MARCO LEARNING

AP Biology Insta-Review

Big Idea 4: Systems Interactions

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AP Biology students are penguins because they are Dressed for Success!
You are now an AP Bio Penguin!

Today's Plan:

Unit 1: Chemistry of Life

Topic 1.1: Structure of Water and Hydrogen Bonding

Topic 1.3: Introduction to Biological Molecules

Topic 1.4: Properties of Biological Molecules

Topic 1.5: Structure & Function of Biological Molecules

Unit 2: Cell Structure & Function

Topic 2.1 Cell Structure: Subcellular Components

Topic 2.2: Cell Structure & Function

Unit 3: Cellular Energetics

Topic 3.7: Fitness

Today’s Plan:

Unit 5: Heredity

Topic 5.5: Environmental Effects on Phenotype

Topic 5.6: Chromosomal Inheritance

Unit 7: Natural Selection

Topic 7.12: Variations in Populations

Topic 7.13: Origin of Life on Earth

Unit 8: Ecology

Topic 8.3: Population Ecology

Topic 8.4: Effect of Density of Populations

Topic 8.6: Biodiversity

Topic 8.7: Disruption to Ecosystem

1.1 Structure of H_2O & Hydrogen Bonding

living systems depend on properties of water that result from its polarity and hydrogen bonding

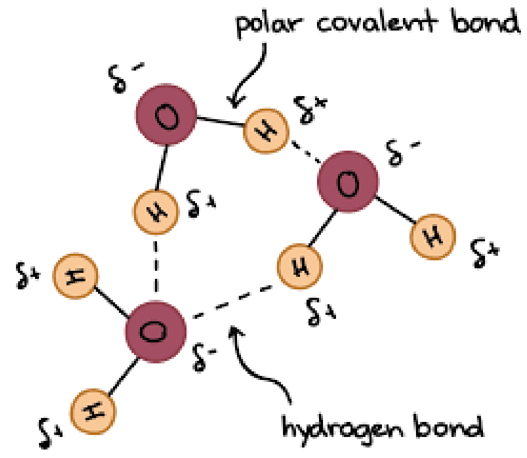
H bonding in Macromolecules

Proteins:

- secondary structure (backbone)
- tertiary/quarternary structure (R groups)

Nucleic Acids:

- between nitrogenous bases



Polar

Polar covalent bonds between oxygen & hydrogen IN the water molecule

Universal Solvent

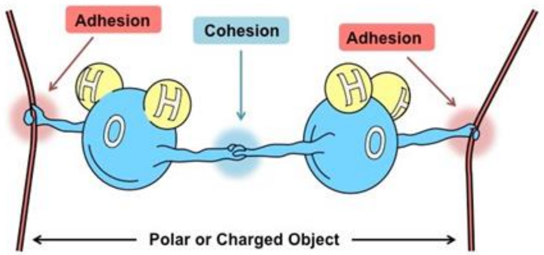
- Partial negative oxygen binds with other polar molecules (partial positive end) & to positively charged ions (cations)
- Partial positive hydrogen binds with other polar molecules (partial negative end) & to negatively charged ions (anions)

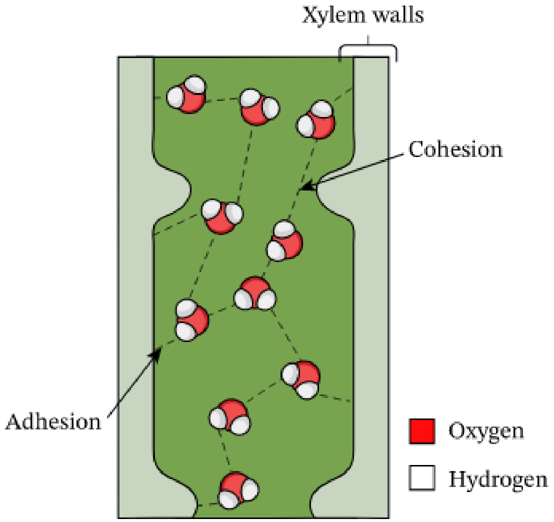
Cohesion

Water molecules attracted to other **WATER** molecules

Adhesion

Water molecules attracted to other **POLAR** substances



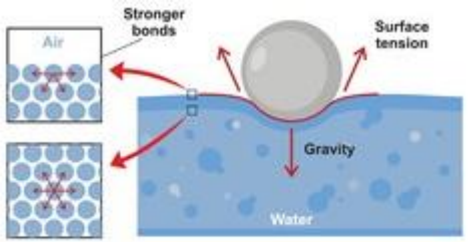


Cohesion & adhesion together leads to Capillary Action

Surface Tension

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

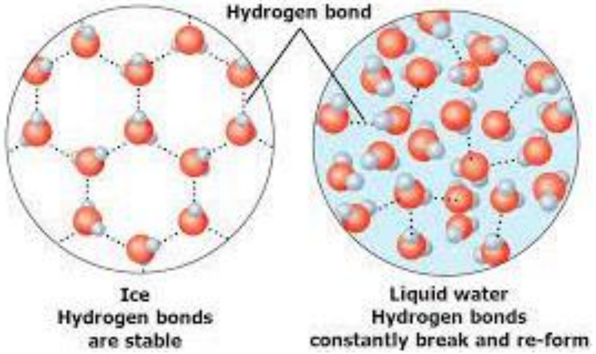
Allows you to skip rocks or water striders to walk on water



Less Dense when Solid

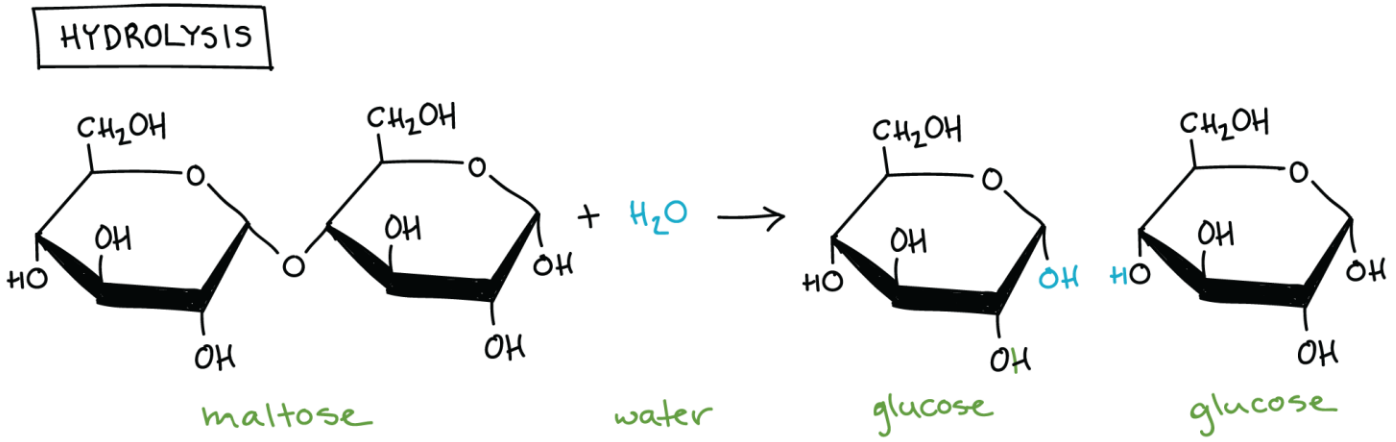
Hydrogen bonds inhibit compaction

Ice floats; temperature buffer

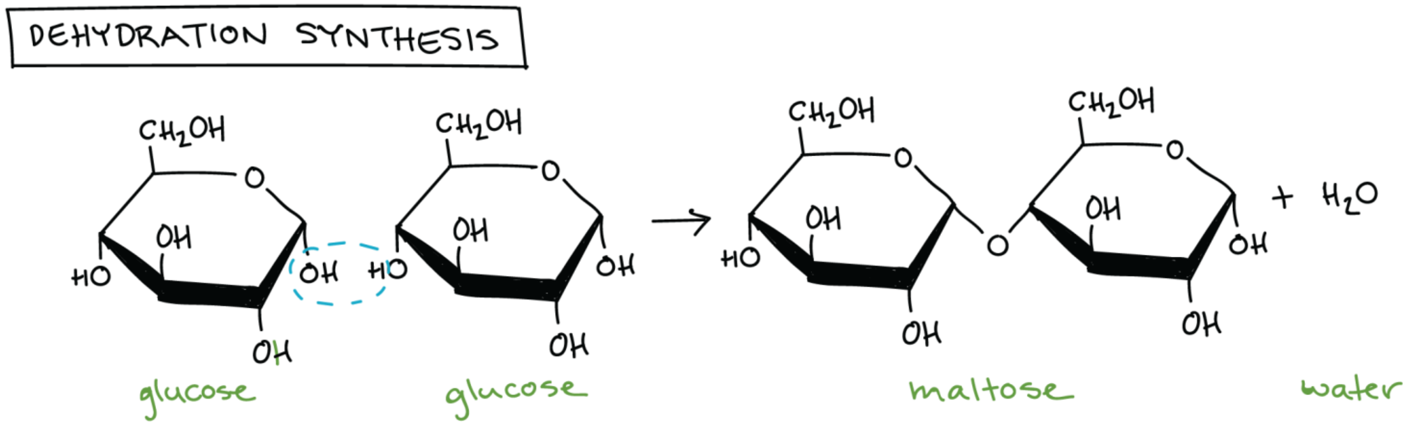


Hydrolysis

BREAKING down polymer into monomers using the splitting of a WATER molecule



Topic 1.3: Intro to Biological Molecules



Dehydration

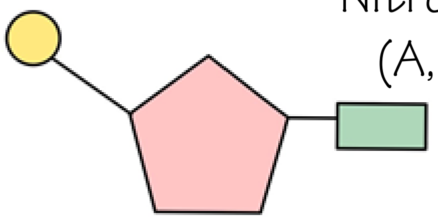
BUILDING polymers from monomers using the formation of a WATER molecule

