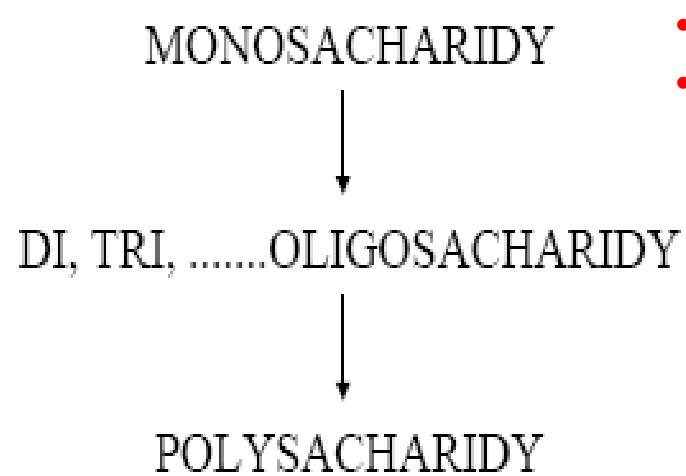


# SACHARIDY

Sacharidy - *saccharum* - *cukr*

**Synonyma** : cukry - glycidy - uhlohydráty *carbohydrates* -  $(\text{CH}_2\text{O})_n$

**Funkce** - zdroj energie      **glukosa**  
zásobní látky      **glykogen, škrob**  
stavební a podpůrná funkce      **celulosa, chitin**  
složky nukleotidů, koenzymů, glyko-proteinů, -lipidů  
prekurzory aminokyselin, lipidů  
antigenní determinanty buněk



- Fotosyntéza
- Glukoneogenese

**Monosacharidy :** → Nemohou být rozloženy na menší jednotky

chemicky - polyhydroxyaldehydy

- polyhydroxyketony

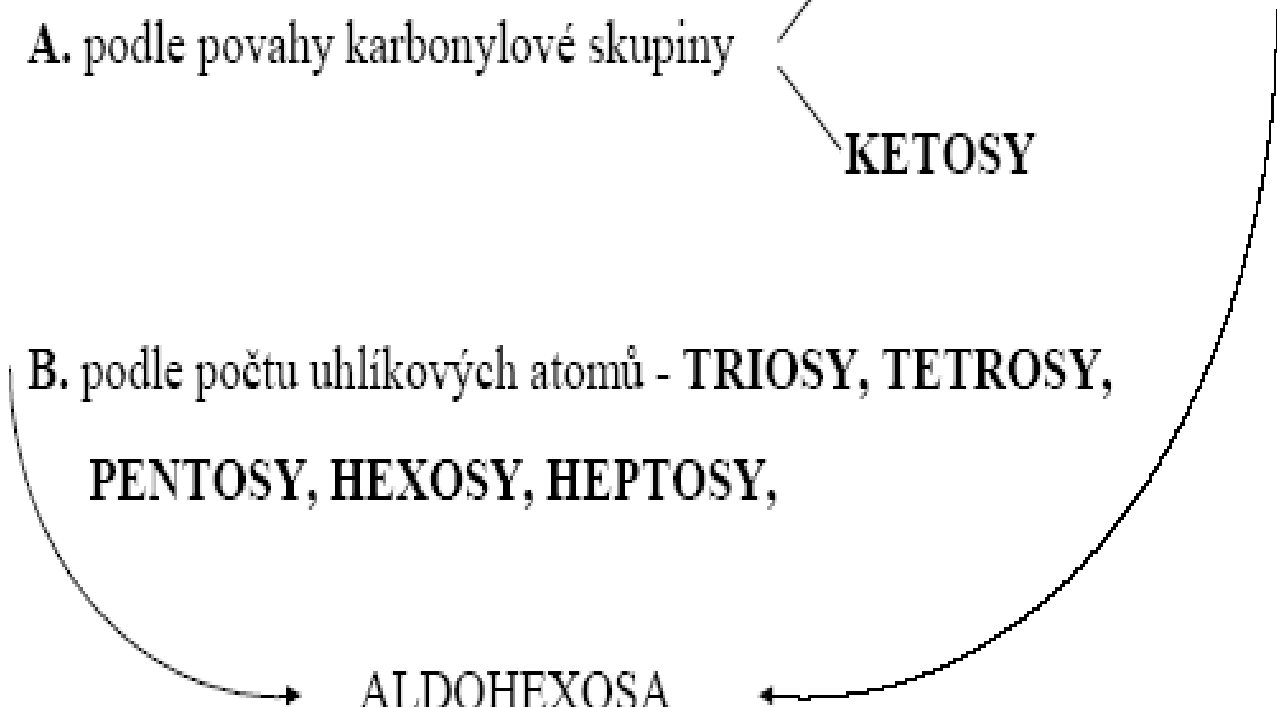
# Rozdělení

A. podle povahy karbonylové skupiny

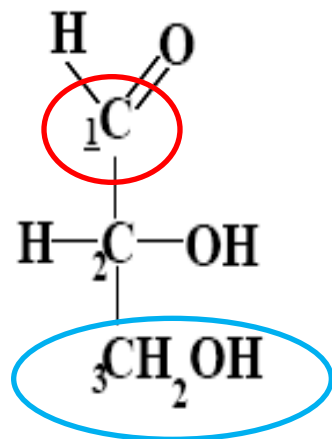
- ALDOSY
- KETOSY

B. podle počtu uhlíkových atomů - TRIOSY, TETROSY,  
PENTOSY, HEXOSY, HEPTOSY,

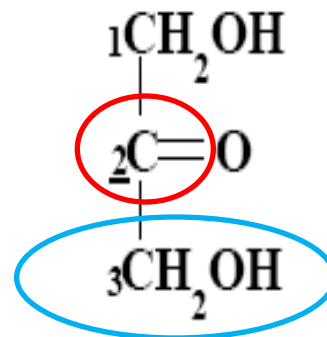
ALDOHEXOSA



## Číslování



D - glyceraldehyd



dihydroxyacetol

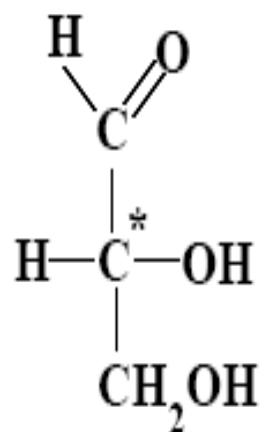
## PRIMÁRNÍ HYDROXYLOVÁ SKUPINA

Názvosloví : triviální

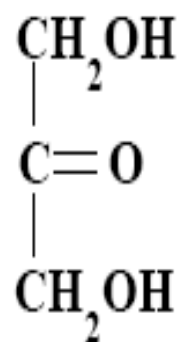
aldosa -OSA

ketosa -ULOSA





D - glyceraldehyd



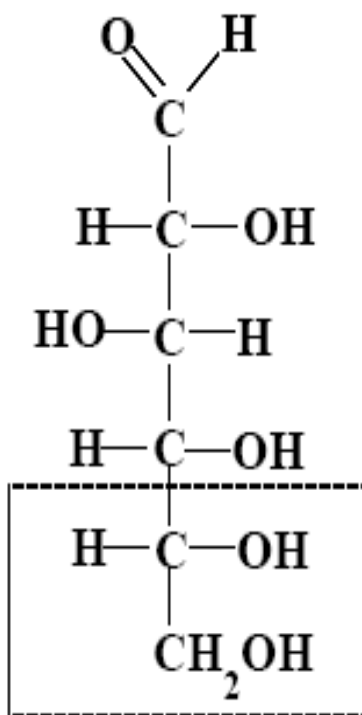
dihydroxyaceton

počet stereoizomerů =  $2^x$  (x = počet  $\text{C}^*$ )

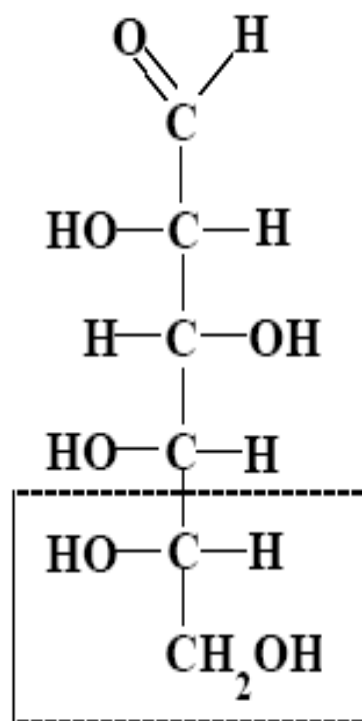
aldosy -  $x = n - 2$

ketosy -  $x = n - 3$

n = počet C atomů



D - glukosa



L - glukosa

# Aldosy

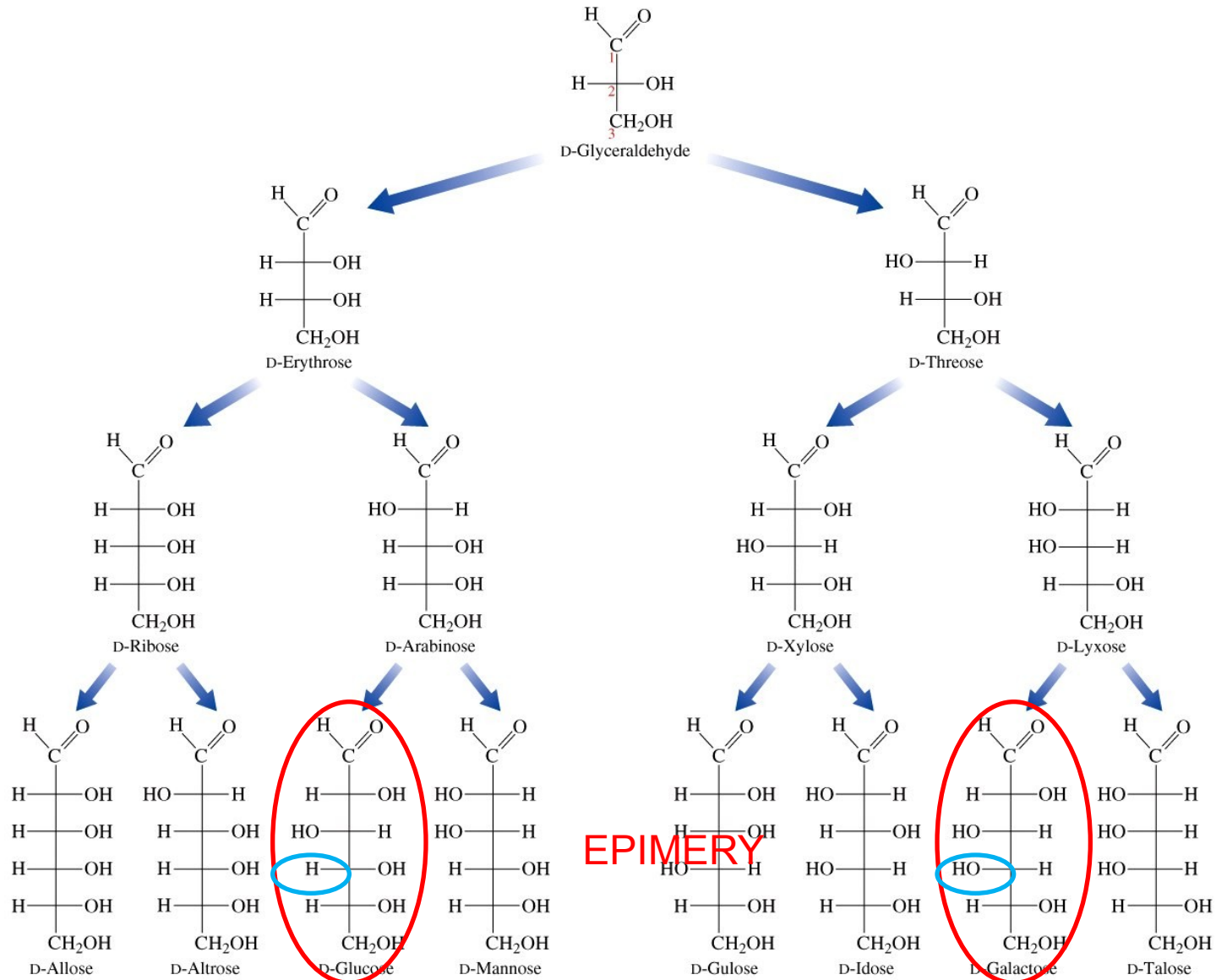


Figure 7-5 Concepts in Biochemistry, 3/e

# Ketose

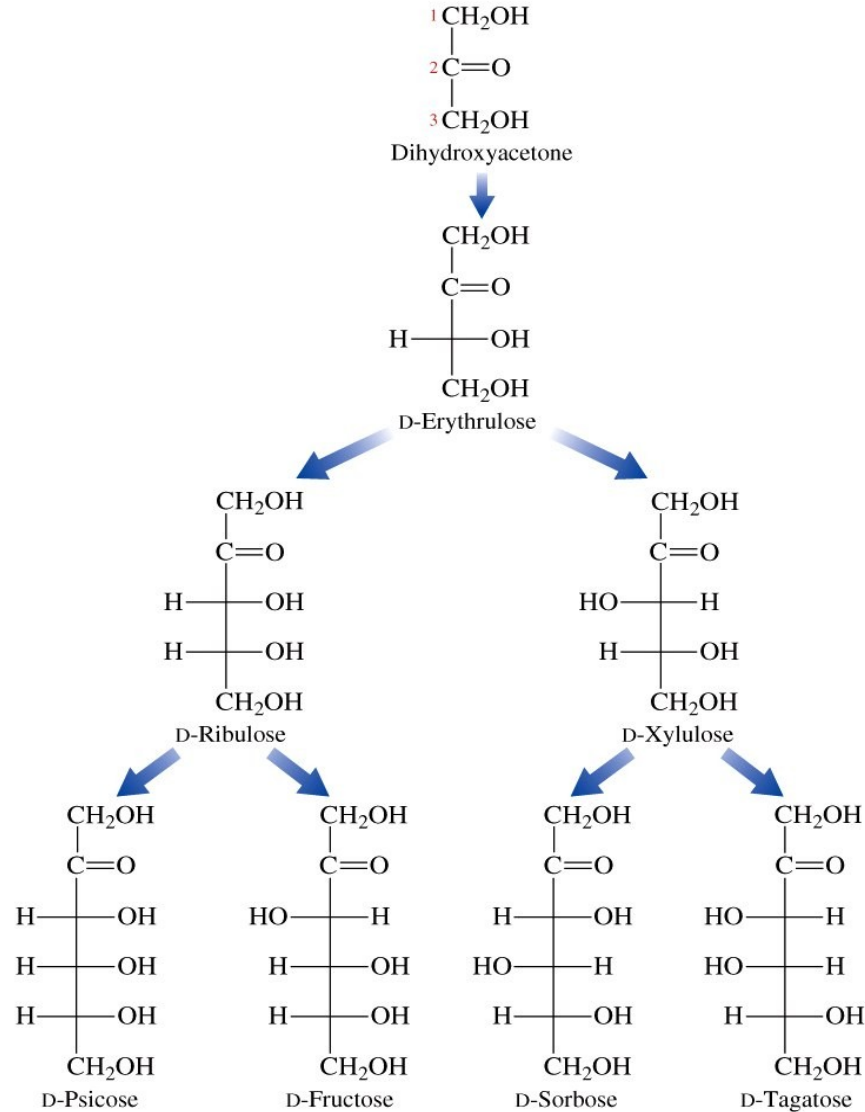
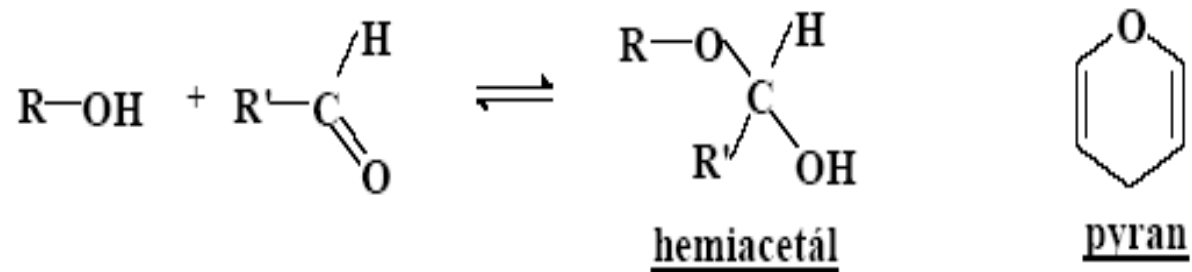
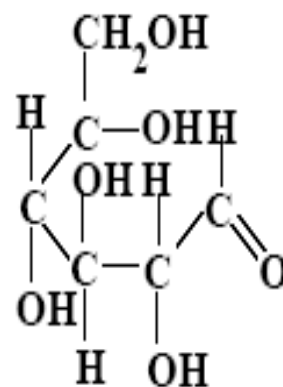
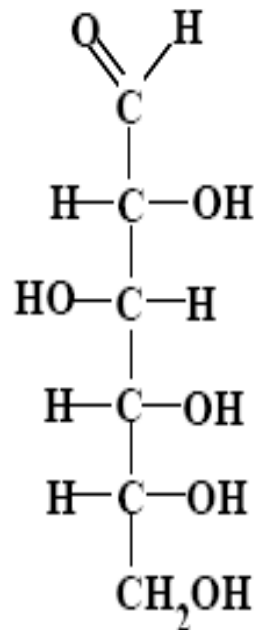


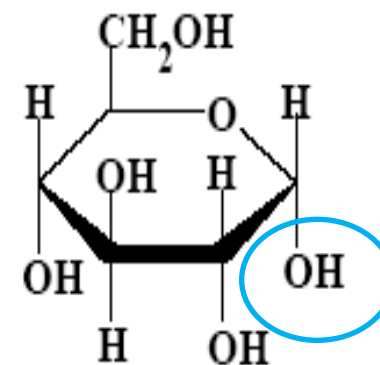
Figure 7-6a Concepts in Biochemistry, 3/e  
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*Fischerovy vzorce*

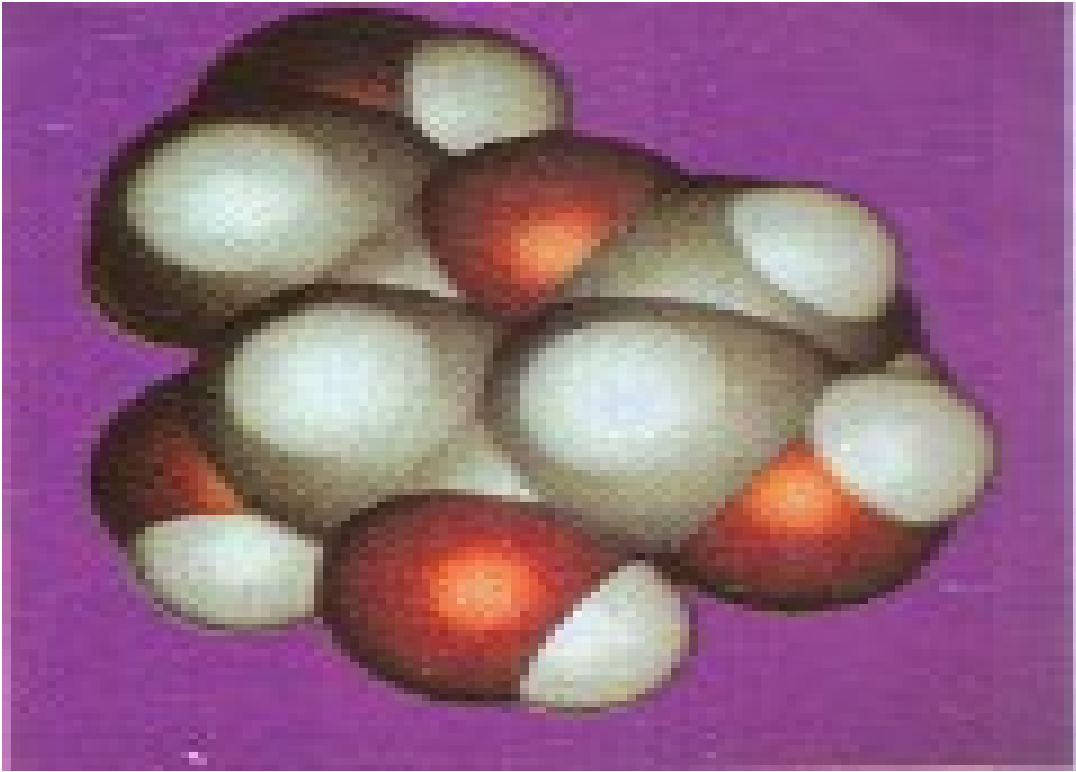


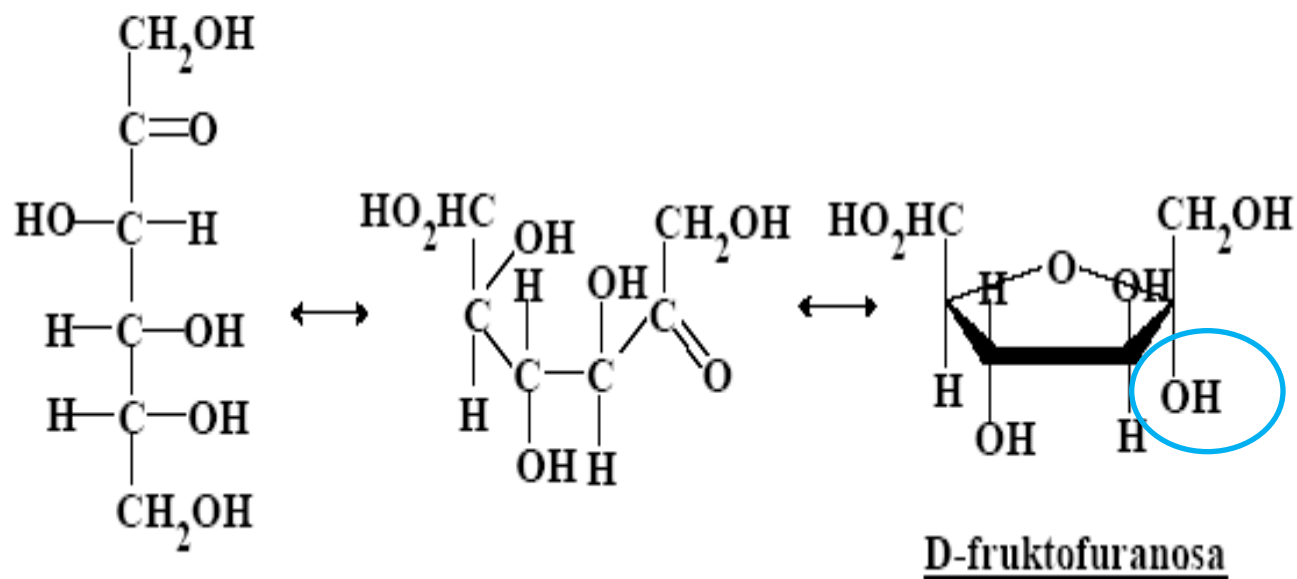
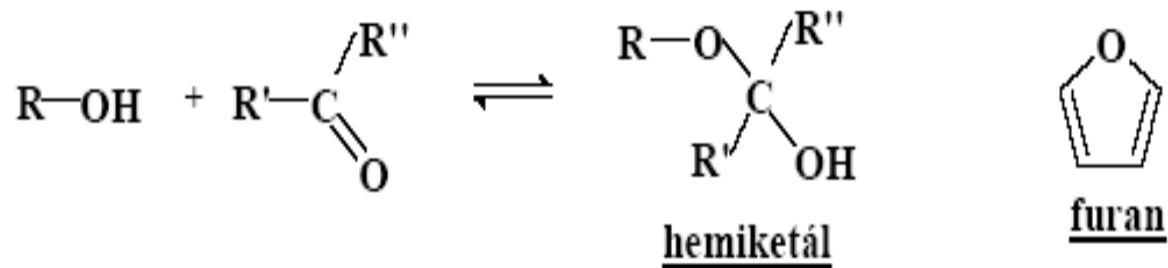
*Haworthovy vzorce*



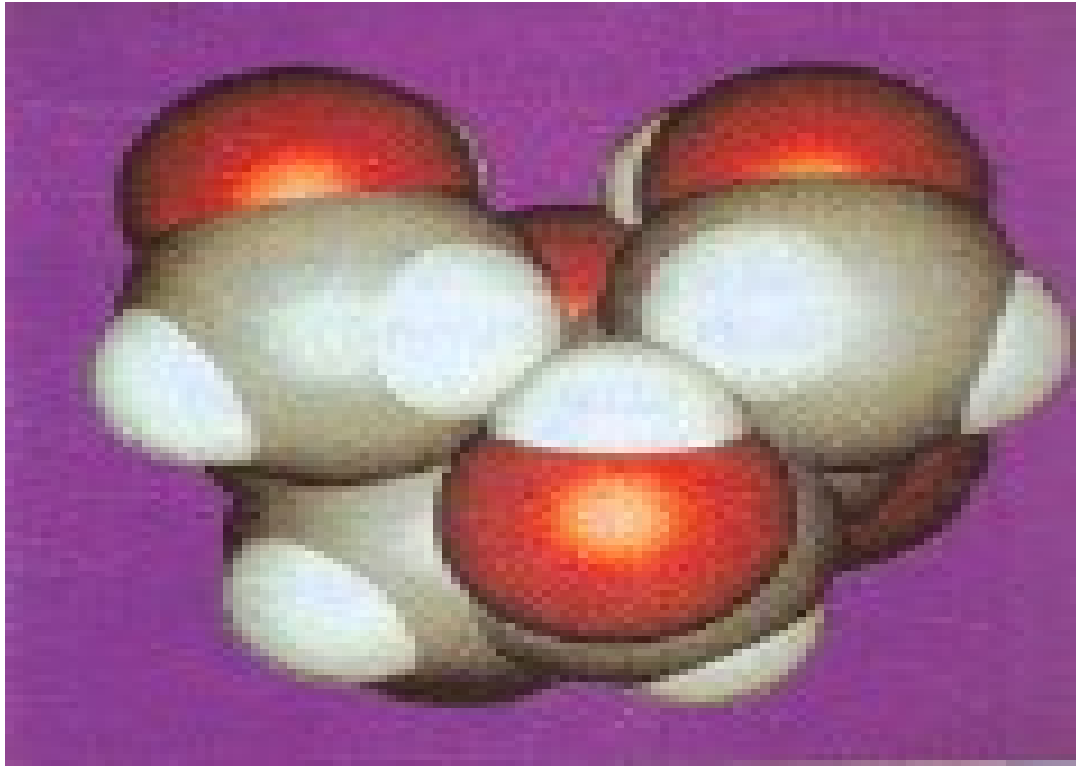
D-glukopyranosa

**POLOACETÁLOVÝ HYDROXYL**

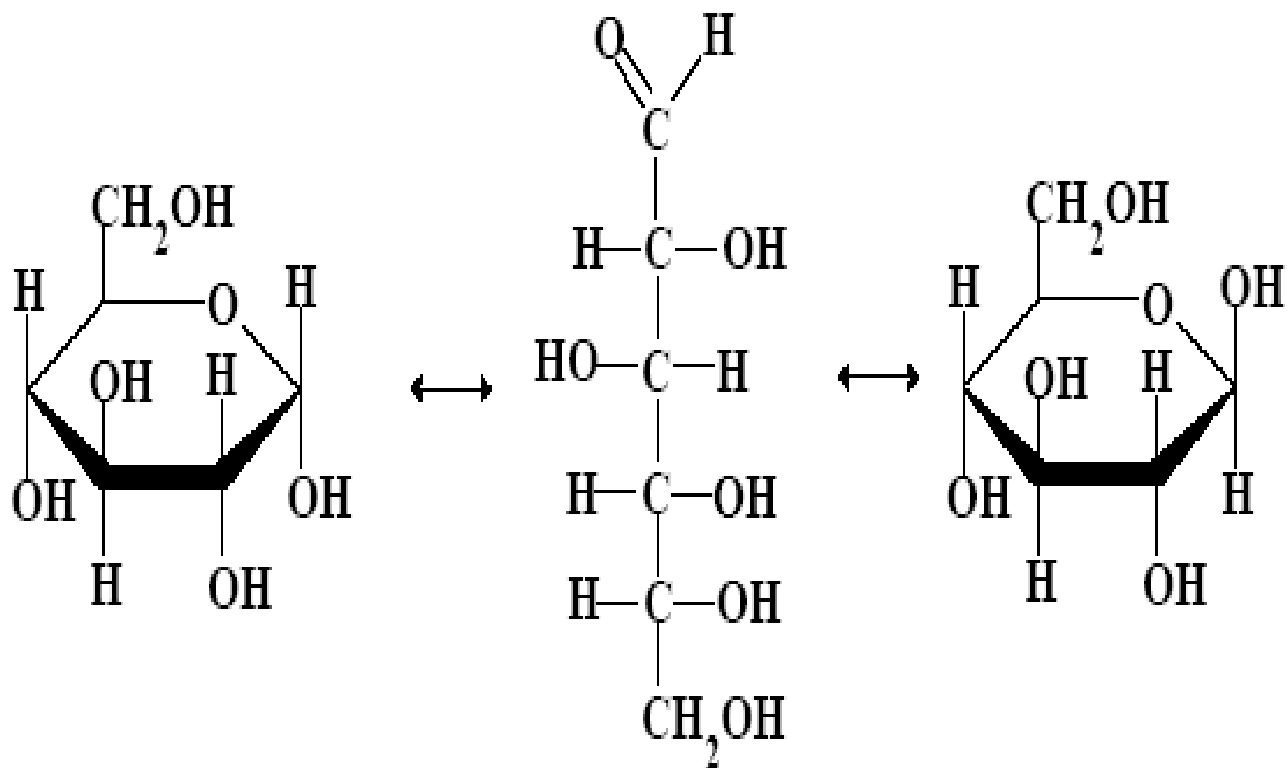




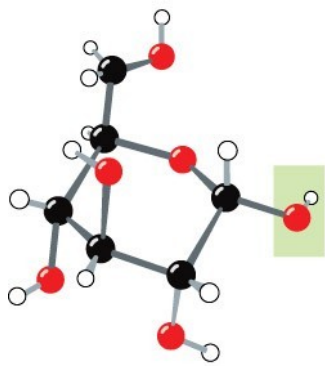
**POLOACETÁLOVÝ HYDROXYL**



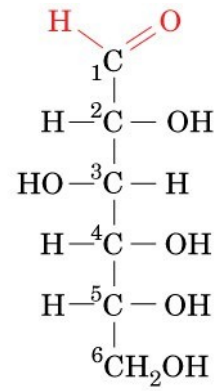
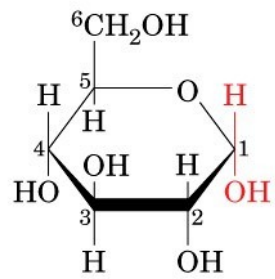




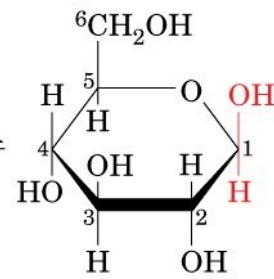
$\alpha$ -anomer (63 %)  $\longleftrightarrow$  MUTAROTACE  $\longleftrightarrow$   $\beta$ -anomer (36 %)



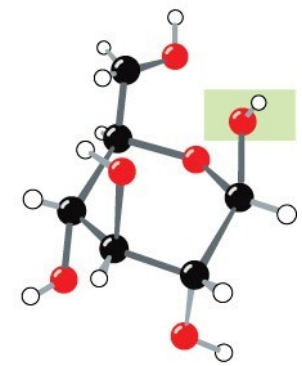
**$\alpha$ -D-Glucopyranose**

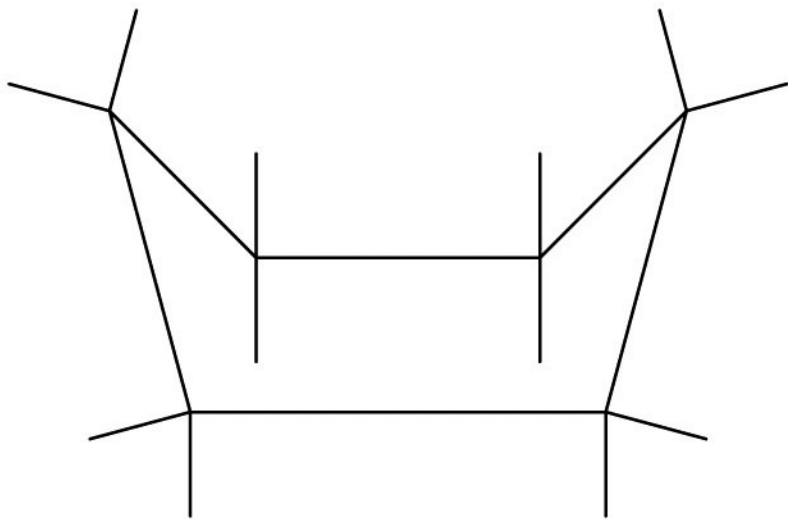


**D-Glucose  
(linear form)**

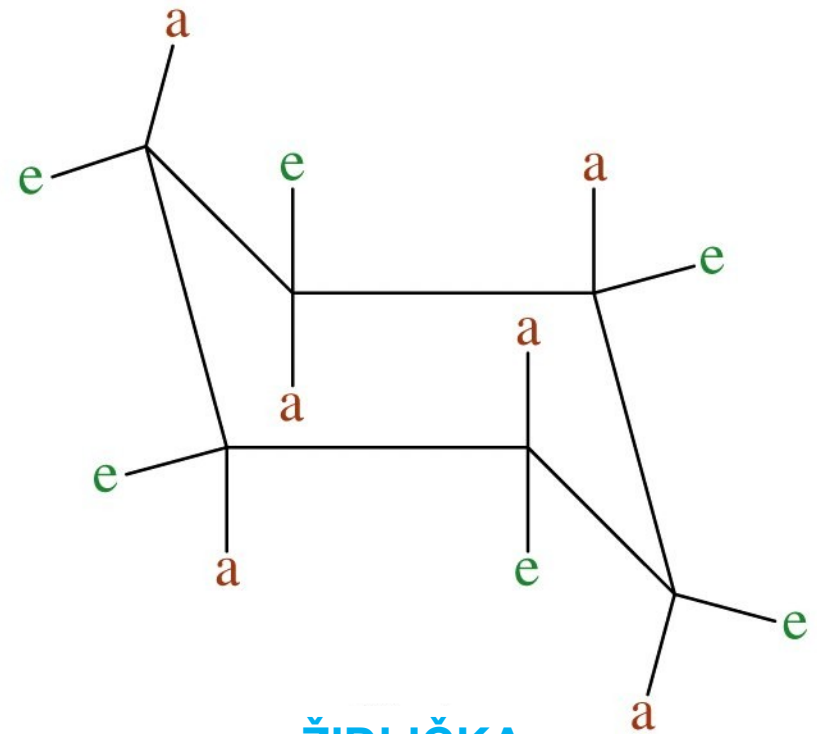


**$\beta$ -D-Glucopyranose**





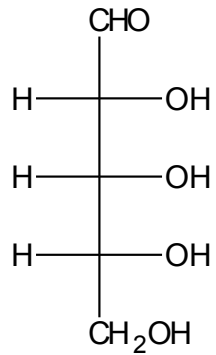
VANIČKA



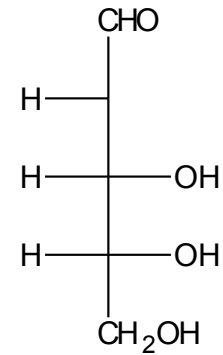
ŽIDLIČKA

Figure 7-10a Concepts in Biochemistry, 3/e  
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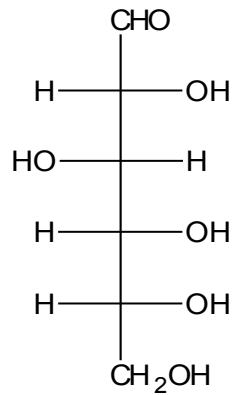
# ***Fischerova projekce:***



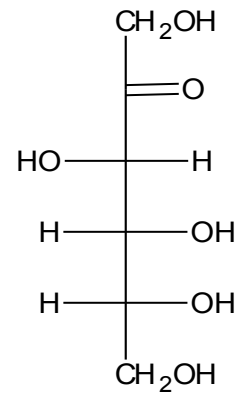
*D-ribose*



*2-deoxy-D-ribose*

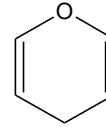
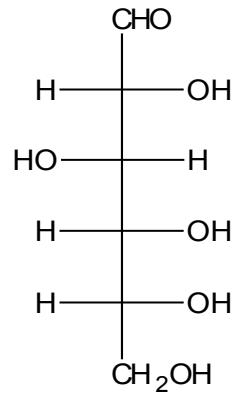


*D-glukosa*

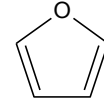


*D-fruktosa*

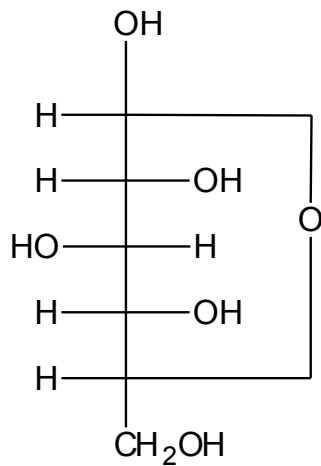
# Tollensovy vzorce *D*-glukosy:



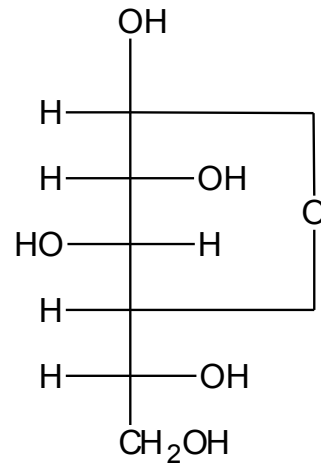
*Pyran*



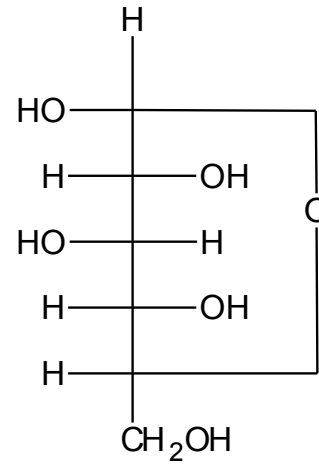
*Furan*



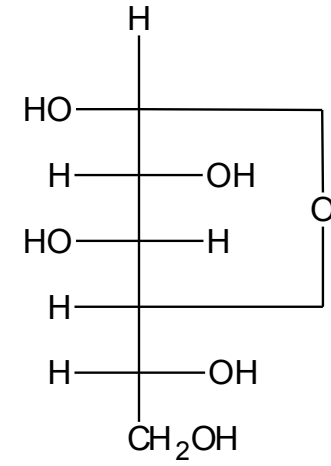
$\alpha$ -*D*-glukopyranosa



$\alpha$ -*D*-glukofuranosa

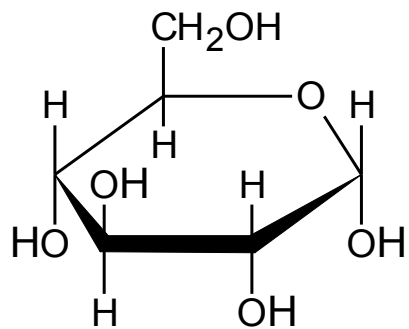
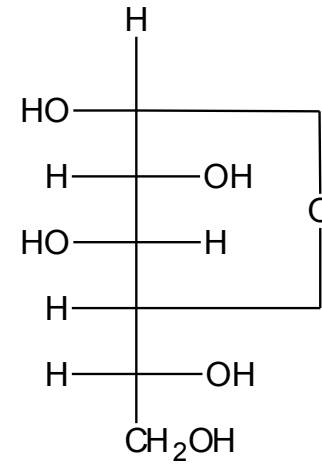
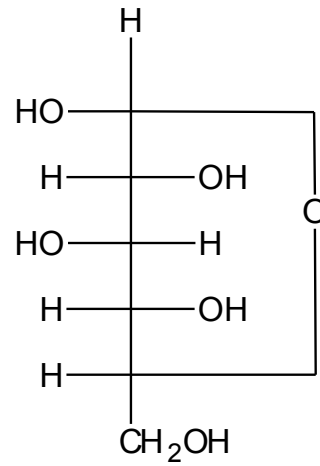
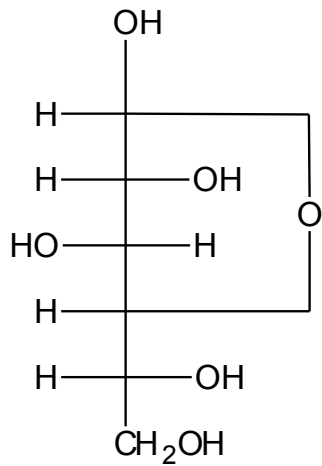
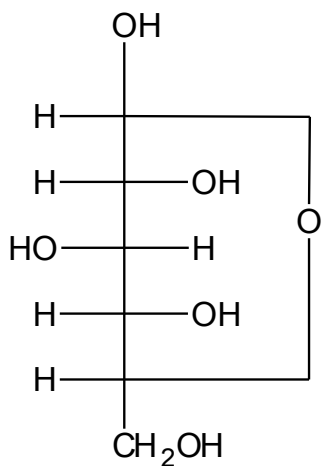


$\beta$ -*D*-glukopyranosa

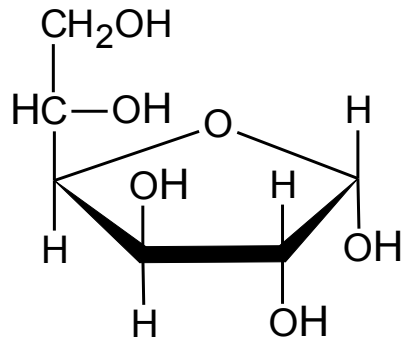


$\beta$ -*D*-glukofuranosa

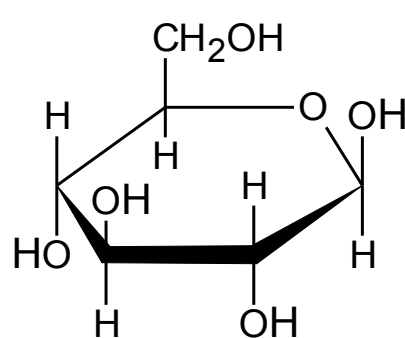
# Haworthovy vzorce *D*-glukosy:



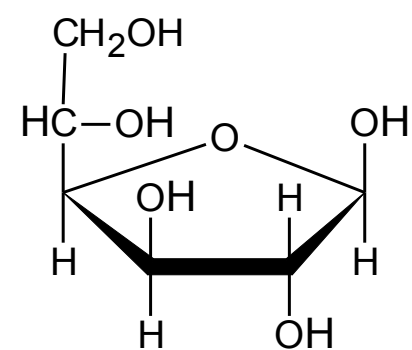
$\alpha$ -D-glukopyranosa



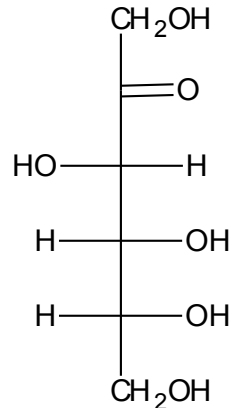
$\alpha$ -D-glukofuranosa



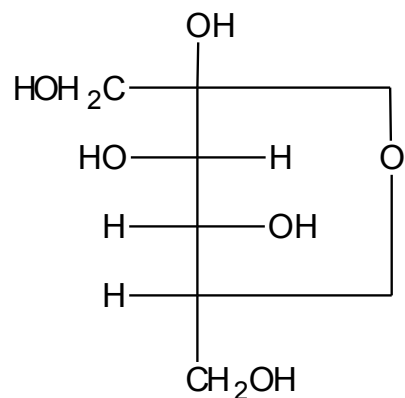
$\beta$ -D-glukopyranosa



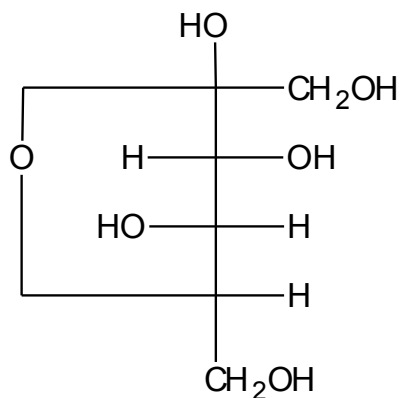
$\beta$ -D-glukofuranosa



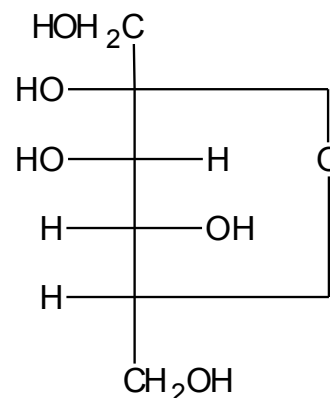
**Tollensovy vzorce fruktofuranosy:**



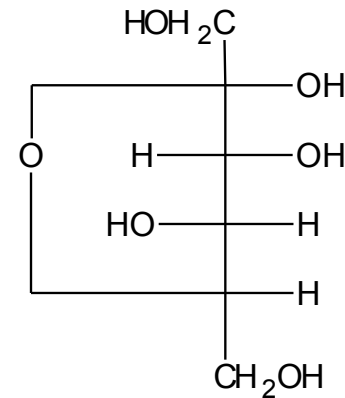
*$\alpha$ -D-fruktofuranosa*



*$\alpha$ -L-fruktofuranosa*

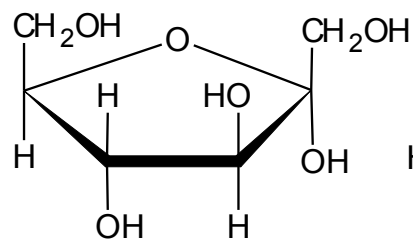


*$\beta$ -D-fruktofuranosa*

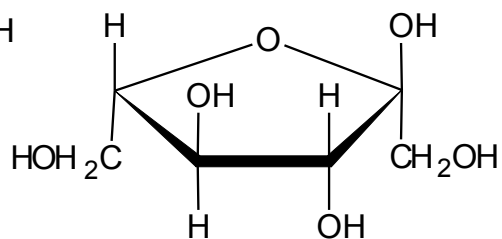


*$\beta$ -L-fruktofuranosa*

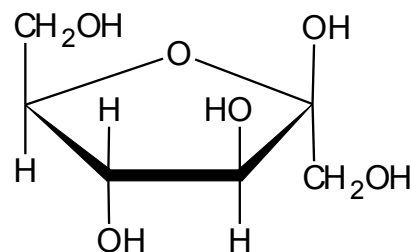
**Haworthovy vzorce fruktofuranosy:**



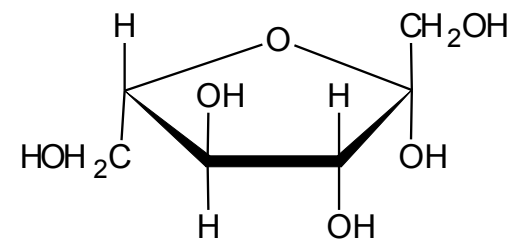
*$\alpha$ -D-fruktofuranosa*



*$\alpha$ -L-fruktofuranosa*



*$\beta$ -D-fruktofuranosa*



*$\beta$ -L-fruktofuranosa*

## Přehled

Triosy - glycerinaldehyd, dihydroxyaceton

Tetrosy - threosa, erythrosa

Pentosy - ribosa, deoxyribosa

Hexosy - glukosa, manosa, galaktosa

fruktosa

Heptosa - sedoheptulosa



# Aldosy

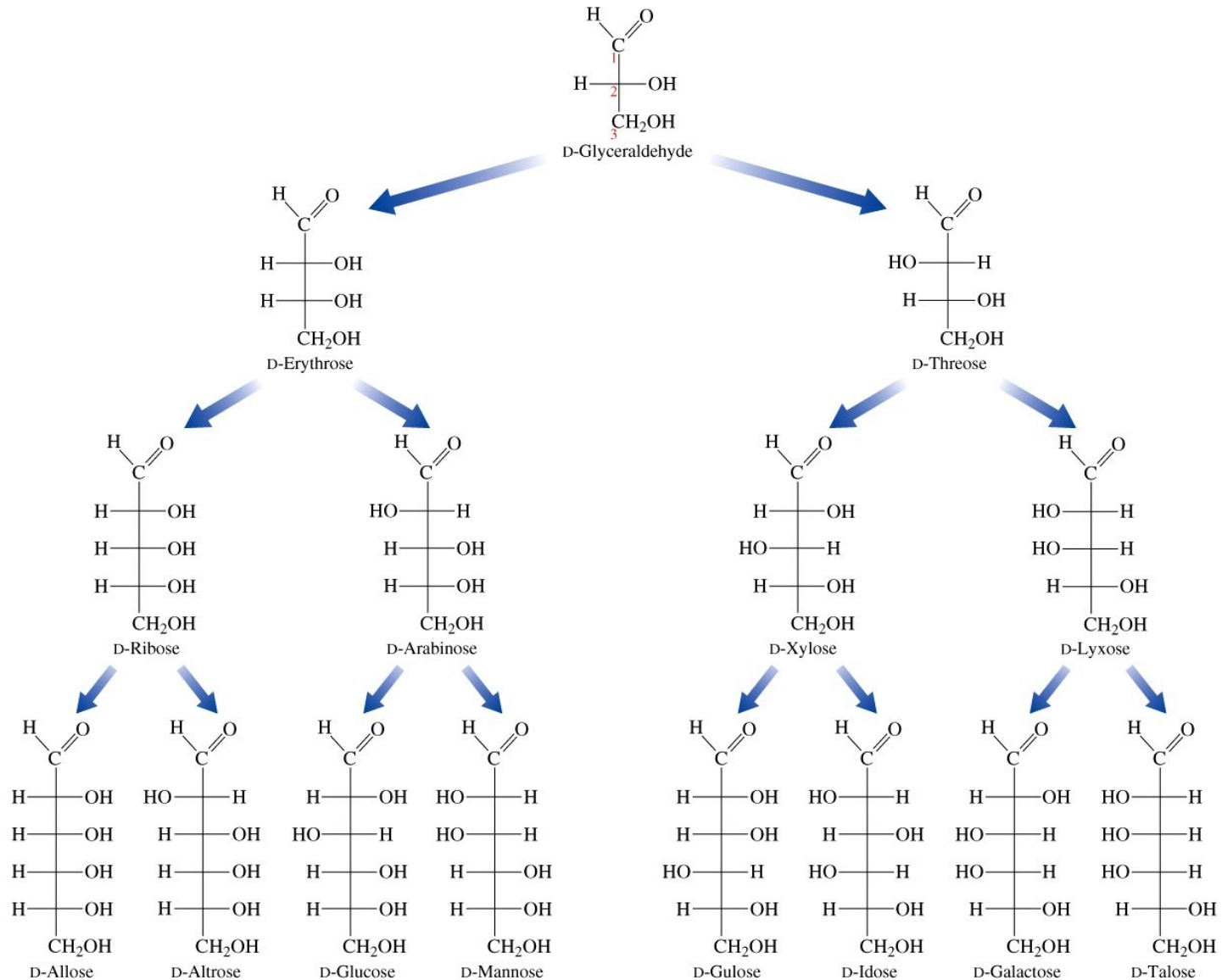


Figure 7-5 Concepts in Biochemistry, 3/e

# Ketose

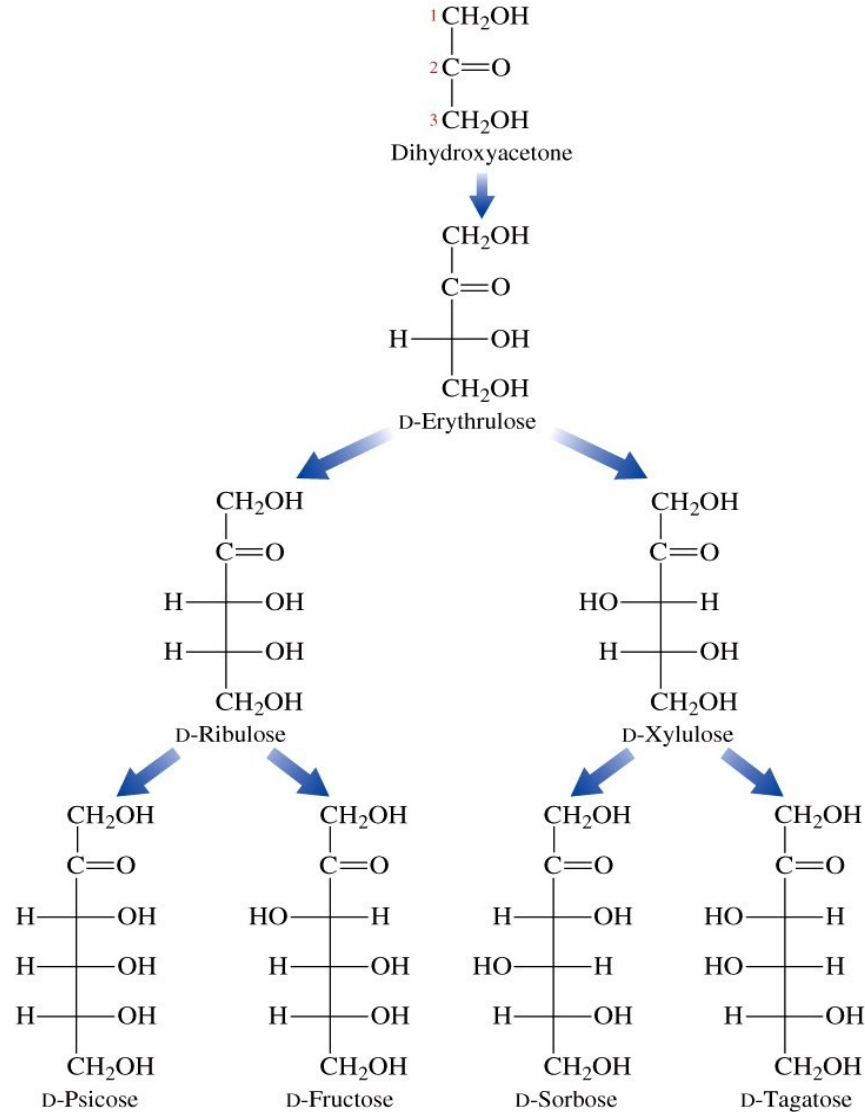
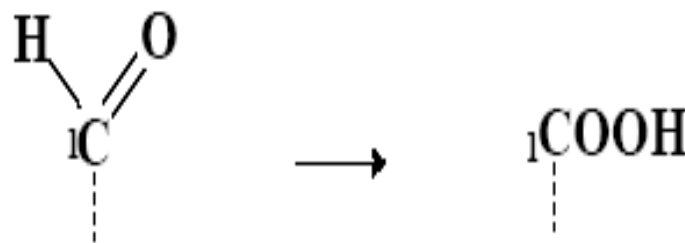


Figure 7-6a Concepts in Biochemistry, 3/e  
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## Deriváty monosacharidů

### Oxidace :

A. Mírná  $\Rightarrow$  aldehydická skupina  $\rightarrow$  karboxylovou skupinu



**ALDONOVÉ KYSELINY** - glukosa  $\rightarrow$  k. glukonová

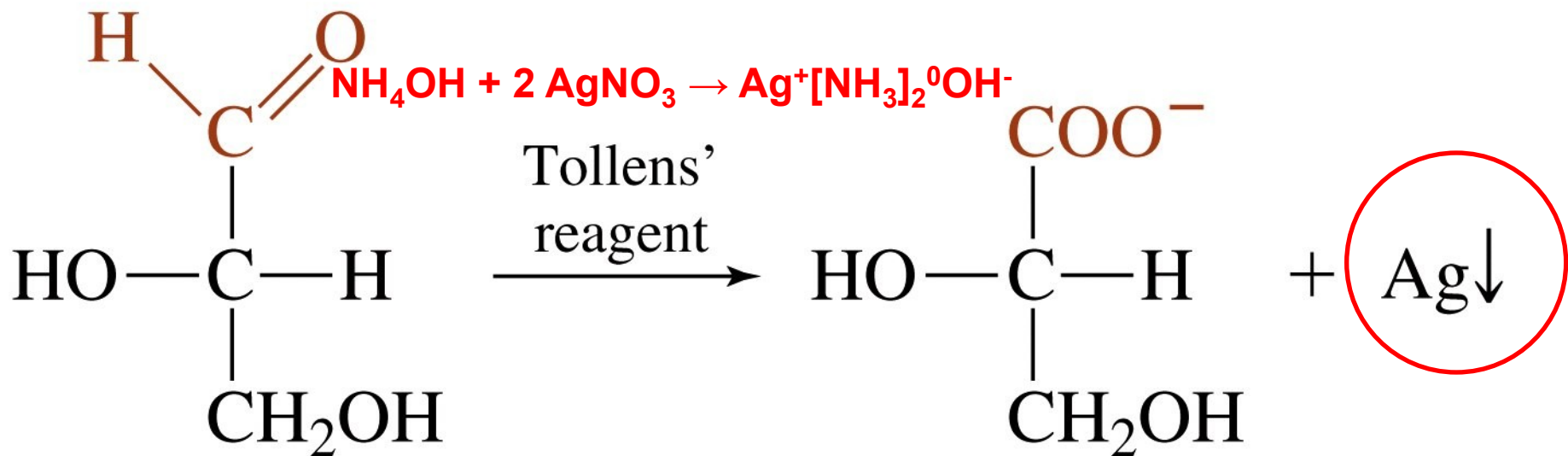


Figure 7-11a Concepts in Biochemistry, 3/e  
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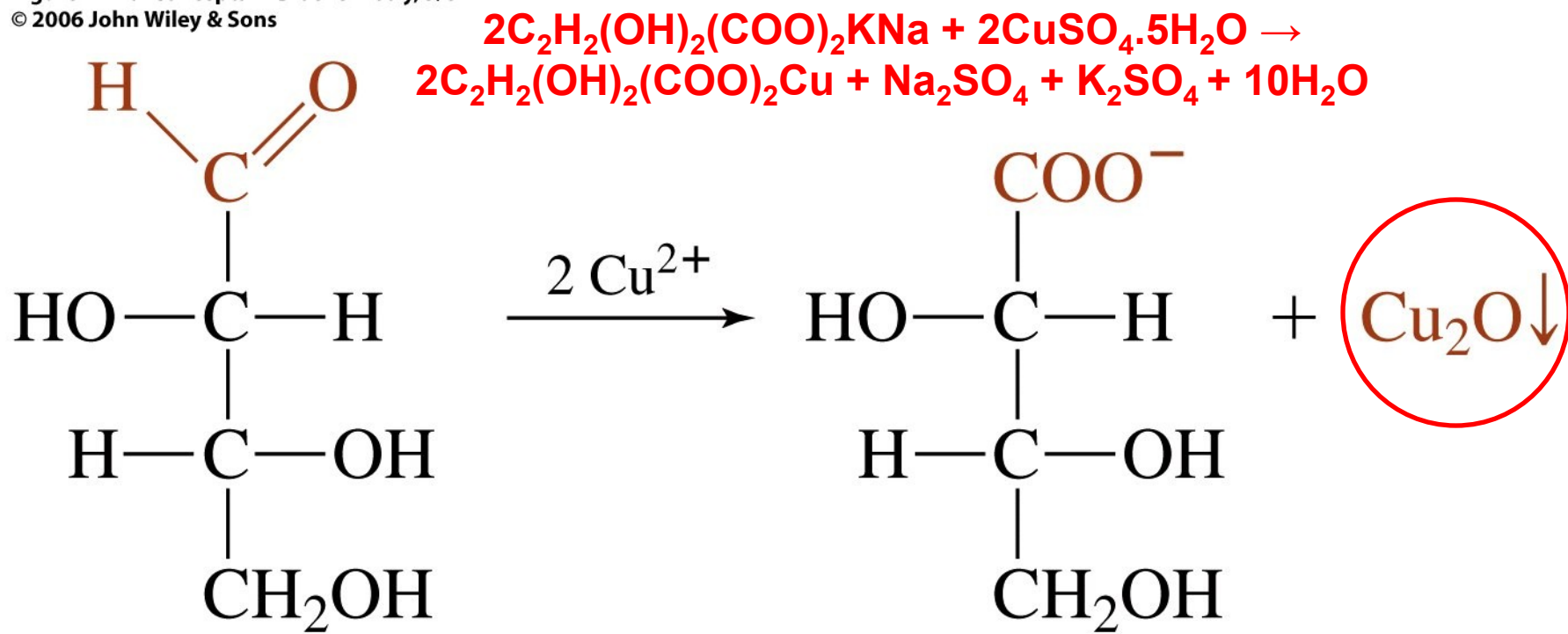


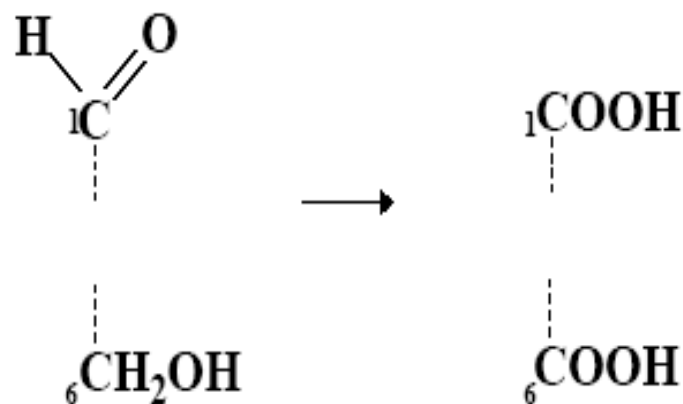
Figure 7-11b Concepts in Biochemistry, 3/e  
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B. Specifická  $\Rightarrow$  primární OH skupina  $\rightarrow$  karboxylovou skupinu



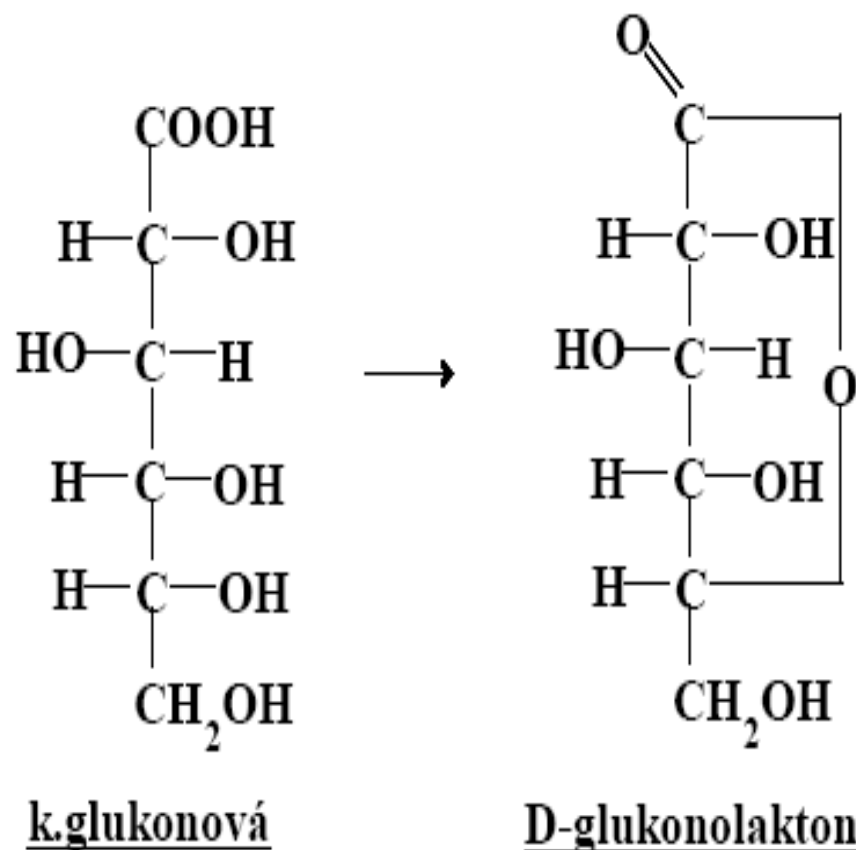
URONOVÉ KYSELINY - glukosa  $\rightarrow$  k. glukuronová

C. Silná  $\Rightarrow$  aldehydická skupina + primární OH skupina



ALDAROVÉ KYSELINY - glukosa  $\rightarrow$  k. glukarová

## Tvorba laktonů u aldonových a uronových kyselin



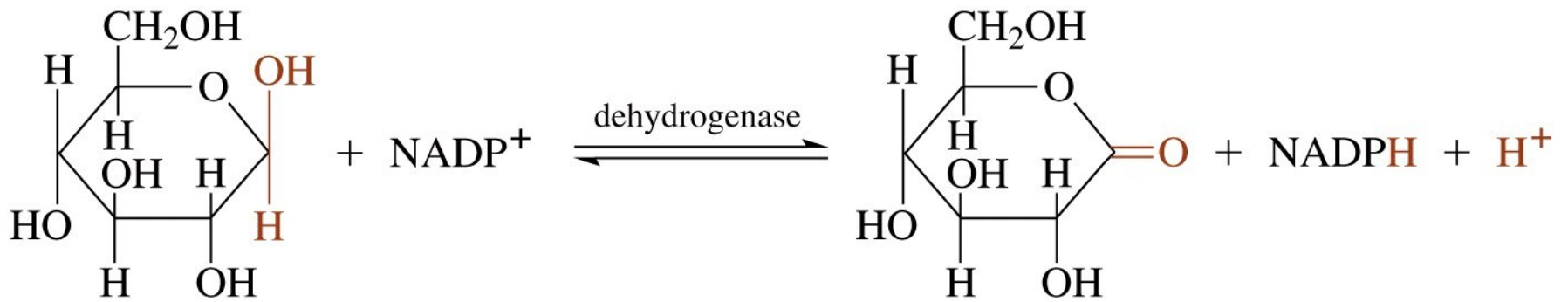
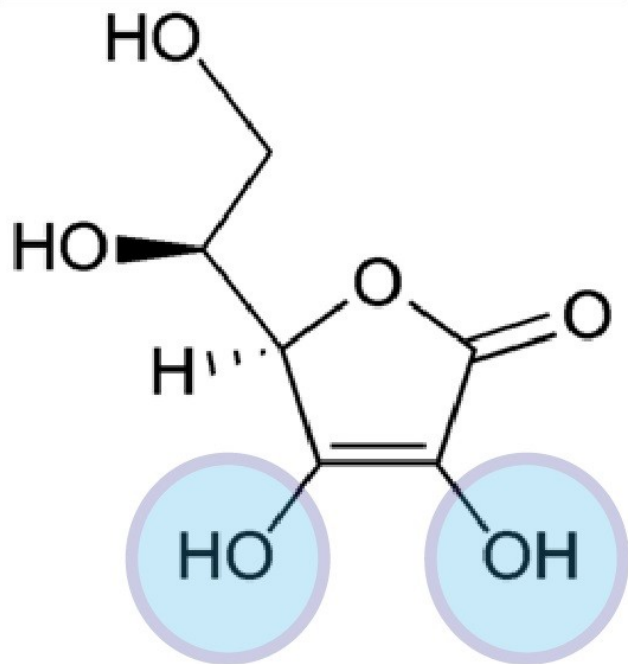
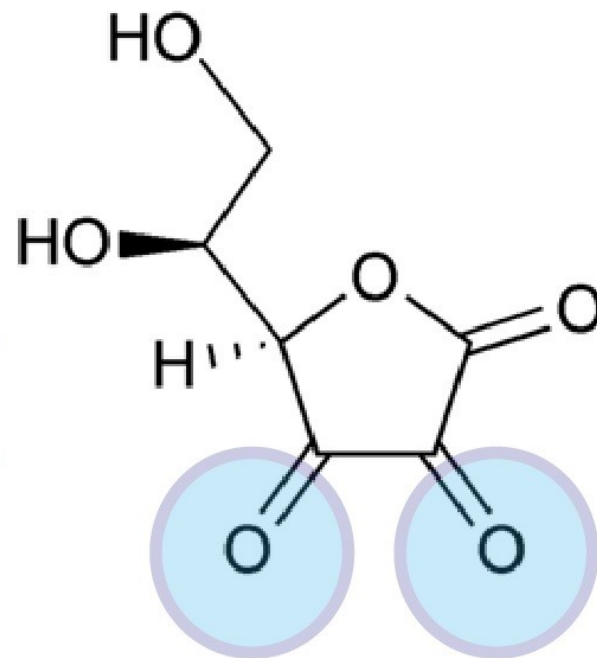
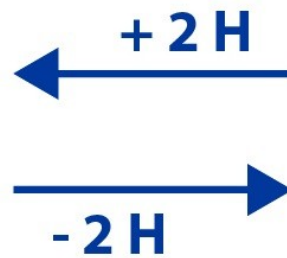


Figure 7-11c Concepts in Biochemistry, 3/e  
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**L-askorbová kyselina**



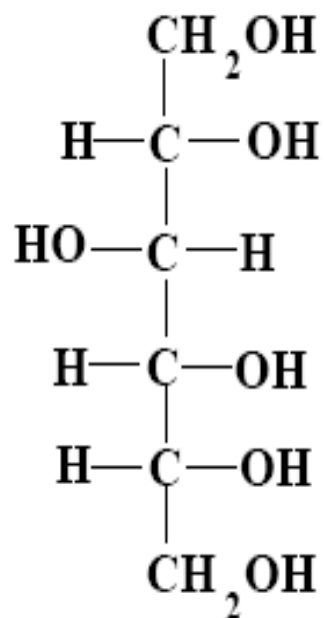
**L-dehydroaskorbová kyselina**



## Redukce :

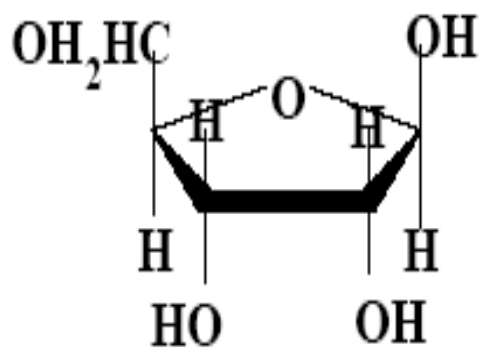
mírná  $\Rightarrow$  karbonylová skupina  $\rightarrow$  hydroxy skupinu

**POLYHYDROXYALKOHOLY - ALDITOLY -itol**

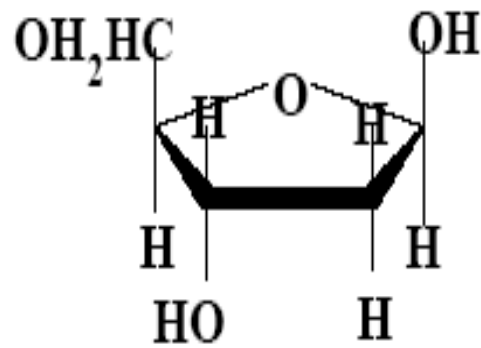


GLUCITOL - SORBITOL

Deoxycukry - OH skupina nahrazena H

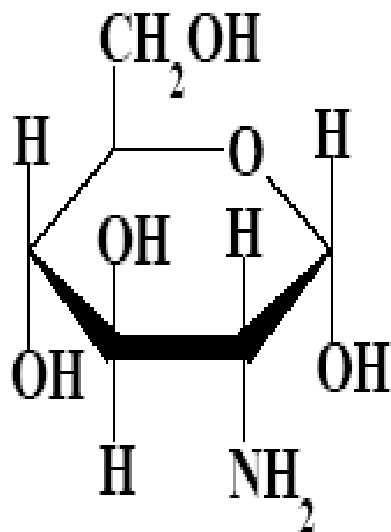


RIBOSA

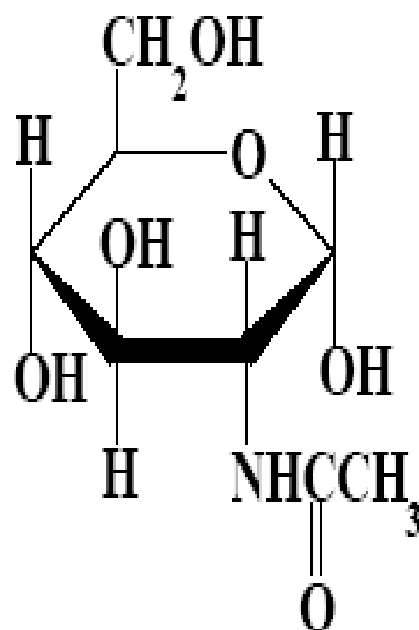


DEOXYRIBOSA

Aminocukry - OH skupina nahrazena NH<sub>2</sub> skupinou

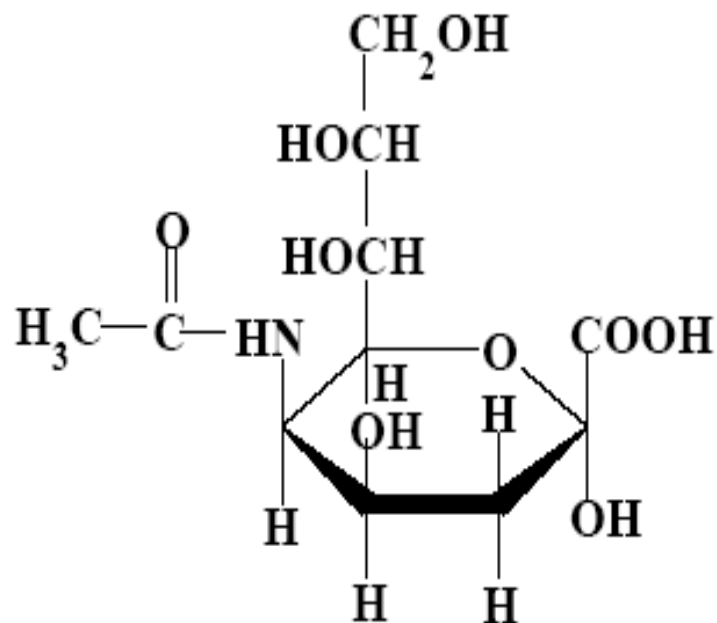


GLUKOSAMIN



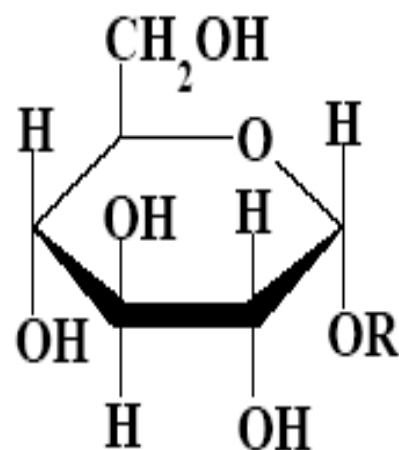
N-ACETYLGLUKOSAMIN

Sialové kyseliny - kondenzace N-acetylmanosaminu + pyruvátu



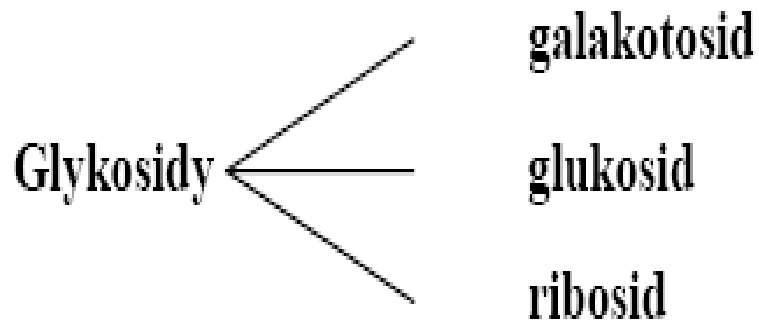
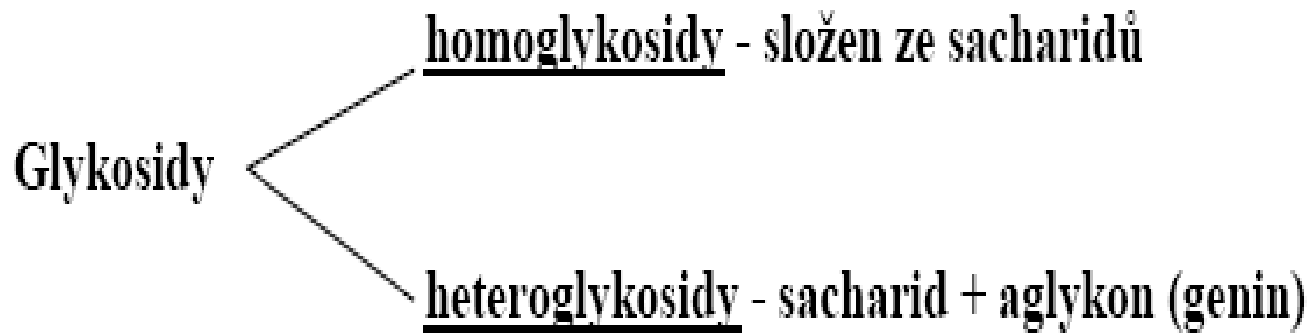
K. SIALOVÁ

Glykosidy :



O-glukosid

glykosidická vazba - OR, SR, NR - specificky štěpí glykosidasy



## Disacharidy :

A. Neredukující - trehalosový typ - yl - id

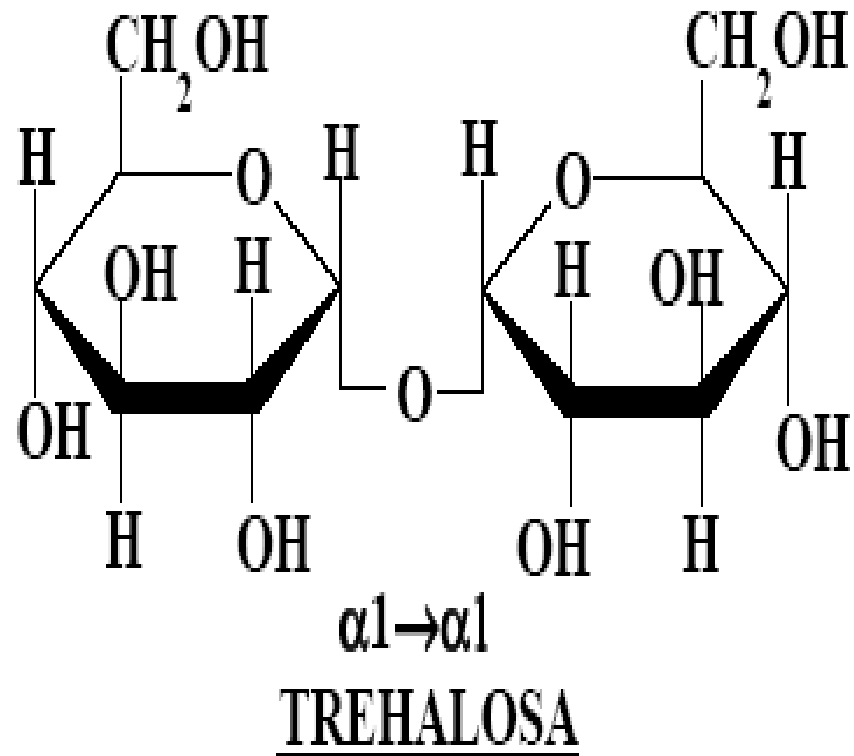
O -  $\alpha$  - D - glukopyranosyl (1 $\rightarrow$ 1) -  $\alpha$  - D - glukopyranosid

B. Redukující - maltosový typ - yl - osa

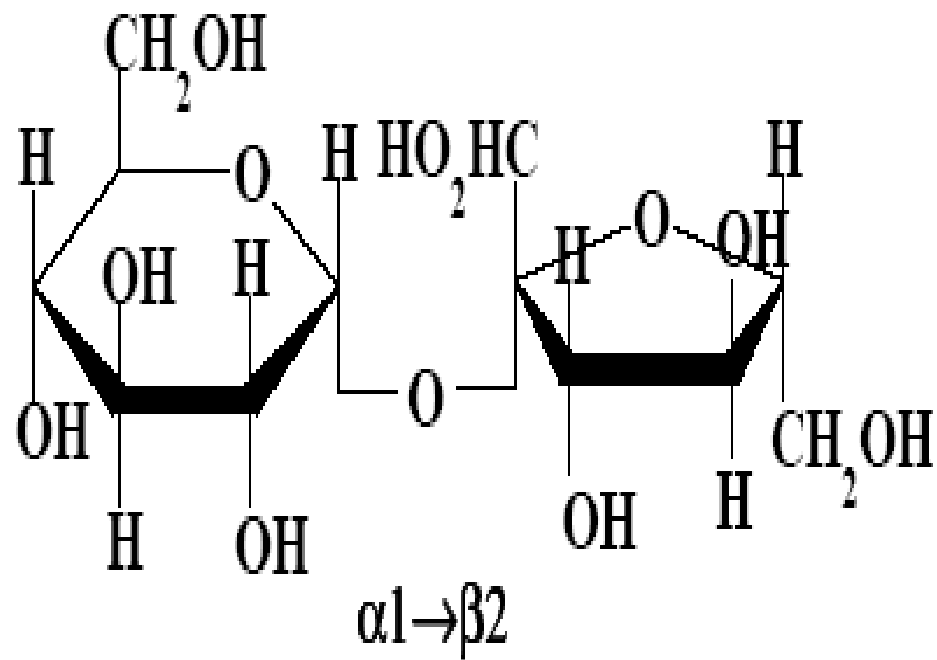
O -  $\alpha$  - D - glukopyranosyl (1 $\rightarrow$ 4) -  $\alpha$  - D - glukopyranosa

# Neredukující disacharidy





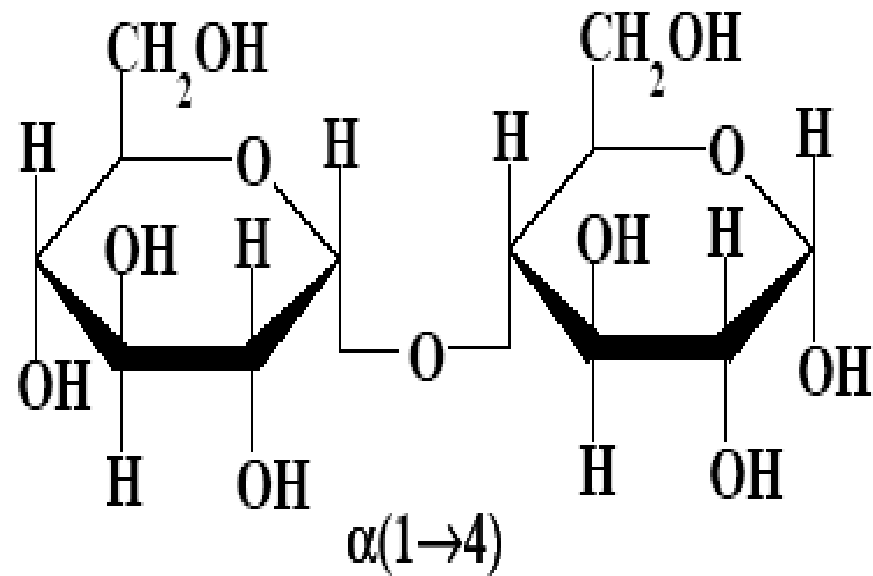
O -  $\alpha$  - D - glukopyranosyl (1 $\rightarrow$ 1) -  $\alpha$  - D - glukopyranosid



SACHAROSA

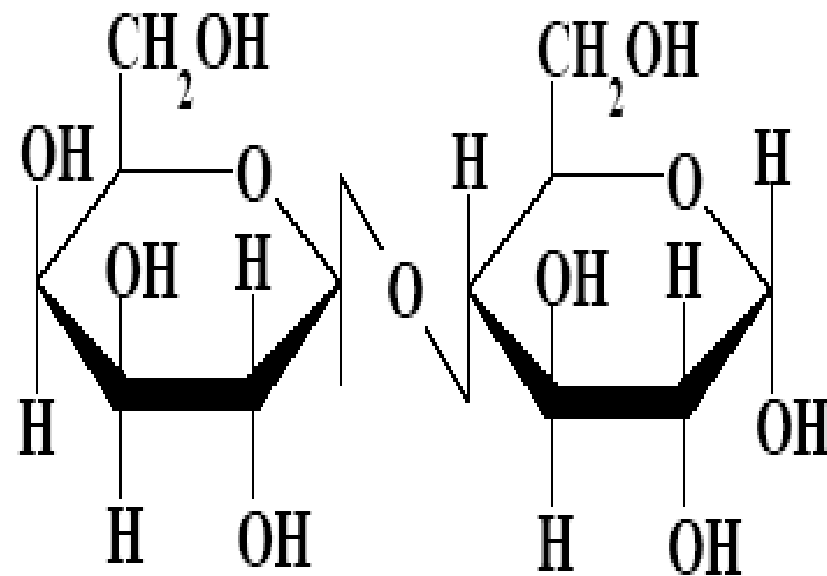
O -  $\alpha$  - D - glukopyranosyl (1 $\rightarrow$ 2) -  $\beta$  - D - fruktofuranosid

# Redukující disacharidy



MALTOSA

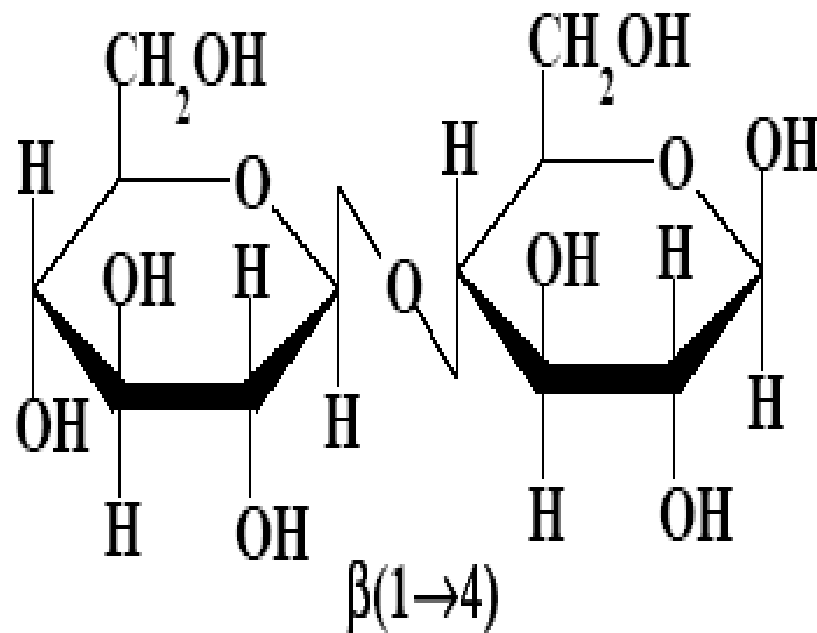
O -  $\alpha$  - D - glukopyranosyl (1 $\rightarrow$ 4) -  $\alpha$  - D - glukopyranosa



$\beta(1 \rightarrow 4)$

LAKTOSA

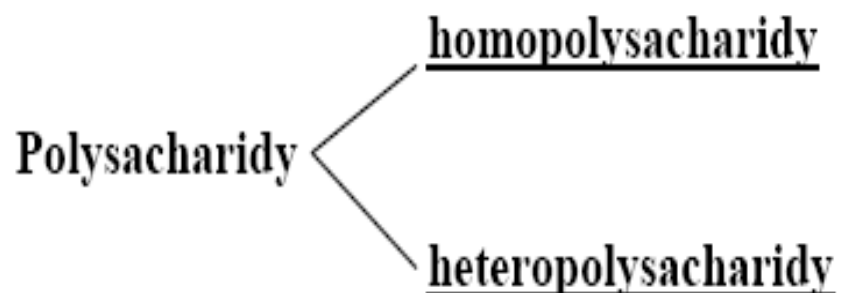
O -  $\beta$  - D - galaktopyranosyl (1  $\rightarrow$  4) -  $\beta$  - D - glukopyranosa



