Shree H. N. Shukla College of Science,
(Affiliated to Saurashtra university)
Nr. Lalpari Lake, B/H Marketing Yard, Rajkot-360 003

F.Y. B.Sc. (Sem. II) (CBCS)

MICROBIOLOGY

[201]: BASICS OF BIOCHEMISTRY AND MICROBIAL CONTROL

Unit 1
SCOPE AND HISTORY OF MICROBIOLOGY

Prepared By

KRUPA BARAVADIYA

CHEMICAL ELEMENTS AND STRUCTURE OF ATOMS

ELEMENTS

- In chemistry, an **element** is a pure substance consisting only of atoms that all have the same numbers of protons in their atomic nuclei. Unlike chemical compounds, chemical elements cannot be broken down into simpler substances by chemical means.
- The number of protons in the nucleus is the defining property of an element, and is referred to as its atomic number (represented by the symbol *Z*) – all atoms with the same atomic number are atoms of the same element.[1] All of the baryonic matter of the universe is composed of chemical elements.
- When different elements undergo chemical reactions, atoms are rearranged into new compounds held together by chemical bonds. Only a minority of elements, such as silver and gold, are found un-combined as relatively pure native element minerals.
- Nearly all other naturally-occurring elements occur in the Earth as compounds or mixtures. Air is primarily a mixture of the elements nitrogen, oxygen, and argon, though it does contain compounds including carbon dioxide and water.
- The history of the discovery and use of the elements began with primitive human societies that discovered native minerals like carbon, sulfur, copper and gold (though the concept of a chemical element was not yet understood).
- Attempts to classify materials such as these resulted in the concepts of classical elements, alchemy, and various similar theories throughout human history. Much of the modern understanding of elements developed from the work of Dmitri Mendeleev, a Russian chemist who published the first recognizable periodic table in 1869.
- This table organizes the elements by increasing atomic number into rows ("periods") in which the columns ("groups") share recurring ("periodic") physical and chemical properties. The periodic table summarizes various properties of the elements, allowing chemists to derive relationships between them and to make predictions about compounds and potential new ones.
- Only about 4% of the total mass of the universe is made of atoms or ions, and thus represented by chemical elements. This fraction is about 15% of the total matter, with the remainder of the matter (85%) being dark matter. The nature of dark matter is unknown, but it is not composed of atoms of chemical elements because it contains no protons, neutrons, or electrons. (The remaining non-matter part of the mass of the universe is composed of the even less well understood dark energy).

- The 94 naturally occurring chemical elements were produced by at least four classes of astrophysical process. Most of the hydrogen, helium and a very small quantity of lithium were produced in the first few minutes of the Big Bang.
- This Big Bang nucleosynthesis happened only once; the other processes are ongoing. Nuclear fusion inside stars produces elements through stellar nucleosynthesis, including all elements from carbon to iron in atomic number.
- Elements higher in atomic number than iron, including heavy elements like uranium and plutonium, are produced by various forms of explosive nucleosynthesis in supernovae and neutron star mergers.
- The light elements lithium, beryllium and boron are produced mostly through cosmic ray spallation (fragmentation induced by cosmic rays) of carbon, nitrogen, and oxygen.

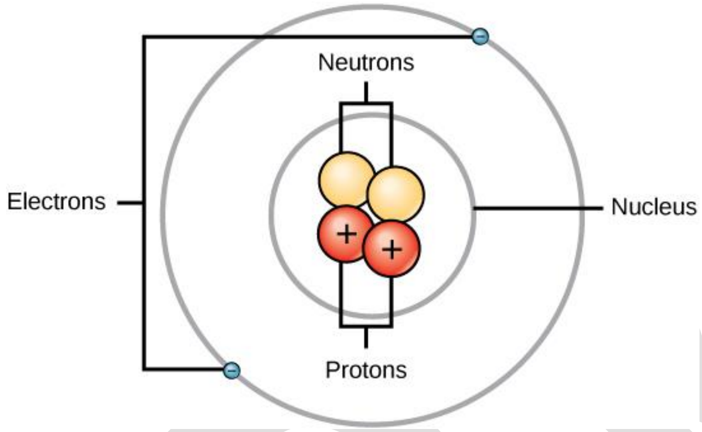
Sr.no.	**Question**	**Answer**
1	.... defines the atomic number of elements	Number of protons
2	Atomic number represent by the symbol.......	*Z*
3	Who published the first recognizable periodic table?	Dmitri Mendeleev
4	Give name of the elements which produced in first few minutes of big bang?	Hydrogen , helium and lithium
5	A light element like lithium is produced through..........	Cosmic ray spallation

ATOMS STRUCTURE AND COMPOSITION

- An atom is the smallest unit of matter that retains all of the chemical properties of an element. Atoms combine to form molecules, which then interact to form solids, gases, or liquids.
- For example, water is composed of hydrogen and oxygen atoms that have combined to form water molecules. Many biological processes are devoted to breaking down molecules into their component atoms so they can be reassembled into a more useful molecule.

Atomic Particles

- Atoms consist of three basic particles: protons, electrons, and neutrons. The nucleus (center) of the atom contains the protons (positively charged) and the neutrons (no charge). The outermost regions of the atom are called electron shells and contain the electrons (negatively charged). Atoms have different properties based on the arrangement and number of their basic particles.
- The hydrogen atom (H) contains only one proton, one electron, and no neutrons. This can be determined using the atomic number and the mass number of the element (see the concept on atomic numbers and mass numbers).



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- **Atomic number**
- The atomic number of an element is equal to the number of protons in each atom, and defines the element. For example, all carbon atoms contain 6 protons in their atomic nucleus; so the atomic number of carbon is 6.
- Carbon atoms may have different numbers of neutrons; atoms of the same element having different numbers of neutrons are known as isotopes of the element.
- The number of protons in the atomic nucleus also determines its electric charge, which in turn determines the number of electrons of the atom in its non-ionized state.
- The electrons are placed into atomic orbitals that determine the atom's various chemical properties. The number of neutrons in a nucleus usually has very little effect on an element's chemical properties (except in the case of hydrogen and deuterium).
- Thus, all carbon isotopes have nearly identical chemical properties because they all have six protons and six electrons, even though carbon atoms may, for example, have 6 or 8 neutrons.
- That is why the atomic number, rather than mass number or atomic weight, is considered the identifying characteristic of a chemical element.
- The symbol for atomic number is Z.

atomic mass

- The mass number of an element, A, is the number of nucleons (protons and neutrons) in the atomic nucleus. Different isotopes of a given element are distinguished by their mass numbers, which are conventionally written as a superscript on the left hand side of the atomic symbol (e.g. ^{238}U).

- The mass number is always a whole number and has units of "nucleons". For example, magnesium-24 (24 is the mass number) is an atom with 24 nucleons (12 protons and 12 neutrons).
- Whereas the mass number simply counts the total number of neutrons and protons and is thus a natural (or whole) number, the atomic mass of a single atom is a real number giving the mass of a particular isotope (or "nuclide") of the element, expressed in atomic mass units (symbol: u).
- In general, the mass number of a given nuclide differs in value slightly from its atomic mass, since the mass of each proton and neutron is not exactly 1 u; since the electrons contribute a lesser share to the atomic mass as neutron number exceeds proton number; and (finally) because of the nuclear binding energy.
- For example, the atomic mass of chlorine-35 to five significant digits is 34.969 u and that of chlorine-37 is 36.966 u. However, the atomic mass in u of each isotope is quite close to its simple mass number (always within 1%).
- The only isotope whose atomic mass is exactly a natural number is ^{12}C, which by definition has a mass of exactly 12 because u is defined as 1/12 of the mass of a free neutral carbon-12 atom in the ground state.
- The standard atomic weight (commonly called "atomic weight") of an element is the *average* of the atomic masses of all the chemical element's isotopes as found in a particular environment, weighted by isotopic abundance, relative to the atomic mass unit.
- This number may be a fraction that is *not* close to a whole number. For example, the relative atomic mass of chlorine is 35.453 u, which differs greatly from a whole number as it is an average of about 76% chlorine-35 and 24% chlorine-37.
- Whenever a relative atomic mass value differs by more than 1% from a whole number, it is due to this averaging effect, as significant amounts of more than one isotope are naturally present in a sample of that element.

