chK

* Carbohydrates

- Cells can extract energy from Carbo. to make ATP

- Compound with General formula $C_n(H_2O)_n$

- Serve many functions:

1 → source of carbon
2 → source of Energy C-H
3 → Some type of carbo. cell-cell interaction
4 → some type of carbo. imp. for the structure of cell

- Cellulose → structure of plant cell
- carbohy. → Bacteria

* Based on the functional Group found in the Carbohydrates

Aldoses | ketoses

- Carbohydrates have a number of carboxyl Group or alcohol Group

* Aldehyde Containing mono. are Called aldoses

* ketone " " " " ketoses

- Monos. is classified based on the number of carbons atom they contain
3-7

- Different mono. have different oreination of the hydroxyl Group

- Mirror Image of Isomers/sterisomers are called enatiomers

* number of carbons will determine number of sterioisomers

4 carbon → 4 different sterios. if they are aldoses

# of chiral carbon → will determine the number of steroisomers

- كنا نبدرس Carbo. كانوا
Our cells will extract energy from Glucous

* Carbohydrates → consist of simple sugars (monosa.), complex sugars (oligo, poly)

- Monosa. classified based on 3 characteristics

1. sugar had functional aldehide or ketose Group

2. number of carbons 3-7

3. Configiration of OH Groups around chiral carbons

* D, L monosa, based on the location of the hydroxyl Group connected to the chiral carbon with the highest carbon number

* The Way we draw the mono. is called the Fischer (linear)

But naturally most sugar have cyclic structure

of mono. form when hydroxyl Group - O2 - on the carbon for the last one attacks the carbon of the carbonyl Group & when this happen in aldose we have a cyclic hemiacetal , In ketose → hemiketal

* Carbon number 1 become the anomeric carbon
↳ used to be the carbon of carbonyl Group

* When the structure become cyclic Now we have to determine the location of hydroxyl Group in the anomeric carbon (α, β)

- In fisher projection if carbon number have hydroxyl Group to right it's α (down) , β left (up)

* Some mono. are called Reducing Sugars (sugars could be oxidized , have a free hydroxyl Group that could be oxidized)

losses $\bar{e}$
& become carbonyl Group
وبلك
cyclic hemiacetal structure
lactose مثل

* We can detect the presence of reducing sugar by using solution called Tollens solution

فيه

sulfur & amonia

- The sulfur atoms Will be releaseed from amonia, now we have sulfur deposition that will cause sulfur Mirror

only if the Group oxidized

* Carbonyl Group could be reduced to produce polyalcohols (بس مش كحول كحول ن)

ex → we have a sugar called Sorbose, If we reduce it's carbonyl Group & now we have an additional hydroxy Group, now we have sorbitol (6 hydroxyl Groups OH-)

Monosa.

Add a reducing agent that Will be oxidized & the sugar will accept ē

* Sorbitol, xyliton → are called aldito & they are sweeteners

- Some reactions of carbohydrates, where some monosa. accept phosphate Group

Five Apple

* Formation of phosphoric esters
(this reaction require enzymes)

- Monosa. could be connected to eachother / & to other molecules by Glycosidic bond

→ carbohydrate (monos.) in which OH of anomeric carbon reacts with another OH in another molecule
Monosa. + sth else = Glycoside

* Disaca. → 2 Monosa. connected together by Glycosidic bond

Number of it, present in the food we eat

sometimes could be branched

* Poly → caracterized by the type of Monomer & the type of Glyco. bond

* Cellulose → polymer of Glucose & we have OH Group, H, O_2 & these can make H-Bond

→ In fats, cell wall made of Cellulose that is very tough cell wall

* starch → is made of Glucose
تفرق عن cellulose بـ
Glycosi. linkage

- 2 Types of starch

1- AMylose
linear poly. of
Glucose, monosa.
connected α form
α (1-4)

2- Amylopectin
branched.
branching point
is the result of
formation of Glyco.
bond of α(1-6)
α(1-4) عيني

* Cellulose & starch → اختلفوا بـ
shape of poly.
linkages & if there
is branch or not

β(1-4)
Not branched
linear

α(1-4), α(1-6)
Could be branched
found in plants

* We can detect starch with Iodine
Could Go inside the helical
structure & now we can see a
dark color

* another type of poly. → Chitin: found
in exoskeleton of insects but also in cell
walls of Algae, fungi

Five Apple

* Pectin → - used in food processing

- Adding it to sth, make it more solid, or consistency of Gel

* Animal cells they have outside them polymers of carbo like Glycoaminoglycan (found in extra cellular, found in connective tissue)

amino sugar

* some mono. have extra atoms like phosphorus, Nitrogen, sulfer

- polysa. could be devided based to it's function to 2 Types

Storage: starch & Glycogen (storage of energy)

Structural: like cellulose & kiten (maintain structure of cell wall)

* Glycogen → هو نفس [illegible]
starch
إنه
Degree of branching is more extensive in Glycogen

* Glycogen storeed in liver, muscle cells & small quantity in kidney

- Enzymes can build/remove Glycogen

* لو أكلتي كيلو كنافة
Some of the sugars will be burned immediately to keep you alive, move your muscle, but the extra sugars - Glucose - will be storeed as Glycogen

↳ limiteed, their is certain capacity
إذا كان storage full بحول
Glucose to fat

صحيتي تاني يوم دخل أساساً تمرنتي بالصباح صباح

the Glycogen storage will provide Glucose to produce Energy

* More branching means that more Glucose could be fit into a smaller space

↳ More Glucose ends

كتير مهم هاكي

Five Apple

* Animals move & in order to be able to move, they need to find the best way to fit all the Glucose in the Glycogen in the small space available

carbo. لي 3 *
connected to proteins &
these proteins are called Glycoproteins

extra cellular
Matrix called
proteoglycan

تأكدي من هالمعلومة :)

* Antibodies are also Glycocelated, they are considered Glyco proteins

- some of oligosaca. of Glyco proteins have antigenic determinats

↳ Recognized by immune system

* ABO system is based on different type of carbohy. attached to the surface of red blood cells

- If I have A-antigen, B-antigen in the surface of Red blood cells. the blood type will be AB

