Biology High School

For Standardized Scholastic Tests

EST2-ACT2 Biology

Coursework

2024-2025

Dr. Mohamed Kabbany

Chapter 1

Introduction to Chemistry

Lesson 1.2.1

Some Basic Stuff

1.2.1-Subtopics: Some Basic Stuff

	1.2- Biochemistry
1	Intorduction to Chemistry
2	Bonding
3	Chemistry of Water
4	pH.
5	Organic Compounds
6	Carbohydrates
7	Lipids and Phospholipids
8	Proteins
9	Nucleic acids
10	Biochemistry Mix

Periodic Table of the Elements

Grade 8 Science Reference Sheet

California Sta n

Key

11	Atomic number
Na	Element symbol
Sodium	Element name
22.99	Average atomic mass*

Period	1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 **H** Hydrogen 1.01																	2 **He** Helium 4.00
2	3 **Li** Lithium 6.94	4 **Be** Beryllium 9.01											5 **B** Boron 10.81	6 **C** Carbon 12.01	7 **N** Nitrogen 14.01	8 **O** Oxygen 16.00	9 **F** Fluorine 19.00	10 **Ne** Neon 20.18
3	11 **Na** Sodium 22.99	12 **Mg** Magnesium 24.31											13 **Al** Aluminum 26.98	14 **Si** Silicon 28.09	15 **P** Phosphorus 30.97	16 **S** Sulfur 32.07	17 **Cl** Chlorine 35.45	18 **Ar** Argon 39.95
4	19 **K** Potassium 39.10	20 **Ca** Calcium 40.08	21 **Sc** Scandium 44.96	22 **Ti** Titanium 47.87	23 **V** Vanadium 50.94	24 **Cr** Chromium 52.00	25 **Mn** Manganese 54.94	26 **Fe** Iron 55.85	27 **Co** Cobalt 58.93	28 **Ni** Nickel 58.69	29 **Cu** Copper 63.55	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.72	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92	34 **Se** Selenium 78.96	35 **Br** Bromine 79.90	36 **Kr** Krypton 83.80
5	37 **Rb** Rubidium 85.47	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.91	40 **Zr** Zirconium 91.22	41 **Nb** Niobium 92.91	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29
6	55 **Cs** Cesium 132.91	56 **Ba** Barium 137.33	57 **La** Lanthanum 138.91	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
7	87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (266)	107 **Bh** Bohrium (264)	108 **Hs** Hassium (269)	109 **Mt** Meitnerium (268)									

58 **Ce** Cerium 140.12	59 **Pr** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.97
90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.

Formulas and Conversions

Density: $D = \frac{m}{V}$

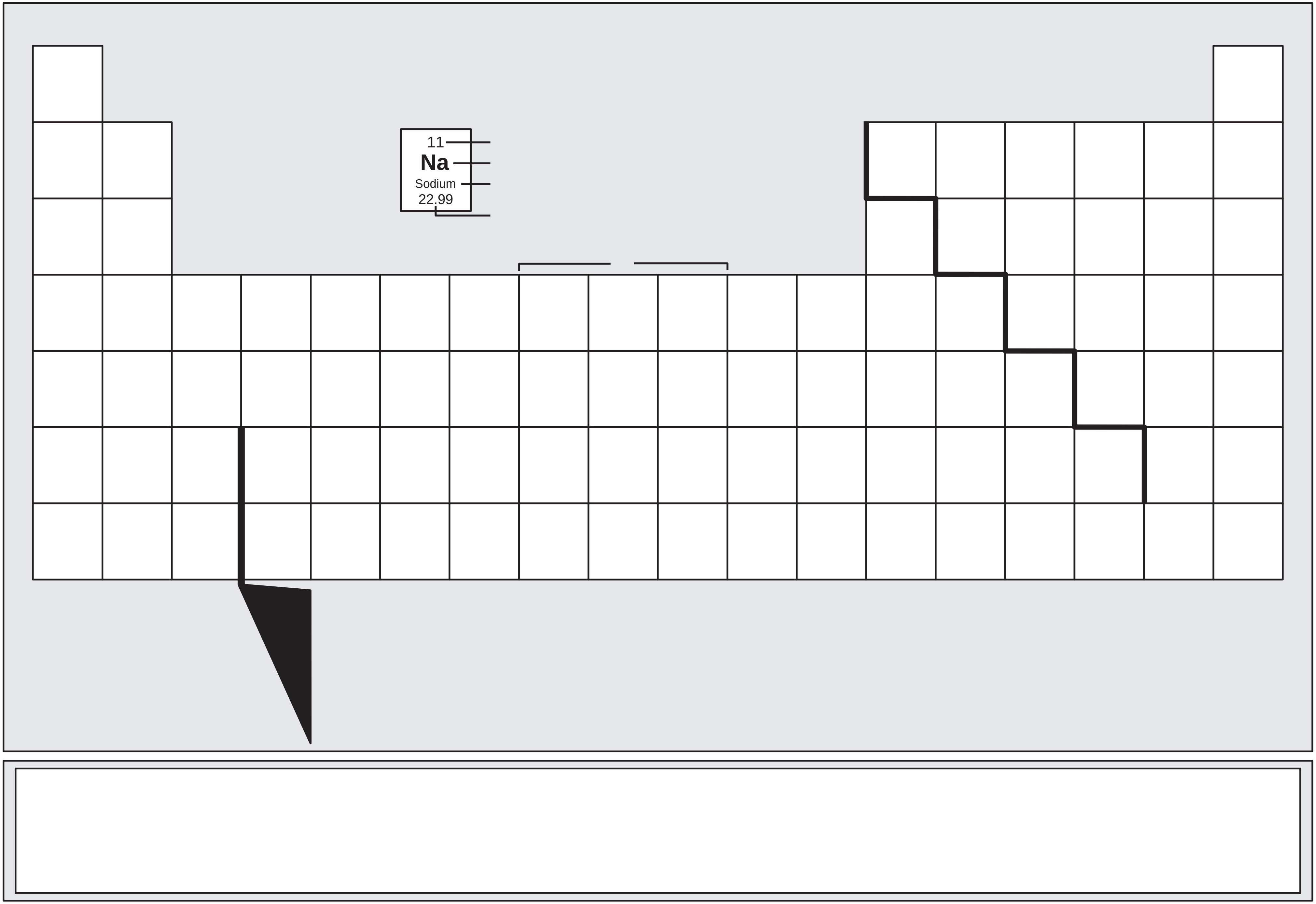
Average Speed: $v = \frac{d}{t}$

Length: 1 m = 100 cm
1 km = 1000 m

Mass: 1 kg = 1000 g

Volume: 1 L = 1000 mL = 1000 cm^3

Water at Room Temperature: 1 mL = 1 cm^3 = 1 g


11
Na
Sodium
22.99

Some Basic Stuff

MATTER

Matter is defined as anything that occupies space and has mass.

MASS

Mass is the quantity of matter which a substance possesses.
A property of mass is to resist a change of position or motion is called **inertia**.

Note: Unit of mass is kilogram (kg). Unit of inertia is kilogram (kg).

WEIGHT

The gravitational force acting on mass.
Newton is the unit of weight. $w = mg$.
Although the **weight** then can vary, the mass of the body is constant.

DENSITY

Density is mass per unit volume. D = m/V
Pure substances differ in their densities.
Different units of density can be used.

Kg/m^3	The S.I. units
g/cm^3	Solids chemicals
g/mL	Liquids, / gases chemicals

Density of gases is expressed in g/cm^3 or g/mL. at S.T.P

S.T.P. = standard conditions of temperature and pressure.
i.e. 1 atm. and 25 K.

States of Matter

Solids

A **solid** has both a definite size and a definite shape.

Liquids

A **liquid** has a definite volume but takes the shape of the container.

Gases

A gas has neither a definite shape nor a definite volume.
Typically it expands to fill any available space.

Plasma

Just as a liquid will boil, changing into a gas when energy is added, heating a gas will form a plasma – a soup of positively charged particles (ions) and negatively charged particles (electrons).

Composition of Matter

Matter consists of:	Distinct substance	and	Mixtures.
Distinct substance are	Elements	or	compounds.

Distinct substance a pure substance made of the same type of molecules.

Mixtures. a mixture of different pure substances with different types of molecules.

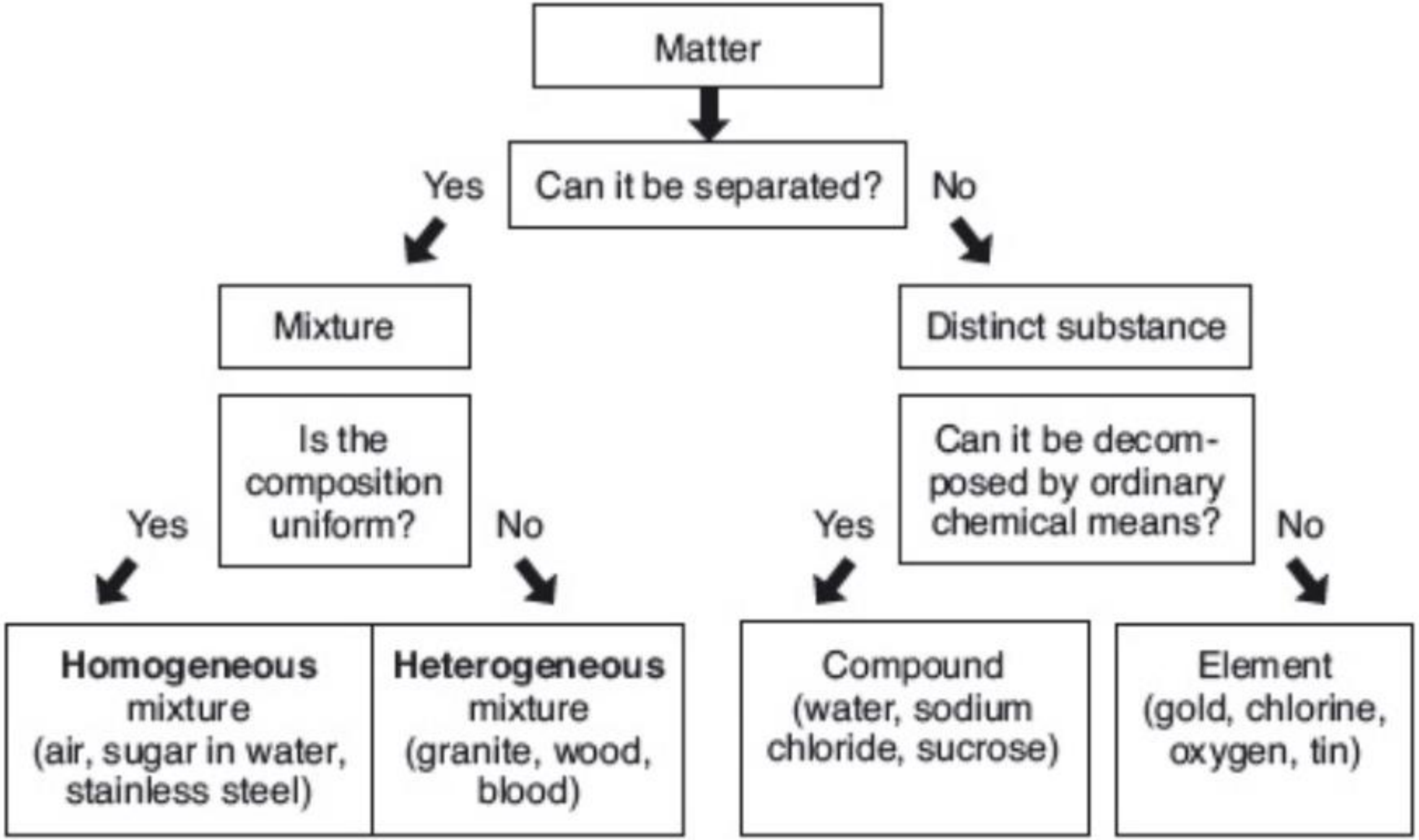
An element a pure substance whose molecules are made up of the same type of atoms.

There are about 92 natural elements arranged in the periodic table

Examples are: Hydrogen, Oxygen, Iron, Sodium, Uranium, etc…..

A compound A substance whose molecules are made of more than one type of atoms combined in a fixed mass ratio.

Properties of a compound is completely different from those of the constituting elements.


Matter
Can it be separated?
Yes
No
Mixture
Distinct substance
Is the composition uniform?
Yes
No
Can it be decom-posed by ordinary chemical means?
Yes
No
Homogeneous mixture (air, sugar in water, stainless steel)
Heterogeneous mixture (granite, wood, blood)
Compound (water, sodium chloride, sucrose)
Element (gold, chlorine, oxygen, tin)

Mixtures	Distinct Substances
1. Composition is indefinite (generally **heterogeneous**).* (Example: marble) 2. Properties of the constituents are retained. 3. Parts of the mixture react differently to changed conditions. *Solutions are mixtures, such as sugar in water, but since the substance, like sugar, is distributed evenly throughout the water, the mixture can be said to be homogeneous.	**ELEMENTS** 1. Composition is made up of one kind of atom. (Examples: nitrogen, gold, neon) 2. All parts are the same throughout (homogeneous). **COMPOUNDS** 1. Composition is definite (homogeneous). (Examples: water, carbon dioxide) 2. All parts react the same. 3. Properties of the compound are distinct and different from the properties of the individual elements that are combined in its make-up.

What is an atom?

The smallest building unit of an element that can enter a chemical reaction without being divide.

The total number of atoms entering the chemical reaction equals those coming in products.

An atom consists of : A centra nucleus. and a cloud of electrons orbiting the nucleus in distinct energy levels.

The nucleus.

Most of the atomic mass is concentrated in the nucleus.

Contains many subatomic particles. Most important: are protons and neutrons.

Protons are positively charged and has a mass of 1 a.m.u.

Neutrons are neutral charged and has a mass of 1 a.m.u.

The nucleus as a whole is positively charged due to protons.

Electrons.

Electrons are negatively charged with negligible mass.

Electrons orbit the nucleus indistinct energy levels

An electron charge equals the proton charge with opposite sign.

Electrons have dual nature, mass and waves.

The atom is neutral	as the number of protons inside the nucleus equals the number of electrons outside it.
Ions:	Atoms losing electrons become positively charged ions, called cations. Atoms gaining electrons become a negatively charged ions called anions.
Why do atoms react?	Atoms react to have their outer most energy level saturated at 8 (except hydrogen saturated at 2) and become similar in electronic configuration to the nearest noble gas i.e. to gain stability like that noble gas atoms. In chemical reactions atoms reach stability by losing, gaining or sharing electrons.
In ionic compound:	A metal atom loses 1 or more electrons and becomes a positive ion, a cation. A non metal atom gains those electrons and becomes a negative ion, an anion. Electrostatic attractive force binds them in an ionic bond to form an ionic compound.
In covalent compounds:	Combining atoms each shares one,2, 3 or 4 atoms to form mono covalent, dicovalent , or tri-covalent bonds to form covalent or called molecular compounds. In covalent bonds, bond electrons are either equally attracted by the nuclei of the combining atoms to give non polar molecules or unequally shared to give polar ones.

Isotopes:

Atomic number: Is the number of protons in the nucleus of the atom.

Electrons orbiting the nucleus have the same number as the atom is neutral.

Number of electrons determine their distribution in the energy levels and those in the outermost energy levels that determine their chemical reactivities.

That is why atomic number is peculiar to each element like an I.D. of yours.

No ever two elements can have the same atomic number although some different atoms can have same mass numbers.

Sometimes atoms of the same elements have different number of neutrons to form **isotopes**.

Isotopes are atoms of the same element with different mass number as they differ in neutron numbers.

Some isotopes are unstable and their nuclei disintegrates producing alpha, beta and/ or gamma rays.

Those are called radioactive isotopes. e.g. radio active Carbon C14, iodin, I131, Uranium and others

Radioactive isotopes have wide range of use in biology, medicine and industry.

Chemical and Physical Properties

Physical properties

Physical properties of matter are those properties that can usually be observed with our senses

They include everything about a substance that can be noted when no change is occurring in the type of structure that makes up its smallest component.

Some common examples are physical state, color, odor, solubility in water, density, melting point, taste, boiling point, and hardness.

Chemical properties

Chemical properties are those properties that can be observed in regard to whether or not a substance changes chemically, often as a result of reacting with other substances.

Some common examples are: iron rusts in moist air, nitrogen does not burn, gold does not rust, sodium reacts with water, silver does not react with water, and water can be decomposed by an electric current.

Chemical and Physical Changes

a **physical change**

a **physical change** alters some aspect of the physical properties of matter, but the composition remains constant.

The most often altered properties are form and state.

Some examples of physical changes are breaking glass, cutting wood, melting ice, and magnetizing a piece of metal.

In some cases, the process that caused the change can be easily reversed and the substance regains its original form.

Water changing its state is a good example of physical changes.

In the solid state, ice, water has a definite size and shape.

As heat is added, it changes to the liquid state, where it has a definite volume but takes the shape of the container.

When water is heated above its boiling point, it changes to steam. Steam, a gas, has neither a definite size, because it fills the containing space, nor shape, because it takes the shape of the container.

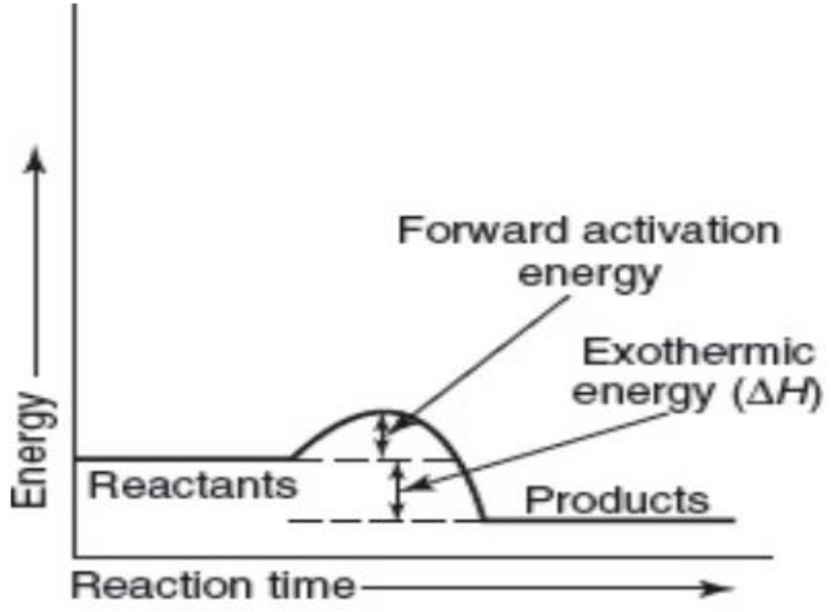
Chemical and Physical Changes

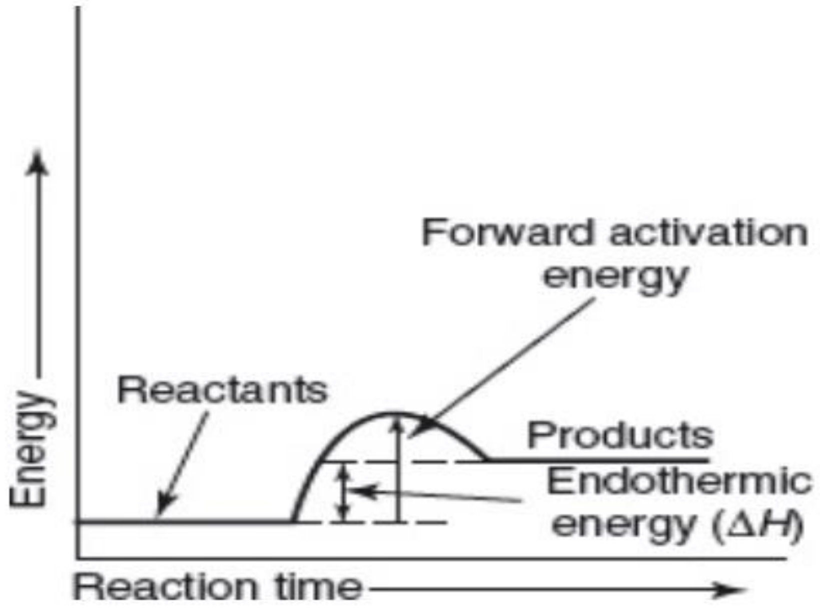
Chemical changes

Chemical changes are changes in the composition and structure of a substance.
They are always accompanied by energy changes.

If the energy released in the formation of a new structure exceeds the chemical energy in the original substances, energy will be given off, usually in the form of heat or light or both.
This is called an **exothermic reaction**.

If, however, the new structure needs to absorb more energy than is available from the reactants, the result is an **endothermic reaction**.





Conservation of Mass

When ordinary chemical changes occur, the mass of the reactants equals the mass of the products.

This can be stated another way:

In a chemical change, matter can neither be created nor destroyed, but only changed from one form to another.

This is referred to as the **Law of Conservation of Matter** (Lavoisier—1785).

This law is extended by the Einstein mass-energy relationship, which states that matter and energy are interchangeable.

$E=mc^2$.

Thank you

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Chapter 1

Cellular and Molecular Biology

Lesson 1.2.1-

Biochemistry

- **BASIC ATOMIC STRUCTURE**
- **BONDING**

BASIC ATOMIC STRUCTURE

The atom consists of subatomic particles: protons, neutrons, and electrons.

Subatomic Particle	Charge	Mass in amu	Location
Proton	+1	1	Nucleus
Neutron	0	1	Nucleus
Electron	–1	0	Outside nucleus

1. An atom in the elemental state always has a neutral charge because the number of protons (+) equals the number of electrons (–).

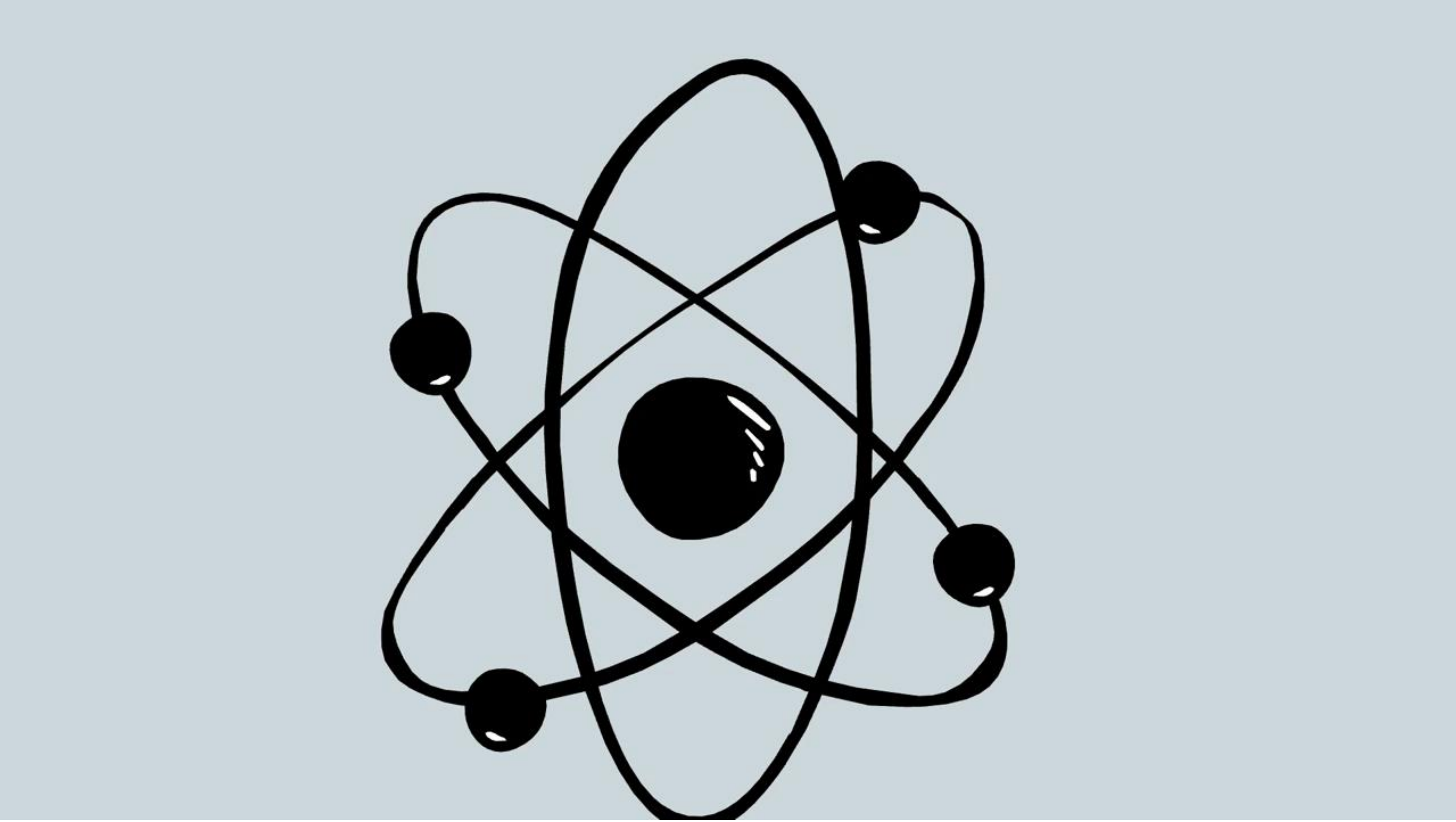
2. Electron configuration is important because it determines how a particular atom will react with atoms of other elements.

3. Electrons in the lowest available energy level are said to be in the ground state.

4. When an atom absorbs energy, its electrons move to a higher energy level. The atom is then said to be in the excited state.

For example, during photosynthesis, chlorophyll molecules absorb light energy, which boosts electrons to higher energy levels. These excited electrons provide the energy to make sugar as they return to their ground state and release the energy they previously absorbed.

Atomic Structure



Link

Isotopes are atoms of one element that vary only in the number of neutrons in the nucleus

Chemically, all isotopes of the same element are identical because they have the same number of electrons.

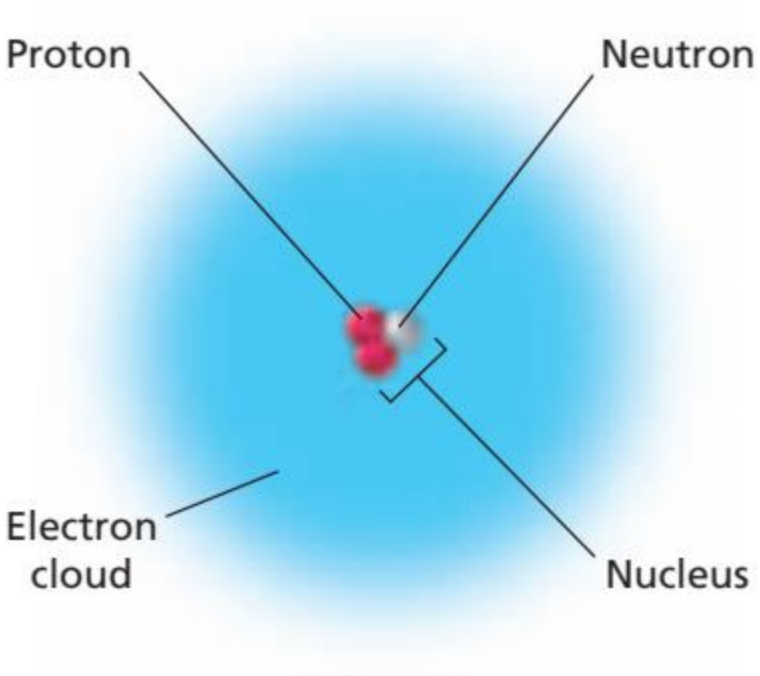
For example, carbon-12 and carbon-14 are isotopes of each other and are chemically identical

They both possess 6 protons and 6 electrons. However, carbon-12 has 6 neutrons, while carbon-14 has 8 neutrons.

