



Cellular and Molecular Biochemistry [FHS1104]

Carbohydrates Chemistry
Lecture {3} section II

MBCHB/BDS
1ST YEAR SEM.-1
2026

Yasser Khater

Quick review

- ✓ Define the carbohydrates
- ✓ What are the physiological functions of Carbohydrates
- ✓ Why the human body use the carbohydrates as first sources of energy
- ✓ Mention the Classification of Carbohydrates according to sugar unit
- ✓ Classify the Monosaccharides and give examples for each class
- ✓ Draw the structure of glucose { straight chain & ring forms}
- ✓ Write about the isomers of monosaccharides
- ✓ Mention three examples of disaccharides
- ✓ Draw the structure of maltose

{Lecture (3) section II (Outline)}

- Oligosaccharides
- Polysaccharides
- Types of Polysaccharides
- Sugar Derivatives

Oligosaccharides

Oligosaccharides:

Are a saccharide polymer containing a **small number** (typically **three to ten**) of Monosaccharides.

Oligosaccharides can have many functions; for example, they are commonly found on the **plasma membrane** of **animal cells** where they can play a role in **cell–cell recognition/ communication**.

Oligosaccharides:

3-10 monosaccharides linked together e.g:

example:

- Maltotriose (3 glucose units , linked by (α -1,4) glycosidic bound produced during the digestion of starch or glycogen.

Polysaccharides

Polysaccharides:

These are carbohydrate , formed of more than **10 monosaccharide units** linked together by glycosidic bonds .

➤ Three concepts to understand polysaccharides :-

1. **homo-polysaccharide** , which contain repeated same sugar units .

2. **hetero-polysaccharide** , which contain repeated different sugar units .

3. Some polysaccharides **branched** , **α 1,6** glycosidic bonds

Types of Polysaccharides:

1.homopolysaccharides { on hydrolysis yield only a single type of monosaccharides }

starch, glycogen, and cellulose,

2.heteropolysaccharides { on hydrolysis yield mixture type of a few monosaccharides or their derivatives }

Agar , Heparin and Proteoglycans.

Types of Polysaccharides:

They are classified { on basis of **function** } in to

1.Storage used as Energy storage for future uses

➤ Starch

➤ Glycogen

2.Structural Used to provide protective walls or Lubricative coating to cells.

➤ Cellulose

➤ Chitin

What types of sugars do we use to make polysaccharides?

1.Storage Polysaccharides

Starch

Starch is a **storage** polysaccharide in plants.

consist of alpha glucose.

Potatoes is major source of **starch** in the human diet

Its structure is identical to glycogen, **except** for a much **lower degree** of branching.

It consists of two types of molecules **un branched** chains called **amylose** (15–20%);

and a **branched** chains known as **amylopectin** (80–85%).

Starch

Starch is a plant polysaccharide composed of amylose and amylopectin.

Amylose is the linear sequence of glucose units linked by $\alpha 1.4$ glycosidic bonds whereas amylopectin is branched with $\alpha 1,6$ linkages at the branching points.

Starch

Energy storage (plants).

Long repeating chain of **α -D-glucose**

Chains up to 4000 units

Amylose

Liner chain that forms coils

α -(1→4) linkage.

Amylopectin

Branched chain structure **α -(1→6)** linkage.

Two forms of starch

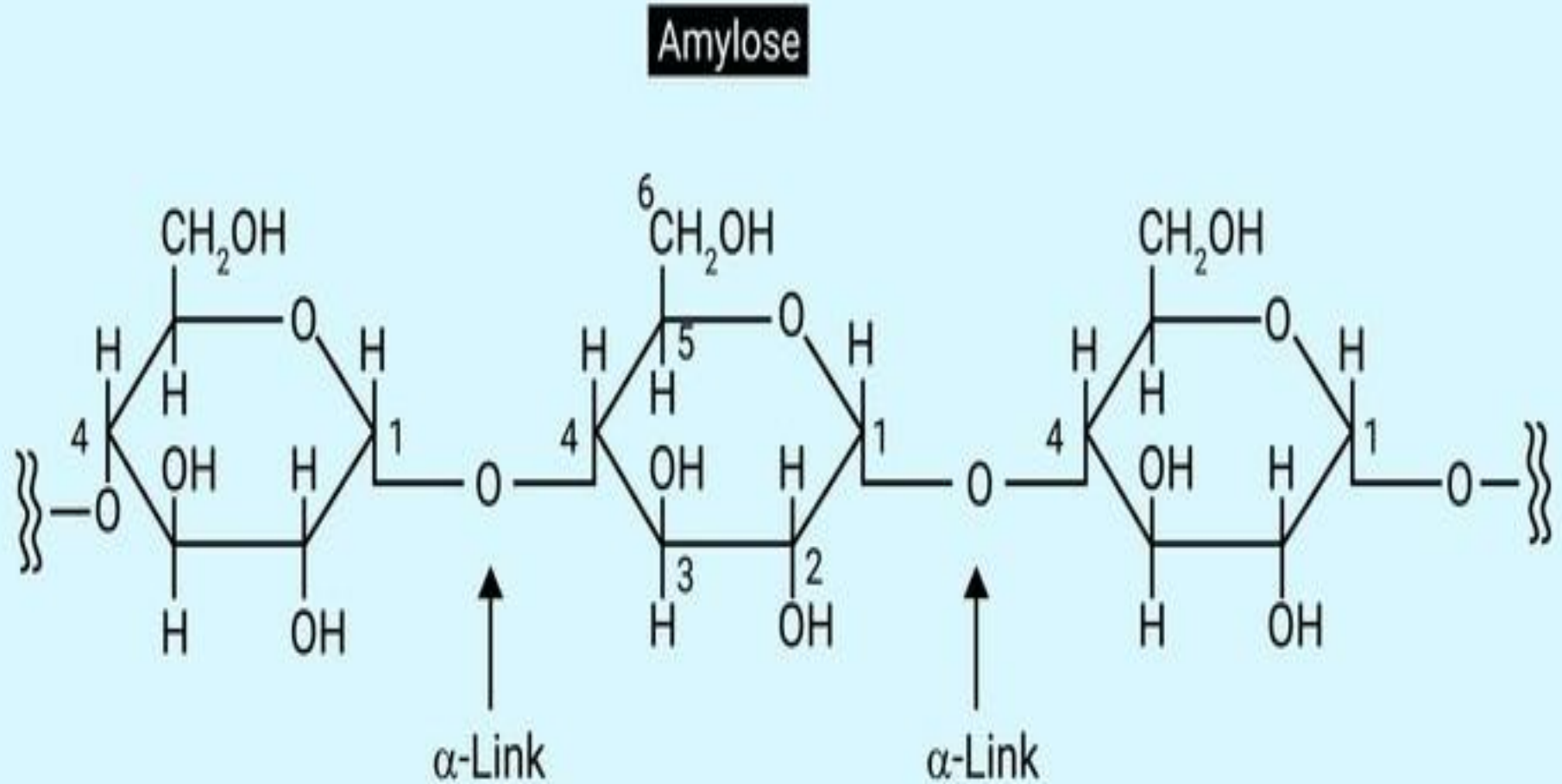
Amylose – long unbranched chain of glucose units

