Carbohydrates and Lipids

Understandings:

- Monosaccharide monomers are linked together by condensation reactions to form disaccharides and polysaccharide polymers
- Fatty acids can be saturated, monounsaturated or polyunsaturated
- Unsaturated fatty acids can be *cis* or *trans* isomers
- Triglycerides are formed by condensation from three fatty acids and one glycerol

Skills:

- Use of molecular visualisation software to compare cellulose, starch and glycogen
- Determination of body mass index by calculation or use of a nomogram

Applications:

- Structure and function of cellulose and starch in plants and glycogen in humans
- Scientific evidence for health risks of *trans* fats and saturated fatty acids
- Lipids are more suitable for long-term energy storage in humans than carbohydrates
- Evaluation of evidence and the methods used to obtain the evidence for health claims made about lipids

Carbohydrates

Hydrolysis and Dehydration

- https://www.youtube.com/watch?v=ZMTeqZLXBSo

Types of Carbohydrates

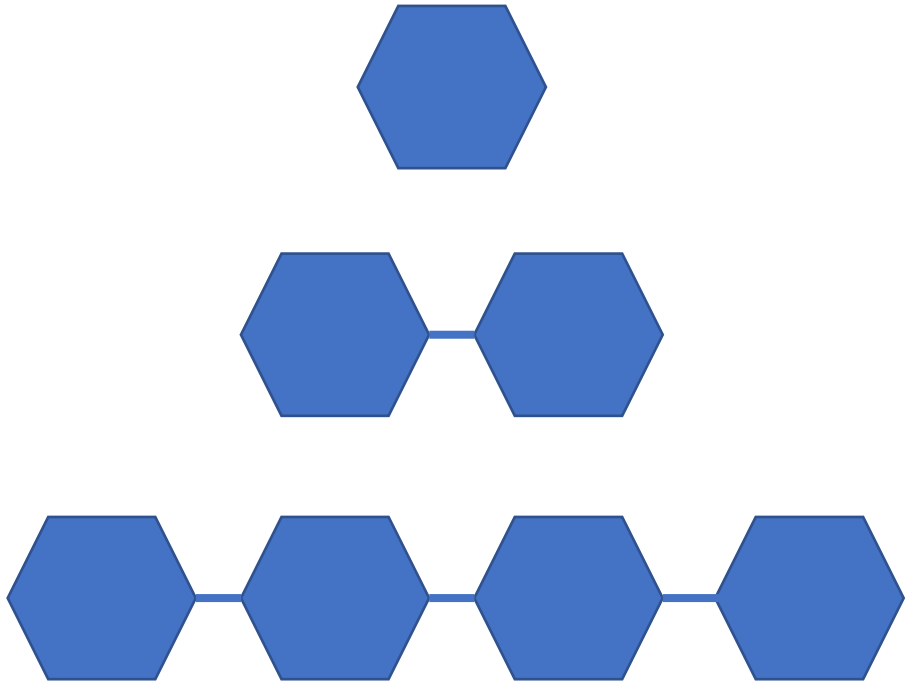
	Monosaccharide	Disaccharide	Polysaccharide
Number of subunits			
Main Function			
Examples			

