Alternative nomenclature of monosaccharides

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What’s wrong with the standard system?

- It is based on **common names** that don’t relate to structures
- There is **A LOT** of different monosaccharides!!
  - 15 pentoses
  - 32 hexoses
  - 61 heptoses
  - 128 octoses
  - …

I have an alternative!

How the alternative works

Examples

- D-galactose -> (1,9)-hexose
- L-galactose -> (1,6)-hexose
- **D-glucose -> (1,11)-hexose**
- L-glucose -> (1,4)-hexose
- D-fructose -> (2,3)-hexose
- L-fructose -> (2,4)-hexose
- D-mannose -> (1,3)-hexose
- L-mannose -> (1,12)-hexose
- D-psicose -> (2,7)-hexose
- L-psicose -> (2,0)-hexose
- D-tagatose -> (2,1)-hexose
- L-tagatose -> (2,6)-hexose

How it works

What do those numbers mean

(1,11)-hexose

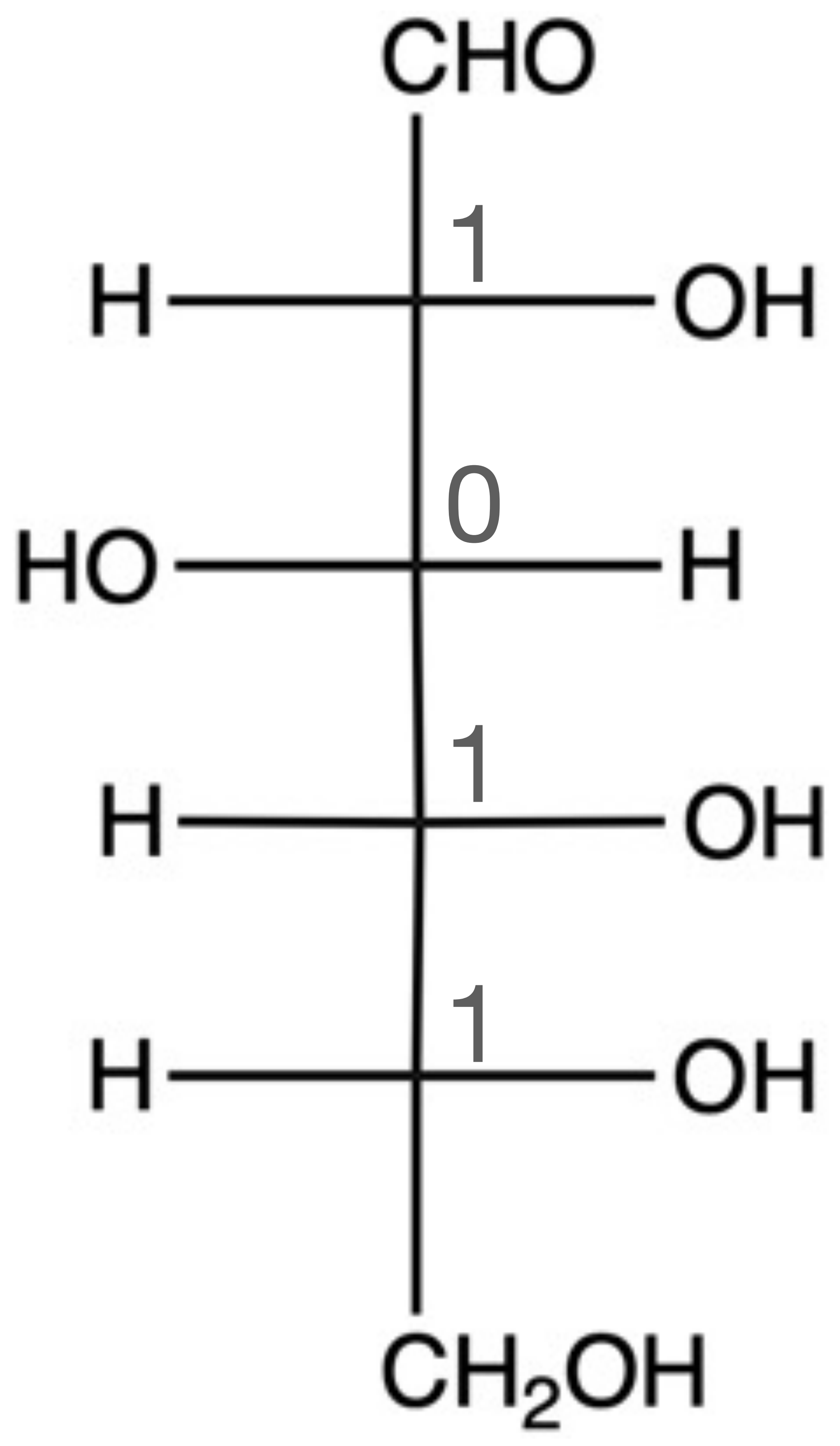
- Number of the carbon on which there is a carbonyl group