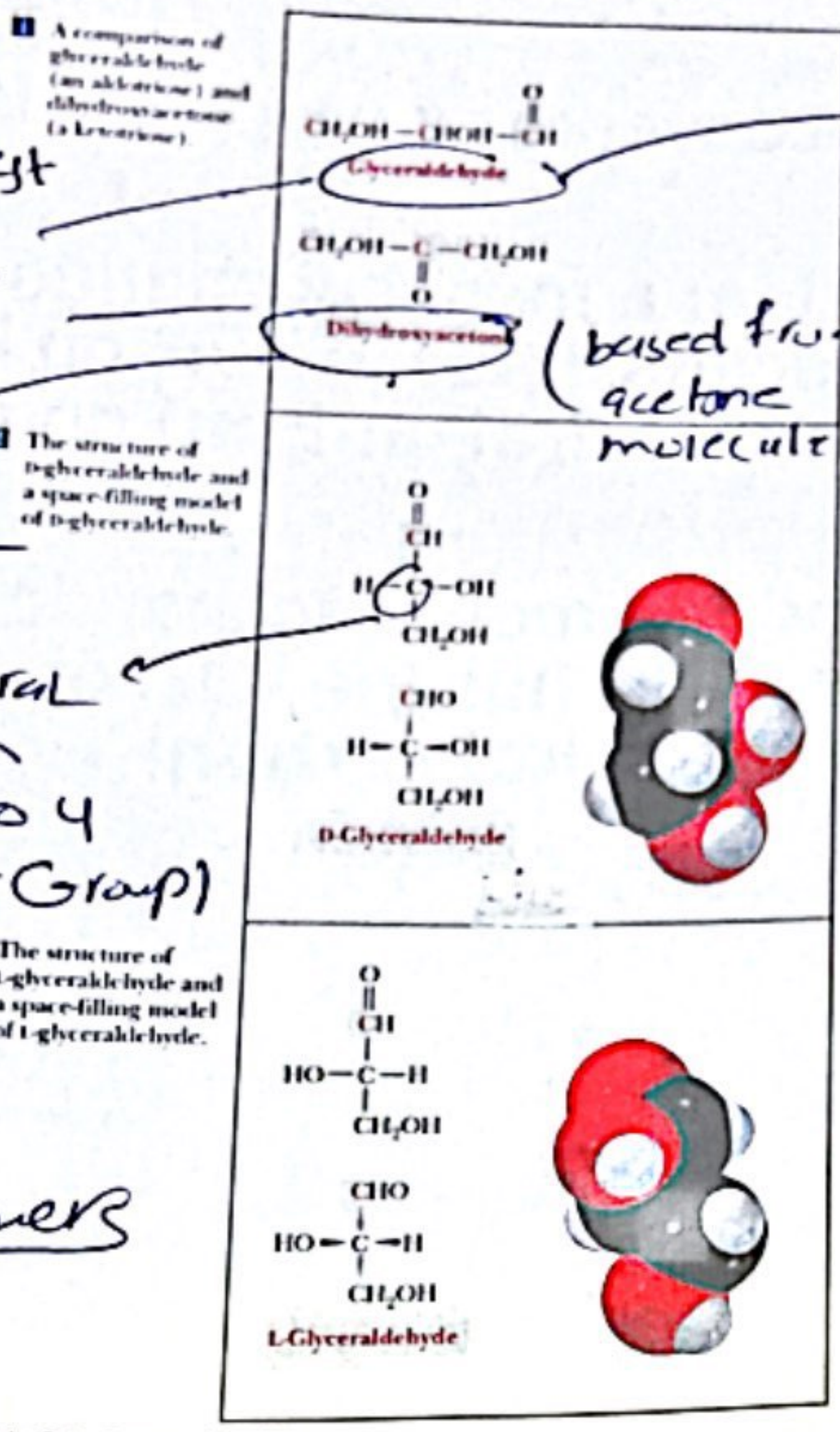
- O & A antigen → A

- O & B " → B
- A & A " → A

- O & O → O
- antibody شو blood type B يلي عنده
  A ؟ يلي عنده

Monosaccharides

2 simplest mon. 3 carbon



Glycerol

H — C — C — C — H (with H above and OH below each carbon)

لو حركت هيدروجين
oxidized & become carbonyl Group
تتغير Glyceraldehyde

H — C — C — C (OH under each carbon)

aldose وعبارة عن
(aldotriose)
3carbon التعبير عن

(based from acetone molecule)

ketotriose

Chiral Carbon (connected to 4 different Group)

