**Characteristics of Life**

* Biotic: Categorized as living
  + ex: bacteria
* Abiotic: Categorized as not living
  + ex: virus
* Abiogenesis:
  + 1. origin of life from non-living organic compounds 2. Creation of life from abiotic factor.
  + Spontaneous generation: Theory of forming organism without a similar organism
    - This was once an accepted scientific theory until 1859, when Louis Pasteur disproved this theory. It was believed that it was possible to create maggots from broth. However, In Pasteur’s experiment, he created a special container for the broth to ensure that no organisms can enter the broth to lay eggs, and no maggots formed. After this, biogenesis is the accepted theory for the formation of life
* All living life must:
  + Take in nutrients
    - (not about eating)
    - Necessary for metabolism
    - Take in materials from the environment and turn them into usable forms
    - Autotrophs: Synthesizes its own nutrition from materials present in environment
      * Ex: plants-photosynthesis
    - Heterotrophs: Finds nutrients in its environment
      * Ex: animals-eating
    - Digest (take in nutrition) > Ingest (take in food-C6H12O6) > Egest (release waste product)
  + Be able to reproduce
    - Not necessary for continuation of life of individual organism, but necessary for continuation of existence of species
    - Produces organisms of same species
    - Sexual: 2 parents, creates offspring with genetic diversity
    - Asexual: 1 parent, creates genetically identical offspring
  + Respirate
    - (not just breathing)
    - Provides organism with constant supply of energy
    - Releases chemical energy in nutrient
    - Chemically burns glucose sugar (C6H12O6)
    - Aerobic respiration: uses oxygen
    - Anaerobic respiration: without oxygen
  + Maintain homeostasis
    - Regulates activities of organism to keep internal balance
    - Nervous and endocrine system is responsible
    - Impulses (animal only) and hormones
  + Transport materials within the organism
    - Take in and distribute usable materials
    - Remove waste
  + Synthesize and assimate materials
    - Synthesis: creating complex substances from simpler ones
    - Assimilation: replacing worn out parts and growing
  + Excrete waste
    - (not just urination)
    - Waste from cell activity
  + Grow
    - Increasing size by assimilation
    - By pattern
    - Plants grow their whole lives
    - Unicellular organisms: increase in size
    - Multicellular organisms: increase cell count

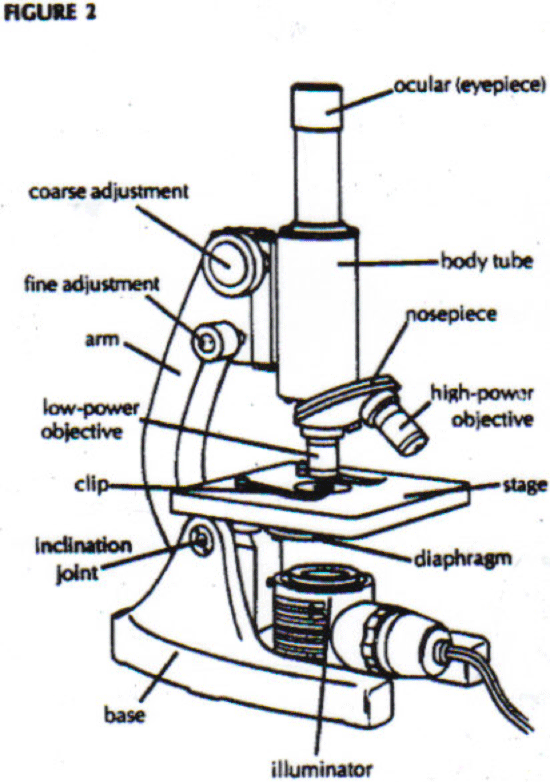
**Taxonomy**

* (The science of classification, nothing to do with taxes)
* Carolus Linnaeus: Father of taxonomy
* Dear King Phylon Came Over For Good Spaghetti
* Domain Kingdom Phylum Class Order Family Genus Species
* Domain Eukarya: eukaryotic-has nucleus
  + Kingdom Plantae, Fungi, Animalia, Protista
* Domain prokaryote: prokaryotic-no nucleus
  + Kingdom Monera
* Binomial nomenclature: naming: Genus+Species
  + Ex: Genus Homo (Wise man) Species Sapien: Homo Sapien
* Only parents of the same species can have fertile offspring

**Scientific Process**

* Independent variable (x): manipulated
* Dependent variable (y): result
* Control: kept consistent
* Scientific method: organized way to investigate
* Make observations
* Create a question
* research the topic
* formulate hypothesis
  + Based on knowledge, not random
* test hypothesis
* Record data
  + Larger samples increases accuracy
* analyze data
* draw conclusion
  + Determine if data supports hypothesis or not
* repeat
* Theory: changeable, based on tests, laws, hypothesis, observations, tested and accepted
* Law: unchangeable, forever true fact about a single phenomenon
* Science is an organized, unbiased understanding of nature, not set in stone
* Observations: based on senses
* Inferences: based on observations

**Microscopes**

* Inverts and flips image
* Magnifies
* Compound: 400x limit
* Electron (for dead things): 1Mx limit
* Dissecting: 40x limit
* 2 lenses: ocular x objective
* Ocular, tube, base, objective, fine and coarse adjustment knobs, stage, stage clips, light, diaphragm, arm, nosepiece
* 