Isotopes

- Isotopes are atoms of the same element (that is, with the same number of protons in their atomic nucleus), but having *different* numbers of neutrons. Thus, for example, there are three main isotopes of carbon.
- All carbon atoms have 6 protons in the nucleus, but they can have either 6, 7, or 8 neutrons. Since the mass numbers of these are 12, 13 and 14 respectively, the three isotopes of carbon are known as carbon-12, carbon-13, and carbon-14, often abbreviated to ^{12}C, ^{13}C, and ^{14}C. Carbon in everyday life and in chemistry is

a mixture of ^{12}C (about 98.9%), ^{13}C (about 1.1%) and about 1 atom per trillion of ^{14}C.

- Most (66 of 94) naturally occurring elements have more than one stable isotope. Except for the isotopes of hydrogen (which differ greatly from each other in relative mass—enough to cause chemical effects), the isotopes of a given element are chemically nearly indistinguishable.
- All of the elements have some isotopes that are radioactive (radioisotopes), although not all of these radioisotopes occur naturally. The radioisotopes typically decay into other elements upon radiating an alpha or beta particle. If an element has isotopes that are not radioactive, these are termed "stable" isotopes.
- All of the known stable isotopes occur naturally (see primordial isotope). The many radioisotopes that are not found in nature have been characterized after being artificially made. Certain elements have no stable isotopes and are composed *only* of radioactive isotopes: specifically the elements without any stable isotopes are technetium (atomic number 43), promethium (atomic number 61), and all observed elements with atomic numbers greater than 82.
- Of the 80 elements with at least one stable isotope, 26 have only one single stable isotope. The mean number of stable isotopes for the 80 stable elements is 3.1 stable isotopes per element.
- The largest number of stable isotopes that occur for a single element is 10 (for tin, element 50).

Half life of radioactive isotopes

- The **half-life of a radioactive isotope** is the amount of time it takes for one-**half** of the **radioactive isotope** to decay.
- The **half-life** of a specific **radioactive isotope** is constant; it is unaffected by conditions and is independent of the initial amount of that **isotope.**
- The radioactive isotope cobalt-60, which is used for radiotherapy, has, for example, a half-life of 5.26 years. Thus after that interval, a sample originally containing 8 g of cobalt-60 would contain only 4 g of cobalt-60 and would emit only half as much radiation.
- After another interval of 5.26 years, the sample would contain only 2 g of cobalt-60. Neither the volume nor the mass of the original sample visibly decreases, however, because the unstable cobalt-60 nuclei decay into stable nickel-60 nuclei, which remain with the still-undecayed cobalt.
- Half-lives are characteristic properties of the various unstable atomic nuclei and the particular way in which they decay. Alpha and beta decay are generally slower processes than gamma decay.

- Half-lives for beta decay range upward from one-hundredth of a second and, for alpha decay, upward from about one one-millionth of a second. Half-lives for gamma decay may be too short to measure (around 10^{-14} second), though a wide range of half-lives for gamma emission has been reported.

Sr.no.	Question	Answer
1	Outermost region of atom is called..........	Electron shells
2	Atomic number of the carbon atom is..........	6
3	Unit of mass number	Nucleons
4	What is the half-life of cobalt – 60?	5.26 years
5	Define isotopes	Isotopes are atoms that have same number of protons and different number of neutrons

MOLECULES AND CHEMICAL BONDS

MOLECULES

- An atom may exist separately, in combination with dissimilar atoms, or in some cases, combined with like atoms e.g. two atoms of hydrogen may share electron to form H_2, oxygen atoms generally paired with O_2.

- Atoms pair with unlike atoms and result in the formation of compounds. A compound that is formed by combination of atoms other than carbon is considered as inorganic compound NaCl, NaOH, those contain carbon are generally termed organic compound. For example CH_4.

- A molecule is formed when two or more atoms join together chemically. A molecule is defined as a group of at least two atoms in a definite arrangement held together by chemical bonds a compound is composed of at least two or more different elements.

- All compounds are molecules but all molecules are not compound. Chemical composition of a molecule is also known As chemical formula.

- Molecules as components of matter are common in organic substances. They also make up most of the oceans and atmosphere. A large number of familiar solid substance, however including most of the minerals that make up the crust, mantle, and core of the earth itself, contain many chemical bonds but are not made of identifiable molecules.

- Most molecules are far too small to be seen with the naked eye, but there are exception, DNA, a macromolecule can reach macroscopic sizes similar to many polymers. The smallest molecule is hydrogen with a length of 0.74A°.

- Molecules commonly used as building blocks for organic synthesis have a dimension of a few A° to several .

- Two hydrogen atoms, each with one electron, combine to form a hydrogen molecule, in which the two electrons are shared between the atoms and serve to give each atom a filled valance shell.

- Chemical bonds are broadly classified into two types. Primary bonds and secondary bonds. Primary bonds are strong bonds and hold atoms together in a molecule. The secondary bonds are weak bonds and are found between biological molecules.

Sr.no.	**Question**	**Answer**
1	What is inorganic compound?	Compound that is formed by combination of atoms other then carbon is called inorganic compound
2	Chemical composition of a molecule is known as...........	Chemical formula
3	Length of hydrogen is.........	0.74A°
4	Chemical bonds are classified into how many types?	2
5	Secondary bonds are found between	biological

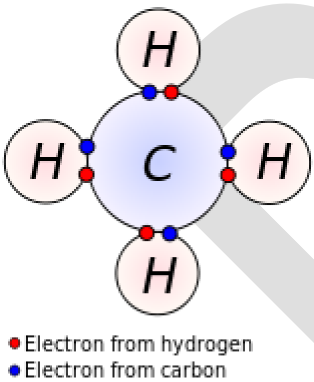
	molecules.	

- Not all atoms bond the same way so, we need to learn the different types of bonds that atoms can form, there are four sometimes five recognized chemical bonds they are

- Covalent, 2) ionic or electrovalent 3) polar covalent, 4) hydrogen, 5) coordinate bonds

COVALENT BOND

- **Covalent bond**

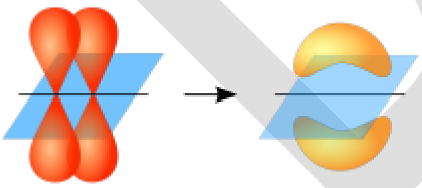


- Non-polar covalent bonds in methane (CH_4). The Lewis structure shows electrons shared between C and H atoms.
- Covalent bonding is a common type of bonding in which two or more atoms share valence electrons more or less equally.
- The simplest and most common type is a single bond in which two atoms share two electrons. Other types include the double bond, the triple bond, one- and three-electron bonds, the three-center two-electron bond and three-center four-electron bond.
- In non-polar covalent bonds, the electronegativity difference between the bonded atoms is small, typically 0 to 0.3. Bonds within most organic compounds are described as covalent.
- The figure shows methane (CH_4), in which each hydrogen forms a covalent bond with the carbon. See sigma bonds and pi bonds for LCAO descriptions of such bonding.

- Molecules that are formed primarily from non-polar covalent bonds are often immiscible in water or other polar solvents, but much more soluble in non-polar solvents such as hexane.
- A polar covalent bond is a covalent bond with a significant ionic character. This means that the two shared electrons are closer to one of the atoms than the other, creating an imbalance of charge.
- Such bonds occur between two atoms with moderately different electronegativities and give rise to dipole–dipole interactions. The electronegativity difference between the two atoms in these bonds is 0.3 to 1.7.

Single and multiple bonds

- A single bond between two atoms corresponds to the sharing of one pair of electrons. The Hydrogen (H) atom has one valence electron. Two Hydrogen atoms can then form a molecule, held together by the shared pair of electrons.
- Each H atom now has the noble gas electron configuration of helium (He). The pair of shared electrons forms a single covalent bond. The electron density of these two bonding electrons in the region between the two atoms increases from the density of two non-interacting H atoms.



