



Sacharidy a glykoinformatika

Význam sacharidů

Aplikovaná bioinformatika, Jaro 2017

ZÁKLADNÍ FUNKCE CUKRŮ

**Zdroj
energie**



Sacharosa, glukosa,...

**Nosič
informace**



Krevní skupiny,...

**Strukturní
role**



Celulosa, chitin...

CUKRY – ZDROJ ENERGIE



Řepa cukrová
(*Beta vulgaris*)

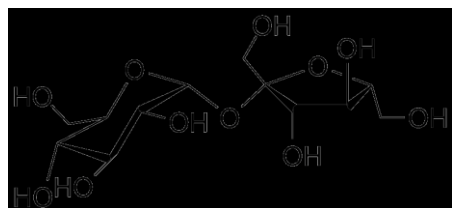


Cukrová třtina
(*Saccharum officinarum*)

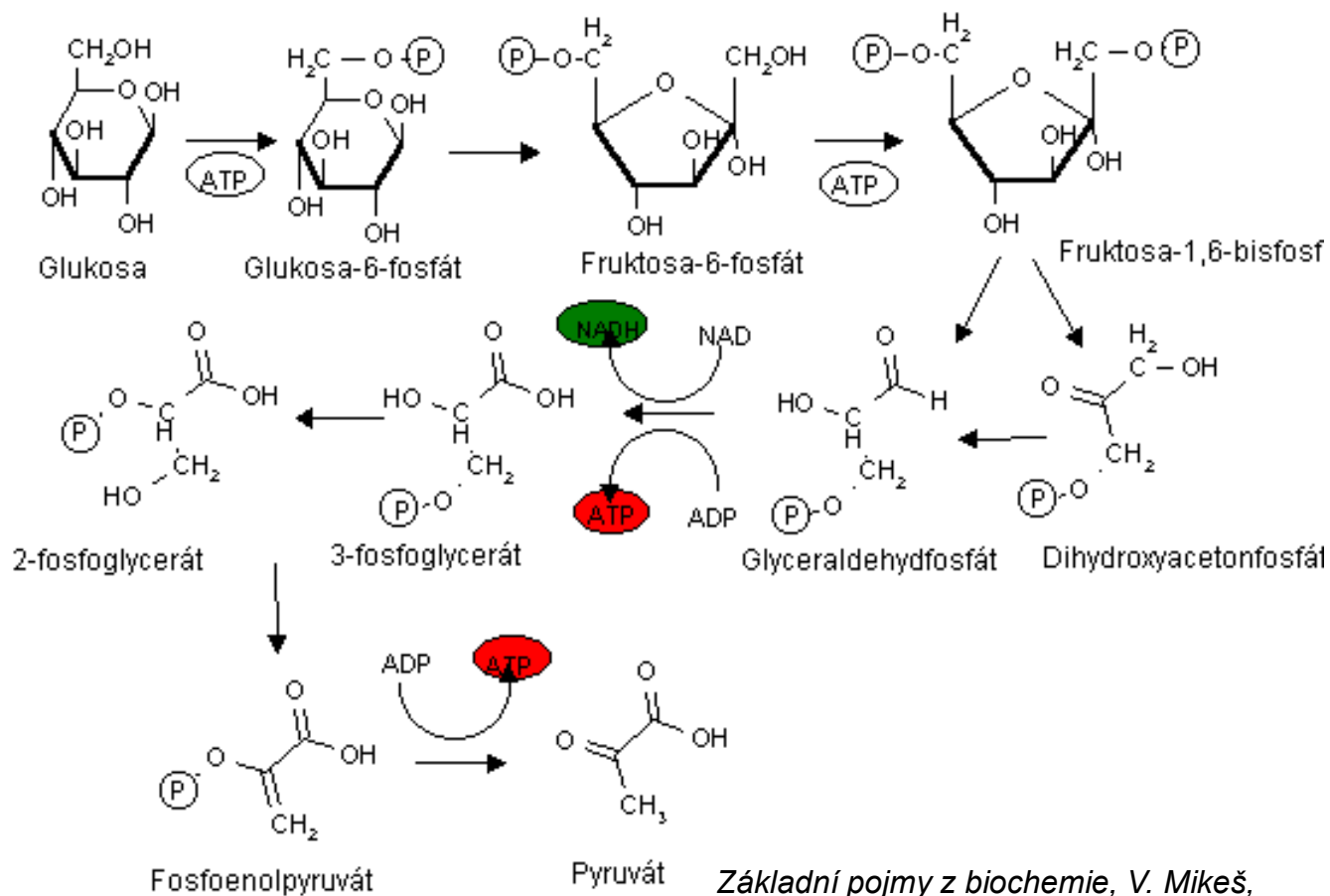


CUKRY – ZDROJ ENERGIE

hydrolyzáza



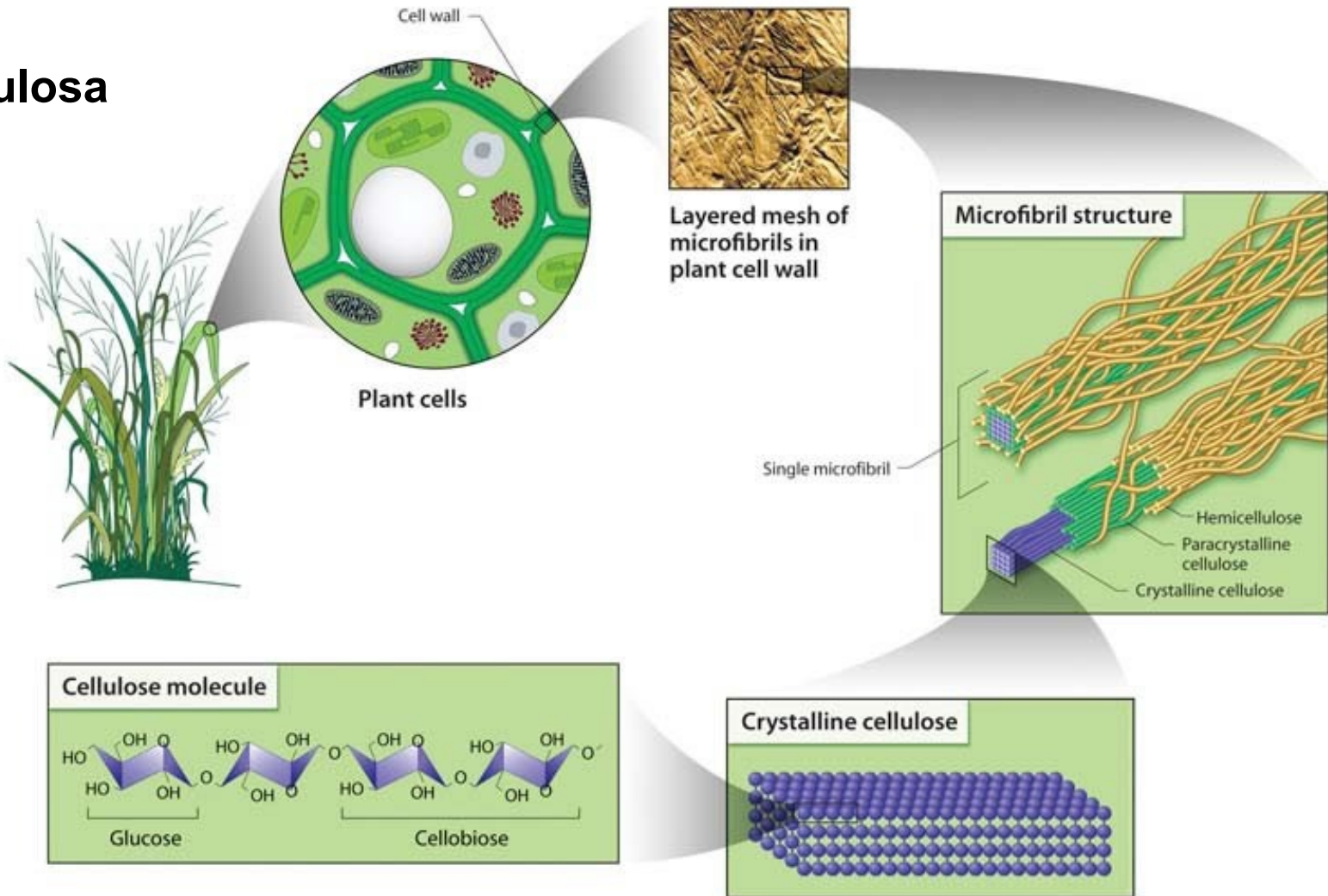
Sacharosa
(α -D-glukopyranosyl- β -D-fruktofuranosid)



Základní pojmy z biochemie, V. Mikeš,
Katedra biochemie PŘF Masarykovy
Univerzity v Brně, 2. doplněné vydání 2001

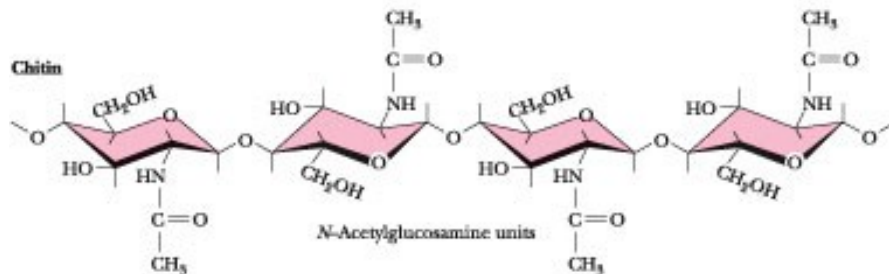
CUKRY – STAVEBNÍ MATERIÁL

Celulosa



CUKRY – STAVEBNÍ MATERIÁL

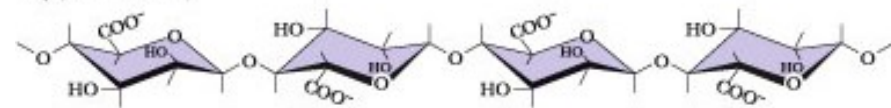
Chitin



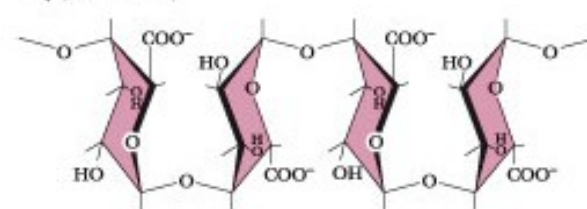
Alginát



Poly (D-Mannuronate)



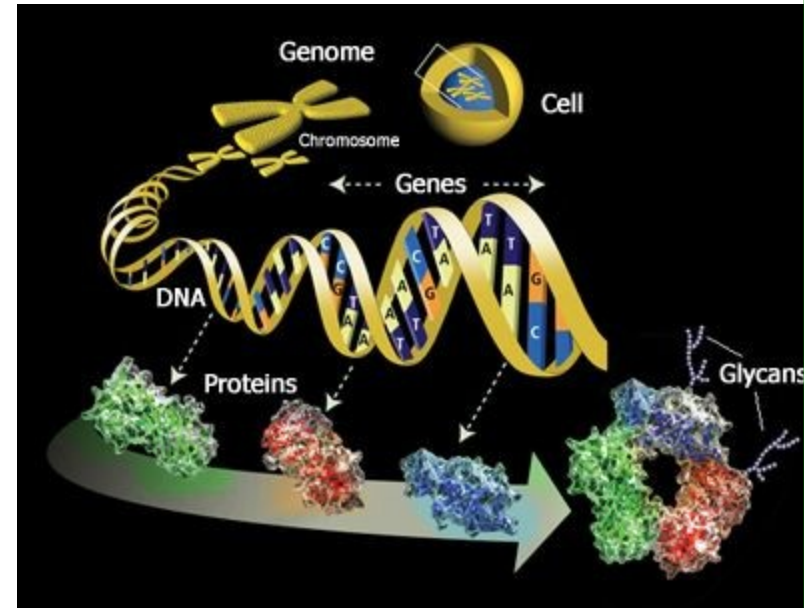
Poly (L-Guluronate)



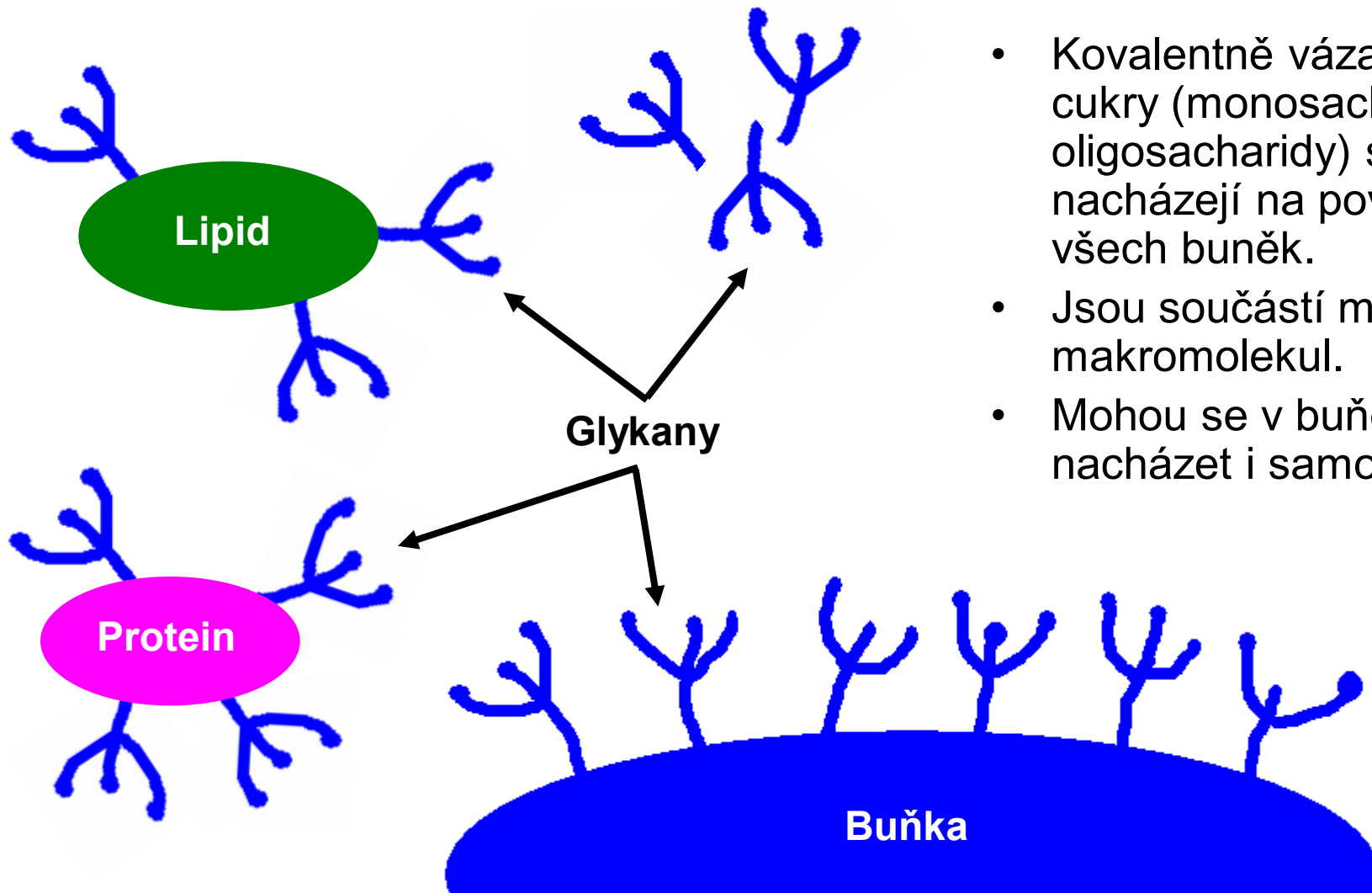
VÝSKYT CUKRŮ V BUŇCE

- Jádru – součást nukleových kyselin (ribosa, deoxyribosa)
- Cytosol – volné monosacharidy
- Endoplasmatické retikulum, Golgiho aparát – glykované proteiny
- Buněčná stěna – vázané oligo a polysacharidy
- Glykokalix – polysacharidy, glykolipidy
- ...

- **Glykom** – soubor všech sacharidů přítomných v/na buňkách určitého organismu ve volné či vázané podobě

