

Al-Farabi Kazakh National University
Higher School of Medicine
Department of Fundamental Medicine

Glycomics

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LEARNING OUTCOMES

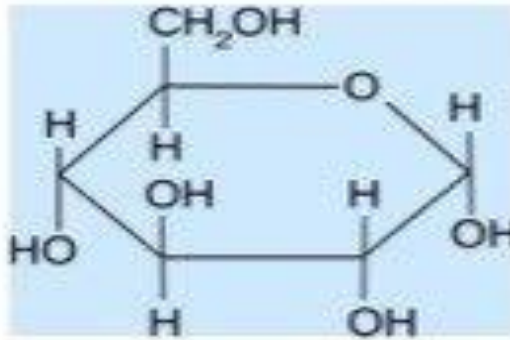
As a result of the lesson you will be able to:

- 1. Give the definitions to the following terms: “carbohydrates”, “monosacharids”, “disacharids”, “polysacharids”, “glycome” and “glycomics”, give the specific examples.
- 2. Analyze the chemical structure and fuctions of different carbohydrates, give the specific examples.
- 3. Describe the chemical structure and functions of glycoproteins and proteoglycans.
- 4. Explain how some glycoproteins (lectins) can participate in cellular recognizing, adhesion and interactions between the cells (so called “sugar code”)?
- 5. Explain different disturbances of carbohydrate metabolism and methods of their diagnostics and treatment, give the specific examples.

Definitions

- **Glycomics** is the comprehensive study of **glycomes**[1] (the entire complement of sugars, whether free or present in more complex molecules of an organism), including genetic, physiologic, pathologic, and other aspects.[2][3] Glycomics "is the systematic study of all **glycan** structures of a given cell type or organism" and is a subset of **glycobiology**. [4] The term glycomics is derived from the chemical prefix for sweetness or a sugar, "**glyco-**", and was formed to follow the omics naming convention established by genomics (which deals with genes) and proteomics (which deals with proteins).

Glucose

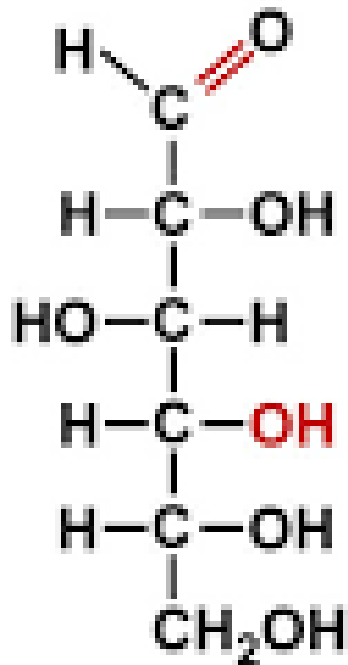


(Chemical formula: $C_6H_{12}O_6$)

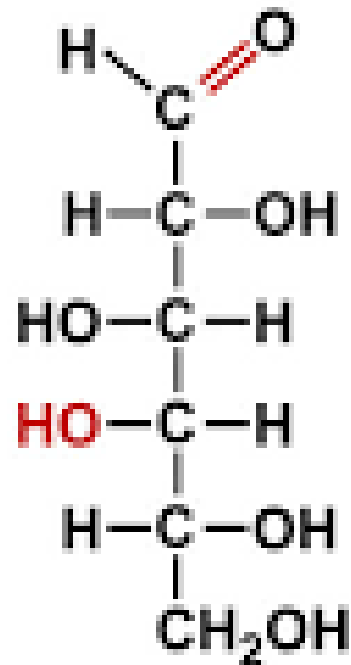
Notice how there are twice as many hydrogen atoms as carbon atoms. Glucose fits the standard CH_2O ratio mentioned above.

