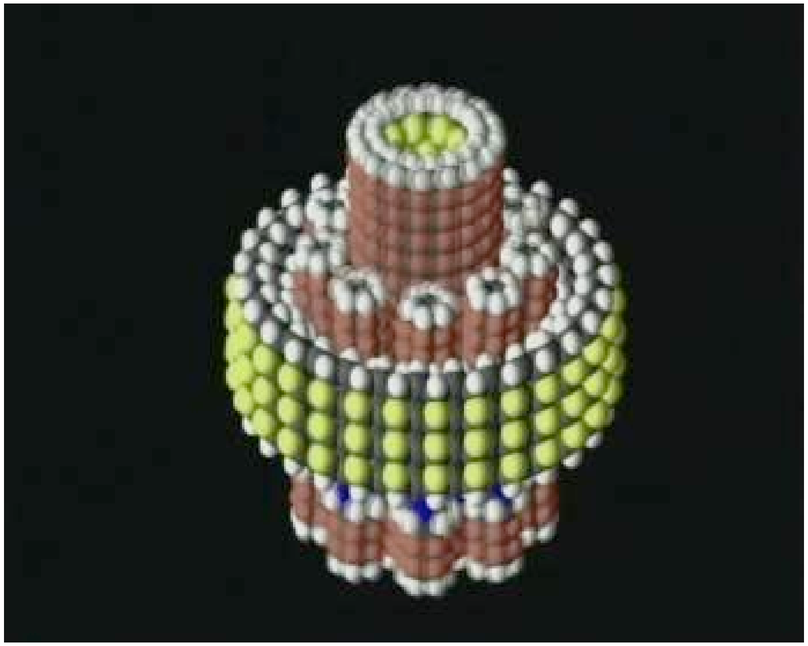
Go to the WIKI:

http://bionano.cs.duke.edu/bionano

Play on the playground.
Read the syntax guide.
Add subtopics to the outline.

Other biological materials…



- Lipids
- Carbohydrates
- Minerals

Lipids

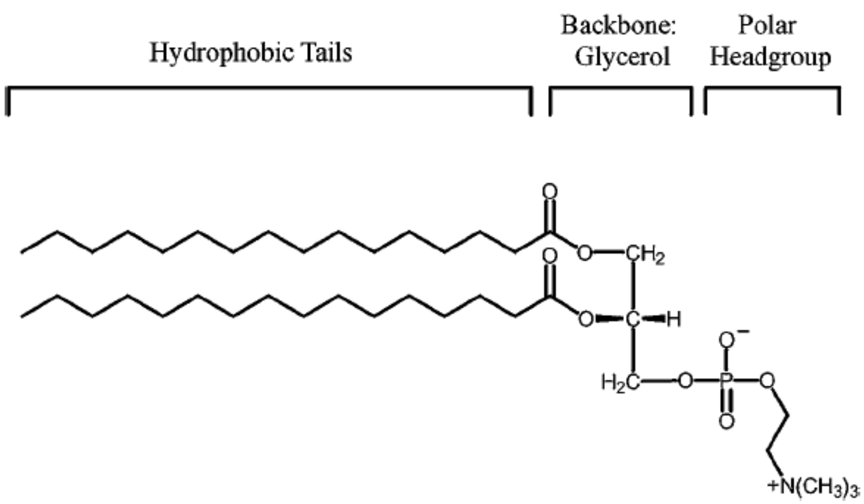


Figure 1 Structural features of lipids, using a glycerophospholipid (phosphatidylcholine) as an example.

- Molecular structure
  - One or more hydrophobic tails, polar headgroup, connecting backbone.
- Supramolecular structure
  - Monolayer, micelle, bilayer, liposome, rafts, hybrids

Annu. Rev. Mater. Res. 2001. 31:237–63

Phospholipid Strategies in Biomineralization and Biomaterials Research

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- Ribbons, tubes, networks
- Containers
  - Carriers
  - Reaction vessels
  - Crystallization chambers
- Templates

