



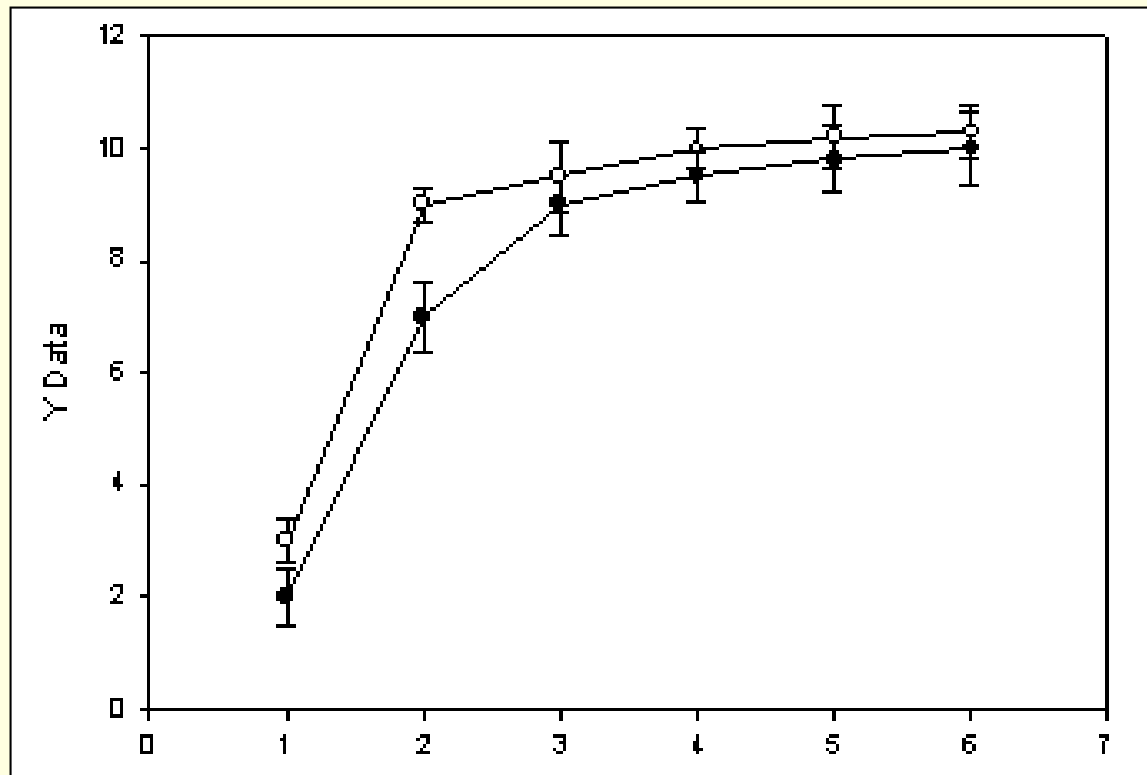
*Unit 1: Statistical Analysis*



Unit 1: Statistical Analysis

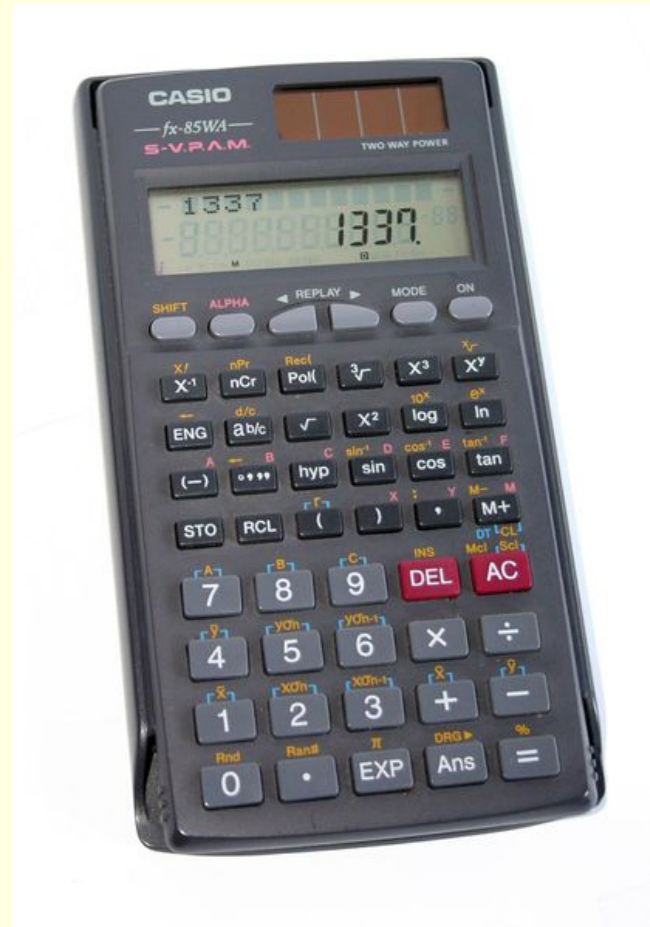
## 1.1.1 State that error bars are a graphical representation of the variability of data.

- Error bars can be used to show either the range of the data or the standard deviation.



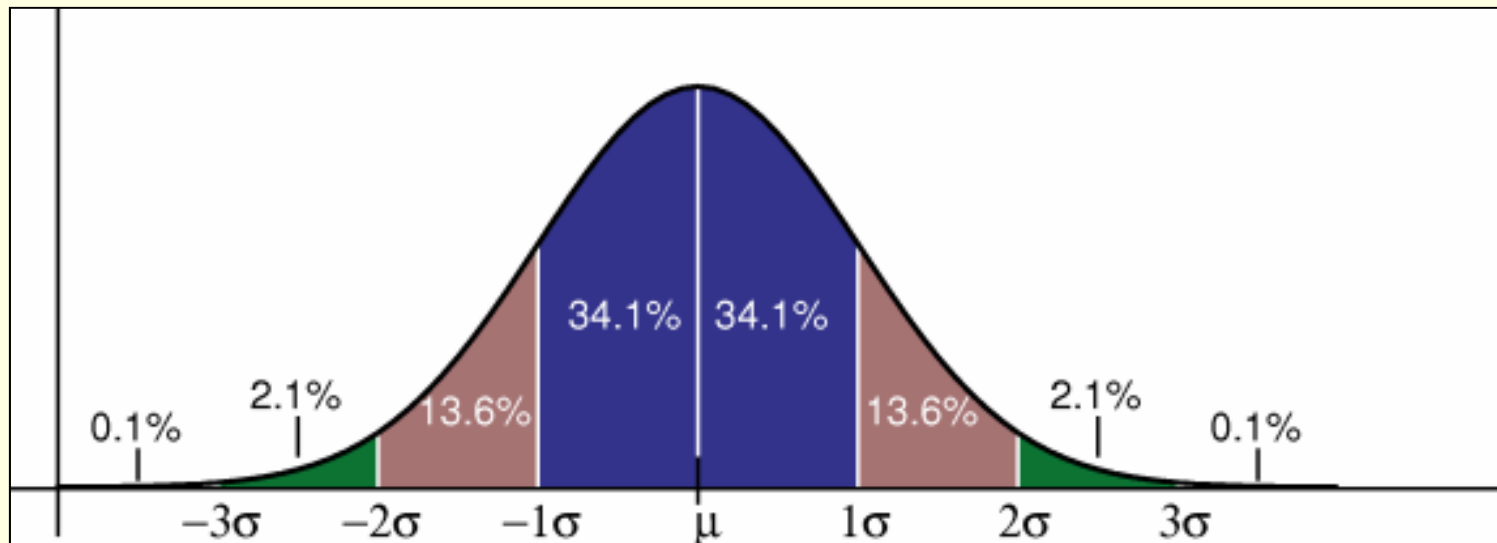
## 1.1.2 Calculate the mean and standard deviation of a set of values.

- Students may use a scientific calculator, and are not required to know the formula.



## 1.1.3 State that the term standard deviation is used to summarize the spread of values around the mean.

- Standard deviation- 68% of all values lie within +/- 1 standard deviation of the mean. 95% of values lie within +/- 2 standard deviations of the mean.



## 1.1.4 Explain how the standard deviation is useful for comparing the means and the spread of data between two or more samples.

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- When comparing data between two sample sets, the closer the means and the standard deviations, the more likely the samples came from the same population.



## 1.1.5 Deduce the significance of the difference between two sets of data using calculated values for $t$ and the appropriate tables.

- Criteria for  $t$ -test:
  - Normal distribution
  - Sample size of at least 10
- The  $t$ -test can be used to compare two sets of data and measure the amount of overlap.(two-tailed, unpaired  $t$  test).
- If the value of  $t$  is  $>$  the critical value at .05, then there is a significant difference between the two sets of data, and the null hypothesis should be rejected.

$$t = \frac{X_1 - X_2}{\sqrt{\left(\frac{SS_1 + SS_2}{n_1 + n_2 - 2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$X_1$  is the mean for group 1,

$X_2$  is the mean for group 2,

$SS_1$  is the **sum of squares** for group 1,

$SS_2$  is the **sum of squares** for group 2,

$n_1$  is the number of subjects in group 1, and

$n_2$  is the number of subjects in group 2.

**DF** (Degrees of freedom ) =  $n_1 + n_2 - 2$

## 1.1.6 Explain that the existence of a correlation does not establish that there is a causal relationship between two variables.

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- A student takes an exam during a lightning storm. The student fails the exam. Did the lightning *cause* the student to fail? No, not necessarily.
- Correlation does not imply causation.



## *Unit 2: Cells*

# Lesson 2.1 Cell Theory

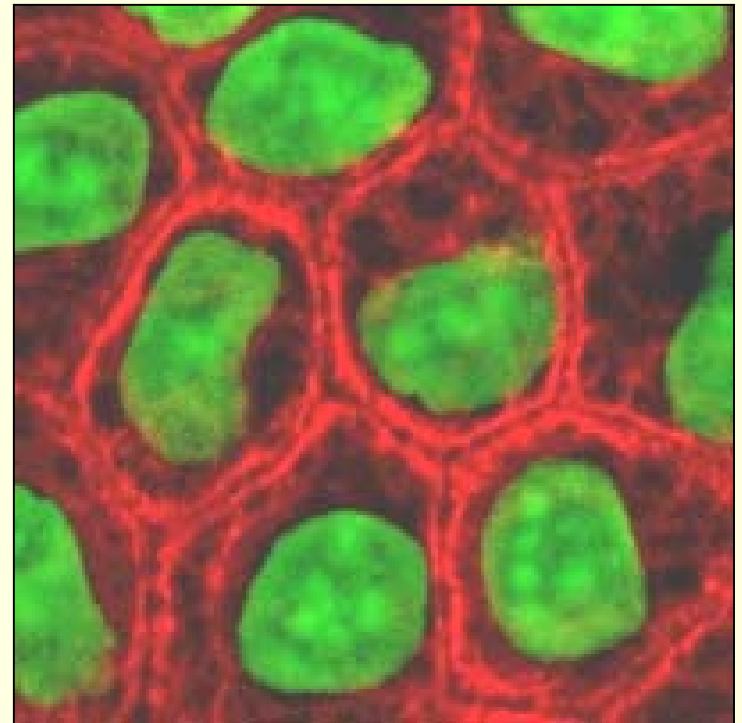


# 2.1.1 Outline the Cell Theory.

## The Cell Theory

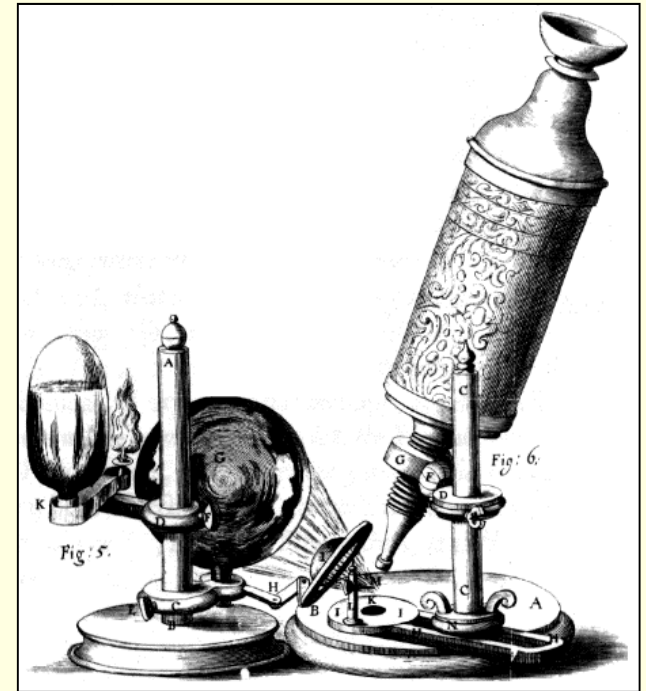
Proposed by Rudolf Virchow in 1855:

- 1) Living organisms are composed of cells.
- 2) Cells are the smallest unit of life.
- 3) Cells come from pre-existing cells.



## 2.1.2 Discuss the evidence for the cell theory.

- 1665 Hooke- examines cork under microscope.
- 1674 Leeuwenhoek- observes simple organisms in pond water.
- 1838 Schleiden- studies plant tissue under microscopes
- Schwann- studies animal tissue under microscopes.
- Virchow- Proposes the Cell Theory.



Hooke's Microscope

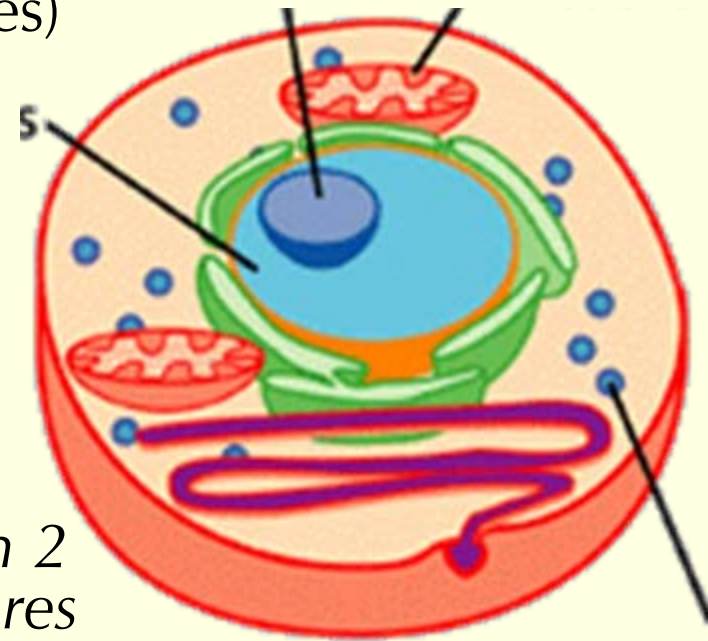
## 2.1.3 State that unicellular organisms carry out all the functions of life.

- Kingdom Protoctista (sometimes called Protista) consist primarily of unicellular organisms. Each individual carries on the full spectrum of metabolic reactions associated with life.
- Pictured here is a paramecium.



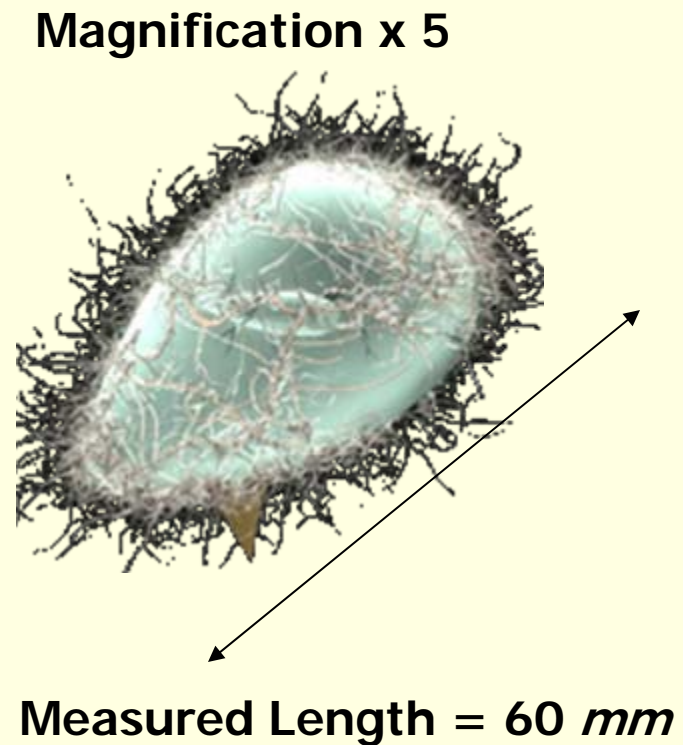
## 2.1.4 Compare the relative sizes of molecules, cell membrane thickness, viruses, bacteria, organelles, and cells.

- Molecules: 1 nm
  - Membranes: 10 nm (on organelles)
  - Viruses: 100 nm
  - Bacteria: 1  $\mu\text{m}$
  - Organelles: up to 10  $\mu\text{m}$
  - Most cells: up to 100  $\mu\text{m}$
- *Note: measurements above are in 2 dimensions, remember all structures have 3 dimensional shape.*



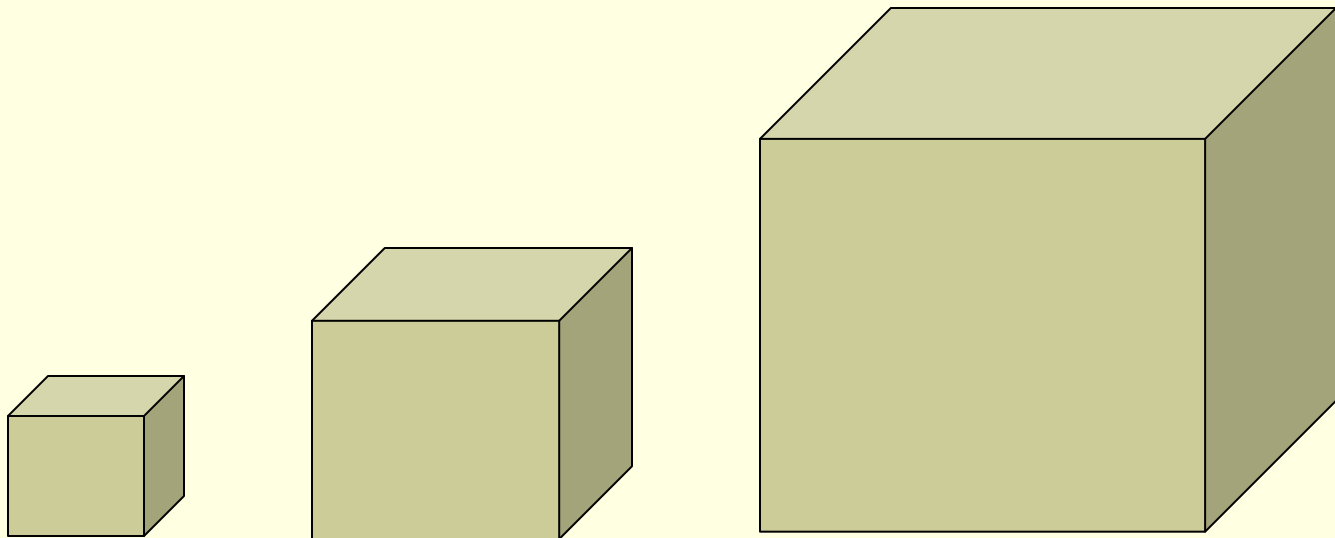
## 2.1.5 Calculate linear magnification of drawings.

- What is the actual size of this specimen in micrometers ( $\mu\text{m}$ )?
- Actual size = measured length/magnification
- $60\text{mm}/5 = 12\text{mm}$
- $12\text{mm} \times 1000 \mu\text{m} = 12,000 \mu\text{m}$



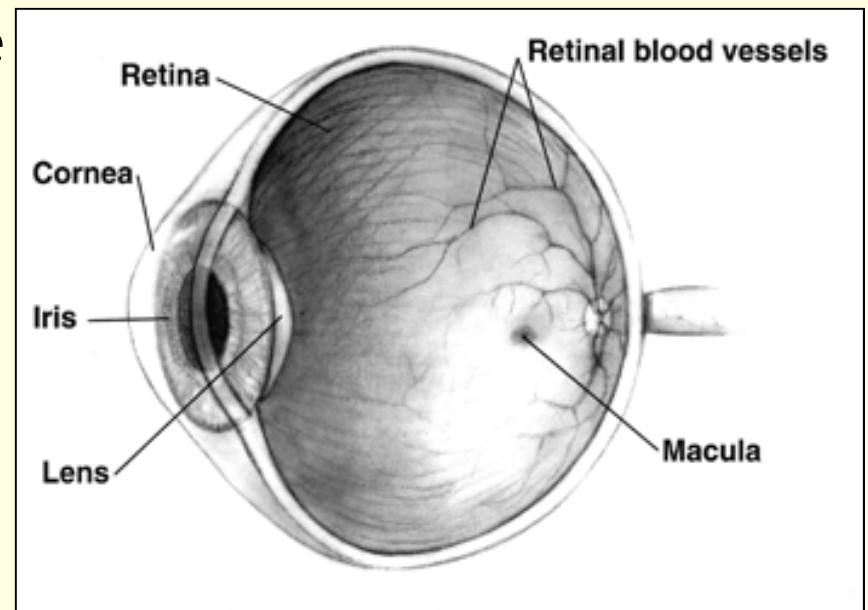
## 2.1.6 Explain the importance of the surface area to volume ratio as a factor limiting cell size.

- As a cell grows larger in volume, its metabolic demands increase faster than the surface area's ability to meet those needs, hence a maximum size is reached.



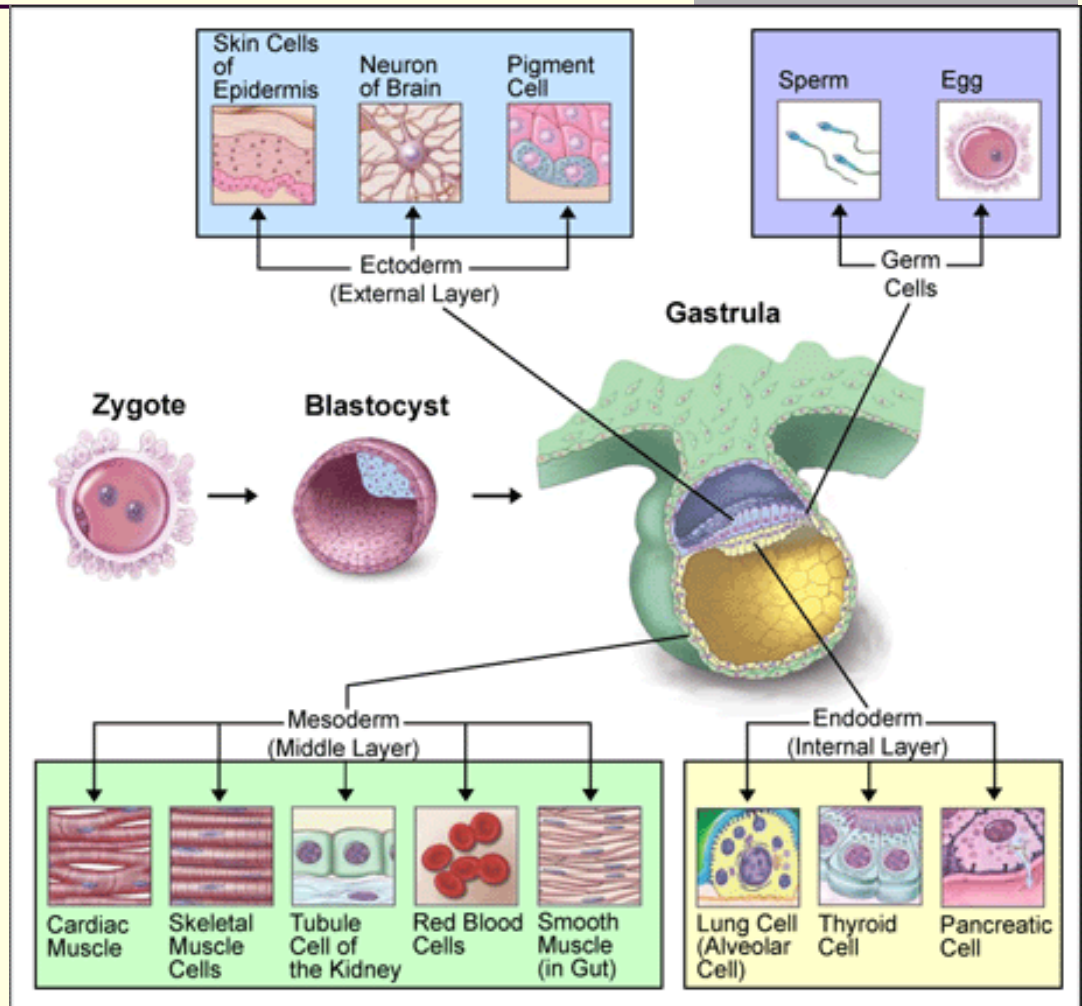
## 2.1.7 State that multicellular organisms show emergent properties.

- Emergent properties arise from the interaction of component parts: the whole is greater than the sum of its parts.



## 2.1.8 Explain how cells in multicellular organisms differentiate.

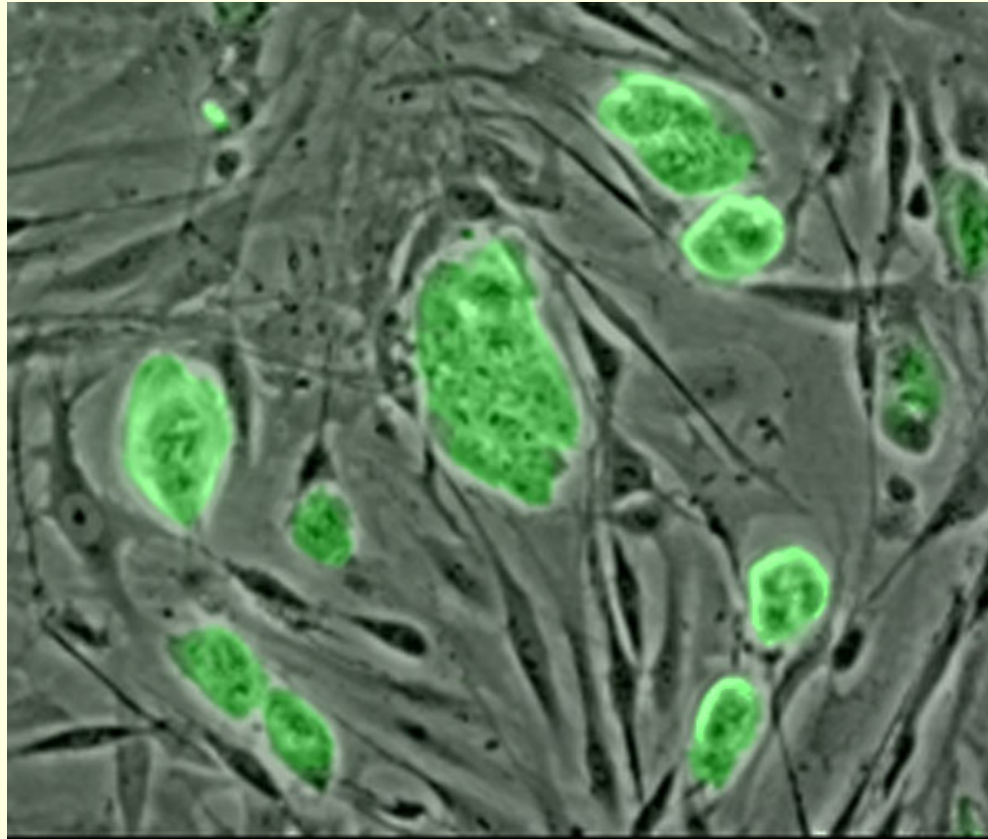
- Cells can differentiate from each other by selectively turning genes on and off.
- Each type of cell switches on those genes specific to its particular role in the body.





## 2.1.9 State that stem cells retain the capacity to divide and have the ability to differentiate along different pathways.

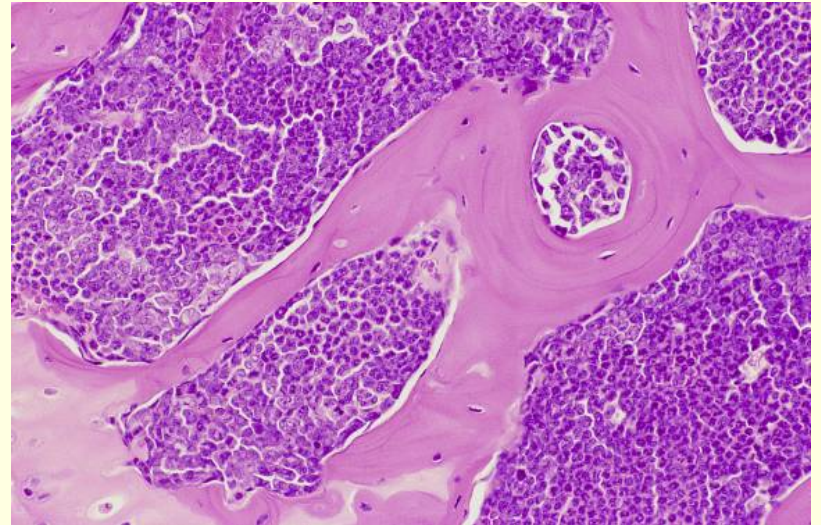
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Mouse embryonic stem cells with a fluorescent marker.

## 2.1.10 Outline one therapeutic use of stem cells.

- Stem cells from bone marrow have been used in the therapeutic treatment of leukemia.



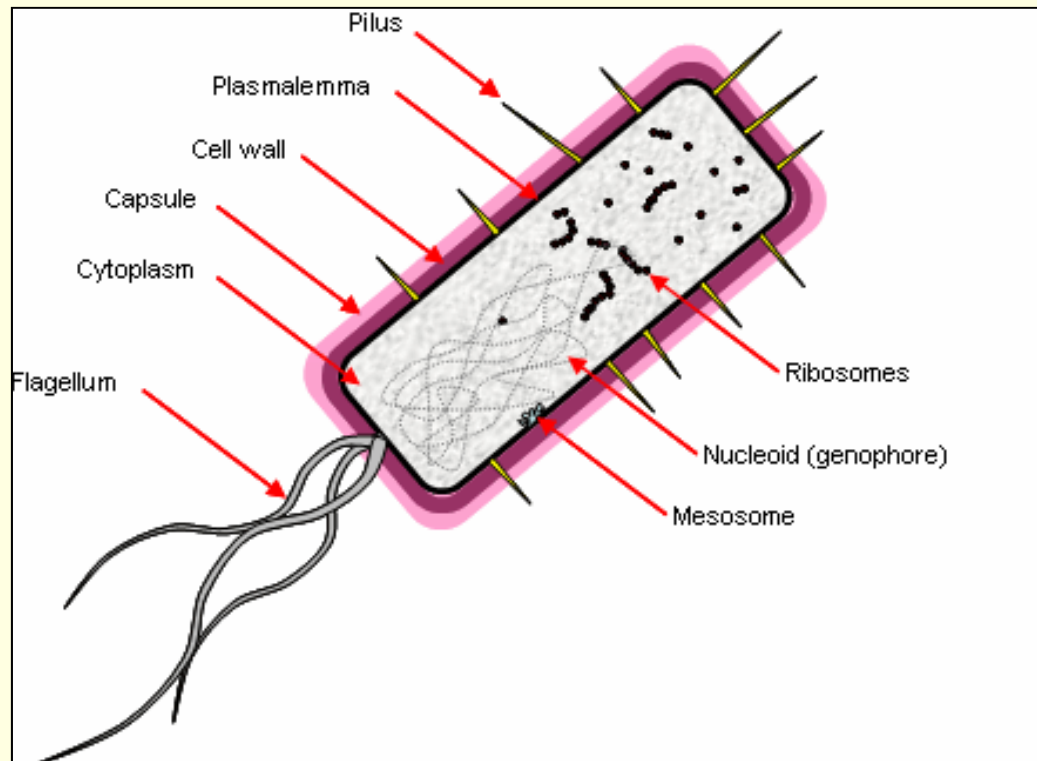
## *Unit 2: Cells*

### Lesson 2.2 Prokaryotic Cells

## 2.2.1 Draw and label a diagram of the ultrastructure of *E. Coli* as an example of a prokaryote.

Locate the following:

Cell wall, plasma membrane, cytoplasm, ribosomes, naked DNA (nucleoid), pili



## 2.2.2 Annotate the diagram from 2.2.1 with the functions of each named structure.

Cell wall- protection.

Cytoplasm- intracellular fluid containing organelles, enzymes, and other molecules.

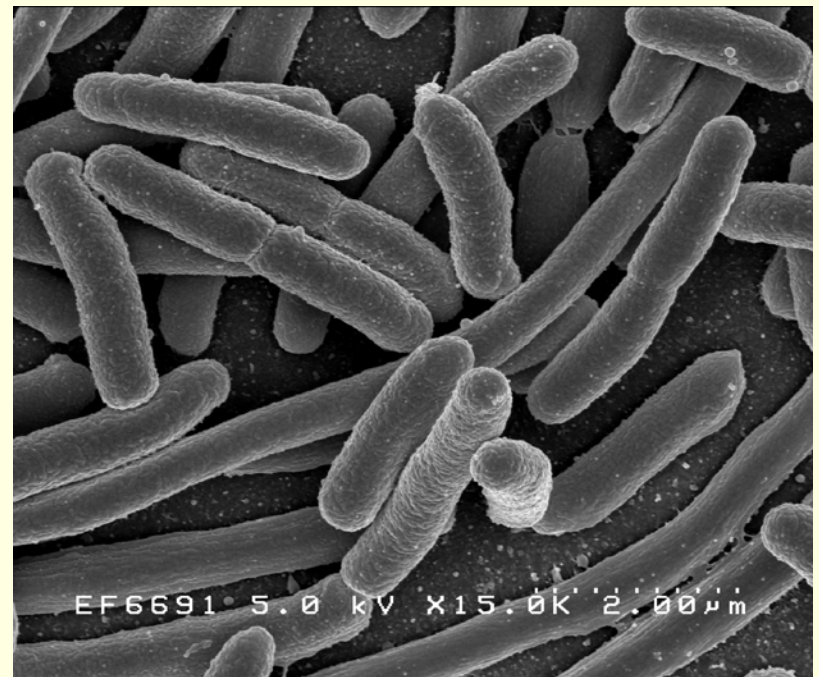
Nucleoid- contains naked (non-membrane bound) DNA.

Ribosomes- synthesize proteins.

Plasma membrane- controls what enters and leaves the cell.

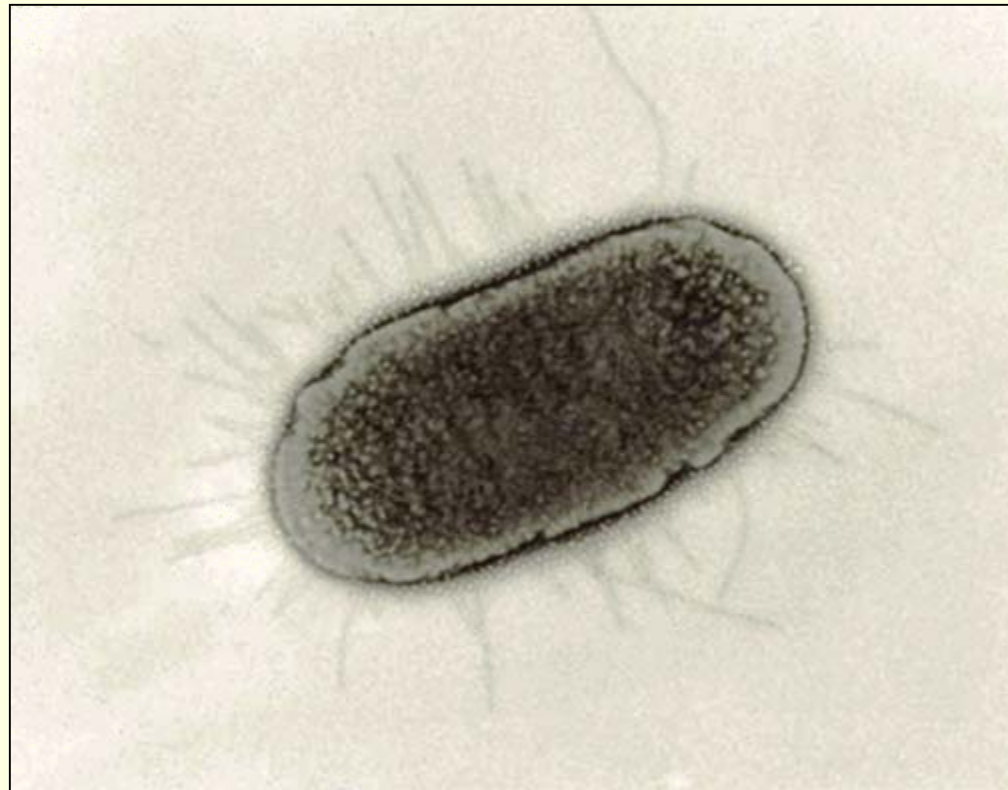
Flagella- cell motility.

Pili- adhesion to other cells and sexual reproduction.



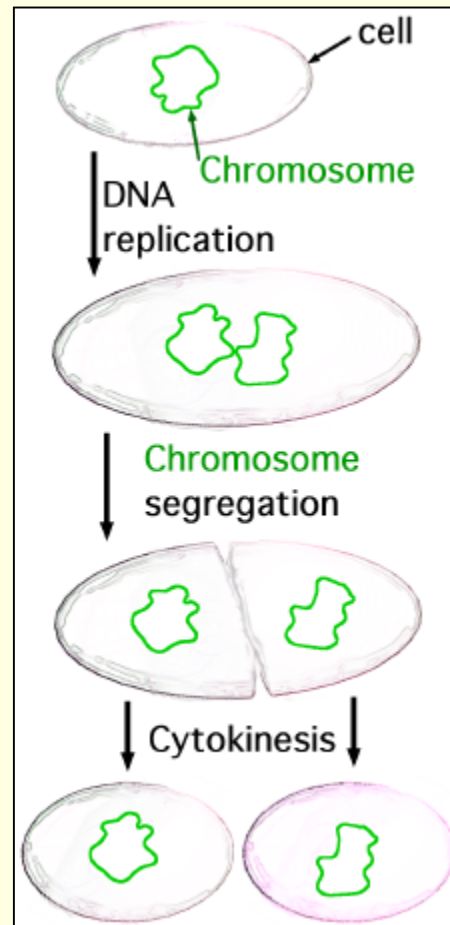
## 2.2.3 Identify structures from 2.2.1 in electron micrographs of *E. Coli*.

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Courtesy of Ohio State University

## 2.2.4 State that prokaryotic cells divide by binary fission.





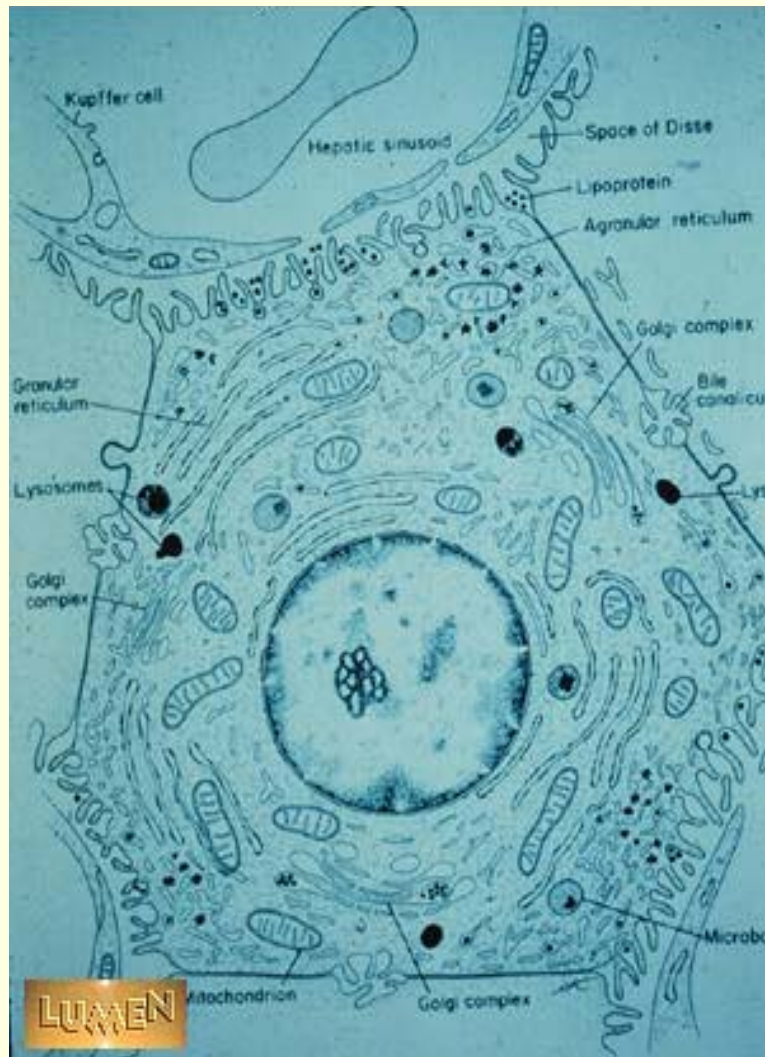
## *Unit 2: Cells*



### Lesson 2.3 Eukaryotic Cells



## 2.3.1 Draw and label a diagram of the ultrastructure of a liver cell as an example of an animal cell.



Courtesy of Loyola University School of Medicine.

## 2.3.2 Annotate the diagram from 2.3.1 with the functions of each named structure.

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Ribosomes- synthesize protein.

Rough endoplasmic reticulum- a network of membrane tubes, dotted with ribosomes, which help transport substances about the cell.

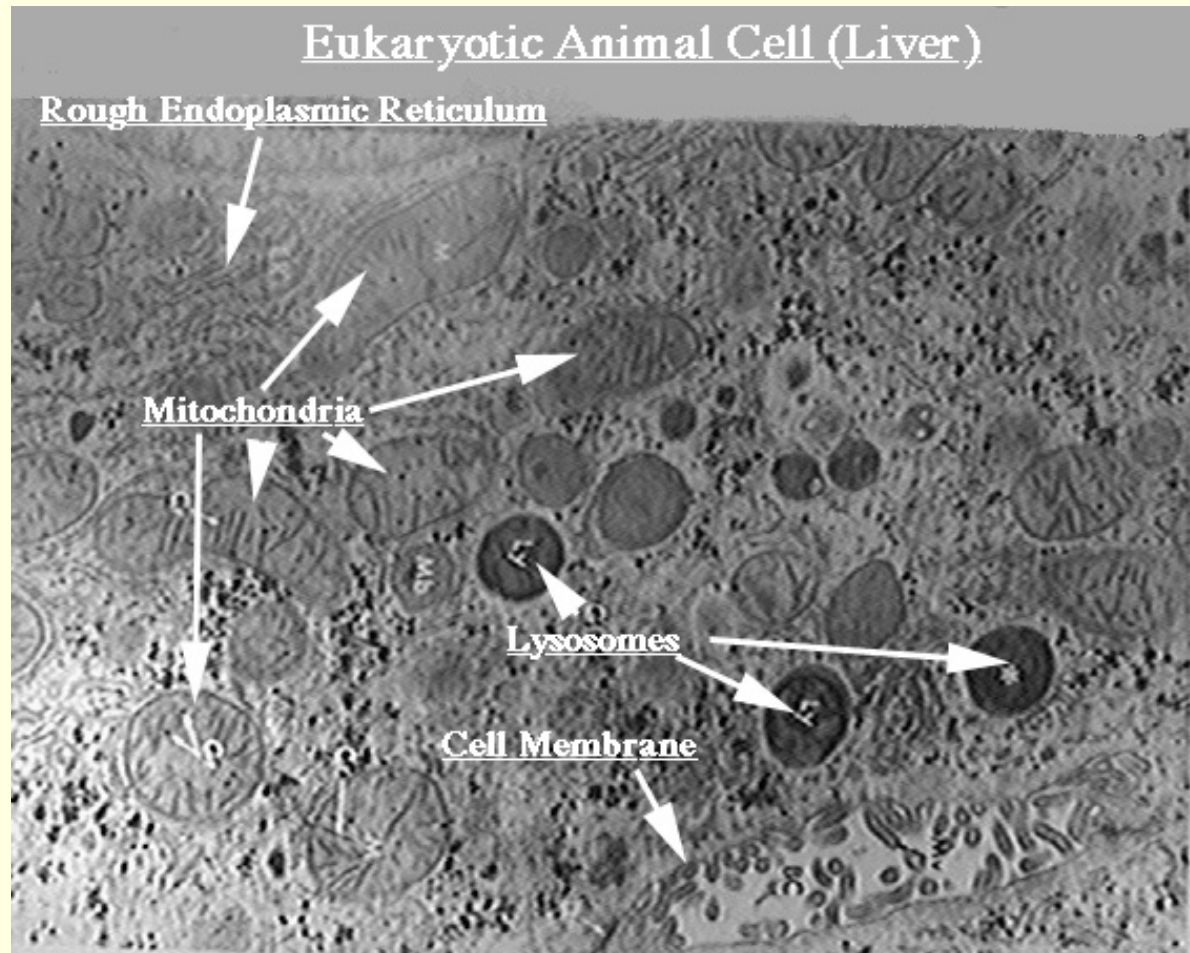
Lysosome- contain digestive enzymes which help break down macromolecules.

Golgi apparatus- process and package proteins for secretion.

Mitochondria- move high energy electrons from glucose to ATP.

Nucleus- contains DNA, the genetic material for a cell.

## 2.3.3 Identify structures from 2.3.1 in electron micrographs of liver cells.



## 2.3.4 Compare prokaryotic and eukaryotic cells.

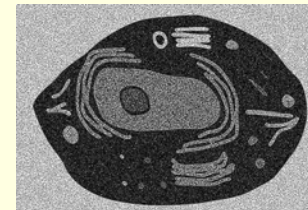
### Prokaryotic Cells:

- Naked DNA
- DNA in cytoplasm
- No mitochondria
- 70s ribosome  
(s=svedberg unit, measurement of the size of organelles.)



### Eukaryotic Cells:

- DNA/Protein combination
- DNA in nuclear envelope
- Mitochondria
- 80s ribosomes
- (s=svedberg unit, measurement of the size of organelles.)

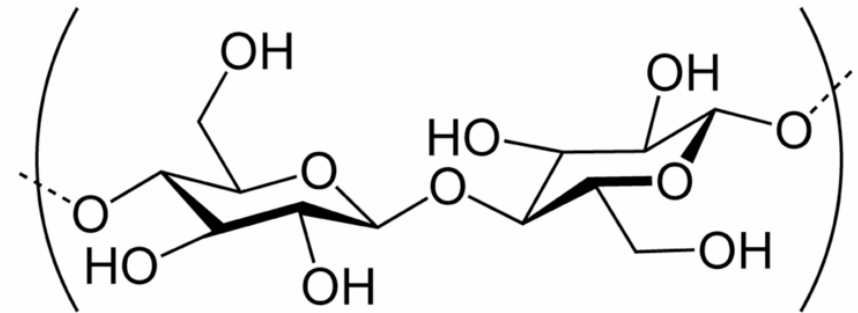


## 2.3.5 Describe three differences between plant and animal cells.

	Plant Cells	Animal Cells
Cell Wall	Yes	No
Chloroplast	Yes	No
Large Central Vacuole	Yes	No
Store energy as	Starch	Glycogen
Centrioles	No	Yes

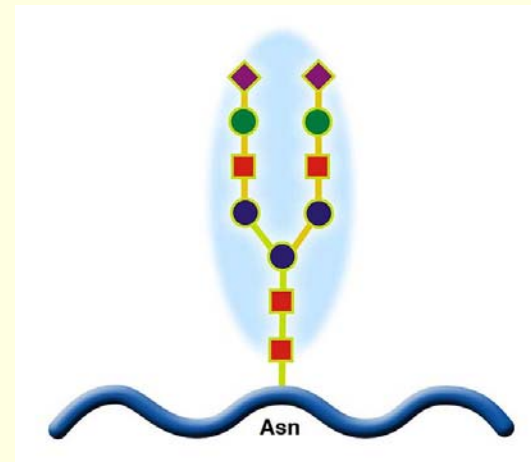
## 2.3.6 Outline two roles of extracellular components.

