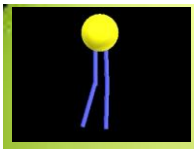
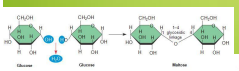
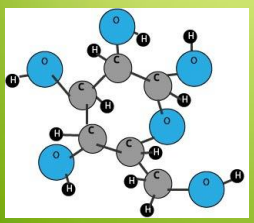


Molecular Biology
2.3 Carbohydrates and lipids



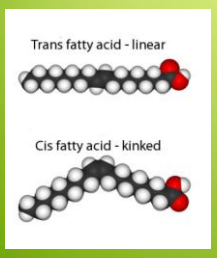
Essential idea:

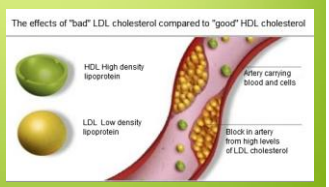
- Compounds of carbon, hydrogen and oxygen are used to supply and store energy.



Nature of Science:

- Evaluating claims
  - Health claims made about lipids in diets need to be assessed. (5.2)





HW: Use Evaluation Criteria to evaluate an article on Saturated Fat, Trans-fat or Cholesterol

International-mindedness

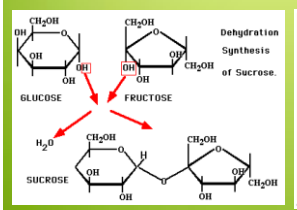
- There is variation in the prevalence of different health problems around the world including obesity, dietary energy deficiency, kwashiorkor (protein malnutrition), anorexia nervosa and coronary heart disease.
- How do cultures affect the occurrences of these disorders.

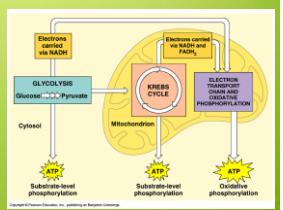
Theory of knowledge:

- There are conflicting views as to the harms and benefits of fats in diets.
- How do we decide between competing views?

Carbohydrates

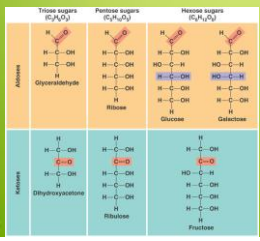
- Monosaccharide monomers whose structures and bonding with each other by dehydration synthesis determine the properties and functions of the molecules

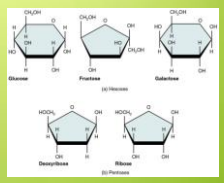




Monosaccharides

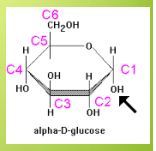
- CH_2O formula
- Simple single sugars
- Used for cellular respiration
- Aldoses and Ketoses

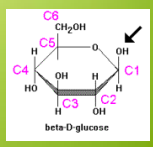


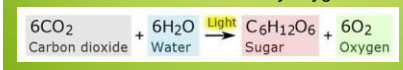


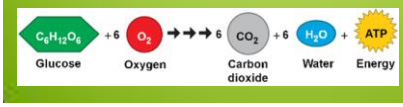
Monosaccharides

- Glucose($C_6H_{12}O_6$)
  - HMade by plants during photosynthesis
  - Metabolized during cellular respiration.
  - Main source of energy for plants and animals
  - Hexose ring structure in water (alpha and beta)
  - 5 of the carbons form corners on the ring with the 6th corner taken by oxygen



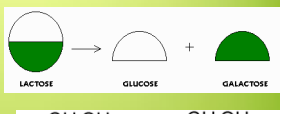


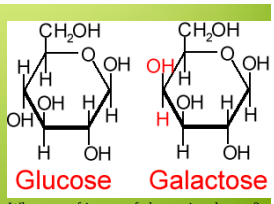




Monosaccharides

- Galactose
  - Found in mainly in milk
  - Hexose sugar
  - Less sweet as glucose
  - Converted by liver to glucose

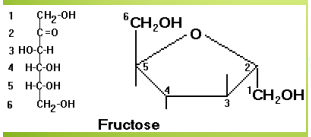




What type of isomer of glucose is galactose?

