Unit One: Chemistry

How Ions Are Formed:

Ions form when electrons move from one atom to another. A **+** (positive) charge states that (an) electron(s) have been lost, while a **-** (negative) charge shows that electrons have been gained.

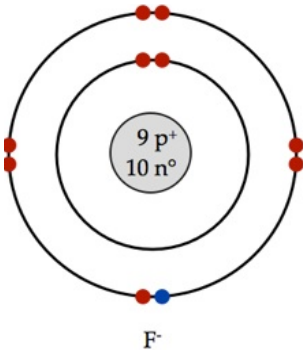
Ionic Charges of the Periodic Table:

Group #	Valence Electrons	Electrons Needed To Lose or Gain	Ionic Charge
1	1	-1	+1
2	2	-2	+2
13	3	-3	+3
14	4	-/+4	+/-4
15	5	+3	-3
16	6	+2	-2
17	7	+1	-1
18	8	0	0

- Valence electrons are the electrons in the outermost shell of an atom. They are loosely bound and available for compound formation.
- The number of valence electrons in an atom is equal to its group number on the periodic table.
- For groups 13-18, remove the 1 to get the number of valence electrons.
- Atoms like to be stable when forming compounds.
- Noble gasses don't form compounds since they're already stable.

Bohr-Rutherford Diagrams:

1. Write the standard atomic notation.
2. Calculate the number of protons, electrons, and neutrons *(PEN).*
3. Draw a circle for the nucleus and write the number of protons and neutrons inside it.
4. Draw a larger circle around the nucleus for the first orbital and dot the number of electrons (max of 2).
5. If needed, continue the pattern, however the max becomes 8
6. If you're drawing an ion rather than an atom, make it stable



Five Special Transition Metals:

1. Copper (Cu): 2+, or 1+
2. Iron (Fe): 3+, 2+
3. Lead (Pb): 4+, 2+
4. Tin (Sn): 4+, 2+
5. Manganese (Mn): 4+, 2+

Compounds:

1. Ionic: An ionic bond between a non-metal and a metal, the metal being positive while the non-metal being negatively charged.
2. Polyatomic: An ion made up of more than one atom that acts as a single particle. A polyatomic compound is similar to an ionic compound, only different being the polyatomic ion acting as the non-metal.
3. Molecular: A substance formed from two or more non-metals.

WRITING CHEMICAL FORMULAS FOR IONIC COMPOUNDS

1. Write the symbols for each element, the metal being first.
2. Write the ionic charges above each symbol.
3. Crisscross the numbers downwards, lose the signs, and then write them as subscripts. Do not write the “1”.
4. Divide subscripts by the highest common denominator.

NAMING IONIC COMPOUNDS

1. Name the metal first using the name on the periodic table.
2. Name the non-metal second, change the ending of the name to “ide”. If one of the metals is one of the five special ones, state their charge with roman numerals.

WRITING CHEMICAL FORMULAS FOR POLYATOMIC COMPOUNDS

1. Write symbols for the metal and polyatomic ion, write the metal first.
2. Write the ionic charges above each symbol, place brackets around the polyatomic ion.
3. Crisscross the numbers downwards, lose the signs and then write them as subscripts. Remove the brackets if the subscript outside is 1.
4. Divide the subscripts by the highest common denominator.

NAMING POLYATOMIC COMPOUNDS

1. Name the metal ion first.
2. Name the polyatomic ion second. Do no change the ending of a polyatomic ion.

WRITING CHEMICAL FORMULAS FOR MOLECULAR COMPOUNDS

1. Write symbols for each non-metal element, the element with the smaller group number first.
2. The prefix indicates the number of atoms for each element. Write it as a subscript behind the element.

NAMING MOLECULAR COMPOUNDS

1. Name the first element.
2. Name the second element, using the ending “ide”.
3. Use the correct prefix to indicate the number of atoms present for each element.

1	2	3	4	5	6	7	8	9	10
Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca

The Law of Conservation of Mass:

In any given chemical reaction, the total mass of the reactants equals the total mass of the products.

Balancing:

WORD EQUATIONS

An equation that uses words to describe the reactants and products but keeps the + symbol and arrow.

