Scientific Method

Theory- Strongest form of evidence in science. Tested many times.

Hypothesis- "educated guess" Must be testable.

Independent variable- What you change in the experiment

Dependent variable- What you are measuring in the experiment

Control group- The group getting the "fake treatment" Used to compare to experimental group to see if the experiment is having an effect.

Experimental group (s) – the groups you are studying.

Types of Bonds

Ionic- Metal + nonmetal. Strongest. Between + and – ion.

Covalent- For nonmetals

Hydrogen- Weakest. Used in water and in the complex structures of DNA and Proteins.

Breaking bonds= energy released

Forming bonds= energy stored.

"Special" bonds-

- Peptide- between Amino acids
- Glyosidic- between nucleotides
- Dehydration synthesis- between any two monomers.

Biomolecules and Scientific Method

Molecule	Shape	Function
Carbs	Rings 1:2:1 ratio	Quick energy. Produced in cellular respiration
Lipids AKA: Fatty acids	Chains of C and H	Energy long term storage/ insulation/ cell membrane
Protein	Amino acids	All major functions: transport structural
Nucleic Acid	Phospha te, sugar base	RNA and DNA

Monomer- base units of biomolecules

Polymer- Long chains of monomers

Molecule	Monomer	Polymers
Carbs	**Monosaccharides -Glucose** Fructose	Glycogen- animals Starch- plants Cellulose- Cell wall of plants
Lipids	FA + Glycerol	Triglycerol Steroids Hormones
Proteins	Amino acids (20 types)	Hemoglobin Protein pumps
Nucleic acids	Nucleotide	RNA DNA

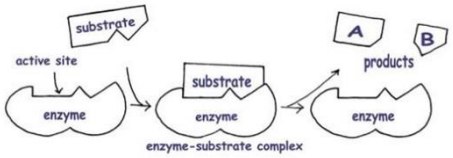
Saturated fat- no double bonds- solid at room temp. BAD for you.

Unsaturated – double bonds- liquids. Better for you.

"CHO CHO CHON CHONP" – elements in each. Carbs and lipids have just CHO. Nucleic acids have CHONP.

Tests for biomolecules-

Ph- Used to compare acidity. Ranges from 0-14. Lower numbers are more acidic.



Enzymes- are PROTEINS

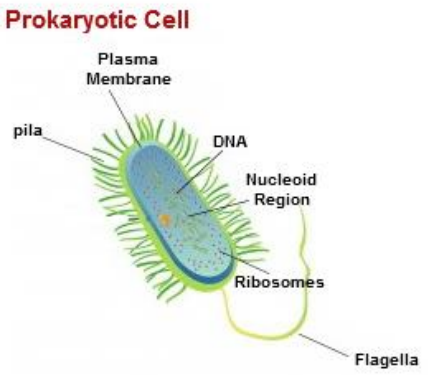
- Speed up chemical rxns
- Lower activation energy
- Denature(change shape) and lose function in different temperatures and pH levels.
- VERY specific to one thing.
- Name ends in –"ASE"

Substrate- The thing that is being changed by the enzyme

Active site- Where substrate binds on enzyme.

CELL STRUCTURE

Prokaryotic cells= no nucleus



Structure-

Ribosomes- protein production

Cell membrane "plasma membrane"- semi permeable membrane

DNA- usually a single round chromosome

Cytoplasm- fluid

Flagella- locomotion

Pili- Transfer of DNA

Eukaryotic Cells

Structures

DNA- in nucleus

Nuclear membrane

Mitochondria- Energy production by cellular respiration

Chloroplasts- Captures suns energy in plants

Endoplasmic Reticulum- Folded membrane

- Smooth- cell membrane
- Rough- has ribosomes for protein production

Golgi apparatus- Ships things out of cell.

Lysosome- digestive enzymes to eat bacteria and foods.

Nucleolus- produces the ribosomes

Vacuole- water storage

Vesicle- any membrane bound structure.

Cell wall- lets anything through it. Made of cellulose in plants and chitin in fungus.

Cytoskeleton- Aids in movement of organelles and chromosomes in cell division. Forms the mitotic spindles.

Differences between plant and animal

1. Plants have large central vacuole- to prevent overexpansion of osmosis.
2. Plants have cell walls
3. Plants have chloroplasts

Fungi- eukaryotic cells

-cannot do photosynthesis. Get food through releasing enzymes into environment. Majority of the fungus is underground. Still have organelles like membrane, golgi, vacuoles.