Cellulose- carbohydrates make up the cell wall and (like scaffolding) help give the cell a definite shape.



Cellulose

Glycoproteins- compose an extracellular matrix which aids in support, adhesion and movement.



Glycoprotein



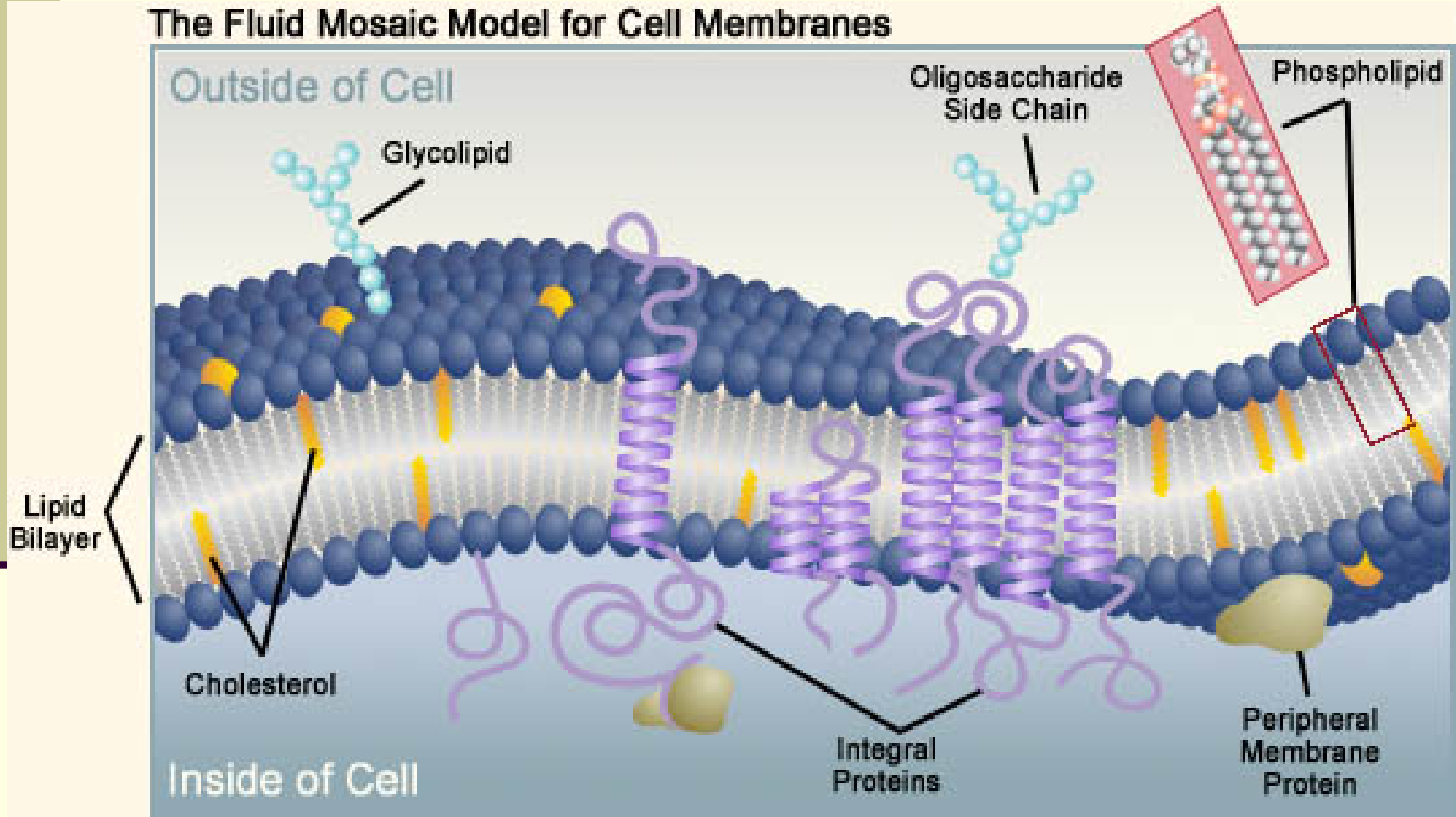
## *Unit 2: Cells*



### Lesson 2.4 Membranes

## 2.4.1 Draw and label a diagram to show the structure of membranes.

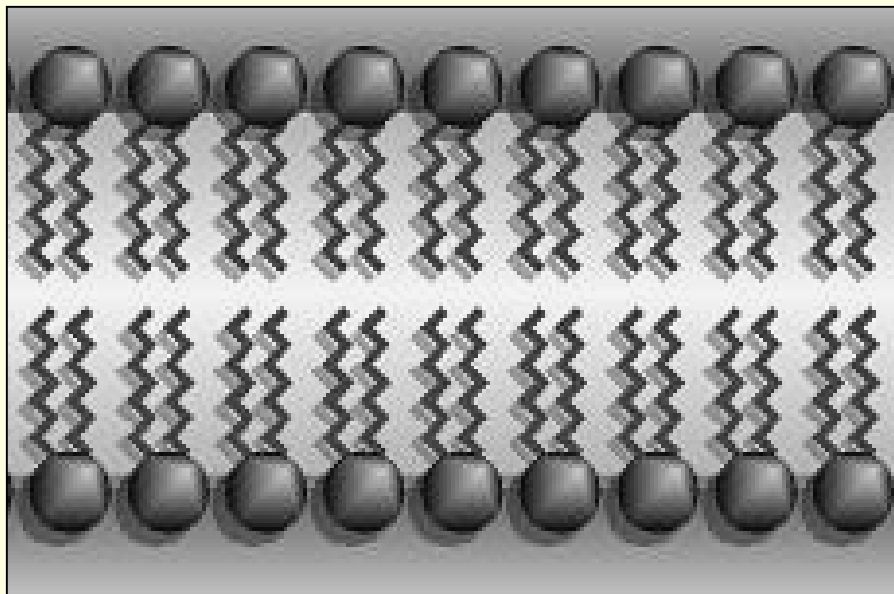
The Fluid Mosaic Model for Cell Membranes





## 2.4.2 Explain hydrophobic and hydrophilic properties of the plasma membrane.

- The exterior heads (circles in picture) are hydrophilic. The fatty acid tails (zigzag in picture) are hydrophobic. The bilayer configuration serve as a barrier to many molecules.

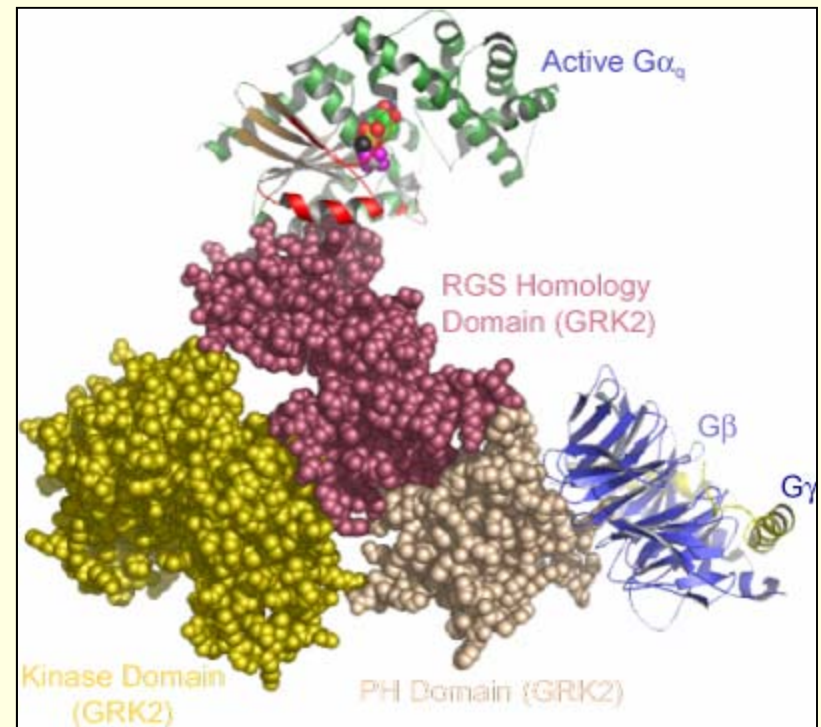


Hydrophilic- water loving

Hydrophobic- water repelling

## 2.4.3 List the functions of membrane proteins.

- Hormone binding sites
- Enzymes
- Electron carriers during photosynthesis and cell respiration
- Channels for passive transport
- Pumps for active transport



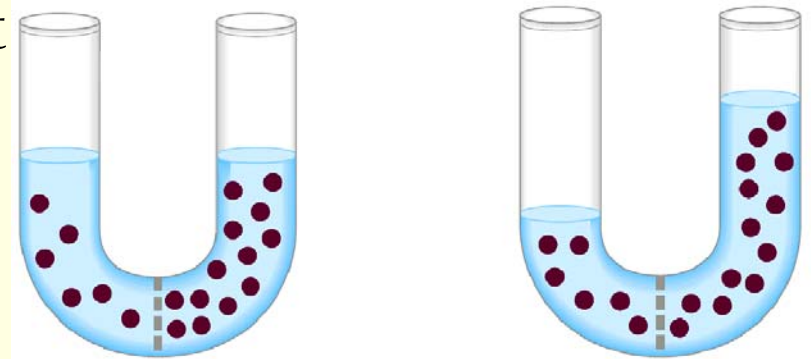
G Protein

## 2.4.4 Define *diffusion* and *osmosis*

- Diffusion- The movement of any molecules from an area of high concentration to an area of low concentration. Example: gas leak.



- Osmosis- the passive movement of water molecules across a partially permeable membrane, from a region of lower solute concentration to a region of higher solute concentration



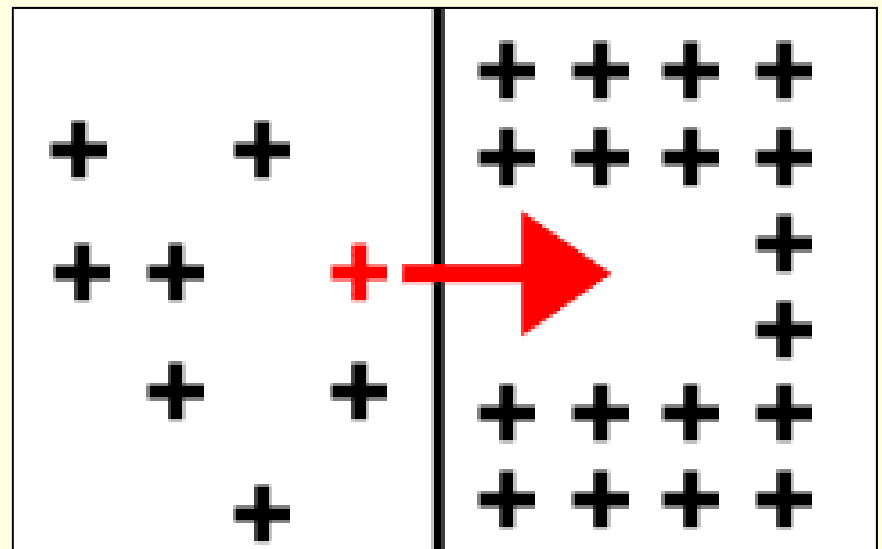
## 2.4.5 Explain passive transport across membranes in terms of diffusion.

Passive diffusion of water is continually occurring, changing the water balance of the cell. Therefore a cell must constantly struggle to maintain homeostasis by shuttling solutes in and out.



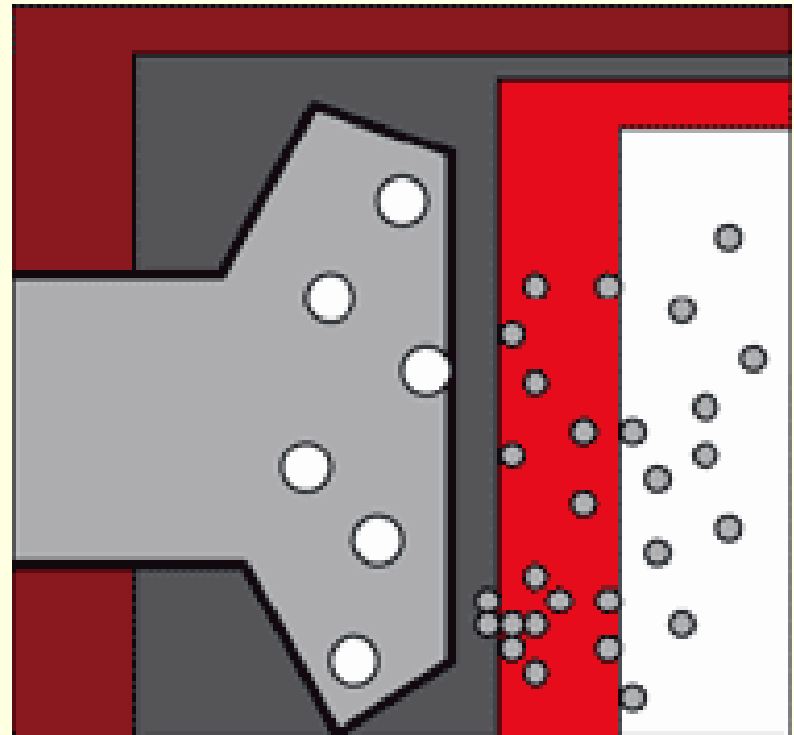
## 2.4.6 Explain the role of protein pumps and ATP in active transport across membranes.

- Protein pumps embedded in the plasma membrane help move molecules in and out of a cell against their concentration gradient. This requires energy, in the form of ATP.



## 2.4.7 Explain how vesicles are used to transport materials within and out of a cell.

- 1) Protein is synthesized in the ribosome of the rough ER
- 2) golgi apparatus processes and packages into a vesicle
- 3) vesicle fuses with plasma membrane and releases protein.



## 2.4.8 Describe how the fluidity of the membrane allows it to change shape, break and reform.

- Fluid mosaic model- phospholipid molecules are like buoys bobbing in the ocean, and can move laterally.
- Exocytosis- the fusion of a vesicle with the plasma membrane to release protein. Enlarges size of overall membrane.
- Endocytosis- the engulfing of material from outside the cell into a vesicle which breaks off inside the cell. Reduces size of overall membrane.



## *Unit 2: Cells*

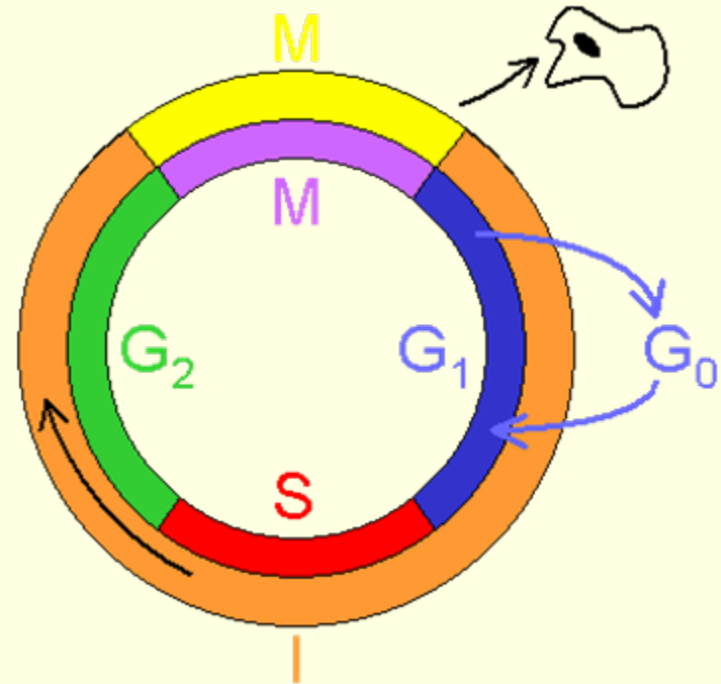
### Lesson 2.5 Cell Division



## 2.5.1 Outline the stages in the cell cycle, including interphase ( $G_1$ , S, $G_2$ ), mitosis and cytokinesis.

### Key to diagram:

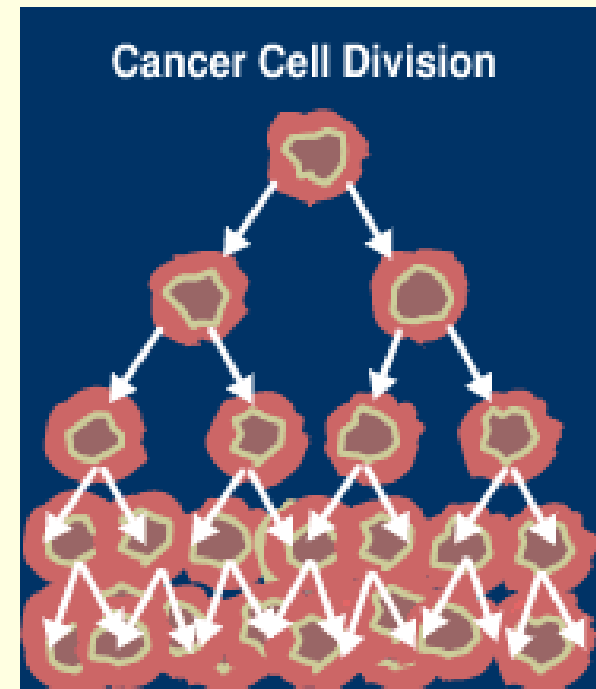
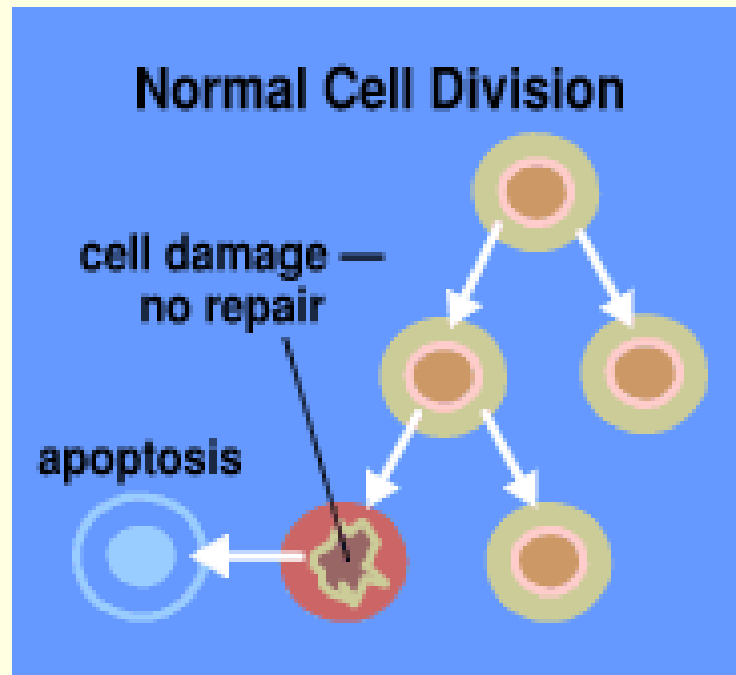
- I = interphase
- $G_1$  = growth 1
- S = synthesis
- $G_2$  = growth 2
- M = mitosis
- Cytokinesis follows shortly  
After mitosis.



Courtesy of Magnus Manske

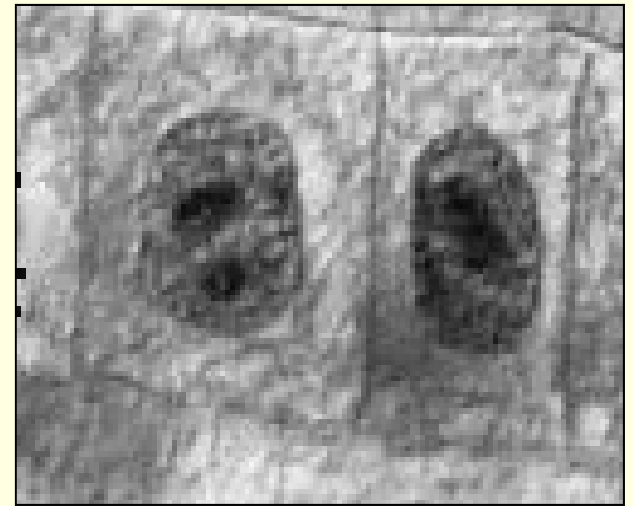
## 2.5.2 State that tumors (cancers) are the result of uncontrolled cell division.

- Uncontrolled cell growth can occur in any living organism.



## 2.5.3 State that Interphase is when many metabolic activities occur.

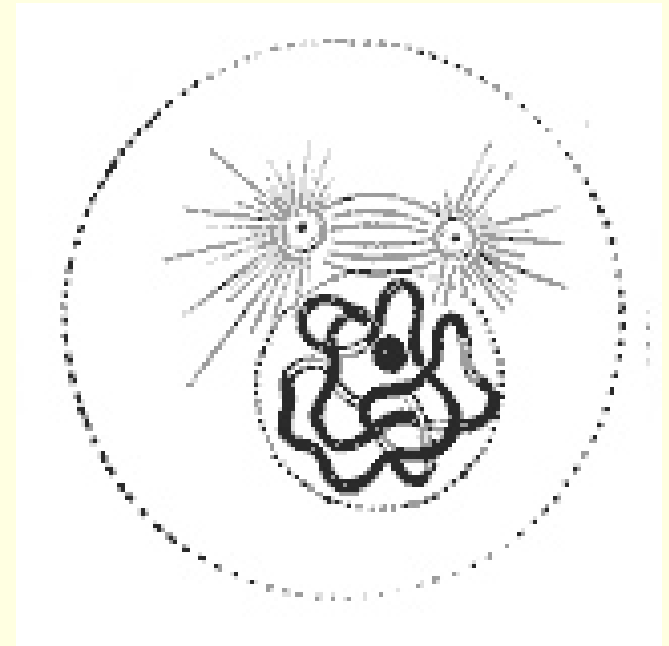
- Interphase is an active period in the life of a cell when many biochemical reactions occur, as well as DNA transcription and DNA replication. Interphase is divided into three stages:
  - 1) G1 (growth 1) - general metabolic activity
  - 2) S (synthesis) - DNA replication
  - 3) G2 (growth 2) - general metabolic activity



## 2.5.4a Describe the events that occur in the four phases of mitosis

### Prophase

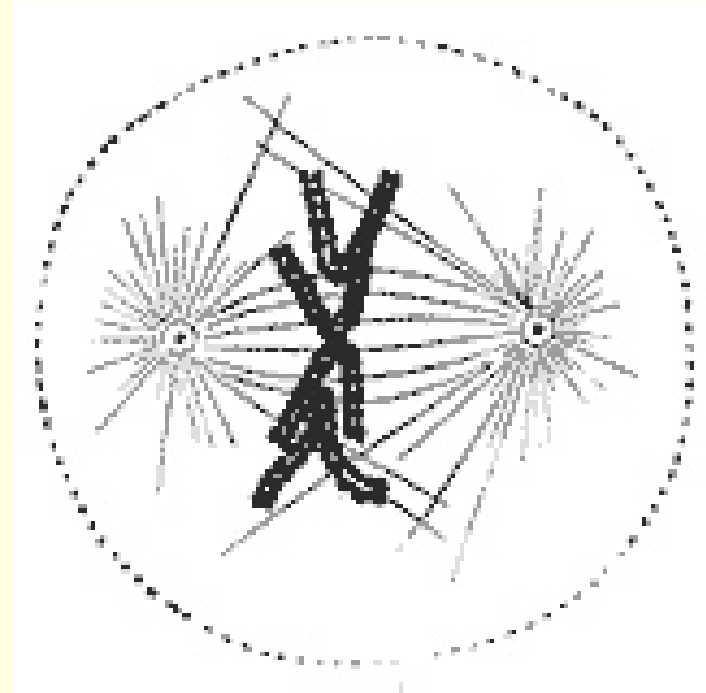
- Supercoiling of chromosomes
- Become visible under microscope
- Centrioles migrate toward opposite poles
- Spindle microtubules appear
- Nuclear membrane disappears



## 2.5.4b Describe the events that occur in the four phases of mitosis

### Metaphase

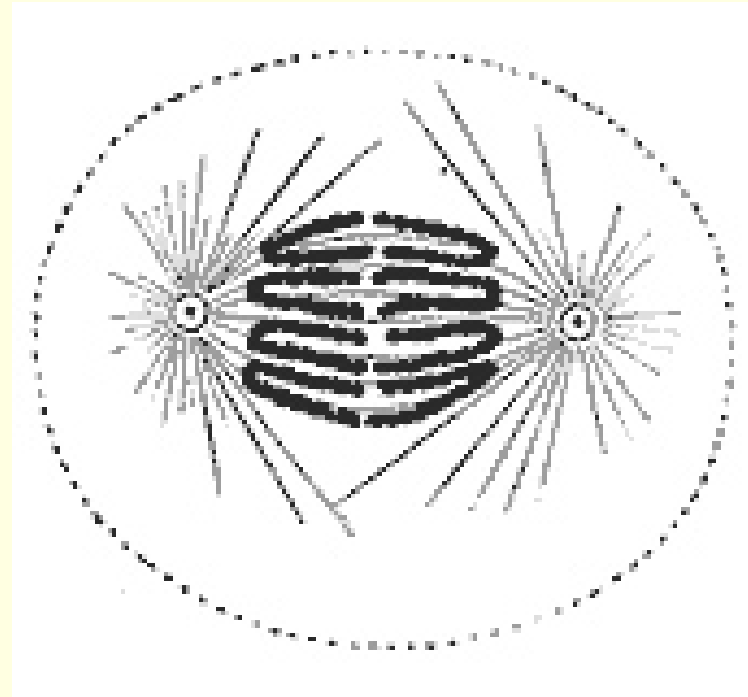
- Chromosomes move toward equatorial plane
- Spindle microtubules attach to centromeres



## 2.5.4c Describe the events that occur in the four phases of mitosis

### Anaphase

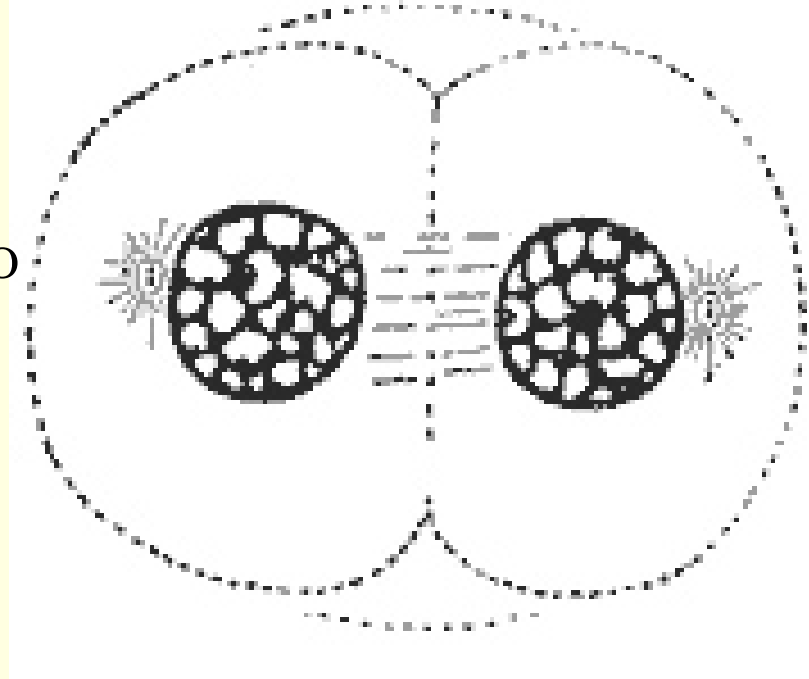
- Centromeres uncouple
- Sister chromosomes move towards opposite poles



## 2.5.4d Describe the events that occur in the four phases of mitosis

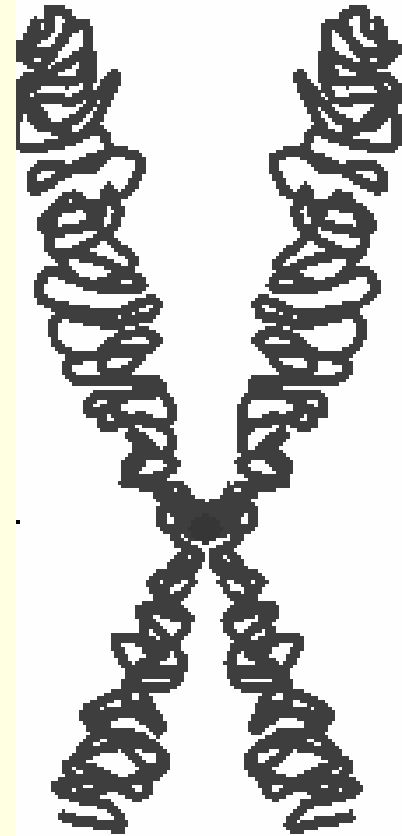
### Telophase

- Nuclear membrane reforms
- Chromosomes relax into chromatin, becoming less visible
- Spindle microtubules disappear



## 2.5.5 Explain how mitosis produces two genetically identical nuclei.

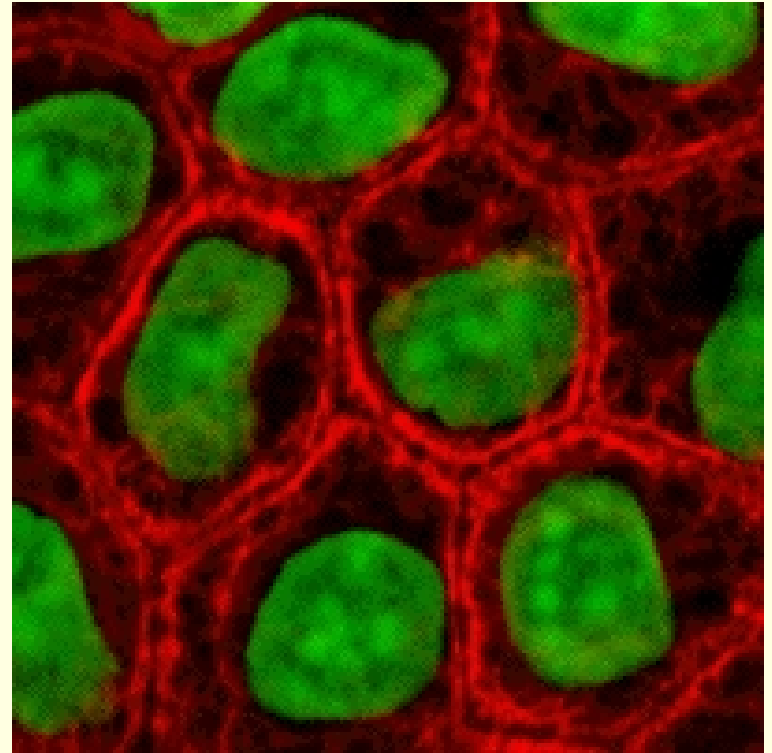
- During DNA replication, each chromosome in the nucleus produces an identical “mirror” of itself.
- At this point they are called chromatids, and are attached at the centromere.
- The chromatids then separate during mitosis, producing two identical daughter nuclei.





## 2.5.6 State that growth, embryonic development and tissue repair and asexual reproduction involve mitosis.

- Growth- cell increase in both surface area and volume.
- Tissue repair- cells divide to replace damaged or lost cells.
- Asexual reproduction- single celled organisms reproduce via mitosis.



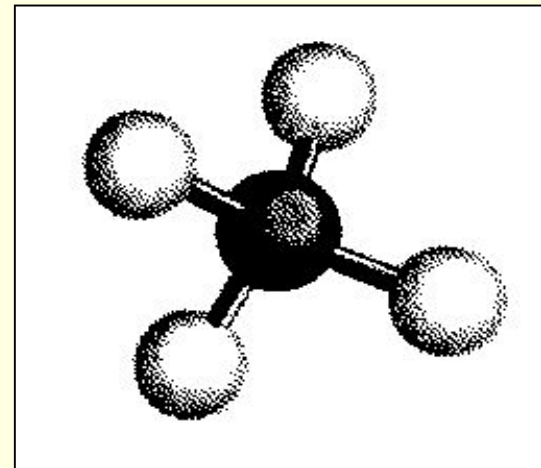
Courtesy of John Schmidt

## *Unit 3: Chemistry of Life*

### Lesson 3.1 Chemical Elements and Water

### 3.1.1 State the most frequently occurring chemical elements in living things.

- Carbon- forms 4 covalent bonds, ex:  $\text{CH}_4$
- Hydrogen- forms 1 covalent bond, ex:  $\text{H}_2$
- Oxygen- forms 2 covalent bonds ex:  $\text{CO}_2$



### 3.1.2 State that a variety of other elements are needed by living organisms.

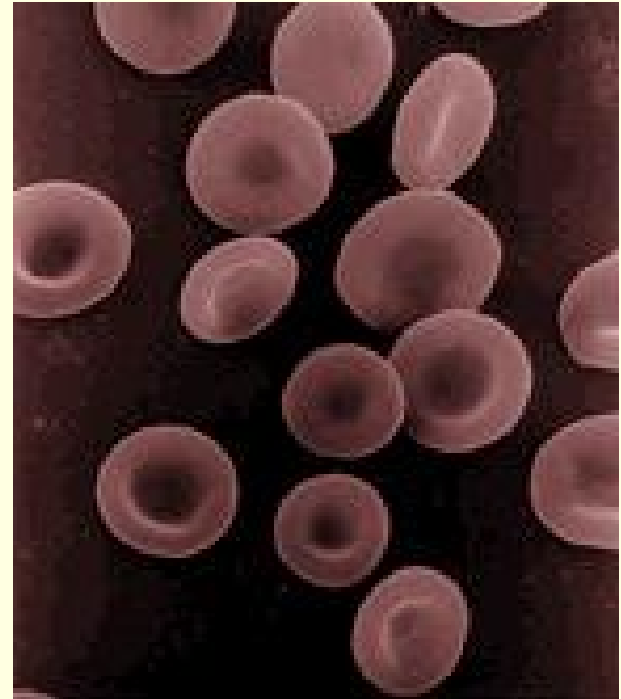
- Nitrogen
- Sulfur
- Calcium
- Phosphorus
- Potassium
- Iron

1	I.A H 1	II.A He 2																
2	Li 3	Be 4											III.A B 5	IV.A C 6	V.A N 7	VI.A O 8	VII.A F 9	VIII.A Ne 10
3	Na 11	Mg 12	III.B	IV.B	V.B	VI.B	VII.B	VIII.B			IX.B	X.B	III.A Al 13	IV.A Si 14	V.A P 15	VI.A S 16	VII.A Cl 17	VIII.A Ar 18
4	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	Ac 89	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Uub 112	Uut 113	Uuq 114	Uup 115	Uuh 116	Uus 117	Uuo 118

6	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
7	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103

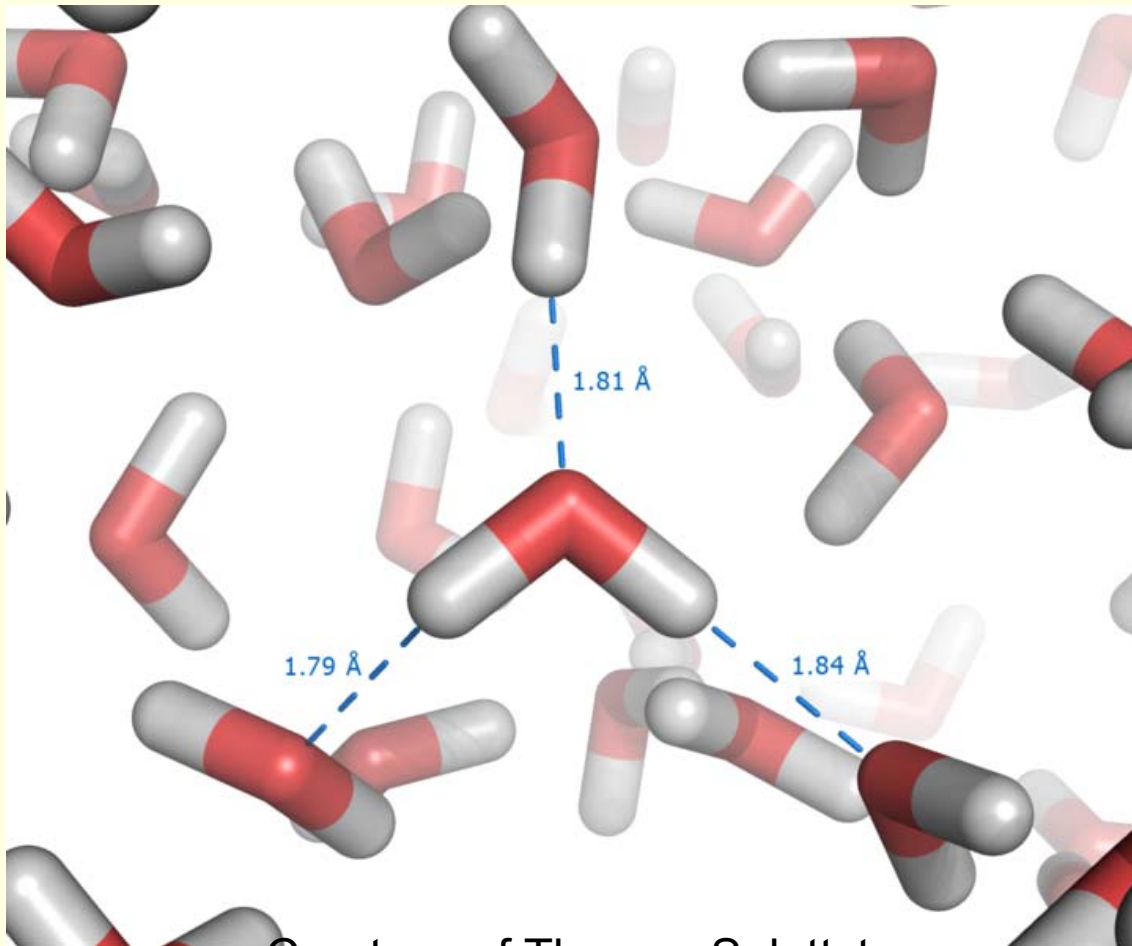
### 3.1.3 State one role for each of the elements named in 3.1.2.

- Nitrogen and Sulfur- found in proteins.
- Calcium- found in bones.
- Phosphorus- found in nucleic acids (DNA & RNA.)
- Sodium & Potassium- help transmit nerve impulses.
- Iron- found in hemoglobin (carries oxygen in blood.)



### 3.1.4 Draw and label a diagram showing the structure of water molecules to show their polarity and hydrogen bond formation.

- Dashed blue lines represent hydrogen bonds.



Courtesy of Thomas Splettstoesser

## 3.1.5 Outline the thermal, cohesive and solvent properties of water.

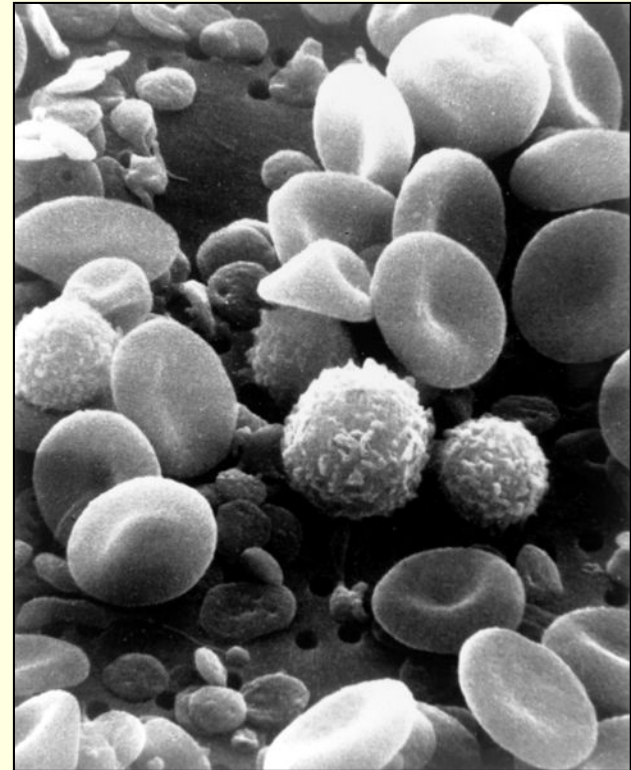
- Thermal- water has a high specific heat.
- Cohesive- water molecules tend to attract each other, which results in high surface tension
- Solvent- polarity of water gives it strong solvent properties.



Courtesy of Michael Apel

### 3.1.6 Explain the relationship between the properties of water and its uses in living organisms.

- Coolant- animals loose heat by sweating.
- Transport medium- blood, plant fluid.
- Metabolic medium- many metabolic reactions take place in water.



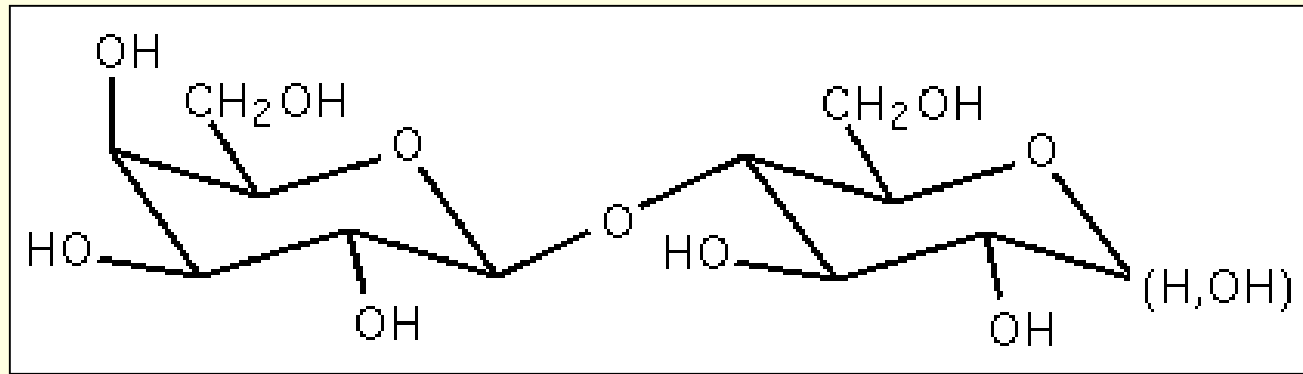
Water serves as a transport medium for blood tissue.



## *Unit 3: Chemistry of Life*

### Lesson 3.2 Carbohydrates, Lipids and Proteins

## 3.2.1 Distinguish between organic and inorganic compounds.

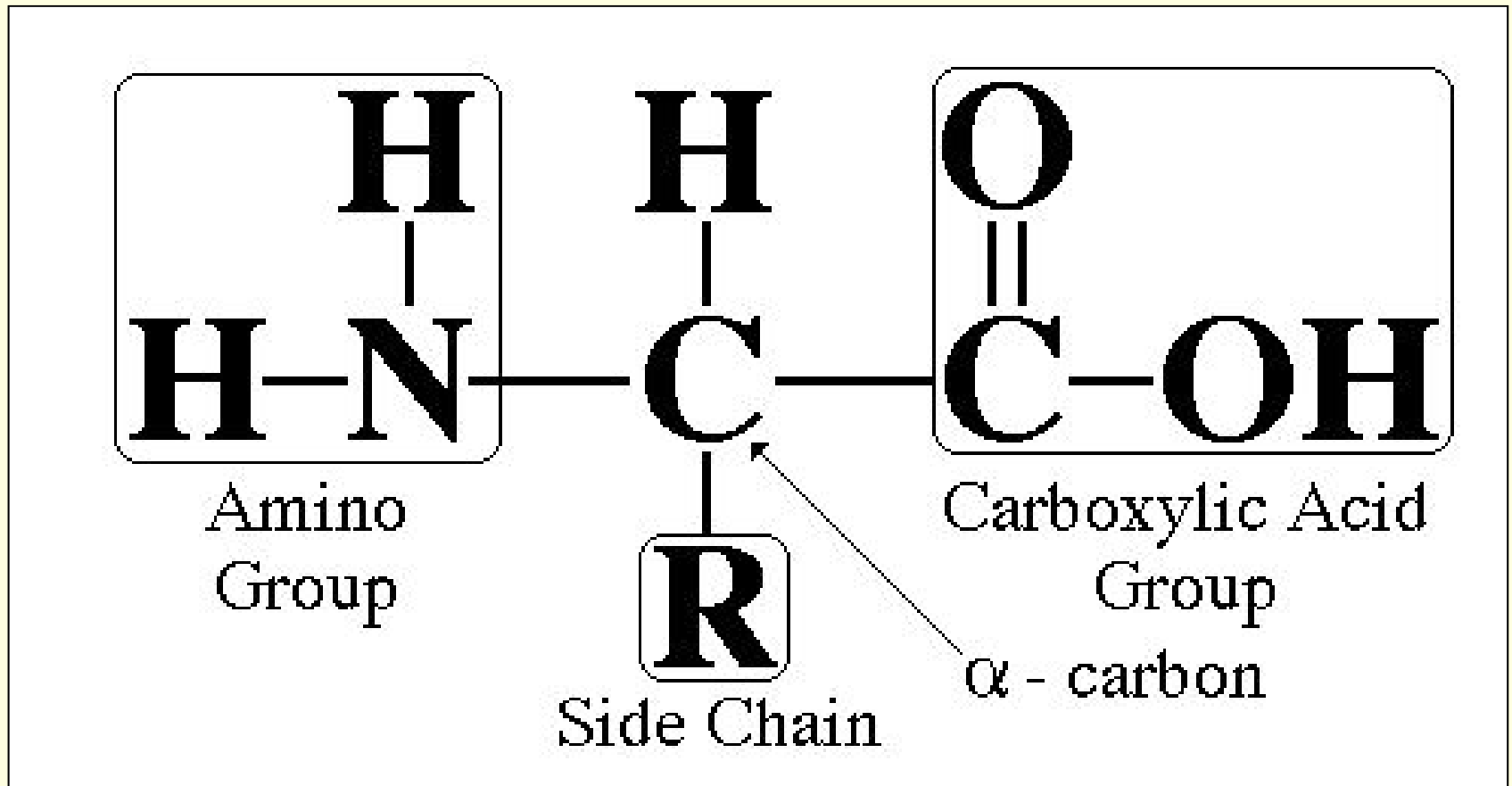


Lactose molecule. Courtesy of Nicolas Grandjean

- Organic compounds- contain carbon and are found in living organisms. (Exceptions: hydrogencarbonates, carbonates, and oxides of carbon).
- Inorganic compounds- do not contain carbon.

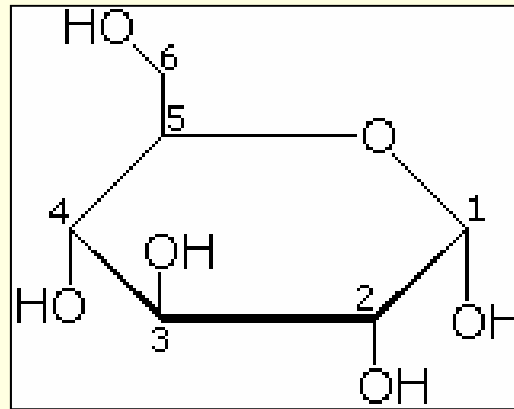
### 3.2.2a Identify amino acids, glucose, ribose and fatty acids from diagrams showing their structure.

