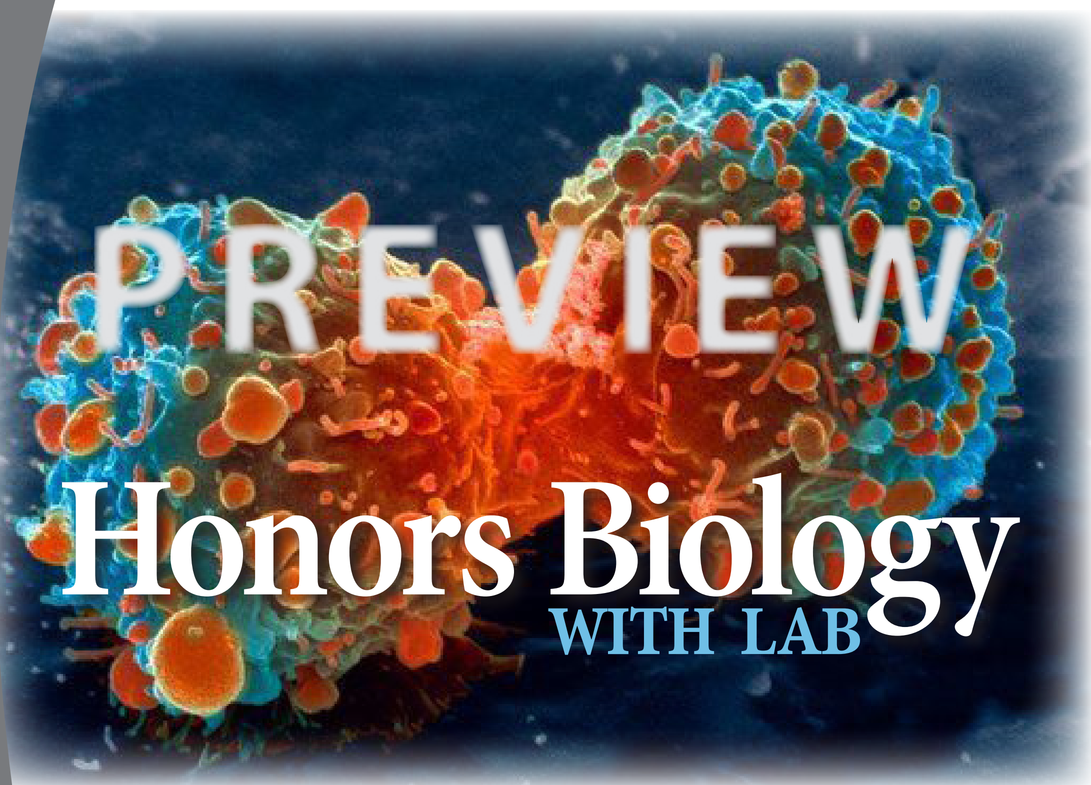
HS COLLEGE-BOUND



Honors Biology
WITH LAB

Diane Speed

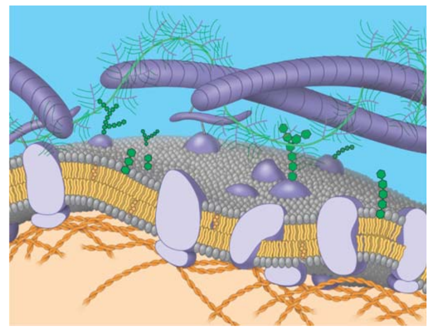
WORKBOOK CONTENTS

- Notetaking sheets
- Definition sheets
- Labs & activities
- Study aids

Plasma membranes encircle cells and organelles

The plasma membrane

- Is the ___________________________ that separates the living cell from its nonliving surroundings
- Keeps ____; separates inside and outside of the cell
- Primarily made up of _____________ or _______________________and _______________________
- Membranes-bound organelles __________________________________, e.g. nucleus, mitochondria, chloroplasts and the membranes inside these bodies



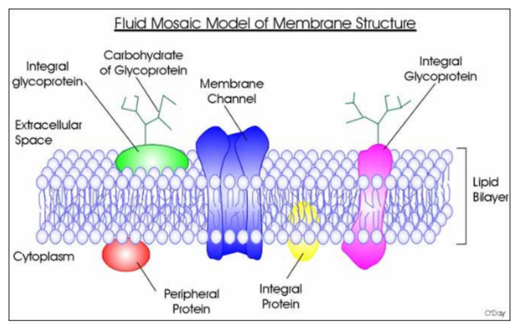
Fluid mosaic model

- Fluid: ____
- Mosaic: ____

Selectively permeable: _______________________________________

Allows substances in and out of the cell through ____

____



- Fluid mosaic of ___________________ and

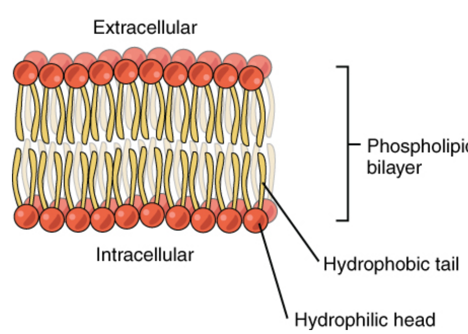
  ____

- Lipid bilayer has a _______________________________

  ________________ and a ____

  - Hydrophilic ____
  - Hydrophobic ____

- Phospholipids line up _________________________with heads out towards the watery part inside or outside the cell
- Contains ____



Structure of molecules

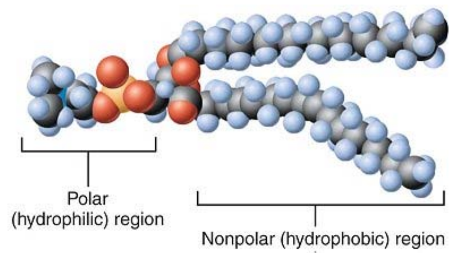
Atoms come together to form molecules by sharing or exchanging electrons

- Sometimes molecules will unevenly share electrons
- If one part of a molecule has a higher concentration of electrons than another part, it is called _______

The phospholipid bilayer in cell membranes is both __________________________ and

_______________________ = ____

Phospholipids

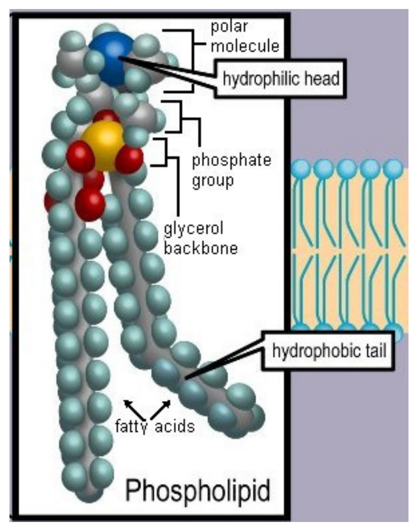


- Are the ___________________________________lipid in the plasma membrane
- Are ____, containing both hydrophilic (head) & hydrophobic regions (tails)
- _______________ composed of phosphate group (PO_4) attached to one carbon of glycerol and is

  ____

- Two fatty acid ________________are

  ____



Membrane permeability

- A cell must ________________________________materials with its surroundings, a process controlled by the plasma membrane
- Membrane _____________________ results in

  ____

Permeability of the lipid bilayer

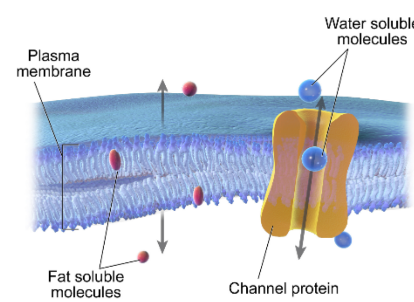
- ____ molecules are ____________________________

  _________________________________ and can pass through the membrane ____________________

- But ____ (which are ***hydrophilic***) do NOT cross rapidly

Transport proteins

- ___________________________________ allow passage of hydrophilic substances across the membrane
- ____________________________________ is diffusion of a substance across a membrane with no energy investment

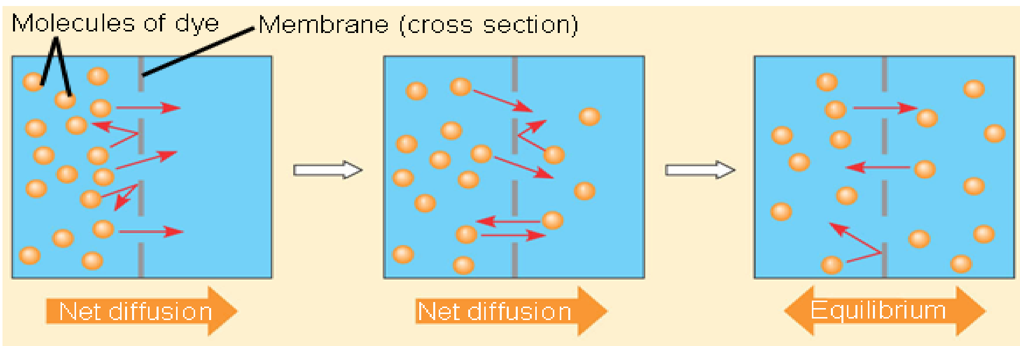


Diffusion Across the Plasma Membrane

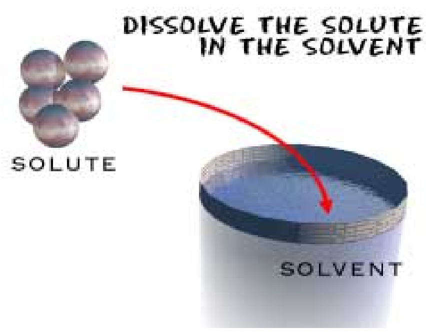
- _________________________________ easily diffuse across plasma membranes
- Diffusion of water is known as _____________________

Diffusion

- Is the tendency for molecules of any substance to **spread out evenly** into the available space
- Move from _____________ to ______________concentration
- ***Down*** the concentration gradient
- ***No energy*** investment necessary



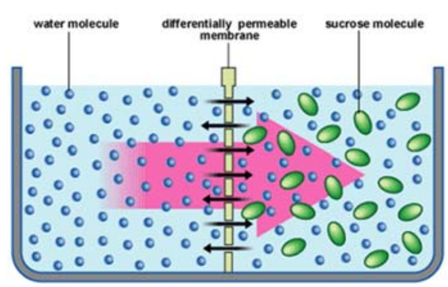
Solute, Solvent, Solutions



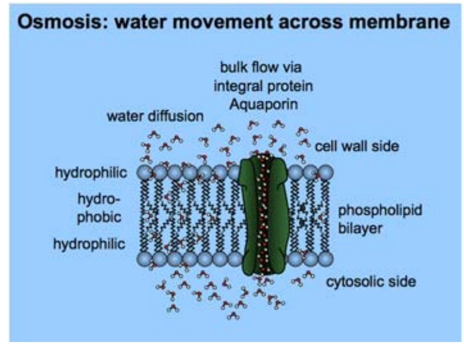
_________________________ is a physical blend of two or more kinds of matter, each of which retains its own identity and properties.

