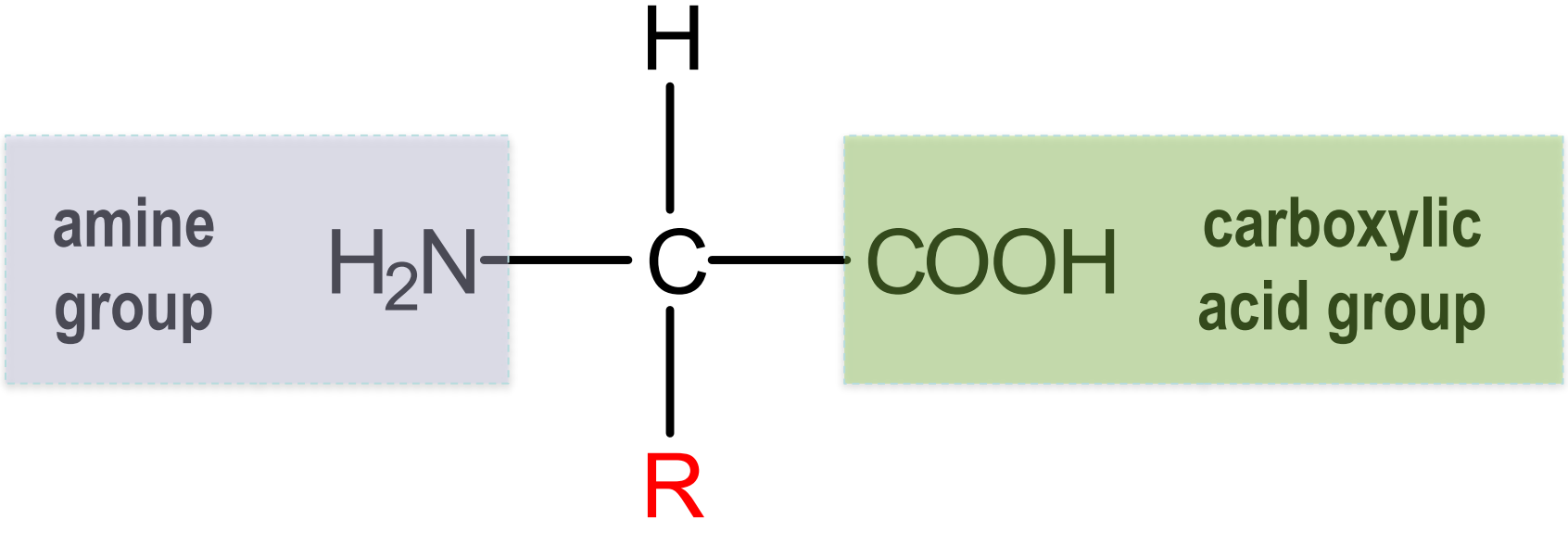
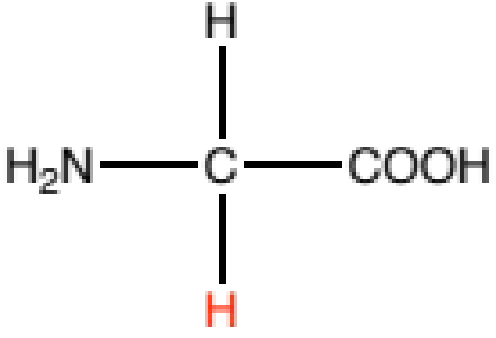
WWW.CHEMSHEETS.CO.UK