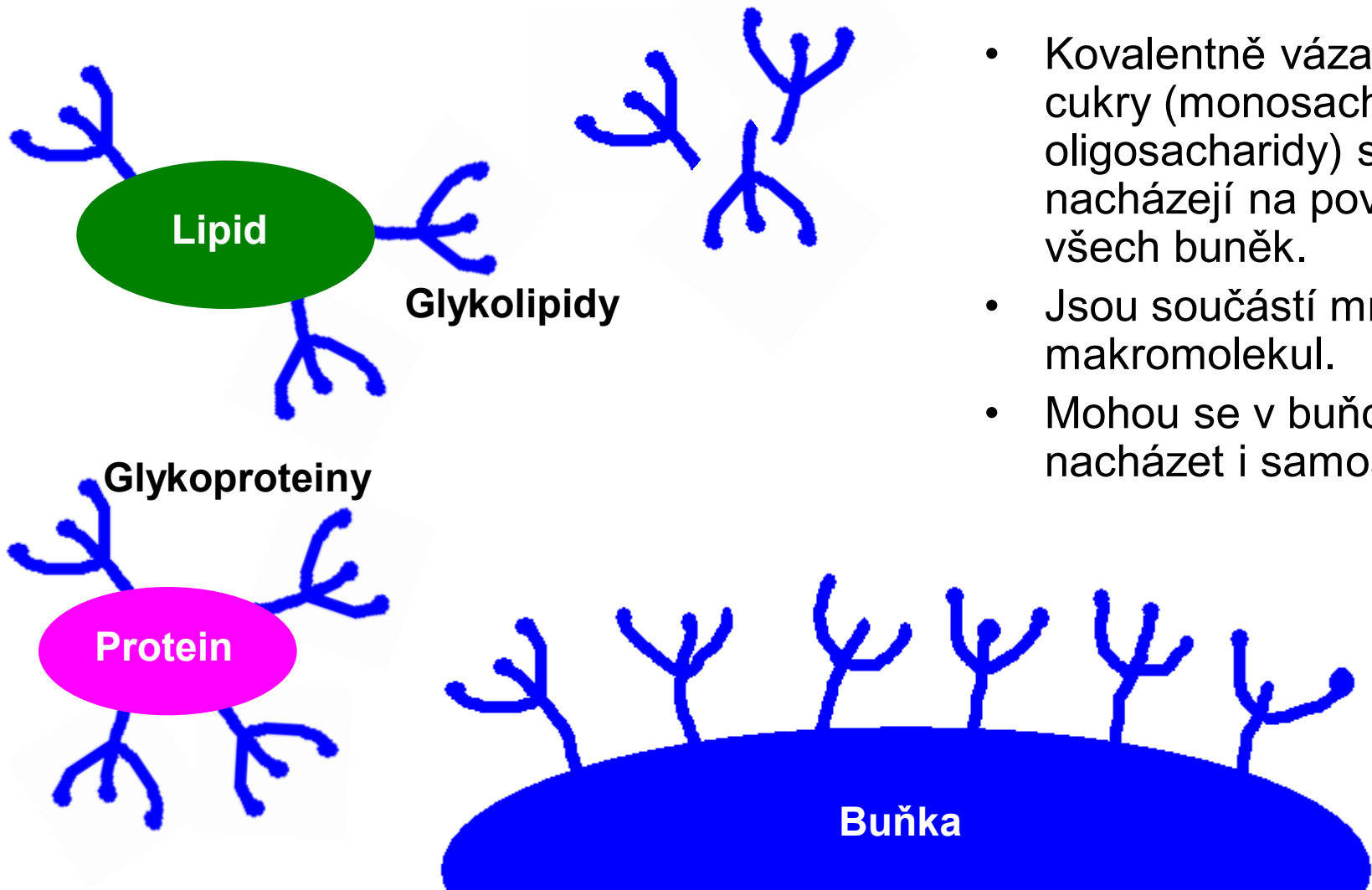


VÝSKYT CUKRŮ V BUŇCE



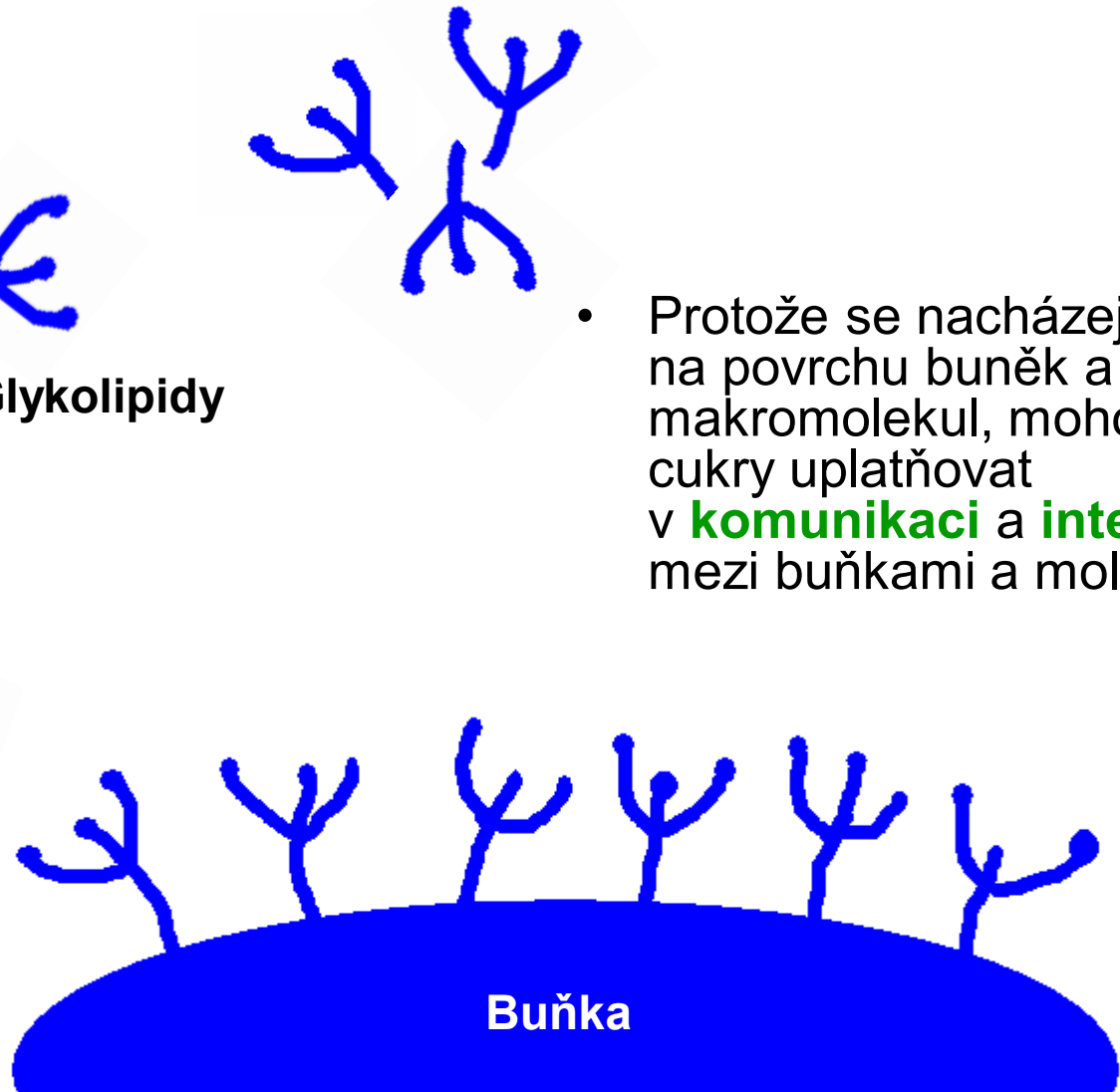
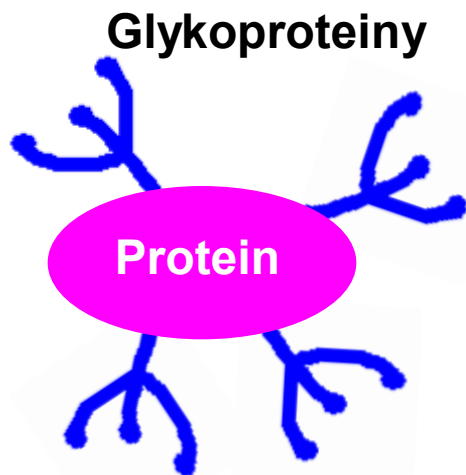
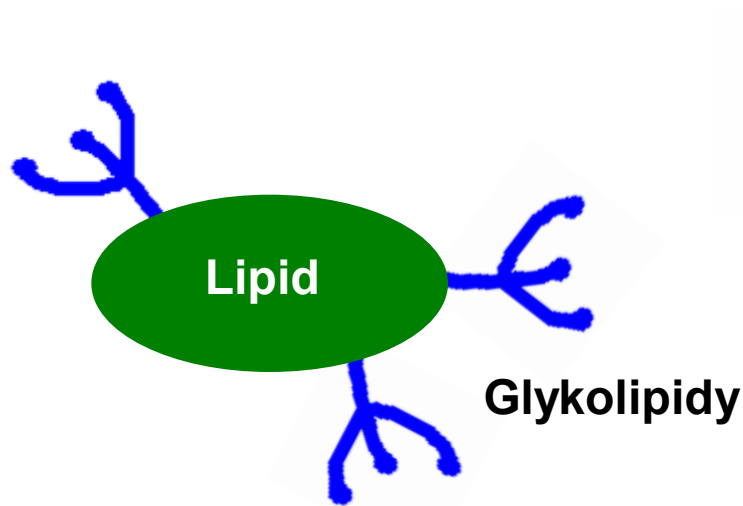
- Kovalentně vázané cukry (monosacharidy, oligosacharidy) se nacházejí na povrchu všech buněk.
- Jsou součástí mnoha makromolekul.
- Mohou se v buňce nacházet i samostatně.

VÝSKYT CUKRŮ V BUŇCE



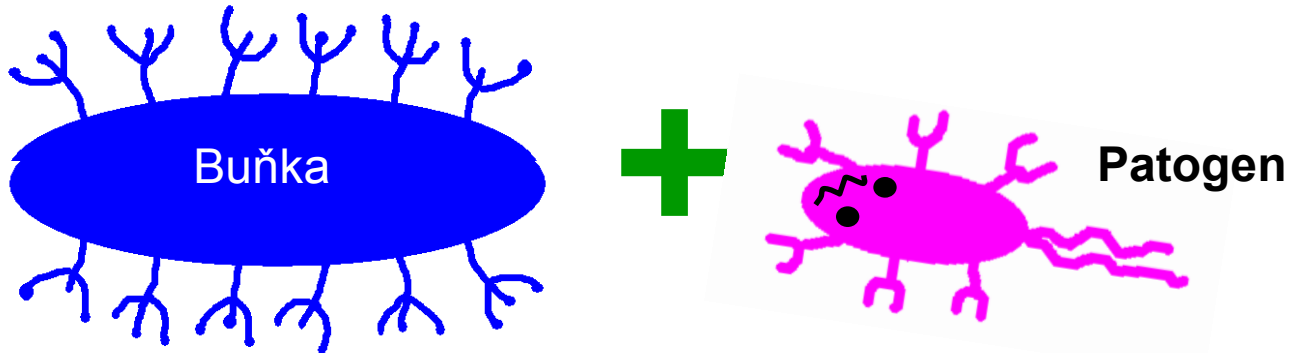
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CUKRY – KOMUNIKAČNÍ NÁSTROJE

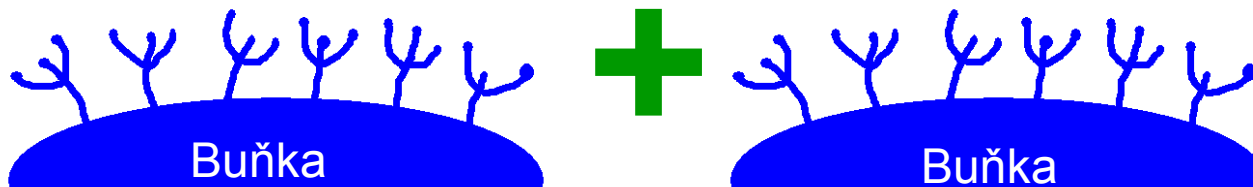
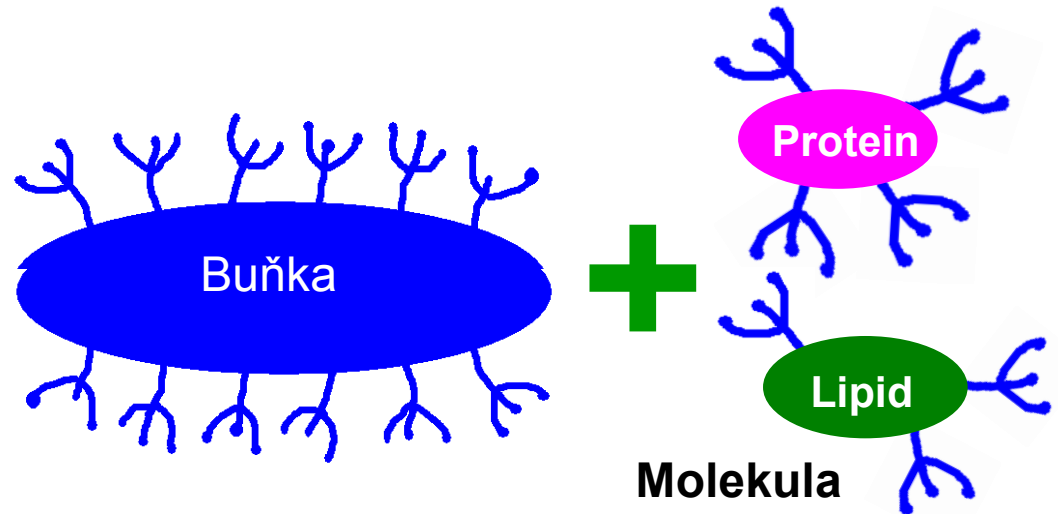


- Protože se nacházejí na povrchu buněk a makromolekul, mohou se cukry uplatňovat v **komunikaci** a **interakcích** mezi buňkami a molekulami.