Topic 1.4: Properties of Biological Molecules

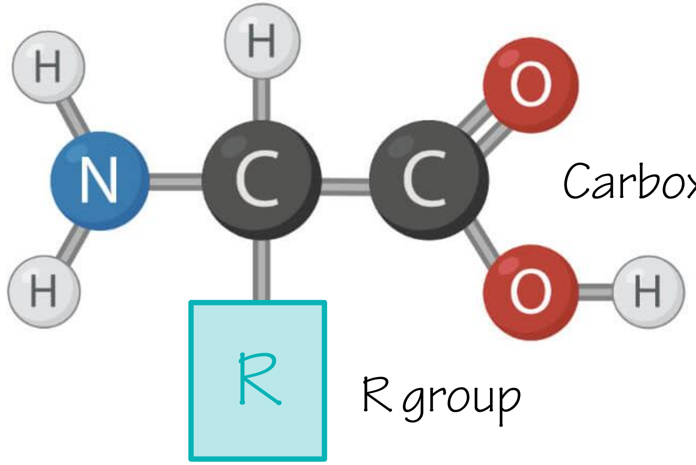
Structure and function of polymers are derived from the way their monomers are assembled

Nucleic Acids

Monomer: Nucleotide
Bond: Phosphodiester linkage
(between phosphate and hydroxyl)

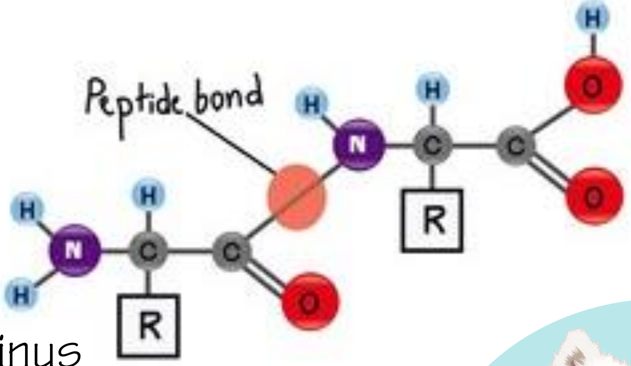


Proteins



Monomer: Amino Acid
Bond: Peptide bond
(between carboxyl & amino groups)

R group	Fold
Hydrophilic	Exterior
Hydrophobic	Interior
Charged	Exterior



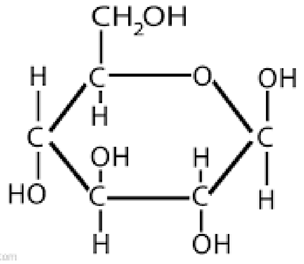
Topic 1.4: Properties of Biological Molecules

Carbohydrates

Monomer: Monosaccharide

Bond: Glycosidic Linkage

Glucose

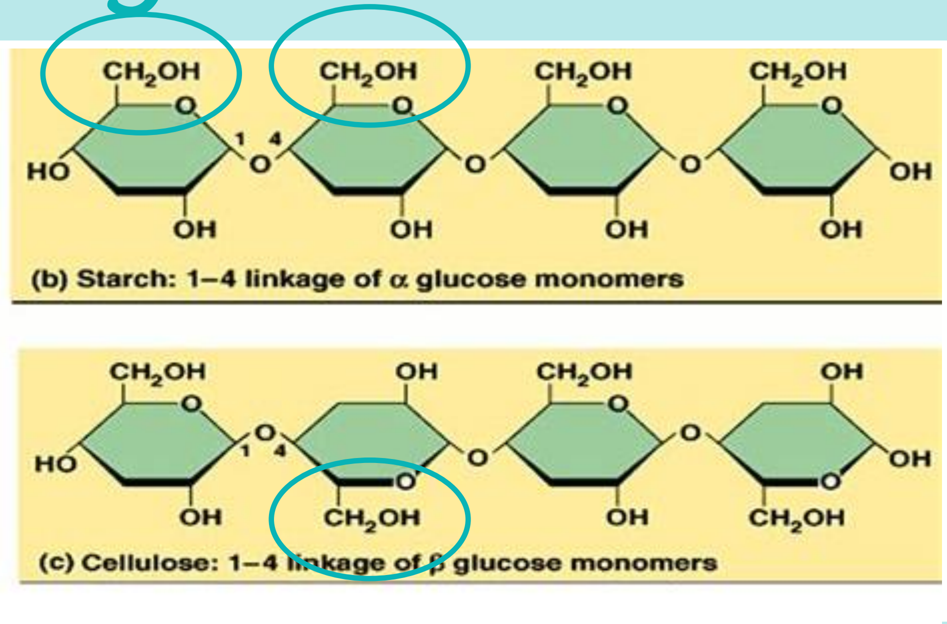


Structural:

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

Storage:

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



(b) Starch: 1–4 linkage of α glucose monomers

(c) Cellulose: 1–4 linkage of β glucose monomers

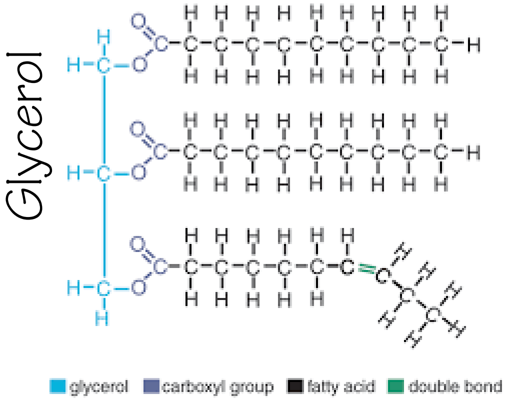
Lipids

Monomer: None

All of the lipids are NONPOLAR!!

Fats

3 fatty acids



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

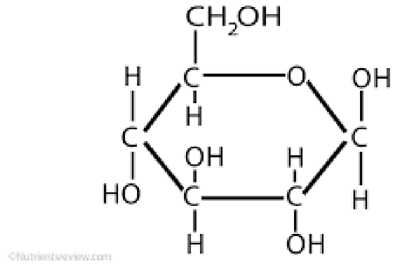
Topic 1.4: Properties of Biological Molecules

Carbohydrates

Monomer: Monosaccharide

Bond: Glycosidic Linkage

Glucose



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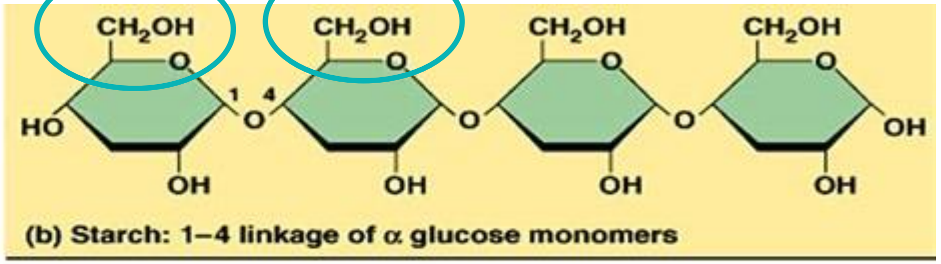
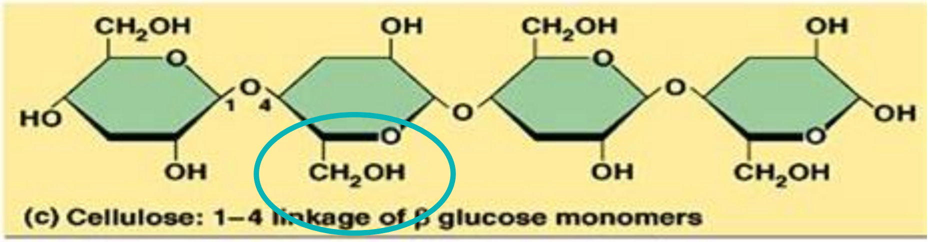




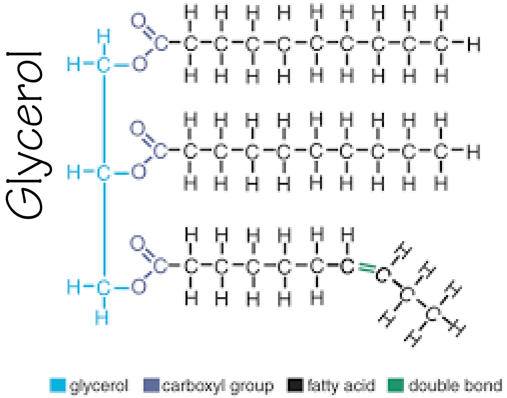
Lipids

Monomer: None

All of the lipids are NONPOLAR!!

