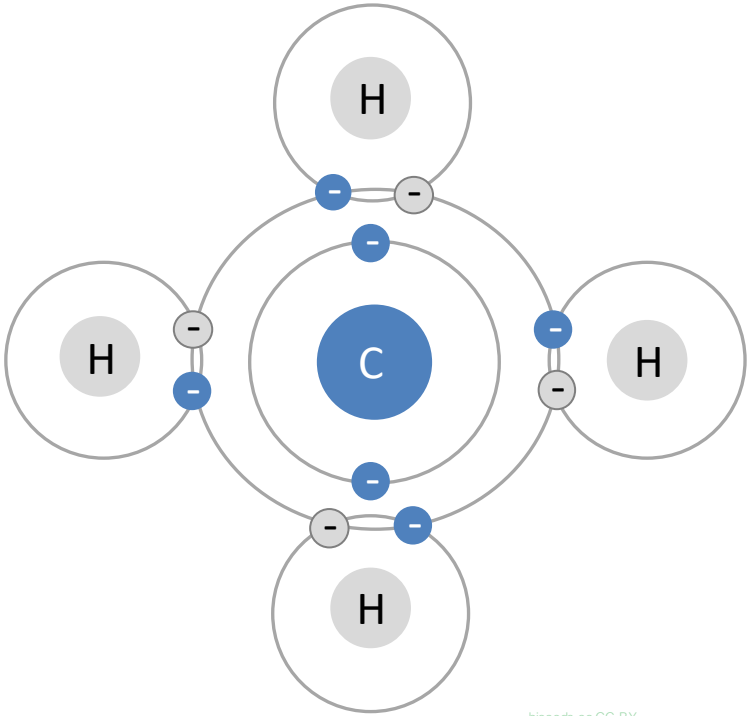
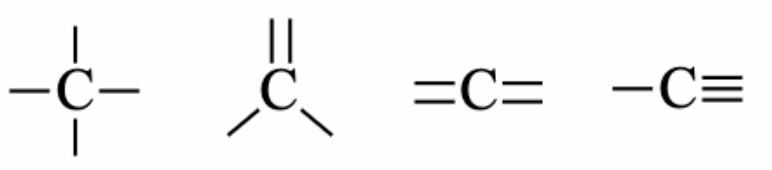
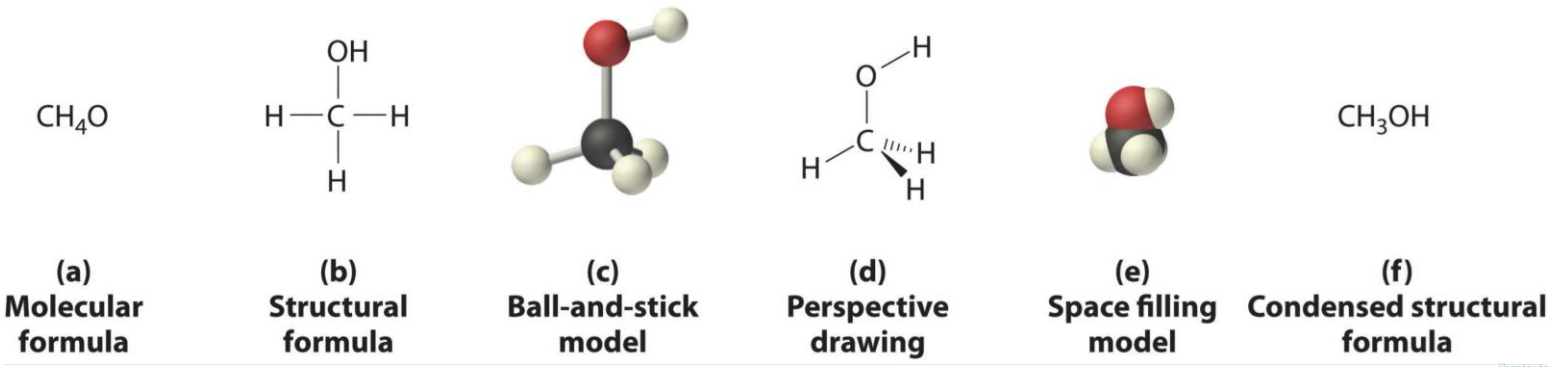
B1.1
Carbohydrates and Lipids

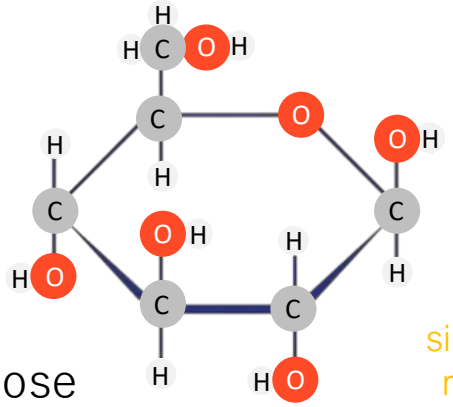
In what ways do variations in form allow diversity of function in carbohydrates and lipids?
How do carbohydrates and lipids compare as energy storage compounds?





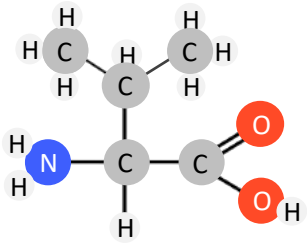


scientific conventions are based on international agreement
(SI metric unit prefixes “kilo”, “centi”, “milli”, “micro” and “nano”)