CELLOBIOSA

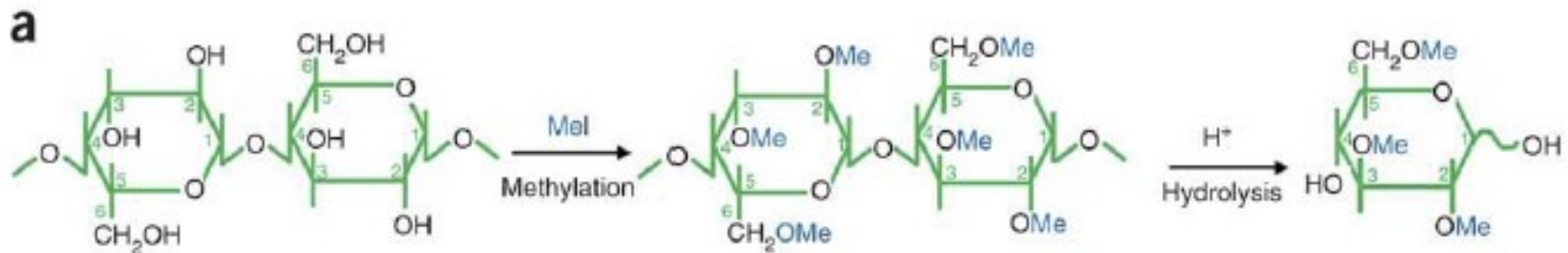
O -  $\beta$  -D - glukopyranosyl (1 $\rightarrow$ 4) -  $\beta$  -D - glukopyranosa

## Polysacharidy :



- Funkce - stavební  
- zásobní

# Metylační analýza





## HOMOPOLYSACHARIDY

*Stavební homopolysacharidy :*

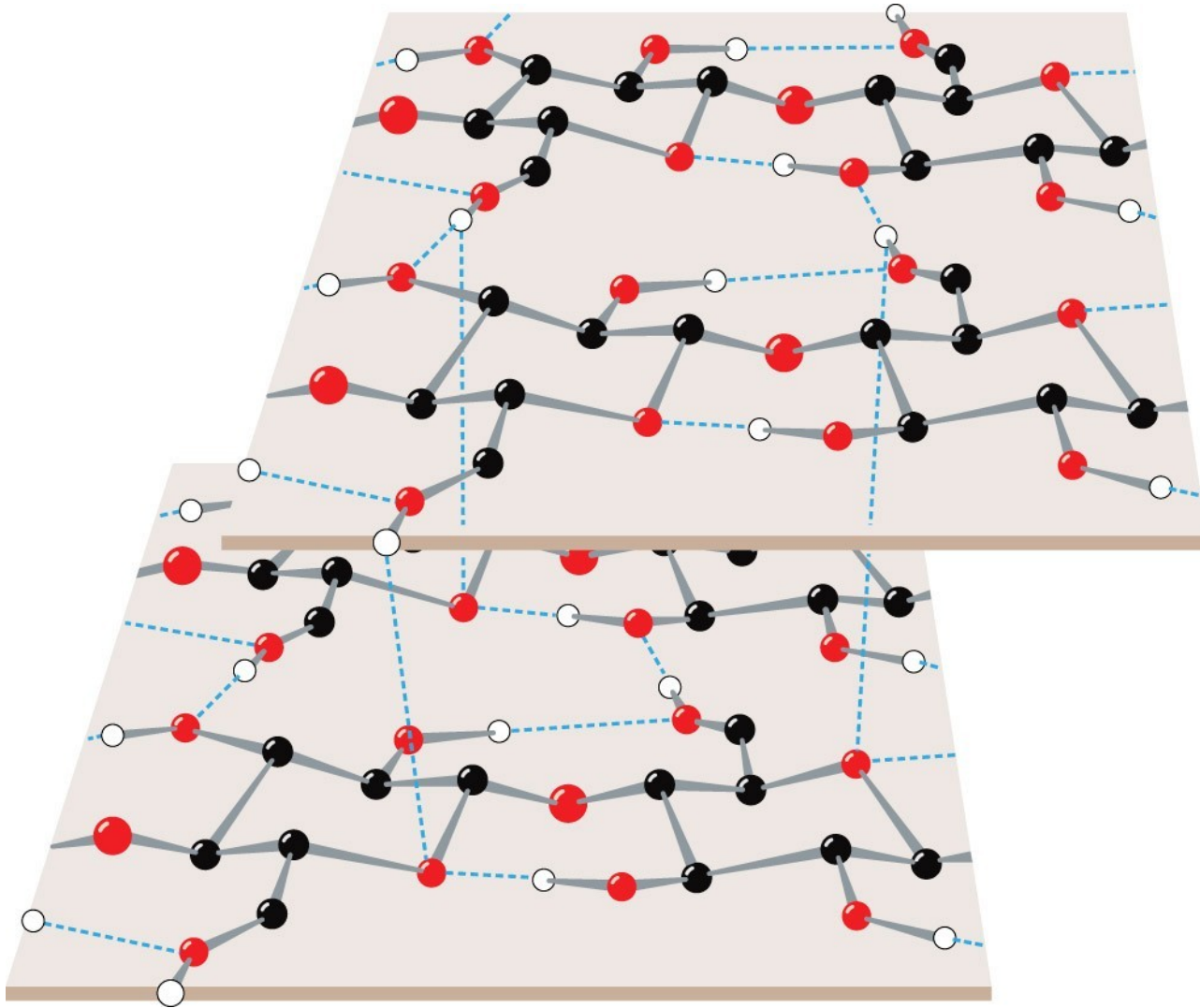
**CELULOZA** - glukosa (celobiosa)

**CHITIN** - N-acetylglukosamin

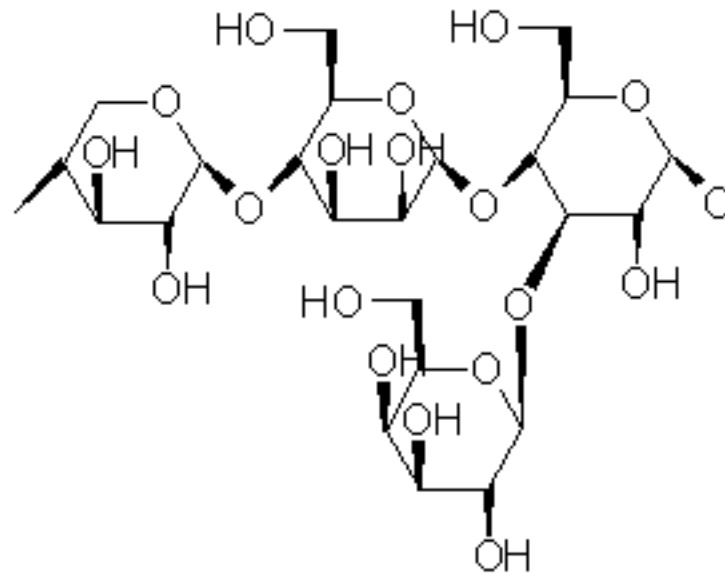
**AGAROSA** - galaktosa + 3, 6 - anhydrogalaktosa

**PEKTINY** - galakturonová kyselina

# Celulosa



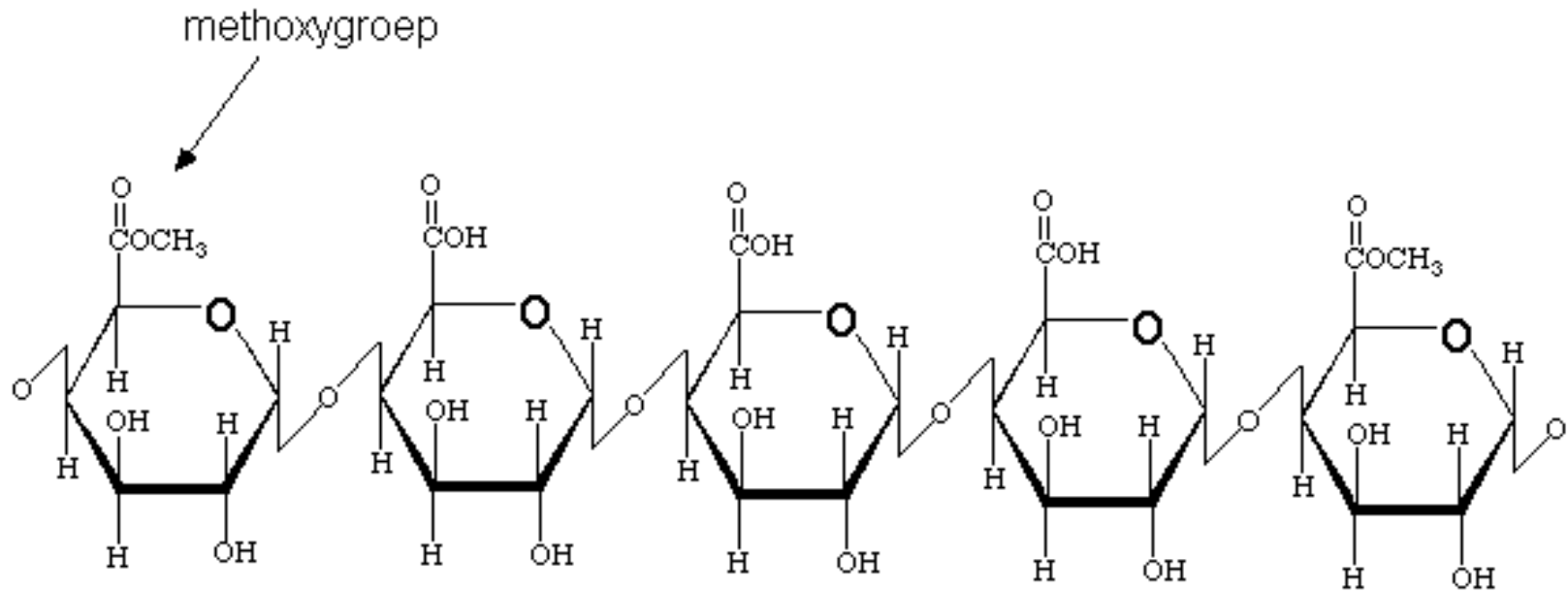
# Hemicelulosa

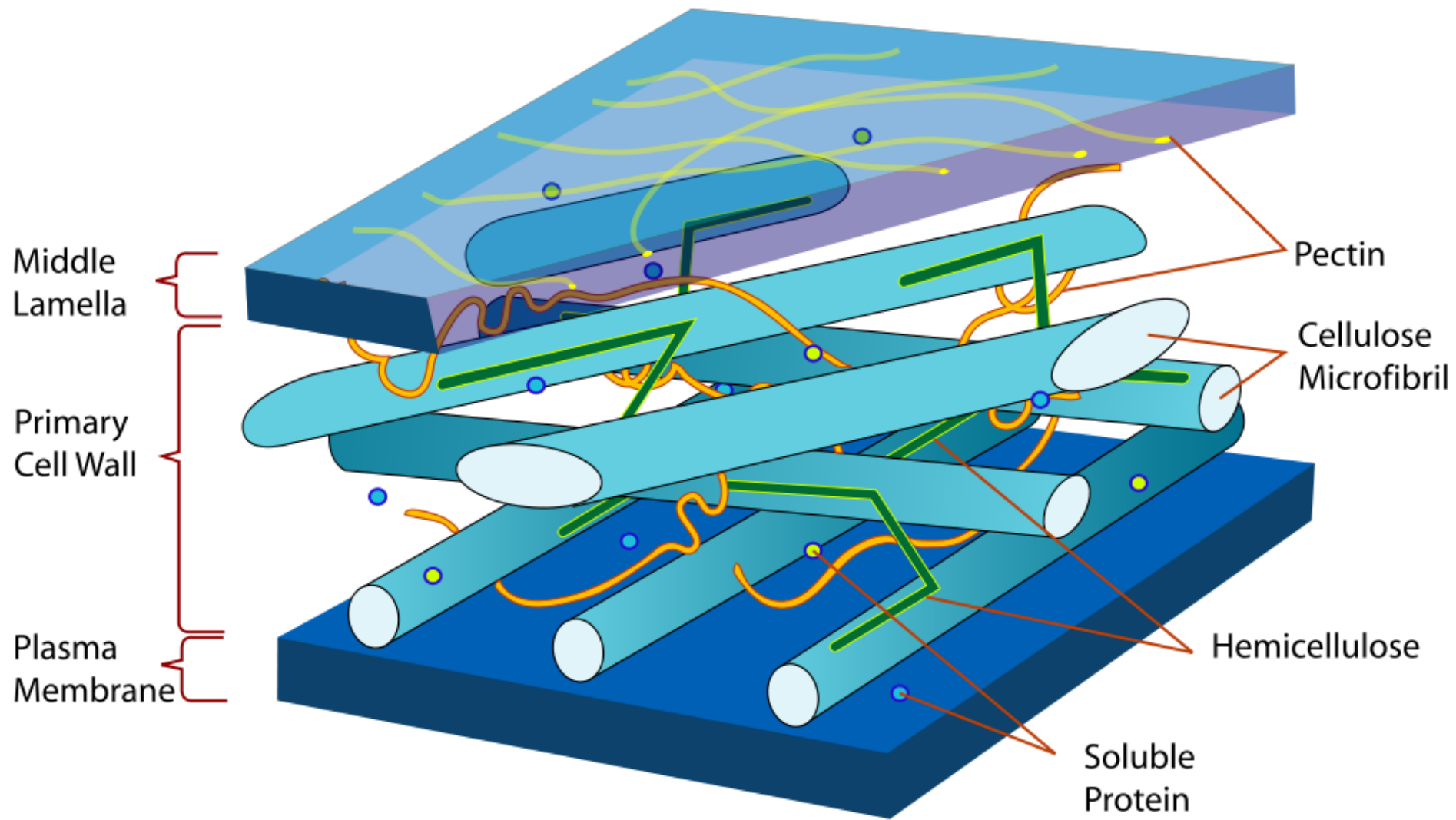


- Xylose -  $\beta(1,4)$  - Mannose -  $\beta(1,4)$  - Glucose -  
-  $\alpha(1,3)$  - Galactose

**Hemicellulose**

# Pektiny



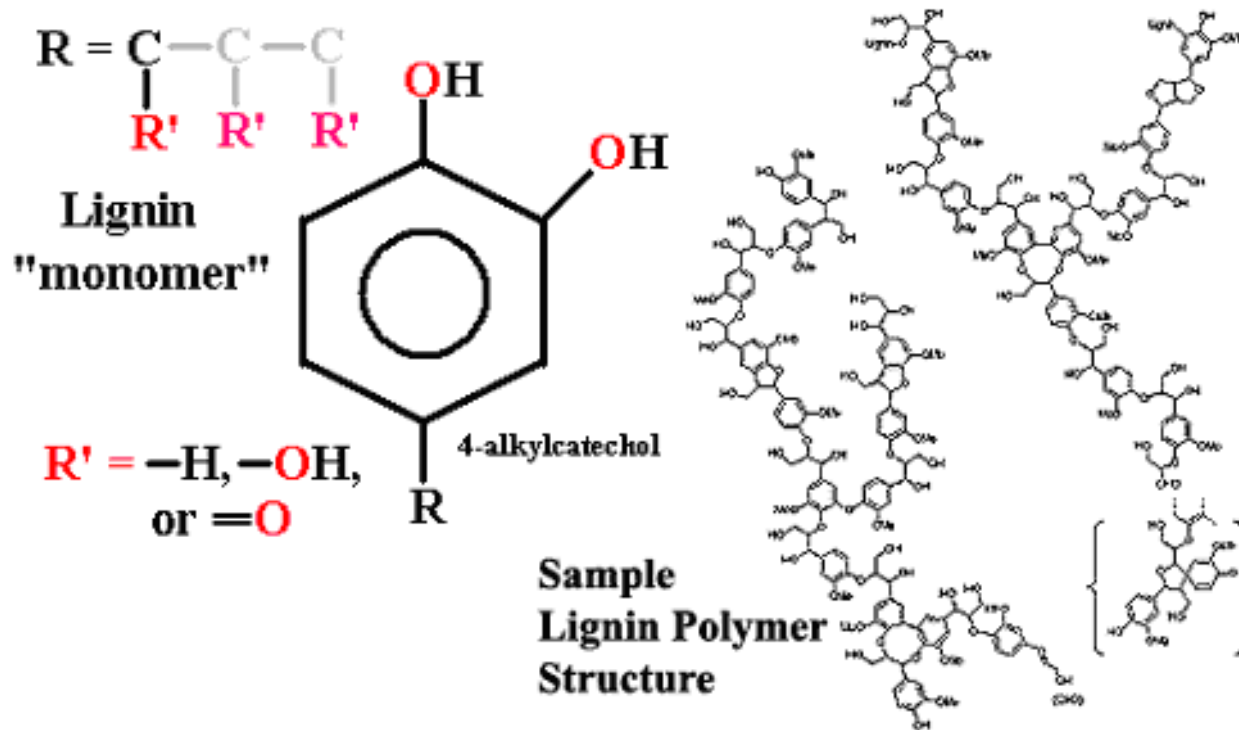


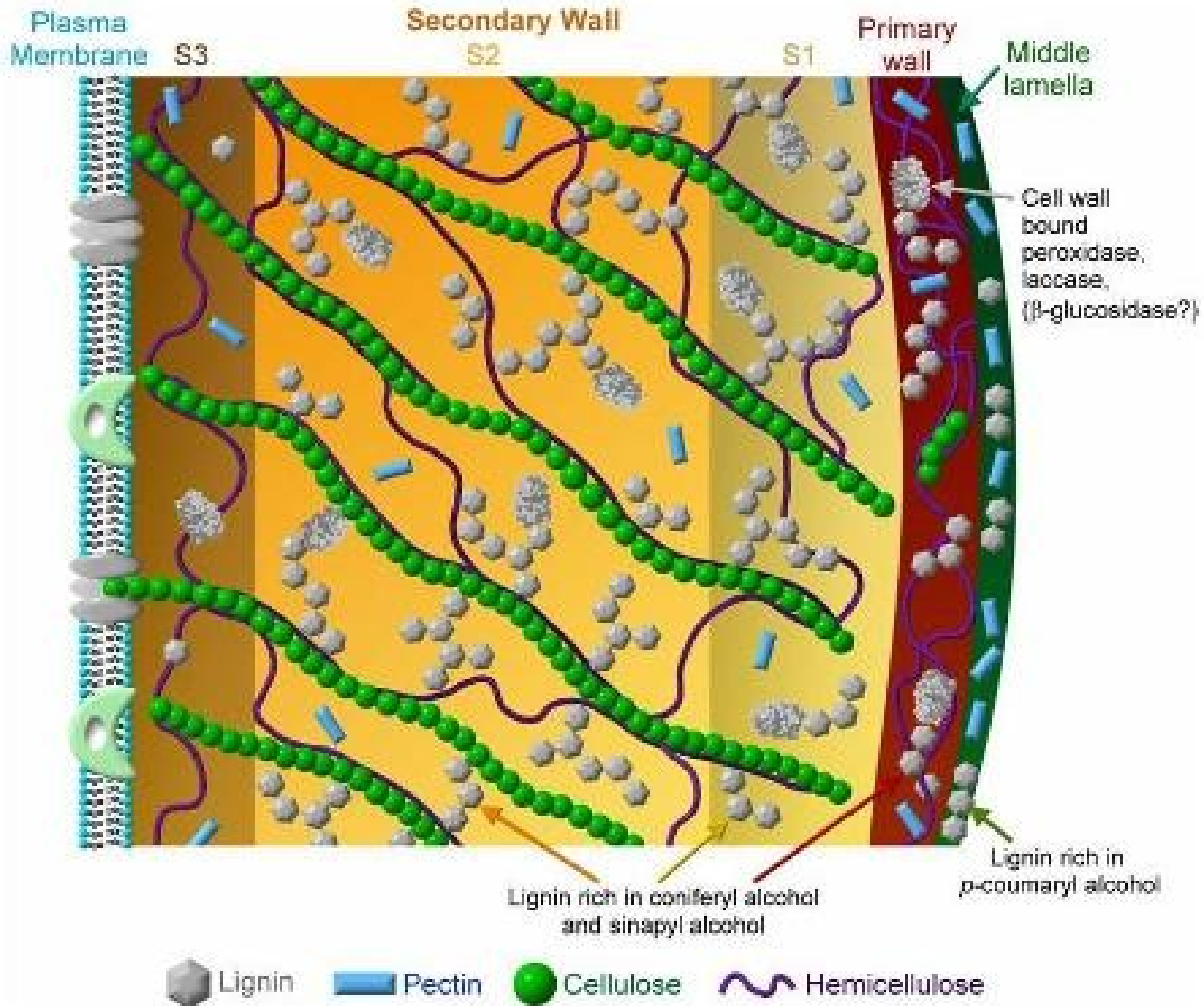






# Lignin

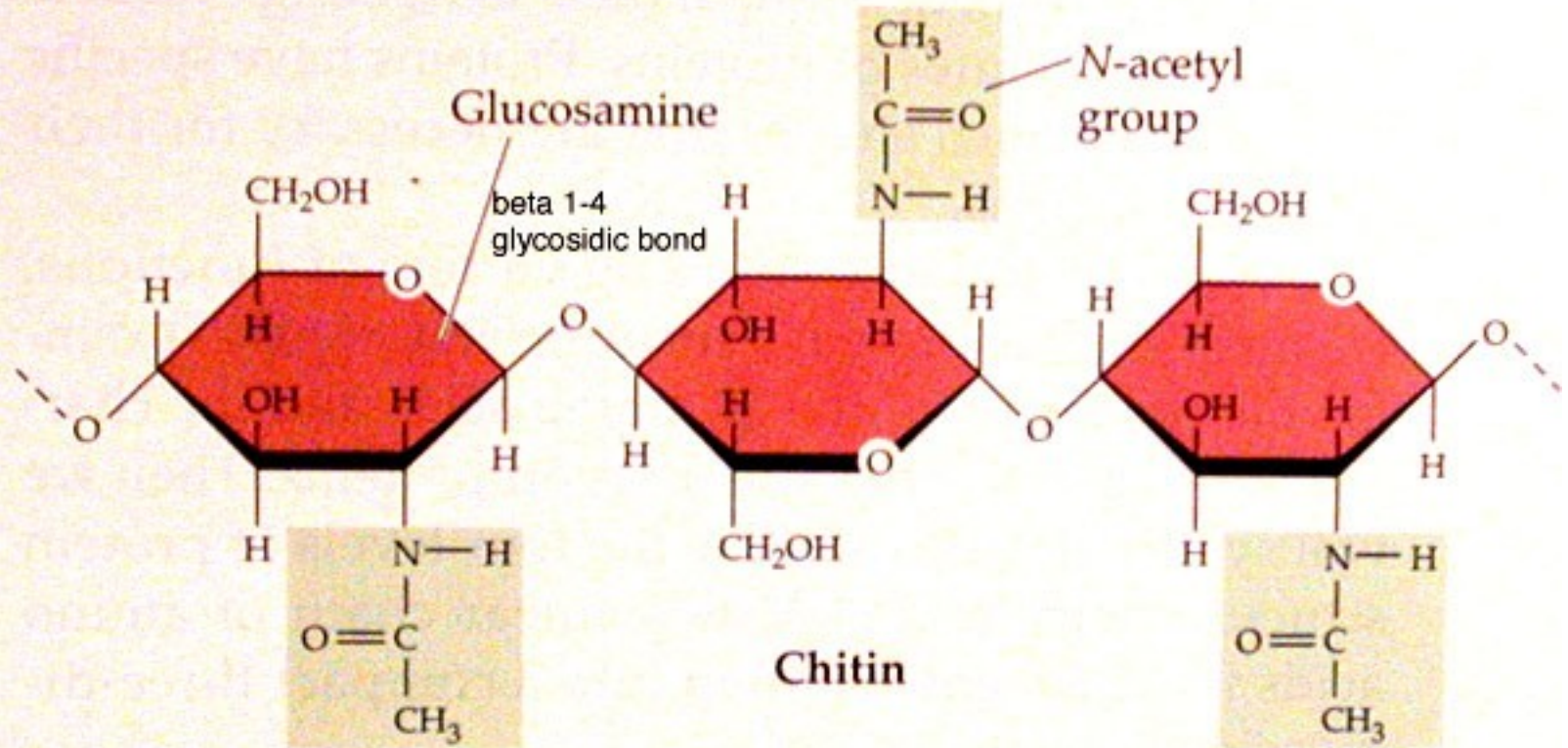






# Chitin

(c) Chitin



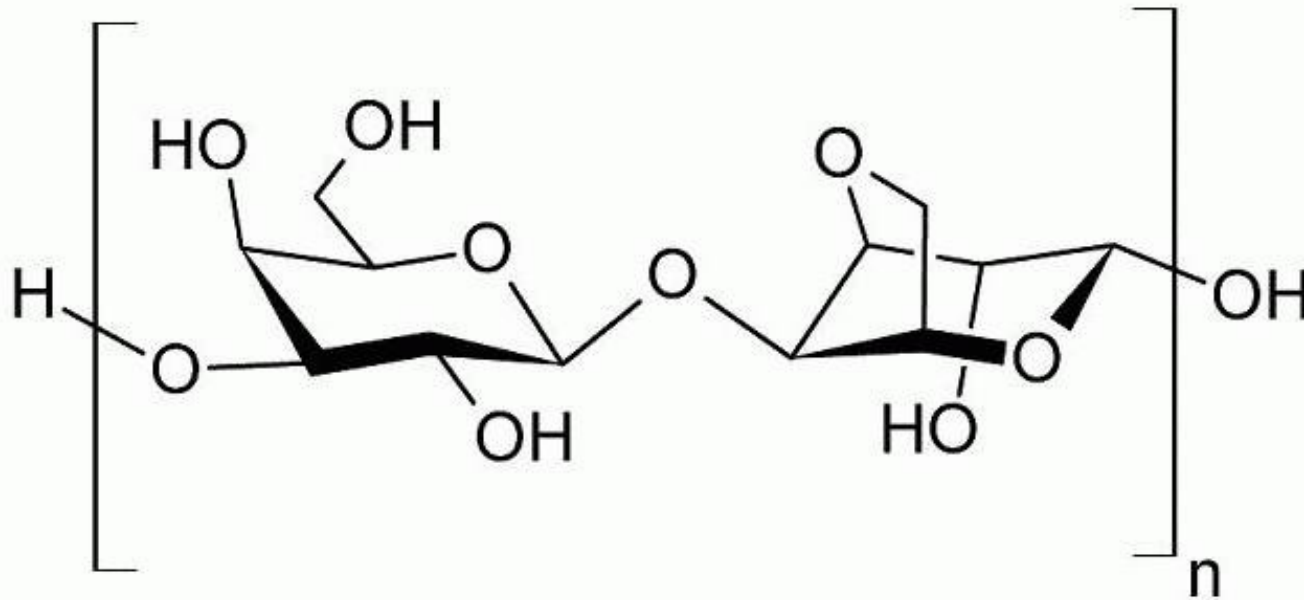
### CELLULOSE



### CHITIN



# Agarosa



*Zásobní homopolysacharidy :*

ŠKROB - amylosa - glukosa -  $\alpha$  (1→4) - 20 %

(40 - 150 000 MW)

amylopektin - glukosa -  $\alpha$  (1→4) +  $\alpha$  (1→6) - 80 %

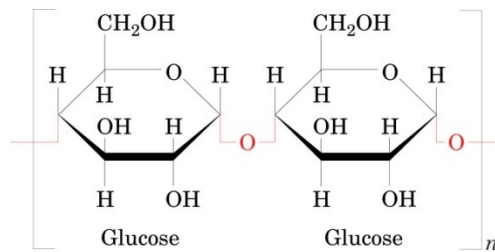
(50 000 MW)

GLYKOGEN - glukosa -  $\alpha$  (1→4) +  $\alpha$  (1→6)

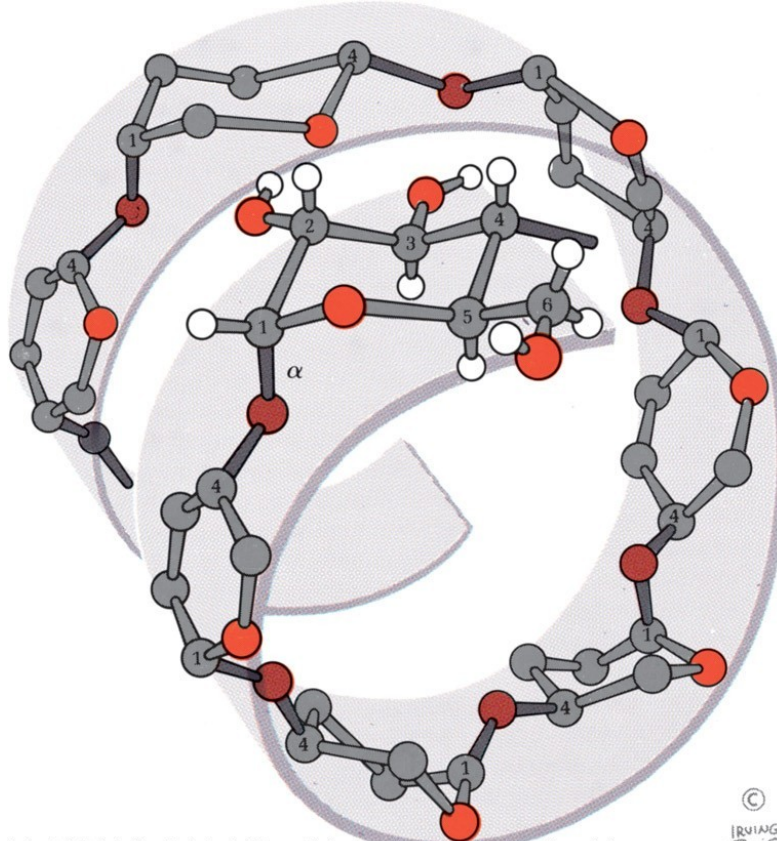
DEXTRAN - glukosa -  $\alpha$  (1→6) +  $\alpha$  (1→4) +  $\alpha$  (1→3)

INULIN - fruktosa  $\beta$ (1→)

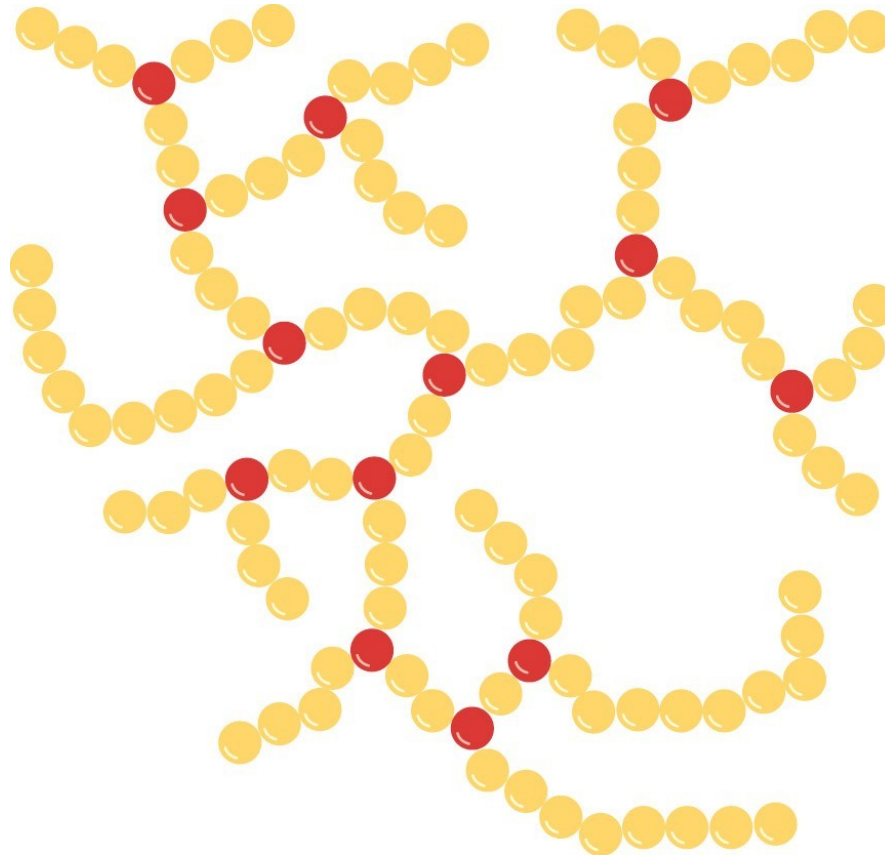
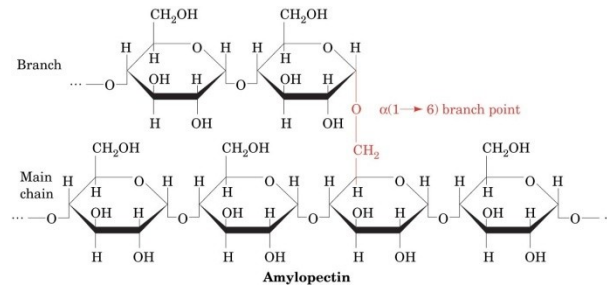
# Amylose



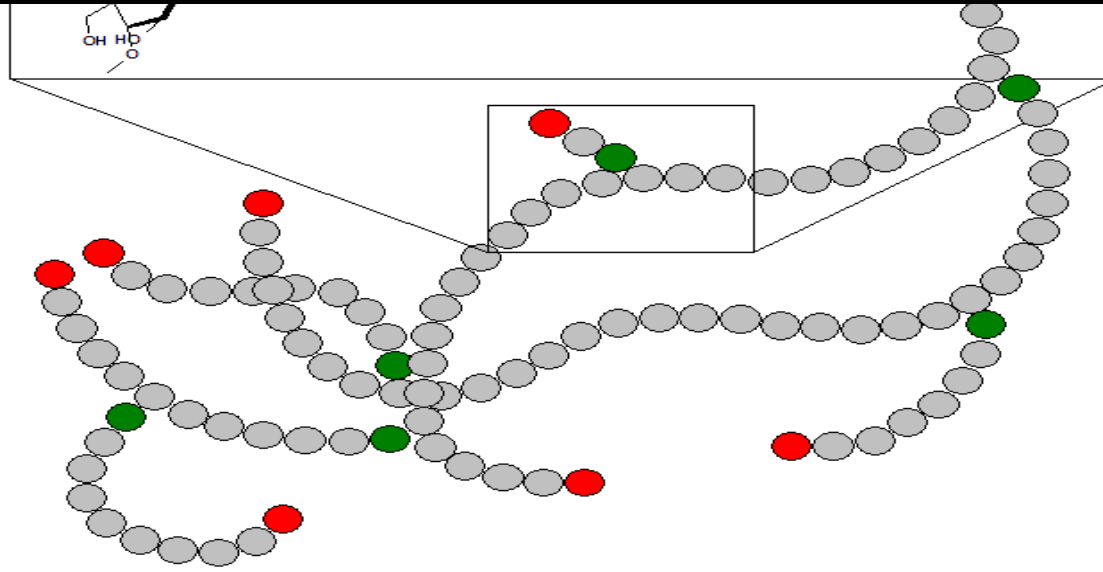
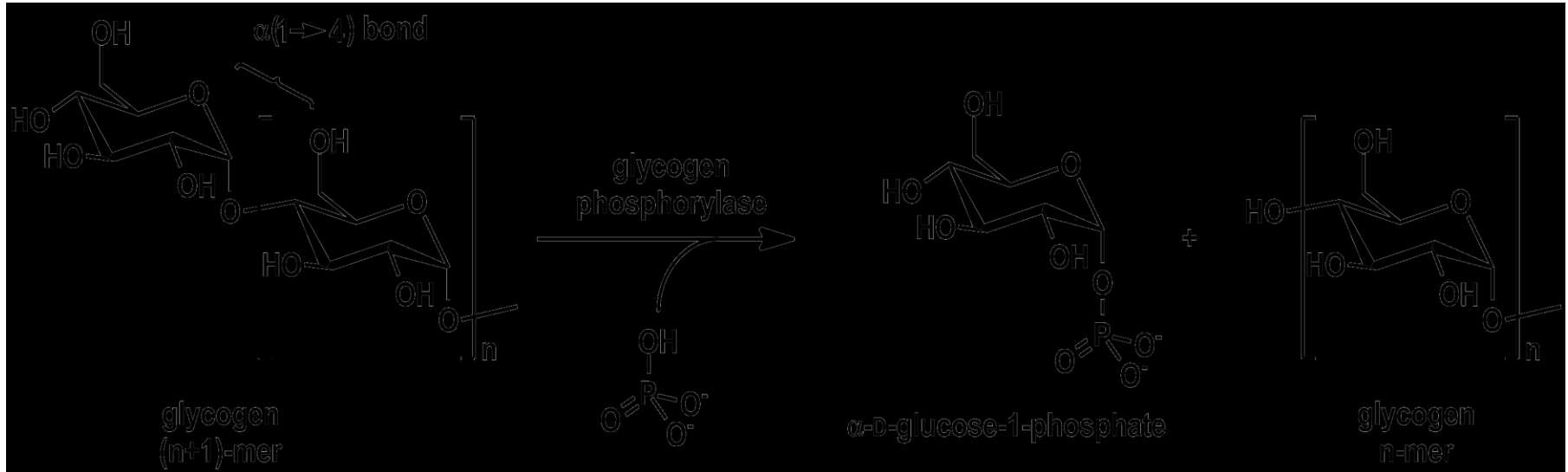
$\alpha$ -Amylose



# Amylopektin



# Glykogen





# Škrob (a) a glykogen (b)

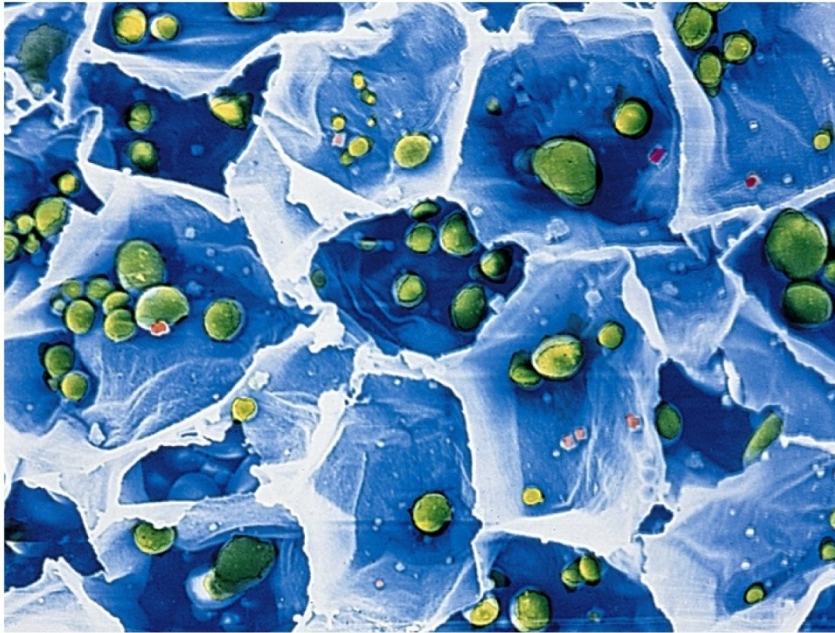


Figure 7-19a Concepts in Biochemistry, 3/e

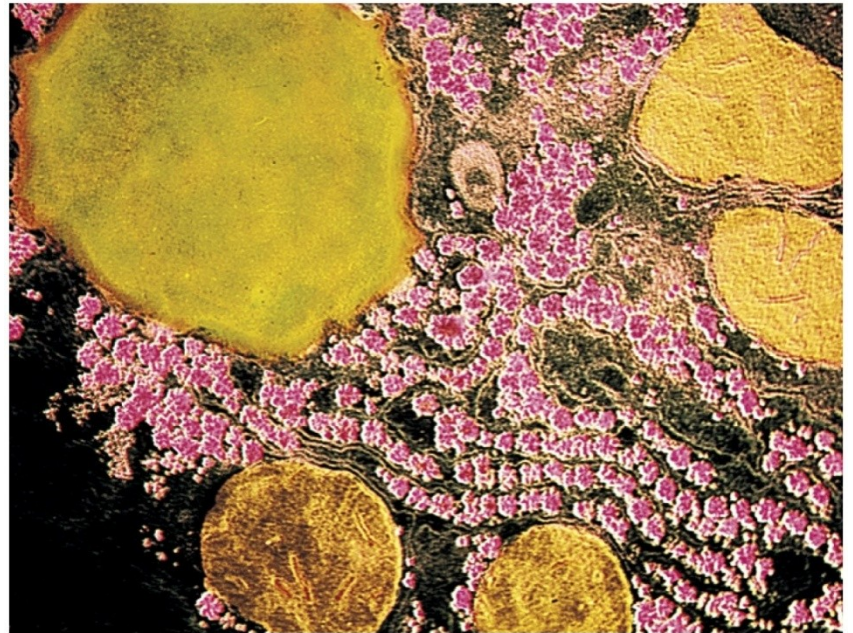
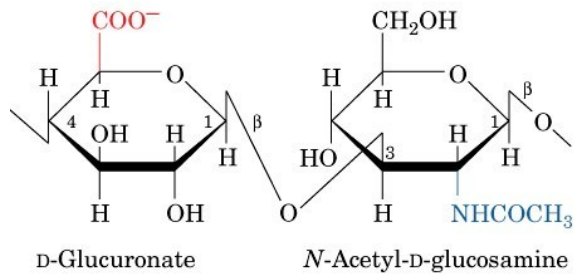


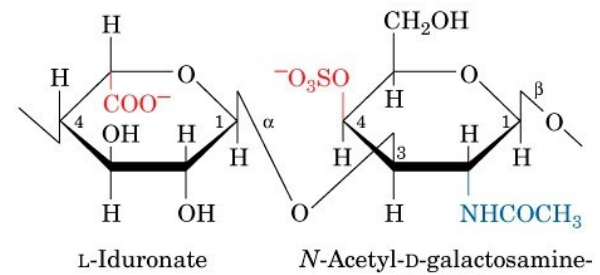
Figure 7-19b Concepts in Biochemistry, 3/e