- Two p-orbitals forming a pi-bond.
- A double bond has two shared pairs of electrons, one in a sigma bond and one in a pi bond with electron density concentrated on two opposite sides of the internuclear axis. A triple bond consists of three shared electron pairs, forming one sigma and two pi bonds. An example is nitrogen. Quadruple and higher bonds are very rare and occur only between certain transition metal atoms.

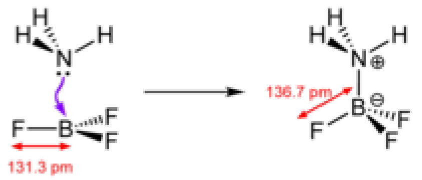
HYDROGEN BONDS

- **hydrogen bond** (often informally abbreviated **H-bond**) is a primarily electrostatic force of attraction between a hydrogen (H) atom which is covalently bound to a more electronegative atom or group, and another electronegative atom bearing a lone pair of electrons—the hydrogen bond acceptor (Ac).

- It is hydrogen bonds that are responsible for holding together such materials as paper and felted wool together, and for causing separate sheets of paper to stick together after becoming wet and subsequently drying.
- Such an interacting system is generally denoted Dn–H ···Ac, where the solid line denotes a polar covalent bond, and the dotted or dashed line indicates the hydrogen bond.
- Hydrogen bonds can be intermolecular (occurring between separate molecules) or intramolecular (occurring among parts of the same molecule). Depending on the nature of the donor and acceptor atoms which constitute the bond, their geometry, and environment, the energy of a hydrogen bond can vary between 1 and 40 kcal/mol.
- This makes them somewhat stronger than a van der Waals interaction, and weaker than fully covalent or ionic bonds. This type of bond can occur in inorganic molecules such as water and in organic molecules like DNA and proteins.
- The hydrogen bond is responsible for many of the anomalous physical and chemical properties of compounds of N, O, and F. In particular, intermolecular hydrogen bonding is responsible for the high boiling point of water (100 °C) compared to the other group 16 hydrides that have much weaker hydrogen bonds.
- Intramolecular hydrogen bonding is partly responsible for the secondary and tertiary structures of proteins and nucleic acids. It also plays an important role in the structure of polymers, both synthetic and natural.

COORDINATE BONDS

- *Coordinate covalent bond (dipolar bond)*



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- Adduct of ammonia and boron trifluoride
- A coordinate covalent bond is a covalent bond in which the two shared bonding electrons are from the same one of the atoms involved in the bond. For example, boron trifluoride (BF_3) and ammonia (NH_3) form an adduct or coordination complex $F_3B{\leftarrow}NH_3$ with a B–N bond in which a lone pair of electrons on N is shared with an empty atomic orbital on B. BF_3 with an

empty orbital is described as an electron pair acceptor or Lewis acid, while NH_3 with a lone pair that can be shared is described as an electron-pair donor or Lewis base.

- The electrons are shared roughly equally between the atoms in contrast to ionic bonding. Such bonding is shown by an arrow pointing to the Lewis acid.
- Transition metal complexes are generally bound by coordinate covalent bonds. For example, the ion Ag^+ reacts as a Lewis acid with two molecules of the Lewis base NH_3 to form the complex ion $Ag(NH_3)_2^+$, which has two Ag←N coordinate covalent bond

IONIC BOND

- **Ionic bond**
- Ionic bonding is a type of electrostatic interaction between atoms that have a large electronegativity difference. There is no precise value that distinguishes ionic from covalent bonding, but an electronegativity difference of over 1.7 is likely to be ionic while a difference of less than 1.7 is likely to be covalent.
- Ionic bonding leads to separate positive and negative ions. Ionic charges are commonly between −3e to +3e. Ionic bonding commonly occurs in metal salts such as sodium chloride (table salt).
- A typical feature of ionic bonds is that the species form into ionic crystals, in which no ion is specifically paired with any single other ion in a specific directional bond. Rather, each species of ion is surrounded by ions of the opposite charge, and the spacing between it and each of the oppositely charged ions near it is the same for all surrounding atoms of the same type.
- It is thus no longer possible to associate an ion with any specific other single ionized atom near it. This is a situation unlike that in covalent crystals, where covalent bonds between specific atoms are still discernible from the shorter distances between them, as measured via such techniques as X-ray diffraction.
- Ionic crystals may contain a mixture of covalent and ionic species, as for example salts of complex acids such as sodium cyanide, NaCN. X-ray diffraction shows that in NaCN, for example, the bonds between sodium cations (Na^+) and the cyanide anions (CN^-) are *ionic*, with no sodium ion associated with any particular cyanide.
- However, the bonds between C and N atoms in cyanide are of the *covalent* type, so that each carbon is strongly bound to *just one* nitrogen, to which it is physically much closer than it is to other carbons or nitrogens in a sodium cyanide crystal.

- When such crystals are melted into liquids, the ionic bonds are broken first because they are non-directional and allow the charged species to move freely.
- Similarly, when such salts dissolve into water, the ionic bonds are typically broken by the interaction with water but the covalent bonds continue to hold. For example, in solution, the cyanide ions, still bound together as single CN^- ions, move independently through the solution, as do sodium ions, as Na^+.
- In water, charged ions move apart because each of them are more strongly attracted to a number of water molecules than to each other. The attraction between ions and water molecules in such solutions is due to a type of weak dipole-dipole type chemical bond. In melted ionic compounds, the ions continue to be attracted to each other, but not in any ordered or crystalline way.

VANDER WAAL'S INTERACTION

- The basis of vander waal's interaction is that the distribution of electronic charge around an atom changes with time. The charge distribution is not perfectly symmetric.
- This asymmetry in the electronic charge around an atom acts through electrostatic interaction to include a complementary asymmetry in the electron distribution around its neighboring atoms.
- The resulting attraction between two atoms increase as they come closer to each other. These are very important type of bonds in biological systems. They can be broken by very little energy.

POLAR COVALENT BONDS

- Polar covalent bonds are usually formed between two nonmetal atoms having different electronegativities.
- Let us consider A and B in which them is electronegativity difference is not equal to zero contains a covalent bond between them. The shared pair of electrons forming a bond between A and B move towards move electronegative B.
- Then B gets partial negative charge and attains 'A' gets partial positive charge them, with two charges (Poles are formed and it is known as Dipolar molecular or dipole or polar covalent module) as in H – Cl. In this molecule the shared pair of electron moves towards high electronegative chlorine atom. Then H atom gets partial positive charge and Cl atom gets a partial negative charge, hence a dipole is formed.

Properties of Polar Covalent Compounds

- **Physical state:** These compounds can exist as solids due to greater force of interactions.
- **Melting and boiling points:** These have greater melting and boiling point than non-polar compounds.

- **Conductivity:** They conduct electricity in the solution state due to the mobility of ions.
- **Solubility:** These are highly soluble in polar solvents like water.

COORDINATE BOND

- **A** covalent bond is formed by two atoms sharing a pair of electrons. The atoms are held together because the electron pair is attracted by both of nuclei. In the formation of a simple covalent bond, each atom supplied electron to the bond but that doesn't have to be the case. A coordinate is a covalent bond in which electron comes from the same atom.

CHEMICAL REACTION

- **Chemical reaction**, a process in which one or more substances, the reactants, are converted to one or more different substances, the products.
- Substances are either chemical elements or compounds. A chemical reaction rearranges the constituent atoms of the reactants to create different substances as products.
- Chemical reactions are an integral part of technology, of culture, and indeed of life itself. Burning fuels, smelting iron, making glass and pottery, brewing beer, and making wine and cheese are among many examples of activities incorporating chemical reactions that have been known and used for thousands of years.
- Chemical reactions abound in the geology of Earth, in the atmosphere and oceans, and in a vast array of complicated processes that occur in all living systems.
- Chemical reactions must be distinguished from physical changes. Physical changes include changes of state, such as ice melting to water and water evaporating to vapour. If a physical change occurs, the physical properties of a substance will change, but its chemical identity will remain the same. No matter what its physical state, water (H_2O) is the same compound, with each molecule composed of two atoms of hydrogen and one atom of oxygen.

