AP Biology Review One Pagers

@marcolearning

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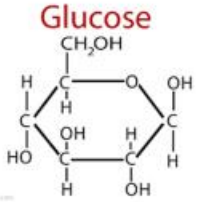
Unit 1:
Chemistry of Life

Carbohydrates

Composed of C, H, & O – Ratio: 1:2:1

Monomer: Monosaccharide



Examples: Glucose, Fructose, Galactose

Disaccharides: Two monosaccharides

Bond: Glycosidic Linkage

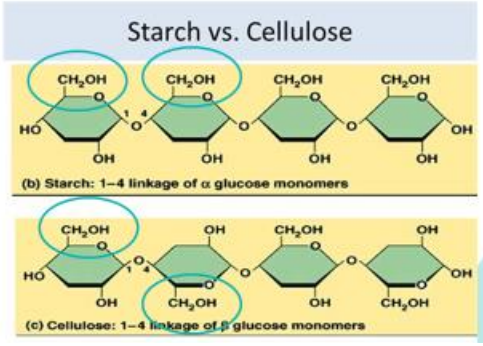
Examples: Sucrose, Lactose, Maltose

Structural:

- Cellulose: found in plant cell walls
- Chitin: found in fungi cell walls & exoskeleton of arthropods

Storage:

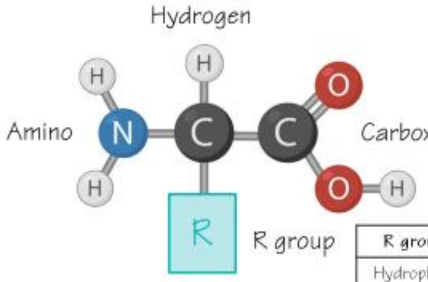
- Starch: found in plants
- Glycogen: found in animals



Proteins

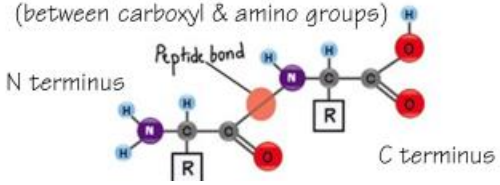
Composed of C, H, O, N, & S

Monomer: Amino Acid



R group	Fold
Hydrophilic	Exterior
Hydrophobic	Interior
Charged	Exterior

Bond: Peptide bond
(between carboxyl & amino groups)



Levels of Protein Structure:

Primary:

- Bond: peptide bonds between amino acids
- Structure: string of amino acids

Secondary:

- Bond: hydrogen bonds between backbone
- Structure: alpha helix or beta pleated sheet

Tertiary:

- Bond: ANY (hydrogen, covalent, ionic, …) between R groups
- Structure: final 3D structure

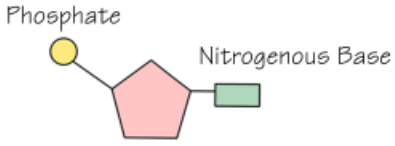
Quaternary :

- Bond: ANY (hydrogen, covalent, ionic, …) between R groups of different polypeptides

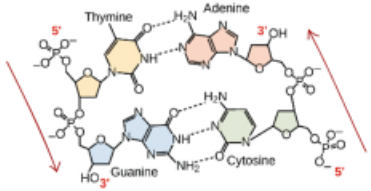
Nucleic Acids

Composed of C, H, O, N, & P

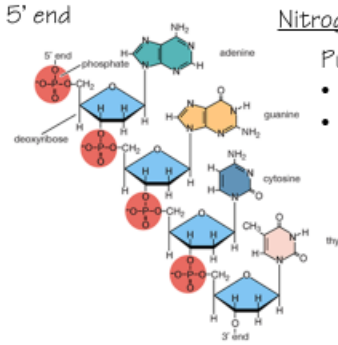
Monomer: Nucleotide



Bond: Phosphodiester linkage
(between phosphate and hydroxyl)



Directionality: 5' → 3'; antiparallel



Nitrogenous Bases

Purine:

- Double Ring
- A & G

Pyrimidine:

- Single Ring
- C, U, T

Base Pairing	H bonds
A & T	2
C & G	3

	DNA	RNA
Nitrogenous Bases	A, T, C, G	A, U, C, G
Sugar	Deoxyribose	Ribose
Strandedness	"double"	"single"

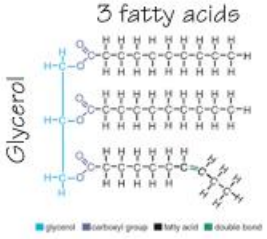
Lipids

Composed of C, H, O, & P (in phospholipids)

All of the lipids are NONPOLAR!!

Monomer: N/A

Fats



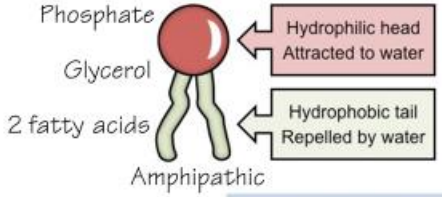
Saturated fatty acid

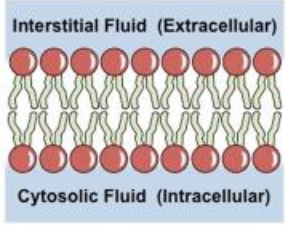
- ALL single bonds
- Each carbon is SATURATED by hydrogen

Unsaturated fatty acid

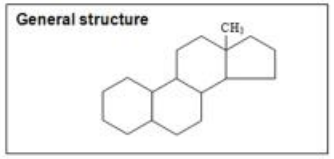
- At least one double bond
- Not all carbons are SATURATED by hydrogen

Phospholipids





Steroids



Four fused rings

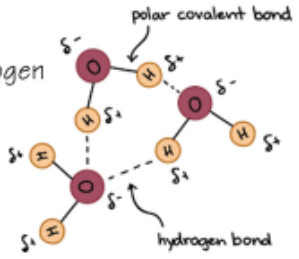
Ligand:

- Intracellular Reception

Polar

Polar covalent bonds between oxygen & hydrogen IN the water molecule

Hydrogen bonds between oxygen & hydrogen BETWEEN water molecules

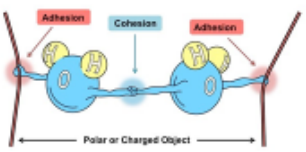


Universal Solvent

Partial negative oxygen binds with other polar molecules (partial positive end) & to positively charged ions (cations)

Partial positive hydrogen binds with other polar molecules (partial negative end) & to negatively charged ions (anions)

Cohesion/Adhesion



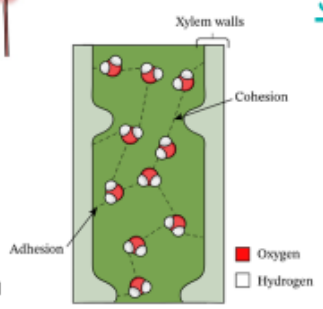
Cohesion:

- Water molecules attracted to other WATER molecules

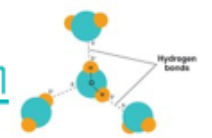
Adhesion:

- Water molecules attracted to other POLAR substances

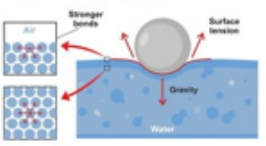
Together leads to Capillary Action



Surface Tension



Cohesion develops a "surface" based on the interaction of hydrogen bonds

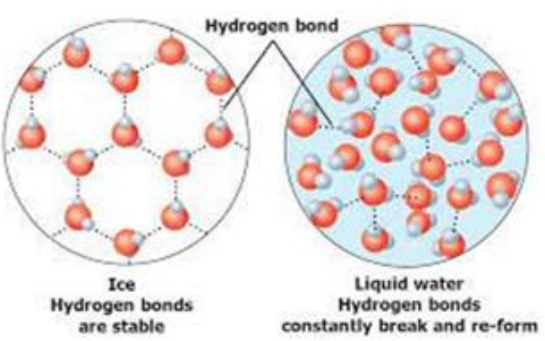


Allows you to skip rocks or water striders to walk on water

Less Dense when Solid

Hydrogen bonds inhibit compaction

Ice floats; temperature buffer



High Specific Heat

Water must absorb or release A LARGE amount of energy to change 1 gram of water by 1°C.