Types of Carbohydrates

- https://www.youtube.com/watch?v=LeOUIXbFyqk

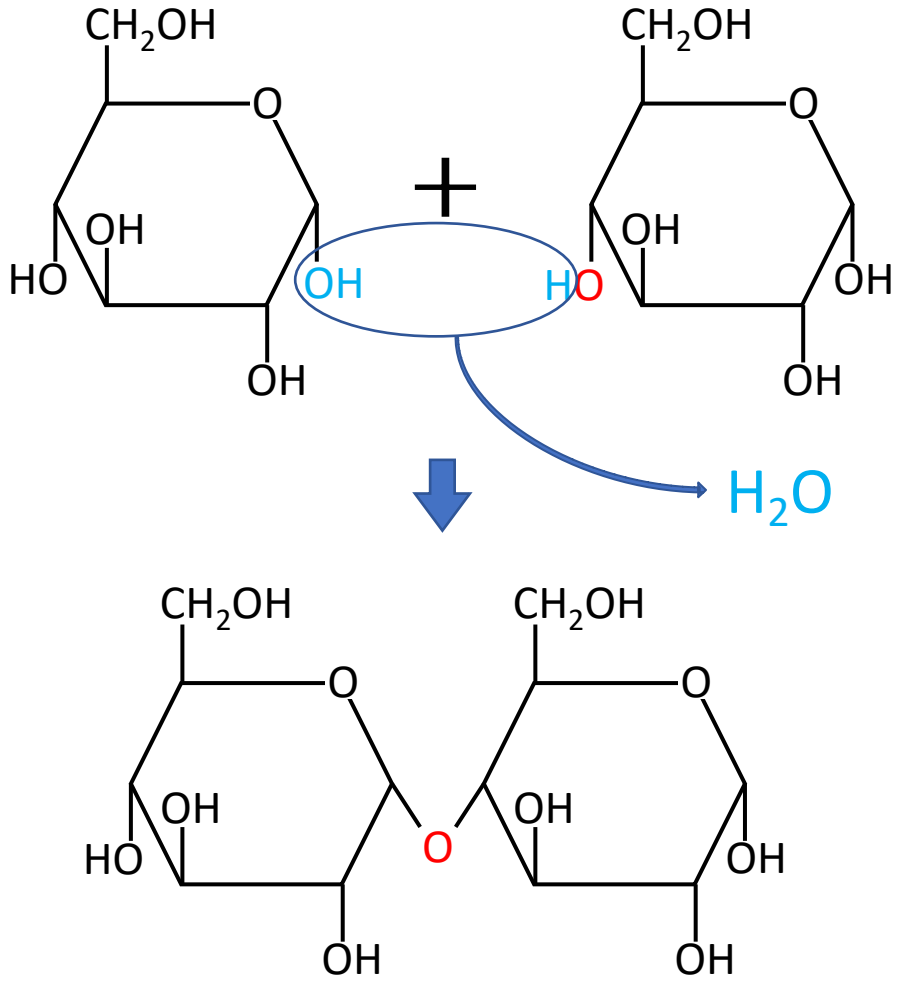
Types of Carbohydrates

- Monosaccharides → gr. “mono” = one
- Disaccharides → gr. “di” = two
- Polysaccharides → gr. “poly” = many



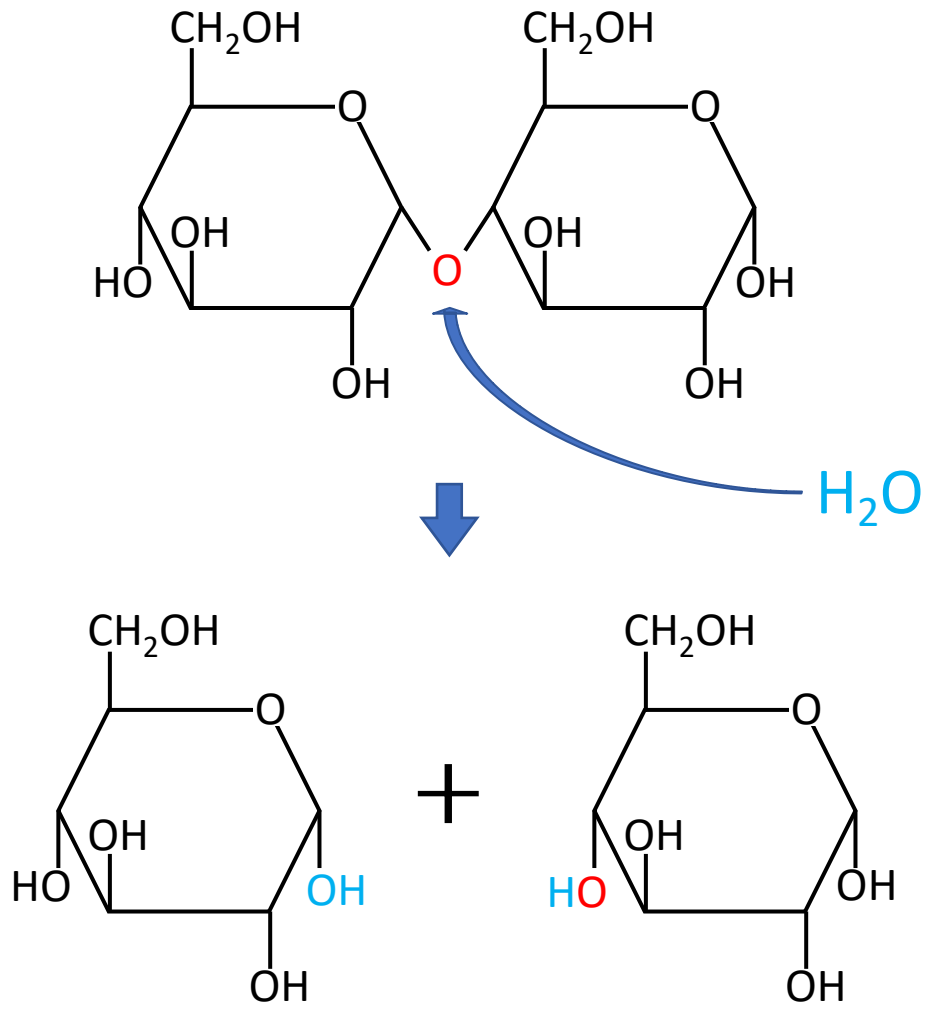
Condensation

- Loss of an –OH from one molecule and –H from another molecules
  → formation of H_2O
- Anabolic process → requires energy



Hydrolysis

- H_2O is split into two parts and added to a molecule
- Molecule then separates into two parts
- Catabolic process
  → releases energy

