Chem 452 - Lecture 7
Carbohydrates
111109

Carbohydrates are one of the four major classes of biomolecules, which include the proteins, lipids and nucleic acids. In terms of total mass, carbohydrates make up the largest fraction of biomolecules in the biosphere. Carbohydrates have the basic chemical formula $(CH_2O)_n$ and derive their diversity of structure from the the multiple stereoisomers that they can form. They play many important biological roles, including sources and storage forms of chemical energy, components of nucleic acids, and structural roles such as cell walls. The are also found covalently bonded to proteins and lipids, where they play important roles in cell-cell communication.

Problem

Question:

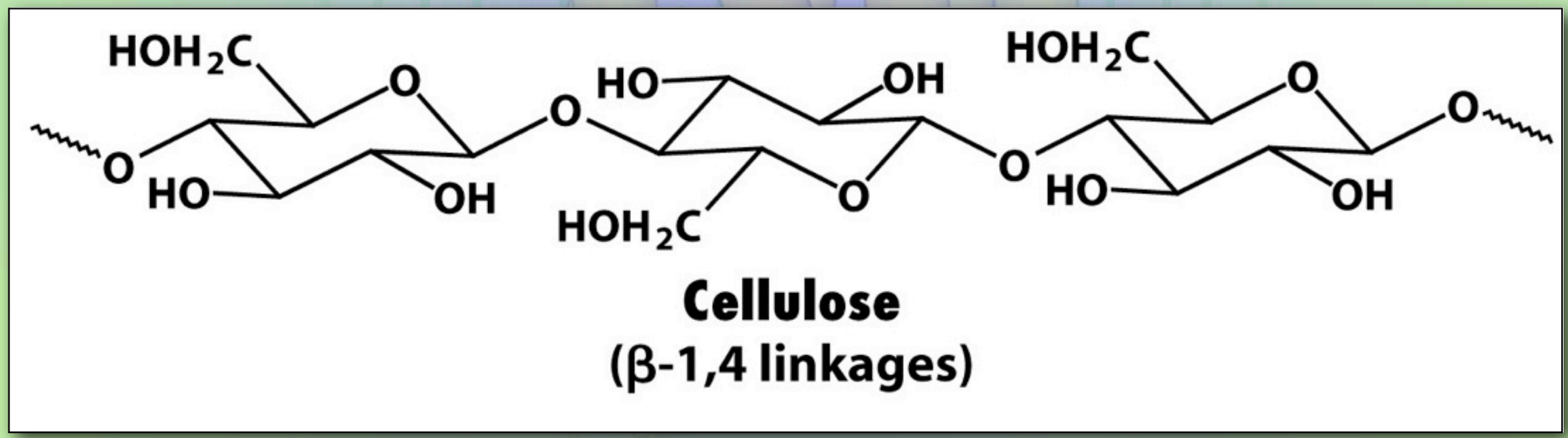
Draw the structure of the β-anomer of the disaccharide formed by linking D-galactose to D-glucose using a β(1->4) glycosidic bond.
(β-D-galactopyranosyl-(1-4)-β-D-glucopyranose)

Name a natural source for this disaccharide.

What is the more common name for this disaccharide?

Complex Carbohydrates

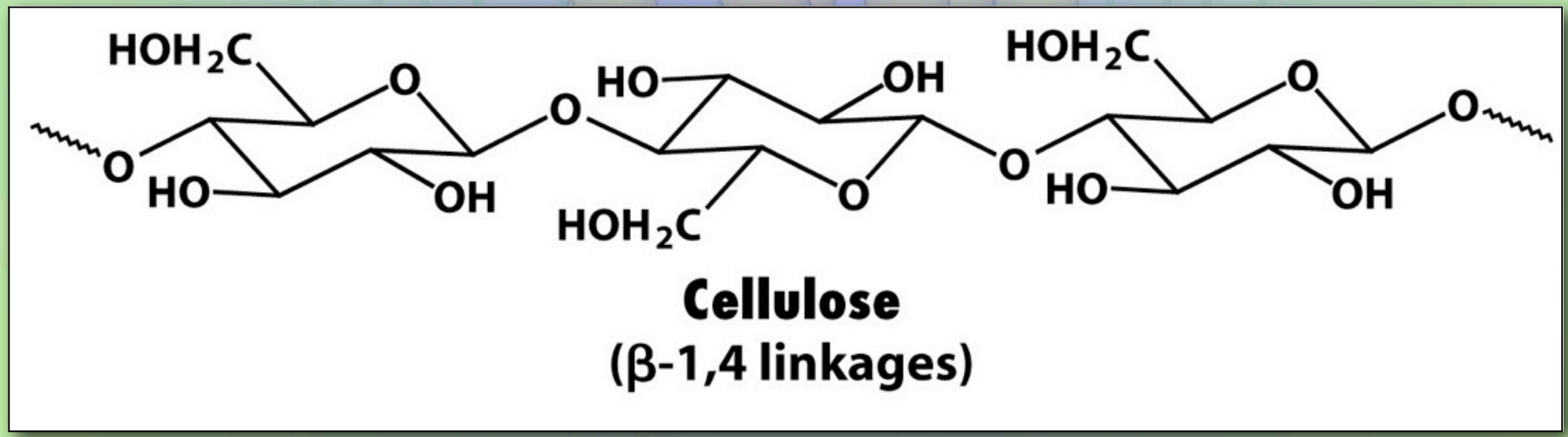
- Multiple monosaccharides can combine using glycosidic bonds to form **oligosaccharides** and **polysaccharides**
  - **Cellulose** is a **homopolymer** of glucose joined by β-1,4 glycosidic bonds.



Cellulose
(β-1,4 linkages)

Complex Carbohydrates

- Cellulose is the most prevalent biomolecule in terms of mass
  - It is very resistant to degradation.
    - Forms insoluble fibers
    - Few organisms have the enzyme (cellulase), required to hydrolyze the β-1,4 linkage

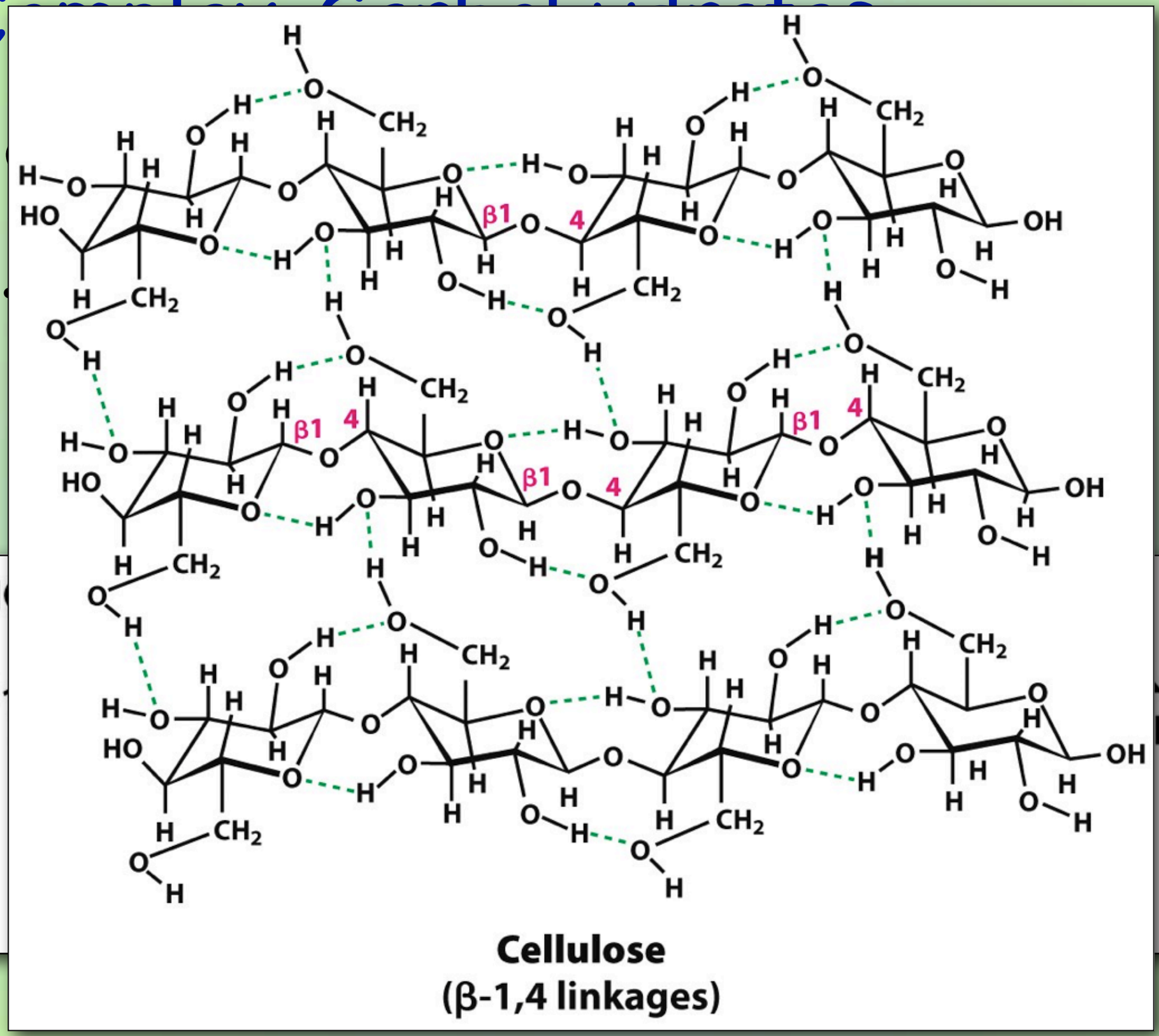


Cellulose
(β-1,4 linkages)

C

- ✦ (

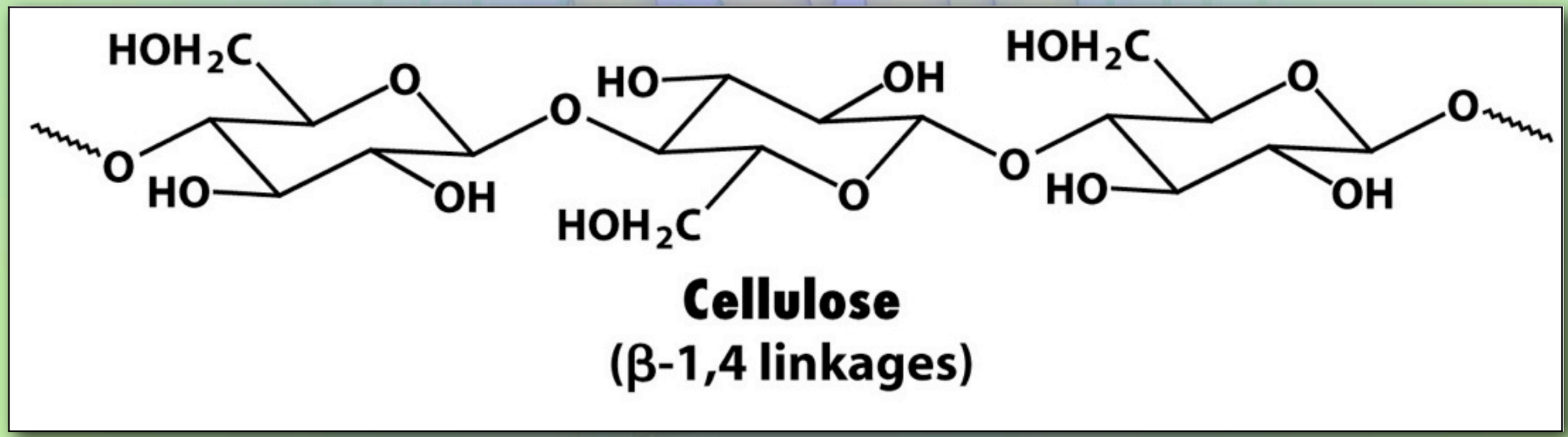
n



Cellulose
(β-1,4 linkages)