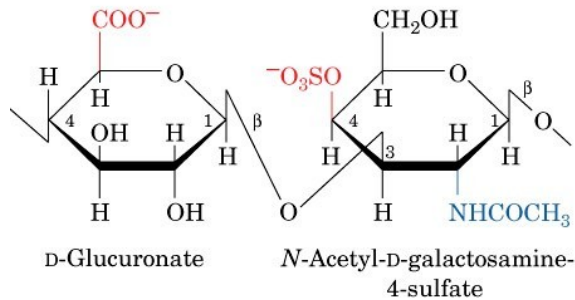
# Heteropolysacharidy



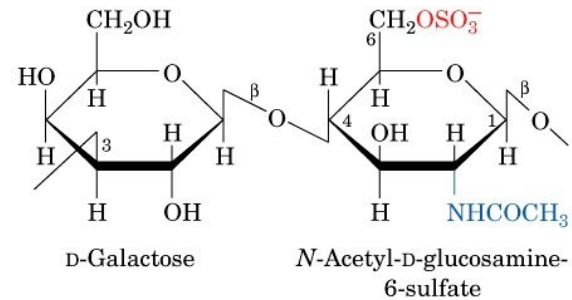
**Hyaluronate**



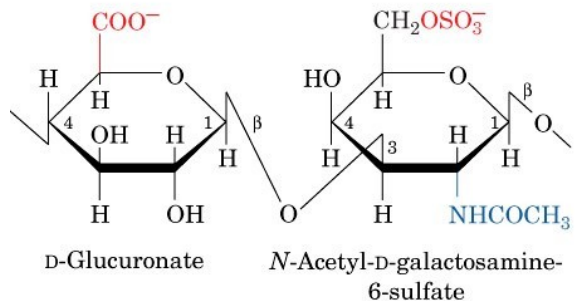
**Dermatan sulfate**



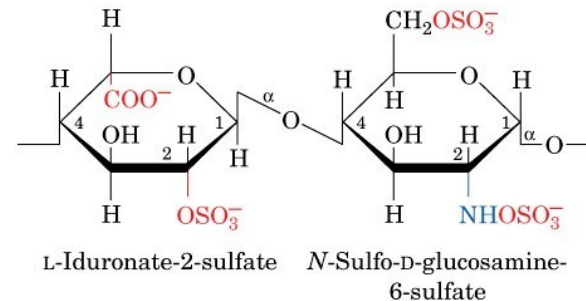
**Chondroitin-4-sulfate**



**Keratan sulfate**



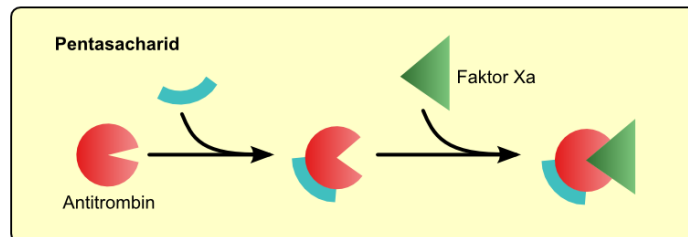
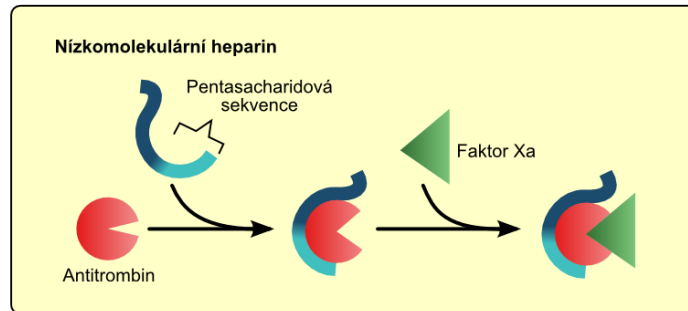
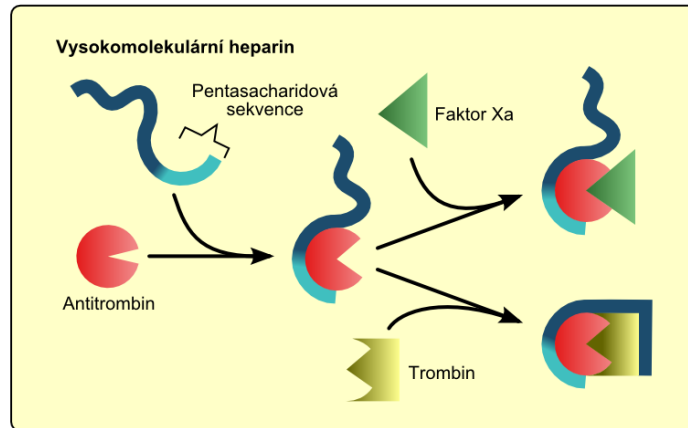
**Chondroitin-6-sulfate**



**Heparin**

# Heparin

## Antikoagulancia - Nepřímé inhibitory trombinu / faktoru Xa



# Složené sacharidy

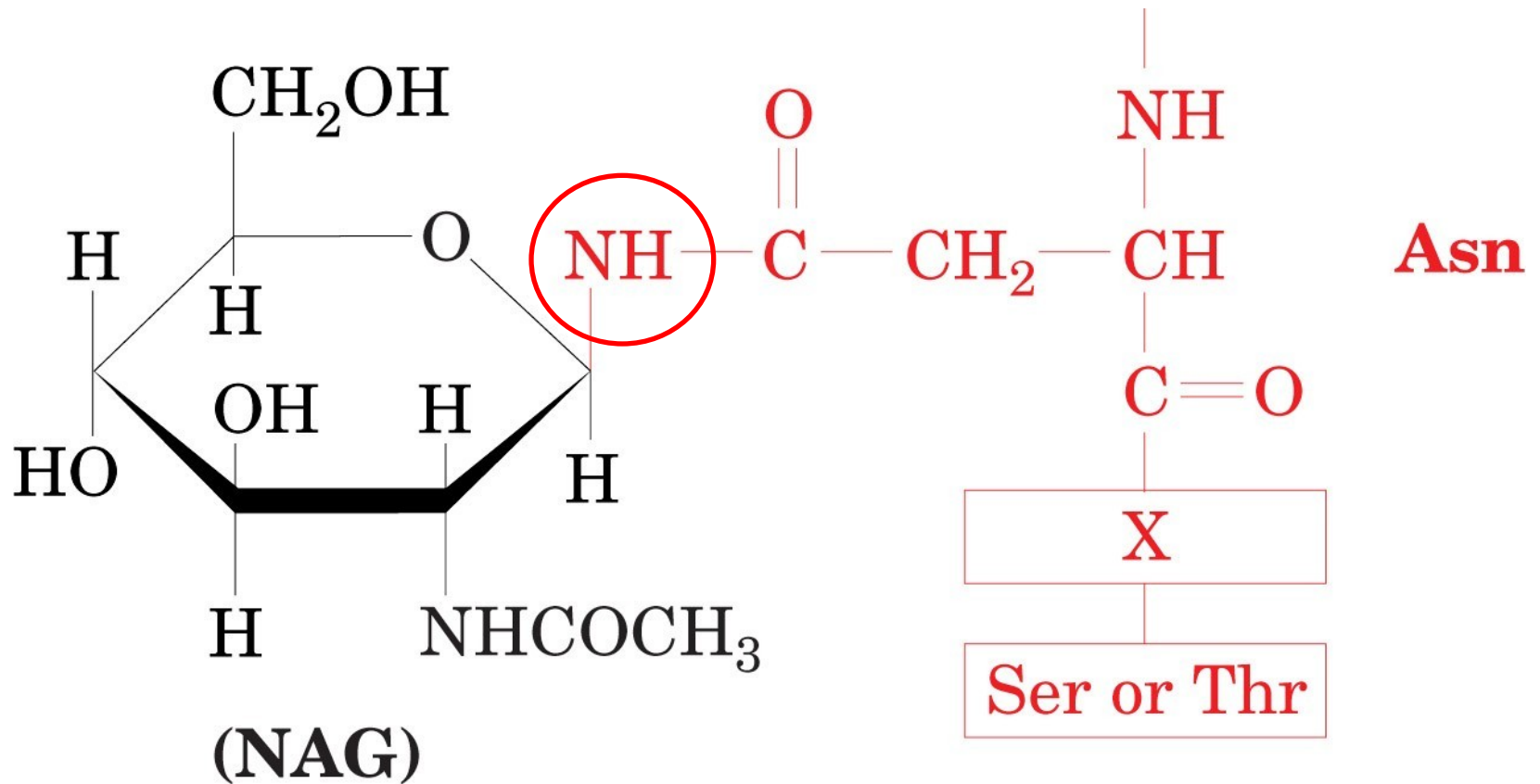
- Glykolipidy

- Glykoproteiny

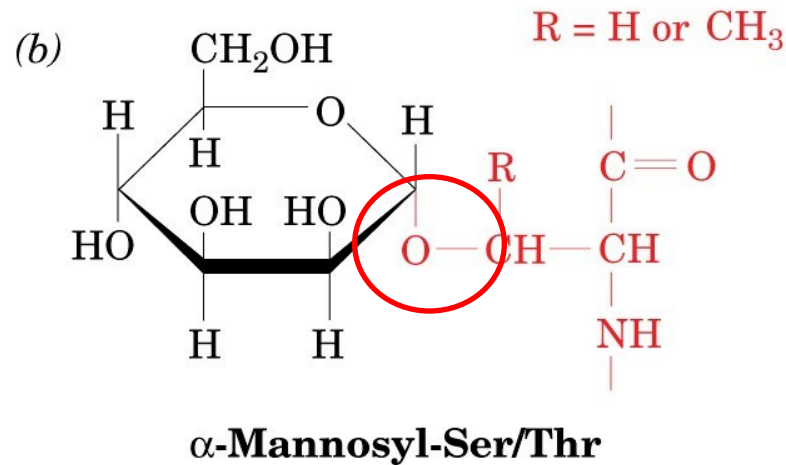
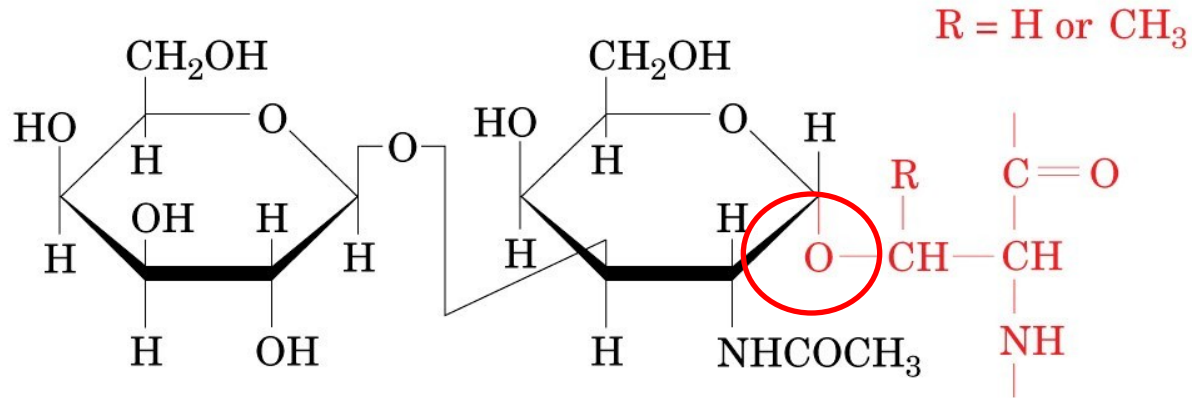
- Proteoglykany

**LIŠÍ SE POMĚREM SLOŽEK**

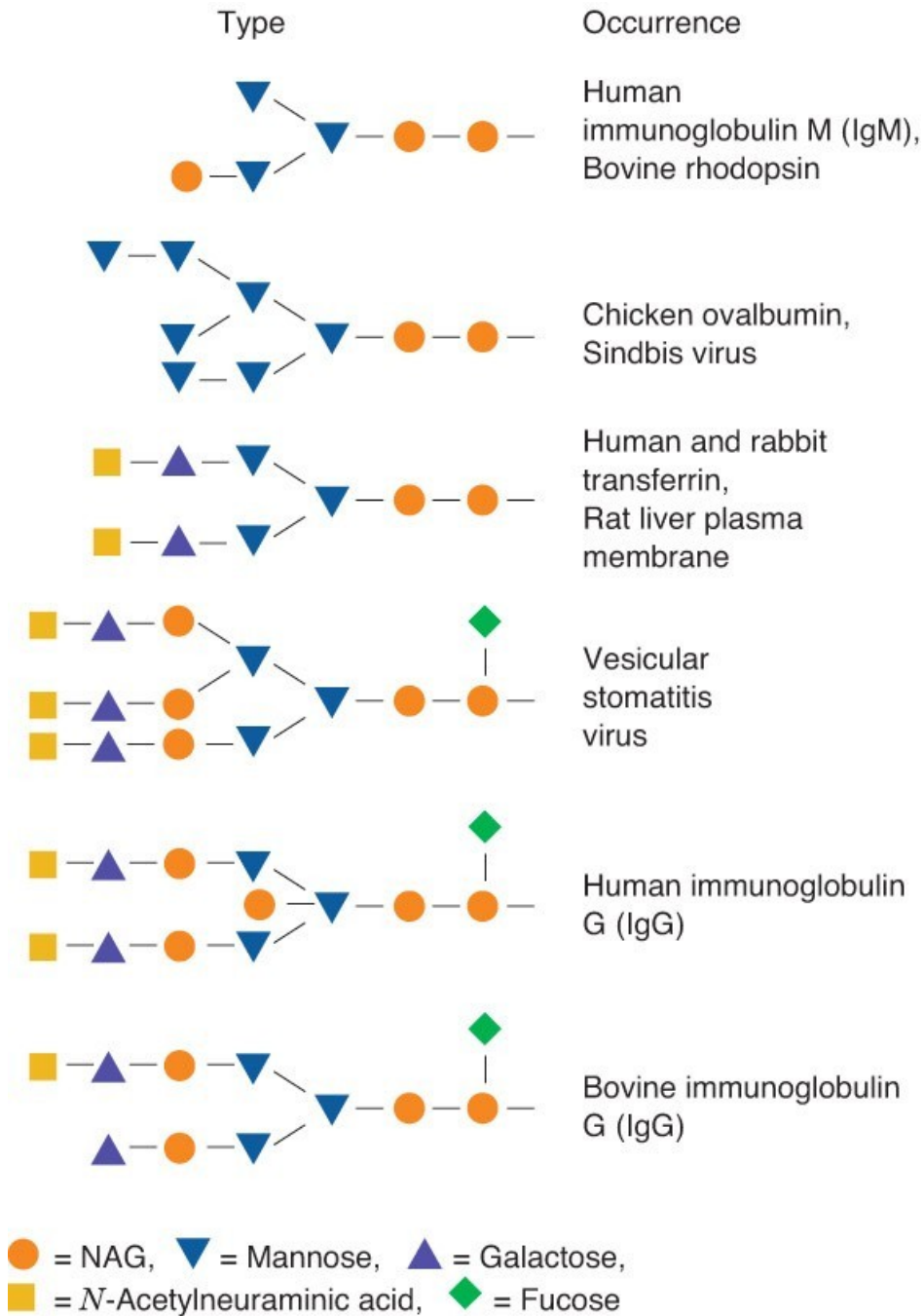
# Glykoproteiny – N-linked



# Glykoproteiny – O-linked







# Glykoproteiny

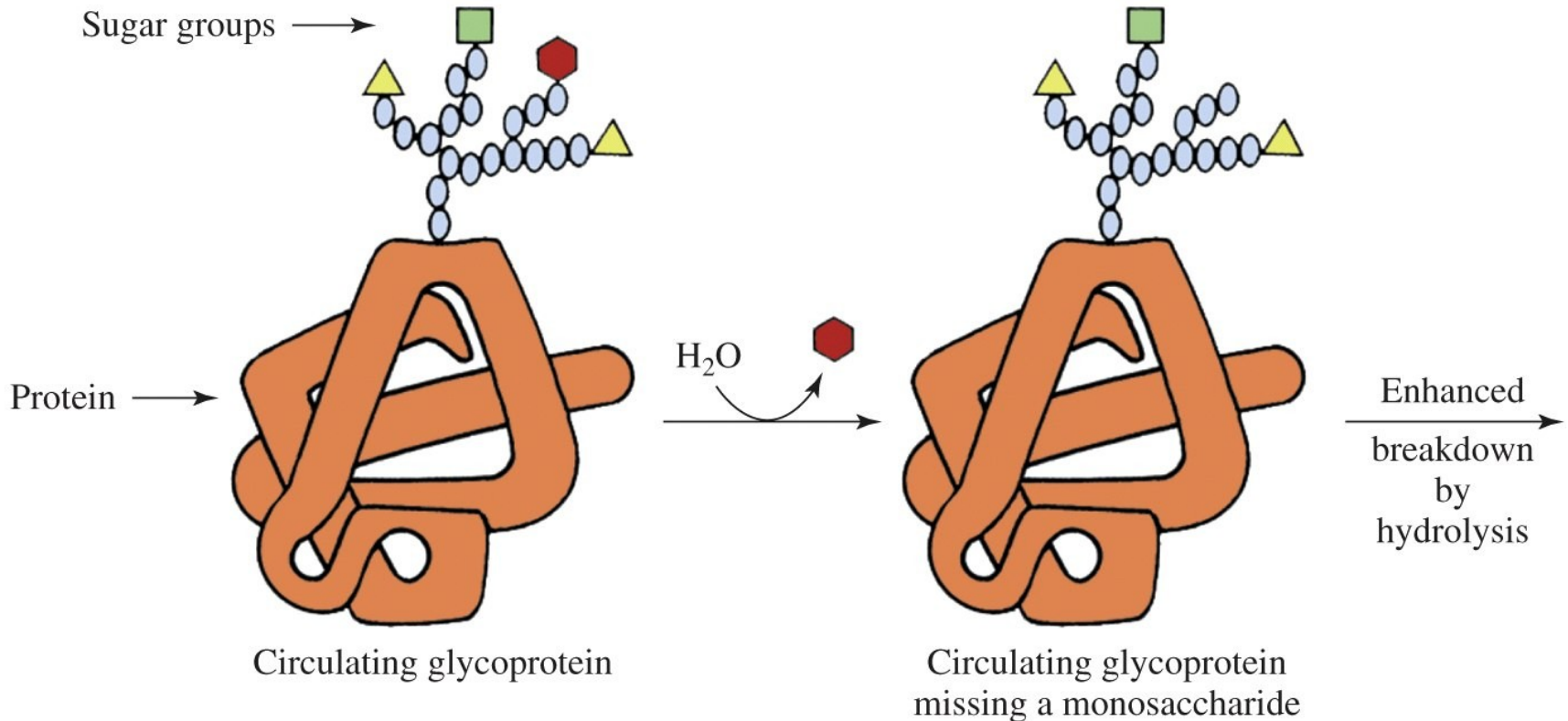


Figure 7-32 Concepts in Biochemistry, 3/e  
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# Antimrazové glykoproteiny



# Krevní skupiny

- V současné době nejméně 21 systémů lidských krevních skupin ( AB0, Rh, MN...)
- Definovaný systém antigenů přítomných na červených krvinkách
- Krevní typ (antigenní fenotyp) je určován pomocí vhodných protilátek



# Krevní skupiny ABO

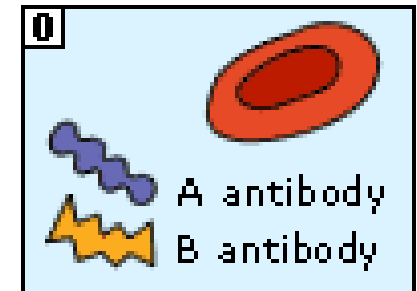
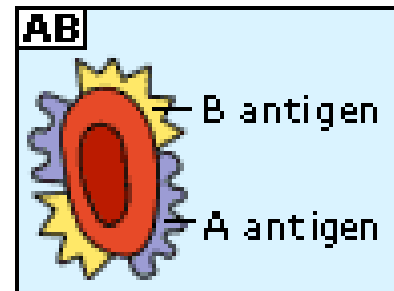
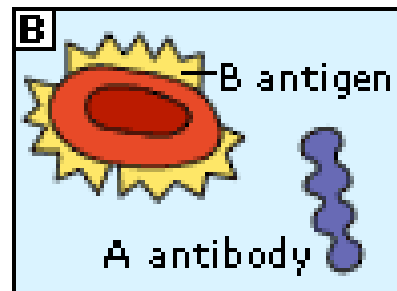
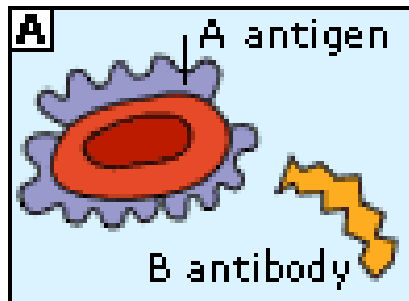
- **Karl Landsteiner**  
(1930 NC)
- Jan Jánský

# Chemická podstata aglutinogenů a aglutininů ABO

- **Aglutinogeny** – antigenní struktury na membránovém povrchu ERY  
Základní jednotka – oligosacharid vzniklý kombinací 4 monosacharidů
- **Aglutininy** patří mezi imunoglobuliny IgM

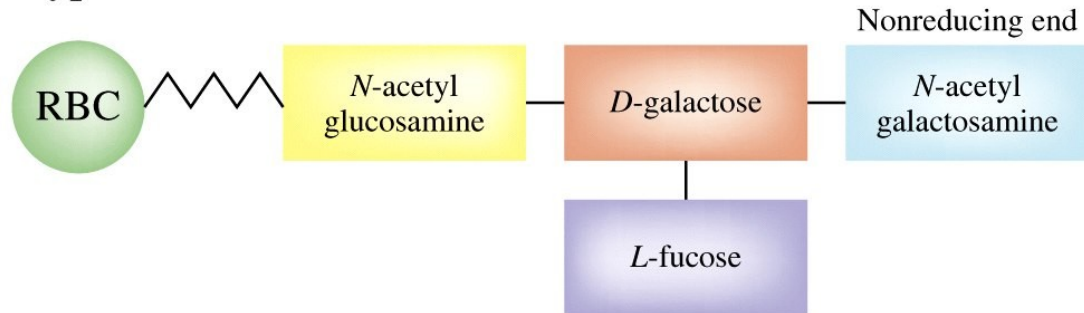
# ABO(H) systém

- 4 základní krevní skupiny – A, B, AB a 0(H) podle přítomnosti aglutinogenů (antigenů) A a B na povrchu membrány ERY
- Protilátky v plazmě (aglutininy) se vytvářejí v 1.roce života, proti těm antigenům, které neobsahují vlastní ERY

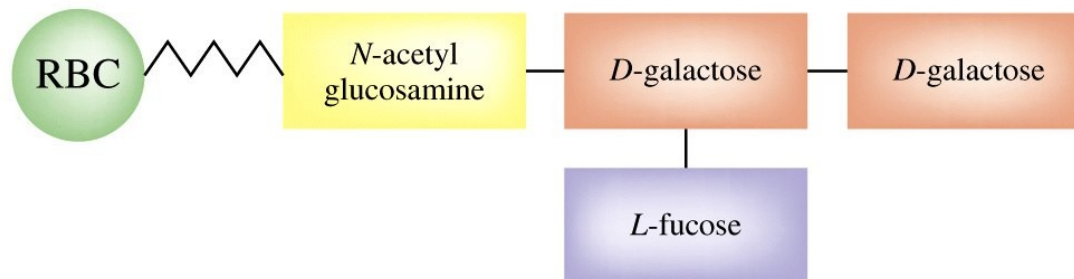


# Krevní skupiny

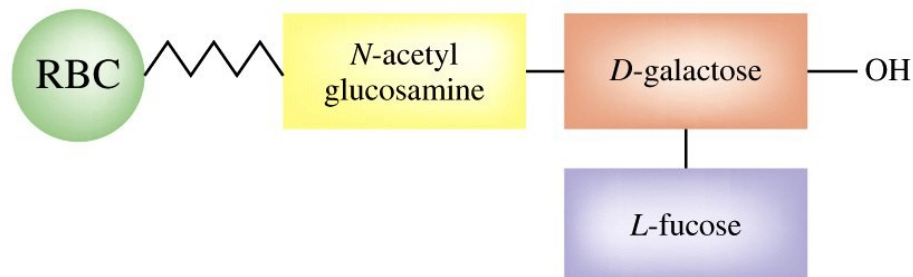
## Type A



## Type B

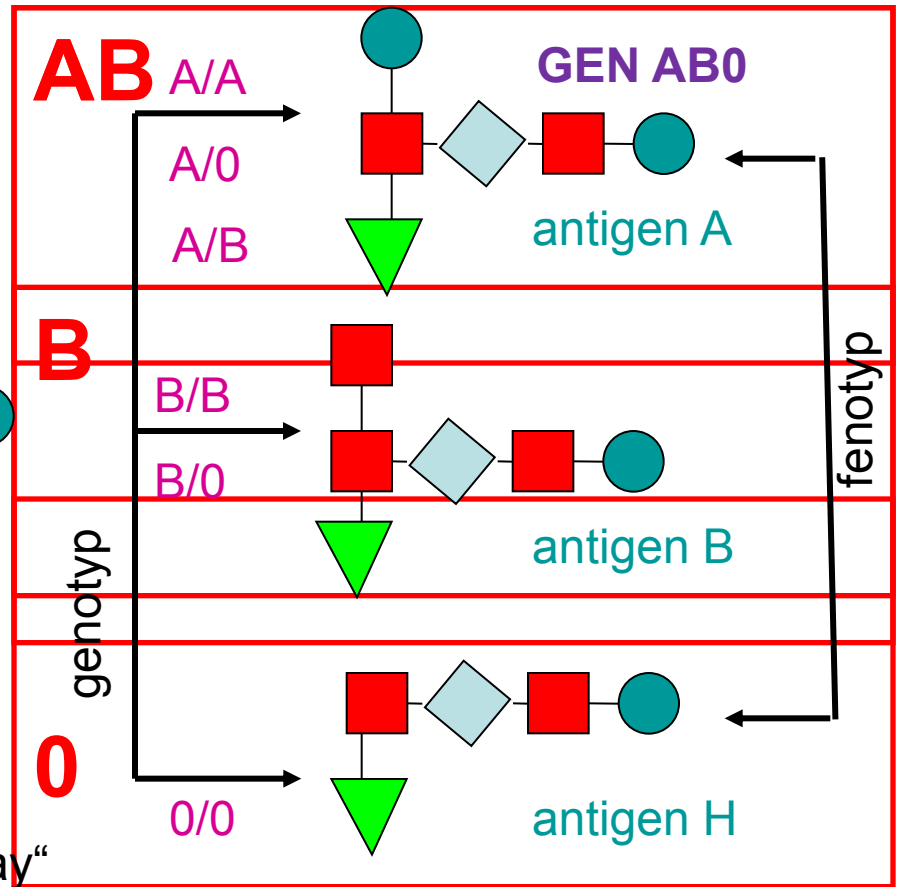
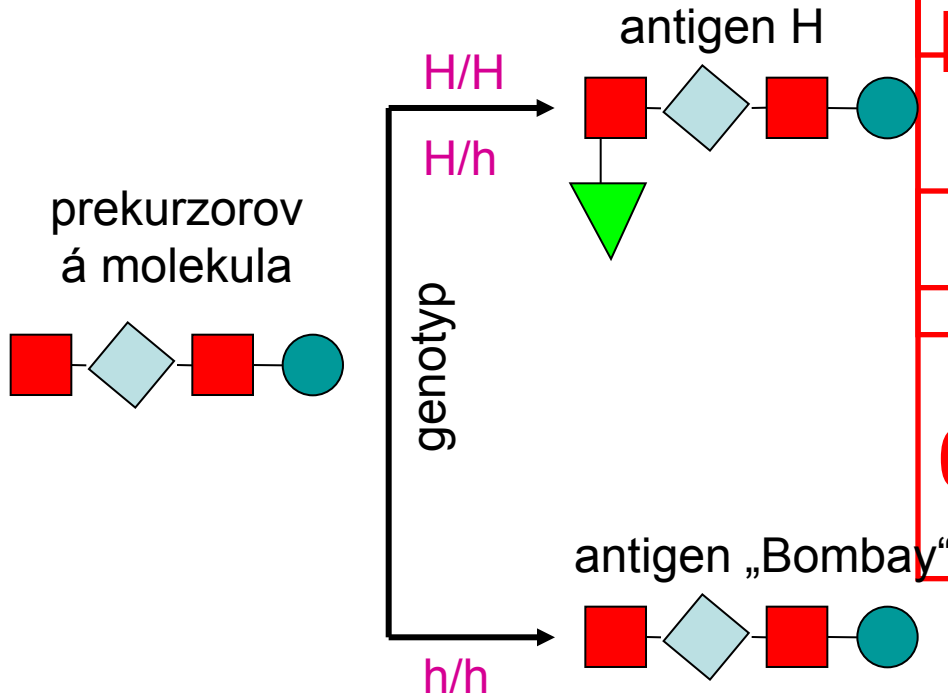


## Type O



GEN H

fucosyl transferase



D-galaktosa






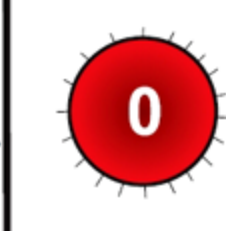






N-acetylgalaktosamin



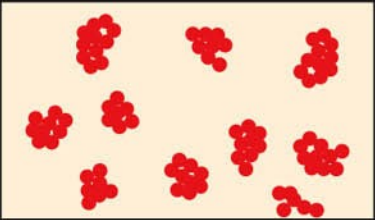
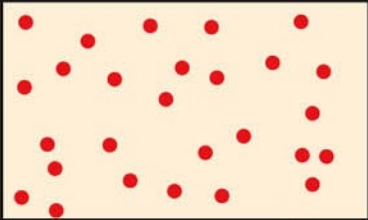
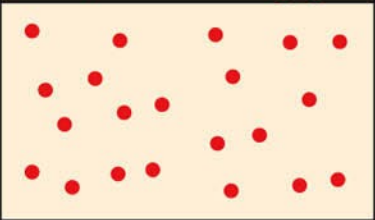
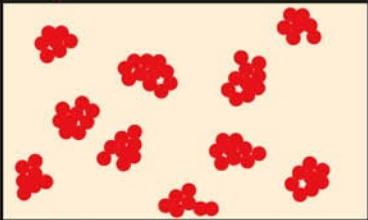
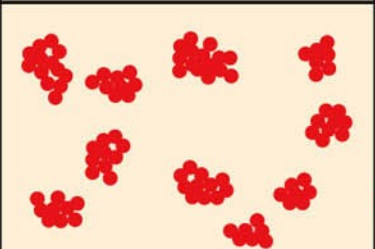
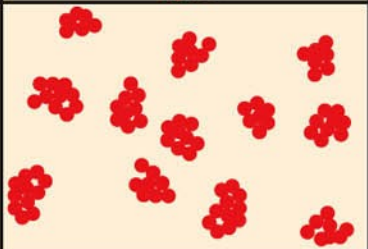
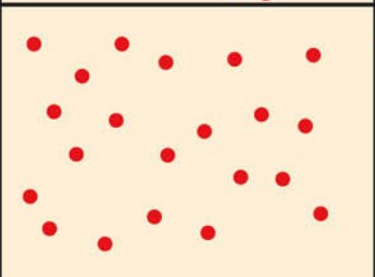
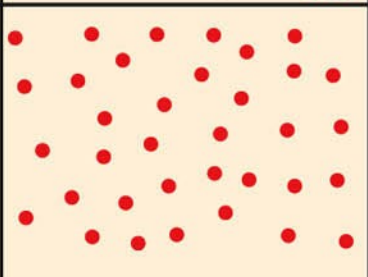
N-acetylglukosamin



L-fukosa

	SKUPINA A	SKUPINA B	SKUPINA AB	SKUPINA 0
erythrocyty				
protilátky	 Anti-B	 Anti-A	žádné	 Anti-A Anti-B
antigeny	 A antigen	 B antigen	 A a B antigeny	žádné



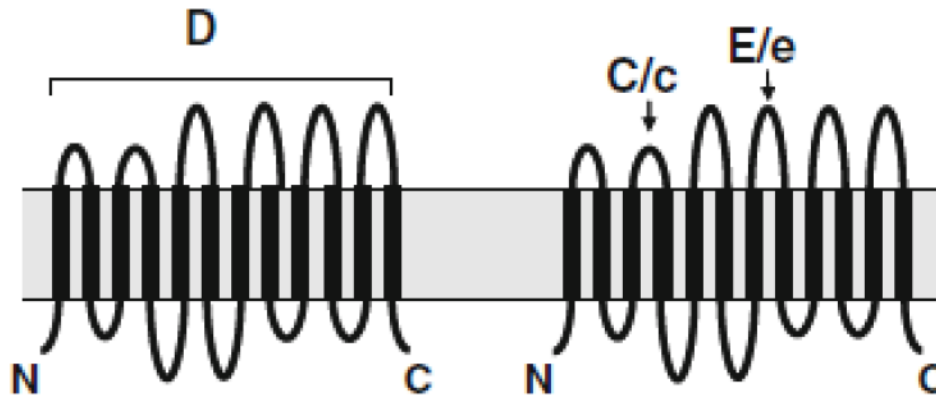
Blood type of cells	Genotype	Antibodies made by body	Reaction to added antibodies	
			Anti-A	Anti-B
A	$I^A I^A$ or $I^A i^O$	Anti-B	 Agglutination (clumping) of red blood cells.	 No agglutination (uniformly distributed red blood cells).
B	$I^B I^B$ or $I^B i^O$	Anti-A	 No agglutination (uniformly distributed red blood cells).	 Agglutination (clumping) of red blood cells.
AB	$I^A I^B$	Neither anti-A nor anti-B	 Agglutination (clumping) of red blood cells.	 Agglutination (clumping) of red blood cells.
O	$i^O i^O$	Both anti-A and anti-B	 No agglutination (uniformly distributed red blood cells).	 No agglutination (uniformly distributed red blood cells).

# Dědičnost krevních skupin

Matka\Otec	0	A	B	AB
0	0	0, A	0, B	A, B
A	0, A	0, A	0, A, B, AB	A, B, AB
B	0, B	0, A, B, AB	0, B	A, B, AB
AB	A, B	A, B, AB	A, B, AB	A, B, AB

# System Rh

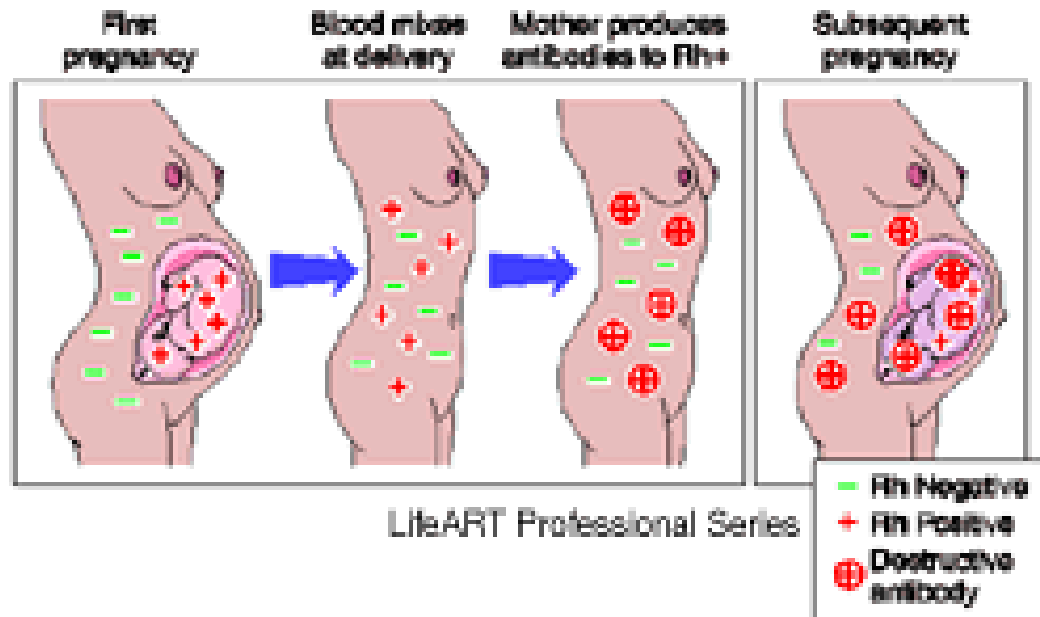
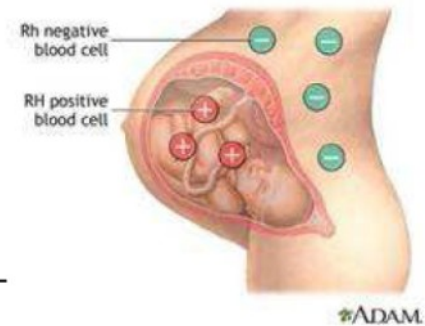
- Antigenní systém Rh je vysoce komplexní
- Antigeny C, **D**, E, c, d, e



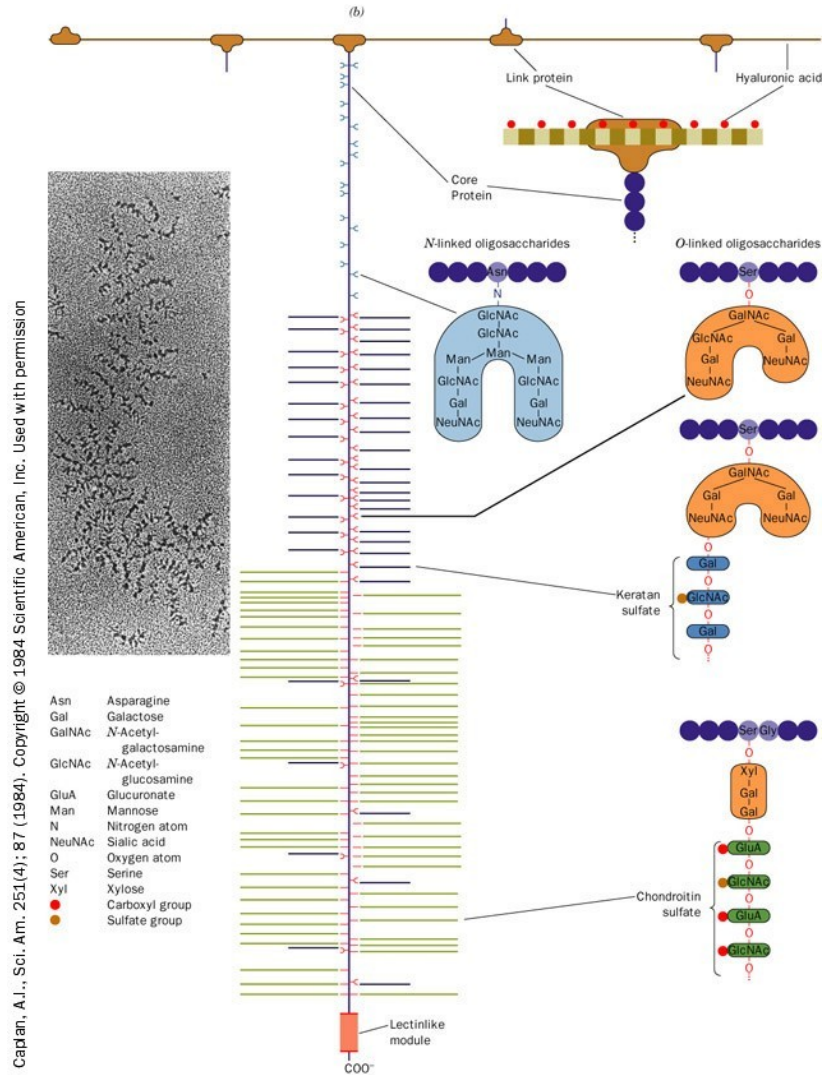
# System Rh

- Je-li přítomen antigen D, **Rh-pozitivní jedinec**
- Chybí-li antigen D, **Rh-negativní jedinec**
- Protilátky anti-D vznikají pouze při imunizaci Rh<sup>-</sup> příjemce krvinkami Rh<sup>+</sup> dárce
- Protilátky jsou imunoglobuliny typu IgG

# Hemolytická nemoc novorozenců











# Proteoglykany

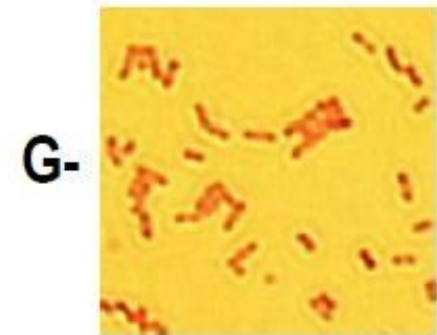
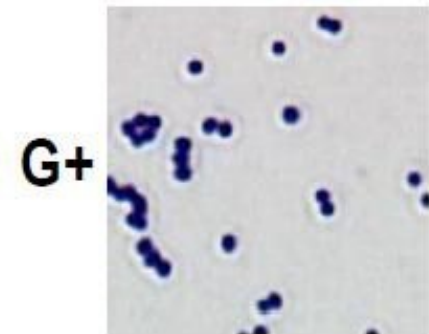


Caplan, A.L., Sci. Am. 251(4): 87 (1984). Copyright © 1984 Scientific American, Inc. Used with permission

# Buněčná stěna bakterií

grampozitivní(a) a gramnegativní(b)

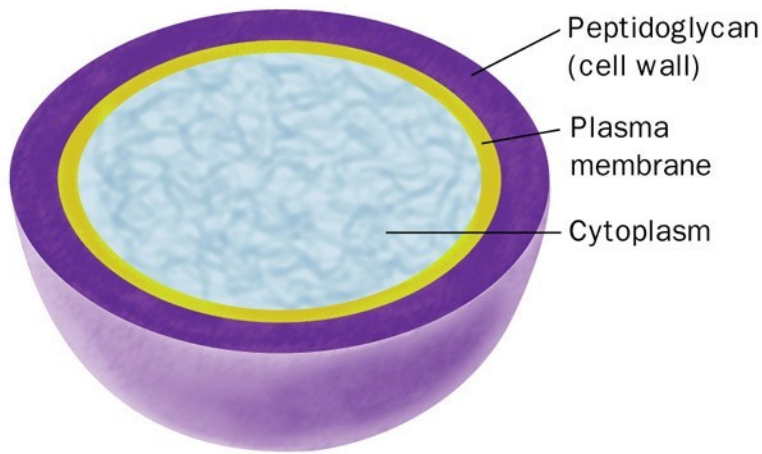
	Gram +	Gram -
1. NEOBARVENÝ PREPARÁT		
2. KRYSTALOVÁ VIOLEŤ		
3. LUGOLŮV ROZTOK		
4. ACETON		
5. ZŘEDĚNÝ KARBOLFUCHSIN		



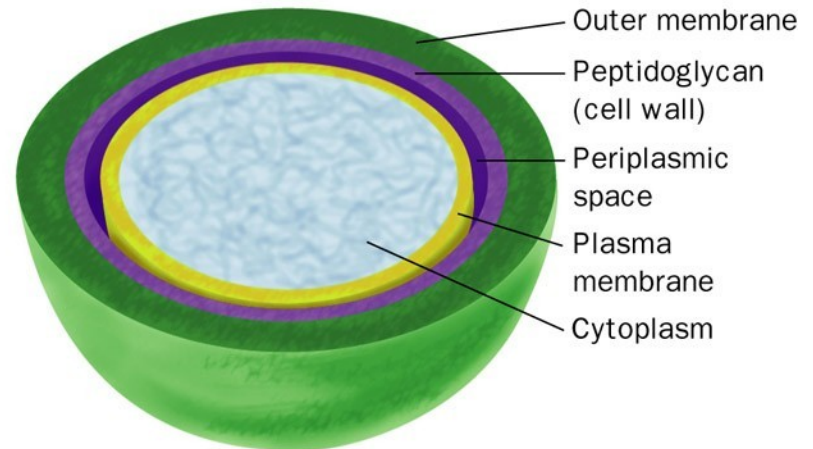
# Buněčná stěna bakterií

grampozitivní(a) a gramnegativní(b)

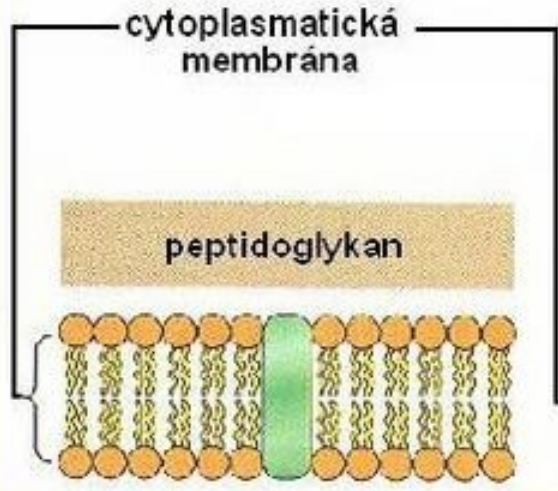
(a) Gram-positive bacteria



(b) Gram-negative bacteria

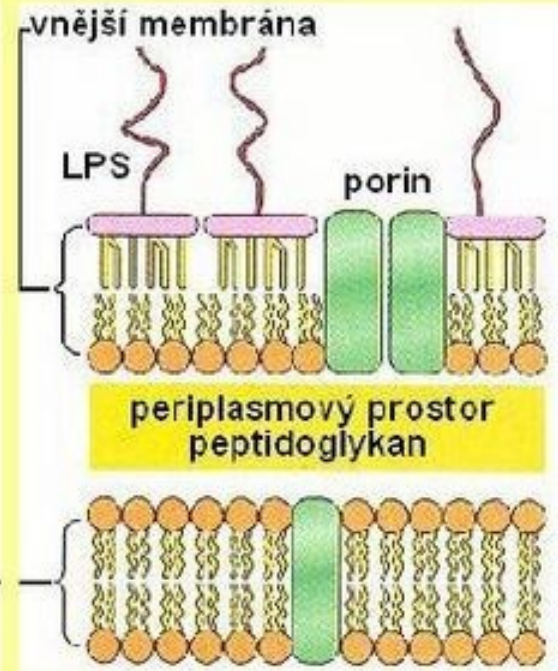






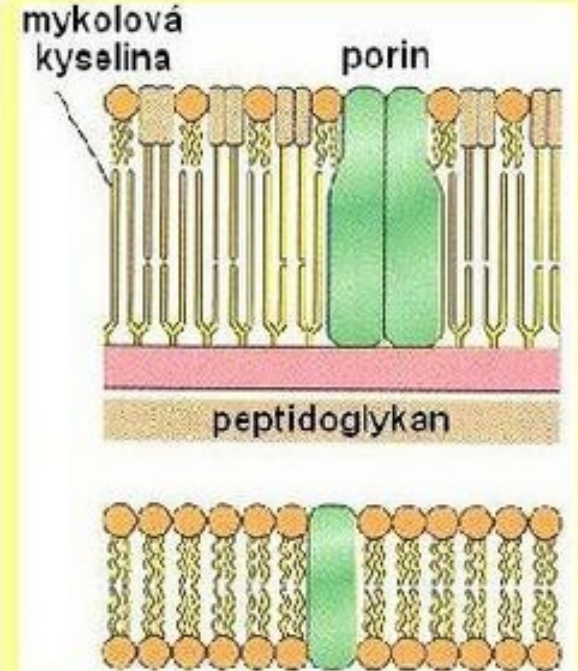
Buněčná stěna je poměrně silná, obsahuje kromě peptidoglykanu proteiny, polysacharidy a kyselinu teichoovou.

