SACHARIDY

Sacharidy - *saccharum - cukr*

Synonyma : cukry - glycidy - uhlohydráty *carbohydrates* - $(CH_2O)_n$

Funkce - zdroj energie glukosa

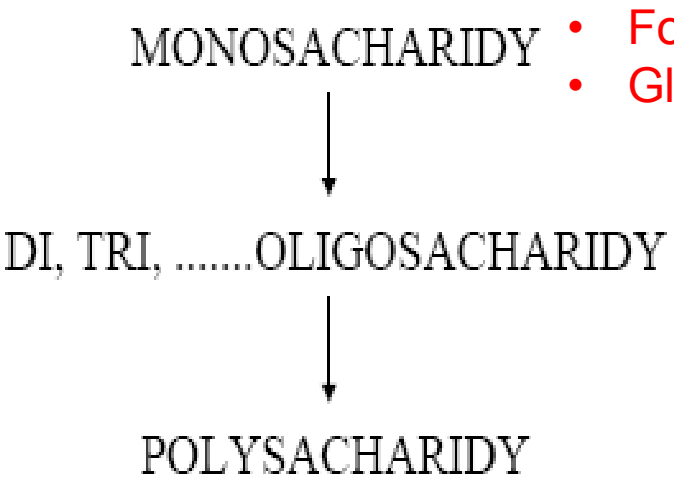
zásobní látky glykogen, škrob

stavební a podpůrná funkce celulosa, chitin

složky nukleotidů, koenzymů, glyko-proteinů, -lipidů

prekurzory aminokyselin, lipidů

antigenní determinanty buněk



- Fotosyntéza (fotoautotrofy)
- Glukoneogenese (heterotrofy)

Monosacharidy : → Nemohou být rozloženy na menší jednotky

chemicky - polyhydroxyaldehydy

- polyhydroxyketony

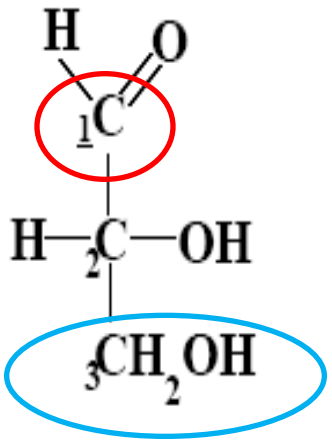
Rozdělení

A. podle povahy karbonylové skupiny
- **ALDOSY**
- **KETOSY**

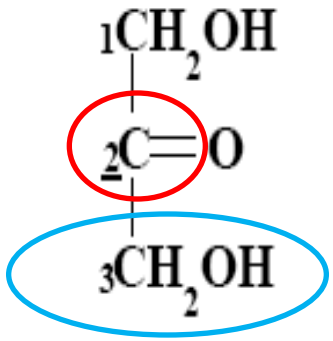
B. podle počtu uhlíkových atomů - **TRIOSY, TETROSY, PENTOSY, HEXOSY, HEPTOSY,**

ALDOHEXOSA

Číslování



D - glyceraldehyd



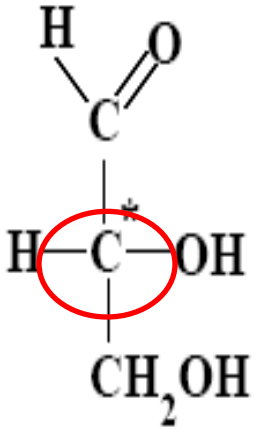
dihydroxyaceton

PRIMÁRNÍ HYDROXYLOVÁ SKUPINA

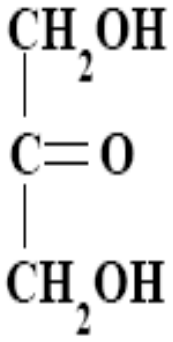
Názvosloví : triviální

aldosa -OSA

ketosa -ULOSA



D - glyceraldehyd



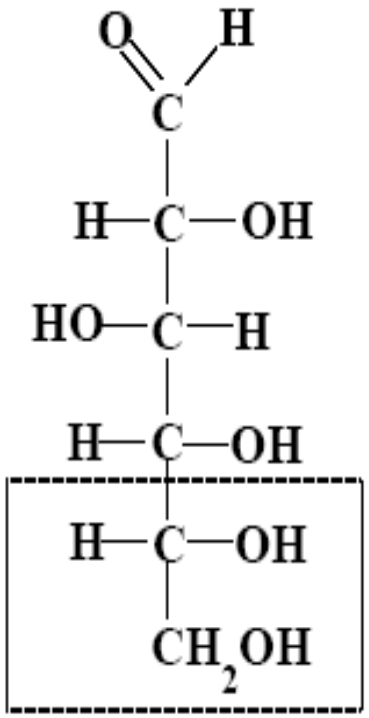
dihydroxyaceton

počet stereoizomerů = 2^X (x = počet C^*)

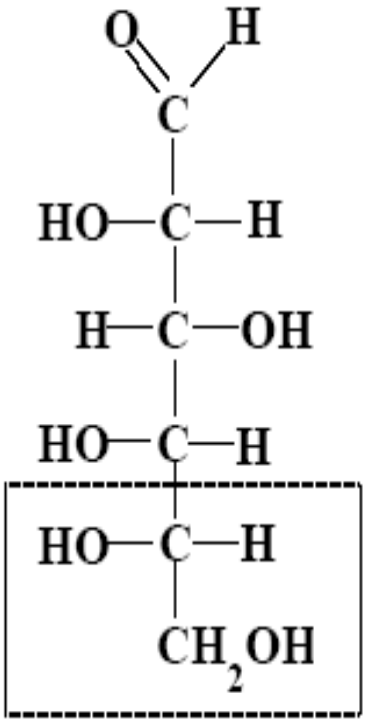
aldosy - x = n - 2

ketosy - x = n - 3

n = počet C atomů



D - glukosa



L - glukosa

Aldosy – 2^{n-2}

D **L**

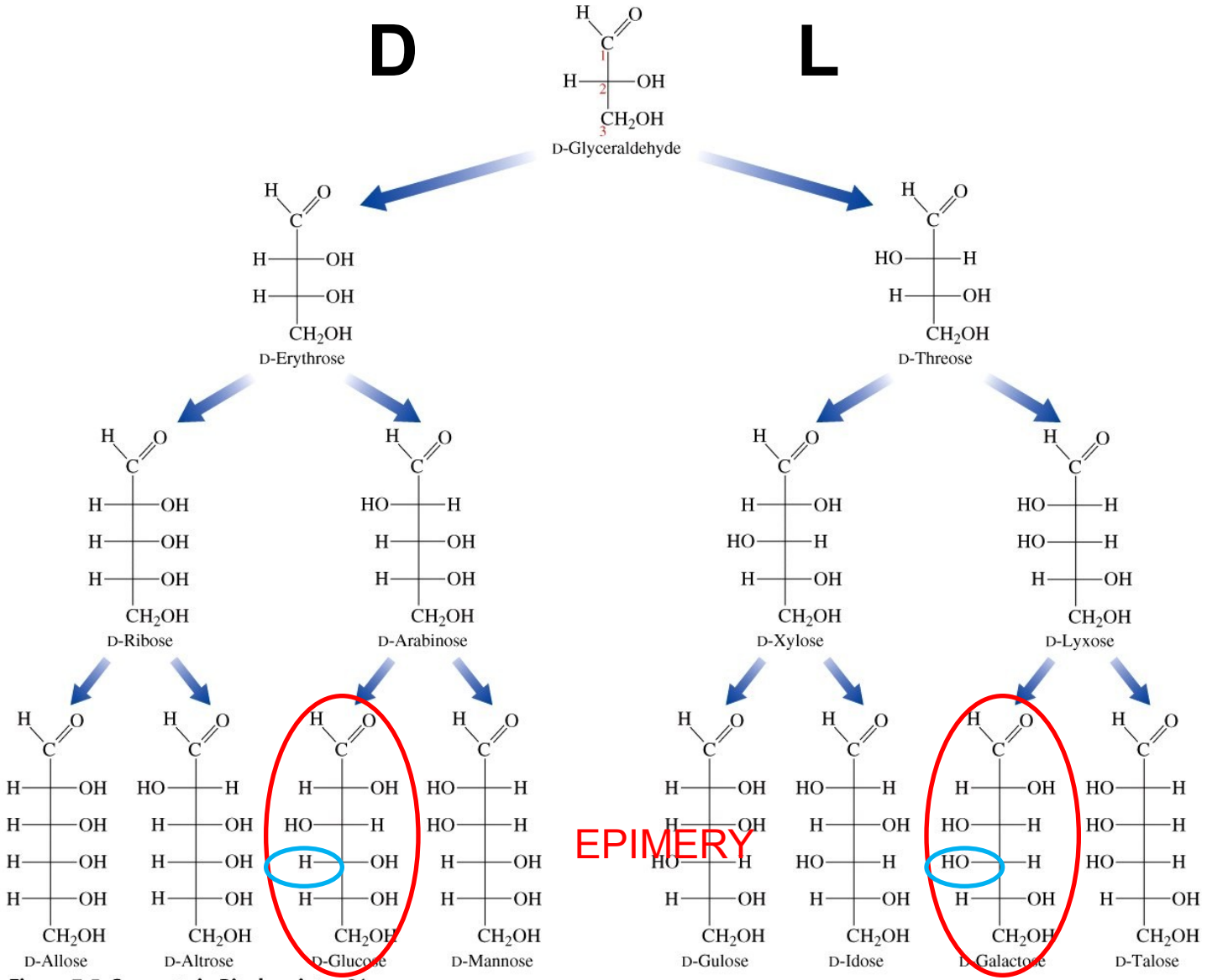


Figure 7-5 Concepts in Biochemistry, 3/e

Ketosy – 2^{n-3}

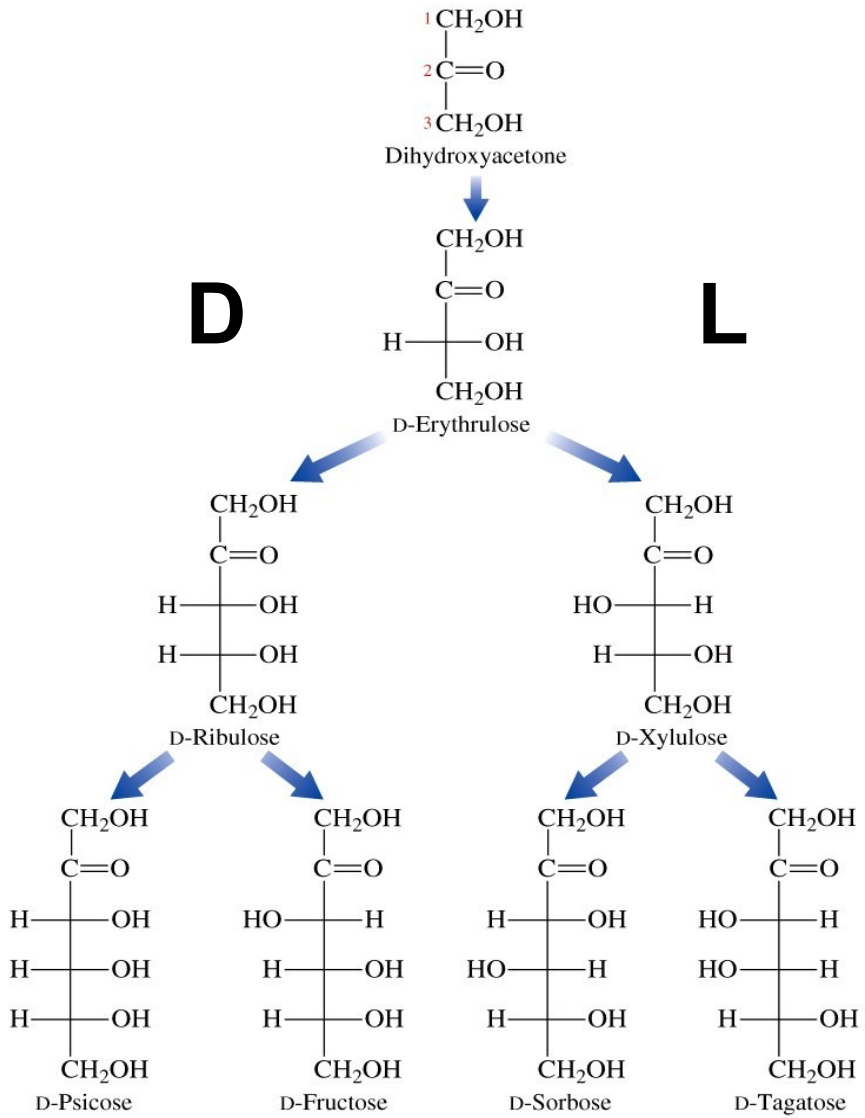
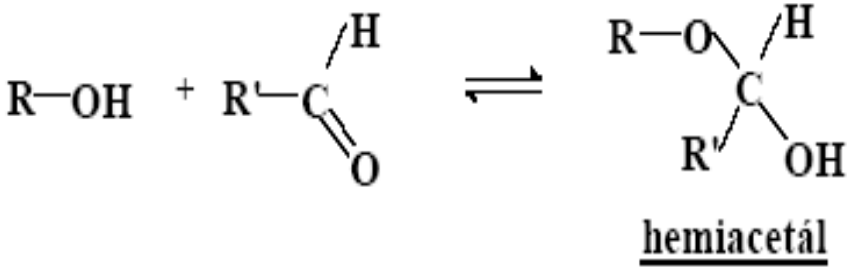


Figure 7-6a Concepts in Biochemistry, 3/e

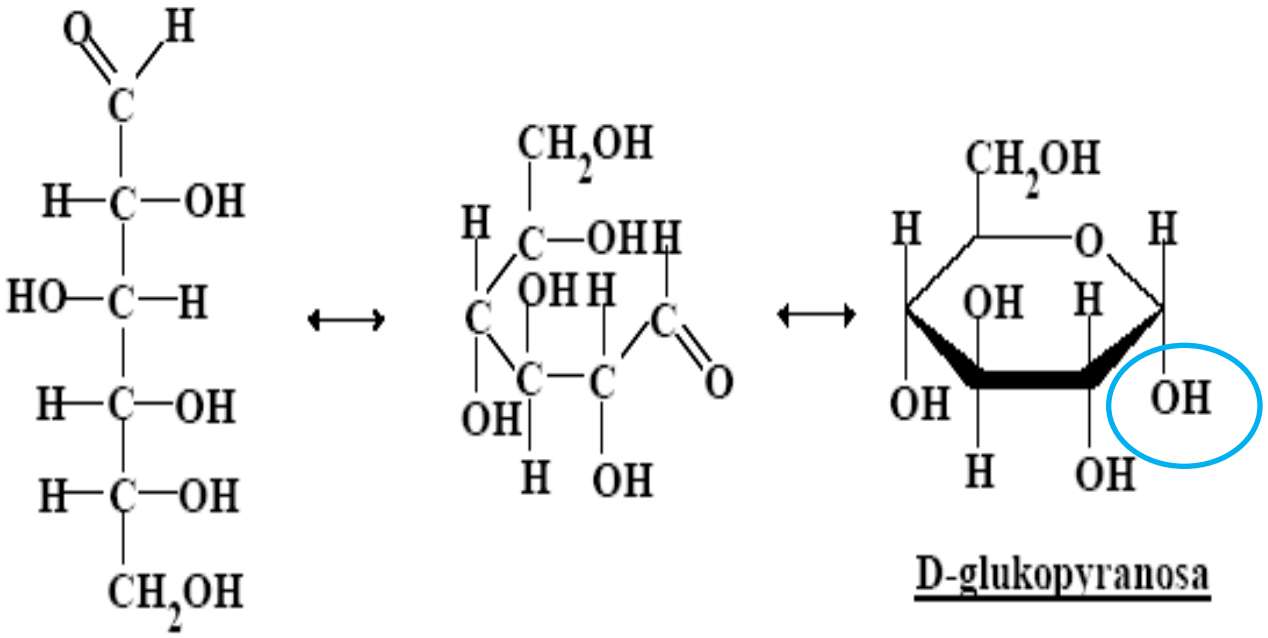


hemiacetál

pyran

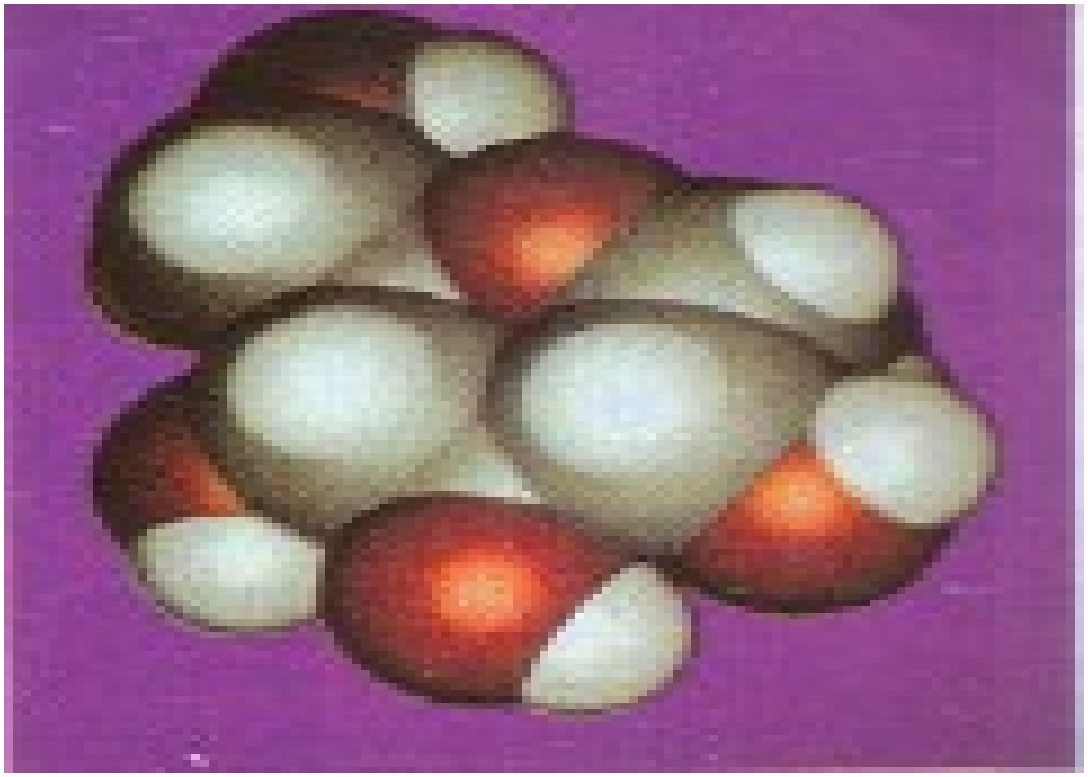
Fischerovy vzorce

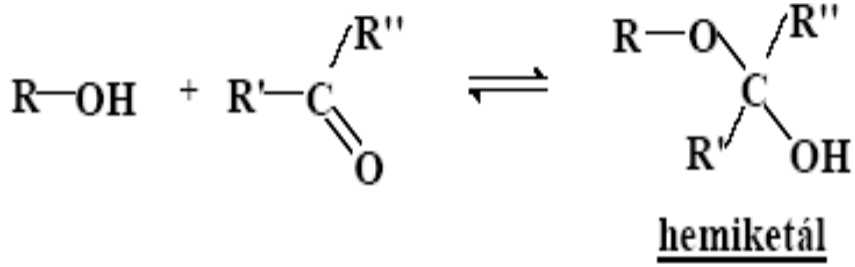
Haworthovy vzorce

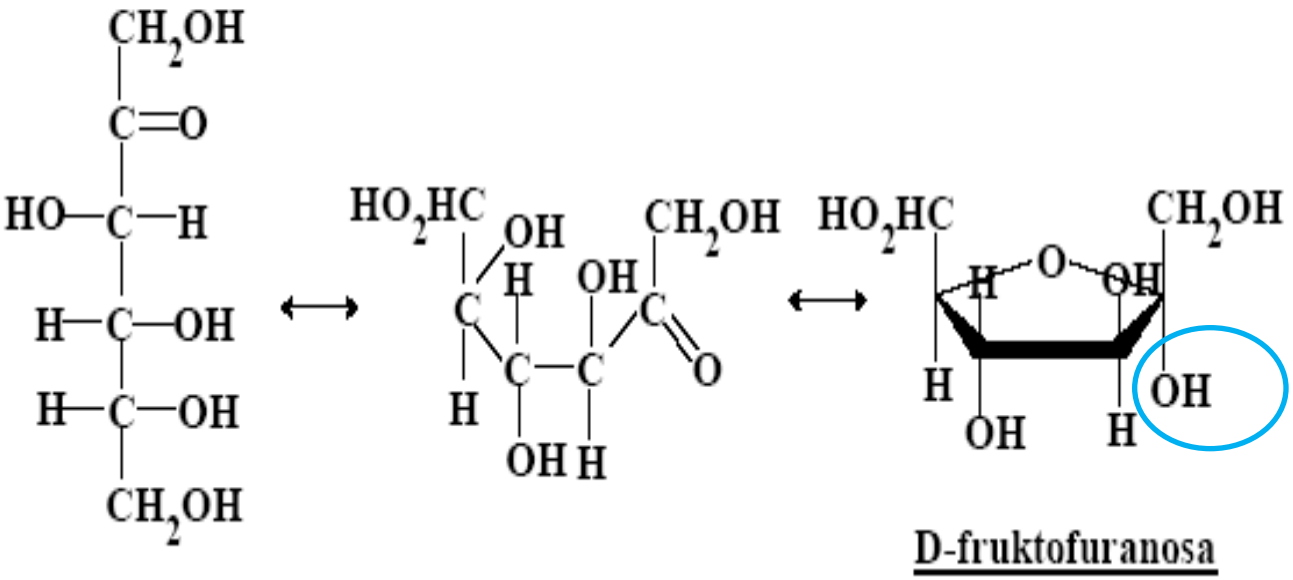


D-glukopyranosa

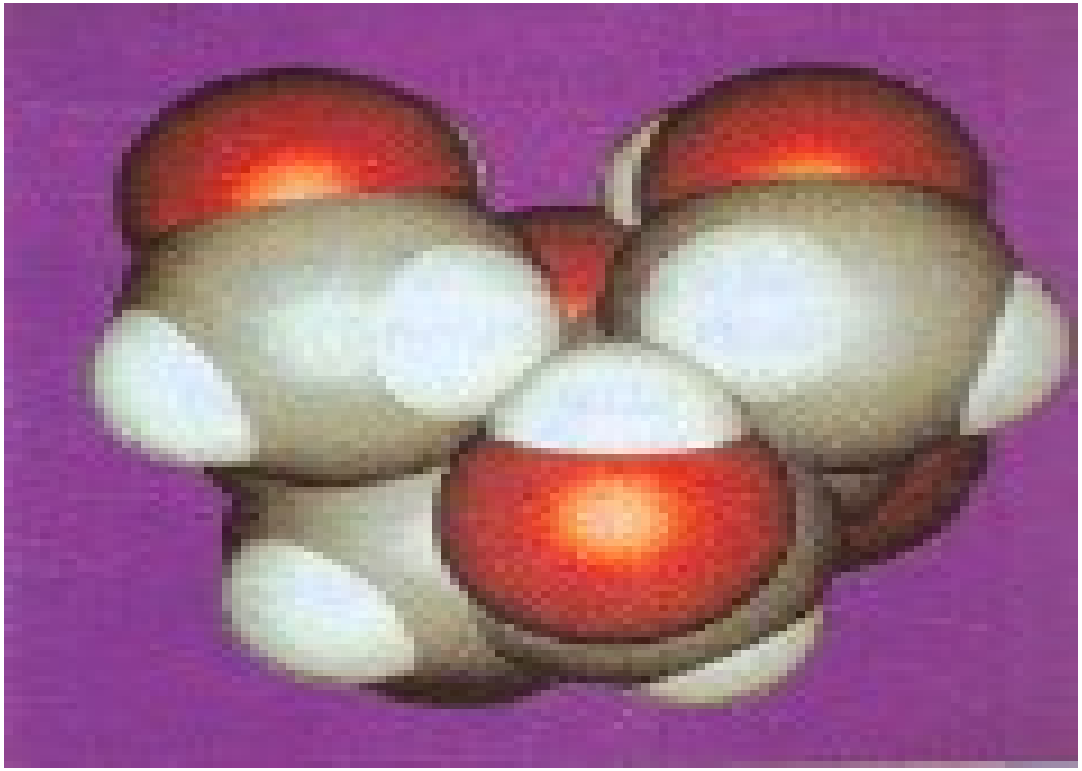
POLOACETÁLOVÝ HYDROXYL - 1

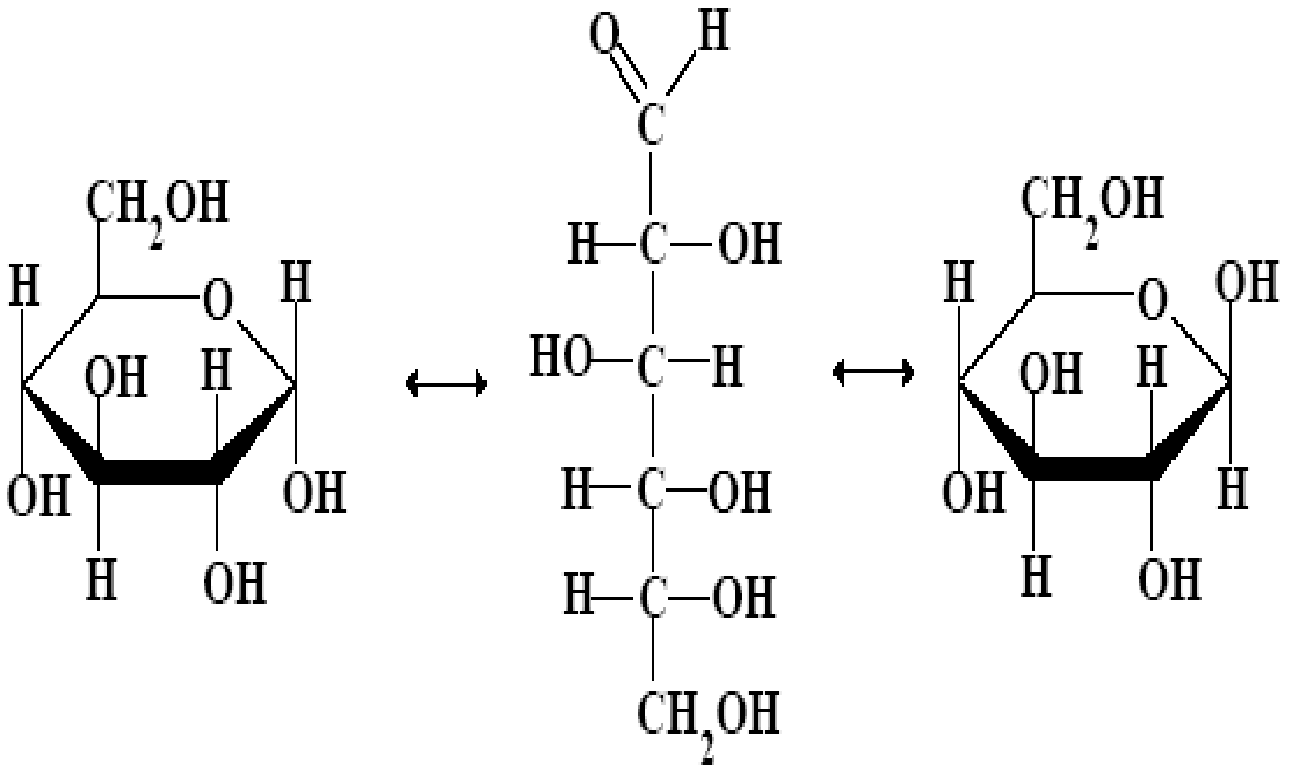




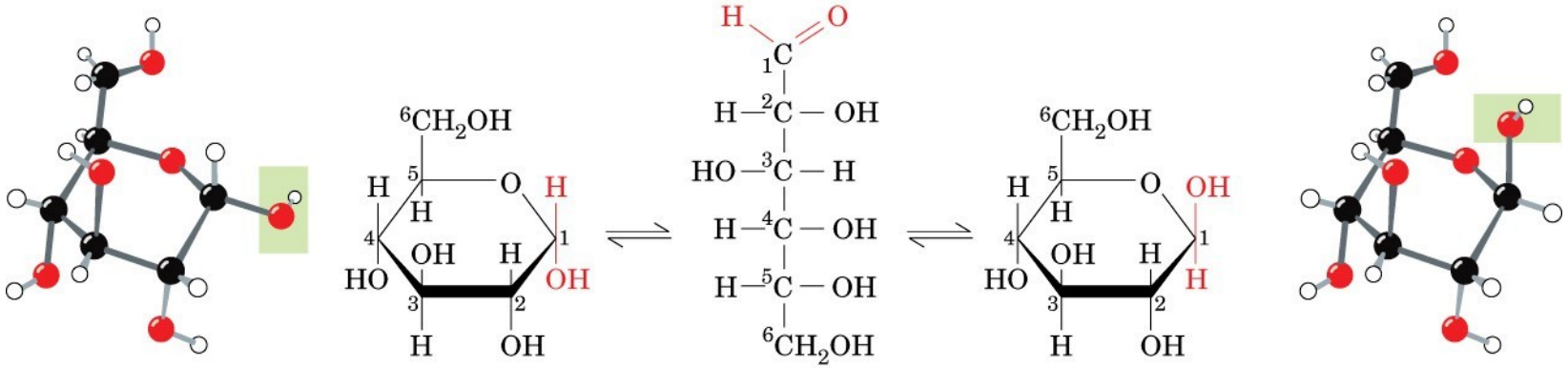


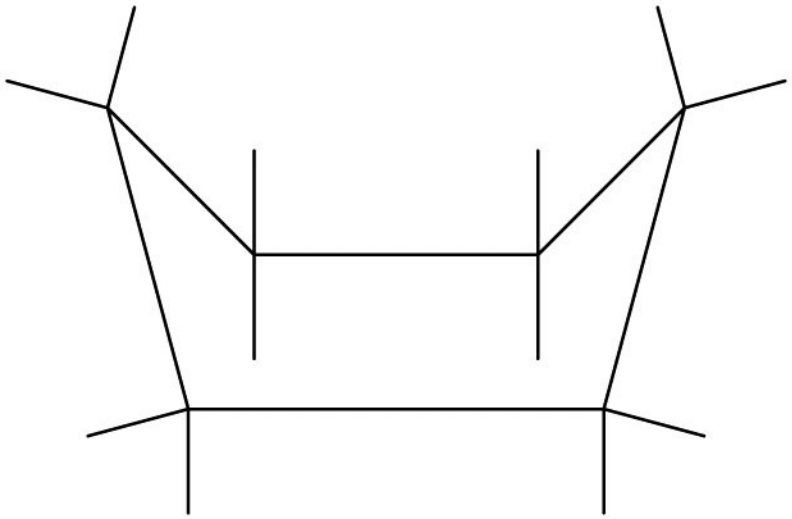
POLOACETÁLOVÝ HYDROXYL - 2



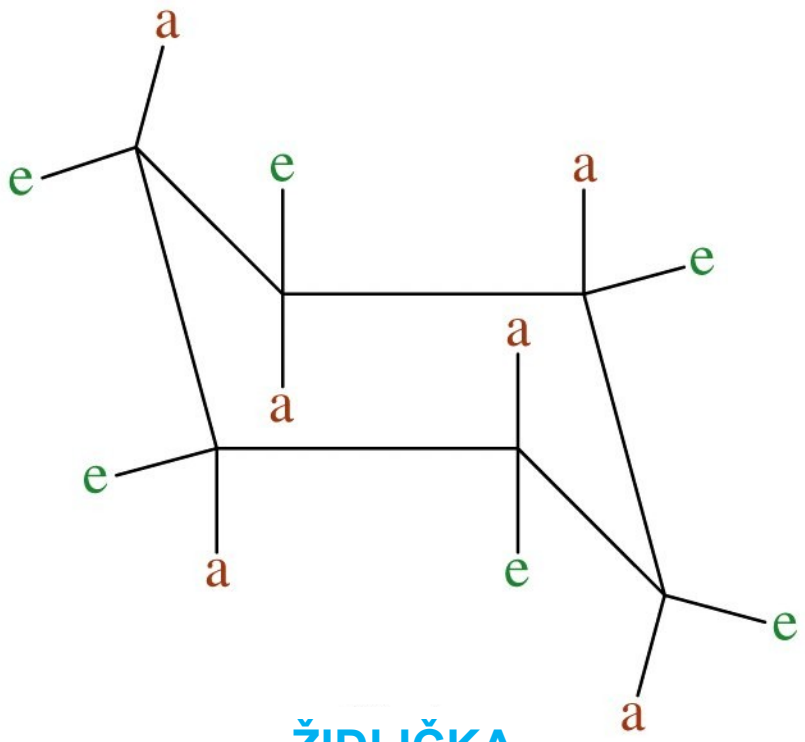


α–anomer (63 %) ⟷ MUTAROTACE ⟷ β–anomer (36 %)


α-D-Glucopyranose
D-Glucose
(linear form)
β-D-Glucopyranose



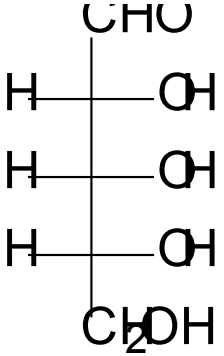
VANIČKA



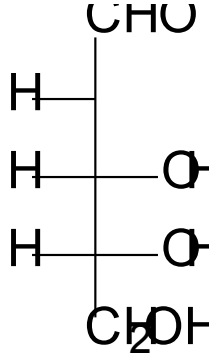
ŽIDLIČKA

Figure 7-10a Concepts in Biochemistry, 3/e

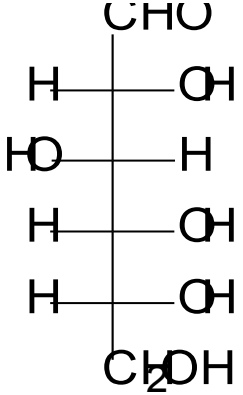
Fischerova projekce:



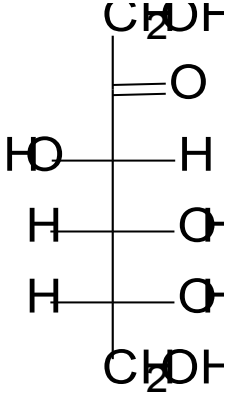
D-ribosa



2-deoxy-D-ribosa

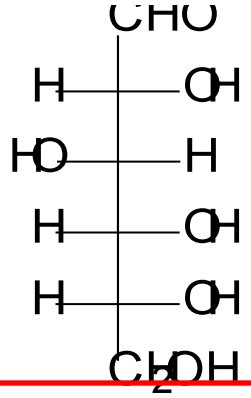


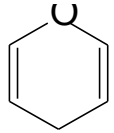
D-glukosa



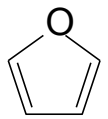
D-fruktosa

Tollensovy vzorce D-glukosy:

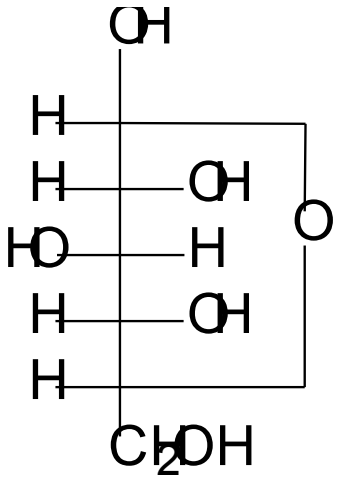




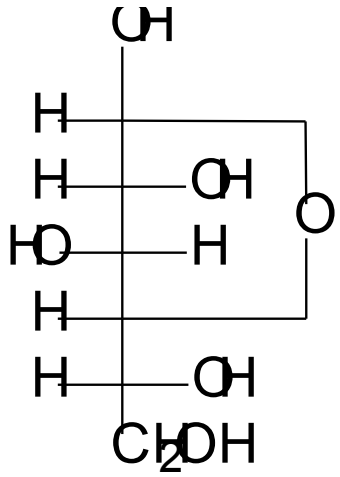
Pyran



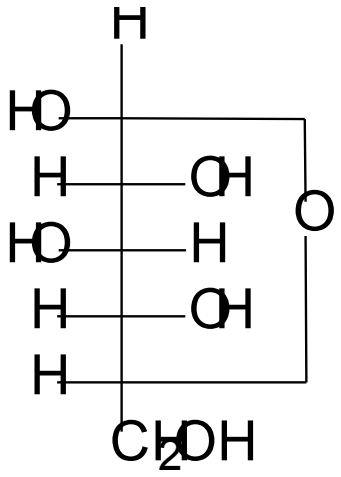
Furan



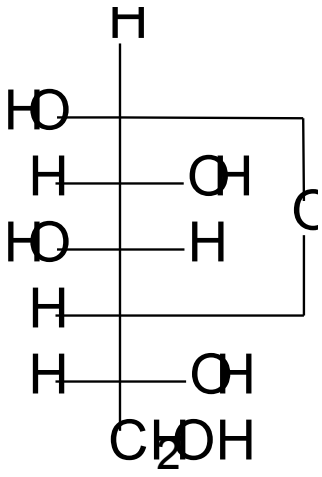
α-D-glukopyranosa



α-D-glukofuranosa

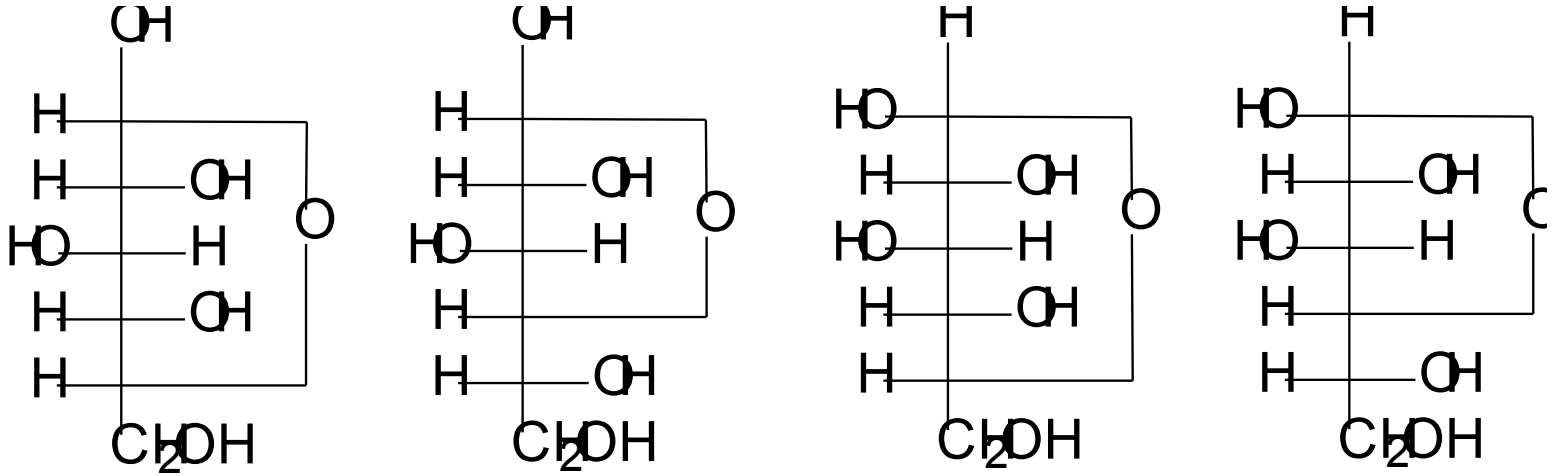


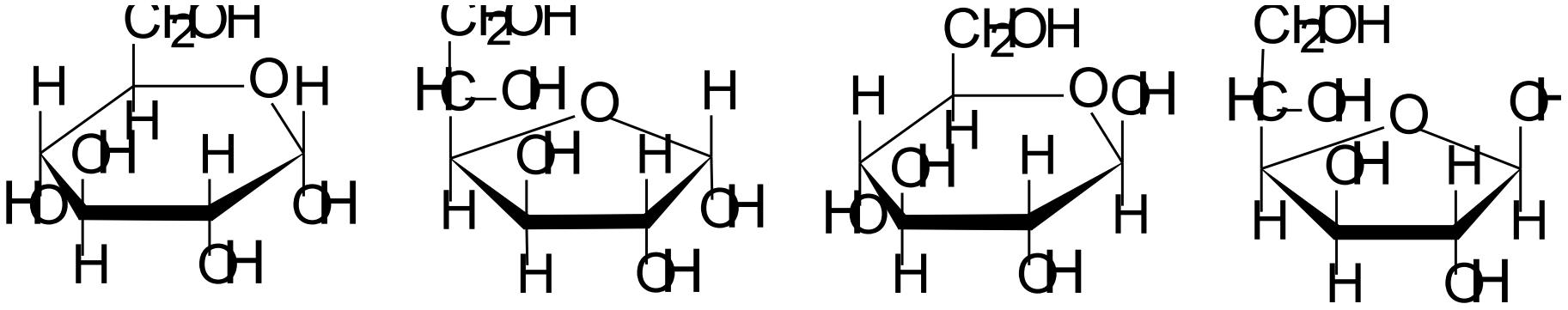
β-D-glukopyranosa



β-D-glukofuranosa

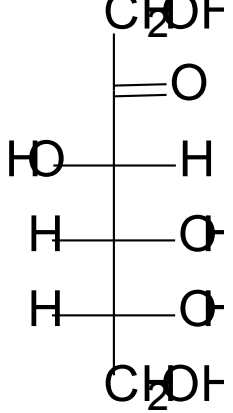
Haworthovy vzorce D-glukosy:



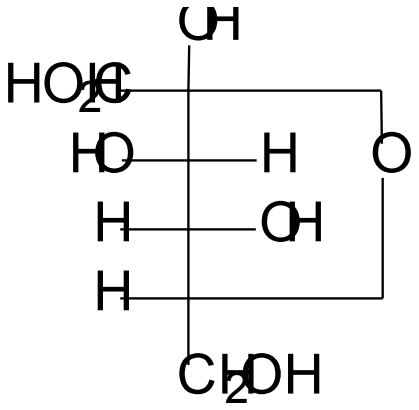


α-D-glukopyranosa *α-D-glukofuranosa* *β-D-glukopyranosa* *β-D-glukofuranosa*

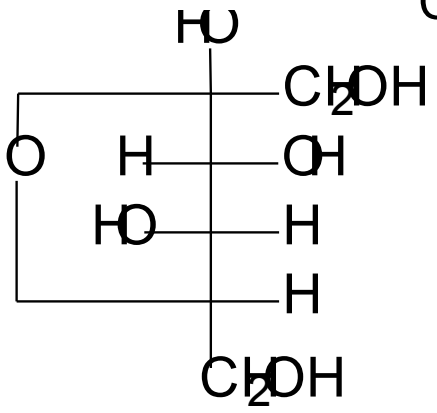
Vlevo – nad **Vpravo - pod**



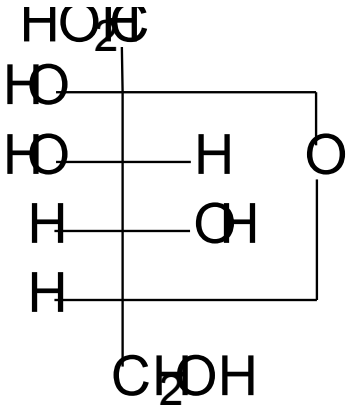
***Tollensovy vzorce fruktofuranosy**:*



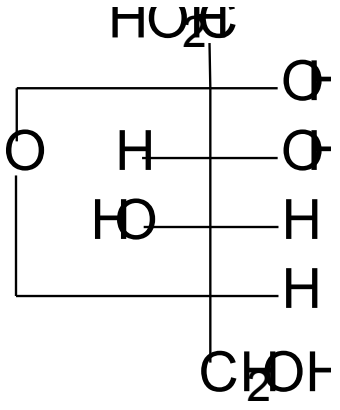
α-D-fruktofuranosa



α-L-fruktofuranosa

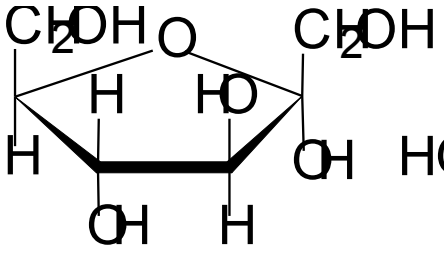


β-D- fruktofuranosa

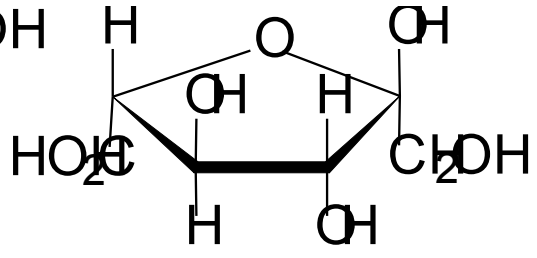


β-L-fruktofuranosa

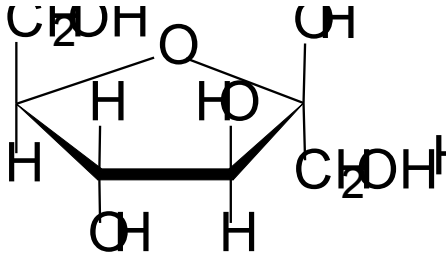
***Haworthovy vzorce fruktofuranosy**:*



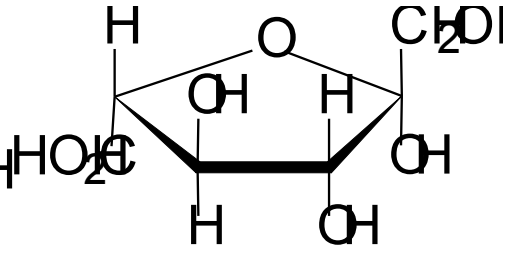
α-D-fruktofuranosa



α-L-fruktofuranosa



β-D-fruktofuranosa



β-L-fruktofuranosa

Přehled

Triosy	-	glyceraldehyd, dihydroxyaceton
Tetrosy	-	threosa, erythrosa
Pentosy	-	ribosa, deoxyribosa
Hexosy	-	glukosa, manosa, galaktosa
		fruktosa
Heptosa	-	sedoheptulosa