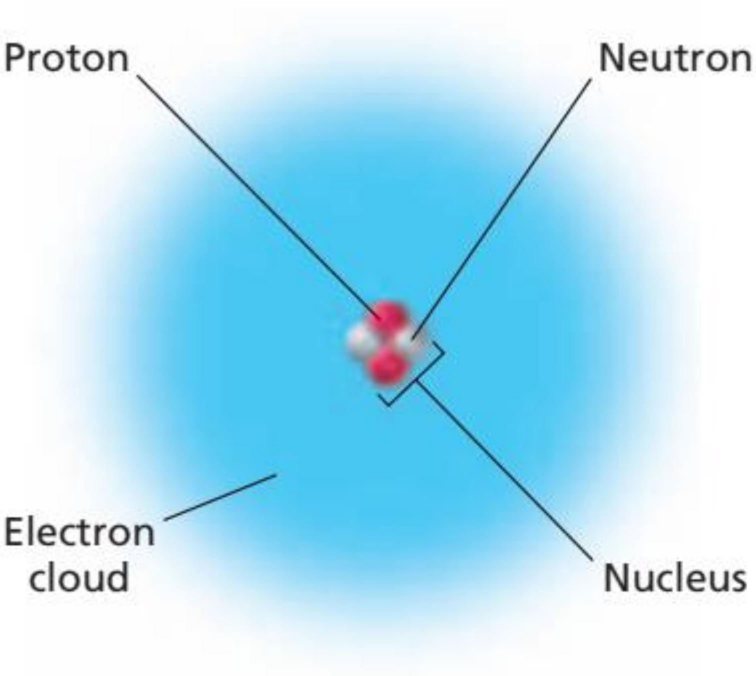
Some isotopes, like carbon-14, are radioactive (called radioisotopes).
The nuclei of radioisotopes emit particles and decay at a known rate called a half-life

Knowing the half-life enables us to measure the age of fossils or to estimate the age of Earth.

Isotopes



Helium-3



Helium-4

Most scientists consider the electron cloud model, shown above, to be the most accurate model of an atom. Here the models show the difference between elements and isotopes. Helium-3 has two protons and one neutron, while Helium-4 has two protons and two neutrons

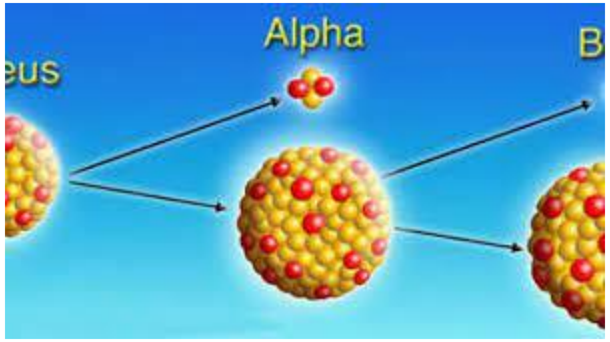
Back

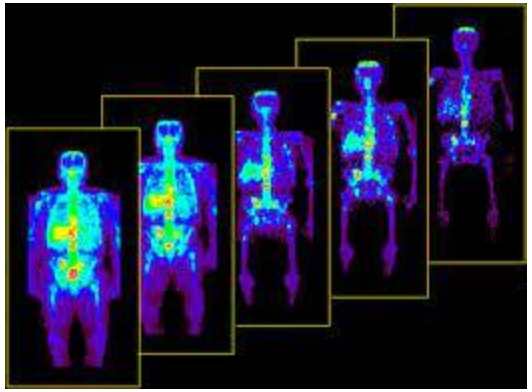
Link

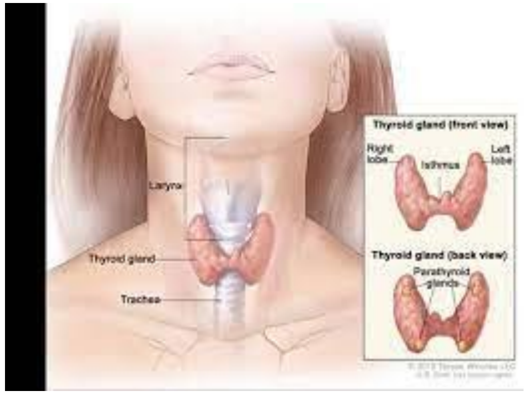
Radioisotopes are useful in other ways.
Besides measuring the age of fossils, they can be used in medical diagnosis, treatment, and research.

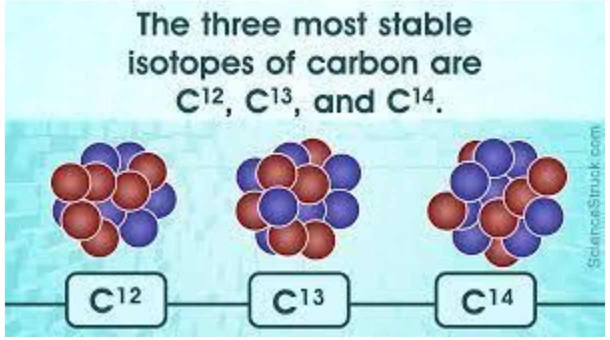
For example: radioactive iodine (I-131) can be used both to diagnose and to treat certain diseases of the thyroid gland.

In addition, radioactive carbon can be used as a tracer, incorporated into molecules of carbon dioxide, and used to track metabolic pathways.









Radioactive Isotopes

Back

BONDING

Link

A bond is formed when two atomic nuclei attract the same electron(s).

Energy is released when a bond is formed.

Energy must be supplied or absorbed to break a bond.

Atoms bond to achieve stability, to acquire a completed outer shell.

There are two main types of bonds, ionic and covalent.

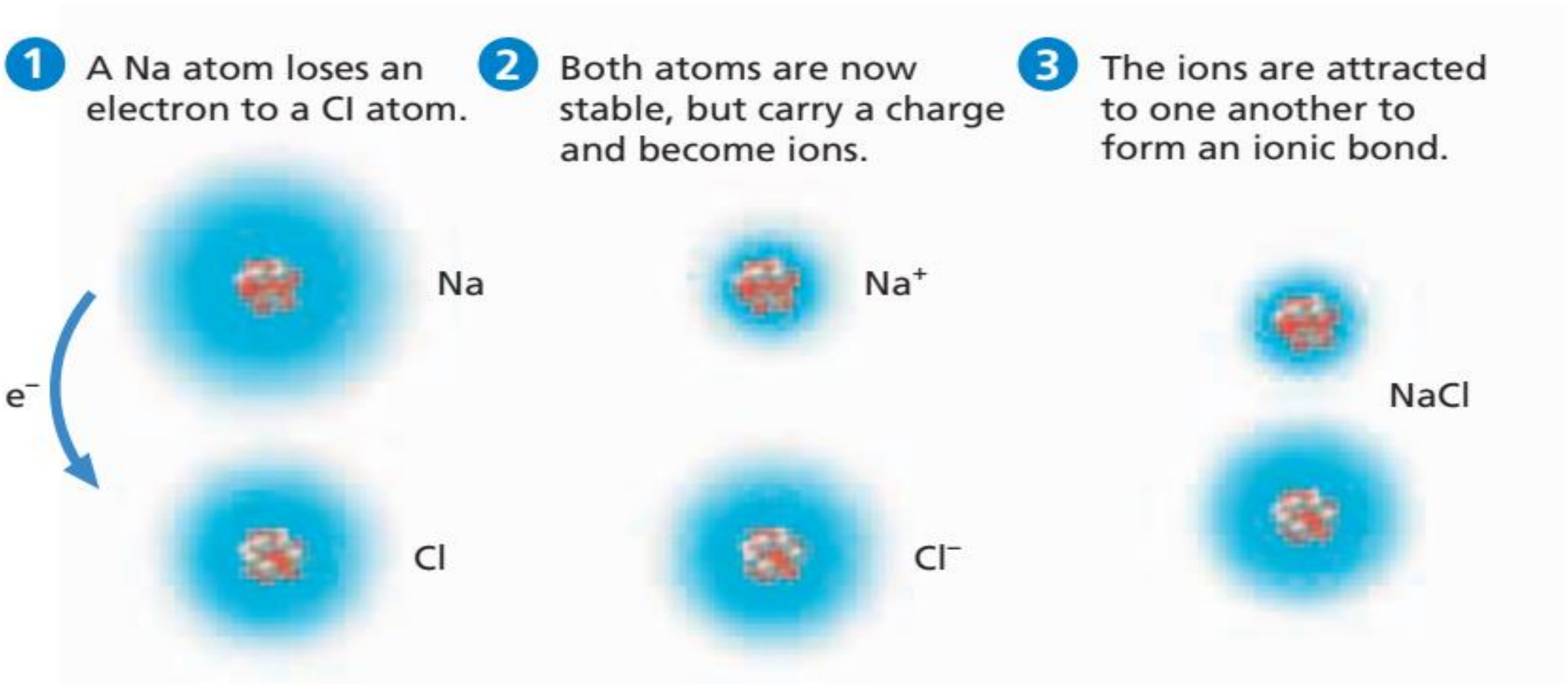
Ionic bonds form when electrons are transferred.

An atom that gains electrons becomes an anion, which stands for a negative ion.

An atom that loses an electron becomes a cation, a positive ion.

Ions such as Cl^-, Na^+, and Ca^{2+} are necessary for normal cell, tissue, and organ function.

Ionic bond



By losing its outermost electron (e), a sodium atom becomes a Na ion.
By gaining one electron, a chlorine atom becomes a Cl ion. Because of their opposite charges, the Na and Cl ions are attracted to each other and form an ionic bond.

Back

Link

Covalent bonds form when atoms share electrons.

The resulting structure is called a molecule.

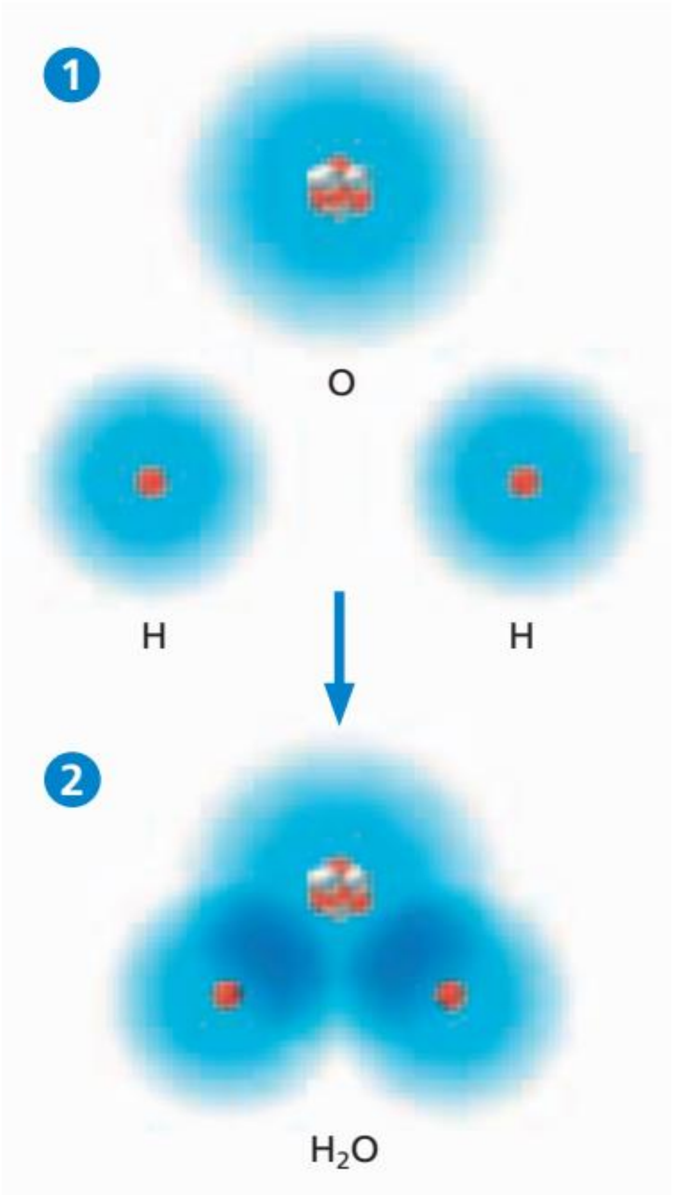
A single covalent bond (–) results when two atoms share one pair of electrons.

A double covalent bond (=) results when two atoms share two pairs of electrons, and a triple covalent bond (≡) results when two atoms share three pairs of electrons.

There are two types of covalent bonds, nonpolar and polar.
This classification is based on whether electrons are shared equally or unequally.

Nonpolar Covalent Bond	Polar Covalent Bond
Electrons shared equally	Electrons shared unequally
Formed between any two atoms that are alike	Formed between any two atoms that are different
Examples: H_2 (H – H) and O_2 (O = O) nonpolar bond ↑ ↑ nonpolar bond	Examples: CO (C = O) and H_2O (H – O – H) polar bond ↑ ↑ ↑ polar bonds

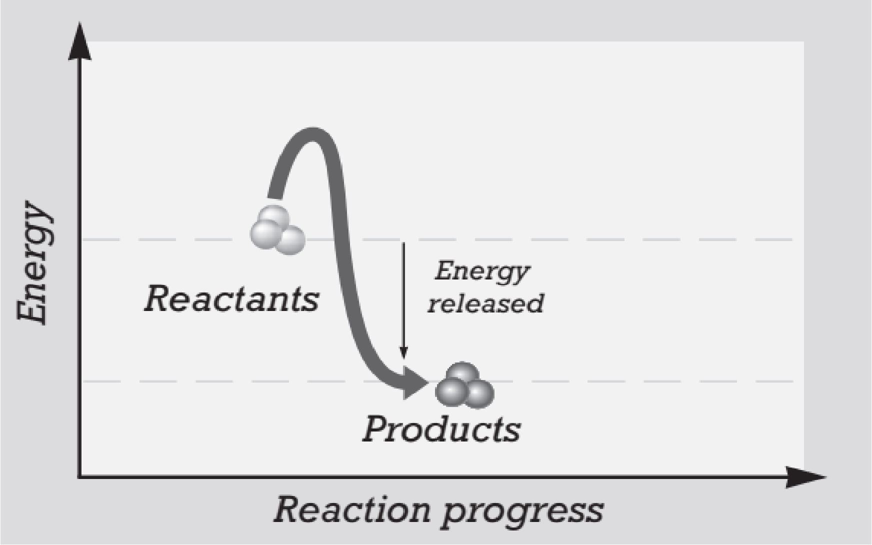
Water

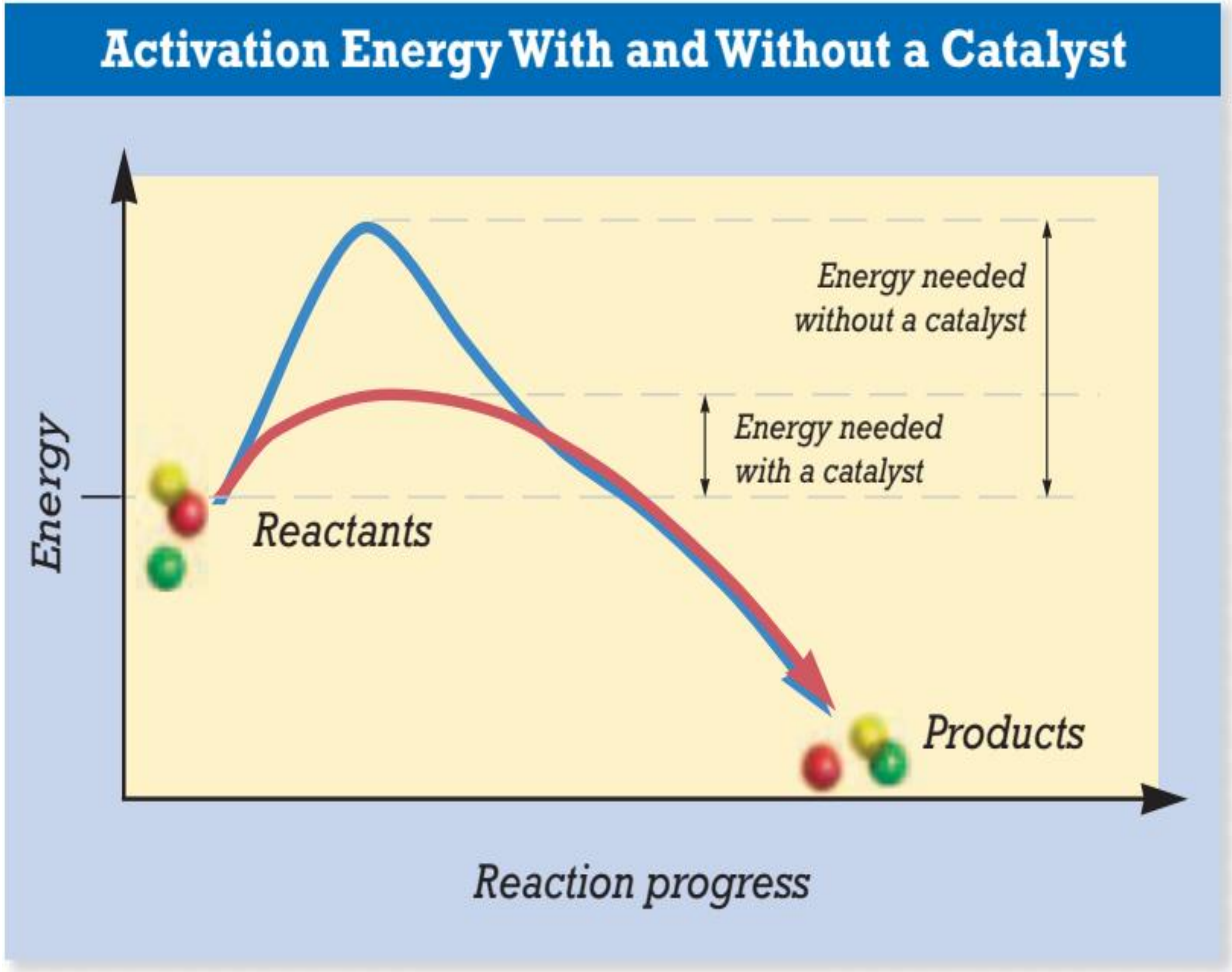


Two atoms of hydrogen and one atom of oxygen share electrons in covalent bonds and thus become stable. Covalent bonding results in the formation of molecules.

Back

Enzymes lower activation energy of reaction





The blue curve shows the activation energy that must be supplied before this reaction can begin. The activation energy can be reduced, as shown by the red curve, by adding a catalyst

Back

Link

Intermolecular Attractions:

Not only do atoms *within* molecules attract each other, but there are also attractions *between* molecules.

There is a variety of these intermolecular attractions. You should know three.

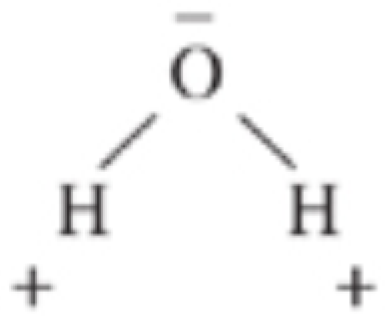
POLAR-POLAR ATTRACTION

When two or more atoms form a bond, the entire resulting molecule is either polar (unbalanced) or nonpolar (balanced).

There are stronger attractions between polar molecules than between nonpolar molecules.

The negative end of one polar molecule attracts the positive end of another polar molecule.

H_2O is a highly polar (unbalanced) molecule. It looks like this:



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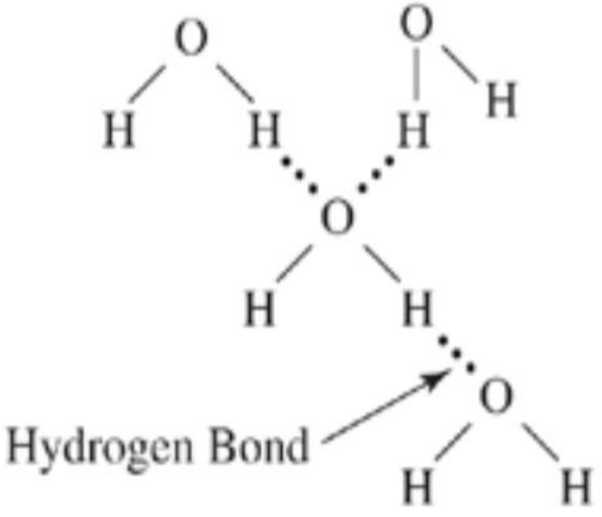
HYDROGEN BONDING

Hydrogen bonding is very important to living things.

- Keeps the two strands of DNA bonded together, forming a double helix.

- Causes water molecules to stick together and is responsible for many special characteristics about water.



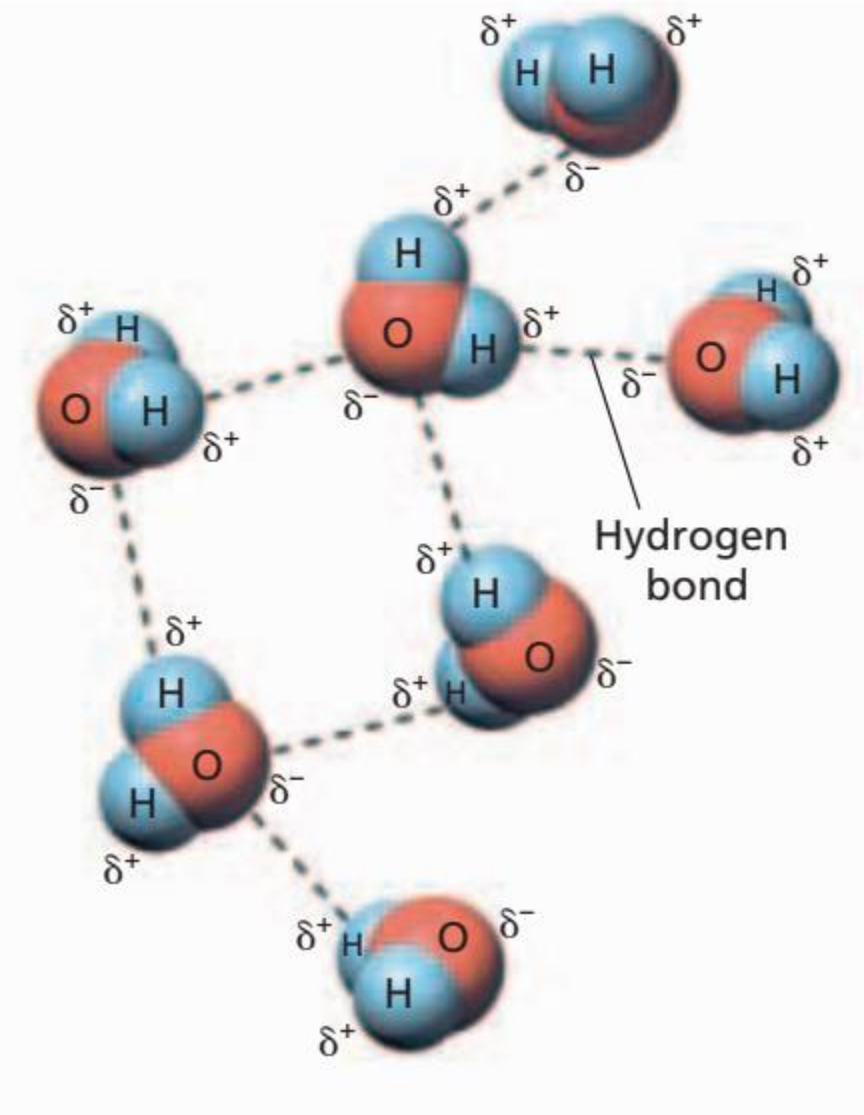
NONPOLAR MOLECULES

Only the weakest attractions (van der Waals) exist between nonpolar molecules.

An example of a nonpolar molecule is CO_2. It is linear and balanced. It looks like this:

$$O = C = O$$

Hydrogen bond



The dotted lines in this figure represent hydrogen bonds. A hydrogen bond is a force of attraction between a hydrogen atom in one molecule and a negatively charged region or atom in a second molecule.

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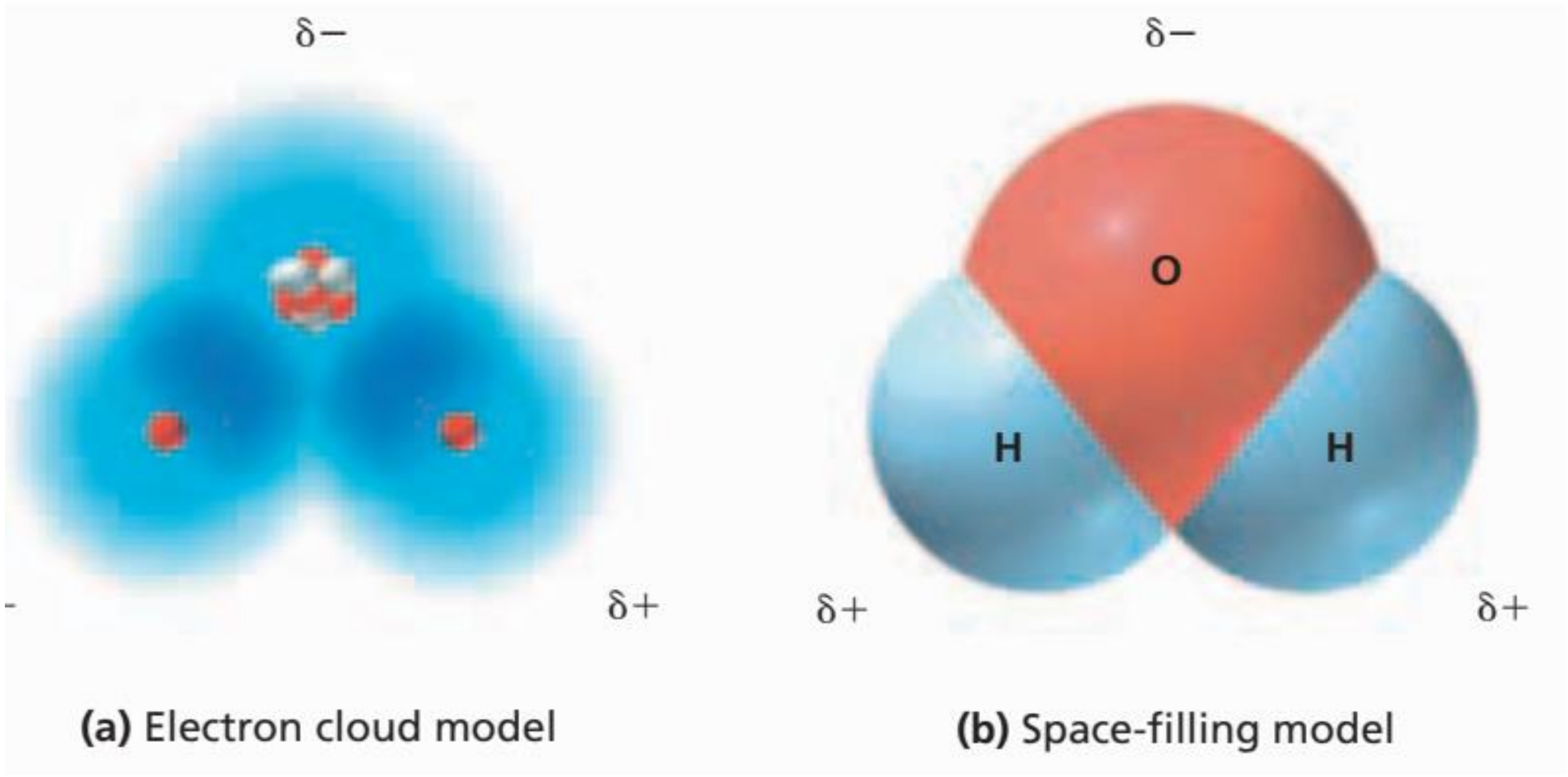
Water



The oxygen region of the water molecule is weakly negative, and the hydrogen regions are weakly positive. Notice the different ways to represent water, H_2O. You are familiar with the electron cloud model (a). The space filling model (b) shows the three dimensional structure of a molecule.