STARCH



Amylopectin – highly branched polymer of glucose units

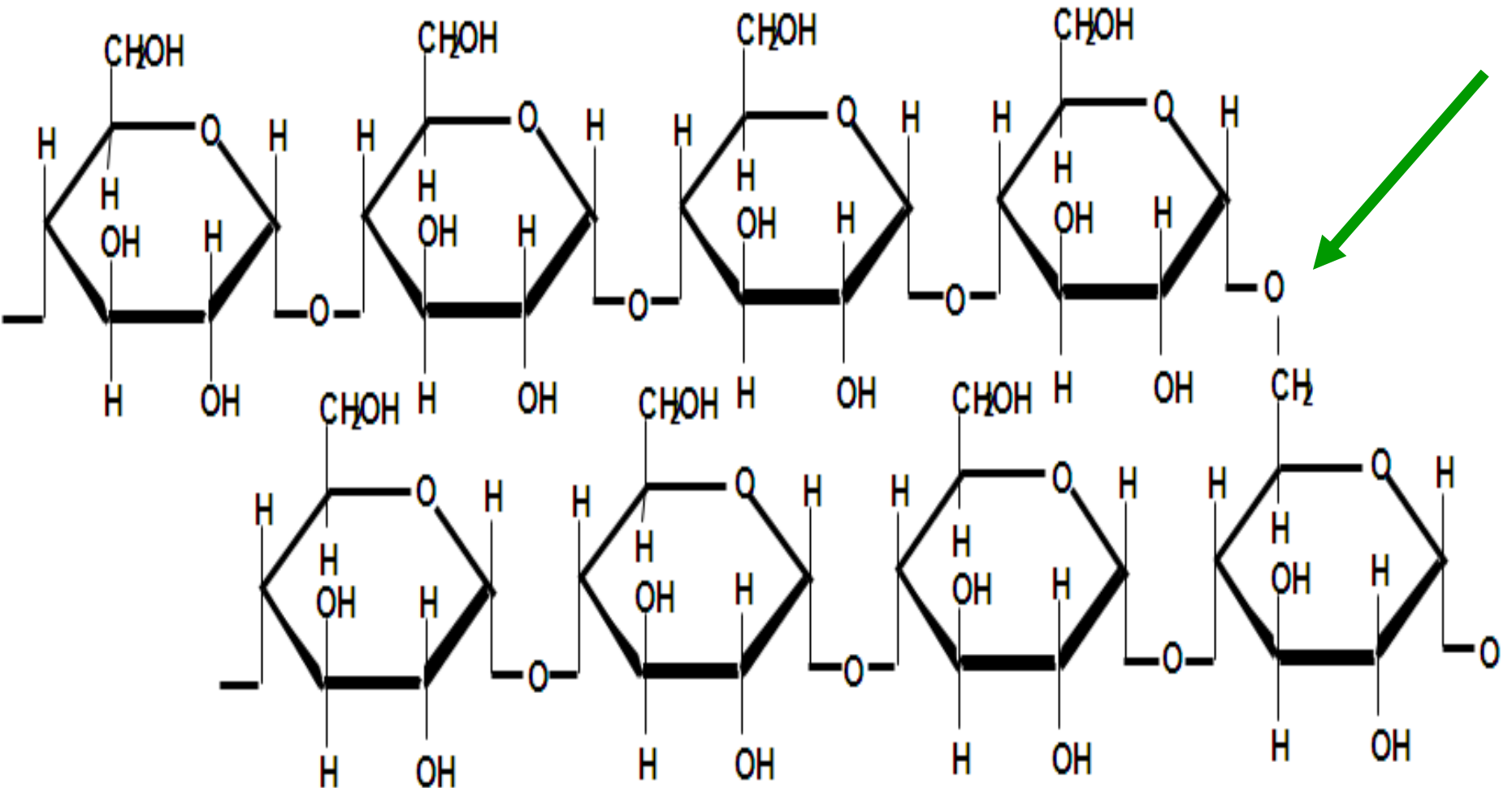
Amylose



shutterstock.com · 2365224517

$\alpha(1 \rightarrow 4)$ glycosidic bonds

Amylopectin



$\alpha(1\rightarrow4)$ glycosidic bonds

$\alpha(1\rightarrow6)$ glycosidic bonds

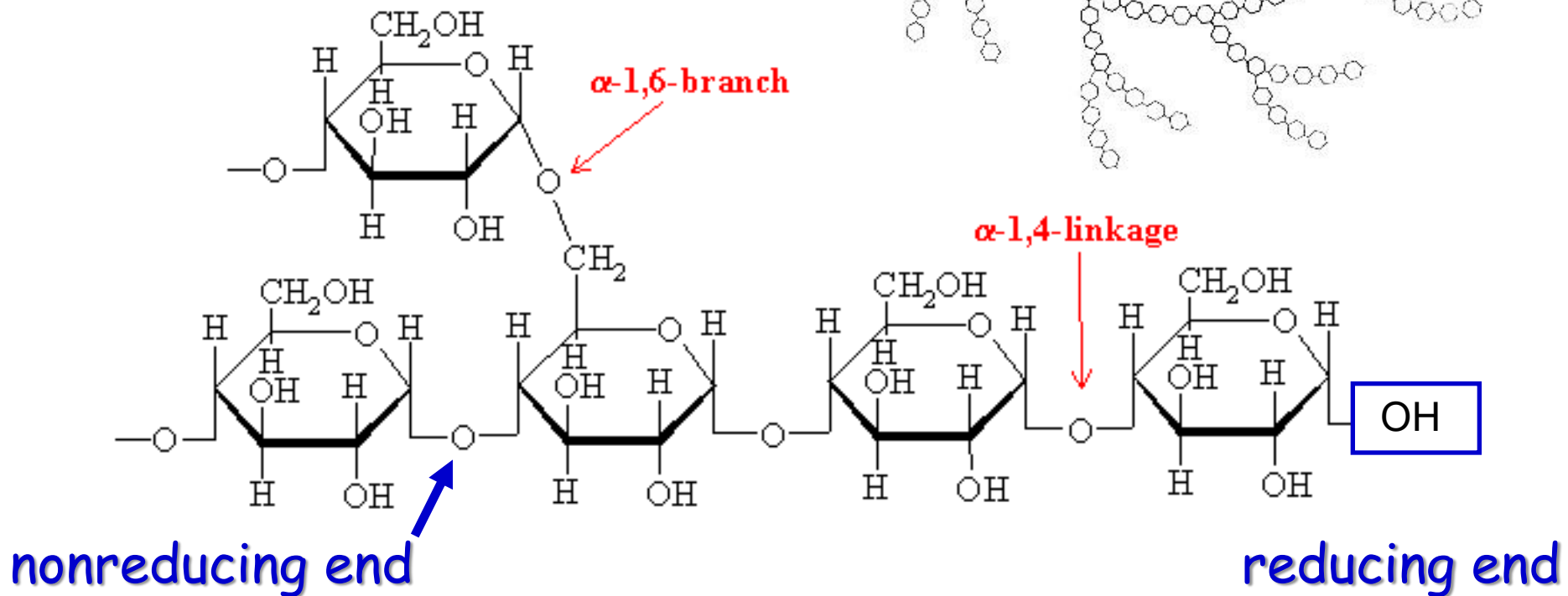
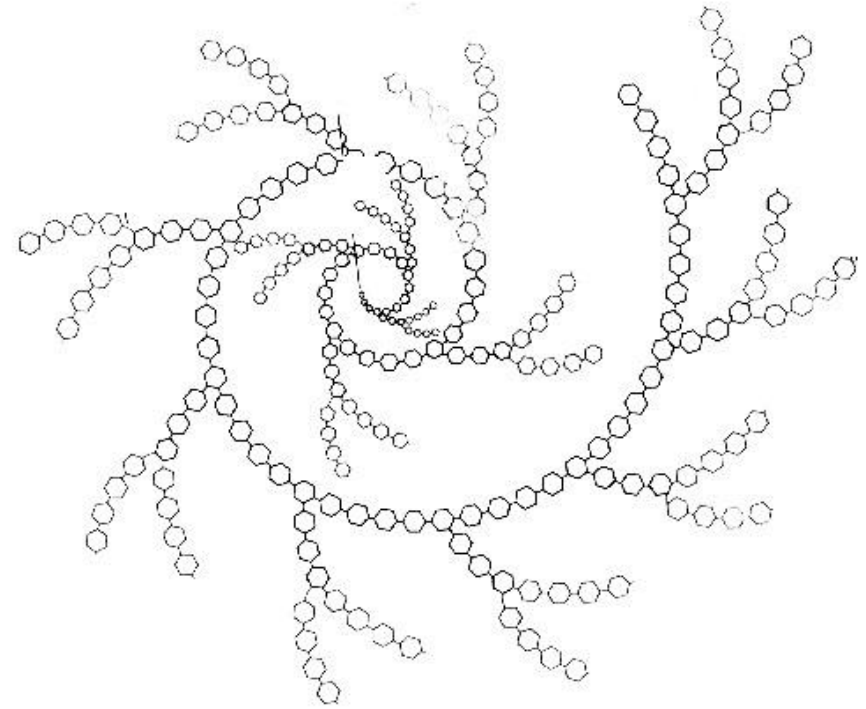
Glycogen (animal starch)