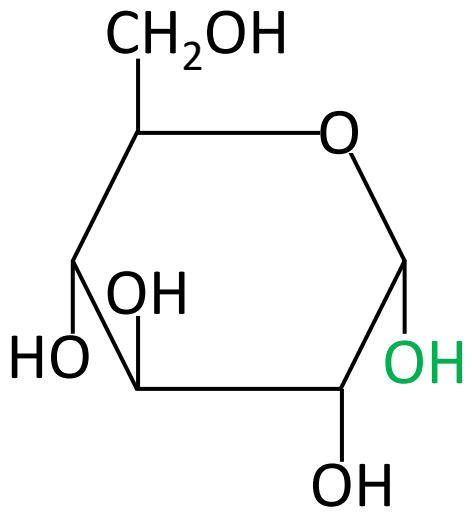


Glycosidic linkages

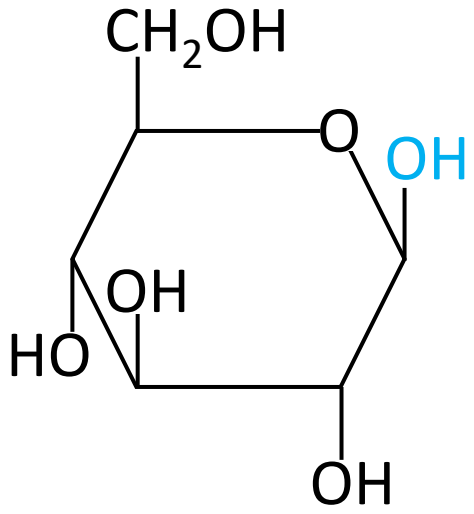
- 1,4-glycosidic linkage

- 1,6-glycosidic linkage

Glucose

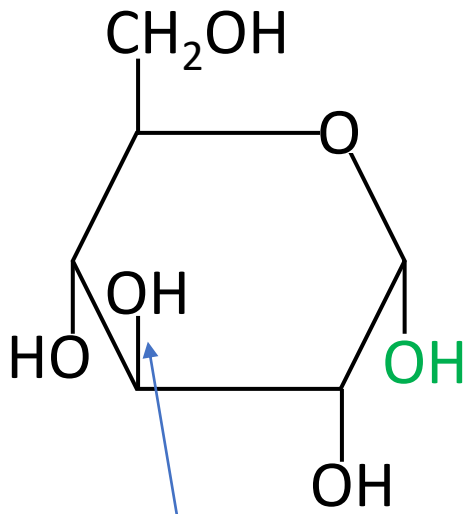


α-glucose



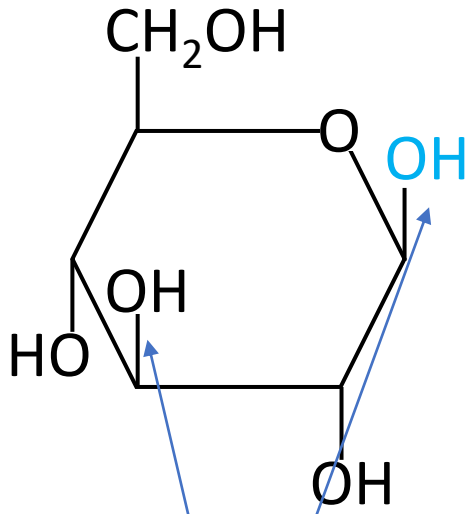
β-glucose

Glucose



α-glucose

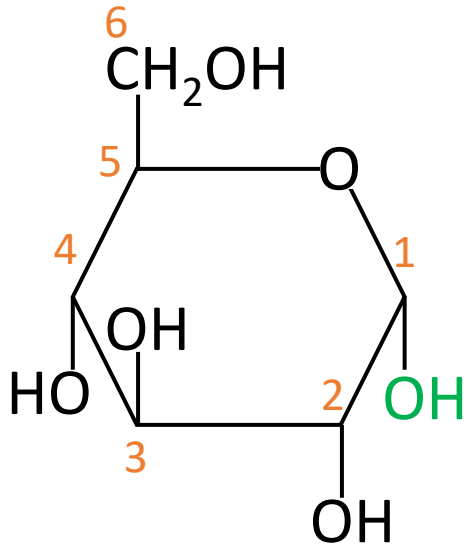
"one stands alone"



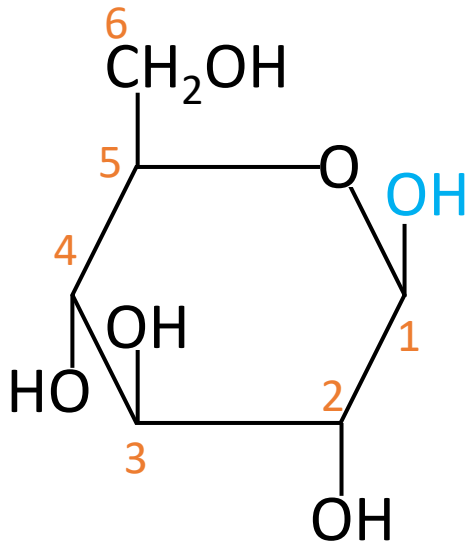
β-glucose

"both point upwards"

Glucose



α-glucose



β-glucose

Glycosidic linkages

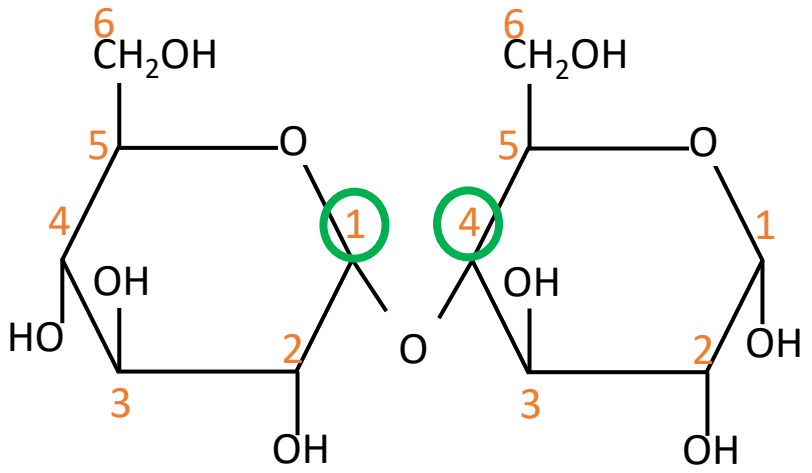
1,4-glycosidic linkage:

bond between:

- C-atom 1 of one molecule

and

- C-atom 4 of the other molecule



Glycosidic linkages

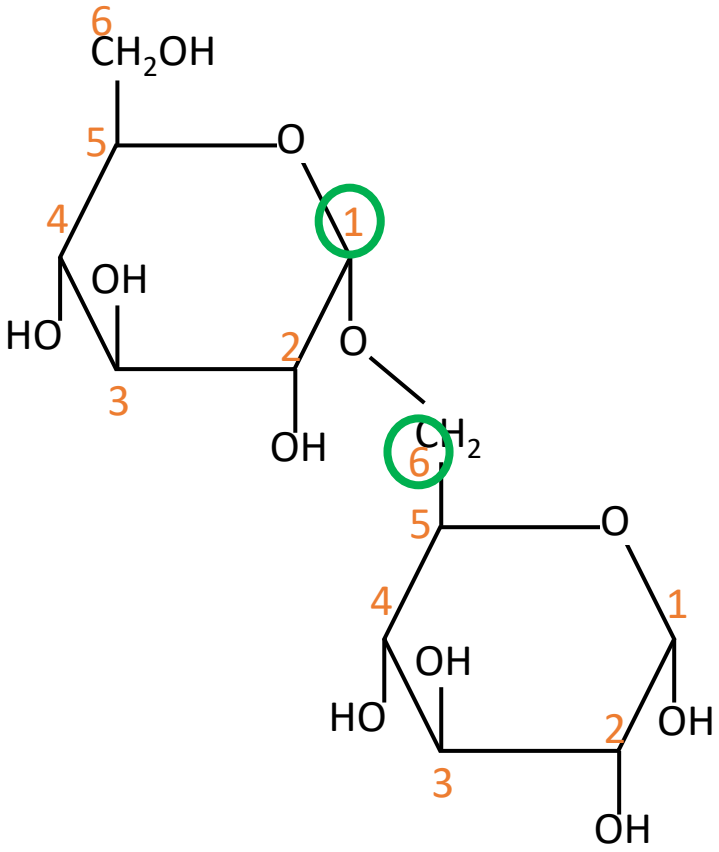
1,6-glycosidic linkage:

bond between:

- C-atom 1 of one molecule

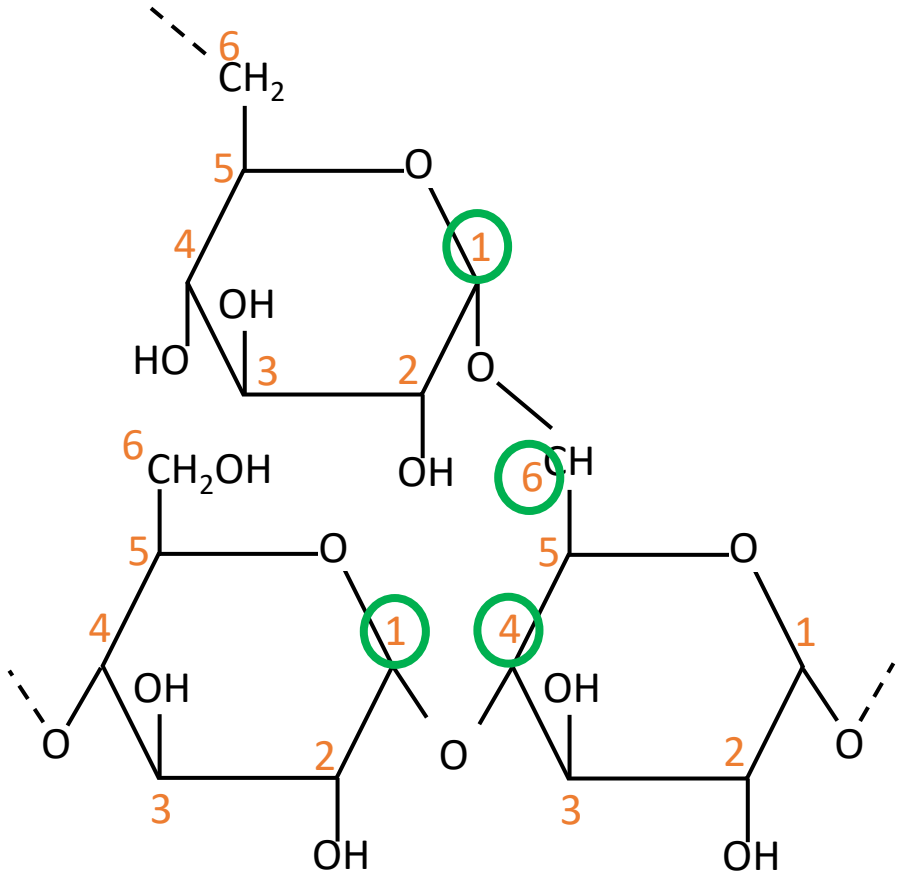
and

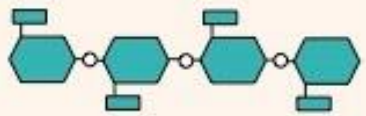
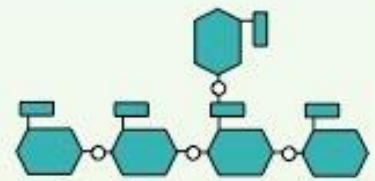
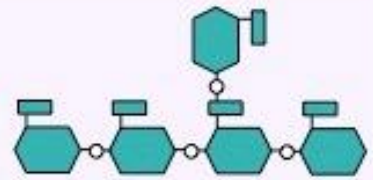
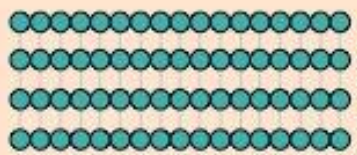
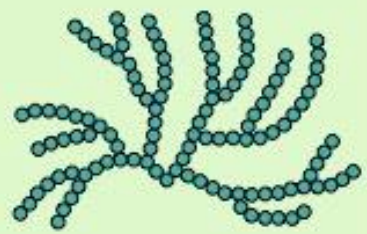
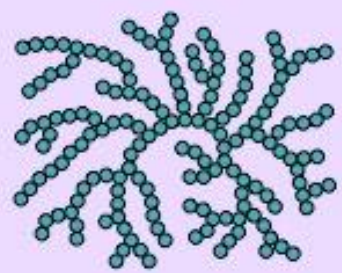
- C-atom 6 of the other molecule



Glycosidic linkages

1,4- and 1,6-glycosidic linkage



	Cellulose	Starch		Glycogen
		Amylose	Amylopectin	
Source	Plant	Plant	Plant	Animal
Subunit	β-glucose	α-glucose	α-glucose	α-glucose
Bonds	1-4	1-4	1-4 *and* 1-6	1-4 *and* 1-6
Branches	No	No	Yes (~per 20 subunits)	Yes (~per 10 subunits)
Diagram				
Shape				

https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/23-carbohydrates-and-lipids/sugar-polymers.html

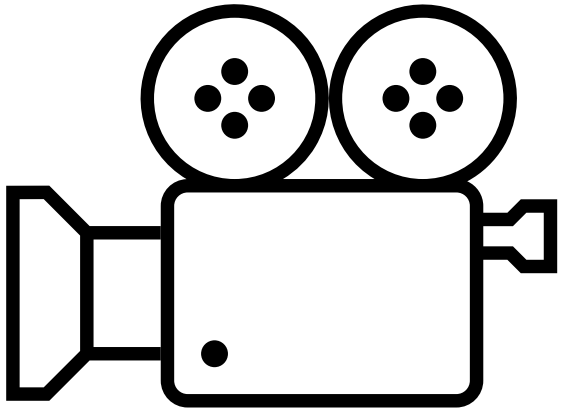
Glycosidic linkages

α-1,4-glycosidic linkage	α-1,6-glycosidic linkage
β-1,4-glycosidic linkage	β-1,6-glycosidic linkage

Lipids

Lipids

- Watch the video and make notes on the handout about lipids:
    - https://www.youtube.com/watch?v=5BBYBRWzsLA



Characteristics of Lipids

- Non-polar and insoluble in water (“hydrophobic”)
- Consist of carbon (C), hydrogen (H) and oxygen (O)
- Colloquial terms:
  - Fats: liquid at body temperature, solid at room temperature
  - Oils: liquid at body temperature and room temperature

Functions of Lipids?

Functions of Lipids

Energy storage

Protection

Insulation

Component of cell membranes

Hormone precursors

Functions of Lipids

Energy storage

Protection

Insulation

Component of cell membranes

Hormone precursors

Mnemonic: EPIC, huh? ☺

Functions of Lipids

Mnemonic to remember: SHIPS

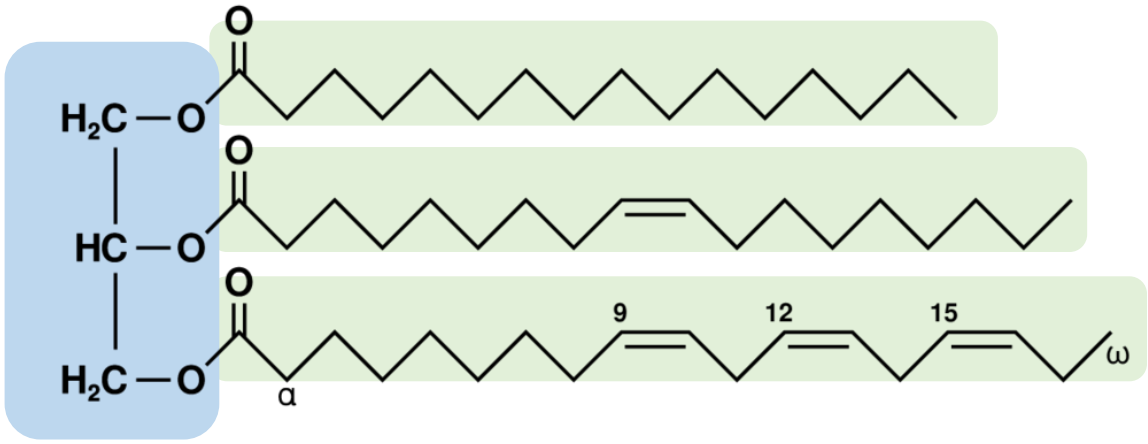
- **S**torage of energy
- **H**ormonal roles
- **I**nsulation
- **P**rotection of internal cavities
- **S**tructural components of cells