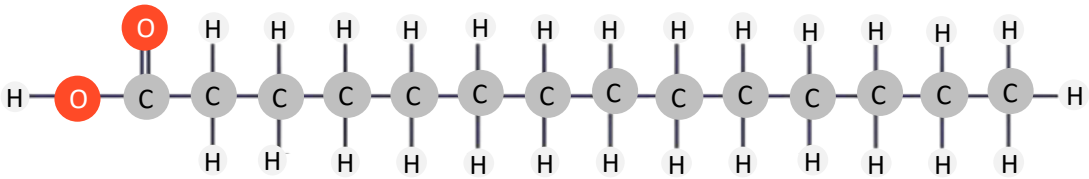
glucose

single ring



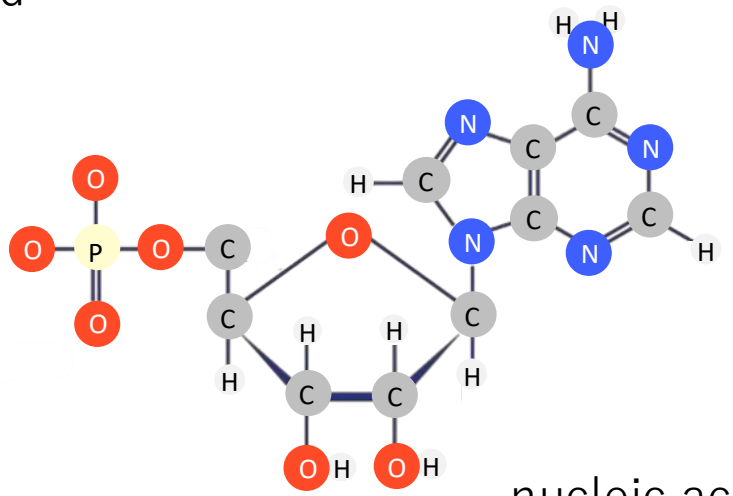
branching chain

amino acid - valine



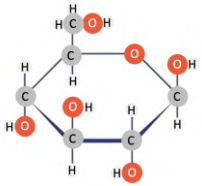
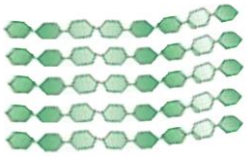
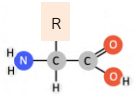
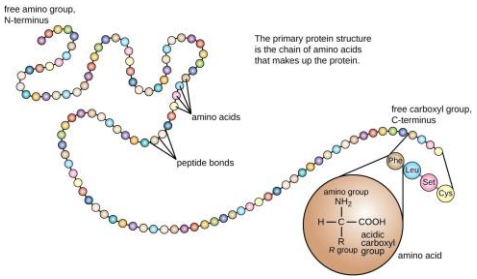
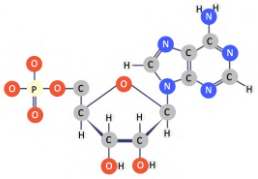
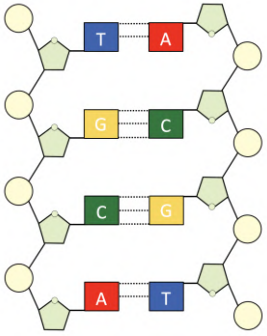
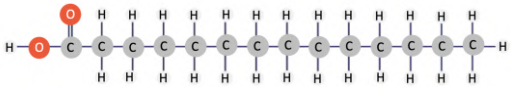
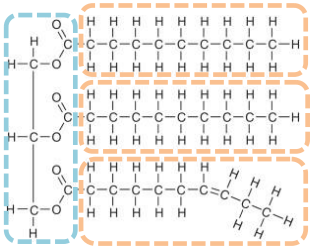
chain

fatty acid



double ring

nucleic acid

monomer / subunit		polymer / macromolecule		examples
carbohydrate	 monosaccharide	polysaccharide		cellulose starch glycogen
protein	 amino acid	polypeptide		amylase hemoglobin
nucleic acids	 nucleotide	polynucleotide		DNA RNA
lipids	 fatty acid	triglyceride	 glycerol fatty acids	plant oil fish oil animal fat