CUKRY – KOMUNIKAČNÍ NÁSTROJE



- Interakce buňka-buňka, buňka-molekula, buňka-patogen



SLOŽENÍ GLYKANŮ

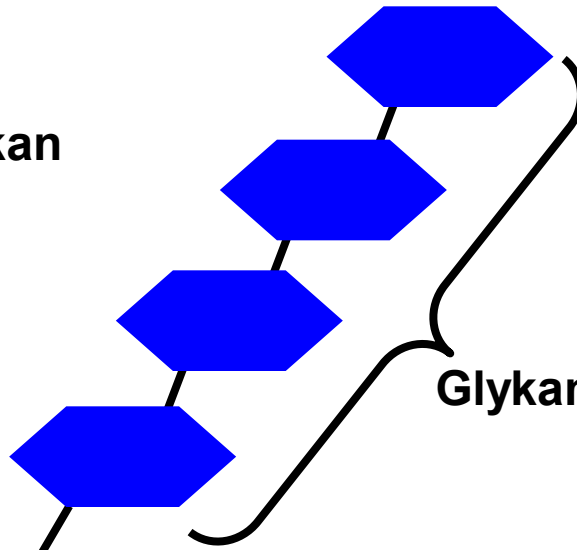
Monosacharid



Glykan

Molekula
-
aglykon

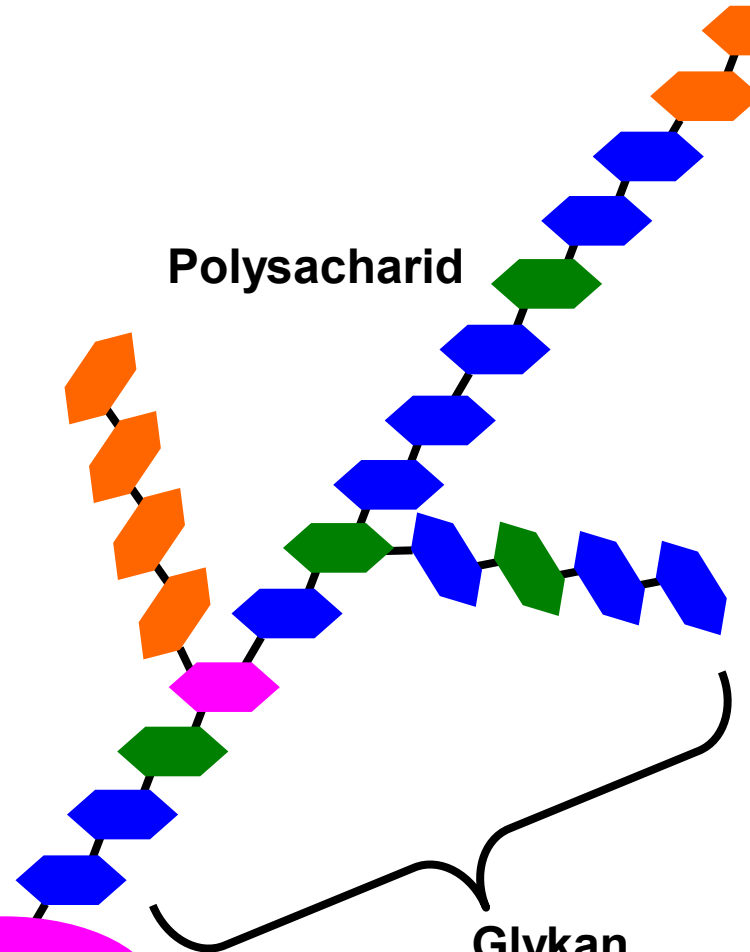
Oligosacharid



Glykan

Molekula

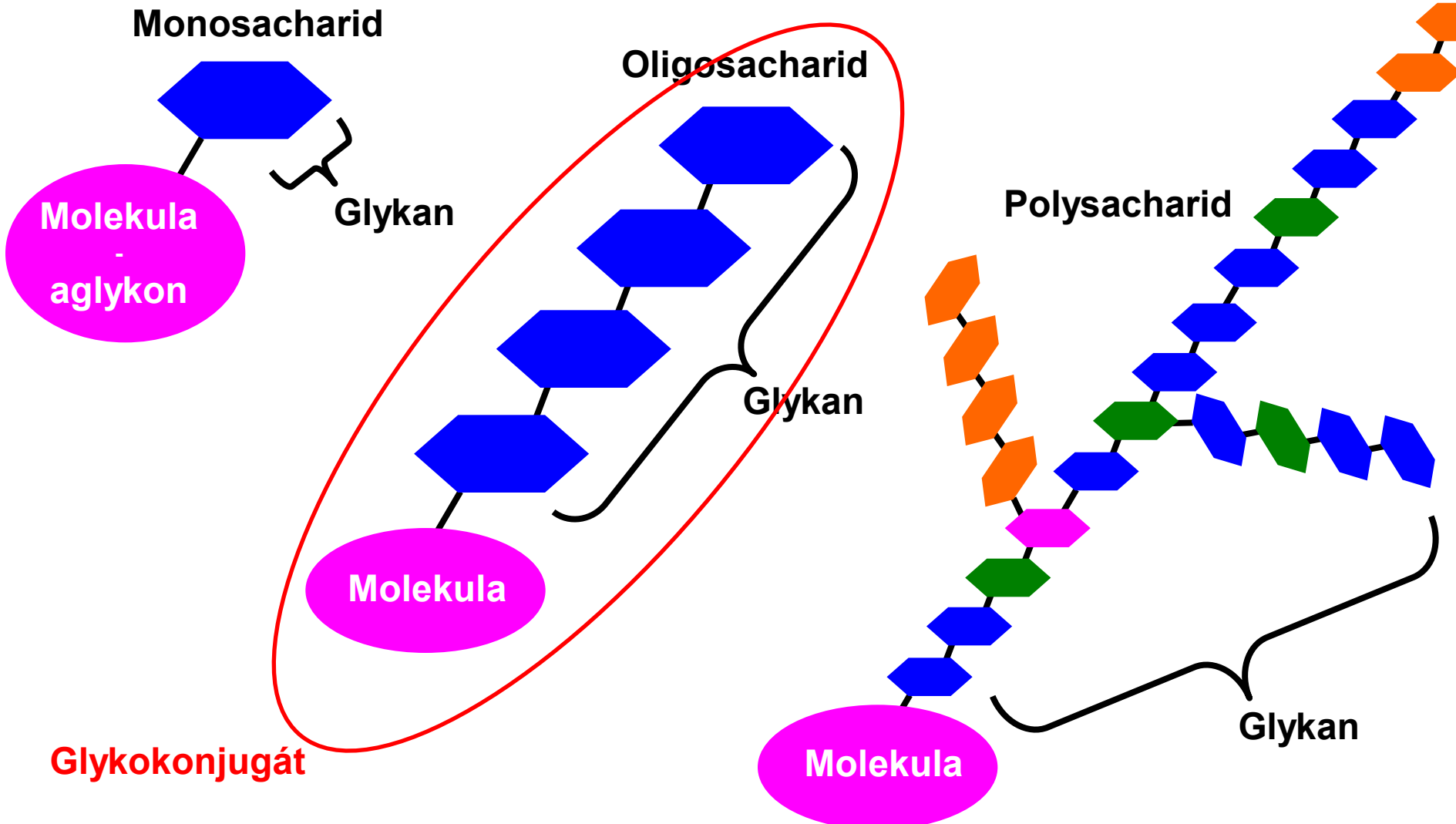
Polysacharid



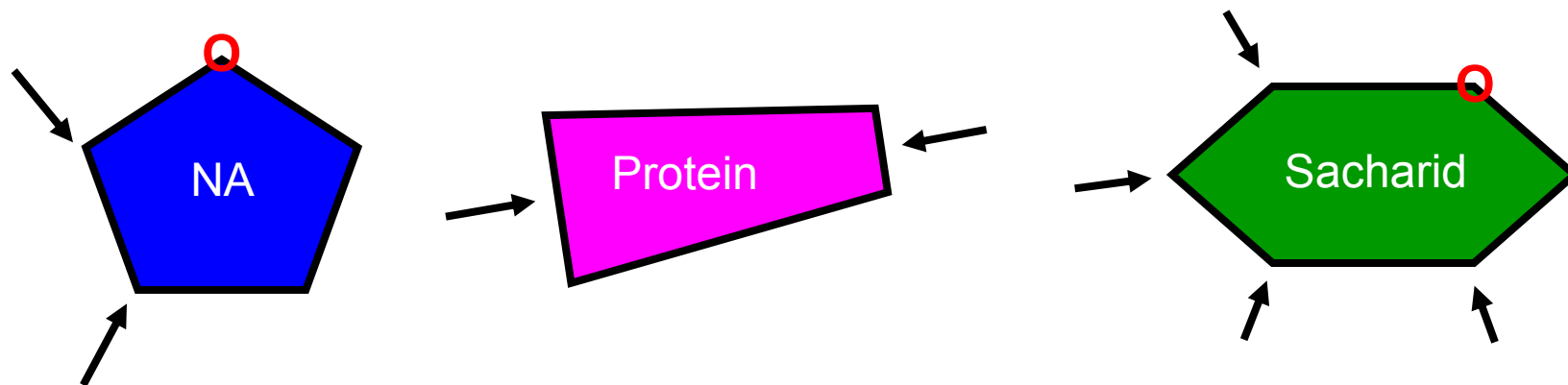
Glykan

Molekula

SLOŽENÍ GLYKANŮ



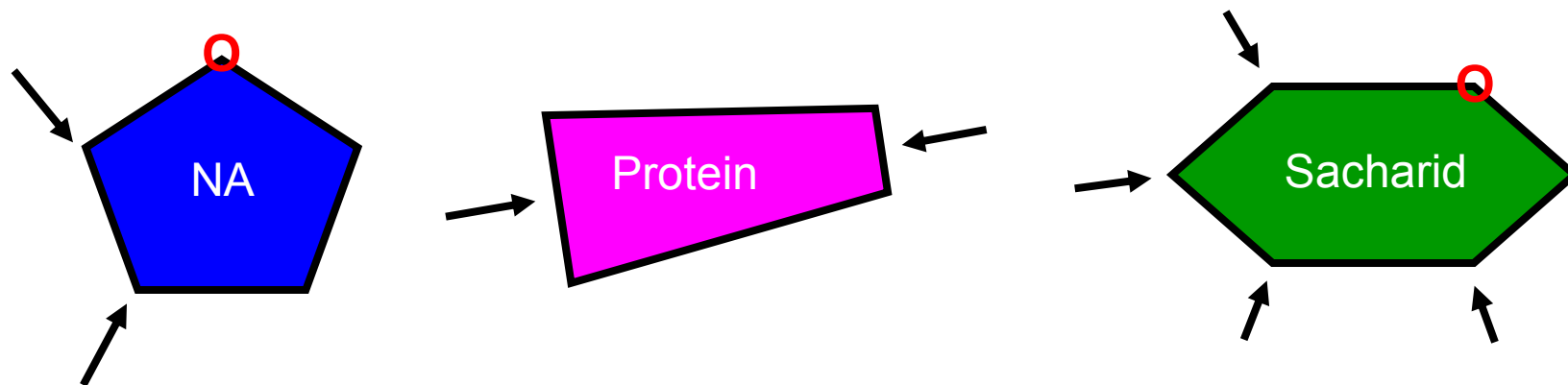
BIOINFORMATICKÝ POTENCIÁL BIOMOLEKUL



- Bioinformatický potenciál je určen množstvím „slov“ (isomerů), které je možné sestavit z jednotlivých „písmen“ (monomerů).
- Nukleotidy a aminokyseliny vytvářejí lineární polymery, spojované stále stejným způsobem (fosfodiesterová vazba, peptidová vazba).
- K dokonalému popisu obsažené informace stačí pouze jednoduchá sekvence (sled) monomerů:

**ATGCTGGTGATTGTGGATGCCGTTACCCTGCTGAGCGCCTATCCGGAAGCCAGCCGTGATC
CGGCCGCCCCGACCGTGATTGATGGTCGCCACCTGTATGTTGTTAGCCCGGGCGATGCCGC**

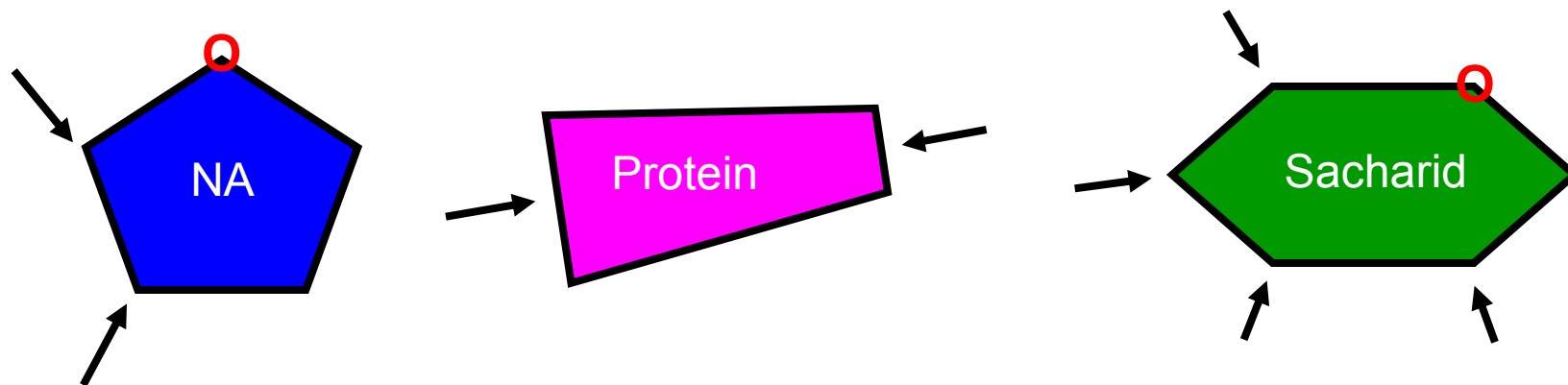
BIOINFORMATICKÝ POTENCIÁL BIOMOLEKUL



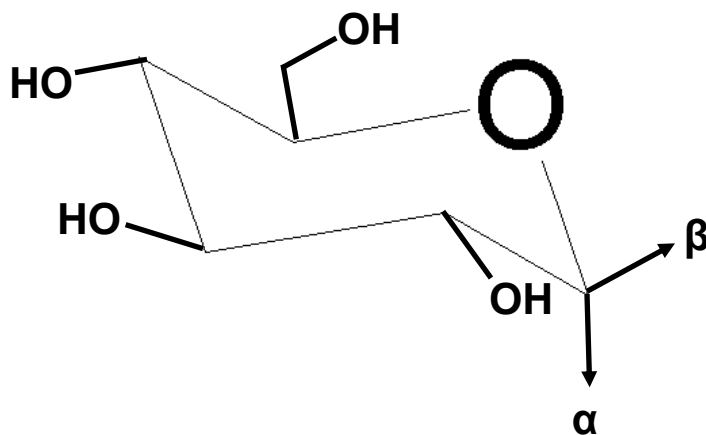
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MLVIVDAVTLLSAYPEASRDPAAPTVIDGRHLYVVSPGDA

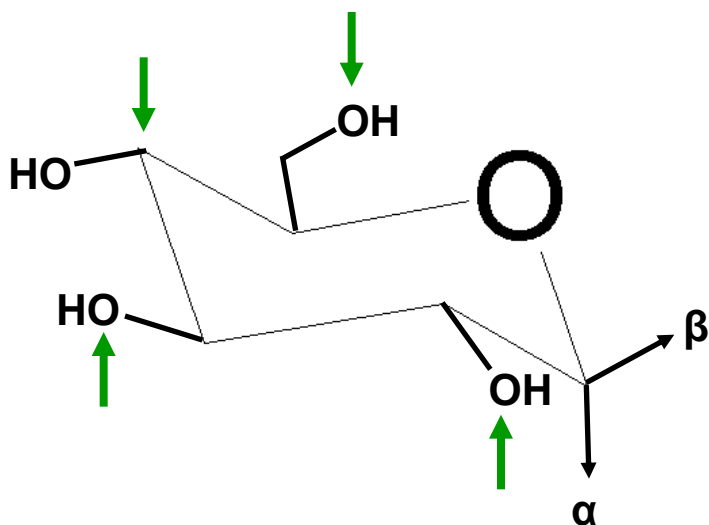
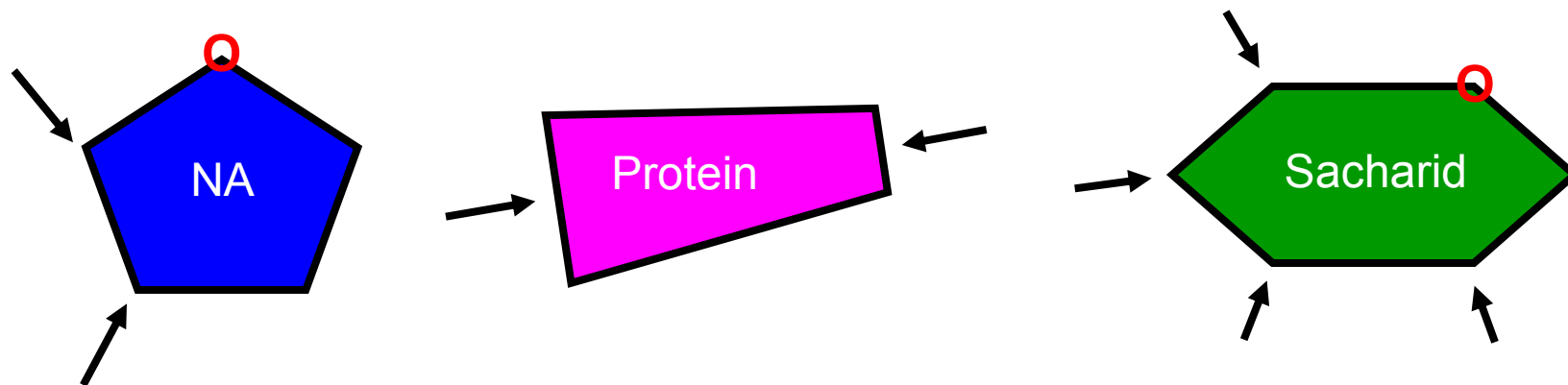
BIOINFORMATICKÝ POTENCIÁL CUKRŮ



- Pro přesný popis oligo(poly)sacharidu je kromě sekvence nutné znát i typ vazby, anomerii a velikost kruhu.



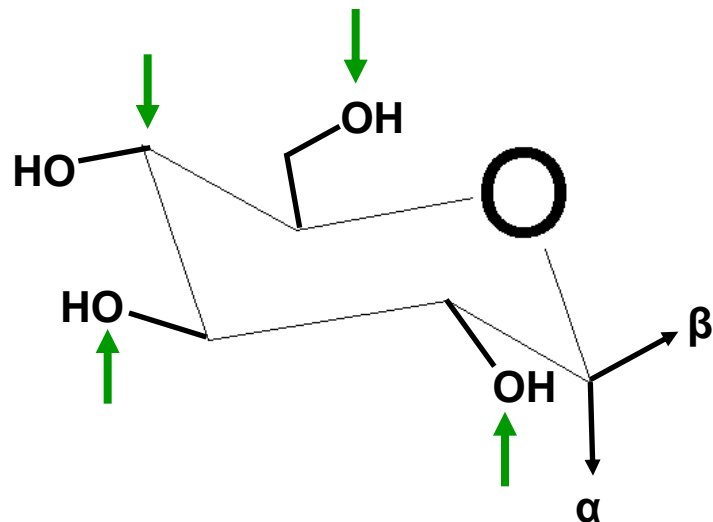
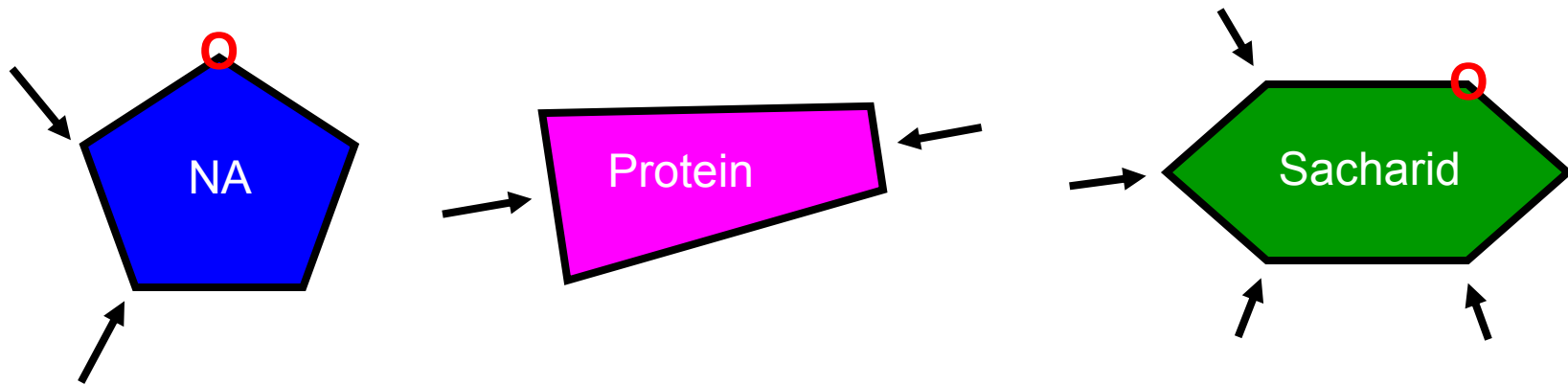
BIOINFORMATICKÝ POTENCIÁL CUKRŮ



D-glukosa + D-glukosa:

α 1-2	kojibiosa
α 1-3	nigerosa
α 1-4	maltosa
α 1-6	isomaltosa
α 1-1 α	trehalosa
β 1-2	soforosa
β 1-3	laminaribiosa
β 1-4	cellobiosa
β 1-6	gentibiosa

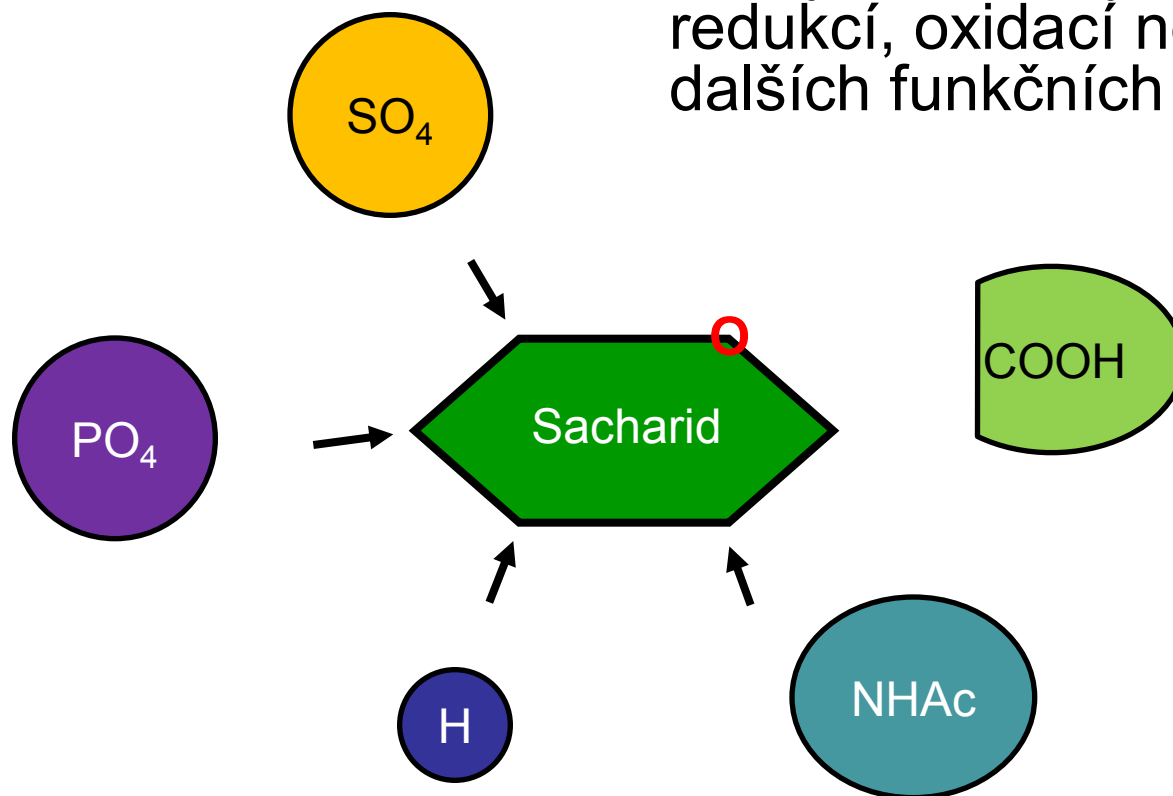
BIOINFORMATICKÝ POTENCIÁL CUKRŮ



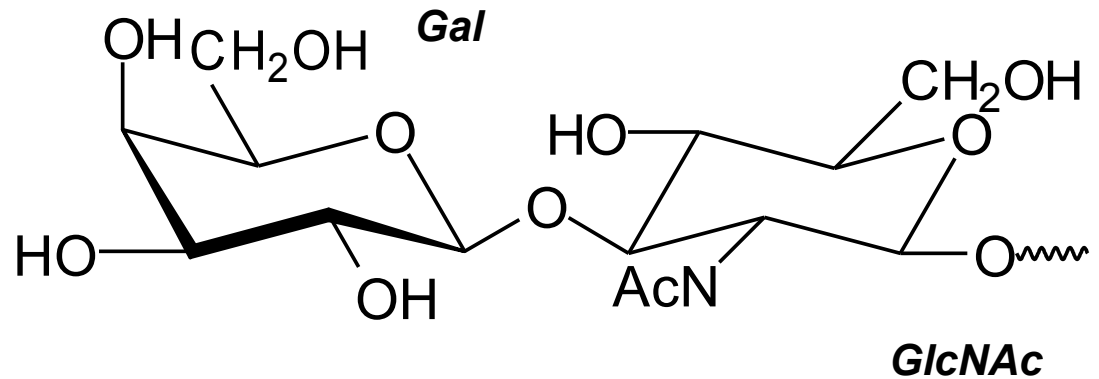
- Glykosidické vazby může tvořit i více než jedna OH skupina, vzniká rozvětvený oligosacharid.
- Klasickým příkladem rozvětvených oligosacharidů jsou antigeny ABH(0) krevních skupin.

BIOINFORMATICKÝ POTENCIÁL CUKRŮ

- Cukry mohou být modifikovány redukcí, oxidací nebo vazbou dalších funkčních skupin.