**Cells**

* (not associated jail cells, nor cell phones, etc)
* Cell theory: developed in 1700, thanks to microscopes
  + Robert Hooke: one of the first microscope users, named cells
  + Matthew Scheidon: all plants are made of cells
  + Theodor Schwann: all animals are made of cells
  + Rudolf Virchow: Cells come from other cells
* Prokaryotes have no nucleus, nor membrane bounded organelles, unlike eukaryotes
* Prokaryotes have plasmid (circular) instead of chromosomes
* Nucleus
  + Holds hereditary info (Deoxyribonucleic acid - DNA)
* Cell/plasma Membrane
  + Selectively permeable
  + Has proteins for signal reception, pumping for transport, etc
  + Antigens
    - Like an ID for a cell
  + Make of a lipid bilayer
    - Each layer made of lipid molecules
      * Each lipid molecule is made of a hydrophilic (attracting water) head and 2 hydrophobic (repelling water) tails
  + Transport
    - Osmosis
    - Passive transport
      * Uses no energy
      * Transports from greater to lower concentration until equilibrium is achieved
      * Diffusion
      * Facilitated diffusion
        + Diffusing large substance that otherwise would diffuse slowly
    - Active transport
      * Used energy
      * Transports from lower to greater concentration
      * Ion pump
      * Exocytosis
        + Releasing contents of vacuole by fusing it to membrane
      * Pinocytosis
        + Ingesting liquid
      * Phagocytosis
        + Ingesting material
        + Ex: white blood cell engulfing bacteria
    - Isotonic
      * (equilibrium)
      * Percent of solute and solvent in and out of cell are equal
      * Cell remains same size
    - Hypotonic
      * Less solvent/more solute in cell than environment
      * Causes water to diffuse into cell and solute to diffuse into environment
      * Cell swells and can burst (so don’t pure water isn’t injected to organisms)
    - Hypertonic
      * More solvent/less solute in cell than environment
      * Causes solvent to diffuse into environment and solute to diffuse into cell
      * Cell shrivels
    - H2O tends to go where there’s more solute
* Endoplasmic reticulum (ER)
  + Transports proteins through cell
  + Rough ER has ribosomes
* Ribosomes
  + Site of protein synthesis
* Mitochondria
  + Site of adenosine triphosphate (ATP) synthesis
  + Has its own genetic makeup, inherited from mother
* Golgi apparatus/body
  + Packages protein for shipping
* Lysosomes
  + Sacs of digestive enzymes
* Centrioles
  + (animal cells only)
  + Produces spindle fibers used in mitosis
* Cytoplasm
  + Gel like fluid in cell
  + Contains water, salt and organic stuff
  + Usually 95% solvent 5% solute
    - (solute dissolves in solvents, water is universal solvent, solute can be substances like salt)
* Cell wall
  + (plant cells only)
  + Made of cellulose
  + Protects and supports cell
* Vacuoles
  + Contains food, waste, water
  + Plants have a large central vacuole
    - When full of water: plant appears straight
    - When lacking water: plant appears wilted
* Chloroplast
  + (plant cells only)
  + Site of autotrophic nutrition
    - (Where plants synthesize starch using light)
  + Contains its own genetic material
* Types of plant cells
  + Epidermal cells
    - Top of leaves, containing lots of chloroplast
  + Floum
  + Root
* Cell cycle (of somatic cells - non sex cells)
  + Interphase
    - Gap 1
      * Organelle replication
      * G1 checkpoint
        + Check nutrition, growth, DNA integrity
    - Gap 0 (optional)
      * Resting state
    - Synthesis
      * DNA replication - to sister chromatids meeting at centromere
    - Gap 2
      * Mitotically necessary enzymes synthesized
      * G2 checkpoint
        + Check cell size, DNA replication
  + Mitosis
  + Cytokinesis

If a checkpoint fails, cell cycle is arrested to correct error before continuing cell cycle. Failure to detect error in a checkpoint leads to mutations in the cell

**Organization**

* (not the skill)
* Smallest to largest:
* Protons, neutrons, electrons
* Atoms
* Molecules
* Organelle
* Cell
* Tissue
* Organ
* Body system
* Organism
* Population
* Community
* Ecosystem
* Biome
* Planet
* Solar system
* Universe

**Tissues**

* (not paper ones; not affiliated with Kleenex, etc)
* Muscle: contracts to create movement
* Nervous: send electrical impulses
  + Neurons
* Epithelial: covers body surfaces (in and out)
  + Ex: skin, organ outlines
* Connective: binds and support body structure
  + Ex: bones

**Body Systems**

* Reproductive - stop thinking weird
  + Creates offsprings
  + Asexual
    - Creates genetically identical offsprings
    - 1 parent
    - Mitosis
      * Cell division
      * Done by somatic cells
      * Creates 1 diploid (2n) daughter cell
      * Prophase
        + Chromosomes condense - becomes visible
        + Nuclear envelope dissolves
      * Metaphase
        + Sister chromatids align at equatorial plate, attached to spindle fibers
        + Metaphase checkpoint

Check spindle fiber alignment

* + - * Anaphase
        + Spindle fiber pulls sister chromatids apart to opposite poles of cell
        + Membrane starts cleaving in middle
      * Telophase
        + Nuclear envelope resolves
        + Chromosome denses - become invisible
        + Membrane continues to cleave, preparing to split
      * Cytokinesis
        + Cell splits
        + Mitosis complete, go to Gap 1
    - Runners
      * Plants
      * Ex: strawberry plant
      * Stem extending from parent that becomes offspring
    - Bulb
      * Plants
      * Underground food storage that can become offspring
      * Ex: onion
    - Tubers
      * Plants
      * Like bulbs
      * Eyes are buds
      * Ex: potatoes - sub to poyato
    - Rhizomes
      * Plants
      * Roots with nodes that develop into offsprings
      * Ex: ginger
    - Cuttings
      * Plants
      * Parts of plant cut off (scion) becomes offspring
      * Ex: duranium, roses, banana trees
    - Grafting
      * Plants
      * Not done naturally
      * Scion attached to body of stock (rooted plant)
      * Ex: seedless orange, grape trees
    - Cloning
      * Not done naturally
    - Sporulation
      * Particles fly around to grow to offspring
      * Ex: mold
    - Budding
      * Plants and unicellular organisms
      * Offspring buds out of parent
      * Ex: hydra, yeast
    - Binary fission
      * Splitting into 2
      * Ex: ameba
    - Regeneration
      * Animals
      * Part cut off from parent becomes offspring
      * Part loss from parent is regrown
      * Ex: starfish, worms
    - Vegetative propagation
      * Plants
      * Part off parent is detached to become offspring
    - Parthenogenesis
      * Animals
      * Fusing 2 polar bodies to create zygote
      * Ex: sharks
  + Sexual reproduction
    - 2 parents
    - Creates new mix of traits, hardier organisms
    - Shuffles genetic material to create new combinations
      * Each is a test case
    - Puberty
      * Organism can produce gametes
      * Appearance of secondary sex characteristics
    - Meiosis
      * Done by primary oocytes and primary spermatocytes
      * Females are born with all their gametes, but aren’t released until after puberty
      * Although 4 haploid (n) daughter cells are produced, only 1 daughter is viable (unless organism can do parthenogenesis), and other 3 daughter cells become polar bodies for females
      * Prophase I
        + Nuclear envelope dissolves
        + Chromosomes condense
        + Tetrads (2 sister chromatids) form and cross over (wrapping the adjacent legs)
      * Metaphase I
        + Tetrads align perpendicular to equatorial plate
      * Anaphase I
        + Tetrads are pulled apart to become sister chromatids by spindle fibers into opposite poles of cell
      * Telophase I
        + Nuclear envelope resolves
        + Chromosomes denses
        + Membrane cleaves to split cell
      * Prophase II
        + Nuclear envelope dissolves
        + Chromosomes condense
      * Metaphase II
        + Sister chromatids align perpendicular to equatorial plate
      * Anaphase II
        + Sister chromatids are pulled apart by spindle fibers into opposite poles of cell
      * Telophase II
        + Nuclear envelope resolves
        + Chromosomes denses
        + Membrane cleaves to split cell
        + Meiosis is complete
    - Male reproductive system
      * Penis
        + Modifies/erects to enter vagina to deposit/ejaculate semen (seminal fluid + sperm, seminal fluid contains alkaline fluids to counteract the acidic fluid in the vagina, and contains glucose for energy to fuse with egg) into vagina of female during intercourse
      * Testis
        + Male gonad
        + Sperm production
        + Produces testosterone and androgen