BIOCHEMISTRY

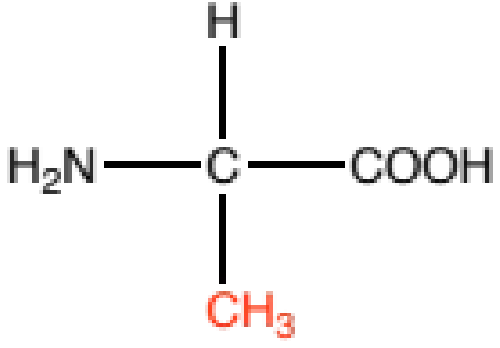
AMINO ACIDS





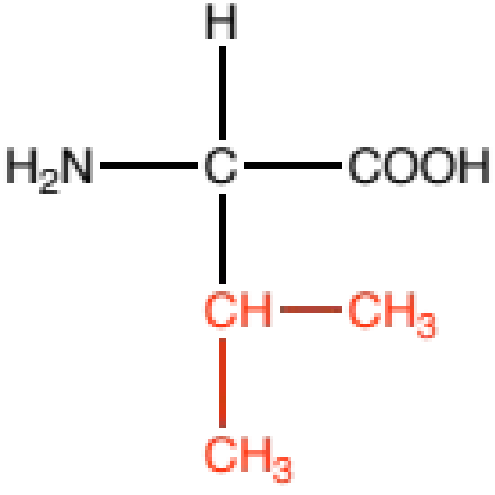
glycine

Gly



alanine

Ala

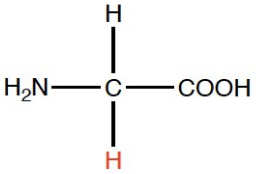


valine

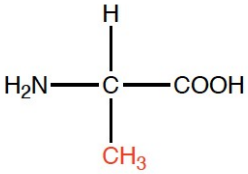
Val

AMINO ACIDS with NON-POLAR R groups

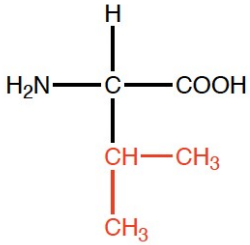
glycine
Gly



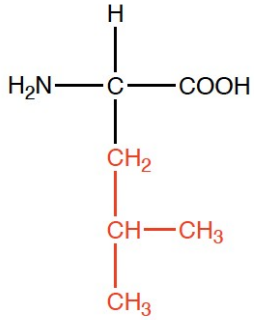
alanine
Ala



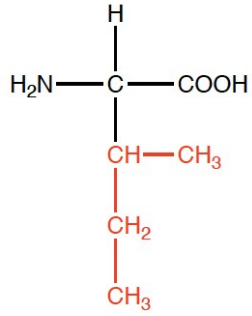
valine
Val



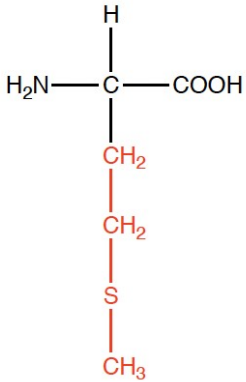
leucine
Leu



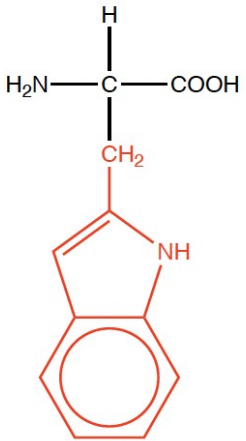
isoleucine
Ile



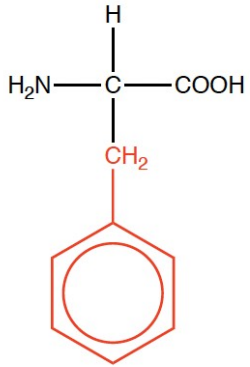
methionine
Meth



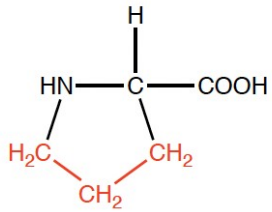
tryptophan
Trp



phenylalanine
Phe

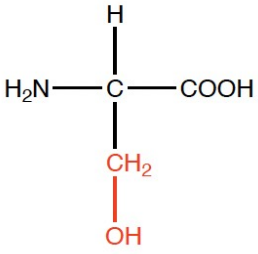


proline
Pro

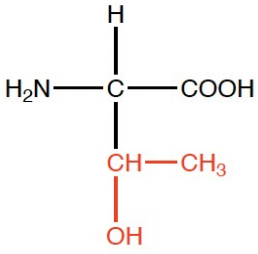


AMINO ACIDS with POLAR R groups

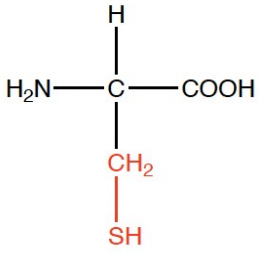
serine
Ser



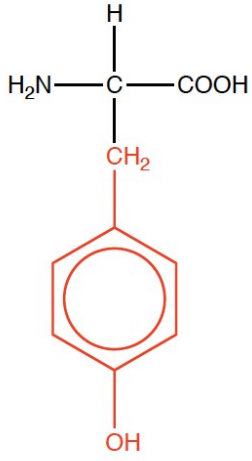
threonine
Thr



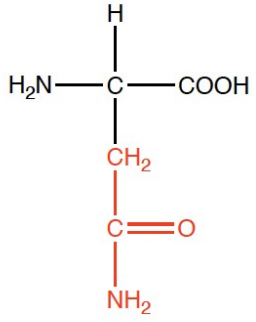
cysteine
Cys



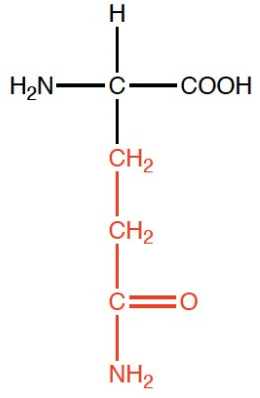
tyrosine
Tyr



asparagine
Asn

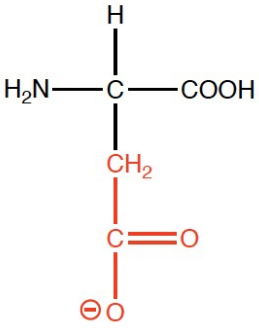


glutamine
Gln

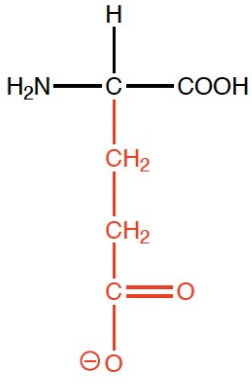


AMINO ACIDS with CHARGED R groups

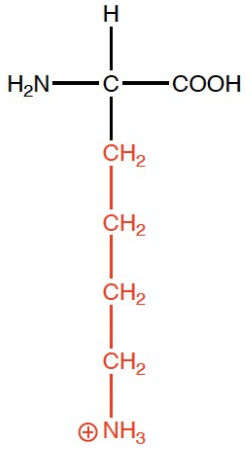
aspartic acid
Asp



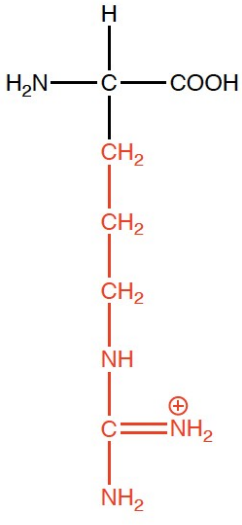
glutamic acid
Glu



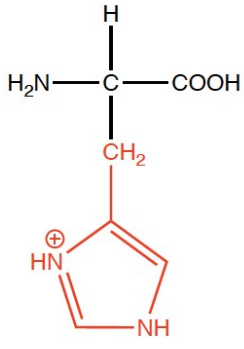
lysine
Lys



arginine
Arg

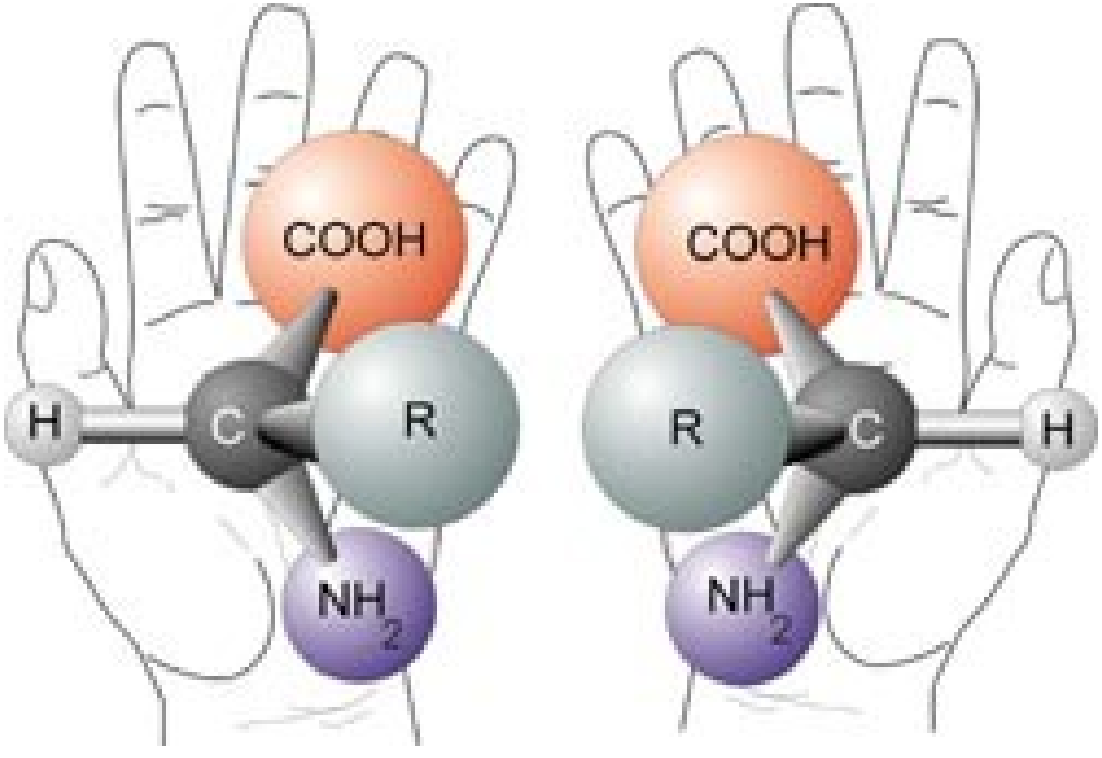


histidine
His

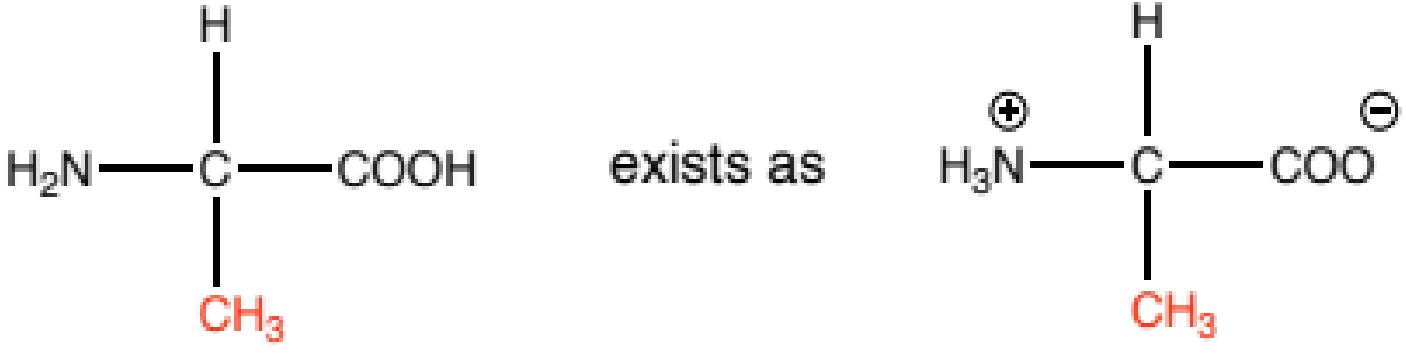


- Amino acids contain a chiral (asymmetric) C atom, i.e. a C atom with four different groups (apart from glycine).