Chirality وعشان
مارلبني! انو في
كثير
2 steroisomers

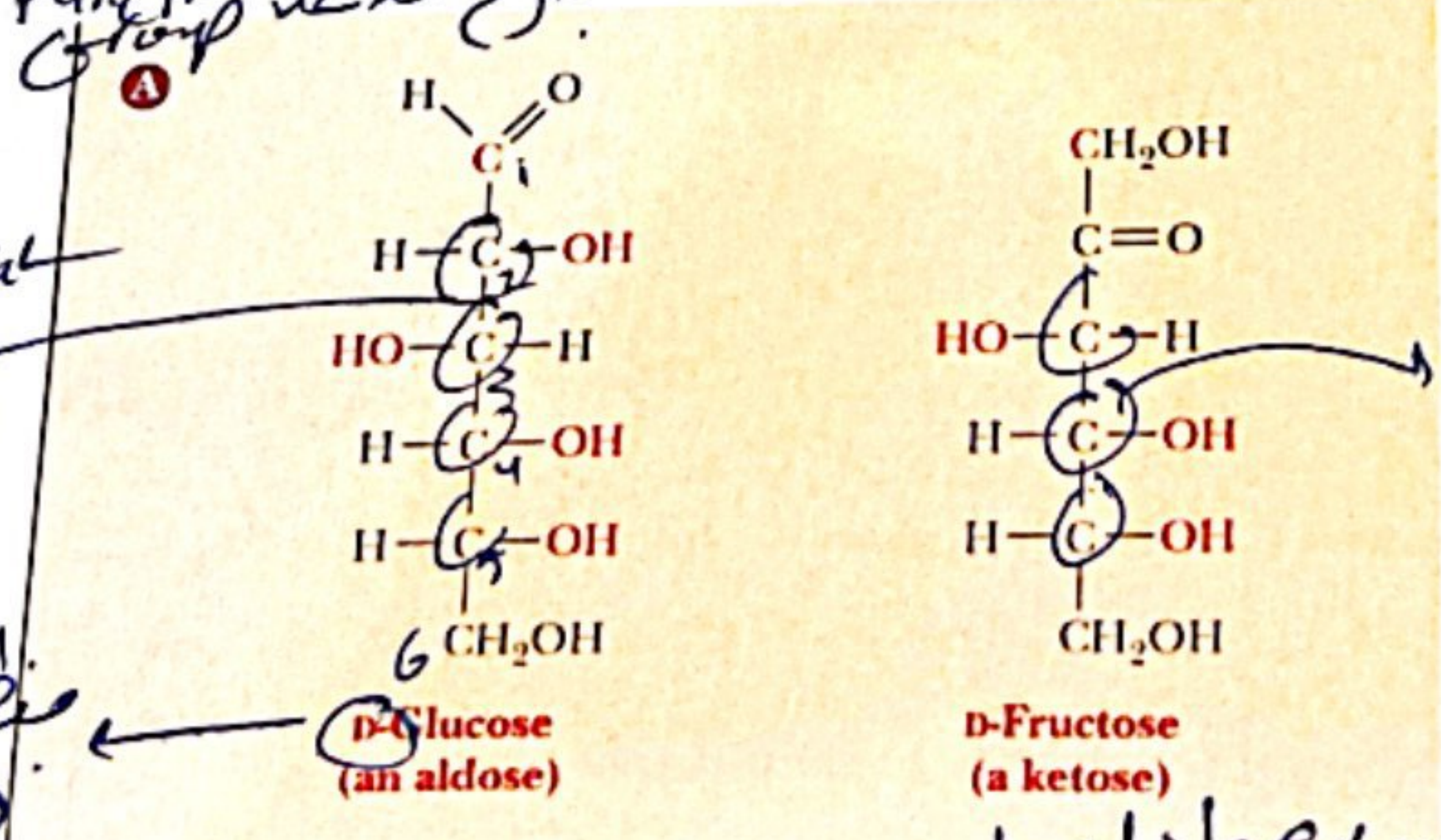
Fischer Projections

- **Fischer projection:** bonds are written in a two dimensional representation showing the configuration of tetrahedral stereocenters
  - Horizontal lines represent bonds projecting **in front the paper**
  - Vertical lines represent bonds projecting to the **behind the paper**

D ← الهيدروكسيل OH

Functional Group بنرقم منه

4 chiral carbons



3 chiral carbons

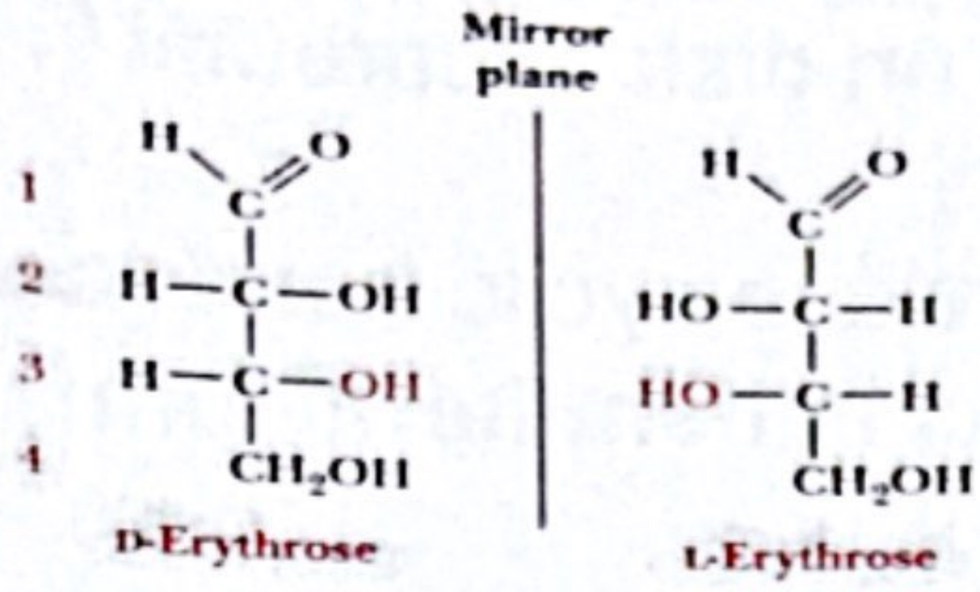
منطلوب carbon مع نعمل... والبعيد تنظر! اذا OH باليمين آخر...

Aldohexose

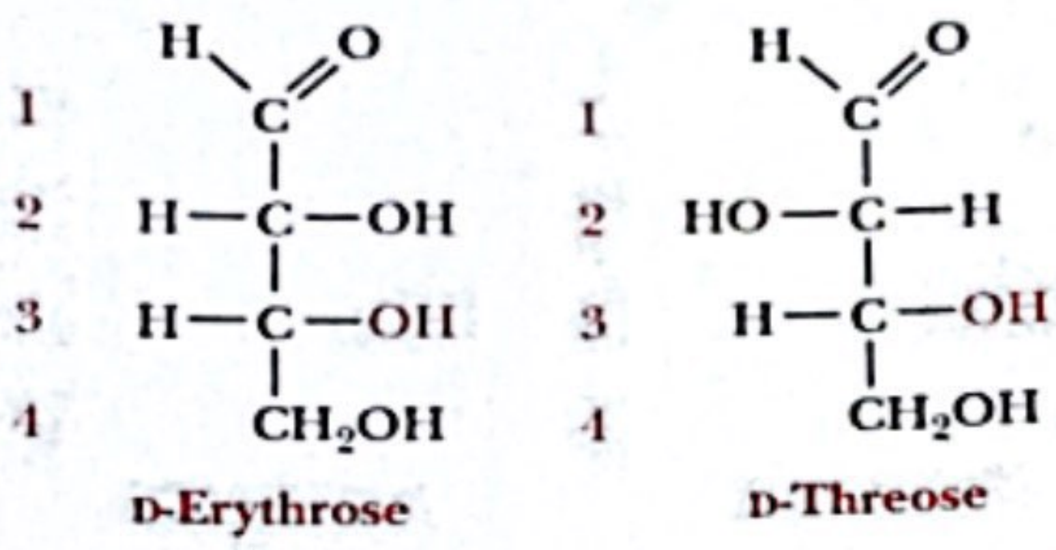
ketohexose

Aldotetroses

- Enantiomers: stereoisomers that are mirror images
  - Example: D-erythrose and L-erythrose



