CARBOIDRATI

sotto forma di zucchero e amido rappresentano una tra le principali fonti di calorie per l'uomo e la maggior parte degli animali e anche per molti microorganismi.
Sono al centro del metabolismo delle piante verdi.

fotosintesi

⇓

carboidrati

⇓

fonte di energia
per cellule non fotosintetiche

FUNZIONI

1) fonte di energia
2) riserva di glucosio (amido e glicogeno)
3) struttura e supporto (pareti cellulari batteri e piante, tessuti connettivi animali)
4) lubrificazione articolazioni (acido ialuronico)
5) informazione: tra cellule ed ambiente circostante
    -marcano proteine (per trasporto o catabolismo)
    -siti di riconoscimento

CLASSIFICAZIONE

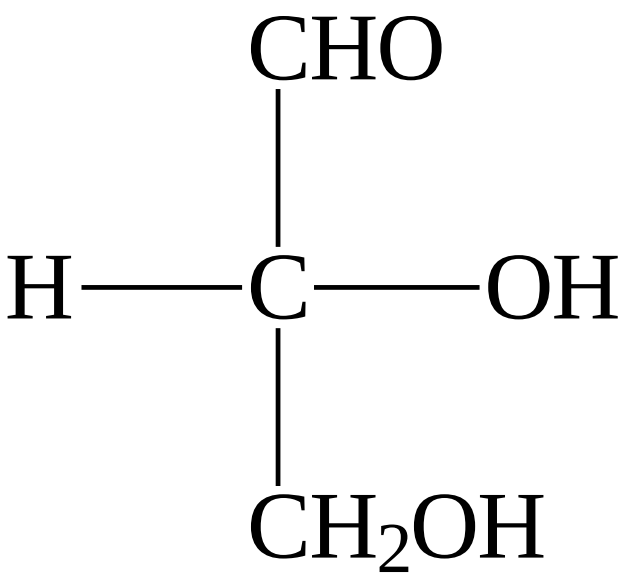
poliidrossi-aldeidi **ALDOSI**
poliidrossi-chetoni **CHETOSI**

monosaccaridi: zuccheri semplici, consistono di una singola unità di poliidrossi aldeide o chetone
es: glucosio, mannosio, galattosio, fruttosio

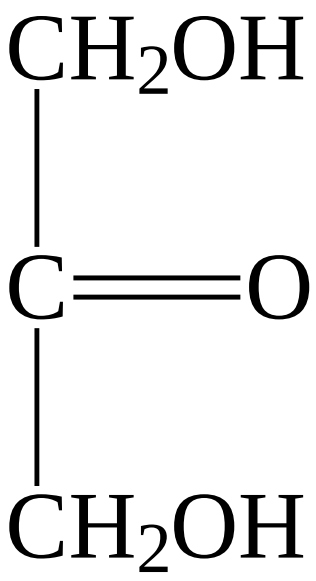
oligosaccaridi: corte catene di monosaccaridi legati da legami covalenti (2-10)
es: saccarosio, maltosio, lattosio

polisaccaridi: lunghe catene di unità monosaccaridiche (>10)
es: cellulosa, glicogeno, amido

TRIOSI

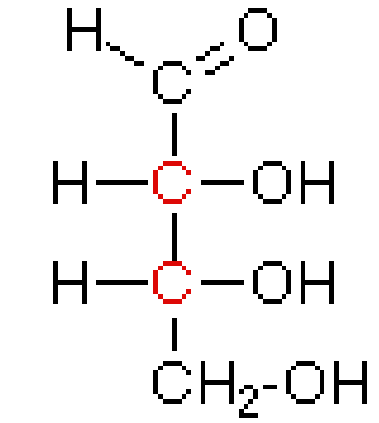


D-gliceraldeide

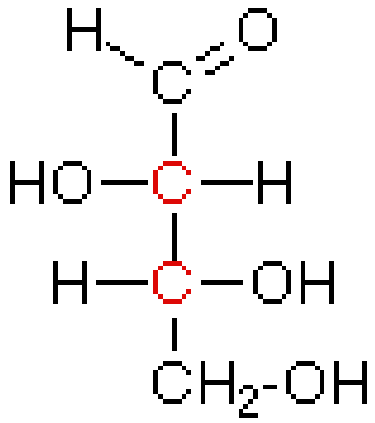


Di-idrossi acetone

TETROSI

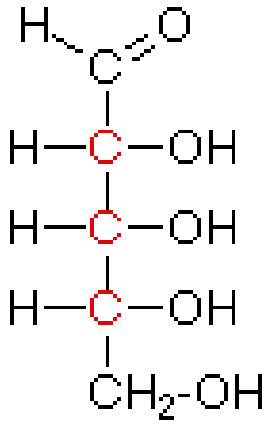


D-(-)-erythrose

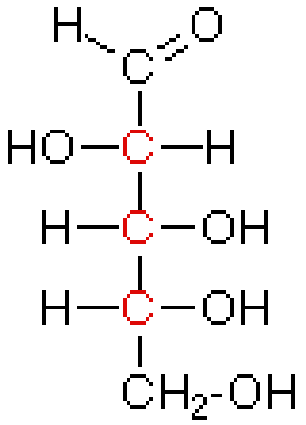


D-(-)-threose

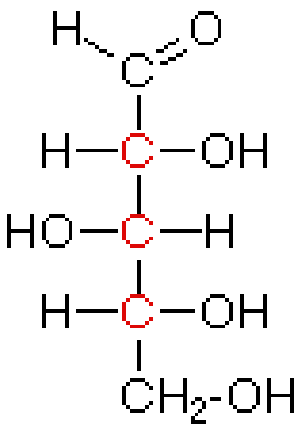
PENTOSI



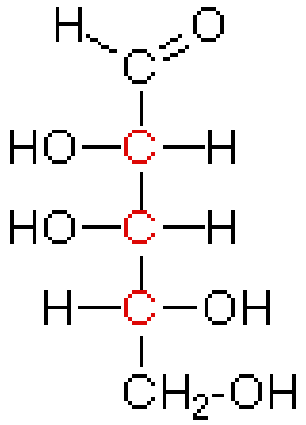
D-(-)-ribose



D-(-)-arabinose

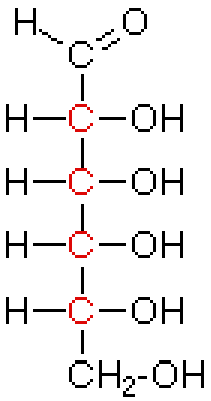


D-(+)-xylose

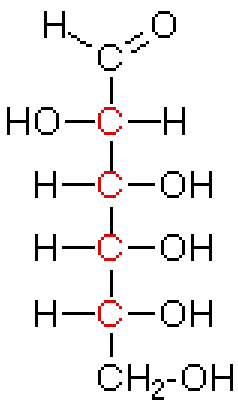


D-(-)-lyxose

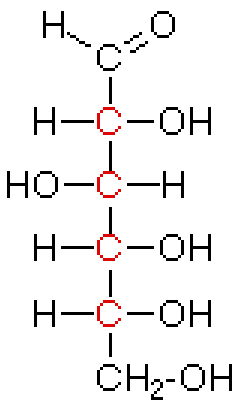
ESOSI



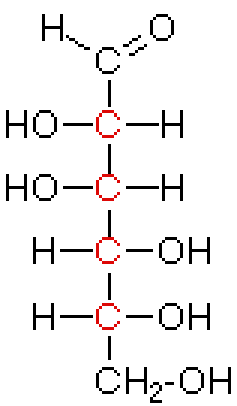
D-(+)-allose



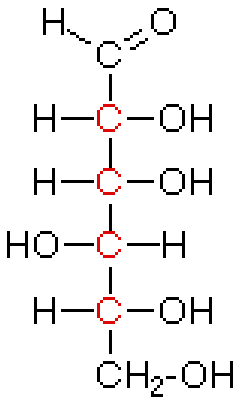
D-(+)-altrose



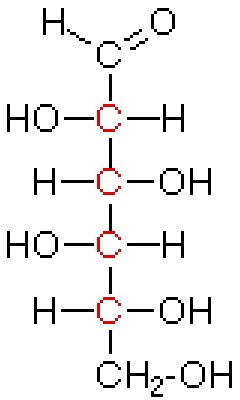
D-(+)-glucose



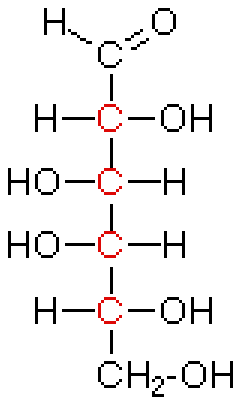
D-(+)-mannose



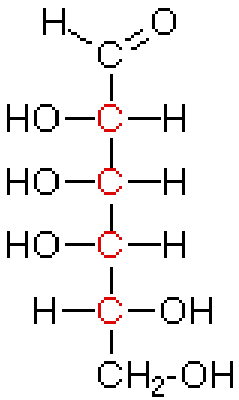
D-(-)-gulose



D-(-)-idose

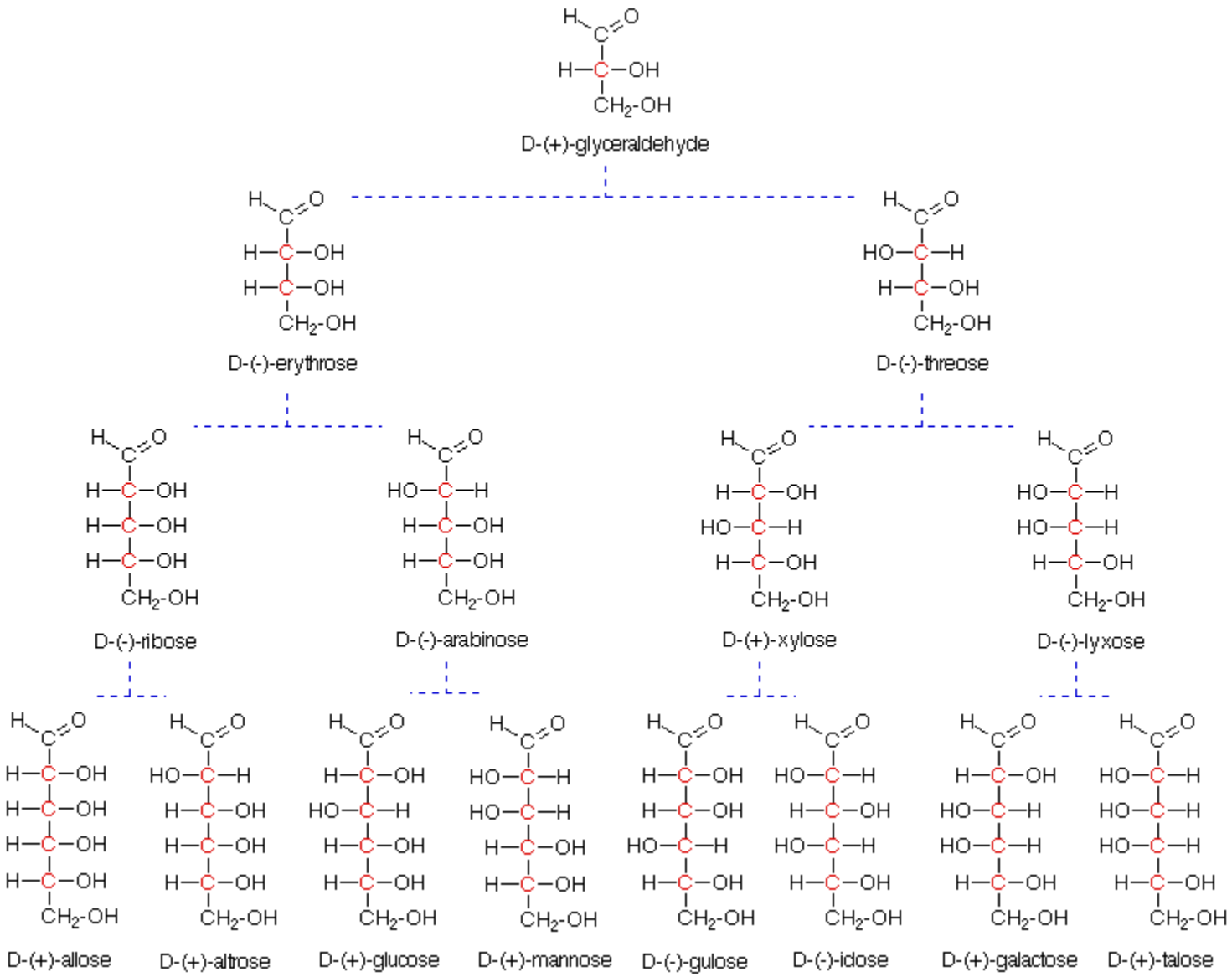


D-(+)-galactose

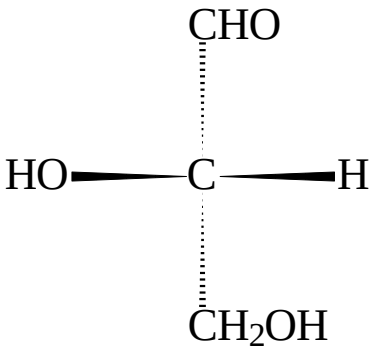


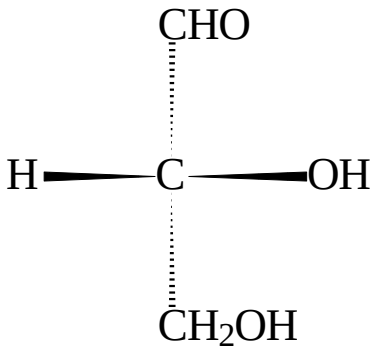
D-(+)-talose

SERIE DEI D ALDOSI

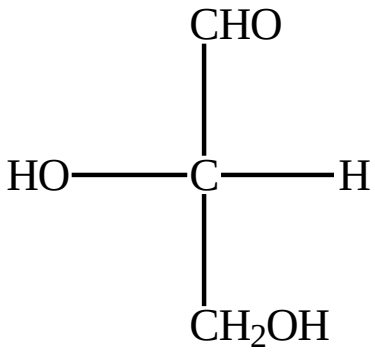


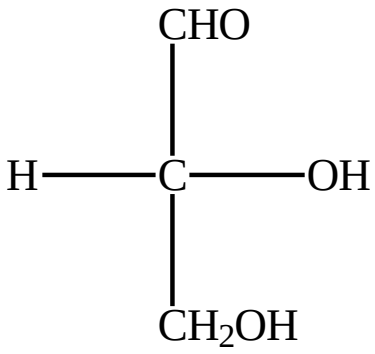
I monosaccaridi hanno centri asimmetrici.