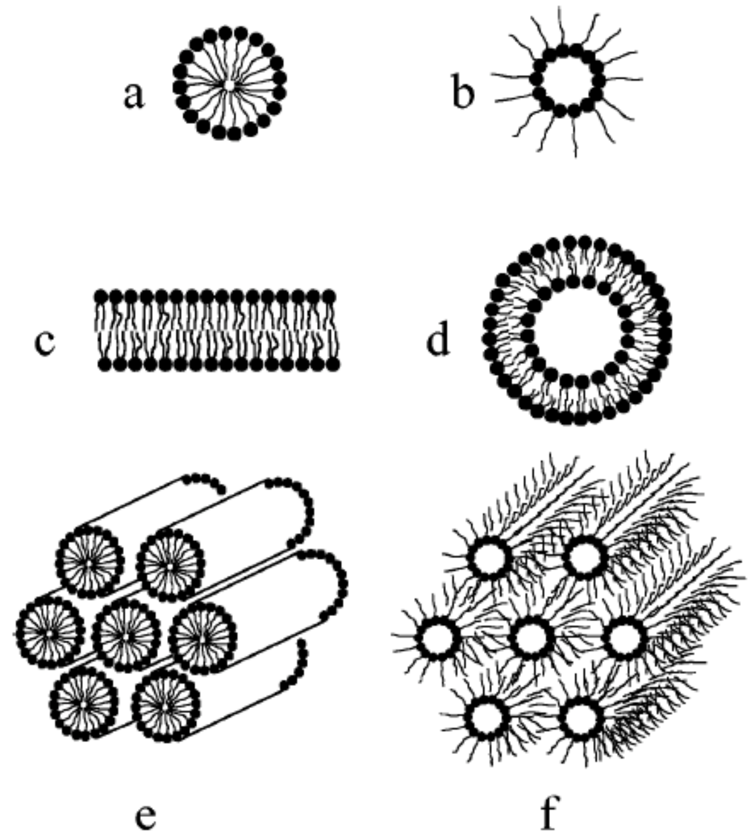
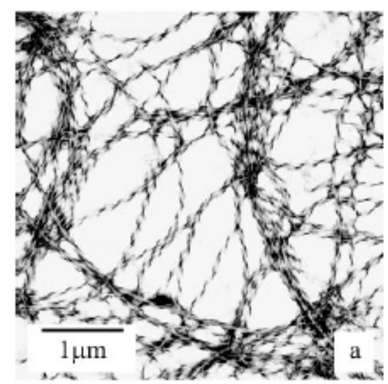


Figure 2 Common lamellar and nonlamellar self-assembled structures of lipids: (*a*) micelle, (*b*) inverse micelle, (*c*) lamellar bilayer, (*d*) bilayer vesicle, (*e*) hexagonal, (*f*) inverse hexagonal.



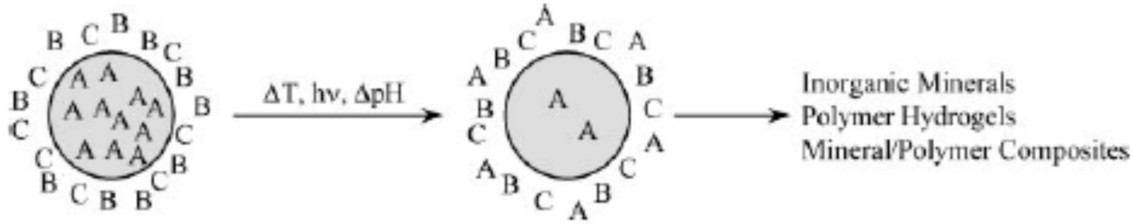
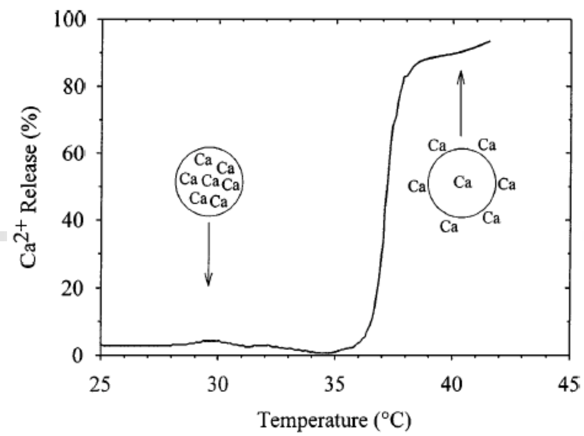


Figure 3 Schematic illustration of general strategy for utilizing stimuli-responsive lipid vesicles for in situ formation of biomaterials. A, B, and C represent reactive solutes, such as organic/inorganic ionic species, low-molecular weight organic molecules, or polymers. Exposure of the liposome suspension to an applied stimulus triggers release of entrapped reagent (A), which reacts with components of the free medium (B and/or C) to form a solid or semi-solid biomaterial. Alternatively, release of entrapped reagent may be used to catalyze reaction between non-entrapped species.