Responsible for secondary male characteristics

Deepening of voice, sperm production, muscle tone, hair growth

* + - * Scrotum
        + Holds testes outside body, so temperature is cooler than body temperature for proper sperm development
      * Vas deferens
        + Connects testes to prostate gland
      * Prostate gland
        + Contains seminal fluid
      * Urethra
        + Exit in penis where semen exits
    - Female reproductive system
      * Vagina
        + Muscular tube connecting uterus to outer environment
        + Receives semen when a male penis enters to deposit semen during intercourse
        + Discharges tissues and blood from menstrual cycle
      * Uterus
        + Womb, where offspring develops
      * Ovary
        + Female gonad
        + Matures eggs
        + Produces estrogen and progesterone

Responsable for secondary female sec characteristics

Breast development, widening of hips, maturing eggs

Estrogen builds up uterus lining

Progesterone maintains uterus lining

* + - * Oviduct/fallopian tube
        + Connects ovaries to uterus
        + Site of fertilization - fusing of egg and sperm
      * Menstrual cycle
        + From puberty to menopause
        + Follicle stage

10-14 days

Follicle stimulating hormones (FSH) from pituitary gland stimulates maturation of eggs

Estrogen stimulate thickening of uterus lining

* + - * + Ovulation

Matured eggs are released

Estrogen prohibits production of FSH and stimulates release of luteinizing hormone (LH) from pituitary gland

* + - * + Corpus luteum stage

10-12 days

Produces progesterone

Stimulates further thickening of uterus lining

* + - * + Menstruation

(if egg isn’t fertilized within 24 hours of release)

Progesterone secretion decreases

Uterus lining degeneres

Tissues and blood discharged out of vagina

* + - Fertilization
      * Sperm fuses with egg to create zygote
        + If multiple eggs were released and fertilized: fraternal twins
        + If zygote splits into 2: identical twins
      * Zygote cleaves
      * 6-10 days later, zygote is implanted to uterus lining
      * Gastrula forms, differentiation (cell function specializes, by activating only genes related to its function), growth occurs
      * Placenta and umbilical cord forms
      * 8 weeks later, embryo becomes fetus
      * Fetus develops until it can live independently
    - Fetal development
      * Amniotic egg
        + Amphibians, reptiles, birds
        + Allowed eggs to be laid out of water
        + Amnion

Filed with amniotic fluid

Surrounds and protects embryo

* + - * + Amniotic fluid

Provides embryo with watery environment

* + - * + Allantois

Attached to reptile embryo

Gas diffusion and waste removal

* + - * + Albumin

Around chorion

Egg white

* + - * + Yolk sac

Food for embryo

* + - * + Egg shell

Prevents egg from drying

Allows air into egg

* + - * + Embryo

Developing offspring

* + - * + Air space

Internal buffer for environmental conditions

* + - * + Chorion

Thin sheet that the albumin is around

* + - * Placental
        + Mammals, marsupials, monotremes
        + Fetus

Developing offspring

* + - * + Placenta

Connects mother to child

Basically put the egg in the parent

Allows through

Mother to child

Digested nutrients

Antibodies

Fatal if it’s against antigens found in embryo

Oxygen

Teratogen - harmful to fetus

Radiation

Toxic chemicals

Ex: mercury

Diseases

Such as rubella, AIDS, herpes, syphilis

Drugs

Such as alcohol, cocaine, heroin

Fetal alcohol syndrome: developmental defects leading to low birth weight, and other defects

Child to mother

Carbon dioxide

Urea - pee

* + - * + Umbilical cord

Connects fetus to placenta

* + - * + Amniotic fluid

Fluid around embryo

* Circulatory
  + Heart
    - Oxygenates deoxygenated blood and pump them around body
    - Cardiac muscles
    - Pulmonary arteries
      * Deoxygenated blood to lungs
    - Pulmonary veins
      * Oxygenated blood from heart to lungs
    - Aorta
      * Oxygenated blood leaves heart
    - Ventricle
      * Lower chambers
    - Atrium
      * Upper chambers
    - Atrioventricular valves
    - Vena cavas
      * Deoxygenated blood enters heart
    - Pumping signals from SA node, AV node, bundle of HIS, purkinje fiber
    - 3 tissues: endocardium, myocardium, pericardium
  + Blood
    - Carries substances through body
    - Plasma
      * Liquid
    - Red blood cells
      * Carry oxygen and carbon dioxide
      * A, B, both or no antigens
      * + or - HR factors
    - White blood cells
      * T and B
    - Platelets
      * Clots cuts
  + Vessels
    - Carries blood
    - Smooth muscles
    - Arteries
      * Oxygenated blood from heart to body
    - Veins
      * Deoxygenated blood from body to heart
    - Capillary
      * Arteries with diameter of 1 cell
* Respiratory
  + Take in oxygen, release carbon dioxide
  + nose/mouth
    - Intakes oxygen
    - Exhale carbon dioxide
  + Pharynx
    - Back of throat
  + Larynx
    - Voice box
  + Trachea
    - Connects pharynx to bronchi
  + Bronchi
    - Branches from trachea to lungs
  + Lungs
    - The 2 sacs used for breathing
  + Bronchioles
    - Bronchi branching in lung
  + Alveoli
    - At end of bronchioles
    - Diffuses oxygen to bloodstream
    - Diffuses carbon dioxide to bronchioles
  + Diaphragm
    - Controls breathing
* Escritory
  + Release waste
  + Nose/mouth
    - Release CO2
  + Pores
    - Release sweat
  + Kidney
    - Nephrons
      * Filters blood
        + Mostly via passive transport, but active transport regulates
        + Loop of Henle

Reabsorbs water, salts

* + - * + Bowman’s capsule, glomerulus

High pressure

Filters water, nitrogenous wastes, glucose, amino acids, vitamins, minerals, bicarbonate ions and hormones