Evaporative Cooling

Release water on surface of organism to absorb heat energy from body (and break the bonds cooling down the organism)

Temperature Buffer

- Coastal Regions
- Body Temperature

pH

$pH = - \log [H^+]$

As the concentration of hydronium/hydrogen ion increases, the pH decreases

Unit 2:
The Cell

Nucleus

Structure:
- Double membrane (nuclear envelope) with pores

Functions:
- Stores genetic information (DNA)
- Synthesis of RNA
- Ribosome subunit assembly

Rough ER

Structure:
- Membrane studded with ribosomes attached to nuclear envelope

Functions:
- Site of membrane-bound protein and secreted protein synthesis
- Cell compartmentalization
- Mechanical support
- Role in intracellular transport

Smooth ER

Structure:
- Folded, tubelike structure (cisternae)

Functions:
- Detoxification
- Calcium Storage
- Lipid synthesis

Cellular Organelles

Structure:
- Membrane-bound structure composed on flattened sacs (cisternae)

Functions:
- Folding and chemical modification of synthesized proteins
- Packaging protein traffic

Golgi Complex

Structure:
- Composed of rRNA and protein
- Large & small subunits
- Types: bound or free (cytoplasmic)

Functions:
- Protein synthesis

Ribosomes

Mitochondria

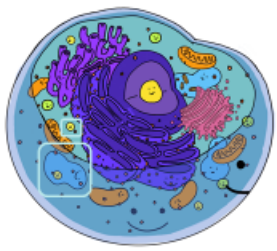
Structure:
- Double membrane (outer: smooth; inner: highly folded)

Functions:
- Site of oxidative phosphorylation (cristae/inner membrane)
- Site of Krebs Cycle (matrix)

Lysosome

Structure:
- membrane-enclosed sacs that contain hydrolytic enzymes

Functions:
- Intracellular digestion (recycle cell organic materials & programmed cell death: apoptosis)



Cellular Organelles

Structure:
- membrane-bound sac

Functions:
- storage and release of macromolecules and cellular waste products
- Central: water retention – turgor pressure
- Contractile: osmoregulation (protist)
- Food: phagocytosis, fuse with lysosome

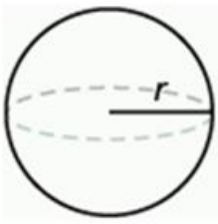
Vacuole

Structure:
- Double outer membrane (thylakoid sac stacked: grana and fluid: stroma)

Functions:
- Site of photosynthesis
- Thylakoid: Light Reactions
- Stroma: Calvin-Benson Cycle

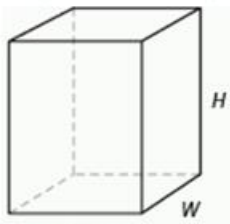
Chloroplast

Surface Area: Volume



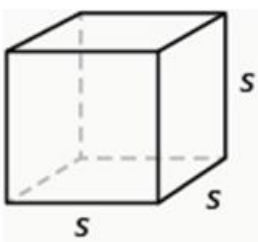
Volume: $V = \frac{4}{3}\pi r^3$

Surface Area: $S = 4\pi r^2$



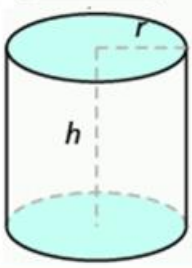
Volume: $V = LWH$

Surface Area: $S = 2LH + 2LW + 2WH$



Volume: $V = s^3$

Surface Area: $S = 6s^2$



Volume: $V = \pi r^2 h$ or $V = Bh$

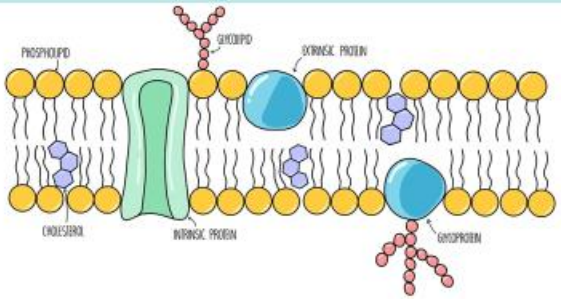
Surface Area: $S = 2\pi r^2 + 2\pi rh$

Smaller cells typically have a higher surface area-to-volume ratio and more efficient exchange of materials with the environment.

Plasma Membrane

Composed of:

- Phospholipids
- Membrane Proteins
- Glycolipids/Glycoproteins
- Cholesterol



Simple Diffusion

- Passive Transport, No NRG
- Down concentration gradient
- Small, Nonpolar
- No transport protein needed
- Examples: CO_2, O_2, N_2, steroids
- Small amount of H_2O leak through membrane

Facilitated Diffusion

- Passive Transport, No NRG
- Down concentration gradient
- Small Molecules
- Requires transport protein
  Channel vs. Carrier protein
- Example: water, Na^+, K^+, Ca^+

Active Transport

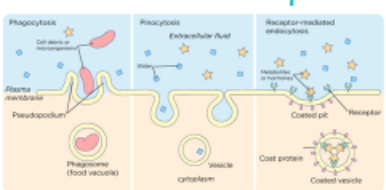
- Requires input of NRG
- Against concentration gradient
- Requires transport protein (carrier protein)
- Example: Na^+, K^+, Ca^+, H^+

Membrane Transport

Endocytosis

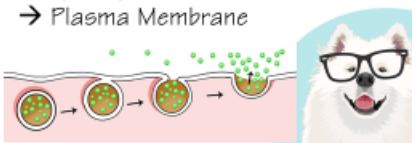
- Import of materials
- Phagocytosis: Cellular Eating
- Pinocytosis: Cellular Drinking
- Receptor-Mediated: Endocytosis

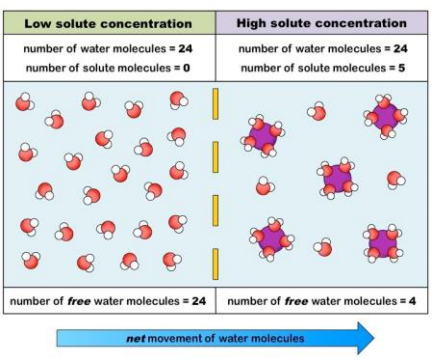
Bulk Transport

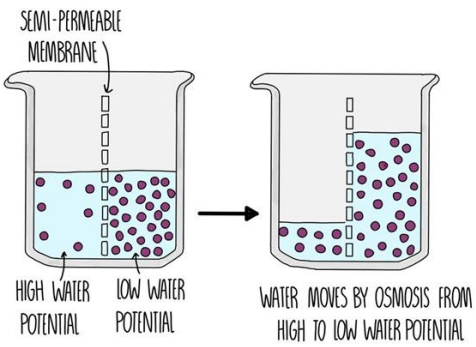


Exocytosis

- Export of materials
- Rough ER (synthesize) → Golgi complex (package/modification) → Plasma Membrane







Hypertonic Solution

- HIGH solute concentration
- LOW free water concentration

- GAINS water from hypotonic solution

Isotonic Solution

- EQUAL solute concentration (as other solution)
- EQUAL free water concentration (as other solution)

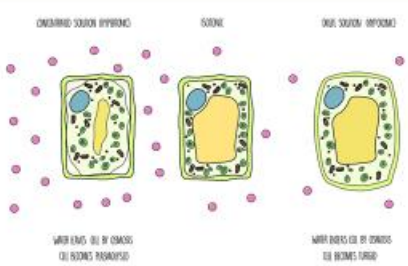
- Equal water movement into and out of solution

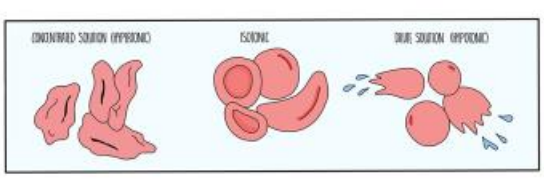
Hypotonic Solution

- LOW solute concentration
- HIGH free water concentration

- LOSES water to hypertonic solution

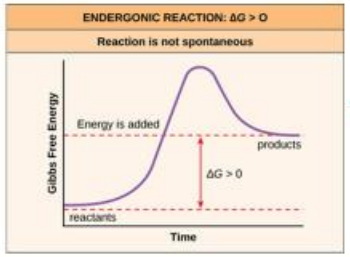
Osmosis





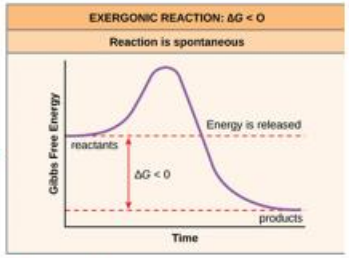
Unit 3:
Cellular Energetics

Endergonic Reaction



- Not spontaneous
- ABSORB energy
- Example: ADP + P_i → ATP

Exergonic Reaction



- Spontaneous
- RELEASE energy
- Example: ATP → ADP + P_i

Gibbs Free Energy & Reactions

What is Gibbs Free Energy?