- In nature, only one of the two enantiomers is present.

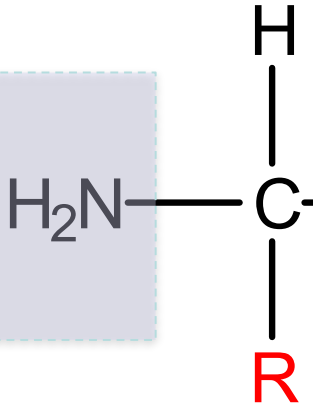


- amino acids usually exist as **zwitterions**
- zwitterions are species that have one part that is positive and one part that is negative
- an acid group from one amino acid protonates the amine group of another amino acid
- amino acids are solids at room temperature due to the +/– ionic attraction between parts of the zwitterions



REACTIONS OF AMINO ACID GROUPS

amine group



carboxylic acid group

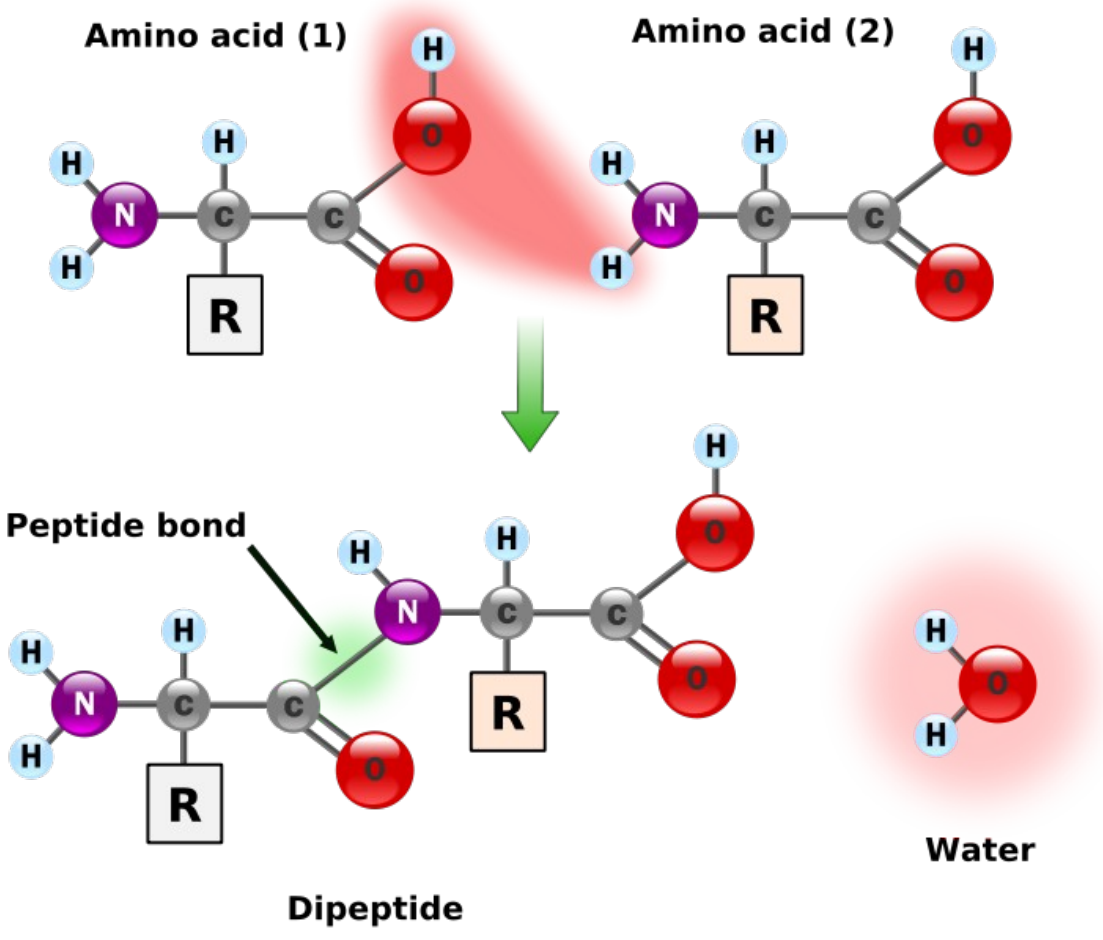
Reactions of amines

- protonated by acids
- substitution with halogenoalkanes
- acylation with acyl chloride or acid anhydrides

Reactions of acids

- deprotonated by bases
- esterification with alcohols (with acid catalyst)