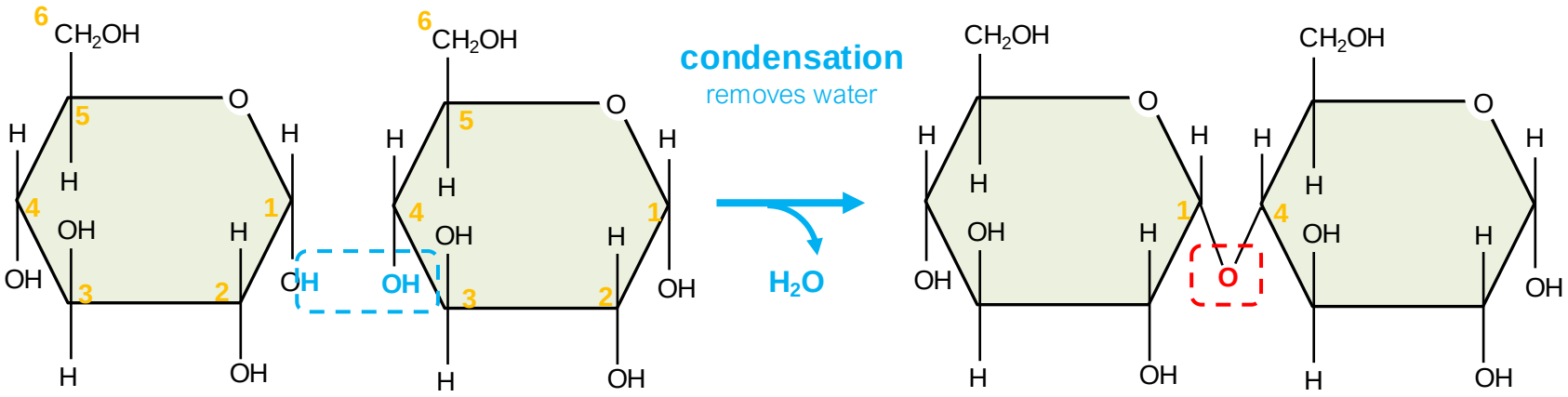
monosaccharides / monomers

α glucose

α glucose

disaccharide

maltose



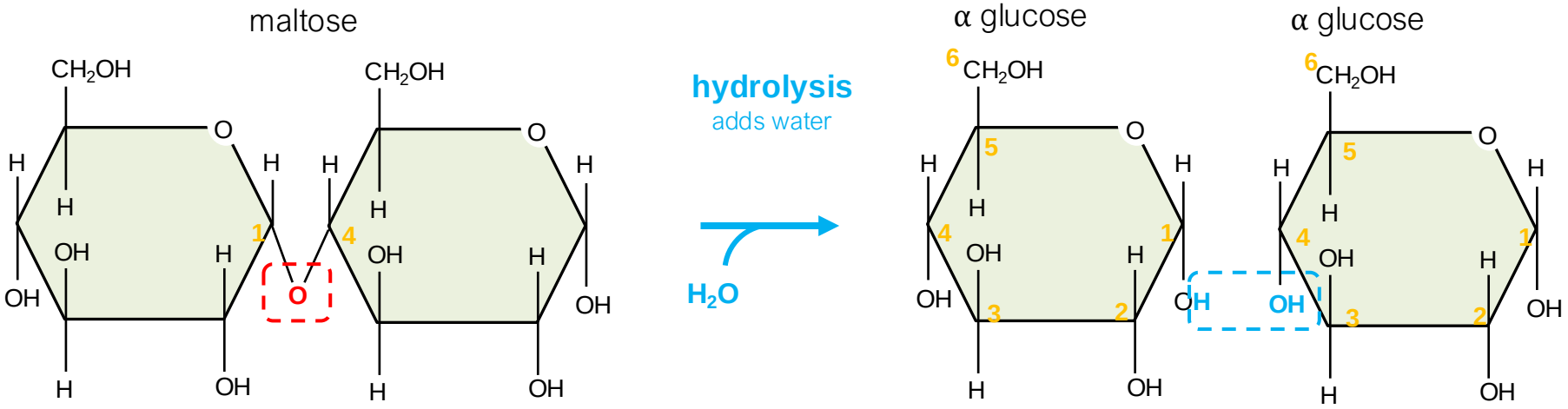
disaccharide

maltose

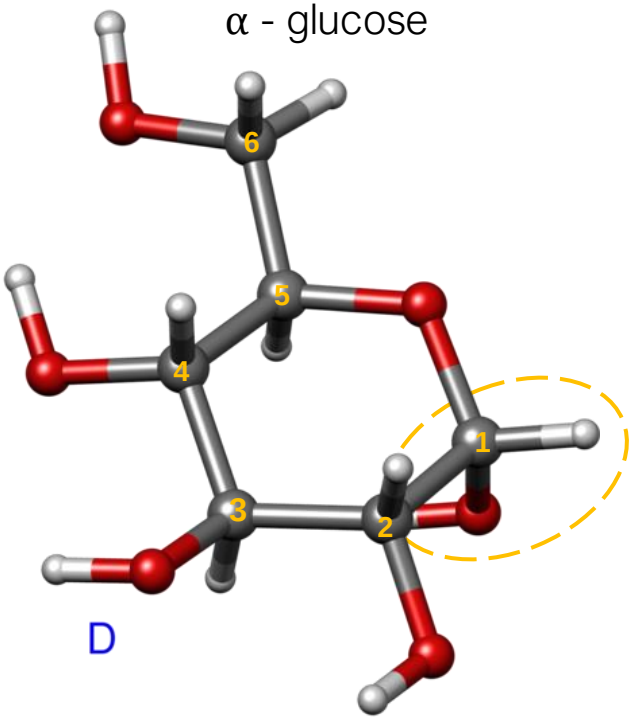
monosaccharides

α glucose

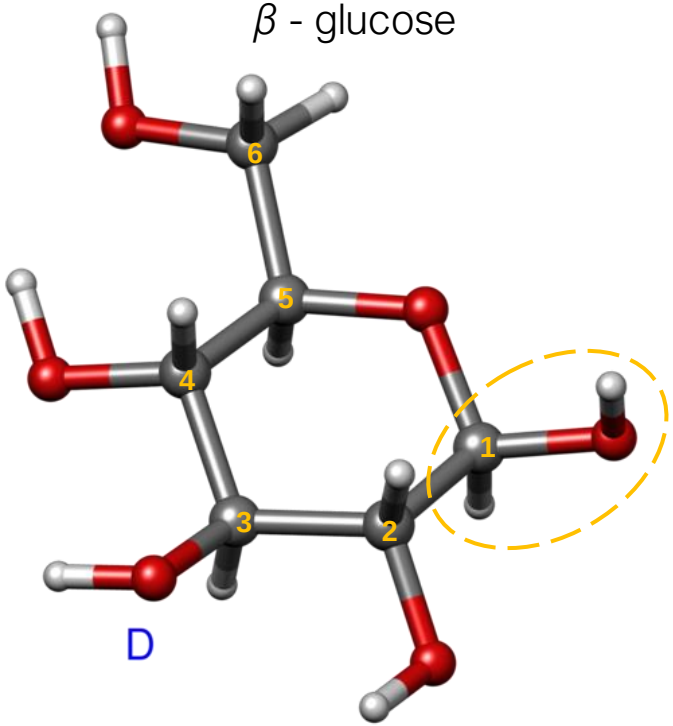
α glucose

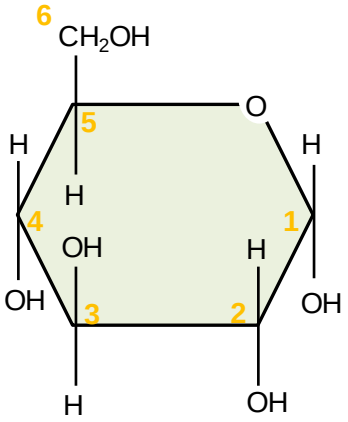