What Are Carbohydrates?
expii.com

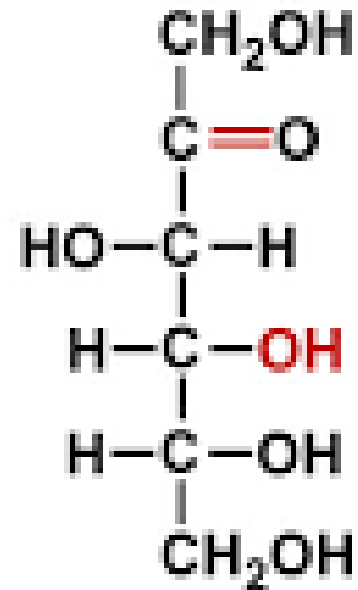
Carbohydrate Isomers



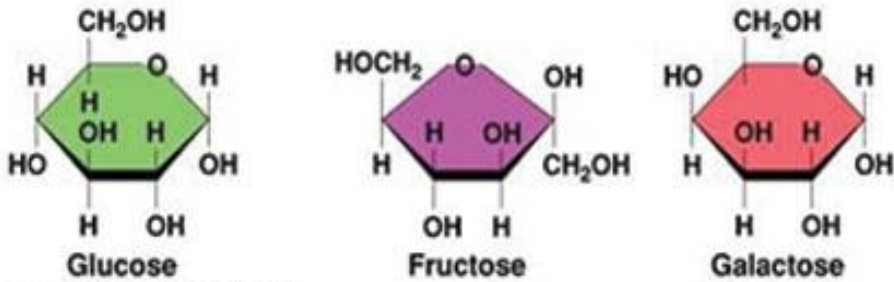
Glucose



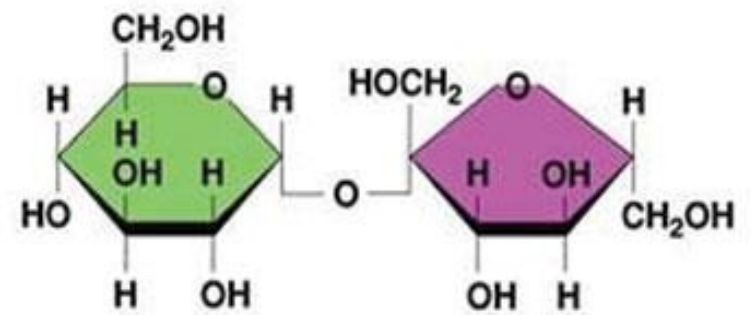
Galactose



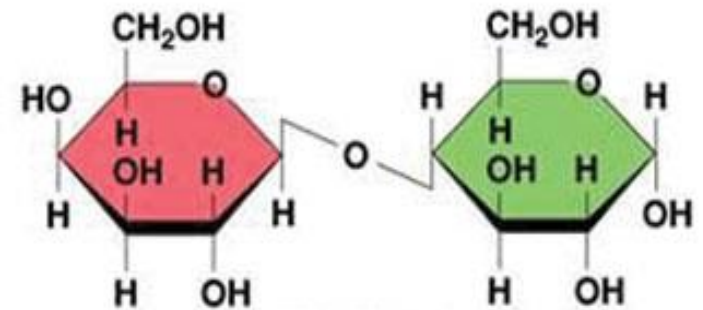
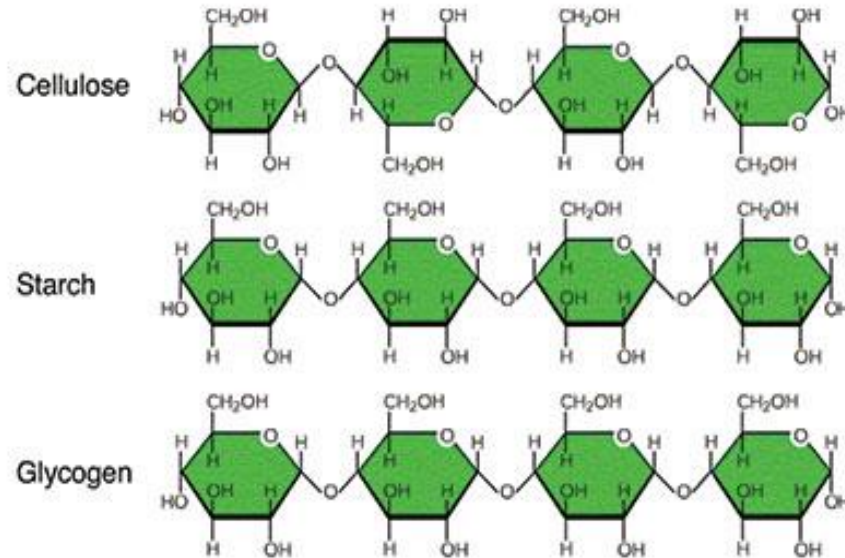
Fructose