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HYDROPHOBIC AND HYDROPHILIC

Hydrophobic means “water hating” or “repelled by water.”

Hydrophilic means “water loving” or “attracted to water.”

Substances that are polar will dissolve in water, while substances that are nonpolar will not dissolve in water.

Remember: like dissolves like.

You are familiar with an open can of soda that quickly loses its fizziness.
This is because **carbon dioxide**, a nonpolar molecule that gives soda pop its fizziness, does not dissolve in water, which is polar.

So gas escapes when you open a can of soda pop and it goes flat.

Link

Lipids, which are nonpolar, are hydrophobic and do not dissolve in water, which is why oil and vinegar salad dressing separates upon standing.

Since the plasma membrane is a phospholipid bilayer, only nonpolar substances can readily dissolve through the plasma membrane.

Large polar molecules cannot diffuse across a plasma membrane.

They can only travel across a membrane through special hydrophilic (protein) channels.

Thank you

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EST2-ACT2- Biology

Coursework

2024-2025

Dr. Mohamed Kabbany

Chapter 1

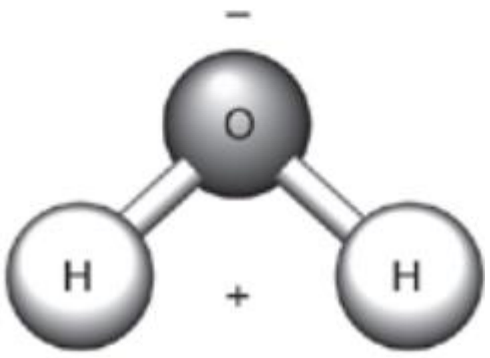
Cellular and Molecular Biology

Lesson 1.2.3

Biochemistry

- **CHARACTERISTICS OF WATER**

CHARACTERISTICS OF WATER



Water is asymmetrical and very polar.

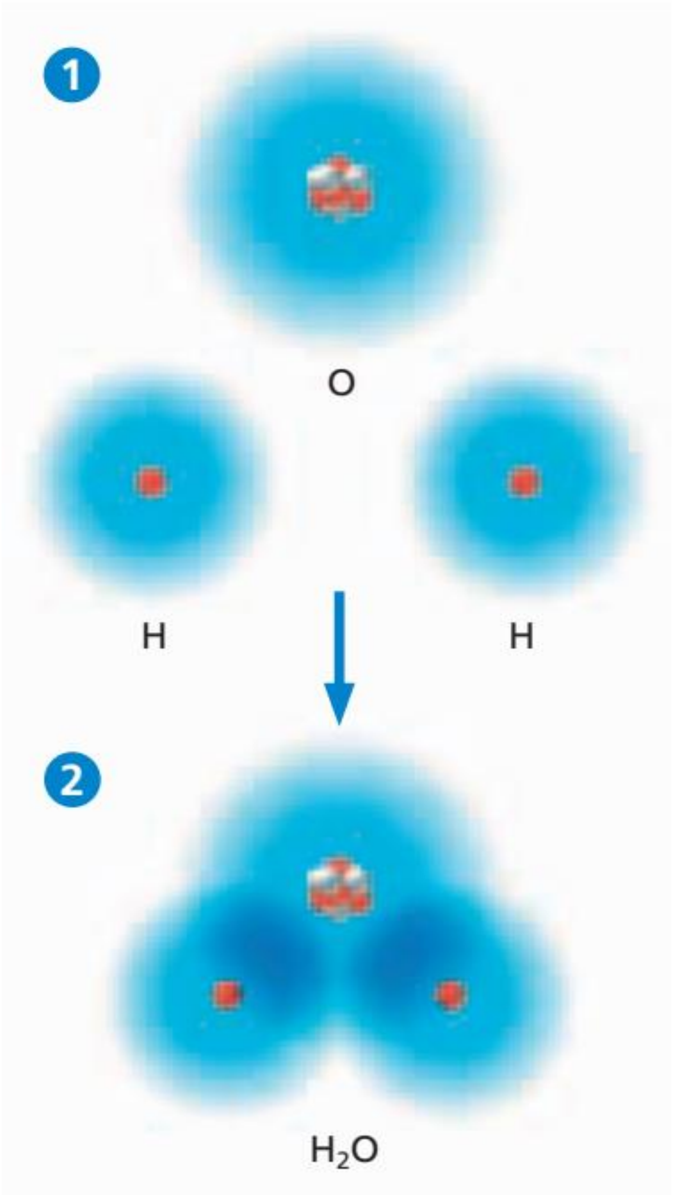
It also has strong intermolecular attractions.

In addition to polar attractions, water exhibits strong hydrogen bonding

Together, these two forces are responsible for the special characteristics of water that affect life on Earth.

1. WATER HAS A HIGH SPECIFIC HEAT.
2. WATER HAS A HIGH HEAT OF VAPORIZATION.
3. WATER HAS HIGH ADHESION PROPERTIES
4. WATER IS THE UNIVERSAL SOLVENT.
5. WATER EXHIBITS STRONG COHESION TENSION.
6. ICE FLOATS BECAUSE IT IS LESS DENSE THAN WATER

Water



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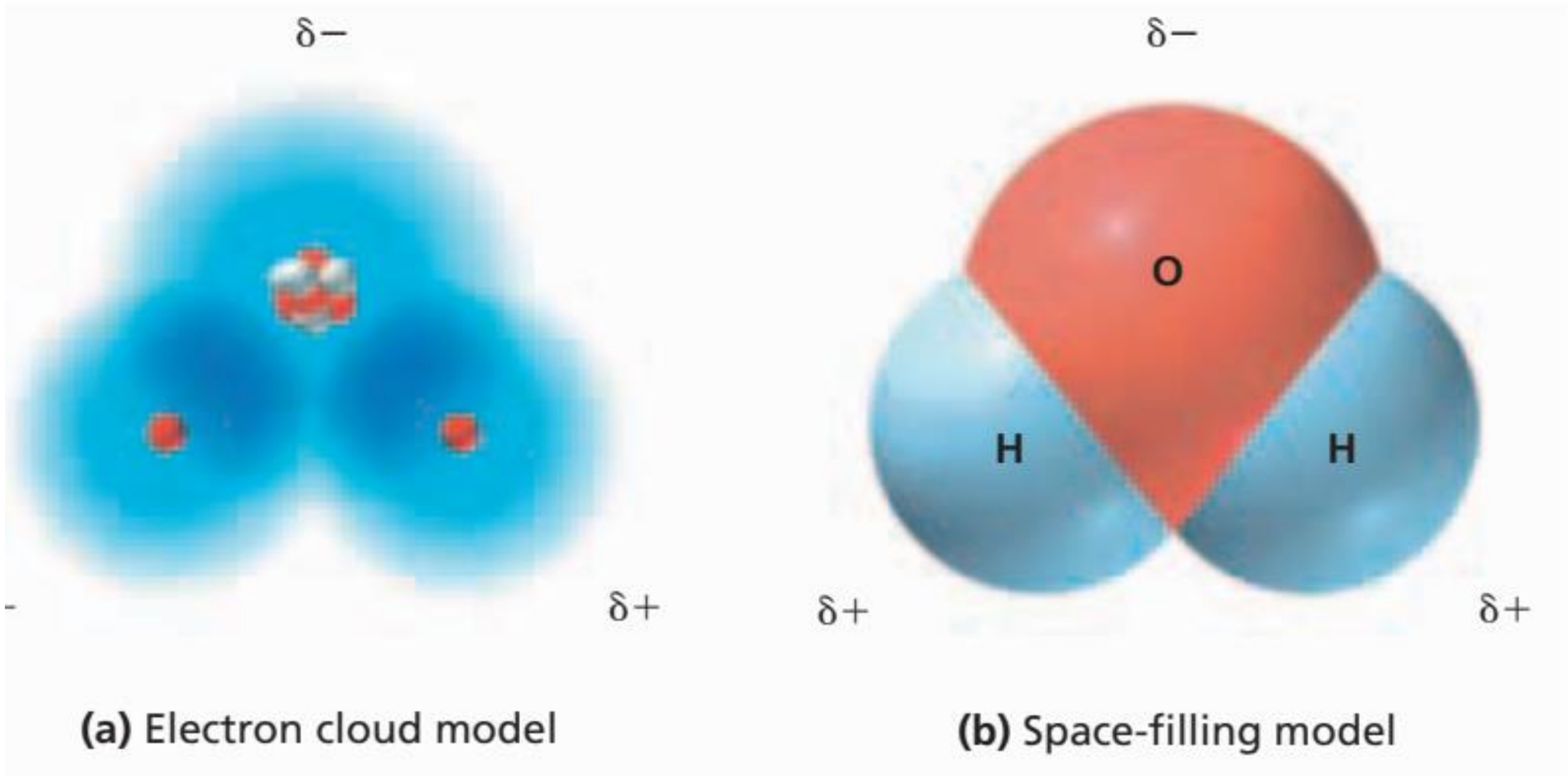
Water



The oxygen region of the water molecule is weakly negative, and the hydrogen regions are weakly positive.
Notice the different ways to represent water, H_2O. You are familiar with the electron cloud model (a).
The space filling model (b) shows the three dimensional structure of a molecule.

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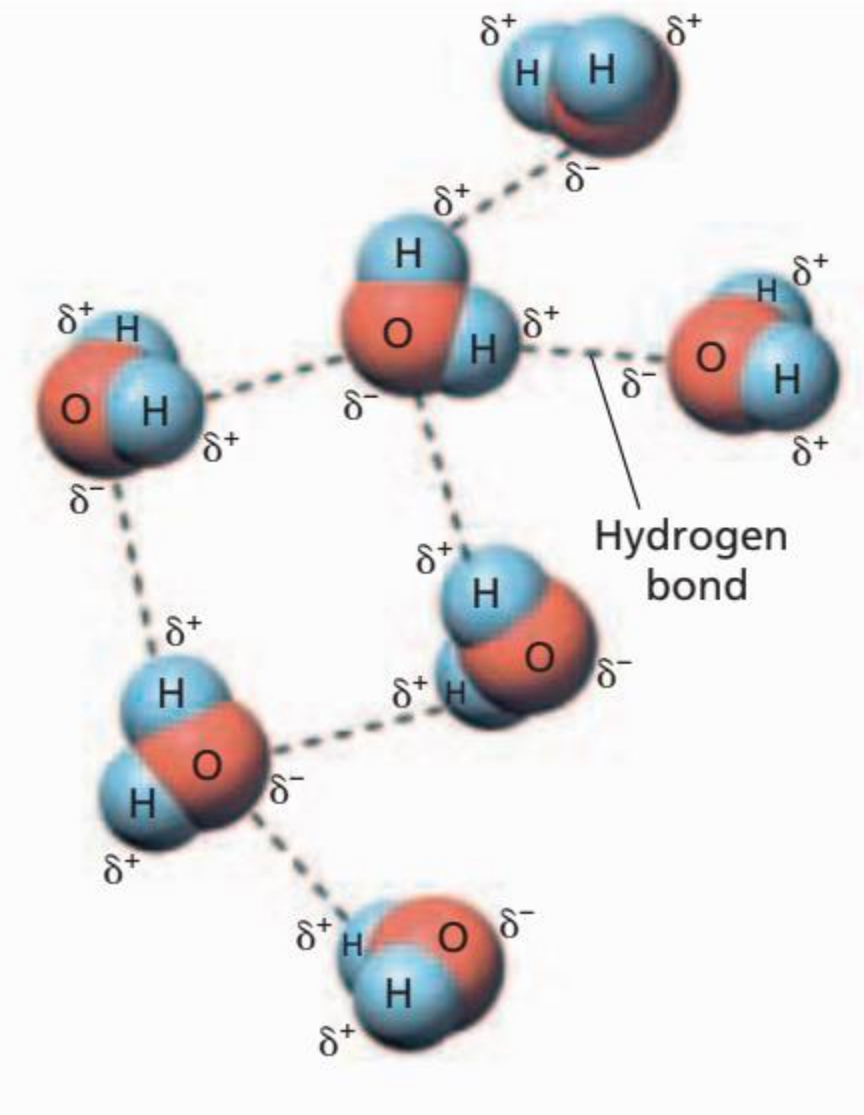
Hydrogen bond



The dotted lines in this figure represent hydrogen bonds. A hydrogen bond is a force of attraction between a hydrogen atom in one molecule and a negatively charged region or atom in a second molecule.

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1.WATER HAS A HIGH SPECIFIC HEAT.

Specific heat is the amount of heat that must be absorbed in order raise the temperature of 1 gram of a substance 1° Celsius (or 1° Kelvin).

This means that large bodies of water, like oceans, absorb a lot of heat and resist changes in temperature.

As a result, they provide a stable environment for the organisms that live in them.

Also, coastal areas exhibit relatively little temperature change because the oceans moderate their climates.

Water forms about two thirds of your body mass.
This is the reason your body resists change in temperature in different climate. An important element of homeostasis, keeping your internal environment constant by keeping temperature suitable for vital processes in the body.

All life processes in your body are controlled by enzymes. Enzymes are proteins that are denatured by temperature. Water by its high specific heat, resists temperature changes in your body .

Keep for a while in the sun by your car and look how the metal gets hot and you do not.

2.WATER HAS A HIGH <u>HEAT OF VAPORIZATION</u>.

This means that a relatively great amount of heat is needed to evaporate water.

As a result, evaporation of sweat significantly cools the body surface.

That is why we make cold fomentation of water to a person in fever.

3.WATER HAS HIGH <u>ADHESION</u> PROPERTIES

Adhesion is the clinging of one substance to another, the force of attraction between the molecules of water and the walls of the container.

That is the reason of the crescent appearance of the surface of the water in test tubes.

It it plays an important role in plant survival.

Forces of adhesion contribute to capillary action, which helps water flow up from the roots of a plant to the leaves.

4.WATER EXHIBITS STRONG COHESION TENSION.

This means that molecules of water tend to stick to each other.

This results in several biological phenomena.

Water moves up a tall tree from the roots to the leaves without the expenditure of energy by what is referred to as transpirational-pull cohesion tension.

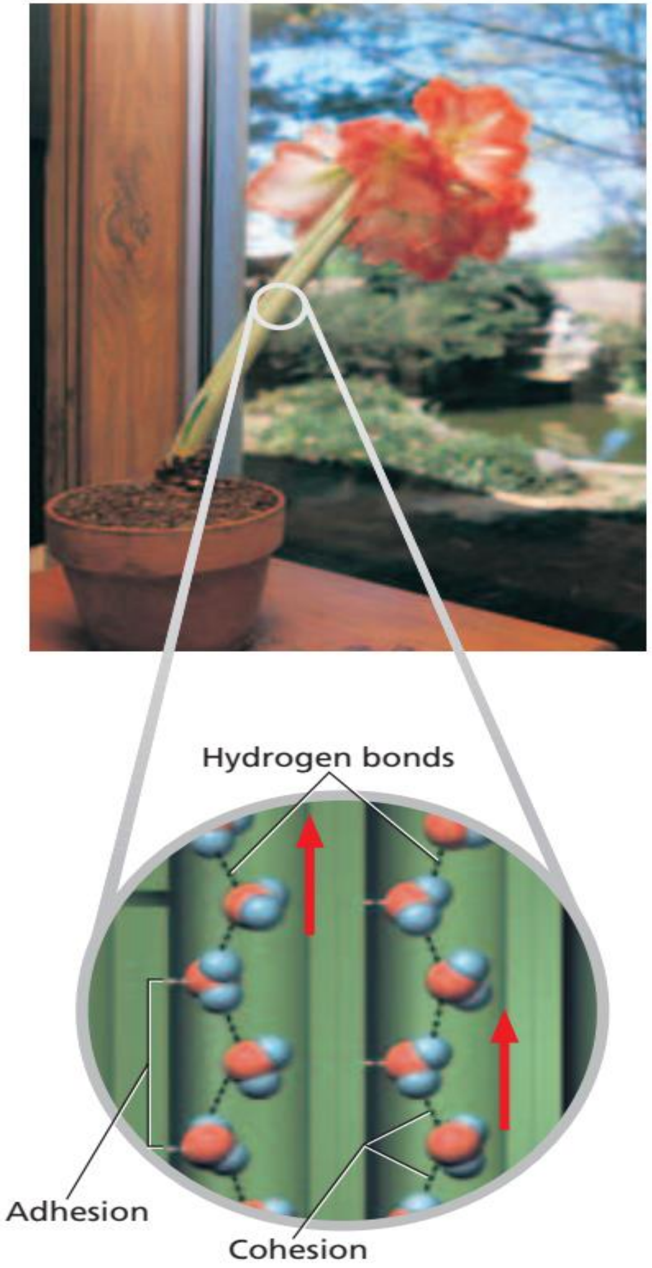
It also results in surface tension that allows insects to walk on water without breaking the surface.

5.WATER IS THE UNIVERSAL SOLVENT.

Because water is a highly polar molecule, it dissolves all polar and ionic substances

That is a vital property of water in the cytoplasm and body fluids.

Cohesion, adhesion, and capillarity



Cohesion, adhesion, and capillarity contribute to the upward movement of water from the roots of plants.

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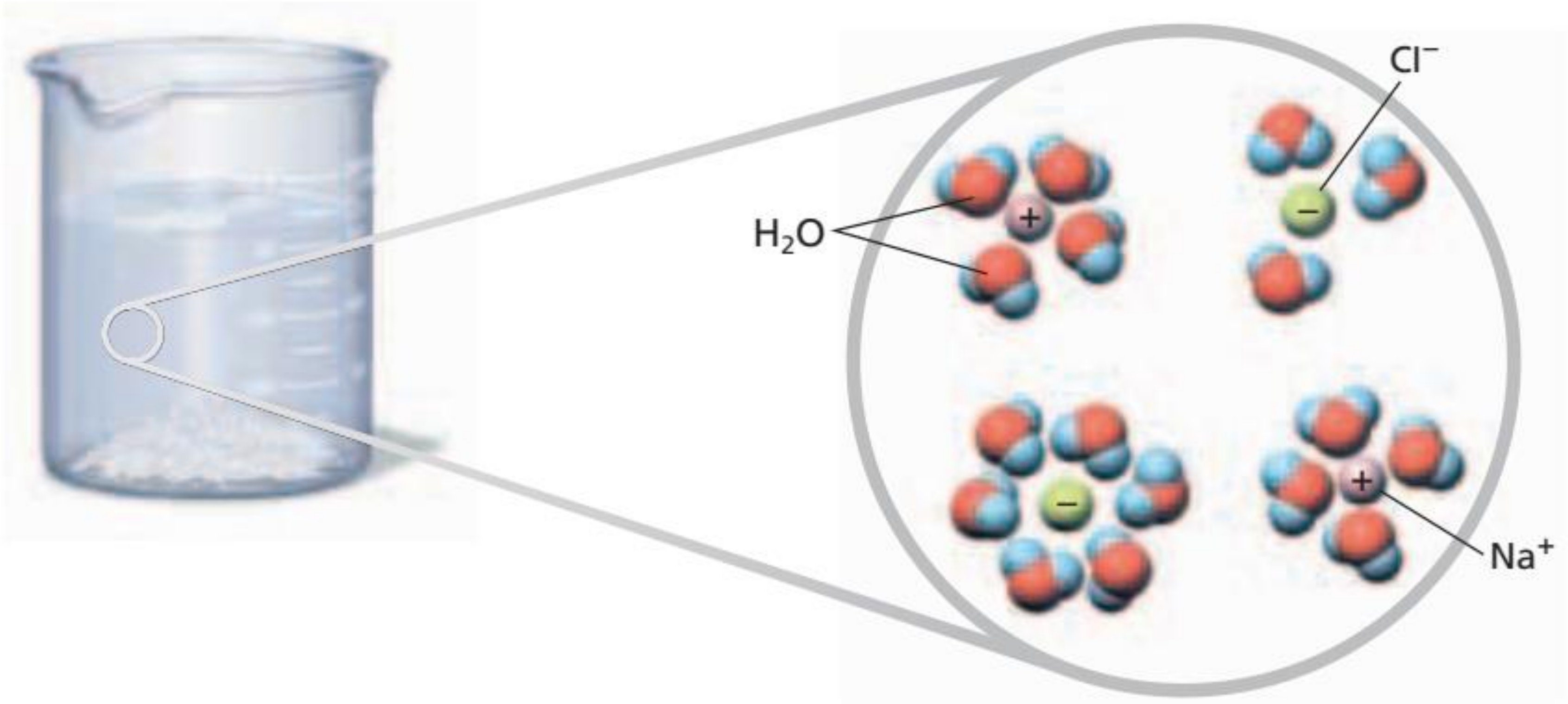
Water is a good solvent



The positive region of a water molecule attracts the negative region of an ionic compound, such as the Cl portion of NaCl. Similarly, the negative region of the water molecule attracts the positive region of the compound—the Na portion of NaCl. As a result, NaCl breaks apart, or dissolves, in water

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6. <u>ICE FLOATS</u> BECAUSE IT IS LESS DENSE THAN WATER

In a deep body of water, floating ice insulates the liquid water below it, allowing life to exist beneath the frozen surface during cold seasons.

The lowest density of water is at 0° *C*. → Floats at the surface of the ice lakes and cold oceans.
The highest density of water is at 4° *C*. →Settles down at the bottom of them

Besides ice is a very weak conductor, it keeps the beneath water from the effect of the subzero temperature in the very cold environment, sometimes at -50° *C,* giving a chance for life in cold oceans.

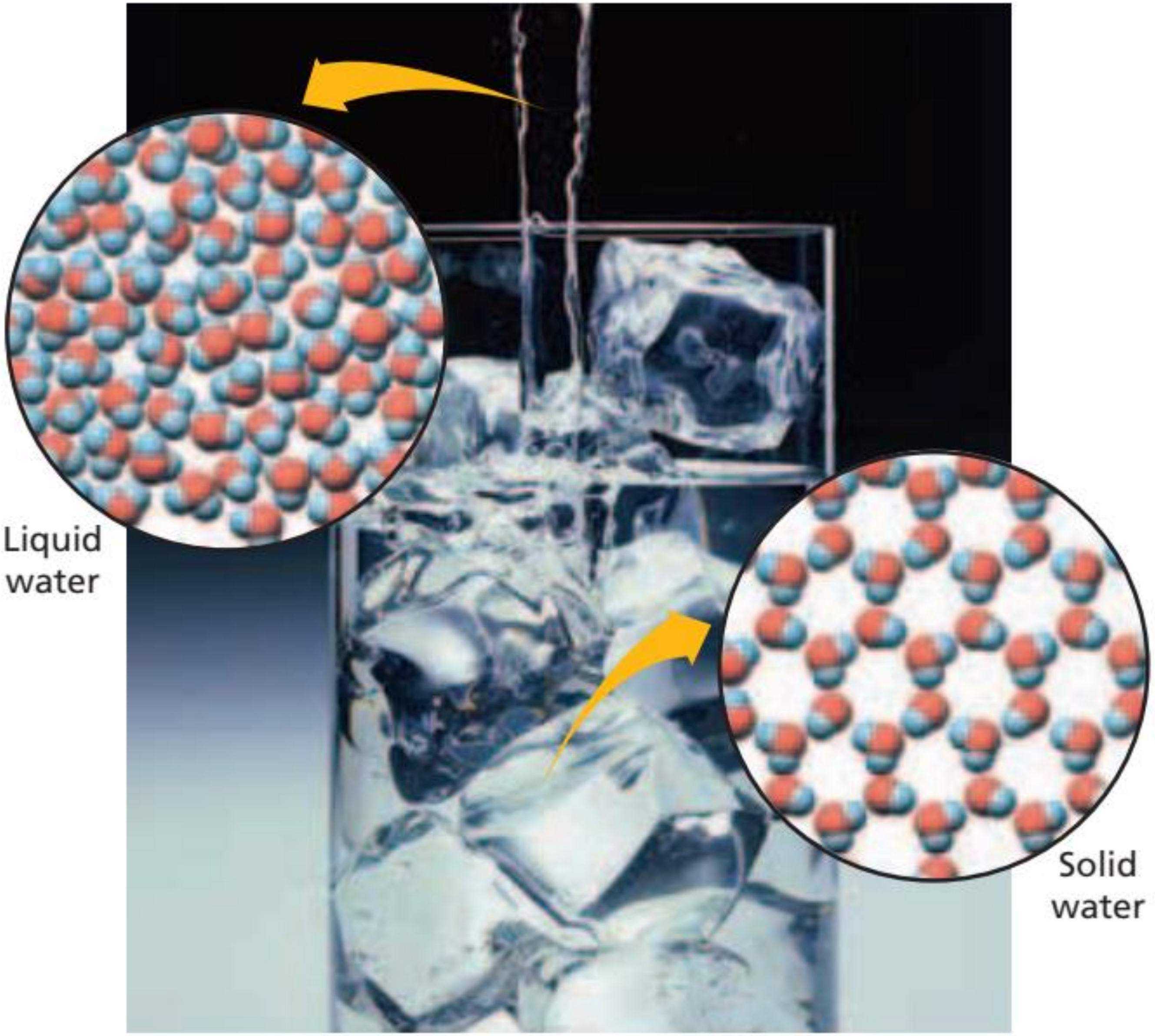
The fact that ice covers the surface of water in a lake in the cold months and melts in the spring results in a stratification of the lake during the winter and considerable mixing in the spring.