* + - * + Proximal convoluted tubule

Reabsorbs glucose, amino acids, potassium ions

Filters toxins, hydrogen ions

* + - * + Distal convoluted tubule

Selective reabsorption of potassium and sodium

* + - Water loss is regulated by ADH
      * More ADH = less water loss
      * Less ADH = more water loss
  + Ureter
    - Carry urea from kidney to bladder
  + Bladder
    - Store urea
  + Ureter
    - Connects bladder to external environment for urination
* Skeletal
  + Structure and protection of body; bones
  + Motile
    - Moves
  + Sessile
    - Not moving
  + Exoskeleton
    - Outer
  + Endoskeleton
    - Inner
  + Axial
    - Protects organs
    - Ex: skull
  + Appendicular
    - Moves
    - Ex: arm
  + Locomotion
    - Movement
  + Flexor
    - Bending joint
  + Extensor
    - Straightens joint
  + Types of bones
    - Hinge
      * Ex: elbows, knee
    - Ball + socket
    - Gliding
      * Ex: wrist, ankle
    - Immovable
      * Skull
    - Pivot
      * Neck
  + Bone marrow produces red and white blood cells (B-cell matures too)
  + [Name of bones]
* Muscular
  + Contracts for movement
  + Cardiac
    - Heart
  + Smooth
    - Involuntary
  + Skeletal
    - Movable
* Immune
  + Defense against foreign substances in organism
  + Specific
    - Specific defense targeting invaders with specific antigen
    - Developed from experience (vaccines, prior infection)
  + Non specific
    - Used against any invader
  + Lines of defense
    - 1st
      * Non specific
      * Always there
      * Skin, mucus
      * Prevents pathogens from entering organism
    - 2nd
      * Non specific protection against pathogens inside organism
      * Operate when necessary
      * Antimicrobial
        + Eosinophils
        + Releases substances toxic to pathogens
      * Inflammation
        + Basophils
        + Increases blood flow to increase white blood cell delivery
      * Fever
        + Cooks pathogen
      * Phagocytes
        + Neutrophils, macrophages
        + Engulfs pathogens
    - 3rd
      * Specific against known antigens
      * White blood cells
        + Specialized lymphocytes
        + Developed in bone marrow
        + B cells

Matured in bone marrow

Recognizes specific antigen and flags it down with specific antibodies

Memory B cells

Lives for a long time

Remembers response against specific antigen

From previous exposure in vaccines (with weakened/dead pathogen), previous infection

Plasma B cells

Secretes antibodies into blood stream

* + - * + T cells

Matured in thymus

Attacks cells flagged by antibodies

Helper T cells

Activates B and T cell

T cell for delayed hypersensitivity

Protects against pathogens

Responsable transplant rejections and allergies (reaction against harmless substance)

Suppressor T cells

Turns off immune system when not needed

Cytotoxic T cells

Destroy flagged cells

Recognizes cancer

* + HIV/AIDS
    - Compromises immune system
* Endocrine
  + Secretes hormones for slower change
  + Thyroid
    - Secretes thyroxine, triiodothyronine
      * Maintains heart rate, blood pressure, temperature
  + Parathyroid
    - Secretes parathyroid hormone (yes, that’s what they’re called)
      * Bone growth, muscle tone, neural activity
  + Adrenal
    - Secretes epinephrine, norepinephrine
      * Fight or flight reaction
        + Increases glucose level and blood flow
      * Secretes ACTH
        + Stimulate cortisol production
  + Testis
    - Secretes androgen and testosterone
      * Secondary sex characteristics for males
  + Pituitary
    - Secretes oxytocin, antidiuretic, GH, release-inhibiting hormones, PRL
      * Stimulates metabolism
  + Thymus
    - Secretes thymosin
      * Stimulate T-cell production
  + Pancreas
    - Secretes insulin, glucagon
      * Control glucose level
  + Ovaries
    - Secretes estrogen, progesterone
      * Secondary sex characteristics for females
  + Pineal
    - Secretes melatonin
      * Regulate sleep pattern
  + Hypothalamus
    - Secretes releasing hormones (yes, that’s what they’re called)
      * Controls pituitary gland
  + Feedback loops
    - Secretion of hormones based on set thresholds (stimulus) to maintain homeostasis
      * Ex: blood glucose level goes above 90 mg / 100 mL causes pancreas to release insulin, until blood glucose level falls below 90 mg / 100 mL, when pancreas releases glucagon, until blood glucose level goes above 90 mg / 100 mL causes pancreas to release insulin, and so on …
* Nervous
  + Releases signals/impulses for quicker change
  + Neurons
    - Dendrites
      * collects neurotransmitters/signals from previous neuron
    - Axon
      * Carries signal to next neuron
    - Myelin sheath
      * Makes signal travel faster down axon
    - Axon terminal
      * End of neuron
    - Synapse
      * Gap between terminal and dendrite
    - Neural Transmitter
      * Signal as chemical sent from terminal to dendrite
  + Brain
    - Cerebellum
      * Coordinate muscle
      * Center of balance
    - Cerebrum
      * Thinking
      * Memory
      * Emotion
      * Sensory
      * Voluntary activities
    - Medula
      * Respiration
      * Heartbeat
      * Peristalsis
      * Involuntary activities
    - Spinal cord
      * Controls involuntary reflexes
      * Connects brain to body
      * Made of nerve cells
      * Protected by backbone
  + Behaviors
    - Voluntary
      * Requires thinking
      * Brain to neuron to corresponding muscle or gland
    - Involuntary
      * Reflex
        + Reflex arc
        + Stimulus (ex: 5 senses) causes signal to go from receptor to sensory neuron to interneuron (in spinal cord) to motor neuron to effector
      * Quick
* Digestive
  + Teeth
    - Mechanical digestion
    - Increase surface area of food
    - Breaks down food
  + Salivary gland
    - Chemical digestion
    - Amylase: breaks starch to monosaccharides/glucose (that’s why starch, such as in crackers taste sweet from soaking it in saliva)
  + Esophagus
    - Smooth muscles does peristalsis to move bolus (chewed up food) to stomach
  + Stomach
    - Mechanical and chemical digestion
    - Churning breaks down food
    - Gastric juice liquifies food, kill bacteria
      * Liquefied food = chime
    - Pepsin: breaks protein to amino acid
  + Liver
    - Produces bile
    - Filters blood
  + Gallbladder
    - Secrete and store bile
  + Pancreas
    - Secretes lipase (breaks fat to glycerol), sodium bicarbonate
  + Small intestine
    - Folds (villi and microvilli) increase surface area
      * Absorbs nutrients
    - Bile and lipase: breaks fat to glycerol (fatty acids)
  + Large intestine
    - Reabsorb water
    - Bring waste to colon
  + Appendix
    - Stores sample of bacteria
  + Colon
    - Releases waste
* Integumentary - dont kick it out, it’s ur skin