1. Write the reactants, separate them with a +
2. Draw an arrow
3. Write the products

For example: iron + sulphur —> iron(II) sulphide

SKELETON EQUATIONS

A skeleton equation replaces the names of the elements/compounds with their formulas.
For example: Fe + S —> FeS

BALANCING

1. Make an element inventory: count the number of atoms of each element on each side of the equation and record the count for the reactants and the products.
2. Multiply each chemical formula by the appropriate coefficient until the inventory for each element is equal on both sides of the arrow.

- When you change a coefficient, update the inventory
- Never change the chemical formulas, only the coefficients
- When the inventory is balanced, the equation is balanced.

WORD Iron + Oxygen = Iron(III) Oxide
SKELETON $Fe + O_2 \longrightarrow Fe_2O_3$
BALANCED $4Fe + 3O_2 \longrightarrow 2Fe_2O_3$

Types of Reactions:

1. **Synthesis Reactions:** Atoms join to form a molecule or elements join to form a compound. For example: A + B = AB
2. **Decomposition Reactions:** Breaking down molecules into atoms or compounds into elements. For example: AB —> A + B
3. **Single Displacement Reactions:** Involves an element and a compound where one element replaces another element. For example: Z + AB —> ZB + A
4. **Double Displacement Reactions:** When elements in different compounds exchange places. For example: AB + XY —> AY + XB
5. **Combustion:** Reaction between a substance and oxygen to produce an oxide and energy. The energy produced is usually in a form of water.
   a) Complete Combustion — Occurs when a hydrocarbon fuel is burnt to produce carbon dioxide, water, and energy
   b) Incomplete Combustion — Occurs when there is not enough oxygen to fully burn the hydrocarbon fuel. In this reaction carbon monoxide, carbon, carbon dioxide, water, and energy are produced.
   - The main difference between the two is in an incomplete combustion: carbon and carbon monoxide are produced alongside the others. To know if it's incomplete, simply look at if carbon monoxide and carbon were produced.
6. **Neutralization:** When acid is added to a base. Products of neutralization are a salt and water. There is no evidence of the reactions because salts dissolve in water. Salt is any ionic compound, metal and a non-metal. For example: **H**Cl + Na**OH** —> H_2O + NaCl

Exothermic and Endothermic:

An exothermic reaction is one that releases energy (heat and/or light) out into the surroundings.
For example: complete combustion of gasoline, gasoline + oxygen —> carbon dioxide + water + energy

An endothermic reaction is one that absorbs energy (heat) from the surroundings.
For example: water (s) + energy —> water

When bonds are formed, energy is released.
When bonds are broken, energy is absorbed.

Acids and Bases:

Acids:
- Sour tasting
- Others are corrosive
- Good conductors
- Very reactive
- H^+ ion present

Bases:
- Bitter-tasting
- Corrosive
- Good conductors
- Slippery when rubbed between fingers
- OH^- ion present

Acids and bases are formed when certain elements react with oxygen to form oxides, which then react with water to form acids or bases.

pH Scale:

The pH of a solution is how strong/weak an acid or base is. It ranges from 0-14, 7 being neutral. Indicators include: litmus paper, phenolphthalein

Unit Two: Optics

Luminosity:

Something is luminous when it produces its own light. For example: the sun, stars, fire, sparks.
Something is non-luminous when it does not produce its own light. For example: a rock, wood, aluminium

Sources of Light:

Incandescence: The process of producing light as a result of high temperature
- Incandescent bulbs require all air in the bulb to be removed
- For example: a burning candle, sparks flying off a grinder

Electric Discharge: The process of producing light by passing an electric current through a gas
- For example: lightning, neon sign

Phosphoresce: The process of producing light by the absorption of ultraviolet light resulting in the emission of visible light over an extended period of time
- Glow-in-the-dark stickers (and such) are coated with phosphorus, special materials that give off light through the process of phosphoresce
- For example: glow-in-the-dark stickers

Fluorescence: The immediate emission of visible light as a result of the absorption of ultraviolet light
- Fluorescent lights are the most common application of fluorescence. The light makes use of both electric discharge and fluorescence and is 4-5x more efficient then incandescent bulbs
- For example: highlighters, detergent, fluorescent bulbs