(a) Monosaccharides

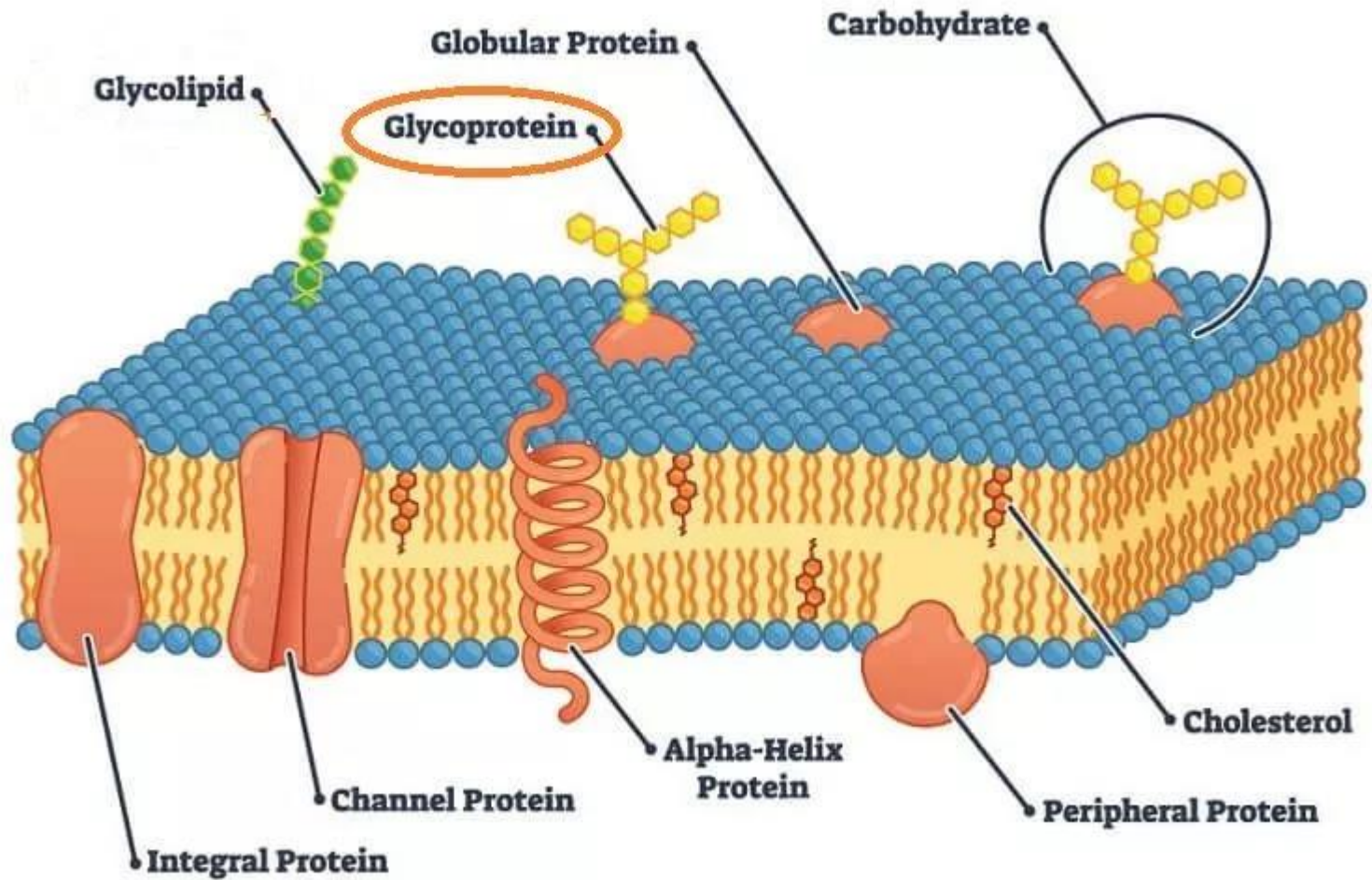


**Sucrose
(Glucose + Fructose)**



