# Polysaccharides

- The majority of carbohydrate material in nature occurs in the form of polysaccharides.
- Polysaccharides include not only those substances composed only of glycosidically linked sugar residues but also molecules that contain polymeric saccharide structures linked via covalent bonds to amino acids, peptides, proteins, lipids, and other structures.

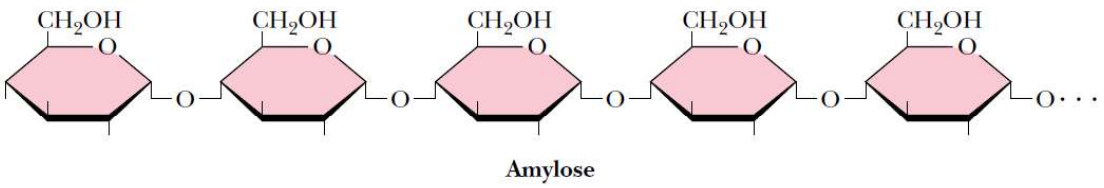
## Classification of Polysaccharides

- **Polysaccharides,** also called **glycans,** consist of monosaccharides and their derivatives and they are considered **non-reducing carbohydrates.**
- If a polysaccharide contains **only one** kind of monosaccharide molecule, it is a **homopolysaccharide,** or **homoglycan.**
- If a polysaccharide contains **more than one** kind of monosaccharide are **heteropolysaccharides**, or **heteroglycan.**
- Common monosaccharide derivatives in polysaccharides include the amino sugars **(D-glucosamine and D-galactosamine).**

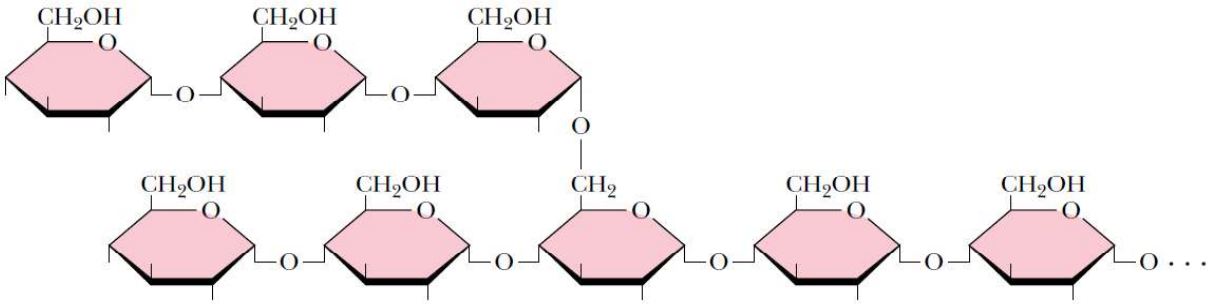
# Homopolysaccharide

## 1)Starch

- It is a homopolysaccharide of glucose sugar units .
- The most common **storage polysaccharide in plants** .
- Exists in two forms:
  - **α-amylose (10-30%).**
  - **Amylopectin (70-90%).**