Unique structures in fungi:

1. Mycelium – "rootlike structure" of fungi. Made of many hyphae.

2. Can have multiple nuclei in each cell.

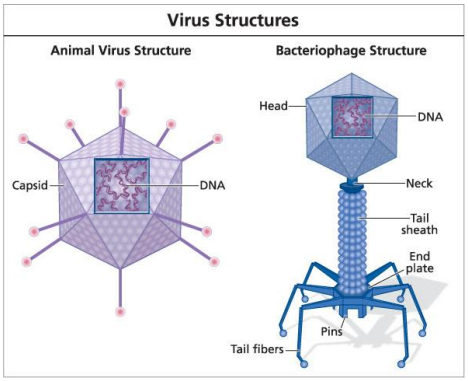
3. Fruiting body- part above ground to reproduce.

4. Hyphae- individual cells of fungi.

5. Cell wall made of chitin.

Yeast- Unicellular fungus.

Viruses



Viruses are NOT ALIVE- require other organisms to reproduce. Have no cell membrane / cell wall/ cytoplasm/ organelles. Can be single or double strand of DNA or RNA.

Capsid- Protective outer layer made of proteins. Surrounds DNA or RNA.

Envelope- lipid and protein structure that helps with attaching to other cells.

Spikes- for attachment to cells

Bacteriophages- viruses that attack bacteria.

Modes of viral reproduction-

1. Lysogenic- virus integrates into the DNA and you have it forever. Does not usually kill host.

2. Lytic-most viruses- results in destruction of host cell to replicate. Short term.

Vaccines- small amounts of virus to help build immunity against future infections. Can be a weakened "attenuated" version or heat killed version.

Prophage- Viral DNA that is integrated into the host DNA.

Prion- Infection proteins" mad cow disease"

HIV- human immunodeficiency virus- "aids" – a retrovirus- can reverse transcription to turn its RNA into host cell DNA. Lysogenic.

Cell membrane- formed of a lipid bilayer of phospholipids. Polar head and nonpolar tails.

-Called Fluid Mosaic- made of many parts that are moving about.

-Selectively Permeable- Regulates what comes into and out of cell

Parts of membrane-

1. Glycoproteins- identification
2. Transport proteins
3. Cholesterol- fluidity

Cell Transport-

Passive transport-no energy involved. From **high to low** concentration.

1.Diffusion- random movement of molecules.

2. Facilitated Diffusion- Uses protein channels. Movement of larger molecules.

3. Osmosis- Movement of water

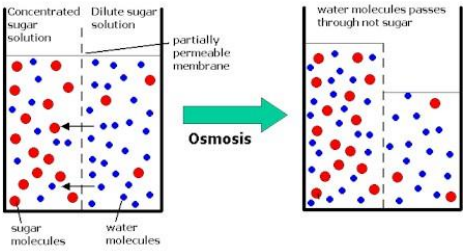
Osmosis-

Follow the **water concentration from high to low concentration**

Hypertonic- H20 out- higher concentration of solutes outside.

Hypotonic- H20 in- lower concentration of solutes inside.

Isotonic- equal concentrations.



Cytolysis- cell expanding

Plasmolysis- cells shrinking

Dealing with osmotic pressure:

1.Cell wall -in plants helps prevent overexpansion due to osmosis. "Turgor pressure"

2. Contractile vacuole- in protists- to pump out water.

Active Transport- Uses ATP to move from low to high concentration.

1. Exocytosis – Large materials out of cell through a vesicle.

2. Endocytosis- Large materials into cell. Pino= cell drinking Phago= cell eating Receptor mediates= more specific form.

3. Protein pumps- Uses ATP to move ions against gradients. Ex: Sodium Potassium Pump.

Homeostasis- maintaining constant internal environment

Dynamic Equilibrium- created by cell membrane- things still go back and forth.

Photosynthesis- occurs in plants + algae

Water and carbon dioxide are turned into oxygen and glucose.

Two phases-

1. **Light Dependent**- Sunlight is absorbed to break water into H+ and O2 (photolysis) in photosystem 1.
2. **Light independent**- uses the products of the light dependent to create glucose.

"AKA'S"

Light Independent AKA Calvin Cycle or Dark reaction.

Products : O2 and glucose

Reactants: Carbon Dioxide and H20

Where does it happen?

Photosynthesis- Chloroplast

Light Dependent- Thylakoid membranes

Light independent- Stroma of chloroplast.