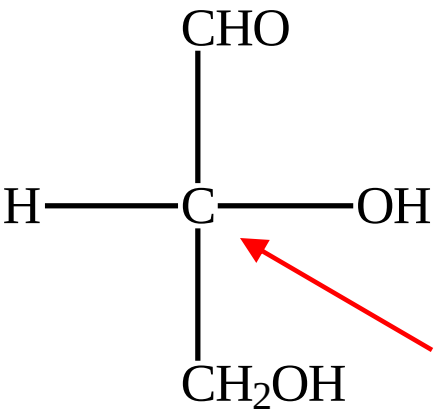
FISCHER



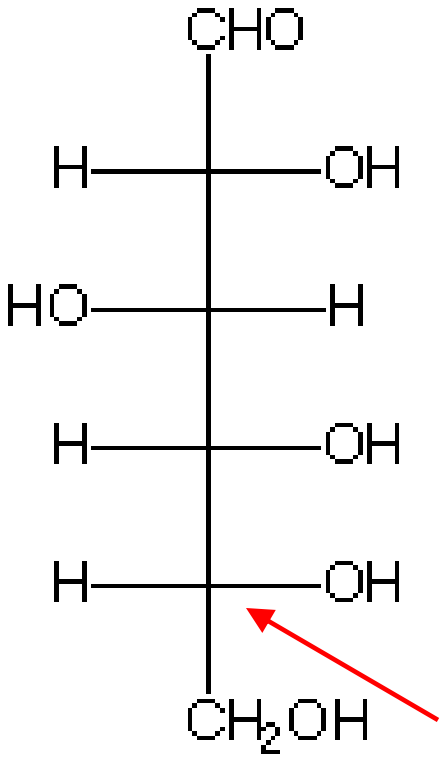


L-gliceraldeide **D-gliceraldeide**

CENTRI CHIRALI

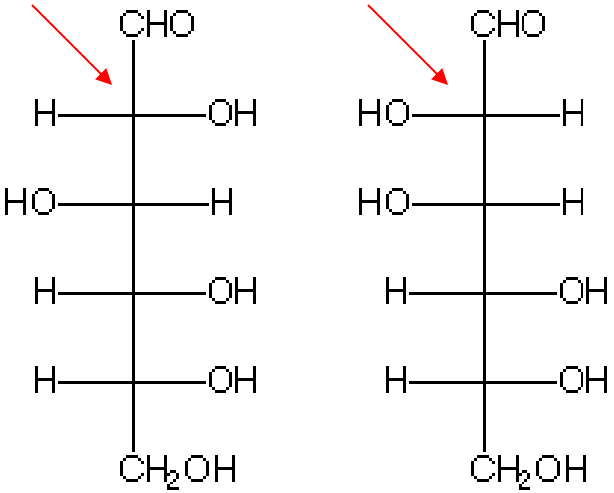


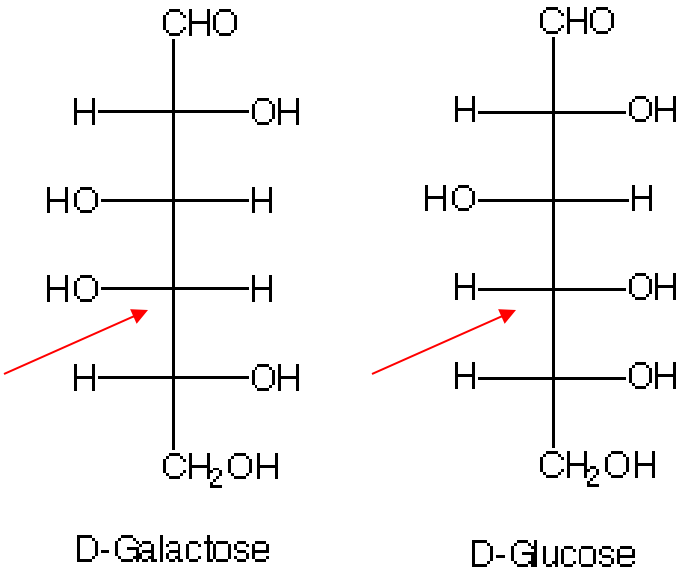
D-gliceraldeide



D-Glucosio

EPIMERI

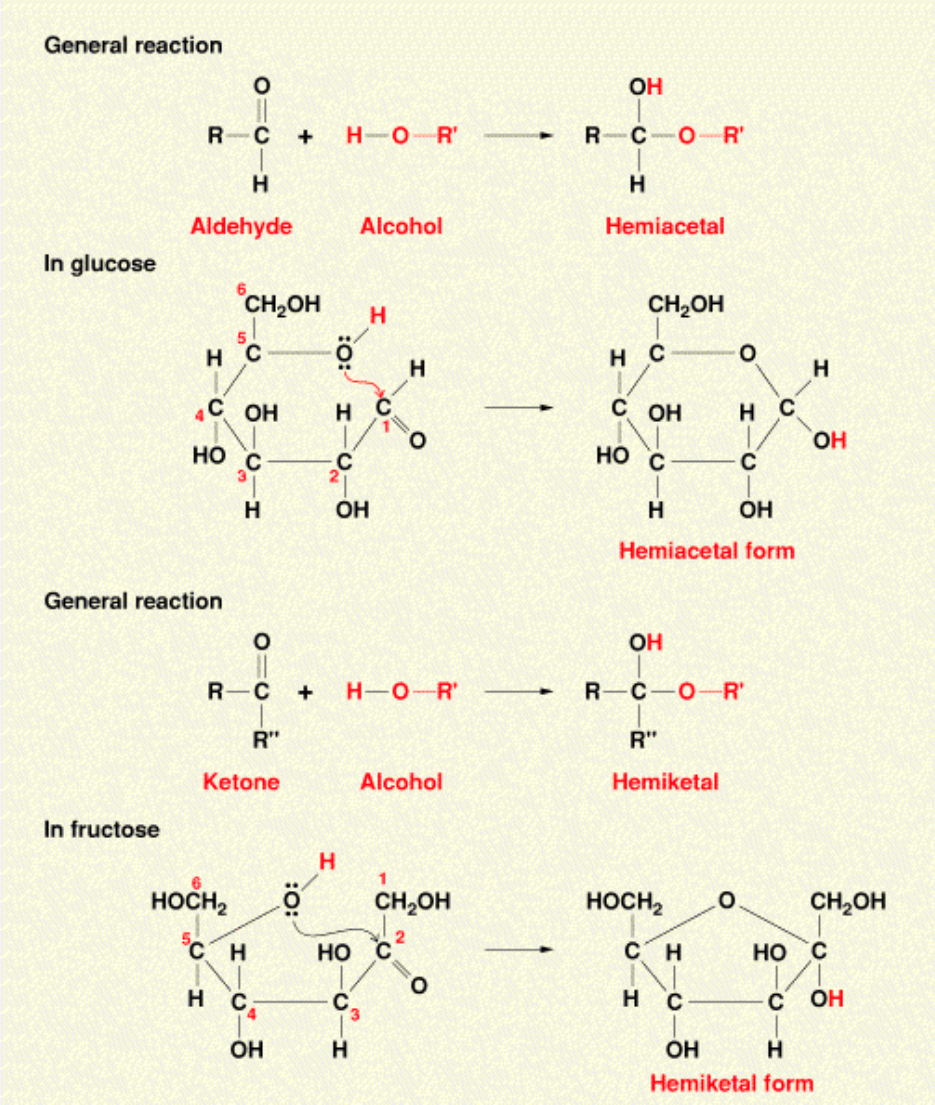




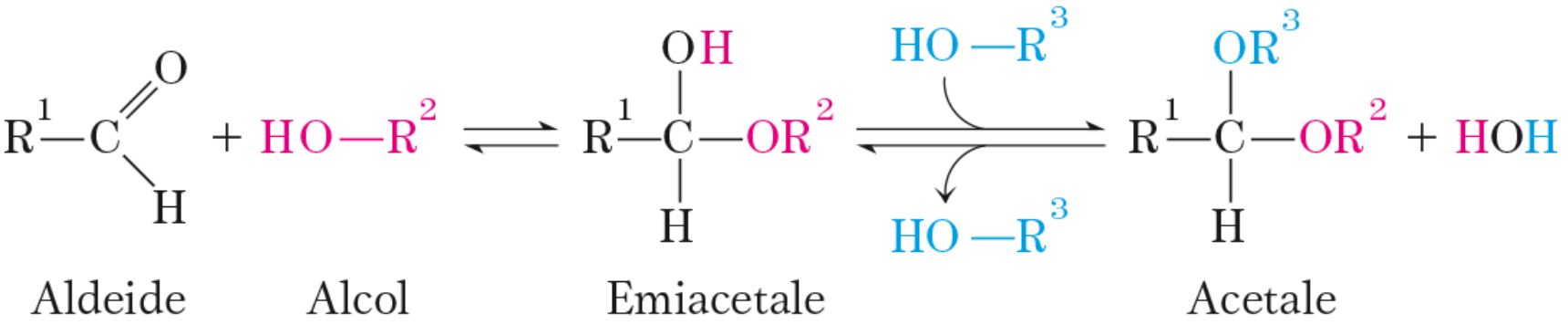
Epimeri in C-2

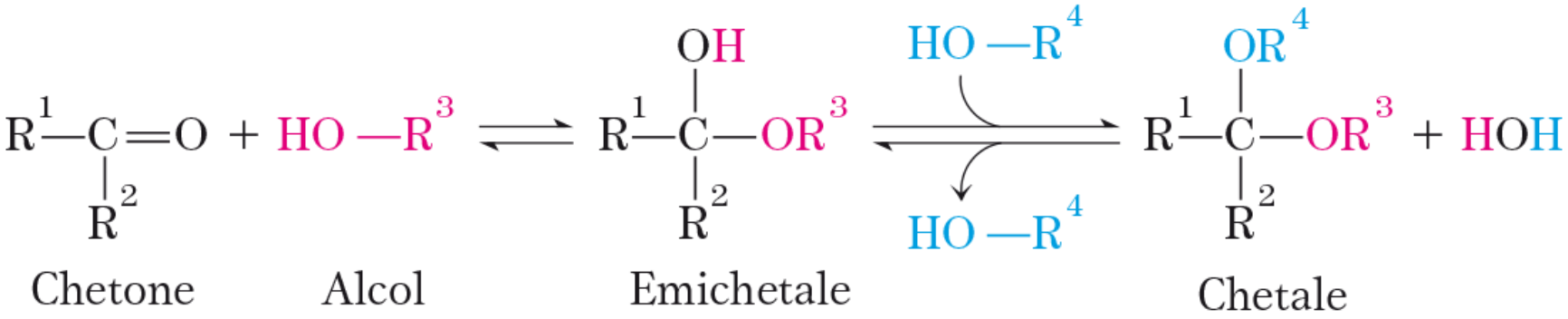
Epimeri in C-4

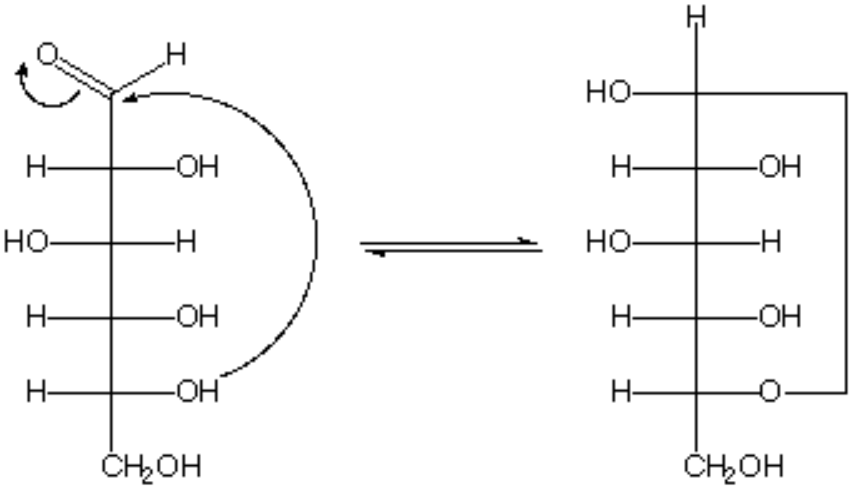
I monosaccaridi assumono forme cicliche



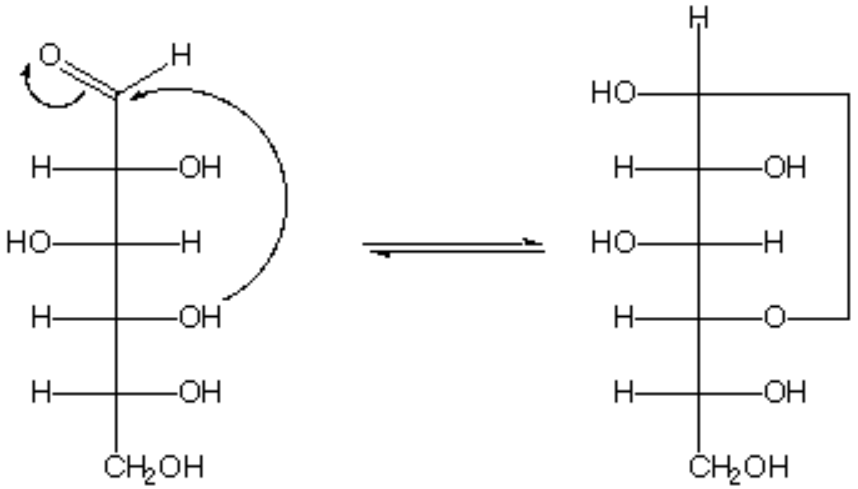
FORMAZIONE DI UN ACETALE E DI UN CHETALE





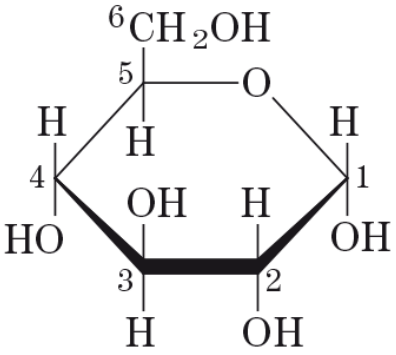


Ciclo a 6 termini

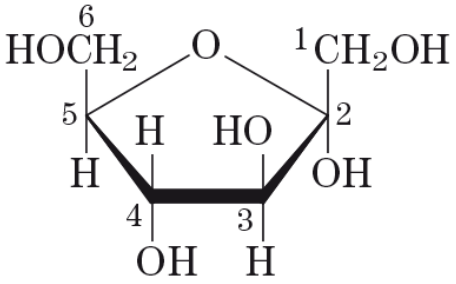


Ciclo a 5 termini

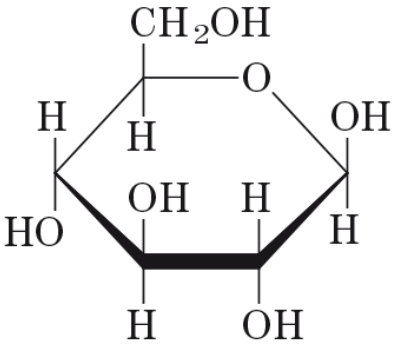
Proiezione di Haworth



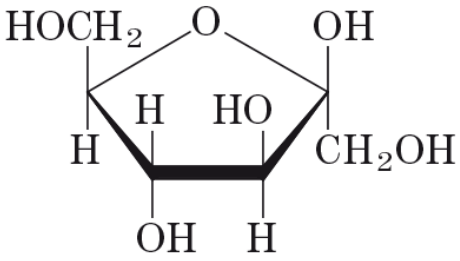
α-D-Glucopiranosio



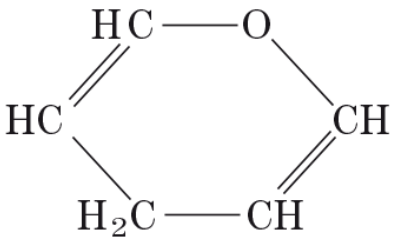
α-D-Fruttofuranosio



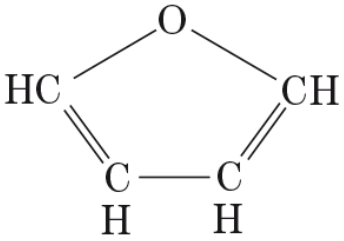
β-D-Glucopiranosio



β-D-Fruttofuranosio

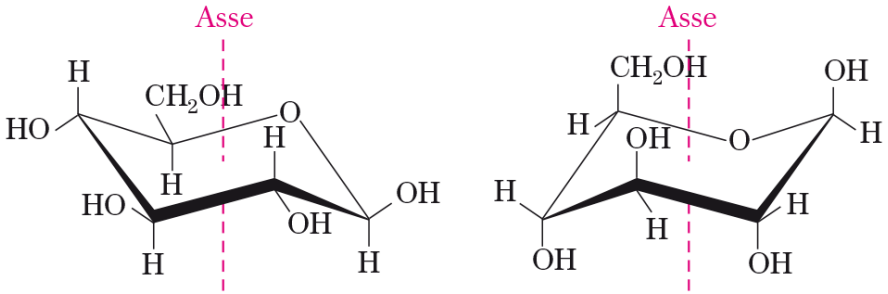


Pirano



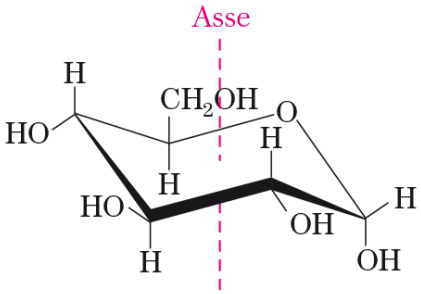
Furano

FORMULE CONFORMAZIONALI



Le due possibili forme a sedia del β-D-glucopiranosio

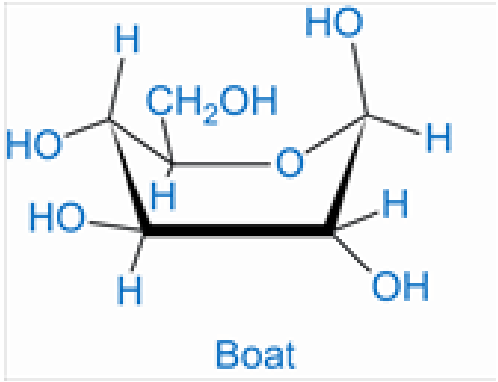
(a)



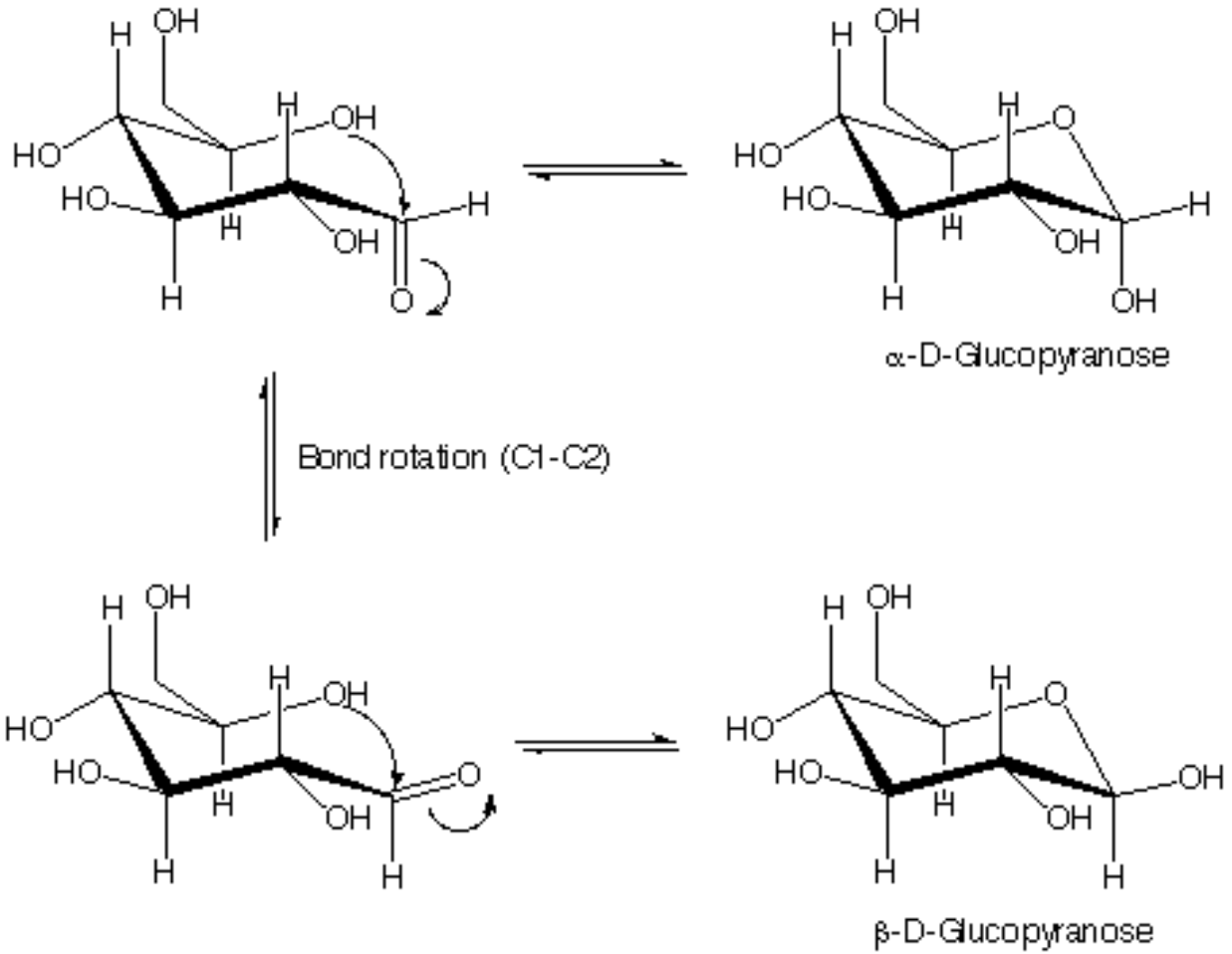
α-D-Glucopiranosio

(b)

