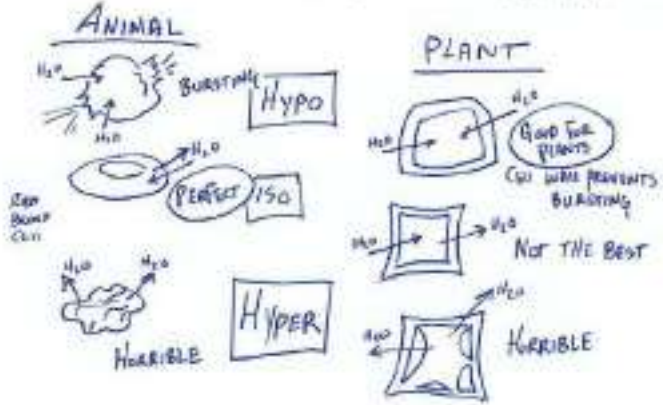
- HYPERTONIC (LOTS STUFF) – THERE IS A LOT OF MATERIAL (SOLUTE) DISSOLVED IN THE WATER (SOLVENT)
- HYPOTONIC – THERE IS A LITTLE AMOUNT OF MATERIAL (SOLUTE) DISSOLVED IN THE WATER (SOLVENT)
- ISOTONIC – THERE IS EQUAL AMOUNT OF MATERIAL DISSOLVED IN BOTH LOCATIONS

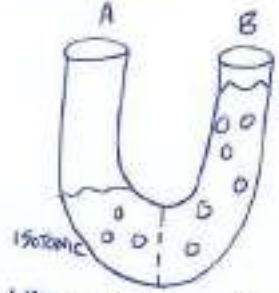


★ NOTICE THAT ALTHOUGH THE LIQUID LEVELS ARE THE SAME, THERE IS LESS ROOM FOR THE WATER ON THE RIGHT. THE SOLUTE TAKES UP SPACE

WATER IS A PARTY ANIMAL!

REAL CELLS



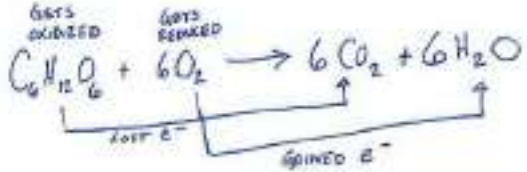


IF THIS WAS KOOL-AID, AT THE BEGINNING SIDE B WOULD BE SWEETER THAN A, BUT AT THE END THEY TASTE THE SAME.

Cellular Respiration and Photosynthesis

Reduction & Oxidation

It is all about the movement of electrons.



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

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

Main Steps

O_2 required

Krebs Cycle (Citric Acid Cycle)

Electron Transport Chain E.T.C.

1 Glucose (6 carbon sugar)

2 ATP

2 Pyruvate 3 carbon sugar

Pyruvate

NADH x2

Cytoplasm

2 Pyruvates

CO_2 x2

2 Acetyl-CoA 2 carbon sugar

4 carbon sugar

6 carbon

Inside of the mitochondria

CO_2

5 carbon

CO_2

4 carbon

NADH x2

ATP x2

NADH x6

$FADH_2$ x2

Mitochondria

H^+

Proton pump

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 twists it churns 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.

Without O_2 the cells must **Ferment.**

For more ATP energy you need the Mighty Mitochondria

* The folds ↑ surface area ↑ ATP. More folds = more E.T.C. = more ATP

Pyruvate 3-carbon → Lactate 3-carbon

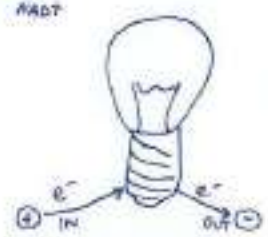
NADH → NAD+

* Recycle NAD+ get rid of the electron so you can do, at least, Glycolysis again.

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

Pyruvate → CO_2 + Ethanol 2-carbon

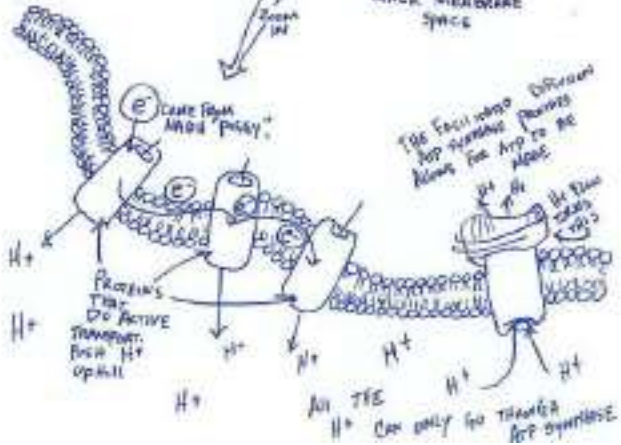
NADH → NAD+



All circuits must have an in and an out.

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

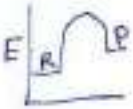
This is why O_2 must be present. To pick up the e⁻.



PHOTOSYNTHESIS

PART 1

ENDERGONIC

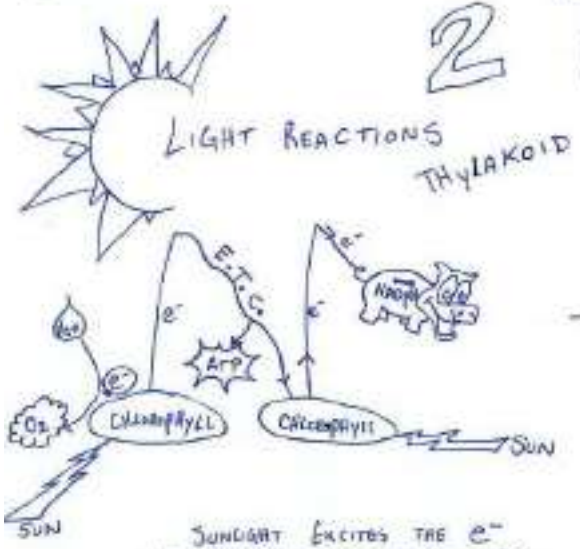


$$\text{SUN} + 6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

LIGHT ENERGY

MAKING SUGAR FROM AIR!

2 MAJOR STEPS



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

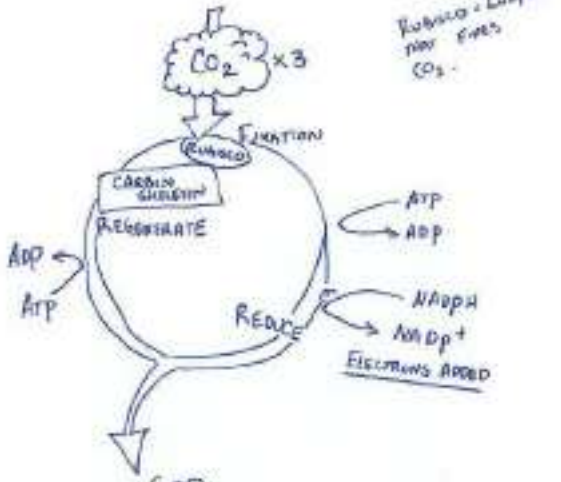
so

$6CO_2$ = 1 GLUCOSE

STROMA

LIGHT INDEPENDENT REACTIONS

CALVIN CYCLE



G3P

GLYCERALDEHYDE-3-PHOSPHATE

½ OF A GLUCOSE

PHOTOSYNTHESIS PART 2

ALL DONE WITH THE COOL CHLOROPLAST

A PLANT HAS ITS OWN BODYGUARDS & TOUR

IN ORDER TO BE MORE EFFICIENT IN ABSORBING LIGHT PLANTS HAVE ACCESSORY PIGMENTS. YOU USUALLY ONLY SEE THOSE COLORS IN THE FALL BUT THEY ARE ALWAYS THERE.

SUNLIGHT PROVIDES THE ENERGY TO TURN LOW ENERGY e^- INTO HIGH ENERGY e^-

GREEN COLOR IS IN THE SPECTRUM. THAT IS WHY PLANTS LOOK GREEN. GREEN WAVELENGTH IS REFLECTED, NOT ABSORBED.

The Problem and the Plants that Found a New Niche

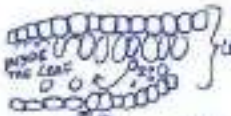
Evolution → opening for growth & diversification

The Problem

is that when things get hot & dry plants tend to

Photo respire

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

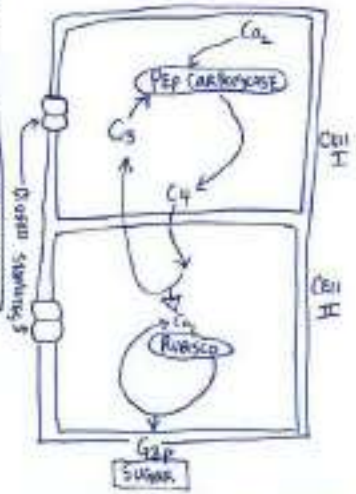


⇒ If they can't get rid of the O_2 & $[CO_2]\downarrow$ then they essentially start breaking the sugar they are attempting to make.

Due to Rubisco's love for O_2 more than CO_2

Photo Respiration

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 lost.

Hot. Close the stomates (mid day) A.M.

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

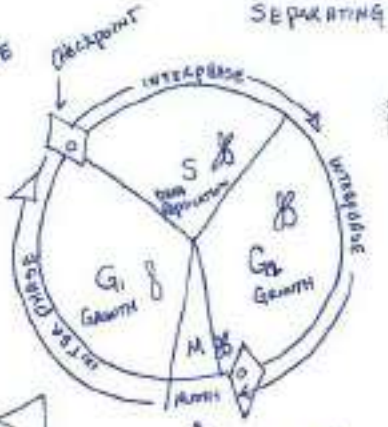
Mitosis and Meiosis

Mitosis

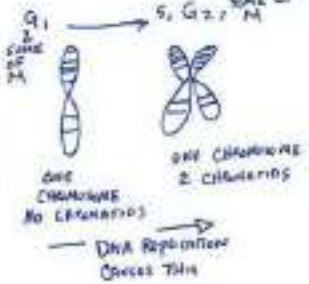
Separating a Cell's DNA part 1

Why?

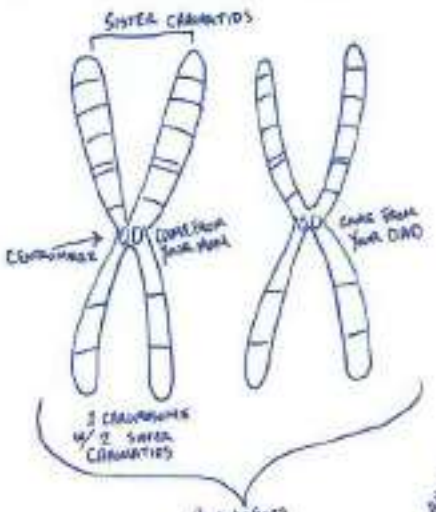
- To Grow
- To Repair
- To Replicate



We can only see chromosomes when cells are in Mitosis.

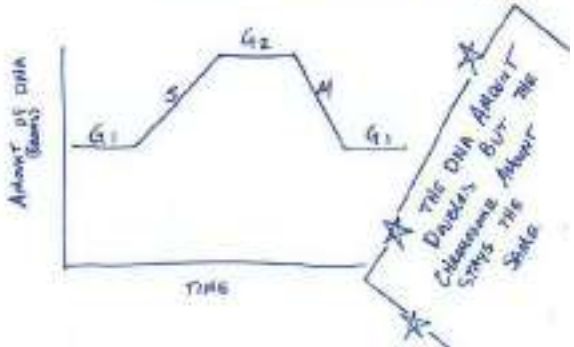


The Chromatid Term is used to show that these are 2 identical copies of DNA attached to each other.



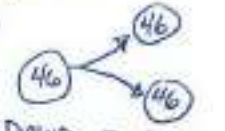
Cells grow organelles and other cellular components in preparation for division. It also duplicates the DNA so that the two resulting cells have the exact same amount.

Checkpoints make sure cells don't move on until they are ready.



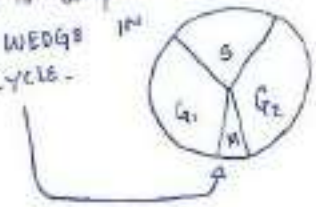
MITOSIS PART 2

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 VISIBLE
- NUCLEUS IS DISSOLVING
- SPINDLE FIBERS FORM & ARE GROWING

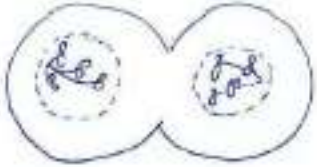
METAPHASE

- CHROMOSOMES ARE AT THE MIDDLE OF THE CELL [EQUATOR PLATE]
- 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 ELONGATE.

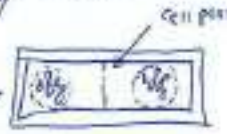
TELOPHASE



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

HOMOLOGOUS PAIRS ARE PRESENT PAIRED UP. BUT NOT

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



MEIOSIS PART I

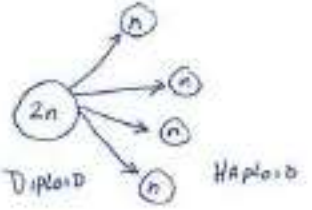
GOAL
- TO REDUCE CHROMOSOME COUNT IN HALF
- REPRODUCTION (SEXUAL)

PMAT I
PMAT II

IT STILL FOLLOWS THE SAME FLOW AS MITOSIS

DOUBLE THE DNA THEN DIVIDE

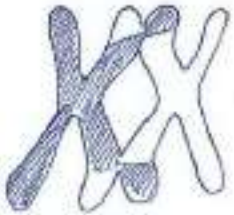
BUT THERE ARE KEY DIFFERENCES.



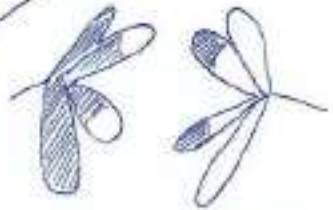
DIPLOID HAPLOID

CROSSOVER

PROPHASE I



ANAPHASE I

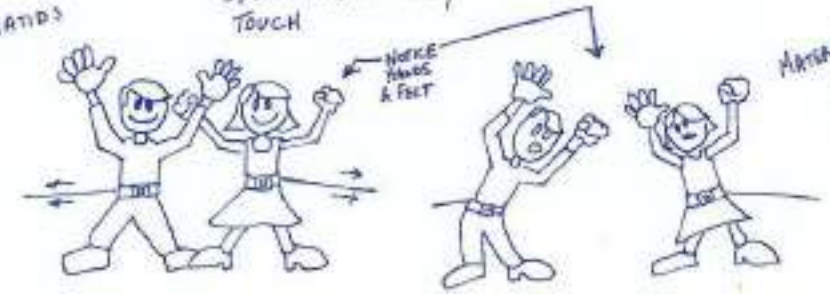


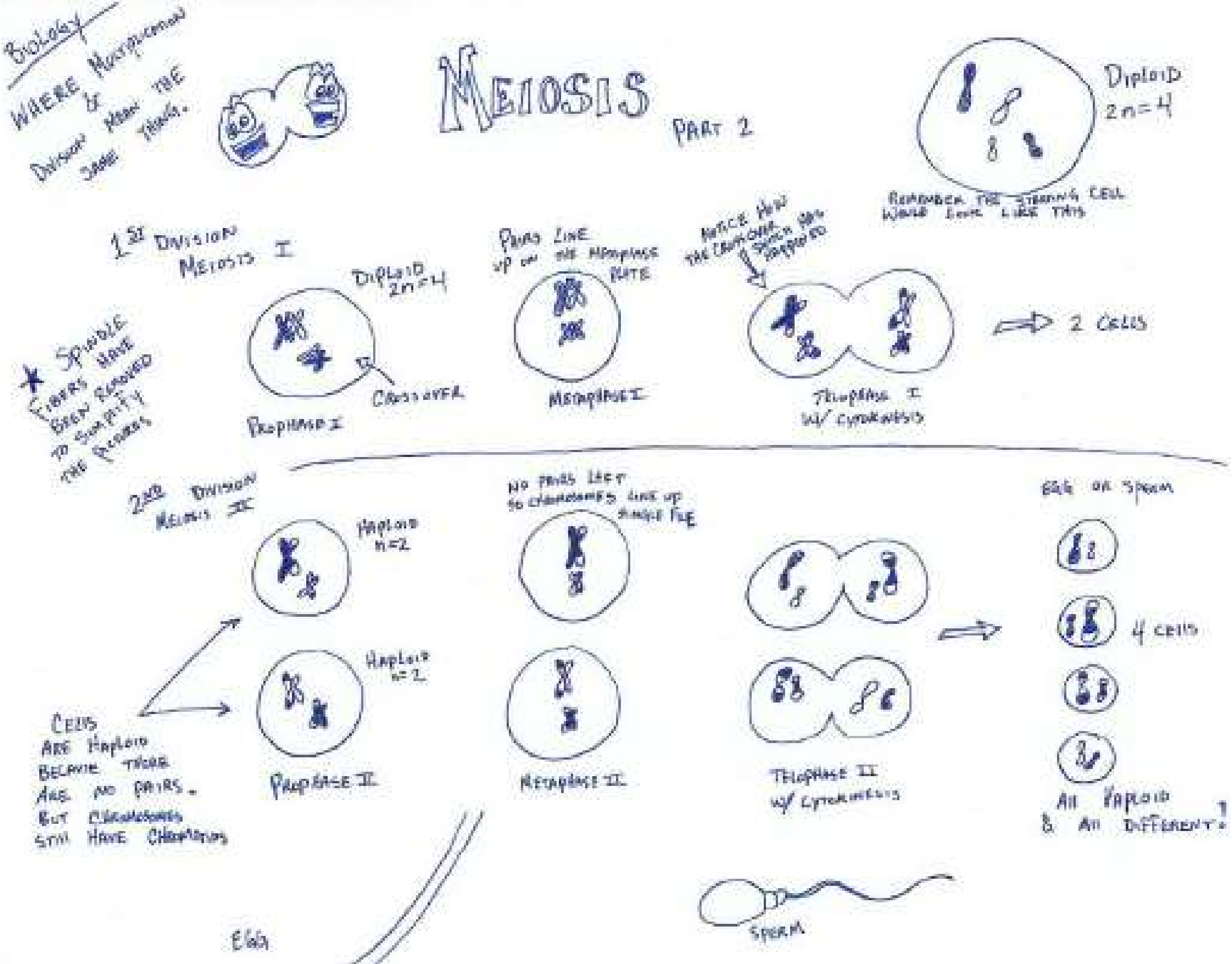
HOMOLOGOUS CHROMOSOMES PAIR UP.

- THE INSIDE CHROMATIDS TOUCH

THE CHROMOSOMES SWITCH INFO AT THOSE SPOTS WHERE THEY TOUCH

HOMOLOGOUS PAIRS ARE PULLED APART




BIOLOGY
WHERE MULTIPLICATION & DIVISION MEAN THE SAME THING.
MEIOSIS
PART 2
DIPLOID
2n=4
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
TELOPHASE I
W/ CYTOKINESIS
2 CELLS
* SPINDLE FIBERS HAVE BEEN REMOVED TO SIMPLIFY THE FIGURES
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

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

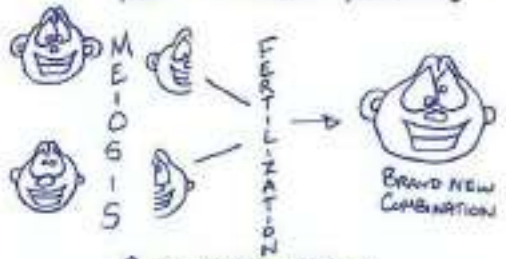
★ SOME CAN DO BOTH
- BUDDING IN JELLYFISH
- RUNNERS ON STRAWBERRIES
- WATER SPROUTS IN TREES

EXCEPTIONS
- SELF FERTILIZATION
- 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

FUTURE

WHY IS VARIATION THE KEY TO THE FUTURE?

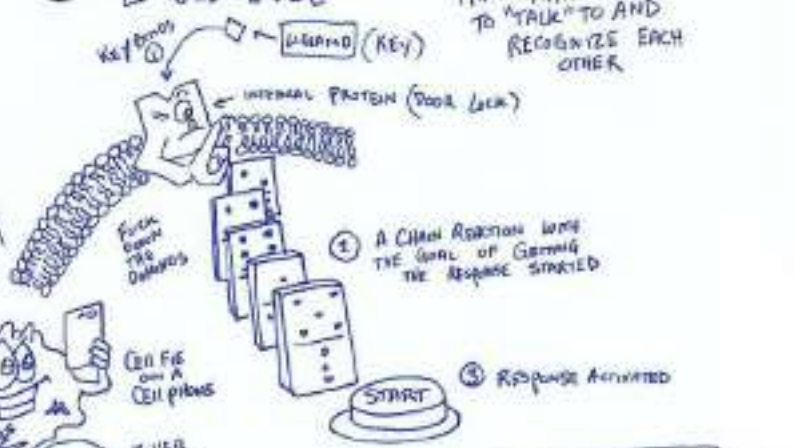
THE EARTH IS CONSTANTLY CHANGING. IF A POPULATION HAS DIVERSITY IN THEIR GENOME AS A GROUP THEY MAY HAVE SOME INDIVIDUALS THAT COULD SURVIVE WHAT THE FUTURE BRINGS.

Cell Communication

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

3 Major Steps

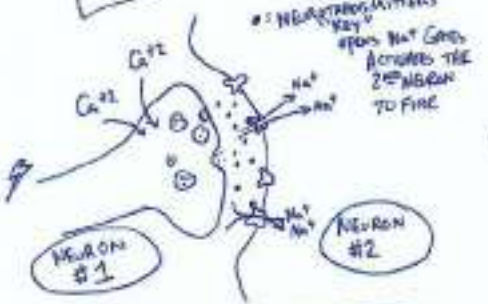
1. **Reception** – A molecule or another cell binds with a cell receptor (like a door lock)
2. **Transduction** – Release the molecule bound to the receptor, a chain reaction happens inside the cell (Relay race type)
3. **Response** – The cellular response occurs (Goal)



Killer T-cells destroy cells that are recognized as sick

Cancer = failure to respond to death signal

Immunity Communication



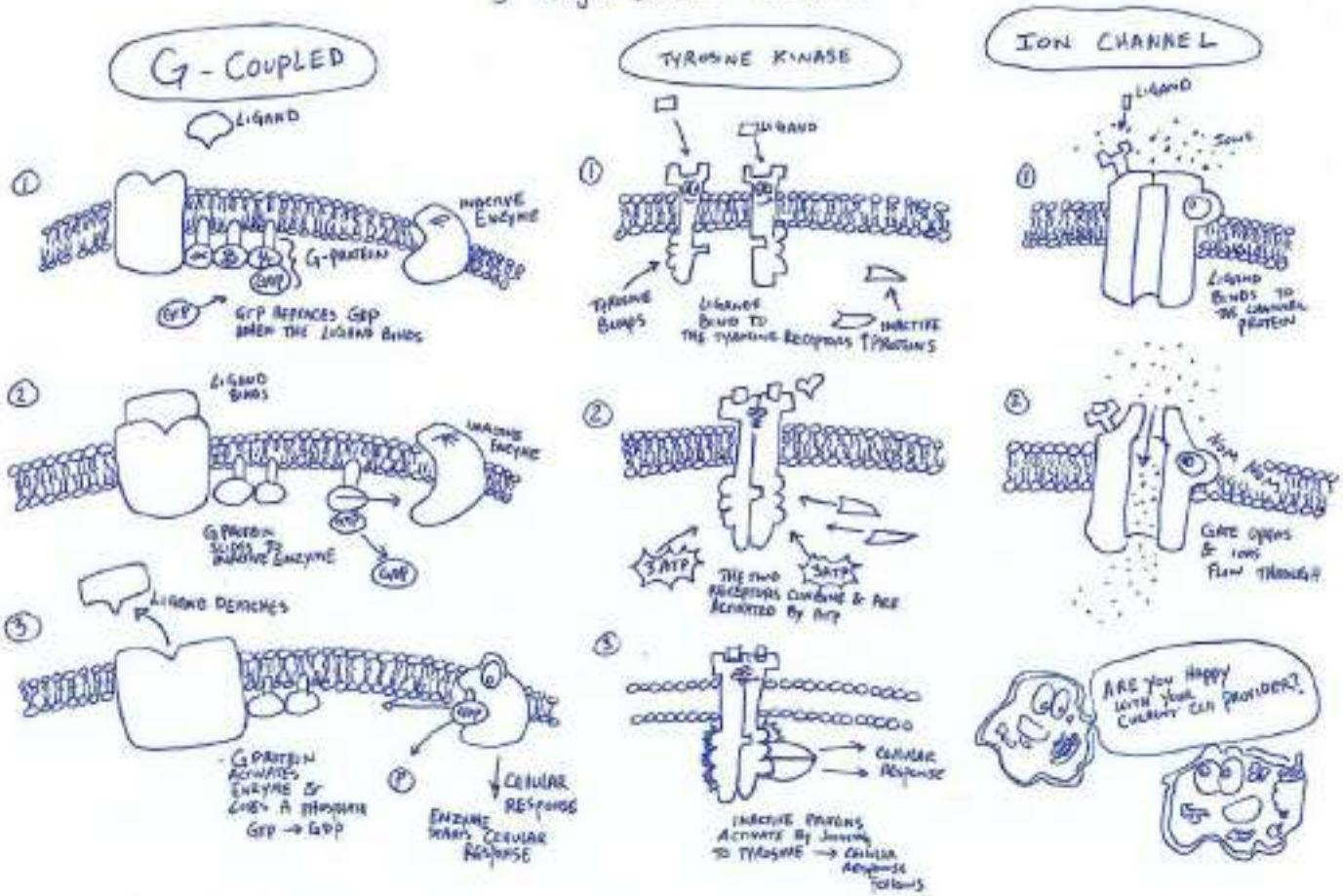
Nervous System Communication

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

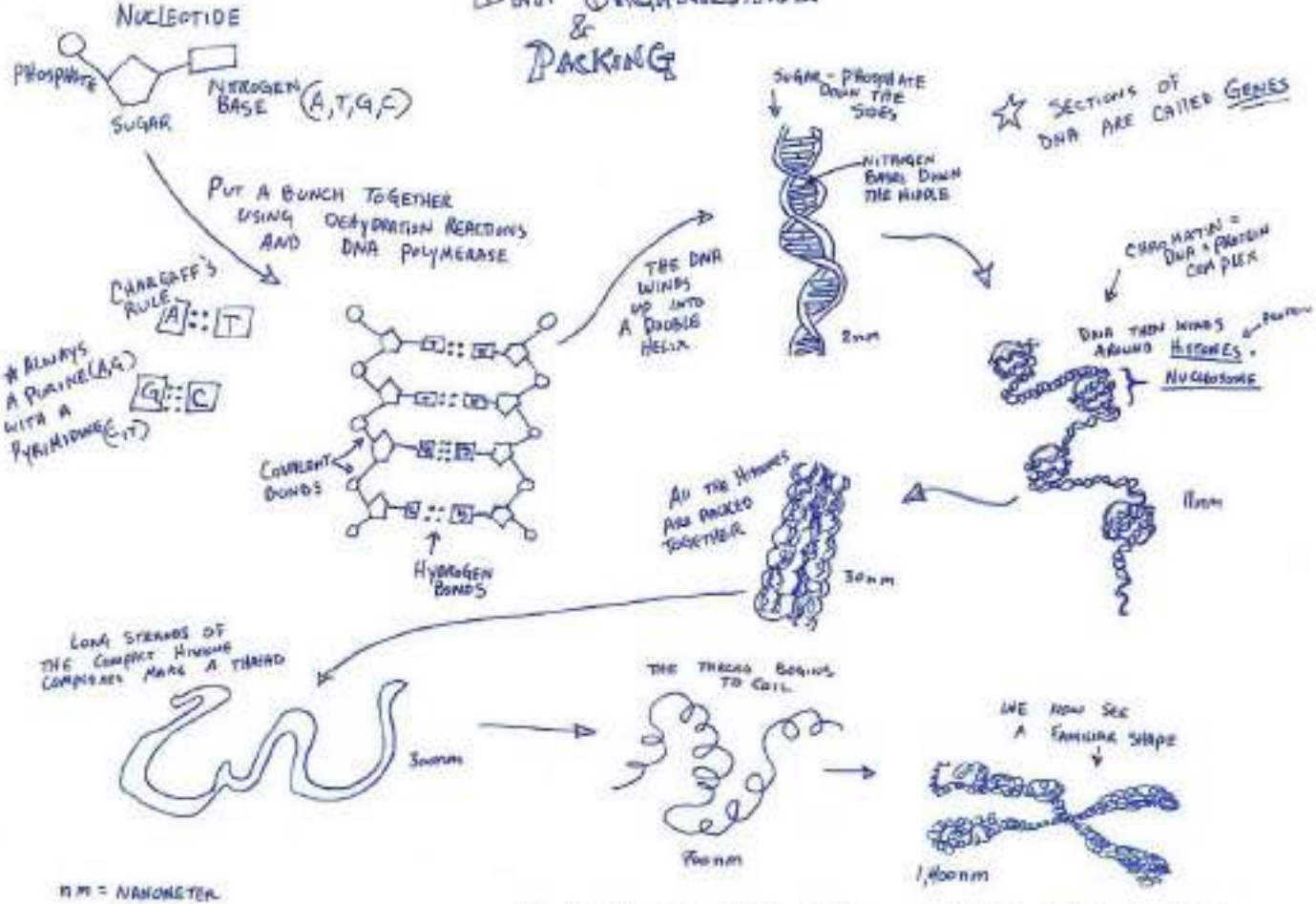
CELL COMMUNICATION

3 MAJOR LIGAND RECEPTORS



DNA Structure, DNA Replication, Protein Synthesis

DNA ORGANIZATION & PACKING



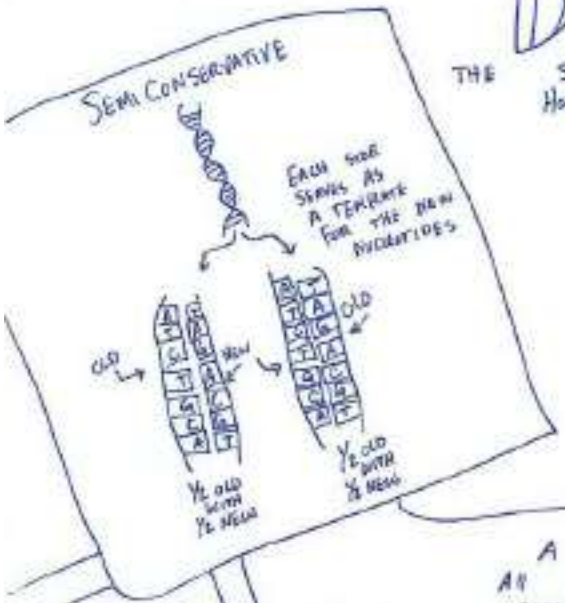
nm = NANOMETER
10^{-9} METERS
OR ONE BILLIONTH OF A METER

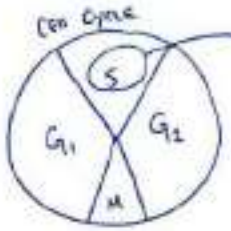
CHROMOSOMES ARE MADE OF GENES WHICH ARE MADE OF DNA

DNA Replication Part 1

THE STRUCTURE OF DNA LEADS TO HOW IT IS DUPLICATED

Must Duplicate Before You Divide





Synthesis of DNA aka DNA Replication

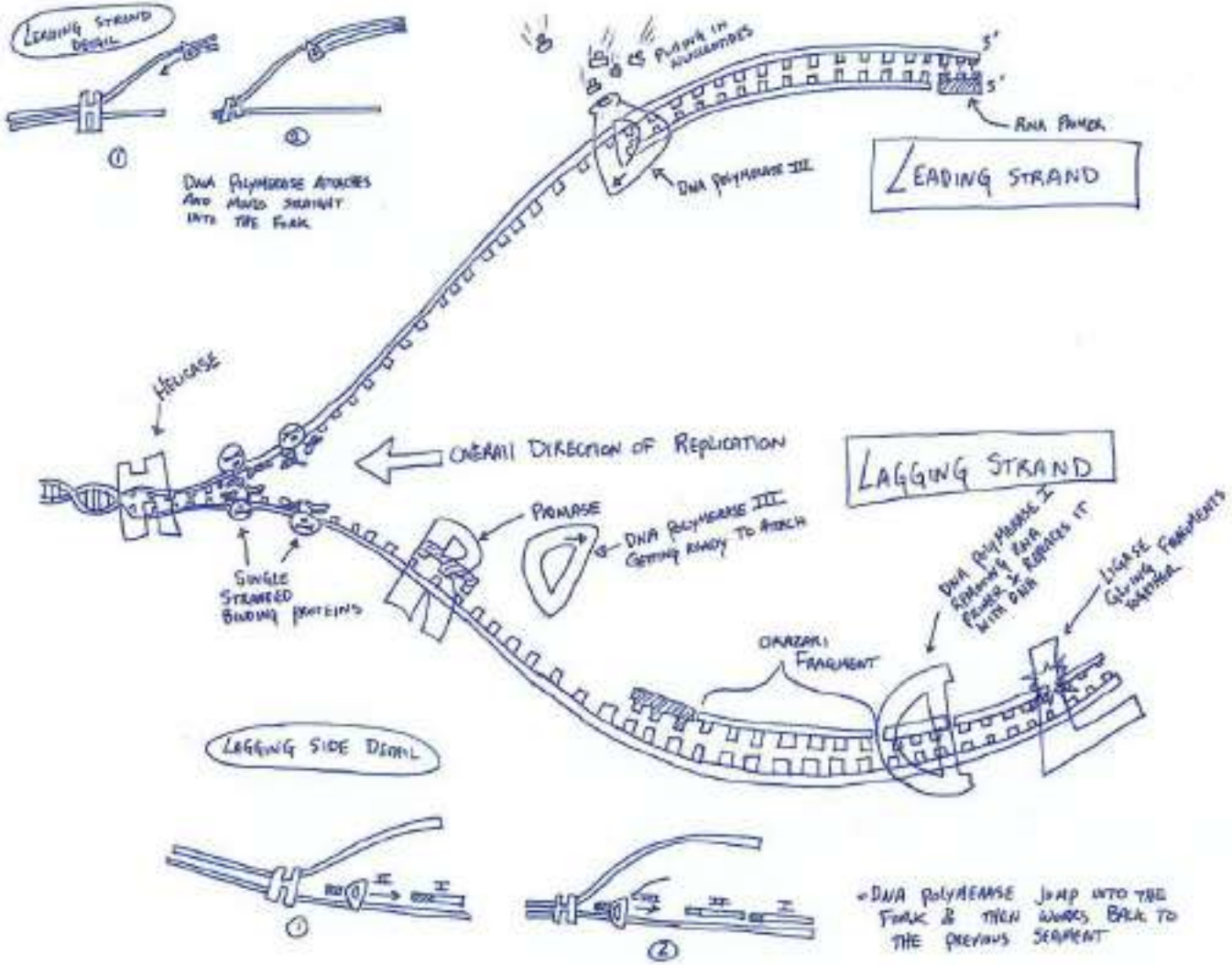
Cells have to duplicate their DNA before they divide.