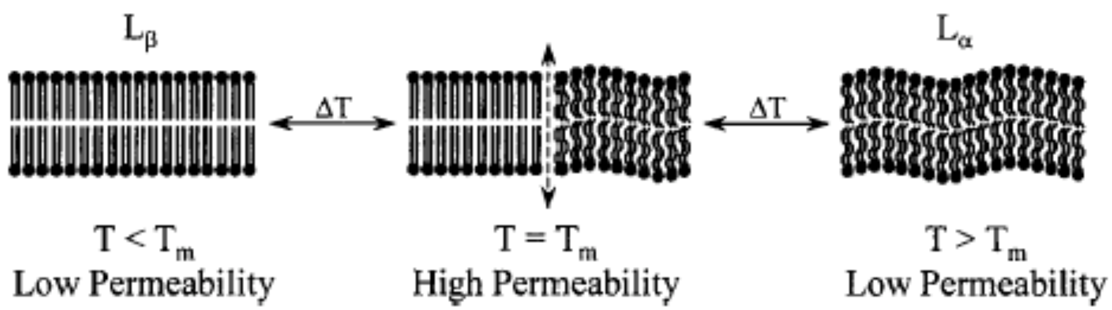
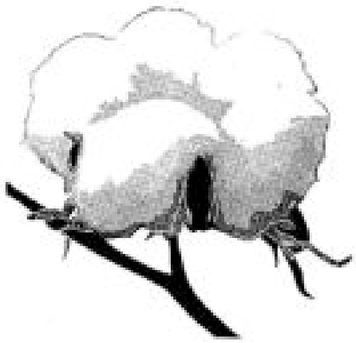


Figure 4 Schematic illustration of the effect of temperature on phospholipid bilayer permeability. Permeability across bilayers is low in the single-phase regions below and above the melting temperature (T_m) but is high in the vicinity of T_m owing to the existence of defect-rich interfacial regions between coexisting gel and fluid domains.

Carbohydrates

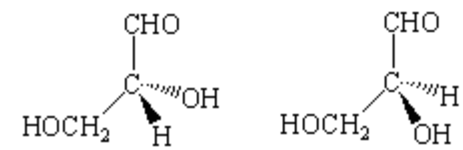


- "hydrates of carbon"
  - $C_n(H_2O)_n$
  - Glucose $C_6H_{12}O_6$ or $C_6(H_2O)_6$
- The most abundant biogenic substances on earth.
- Monosaccharides, disaccharides, sugars, oligosaccharides, polysaccharides, glycogen, starch, cellulose, chitin
- Etc…

SEE ALSO - http://www.cns.uni.edu/~macmilla/mcmurry/mcmurry_chapter_26/sld001.htm

Monosaccarides

- Aldose - polyhydroxy aldehydes
- Ketose - polyhydroxy ketone
- Hemiacetal - cyclic form
- Pyranose - six membered ring
- Furanose - five membered ring
- D- vs L- isosteriomers (D used in nature)



D-Glyceraldehyde L-Glyceraldehyde

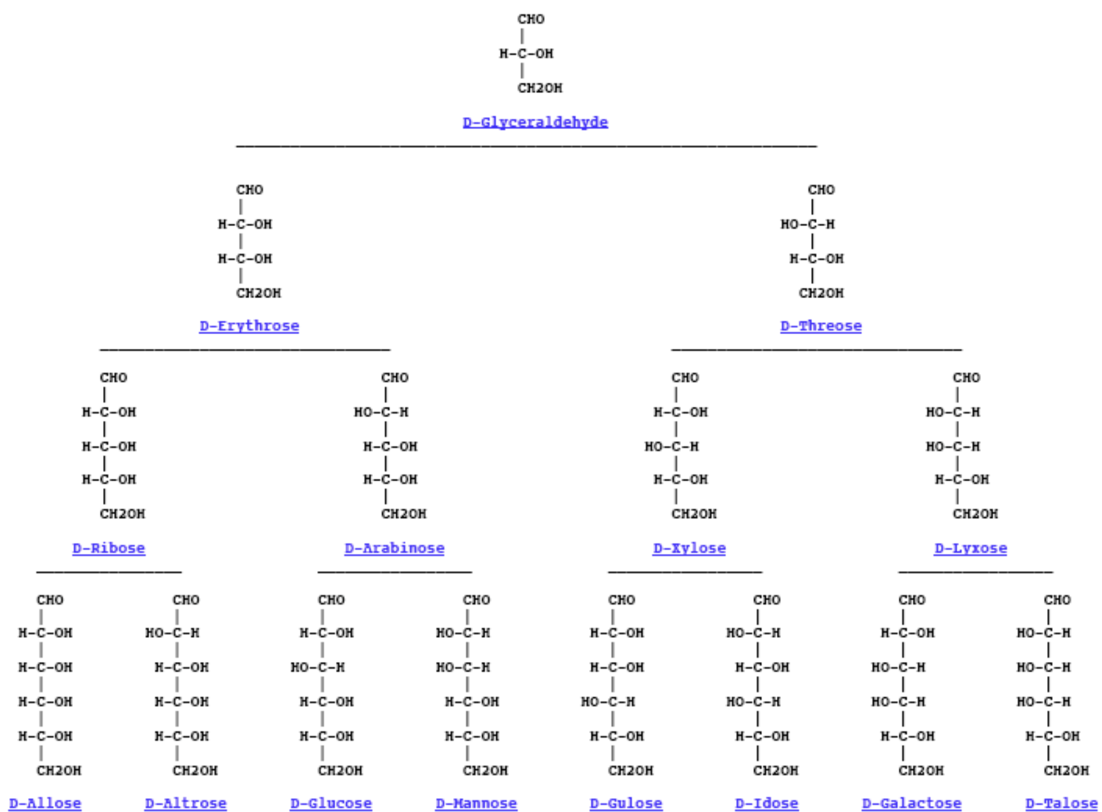
D-Glyceraldehyde L-Glyceraldehyde.