Chlorophyll- pigment in plants to absorb sunlight.

Energy Transfer Molecules-

NADPH- transfer molecule in photosynthesis- H is higher energy form.

ATP- another transfer molecule

NADH- in cellular respiration

FADH2 – In cellular respiration

Cellular Respiration- plants AND animals both do it in the mitochondria. Use Oxygen and glucose for energy and create water and CO2.

Three phases:
1. Glycolysis- Always done first. Anaerobic stage- Occurs in cytoplasm.

2. Kreb's Cycle AKA "Citric acid cycle" – matrix of mitochondria- breaks down the glucose into usable forms of energy for the electron transport chain. Aerobic – requires oxygen.

3. Electron Transport Chain- Turns all of the energy into ATP, oxygen is the final electron acceptor to make water. Series of proteins in the inner mitochondrial membrane.

Fermentation – to restore NADH if there in no oxygen present "anaerobic"

1. lactic acid- in humans, produces muscle burning sensation.

2. Alcoholic – produces CO2 and alcohol. Yeast. Used for brewing and breadmaking.

Order of Anaerobic respiration- 1. Glycolysis 2. fermentation

Order of Aerobic respiration – 1.Glycolysis 2.Krebs cycle 3.electron transport chain.

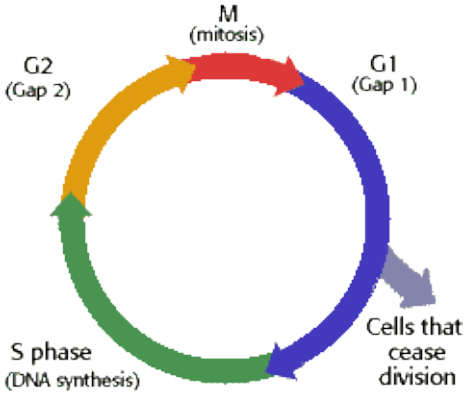
ATP- Adenine TriPhosphate-
energy currency of cell

Similar to nucleic acids- made up of 3 phosphates, ribose, and adenine base.

Breaking off one phosphate= energy released to form ADP.

Adding phosphate in cellular respiration= storing energy.

Chemiosmosis – production of ATP using hydrogen gradient.



Interphase- cell is growing and doing normal functions.

3 parts of interphase:

1. G1- Growth of cell and organelles.
2. S- DNA Replication
3. G2- Preparation to divide
4. G0- Dormant cells.

Cell cycle order- g1- s- g2 – mitosis – cytokinesis.

Cytokinesis- Cytoplasm of cell splitting.

- Animals – cleavage furrow
- Plants – cell plate

Checkpoints :

1. G1 – are you large enough for divison?
2. G2- Did DNA replicate properly?
3. M- Are the chromosomes properly aligned during metaphase.

Checkpoints make sure the cell cycle is functioning properly.

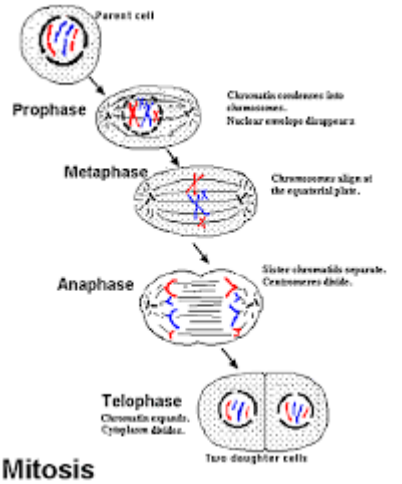
Cancer- loss of control of cell cycle. Uncontrolled cell division.

Benign tumor- localized mass of cells. Usually easier to remove by surgery.

Malignant tumor- spreading throughout body.

Treatments for cancer:

1. Radiation- high dose of x – rays to kill all cells in area.
2. Chemotherapy- Drugs that target fast growing cells.
3. Surgery- Removing portions of tumor.



Mitosis – formation of 2 identical daughter cells from a parent cell.

Use: Replenish old cells and growth.

Phases of mitosis – PMAT

Prophase- Chromosomes form and spindles form. Nuclear membrane breaks down.

Metaphase- Chromosomes line up and spindles attach.

Anaphase- chromatids pulled apart.

Telophase- nuclear membrane reforms.

Stem Cells-potential to become many different types of cells.