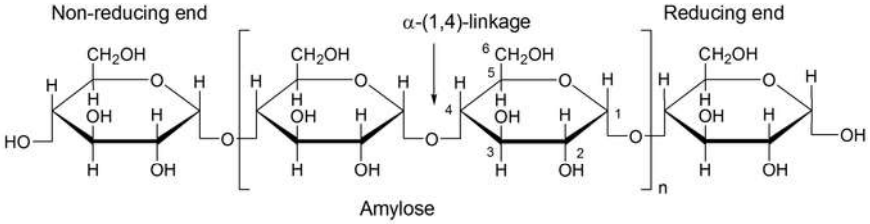
Amylose

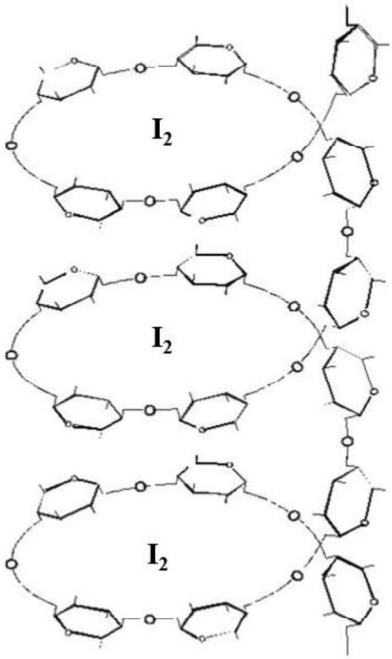


Amylopectin

# α-amylose

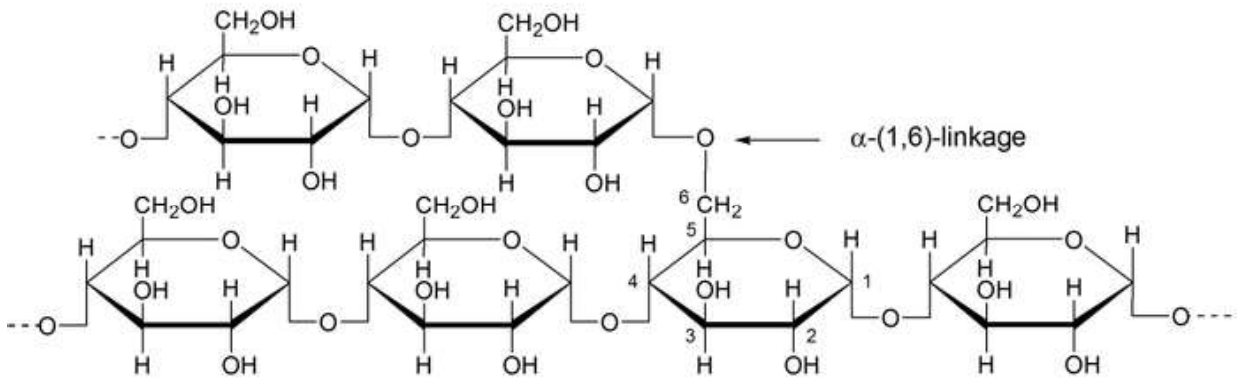
- α-amylose is composed of linear chains of D-glucose α (1→4) linkages.
- The chains are of varying length with a reducing end and a nonreducing end.
- It is poorly soluble in water, and forms micelles in which the polysaccharide chain has a helical conformation.
- Iodine reacts with α-amylose to give a characteristic blue color, which arises from the insertion of iodine into the middle of the hydrophobic amylose helix.



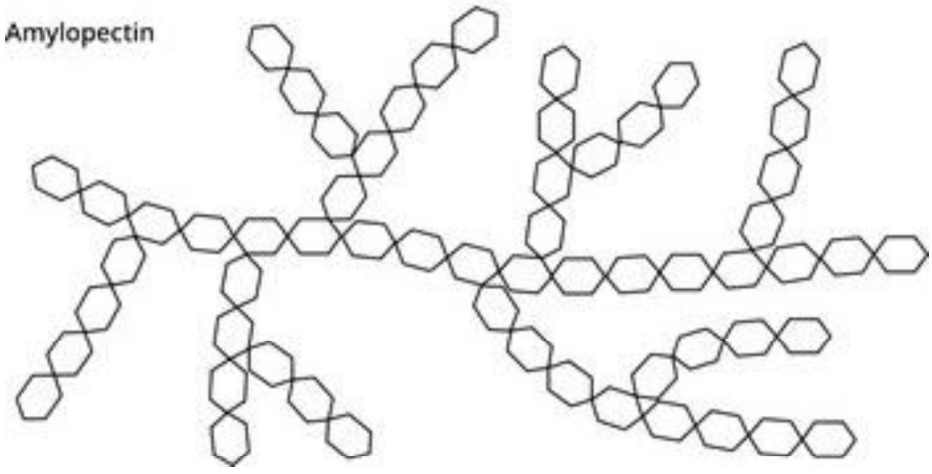



# Amylopectin

- Amylopectin, is a highly branched chain of glucose units.
- Branches occur in these chains every 12 to 30 residues.
- The average branch length is between 24 and 30 residues.
- The **linear** linkages in amylopectin are **α (1⟶4)** whereas the **branch** linkages **α (1→6).**
- Amylopectin forms micellar suspensions in water; **iodine** reacts with such suspensions to produce a **red-violet color.**