„CUKERNÝ“ KÓD

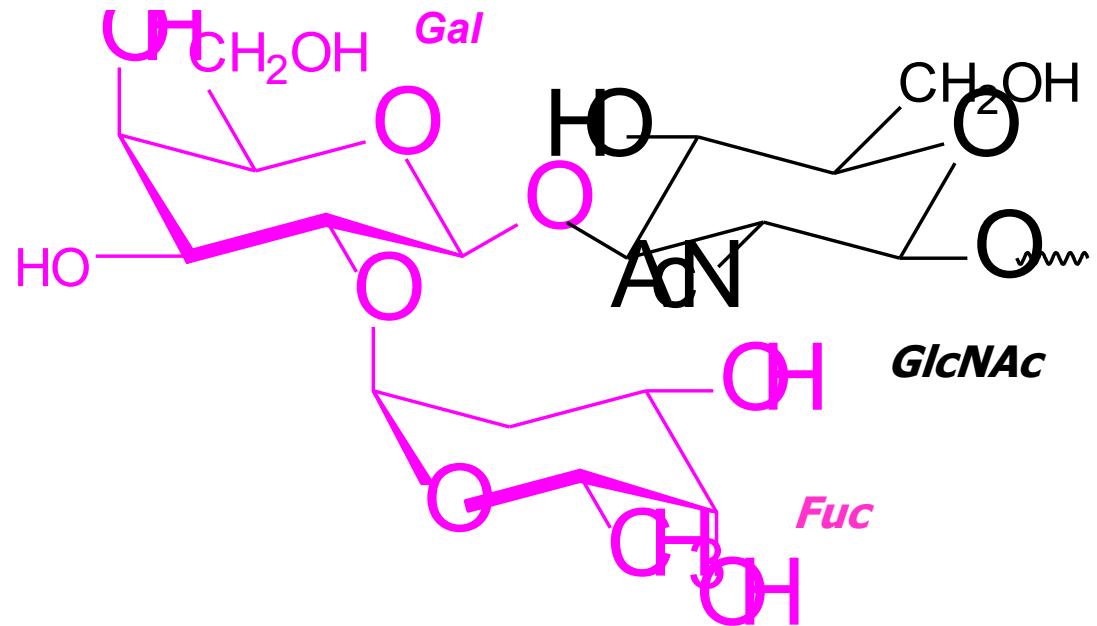


Krevní skupina



Tkáňové a krevní skupiny ABO (H)

„CUKERNÝ“ KÓD

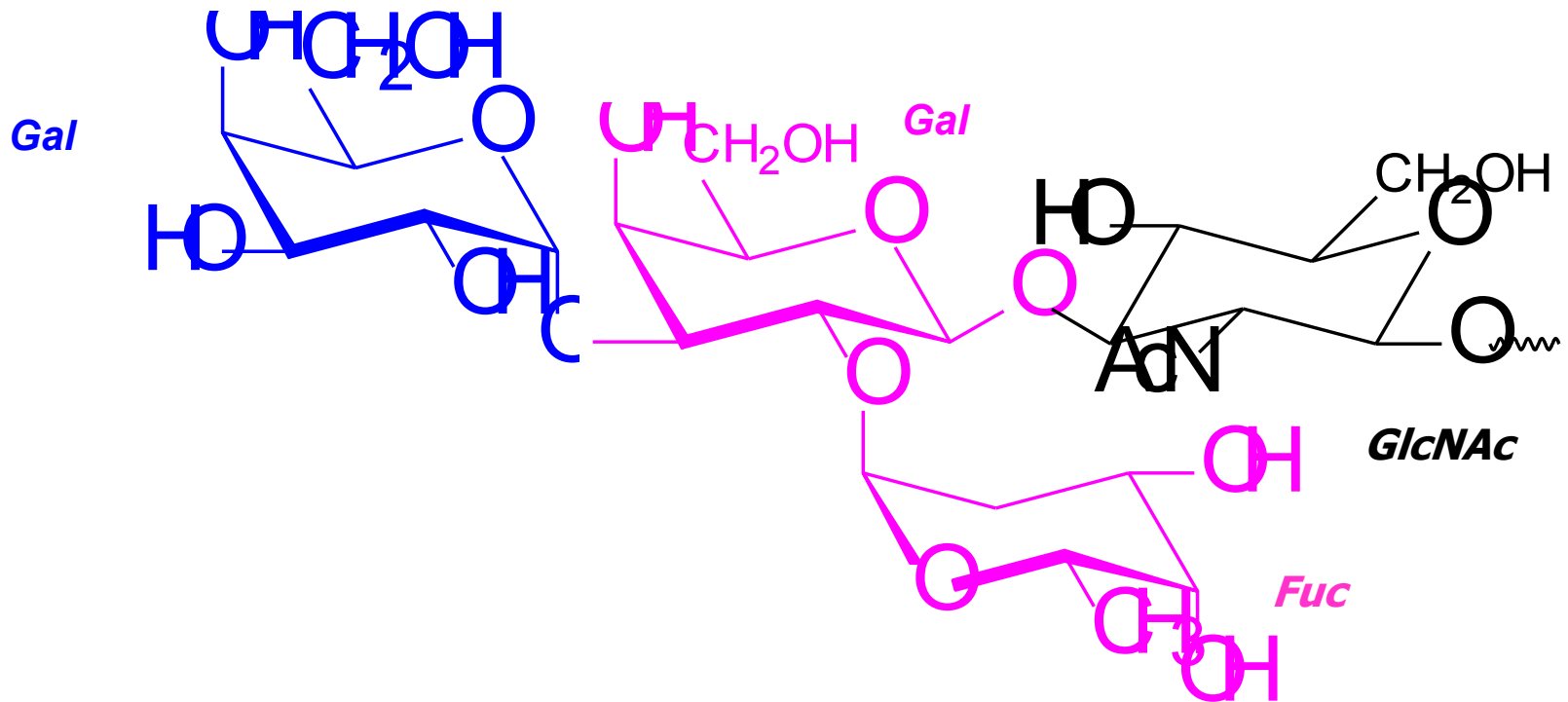


Krevní skupina **H (0)**

Tkáňové a krevní skupiny **ABO (H)**



„CUKERNÝ“ KÓD

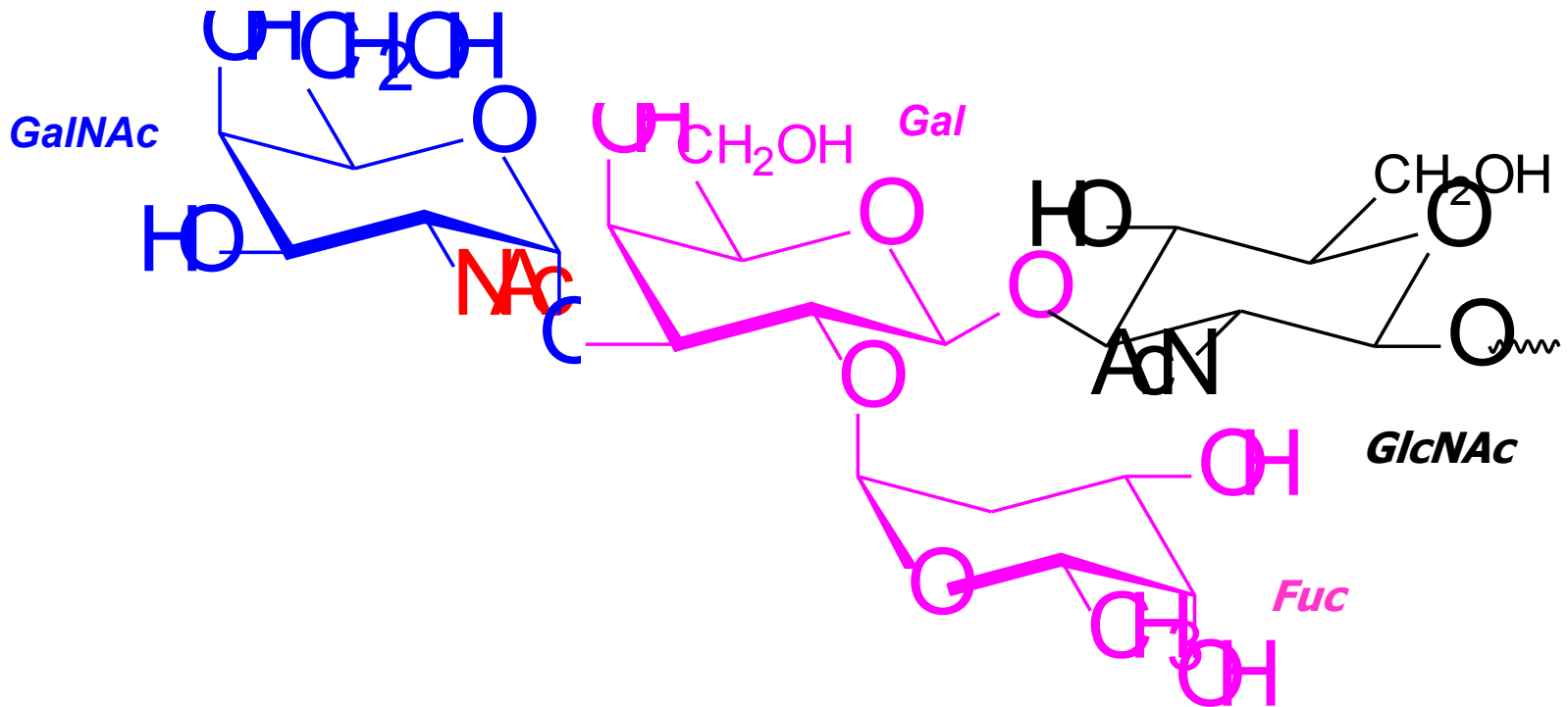


Krevní skupina **B**



Tkáňové a krevní skupiny ABO (H)

„CUKERNÝ“ KÓD

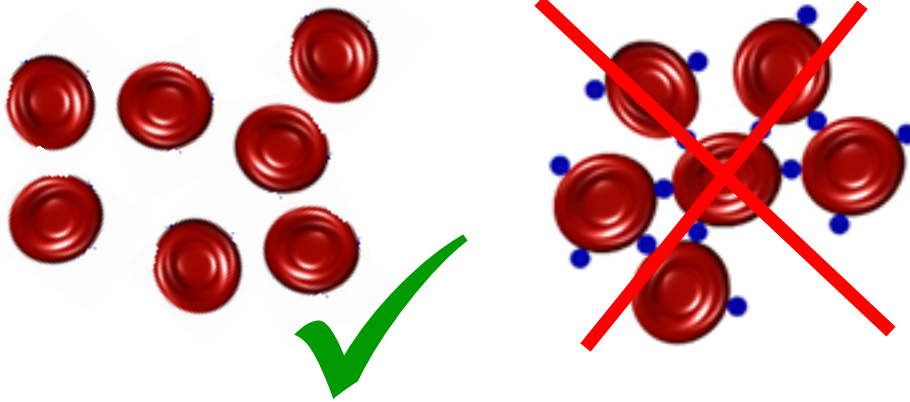


Krevní skupina **A**



Tkáňové a krevní skupiny ABO (H)

„CUKERNÝ“ KÓD



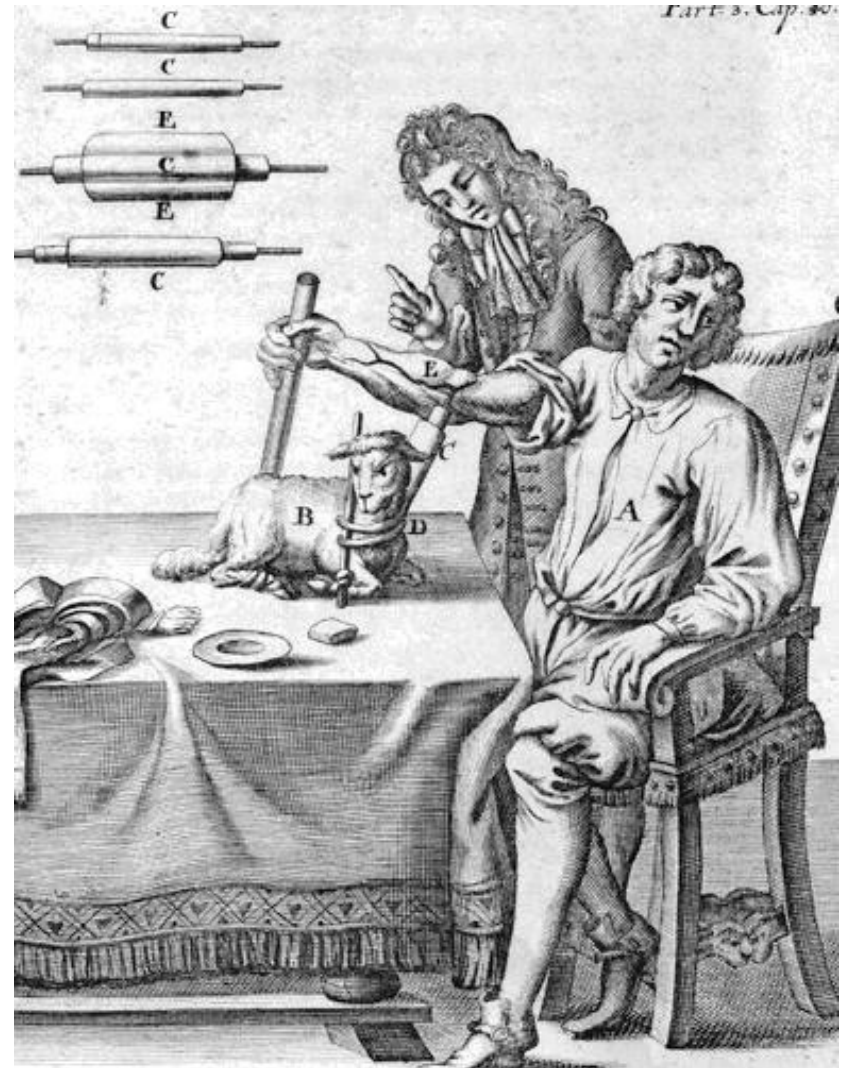
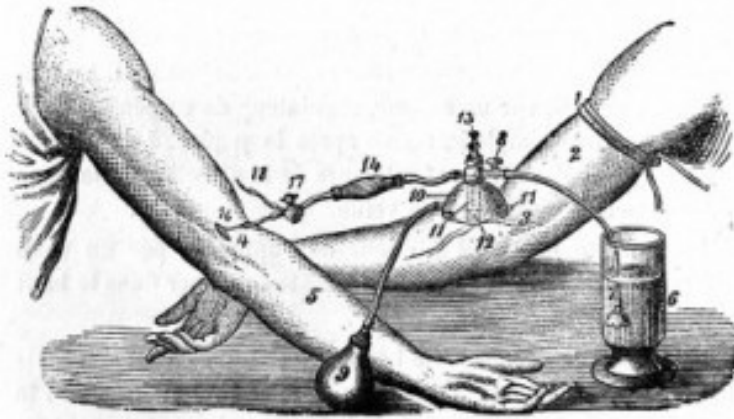
Transfuzní oddělení a krevní banka



Příjemce krevní skupina	Dárce krevní skupina
A	A 0
0	0
B	B 0
AB	A B 0 AB



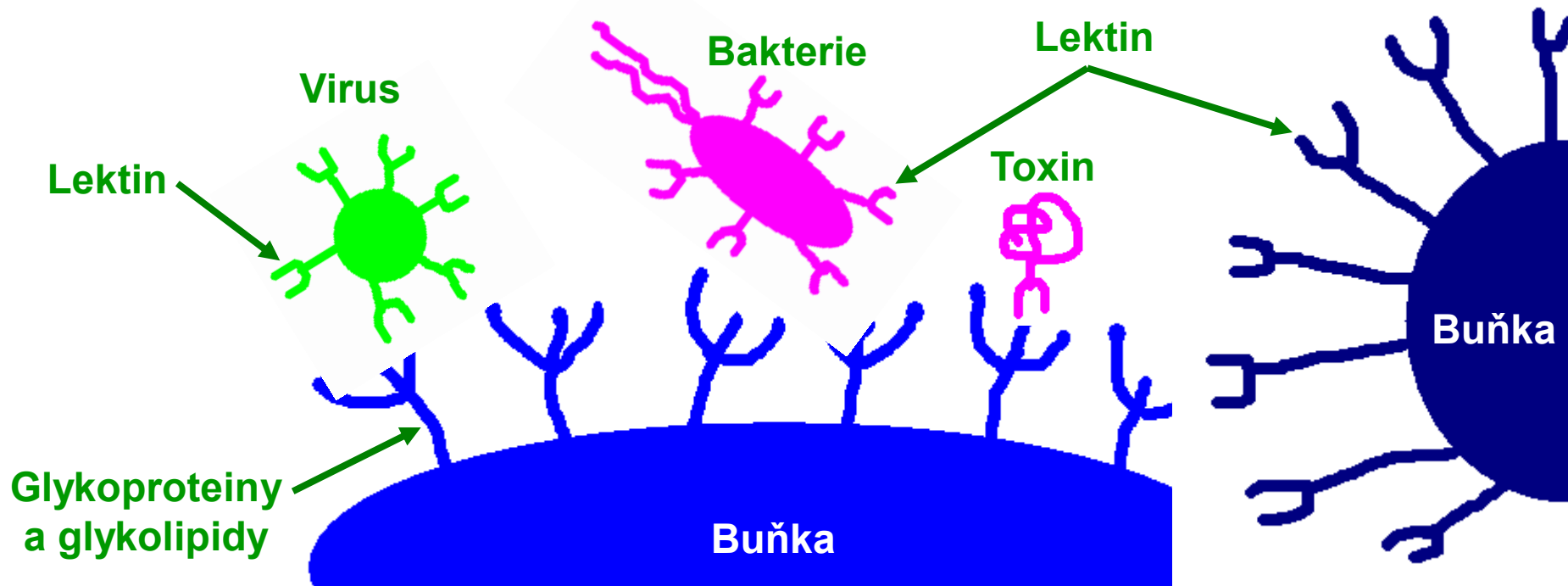
„CUKERNÝ“ KÓD



Příjemce krevní skupina	Dárce krevní skupina
A	JEHNĚ ?
0	JEHNĚ ?
B	JEHNĚ ?
AB	JEHNĚ ?

ČTENÍ „CUKERNÉHO“ KÓDU

- Lektiny plní rozpoznávací a adhezivní funkci v mnoha různých biologických procesech.