Fats

3 fatty acids

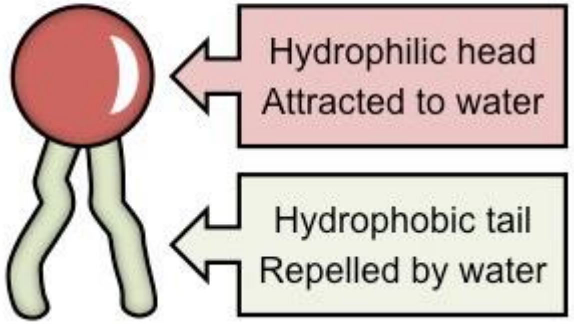


Phospholipids

Phosphate

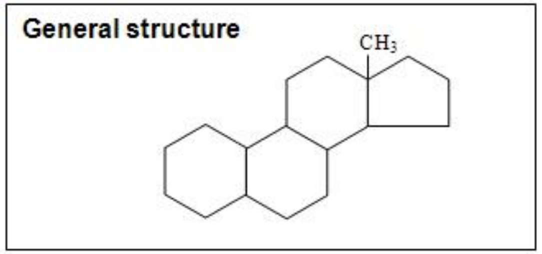
Glycerol

2 fatty acids



Amphipathic

Steroids



Four fused rings

<u>Ligand:</u>

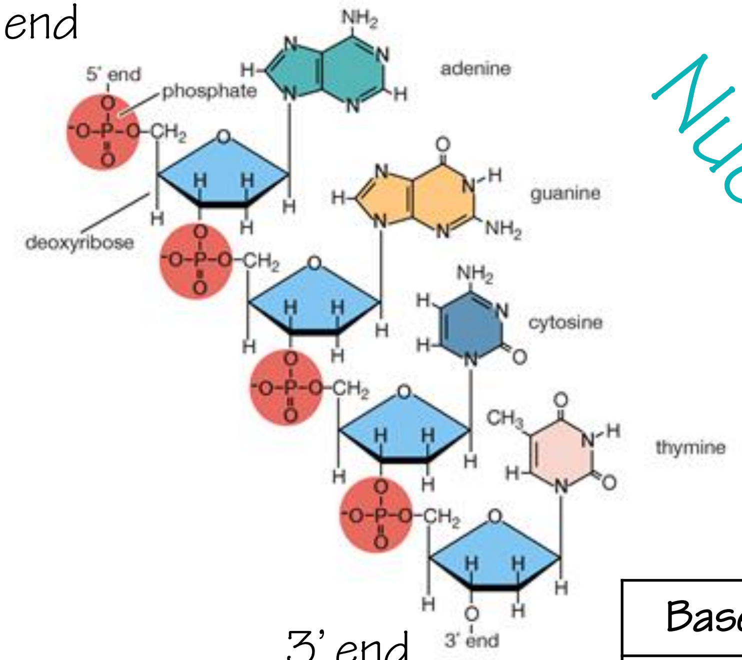
- Intracellular Reception

Topic 1.5: Structure & Function of Bio Molecules

Directionality of the subcomponents influences structure and function of the polymer