- However, if water, as ice, liquid, or vapour, encounters sodium metal (Na), the atoms will be redistributed to give the new substances molecular hydrogen (H_2) and sodium hydroxide (NaOH). By this, we know that a chemical change or reaction has occurred.

Sr.no.	Question	Answer
1	In non-polar covalent bond the electro negativity difference between the bonds is.......	0 to 0.3

2	Energy of hydrogen bond can vary between.........	1 and 40 kcal/mol
3	.... metal complexes are generally bound by coordinate covalent bonds	transition
4	Ionic charges are commonly between..........	-3e to $^{+}$3e
5	How covalent bond is formed?	A covalent bond is formed by two atoms sharing a pair of electrons

- **BIOCHEMICAL REACTION(enzymatic reaction)**

- Enzymatic reactions have the advantage of being specific; for example, hydrolysis of sucrose is more accurate using invertase than an acid.

- A wide range of sugar analysis kits is available commercially; for example, sucrose/glucose/fructose kits are particularly suitable for fruit and fruit products. They, in common with the copper reduction methods, have the advantage of simple sample preparation techniques.

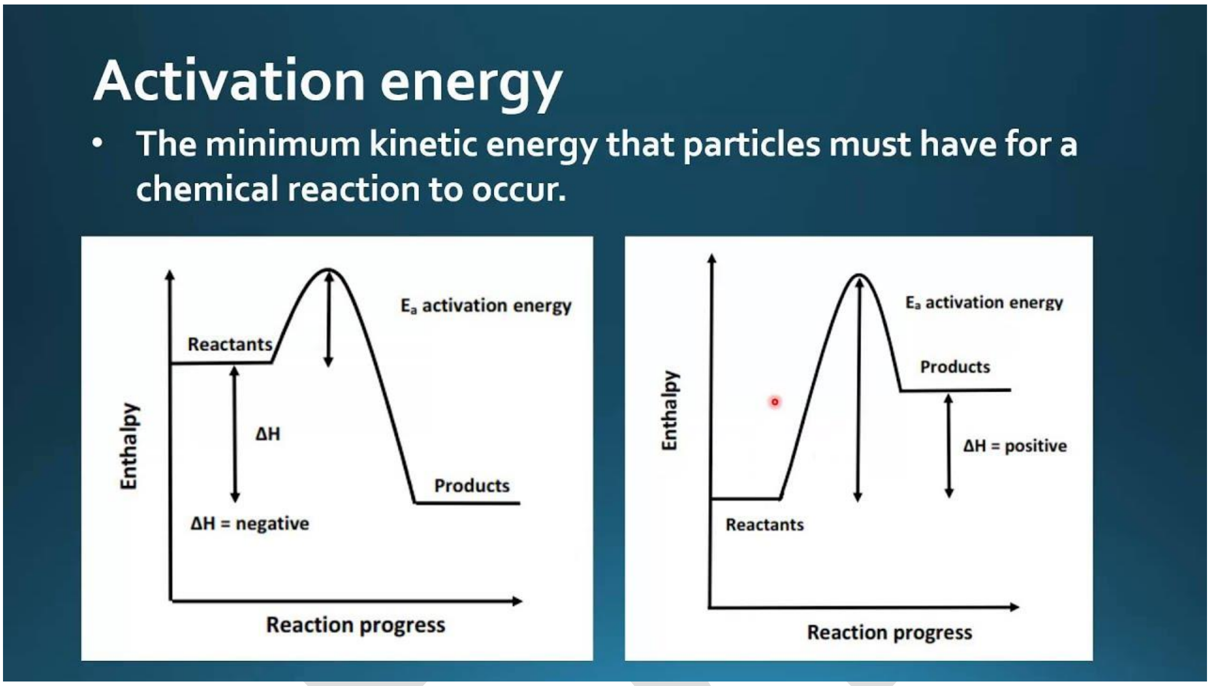
- The enzymatic reactions involved cause the reduction of $NADP^+$, the concentration of which is determined by spectrophotometry at 340 or 366 nm. Great care is needed in their use because of the very precise quantities involved; however, the results obtained compare favorably with more traditional methods and the methods are now widely accepted.

- All chemical reaction an input of energy, irrespective of it being as endothermic or exothermic reaction, to begin the reaction. This energy is used to rearrange the electrons of reactants in such a way that they become ready to participate in the reaction process and gets transformed in to a product.

- This energy is called activation energy. This energy is generally obtained by the collision of the molecules of the reactants.

- Chemical reaction can be fastening up by lowering the activation energy. This can be achieved in a laboratory by heating the reaction mixture.

- Biochemical reaction take place within a living cell where increasing the reaction temperature is not feasible. Such reaction are mainly controlled by enzymes.

- 

- enzymes are proteins that act as biological catalyst to speed up the rate of biological reaction by lowering the activation energy of the reaction.

- They allow all the biochemical reaction to occur at physiological temperature. Enzyme can specifically catalyze a single reaction, so that reaction can be controlled very precisely.

- The reaction takes place in the active site, a small part of the enzyme which is usually found in a cleft or pocket lined by amino acid residues, and the rest of the enzyme is used mainly for stabilization.

- The catalytic action of enzyme relies on several mechanisms including the molecular shape “induced fit” bond strain, proximity and orientation of molecules relatively to the enzyme proton donation or withdrawal, electrostatic interaction and many others.

- The biochemical reaction that occur in living organisms are collective known as metabolisms.

- Among the most important its mechanisms is the anabolism, in which different DNA and enzyme controlled processes result in the production of large molecules such as protein and carbohydrates from smaller units. Bioenergetics studies the sources of energy for such reactions.

- An important energy sources is glucose, which can be produced by plants via photosynthesis or assimilated from food.

- All organisms use this energy to produce ATP which can then be used to energize other reaction.

Sr.no.	Question	Answer
1	How activation energy is generated?	By the collision of the molecules of the reactants
2	How chemical reaction is fasting up?	By lowering the activation energy
3	Enzymatic reaction takes place at......	Active site of enzymes
4	What is metabolism?	The biochemical reactions that occur in living organisms are collective known as metabolisms.
5	Give name of an important energy source	glucose

OXIDATIN REDUCTION REACTION

- Many biochemical reaction, especially those involved in energy generation and utilization are of oxidation-reduction type. They are also called redox reaction.

- Oxidation reduction reactions are a type of chemical reaction that involves a transfer of electrons between two species. A number of a molecule, atom or ion changes by gaining or losing an e.

- they occur every day and are vital to some of the Basic function of life. Some examples include photosynthesis, respiration, combustion, corrosion or rusting.

- **Oxidation** is the loss of electron or increase in oxidation state a molecule atom or ion.

- **Reduction** is the gain of electron or decrease in oxidation state by a molecule, atom or ion.

- **Oxidizing agent** is substances that have the ability to oxidize other substances. Oxidizing agent removes electrons from another substances, and is thus itself reduced, and because it accepts electrons, the oxidizing agent is also called an electron acceptor, hence the name. oxygen is the quintessential oxidizer.

- Oxidants are usually chemical substances with elements in high oxidation states or else highly elecreonegative elements.

- **Reducing agent** is substance that have the ability to reduce other substances. The reductant transfer electron to another substance, and is thus itself oxidized, And because it donates electrons the reducing agent is also called an electron donor.

- Electron donor can also form charge transfer complexes with electron acceptors.

- To understand these types of reactions, you must first understand oxidation numbers or states. Which can be explained by transfer of electrons between molecules from reducing agent to another oxidizing agent.

- In this process, the reducing agent is oxidized and the oxidizing agent is reduced. It generate redox. Oxidation can be defined as an increase in oxidation number, and reduction as a decrease in oxidation number.

- In practice the transfer of electrons will always change the oxidation number, but there are many reactions that are classed as "redox" even though no electron transfer occurs, ex. Formation of covalent bonds.