VÝSKYT LEKTINŮ

Rostliny

Zvířata

Houby

Bakterie

Viry

Ricin

MBP

AAL

PA-IIL

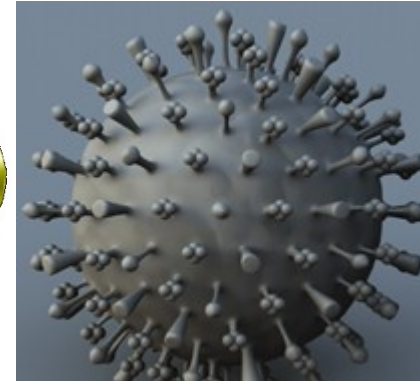
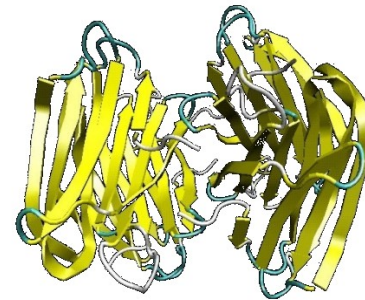
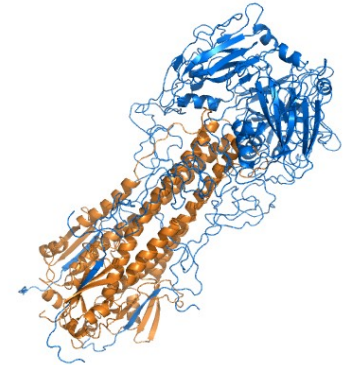
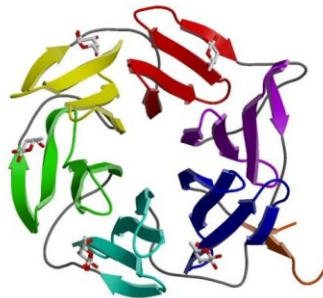
Hemagglutinin

(*Ricinus communis*)

(*Homo sapiens*)

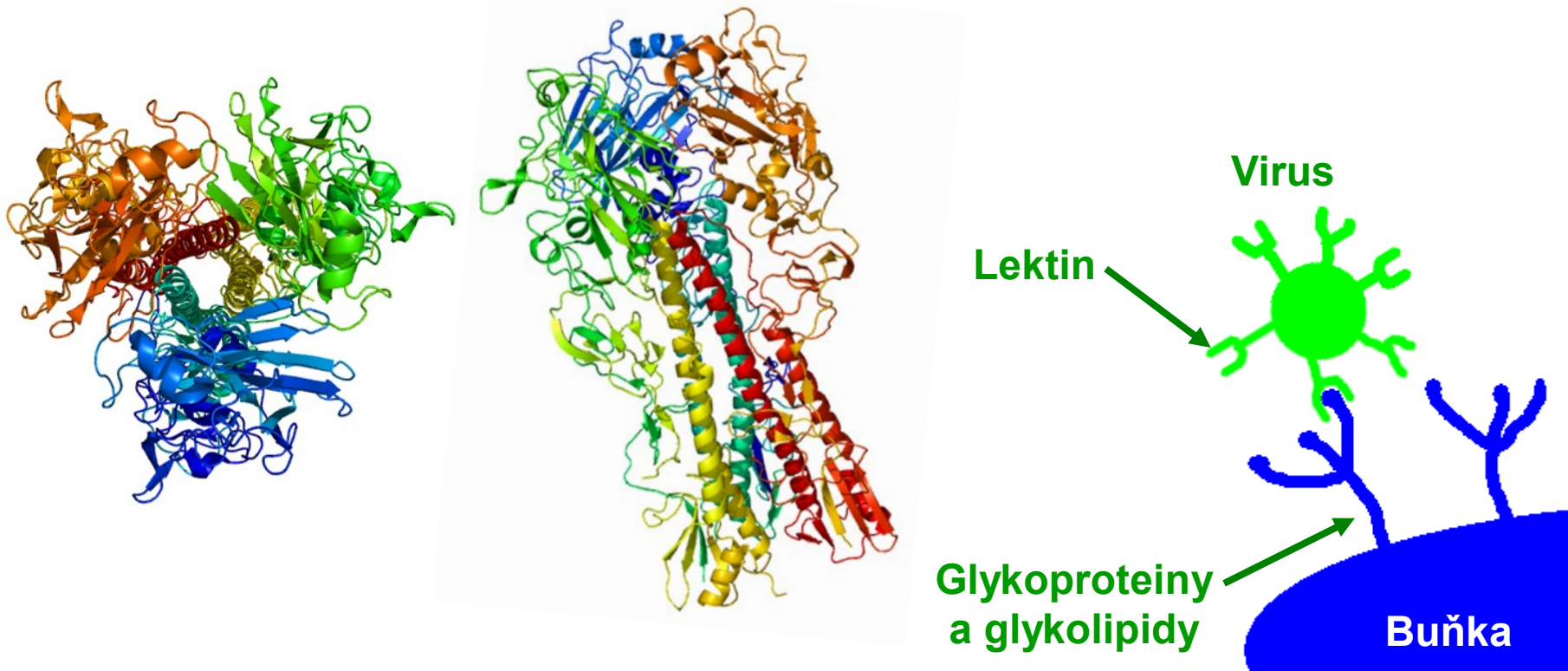
(*Aleuria aurantia*) (*Pseudomonas aeruginosa*)

(*Influenza virus*)



HEMAGLUTININ VIRU CHŘIPKY

- Virus chřipky A obsahuje povrchový glykoprotein, hemagglutinin (HA). Tento protein je lektin, který rozpoznává hostitelské buňky a řídí adhezi a vstup viru do buněk.

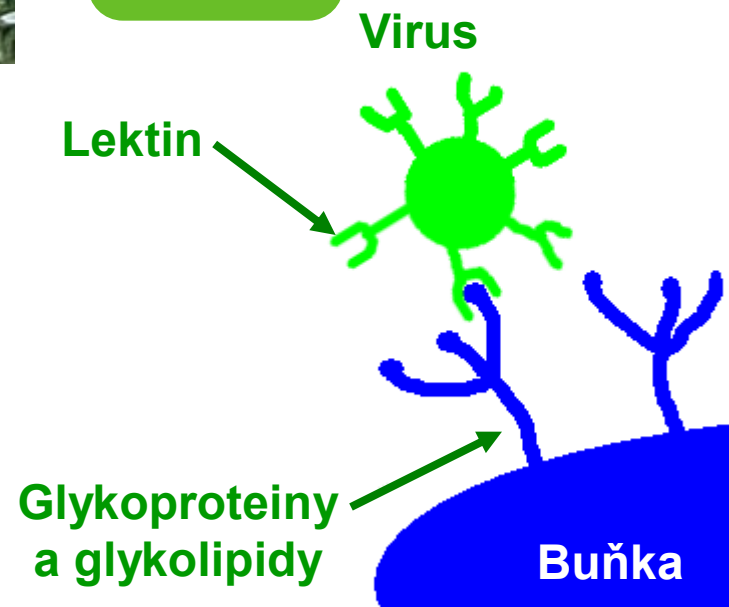


HEMAGLUTININ VIRU CHŘIPKY

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Chřipka,
chřipka
v revíru!



HEMAGLUTININ VIRU CHŘIPKY

Označení	Antigenní typ	Vznik	Poznámka
Španělská chřipka	H1N1	Antigenní posun	Pandemie v roce 1918/1919 způsobila smrt 20 miliónů lidí. Virus byl přenesen do Evropy americkými vojáky z Kansasu.
Asijská chřipka	H2N2	Antigenní zvrát, kmen H1N1 získal nové alely z ptačího rezervoáru	V roce 1957 nahrazuje H2N2 kmen H1N1.
Hong Kong	H3N2	Antigenní zvrát, nové alely opět získány z ptačího viru.	Nastupuje v roce 1968 s rozsáhlou pandemií.
Ruská chřipka	H1N1	Pravděpodobný únik z laboratoře	Nastupuje v roce 1977, od této doby působí v lidské populaci kmeny H3N2 i H1N1.

KDO ČEKÁ ZA DVEŘMI?



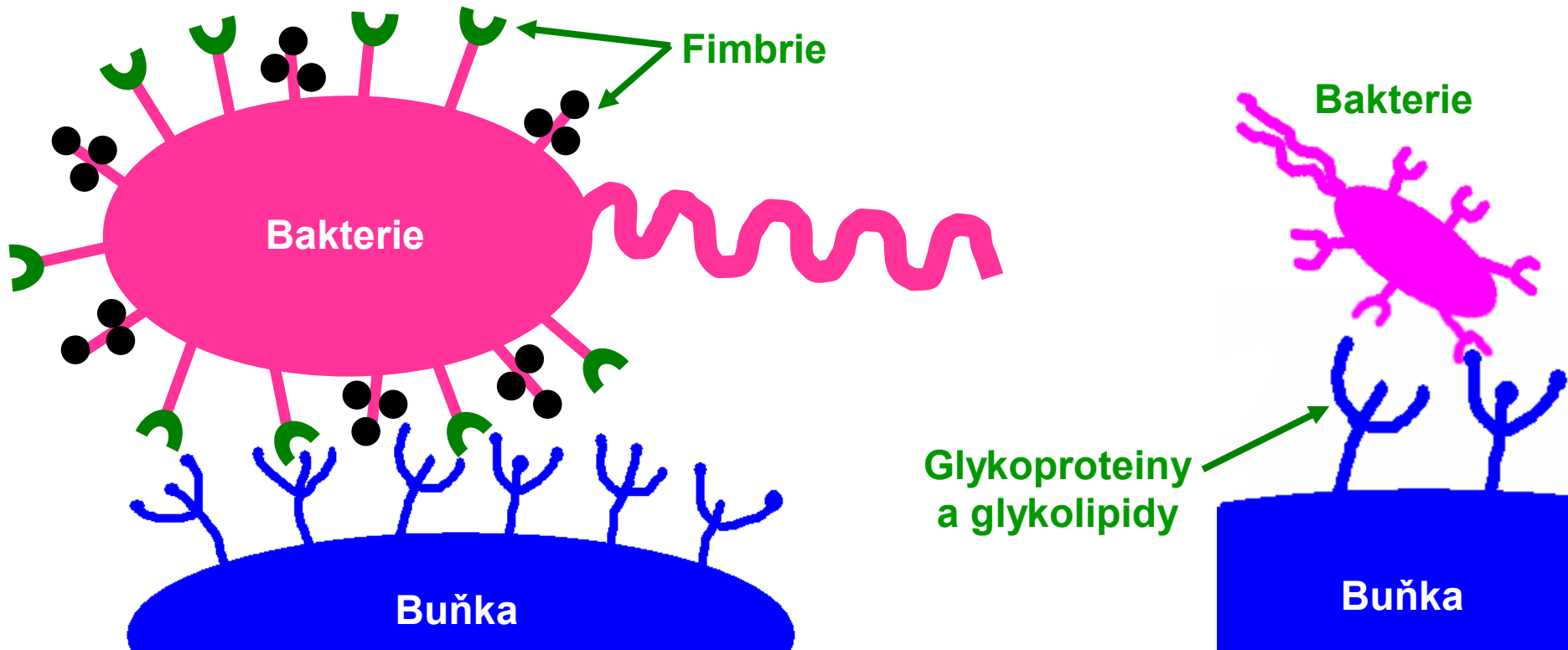
H5N1
Ptačí chřipka
1990

H1N1
(nový a lepší)
Prasečí chřipka
2009

**Nebezpečí hrozí, pokud virus získá schopnost
snadného přenosu z člověka na člověka...**

FIMBRIE *E. COLI*

- Bakterie většinou obsahují lektiny na povrchu fimbrií, příkladem mohou být mannosa-specifické fimbrie *E. coli*. Pomocí těchto fimbrií mohou některé kmeny *E. coli* adherovat na sliznice močových cest a způsobovat infekce.

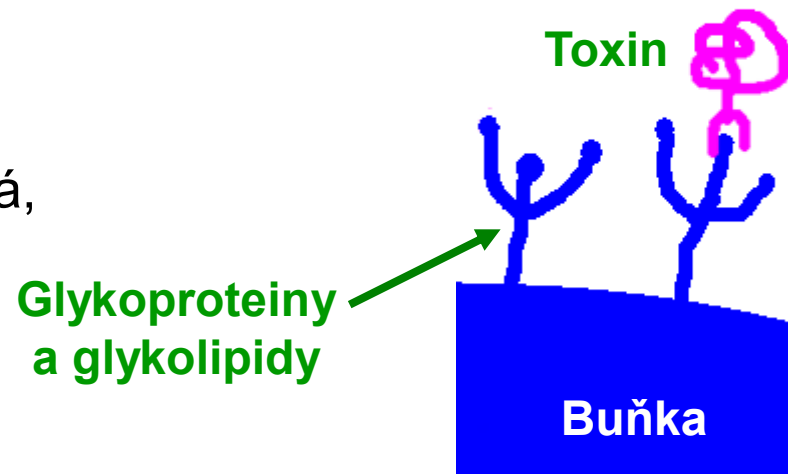


RICIN – NEJSLAVNĚJŠÍ LEKTIN

- Ricin je toxin produkovaný rostlinou *Ricinus communis* (skočec obecný).



- Často využíván jako okrasná rostlina.
- Ricin se vyskytuje nejvíce v semenech.
- Pro otrávení jsou celá semena nevhodná, je nutné je pořádně rozžvýkat.



RICIN – NEJSLAVNĚJŠÍ LEKTIN

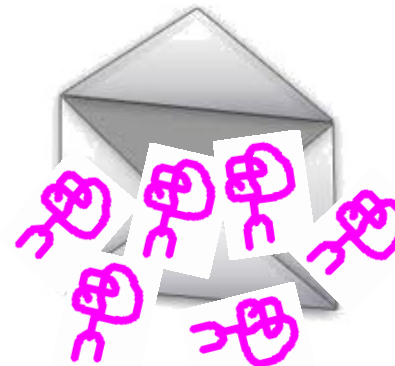
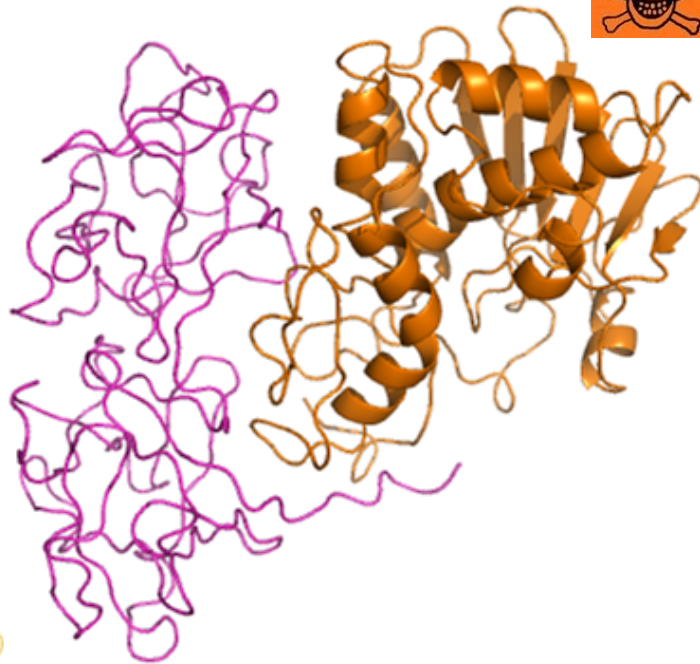
- Ricin je toxin produkovaný rostlinou *Ricinus communis* (skočec obecný).



Toxická část



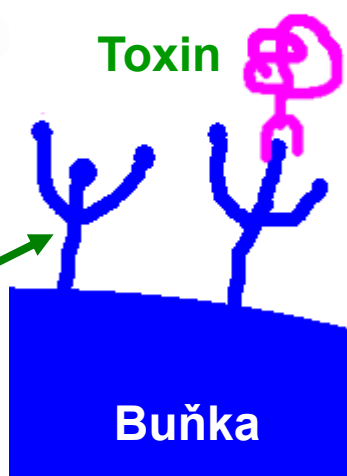
Adhezivní část



Toxin

Glykoproteiny
a glykolipidy

Buňka



Tajné služby zadržely otrávený dopis pro Obamu. Obsahoval jed ricin

17. dubna 2013 18:06, aktualizováno 21:07    

Americké tajné služby zajistily v úterý dopis adresovaný prezidentu Baracku Obamovi, který obsahoval podezřelou látku. Dopis byl zachycen v objektu, který leží mimo komplex Bílého domu. Podle prvních testů federální policie obsahoval jedovatý ricin.

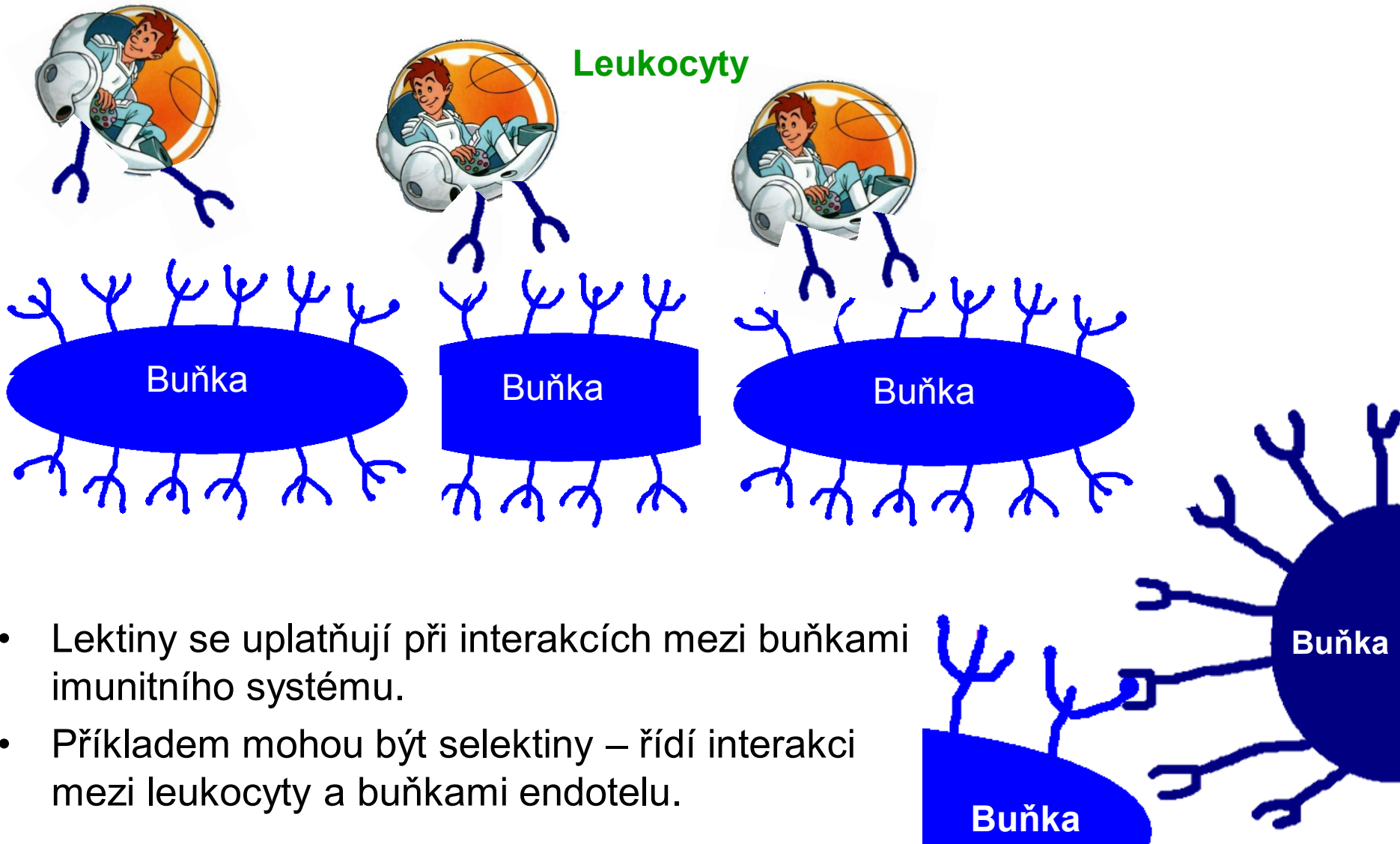
Americkému senátorovi poslali dopis s ricinem

Dopis zasláný republikánskému senátorovi za stát Mississippi Rogeru Wickerovi obsahoval ricin. Potvrdil to předběžný test, jsou ale ještě potřeba další zkoumání. List se podařilo zachytit ještě v oddělení, které pro zákonodárce poštu zpracovává. O nález informoval šéf policie v Capitolu Kim Dine s tím, že případ převzal Federální úřad pro vyšetřování (FBI).