**Chemistry in Bio**

* Proton (+), neutron, electron (-)
  + Smallest unit of matter
* Isotopes
  + Atom with different numbers of neutrons
* Element
  + A type of atom
* Compound
  + 2+ atoms
* Molecule
  + Smallest unit of compound
    - Ex: nucleotides, ADP, ATP
* Organic compound
  + Compound with carbon
* Carbon
  + 4 electrons, ready to be bonded, so they can be stable
* Polymer
  + Composed of monomers (simpler molecules)
  + Hydrolysis
    - Adding H2O to break polymer into monomers
  + Dehydration synthesis
    - Taking away H2O to bond monomers, forming polymer
  + Biological polymers
    - Carbohydrate (starch)
      * Monomer: monosaccharide (glucose)
    - Protein
      * Monomer: amino acid
    - Lipid
      * Monomer: fatty acid
    - Nucleic acid
      * Monomer: nucleotide

**Cellular Respiration**

* (all organisms)
* Aerobic respiration
  + Produces adenosine triphosphate (ATP)
    - Made of adenine + ribose + 3 bonded phosphate groups
      * Energy is stored by bonding a 3rd phosphate group to adenosine diphosphate (ADP - 2 phosphates)
      * Energy is released by breaking the 3rd phosphate group’s bond
  + C6H12O6 + 6O2 -enzymes> 6CO2 + 6H2O + 36ATP
  + Oxygen + Glucose -enzymes> Water + Carbon Dioxide
  + Step 1: Glycolysis
    - In cytoplasm
    - Adds iP to 2 ADP turning them to ATP
    - Turns 2 NAD+ to 2 NADH + 2 H+
  + Step 2: Krebs Cycle/Citric Acid Cycle
    - In mitochondria
    - 2 CO2 waste
    - Turns 3 NAD+ to 3 NADH
    - Turns 6C (citric acid) to 4C (OAA)
    - Turns 1 FADH to FADH2
    - Adds iP to 1 ADP turning it to ATP
  + Step 3: Electron Transport Chain
    - In mitochondria
    - Turns NADH to NAD+ and H+
    - Turns FADH2 to FAD
    - H+ is transported out of a mitochondria internal membrane
    - 2H+ + ½O2 turns to H2O
    - In an ideal situation, ~34-38 ADP becomes ATP
* Anaerobic respiration
  + Alcohol fermentation
    - Done by some bacteria
      * Ex: yeast
    - Glucose (glycolysis process) -> ethanol + CO2 +ATP
  + Lactic acid fermentation
    - Done by animals
    - Glucose (glycolysis process) -> lactic acid + ATP

**Photosynthesis**

* By plants producing starch/food from light, to be used in cellular respiration
* Light dependent reactions
  + Light energy turns to chemical energy
  + H2O splits to H and O
  + O is released
  + Occurs in thylakoid membrane
* Light independent reactions
  + Synthesize glucose from CO2
  + Calvin cycle
    - Occurs in stroma
    - CO2 binds with RuBP
    - 6CO2 become 2 x 3CO2
    - 3-PGA becomes G3P
    - G3P becomes carbohydrate
* Uses all wavelengths except green (thus plants appear green)
* 6CO2 + 6H2O light> C6H12O6 + 6O2

**Nutrition**

* Water
* Carbohydrates
* Fats
* Vitamins
* Minerals
* Proteins

**Leaves**

* Cuticle
  + Protects leaf
* Guard cells
  + Regulates stomata
* Stomata
  + Openings on bottom of leaf that regulates water loss, carbon dioxide entry and oxygen leaving
* Vascular bundle
  + Phloem
    - Carries sugar downwards for storage
  + Xylem
    - Carries water up from root
* Epidermis
  + Protects leaf
* Palisade layer and spongy mesophyll
  + Contains most chloroplast
* Sheath
  + Protects vascular bundle
* Midrib
  + Center line of leaf
* Blade
  + Longer length of leaf
* Dicots and monocots

**Diseases**

* Infectious diseases
  + caused by pathogens - organism or virus that causes disease
  + Fungi
    - Ex: athlete foot
  + Bacteria
    - Ex: syphilis
  + Virus
    - Ex: HIV
  + Parasites
    - Ex: malaria
  + Protists
    - Pinworm
  + Faught by immune system
* Cancer
  + Caused by loss of control of cell cycle
    - Ex: sarcomas
      * Cancer growth in bone, muscle tissue
    - Ex: lymphomas
      * Solid tumor in tissue that makes blood cells (which is in bone marrow)
  + Tumor
    - Mass of cancerous cells
  + Benign
    - Tumor cells stay within tumor
  + Malignant
    - Tumor cells exits tumor to invade and destroy healthy cells in organism
  + Metastasis
    - Cancer cells spread
  + Carcinogen
    - Substances increasing risk of cancer
      * Ex: coffee, wood dust, UV lights, tobacco
  + Mutagen
    - Agent creating mutations in cell
  + Proto oncogenes
    - Controls cell growth and differentiation
  + Tumor suppressor genes
    - Prevents uncontrollable rate of cell division