- Diastereomers: stereoisomers that are not mirror images
  - Example: D-erythrose and D-threose
  - Epimers: are diastereomers differ in their structures in only one chiral C



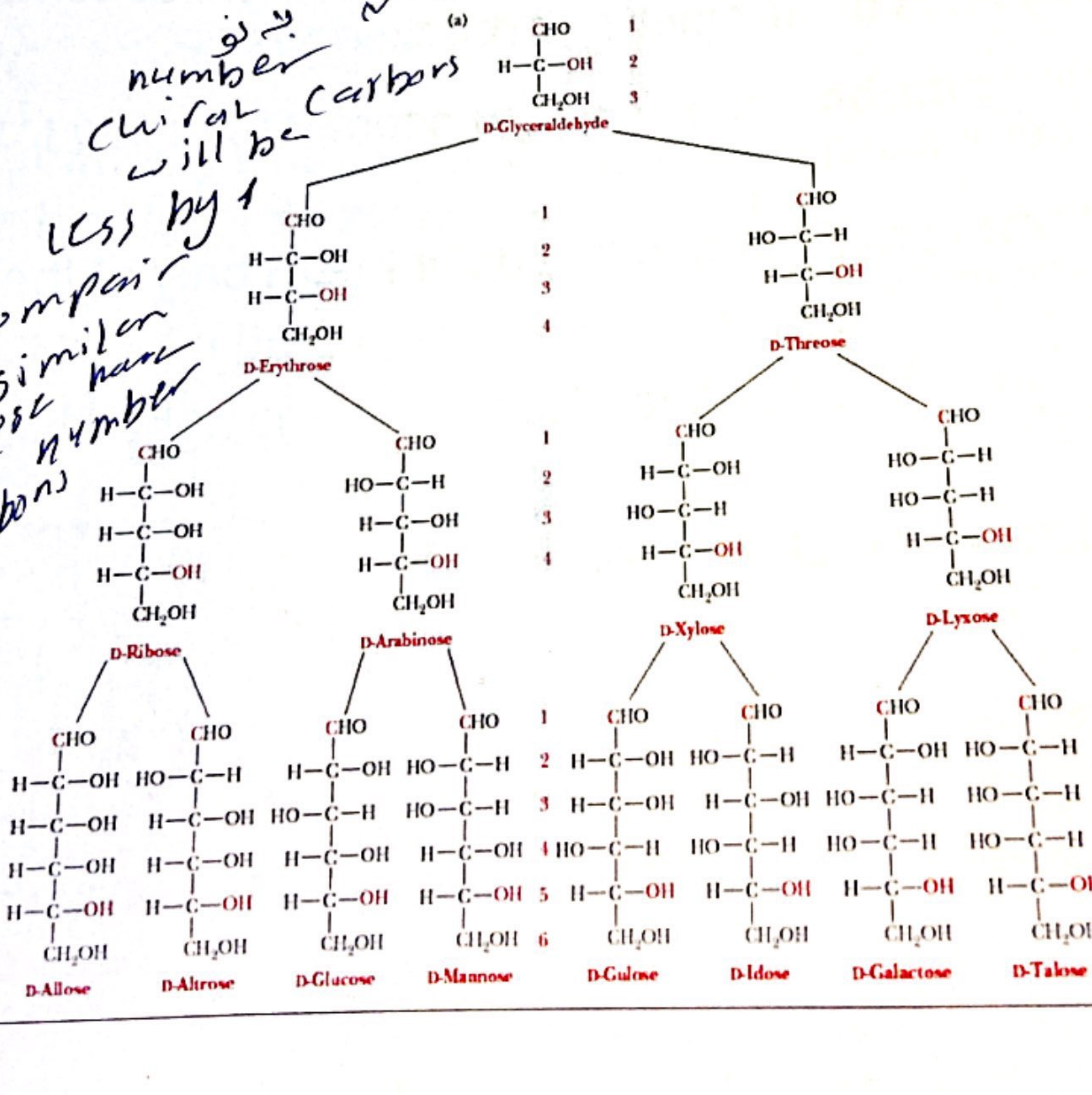
→ still stereoisomers (same chemical formulas, same number of C, H, O) but not mirror image

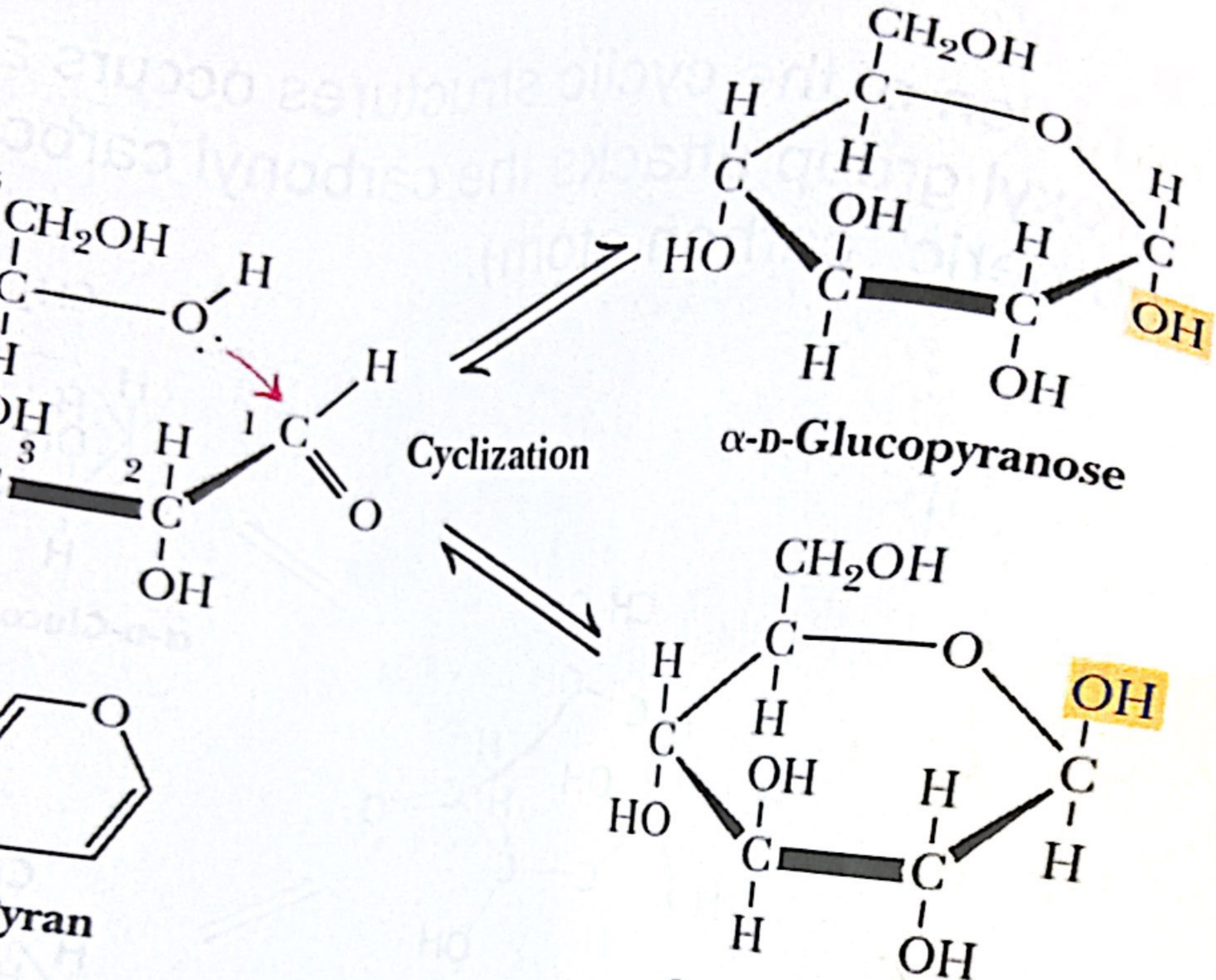
differ in oreintation of functional Group