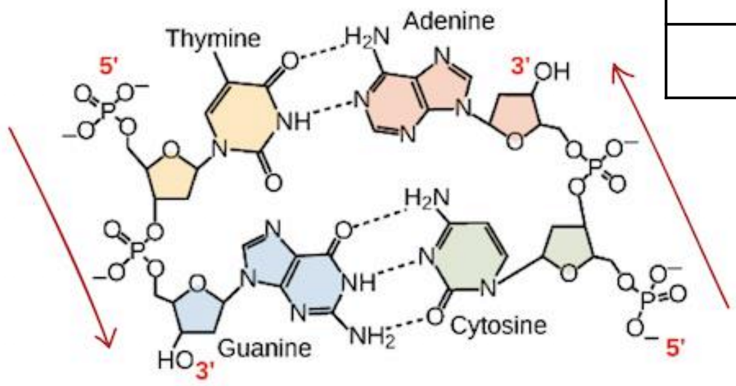
Nucleic Acids

5' end



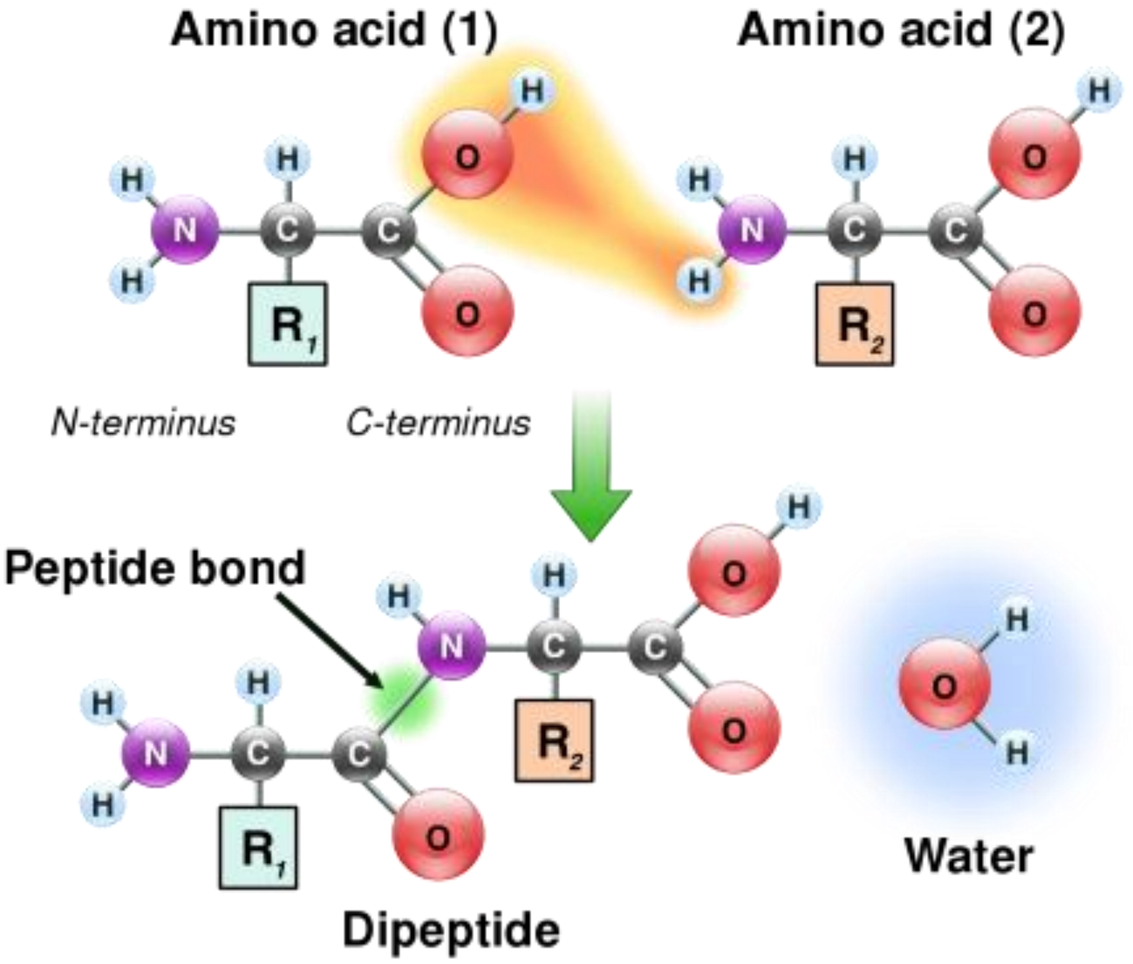
3' end

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



Directionality: 5' → 3'; antiparallel

Proteins



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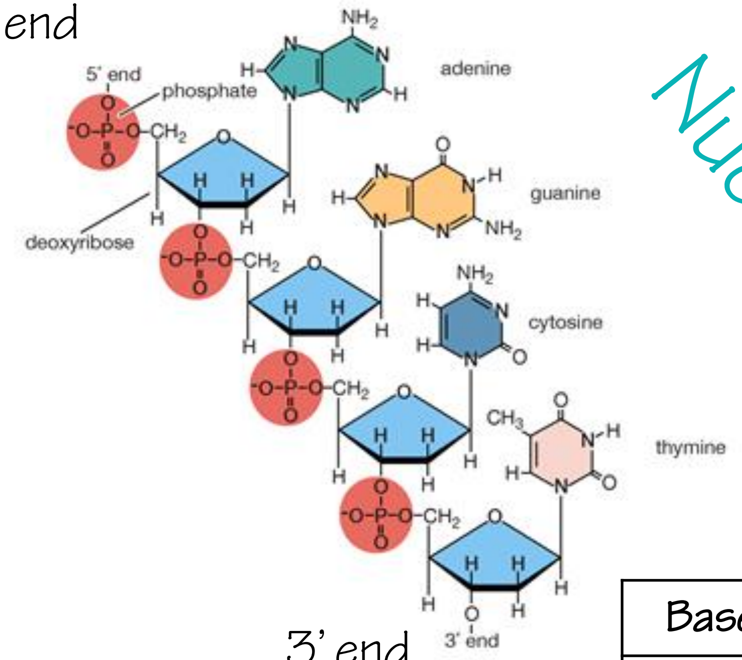

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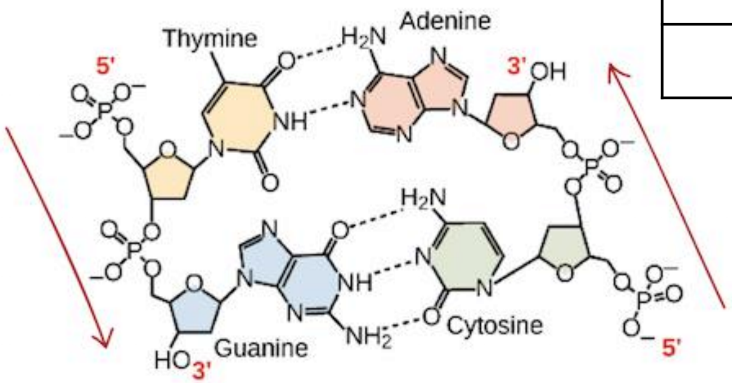

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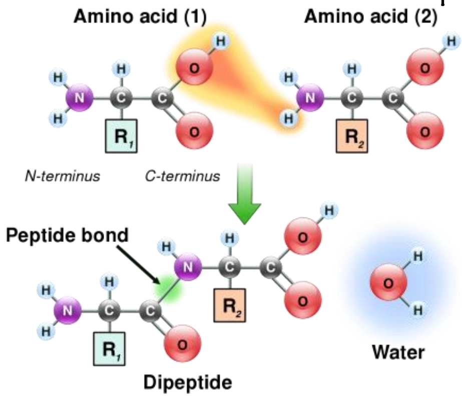


Primary:
- Bond: peptide bonds between amino acids
- Structure: string of amino acids

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

Topic 2.1: Cell Structure (Subcellular Components)

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

Golgi Complex

Structure:

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

Functions:

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

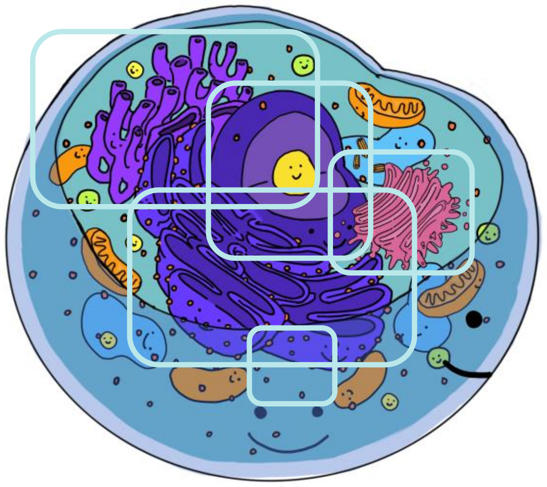
Ribosomes

Structure:

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

Functions:

- Protein synthesis



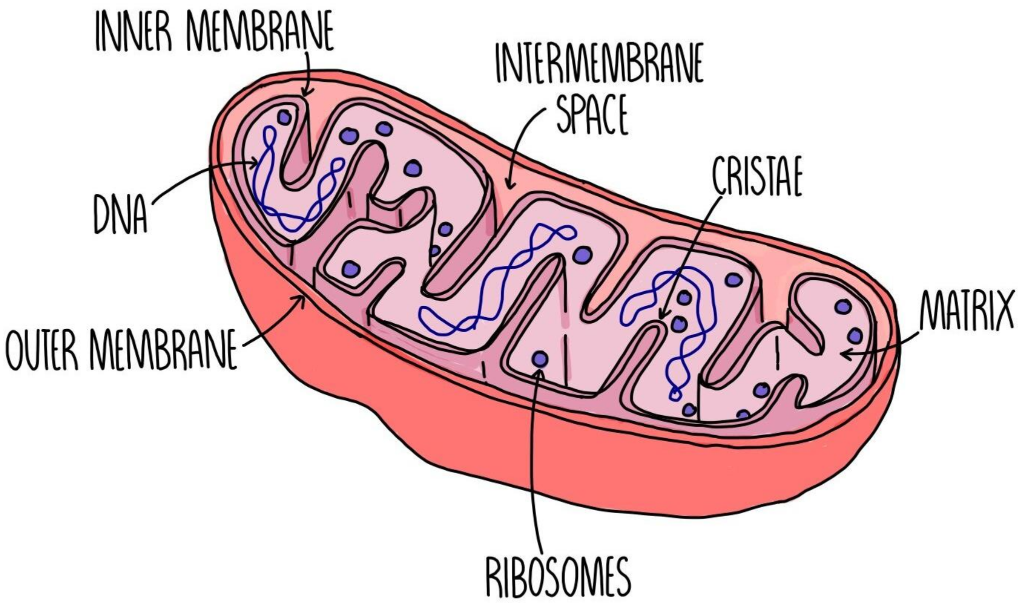
Mitochondria

Structure:

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

Functions:

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



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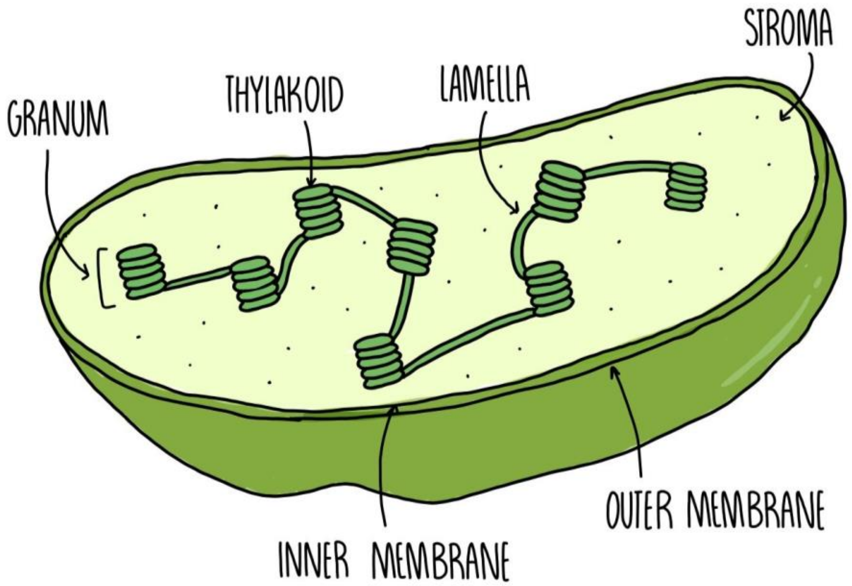


Structure:

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

Functions:

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

Chloroplast

Mitochondria

Structure:

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

Functions:

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

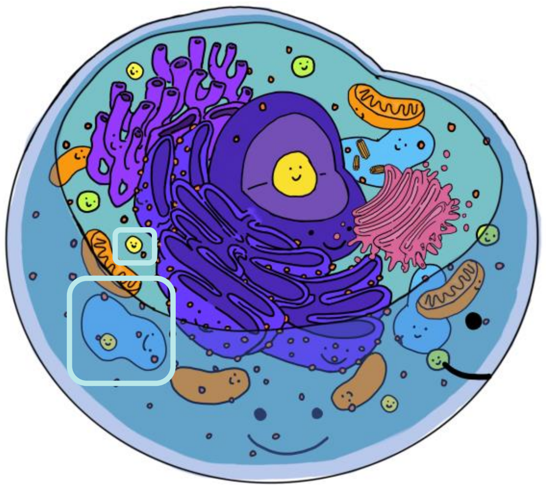
Lysosome

Structure:

- membrane-enclosed sacs that contain hydrolytic enzymes

Functions:

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



Topic 2.1: Cell Structure (Subcellular Components)

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

Topic 2.2: Cell Structure & Function

Organelles and subcellular structures, and the interactions among them, support cellular function

Endoplasmic Reticulum (ER):

- Mechanical support
- Protein synthesis on membrane-bound ribosomes
- Role in intracellular transport

Mitochondria:

- Double membrane provides compartments for different metabolic reactions

Lysosomes:

- Contain hydrolytic enzymes (intracellular digestion)
- Role in recycling cell's organic materials
- Role in programmed cell death (apoptosis)

Vacuoles:

- Storage and release of macromolecules/cellular waste products
- Aids in retention of water for turgor pressure

Structural features of a cell that allow organisms to capture, store, and use energy

Mitochondria:

- Folding of inner membrane increases SA to allow more ATP synthesis

Chloroplast:

- Contains thylakoid and stroma

Thylakoid ->

- Organized in stacks (grana)
- Chlorophyll pigments and ET proteins in membrane (photosystems)

Stroma ->

- Fluid within the inner chloroplast membrane

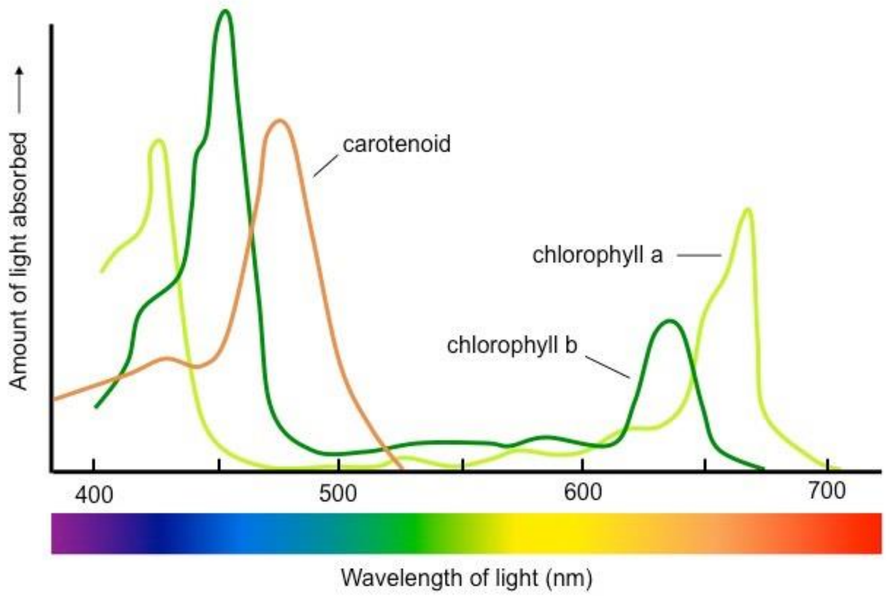
Reactions (P = Photosynthesis & C = Cell Resp):

- Light-Dependent Reactions (P) = grana
- Carbon Fixation/Calvin Cycle (P) = stroma
- Krebs Cycle/Citric Acid Cycle (C) = matrix
- ETC/ATP Synthesis (C) = inner mitochondrial membrane

Topic 3.7: Fitness

Variation at the molecular level provides organisms with the ability to respond to a variety of environmental stimuli.

Variation in the number and types of molecules within cells provides organisms a greater ability to survive and/or reproduce in different environments.

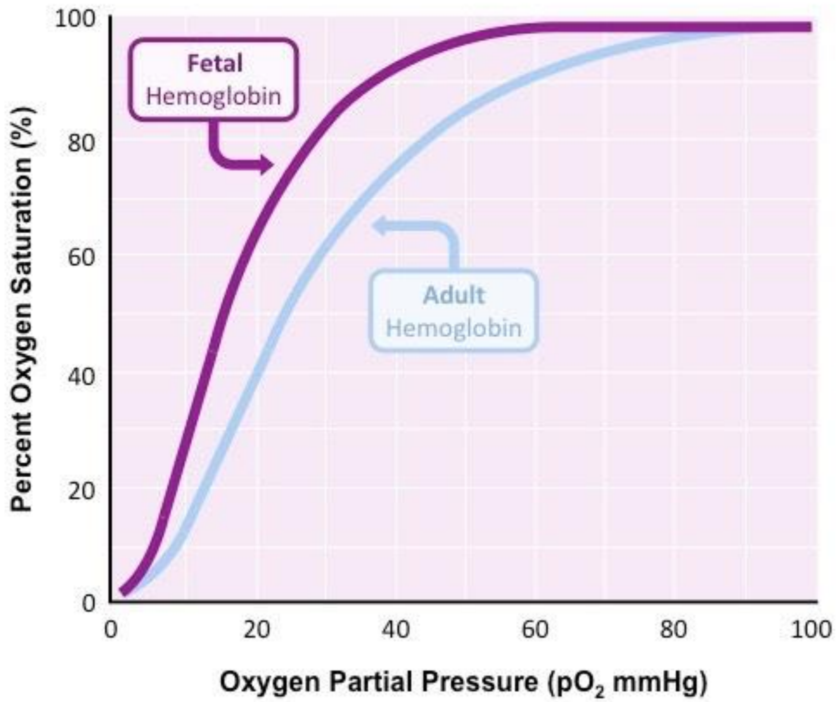


Chlorophyll

Multiple molecules increase the efficiency of absorption of light energy to fuel photosynthesis

Hemoglobin

Fetal hemoglobin has a higher affinity for oxygen than adult hemoglobin. They are able to obtain more oxygen which increases fitness.



Phenotype Plasticity

- Result of environmental factors influencing gene expression
- individuals with the same genotype exhibit different phenotypes in different environments

Normal conditions: only rabbit's feet, tail, ears and nose are black
If ice pack placed on back (with absent fur), the new fur will grow back black

Topic 5.5: Enviro. Effects on Phenotype

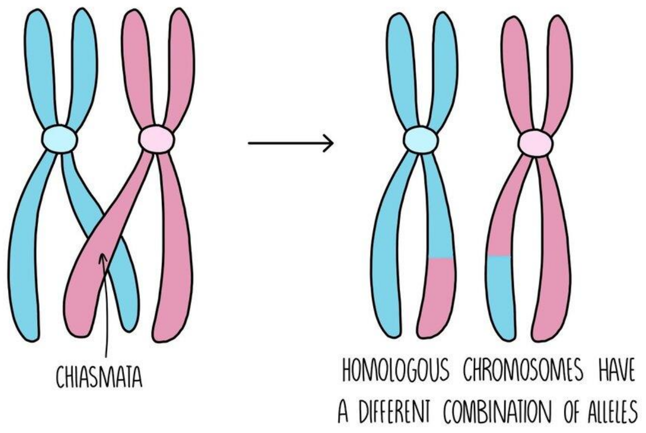
Diets lacking carotenoids result in very little color in normally pigmented species. Population differences have been related to the presence of specific food plants.

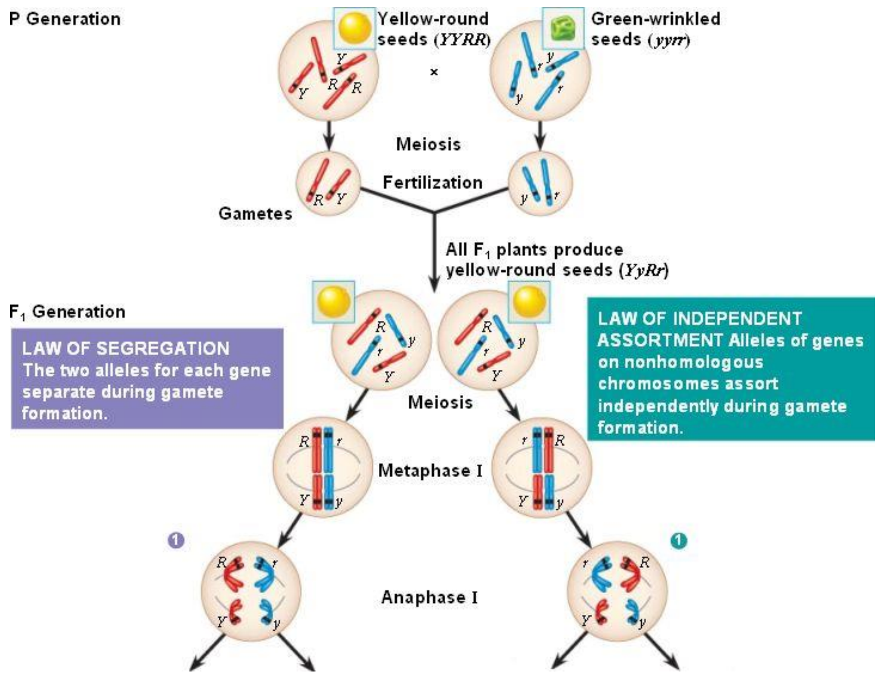
Hydrangea flowers have a range of phenotypes based on the acidity and aluminum content of the soil.

