

## CHAPTER-2

# BIOLOGICAL MOLECULES

## Science Titbits

Do not confuse involvement of water in hydrolysis with making a solution, in which the role of water is to act as a solvent: rather than taking part in a chemical reaction. Hydration is yet another completely different process, involving the addition of water, but not breaking of bonds. Also do not assume that this breakdown releases energy, which is usually produced when the simpler substances are oxidized in respiration.

## Critical Thinking

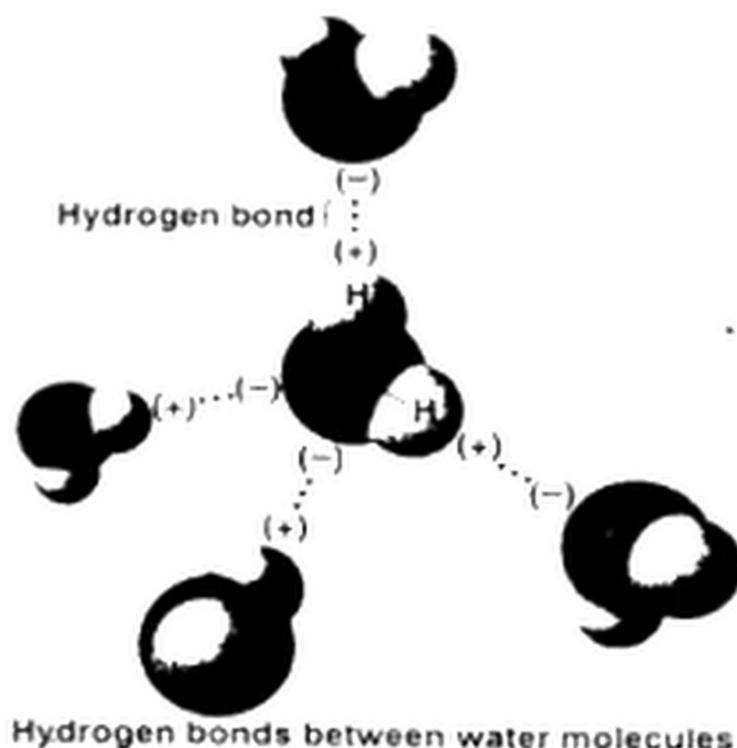
**When hydrogen gas combines with oxygen gas to form water, is the hydrogen reduced or oxidized?**

**Ans:** When hydrogen gas combines with oxygen gas to form water, the hydrogen is oxidized. When molecular hydrogen ( $H_2$ ) and oxygen ( $O_2$ ) are combined and allowed to react together, energy is released and the molecules of hydrogen and oxygen can combine to form either water or hydrogen peroxide.

### **Skills: Analyzing, Interpreting and Communication**

- **Draw model diagrams to describe the hydrogen bonding.**

**Solution:**



- **Develop a table to align the properties of water with the benefits to life.**

**Solution:** See Q#46 From (Extensive Questions)

### Teacher's Point

Teacher would guide the students to develop a table to align the properties of water with the benefits.

### Science Titbits

Any carbohydrate which is capable being oxidized and causes the reduction of other substances without having to be hydrolyzed first is known as reducing Sugar, but those which are unable to be Oxidized and do not reduce the other Substances are known as non-reducing Sugars. All monosaccharides and two of three types of disaccharides (maltose and lactose) have the open chemical structure needed to act as reducing agents. The third type of disaccharides, sucrose, and polysaccharides are non-reducing sugars.