- _________________________: not uniform in composition
- _________________________: completely uniform in composition
  - ***Solution*** is the special name given to homogeneous mixtures.
- _________________________: a homogeneous mixture
- **Solute**: _____________________________________
- **Solvent**: the medium _____________________________

Osmosis



- Is the movement of _____________ across a ____membrane



- Is *affected* by the *concentration gradient of dissolved substances*

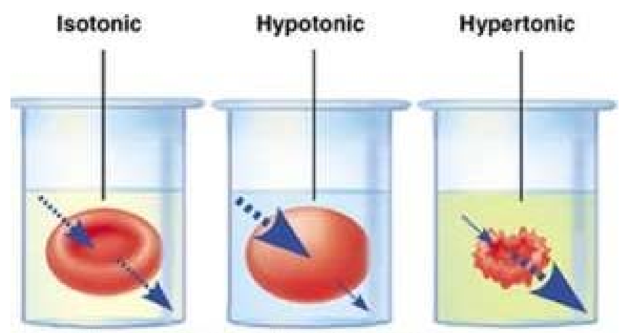
  called the solution's ________________________________

- _____________________ causes a cell to gain or lose water

Three states of tonicity: Isotonic, Hypertonic, Hypotonic

Tonicity is a **relative** measurement; comparing solute concentrations of two systems

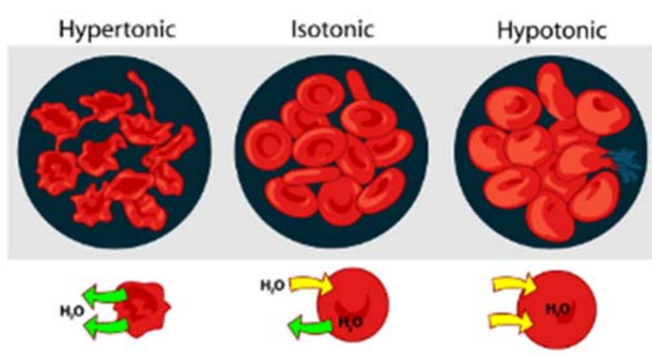
1. _______________________: the **concentration of solutes** in the *solution* is the **same** as the concentration of solutes **in the *cell.***



   - No net movement of water into or out of cell.
   - Water moves into and out of cell, but the concentration of solutes remains unchanged.
   - The cell size is unchanged.

2. _______________________: the **concentration of solutes** in the *solution* **is greater** than the concentration of solutes **in the *cell.***
   - The cell will lose water.
   - This causes the cell to shrink
   - This process is called ***plasmolysis***.
   - In plant cells put into salt solution, the cell membrane pulls away from the cell wall during plasmolysis.

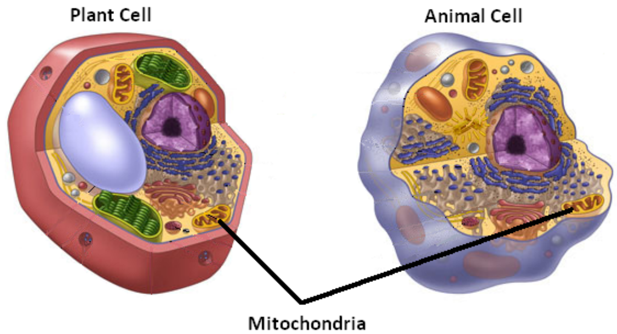
- _______________________: the **<u>concentration of solutes</u>** in the *solution* **<u>is less</u>** than the concentration of solutes **in the *cell***.



   - The cell will gain water.
   - If it gains so much water, the cell will eventually burst.
   - This is called ***cytolysis***.

Part 2: The process of cellular respiration

Mitochondria: Chemical Energy Converters



Mitochondria are in nearly all eukaryotic cells.

Cellular respiration takes place in the cytoplasm and

in the ________________________.

- Bacteria, which do not have mitochondria, use their outer membranes to perform respiration.

- Cellular respiration converts ______________________ into _________.
  - ATP is the gasoline cells use for all their cellular functions
  - It is the energy for life's processes
- Cellular respiration: the process of breaking down glucose molecules and releasing energy in the form of ATP for cell work

Respiration occurs in ALL cells and can take place ____ present.

Cellular Respiration - Two types:

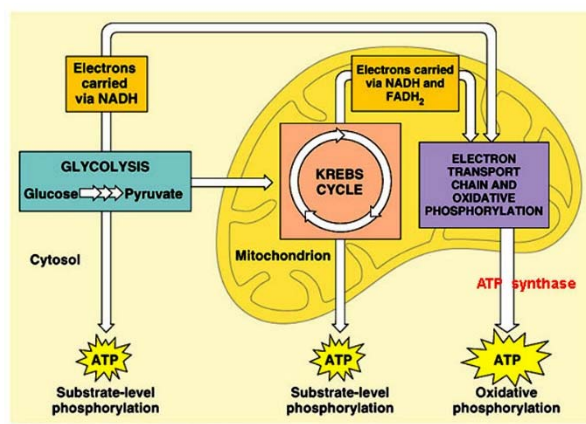
1. ___________________________________: respiration in the presence of oxygen

2. ___________________________________: respiration when no oxygen is present. Two types:

   1) fermentation (producing ethanol)

   2) lactic acid cycle (occurs in muscles, e.g. during sprinting)

The process of cellular respiration



- Begins in the ______________________________, then

  moves to the ____________________________ of the cell

- Total of ____________ molecules produced
- General formula

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

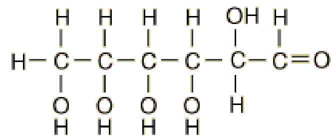
____

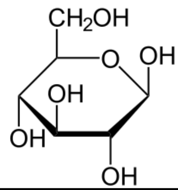
Energy of respiration

Where does the energy come from? ___________________________

____

Glucose – linear structure





Glucose – ring structure

Mitochondrial Structure

The most important processes happen in the membranes of the mitochondria

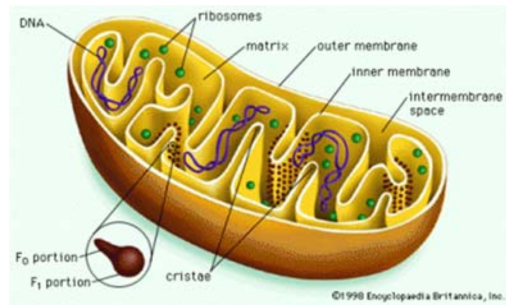
- Outer membrane ______________________________________
- Inner membrane ____;

  site of ____

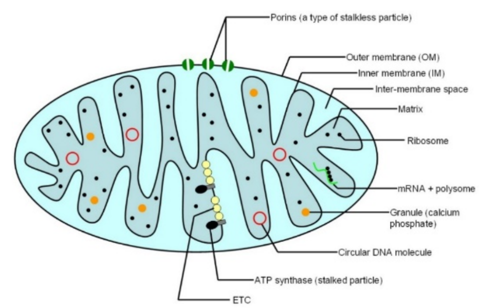
  ____
- Cristae ____– where cellular respiration actually occurs
- Intermembrane space _______________________________________

  ____
- Matrix ____________________________________ the folded area;

  site of acetyl CoA formation and the ________________________________



Structure of a mitochondrion



Facts about DNA in mitochondria and chloroplasts:

- DNA and ribosomes inside the matrix – DNA can reproduce by ____________________________
- Characteristics of mitochondrial DNA:

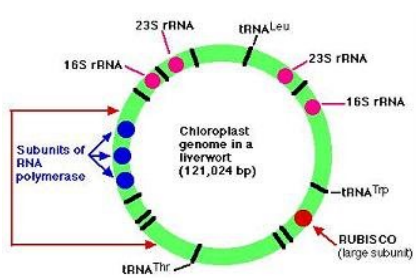
1. ___________________________________
2. ___________________________________

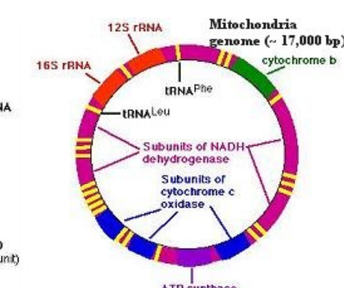
- Characteristics of DNA in chloroplasts:

1. ___________________________________
2. ___________________________________

DNA in the *mitochondria* codes for 13 polypeptides required for oxidative phosphorylation, 22 transfer RNAs, and 2 ribosomal RNAs.

DNA in *chloroplasts* codes for proteins involved in electron transport system and enzymes used in photosynthesis.