Coenzymes

- A coenzyme is an organic non-protein compound that binds with an enzyme to catalyze a reaction. Coenzymes are often broadly called cofactors, but they are chemically different. A coenzyme cannot function alone, but can be reused several times when paired with an enzyme.

Functions of Coenzymes

- An enzyme without a coenzyme is called an *apoenzyme*. Without coenzymes or cofactors, enzymes cannot catalyze reactions effectively. In fact, the enzyme may not function at all. If reactions cannot occur at the normal catalyzed rate, then an organism will have difficulty sustaining life.

- When an enzyme gains a coenzyme, it then becomes a *holoenzyme*, or active enzyme. Active enzymes change substrates into the products an organism needs to carry out essential functions, whether chemical or physiological.

- Coenzymes, like enzymes, can be reused and recycled without changing reaction rate or effectiveness. They attach to a portion of the active site on an enzyme, which enables the catalyzed reaction to occur. When an enzyme is denatured by extreme temperature or pH, the coenzyme can no longer attach to the active site.

Types of Enzymes

- Cofactors are molecules that attach to an enzyme during chemical reactions. In general, all compounds that help enzymes are called cofactors. However, cofactors can be broken down into three subgroups based on chemical makeup and function:

- **Coenzymes**

- These are reusable non-protein molecules that contain carbon (organic). They bind loosely to an enzyme at the active site to help catalyze reactions. Most are vitamins, vitamin derivatives, or form from nucleotides.

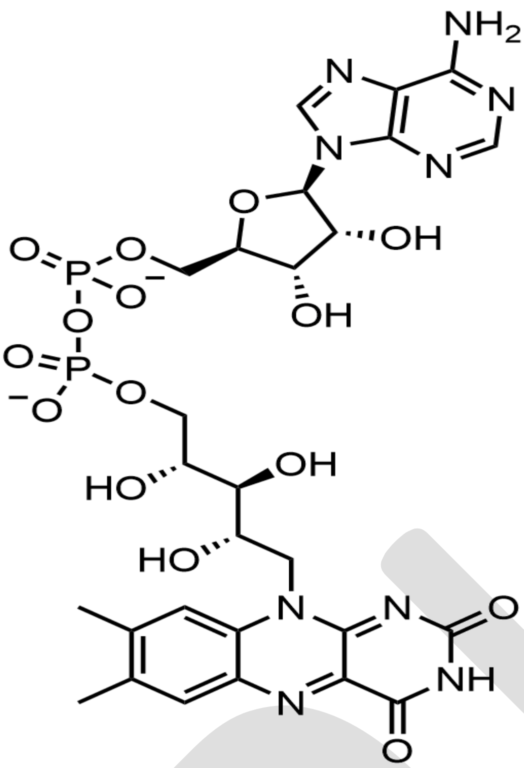
- **Nicotinamide adenine dinucleotide (NAD)**

- **Nicotinamide adenine dinucleotide** (**NAD**) is a coenzyme central to metabolism. Found in all living cells, NAD is called a dinucleotide because it consists of two nucleotides joined through their phosphate groups. One nucleotide contains an adenine nucleobase and the other nicotinamide.

- NAD exists in two forms: an oxidized and reduced form, abbreviated as **NAD$^+$** and **NADH** (H for hydrogen) respectively.

- **Flavin adenine dinucleotide(FAD)**

- in biochemistry, **flavin adenine dinucleotide** (**FAD**) is a redox-active coenzyme associated with various proteins, which is involved with several enzymatic reactions in metabolism. A flavoprotein is a protein that contains a flavin group, which may be in the form of FAD or flavin mononucleotide (FMN).
- Many flavoproteins are known: components of the succinate dehydrogenase complex, α-ketoglutarate dehydrogenase, and a component of the pyruvate dehydrogenase complex.



- Structure of FAD

- FAD can exist in four redox states, which are the flavin-N(5)-oxide, quinone, semiquinone, and hydroquinone.[1] FAD is converted between these states by accepting or donating electrons. FAD, in its fully oxidized form, or quinone form, accepts two electrons and two protons to become $FADH_2$ (hydroquinone form).

- The semiquinone (FADH·) can be formed by either reduction of FAD or oxidation of $FADH_2$ by accepting or donating one electron and one proton, respectively. Some proteins, however, generate and maintain a superoxidized form of the flavin cofactor, the flavin-N(5)-oxide.

Sr.no.	Question	Answer
1	What is redox reaction?	Oxidation reduction reactions are called redox reaction
2	What is oxidation?	Oxidation is the loss of electron or increase in oxidation state a molecule atom or ion.

3	What is reduction?	Reduction is the gain of electron or decrease in oxidation state by a molecule, atom or ion.
4	Give full form of FAD	Flavin adenine dinucleotide
5	Give full form of NAD	Nicotinamide adenine dinucleotide

- **REDUCTION POTENTIAL**
- Reduction potential is a measure of the tendency of a chemical species to acquire electrons and thereby be reduced. Reduction potential measured in volts or millivolts. Each species has its own intrinsic reduction potential the more positive the potential the grater the species affinity for electrons and tendency to be reduced. ORP is a common measurement for water quality.
- The reduction potential for the reduction of hydrogen ion to hydrogen has been arbitrarily assigned a value of 0.0 volts.
- A substance whose reduction potential is less than that of hydrogen ion is reduced less easily than is hydrogen ion, a substance whose eduction potential is positive is more easily reduced than hydrogen.
- **Acid base reactions:**
- When an acid and a base are placed together, they react to neutralize the acid and base properties, producing salt. The H^+ cation of the acid combine with the OH^- anion of the base to form water.
- The compound formed by the cation of the base and anion of the acid is called a salt. The combination of hydrochloric acid and sodium hydroxide produces common table salt, NaCl
- $HCl + NaOH \rightarrow NaCl + H_2O$
- The word salt is a general term which applies to the products of all such acid base reaction.
- An **acid–base reaction** is a chemical reaction that occurs between an acid and a base. It can be used to determine pH.

- Several theoretical frameworks provide alternative conceptions of the reaction mechanisms and their application in solving related problems; these are called the acid–base theories, for example, Brønsted–Lowry acid–base theory.
- Their importance becomes apparent in analyzing acid–base reactions for gaseous or liquid species, or when acid or base character may be somewhat less apparent. The first of these concepts was provided by the French chemist Antoine Lavoisier, around 1776.
- It is important to think of the acid-base reaction models as theories that complement each other.
- For example, the current Lewis model has the broadest definition of what an acid and base are, with the Brønsted-Lowry theory being a subset of what acids and bases are, and the Arrhenius theory being the most restrictive.
- **Arrhenius definition**

- Svante Arrhenius
- The first modern definition of acids and bases in molecular terms was devised by Svante Arrhenius.
- A hydrogen theory of acids, it followed from his 1884 work with Friedrich Wilhelm Ostwald in establishing the presence of ions in aqueous solution and led to Arrhenius receiving the Nobel Prize in Chemistry in 1903.
- As defined by Arrhenius:
- *an Arrhenius acid* is a substance that dissociates in water to form hydrogen ions (H^+); that is, an acid increases the concentration of H^+ ions in an aqueous solution.
- This causes the protonation of water, or the creation of the hydronium (H_3O^+) ion.
- Thus, in modern times, the symbol H^+ is interpreted as a shorthand for H_3O^+, because it is now known that a bare proton does not exist as a free species in aqueous solution.
- *an Arrhenius base is a substance that dissociates in water to form hydroxide (OH^-) ions; that is, a base increases the concentration of OH^- ions in an aqueous solution."*

- The Arrhenius definitions of acidity and alkalinity are restricted to aqueous solutions, and refer to the concentration of the solvent ions. Under this definition, pure H_2SO_4 and HCl dissolved in toluene are not acidic, and molten NaOH and solutions of calcium amide in liquid ammonia are not alkaline.
- This led to the development of the Brønsted-Lowry theory and subsequent Lewis theory to account for these non-aqueous exceptions.[15]
- Overall, to qualify as an Arrhenius acid, upon the introduction to water, the chemical must either cause, directly or otherwise:an increase in the aqueous hydronium concentration, or a decrease in the aqueous hydroxide concentration.
- Conversely, to qualify as an Arrhenius base, upon the introduction to water, the chemical must either cause, directly or otherwise: a decrease in the aqueous hydronium concentration, or an increase in the aqueous hydroxide concentration.
- The reaction of an acid with a base is called a neutralization reaction. The products of this reaction are a salt and water.

  acid + base → salt + water
- In this traditional representation an acid–base neutralization reaction is formulated as a double-replacement reaction.
- For example, the reaction of hydrochloric acid, HCl, with sodium hydroxide, NaOH, solutions produces a solution of sodium chloride, NaCl, and some additional water molecules.