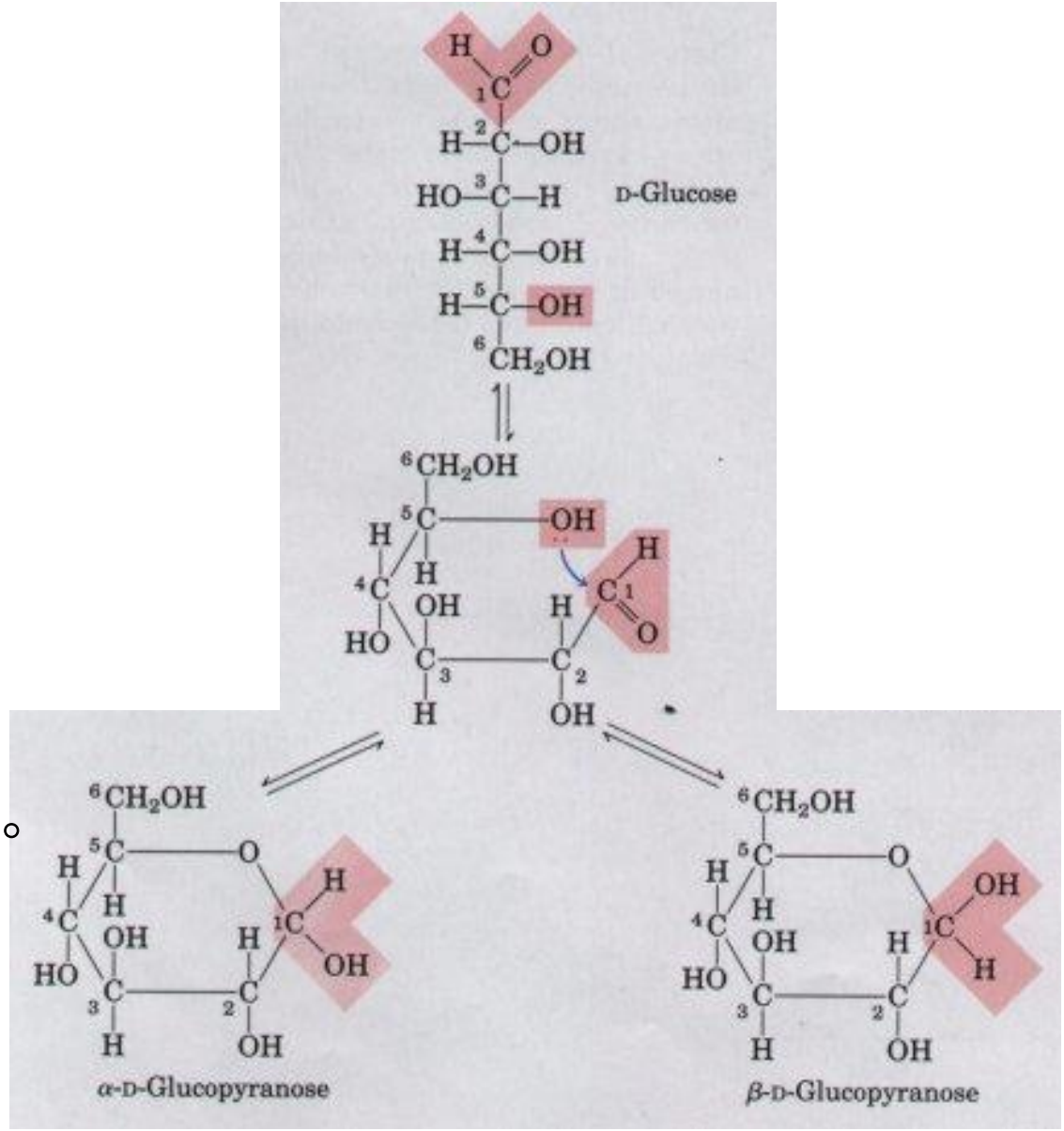
sedia



barca


α-D-Glucopyranose
Bond rotation (C1-C2)
β-D-Glucopyranose

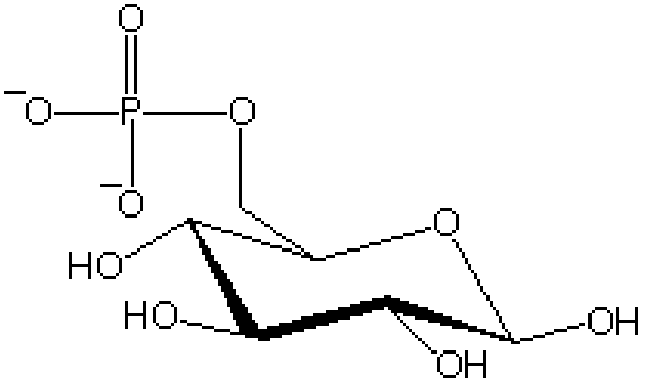
ANOMERI α e β e MUTAROTAZIONE



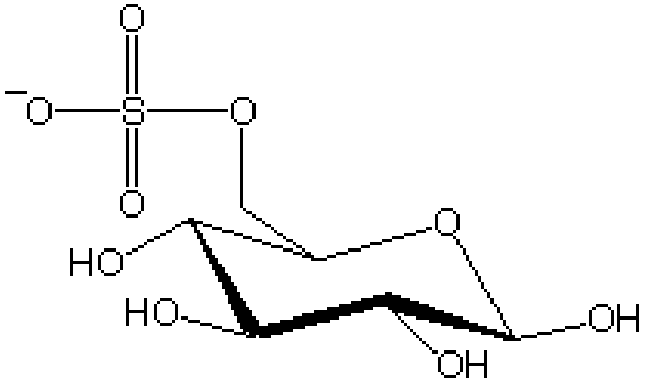
$[\alpha]_D^{20} = +112.2°$

$[\alpha]_D^{20} = +18.7°$

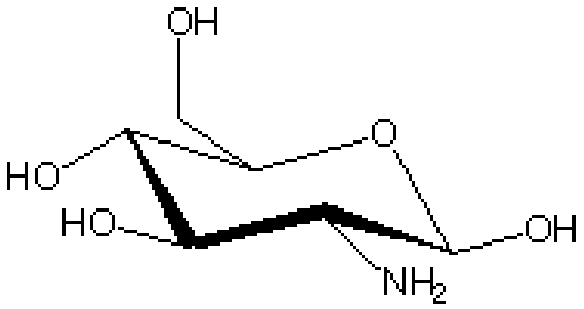
DERIVATI DEL GLUCOSIO



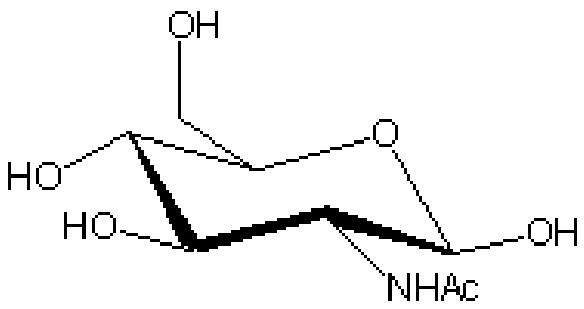
β-D-glucopyranose-6-phosphate



β-D-glucopyranose-6-sulfate



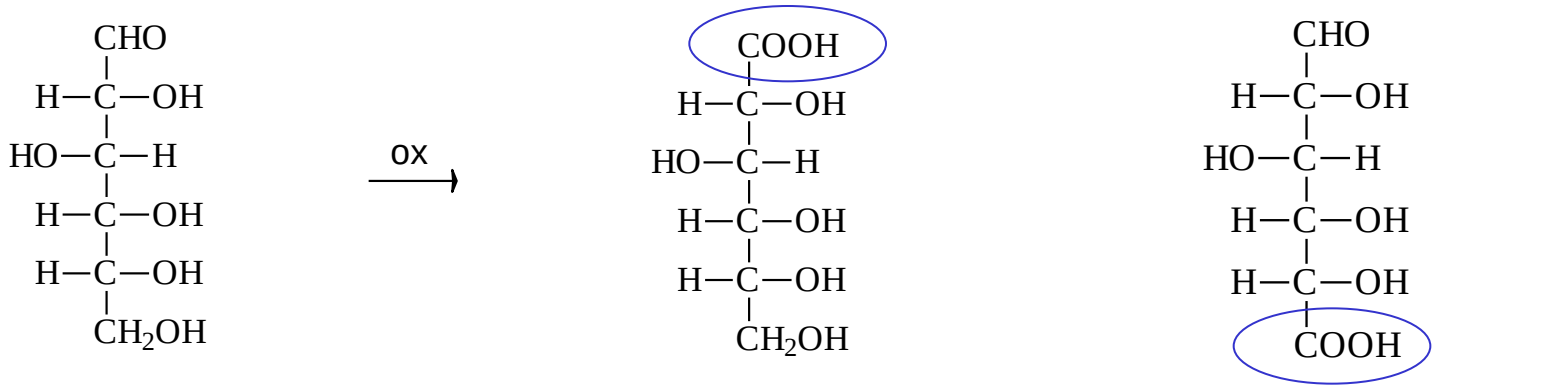
β-D-glucopyranose-2-amine
(glucosamine)



N-Acetyl-β-D-glucopyranose-2-amine
(N-acetylglucosamine)

OSSIDAZIONE DEL GLUCOSIO

I monosaccaridi riducono facilmente agenti ossidanti. Lo zucchero viene ossidato a livello del carbonile, mentre l'agente ossidante si riduce. Per questo vengono chiamati zuccheri riducenti. Questa proprietà è importante per l'analisi degli zuccheri. Misurando la quantità di agente ossidante che viene ridotto da una soluzione di zucchero, si determina anche la concentrazione dello zucchero.

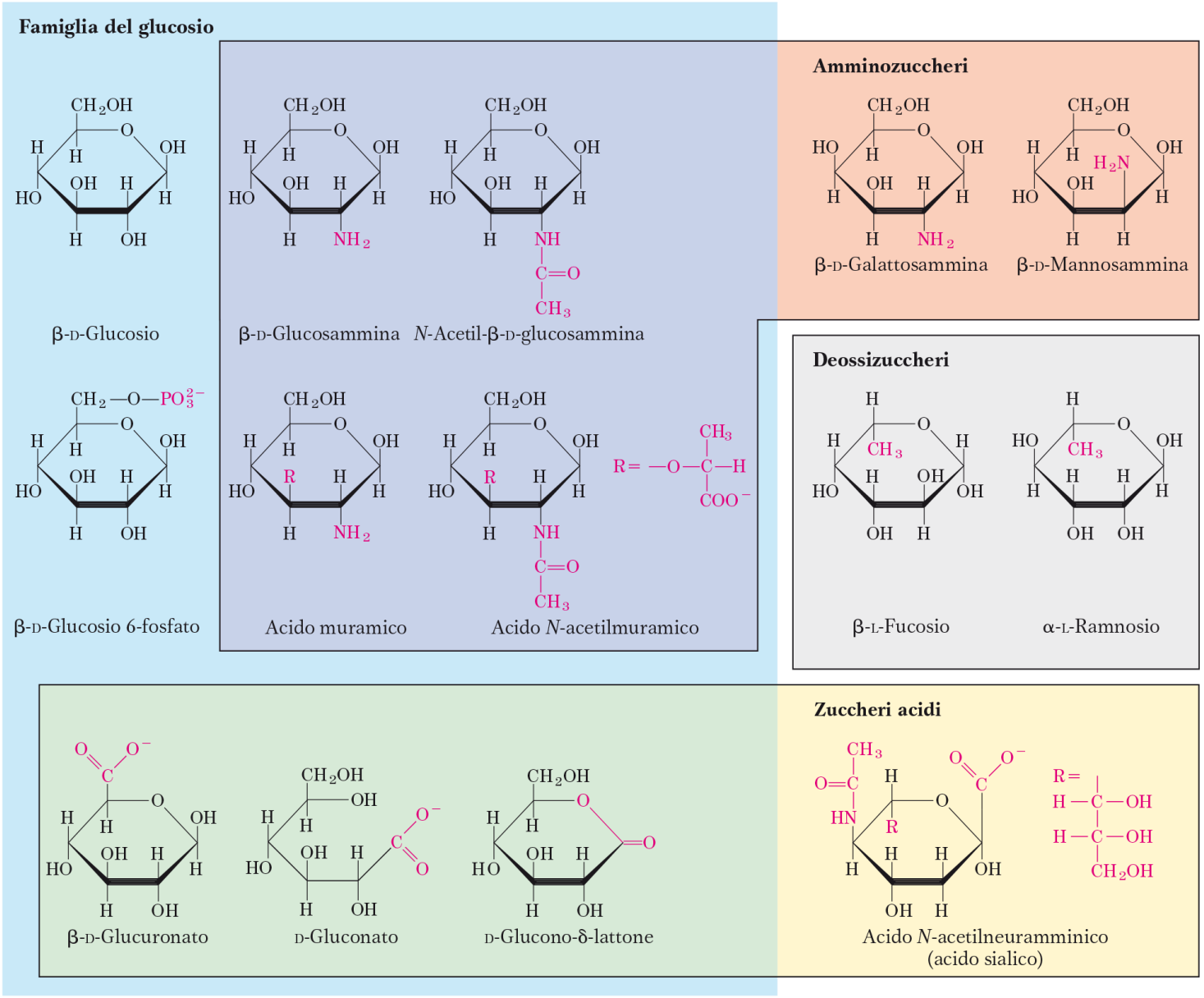


D-glucosio

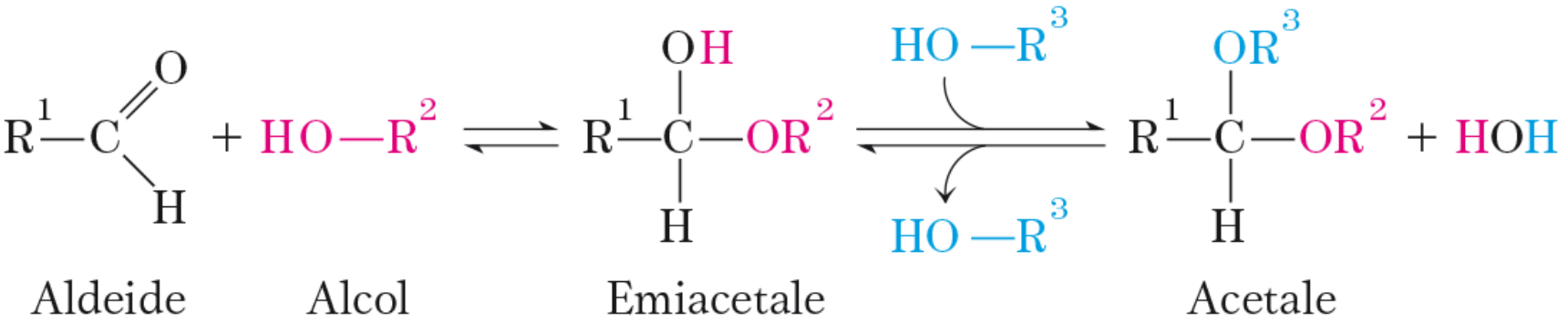
Acido D-gluconico

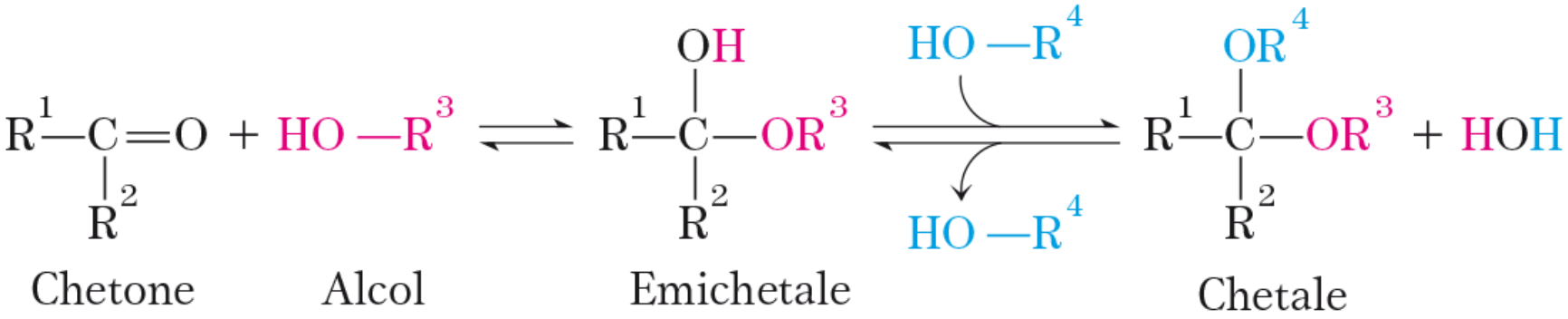
Acido glucuronico

DERIVATI DEGLI ESOSI

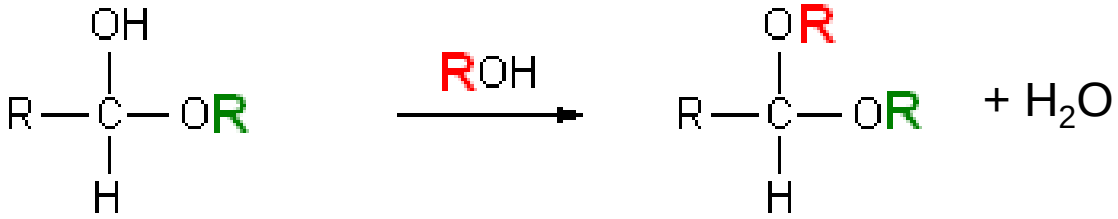


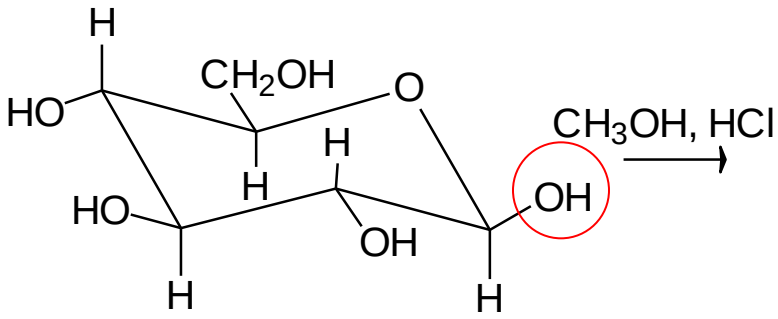
FORMAZIONE DI UN ACETALE E DI UN CHETALE