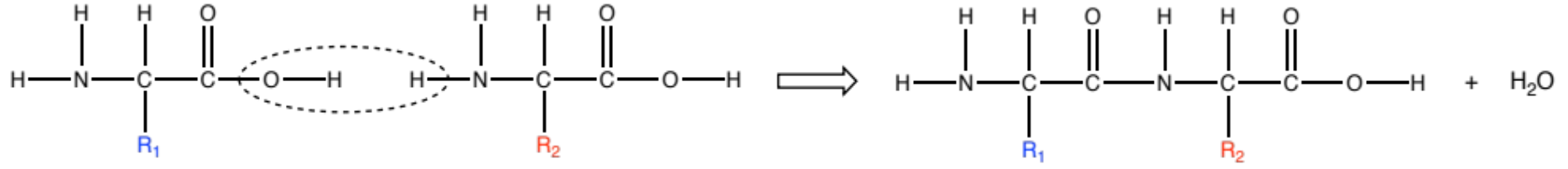
JOINING AMINO ACIDS TOGETHER



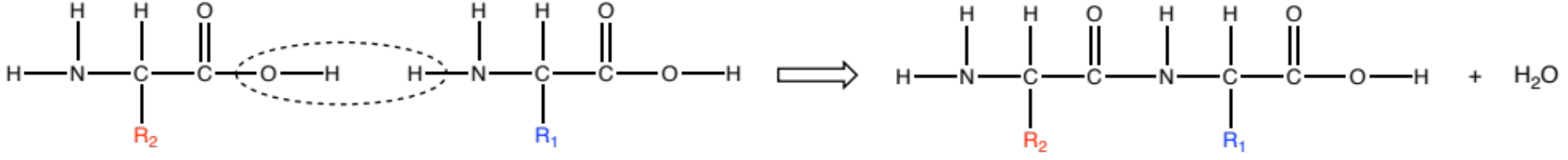
Public domain image from wikipedia

JOINING AMINO ACIDS TOGETHER

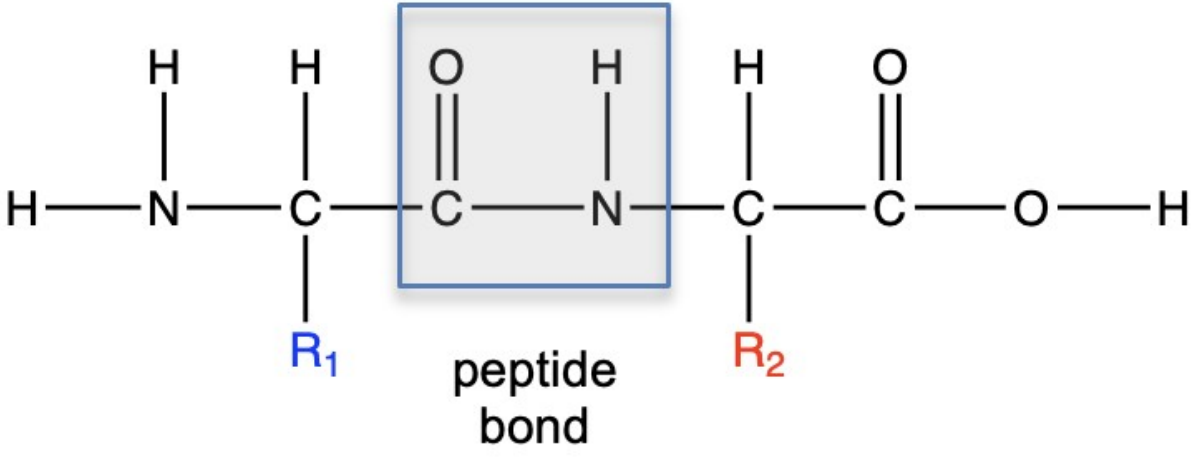
- Amino acids can react with each other and join together in a **condensation** reaction.
- This makes a dipeptide and water.



or

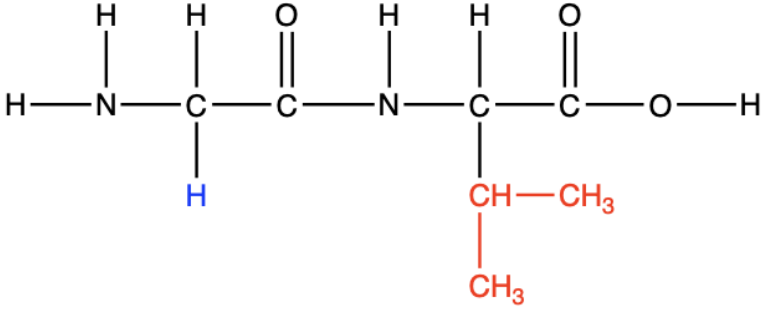


- The bond between the two amino acids is called a **peptide bond** or **peptide link**.

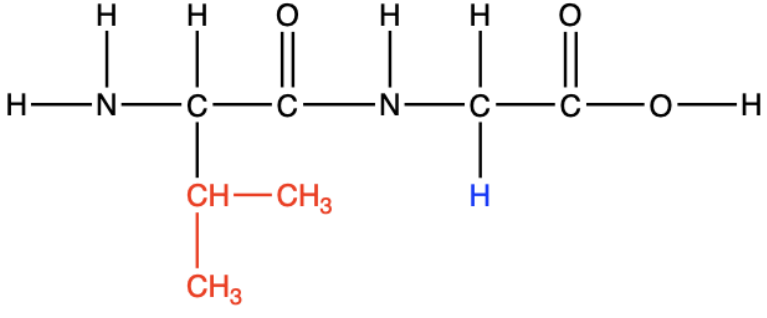


- Tripeptides contain three amino acids joined together.
- Polypeptides contain many amino acids joined together.
- Proteins typically contain 50-2000 amino acids joined together

- Peptides can be named by listing the sequence of the amino acids.
- The convention is to start from the amine group end.

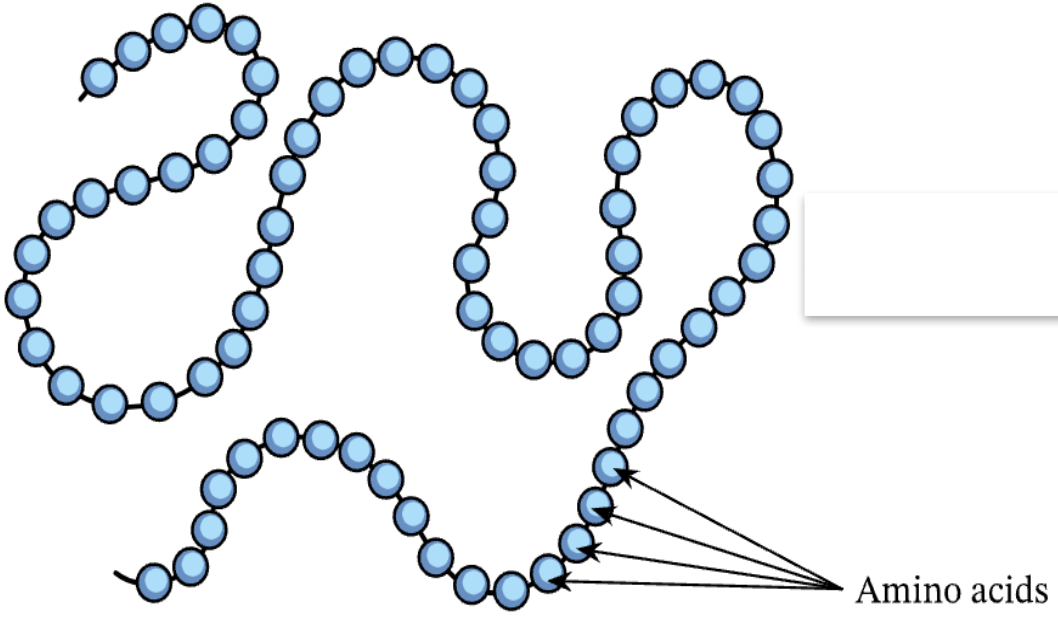


Gly–Val



Val–Gly

Primary structure



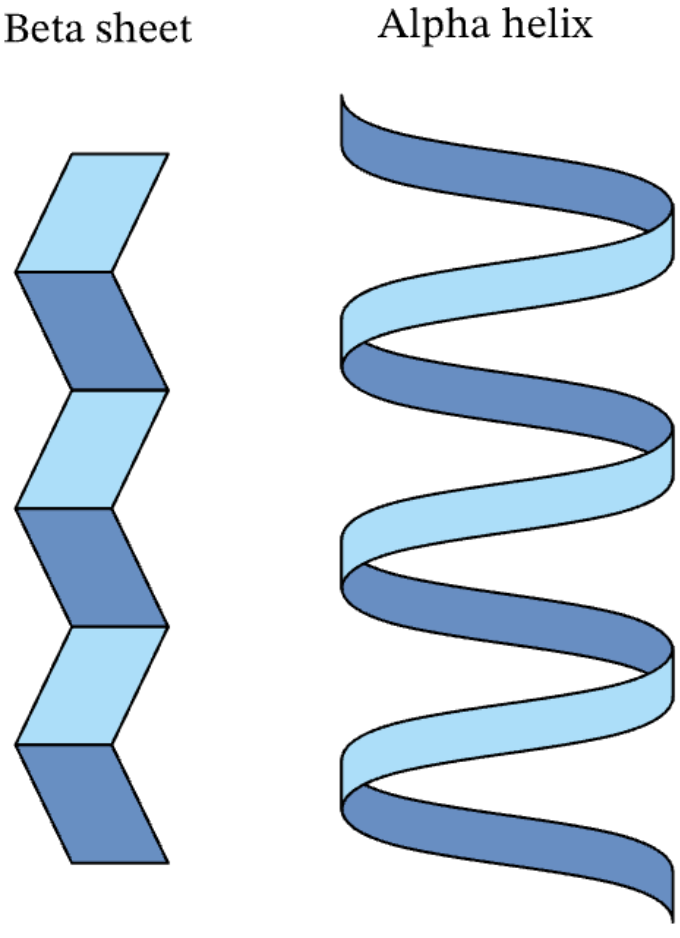
the sequence in which amino acids are joined together.