Glycogen has the **same** overall structure as amylopectin but there is **more branching** in the molecule.

It is a **homo-polymer** of glucose in α -(1,4) linkage.

It is highly **branched**, with α -(1,6) branch linkages occurring every **8-11** glucose residues.
(systematically).

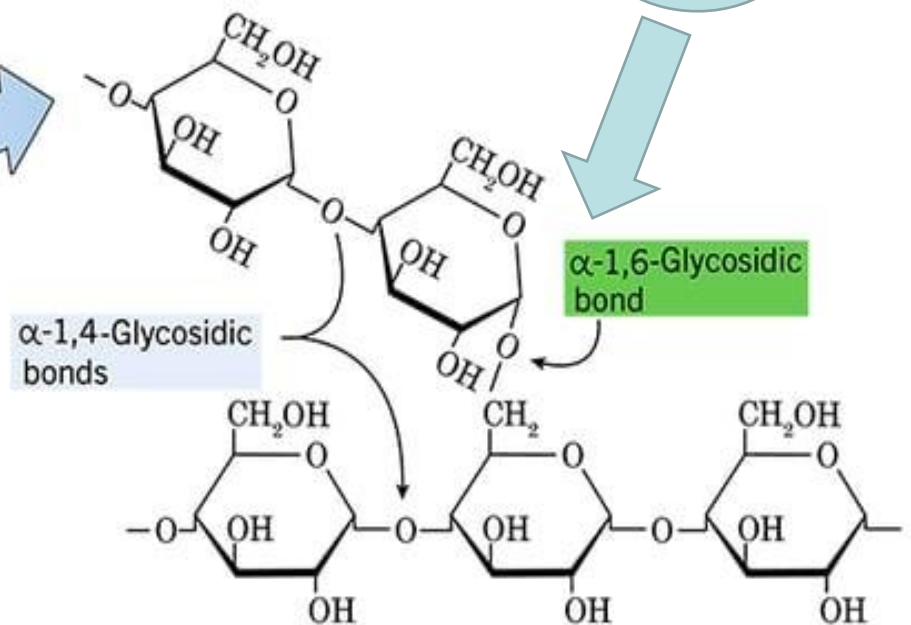
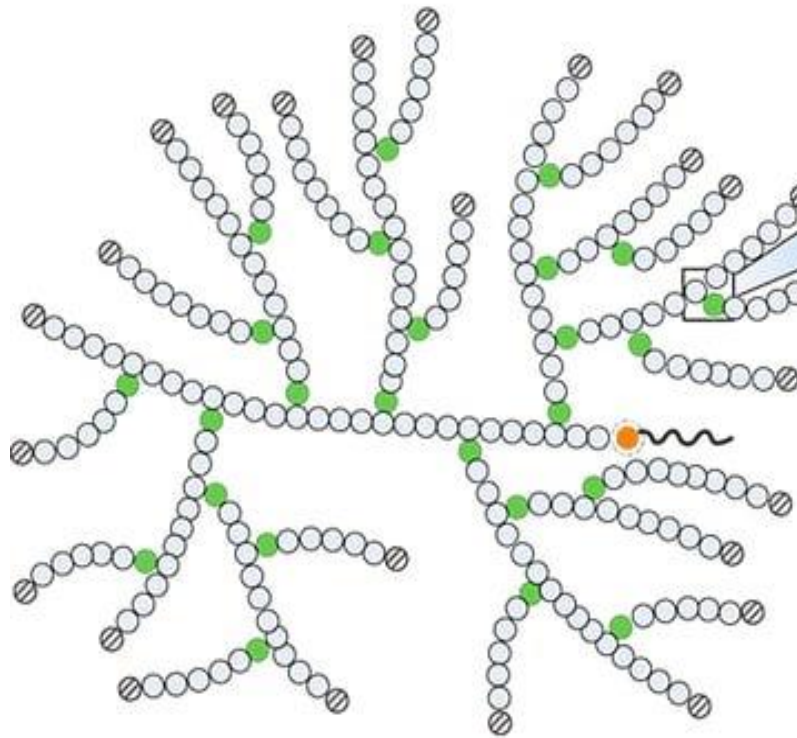
GLYCOGEN