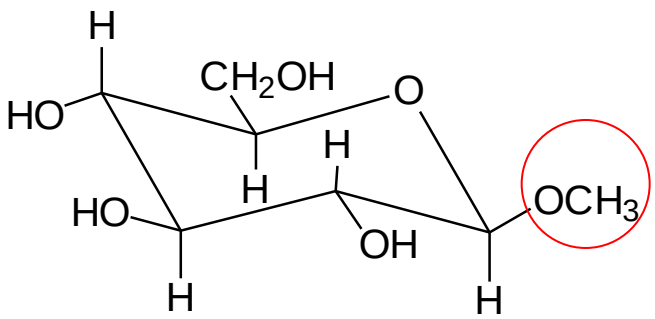




FORMAZIONE DI UN ACETALE



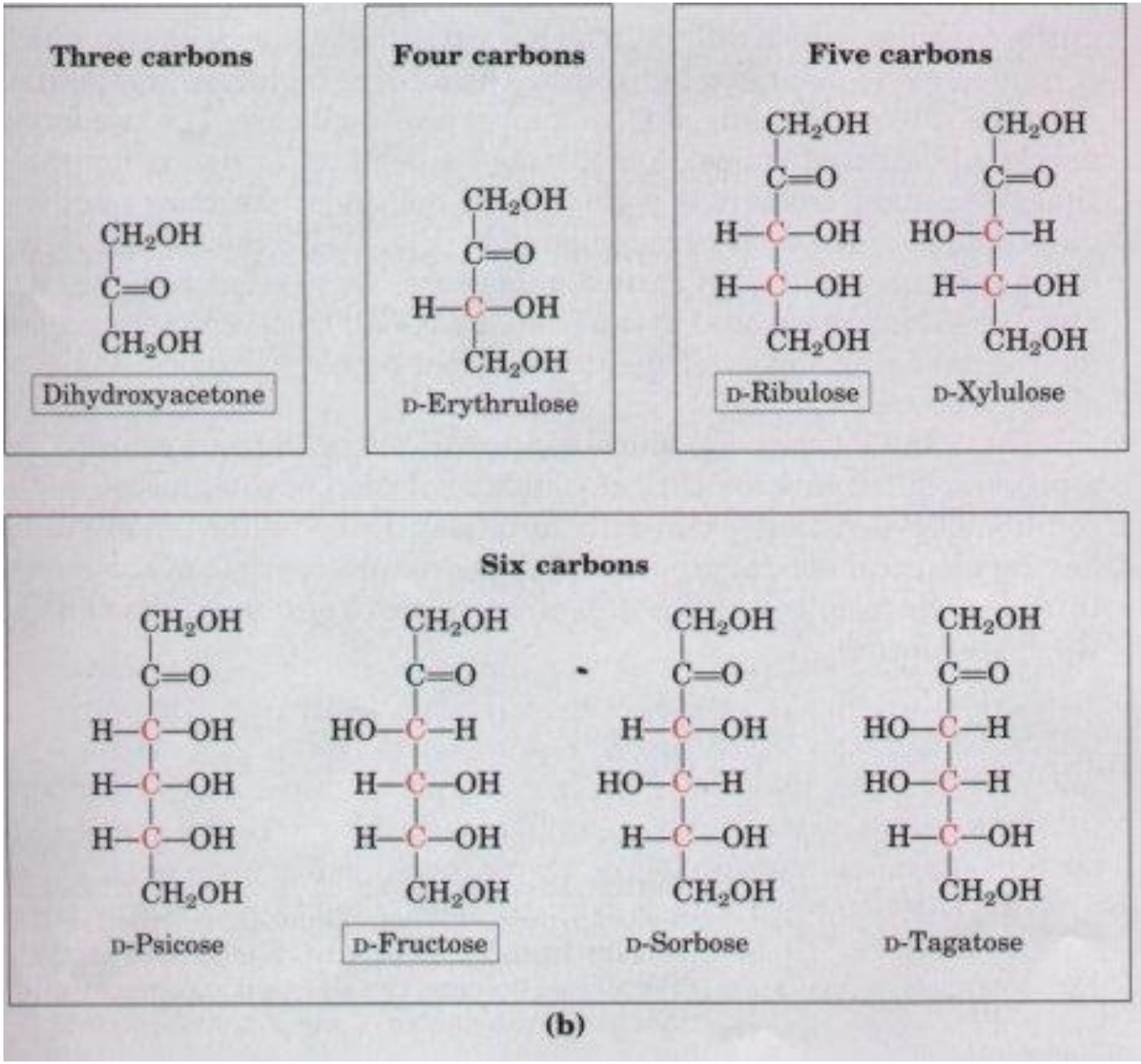




β -D-glucosio

Metil β-D-glucoside

D-chetosi


Three carbons
CH2OH
C=O
CH2OH
Dihydroxyacetone
Four carbons
CH2OH
C=O
H—C—OH
CH2OH
D-Erythrulose
Five carbons
CH2OH
C=O
H—C—OH
H—C—OH
CH2OH
D-Ribulose
CH2OH
C=O
HO—C—H
H—C—OH
CH2OH
D-Xylulose
Six carbons
CH2OH
C=O
H—C—OH
H—C—OH
H—C—OH
CH2OH
D-Psicose
CH2OH
C=O
HO—C—H
H—C—OH
H—C—OH
CH2OH
D-Fructose
CH2OH
C=O
H—C—OH
HO—C—H
H—C—OH
CH2OH
D-Sorbose
CH2OH
C=O
HO—C—H
HO—C—H
H—C—OH
CH2OH
D-Tagatose
(b)

FRUTTOSIO

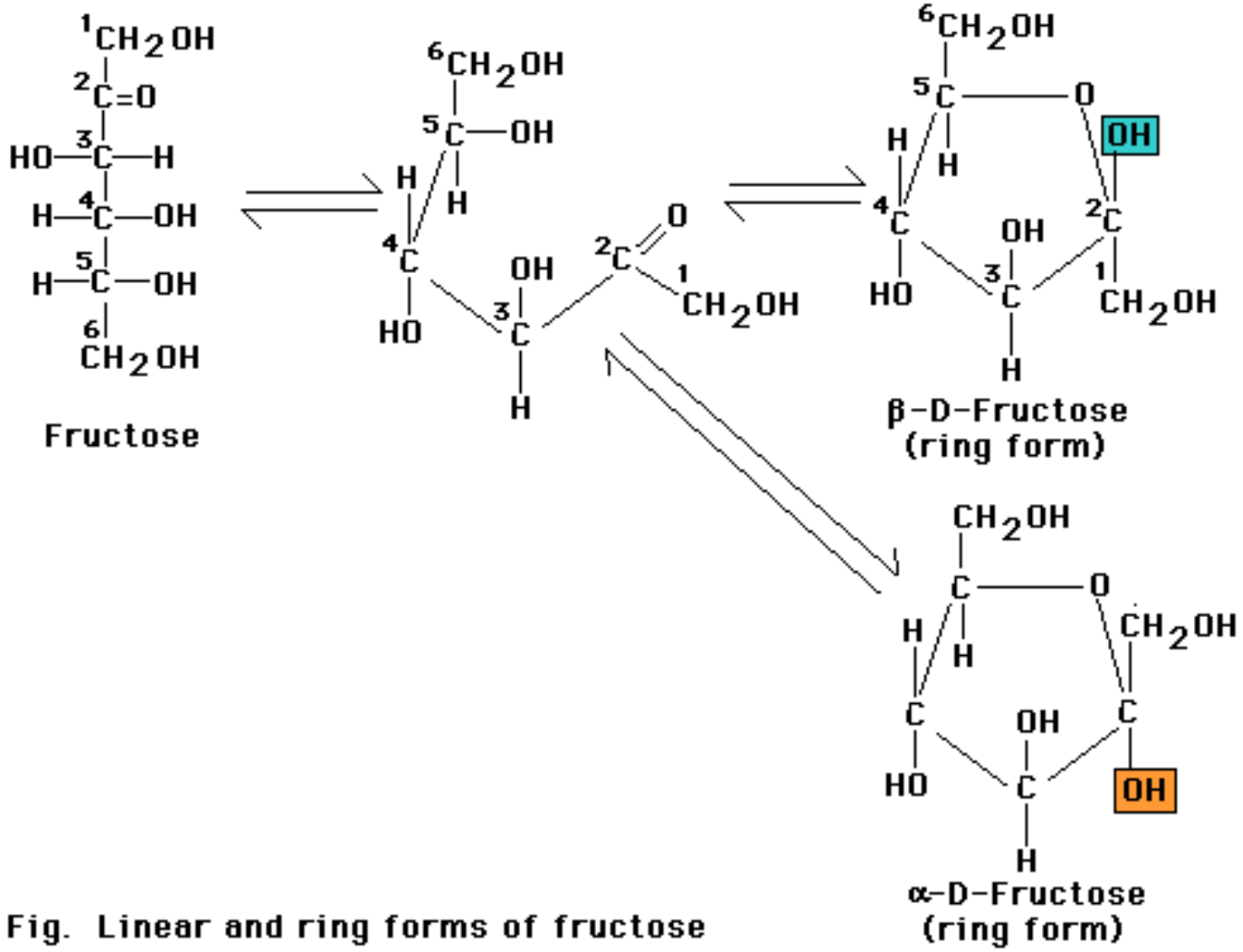
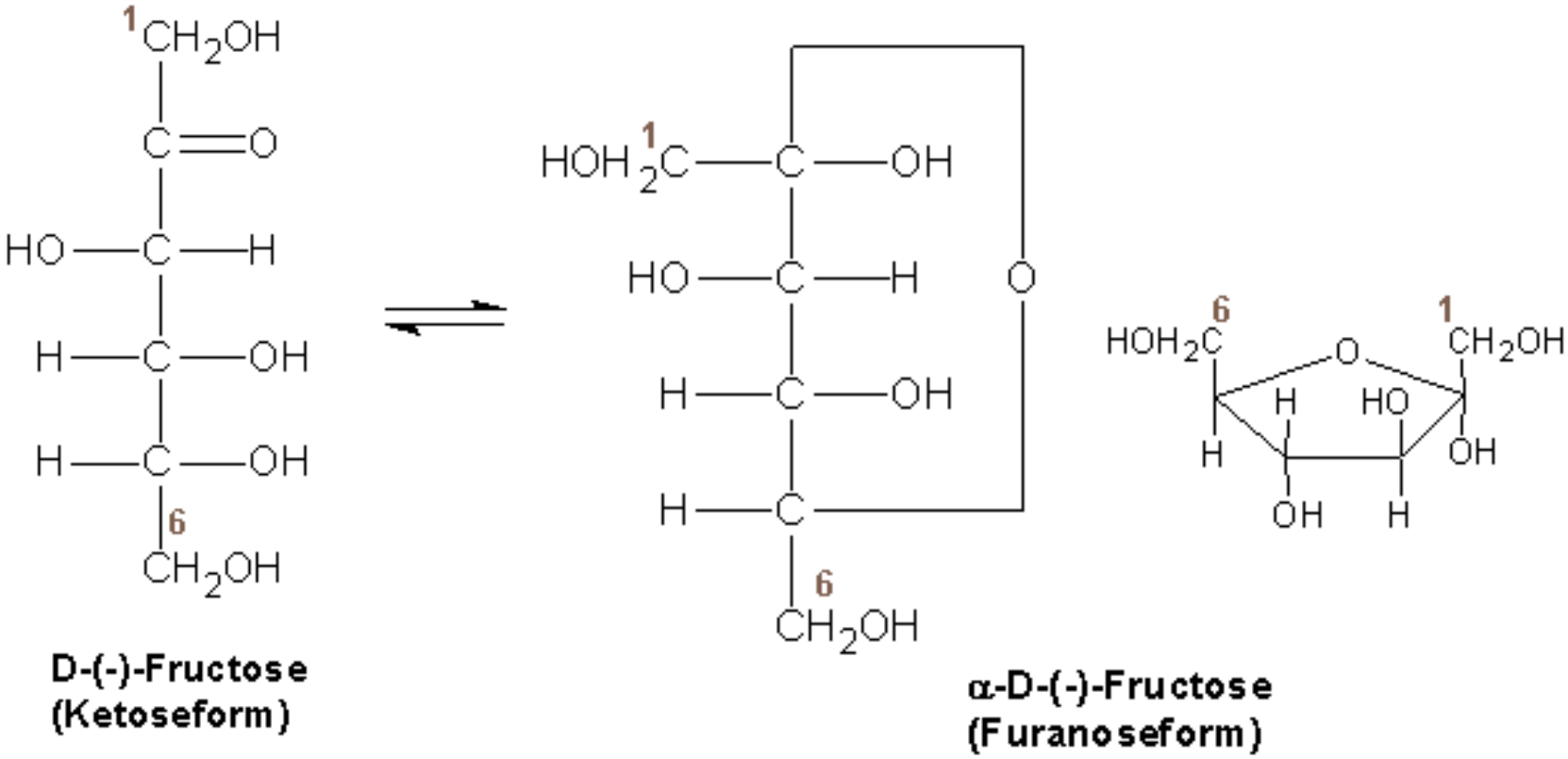


Fig. Linear and ring forms of fructose

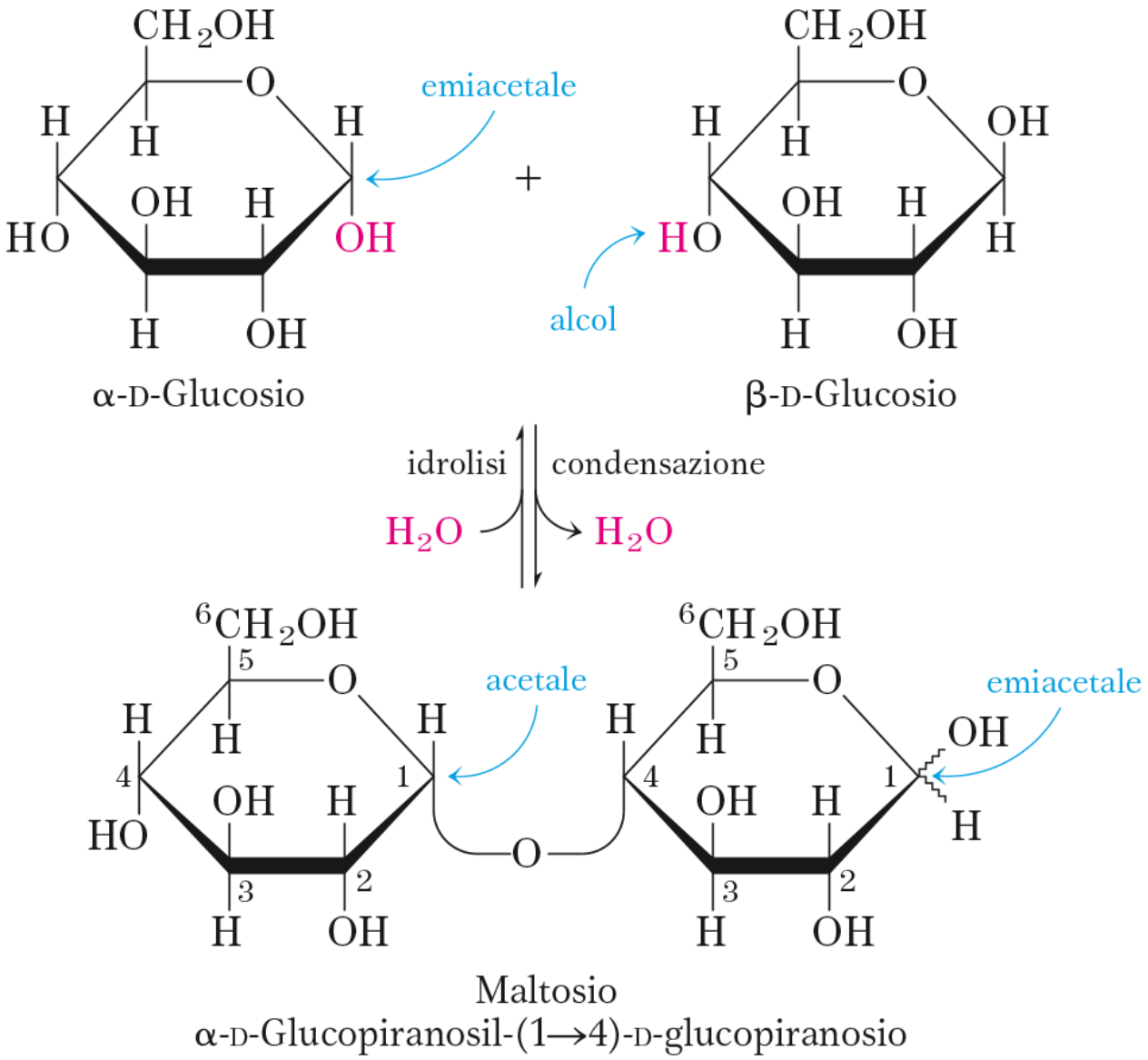
FRUTTOSIO



D-(-)-Fructose
(Ketoseform)

α-D-(-)-Fructose
(Furanoseform)

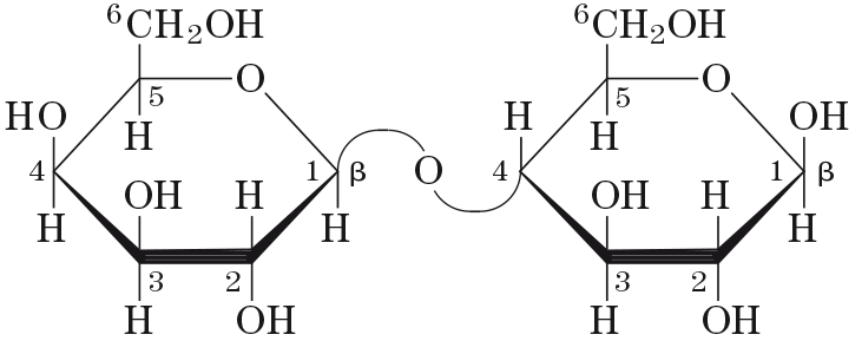
LEGAME GLICOSIDICO



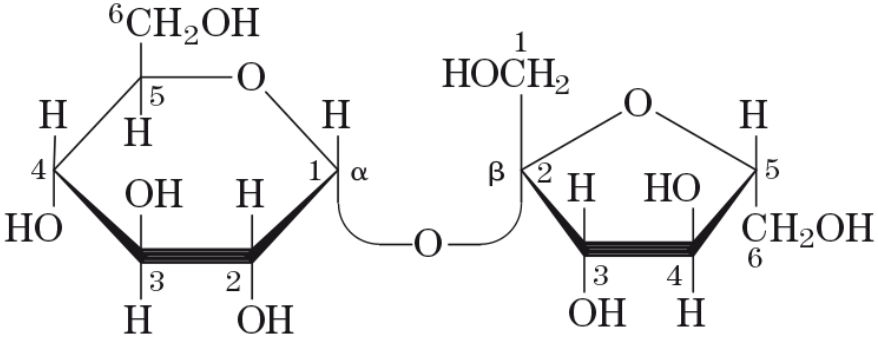
Il legame *O*-glicosidico si forma quando un gruppo ossidrilico di un monosaccaride reagisce con l'atomo di carbonio anomerico di un altro monosaccaride.