Stages of Cellular Respiration

Four stages in cellular respiration:

The Structure of Animals

Animals – Common characteristics

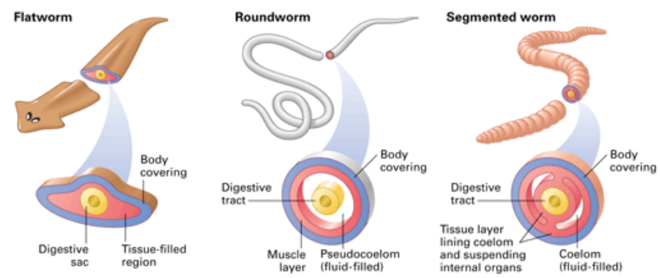
- ________________________
- Kingdom____________________________
- Division_____________________________

Two important differences

1. Vertebrates: ________________________
2. Invertebrates: ____

Animals are Metazoa

- ____



All animals having a body composed of

1. ____
2. ____

- Coelom: ____

Animals are one of the following

- Acoelomates: ____
- Pseudocoelomates: ____
- Coelomates: ____

Invertebrates: animals without a backbone

- _______________________________________
- _______________________________________
- _______________________________________
- _______________________________________
- _______________________________________
- _______________________________________
- _______________________________________
- _______________________________________

Chordates: All vertebrates are chordates, but not all chordates are vertebrates.

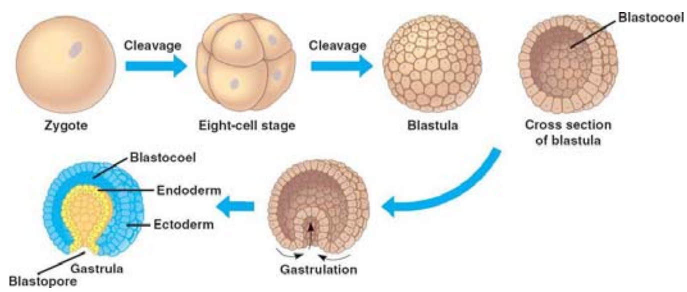
- ____________________________________
- ____________________________________
- ____________________________________
- ____________________________________
- ____________________________________
- ____________________________________
- ____________________________________

adult tunicates (sea squirts)

Common characteristics of animals

- __________________________
- __________________________
- __________________________
- __________________________
- Motile: ____
- Blastula: _____________________________________

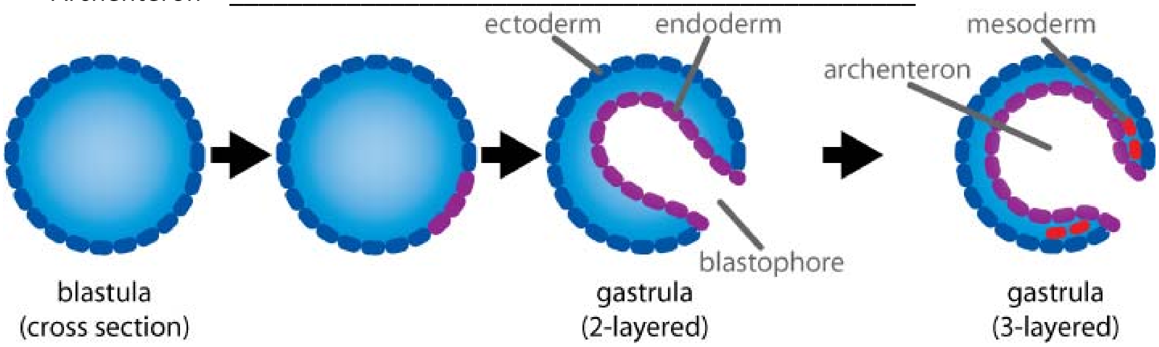
  ____



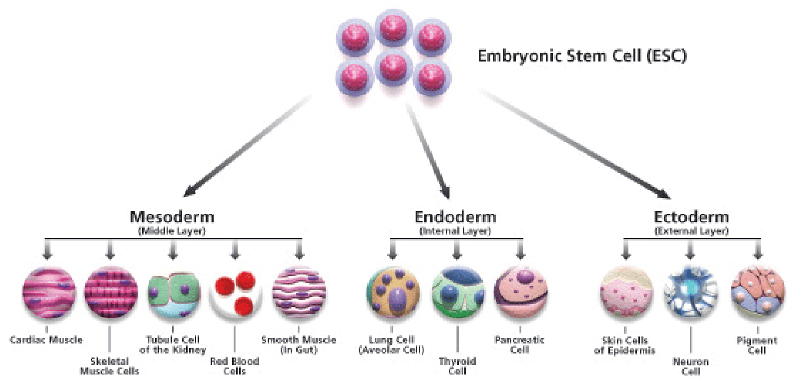
Embryology: early development of life

Zygote → Blastula → Gastrula → Embryo

- The fertilized egg, i.e. __________________ divides through *mitosis* until it forms a _______________
- A blastula is a ____
- The blastula ________________________ in on itself to change into a _________________________
- The gastrula folds to form an indentation or a hole on the side called the ________________________
- The fate of the blastopore is another identifying characteristic. It either develops into ______________
- This blastopore indents all the way through the ball of cells to become the *archenteron*.
- Archenteron – ____



Germ layers

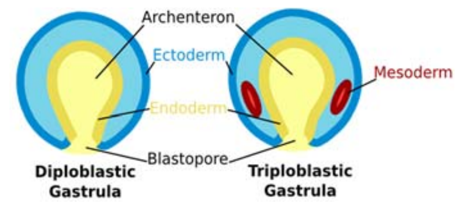


Cells of the gastrula begin to differentiate into cells of tissues, i.e. specialized cells.

During gastrulation, the cells change from stem cells into
more specialized cells that form layers called germ layers.

Triploblastic: ______________________

- ______________________________ forms the nervous tissue and skin
- ______________________________forms muscles and bones
- ______________________________forms the linings of organs
- From gastrula, the cells become an ________________________



Diploblastic

Some species form two, not three, germ layers

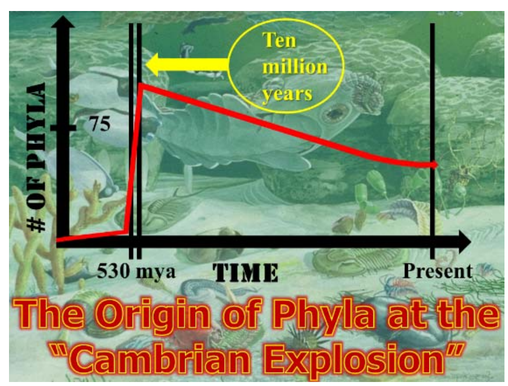
Ciderians (jellyfish) form of two germ layers.

____

Cnidarians do not form a mesoderm.

Two germ layers (endoderm + ectoderm) is separated by ________________________, a jelly-like substance, not a true germ layer

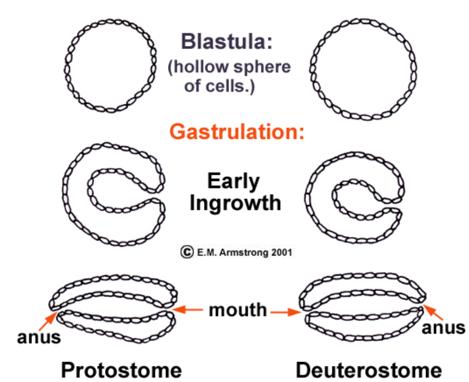
Cambrian Explosion



- ____
- ____
- ____

Fate of Blastopore

- ____: in the gastrula stage, the indentation forms a *mouth*. More phyla are protostomes.
- ____: in the gastrula stage, the indentation forms an anus. Includes chordates (us!) and echinoderms (sea stars).



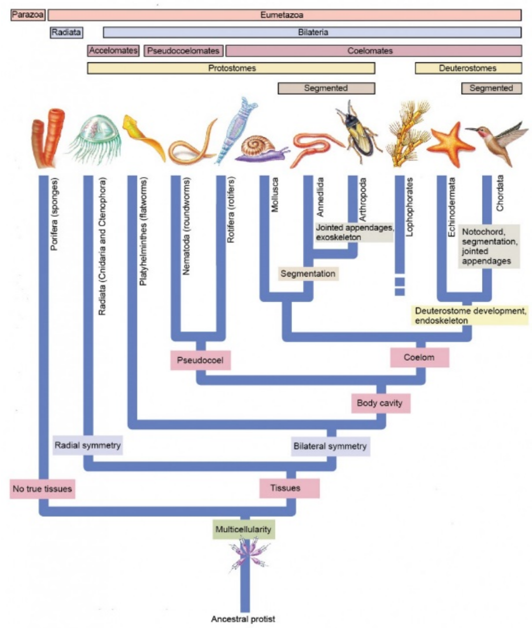
Dichotomous Key – Two types of invertebrates

- ____
- ____

Invertebrates with true tissues are classified by symmetry

- ____
- ____

Invertebrates with bilateral symmetry



- Protostomes____
- Deuterostomes____

Appearance of body cavity

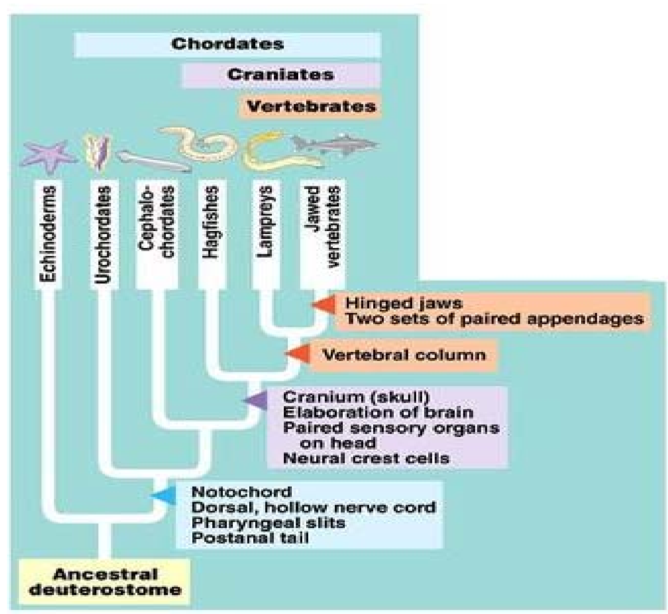
- Pseudocoelomates_______________________________________
- Coelomates____

Deuterostomes

- Echinoderms____
- Chordates____

Development of vertebrate characteristics

- Lancelets & Sea squirts__________________________
- Lamprey_____________________________________
- Cartilaginous fishes ___________________________
- Bony fishes ________________________________
- Lobed-finned fishes ___________________________
- Amphibians__________________________________
- Reptiles_____________________________________
- Birds____
- Mammals_____________________________________



Instructions: Define the terms found in the indicated section of your Campbell-Reece *Biology*.