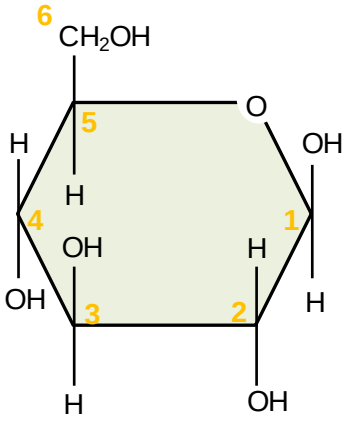
α - glucose

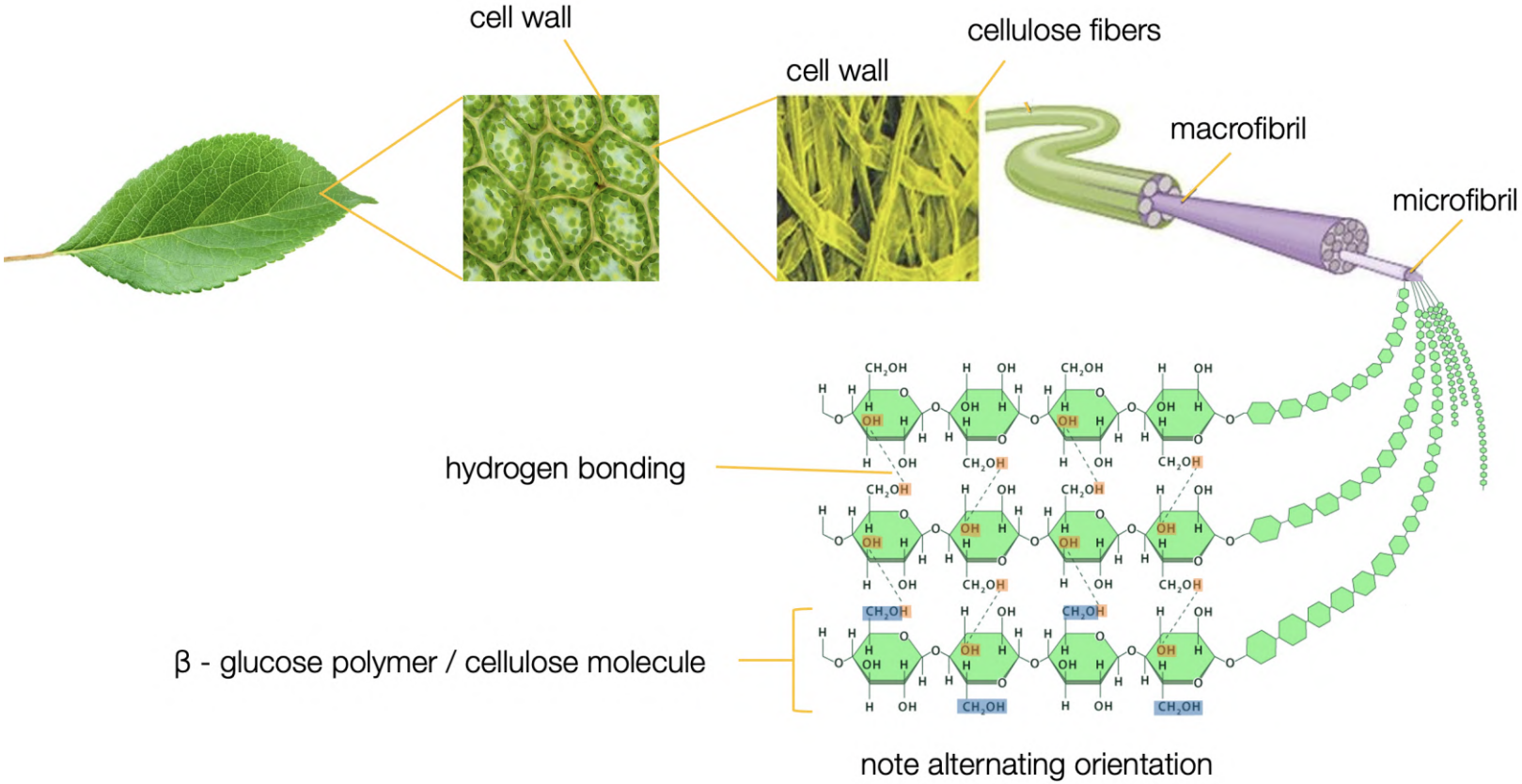


β - glucose

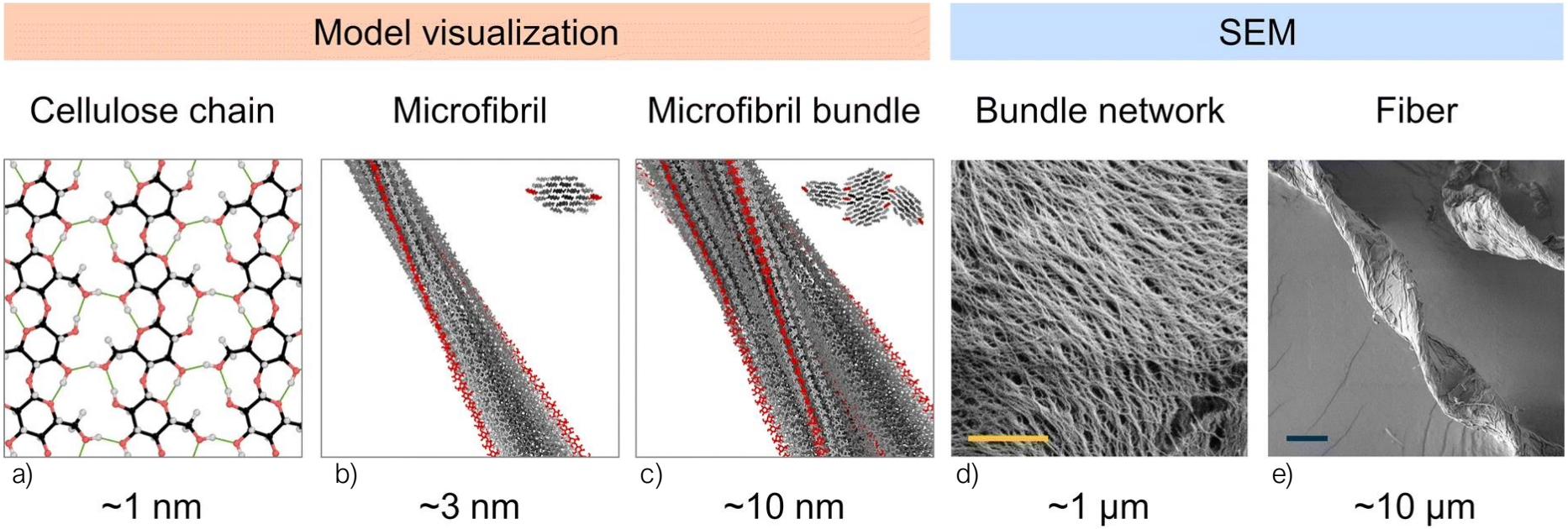







cell wall
cell wall
cellulose fibers
macrofibril
microfibril
hydrogen bonding
β - glucose polymer / cellulose molecule
note alternating orientation