- Energy available to do work

$$\Delta G = \Delta H - T\Delta S$$

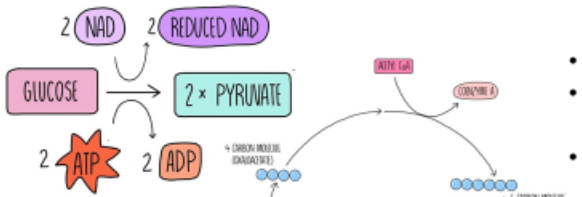
- ΔG: Change in Gibbs Free Energy
- ΔH: Change in Enthalpy
- T: Temperature (K)
- ΔS: Change in Entropy

$$\Delta G = \Delta G_f - \Delta G_i$$

Cellular Respiration

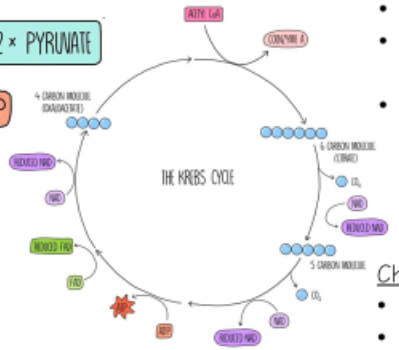
Glycolysis

- Location: Cytosol
- Starting Material:
  - Glucose
- Products:
  - 2 Pyruvate
  - 2 NADH
  - 2 ATP



Krebs Cycle

- Location: Mitochondrial Matrix
- Staring Material:
  - Acetyl CoA
- Products:
  - 2 CO_2
  - 3 NADH
  - 1 $FADH_2$
  - 1 ATP



Oxidative Phosphorylation

- Location: Mitochondrial Cristae
- Starting Material:
  - NADH/$FADH_2$ (electrons)
- Product:
  - ATPs
- Two Parts:

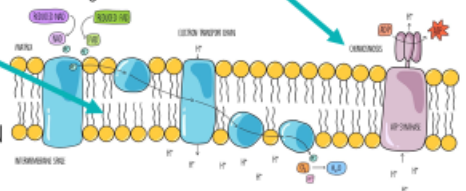
Electron Transport Chain & Chemiosmosis

Chemiosmosis

- ATP Synthase uses proton gradient
- Synthesizes ATP

Electron Transport Chain

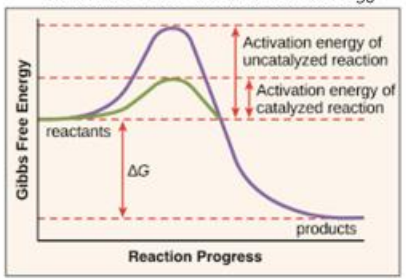
- Protons pumped into IM space
- Generates proton gradient
- Final electron acceptor: OXYGEN



Enzymes

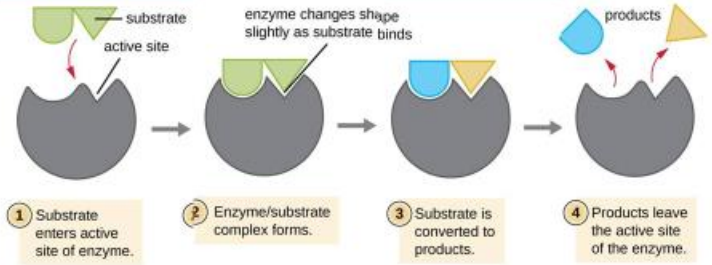
Functions

- Biological catalyst
- Speeds up chemical reactions
- Reduces the activation energy



Important Notes:

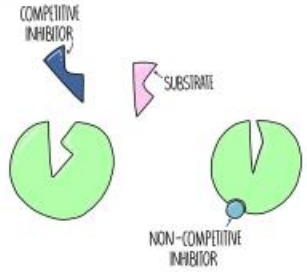
- Enzymes are PROTEINS
- Are NOT consumed by the reaction
- Have no effect on the change in Gibbs Free Energy



Inhibitors

Competitive:
- Binds to active site

Noncompetitive:
- Binds to allosteric site



Denaturation

Environmental Temperatures
pH
(outside of optimal range)
Salinity

Photosynthesis

Light Reactions

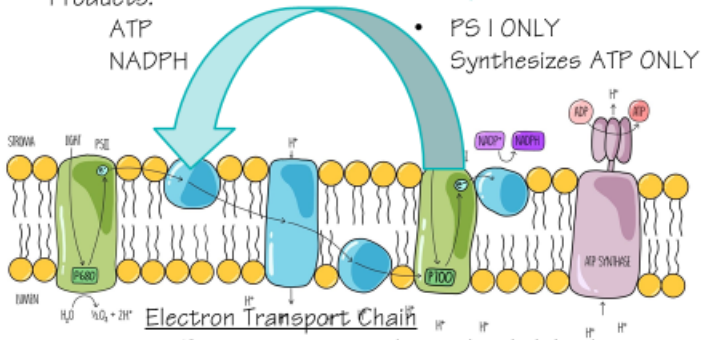
- Location: Thylakoid Membrane
- Starting Material:
  - Water (electrons)
  - Photons (energy)
- Products:
  - ATP
  - NADPH

Linear Electron Flow

- PS I & PS II
- Synthesizes ATP & NADPH

Cyclic Electron Flow

- PS I ONLY
- Synthesizes ATP ONLY

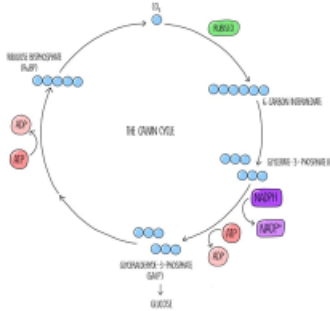


Electron Transport Chain

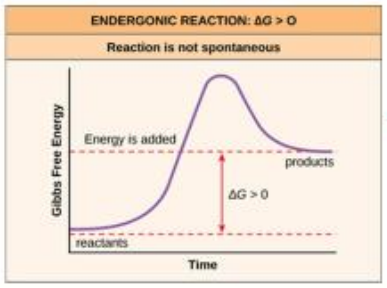
- Protons are pumped into the thylakoid space

Calvin Cycle

- Location: Stroma
- Starting Material:
  - 3 CO_2
  - 9 ATP
  - 6 NADPH
- Products:
  - G3P



Endergonic Reaction



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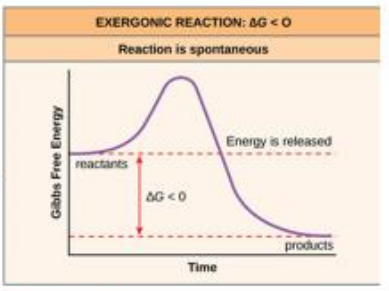


- Spontaneous
- RELEASE energy
- Example: ATP → ADP + P_i

Exergonic Reaction

Gibbs Free Energy & Reactions

Temperature (K)

Change in Gibbs Free Energy — $\Delta G = \Delta H - T\Delta S$ — Change in Entropy

Change in Enthalpy

What is Gibbs Free Energy?