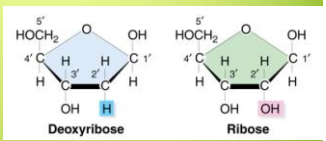
Monosaccharides

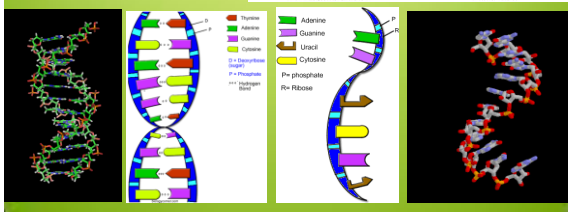
- Fructose
  - Pentose sugar
  - Found in fruit and honey.
  - Sweetest natural sugar.



Monosaccharides

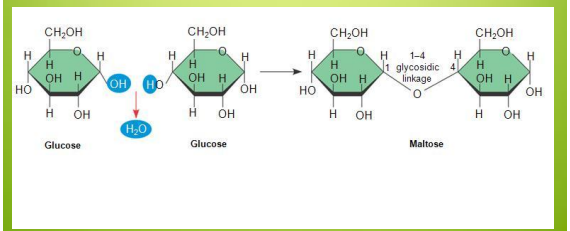
- Deoxyrobose- DNA
- Ribose- RNA
- Both are pentose sugars
- Difference is at carbon 2





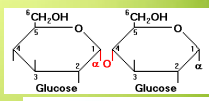
Disaccharides

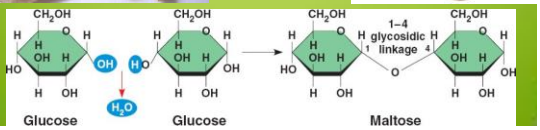
- Form by Glycosidic linkage
- Covalently bond by dehydration reaction



Disaccharides

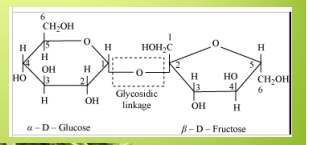
- Maltose ($C_{12}H_{22}O_{12}$)
  - Glucose + Glucose dimer
  - Produced by hydrolysis of malt in grains





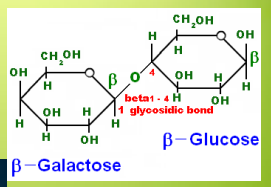
Disaccharides

- Sucrose ($C_{12}H_{22}O_{11}$)
  - Fructose + Glucose
  - Table sugar
  - From beets and cane



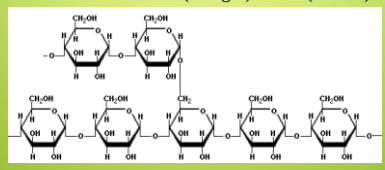
Disaccharides

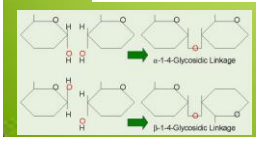
- Lactose ($C_{12}H_{22}O_{11}$)
  - Glucose + Galactose
  - Found in milk

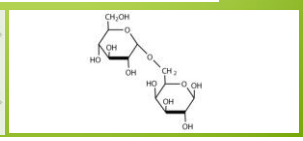


Polysaccharides

- Three or more monosaccharides
- Glycosidic bonds can be 1-4 (straight) or 1-6 (branch)

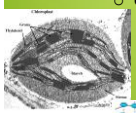


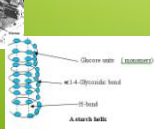


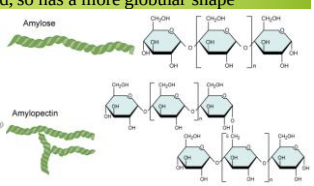


Polysaccharides

- Starch
  - The way plants store glucose (energy)
  - α-glucose linkages (spiral)
    - Amylose
      - un-branched and forms a helix
    - Amyopectin
      - chain is branched, so has a more globular shape

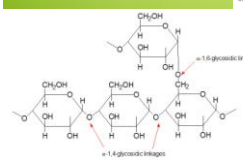


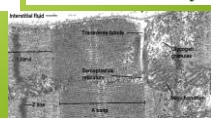




Polysaccharides

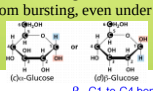
- Glycogen
  - 1-4 and 1-6 linkages on α-glucose
  - Creates spiral, branching and compaction
  - The way animals and some fungi store glucose.
  - In liver and muscle