In the spring, surface ice melts, becomes denser water, and sinks to the bottom of the lake, causing water to circulate throughout the lake.

Oxygen from the surface is returned to the depths, and nutrients released by the activities of bottom-dwelling bacteria are carried to the upper layers of the lake.

This cycling of the nutrients in the lake is known as the spring overturn and is necessary to the health of a lake.

Ice is less dense



Ice (solid water) is less dense than liquid water because of the structure of ice crystals. The water molecules in ice are bonded to each other in a way that creates large amounts of open space between the molecules, relative to liquid water.

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Coursework

2024-2025

Dr. Mohamed Kabbany

Chapter 1

Cellular and Molecular Biology

Lesson 1.2.4

Biochemistry

- **pH**

Discussion:

Hydrogen burns in oxygen to give water. This is a one way reaction.

$$2H_2 + O_2 \xrightarrow{\Delta} 2\,H_2O$$

Nitrogen, under certain conditions of temperature and pressure, combines with Hydrogen to give ammonia.

The reaction is reversible. This means some products split to form reactants.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

At the beginning of the reaction only H2 and N2 are present. Then the product NH3 is produced.
By time concentration of N2 and H2 decrease and concentration of products increase till they reach a state of equilibrium where there is a fixed ratio of products to reactants. It is a dynamic equilibrium.

Acids are acids because dissolve in water giving H^+ ions.

H^+ ion is a proton. It cannot exist alone. So it is carried by water molecules to give hydronium ions $(H^3O)^+$

Strong acids dissociates nearly completely   It is a one way reaction.

Examples of strong acids are: HCl, H_2SO_3, H_2SO_4, and $HNO_{3....}$

$$HCl \longrightarrow H^+ + Cl^-$$

$$HCl + H_2O \longrightarrow (H_3O)^+ + Cl^-$$

$$H_2SO_4 + H_2O \longrightarrow 2(H_3O)^+ + (SO_4)^-$$

Alkalis are alkalis because dissolve in water giving $(OH)^-$ ions.

Strong alkalis dissociates nearly completely It is a one way reaction.

Examples of strong alkalis are: LiOH, NaOH, KOH, $Ca(OH)_2$, Etc… ….

$$NaOH \longrightarrow Na^+ + (OH)^-$$

$$KOH \longrightarrow K^+ + (OH)^-$$

$$Ca(OH) \longrightarrow Ca^+ + 2(OH)^-$$

Reactions are irreversible and reversible:

Hydrogen burns in oxygen to give water. This is a one way reaction, Irreversible.

$$2H_2 \quad + \quad O_2 \quad \xrightarrow{\Delta} \quad 2\ H_2O$$

Nitrogen, under certain conditions of temperature and pressure, combines with Hydrogen to give ammonia.
Some ammonia dissociates to form Nitrogen and Hydrogen again. This a reversible reaction.
Finally the reaction reaches a state of kinetic equilibrium where rate of forward reaction = rate of reversible reaction.
At this point each of the reactants loses a portion of its concentration to form products.
Suppose a one mole of N2 and 3 moles of H2 react. Each loses an [x] mole to form [x] mole of NH3

$$N_2 \quad + \quad 3H_2 \quad \rightleftharpoons \quad 2HH_3$$

Substances that dissociate in water to its components are called electrolyte.

Strong electrolytes dissociate completely. Examples are ionic salts, strong acids and strong alkalis.

$$NaCl \longrightarrow Na^+ + Cl^-$$

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

$$NaOH \longrightarrow Na^+ + (OH)^-$$

Substances that dissociate in water to its components are called electrolyte.

Weak electrolytes dissociate partially. Examples are weak salts, weak acids and weak alkalis.

$$NaHCO_3 \rightleftharpoons Na^+ + (HCO_3)$$

$$CH_3COOH + H_2O \rightleftharpoons (H_3O)^+ + (CH_3COOH)^-$$

Acetic acid, a weak acid

$$NH_4OH \rightleftharpoons (NH_4)^+ + (OH)^-$$

Ammonium hydroxide, a weak alkali

Water is a very weak electrolyte, i.e. a very small portion of water dissociates to form ions.

Only 10^{-7} of molecules of water dissociates to give H ions $(H)^+$ and OH ions $(OH)^-$.

$$H_2O \rightleftharpoons H^+ + (OH)^-$$

1 mole - 10^{-7}moles 10^{-7}moles 10^{-7}moles

An acid is acid as it gives H+ ions

An alkali is alkaline as it gives OH- ions

Water is neutral because $H^+ = (OH)^-$

H^+

Each mole of water contains 10^{-7}moles of H^+ and 10^{-7}moles of $(OH)^-$

So hydrogen ion concentration $[H^+]$ in water = 10^{-7}

Link

What is p.H

pH is a measure of acidity (H+) and alkalinity (OH-) of a solution.

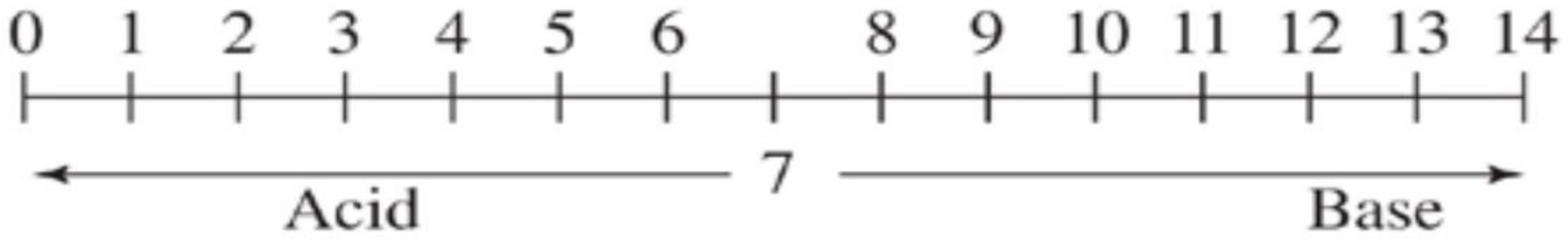
It is the negative logarithm of the hydrogen ion concentration in moles per liter. $pH.=-log [H^+]$

As the concentration of H^+ increases, the pH decreases

A substance with a pH of 7 is neutral, like pure water.

Anything with a pH of less than 7 is acidic

Anything with a pH value greater than 7 is alkaline or basic.

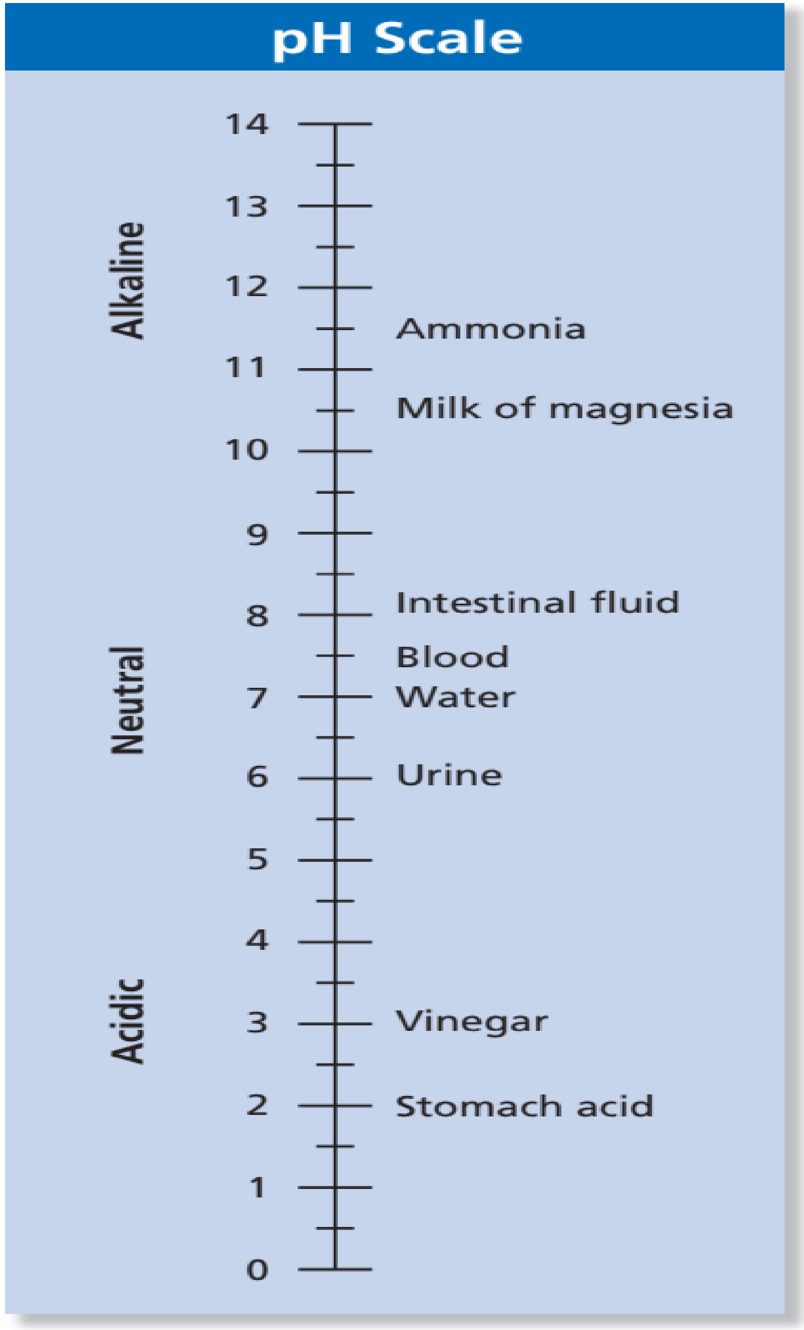


Link

As shown in the table, a solution of pH 1 is 10 times more acidic than a solution with a pH of 2, and 100 times more acidic than a solution with a pH of 3.
It is 1,000 times more acidic than a solution with a pH of 4.

pH	Concentration of H+ ions in Moles per Liter
1	1×10^{-1} molar = 0.1 molar
2	1×10^{-2} molar = 0.01 molar
3	1×10^{-3} molar = 0.001 molar
4	1×10^{-4} molar = 0.000 1 molar
7	1×10^{-7} molar = 0.000 000 1 molar
13	1×10^{-13} molar = 0.000 000 000 000 1 molar

pH scale



Some of your body fluids are acidic, and others are alkaline. A solution with a pH above 7 is alkaline, and a solution with a pH below 7 is acidic. Each unit on the pH scale reflects a 10-fold change in acidity or alkalinity

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Link

The pH of some common substances

Substance	pH
Stomach acid	2
Orange juice 3.5	3.5
Carbonated drinks 3.0	3.0
Acid rain <5.6	<5.6
Milk 6.5	6.5
Human blood 7.4	7.4
Seawater	8.5

Acid rain

Sulfur dioxide, SO_2, which is produced when fossil fuels are burned, reacts with water in the atmosphere to produce acid precipitation. Acid precipitation, or acid rain, can make lakes and rivers too acidic to support life and can even corrode stone, such as the face of this statue.

Back

The internal pH of most living cells is close to 7.
Even a slight change can be harmful.

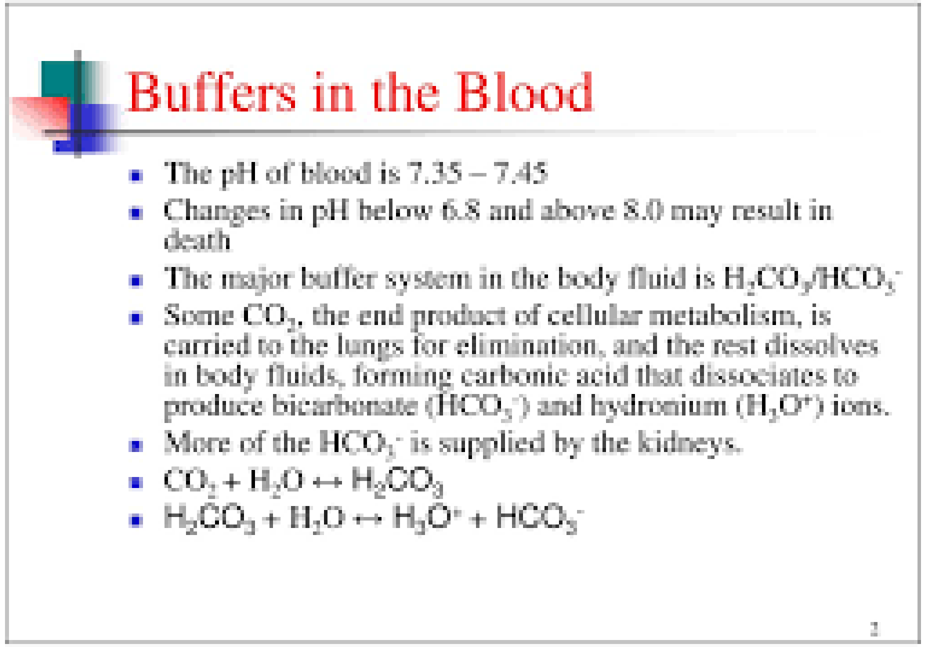
Biological systems regulate their pH through the presence of **buffers**, substances that resist change in pH. Link

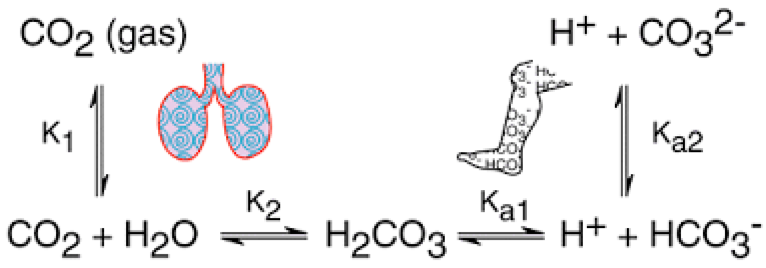
A buffer works by absorbing excess hydrogen ions or donating hydrogen ions when there are too few.

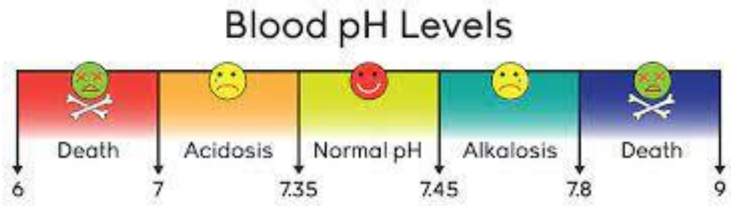
The most important buffer in human blood is the bicarbonate ion (HCO^{3-}).

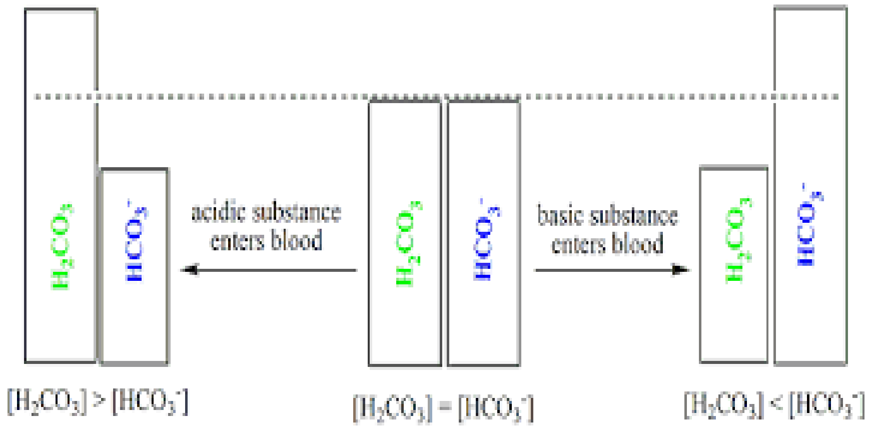
Acid rain, which results from certain pollutants in the air (like SO_2, SO_4, and CO_2), has caused damage and destruction to many lakes and stone architecture worldwide. Link

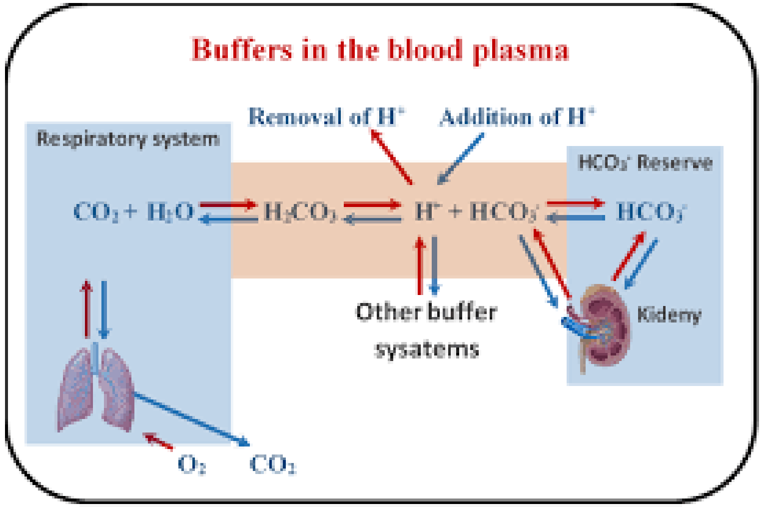
Buffers in the blood

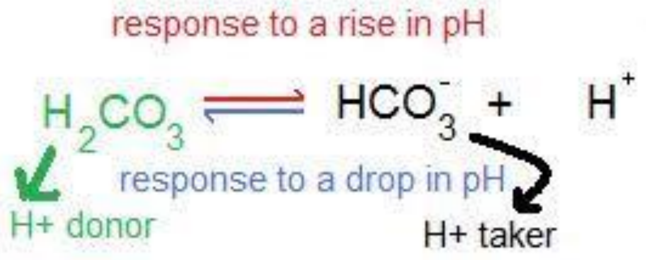












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Complete the table and find the pH of the following solutions:

H^+ concentration , $[H^+]$	pH	
10^{-1}	1	acidic
10^{-2}		
10^{-4}		
10^{-6}		
10^{-7}		
10^{-8}		
10^{-10}		
10^{-11}		
10^{-14}		
$1\ (10^{-0})$		

Thank you

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2023-2024

Dr. Mohamed Kabbany

Chapter 1

Cellular and Molecular Biology

Lesson 1.2.5

Biochemistry

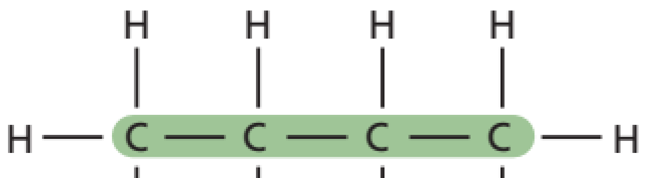
- **Organic compounds**

ORGANIC COMPOUNDS

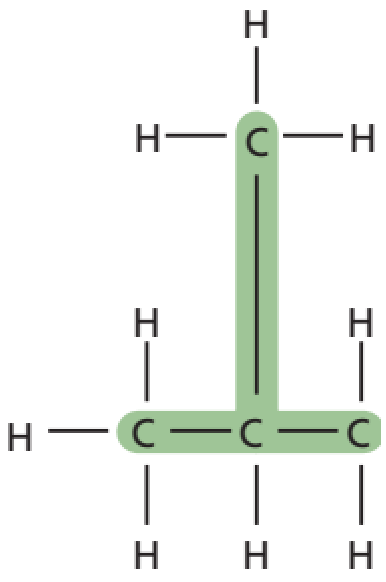
Organic compounds are compounds that contain carbon.

There are four classes of organic compounds in the body: carbohydrates, lipids, proteins, and nucleic acids.

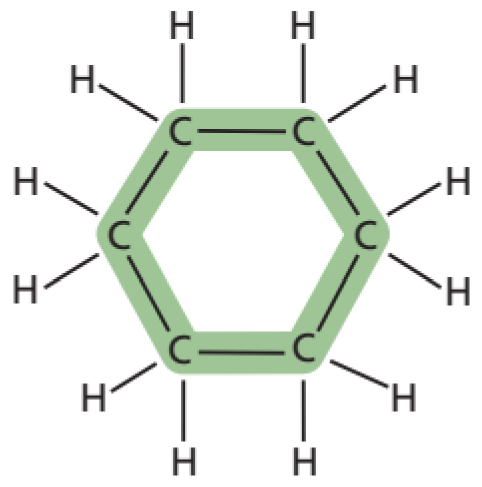
hydrocarbons



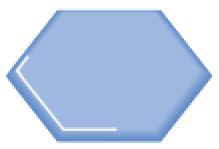
Straight carbon chain



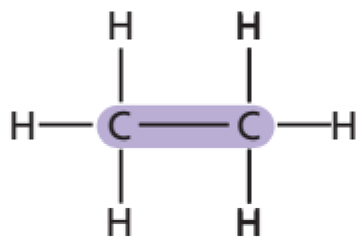
Branched carbon c



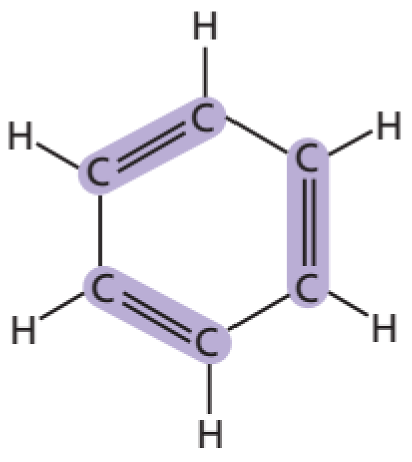
Carbon ring



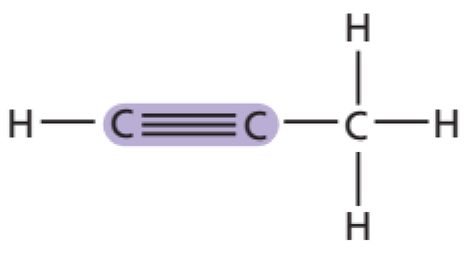
Simplified view of a carbon ting



(a)



(b)



(c)

Carbon atoms can form single (a), double (b), or triple (c) bonds. Organic molecules can have many different shapes and patterns of bonding.

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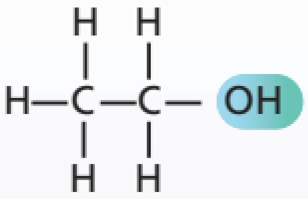
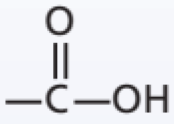
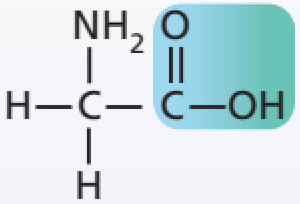
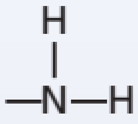
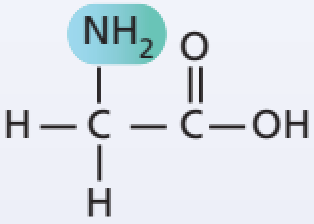
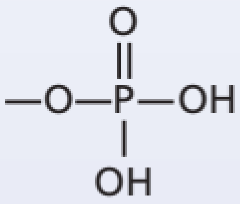
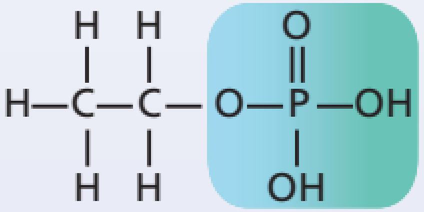
Common Functional Groups

Functional group	Structural formula	Example
Hydroxyl	—OH	
Carboxyl		
Amino		
Phosphate		

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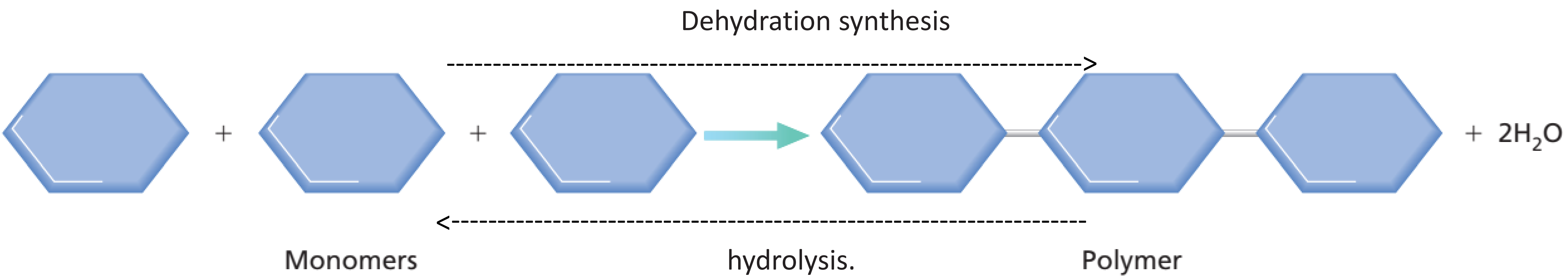
Monomers combine to form polymers

Polymers hydrolyze to form Monomers



Remember:

A polymer is the result of bonding between monomers. In this example, each monomer is a six-sided carbon ring. The starch in potatoes is an example of a molecule that is a polymer.

Some more details

ORGANIC CHEMISTRY

Organic chemistry may be defined simply as the chemistry of the compounds of carbon.
Since Friedrich Wöhler synthesized urea in 1828, chemists have synthesized thousands of carbon compounds in areas of dyes, plastic, textile fibers, medicines, and drugs.
The number of organic compounds has been estimated to be in the neighborhood of a million and constantly increasing.

Carbon atom

The carbon atom (atomic number 6) has four electrons in its outermost energy level, which show a tendency to be shared (electronegativity of 2.5) in covalent bonds.
By this means, carbon bonds to other carbons, hydrogens, halogens, oxygen, and other elements to form the many compounds of organic chemistry.

HYDROCARBONS

Hydrocarbons, as the name implies, are compounds containing only carbon and hydrogen in their structures.

The simplest hydrocarbon is methane, CH4.
This type of formula, which shows the kinds of atoms and their respective numbers, is called an **empirical** formula.

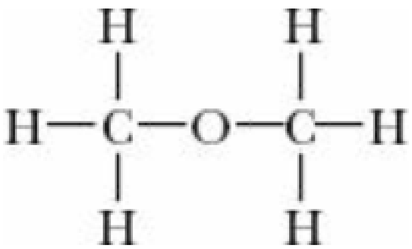
In organic chemistry this is not sufficient to identify the compound it is used to represent.

For example, the empirical formula C_2H_6O could denote either an ether or an ethyl alcohol.

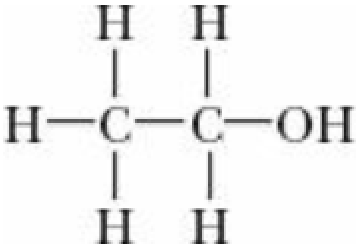
For this reason, a **structural** formula is used to indicate how the atoms are arranged in the molecule.