**G+ bakterie**



Vrstva peptidoglykanu (PG) je tenčí. Nad ní je vnější membrána (VM) – fosfolipidová dvojvrstva - spojená s PG molekulami lipoproteinu. Mezi PG a VM je periplasmový prostor. Zevní strana VM obsahuje lipopolysacharid (LPS). LPS se skládá z toxického lipidu A (endotoxin), základního polysacharidu a specifického polysacharidu, který vyčnívá z buňky (O antigen).

**G- bakterie**



Odlíšné složení buněčné stěny  
U kyseliny muramové v PG je místo N-acetylu N-glykol  
Ve stěně je velké množství volných i vázaných lipidových komponent obsahujících mykolové kyseliny.  
Povrch je hydrofobní, chrání proti vyschnutí, detergentům, kyselinám a alkoholu - acidorezistence.  
Nebarví se Gramovým barvením.

**mykobakterie**

# LIPIDY

*Lipos* - tuk

**Funkce : zdroj a reserva energie**

**Jednoduché - neutrální**

**strukturní funkce**

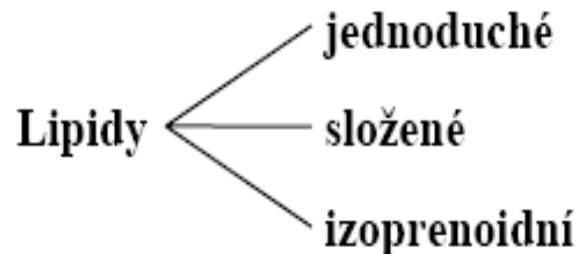
**Složené - polární, izoprenoidní - steroidní**

**ochranná a izolační funkce**

**Jednoduché - neutrální**

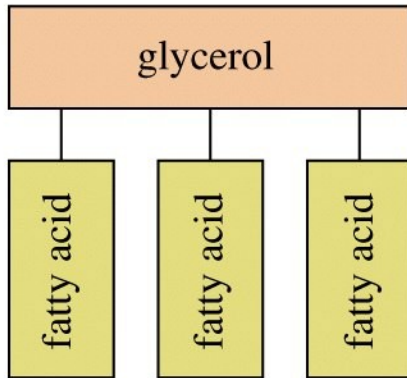
**různé biologické funkce**

**Izoprenoidní - steroidní**



## Neutrální

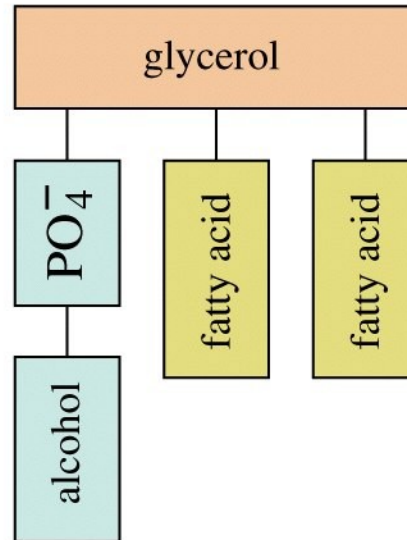
### Triacylglycerols



Storage lipids (nonpolar)  
(a)

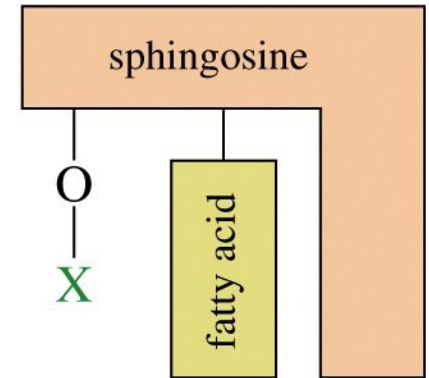
## Polární

### Glycerophospholipids



Membrane lipids (polar)  
(b)

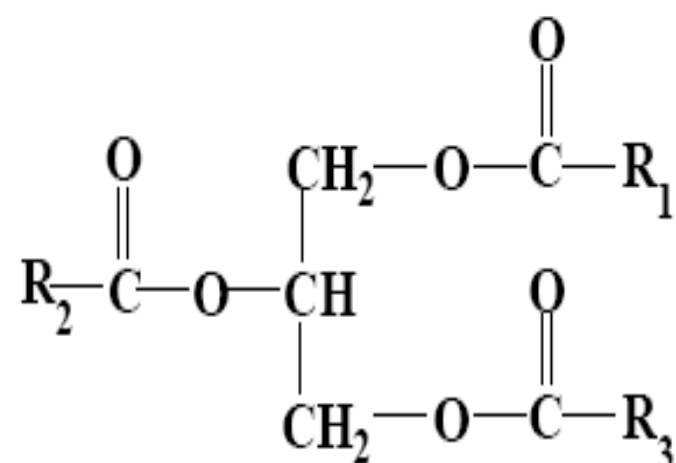
### Sphingolipids



Jednoduché lipidy :

chemicky - estery mastných kyselin a alkoholů

ACYLGLYCEROLY - triglyceridy - estery mastných kyselin a glycerolu





# Adipocyty

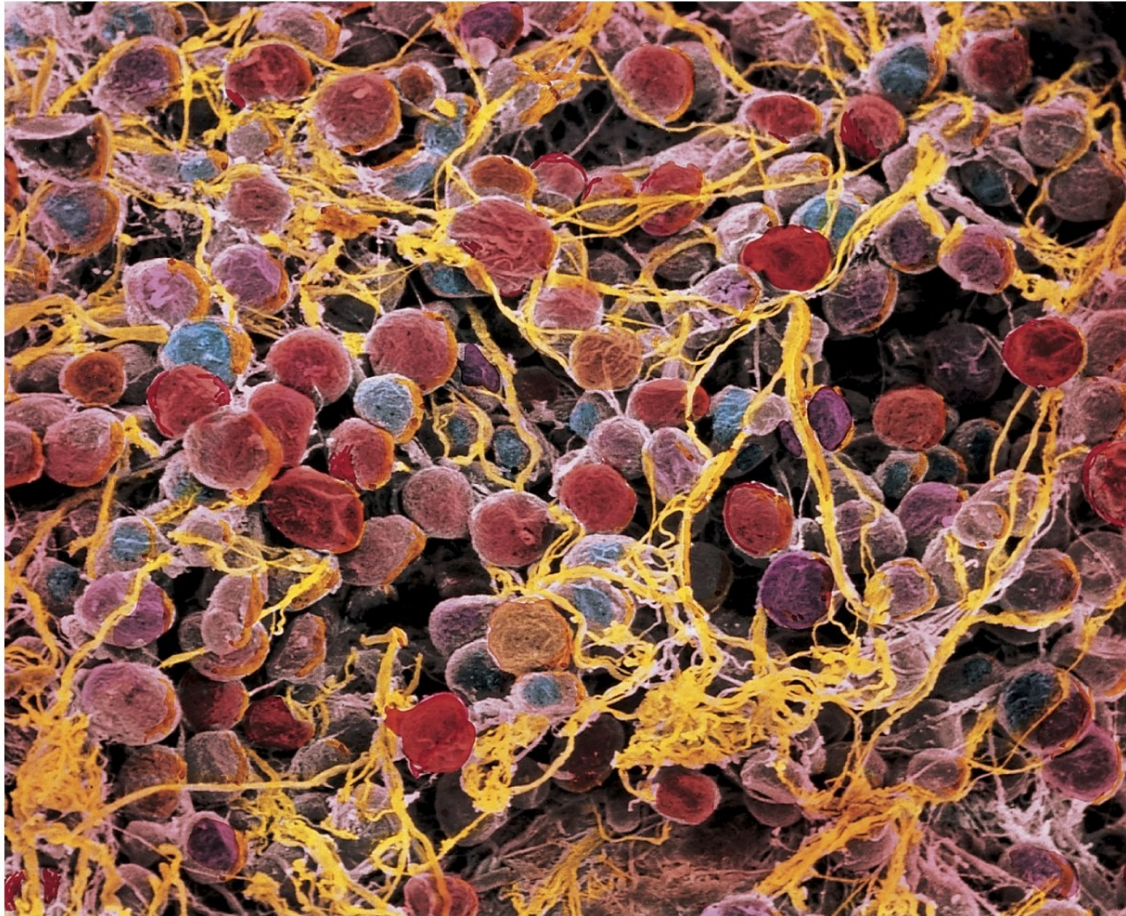
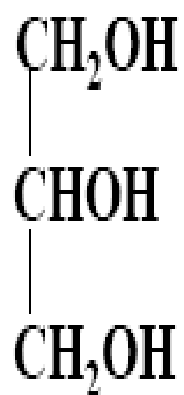
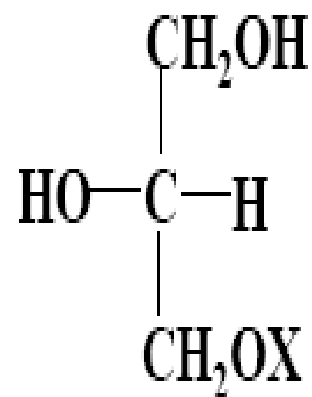


Figure 8-4 Concepts in Biochemistry, 3/e

## Alkohol

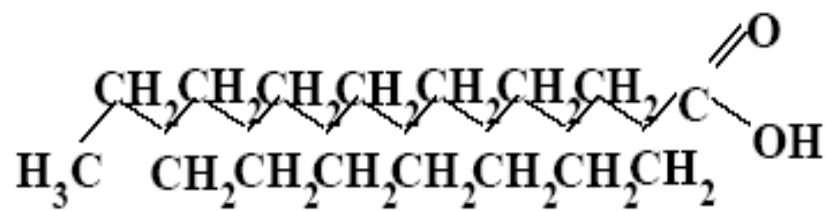


glycerol

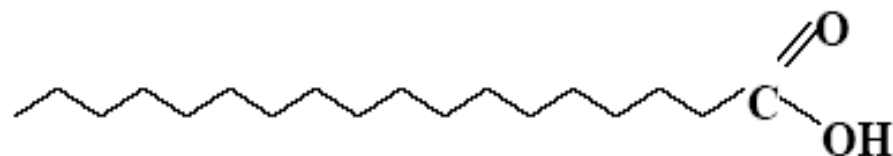
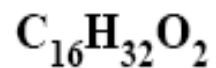


derivát sn-glycerol  
(L-glycerol)

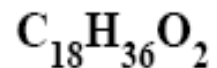
Mastné kyseliny - nasycené



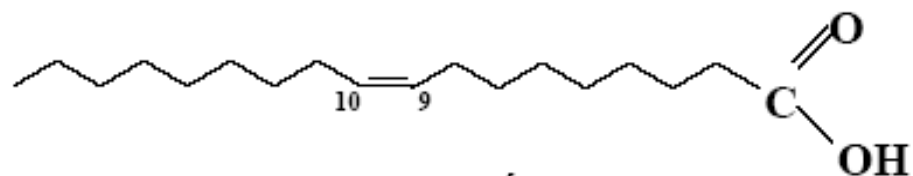
K. PALMITOVÁ



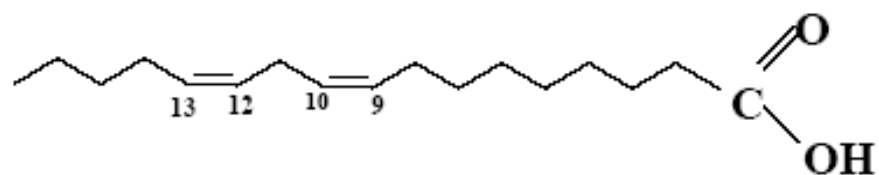
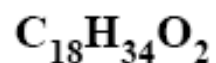
K. STEAROVÁ



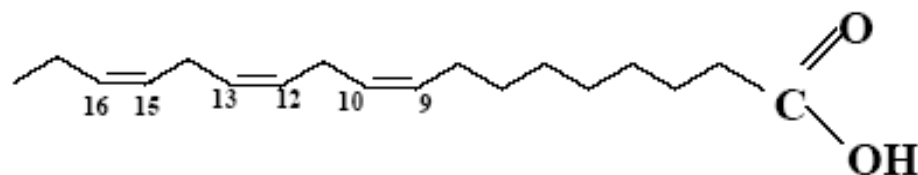
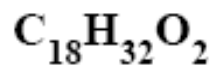
## Mastné kyseliny - nenasycené



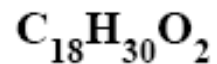
**K. OLEJOVÁ**



**K. LINOLOVÁ**



**K. LINOLENOVÁ**







**Saturated  
chain**

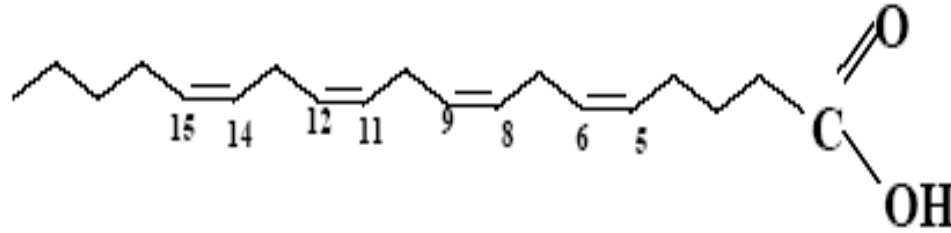


***trans*  
Double bond**

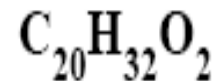


***cis*  
Double bond**

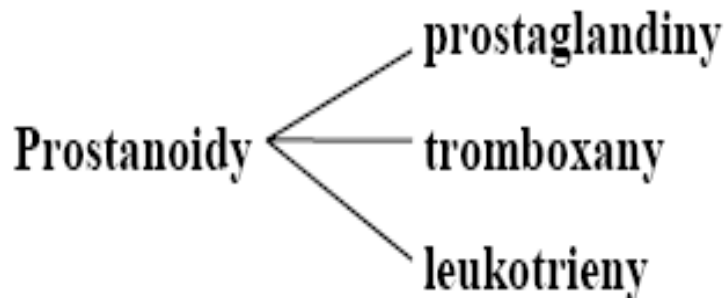




## KARACHIDONOVÁ

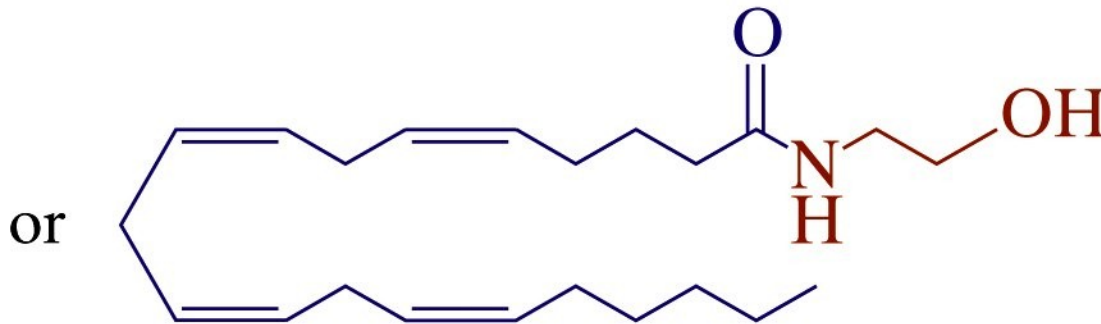
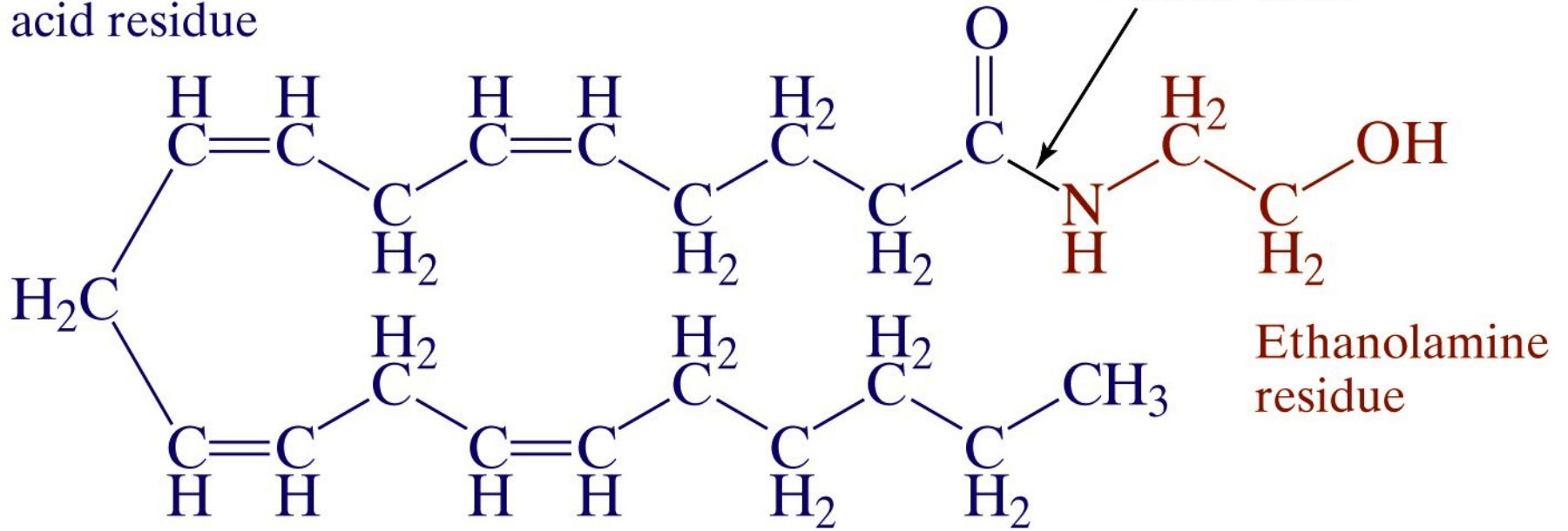


- Srdeční systém
- Respirační systém
- Reprodukční systém
- Gastrointestinální trakt



- Pocity bolesti
- Horečka
- Regulace krevního tlaku
- Indukci srážení krve
- Reprodukční funkce
- Regulace cyklu spánku

Arachidonic acid residue



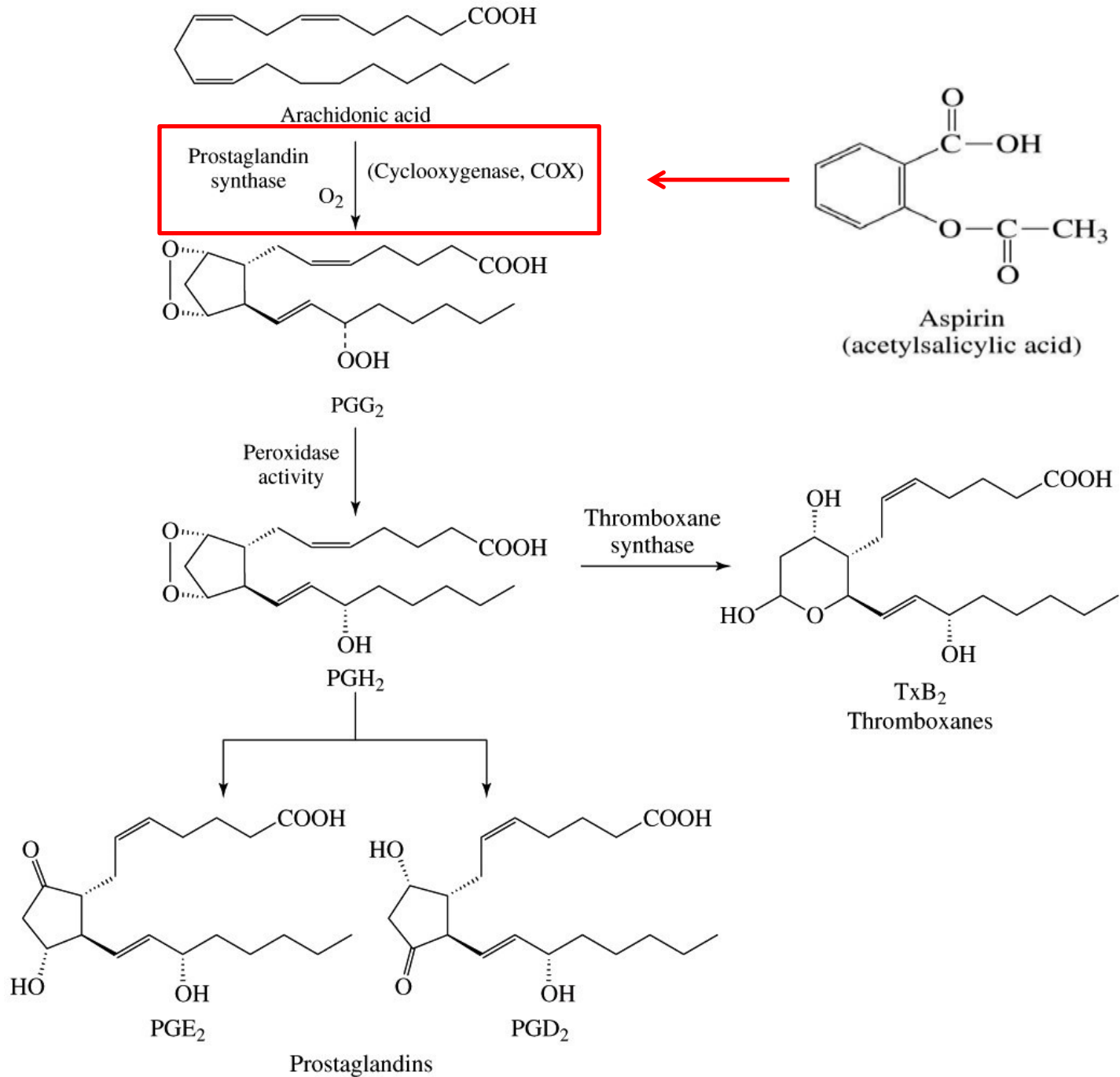
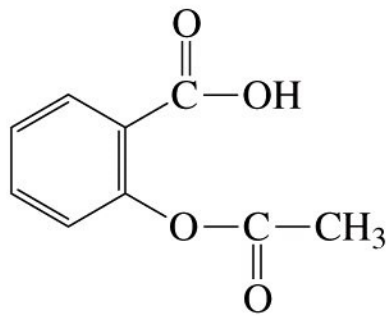
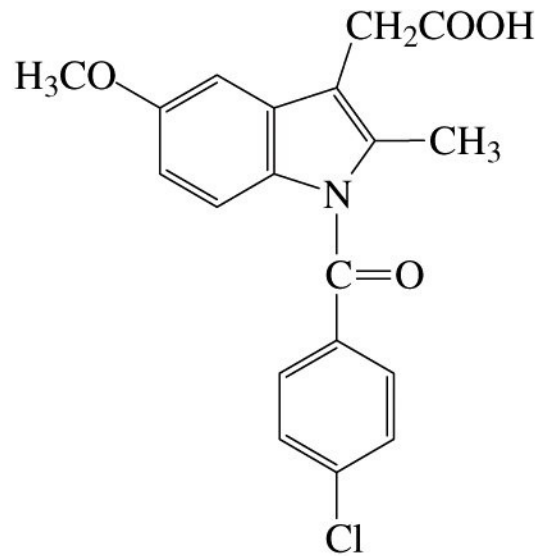


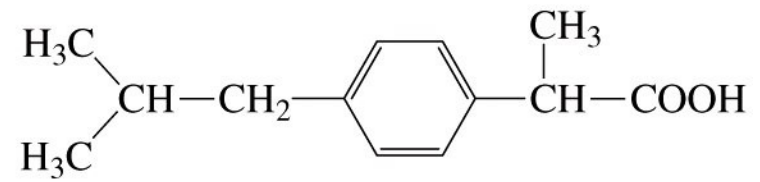
Figure 8-14 Concepts in Biochemistry, 3/e



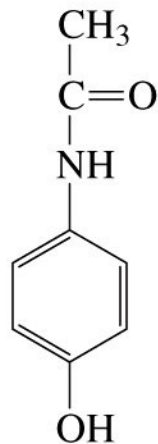
Aspirin  
(acetylsalicylic acid)



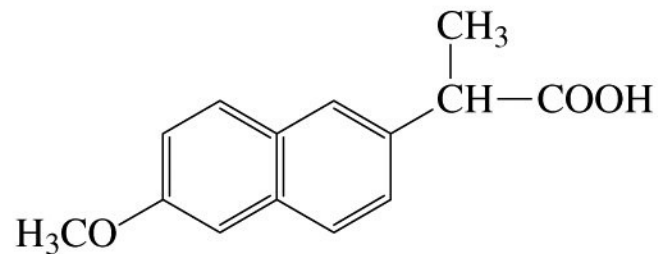
Indomethacin



Ibuprofen



Acetaminophen

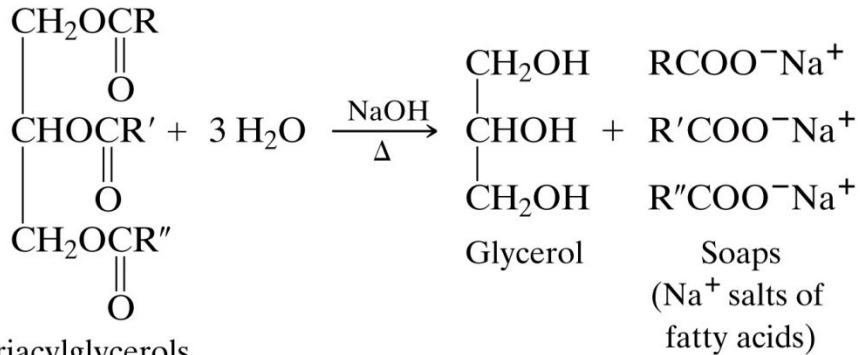


Naproxen (Aleve)

# Důležité reakce tuků - zmydlování - NaOH

- ztužování - H<sub>2</sub>

- žluknutí - O<sub>2</sub>



Triacylglycerols

Unnumbered figure pg238b Concepts in Biochemistry, 3/e  
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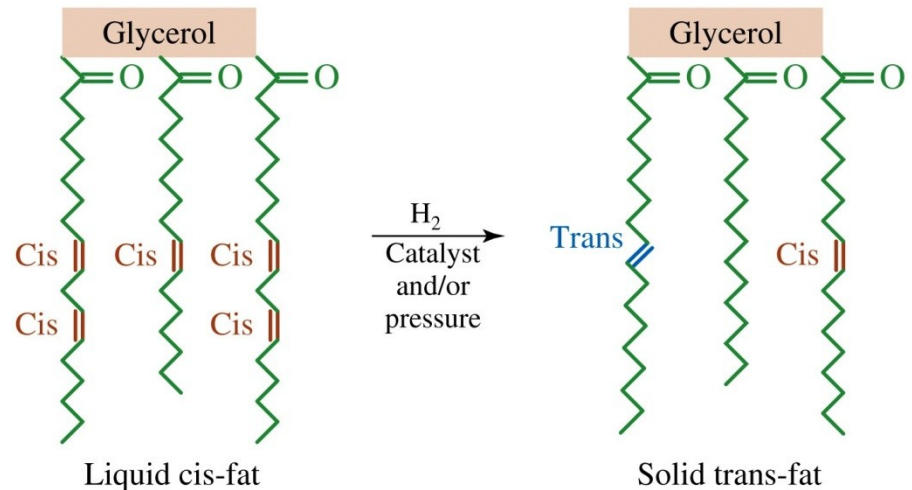
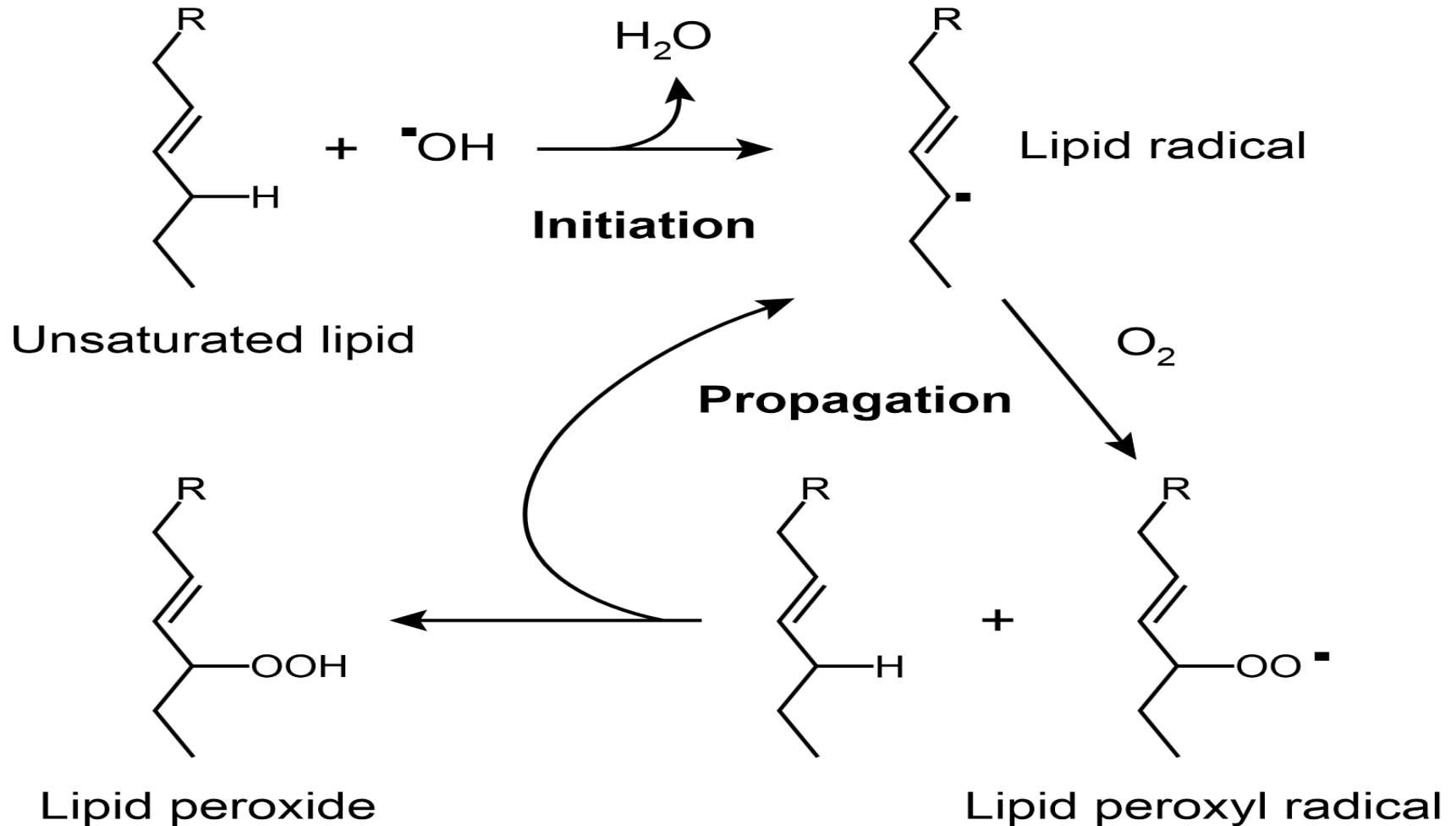


Figure 8-3 Concepts in Biochemistry, 3/e  
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# Lipoperoxidace

## reaktivní formy kyslíku (ROS)





**VOSKY - estery mastných kyselin a alifatických alkoholů**

**včelí vosk - palmitan myricylnatý ( $C_{30}H_{61}OH$ )**

**vorvaňovina - palmitan cetylnatý ( $C_{16}H_{33}OH$ )**

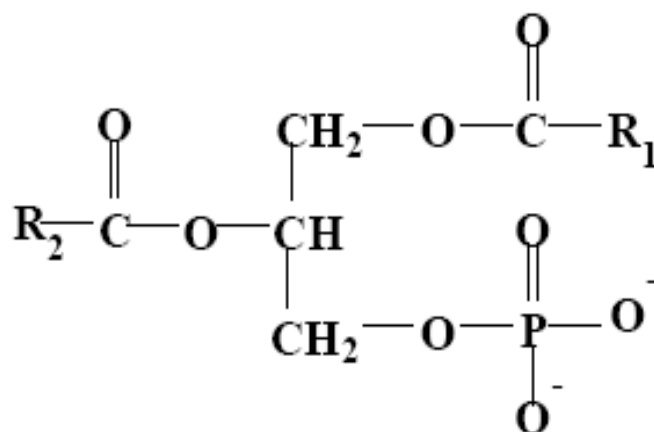
**lanolin**

**karnaubský vosk**

Složené lipidy :

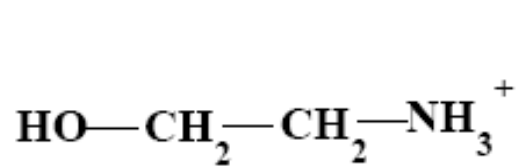
## FOSFOLIPIDY

A. Fosfoacylglyceroly - fosfatidy

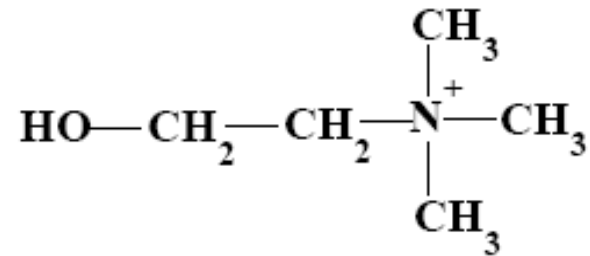


### K. FOSFATIDOVÁ

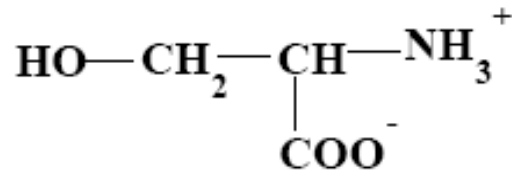
1,2-diacyl-glycerol-3-fosforečná k.



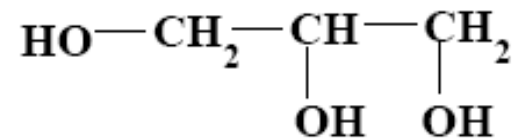
ETHANOLAMIN



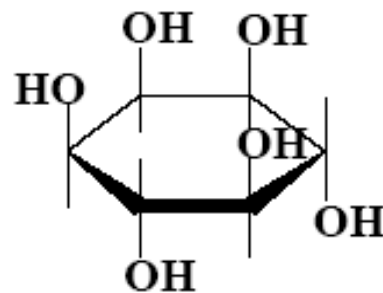
CHOLIN



SERIN



GLYCEROL

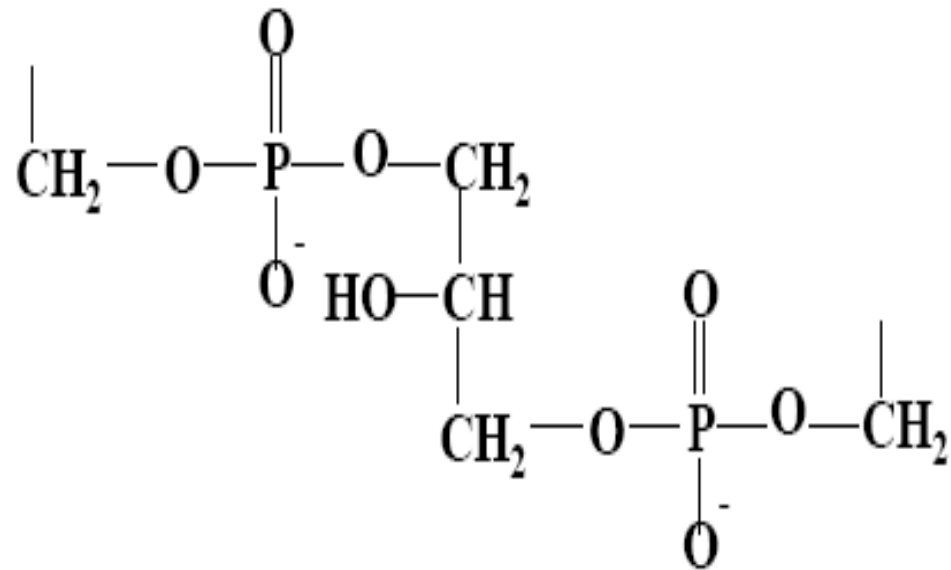


INOSITOL

Fosfatidylcholin - lecitiny

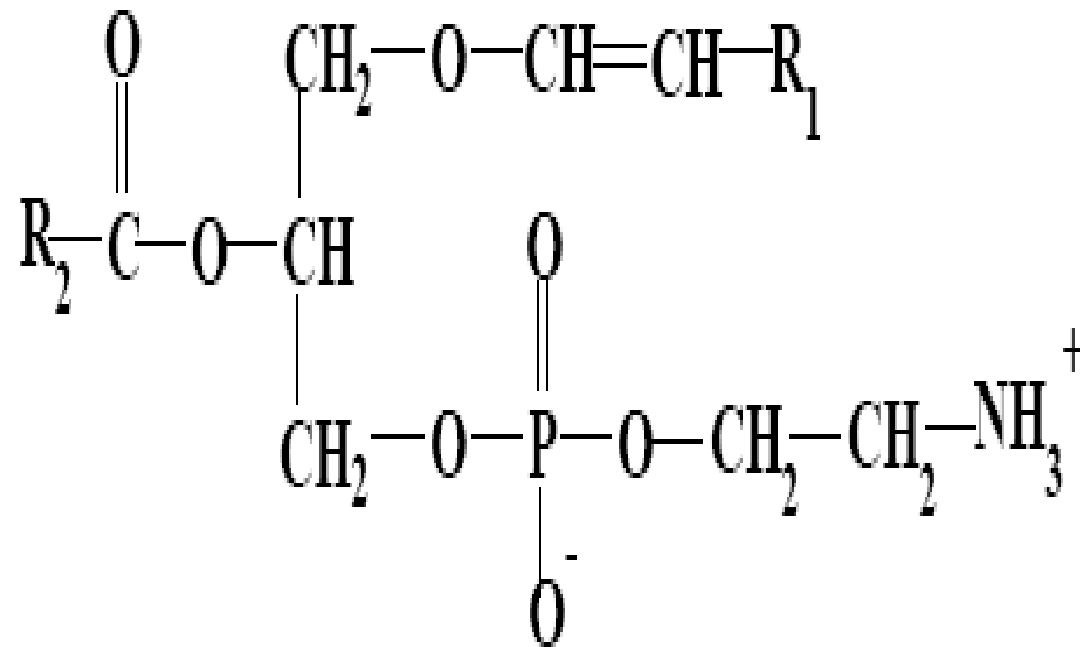
Fosfatidylethanolamin - kefaliny

Bisfosfatidylglycerol - kardiolipin



Fosfatidylinositol

# Plazmalogeny



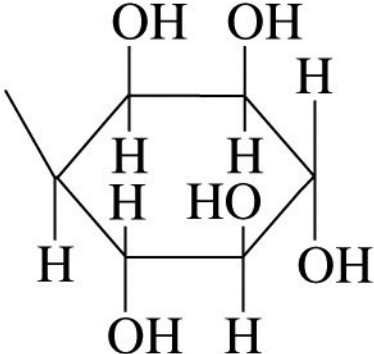
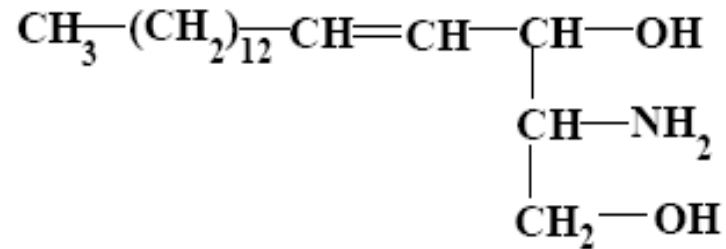
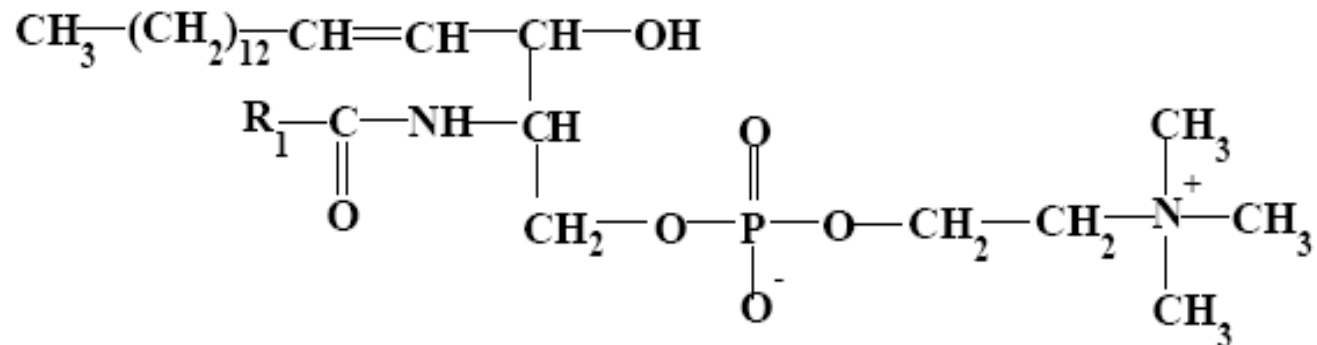
Name of <b>X</b>	Structure of <b>X</b>	Name of Glycerophospholipids
(a) Hydrogen	—H	Phosphatidic acid
(b) Ethanolamine	—CH <sub>2</sub> —CH <sub>2</sub> — $\overset{+}{\text{N}}\text{H}_3$	Phosphatidylethanolamine
(c) Choline	—CH <sub>2</sub> —CH <sub>2</sub> — $\overset{+}{\text{N}}(\text{CH}_3)_3$	Phosphatidylcholine
(d) Serine	$\begin{array}{c} \text{—CH}_2\text{—CH—}\overset{+}{\text{N}}\text{H}_3 \\   \\ \text{COO}^- \end{array}$	Phosphatidylserine
(e) Inositol		Phosphatidylinositol

Figure 8-7 part 2 Concepts in Biochemistry, 3/e  
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B. Sfingomyelin - sfingofosfolipidy



