Polysaccharides

1. Introduction

Polysaccharides are high molecular weight carbohydrates composed of more than 10 monosaccharide units joined by **glycosidic bonds**. They are also called **glycans**.

General formula:

$(C_6H_{10}O_5)_n$

They are formed by condensation reactions between monosaccharides with elimination of water.

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2. Classification of Polysaccharides

A. On the Basis of Composition

(i) Homopolysaccharides

Contain only one type of monosaccharide.

Examples:

- Starch (glucose)
- Glycogen (glucose)
- Cellulose (glucose)
- Inulin (fructose)

(ii) Heteropolysaccharides

Contain two or more different types of monosaccharides.

Examples:

- Hyaluronic acid
- Heparin
- Peptidoglycan
- Chondroitin sulfate

B. On the Basis of Function

Type	Function	Examples
Storage polysaccharides	Energy storage	Starch, Glycogen
Structural polysaccharides	Structural support	Cellulose, Chitin

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3. Important Homopolysaccharides

3.1 Starch

Starch is the storage polysaccharide of plants.

It consists of two components:

(i) Amylose

- Linear polymer of α-D-glucose
- α(1→4) glycosidic linkages
- Helical structure
- Gives blue color with iodine

(ii) Amylopectin

- Branched polymer
- α(1→4) linkages in chains
- α(1→6) linkages at branching points
- Branching occurs every 24–30 glucose units

Properties:

- Insoluble in cold water
- Hydrolyzed by amylase enzyme

3.2 Glycogen

Glycogen is the storage polysaccharide of animals.

- Present in liver and muscles
- Structure similar to amylopectin
- More highly branched
- Branching every 8–12 glucose units
- Also gives reddish-brown color with iodine

3.3 Cellulose

Cellulose is a structural polysaccharide found in plant cell walls.

- Linear polymer of β-D-glucose
- β(1→4) glycosidic bonds
- Forms long straight chains
- Chains held together by hydrogen bonding
- Forms microfibrils

Important Points:

- Humans lack cellulase enzyme
- Cannot digest cellulose
- Provides dietary fiber

3.4 Chitin

- Polymer of N-acetyl-D-glucosamine
- β(1→4) linkages
- Found in exoskeleton of arthropods and fungal cell walls

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4. Important Heteropolysaccharides

4.1 Hyaluronic Acid

- Found in connective tissue
- Acts as lubricant in joints
- Composed of glucuronic acid and N-acetylglucosamine

4.2 Heparin

- Natural anticoagulant
- Present in liver and lungs
- Highly sulfated polysaccharide

4.3 Peptidoglycan

- Present in bacterial cell wall
- Alternating units of N-acetylglucosamine (NAG) and N-acetylmuramic acid (NAM)

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5. Properties of Polysaccharides

- High molecular weight
- Insoluble or form colloidal solutions
- Do not show reducing properties (except at one free end)
- Tasteless
- Non-sweet

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6. Biological Importance

1. Energy storage (starch, glycogen)
2. Structural support (cellulose, chitin)
3. Lubrication (hyaluronic acid)
4. Anticoagulant action (heparin)
5. Cell recognition and signaling

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7. Differences Between Important Polysaccharides

Feature	Starch	Glycogen	Cellulose
Type	Storage	Storage	Structural
Monomer	α-glucose	α-glucose	β-glucose
Branching	Moderate	Highly branched	No branching
Digestible in humans	Yes	Yes	No
Bond type	α(1→4), α(1→6)	α(1→4), α(1→6)	β(1→4)

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8. Hydrolysis of Polysaccharides

On hydrolysis (acid or enzyme), polysaccharides break down into:

- Oligosaccharides
- Disaccharides
- Monosaccharides

Example:
Starch → Dextrin → Maltose → Glucose

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9. Summary

Polysaccharides are complex carbohydrates essential for life. They serve as energy reservoirs and structural materials. Their properties depend on:

- Type of monosaccharide
- Type of glycosidic bond
- Degree of branching