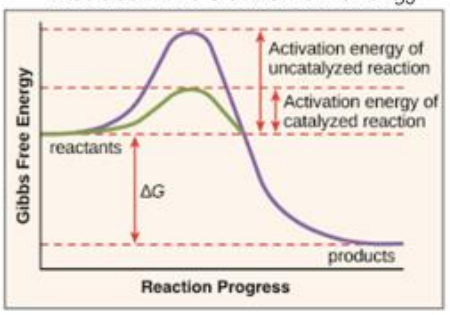
- Energy available to do work

$$\Delta G = \Delta G_f - \Delta G_i$$

Enzymes

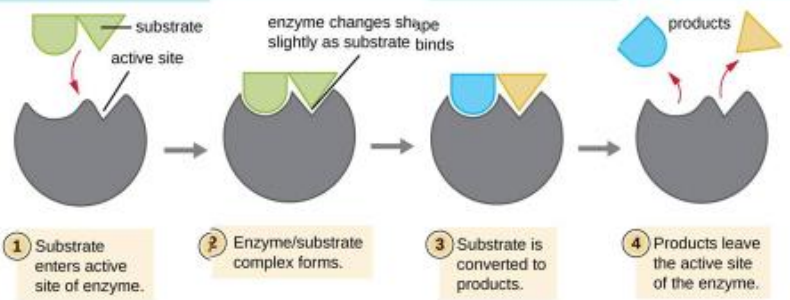
Functions

- Biological catalyst
- Speeds up chemical reactions
- Reduces the activation energy



Important Notes:

- Enzymes are PROTEINS
- Are NOT consumed by the reaction
- Have no effect on the change in Gibbs Free Energy



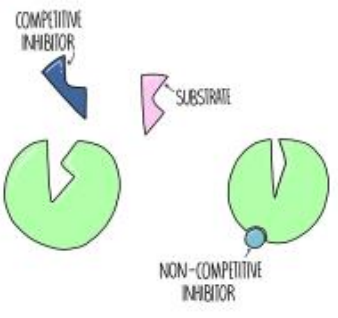
Inhibitors

Competitive:

- Binds to active site

Noncompetitive:

- Binds to allosteric site



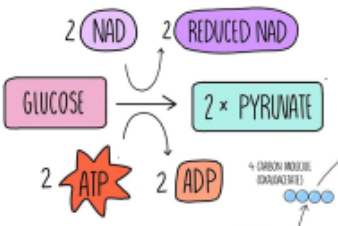
Denaturation

Environmental Temperatures
pH
(outside of optimal range)
Salinity

Cellular Respiration

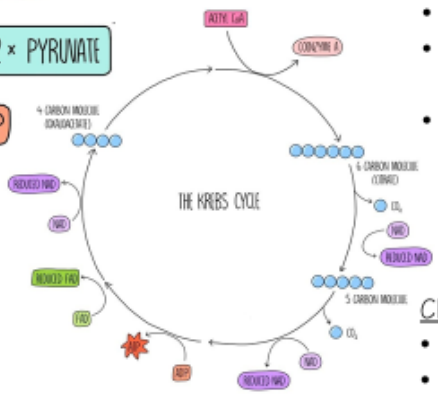
Glycolysis

- Location: Cytosol
- Starting Material:
  - Glucose
- Products:
  - 2 Pyruvate
  - 2 NADH
  - 2 ATP



Krebs Cycle

- Location: Mitochondrial Matrix
- Staring Material:
  - Acetyl CoA
- Products:
  - 2 CO_2
  - 3 NADH
  - 1 $FADH_2$
  - 1 ATP



Oxidative Phosphorylation

- Location: Mitochondrial Cristae
- Starting Material:
  - NADH/$FADH_2$ (electrons)
- Product:
  - ATPs
- Two Parts:

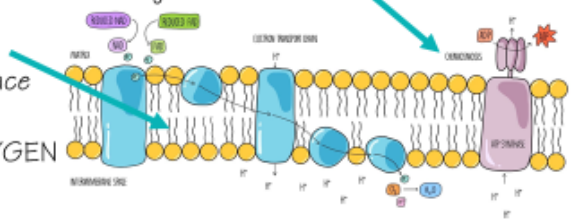
Electron Transport Chain & Chemiosmosis

<u>Electron Transport Chain</u>

- Protons pumped into IM space
- Generates proton gradient
- Final electron acceptor: OXYGEN

<u>Chemiosmosis</u>

- ATP Synthase uses proton gradient
- Synthesizes ATP



Photosynthesis

Light Reactions

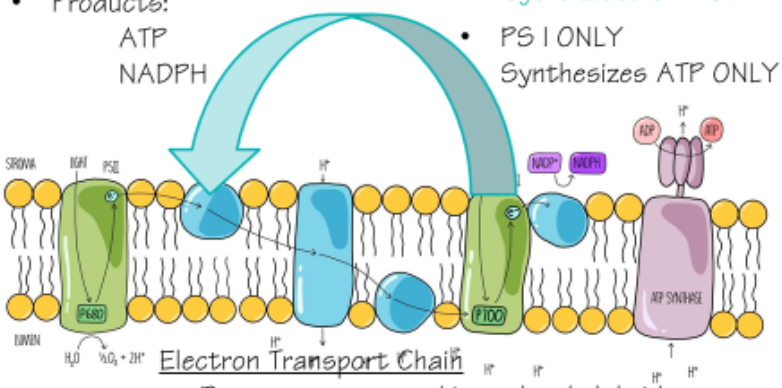
- Location: Thylakoid Membrane
- Starting Material:
  - Water (electrons)
  - Photons (energy)
- Products:
  - ATP
  - NADPH

Linear Electron Flow

- PS I & PS II
- Synthesizes ATP & NADPH

Cyclic Electron Flow

- PS I ONLY
- Synthesizes ATP ONLY



<u>Electron Transport Chain</u>

- Protons are pumped into the thylakoid space

Calvin Cycle

- Location: Stroma
- Starting Material:
  - 3 CO_2
  - 9 ATP
  - 6 NADPH
- Products:
  - G3P

Unit 4/5:
Cellular Communication & Cell Cycle

Cellular Communication

Reception

Ligand (signaling molecule) binds to receptor
Causes confirmational shape change
Ex: G protein coupled receptor

Steroid Hormone

Release: Simple Diffusion
Receptor: Intracellular
Example: Testosterone, Estrogen

Protein Hormone

Release: Exocytosis
Receptor: Extracellular
Example: Insulin

Transduction

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals

Phosphorylation Cascade

Protein Kinase
Phosphorylate relay molecules

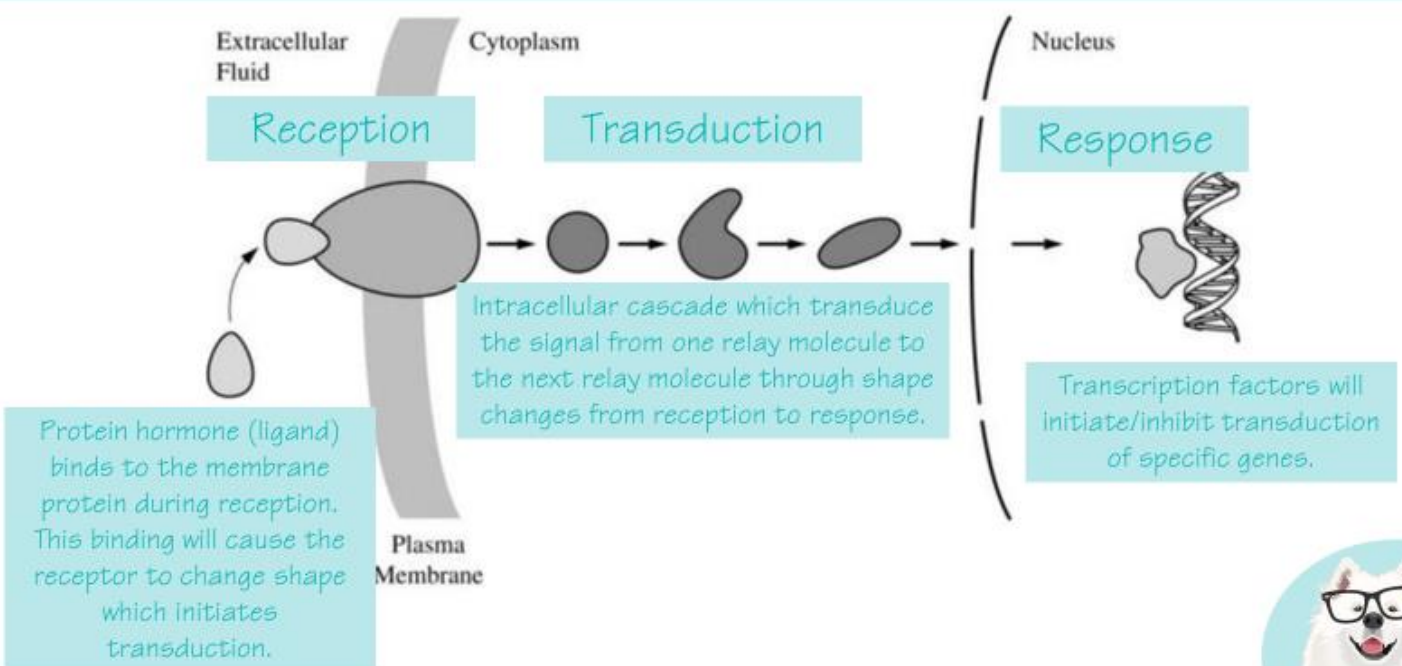
Secondary Messengers

Ca^{2+}
cAMP

Response

cell growth
secretion of molecules
gene expression
apoptosis

Cellular Communication



	Parent Cell Ploidy	Rounds of DNA Replication	Rounds of Nuclear Division	Daughter Cell Ploidy	Number of Daughter Cells
Mitosis	Diploid	1	1	Diploid	2
Meiosis	Diploid	1	2	Haploid	4