The ether of C_2H_6O looks like this:

The ether of C_2H_6O looks like this:

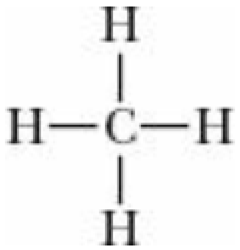


The alcoho of C_2H_6O looks like this:



For this, structural formulas are more often used than empirical formulas in organic chemistry.

The structural formula of methane is



Alkane Series (Saturated)

Alkanes are saturated hydrocarbons made up of carbon and max number of hydrogen atoms.

Methane is the first member of **alkanes** (or paraffin series).

The general formula for this series is C_nH_{2n+2}, where *n* is the number of carbons in the molecule.

As the number of carbons in the chain increases, the boiling point also increases.

The first four alkanes are gases at room temperature; the subsequent compounds are liquid, then become more viscous with increasing length of the chain.

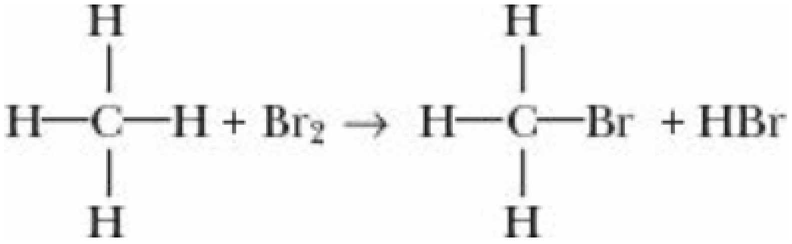
The alkanes are found in petroleum and natural gas.

They are usually extracted by fractional distillation, which separates the compounds by varying the temperature so that each vaporizes at its respective boiling point.

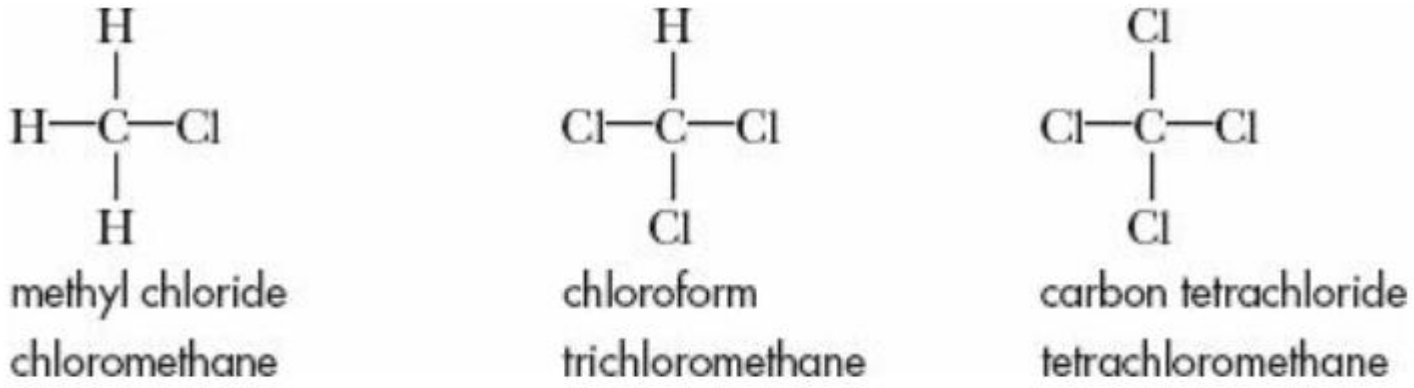
When the alkanes are burned with sufficient air, the compounds formed are CO_2 and H_2O.
An example is:

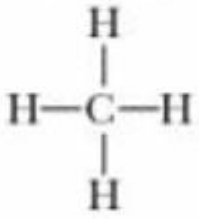
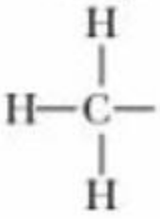
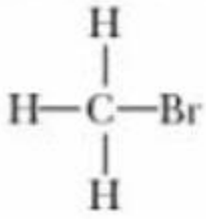
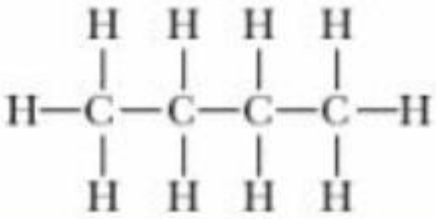
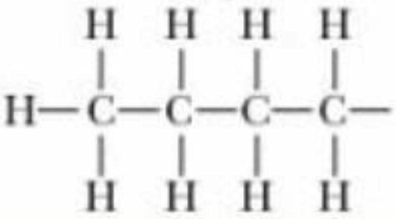
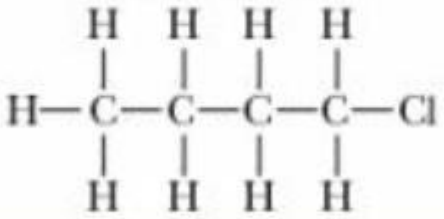
$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$$

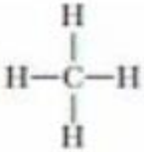
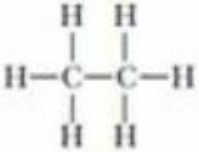
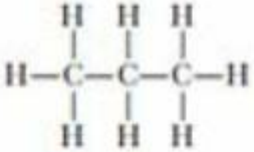
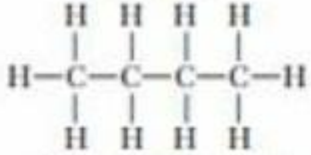
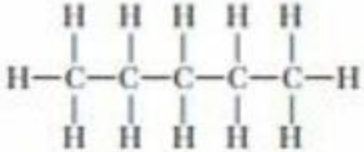
The alkanes can be reacted with halogens so that hydrogens are replaced by a halogen atom:
These are called **alkyl halides**.



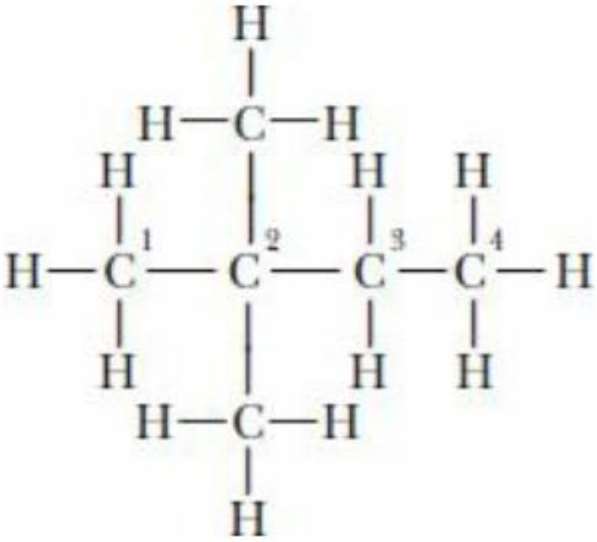
Some common substitution compounds of methane are:



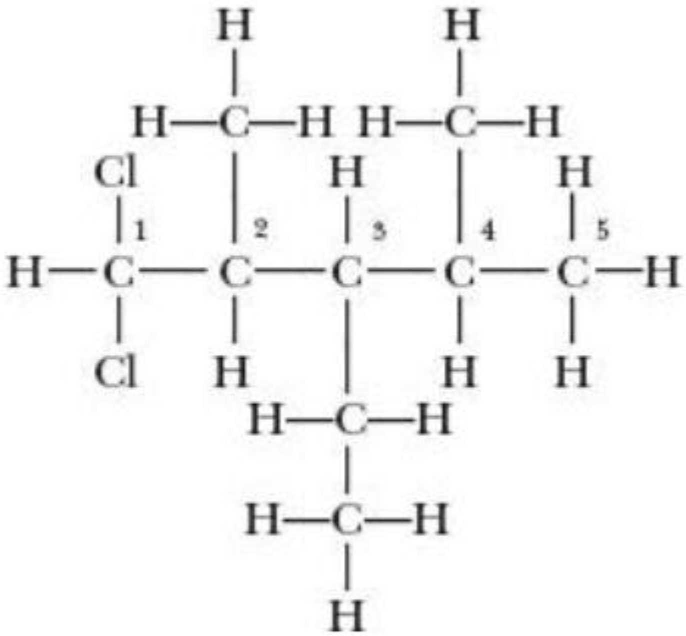
Alkane	Alkyl Group	Compounds
methane 	methyl 	bromomethane 
butane 	butyl 	1-chlorobutane 

IUPAC Name	Molecular Formula	Number of Structural Isomers	Structure	State at Room Temperature	Boiling Point (°C)
Methane	CH_4	1		Gas	–162
Ethane	C_2H_6	1		Gas	–89
Propane	C_3H_8	1		Gas	–42
n-Butane	C_4H_{10}	2		Gas	0
n-Pentane	C_5H_{12}	3		Liquid (*Note:* Solids at 17 carbons in the chain.)	36
n-Hexane	C_6H_{14}	5	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$	Liquid	69
n-Heptane	C_7H_{16}	7	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$	Liquid	98
n-Octane	C_8H_{18}	18	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$	Liquid	126
n-Nonane	C_9H_{20}	35	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$	Liquid	151
n-Decane	$C_{10}H_{22}$	75	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$		174

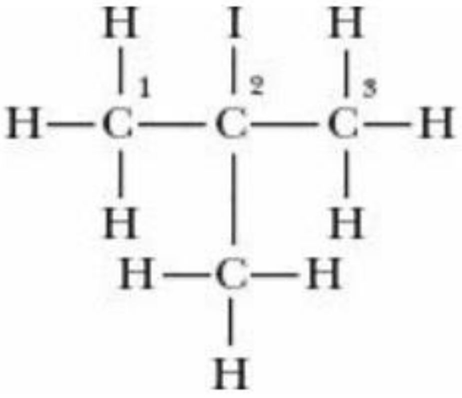
EXAMPLE 1 2,2-dimethylbutane



1,1-dichloro-3-ethyl-2,4-dimethylpentane



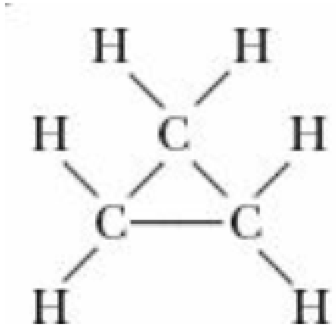
2-iodo-2-methylpropane

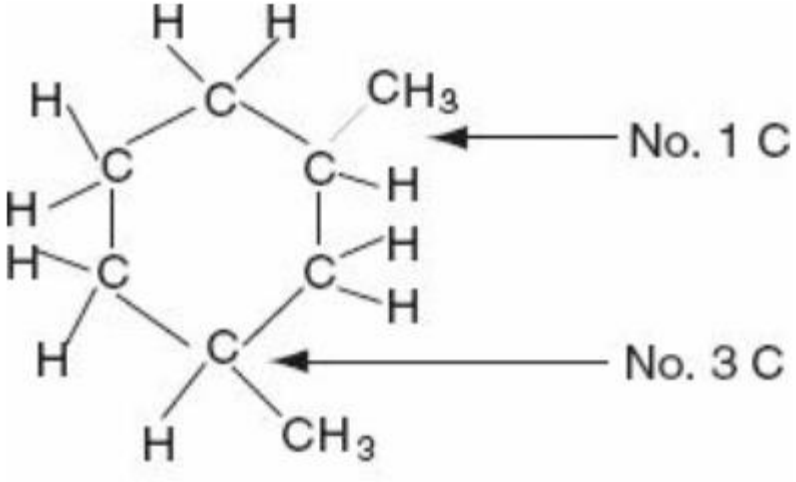


CYCLOALKANES.

Starting with propane in the alkane series, it is possible to get a ring form by attaching the two chain ends. This reduces the number of hydrogens by two.

The general formula is C_nH_{2n}.



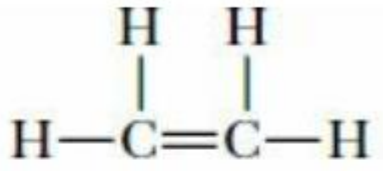


1,3-dimethylcyclohexane

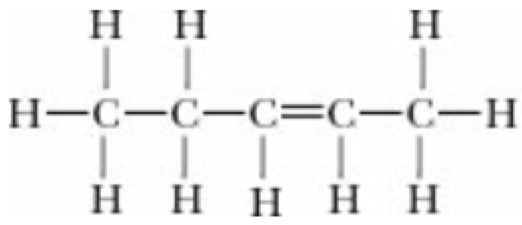
Alkene Series (Unsaturated)

The **alkene** series has a double covalent bond between two adjacent carbon atoms.
The general formula of this series is C_nH_{2n}.

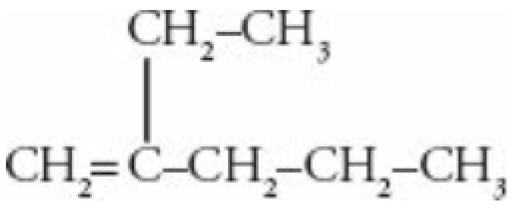
In naming these compounds, the suffix of the alkane is replaced by - *ene*.



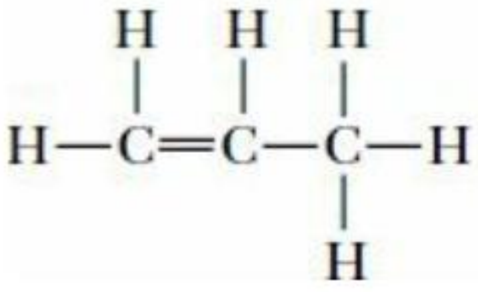
ethene (common name: ethylene)



2-pentene



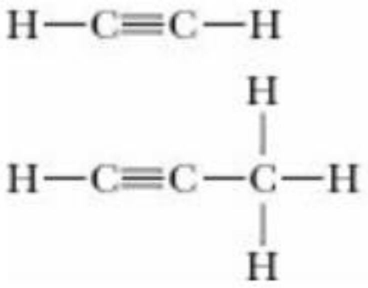
2-ethyl-1-pentene



1-propene (common name: propylene)

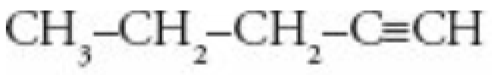
Alkyne Series (Unsaturated)

The **alkyne** series has a triple covalent bond between two adjacent carbons.
The general formula of this series is C_nH_{2n-2}.
In naming these compounds, the alkane suffix is replaced by -*yne*.

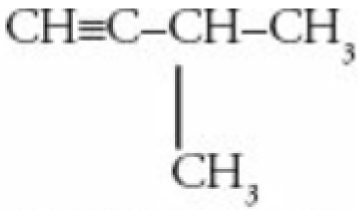


ethyne (common name: acetylene

propyne



1-pentyne

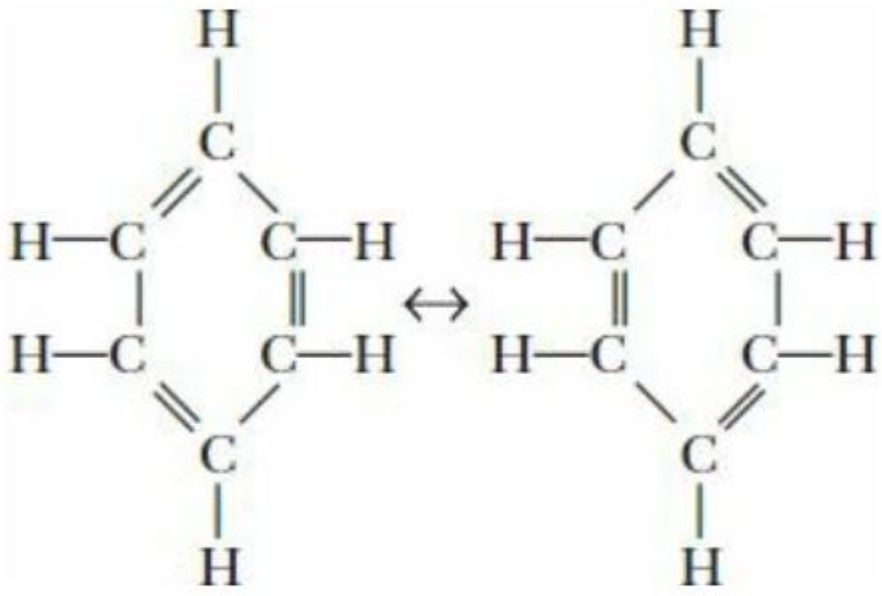


3-methyl-1-butyne

Aromatics

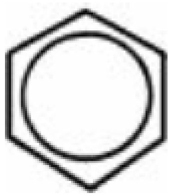
The aromatic compounds are unsaturated ring structures.
The basic formula of this series is C_nH_{2n-6}, and the simplest compound is benzene (C_6H_6).

The benzene structure is a resonance structure that is represented like this:



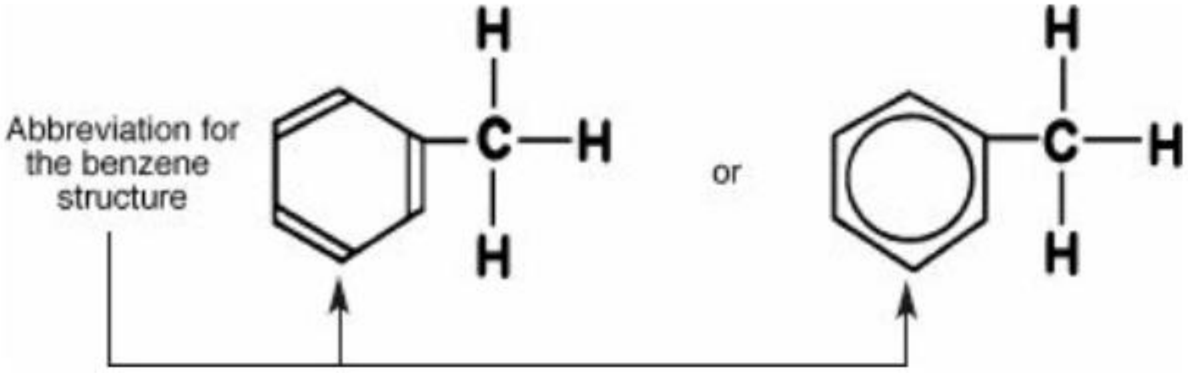
The carbon-to-carbon bonds are neither single nor double bonds but hybrid bonds.
This structural representation is called **resonance structures**.

The benzene resonance structure can also be shown like this:

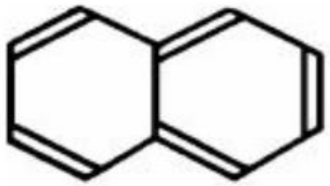


Most of the aromatics have an aroma, thus the name “aromatic.

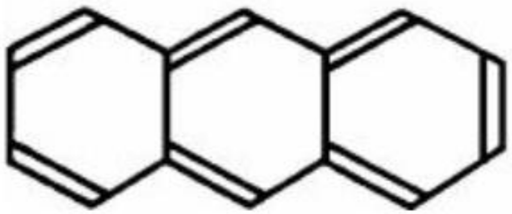
The C_6H_5 group is a substituent called phenyl.
This is the benzene structure with one hydrogen missing.
If the phenyl substituent adds a methyl group, the compound is called toluene or methyl benzene.



Two other members of the benzene series and their structures:

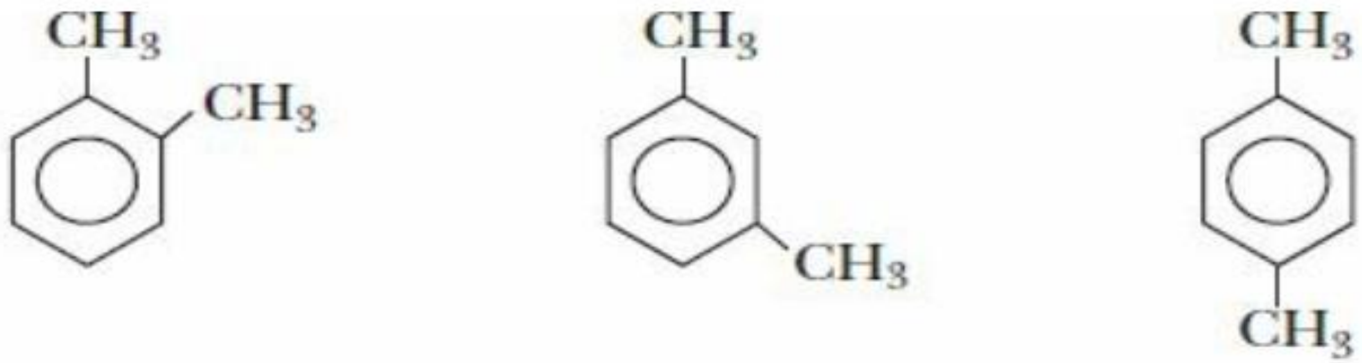


$C_{10}H_8$ naphthalene



$C_{14}H_{10}$ anthracene

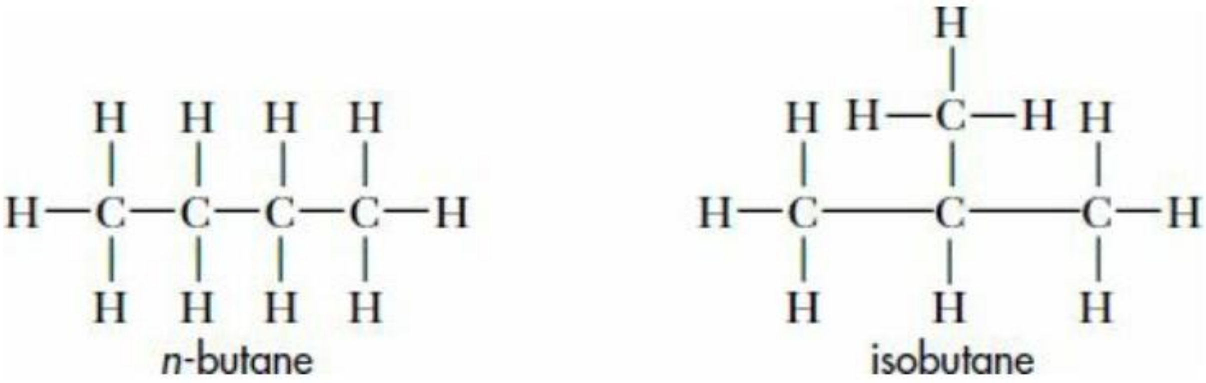
The IUPAC system of naming benzene derivatives, as with chain compounds, involves numbering the carbon atoms in the ring in order to pinpoint the locations of the side chains.
However, if only two groups are substituted in the benzene ring, the compound formed will be a benzene derivative having three possible isomeric forms. In such cases, the prefixes **ortho-**, **meta-**, and **para-**, abbreviated as *o*-, *m*, and *p*-, may be used to name the isomers.
In the ortho- structure, the two substituted groups are located on adjacent carbon atoms. In the meta- structure, they are separated by one carbon atom.
In the para- structure, they are separated by two carbon atoms.



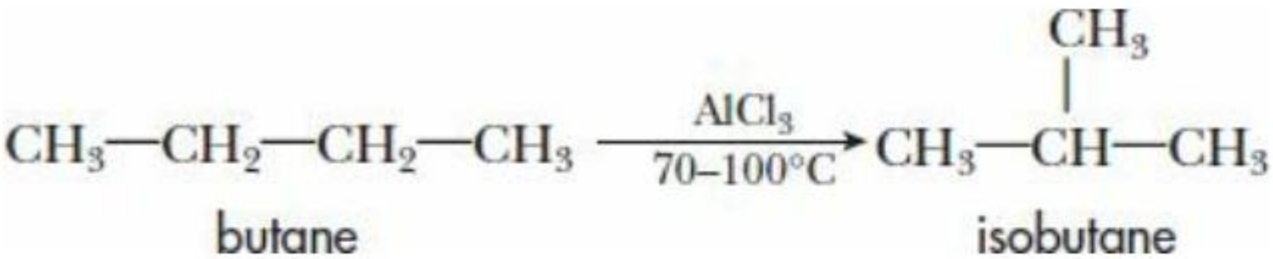
ortho- structure 1,2-dimethylbenzene or *o*-xylene	meta- structure 1,3-dimethylbenzene or *m*-xylene	para- structure 1,4-dimethylbenzene or *p*-xylene

Isomers

Many of the chain hydrocarbons can have the same formula, but their structures may differ.
For example, butane is the first compound that can have two different structures or **isomers** for the same formula.



This isomerization can be shown by the following equation:

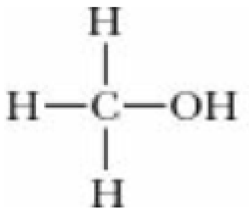


The isomers have different properties, both physical and chemical, from those of hydrocarbons with the normal structure.