Newyorskému starostovi poslali dopis s ricinem

Dopisy adresované newyorskému starostovi Michaelu Bloombergovi a organizaci podporující omezení prodeje zbraní, obsahovaly jedovatý ricin, uvedly úřady po testech. Jeden z bezpečnostních pracovníků, který přišel s dopisem do styku, vykazuje drobné příznaky kontaktu s ricinem.

SELEKTINY



- Lektiny se uplatňují při interakcích mezi buňkami imunitního systému.
- Příkladem mohou být selektiny – řídí interakci mezi leukocyty a buňkami endotelu.

Multivalent glycoconjugates as anti-pathogenic agents†

Anna Bernardi,^a Jesus Jiménez-Barbero,^b Alessandro Casnati,^c Cristina De Castro,^d Tamis Darbre,^e Franck Fieschi,^f Jukka Finne,^g Horst Funken,^h Karl-Erich Jaeger,^h Martina Lahmann,ⁱ Thisbe K. Lindhorst,^j Marco Marradi,^k Paul Messner,^l Antonio Molinaro,^d Paul V. Murphy,^m Cristina Nativi,ⁿ Stefan Oscarson,^o Soledad Penadés,^k Francesco Ricci,^p Roland J. Riseman,^q Olivier Renaudat,^r Jean-Louis Reymond,^s Barbara Christina Schäffer,^l W. Bruce Stéphanie Vincent,^w Tom V

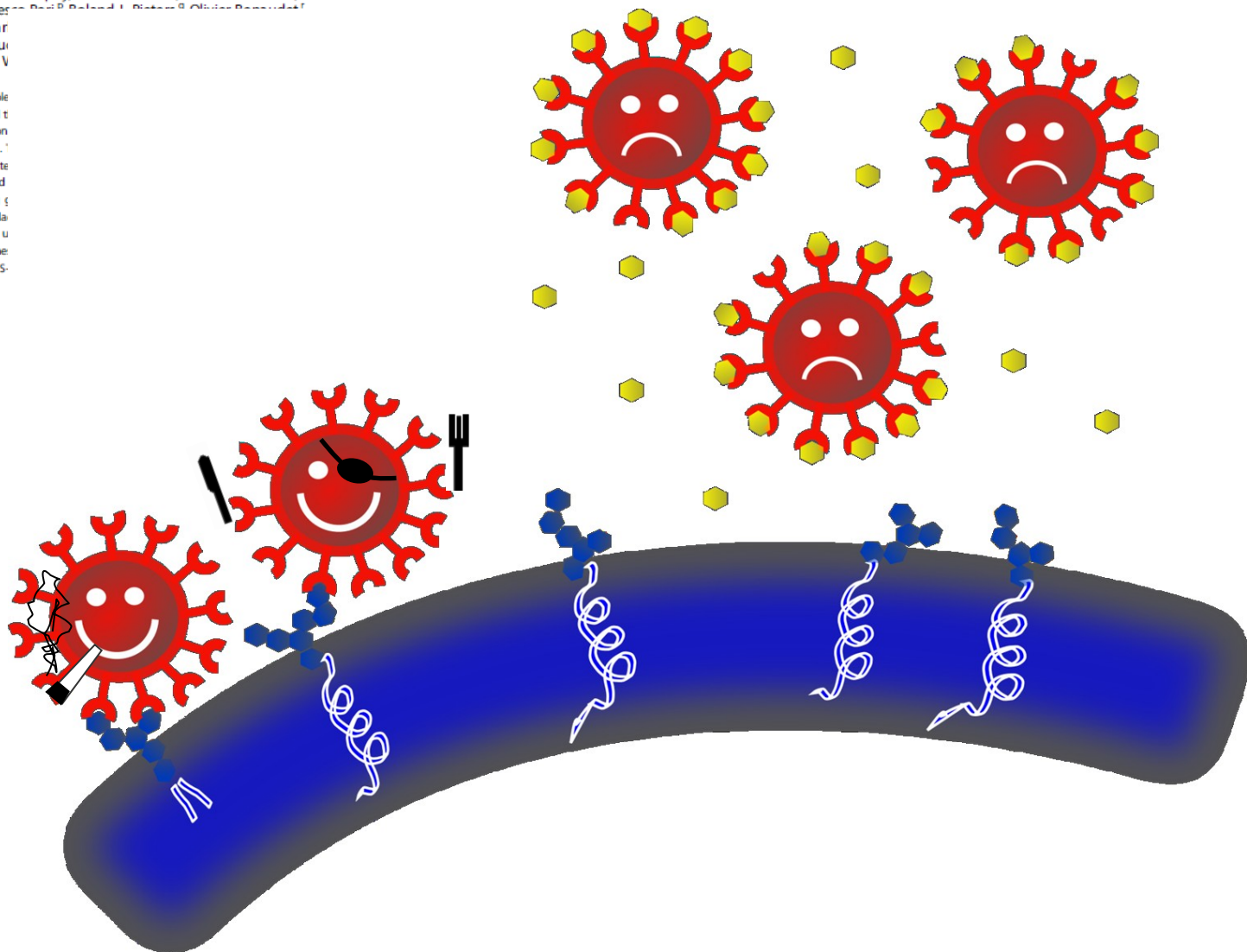
Multivalency plays a major role pathogenic microorganisms and t during the first steps of infection stages of the immune response. the combination of carbohydrate glyco-compounds with controlled such glyco-compounds including the potential to improve or repla glycoconjugates have also been u with carbohydrate-based vaccine such as lipopolysaccharides and S-

Received 4th October 2012

DOI: 10.1039/c2cs35408g

www.rsc.org/csr

ANTIADHEZIVNÍ TERAPIE



„DRUG-TARGETING“

Lectin-mediated drug targeting: history and applications

Christiane Bies^a, Claus-Michael Lehr^a, John F. Woodley^{b,*}

^aDepartment of Biopharmaceutics and Pharmaceutical Technology, Saarland University, Saarbrücken, Germany

^bLaboratoire de Clinique des Xénobiotiques, Faculté des Sciences Pharmaceutiques, 35 chemin des Maréchaux, 31062 Toulouse, France

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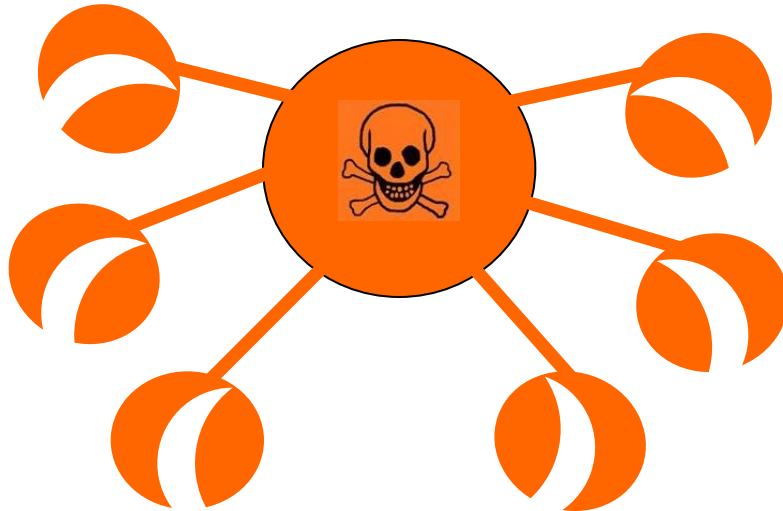
Abstract

The purpose of this paper is to review the history of using lectins to target and deliver drugs to their site of action. The hour of birth of “lectinology” may be defined as the description of the agglutinating properties of ricin, by Hermann Stillmark in 1888, however, the modern era of lectinology began almost 100 years later in 1972 with the purification of different plant lectins by Sharon and Lis. The idea to use lectins for drug delivery came in 1988 from Woodley and Naisbet, who proposed the use of tomato lectin (TL) to target the luminal surface of the small intestine. Besides the targeting to specific cells, the lectin–sugar interaction can also be used to trigger vesicular transport in to or across epithelial cells. The concept of bioadhesion via lectins may be applied not only for the GI tract but also for other biological barriers like the nasal mucosa, the lung, the buccal cavity, the eye and the blood–brain barrier.
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Keywords: Lectin; Protein–sugar interaction; Bioadhesion; Drug delivery; Gene delivery; Transcytosis; Vesicular transport; Endocytosis

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CHCETE VĚDĚT VÍČ?

Carbohydrates

Robert J Sturgeon, Heriot-Watt University, Edinburgh, UK

The carbohydrates comprise one of the major groups of naturally occurring organic molecules and are amongst the most abundant constituents of plants, animals and microorganisms. In general, carbohydrates are polyhydroxy-aldehydes or ketones. They may contain, in addition, amino, acetalamido and carboxyl functional groups.

Introduction

The term carbohydrate includes monosaccharides, oligosaccharides and polysaccharides. Also included are substances derived from monosaccharides such as alditols, which are derived by reduction of the carbonyl group and carboxylic acids, which are derived by oxidation of one or more terminal groups. Replacement of a hydroxyl group with a hydrogen atom produces a deoxy-sugar and replacement of a hydroxyl group with an amino group produces an amino sugar. The term 'sugar' is frequently applied to monosaccharides and lower molecular weight oligosaccharides.

Classification

Carbohydrates are usually classified in three groups: monosaccharides, oligosaccharides and polysaccharides. Monosaccharides are simple sugars that cannot be hydrolysed to smaller molecules. They exist in nature in the free form or linked by glycosidic bonds to other monosaccharides in the formation of oligosaccharides or polysaccharides. Oligosaccharides are defined as simple polymers of monosaccharides containing between two and approximately 10 monosaccharide residues. They are termed disaccharides, trisaccharides, tetrasaccharides, pentasaccharides, and so on, according to the number of monosaccharide units they contain. Polysaccharides (glycans) are higher molecular weight polymers of monosaccharides. Glycoconjugates are defined as either glycoproteins, glycolipids and proteoglycans. Glycoproteins are conjugated proteins containing either oligosaccharide groups or polysaccharide groups, having a fairly low molecular mass. Glycolipids are conjugated lipids containing oligosaccharide groups, and proteoglycans are proteins linked to polysaccharides of high molecular mass.

Monosaccharides

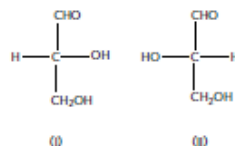
Monosaccharides are polyhydroxyaldehydes $\text{H}[\text{CHOH}]_n\text{-CHO}$ or polyhydroxyketones $\text{H}[\text{CHOH}]_n\text{-CO}[\text{CHOH}]_m\text{-H}$ with three or more carbon atoms. Monosaccharides bearing an aldehydic carbonyl group are called aldoses, whereas those with a ketonic carbonyl group are called

ketoses. As monosaccharides are normally found as cyclic structures, containing either a hemiacetal or hemiketal group arising from ring closure of the linear polyhydroxy-carbonyl compounds, monosaccharides are considered to contain a potential aldehydic carbonyl group (hemiacetal) or potential ketonic carbonyl group (hemiketal). Cyclic hemiacetals or hemiketals of sugars with a five-membered (tetrahydrofuran) ring are described as furanoses and those with a six-membered (tetrahydropyran) ring are called pyranoses.

Monosaccharides are classified, according to the number of carbon atoms they contain, as trioses, tetraoses, pentoses, hexoses, etc.

Stereoisomerism and configuration

In the early 1890s Emil Fischer published detailed studies on the configuration of aldoses. Molecules containing one centre of chirality (asymmetrical carbon atom – which is a carbon atom to which four different atoms or groups are attached) exist in two isomeric forms. They are stereoisomers, differing only in the arrangement of groups in space. Thus the simplest sugar, glyceraldehyde, exists in two nonsuperimposable stereoisomeric molecules, which are mirror images. The two stereoisomers are called enantiomers, or an enantiomeric pair. It is known that these projections correspond to absolute configurations, which are referred to as D-glyceraldehyde (I) and L-glyceraldehyde (II).



Introductory article

Article Contents

- Introduction
- Monosaccharides
- Higher-order Structures
- Naturally Occurring Oligosaccharides and Glycolipids
- Plant and Algal Polysaccharides
- Polysaccharides in Fungi and Invertebrates
- Polysaccharides and Glycoconjugates of Bacteria
- Polysaccharides and Glycoconjugates in Higher Animals
- Carbohydrates in Recognition Processes
- Summary

Lectins

Nathan Sharon, Weizmann Institute of Science, Rehovot, Israel

Based in large part on the previous version of this Encyclopedia of Life Sciences (ELS) article, Lectins by Nathan Sharon and Haimo Li.

Lectins, a class of sugar-specific and cell-agglutinating proteins of non-immune origin that are devoid of enzymatic activity, are ubiquitous in nature. Plant lectins are invaluable tools for the study of carbohydrates, in solution and on cells, and are also employed for purging of bone marrow for transplantation into 'bubble children'. Bacterial cell surface lectins mediate the attachment of the organisms to host cell surfaces in the initiation of infection; their blocking by suitable sugars can serve as a basis of anti-adhesion therapy of bacterial diseases. Those of animals control the biosynthesis of glycoproteins, play key roles in cell interactions in the immune system and serve as innate immunity agents against microbial pathogens. They also monitor the migration of leucocytes in blood vessels and contribute to proliferation and metastasis of tumour cells.

Introduction

Lectins (from Latin, *legere*, to select or choose) are proteins that bind mono- and oligosaccharides specifically and reversibly similarly to anticarbohydrate antibodies, but are not products of an immune response. However, they differ from antibodies in several important aspects. Thus, numerous lectins are present in plants, microorganisms and viruses, which are not capable of an immune response. Another marked difference between the two classes of protein is that antibodies are structurally similar, whereas lectins are structurally diverse. In general, lectins are oligomeric proteins composed of subunits, one or more of which carries a sugar-binding site. They vary, however, in size, amino acid composition, metal requirement, domain organization, subunit number and assembly, as well as in three-dimensional structure (Figure 1). In their structural diversity, lectins are akin to enzymes, although they are devoid of catalytic activity. In spite of their structural variation, lectins can be grouped in families of homologous proteins.

Lectins typically contain two or more carbohydrate-combining sites per molecule, that is, they are divalent or polyvalent, although exceptions also occur. Therefore, binding of a lectin to sugars on the surface of cells, for example, erythrocytes may cause cross-linking of the cells and their subsequent precipitation, a phenomenon referred

ELS subject area: Biochemistry

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Introductory article

Article Contents

- Introduction
- Carbohydrate Specificity
- Plant Lectins
- Microbial Lectins
- Animal Lectins
- Lectins in Recognition and Adhesion Molecular
- Applications

Online posting date: 15th September 2009

to as cell agglutination. The erythrocyte agglutinating, or haemagglutinating, activity of lectins is a major attribute of these proteins and serves routinely for their detection and characterization. It was actually by this activity that lectins were first detected in extracts of plant seeds at the turn of the nineteenth century. For a long time such haemagglutinating proteins were known as 'phytohaemagglutinins', because they were found almost exclusively in plants. A turning point in lectin research came in 1936 with the work of James B Sumner on jackbean lectin, concanavalin A, still the best-characterized protein of this class. He reported that concanavalin A also precipitates polysaccharides and glycoproteins and that both the haemagglutinating and precipitating activities are inhibited by mannose and glucose (the sugars are of the D-configuration except for fucose which is L). With much foresight, Sumner suggested that these activities might be the consequence of a reaction of the lectin with carbohydrates on the erythrocyte surface. In fact, testing the inhibition of haemagglutination or polysaccharide precipitation by a panel of sugars is still the simplest way to establish the specificity of a lectin. See also: Membrane Proteins; Sumner, James Batcheller

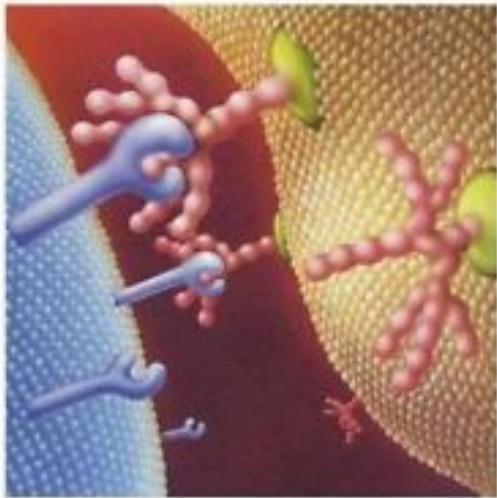
Another turning point was the discovery, in the late 1940s, by William C Boyd (who coined the term lectin) and independently by Karl O Renkonen, that certain lectins exhibit blood type A, B or O specificity. Soon thereafter, such lectins played a crucial role in the identification, by Walter JT Morgan and Winifred M Watkins, of the chemical nature of the blood-type ABO determinants: α -N-acetylgalactosamine for the A type, α -galactose for the B type and α -fucose for the O type. However, lectin research started to gain momentum only in the 1960s, thanks to two major developments. The first was the finding by Peter C Nowell that some lectins are mitogenic, that is that they stimulate lymphocytes to undergo mitosis. This discovery had a revolutionary impact on immunology in that it

CHCETE VĚDĚT *mnohem* VÍC?