○ $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O$

- The modifier (aq) in this equation was implied by Arrhenius, rather than included explicitly. It indicates that the substances are dissolved in water. Though all three substances, HCl, NaOH and NaCl are capable of existing as pure compounds, in aqueous solutions they are fully dissociated into the aquated ions H^+, Cl^-, Na^+ and OH^-.
- **Brønsted–Lowry definition**
- *Main article: Brønsted–Lowry acid–base theory*


- Johannes Nicolaus Brønsted and Thomas Martin Lowry

- The Brønsted–Lowry definition, formulated in 1923, independently by Johannes Nicolaus Brønsted in Denmark and Martin Lowry in England, is based upon the idea of protonation of bases through the deprotonation of acids – that is, the ability of acids to "donate" hydrogen ions (H^+)—otherwise known as protons—to bases, which "accept" them.
- An acid–base reaction is, thus, the removal of a hydrogen ion from the acid and its addition to the base. The removal of a hydrogen ion from an acid produces its *conjugate base*, which is the acid with a hydrogen ion removed. The reception of a proton by a base produces its *conjugate acid*, which is the base with a hydrogen ion added.
- Unlike the previous definitions, the Brønsted–Lowry definition does not refer to the formation of salt and solvent, but instead to the formation of *conjugate acids* and *conjugate bases*, produced by the transfer of a proton from the acid to the base.
- In this approach, acids and bases are fundamentally different in behavior from salts, which are seen as electrolytes, subject to the theories of Debye, Onsager, and others. An acid and a base react not to produce a salt and a solvent, but to form a new acid and a new base. The concept of neutralization is thus absent.
- Brønsted–Lowry acid–base behavior is formally independent of any solvent, making it more all-encompassing than the Arrhenius model. The calculation of pH under the Arrhenius model depended on alkalis (bases) dissolving in water (aqueous solution).
- The Brønsted–Lowry model expanded what could be pH tested using insoluble and soluble solutions (gas, liquid, solid).
- The general formula for acid–base reactions according to the Brønsted–Lowry definition is:

○ $HA + B \rightarrow BH^+ + A^-$

- where HA represents the acid, B represents the base, BH^+ represents the conjugate acid of B, and A^- represents the conjugate base of HA.
- For example, a Brønsted-Lowry model for the dissociation of hydrochloric acid (HCl) in aqueous solution would be the following:

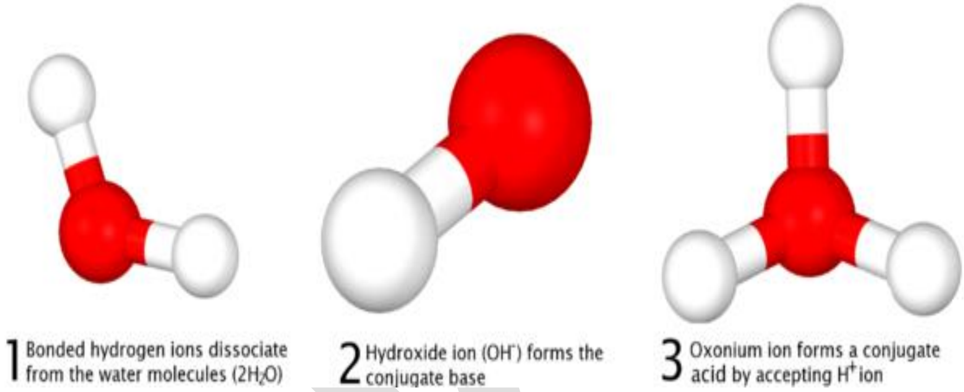
○ $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

- The removal of H^+ from the HCl produces the chloride ion, Cl^-, the conjugate base of the acid. The addition of H^+ to the H_2O (acting as a base) forms the hydronium ion, H_3O^+, the conjugate acid of the base.

- Water is amphoteric—that is, it can act as both an acid and a base. The Brønsted-Lowry model explains this, showing the dissociation of water into low concentrations of hydronium and hydroxide ions:

  - $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$

    - This equation is demonstrated in the image below:



- Here, one molecule of water acts as an acid, donating an H^+ and forming the conjugate base, OH^-, and a second molecule of water acts as a base, accepting the H^+ ion and forming the conjugate acid, H_3O^+.
- As an example of water acting as an acid, consider an aqueous solution of pyridine, C_5H_5N.

  - $C_5H_5N + H_2O \rightleftharpoons [C_5H_5NH]^+ + OH^-$

- In this example, a water molecule is split into a hydrogen ion, which is donated to a pyridine molecule, and a hydroxide ion.
- In the Brønsted-Lowry model, the solvent does not necessarily have to be water, as is required by the Arrhenius Acid-Base model. For example, consider what happens when acetic acid, CH_3COOH, dissolves in liquid ammonia.

  - $CH_3COOH + NH_3 \rightleftharpoons NH^+_4 + CH_3COO^-$

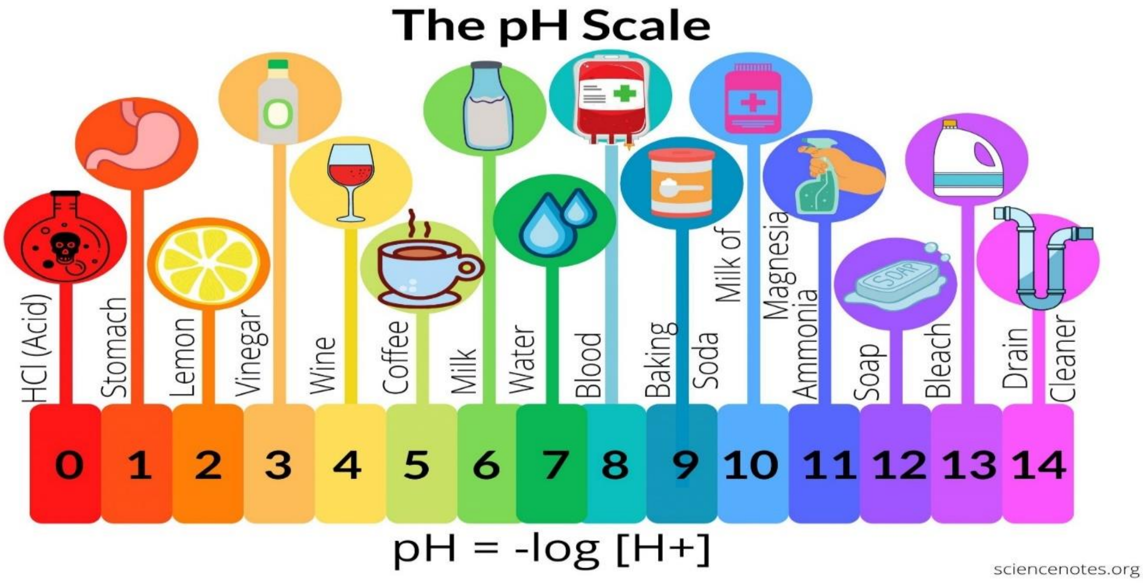
- An H^+ ion is removed from acetic acid, forming its conjugate base, the acetate ion, CH_3COO^-. The addition of an H^+ ion to an ammonia molecule of the solvent creates its conjugate acid, the ammonium ion, NH^+_4.
- The Brønsted–Lowry model calls hydrogen-containing substances (like HCl) acids. Thus, some substances, which many chemists considered to be acids, such as SO_3 or BCl_3, are excluded from this classification due to lack of hydrogen. Gilbert N. Lewis wrote in 1938, "To restrict the group of acids to those substances that contain hydrogen interferes as seriously with the systematic understanding of chemistry as would the restriction of the term oxidizing agent to substances containing oxygen."