Mitosis vs. Meiosis

	Compare to Parent Cell	Crossing Over	Independent Assortment
Mitosis	Identical	Does not occur	Does not occur
Meiosis	Genetically Distinct	Occurs in Prophase I	Occurs in Metaphase I

Cell Cycle

G_1

The cell grows through all the different phases of interphase

Duplication of cell organelles
Synthesis of proteins, RNA, and building blocks

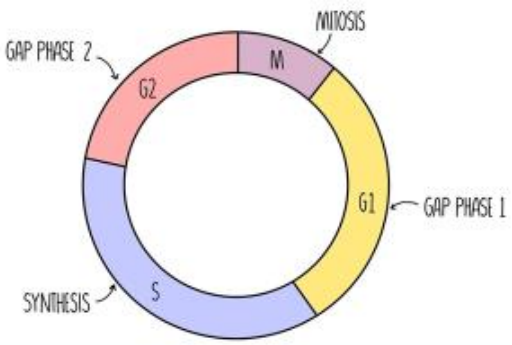
S

Replication of genetic material and centrosomes

G_2

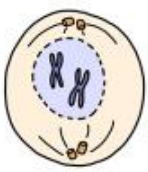
Synthesis of proteins and RNA
Makes organelles
Reorganizes cellular contents

Interphase



M

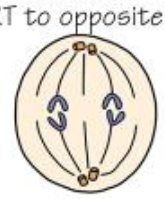
PREPARE to divide



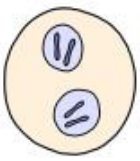
PROPHASE

Sister Chromatids pulled APART to opposite poles

METAPHASE
Sister Chromatids line up in the MIDDLE



ANAPHASE



TELOPHASE
TWO new nuclei are formed

Cytokinesis

Division of the cytoplasm

CYTOKINESIS

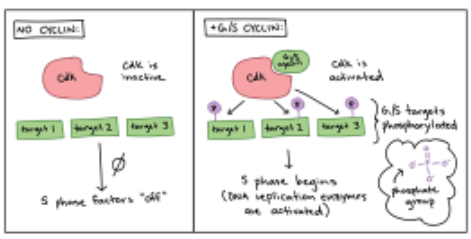
Checkpoints

G_1

During G_1, determines whether to complete the cell cycle

- Growth factor
- Adequate reserves
- Check for DNA damage

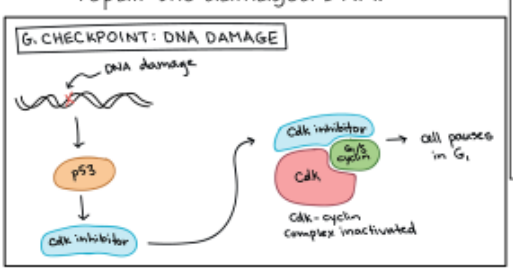
If do not pass, enter G_0 (nondividing state)



G_2

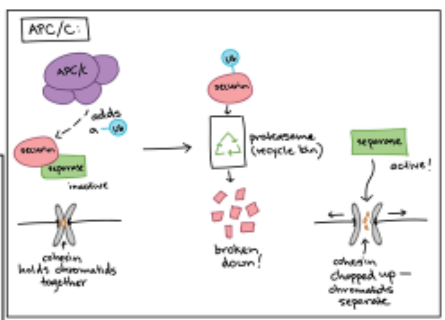
Check all DNA replicated and not damaged.

If detect problems with DNA, the cell cycle is halted, to complete DNA replication or repair the damaged DNA.



M

Check sister chromatids attached to the spindle microtubules



Prophase I

Chromatin condenses
Sister chromatids/ homologous chromosomes align
CROSSING OVER

Metaphase I

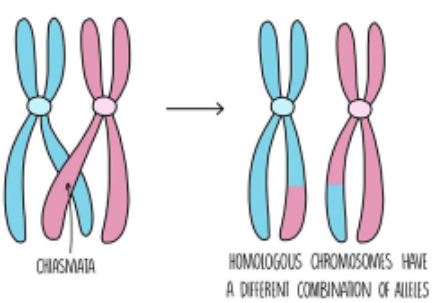
HOMOLOGOUS CHROMOSOMES align on the metaphase plate
INDEPENDENT ASSORTMENT

Anaphase I

HOMOLOGOUS CHROMOSOMES separate to opposite poles

Telophase I

Nuclear envelope forms around the HAPLOID daughter cells



Meiosis

Meiosis I – Homologous Chromosomes
Meiosis II – Sister Chromatids

Chromatin condenses
Sister chromatids align

SISTER CHROMATIDS align on the metaphase plate

SISTER CHROMATIDS separate to opposite poles

Nuclear envelope forms around the HAPLOID daughter cells

Prophase II

Metaphase II

Anaphase II

Telophase I

Unit 5/6:
Heredity & Molecular Genetics

Inheritance Patterns

Complete Dominance

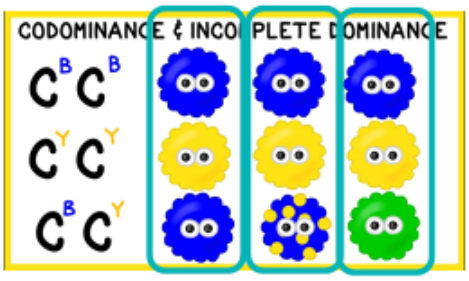
Homozygous dominant and heterozygous look the same

Codominance

Heterozygous is both dominant traits in organism

Incomplete Dominance

Heterozygous is a blend between the two dominant traits



	Y	y
Y	YY	Yy
y	Yy	yy

Yellow: ¾
Green: ¼

	R	r
R	RR	Rr
r	Rr	rr

Round: ¾
Wrinkled: ¼

Yellow & Round: ¾ x ¾ = 9/16
Yellow & Wrinkled: ¾ x ¼ = 3/16
Green & Round: ¼ x ¾ = 3/16
Green & Wrinkled: ¼ x ¼ = 1/16

Monohybrid

Heterozygous for ONE trait

Complete Dominance:
3:1 ratio
Incomplete or Codominance:
1:2:1

Dihybrid

Heterozygous for TWO traits

Complete Dominance:
9:3:3:1 ratio
Incomplete or Codominance:
6:3:3:2:1:1

Inheritance Patterns

Autosomal Inheritance

Allele is located on an autosome (non-sex chromosome)

Sex-Linked

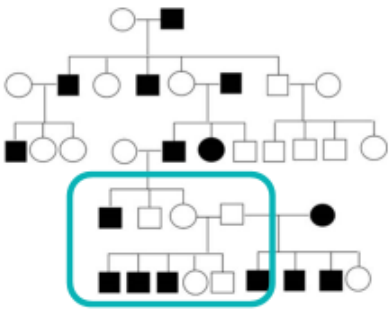
Allele is located on a sex chromosome

Maternal Inheritance

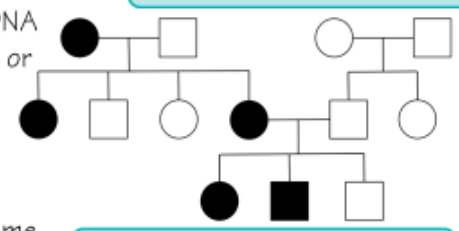
Allele is located on the DNA found in a mitochondrial or chloroplast