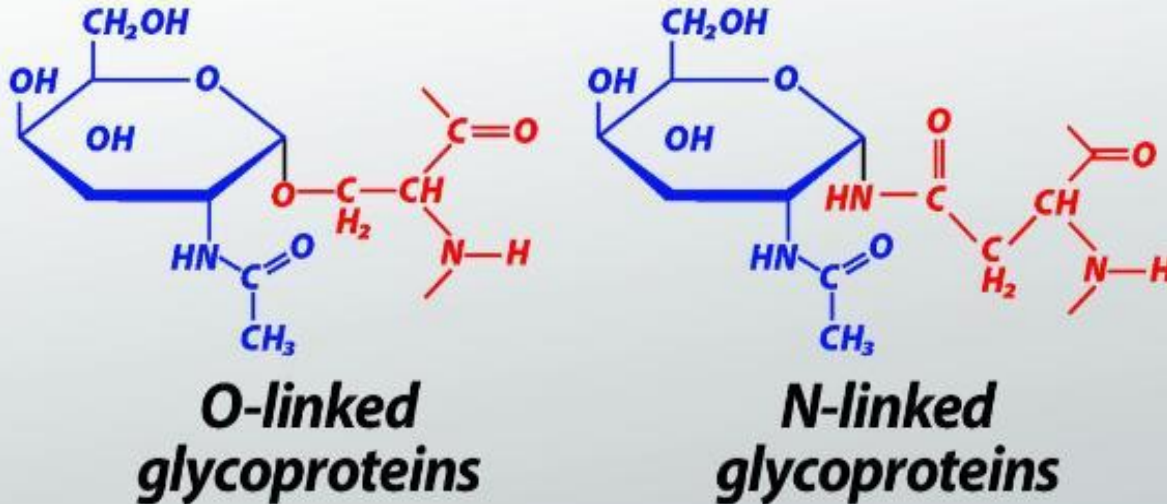
**Lactose
(Galactose + Glucose)**
(b) Disaccharides