SECTION 6.1

Microscopy

Instructions: Read section 6.1 of Campbell Reece on MICROSCOPY, p. 94 – 96. Please note the different types of microscopes (light microscopes [LM] and the two types of electron microscopes [EM] — scanning [SEM] and transmission [TEM]). Answer the following questions.

How are specimens prepared when using SEM? Why?

How are specimens prepared when using TEM? Why?

When examining a live specimen, which type of microscope is best – LM or EM?

SECTION 6.2

Comparing Prokaryotic and Eukaryotic Cells

cytosol

eukaryotic cell

prokaryotic cell

nucleoid

cytoplasm

plasma membrane

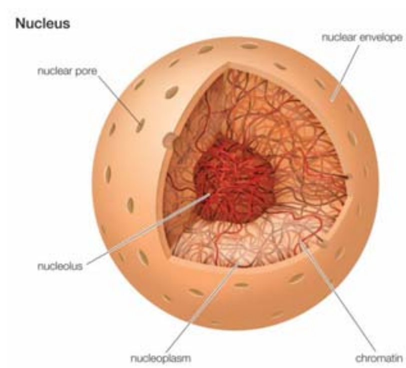
What is the difference between larger organisms and smaller ones? Cell size or quantity of cells? (p. 98)

Examine Figure 6.7 (p. 98) and state its meaning.

Examine the figures on p. 100-101. Note differences & similarities between animal and plant cells.

SECTION 6.3

The Nucleus: Information Central



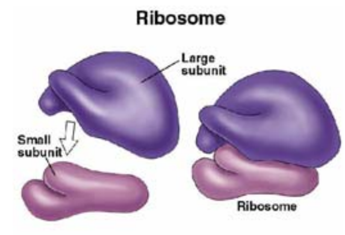
nucleus

nuclear envelope

nuclear lamina

chromosomes

chromatin

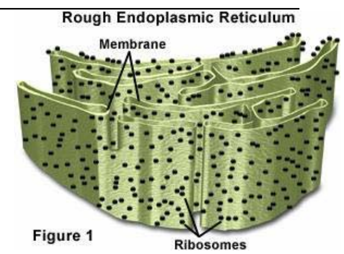


Ribosomes: Protein Factories

ribosomes

SECTION 6.4

Endomembrane system



vesicles

The Endoplasmic Reticulum: Biosynthetic Factory

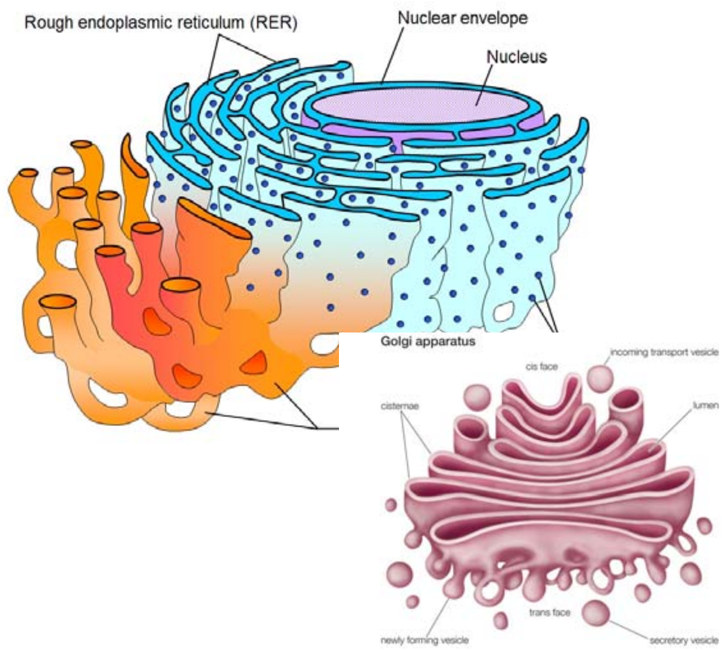
Endoplasmic reticulum (ER)

Smooth ER

Rough ER

Function of rough ER

Glycoproteins

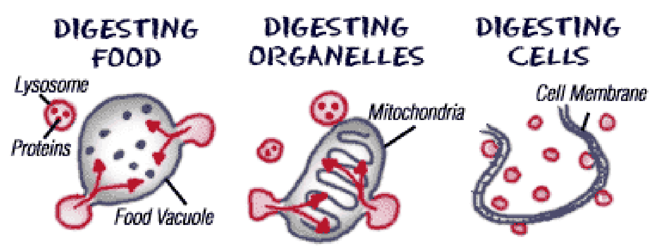


Transport vesicles

The Golgi Apparatus: Shipping and Receiving Center

Golgi apparatus

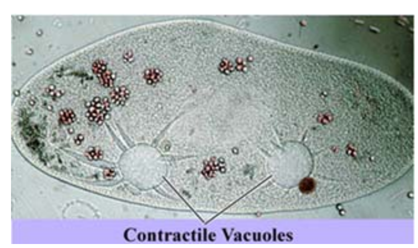
Lysosomes: Digestive Compartments



Lysosome

Phagocytosis

Vacuoles: Diverse Maintenance Compartments



Food vacuoles

Contractile vacuoles

Central vacuole

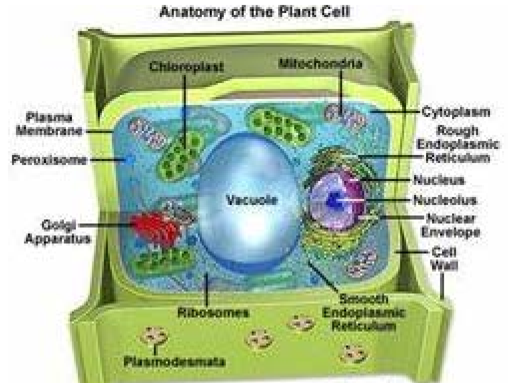


Figure 1

SECTION 6.5

Mitochondria and chloroplasts change energy from one form to another

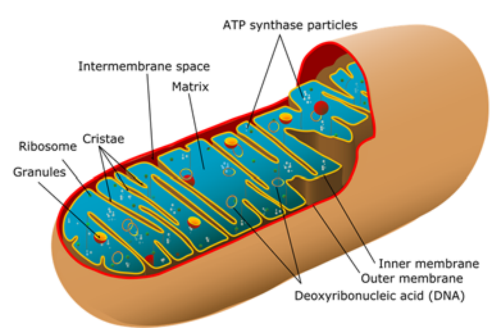
Mitochondria

Chloroplasts

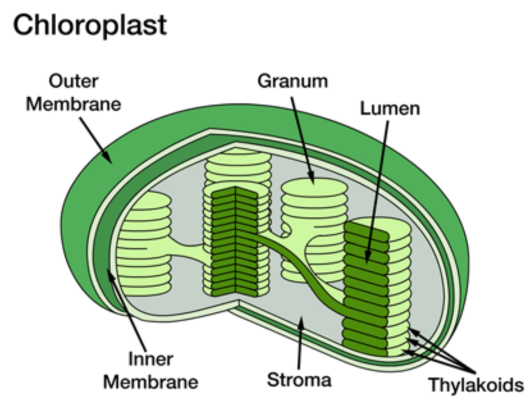
Endosymbiont theory

Mitochondria: Chemical Energy Conversion

Cristae



Mitochondrial matrix



Chloroplasts: Capture of Light Energy

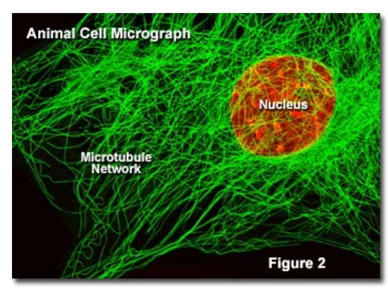
Thylakoids

Granum

Stroma

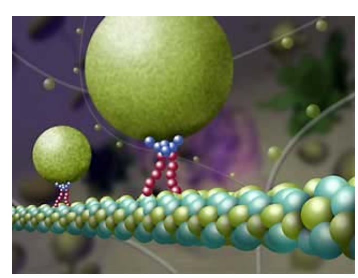
SECTION 6.6

Roles of the Cytoskeleton: Support and Motility



Cytoskeleton

Motor proteins



Background

In this lab, you will study the catalase found in liver cells. You will be using chicken or beef liver.

The purpose or job of the liver is to detoxify substances in the organism's body.

It might seem strange to use dead cells to study the function of enzymes. This is possible because when a cell dies, the enzymes remain intact and active for several weeks, as long as the tissue is kept refrigerated.

Catalase speeds up a reaction which breaks down hydrogen peroxide, a toxic chemical, into two harmless substances – water and oxygen.