- Furthermore, KOH and KNH_2 are not considered Brønsted bases, but rather salts containing the bases OH^- and NH^-_2.

Lewis definition

- The hydrogen requirement of Arrhenius and Brønsted–Lowry was removed by the Lewis definition of acid–base reactions, devised by Gilbert N. Lewis in 1923,[20] in the same year as Brønsted–Lowry, but it was not elaborated by him until 1938.
- Instead of defining acid–base reactions in terms of protons or other bonded substances, the Lewis definition defines a base (referred to as a *Lewis base*) to be a compound that can donate an *electron pair*, and an acid (a *Lewis acid*) to be a compound that can receive this electron pair.[21]
- For example, boron trifluoride, BF_3 is a typical Lewis acid. It can accept a pair of electrons as it has a vacancy in its octet. The fluoride ion has a full octet and can donate a pair of electrons. Thus
  - $BF_3 + F^- \rightarrow BF^-_4$
- is a typical Lewis acid, Lewis base reaction. All compounds of group 13 elements with a formula AX_3 can behave as Lewis acids. Similarly, compounds of group 15 elements with a formula DY_3, such as amines, NR_3, and phosphines, PR_3, can behave as Lewis bases.
- Adducts between them have the formula $X_3A \leftarrow DY_3$ with a dative covalent bond, shown symbolically as ←, between the atoms A (acceptor) and D (donor). Compounds of group 16 with a formula DX_2 may also act as Lewis bases; in this way, a compound like an ether, R_2O, or a thioether, R_2S, can act as a Lewis base.
- The Lewis definition is not limited to these examples. For instance, carbon monoxide acts as a Lewis base when it forms an adduct with boron trifluoride, of formula $F_3B \leftarrow CO$.
- Adducts involving metal ions are referred to as co-ordination compounds; each ligand donates a pair of electrons to the metal ion.[21] The reaction
  - $[Ag(H_2O)_4]^+ + 2NH_3 \rightarrow [Ag(NH_3)_2]^+ + 4H_2O$
- can be seen as an acid–base reaction in which a stronger base (ammonia) replaces a weaker one (water)
- The Lewis and Brønsted–Lowry definitions are consistent with each other since the reaction is an acid–base reaction in both theories.

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



➢

➢ **CONDENSATION AND HYDROLYSIS REACTION**

➢ **Condensation** is the change of the physical state of matter from the gas phase into the liquid phase, and is the reverse of vaporization. The word most often refers to the water cycle.

➢ It can also be defined as the change in the state of water vapor to liquid water when in contact with a liquid or solid surface or cloud condensation nuclei within the atmosphere. When the transition happens from the gaseous phase into the solid phase directly, the change is called deposition.

➢ Condensation is initiated by the formation of atomic/molecular clusters of that species within its gaseous volume—like rain drop or snow flake formation within clouds—or at the contact between such gaseous phase and a liquid or solid surface.

➢ In clouds, this can be catalyzed by water-nucleating proteins, produced by atmospheric microbes, which are capable of binding gaseous or liquid water molecules

➢ HYDROLYSIS is any chemical reaction in which a molecule of water breaks one or more chemical bonds. The term is used broadly for substitution, elimination, and solvation reactions in which water is the nucleophile.

➢ Biological hydrolysis is the cleavage of biomolecules where a water molecule is consumed to effect the separation of a larger molecule into component parts.

- When a carbohydrate is broken into its component sugar molecules by hydrolysis (e.g., sucrose being broken down into glucose and fructose), this is recognized as saccharification.
- Hydrolysis reactions can be the reverse of a condensation reaction in which two molecules join together into a larger one and eject a water molecule. Thus hydrolysis adds water to break down, whereas condensation builds up by removing water.

Sr.no.	**Question**	**Answer**
1	Reduction potential measured in .... or........	Volts or millivolts
2	Acid – base reaction is used to determine........	pH
3	The first modern definition of acid and base derive by	Svante Arrhenius
4	What is the pH of blood in pH scale	8
5	By saccharification sucrose is broke down into .... &.........	Glucose & fructose

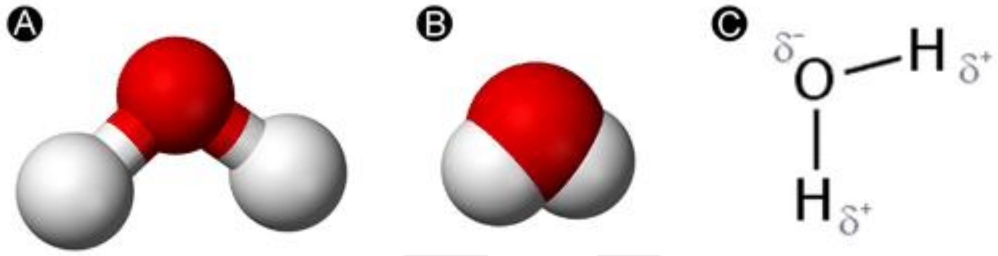
-

WATER AND pH

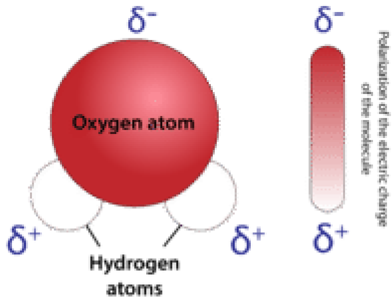
Introduction to water

- Water is a major chemical components of the earth's surface as well as living organisms. It is indispensable to life. Indeed, it is the only liquid that most organisms ever encounter. We alternately take it for granted because of its ubiquity and bland nature or marvel at its many unusual and fascinating properties. As the centre of this fascination is the role of water as the medium of life. Life originated evolved and thrives in the seas.
- Organisms invaded and occupied terrestrial and aerial niches but none gained true independence from water. Due to various fantastic properties of the water, it is the basic molecule of life. First living organisms was originated in water.
- Organisms contains 70-90% water, no cellular metabolism occurs in the absence of water, water can able to ionize in H^+ and OH^- ion and hence plays an important role in the metabolic processes, as a solvent and many more functions.
- **Structure of water**
- Water is a simple molecule consisting of one oxygen atom bonded to two different hydrogen atoms. Because of the higher **electronegativity** of the oxygen atom, the bonds are polar covalent (**polar bonds**).

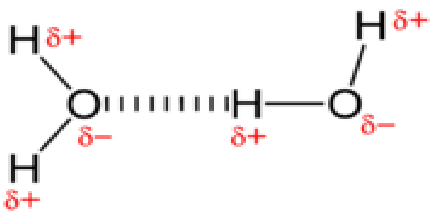
- The oxygen atom attracts the shared electrons of the covalent bonds to a significantly greater extent than the hydrogen atoms. As a result, the oxygen atom requires a partial negative charge (δ−)(δ−), while the hydrogen atoms each acquire a partial positive charge (δ+)(δ+). The molecule adopts a bent structure because of the two lone pairs of electrons on the oxygen atom.
- The H−O−HH−O−H bond angle is about 105o105o, slightly smaller than the ideal 109.5o109.5o of an sp3sp3 hybridized atomic orbital.