Chemiluminescence: The production of light as a direct product of a chemical reaction
- Almost no heat is produced
- For example: light sticks

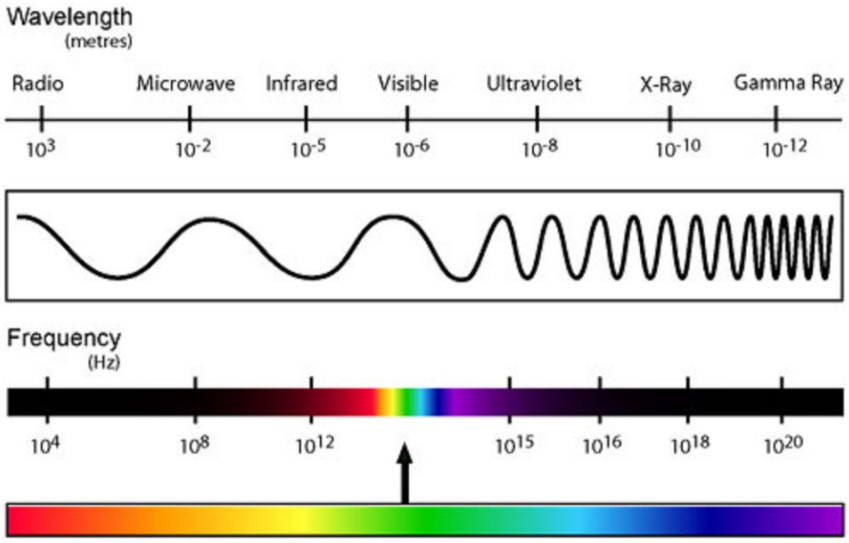
Bioluminescence: When chemiluminescence occurs in living organisms
- Bioluminescence is used by organisms so that they can protect themselves from predators, to lure pray, or to attract mates
- For example: fireflies, some jelly fish

Triboluminescence: The production of light when certain crystals are scratched, crushed, or rubbed
- No known practical applications

Transparent, Translucent, Opaque:

Something is transparent when it allows light to pass through it, objects in front/behind it can be seen distinctly.
Something is translucent when it allows some light to pass through it, objects in front/behind it can be seen, but not detailed.
Something is opaque when no light passes through it, nothing can be seen through it.

Electromagnetic Spectrum:



A wavelength is the distance between two crests (highest point in a wave).

Frequency is the number of waves that pass through a specific area.

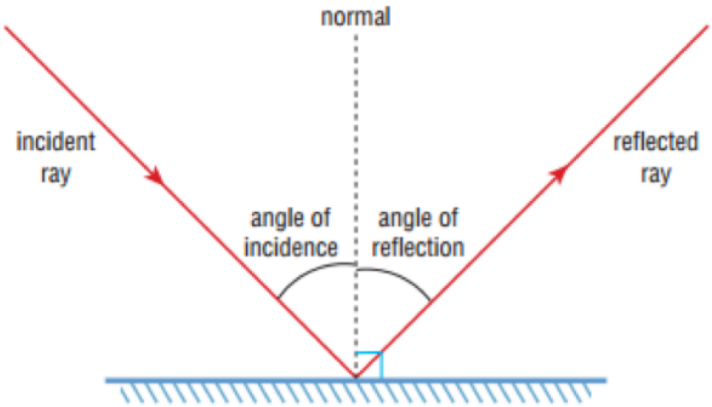
Energy is the same as frequency, but has the potential to do work.

Plane Mirror:

The **incident ray** is the incoming ray that strikes a surface.

The **reflected ray** is the ray that bounces off a reflective surface.

The **angle of incidence** is the angle between the incident ray and the normal.



The **angle of reflection** is the angle between the reflected ray and the normal.

The **normal** is the perpendicular line to a mirror surface.

Law of Reflection:

The law states that:
1. The angle of incidence equals the angle of reflection.
2. The incident ray, the reflected ray, and the normal all lie in the same plane.

Bending of Light (Refraction):

Refraction is the bending of light as it enters a different medium. This occurs because light travels in a straight line and changes its speed and direction when it enters a different medium.