Amylopectin



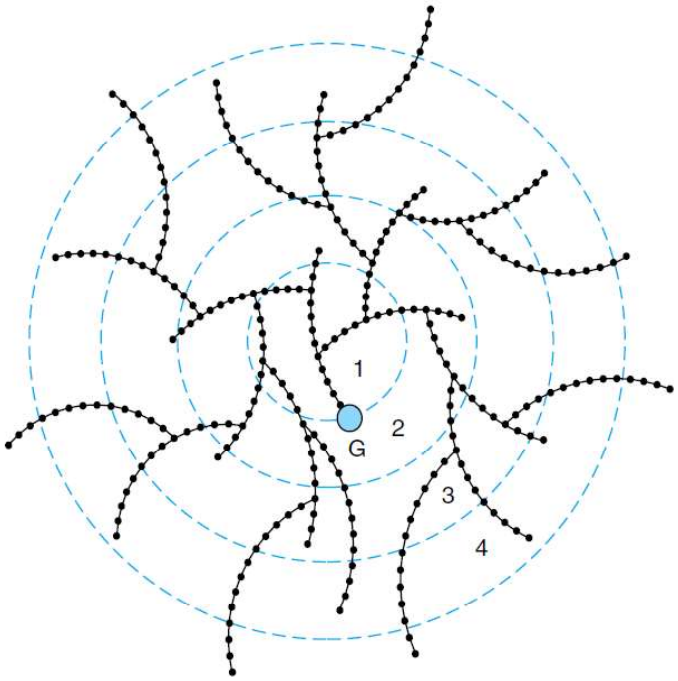
# 2)Glycogen

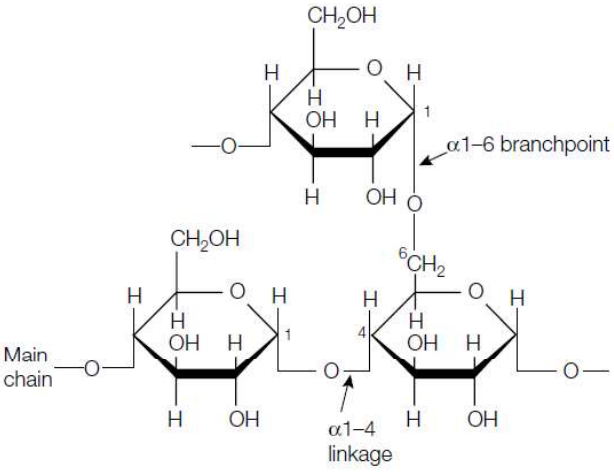
- The major form of **storage polysaccharide in animals** is **glycogen.**
- Glycogen is found mainly in :

❑ **Liver** (where it may amount to as much as 10% of liver mass).

❑ **Skeletal muscle** (where it accounts for 1 to 2% of muscle mass).

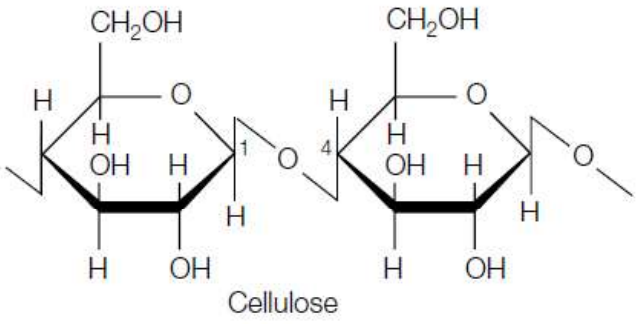
- Liver glycogen consists of granules containing highly branched molecules, with α (1→4) linkages in the straight chain α (1→6) branches occurring every 8 to 12 glucose units.
- Like amylopectin, glycogen yields a **red-violet color** with iodine.