- **Binary index**
- I'll explain this on further slides

- Name indicating number of carbons in a carbohydrate

Binary index

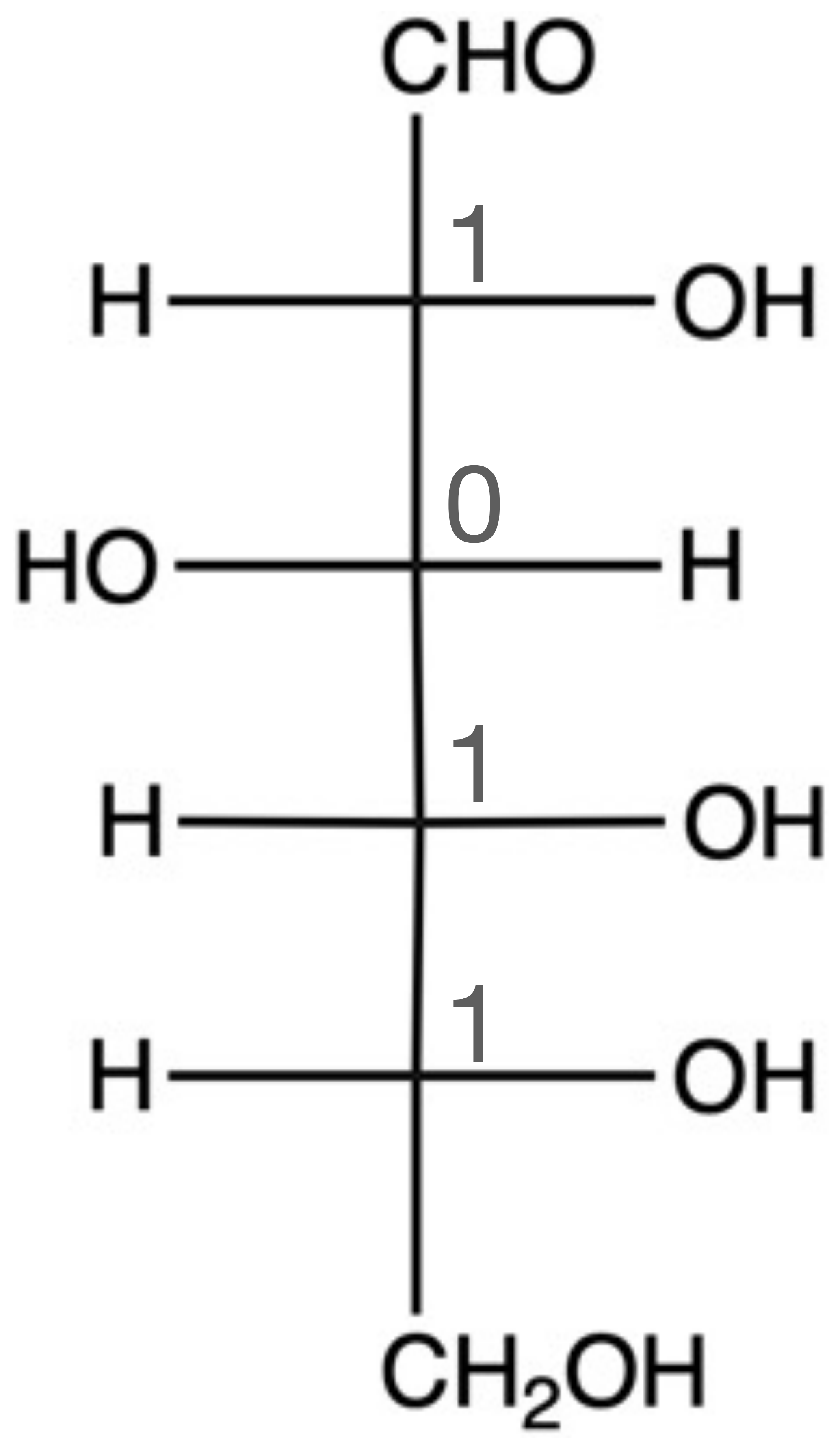
How to obtain it



- Identify the number of chiral centers (4 in D-glucose)
- Mark every chiral center with
  - 1, if there is an **OH group on the right**
  - 0, if there is an **H group on the right**

Binary index

How to obtain it



- Read off the resulting binary number **from top to bottom**
    - 1011
- **Binary index** is the decimal form of the number, in this case
    - 1011 = 1 + 2 + 0 + 8 = **11**

Hence (1,**11**)-hexose

Why to use it

Advantages

- Every pair of numbers (p,q) with reasonable constraints corresponds to **only one** sugar. That means that **every structure has a name***
- Epimers can only differ in binary index **by a power of 2** (1, 2, 4, 8, 16, etc)
- Every D-isomer has **odd** binary index, and every L-isomer has **even** binary index
- Some problems, like products of Kiliani Fischer reaction, become **much easier** to name
- Enantiomers complement each other to $\mathbf{2^k-1}$, where k is the number of chiral centers
  - (1,11)-hexose is an enantiomer of (1,4)-hexose, because **11+4=15, 15=**$\mathbf{2^4-1}$

*there are possible nomenclature repeats, so for a given structure there might be two names using this nomenclature

Why to use it

Finding enantiomers