Amino Acid

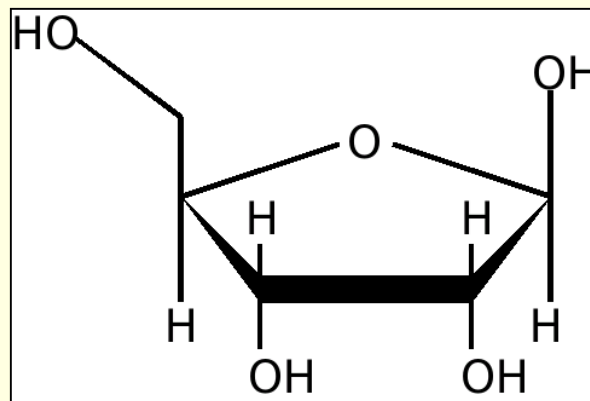


### 3.2.2b Identify amino acids, glucose, ribose and fatty acids from diagrams showing their structure.

■ Glucose

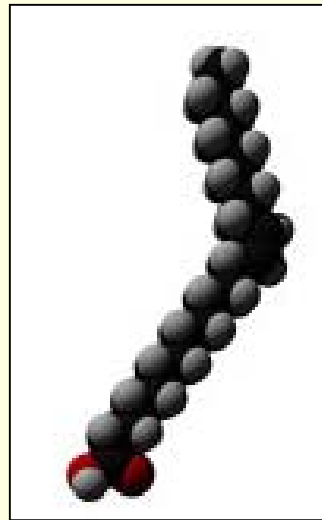


■ Ribose

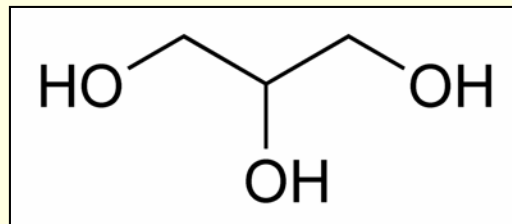


### 3.2.2c Identify amino acids, glucose, ribose and fatty acids from diagrams showing their structure.

■ Fatty Acid



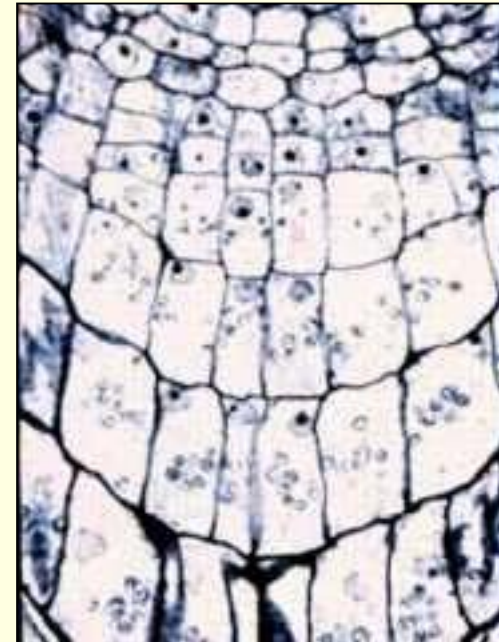
■ Glycerol



### 3.2.3 List three examples each of monosaccharides, disaccharides and polysaccharides.

---

- Monosaccharides- glucose, galactose, fructose.
- Disaccharides- maltose, lactose, sucrose.
- Polysaccharides- starch, glycogen, cellulose.



Starch granules visible in plant cells.

### 3.2.4 State one function of glucose, lactose and glycogen in animals, and of fructose, sucrose and cellulose in plants.

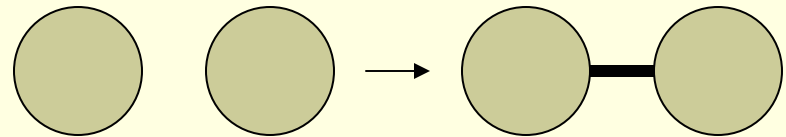
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- Glucose, lactose, fructose and sucrose are all simple sugars which function as short term energy storage molecules.
- Glycogen is a polysaccharide, stored in the liver, which functions as longer term energy storage than simple sugars.
- Cellulose- helps cell walls in plants maintain their structure and rigidity.

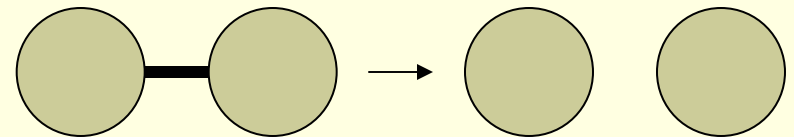
### 3.2.5 Outline the role of condensation and hydrolysis in the relationships between organic macromolecules.

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Condensation synthesis- the removal of water from monomers during the synthesis of polymers.



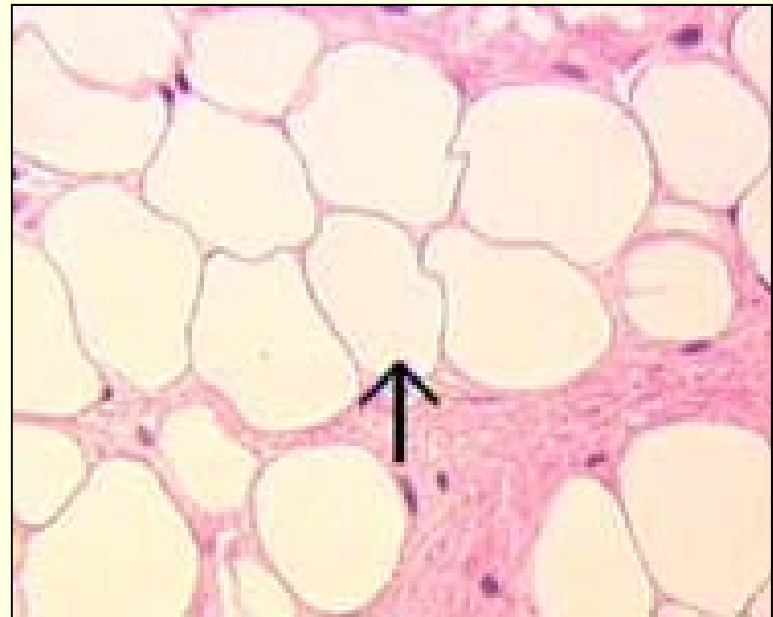
Hydrolysis- the addition of water to polymers which result in a break down to monomers.





## 3.2.6 State three functions of lipids.

- 1) Energy storage
- 2) Heat insulation
- 3) Buoyancy



Adipose (fat) cell.

### 3.2.7 Compare the use of carbohydrates and lipids in energy storage.

Carbohydrates and lipids both store energy, but the way they store energy differs.

- Lipids- store more energy per unit of mass, not soluble in water.
- Carbohydrates- store less energy per unit of mass, but is more accessible, and is soluble in water, therefore it is easier to transport in blood and plant fluid.

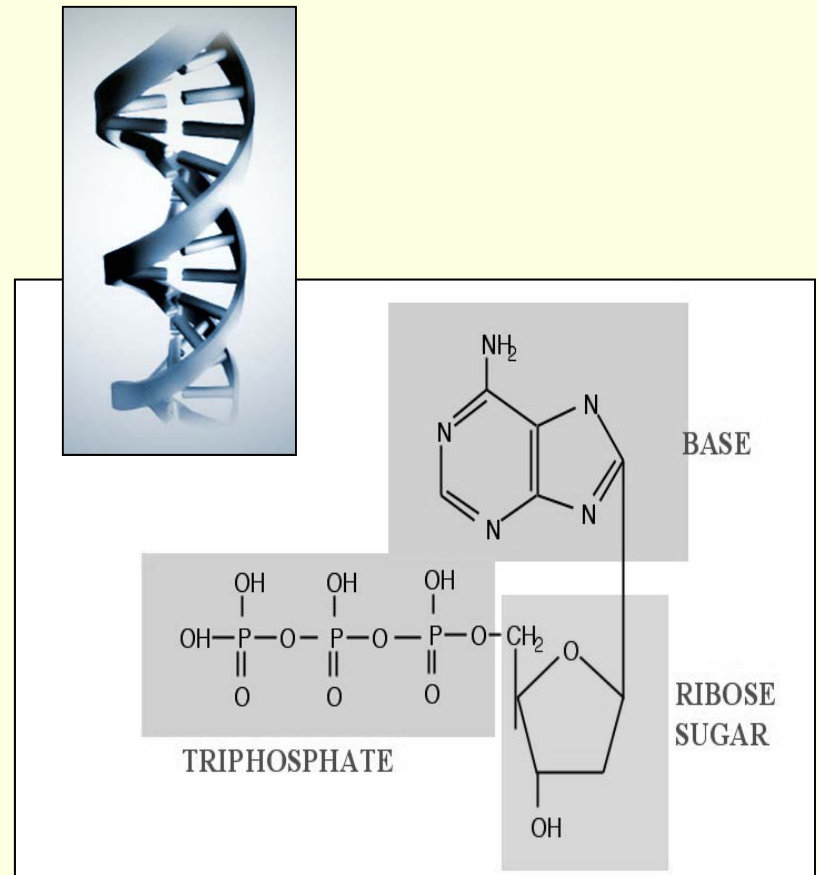


## *Unit 3: Chemistry of Life*

### Lesson 3.3 DNA Structure

### 3.3.1 Outline DNA nucleotide structure in terms of sugar (deoxyribose), base and phosphate.

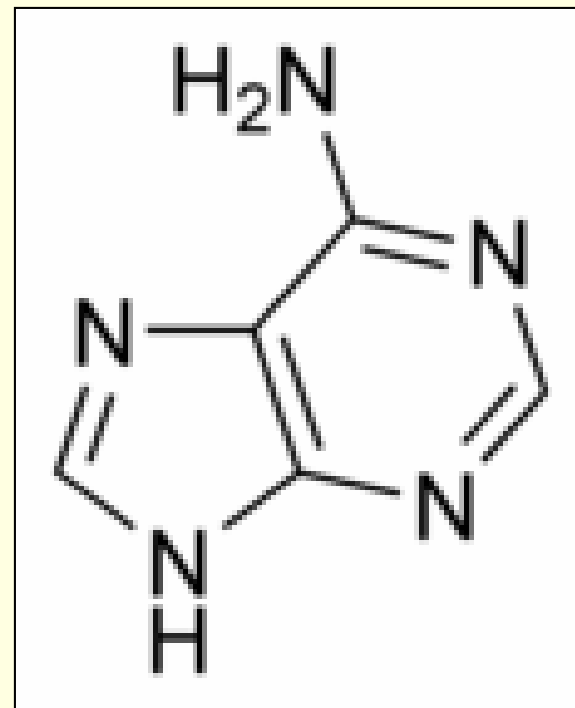
- The phosphate and sugar are always the same, and are always found in the backbone. The base is in the center of the double helix.



## 3.3.2 State the names of the four bases in DNA.

- The base found in each nucleotide of DNA is one of four possible types:

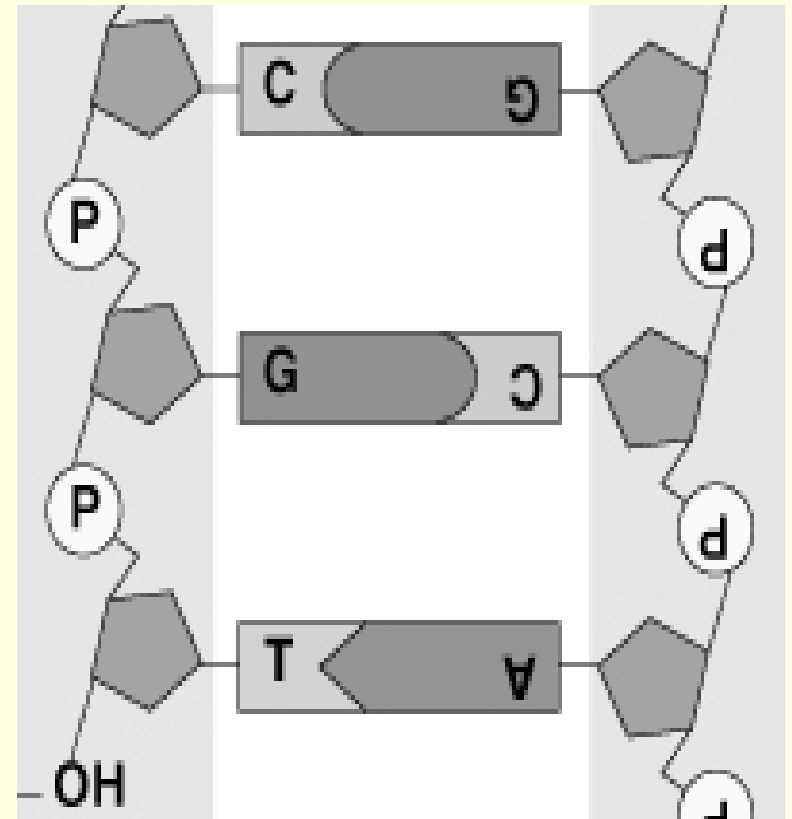
- A- adenine
- T- thymine
- G- guanine
- C- cytosine



Adenine

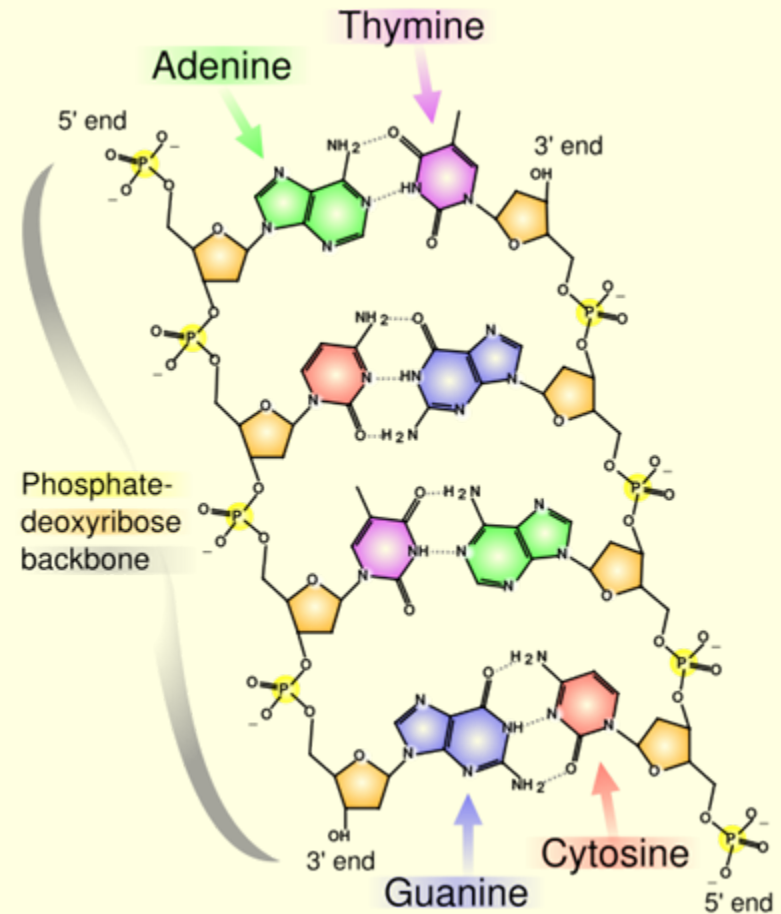
### 3.3.3 Outline how the DNA nucleotides are linked together by covalent bonds into a single strand.

- The bonds between the phosphate group and the sugar (pentagon) are covalent, and make the 'backbone' of the ladder.

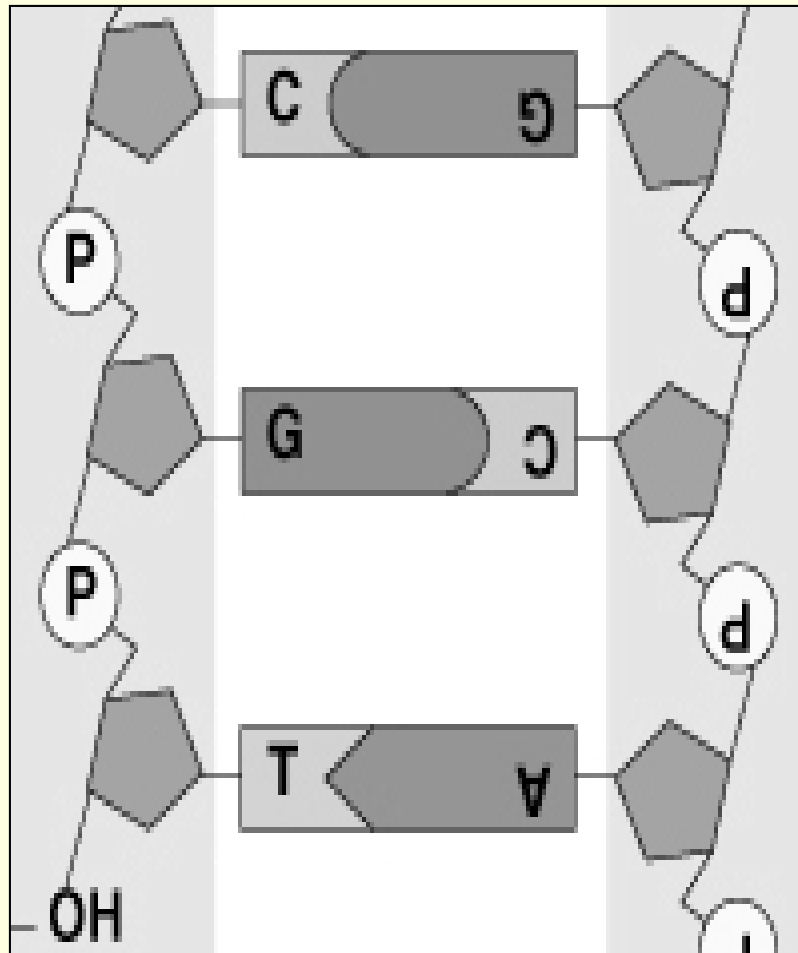


### 3.3.4 Explain how a DNA double helix is formed using complimentary base pairing and hydrogen bonds.

- Weaker, hydrogen bonds exist in the center of the double helix, between base pairs (A-T, C-G).



### 3.3.5 Draw a simple diagram of the molecular structure of DNA.



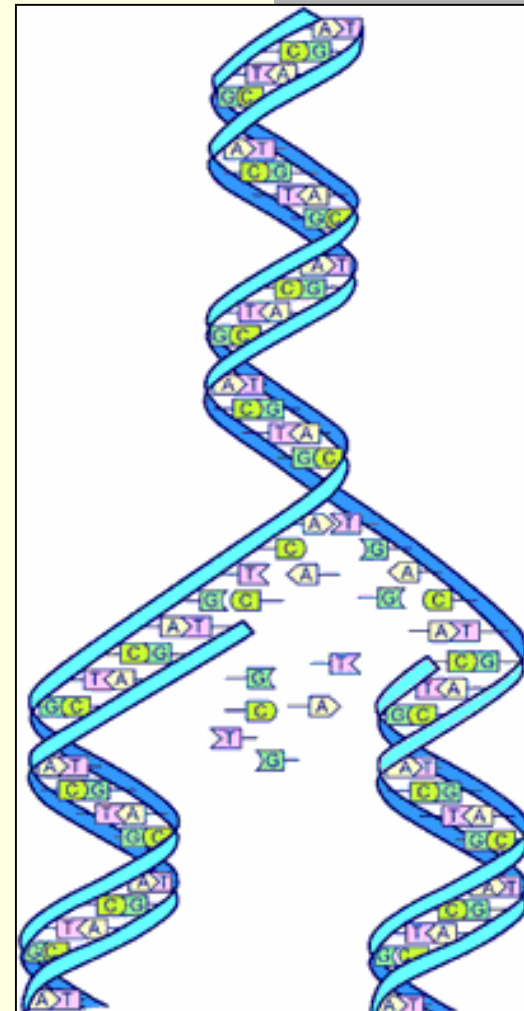


## *Unit 3: Chemistry of Life*

# Lesson 3.4 DNA Replication

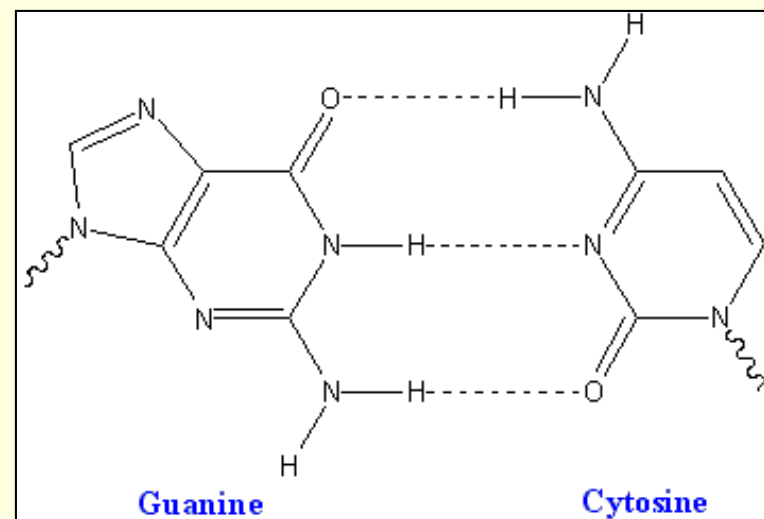
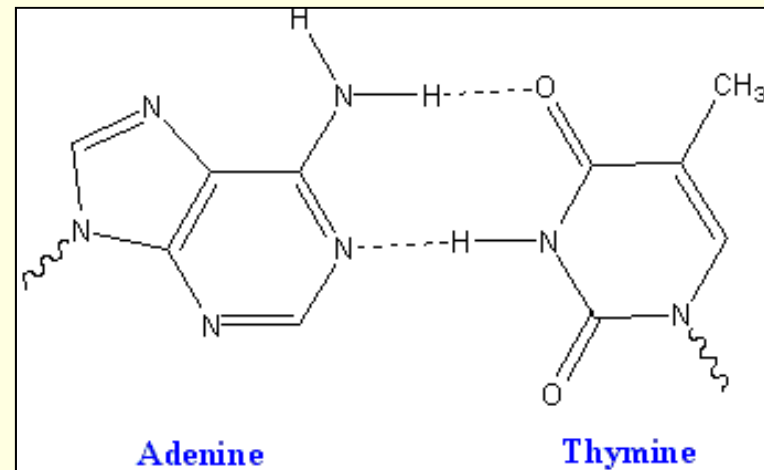
## 3.4.1 Explain DNA Replication

- 1) Unwinding of the double helix.
- 2) Separation of strands by helicase.
- 3) Formation of new complementary strands by DNA polymerase.



### 3.4.2 Explain the significance of complementary base pairing in the conservation of the base sequence of DNA.

- Adenine can only pair with thymine, and guanine can only pair with cytosine. This way, when one side of the strand is exposed, it can only couple with its complementary base pair, making a mirror image of the original.

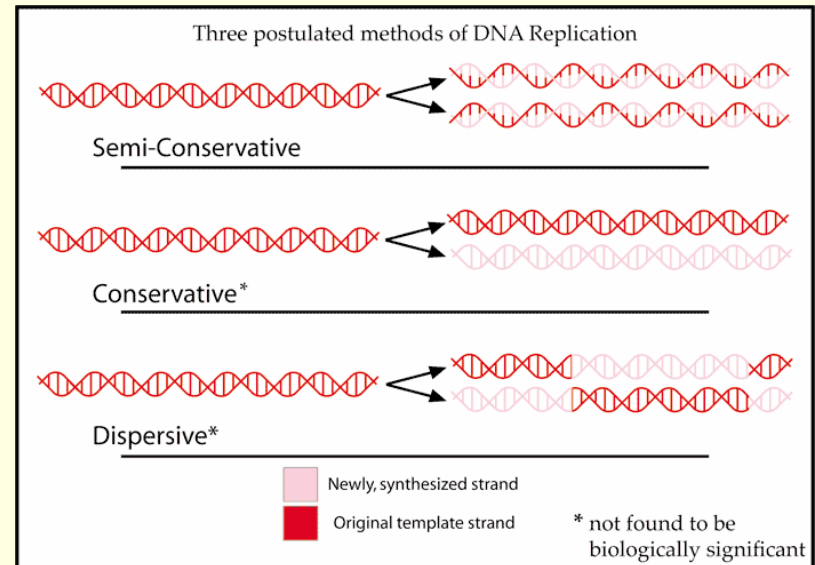


Photos courtesy of Willow W.

### 3.4.3 State that DNA replication is semi-conservative.

#### Semi conservative

one side of the double helix is preserved during replication, whereas the other side is created new. This is opposed to *conservative*, where the entire DNA strand would be preserved, or *dispersive*, where the original is destroyed in the process of making the new strand.



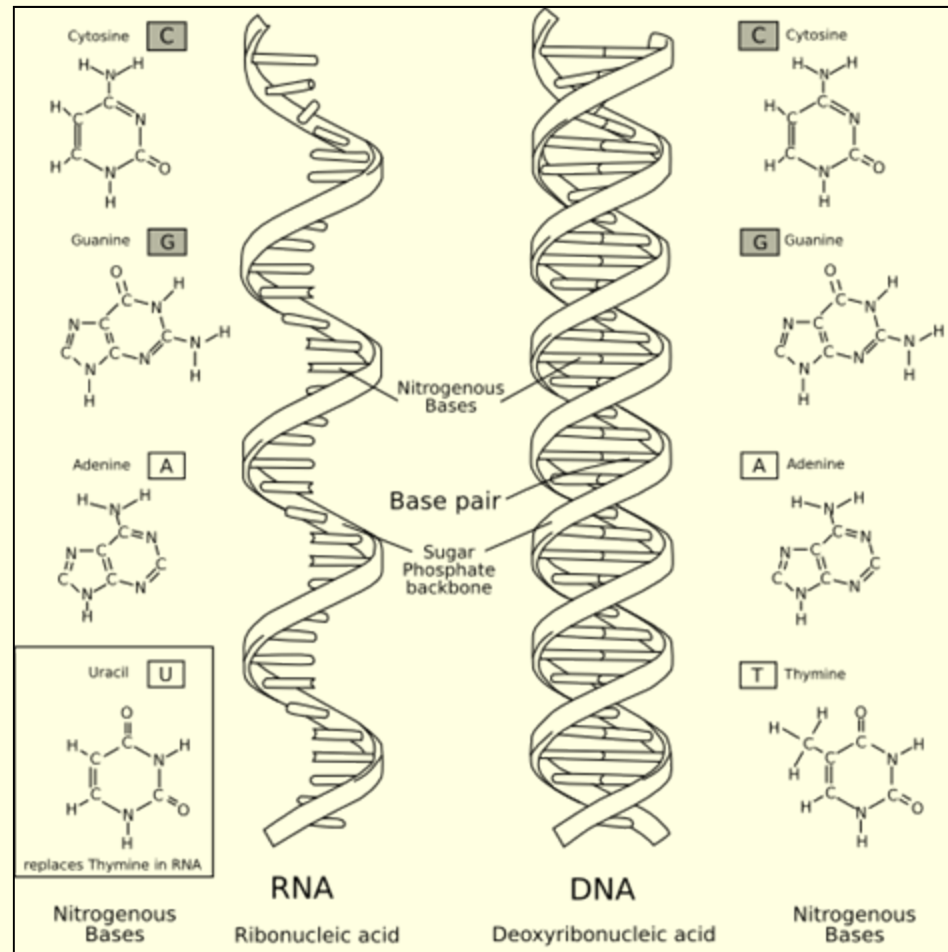
Courtesy of Mike Jones

## *Unit 3: Chemistry of Life*

### Lesson 3.5 Transcription and Translation

## 3.5.1 Compare the structure of RNA and DNA.

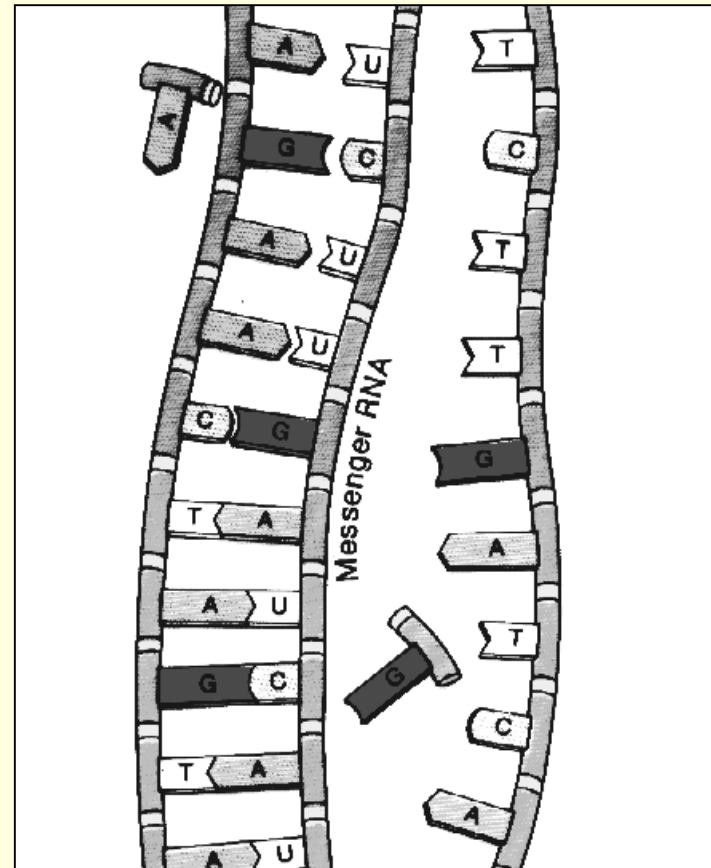
- DNA is a double helix and contains the base thymine.
- RNA is a single helix, and contains the base uracil instead of thymine.



(Picture courtesy of Tim Sailor)

## 3.5.2 Outline DNA transcription.

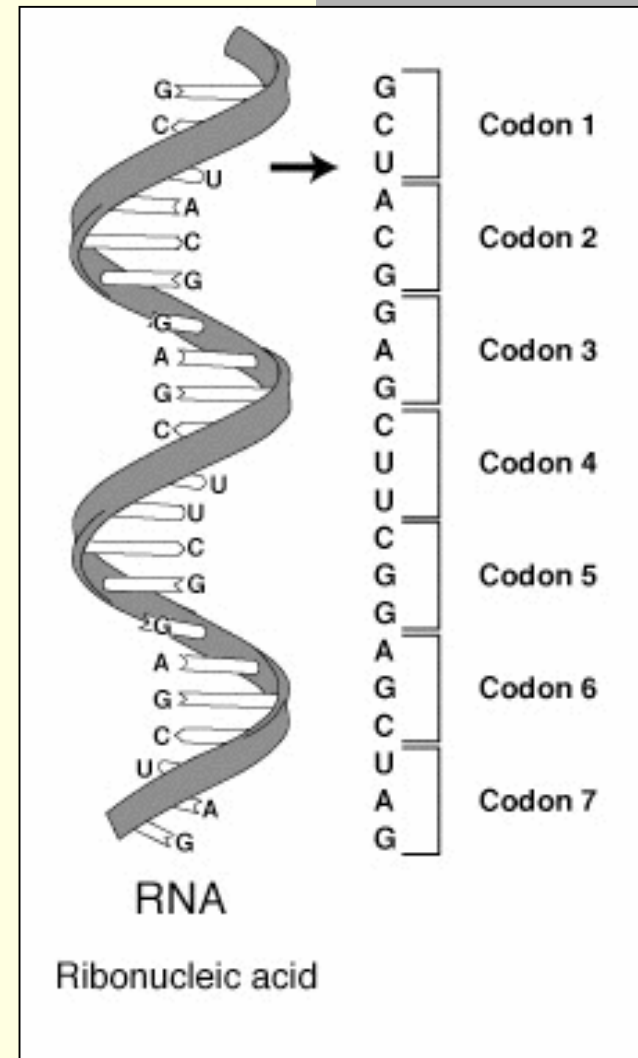
- 1) DNA unwinds.
- 2) Helicase unzips the H-bonds between bases.
- 3) One side of the strand, called the sense strand, becomes the template for RNA.
- 4) RNA polymerase facilitates the binding of RNA nucleotides to the complementary sense strand.



### 3.5.3 Describe the genetic code in terms of codons composed of triplets of bases.

If bases are the “letters” in the language of DNA, codons are the words. A codon is always three bases, for example, ATG, CCC, GTA, etc.

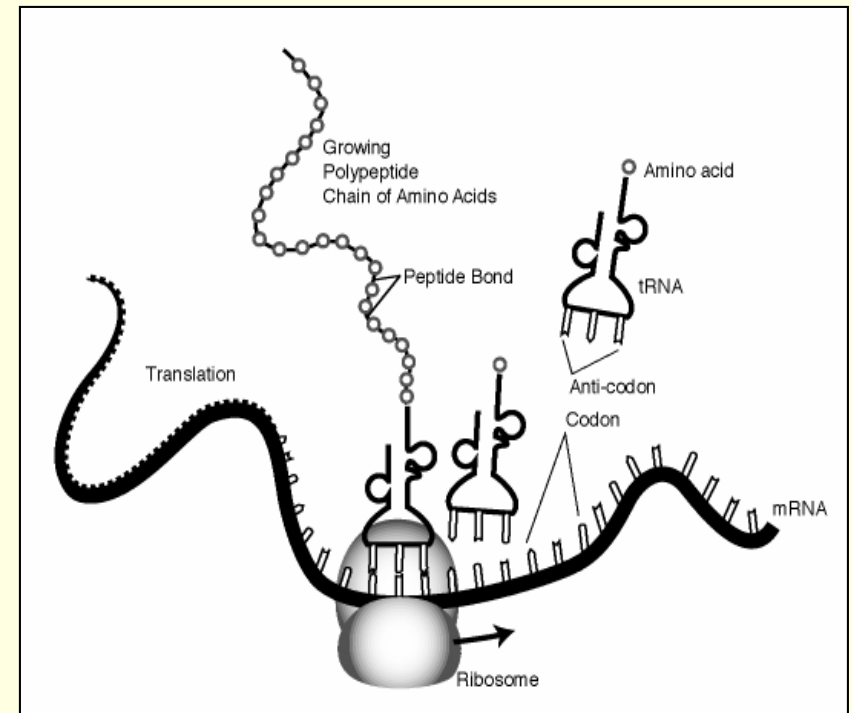
As DNA codes for the building of amino acids (protein), each amino acid has its origin from a codon. Sometimes, one amino acid can be made from several different codons. This means that the code is *degenerate*.





## 3.5.4 Explain the process of translation.

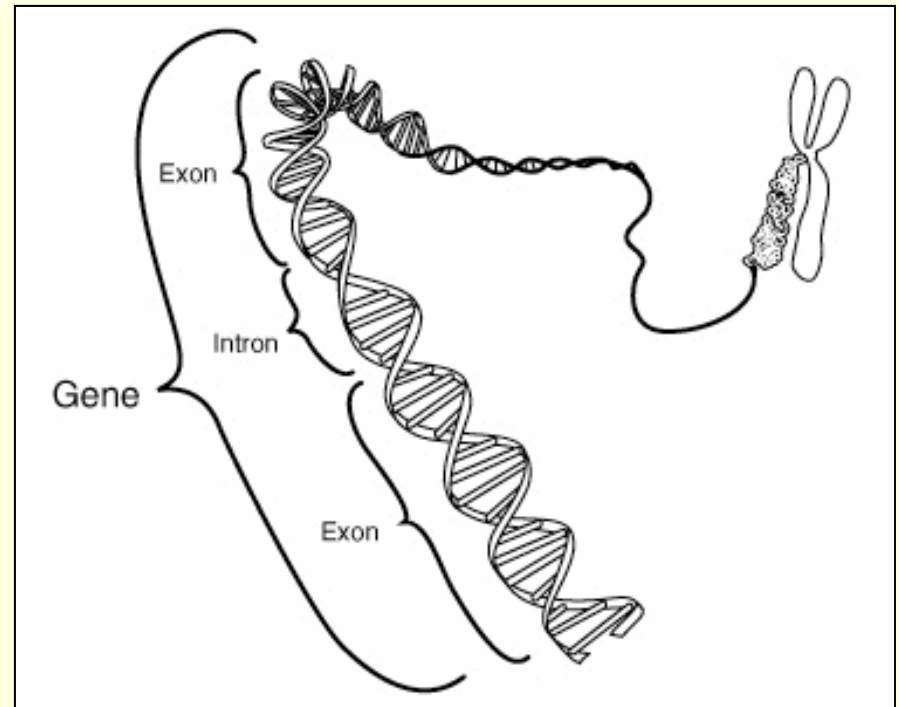
- 1) Messenger RNA attaches to ribosome.
- 2) Ribosome 'reads' mRNA, one codon at a time
- 3) For each codon sequence, a transfer RNA briefly attaches its complimentary anticodon to the codon.
- 4) The amino acid associated with that tRNA is added to the growing polypeptide chain.



### 3.5.5 Explain the relationship between one gene and one polypeptide.

Each protein synthesized in the body originates from one particular section of DNA on a chromosome.

This section, called a gene, can be several hundred to several thousand base pairs long.



## *Unit 3: Chemistry of Life*

### Lesson 3.6 Enzymes

## 3.6.1 Define *Enzyme* and *Active Site*.

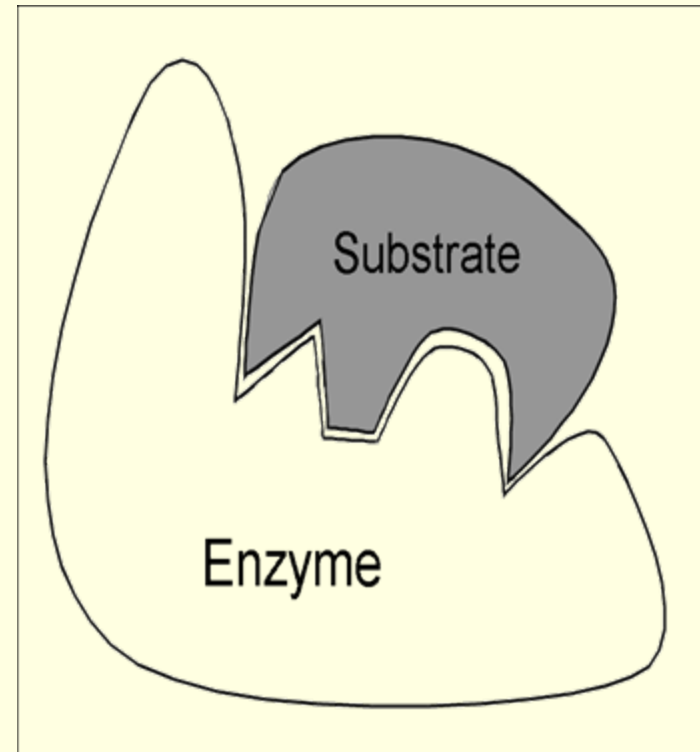
Enzyme- a globular protein that changes the rate of a chemical reaction, usually by speeding it up.

Active site- the location where a substrate binds to an enzyme. The substrate is the reactant of a chemical reaction.



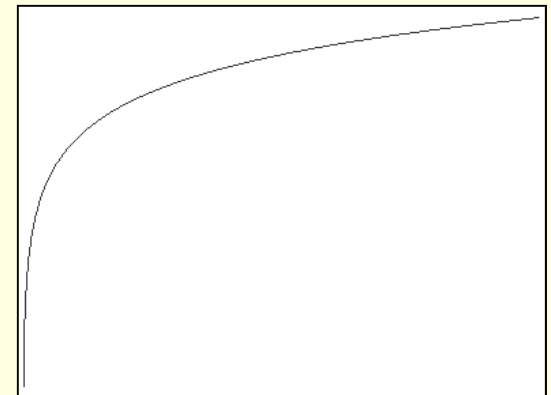
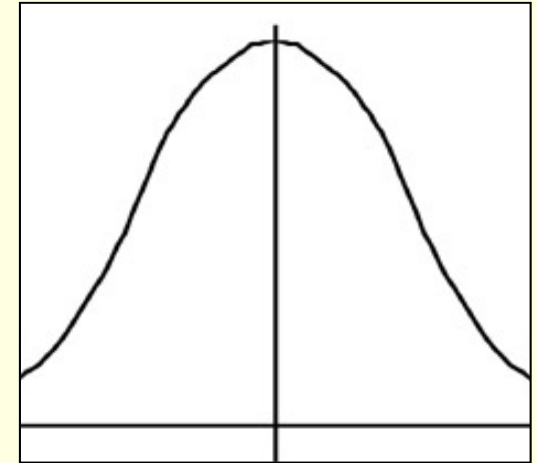
## 3.6.2 Explain enzyme-substrate specificity.

- Enzymes are specific to certain substrates, like a lock is to a certain key. The shape of the active site determines which substrates the enzyme can act upon.



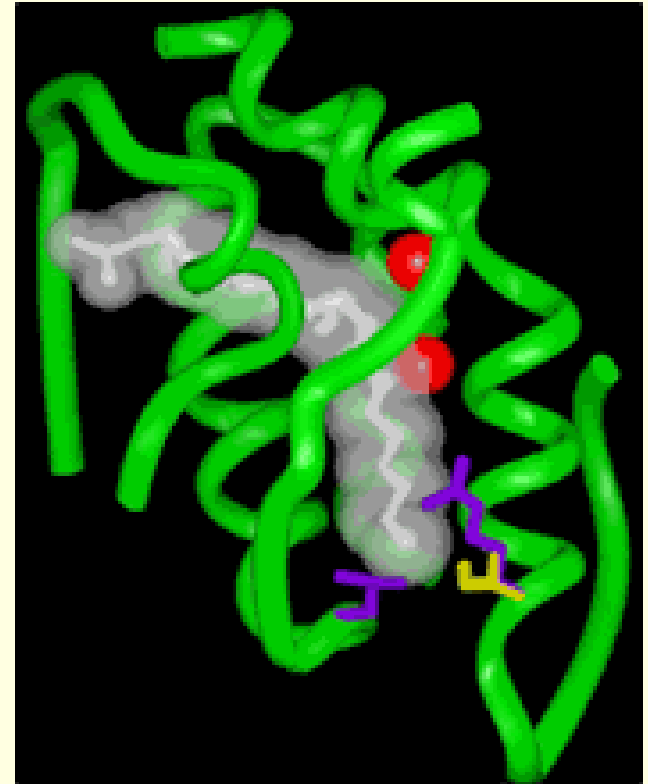
### 3.6.3 Explain the effects of temperature, pH and substrate concentration on enzyme activity.

- Temperature- there is an optimum temperature at which most enzymes perform. Deviating from this in either direction will slow the reaction.
- pH- there is an optimum pH at which most enzymes perform. Deviating from this in either direction will also slow the reaction.
- Substrate concentration- as substrate concentration increases, so does the rate of the reaction, until it is running at maximum efficiency, at which point the rate reaches a plateau.



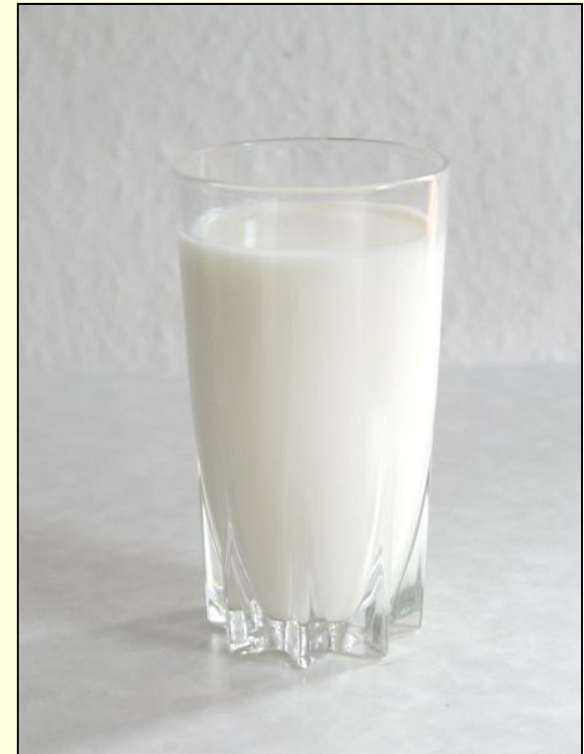
### 3.6.4 Define *denaturation*.

- Denaturation- a change in the shape of an enzyme, which in turn, affects the shape of the active site, compromising it's ability to act upon a substrate. Often caused by temperature or pH variations.



### 3.6.5 Explain the use of lactase in the production of lactose-free milk.

- Lactase is an enzyme which breaks down the sugar lactose, naturally found in milk. Lactose free milk is made by adding lactase during the industrial process of preparing the milk for sale and distribution.
- Some people are lactose intolerant (with a high proportion of the Asian population), and if not for the treatment of milk with lactase would be unable to consume it healthfully.



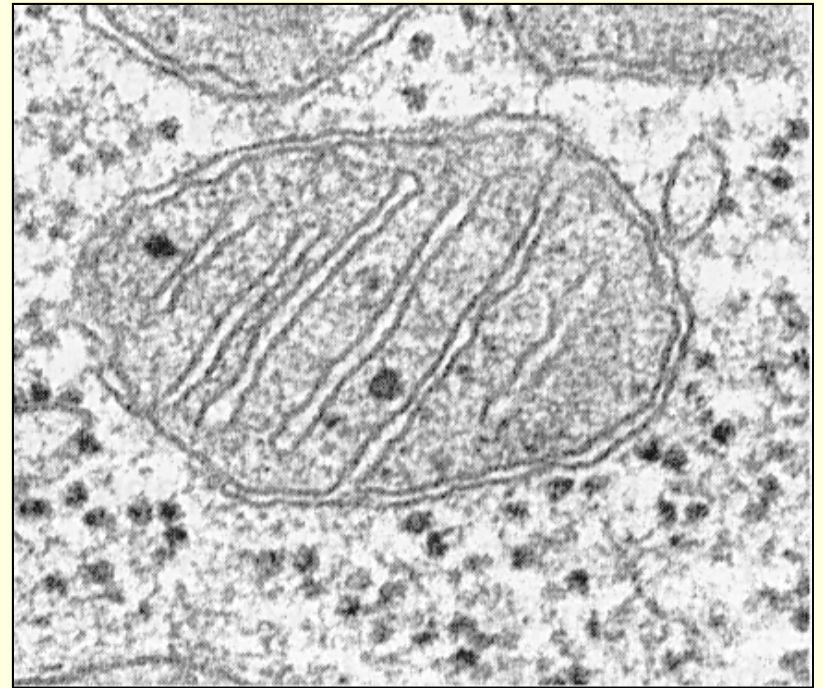


## *Unit 3: Chemistry of Life*

# Lesson 3.7 Cell Respiration

## 3.7.1 Define Cell Respiration.

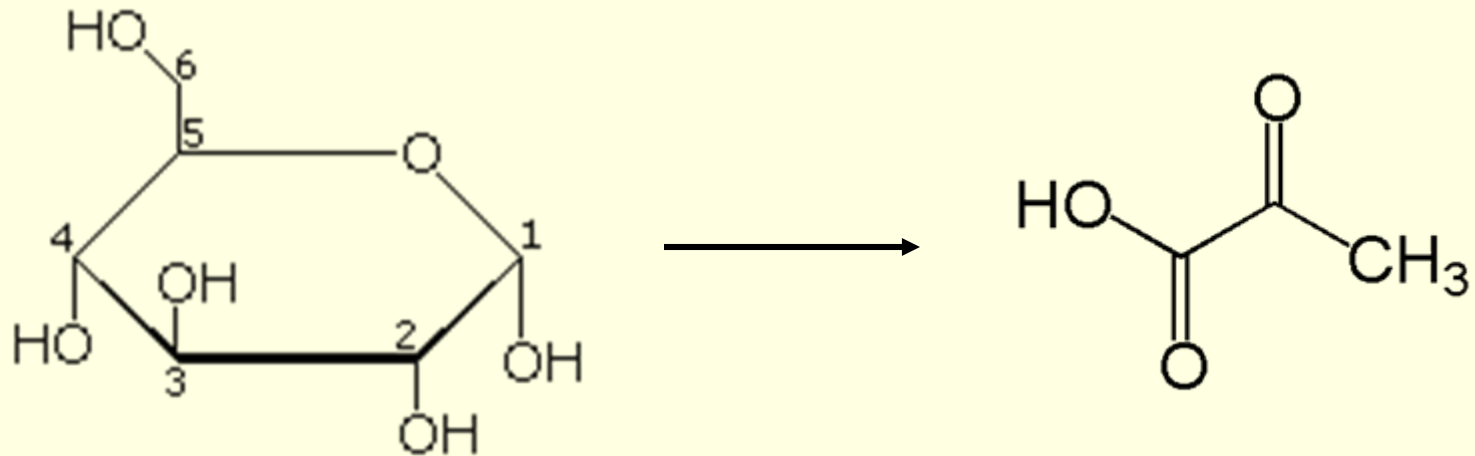
- Cell Respiration- the *controlled* release of energy in the form of ATP from organic compounds in cells.



Picture courtesy of IUPS Physiome Project

## 3.7.2 State what happens to glucose during cell respiration.

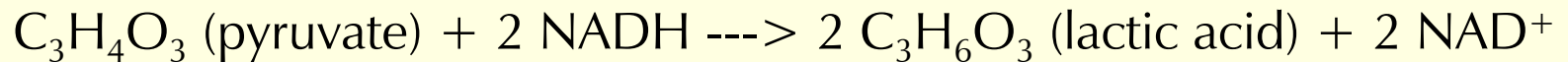
- Glucose is broken down into pyruvate in the cytoplasm during cell respiration, with a small yield of ATP.