!?

- Aldopentose has 8 possible steroeisomers (4 d and 4L forms)
- n-carbon aldose have 2^{n-2} stereoisomers.
- n-carbon ketoses have 2^{n-3} stereoisomers.

number chiral carbons will be less by 1 compare to similar aldose have same number of carbons





β-D-Glucopyranose
HAWORTH PROJECTION FORMULAS

Cycliz structure
similar to pyran ring

Fig. 16-5b, p.439

orth Projections

hown by the infix –**pyran** - (pyranose)

–membered ring is more accurately
r conformation

hown by the infix

Compari

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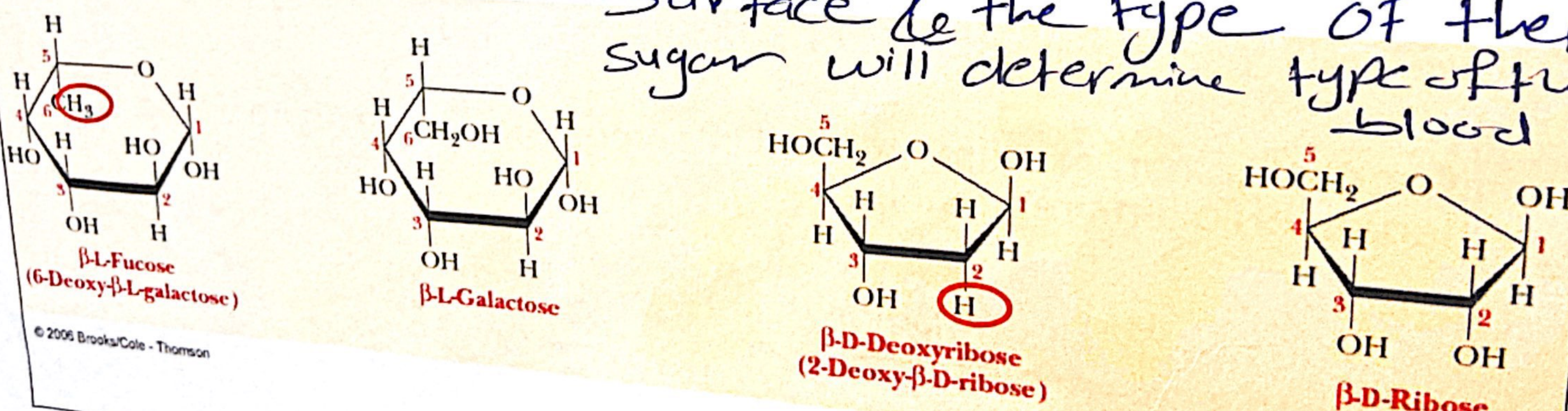
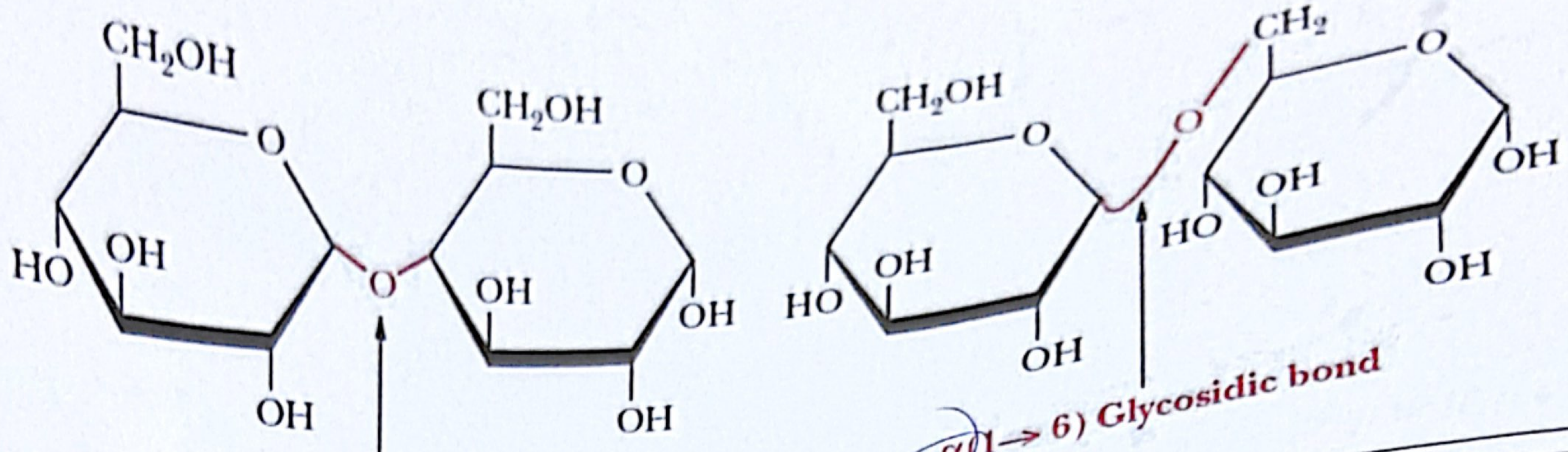
Fig. 16-9, p.441