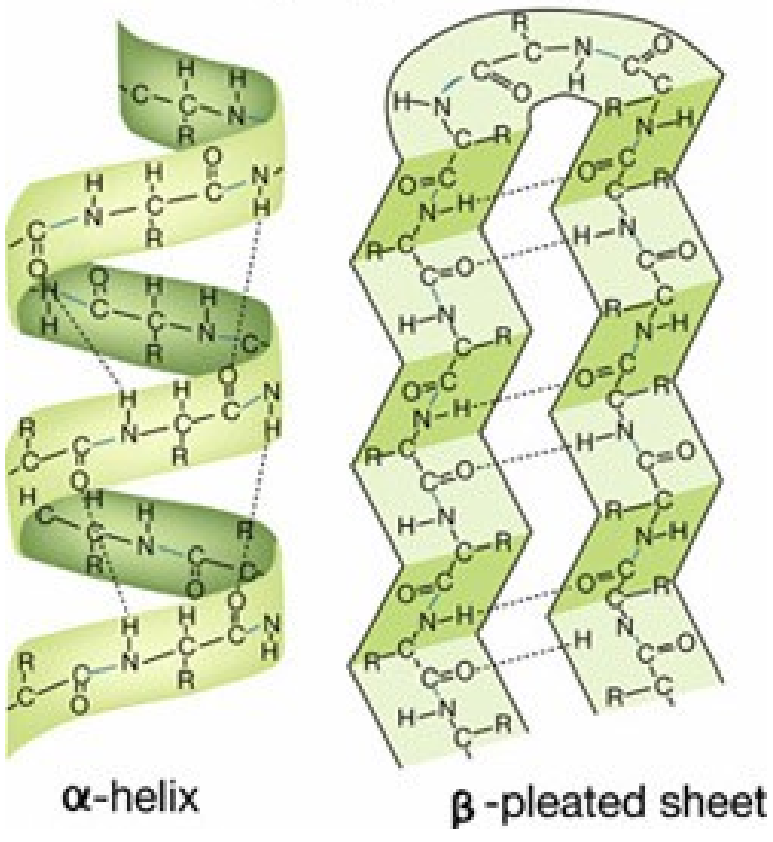
e.g. Val-Gly-Phe-Gln-Thr-Gly-Met-etc……

Secondary structure

The secondary structure is held together by hydrogen-bonds

These H-bonds are between the δ+H of an NH group to the lone pair on the O: of a CO group).





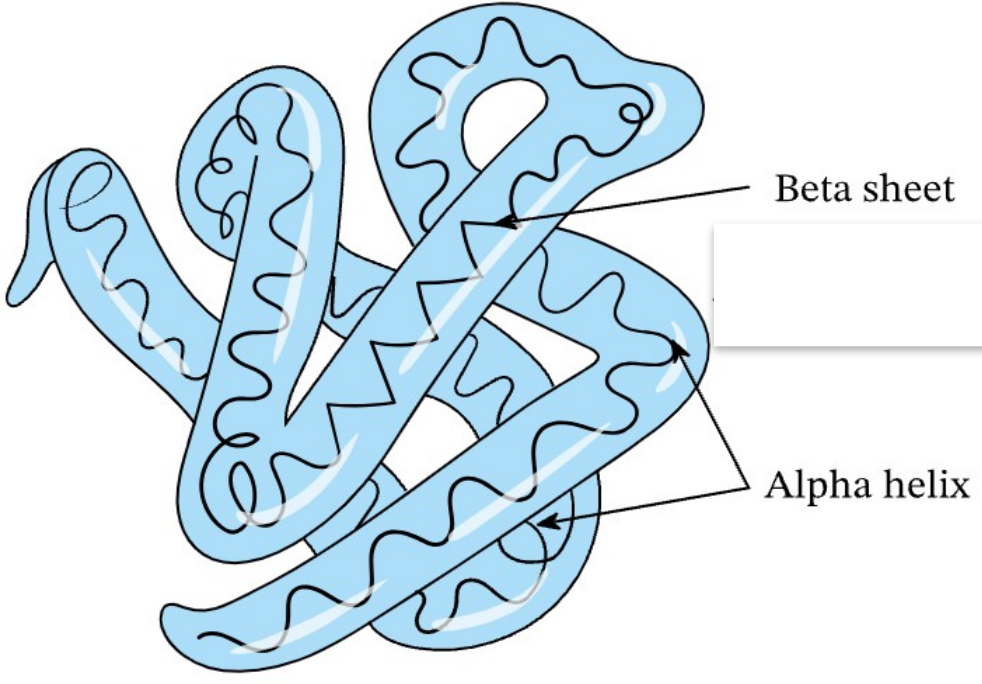
Tertiary structure

How the α-helix (or β-sheet) folds around into a specific shape

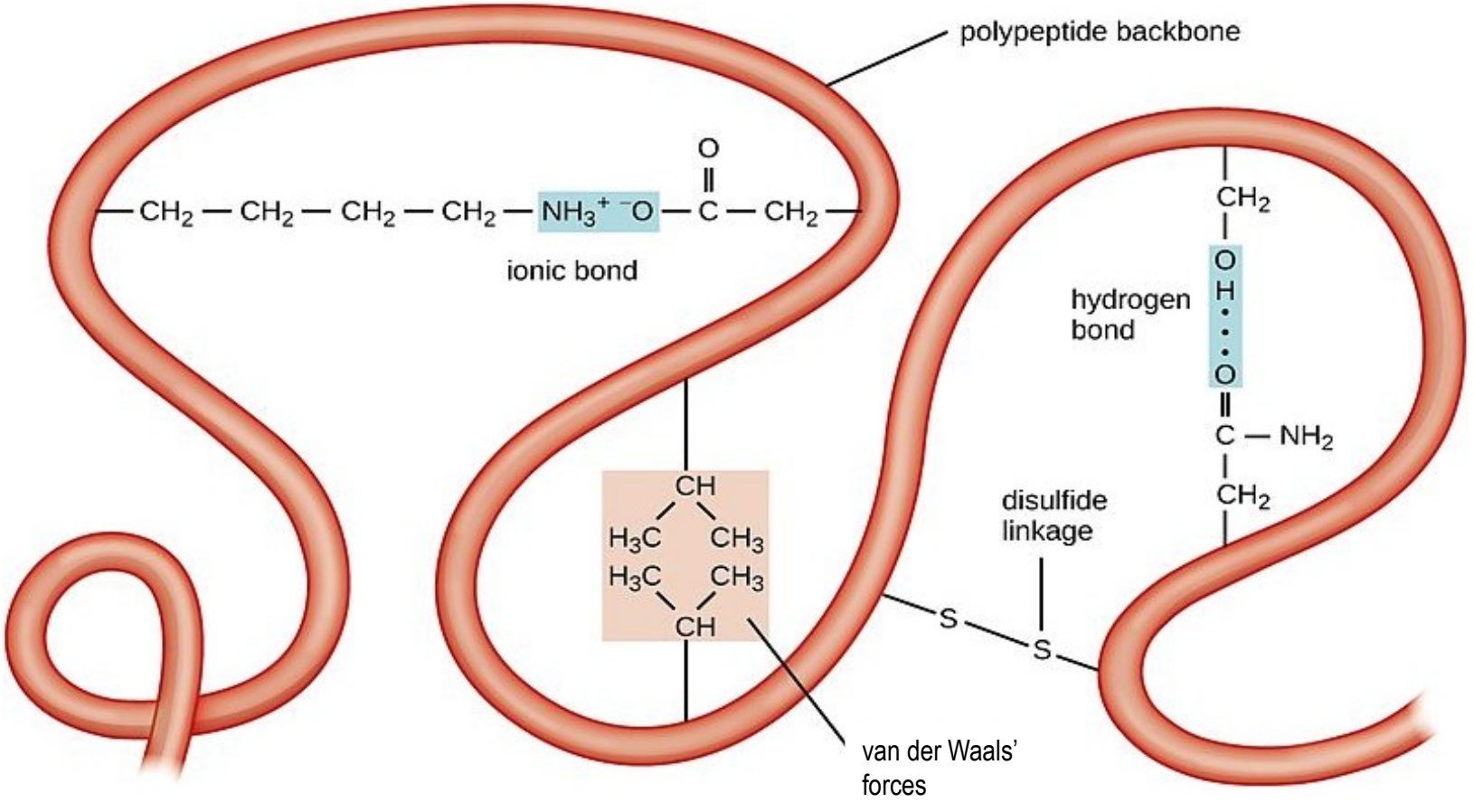
This tertiary shape is held together by interactions between the R groups on amino acids.