A complicated process but is all run by special proteins called Enzymes.

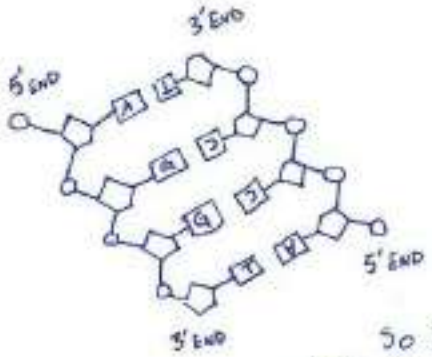
DNA Polymerase Rules ★
- Can only go 5' → 3'
- Most have nucleotides present to attach

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

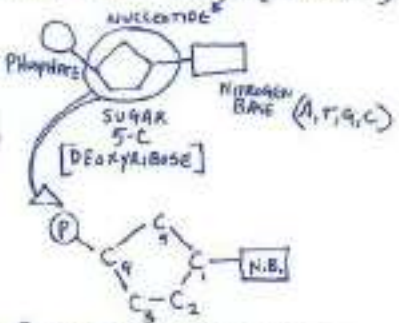

LEADING STRAND DETAIL
1
2
DNA POLYMERASE ATTACHES AND MOVES STRAIGHT INTO THE FORK
DNA POLYMERASE III PUSHES IN NUCLEOTIDES
5'
5'
RNA PRIMER
DNA POLYMERASE III
LEADING STRAND
HELICASE
OVERALL DIRECTION OF REPLICATION
LAGGING STRAND
PRIMASE
DNA POLYMERASE III GETTING READY TO ATTACH
SINGLE STRANDED BINDING 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 PARRALLEL 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 IS BOUND TO BE PRONE TO ERROR.

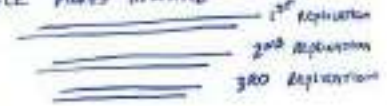
NUCLEASE I.D.'S THE MISTAKE AND CUTS IT OUT

DNA POLYMERASE ADD THE NEW NUCLEOTIDES

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

LIGASE GLUES THE PIECES TOGETHER

EVERY TIME DNA GETS REPLICATED THE ENDS GET SHORTER. THIS IS DUE 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

COLORED SECTION IS YOUR GENOME AKA. GENES THAT CODE FOR YOUR TRAITS = PHENOTYPE

THIS JUST CUT YOUR GENOME SO NOW THE CELL CAN NO LONGER DIVIDE.

THOSE ENDS OF A CHROMOSOME ARE CALLED TELOMERES. THEY ARE A LOT LIKE THE PLASTIC PROTECTOR OF YOUR SHOE LACE.

TELOMERES

THEY PROTECT THE CHROMOSOME FROM DAMAGE. ONLY ONE ENZYME MAKES THIS PROTECTIVE NON SENSE DNA CODE

TELOMERASE ENZYME

TELOMERASE IS ONLY ACTIVE IN TWO TYPES OF CELLS

CANCER CELLS — IMMORTAL

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.

TUMOR

HEALTHY CELLS WON'T DO THIS

STEM CELLS — IMMORTAL

THEY ARE CALLED STEM CELLS BECAUSE THEY HAVE THE POTENTIAL TO BRANCH OUT AND TURN INTO MANY TYPES OF CELLS

LIKE A TREE

MULTIPOTENT - HAVE FLEXIBILITY BUT IT IS LIMITED. BLOOD STEM CELLS CAN TURN INTO RED, OR 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

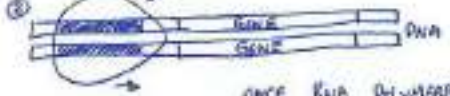
Step 1. Transcription

Turn DNA into RNA. But why? →

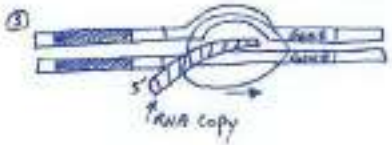
DNA is super important so we don't want it damaged

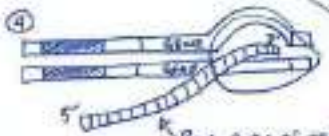
If we make a copy it is ok if it accidentally gets damaged. We can make another copy

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

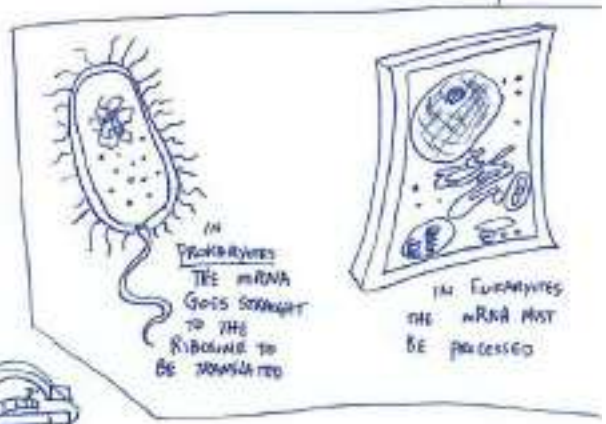


Once RNA polymerase attaches it simultaneously unzips and copies the DNA into RNA 5'→3' direction





} A.K.A mRNA (m = 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 tweaked.

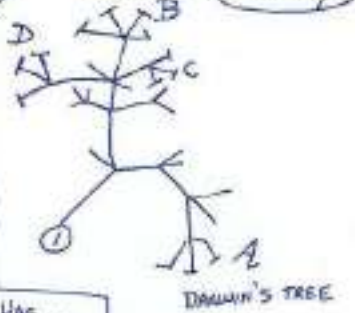
Cap + tail on a mRNA will protect the transcript from endonucleases (restriction enzymes) that may damage the RNA before it is translated

E= Exons
I= Introns

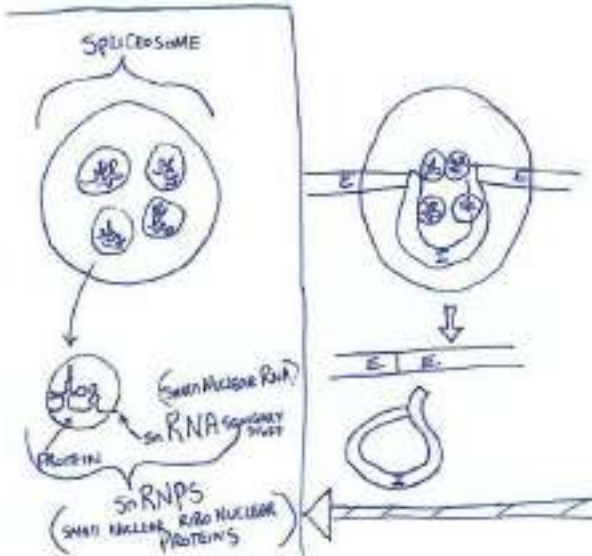
- Exons are transcribed & translated sections of a Eukaryotic Chromosome
- Introns must be removed

Evolutionary Benefit of Introns

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



Darwin's tree



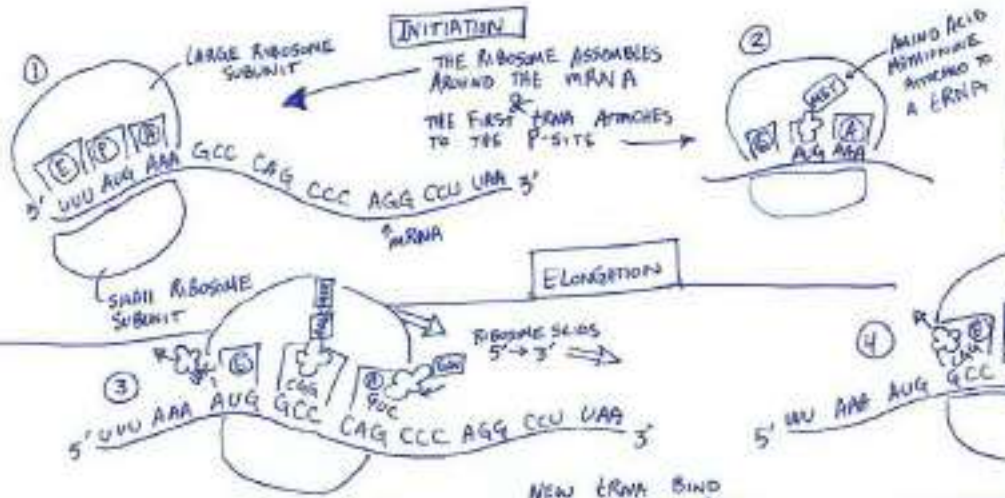
1. The spliceosome identifies the ends of an intron
2. The spliceosome folds the chromosome
3. The spliceosome cuts out the intron & bonds the two exons together

- 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



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

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 lungfish!

Lungfish

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

GENE CHANGES IN FULL GENE SECTIONS

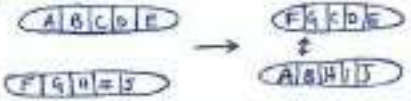
- DUPLICATION

FULL CHROMOSOME WITH MULTIPLE GENES

- DELETION

- INVERSION

- TRANSLOCATION



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

ANEUPLOIDY = WRONG # OF CHROMOSOMES

★ NONDISJUNCTION IN MEIOSIS

HUMANS NORMAL

ANEUPLOID 45 ← 46 → 47 ANEUPLOIDY

TURNERS 45X

47 · KLEINFELTERS OR · DOWNS

Genetics

Basic Genetic Laws

often referred to as Mendel's Laws

Father of Genetics

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

Law of Segregation

- Homologous pairs, and chromatids, should separate during anaphase, anaphase I, and anaphase II

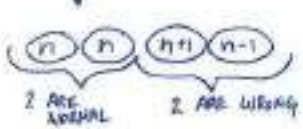
Mutation

Non Disjunction – Failure of chromosomes to separate properly. → can be visable on a Karyotype

This side has too many

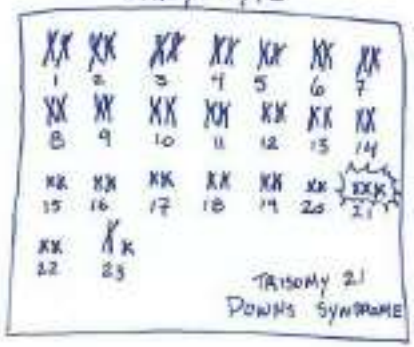
This side has too few

Meiosis II



2 are normal

2 are wrong



n+1 = Haploid amount + 1 extra chromosomes

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

Meiosis I

Gamete Results

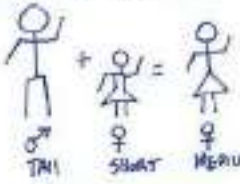
All 4 gametes are wrong

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



VARIATION IN A GENE

ALLELE
ALTERNATIVE FORMS OF A GENE

A = CAPITAL LETTER DENOTES THAT IT IS DOMINANT

MENDEL EXPERIMENT EXAMPLE

RED FLOWER POLLEN × WHITE FLOWER EGG — P GENERATION

ALL THE FLOWERS WERE RED

- SO THEN WE CROSSED THE CHILDREN TOGETHER

F_1 GENERATION

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

F_2 GENERATION

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.

GENOTYPE
REPRESENTATION OF THE DNA COMPOSITION FOR A TRAIT

[AA - Aa - aa]

PHENOTYPE - PHYSICAL CHARACTERISTIC

IN THIS CASE IT IS BEING AWESOME.

HEY PHENOTYPE & PHYSICAL BOTH START WITH 'PH'

SAME ALLELES AA OR aa
HOMOZYGOUS

DIFFERENT ALLELES Aa
HETEROZYGOUS

GENETICS PART 2.

PUNNETT SQUARES

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

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

ELE-PHANT-RHINO!

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

GAMETES

RED FLOWERS Aa

EGG POSSIBILITIES A OR a

A a FEMALE GAMETES

MALE GAMETES

A

a

	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

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

GENOTYPE

3/4 POSSIBILITY OF THE CHILD BEING RED

1/4 POSSIBILITY OF THE CHILD BEING WHITE

PHENOTYPE

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 MULTIPLYING 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

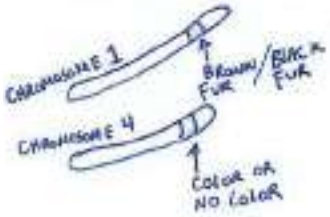
PLEIOTROPY - ONE GENE HAS MULTIPLE PHENOTYPIC RESULTS.

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

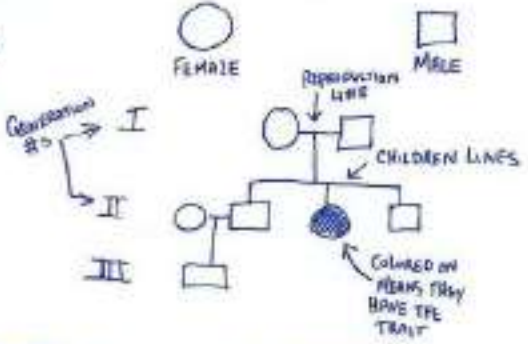
$I^A I^B$ $I^A i$ $I^A I^A$ ETC.

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

OUTBREEDED 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

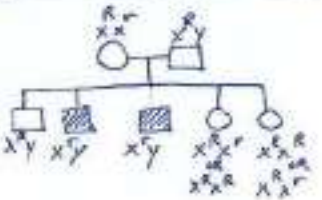
AUTOSOMES - IN HUMANS THEY ARE CHROMOSOMES 1-22

SEX CHROMOSOMES - IN HUMANS IT IS THE 23RD

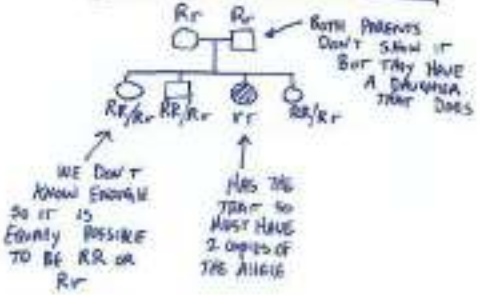
FEMALES CAN BE CARRIER BUT MALES ONLY GET ONE COPY

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

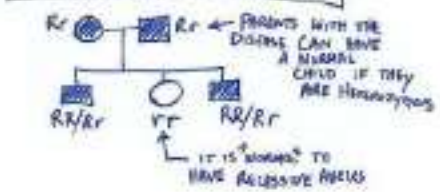
SEX-LINKED OR X-LINKED RECESSIVE



AUTOSOME RECESSIVE PATTERN



AUTOSOMAL DOMINANT PATTERN



GENETICS

HUMAN DISEASE & TRAITS

AUTOSOMAL RECESSIVE [ON A NON-SEX CHROMOSOME]

MUST BE aa TO 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 - PHENYKETONURIA - CANNOT PROCESS PHENYLALANINE AND IN TURN IT BUILDS UP IN TISSUES.

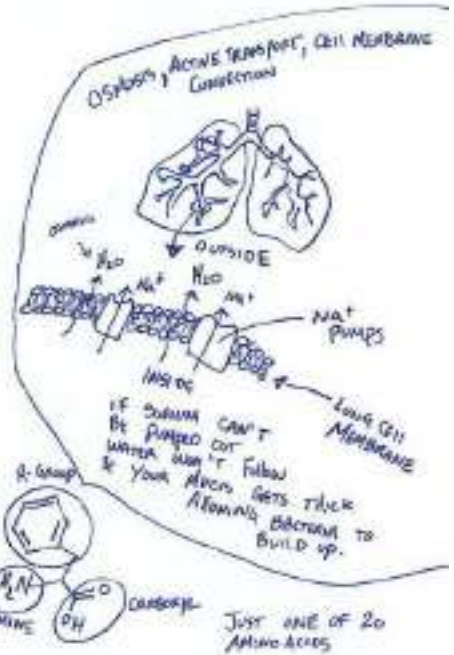
AUTOSOMAL DOMINANT [ON A NON-SEX CHROMOSOME]

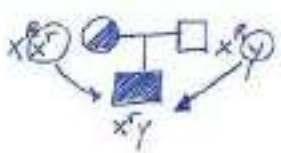
MUST BE Aa OR AA TO GET THE TRAIT

- 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 YEARS OLD)
- ACHONDROPLASTIC DWARFISM - SHORT STATURE CAUSED 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





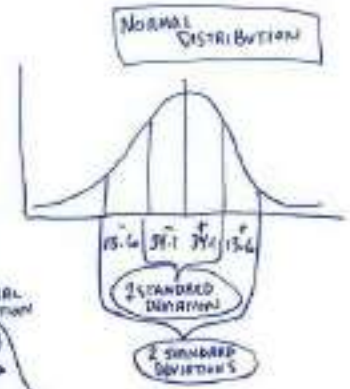
Chi Squared & Genetics

THE FORMULA

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

O = OBSERVED, e = EXPECTED, Σ = SUM, χ^2 = CHI SQUARED

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 | SEPIA EYED

OBSERVED: 741 | 259

SO NOW WE NEED TO TRY THE FORMULA

THIS LOOKS CLOSE

SO BASED ON THE RESULTS YOU MAY THINK COMPLETE DOMINANCE INHERITANCE.

MAKE A PUNNETT SQUARE

	R	r
R	RR	Rr
r	Rr	rr

¾ RED
¼ SEPIA

	R	R
R	RR	RR
r	Rr	Rr

ALL ARE RED

CONVERT YOUR PUNNETT SQUARE RATIOS INTO NUMBERS RELEVANT TO YOUR EXPERIMENT.

¾ × 1000 TOTAL FLIES = 750 EXPECTED

¼ × 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

IF 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

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 WHOLE GENE WITH THE SAME TYPE OF RESTRICTION ENZYME

STEP 4:

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

LIGASE ENZYME TO GLUE

RECOMBINANT DNA

STEP 5:

ALLOW BACTERIA TO TAKE THE PLASMID [TRANSFORMATION]

CELLS = 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

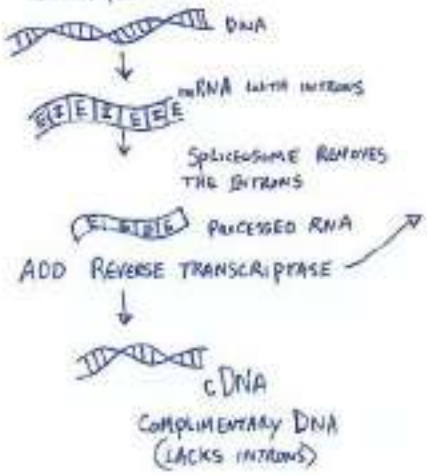
Part 2

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



H.I.V. = Human Immunodeficiency Virus

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

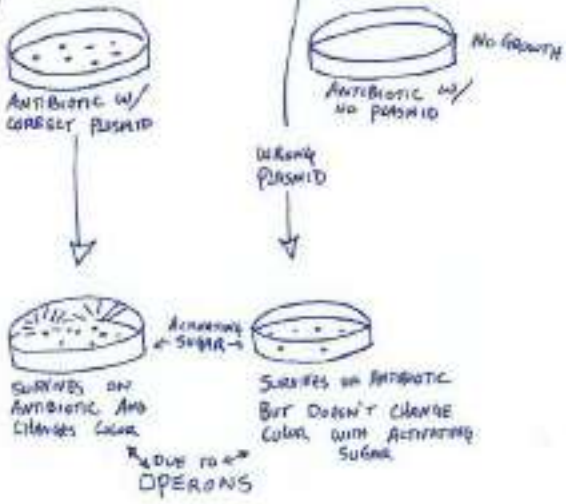
It does this before it hijacks your cells.

Screening

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

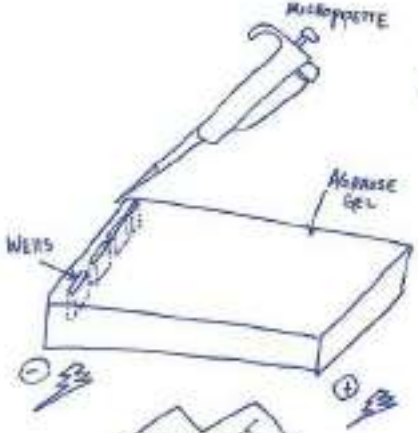
Good Plasmid → Put the bacteria on an antibiotic

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



Gel Electrophoresis

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

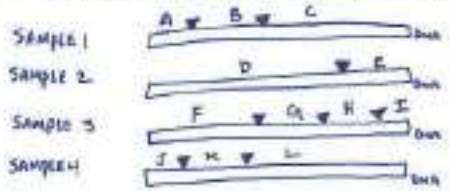


Can be used for:
1) Crime scene analysis
2) Paternity tests
3) Disease detection
4) Species comparisons

→ 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.

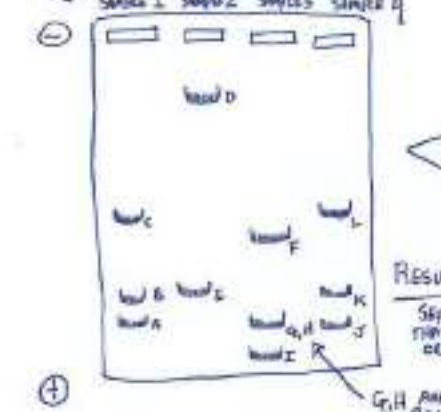


▼ = Restriction site found & DNA is cut

Resulting segments have been separated

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)

Referred to as a DNA fingerprint



Results: The fragments separate by size. Notice that they may be out of order.

Analysis

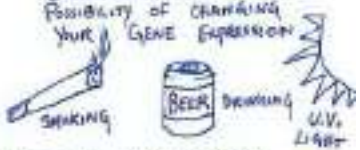
- Sample 1 & 4 have the same fingerprint (DNA bands of the same size)
- Very high probability that suspect 1 was at the crime scene

EPIGENETICS

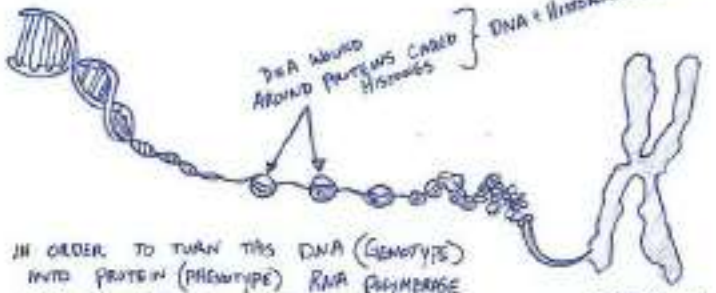
ABOVE THE GENETICS OR GENOME.
YOUR ENVIRONMENT CAN CHANGE HOW DNA IS TURNED INTO PROTEIN.

THIS IS WHY IDENTICAL TWINS LOOK DIFFERENT!

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

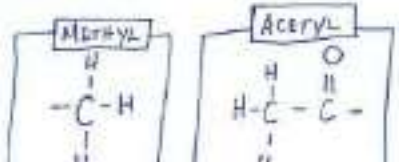
YOUR ENVIRONMENT WILL ADD OR REMOVE THE ACETYL & METHYL GROUPS

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

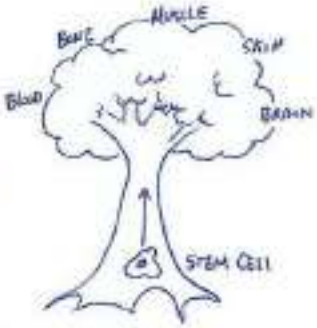
CONDENSE THE DNA OR INACTIVATE A GENE

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



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)

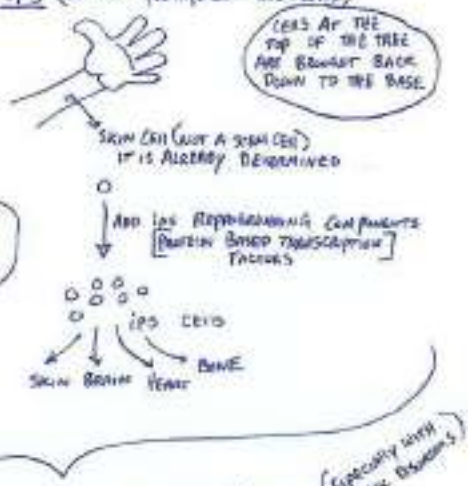
Pluripotent

- Have flexibility to turn into Any type of cell

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

Embryonic

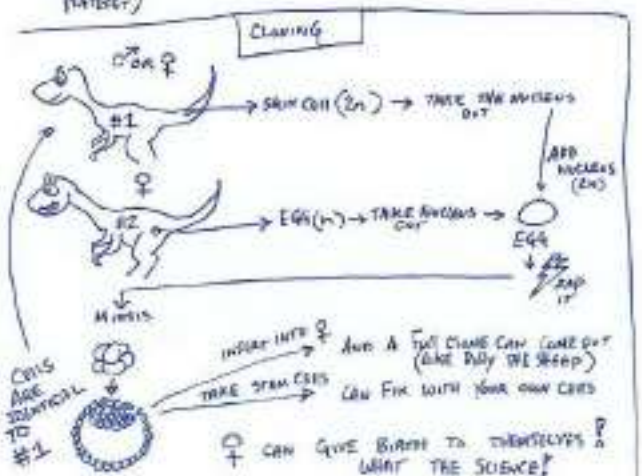
IPS (Induced pluripotent stem cells)



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

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

Cloning



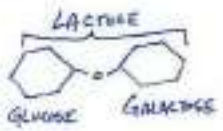
OPERONS

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

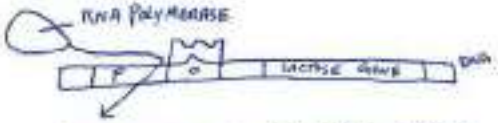
REMEMBER

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



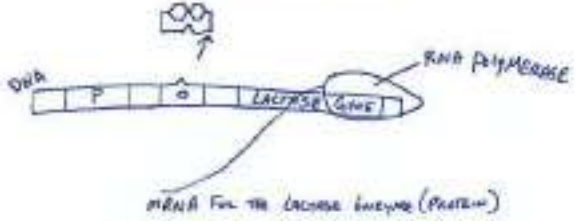
① THE PROMOTER "CALLS" IN RNA POLYMERASE TO MAKE A mRNA TRANSCRIPT OF THE LACTASE GENE BUT THE REPRESSOR BLOCKS IT FROM GETTING TO THE LACTASE GENE



★ 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.

MOM HAS HUNTINGTON'S

Hh hh DAD DOESN'T

SUN 50% CHANCE

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 EVENTUARY 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. DICER ENZYME → A PROTECTIVE ENZYME THAT CHOPS UP dsRNA
3. siRNA → SHORT INTERFERING RNA IS THE RESULT OF dsRNA CUT UP
4. RISC → RNA INDUCED SILENCING COMPLEX USES THE SIRNA TO "HUNT" FOR mRNA COMPLIMENTS TO DESTROY.
5. NOM NOM. mRNA — RISC DESTROYS THE MRNA BEFORE IT CAN BE TRANSLATED

★ PREVENTS THE VIRUS FROM SPREADING ★

C.R.I.S.P.R.

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 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.

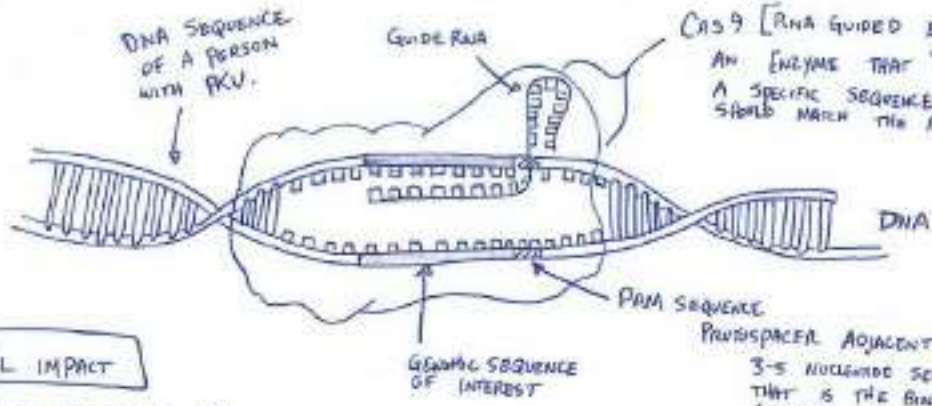
Humans & Medicine

- 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

CRISPR

CAS 9

CLUSTER REGULARLY INTERSPACED SHORT PALINDROMIC REPEATS



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.

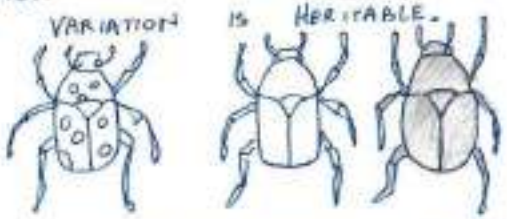
Evolution

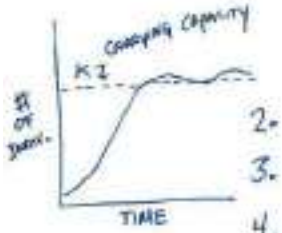
EVOLUTION

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.



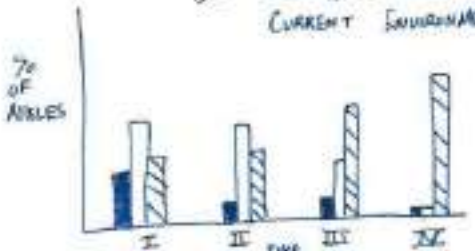


2. POPULATIONS TEND TO MAKE LOTS OF OFFSPRING.

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. Ex: Gravitational, Germ, Plate Tectonics, Cell, Relativity

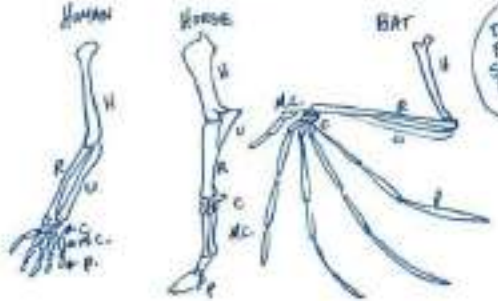
1. **Fossils** - Preserved remains of extinct organisms. Tend to form in sedimentary rock.