SFINGOSIN



SFINGOMYELIN

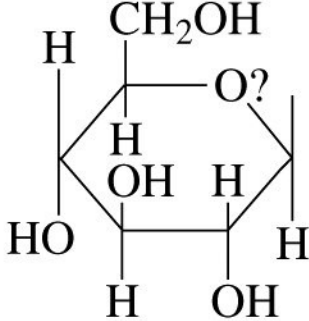
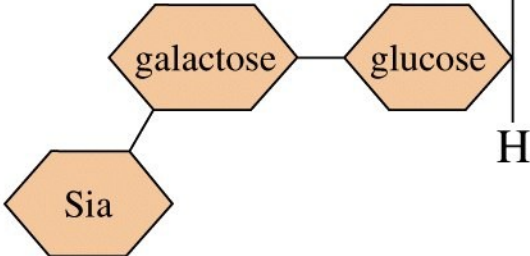
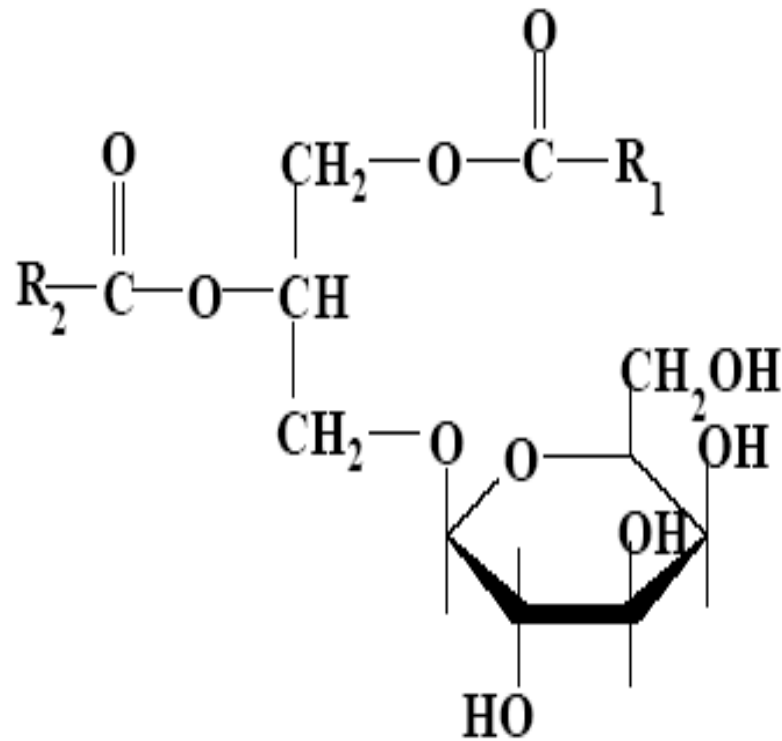
Name of <b>X</b>	Structure of <b>X</b>	Name of Sphingolipid
(b) Hydrogen	—H	Ceramide
(c) Phosphocholine	$\begin{array}{c} \text{O} \\ \parallel \\ \text{—P—O—CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_3 \\   \\ \text{O}^- \end{array}$	Sphingomyelin
(d) Glucose		Glucosylcerebroside
(e) Complex oligosaccharide		Ganglioside

Figure 8-8 part 2 Concepts in Biochemistry, 3/e  
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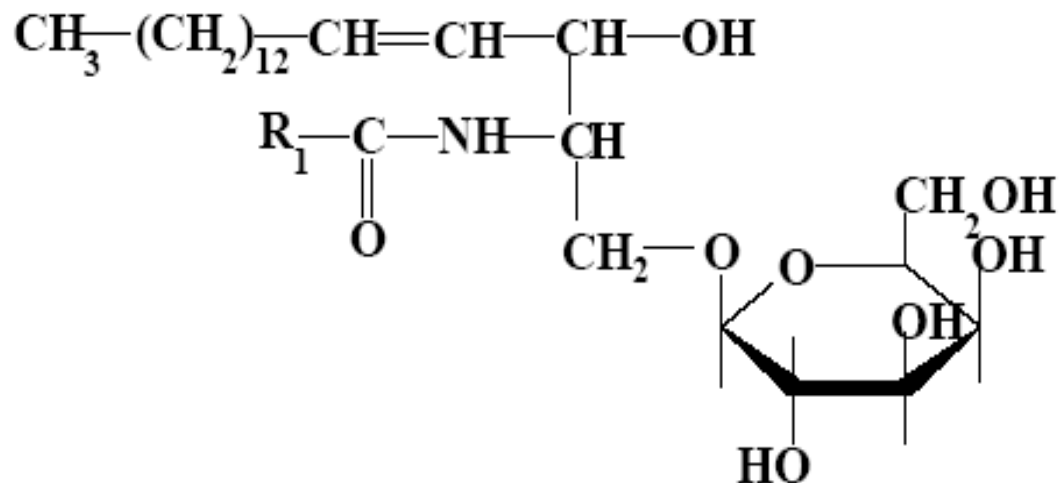


# GLYKOLIPIDY

## A. Glycerolglykolipidy



## B. Cerebrosidy



galaktocerebrosidy - mozek

sulfatidy

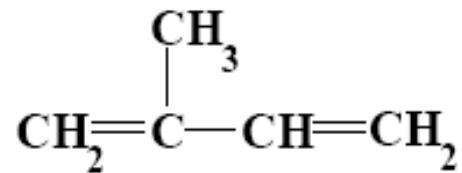
glukocerebrosidy - ostatní tkáně

## C. Glykosfingolipidy

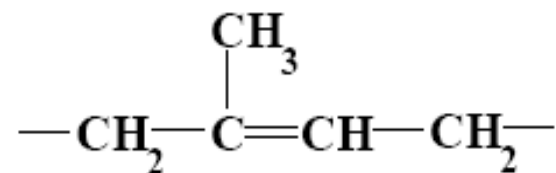
gangliosidy - sialová kyselina - ganglie nervových buněk

## Izoprenoidní lipidy :

Základní strukturální jednotka - izopren 2-methyl-1,3-butadien

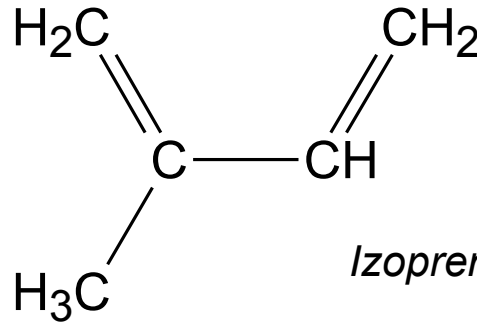


izopren

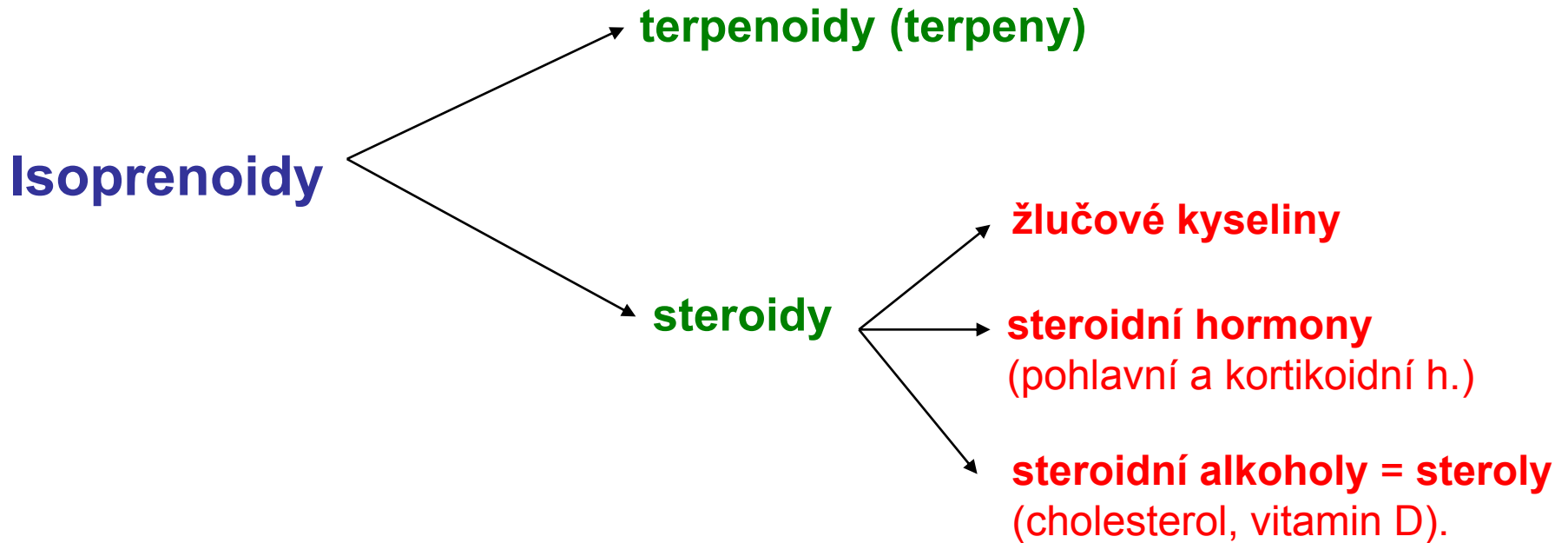


izopentenyl

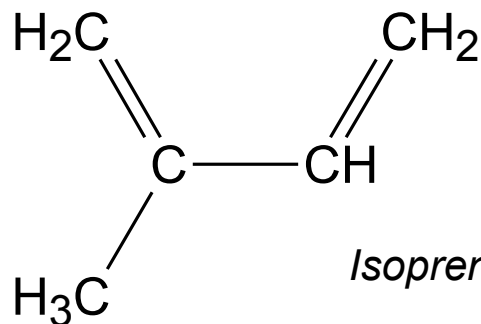
# Izoprenoidy



*Izopren (2-methylbuta-1,3-dien)*



## a) Terpenoidy = terpeny



*Isopren (2-methylbuta-1,3-dien)*

Monoterpeny	C <sub>10</sub> , 2 isopreny	<b>Limonen, menthol, kafr, pinen</b>
Seskviterpeny	C <sub>15</sub> , 3 isopreny	
Diterpeny	C <sub>20</sub> , 4 isopreny	<b>Vitamin A (retinol), fytol</b>
Triterpeny	C <sub>30</sub> , 6 isoprenů	
Tetraterpeny	C <sub>40</sub> , 8 isoprenů	<b>Karotenoidy, skvalen</b>
Polyterpeny	C <sub>5n</sub> , n isoprenů	<b>Přírodní kaučuk</b>

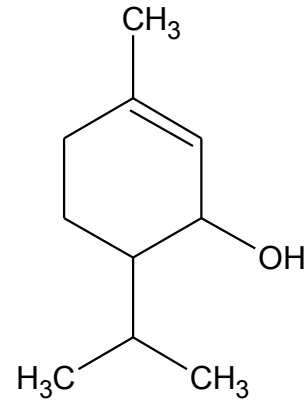
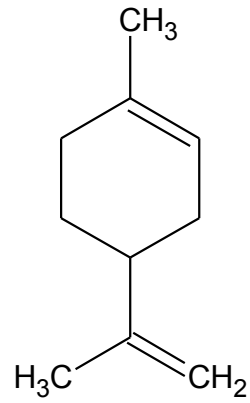
# Izoprenoidy

**zdroje:** *silice* (éterické oleje) – vonící těkavé kapaliny  
(hlavně květy a plody rostlin)

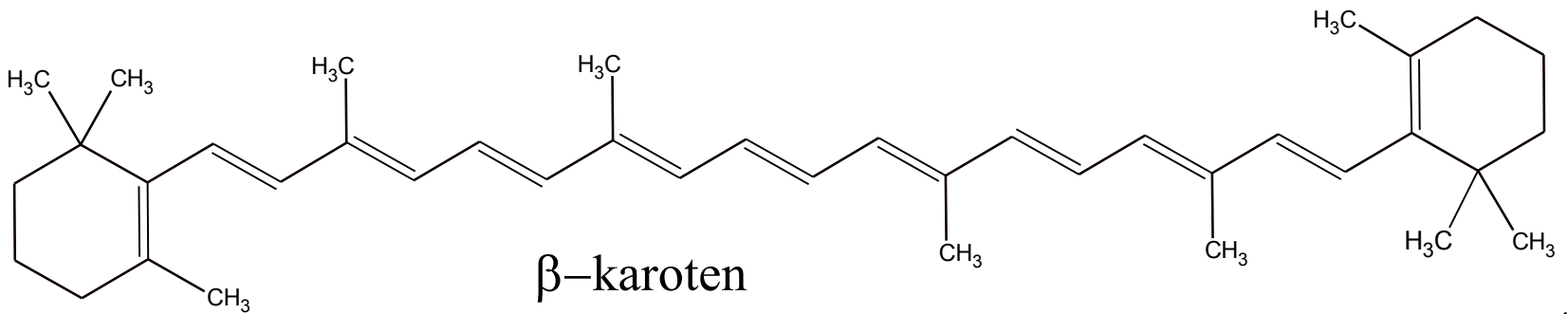
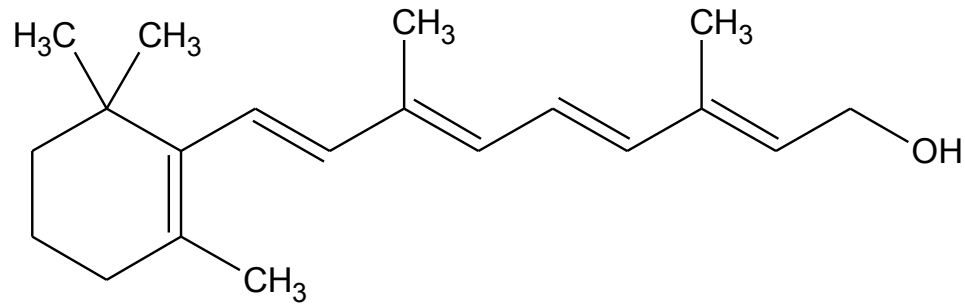


nerozpustné ve vodě, vznikají oxidací silic v místech  
porušení kůry jehličnanů, specifická vůně  
*balzámy* – polotekuté směsi silic a pryskyřic

Silice:



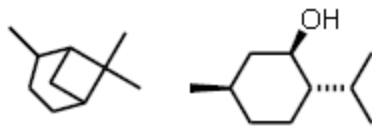
Vitamin A karotenoidy:



# Terpeny (Terpenoidy, Isoprenoidy)

## Monoterpenes

$C_{10}$

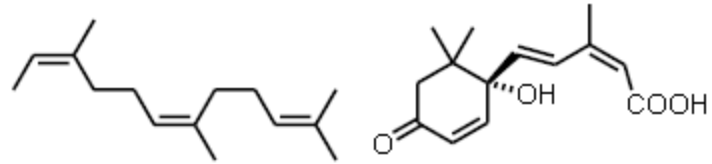


pinane

menthol

## Sesquiterpenes

$C_{15}$

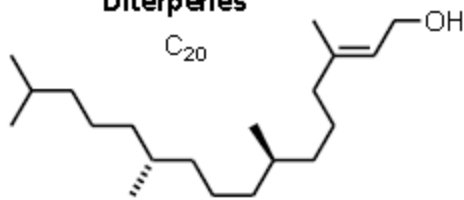


farnesane

abscisic acid

## Diterpenes

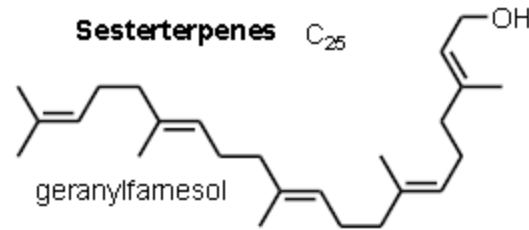
$C_{20}$



phytol

## Sesterterpenes

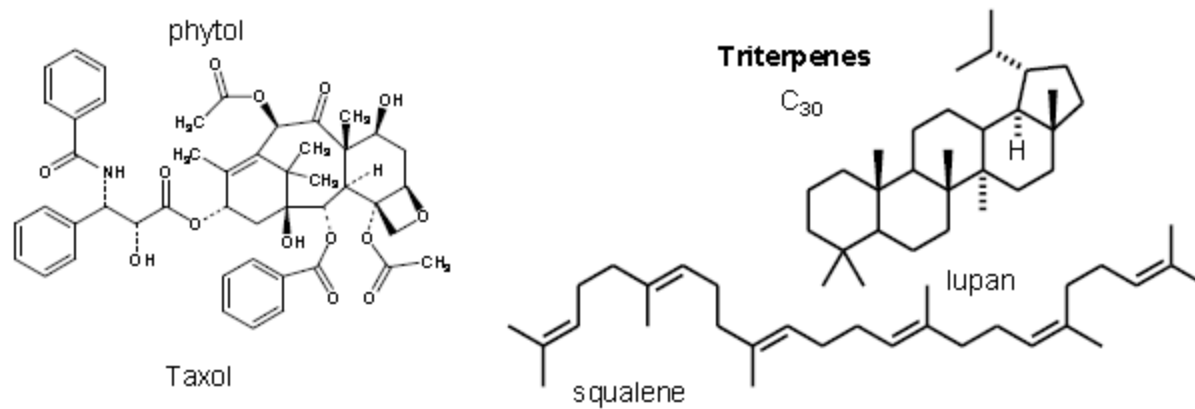
$C_{25}$



geranyl farnesol

## Triterpenes

$C_{30}$



Taxol

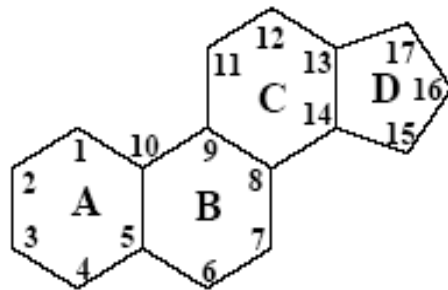
lupan

squalene

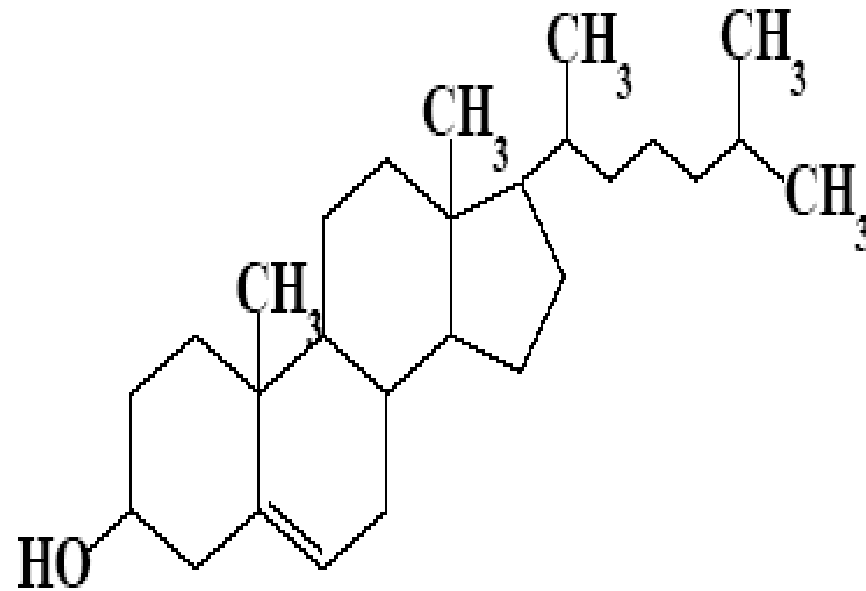


**STEROIDY**

**STERAN - cyklopentanoperhydrofenantren**

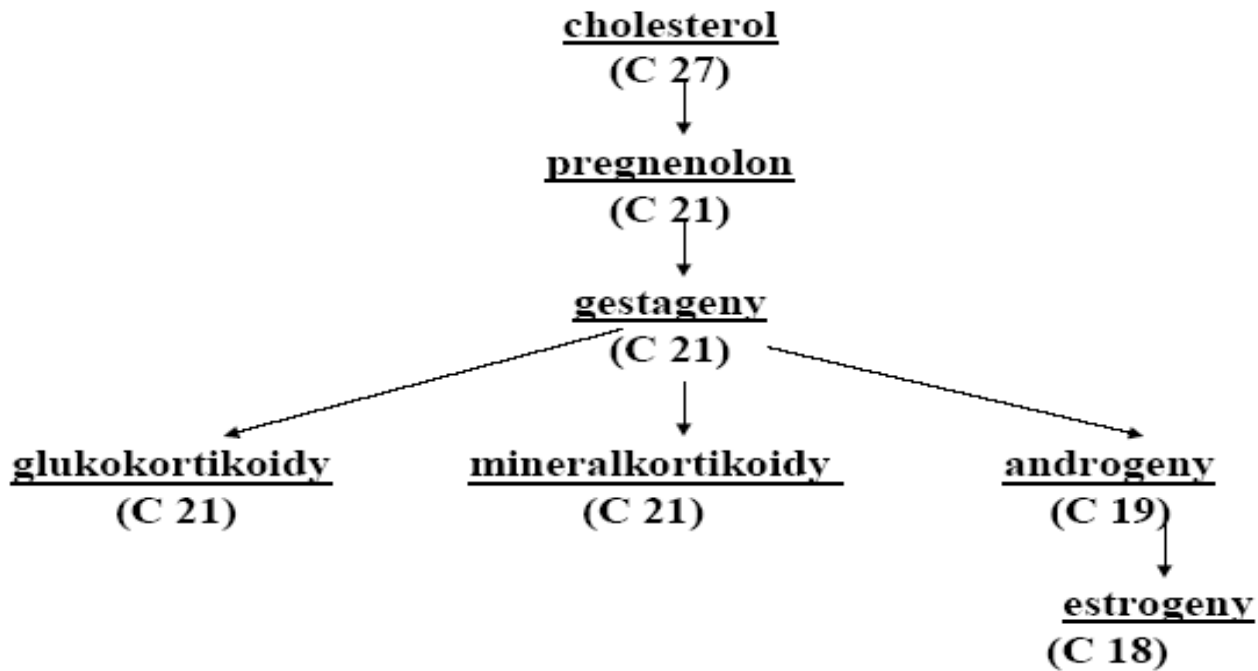


A. Steroly



**CHOLESTEROL**

## Steroidní hormony



*Glukokortikoidy* - kortisol, kortikosteron - kůra nadledvinek

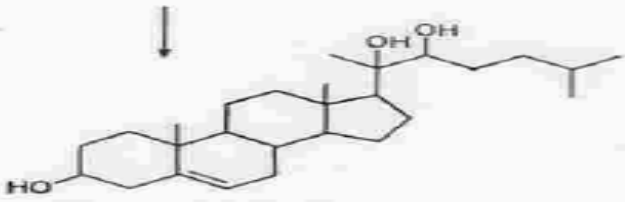
*Mineralkortikoidy* - aldosteron - kůra nadledvinek

*Androgeny* - testosteron - varlata

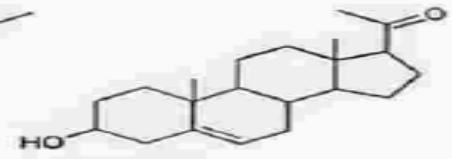
*Estrogeny* - estron, estradiol, estratriol - vaječníky

*Gestageny* - progesteron - vaječníky

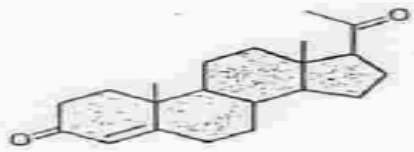
cholesterol  $\rightleftharpoons$  ester cholesterolu  
(5-cholesten-3 $\beta$ -ol)



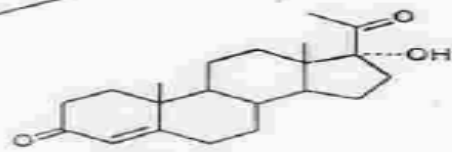
20,22-dihydroxycholesterol  
(20,22-dihydroxy-5-cholesten-3 $\beta$ -ol)



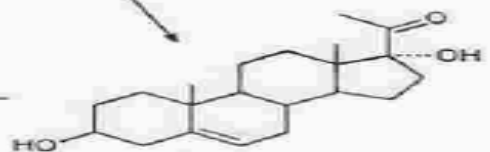
pregnenolon  
(3 $\beta$ -hydroxy-5-pregnen-20-on)



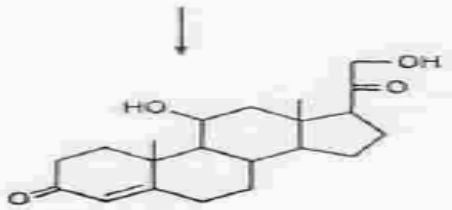
progesteron  
(4-pregnen-3,20-dion)



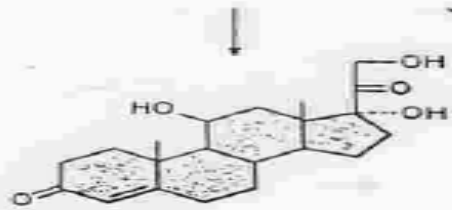
17-hydroxyprogesteron  
(17-hydroxy-4-pregnen-3,20-dion)



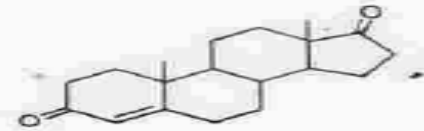
17-hydroxypregnenolon  
(3 $\beta$ ,17-dihydroxy-5-pregnen-20-on)



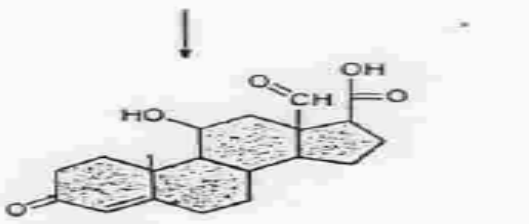
kortikosteron  
(11 $\beta$ ,21-dihydroxy-4-pregnen-3,20-dion)



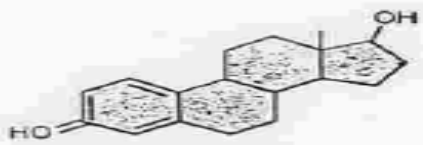
kortisol  
(11 $\beta$ ,17,21-trihydroxy-4-pregnen-3,20-dion)



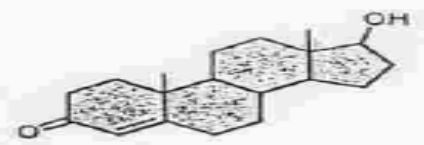
androstendion  
(4-androsten-3,17-dion)



aldosteron  
(11 $\beta$ ,21-dihydroxy-3,20-dioxo-4-pregnen-18-al)

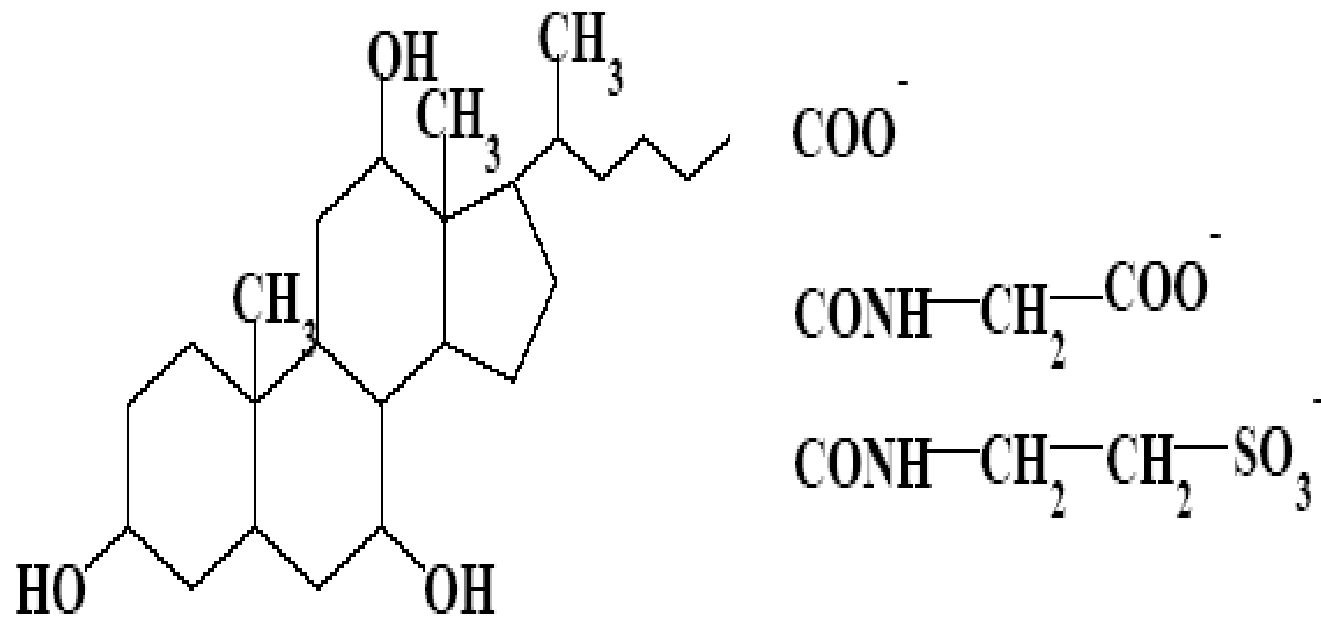


17 $\beta$ -estradiol  
(1,3,5(10)-estratrien-3,17 $\beta$ -diol)



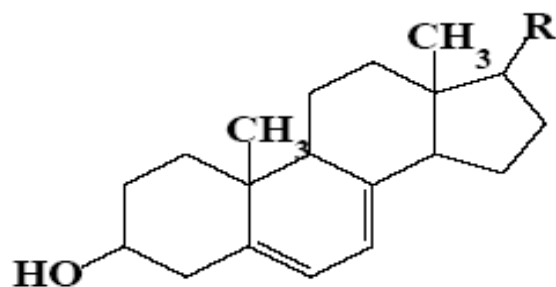
testosteron  
(17 $\beta$ -hydroxy-4-androsten-3-on)

B. Žlučové kyseliny - k.cholová, k. glykocholová, k. taurocholová

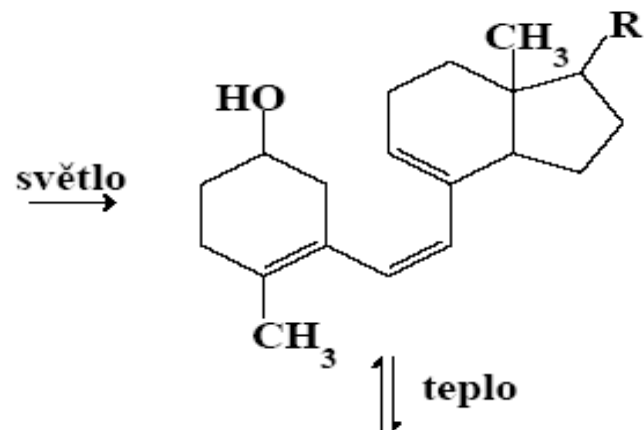


C. Kalciferoly - vitaminy - D<sub>3</sub> - cholekalciferol, D<sub>2</sub> - ergokalciferol

provitamin D

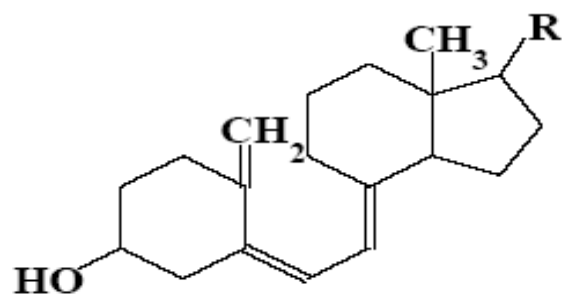


prekalciferol

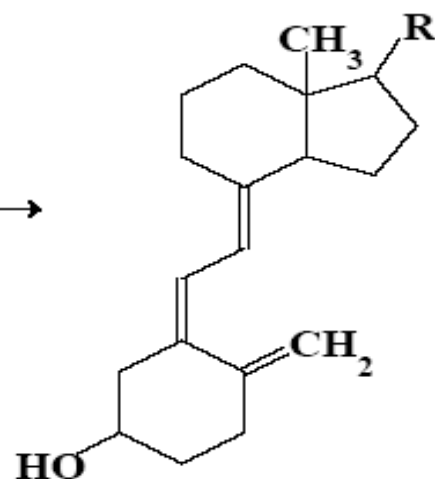


světlo  
→

↕ teplo



↔



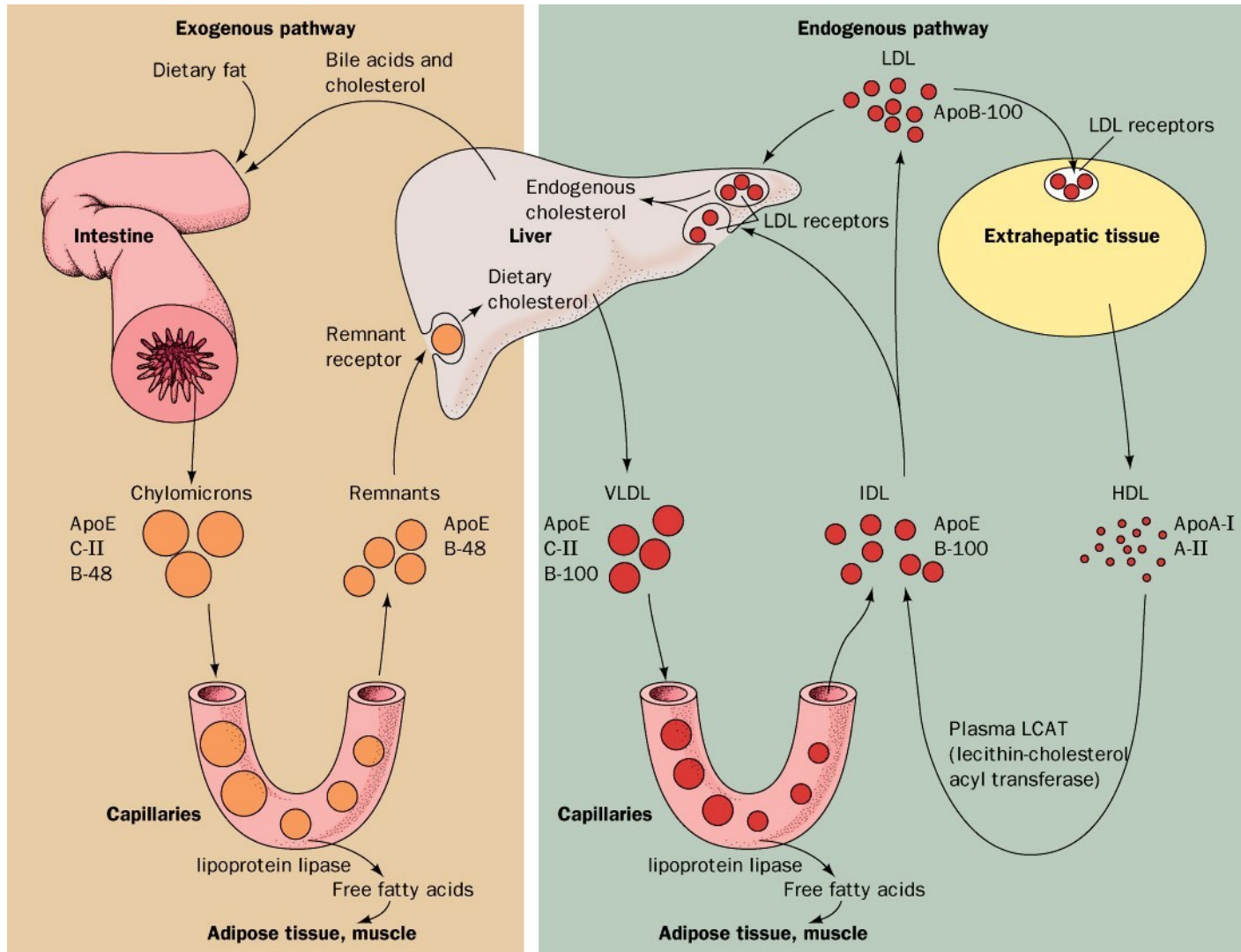
kalciferol

# Plazmatické lipoproteiny

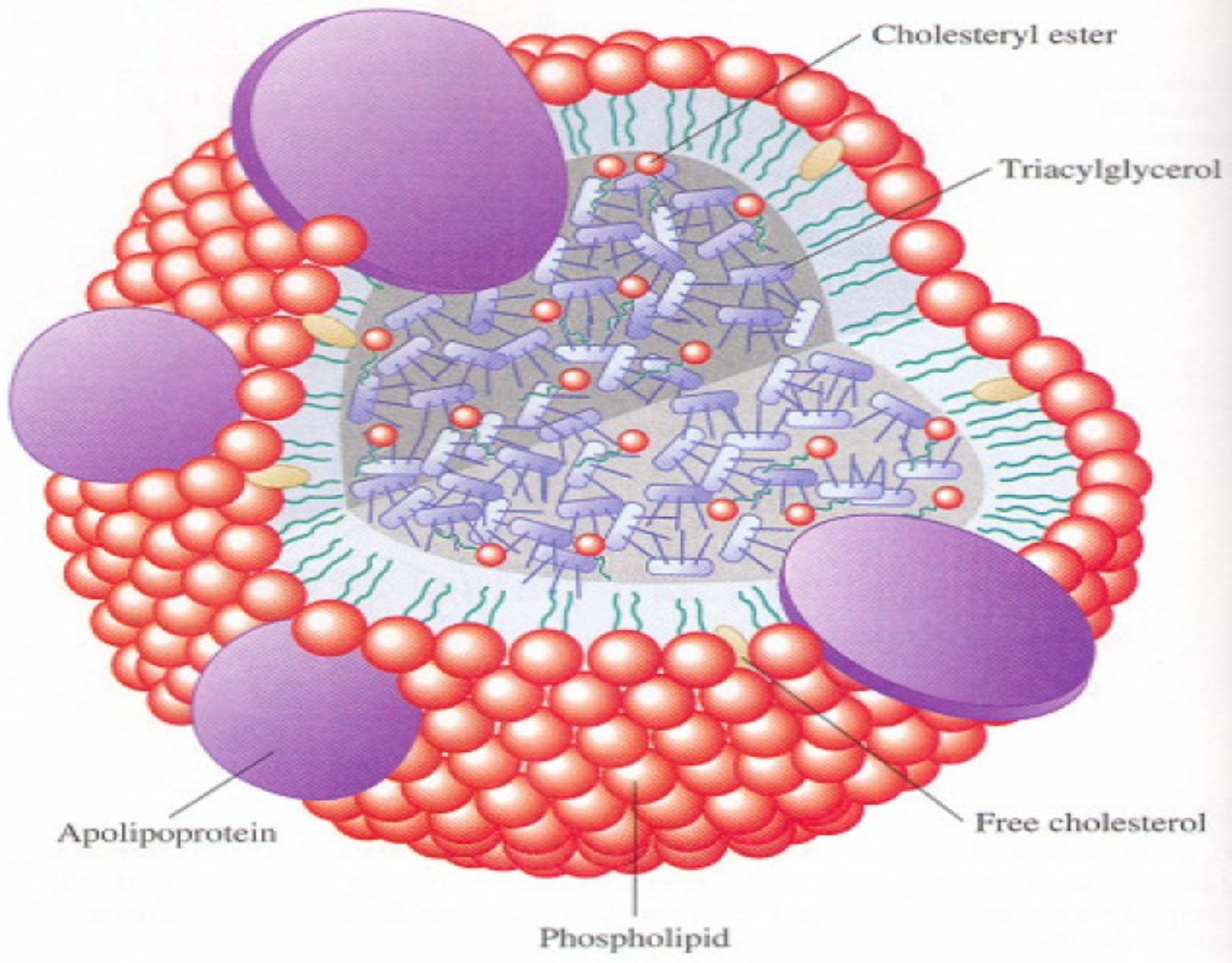
Charakteristiky hlavních tříd lipoproteinů v lidské plasmě

Třída lipoproteinů	Hlavní lipidy <sup>a</sup>	Apoproteiny	Hustota g / mL	Průměr částice nm
Chylomikrony a zbytky	triacylglyceroly v dietě	A-I,A-II,B-48, C-I,C-II,C-III, E	<0,95	80–500
VLDL	endogenní triacylglyceroly, estery cholesterolu, cholesterol	B-100,C-I,C-II	0,95–1,006	30–80
IDL	estery cholesterolu, triacylglyceroly, cholesterol	B-100,C-III,E	1,006–1,019	25–35
LDL	estery cholesterolu, cholesterol, triacylglyceroly,	B-100	1,019–1,063	18–28
HDL	estery cholesterolu, cholesterol	A-I,A-II,C-I,	1,063–1,210	5–12

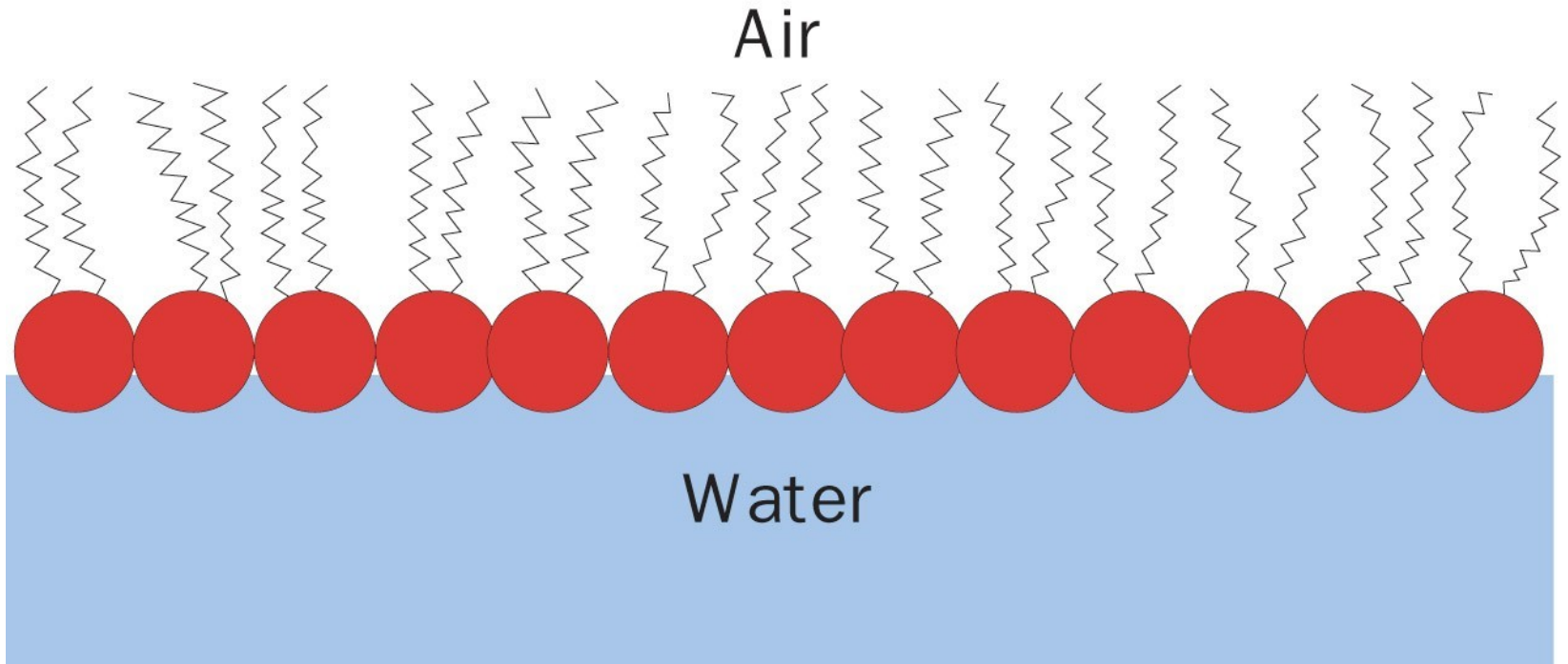
# Plazmatické lipoproteiny







# Membrány



# Membrány

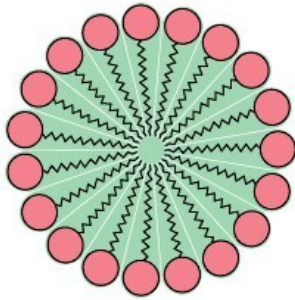
detergenty, tenzidy,

(a)