Types of Lipids - Examples

- Triglycerides
- Phospholipids
- Steroids
- Waxes

Triglyceride

- Form:
  - Three fatty acids
  - One glycerol molecule
- Main function:
  - Energy storage → energy can be released by aerobic cell respiration
  - Heat insulators



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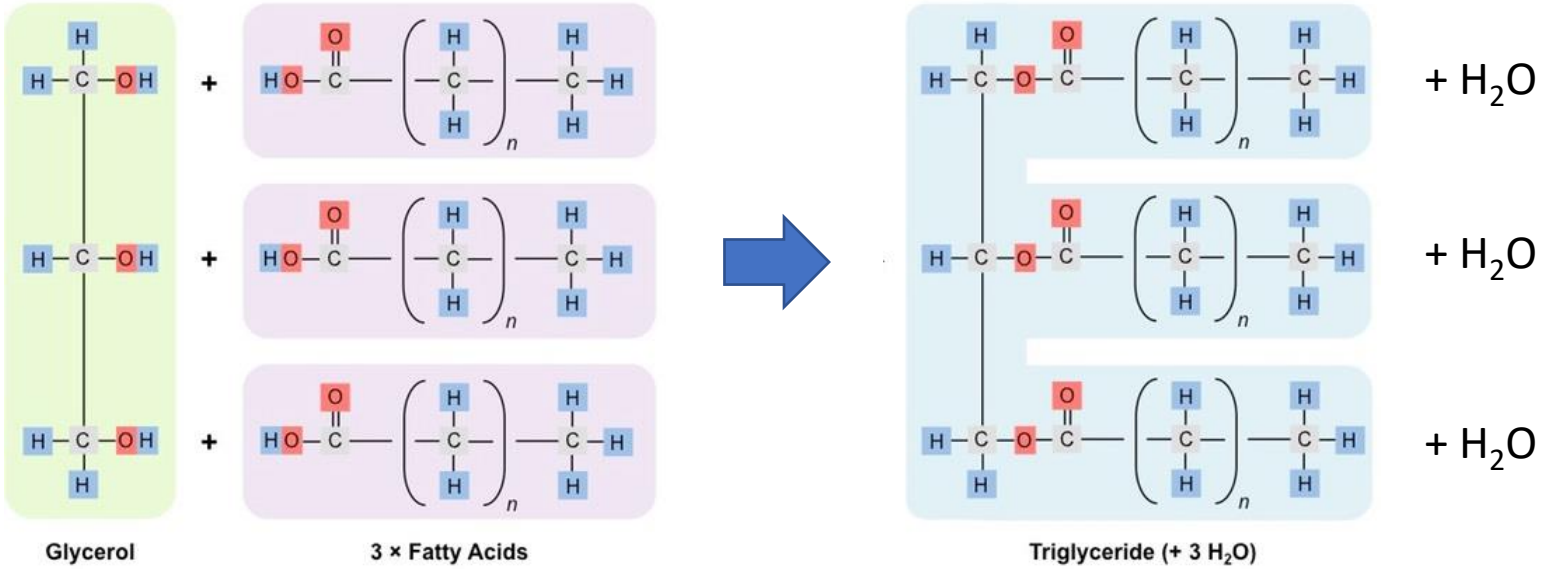
Triglycerides

- Formation:
  - Fatty acids are linked to glycerol by condensation reaction
    → *ester bonds* are formed
    → 3 water molecules are produced



Adapted from: https://ib.bioninja.com.au/standard-level/topic-2-molecular-biology/23-carbohydrates-and-lipids/triglycerides.html

Fatty Acids

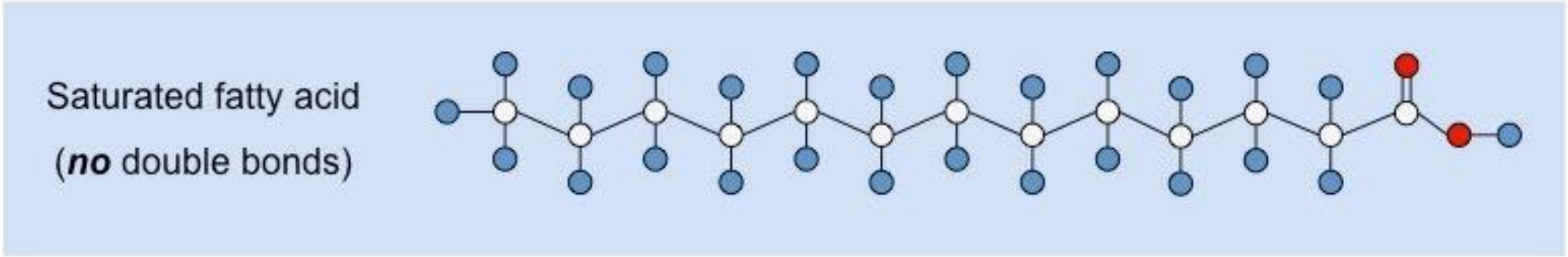
- Structure:
  - -COOH group
  - Long hydrocarbon chain