Aldosy

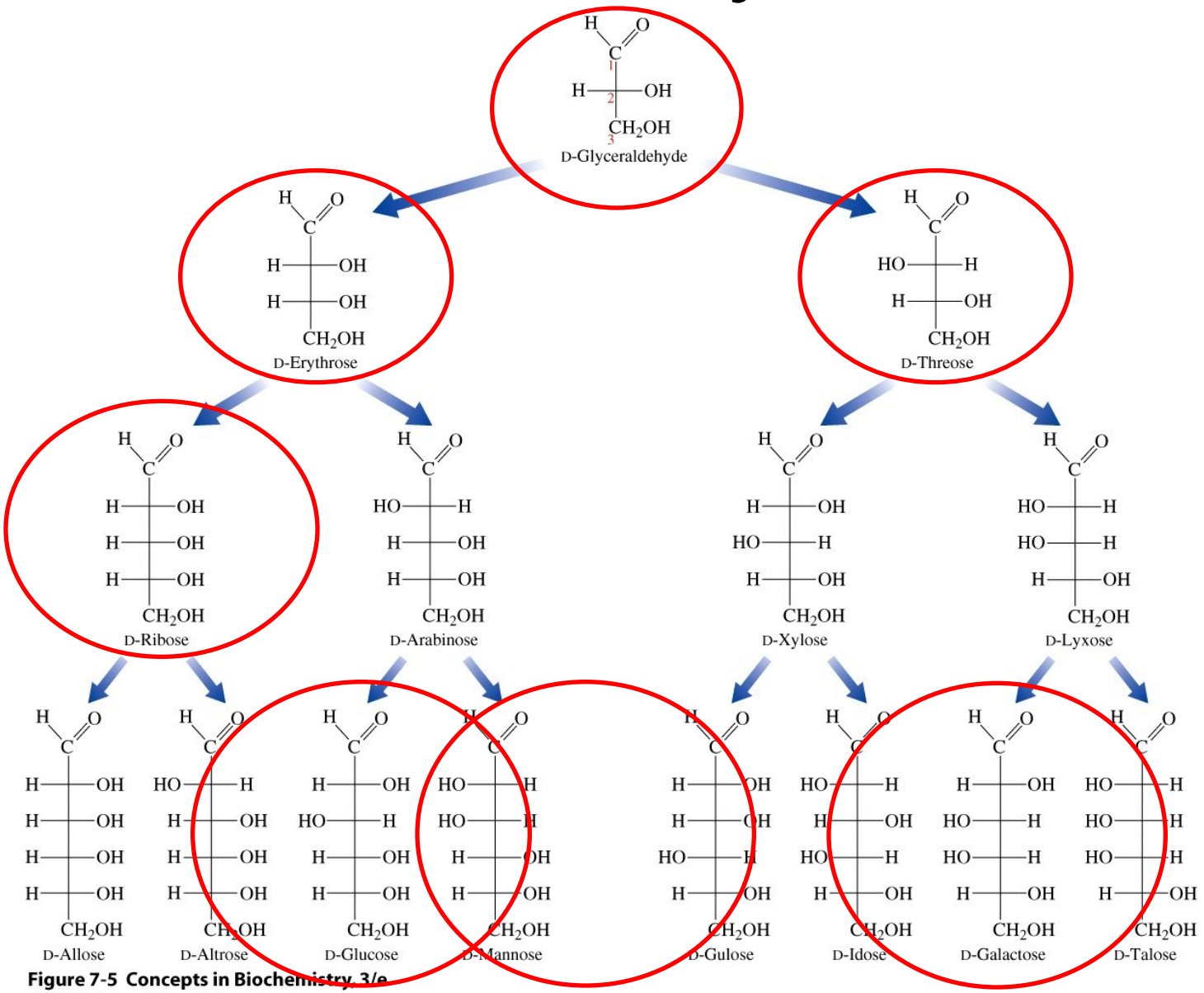


Figure 7-5 Concepts in Biochemistry, 3/e

Ketosy

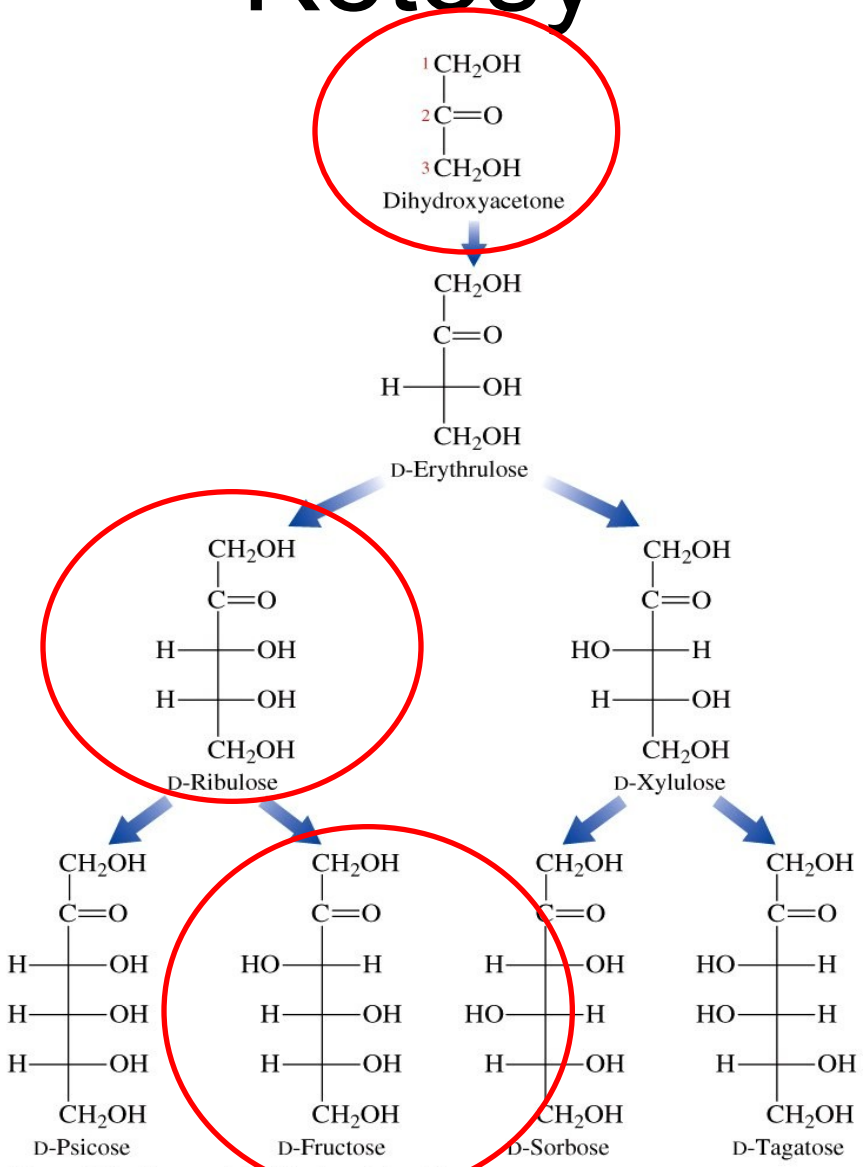
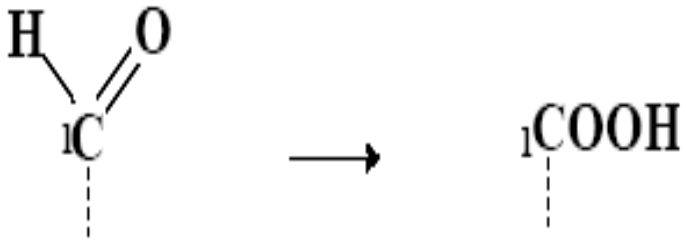


Figure 7-6a Concepts in Biochemistry, 3/e

Deriváty monosacharidů

Oxidace :

A. Mírná ⇒ aldehydická skupina → karboxylovou skupinu



ALDONOVÉ KYSELINY - glukosa → k. glukonová

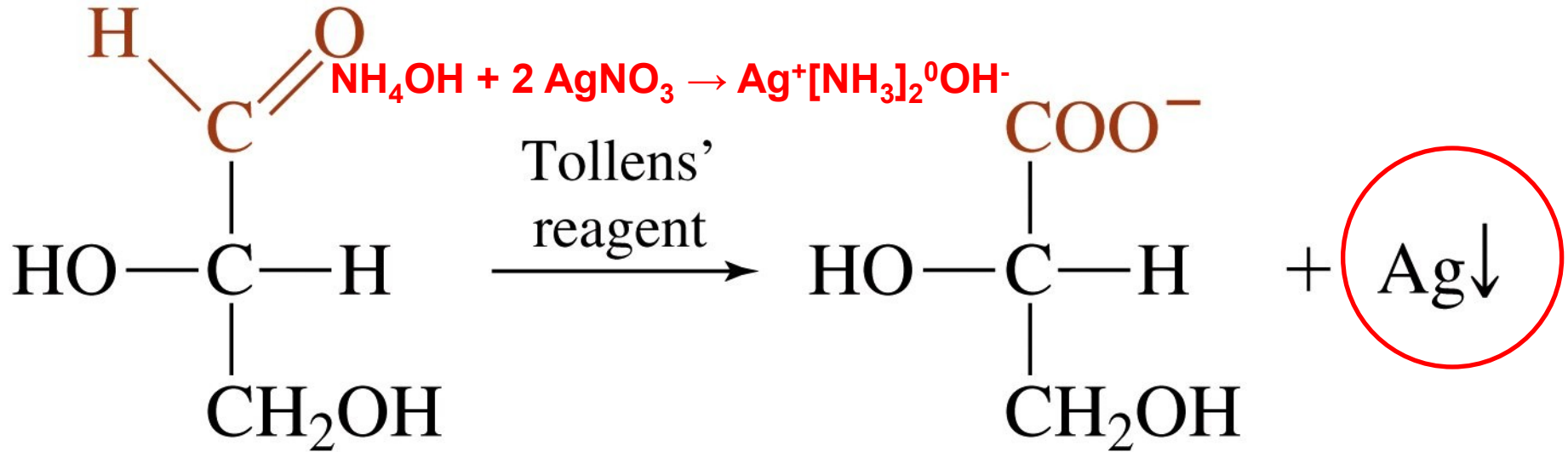


Figure 7-11a Concepts in Biochemistry, 3/e

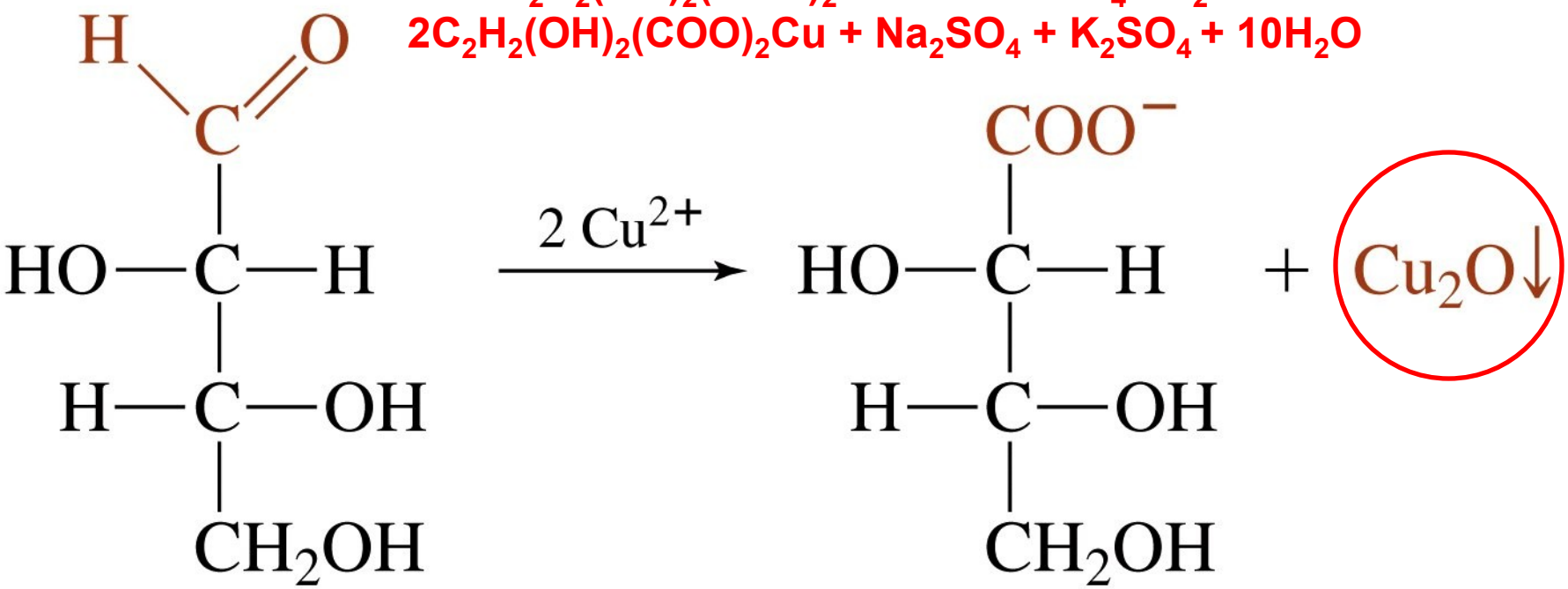
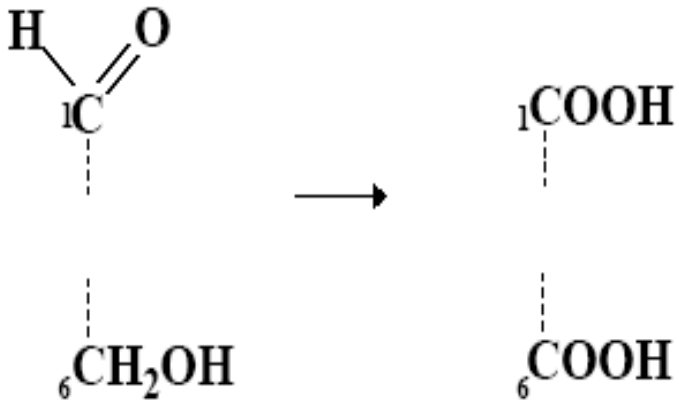


Figure 7-11b Concepts in Biochemistry, 3/e

B. Specifická ⇒ **primární OH skupina → karboxylovou skupinu**

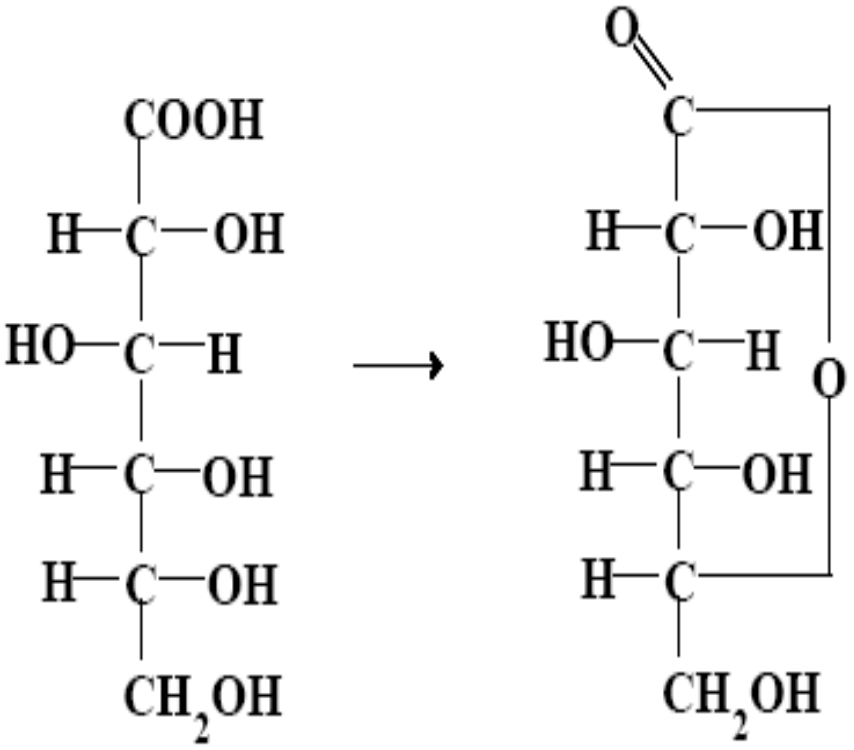
URONOVÉ KYSELINY - glukosa → k. glukuronová

C. Silná ⇒ **aldehydická skupina + primární OH skupina**



ALDAROVÉ KYSELINY - glukosa → k. glukarová

Tvorba laktonů u aldonových a uronových kyselin



k.glukonová D-glukonolakton

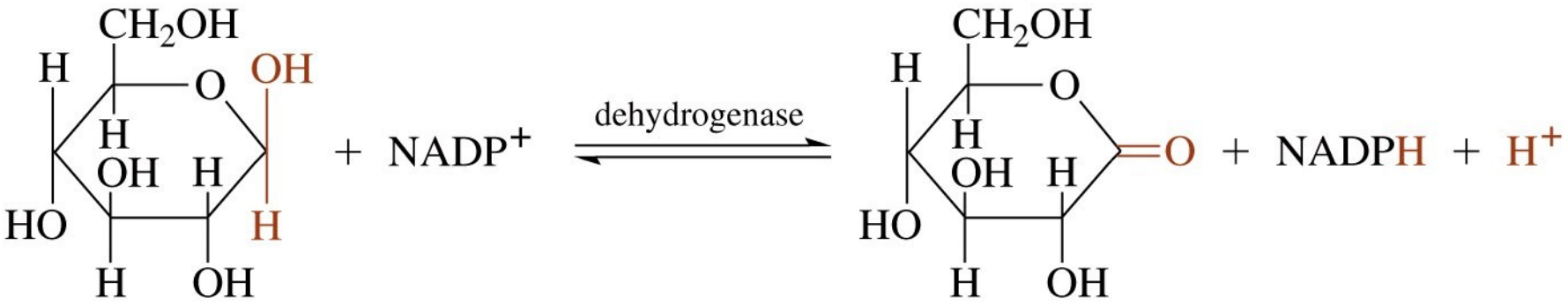
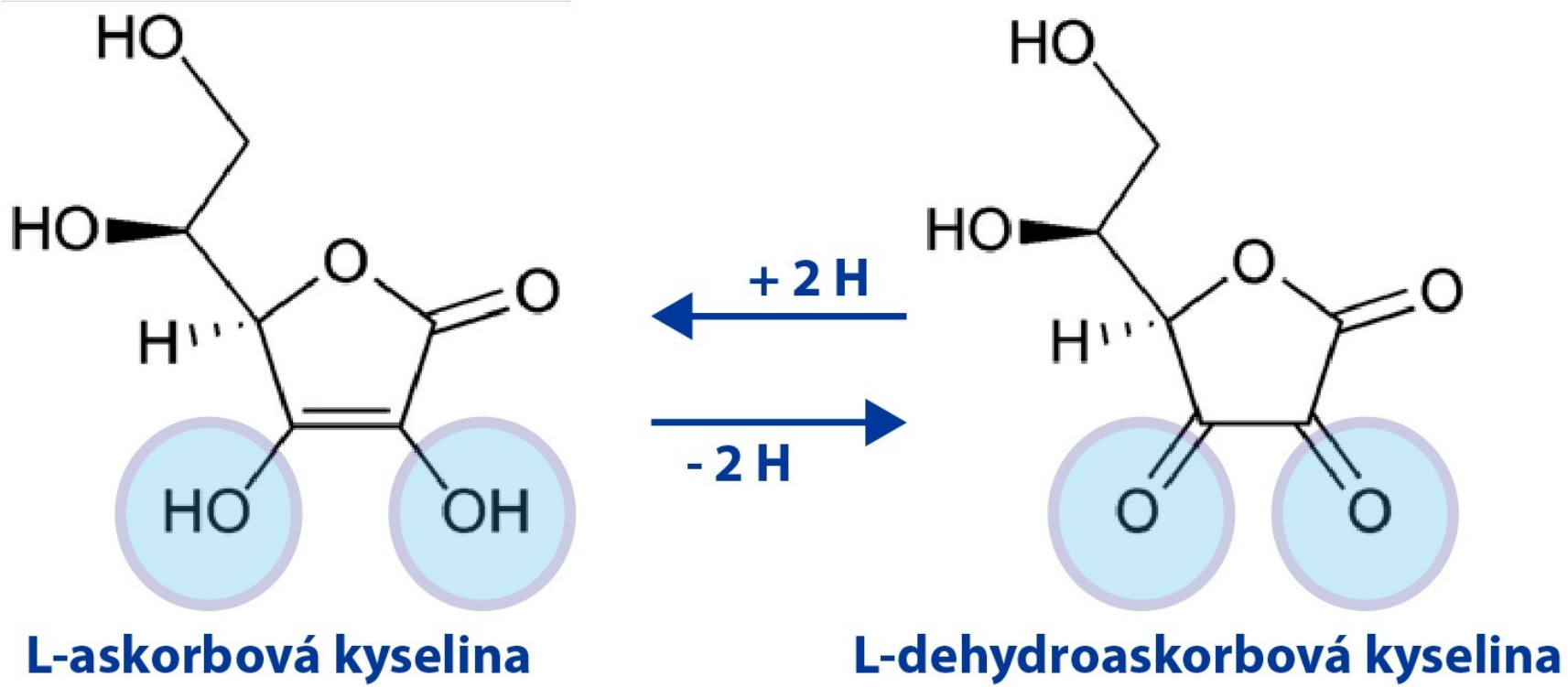


Figure 7-11c Concepts in Biochemistry, 3/e



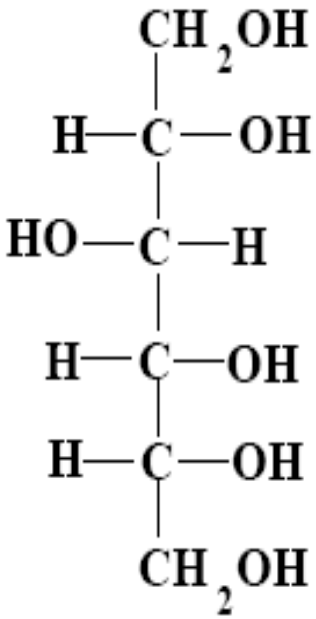
L-askorbová kyselina **L-dehydroaskorbová kyselina**

γ- lakton kyseliny dioxogulonové

Redukce :

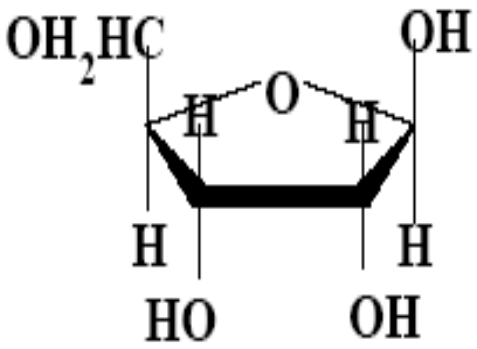
mírná ⇒ **karbonylová skupina → hydroxy skupinu**

POLYHYDROXYALKOHOLY - ALDITOLY -itol

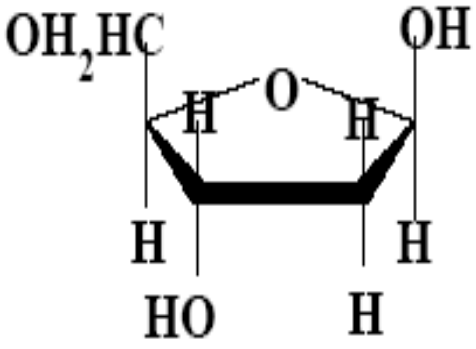


GLUCITOL - SORBITOL

Deoxycukry - OH skupina nahrazena H

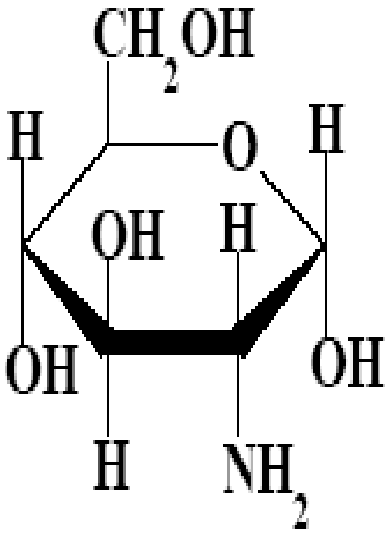


RIBOSA

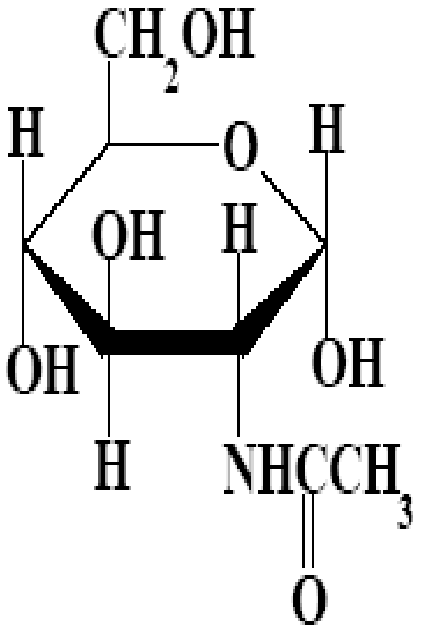


DEOXYRIBOSA

Aminocukry - OH skupina nahrazena NH_2 skupinou



GLUKOSAMIN

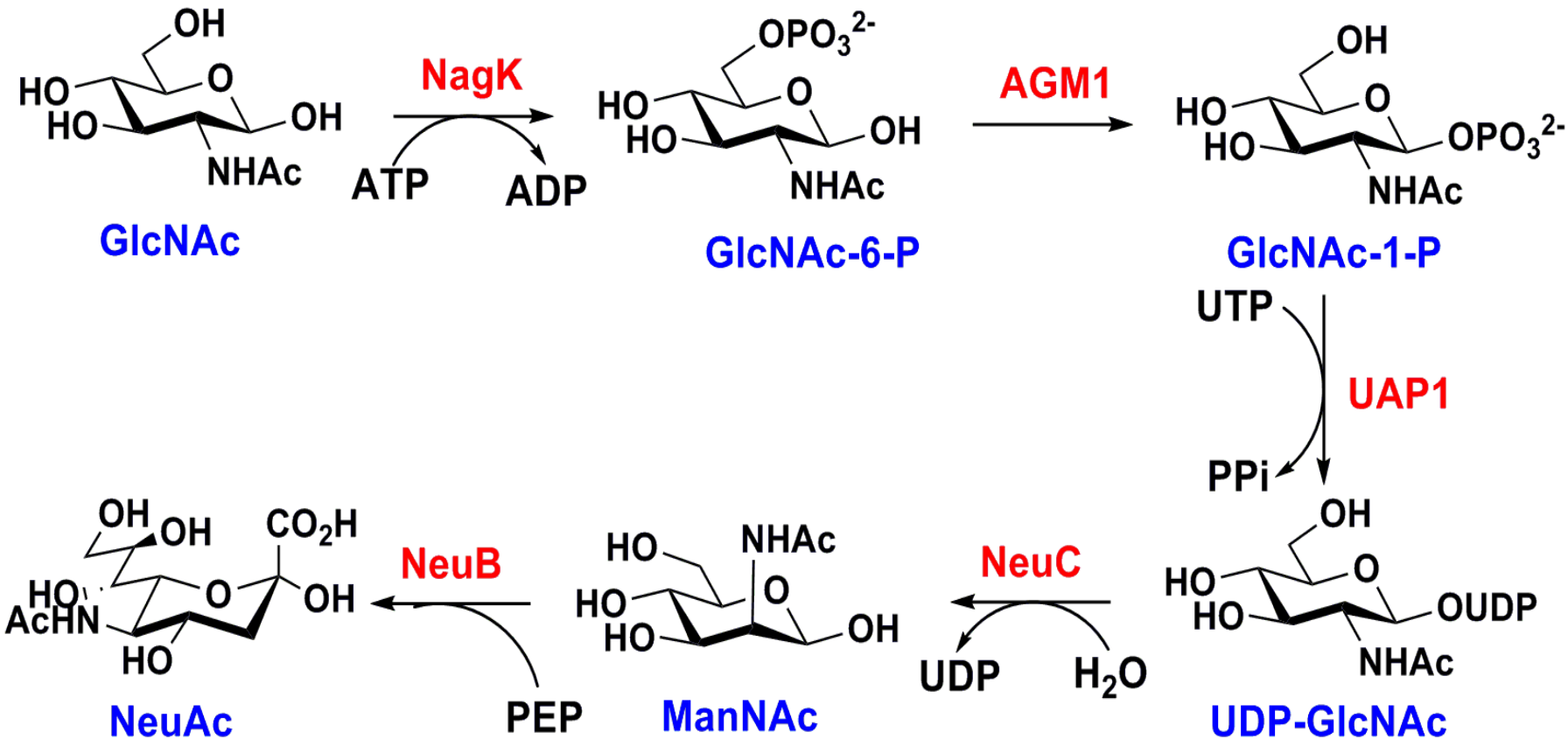


N-ACETYLGLUKOSAMI

glukosamin + galaktosamin – v glykoproteinech

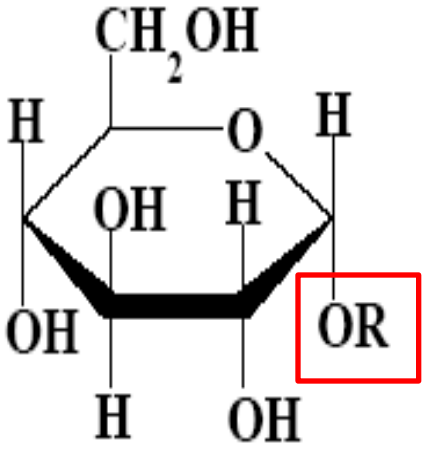
***N*-acetylglukosamin – chitin** **_N_-acetylgalaktosamin – chondrotinisulfát**

Sialové kyseliny - kondenzace N-acetylmanosaminu + pyruvátu



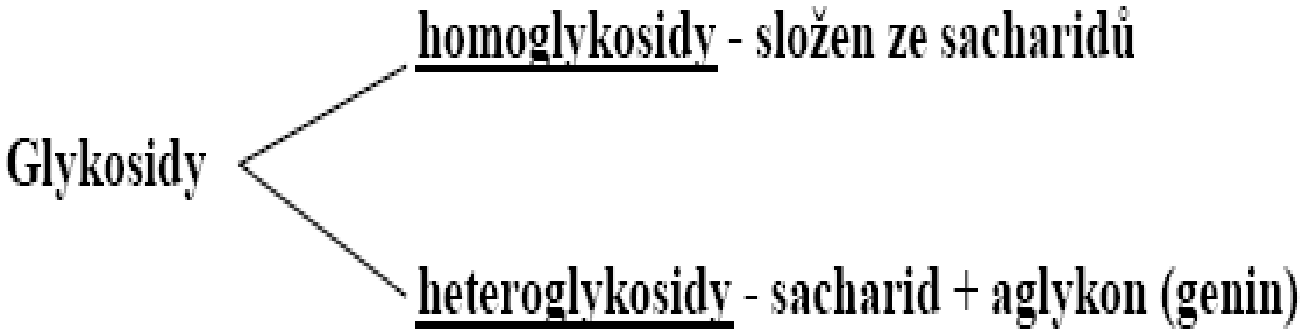
Antigenní determinanty na povrchu buněk

Glykosidy :

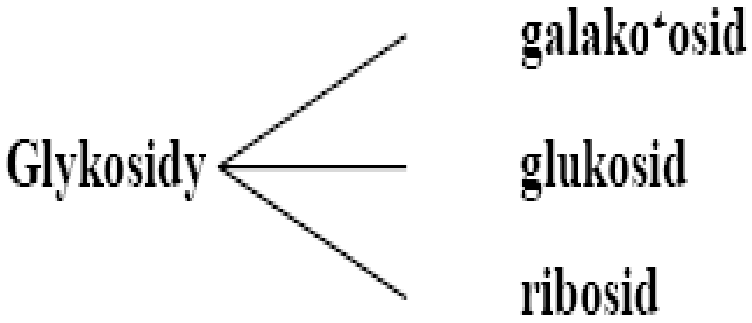


O-glukosid

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



Amygdalin, digitonin, anthokyany, flavony, antibiotika



Disacharidy :

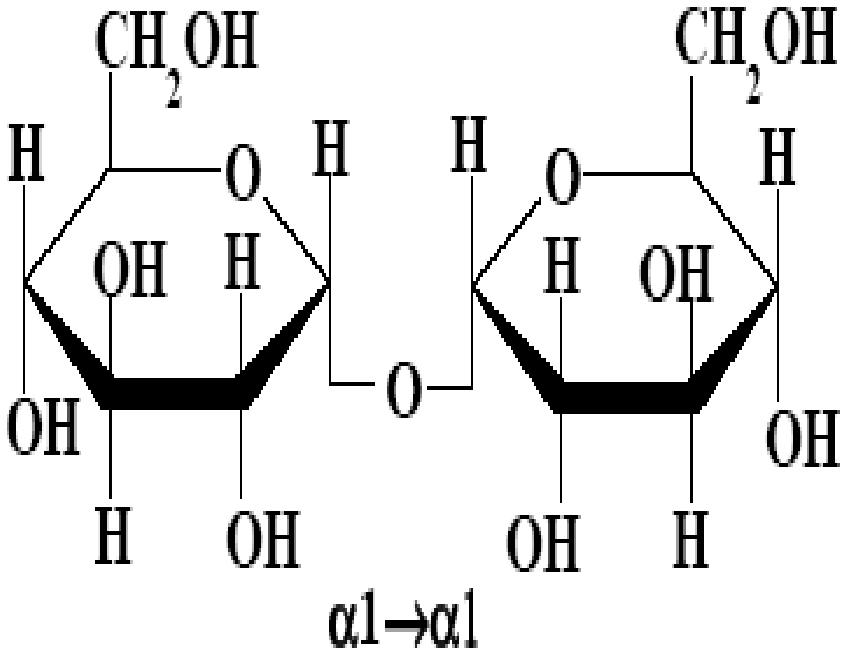
A. Neredukující - trehalosový typ - yl - id

O - α -D - glukopyranosyl (1→1) - α - D - glukopyranosid

B. Redukující - maltosový typ - yl - osa

O - α -D - glukopyranosyl (1→4) - α - D - glukopyranosa

Neredukující disacharidy

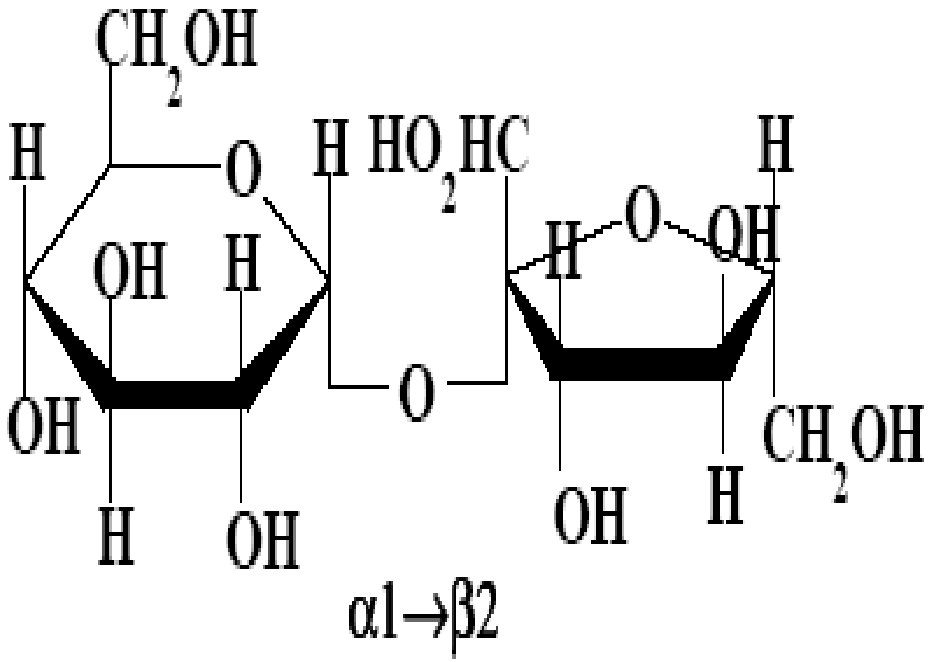


α1→α1

TREHALOSA

O - α -D - glukopyranosyl (1→1) - α -D - glukopyranosid

Krevní cukr hmyzu



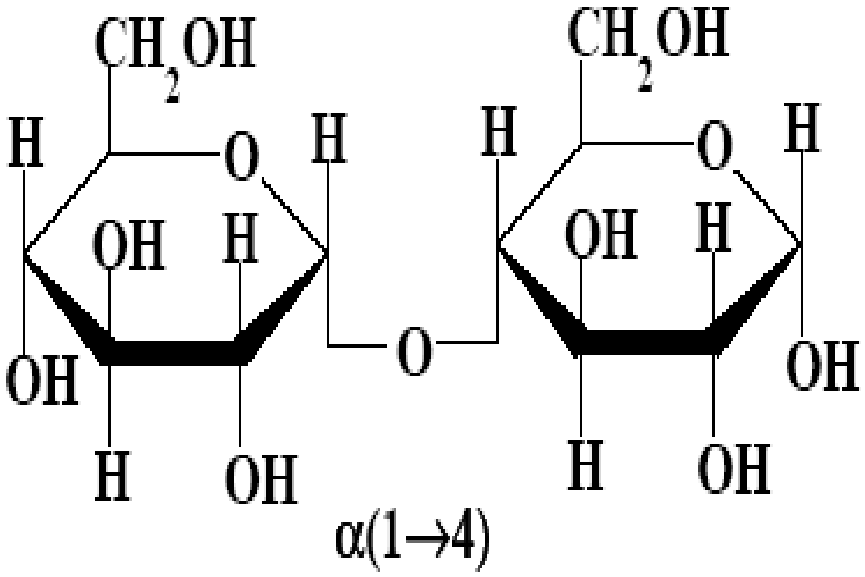
α1→β2

SACHAROSA

O - α -D - glukopyranosyl (1→2) - β - D - fruktofuranosid

Cukr řepný, třtinový

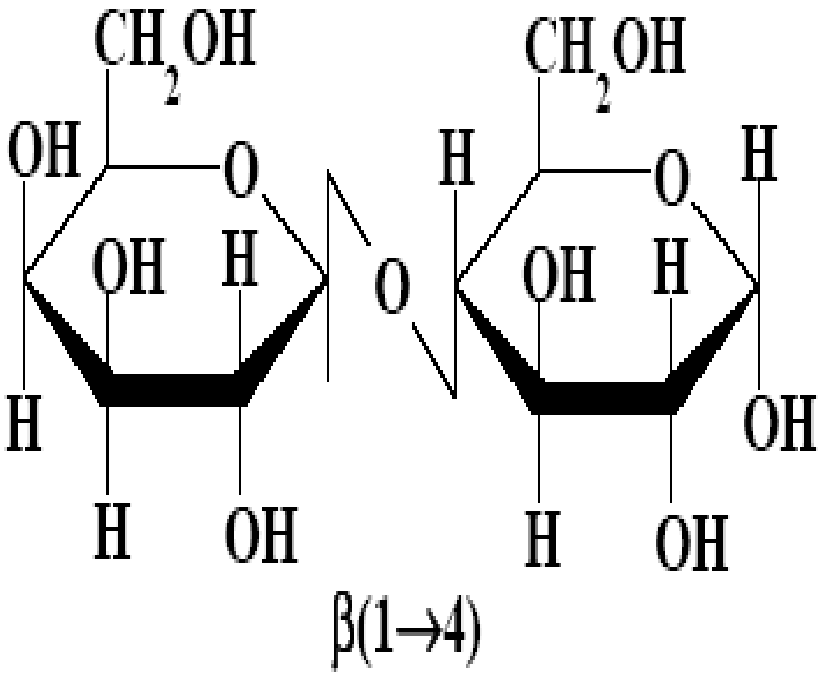
Redukující disacharidy



MALTOSA

O - α -D - glukopyranosyl (1→4) - α -D - glukopyranosa

Cukr sladový



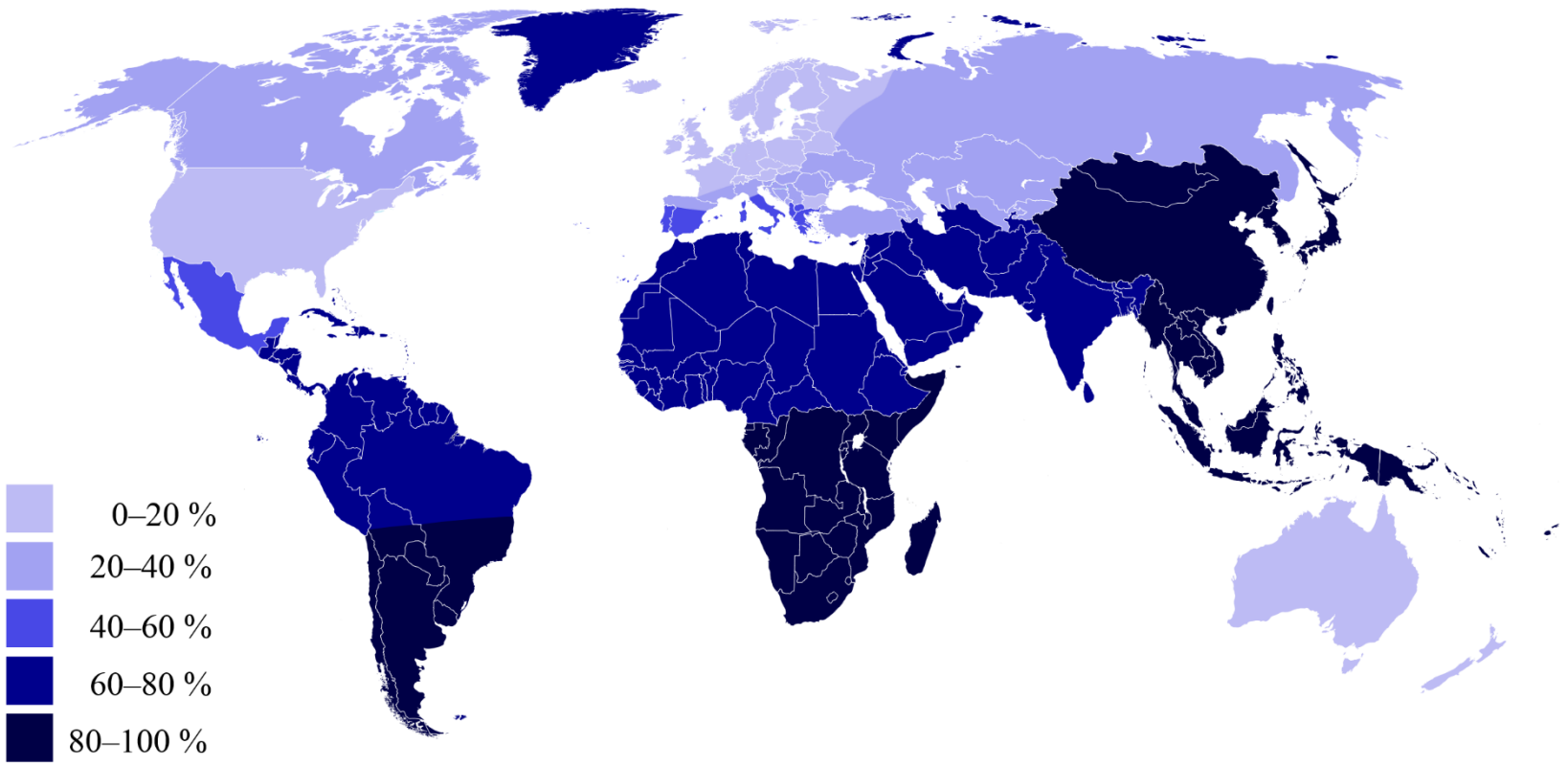
β(1→4)

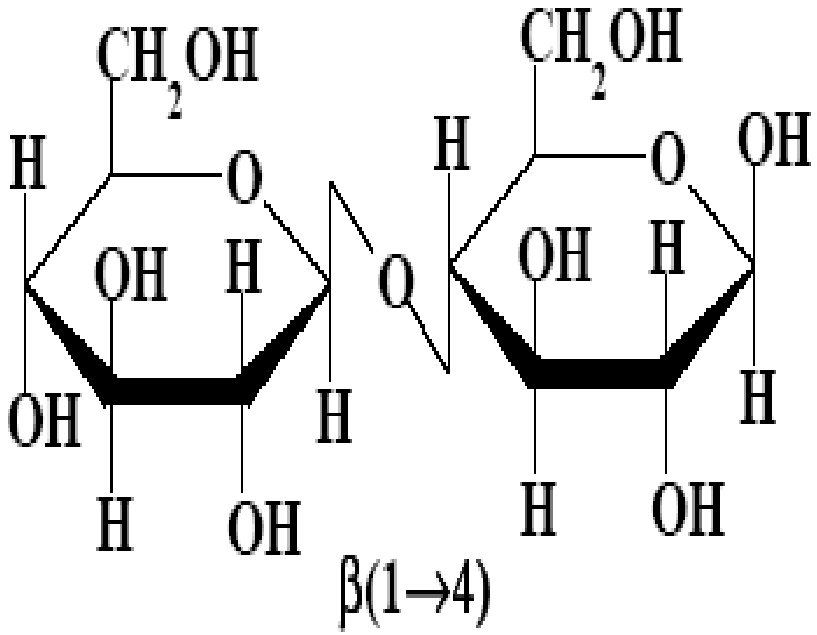
LAKTOSA

O - β -D - galaktopyranosyl (1→4) - β -D - glukopyranosa

Cukr mléčný

Intolerance na laktosu



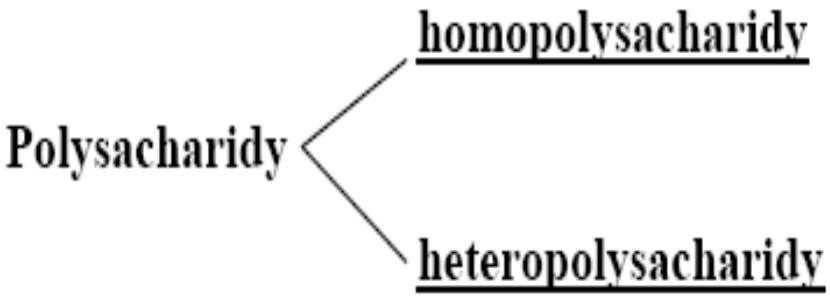


CELLOBIOSA

O - β -D - glukopyranosyl (1→4) - β -D - glukopyranosa

Součást celulosy

Polysacharidy :



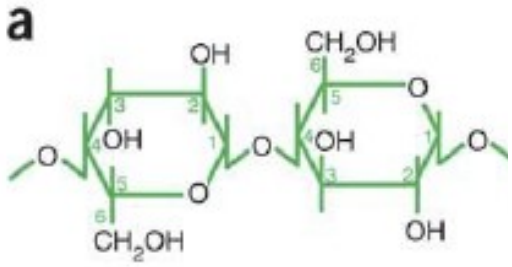
Funkce - stavební

- zásobní

Analýza struktury a funkce

- Jsou heterogenní z hlediska složení a MW
- Nelze použít genetickou analýzu – sekvence dána působením enzymů
- Vzhledem k jejich pasívnímu působení není jednoduché odhalit jejich funkci

Metylační analýza



HOMOPOLYSACHARIDY

Stavební homopolysacharidy :

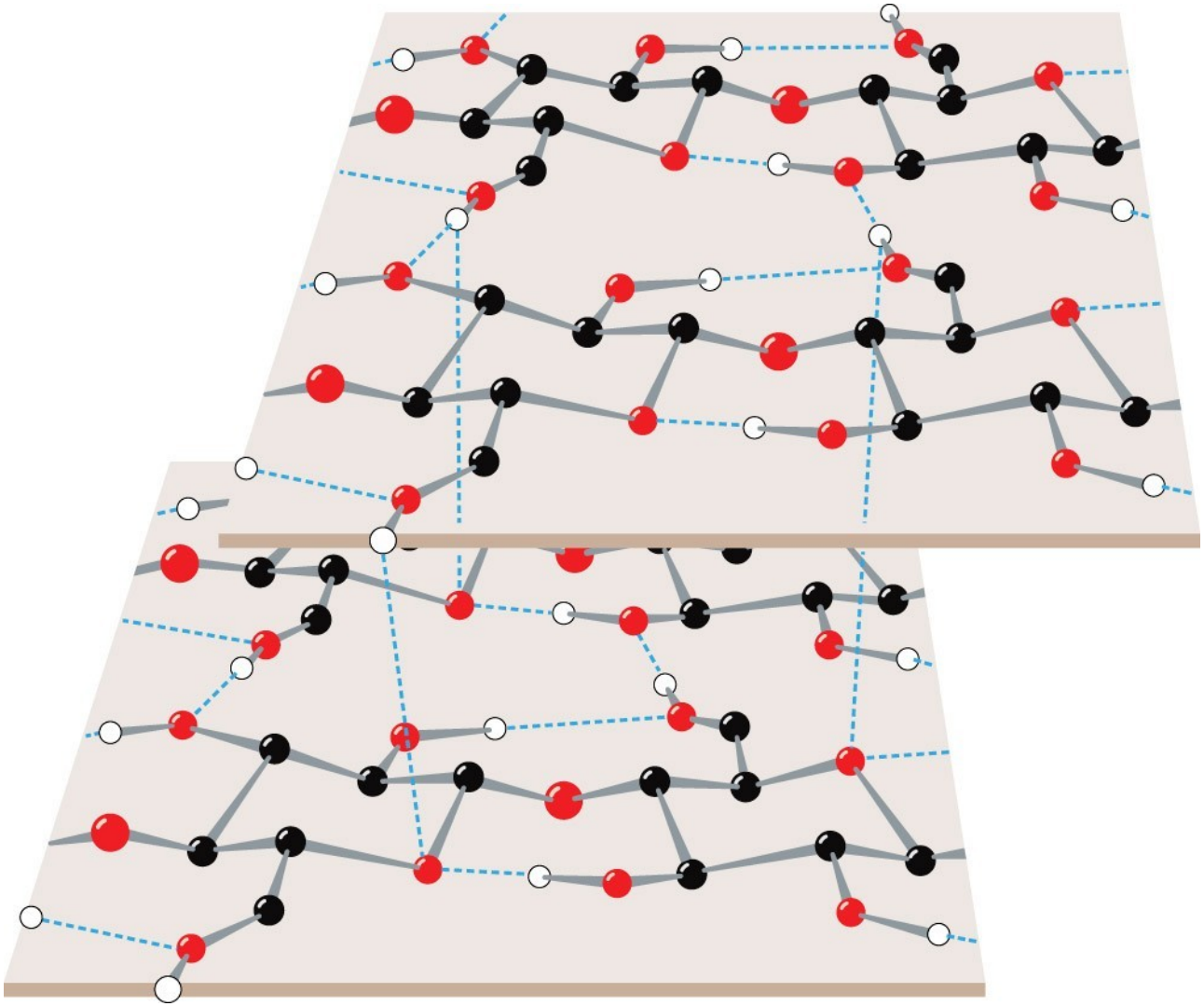
CELULOSA - glukosa (celobiosa)