Glycogen

Glycogen

More of these branch points form



○ Glucose residue linked α -1,4 ● Glucose residue linked α -1,6

Glycogen

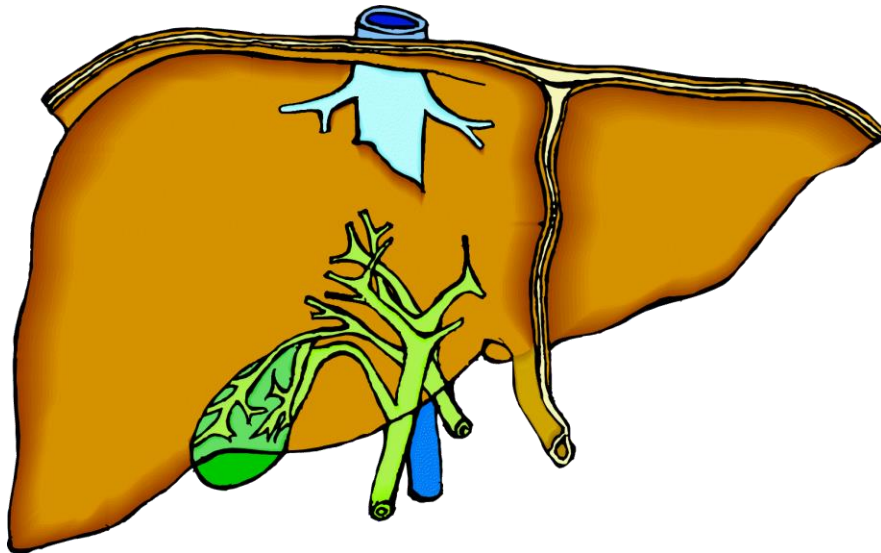
Glycogen is the storage form of glucose in **animals** as is starch in plants.

It is stored in **liver** and **muscle**.

Due to more **muscle mass** the quantity of glycogen in muscle is about **three times** higher than that in the liver.

Glycogen

GLUCOSE is stored as **Glycogen** in large amount in both **Liver** and **Muscle**.



Glycogen

The prime function of liver glycogen is to maintain the blood glucose levels. Liver glycogen stores increase in well-fed state which depleted during fasting.

Muscle glycogen serves as a fuel reserve for the supply of ATP during muscle contraction.

2.Structural Polysaccharides

2. Structural Polysaccharides:

1– Cellulose. { plants cell wall }

2– Chitin. {exoskeleton of insect }

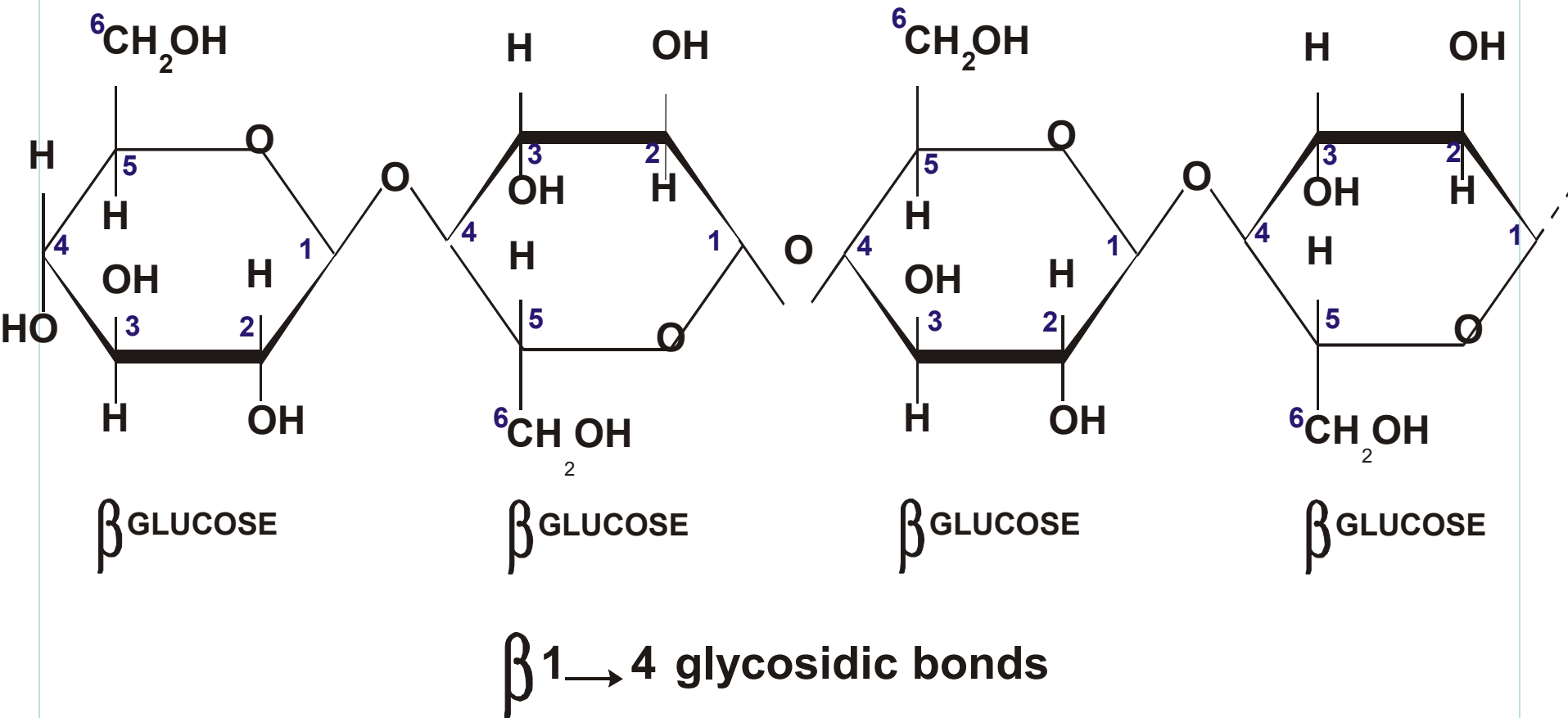
Cellulose

A major constituent of plant cell walls, consists of long **linear chains** of glucose.

The **β** linkage of cellulose makes it **indigestible** to animals such as humans (**Cannot** be digested by **humans** because humans **cannot** break down **β -1,4-glycosidic** bond due to the lacking **cellulase** enzyme).

Its present in diet is important because it stimulates the **intestinal movement** and prevent **constipation** .