Monosaccharides, Disaccharides, Polysaccharides
microbenotes.com



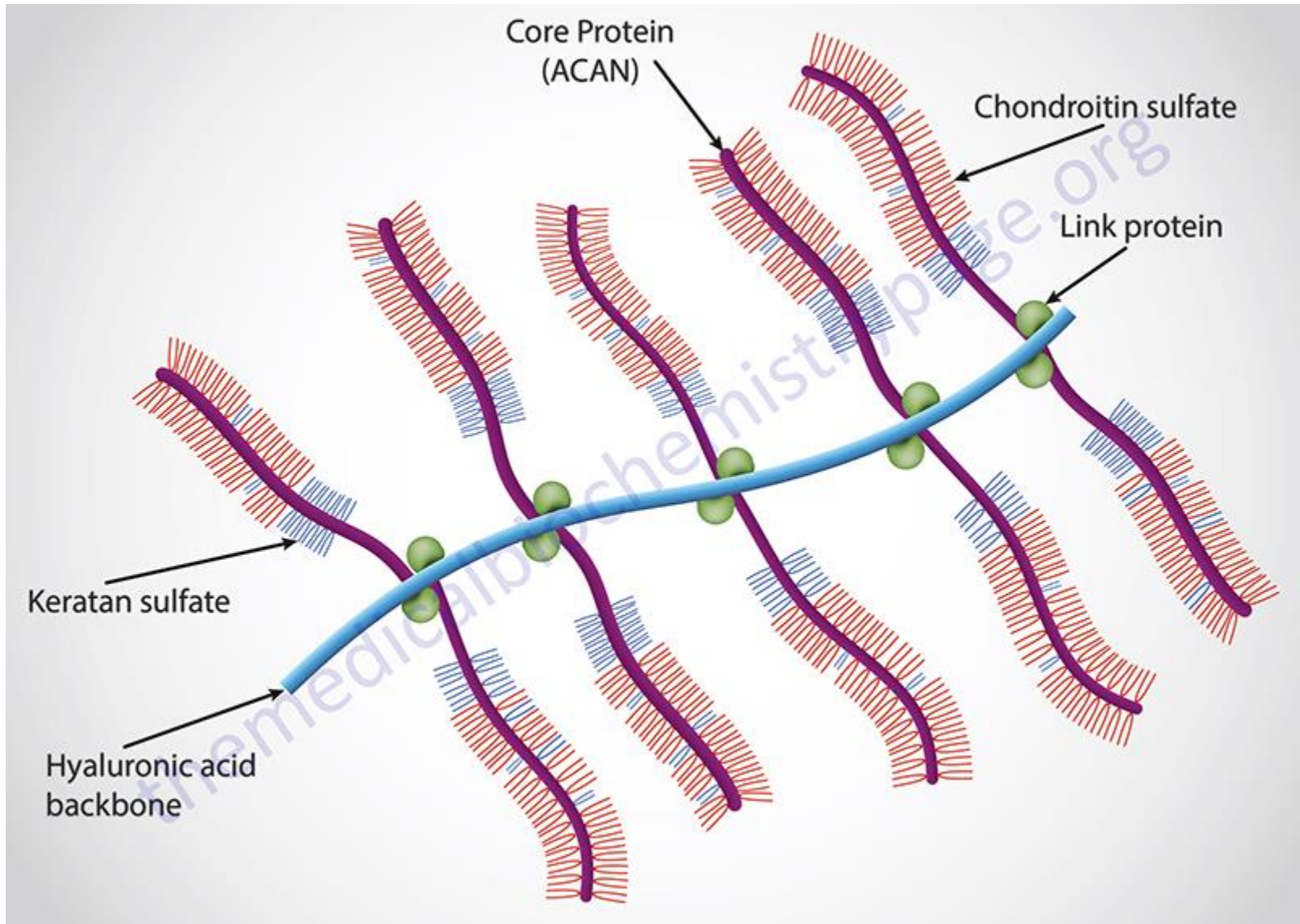
Glycoprotein - The Definitive Guide
biologydictionary.net

WHAT ARE GLYCOPROTEINS?



© Study.com

What Are Glycoproteins? – Definition, Functions & Examples
study.com

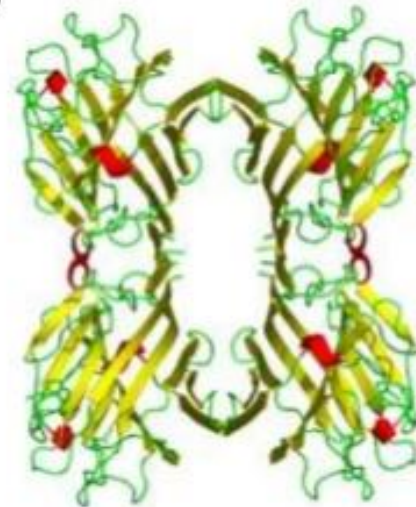


Glycosaminoglycans and Proteoglycans
themedicalbiochemistrypage.org

STRUCTURE:

BINDING INTERACTION

- ❖ Lectins are tetramer made up of 4 nearly identical subunits
- ❖ Made up of carbohydrate binding proteins,
- ❖ They are highly specific to carbohydrate moieties
- ❖ The binding of lectins is reversible and
- ❖ Non covalent with carbohydrate conjugates