Topic 5.6: Chromosomal Inheritance

Genetic Variation

- Crossing Over
- Independent Assortment
- Law of Segregation
- Random Fertilization





Chromosomal Basis of Inheritance

concept that genes are located on chromosomes and are passed from parent to offspring during reproduction.

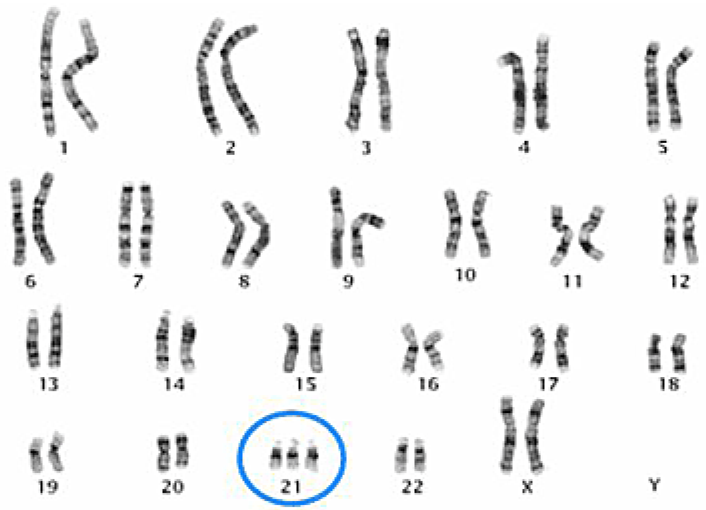
Human Genetic Disorders

Single Affected/Mutated Allele

- Sickle Cell Disease
- Tay Sachs Disease
- Huntington's Disease

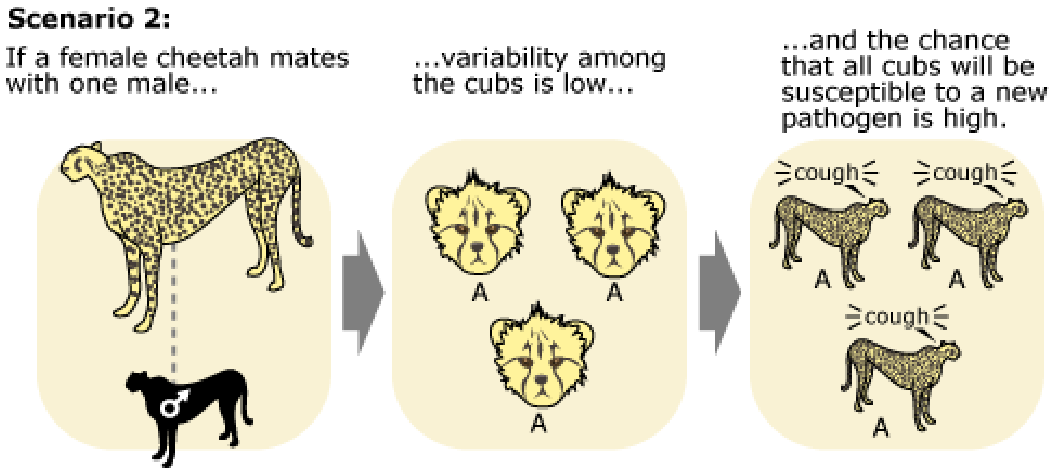
Chromosomal Changes

- Downs Syndrome/Trisomy 21
- Klinefelter Syndrome/XXY
- Turner Syndrome/XO



Low Genetic Variation

Population ability to respond to changes in the environment is influenced by genetic diversity. Species and populations with little genetic diversity are at risk of decline or extinction.

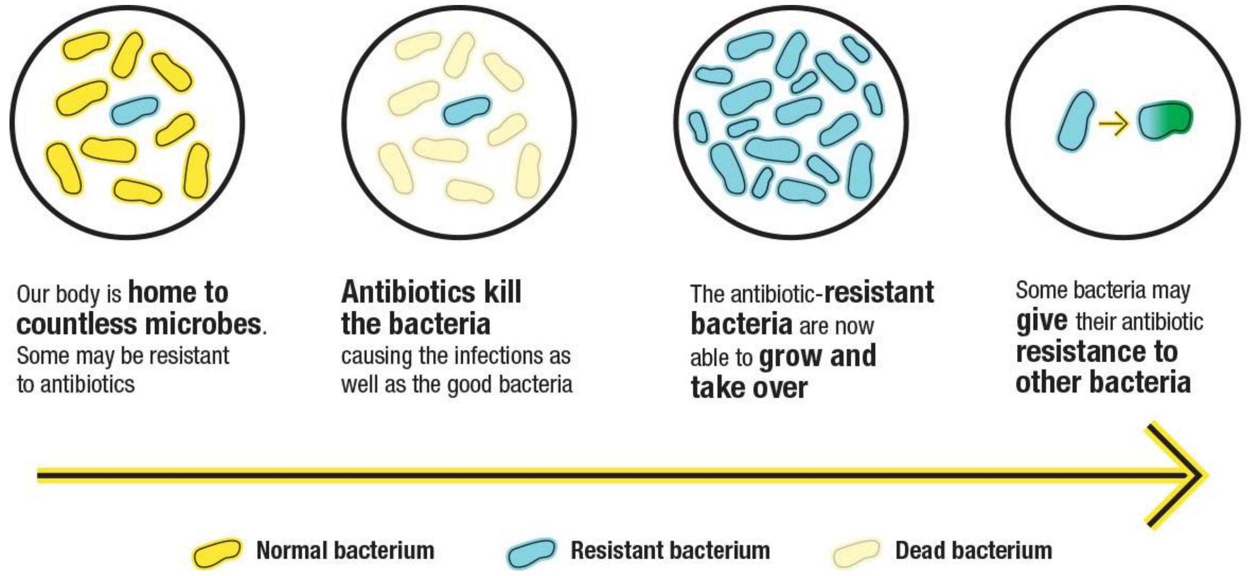


Alleles that are adaptive in one environmental condition may be deleterious in another because of different selective pressures.

Topic 7.12: Variations in Populations

Genetically Diverse

Genetically diverse populations are more resilient to environmental perturbation because they are more likely to contain individuals who can withstand the environmental pressure.



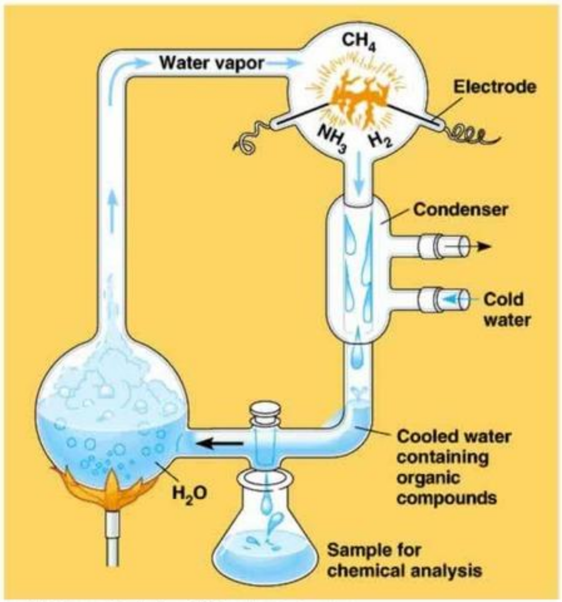
Topic 7.13: Origin of Life on Earth

Important Dates

- Earth formed approximately **4.6 billion years ago** (bya).
- The environment was too hostile for life until **3.9 bya**.
- The earliest fossil evidence for life dates to **3.5 bya**.