Fischer projection

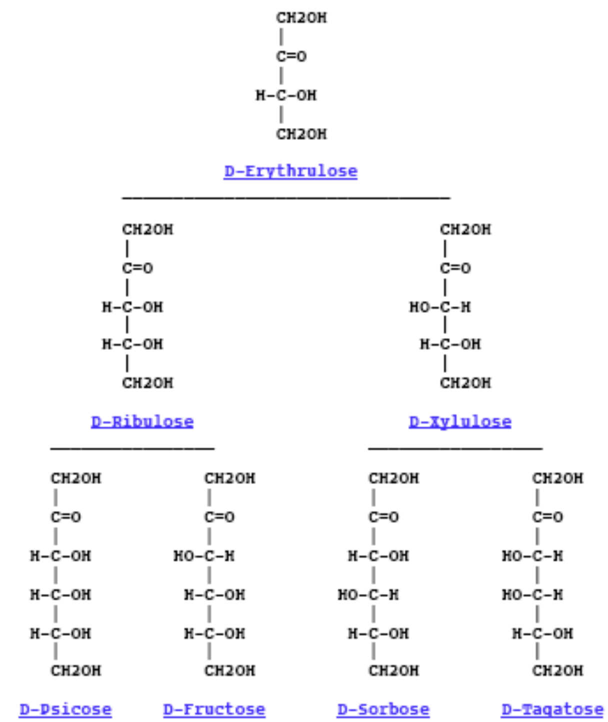
Aldoses & Ketoses

Aldehyde O=C-H
|

Ketone -(CH_2)-C-(CH_2)-
||
O



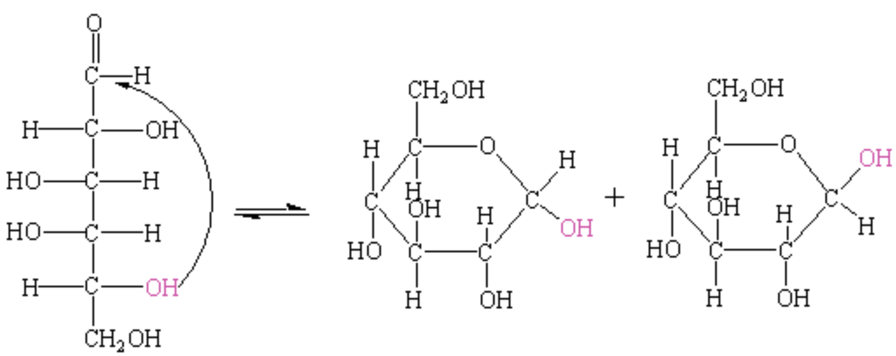
Aldoses



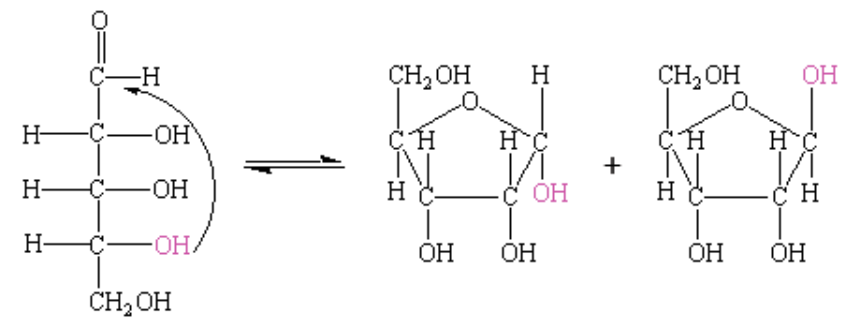
Ketoses

Hemiacetal formation

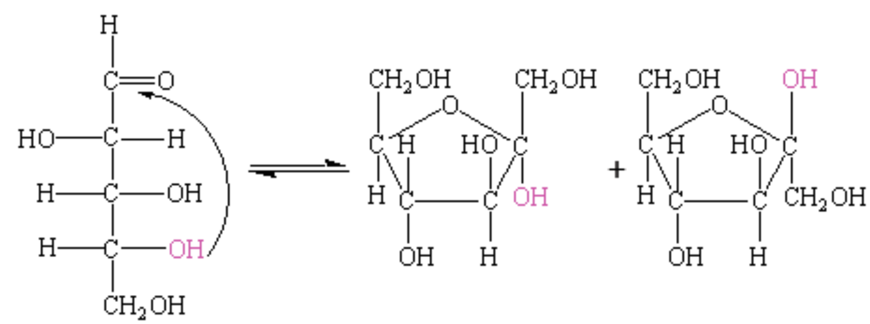
See also - http://www.usm.maine.edu/~newton/Chy251_253/Lectures/CarbohydratesIII/Carbo3FS.html



D-glucose α–D-glucopyranose β–D-glucopyranose



D-ribose a-D-ribofuransoe b-D-ribofuranose