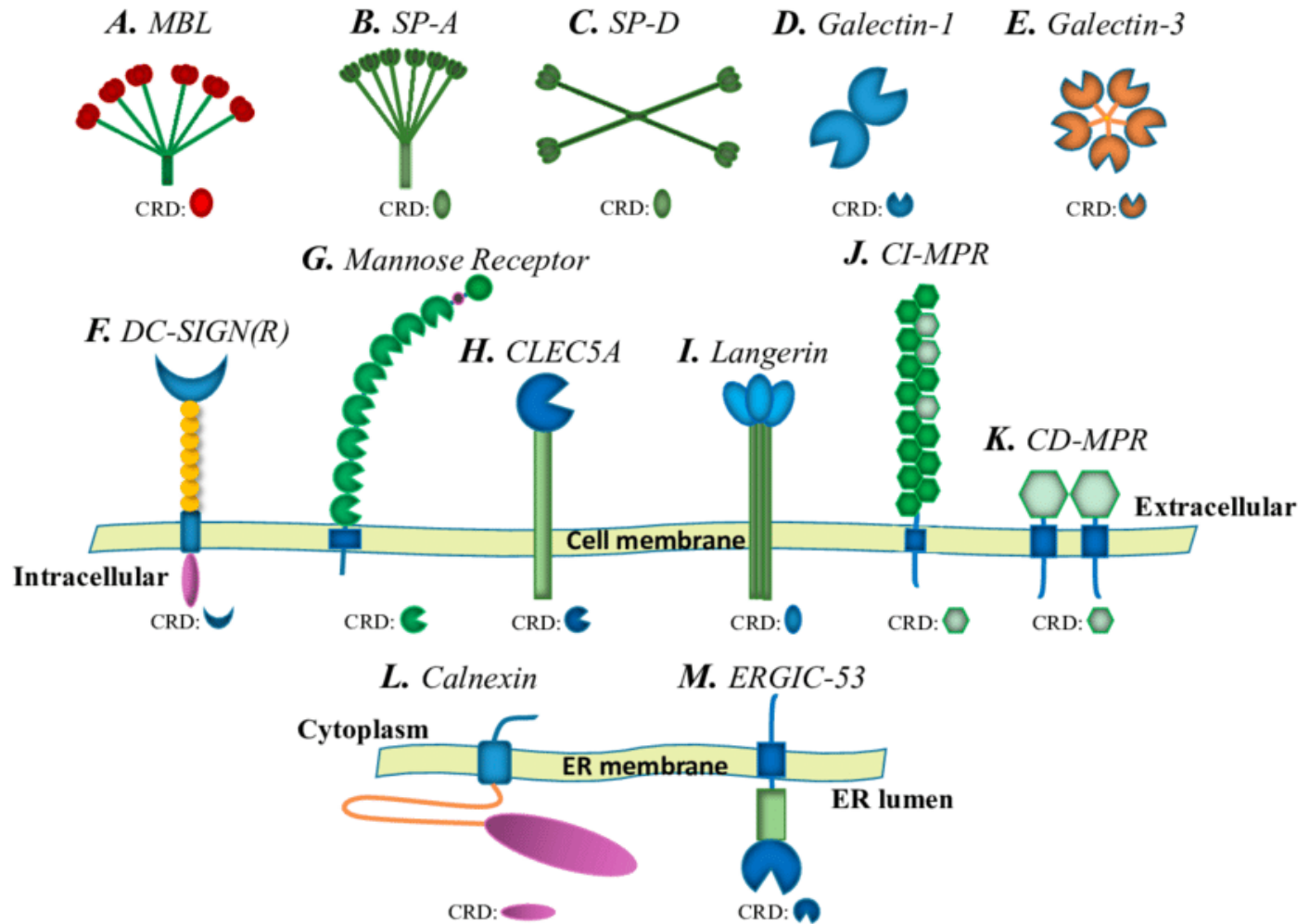
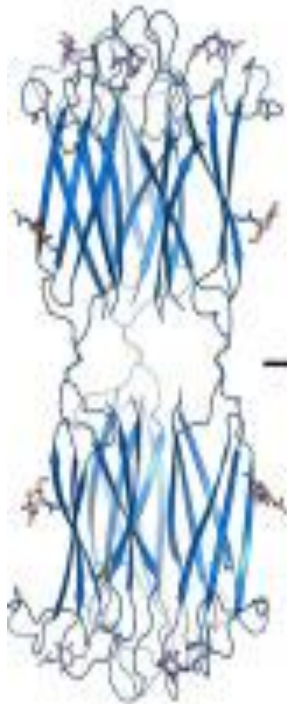
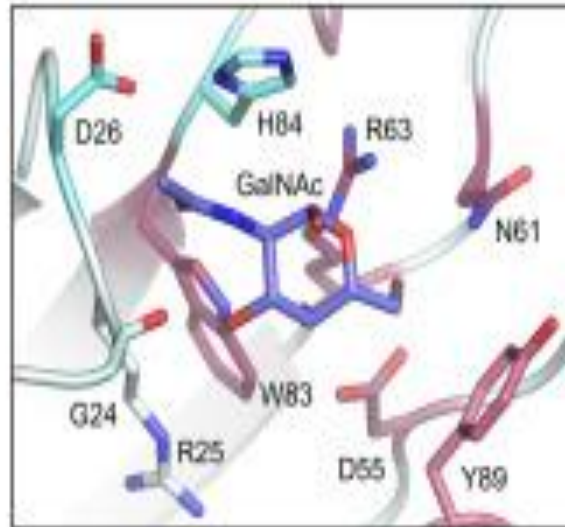