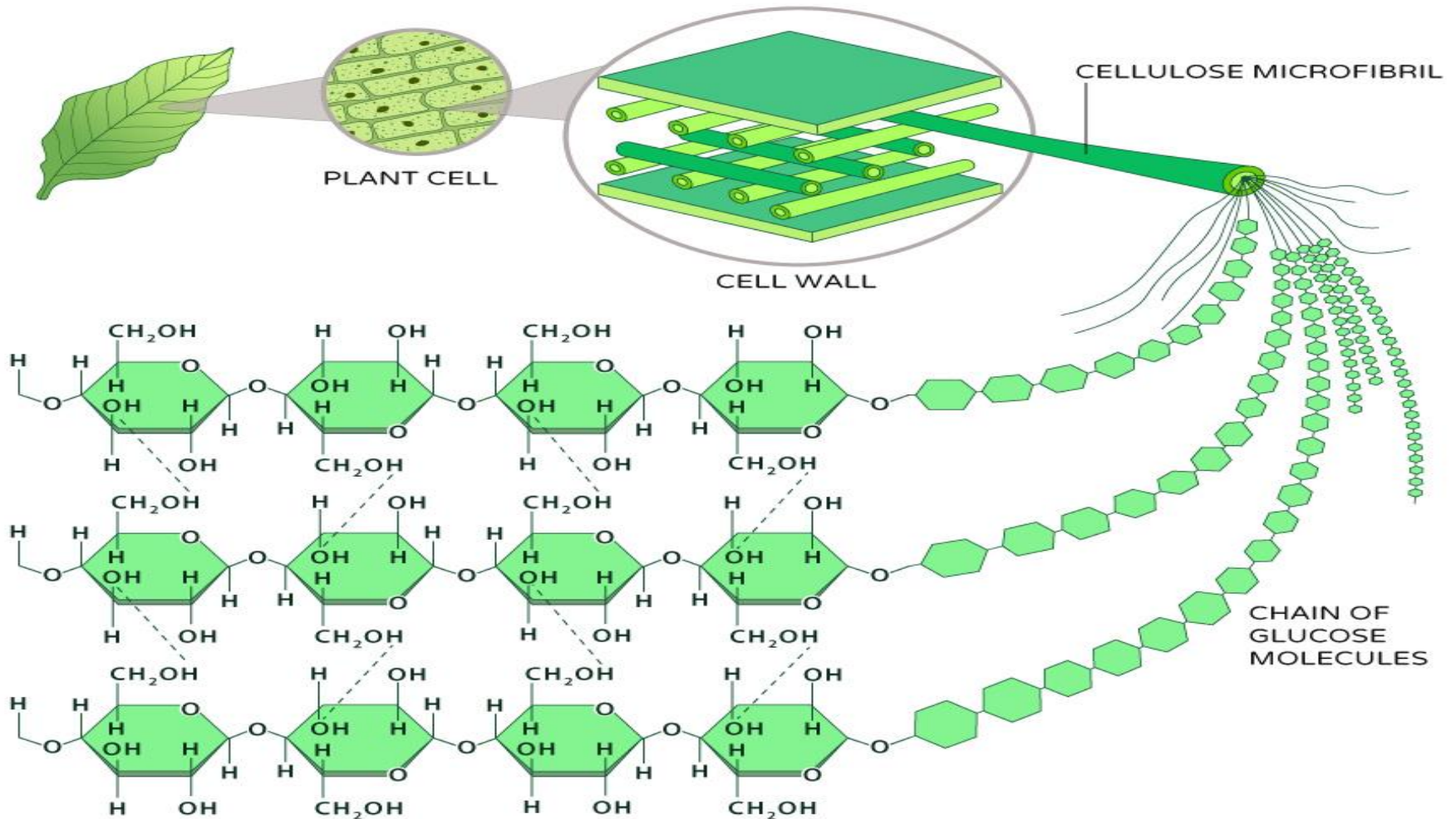
Cellulose is a polymer of beta glucose units