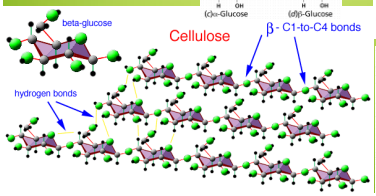


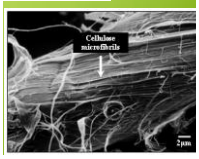


Polysaccharides

- Cellulose
  - Cell walls of plants
  - 1-4 linkage of β-glucose molecules (linear)
  - Hydrogen bonds link the molecules together (microfibrils)
  - They have very high tensile strength.
  - Prevents plant cells from bursting, even under very high (water) pressure



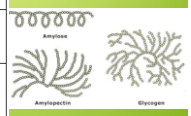


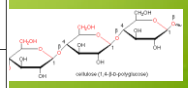


Carbohydrate Directionality

- The nature of the bonding between carbohydrate subunits determines their relative orientation in the carbohydrate
- This determines the secondary structure of the carbohydrate.

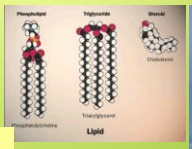
Polysacc	Monosac	Bonds	Diagram
Starch: Amylose	α - glucose	1-4	
Starch: Amylopectin	α - glucose	1-4 and 1-6	
Glycogen (NOT starch!)	α - glucose	1-4 and 1-6 (more 1-6 than amylo-pectin)	
Cellulose	β - glucose	1-4	

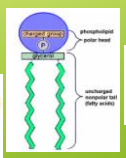


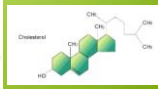


Lipids

- In general, lipids are nonpolar
- Don't dissolve in water
- More suitable for long term energy storage in humans than carbohydrates
- Fats, oils, waxes, phospholipids, steroids.

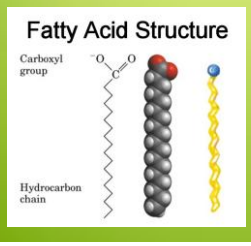


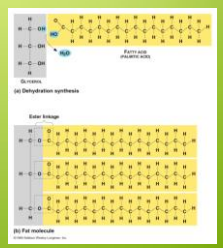




Fatty Acids

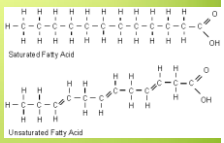
- The monomer that makes most lipids
  - hydrophilic carboxyl (COOH)
  - non-polar C-H bonds in fatty acid 'tails' (hydrophobic)
- Ester linkage: 3 fatty acids to 1 glycerol (condensation reaction)

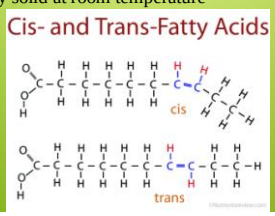




Fatty Acids

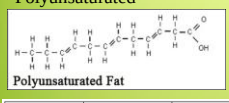
- Saturated (not Kinky)- only single bonds
- Unsaturated (Kinky)- some double bonds
  - Cis isomers
    - low melting points
    - usually liquid at room temperature
  - Trans isomers
    - high melting points
    - usually solid at room temperature



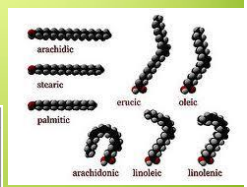


Fatty Acids

- Polyunsaturated



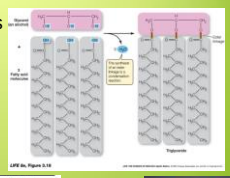
Properties	Cis Fatty acids	Trans Fatty acids
Health implications	Good	Detrimental; lowers good cholesterol and increases the level of bad cholesterol in the body.
Natural occurrence	Yes	Very less, hence produced artificially by partial hydrogenation of polyunsaturated fatty acids.
Orientation at double bonded carbon atoms	Hydrogen atoms at double bonded carbon atoms on same side	Hydrogen atoms at double bonded carbon atoms on opposite side
Recommended consumption	Can consume as per requirment	No more than 1% of total calories per day
Commonly found in	Natural fatty acids	Processed food, fast foods, butter and milky products.
Melting point	Lower	Higher

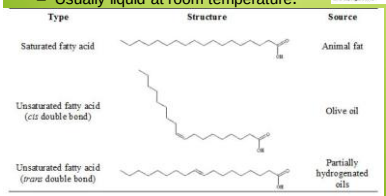


Which are best?