- Different forms:
  - Saturated fatty acids
  - Unsaturated fatty acids
    - Monounsaturated
    - Polyunsaturated

    or
    - Cis-fatty acid
    - Trans-fatty acid

Saturated Fatty Acids

- No double bonds → linear
- Usually solid at room temperature
- Found in animals



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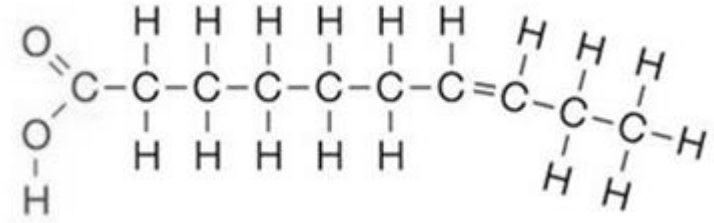
Unsaturated Fats – Mono- and Polyunsaturated Fatty Acids

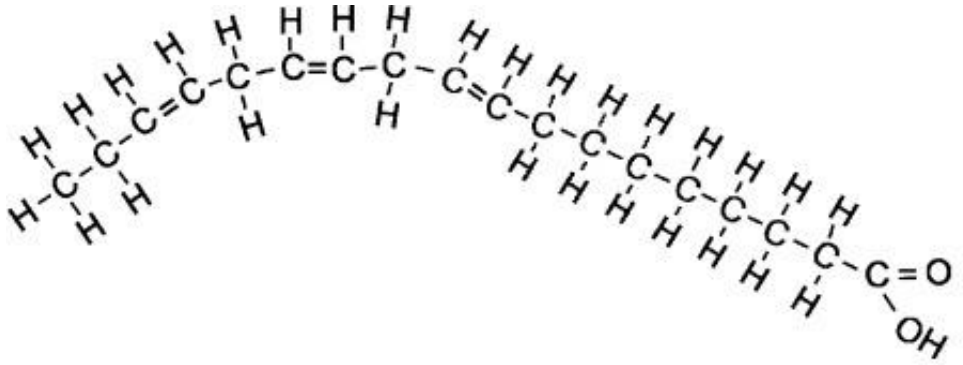
Monounsaturated Fats

- gr. *monos* = “one”, “single”
- Fatty acid contains one double bond somewhere in the chain
- Bent molecule
- Source: Plants/animals

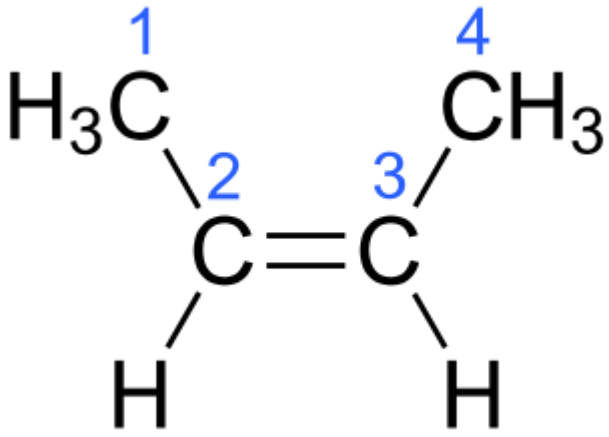


Polyunsaturated Fats

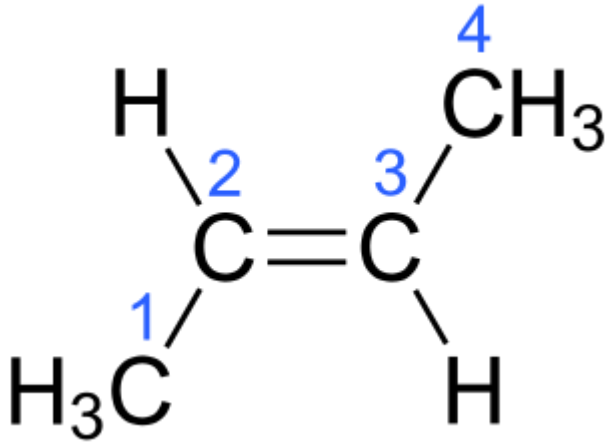
- gr. *polys* = “many”
- Fatty acid contains at least two double bonds
- Many bends in the chain
- Source: plants