DISACCARIDI

sono costituiti da 2 monosaccaridi legati da un legame *O*-glicosidico

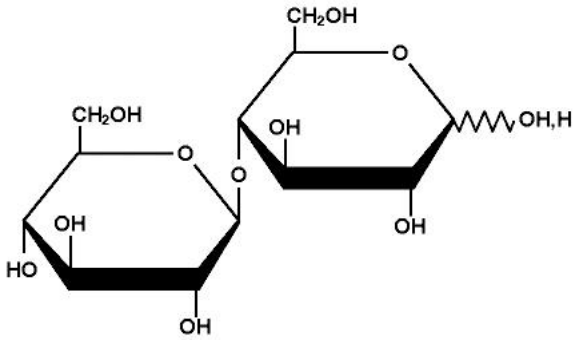


Lattosio (forma β)
β-D-galattopiranosil-(1→4)-β-D-glucopiranosio
Gal(β1→4)Glc



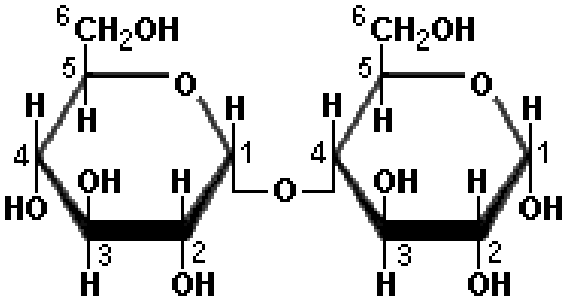
Saccarosio
β-D-fruttofuranosil α-D-glucopiranoside
Fru(2β⟷α1)Glc ≡ Glc(α1⟷2β)Fru

DISACCARIDI



Cellobiosio:

β -D-glucopiranosil-(1→4)-β -D-glucopiranosio



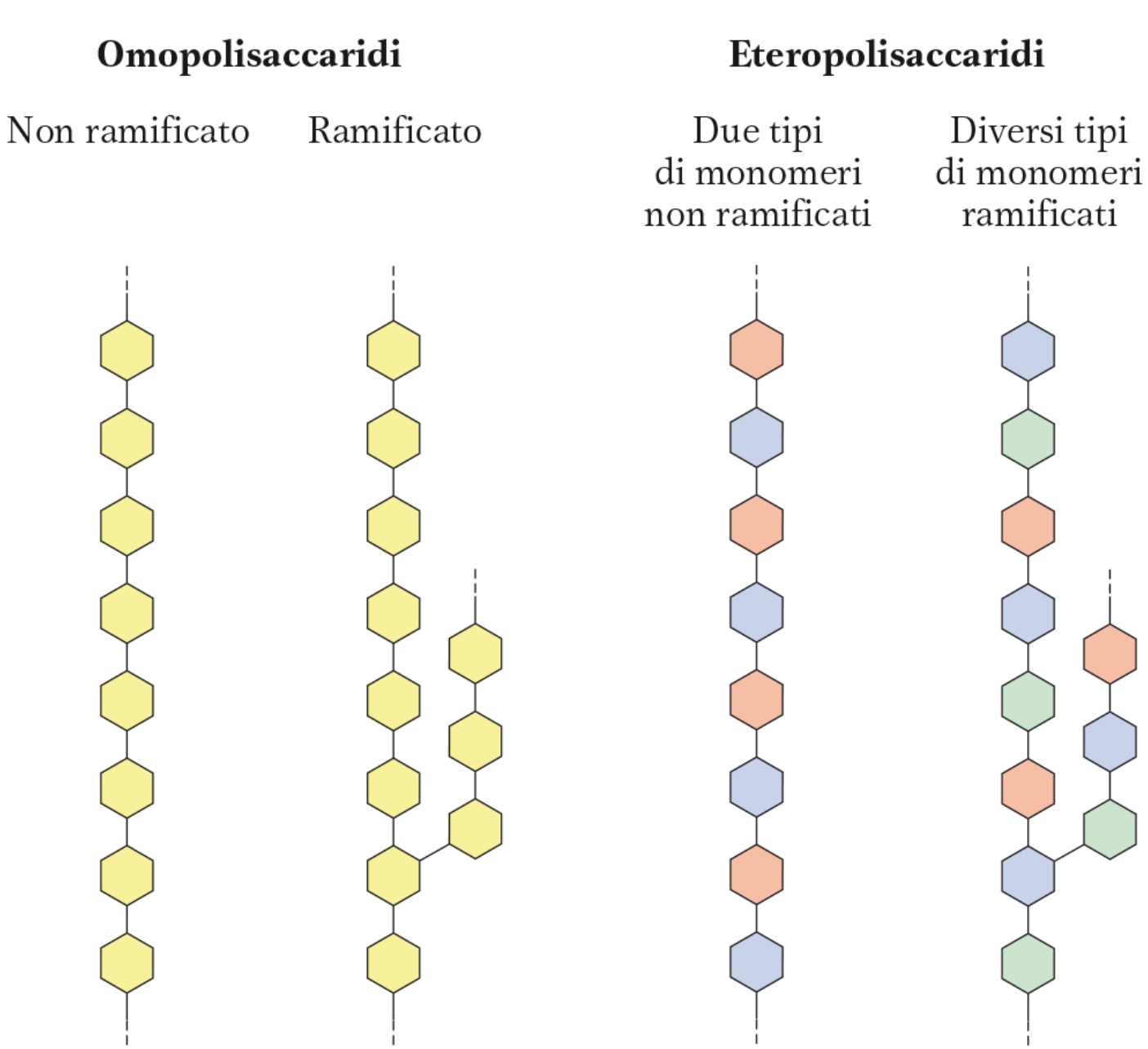
Maltosio:

α-D-glucopiranosil-(1→4)-β -D-glucopiranosio

POLISACCARIDI

1) forma di riserva di monosaccaridi (amido e glicogeno)
2) elementi strutturali nelle pareti cellulari e nei tessuti connettivi

A seconda dei monosaccaridi che li costituiscono si dividono in: omopolisaccaridi ed eteropolisaccaridi


Omopolisaccaridi
Eteropolisaccaridi
Non ramificato
Ramificato
Due tipi di monomeri non ramificati
Diversi tipi di monomeri ramificati

POLISACCARIDI DI RISERVA

sono presenti nelle cellule sotto forma di granuli. Sono molecole fortemente idratate

AMIDO

costituito da amilosio e amilopectina

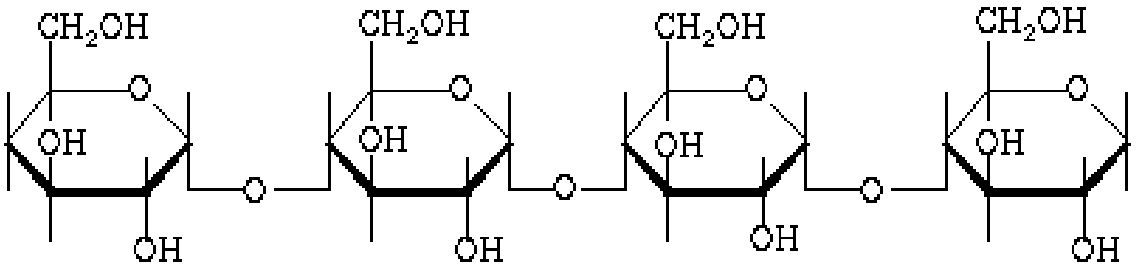
amilosio: lunghe catene di D-glucosio legate da legami α(1-4). Il peso molecolare varia da poche migliaia a 500000.

amilopectina: catene di D-glucosio legate da legami α(1-4) e ramificazioni α(1-6) ogni 23-30 residui. Il peso molecolare è più elevato di quello dell'amilosio.

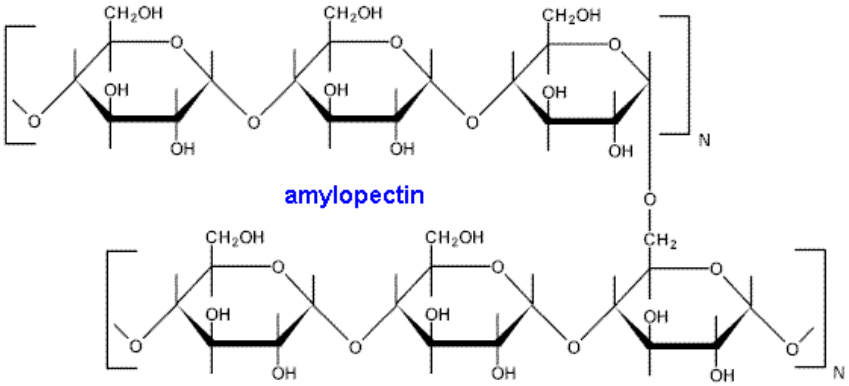
GLICOGENO

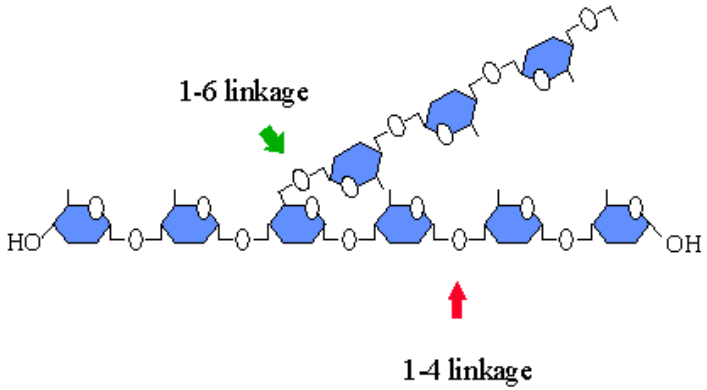
E' simile all'amilopectina, ma è molto più ramificato, circa ogni 8-12 residui. E' molto abbondante nel fegato e nel muscolo scheletrico.

Perchè il glucosio non viene conservato tal quale?