CHITIN - N-acetylglukosamin

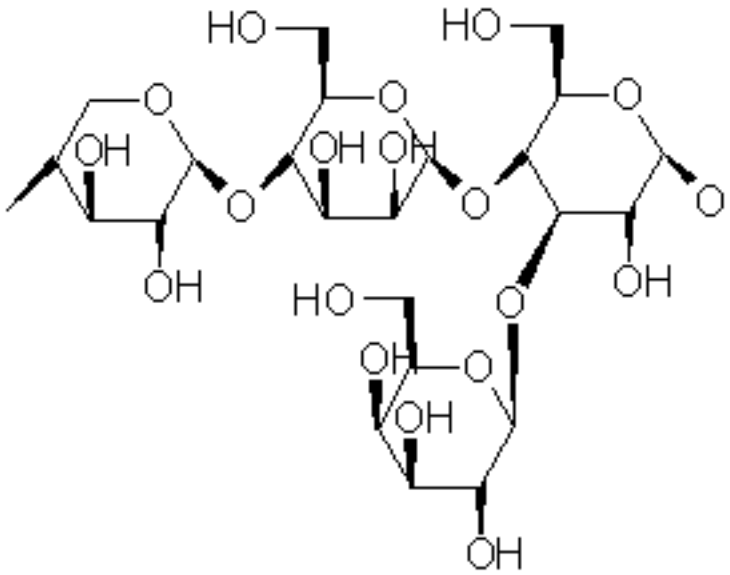
AGAROSA - galaktosa + 3, 6 - anhydrogalaktosa

PEKTINY - galakturonová kyselina

Celulosa



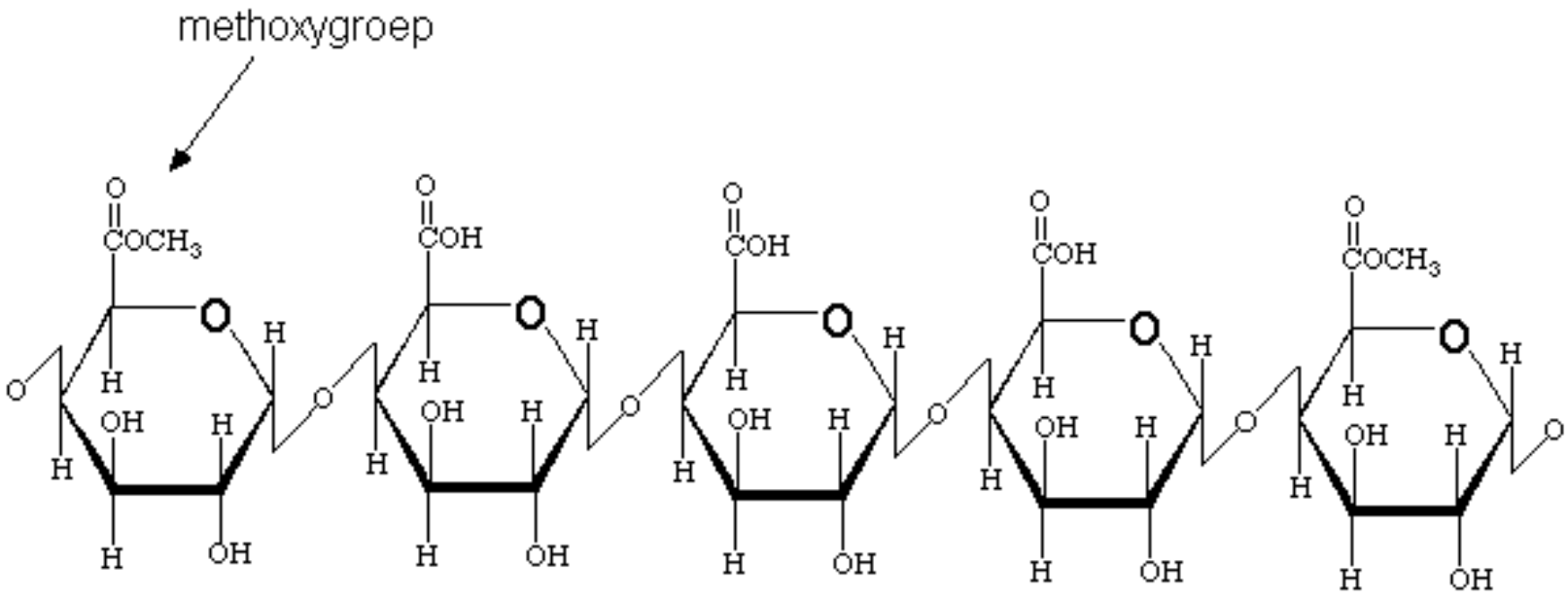
Hemicelulosa

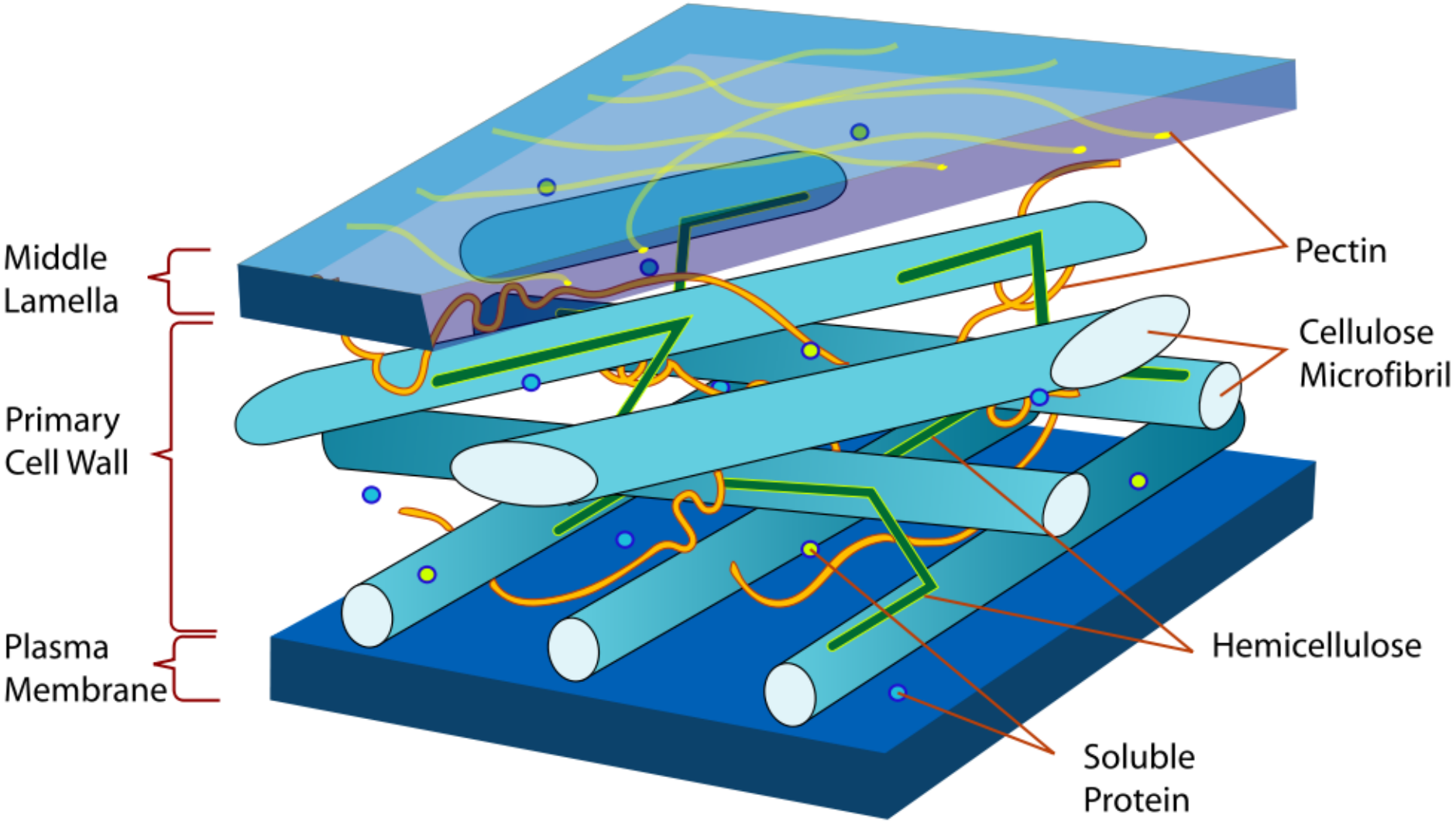


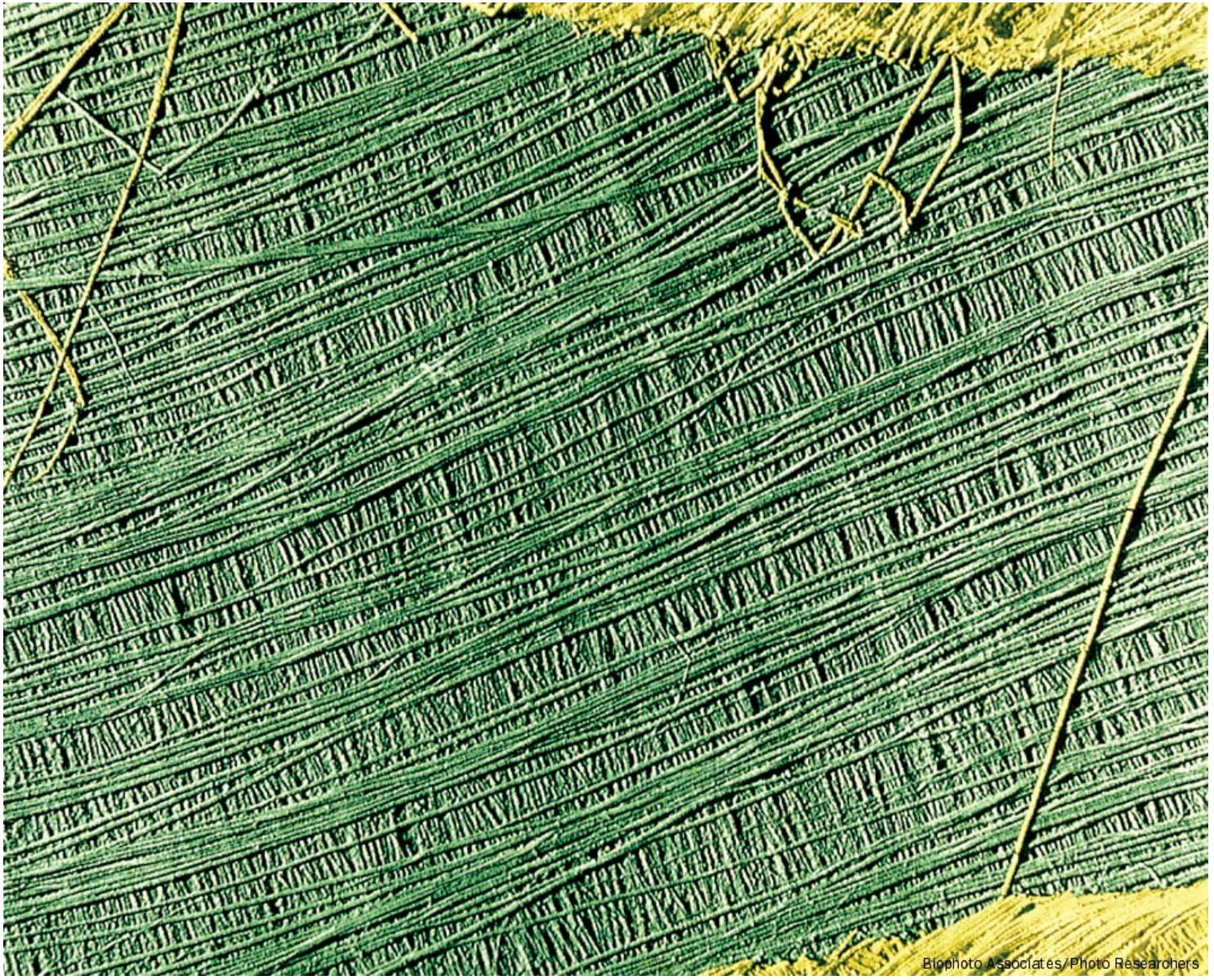
- Xylose - ß(1,4) - Mannose - ß(1,4) - Glucose -
- alpha(1,3) - Galactose

Hemicellulose

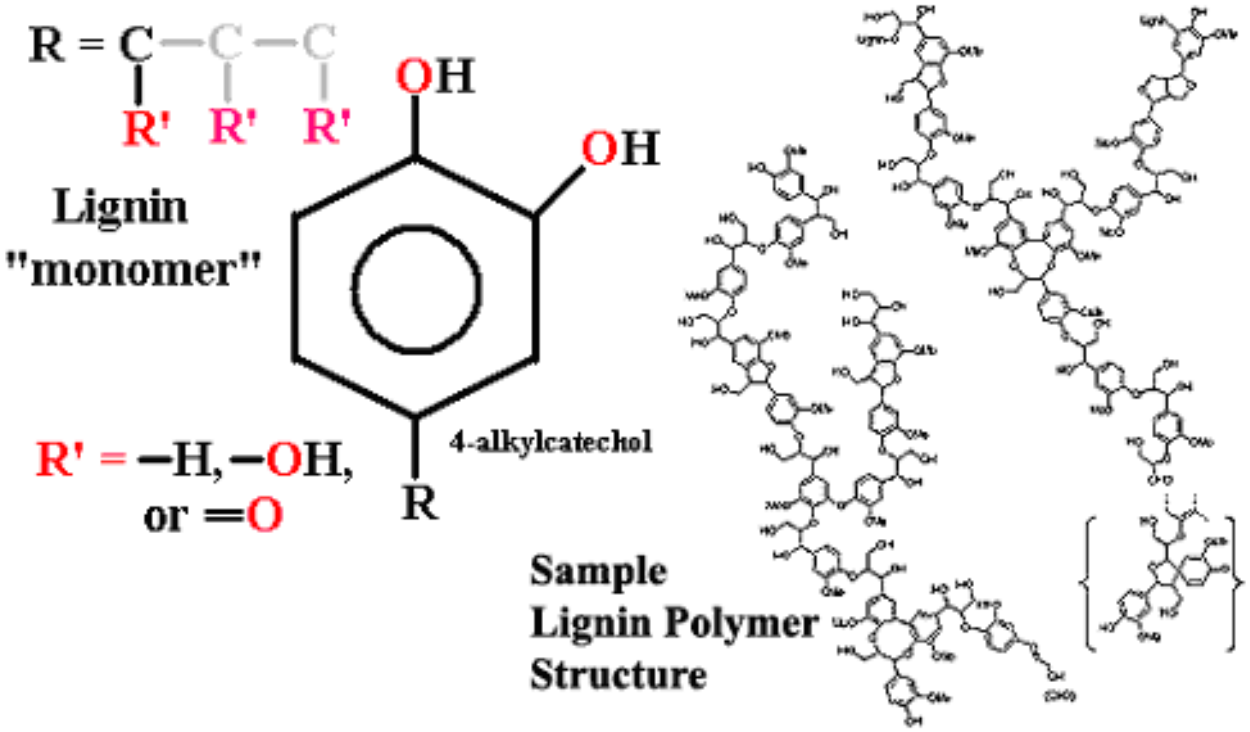
Pektiny

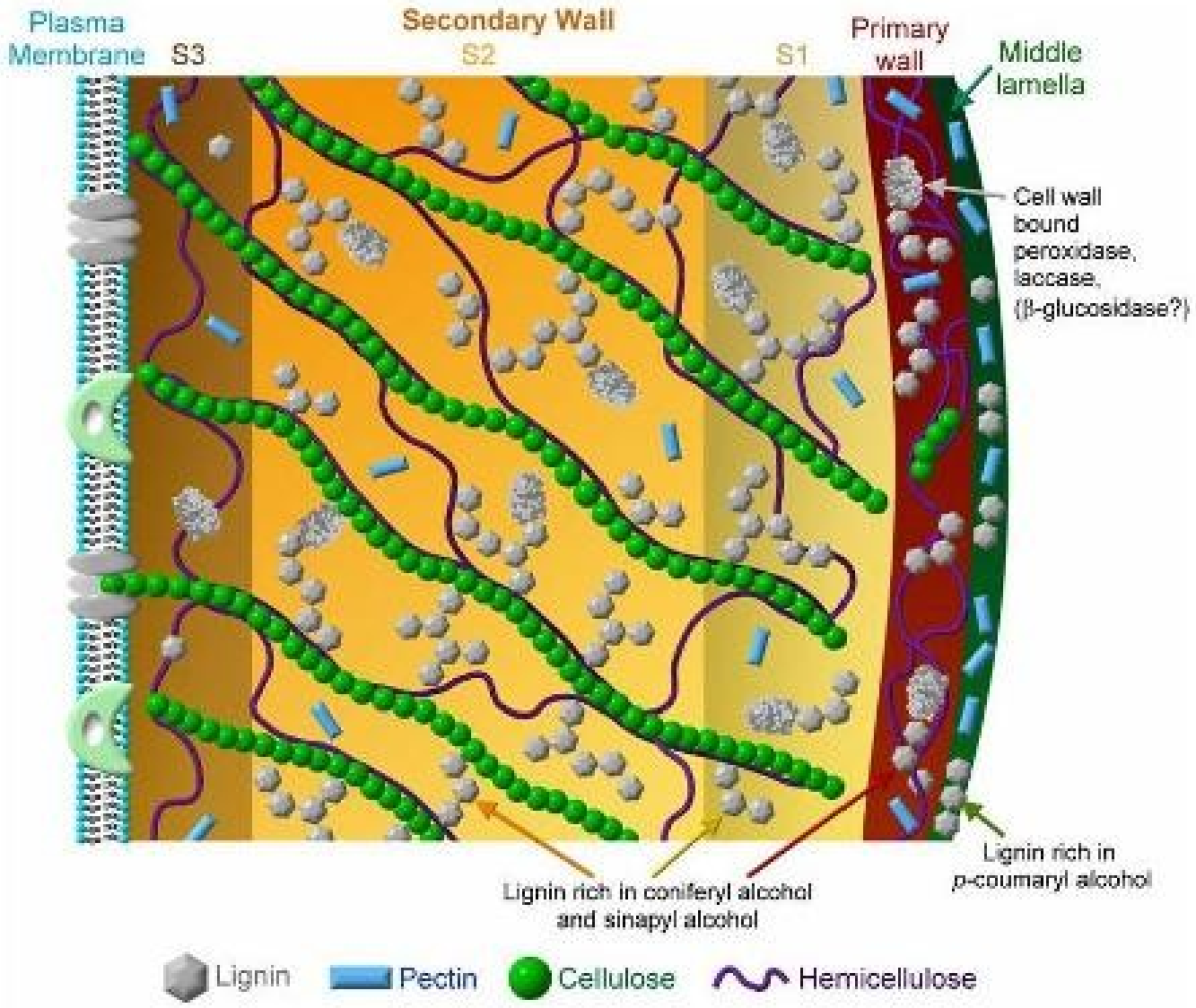



Middle Lamella
Primary Cell Wall
Plasma Membrane
Pectin
Cellulose Microfibril
Hemicellulose
Soluble Protein

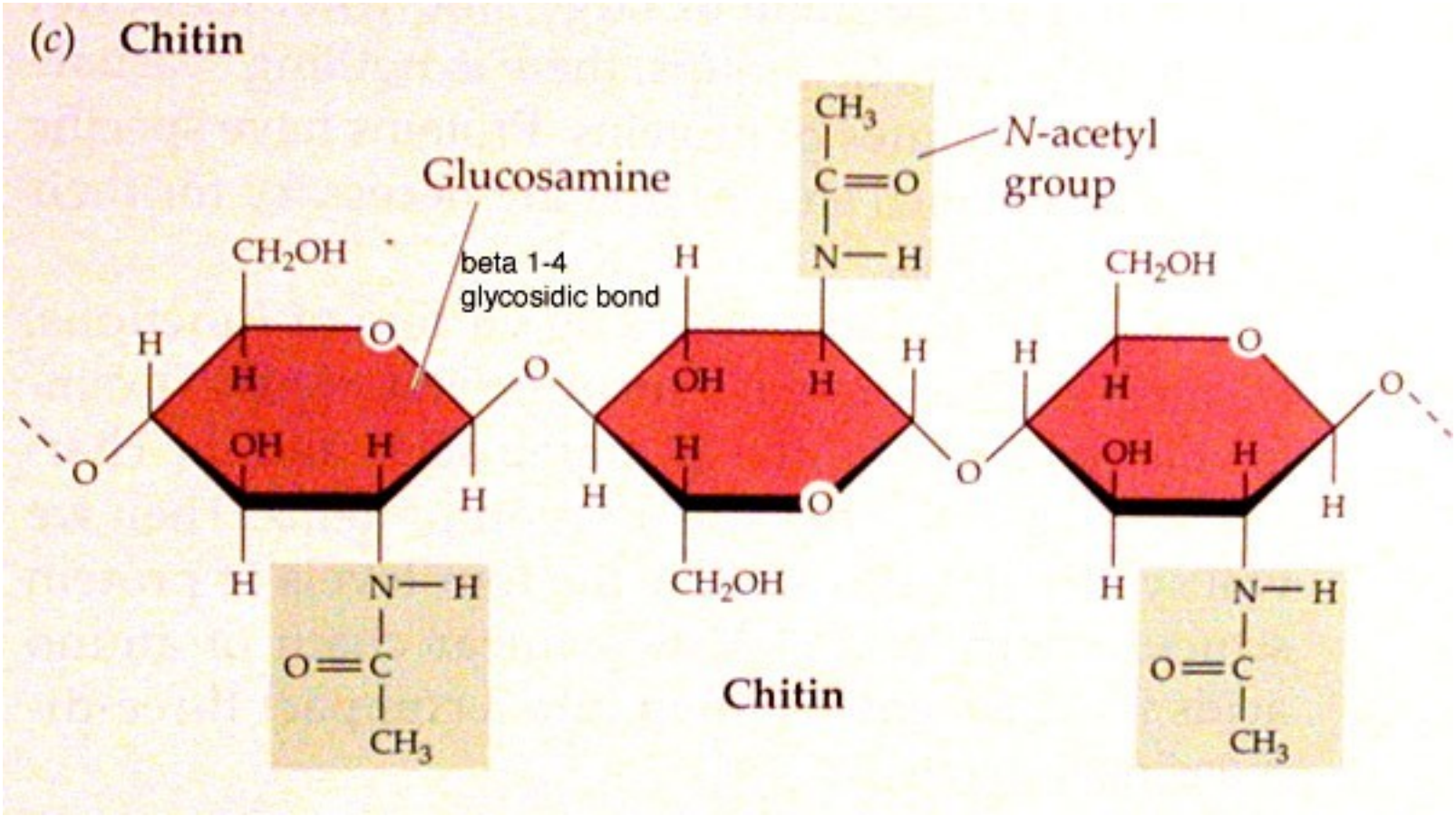

Biophoto Associates/Photo Researchers

Lignin


R = C — C — C
R' R' R'
Lignin
"monomer"
OH
OH
4-alkylcatechol
R
R' = —H, —OH,
or =O
Sample
Lignin Polymer
Structure


Plasma Membrane
S3
Secondary Wall
S2
S1
Primary wall
Middle lamella
Cell wall bound peroxidase, laccase, (β-glucosidase?)
Lignin rich in coniferyl alcohol and sinapyl alcohol
Lignin rich in p-coumaryl alcohol
Lignin
Pectin
Cellulose
Hemicellulose

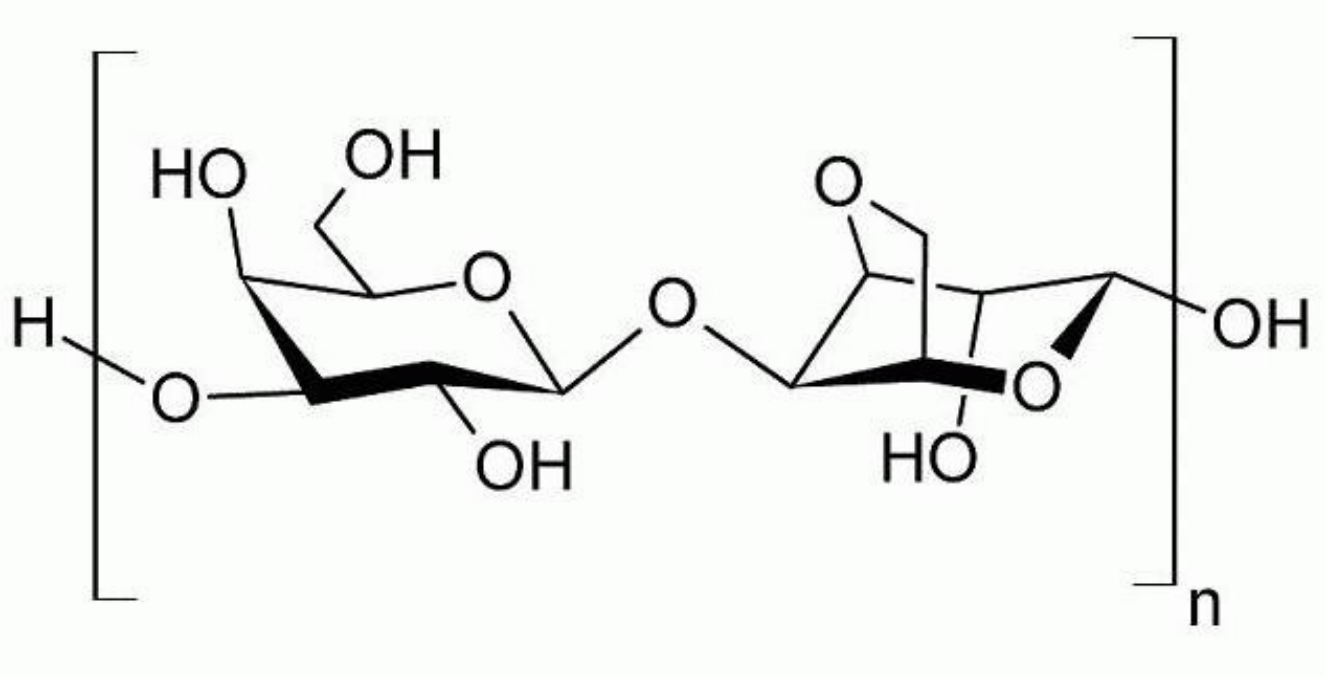
Chitin


(c) Chitin
Glucosamine
beta 1-4
glycosidic bond
N-acetyl
group
Chitin

CELLULOSE

CHITIN

Agarosa



Zásobní homopolysacharidy :

ŠKROB - amylosa - glukosa - α (1→4) - 20 %

(40 - 150 000 MW)

amylopektin - glukosa - α (1→4) + α (1→6) - 80 %

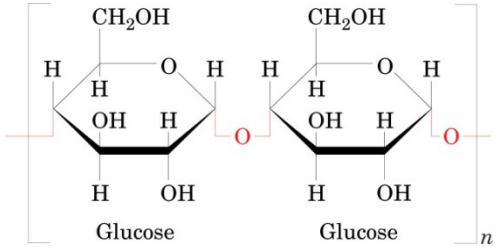
(50 000 MW)

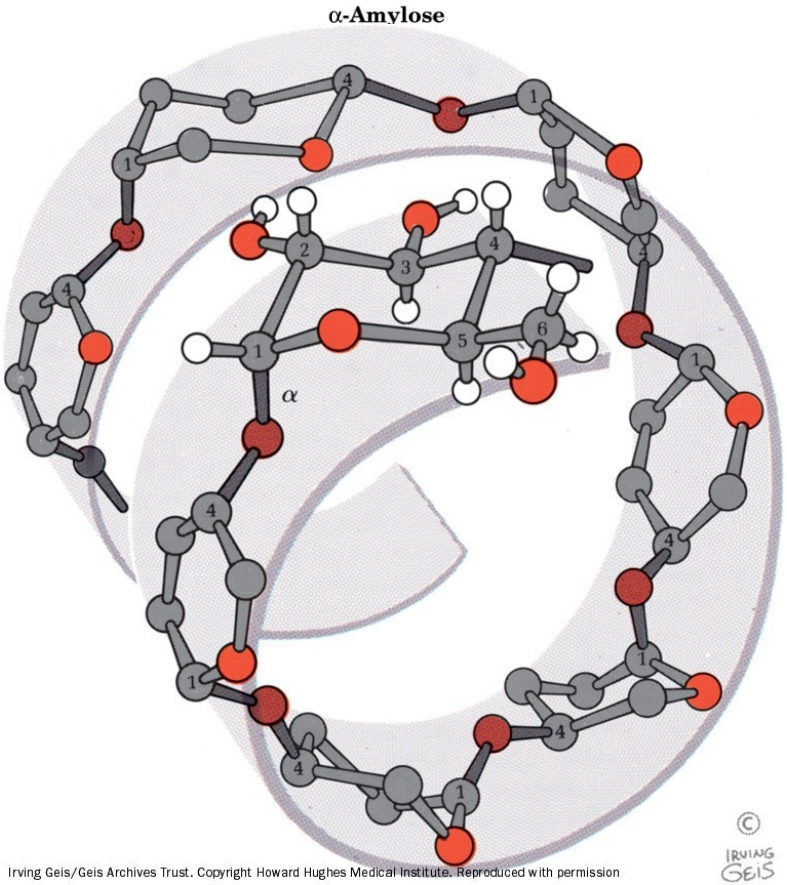
GLYKOGEN - glukosa - α (1→4) + α (1→6)

DEXTRAN - glukosa - α (1→6) + α (1→4) + α (1→3)

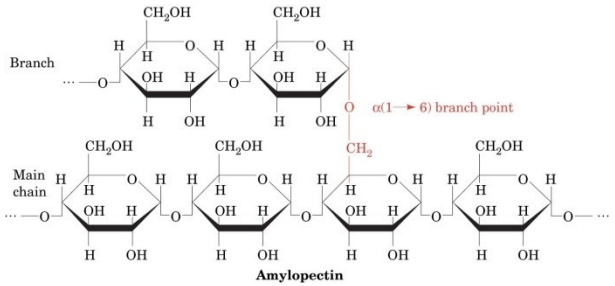
INULIN - fruktosa β(1→)

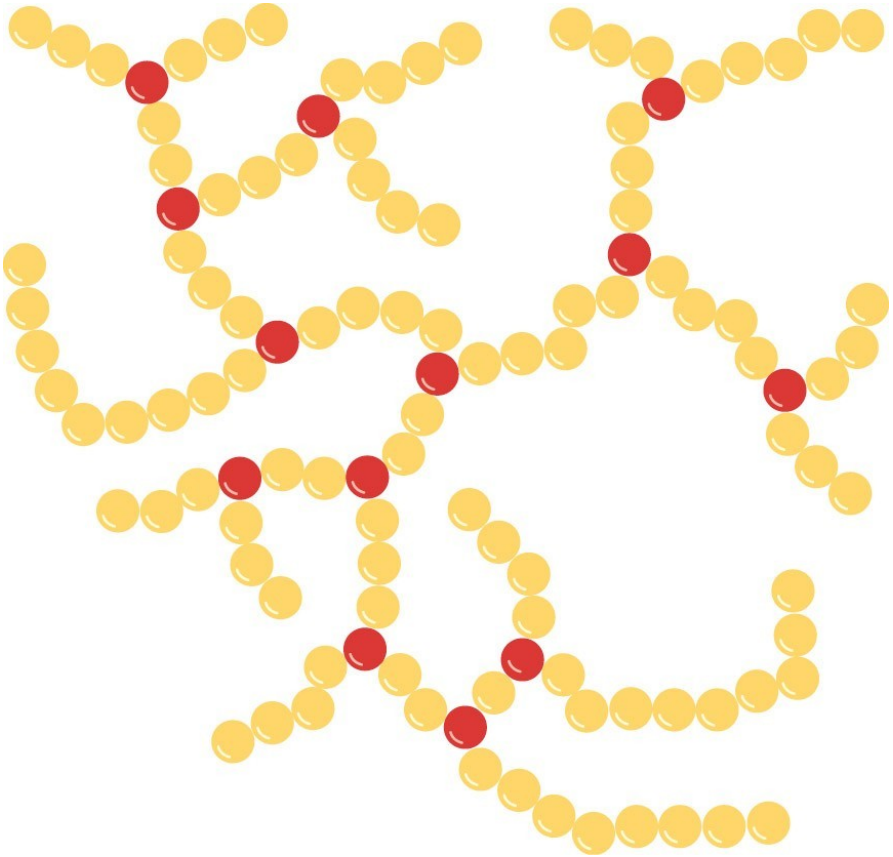
Amylosa


CH2OH
CH2OH
H
O
H
OH
O
Glucose
Glucose
n


α-Amylose
α
Irving Geis/Geis Archives Trust. Copyright Howard Hughes Medical Institute. Reproduced with permission
IRVING GEIS

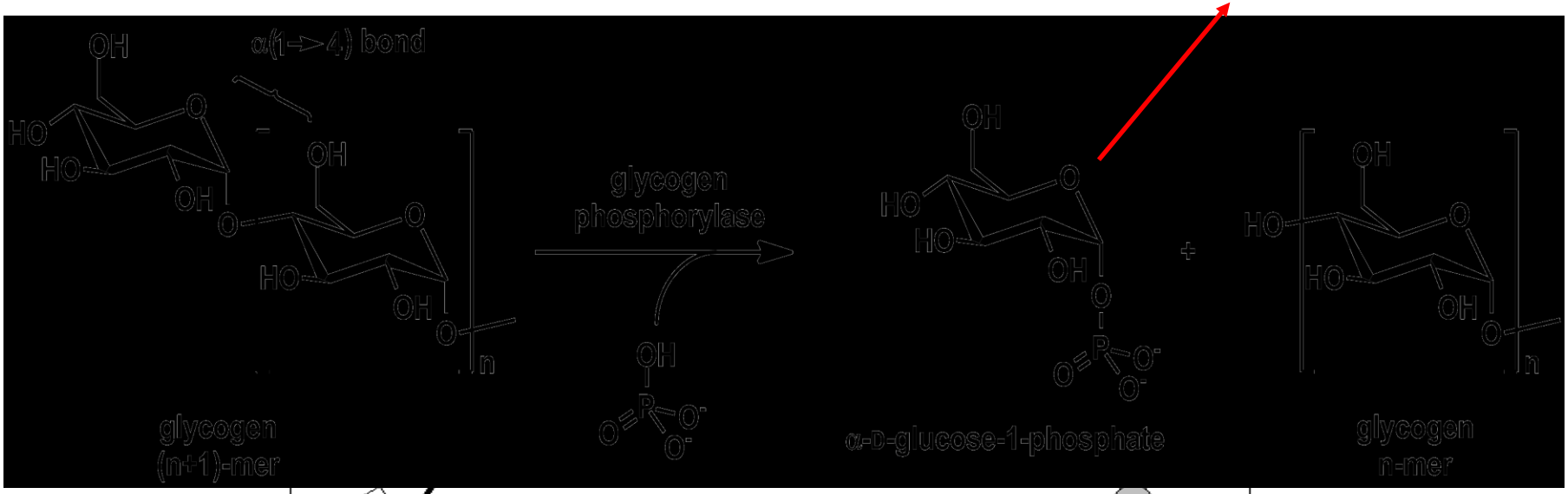
Amylopektin

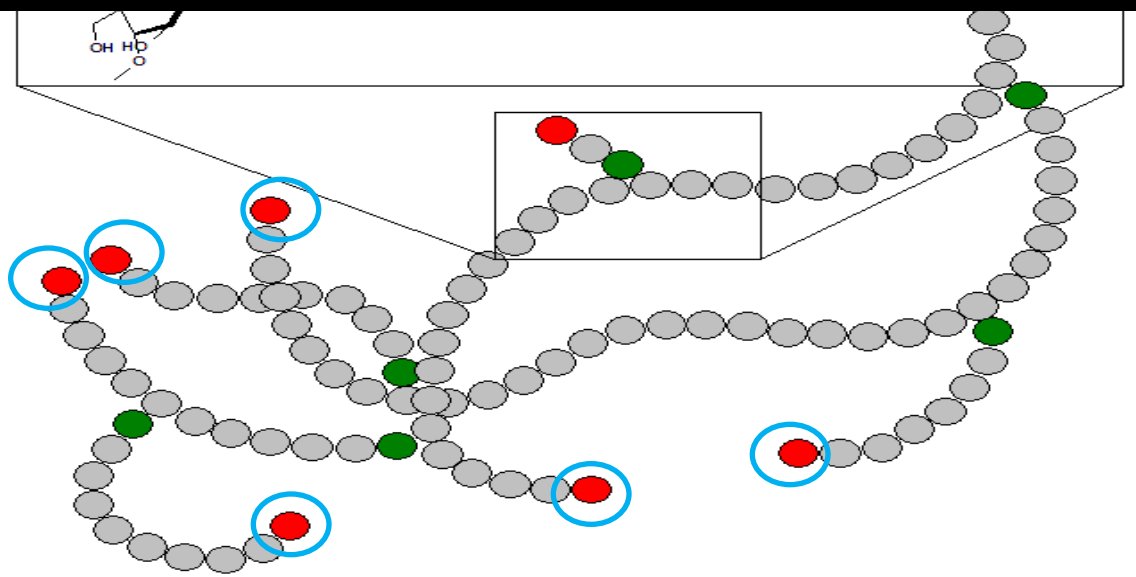




Glykogen

glykolysa





Škrob (a) a glykogen (b)

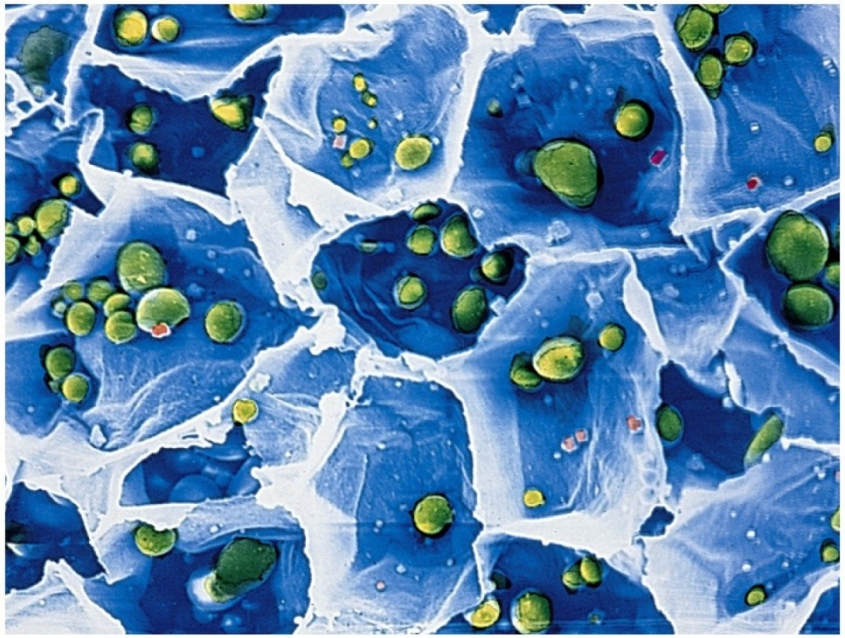


Figure 7-19a Concepts in Biochemistry, 3/e

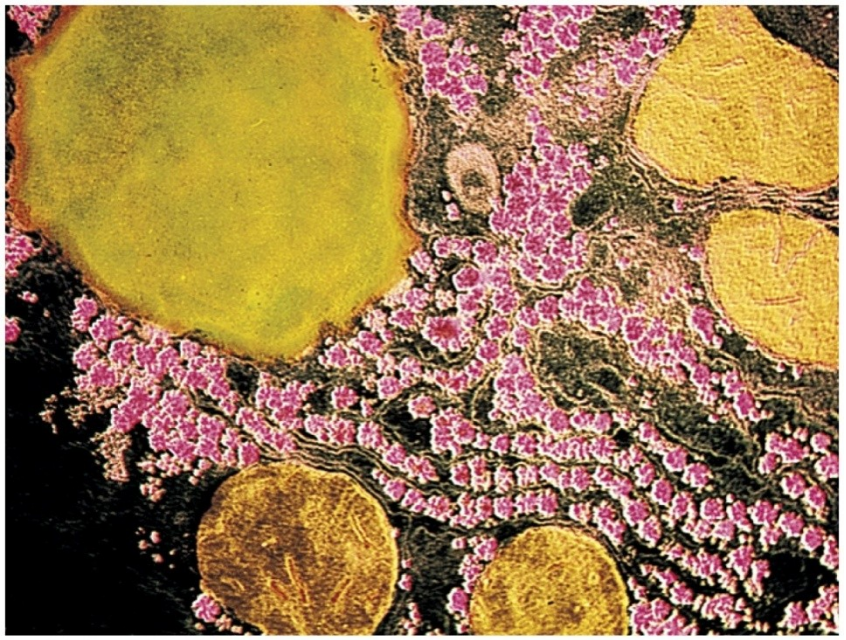
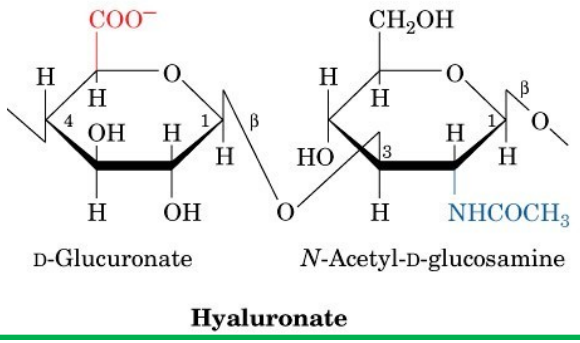
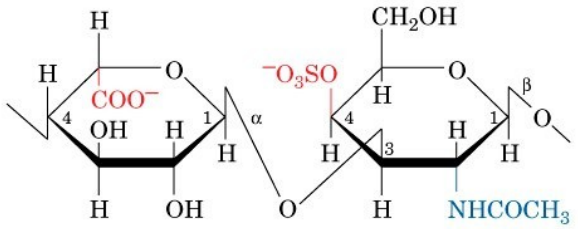