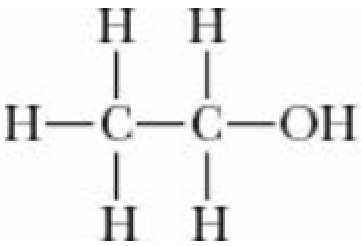
HYDROCARBON DERIVATIVES

Alcohols—Methanol and Ethanol

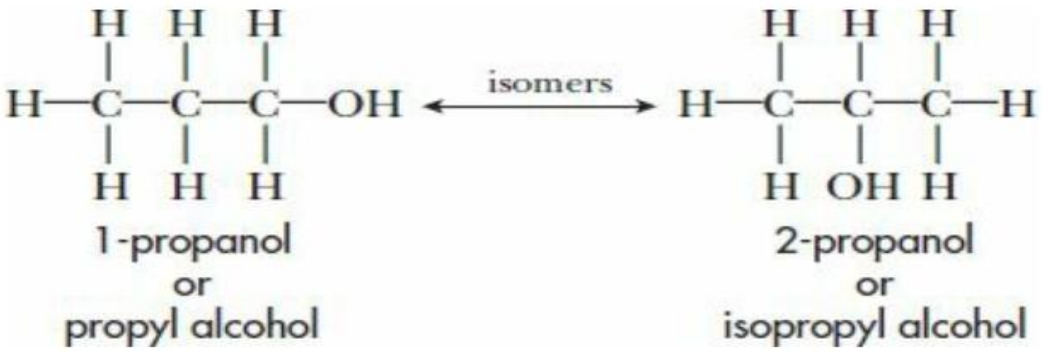
The simplest alcohols are alkanes that have one or more hydrogen atoms replaced by the hydroxyl group, —OH.   This is called its **functional group**

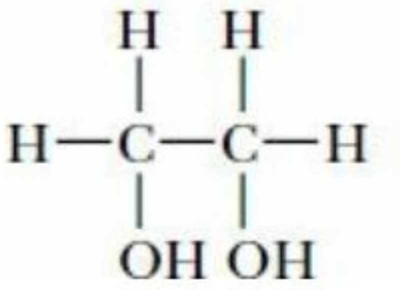


Methanol

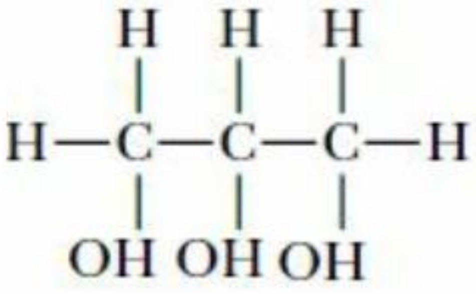


Ethanol



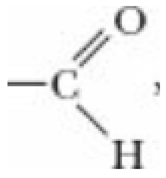


ethylene glycol
or
1,2-ethanediol



glycerine
or
glycerol
or
1,2,3-propanetriol

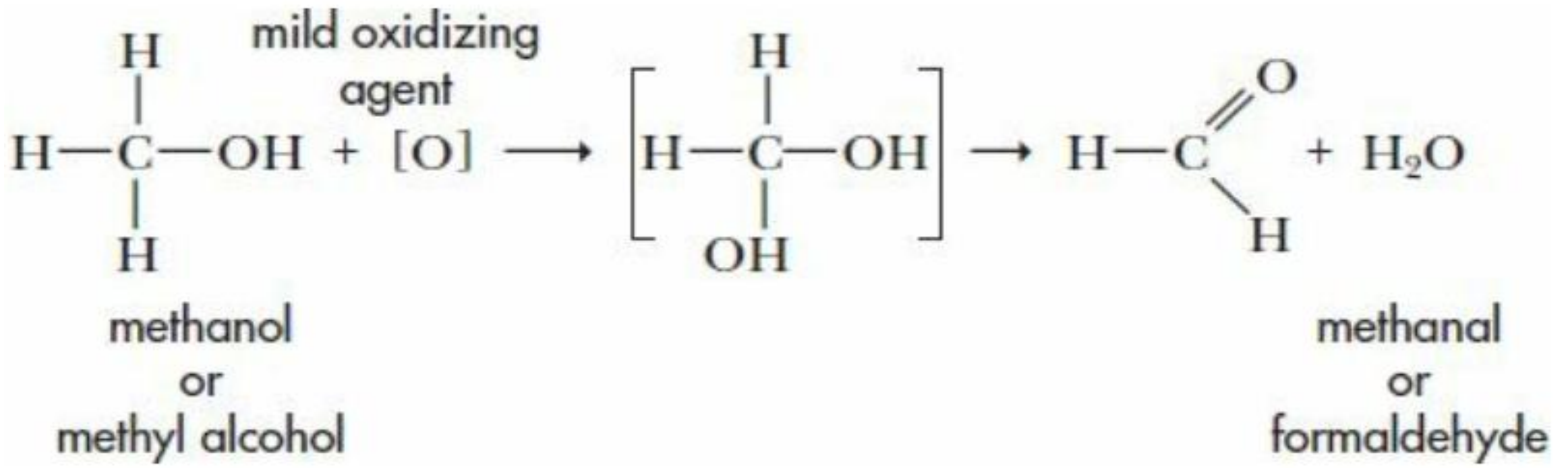
Aldehydes

The functional group of an aldehyde is  the formyl group.

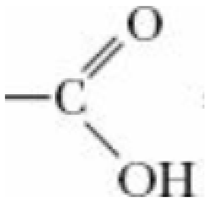
The general formula is RCHO, where R represents a hydrocarbon radical.

Aldehydes can be prepared by the oxidation of an alcohol.
This can be done by inserting a hot copper wire into the alcohol.

A typical reaction is:



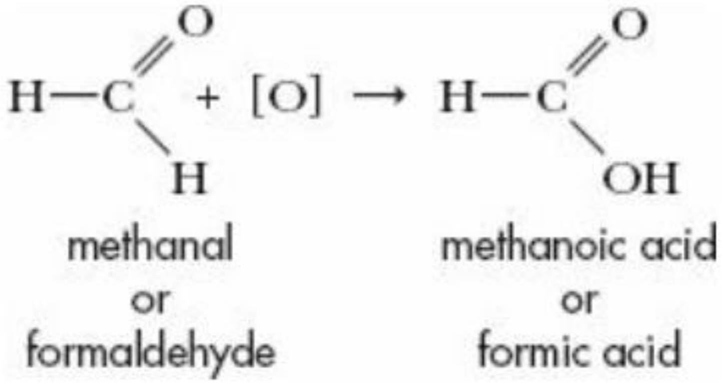
Organic Acids or Carboxylic Acids

The functional group of an organic acid is the  , carboxyl group.

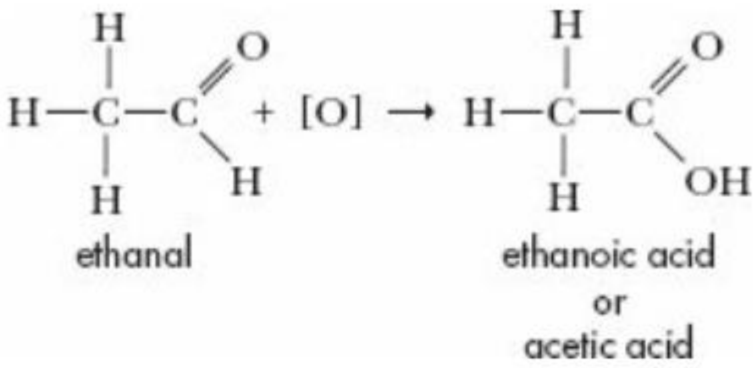
The general formula is R—COOH.

Organic acids can be prepared by the mild oxidation of an aldehyde.
The simplest acid is methanoic acid, which is present in ants, bees, and other insects.

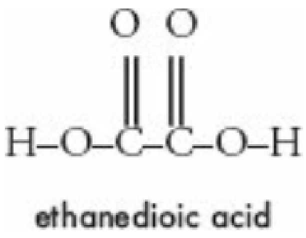
Atypical reaction is:



Ethanal can be oxidized to ethanoic acid:

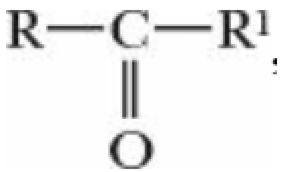


It is possible to have more than one carboxyl group in a carboxylic acid.
In the ethane derivative, it would be ethanedioic acid with a structure like this:



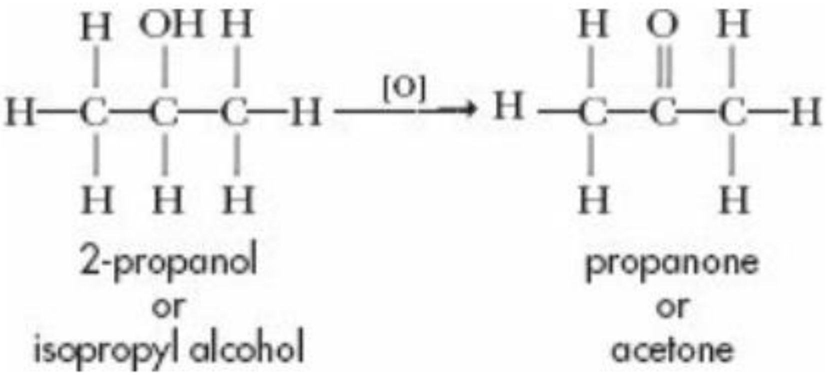
Ketones

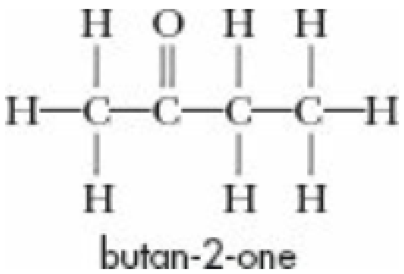
When a secondary alcohol is slightly oxidized, it forms a compound having the functional group



,and called a ketone.

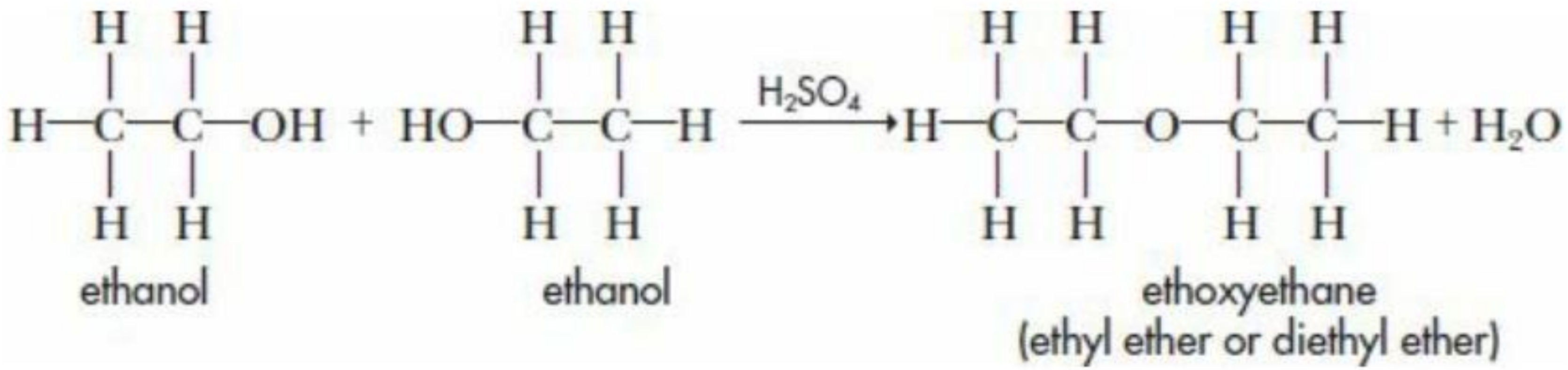
The R1 indicates that this group need not be the same as R.
An example is:

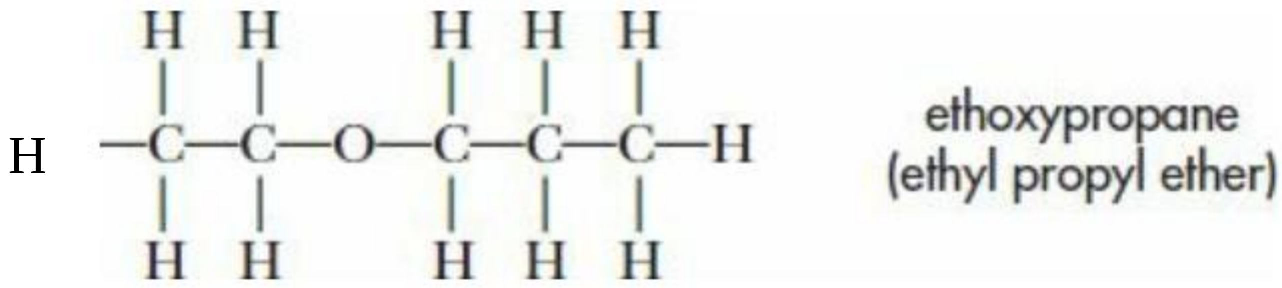




Ethers

When a primary alcohol, such as ethanol, is dehydrated with sulfuric acid, an ether forms.
The functional group is R—O—R1, in which R1 may be the same hydrocarbon group, as shown in example 1 below, or a different hydrocarbon group, as shown in example 2.



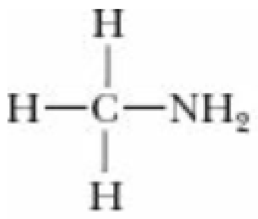


Diethyl ether is commonly referred to as ether and is used as an anesthetic.

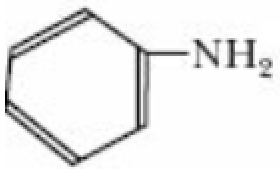
Amines and Amino Acids

The group NH_2- is found in the amide ion and the amino group.
Under the proper conditions, the amide ion can replace a hydrogen in a hydrocarbon compound.
The resulting compound is called an **amine**.

Two examples:

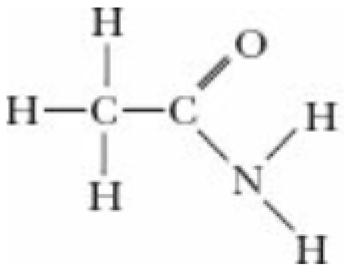


methylamine



aniline

In *amides*, the NH_2- group replaces a hydrogen in the carboxyl group.
When naming amides, the *–ic* of the common name or the -*oic* of the
For example:



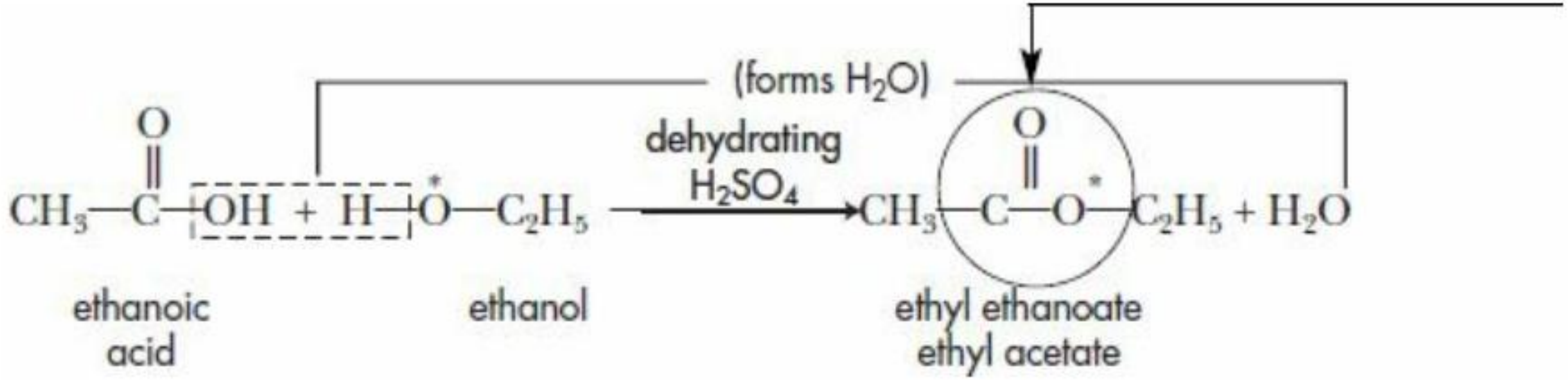
acetamide or ethanamide

Amino acids are organic acids that contain one or more amino groups.
The simplest uncombined amino acid is glycine, or amino acetic acid, NH_2CH_2—COOH.
More than 20 amino acids are known, about half of which are essential in the human diet because they are needed to make up the body proteins.

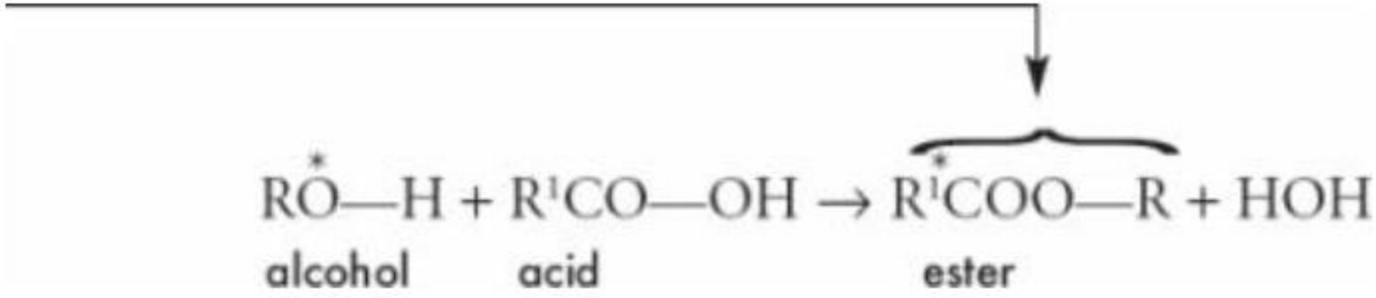
Esters

Esters are often compared to inorganic salts because their preparations are similar.
To make a salt, you react the appropriate acid and base.
To make an ester, you react the appropriate organic acid and alcohol.

For ex

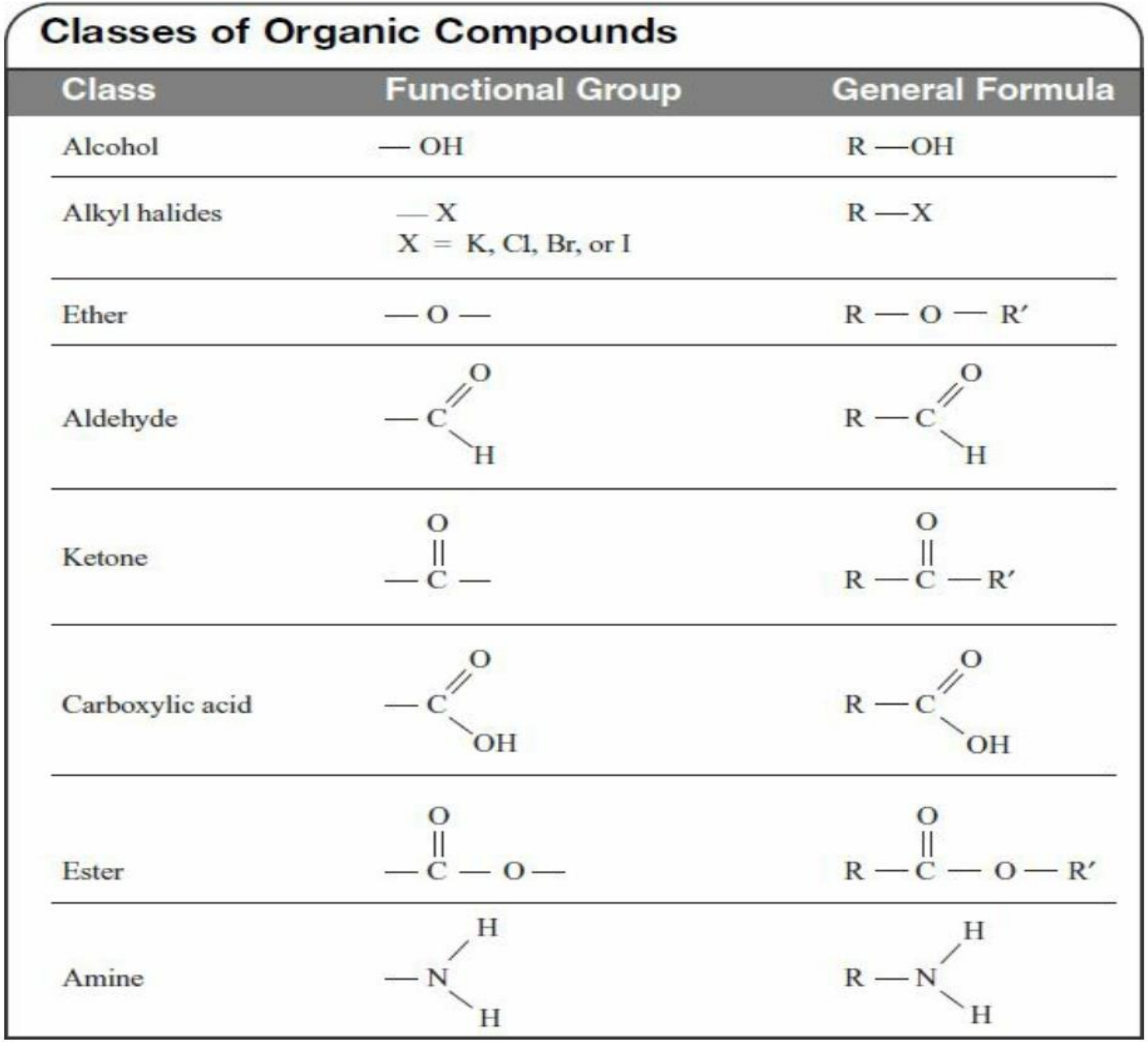


The name is made up of the alkyl substituent of the alcohol and the acid name, in which -*i c* is replaced with -*ate*.



Esters usually have sweet smells and are used in perfumes and flavor extracts.

The chart summarizes the organic structures and formulas discussed in this section.



Classes of Organic Compounds

Class	Functional Group	General Formula
Alcohol	— OH	R —OH
Alkyl halides	— X X = K, Cl, Br, or I	R —X
Ether	— O —	R — O — R′
Aldehyde	— C(=O)—H	R — C(=O)—H
Ketone	— C(=O) —	R — C(=O) — R′
Carboxylic acid	— C(=O)—OH	R — C(=O)—OH
Ester	— C(=O) — O —	R — C(=O) — O — R′
Amine	— N(H)—H	R — N(H)—H

Thank you

Biology High School

For Standardized Scholastic Tests

EST2-ACT2- Biology

Coursework

2024-2025

Dr. Mohamed Kabbany

Chapter 1

Cellular and Molecular Biology

Lesson 1.2.6

Biochemistry

- **Carbohydrates**

There are four classes of organic compounds in the body:
carbohydrates, lipids, proteins, and nucleic acids.

Carbohydrates

Carbohydrates consist of only three elements: carbon, hydrogen, and oxygen

Carbohydrates supply quick energy.

One gram of any carbohydrate will release 4 calories of heat when burned.

Dietary sources include rice, pasta, bread, and cookies.

There are three classes of carbohydrates:
monosaccharides, disaccharides, and polysaccharides.

Link

MONOSACCHARIDES

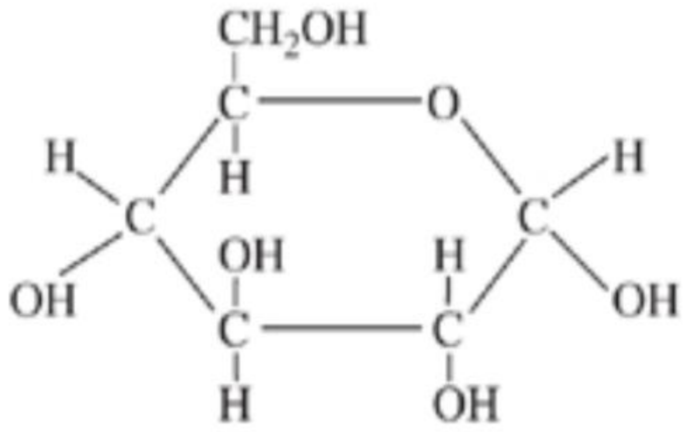
Monosaccharides have a chemical formula of $C_nH_{2n}O_n$.
A common formula is $C_6H_{12}O_6$.

Examples are glucose, galactose, and fructose, which are all isomers of each other

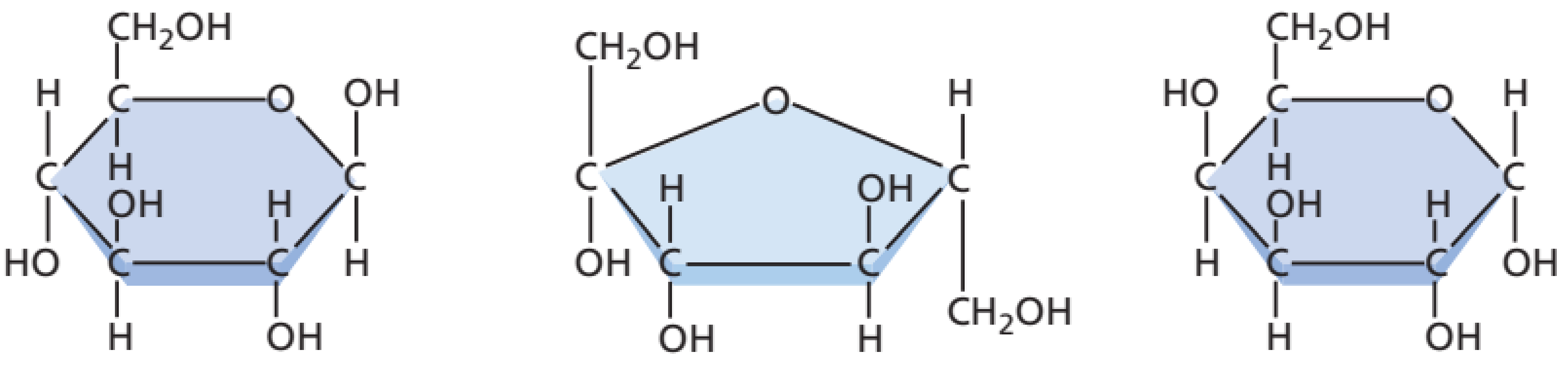
Isomers are compounds with the same molecular formula, but with different structural formula.

Therefore, they have different physical and chemical properties.

Structural formula of glucose.



monosaccharides



Glucose Fructose Galactose

Glucose, fructose, and galactose have the same chemical formula, but their structural differences result in different properties among the three compounds.

Back

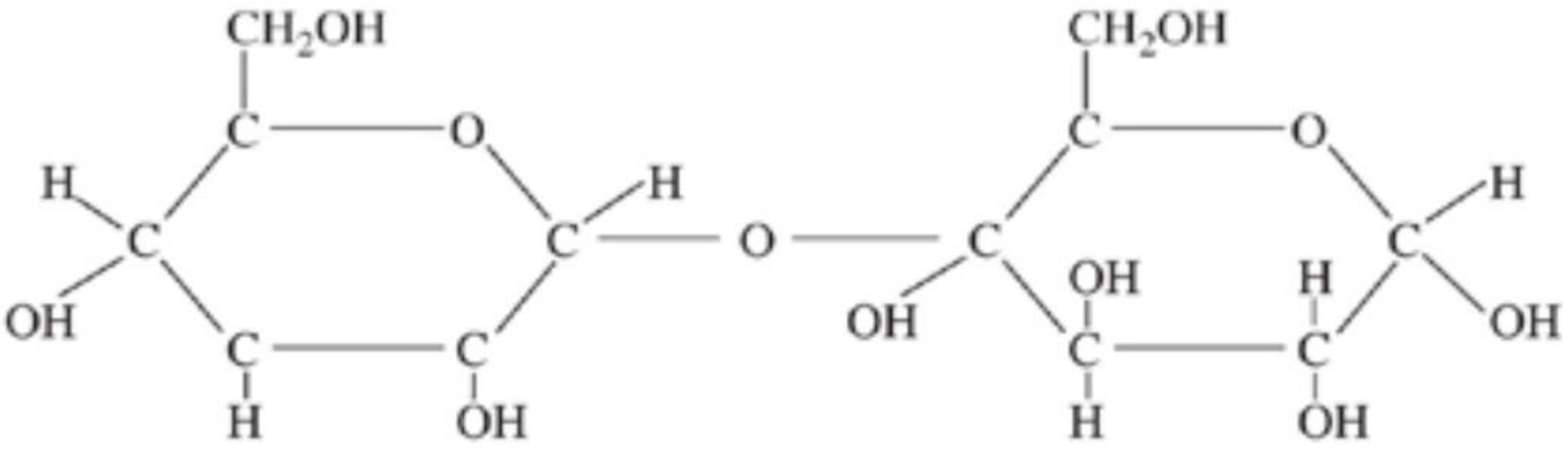
Link

DISACCHARIDES

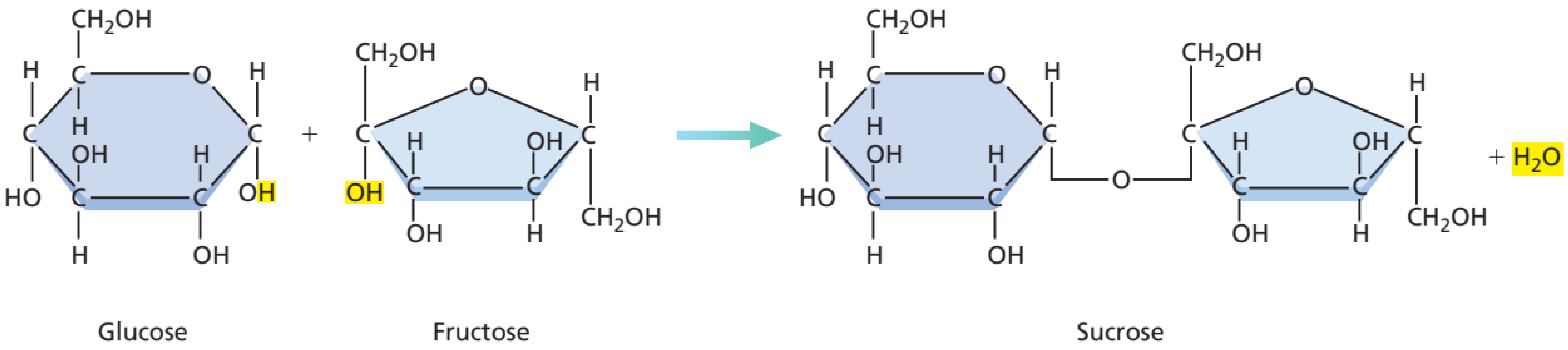
All disaccharides have the chemical formula $C_{12}H_{22}O_{11}$.