Linked Genes

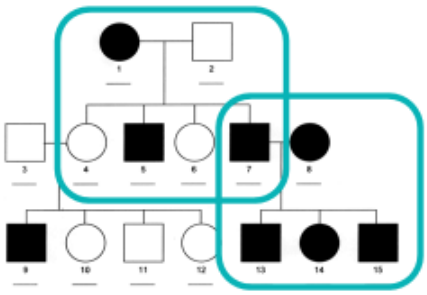
Genes located on the same chromosome closely together



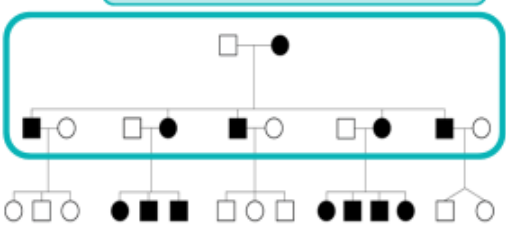
Autosomal Recessive



Autosomal Dominant



Sex-Linked Recessive



Maternal Inheritance

Central Dogma

replication

DNA → RNA → Polypeptide

transcription

translation

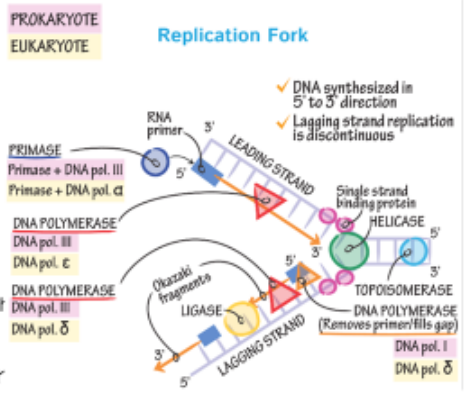
Retroviruses will use reverse transcriptase to synthesize DNA from their RNA genome

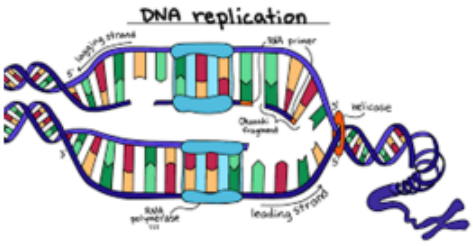
Replication

Location
- Eukaryotes: nucleus
- Prokaryotes: nucleoid

Structure
- Eukaryotes: multiple linear
- Prokaryotes: single circular

Important Enzymes
- Helicase unwinds the DNA strands
- Topoisomerase relaxes supercoiling in front of the replication fork.
- Primase synthesizes the RNA primer (DNA polymerase requires RNA primers to initiate DNA synthesis).
- DNA polymerase synthesizes new strands of DNA continuously on the leading strand and discontinuously on the lagging strand.
- Ligase joins the fragments on the lagging strand.





Reminders about DNA:
- DNA made up of:
  - nitrogenous base (A, T, C, G)
  - pentose sugar (deoxyribose)
  - phosphate group
- Purine (A/G) have a double ring structure
- Pyrimidine (C/T) have a single ring structure
- Base Pair Rules
  - A & T with 2 H bonds
  - C & G with 3 H bonds
- Sideedness
  - 5' end: phosphate
  - 3' end: hydroxyl group
- Directionality
  - Read 3' to 5'
  - Synthesize 5' to 3'

(Remember ANTIPARALLEL)

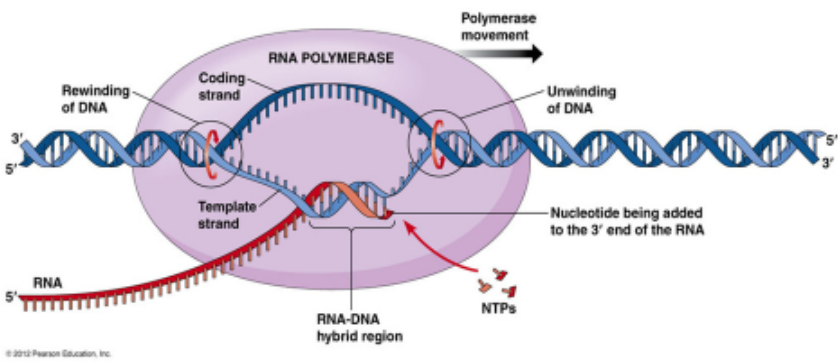
Transcription

Template Strand
(noncoding strand,
minus strand, or antisense strand)

Location
- Eukaryotes: nucleus
- Prokaryotes: nucleoid (cytosol)

Reminders about RNA:
- DNA made up of:
  - nitrogenous base (A, U, C, G)
  - pentose sugar (ribose)
  - phosphate group
- Purine (A/G) have a double ring structure
- Pyrimidine (C/U) have a single ring structure
- Base Pair Rules
  - A & T(DNA)/U(RNA) with 2 H bonds
  - C & G with 3 H bonds
- Sidenesses
  - 5' end: phosphate
  - 3' end: hydroxyl group
- Directionality
  - Read 3' to 5'
  - Synthesize 5' to 3'

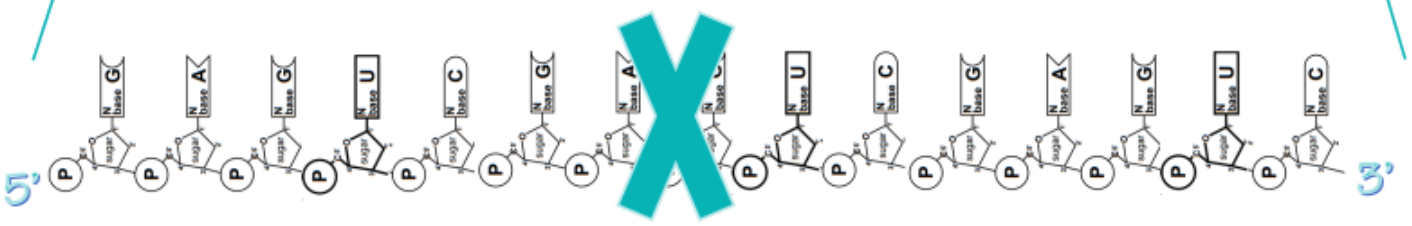
Important Enzyme & Components
- RNA polymerase synthesizes mRNA molecules in the 5' to 3' direction by reading the template DNA strand in the 3' to 5' direction.
- Promoter: site where RNA polymerase binds to start transcription
- Transcription Factors: activators/inhibitors to turn on/off gene expression



Post-Transcriptional Modifications

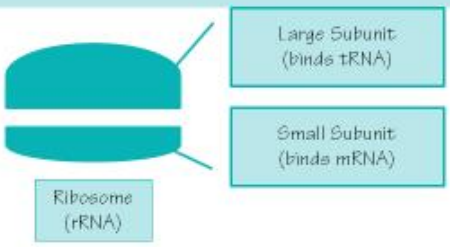
5' Guanine Cap
- Signals the "start" of the mRNA transcript for ribosome to bind
- Facilitates export from nucleus

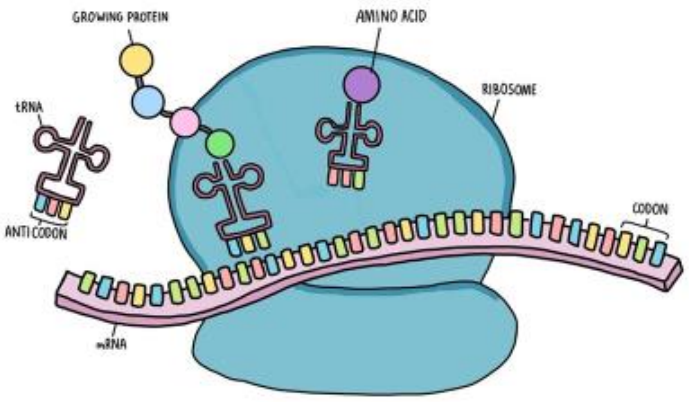
Poly-A Tail
- Inhibits degradation from hydrolytic enzymes in cytosol