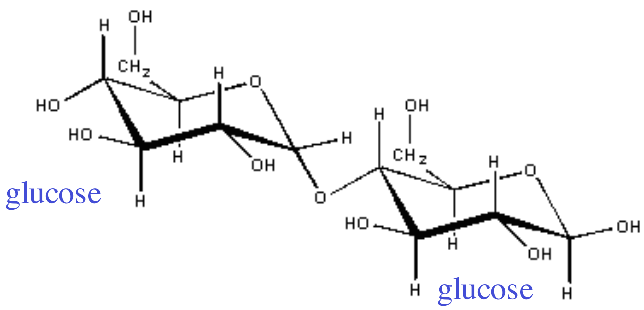


D-fructose a-D-fructofuranose b-D-fructofuranose

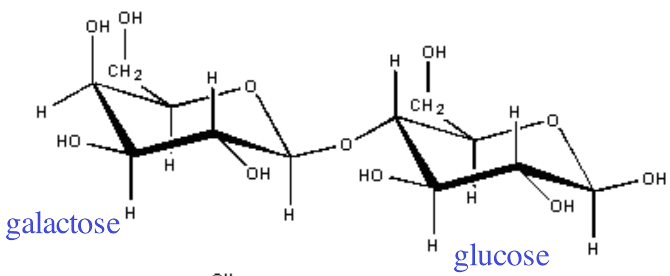
In solution, the aldehyde group at one end reacts with a hydroxyl group at the other end to form a cyclic structure.

Alpha and beta anomers

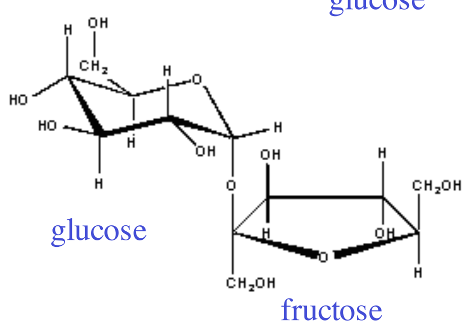
Disaccharides



Maltose



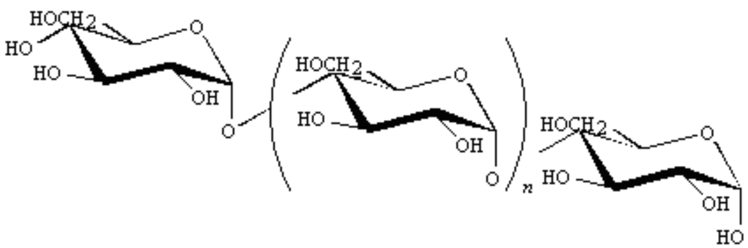
Lactose



Sucrose

- Sugar dimers
- How is polymer structure different than DNA, RNA, protein?
  - Backbone?
  - Sidechain?