Multipotent- Adult stem cells- Are limited to becoming only several types of cells. Found in some bones.

Pluripotent- Embryonic stem cells- can become any tissue type.

Induced Pluripotent- Genetically engineering normal cells to act like pluripotent stem cells.

Meiosis- formation of 4 non-identical haploid sex cells.

Order of meiosis- Interphase, PMAT1, Cytokinesis, PMAT2, cytokinesis.

Use: Increase genetic variation through sexual recombination.

3 ways meiosis increases genetic diversity:

1. Crossing over- prophase 1- homologous chromosomes switch genetic info
2. Independent assortment- random assortment of chromosomes.
3. Random fertilization- only one sperm fertilizes the egg.

DNA

Chromosomes- organized DNA. 23 pairs of chromosomes -46 total

Chromatin- unorganized DNA in interphase.

- Histones- proteins to coil up DNA.

Genes- segments of DNA that code for a specific protein.

Genome- Entire set of DNA of organism.

Diploid- 2 complete sets of chromosomes. One from mom and one from dad. (somatic cells)

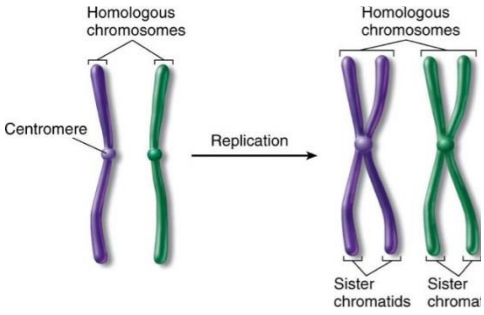
Haploid- One set of chromosomes- Egg and sperm cells (gametes)

Zygote- fertilized egg. Diploid.

Nucleotide- base unit of DNA

3 Parts of nucleotide: 1. Phosphate group 2. Sugar 3. Nitrogen base.

Differences between DNA and RNA: The sugar is ribose in RNA and Deoxyribose in DNA. DNA is double stranded and RNA is single stranded.



Chromatids- identical copies of chromosomes after S phase.

Centromere- Holds chromatids together.

Homologous chromosomes – one of the 23 pairs of chromosomes, one from mom and one from dad.

Central Dogma- dna -> RNA -> Protein

Replication- DNA TO DNA, occurs in nucleus

- C to G, A to T
- EX. Replicate CGTA = GCAT

Transcription- DNA creates messenger RNA. Occurs in Nucleus.

- C to G, **A to U**
- Ex.Transcribe CGTA = GCAU

Translation- RNA is translated into protein. Occurs in cytoplasm. Uses genetic code.

- Codon- 3 base segments that code for an amino acid.
- There are 64 codons and 20 amino acids so there are more than one code per amino acid.

Types of RNA-

1.Mrna- messenger- carries "recipe" from nucleus to ribosome.

2. Trna- Transfer- brings amino acids to ribosomes.

3. Rrna- Ribosomal- forms ribosomes- site of protein synthesis.

DNA mutations- Can be caused by mutagens- things that increase

mutations such as UV light, cigarette smoke, pesticides, etc.

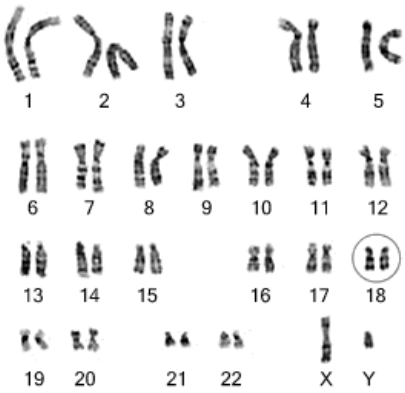
Point mutations-

1. Substitution- changing a single base- Could change the amino acid or keep it the same depending on the genetic code.
2. Frameshift mutations- adding or deleting a nucleotide. Much worse. Causes many amino acids to be incorrect.

Chromosome mutations- larger scale.

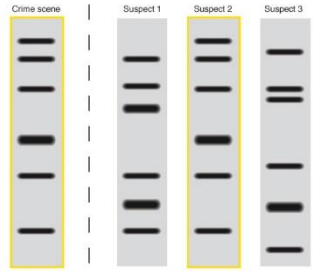
1. Deletion- of segment of chromosome
2. Duplication- genes are copied.
3. Inversion- Genes move around.

DNA biotechnology



Karyotype- picture of all of the Chromosomes.

