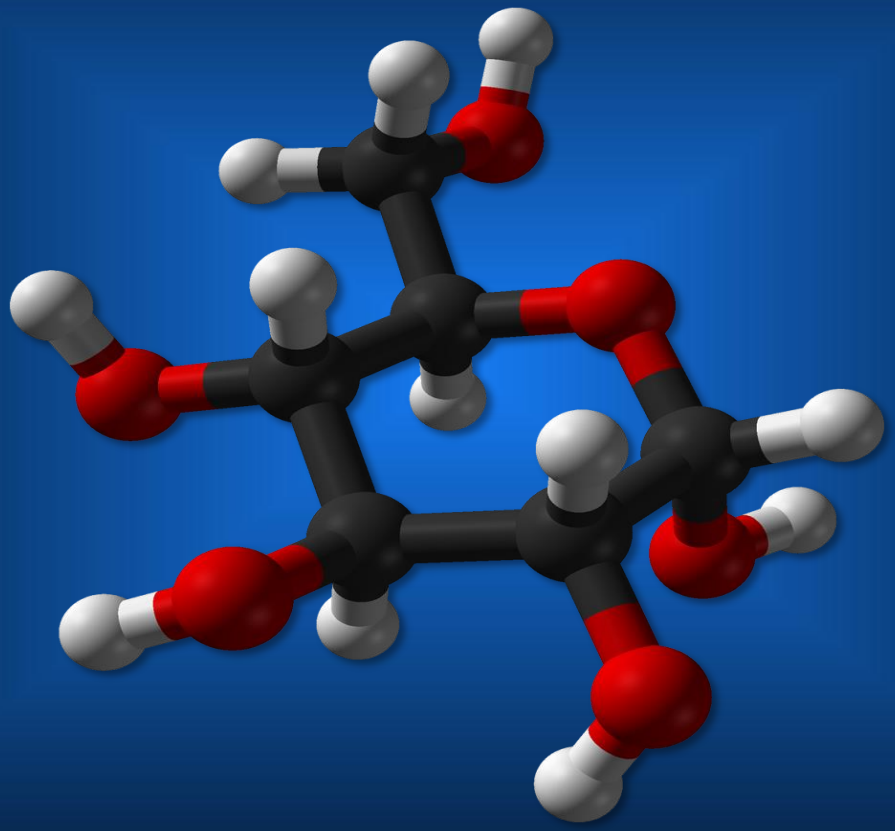
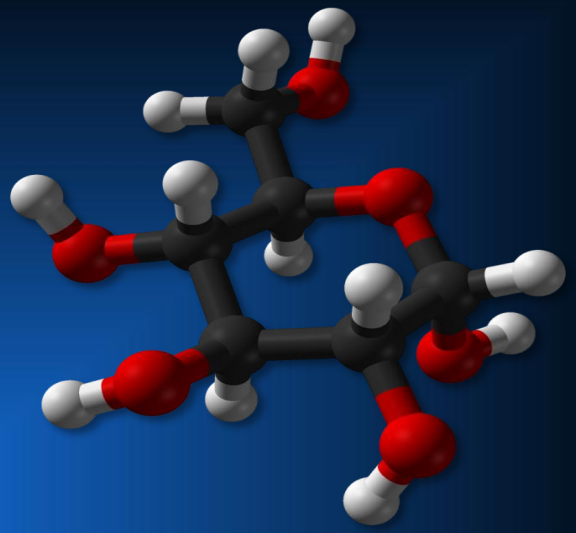
Estrutura e Função dos Carboidratos



Ana Paula Jacobus

Funções dos carboidratos



Geração de energia, intermediários metabólicos;

Reserva energética: amido, glicogênio;

Estrutura celular : peptideoglicanos, proteoglicanos, quitina e celulose;

Reconhecimento, comunicação e adesão celular.

CARBOIDRATOS-INTRODUÇÃO

- Outras denominações:
  - Hidratos de carbono
  - Glicídeos, sacarídeos
  - Açúcares.

- Ocorrência e funções gerais:

  São amplamente distribuídos nas plantas e nos animais, onde desempenham funções estruturais e metabólicas.

CARBOIDRATOS

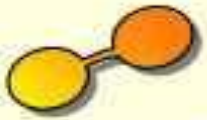
- Composição
  - São formados por C, H, O.

- Fórmula Geral

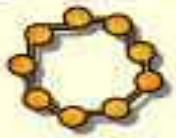
$$C_n(H_2O)_n \quad n \geq 3$$

All carbohydrates consist of the following molecules:

Mono-saccharide
contains one saccharide molecule



Di-saccharide
contains two saccharide molecules



Poly-saccharide
contains many saccharide molecules

CARBOIDRATOS

- **Monossacarídeos** — Glicose, frutose, Galactose
- **Dissacarídeos** — Sacarose, lactose e maltose
- **Polissacarídeos** — Amido, Glicogênio

ARMAZENAMENTO DOS CARBOIDRATOS

Vegetais → AMIDO

Animais → GLICOGÊNIO

Fígado

Músculos

CLASSIFICAÇÃO
(QUANTO AO NÚMERO DE MONÔMEROS)

- Monossacarídeos
  - Açúcares Fundamentais (não necessitam de qualquer alteração para serem absorvidos)
  - Propriedades:

    solúveis em água e insolúveis em solventes orgânicos

    brancos e cristalinos

    maioria com saber doce

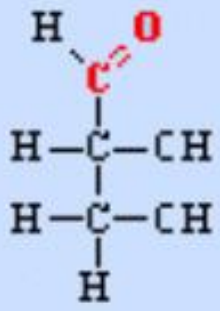
    estão ligados à produção energética.

MONOSSACARÍDEOS

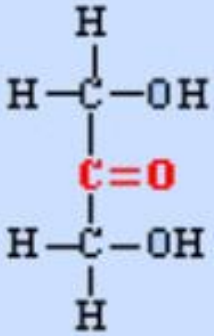
- O nome genérico do monossacarídeo é dado baseado no número de carbonos mais a terminação "ose".
  - 03 carbonos – trioses
  - 04 carbonos – tetroses
  - 05 carbonos – pentoses
  - 06 carbonos – hexoses
  - 07 carbonos – heptoses

  Podem ser classificados ainda como aldoses ou cetoses.

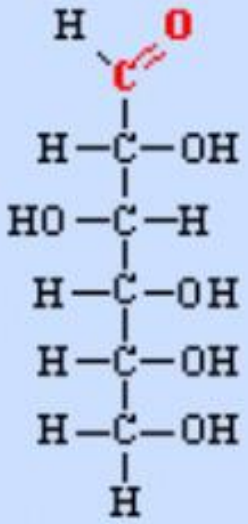
ALDOSE X CETOSE



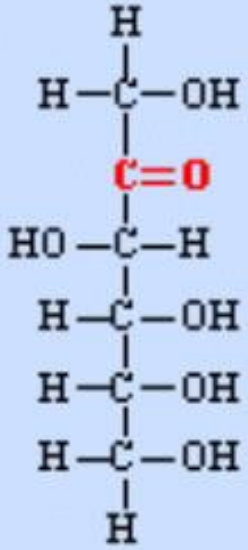
Gliceraldeído



Dihidroxiacetona



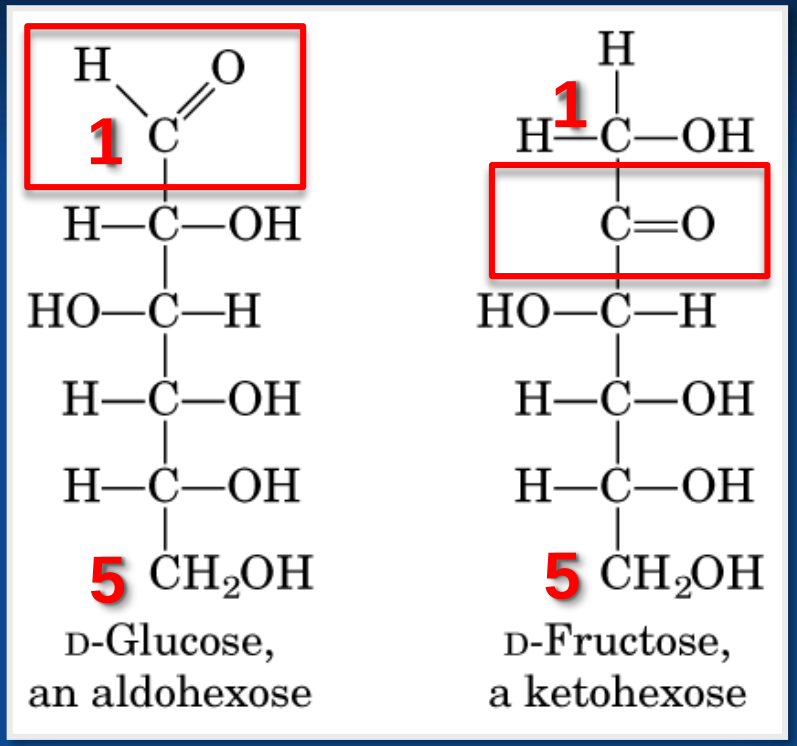
Glicose
(**aldose**)



Frutose
(**cetose**)

Estrutura dos carboidratos: fórmula planar e enantiomeria

Aldeído

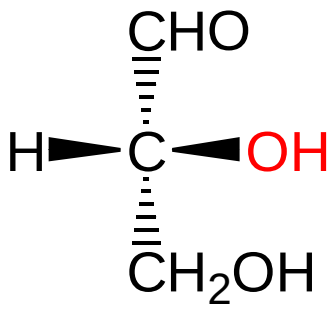


Cetona

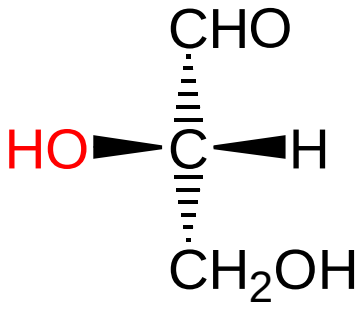
DESIGNAÇÃO D VS L

Baseado na configuração de um C assimétrico

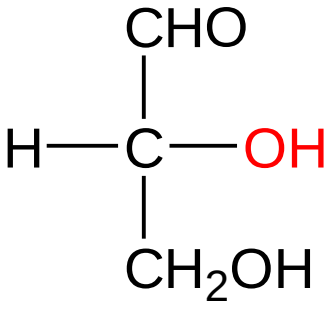
Projeções de Fischer.



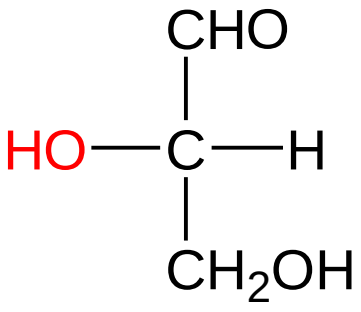
D-glyceraldehyde



L-glyceraldehyde



D-glyceraldehyde

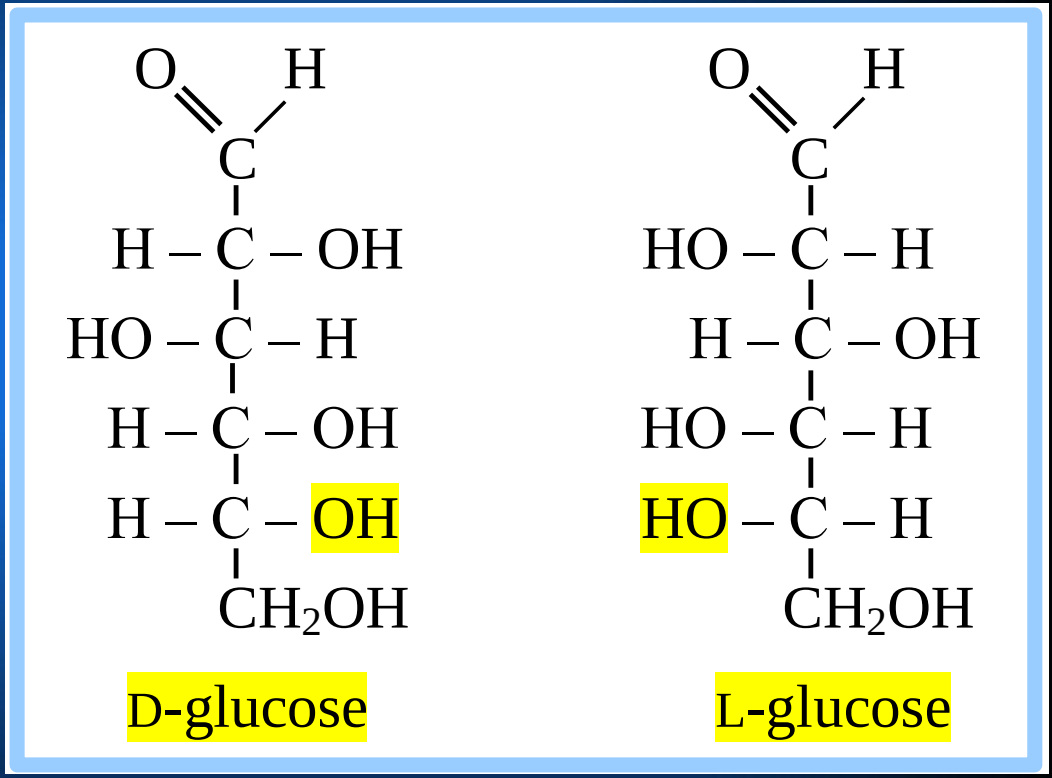


L-glyceraldehyde

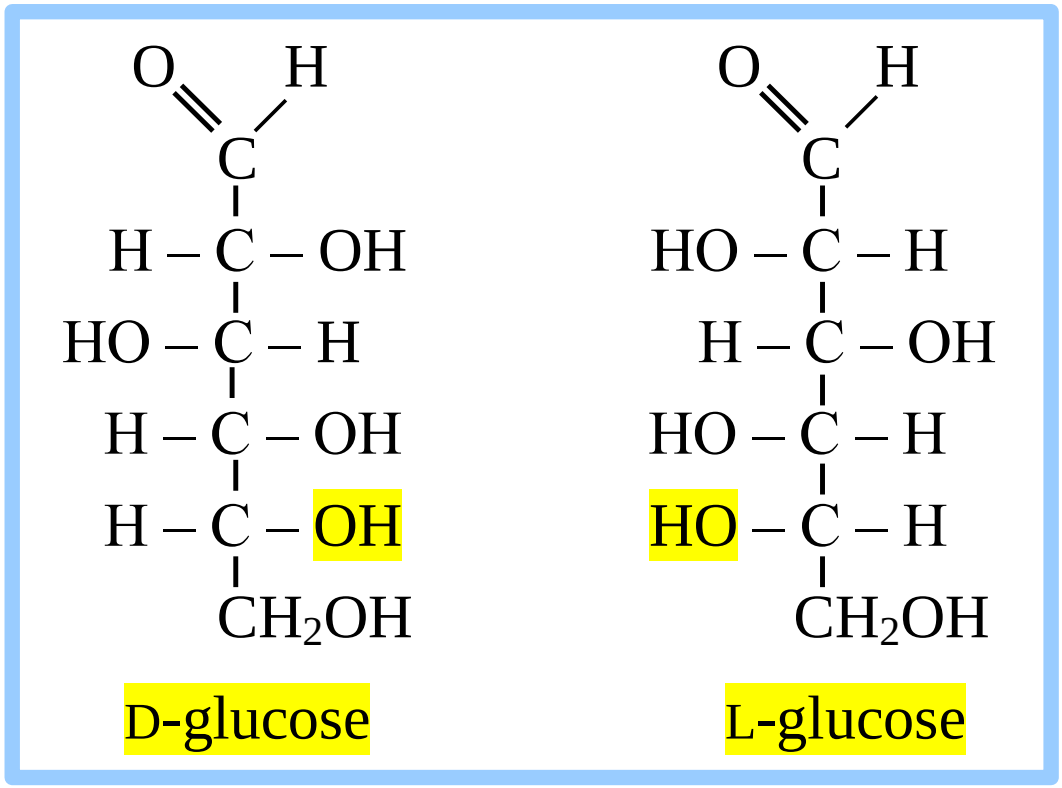
NOMENCLATURA

Para açúcares com mais de um centro **Chiral D** ou **L** refere-se ao carbono mais afastado do grupamento aldeído ou cetona.