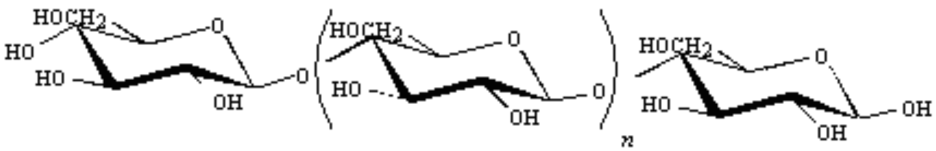
Polysaccharides



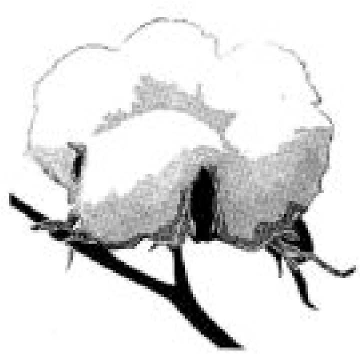
Amylose

- Starch, glycogen, cellulose, chitin
- Used for glucose (energy) storage and mechanical structure of cells
- Starch & Glycogen
  - Amylose - algae. linear. ~600 glucose residues.
  - Amylopectin - plants. branched (~1 in 24). ~6000 glucose residues.
  - Glycogen - animals. ~twice as big and twice as branched as amylopectin.

Cellulose

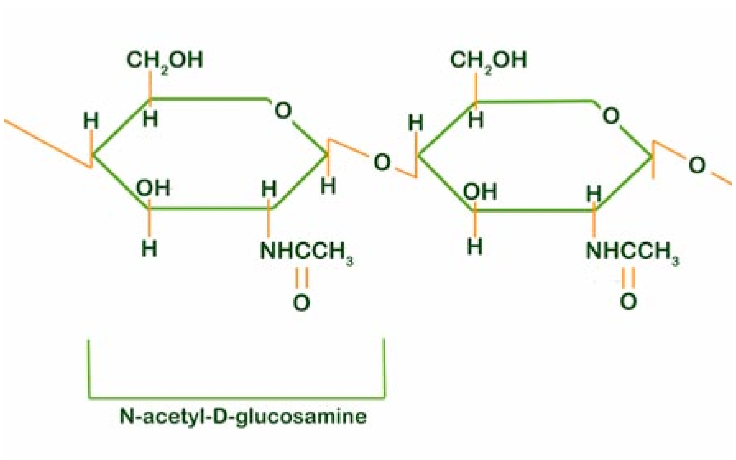


Cellulose
$n = 5000 - 10{,}000$



- Linear polymer of B-glucopyranose units.
- (Starches use a-glucopyranose units).
- Plant cell walls.
- The most abundant biomolecule.

Chitin

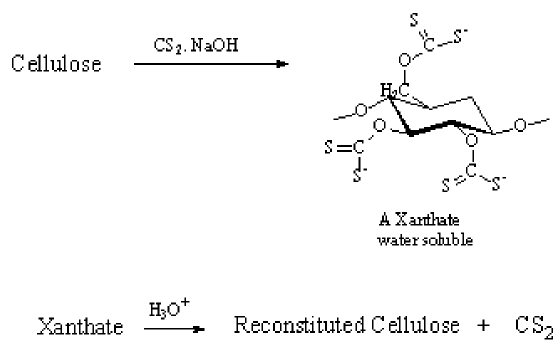


- A main component of fungi cell walls, the exoskeletons of insects and other arthropods, and in some other animals.
- Made of units of acetylglucosamine (N-acetyl-D-glucos-2-amine). These are linked together in β-1,4 fashion, the same as the glucose units that make up cellulose.
- Chitin is like cellulose with one hydroxyl group on each monomer replaced by an acetylamino group. This allows for increased hydrogen bonding between adjacent polymers, giving the material increased strength.
- The strength and flexibility of chitin is the reason it is the material of choice for surgical thread.

Polysaccharides

Rayon

- Reactions of cellulose



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- Other uses in nature:
  - Protein glycosylation
  - Xanthan gum
  - Lipopolysaccharides - bacterial cell walls, endotoxin of gram- bacteria
- Have been used as templates for inorganic nanostructures.
- Targets for nanoengineering?
  - Branched, diverse.
  - Structural.
  - Programmable?