Complex Carbohydrates

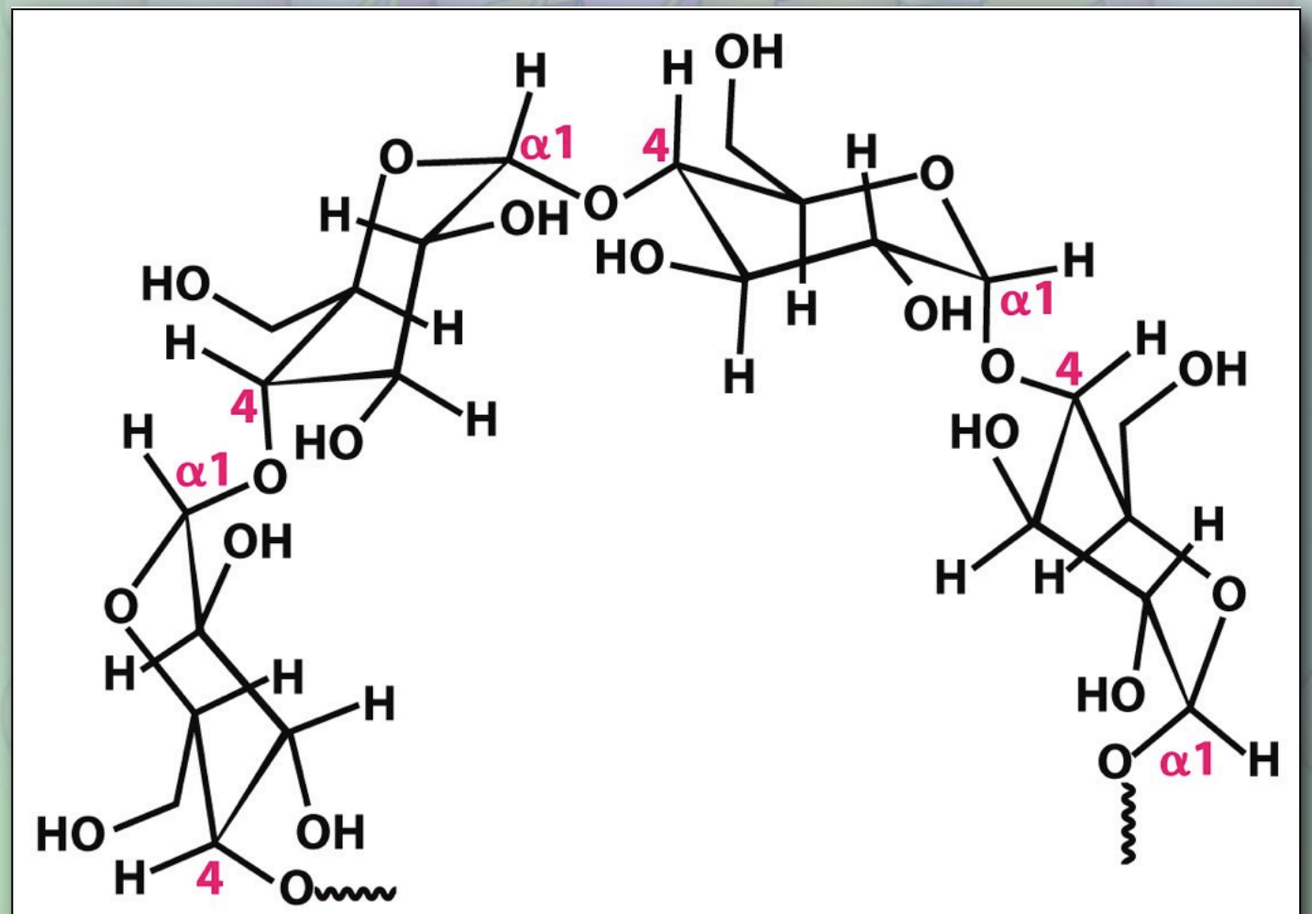
- Cellulose is the most prevalent biomolecule in terms of mass
  - It is very resistant to degradation.
    - Forms insoluble fibers
    - Few organisms have the enzyme (cellulase), required to hydrolyze the β-1,4 linkage



Cellulose
(β-1,4 linkages)

Complex Carbohydrates

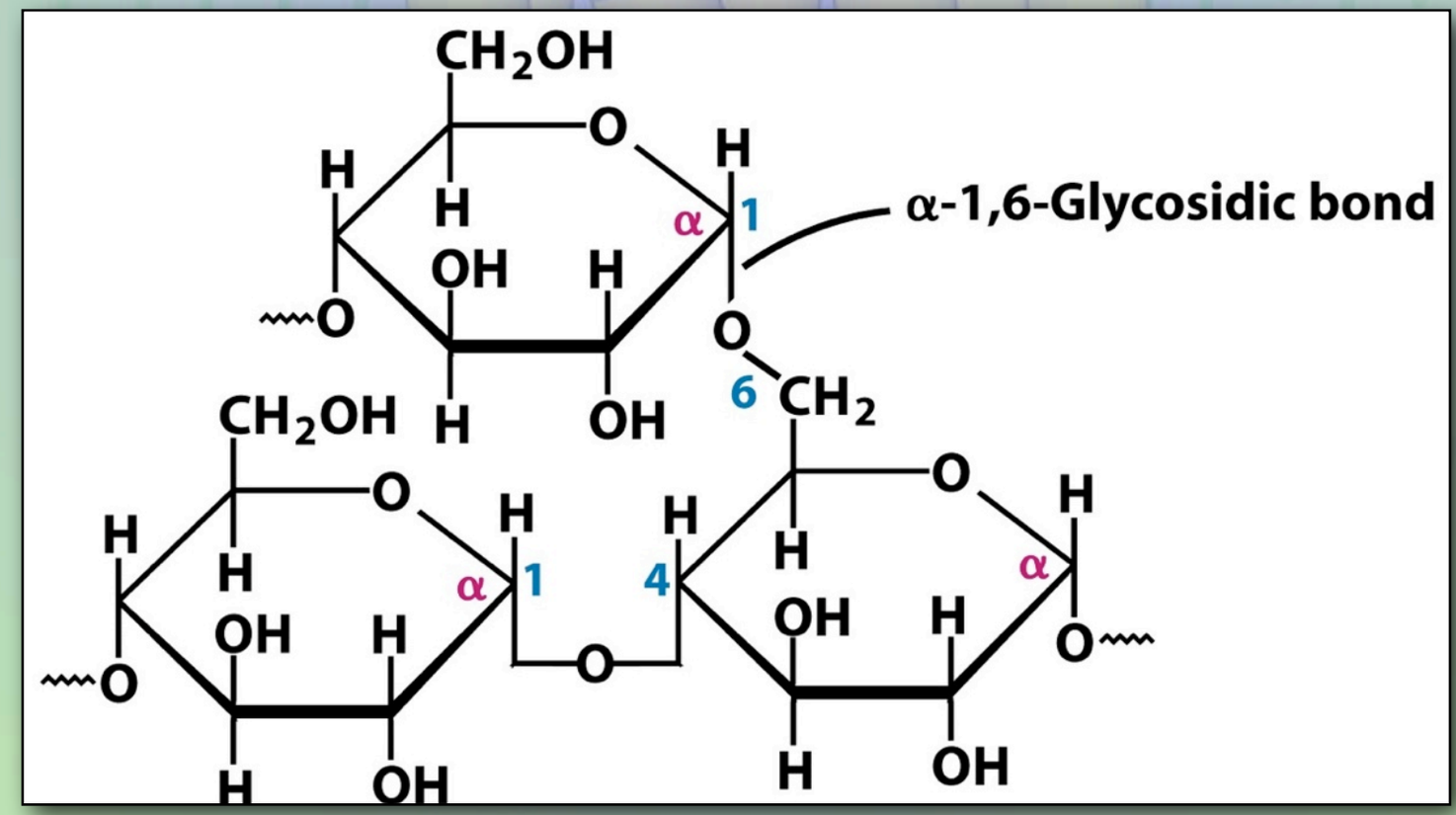
- **Amylose (Starch)** is a **homopolymer** of glucose joined by α-1,4 glycosidic bonds.



Starch and glycogen
(α-1,4 linkages)

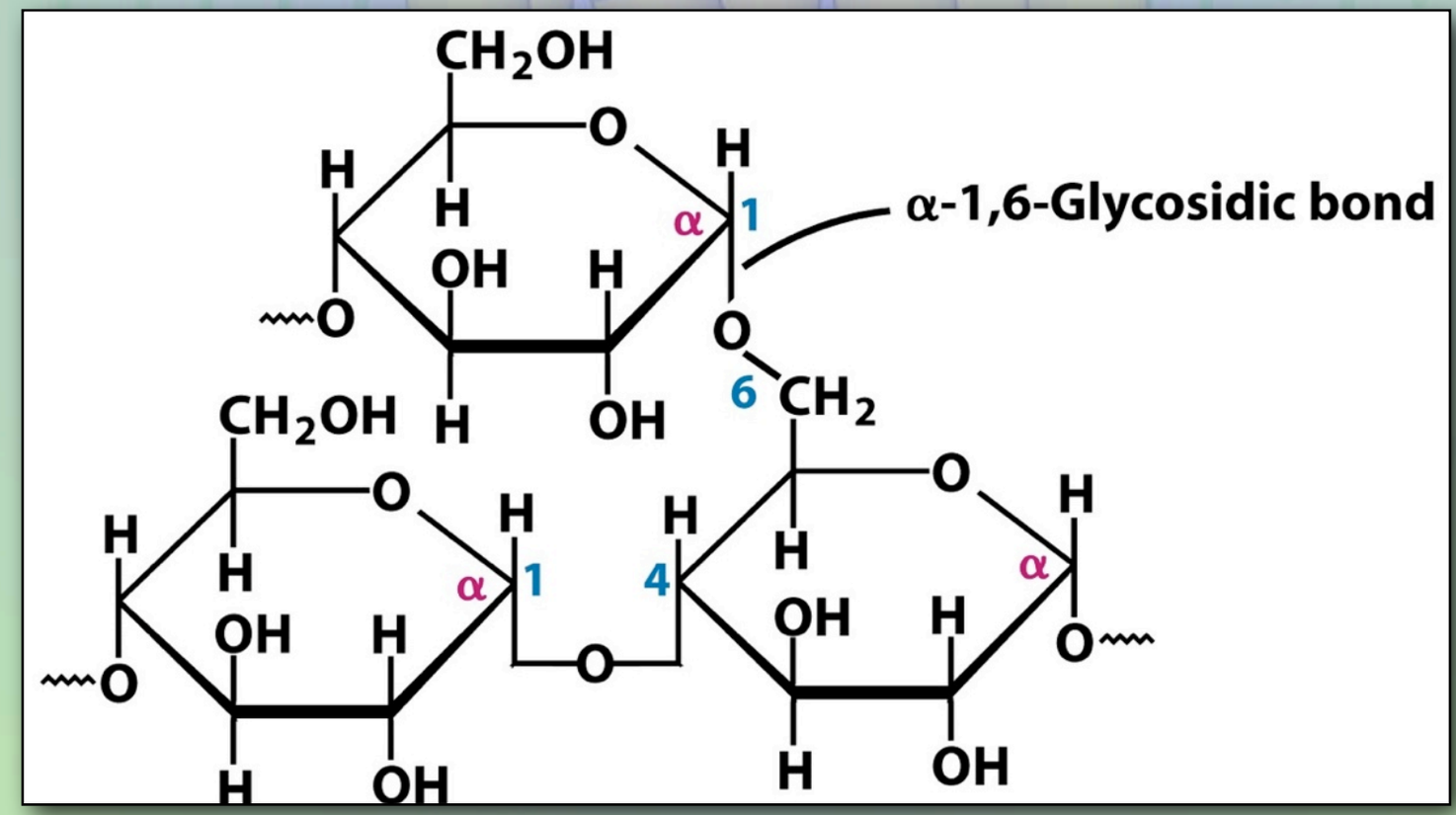
Complex Carbohydrates

- **Amylopectin (another form of Starch)** and **Glycogen are** are **homopolymers** of glucose joined by α-1,4 glycosidic bonds, along with α-1,6 branch points.