**Genetics**

* Mendelian genetics
  + Gregor Mendel grew a lot of plants and found the law of hereditary
  + Dominant to recessive ratio = 3:1
  + Filial 1 generation (F1)
    - Offsprings from homozygous dominant parent and homozygous recessive parent
    - 100% heterozygous
  + Filial 2 generation (F2)
    - Offsprings from members of the F1 generation
    - 1:2:1 ratio: 25% homozygous dominant, 50% heterozygous, 25% homozygous recessive
* Genotype
  + Letters denoting the phenotype
* Phenotype
  + The expression of the allele
  + Expression can be influenced
    - Diet/nutrients
    - pH
    - Temperature
    - Wind exposure
    - Sunlight
* Allele
  + Versions of a gene
  + Dominant
    - Requires 1 copy to affect phenotype
    - Genotype denoted uppercase
  + Recessive
    - Requires 2 copies to affect phenotype
    - Having 1 makes an organism a carrier
    - Genotype denoted lowercase
  + Heterozygous
    - Both alleles are the different
  + Homozygous
    - Both alleles are the same
  + Incomplete dominance
    - When recessive allele is present, dominant allele isn’t fully expressed
    - Ex: red + white = pink
  + Codominance
    - When both phenotypes are present and expressed Ex: black + white = spotted
    - Different letters used as genotype
  + Polygenic traits
    - Traits’ expression depends on multiple genes
  + Epistasis
    - A gene depends on another gene in order to be expressed
  + Segregation
    - (not about races)
    - When the alleles are separated into different gametes
  + Independent assortment
    - A trait can individually pass on
  + Sex linked
    - Male = XY
    - Female = XX
    - Y chromosome only contains information on how to have male parts and produce sperm
    - Females have 2 copies of the X chromosome, domination works the same as autosomes (non sex chromosomes)
    - Males only have 1 copy of the X chromosome, so what the get is what they express
    - Assuming usual genotypes are denoted ?, genotypes for sex linked traits are denoted X?.
* Punnett squares
  + Crosses to show predicted genotypes
  + Monohybrid cross
    - Crosses 1 trait from each parent
  + Hybrid cross
    - Crosses 2 traits from each parent
    - Usually for epistatic traits
* DNA - deoxyribonucleic acid
  + Composed of nucleotides, which is composed of
    - A phosphate sugar
    - Base
      * Guanine, adenine, cytosine, thymine
      * Base pair rule
        + Guanine always pairs with cytosine, while adenine always pair with thymine
      * Chargaff rule
        + The ratio between guanine and cytosine is 1:1, while the ration between adenine and thymine is also 1:1
      * Thymine bonds with adenine using 2 hydrogen bonds, while cytosine and guanine binds using 3 hydrogen bonds
    - Hydrogen bonds
      * Weak, allows for easy DNA replication
    - Deoxyribose sugar
      * Corners are number from 1’ to 5’
      * It’s only possible to add a nucleotide to the 3’
      * One strand of the DNA runs from 1’ to 5’, while another runs from 5’ to 1’
  + 2 complementary strands make 1 helix, which wraps around histone proteins to create chromatin, which wraps on each other to create chromatids/chromosomes.
  + DNA carry instruction on protein synthesis
* DNA replication
  + In S phase of cell
  + Helicase unwinds helix at origin (there’re MANY origins in a chromosome) into 2 strands
  + Primase flags starting point for polymerase
  + DNA polymerase attaches complementary base to the stand
  + Ligase closes off gaps
  + There is a leading strand, which replicates faster than the lagging strand.
  + Segments on the lagging strand are okazaki fragments
* Mutations
  + Drives evolution forward
  + Point change
    - Changes only one point
    - Substitution
    - Inversion
  + Frame shift
    - Changes everything after point of mutation
    - Insertion
    - Deletion
    - Duplication
  + Non disjunctions
    - Sister chromosomes fail to separate during cell division
    - Monosomy
      * Daughter cell only has one copy of a chromosome
    - Trisomy
      * Daughter cell has 3 copies of a chromosome
    - Polyploid
      * For plants during meiosis
      * Man made
      * Cause nondisjunction (tetrads don’t separate in anaphase), to create offsprings with extra chromosomes, to get larger crops
* Genome
  + Genetic makeup of organism
  + Genome project: attempt to decode genomes
    - Controversial
      * Complex organisms don’t reproduce fast enough
      * Privacy of an individual’s genes
      * Ethics
      * Bias based on genetics
        + Ex: health insurances rejecting people because of mutations in genes
* Studying genetics
  + Biotechnology
    - Using technology to understand genetics
  + Restriction enzymes
    - Cut DNA into restriction fragments at set points (ex: such as between A and T)
  + Gel electrophoresis
    - DNA has negative charge
    - DNA is cut into restriction fragments with restriction enzymes
    - Fragments are placed into well
    - DNA moves towards positive charge side of the board
    - Larger fragments move slower than smaller fragments
    - Bandings are compared to find similarities
      * Used for catching criminals, finding similarities in species
    - Southern blotting
      * Using gel electrophoresis to locate desired gene
  + Polymerase chain reaction - PCR
    - Making more copies of a strand of DNA
      * Heat DNA until it splits into 2 strands
      * Primase is manually added to the strands
      * DNA polymerase is introduced to create complementary strands
      * Repeat
  + Karyotypes -sub to Kariyu
    - View of chromosomes
    - Pictures of chromosomes are taken during anaphase, and cropped out to put in karyotype picture
* Genetic engineering
  + Used to yield desired offsprings, by means of science
    - Such as larger size, producing more fruits, GMOs, traits for better survival, disease prevention
  + Selective breeding
    - Done for many years
    - Choosing parents to get desired traits in offsprings
    - Hybridization
      * Crossing different individuals to get the best of both
    - Inbreeding
      * (what some people manage to call it incest)
      * Breeding similar individuals to preserve their traits
  + Recombinant DNA
    - Combining DNA of multiple organisms
    - Ex: in bacteria
      * Desired DNA fragment is inserted into plasmid of bacteria, so that bacteria expresses those traits, and pass them on to offsprings
      * Ex: bacteria producing human insulin
  + Transgenic organisms
    - Organisms with recombinant DNA
    - Bacteria with recombinant DNA is inserted into an organism, so that the bacteria modifies the organism’s DNA by inserting the DNA that the bacteria received
  + Cloning
    - Creating a genetically identical offspring
    - Originally done with tadpoles
    - Dolly the sheep
    - Donor nucleus is extracted from a somatic cell of donor organism
    - Nucleus is removed from surrogate egg
    - Donor nucleus is fused into surrogate egg
    - Surrogate egg is implanted into uterus for development

**Protein**

* (polypeptide) large size
* Composed of amino acids
  + There are 20 different amino acids and 64 different codons
  + Some amino acids can be synthesised by the body, while others need to be consumed
* Function determined by shape
* Created by RNA using DNA’s instruction
* Ex: hormones
  + Secreted by endocrine glands to create gradual change in organism
  + Goes to target (fitting shape) hormone receptor on cell membrane to affect target cell
* Ex: enzymes
  + Organic catalases to lower activation energy to start reaction, speeding up chemical reactions
  + >75000 enzymes
  + Enzymes acts on substrates to create product
  + It takes 1.002 seconds for a chemical reaction to complete
  + Lock and key model
    - Enzymes fit by shape
  + Enzyme substrate complex
    - When enzyme is in contact with substrate
  + Enzymes usually end in -ase
  + Substrates usually end in -ose
  + Can be affected and denatured -broken by
    - Being out of optimal temperature
    - Being out of optimal pH level
    - Substrate concentration too high
    - Enzyme concentration too low
  + Poisons can bind to enzymes to prevent vital chemical reactions from happening
* RNA - ribonucleic acid
  + Single stranded
  + Shorter than DNA
  + Uses uracil in lieu of thymine
  + Uses ribose sugar in lieu of deoxyribose sugar
  + 3 types of RNA
    - tRNA - transfer
      * Carries anticodon (complementary to codon) and its corresponding amino acid
    - mRNA - messenger
      * Carries protein synthesis instructions from nucleus to ribosome
    - rRNA - ribosomal
      * Makes up ribosome
* Protein synthesis
  + Transcription
    - Prokaryotes
      * In cytoplasm
    - Eukaryotes
      * In nucleus
    - RNA polymerase opens a promoter in the DNA
    - RNA polymerase creates a mRNA strand complementary to the template
    - Strand is edited
    - Completed strand exits out nuclear pore
  + Translation
    - mRNA goes to ribosome
    - tRNA bonds with its complementary codon (every 3 base is a codon), carrying its corresponding amino acid
    - Amino acids bind together to become protein