### 3.7.3 Explain what happens during anaerobic respiration.

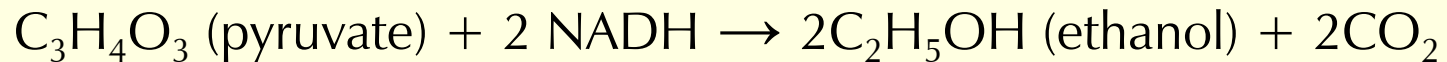
- Pyruvate is converted either to lactate or ethanol, with *no further yield of ATP*.

#### Lactate:



Ex: human muscle tissue.

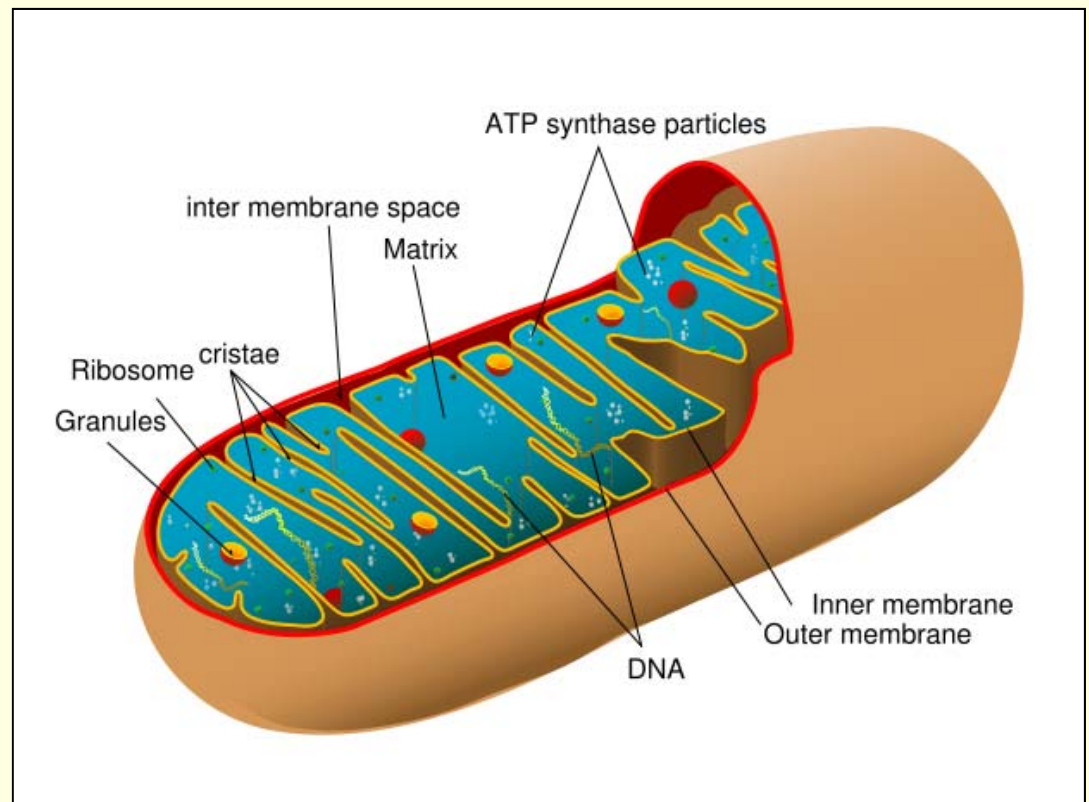
#### Ethanol:



Ex: yeast

## 3.7.4 Explain what happens during aerobic respiration.

- Inside the mitochondria, pyruvate is broken down into  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , with a large yield of ATP.



## *Unit 3: Chemistry of Life*

# Lesson 3.8 Photosynthesis

## 3.8.1 State what happens during photosynthesis with regard to energy.

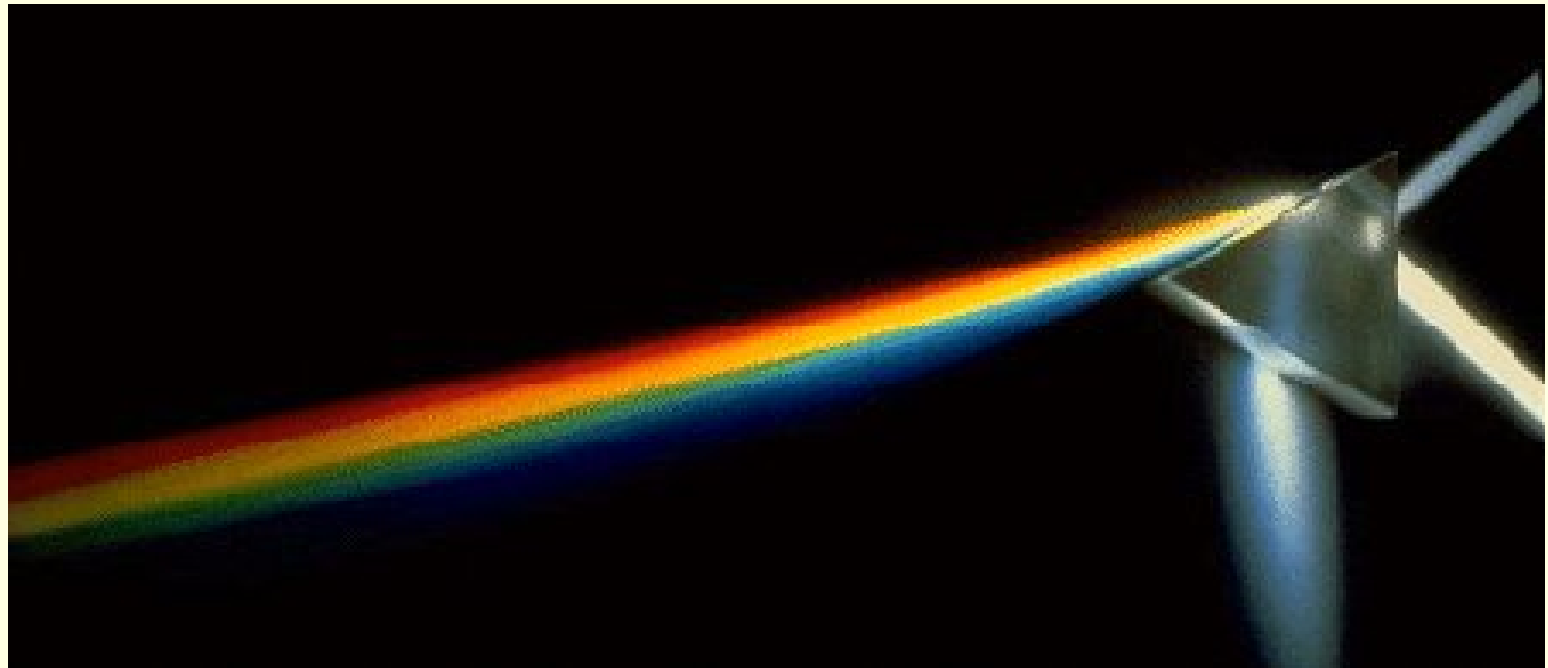
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- During photosynthesis, light energy is converted into chemical energy.



### 3.8.2 State that light from the sun is composed of a range of wavelengths.

- ROY G. BIV:
- Red, orange, yellow, green, blue, indigo, violet. These are the wavelengths that compose the visible spectrum.





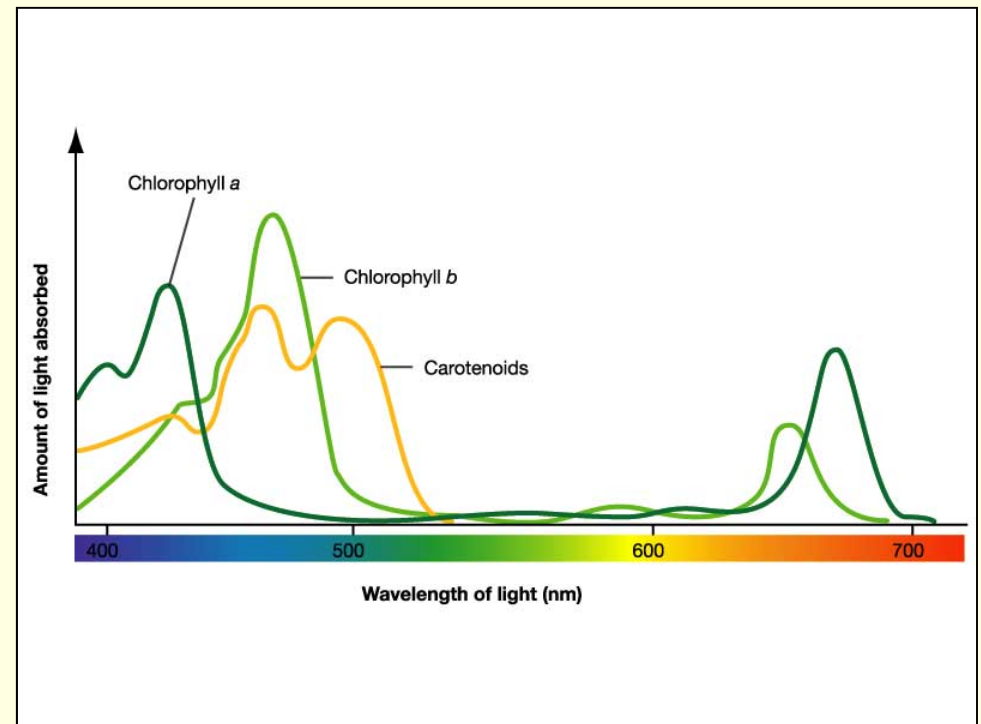
### 3.8.3 State that chlorophyll is the main photosynthetic pigment.

- Plant cells appear green due to the pigment chlorophyll. Chlorophyll is found in the chloroplasts, the light converting organelles found in plant cells.



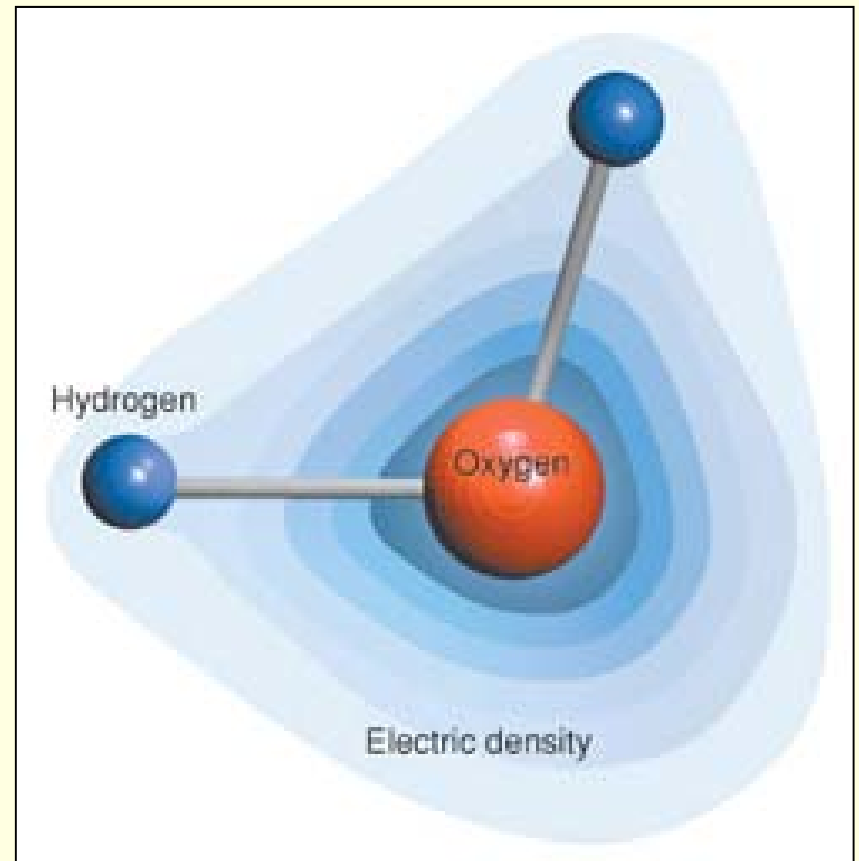
### 3.8.4 Outline the differences in the absorption of red, blue and green light by chlorophyll.

- Blue light is most readily absorbed by chlorophyll, followed by red light. Green light is either transmitted or refracted, which is why plants appear green to the eye.



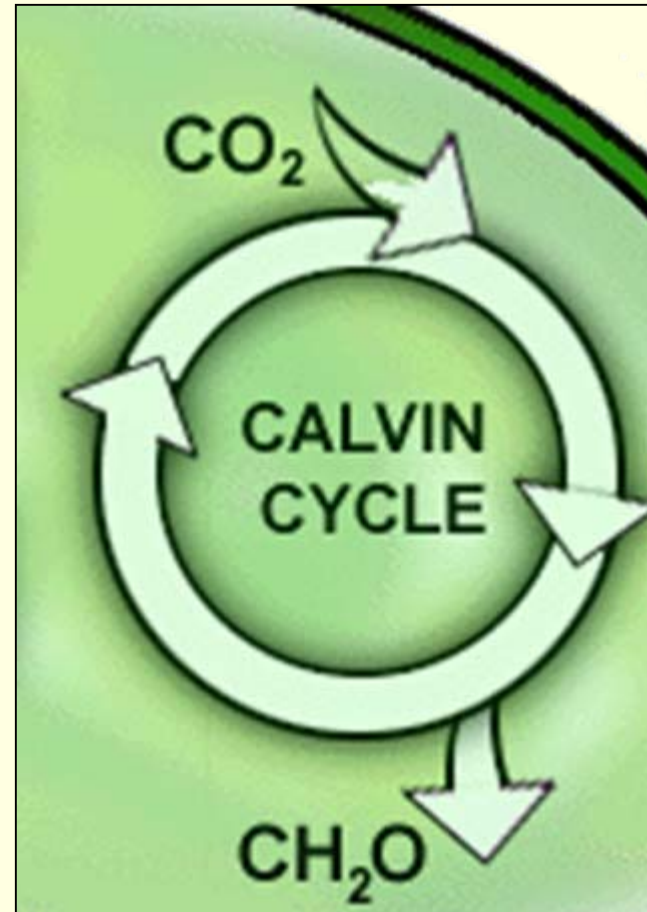
### 3.8.5 State that light energy is used to split water molecules.

- Photolysis- the splitting of water which results in oxygen, hydrogen and electrons.



### 3.8.6. Explain how carbon dioxide is “fixed” during photosynthesis.

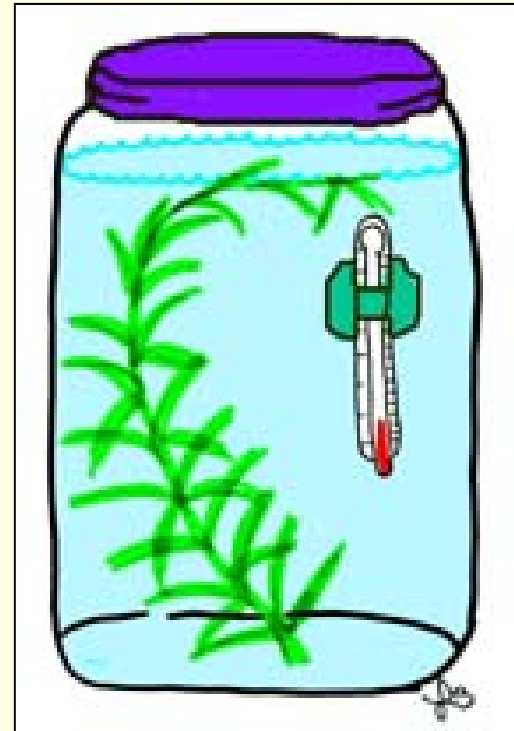
- ATP and  $H^+$  ions aid in the transfer of high energy electrons from glucose to carbons which originated from carbon dioxide.
- The attachment of high energy electrons to a carbon backbone is termed *carbon fixation*.



(Photo courtesy of University of the Western Cape)

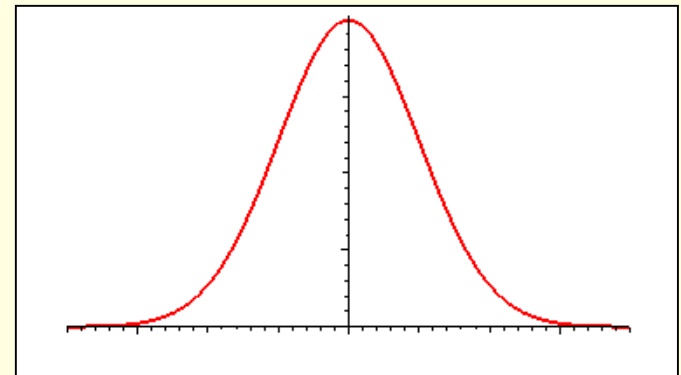
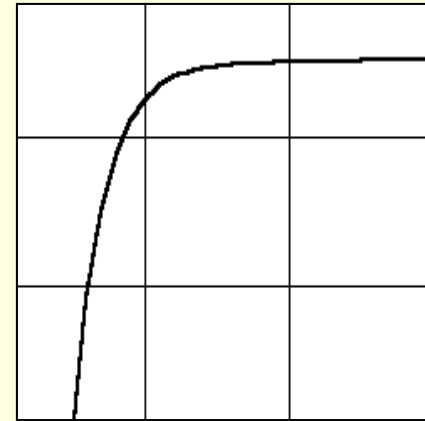
### 3.8.7 Explain how the rate of photosynthesis can be measured.

- The rate of photosynthesis can be measured in three ways:
  - 1) Production of oxygen
  - 2) Uptake of carbon dioxide
  - 3) Indirectly by the measurement of biomass



### 3.8.8 Outline the effects of temperature, light intensity and CO<sub>2</sub> concentration on the rate of photosynthesis.

- Light intensity and CO<sub>2</sub> concentration impact photosynthesis similarly. As the variable increases, photosynthetic rate increases, until maximum efficiency is reached, at which point the rate plateaus.
- Usually, there is an optimum temperature at which photosynthesis occurs, and any deviation in either direction reduces the rate.

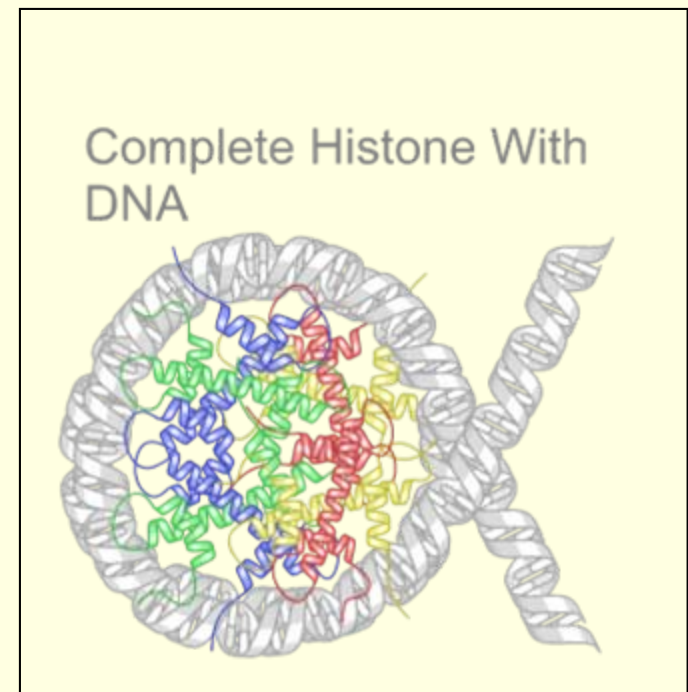


## *Unit 4: Genetics*

### Lesson 4.1 Chromosomes, Genes, Alleles and Mutations

## 4.1.1 State the eukaryote chromosomes are made of DNA and proteins.

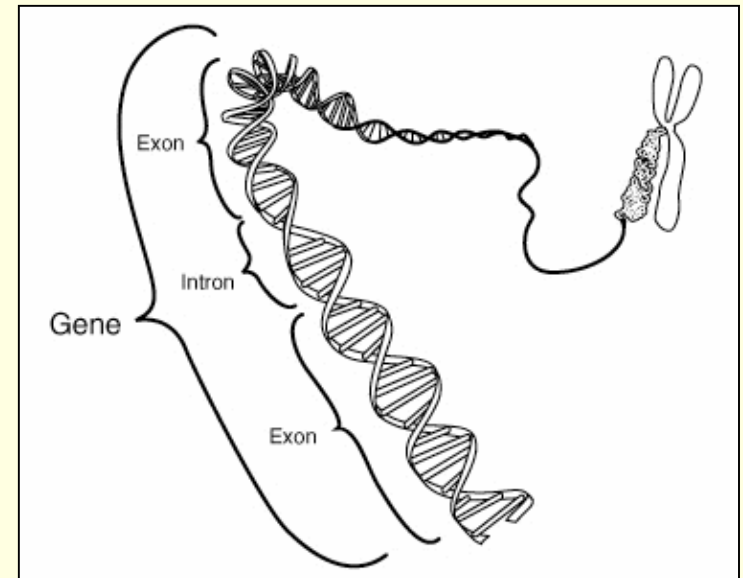
- DNA is tightly coiled, like string on a spool. The “spools” are proteins called histones.





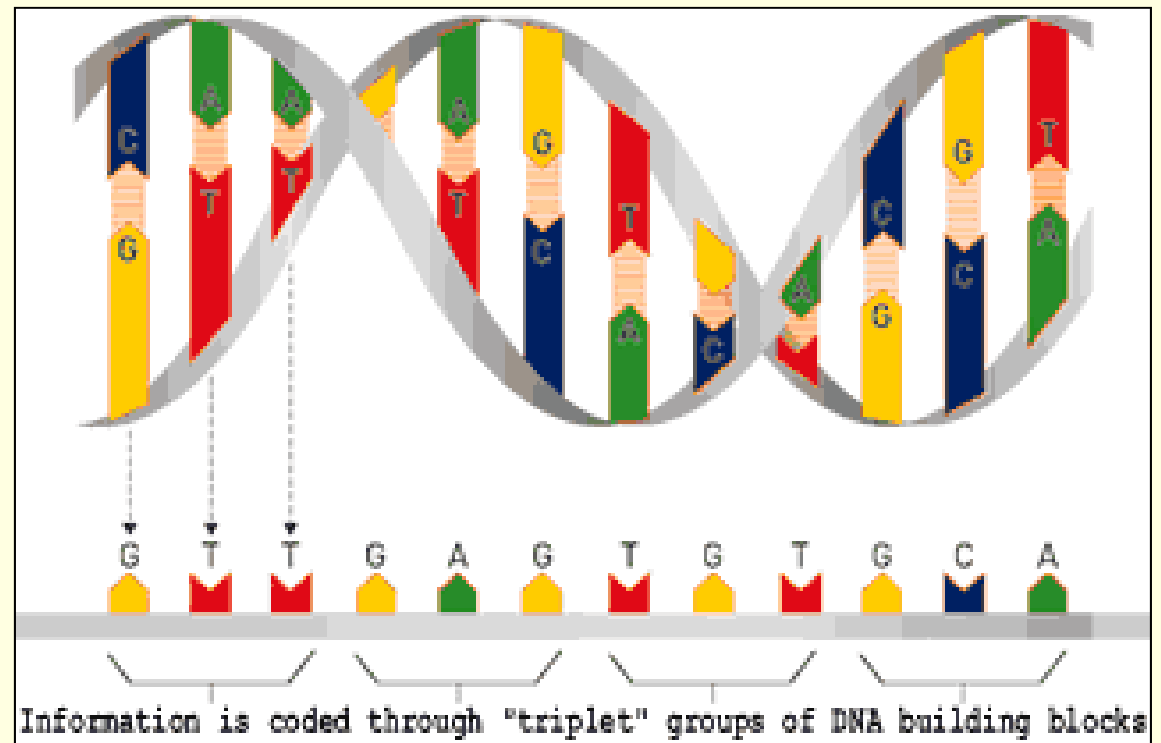
## 4.1.2 Define *gene*, *allele*, and *genome*.

- Gene- a heritable factor that controls a specific characteristic.
- Allele- one specific form of a gene, differing from other alleles by one or a few bases only and occupying the same gene locus as other alleles of the gene.
- Genome- all the genetic information of an organism (the sum total of all possible alleles available in a particular species).



## 4.1.3 Define *gene mutation*.

- Gene Mutation- occurs when there is a change in the base sequence of a gene.



Courtesy of Biotechnology and Biological Sciences Research Council.

## 4.1.4 Explain the consequence of a base substitution mutation in relation to the process of transcription and translation.

- Sickle Cell Anemia- GAG has mutated to GTC causing glutamic acid to be replaced by valine, hence sickle cell anemia.

Ss = resistant to malaria

ss = sickle cell

SS = no sickle cell.



# *Unit 4: Genetics*

## 4.2 Meiosis

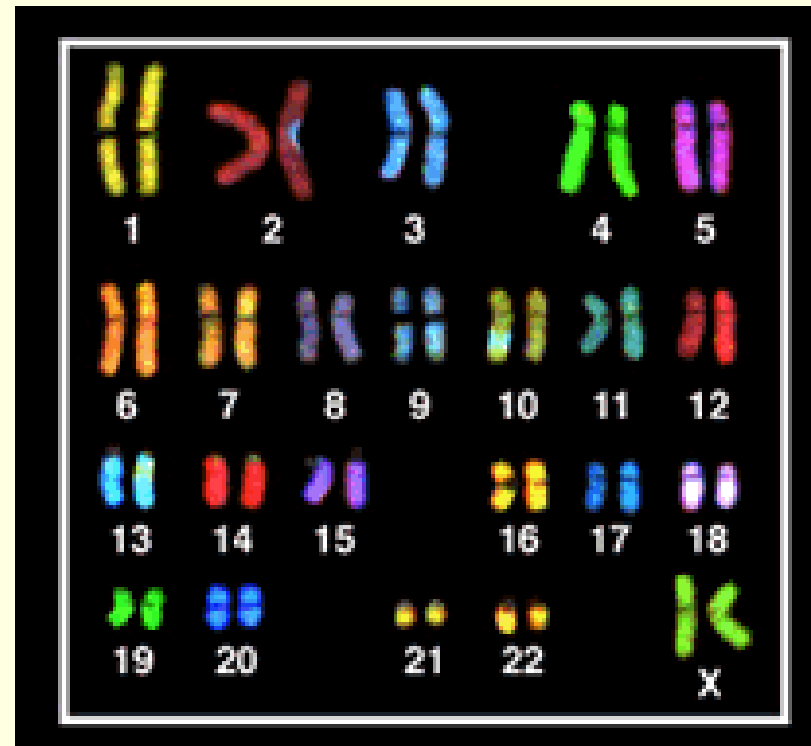
## 4.2.1 State that meiosis is a reduction division in terms of diploid and haploid numbers of chromosomes.

- The goal of meiosis is to make gametes.
- Gametes- sperm and egg.
- $2n = \text{diploid} =$  two sets of each chromosome present.
- $1n = \text{haploid} =$  one set of each chromosome present.
- The formation of a gamete is considered a reduction division, because the number of chromosomes goes from  $2n \rightarrow 1n$ .



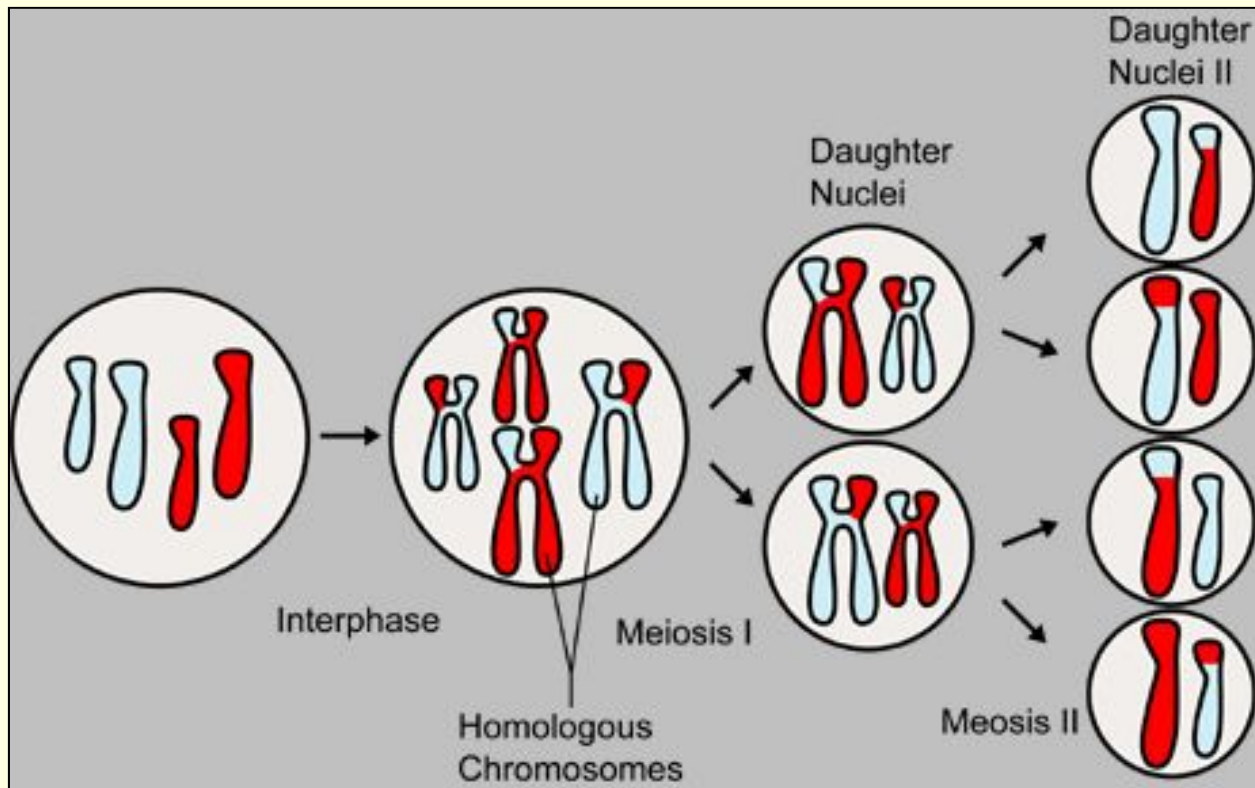
## 4.2.2 Define *homologous chromosomes*.

- Homologous chromosomes- two chromosomes that are the same size and show the same banding pattern



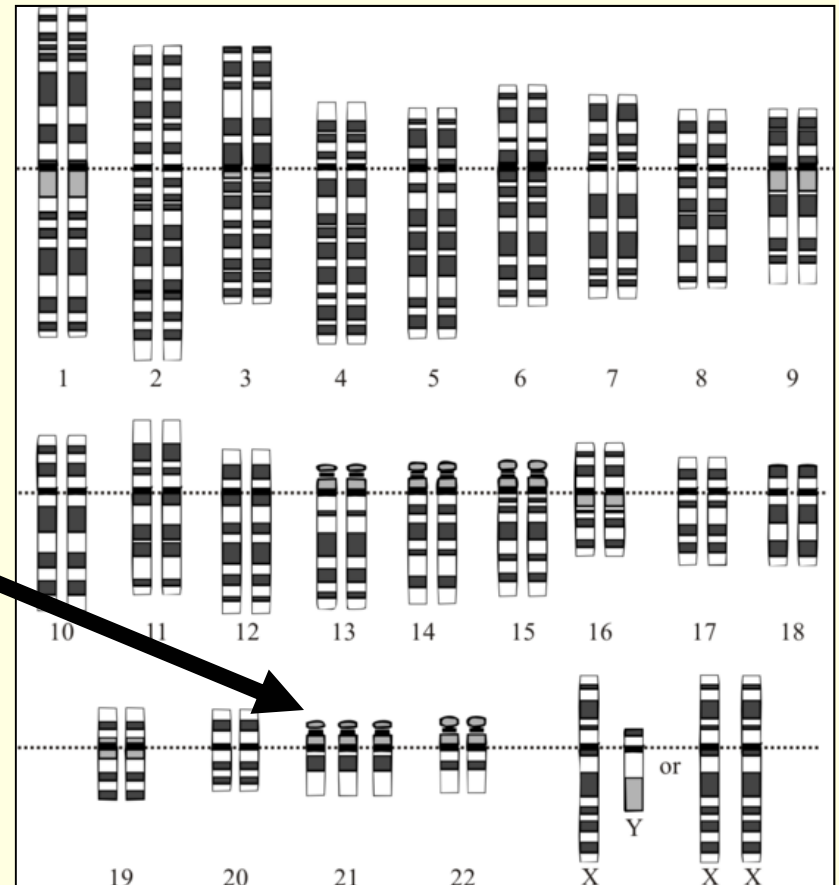
## 4.2.3 Outline the process of meiosis.

- 1) Pairing of homologous chromosomes
- 2) Two divisions
- 3) Result: four haploid ( $1n$ ) cells



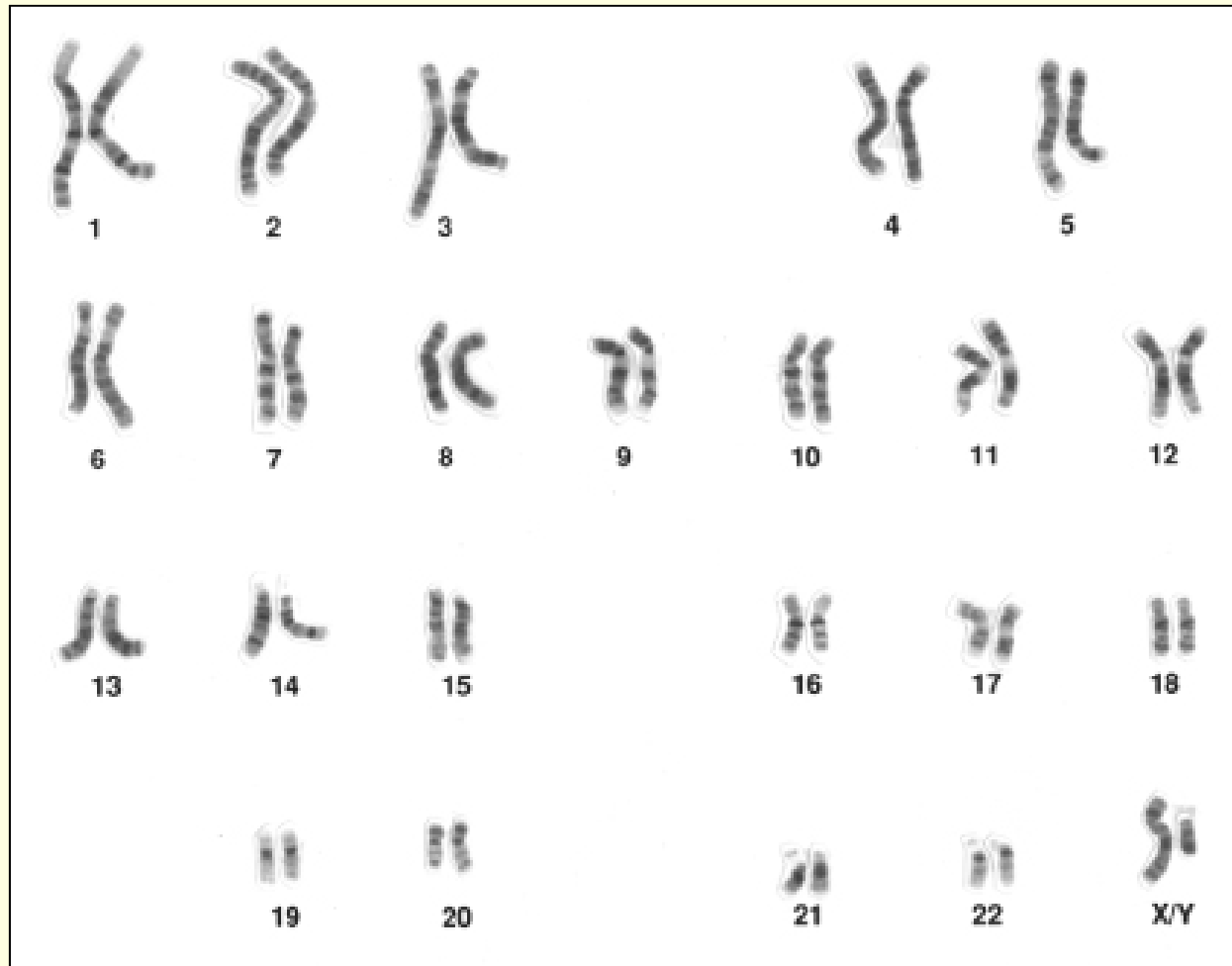
## 4.2.4 Explain that non-disjunction can lead to changes in chromosome number.

Non-disjunction-centromeres don't uncouple. leading to an extra or missing chromosome. Non-disjunction is the cause of Down Syndrome, which is evident by the presence of an extra 21<sup>st</sup> chromosome.





## 4.2.5 State that, in karyotyping, chromosomes are arranged in pairs according to their size and structure.



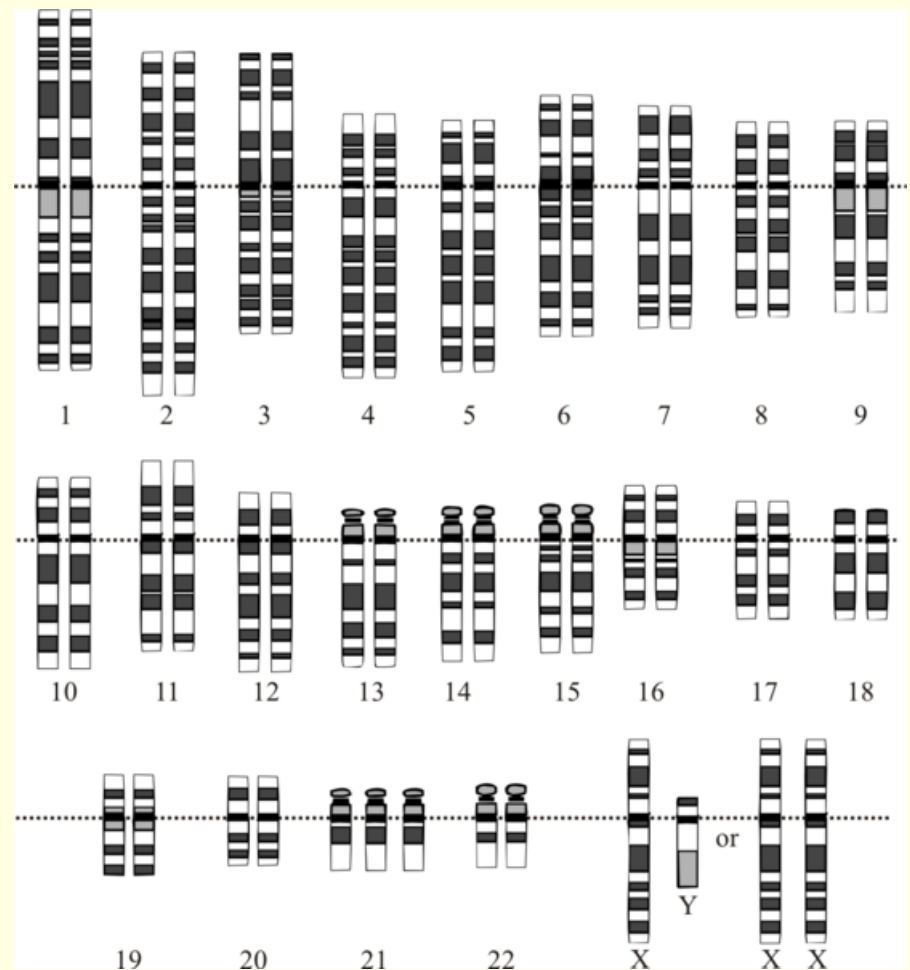
## 4.2.6 State how Karyotyping is performed.

- Karyotyping is performed using cells collected by chorionic villus sampling or amniocentesis, for pre-natal diagnosis of chromosome abnormalities.



## 4.2.7 Analyze a human karyotype to determine gender and whether or not non-disjunction has occurred.

- Female with Down Syndrome, due to trisomy on chromosome #21.



## *Unit 4: Genetics*

### Lesson 4.3

## Theoretical Genetics

### 4.3.1a Define: genotype, phenotype, dominant allele, recessive allele, codominant alleles, locus, homozygous, heterozygous, carrier, and test cross.

---

- Genotype- the alleles possessed by an organism. Eg: B, b.
- Phenotype- the characteristics of an organism. Eg: “Brown” hair.
- Dominant allele- an allele that has the same effect on the phenotype whether it is present in the homozygous or heterozygous state. Ex: Bb and BB give you brown hair.
- Recessive allele- an allele that only has an effect on the phenotype when present in the homozygous state. Eg: only bb gives you blond hair, not Bb.
- Codominant alleles- pairs of alleles that both affect the phenotype when present in a heterozygote. Eg:  $C^R C^W$  = pink flower, because both red and white gene are codominant.

### 4.3.1b Define: genotype, phenotype, dominant allele, recessive allele, codominant alleles, locus, homozygous, heterozygous, carrier, and test cross.

---

- Locus- the particular position on the homologous chromosomes of a gene.
- Homozygous- having two identical alleles of a gene. Ex: BB or bb
- Heterozygous- having two different alleles of a gene. Ex: Bb
- Test Cross- testing a suspected heterozygote by crossing it with a known homozygous recessive.

## 4.3.2 Determine the genotypes and phenotypes of the offspring of a monohybrid cross using a punnett square.

		Parent 1	
		F	f
Parent 2	F		
	f		

Courtesy of Explore Learning.

- Offspring genotypes: FF, Ff, Ff, ff
- Offspring phenotypes: 25% homozygous dominant, 50% heterozygous, 25% homozygous recessive

### 4.3.3 State that some genes have more than two alleles (multiple alleles).

- Human blood genotypes can be derived from three different alleles, “A”, “B”, and “O”.

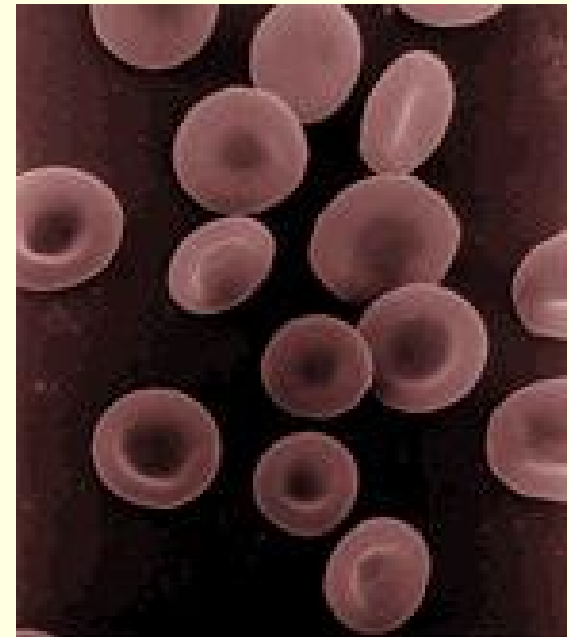
BLOOD GROUP	CAN DONATE BLOOD TO	CAN RECEIVE BLOOD FROM
O	O, A, B, AB	O
A	A, AB	O, A
B	B, AB	O, B
AB	AB	O, A, B, AB



## 4.3.4 Describe ABO blood groups as an example of codominance and multiple alleles.

---

- The blood type “AB” is codominant because neither “A” nor “B” dominate over the other. They are both expressed phenotypically.



## 4.3.5 Explain how sex chromosomes control gender.

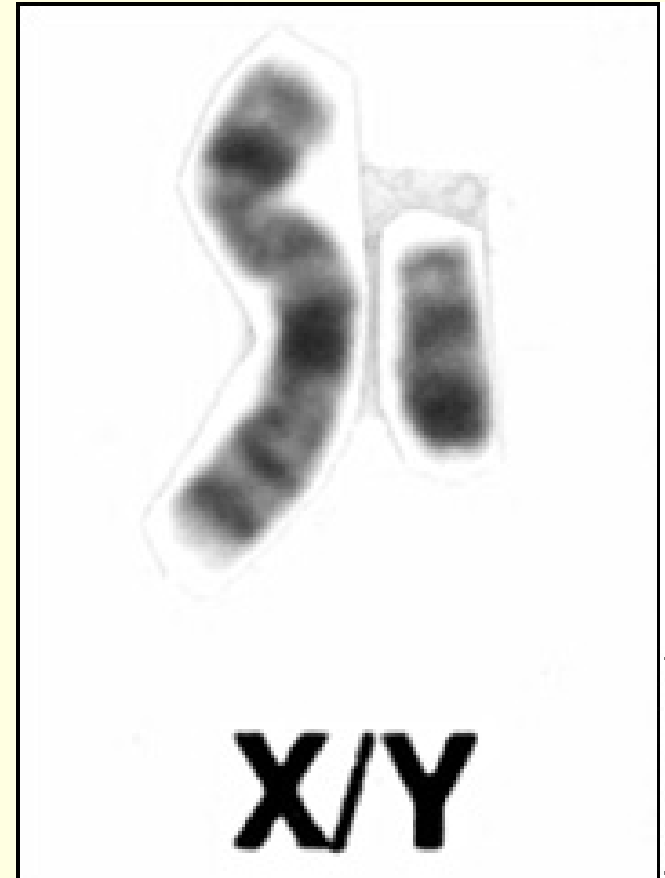
- Each person is created from one egg and one sperm. The egg always contributes an X chromosome, whereas there are two different types of sperm, X sperm and Y sperm. If an X sperm fertilizes the egg, the zygote is female. If a Y sperm fertilized the egg, the zygote is male.



Courtesy of ScienceMuseum.org

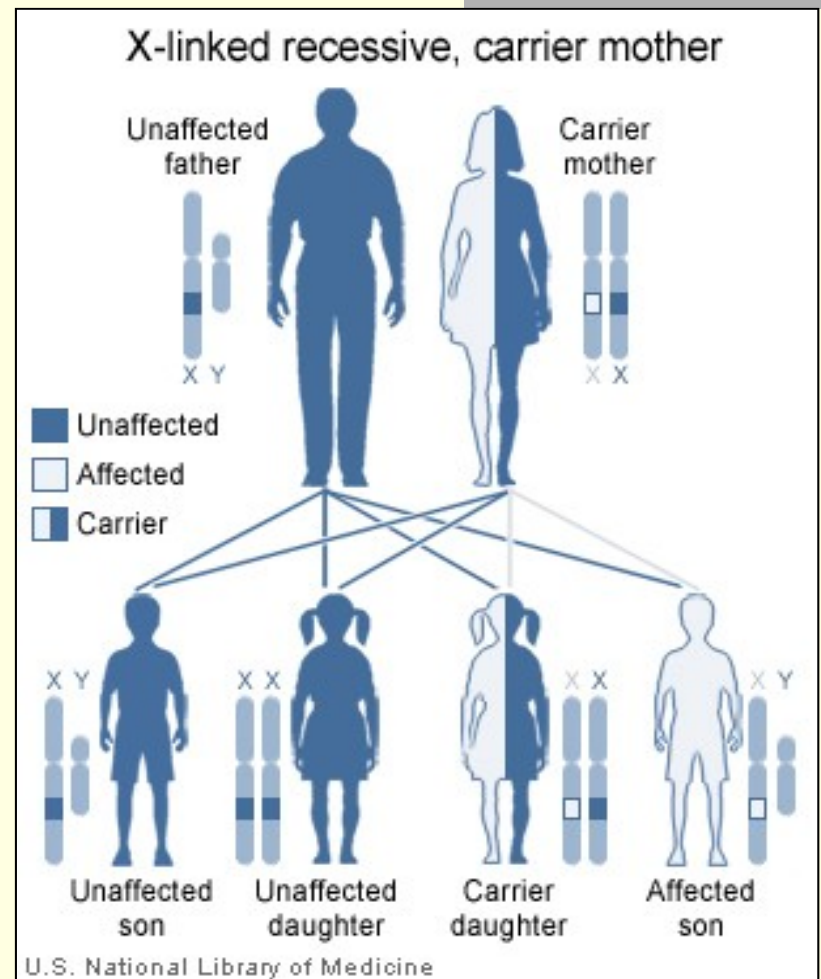
#### 4.3.6 State that some genes are present on the X chromosome and absent from the shorter Y chromosome in humans.

- By virtue of size, the X chromosome contains more genes.



## 4.3.7 Define *sex linkage*.

Sex linkage- genes that are carried on the sex chromosomes, almost always the "X".