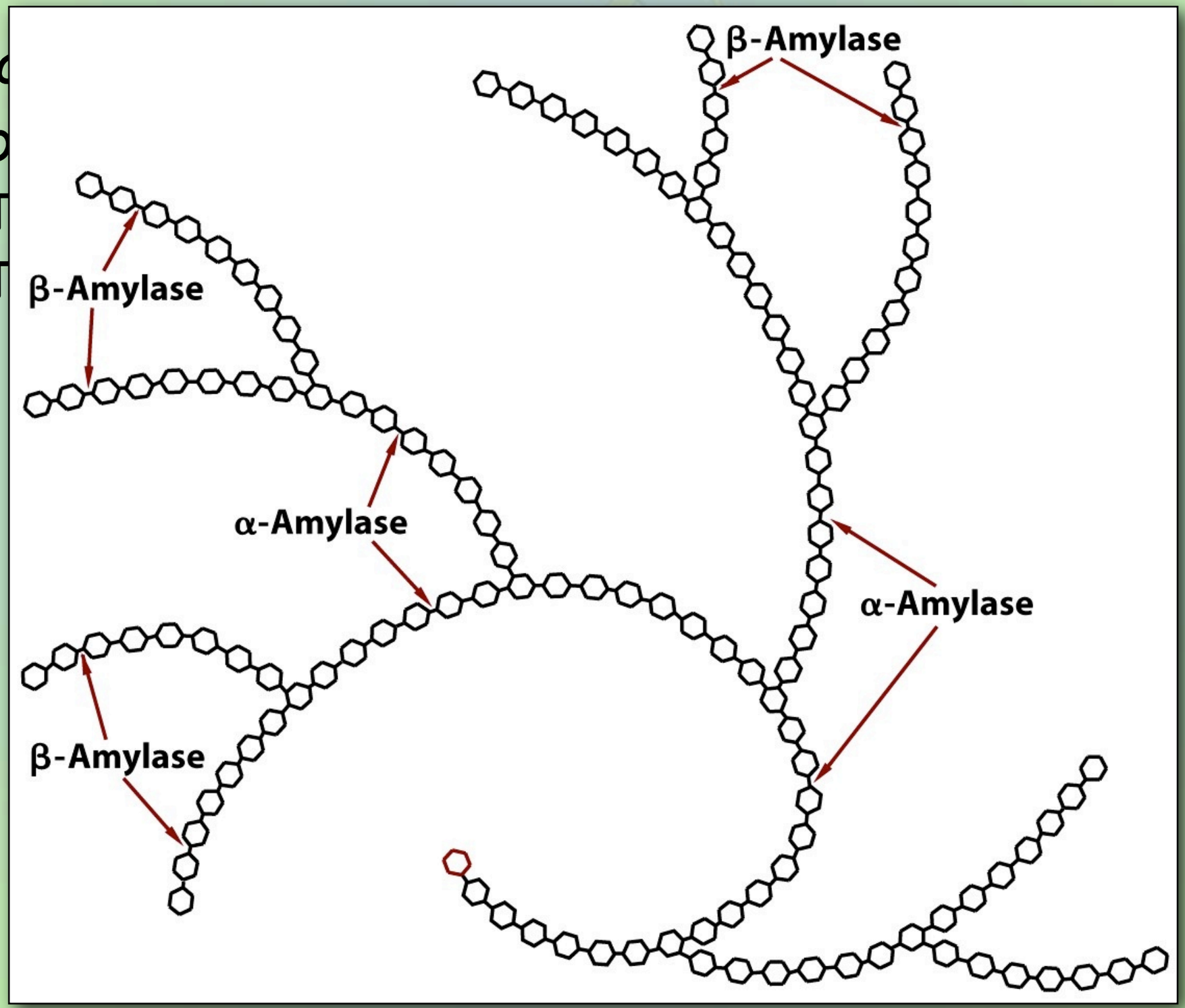
Complex Carbohydrates

- Starch (plants) and glycogen (animals) are storage forms of glucose.
  - They are water soluble and easily hydrolyzed
  - They have a very open structure.



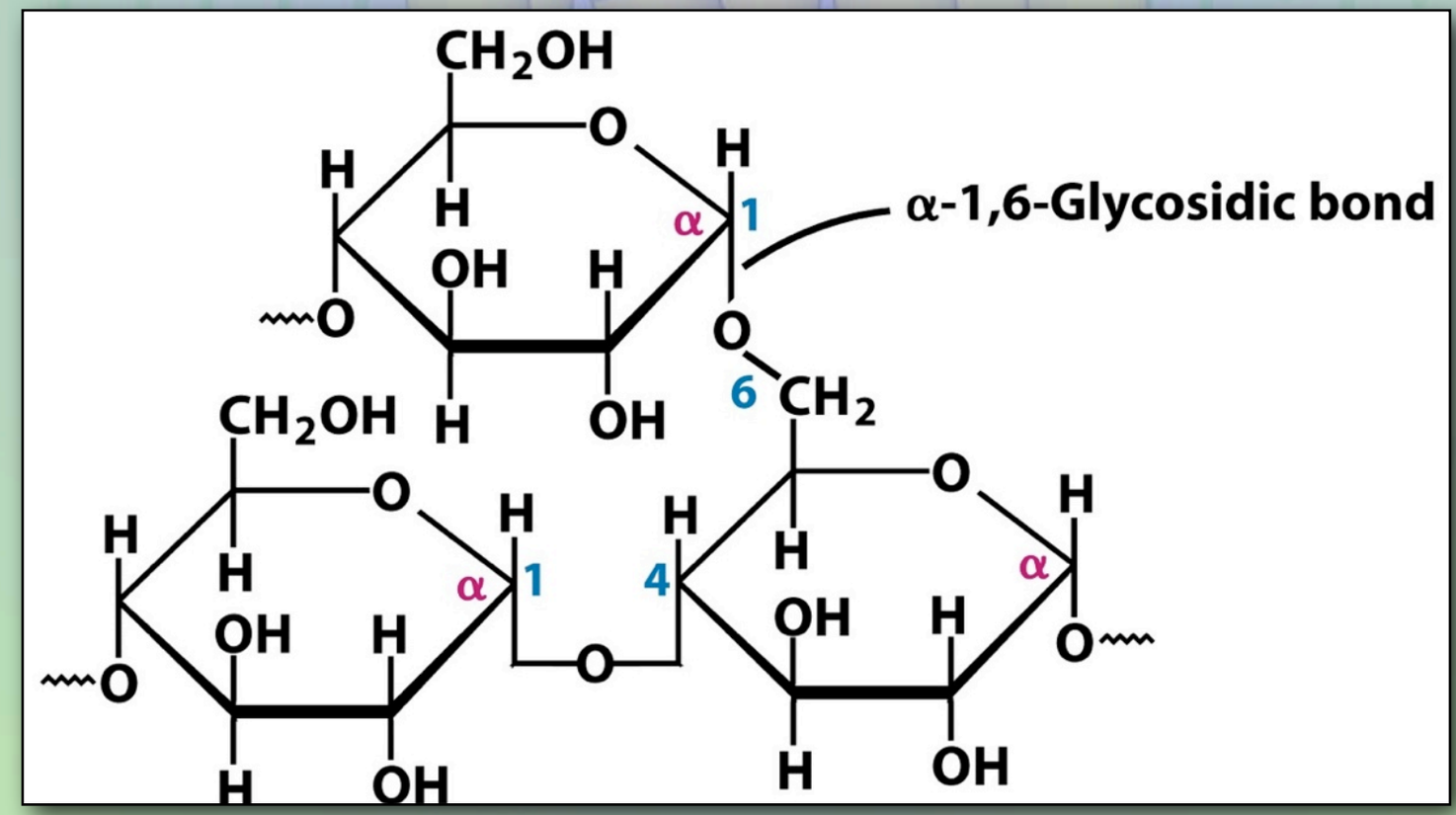
Complex Carbohydrates

- Sto
  sto
  - T
  - T



Complex Carbohydrates

- Starch (plants) and glycogen (animals) are storage forms of glucose.
  - They are water soluble and easily hydrolyzed
  - They have a very open structure.

