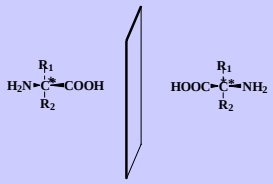
Biopolymers

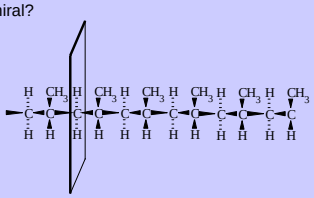
Chiral aminoacids
chirality = no mirror plane



optically active ***enantiomers*** (left or right handed)

C* = "asymmetric centre"; all 4 substituents different

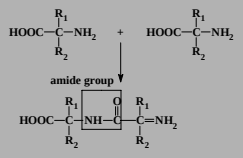
Is i-PP chiral?



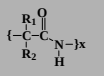
No, there is a mirror plane through every backbone carbon.

(Difference in distance to the two chain ends does not count in practice.)

Proteins



Carboxylic acid + amine → **amide** + H_2O

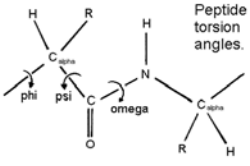


polypeptide

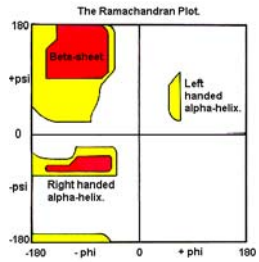
Proteins

- 30+ aminoacids make up all proteins in nature.
- Proteins are aperiodic, but have the same polypeptide backbone.
- All natural aminoacids have the same handedness.
- Only two basic conformations of protein chain segments:
  - **α-helix**
  - **β-sheet**

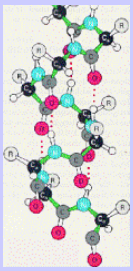
Conformation of polypeptides



Ω fixed



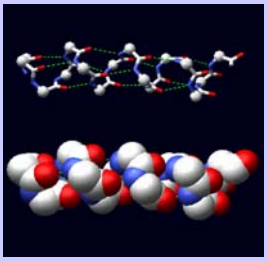
α-Helix

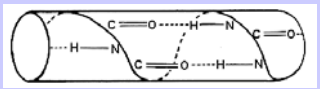


α-helix

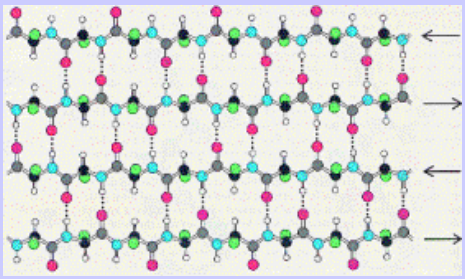
18/5 helix
(L. Pauling)

Stabilized by intramolecular H-bonding
C=O·····H-N

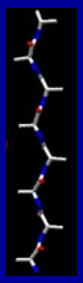


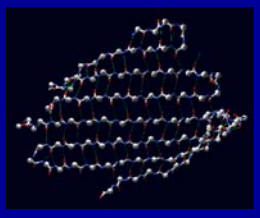


β-sheet - planar zigzag
(like polyethylene, except $-C(R_1,R_2)-CO-NH-$ replaces $-CH_2-$)



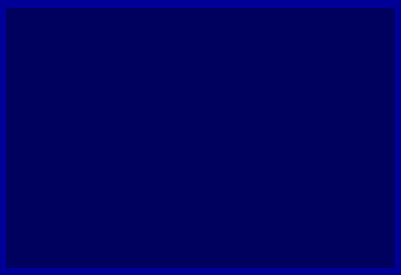
β-Sheet





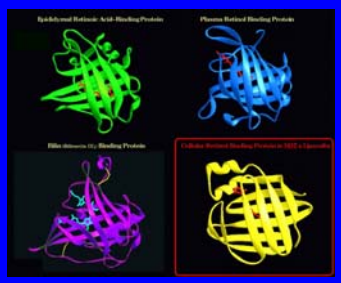
6-strand antiparallel β-sheet

- regular conformations stabilized by H-bonds even though the chains are **not crystalline**.
  (in **synthetic polymers** regular helix is only possible when **stabilized by crystallization**)
- A complete protein moleule = "**tertiary structure**"
  – straight sections of α-helix and β-sheet + folds