## 4.3.8 Describe the inheritance of color blindness and hemophilia as examples of sex linkage.

### ■ Colorblindness

$X^B$  = normal vision

$X^b$  = colorblindness

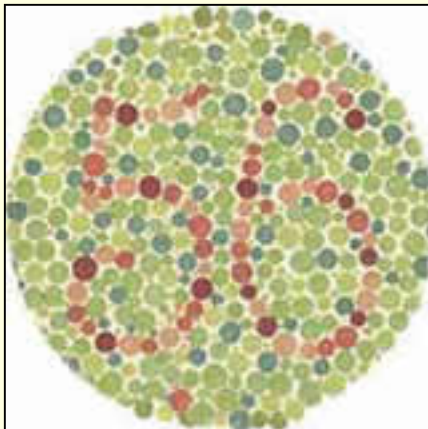
$X^B X^B$  = normal female

$X^B X^b$  = carrier female

$X^b X^b$  = colorblind female

$X^B y$  = normal male

$X^b y$  = colorblind male



### ■ Hemophilia

$X^H$  = normal

$X^h$  = hemophilia

$X^H X^H$  = normal female

$X^H X^h$  = carrier female

$X^H y$  = normal male

$X^h y$  = hemophilia male

$X^h X$  = homozygous lethal



## 4.3.9 State that a human female can be homozygous or heterozygous with respect to sex-linked genes.

---

Females and the Hemophilia gene:

$X^H X^H$  = normal female = homozygous

$X^H X^h$  = carrier female = heterozygous



## 4.3.10 Explain that female carriers are heterozygous for X-linked recessive alleles.

---

With hemophilia, a woman who has the genotype  $X^h X^h$  would be homozygous lethal, and would bleed to death during her first menstrual cycle. The probability of obtaining this genotype is so rare, the females are routinely only characterized as being heterozygous for X-linked traits.



## 4.3.11 Predict the genotypic and phenotypic ratios of offspring of a monohybrid cross.

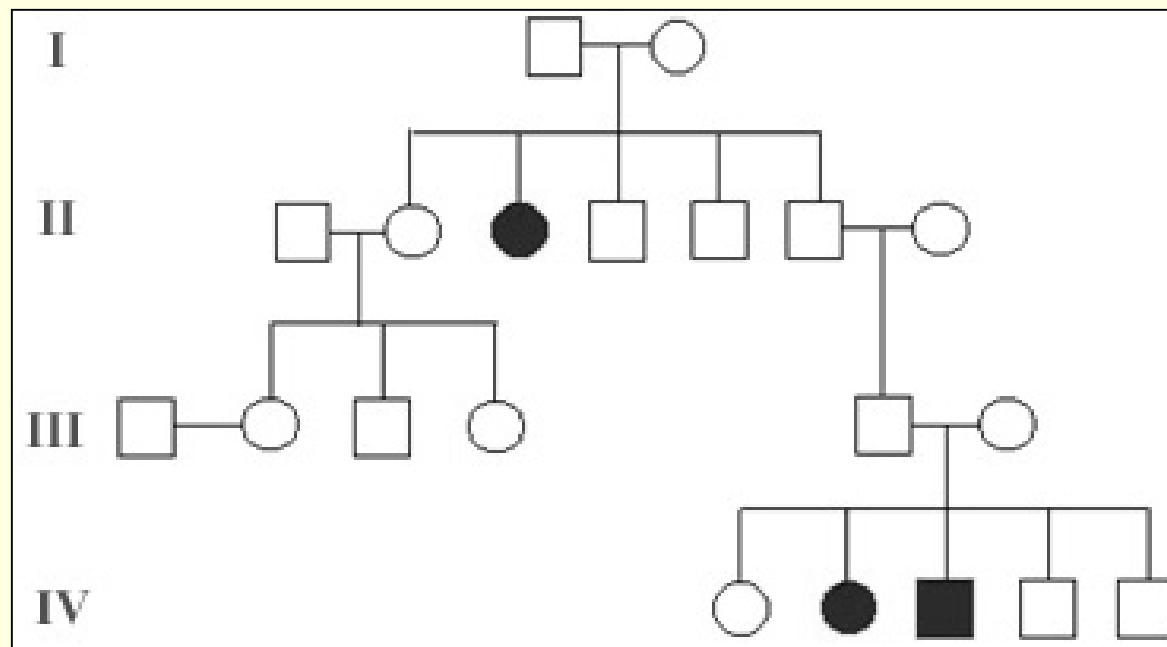
- B = brown hair
- b = blond hair
  
- Bb x Bb
- BB = 25%
- Bb = 50%
- bb = 25%
  
- Brown = 75%
- Blond = 25%

	B	b
B	BB	Bb
b	Bb	bb



## 4.3.12 Deduce the genotypes and phenotypes of individuals in pedigree charts.

- This pedigree chart shows a disorder which is autosomal recessive. It is autosomal because it occurs in both males and females, and recessive because those affected came from parents who showed no symptoms.



# *Unit 4: Genetics*

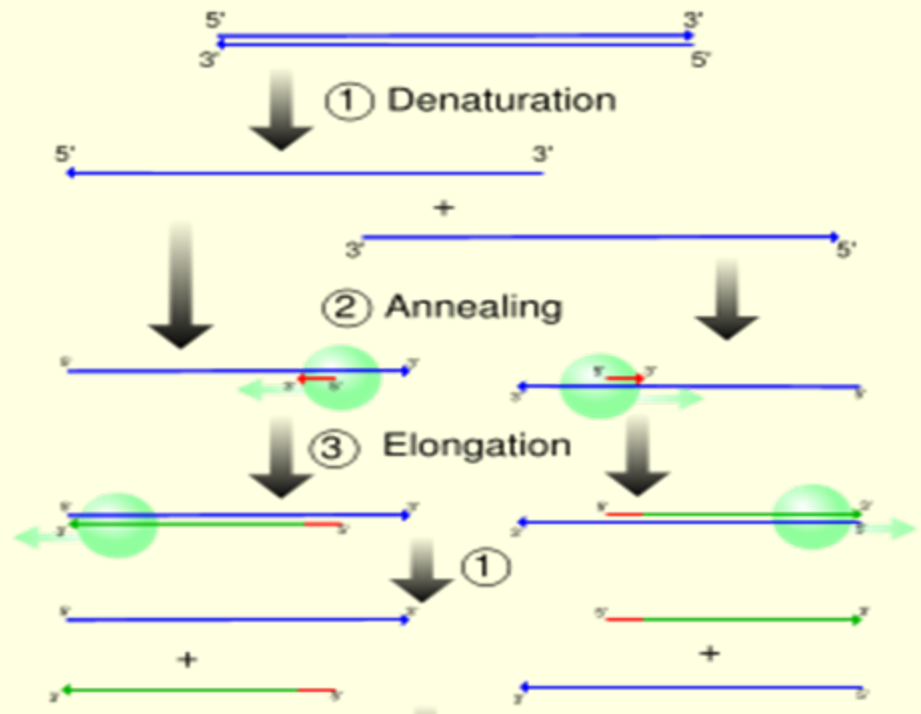
## Lesson 4.4

# Genetic Engineering and Biotechnology

## 4.4.1 Outline the use of polymerase chain reaction (PCR) to copy and amplify minute quantities of DNA.

- 1) Denaturation of DNA via heat.
- 2) Annealing of primers to DNA
- 3) Elongation of DNA strand.

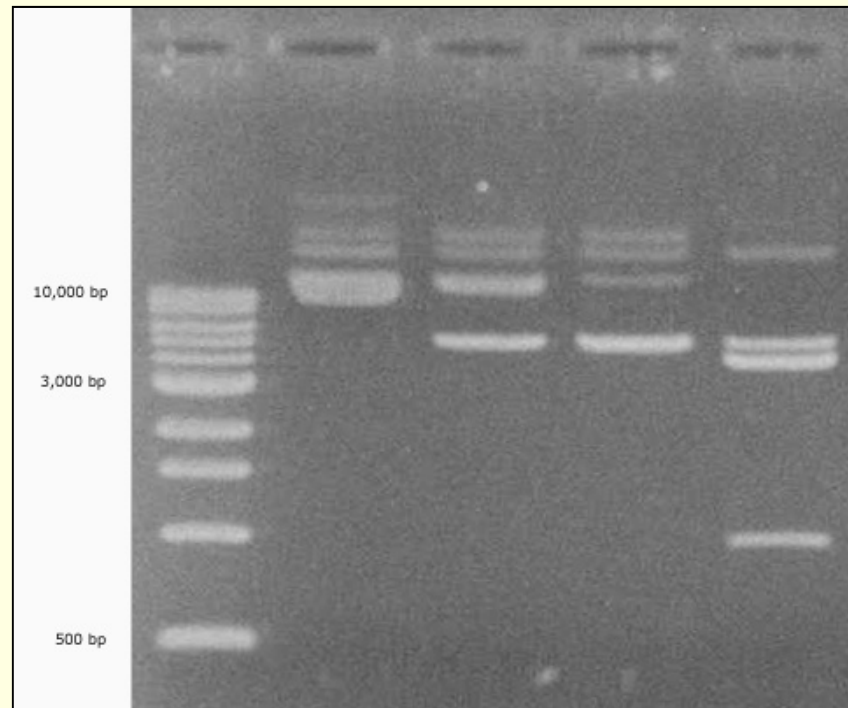
Cycle is repeated multiple times, which results in an exponential gain of the target DNA sequence.



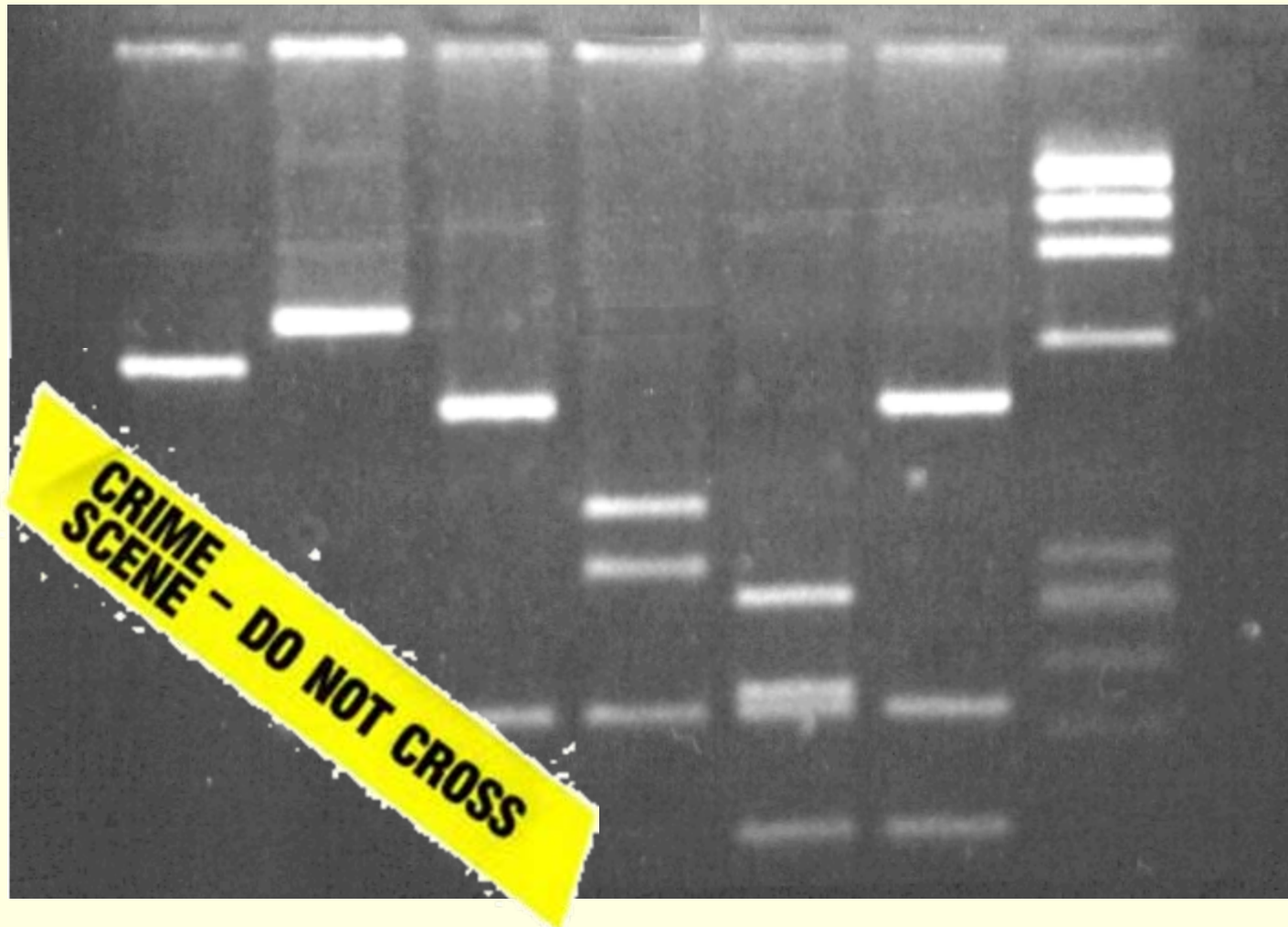
Courtesy of Madeleine Ball

## 4.4.2 State that gel electrophoresis involves the separation of fragmented pieces of DNA according to their charge and size.

- The wells are at the top of the picture. The smallest fragments move the greatest distance from the well, and are found closer to the bottom of the picture.



### 4.4.3 State that gel electrophoresis of DNA is used in DNA profiling.



## 4.4.4 Describe two applications of DNA profiling.

- 1) Paternity testing- child shows two bands, one matches the mother, the other matches the father.
- 2) Crime scene investigation- drops of blood and other sources of DNA from the crime scene can be compared to a suspect's DNA.

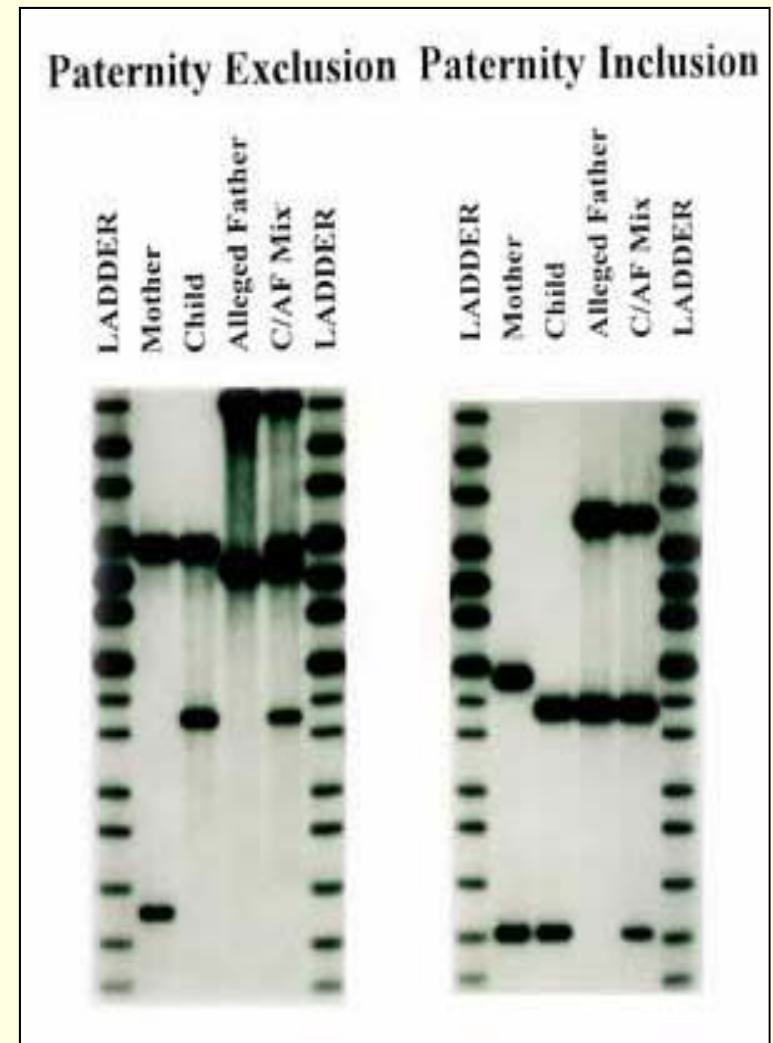


## 4.4.5 Analyze DNA profiles to draw conclusions about paternity or forensic investigations.

On the left gel, the alleged father is not the actual father.

On the right gel, the alleged father is the actual father.

Of the two bands for the child, one must come from the mother and one from the father.



## 4.4.6 Outline three outcomes of sequencing the complete human genome.

- 1) Future understanding of many genetic diseases.
- 2) Advanced, targeted pharmaceutical production.
- 3) Bioethical implications, e.g. potential genetic discrimination.



Courtesy of David Richfield



4.4.7 State that when genes are transferred between species, the amino acid sequence of polypeptides is unchanged because the code is universal.

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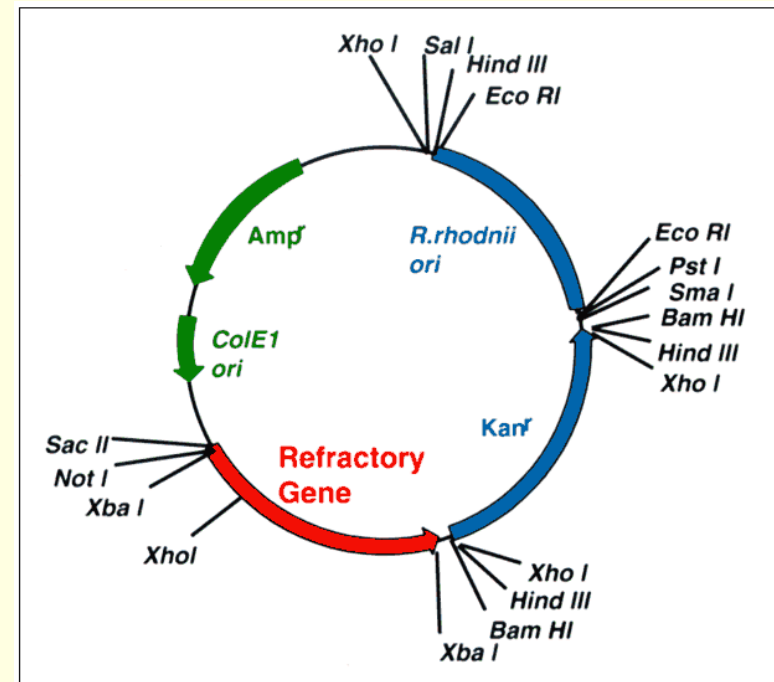
■ Glowing Mice

The gene responsible for phosphorescence in jellyfish is inserted into mouse embryo's, causing them to glow under an ultraviolet light.



## 4.4.8 Outline the basic technique for gene transfer using plasmids, a host cell, restriction enzymes, and DNA ligase.

- 1) Select a gene of interest.
- 2) Select a plasmid from a bacterium.
- 3) Use the same restriction enzyme to cut both gene and plasmid.
- 4) Insert gene into plasmid and ligate.
- 5) Insert plasmid into bacteria.
- Result: Bacteria multiply exponentially, making many copies of the gene.



## 4.4.9 State two examples of current uses of genetically modified crops or animals

1) Delayed ripening of tomatoes.



2) Herbicide resistance in crop plants.



C00-300-71

## 4.4.10 Discuss the potential benefits and possible harmful effects of one example of genetic modification.

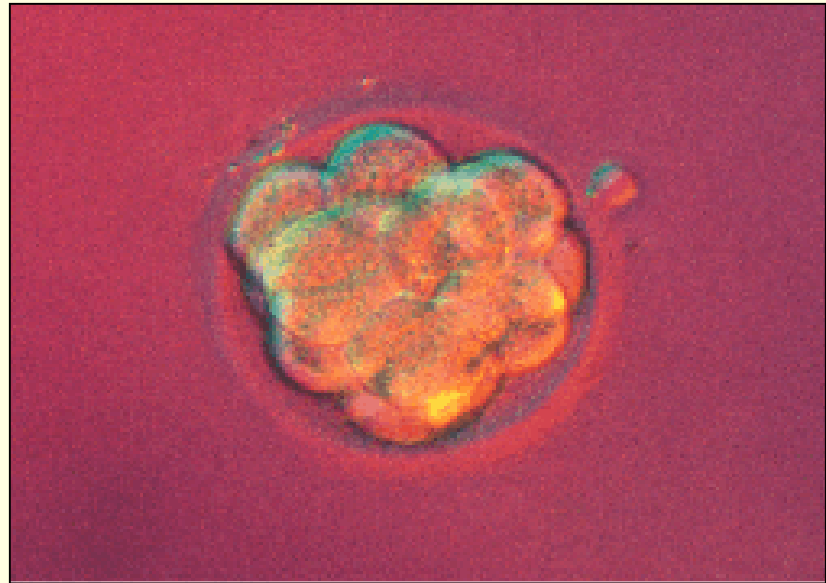
- Golden Rice- genetically modified to contain enhanced beta-carotene, a source of vitamin A.
- Benefit- helps combat childhood blindness in communities where there is a nutritional deficiency of vitamin A.
- Possible harmful effects- rice crops are not contained, and it's always of concern how a genetically modified crop will impact the ecosystem where it resides.



Golden rice and white rice.

## 4.4.11 Define *clone*.

Clone- a group of genetically identical organisms or a group of cells artificially derived from a single parent cell.



## 4.4.12 Outline a technique for cloning using differentiated cells.

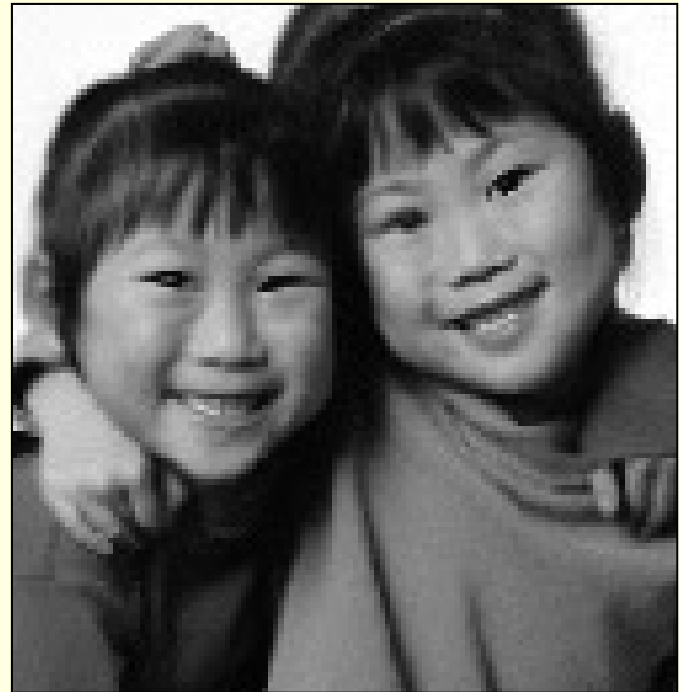
Dolly the sheep- take DNA from one cell and inject it into the nucleus of another cell (it's own DNA removed). Zap with electricity to start development.



Courtesy of Roslyn Institute

## 4.4.13 Discuss the ethical issues of cloning in humans.

- Positive- cloning just extends what nature does naturally when identical twins are produced.
- Negative- this power has the potential to be abused through eugenics, and the selection of certain traits over others.



# *Unit 5: Ecology and Evolution*

## Lesson 5.1 Communities and Ecosystems



## 5.1.1 Define ecology, ecosystem, population, community, species and habitat.

---

Ecology- study of the relationship between organisms and their environment.

Ecosystem- a community and its abiotic environment.

Population- a group of organisms of the same species living in the same environment at the same time who are capable of interbreeding.

Community- a group of populations living and interacting with each other in a habitat.

Species- a group of organisms which look alike, can interbreed and produce fertile offspring.

Habitat- the physical environment where individuals of a certain species can be found.

## 5.1.2 Distinguish between *autotroph* and *heterotroph*.

- Autotroph (producer) - synthesizes its own food.
- Heterotroph (consumer) - cannot synthesize its own food. Heterotrophs obtain their food from other sources.



Plants are autotrophs

## 5.1.3 Distinguish between consumers, *detritivores* and *saprotrophs*.

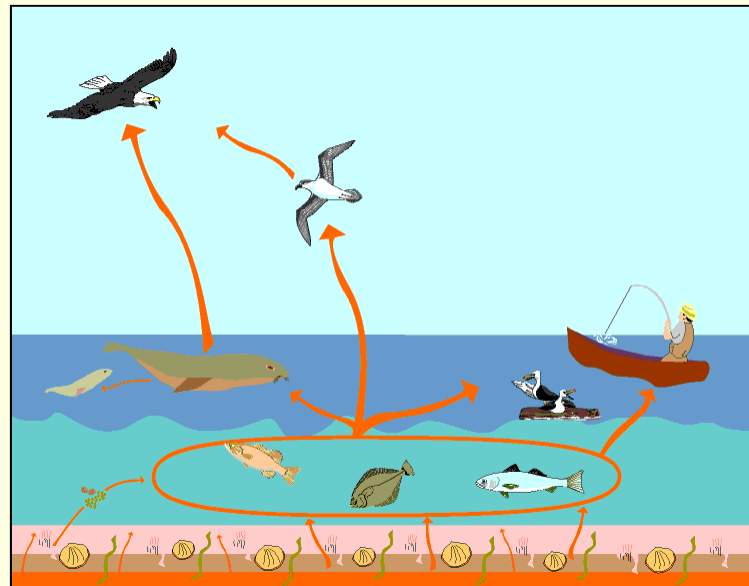
- Consumer- obtain nutrients from other living organisms
- Decomposer – obtain nutrients from dead organic matter.
  - Detritivore- ingests organic matter and then breaks it down, eg. earthworms, vultures.
  - Saprotroph- secretes enzymes externally and then absorbs broken down products, eg. mushrooms, bacteria.



Mushrooms are saprotrophs

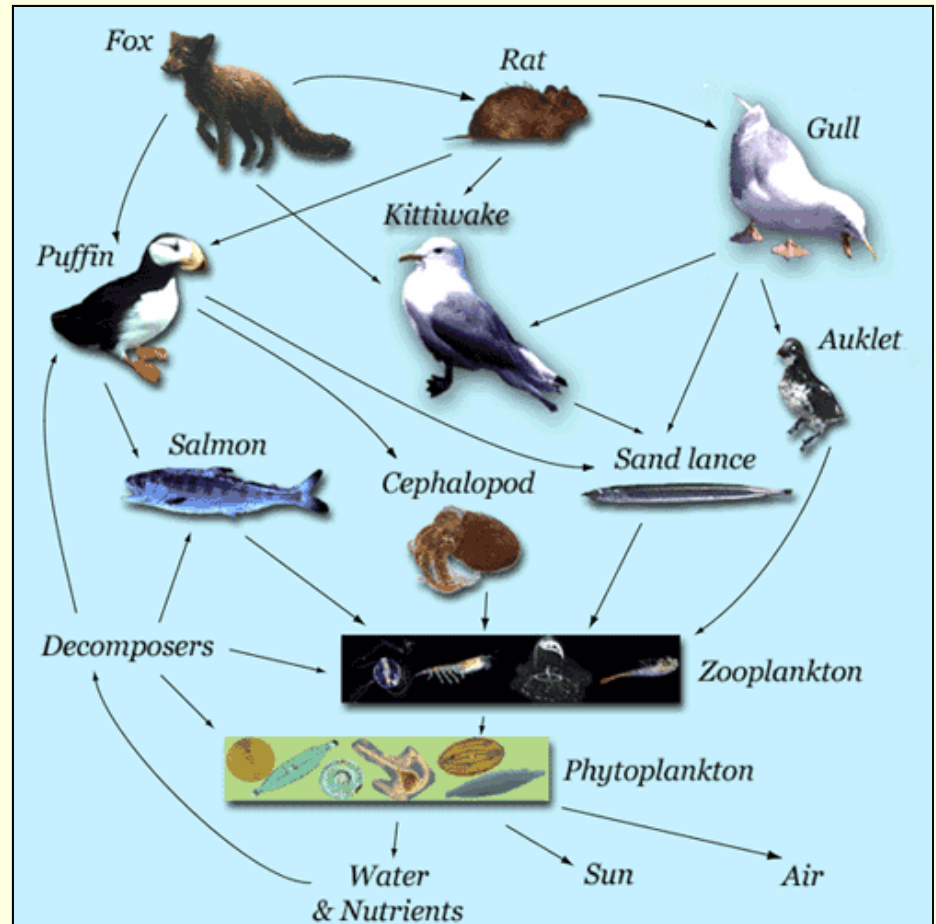
## 5.1.4 Describe what is meant by a food chain giving three examples, each with at least three linkages (four organisms).

- Food chains illustrate feeding relationships between members of a community.
- One food chain in this picture is: plankton → fish → seagull → eagle
- What other food chains do you observe in this picture?



## 5.1.5 Describe what is meant by a food web.

- Food webs, like food chains, show the feeding relationships between community members. Food webs are non-linear and branching.



## 5.1.6 Define *trophic level*.

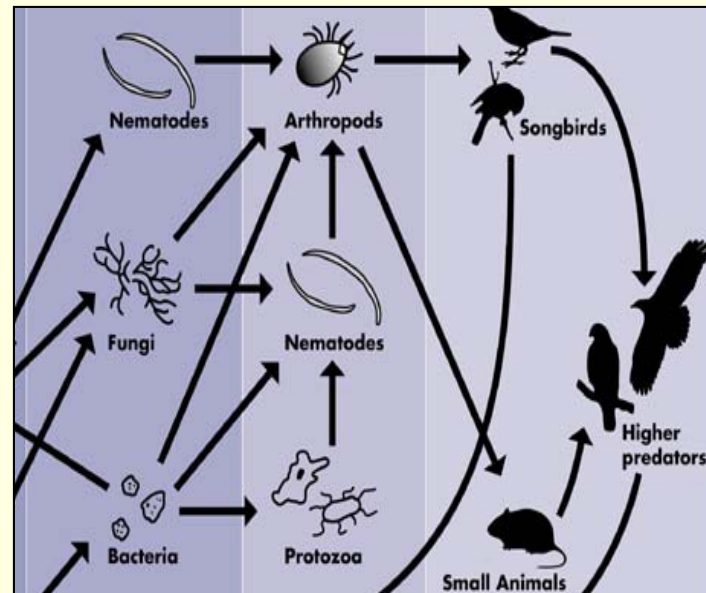
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- Trophic level- the level of the food chain at which an organism is found. The hierarchal levels are shown below:

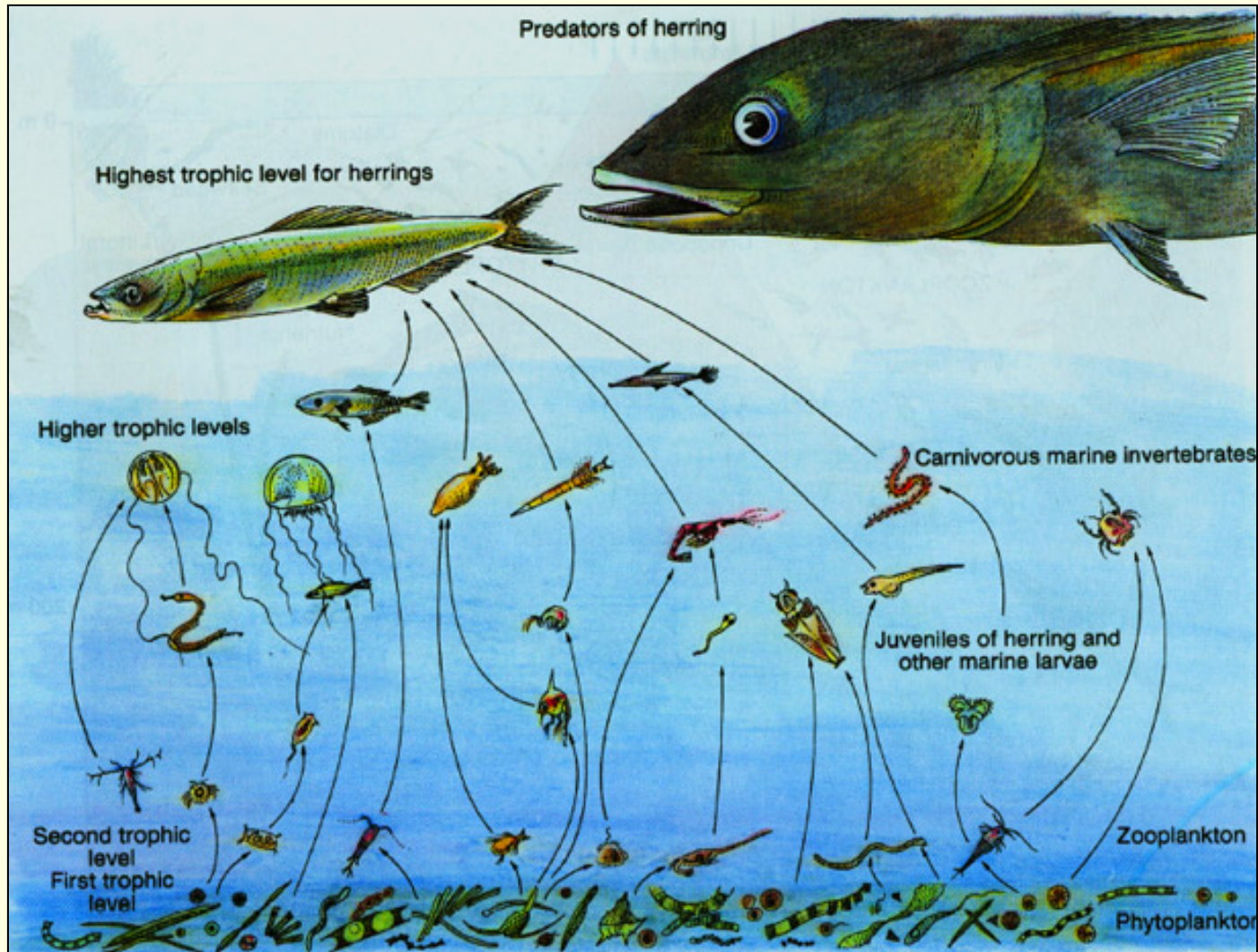
producer → primary consumer → secondary consumer → tertiary consumer

## 5.1.7 Deduce the trophic level of organisms in a food chain and a food web.

- Photosynthetic organisms are always producers. With each arrow, consumers move one generation away from the producer, eg. primary consumer, secondary consumer, tertiary consumer. When consumers (and producers) die they are decomposed, and their nutrients recycled.



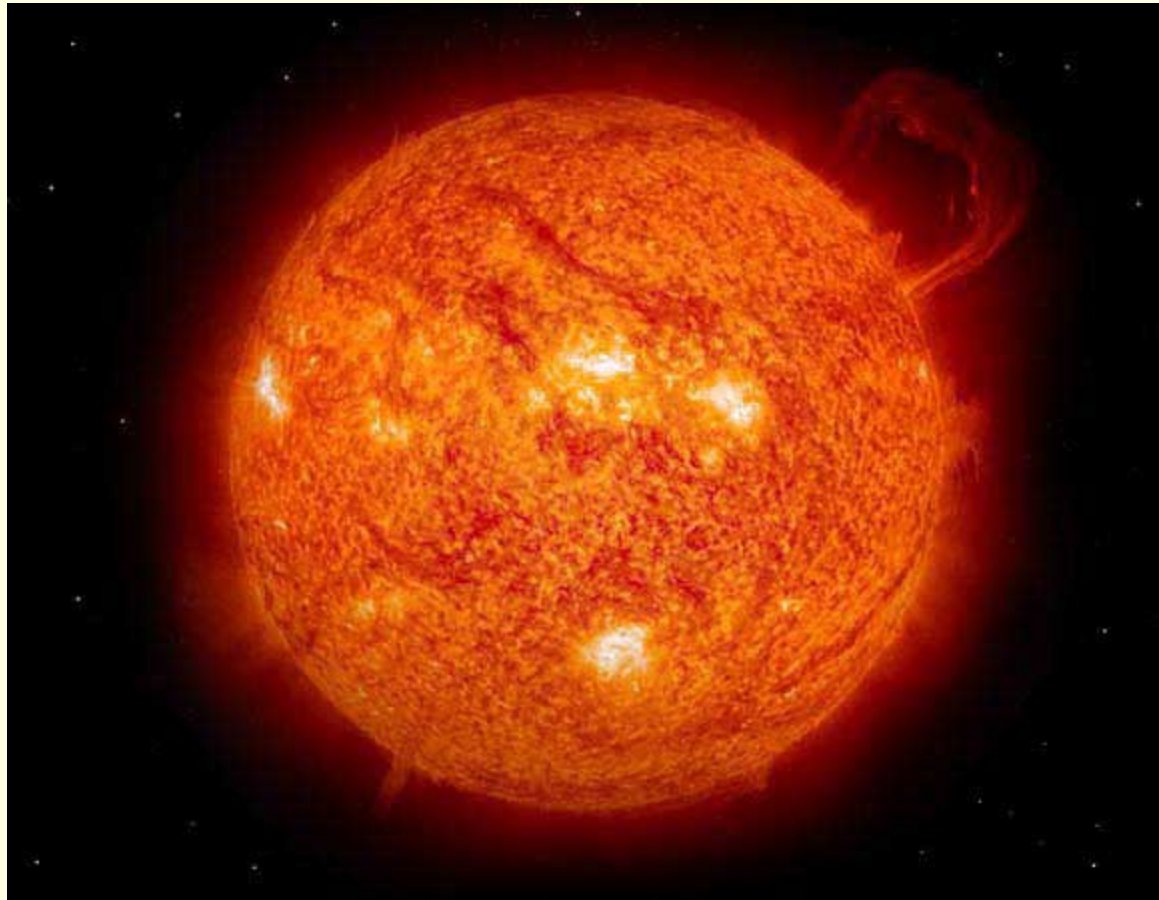
# 5.1.8 Construct a food web containing up to 10 organisms, given appropriate information.





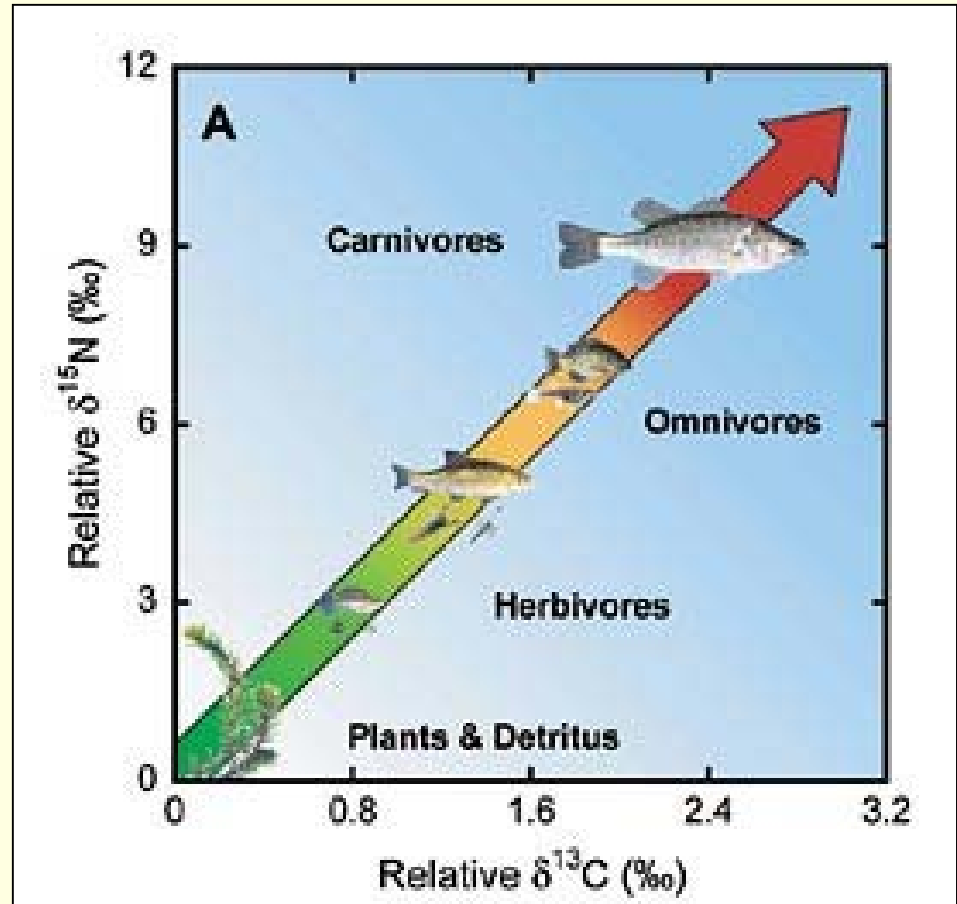
## 5.1.9 State that light is the initial energy source for almost all communities.

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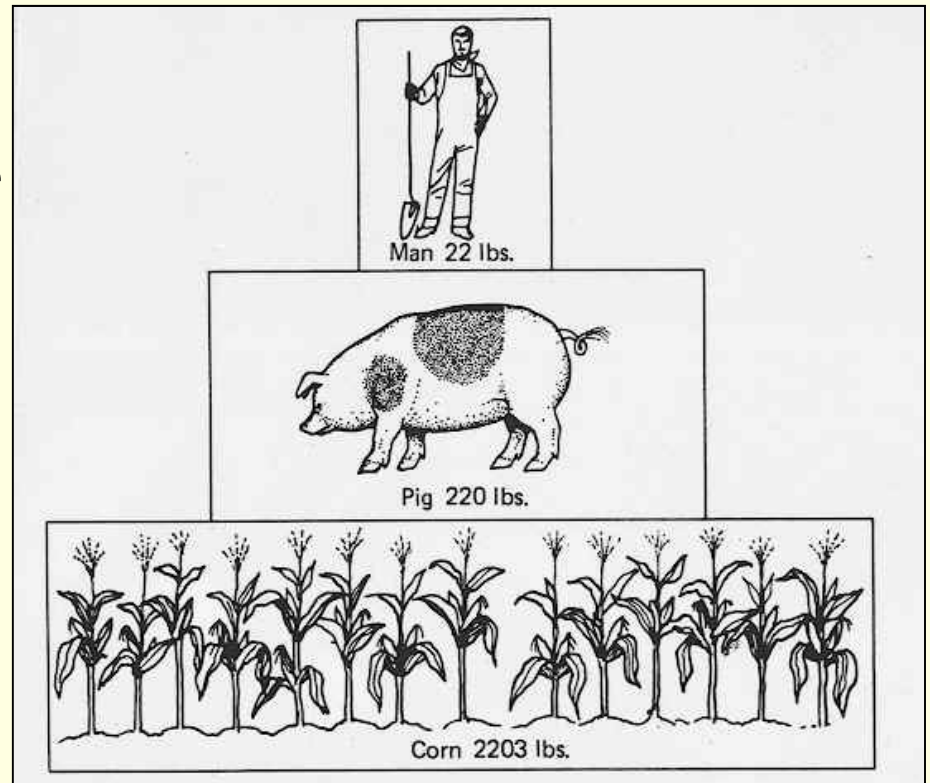
## 5.1.10 Explain the energy flow in a food chain.

- Energy losses between trophic levels include material not consumed or material not assimilated, and heat loss through cell respiration.



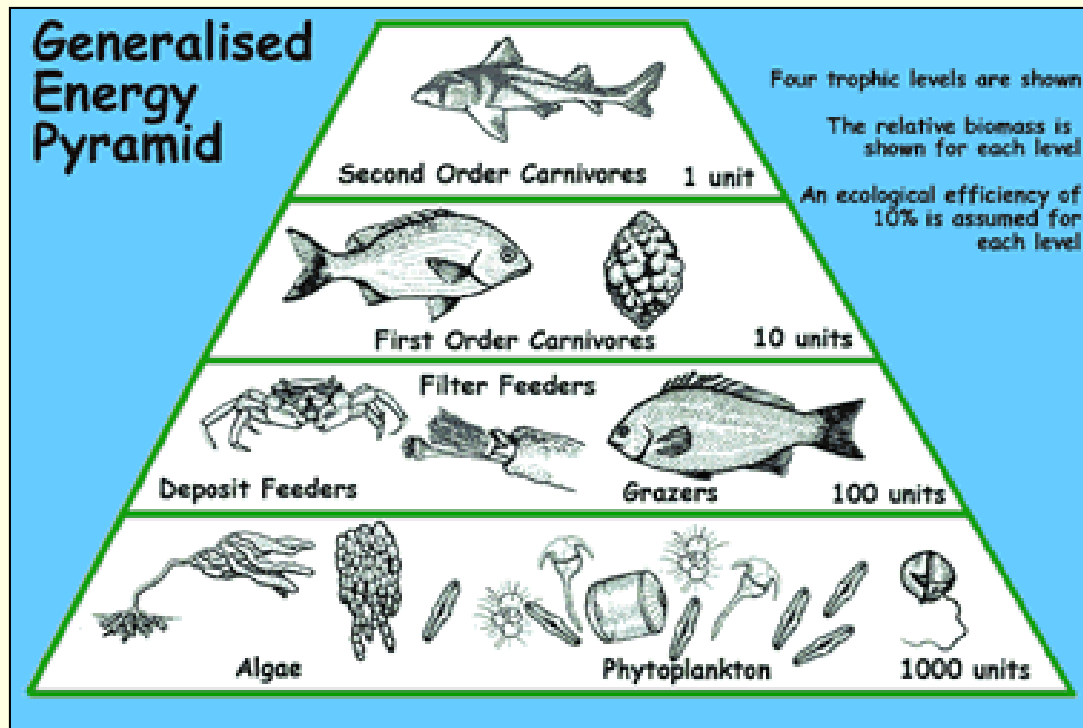
## 5.1.11 State that energy transformations are never 100% efficient.

- When energy transformations take place, including those in living organisms, the process is never 100% efficient. Commonly, it is between 10-20%.



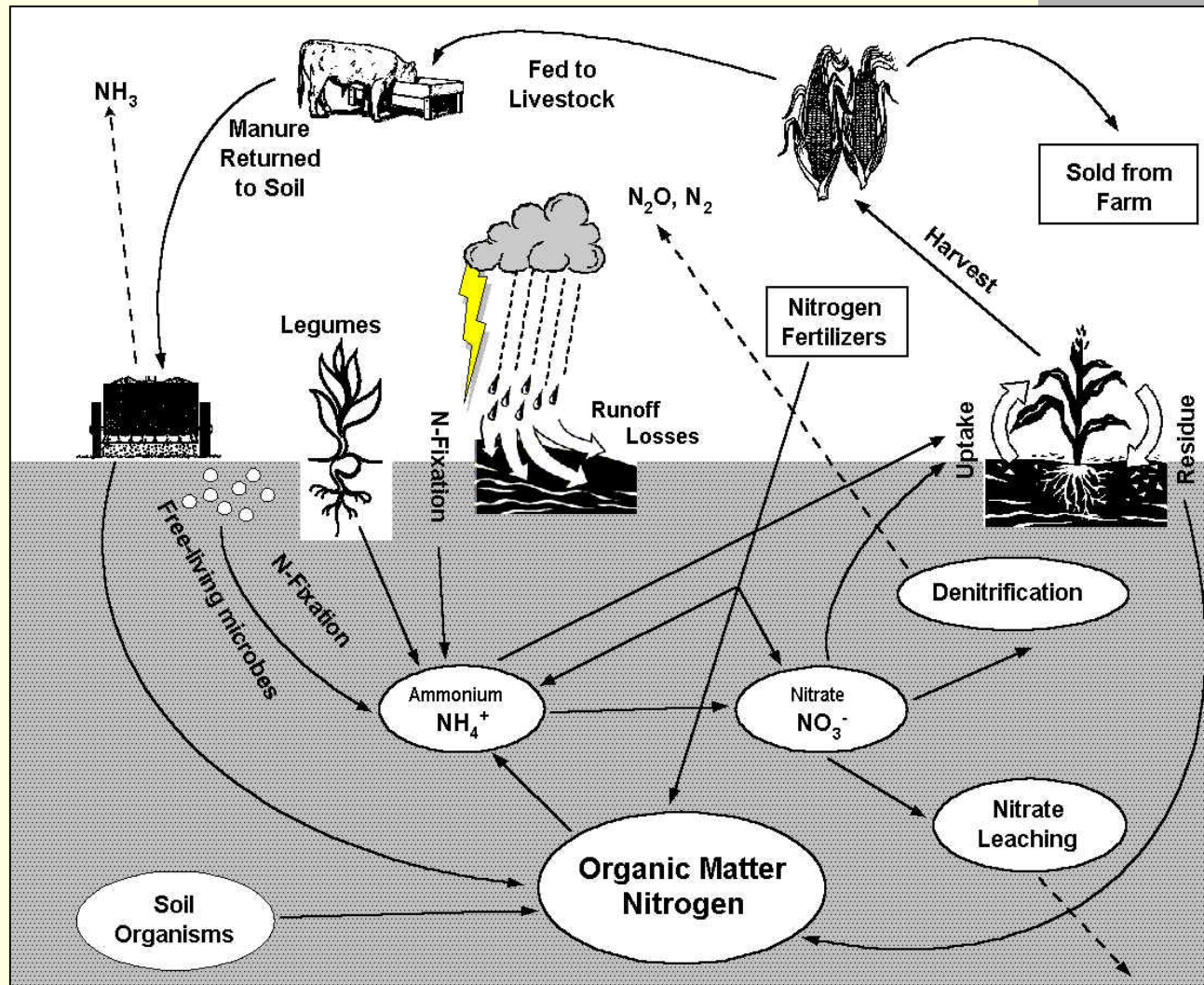
## 5.1.12 Explain what is meant by a pyramid of energy and the reasons for its shape.