LECTINS

Second Edition

by
Nathan Sharon and Halina Lis

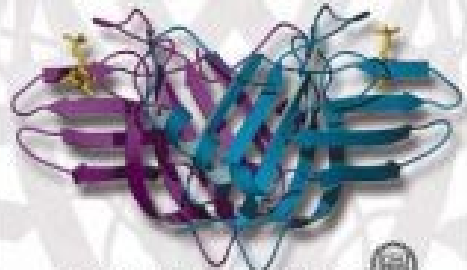


 Springer

Essentials of Glycobiology

Edited by

Ajit Varik
Richard Cummings
Jeffrey Esko
Hudson Freeze
Gerald Hart
James Marth



GOLD SMITH HANSON LABORATORY PRESS



Edited by Hans-Joachim Gabius

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The Sugar Code

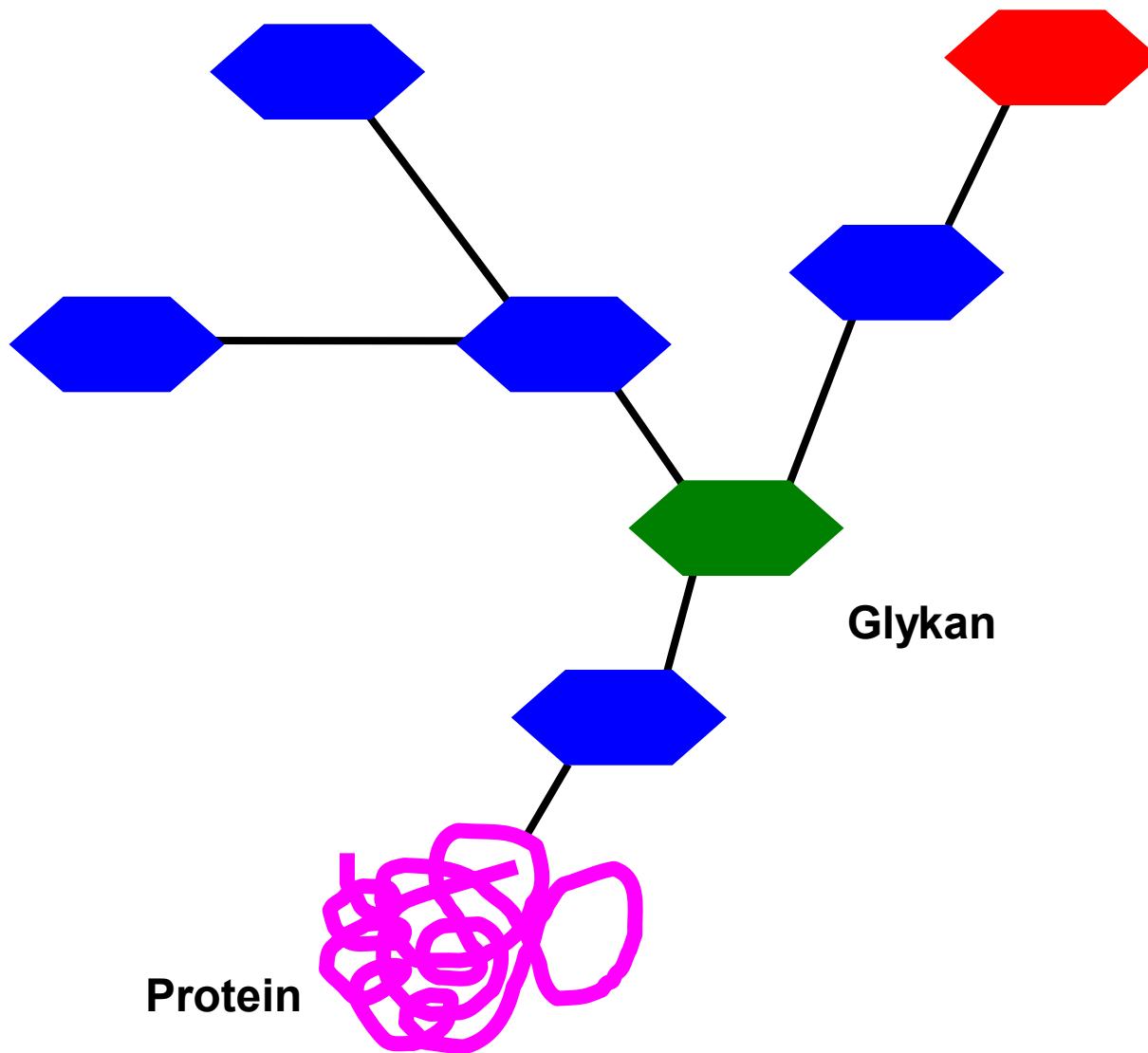
Fundamentals of Glycosciences

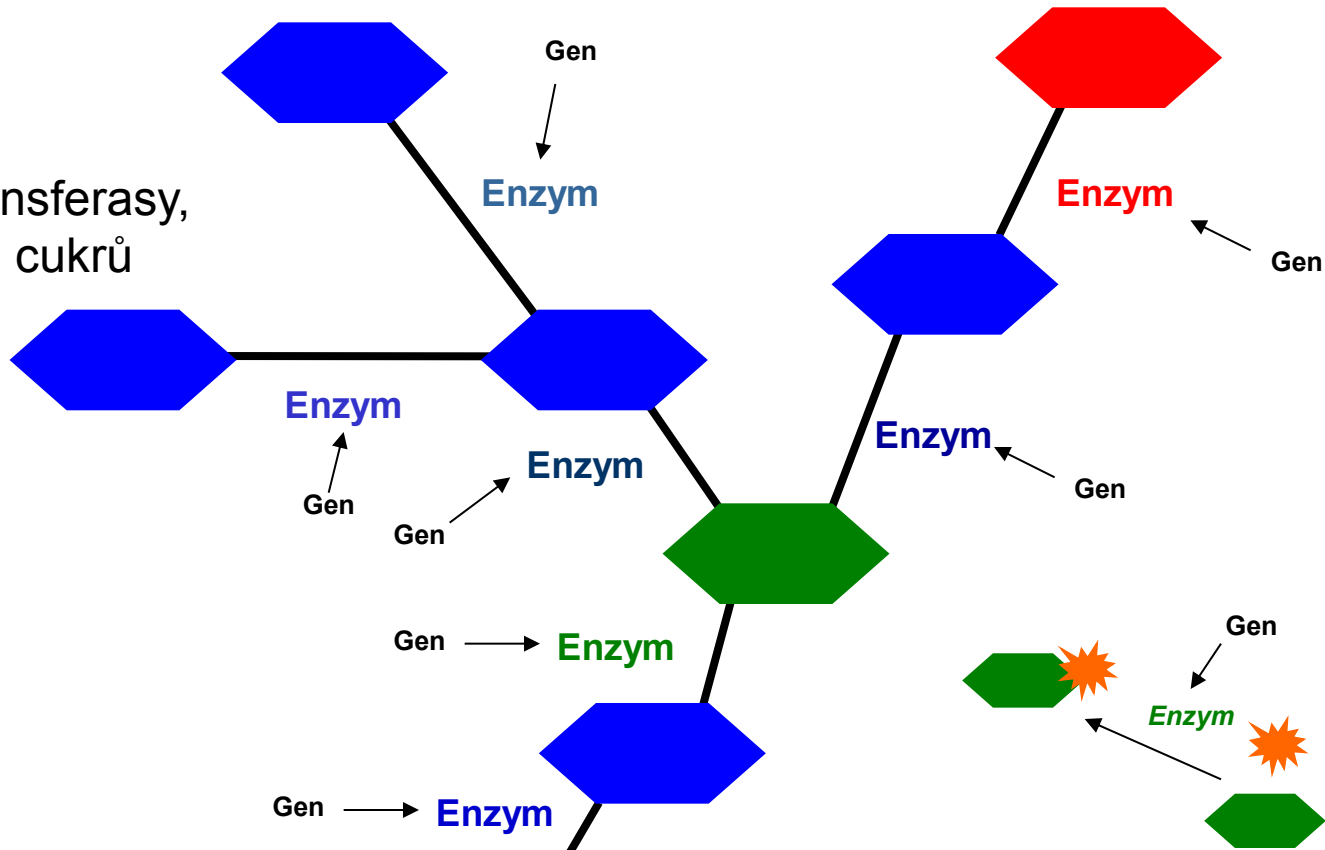


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JAK JE STRUKTURA GLYKOPROTEINŮ ZAKÓDOVÁNA V GENOMU?





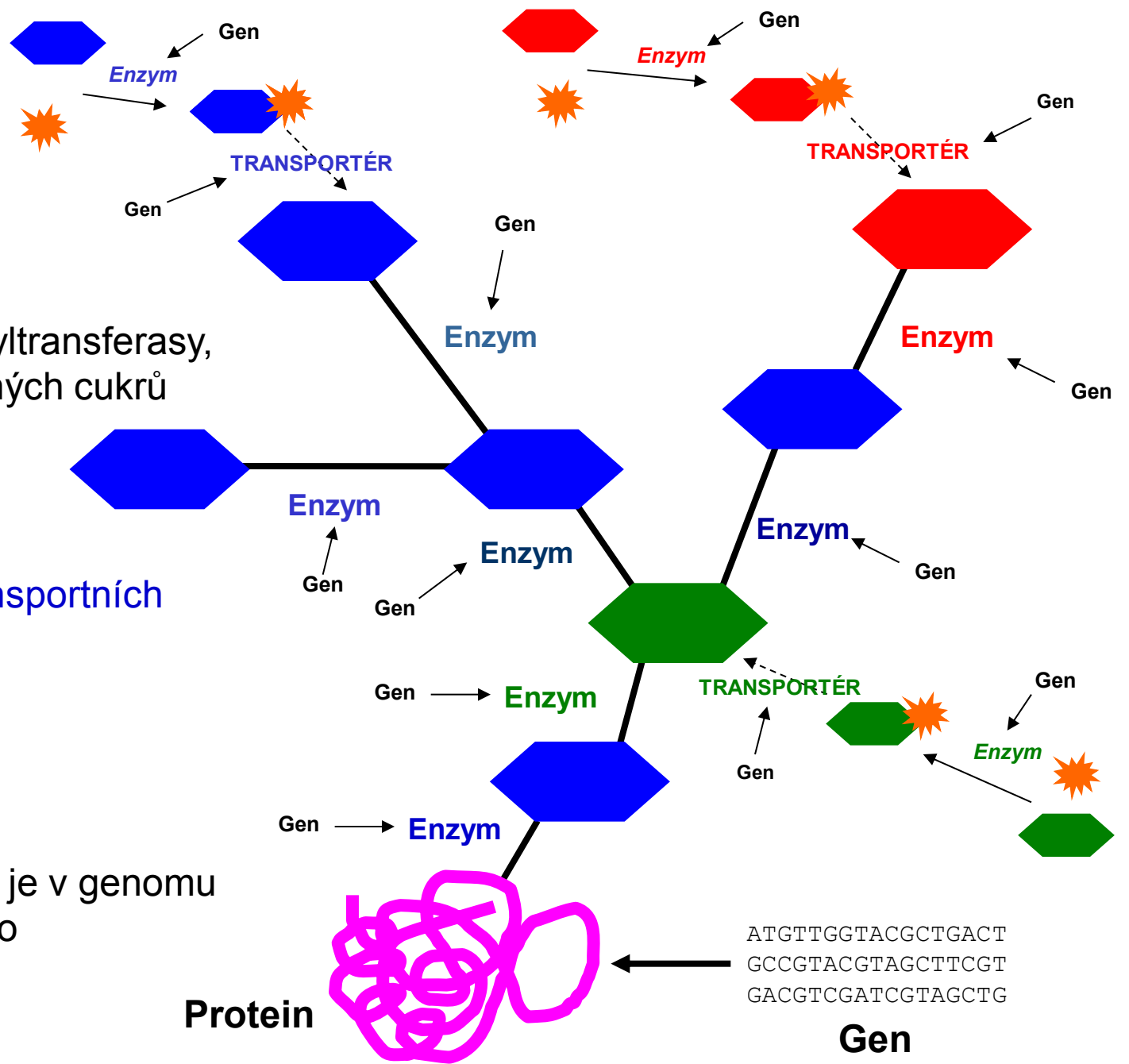
Enzymy = glykosyltransferasy,
syntéza aktivovaných cukrů

Struktura glykanů je v genomu
kódována nepřímo



ATGTTGGTACGCTGACT
GCCGTACGTAGCTTCGT
GACGTCGATCGTAGCTG

Gen



Enzymy = glykosyltransferasy,
syntéza aktivovaných cukrů

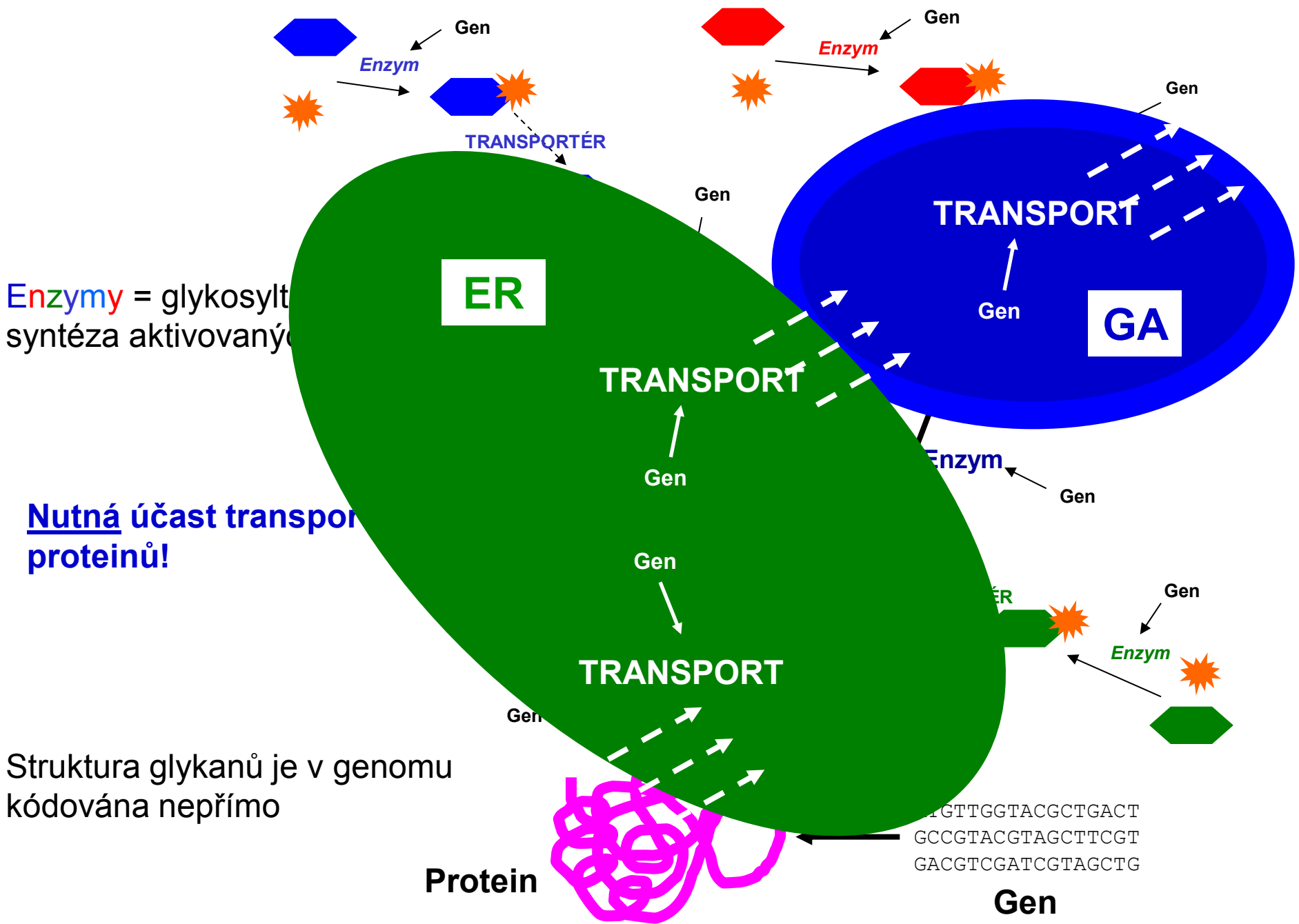
Nutná účast transportních
proteinů!

Struktura glykanů je v genomu
kódována nepřímo

ATGTTGGTACGCTGACT
GCCGTACGTAGCTTCGT
GACGTCGATCGTAGCTG

Protein

Gen



Enzymy = glykosylt
 syntéza aktivovaný

**Nutná účast transpor
 proteinů!**

Struktura glykanů je v genomu
 kódována nepřímo

GTGGTACGCTGACT
 GCCGTACGTAGCTTCGT
 GACGTCGATCGTAGCTG

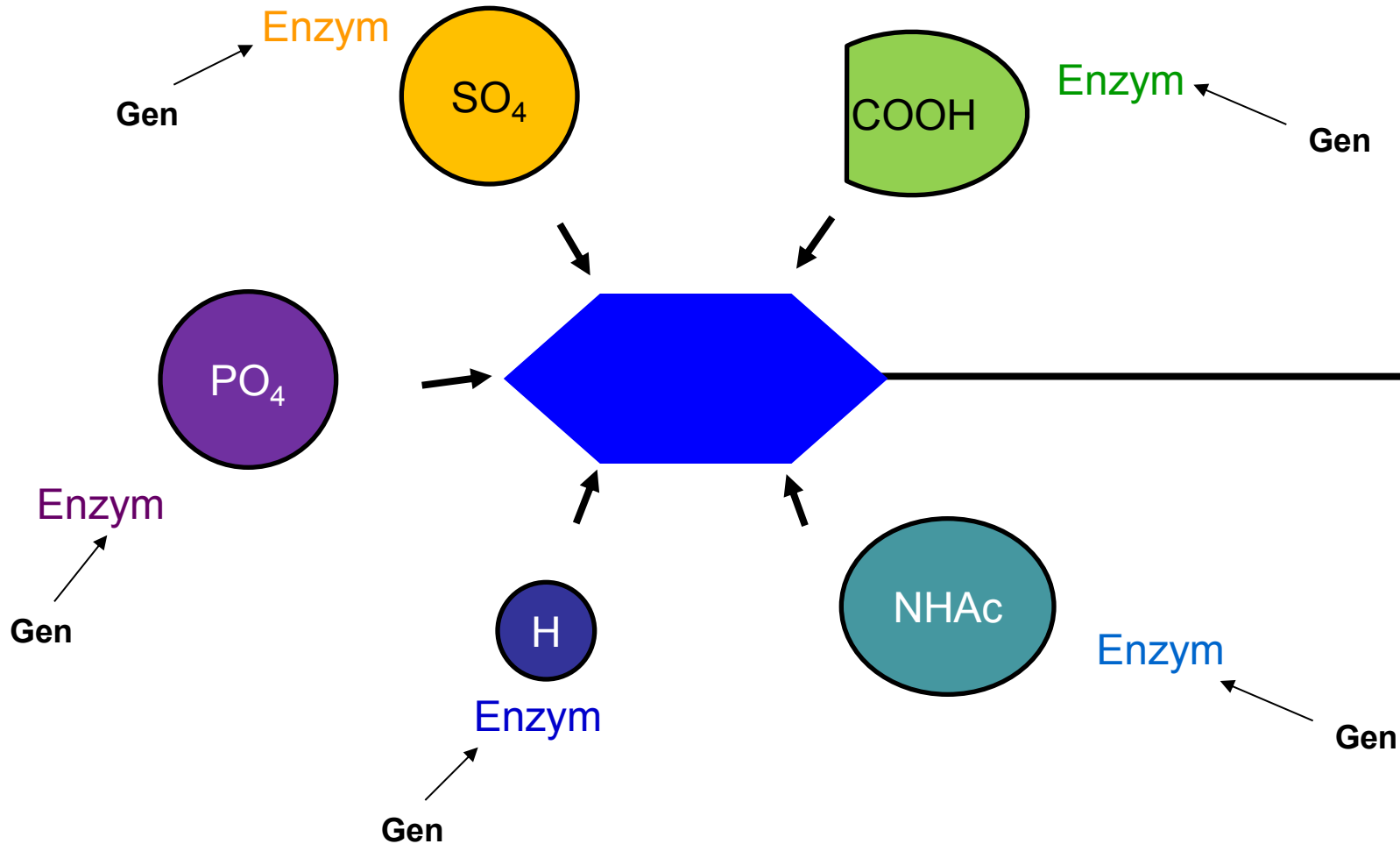
Gen

Protein

Enzymy = glykosyltransferasy,
syntéza aktivovaných cukrů,
modifikace glykanů, glykosidasy

Nutná účast transportních proteinů!