- Can show boy (XY) or girl (XX)
- Arranged from big to small
- Used to look for genetic disorders.



DNA fingerprinting – used for crime scenes and paternity testing. Match up the lines.

Gel electrophoresis- Separates DNA into segments. Smaller segments travel further. Longer, heavier ones do not travel as far. Used to make "fingerprint".

- Restriction enzymes- cut the DNA

Gene therapy- inserting a normal gene into an individual to treat a disease.

Cloning – Creating an exact duplicate of a living organism.

Genetic Engineering – Adding the DNA of one organism into another organism.

- Splicing- adding the DNA
- Ex. "Round up" ready corn
- Transgenic organism- an organism with the DNA of two species.

Genetics-study of passing on traits to the next generation.

Dominant trait- Always a capital letter. Only need one copy to show it.

Recessive trait- small letter, need two letters to show it..

Allele- different versions for a gene. Ex. T= tall t = short

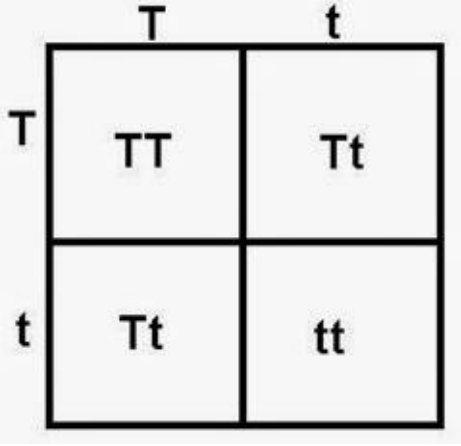
Heterozygous- One dominant and one recessive allele.

Homozygous- two dominant or two recessive alleles. "true or pure breeding"

Genotype- your alleles for a trait "Aa"

Phenotype- what you look like ex. Tall.

Monohybrid cross- between one trait.



3:1 phenotype ratio

1:2:1 genotype ratio

Punnett square- parent's gametes go on outside.

P generation- parents

F1- First generation

F2- Second generation by crossing two offspring of first generation.

Sex linked traits- on X or Y (usually x)

-Remember males are XY and females XX. Females need two copies to display it while males only need one. More common in males.

Non-Mendelian Patterns-

1. Codominance- both alleles are dominant. Heterozygote (Aa) displays a mix of BOTH phenotypes.

2. Incomplete dominance- 3 phenotypes. Aa is a blend in between the dominant and recessive allele.

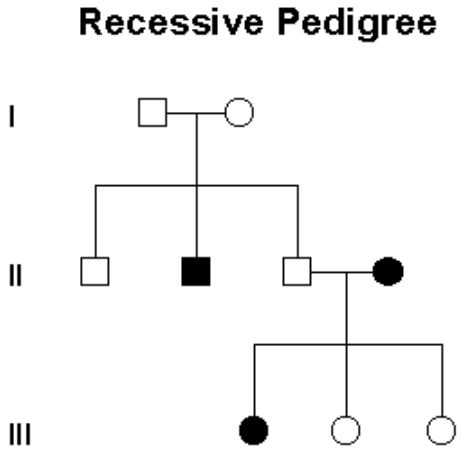
3. Polygenic traits- multiple genes coding for one trait.

- ex. Height, skin color

- Wide range of phenotypes represented by a bell curve.

4. Multiple alleles- more than two different alleles for one trait. Ex. ABO blood typing.

Pedigrees-looking at family tree to trace back origin of a genetic disease.



Males are squares/ females circles. Dark shading means they have the disease. No shading could be carrier or normal phenotype.

Genetic Diseases- Usually recessive in nature.

Nondisjunction- issues with meiosis cause extra or missing chromosomes.

- Down's syndrome- trisomy 21. Nondisjunction of chromo. 21. More common as the female gets older.

Evolution

Darwin: travelled 5 years on a ship to South America, Galapagos, and Australia.

Natural Selection: organisms change over time.

1. There is variation in a population.

2. Individuals in a population need to compete for resources (food).

3. Some traits are beneficial for survival, some are bad.

4. The most fit (best able to survive) are most likely to pass on their genes.

5. Over time the population will shift according to which traits are "selected" for.

Evidence of evolution:

1. Fossils – Show things go extinct, show change in species over time.

2. Embryology- Very different organisms have very similar beginning stages as an embryo.

3. Vestigial organs- things that are no longer needed are left behind by evolution. Ex. Appendix, tailbone, goosebumps.

4. DNA sequencing-if you sequence specific genes that are common to different species, the closer they are in common base pairs, the more closely related they are.