CASE 1: LIGHT SLOWS DOWN
The refracted ray bends toward the normal when travelling from a less dense material to a more dense material.

CASE 2: LIGHT SPEEDS UP
The refracted ray bends away from the normal when travelling from a more dense material to a less dense material.

Index of Refraction:

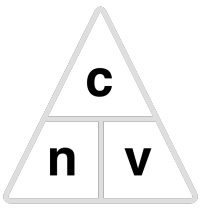
The measure of the slowing of the speed of light is called the index of refraction. The index of refraction is a ratio of the speed of light in a vacuum to the speed of light in the medium.

index of refraction

$$n = \frac{c}{v}$$

velocity of light in vacuum

velocity of light in the medium



The speed of light is **3.0x10^{8}m/s**

Calculation example:
Calculate the index of refraction for water (v = 2.25x10^{8}m/s)
n = c / v
n = 3.0x10^{8}m/s **/** 2.25x10^{8}m/s
n = 1.33

Calculate the speed of light in diamond (n = 2.42)
v = c / n
v = 3.0x10^{8}m/s / 2.42
v = 1.24x10^{8}m/s

Ray Diagrams (SALT):

CONCAVE MIRRORS

Object Location	Size (S)	Altitude (A)	Location (L)	Type (T)
Beyond C	Smaller	Inverted	Between C & F	Real
At C	Same	Inverted	On C	Real
Between C & F	Larger	Inverted	Beyond C	Real
At F	No Image	No Image	No Image	No Image
Between F & V	Larger	Upright	Behind Mirror	Virtual

CONVEX MIRRORS

Object Location	Size (S)	Altitude (A)	Location (L)	Type (T)
—	Smaller	Upright	Behind Mirror	Virtual

CONVERGING LENS

Object Location	Size (S)	Altitude (A)	Location (L)	Type (T)
Beyond 2F'	Smaller	Inverted	Between F and 2F	Real
At 2F'	Same	Inverted	At 2F'	Real
Between 2F' & F'	Larger	Inverted	Beyond 2F	Real
At F'	No Image	No Image	No Image	No Image
Between F' and O	Larger	Upright	Behind Lens	Virtual

DIVERGING LENS

Object Location	Size (S)	Altitude (A)	Location (L)	Type (T)
—	Smaller	Upright	Behind Lens	Virtual

Diagrams not included, look in your book.

Total Internal Reflection:

The **critical angle** is the angle of incidence that results in an angle of refraction of 90°.
Total internal reflection is the situation when the angle of incidence is greater than the critical angle. This occurs when:

1. Light is travelling slower in the first medium than in the second.
2. The angle of incidence is large enough that no refraction occurs in the second medium. Instead, the ray is reflected back into the first medium.

Total internal reflection is applied with: fibre optics (internet), optical devices (periscopes, binoculars), triangular prism, cutting diamonds

Thin Lens Equation and the Magnification Equation:

TERMINOLOGY

d_o is the distance from the object to the optical center.
d_i is the distance from the image to the optical center.
h_o is the height of the object.
h_i is the height of the image.
f is the focal length of the lens, distance from the optical center to the principal focus (f).

Thin Lens Equation

$$\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$$

Magnification Equation

$$M = \frac{h_i}{h_0} = -\frac{d_i}{d_0}$$

SIGN CONVENTIONS FOR LENSES

Variable	Positive	Negative
d_o (object distance)	Always	Never
d_i (image distance)	Real image	Virtual image
h_o (height of object)	When measured upwards	When measured downwards
h_i (height of the image)	When measured upwards	When measured downwards
f (focal length)	Converging lens	Diverging lens
m (magnification)	Upright image	Inverted lens