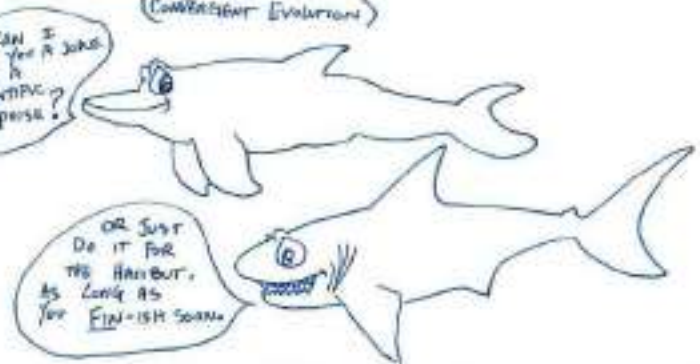
2. **Artificial Selection** - Humans selecting which organisms survive & reproduce. So the future population have traits that humans have selected

3. **Comparative Structures**

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

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



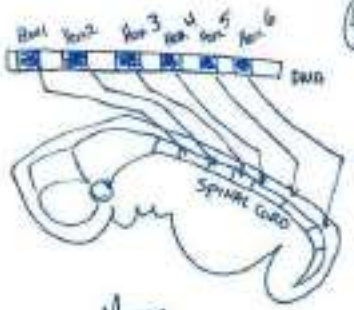


Evidence of Evolution

Continued

Part 2

Hox Genes = Body Plan Controller Genes

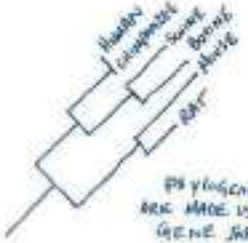


Mouse Embryo

Chicken Embryo

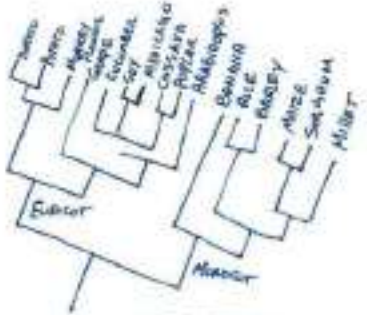
4. Common Genes & Proteins

Shared sequences help us to understand not only how structures develop but also supports shared ancestry.



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

Pangea

Paleozoic Era

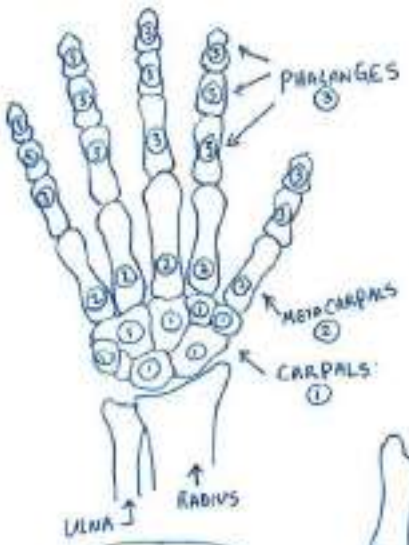
Fossils of reptiles can be found on the east coast of South America & the west coast of Africa that are so long apart.

Cynognathus

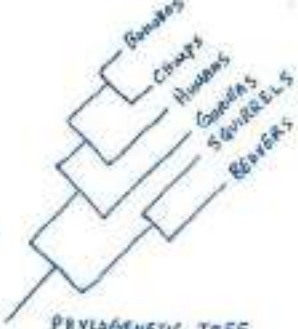
Catfish – Still has an eye socket but no eyeballs.

HOMOLOGOUS STRUCTURES

ARE STRUCTURES FOUND IN DIFFERENT ORGANISMS THAT ARE EVOLUTIONARILY RELATED. THEY MAY HAVE DIFFERENT FUNCTIONS BUT HAVE SIMILAR MAKEUP.



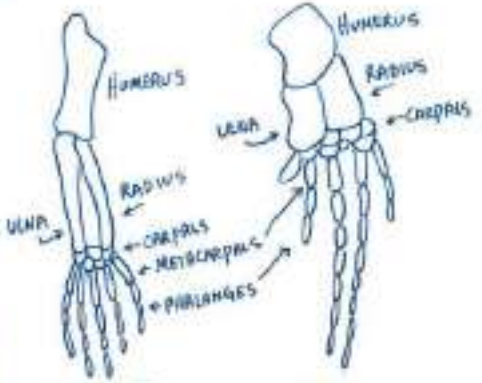
HUMAN HAND



PHYLOGENETIC TREE

THE CLOSER THEY ARE ON THE TREE THE MORE THEY ARE RELATED.

DO THEY ALL HAVE THE FIBONACCI SEQUENCE?



LIZARD

GOOD FOR RUNNING AND CLIMBING

WHALE

GOOD FOR SWIMMING

BAT

GOOD FOR FLYING

NOT ALL "HANDS" ARE GOOD FOR GRASPING AND MANIPULATING. EACH SPECIES HAS THEIR OWN NICHE.

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

THE MUTATIONS CANNOT BE PASSED IN THE GAMETES

1. NO NET MUTATIONS - SO NO NEW ALLELES

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

PHENOTYPE DOESN'T MATTER OR WHETHER YOU SURVIVE OR NOT

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

FOUNDER EFFECT
SMALL GROUP SEPARATES 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 MET 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 EQUATIONS

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

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 INDIVIDUALS 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 $\sqrt{.0001} = q = 0.01$

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!

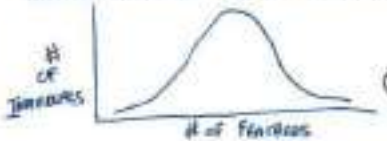
* MUTATIONS ARE RANDOM AND CAN BE HEREDITABLE.

INCREASE DIVERSITY

* CROSSING OVER & FERTILIZATION ARE RANDOM.

PROPOSE I

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



BIRDS

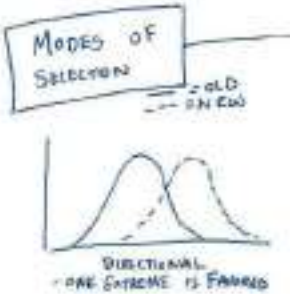
THE ENVIRONMENT CHANGES IN THE BIRD'S BIOME & IT GETS COLDER. THOSE WITH GENES THAT CODE FOR MORE FEATHERS STAY WARMER (HIGHER FITNESS) & ARE ABLE TO REPRODUCE EASIER. ↑ THE NUMBER OF INDIVIDUALS WITH MORE FEATHERS IN FUTURE GENERATIONS

BIOME
A MAJOR ECOLOGICAL COMMUNITY CHARACTERIZED BY A LARGE AREA WHOSE STABILITY IS DECIDED BY ITS ABIOTIC FACTORS & BIOTIC FACTORS

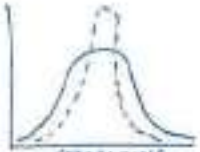
DIVERSITY IS VITAL FOR A POPULATION'S LONGEVITY.

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

MODES OF SELECTION



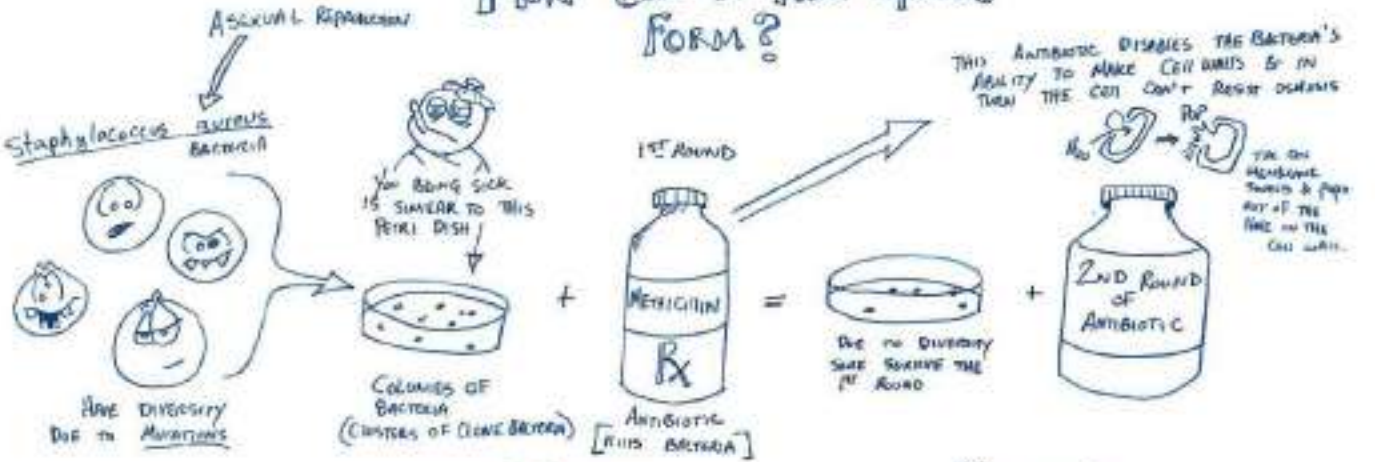
DIRECTIONAL
- ONE EXTREME IS FAVORED



STABILIZING
- THE AVERAGE IS SELECTED FOR.

DIVERSIFYING OR DISRUPTIVE
- THE TWO EXTREME PHENOTYPES ARE SELECTED FOR.

How Can A New Species Form?



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 80,000 people world wide

Types of Speciation

All speciation requires separation of a population

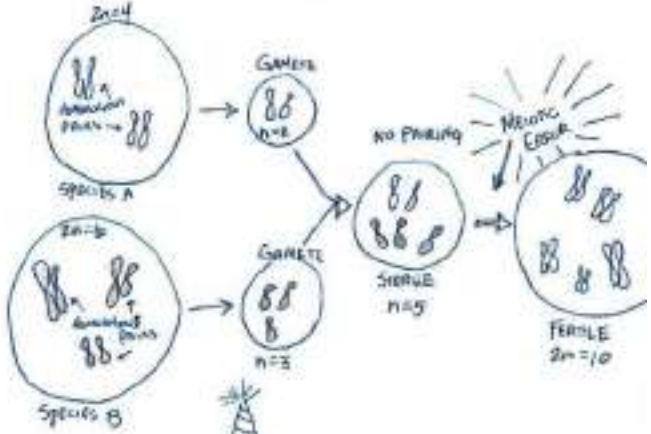
Allopatric Speciation

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

GAMETIC
THE SPERM CANNOT FERTILIZE THE EGG

POSTZYGOTIC

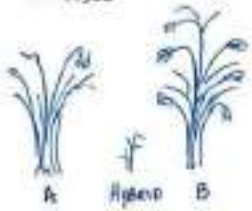
REDUCED HYBRID VIABILITY
THE HYBRID OFFSPRING DON'T HAVE GOOD TRAITS TO SURVIVE.

REDUCED HYBRID FERTILITY
THE HYBRID OFFSPRING IS STERILE

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

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

HYBRID BREAKDOWN
CONTINUAL MATINGS OF HYBRID = YIELD DECREASED



Statistics

STATISTICS

GENERAL PART 1

PURPOSE

TO ANALYZE DATA SETS IN ORDER TO SUPPORT OR REFUTE HYPOTHESES

COLLECTING DATA

QUANTITATIVE COMES IN TWO TYPES

QUALITATIVE - 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

PAIR A... PAIR A... PAIR A DICE

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?

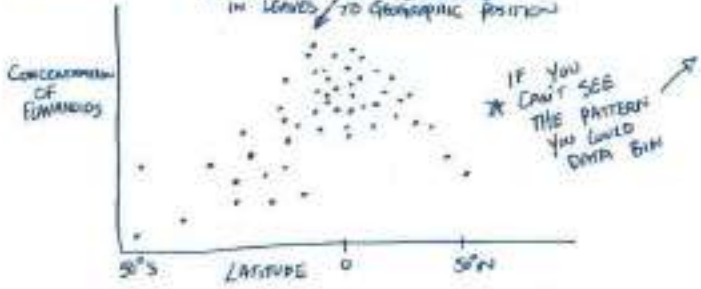
CAN USE A FREQUENCY TABLE

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 CO NUMBER OF VALUES WITHIN A RANGE. EX: HEIGHT OF SUNFLOWERS IN JULY

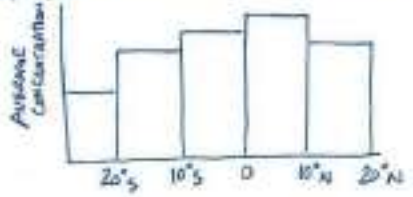
BECAUSE OF THIS IT MAY BE HARDER TO SEE A PATTERN



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

DATA BINNING

A WAY TO GROUP NUMBERS IN A CONTINUOUS DATA SET. MAYBE INSTEAD OF PLOTTING CONCENTRATIONS OF PLANTS USING LATITUDES DOWN TO A HUNDREDTH 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.

IT'S LEADING AS A RYE.

EX: TEST SCORES IN A CLASS:
91%, 0%, 63%, 36%, 87%, 45%, 29%, 86%, 98%, 92%

MEAN = 72.3%

THE AVERAGE DOESN'T LOOK BAD BUT THE CLASS HAS 3 FAILURES, 1 D, 1 B, 4 A. 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

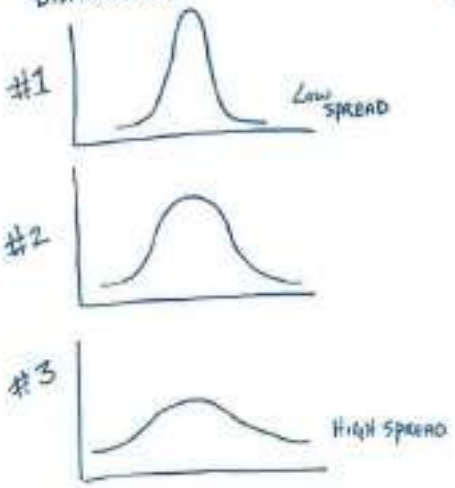
TAKING INTO ACCOUNT MEDIAN & MODE OF YOUR DATA SET WILL GIVE YOU A BETTER VIEW OF YOUR DATA SET BUT YOU MUST LOOK @ HOW DISTRIBUTED YOUR DATA IS.

STATISTICS

GENERAL PART 3

DISTRIBUTION OF YOUR DATA

CONSIDER THESE NORMAL DISTRIBUTIONS



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

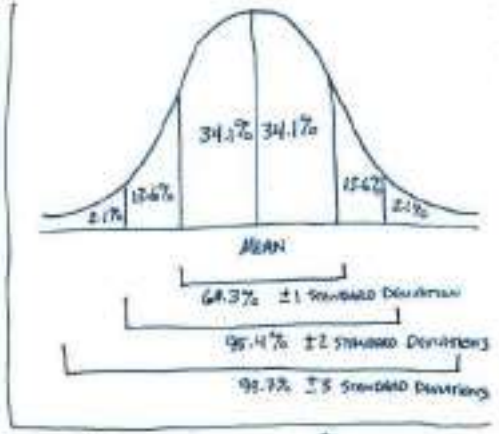
$\bar{x}$ = AVERAGE OF ALL OF DATA

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

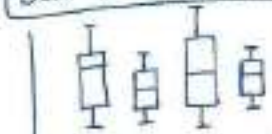
THESE ARE LINES SHOWN ON A GRAPH THAT REPRESENT HOW VARIABLE THE DATA IS. THE MORE VARIABLE THE MORE ERROR A DATA SET CAN BE

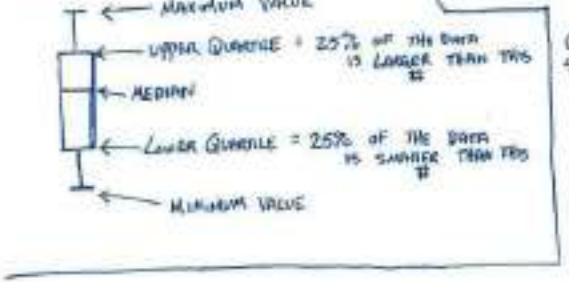
THE ENDS OF THE BARS ARE 1 S.D. FROM THE DOT. THE DOT IS THE MEAN

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 ± 2.5 σ FROM THE MEAN SO 5% CAN FAIL 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

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.

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

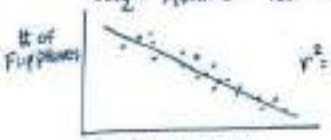
EX: WHEN ANALYZING TEST SCORES IN A POPULATION OF STUDENTS WE WOULD EXPECT ♂ & ♀ TO BE EQUAL

$$H_0 = \mu_1 = \mu_2$$

H_0 = NULL HYPOTHESIS

μ_1 = MEAN OF TEST SCORES FOR ♂

μ_2 = MEAN OF TEST SCORES FOR ♀



JUST REMEMBER

CORRELATION DOES NOT = CAUSATION

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

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

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

STATISTICS

GENERAL PART 5

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.

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

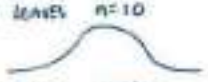
BETTER PICTURE OF ERROR

☆ 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 CORRECT MORE THE MEAN

YOU DON'T GET IT? YOU CAN LEAF

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, 63, 69, 68, 62, 64, 68, 59 } # HOTDOGS EATEN BY CONTESTANTS AT CONEY ISLAND HOTDOG CONTEST / 10 MIN.

S.D. = 5.34

$\bar{x}$ = 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

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

Tissues

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

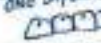
★ Categorized by cell shape & # of layers

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 & Absorption

Simple Columnar
One layer of rectangles

★ Found lining the digestive tract
- stomach & sm. intestines

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 & 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 CELLS (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
- MAINTAINS SHAPE
- GLASSY APPEARANCE
- MOST ABUNDANT CARTILAGE
- JOINTS, TRACHEA

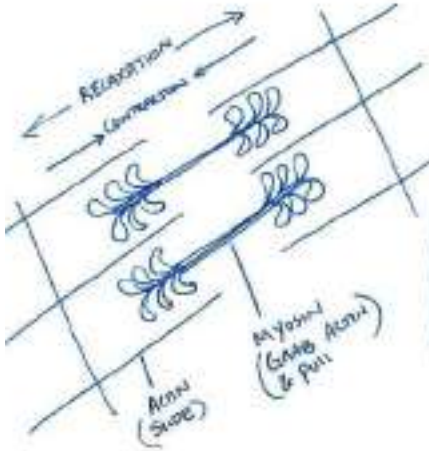
ELASTIC CARTILAGE

- CHONDROCYTES
- ELASTIC FIBERS
- MAINTAINS FLEXIBILITY & SHAPE
- OUTER EAR
- LARYNX

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

Central Nervous
Brain & Spinal (CNS)
Peripheral Nervous
Branches off CNS (PNS)

Tissues

Glial means glue + holds system together

Support Cells

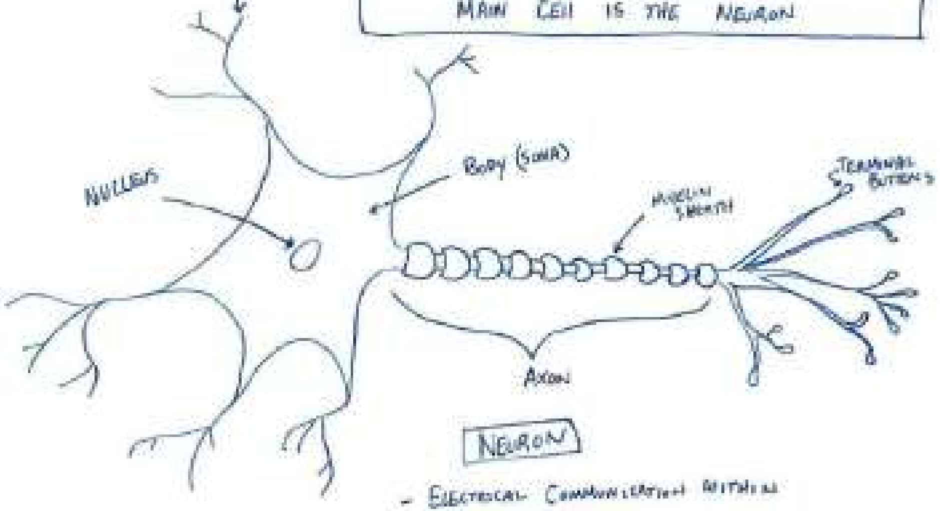
Known as glial cells

- 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 guard
- Astrocytes - link neurons to their blood supply

Nervous Tissue

The main tissue which regulates & controls bodily functions & activities

Main cell is the neuron



Neuron

- Electrical communication within
- Chemical communication between

Mood

The feel good movie of the year

Written by Sarah Tann

Circulatory System

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 tubes that carries blood away from the heart
- Lots of flex
- High pressure

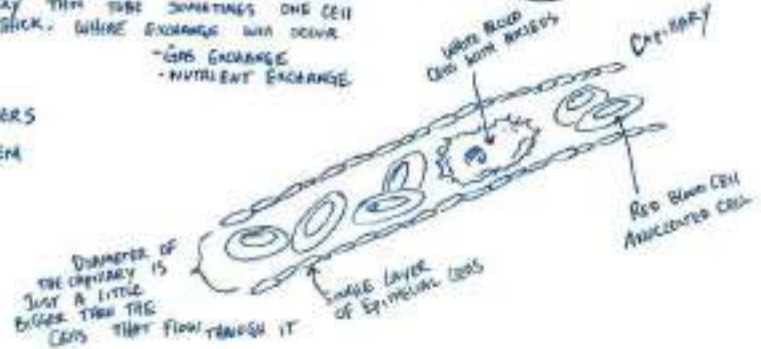
Arteriole - A smaller diameter artery - highly branched connected to capillary beds.

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

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

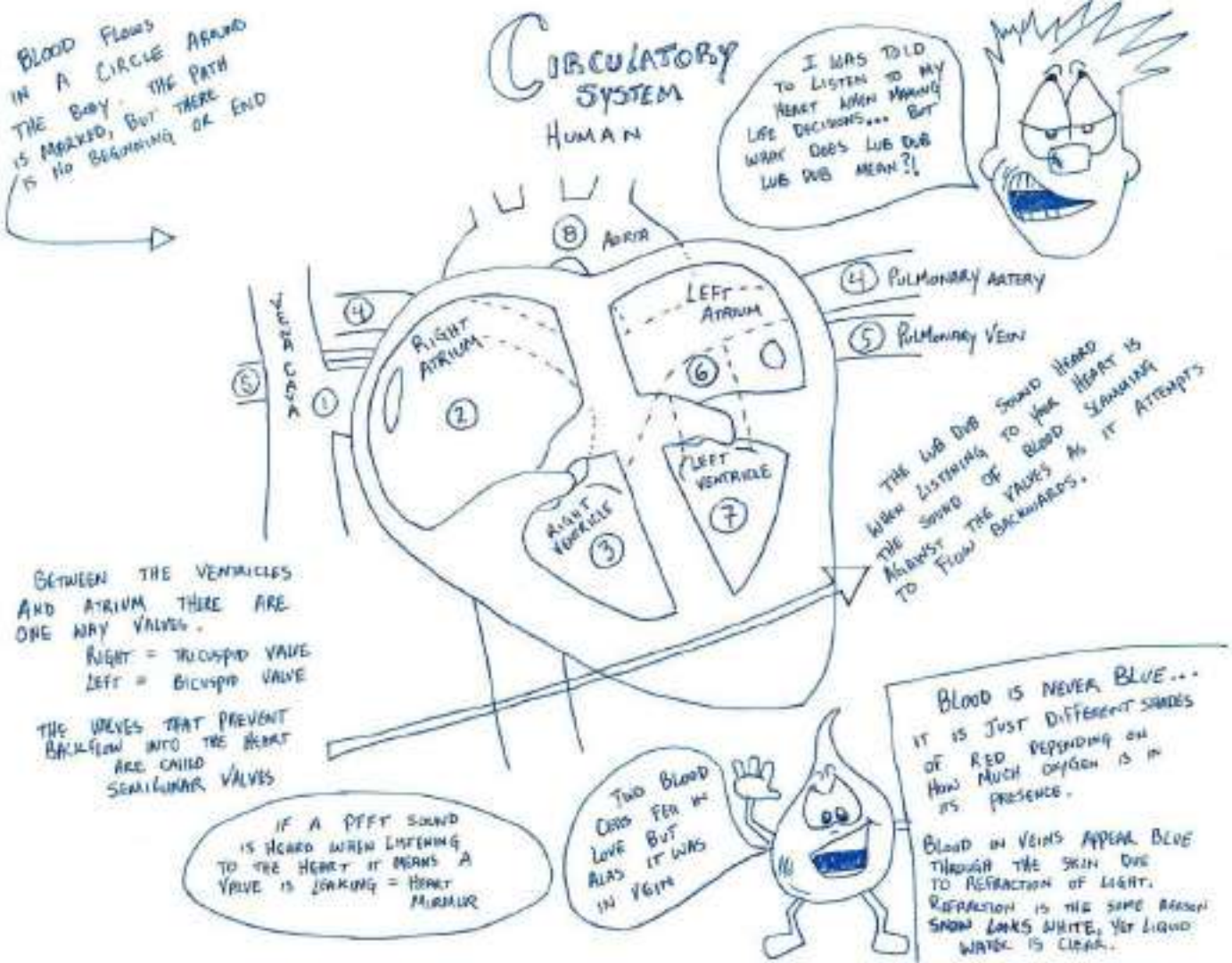
Capillary - Very thin tube sometimes one cell thick. Where exchange with occur
- Gas exchange
- Nutrient exchange

Blood Components



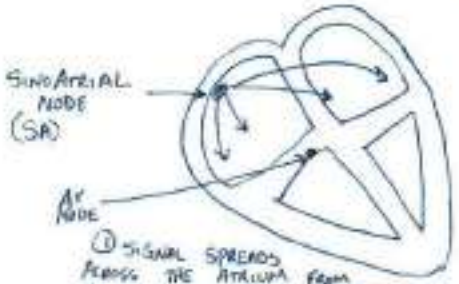
Circulatory System

Human



Circulatory System

Electrical Control



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

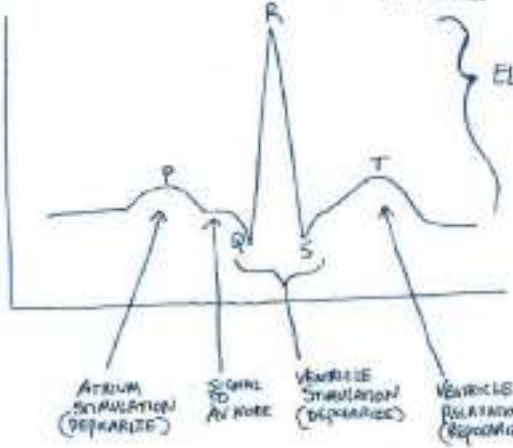
② a. The Atrium Contract (top down)

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

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

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

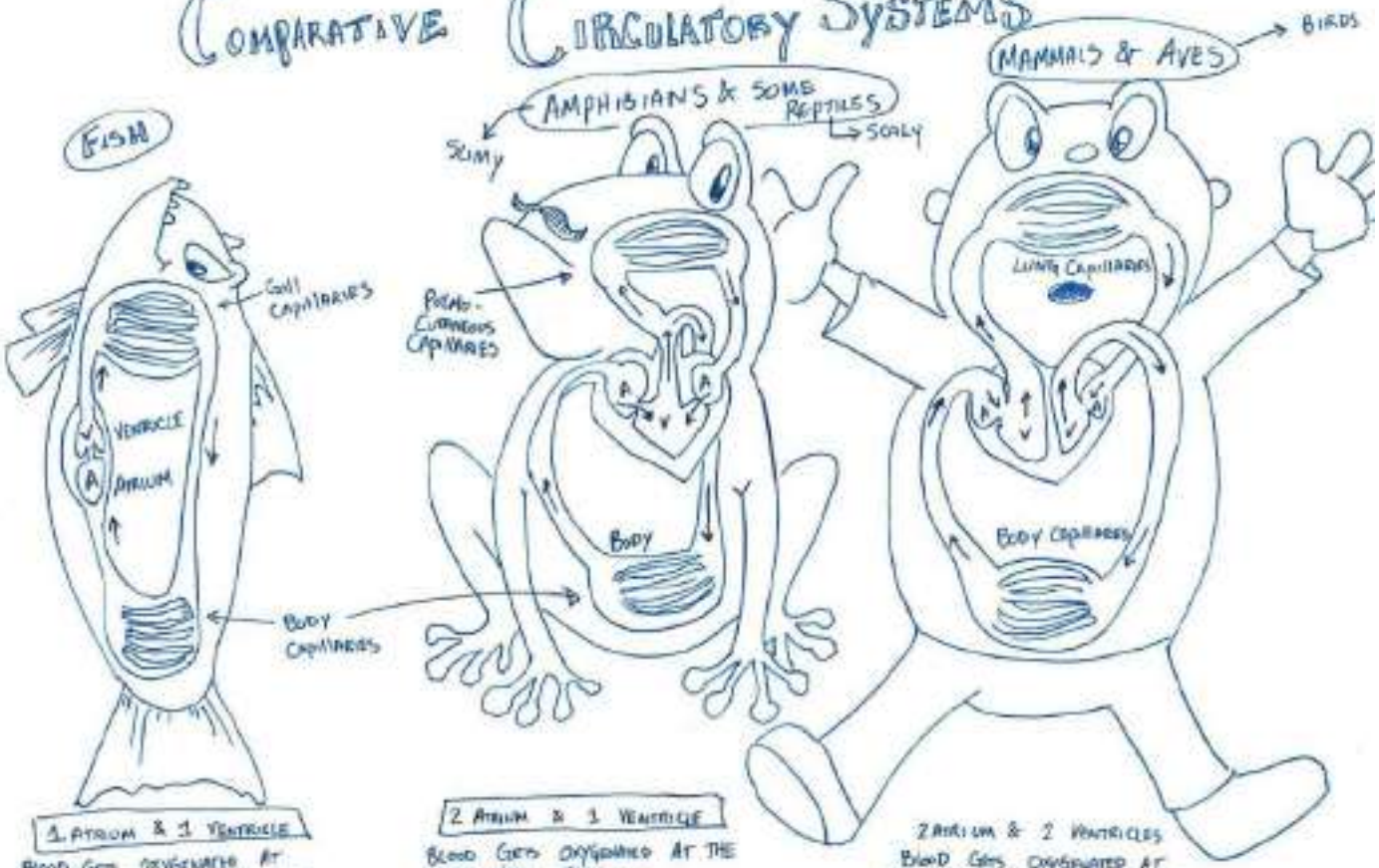
You are probably dead



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 makes 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

DIGESTIVE SYSTEM PART 1

GOAL

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

YOU ARE A FANCY DONUT!

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

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

ARE ALL MADE OF THE SAME AVERAGE PIECES (MONOMERS) DIGESTION JUST BREAKS APART BIG STRUCTURES INTO THESE 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.