Ocorrência natural são isômeros D.

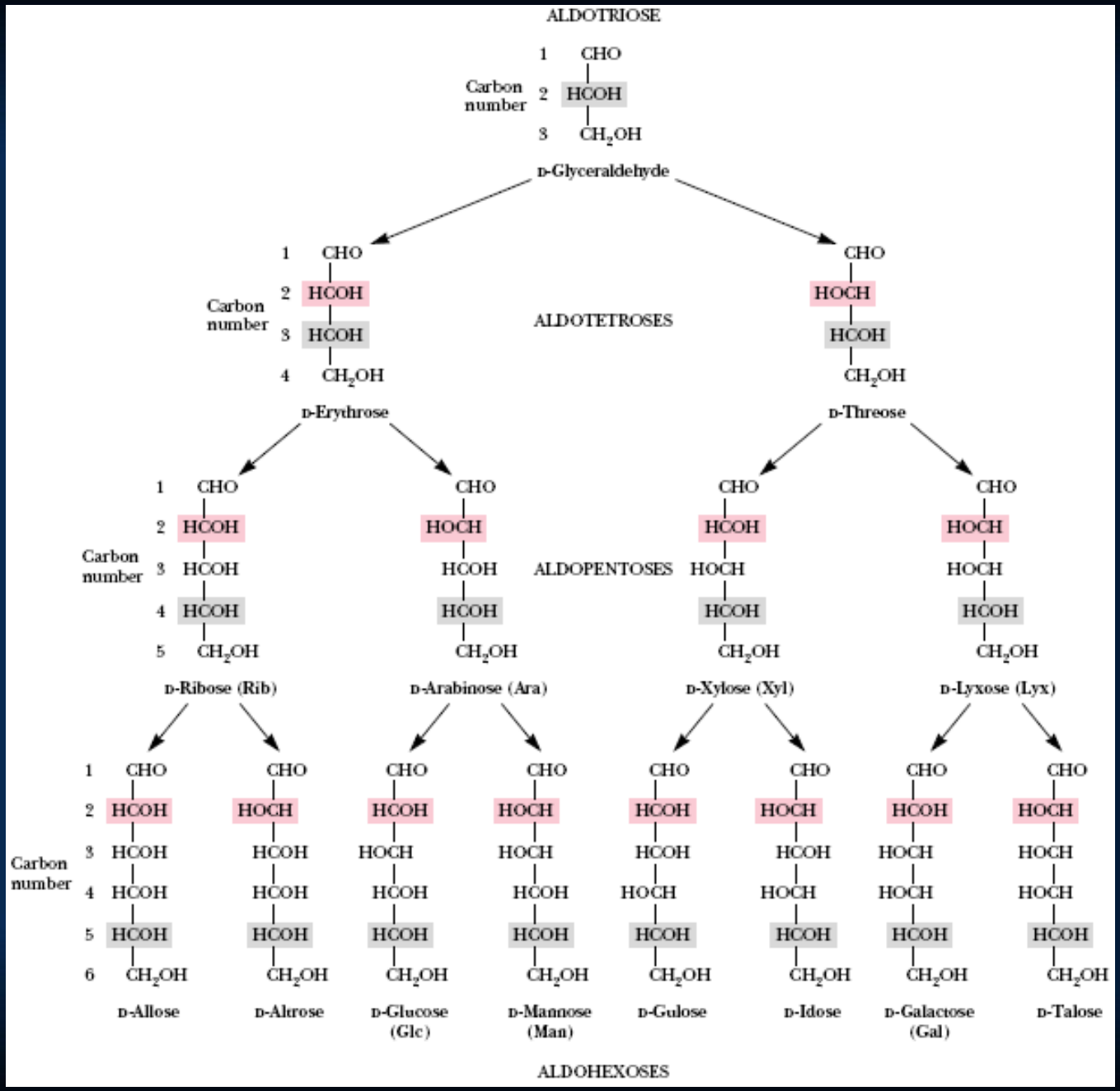


- D & L compostos são Como imagens no espelho
- Tem o mesmo Nome D-glicose & L-glicose.
- Estereoisômeros tem Nomes únicos, Ex: glicose, manose, galactose, etc.



- O números de estereoisômeros é 2^n, onde **n** é o números de centros assimétricos

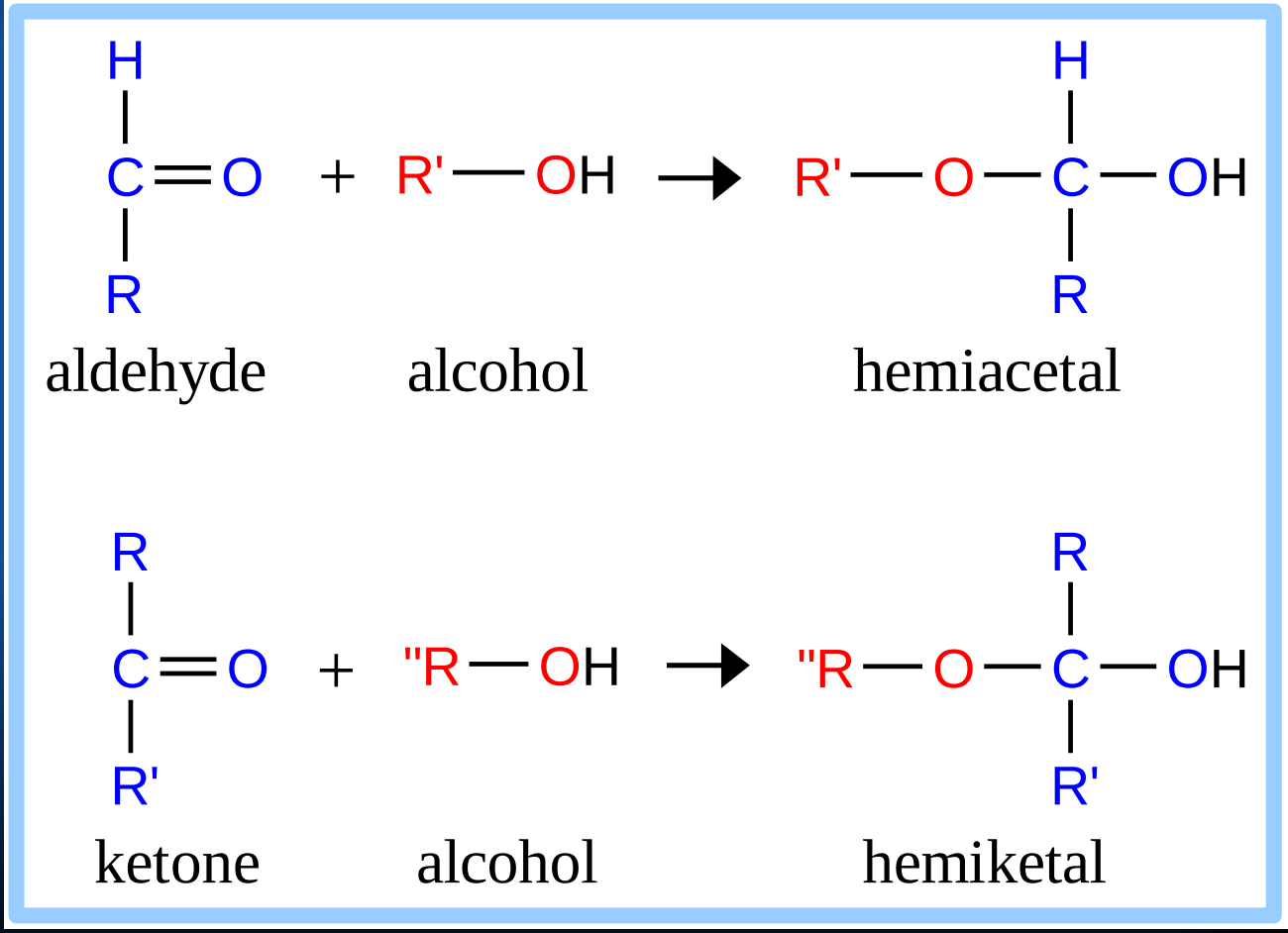
Ex: 6-C aldoses tem 4 centros assimétricos. Tem 16 estereoisômeros (8 D e 8 L).


ALDOTRIOSE
Carbon number
1 CHO
2 HCOH
3 CH2OH
D-Glyceraldehyde
ALDOTETROSES
1 CHO
2 HCOH
3 HCOH
4 CH2OH
D-Erythrose
CHO
HOCH
HCOH
CH2OH
D-Threose
ALDOPENTOSES
1 CHO
2 HCOH
3 HCOH
4 HCOH
5 CH2OH
D-Ribose (Rib)
CHO
HOCH
HCOH
HCOH
CH2OH
D-Arabinose (Ara)
CHO
HCOH
HOCH
HCOH
CH2OH
D-Xylose (Xyl)
CHO
HOCH
HOCH
HCOH
CH2OH
D-Lyxose (Lyx)
ALDOHEXOSES
1 CHO
2 HCOH
3 HCOH
4 HCOH
5 HCOH
6 CH2OH
D-Allose
CHO
HOCH
HCOH
HCOH
HCOH
CH2OH
D-Altrose
CHO
HCOH
HOCH
HCOH
HCOH
CH2OH
D-Glucose (Glc)
CHO
HOCH
HOCH
HCOH
HCOH
CH2OH
D-Mannose (Man)
CHO
HCOH
HCOH
HOCH
HCOH
CH2OH
D-Gulose
CHO
HOCH
HCOH
HOCH
HCOH
CH2OH
D-Idose
CHO
HCOH
HOCH
HOCH
HCOH
CH2OH
D-Galactose (Gal)
CHO
HOCH
HOCH
HOCH
HCOH
CH2OH
D-Talose

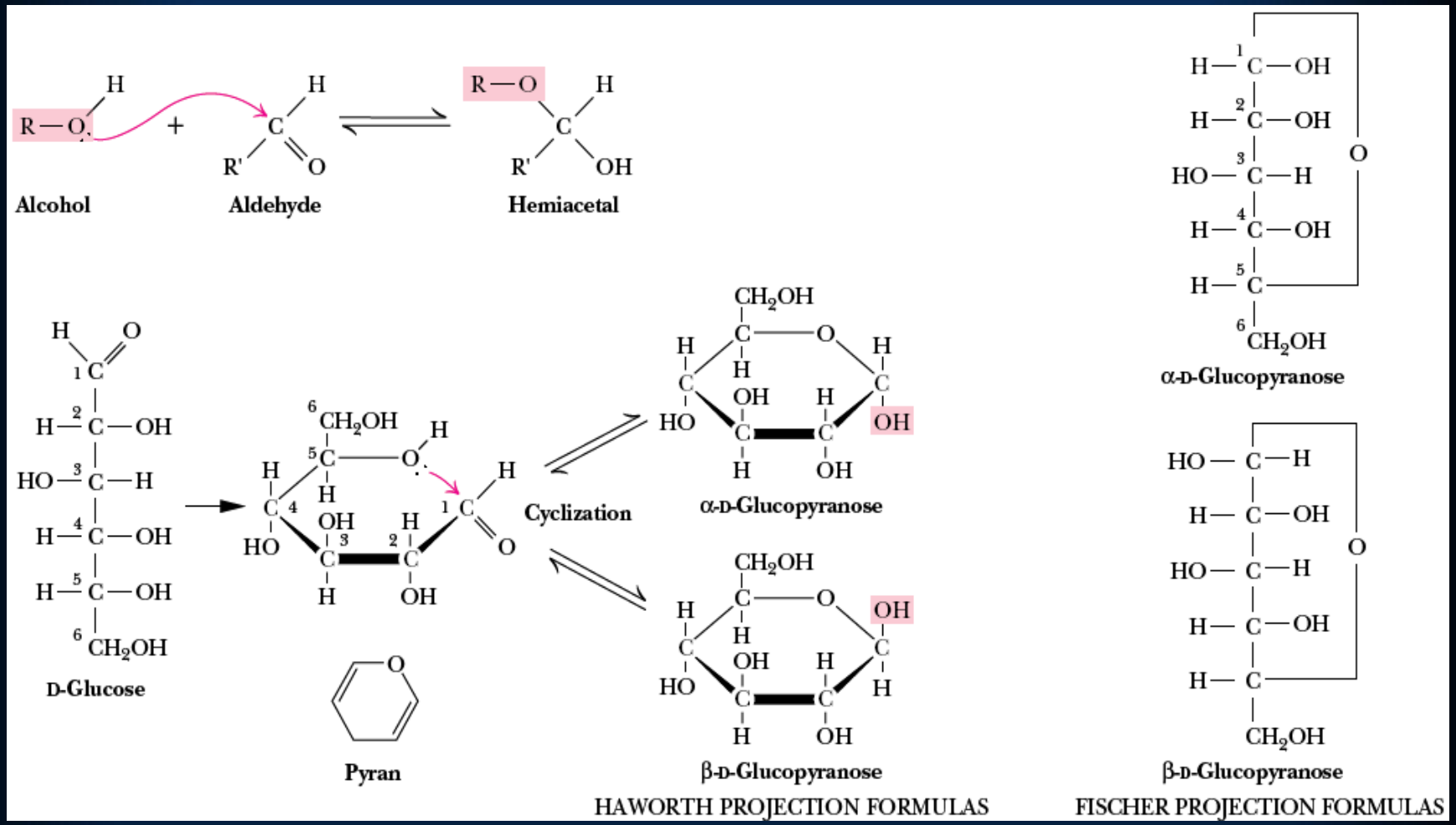
HEMIACETAL & HEMICETAL

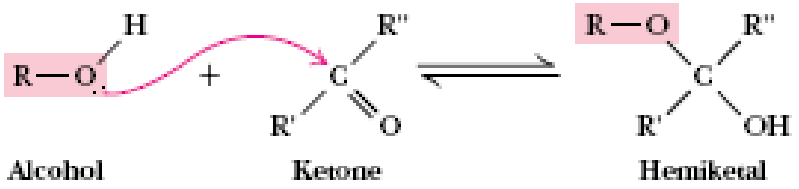
Um aldeído pode reagir com um álcool formando um hemiacetal.

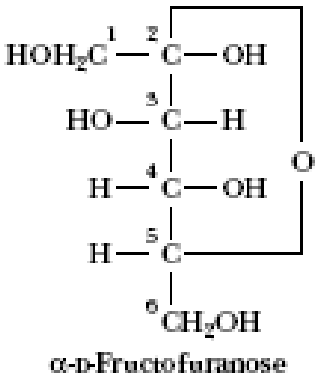
Uma cetona pode reagir com um álcool formando um hemicetal.