The reaction is: $2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

Toxic hydrogen peroxide is converted into two harmless materials, water and oxygen gas, due to catalase.

All tissues – both animal and plant – contain catalase, but some tissues contain more than others.

Materials

- Hydrogen peroxide (H_2O_2), (3%), the kind found in stores - 40 ml or ¼ cup
- Vinegar (acetic acid CH_3COOH) - 1 tablespoon or 10 ml
- Baking soda ($NaHCO_3$) - ¼ teaspoon or 5 g
- Fresh liver, chicken or beef – 1 oz
- Apple – ¼
- Potato – ¼
- Water: room temperature, warm, boiling, ice
- Pans or vessels for water baths – 2. (Note: A boiling water bath, an ice bath, and a warm water bath are all used in this experiment. At one point you'll need two at the same time. Be sure the containers for the baths are large enough to hold the glass vessel of your choice.)
- Knife or straight edge to cut liver, apple, potato
- Small glasses, jars, or test tubes – 6
- Measuring spoons, measuring pipette, or 10 ml graduated cylinder
- Watch or stop watch
- Sharpie to write on glass vessels
- Pot holder, mitt, or test tube holder
- pH paper (optional)

Sample ice bath

PART A - Observe Normal Catalase Reaction

Procedure

1. Place 1 teaspoon or 5 ml of the 3% hydrogen peroxide solution into a clean glass, jar or test tube.
2. Cut a small piece of liver and add it to the vessel. Be sure it is covered by the hydrogen peroxide. Observe the bubbles.

Observation and analysis

What gas is being released? (Consider the equation above.) ________________________

Throughout this investigation you will estimate the rate of the reaction. The reaction rate is the speed of the reaction. You can observe the speed by noting how rapidly the solution bubbles. Please use a scale of 0-5, where 0 = no reaction, 1 = slow, ... 5 = very fast.

Reaction Rate of normal catalase reaction (0 – 5) ___________

Assume that the reaction in step 2 proceeded at a rate of "4."

Recall that a reaction that absorbs heat is *endothermic*; a reaction that gives off heat is *exothermic*. Now, feel the temperature of the vessel with your hand. If you cannot feel a temperature change, note that below.

Has it gotten warmer or colder? ___________

Is the reaction endothermic or exothermic? ____________________

Procedure

3. After the reaction subsides, pour off the liquid (not foam) into a second vessel. Assume the reaction is complete. What is this liquid composed of? ___________________ (Look back at the equation of the reaction.)

Observation and analysis

What do you think would happen if you added more liver to this liquid? Why? _______________________

____

Procedure

Test your hypothesis; add a small piece of liver to the liquid and record the reaction rate.

Reaction Rate (0 – 5)___________

4. Add another teaspoon or 5 ml of hydrogen peroxide to the liver remaining in the first vessel.

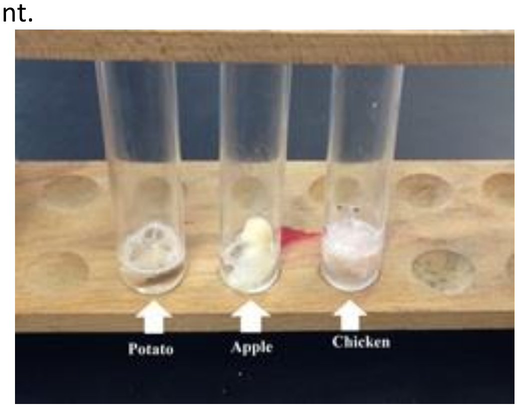
Observation and analysis

What is the reaction rate? ________
Is catalase reusable? Explain how you know.

Procedure

Wash out vessels so that they can be used in next part of the experiment.

Part B – Determining which tissues contain catalase



You will now test for the presence of catalase in tissues other than liver.

Place 1 teaspoon or 5 ml of hydrogen peroxide in each of three clean vessels.

Into each vessel, add one of the following three test substances.

As you add each test substance, record the reaction rate (0-5) for each vessel. (See table below.)

Substance	Rate of Reaction (0-5)
Potato	
Apple	
Chicken	

Observation and analysis

- Based on your observations, which tissue(s) contained catalase? ________________________________
- Do some substances contain more catalase than others? How can you tell? _______________________

  ____

Wash out vessels so that they can be used in next part of the experiment.

PART C - Determining the effect of temperature on catalase activity

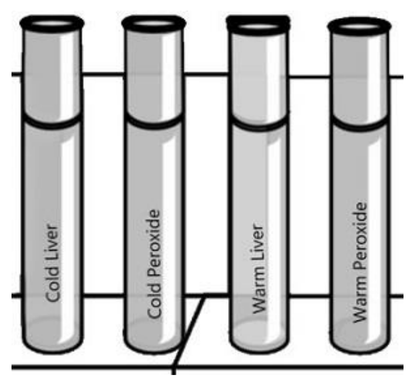
Procedure

1. Put a piece of liver into the bottom of a clean vessel and cover it with a small amount of water (room temperature). Place this vessel in a boiling water bath for 5 minutes.

- Remove the vessel from the hot water bath, allow it to air cool*, then pour out the water.
- Add 1 teaspoon or 5 ml of hydrogen peroxide. Observe the reaction rate.

** While cooling, set up Step 2.*

Record the reaction rate for the boiled liver and peroxide _____



2. Put equal quantities of liver into two clean vessels and ½ teaspoon or 2-3 ml H_2O_2 into two other vessels.

- Put one vessel of liver and one of H_2O_2 into an ice bath.
- Place the other set (one vessel of liver and one of H_2O_2) in a warm water bath (not boiling).
- After 3 minutes, pour each vessel of H_2O_2 into the corresponding vessel of liver and observe the reaction, i.e. cold peroxide into vessel with cold liver, warm peroxide in Bessel with warm liver. Observe each reaction and rate reaction rates below.

What is the reaction rate for the <u>cold</u> liver/peroxide? ______

What is the reaction rate for the <u>warm</u> liver/peroxide? ______

Wash out vessels so that they can be used in next part of the experiment

PART D - Determining the effect of pH on catalase activity

Background

The pH of a solution can have several effects of the structure and activity of enzymes.

- For example, pH can have an effect on the state of ionization of acidic or basic amino acids.
  - Acidic amino acids have carboxyl functional groups in their side chains (R groups).
  - Basic amino acids have amine functional groups in their side chains.
- If the state of ionization of amino acids in a protein is altered then the ionic bonds that help to determine the 3-D shape of the protein can be altered. This can lead to altered protein recognition or an enzyme might become inactive.

Changes in pH *may not only* affect the shape of an enzyme, but it may also change the shape or charge properties of the *substrate.* That means either the substrate cannot bind to the active site or it cannot undergo catalysis.
In general enzymes have a *pH optimum*. However the optimum is not the same for each enzyme.

In the liver, the catalase's reaction increases in proportion to the increasing basicness of the solution. Extreme environments, such as very acidic, very basic, or temperature, denatures – or changes the shape of – the catalase. This denaturing causes the catalase to react more dramatically.

- Acidic solutions added to catalase have smaller and slow reactions.
- Basic solutions have bigger and more rapid reactions.
- Neutral solutions added to catalase have an average reaction and therefore, have the optimum pH for catalase activity in organisms and living things.

This neutral pH of 7 allows for a speedy but not ***dramatic*** reactions. This is crucial for the catalase functioning correctly without harming its host organism, as acidic/slow or basic/rapid could be harmful. H_2O with its neutral pH is highly accessible in most organisms so it is also convenient for the catalase's reaction.

Enzymes and buffers – such as basic salts and acids –are related in the sense that they are both used in the maintenance of homeostasis. Buffers could be released to speed up or slow down the functions of the enzymes. If there is a deadly solution that needs to be broken down immediately a basic buffer may be released to mix with the enzyme of an organism and speed up the process. Both buffers and enzymes are present and crucial in most living things.

Procedure

1. Create a basic solution of baking soda or sodium bicarbonate (NaHCO3). In a separate vessel, dissolve $\frac{1}{8}$ teaspoon or 1 g of baking soda in one tablespoon of water. (Distilled water is preferable, but tap water may be used.) This is the basic solution referred to below.
2. Add 1 teaspoon or 5 ml hydrogen peroxide to each of three clean vessels. Using a sharpie, label each either 1, 2, & 3.
   - Vessel 1 – add 1 teaspoon or 5 ml of acetic acid – CH_3COOH – (acid: vinegar). Acetic acid pH = 2.4
   - Vessel 2 – add 1 teaspoon or 5 ml of basic solution, $NaHCO_3$. Sodium bicarbonate pH = 8.4
   - Vessel 3 – add 1 teaspoon or 5 ml of water (neutral). Water pH = 7

(Optional) Using pH paper, determine the pH of your samples.

- Vessel 1 pH = ______
- Vessel 2 pH = ______
- Vessel 3 pH = ______

3. Now add liver to each of the three vessels.
4. Then add 1 teaspoon or 5 ml of H_2O_2 to each.

Try to do it all at about the same time, so you can easily compare.

Rate of Reaction for: Acid _____ Base_____ Neutral ______

Litmus paper measures pH

Part E - Design an Experiment (optional)

Lactaid is a product designed to help people missing the enzyme, lactase; this condition results in the inability to digest milk sugar (lactose). Lactose intolerance is a condition caused by a genetic anomaly. Lactase breaks down lactose into two subunits: glucose and galactose.

To test for the conversion of lactose into glucose, a food sample is dissolved in water. A small amount of Benedict's reagent is added to the vessel containing the food. Benedict’s reagent does not interact with compounds in reaction; it is simply an indicator of the presence of saccharides. Lactaid is added, and the experiment is underway. As the experiment progresses, the solution changes in color (due to the Benedict’s reagent) blue (indicating no glucose is present), green, yellow, orange, red, and then brick red or brown (indicating a high glucose presence).