5. Homologous structures- ex. Forearms of humans, whales, bats. Similar structures in species that are very different. Believed that have evolved in a common ancestor.

Fitness- ability to reproduce

Species- a group of organisms that can reproduce.

Hybrid- A mixture of two species that can survive but not reproduce. – ex. Mule

Speciation- production of a new species.

Decent with modification- Species gradually become new species over time by changing characteristics.

Artificial selection- (dogs) – selectively breeding dogs for desired characteristics such as fur length or size.

Analogous structures- things that evolve similarly in two different species. Ex. Wings of bats and birds.

What can increase speciation?

1. Geographical isolation- Two populations cannot get to each other to mate and will grow more and more different over time.

2. Temporal isolation- time differences in reproduction. Ex. Orchids only open 1 day a year in certain forests.

3. Behavioral – Sexual selection in mates such as in birds picking mates by song or colors or dances.

Prezygotic barriers- before fertilization

Postzygotic- After fertilization.

Types of evolution:

1.Coevolution- two species evolving in response to each other.

2. Divergent – Two different species becoming more alike in traits.

- ex. Wings of bats and birds.

3. Convergent- Two similar species becoming more and more different.

-Ex. Beaks of finches.

Patterns of speciation

1. Directional- one end of the bell curve is more fit than the rest. The curve will shift one way or the other.

2. Stabilizing- the middle phenotype is most fit, the curve will become narrower and taller.

3. Disruptive- The middle ground is least fit (better to be either extreme) the curve will become two separate humps.

Polyploidy- plants can accumulate multiple sets of chromosomes. Ex. 4n instead of 2n. (diploid).

- Results in sterile hybrid. How we get seedless watermelon.

Classification- Linnaeus.

Domain- Broadest level of organization.

1. Eukrya- nucleus

2. Bacteria

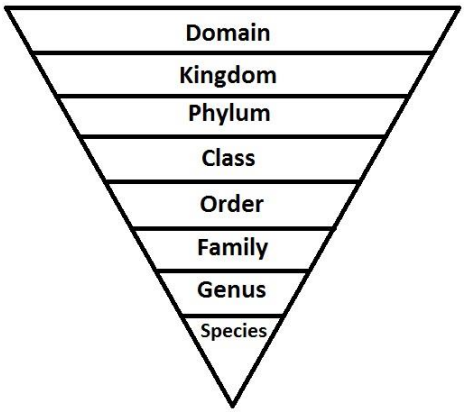
3. Archea- no nucleus

Kingdoms- next highest level.

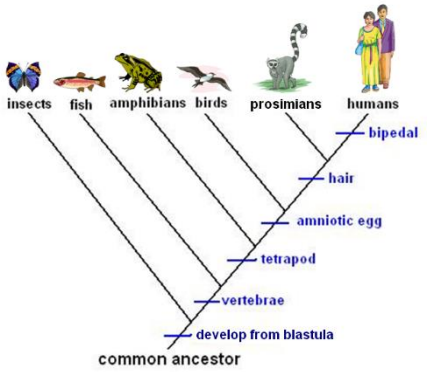
- Eukaryotes have 4 kingdoms; animals, plants, fungi, and protists.

Binomial nomenclature- Genus and species name. Used so scientists around the world can have common language.

Levels of classification- from big to small



Cladograms –Used to show shared characteristics in a group of organisms.



- **DOES NOT** show a path of evolution.
- Everything to the right of a characteristic shares that trait.

Dichotomous Key- uses distinguishing features to **identify** an organism using yes/ no questions.

Important People

Mendel- genetics / pea plants

Darwin- Natural selection

Watson and Crick- DNA structure

Franklin- X RAY "picture"

Griffith- transformation in rats

Hershey chase- used bacteriophages to show DNA is genetic material

Robert Hooke- Discovered cells

Van Leeuwenhoek- "animalicules" – observed single cell organisms.

Ed Jenner- smallpox vaccine

Louis Pasteur- pasteurization of milk

Chargoff- base pairing rule

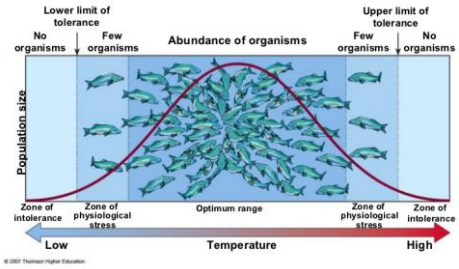
Rachel Carson- warned public of pesticide danger with DDT.