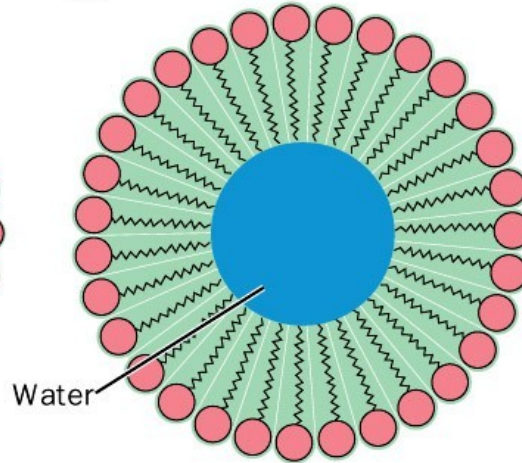


van der Waals  
envelope

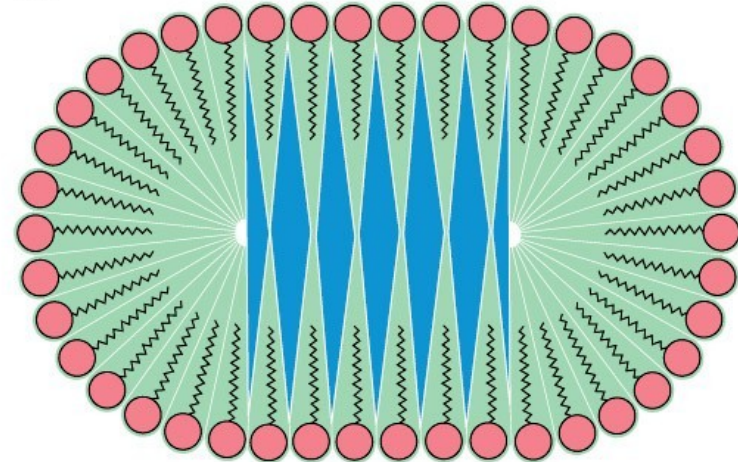
(b)



(c)



(d)

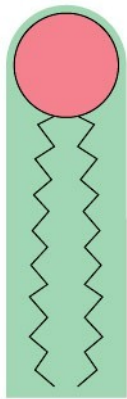




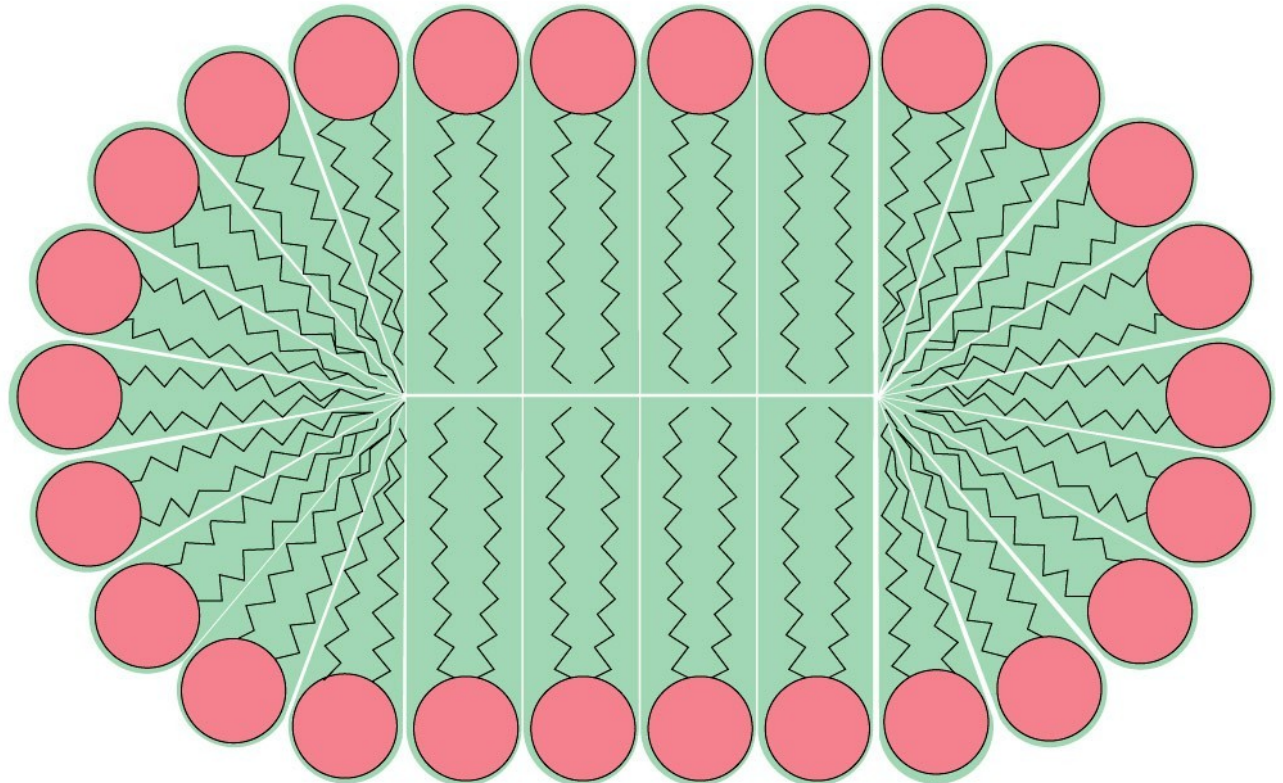
# Membrány

fosfolipidy

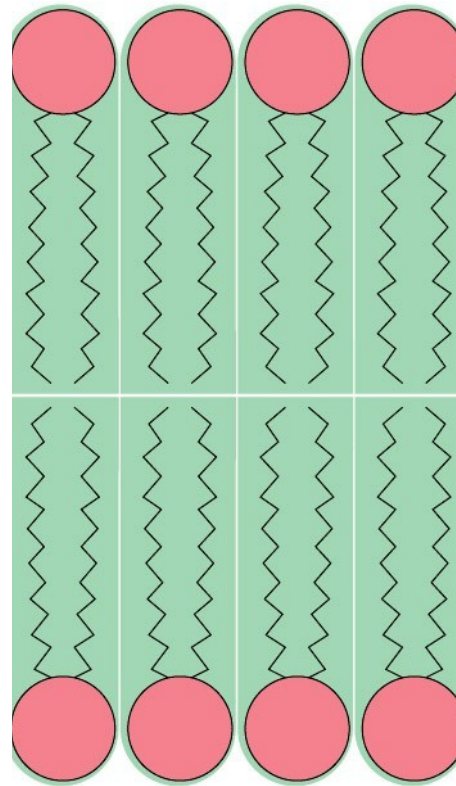
(a)

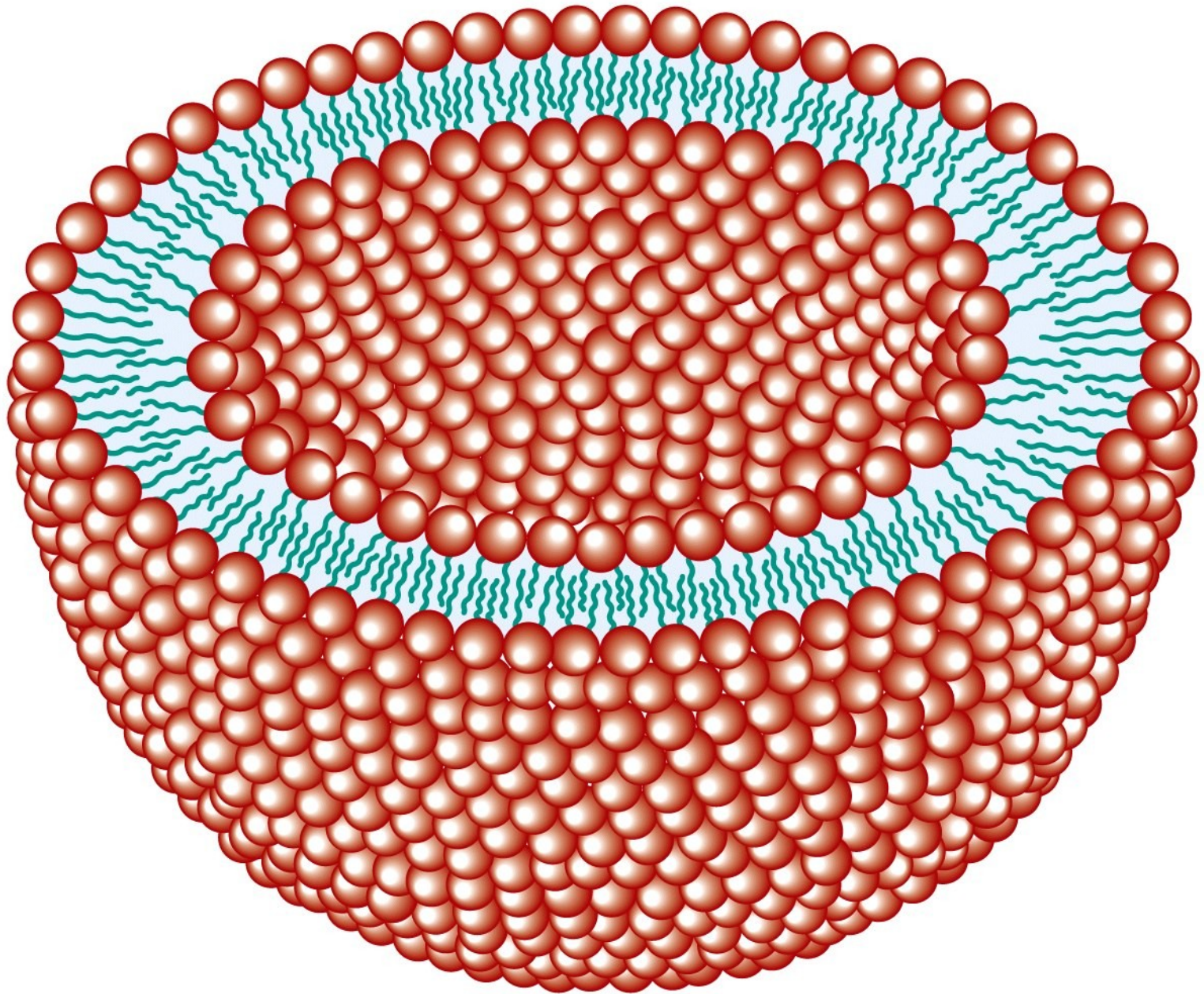


(b)



# Membrány





**Figure 9-1b** Concepts in Biochemistry, 3/e  
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**Biomembrány : agregované formy biolipidů**

**Význam biomembrán - transport**

**- kompartmentace**

**- komunikace**

## Biomembrány : agregované formy biolipidů

### Molekulové složení membrán

<b>Membrána</b>	<b>proteiny</b> %	<b>lipidy</b> %	<b>sacharidy</b> %
<b>cytoplazmatická</b>	<b>49</b>	<b>43</b>	<b>8</b>
<b>jaderná</b>	<b>59</b>	<b>35</b>	<b>2</b>
<b>mitochondriální vnější</b>	<b>52</b>	<b>46</b>	<b>2</b>
<b>mitochondriální vnitřní</b>	<b>76</b>	<b>23</b>	<b>1</b>
<b>myelinová</b>	<b>18</b>	<b>79</b>	<b>3</b>

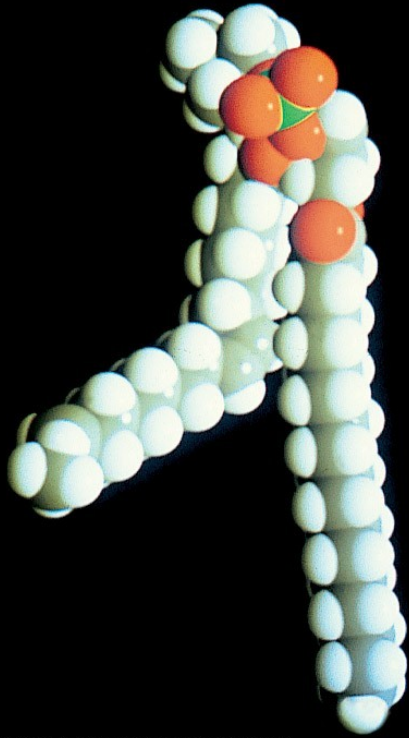


- *Lipidy* - fosfolipidy, cholesterol

funkce - strukturní

Lipid (%)	erythrocyt	myelin	mitochondrie	E.coli
fosfatidylcholin	19	10	39	0
fosfatidylethanolamin	18	20	27	65
fosfatidylglycerol	0	0	0	18
kardiolipin	0	0	23	12
sfingomyelin	18	9	0	0
glykolipidy	10	26	0	0
cholesterol	25	26	3	0

# Fosfolipid, sfingomyelin, gangliosid, kolesterol



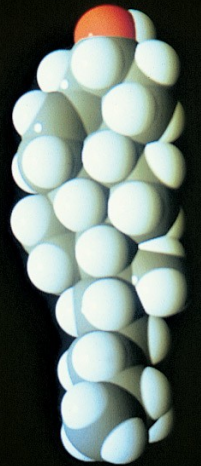
Courtesy of Richard Pastor, FDA, Bethesda, Maryland



Courtesy of Richard Pastor, FDA, Bethesda, Maryland



Courtesy of Richard Venable, FDA, Bethesda, Maryland



Courtesy of Richard Pastor, FDA, Bethesda, Maryland

- *Bílkoviny* - integrální, periferní

funkce - enzymy

přenašeče

receptory

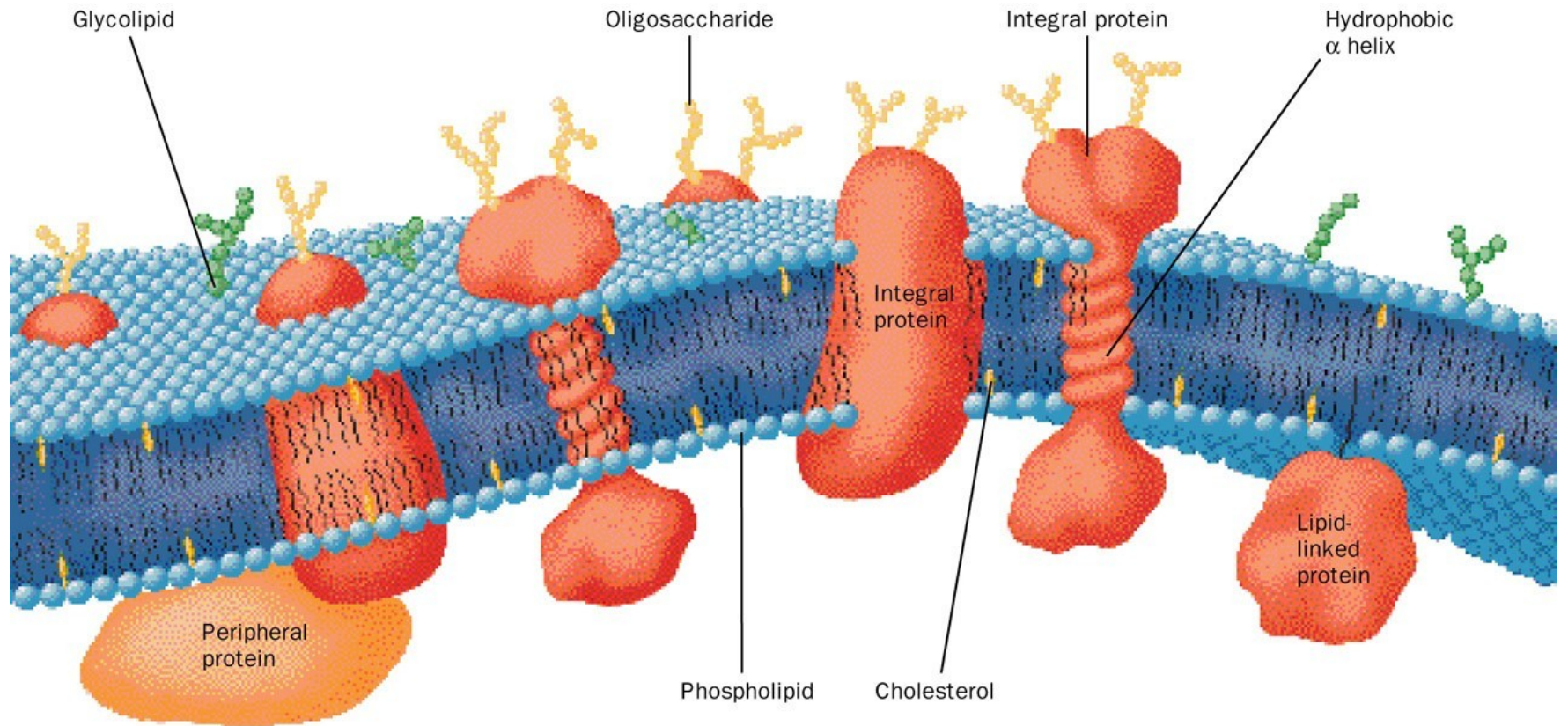
strukturní

- *Sacharidy* - glykolipidy, glykoproteiny

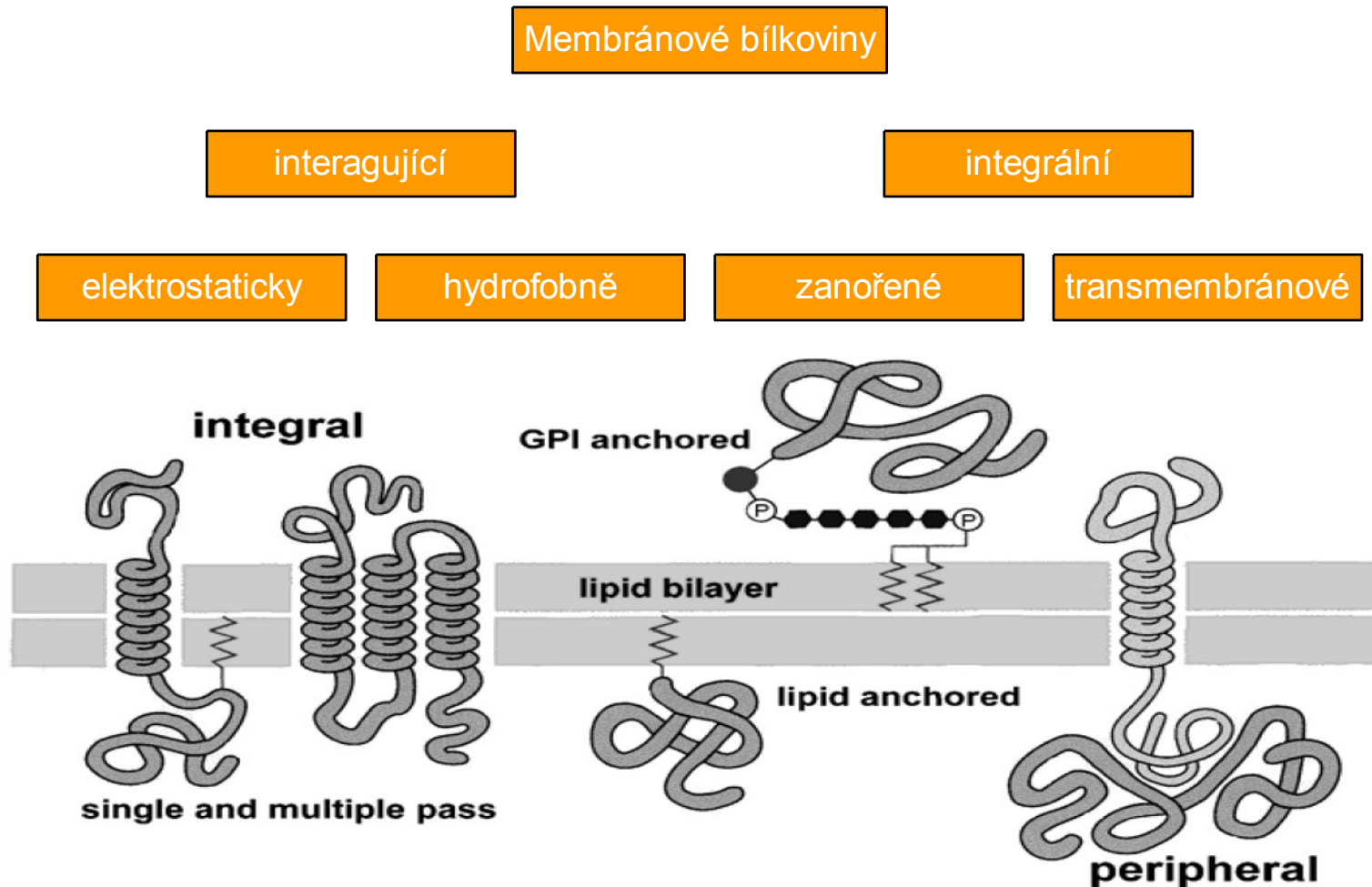
funkce - kotvení glykolipidů a glykoproteinů

v membránách

- rozpoznávací



# Membránově vázané bílkoviny



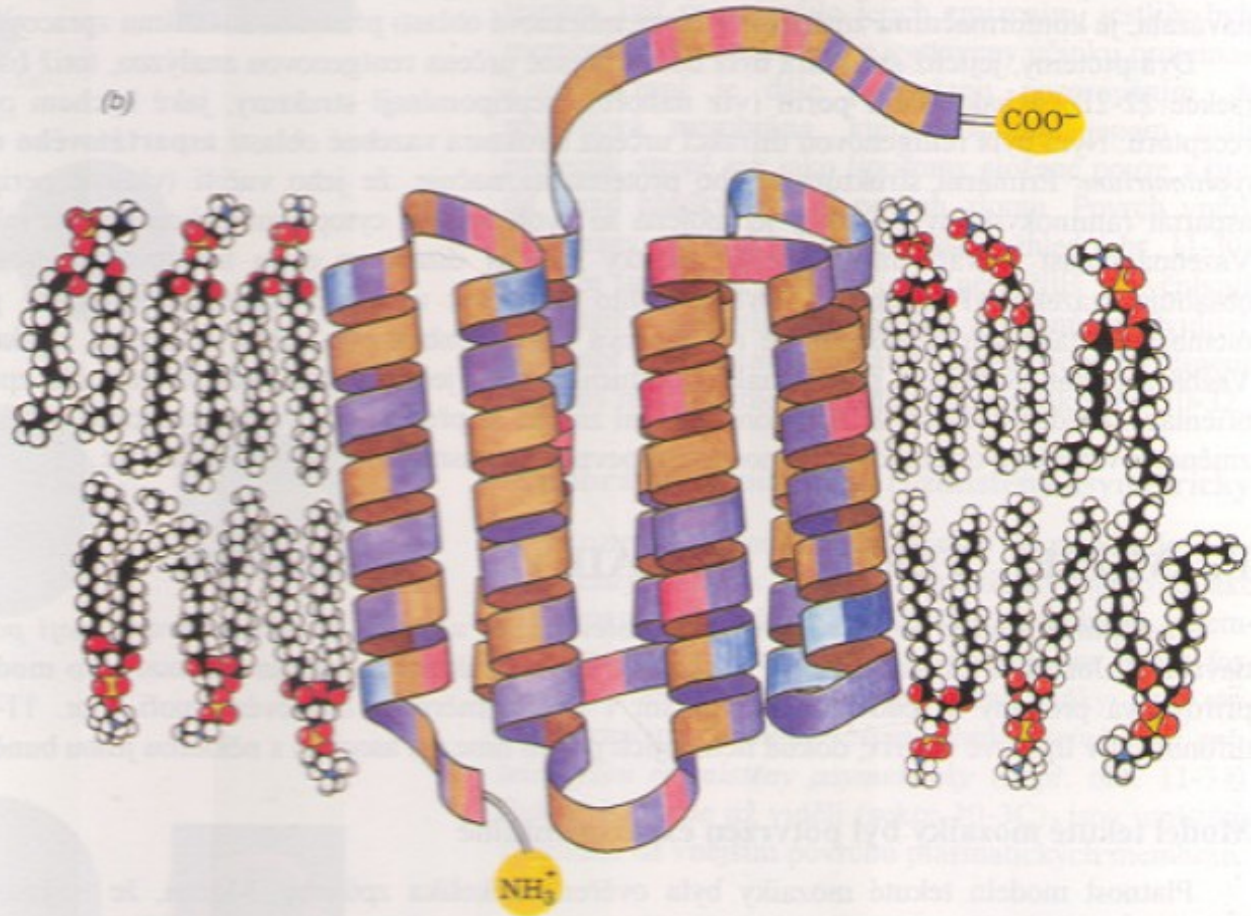


# Bakteriorhodopsin

(a)



(b)



## Modely membrán :

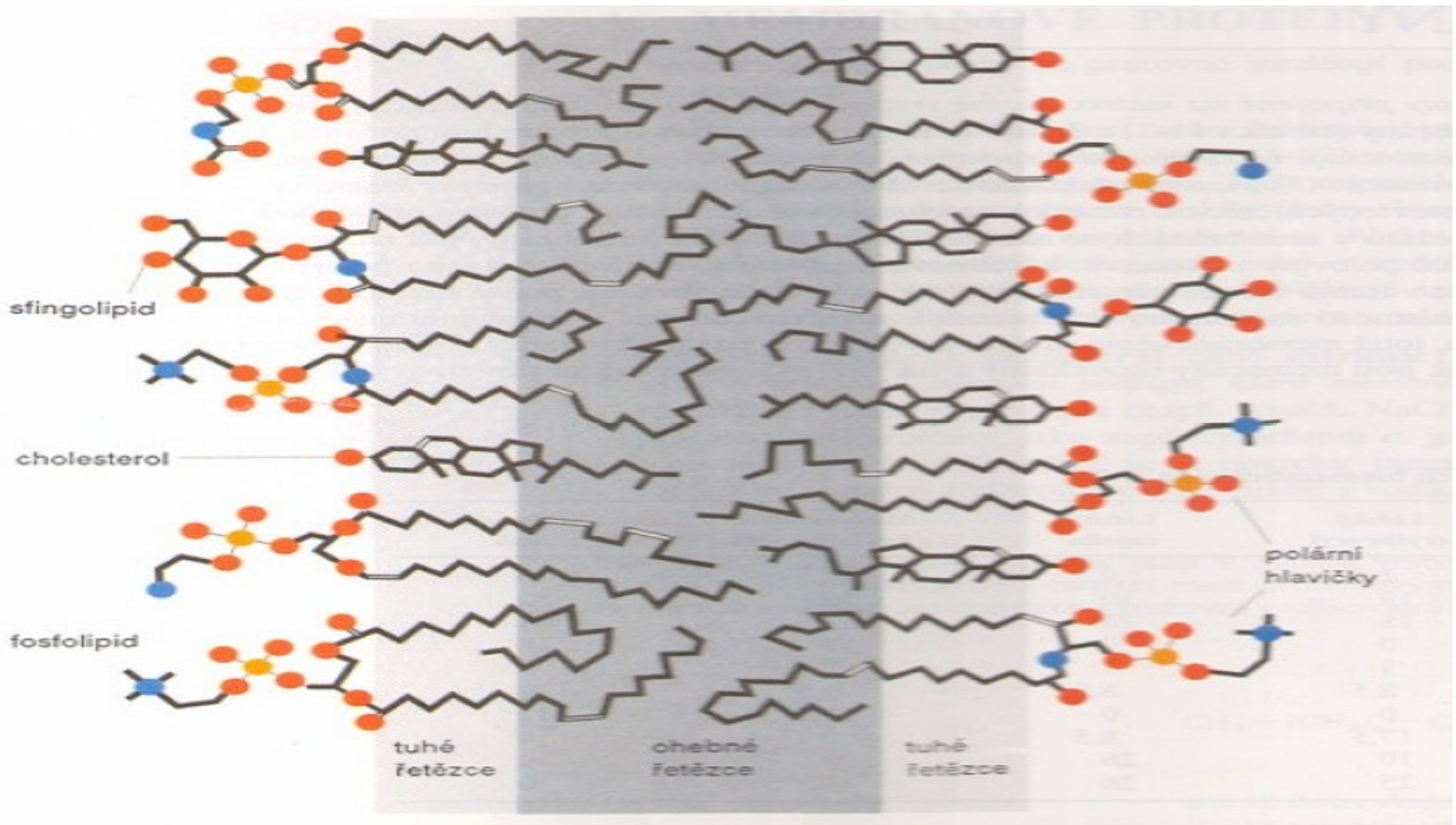
GORTER a GRENDL (1925) - Lipidová dvojvrstva

SINGER a NICHOLSON (1972) - Model tekuté mozaiky



# Lipidická dvojvrstva

## 5 – 7.5 nm



# Model tekuté mozaiky

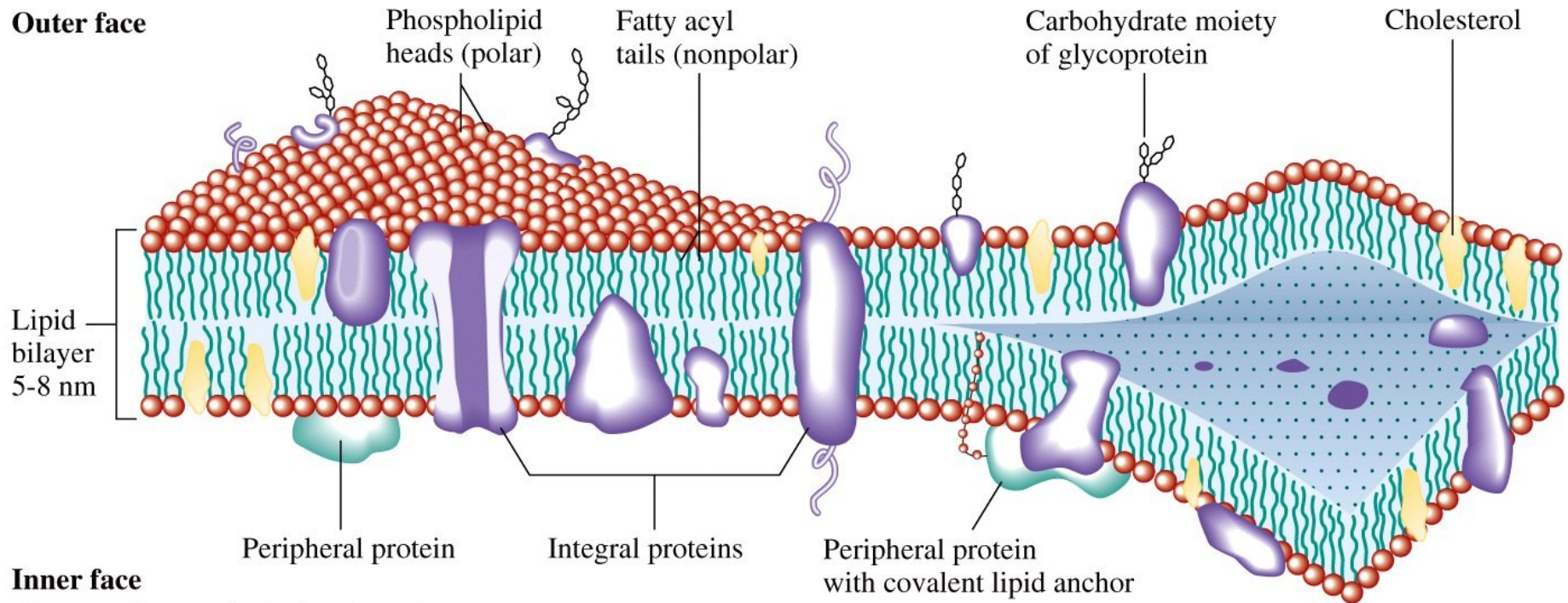
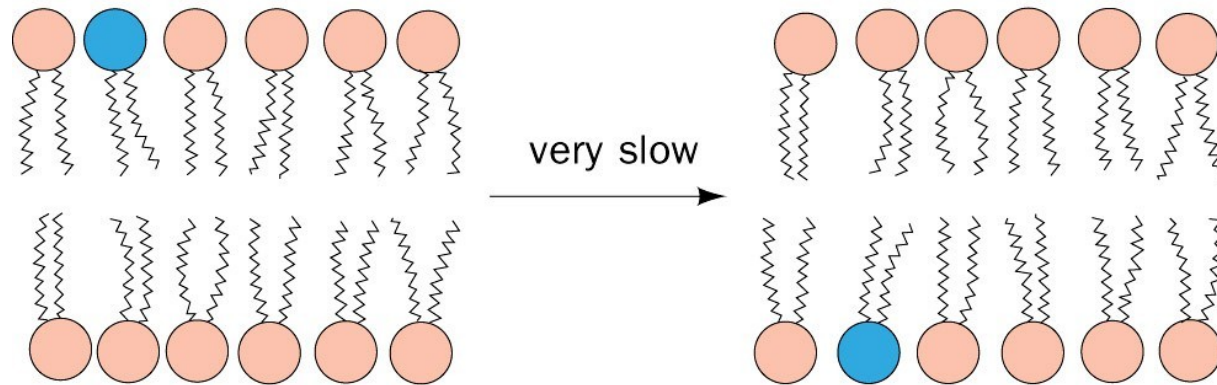


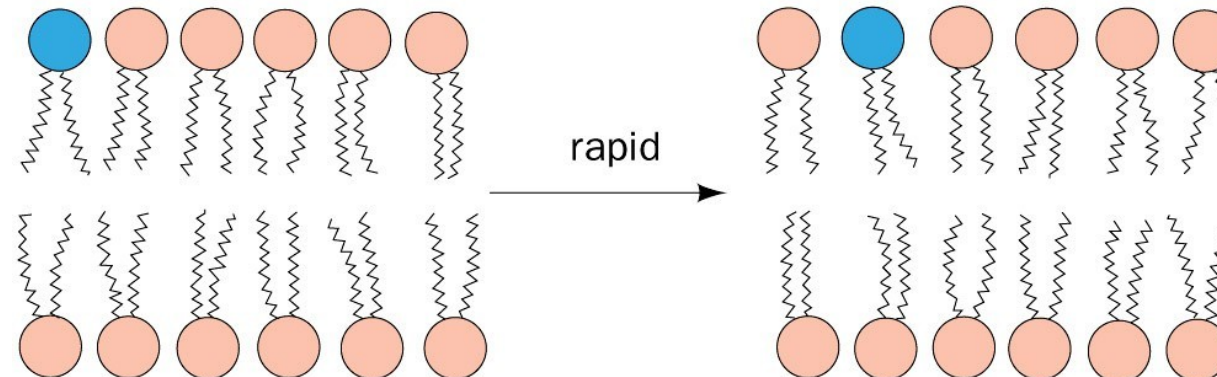
Figure 9-6 Concepts in Biochemistry, 3/e  
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# Difuze lipidů v membráně

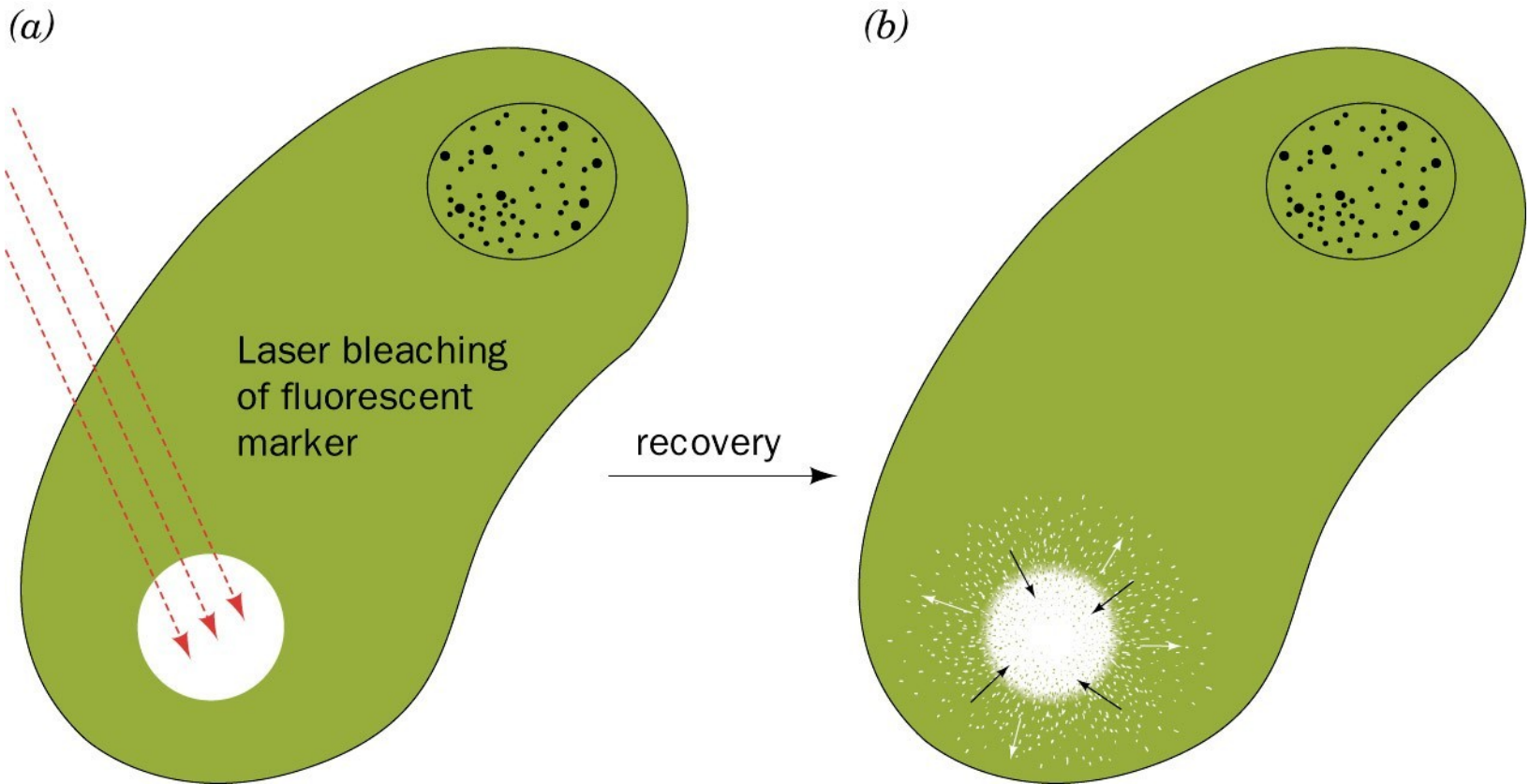
(a) Transverse diffusion (flip-flop)



(b) Lateral diffusion

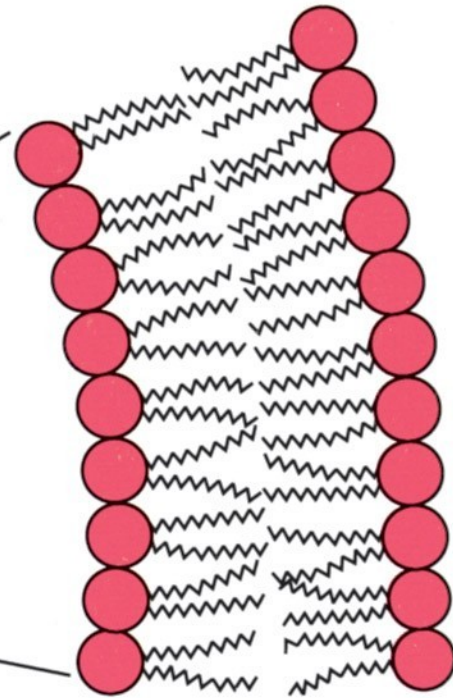
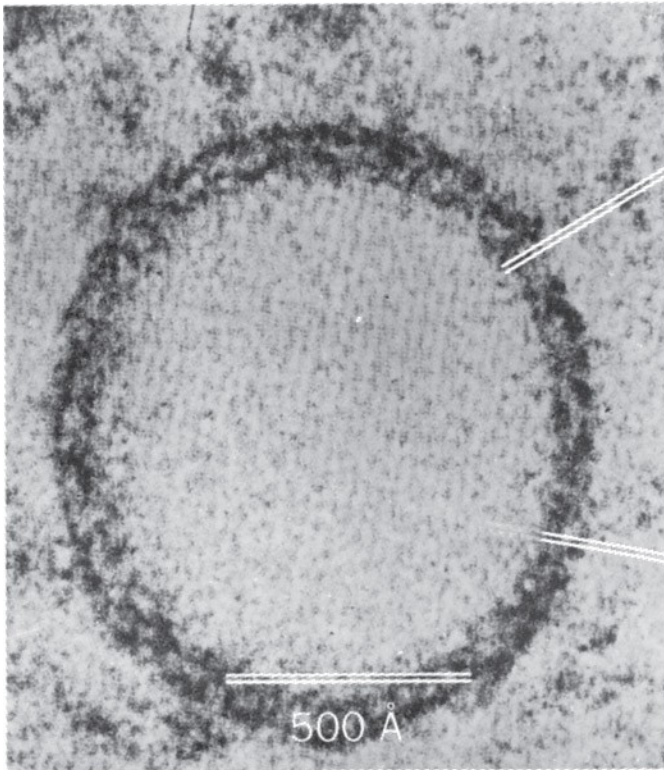