Splicing
- Removal of introns from pre-mRNA transcript

Translation





Location
- Eukaryotes: cytosol/rough ER
- Prokaryotes: cytosol

Steps of Translation
- Initiation: start codon (AUG)
- Elongation: base pair between tRNA/mRNA with amino acid added
- Termination: stop codon (UAG, UAA, UGA)

Mutations

Point Mutations

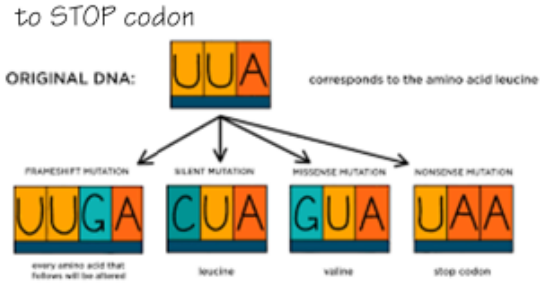
Mutation at one nucleotide base pair

Silent
no change in amino acid (AA)

Missense
change from one AA to another AA

Nonsense
change from AA to STOP codon

Frameshift
insertion/deletion of 1 or 2 nucleotide base pairs shifts the reading frame for codons



Chromosomal Mutations

Rearrangement of chromosome parts or changes in chromosome numbers

Rearrangement
Insertion
Deletion
Duplication
Inversion
Translocation

Changes in Chromosome Number
Nondisjunction
Polyploidy

Operons

Gene Regulation found in prokaryotes

Promoter	Operator	Genes
Site when RNA polymerase binds	Site when repressor binds	DNA

Repressible Operon

Example: Trp Operon
synthesizes tryptophan

Starts: ON
Repressor: INACTIVE

If trp is present...
Trp binds to repressor to ACTIVATE
Repressor binds to operator to turn the operon OFF

Inducible Operon

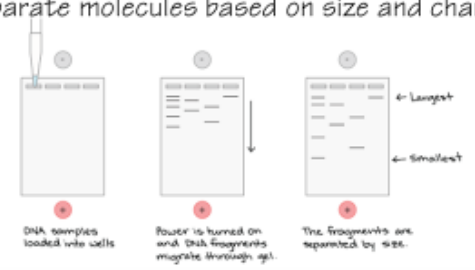
Example: Lac Operon
synthesizes enzymes to break down lactose

Starts: OFF
Repressor: ACTIVE

If lactose is present...
lactose binds to repressor to INACTIVATE
Repressor no longer binds to operator to turn the operon ON

Gel Electrophoresis

Separate molecules based on size and charge

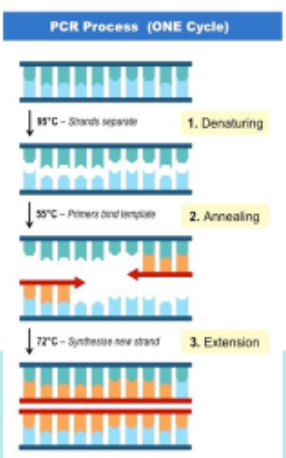


Polymerase Chain Reaction (PCR)

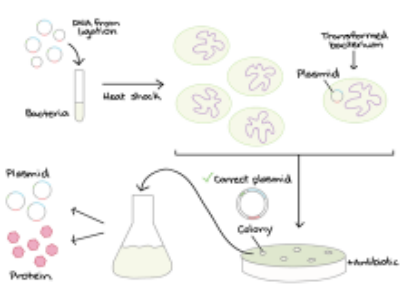
Makes multiple copies of DNA fragments

Steps

1. Heating
2. Cooling
3. Annealing



BioTechnology

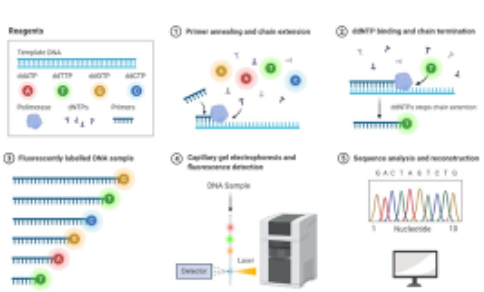


Bacterial Transformation

Introduce genetic material (plasmid) to bacteria

DNA Sequencing

Use radioactive nucleotides to determine the sequence of a DNA strand



Unit 7:
Natural Selection

Natural Selection

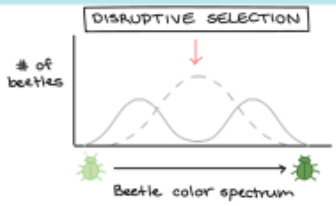
- Developed by Charles Darwin
- Establish due to variation in the population and competition for resources
- Organisms with more favorable trait, more likely to survive and produce more offspring to pass on their traits to next generation
- Examples:
  - Peppered Moths
  - Antibiotic Resistance

Artificial Selection

- Organisms with certain traits are bred until population has that trait
- Humans affect variation in the population
- Examples:
  - Dog Breeds
  - Corn from Maize
  - Wild Mustard → Cauliflower, Broccoli, Cabbage, Kale, & Kohlrabi

Beware of Lamarckian statements

Selection

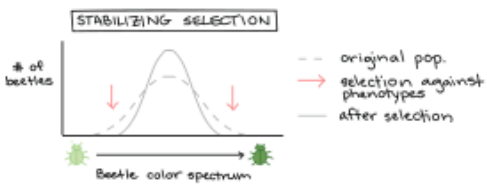


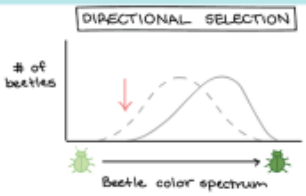
Disruptive Selection

Selection for the two extreme phenotypes
Selection against the intermediate phenotype

Stabilizing Selection

Selection for the intermediate phenotype
Selection against the two extreme phenotypes





Directional Selection

Selection for an extreme phenotype
Selection against the other phenotypes

Hardy-Weinberg

"Five Fingers of Evolution"

1. Extremely LARGE population size
2. Random mating
3. No mutations
4. No gene flow (immigration/emigration)
5. No natural selection

Genetic Drift

Founder's Effect

- Small population is isolated from original population

Bottleneck Effect

- Population is reduced by a natural disaster (fire, flood, etc) where there was no selection based on traits

These reduce the population size and could decrease genetic diversity making them more susceptible to environmental impact or could fix harmful alleles

Equations

Variables

p = frequency of the dominant allele
q = frequency of the recessive allele
p2 = frequency of homozygous dominant
2pq = frequency of the heterozygous
q^2 = frequency of the homozygous recessive

Hardy-Weinberg Equilibrium

$p + q = 1$
$p2 + 2pq + q^2 = 1$

p	q	p^2	2pq	q^2

Counting Alleles

$$p = \frac{2AA+Aa}{2 \times \#\ individuals}$$

$$q = \frac{2aa+Aa}{2 \times \#\ individuals}$$

p^2 = #AA/total
2pq = #Aa/total
q^2 = #aa/total

Did the population evolve?

If the allele/genotypic frequency changes, the population has evolved.

Example Problems

The garden at your school always has red, pink, and white snapdragons. There are 200 red flowers, 300 pink flowers, and 500 white flowers. Determine the allele frequency of the flower allele color.

Red (p^2) = 200/1000 = 0.2
Pink (2pq) = 300/1000 = 0.3
White (q^2) = 500/1000 = 0.5

$$p = \frac{2(200)+300}{2(1000)} = \frac{700}{2000} = 0.35$$

$$q = \frac{2(500)+300}{2(1000)} = \frac{1300}{2000} = 0.65$$

p	q	p^2	2pq	q^2
0.19	0.81	0.04	0.31	0.65

Tip: Always start with q^2 for H-W problems

Phylogeny

Evidence of Evolution

Biochemical
DNA or protein
Comparison of the number of differences

Morphological
Homologous structures: similar structures due to common ancestry
Ex: Bat wing and Cat arm

Ancestral/Derived Traits: characteristics derived from ancestor or from descendants

BEWARE: Analogous structures are due to convergent evolution

Biogeography
distribution of species and ecosystems in geographic space & through geological time

Phylogenetic Tree

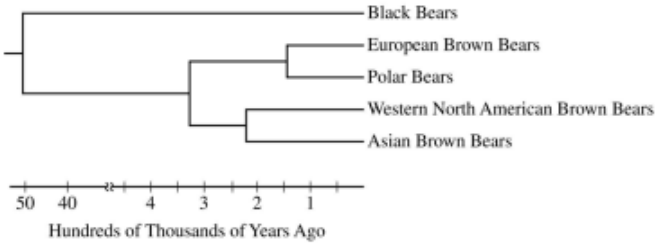
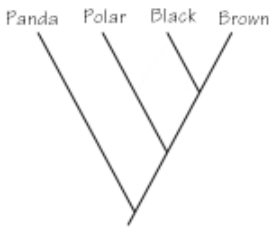


Figure 1. Phylogenetic tree representing the evolutionary relatedness among bear populations based on mitochondrial DNA sequence comparisons

Cladogram

TABLE 1. AMINO ACID DIFFERENCES IN THE LYST PROTEIN AMONG BEAR SPECIES

	Panda	Black	Brown	Polar
Panda	–			
Black	33	–		
Brown	34	1	–	
Polar	40	7	8	–



Prezygotic

Before zygote is created

Behavioral
Two organisms have different mating rituals (dance, song, etc)

Temporal
Two organisms mate at different times (day, month, year, etc.)