Reduced sugars

- Deoxy sugars H substituted one OH
  - β-L-Deoxyribose
    - DNA
  - β-L-fucose → imp. for determining blood type, because red blood cells they have sugars on them surface & the type of these sugar will determine type of the blood
    - ABO system



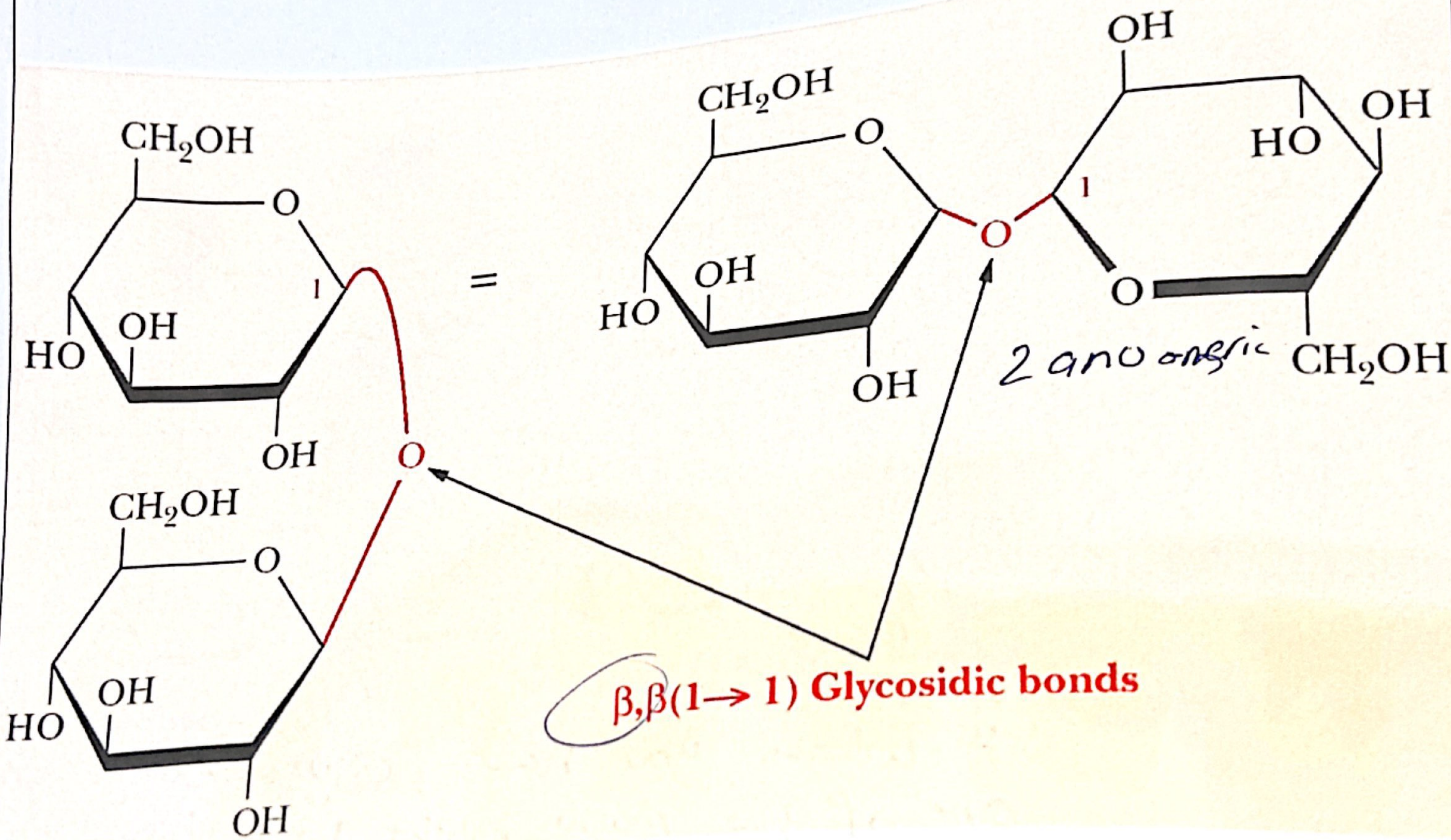
linkage



α(1→ 4) Glycosidic bond

α(1→ 6) Glycosidic bond

1 ano
no



2 ano omeric

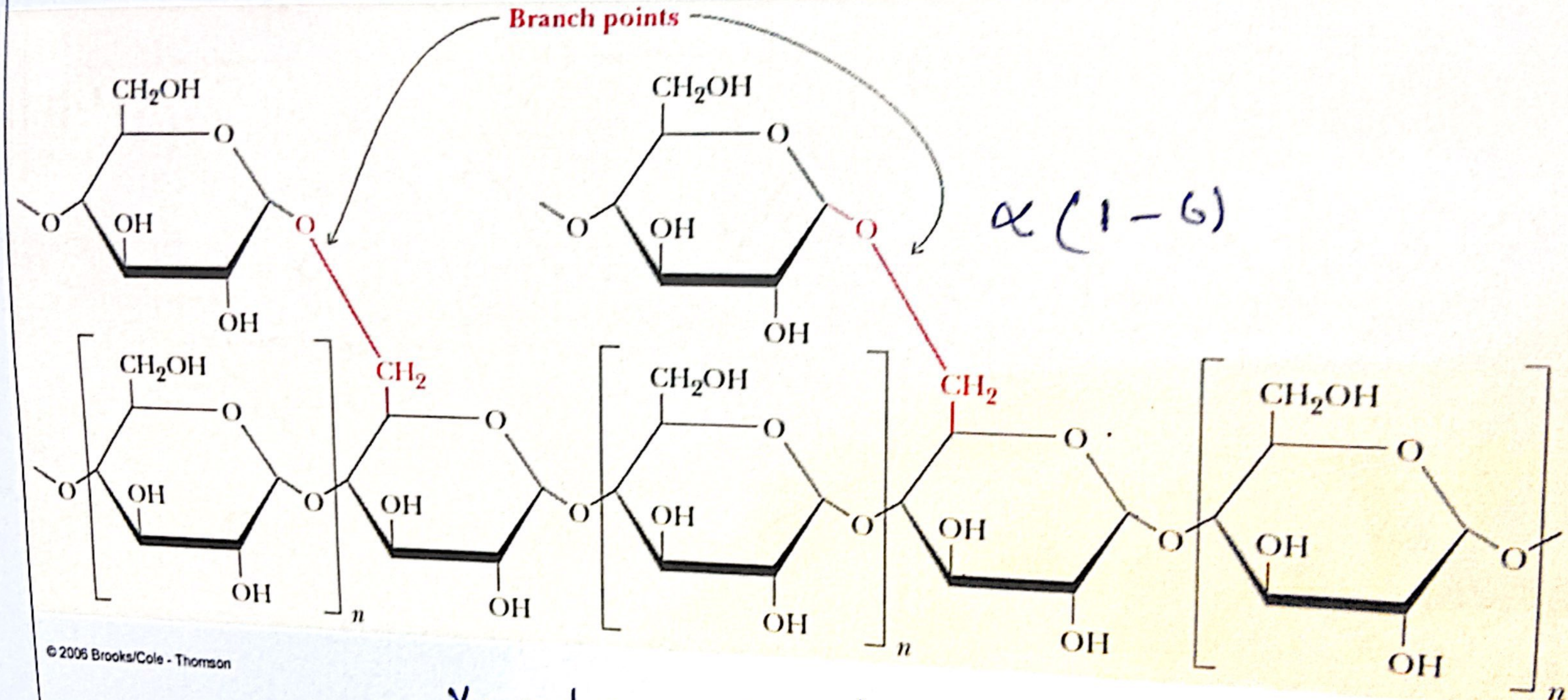