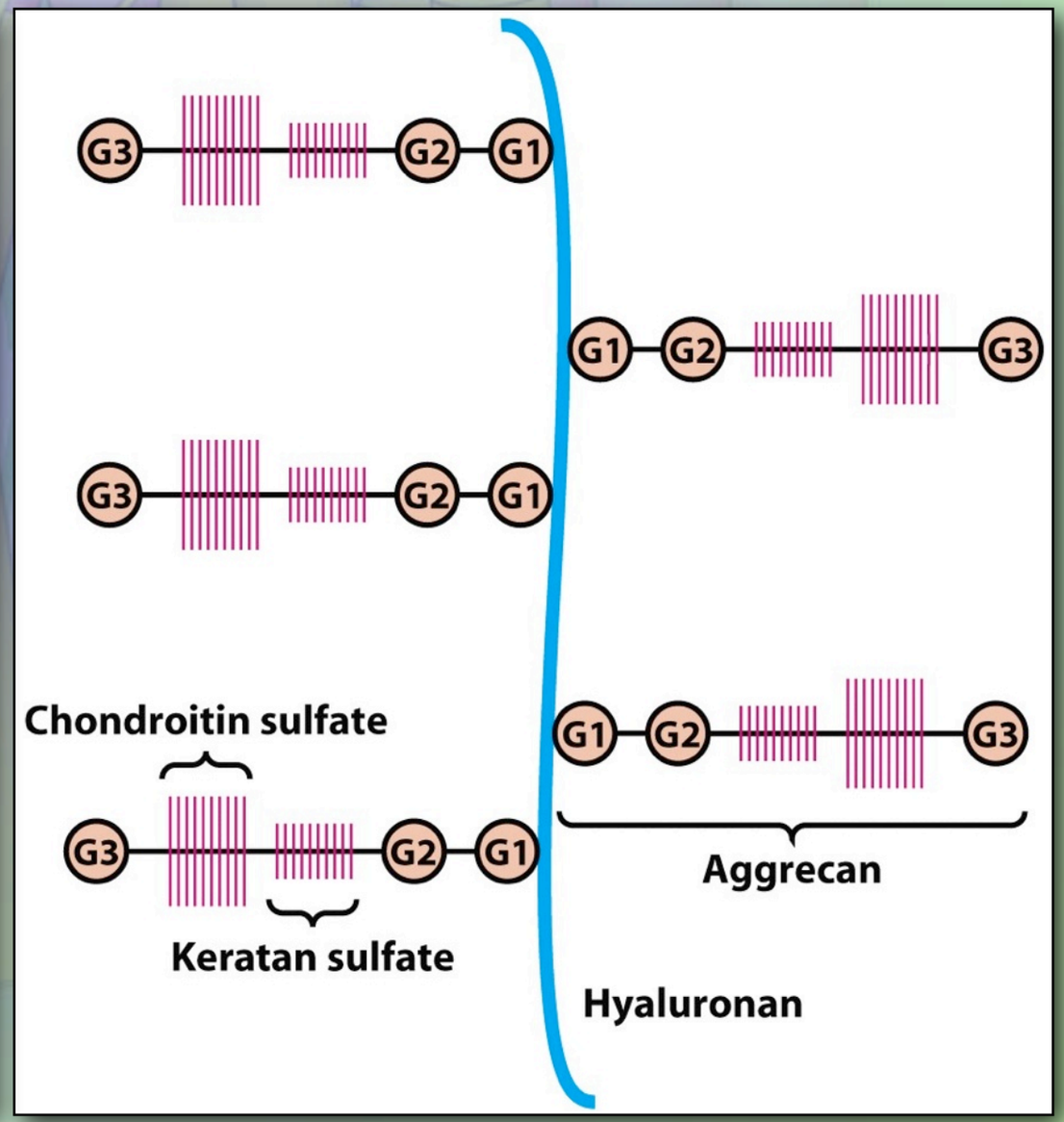


Complex Carbohydrates

- **Proteoglycans** are a combination of protein and oligosaccharides called **glycosaminoglycans**.
  - They are used to cushion and lubricate joins.

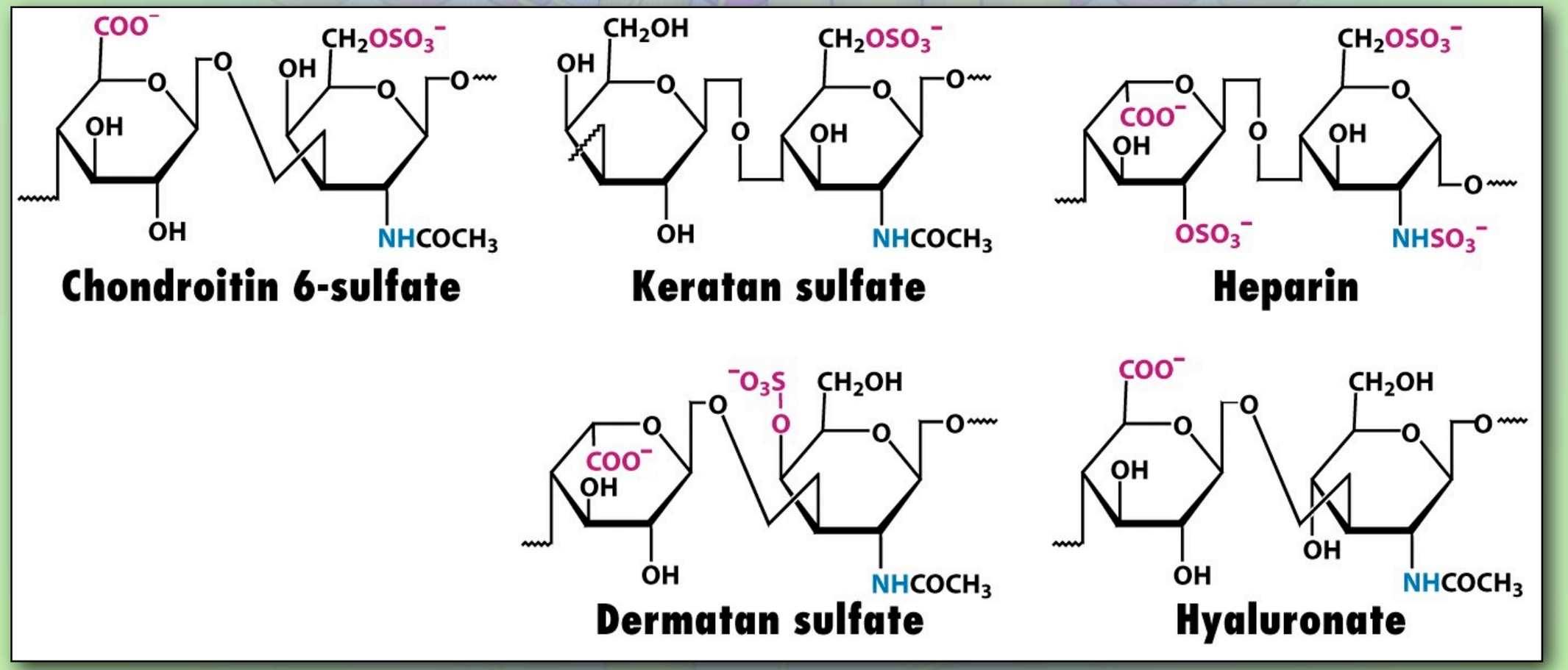
Complex Carbohydrates

- **Proteoglycans** are a combination of protein and oligosaccharides called **glycosaminoglycans**.



Complex Carbohydrates

- **Glycosaminoglycans** are highly charged and very hydrophyllic

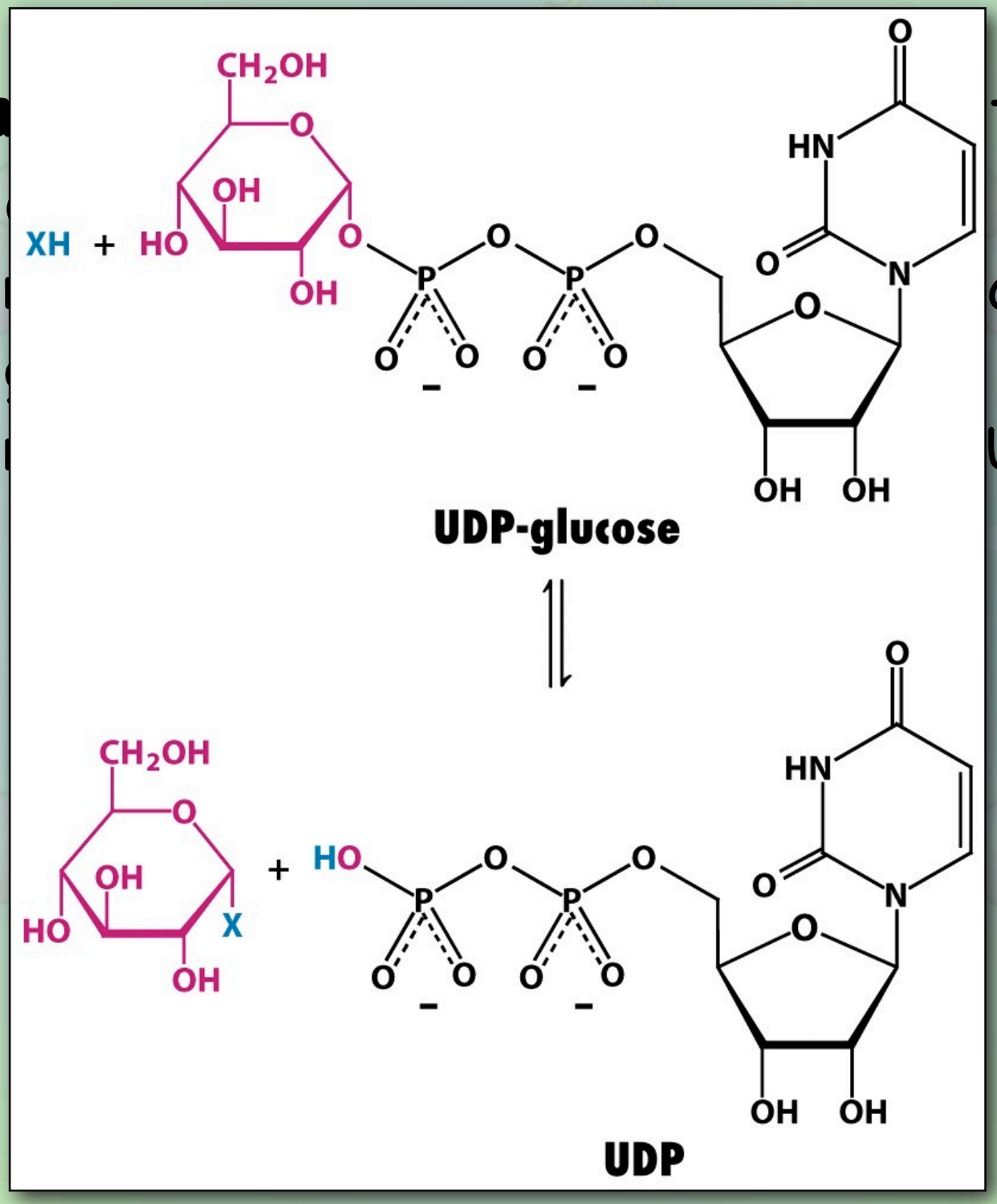


Complex Carbohydrates

- **Glycotransferases** are enzymes used to form glycosidic bond.
  - The monosaccharides are added to the non-reducing end.
  - The monosaccharides are activated with UDP