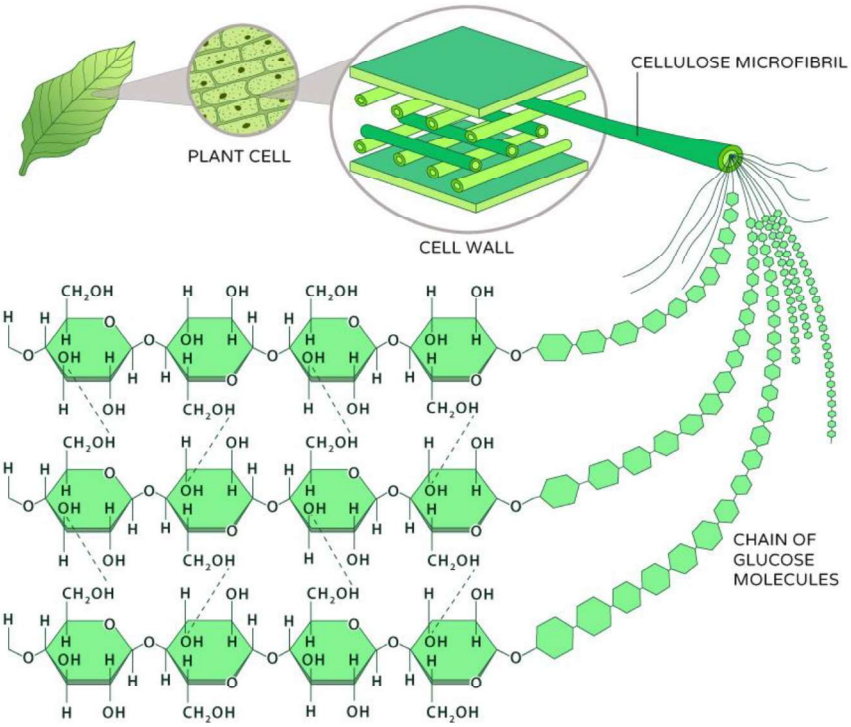



# 3)Cellulose

- Cellulose is the most abundant natural polymer found in the world.
- It is a structural polysaccharide found in the cell walls of nearly all plants, providing physical structure and strength.
- Cellulose is a linear homopolymer of D-glucose units are linked by **β(1→4)** glycosidic bonds.

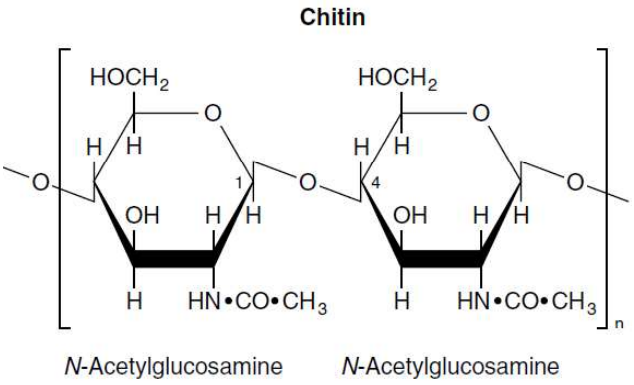


Cellulose



# 4)Chitin

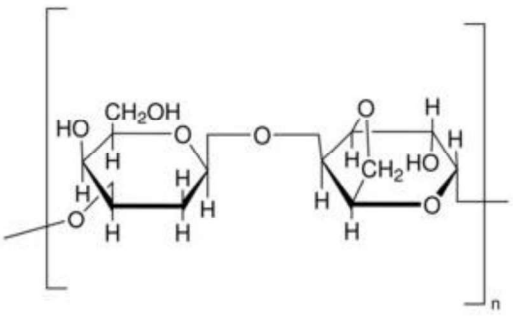
- **Chitin** is a the **second most abundant** carbohydrate polymer after cellulose.
- It is a **structural polysaccharide** in the exoskeleton of crustaceans and insects, spiders and also in mushrooms.
- It consists of *N*-acetyl-D-glucosamine units (the -OH group on each C-2 is replaced by -NHCOCH3) joined by **β(1→4)** glycosidic linkages.