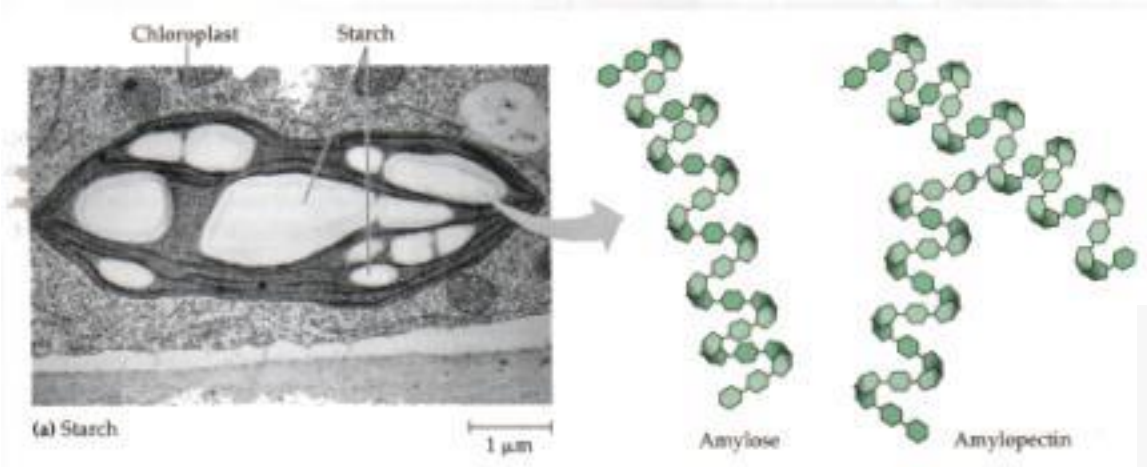


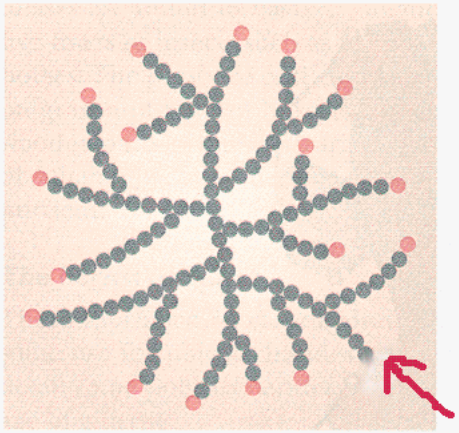
amilosio

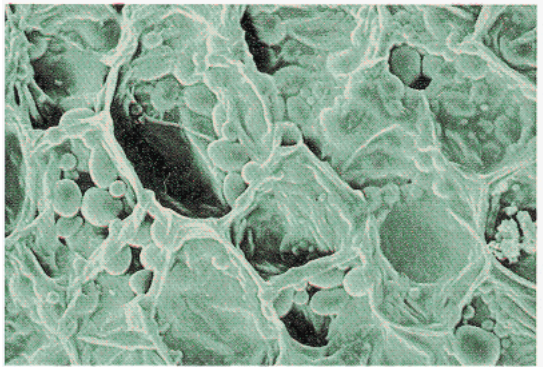




amilopectina


Chloroplast
Starch
(a) Starch
1 μm
Amylose
Amylopectin





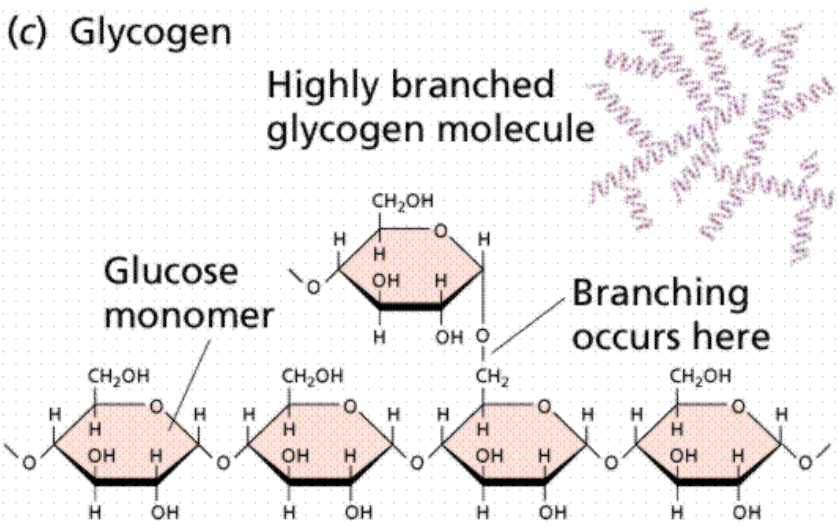
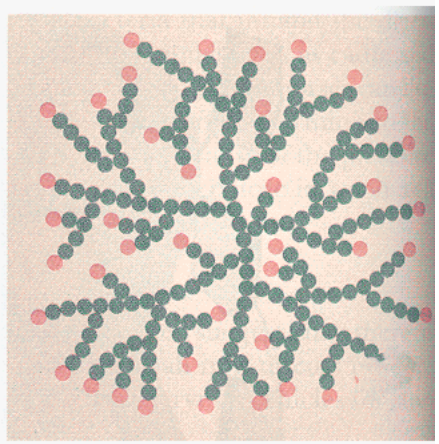
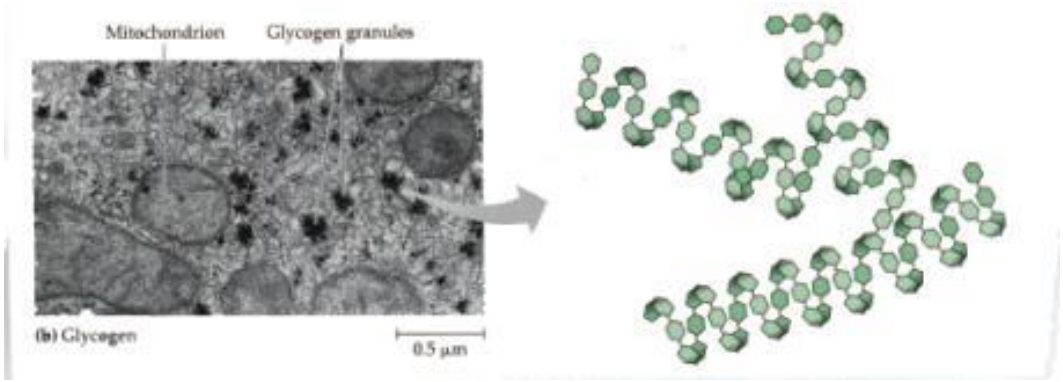
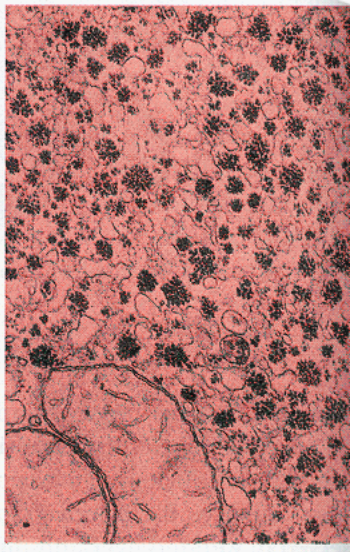
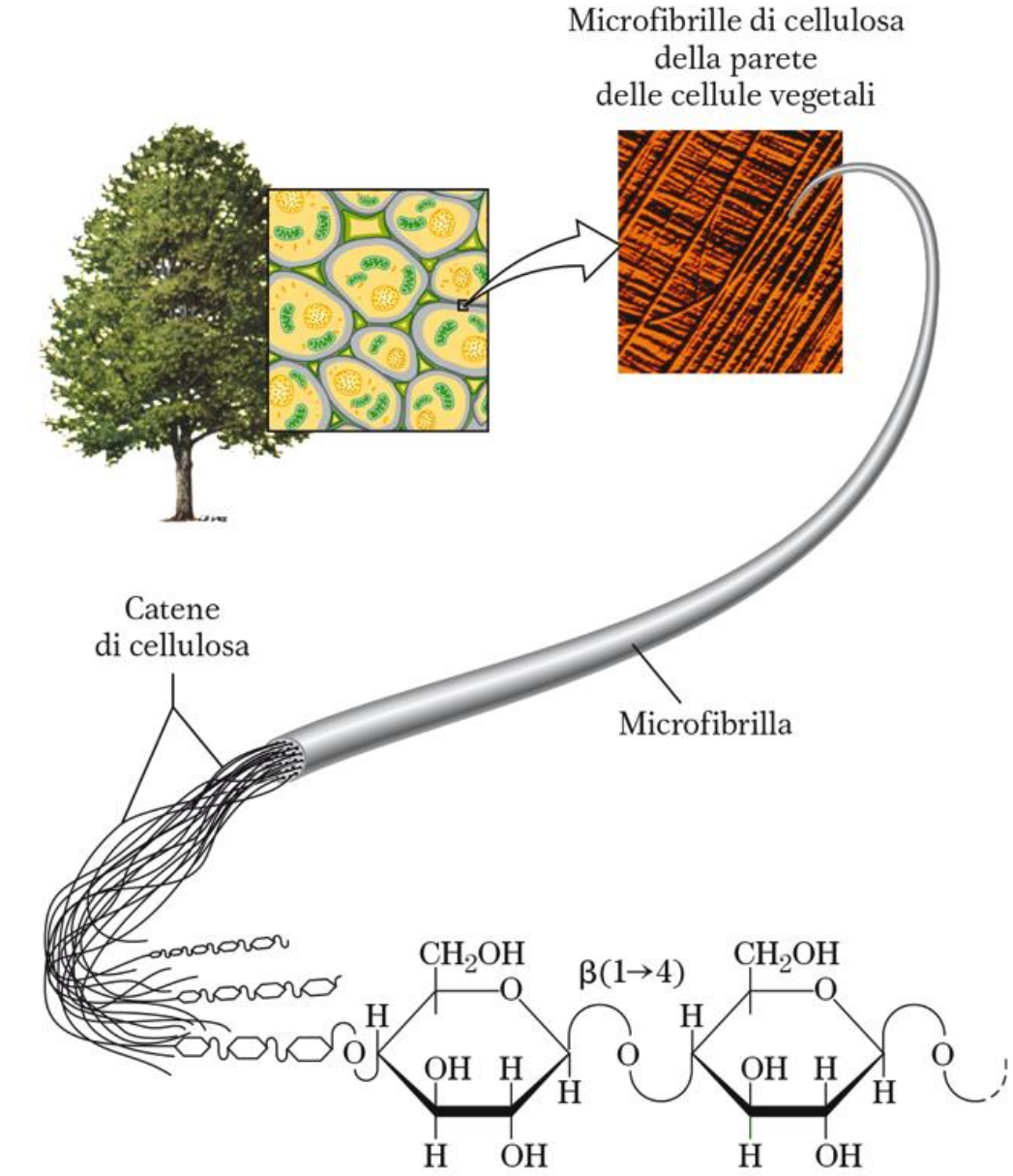

(c) Glycogen
Highly branched glycogen molecule
Glucose monomer
Branching occurs here

Figure 3.12 (3)



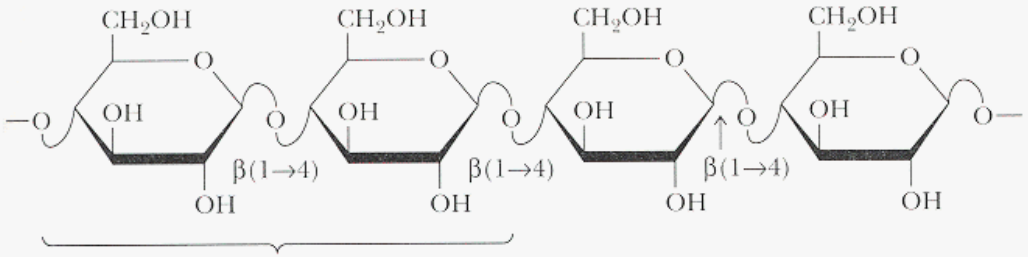

Mitochondrion
Glycogen granules
(b) Glycogen
0.5 μm

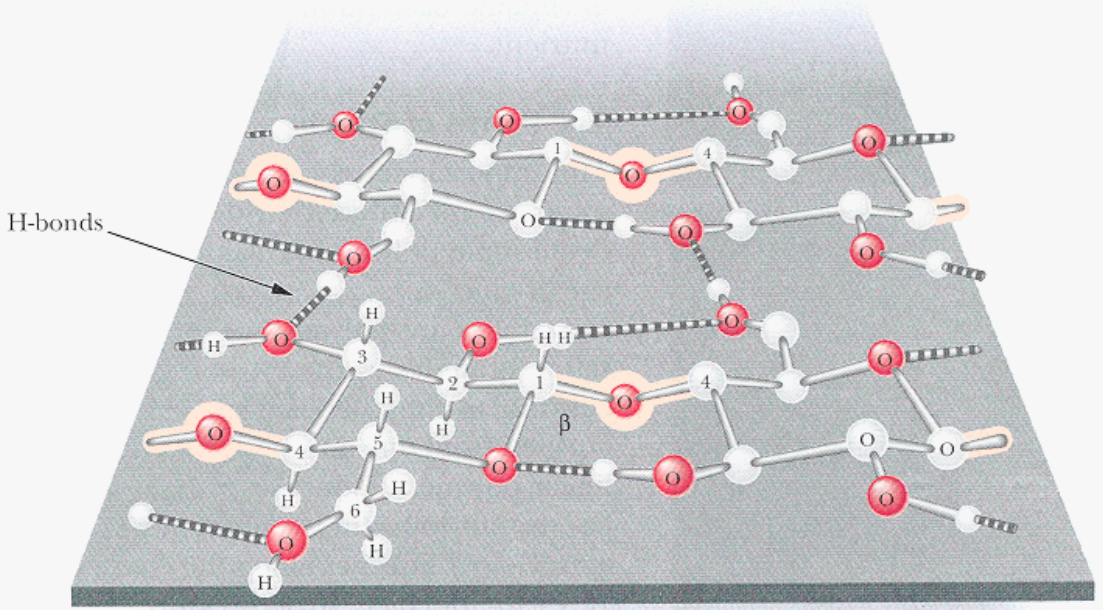



Microfibrille di cellulosa
della parete
delle cellule vegetali
Catene
di cellulosa
Microfibrilla
CH2OH
O
H
OH H
H
H OH
β(1→4)
O
CH2OH
O
H
OH H
H
H OH
O

CELLULOSA

presente nella parete cellulare delle piante. Sostanza fibrosa, resistente e insolubile, costituita da unità di D-glucosio legate con legame β(1-4).





PARETE CELLULARE BATTERICA

La parete cellulare è costituita da catene polisaccaridiche lunghe e parallele, legate una all'altra da corte catene peptidiche

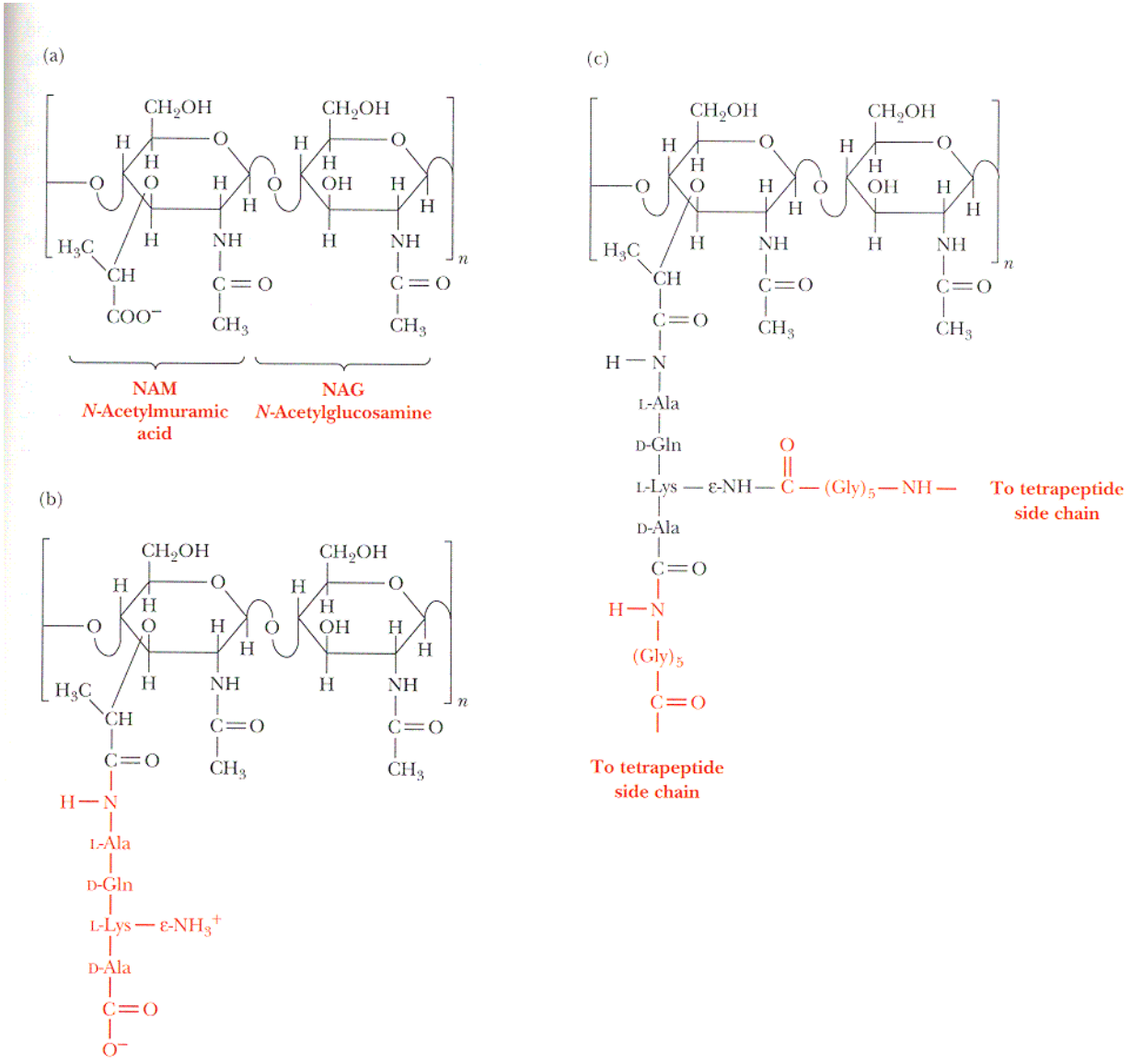
Le catene polisaccaridiche contengono:

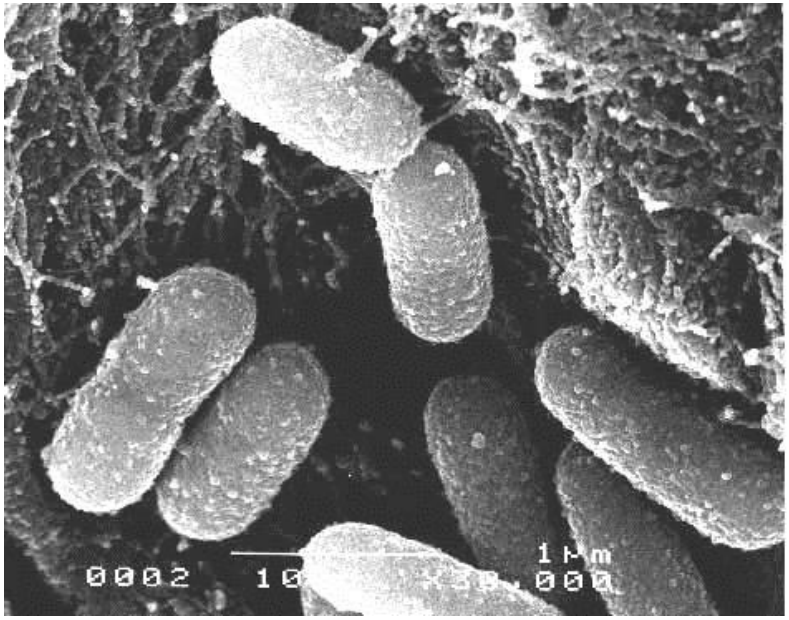
N-acetil-D-glucosammina e acido N-acetil murammico

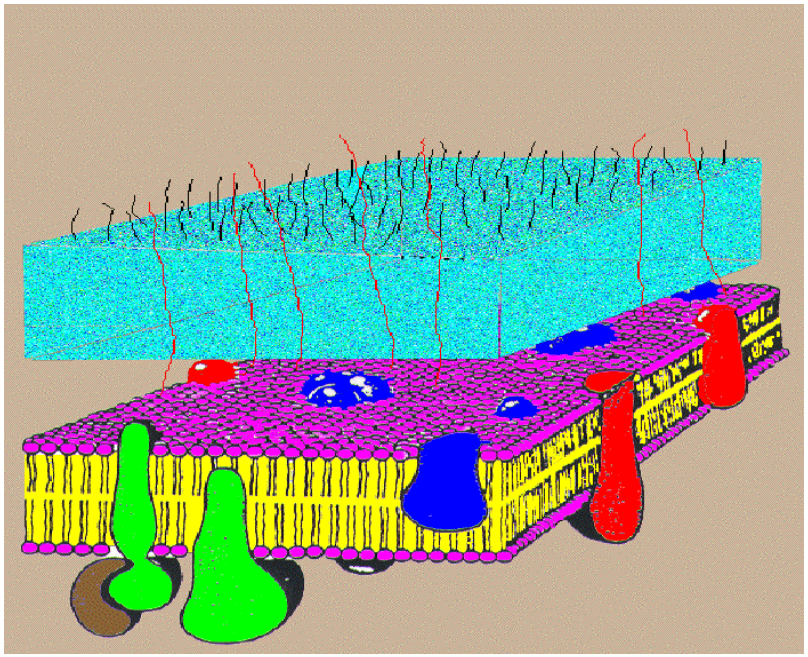
Questa struttura si chiama peptidoglicano. Esso è continuo intorno alla cellula batterica. Conferisce protezione alla cellula batterica.

PARETE CELLULARE BATTERICA

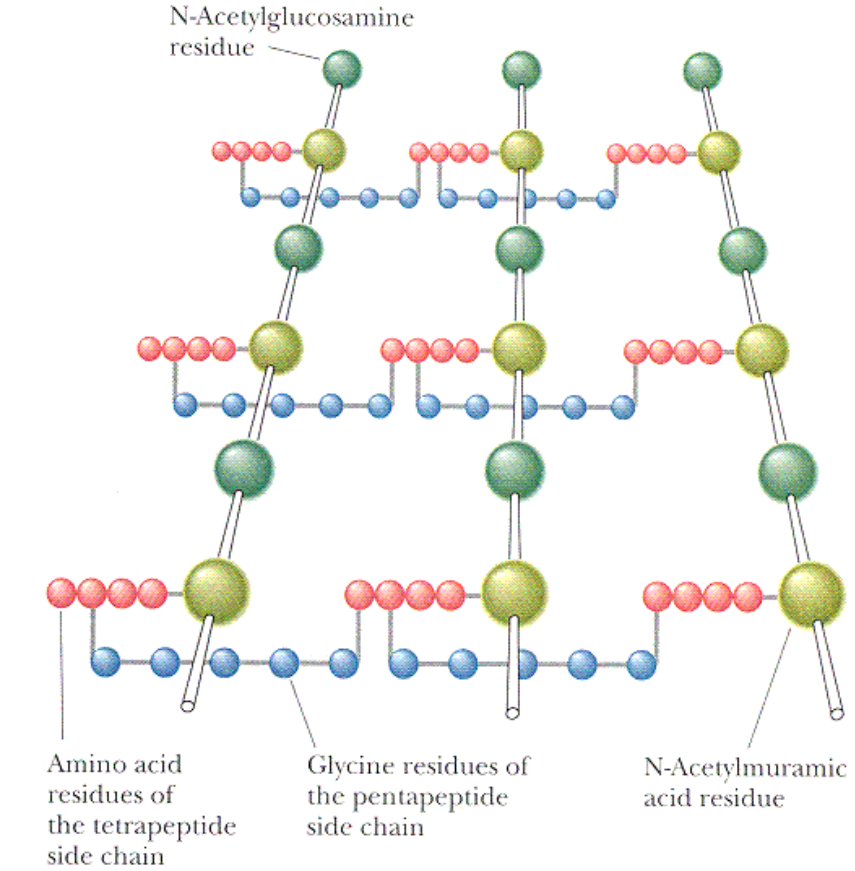
costituita da catene polisaccaridiche lunghe e parallele, legate una all'altra da corte catene peptidiche
Catene polisaccaridiche: N-acetil-D-glucosammina e acido N-acetil murammico
Questa struttura si chiama peptidoglicano.
Esso è continuo intorno alla cellula batterica.
Conferisce protezione alla cellula batterica.