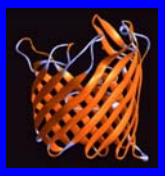


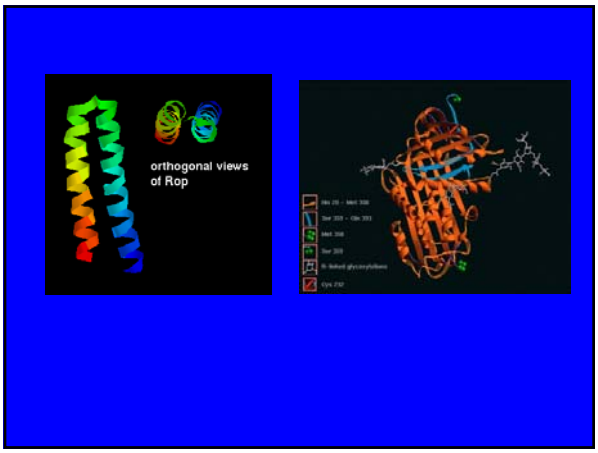
http://www.avatar.se/molscript/examples

"β-sandwich" structure



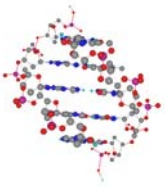
"β-barrel"

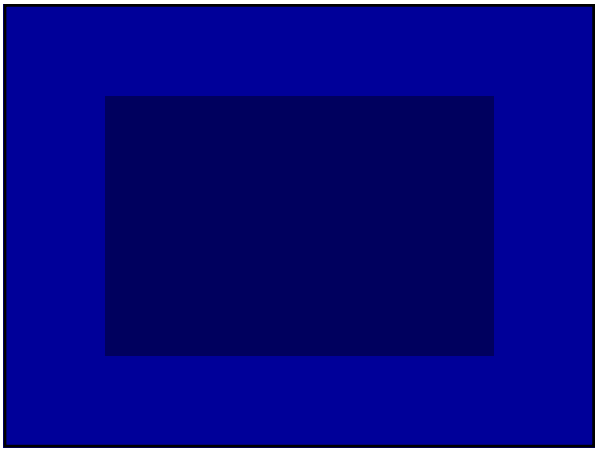




DNA double helix

•triplets of paired “bases” connected by multiple H-bond
•“lock-and-key” (molecular recognition)
•mechanism of DNA replication

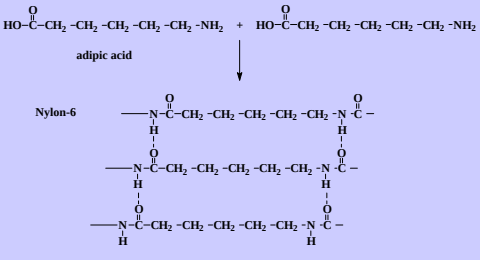




Triple helix of collagen

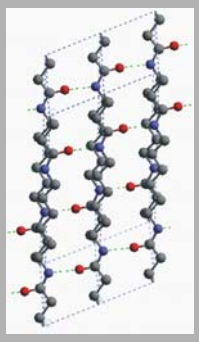
- stiff protein fibres in tendon tissue

Hydrogen bonding in synthetic polymers

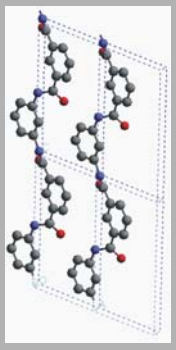


Note: Nylon-2 is a polypeptide

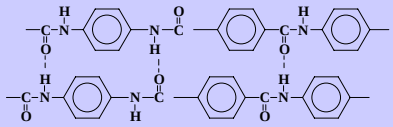
NYLON- 6,6



NOMEX



Kevlar and Nomex



Kevlar

Kevlar: 1,4 substitution (*para*)
Nomex: 1,3 substitution (*meta)*

Aromatic polyamides (Aramides)

PIEZOELECTRIC POLYMERS

- Poly(vinylidene fluoride)
  $-CH_2-CF_2-CH_2-CF_2-$
- - Crystals are non-centrosymmetric.
  (lack centre of inversion)
- → **ferroelectric**
  (spontaneously polarize, have net electric dipole)
- → **piezoelectric**
  (change polarization under pressure)
  → use in computer keyboards

Poly(vinylydene fluoride (PVDF)