Cellulose SEM images and predicted microfibril structure

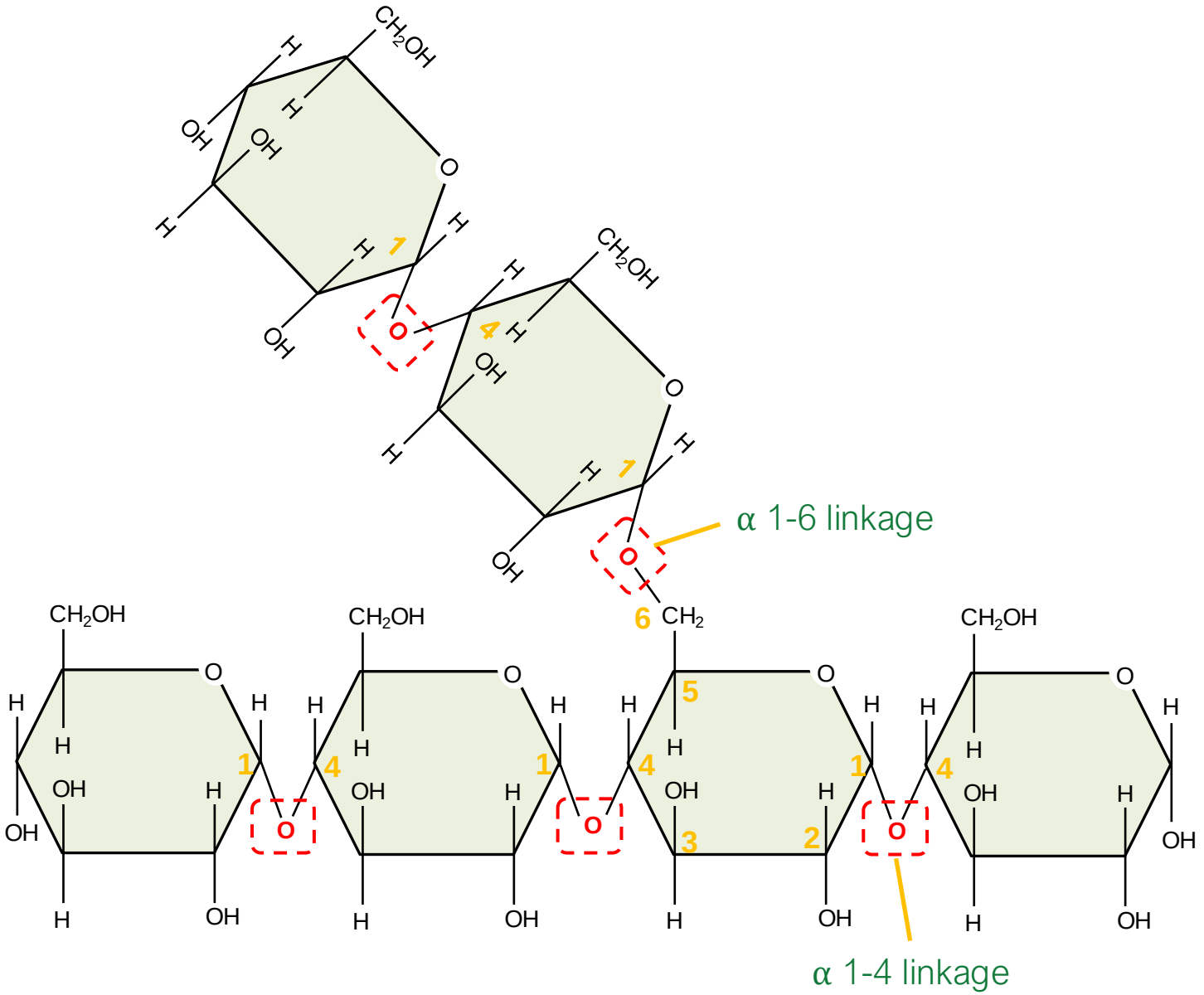


a) molecular visualization of a layer of cellulose chains (hydrogen bonds shown in green)
b) a microfibril
c) a bundle of four microfibrils
d) network of microfibril bundles
e) a whole fibre

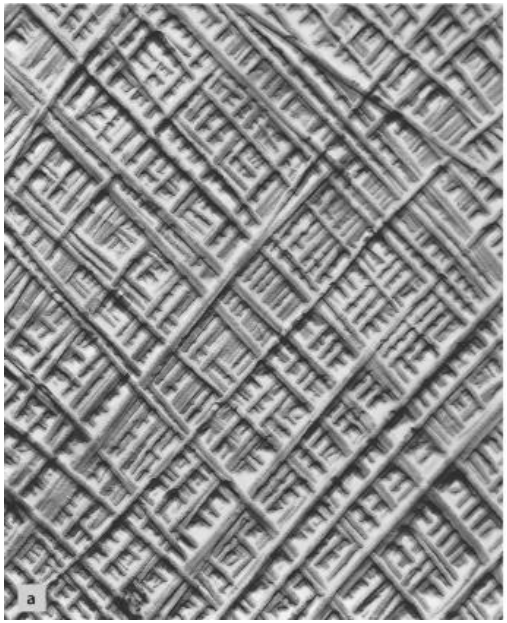
The orange and blue scale bars in the micrographs indicate 1 µm and 10 µm, respectively.

Optional Extension (not required for IB exams)
The Scientific Problems with Chemical Evolution | Polymerization

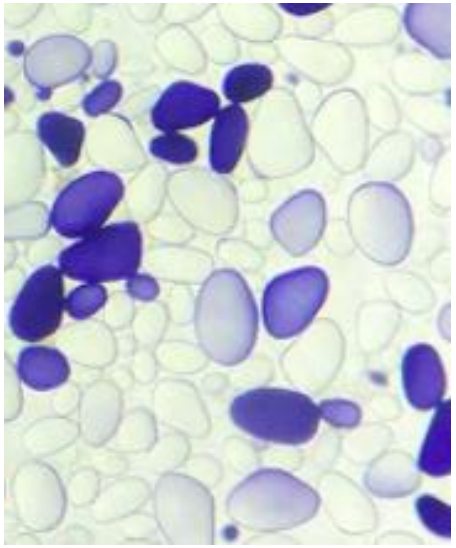
Amylopectin and glycogen are made from α - glucose, branching is due to 1-6 bonds.



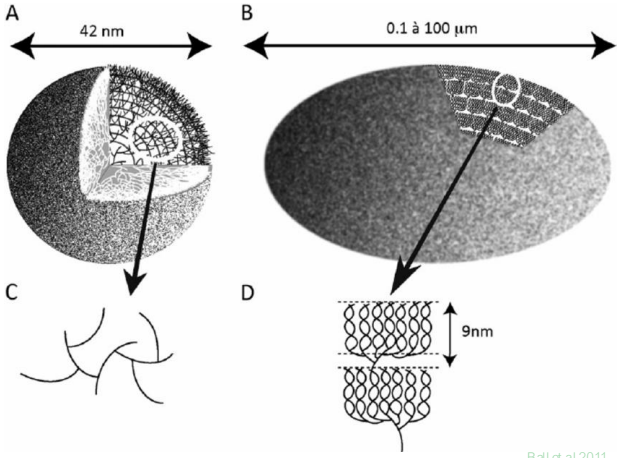
"The ingenious microstructural and architectural design of plant epidermal cell walls suggests ways to engineer strong and extensible fibrous materials with multifunctional applications."
Yao Zhang et al 2021



Cellulose fibrils of a cell wall in an algae *Neglectella solitaria*. Nick 2021

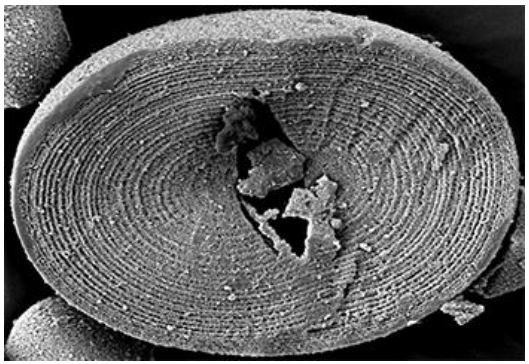


Starch grains light microscope.