Diagram of lectin structures.
researchgate.net

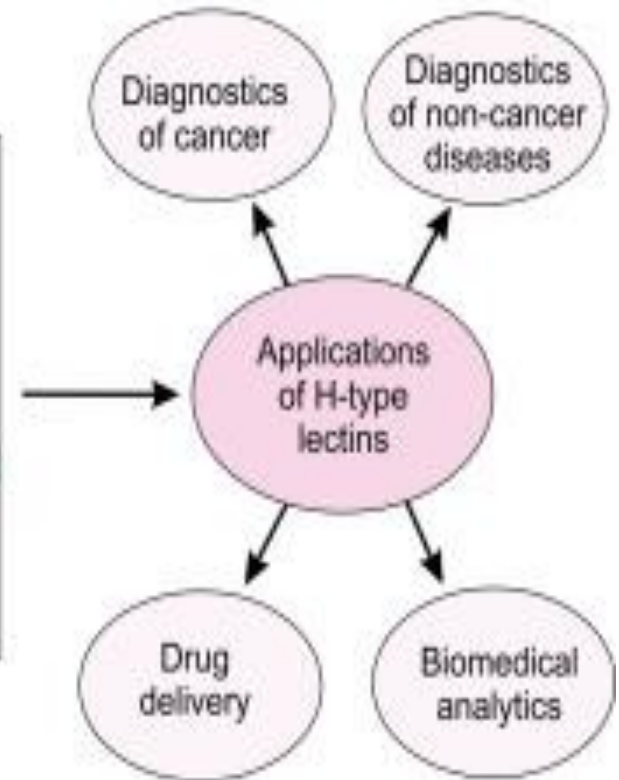
H-type lectins



Crystal structure



Analysis of lectin-carbohydrate interactions



H-type lectins
sciencedirect.com

Human diseases of carbohydrate metabolism

Inherited enzyme deficiencies

Mutations that change enzyme function or abolish enzyme activity

Most are recessive since only one functional copy of gene is sufficient for needed activity