Unsaturated Fats – Cis- and Trans-Fatty Acids



cis



trans

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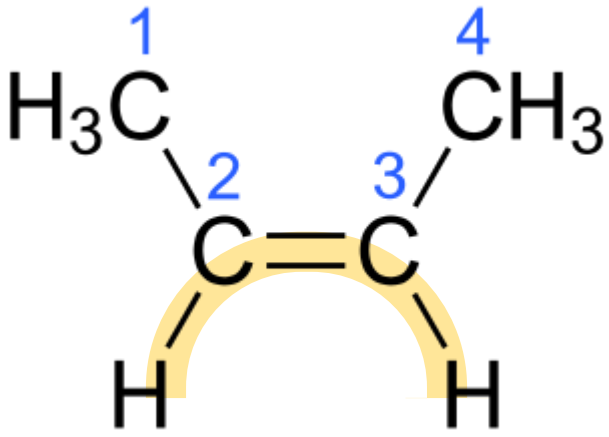
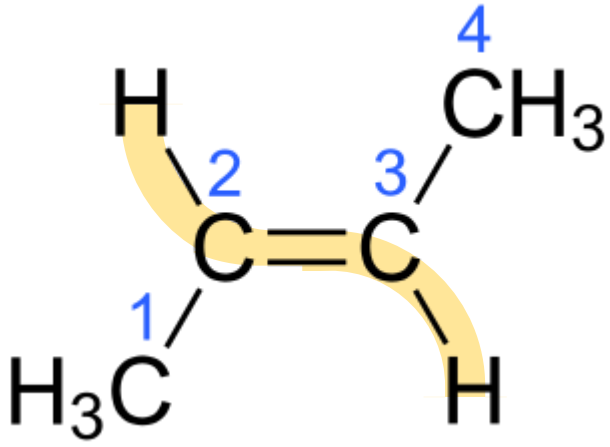
Unsaturated Fats – Cis- and Trans-Fatty Acids



cis

Looks like a “c” - as in **c**is



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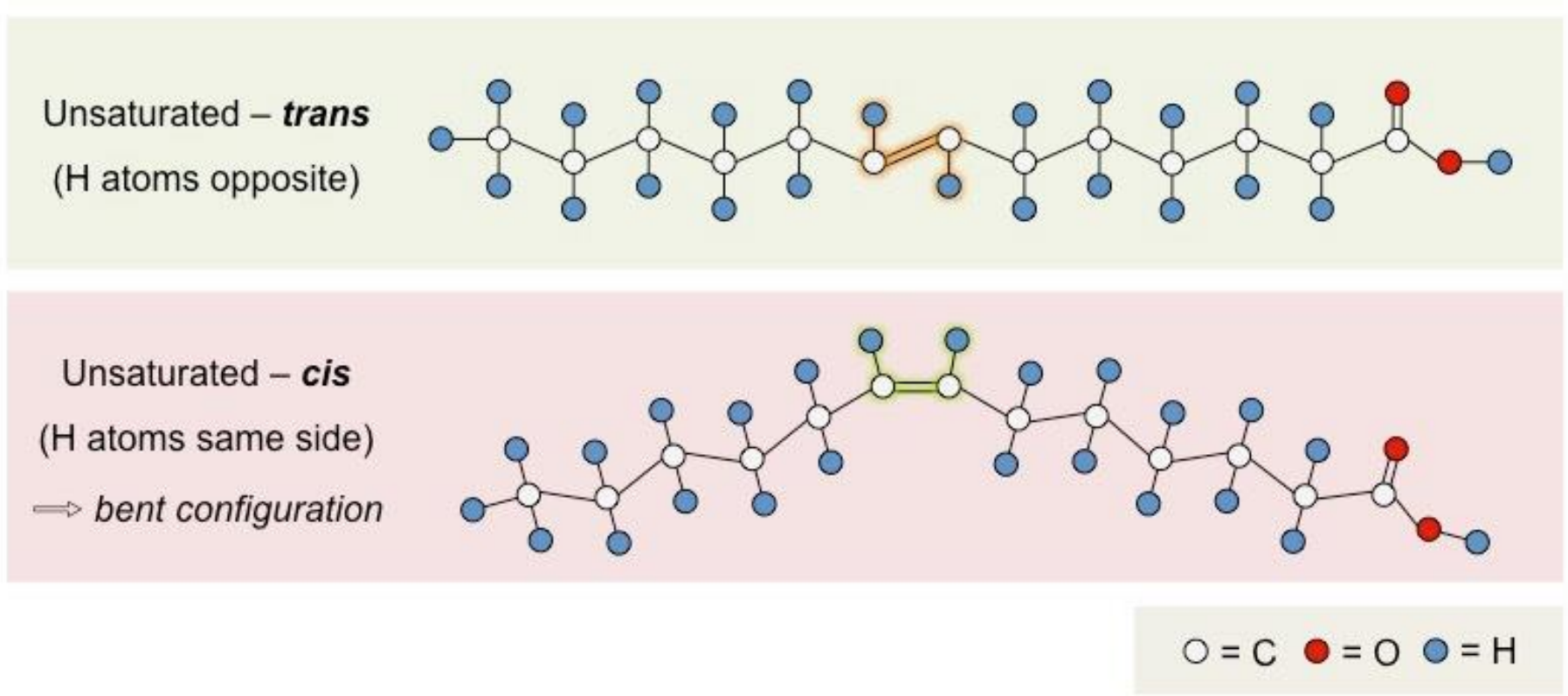
Unsaturated Fats – Cis- and Trans-Fatty Acids



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Energy storage

- What is better for long-term storage, carbohydrates or lipids?

Energy storage

Carbohydrate *(Glycogen)*		**Lipid** *(Triglyceride)*
Short-term energy storage	**S**torage	Long-term energy storage
More effect on osmotic pressure	**O**smolality	Less effect on osmotic pressure
More readily digested – used for aerobic or anaerobic respiration	**D**igestion	Less easily digested – can only be used for aerobic respiration
Stores half as much ATP per gram (~1760kJ per 100g)	**A**TP Yield	Stores twice as much ATP per gram (~4000kJ per 100g)
Water soluble as monomers / dimers – easier to transport	**S**olubility	Not water soluble (hydrophobic) – more difficult to transport