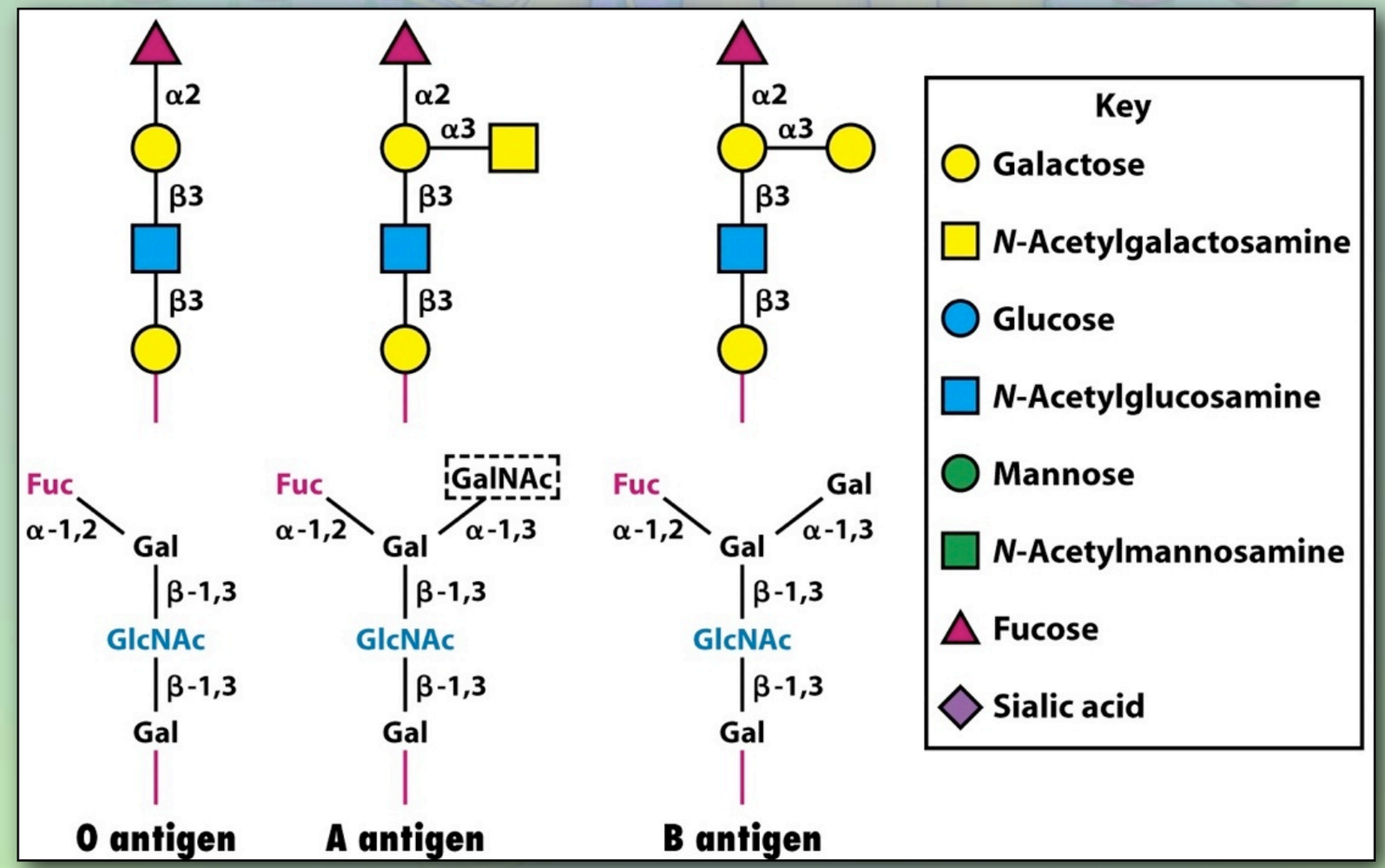
Complex Carbohydrates

- **Glycotra** to form glycosidi
  - The mo on-reducin
  - The mo UDP



Complex Carbohydrates

- The human ABO blood types are determined by oligosaccharides attached to proteins and membrane lipids.



Complex Carbohydrates

Question:

Can you speculate on way persons with blood type "O" can serve as universal donors.

A can give blood only to A

B can give blood only to B

AB can give blood to A, B, AB

O can give blood to A, B, AB, O

Complex Carbohydrates

Question:

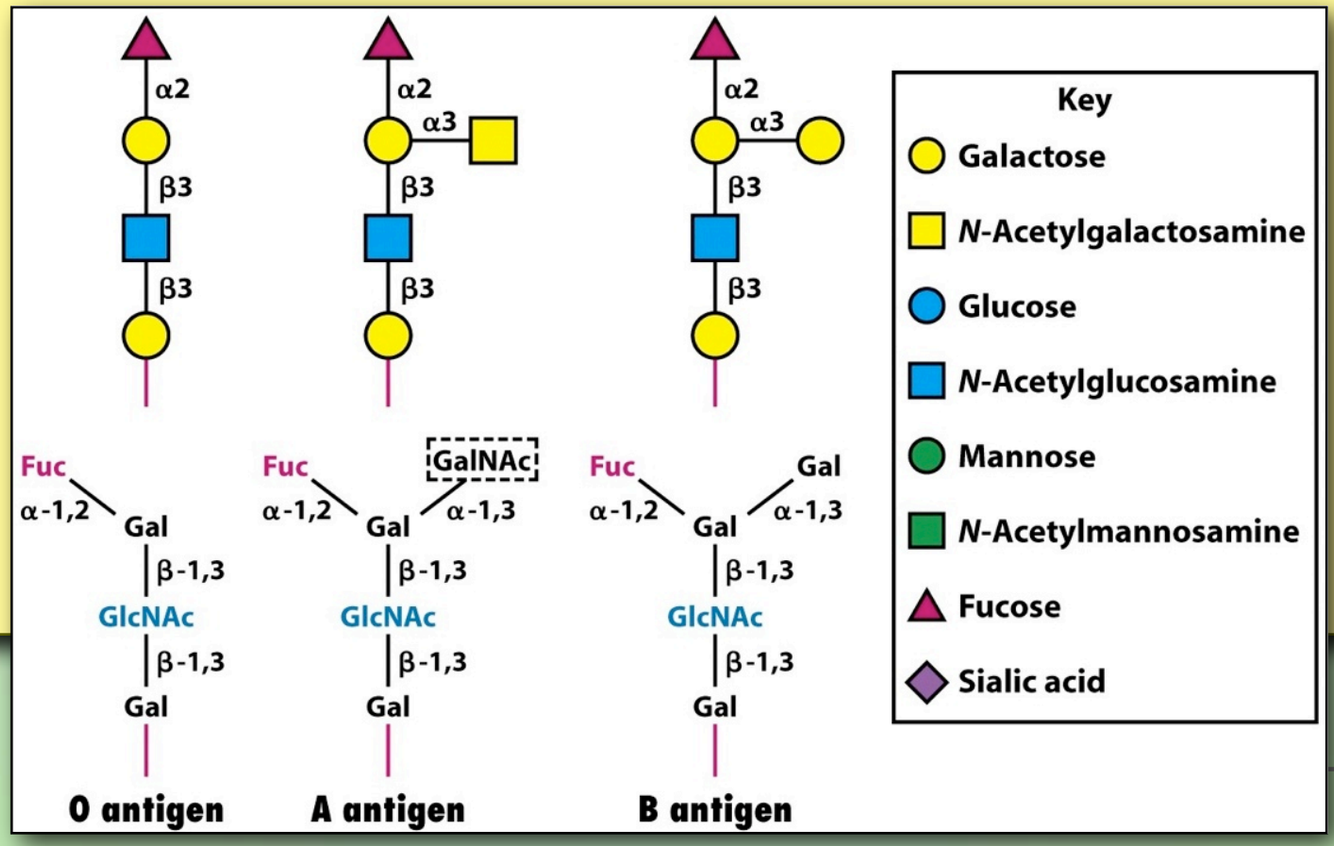
Can you speculate on way persons with blood type "O" can serve as universal donors.

A can give blood only to A

B can give blood only to B

AB can give blood to A, B, AB

O can give blood to A, B, AB, O



Complex Carbohydrates

Question:

Can you speculate on way persons with blood type "O" can serve as universal donors.

A can give blood only to A

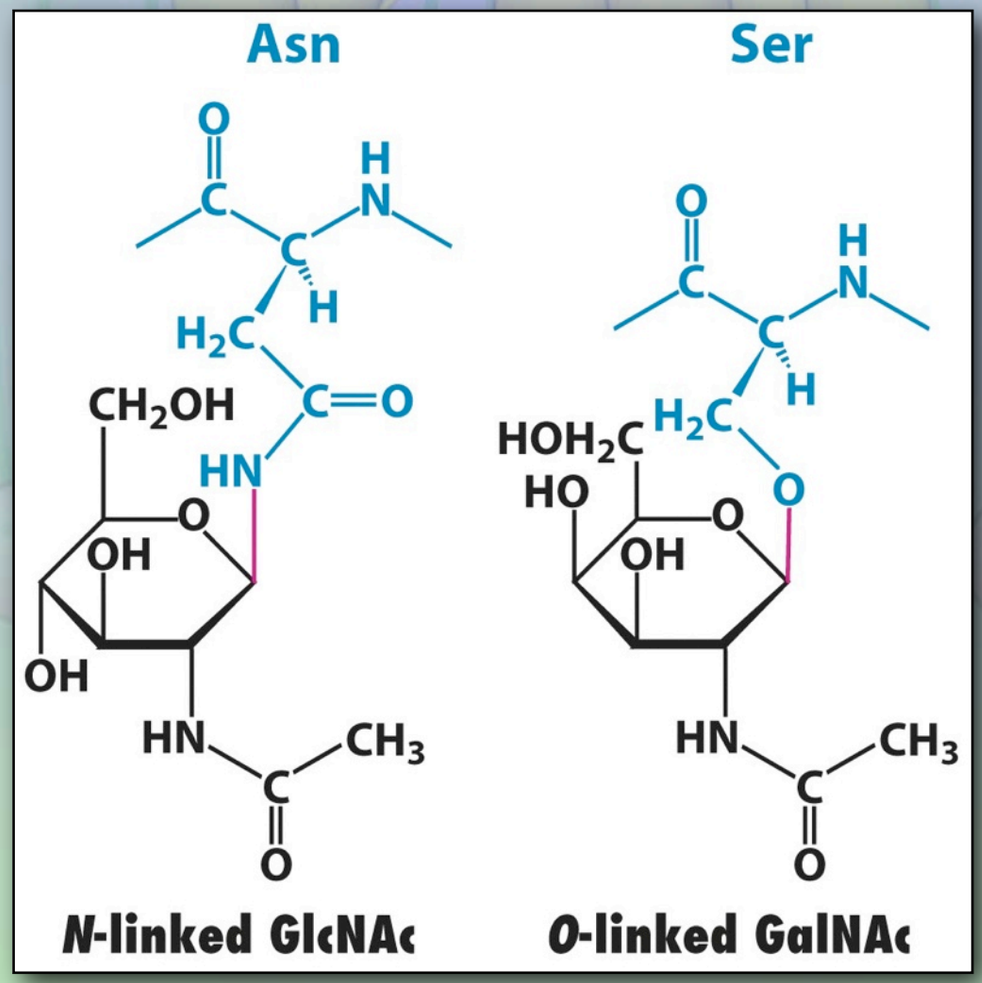
B can give blood only to B

AB can give blood to A, B, AB

O can give blood to A, B, AB, O

Glycoproteins

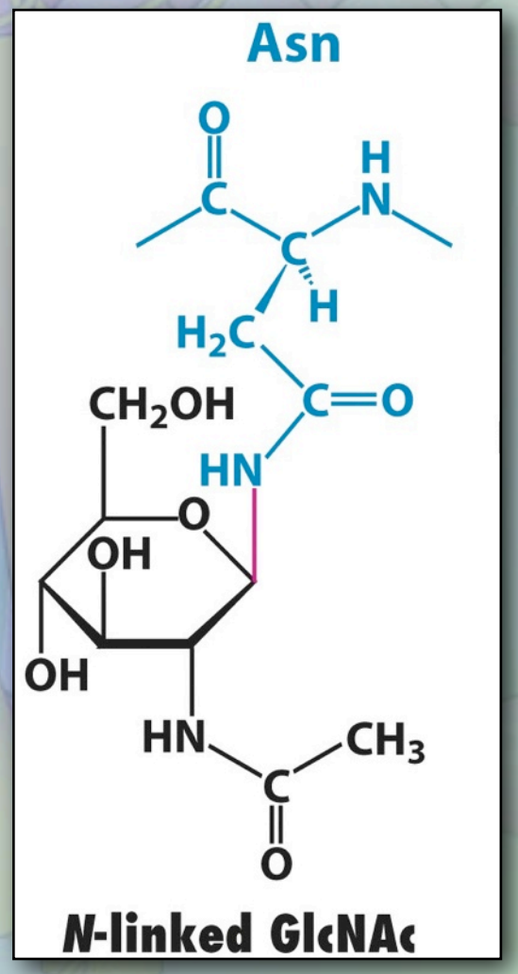
- Membrane and extracellular proteins are often glycosylated with oligosaccharides.
  - These linked to either serine or asparagine residues.