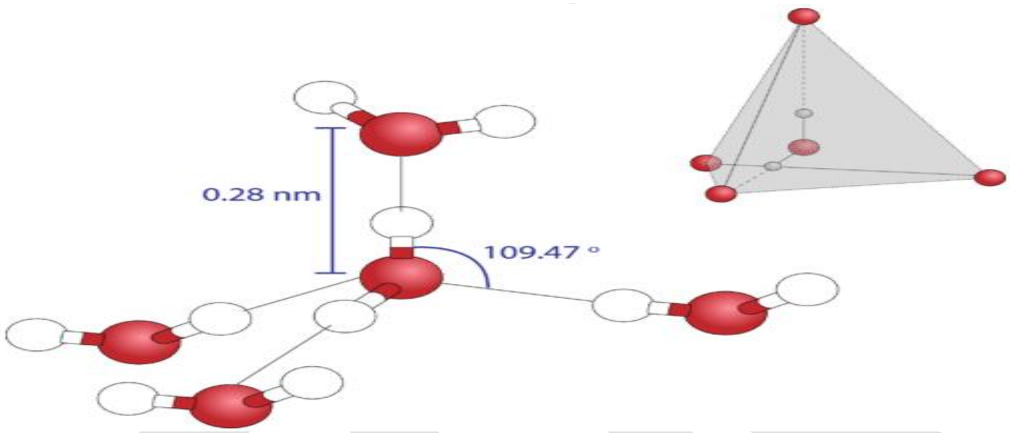
- The bent shape of the water molecule is critical because the polar O−HO−H bonds do not cancel one another and the molecule as a whole is polar.
- The figure below illustrates the net polarity of the water molecule. The oxygen is the negative end of the molecule, while the area between the hydrogen atoms is the positive end of the molecule.



- Figure : Water is a polar molecule, as greater electron density is found around the more electronegative oxygen atom.
- Polar molecules attract one another by dipole-dipole forces, as the positive end of one molecule is attracted to the negative end of the nearby molecule. In the case of water, the highly polar O−HO−H bonds results in very little electron density around the hydrogen atoms.
- Each hydrogen atom is strongly attracted to the lone-pair electrons on an adjacent oxygen atom. These are called hydrogen bonds and are stronger than conventional dipole-dipole forces.



- Figure : A hydrogen bond is the attraction between a lone pair of electrons on the oxygen atom of one molecule and the electron-deficient hydrogen atom of a nearby molecule.
- Because each oxygen atom has two lone pairs, it can make hydrogen bonds to the hydrogen atoms of two separate other molecules.
- The figure below shows the result—an approximately tetrahedral geometry around each oxygen atom, consisting of two covalent bonds and two hydrogen bonds.



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- Figure: As a result of two covalent bonds and two hydrogen bonds, the geometry around each oxygen atom is approximately tetrahedral.
- **Dielectric constant**
- This is the property of water to ionize and interaction with opposite charge ions. This interaction can be measured by dielectric constant.
- **F=I1&I2/Dr2**
- Where D= dielectric constant
- F= force between two opposite charge ions
- I1&i2 =charges of two molecules
- r= distance between two ions.
- Polar molecules forms hydrogen and vanderwaal's bond with water and hence readily dissolve in water. Nonpolar molecule cant able to form these bonds easily with water and difficult to dissolve.

Sr.no.	Question	Answer
1	What is the bond angle of H-O-H ?	150˚
2	.... Hybridizes atomic orbital of water molecules?	sp3 sp3

3	Water is .... molecule	polar
4	What is the symbol of dielectric constant?	D
5	.... molecules easily dissolve in water	polar

- **INTRODUCTION TO pH.**
- In chemistry, **pH** (/piːˈeɪtʃ/, denoting 'potential of hydrogen' or 'power of hydrogen') is a scale used to specify the acidity or basicity of an aqueous solution.
- Acidic solutions (solutions with higher concentrations of H^+ ions) are measured to have lower pH values than basic or alkaline solutions.
- The pH scale is logarithmic and inversely indicates the concentration of hydrogen ions in the solution. This is because the formula used to calculate pH approximates the negative of the base 10 logarithm of the molar concentration of hydrogen ions in the solution.
- More precisely, pH is the negative of the base 10 logarithm of the activity of the H^+ ion.
- At 25 °C, solutions with a pH less than 7 are acidic, and solutions with a pH greater than 7 are basic. Solutions with a pH of 7 at this temperature are neutral (e.g. pure water).
- The neutral value of the pH depends on the temperature – being lower than 7 if the temperature increases. The pH value can be less than 0 for very strong acids, or greater than 14 for very strong bases.
- the **equilibrium constant** of a chemical reaction is the value of its reaction quotient at chemical equilibrium, a state approached by a dynamic chemical system after sufficient time has elapsed at which its composition has no measurable tendency towards further change.
- For a given set of reaction conditions, the equilibrium constant is independent of the initial analytical concentrations of the reactant and product species in the mixture. Thus, given the initial composition of a system, known equilibrium constant values can be used to determine the composition of the system at equilibrium.
- However, reaction parameters like temperature, solvent, and ionic strength may all influence the value of the equilibrium constant.
- Equilibrium constant of strong acid can be represented by following equation ,
- $\mathbf{HCl + H_2O \rightarrow H_3O^+ + Cl^-}$

- **K_a = [H^+][Cl^-]/[HCl]**
- Solution that resist in the change of pH, known as buffer. Buffer systems important in biological system.

THE SCOPE OF BIOCHEMISTRY

- the scope of biochemistry is to understand chemical process that take place in living organisms and in fact of life.
- Our understanding of biochemistry has had and will continue to have extensive effects on many aspects of human endeavor.
- First biochemistry is an intrinsically beautiful and fascinating body of knowledge.
- We now know the essence and many of the details of the most fundamental processes in biochemistry, such as how the sequence of bases in the DNA molecule determines the sequence of amino acids in an encoded protein.
- Our ability to describe these processes in detailed, mechanistic terms places firm chemical foundation under other biological sciences.
- Moreover the realization that we can understand essential life processes such as the transmission of hereditary information, as chemical structure and their reaction has significant philosophical implications.
- It means biochemical sciences gives an idea related to evolution and differences of bacteria, plants animals and humans.
- Second, biochemistry is greatly influencing medicine and other fields. The molecular lesions causing sickle-cell anemia, cystic fibrosis, hemophilia and many other genetic disease have been elucidated at the biochemical level.
- Some of the molecular events that contribute to cancer development have been identified. An understanding of the underlaying defects opens the door to the discovery of effective therapies.
- Biochemistry makes possible the rational design of new drugs, including specific inhibitors of enzymes required for the replication of viruses such as human immunodeficiency virus (HIV).
- Genetically engineered bacteria or other organisms can be used as "factories" to produce valuable proteins such as insulin and stimulators of blood cell development, biochemistry is also contributing richly to clinical diagnosis.
- DNA probes are coming into play in the precise diagnosis of inherited disorders, infectious disease, and cancers. Agriculture, too, is benefiting from advance in biochemistry with the development of more effective, environmentally safer herbicides and pesticides and the creation of genetically engineered plants that are, for example, more resist to insects.

- Third advances in biochemistry are enabling researchers to tackle some of the most exciting question in biology and medicine.
- Biochemistry is an important part to understand biochemical evolution,
- How energy from chemicals or from sunlight is converted into usable forms and how this conversion is regulated. Function of molecules such as ATP act as energy currencies that allow energy, however captured, to be utilized in a variety of biochemical processes.
- Important pathways for the conversion of environmental energy into molecules such as ATP and uncovers many unifying principles.
- Synthesized the molecule of life. Illustrate the use of the molecules to synthesize key molecular building blocks, such as the bases of DNA and amino acids, and then shows how these precursors are assembled into DNA, RNA, and proteins.
- Environmental changes explores some of the mechanisms that cells and multicellular organisms have evolved to detect and respond to change in the environment.
- Biochemistry with other fields such as cell biology, immunology, and neuroscience.
- Methodologies for the isolation and identification of macromolecules efficiently. Techniques like electrophoresis, chromatography, centrifugation, UV-Vis spectroscopy, mass spectroscopy, MALDI-TOF etc.

Sr.no.	**Question**	**Answer**
1	➢ What is pH?	pH is the negative of the base 10 logarithm of the activity of the H^+ ion.
2	At 25 °C, solutions with a pH less than 7 are......	Acids
3	At 25 °C, solutions with a pH more than 7 are......	alkalis
4	Solution that resist in the charge of pH, known as.......	buffer
5	Full form of HIV	Human immunodeficiency virus