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

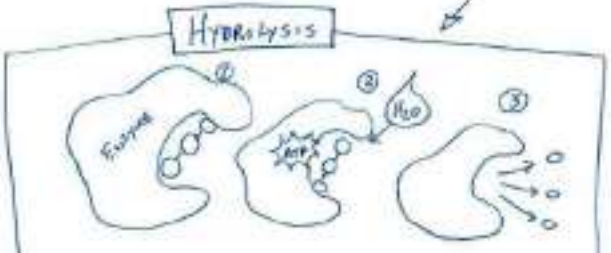
SURROUND, ENGULF, AND BREAKDOWN INSIDE THE CELL

EX: AMOEBA, PHAGOCYTOSIS, WHITE BLOOD CELL

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

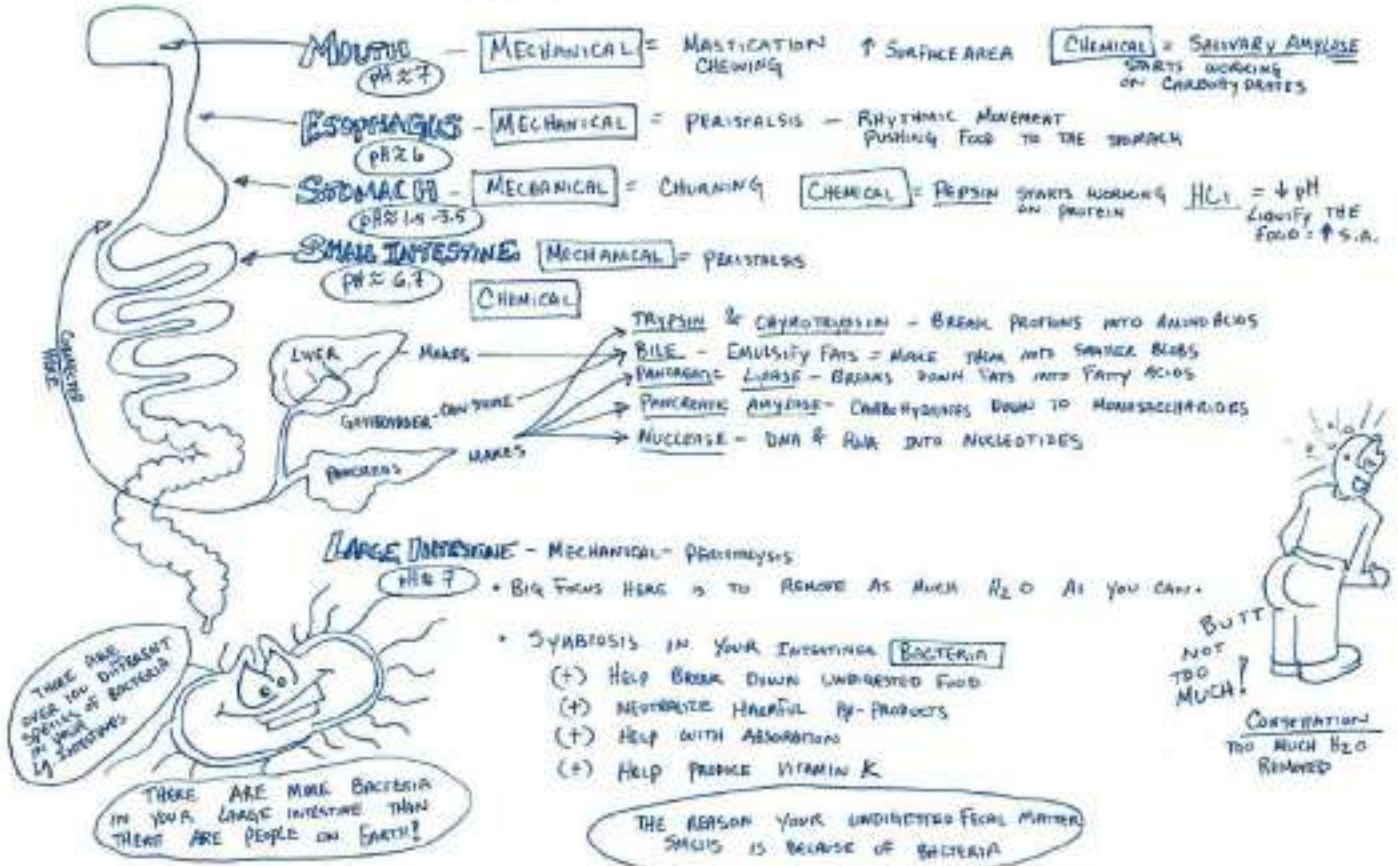
↑ SURFACE AREA

ENZYMATIC - USING ENZYMES, TURN POLYMERS INTO MONOMERS.



DIGESTIVE SYSTEM
PART 2

WORKS BASED ON COMPARTMENTALIZATION



DIGESTIVE SYSTEM

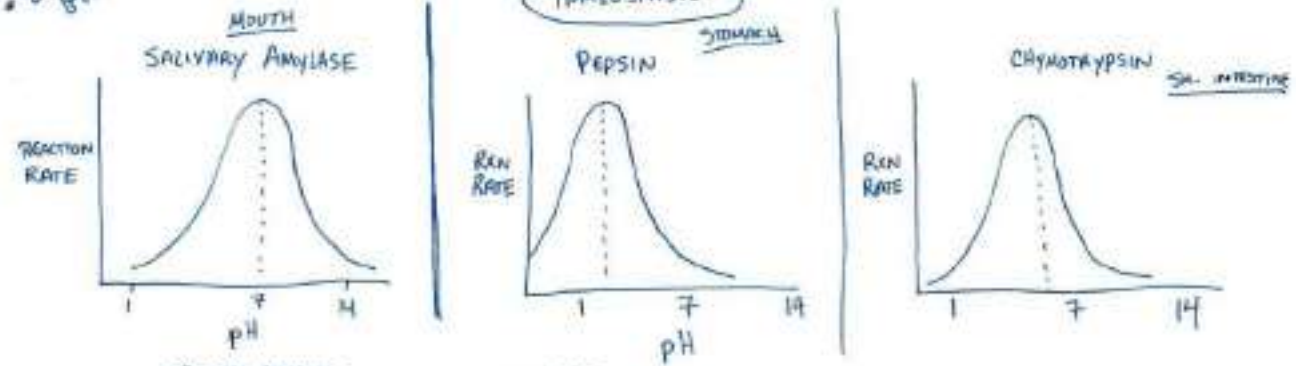
PART 3

You will see similar optimal curves for temperature & salinity

Why is compartmentalization so important?
- Enzyme function

Each section of the system has its own role
Thus own environment it must maintained

Homeostasis



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.

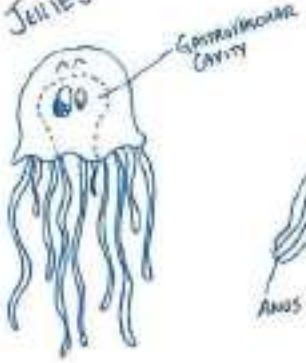
DIGESTIVE SYSTEM PART 4

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

EARTHWORMS

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

COWS

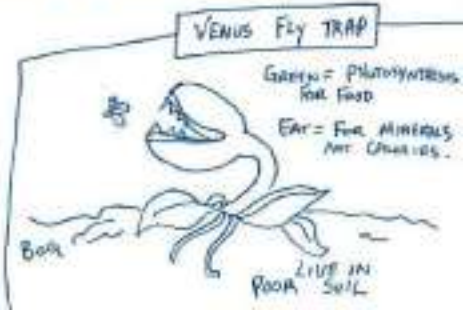
ALL HERBIVORES HAVE SOME SORT OF CHAMBER THAT HOUSES THESE MICROORGANISMS. THESE ORGANISMS CAN BREAK DOWN GLYCOSIDIC LINKAGES OF CELLULOSE → ALLOWING THE HERBIVORE TO ACCESS THE ENERGY

ALLIGATOR

- 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



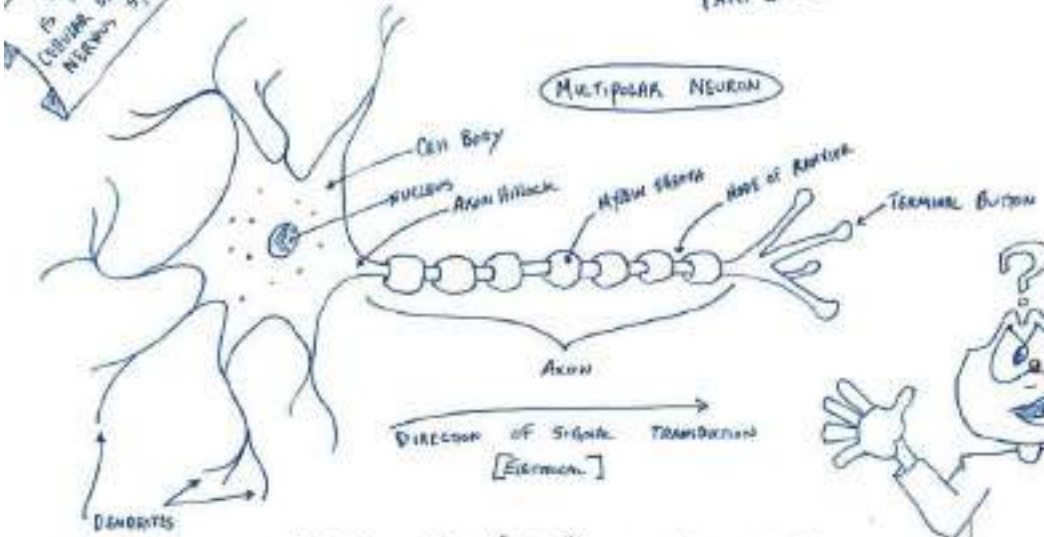
GREEN = PHOTOSYNTHESIS FOR FOOD

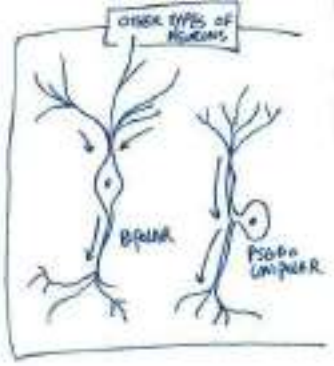
EAT = FOR MINERALS AMT CARBOHYDRATES

Nervous

NERVOUS SYSTEM
PART 1

NEURON IS THE BASIC CELLULAR UNIT OF THE NERVOUS SYSTEM





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

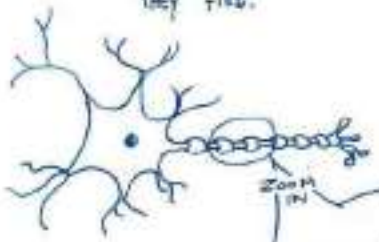
ONE NEURON TALKS TO ANOTHER NEURON (OR OTHER CELL) THROUGH CHEMICAL MEANS

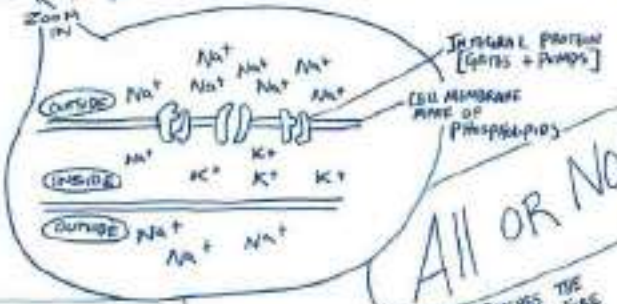
GENERALLY NEUROTRANSMITTERS ARE RELEASED INTO THE GAP JUNCTION BETWEEN NEURONS CAUSING AN EFFECT.

NEURONS

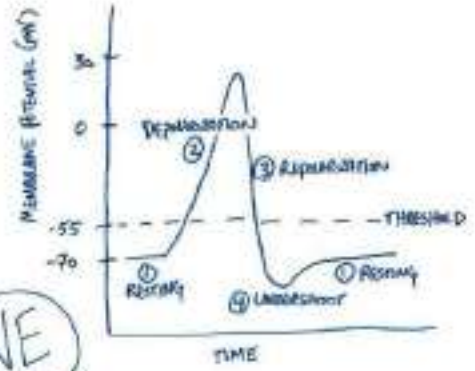
THE DIFFERENCE IN PERCEPTION OF A SIGNAL IS BASED ON HOW MANY NEURONS PARTICIPATE & HOW FREQUENTLY THEY FIRE.

THE ELECTRICAL SIGNAL



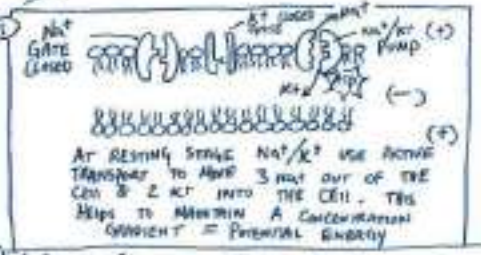


AT REST THE NEURON IS MORE (−) INSIDE COMPARED TO OUTSIDE



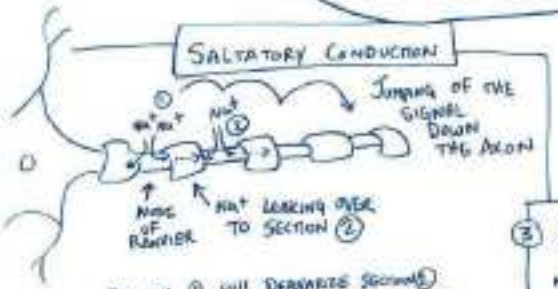
ALL OR NONE

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 THIS WILL CAUSE THE Na^+ GATES 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.

SOMEBODY 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 (+).

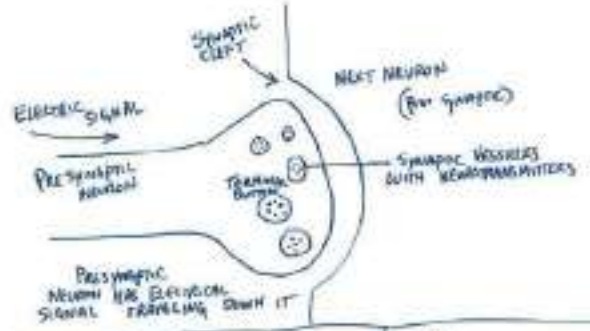
UNDERSHOOT (4)

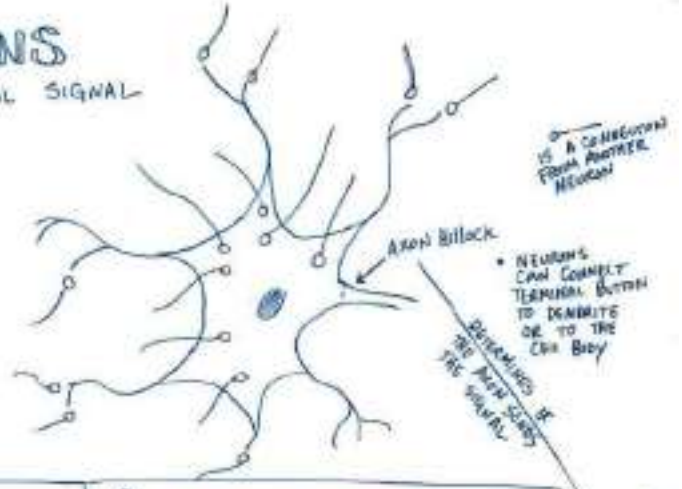
THE K^+ PUMPS STAY OPEN LONGER & THE CELL BECOMES HYPERPOLARIZED (EVEN MORE NEGATIVE THAN ITS NORMAL RESTING −70mV.) THIS PREVENTS THE NEURON FROM BACKFIRING & KEEPS THE SIGNAL MOVING IN ONE DIRECTION.

CELL BODY → TERMINAL BUTTON

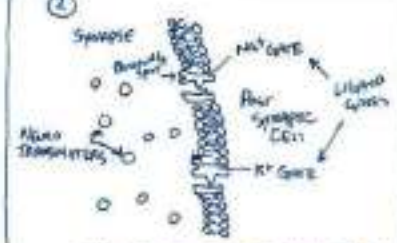
NEURONS

THE CHEMICAL SIGNAL





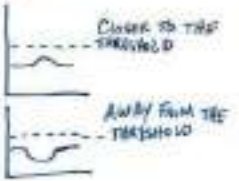
① THE ELECTRICAL SIGNAL GETS TO THE TERMINAL BUTTON & CAUSES RELEASE OF THE NEUROTRANSMITTER INTO THE SYNAPTIC CLEFT



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

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

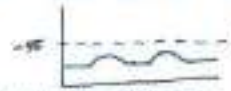


③ THE NEURON DOES NOT FIRE UNLESS THE THRESHOLD IS MET.

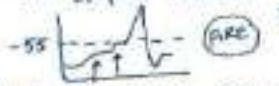
BASED ON HOW FREQUENTLY & WHAT KIND OF SIGNAL IS BEING SENT TO THE NEURON THE AXON HILLOCK DETERMINES IF IT WILL FIRE

SUMMATION = THE ADDED EFFECT OF EPSP & IPSP

EX: EPSP BUT NOT FREQUENT

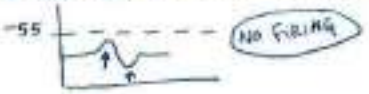


EX: EPSP & FREQUENT



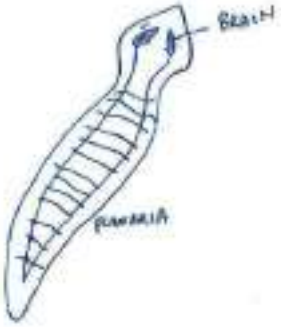
★ THIS COULD BE MULTIPLE NEURONS CONNECTING AND THEY ARE ALL EPSP

EX: IPSP & EPSP COUNTERACT EACH OTHER.



NERVOUS SYSTEMS
COMPARATIVE

CNIDARIA (JELLIES)
HAVE A VERY BASIC NERVE NET. THIS ALLOWS THEM TO SENSE & RESPOND TO THEIR ENVIRONMENT

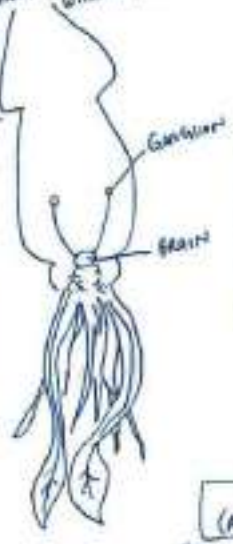


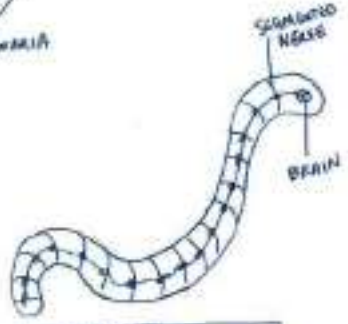
PLATYHELMINTHES (FLAT WORMS)
- HAVE TWO "BRAINS" WHERE EYE-SPOTS ARE FOUND. THESE EYESPOTS DETECT LIGHT AND THE INFORMATION CAN BE SENT DOWN THE LENGTH OF THE WORM AND ACROSS IN A COORDINATED FASHION

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

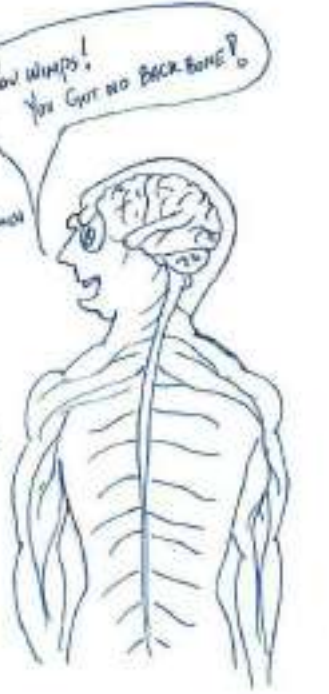
MOLLUSCA
(SOFT BODIED WITH SHELLS)
- OFTEN HAVE A WIDE VARIETY OF GANGLIA FOR PROCESSING VISUAL, TASTE, PROPRIOCEPTIVE, AND TOUCH INFORMATION. MANY MORE CONNECTIONS FOR COMPLEX MOVEMENT & COMMUNICATION WITH OTHERS

* CEPHALOPODS HAVE A VERTEBRAL SKULL





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

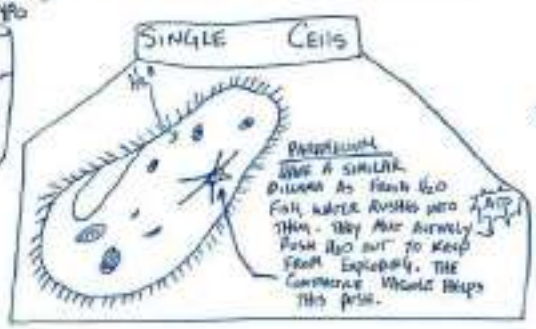


CHORDATA
(ANIMALS WITH A NOTOCORD)
VERTEBRATES ARE A GROUP
HAVE A BRAIN AND DORSAL NERVE CORD THAT IS CONNECTED TO AN EXTENSIVE PERIPHERAL NERVOUS SYSTEM. ABILITY TO SENSE LIGHT, TOUCH, CHEMICAL, EQUILIBRIUM AND OTHER CHANGES IN THE ENVIRONMENT.

Water Balance

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.



OSMOSIS

DIFFUSION OF H_2O ACROSS A MEMBRANE. PASSIVE

* REMEMBER: FROM HYPOTONIC TO HYPERTONIC.

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.

• 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

WHY FILTER?

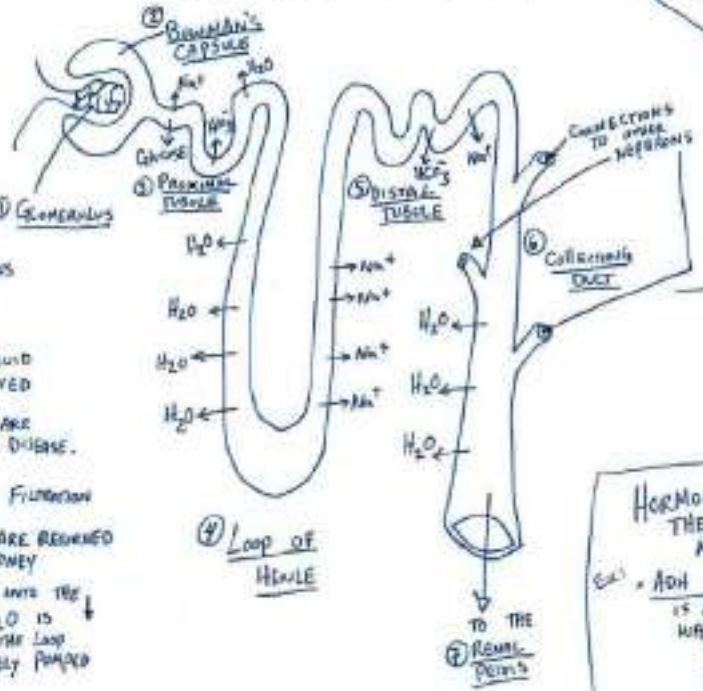
- IT SEEMS LIKE ALL WE DO IS PUT THINGS OUT OF THE FLUID. WHAT STAYS IN THE URINE? AND EXCESS NITROGENOUS WASTE AND EXCESS THE BODY CAN BE Na^+, K^+, HCO_3^-, ETC.

NITROGENOUS WASTE

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

THE NEPHRON

THE FUNCTIONAL UNIT OF THE KIDNEY



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 REABSORBED TO THE TISSUE OF THE KIDNEY
4. THE LOOP OF HENLE DIVES INTO THE KIDNEY (SALINE 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.

CORTEX

"LESS SALTY"

MEDULLA

"MORE SALTY"

HORMONES CAN HELP THE NEPHRON REABSORB MORE H_2O.

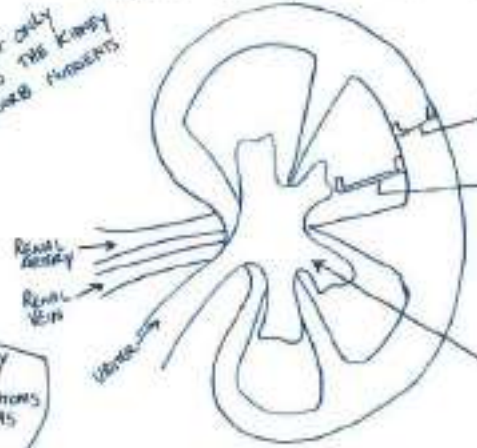
- ADH (ANTIDIURETIC HORMONE)
  - IS RELEASED BY THE BRAIN WHEN BLOOD OSMOLARITY IS ABOVE 300 mOsm/L. ADH TARGETS THE COLLECTING DUCT, MAKING IT REABSORB MORE H_2O BACK INTO THE TISSUES OF THE KIDNEY

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



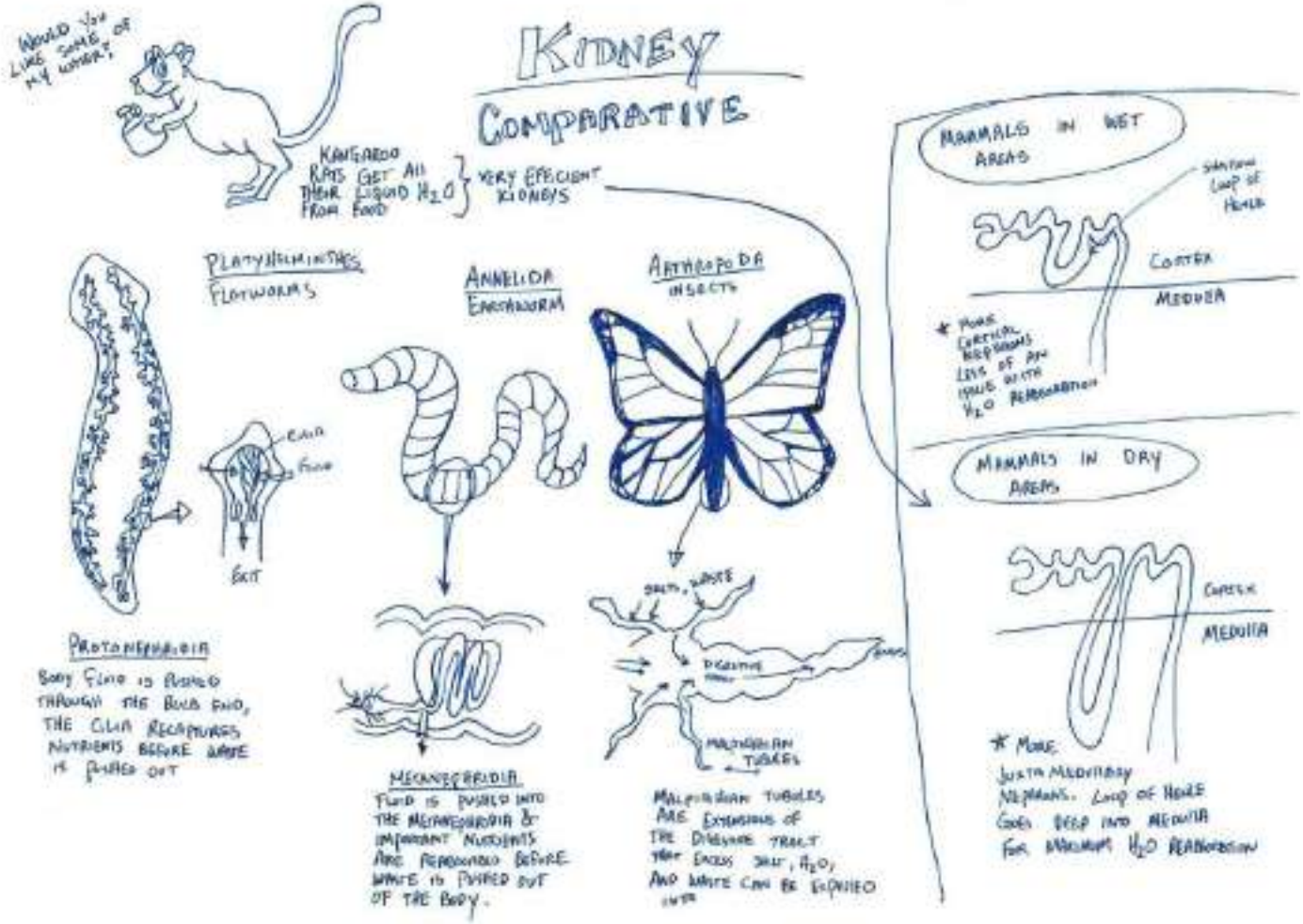
KIDNEY STONES

- CRYSTALS OF SOME TYPE OF COMPOUNDS EXAMPLES
  - CALCIUM STONES
    CAN FORM FROM DIET OR METABOLIC DISORDERS
  - ★ URIC ACID STONES
    UREA CRYSTALS FORM FROM TOO LITTLE H2O OR TOO MUCH PROTEIN
  - STRUVITE STONES
    DUE TO AN INFECTION

TOO MUCH WATER IS A BAD THING AS WELL!

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 EXCRETED TO THE RENAL PELVIS → URETER → URINARY BLADDER → URETHRA.

DRINK PLENTY OF H_2O!


WOULD YOU LIKE SOME MY WOMBAT OF
KIDNEY
COMPARATIVE
KANGAROO RATS GET ALL THEIR LIQUID H_2O FROM FOOD
VERY EFFICIENT KIDNEYS
MAMMALS IN WET AREAS
SIMILAR LOOP OF HENLE
CORTEX
MEDULLA
* MORE CORTICAL NEPHRONS LESS OF AN ISSUE WITH H_2O REABSORBTION
MAMMALS IN DRY AREAS
CORTEX
MEDULLA
* MORE JUXTA MEDULLARY NEPHRONS. LOOP OF HENLE GOES DEEP INTO MEDULLA FOR MAXIMUM H_2O REABSORBTION
PLATYHELMINTHES
FLATWORMS
CILIA
FLUID
EXIT
PROTONEPHRIDIA
BODY FLUID IS PUSHED THROUGH THE BULB END, THE CILIA RECAPTURES NUTRIENTS BEFORE WASTE IS PUSHED OUT
ANNELIDA
EARTHWORM
METANEPHRIDIA
FLUID IS PUSHED INTO THE METANEPHRIDIA & IMPORTANT NUTRIENTS ARE REABSORBED BEFORE WASTE IS PUSHED OUT OF THE BODY.
ARTHROPODA
INSECTS
SALTS, WASTE
DIGESTIVE TRACT
MALPIGHIAN TUBULES
MALPIGHIAN TUBULES ARE EXTENSIONS OF THE DIGESTIVE TRACT THAT EXCESS SALT, H_2O, AND WASTE CAN BE EXPELLED INTO

Immunity

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 INFECTION

LYSOZYME - ENZYME SECRETIONS 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.