Ecology

Biotic factors- Living (plants, animals, people)

Abiotic – Nonliving (rocks, water, wind, temperature, light)

Tolerance range- the abiotic conditions that a species can survive. Each species has a optimal range.



Hierarchy of life (from small to big)- atom < molecule < cell < tissue < organ < system < organism < population < community < ecosystem < biosphere

Population-a group of one species that can interbreed to make a fertile offspring.

Community- several interacting populations that inhabit a common environment.

Ecosystem- Populations and their abiotic factors with which they interact.

Biosphere- Highest level of organization.

Habitat- the place where an organism lives "address"

Niche- The role a species plays in a community "how it make living"

- How it interacts with biotic and abiotic factors.

Producers

- Autotrophs- make own food. Bottom of food chain.

Consumers

1. Primary- eat plants "herbivores"

2. Secondary or tertiary
   - Carnivores – eat meat only
   - omnivores- eat both meat and plants
   - Scavengers- eat already dead meat
   - Decomposers – Breakdown dead and decaying plants and animals.

Symbiosis – organisms living with each other.

1. Mutualism – both organisms benefit.

2. Parasitism- one benefits, the other is harmed.

3. Commensalism- One benefits, the other is not harmed.

Trophic levels – The higher up you go in a food chain, the amount of energy decreases.

Rule of 10- each trophic level can only use 10% of the energy of the past trophic level.

- Why we see such low numbers of apex predators.

Keystone species- More important than other species for the stability of the entire food web. Ex. Sea otters, wolves.

Apex predator- top of the food chain.

Biomagnification- Energy decreases as you go up food chain, but toxins increase in potency.

- Ex. DDT and bald eagles.

Water Cycle

Evaporation- water converted into gas.

Transpiration- water in plants evaporating.

Condensation – gas into liquid "dew"

Percolation – Water moving slowly through soil to groundwater.

Nitrogen Cycle

Assimilation- integrating nitrogen from soil into a plant.

Nitrogen fixation- bacteria in root nodules of legumes or soil take nitrogen from air and make it an organic compound.

Population Dynamics

Need to look a size, density (how many individuals in a particular area, and distribution (randomly spread or clumped)

Immigration – movement of individuals into population.

Emigration – movement of individuals out of population.

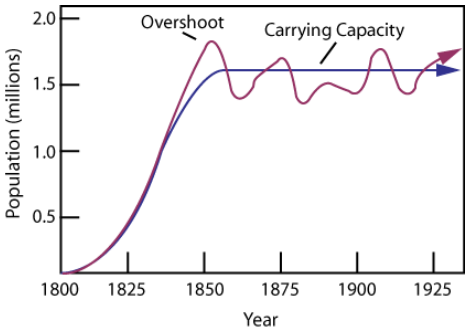
Density dependent factors – Biotic factors that a larger effect on increasing population size.

1. Disease
2. Competition
3. Parasites

Density independent factors- Abiotic factors that affect populations regardless of their density.

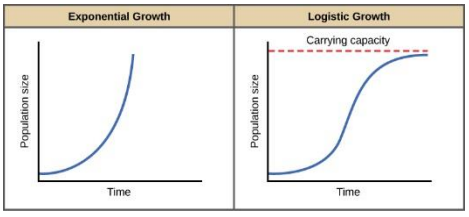
1. Temperature
2. Storms
3. Habitat destruction
4. Drought.

Carrying capacity- maximum population size that can be supported by the available resources.



Exponential growth- starts slow and then becomes much more rapid. Occurs when there are unlimited resources and low competition.

Logistical growth- "s curve" – Slow start then rapid increase, followed by a leveling off at the carrying capacity.



Succession –gradual replacement of plant community.

1. Primary- begins with no soil
   a. Volcanoes
   b. Landslides
   c. Flooding

Pioneer species- first to inhabit an area. Do not need soil to survive.

- Lichens- help create soil.

2. Secondary- already has soil but has been disrupted.
   a. Forest Fire
   b. Human disruption

Climax community- Stable group of plants and animals at the end of succession. Does not mean large trees always. Ex. Desert or prairie grass.

Invasive species- nonnative plant or animal that has been introduced.

- Often has no predators and will outcompete native plants.