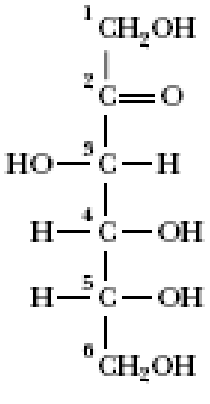


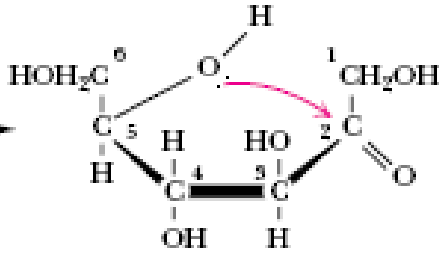
CICLIZAÇÃO DE MONOSSACARÍDEOS

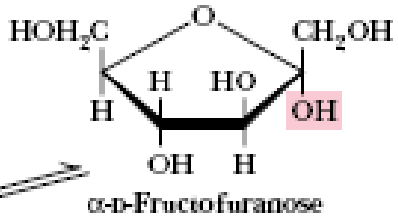




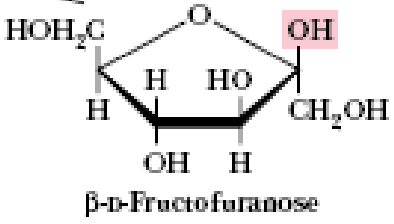




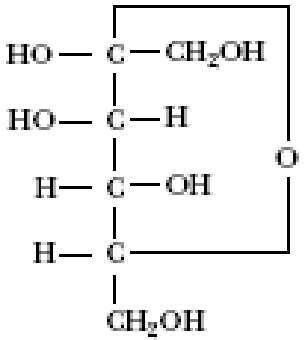




Cyclization

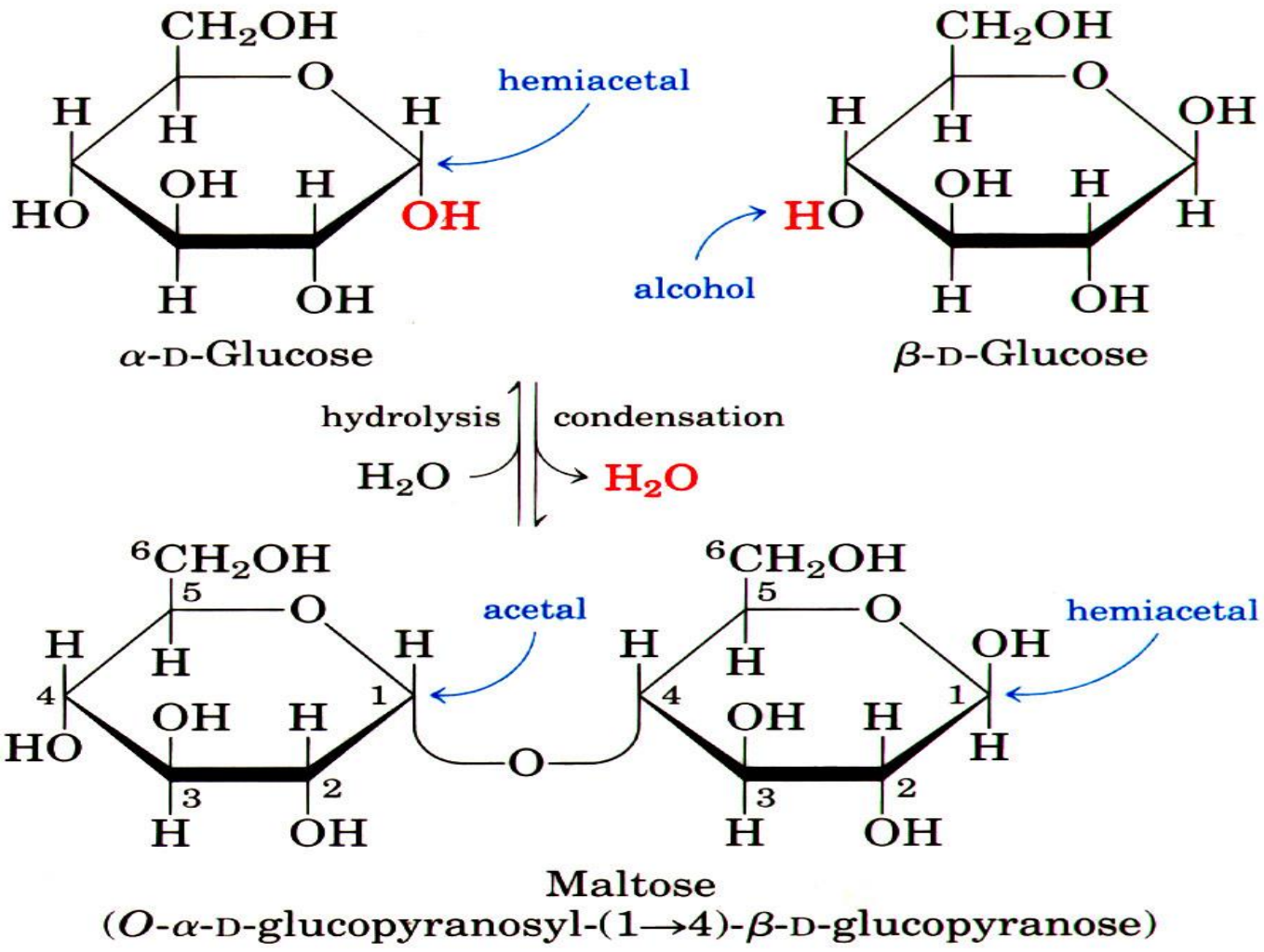


HAWORTH PROJECTION FORMULAS

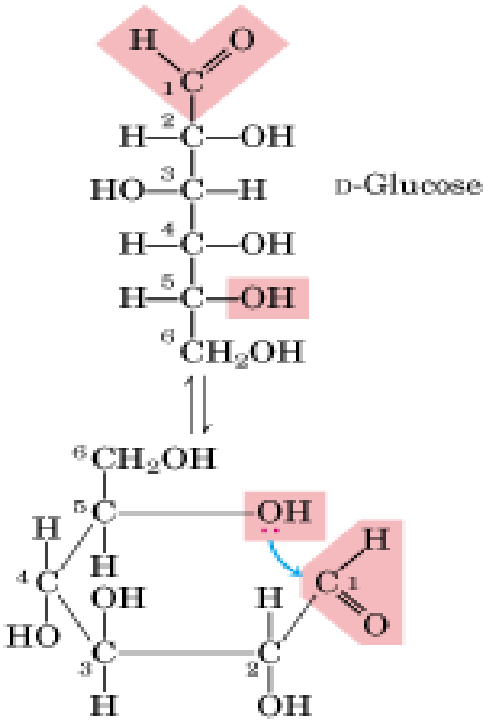


FISCHER PROJECTION FORMULAS

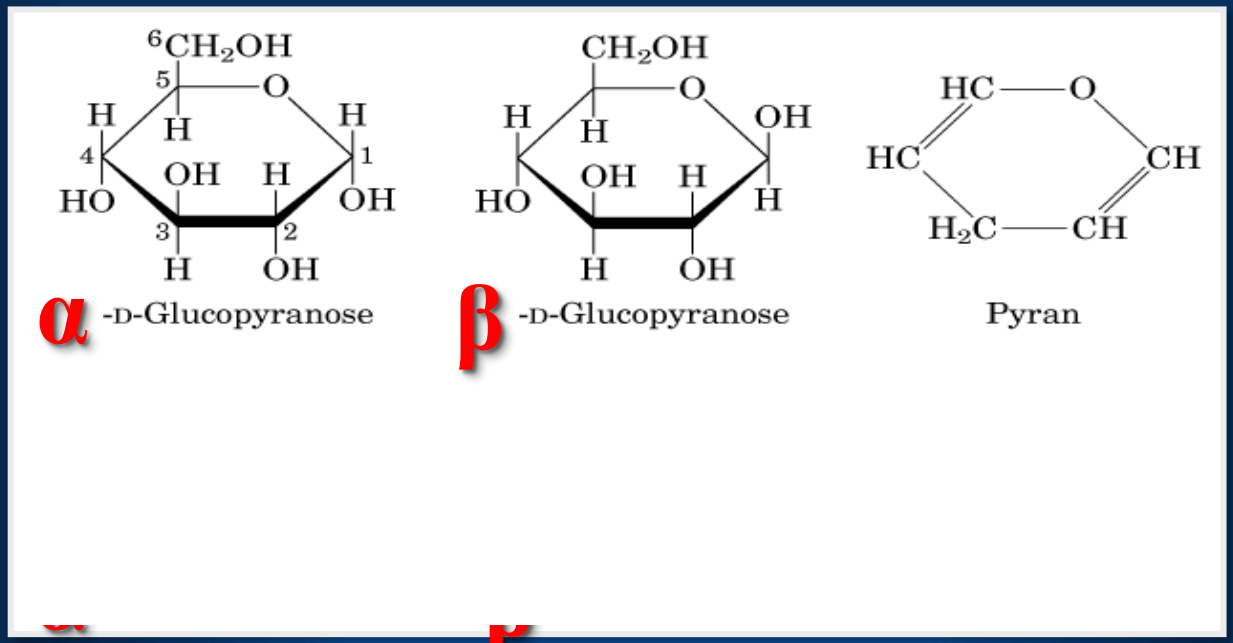
LIGAÇÃO GLICOSÍDICA (MALTOSE)



Estrutura dos carboidratos: Ciclização



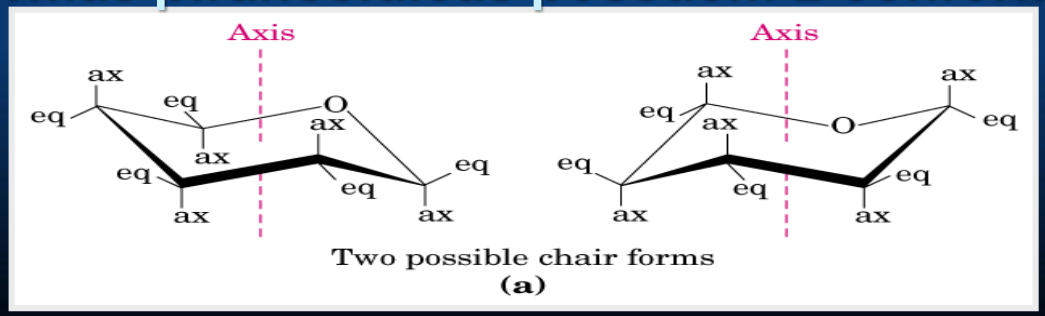
Estrutura dos carboidratos: piranoses e furanoses

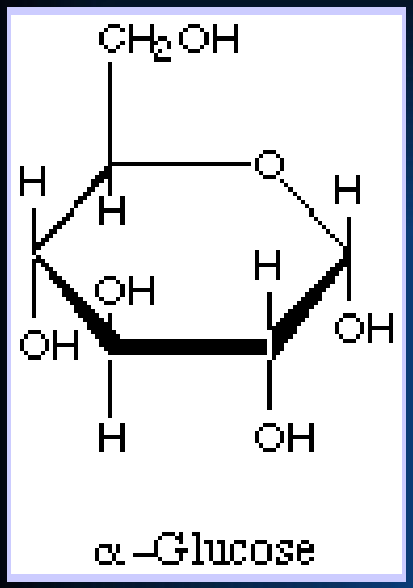


Hexágono

Pentágono

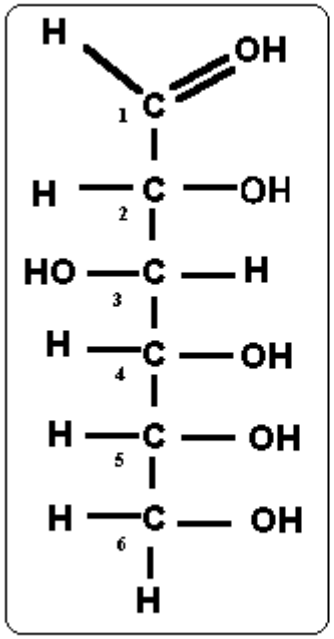
Formas piranosídicas possuem 2 conformações



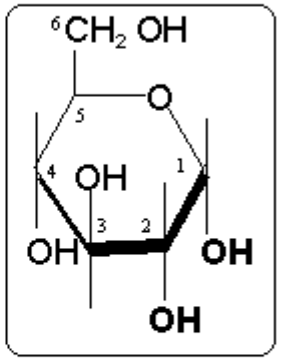


α –Glucose

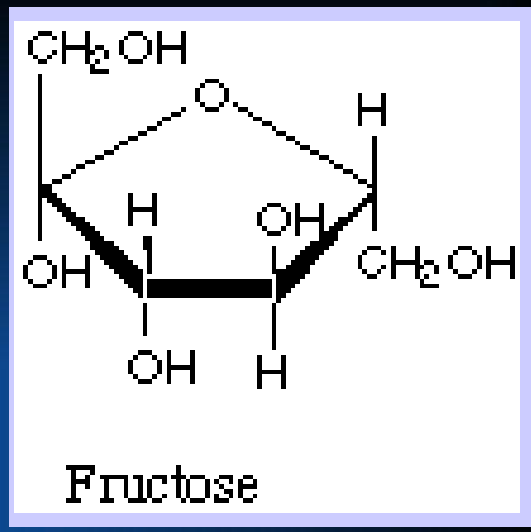
GLICOSE



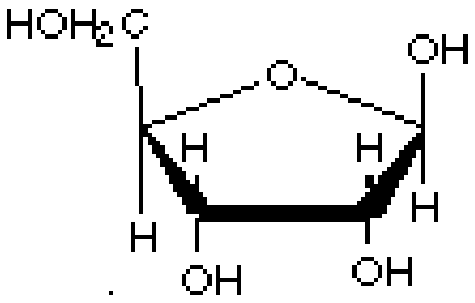
forma linear



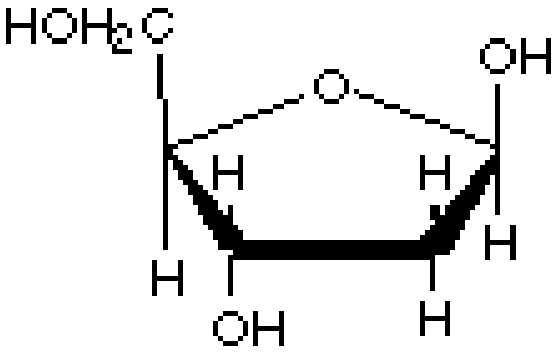
forma cíclica



Fructose



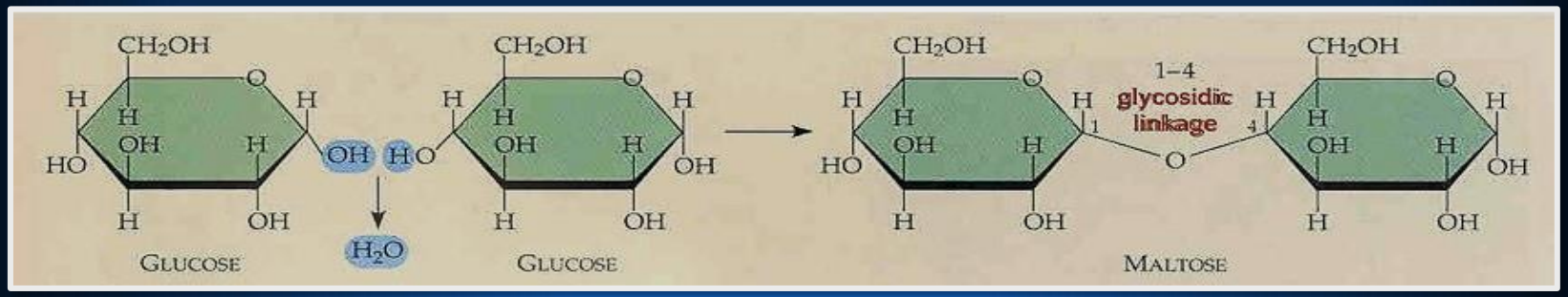
Ribose
(in RNA)



Deoxyribose
(in DNA)