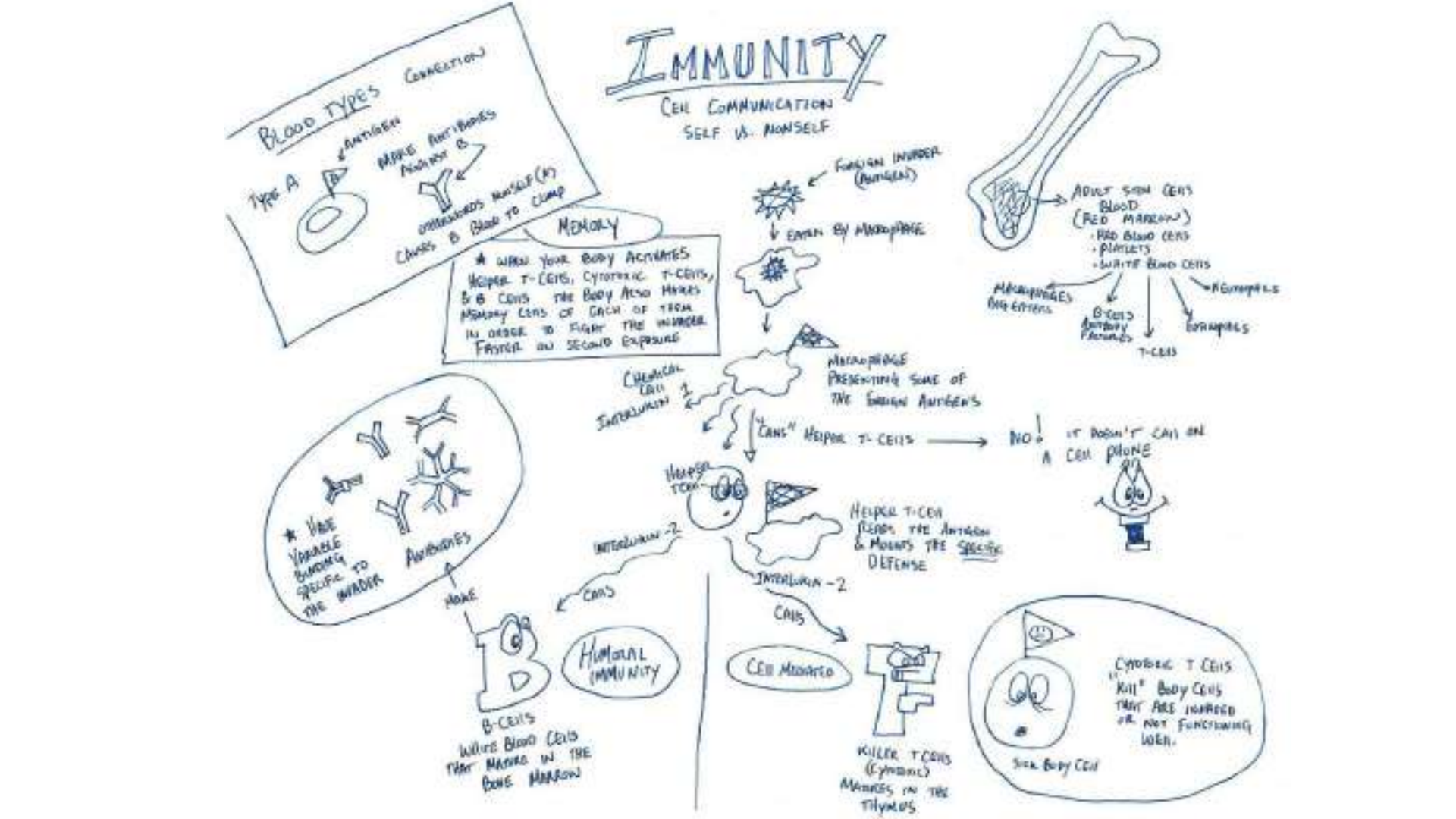
FEVER

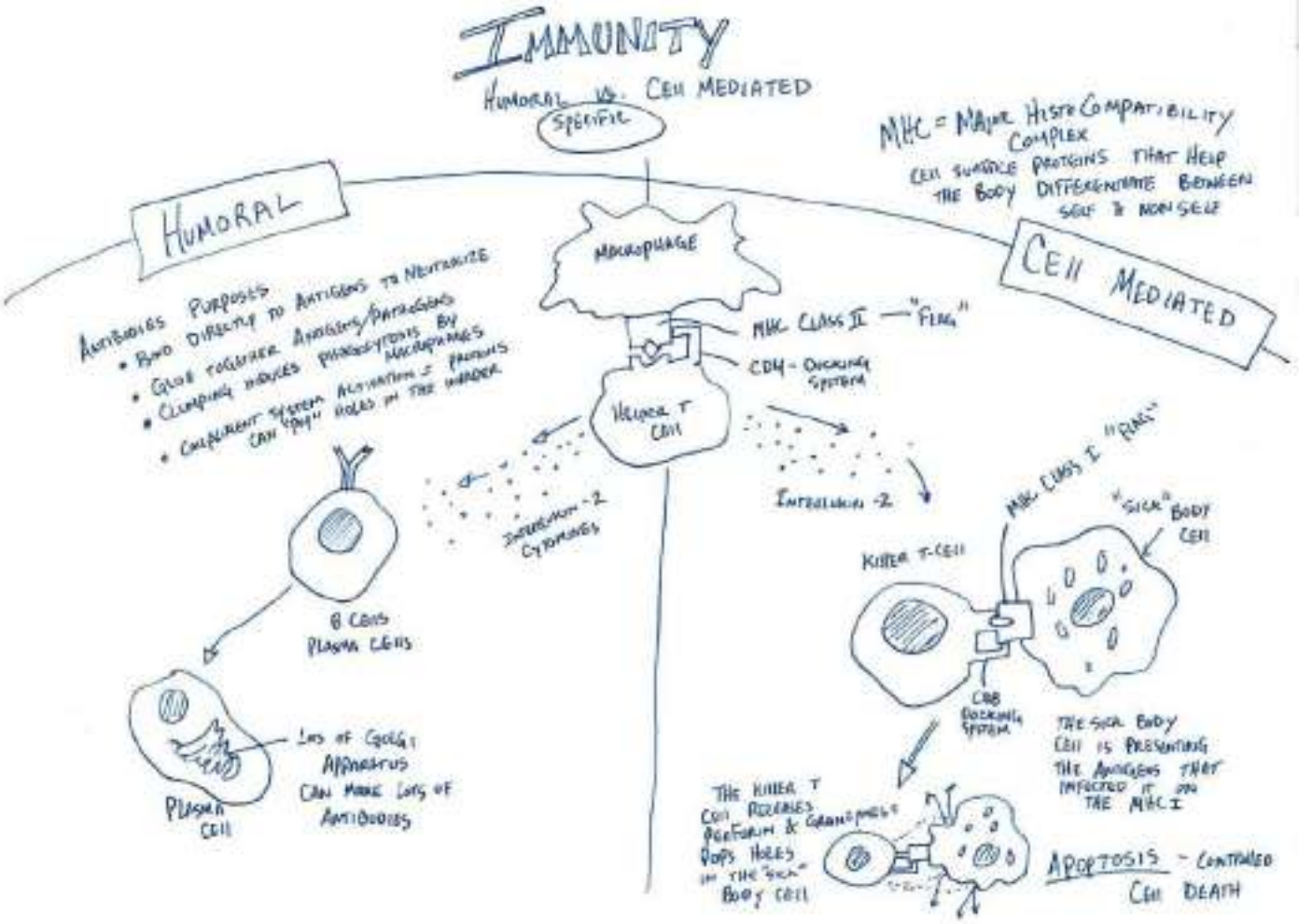
TEMPERATURE INCREASE = FEVER

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
ANTIBODIES RECOGNIZE (X) 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)
TAKEN BY MACROPHAGE
ADULT STEM CELLS BLOOD (RED MARROW)
- RED BLOOD CELLS
- PLATELETS
- WHITE BLOOD CELLS
MACROPHAGES BIG EATERS
B-CELLS ANTIBODY FACTORIES
T-CELLS
NEUTROPHILS
EOSINOPHILS
MACROPHAGE PRESENTING SOME OF THE FOREIGN ANTIGEN'S
CHEMICAL CELL COMMUNICATION 1
"CALLS" HELPER T-CELLS
NO! IT DOESN'T CALL ON A CELL PHONE
HELPER T-CELL
HELPER T-CELL FINDS THE ANTIGEN & MOUNTS THE SPECIFIC DEFENSE
INTERLEUKIN -2
CALLS
INTERLEUKIN -2
CALLS
★ HAVE VARIABLE BINDING SPECIFIC TO THE INVADER
ANTIBODIES
MAKE
B
B-CELLS
WHITE BLOOD CELLS THAT MATURE IN THE BONE MARROW
HUMORAL IMMUNITY
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


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 MAKES PHAGOCYTOSIS BY MACROPHAGES
• COMPLEMENT SYSTEM ACTIVATION & PROTEINS CAN "POKE" HOLES IN THE INVADER
MACROPHAGE
MHC CLASS II — "FLAG"
CD4 - DOCKING SPOTBOT
HELPER T CELL
INTERLEUKIN -2
INTERLEUKIN CYTOKINES
B CELLS
PLASMA CELLS
LOTS OF GOLGI APPARATUS
CAN MAKE LOTS OF ANTIBODIES
PLASMA CELL
MHC CLASS I "FLAG"
"SICK" BODY CELL
KILLER T-CELL
CD8 DOCKING SPOTBOT
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

VACCINES

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

VACCINE COMES FROM THE WORD VACCA = COW

FIRST EXPOSURE VS SECOND EXPOSURE

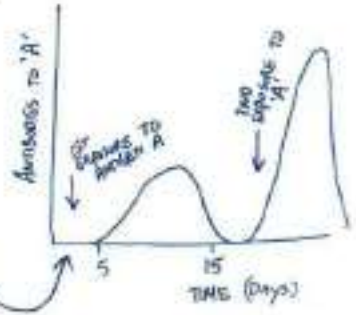
WHEN YOUR BODY FIRST COMES INTO CONTACT WITH A PATHOGEN (CONTAINING ANTIGENS) IT GOES THROUGH THE LONG PROCESS OF MACROPHAGE → HELPER T CELL → B-CELLS → ANTIBODIES

→ KILLER T CELLS

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

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

LAG



ACTIVE IMMUNITY

WHAT IS IN A VACCINE?

"DEAD" OR WEAKENED VIRUSES

VIRUS FRAGMENTS

TOXINS FROM A VIRUS OR BACTERIA

MEMORY CELLS ALLOW YOU TO MOUNT AN ATTACK FASTER

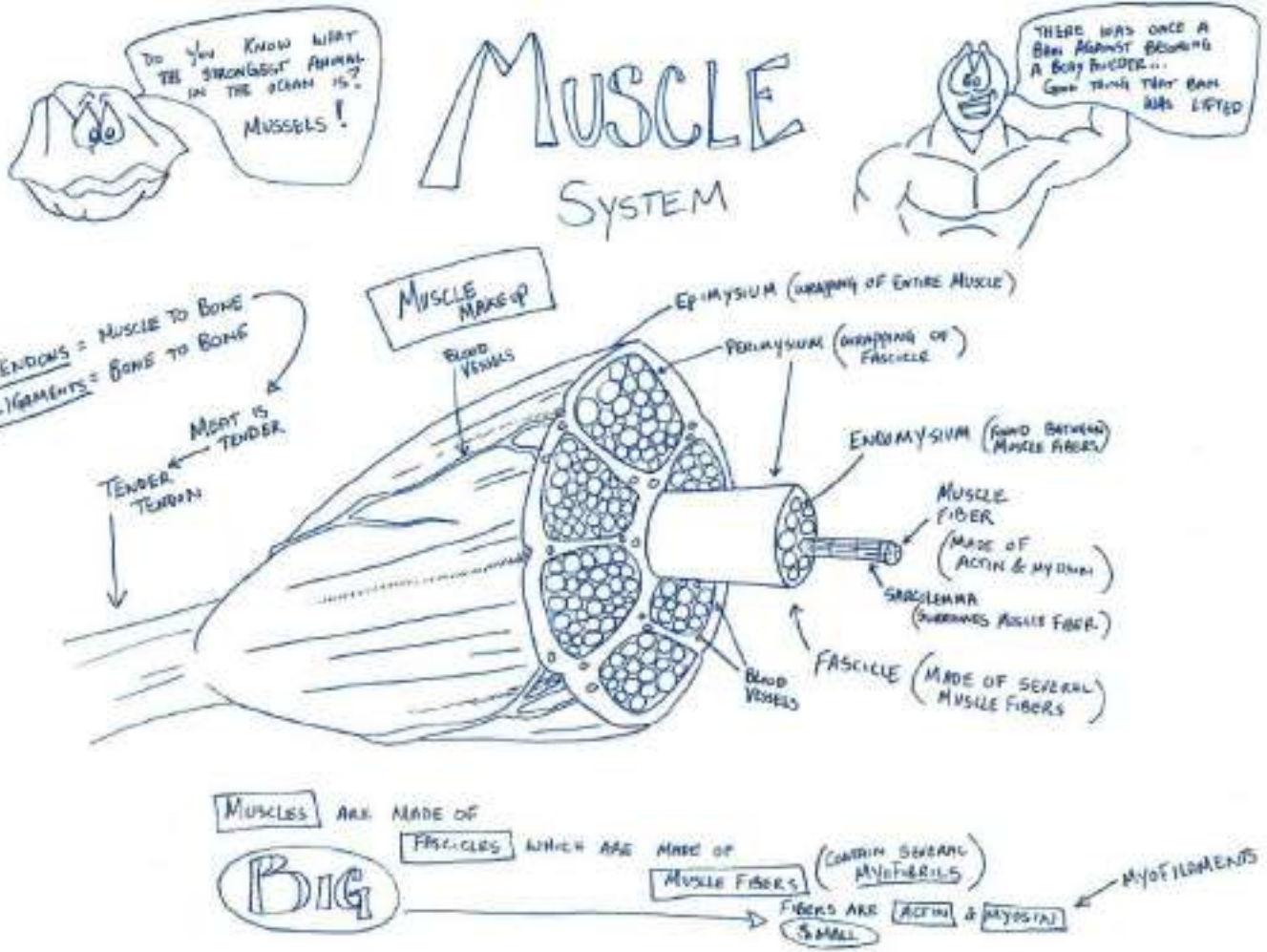
JONAS SALK

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

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

I REMEMBER THIS ONE! GET EM"!

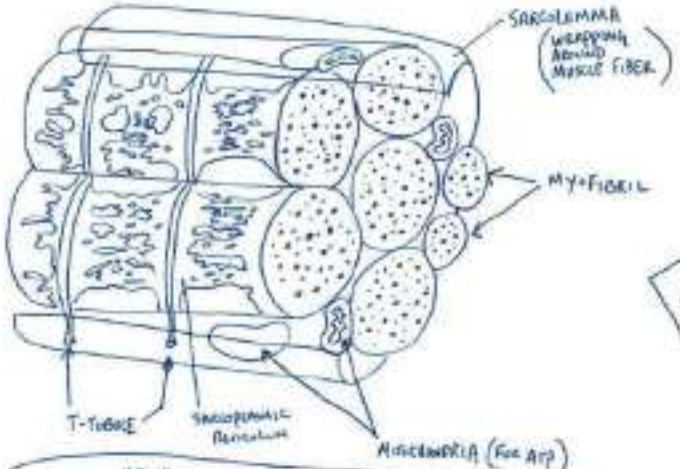
Muscular

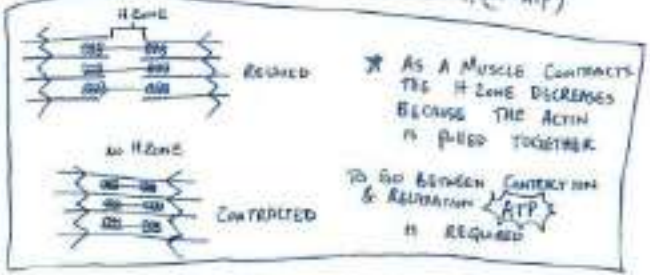

DO YOU KNOW WHAT THE STRONGEST ANIMAL IN THE OCEAN IS?
MUSSELS!
MUSCLE
SYSTEM
THERE WAS ONCE A MAN AGAINST BECOMING A BODY BUILDER... UNTIL THAT MAN WAS LIFTED
TENDONS = MUSCLE TO BONE
LIGAMENTS = BONE TO BONE
MEAT IS TENDER
TENDER TENDON
MUSCLE MAKE UP
BLOOD VESSELS
EPIMYSIUM (WRAPPING OF ENTIRE MUSCLE)
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
FIBERS ARE ACTIN & MYOSIN
SMALL
BIG

From Muscle Fiber to the Working Unit of Muscle

The Sarcomere

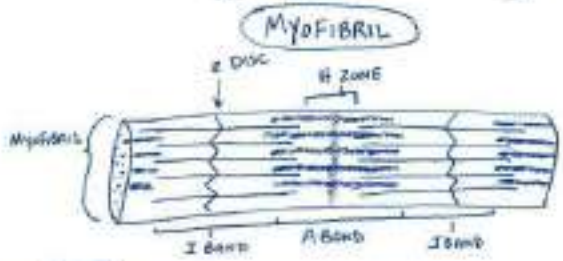
Muscle Fiber

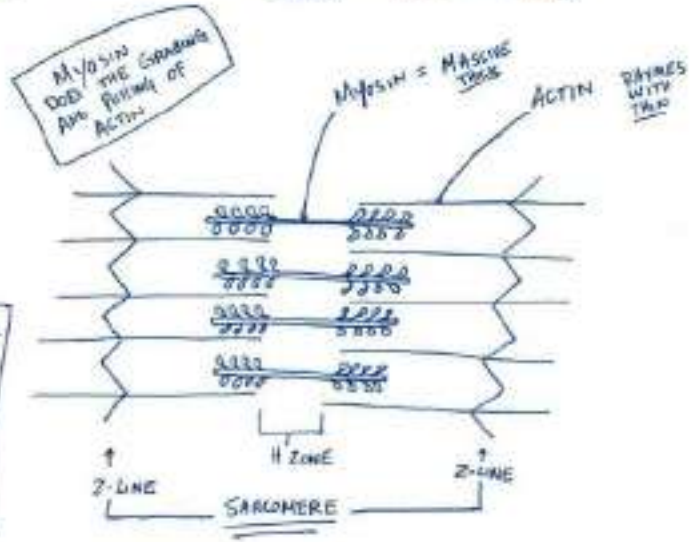




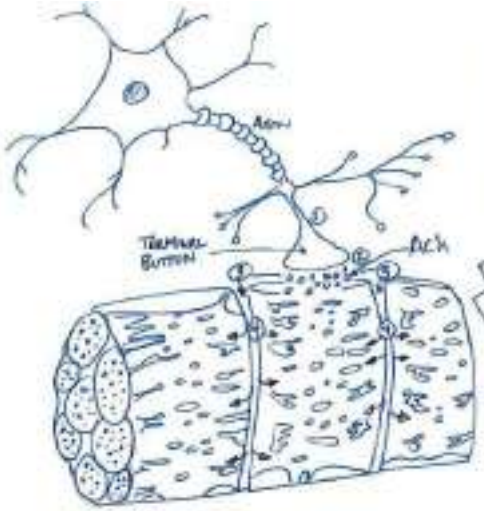
Actin + Myosin

[Sliding Filament Model]



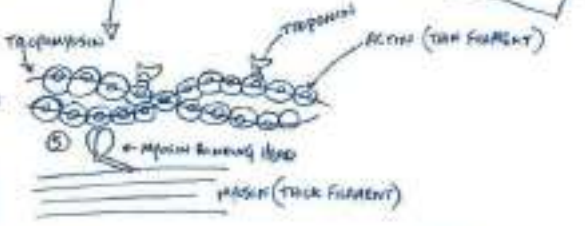


Neuromuscular Junction & Muscle Contraction



Tetanus
Caused by Clostridium tetani (bacteria) the bacteria produce a neurotoxin that keeps ACh in the synaptic cleft = continual muscle contraction

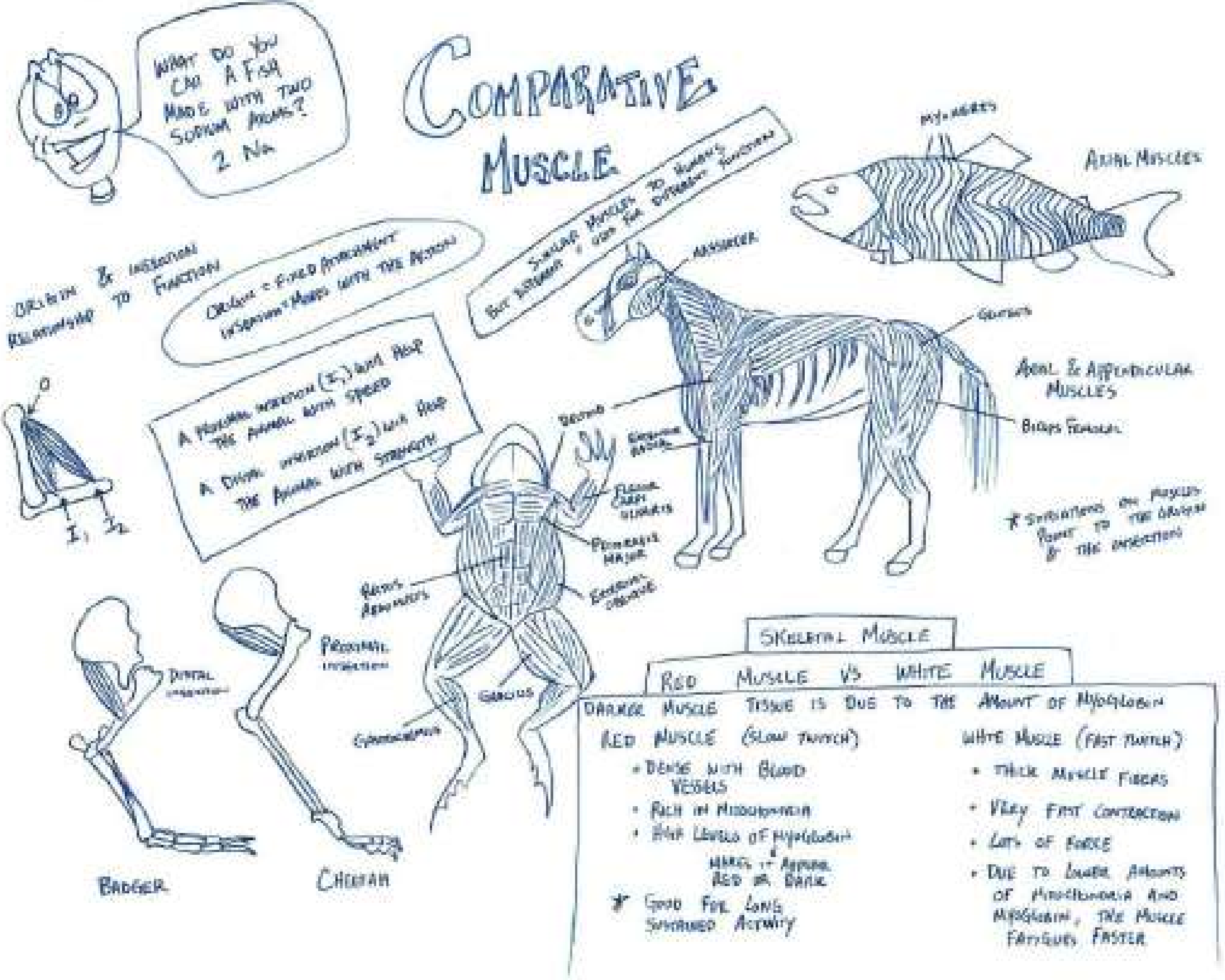
How Can We Control Muscle Contraction?
- Vary the Amount of ACh
- Vary the Amount of Ca^{+2}
- Vary the Amount of ATP
- Vary the Amount of Muscle Fibers Being Used



5. Myosin can't bind to actin when tropomyosin blocks it

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
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

6. When Ca^{+2} binds to troponin it causes tropomyosin to slide off the myosin binding site
7. Myosin binds to actin
8. The myosin changes shape and shifts the actin
9. ATP is required to release myosin from actin

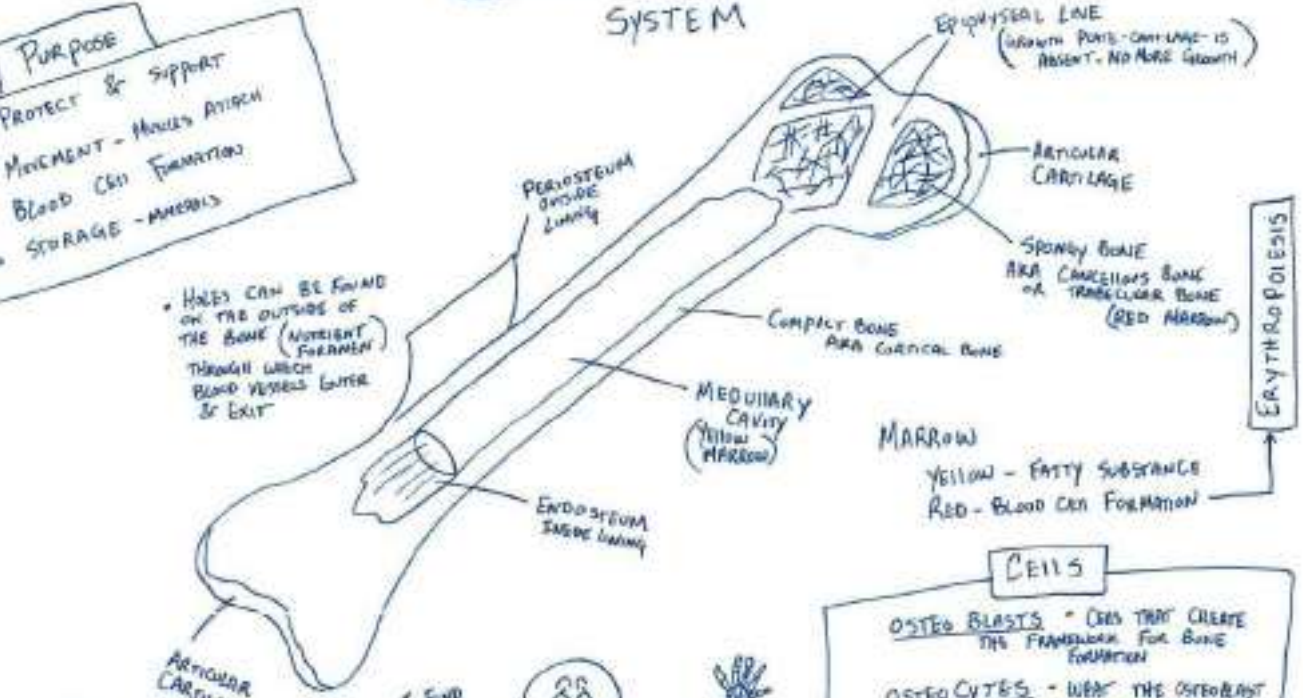

What do you call a fish made with two sodium atoms?
2 Na
Comparative Muscle
Similar muscles to humans but different uses for different function
Myomeres
Axial Muscles
Origin & insertion relationship to function
Origin = fixed attachment
Insertion = moves with the action
A proximal insertion (I_1) will help the animal with speed
A distal insertion (I_2) will help the animal with strength
O
I_1 I_2
Masseter
Gluteus
Axial & Appendicular Muscles
Biceps Femoral
Deltoid
Pectoralis major
Rectus abdominis
External oblique
Gracilis
Gastrocnemius
* Striations on muscles point to the origin & the insertion
Distal insertion
Proximal 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

SKELETAL SYSTEM

PURPOSE

- PROTECT & SUPPORT
- MOVEMENT - MUSCLES ATTACH
- BLOOD CELL FORMATION
- STORAGE - MINERALS



ERYTHROPOIESIS

MARROW

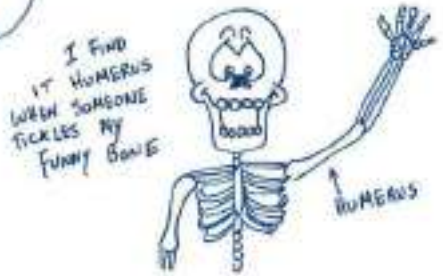
YELLOW - FATTY SUBSTANCE
RED - BLOOD CELL FORMATION

CELLS

OSTEOBLASTS - CELLS THAT CREATE THE FRAMEWORK FOR BONE FORMATION

OSTEOCYTES - WHAT THE OSTEOBLAST TURNS INTO WHEN THE BONE FORMS

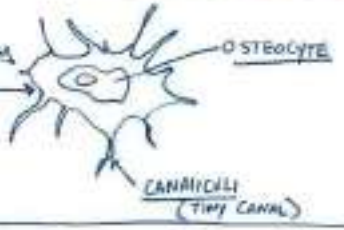
OSTEOCLASTS - ABSORBS BONE WHEN HEALING OR GROWING

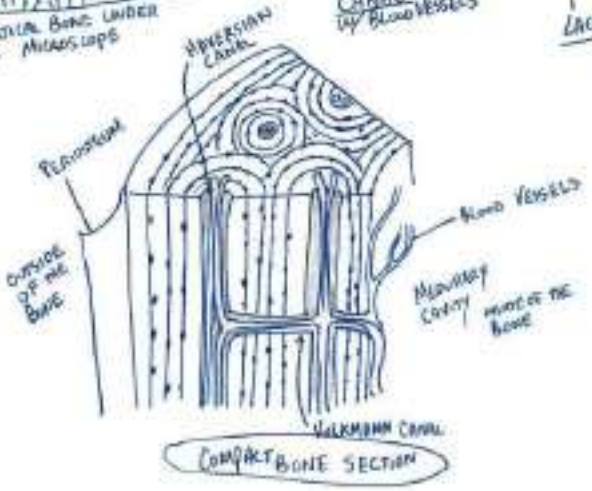


UNITS OF BONE

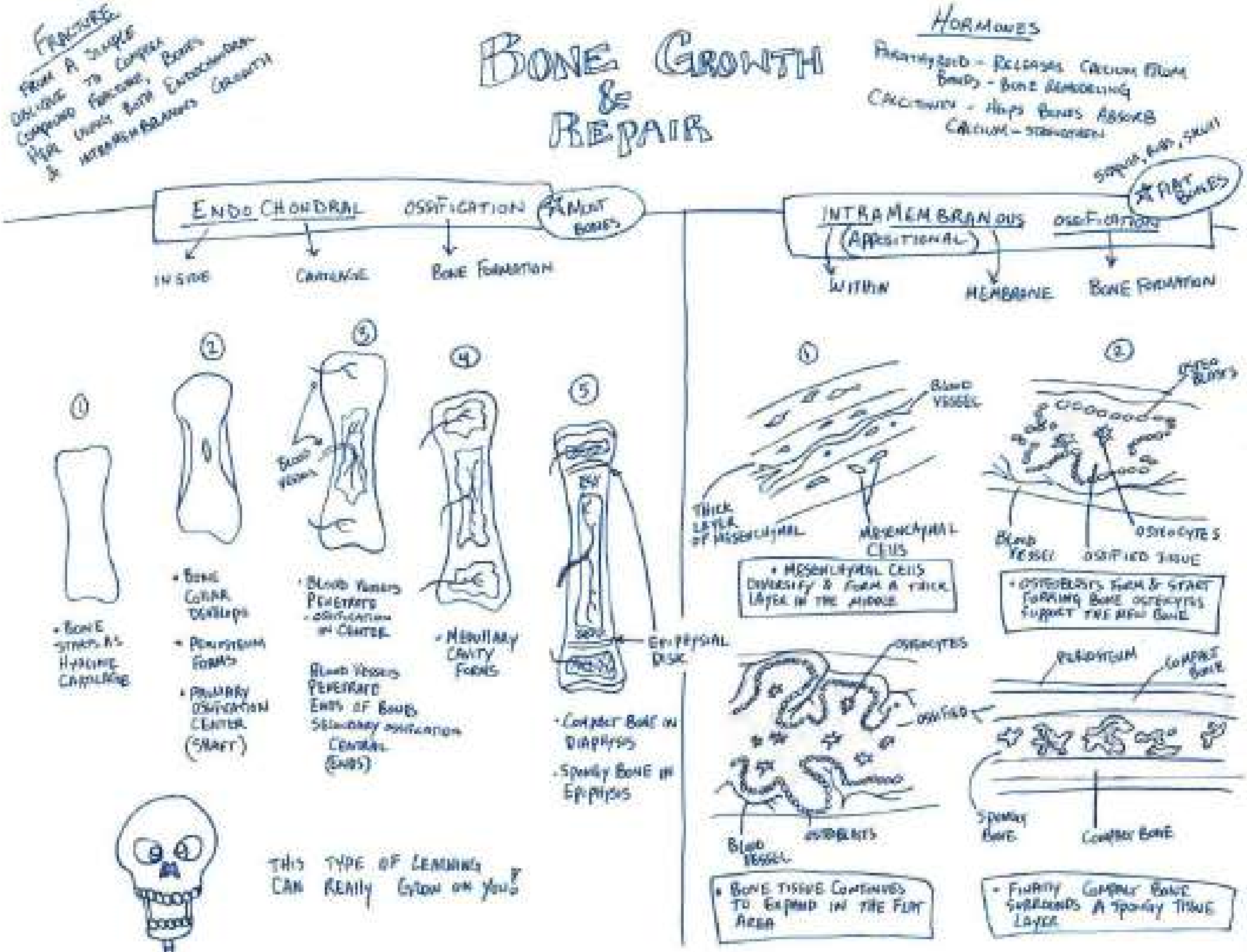
THE COMPACT BONE GROWS IN DISTINCT RINGS
THESE RING UNITS ARE CALLED OSTEONS

CORTICAL BONE UNDER THE MUSCLE



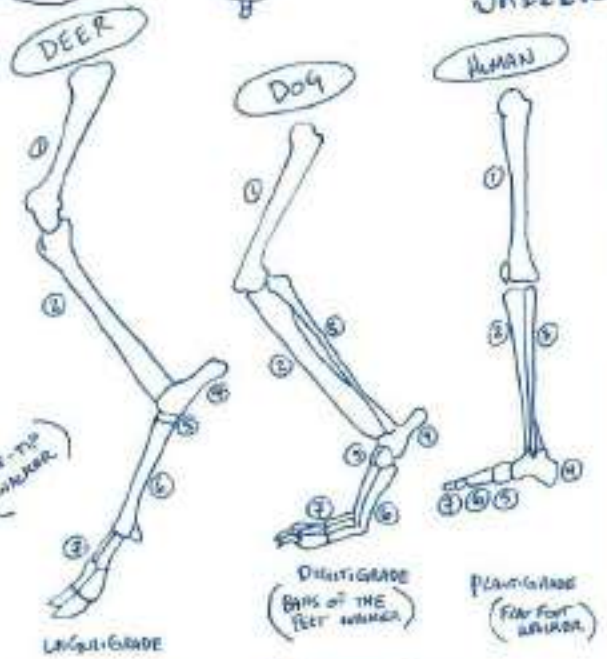


OSTEOCYTES MAINTAIN THE CALCIFIED BONE MATRIX. MATERIALS (NUTRIENTS AND WASTE) ARE PASSED BETWEEN LACUNAE VIA THE CANALICULI. MATERIALS & WASTE ARE ALSO TRANSPORTED IN & OUT OF THE BONE VIA THE BLOOD VESSELS FOUND IN THE HAVERSIAN & VOLKMANN CANALS