Figure 7-19b Concepts in Biochemistry, 3/e

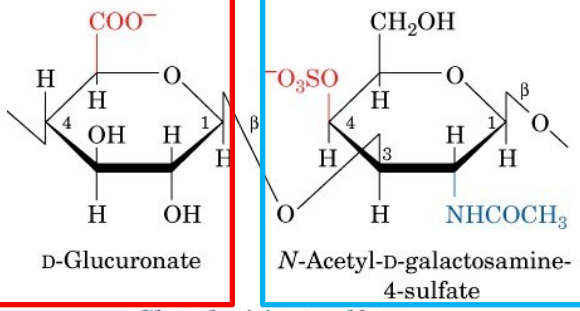
Heteropolysacharidy



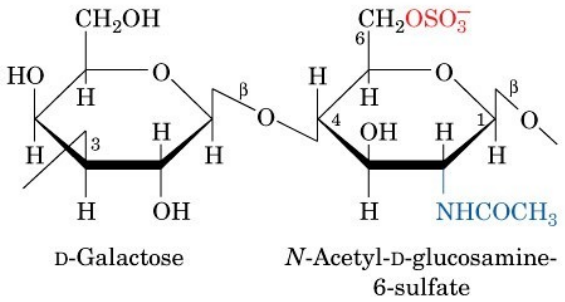
Hyaluronate



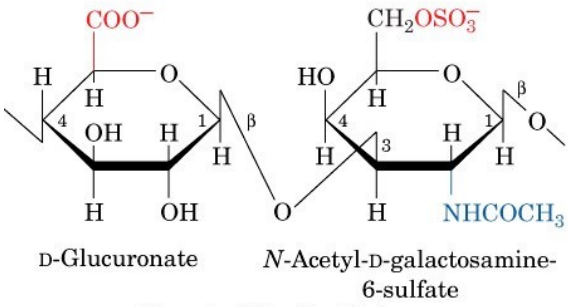
Dermatan sulfate



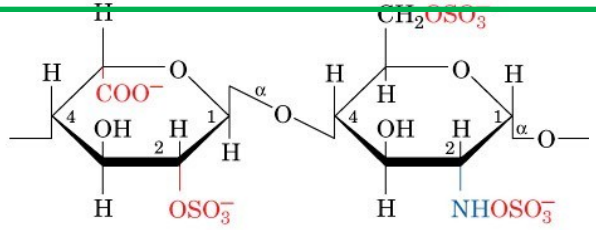
Chondroitin-4-sulfate



Keratan sulfate

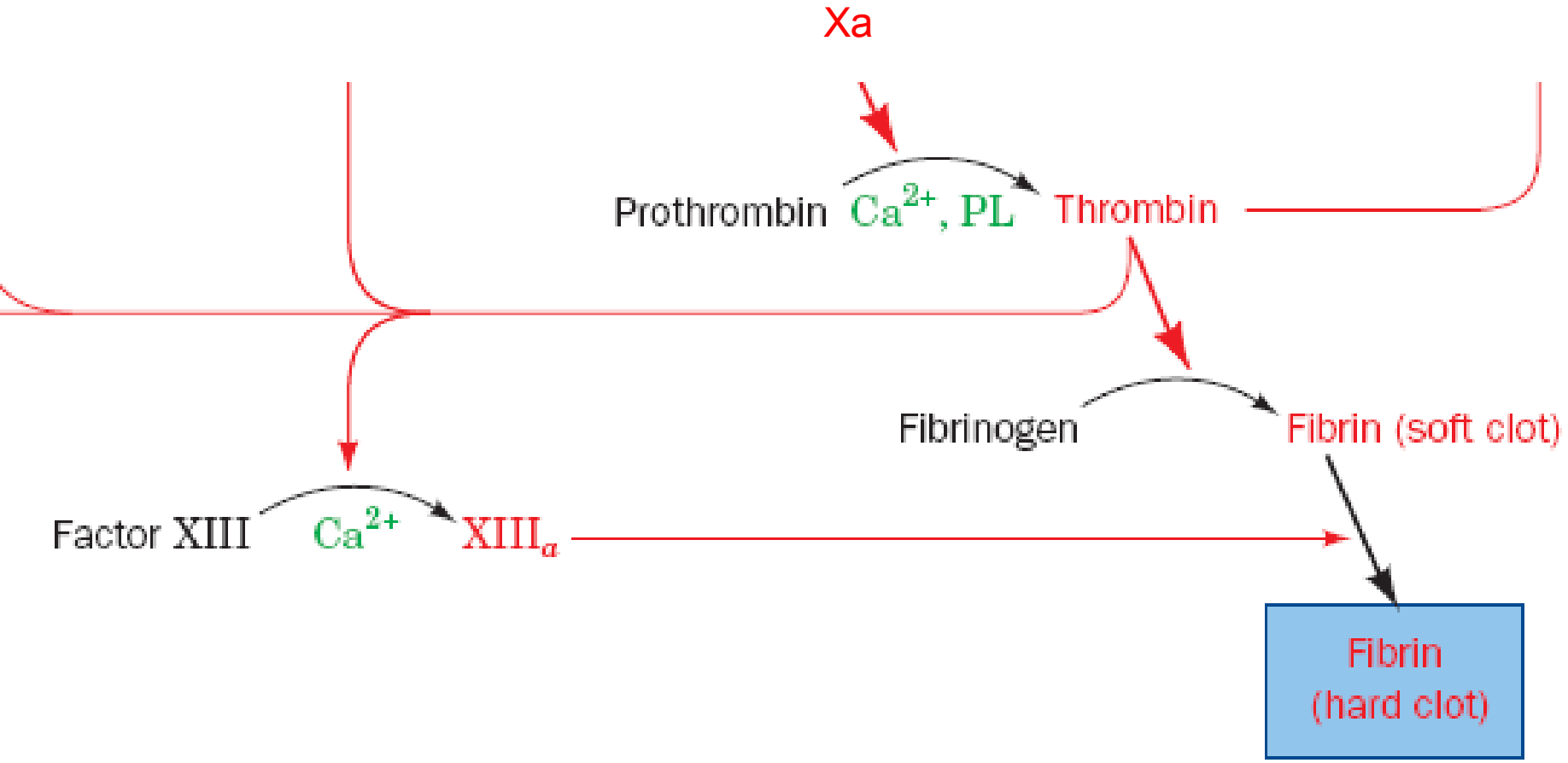


Chondroitin-6-sulfate

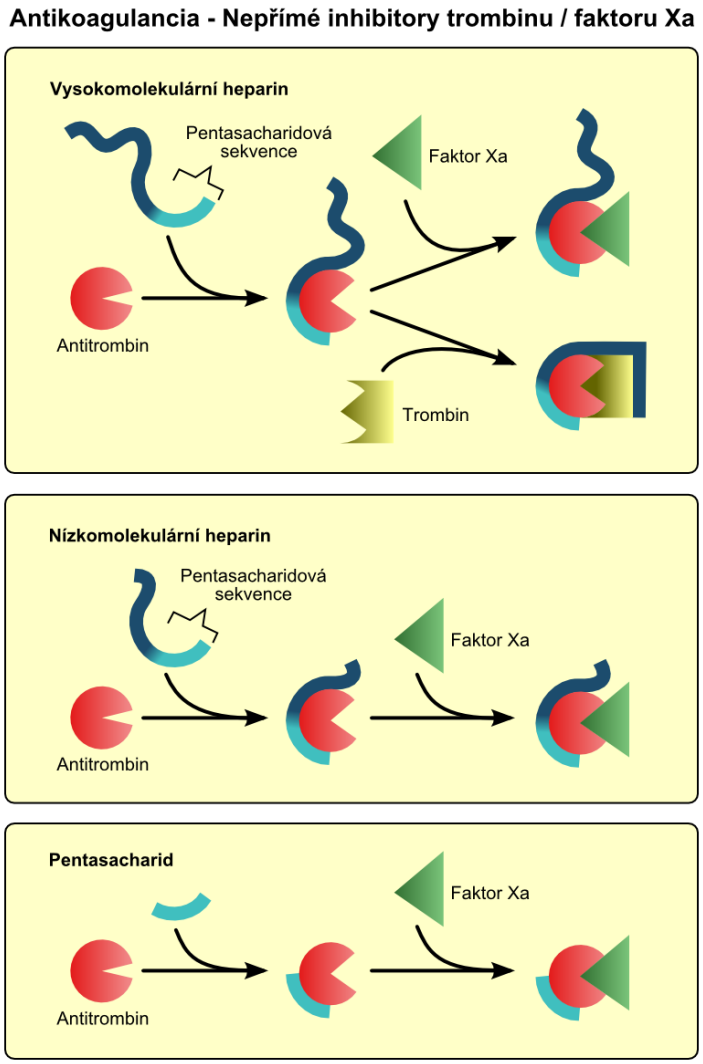


Heparin

Fibrinogen x fibrin



Heparin

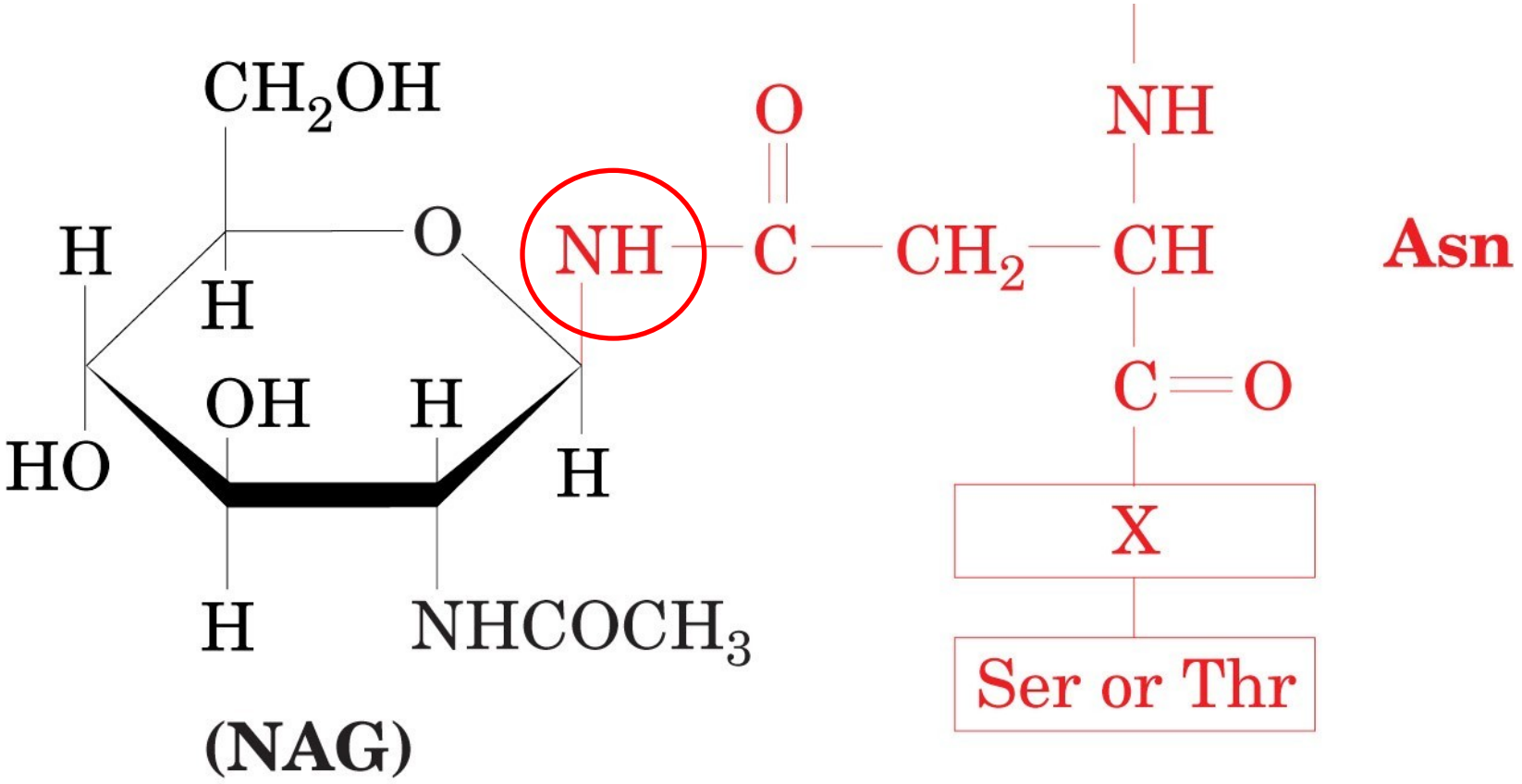

Antikoagulancia - Nepřímé inhibitory trombinu / faktoru Xa
Vysokomolekulární heparin
Pentasacharidová sekvence
Faktor Xa
Antitrombin
Trombin
Nízkomolekulární heparin
Pentasacharidová sekvence
Faktor Xa
Antitrombin
Pentasacharid
Faktor Xa
Antitrombin

Složené sacharidy

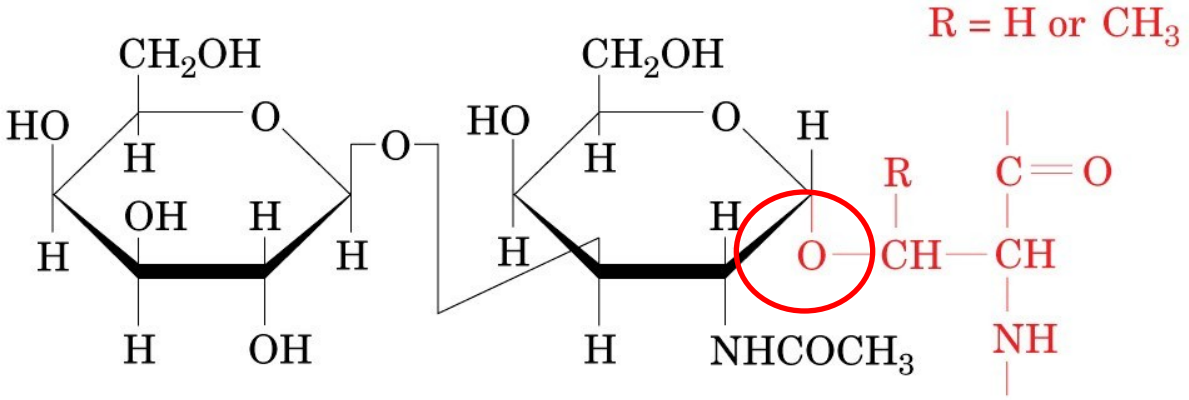
- Glykolipidy
- Glykoproteiny
- Proteoglykany

LIŠÍ SE POMĚREM SLOŽEK

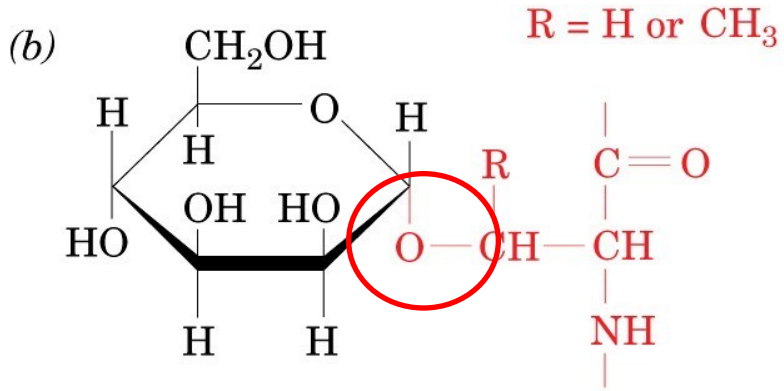
Glykoproteiny – N-linked



Glykoproteiny – O-linked



β-Galactosyl-(1→3)-α-*N*-acetylgalactosaminyl-Ser/Thr



α-Mannosyl-Ser/Thr

Glykoproteiny

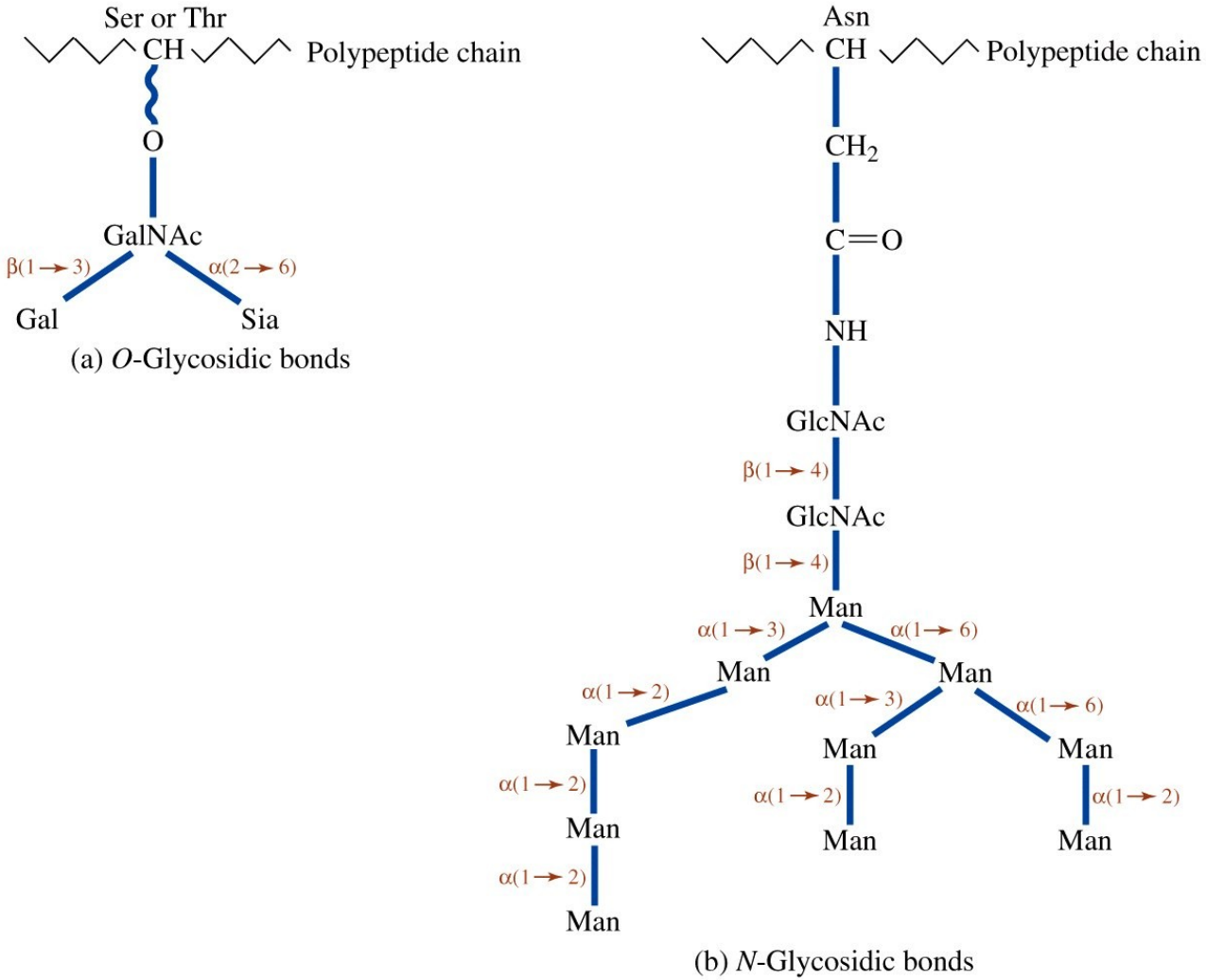
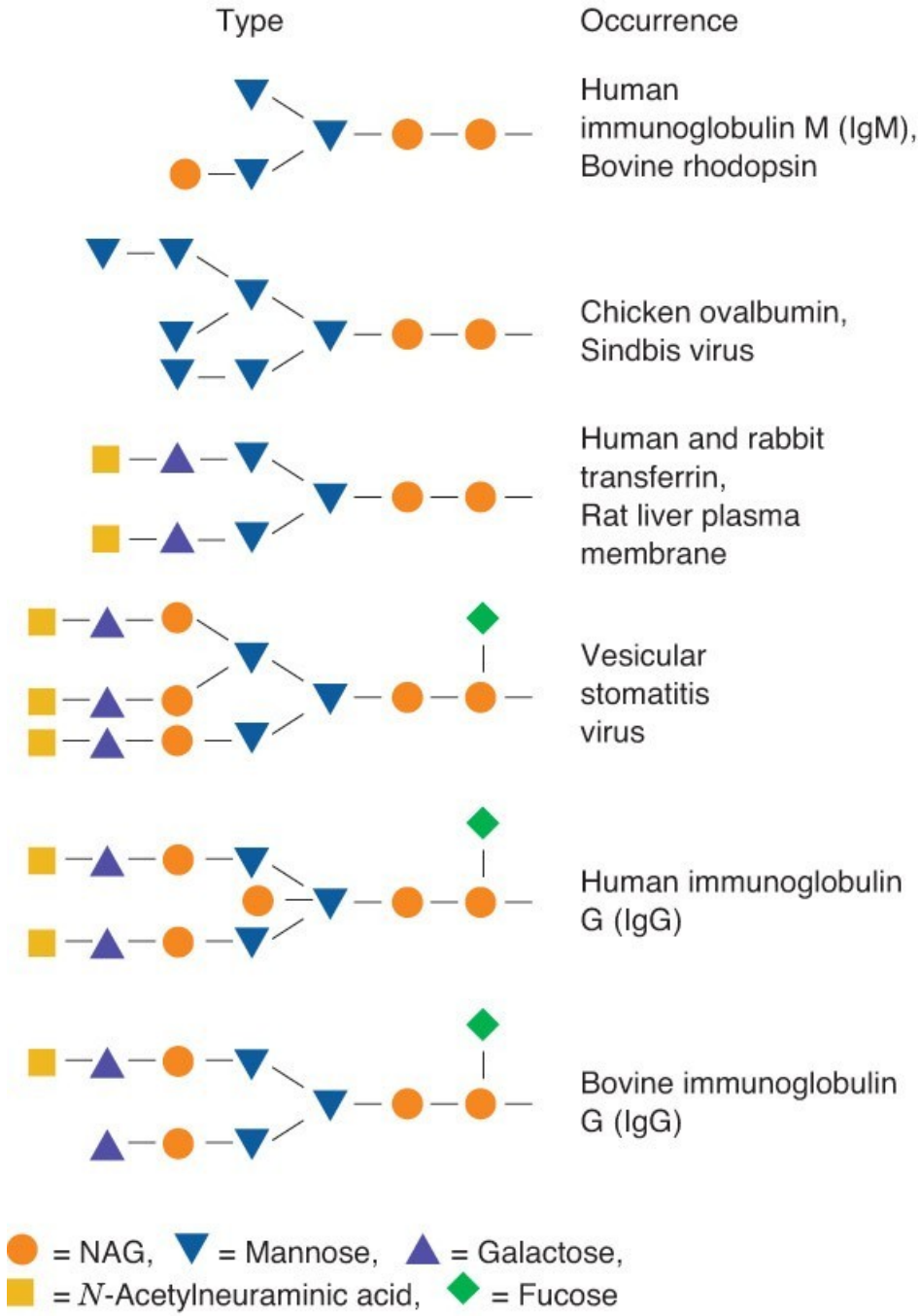


Figure 7-31 Concepts in Biochemistry, 3/e


Type
Occurrence
Human immunoglobulin M (IgM), Bovine rhodopsin
Chicken ovalbumin, Sindbis virus
Human and rabbit transferrin, Rat liver plasma membrane
Vesicular stomatitis virus
Human immunoglobulin G (IgG)
Bovine immunoglobulin G (IgG)
= NAG, = Mannose, = Galactose,
= N-Acetylneuraminic acid, = Fucose

Glykoproteiny

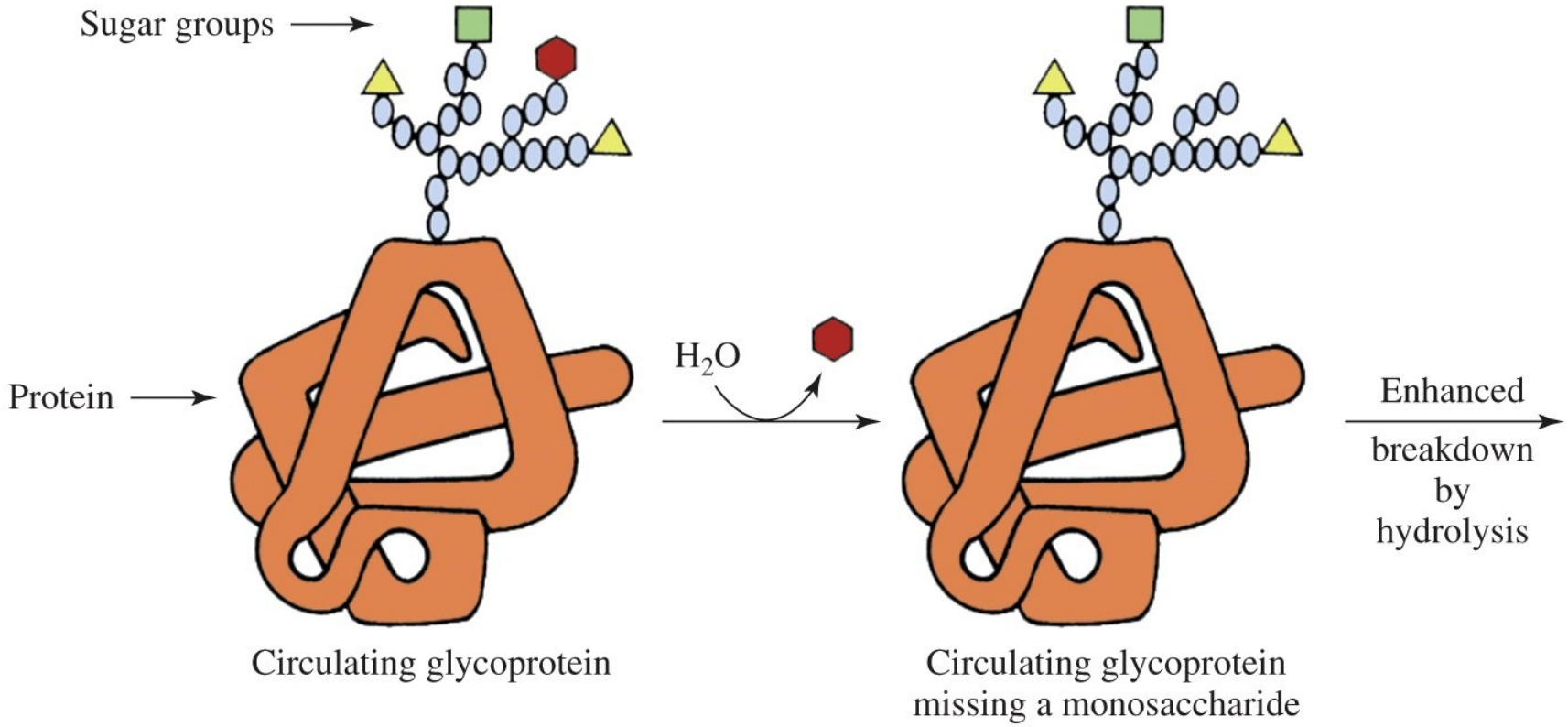


Figure 7-32 Concepts in Biochemistry, 3/e

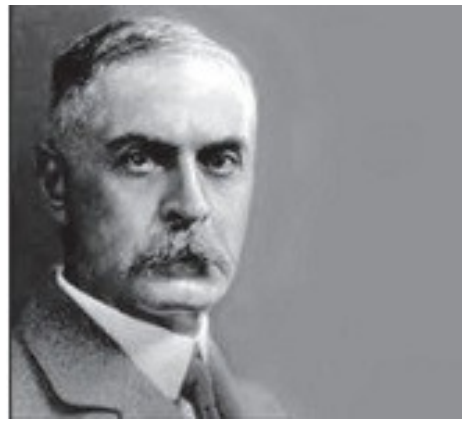
Antimrazové glykoproteiny

Krevní skupiny

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

Krevní skupiny AB0

- **Karl Landsteiner 1900** (1930 NC)

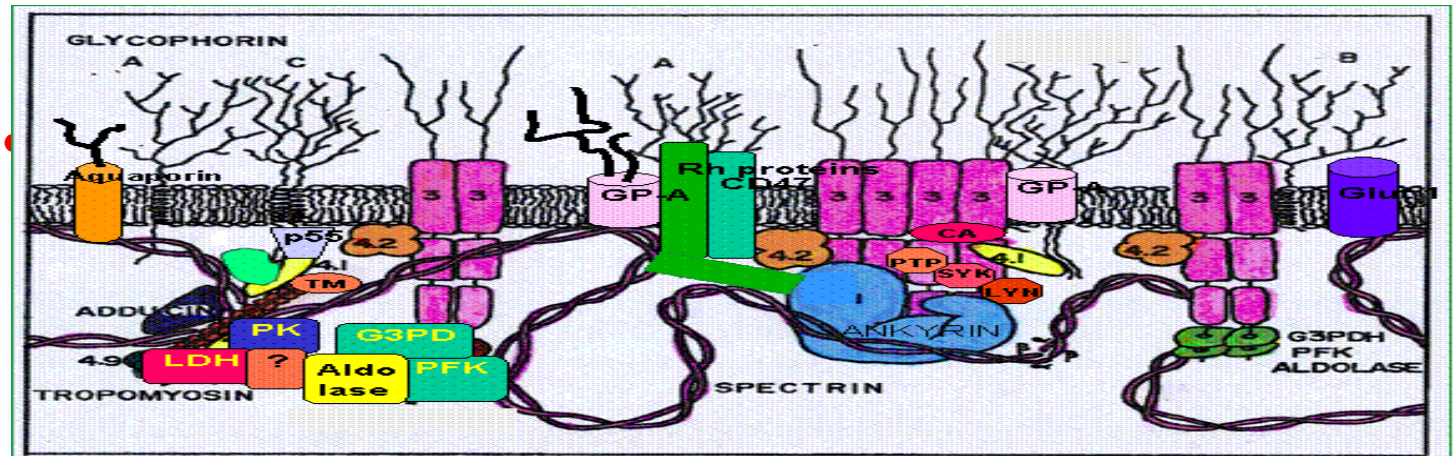


- Jan Jánský 1907

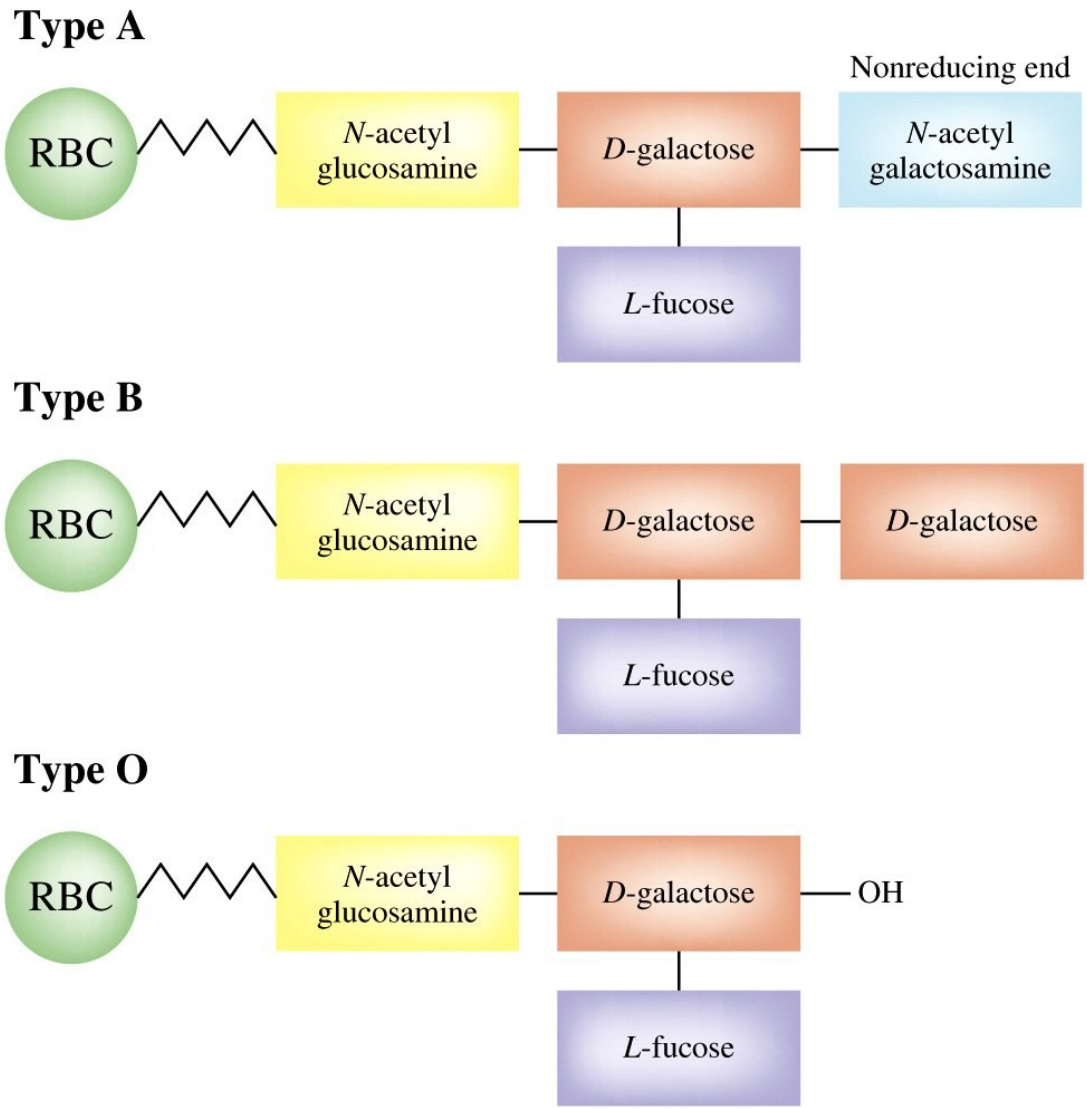
Chemická podstata aglutinogenů a aglutininů AB0

- **Aglutinogeny** – antigenní struktury na membránovém povrchu ERY

  Základní jednotka – oligosacharid vzniklý kombinací 4 monosacharidů



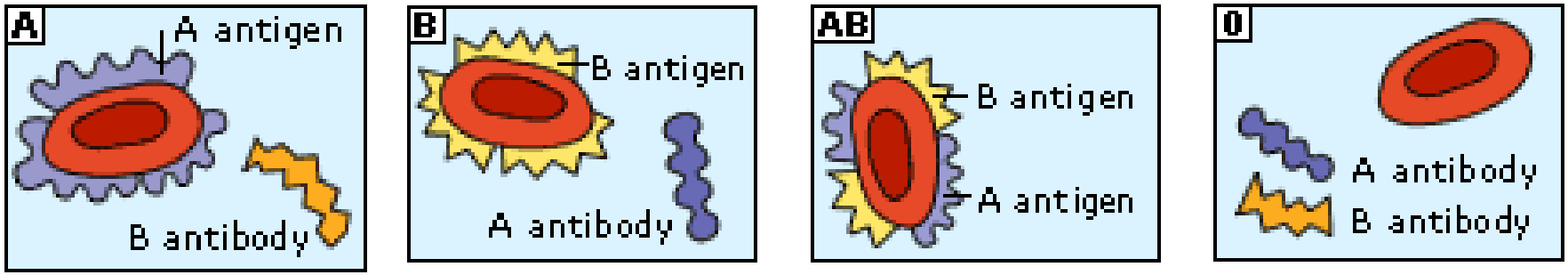
Krevní skupiny

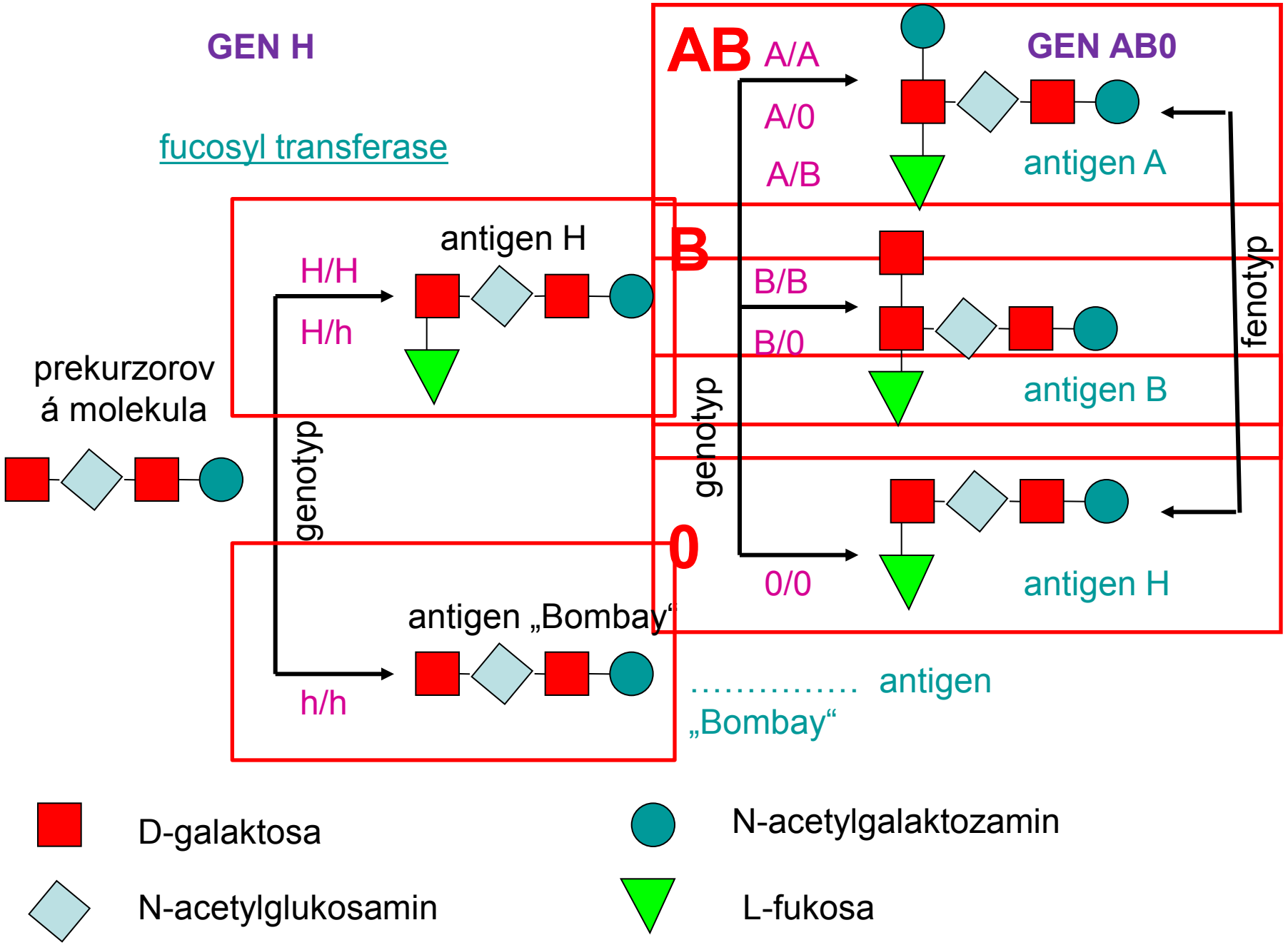


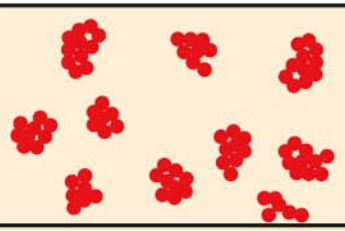
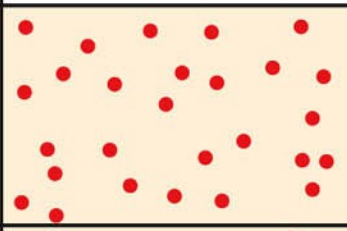
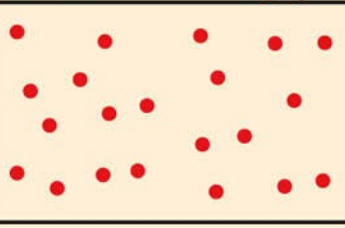
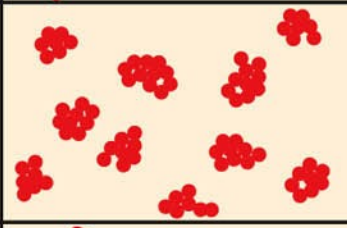
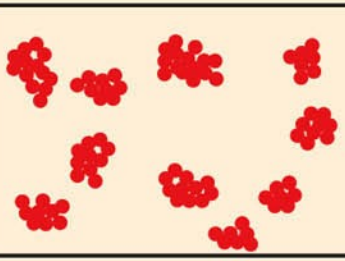
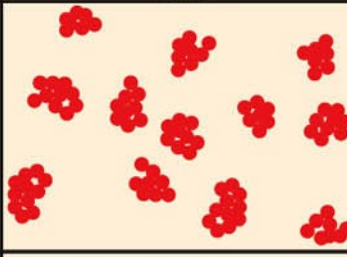
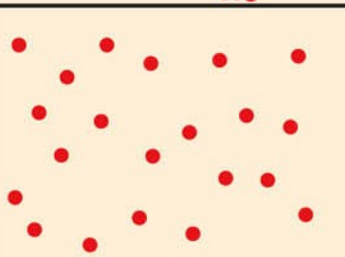
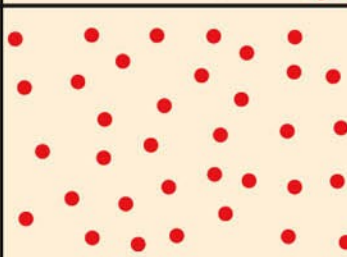
Unnumbered figure pg 225 Concepts in Biochemistry, 3/e

AB0(H) systém

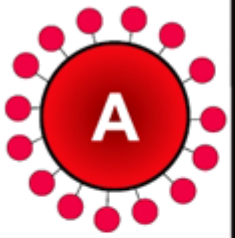
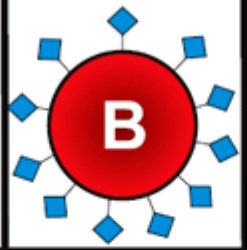
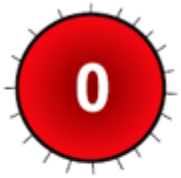
- 4 základní krevní skupiny – A, B, AB a 0(H) podle přítomnosti aglutinogenů (antigenů) A a B na povrchu membrány ERY
- Protilátky v plazmě (aglutininy) se vytvářejí v 1.roce života, proti těm antigenům, které neobsahují vlastní ERY

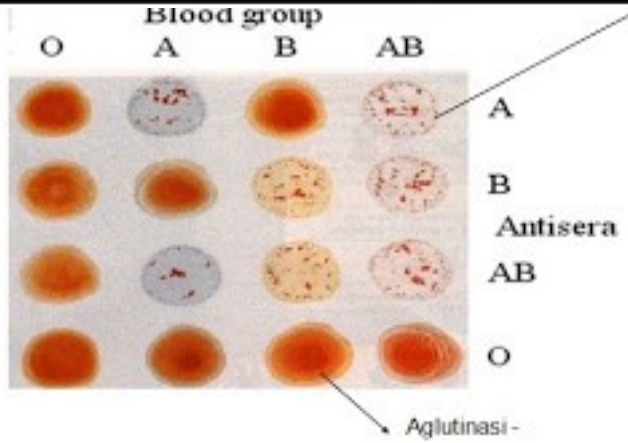



GEN H
fucosyl transferase
prekurzorová molekula
H/H
H/h
antigen H
genotyp
h/h
antigen „Bombay“
AB
A/A
A/0
A/B
GEN AB0
antigen A
B
B/B
B/0
antigen B
0
0/0
antigen H
genotyp
fenotyp
…… antigen „Bombay“
D-galaktosa
N-acetylglukosamin
N-acetylgalaktozamin
L-fukosa

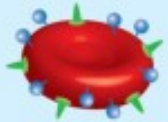
Blood type of cells	Genotype	Antibodies made by body	Reaction to added antibodies	
			Anti-A	Anti-B
A	$I^A I^A$ or $I^A i^O$	Anti-B		
B	$I^B I^B$ or $I^B i^O$	Anti-A		
AB	$I^A I^B$	Neither anti-A nor anti-B		
O	$i^O i^O$	Both anti-A and anti-B		

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.14 ABO Blood Reactions Are Important in Transfusions**

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



Antigen Bombay

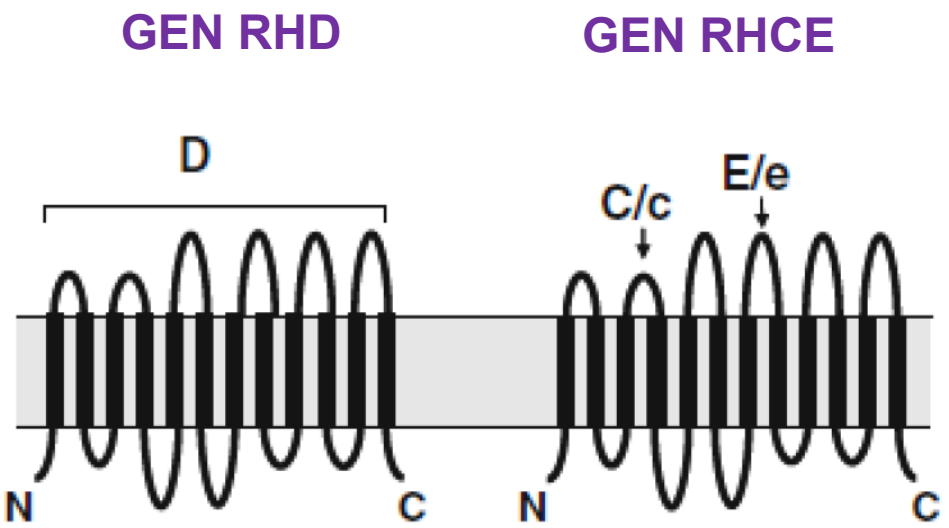
ABO BLOOD GROUPS					
Antigen (on RBC)	Antigen A (A_1,A_2, A_x, etc)  Density ≈ 10^6/cell	Antigen B  Density ≈ 7.5 x 10^5/cell	Antigen A + B  Density ≈ 8.5 x 10^5/cell	Neither A or B  Density ≈ 10^6 H-antigens/cell	Neither A or B or H 
Antibody (in Serum or Plasma)	Anti-B Antibody 	Anti-A Antibody 	Neither Antibody	Anti-A, Anti-B and Anti-A,B 	Anti-A, Anti-B, Anti-A,B and Anti-H 
Blood Type	**Type A** A-subsets can produce anti-A_1 (A_2≈1%; A_2B≈ 25%) Anti-B and anti-A_1 can be clinically significant IgM, IgG, IgA Hemolysin due to complement activation Antibodies found in IVIG	**Type B** Anti-A is more potent with higher titers than anti-B Can be clinically significant IgM, IgG, IgA Hemolysin due to complement activation Antibodies found in IVIG	**Type AB** Type AB No isoagglutinins Ideal for producing IVIG	**Type O** Anti-A and Anti-B similar to Type A and Type B blood Anti-A,B mostly IgG Hemolysin due to complement activation Antibodies found in IVIG Anti-A,B recognizes an antigen that is similar but different from A or B, may be difficult to remove	**Type Bombay** Anti-A, Anti-B and Anti-A,B similar to Type O blood Anti-H highly clinically significant IgM, IgG Rare, likely not ever found in IVIG

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

Systém Rh Landstein Wiener

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

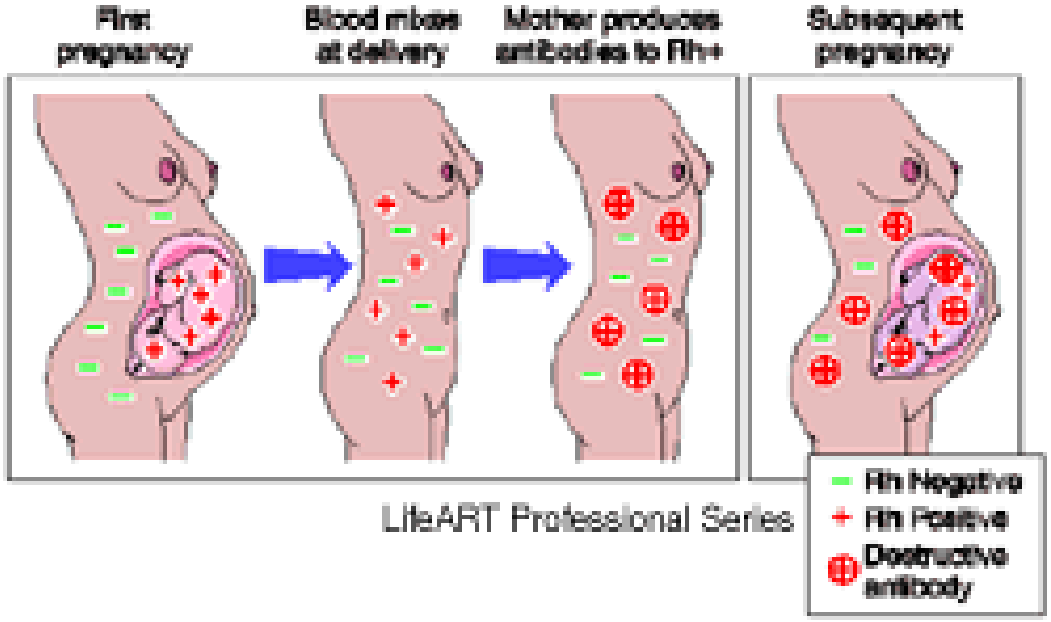


Systém Rh

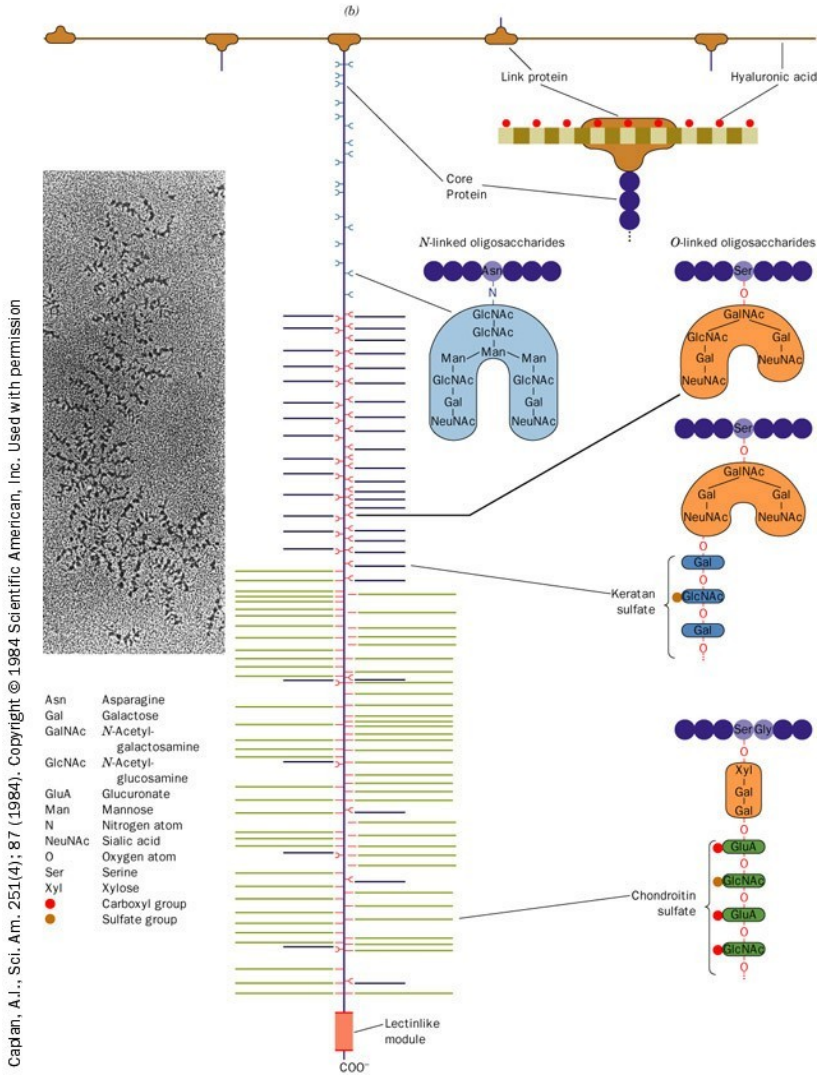
- Je-li přítomen antigen D, Rh-pozitivní jedinec
- Chybí-li antigen D, Rh-negativní jedinec
- Protilátky anti-D vznikají pouze při imunizaci Rh^- příjemce krvinkami Rh^+ dárce
- Protilátky jsou imunoglobuliny typu IgG

Hemolytická nemoc novorozenců

Fetální erytroblastosa
Matka Rh - Otec Rh +



Proteoglykany – 95 % sacharid

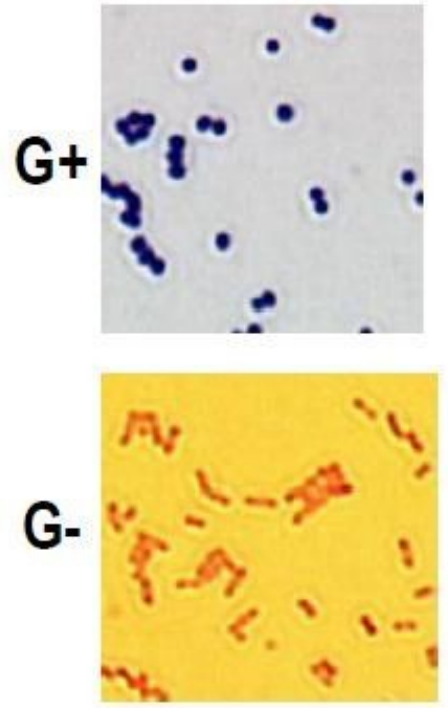


Buněčná stěna bakterií

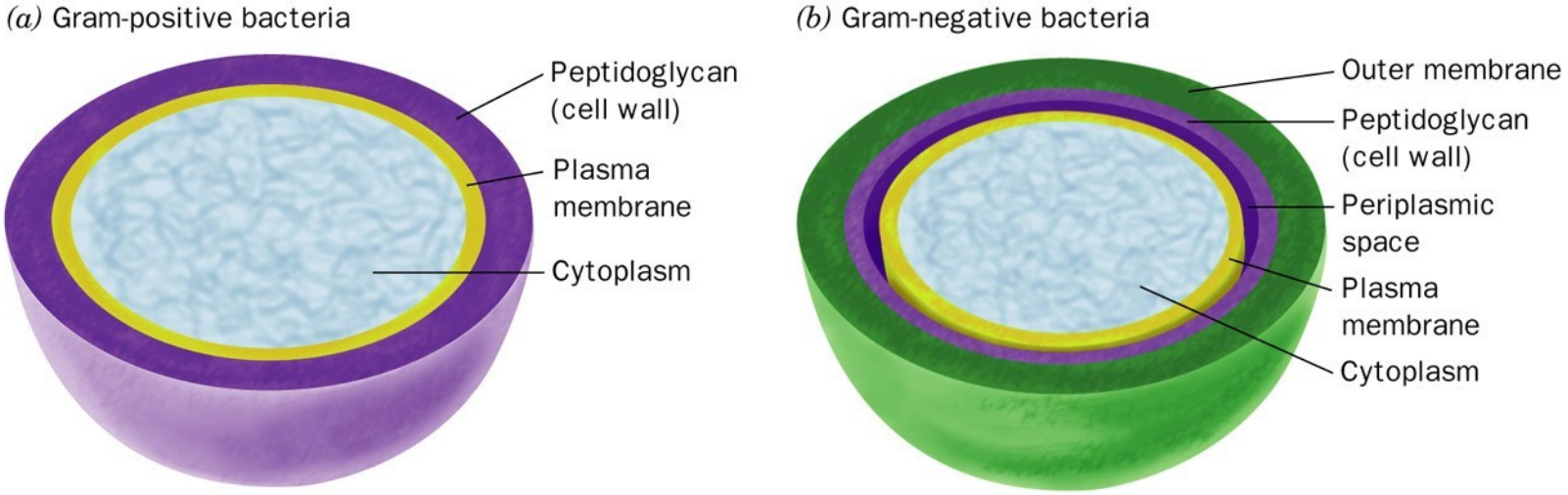
grampozitivní(a) a gramnegativní(b)

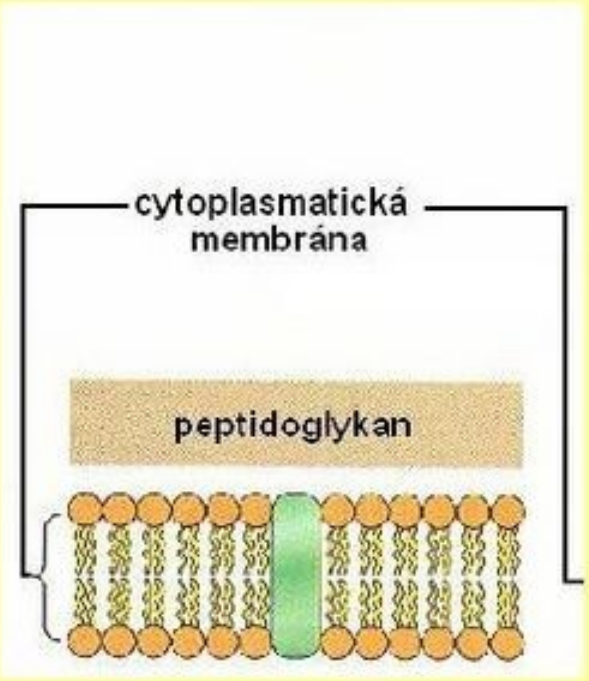
Fixace

	Gram +	Gram -
1. NEOBARVENÝ PREPARÁT		



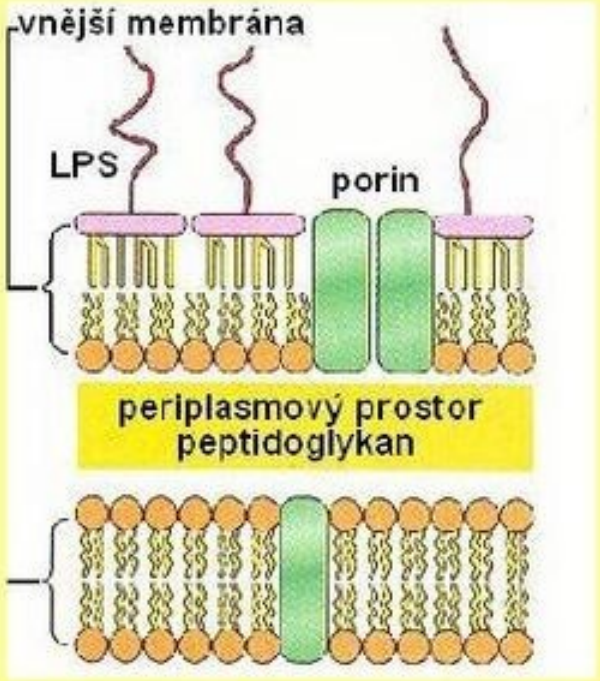
Buněčná stěna bakterií
grampozitivní(a) a gramnegativní(b)





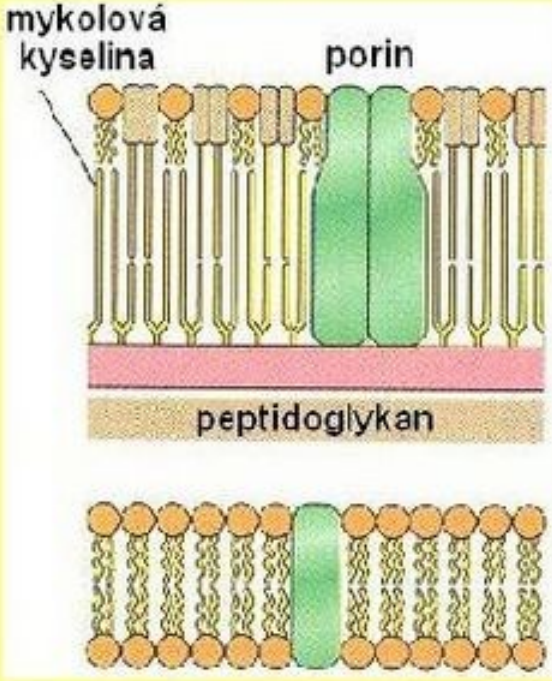
Buněčná stěna je poměrně silná, obsahuje kromě **peptidoglykanu proteiny, polysacharidy a kyselinu teichoovou**.