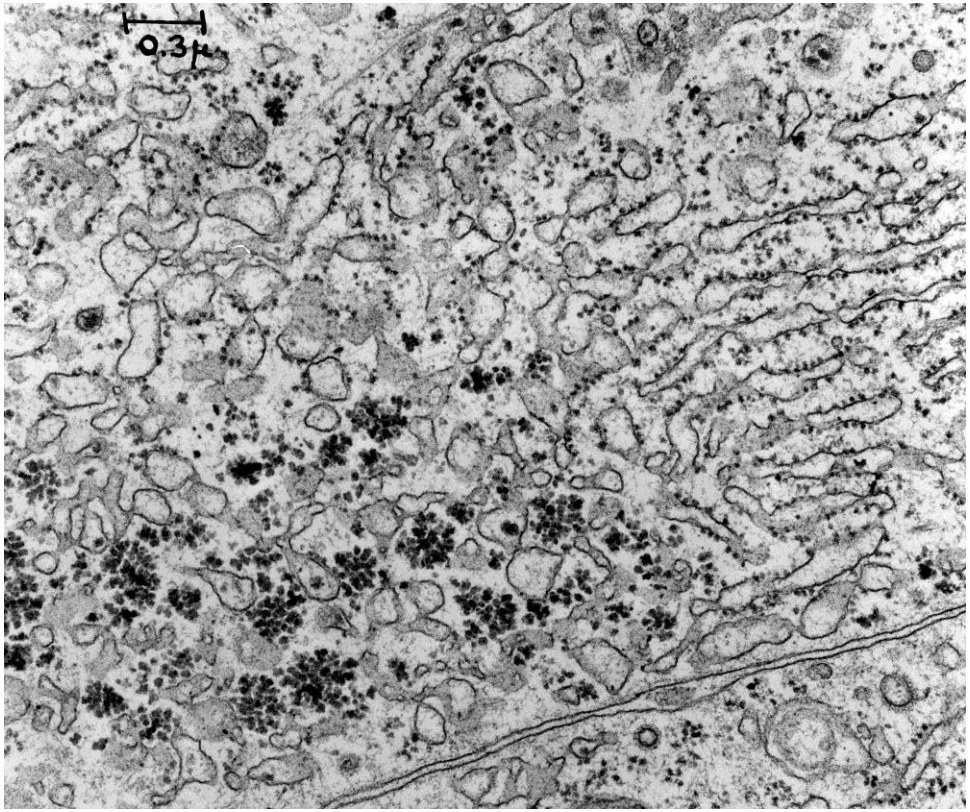
Ball et al 2011

A - glycogen granule B - starch granule



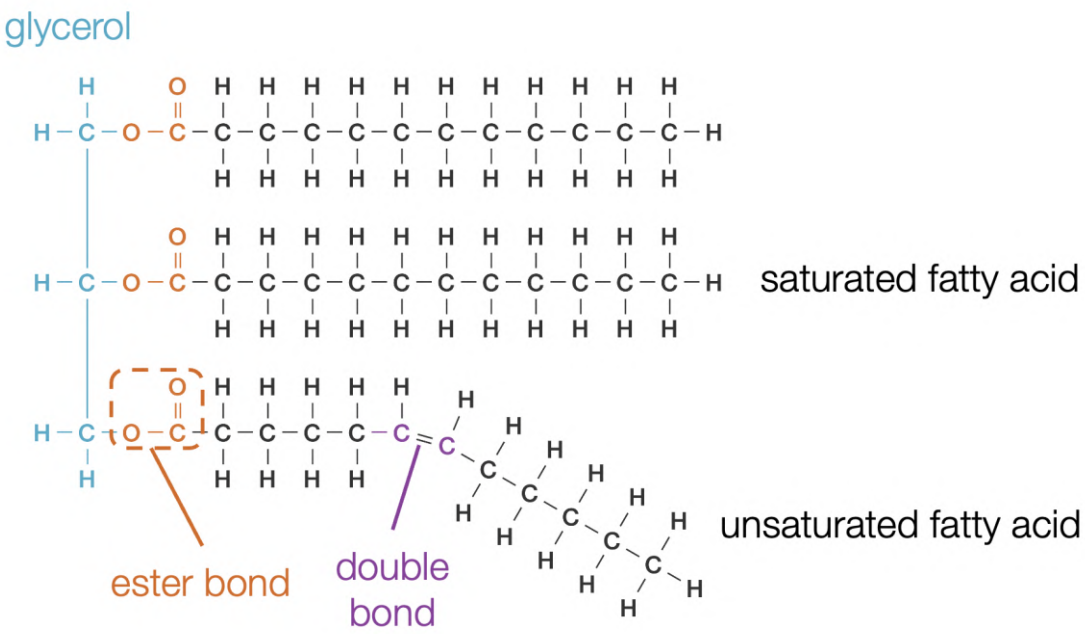
Starch grain SEM

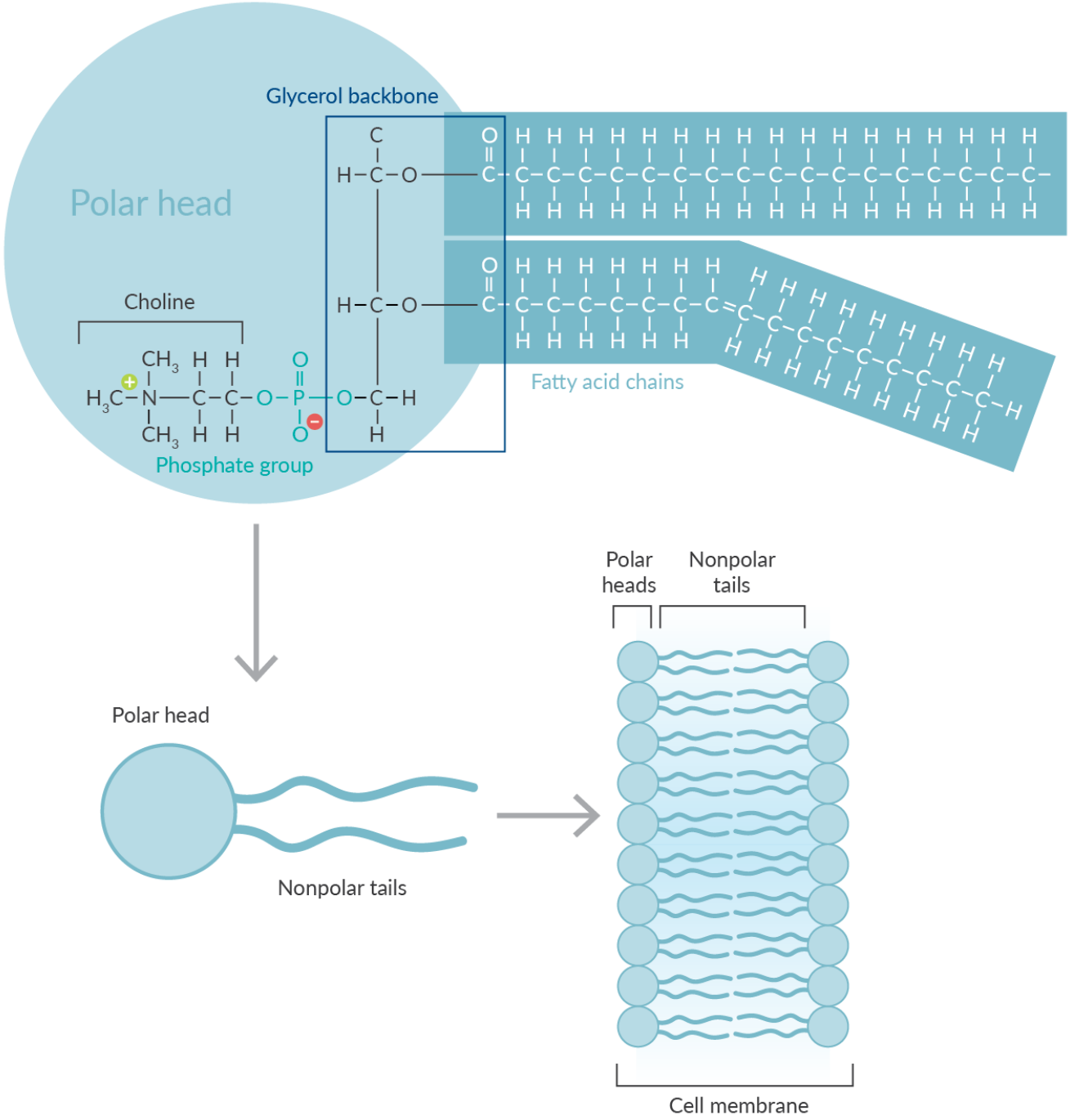
The glucose song.