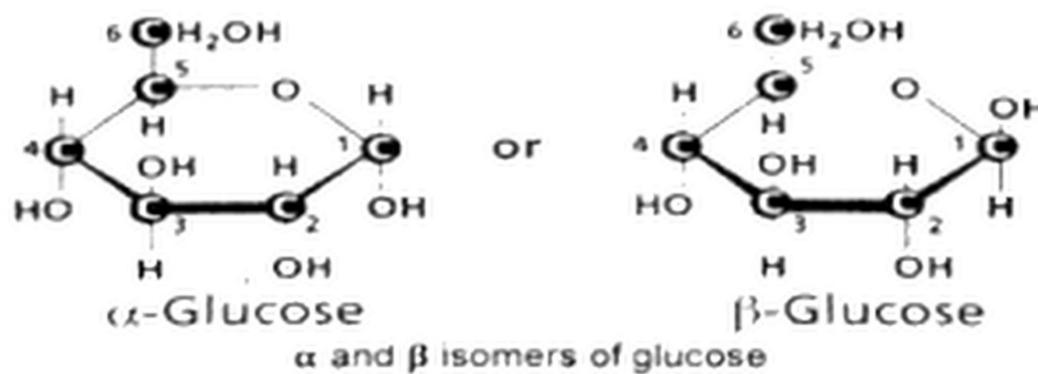
## Science Titbits

Cellulose cannot be digested by human body but it has to be taken into diet because it works as roughage or fiber so it prevents abnormal absorption of food in intestine. However, herbivore animals have some symbiotic bacteria that secrete cellulase enzyme for its digestion. Upon hydrolysis it first yields a disaccharide, the cellubiose and then cellubiose is further digested into glucoses.

### Skills: Analyzing, Interpreting and Communication

- Draw the ring forms of alpha and beta glucose.

**Solution:**



- Illustrate the formation and breakage of maltose, sucrose and lactose.

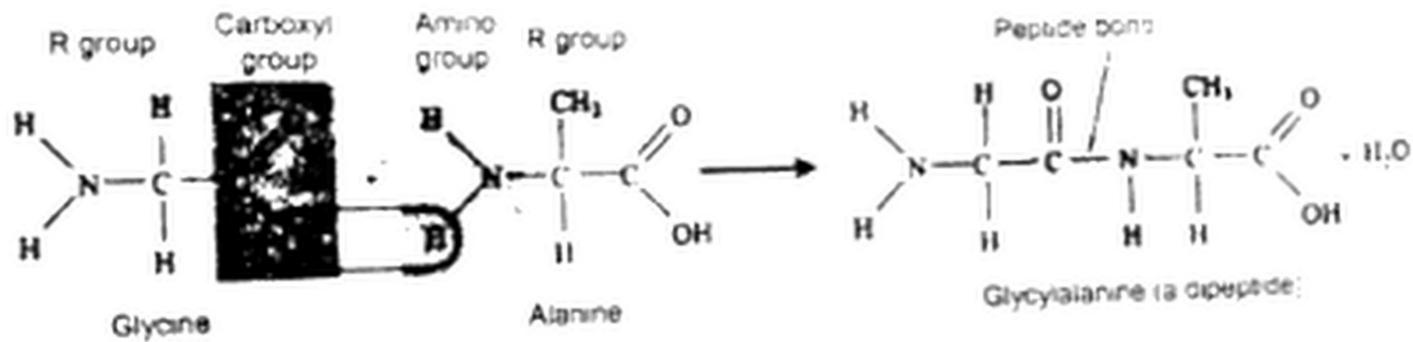
**Solution:** See Q#19 from (Short Questions)

**Q1. Explain the formation of dipeptides and polypeptides.**

**Ans: Dipeptides and Polypeptides:**

Dipeptides and polypeptides are formed by the condensation of amino acids on the ribosome under the instructions of mRNA which takes these instructions from DNA. This process is known as translation. During this process, when an amino acid reacts with another amino acid, the —OH from

carboxylic acid group of one amino acid and -H from amino group of other amino acid are liberated and form a water molecule, as a result a bond is established between C of carboxylic acid group and N of amino group of two amino acids called peptide bond. Hence, a product of two amino acids is formed which is known as dipeptide.



A dipeptide has two ends, one is called amino or —N terminal end while other called carboxylic acid or —C terminal end. A new amino acid can be added in this chain from its carboxylic acid or —C terminal end in the same way. Thus, a tripeptide (a product of three amino acids) is formed and another water molecule is also released. Similarly, when several amino acids are linked together by many peptide bonds, the polypeptide chain is formed.

### Skills: Analyzing, Interpreting and Communication

- Draw table to illustrate different structural and functional proteins with roles of each.

**Solution:** See Q#55 from (Extensive Questions)

### Science, Technology and Society Connections

- Relate the role of prostaglandin in inflammation with the inhibition of prostaglandin synthesis through aspirin.