**Evolution**

* Change over time
* Driven by mutations
* Early theories
  + Earth is ancient, therefor Earth must have changed
  + Darwin
    - Worked on his trip in the HMS Beagle
    - Species varies globally
      * In different parts of world, different species are found, with similar ecological function
        + Ex: Kangaroos jumping in Australia, while bunnies jump in Africa
    - Species varies locally
      * In the same part of the world, varieties can be found within a species in different regions of the same part of the world
        + Ex: finches had different shaped beaks in different islands in the Galapagos
    - Changed happens over time
      * Species in the past looks different from their modern evolution
        + Ex: the fossil of an older armadillo is larger than the modern armadillo
    - Natural selection
      * Without this, there would be overpopulation
      * Happens quickly in species with short reproductive cycles
      * Within a population, there are varieties
      * Competition (for limited food, shelter, etc) kills of those with unfavorable traits to prevent overpopulation
        + Ex: long neck giraffes can reach more food than short neck giraffes, therefor short neck giraffes are prone to starving and dying
        + Traits can be an advantage or disadvantage

Ex: lighter moths stood out and got eaten

* + - * Survival of the fittest
        + Favors and passes on favorable traits
        + Fittest

Able to survive and reproduce to pass on traits

Having favorable traits makes it easier to be fit

* + Lemark
    - Believed evolution happened because organisms have a drive for perfection
      * Drive for perfection leads to organism aquiring useful traits
        + Acquired traits were believed to be passed on to offsprings

Disproved later on

Weissman

He cut off the tail of 100 white mice, and made them reproduce. All the offsprings have normal sized tails, proving that acquired traits can’t be passed on. (As it doesn’t change the genetics of the gametes -not what he learned, but true)

* + - Believed species didn’t go extinct; they evolved into something else
* Studying evolution with these concepts
  + Fossils
    - Preserved remains/imprints of a dead organism
    - Mold fossil
      * Deceased organism is buried in sediments
      * Minerals take the place of the deceased organism as it decays
    - Trace fossil
      * Imprint made by organism
    - True form fossil
      * Deceased organism is preserved in a way in which it didn’t decay
    - Dated to study evolution -as in put in chronological order
      * Relative dating -Mr. Ng
        + Used to find which fossils are older than which
        + Law of superposition

If the earth hasn’t been disturbed, the closer a fossil is to the surface, the younger it is

* + - * + Index fossils are used for correlation

Index fossils are from species that lived in a wide area and lived for a short period of time

Used to correlate the order of fossils from different places

* + - * Absolute/radioactive/radiometric dating
        + Studies half lives of radioactive elements
        + Radioactive elements

Carbon 14

Used to study recent organisms, due to its short half life

Potassium 40

Uranium 238

Rubidium 87

Long half life, used for ancient organisms

* + - * + Half life

Since radioactive isotopes are unstable, after every half life, half of the unstable isotopes become stable. The ratio between stable and unstable isotopes and the knowledge of how long a half life is is used to find the absolute date of a fossil, and rocks

* + Geological time scale
    - Chronological organization of Earth’s events
    - Eon>Era>Period>Epoch>Age
    - Earth is very old, and changed over time
    - Earth’s life contained many mass extinctions
      * Ex: Permian, Cretaceous, Megafaunal, sixth
      * At least 99% of all species that ever existed are now extinct
      * Emptied environments for new species to take over
      * Extinct: species no longer existing
        + Endangered: at risk of being extinct
    - In a community within an age, there is a dominant species
      * Most hardiest, influential to the ecosystem (ex: human rn)
  + Comparative anatomy
    - Having homologous and analogous body structures prove common ancestor
      * Homologous
        + Same components, different function/adaptations (adaptive radiation)
        + Ex: pentadactyl limb in humans, birds, dogs
      * Analogous
        + Different components, same function
  + Comparative embryology
    - Species looks most alike while as a developing embryo than as an adult
    - Similar embryonic development shows common ancestor
    - Ontogeny recapitulates phylogeny
      * Disproved
      * Ontogeny
        + An individual’s development
      * Recapitulates
        + Shows
      * Phylogeny
        + A species’ evolution
      * The stages of embryonic development shows sequence in which the species evolved
  + Comparative biochemistry
    - DNA sequences can be compared
      * More bases being the same means more related
      * Can be compared by mixing blood
        + More precipitation means more similarity
      * Can be done by bonding 2 strands of DNA, and see how strong bond is
        + If higher temperatures are needed to break bond, then it is more similar than lower temperature
  + Vestigial structures
    - Body structures that no longer perform its original task
      * Debated: if it still does a small, vital task, or totally useless
      * Environment made it structure necessary for survival
        + Ex: a whale’s hip

Do to increase in water on Earth, the whale is no longer terrestrial, leaving behind a tiny, unused hip

* + - * Mutations made it not perform its original task
        + Ex: wisdom tooth