They consist of two monosaccharides joined by a process known as dehydration synthesis or condensation (molecules combine with removal of water).

The structure of the disaccharide, maltose, is shown



Condensation reaction



The condensation reaction shows how glucose links with fructose to form sucrose. One water molecule is produced each time two monomers form a covalent bond.

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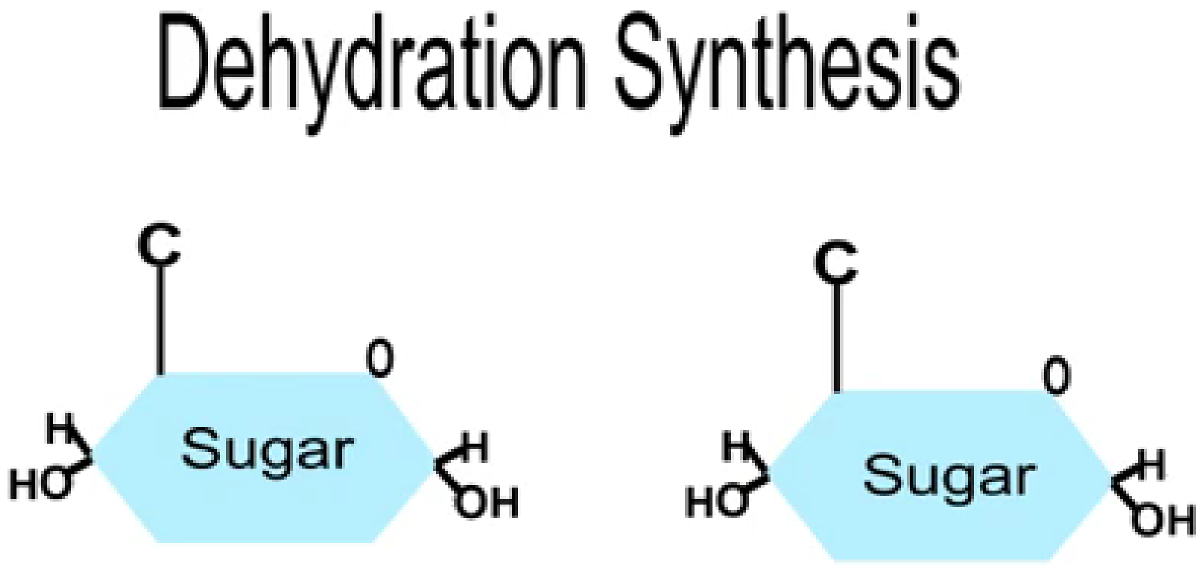
Condensation reaction



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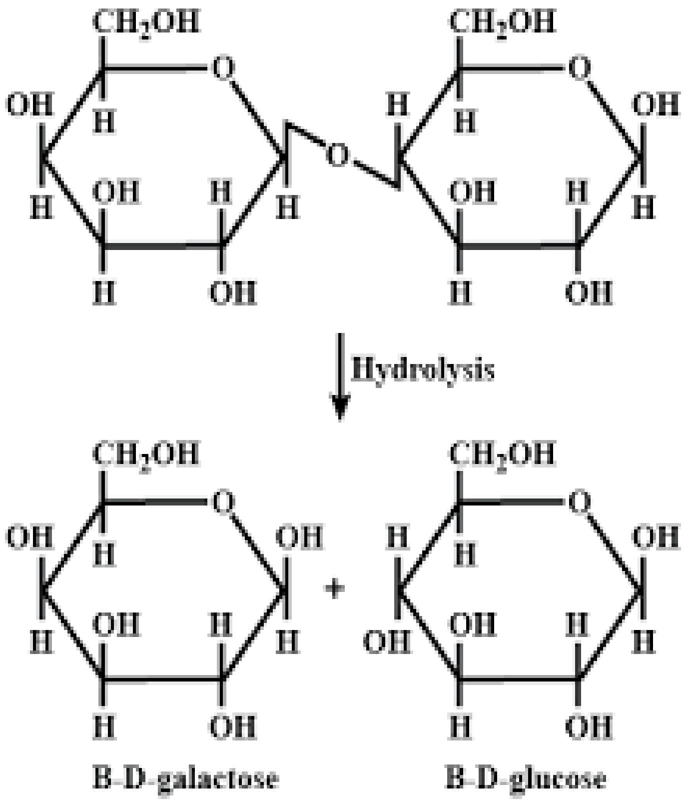
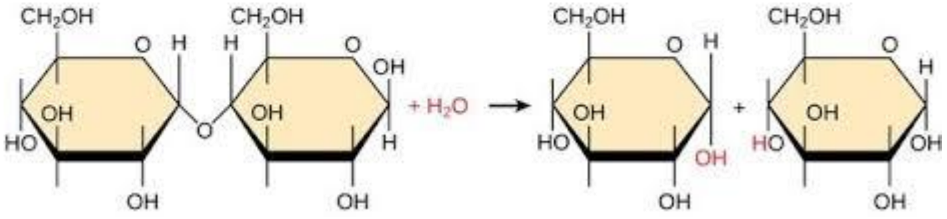
Hydrolysis

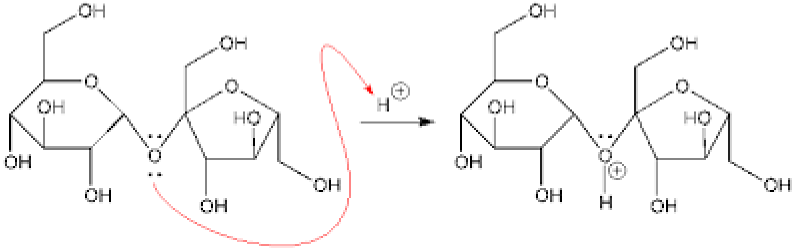


$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or Invertase}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or Maltase}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Glucose}}{C_6H_{12}O_6}$$

$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or Lactase}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Galactose}}{C_6H_{12}O_6}$$





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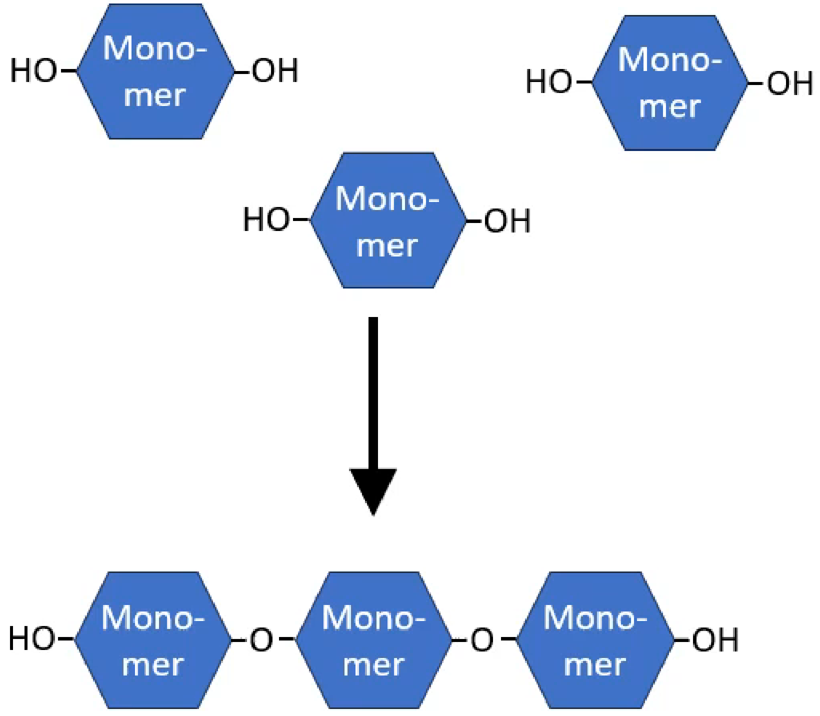
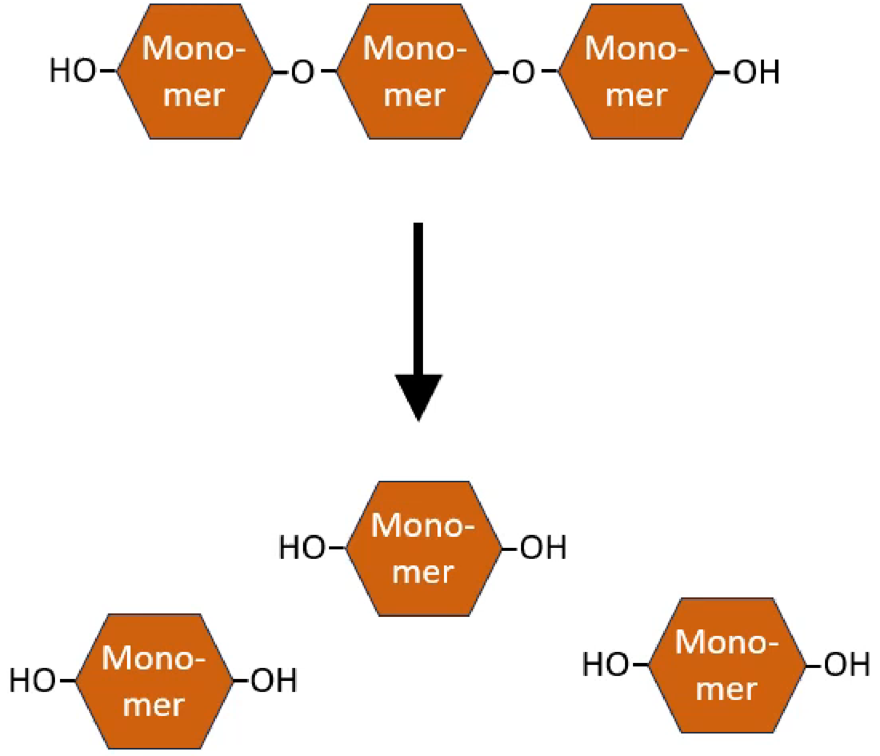
Hydrolysis





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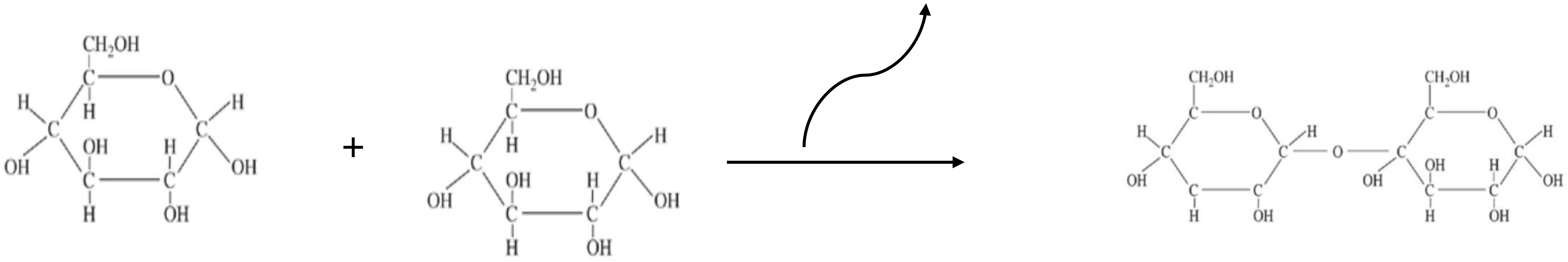
DISACCHARIDES

[Link]

Water

H_2O



$C_6H1_{12}O_6$ + $C_6H_{12}O_6$ → $C_{12}H_{22}O_{11}$ + H_2O_6

Glucose + Glucose → Maltose + Water

Dehydration synthesis

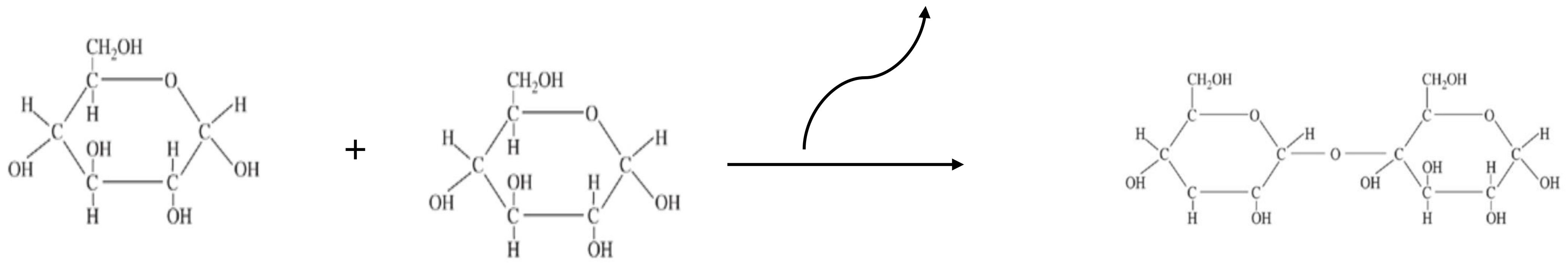
Sometimes called condensation

Water

H_2O

Link

DISACCHARIDES



$C_6H1_{12}O_6$ + $C_6H_{12}O_6$ → $C_{12}H_{22}O_{11}$ + H_2O_6

Glucose + Glucose → Maltose + Water

Grape sugar

Glucose + Fructose → sucrose + Water

cane sugar (table sugar)

Glucose + Galactose → Lactose + Water

Milk sugar

Link

Hydrolysis

Hydrolysis is the opposite of dehydration synthesis.

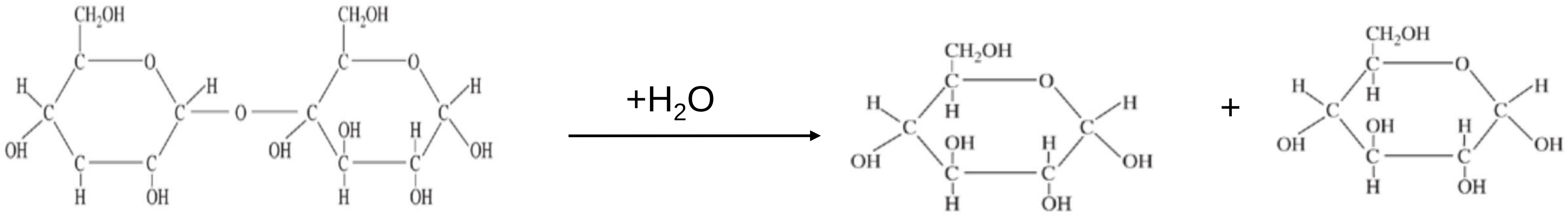
It is the breakdown of a compound with the addition of water.

Maltose + Water → Glucose + Glucose

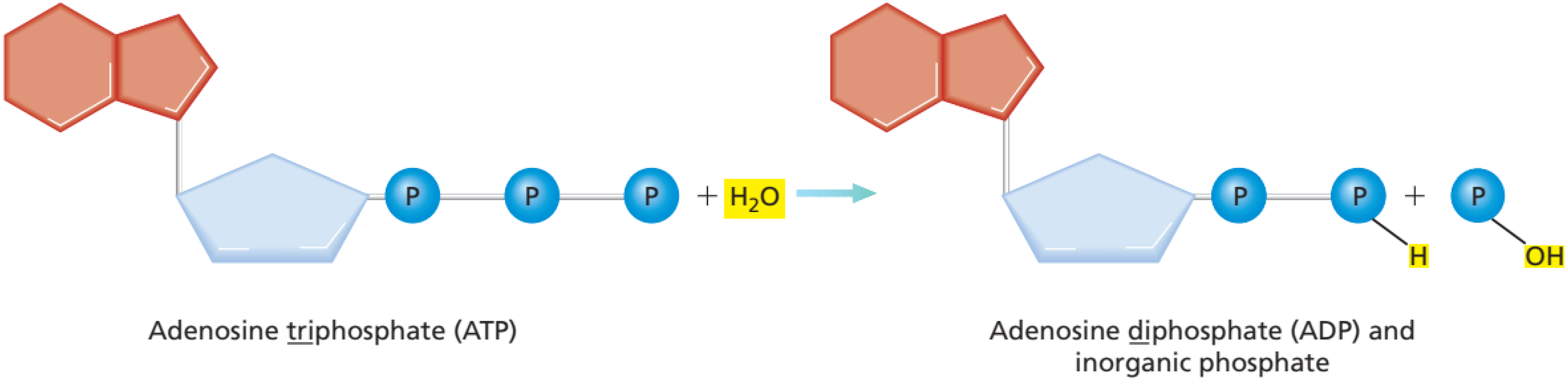
Sucrose + Water → Glucose + Fructose

Lactose + Water → Glucose + Galactose

It is what occurs during digestion and is the reverse of dehydration synthesis.



Hydrolysis



The hydrolysis of ATP yields adenosine diphosphate (ADP) and inorganic phosphate.
In hydrolysis, a hydrogen ion from a water molecule bonds to one of the new molecules, and a hydroxide ion bonds to the other new molecule. Most hydrolysis reactions release energy

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POLYSACCHARIDES

Polysaccharides are polymers of carbohydrates.

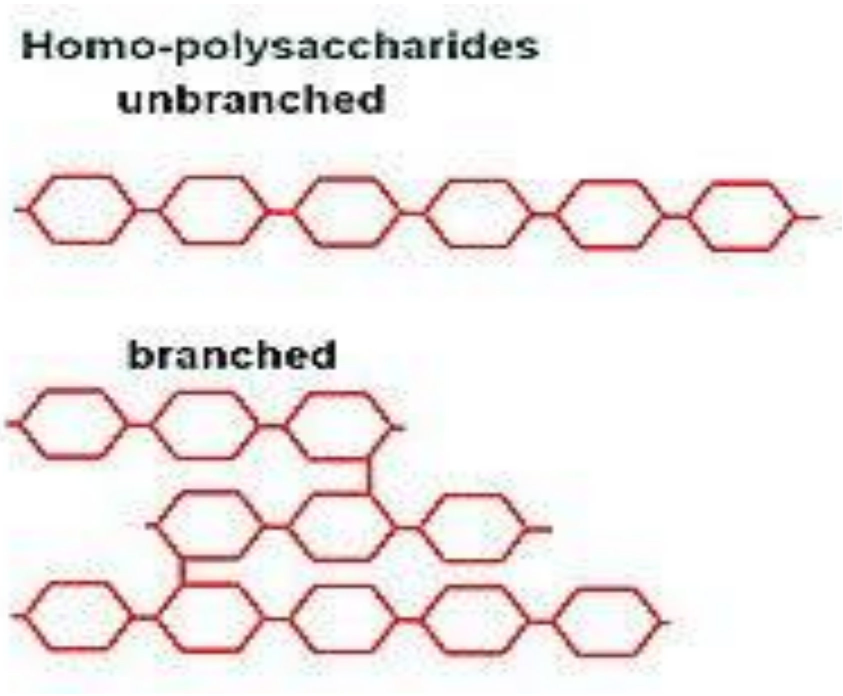
They form as many monosaccharides are joined together by dehydration synthesis.

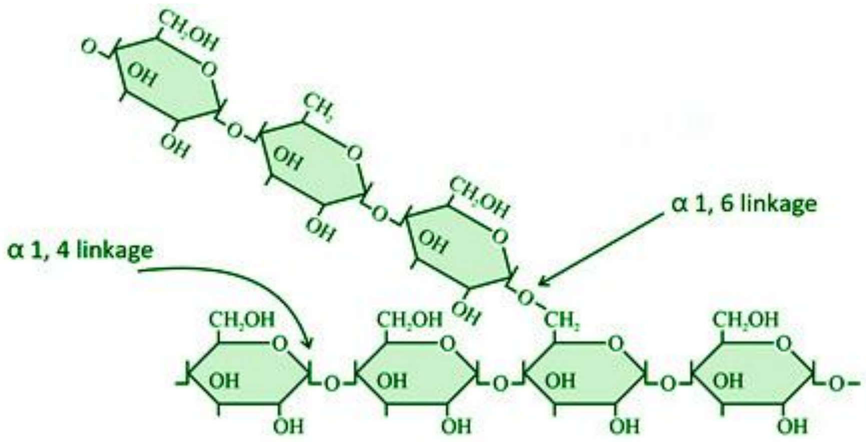
Four important polysaccharides you should know:

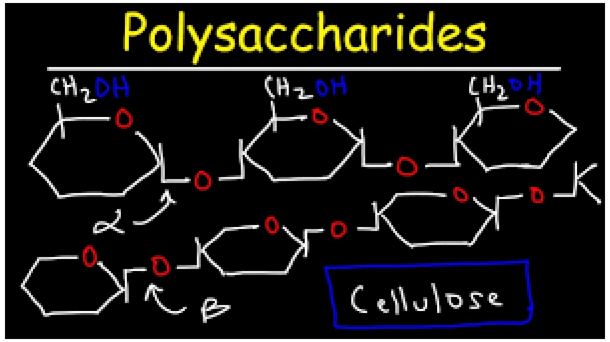
cellulose starch chitin and glycogen.

cellulose	→	Found in plants only→ Makes up plant cell walls
starch	→	Found in plants only→ The way plants store carbohydrates
chitin	→	Found in Animals only → Makes up the exoskeleton in arthropods and cell walls in mushrooms
glycogen.	→	Found in Animals only → "Animal starch"; in humans, this is stored in the liver and skeletal muscle

Polysaccharides







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Chapter 1

Cellular and Molecular Biology

Lesson 1.2.7

Biochemistry

- **Lipids**

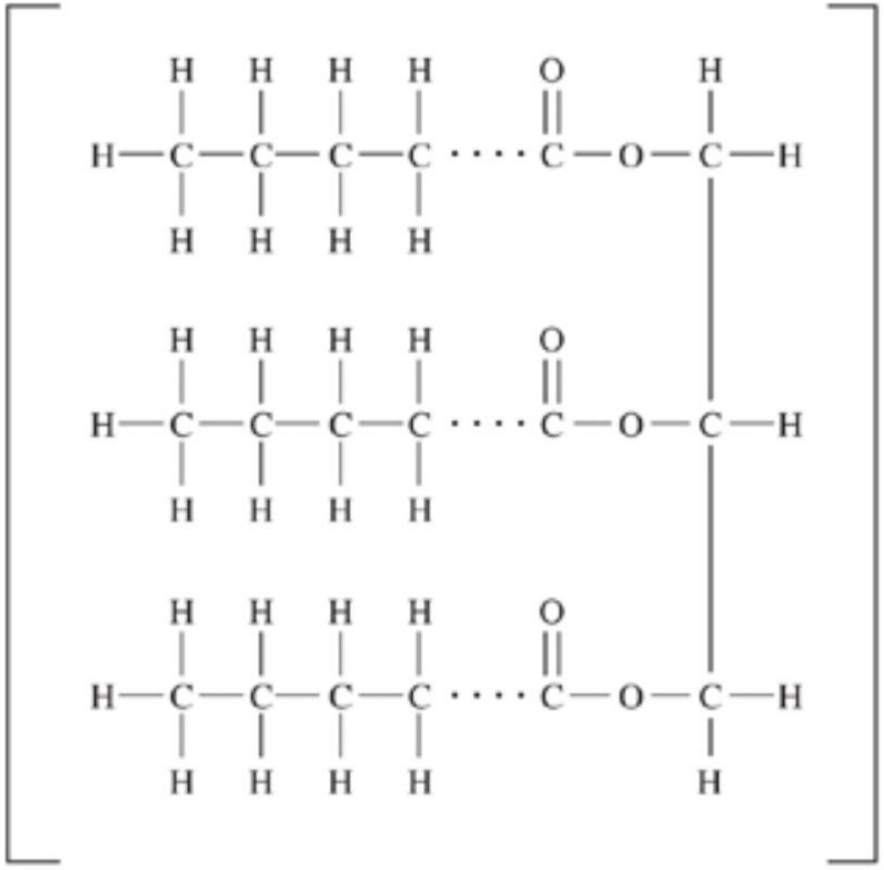
Link

Lipids

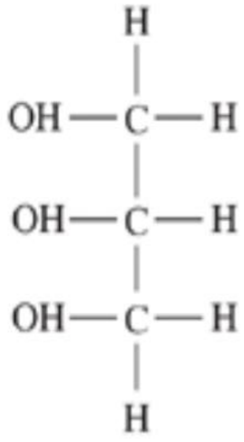
Lipids are a diverse class of organic compounds that include fats, oils, and waxes.