Ligações glicosídicas

Ligação *O*-glicosídica



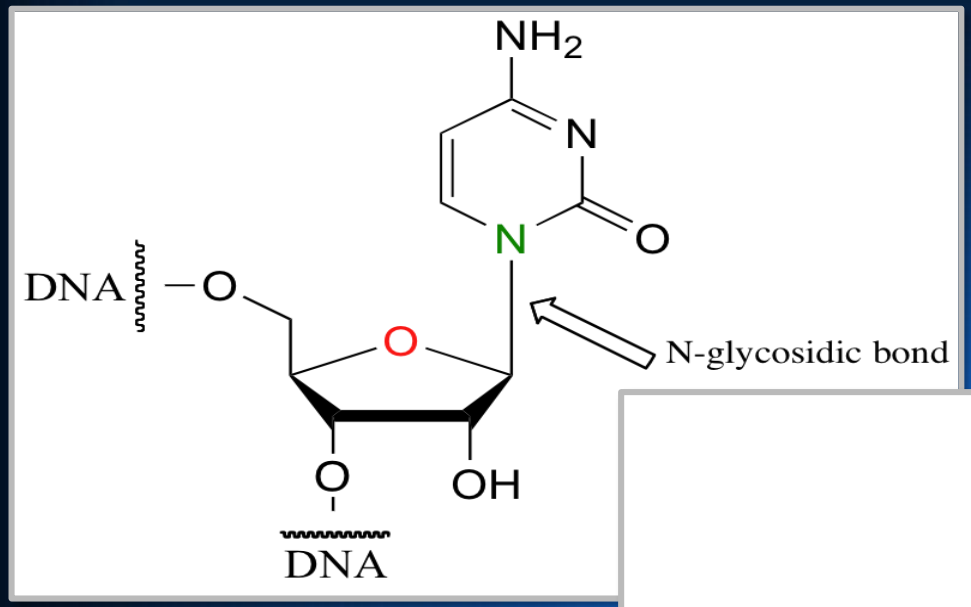
Glicose-α(1→4)-glicose

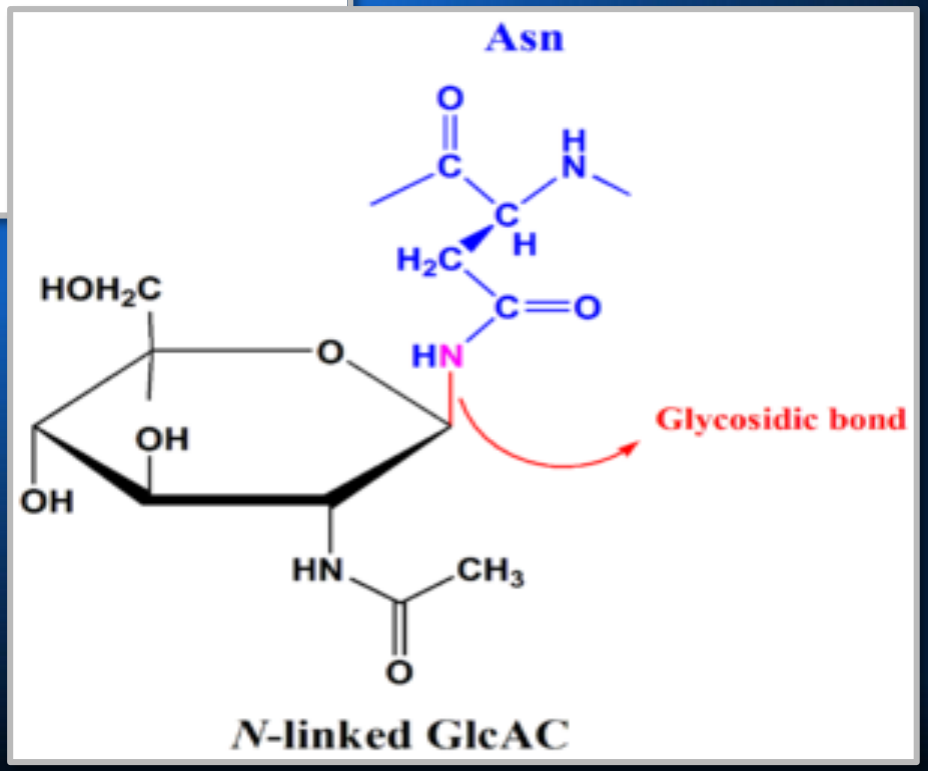
Cerveja!

Amido

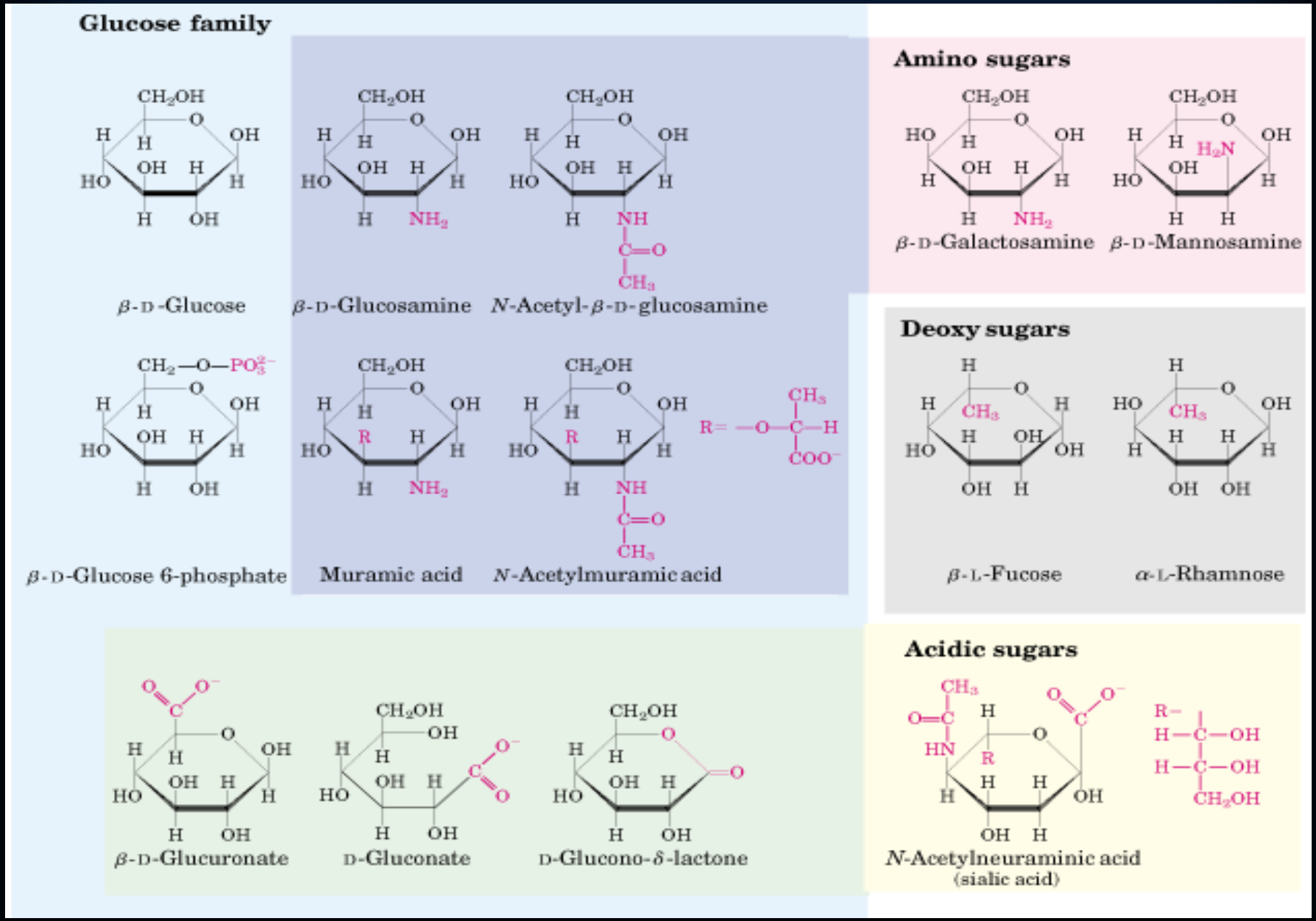
Malte (principalmente maltose)

Ligações N-glicosídicas





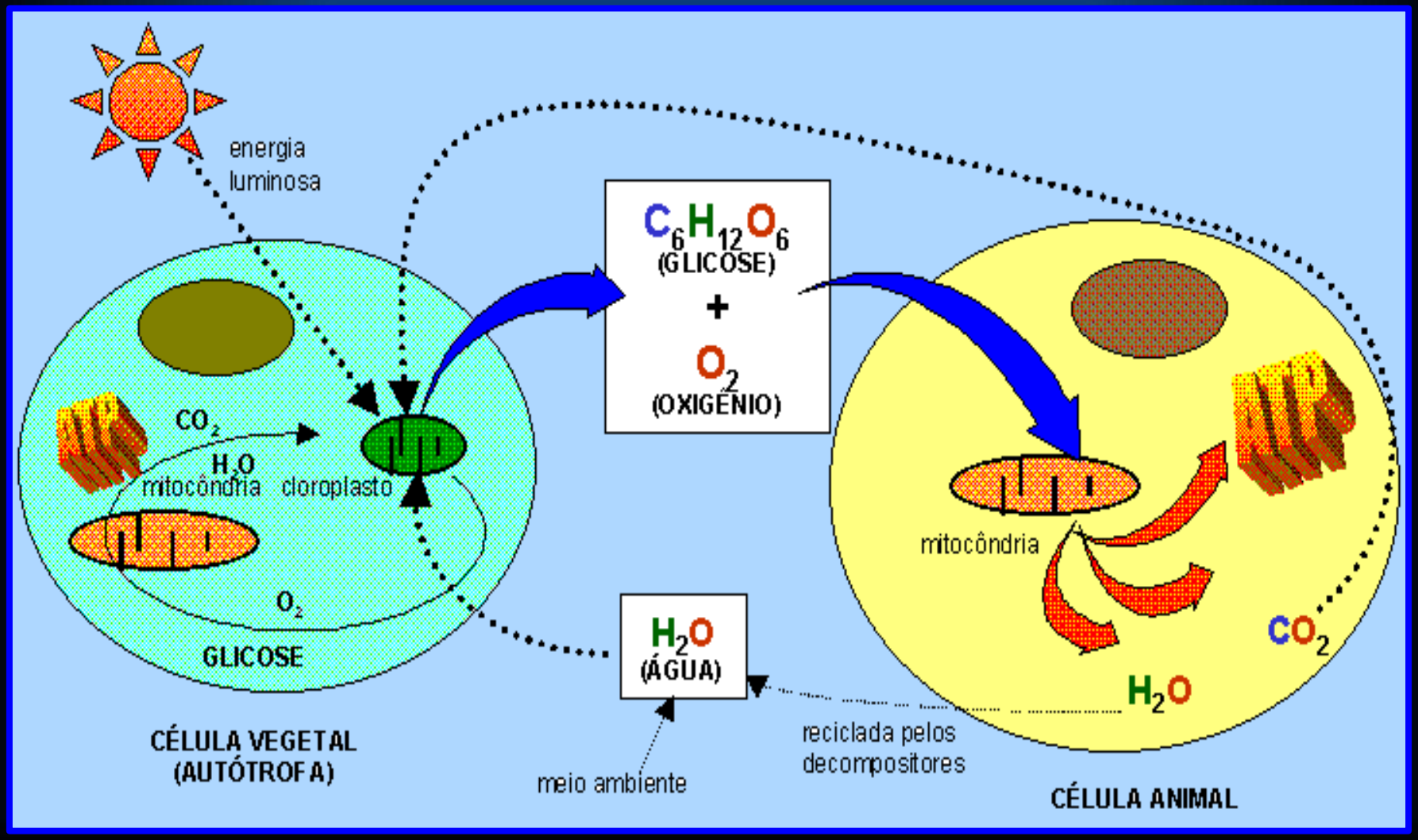
Monosacarídeos modificados



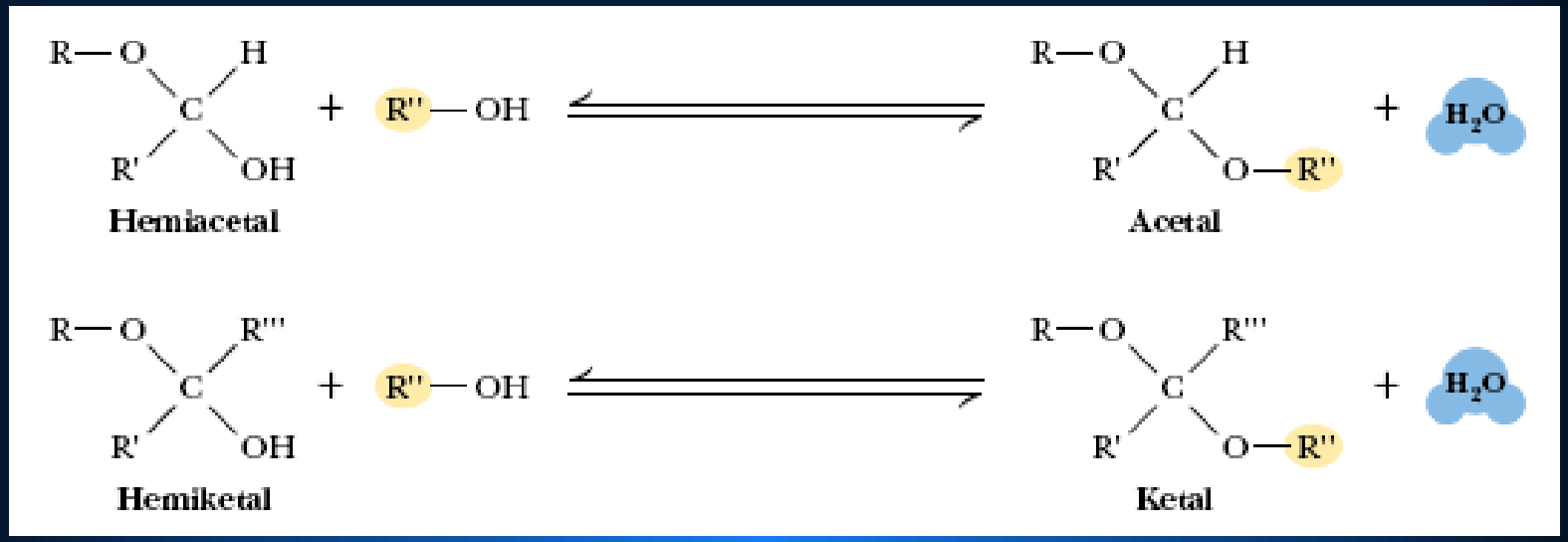
OXIDAÇÃO

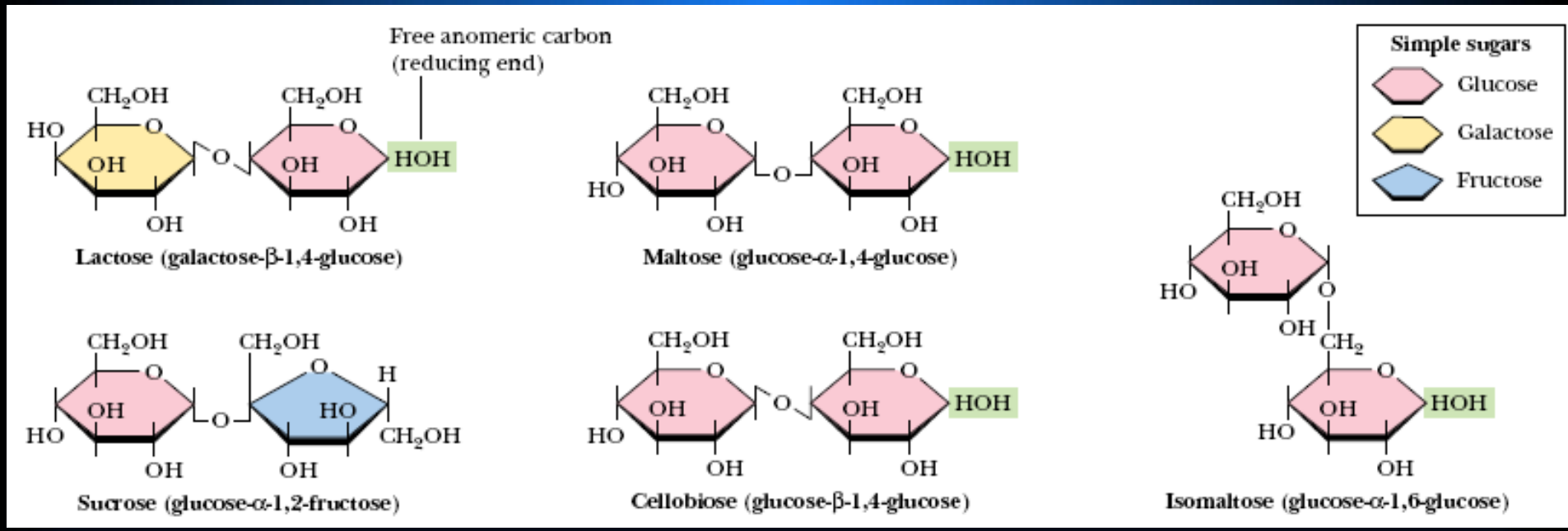
- A oxidação do açúcar fornece energia para a realização dos processos vitais dos organismos.
- A oxidação (completa) fornece CO_2 e H_2O.
- Cada grama fornece aproximadamente 4 kcal, independente da fonte.
- O oposto desta oxidação é o que ocorre na fotossíntese.

