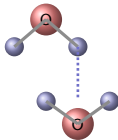


Chemistry of Life

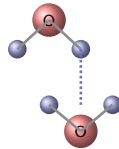
AP Biology ■ Unit 1

AP Biology



What we will cover

- 1 Water and hydrogen bonding
- 2 Elements and carbon
- 3 Macromolecules
- 4 Carbohydrates
- 5 Lipids
- 6 Nucleic acids
- 7 Proteins



Water and hydrogen bonding

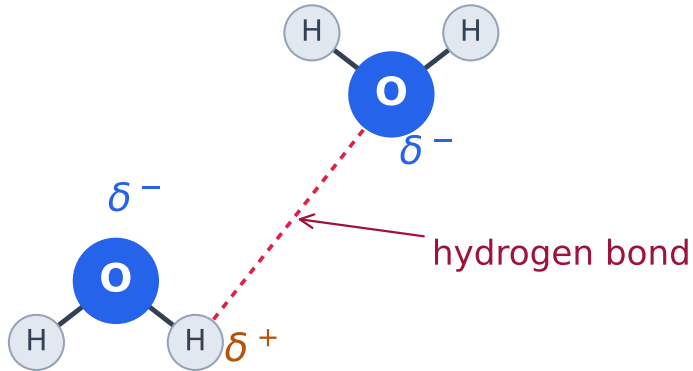
Water is a **polar molecule** 极性分子: oxygen is more **electronegative** 电负性强的, so it is a **dipole** 偶极 (δ^- O, δ^+ H). Neighbours attract by **hydrogen bonds** 氢键.

Many weak bonds give **emergent properties** 涌现性质: cohesion, high specific heat, ice floats.



Ice floats – hydrogen bonds hold an open lattice

Water and hydrogen bonding



Elements and carbon

Just six elements (**CHNOPS**) are 98% of life. **Carbon** 碳 is the backbone – **four bonds** build chains, rings, branches.

Functional groups 官能团 give a predictable personality; **isomers** 同分异构体 share a formula but differ in shape.

hydroxyl –OH: polar

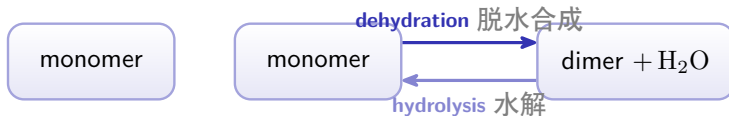
carboxyl –COOH: acid

amino –NH₂: base

phosphate: energy

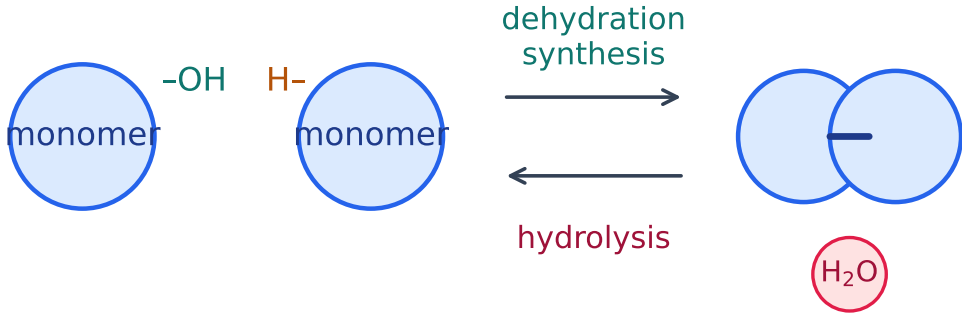
Macromolecules

Four classes – all built and broken the same way:



Carbohydrates 碳水化合物, **lipids** 脂质, **nucleic acids** 核酸, **proteins** 蛋白质 –
the same alphabet spells millions of molecules.

Macromolecules



Carbohydrates and lipids

Carbohydrates 碳水化合物: sugars, $(\text{CH}_2\text{O})_n$. **Glucose** 葡萄糖 monomers join by a **glycosidic bond** 糖苷键.

- **starch** 淀粉 – plant store
- **glycogen** 糖原 – animal store
- **cellulose** 纤维素 – rigid fibre

Lipids 脂质 are **nonpolar** (not true polymers). A **triglyceride** 甘油三酯 = glycerol + 3 fatty acids.

Phospholipids 磷脂 have a hydrophilic head + hydrophobic tails $\Rightarrow$ the **bilayer** 双分子层 of every membrane.

Carbohydrates and lipids



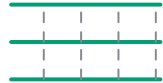
amylose
(coiled)



amylopectin
(branched)



glycogen
(many branches)



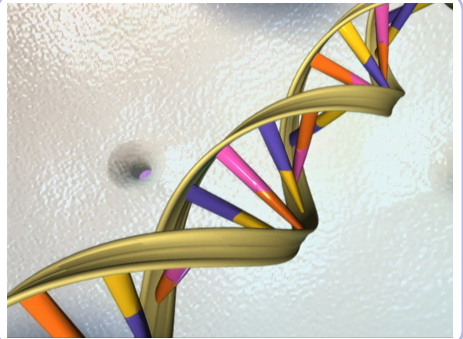
cellulose
(straight chains)

Nucleic acids

DNA 脱氧核糖核酸 stores information; its monomer is a **nucleotide** 核苷酸 (sugar + phosphate + base).

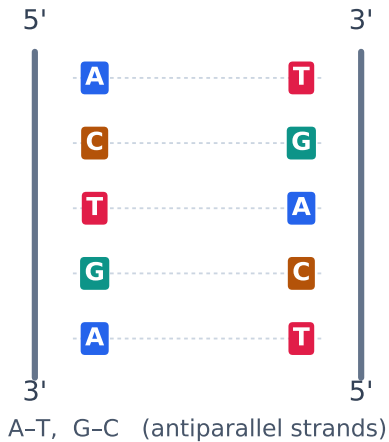
- a **sugar-phosphate backbone** 糖-磷酸骨架, read $5' \rightarrow 3'$
- a **double helix** 双螺旋 of two **antiparallel** 反平行的 strands

A-T, G-C: each base has one partner, so a strand can template its copy.



Base pairing makes DNA a template for copies

Nucleic acids



Proteins

Proteins 蛋白质 do almost everything. The monomer is an **amino acid** 氨基酸 (20 of them, each with a variable **R group** 侧链), joined by a **peptide bond** 肽键.

Shape comes from sequence – so one wrong base can cripple a protein.
Heat or pH can **denature** 变性 it.

1°: amino-acid sequence

2°: α -helix, β -sheet

3°: full 3-D fold

4°: several chains

Proteins



primary (1°)

order of
amino acids



secondary (2°)

α -helix & β -sheet
(hydrogen bonds)



tertiary (3°)

folded into a
precise 3-D shape



quaternary (4°)

two or more
chains together

Unit 1 – key takeaways

1 Water

polar; hydrogen bonds give life's emergent properties

2 Carbon

four bonds; functional groups; build/break by water

3 Polymers

carbs, lipids, nucleic acids, proteins from monomers

4 Structure

DNA A-T/G-C; protein shape from sequence

Check yourself

- 1 What kind of bond holds two water molecules together?
- 2 How many covalent bonds can one carbon atom form?
- 3 In DNA, what base pairs with guanine?
- 4 What determines a protein's final shape?



Answers 1. a hydrogen bond 2. four 3. cytosine (C) 4. its amino-acid sequence