Cellulose is a polymer of beta glucose units

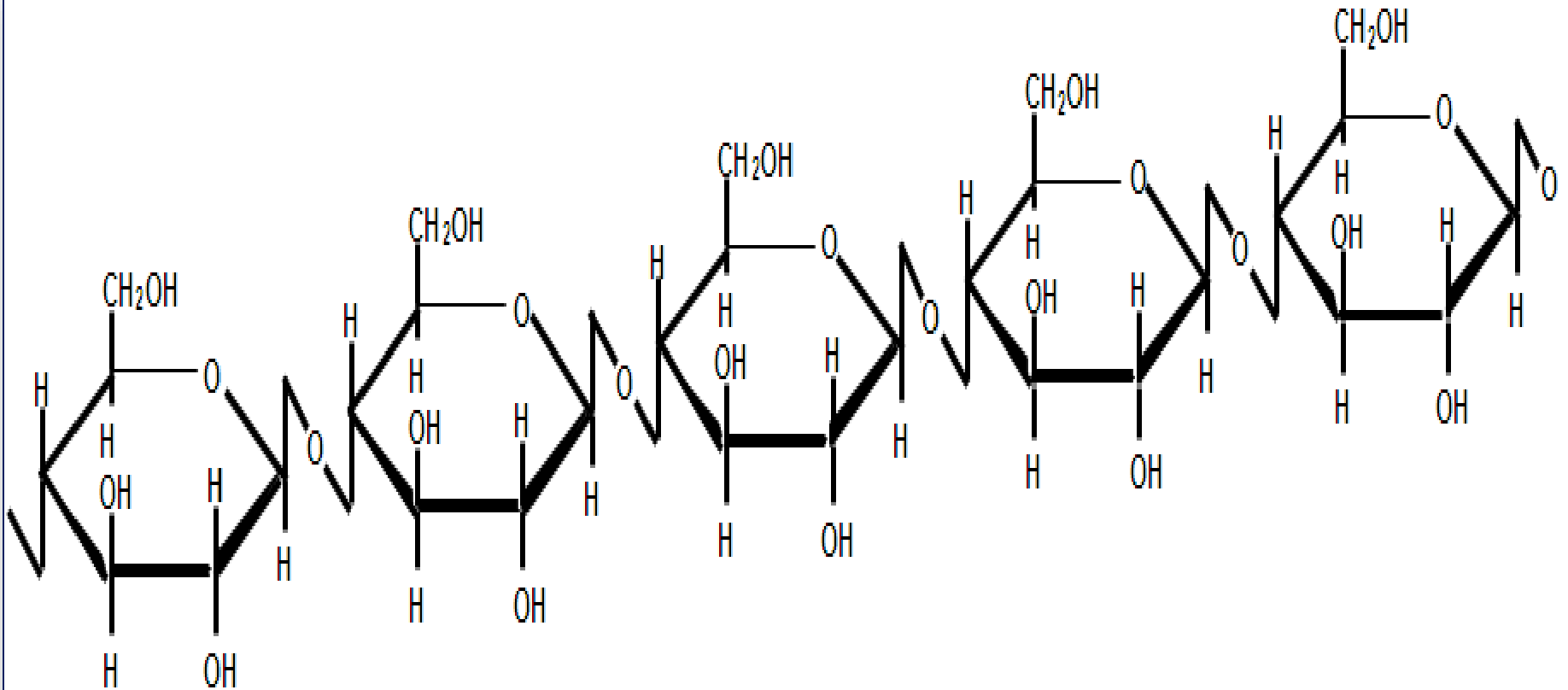
STRUCTURE OF CELLULOSE

ScienceFacts.net

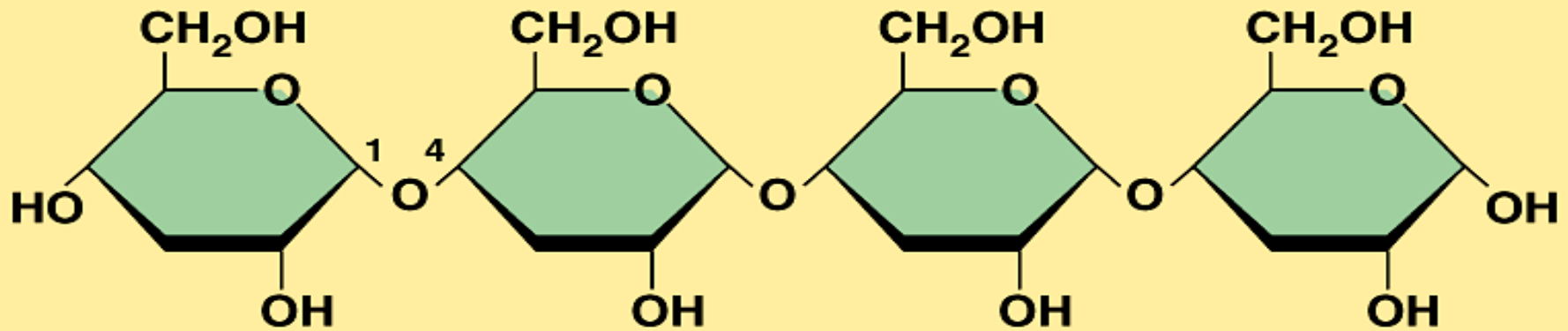


Cellulose

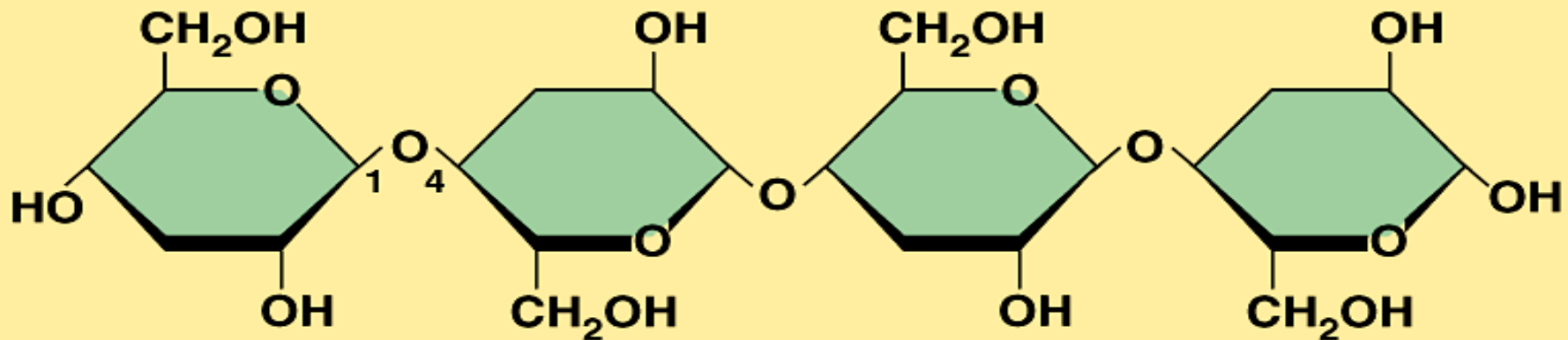
- Most abundant polysaccharide in plants
- $\beta(1 \rightarrow 4)$ glycosidic linkages.
- Result in long fibers - for plant structure.