0002
1 µm

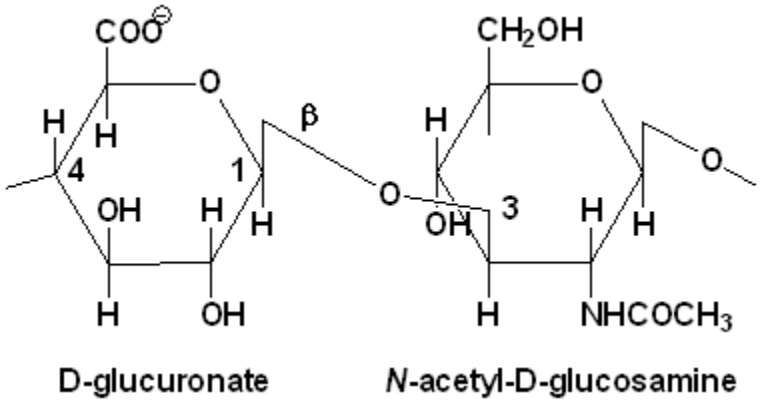


(d)

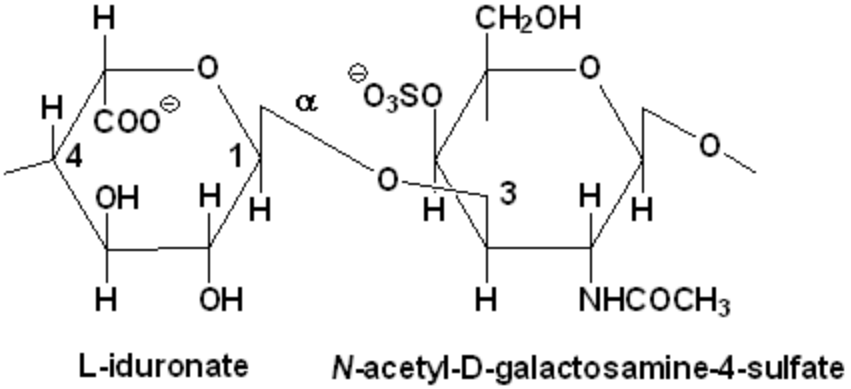

N-Acetylglucosamine residue
Amino acid residues of the tetrapeptide side chain
Glycine residues of the pentapeptide side chain
N-Acetylmuramic acid residue

ETEROPOLISACCARIDI

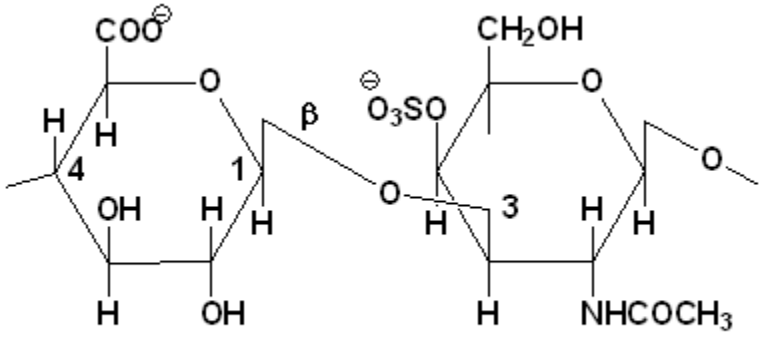
GLICOSAMMINOGLICANI



IALURONATO:
D-GlcA + GlcNAc
legame β (1, 4)

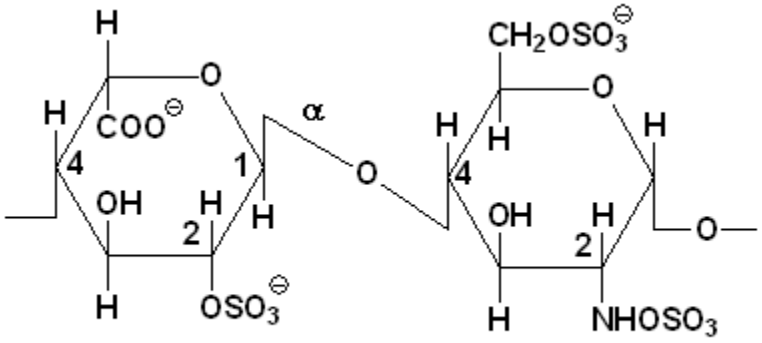


DERMATAN SOLFATO:
L-IduA (presenza di S) + GalNAc-4-sulfate
legame β (1, 4)



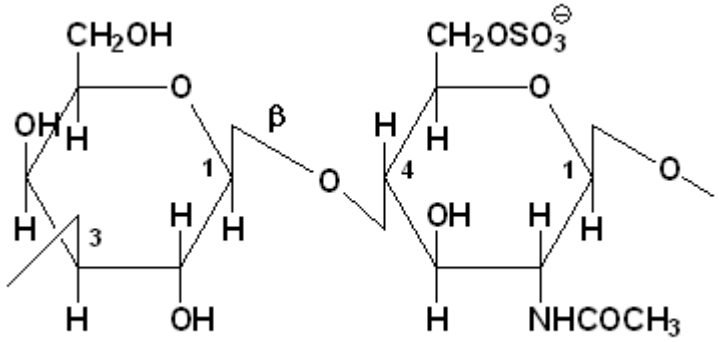
D-glucuronate *N*-acetyl-D-glalactosamine-4-sulfate

CONDROITINA 4 O 6 SOLFATO :
D-GlcA + GalNAc-4- o 6-sulfate
legame β(1, 4)



L-iduronate-2-sulfate *N*-sulfo-D-glucosamine-6-sulfate

EPARINA E EPARAN SOLFATO:
L-Idu-sulfate (**D**-GlcA-2-sulfate) + *N*-sulfo-**D**-GlcNe-6-S
legame α (1, 4)
(heparans have less sulfate than heparins)



D-galactose *N*-acetylD-glucosamine-6-sulfate

CHERATAN SOLFATO:
Gal + GlcNAc-6-S
legame β(1, 3)

CARATTERISTICHE DEI GAG

GAG	Localizzazione	Commenti
Ialuronato	Liquido sinoviale, umor vitreo, matrice extracellulare tessuto connettivo molle	Polimero ad alto MW, resistente ala compressione
Condroitin solfato	Cartilagine, osso, valvole cardiache	GAG più abbondante
Eparan solfato	Membrana basale, superficie cellulare	
Eparina	Componente dei granuli intracellulari dei mastociti che si trovano nelle arterie dei polmoni, fegato e pelle	Più solfato dell'eparan solfato
Dermatan solfato	Pelle, vasi sanguigni, valcole cardiache	
Cheratan solfato	Cornea, osso, cartilagine	

PROTEOGLICANI

•Macromolecole della superficie cellulare e della matrice extracellulare

•Sono costituiti da una proteina a cui sono legati i GAG

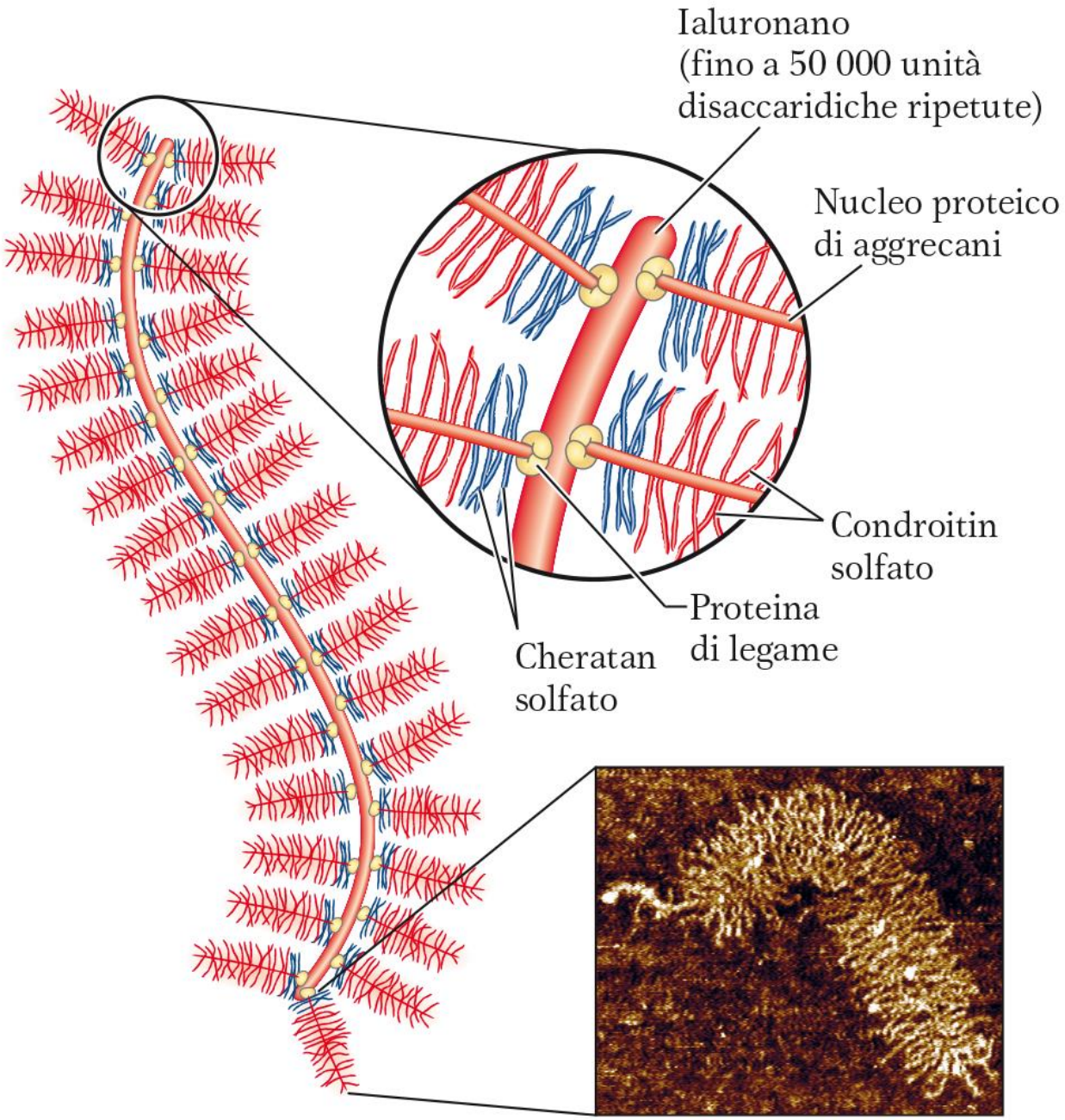
•Forniscono un punto di adesione, di riconoscimento e di informazione tra le cellule, o tra le cellule e la matrice extracellulare.

•La secrezione di alcuni proteoglicani è coinvolta nella proliferazione e nel differenziamento cellulare.

•Possono legare molecole segnale extracellulari e quindi aumentare la loro concentrazione locale, rinforzando il legame di queste molecole segnale con i recettori cellulari.

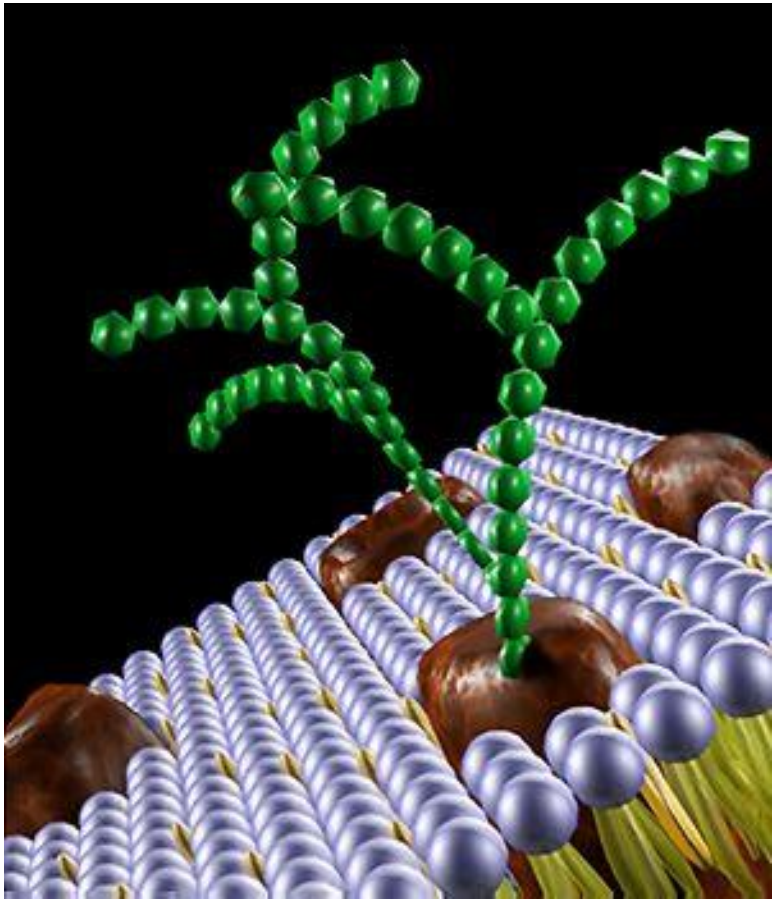
AGGRECANO:

un proteoglicano che contiene condroitin solfato. Forma complessi con lo ialuronano. E' il principale componente della cartilagine articolare.



GLICOPROTEINE

proteine che hanno legati covalentemente monosaccaridi od oligosaccaridi. Quasi tutte si trovano sulla superficie esterna delle cellule animali. La maggior parte delle proteine che vengono secrete sono glicoproteine.



Esempi di glicoproteine: proteine della superficie cellulare, proteine extracellulari, proteine secrete (mucine, anticorpi, lattalbumina), molte proteine dei lisosomi.

I monosaccaridi possono dar luogo a una varietà enorme di strutture di oligosaccaridi.

FUNZIONI

Gli oligosaccaridi delle glicoproteine:

•influenzano il ripiegamento e la stabilità delle proteine;

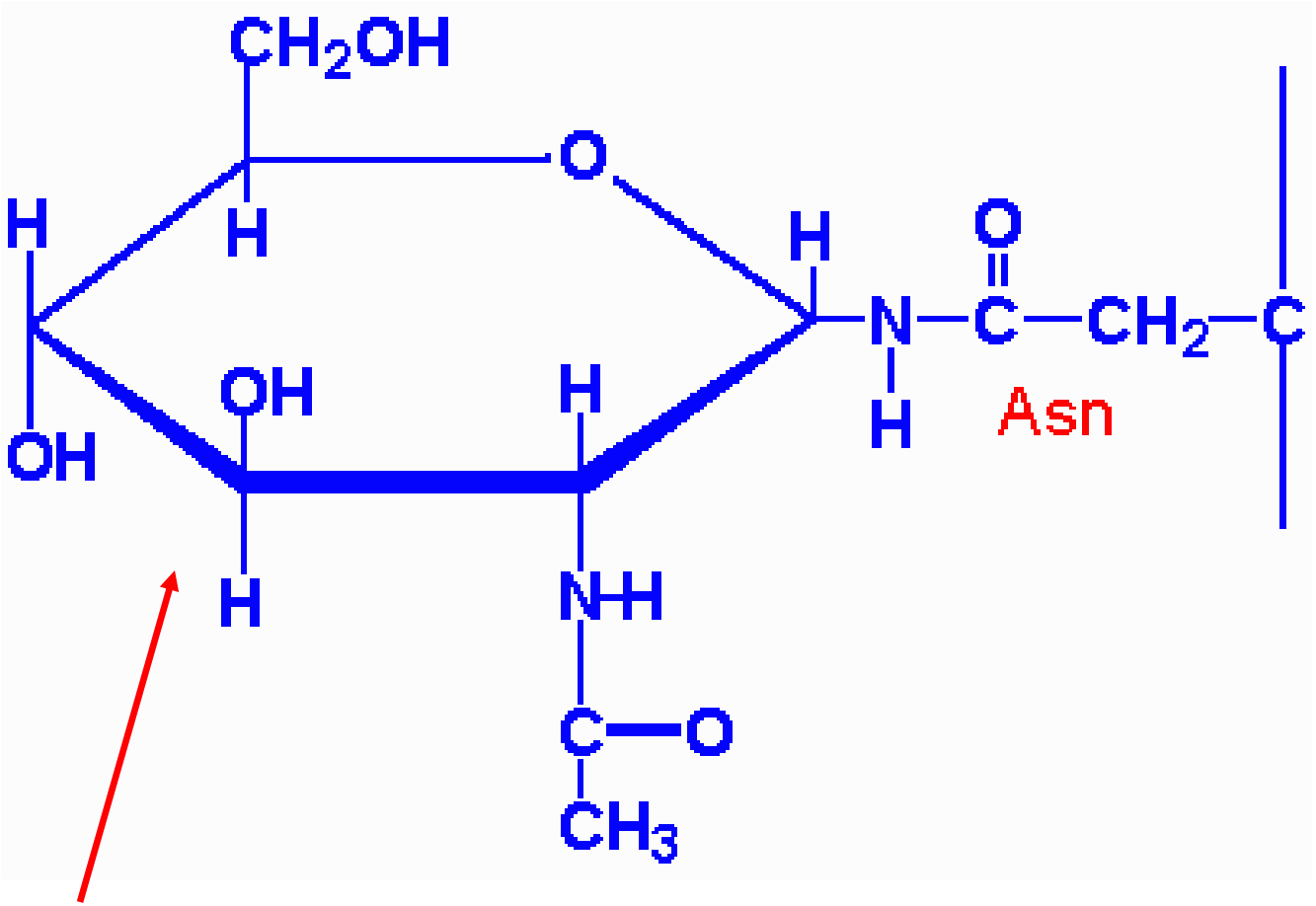
•sono etichette di riconoscimento per la destinazione delle proteine;