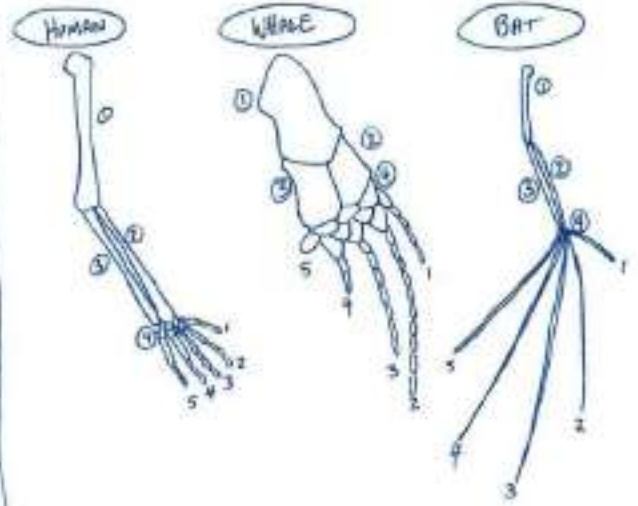


BONE GROWTH & REPAIR
FRACTURE
FROM A SIMPLE OBLIQUE TO COMPLEX COMPOUND FRACTURE, BONES HEAL USING BOTH ENDOCHONDRAL & INTRAMEMBRANOUS GROWTH
HORMONES
PARATHYROID - RELEASES CALCIUM FROM BONES - BONE REMODELING
CALCITONIN - HELPS BONES ABSORB CALCIUM - STRENGTHEN
ENDOCHONDRAL OSSIFICATION
MOST BONES
INSIDE
CARTILAGE
BONE FORMATION
1
BONE STARTS AS HYALINE CARTILAGE
2
BONE COLLAR DEVELOPS
PERIOSTEUM FORMS
PRIMARY OSSIFICATION CENTER (SHAFT)
3
BLOOD VESSELS
BLOOD VESSELS PENETRATE
OSSIFICATION IN CENTER
BLOOD VESSELS PENETRATE ENDS OF BONES
SECONDARY OSSIFICATION CENTERS (ENDS)
4
MEDULLARY CAVITY FORMS
5
EPIPHYSEAL DISC
COMPACT BONE IN DIAPHYSIS
SPONGY BONE IN EPIPHYSIS
THIS TYPE OF LEARNING CAN REALLY GROW ON YOU!
INTRAMEMBRANOUS OSSIFICATION
(APPOSITIONAL)
FLAT BONES
SKULL, RIBS, SKULL
WITHIN
MEMBRANE
BONE FORMATION
1
BLOOD VESSEL
THICK LAYER OF MESENCHYMAL
MESENCHYMAL CELLS
MESENCHYMAL CELLS DIVERSIFY & FORM A THICK LAYER IN THE MIDDLE
2
OSTEOBLASTS
BLOOD VESSEL
OSSIFIED TISSUE
OSTEOCYTES
OSTEOBLASTS FORM & START FORMING BONE. OSTEOCYTES SUPPORT THE NEW BONE
OSTEOCYTES
OSSIFIED
BLOOD VESSEL
OSTEOBLASTS
BONE TISSUE CONTINUES TO EXPAND IN THE FLAT AREA
PERIOSTEUM
COMPACT BONE
SPONGY BONE
COMPACT BONE
FINALLY COMPACT BONE SURROUNDS A SPONGY TISSUE LAYER

COMPARATIVE SKELETONS



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



① HUMERUS ② RADIUS ③ ULNA ④ CARPALS
⑤ FINGERS
1 = THUMB 5 = PINKIE

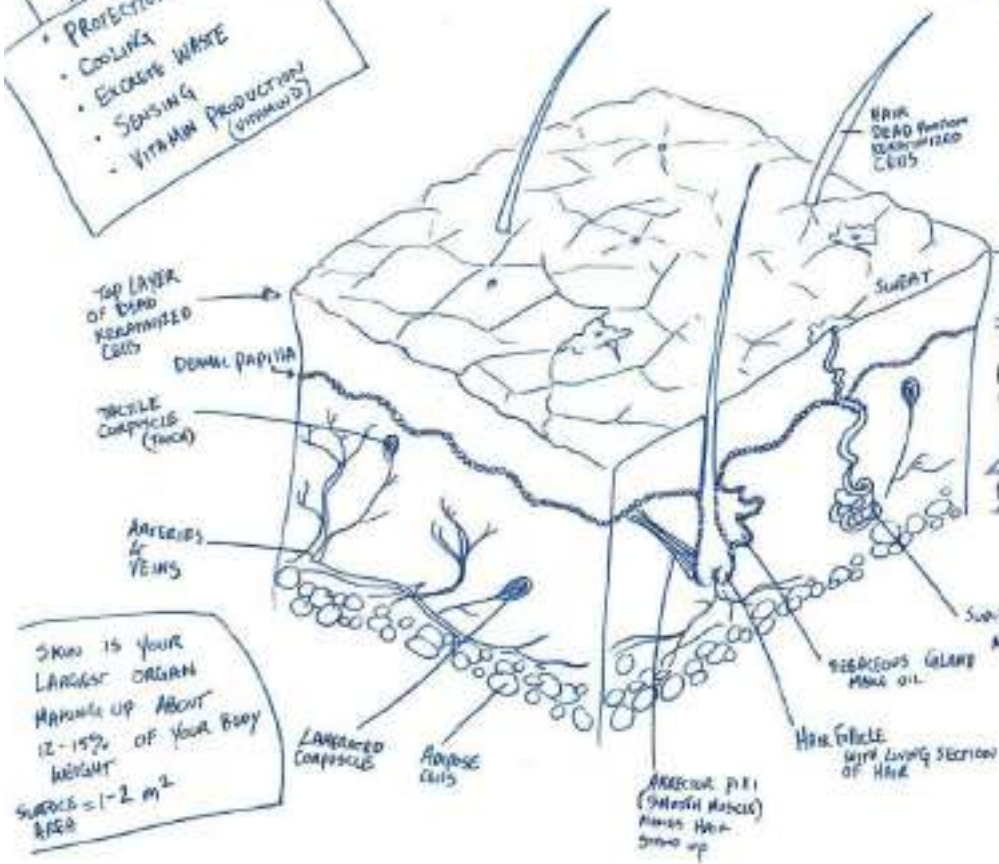
Integumentary

Integumentary System

Purpose
- Protection
- Cooling
- Excrete Waste
- Sensing
- Vitamin Production (Vitamin D)

Dermis = Skin

Includes
- Hair
- Exocrine Glands
  - Sweat
  - Oil
  - Wax
- Nails
- Adipose Tissue
- Vascular Tissue
- Nervous Tissue
- Involuntary Muscles - Smooth

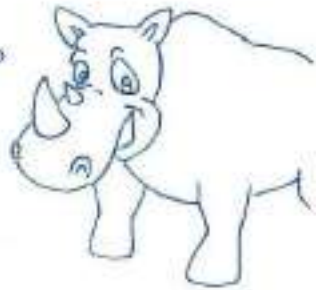


Three Layers of Skin

Skin is your largest organ making up about 12-15% of your body weight

Surface = 1-2 m^2 area

Rhino Horn is compressed hair, not bone!



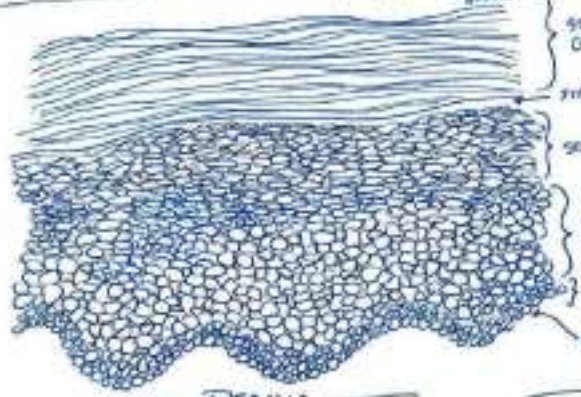
INTEGUMENTARY SYSTEM

EPIDERMIS LAYERS

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

SKIN ALWAYS FLAKING OFF = DUST IN YOUR HOUSE



DERMIS

MELANOCYTES

COLOR CELLS

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

1. BASEMENT MEMBRANE ATTACHES EPIDERMIS TO THE DERMIS
2. STRATUM BASALE - MITOTIC LAYER. CLOSEST TO BLOOD SUPPLY FOUND IN THE DERMIS. AS THE CELLS AGE THEY MIGRATE UP TO THE NEXT LAYER
3. STRATUM SPINOSUM - KERATIN (PROTEIN) FIBERS BECOMINGS
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 THE LAYER'S SURFACE.

CANCERS

1. BASAL CELL - STEMS IN 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

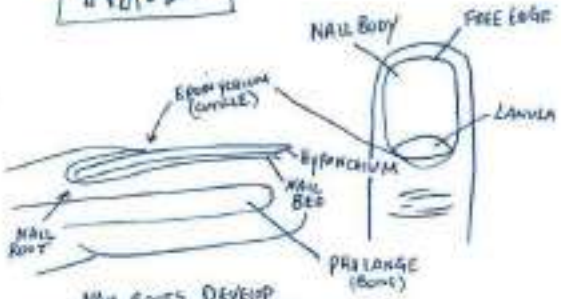
PROTECT AGAINST U.V. RADIATION WHICH CAN DAMAGE DNA LEADING TO CANCER & PREVENT FOLIC ACID BREAKDOWN

INTEGUMENTARY SYSTEM

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

HAIR

NAIL



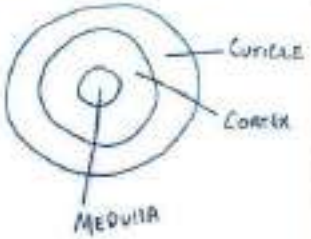
NAIL ROOTS DEVELOP FROM THE DOWNWARD PUSH OF THE EPIDERMIS

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	CATAGEN	TELOGEN
ACTIVE GROWTH OF HAIR. LOTS OF MITOSIS & RUSH OF NEW CELLS NEEDED	TRANSITIONAL PHASE WHERE GROWTH STOPS AND PREPS FOR TELOGEN	RESTING PHASE USUALLY WHEN THE HAIR FALLS OUT
≈ 2-6 YEARS - SCALP	≈ 2-3 WEEKS	≈ 100 DAYS SCALP
30-45 DAYS ON ARMS, LEGS		LONGER ON ARMS, LEGS
		EYEBROWS

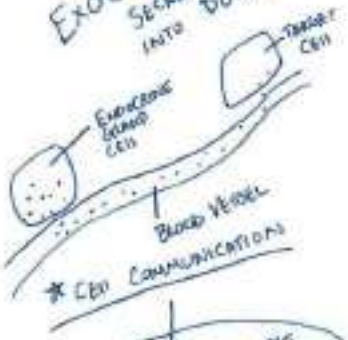
YOU KNOW WHAT THEY SAY
HAIR TODAY GONE TOMORROW

Endocrine

ENDOCRINE SYSTEM

ENDOCRINE - SECRETE CONTENTS INTO THE BLOOD STREAM DUCTLESS

EXOCRINE - SECRETE CONTENTS INTO DUCTS



* CELL COMMUNICATION

FEEDBACK GUIDANCE

TWO COMMUNICATION PATHS IN ANIMALS
- NERVOUS SYSTEM & ENDOCRINE
  - BOTH RESPOND & "TALK" TO EACH OTHER

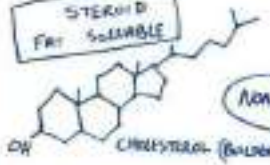
- ENDOCRINE SYSTEM HELPS MAINTAIN HOMEOSTASES

DIFFERENT TYPES OF HORMONES

HORMONES FOLLOW THE CELL COMMUNICATION PATHWAY

- LIGAND BINDING (RECEPTION)
  - ATTACHING TO SURFACE CARBOHYDRATE
- ENZYME CHAIN REACTION INSIDE CELL (TRANSDUCTION)
  - A —Enz 1→ B —Enz 2→ C —Enz 3→ D
- RESPONSE

STEROID FAT SOLUBLE



CHOLESTEROL (BASED)

NONPOLAR

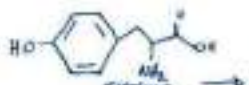
- TESTOSTERONE
- ESTRADIOL

PEPTIDE PROTEIN BASED

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

AMINO ACID-DERIVED

POLAR



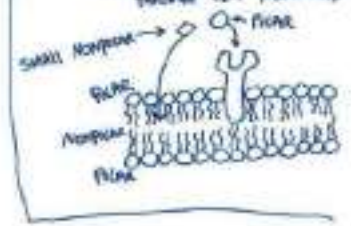
- EPINEPHRINE
- MELATONIN
- THYROXINE

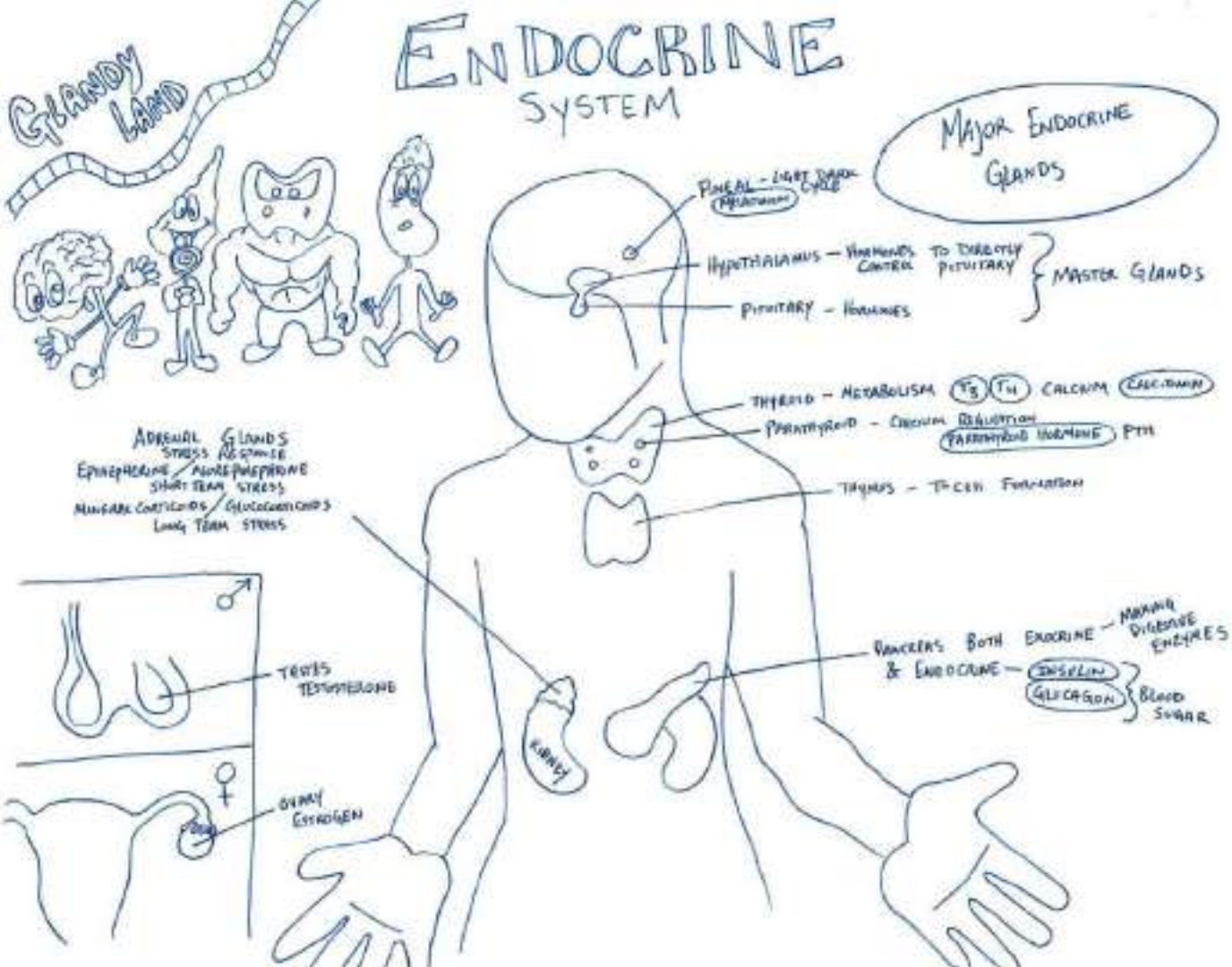
POLAR VS. NONPOLAR

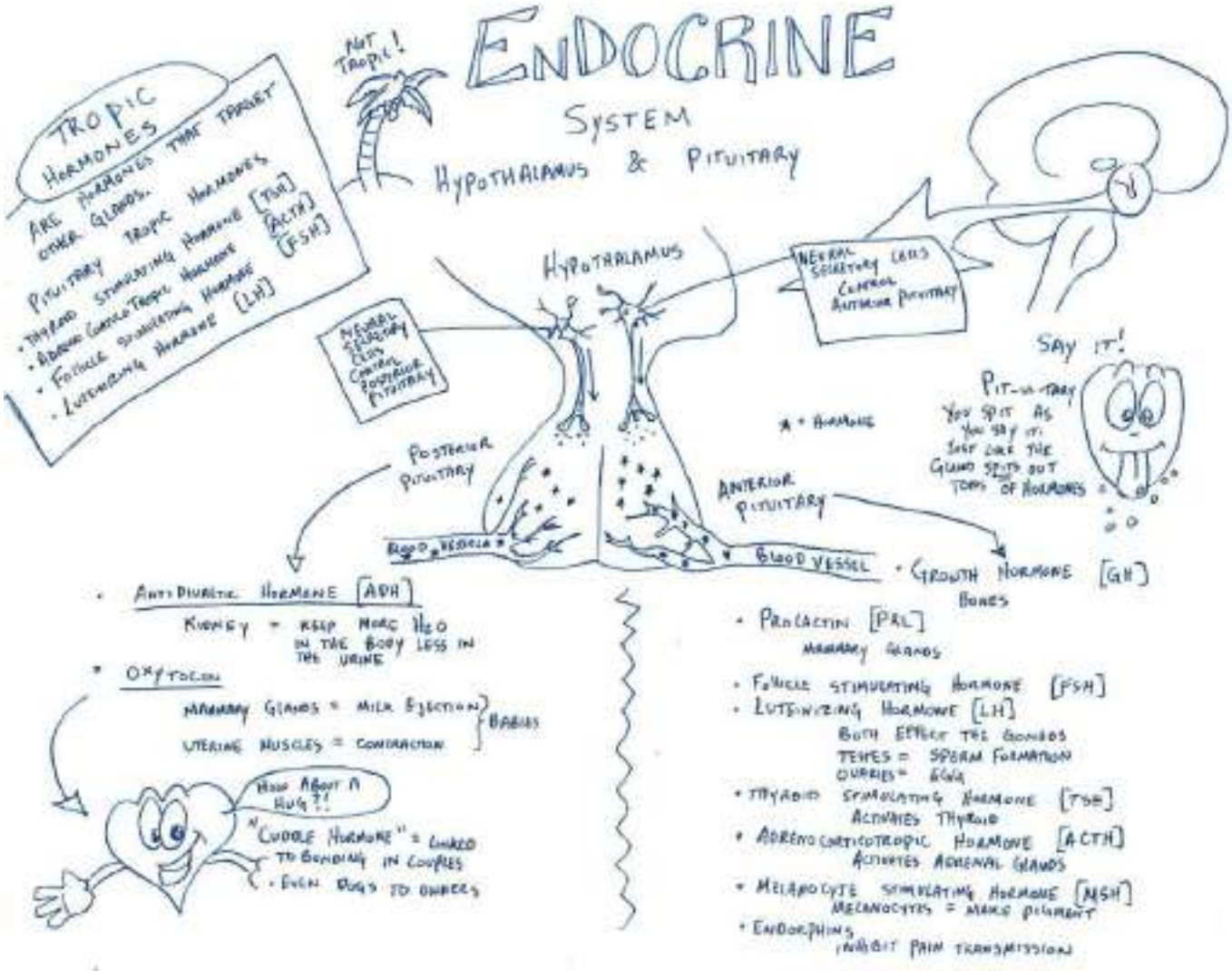
POLAR

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

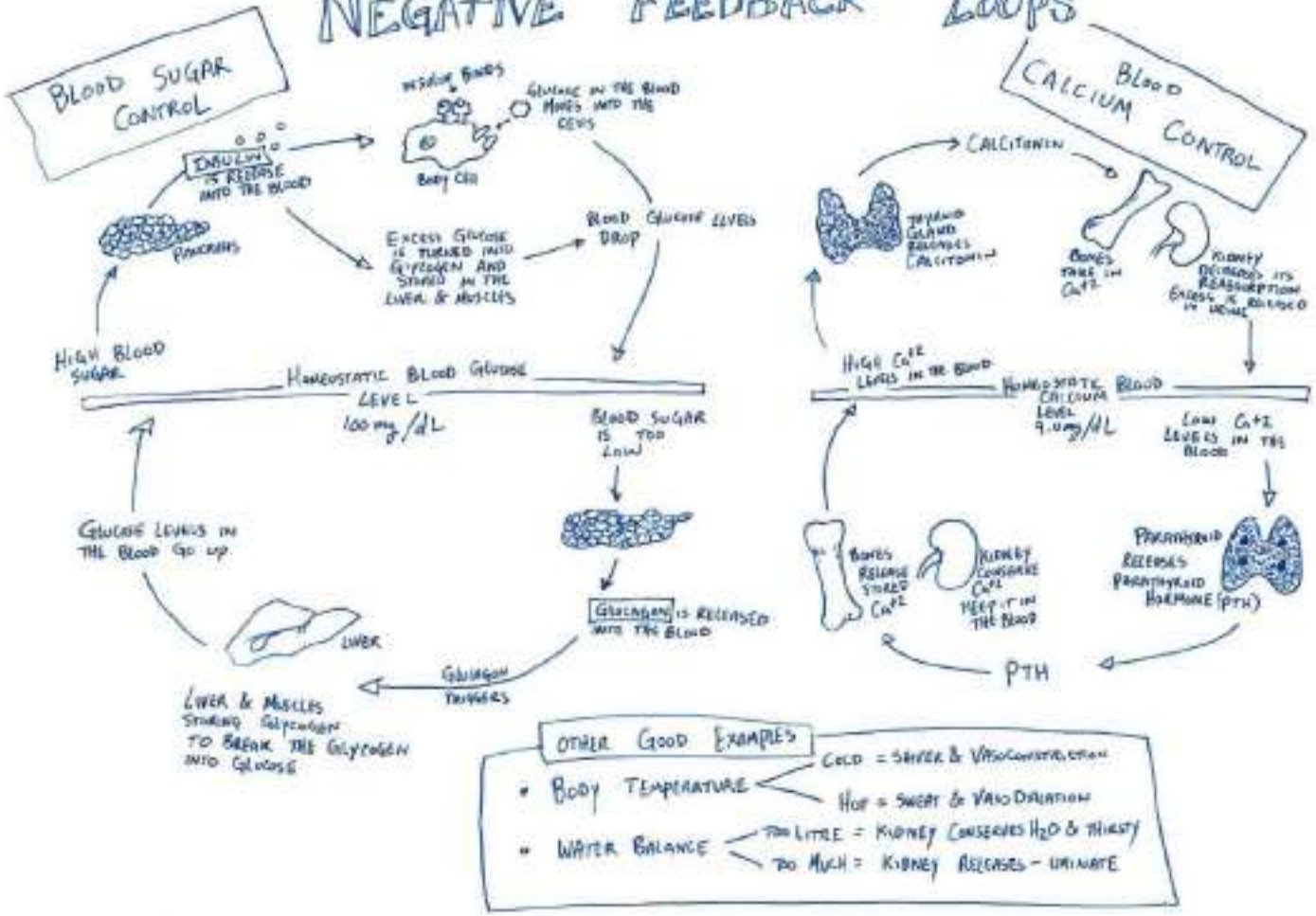
NONPOLAR - CAN MOVE THROUGH CELL MEMBRANE




GLANDY LAND
ENDOCRINE SYSTEM
MAJOR ENDOCRINE GLANDS
PINEAL – LIGHT DARK CYCLE
MELATONIN
HYPOTHALAMUS – HORMONES CONTROL TO DIRECTLY 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
EPINEPHRINE / NOREPINEPHRINE
SHORT TERM STRESS
MINERAL CORTICOIDS / GLUCOCORTICOIDS
LONG TERM STRESS
TESTES
TESTOSTERONE
OVARY
ESTROGEN
KIDNEY
PANCREAS BOTH ENDOCRINE & EXOCRINE – DIGESTIVE ENZYMES
INSULIN
GLUCAGON
BLOOD SUGAR

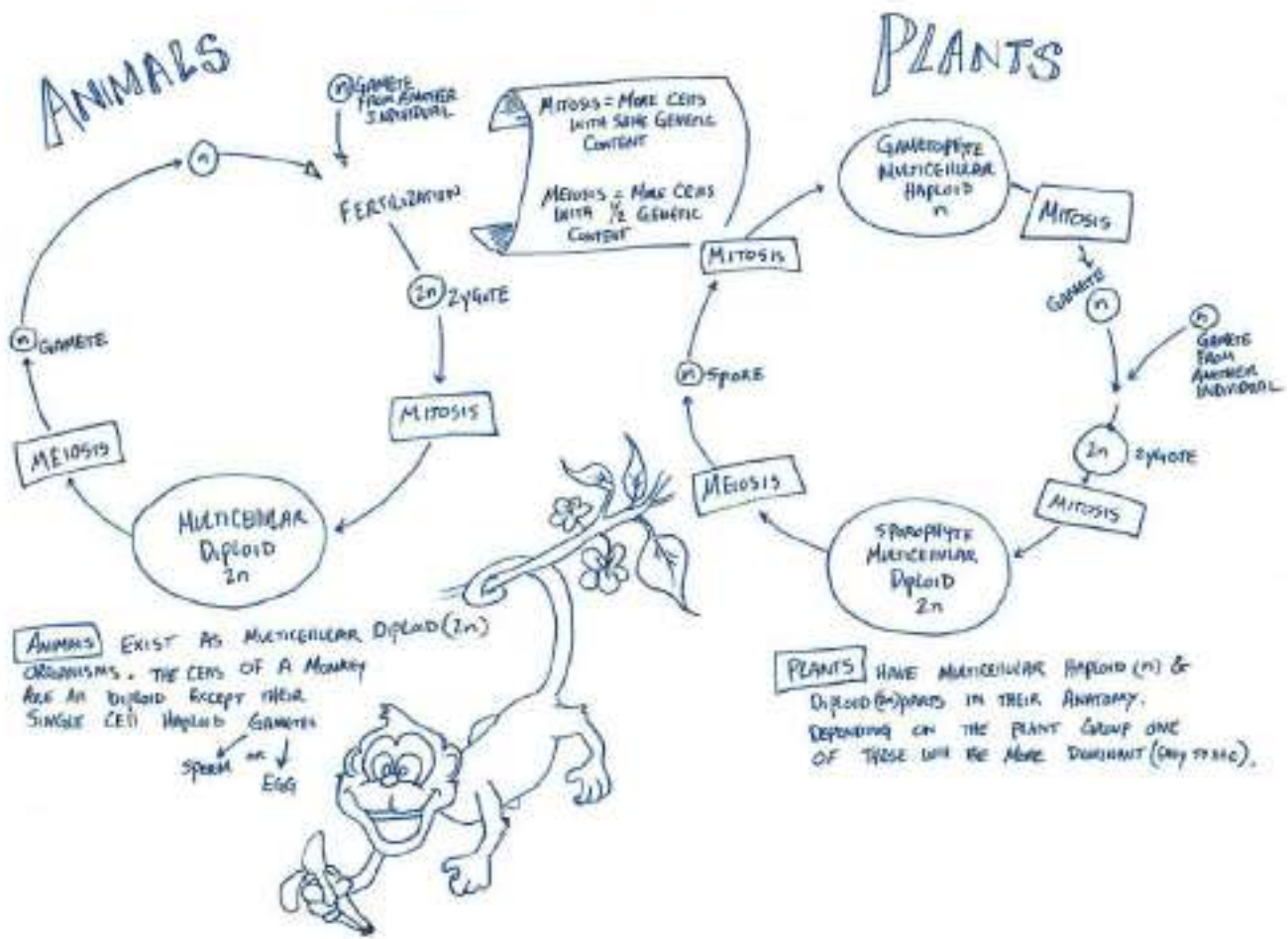

ENDOCRINE
SYSTEM
HYPOTHALAMUS & PITUITARY
NOT TROPIC!
TROPIC HORMONES
ARE HORMONES THAT TARGET OTHER GLANDS.
PITUITARY TROPIC HORMONES
• THYROID STIMULATING HORMONE [TSH]
• ADRENO CORTICOTROPIC HORMONE [ACTH]
• FOLLICLE STIMULATING HORMONE [FSH]
• LUTEINIZING HORMONE [LH]
HYPOTHALAMUS
NEURAL SECRETORY CELLS CONTROL POSTERIOR PITUITARY
NEURAL SECRETORY CELLS CONTROL ANTERIOR PITUITARY
SAY IT!
PIT-U-TARY
YOU SPIT AS YOU SAY IT. JUST LIKE THE GLAND SPITS OUT TONS OF HORMONES
H = HORMONE
POSTERIOR PITUITARY
ANTERIOR PITUITARY
BLOOD VESSEL
• GROWTH HORMONE [GH]
BONES
• ANTI DIURETIC HORMONE [ADH]
KIDNEY = KEEP MORE H2O IN THE BODY LESS IN THE URINE
• OXYTOCIN
MAMMARY GLANDS = MILK EJECTION
UTERINE MUSCLES = CONTRACTION
BABIES
HOW ABOUT A HUG?!
"CUDDLE HORMONE" = LINKED TO BONDING IN COUPLES
• EVEN DUGS TO OWNERS
• PROLACTIN [PRL]
MAMMARY GLANDS
• FOLLICLE STIMULATING HORMONE [FSH]
• LUTEINIZING HORMONE [LH]
BOTH EFFECT THE GONADS
TESTES = SPERM FORMATION
OVARIES = EGGS
• 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



Plants

LIFE CYCLES


ANIMALS
n GAMETE FROM ANOTHER INDIVIDUAL
n
FERTILIZATION
2n ZYGOTE
MITOSIS = MORE CELLS WITH SAME GENETIC CONTENT
MEIOSIS = MORE CELLS WITH ½ GENETIC CONTENT
MITOSIS
n GAMETE
MEIOSIS
MITOSIS
MULTICELLULAR DIPLOID 2n
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
GAMETOPHYTE MULTICELLULAR HAPLOID n
MITOSIS
GAMETE n
n GAMETE FROM ANOTHER INDIVIDUAL
2n ZYGOTE
MITOSIS
SPOROPHYTE MULTICELLULAR DIPLOID 2n
MEIOSIS
n SPORE
MITOSIS
PLANTS HAVE MULTICELLULAR HAPLOID (n) & DIPLOID (2n) PHASES IN THEIR ANATOMY. DEPENDING ON THE PLANT GROUP ONE OF THESE WILL BE MORE DOMINANT (ONLY TO SEE).