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



Odlišné 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

Nebezpečnější

LIPIDY

Lipos - tuk

Funkce : **zdroj a reserva energie**

strukturní funkce

ochranná a izolační funkce

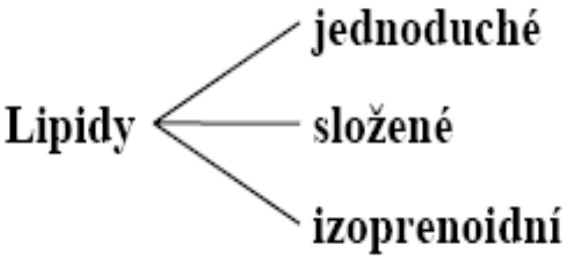
různé biologické funkce

Jednoduché - neutrální

Složené - polární, izoprenoidní - steroidní

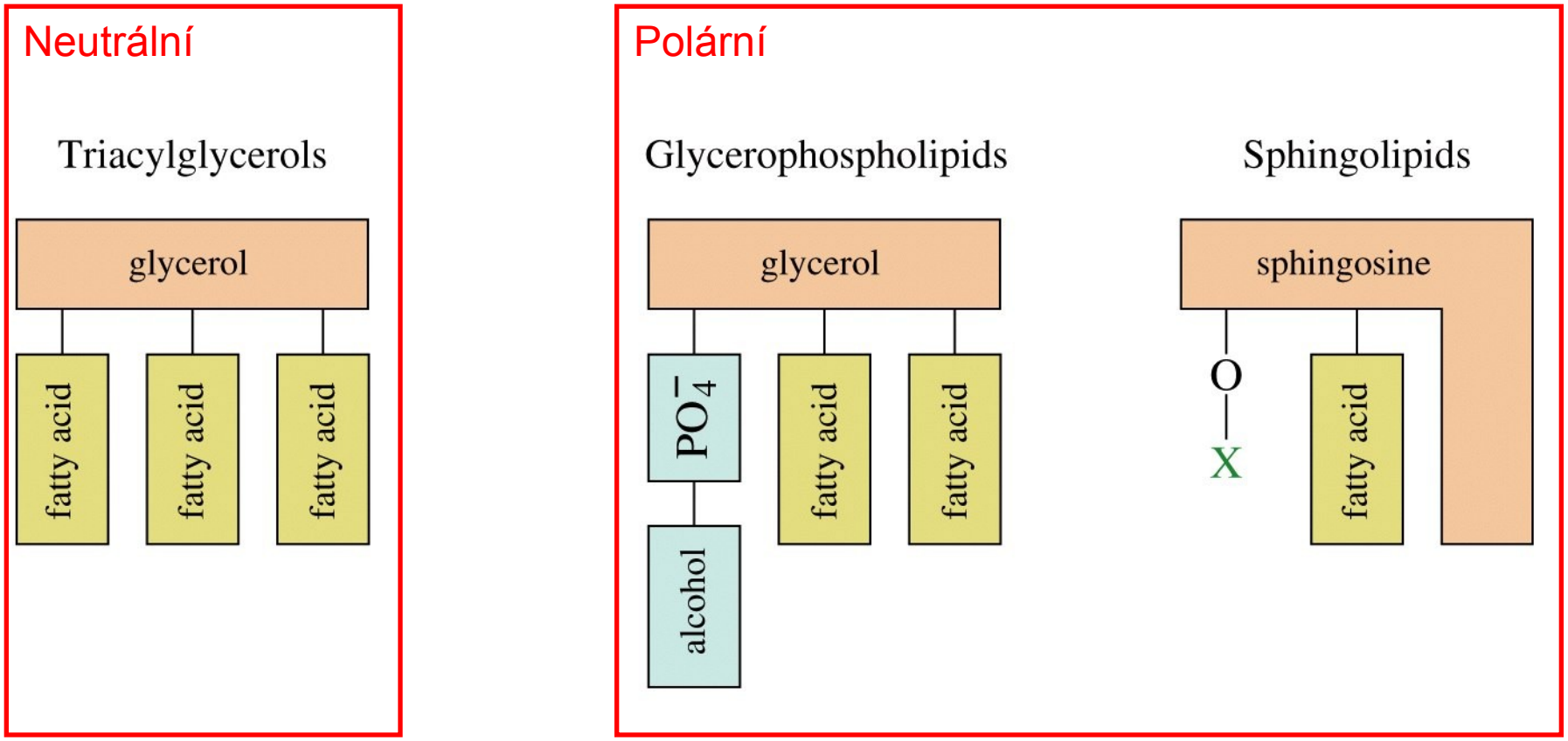
Jednoduché - neutrální

Izoprenoidní - steroidní



Neutrální

Polární



Storage lipids (nonpolar)
(a)

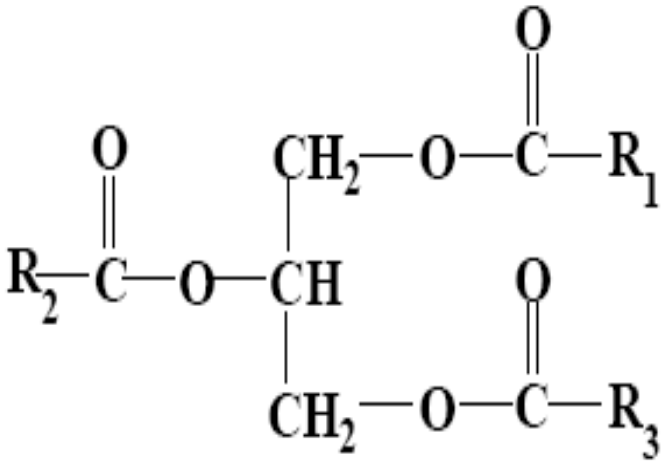
Membrane lipids (polar)
(b)

Figure 8-6 Concepts in Biochemistry, 3/e

Jednoduché lipidy :

chemicky - estery mastných kyselin a alkoholů

<u>ACYLGLYCEROLY</u> - triglyceridy - estery mastných kyselin a glycerolu



Adipocyty

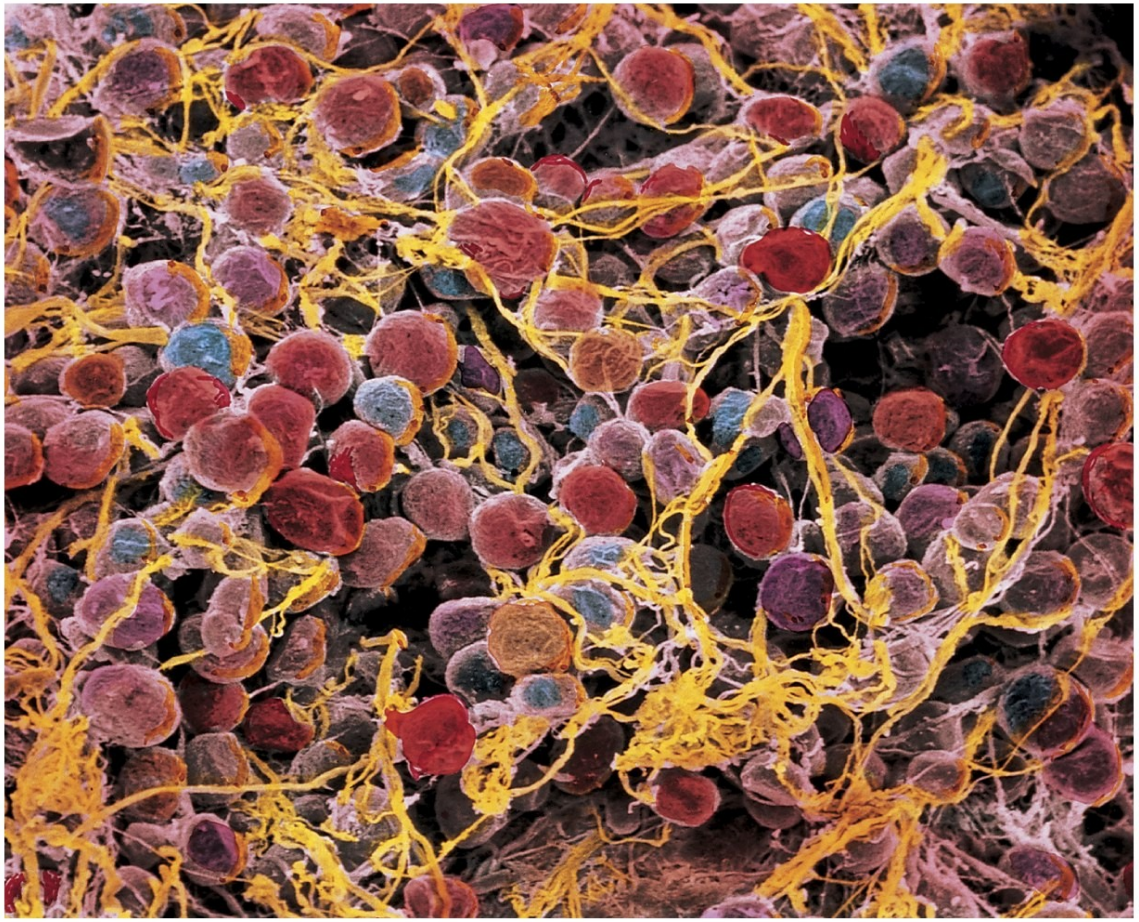
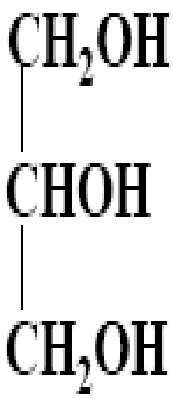
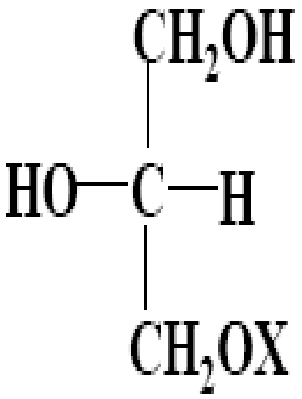


Figure 8-4 Concepts in Biochemistry, 3/e

Alkohol



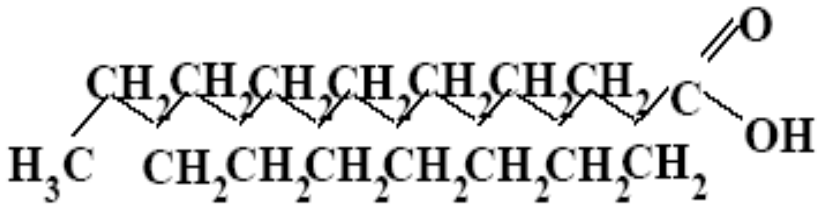
glycerol



derivát sn-glycerolu
(L-glycerol)

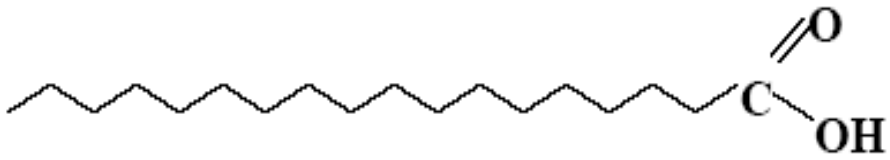
Mastné kyseliny - nasycené

$-(CH_2-CH_2)-$ ⟵ AcetCoA



K .PALMITOVÁ

$C_{16}H_{32}O_2$

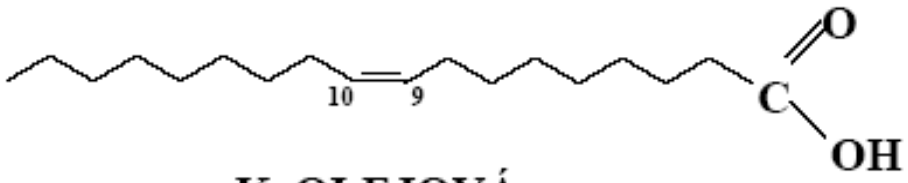


K. STEAROVÁ

$C_{18}H_{36}O_2$

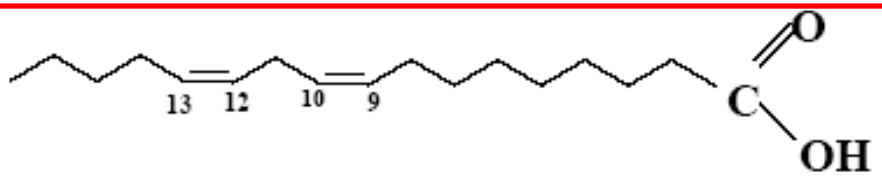
Mastné kyseliny - nenasycené

Vitamín F



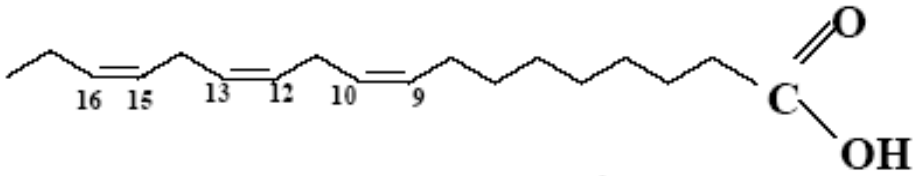
K. OLEJOVÁ

$C_{18}H_{34}O_2$



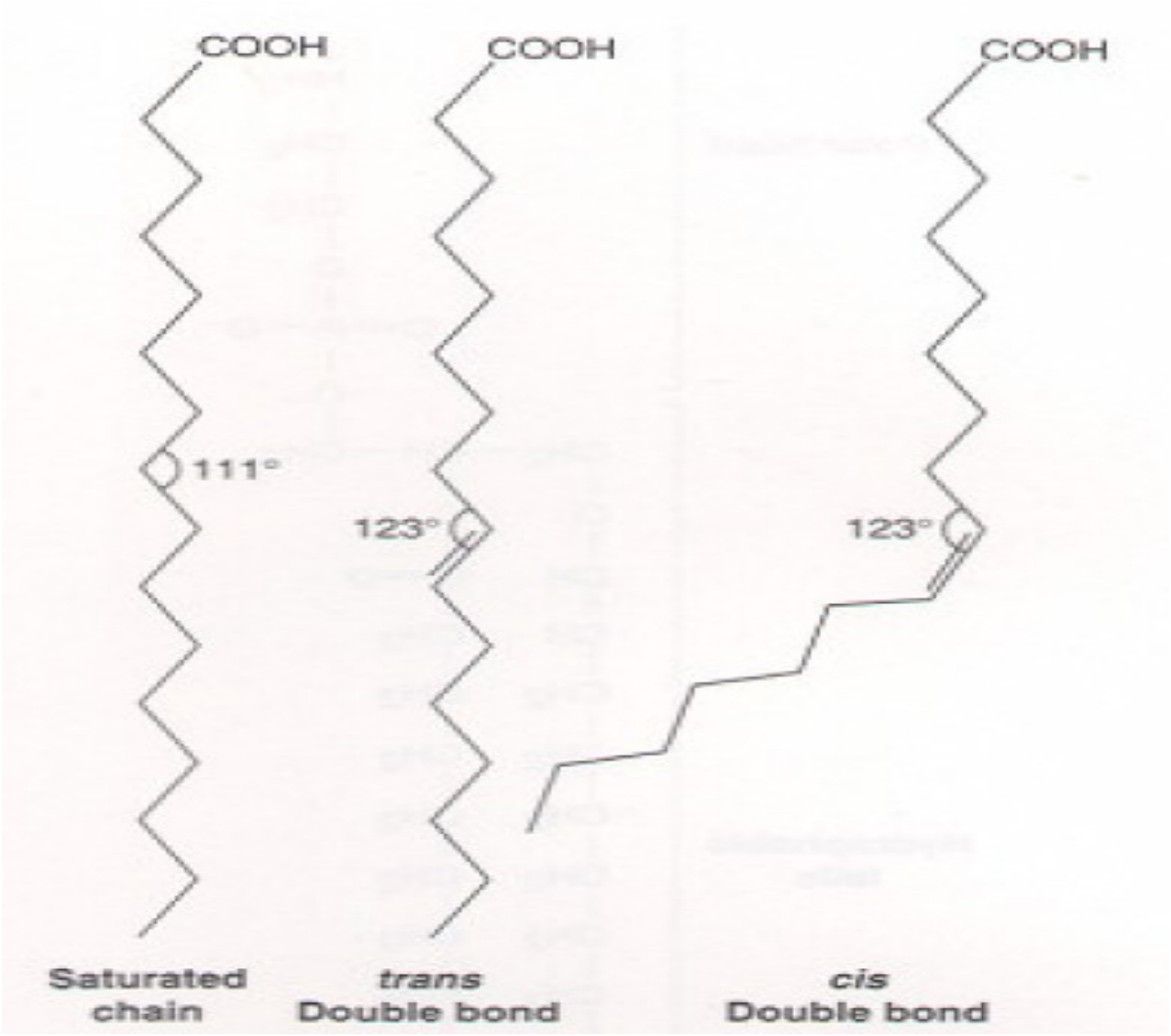
K. LINOLOVÁ

$C_{18}H_{32}O_2$



K. LINOLENOVÁ

$C_{18}H_{30}O_2$


COOH
111°
COOH
123°
COOH
123°
Saturated chain
trans Double bond
cis Double bond

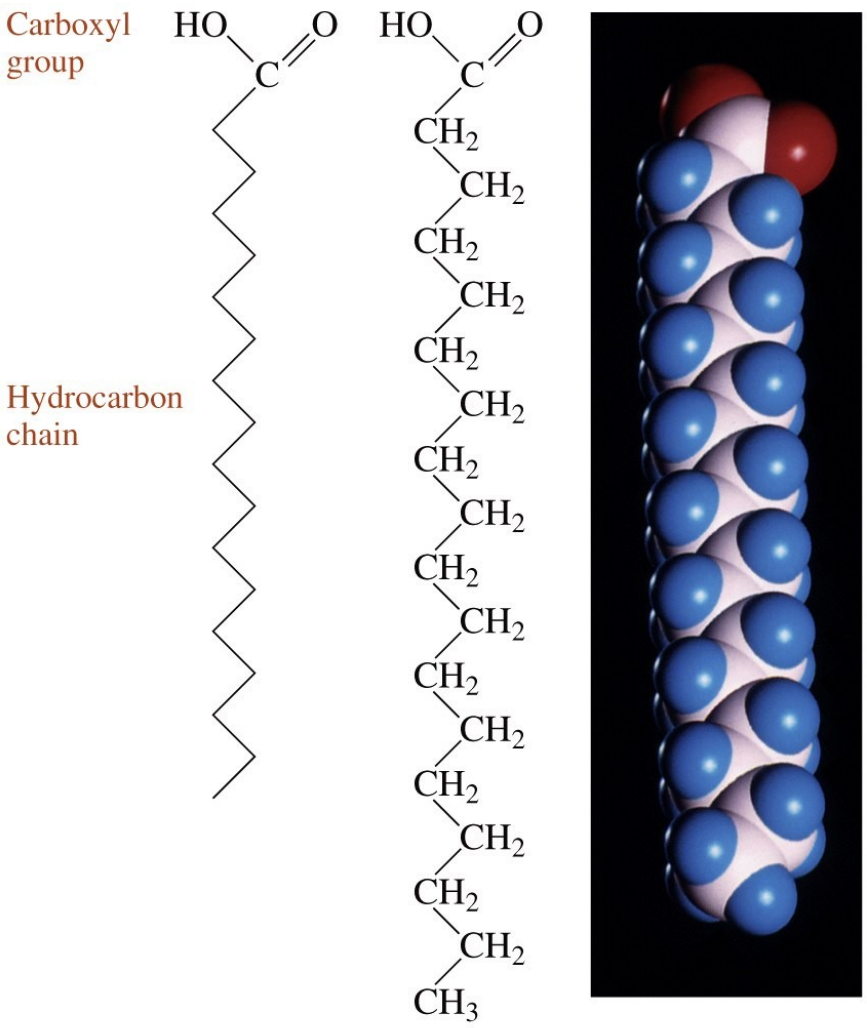


Figure 8-1a Concepts in Biochemistry, 3/e

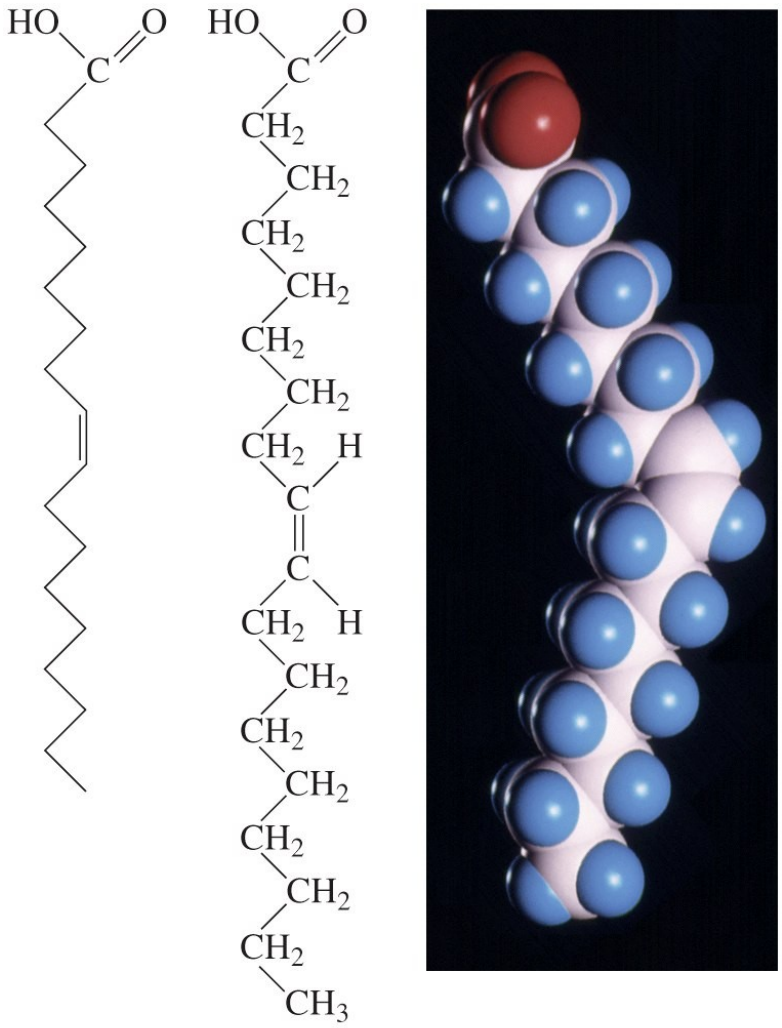
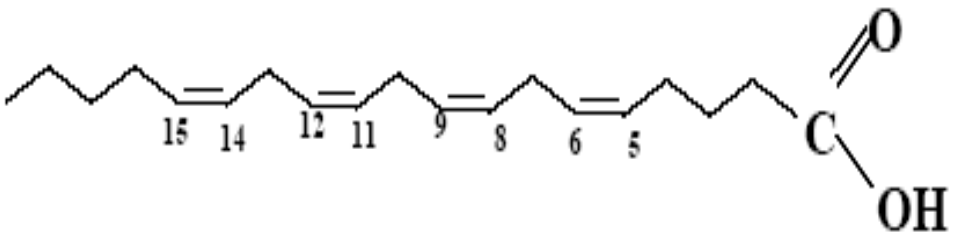


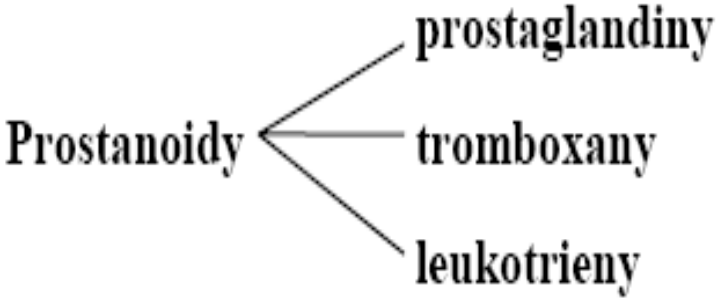
Figure 8-1b Concepts in Biochemistry, 3/e



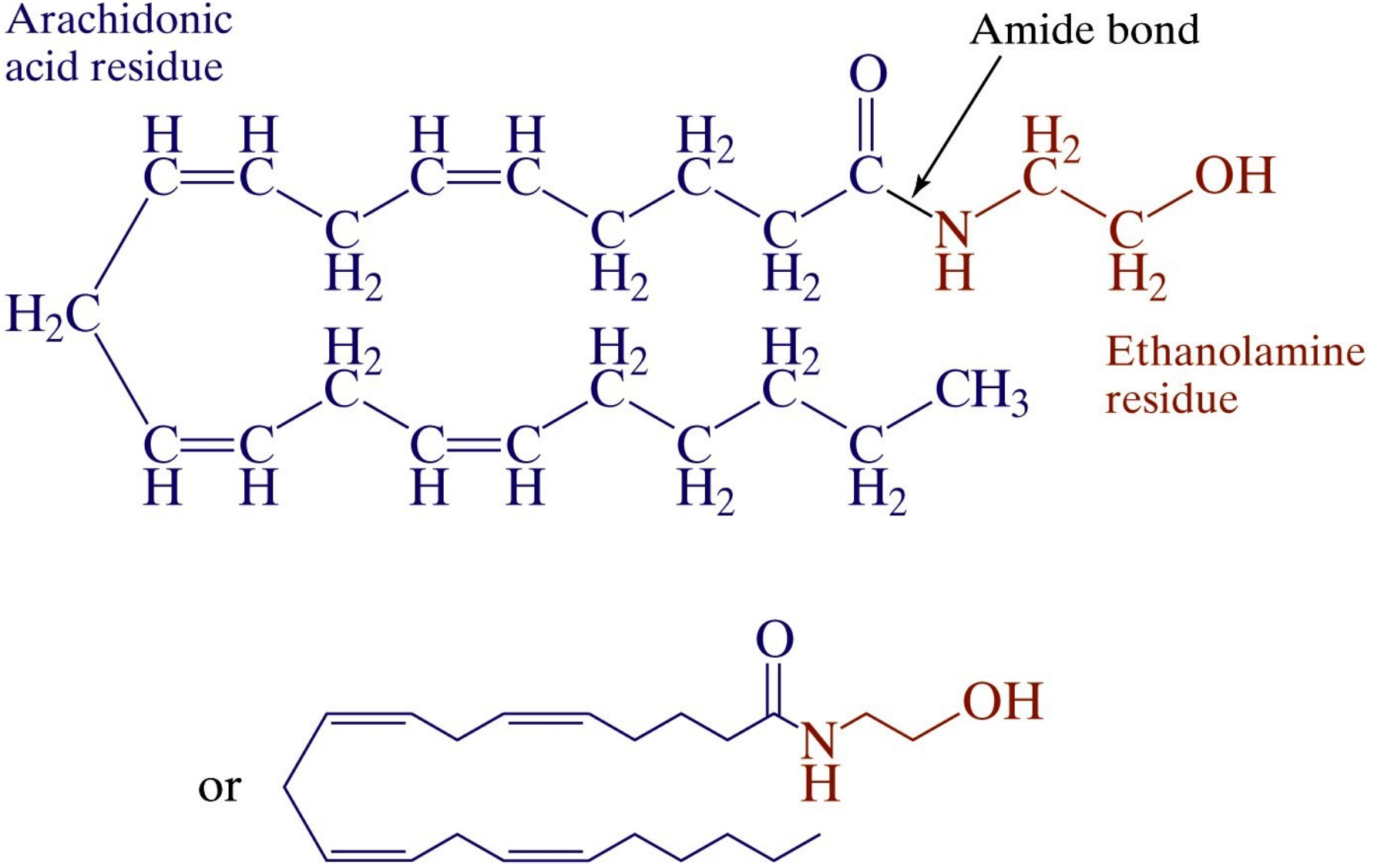
K.ARACHIDONOVÁ

$C_{20}H_{32}O_2$

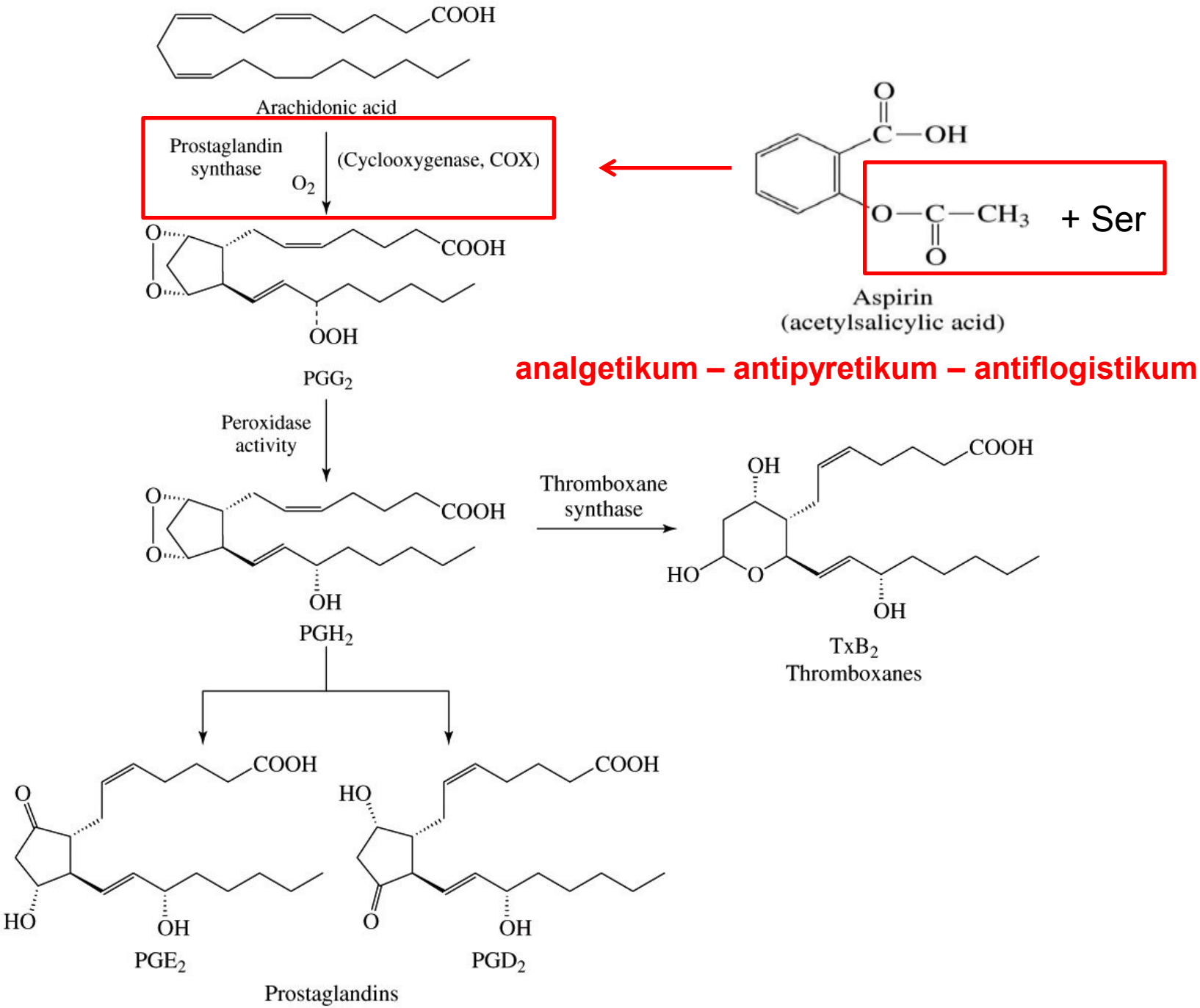
- Srdeční systém
- Respirační systém
- Reprodukční systém
- Gastrointestinální trakt



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

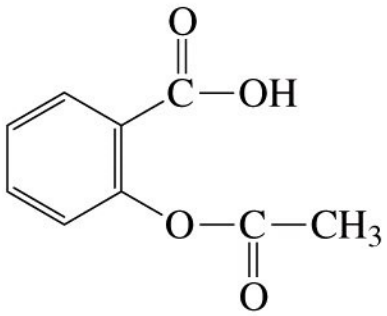


Unnumbered figure pg235 Concepts in Biochemistry, 3/e

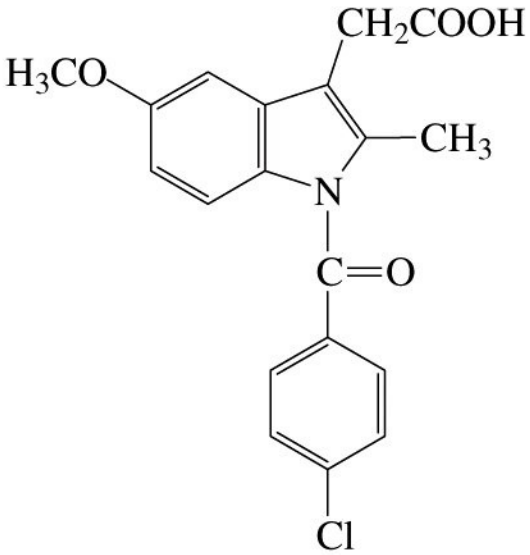


analgetikum – antipyretikum – antiflogistikum

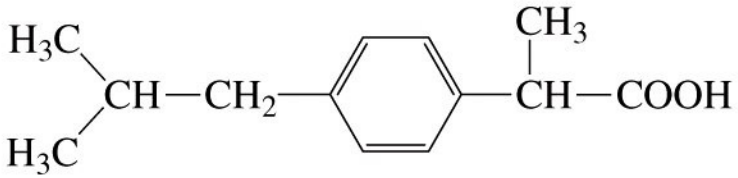
Figure 8-14 Concepts in Biochemistry, 3/e



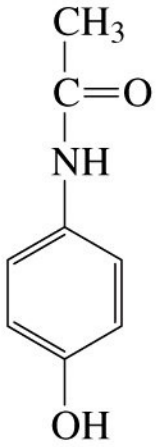
Aspirin
(acetylsalicylic acid)



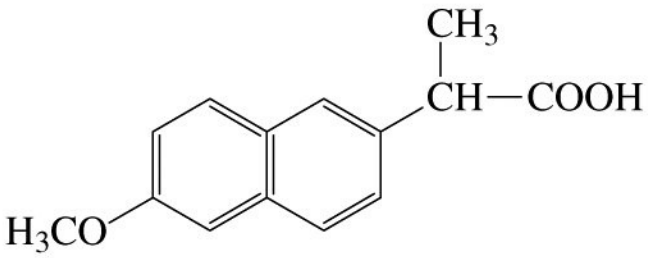
Indomethacin



Ibuprofen



Acetaminophen



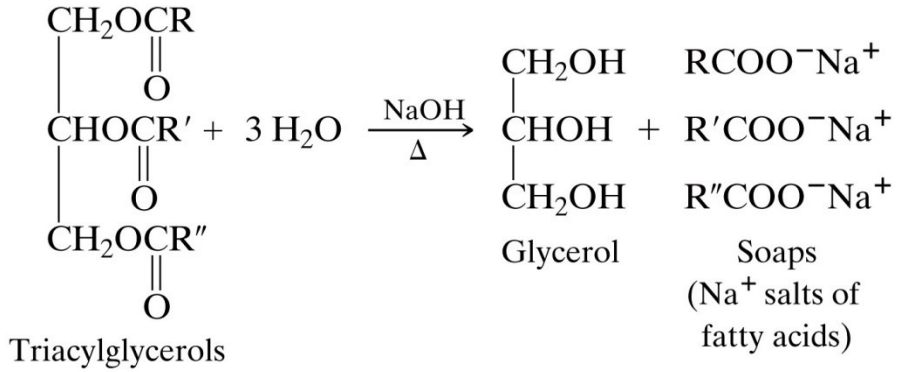
Naproxen (Aleve)

Figure 8-15a Concepts in Biochemistry, 3/e

Důležité reakce tuků - zmýdelňování - NaOH

- ztužování - H_2

- žluknutí - O_2



Unnumbered figure pg238b Concepts in Biochemistry, 3/e

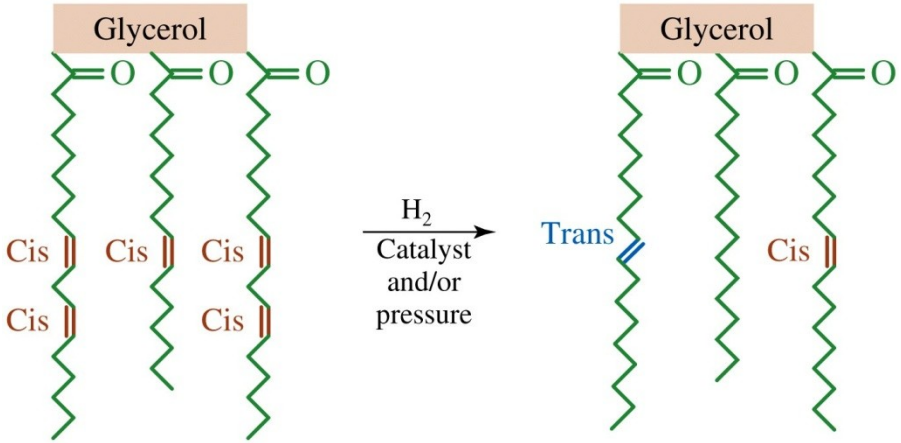
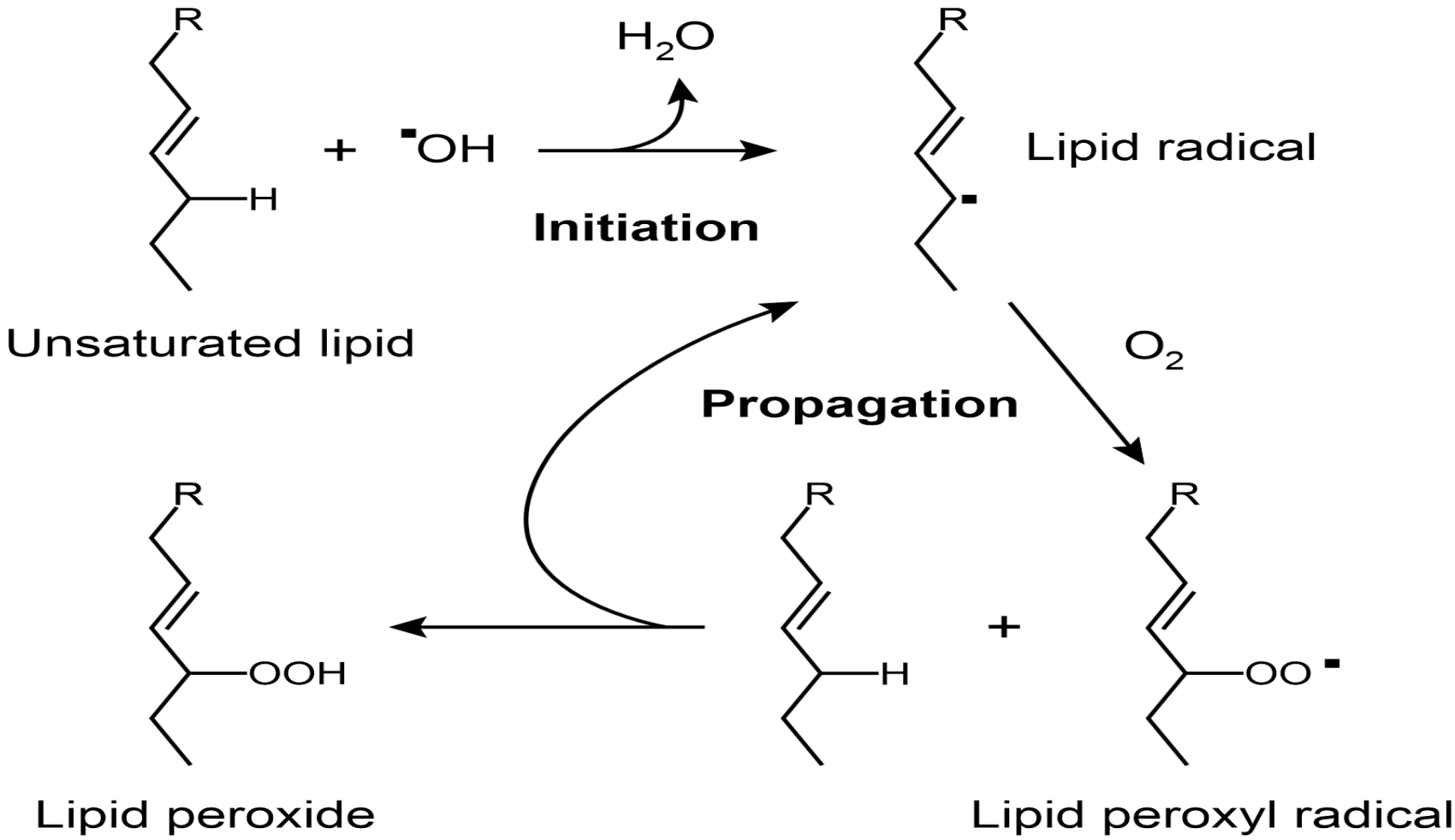


Figure 8-3 Concepts in Biochemistry, 3/e

Lipoperoxidace
reaktivní formy kyslíku (ROS)



VOSKY - estery mastných kyselin a alifatických alkoholů

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

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

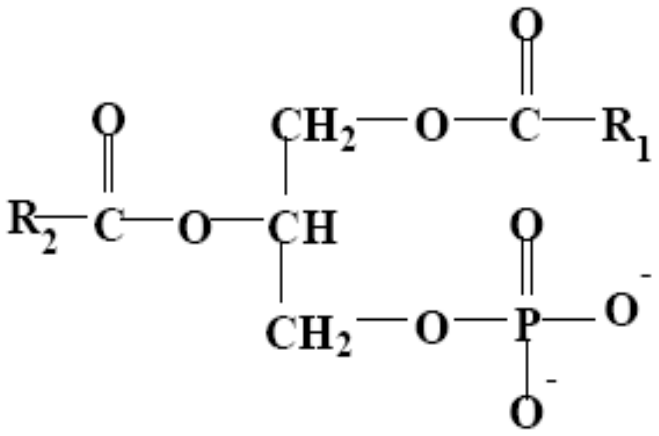
lanolin

karnaubský vosk

Složené lipidy :

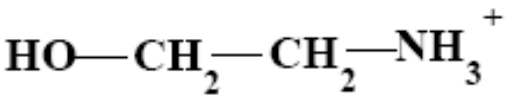
FOSFOLIPIDY

A. Fosfoacylglyceroly - fosfatidy

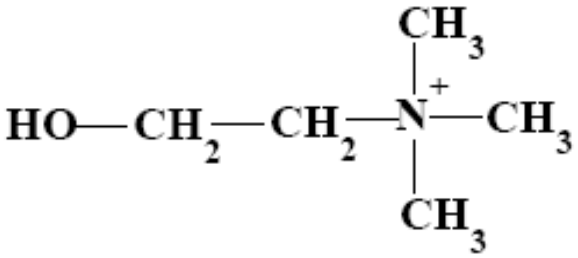


K. FOSFATIDOVÁ

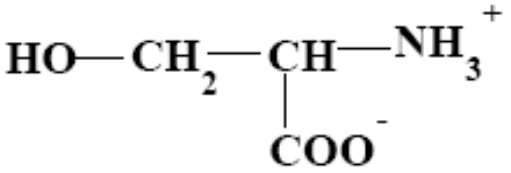
1,2-diacyl-glycerol-3-fosforečná k.