Glycoproteins

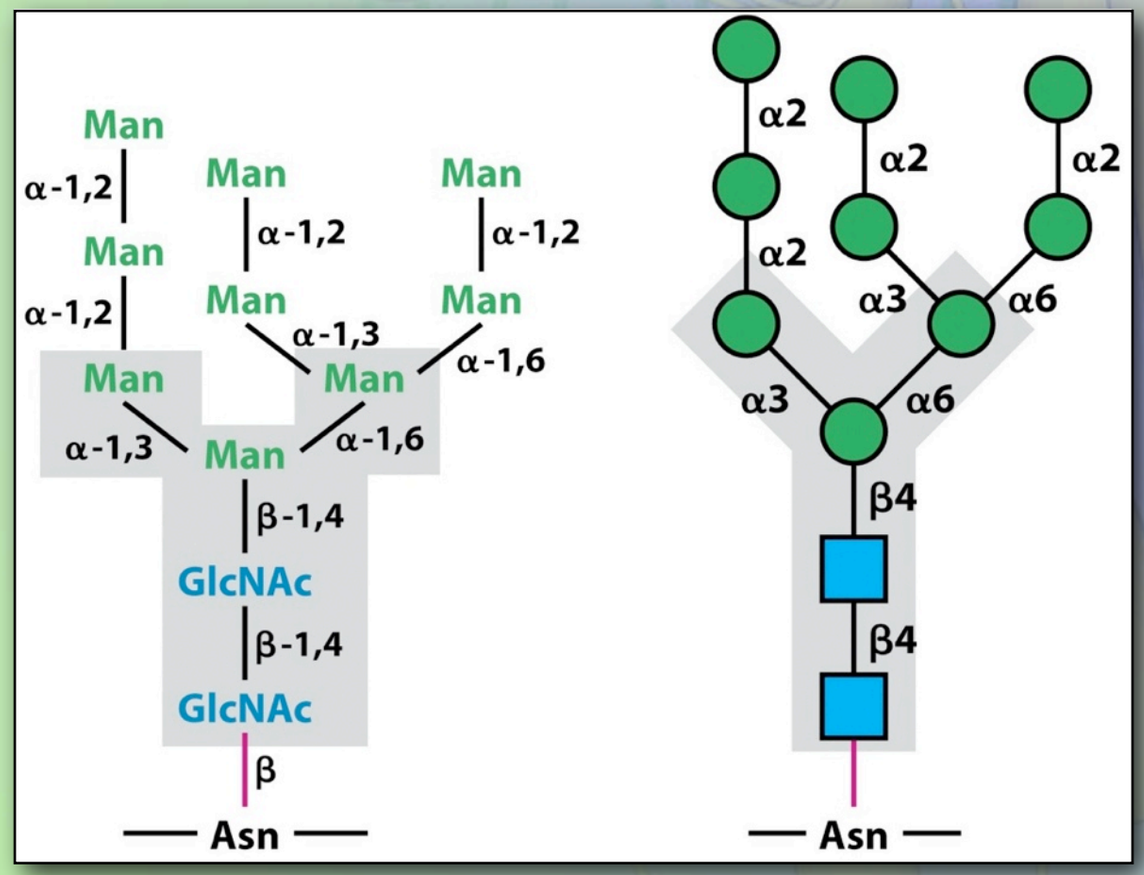
- N-linked oligosaccharides attached at specific sequences.

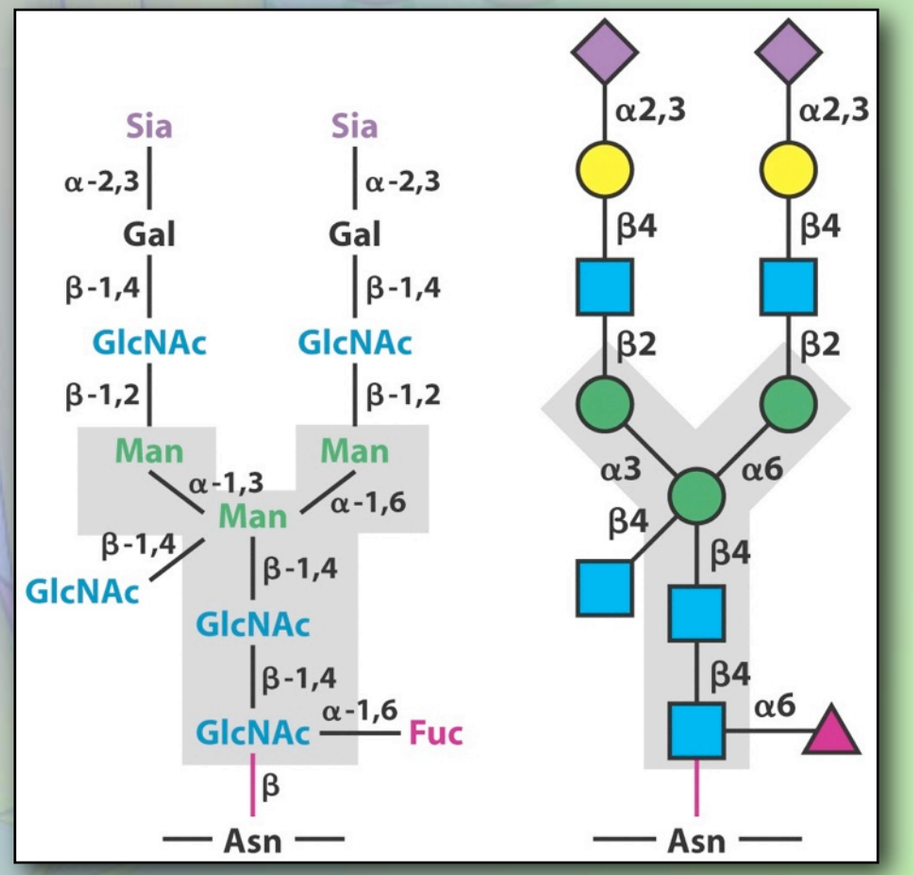
Asn-X-Ser
Asn-X-Thr



Glycoproteins

- N-linked oligosaccharides have a pentasaccharide core.