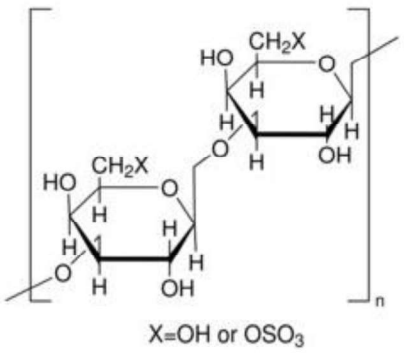

# Heteropolysaccharide

## Agar

- An important polysaccharide mixture isolated from marine red algae is **agar.**
- Agar consists of two components, **agarose (70%)** and **agaropectin (30%).**
- **Agarose** is a chain of alternating **D-galactose** and **3,6-anhydro-L-galactose**.
- **Agaropectin** is chain of alternating **D-galactose** and **L-galactose** heavily modified with **acidic side-groups**, such as **sulfate, glucuronate, and pyruvate**
- Agarose and agaropectin readily form gels containing large amounts (up to 99.5%) of water.




Agarose



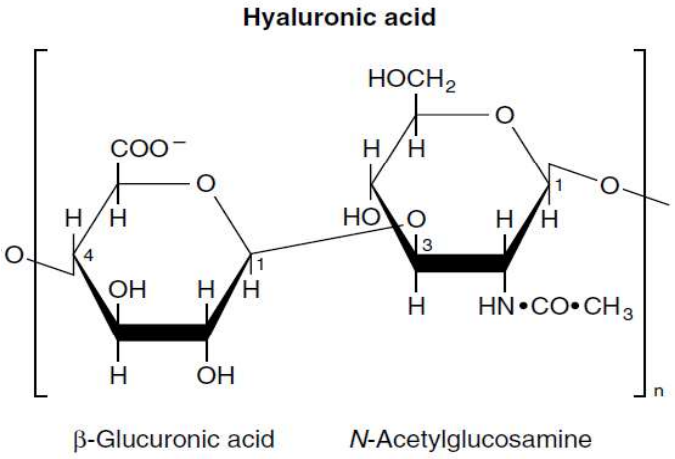

Agaropectin

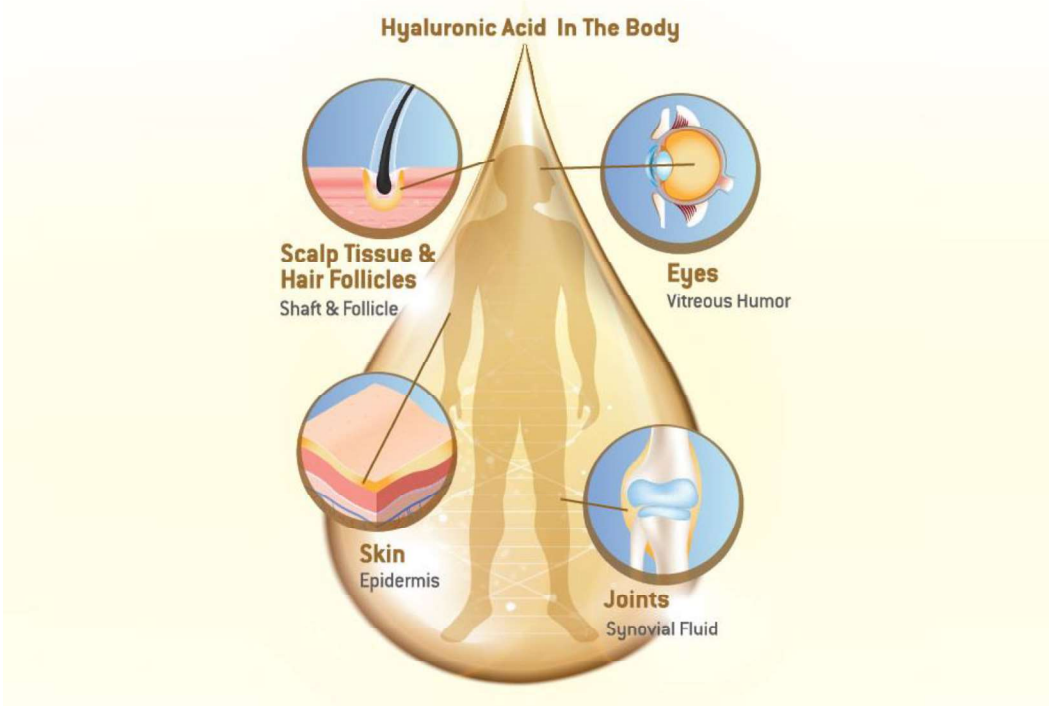
# **Glycosaminoglycans** (mucopolysaccharides)

- Glycosaminoglycans consist of linear chains of **repeating disaccharides** in which one of the **monosaccharide units is an amino sugar** and one (or both) of the monosaccharide units contains at least one **negatively charged sulfate or carboxylate group.**
- When these chains are attached to a **protein molecule**, the result is a **proteoglycan.**
- **Proteoglycans** provide the ground substance of **connective tissues.**
- Examples of glycosaminoglycans are:
  - ❑ **Hyaluronic acid.**