# Difuze lipidů v membráně



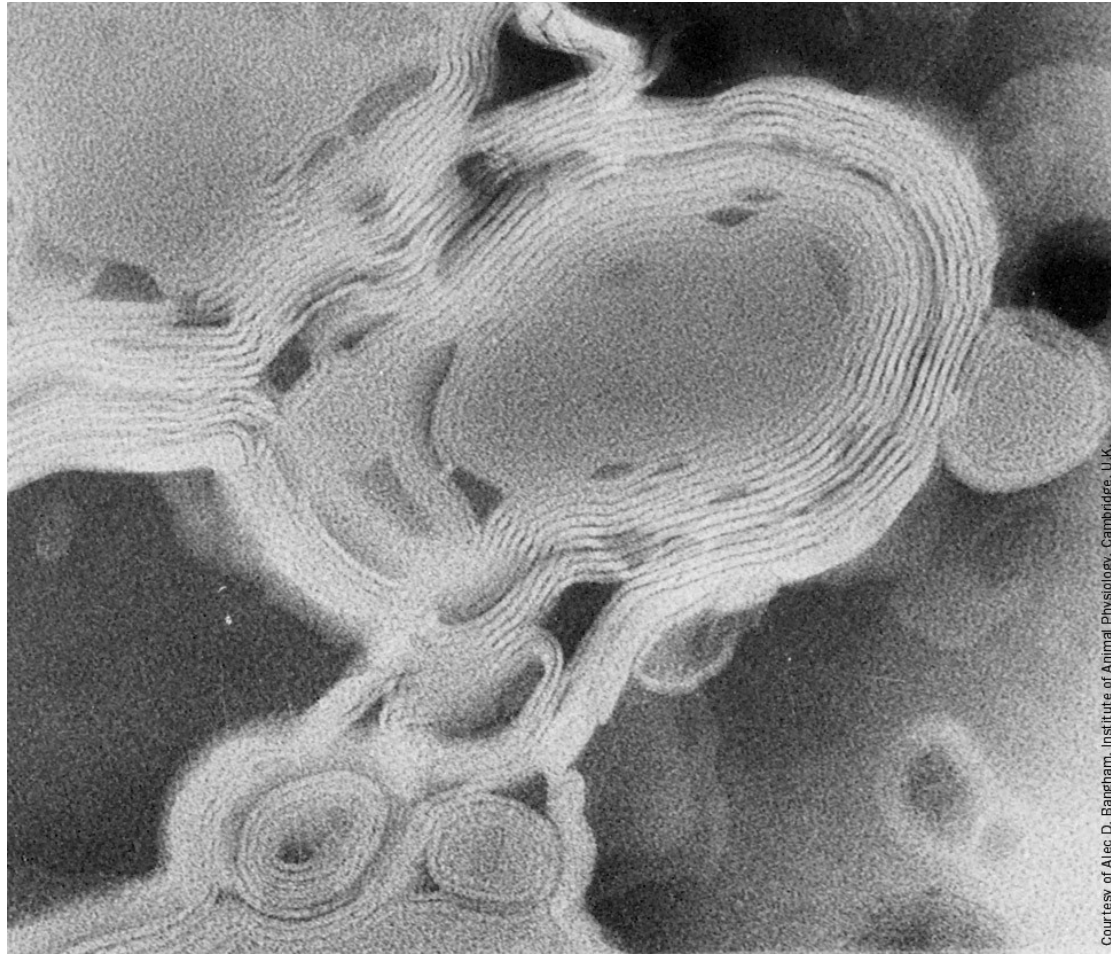


# Liposomy



Courtesy of Walter Stoeckenius, University of California at San Francisco

# Liposomy

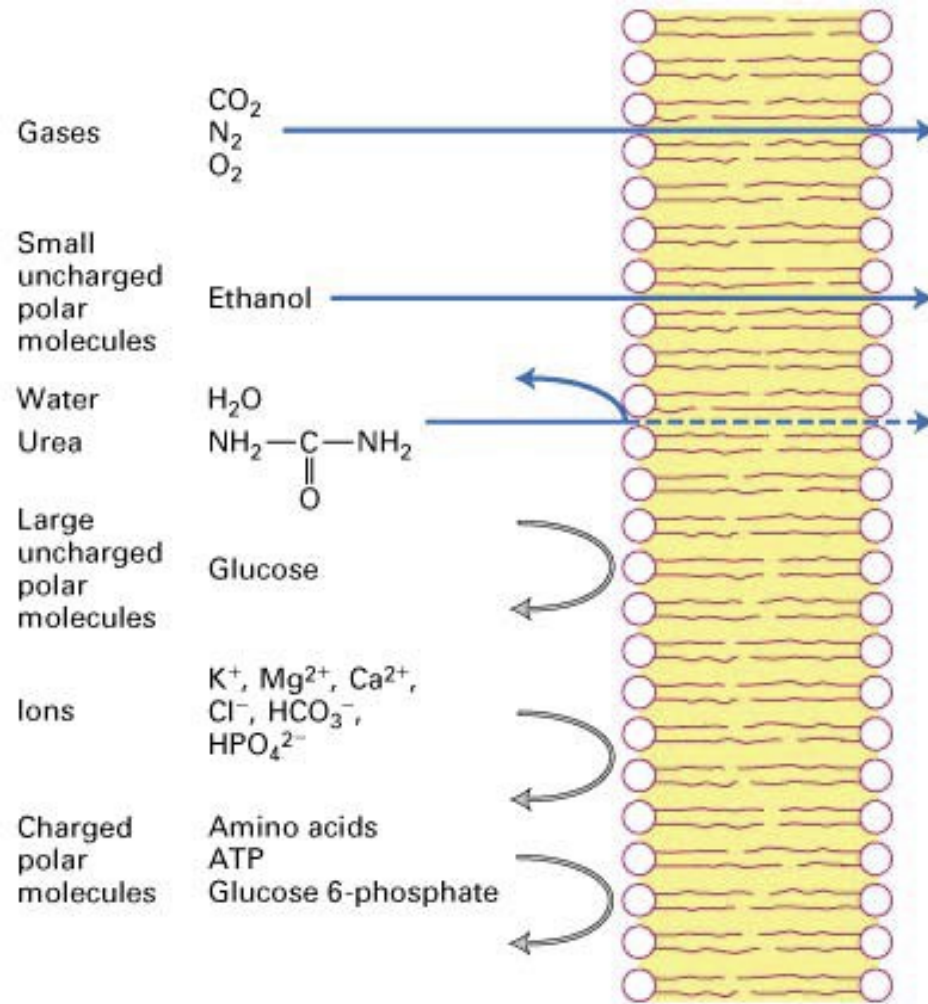


# Transport

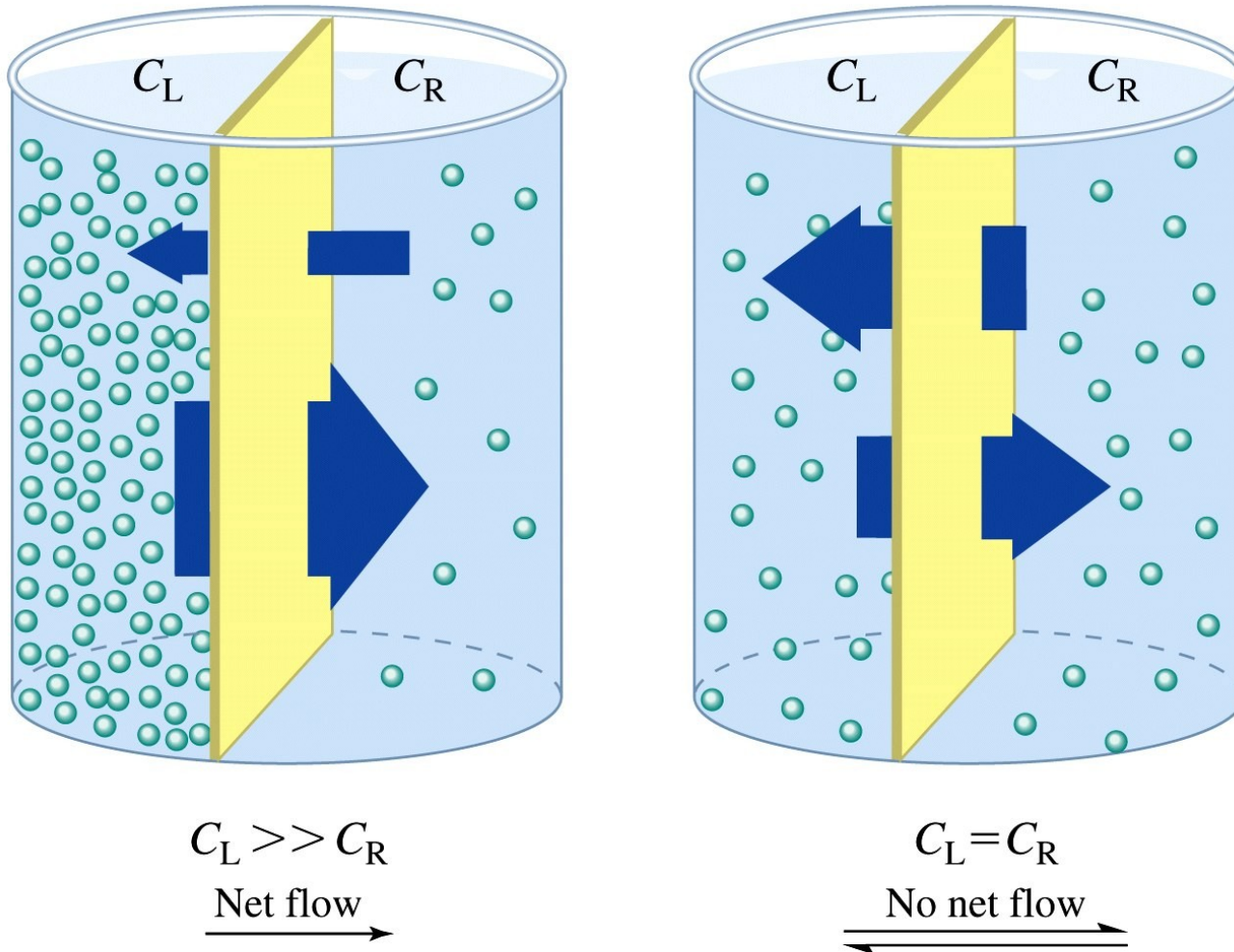
- Přísun živin
- Odstraňování odpadních látek
- Udržení osmotické rovnováhy
- Udržování potřebných chemických a elektrochemických rovnováh



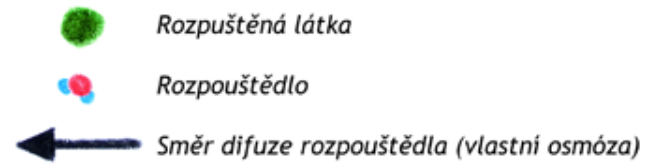




# Prostá difuze



# Osmóza

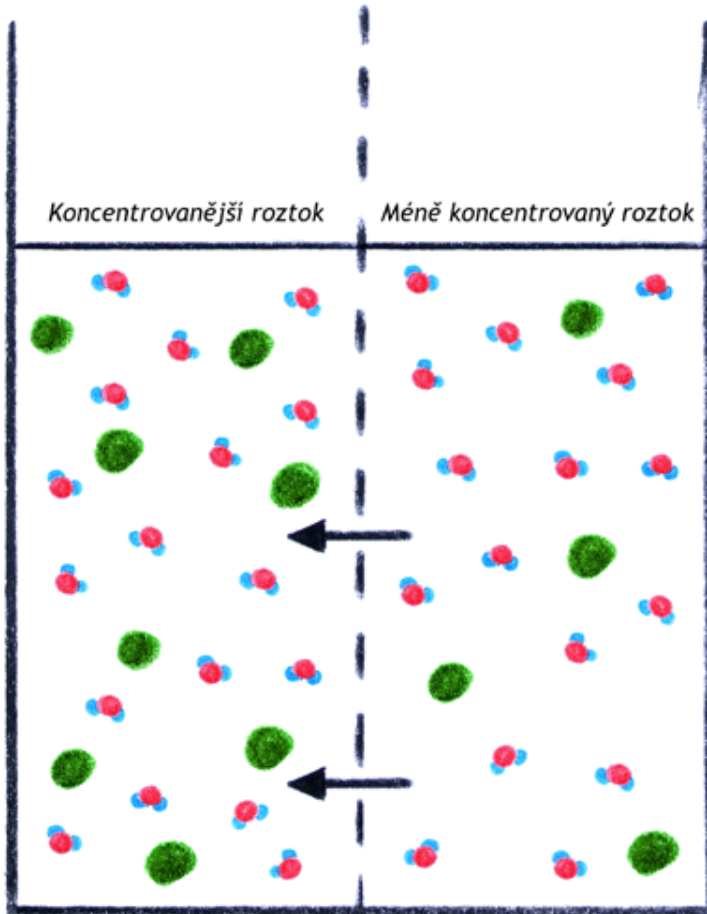


STAV 1

Polopropustná  
membrána

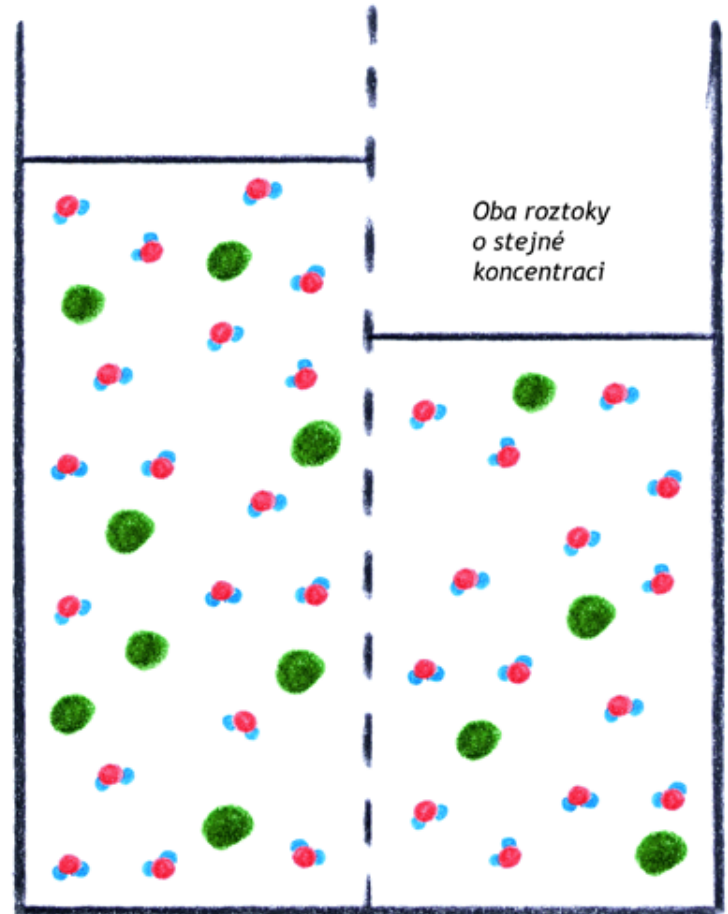
Koncentrovanější roztok

Méně koncentrovaný roztok



STAV 2

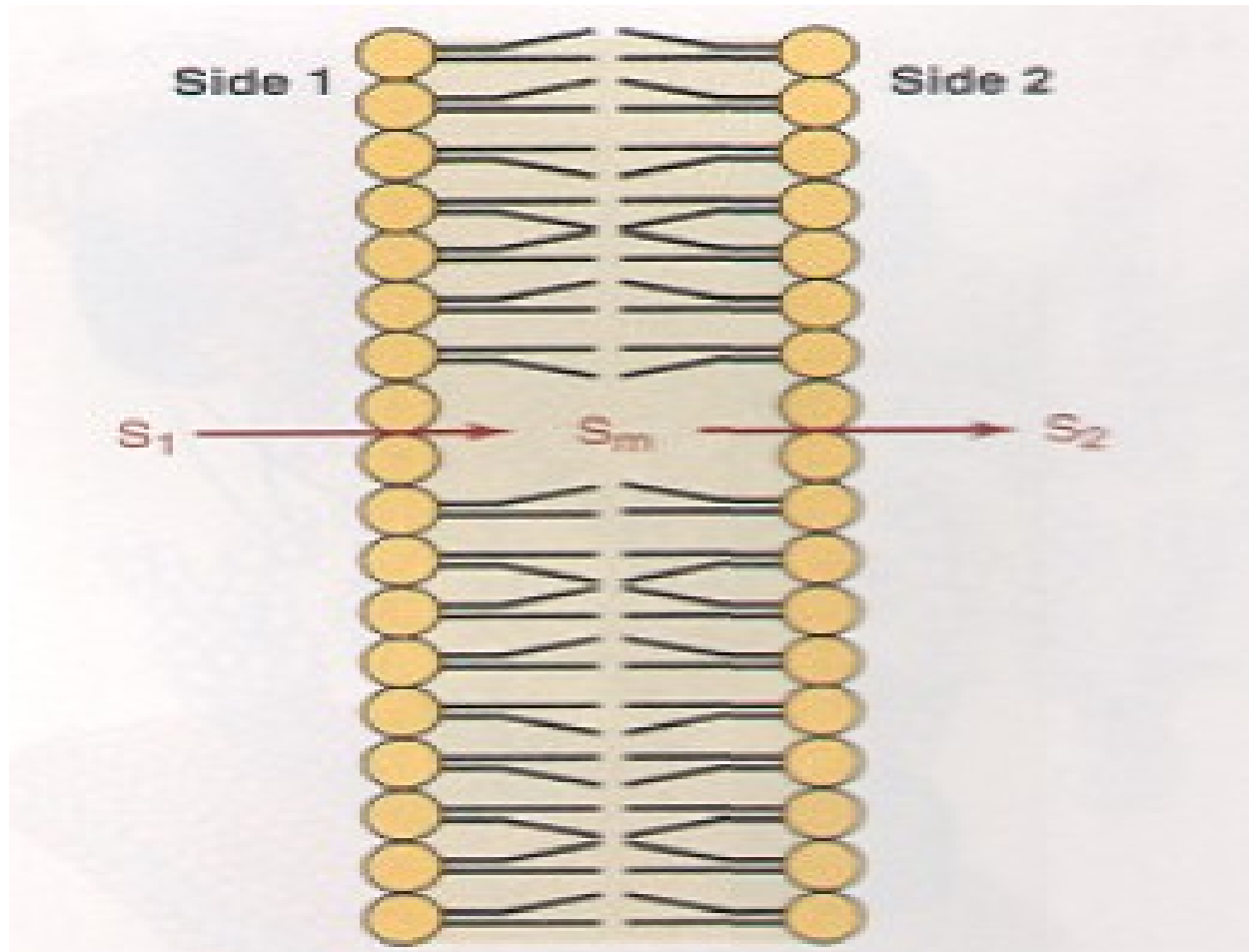
Oba roztoky  
o stejné  
koncentraci



# Nespecifický transport

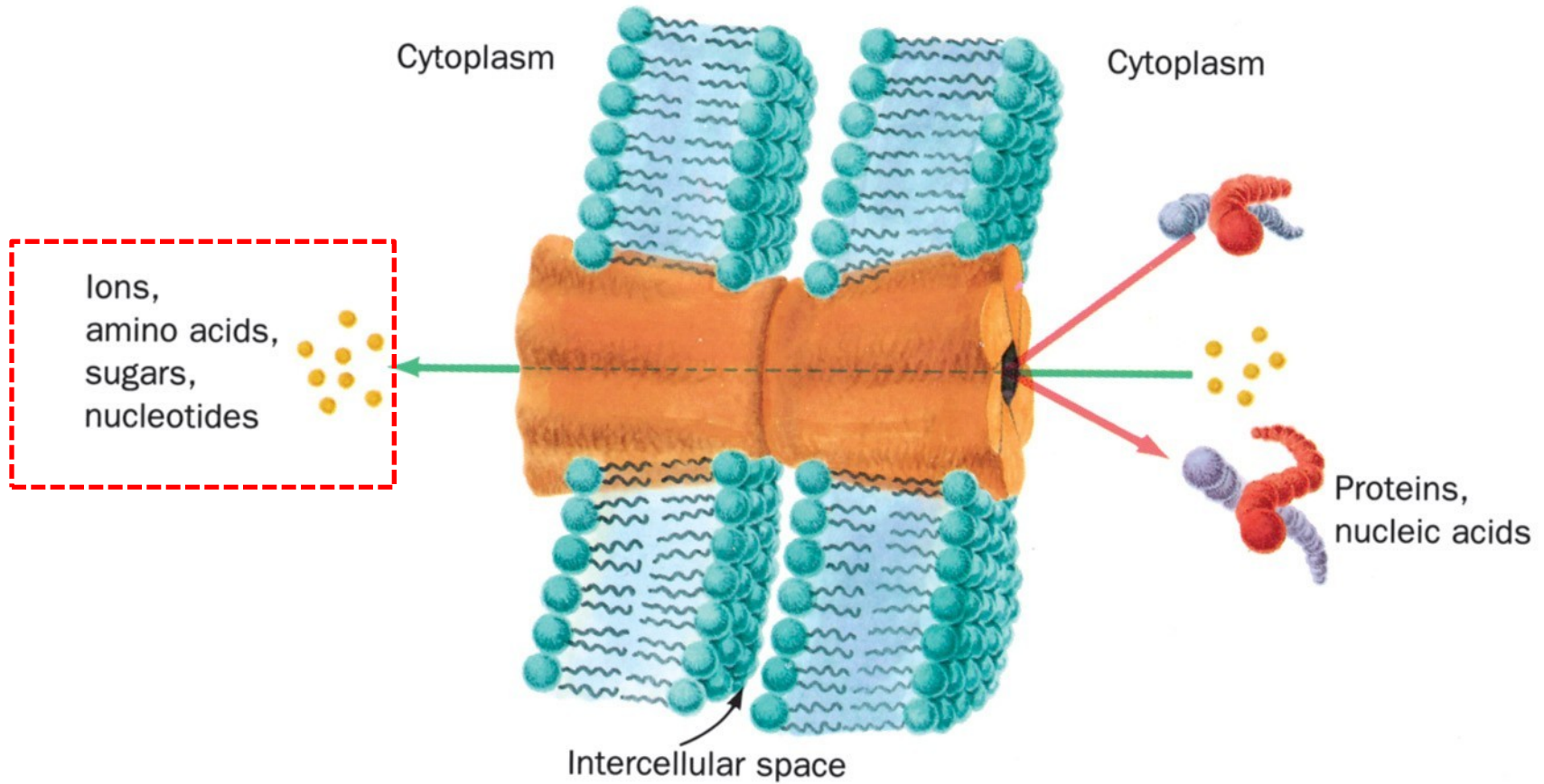
- Rozpuštěním v membránových lipidech – plyny, organické látky
- Nepravidelnostmi v uspořádání lipidů –  $H_2O$
- Póry

# Prostá difuze - pory

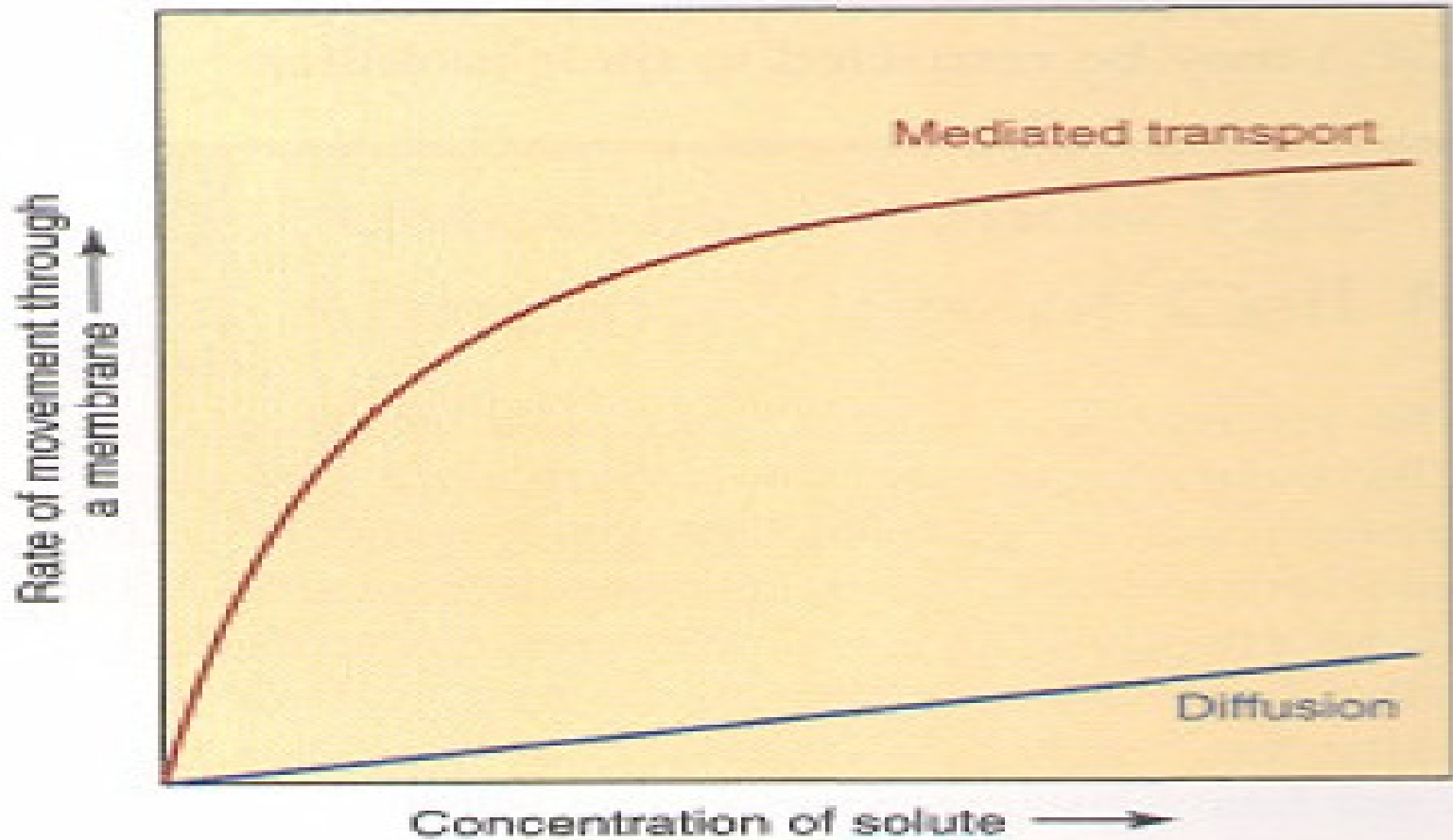


- Rozpuštěním v membránových lipidech – plyny, organické látky
- Nepravidelnostmi v uspořádání lipidů –  $H_2O$
- Póry
- Hydrofilními kanálky

# Mezerový spoj - konexin

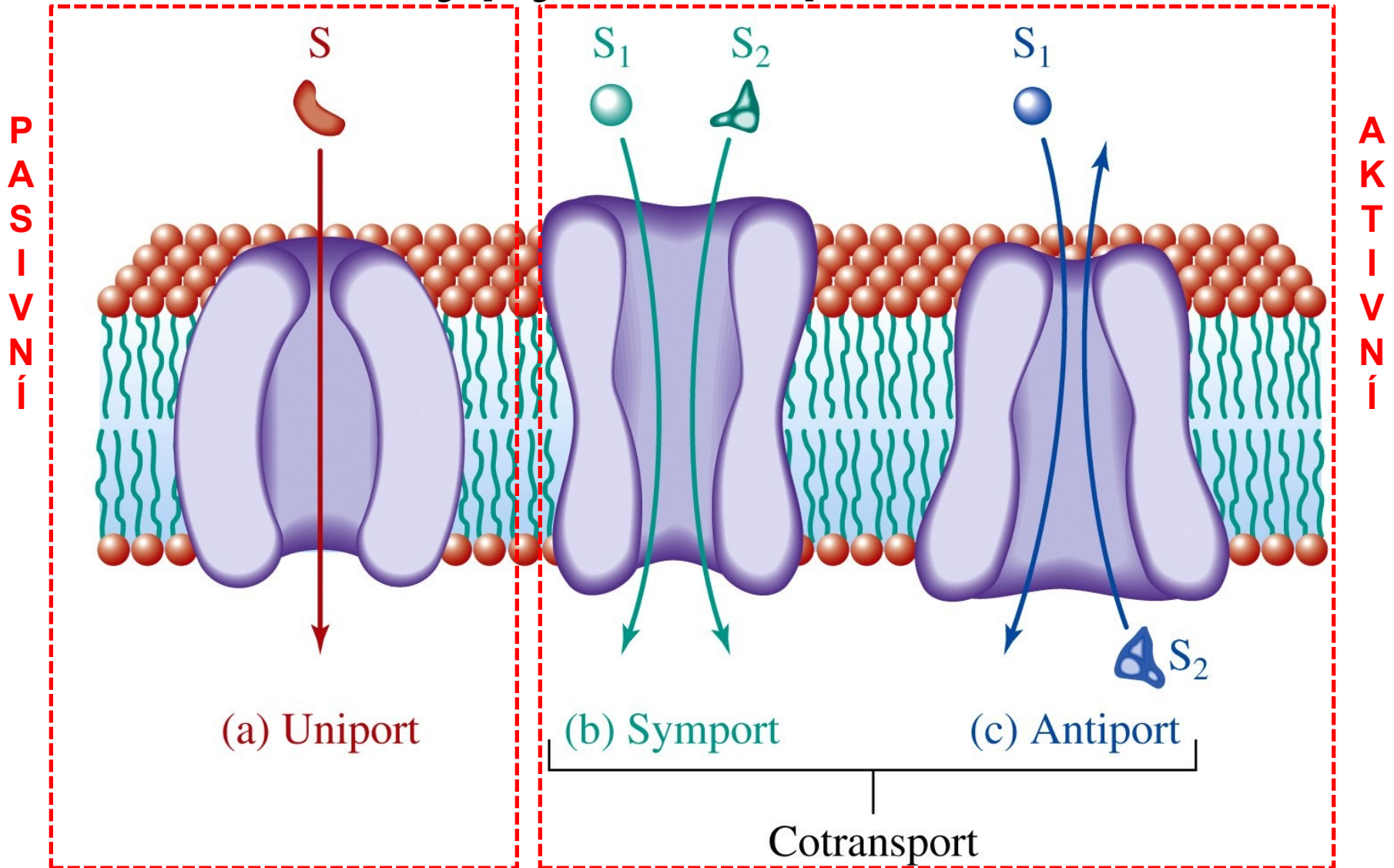


# Difuze prostá versus usnadněná

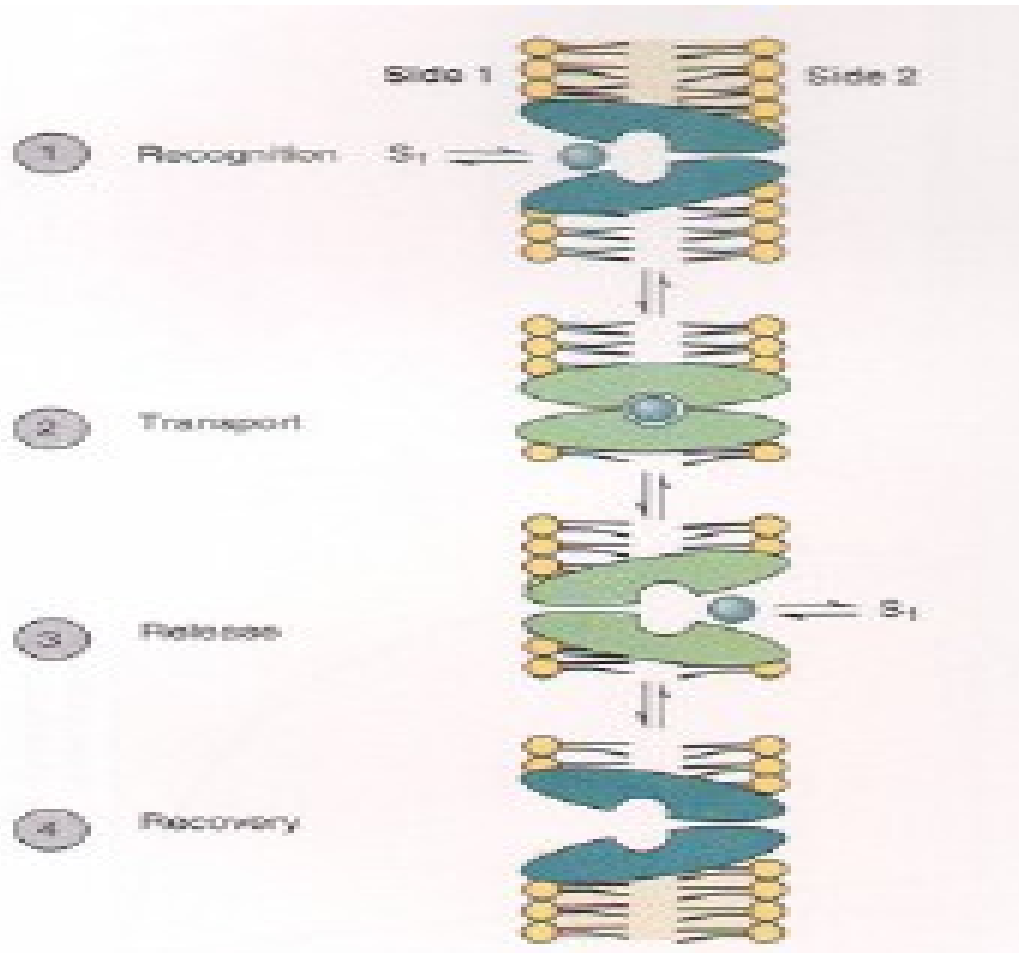




# Typy transportu



# Pasivní transport – usnadněná difuze



# Usnadněná difuze

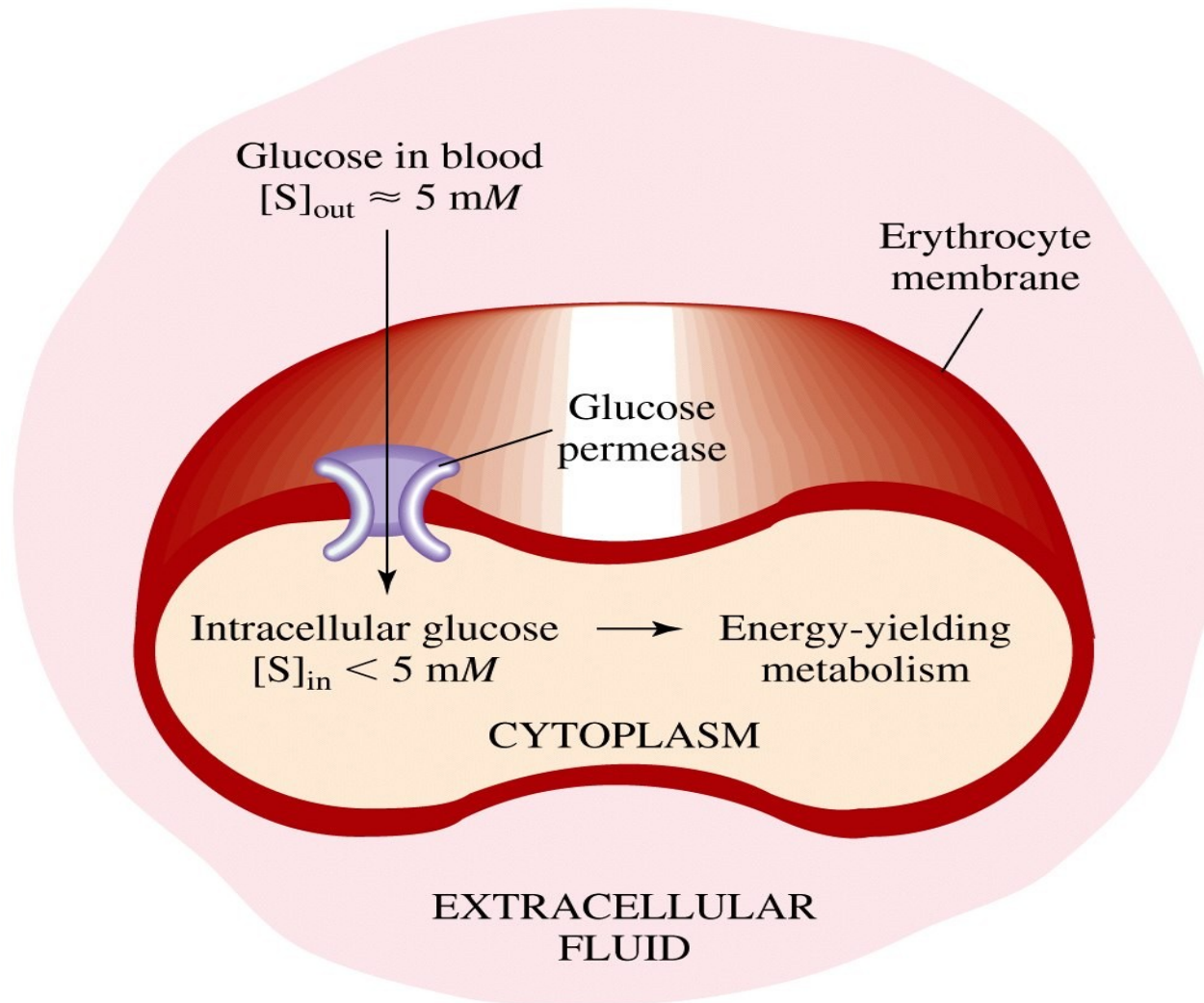


Figure 9-13 Concepts in Biochemistry, 3/e  
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# Aktivní transport

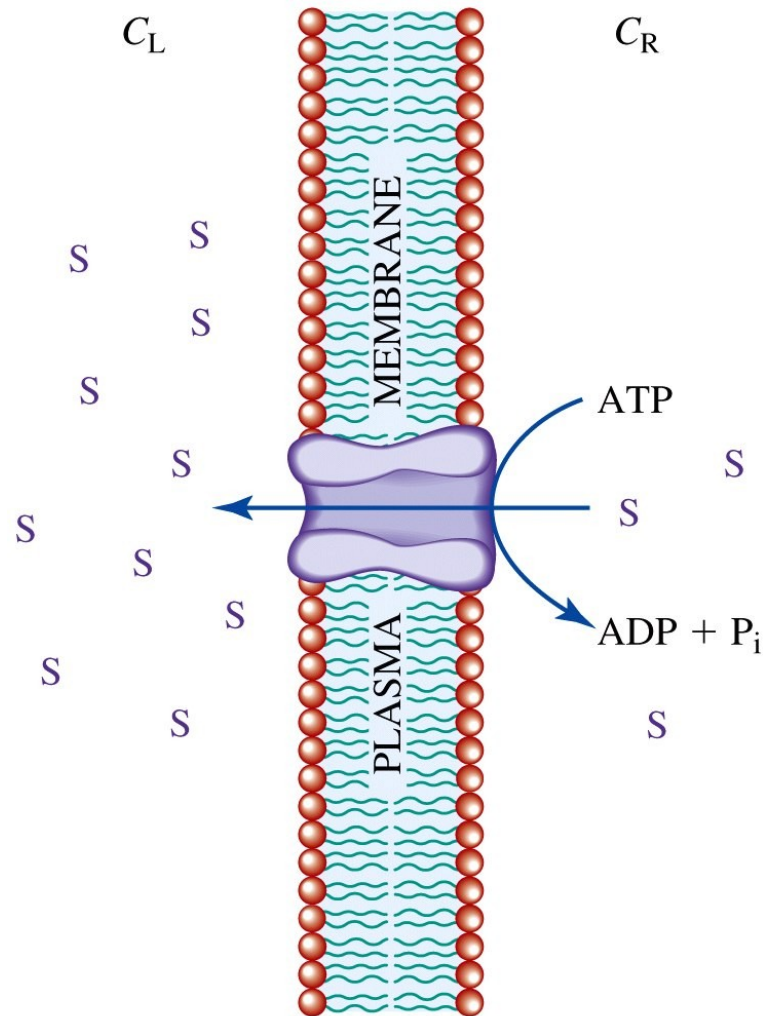
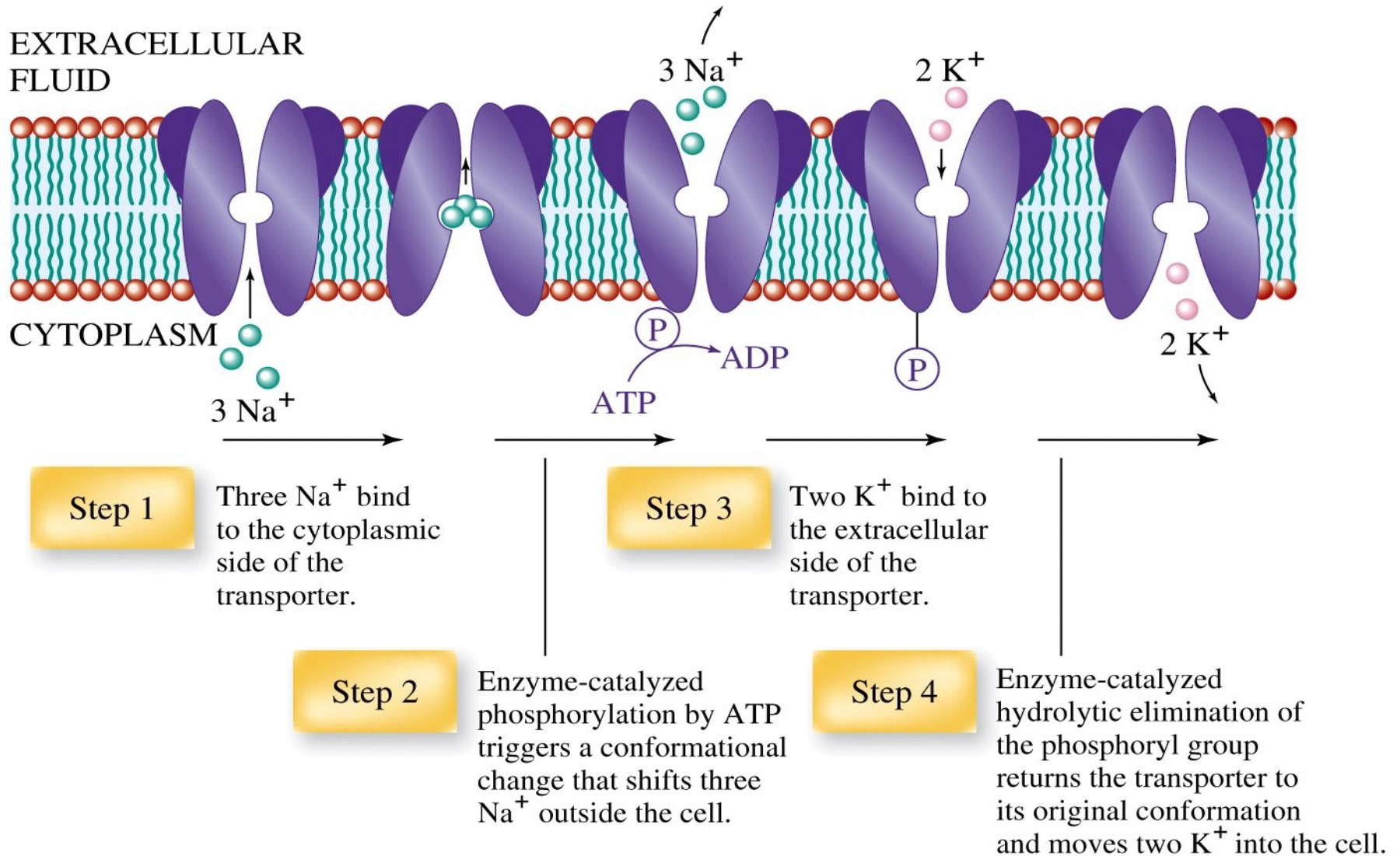


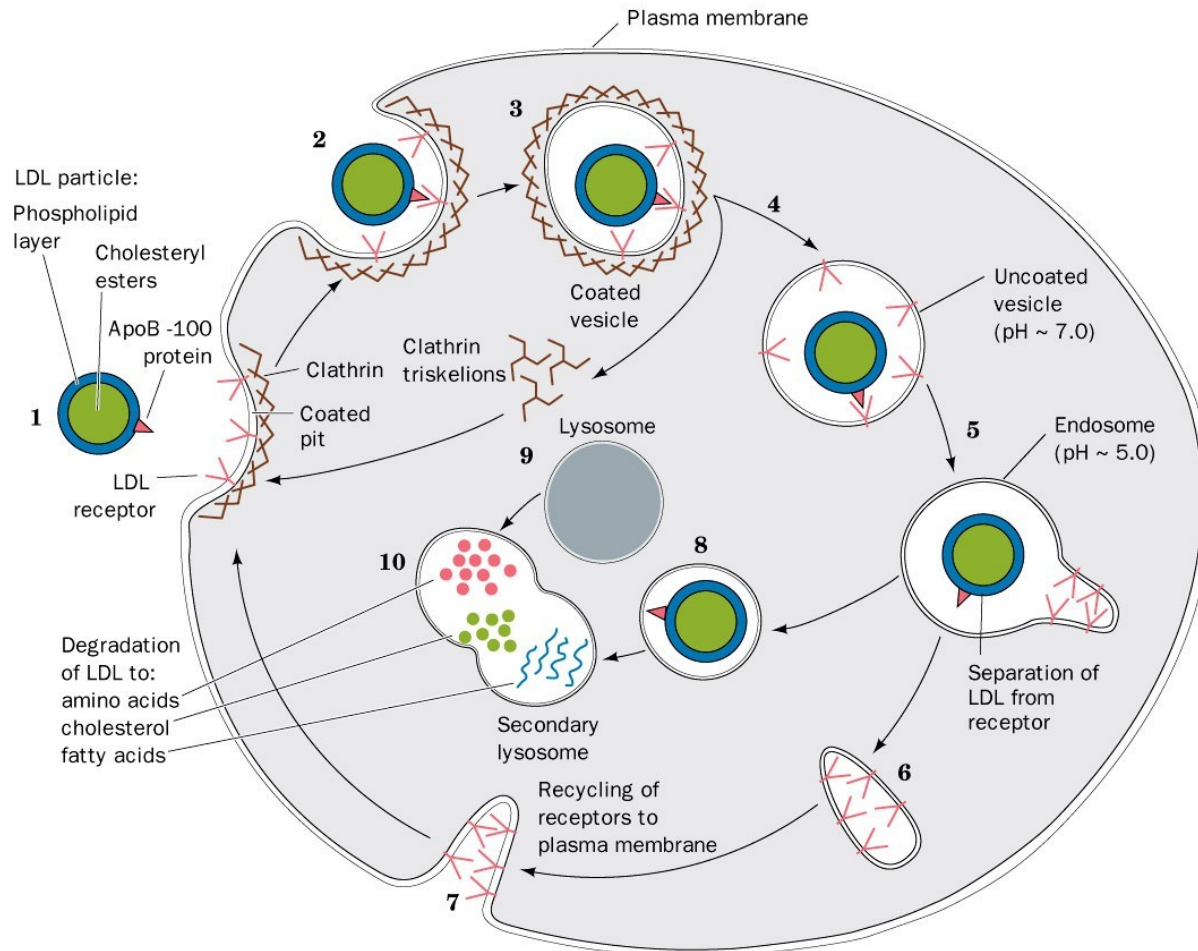
Figure 9-9 Concepts in Biochemistry, 3/e  
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# Na<sup>+</sup> ATPase





# Pinocytoza - endocytoza



# Pinocytoza - exocytoza