Struktura glykanů je v genomu
kódována nepřímou



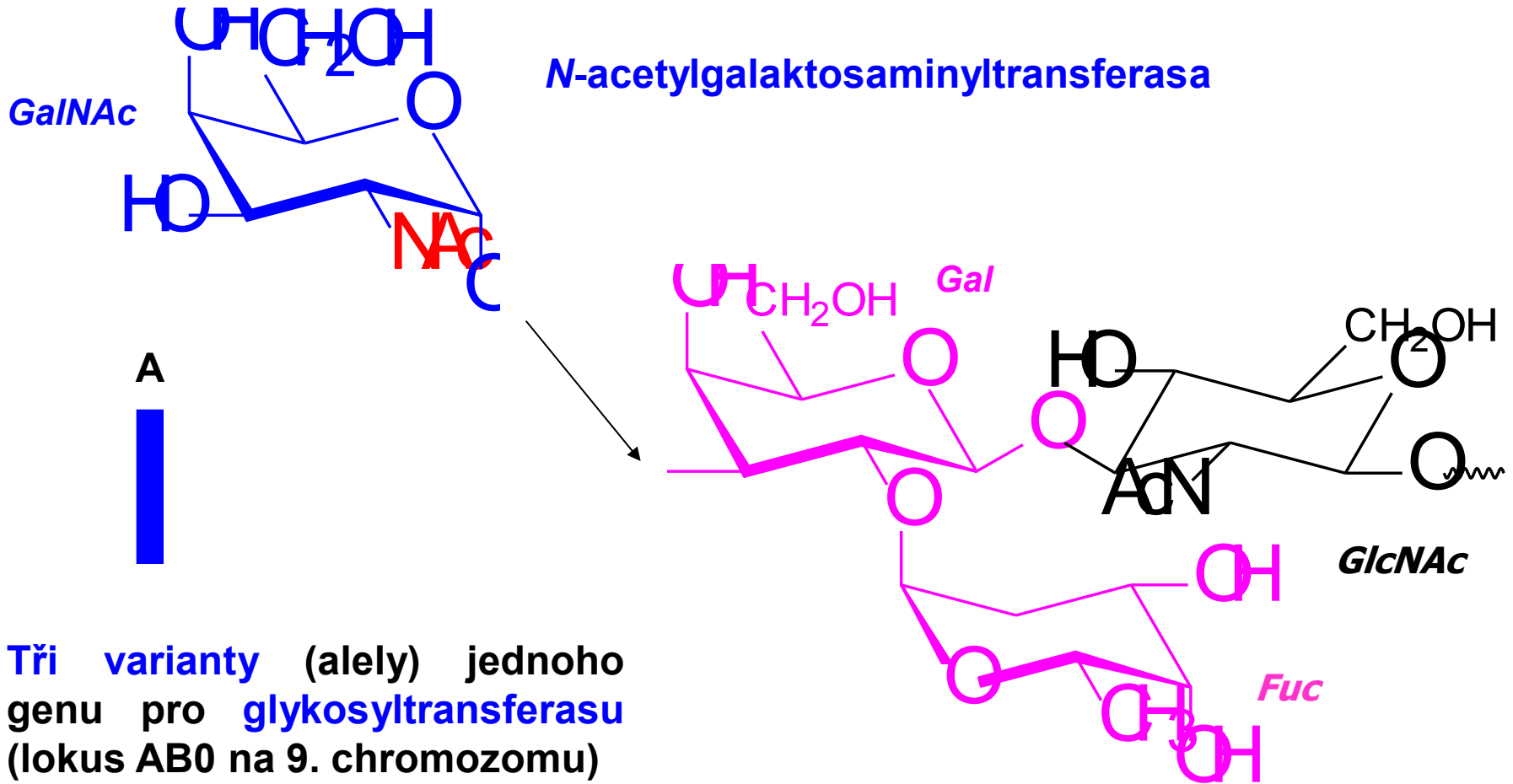
JAK JE STRUKTURA GLYKOPROTEINŮ ZAKÓDOVÁNA V GENOMU?



Edvard Munch... Křik. Prapůvodní inspirace pro

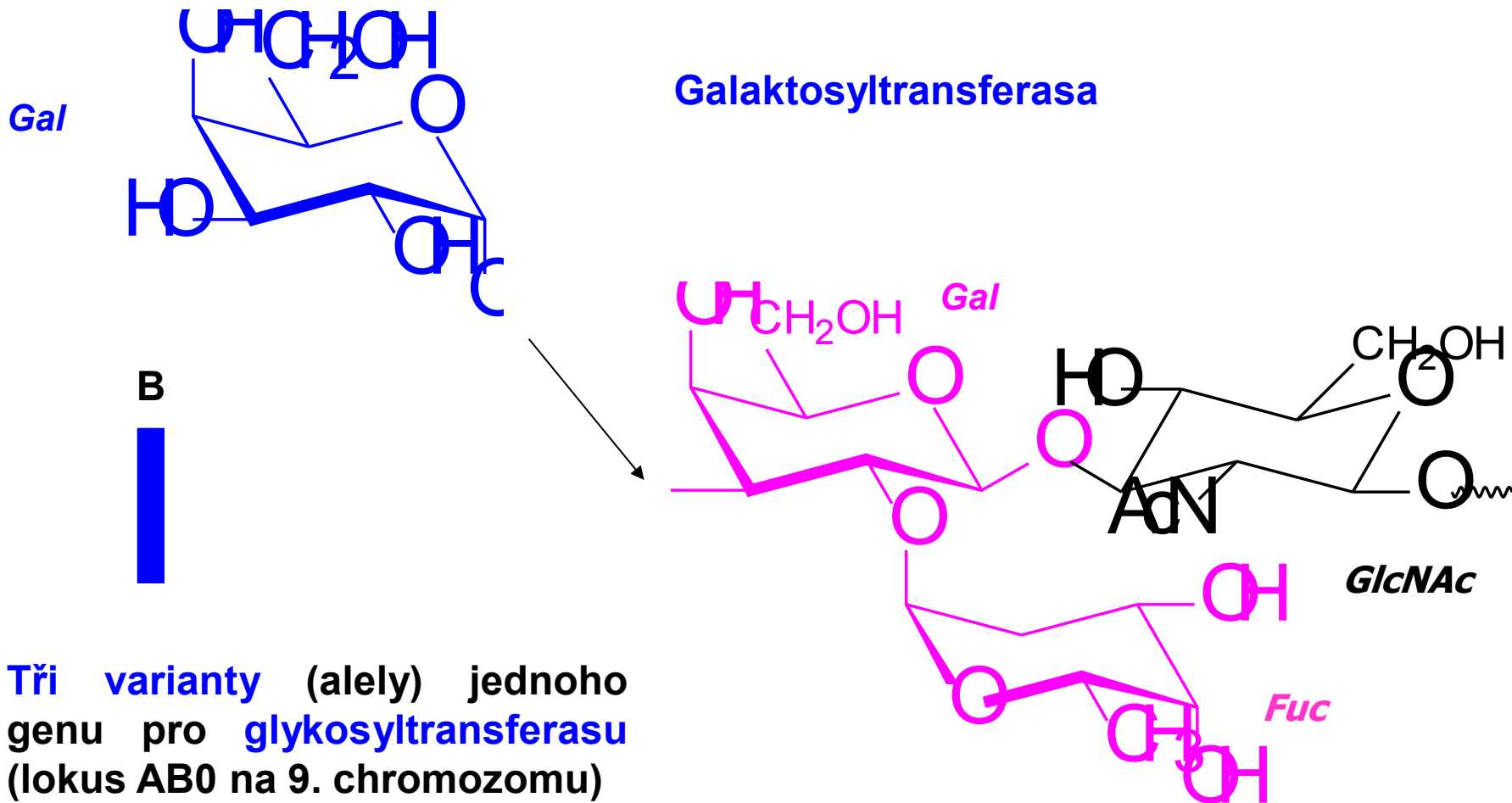


DĚDIČNOST KREVNÍCH SKUPIN



H antigen

DĚDIČNOST KREVNÍCH SKUPIN

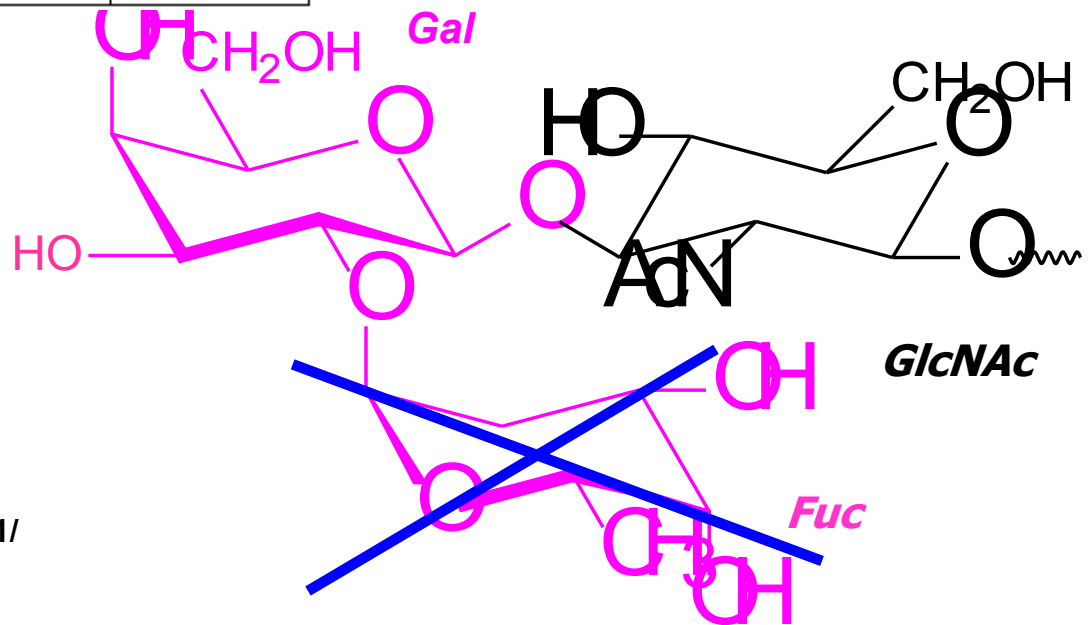
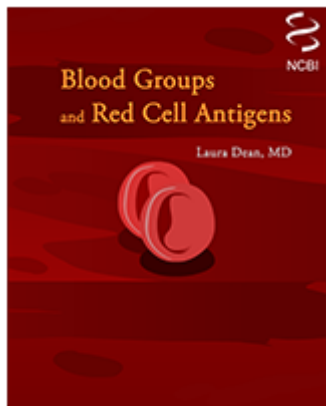


H antigen

DĚDIČNOST KREVNÍCH SKUPIN

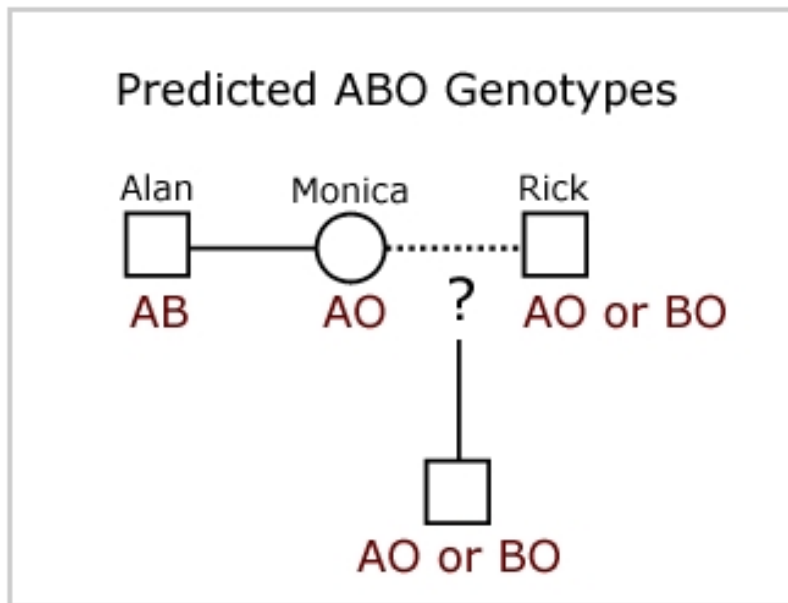
ABO genotype in the offspring		ABO alleles inherited from the mother		
		A	B	O
ABO alleles inherited from the father	A	A	AB	A
	B	AB	B	B
	O	A	B	O

Bombajský fenotyp. Jedinci tvoří protilátky anti A, anti B i **anti H** (0). Jelikož se jejich krev ve standardních testech „tváří“ jako 0, je to problém...



DĚDIČNOST KREVNÍCH SKUPIN

In the show "General Hospital", the father of Monica's child was in doubt. Monica had blood type A (genotype AO) and her child had blood type O (genotype OO). Because the child must inherit an O allele from the father, the father could have the genotype AO, BO, or OO. In other words, the child's father could have blood group A or B or O, which rules out Monica's husband Alan (type AB) and implicates Rick (type O).

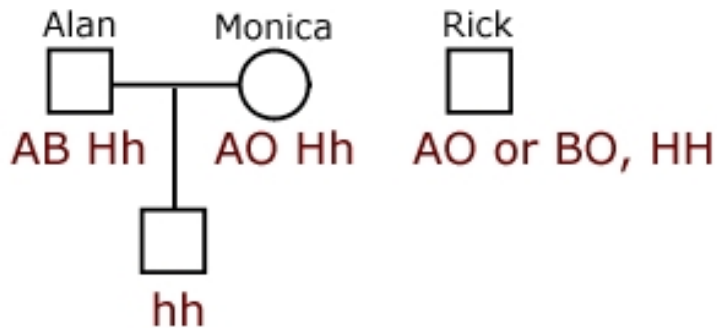


Monika má krevní skupinu **A**,
Alan má krevní skupinu **AB**.
Dítě má **O**. Podvedla Monika
Alana s Rickem???

DĚDIČNOST KREVNÍCH SKUPIN

However, Alan is the father! This is possible because both he and Monica are carriers of incomplete H deficiency (H/h). Their h/h child is unable to produce any ABO blood group antigens and so despite inheriting the A or B allele from Alan, the child's RBC's lack the A and B antigens as in blood type O.

Actual ABO and Hh Genotypes



Alan je tatínek! Ale možná je příbuzný s Monikou...Vhodný námět pro další díl.

CHCETE VĚDĚT VÍC?

Glycoconj J (2013) 30:41–50
DOI 10.1007/s10719-012-9397-y

Genomics and epigenomics of the human glycome

Vlatka Zokloš · Mislav Novokmet · Ivona Bečeheli ·
Gordan Lauc

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Abstract The majority of all proteins are glycosylated and glycans have numerous important structural, functional and regulatory roles in various physiological processes. While structure of the polypeptide part of a glycoprotein is defined by the sequence of nucleotides in the corresponding gene, structure of a glycan part results from dynamic interactions between hundreds of genes, their protein products and environmental factors. The composition of the glycome attached to an individual protein, or to a complex mixture of proteins, like human plasma, is stable within an individual, but very variable between individuals. This variability stems from numerous common genetic polymorphisms reflecting in changes in the complex biosynthetic pathway of glycans, but also from the interaction with the environment. Environment can affect glycan biosynthesis at the level of substrate availability, regulation of enzyme activity and/or hormonal signals, but also through gene-environment interactions. Epigenetics provides a molecular basis how the environment can modify phenotype of an individual. The epigenetic information (DNA methylation pattern and histone code) is especially vulnerable to environmental effects in the

early intrauterine and neo-natal common late-onset diseases take evidences showing the link glycosylation are accumulating, throughput glycomics, genomics first epidemiological and genome the glycome, which are presented

Keywords Glycosylation · Glyc association study · Epigenetics · interactions

Genetics of protein glycosylation

According to the central dogma of each protein is determined by its by the nucleotide sequence in. However, in the case of glycan there are several additional layers genes and the final glycan structure each glycan is therefore not encoded

Protein Glycosylation, an Overview

Elwira Lisowska, *Ludwik Hirszfeld Institute of Immunology and Experimental Therapy, Wroclaw, Poland*

Glycosylation is the most common posttranslational modification of proteins. It is a complex process involving many functional proteins and resulting in a great diversity of structures. Biological role of glycosylation and molecular and genetic basis of glycosylation disorders have recently been extensively explored. The goal of this short article is to signalize the variety of problems of this vast field of research.

Types of Glycosylation

Analysis of the SWISS-PROT database indicated that more than half of all proteins are glycosylated. There are various types of carbohydrate–protein linkage (Table 1), involving most known monosaccharides and functional groups of amino acid side chains. The protein-linked monosaccharides are usually extended (exceptions are GlcNAc β -Ser/Thr and Man α -Trp) by attachment of other monosaccharides that gives multiple oligosaccharide structures.

The most common protein-linked oligosaccharides are *N*-glycosidic chains (linked to Asn via GlcNAc β) which exist in two major forms: (1) oligomannosidic (or 'high-Man') *N*-glycans with branched or linear oligomannosidic chains attached to both α -mannose residues of the core structure shown in Table 1 and (2) complex chains containing 2–4 linear or branched antennae composed of one or more LacNAc (Gal β 1-4GlcNAc β) units and linked to α -mannose residues of the core structure. These antennae (and also β -mannose and Asn-linked GlcNAc) are ideas

Introductory article

Article Contents

- Types of Glycosylation
- Multiple Proteins Involved in Glycosylation Process
- Biological Role of Glycosylation
- Protein Glycosylation and Disease

Online posting date: 30th April 2008

linked to Gal or/and GalNAc, or by more complex core2 *O*-glycans containing LacNAc-type chains. Generally, the structures (or arrays of structures) of protein-linked glycans are determined by the type of carbohydrate–protein linkage. However, the LacNAc-type chains present in *N*- and *O*-glycans can carry the same terminal nonreducing units, e.g. blood group ABH/Lewis (Le) antigens. See also: [Blood Groups: Molecular Genetic Basis](#)

In addition to other types of carbohydrate–protein linkage listed in Table 1, carbohydrates can be linked to proteins via phosphoester linkage. A distinct form of protein-linked oligosaccharides is a glycosylphosphatidylinositol (GPI, linked to the *C*-terminal group of the protein) which anchors some proteins in the cell membrane lipid bilayer.

The diverse glycan structures can be found in GlycosuiteDB (see <http://www.glycosuite.com>). This database contains 3238 unique glycan structures (Release 8.0, August 2005), and if known, the proteins to which the glycans are attached are described.