Antheridia - ♂ Gametophyte Makes Sperm

Archegonium - ♀ Gametophyte Makes Eggs

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) This is Small
- Water Required for Fertilization Sperm Swims to Archegonia ♀ Egg Archegonia ♀
- Sporophyte Grows Out of the Archegonia
- Spores Spread through the Air ★ How the Population Inhabits New Locations

Ferns
Pteraphytes

- Dominant Sporophyte with a Reduced Gametophyte
- Rhizome Roots
- Vascular Plant Tubes (xylem & phloem) Grow Height
- Water Required for Fertilization Sperm swims to Egg Antheridium ♂ Archegonium ♀ 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 with (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 Distribution

↓

Very Diverse

PLANT ANATOMY

Angiosperm perspective

ROOTS - optimize uptake of H_2O & minerals

Roots of plants
- Symbiosis with bacteria - help to put nitrogen out of the air

Types

Fibrous	Tap
Spread to optimize H_2O uptake	- Touch & can reach nutrients
Grasses	Carrot

SEED

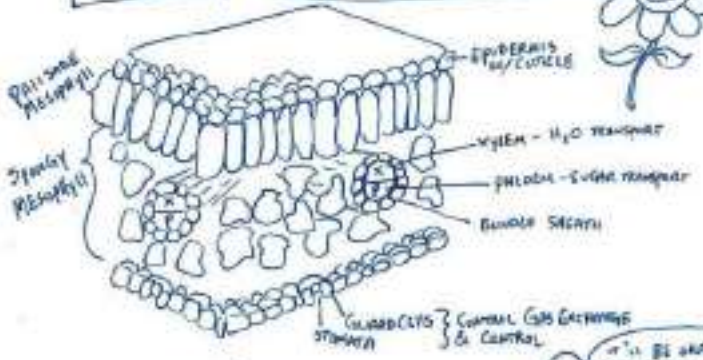
Endosperm is the food for the embryo before it can get roots & leaves to do photosynthesis

To humans it is delicious calories

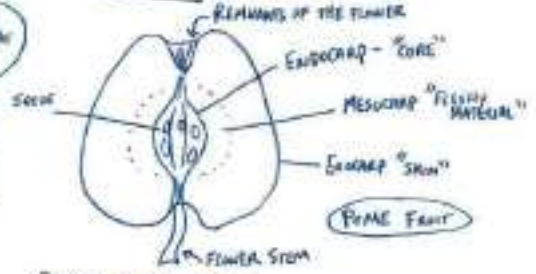
Bread - grain - seed

Endosperm - food reserve for embryo

LEAVES - optimize photosynthesis



FRUIT - enlarged ovary



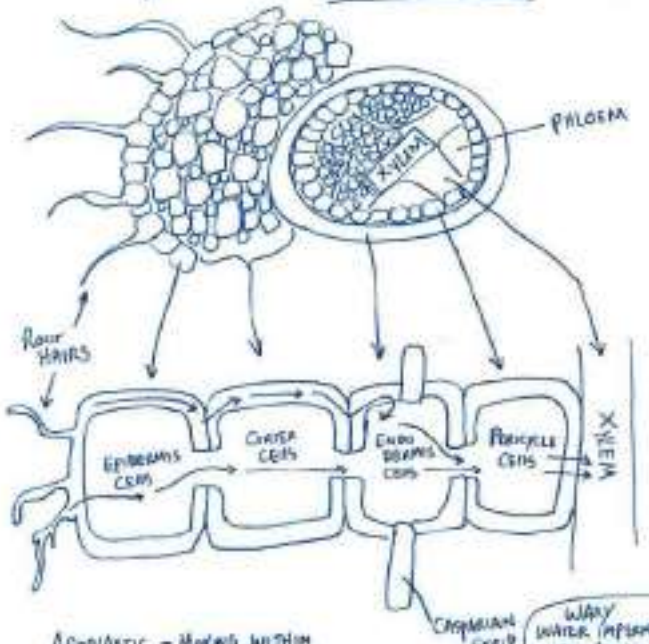
Diversity of Fruits - some examples -

TRANSPORT IN PLANTS

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

WATER & MINERAL TRANSPORT

ROOT CROSS SECTION



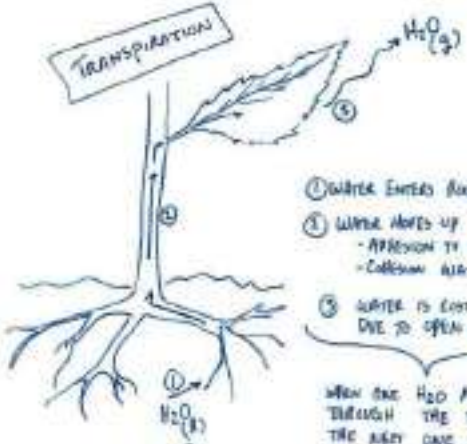
WAXY WATER IMPERMEABLE STRIP THAT PREVENTS MOVEMENT THROUGH CELL WALLS

APOPLASTIC – MOVING WITHIN THE CELL WALLS

SYMPLASTIC – MOVING BETWEEN CELLS THROUGH THE PLASMODESMATA

TRANSMEMBRANE – MOVE STRAIGHT THROUGH WALLS & MEMBRANES VIA WATER CHANNELS

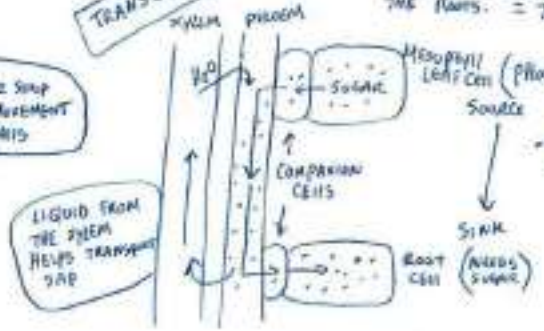
TRANSPIRATION



1. WATER ENTERS ROOTS VIA OSMOSIS
2. WATER MOVES UP XYLEM CELLS
   - ADHESION TO CELL WALLS
   - COHESION BETWEEN 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



LIQUID FROM THE PHLOEM HELPS TRANSPORT SAP

- TRANSPORT OF SUGAR FROM SOURCE TO SINK

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 GROW THICKNESS BY ADDING XYLEM & PHLOEM

HYDROTROPISM

GROWTH/MOVEMENT TOWARDS WATER

THIGMOTROPISM

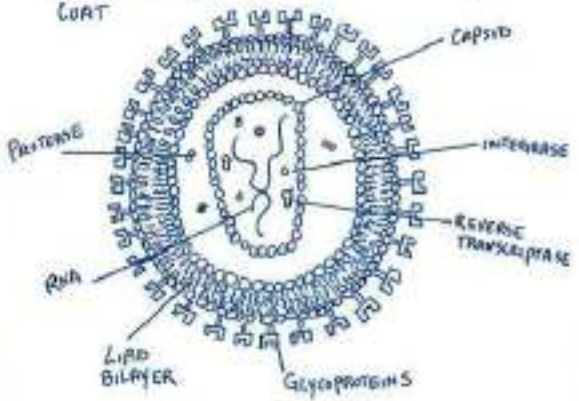
GROWTH/MOVEMENT IN RESPONSE TO TOUCH

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

Bacteria, Viruses, Fungi, Protists

VIRUSES

VIRUSES ARE SMALL "THINGS" THAT ARE PARASITIC. THEY CONTAIN GENETIC MATERIAL THAT IS SURROUNDED BY A PROTEIN COAT

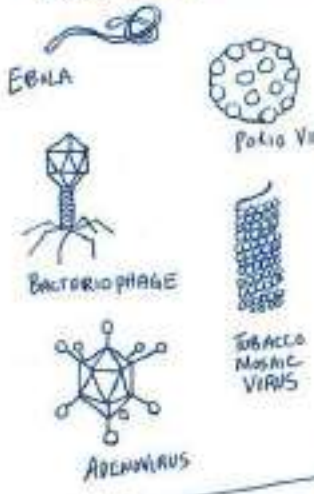


VIRUS GENETIC DIVERSITY

VIRUS MATERIAL

VIRUS DIVERSITY

MANY SHAPES & ORGANISMS THEY RESIDE IN



SIZE

GENERALLY AROUND 10-300 nm

ABOUT 175 MILLION VIRUSES COULD FIT IN ONE HUMAN BODY CELL

H.I.V.

HUMAN IMMUNODEFICIENCY VIRUS

RNA - GENETIC MATERIAL

PROTEASE - BREAK PROTEINS DURING INFECTION

INTEGRASE - PUTS VIRUS DNA INTO HOST'S DNA

REVERSE TRANSCRIPTASE - TURNS THE RNA → DNA

CAPSID - ATTACHMENT & INFECTION PURPOSE

WHO SUFFERS FROM VIRAL INFECTIONS?

- ALL ANIMALS
- PLANTS
- FUNGUS
- EVEN BACTERIA

LYTIC CYCLE ① THE VIRUS INFECTS THE HOST CELL ② INCORPORATES ITS DNA INTO THE HOST DNA ③ HOST CELL REPLICATES THEM ④ HOST CELL RUPTURES RELEASING MORE OF THE VIRUS

LYSOGENIC CYCLE IS SIMILAR TO THE LYTIC CYCLE EXCEPT THEY DO NOT RUPTURE THE CELL RIGHT AWAY. THE VIRAL DNA CAN BE PASSED FROM HOST CELL TO HOST CELL

BACTERIA

MORPHOLOGY

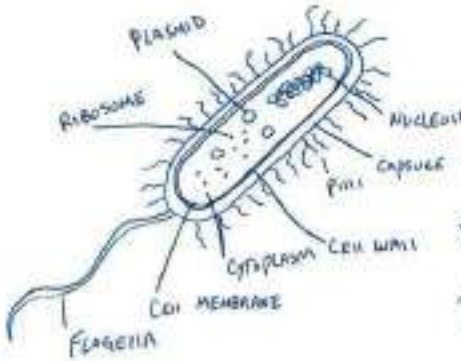
SHAPES

1. SPHERE = COCCI
2. RODS = BACILLUS
3. SPIRALS = SPIRNA

AN OF THESE SHAPES CAN BE FOUND IN DIFFERENT WAYS

EX: COCCI CHAIN

CURVED RODS



1. CELL MEMBRANE - BARRIER THAT WORKS SIMILAR TO AN OTHER MEMBRANES
2. RIBOSOME - PROTEIN PRODUCTION
3. CYTOPLASM - CELL SOLUTION (MOSTLY H_2O)
4. NUCLEOID - BACTERIA DNA
5. PLASMID - CIRCULAR DNA - CONTAINS EXTRA GENES
6. CELL WALL - PROTECTION - MADE OUT OF PEPTIDOGLYCAN (PROTEIN + SUGAR)
7. CAPSULE - EXTRA COATING AROUND THE CELL WALL
8. PILI - STIFF PROTEIN FILAMENTS USED TO ATTACH TO SURFACES
9. FLAGELLA - ALLOWS THE BACTERIA TO MOVE THROUGH ITS ENVIRONMENT

GRAM POSITIVE VS. NEGATIVE

- A TECHNIQUE USED TO DIFFERENTIATE BETWEEN TWO MAJOR GROUPS OF BACTERIA

GRAM (-) = HAVE AN OUTER LIPID COAT

GRAM (+) = HAVE AN EXTERIOR OF PROTEIN = STAIN RED-VIOLET

ENVIRONMENT

ECOSYSTEMS ON BOTH LAND & IN H_2O ARE RELIANT ON VARIOUS BACTERIA

- NITROGEN FIXATION - BACTERIA HAVE SYMBIOTIC RELATIONSHIPS WITH PLANTS = PROVIDE NITROGEN TO THEM
- DECOMPOSITION - IF BACTERIA DID NOT BREAK DOWN DEAD THINGS, NUTRIENTS WOULD NOT BE ABLE TO RE-ENTER THE FOOD CHAIN

YOU

ONLY A SMALL PORTION OF THE EARTH'S BACTERIA ARE PATHOGENIC. MOST OF THE BACTERIA ARE ESSENTIAL FOR YOUR HEALTH & WELL BEING OR CAUSE YOU NO PROBLEMS WHATSOEVER

MICROBIOME

DOMINANT

BACTERIA RULE THE PLANET

THEY CAN BE FOUND EVERYWHERE

FUNGI PART 1

REPRODUCTION

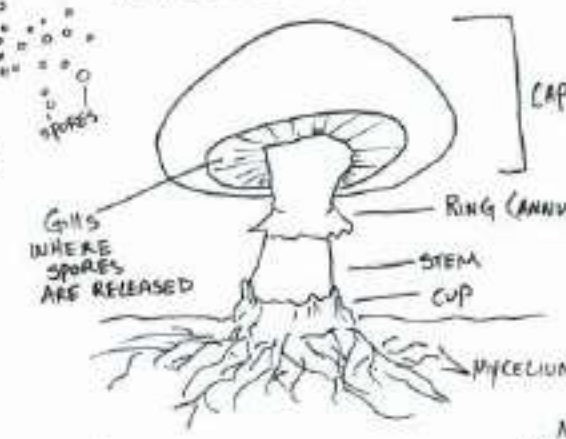
Both SEXUALLY & ASEXUALLY

MAKE GENETICALLY IDENTICAL HAPLOID (n) SPORES

SPORES

MYCELIUM OF TWO FUNGI FUSE & THE HAPLOID NUCLEI STAY IN THE SAME CELL

EUKARYOTIC - MULTICELLULAR ORGANISMS
MOST CELLS ARE HAPLOID



REPRODUCTIVE STRUCTURE

ROOT-LIKE STRUCTURE

JUST LIKE ME, THESE EUKARYOTES ARE ALWAYS INVITED TO PARTIES. JUST FUN-GUYS

FUNGI

- CAN CAUSE DISEASE
  - RINGWORM
  - ATHLETE'S FOOT
- CAN BE POISONOUS
- BUT MOST HAVE LARGE ENVIRONMENTAL IMPACT.

HETEROTROPHIC CELLS WITH CELL WALLS

MUST CONSUME ORGANIC MATERIAL

MADE OF CHITIN

① NEW CELL HETEROKARYOTIC (n+n)

HAPLOID (n) CELL FROM FUNGUS #1

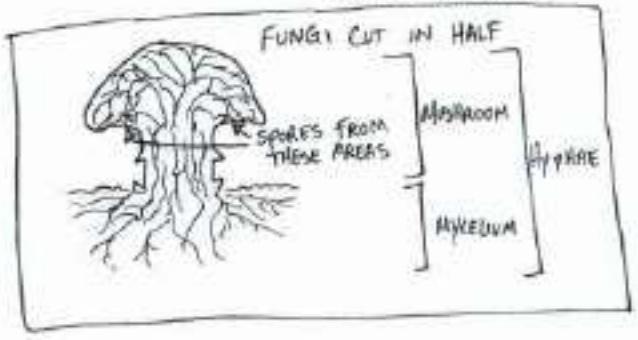
HAPLOID (n) CELL FROM FUNGUS #2

② HETEROKARYOTIC CELL WILL HAVE THE NUCLEI FUSE EVENTUALLY KARYOGAMY

DIPLOID NUCLEI

THIS NEW ZYGOSPORANGIUM IS TOUGH & RESISTS HARSH CONDITIONS

③ ZYGOSPORANGIUM GOES THROUGH MEIOSIS TO PRODUCE NEW HAPLOID SPORES = NEW DIVERSE FUNGI.



FUNGI

ENVIRONMENTAL SIGNIFICANCE

FOOD & FUEL

- WE USE YEAST (FUNGI) FOR BREAD, BEER, WINE = CALORIES
- WE CAN ALSO USE YEAST TO MAKE BIOFUELS.

SYMBIOSIS

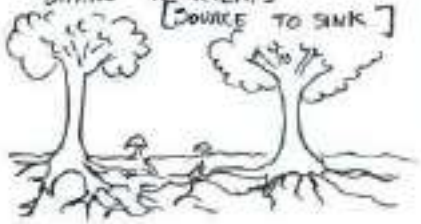
TOGETHER — LIFE

ANIMAL SYMBIOSIS

- SOME INSECTS WILL TAKE PLANTS TO AN "UNDERGROUND CHAMBER" WHERE THE FUNGI ARE. THE FUNGI DIGEST THE PLANTS & THE INSECTS CONSUME SOME OF FUNGUS.

PLANT SYMBIOSIS

- MANY PLANTS HAVE A MYCORRHIZAL INTERACTION WITH FUNGI = ↑ SURFACE AREA OF ROOTS = ↑ H_2O ABSORPTION.
- MAY ALSO HELP PLANTS SHARE NUTRIENTS [SOURCE TO SINK]



MEDICINE

- FUNGI ARE CONSTANTLY BATTLING BACTERIA & PRODUCE SUBSTANCES TO KILL THEM.
  - WE USE THESE FUNGI PRODUCED SUBSTANCES TO KILL BACTERIA AS WELL = ANTIBIOTICS

EX: · PENICILLIN
· AZITHROMYCIN
· ERYTHROMYCIN

LICHENS

- MUTUALISTIC RELATIONSHIP BETWEEN FUNGI & ALGAE
- CAN GROW WHERE MANY PLANTS CAN'T = NEW ECOSYSTEMS

Review Sheets

BIOCHEM

REVIEW ①

CARBOHYDRATES

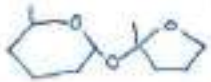
PURPOSES: PRIMARY ENERGY SOURCE

EX: GLYCOLIPIDS
FUCOSE
STARCH
CELLULOSE

ELEMENTS: C, H, O

MONO/POLY:

BOND: GLYCOSIDIC LINKAGE



PROTEIN

EXAMPLES: INSULIN, ENZYMES
COLLAGEN, ANTIBODIES

PURPOSES:

ELEMENTS

MONO/POLY:

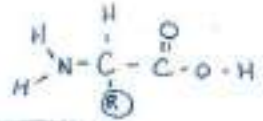
BOND: PEPTIDE

PRIMARY

SECONDARY

TERTIARY

QUATERNARY



NUCLEIC ACIDS

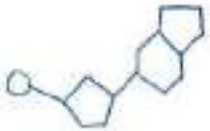
PURPOSES:

BONDS:

EX:

ELEMENTS:

MONO/POLY:



LIPIDS

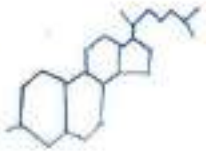
PURPOSES:

ELEMENTS:

MONO/POLY:

EX: CELL MEMBRANES
ESTROGEN
ADIPOSE

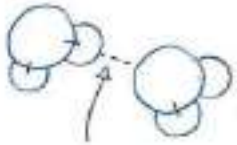
BOND:



BIOCHEM

REVIEW ①

WATER



INTRAMOLECULAR FORCE

INTERMOLECULAR FORCE

PROPERTIES

1. EXCELLENT SOLVENT
2. - TAKES SUBSTANTIAL HEAT TO WARM IT UP. (4.18 J/g °C)
3. COHESION/ADHESION
4. DENSITY
   s → l → g
5.

FUNCTIONAL GROUPS

1. ALCOHOL — CAN ↑ SOLUBILITY IN WATER
2. CARBONYL — FOUND IN SUGARS
3.
4. AMINO — BASIC AMINO ACIDS
5. SULFHYDRAL — DISULFIDE BRIDGES
6. PHOSPHATE

ENZYMES

BIOLOGICAL CATALYSTS MADE OUT OF

ENVIRONMENT INFLUENCE

1. ↑ [ENZYME] = ↑ RATE
2. ↑ [SUBSTRATE] = ↑ RATE
3. ↑ pH =  DENATURE =
4. ↑ TEMP = 

ECOLOGY

REVIEW ①

BEHAVIORAL

INNATE

TAXIS & KINESIS

FIXED ACTION PATTERN

MIGRATION

IMPRINTING

LEARNED BEHAVIOR

- CLASSICAL
- OPERANT

EVENT 1 → RESPOND → PROCESS → EVENT 2 → MODIFIED RESPONSE

BEHAVIOR IS A PHENOTYPE - WHY IS THAT IMPORTANT?

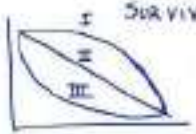
POPULATION

POPULATION: A GROUP OF INDIVIDUALS OF THE SAME SPECIES LIVING IN A GIVEN AREA

DETERMINATION OF POPULATION GROWTH

COHORT DYNAMIC
AGE TO REPRO

- BIRTH
- DEATH
- IMMIGRATION
- EMMIGRATION



SURVIVORSHIP CURVES

DENSITY INDEPENDENT GROWTH FACTORS

DENSITY DEPENDENT GROWTH FACTORS

K SELECTED

R SELECTED

ECOLOGY

REVIEW ①

COMMUNITY

NO SPECIES EVOLVES IN ISOLATION

BIODIVERSITY: THE VARIATION OF ORGANISMS & THE VARIATION OF GENES

COMMUNITY = A GROUP OF POPULATIONS INTERACTING WITH EACH OTHER IN A GIVEN AREA

SUCCESSION: CHANGE OF AN ECOSYSTEM OVER TIME

PRIMARY

SECONDARY

SYMBIOSIS:

MUTUALISM

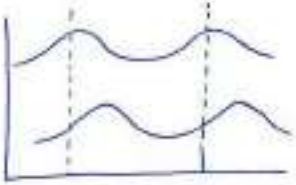
COMMENSALISM

PARASITISM/PREDATION

EXAMPLES

HOW DO PREDATORS INFLUENCE PREY & VISA VERSA

AS PREY CHANGES SO DOES THE PREDATOR



HORNS
TEETH
CLAWS
SPEED
} ADAPTATIONS

COLORATION

APOSEMATIC

CRYPTIC

MIMICRY

BATESIAN

MULLERIAN

LACK OF PREDATORS

CELLS

ENDOSYMBIOSIS THEORY
FORMATION OF THE FIRST EUKARYOTIC CELLS

4 MAJOR THINGS ALL CELLS HAVE

1. GENETIC MATERIAL
2.
3.
4.

REVIEW ①

ORGANELLES TINY ORGANS	JOB

1. NUCLEUS
2. NUCLEOLUS
3. RIBOSOME
4. ENDOPLASMIC RETICULUM
   ROUGH
   SMOOTH
5. GOLGI APPARATUS
6. VACUOLE
7. MITOCHONDRIA
8. CHLOROPLAST
9. CYTOSKELETON

PROKARYOTIC

EUKARYOTIC

ENDOMEMBRANE SYSTEM FOR PROTEIN PRODUCTION

NUCLEUS DNA → RNA → RIBOSOME ON E.R. PROTEIN → TRAVEL THROUGH E.R.

CELL SURFACE

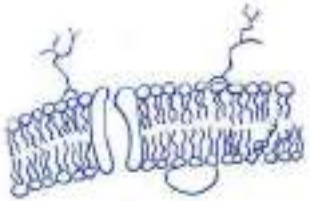
1. TIGHT JUNCTIONS
2. DESMOSOMES
3. GAP JUNCTIONS
4. PLASMA DESMATA

CELLS REVIEW

CELL MEMBRANE

COMPONENTS — PURPOSE

1. PHOSPHOLIPIDS
2. INTEGRAL PROTEINS
3. PERIPHERAL PROTEINS
4. CHOLESTEROL
5. SURFACE CARBOHYDRATES



TRANSPORT ACROSS THE CELL MEMBRANE

PASSIVE TRANSPORT — FROM HIGH → LOW

- DIFFUSION
- FACILITATED DIFFUSION
- OSMOSIS

ACTIVE TRANSPORT — FROM LOW → HIGH

- PUMPS
- ENDOCYTOSIS
- EXOCYTOSIS

CONCENTRATION GRADIENT

OSMOSIS

HYPOTONIC
HYPERTONIC
ISOTONIC

ANIMAL CELLS PREFER

BALANCED SOLUTION

PLANT CELLS PREFER

Photosynthesis & Respiration

FORMULA

Cellular Respiration

Glycolysis

INPUT : Glucose, NAD^+, ATP, ADP

OUTPUT :

LOCATION:

ENZYMES

Krebs

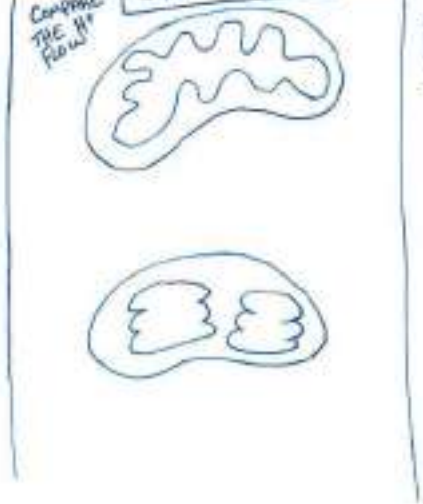
E.T.C.

REVIEW

What is the overall goal of these two processes?

Compare the H^+ flow

Chemiosmosis



FORMULA

$6CO_2 + 6H_2O \rightarrow$

Carbon Dioxide Water

Photosynthesis

Light Dependent Reaction

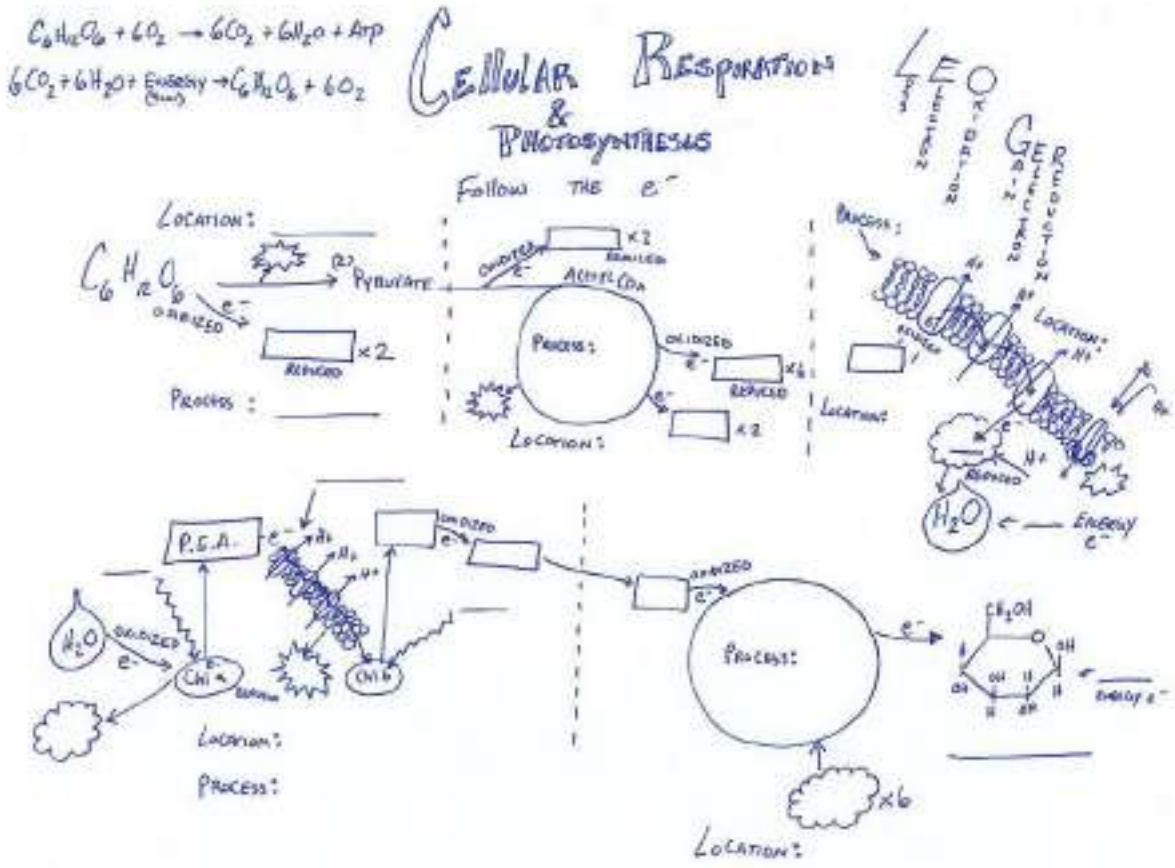
INPUT:

OUTPUT:

LOCATION:

ENZYMES:

Light Independent Reaction


$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$
$6CO_2 + 6H_2O + Energy \rightarrow C_6H_{12}O_6 + 6O_2$
CELLULAR RESPIRATION & PHOTOSYNTHESIS
LEO
GER
Follow the e⁻
Location:
Process:
Pyruvate
Acetyl CoA
Oxidized
Reduced
P.S.A.
Chl a
Chl b
H_2O
Energy
CO_2
O_2
H^+
e^-
×2
×6

GENETICS

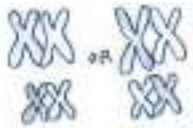
REVIEW ①

BLOOD TYPE ABO

MENDELIAN LAWS

1. LAW OF SEGREGATION

2.



MODES OF INHERITANCE

	DESCRIPTION	EXAMPLE
COMPLETE DOMINANCE		
INCOMPLETE DOMINANCE		
CODOMINANCE		
EPISTASIS	ONE GENE AFFECTS ANOTHER GENE'S OUTCOME	
PLEIOTROPY		
POLYGENIC		HUMAN HAIR COLOR

ERROR

MUTATION:

NON DISJUNCTION: FAILURE OF CHROMOSOMES TO SEPERATE IN MEIOSIS ⇨ ANEUPLOIDY = WRONG # OF CHROMOSOMES

GENE [A|B|C|D]

DELETION: [A|C|D]

DUPLICATION:

INVERSION:

TRANSLOCATION:

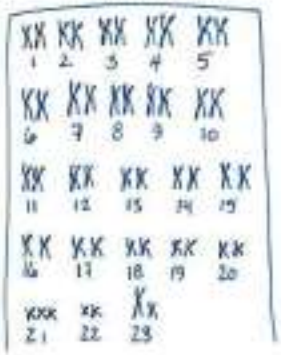
NORMAL
46 XX
OR
46 XY

AUTOSOME

- DOWNS TRISOMY 21
- PATAU
- EDWARDS

SEX CHROMOSOME

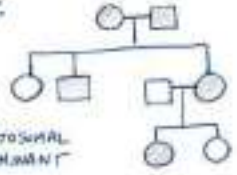
- KLEIN FELTER 47 XXY
- TURNERS
- JACOBS
- TRISOMY X 47 XXX



GENETICS
REVIEW ②

PEDIGREE
FOLLOWING A TRAIT/DISEASE THROUGH FAMILY HISTORY

EX:



AUTOSOMAL DOMINANT

PUNNETT SQUARES FOR EXPECTED

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

MATH TO SUPPORT YOUR INHERITANCE PREDICTION

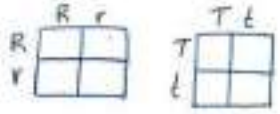
$Rr\,Tt \times Rr\,Tt = ?\ R\_\,TT$

RED = R WHITE = r

TALL = T SHORT = t

RULE OF MULTIPLICATION:

RULE OF ADDITION:



? RED & SHORT

LINKED GENES
GENES INHERITED ON THE SAME CHROMOSOME

NEW COMBOS DUE TO

★ PATTERN NOTICED = THE FURTHER GENES ARE FROM EACH OTHER ON THE SAME CHROMOSOME

→ GENE MAP

SEX-LINKED:

X-LINKED HUMAN GENETIC DISEASES
- RED/GREEN COLORBLINDNESS
- HEMOPHILIA
- DUCHENNE MUSCULAR DYSTROPHY

WHO GIVES IT?

WHO GETS IT MORE?

GENOTYPE:

PHENOTYPE:

FLOWER COLOR

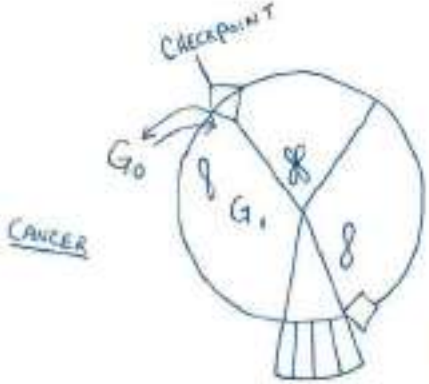
MITOSIS & MEIOSIS

REVIEW

MITOSIS

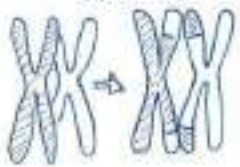
PURPOSE:

WHY WOULD AN ORGANISM TRIGGER MITOSIS?



CANCER

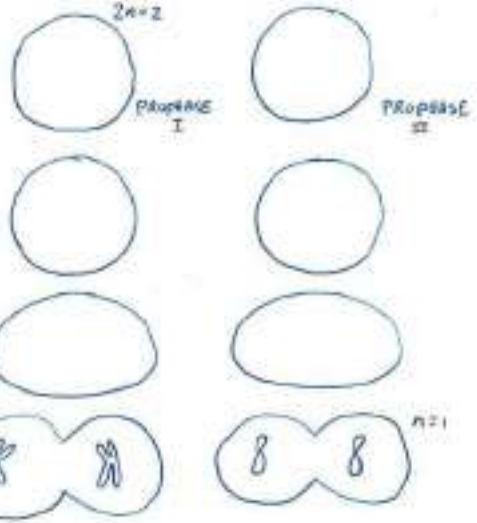
CROSSOVER:



MEOSIS

PURPOSE:

WHY WOULD AN ORGANISM TRIGGER MEIOSIS?