These interactions could be

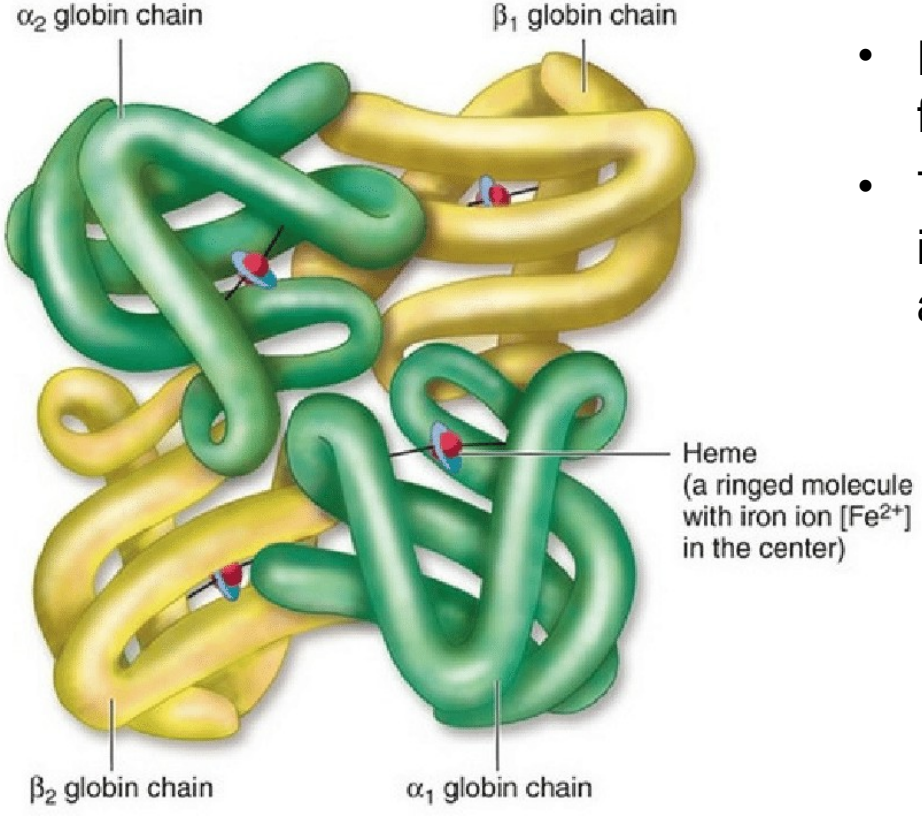
- disulfide bonds
- ionic attractions
- hydrogen-bonds
- van der Waals' forces