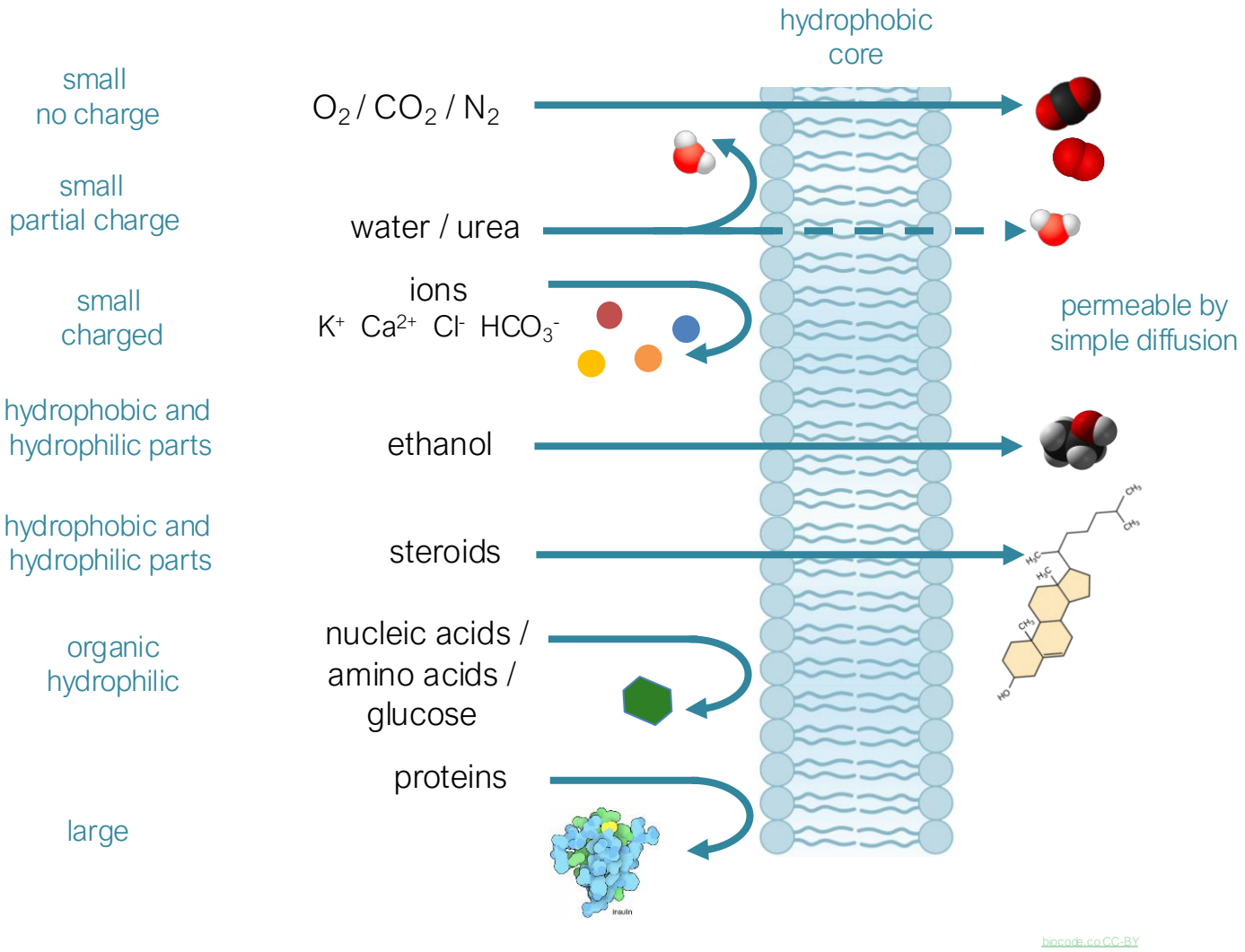


George Palade

Glycogen granules in rat liver.


glycerol
saturated fatty acid
unsaturated fatty acid
ester bond
double bond




hydrophobic core
small no charge
O_2 / CO_2 / N_2
small partial charge
water / urea
small charged
ions
K^+ Ca^{2+} Cl^- HCO_3^-
permeable by simple diffusion
hydrophobic and hydrophilic parts
ethanol
hydrophobic and hydrophilic parts
steroids
organic hydrophilic
nucleic acids / amino acids / glucose
proteins
large
Insulin
biocode.co CC-BY

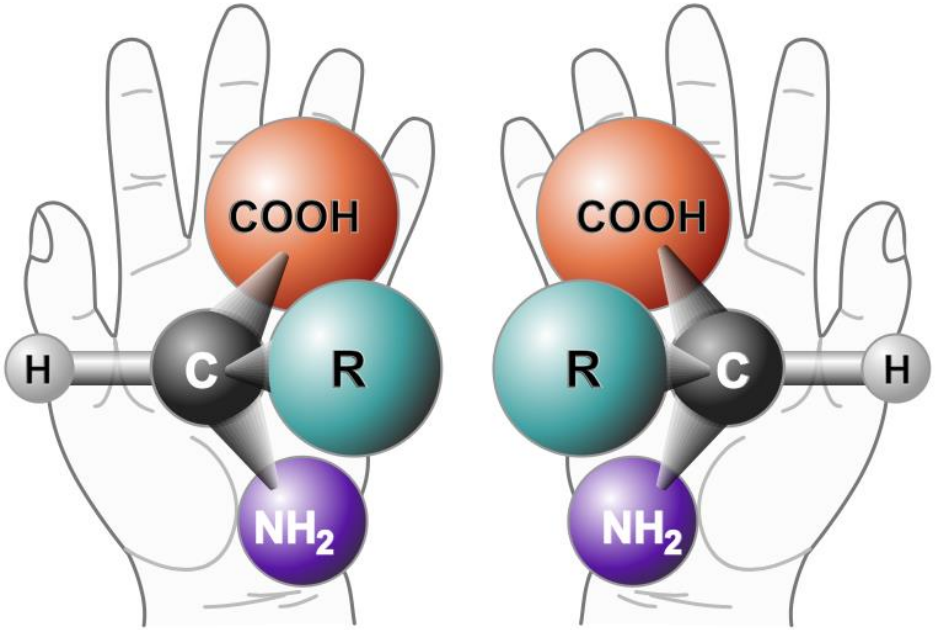
Optional Extension (not required for IB exams)