On a separate sheet of paper or in the space below, design an experiment in which you determine how quickly Lactaid works to break down milk sugar. Be specific in your description. Use drawings if useful.

Data Analysis

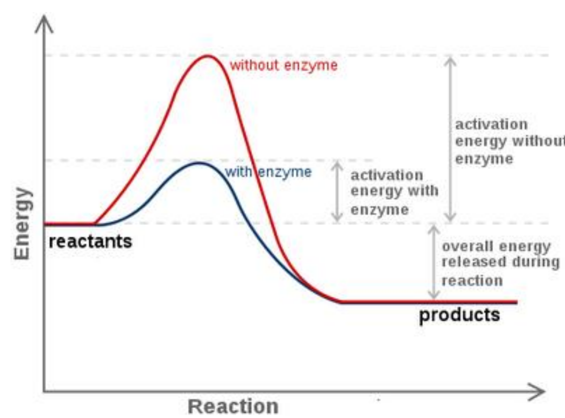
1. (Part A) Is catalase reusable? Use your data to support your answer.

2. (Part C) How does temperature affect the reaction rate of catalase? Why? Consider how temperature affects the movement of molecules.

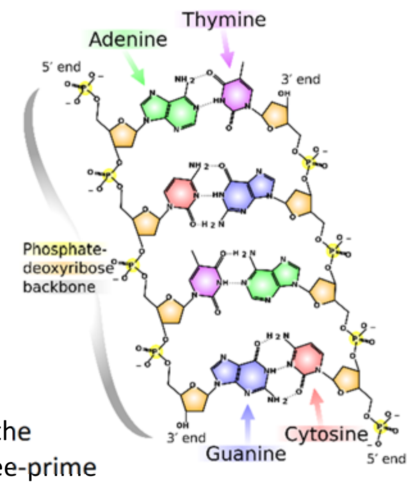
3. (Part D) The presence of acid and base (buffers) affected the reaction rate. Describe how so. When would an organism use the addition of a buffer – either an acid or a base?

4. Propose a theory for why catalase might be present in larger amounts in liver than in vegetables.

5. In 2-3 sentences, summarize the data and information displayed in this graph.



DNA Model



Background

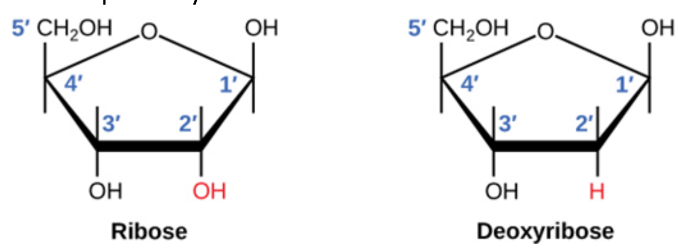
DNA exists most commonly in nature as a double helical structure. The double helix of DNA resembles a twisted ladder. A closer inspection of the chemical structure of the DNA ladder reveals that **the side rails are made of alternating sugar and phosphate molecules**.

The repeating sugar-phosphate groups making up a single strand of DNA are often referred to as the <u>**molecular backbone**</u>.

The deoxyribose sugar (see Figure 1 below) has two connecting sites for the phosphate: the OH groups found on the 3'- and 5'- carbons (spoken "three-prime and five-prime carbons").

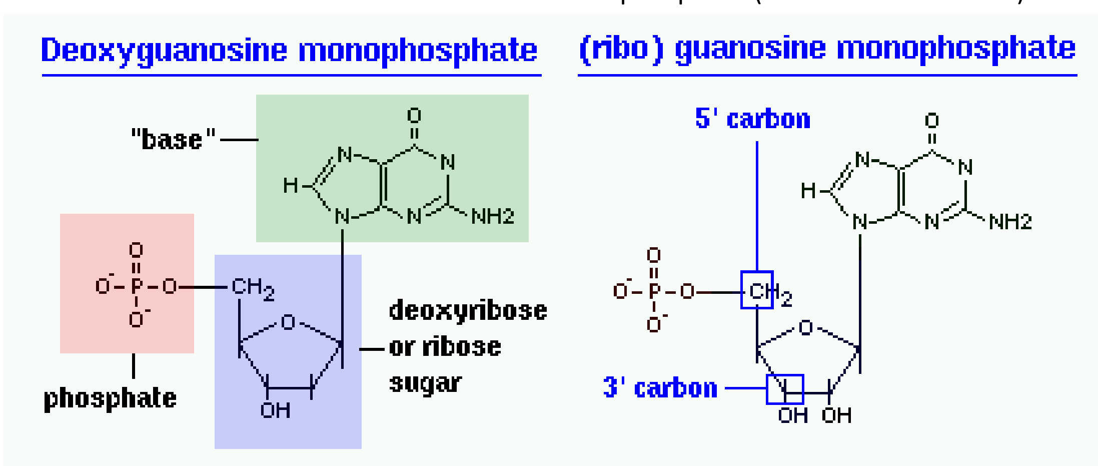
- The reason these carbons are numbered with the prime system is because the attached nitrogen-containing bases are the starting point for the molecular numbering system.
- Carbons on attached molecules are numbered with the prime system.

Figure 1–Chemical structures and numbering systems for sugars found in DNA and RNA.



Individual nucleotides are formed with the phosphate attached to the 5'- carbon.

- As new DNA strands are formed, new deoxyribose sugars with phosphates already attached to their 5'- carbons always connect to the growing strand by bonding to the OH of the 3'-carbon of the last sugar of the growing chain.
- To visualize this process, one can think of the phosphate on the 5'- carbon of the new nucleotide as a lasso that is used to grab the 3'- OH and attach the new unit to the growing chain. As a result, every strand of DNA has one free 5'- end with an unattached phosphate (the first unused lasso).



The "**rungs**" of the DNA ladder are composed of **nitrogen-containing bases, or nitrogenous bases**.

There are four different nitrogen-containing bases in the DNA molecule:

1. adenine (blue in simulation)
2. thymine (yellow)
3. cytosine (red)
4. guanine (green)

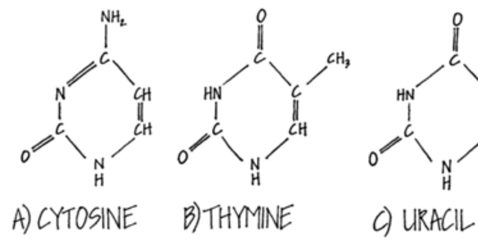


Figure 2 – Chemical structures for the pyrimidine class of nitrogen-containing bases found in DNA and RNA.

These nitrogen-containing bases pair in a very specific way to form the individual **rungs** of the ladder.

- adenine always pairs with thymine
- cytosine always pairs with guanine

These pairs, adenine bonded to thymine and cytosine bonded to guanine, are called **complementary** base pairs.

These pairings maintain the **parallel sides** of the DNA molecule because they have a common length. One larger purine base always pairs with one smaller pyrimidine base (see Figures 2 and 3).

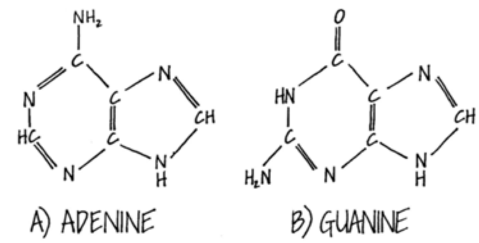


Figure 3 – Chemical structures for the purine class of nitrogen-containing bases found in DNA and RNA.

<u>**Thymine**</u> and <u>**Cytosine**</u> belong to the class of compounds called pyrimidines, which are based on a common 6-atom, **single ring** structure.

<u>**Adenine**</u> and <u>**Guanine**</u> belong to a class of compounds called purines, all of which have a common 9-atom, **double-ring** structure.

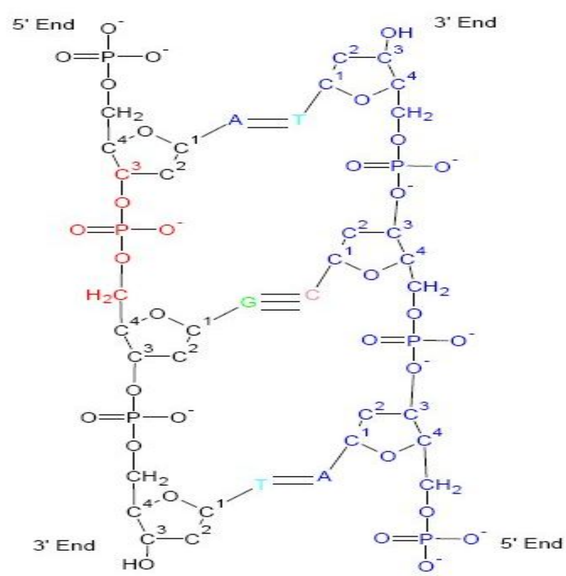
Adenine, thymine, cytosine, and guanine are usually referred to by one-letter codes: **A, T, C, and G** respectively, when recording their sequence in a single strand of DNA.

When DNA forms a ladder or double-stranded structure, the sequence of one strand is always **complementary** to the other.

For example, a strand with the sequence 5’-AACGGT-3’ will bind to a strand with the complementary sequence 3’-TTGCCA-5’.

5’-aaCggT-3’

3’-TTgCCa-5’



These sequences code for specific amino acids. Change the sequence, change the amino acid.

The complementary base pairs forming each rung of the ladder are firmly held together by multiple hydrogen bonds.