- A pyramid of energy shows the flow of energy from one trophic level to the next in a community. The units of pyramids of energy are therefore energy per unit area per unit time, eg:  $\text{Jm}^{-2}\text{yr}^{-1}$



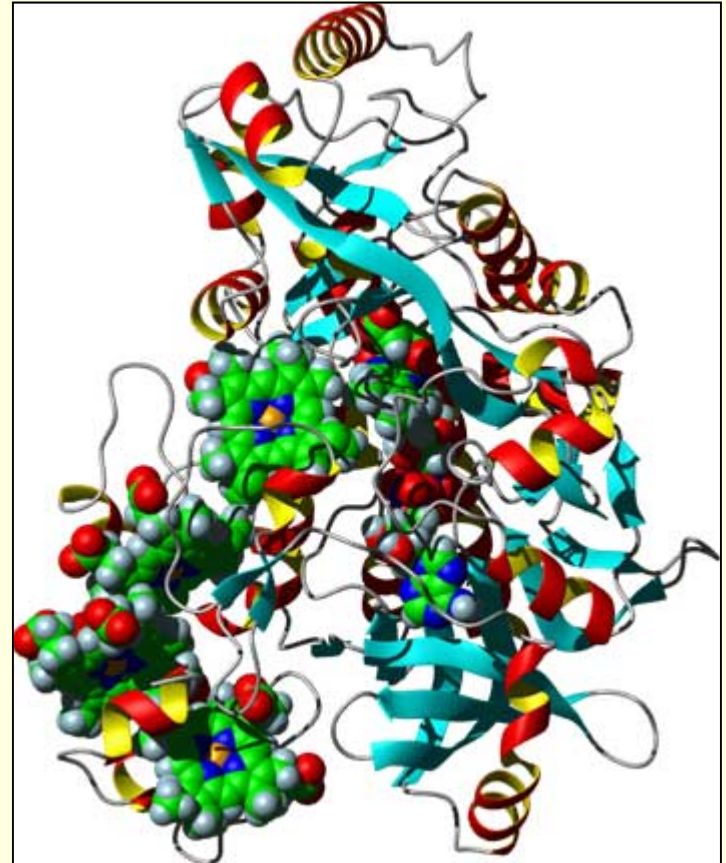
Courtesy of Marine Education Society of Australasia

# 5.1.13 Explain that energy can enter and leave an ecosystem, but that nutrients must be recycled.



## 5.1.14 State that saprotrophic bacteria and fungi (decomposers) recycle nutrients.

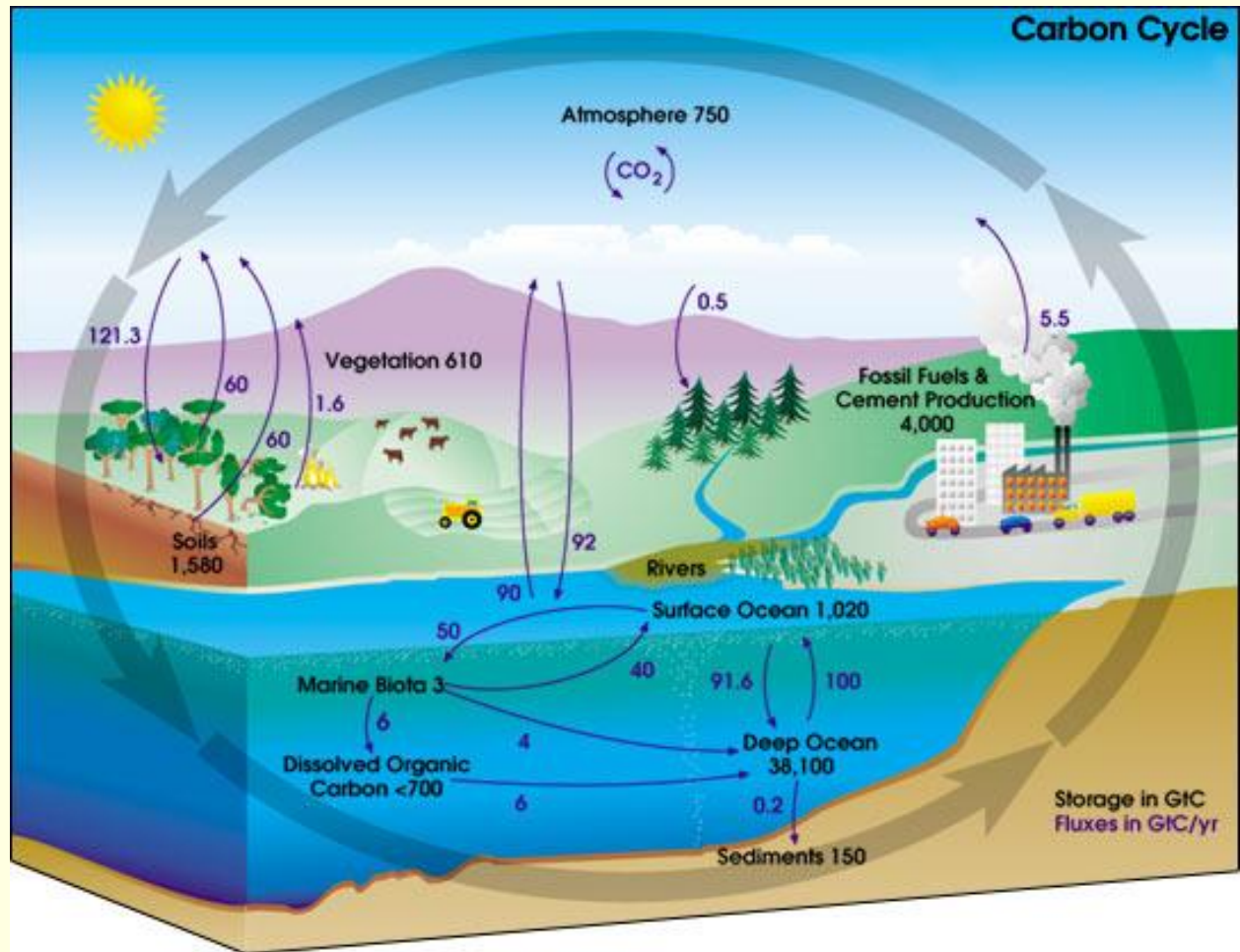
- During metabolism, living organisms build organic macromolecules in the form of polymers. Saprotrophs break down these polymers into monomers, so that they can be customized into new, specific polymers beneficial to the next organism which ingests them.



## *Unit 5: Ecology and Evolution*

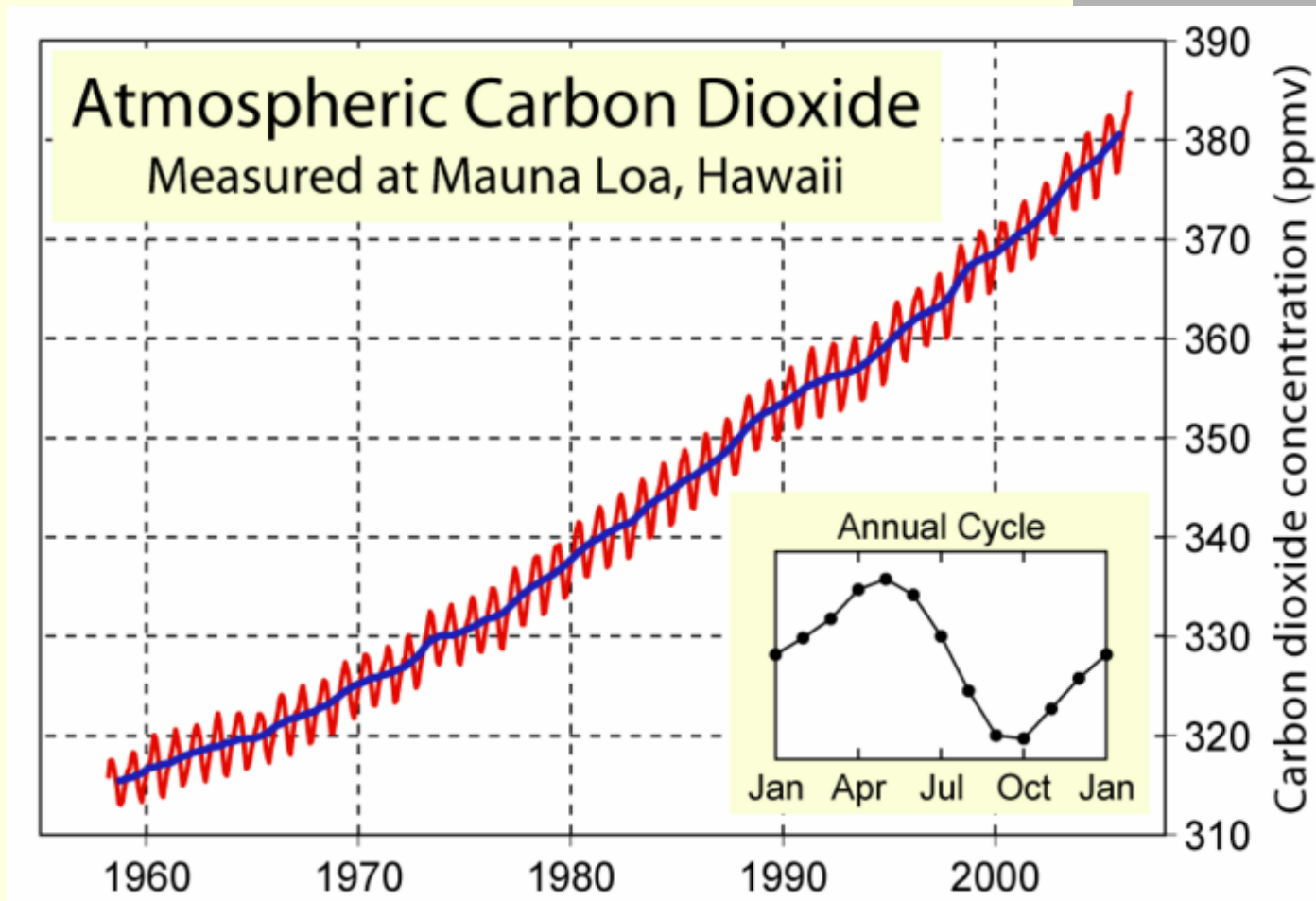
### Lesson 5.2 The Greenhouse Effect.

## 5.2.1 Draw and label a diagram of the carbon cycle to show the processes involved.





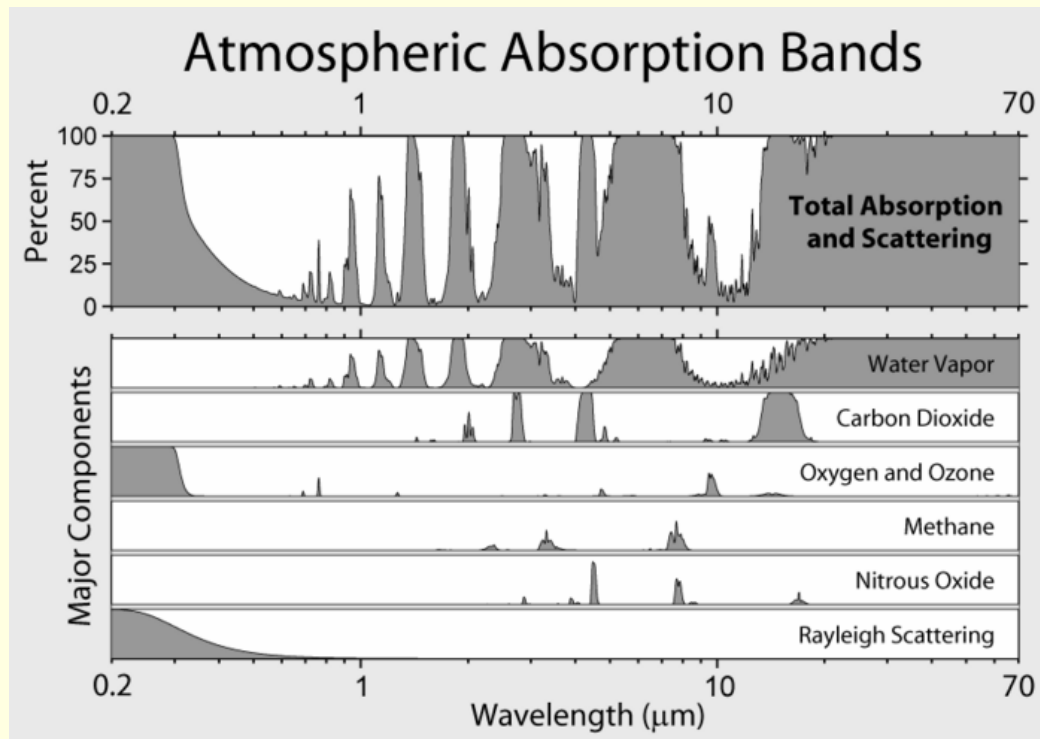
## 5.2.2 Analyze the changes in concentration of atmospheric carbon dioxide using historical records.



Courtesy of Global Warming Art

## 5.2.3 Explain the relationship between rises in concentrations of atmospheric carbon dioxide, methane and oxides of nitrogen and the enhanced green house effect.

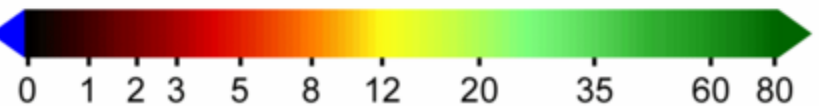
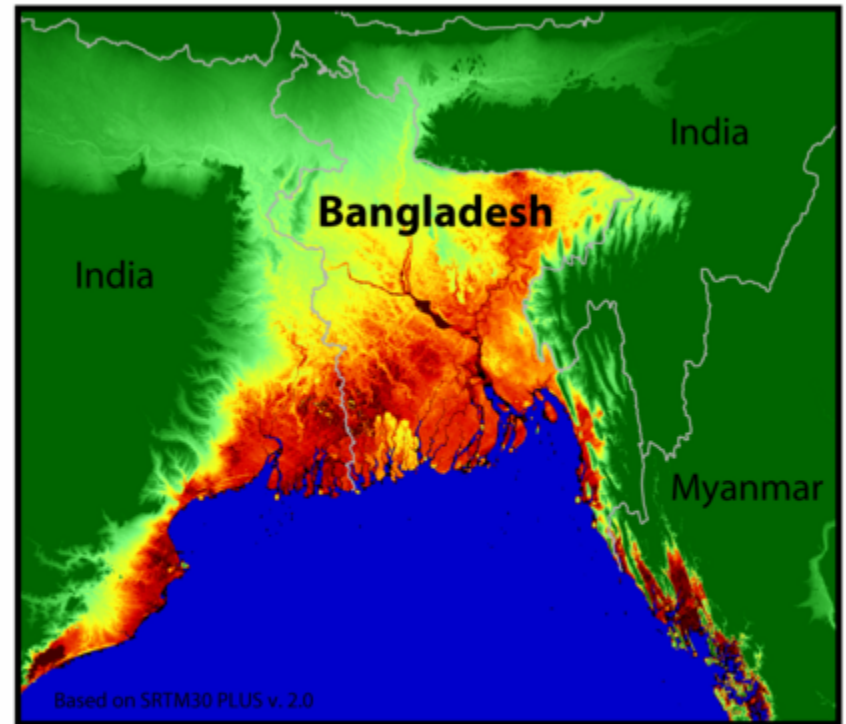
- Greenhouse gases help retain atmospheric heat generated from solar radiation. As man made behaviors (deforestation, burning of fossil fuels) increase greenhouse gas levels, the warming effect is amplified beyond what occurs in the natural cycle.



## 5.2.4 Outline the Precautionary Principle

- If an action is potentially catastrophic, the burden of proof falls upon the advocates of such action to prove that the catastrophe won't occur before such action is implemented.

Sea Level Risks - Bangladesh



Height Above Sea Level (m)

Courtesy of Global Warming Art<sup>163</sup>

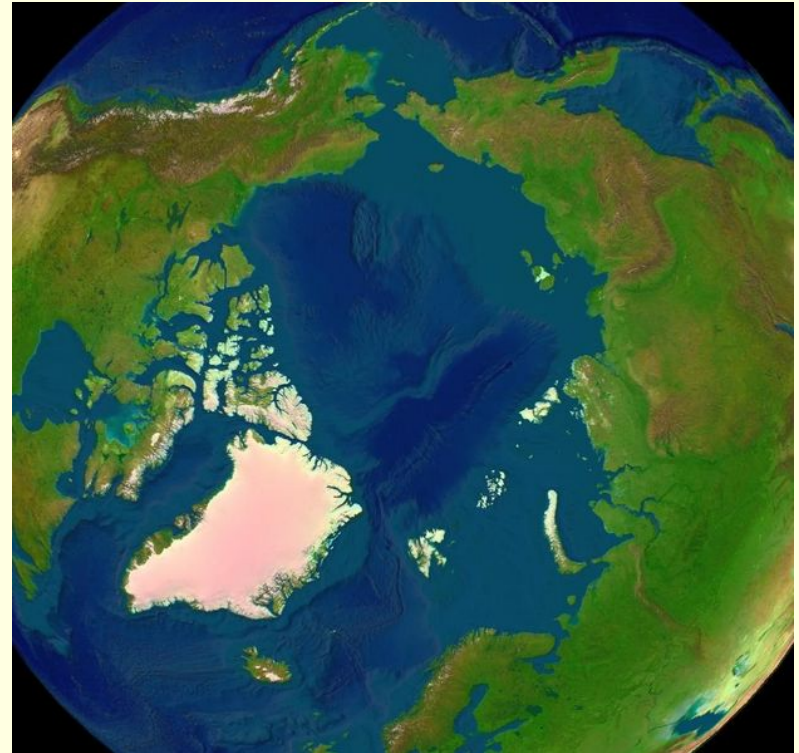
## 5.2.5 Evaluate the precautionary principle as a justification for strong action in response to threats posed by the enhanced greenhouse effect.

- Consider whether the economic harm of measures taken now to limit global warming could be balanced against the potentially much greater harm for future generations of taking no action now?
- What are your thoughts?



## 5.2.6 Outline the consequences of a global temperature rise on arctic ecosystems.

- Melting of ice shelves, resulting in a global rise in sea level
- Disruption arctic food chains with potential species extinction.
- Release of carbon from organic matter in previously frozen soil.





*Unit 5: Ecology and Evolution*

Lesson 5.3 Populations

## 5.3.1 Outline how a population size can be affected by natality, immigration, mortality and emigration.

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Natality- birth rate.

Mortality- death rate.

Immigration- # members moving in.

Emigration- # members moving out.

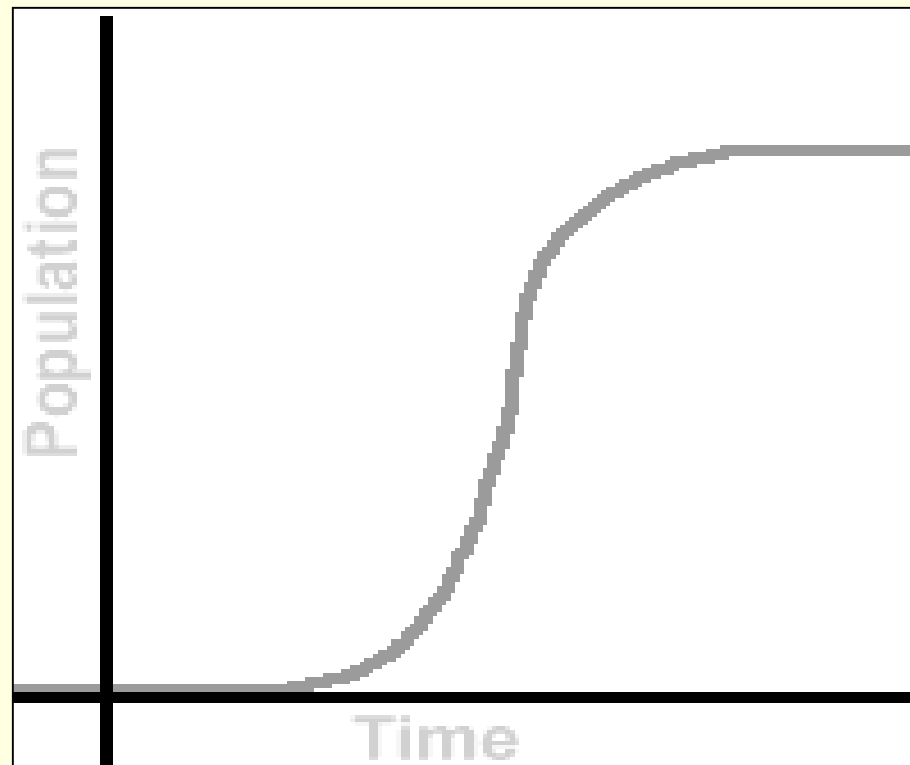
Population change =

(natality + immigration) – (mortality + emigration)



## 5.3.2 Draw and label a graph showing the sigmoid (S-shaped) population growth curve.

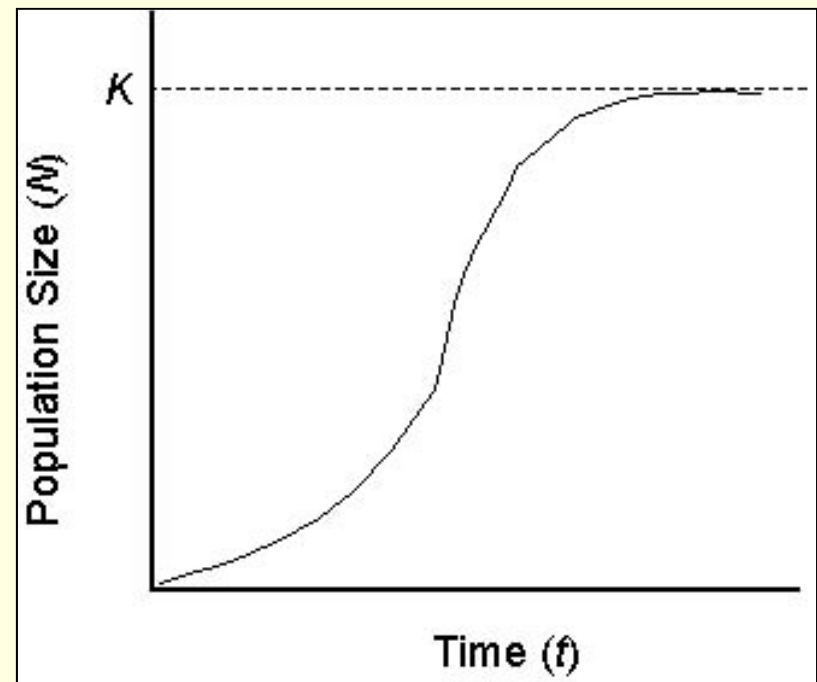
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### 5.3.3 Explain reasons for the exponential growth phase, the plateau phase and the transitional phase between the two.

- Exponential growth phase- initially, when population sizes are small, there are little to no limiting factors.
- Transitional phase- as population size increases, competition for resources becomes more prominent, and the growth rate slows
- Plateau phase- the population is near or at carrying capacity.



## 5.3.4 List three factors which set limits to population increase.

- Density Dependant:
  - Food
  - Territory
  
- Density Independent:
  - Natural Disasters  
(flood, avalanche, earthquake, etc.)



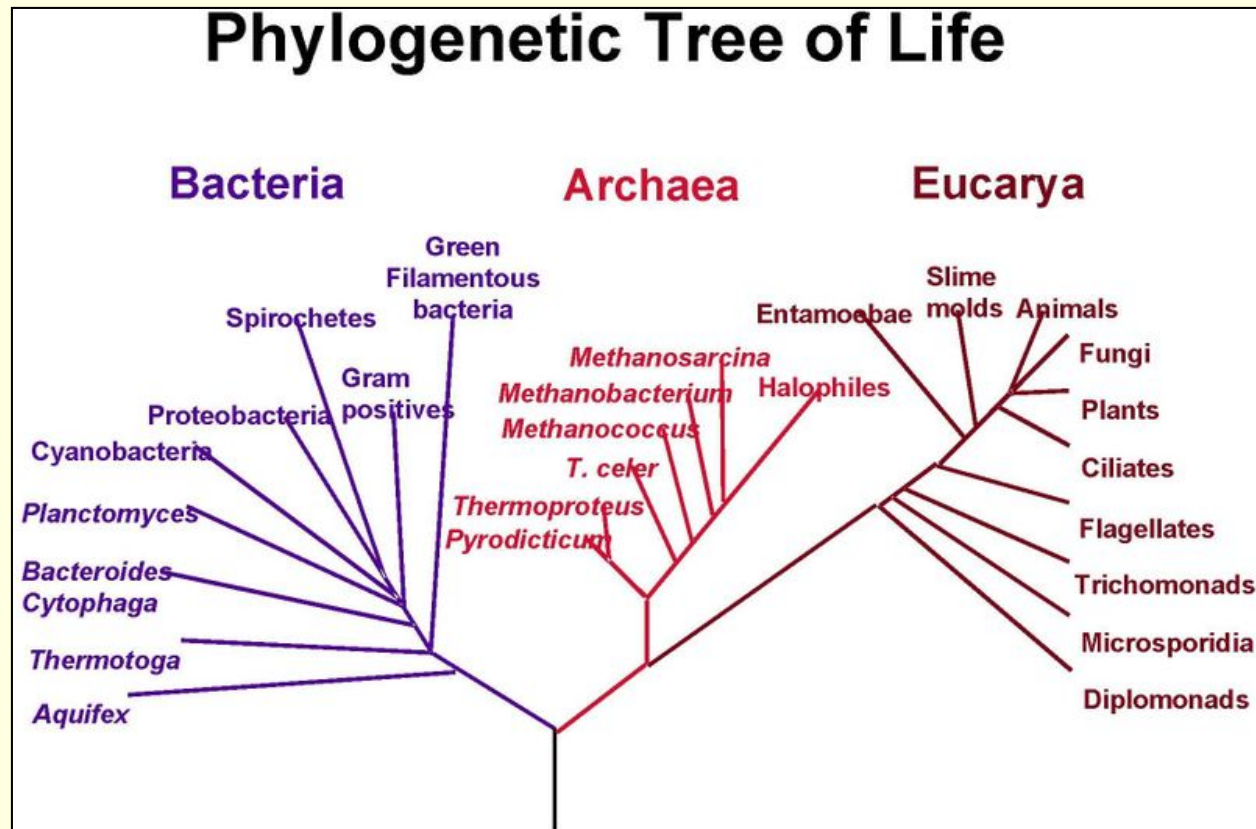


*Unit 5: Ecology and Evolution*

Lesson 5.4 Evolution

## 5.4.1 Define *evolution*.

- Evolution- the process of cumulative change in the heritable characteristics of a population.



## 5.4.2a Outline the evidence for evolution provided by the fossil record, selective breeding of domesticated animals, and homologous structures.

---

- Fossils are remains or traces of living organisms. Fossils are often found in rock layers which can be dated using radiometric dating techniques.
- Placing fossils in a relative time sequence help give scientists insight into the evolution of the phylogenetic tree.



## 5.4.2b Outline the evidence for evolution provided by the fossil record, selective breeding of domesticated animals, and homologous structures.

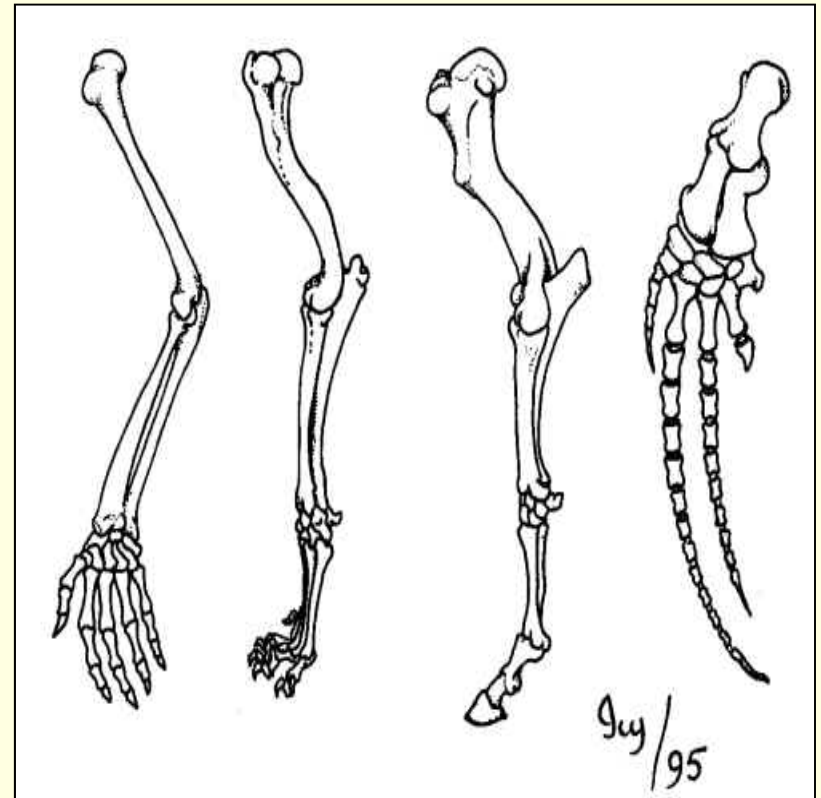
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- For centuries, humans have been selectively breeding dogs for purposes of increasing work output and for show.



## 5.4.2c Outline the evidence for evolution provided by the fossil record, selective breeding of domesticated animals, and homologous structures.

- Homologous structures across species lines are indicative of a previous common ancestor.



5.4.3 State that populations tend to produce more offspring than the environment can support.

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## 5.4.4 Explain that the consequence of the potential overproduction of offspring is a struggle for survival.

- Overproduction in a population makes resources more scarce, spurning competition for survival.



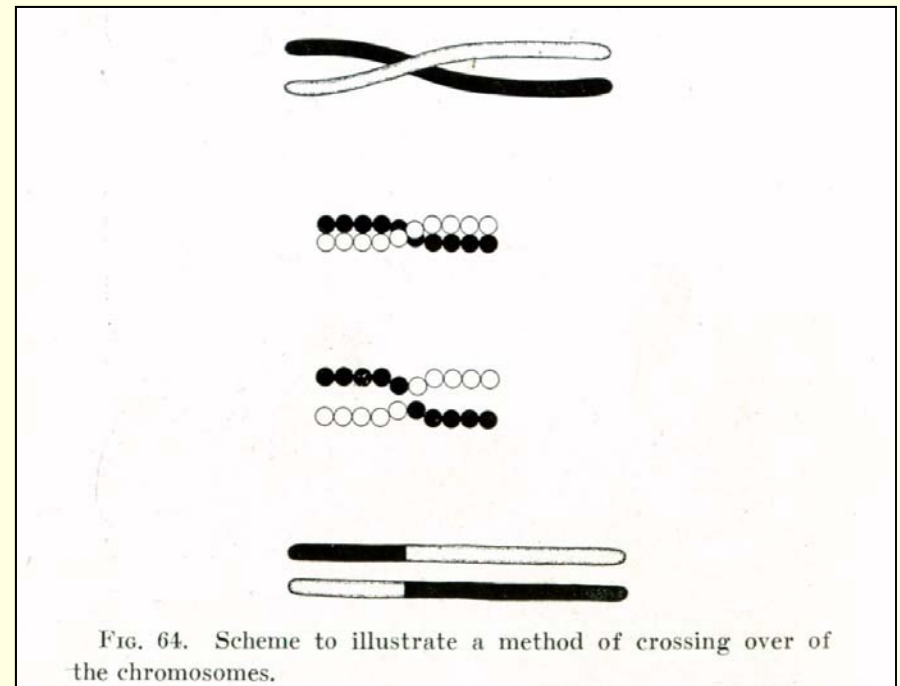
## 5.4.5 State that the members of a species show variation.

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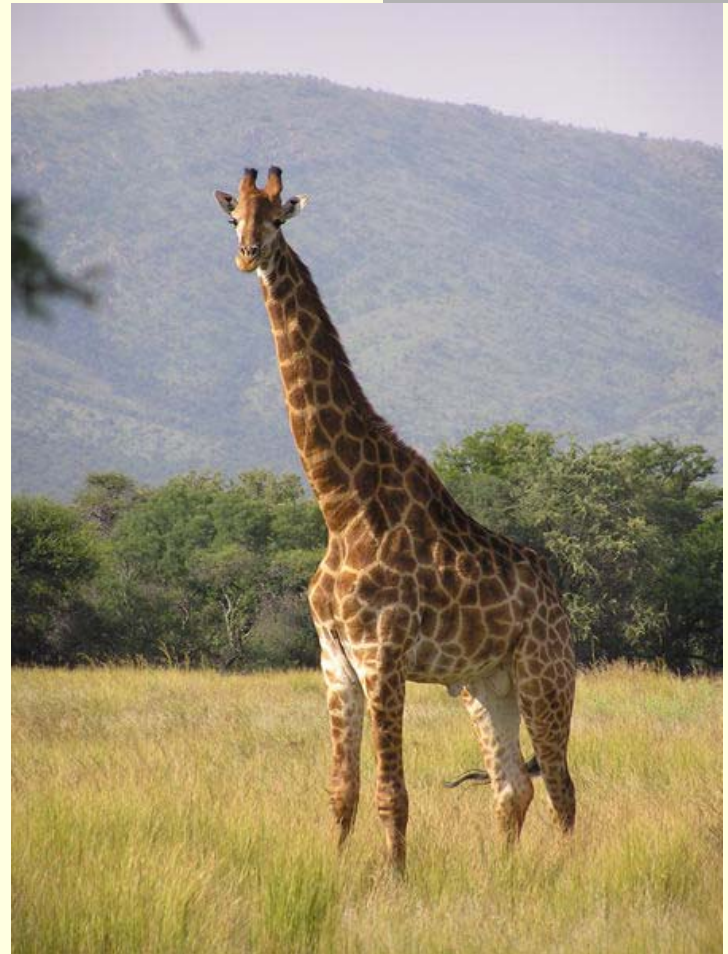
## 5.4.6 Explain how sexual reproduction promotes variation in a species.

- Meiosis-
  - 1) Law of independent assortment.
  - 2) Crossing over.
- Fertilization- any individual sperm has the potential to combine with an egg.
- Meiosis and Fertilization increase genetic variety.



## 5.4.7 Explain how natural selection leads to evolution.

- The struggle for survival favors individuals whose qualities make them better adapted to their environment. These individuals produce more offspring, and over time the complexion of a population will shift.



## 5.4.8 Explain two examples of evolution in response to environmental change.

- 1) Antibiotic resistance to bacteria- the rapid rate at which bacteria reproduce accelerate their resistance to antibiotics.
- 2) Peppered moth- as the barks of trees became darker from industrial pollution, natural selection favored darker moths, which blended into the bark and were harder for predators to spot.

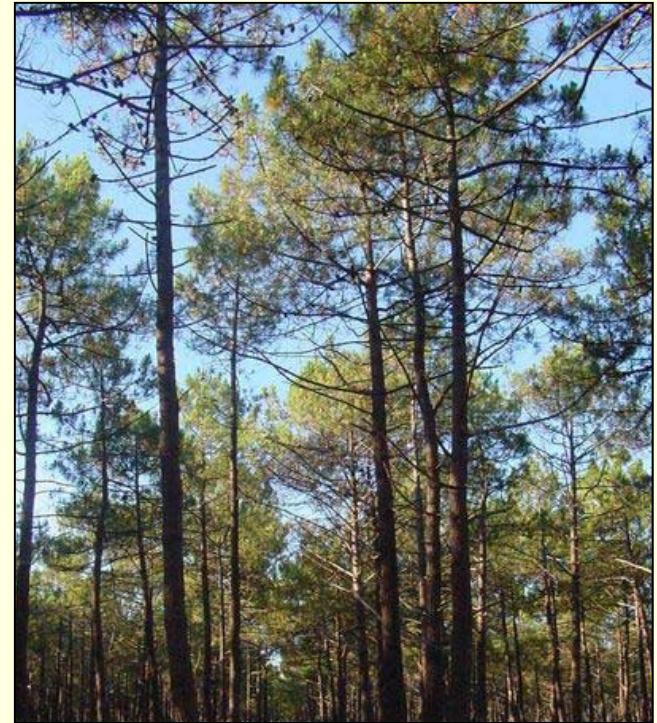


# *Unit 5: Ecology and Evolution*

## Lesson 5.5 Classification

## 5.5.1 Outline the binomial system of nomenclature.

- Binomial nomenclature- a system of identifying organisms by their genus and species name. The genus name is first, followed by the species name. The genus name is capitalized, the species name is not. Usually written in italics (if hand written underlining is acceptable).
- Examples:
  - *Homo sapiens* (humans)
  - *Pinus ponderosa* (ponderosa pine)



## 5.5.2 List the seven levels of hierarchy of taxa, using two examples from different kingdoms.

Kingdom:	Monera (Bacteria)	Protista (Protoctista)	Fungi	Plantae	Animalia
Phylum				Tracheophyta	Chordata
Class				Angiospermae	Mammalia
Order				Asterales	Primate
Family				Asteraceae	Hominid
Genus				Taraxacum	Homo
Species				Taraxacum officinale	Homo sapiens
Common Name				<i>Dandelion</i>	<i>Human</i>



## 5.5.3a Distinguish between the following phyla of plants, using simple external recognition features:

### Bryophytes:

Mosses and liverworts, which require water for reproduction, even though they lack true vascular tissue (roots, stems, leaves). Therefore they are usually found in damp areas. Bryophyte gametes are flagellated and motile.



## 5.5.3b Distinguish between the following phyla of plants, using simple external recognition features:

Filicinophytes- ferns are plants which have true vascular tissue (roots, stems and leaves). The male gamete swims to the female gamete.



### 5.5.3c Distinguish between the following phyla of plants, using simple external recognition features:

---

Coniferophytes- cone bearing plants. Seeds are non-motile, and often depend on wind for transport.



## 5.5.3d Distinguish between the following phyla of plants, using simple external recognition features:

---

Angiosperophytes- flower bearing plants. Divided into two categories: woody and non-woody.



## 5.5.4a Distinguish between the following phyla of animals, using simple external recognition features:

---

- Porifera (sponges)
- Sessile, multicellular marine animals. Lack nerves and muscles.



## 5.5.4b Distinguish between the following phyla of animals, using simple external recognition features:

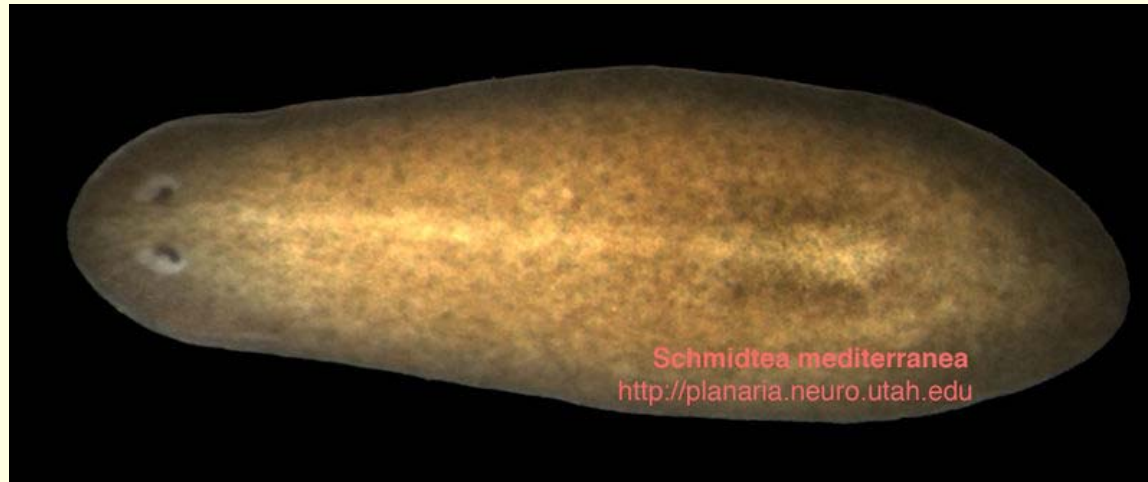
- Cnidaria (coral, jellyfish, and sea anemone). Radial symmetry, usually with specialized stinging cells.



## 5.5.4c Distinguish between the following phyla of animals, using simple external recognition features:

---

- Platyhelminthes: flat worms.



Planaria

## 5.5.4d Distinguish between the following phyla of animals, using simple external recognition features:

- Annelida:  
segmented worms



Boresenwürmer des Meeres.  
1. *Alciostomatobdella* Quat. 2. *Bolores* des Sibilla in Kalkstein. 3. *Terebralia* *Fraxinea* Quat.  
4. *Serpula* *fraxinea* Lam. und *Serpula* *trigonata* Quat. 5. *Helice* *Schmiedek* Quat.  
6. *Zinnia* *marginata* Quat. 7. *Syllolima* *ovalata* Noy. 8. *Coronula* *ovata* Quat.



## 5.5.4e Distinguish between the following phyla of animals, using simple external recognition features:

---

- Mollusca (snails, clams, cuttlefish, squid, octopus). Primarily marine based. Soft body with mantle, which may secrete a shell.



## 5.5.4f Distinguish between the following phyla of animals, using simple external recognition features:

- Arthropoda- segmented with jointed appendages and an exoskeleton.



## 5.5.5 Apply and/or design a dichotomous key for a group of up to eight organisms.

### ■ Oak Classification using a dichotomous key:

1a. Leaves usually without teeth or lobes: 2

1b. Leaves usually with teeth or lobes: 5

2a. Leaves evergreen: 3

2b. Leaves not evergreen: 4

3a. Mature plant a large tree — Southern live oak *Quercus virginiana*

3b. Mature plant a small shrub — Dwarf live oak *Quercus minima*

4a. Leaf narrow, about 4-6 times as long as broad — Willow oak  
*Quercus phellos*

4b. Leaf broad, about 2-3 times as long as broad — Shingle oak  
*Quercus imbricaria*

5a. Lobes or teeth bristle-tipped: 6

5b. Lobes or teeth rounded or blunt-pointed, no bristles: 7

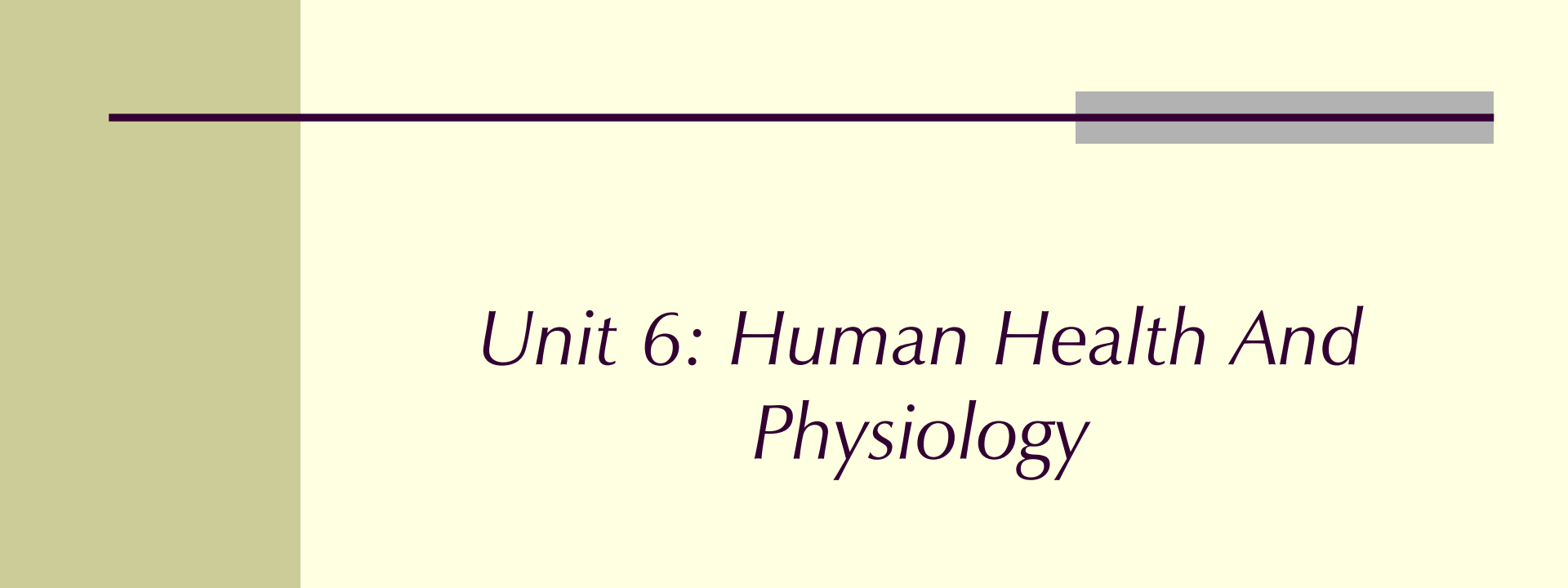
6a. Leaves mostly with 3 lobes — Blackjack oak *Quercus marilandica*

6b. Leaves mostly with 7-9 lobes — Northern red oak *Quercus rubra*


7a. Leaves with 5-9 deep lobes — White oak *Quercus alba*

7b. Leaves with 21-27 shallow lobes — Swamp chestnut oak *Quercus prinus*





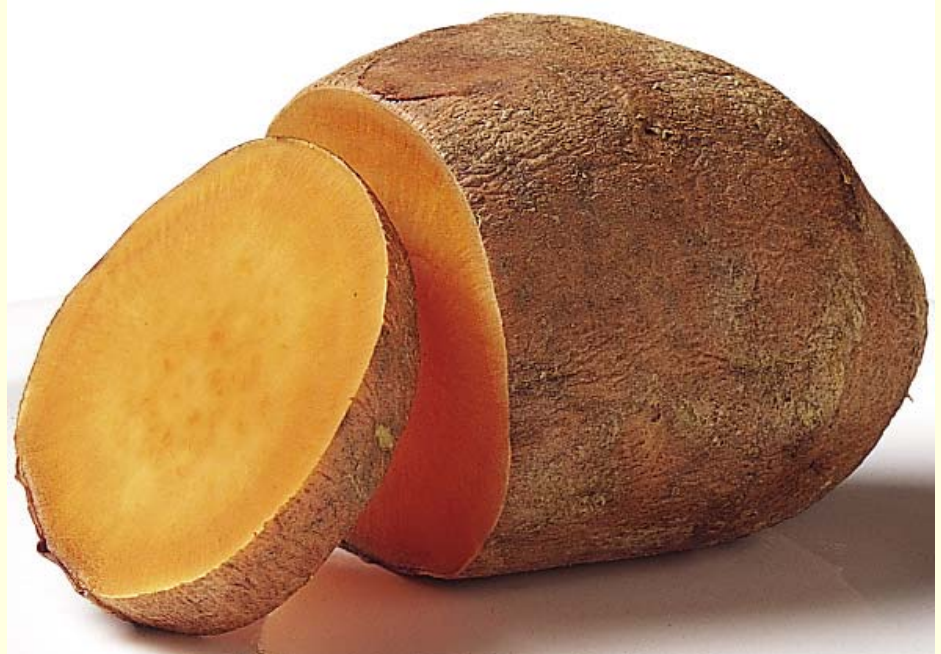
*Unit 6: Human Health And  
Physiology*



Lesson 6.1 Digestion

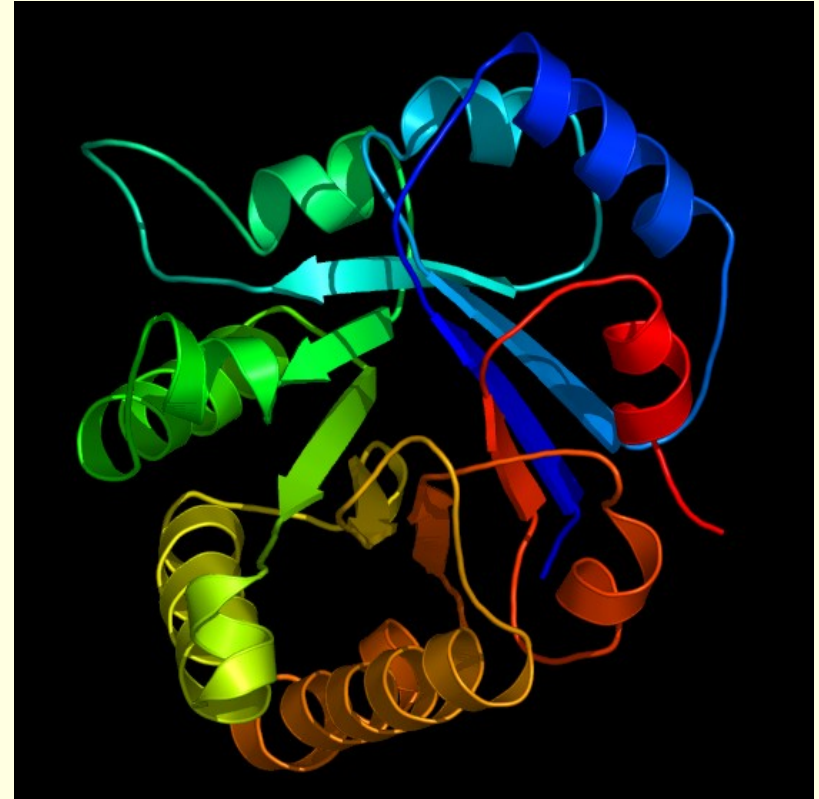
## 6.1.1 Explain why digestion of large food molecules is essential.