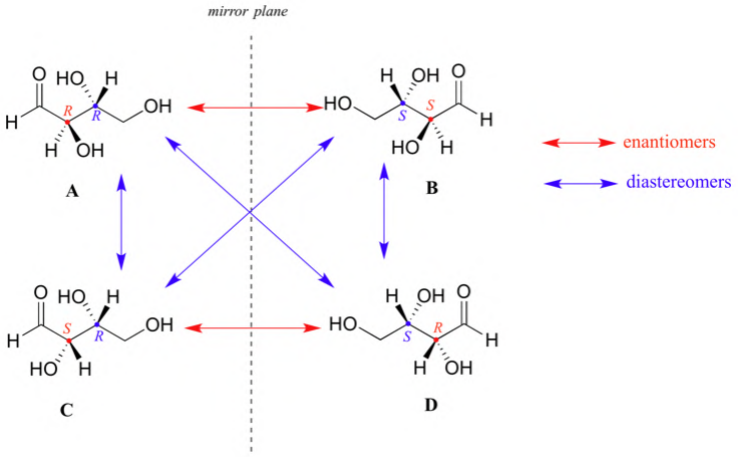
"Those who think scientists understand the issues of prebiotic chemistry are wholly misinformed. Nobody understands them. Maybe one day we will. But that day is far from today. It would be far more helpful (and hopeful) to expose students to the massive gaps in our understanding. They may find a firmer—and possibly a radically different—scientific theory. The basis upon which we as scientists are relying is so shaky that we must openly state the situation for what it is: it is a mystery."

Dr James Tour

Dr James Tour Lipids: A Course on Abiogenesis

Optional Extension (not required for IB exams)





DNA in all living things is right-handed.

Sugars in all living things are left-handed.

Amino acids in all living things are left-handed.

A 100 amino acid chain in a specific sequence is similar to 100 flips of a coin landing on heads.
A 6 glucose chain is similar to 1 trillion dice rolls landing on 6.

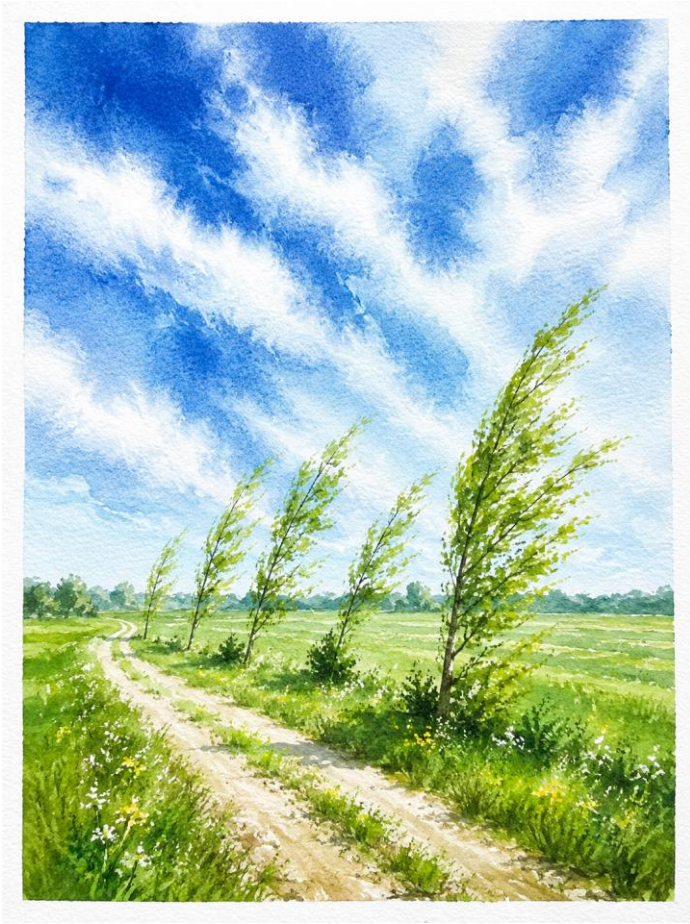
Optional Extension (not required for IB exams)

45. Dark Kangaroo Mouse Microdipodops megacephalus
46. Pallid Kangaroo Mouse Microdipodops pallidus
47. Desert Kangaroo Rat Dipodomys deserti
48. Banner-tailed Kangaroo Rat Dipodomys spectabilis
49. Nelson's Kangaroo Rat Dipodomys nelsoni
50. Texas Kangaroo Rat Dipodomys elator
51. Plateau Kangaroo Rat Dipodomys ornatus
52. Phillips's Kangaroo Rat Dipodomys phillipsu
53. San Quintin Kangaroo Rat Dipodomys gravipes
54. Merriam's Kangaroo Rat Dipodomys merriami
55. Ord's Kangaroo Rat Dipodomys ordu
56. Gulf Coast Kangaroo Rat Dipodomys compactus
57. California Kangaroo Rat Dipodomys californicus
58. Narrow-faced Kangaroo Rat Dipodomys venustus
59. Agile Kangaroo Rat Dipodomys agilis
60. Dulzura Kangaroo Rat Dipodomys simulans
61. Giant Kangaroo Rat Dipodomys ingens
62. Chisel-toothed Kangaroo Rat Dipodomys microps
63. San Joaquin Kangaroo Rat Dipodomys nitratoides
64. Stephens's Kangaroo Rat Dipodomys stephenst
65. Heermann's Kangaroo Rat Dipodomys heermanni
66. Panamint Kangaroo Rat Dipodomys panamintinus

Who Has Seen the Wind?
BY CHRISTINA ROSSETTI

Who has seen the wind?
Neither I nor you:
But when the leaves hang trembling,
The wind is passing through.

Who has seen the wind?
Neither you nor I:
But when the trees bow down their heads,
The wind is passing by.



AI image