- D-tagatose
- L-tagatose
- (2,1)-hexose
- (2,6)-hexose
- 3 chiral centers
- $1 + x = 2^3 - 1 = 7$
- $x = 6$

Downsides

Drawbacks

- **NOT EVERY** pair of numbers gives a sugar
    - (1,16)-hexose, (1,17)-hexose, (1,18)-hexose, etc **don't exist**
    - (2,8)-hexose, (2,9)-hexose, (2,10)-hexose, etc **don't exist**
- Sometimes carbohydrates may have **different names**, but be **identical**
    - The problem only happens in carbohydrates with **odd** number of carbons, like pentose
    - (3, 3)-pentose and (3, 0)-pentose are **identical**
- Conversion between the name and a structure takes calculations, but unlike in the standard nomenclature **it's possible with no memorization**

So why shouldn’t we switch?

Why to use it

Finding epimers

- The epimeric difference rule helps in finding the epimers, just from the names
- All epimers of (1,11)-hexose (D-glucose) are:
  - (1,10)-hexose (L-idose)
  - (1,9)-hexose (D-galactose)
  - (1,15)-hexose (D-allose)
  - (1,3)-hexose (D-mannose)

Why to use it

Advantages

It’s **extremely easy** to list all monosaccharides, and then draw the structures with **no memorization needed**

- (1,0)-hexose
- (1,1)-hexose
- (1,2)-hexose
- (1,3)-hexose
- …
- (1,15)-hexose

- (2,0)-hexose
- (2,1)-hexose
- (2,2)-hexose
- (2,3)-hexose
- …
- (2,7)-hexose

- (3,0)-hexose
- (3,1)-hexose
- (3,2)-hexose
- (3,3)-hexose
- …
- (3,7)-hexose