OXIDAÇÃO DA GLICOSE



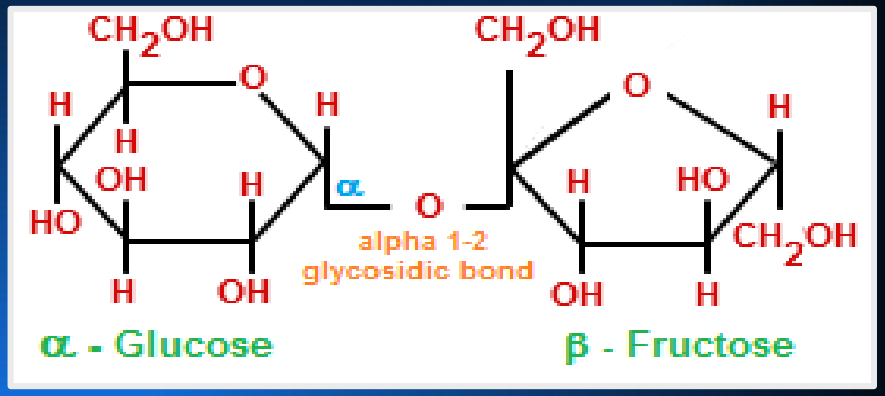
Dissacarídeos



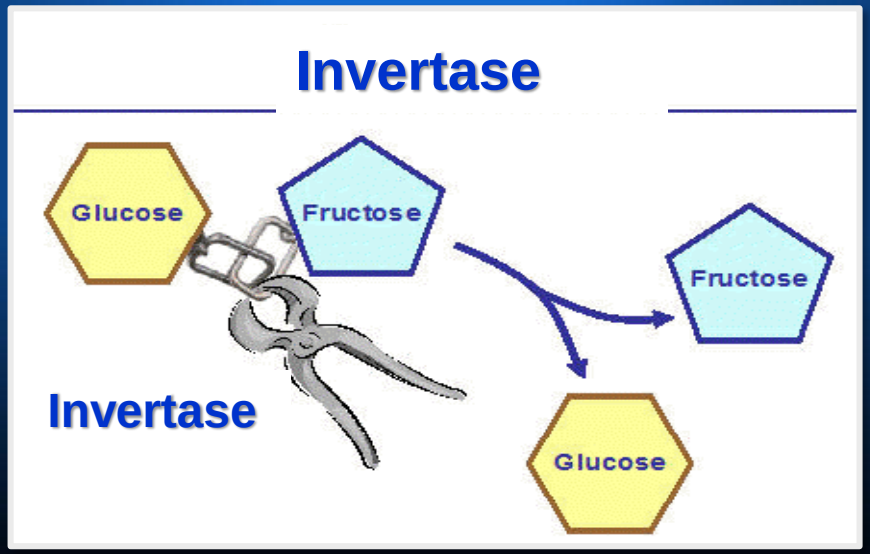


Dissacarídeos

Sacarose

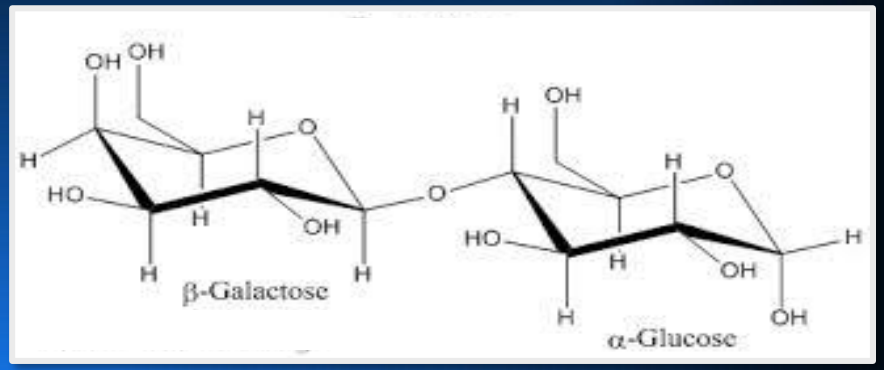


Glicose-α(1→β2)-frutose

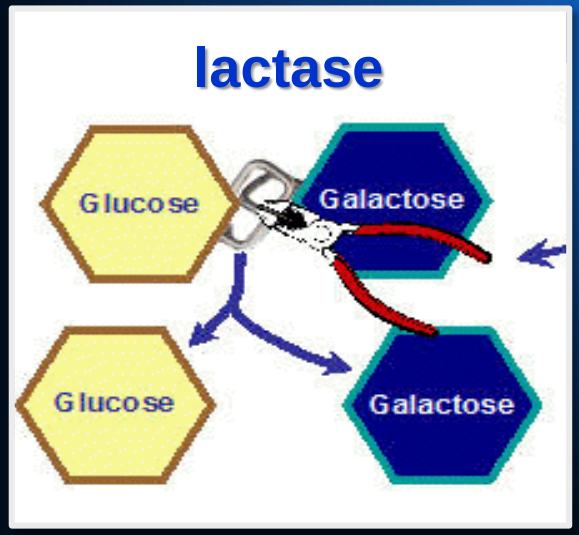


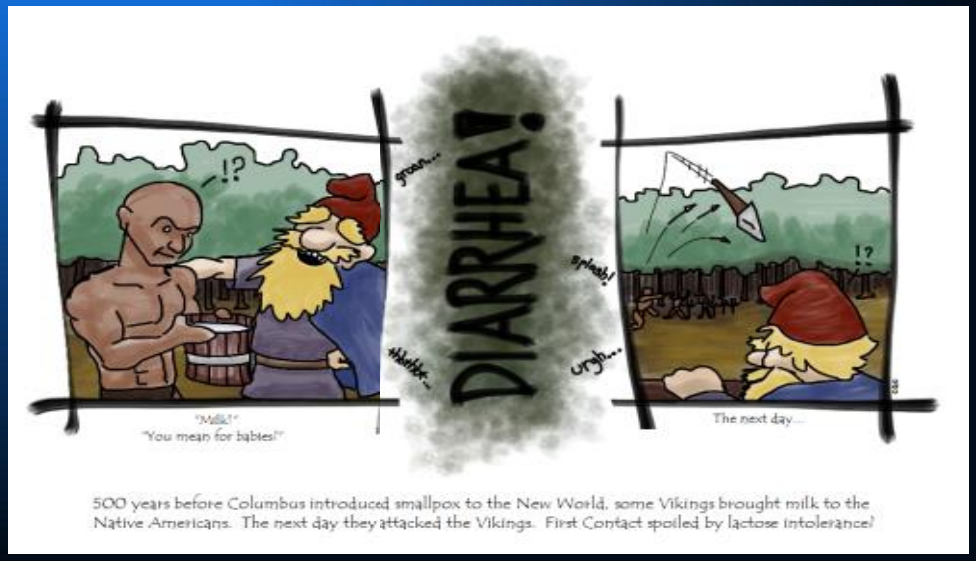
Dissacarídeos

Lactose



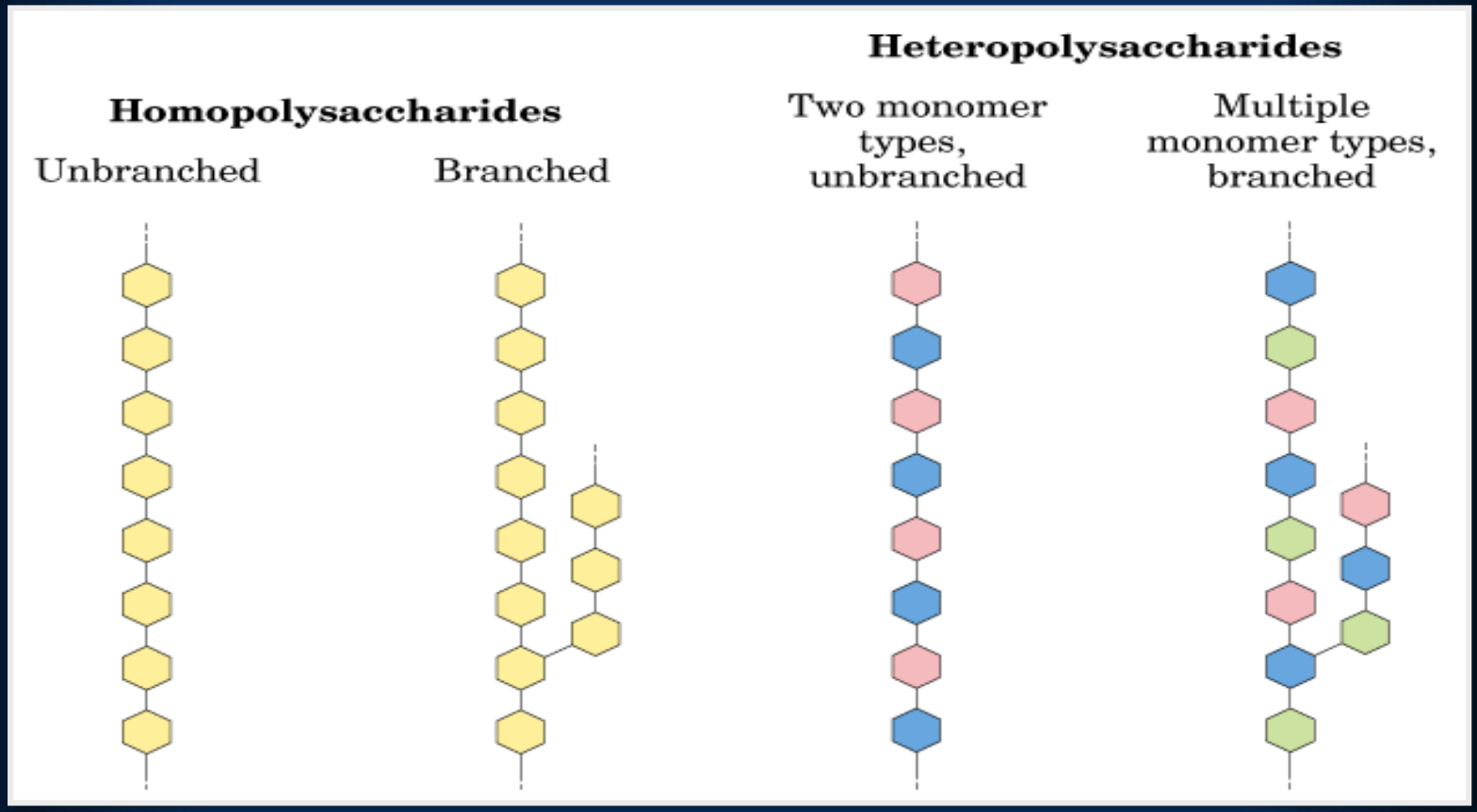
Galactose-*β*(1→4)-glicose





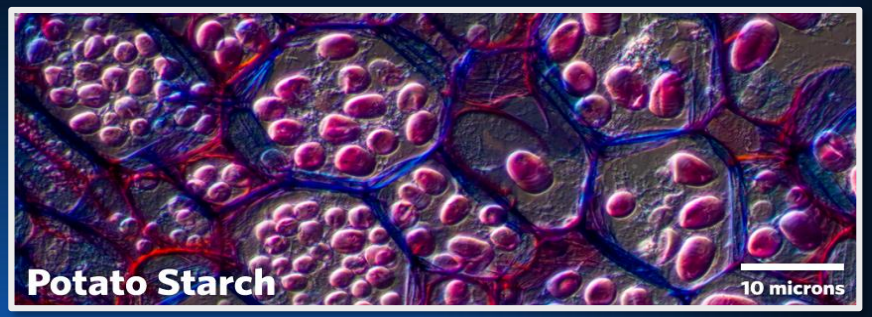
Intolerância a lactose

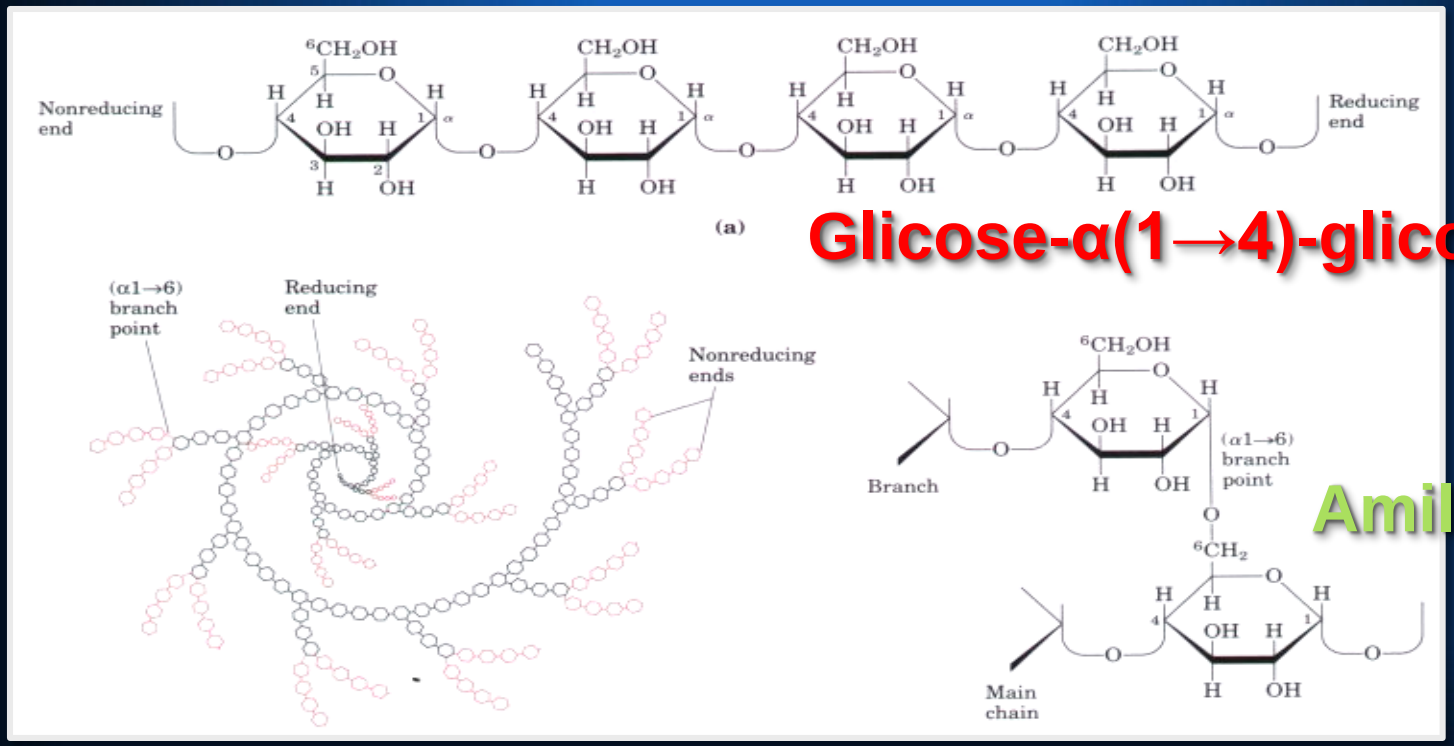
Polissacarídeos:



POLISSACARÍDEO	FUNÇÃO E FONTE
Glicogênio	Açúcar de reserva energética de animais e fungos
Amido	Açúcar de reserva energética de vegetais e algas
Celulose	Função estrutural. Compõe a parede celular das células vegetais e algas
Quitina	Função estrutural. Compõe a parede celular de fungos e o exoesqueleto de artrópodes
Ácido hialurônico	Função estrutural. Cimento celular em células animais

Polissacarídeos: Amido





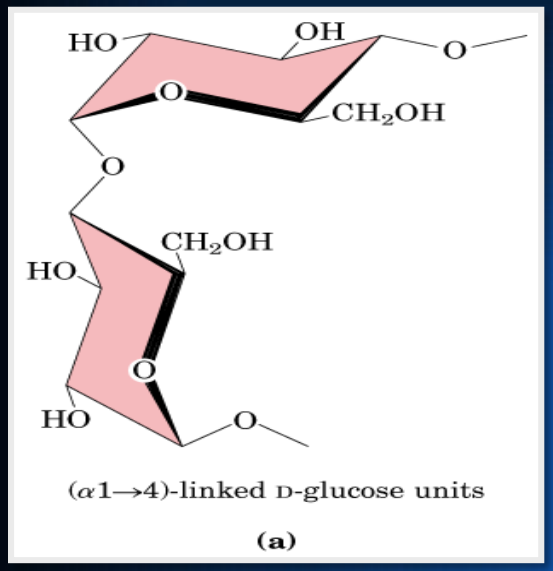
Amilose

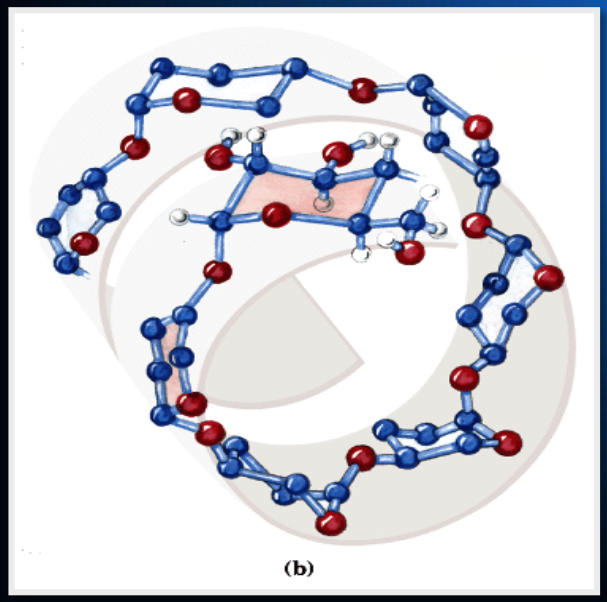
Glicose-α(1→4)-glicose

Amilopectina

Glicose-α(1→6)-glicose

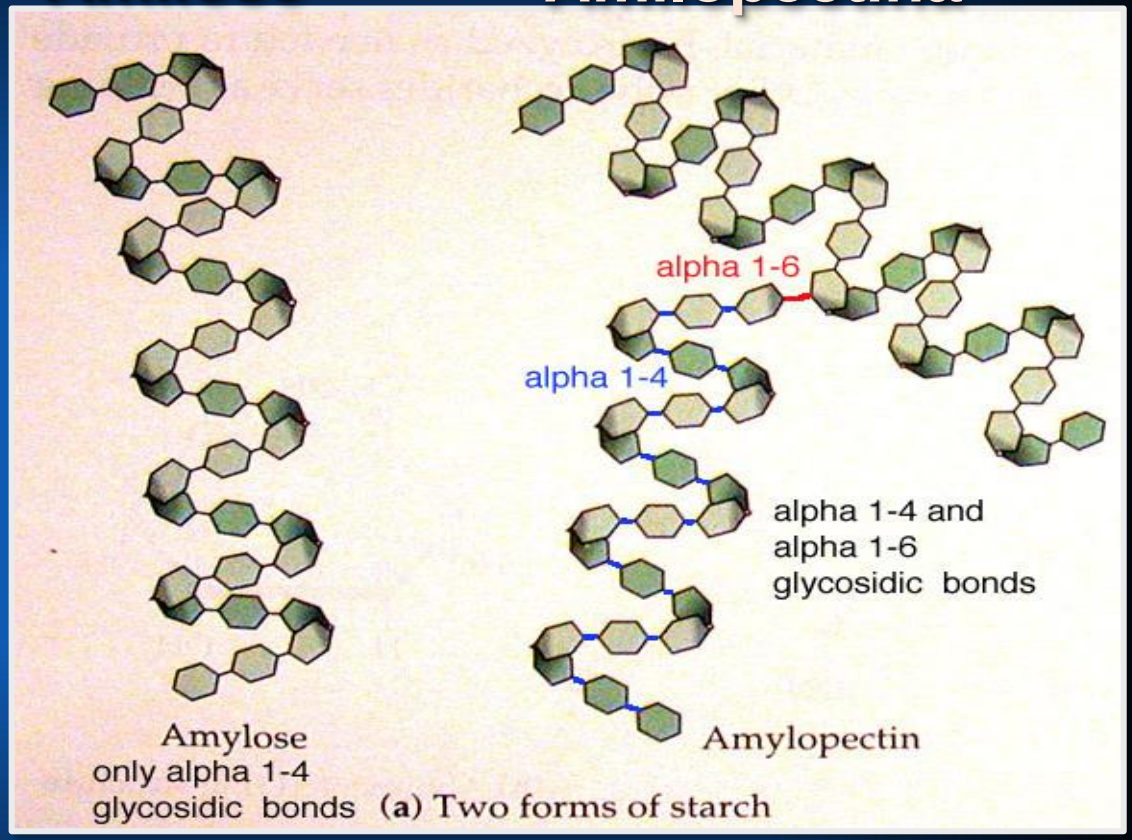
Polissacarídeos: Amido





Amilose

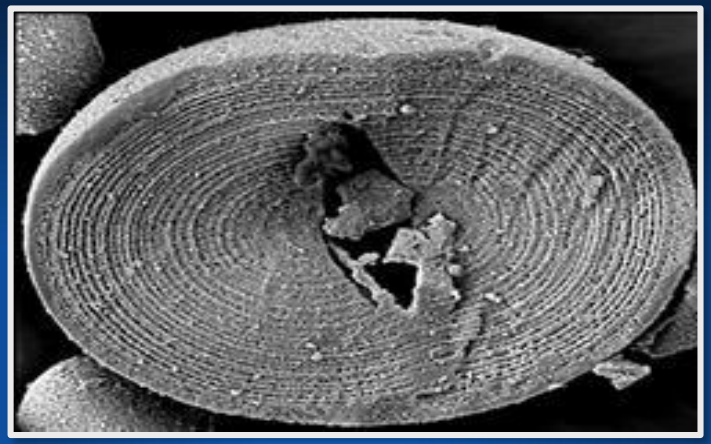
Amilopectina

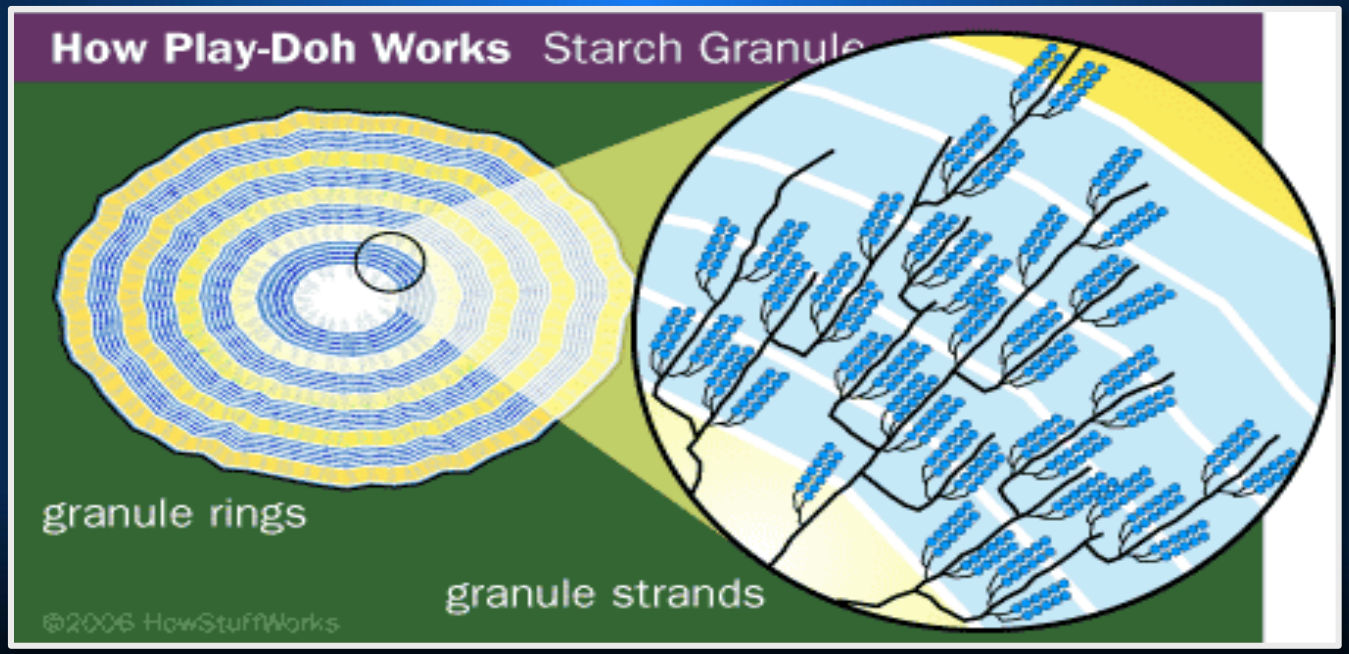


Amilopectina: ligações glicosídicas (α1→4) e (α1→6) a cada 24 a 30 resíduos

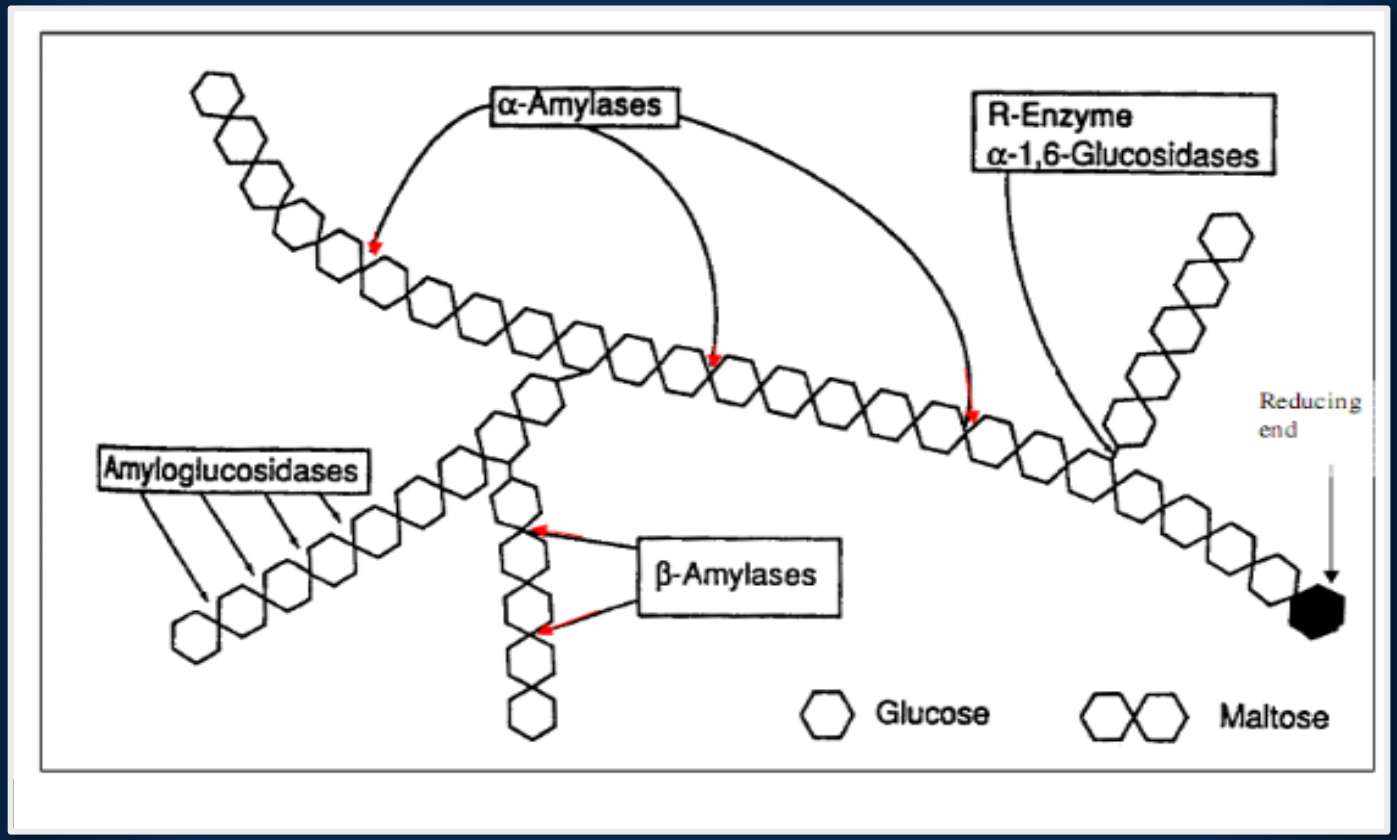
Polissacarídeos: Amido

grânulo de amido

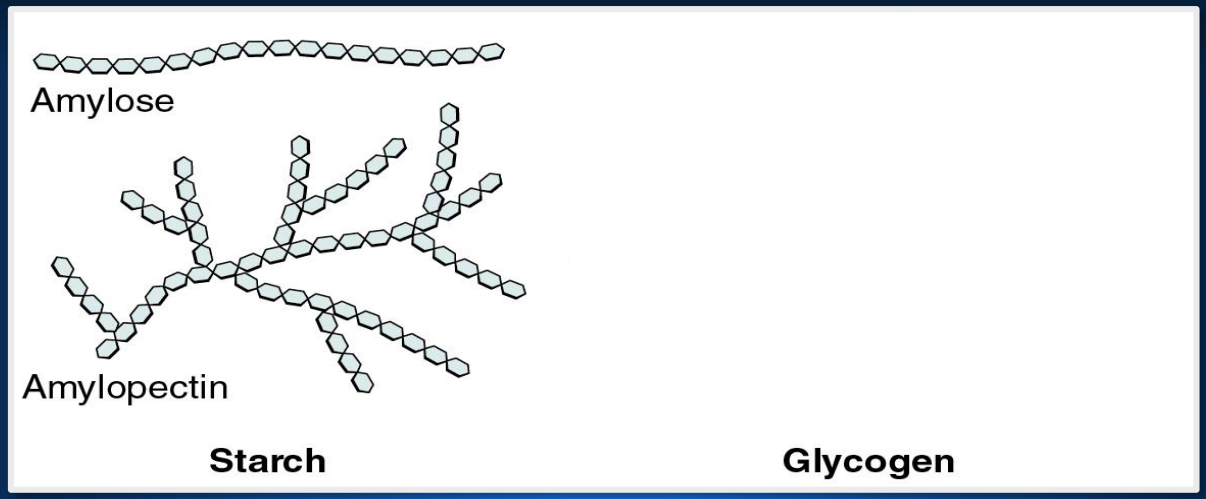


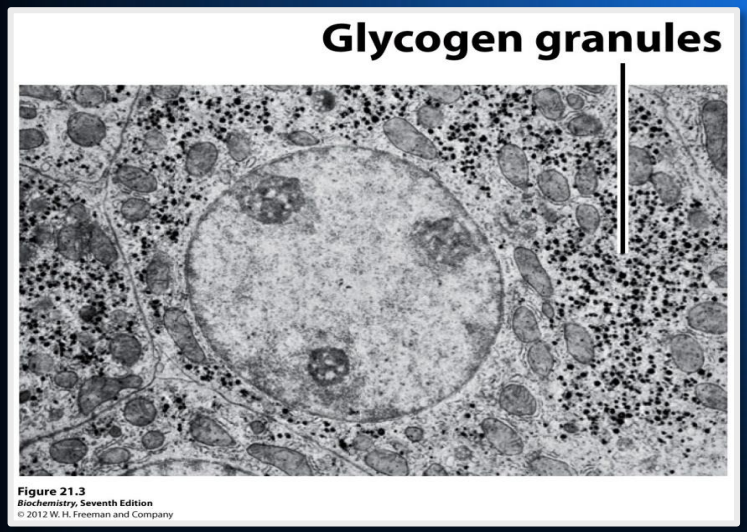


Polissacarídeos: Amido



Polissacarídeos: Glicogênio

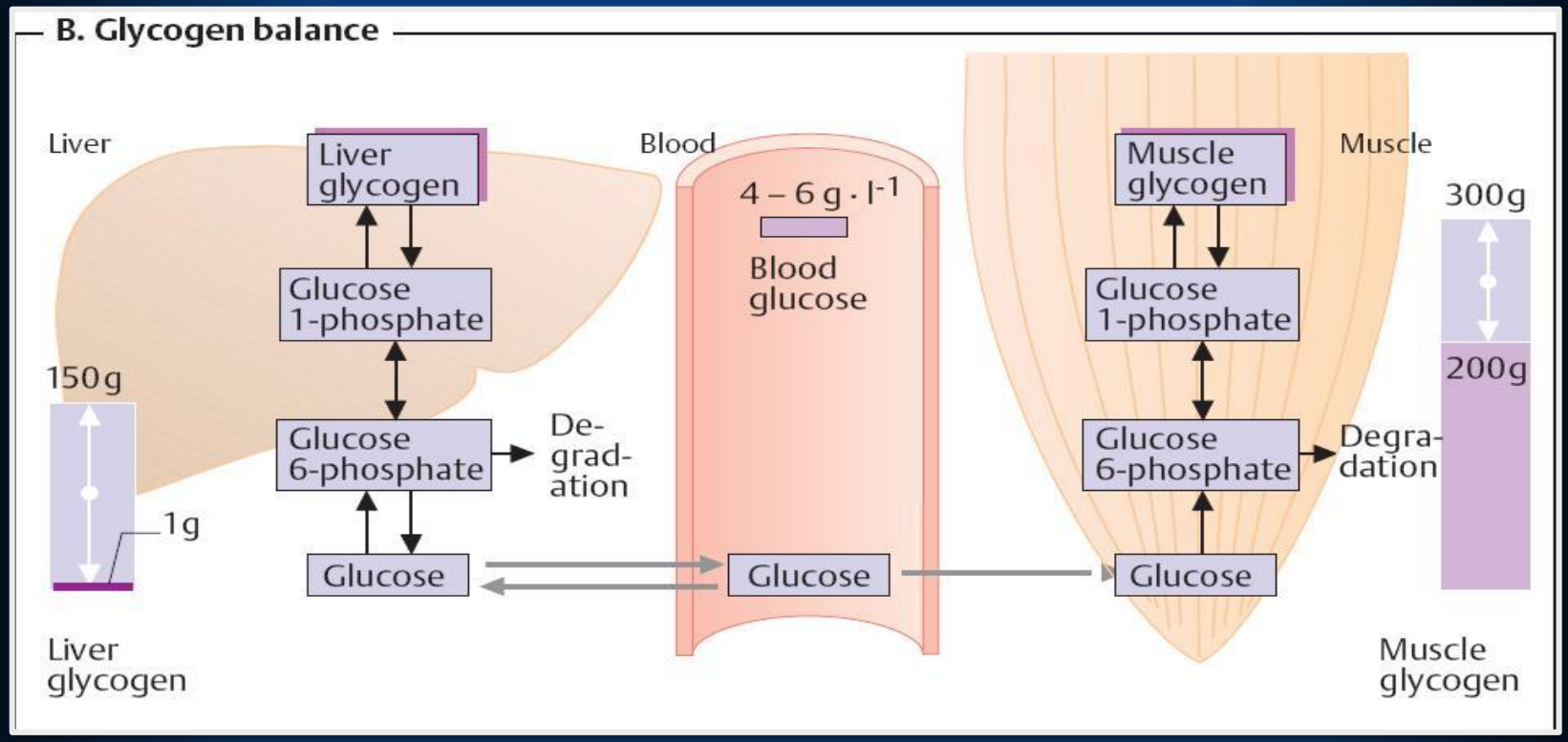