β,β(1→ 1) Glycosidic bonds

سؤال محتمل

لازم انتبه

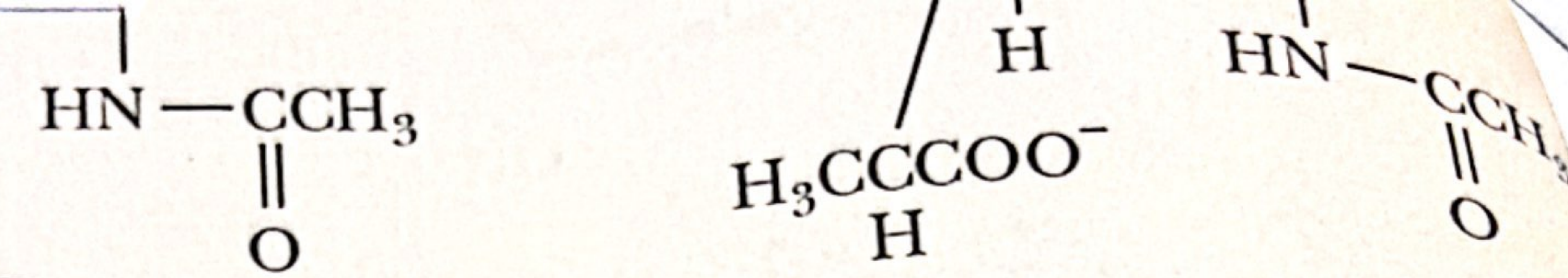
which carbon connected to Glycosidic bond & to direction of Glyco...

Fig. 16-14, p.445



$\alpha(1-6)$

* when you have Glyco. bond one of the mono. might loss it's reducing end



N-Acetyl-β-D-glucosamine

N-Acetylmuramic acid

because we have an acetyl Group that is connected to nitrogen

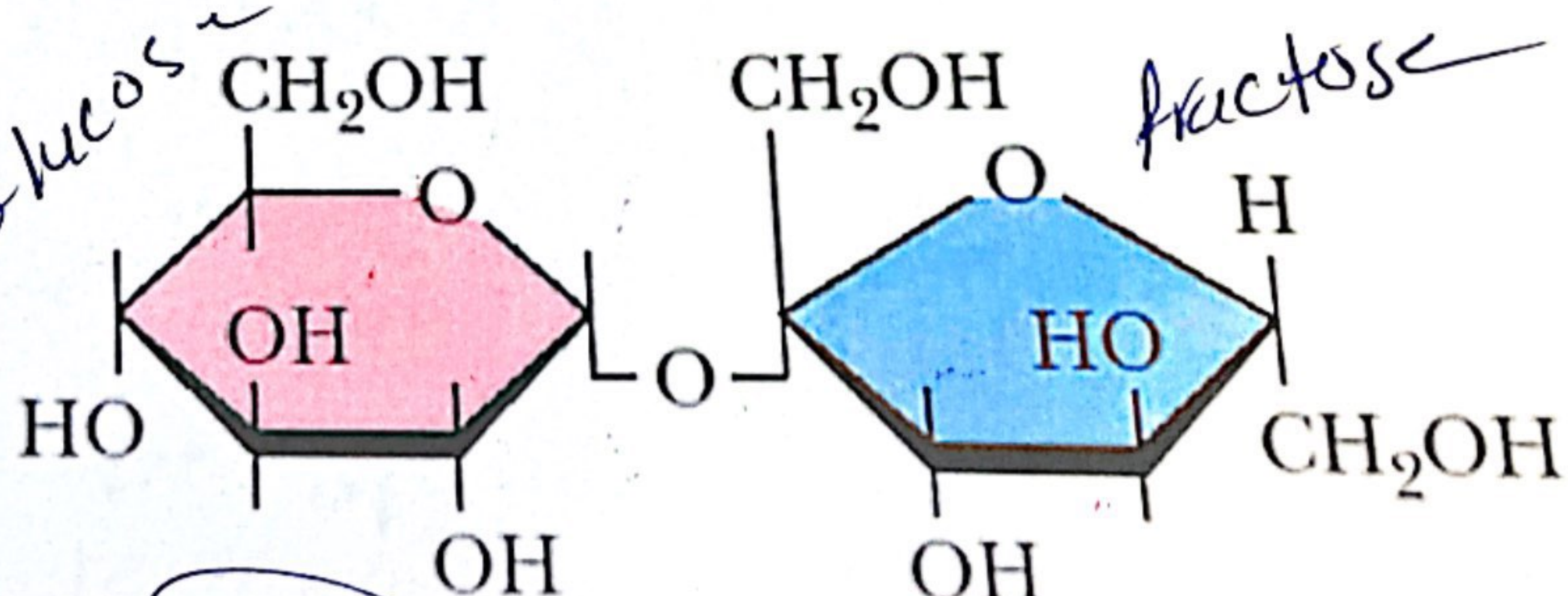
Disaccharides

Sucrose:

- Table sugar; obtained from the juice of sugar cane and sugar beet
- One unit of D-glucose and one unit of D-fructose joined by an α-1,β2-glycosidic bond
- Both anomeric involve in glycosidic linkage (non reducing sugar)

Glucose

fructose



Sucrose (glucose-α-1,2-fructose)

Simple sugars: Glucose, Galactose, Fructose

α,β → for anomeric carbon

Bacterial cell wall موجودة في

Peptidoglycan

peptidoglycan layer

- Bacterial cell walls cross-linking between NAM-NAG with of small peptides

- Lactic acid join with Tetrapeptides

- Further cross linked by other small peptide (5 a.a. long(Gly))
    - Two cross links

- Peptide might contain L and D-amino acid

- D-amino acid and NAM occur in Prokaryotic but not in plants cell wall
    - Cross-linking gives strength

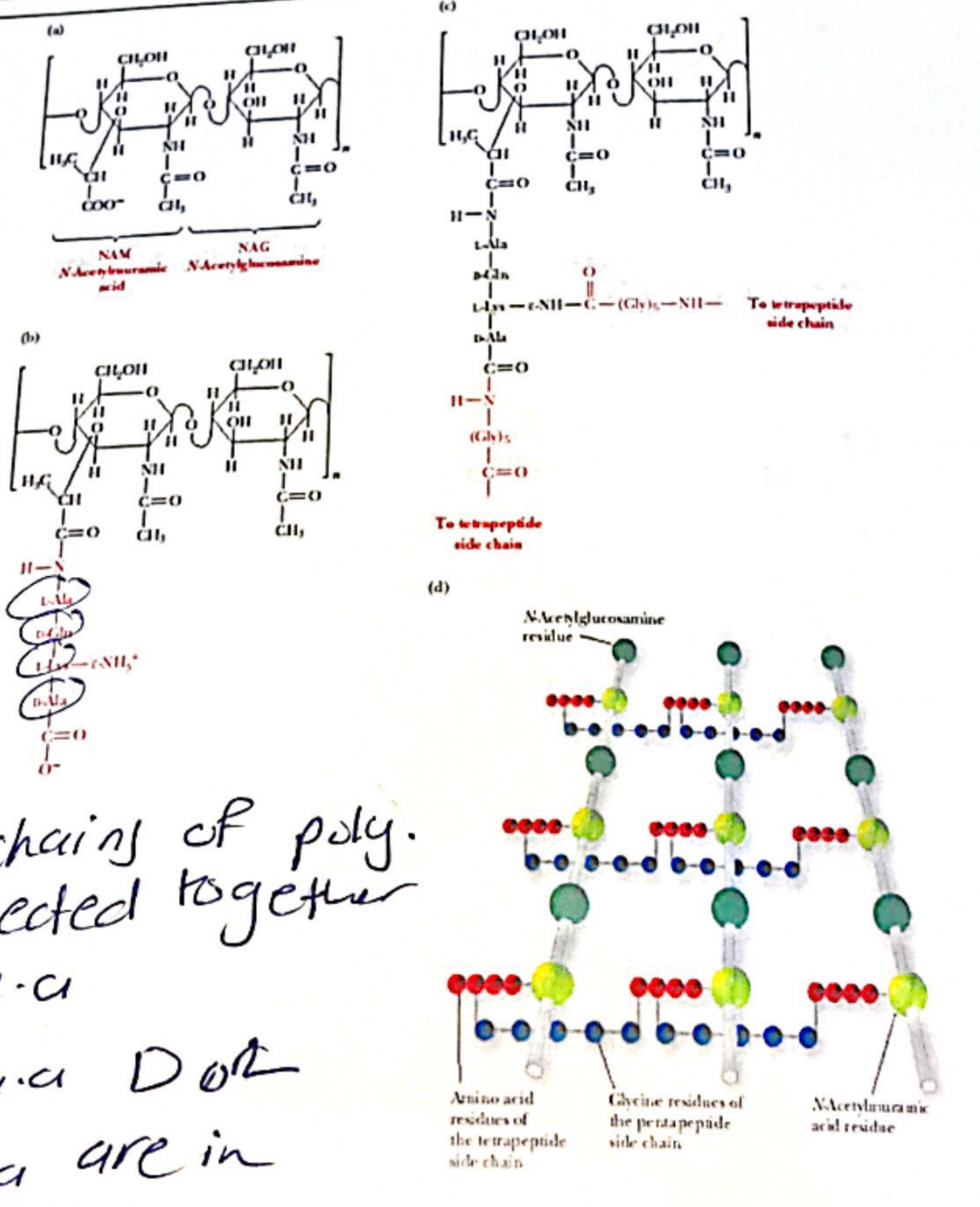


Fig. 16-25, p.456

* These chains of poly. are connected together by a.a

* Some a.a D or

* Most a.a are in the L form

Plant Cell Walls

- Contain little peptides and or protein
- Consist largely of cellulose
  - Also contain pectin which functions as an intercellular cementing material

monomer (galactose have carboxylic acid)

- **Pectin** is a polymer of D-Galactouronic acid joined by α-1,4-glycosidic bonds
  - Galactose derivative where OH on C6 is oxidized to carboxyl group
- Gelling agent in food processing
  - Jams, yogurt and jellies

3

- **Lignin** is non-polysaccriade component of plant (woody plant)
  - Consist of coniferyl alcohol

Glycogen

another poly. sa. found in animal cells / similar to starch

- *Animal carbohydrate storage polymer.*
- *Branched-chain polymer of α-D-glucose (like amylopectin) ⇨ α (1→6) linkage along the chain of ⇨ α (1→4).*

The main difference between glycogen and amylopectin ⇨ Glycogen is more highly branched

- Branch point occur ~ every 10 residues in glycogen and ~every 25 residues in amylopectin.
- More branching mean more water soluble
    - Glycogen storage disease (crystals in muscle and liver)

Phosphorylase cleaves glucose from non-reducing end

- Branching increase efficacy for cleavage and freeing glucose

Debranching enzymes also present and result in complete glycogen breakdown

Branching

Glucose end that could be released from Glycogen immedtly