Geographic
Two organisms are separated by a geographical barrier

Habitat/Ecological
Two organisms mate in different ecological environments

Mechanical
Two organisms are incompatible anatomically

Gametic
Two gametes are unable to fuse

Biological Species Concept:
two organisms are of the same species if they can INTERBREED and produce FERTILE, VIABLE offspring

Postzygotic

After zygote is created

Reduced Hybrid Viability
Hybrid is not healthy/viable

Reduced Hybrid Fertiliity
Hybrid is not fertile

Hybrid breakdown
First generation hybrid is ok
But second and more generations the hybrid starts decreasing viability and fertility

Speciation

Creation of new species

Sympatric

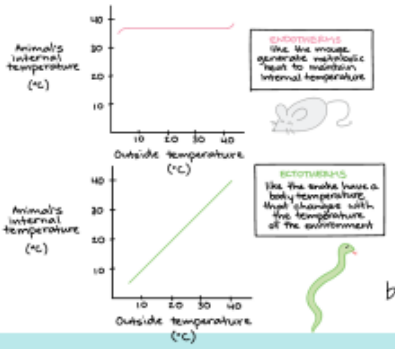
New species from a surviving ancestral species while both continue to inhabit the same geographic region

Habitat isolation, Behavioral isolation, Sexual Selection, Polyploidy

Allopatric

Occurs when biological populations of the same species become isolated due to geographical changes

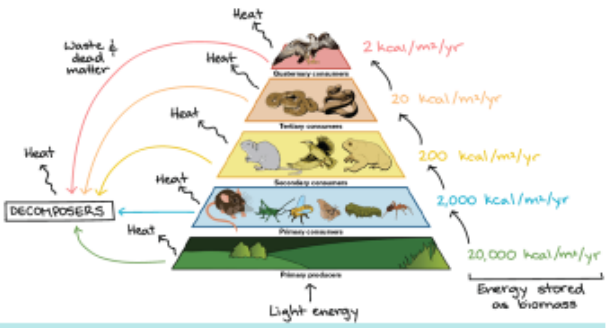
Unit 8: Ecology



Body Temperature

Endotherm
Maintains body temperature through metabolism

Ectotherm
Maintains body temperature through behaviors (bask in sunlight, aggregation)



Energy Flow

Organisms use energy to maintain, organize, grow and reproduce

Trophic Structure

Autotroph
Capture energy from physical or chemical source
- Photosynthetic - sunlight
- Chemosynthetic - small inorganic molecules in environment (sometimes without oxygen)

energy

Heterotroph
Capture energy present in carbon compounds produced by other organisms

Metabolize carbohydrates, lipids, and proteins (notice: not nucleic acids) for energy through hydrolysis

Changes in Availability

Change in Energy Resource
Affects number and size of trophic levels

Change in Producer Level
Affects number and size of trophic levels

Animal Behavior

Communication

Signaling allows for changes in behaviors of organisms to allow for differential reproductive success

Types of Communication:
- Visual
- Auditory
- Electrical
- Chemical

Function:
- Indicate Dominance
- Foraging (Finding Food)
- Establish Territory
- Ensure Reproductive Success

Altruistic Behaviors

Reduces individual fitness but increases inclusive fitness.

Intersexual Selection

Reproductive behaviors to attract a mate
Individuals of one sex choose members of the opposite sex

Examples
- Blue Footed Booby – mating dance (visual)
- Frogs – croaking (auditory)
- Pheromones – (chemical)

Intrasexual Selection

Reproductive behaviors to indicate dominance and compete for access to mates

Examples
- Deer: antler size
- Horned Beetles: strength and size of "horn"

Population Ecology

Exponential Growth

Unlimited growth of population

$r = b - d$

rate of increase = birth rate – death rate

$$\frac{dN}{dt} = rN$$

Example:

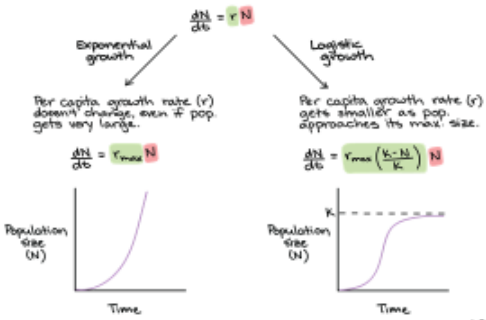
If a population has 400 individuals with a rate of increase of 0.5, how many individuals after 2 generations?

$$\frac{dN}{dt} = (0.5)(400) = 200$$

After generation 1: 600

$$\frac{dN}{dt} = (0.5)(600) = 300$$

After generation 2: 900



<u>Density Dependent Factors</u>

Factors that intensifies as population increases

Ex: competition, predation, disease

<u>Density Independent Factors</u>

Factors that affect all individuals regardless of size, population, density

Ex: natural disasters, human activity

Logistic Growth

Population size limited by carrying capacity

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right) = 200$$

Example:

If a population has 400 individuals with a rate of increase of 0.5 and a carrying capacity of 500, how many individuals after 2 generations?

$$\frac{dN}{dt} = (0.5)(400)\left(\frac{800-400}{800}\right) = 100$$

After generation 1: 500

$$\frac{dN}{dt} = (0.5)(500)\left(\frac{800-500}{800}\right) = 75$$

After generation 1: 575

Species Diversity

Simpson's Index: measures biodiversity (species composition and diversity)

$$Simpson\ Diversity = 1 - \sum\left(\frac{n}{N}\right)^2$$

n = total number of organisms of particular species

N = total of organisms of all species

Species	Number
Sloth	18
Penguin	13
Total	31

$$1 - \left(\left(\frac{18}{31}\right)^2 + \left(\frac{13}{31}\right)^2\right)$$

$$1 - ((0.58)^2 + (0.42)^2)$$

$$1 - (0.34 + 0.18)$$

$$1 - 0.52 = 0.48$$

Keystone Species

Organism with disproportionate to their abundance effect, and when they are removed from the ecosystem, the ecosystem often collapses.

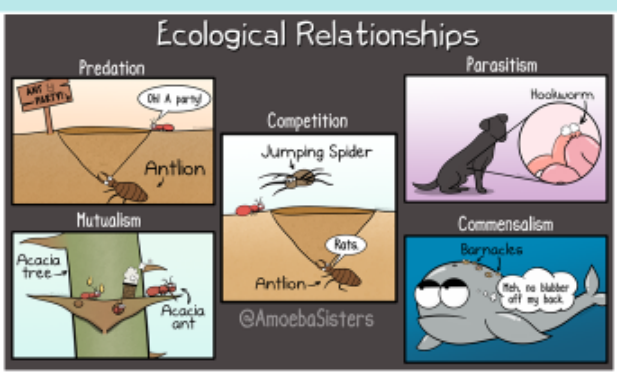
Examples: Sea Otter

Community Ecology

Interactions

Predator/Prey (+/-)
Herbivory (+/-)
Competition (-/-)

Symbiosis
Parasitism (+/-)
Mutualism (+/+)
Commensalism (+/0)



Invasive Species

Organism that is not indigenous, or native, to a particular area with no natural predators and unlimited resources

Examples:

- Zebra Mussel: clogging water way
- Lionfish: venomous species