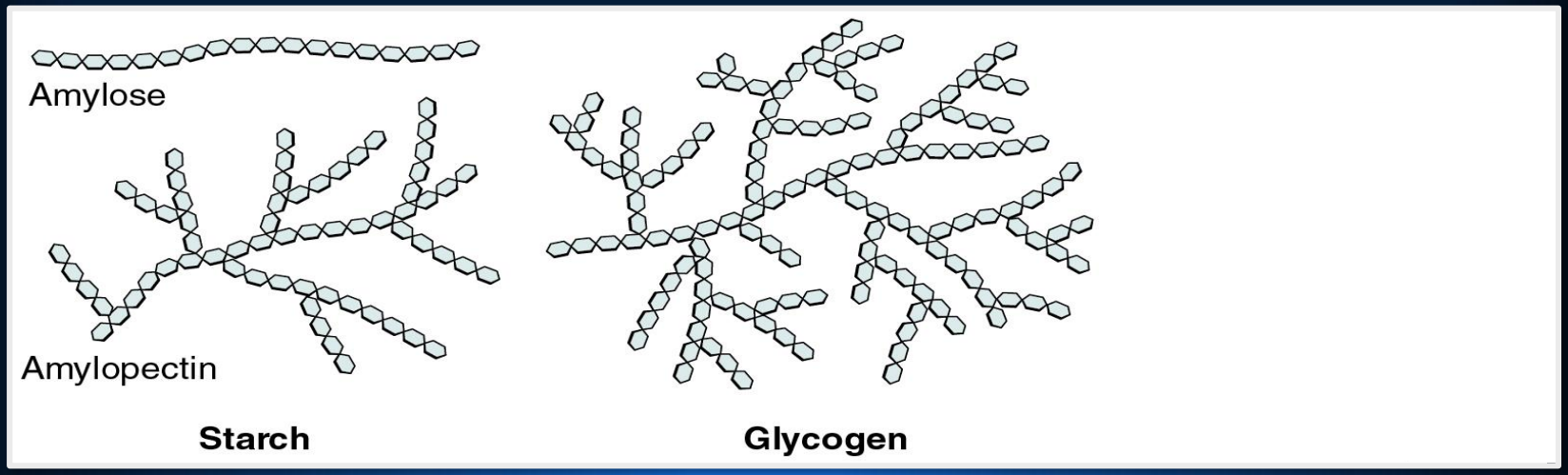
Similar à amilopectina, porém mais densamente ramificado: cada ramo 8-12 resíduos

Encontrado no fígado e músculos esqueléticos

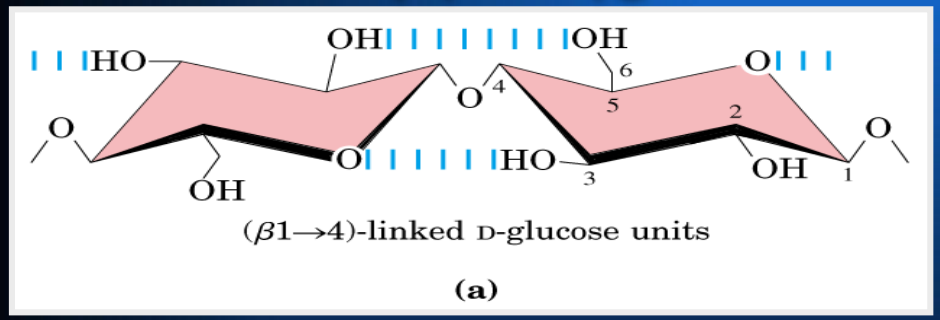
Polissacarídeos: Glicogênio

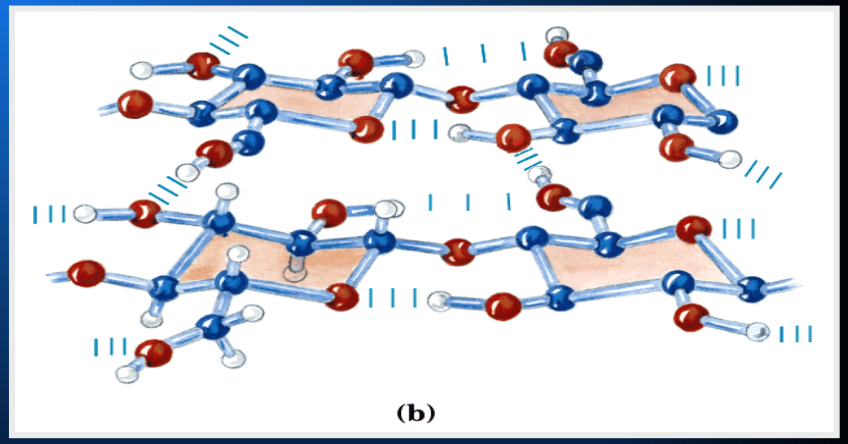


Polissacarídeos: Celulose



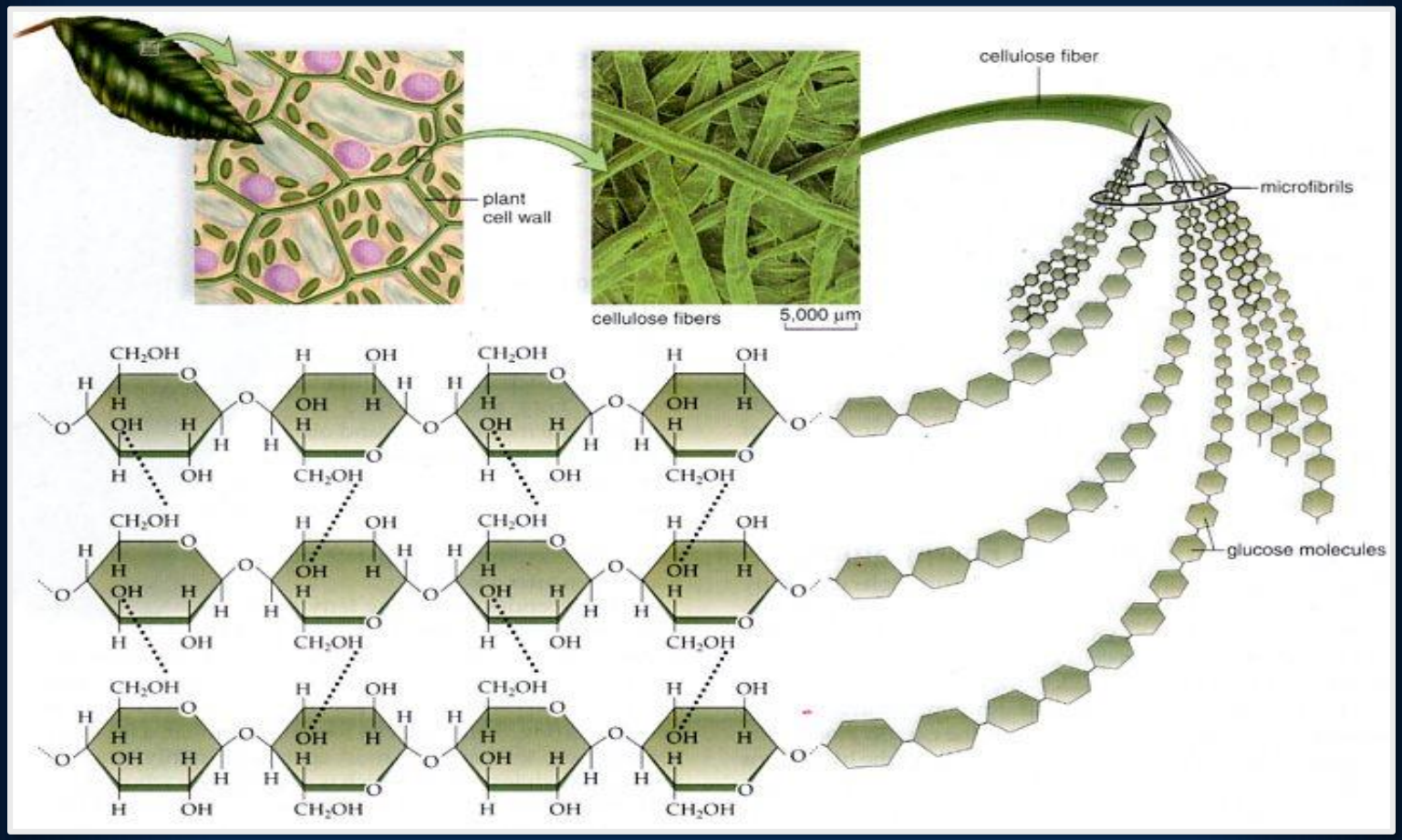
Glicose-$\beta(1\rightarrow4)$glicose





(flip 180° de cada unidade)

Polissacarídeos: Celulose

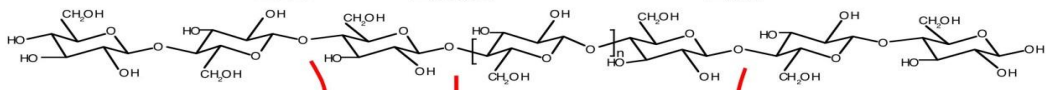


10.000 a 15.000 D-glicose cadeias lineares alinhadas lado a lado e estabilizadas por ligacões de H intra- e intercadeias

Polissacarídeos: Celulose

Cellulases

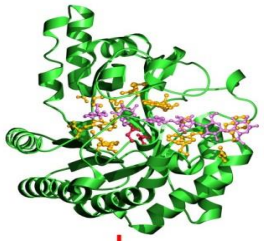
Exo ***Endo*** ***Exo***



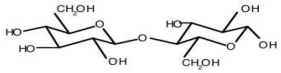
Cellobiohydrolase

Acting from non-reducing end

E.g. Piromyces sp. E2 Cel6A



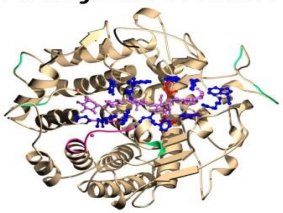
Product - cellobiose



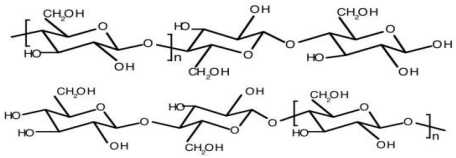
Endoglucanase

Acting from the middle

E.g. Piromyces E2 Cel9A



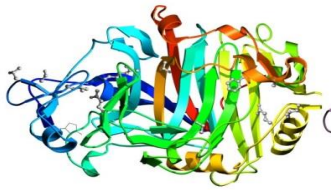
Product - oligosaccharides of different sizes