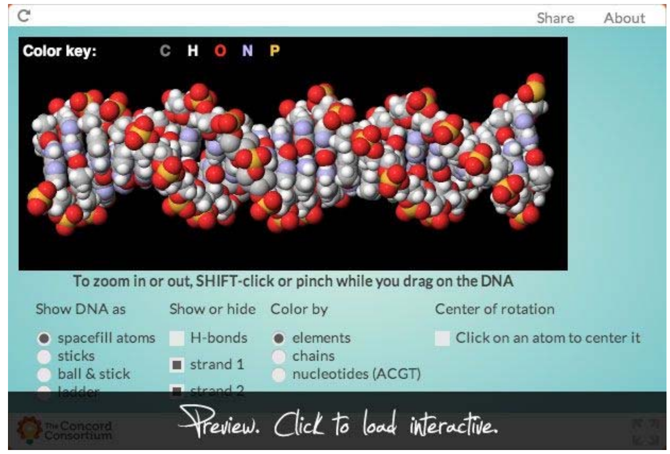
Note the **two hydrogen bonds** between adenine and thymine and the **three hydrogen bonds** between cytosine and guanine.

Procedure

Use the simulation at http://mw.concord.org/nextgen/#interactives/biology/dna/dna-double-helix

The url for the simulation should have been sent in a homework email.

Using the control in the lower right-hand corner of the screen, go full screen with the image of the simulation. Note the instructions for how to zoom and how to manipulate the DNA molecule.



- Note the color key at the top of the simulation.

Select the following:

- Show DNA as a <u>ladder</u>
- Color by <u>elements</u>
- Show <u>Strand 1</u>
- Show <u>Strand 2</u>
- Show <u>H bonds</u>

Zoom in and orient the molecule so that you can perceive the "rungs" of the helix.

As you use your mouse to turn the molecule, make the following observations.

- Note that some nucleotides bond with two H bonds, while others bond with three.
- Note that there is a regular pairing of purines and pyrimidines.
- Note that some bases have two rings, while others have three.

Now select Show DNA as <u>sticks</u>.

- Observe the H bonds.

Now select Color by <u>nucleotides</u>.

- Make note of the color pattern you see.

Data Analysis

1. Explain complementary base pairing and how it affects the DNA molecule structure.

____

____

____

2. Why do some bases pair with two H bonds, while other pair with three?

____

____

____

3. Draw a picture of or describe in words what the DNA ladder would look like if purines matched with purines and pyrimidines matched with pyrimidines.

4. When *Color by* *nucleotides* was selected, describe what you observed about the pattern of the colors.

____

____

____

5. Hypothesize why specific nucleotide sequences and complementary base-pairing are important to the function and structure of the DNA molecule.

____

____

____

6. What consequences may occur if sequences of nucleotides in the DNA are altered?

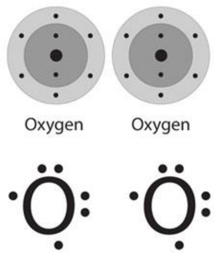
____

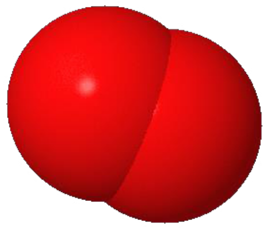
____

____

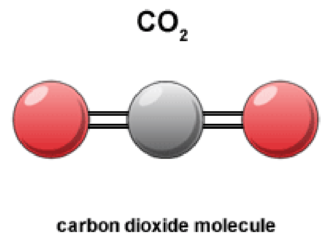
Simple molecules essential to life

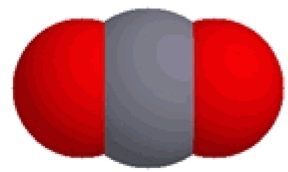
1. Oxygen gas: O_2



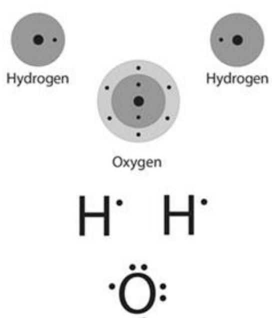


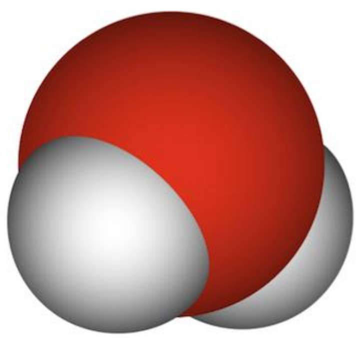
2. Carbon dioxide gas: CO_2





3. Water



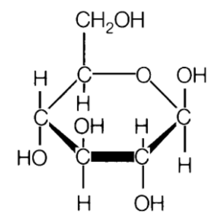


Biological molecules

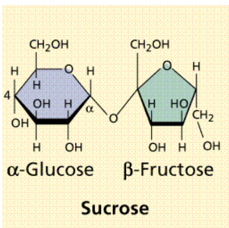
1. Carbohydrates are made from sugars.

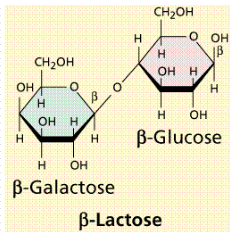
    - Sugars: a type of carbohydrate called a saccharide
    - Glucose is used by cells to create fuel (ATP) for cellular activities
    - Sugars always end in -ose

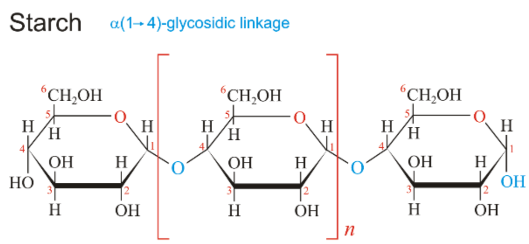
Glucose



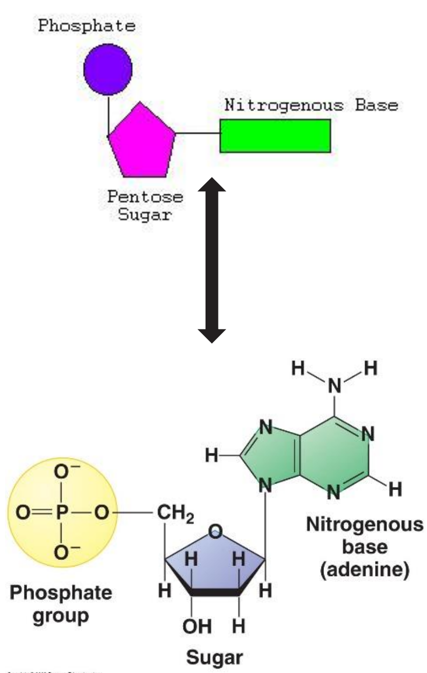
Polysaccharide

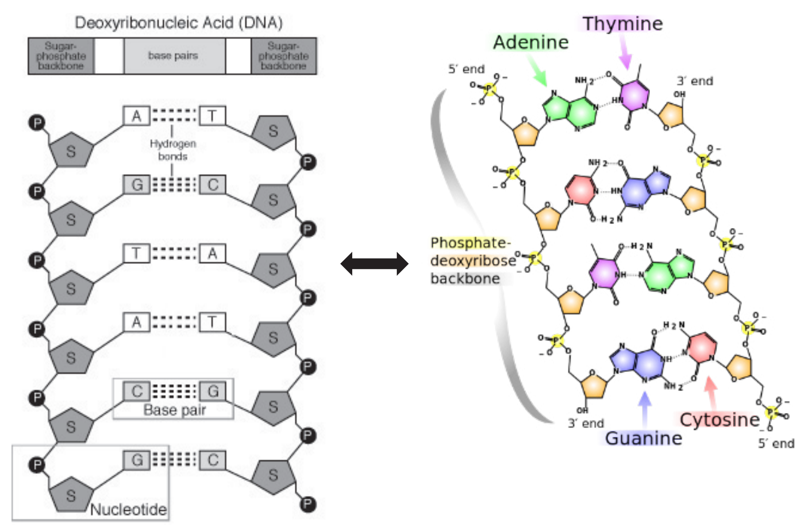




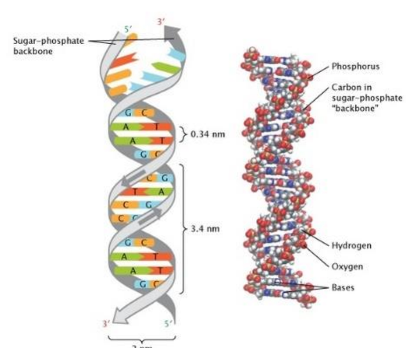


2. Nucleotides – the building blocks of nucleic acids (DNA & RNA)

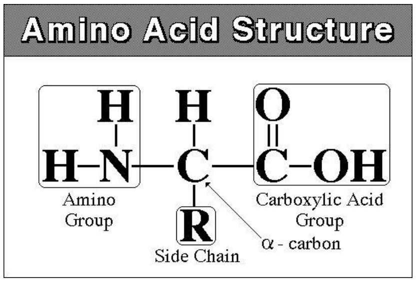


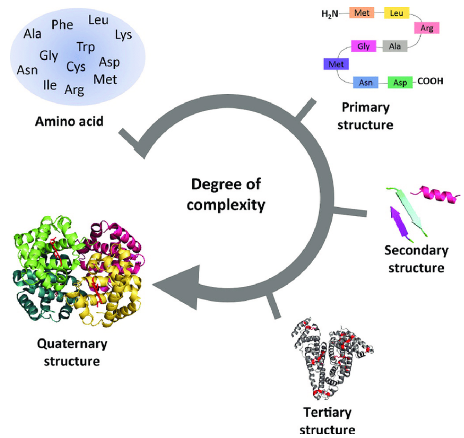


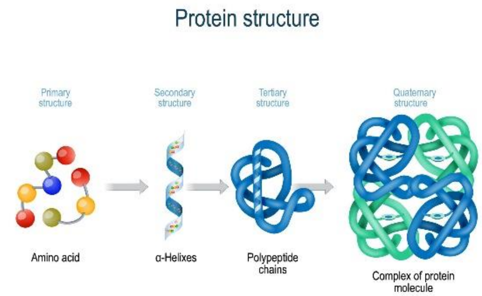
DNA



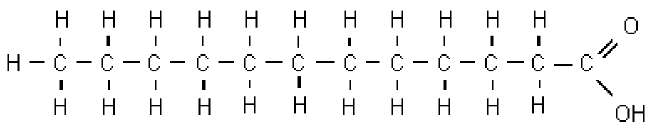
3. Amino acids join together to form polypeptides which form complex proteins