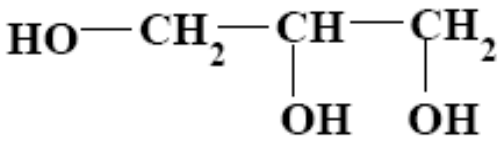
ETHANOLAMIN



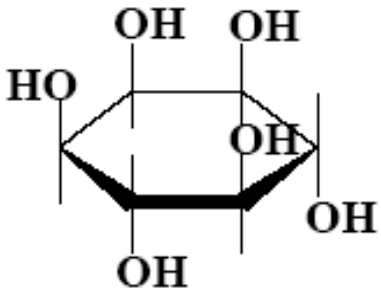
CHOLIN



SERIN



GLYCEROL

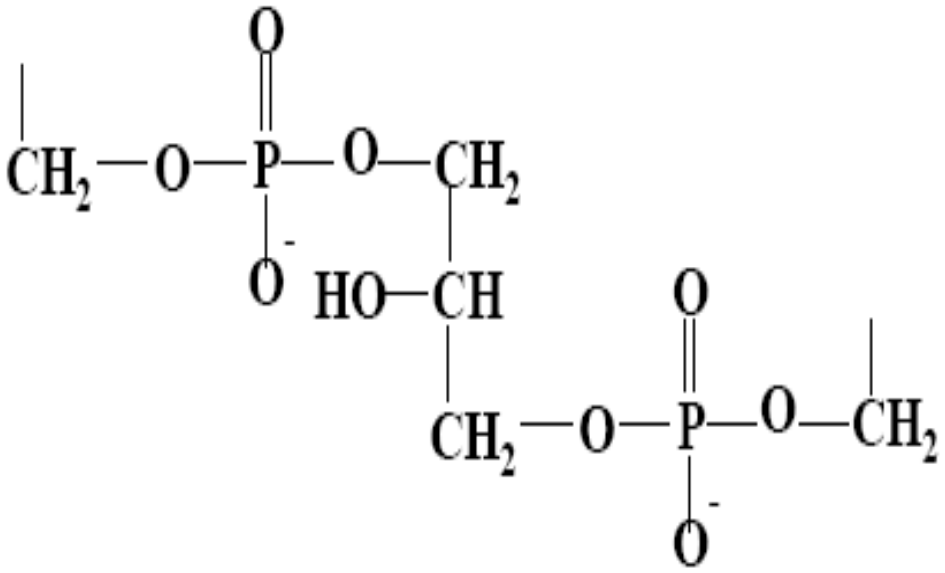


INOSITOL

Fosfatidylcholin - lecitiny

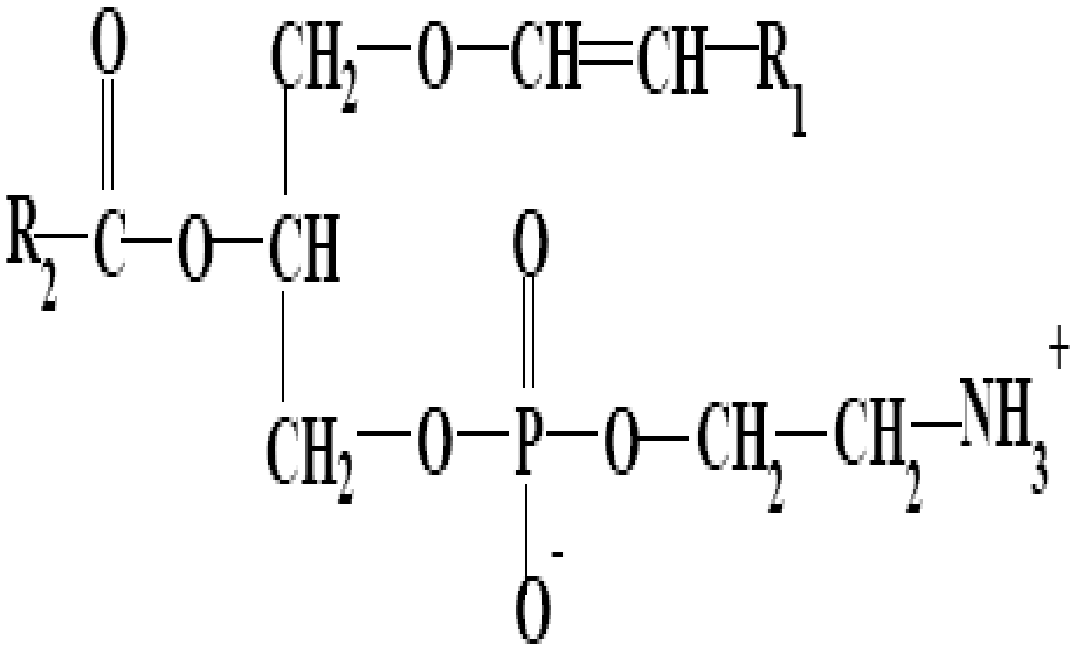
Fosfatidylethanolamin - kefaliny

Bisfosfatidylglycerol - kardiolipin



Fosfatidylinositol

Plazmalogeny



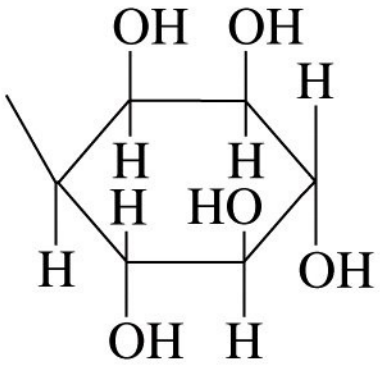
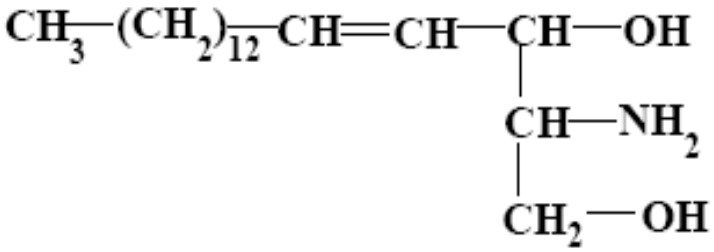
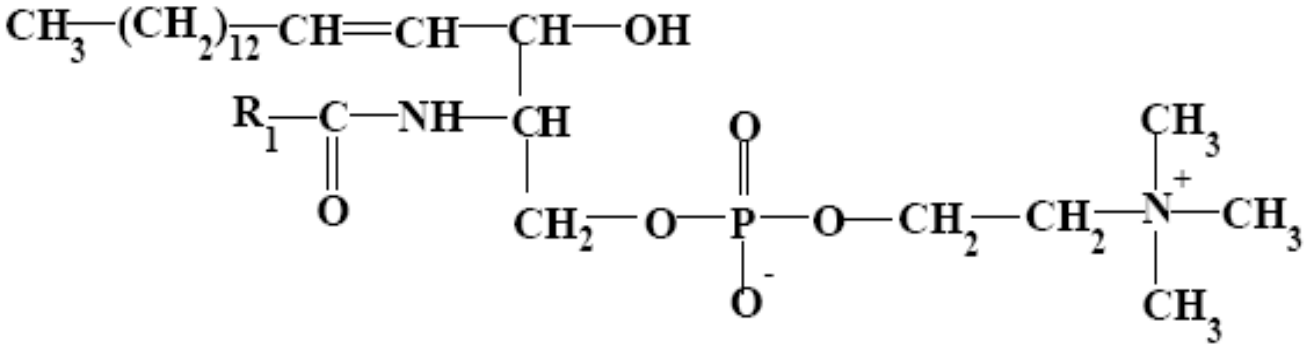
Name of **X**	Structure of **X**	Name of Glycerophospholipids
(a) Hydrogen	—H	Phosphatidic acid
(b) Ethanolamine	$—CH_2—CH_2—\overset{+}{N}H_3$	Phosphatidylethanolamine
(c) Choline	$—CH_2—CH_2—\overset{+}{N}(CH_3)_3$	Phosphatidylcholine
(d) Serine	$—CH_2—CH(\overset{+}{N}H_3)—COO^-$	Phosphatidylserine
(e) Inositol		Phosphatidylinositol

Figure 8-7 part 2 Concepts in Biochemistry, 3/e

B. **Sfingomyeliny** - **sfingofosfolipidy**



SFINGOSIN



SFINGOMYELIN

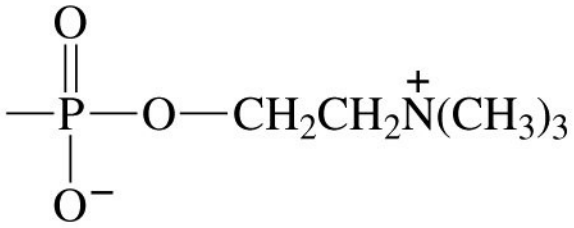
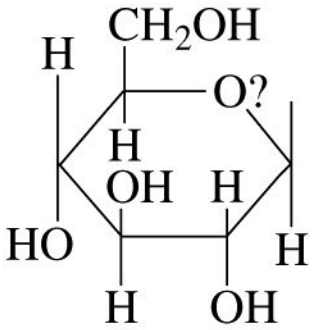
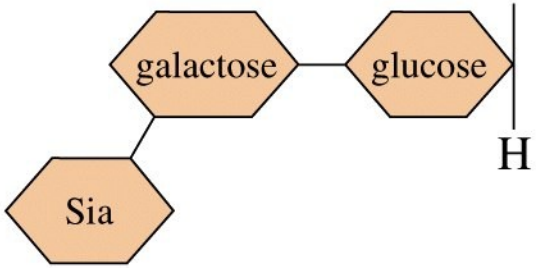
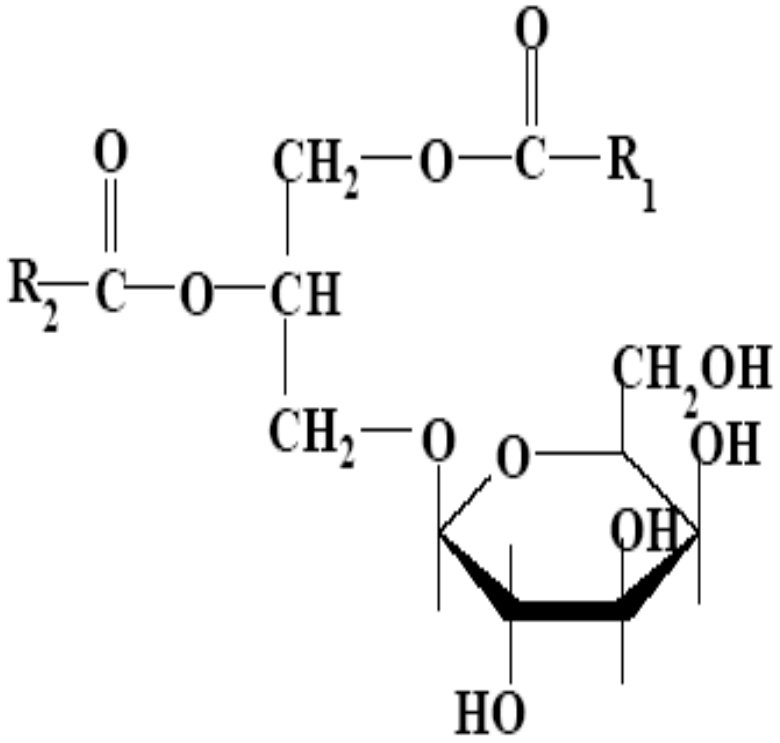
Name of **X**	Structure of **X**	Name of Sphingolipid
(b) Hydrogen	—H	Ceramide
(c) Phosphocholine		Sphingomyelin
(d) Glucose		Glucosylcerebroside
(e) Complex oligosaccharide		Ganglioside

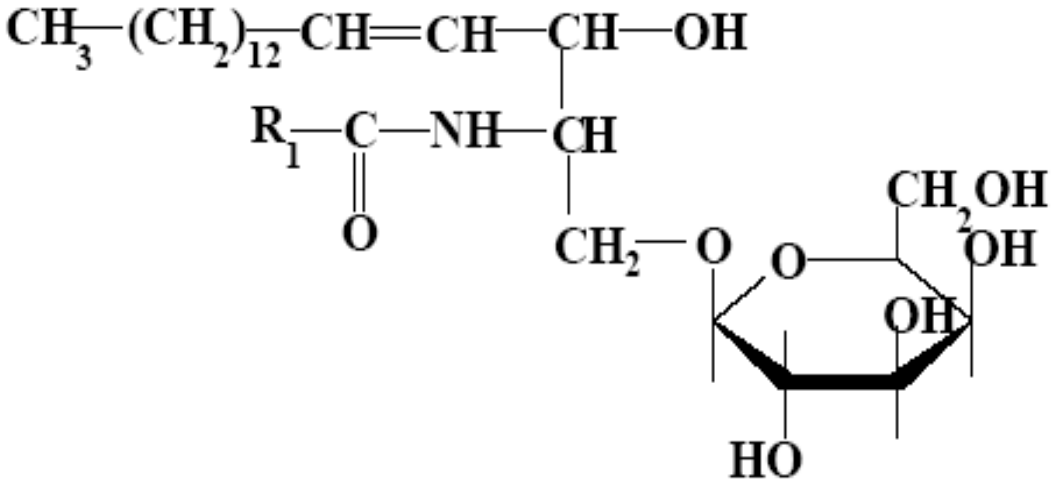
Figure 8-8 part 2 Concepts in Biochemistry, 3/e

GLYKOLIPIDY

A. Glycerolglykolipidy



B. Cerebrosidy



galaktocerebrosidy - mozek

sulfatidy

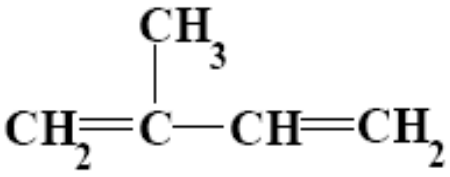
glukocerebrosidy - ostatní tkáně

C. Glykosfingolipidy

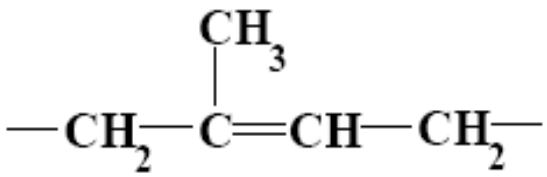
gangliosidy - sialová kyselina - ganglie nervových buněk

Izoprenoidní lipidy :

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

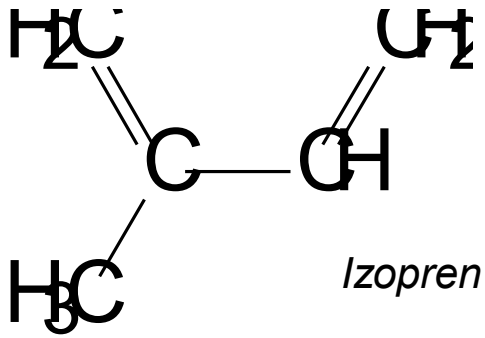


izopren



izopentenyl

Izoprenoidy



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

Isoprenoidy

terpenoidy (terpeny)

lineární

steroidy

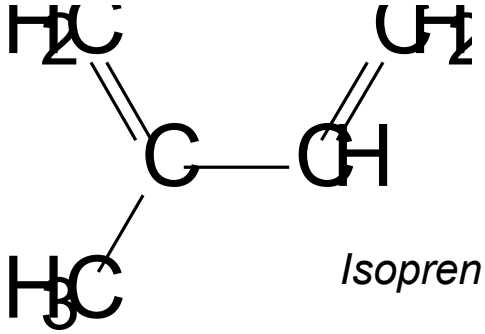
cyklické

žlučové kyseliny

steroidní hormony
(pohlavní a kortikoidní h.)

steroidní alkoholy = steroly
(cholesterol, vitamin D).

a) Terpenoidy = terpeny



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

Monoterpeny	C10, 2 isopreny	**Limonen, menthol, kafr, pinen**
Seskviterpeny	C15, 3 isopreny	
Diterpeny	C20, 4 isopreny	**Vitamin A (retinol), fytol**
Triterpeny	C30, 6 isoprenů	
Tetraterpeny	C40, 8 isoprenů	**Karotenoidy, skvalen**
Polyterpeny	C5n, n isoprenů	**Přírodní kaučuk**

Izoprenoidy

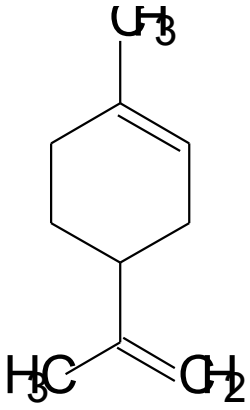
zdroje: *silice* (éterické oleje) – vonící těkavé kapaliny
(hlavně květy a plody rostlin)

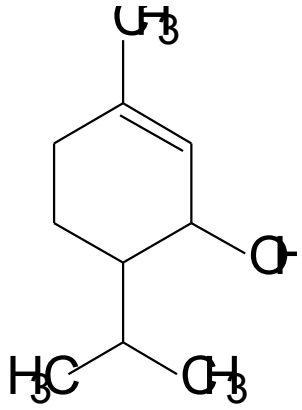



nerozpustné ve vodě, vznikají oxidací silic v místech porušení kůry jehličnanů, specifická vůně

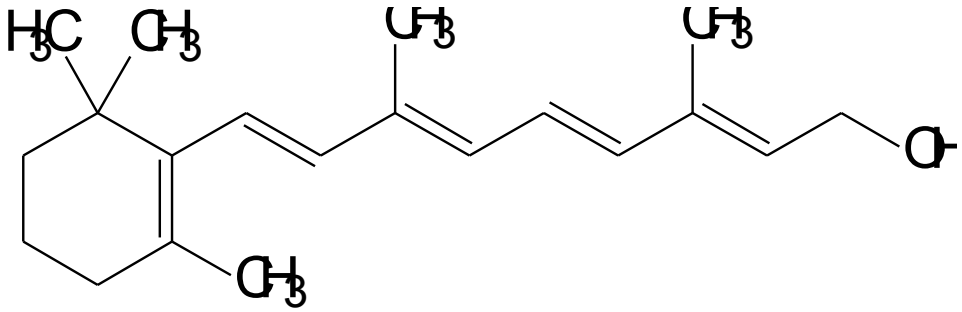
balzámy – polotekuté směsi silic a pryskyřic

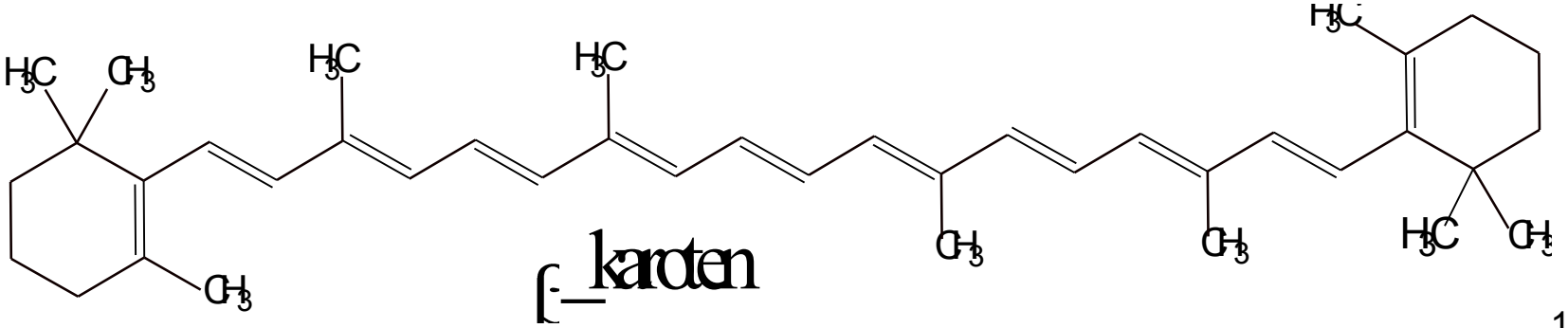
Silice:





Vitamin A a karotenoidy:



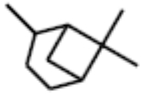


β-karoten

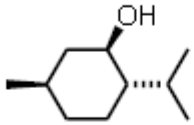
Terpeny (Terpenoidy, Isoprenoidy)

Monoterpenes

C_{10}



pinane

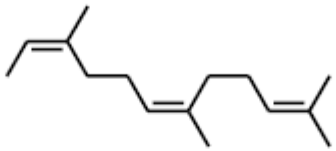


menthol

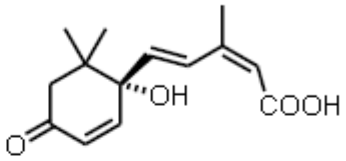
silice v terpentýnu silice v mátě

Sesquiterpenes

C_{15}



farnesan

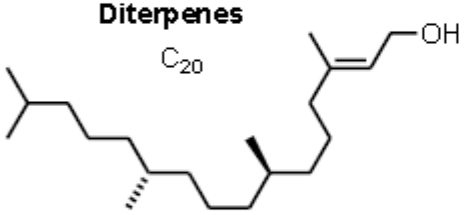


abcisic acid

vůně zralých jablek rostlinný hormon

Diterpenes

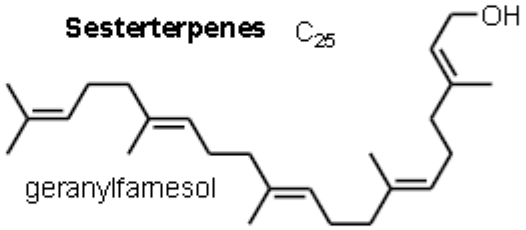
C_{20}



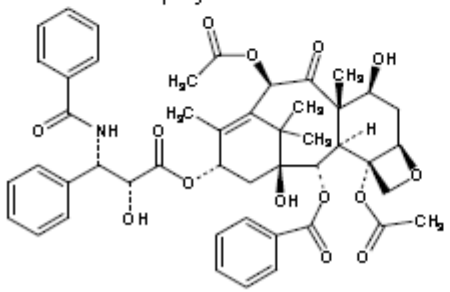
součást chlorofylu

phytol

Sesterterpenes C_{25}



geranylfarnesol

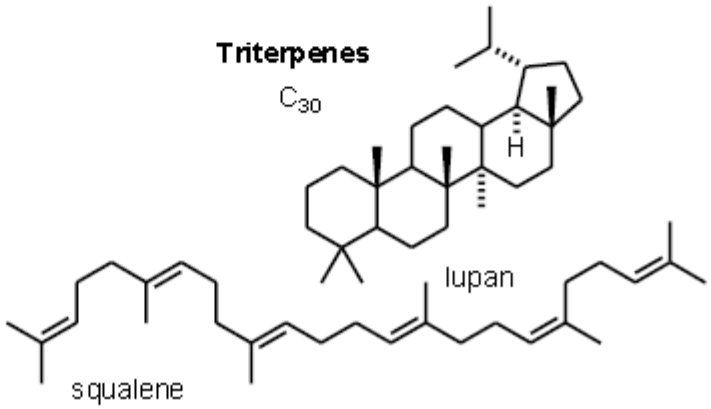


Taxol

alkaloid z tisu

Triterpenes

C_{30}



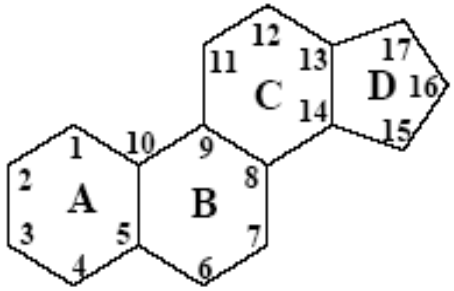
lupan

squalene

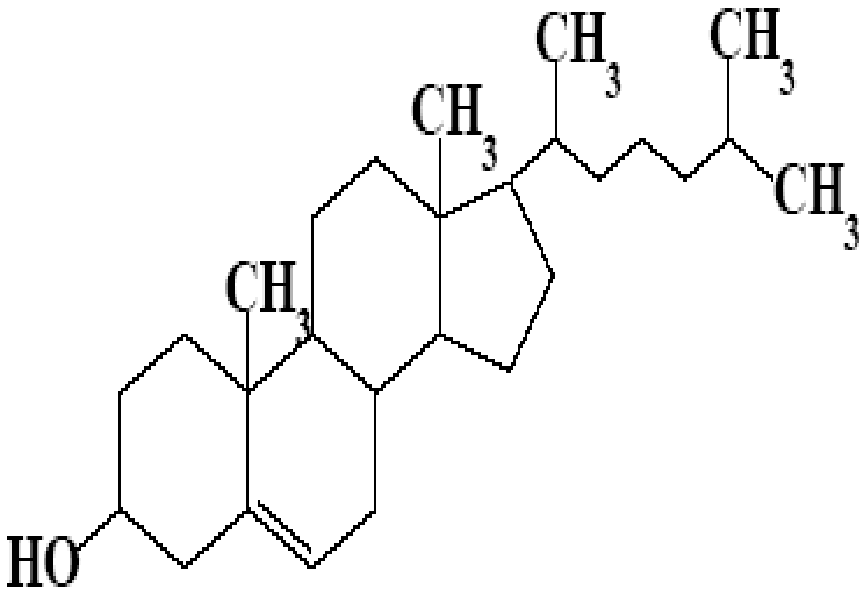
játra žraloka

STEROIDY

STERAN - cyklopentanoperhydrofenantren

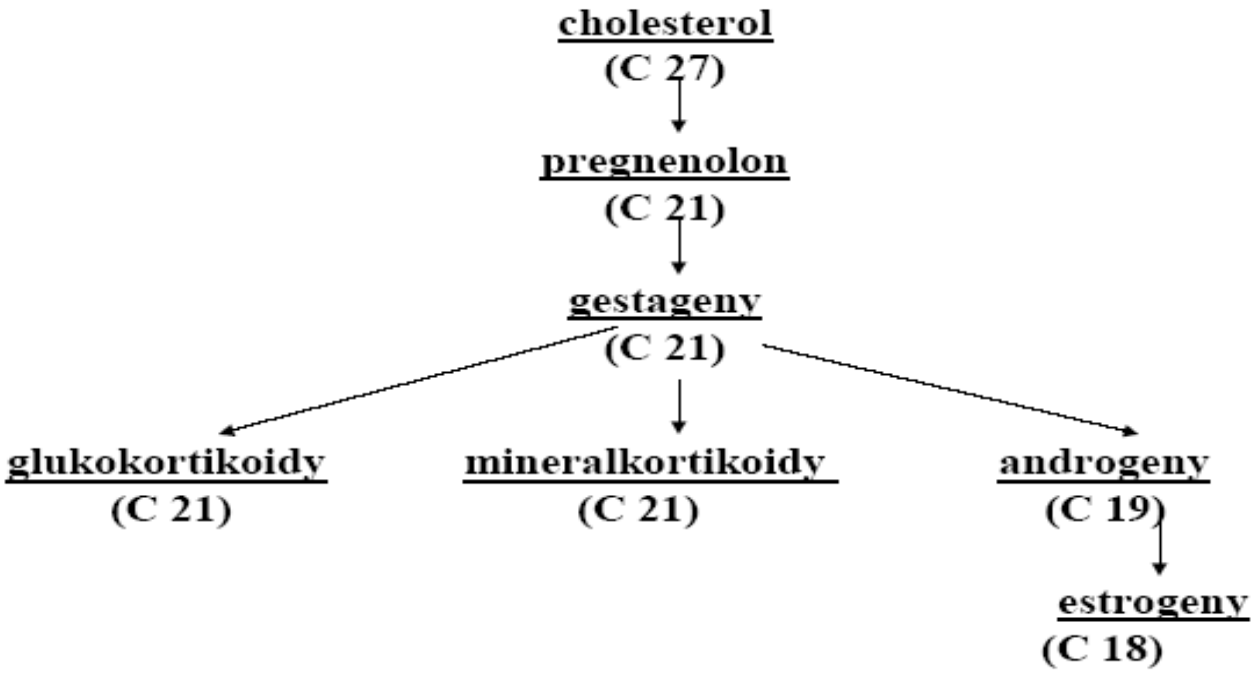


A. Steroly



CHOLESTEROL

Steroidní hormony



+biosyntesa glykogenu
- proteosyntesa

Glukokortikoidy - kortisol, kortikosteron - kůra nadledvinek

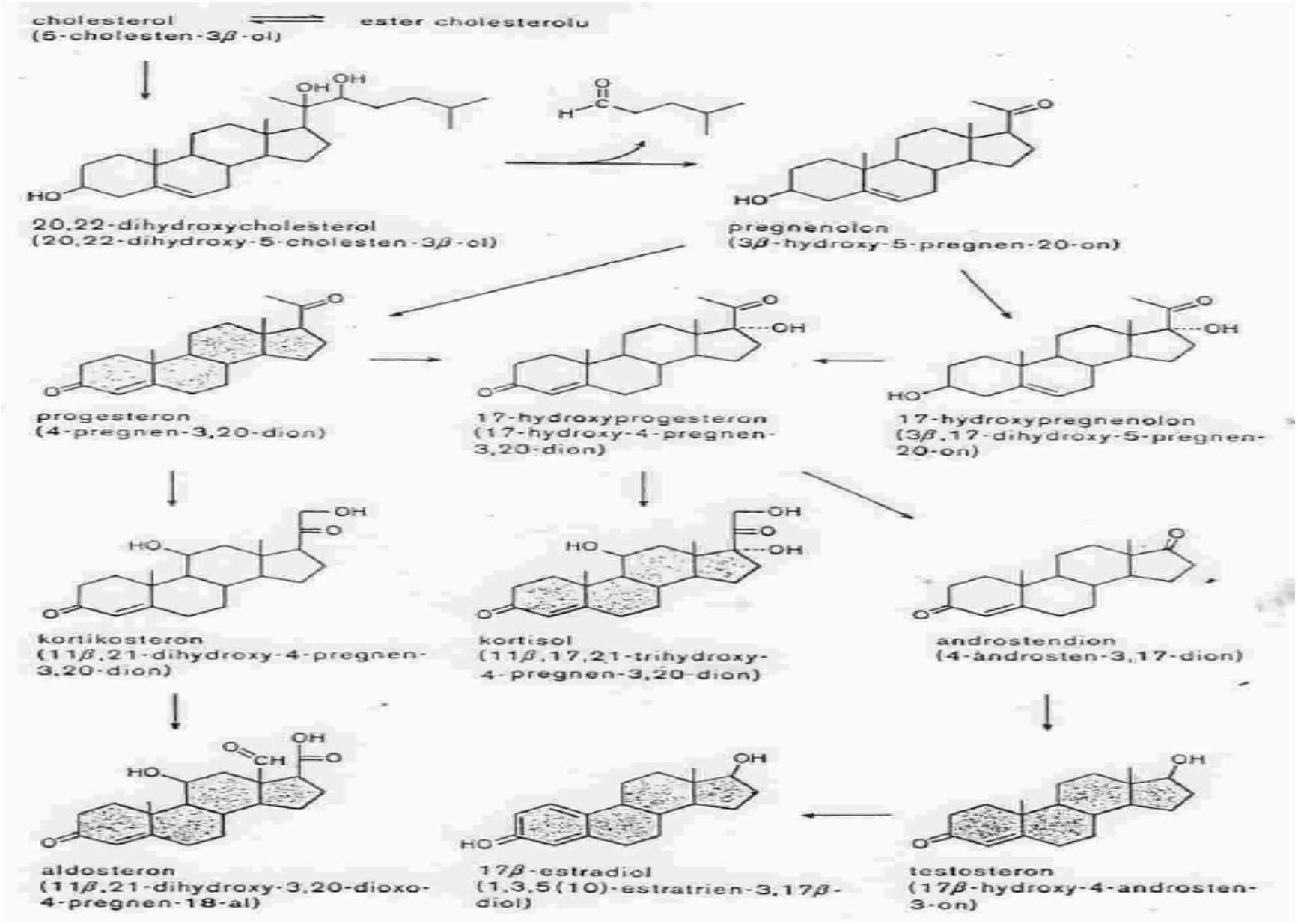
Mineralkortikoidy - aldosteron - kůra nadledvinek

zadržování Na^+, Cl^-. HCO_3^-
vylučování K^+

Androgeny - testosteron - varlata

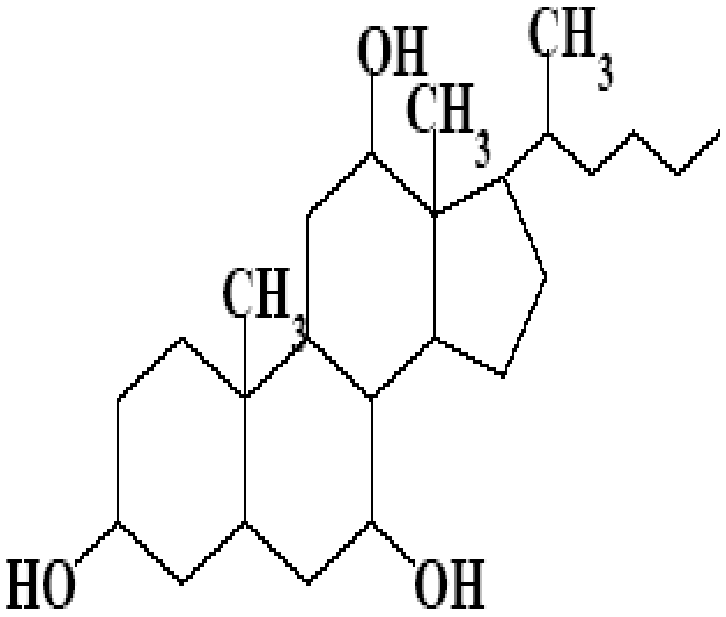
Estrogeny - estron, estradiol, estratriol - vaječníky

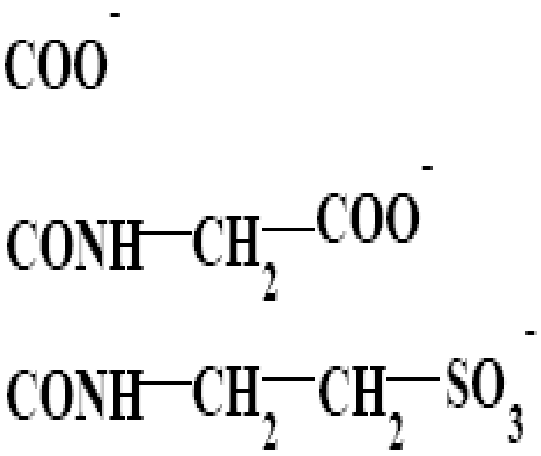
Gestageny - progesteron - vaječníky


cholesterol
(5-cholesten-3β-ol)
ester cholesterolu
20,22-dihydroxycholesterol
(20,22-dihydroxy-5-cholesten-3β-ol)
pregnenolon
(3β-hydroxy-5-pregnen-20-on)
progesteron
(4-pregnen-3,20-dion)
17-hydroxyprogesteron
(17-hydroxy-4-pregnen-3,20-dion)
17-hydroxypregnenolon
(3β,17-dihydroxy-5-pregnen-20-on)
kortikosteron
(11β,21-dihydroxy-4-pregnen-3,20-dion)
kortisol
(11β,17,21-trihydroxy-4-pregnen-3,20-dion)
androstendion
(4-androsten-3,17-dion)
aldosteron
(11β,21-dihydroxy-3,20-dioxo-4-pregnen-18-al)
17β-estradiol
(1,3,5(10)-estratrien-3,17β-diol)
testosteron
(17β-hydroxy-4-androsten-3-on)

játra → žlučník

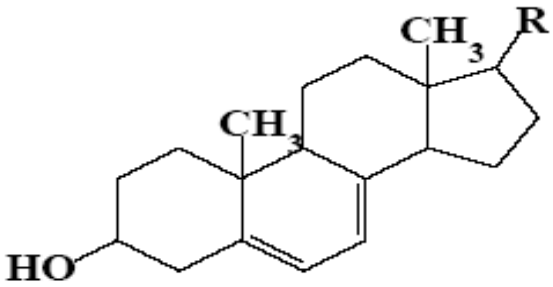
B. Žlučové kyseliny - k.cholová, k. glykocholová, k. taurocholová





C. Kalciferoly - vitaminy - D_3 - cholekalciferol, D_2 - ergokalciferol

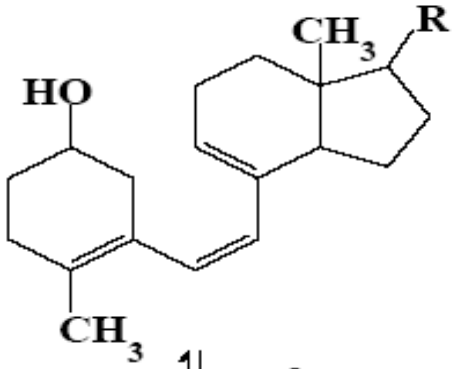
provitamin D



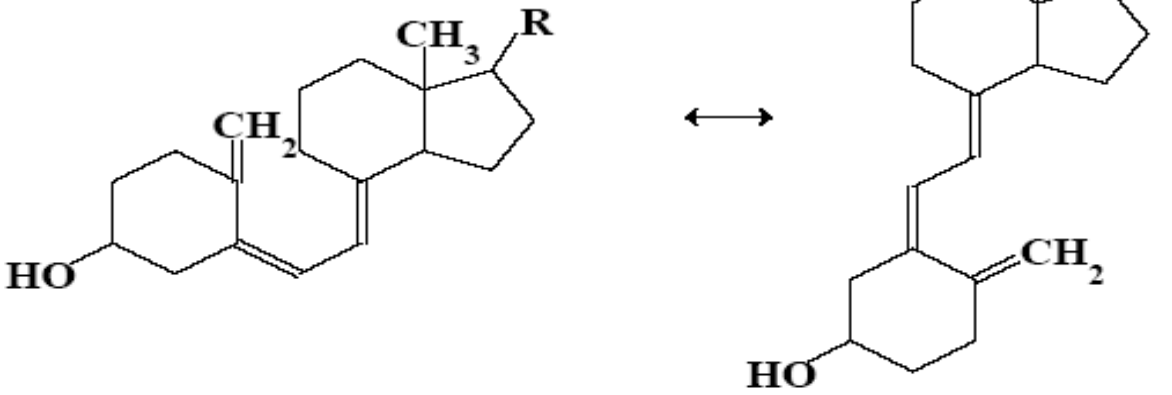
kůže

světlo →

prekalciferol

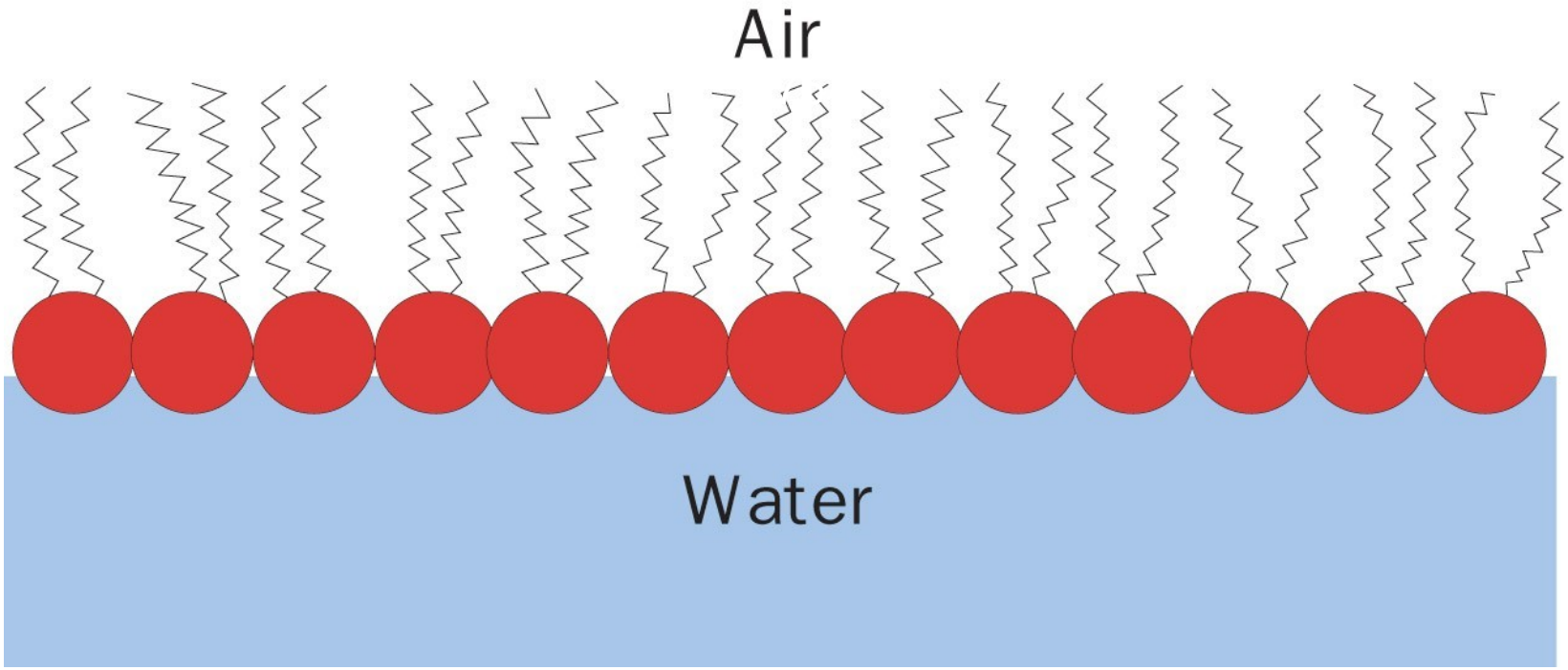


⇌ teplo



kalciferol

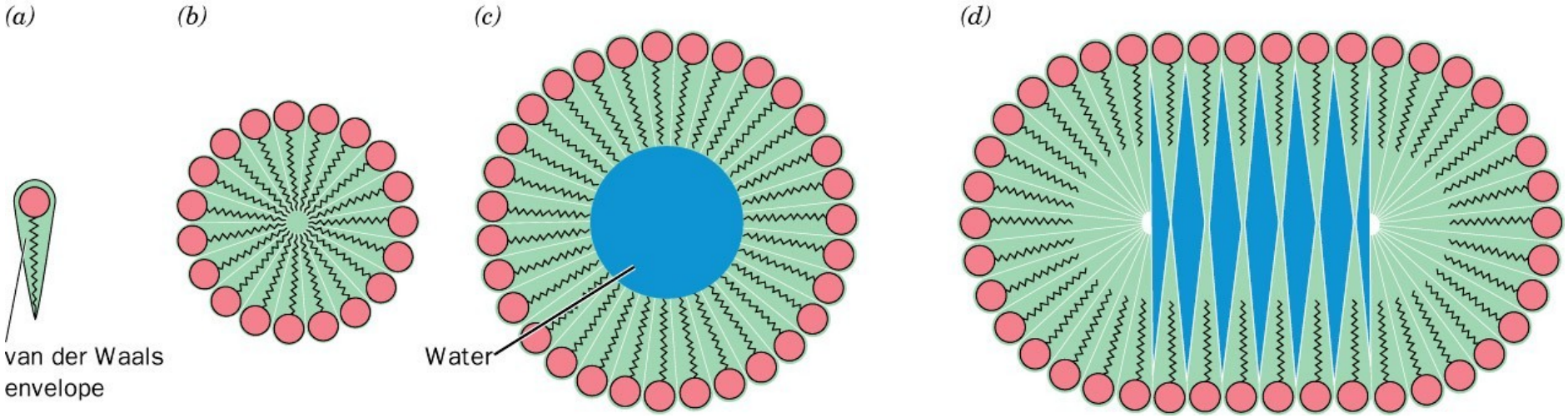
Membrány



"oil drop" experiments

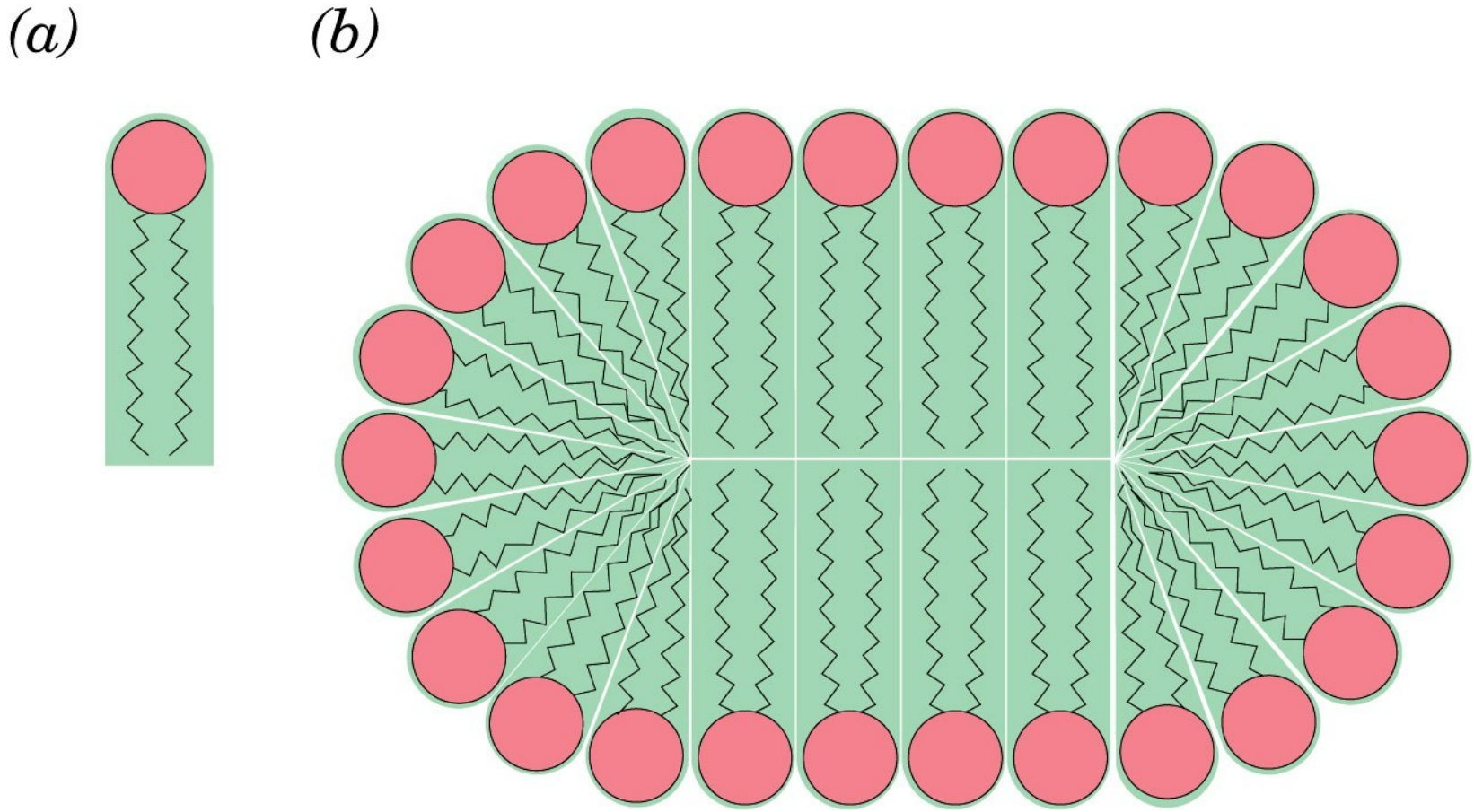
Membrány

detergenty, tenzidy,

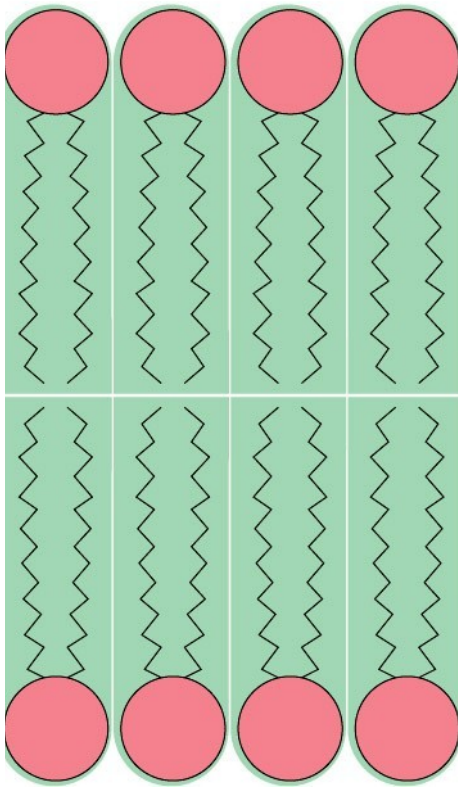


Membrány

fosfolipidy



Membrány



5 – 7.5 nm

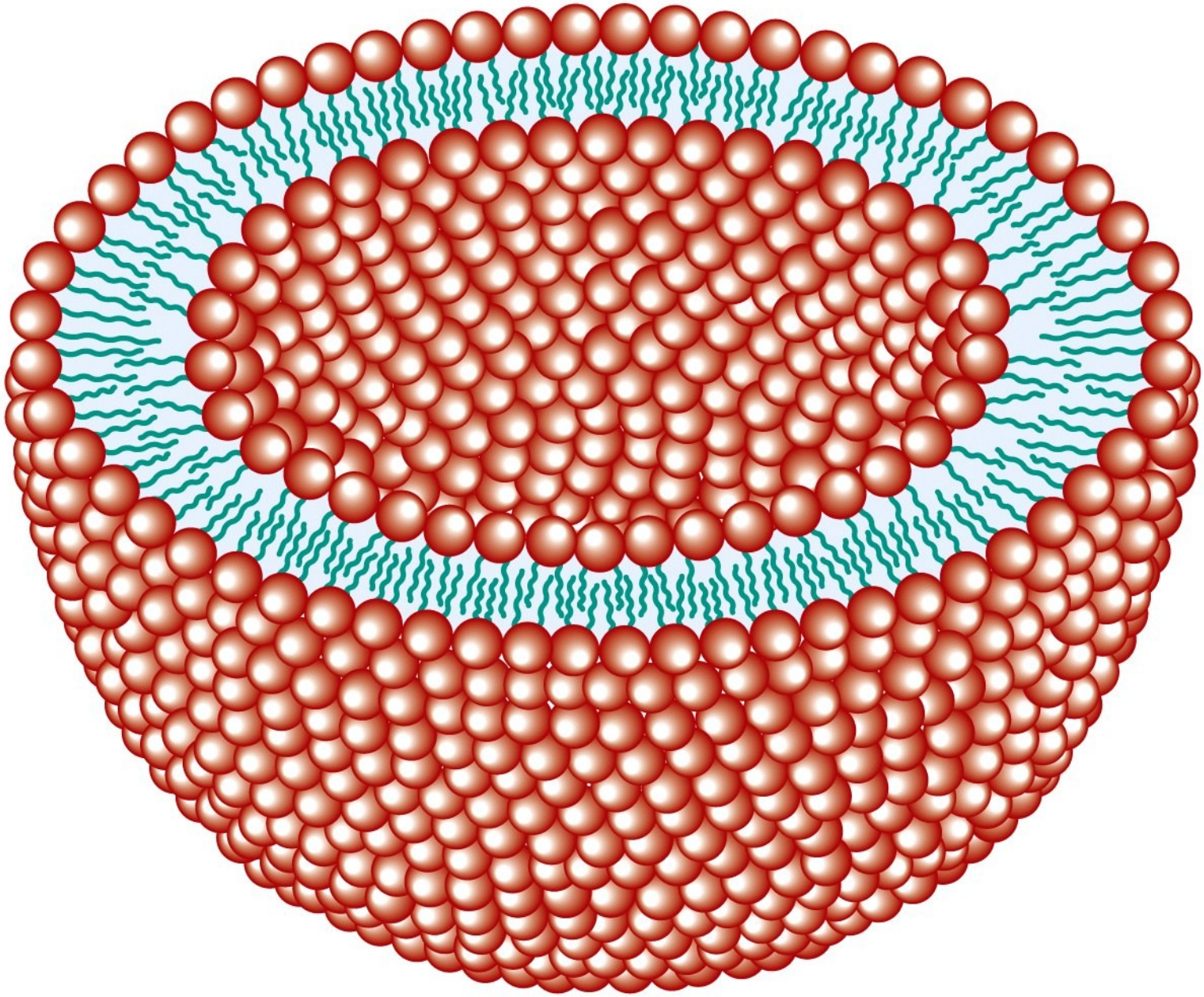


Figure 9-1b Concepts in Biochemistry, 3/e

Biomembrány : agregované formy biolipidů

<u>Význam biomembrán</u> - transport

- kompartmentace

- komunikace

Biomembrány : agregované formy biolipidů

Molekulové složení membrán

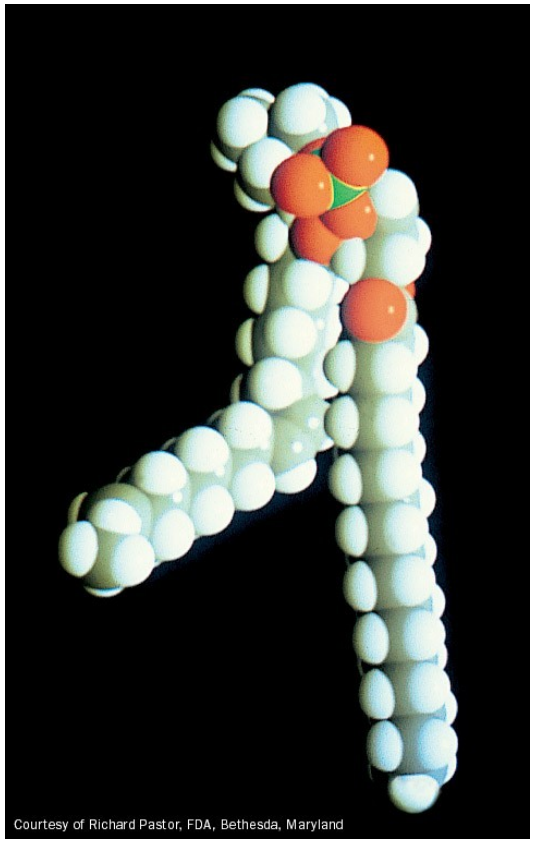
Membrána	proteiny %	lipidy %	sacharidy %
cytoplazmatická	49	43	8
jaderná	59	35	2
mitochondriální vnější	52	46	2
mitochondriální vnitřní	76	23	1
myelinová	18	79	3