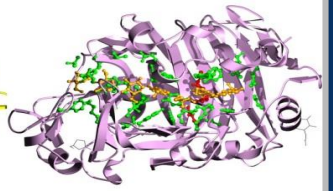
Cellobiohydrolase

Acting from reducing end

E.g. Phanerochaete Cel7s

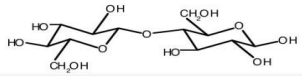


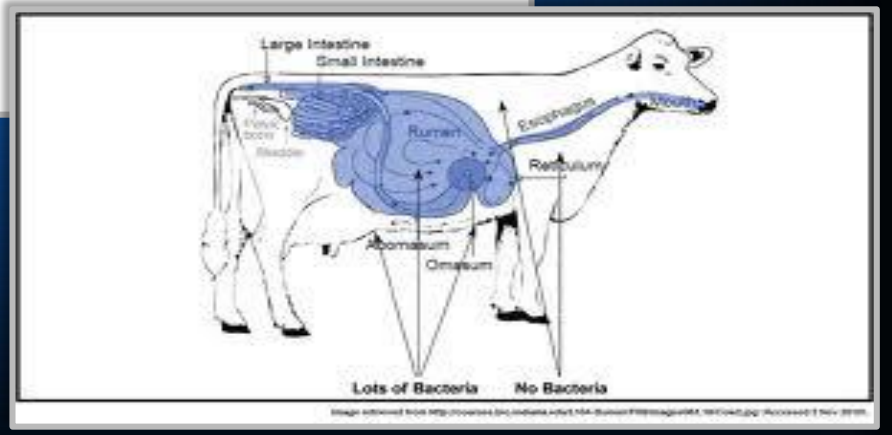
Pc_Cel7A



Pc_Cel7D

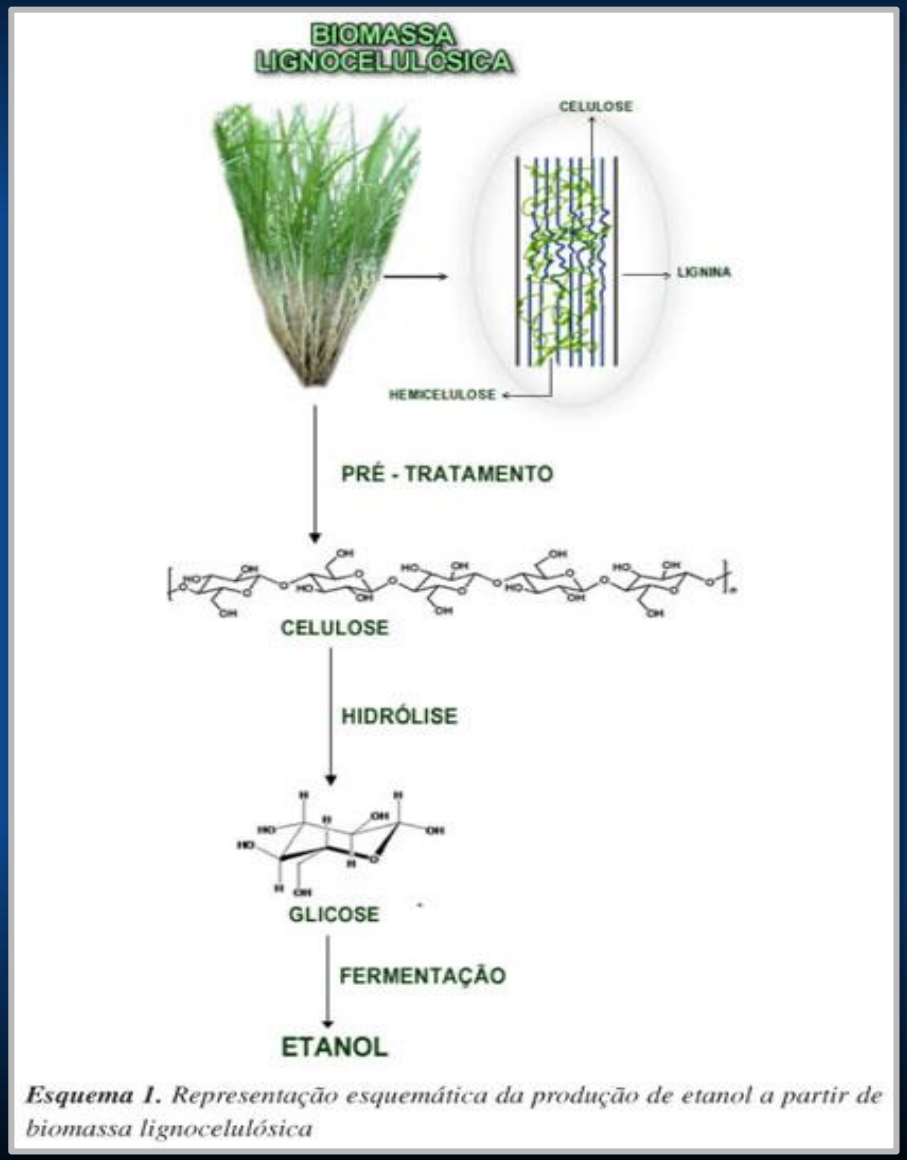
Product - cellobiose





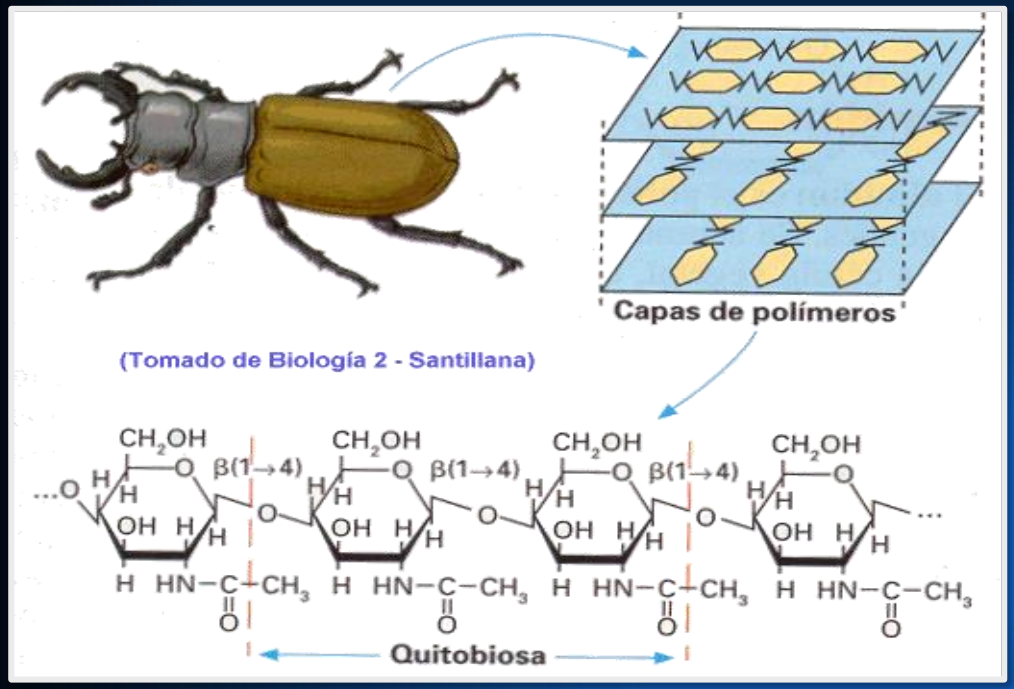
Polissacarídeos: Celulose

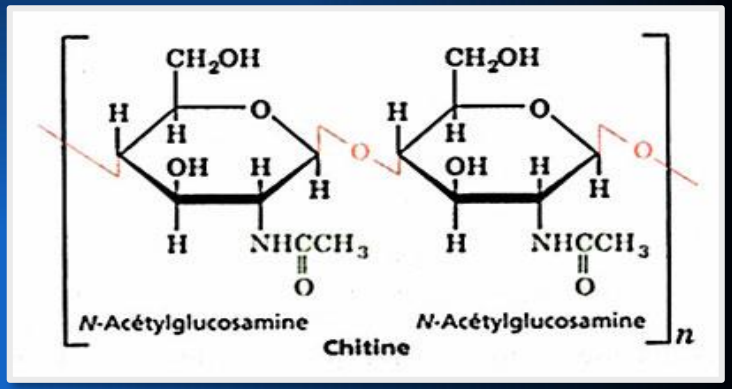
Etanol de segunda geração



Esquema 1. *Representação esquemática da produção de etanol a partir de biomassa lignocelulósica*

Polissacarídeos: Quitina





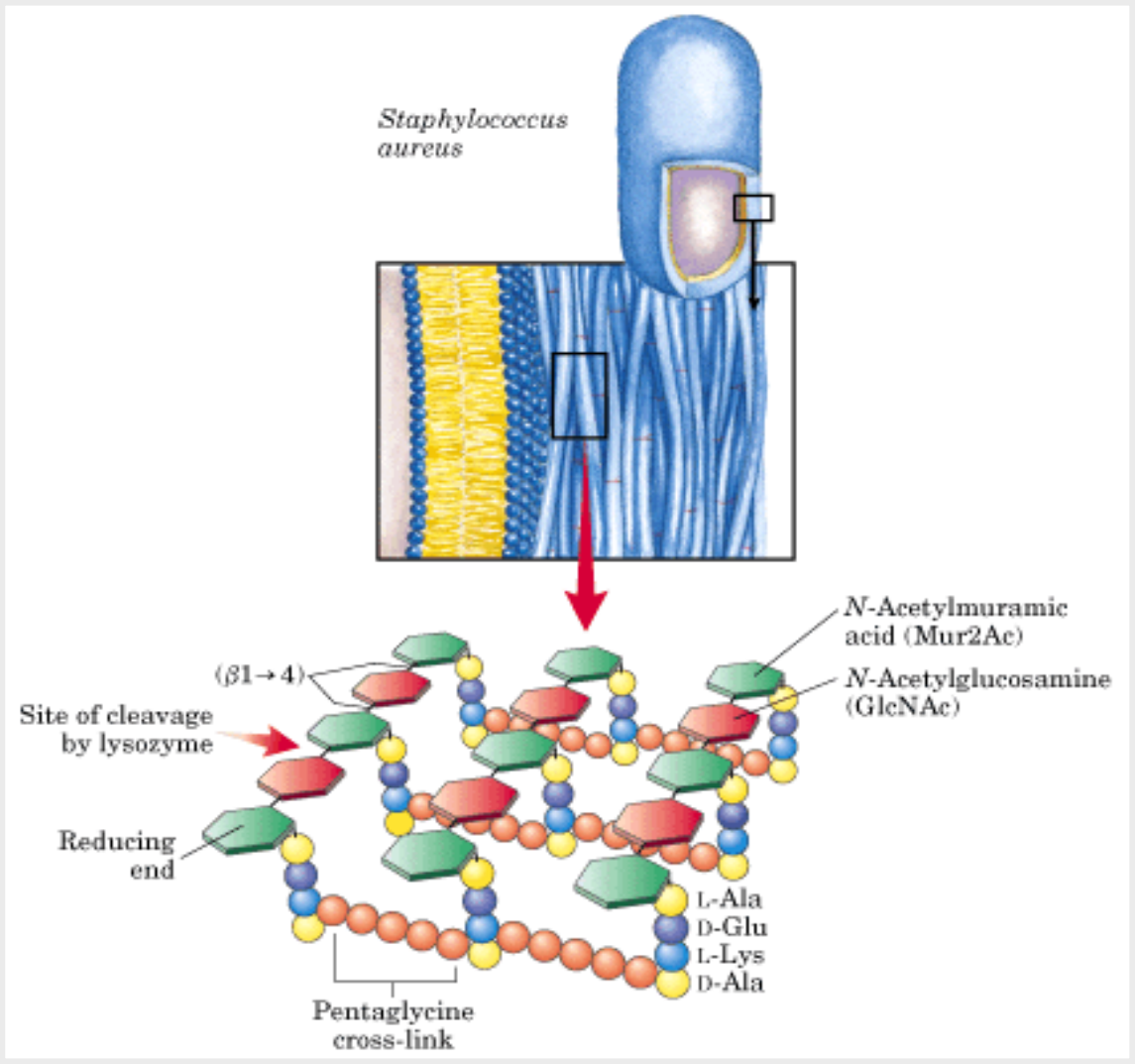
Poli-(β1→4)-N-acetilglicosamina

- **Principal componente do exoesqueleto de artrópodes Insetos, caranguejos, lagostas.**

- **Segundo + abundante polissacarídeo depois da celulose**

Polissacarídeos: Peptideoglicanos em bactérias

_N_-acetilglicosamina alternado com ác. _N_-acetilmurâmico ligações (β1→4)



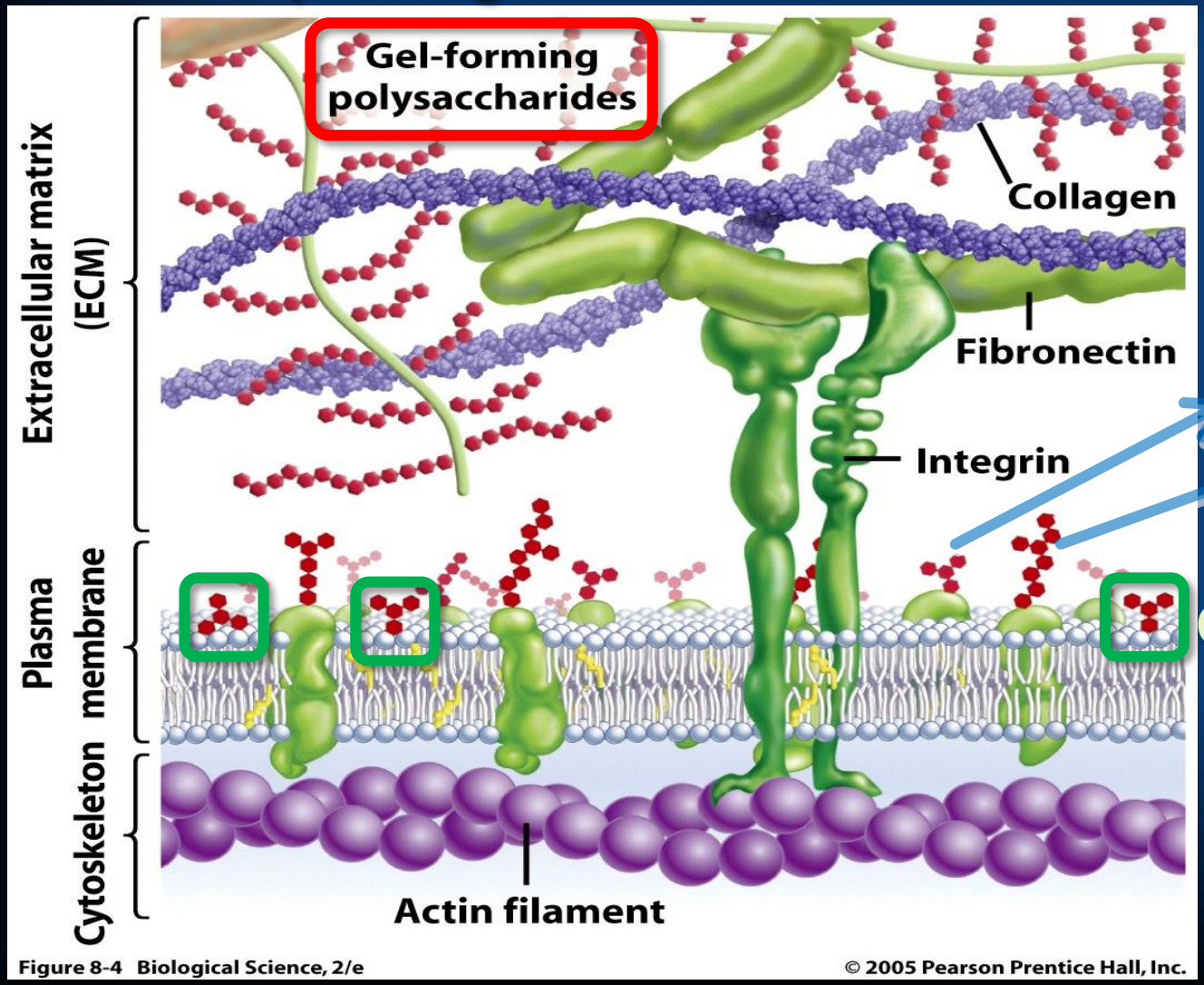
Forma um envelope que protege a bactéria de lise osmótica.

Lisozima: rompe a Ligação β1→4

Penicilina (Fleming) inibe a enzima transpeptidase responsável pelas ligações cruzadas: bactéria é lisada

Polissacarídeos na membrana plasmática e matriz extracelular eucariótica

proteoglicanos



glicoproteinas

Glicolipídeos

Polissacarídeos: Reconhecimento, comunicação e adesão celular