- Large food molecules are polymers, which must be broken down into monomers (via hydrolysis) in order to be absorbed into the blood.



## 6.1.2 Explain the need for enzymes in digestion.

- Enzymes speed up the rate at which polymers are broken down into monomers.

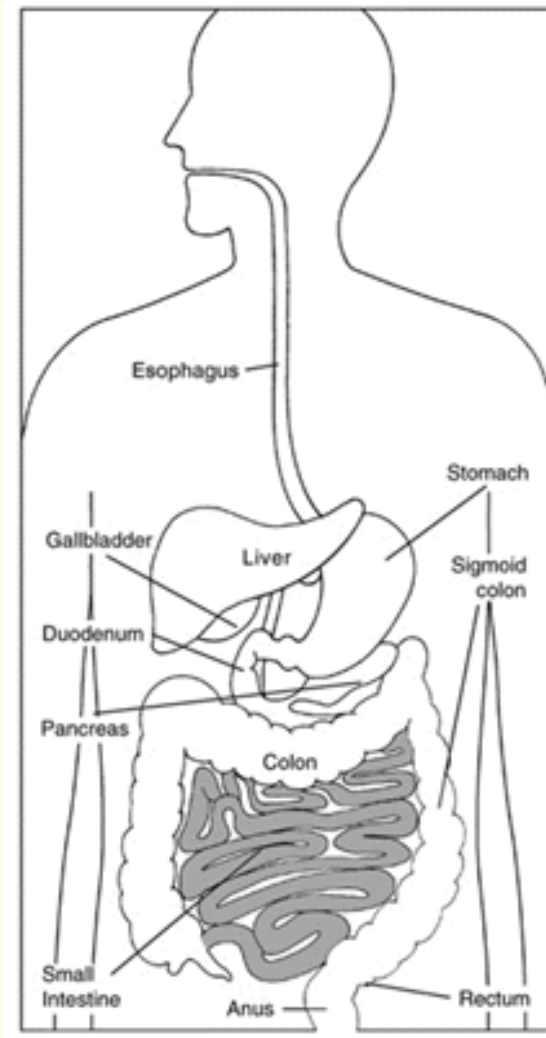


### 6.1.3 State the source, substrate, product and optimum pH conditions for one amylase, one protease and one lipase.

	<b>Amylase</b>	<b>Protease</b>	<b>Lipase</b>
Example of this enzyme	Salivary amylase	Pepsin	Pancreatic lipase
Source	Salivary glands	Wall of stomach	Pancreas
Substrate	Starch	Proteins	Triglycerides (fats and oils)
Product	Maltose	Small polypeptides	Fatty acids and glycerol
Optimum pH	7-8	1.5-3	7-8

## 6.1.4 Draw and label a diagram of the digestive system.

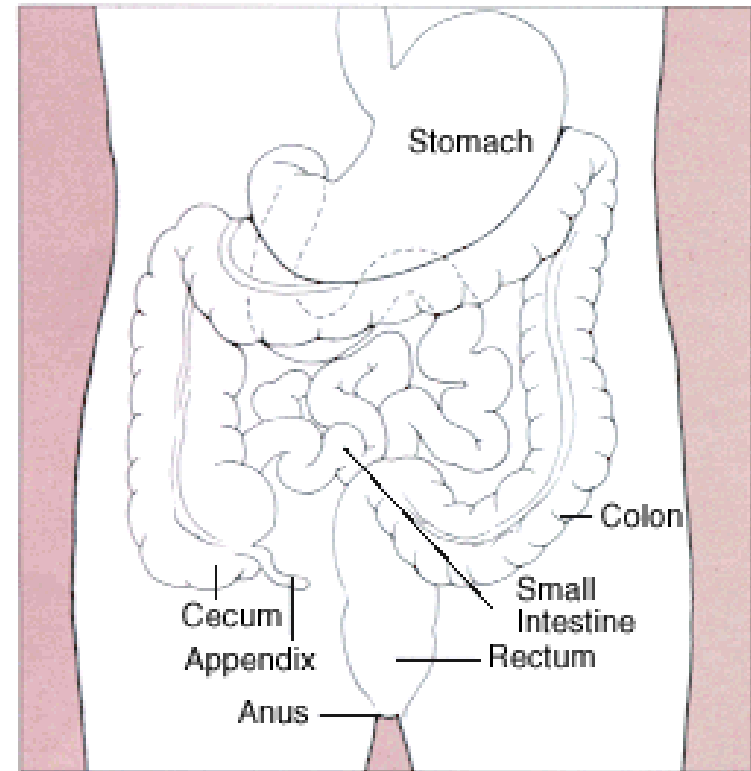
- Locate: mouth, esophagus, stomach, small intestine, large intestine, anus, liver, pancreas, gall bladder.





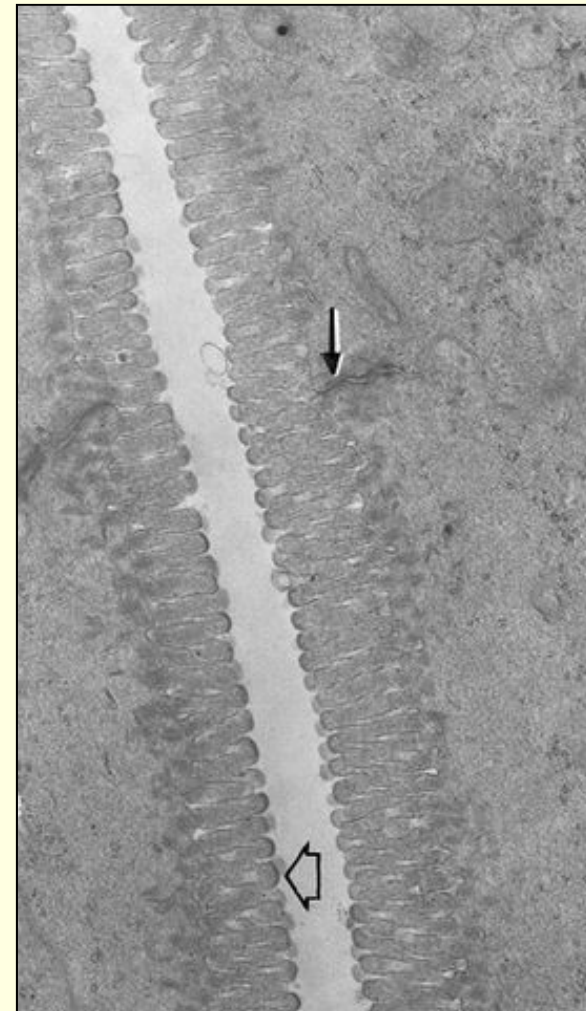
## 6.1.5 Outline the function of the stomach, small intestine and large intestine.

- Stomach- primary site for protein digestion.
- Small intestine- primary site for nutrient absorption.
- Large intestine- water used in the digestive process is reabsorbed back into the body.



## 6.1.6 Distinguish between absorption and assimilation.

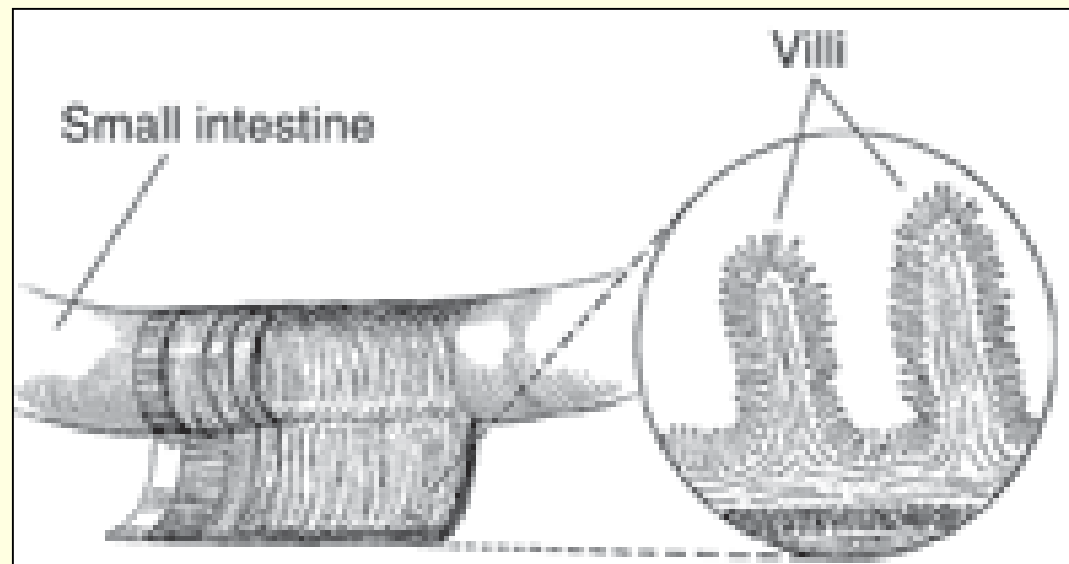
- Absorption- the transfer of nutrients from the digestive tract into the blood stream, usually through villi in the small intestine.
- Assimilation- uptake of nutrients from blood stream into body tissue. Occurs after absorption.



Pictured: microvilli on a villus.

## 6.1.7 Explain how the structure of the villus is related to its role in absorption of the end products of digestion.

- Villi have a large surface area, gated ion channels, and are dense in mitochondria, which provide energy for the active transport of nutrients.

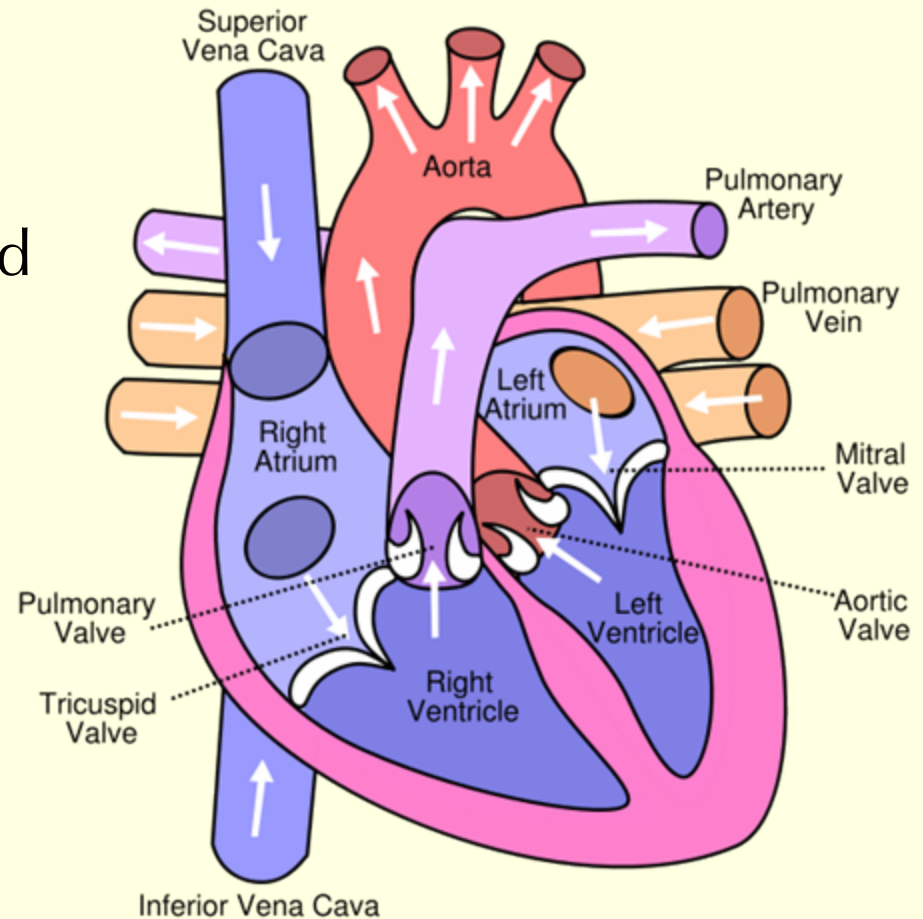


# *Unit 6: Human Health And Physiology*

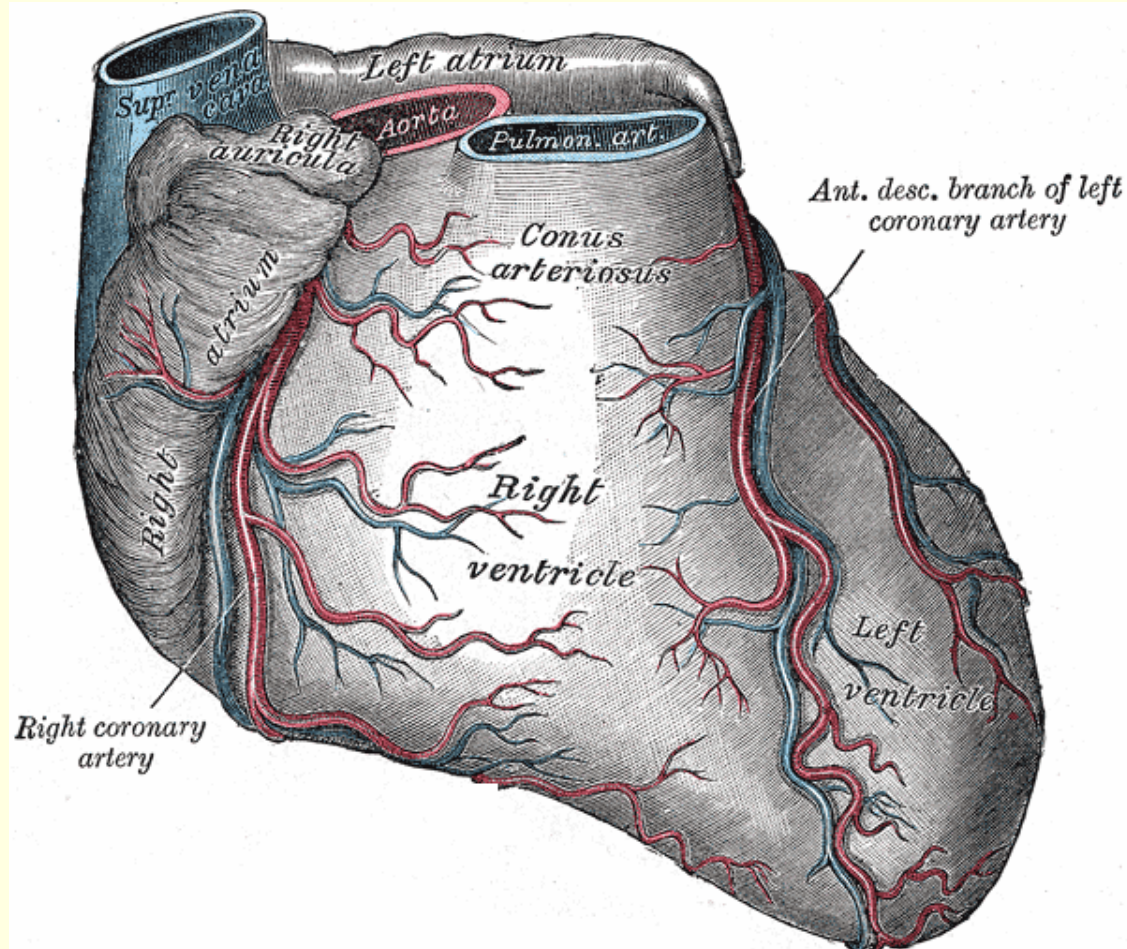
## Lesson 6.2 The Transport System

## 6.2.1 Draw a diagram of the heart showing all four chambers, associated blood vessels and valves.

- Note that the left side is actually thicker than the right side. The left side pumps oxygenated blood to the rest of the body, whereas the right side pumps deoxygenated blood to the lungs.

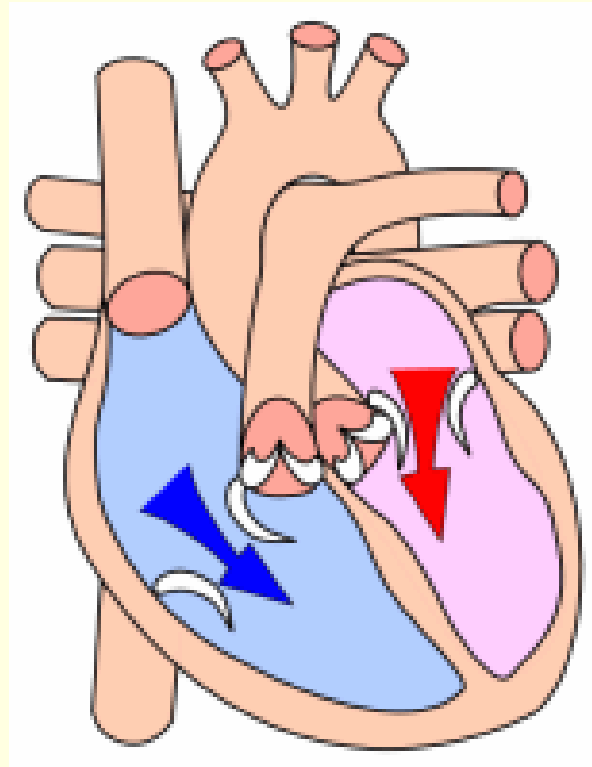


## 6.2.2 State that the coronary arteries supply heart muscle with oxygen and nutrients.



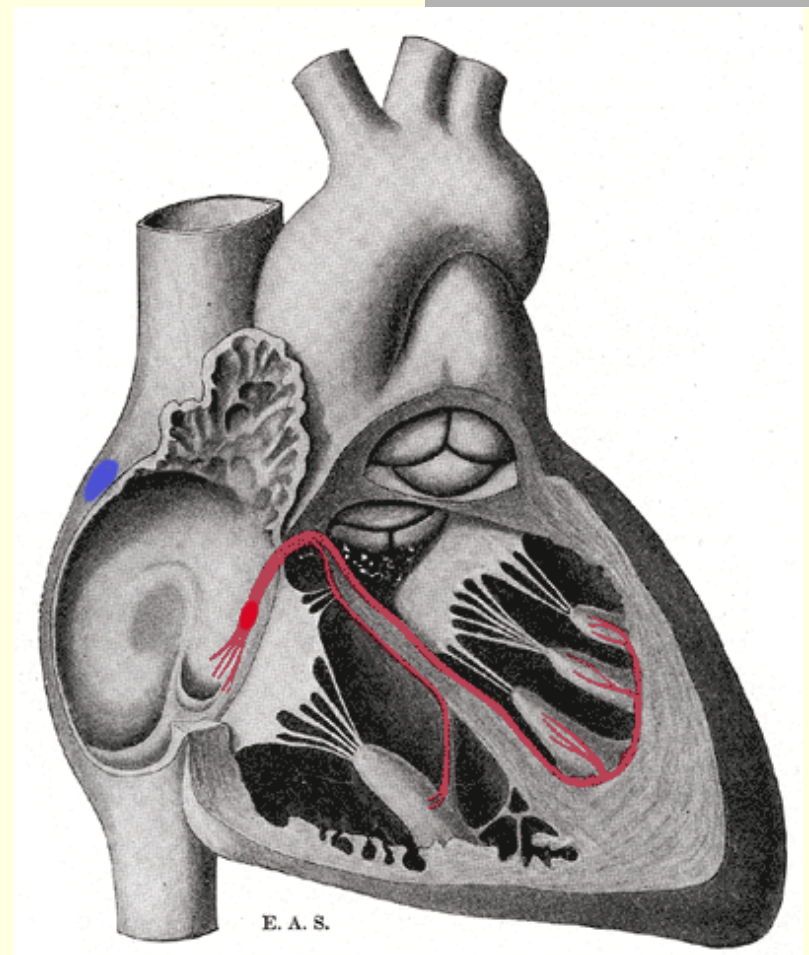
## 6.2.3 Explain the action of the heart in terms of collecting blood, pumping blood, and opening and closing of valves.

- Atria- collect blood into heart
- Ventricles- send blood out of the heart.
- The direction of flow is controlled by atrio-ventricular and semilunar valves. When open, blood flows from the atrium to the ventricle. When closed, blood remains in the atrium.



## 6.2.4 Outline the control of the heartbeat in terms of myogenic muscle contraction, the pacemaker, nerves, the medulla of the brain and adrenalin.

- Myogenic- a term meaning the heart beats “of its own accord”. The signal for each heartbeat originates from the heart itself, not from the brain, through the SA node.
- The medulla of the brain does regulate heart rate, using nerves and hormones to speed it up (adrenaline) and slow it down.





## 6.2.5 Explain the relationship between the structure and function of arteries, capillaries and veins.

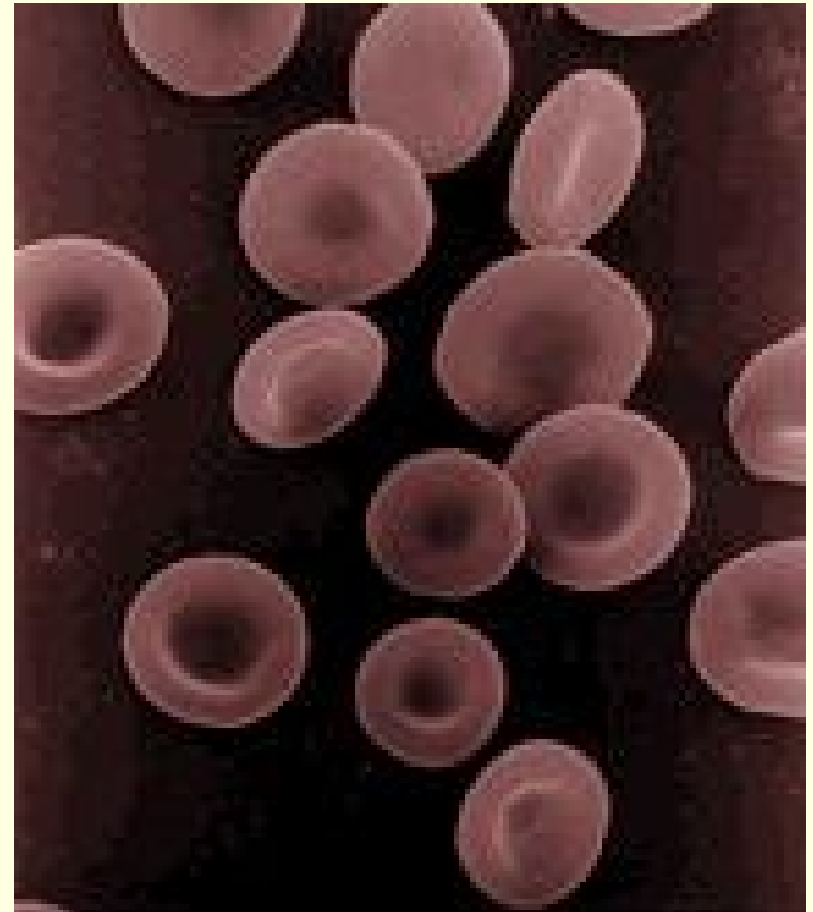
- Arteries- generally move blood away from the heart. Have thick walls but no interior valves.
- Veins- generally move blood toward the heart. Have thinner walls and interior valves to prevent backflow.
- Capillaries- bridges between arteries and veins. Capillary tissue is only 1 cell width thick, enabling diffusion in and out of the vessels.



Courtesy of Pdefer.

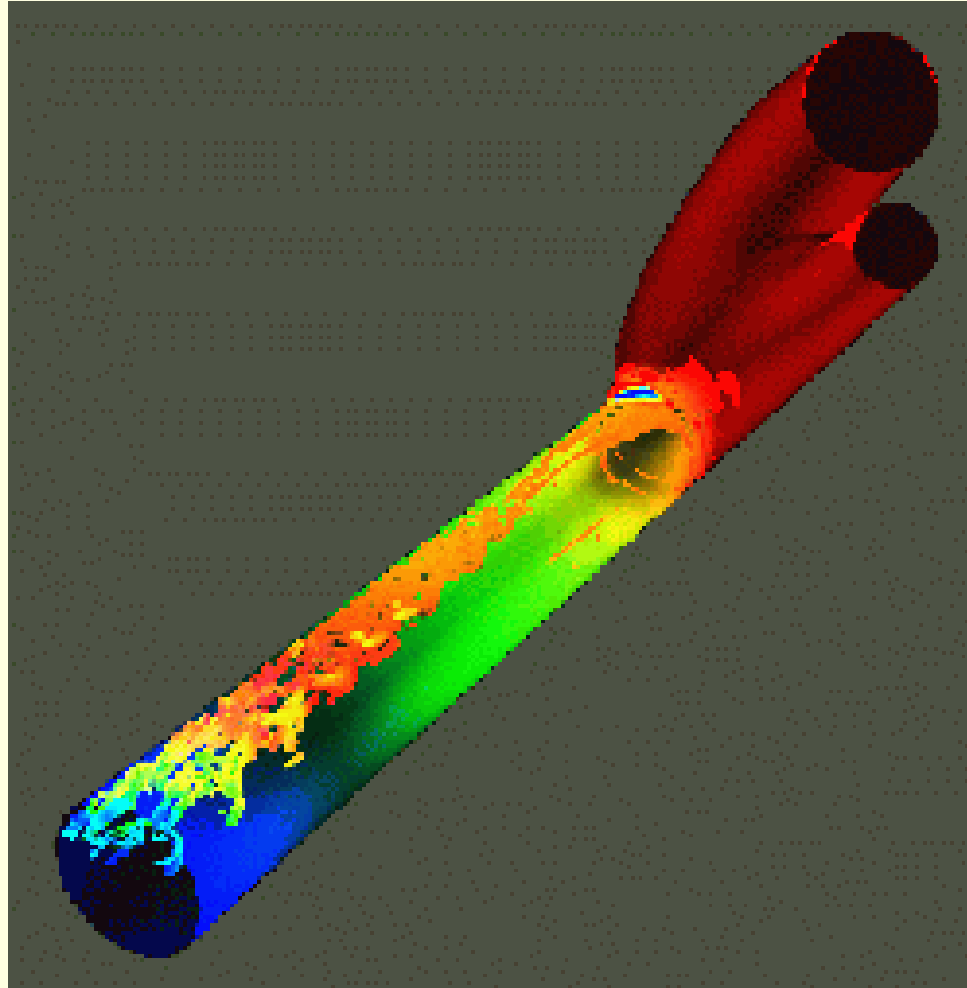
## 6.2.6 State that blood is composed of plasma, erythrocytes, leucocytes (phagocytes and lymphocytes) and platelets.

- Plasma- fluid portion of blood
- Erythrocytes- red blood cells
- Leucocytes- white blood cells
  - Phagocytes- engulf and ingest antigens
  - Lymphocytes- produce antibodies
- Platelets- aid in blood clotting



6.2.7 State that the following are transported by the blood:  
nutrients, oxygen, carbon dioxide, hormones,  
antibodies and urea.

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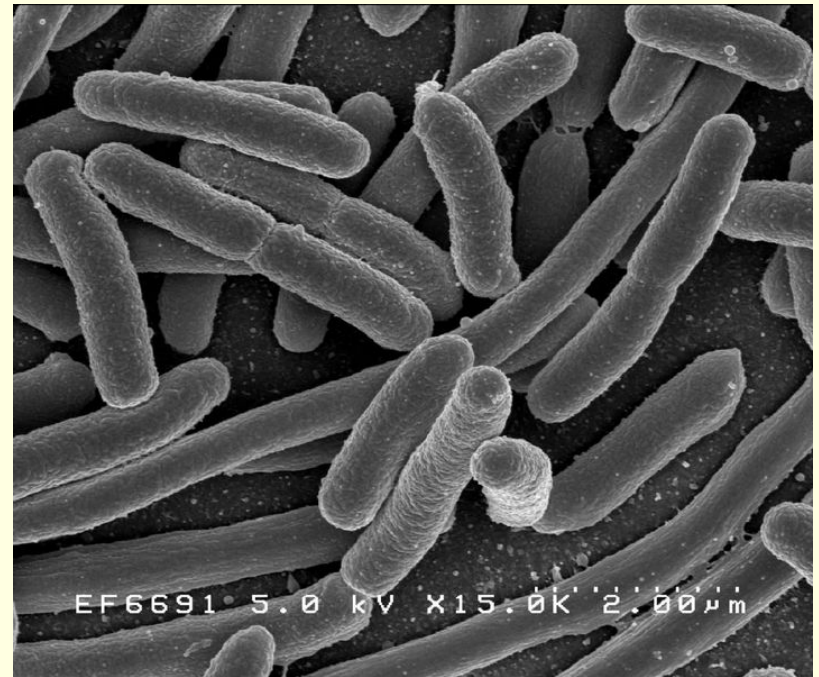


# *Unit 6: Human Health And Physiology*

## Lesson 6.3 Defense Against Infectious Disease

## 6.3.1 Define *pathogen*.

- Pathogen- an organism or virus that causes a disease.



## 6.3.2 Explain why antibiotics are effective against bacteria but not viruses.

- Antibiotics block metabolic pathways found in bacteria, but not in eukaryotic cells. Viruses reproduce using the metabolic pathways of the host cell and are not affected by antibiotics.



## 6.3.3 Outline the role of skin and mucous membranes in defense against pathogens.

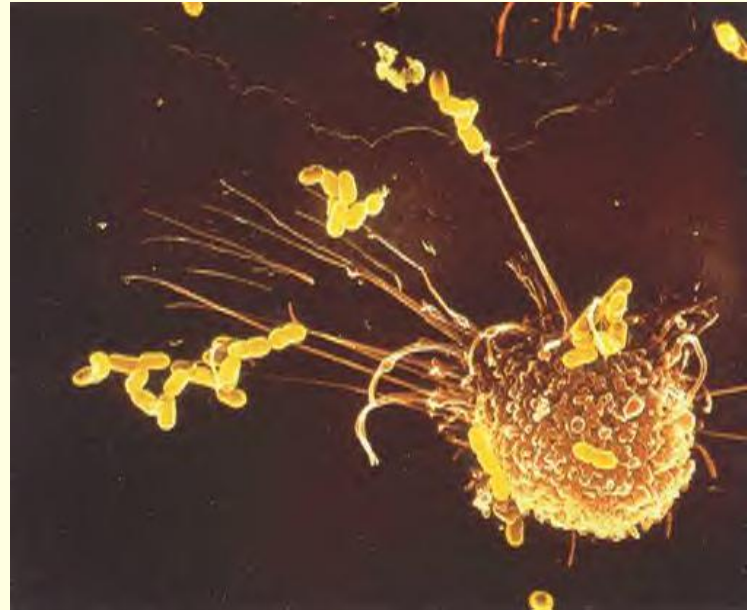
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- The skin is a physical, waterproof barrier to pathogens. Mucus is continually secreted by mucous membranes, which flush out pathogens from openings into the body.



## 6.3.4 Outline how phagocytic leucocytes ingest pathogens in the blood and in body tissues.

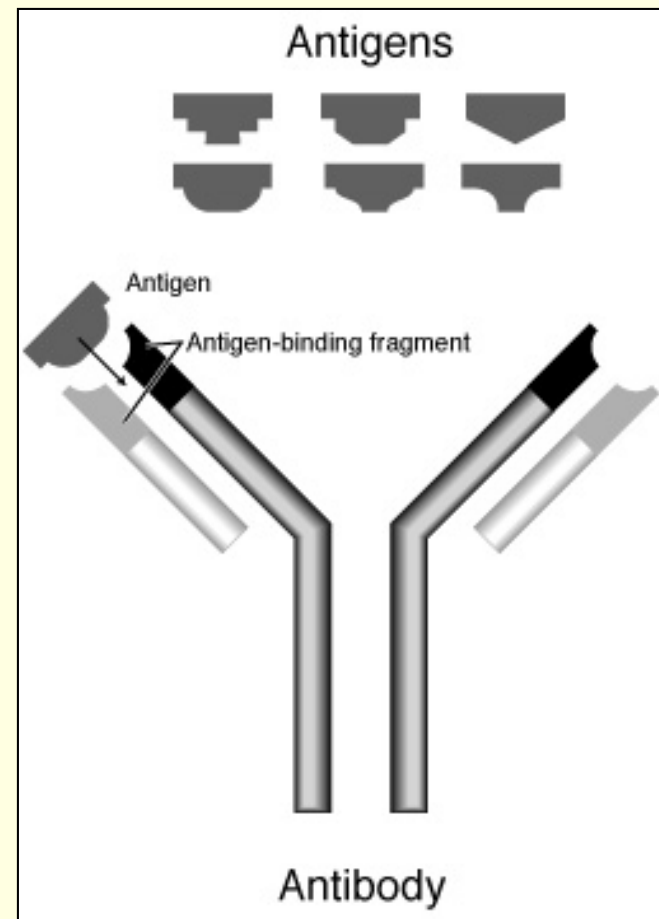
- Phagocytes engulf pathogens which have managed to cross the bodies barriers and penetrated into tissue.





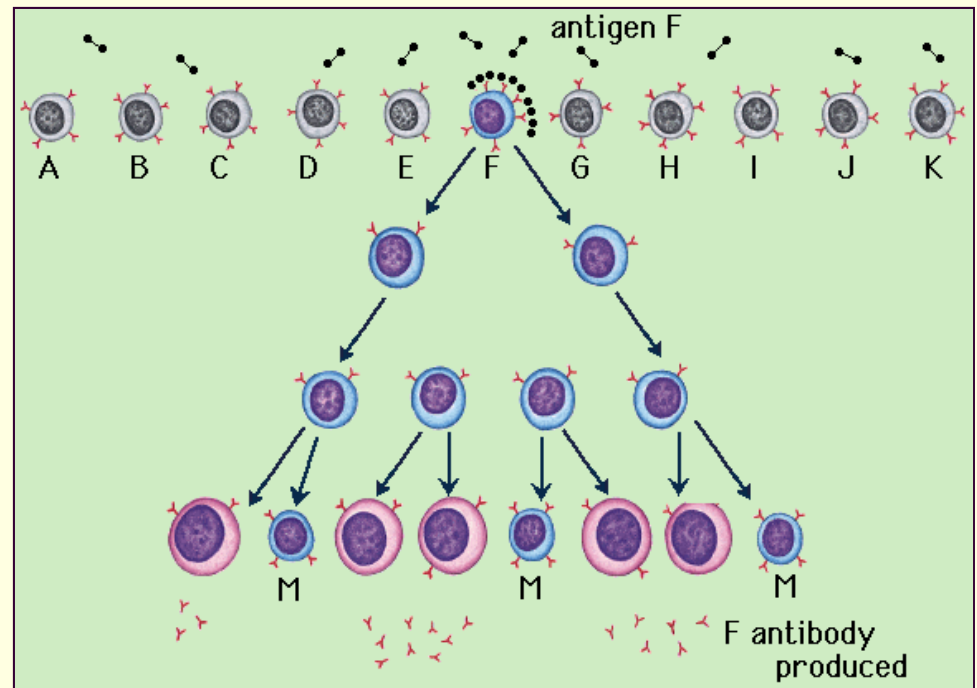
## 6.3.5 Distinguish between antigens and antibodies.

- Antigen- a molecule considered foreign by the body's immune system.
- Antibody- a globular protein manufactured by the immune system which recognizes and targets a specific antigen.



## 6.3.6 Explain antibody production.

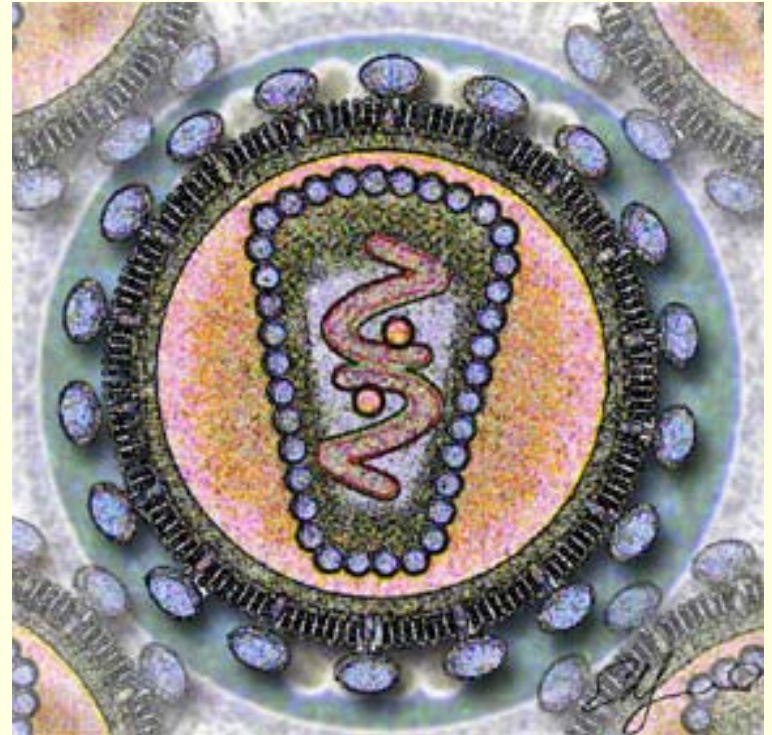
- Many different types of lymphocytes exist. Each type recognizes one specific antigen and responds, upon encountering such antigen, by dividing rapidly to form clones. The clones then secrete specific antibodies against the antigen.



Courtesy of the University of Florida

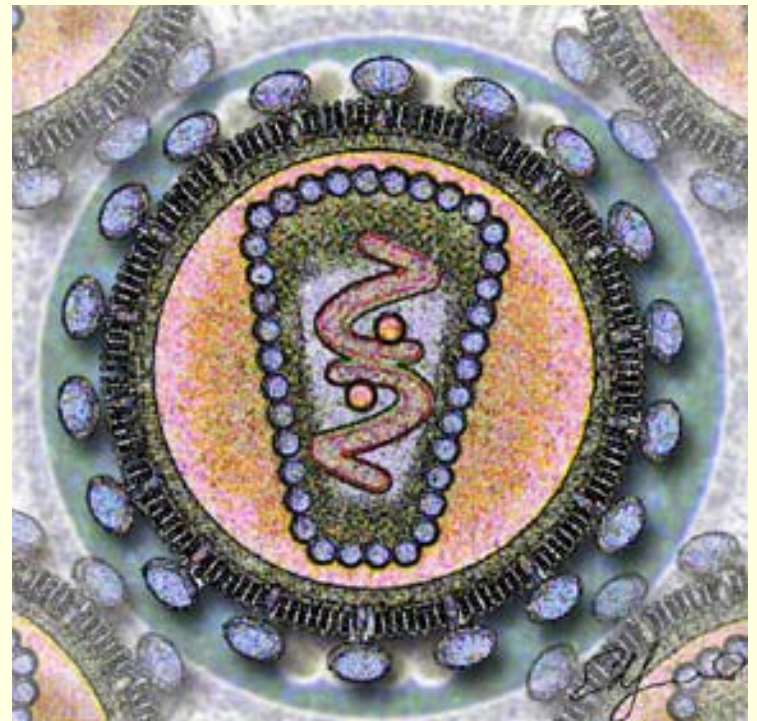
## 6.3.7 Outline the effects of HIV on the immune system.

HIV destroys cd-4 T-cells, which impairs the body's ability to fight pathogens.



## 6.3.8 Describe the cause, transmission and social implications of AIDS.

- Cause- RNA based virus which attacks human CD-4 T cells.
- Transmission: through sexual contact and blood.
- Social Implications: was first stigmatized as a “gay” disease, although currently more heterosexuals worldwide are affected than homosexuals. In sub-saharan Africa (as well as several other locations), AIDS has reached crisis epidemic proportions.



# *Unit 6: Human Health And Physiology*

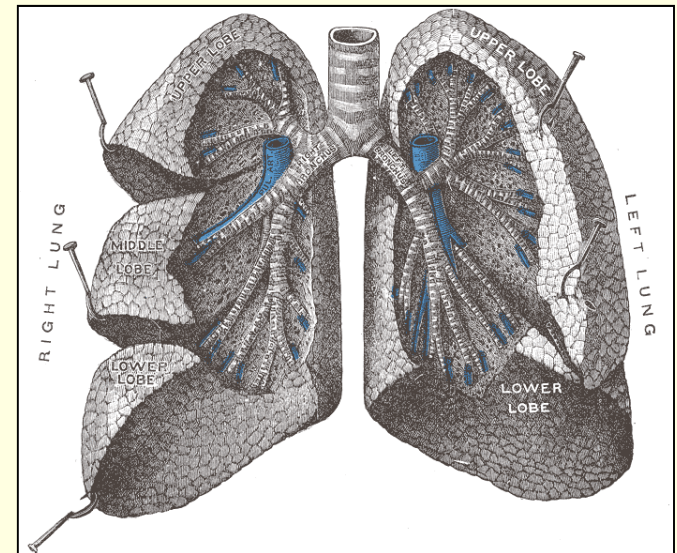
## Lesson 6.4 Gas Exchange

## 6.4.1 Distinguish between ventilation, gas exchange and cell respiration.

Ventilation- the movement of air into and out of the lungs from muscular contractions of the rib cage and diaphragm. Ventilation leads to...

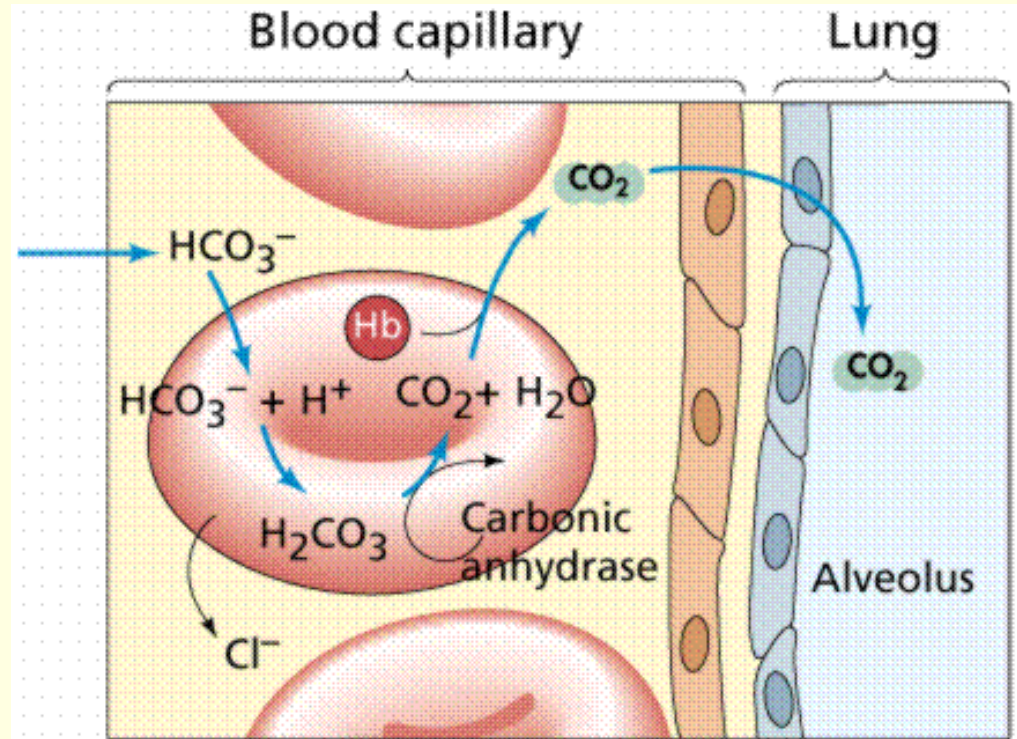
Gas exchange- the transfer of gas between alveoli and capillaries in the lung due to concentration gradients. Gas exchange leads to...

Cell respiration- the harvesting of glucose to convert  $\text{ADP} \rightarrow \text{ATP}$ . Cell respiration occurs in the cellular tissue.



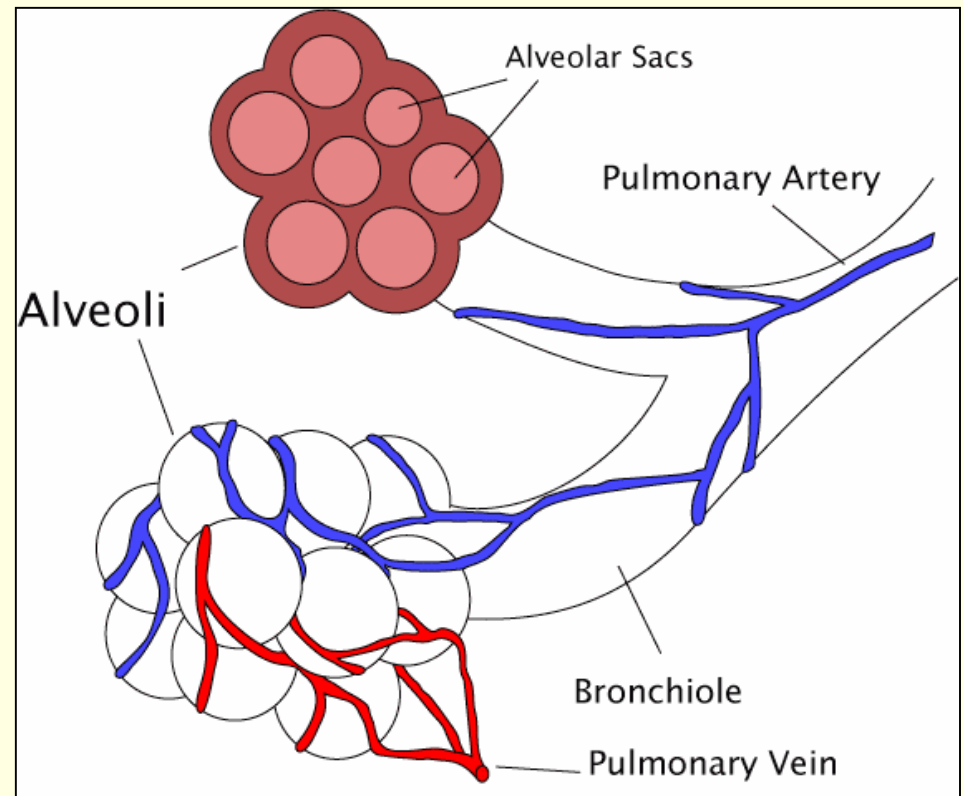
## 6.4.2 Explain the need for a ventilation system.

- A ventilation system is needed to maintain concentration gradients in the alveoli.