Prostaglandins play a pivotal role in inflammation a process characterized by redness (rubor), heat (calor), pain (dolor), and swelling (tumor). The changes associated with inflammation are due to dilation of local blood vessels that permits increased blood flow to the affected area. The blood vessels also become more permeable leading to the escape of white blood cells (leukocytes) from the blood into the inflamed tissues.

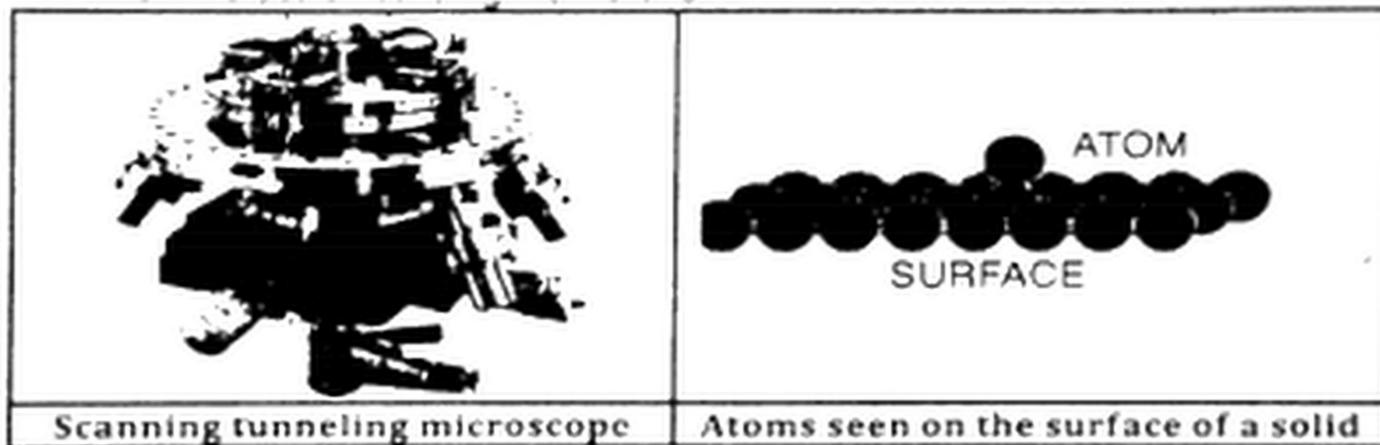
Aspirin is anti-inflammatory, analgesic, and antipyretic. Aspirin inhibits prostaglandin synthetase salicylate. This drug affects the metabolism of arachidonate via the lipoxygenase pathway by inhibiting the conversion of 12-hydroperoxy- to 12-hydroxy-5, 8, 10, 14-eicosatetraenoic acid.

### **Science Tidbits**

Watson and Crick assembled the molecular model and published their two-page article on their molecular model of DNA in the journal "Nature" in April 1953. Few milestones in the history of biology have as broad an impact as their double helix. They were awarded Nobel Prize in 1962 for their model of DNA.

### **Science, Technology and Society Connections**

- Correlate the scanning tunneling microscope as the latest advancement for seeing the atoms of DNA. The Scanning tunneling microscope was invented in 1980. It can allow scientists to view atoms on the surface of a solid. It is a very powerful tool that can be used to resolve features less than a nanometer. The microscope's inventors, Gerd Binnig and Heinrich Rohrer were awarded Nobel Prize in Physics in 1986. Seer-nan's group worked on the DNA nanotechnology, they constructed molecular building blocks of DNA.