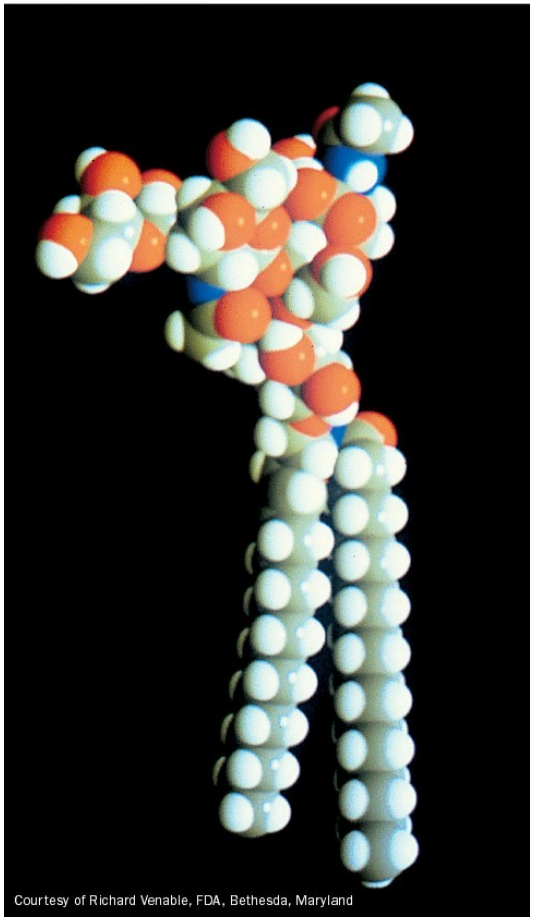
- *Lipidy* - fosfolipidy, cholestorol

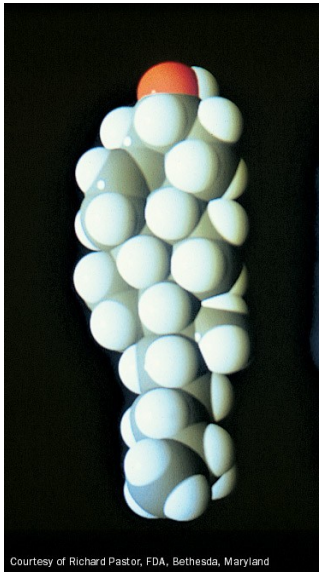
funkce - strukturní

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, cholesterol







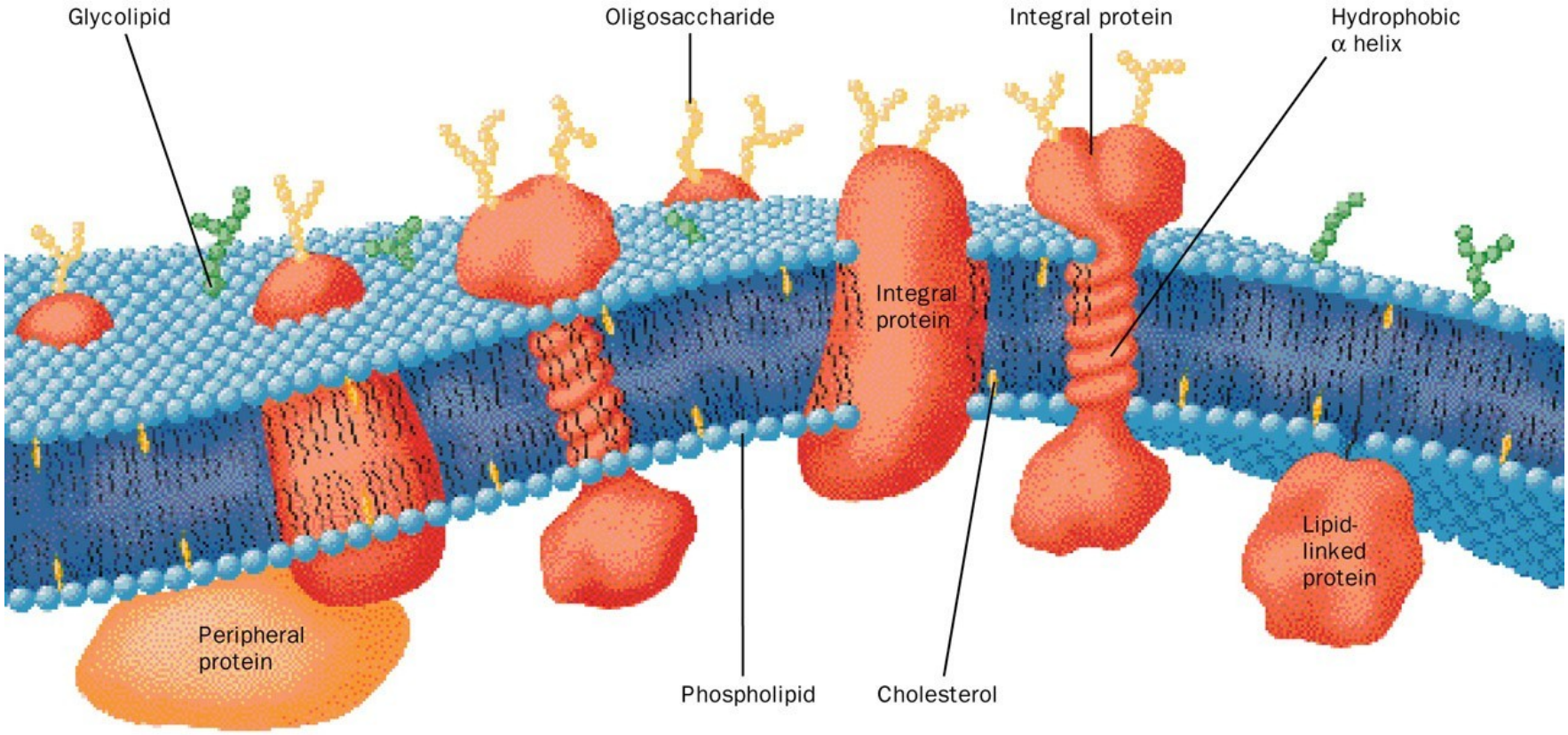
- *Bílkoviny* - integrální, periferní

  funkce - enzymy

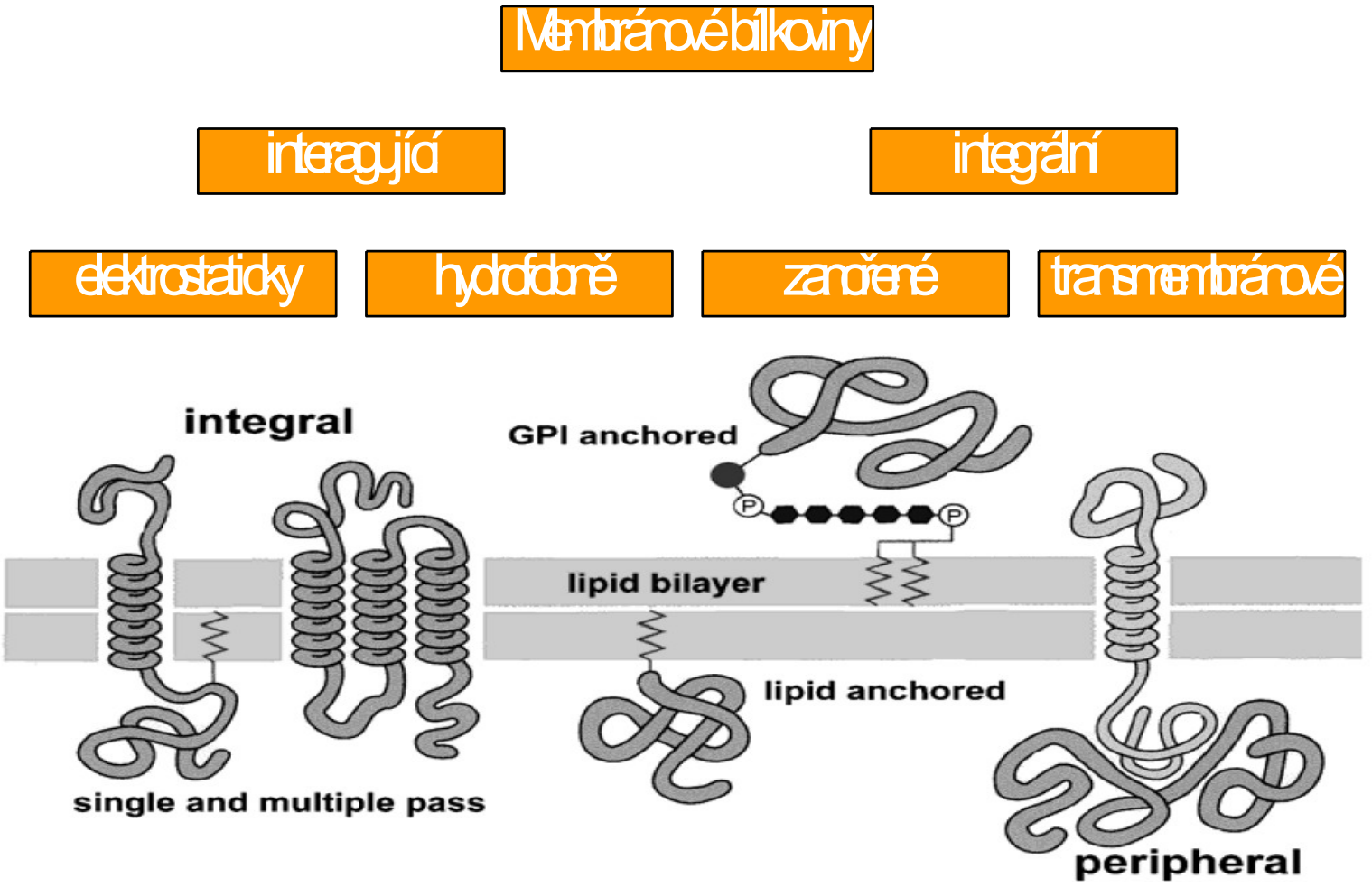
  přenašeče

  receptory

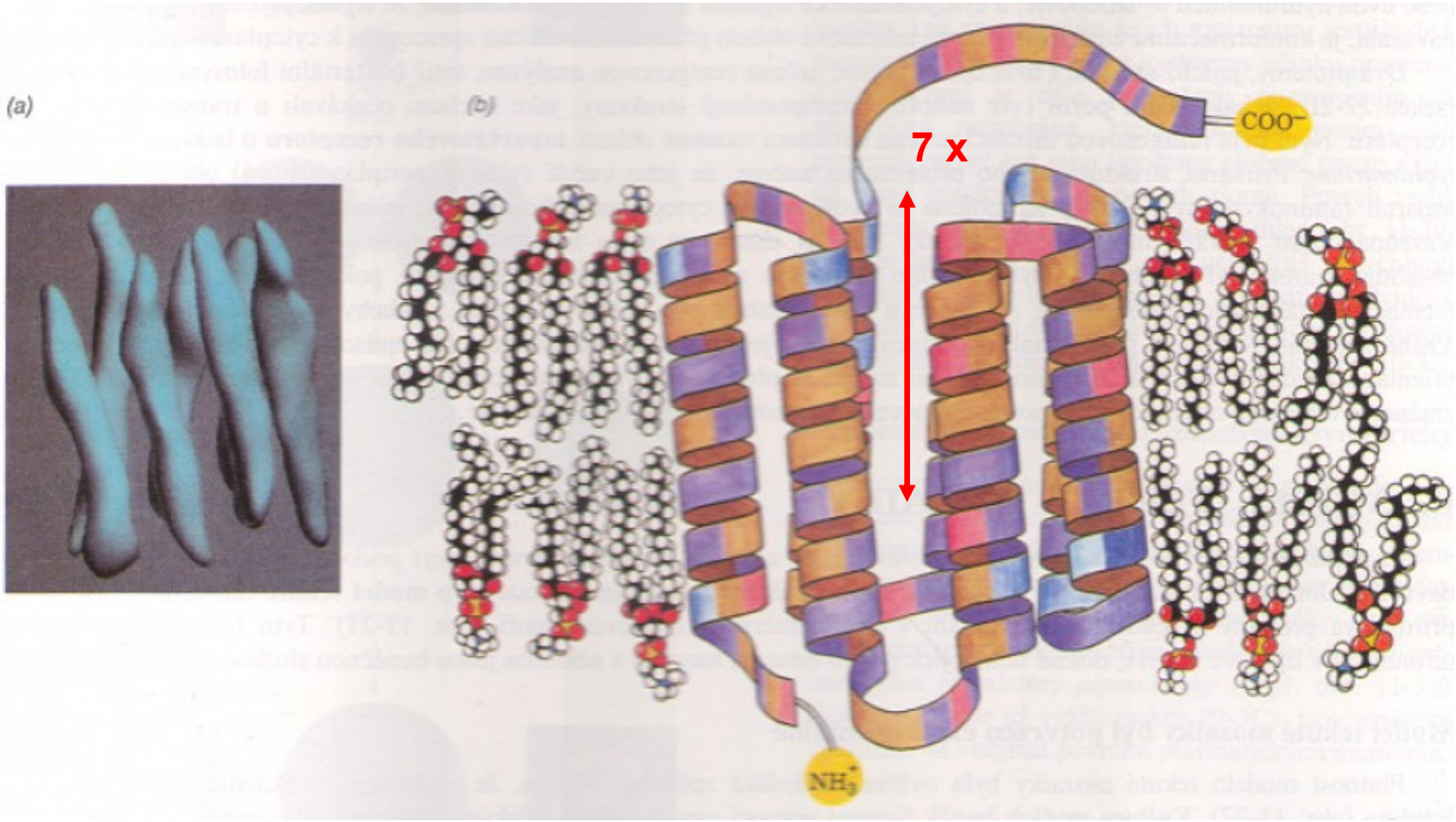
  strukturní


Glycolipid
Oligosaccharide
Integral protein
Hydrophobic
α helix
Integral
protein
Lipid-
linked
protein
Peripheral
protein
Phospholipid
Cholesterol

Membránově vázané bílkoviny



Bakteriorhodopsin



- *Sacharidy* - glykolipidy, glykoproteiny

  funkce - kotvení glykolipidů a glykoproteinů

  v membránách

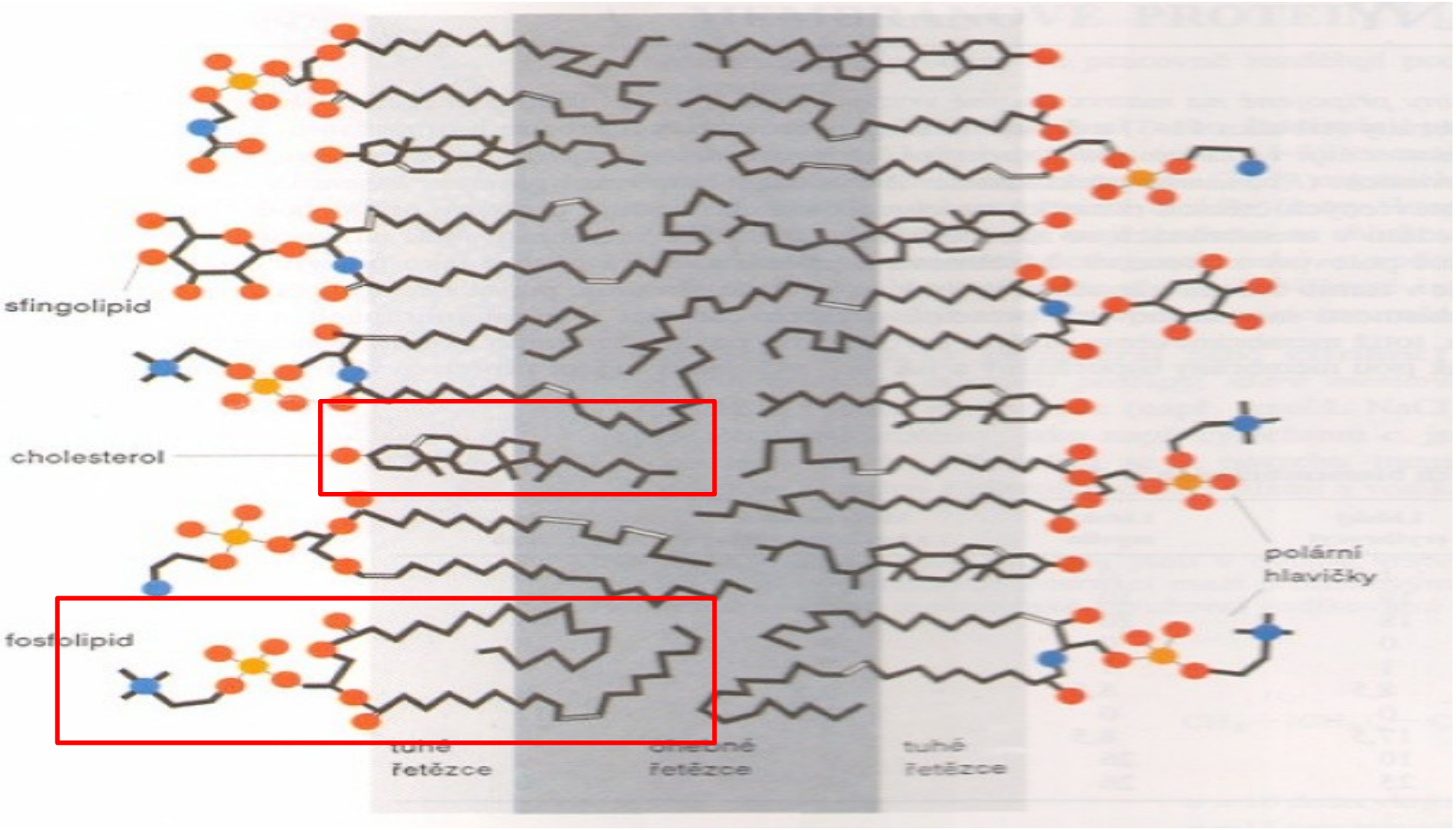
  - rozpoznávací

Modely membrán :

GORTER a GRENDL (1925) - Lipidová dvojvrstva

SINGER a NICHOLSON (1972) - Model tekuté mozaiky

Lipidická dvojvrstva
5 – 7.5 nm



Model tekuté mozaiky

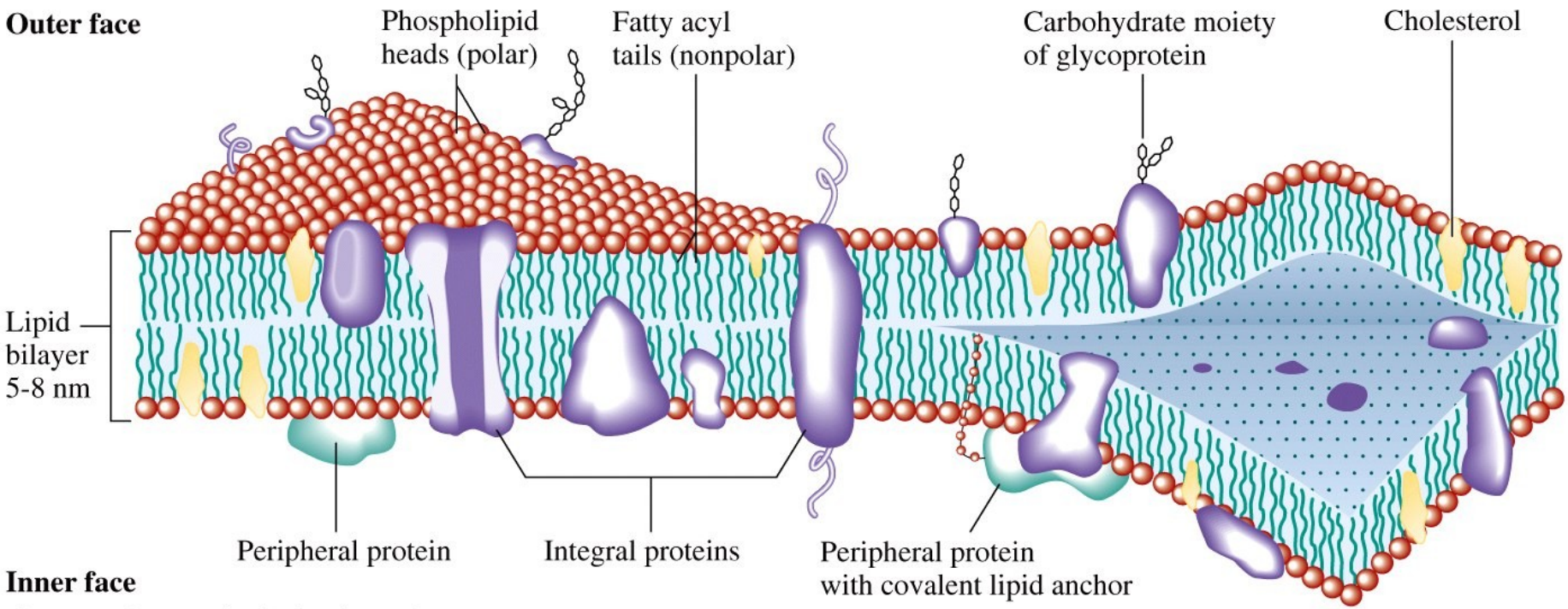
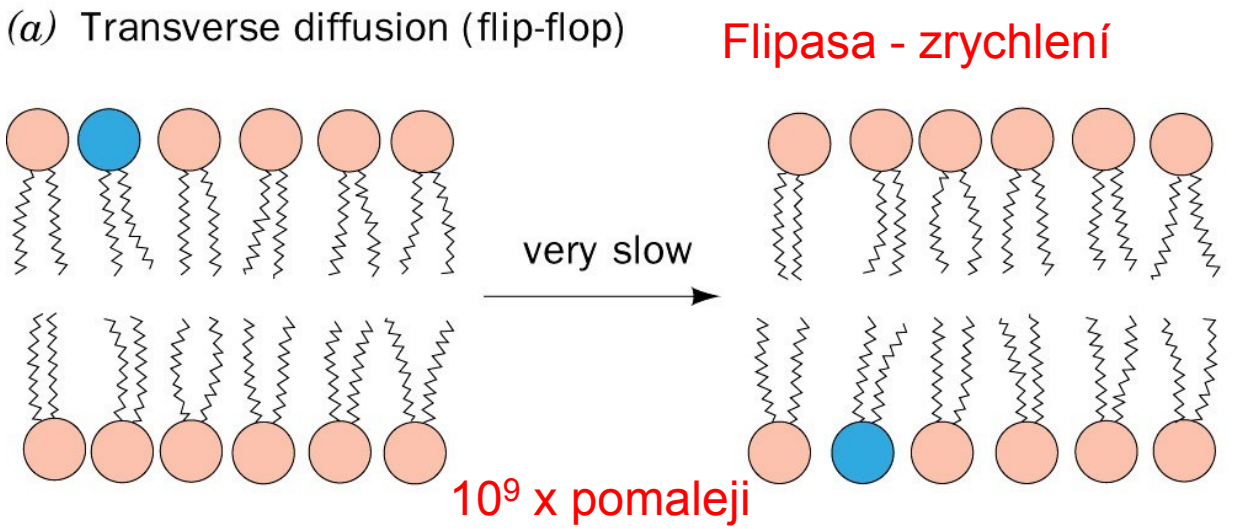
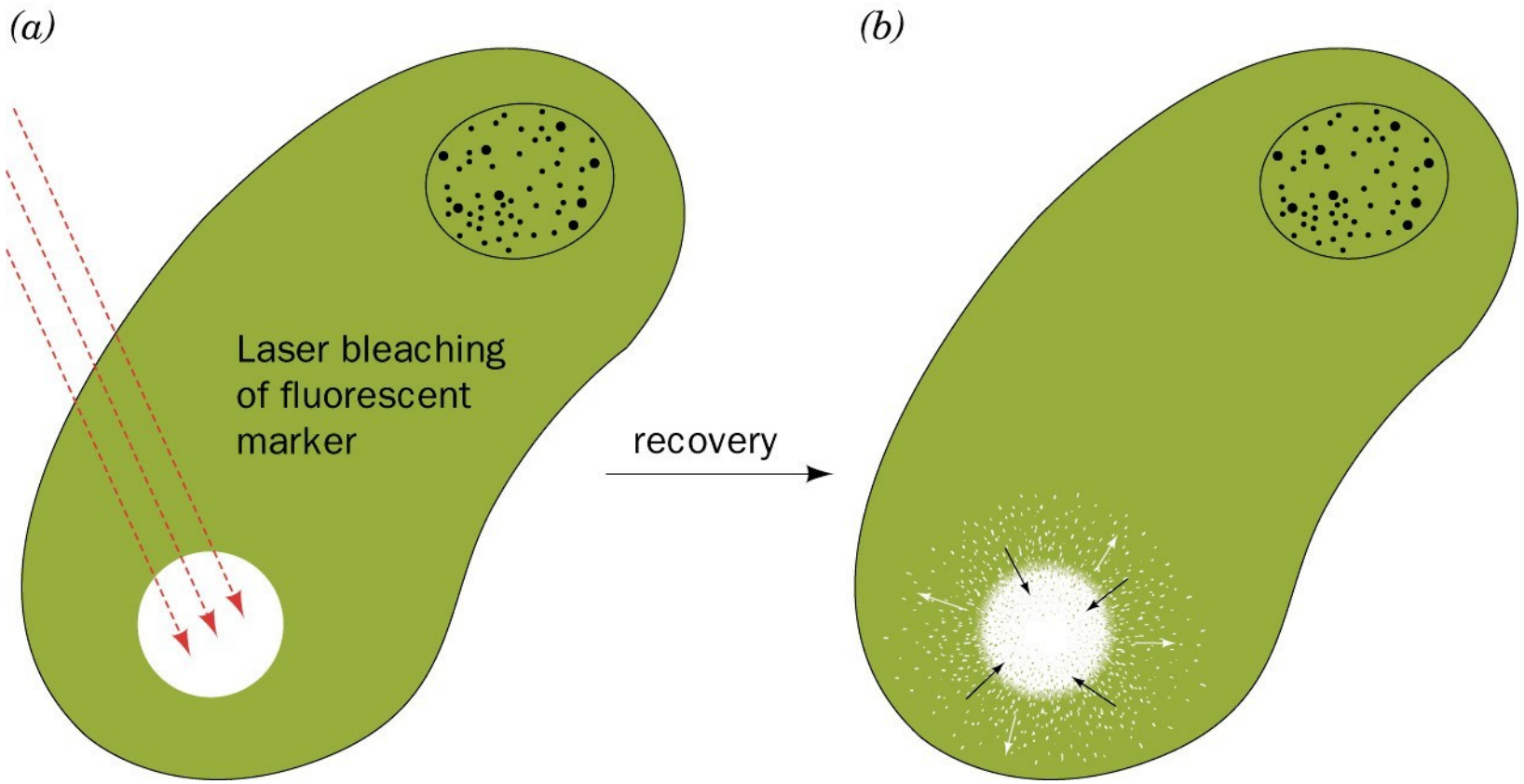


Figure 9-6 Concepts in Biochemistry, 3/e

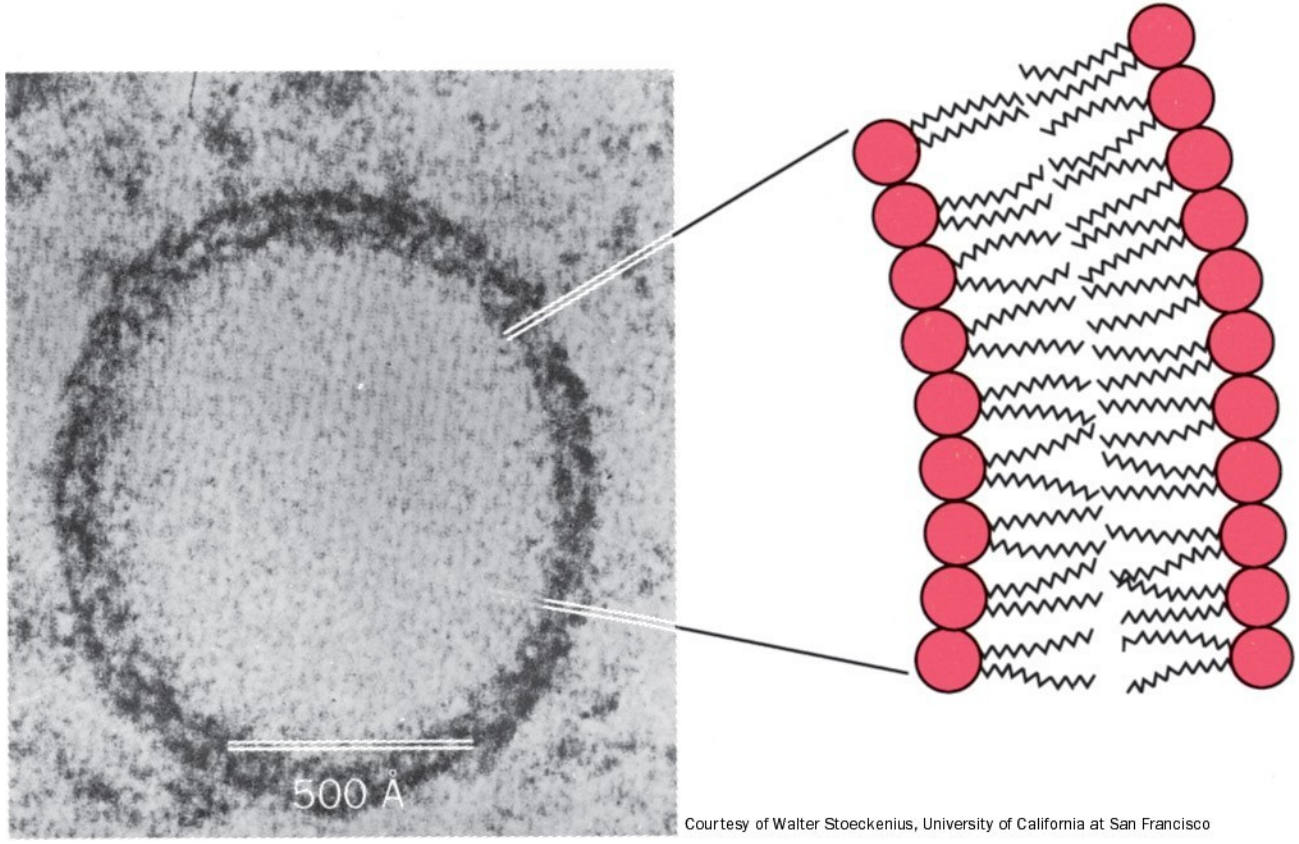
Difuze lipidů v membráně



Difuze lipidů v membráně

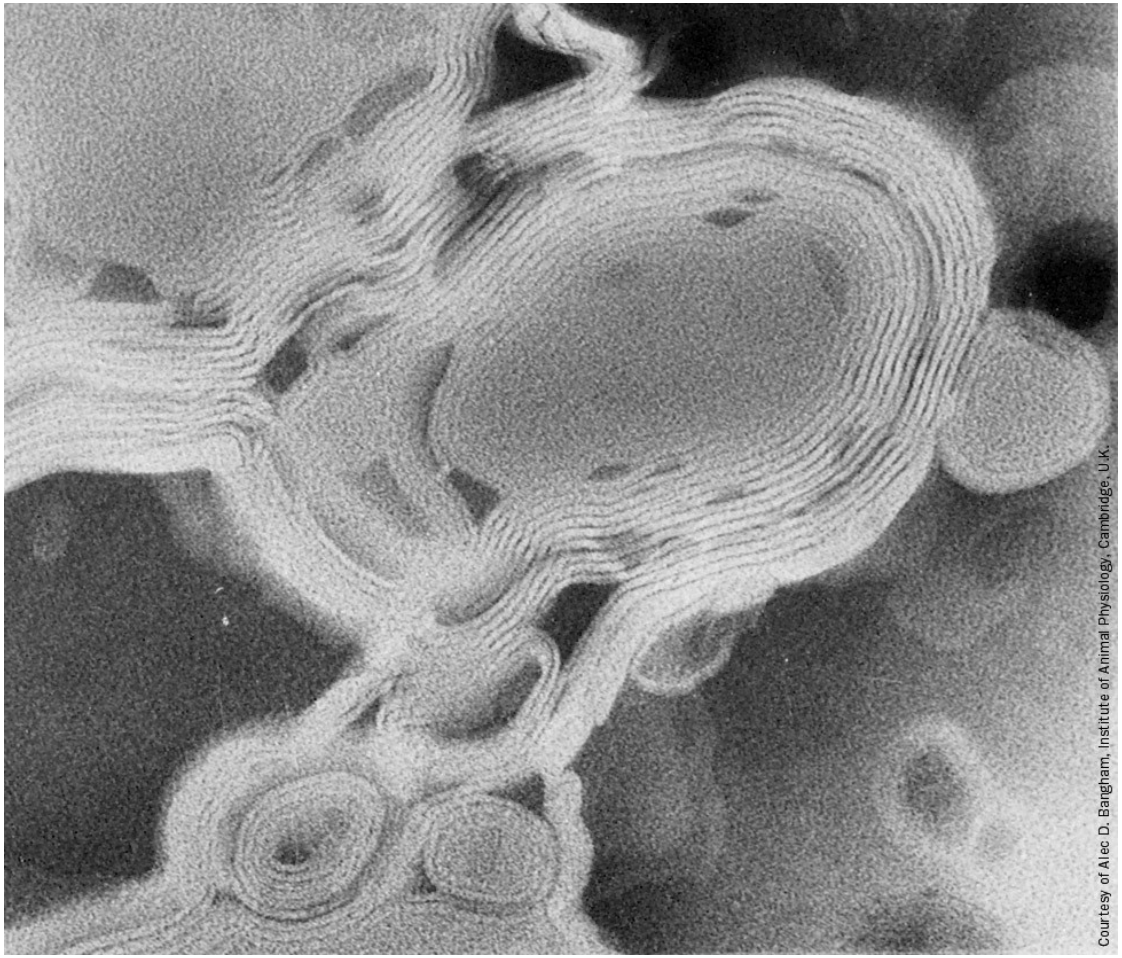


Liposomy



Courtesy of Walter Stoeckenius, University of California at San Francisco

Liposomy


Courtesy of Alec D. Bangham, Institute of Animal Physiology, Cambridge, U.K.

Transport

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

Transport látek membránami :

- Nespecifická permeace **Bez přenašeče**
- Specifický přenášečový systém - pasivní transport - usnadněná

  S přenašečem - bílkovina

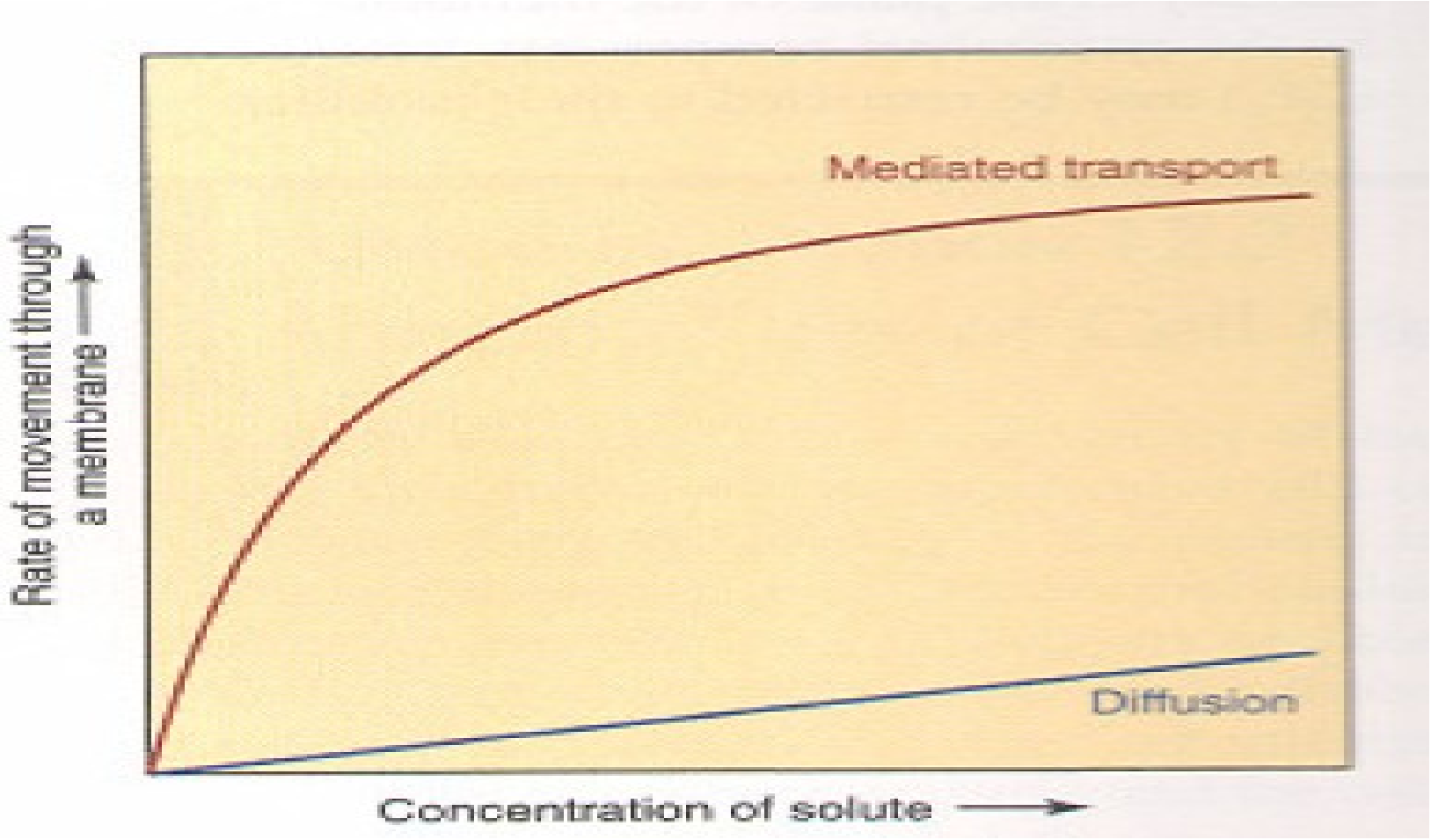
  a výměnná

  difuze

  - aktivní transport
- Pinocytóza - **Endocytóza**

  - **Exocytóza**

Difuze prostá versus usnadněná



Prostá difuze

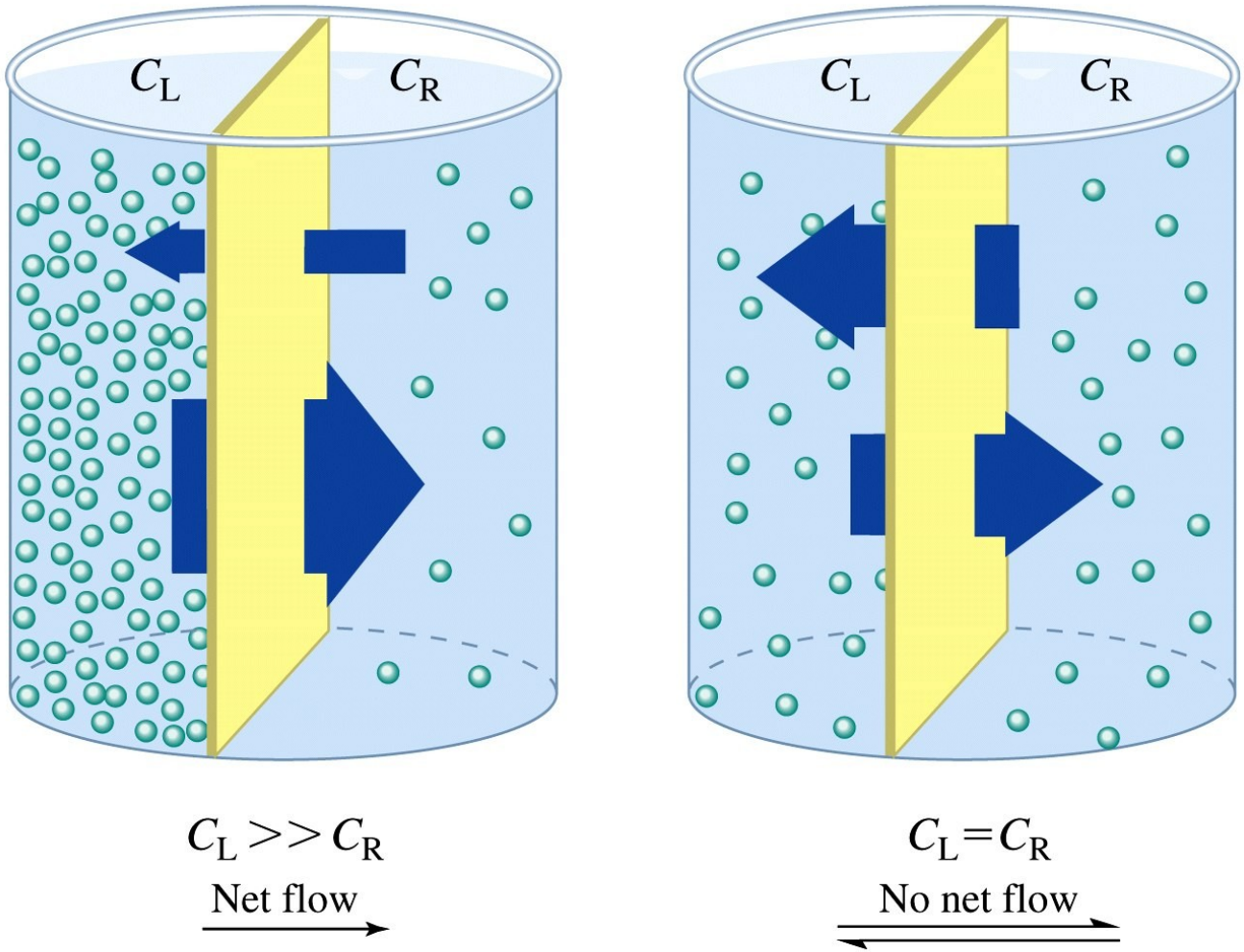
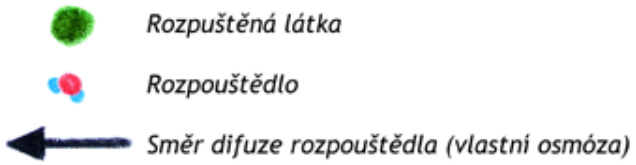
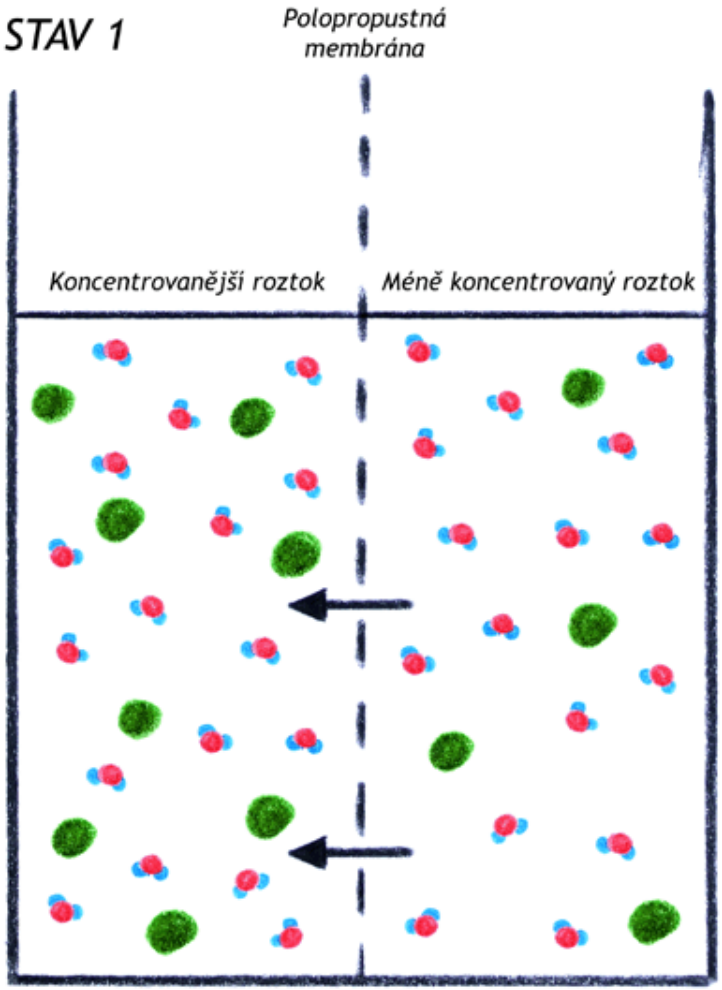
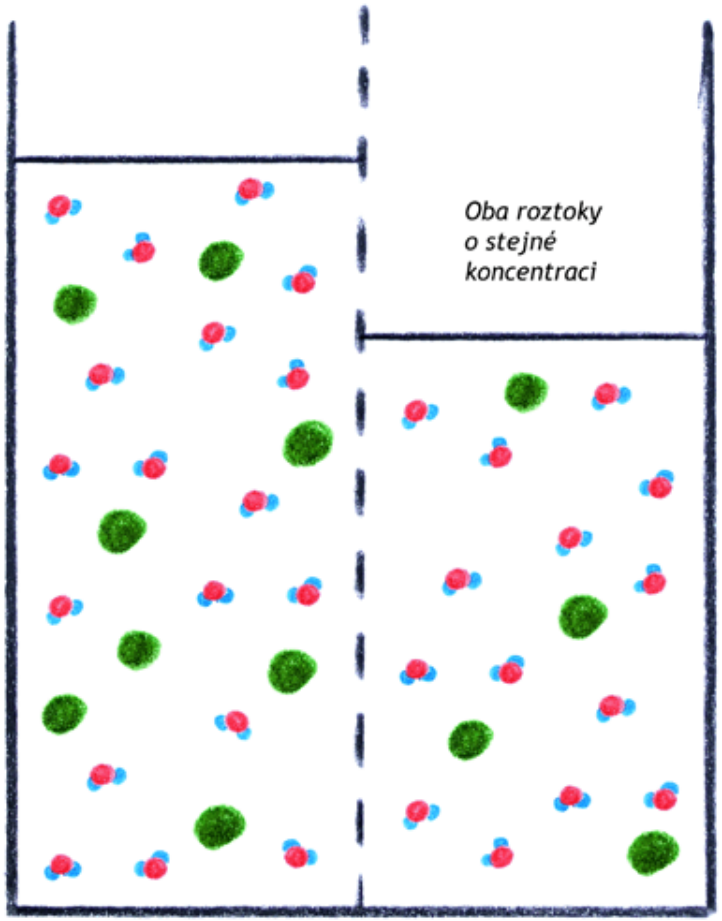