Diabetes

Lactose intolerance

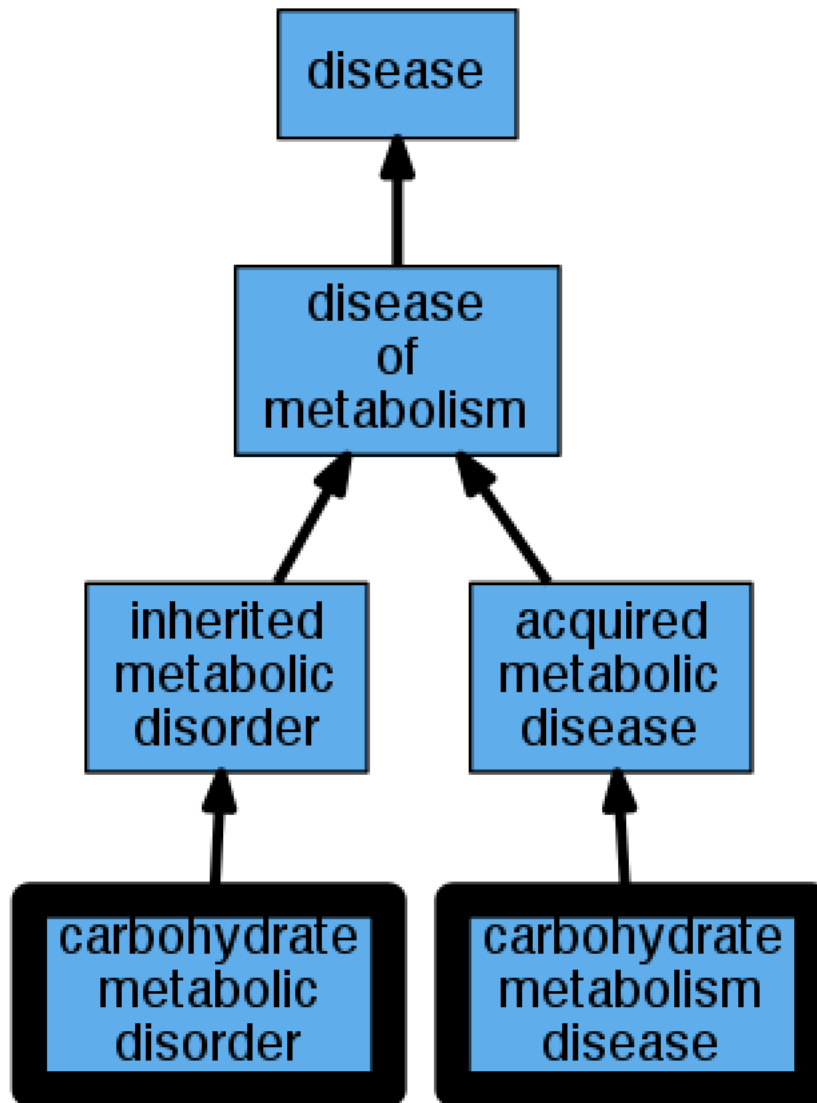
Galactosemia

Glycogen storage disease

Understand how enzyme deficiency leads to accumulation of glycogen

Other symptoms

Treatment, if any



carbohydrate metabolic disorder vs carbohydrate metabolic disease
github.com

Glucogen storage diseases

type	enzyme defect
type I (von Gierke disease)	glucose-6-phosphatase
type II (Pompe disease)	lysosomal acid alpha-glucosidase
type III (Forbe disease, Cori disease)	amylo-1,6-glucosidase (debrancher enzyme)
type IV (Andersen disease)	brancher enzyme
type V (McArdle disease)	myophosphorylase
type VI (Hers disease)	liver phosphorylase
type VII (Tarui disease)	muscle phosphofructokinase
type IX	phosphorylase kinase
type 0	liver glycogen synthetase

Carbohydrate metabolism
ppt-online.org

References

1. Rudd, P; Karlsson, NG; Khoo, KH; Packer, NH; Varki, A; Cummings, RD; Esko, JD; Stanley, P; Hart, GW; Aebi, M; Darvill, AG; Kinoshita, T; Packer, NH; Prestegard, JH; Schnaar, RL; Seeberger, PH (2015). "Glycomics and Glycoproteomics". doi:10.1101/glycobiology.3e.051 (inactive 2021-01-18). PMID 28876822.
2. Aoki-Kinoshita KF; Lewitter, Fran (May 2008). Lewitter, Fran (ed.). "An Introduction to Bioinformatics for Glycomics Research". PLOS Comput. Biol. 4 (5): e1000075. Bibcode:2008PLSCB...4E0075A. doi:10.1371/journal.pcbi.1000075. PMC 2398734. PMID 18516240.
3. Srivastava S (May 2008). "Move over proteomics, here comes glycomics". J. Proteome Res. 7 (5): 1799. doi:10.1021/pr083696k. PMID 18509903.
4. Essentials of Glycobiology (2nd ed.). Cold Spring Harbor Laboratory Press. 2009. ISBN 978-087969770-9.