### Teacher's Point

Teachers would guide the students to hypothesize, which came first DNA or RNA

### Science Titbits

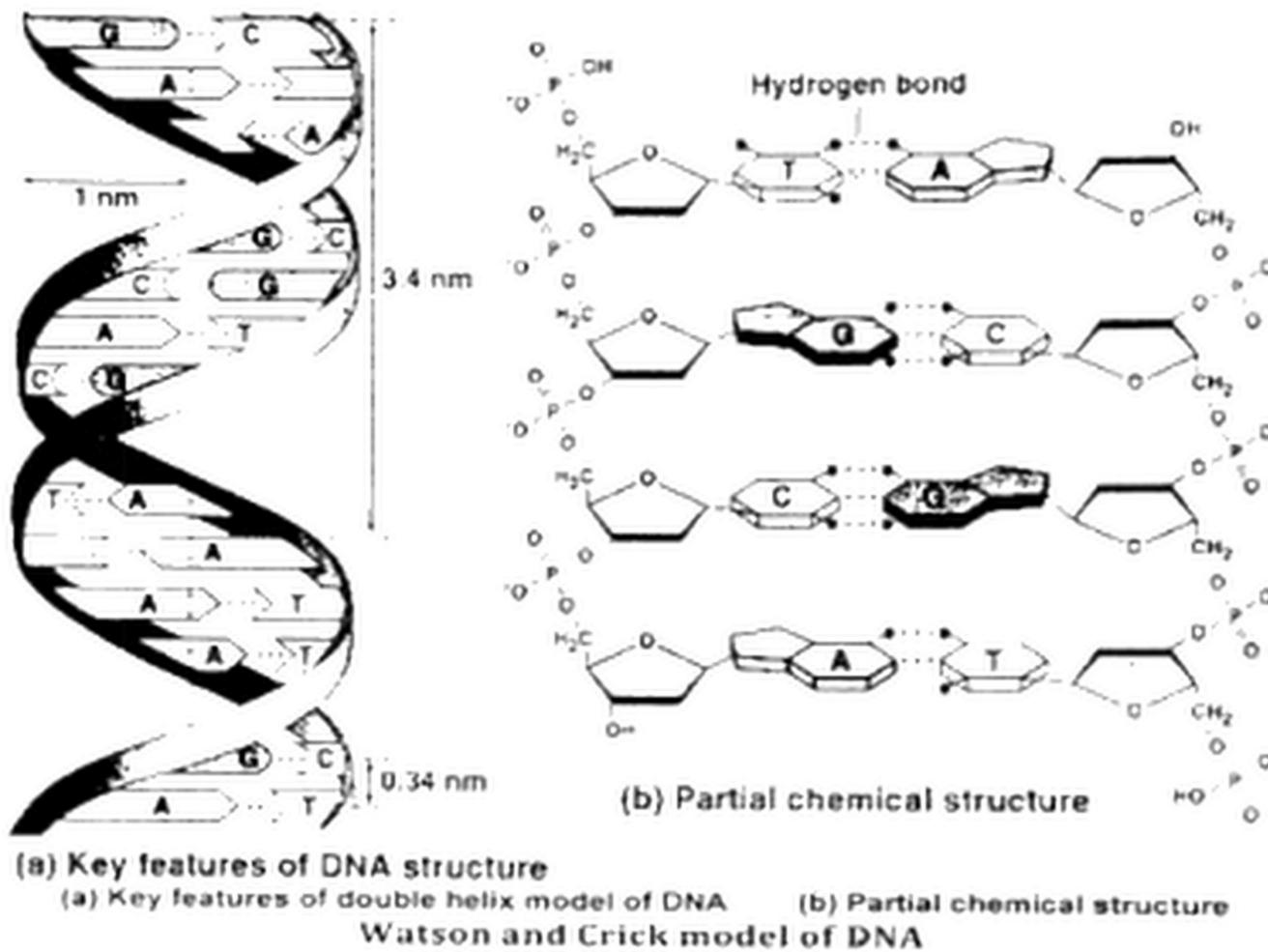
**Why do the nucleotides in DNA have a hydrogen atom at the 2' carbon instead of the hydroxyl group in ribose?**

**Ans:** The answer is that a hydroxyl group at the 2' position can participate in a reaction that cleaves the phosphodiester bond, Thus, DNA can act as a stable long- term repository for genetic information. RNA is usually degraded within your cells in 30 minutes.