Starch **Vs.** cellulose



(b) Starch: 1–4 linkage of α glucose monomers

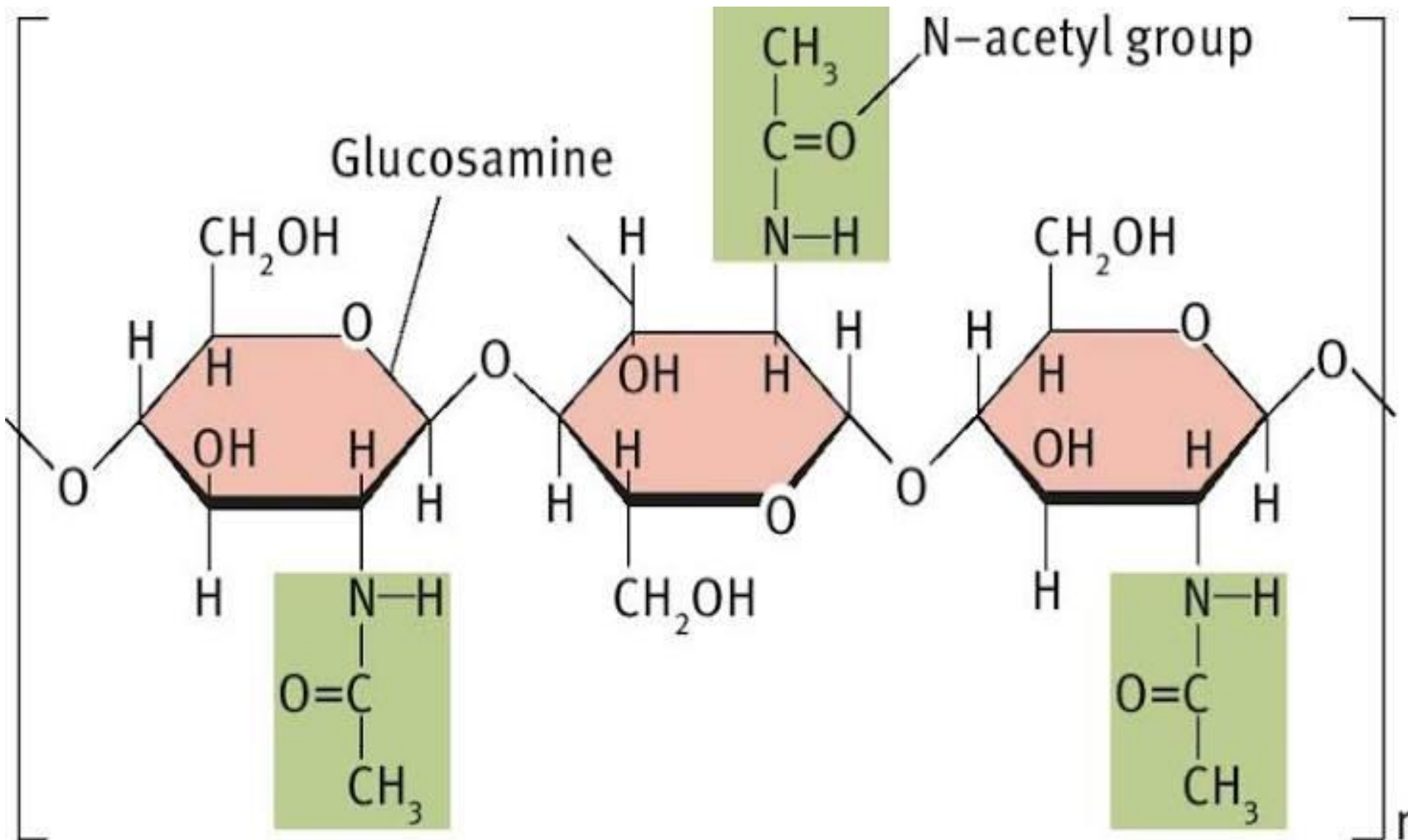


(c) Cellulose: 1–4 linkage of β glucose monomers

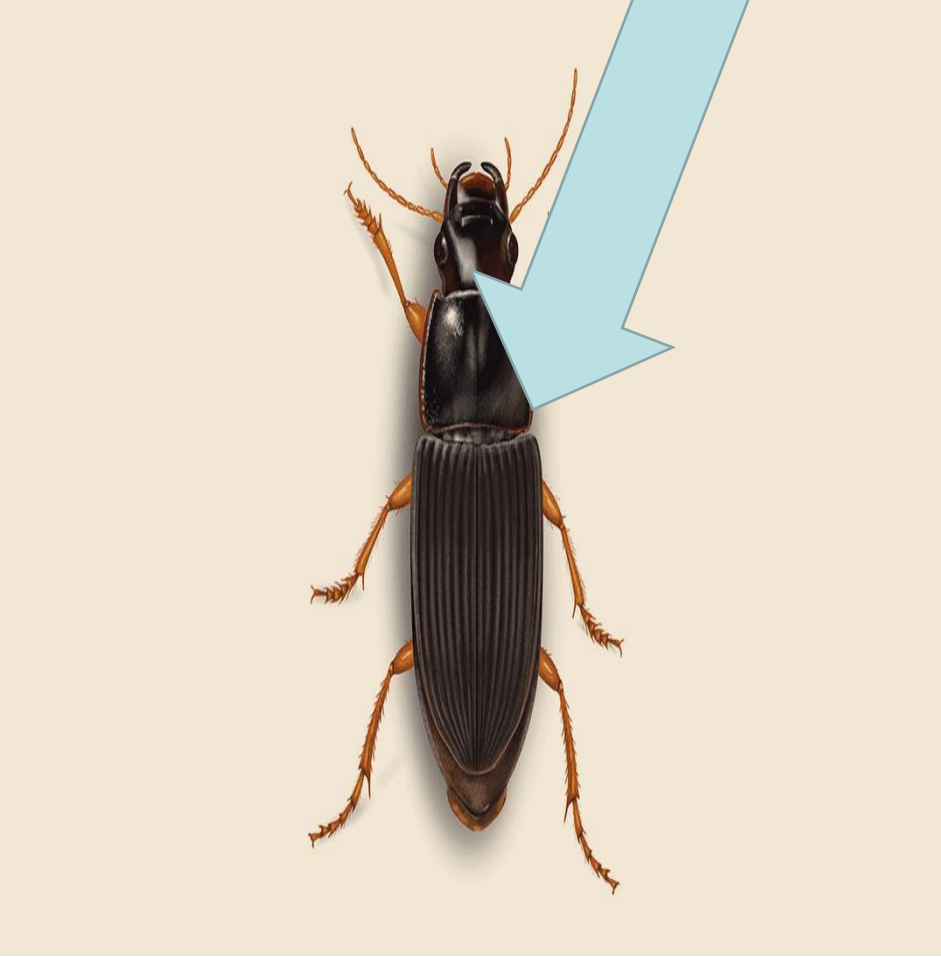
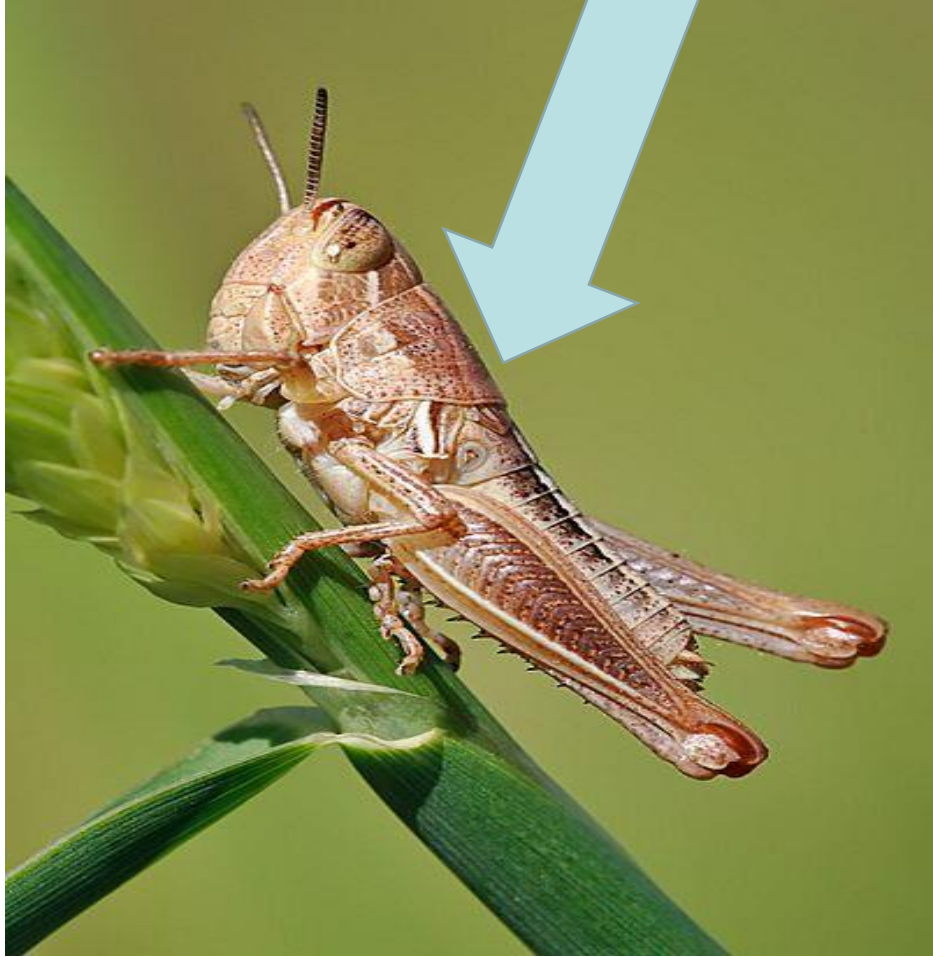
Chitin

- It is a long-chain polymer made of **N-acetylglucosamine** units, which are modified glucose molecules containing **nitrogen**.
- Chitin found in the **exoskeleton of insects**. Such as beetles, ants, and butterflies.