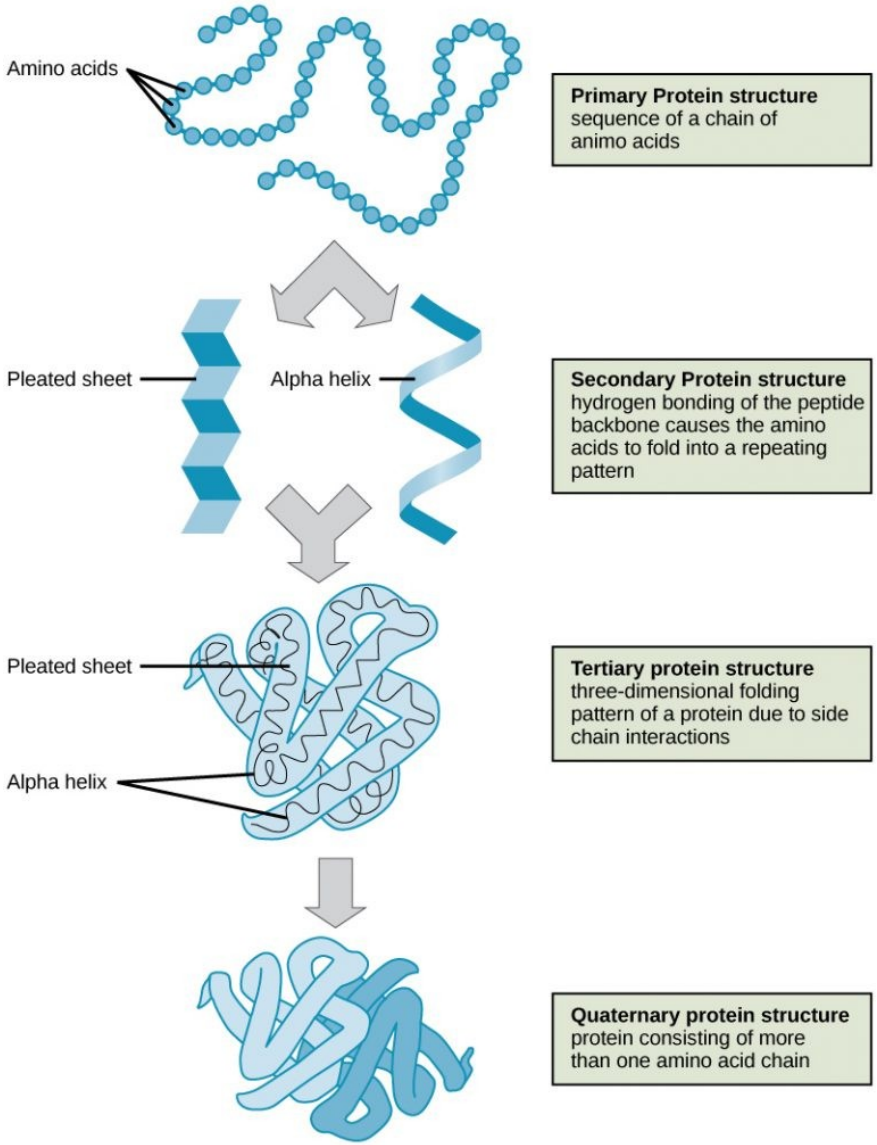
Tertiary structure

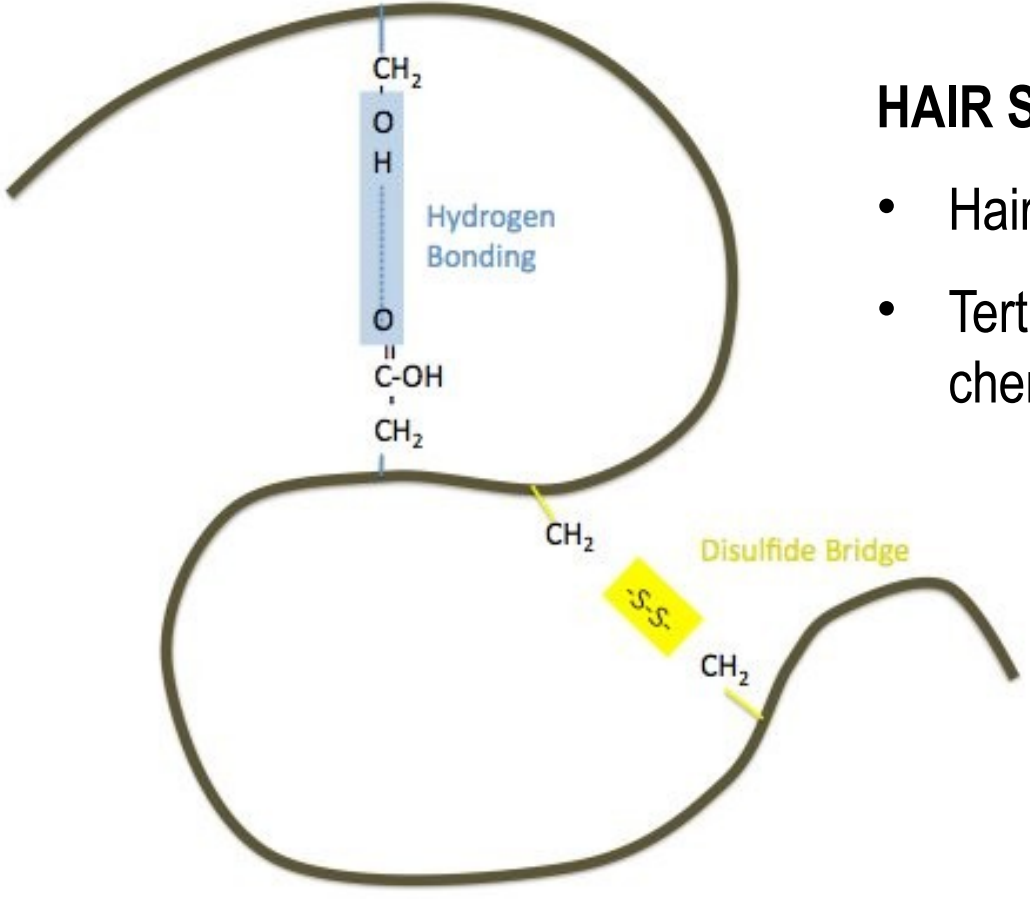


Quaternary structure



- Some proteins just contain a single polypeptide chain, but some are a combination of several polypeptide chain units
- For example, haemoglobin is a combination of four globin subunits.
- The quaternary structure is also held together by interactions between the R groups on amino acids


Amino acids
Primary Protein structure
sequence of a chain of animo acids
Pleated sheet
Alpha helix
Secondary Protein structure
hydrogen bonding of the peptide backbone causes the amino acids to fold into a repeating pattern
Pleated sheet
Alpha helix
Tertiary protein structure
three-dimensional folding pattern of a protein due to side chain interactions
Quaternary protein structure
protein consisting of more than one amino acid chain

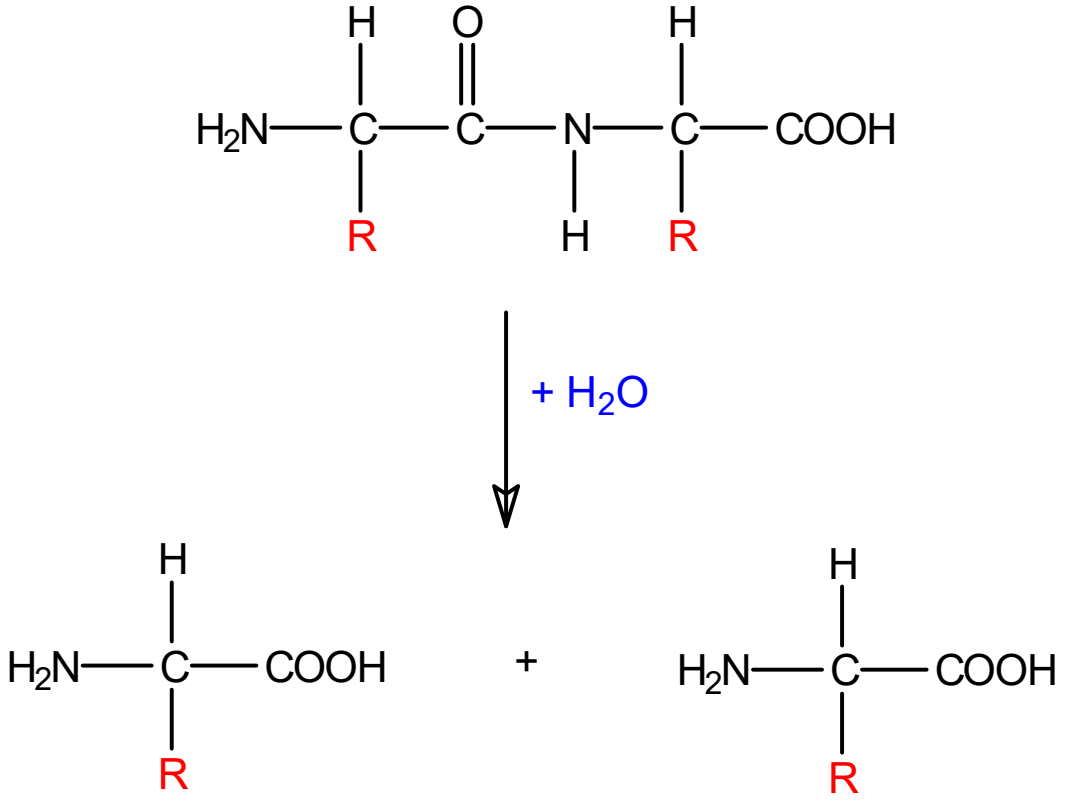


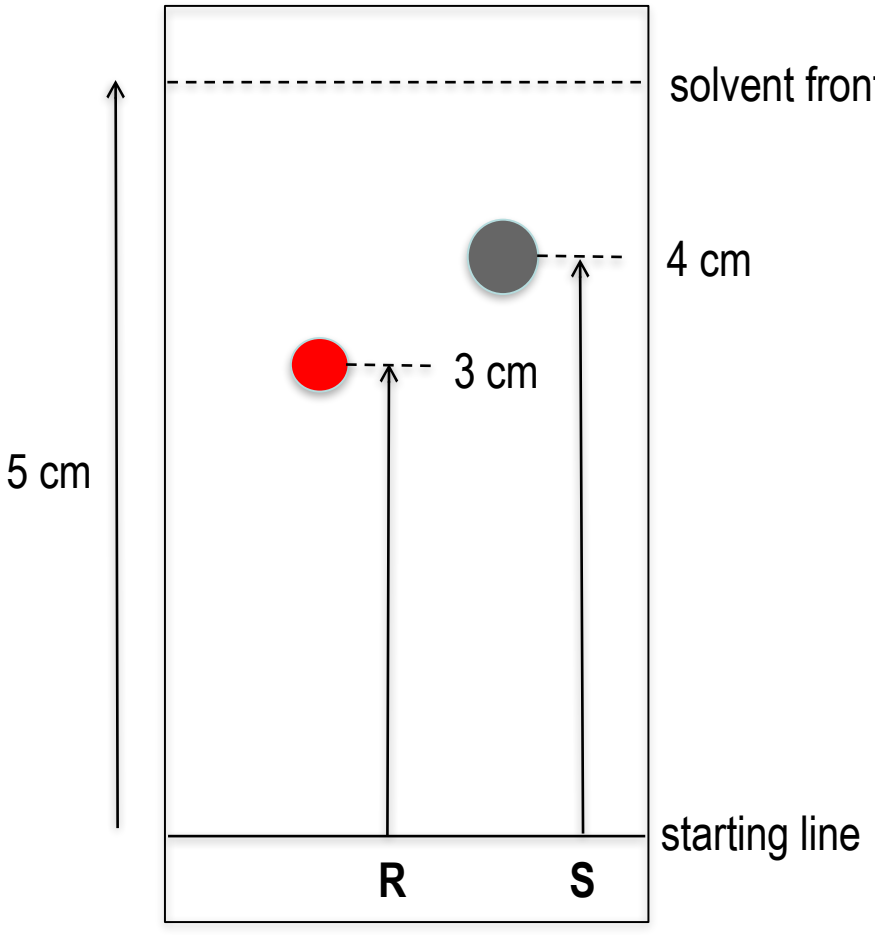
HAIR Straightening and curling

- Hairs are proteins
- Tertiary structure is broken by heat / chemicals

ANALYSIS OF PROTEINS

- Break proteins down into amino acids by **hydrolysis**
- Heat with 6 mol dm^{-3} HCl