Unit Three: Biology

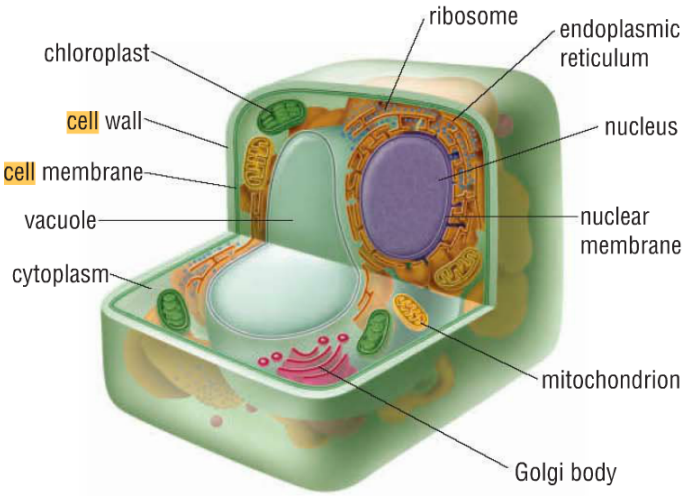
Parts of Cells:

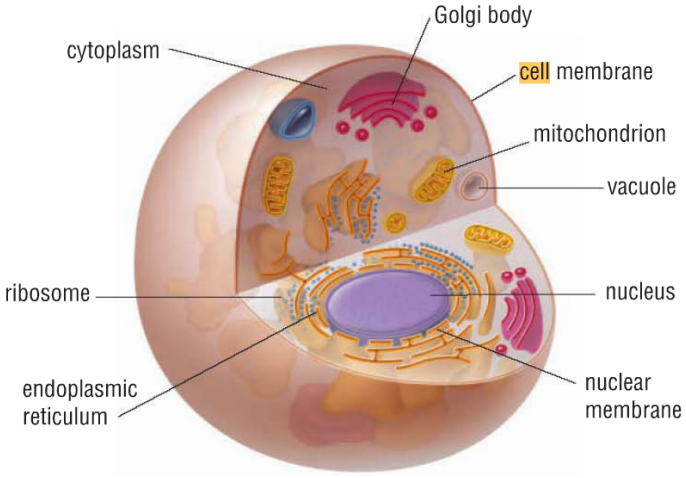
Nucleus
- The brain of the cell
- It holds genetic information [in the form of deoxyribonucleic acid (DNA), packed as chromosomes], that controls all cell activities

Cell Membrane
- Flexible, double layered
- Supports the cell, allows only certain substances to pass through while keeping others out (semi-permeable)

Cytoplasm
- Suspends all organelles
- Mostly water but also stores other stuff until it is needed
- Can change from jelly-like to liquid, allowing organelles to move around

Mitochondria
- Carriers out cellular respiration which converts stored energy to usable energy
- The more active the cell, the more mitochondria





Ribosome
- Small and granular structure located on rough endoplasmic reticulum
- Involved in the manufacture of proteins

Endoplasmic Reticulum
- A folded membrane that forms a system of canals
- Transports material to different parts of the cell

Vacuole
- Fluid-filled structure
- Stores water, food, wastes, and other material

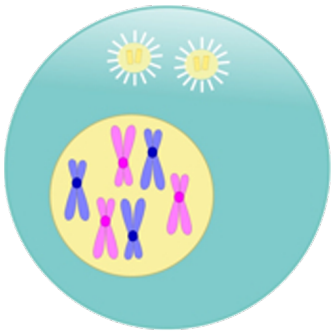
Golgi Body
- Stacks of membranes
- Packages and moves materials out of the cell

Cell Wall
- Fibrous; rigid structure surrounding the cell membrane of plants and bacteria
- Protects and supports the cell

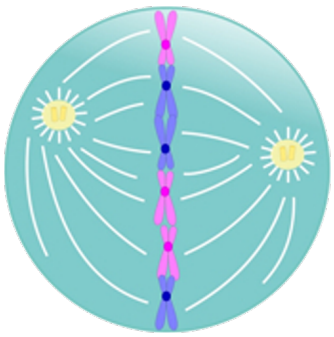
Chloroplast
- Structure that contains chlorophyll
- Helps make carbohydrates through out the process of photosynthesis

Lysosome
- Sac-like structure filled with digestive enzymes
- Breaks down food and digests wastes and worn out cell parts

Phases of Mitosis:

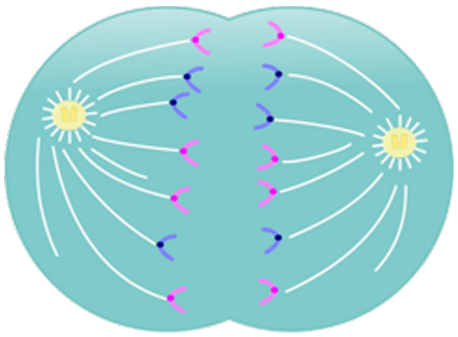


1. Prophase
- Chromatin condenses into **double-stranded chromosomes** that are now visible
- A chromosome is made of two identical strands of DNA, called **sister chromatids**, held together by a **centromere**.
- The nucleolus and nuclear membrane disappear.
- **Spindle fibres** begin to form and stretch across the cell from **centrioles** that have moved to opposite ends of the cell.

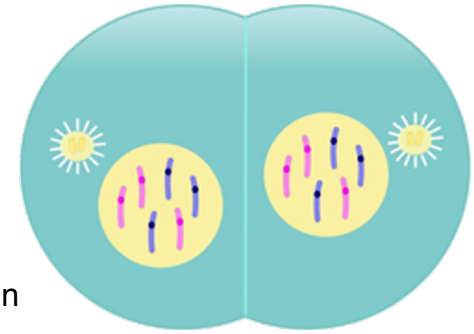


2. Metaphase
- Tugging action of the spindle fibres pull the double-stranded chromosomes into a line across the **equator** (middle of the cell).

3. Anaphase
- Spindle fibres contract and shorten causing the centromeres to be pulled apart.
- Each **single-stranded, daughter chromosome** moves to opposite **poles** (ends of the cell).



4. Telophase



- One complete set of chromosomes is now at each pole of the cell.
- Spindle fibres begin to disappear.
- Nuclear membranes begin to form around each set of chromosomes.
- Nucleolus appears within each new nucleus.
- Single-stranded chromosomes start to **uncoil** into thin strands of chromatin.
- Now there are two identical nuclei in one cell and the cell itself is ready to divide.

Tissues:

Muscle

- Made of cells that contract to allow movement
- 3 types:
    1. Skeletal: voluntary, striated (you control movement)
    2. Smooth: involuntary, smooth (you don't need to control movement)
    3. Cardiac: involuntary, striated
- Heart, stomach, biceps

Epithelial

- Made of tightly packed cells that cover body surfaces and line internal organs
- Can be many layers thick or a single layer of cells
- Single layer allows materials to pass through
- Skin cells, stomach lining

Connective

- Made of both specialized cells and non-living substances
- Blood connects body systems by bringing and removing substances
- Bone is made of living bone cells surrounded by hard non-living material, provides support
- Cartilage forms the cushions between bones, provides protection
- Blood, bone, cartilage

Nervous

- Most complex tissue
- Transmits electrical signals throughout the body
- 3 types:
    1. Sensory neurons: carry info from the body to the brain

2. Motor neurons: carry info from the brain, spinal cord, and nerves to the brain to the body
3. Interneurons: connects sensory and motor neurons

- Brain, spinal cord, nerves

Benign Tumour vs. Malignant Tumour:

A benign tumour does not affect surrounding tissues other than by physically crowding them, while a malignant tumour does. Malignant tumours break away from the original tumour and establish other tumours elsewhere in the body.

Treatments for Cancer:

1. Surgery: Open the patient's body and physically remove the cancer cells.
2. Radiation: Radiating the cancer cells.
3. Chemotherapy: Injecting drugs in one's bloodstream that kill cancer cells.

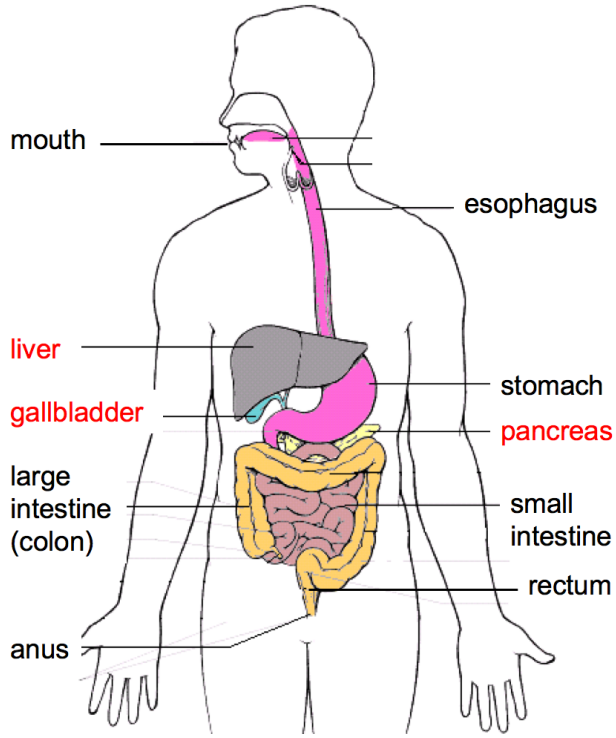
Body Systems:

1. Respiratory system: Responsible for taking in oxygen and expelling carbon dioxide.
2. Circulatory system: Transports substances throughout the body including gasses, nutrients, and wastes.
3. Digestive system: Digestion and absorption.

WAYS THEY RELY ON EACH OTHER

- The circulatory system needs oxygen from the respiratory system and nutrients from the digestive system to transport throughout the body
- The digestive system requires oxygen, which it receives from the circulatory system
- The respiratory system depends on the circulatory system for blood flow

Digestive System Parts:

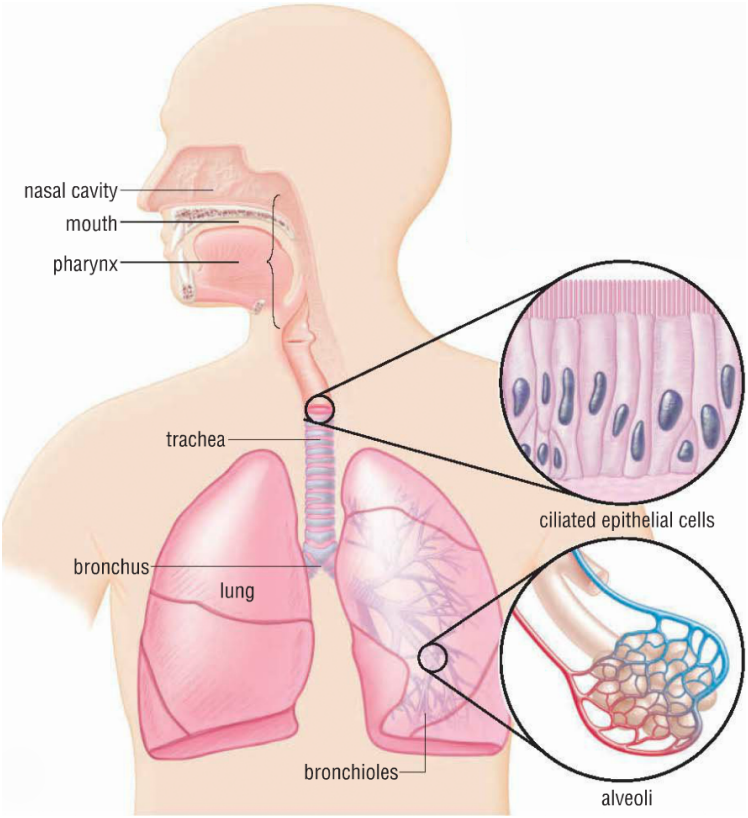


*Red = Accessory parts

PATH

mouth —> esophagus —> stomach —> small intestine —> large intestine —> rectum —> anus

Respiratory System Parts:



PATH

mouth/nostrils —> pharynx —> trachea —> bronchus —> bronchioles —> alveoli

Gas Exchange:

- The bronchi continue to divide into smaller and smaller branches inside the lungs called bronchioles
- There are tiny air sacs at the end of the branches called alveoli
- Each sac is surrounded by capillaries (circulatory system) to allow for diffusion of gasses across the thin membranes
- The oxygen we breathe in moves from the alveoli into the capillary and then into red blood cells
- Red blood cells take the O_2 to other body parts and it diffuses into the tissues

Three Types of Blood Vessels:

1. Arteries: Carry blood away from the heart; thicker; higher pressure
2. Veins: Carry blood back to the heart; less thick; lower pressure
3. Capillaries: Where arteries and veins are linked; supplies every body part; has very thin walls to allow for the exchange of gas, nutrients and wastes between the blood and body tissues