•sono siti di riconoscimento specifico per proteine chiamate **LECTINE;**

•sono siti di riconoscimento per batteri, virus e alcuni parassiti**.**

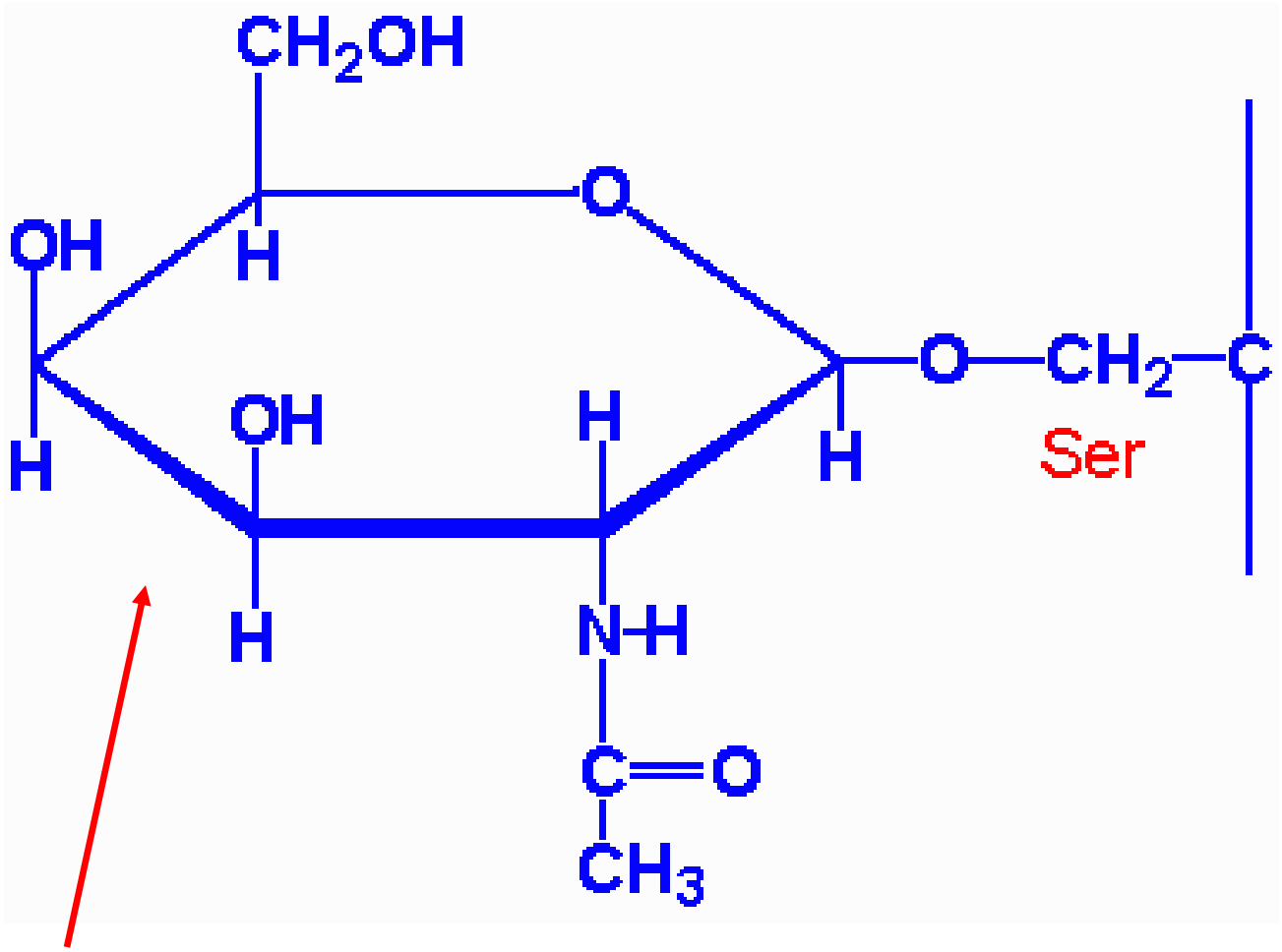
Le lectine si trovano sulla superficie esterna delle cellule e prendono parte ai processi di interazione con altre cellule.

Legame N-glicosidico sulla catena laterale della asparagina



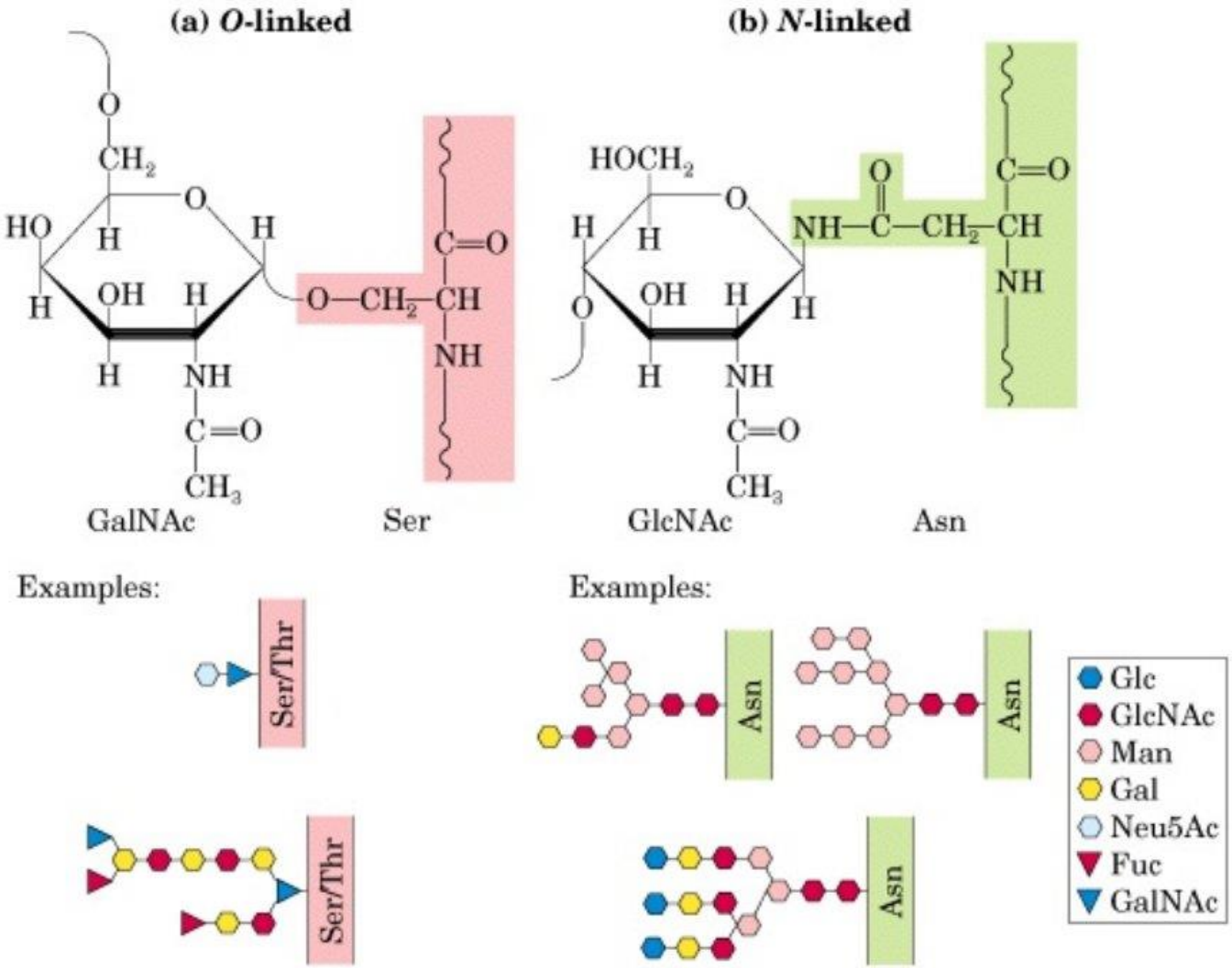
2-N-Acetilglucosammina

Legame O-glicosidico sulla catena laterale della serina



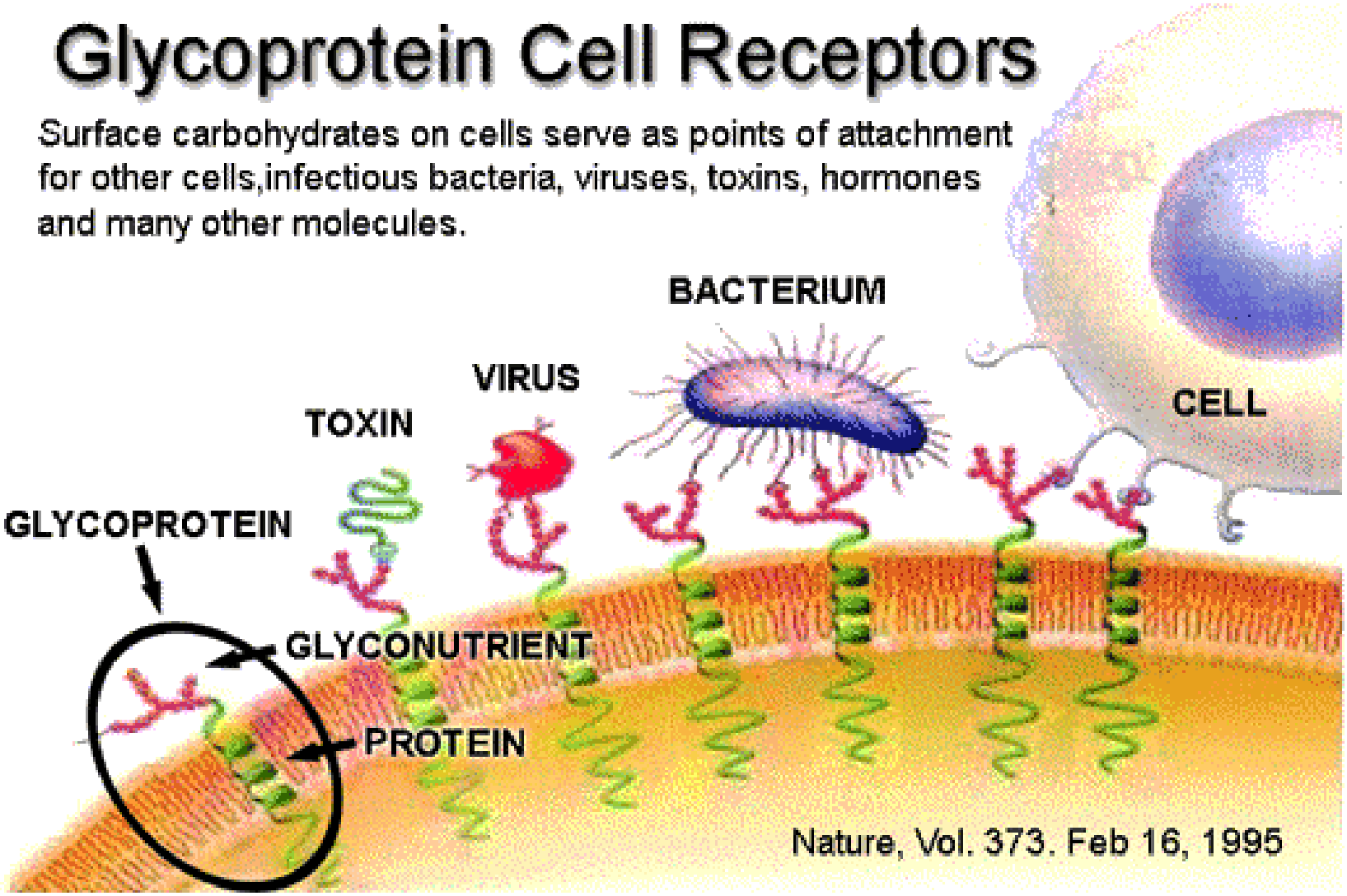
2-N-Acetilgalattosammina

N & O glycoproteins



Glycoprotein Cell Receptors

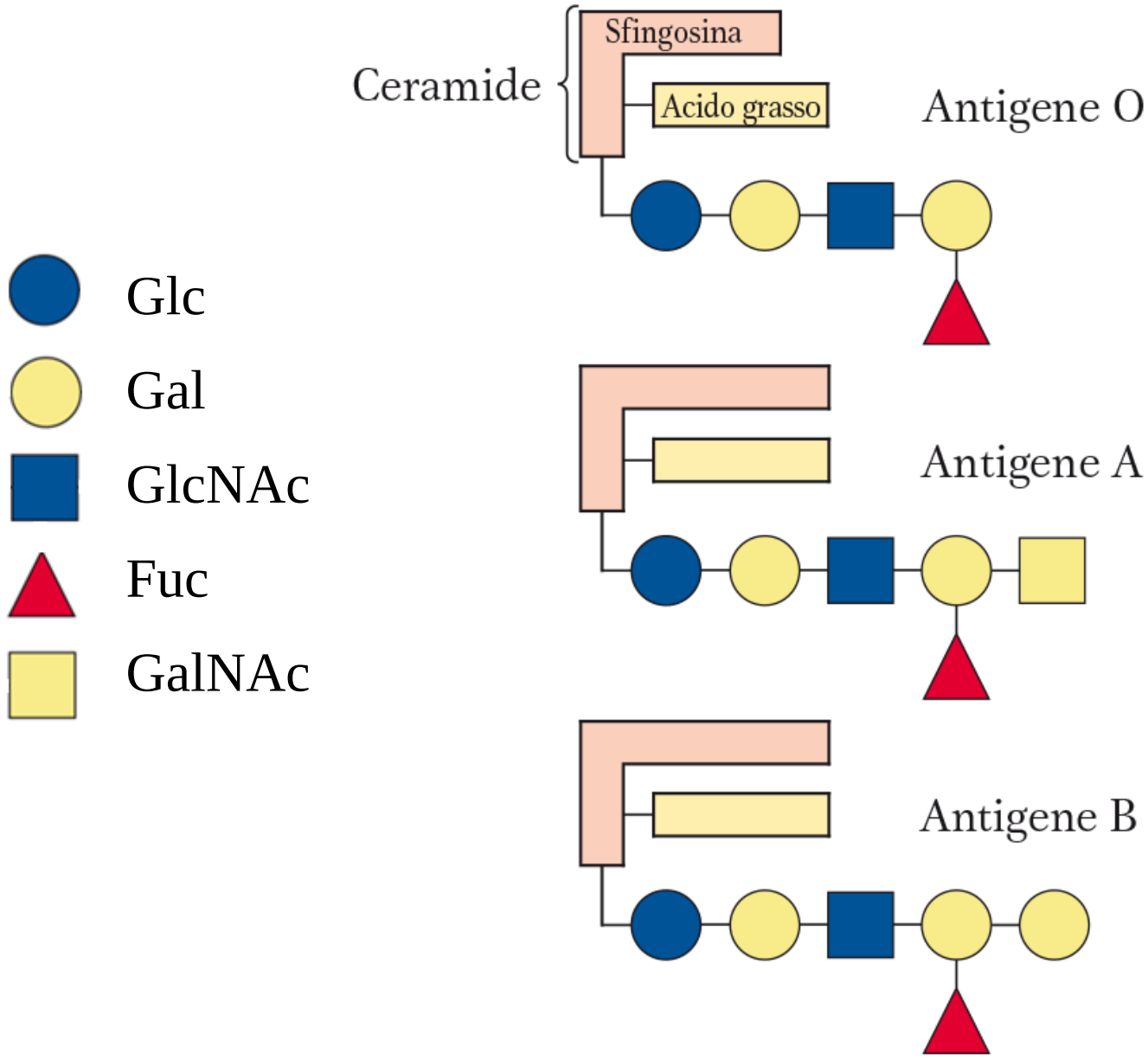
Surface carbohydrates on cells serve as points of attachment for other cells,infectious bacteria, viruses, toxins, hormones and many other molecules.



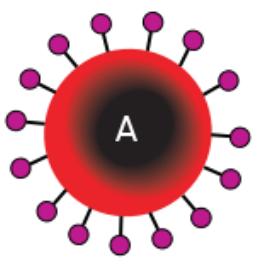
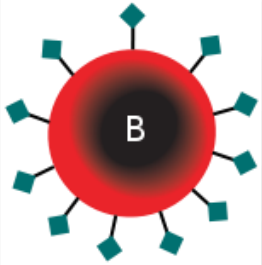
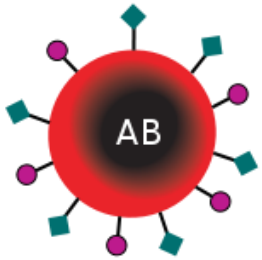
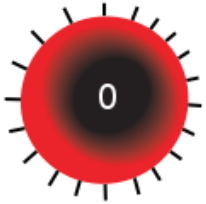
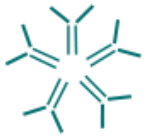
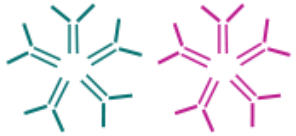
ANTIGENI DEI GRUPPI SANGUIGNI UMANI

Le proteine sulla superficie degli eritrociti sono glicosilate e la parte saccaridica è responsabile della distinzione tra i gruppi sanguigni. Esistono 4 gruppi nell'uomo: A, B, AB e 0

ANTIGENI DEI GRUPPI SANGUIGNI UMANI



ANTIGENI DEI GRUPPI SANGUIGNI UMANI

	Gruppo A	Gruppo B	Gruppo AB	Gruppo 0
Tipi di GLOBULI ROSSI				
Anticorpi presenti	 Anti-B	 Anti-A	Nessuno	 Anti-A e Anti-B
Antigeni presenti	 A	 B	 A e B	Nessuno