PROTEIN SYNTHESIS
REVIEW ②

PURPOSE:

GENOTYPE → DNA → RNA → PROTEIN

TRANSCRIPTION

DNA →

LOCATION: IN EUKARYOTE

PROMOTER REGION:

RNA POLYMERASE:

PRE mRNA E I E I E I E

SPLICEOSOME & RNA PROCESSING

TRANSLATION

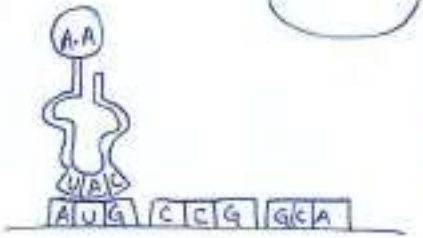
mRNA →

LOCATION:

mRNA

tRNA

rRNA



INITIATION:

ELONGATION:

TERMINATION:

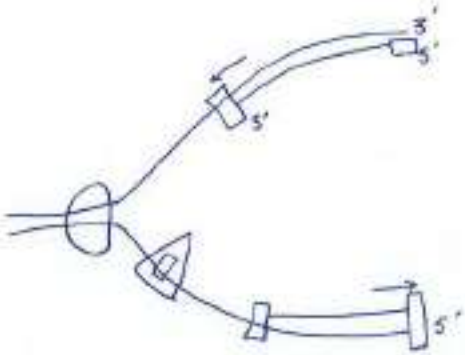
DNA Replication

Review ①

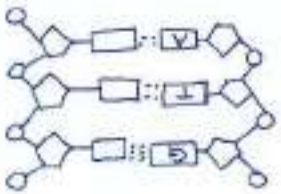
Purpose:

When does it happen?:

List of Workers	Action
1. DNA polymerase I	
2. Primase	
3. SSBP	
4. Helicase	
5. DNA polymerase III	
6. Ligase	
7. Nuclease	
8. Telomerase	



32% A 32%
% G % C

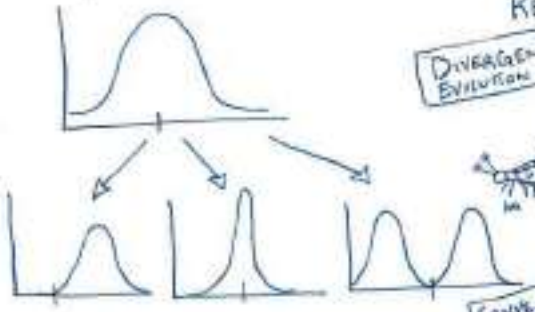


Leading strand vs. Lagging strand

Telomeres:

EVOLUTION REVIEW

SELECTION PATTERNS



DIVERGENT EVOLUTION

TYPES OF SPECIATION

- Allopatric
- Sympatric

CONVERGENT EVOLUTION

BIOLOGICAL SPECIES CONCEPT

A GROUP OF INDIVIDUALS WHO LIVE IN THE SAME AREA WHO CAN BREED & PRODUCE VIABLE OFFSPRING

POSSIBLE STEPS TO THE FORMATION OF A NEW SPECIES

1. GEOGRAPHIC ISOLATION OF 2 GROUPS
2. POPULATIONS ARE SUBJECT TO DIFFERENT SELECTIVE PRESSURES
3. POPULATIONS DIVERGE FROM EACH OTHER
4. WHEN POPULATIONS COME BACK TOGETHER AGAIN IN THE FUTURE →

PREZYGOTIC BARRIERS

1. TEMPORAL
2. MECHANICAL
3. HABITAT
4. BEHAVIORAL
5. GAMETIC

POST ZYGOTIC BARRIERS

1. HYBRID INVIABILITY
2. HYBRID STERILITY
3. HYBRID BREAKDOWN

DEFINE WHAT AN ISLAND IS

HOW ARE ISLANDS PART OF EVOLUTION?

ADAPTATION =

EVOLUTION

REVIEW SHEET

GENOTYPE → PHENOTYPE

TRAITS THAT ALLOW AN ORGANISM TO SURVIVE & REPRODUCE

CENTRAL COMPONENTS OF NATURAL SELECTION

1. POPULATIONS CONTAIN DIVERSITY

2.

3.

4. THOSE WITH TRAITS BETTER SUITED FOR SURVIVAL WILL REPRODUCE & PASS ON THEIR BENEFICIAL TRAITS

FUTURE POPULATIONS WILL HAVE MORE OF THE BENEFICIAL TRAITS

EVIDENCE OF EVOLUTION

	EXAMPLES
1. ARTIFICIAL SELECTION	
2. FOSSILS	
3. HOMOLOGOUS STRUCTURES	
4. ANALOGOUS STRUCTURES	
5 DNA/PROTEIN	
6. BIOGEOGRAPHY	

HARDY WEINBERG

NON EVOLVING POPULATION

1. NO MUTATIONS
2. RANDOM MATING
3. NO GENE FLOW
4.
5.

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

$p + q = 1$

GENETIC DRIFT:

450 ARE RECESSIVE OUT OF 1,200. HOW MANY ARE CARRIERS

DNA

CENTRAL DOGMA

DNA → mRNA → PROTEIN

GENOTYPE

TECHNOLOGY REVIEW

EPIGENETICS

DEFINITION

METHYLATION

ACETYLATION

MEDICAL IMPLICATIONS

LAMARCK CONNECTION?

RNAi

DEFINITION

dsRNA

DICER

siRNA

RISC

MEDICAL IMPLICATIONS

CRISPR

DEFINITION

CAS9

- HOW CAN IT BE USED TO LEARN HOW A GENE WORKS?

HOW CAN IT BE USED TO FIX GENETIC PROBLEMS?

MAKING PHYLOGENETIC TREES

DNA TECHNOLOGY

MOLECULAR SCISSORS
RESTRICTION ENZYMES

PALINDROME SEQUENCE

ENGINEER A PLASMID

1. EXTRACT PLASMID FROM BACTERIA
2. CUT WITH
3. EXTRACT DNA FROM A JELLYFISH
4. CUT OUT GFP GENE WITH
5. RECOMBINE & LIGATE
6.
7. SCREEN -

GFP
GREEN FLOURESCENT PROTEIN

NO AMP

AMP

P.C.R.

- REQUIRED MATERIALS
- RESULT
- PURPOSE

ELECTROPHORESIS

- PURPOSE

SOUTHERN BLOT

- PURPOSE
- MATERIALS

- RESULTS

1	2	3	4
–	–		=
=	=		=
–	–	–	–
–		–	
		–	
			=

WHY DO YOU GET DIFFERENT BANDS?

WHAT DO THEY MEAN?

G.M.O - GENETICALLY MODIFIED ORGANISM

POTENTIAL BENEFITS

POTENTIAL PROBLEMS

A TISSUE IS DEFINED AS

TISSUES

CELLS MAKEUP TISSUES
TISSUES MAKEUP ORGANS
ORGANS MAKEUP ORGAN SYSTEMS

REVIEW

4 MAJOR TYPES OF TISSUES

EPITHELIAL	CONNECTIVE	MUSCLE
SIMPLE SQUAMOUS FLAT CELLS ONE LAYER GAS & NUTRIENT EXCHANGE	BLOOD	
SIMPLE CUBOIDAL	ADIPOSE CELLS FULL OF FAT LONG TERM STORAGE	
SIMPLE COLUMNAR	AREOLAR	
STRATIFIED SQUAMOUS	RETICULAR	
STRATIFIED CUBOIDAL	CARTILAGE (3 TYPES) HYALINE - ELASTIC - EAR & LARYNX FIBROUS - BETWEEN VERTEBRA	
STRATIFIED / PSEUDO STRATIFIED COLUMNAR	TENDONS & LIGAMENTS TENDONS - MUSCLE TO BONE LIGAMENTS - BONE TO BONE	
TRANSITIONAL	BONE	

INTEGUMENTARY SYSTEM

REVIEW

PURPOSES

MAIN: SERVE AS A BARRIER TO PROTECT THE BODY FROM THE OUTSIDE WORLD

OTHER PURPOSES: RETAIN WATER

SKIN

CONTAINS NERVES TO SENSE TOUCH

ADIPOSE CELLS FOR

	PURPOSE & IMPORTANT FEATURES
EPIDERMIS	
DERMIS	
HYPODERMIS	

GLANDS

→ EXOCRINE = RELEASE CONTENTS INTO DUCTS

PRODUCED BY DOWNWARD FOLD OF THE EPIDERMIS.

SUDORIFEROUS

SEBACEOUS

CERUMINOUS

HAIR

→ CAN BE RAISED & LOWERED BY MUSCLE CALLED =

PRODUCED BY DOWNWARD FOLD OF THE EPIDERMIS

MEDULLA

CORTEX

CUTICLE

CIRCULATORY SYSTEM

REVIEW

PURPOSE :

TYPES OF VESSELS & MAJOR FEATURES

ARTERIES

ARTERIOLES

CAPILLARIES

VENULES

VEINS

LABEL

COMPONENTS OF BLOOD

PLASMA - MOSTLY WATER & DISSOLVED NUTRIENTS LIKE

CELLS -

RED =

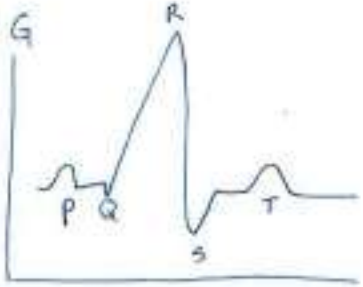
WHITE =

FLOW OF THE BLOOD

STARTING WITH THE RIGHT ATRIUM & RETURNING BACK TO THE RIGHT ATRIUM

RIGHT ATRIUM → A/V VALVE → RIGHT VENTRICLE → SEMILUNAR VALVE →

EKG



DIGESTIVE SYSTEM REVIEW

PURPOSE:

MECHANICAL DIGESTION VS. CHEMICAL DIGESTION

ACCESSORY STRUCTURES

SALIVARY GLANDS

LIVER

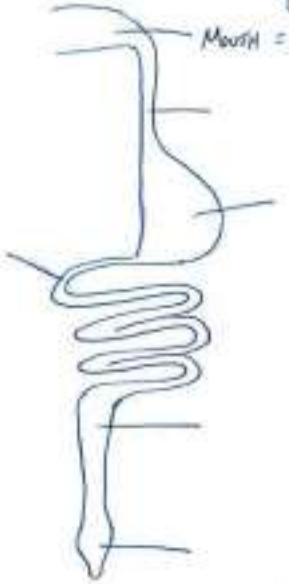
GALL BLADDER

PANCREAS (ENDOCRINE & EXOCRINE)

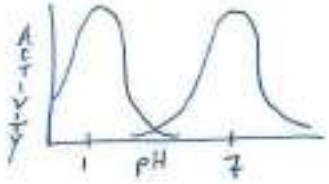
THE DIGESTIVE TUBE

LABEL & DESCRIBE GENERAL ACTIVITY

MOUTH = CHEWING = ↑ SURFACE AREA



ENZYMES ARE SPECIFIC & WORK BEST IN SPECIFIC ENVIRONMENTS



MAJOR ENZYMES AND MACROMOLECULE THEY WORK ON

SALIVARY AMYLASE

PEPSIN / PEPSINOGEN

BILE

PANCREATIC AMYLASE

LIPASE

PROTEASES

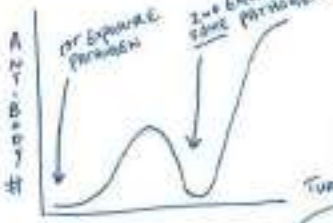
NUCLEASE

IMMUNE SYSTEM REVIEW

LINES OF DEFENSE

NONSPECIFIC

SPECIFIC



EXPLAIN ABOVE

WHAT IS AN ANTIGEN?

PATHOGEN WITH ANTIGEN

CONSUMED BY

MACROPHAGE

RELEASE IL-1 AND ACTIVATE

RELEASE IL-2 ACTIVATE

B-CELL

TURN INTO

PLASMA CELL

PRODUCE

ANTIBODY

HUMORAL IMMUNITY

FOR FUTURE EXPOSURE

MEMORY B-CELL

RELEASE IL-2 ACTIVATE

KILLER T-CELL

FOR FUTURE EXPOSURE

FIND INFECTED OR DAMAGED BODY CELLS AND

CELL MEDIATED IMMUNITY

FOR FUTURE EXPOSURE

ANTIBODY DEFINE & PURPOSE

TYPES OF WHITE BLOOD CELLS

MONOCYTE -

LYMPHOCYTE -

NEUTROPHILS -

BASOPHILS -

EOSINOPHILS -

Muscular System Review

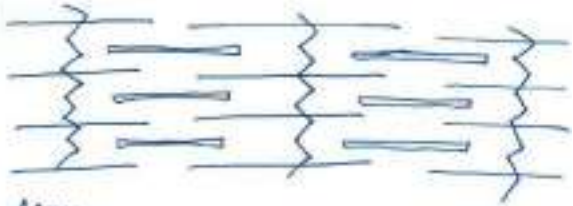
Purpose is to produce movement

Bundles inside bundles inside bundles inside bundles

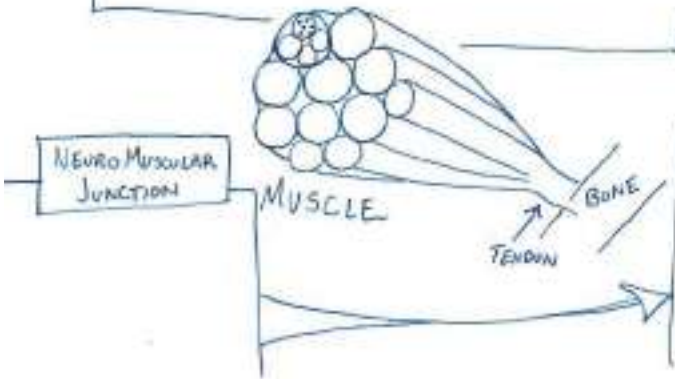
- Epimysium
- Fascicle
- Perimysium
- Endo mysium
- Muscle Fiber
- Myo Fibrils
- Myo Filaments

Sliding Filament Model

- 2 Myofilaments
- Pieces move parallel to each other



- Actin
- Myosin
- Z line
- Sarcomere
- H Zone



Control Muscles

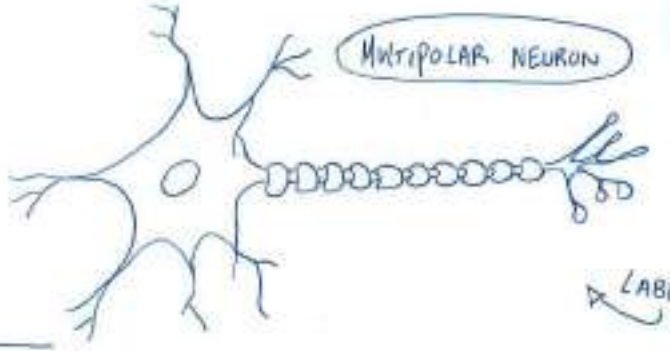
- AcH
- $[Ca^{+2}]$
- Troponin & tropomyosin

NERVOUS SYSTEM REVIEW

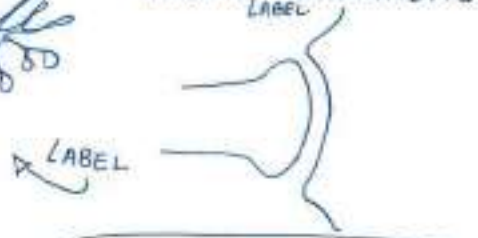
NEUROGLIA
SUPPORT CELLS

- OLIGODENDROCYTES
- ASTROCYTES
- EPENDYMAL CELLS
- MICROGLIA
- SCHWANN CELLS
- SATELLITE CELLS

SALTATORY VS. CONTINUOUS CONDUCTION
HOW THE SIGNAL MOVES DOWN THE NEURON



NEUROTRANSMITTERS

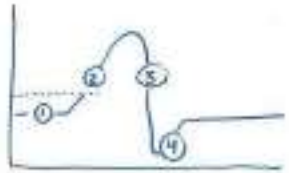


EPSP VS IPSP
EXCITATORY

INHIBITORY

PARTS OF A NEURON & THEIR ROLE
- SOMA
- NUCLEUS
- DENDRITES
- NODE OF RANVIER
- MYELIN SHEATH
- TERMINAL BUTTONS

STIMULATING
① RESTING = Na^+ & K^+ GATES CLOSED



SKELETAL SYSTEM REVIEW

MAIN PURPOSE

STRUCTURAL SUPPORT

OTHER PURPOSES

- PROTECT ORGANS

CELLS OF THE SKELETAL SYSTEM

- OSTEOBLASTS
- OSTEOCYTES
- OSTEOCLASTS

ADD TO THE DIAGRAM

THIS IS AN EXAMPLE OF A LONG BONE

OTHER BONE TYPES INCLUDE:

LOCATION & PURPOSE

- ENDOSTEUM
- PERIOSTEUM
- ARTICULAR CARTILAGE
- NUTRIENT FORAMEN
- EPIPHYSEAL LINE
- COMPACT BONE
- SPONGY BONE
- MEDULLARY CAVITY

MARROW

RED = BLOOD CELL FORMATION

YELLOW = FAT STORAGE

BONE FORMATION

- ENDOCHONDRAL
- INTRAMEMBRANOUS

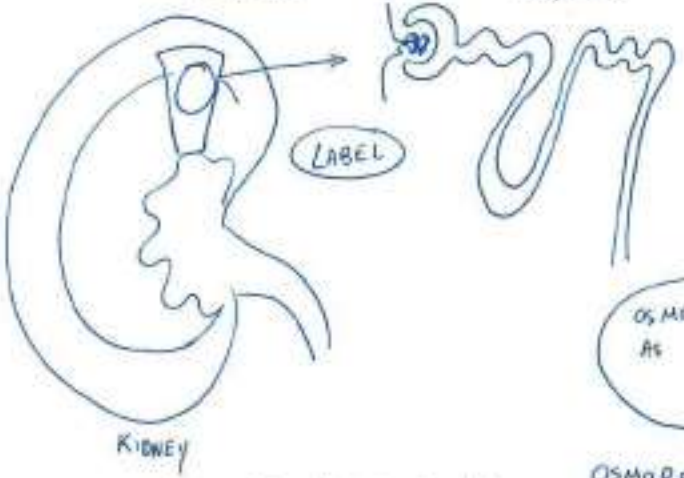
WATER BALANCE

WHY IS WATER BALANCE NEEDED FOR LAND-BASED ORGANISM

WHAT IS THE PURPOSE OF THE KIDNEY?

REVIEW

NEPHRON



- TROPICAL RAINFOREST VS - DESERT

NITROGENOUS WASTE IS A RESULT OF:

OSMOSIS IS DEFINED AS

OSMOREGULATORS

OSMOCONFORMERS

TYPES OF NITROGENOUS WASTES

AMMONIA UREA URIC ACID

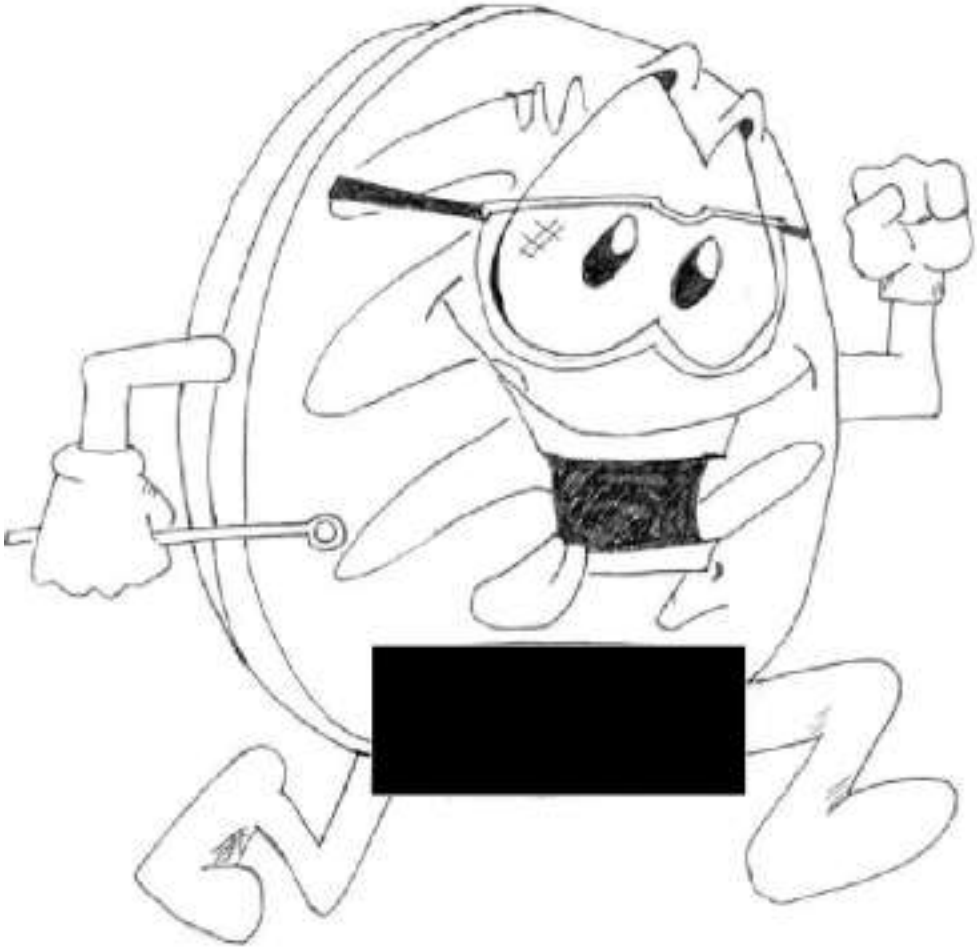
THE KIDNEY & THE ENDOCRINE SYSTEM

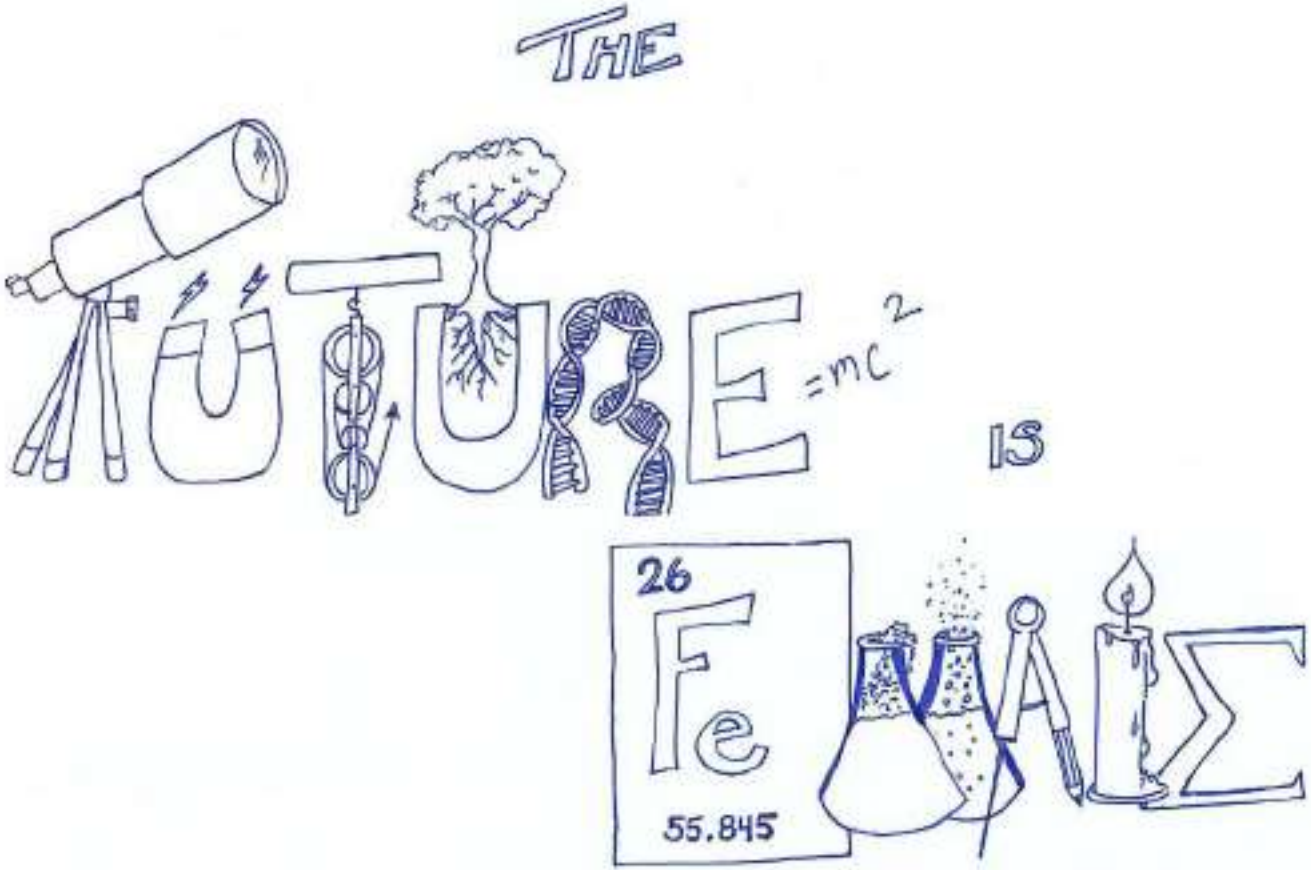
ADH

RENIN/ANGIOTENSIN

ERYTHROPOIETIN

Bonus Drawings




THE
FUTURE
$E=mc^2$
IS
26
Fe
55.845

FIBONACCI SEQUENCE

LEONARDO FIBONACCI
ITALIAN MATHEMATICIAN

1, 1, 2, 3, 5, 8, 13, 21, 34...

THE GOLDEN RATIO φ
1.6180339875

φ GREEK LETTER PHI USED TO SYMBOLIZE THE RATIO

WANT ME TO EXPLAIN INFINITY? I COULD TALK ABOUT IT FOREVER

TRY IT! MEASURE THE BOX USING A RULER

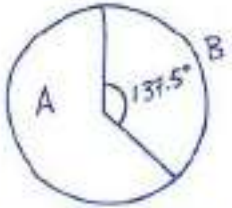
A	B

$$\frac{A}{B} = \frac{A+B}{A} = 1.618$$

PLUG THE NUMBERS INTO THE FORMULA

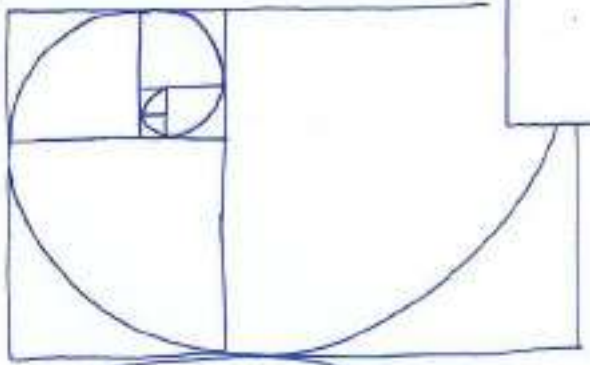
YOUR WORK HERE:

THE GOLDEN ANGLE
137.5°



TRY THIS ONE: USING ANGLES SHOWN ABOVE PLUG THE ANGLES INTO THE FORMULA

YOUR WORK HERE:



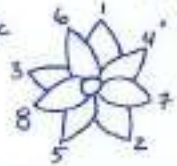
FIBONACCI CURVE

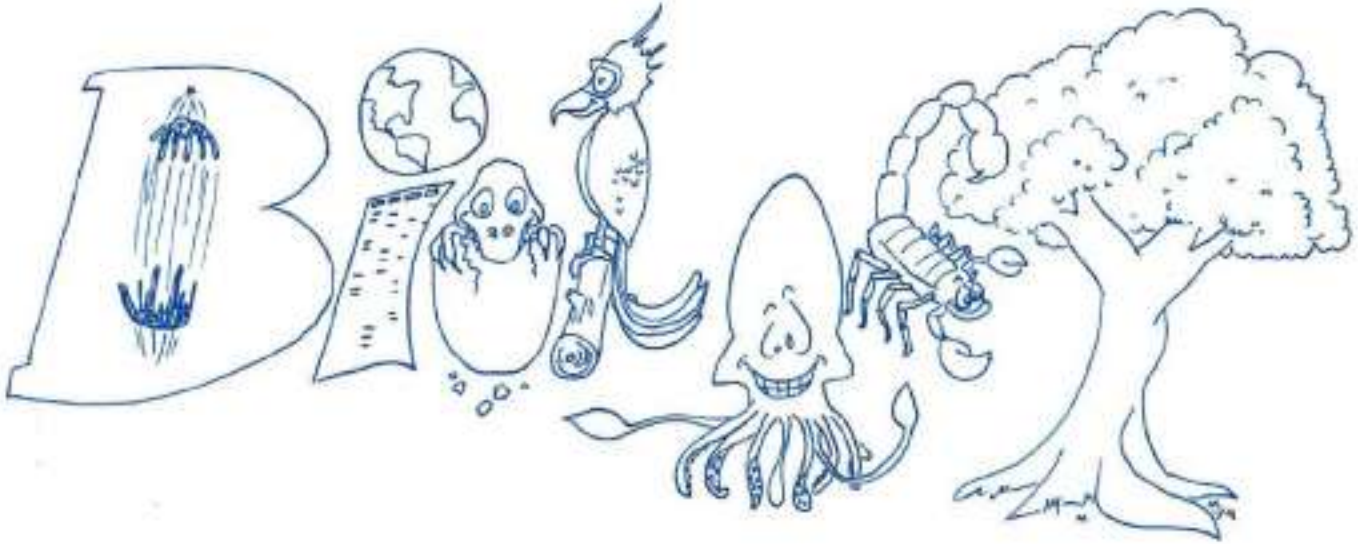
EACH BOX GETS BIGGER AND AN ARC CONNECTS THE CORNERS.

BOXES WILL FOLLOW THE 1, 1, 2, 3, 5, 8... SEQUENCE

WHERE CAN WE FIND THIS SEQUENCE/RATIO IN NATURE?

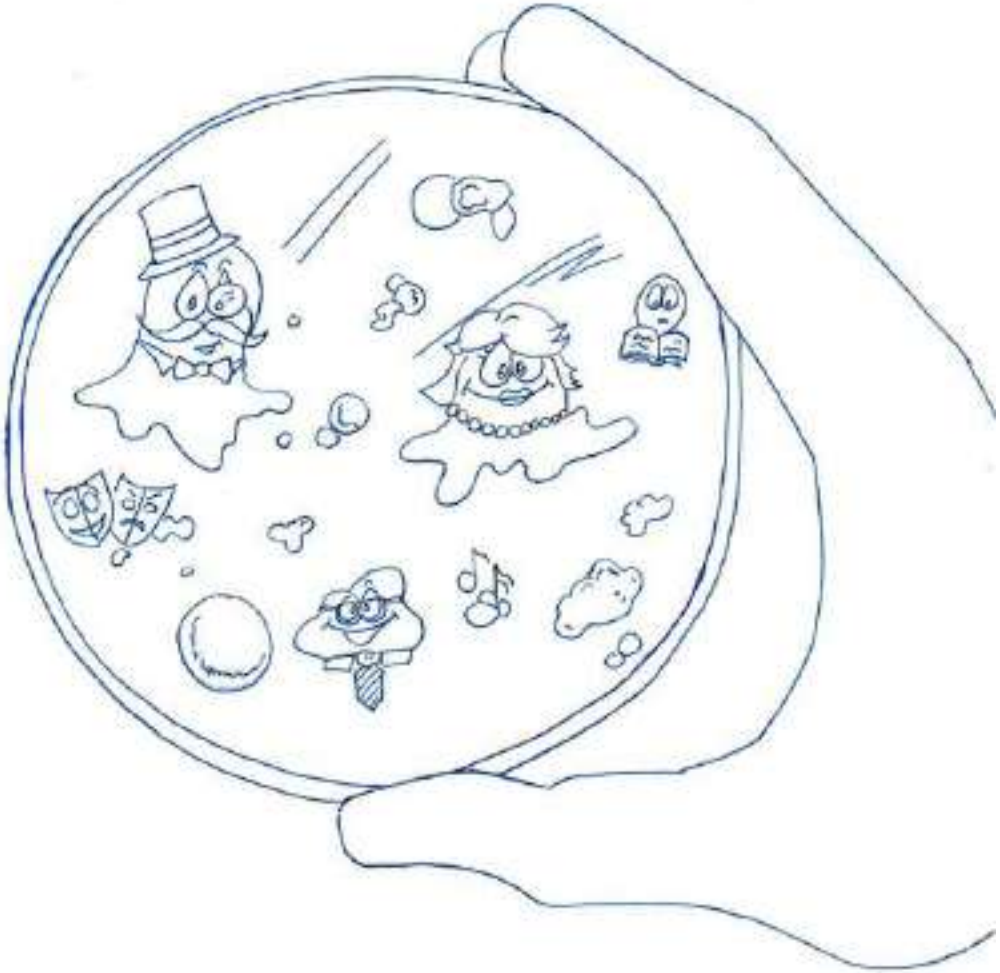
- SWIRL OF A HURRICANE
- BLOOM OF A FLOWER
- NAUTILUS SHELL






1
1
ONE
1
1
1
BIG BUCK
MULTARE SUPER TEMPORE


I SMELL A BAD PUN COMING
WHO NOSE WHAT IT COULD BEE
FIVE SCENTS



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Email me if you have any questions - jgrant@csd99.org