Structurally, most lipids consist of one glycerol and three fatty acids, as shown :

3 fatty acids



1 glycerol



Link

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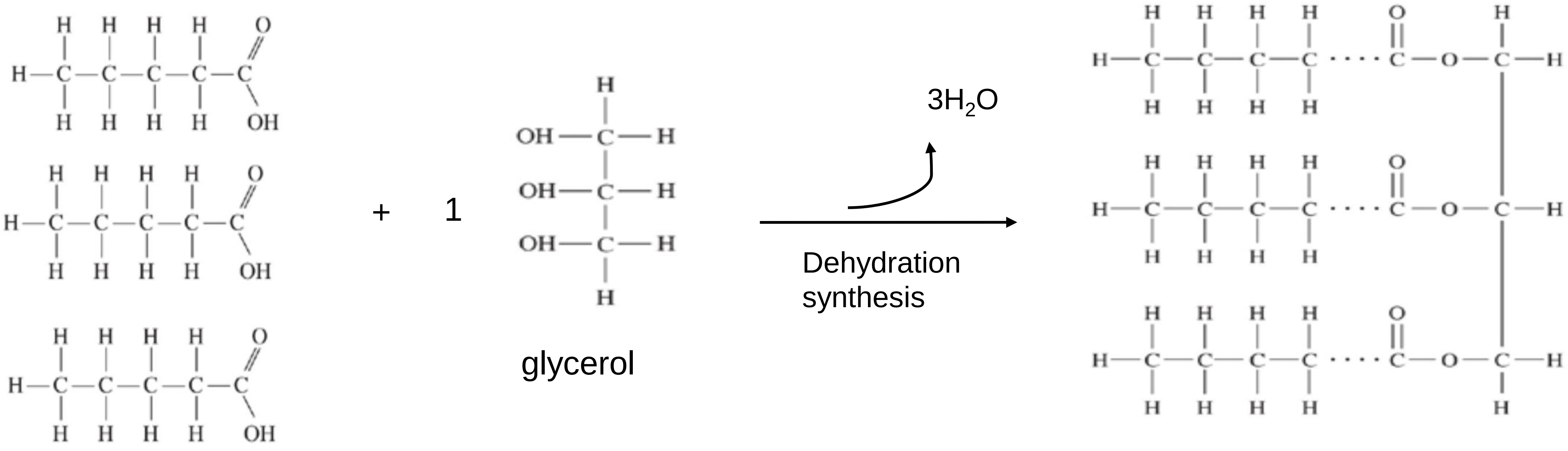
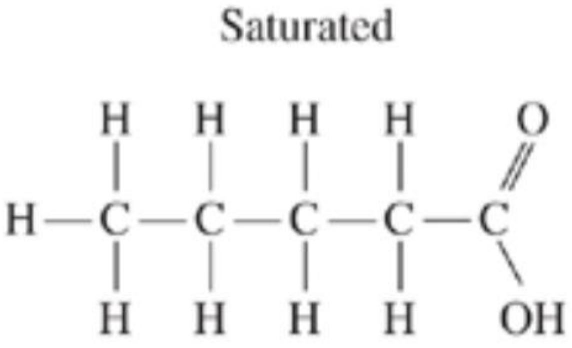


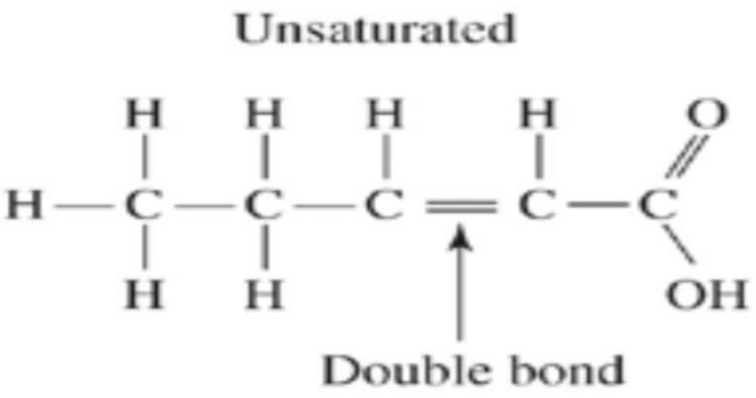
3 fatty acids

Lipid (triglyceride)

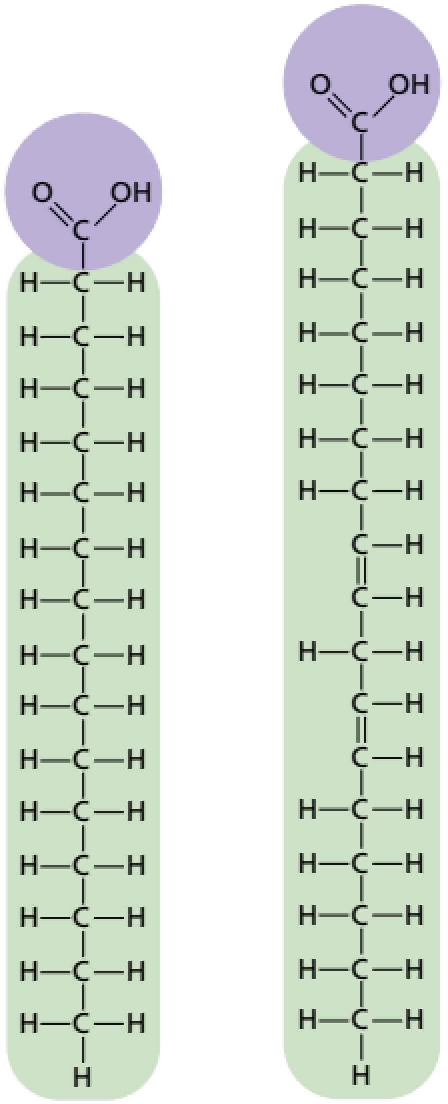
[Link](#)

A fatty acid is a hydrocarbon chain with a carboxyl group at one end. Fatty acids exist in two varieties: **saturated and unsaturated**.





Fatty acids



Palmitic acid Linoleic acid

Fatty acids have a polar carboxyl head, highlighted in purple, and a nonpolar hydrocarbon tail, highlighted in green.

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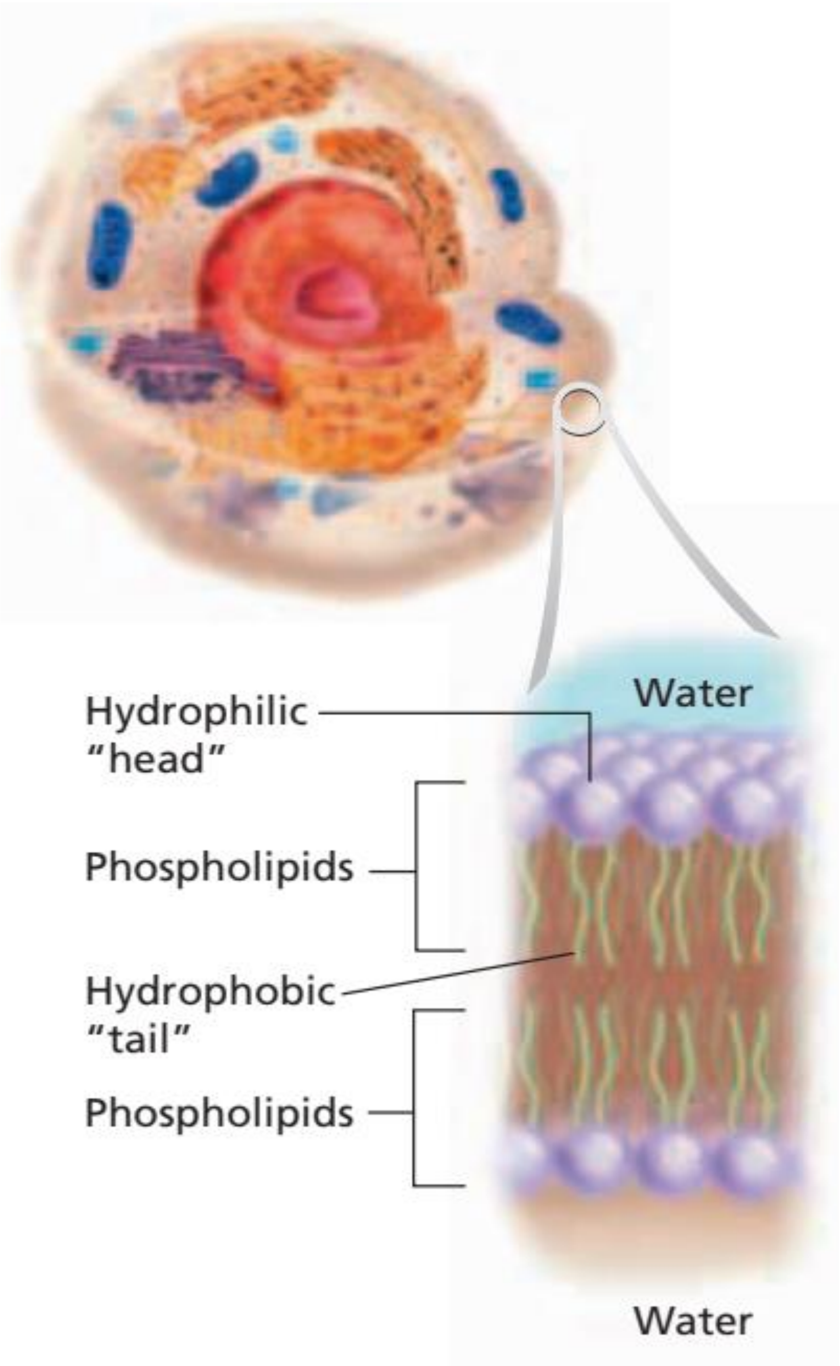
Phospholipid



The lipid bilayer of a cell membrane is a double row of phospholipids. The "tails" face each other. The "head" of a phospholipid, which contains a phosphate group, is polar and hydrophilic. The two tails are two fatty acids and are nonpolar and hydrophobic.

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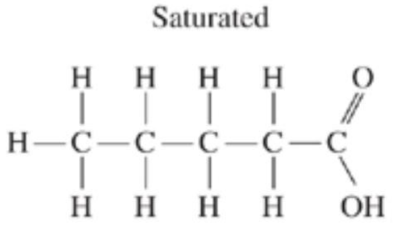
SATURATED FATS



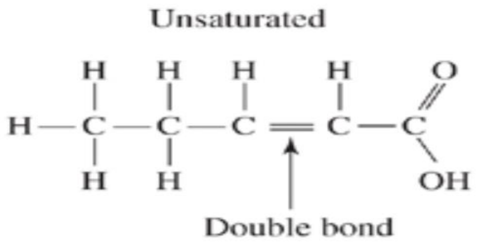
Saturated fatty acids contain only single bonds between carbon atoms.

Saturated fats, with a few exceptions, come from animals..

They are solid at room temperature and when ingested in large quantities, are linked to heart disease.

An example of a saturated fat is butter.

UNSATURATED FATS



and are considered the “good dietary fats.”

Unsaturated fatty acids, are extracted from plants.

are liquid at room temperature,

Unsaturated fatty acids have at least one double bond between carbon atoms in the hydrocarbon chain. Thus, they have fewer hydrogen atoms.

Link

LIPID FUNCTIONS

1. ENERGY STORAGE:

   1 gram of any lipid will release 9 calories of heat per gram when burned in a calorimeter. Glucose gives 4 calories.

2. STRUCTURAL:

   Phospholipids are a major component of the cell membrane.

3. ENDOCRINE:

   Some lipids are hormones e.g. steroid hormones like cortisone.

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Chapter 1

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Proteins and Protein Structure

Link

PROTEIN STRUCTURE

Proteins have many functions in living things.

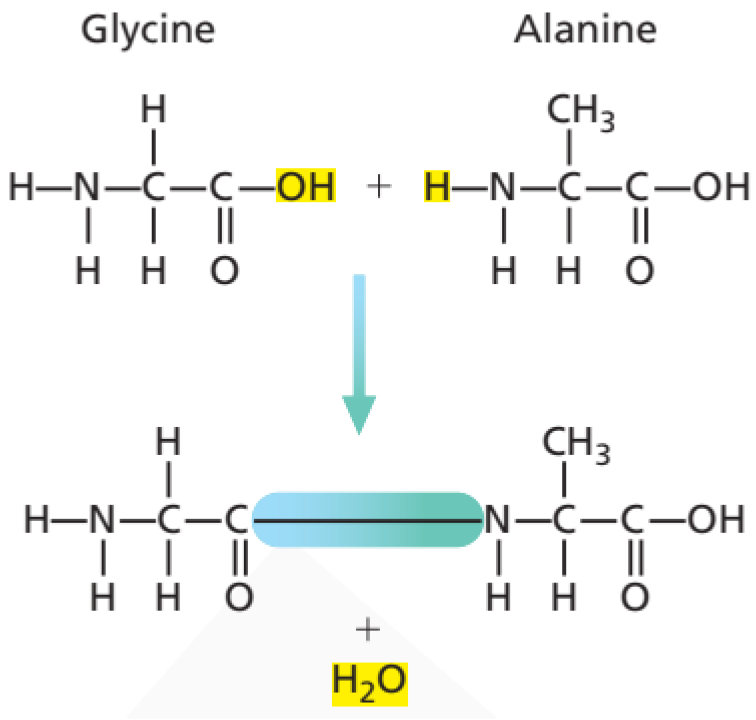
They act as enzymes, membrane channels, and hormones……

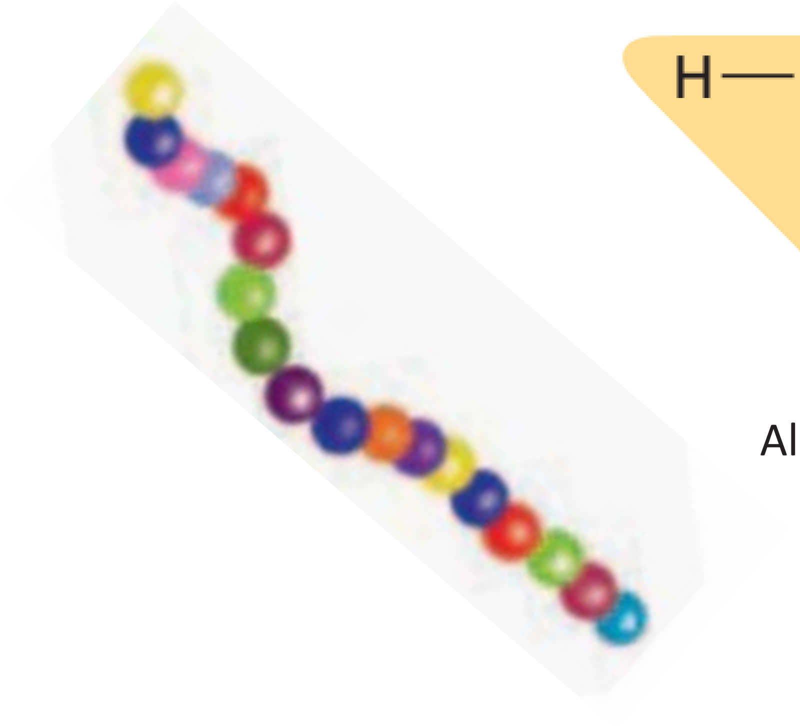
In every case, the function of the protein depends on its shape.

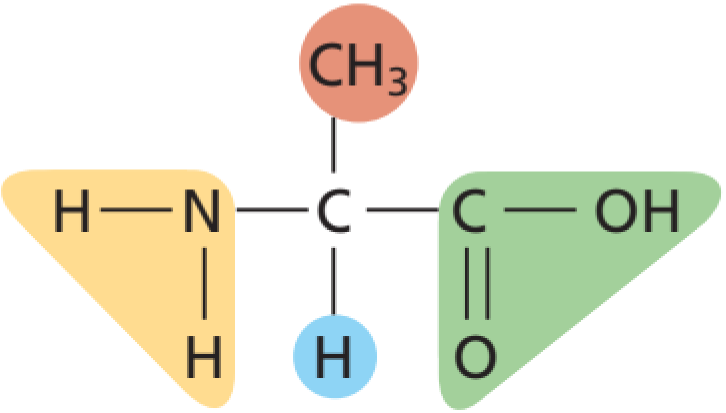
The shape of a protein, in turn, is the result of four levels of structure:

primary, secondary, tertiary, and quaternary.

=== bond







Alanine (an amino acid)

The peptide bond (shaded blue) that binds amino acids together to form a polypeptide results from a condensation reaction that produces water. Polypeptides are commonly shown as a string of balls in this textbook and elsewhere. Each ball represents an amino acid.

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Primary structure results from the sequence of amino acids that make up the protein chain.

Secondary structure results from the hydrogen bonding within the molecule.

The helical nature of many proteins is the result of hydrogen bonding.

Tertiary structure is the intricate, three-dimensional shape or conformation of a protein and *most directly determines the way it functions and its specificity*.

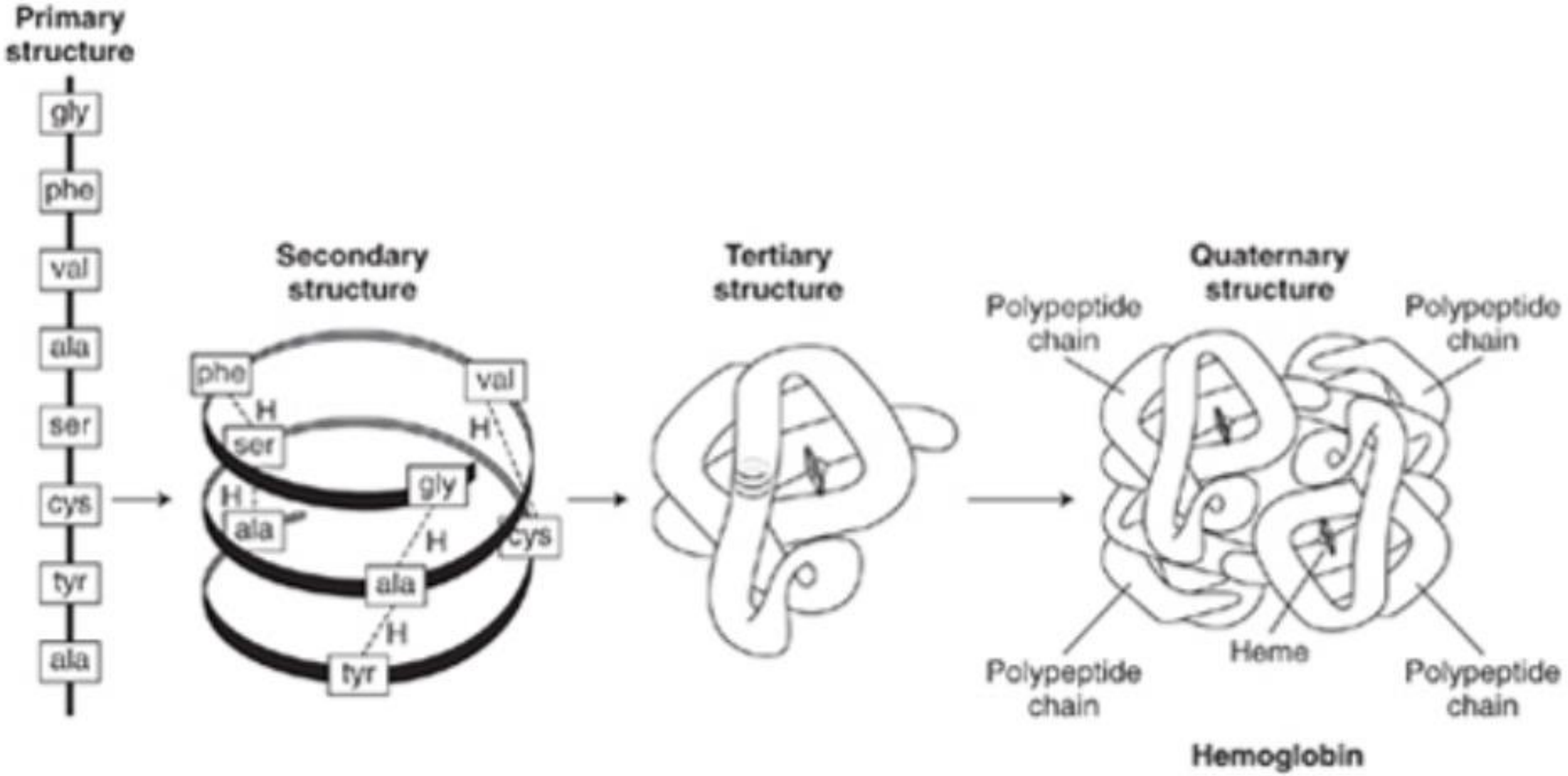
Tertiary structure is directly responsible for the shape of a protein and how it functions

Enzymes denature (lose their natural shape) in high temperatures or adverse pH. When a protein/enzyme denatures, it cannot function because its tertiary structure has been altered beyond repair.

Quaternary structure refers to proteins that consist of more than one polypeptide chain.

Hemoglobin, for example, exhibits quaternary structure because it consists of four chains;

Link



Hemoglobin, for example, exhibits quaternary structure because it consists of four chains;

Link

PRIONS—PROTEINS THAT CAUSE DISEASE

Prions are infectious proteins that cause several brain diseases, including mad cow disease.

A prion is a misfolded version of a protein normally found in the brains of mammals.

If a prion gets into a normal brain, it causes all the normal proteins to misfold in the same way.

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Chapter 1

Cellular and Molecular Biology

Lesson 1.2.9

Biochemistry

- **Nucleic Acids**

Link

Nucleic Acids:

The nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

They carry hereditary information.

They are polymers (chains of repeating units) of nucleotides.

A single nucleotide consists of a phosphate, a 5-carbon sugar (either deoxyribose or ribose), and a nitrogenous base.

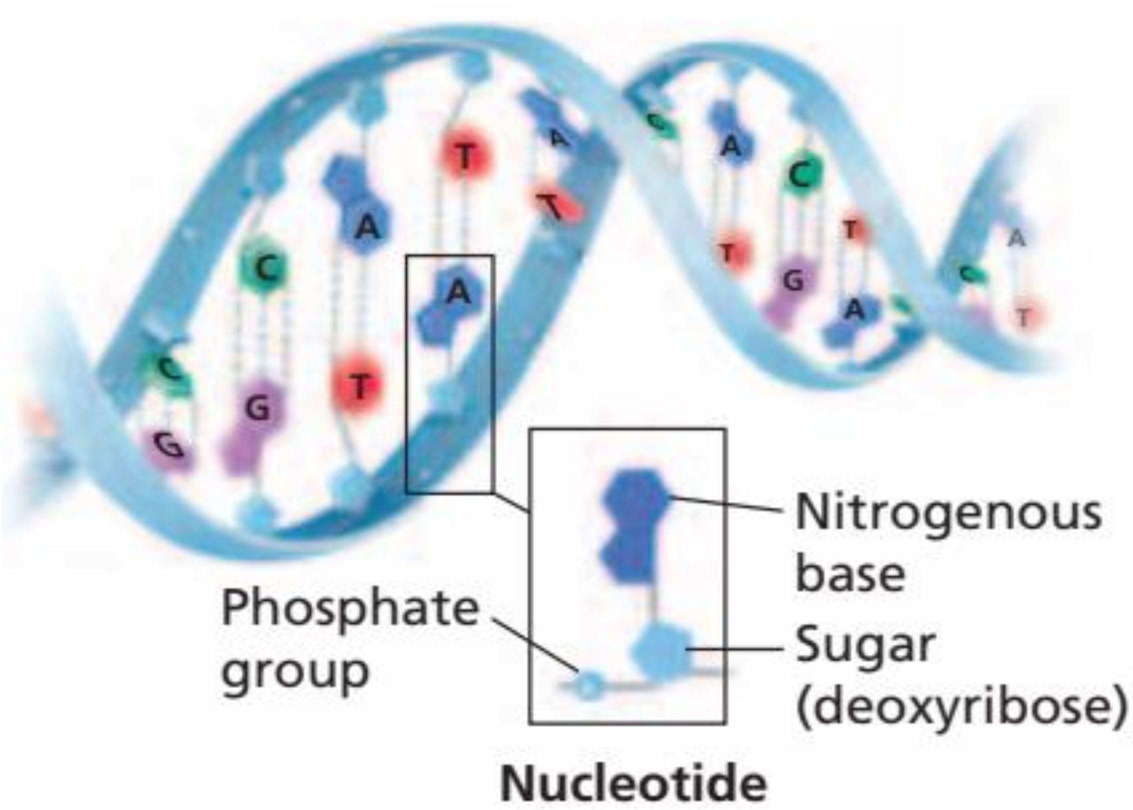
In DNA the nitrogen bases are: adenine, cytosine, guanine, and thymine.

In RNA the bases are: adenine, cytosine, guanine, and uracil, in place of thymine.

Adenine and guanine are purines.

Cytosine, thymine, and uracil are pyrimidines

Nucleotide



DNA as shown below, and RNA, are very large molecules formed from nucleotides linked together in a chain.
A nucleotide consists of a phosphate group, a five carbon sugar, and a ring-shaped nitrogenous base.

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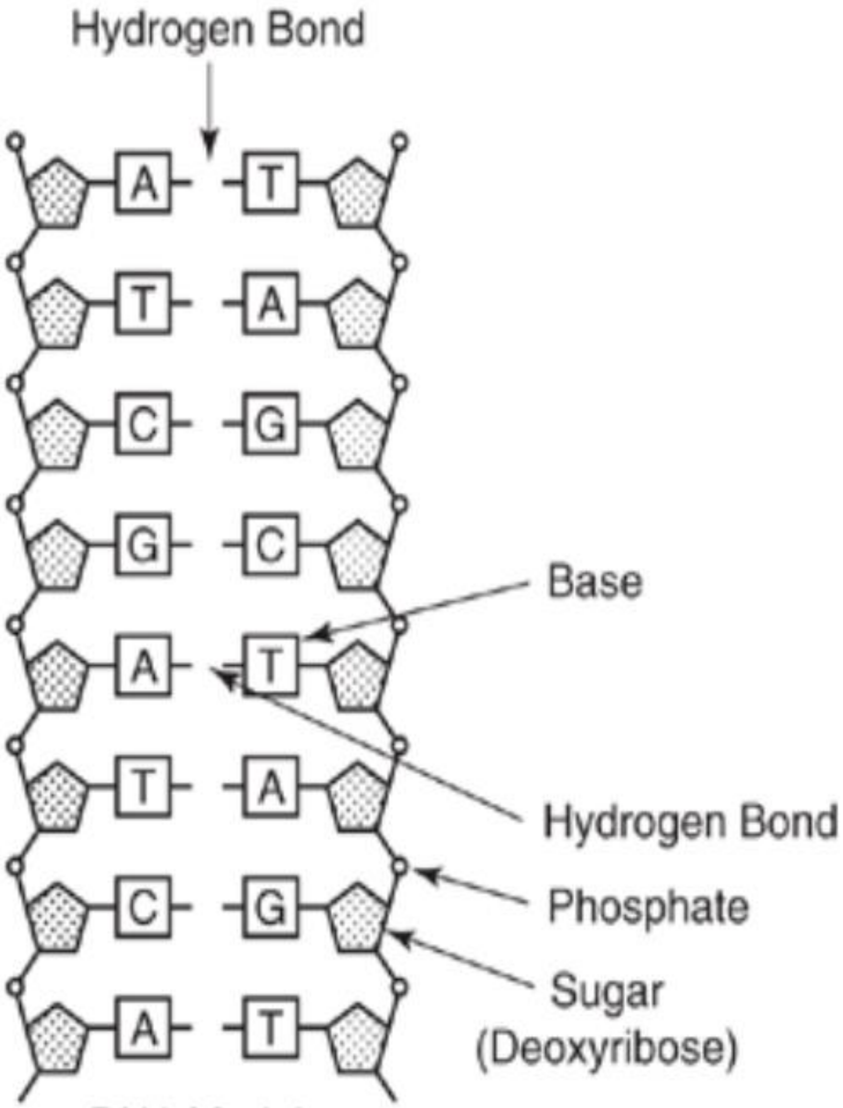

DNA Model

DNA Structure

Thank you