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Fundamentals of Biochemistry Second Edition

Chapter 8: Carbohydrates

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Chapter 8 Opener Fundamentals of Biochemistry, 2/e

multiple roles in all forms of life

1. 에너지 저장, 연료, 대사 중간산물로서의 역할

2. DNA, RNA 구조의 구성요소(ribose and deoxyribose)

3. 미생물과 식물체들의 세포벽과 절족류 외골격의 구성요소 (다당류)

4. 단백질과 지질에 연결 (발달과정에서 세포상호인식에 중요)

Monosaccharides

aldose: contains aldehyde group

ketose: contains keto group



D-aldoses

Enantiomers disastereoisomers Epimers



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Figure 8-2 part 1 Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons



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Alcohols react with the carbonyl groups



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Cyclization of glucose and fructose



Figure 8-3 Fundamentals of Biochemistry, 2/e

Additional asymmetric carbon: anomeric carbon C1 in glucose





Figure 8-3a Fundamentals of Biochemistry, 2/e

Additional asymmetric carbon C2 in fructose





Figure 8-3b Fundamentals of Biochemistry, 2/e



Pyranose Glucopyranose furanose fructofuranose

α and β anomers



2/3

Sugars are conformationally variable But sugars are not planar

The two chair conformations of β -D-glucopyranose





reduction



Unnumbered figure pg 212b Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons Flavin component HO HHHH HOH **myo-Inositol**

OH

ſ

H

OH

HO

Η

н

Polyhydroxy alcohol Lipid component

Deoxy sugars



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Amino sugars



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α-D-Galactosamine (2-amino-2-deoxyα-D-galactopyranose)

sialic acid



(linear form) Figure 8-6 Fundamentals of Biochemistry, 2/e

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Important component of glycoproteins and glycolipids

Glycosidic bonds

Anomeric carbon condensed with alcohol



O-glycosidic bond Usually β-configuration in natural compounds



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N-glycosidic bond



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Polysaccharides

Common disaccharides: lactose, sucrose ***Reducing end, nonreducing end



O-β-D-galactopyranosyl-(1→4)-β-D-glucopyranose Gal(β 1→4)Glc



O-α-D-glucopyranosyl-(1→2)-β-D-fructofuranoside

Artificial sweetners



Linear polymer of up to 15,000 D-glucose residues linked by $\beta(1 \rightarrow 4)$ glycosidic bonds



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Figure 8-9 Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons

Principal components of the exoskeletons of invertebrates



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Starch Composed of α-amylose and amylopectin



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α -amylose



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Figure 8-11 Fundamentals of Biochemistry, 2/e

Glycosaminoglycans

Gel-like matrix in extracellular spaces, those of connective tissues such as cartilage, tendon, skin, and blood vessels



Hyaluronate solution: viscoelastic behavior





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Plant shock absorbers pectin: major cell wall components $\alpha(1-4)$ -linked galacturonate interspersed with rhamnose



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EM of hyaluronic acid



Bacterial cell walls



Gram-negative bacteria



Figure 8-15b Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons Peptidoglycan: N-acetylglucosamine-N-acetylmuramic acid



Figure 8-16a Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons

Antibiotics interfering with peptidoglycan synthesis inhibits transpeptidase penicillin, vancomycin





Box 8-3 figure 3 Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons

Glycosylated proteins

almost all the secreted and membrane-associated proteins of eukaryotic cells are glycosylated

N-glycosylation: occur cotranslationally



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O-linked oligosaccharides

Synthesized in golgi (completed polypeptide)

2nd or 3rd structure rather than sequence



Functions of oligosaccharides

Glycoproteins: differ in the sequences, locations, and numbers Glycoforms: the variant species of a glycoproteins Any particular function of the oligosaccharides?

Structure effect



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Quality control



Protein sorting

Lysosomal proteins: N-linked mannose phosphate

Mediate recognition events

Potential to carry more biological information

(two different hexoses can combine in 36 different ways) Intercellular communications



Figure 8-20 Fundamentals of Biochemistry, 2/e

EM of the erythrocyte surface

Protein-carbohydrate interactions lectins (proteins that bond carbohydrates) specifically bind to oligosaccharides



Figure 8-21 Fundamentals of Biochemistry, 2/e

Selectins on the surface of leukocytes and endothelial cells

Mammalian spermatozoa: surface proteins recognize GlcNAc or gal on the glycoproteins of the ovum

Antigenic determinants

ABO blood group antigens

Antigen^a Type $Gal\beta(1\rightarrow 4)GlcNAc\cdots$ Η 1,2 L-Fucα $GalNAc\alpha(1\rightarrow 3)Gal\beta(1\rightarrow 4)GlcNAc\cdots$ A 1,2 L-Fuca $Gal\alpha(1\rightarrow 3)Gal\beta(1\rightarrow 4)GlcNAc\cdots$ B 1,2 L-Fuca

^{*a*}Gal, Galactose; GalNAc, *N*-acetylgalactosamine; GlcNAc, *N*-acetylglucosamine; L-Fuc, L-fucose. Table 8-1 Fundamentals of Biochemistry, 2/e © 2006 John Wiley & Sons

Table 8-1Structures of the A, B, and H AntigenicDeterminants in Erythrocytes