Triglycerides

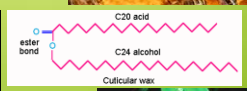
- Condensation from three fatty acids and one glycerol (ester bonds)
- Fats (saturated)
  - Usually found in animals
  - Usually a solid at room temperature
- Oils (cis unsaturated)
  - Usually found in plants
  - Usually liquid at room temperature.





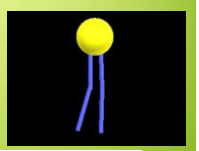
Waxes

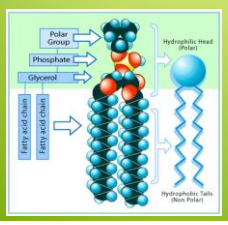
- Long fatty acid connected to long alcohol
- Long fatty acid = hydrophobic
- Protective barriers in plants and animals.

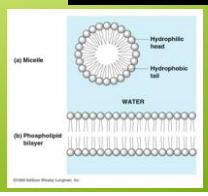


Phospholipids

- 2 fatty acids and one phosphate group
- 'Tails' hydrophobic; 'heads' hydrophilic
- *Micelle* (phospholipid droplet in water)
- *Bilayer* (double layer); cell membranes

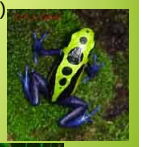


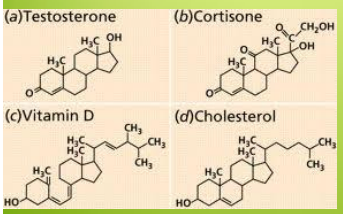


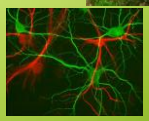


Steroids

- 4 fused carbon rings (does not dissolve in water)
- No fatty acids.
- Found in hormones, nerve tissue, toad venoms, plant poisons.

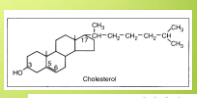


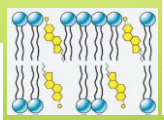


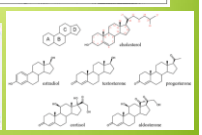


Steroids

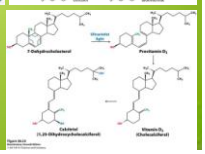
- Cholesterol
  - Cell membranes (structural stablility)
  - Precursor for other steroids
  - Precursor for vitamin D
  - HDL vs LDL







The End



Health Claims

- There have been many claims about the effects of different types of fat on human health. The main concern is coronary heart disease (CHD). In this disease the coronary arteries become partially blocked by fatty deposits, leading to blood clot formation and heart attacks.
  - A positive correlation has been found between saturated fatty acid intake and rates of CHD in many studies.
  - Correlation ≠ causation. Another factor, e.g. dietary fiber could be responsible.
  - There are populations that do not fit the correlation such as the Maasai of Kenya. They have a diet that is rich in meat, fat, blood and milk. They therefore have a high consumption of saturated fats, yet CHD is almost unknown among the Maasai.
  - Diets rich in olive oil, which contains cis-monounsaturated fatty acids, are traditionally eaten in countries around the Mediterranean. The populations of these countries typically have low rates of CHD and it has been claimed that this is due to the intake of cis-monounsaturated fatty acids.
  - Genetic factors in these populations could be responsible.
  - Other aspects of the diet could explain the CHD rates.
  - There is also a positive correlation between amounts of trans-fat consumed and rates of CHD.
  - Other risk factors have been tested, to see if they can account for the correlation, but none did. Trans-fats therefore probably do cause CHD.
  - In patients who had died from CHD, fatty deposits in the diseased arteries have been found to contain high concentrations of trans-fats, which gives more evidence of a causal link.

Back

Chris Paine https://bioknowledgy.weebly.com/