Figure 9-7 Concepts in Biochemistry, 3/e

Osmóza

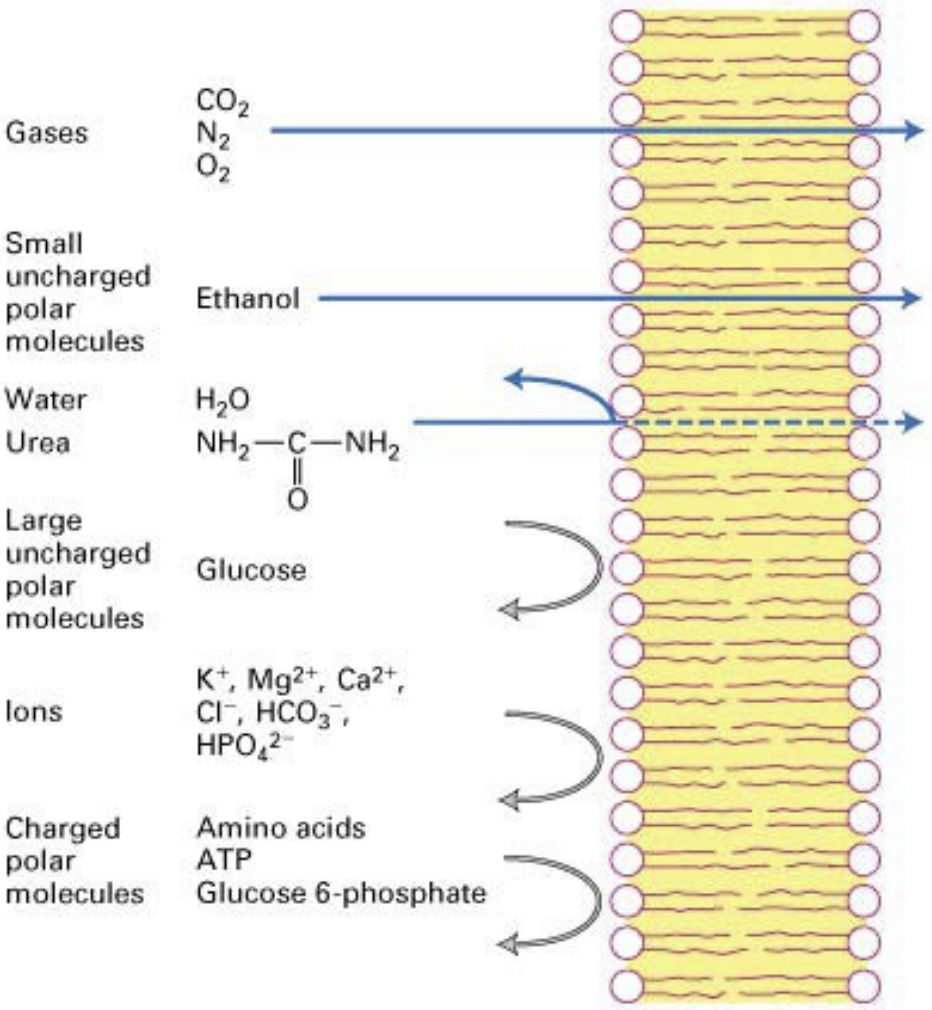

Rozpuštěná látka
Rozpouštědlo
Směr difuze rozpouštědla (vlastní osmóza)


STAV 1
Polopropustná membrána
Koncentrovanější roztok
Méně koncentrovaný roztok

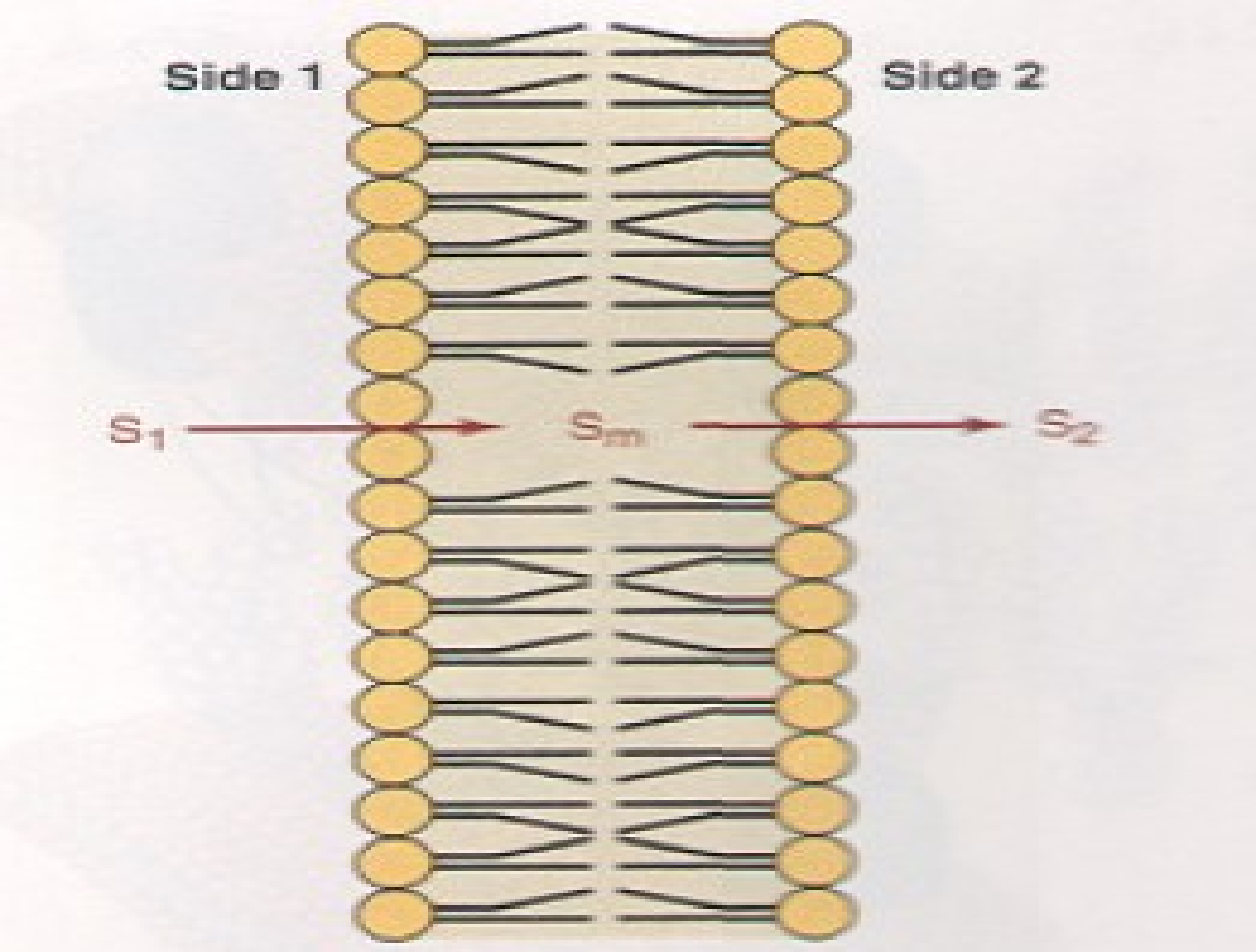

STAV 2
Oba roztoky o stejné koncentraci

Nespecifický transport

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

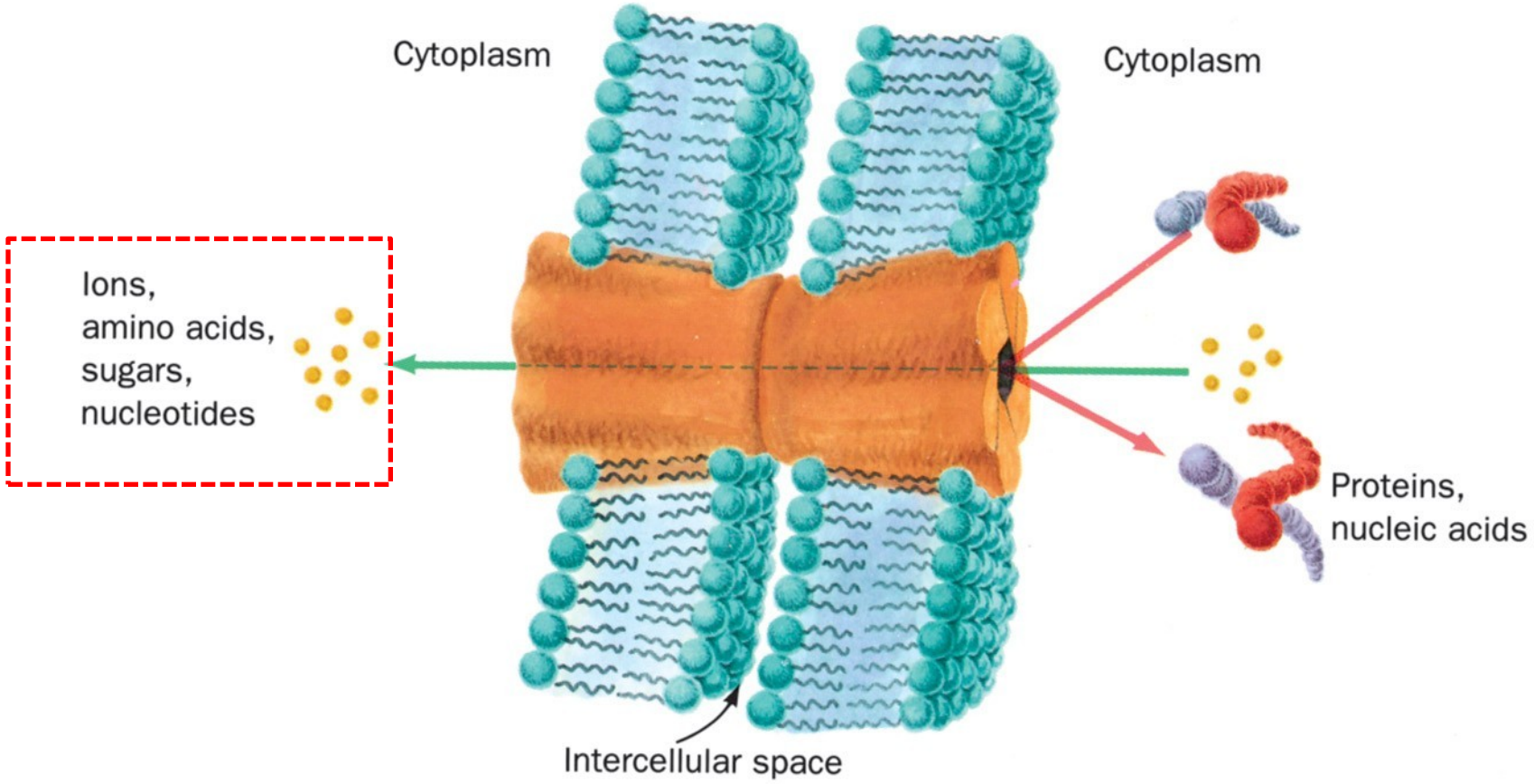

Gases
CO_2
N_2
O_2
Small uncharged polar molecules
Ethanol
Water
H_2O
Urea
$NH_2—C(=O)—NH_2$
Large uncharged polar molecules
Glucose
Ions
K^+, Mg^{2+}, Ca^{2+}, Cl^-, HCO_3^-, HPO_4^{2-}
Charged polar molecules
Amino acids
ATP
Glucose 6-phosphate

Prostá difuze - pory



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

Mezerový spoj - konexin



Typy transportu usnadněná difuse

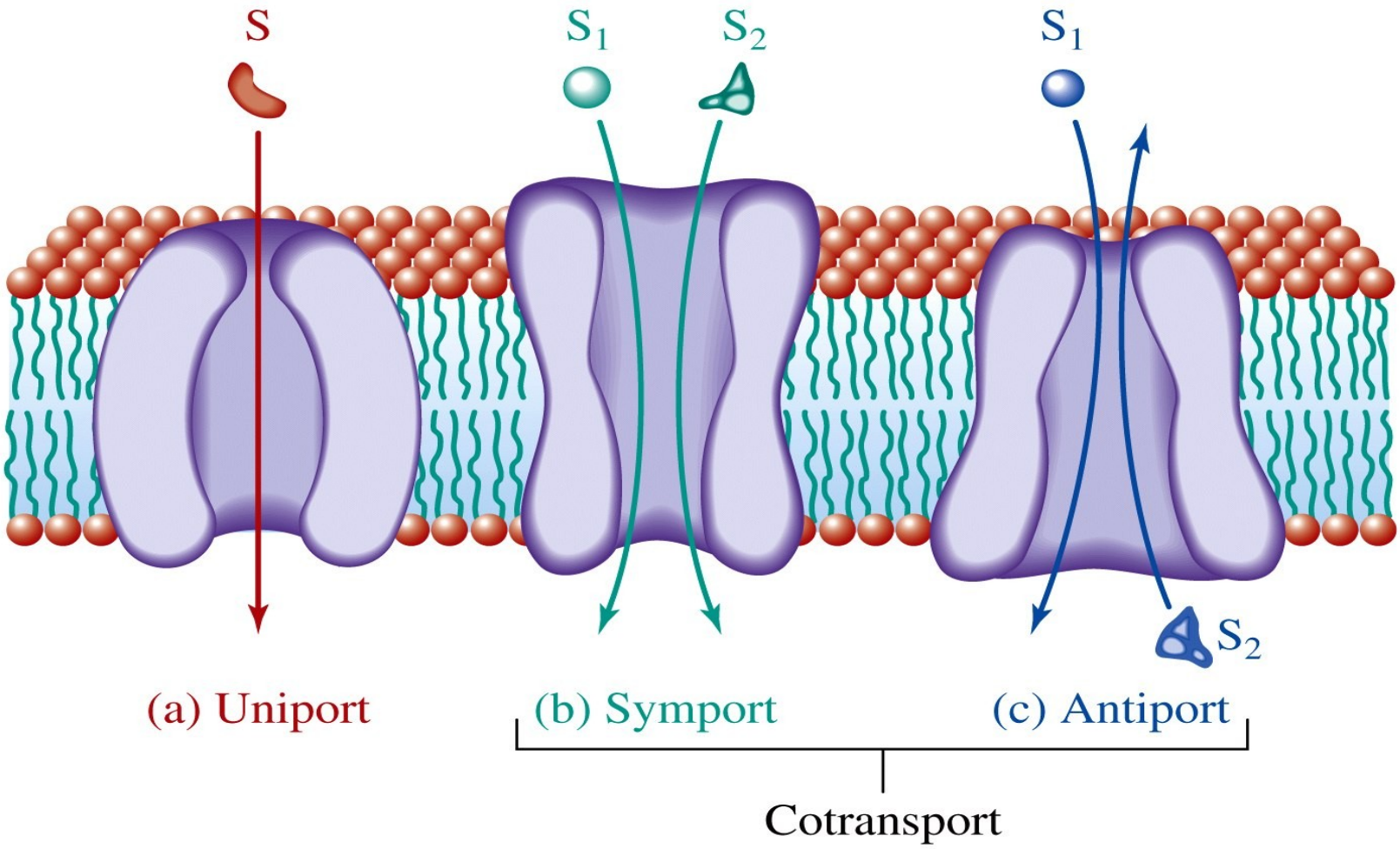
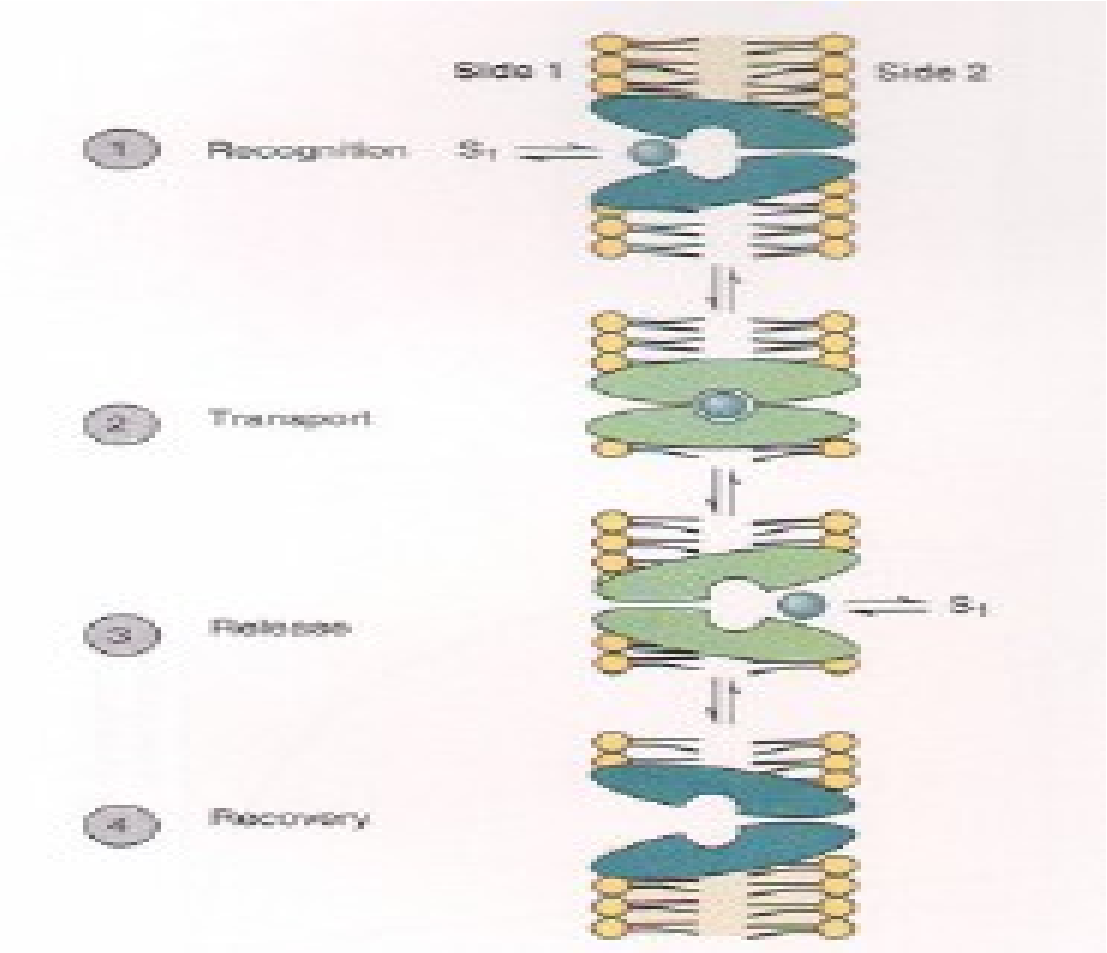


Figure 9-8 Concepts in Biochemistry, 3/e

Pasivní transport – usnadněná difuze



Usnadněná difuze

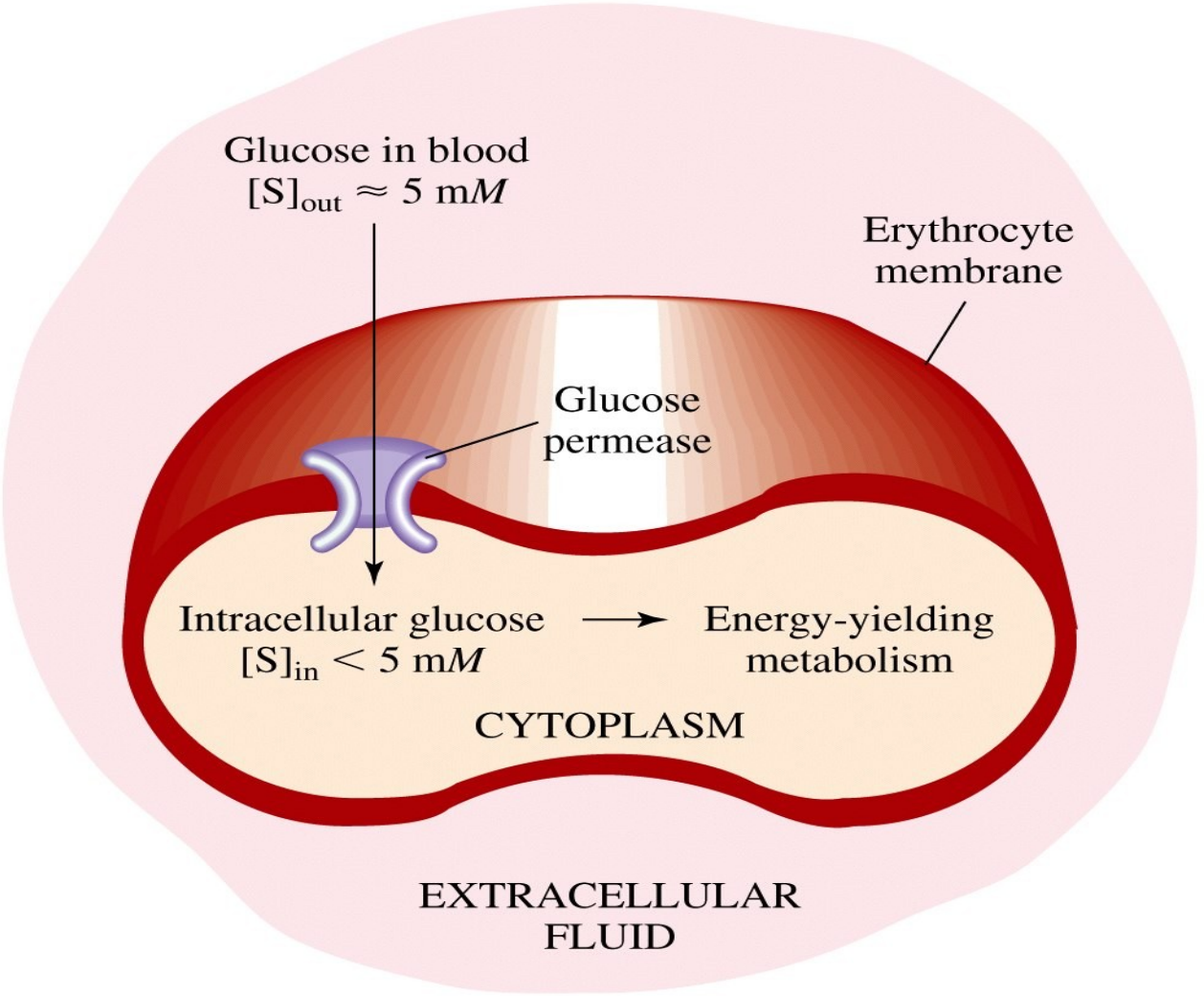


Figure 9-13 Concepts in Biochemistry, 3/e

Aktivní transport

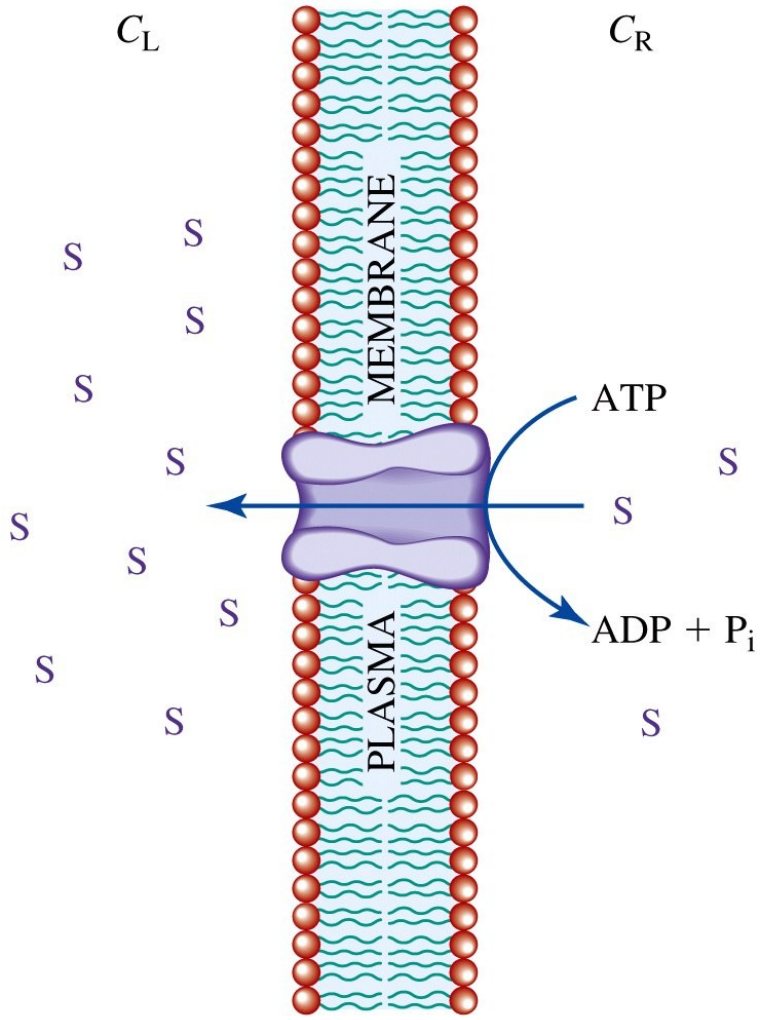
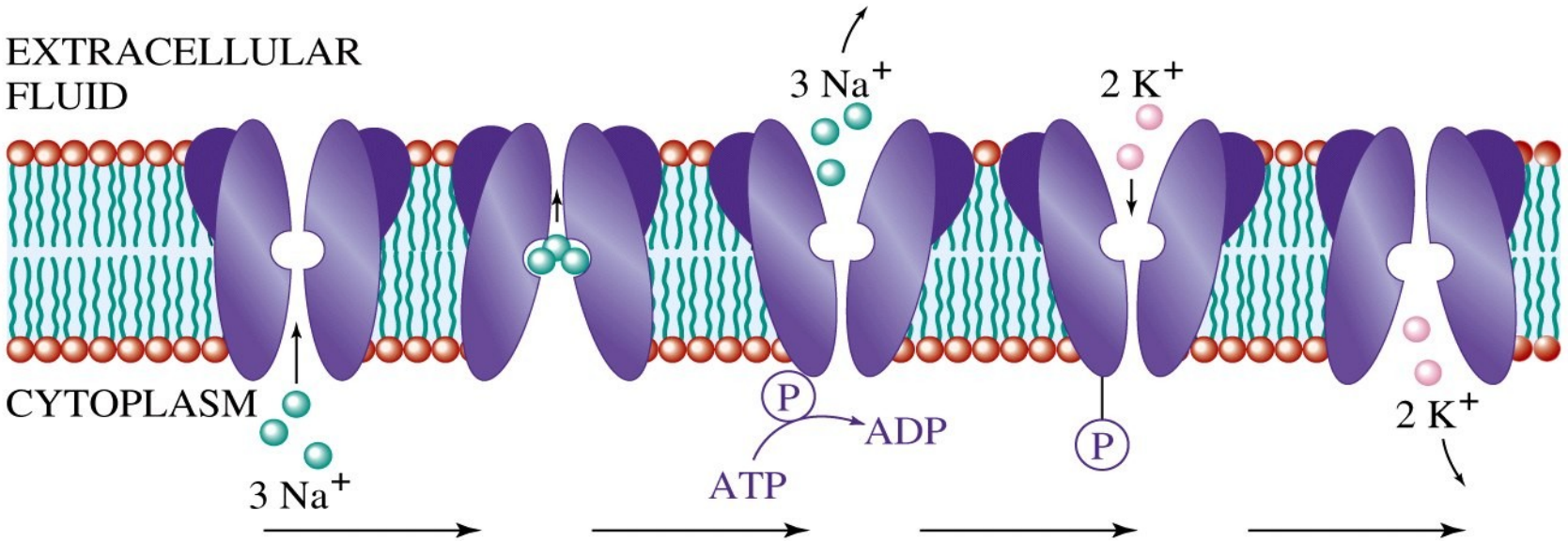


Figure 9-9 Concepts in Biochemistry, 3/e

Na^+ ATPasa



Step 1 Three Na^+ bind to the cytoplasmic side of the transporter.

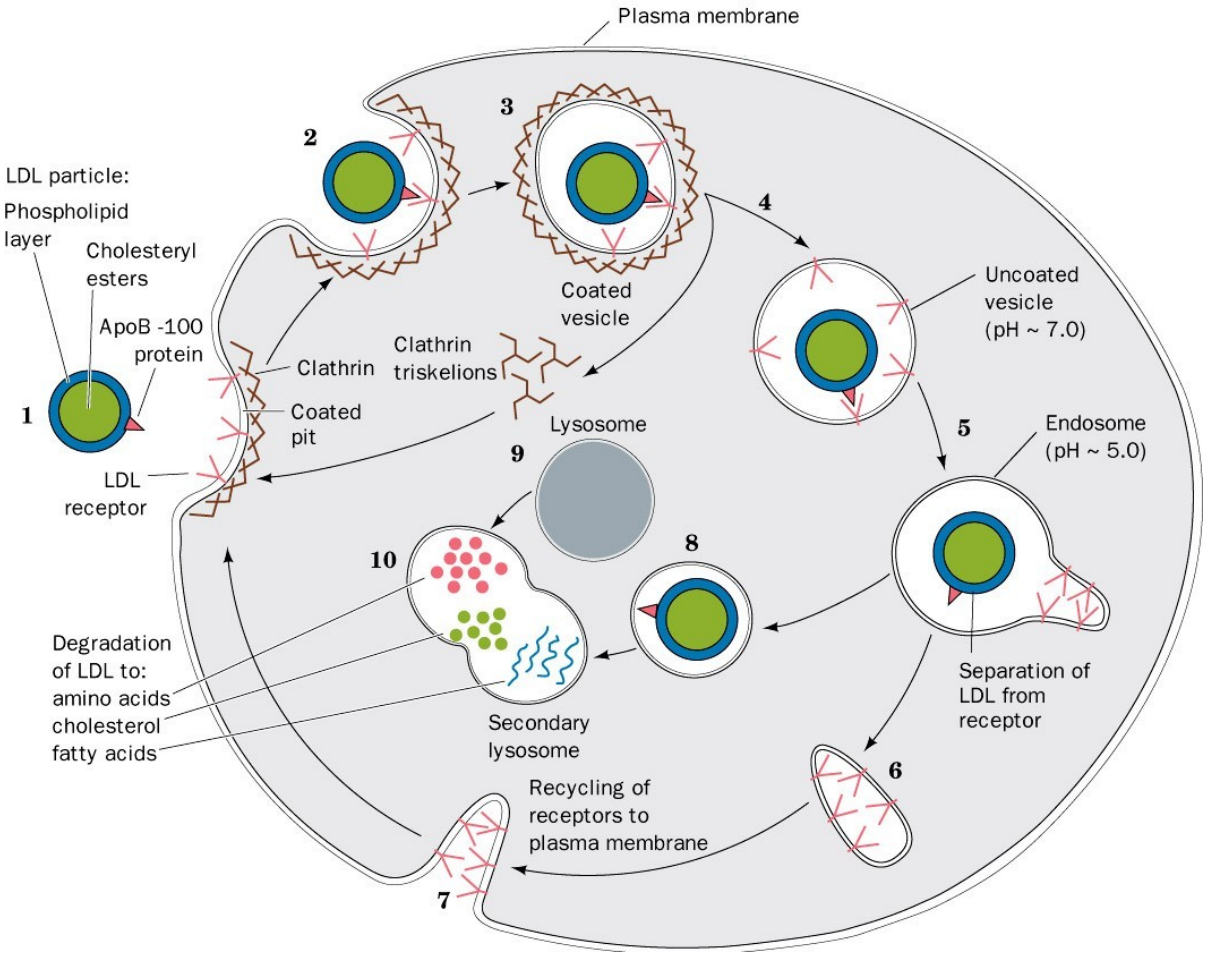
Step 2 Enzyme-catalyzed phosphorylation by ATP triggers a conformational change that shifts three Na^+ outside the cell.

Step 3 Two K^+ bind to the extracellular side of the transporter.

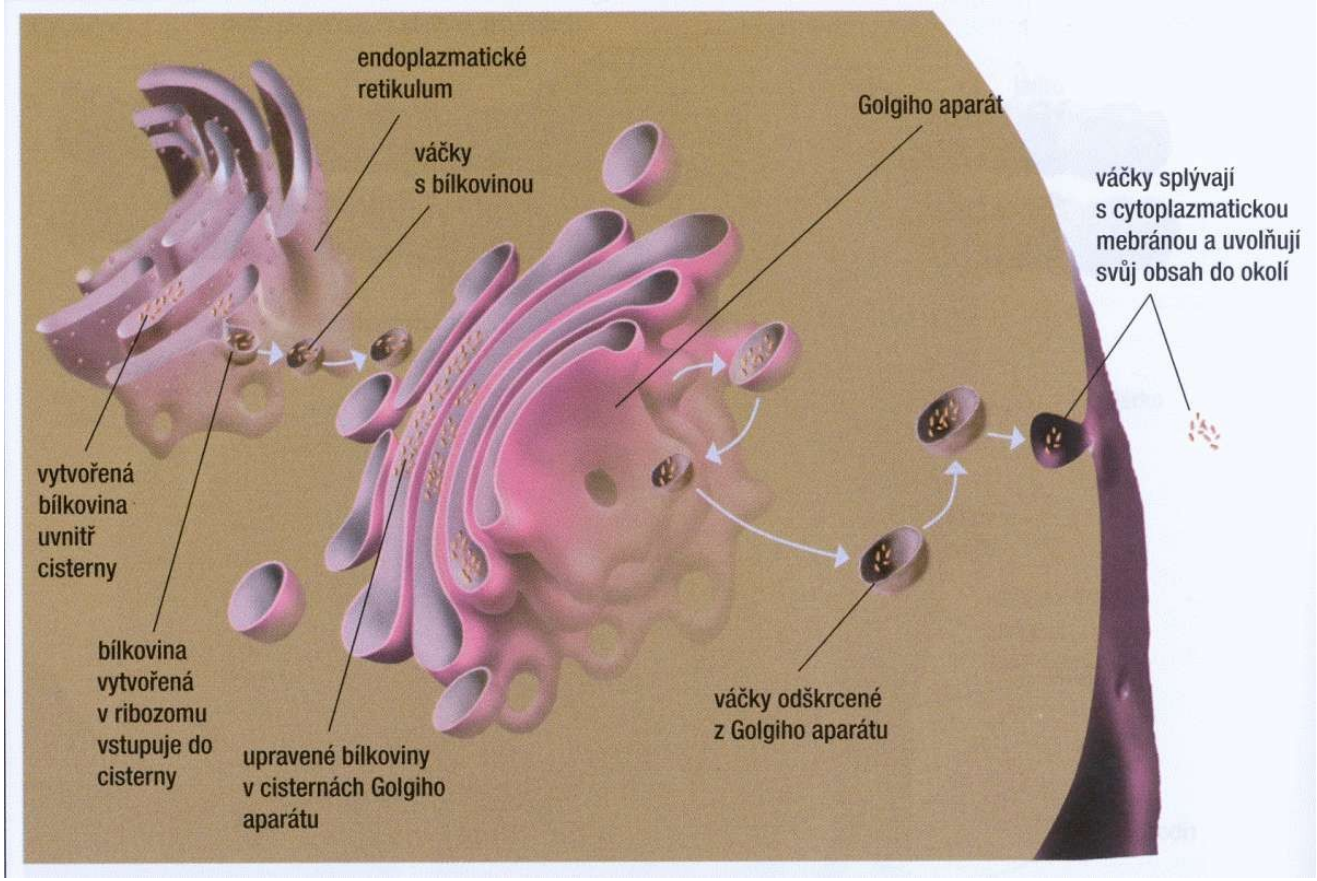
Step 4 Enzyme-catalyzed hydrolytic elimination of the phosphoryl group returns the transporter to its original conformation and moves two K^+ into the cell.

Figure 9-16 Concepts in Biochemistry, 3/e

Pinocytoza - endocytoza



Pinocytoza - exocytoza



Plazmatické lipoproteiny

Charakteristiky hlavních tříd lipoproteinů v lidské plasmě

Třída lipoproteinů	Hlavní lipidy [a]	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

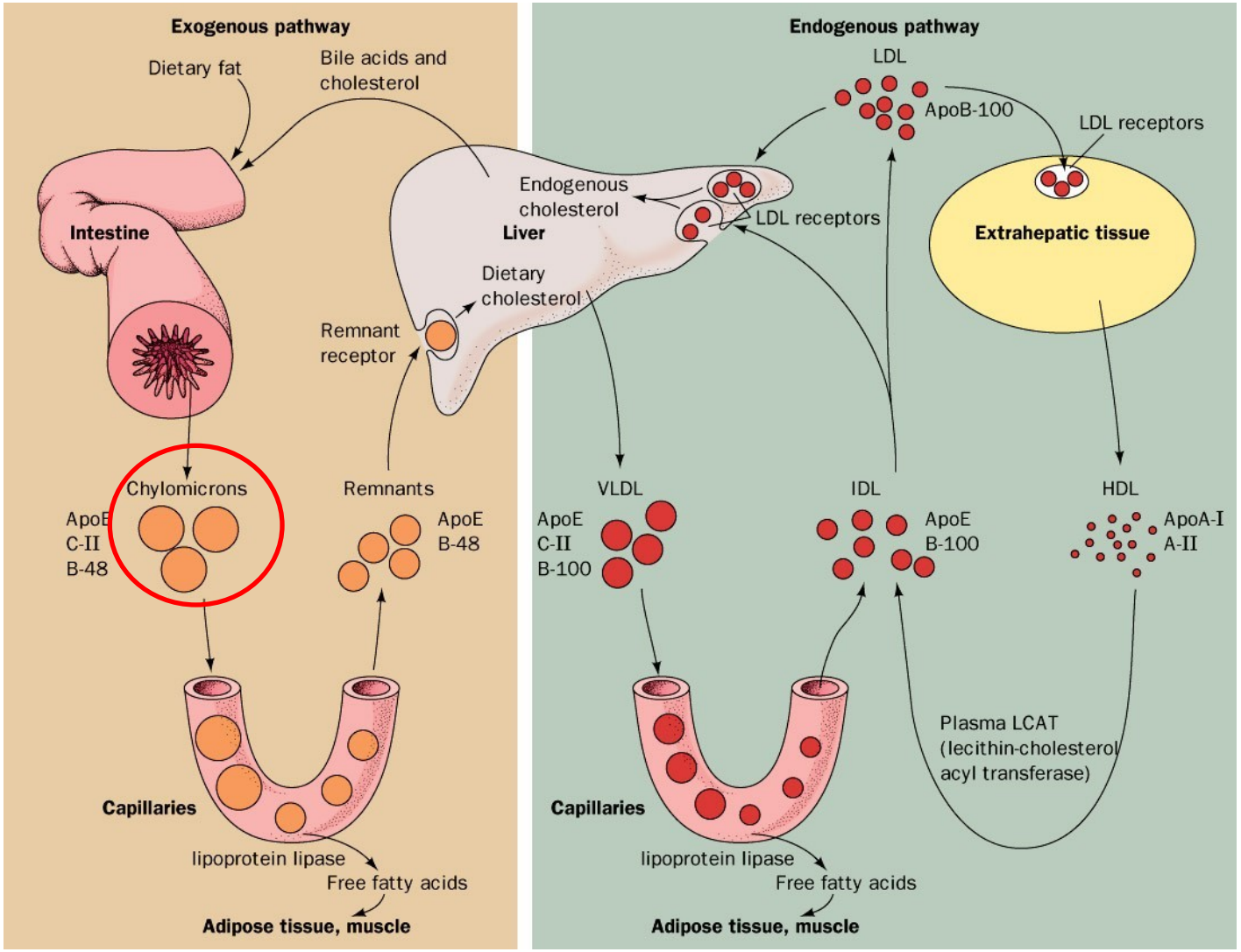
Transport triacylglycerolů do jater

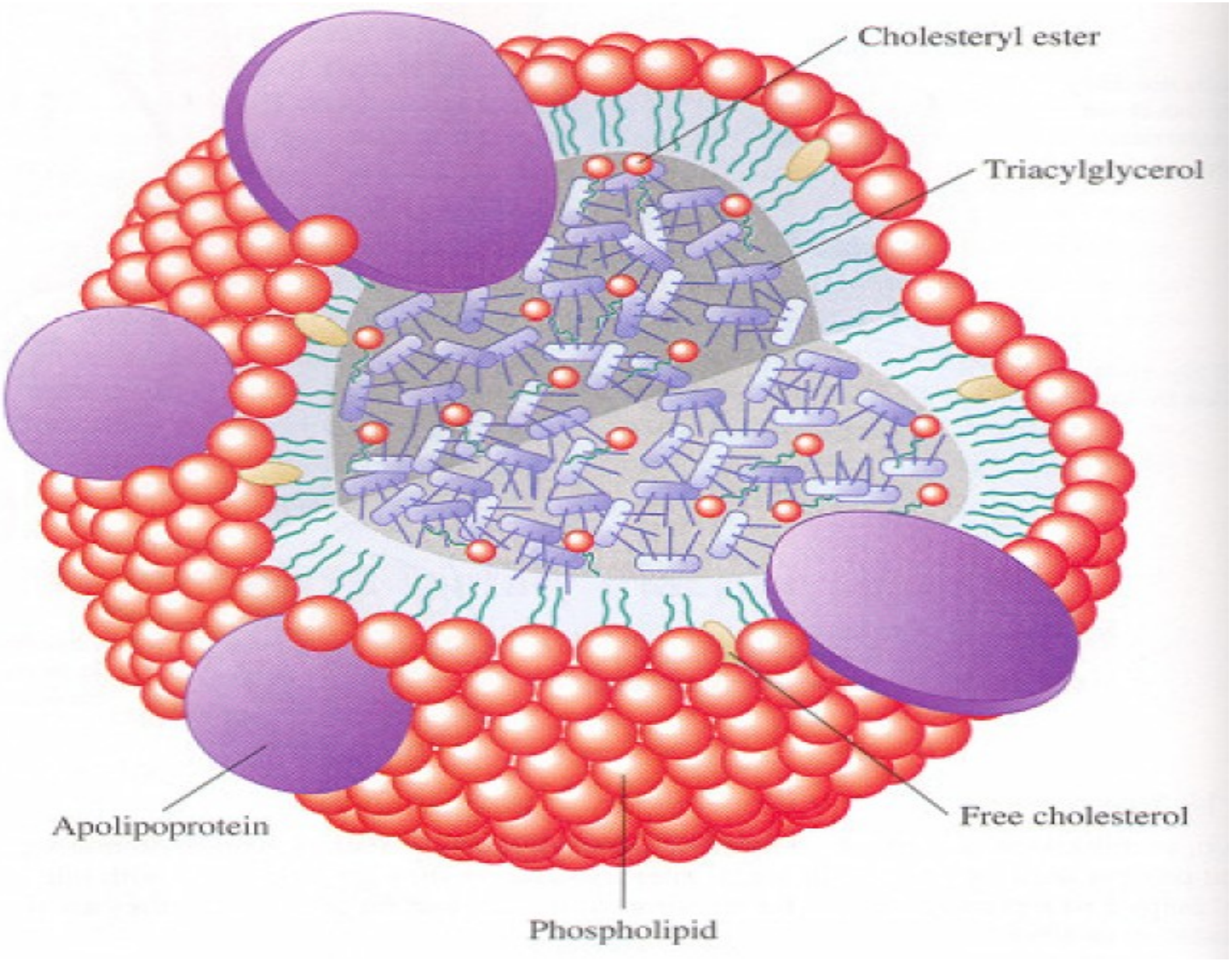
Transport triacylglycerolů do tkání

Transport cholesterolu do tkání - špatný

Transport cholesterolu do jater - dobrý

Plazmatické lipoproteiny




Cholesteryl ester
Triacylglycerol
Apolipoprotein
Free cholesterol
Phospholipid

Plazmatické lipoproteiny