- Vessels that are larger are closer to the heart

Why People are Against Organ Donations and Stem Cell Use:

- Misconception that doctors will put less effort in saving their lives and instead rather harvest their organs
- Religious reasons
- Don't want their organs in people who “don't deserve them”
- Those against embryonic stem cell use believe that is it immoral and unethical to destroy one life to save another

Pros and Cons of Organ Donation/Stem Cell Research:

PROS

- Saves lives
- Opportunities for medical research

CONS

- Long waiting time
- Potential transplant rejection
- Can be unethical

Unit Four: Climate Change

Difference Between Weather and Climate:

Weather is a description of the atmospheric conditions, including temperature, precipitation, wind, and humidity, in a particular location over a short period of time.
For example:
- It snowed 5 inches last night
- It has not rained this month

Climate is the average weather in a region over a long period of time, usually 30 years.
For example:
- Typically rainfall in June will be under 1 inch
- This winter should be colder than normal
- It has never gone above 50^{o}C in the month of May

Climate System:

A complex and interactive system defined by four parts.
1. Atmosphere: Includes all gasses surrounding Earth
2. Hydrosphere: Includes all water found on Earth
3. Lithosphere: Includes all rocks and land surfaces on Earth
4. Biosphere: All living things found on Earth

Greenhouse Effect:

A natural process where gasses and clouds absorb infrared radiation emitted from the Earth's atmosphere and Earth's surface. The process is needed for Earth to be habitable.

Greenhouse Gas:

Any gas in the atmosphere (such as water vapour, carbon dioxide, or methane) that absorbs lower energy infrared radiation.

Most Effective and Least Effective Greenhouse Gas:

The most effective greenhouse gas is nitrous oxide while the least effective is ozone.

Most Abundant Human Produced Greenhouse Gas:

The most abundant human produced greenhouse gas is carbon dioxide.

Anthropogenic vs. Natural Sources of Greenhouse Gasses:

Anthropogenic means caused or produced by human activities.
For example: burning fossil fuels, deforestation, raising of livestock, use of fertilizers

Natural means existing in or caused by nature, not made or caused by humans.
For example: water vapour, ozone, carbon dioxide, methane, nitrous oxide

Evidence of Climate Change:

- Atmosphere is getting hotter
- Oceans are getting hotter and much more acidic
- Ice cores
- Sea levels are rising

Impacts of Climate Change:

- Species becoming extinct
- Droughts and heatwaves
- Natural disasters (hurricanes, tsunamis)
- Freshwater shortages

Investigating Past Climates:

Ice Cores
- Scientists drill deep into ice that is thousands of centuries old
- They extract long cylinders of ice called ice cores
- They then cut the bottom of the core in very thin slices and test the air bubbles for various gasses
- The tests establish how much carbon dioxide, methane, and nitrous oxide were in the air when the bubbles formed
- To find the temperature hundreds of thousands of years ago, scientists test the ice cores for oxygen

Tree Rings

- Trees create one growth ring per year
- The thicker the ring, the better the growing condition
- Scientists gather both living and dead trees and collect records of climate by looking at the rings
- Can go as far as 10,000 years ago

Suggested Review Questions:

CHEMISTRY

Atoms versus Ions (including Bohr-Rutherford Diagrams)

p. 216 #4, 7, 14

Ionic, Molecular and Polyatomic Compounds (Identifying, Naming, Writing Formulas)

p. 216 #6, 8, 11

Balancing Equations & Identifying Types of Reactions

p. 258 #3, 7, 9

*p. 302 to 305, choose which types of questions you require more help with!

OPTICS

Index of Refraction (n) Calculations

p. 542 #15-20

Ray Diagrams for Mirrors and Lenses

p. 582 #13, 23

Thin Lens Equation Calculations

p. 582 #17, 21

Magnification Equation Calculations

p. 582 #18-20

*p.590 to 594, choose which types of questions you require more help with!

I do not take full credit for the work, the information comes from various sources.
Use the notes at your own risk. I am not to blame if anything is incorrect or missing.

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