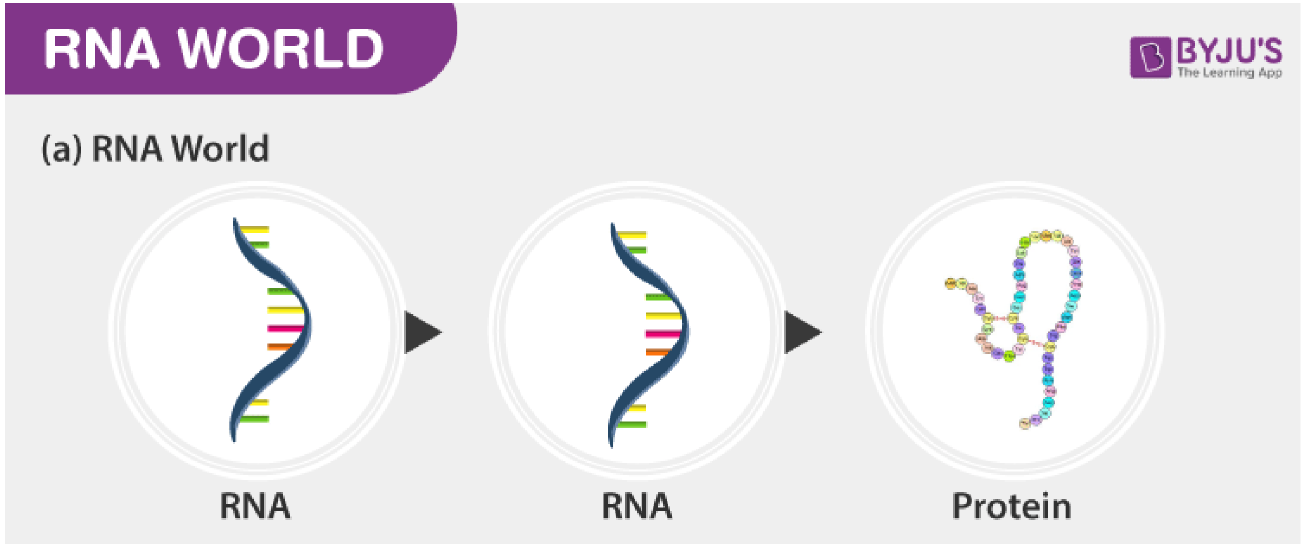
Origin of Life

- Primitive Earth provided inorganic precursors from which organic molecules could have been synthesized
- Organic molecules could have been transported to Earth by a meteorite or other celestial event.
- Abiotic synthesis of polymers from monomers



RNA World Hypothesis

RNA could have been the earliest genetic material

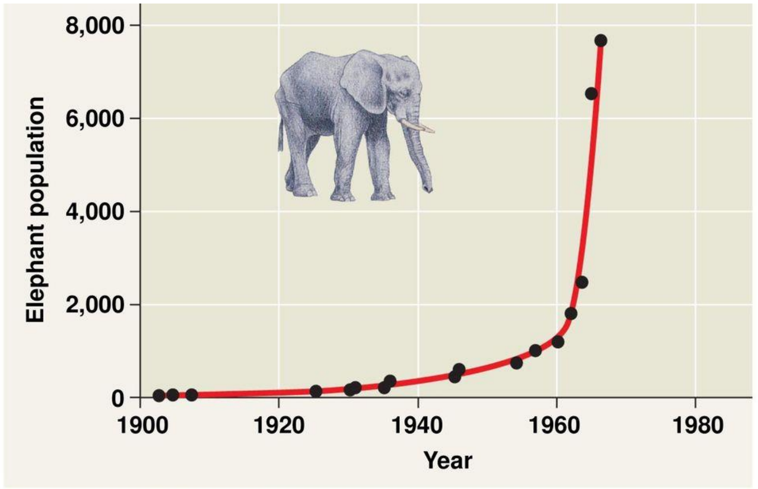


Topic 8.3: Population Ecology

Population Growth

$$\frac{dN}{dt} = B - D$$

where:
dt = change in time
B = birth rate
D = death rate
N = population size



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

Population

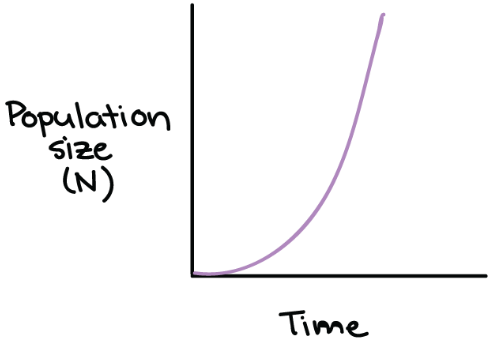
Organisms of the same species living in the same area

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

Exponential growth

Per capita growth rate (r) doesn't change, even if pop. gets very large.

$\frac{dN}{dt} = r_{max}N$



Topic 8.4: Effect of Density on Population

Factors to Limit Growth

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

Density Dependent Factors

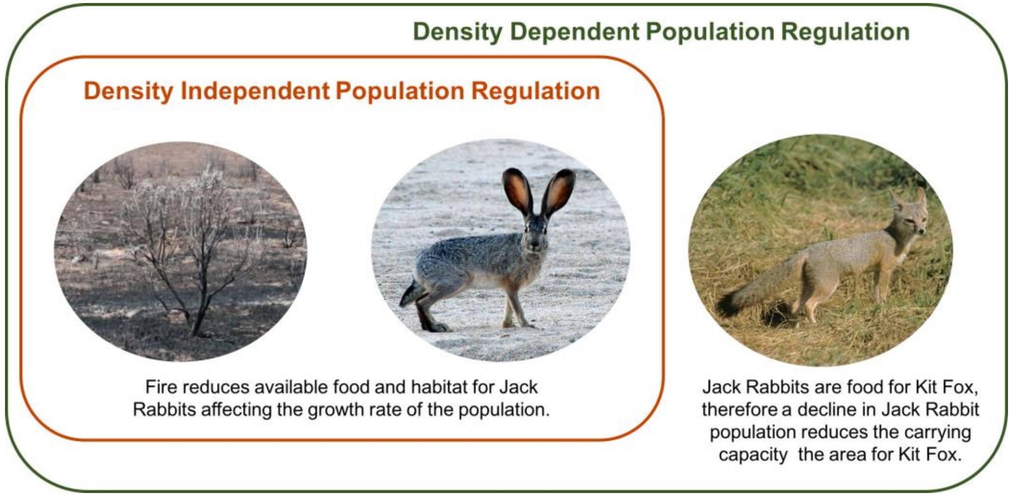
Factors that intensifies as population increases

Ex: competition, predation, disease

Density Independent Factors

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

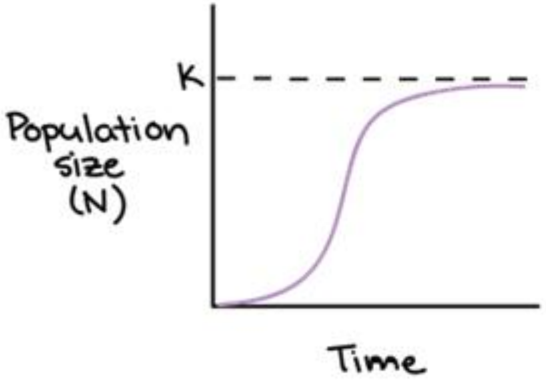
Ex: natural disasters, human activity



Logistic growth

Per capita growth rate (r) gets smaller as pop. approaches its max. size.

$\frac{dN}{dt} = r_{max}\left(\frac{K-N}{K}\right)N$



Logistic Growth

Population size limited by carrying capacity

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

Example:

If a population has 400 individuals with a rate of increase of 0.5 and a carrying capacity of 800, how many individuals after 2 generations?

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

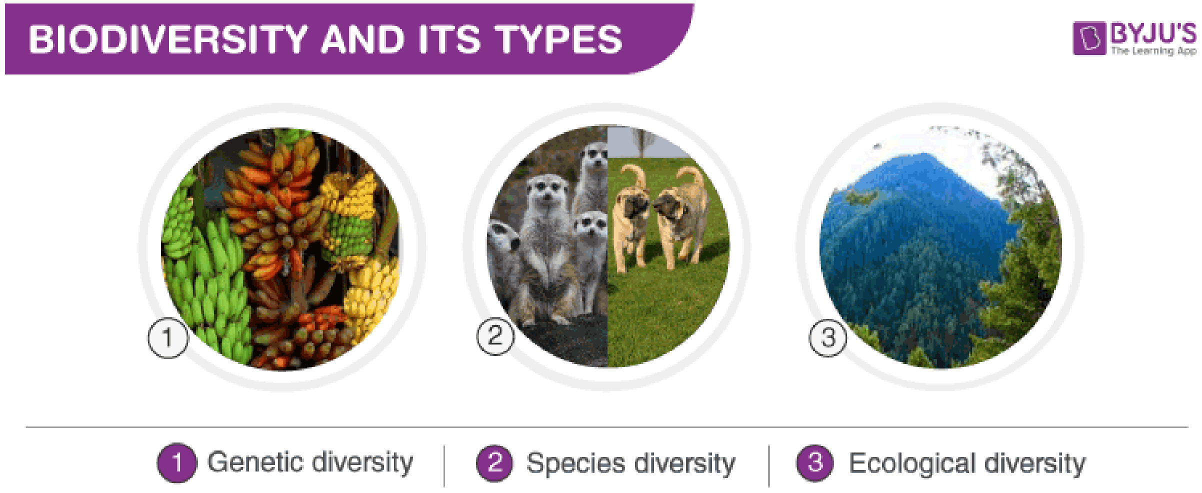
After generation 1: 500

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

After generation 1: 575

8.6 Biodiversity

Natural and artificial ecosystems with fewer component parts and with little diversity among the parts are often less resilient to changes in the environment.