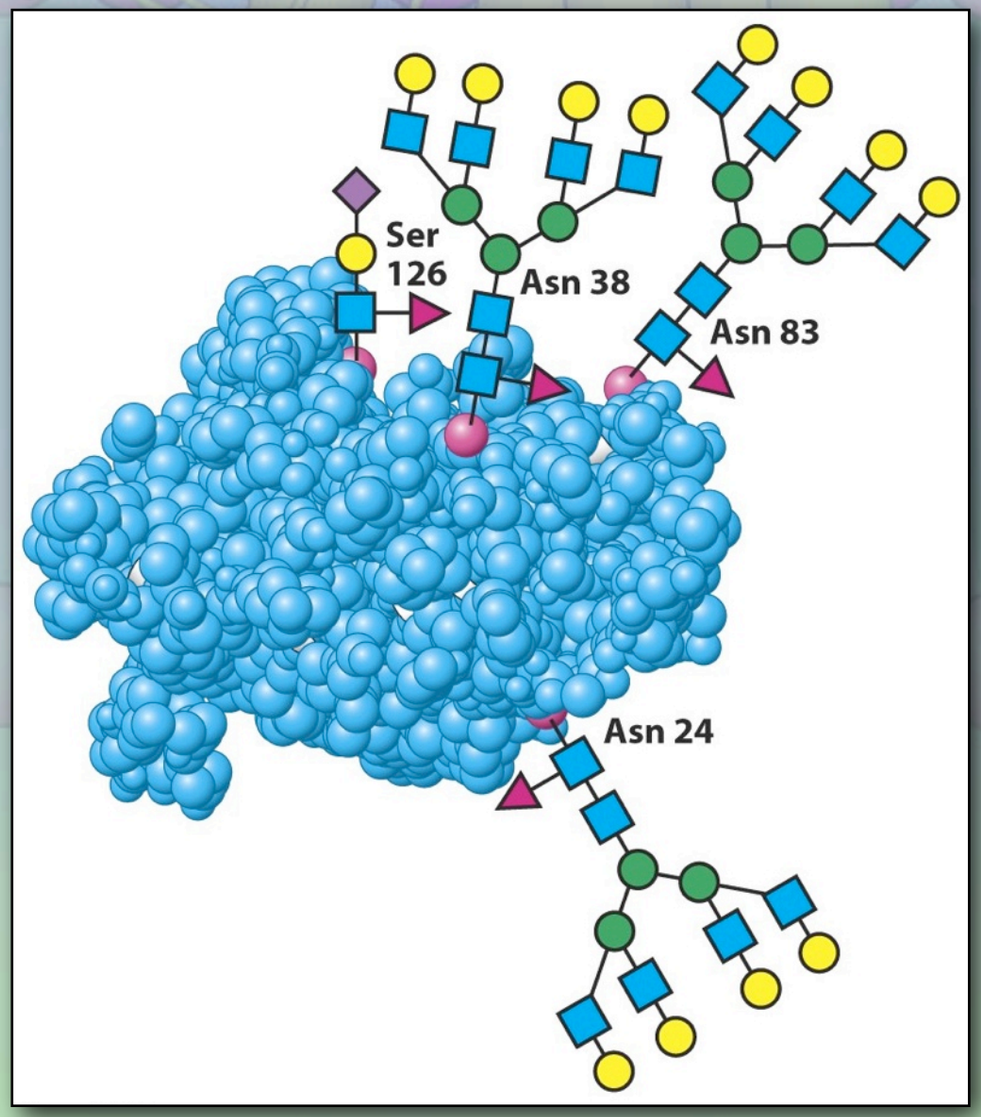




Glycoproteins

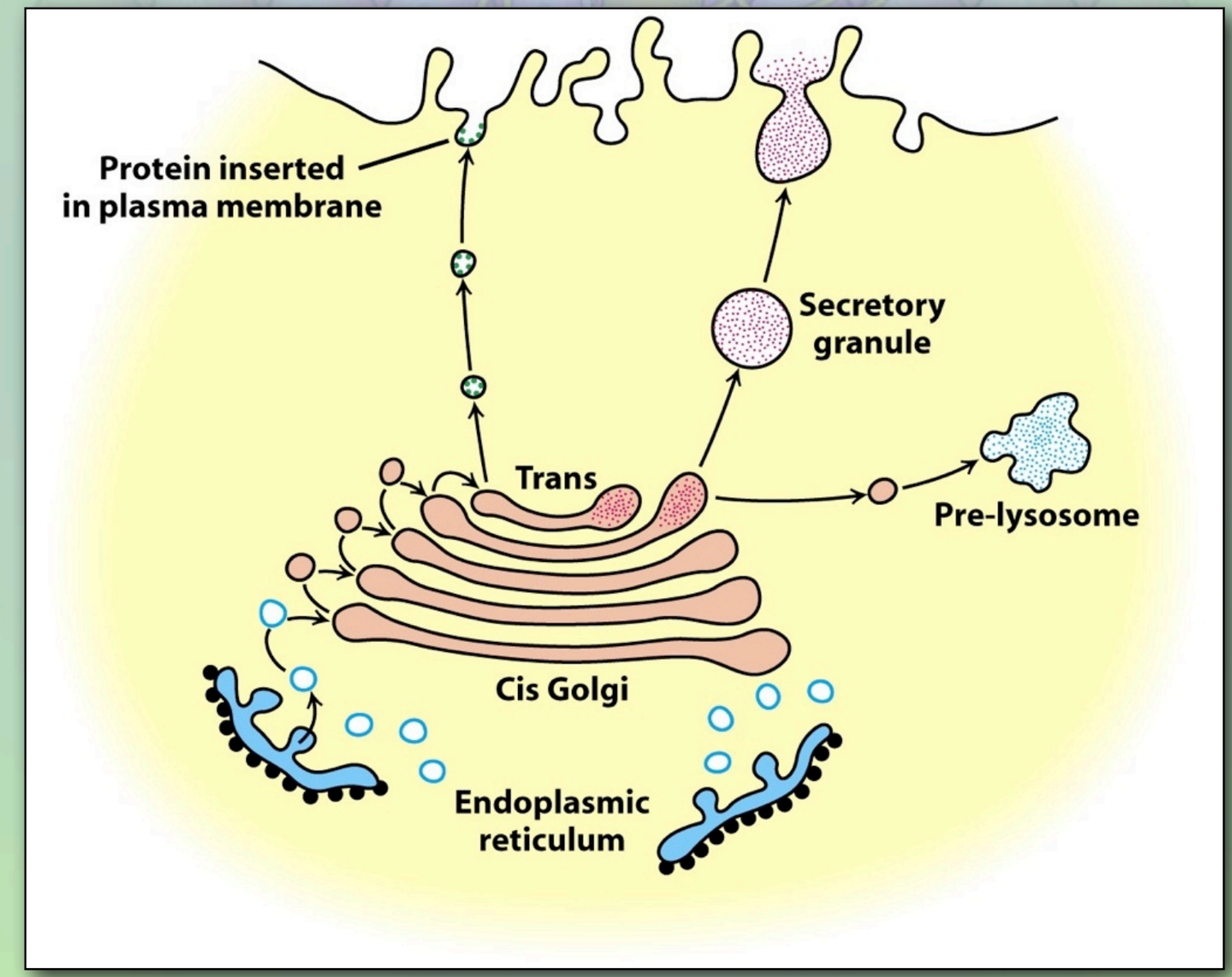
- Erthropoietin stimulates RBC production and contains examples of both N-linked and O-linked oligosaccharides.

Erythropoietin is 40% carbohydrate by weight.



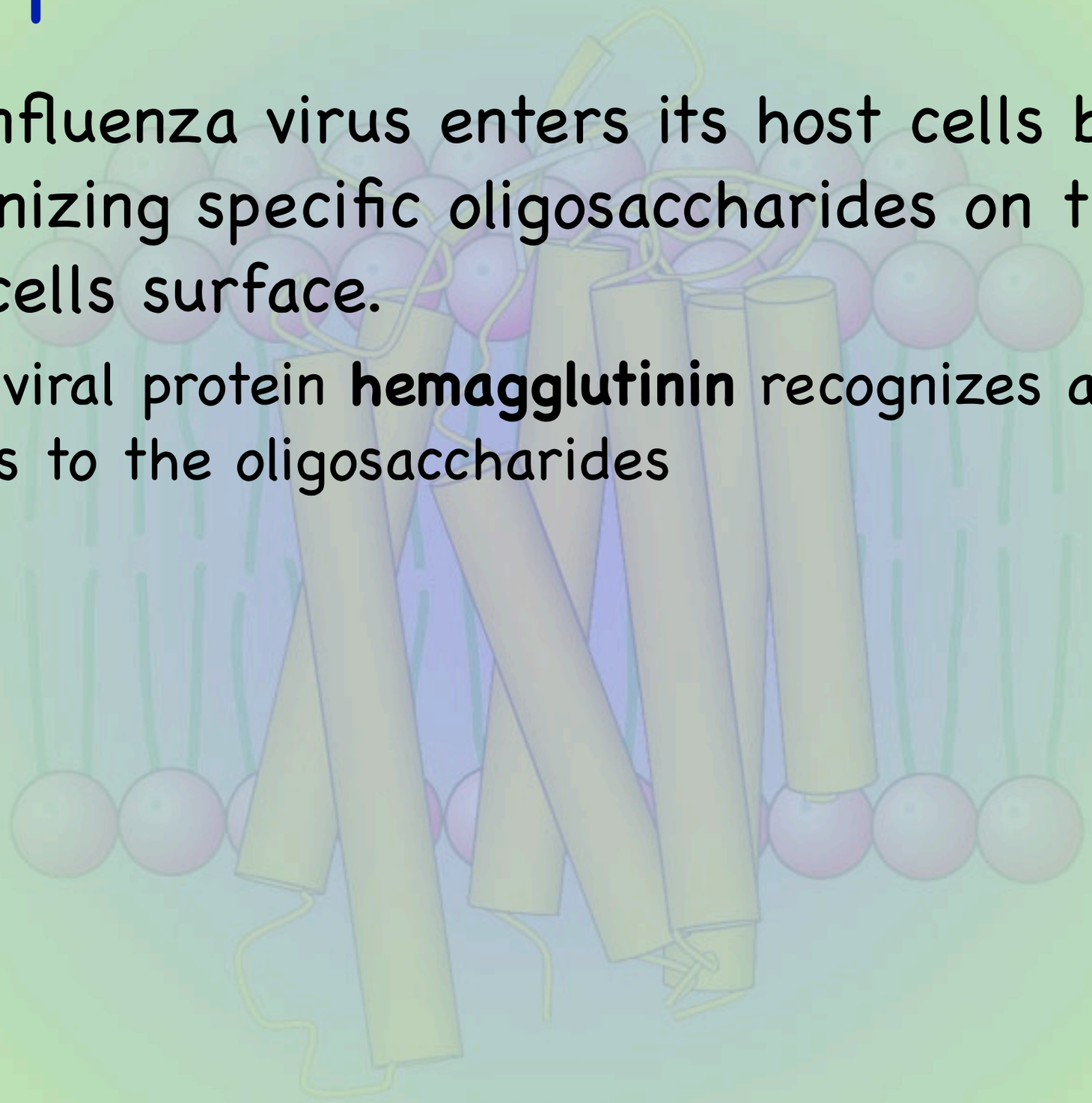
Glycoproteins

- Glycosylation takes place in the endoplasmic reticulum and the Golgi apparatus.



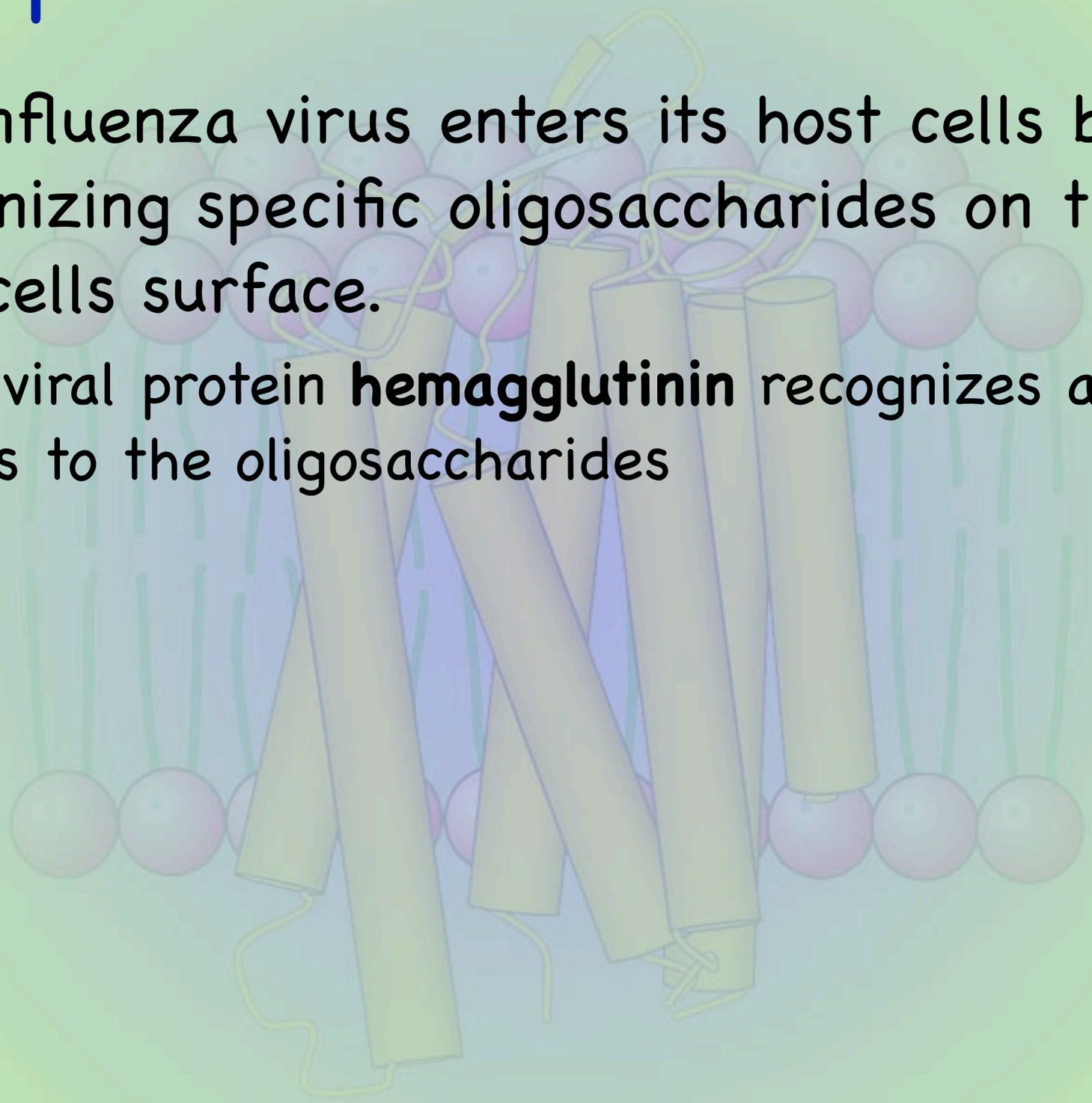
Glycoproteins

- The influenza virus enters its host cells by recognizing specific oligosaccharides on the host cells surface.
  - The viral protein **hemagglutinin** recognizes and binds to the oligosaccharides