Mouth is now shorter, making it not be like a regular tooth

* + - * Still present if natural selection doesn’t act on it, if it doesn’t hinder an organism’s fitness
  + Industrial melanism
    - Melanism: becoming darker
    - Pollution makes environment darker, making lighter color organisms stand out, making them vulnerable to predators
      * Ex: white moths standing out from pollution, eaten, now most moths are black
  + Adaptations
    - Larger extremities to release heat in hot places
      * Smaller to save heat
    - Larger bodies to generate more heat
      * Smaller to generate less
    - Adapting a homologous structure - adaptive radiation
    - Antibiotic resistance
      * Bacteria mutate to be immune, and reproduce to pass on immunity
      * Caused by overuse of antibiotics
      * Some disease are now untreatable with antibiotics
  + Species with well documented evolutions
    - Horses
      * Started smaller, grew larger
      * Toes compacted into hooves
    - Whale
      * Started tiger like, terrestrial
      * More water cause adaptation to lose legs, learn to swim
        + Residual pelvic bone
    - Human
      * 200000 years ago from Africa
      * Closest relative: Neanderthals
      * Homo genus, modern sapien
      * Started as hunter gatherers
      * Faced many survival challenges
  + Origin of life (like all the way back then, when nothing was alive to create life)
    - 4.29 billion years ago
    - Organic compounds were formed from electric shocking materials in atmosphere
    - Heterotrophs were the first life form
      * Endosymbiont -heterotroph didn't digest their food, so ingested things developed symbiotic relationship with the eater, and later became organelles of the eater (cell)
    - First organism was bacteria that survived the toxic ecosystem
  + Speciation
    - For 2 species to be in the same species, they need to be able to produce a fertile offspring
    - Hybrid: sterile offspring from parents of different species
    - Speciation: creation of new species
      * Happens when organisms of a species are separated long enough for big differences to occur to the gene pools
        + Separation can be caused by isolations

Allopatric

Geography isolates to prevent breeding

Sympatric

Prezygotic barrier

Prevents fertilization

Behaviors of one organism may not attract another

Temporal isolation

Different breeding cycles prevent breeding

Organisms may prefer different habitats, isolating them

Postzygotic barrier

Hybrids can’t reproduce

In some cases, hybrids can’t develop or live

**Ecology**

* The study of organisms’ interaction with their environment
* Organization
  + Species
    - Organisms of the same species
  + Population
    - The members of a species within an area
  + Community
    - The populations in an area
  + Ecosystem
    - Community and its environment
    - Stable when
      * There is constant energy supply
      * Organisms incorporating energy into organic compounds
      * Materials are recycled
    - Factors
      * Limiting
        + Controls number and kinds of organisms in ecosystem
      * Abiotic
        + Soil

Sand, clay, rick, swamp, acidic, alkaline, loam

* + - * + Water
        + Air

Gases: oxygen, nitrogen, hydrogen, carbon dioxide

Respiration

* + - * + Light

Photosynthesis

* + - * + Temperature

Need to be between 0-50 C

* + - * + Mineral

Ex: nitrogen, sodium, calcium, carbon, iron, potassium

* + - * Biotic
        + Producers

Manufactures food with resources in environment

* + - * + Consumer

Consumers producers and producers

* + - * + Decomposer

Breaks down dead organisms to recycle materials

* + Habitats
    - Biome ~~Minecraft~~
      * Part of biosphere with specific type of dominant plant and animal, geography, climate
      * Terrestrial
        + Tundra

Permanently frozen subsoil

* + - * + Taiga

Long, severe winters

Summers thaws subsoil

* + - * + Temperate deciduous forest

Temperate precipitation and climate

Deciduous (leaves fall) tree

Cold winters

Warm summers

* + - * + Tropical rainforest

Heavy rains

Tropical -hot

* + - * + Grassland

Rainfall and temperature variates

Strong wind

* + - * + Desert

Little rainfall

Volatile temperature

* + - * Aquatic
        + Stablest

Water has a high heating point

* + - * + Factors: oxygen and carbon dioxide concentration, temperature, light, minerals and particles present
        + Producers are photosynthetic up until 30 m deep, until light can’t penetrate
        + Marine (salt)

Ex: oceans

Stablest

* + - * + Freshwater

Ex: pond, lake, stream, river: each with differences

* + - Biosphere
      * Part of Earth that hosts life
    - Habitat
      * Ecosystem that organism lives
      * Carrying capacity is limited, based on factors (competition, resources, etc)
    - Niche
      * Organism’s role in habitat
* Interactions
  + Food
    - Saprophytes
      * Aka decomposers
    - Herbivores
      * Feeds on plants
    - Carnivores
      * Feeds on other animals
        + Predators

Kills prey to eat

* + - * + Scavenger

Eats dead animals

* + - * Omnivores
        + Eats both plants and animals
      * Food chain
        + Path in which energy travels through consumers
        + Energy source > producer > primary consumer > secondary consumer > tertiary consumer > top level consumers , decomposer can connect to each level

90% energy is lost at each level

Biomass decreases at each level

* + - * + Food web

Interconnected food chains in a habitat

Increases stability in case of extinctions

* + Symbiosis
    - Organisms live together, at least 1 is benefited
    - Mutualism
      * All organisms are benefited
    - Commensalism
      * Some organisms benefit, some are unaffected
    - Parasitism
      * Parasite harms host
  + Cycles
    - Carbon oxygen
      * Photosynthesis and cellular respiration cycles carbon to oxygen
    - Water
      * Water up to clouds and back down
    - Nitrogen
      * Nitrogen cycling between forms to suit organism needs
* Successions
  + Replace a population with another
    - Over time, a habitat is better suited for the next succession than the current one
    - Pioneer
      * First to live in a habit
    - Exploding populations, competition, can cause instability, causing succession
    - Climax
      * Everything stable, no succession unless disaster disturbs it
* Human impact
  + Humans need clean air and food, nutritious food, fertile soil, shelter and living space
  + Humans depend on other species, as other species depend on humans
  + Human population is now rapidly increasing, due to scientific advancements
  + Pollution
    - Water
      * Reduce amount of pure water
      * Thermal, pesticides, sewage, metals, chemicals
      * Suffocated and poisons aquatic life
    - Air
      * Reduces amount of clean air
      * Smoke, ash, soot
      * Carbon dioxide creates greenhouse effect
      * Sulfur, nitrogen oxides creates acid rain
      * Smoke creates smog
    - Soil
      * Limits clean water wells, good parks, kills decomposers
      * Chemicals, waste, pesticides
  + Exploitation and overhunting of species disrupts ecosystem
  + Importing exotic species that don’t have natural predators overpopulates
  + Biocide
    - Kills undesired organisms
    - Herbicides
      * Kills undesired plants
    - Pesticides
      * Kills undesired animals
    - Better to use natural biocides
  + Waste
    - Biodegradable
      * Can be naturally broken down
    - Non Biodegradable
      * Can’t be naturally broken down
  + Educating public, passing laws can help improve environment
  + Conservation
    - Protection and careful use of natural resources
    - Renewable
      * Can be reused, replaced
    - Nonrenewable
      * Can’t be reused, replaced
    - Prevent loss of rainwater
      * Watersheds
    - Prevent soil erosion
      * Strip cropping, terracing, contour plowing
    - Prevent extinctions

<https://drive.google.com/file/d/1ia9wkWPrL--n0blQTG8igNVpf3RNYoMJ/view?usp=sharing> this one has info on the state labs