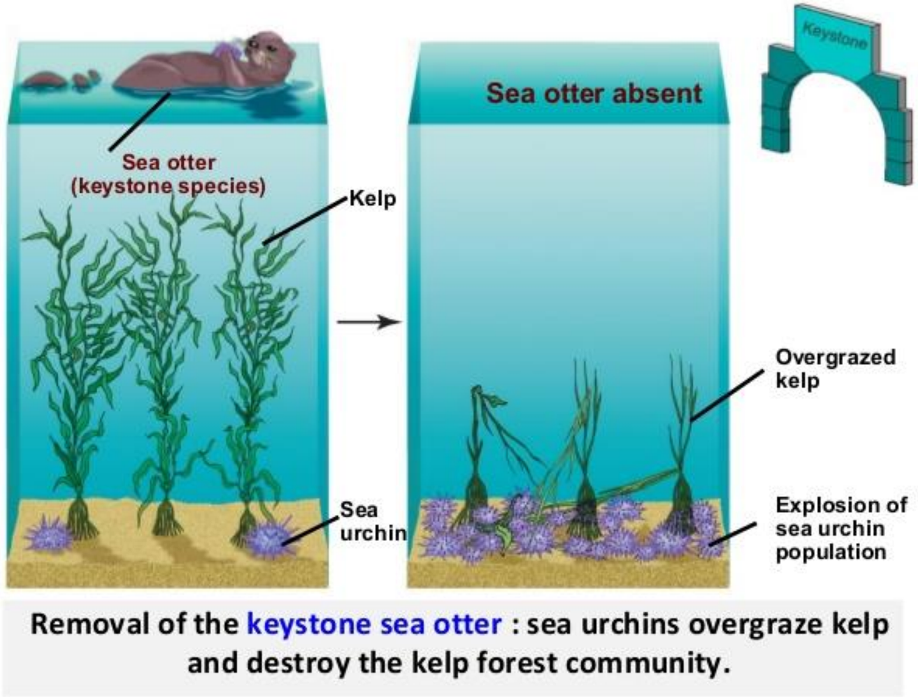


Keystone species, producers, and essential abiotic and biotic factors contribute to maintaining the diversity of an ecosystem.

Keystone Species

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

Examples: Sea Otter



Topic 8.7: Disruptions to Ecosystems

Invasive Species

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

Examples:

- Brown Tree Snake
- Bigheads and Silver Carp

No natural predators

Brown tree snakes were accidentally brought to Guam. No animals hunted the snakes, but the island was filled with birds, rodents, and other small animals that the snakes hunt. The snakes quickly multiplied, and they are responsible for the extinction of nine of the island's 11 forest-dwelling bird species.

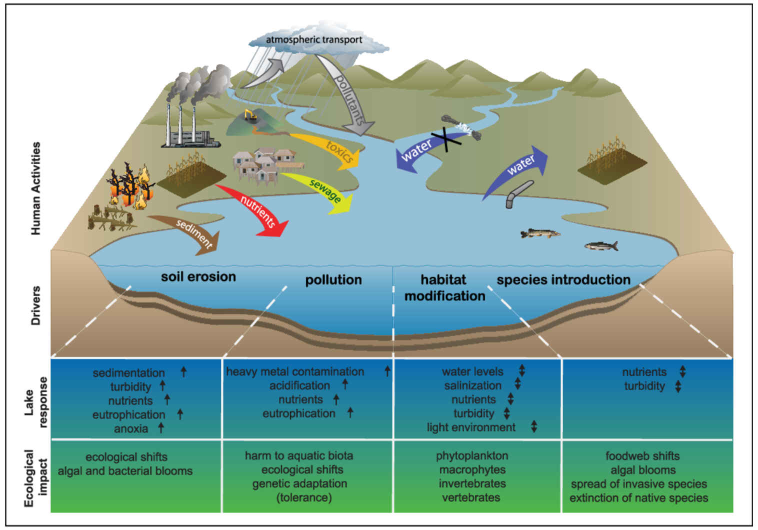
Outcompete natives

Bighead and silver carp are now common in the Missouri River. These fish feed on plankton, tiny organisms floating in the water. Many native fish species (paddlefish), also feed on plankton. The feeding cycle of the paddlefish is slower than that of the carp. There are now so many carp in the lower Missouri River that paddlefish do not have enough food.

Human Impacts

The introduction of new diseases can devastate native species.

Habitat change can occur because of human activity.



Geological/Meteorological Impacts

Geological and meteorological events affect habitat change and ecosystem distribution. Biogeographical studies illustrate these changes.

Scientists have found that the existing populations of a certain species of amphibian are small in number, lacking in genetic diversity, and separated from each other by wide areas of dry land. Which of the following human actions is most likely to improve the long-term survival of the amphibians?

a. Cloning the largest individuals to counteract the effects of aggressive predation

b. Reducing the population size by one-fifth to decrease competition for limited resources

c. Constructing a dam and irrigation system to control flooding

d. Building ponds in the areas of dry land to promote interbreeding between the separated populations

Free Response Practice:

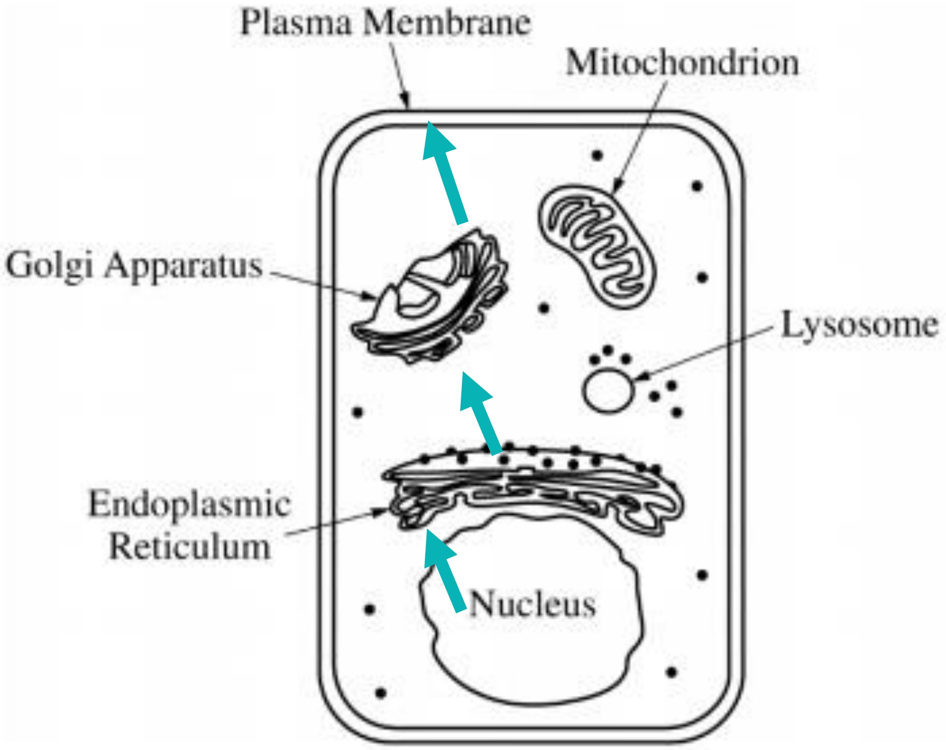
Geneticists investigated the mode of inheritance of a rare disorder that alters glucose metabolism and first shows symptoms in adulthood. The geneticists studied a family in which some individuals of generations II and III are known to have the disorder. Based on the pedigree (Figure 1), the geneticists concluded that the disorder arose in individuals II-2 and was caused by a mutation in mitochondrial DNA.

(a) The disorder alters glucose metabolism. **Describe** the atoms AND types of bonds in a glucose molecule.

The disorder alters glucose metabolism. **Describe** the atoms AND types of bonds in a glucose molecule.

- The atoms are carbon, hydrogen, and oxygen (C, H, and O) and are held together by covalent bonds.

Free Response Practice:



Cystic fibrosis is a genetic condition that is associated with defects in the CFTR protein. The CFTR protein is a gated ion channel that requires ATP binding in order to allow chloride ions (Cl-) to diffuse across the membrane.

(a) In the provided model of a cell, **draw** arrows to describe the pathway for production of a normal CFTR protein from gene expression to final cellular location.

Free Response Practice:

Cystic fibrosis is a genetic condition that is associated with defects in the CFTR protein. The CFTR protein is a gated ion channel that requires ATP binding in order to allow chloride ions (Cl^-) to diffuse across the membrane.

(b) **Identify** the most likely cellular location of the ribosomes that synthesize CFTR protein.

Identification (1 point)

- (Rough) Endoplasmic Reticulum/ER

(c) **Identify** the most likely cellular location of a mutant CFTR protein that has an amino acid substitution in the ATP-binding site.

Identification (1 point)

- In the (cellular/plasma) membrane

Q & A

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