  - ❑ **Heparin.**
  - ❑ **Chondroitin sulfate**
  - ❑ **Keratan sulfate.**
  - ❑ **Dermatan sulfate.**

# 1) Hyaluronic acid

- **Hyaluronic acid** molecules may consist of as many as 25,000 disaccharide units **(β-glucuronic acid and *N*-Acetylglucosamine).**
- Hyaluronic are important components of the **vitreous humor in the eye** and of **synovial fluid**, the lubricant fluid of joints in the body.

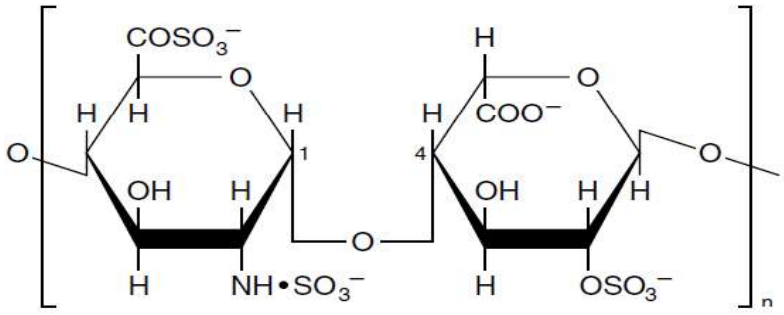


# 2) Heparin

- Heparin is a natural anticoagulant substance.
- It binds strongly to antithrombin III (a protein involved in terminating the clotting process) enhancing its effect and inhibits blood clotting.
- It is used in the treatment of heart attacks and unstable angina.
- Consists of a variably sulfated repeating disaccharide unit.
- The most common disaccharide unit is composed of a **2-O-sulfated iduronic acid** and **6-O-sulfated, N-sulfated glucosamine**.

**Heparin**




Sulfated glucosamine  Sulfated iduronic acid

# 3) Chondroitin, Keratan and Dermatan sulfates

- **Chondroitin and keratan sulfates** are found in:
  - ❑ Tendons.
  - ❑ Cartilage.
  - ❑ Other connective tissue .
- **Dermatan sulfate** is a component of the **extracellular matrix of skin.**