Chitin Structure:

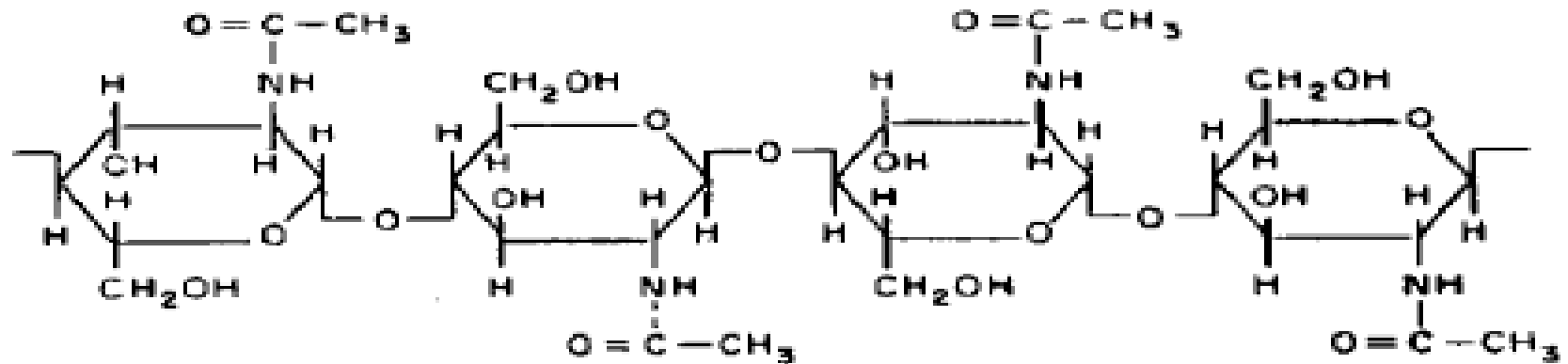


Chitin Structure:



Chitin Vs. Cellulose

CHITIN



CELLULOSE

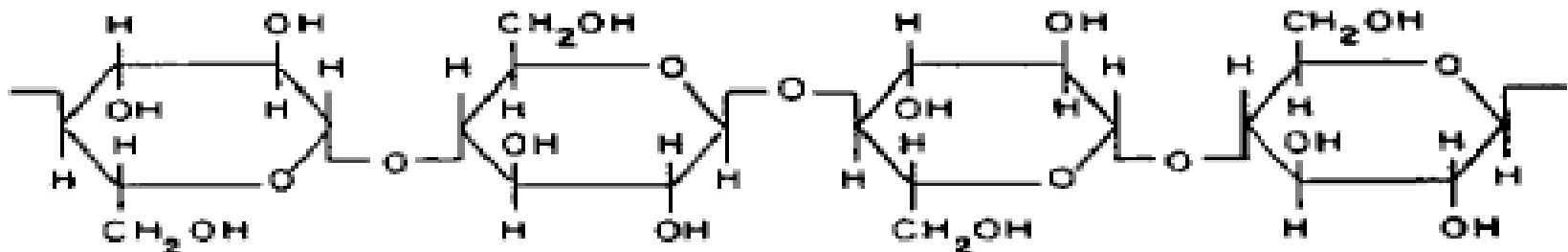


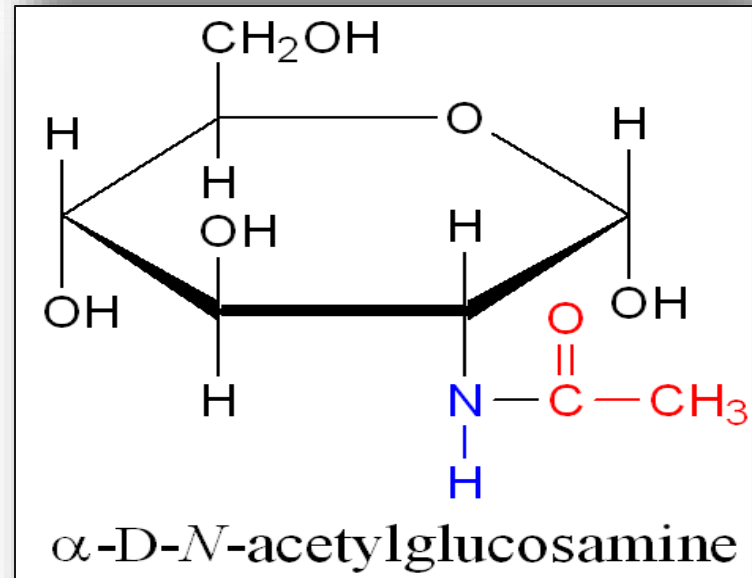
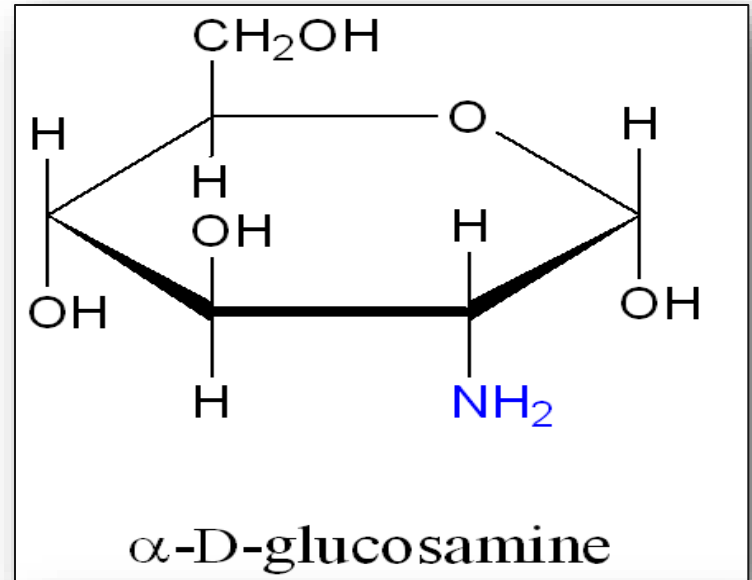
Figure 1. Comparison of chitin and cellulose molecular structure.

Sugar Derivatives : Glycoproteins

- **Proteins** that carry covalently bound **carbohydrate** units.
- They have many biological functions.
e.g. Cell-cell recognition

Sugar Derivatives : Amino Sugars

- **Amino sugar:** hydroxyl group **C2** substituted by amino group.
- Example is **glucosamine**.
- The amino group may be acetylated, as in **N-acetylglucosamine**.



References:

- 1-lipincotts biochemistry 8th edition 2022**
- 2. Harpers 25th , 27th and 32nd edition 2023**
- 3- Lehninger principles biochemistry 8th edition 2021**
- 4- Medical biochemistry 6th edition 2023**
- 5- Mark Basic Medical biochemistry 6th edition 2023**
- 6- Stryer biochemistry**



Thank You