### Skills: Analyzing, Interpreting and Communication

- Draw the Watson - Crick model of DNA

**Solution:**



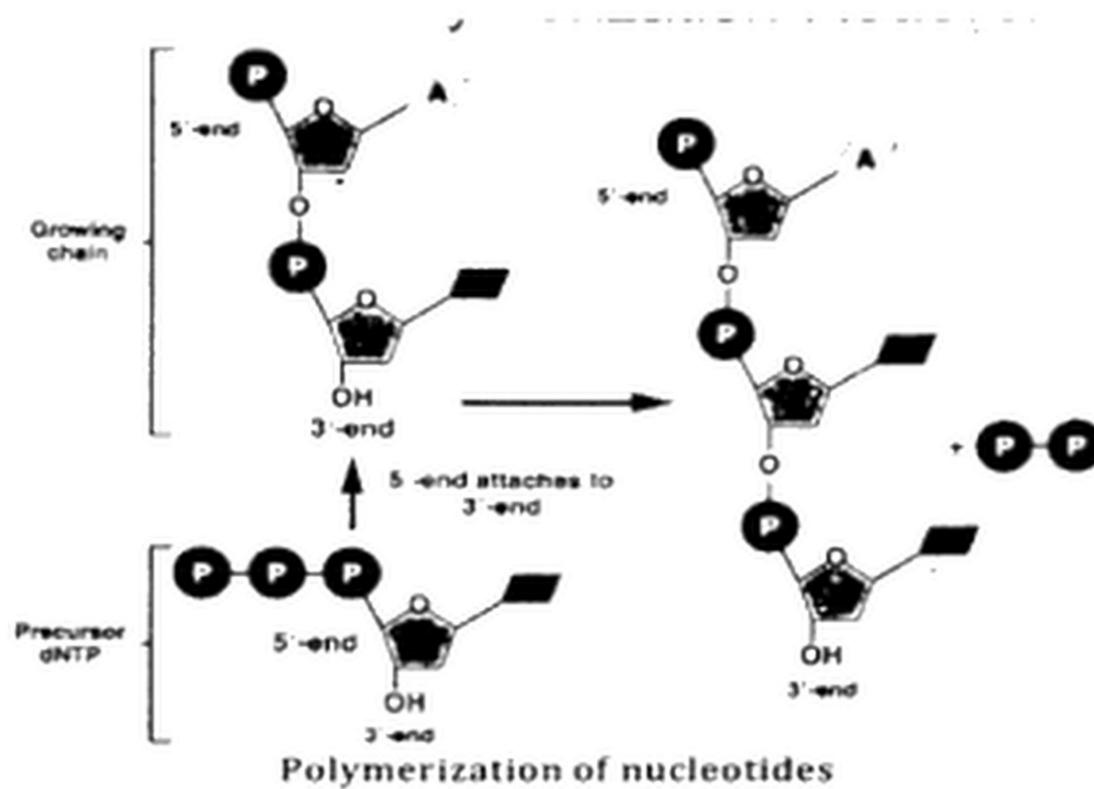
- Illustrate the formation of phosphodiester linkage

**Solution:**

**Polymerization of nucleotides (Formation of polynucleotide):**

Nucleotides are also joined together by a condensation reaction like other biomolecules. Unlike proteins, carbohydrates, and lipids, however, the molecule that is released is not water but pyrophosphate (two phosphate groups bound together). When pyrophosphate is cleaved by the addition of water, a great deal of free energy is released which drives the process. In this way nucleotides begin to link by phosphodiester bonds and a polymer of nucleotides (polynucleotide) is formed. Polynucleotides have a free 5' phosphate group at one end and a free 3' hydroxyl group at the other end. By convention, these sequences are named from 5' to 3'.

## Nucleotide Polymerization Reaction



## Science, Technology and Society Connections

- List the career opportunities in the field of biochemistry. Biochemistry, the study of chemical processes that take place in living organisms, is a broad field that offers a wide range of career options. Biochemists can pursue stem cell or genetic research that has the potential to result in dramatic medical or scientific breakthroughs. Some biochemists study the body's immune response to germs and allergens or the effectiveness of drugs in treating a wide array of afflictions. Other biochemists work in the commercial food or agricultural field looking for ways to improve products and crops. The many and diverse applications of biochemistry include pharmacology, genetics, immunology, bioinformatics, environmental science, forensics, toxicological studies and food science. The career options are nearly endless, and still unfolding, as new applications for this exciting field of study continue to evolve.

## Activity

1. Performing Benedict's test for reducing sugars and confirmation of the presence of starch through iodine test
2. Confirmation of the presence of proteins through Biuret test
3. Confirmation of the presence of lipids through Emulsion test
4. Demonstration of the presence of nucleic acids in biological materials  
e.g. onion