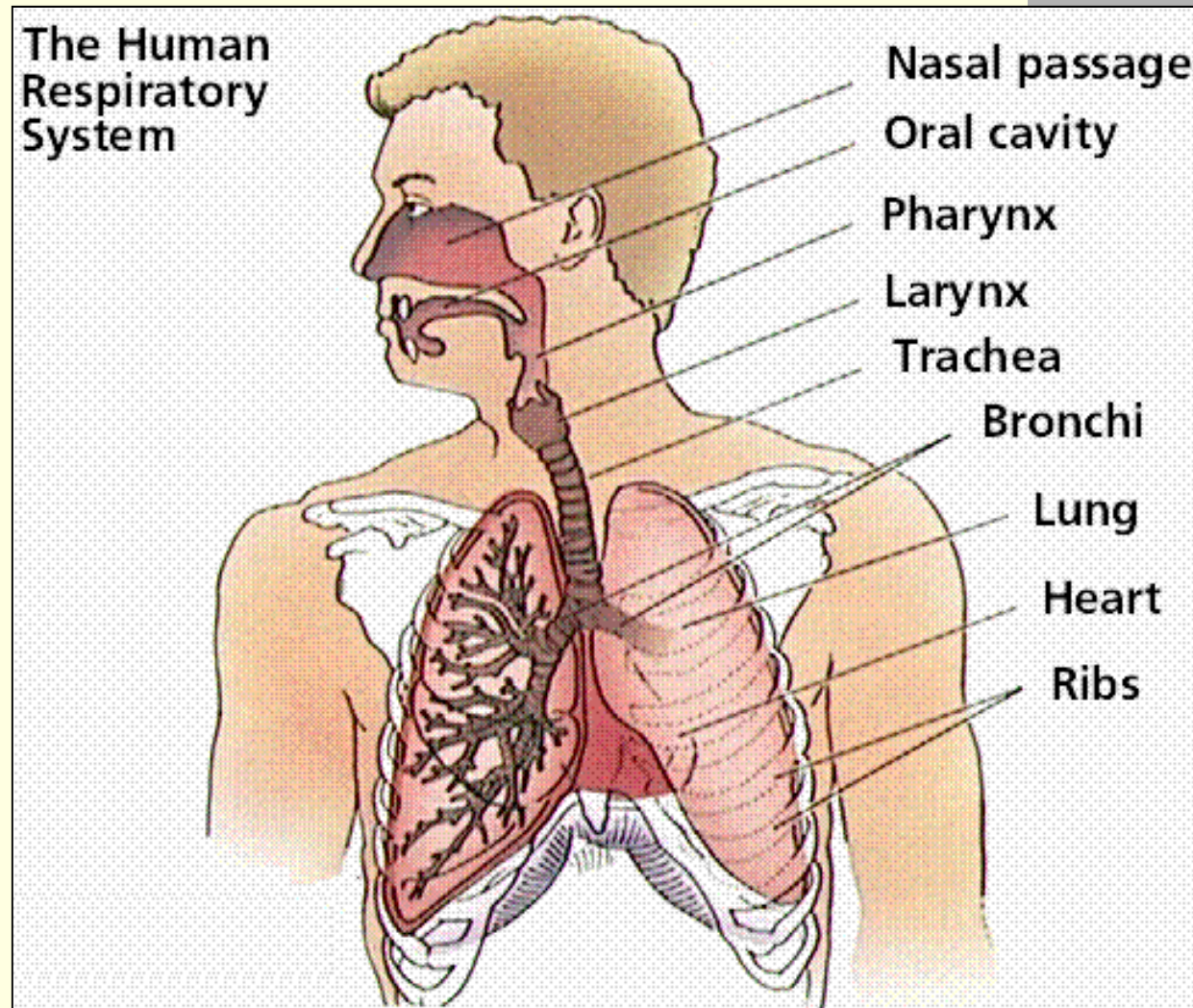
## 6.4.3 Describe the features of alveoli that adapt them to gas exchange.

- 1) large total surface area
- 2) a wall consisting of a single layer of flattened cells
- 3) moist lining
- 4) dense network of capillaries





## 6.4.4 Draw a diagram of the ventilation system including trachea, bronchi, bronchioles and lungs.



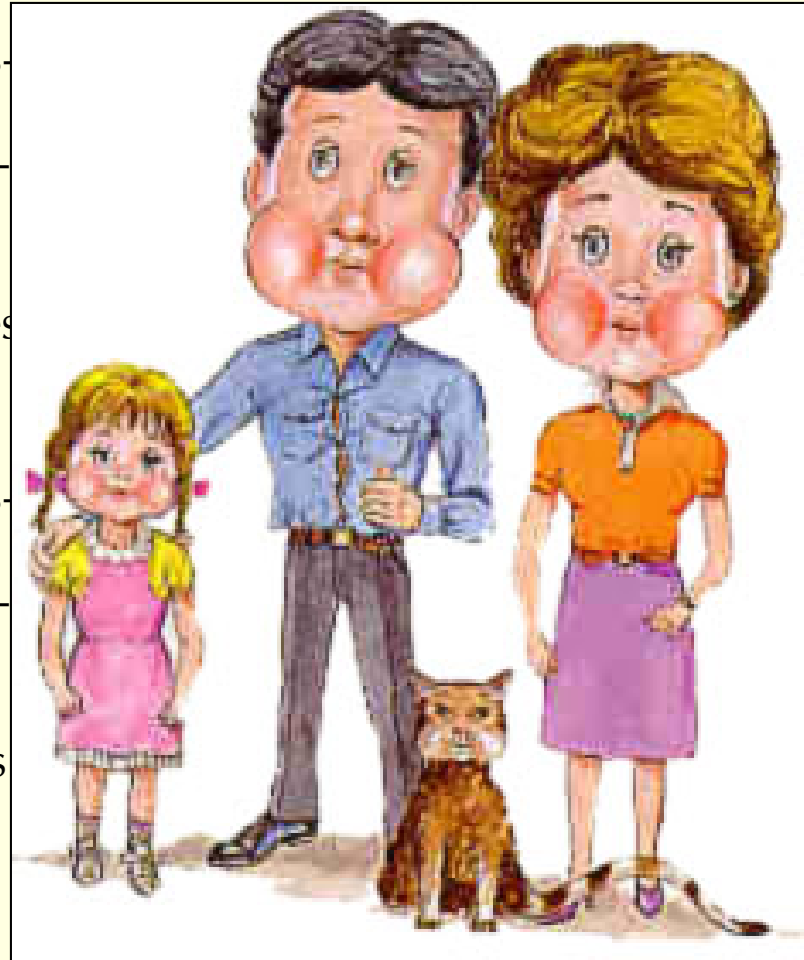
## 6.4.5 Explain the mechanism of ventilation in human lungs.

### ■ Inhalation

- External intercostal muscles- contract
- Internal intercostal muscles- relax
- Diaphragm- contracts
- (positive) Pressure decreases
- Volume increases

### ■ Exhalation

- External intercostal muscles- relax
- Internal intercostal muscles- contract
- Diaphragm- relax
- (positive) Pressure increases
- Volume decreases

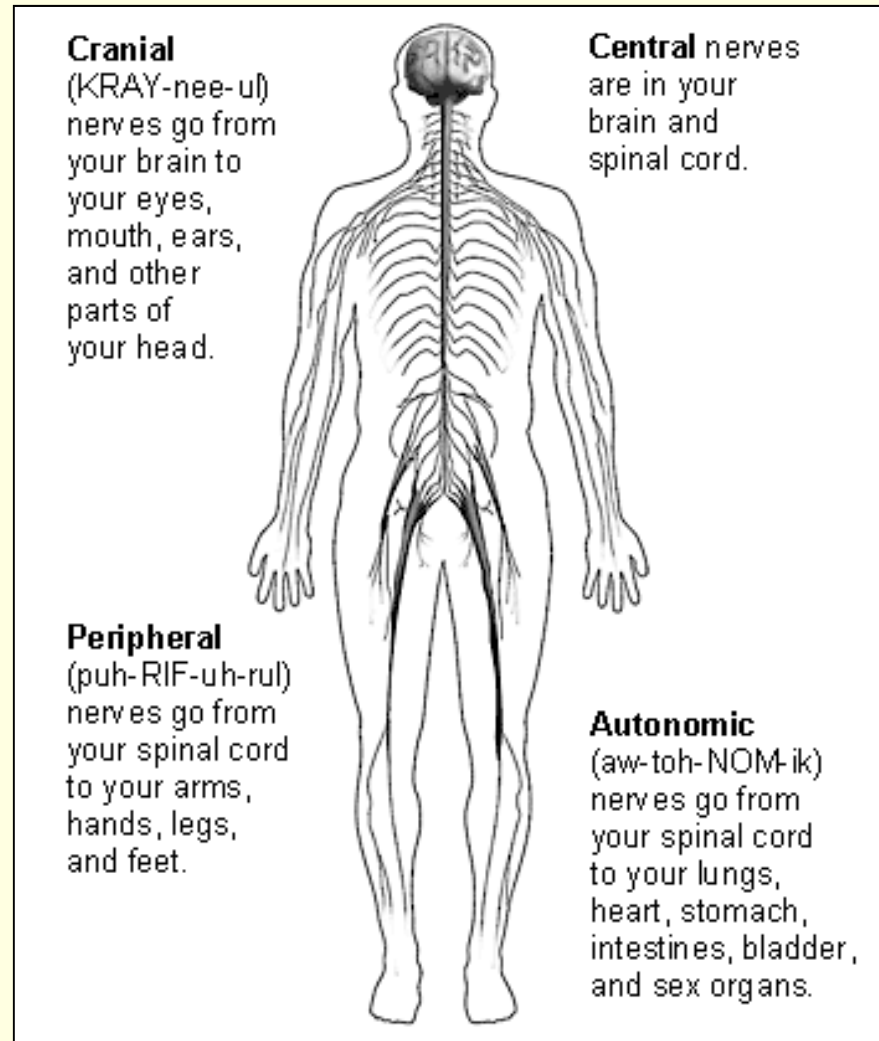


# *Unit 6: Human Health And Physiology*

## Lesson 6.5 Nerves, Hormones and Homeostasis.

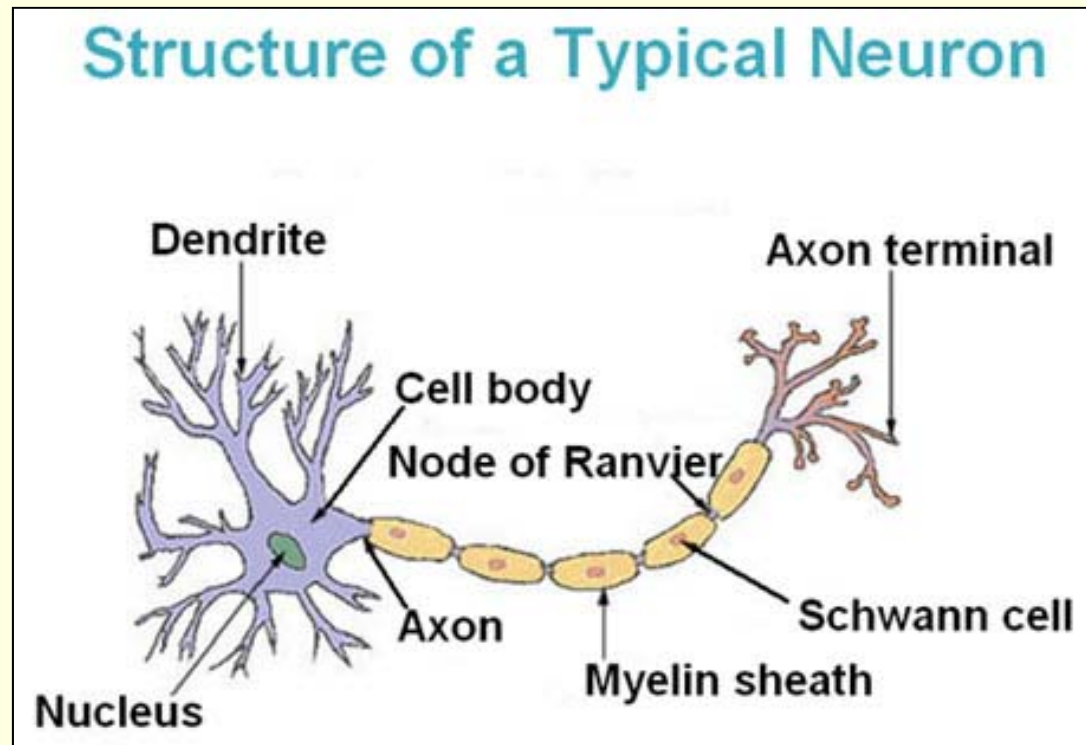
## 6.5.1 State that the nervous system consists of the CNS, PNS and cell called neurons that can carry rapid electrical impulses.

- CNS = Central Nervous System: (brain and spinal cord)
- PNS= Peripheral Nervous System.

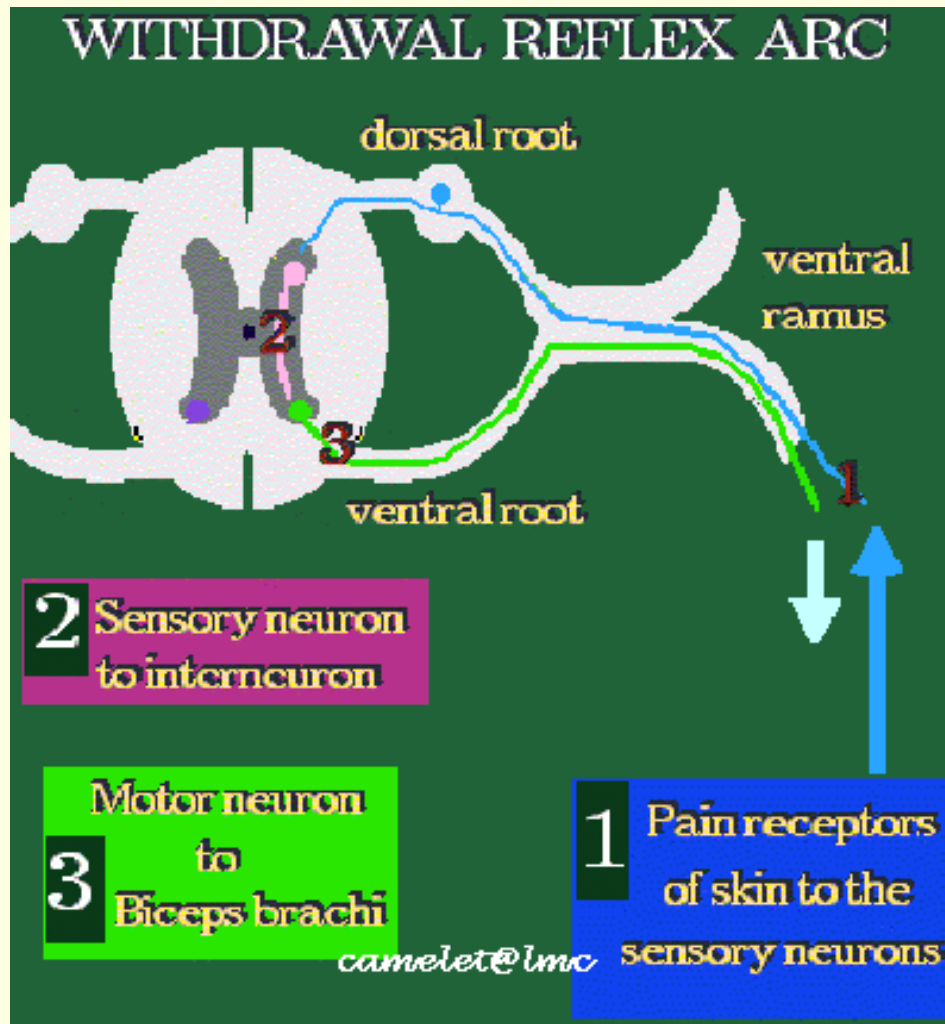


## 6.5.2 Draw and label a diagram of the structure of a motor neuron.

- Show dendrites, cell body with nucleus, elongated axon, myelin sheath, nodes of Ranvier and motor end plates.



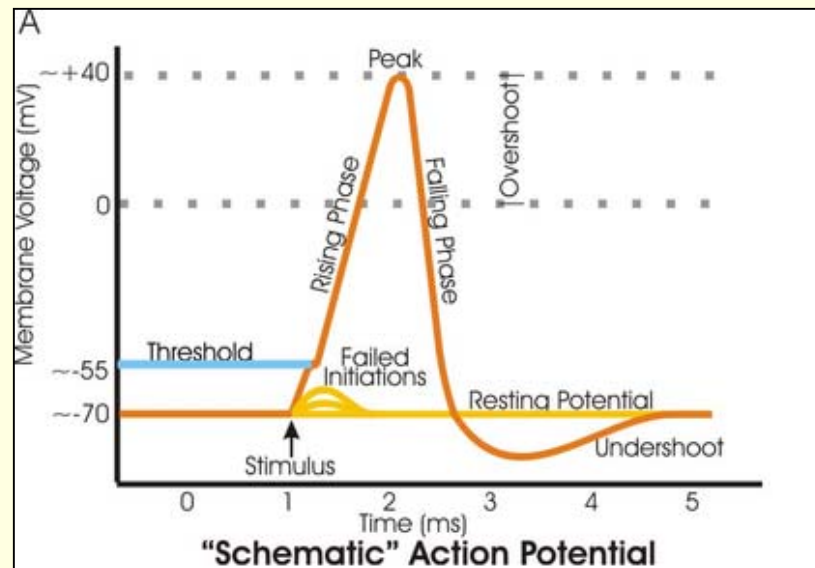
6.5.3 State that nerve impulses are conducted from receptors to the CNS by sensory neurons, and from the CNS to effectors by motor neurons.



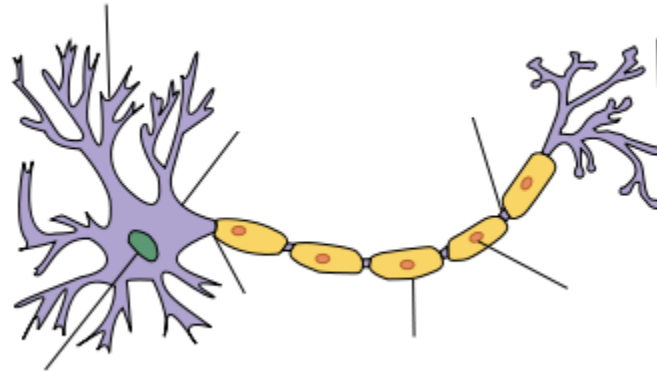
## 6.5.4 Define *resting potential* and *action potential*.

Resting potential- the difference in charge between the inside and outside of a neuron when an electrical impulse is *not* being propagated. Usually about -70 mv.

Action potential- the reversal and restoration of an electrical difference between the inside and outside of a nerve cell *during* propagation of an impulse.



## 6.5.5 Explain how a nerve impulse passes along a non-myelinated neuron (axon).

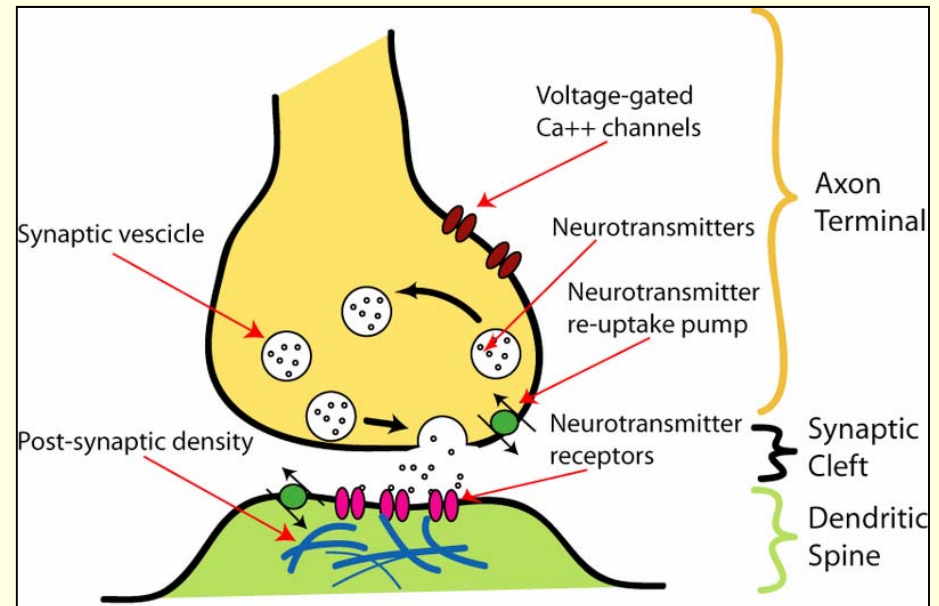


- Na<sup>+</sup> ions- upon stimulation, Na<sup>+</sup> ion channels open and Na<sup>+</sup> rushes into the cell.
- K<sup>+</sup> ions- Shortly after Na<sup>+</sup> rushes in, K<sup>+</sup> ion channels open and K<sup>+</sup> rushes out of the cell.
- Voltage gated ion channels- control when ions cross the membrane.
- Active transport- restores Na<sup>+</sup> and K<sup>+</sup> to their original place, via the sodium/potassium pump.
- Changes in membrane polarization- happen in sequence, starting with stimulation of the sensory nerve.

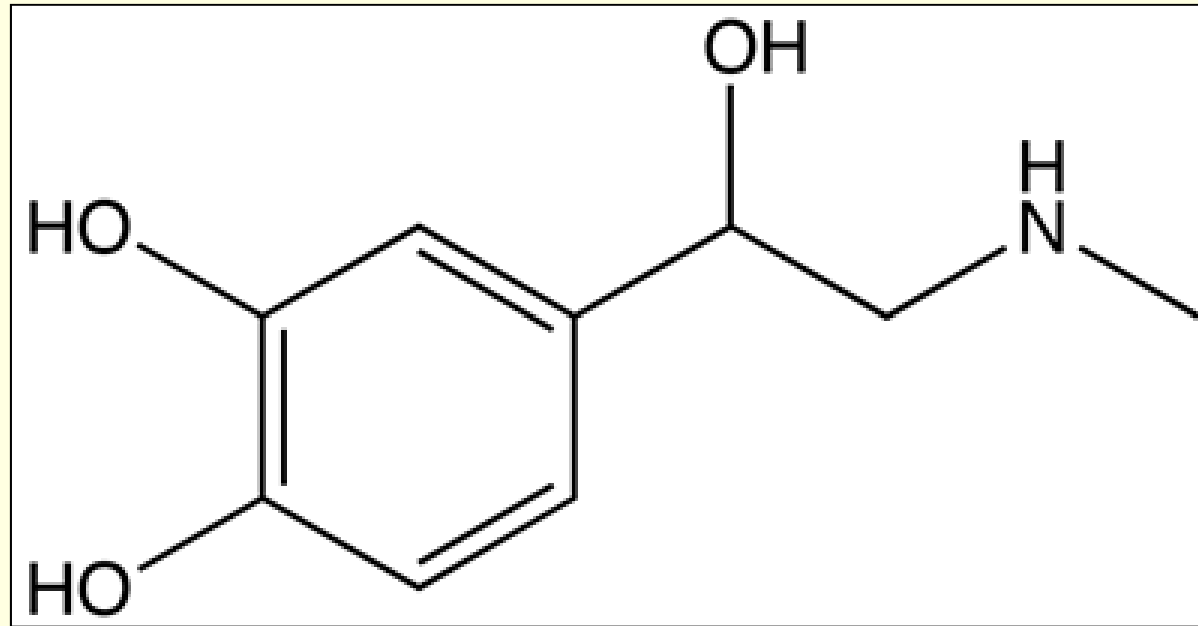


## 6.5.6 Explain the principles of synaptic transmission.

- $\text{Ca}^{+}$  influx
- Release, diffusion and binding of the neurotransmitter
- Depolarization of the post-synaptic membrane
- Subsequent removal of neurotransmitter



6.5.7 State that the endocrine system consists of glands which release hormones that are transported in the blood.



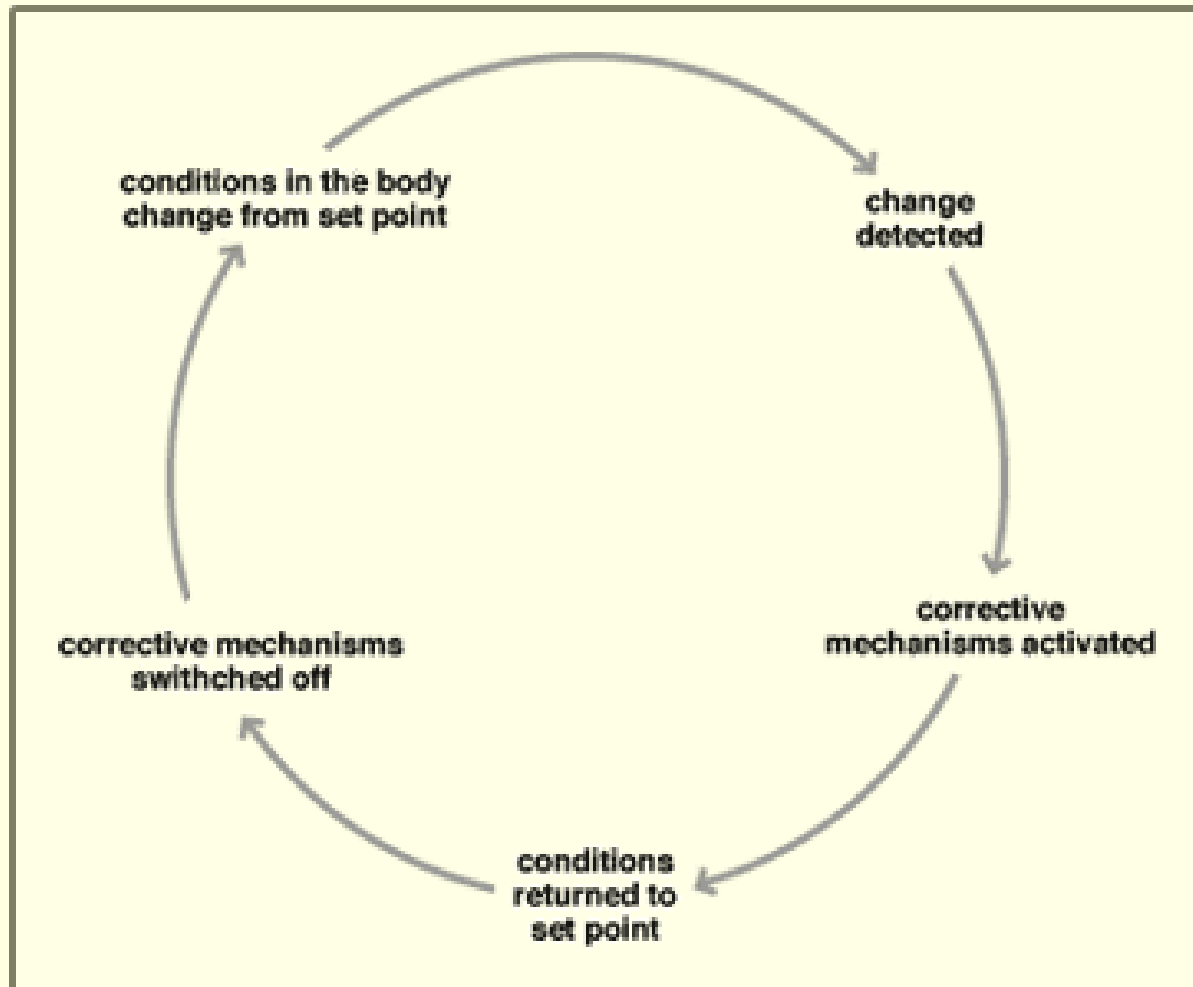
Epinephrine- released by the adrenal glands.

## 6.5.8 State that homeostasis involves maintaining the internal environment at a constant level or between narrow limits.

- Homeostatic Factors:
  - 1) blood pH
  - 2) oxygen and CO<sub>2</sub> concentrations
  - 3) blood glucose
  - 4) body temperature
  - 5) water balance

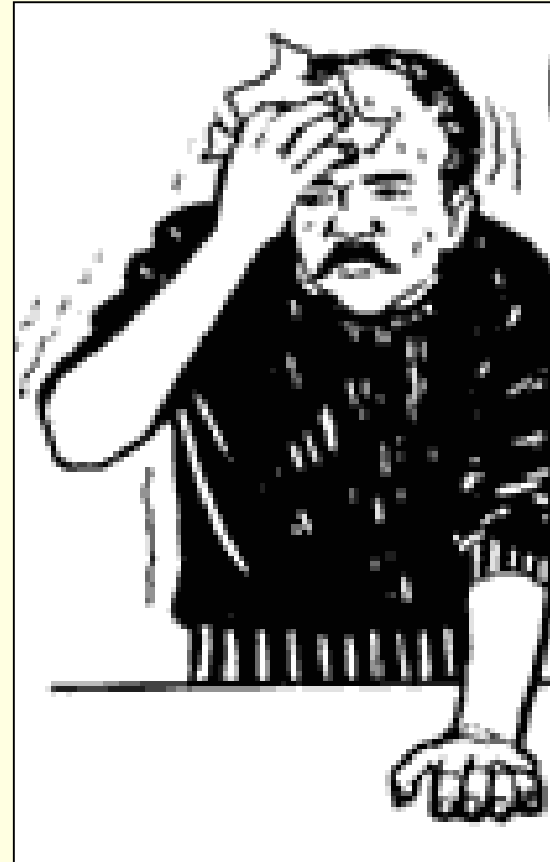


## 6.5.9 Explain that homeostasis involves monitoring levels of variables and correcting changes in levels by negative feedback mechanisms.



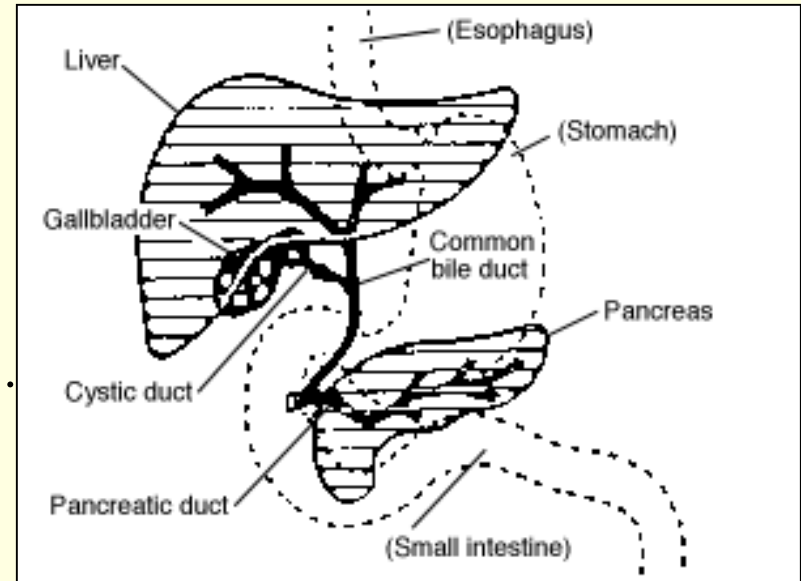
## 6.5.10 Explain the control of body temperature, including:

- Blood- transfers heat between tissues of the body.
- Hypothalamus- regulates with hormones.
- Sweat glands/skin arterioles- release heat from body.
- Shivering- generates heat in muscle tissue to warm body.



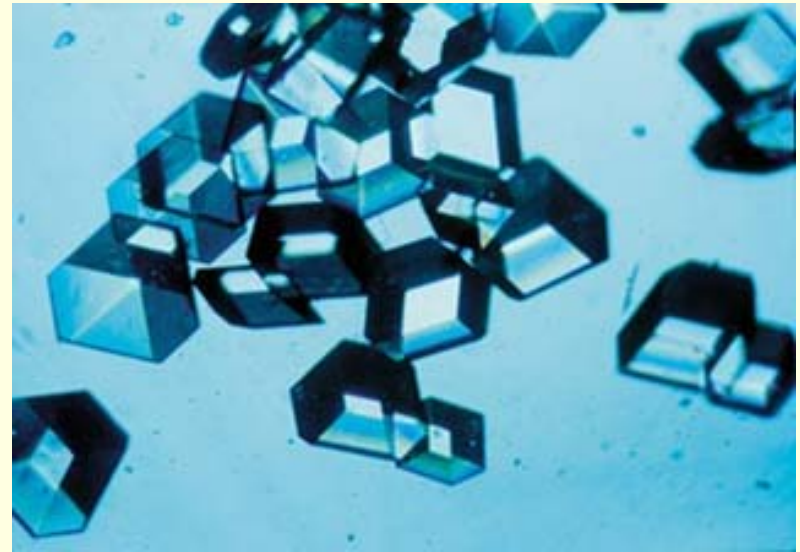
## 6.5.11 Explain the control of blood glucose concentration.

- Glucagon- raises blood sugar by triggering the release of glycogen.
- Insulin- lowers blood sugar.
- Alpha islet cells- produce glucagon.
- Beta islet cells- produce insulin.
- Islet cells are located in the pancreas.
- Glycogen is stored in the liver.

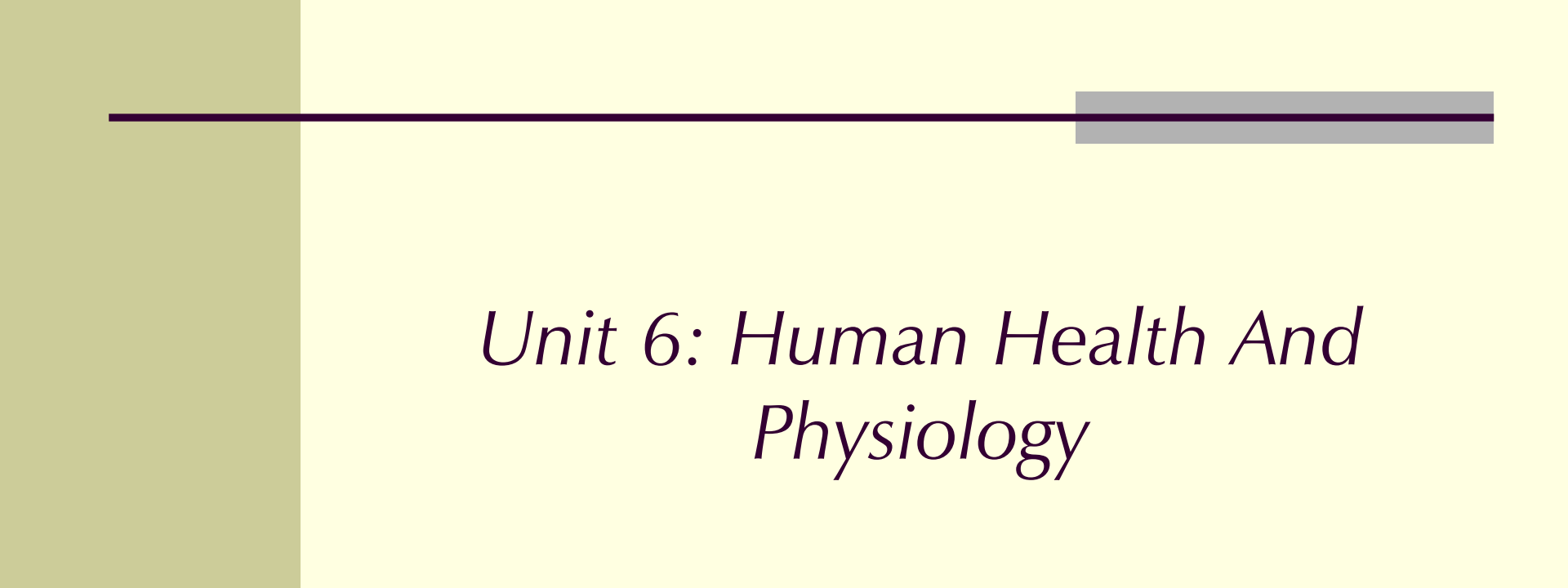


## 6.5.12 Distinguish between Type I and Type II Diabetes.

- Type I Diabetes- often begins in childhood, caused by inability of beta islet cells to produce insulin. Most likely genetically caused.
- Type II Diabetes- often has onset in adulthood, usually due to inefficient insulin secretion or decreased insulin sensitivity. May be due to obesity and other environmental factors.



Insulin crystals



*Unit 6: Human Health And  
Physiology*



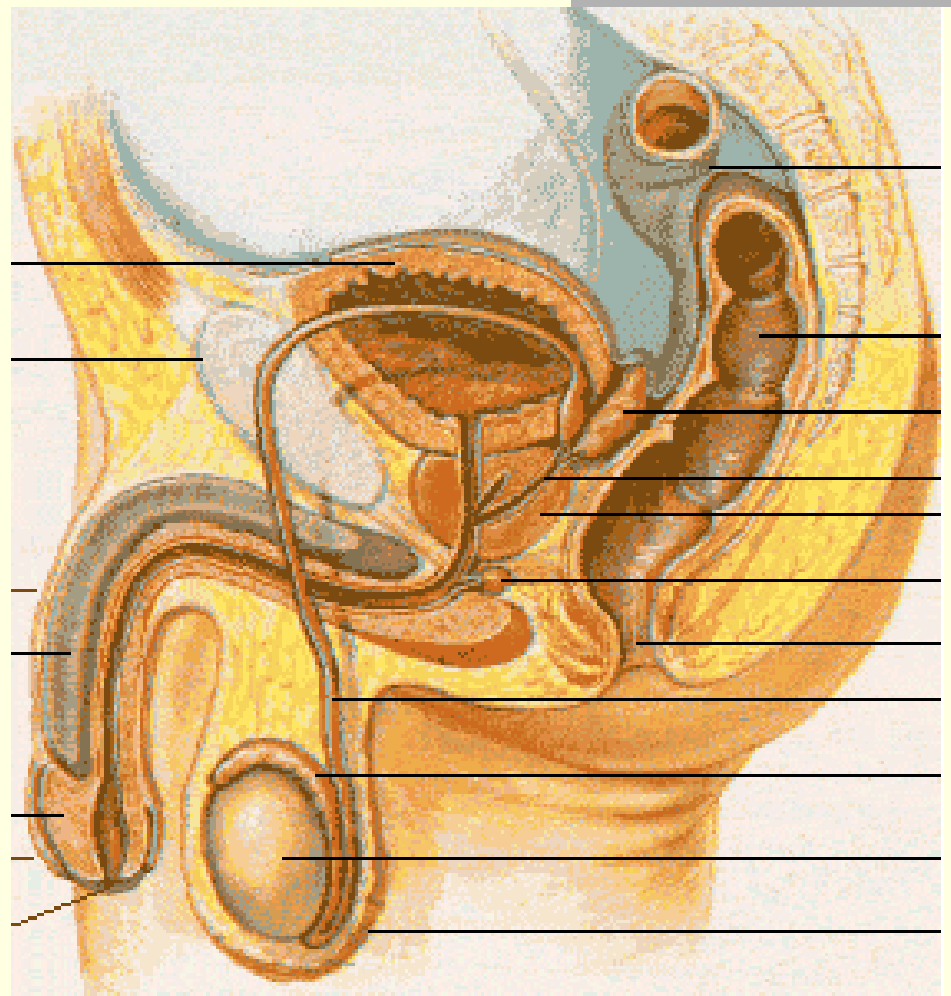
Lesson 6.6 Reproduction



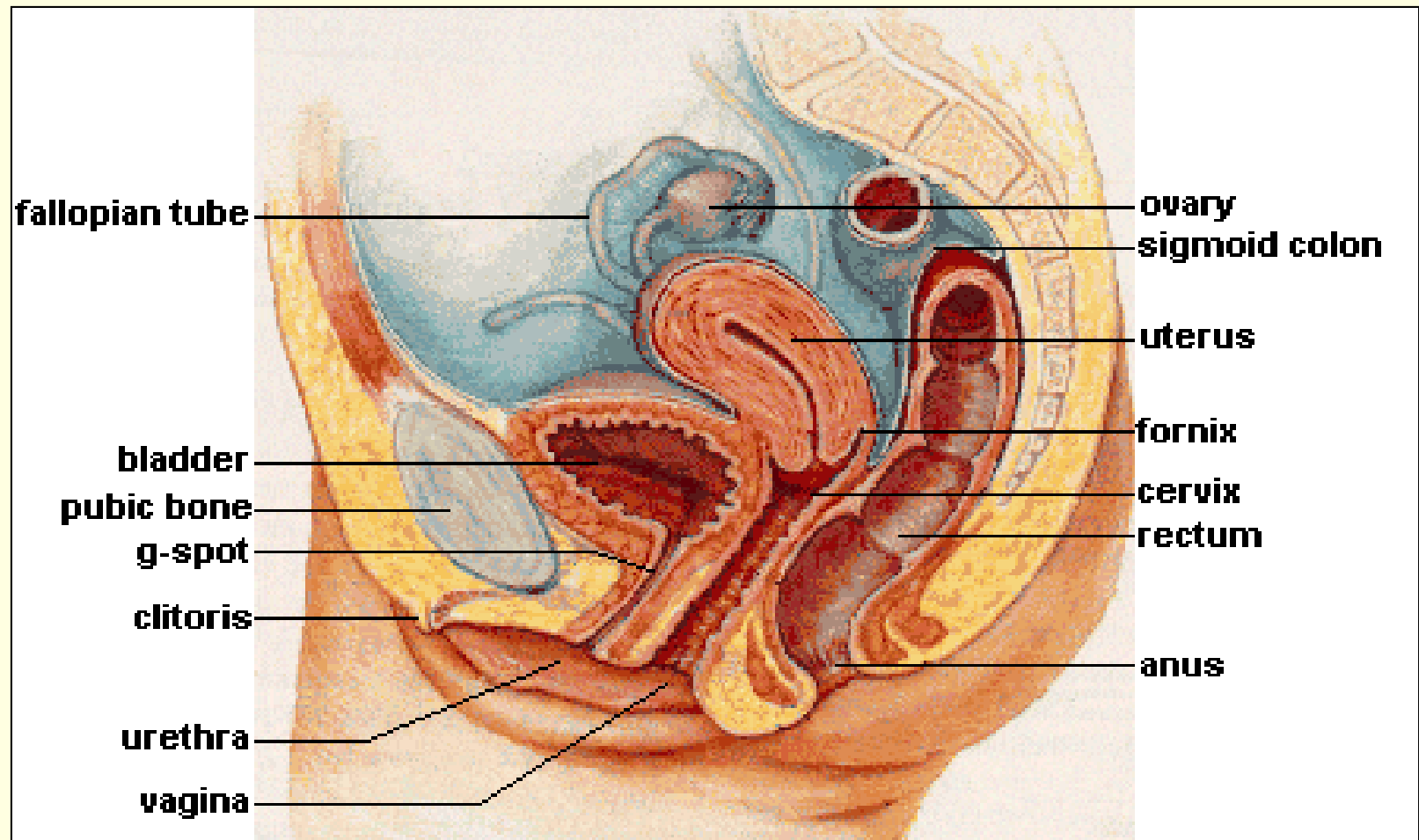
## 6.6.1a Draw and label diagrams of the adult male and female reproductive systems.

Locate the following:

- penis
- urethra
- testis
- epididymis
- scrotum
- vas deferens
- bladder
- seminal vesicle
- cowper's gland
- prostate gland
- anus



## 6.6.1b Draw diagrams of the adult male and female reproductive systems.



## 6.6.2 Outline the role of hormones in the menstrual cycle.

Estrogen- promotes secondary sexual characteristics, thickens uterine lining.

FSH- stimulates development of follicle

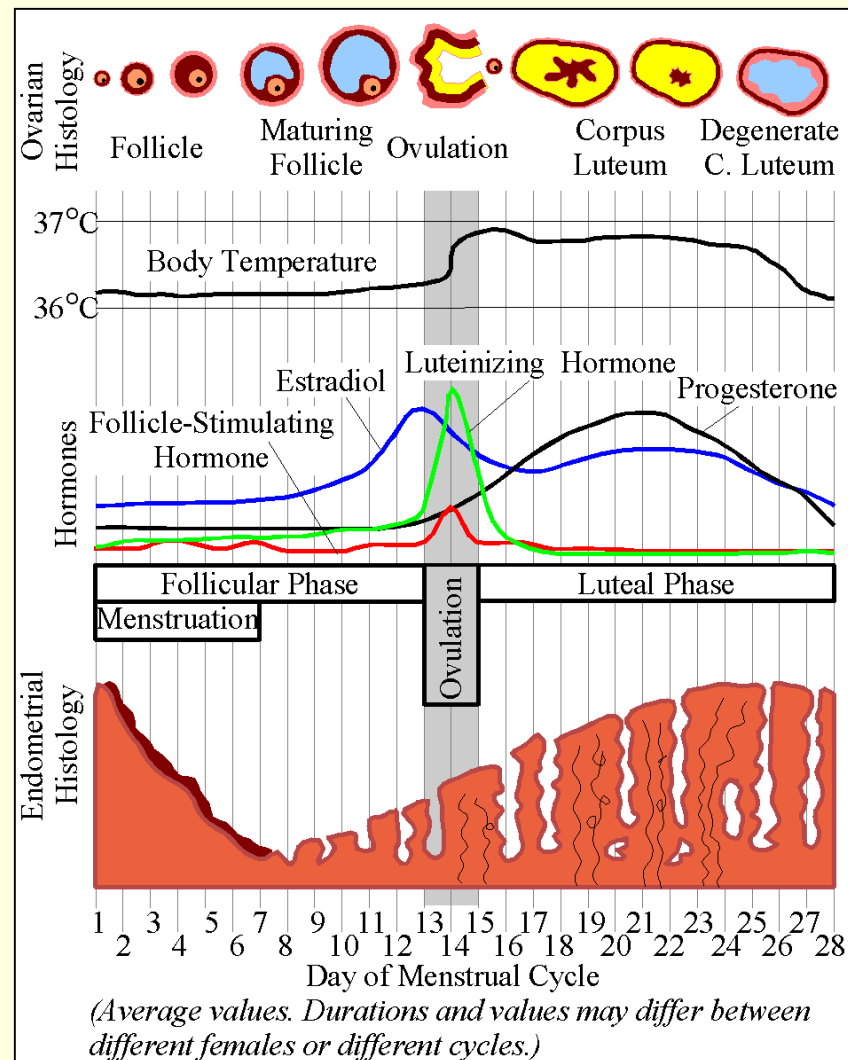
LH- stimulates the release of egg from follicles

Progesterone- maintains thickening of uterine lining.



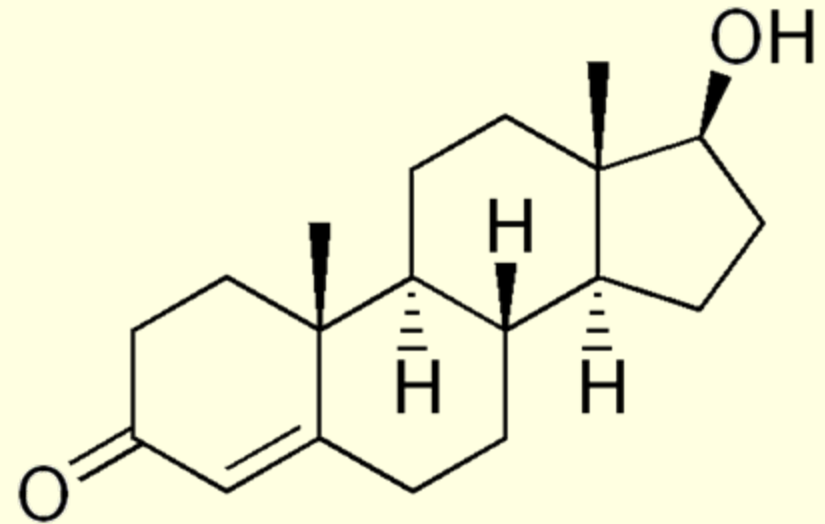
Ovulation

## 6.6.3 Annotate a graph showing hormone levels in the menstrual cycle.



## 6.6.4 List three roles of testosterone in males.

- 1) Development of secondary sexual characteristics.
- 2) Enlargement of organs such as heart and lungs.
- 3) Plays a role in the masculinization of the brain in a male fetus.



Testosterone

## 6.6.5 Outline the process of in vitro fertilization (IVF).

- 1) ovarian stimulation
- 2) oocyte (egg) retrieval
- 3) in vitro fertilization
- 4) embryo transfer into uterus



## 6.6.6 Discuss the ethical issues of IVF.

- 1) gender selection: ability to implant embryos of only one gender.
- 2) frozen embryos: what happens to those which are not used? Who has custody?