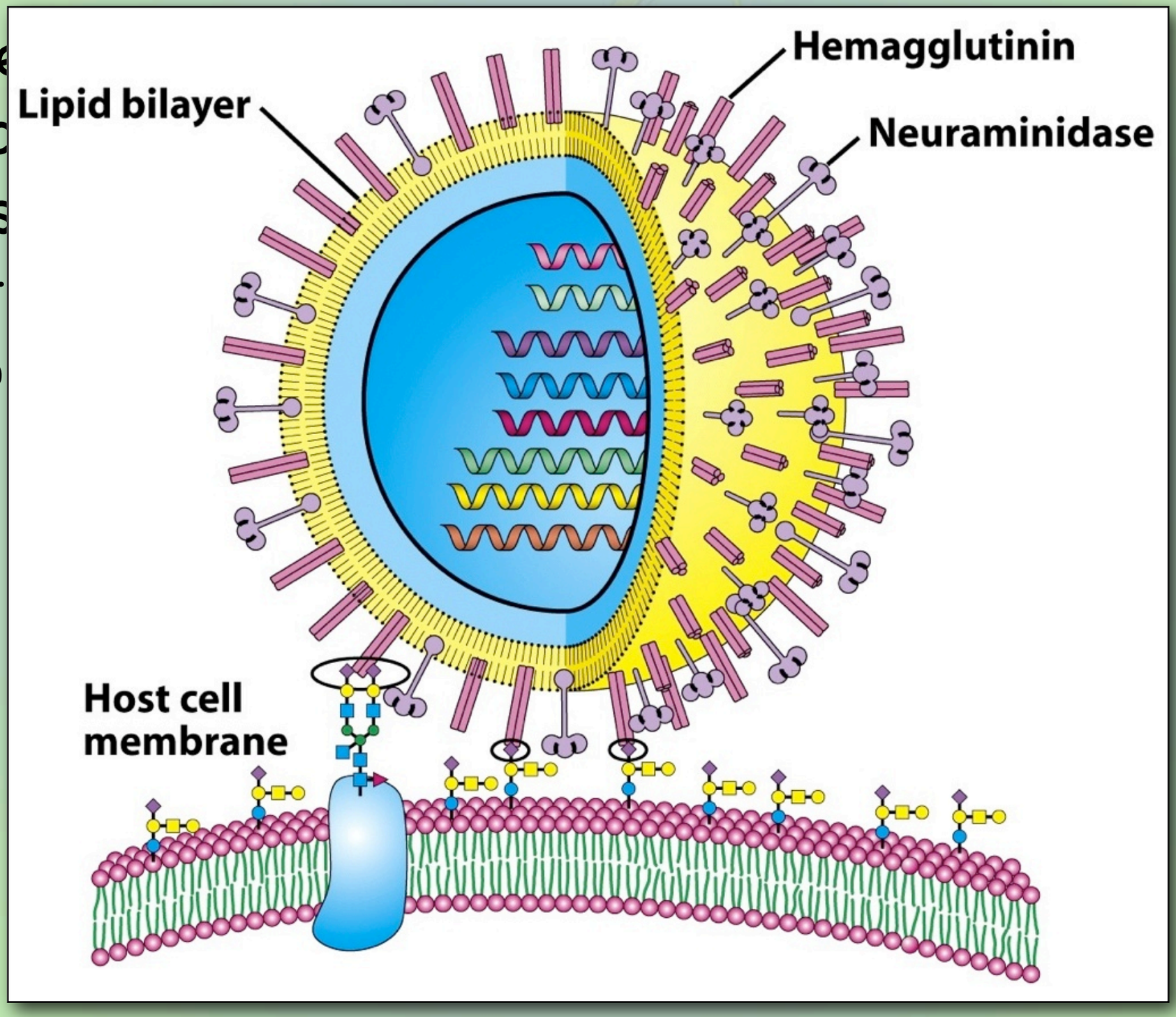
Glycoproteins

- The influenza virus enters its host cells by recognizing specific oligosaccharides on the host cells surface.
  - The viral protein **hemagglutinin** recognizes and binds to the oligosaccharides



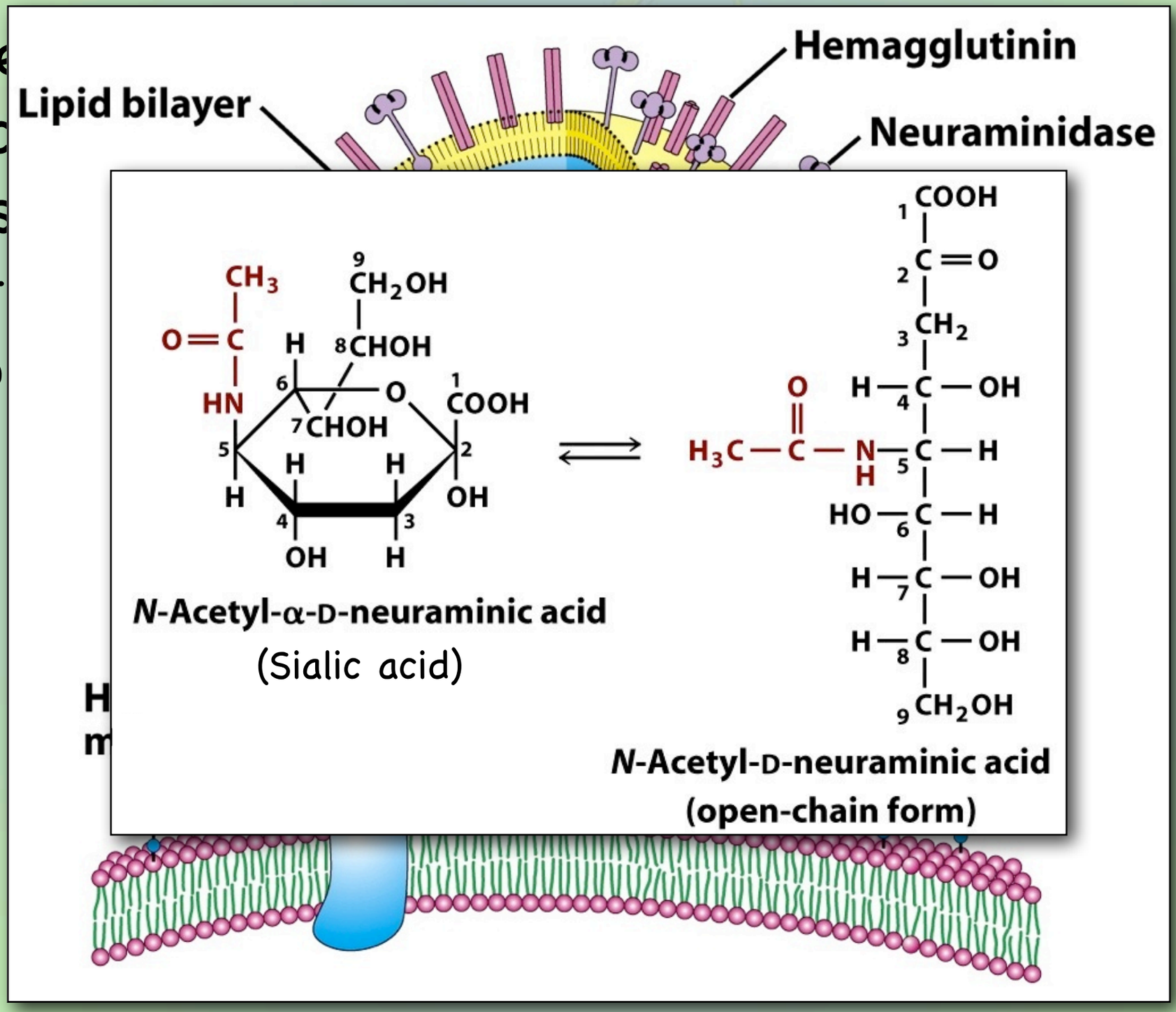
Glycoproteins

- The
  rec
  hos
  - T
    b



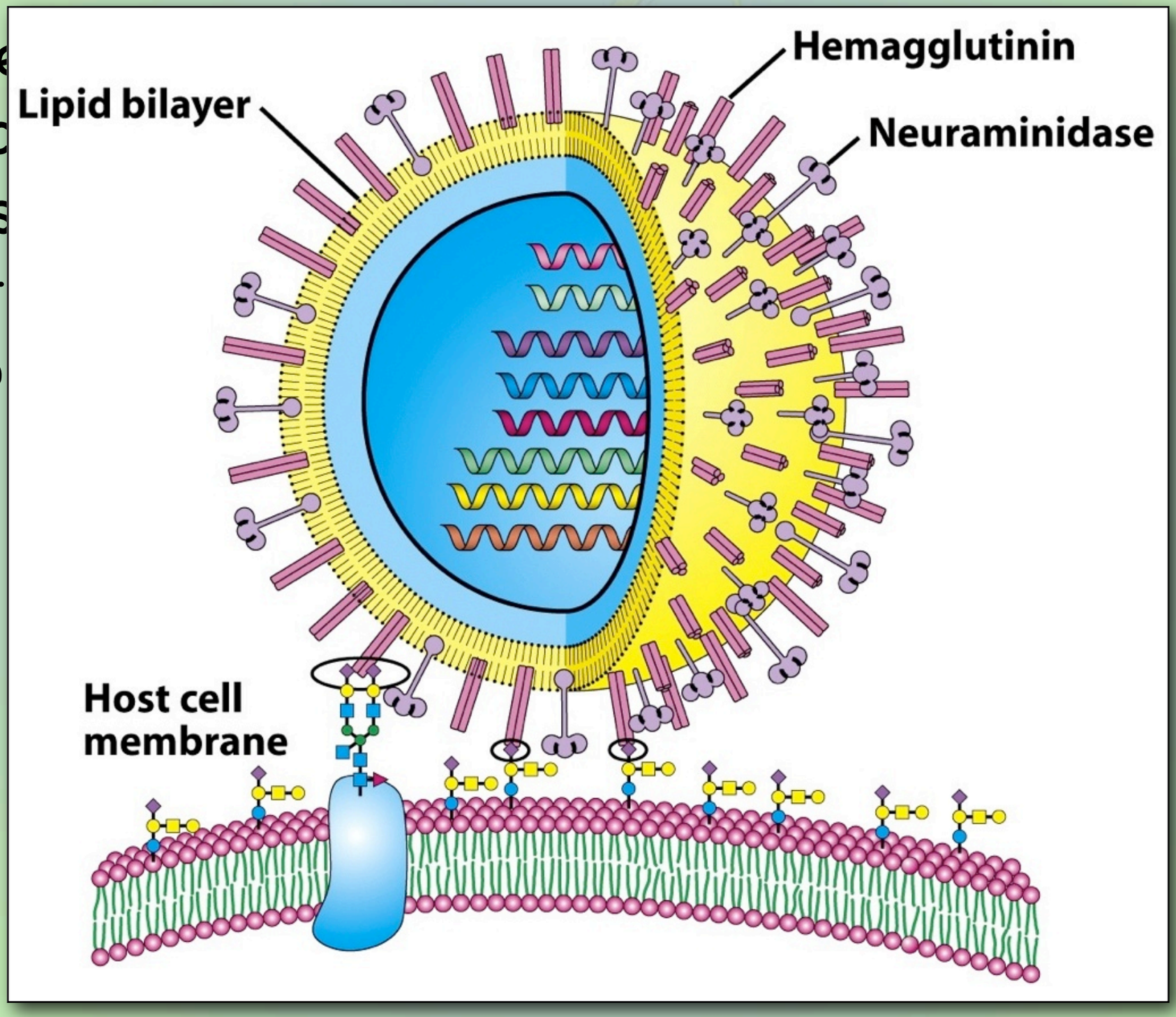
Glycoproteins

- The
  rec
  hos
  - T
    b



Glycoproteins

- The
  rec
  hos
  - T
    b



Next up

- Unit IV, Lecture 8 - Lipids and Cell Membranes (Chapter 12)