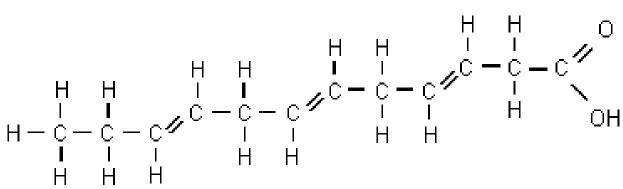




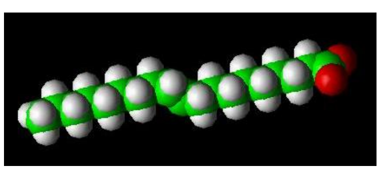
4. Fatty acids, aka lipids, are long strings of bonded carbons



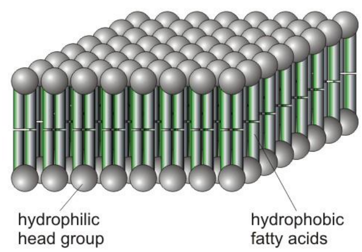
Saturated Fatty Acid

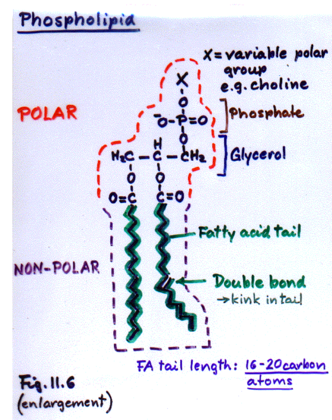


Unsaturated Fatty Acid

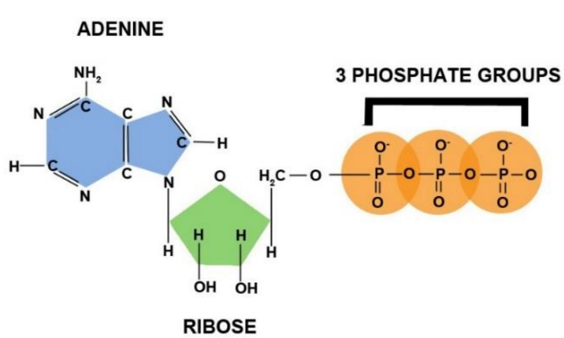


Phospholipid bilayer

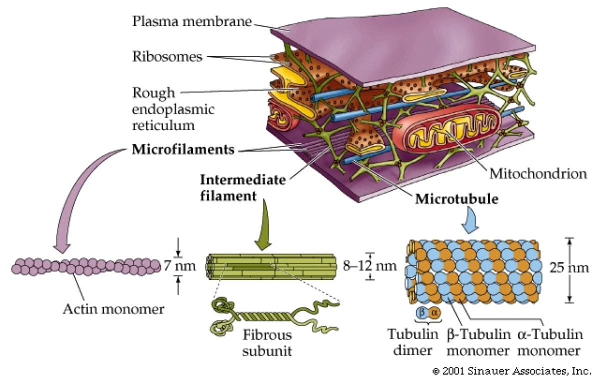




5. ATP: Adenosine triphosphate – the fuel used by cells to do all cellular activities



CYTOSKELETON: SUPPORT, MOTILITY & REGULATION

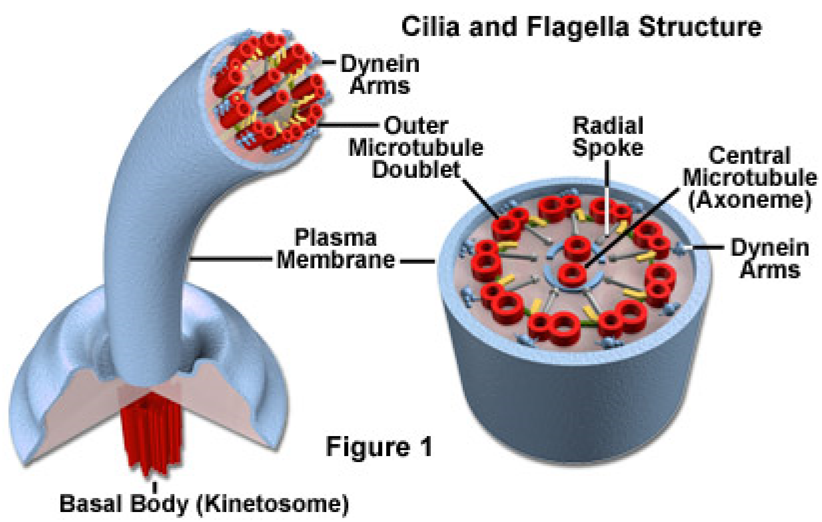


- A network of fibers that organizes structures and activities in the cell
- It extends throughout the cytoplasm
- It anchors many organelles
- It enables the cell to move

It is composed of three types of molecular structures

- *Microtubules* are the thickest of the three, but are hollow. Create spindle during mitosis, move organelles and vesicles, form centriole, cilia and flagella in animal cells
- *Microfilaments*, also called actin filaments, are the thinnest components, provide the 3D shape of the cell, are responsible for muscle contraction, cytoplasmic streaming, amoeboid movement
- *Intermediate filaments* are fibrous proteins supercoiled into thicker cables, rope-like structure; maintain cell shape & form the nuclear lamina

SPECIAL MICROTUBULES: CILIA & FLAGELLA



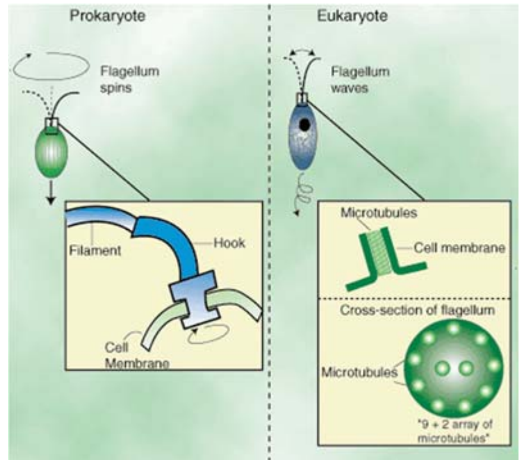
- Come from an extension of the plasma membrane
- Bundles of microtubules covered with plasma membrane
- Nine fused pairs of microtubules surrounded by one pair, unfused, in the center (9+2 structure)
- The motor protein Dynein drives the bending movement of cilium or flagellum
- Microtubule doublets with dynein arms and spoking patterns
- The "Basal Body" is a cylindrical organelle that anchors the cilium or flagellum – triplets of microtubules

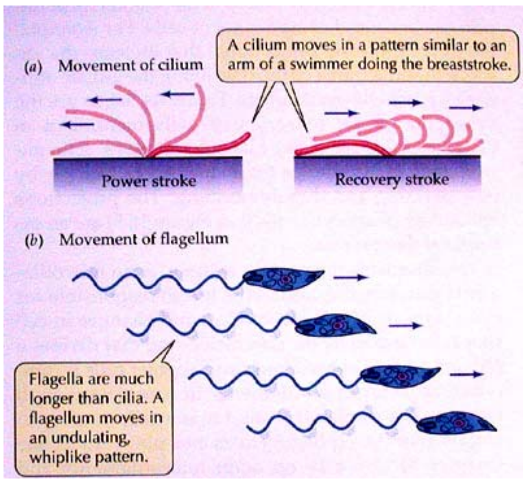
Cilia: Latin - "eyelash"

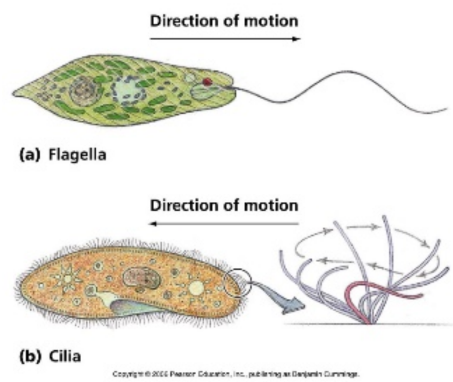
- Hair-like extensions covering cell surface
- Example: lining of lungs, act as filter
- Provide cell movement or move substances across cell surface
- Occur in large numbers on cell surface
- Move like oars

Flagella

- Whip-like extensions
- Few
- Provide cell movement
- Prokaryotic Flagella and Eukaryotic Flagella are NOT the same – in structure or in movement

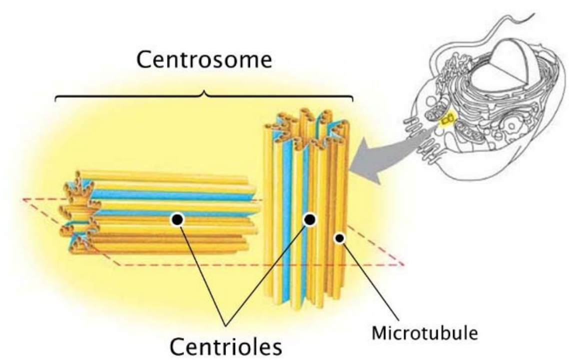






Special Microtubules – Centriole

- Pair of cylindrical structures in animal cells arranged at right angles to each other
- Move & separate the cell's chromosomes during cell division
- Two centrioles = centrosome (*soma* = body, Gr.)



NUCLEUS

- The nucleus contains most of the DNA in a eukaryotic cell