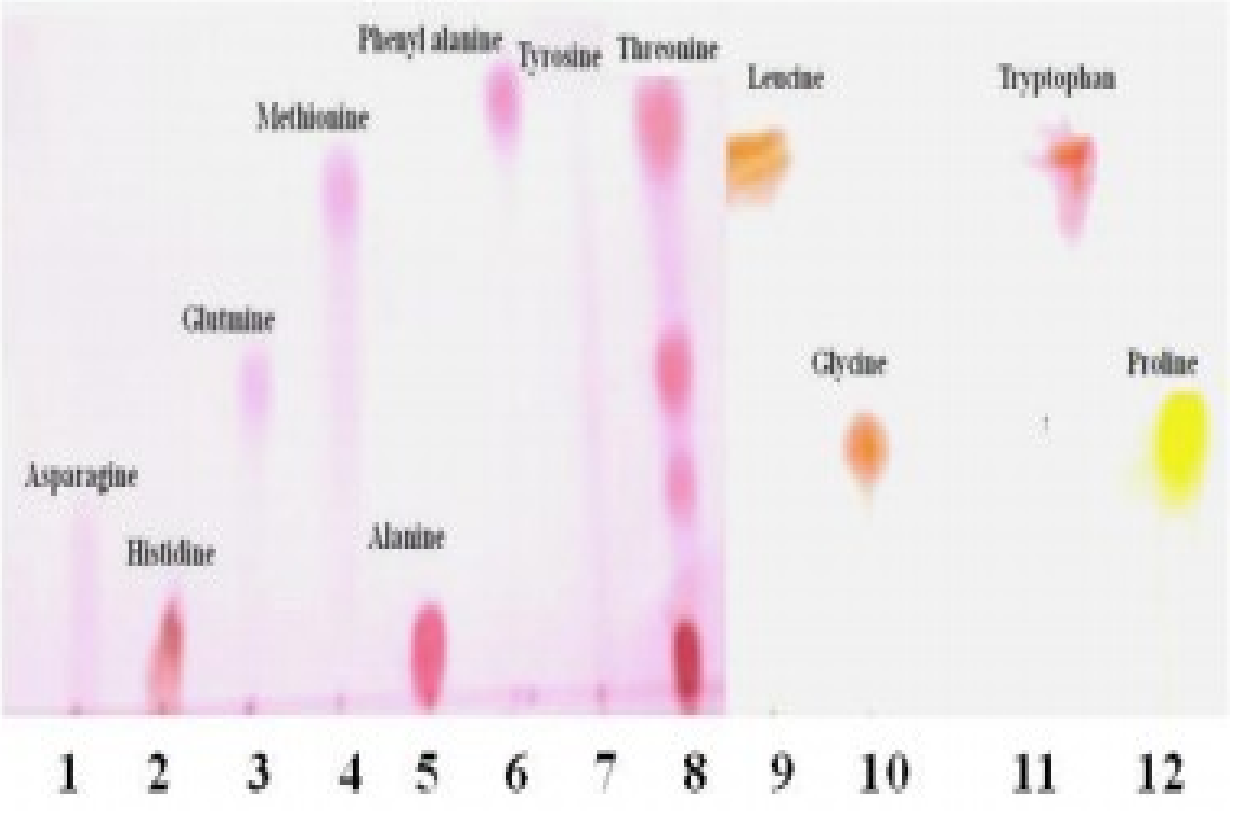
R_f values can identify amino acids

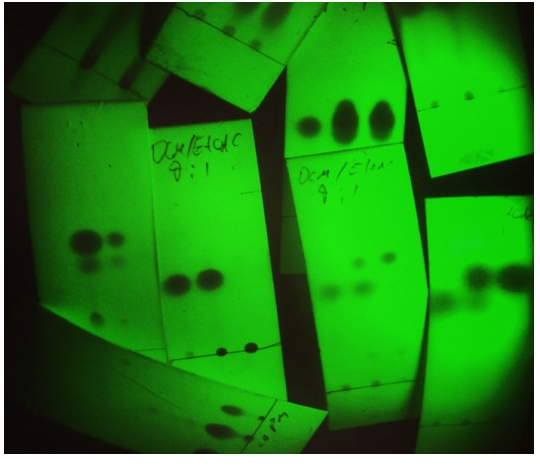
For substance **R** R_f = = 0.60

For substance **S** R_f = = 0.80

ANALYSIS OF PROTEINS

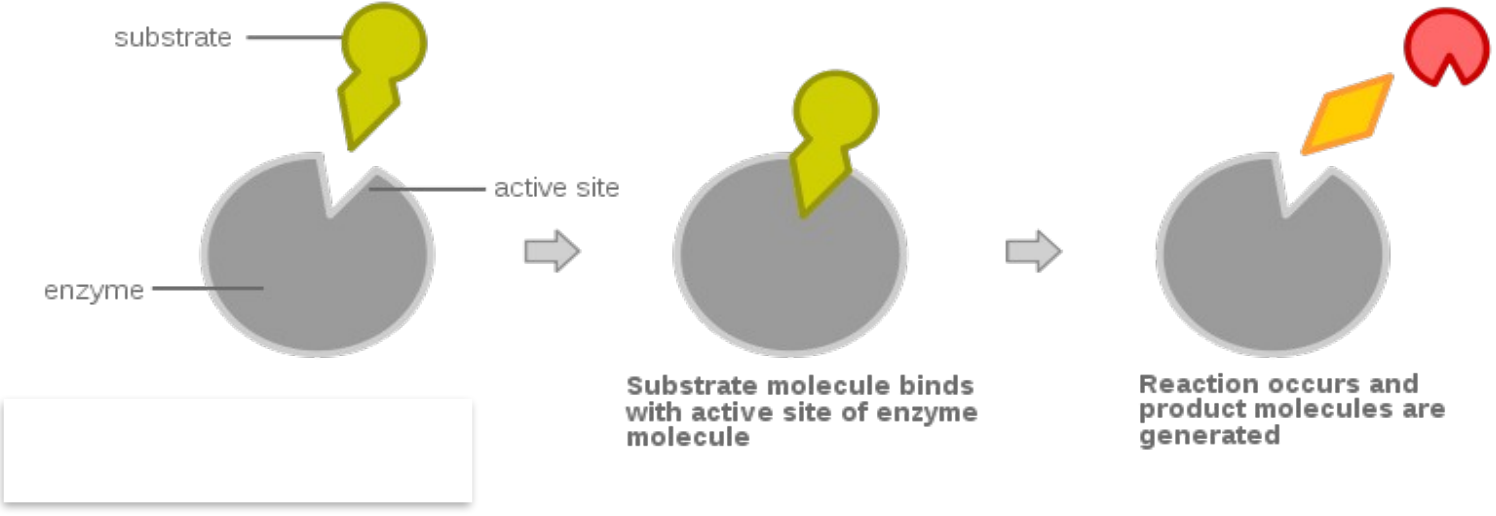
- Use thin-layer chromatography (TLC) to analyse the amino acids





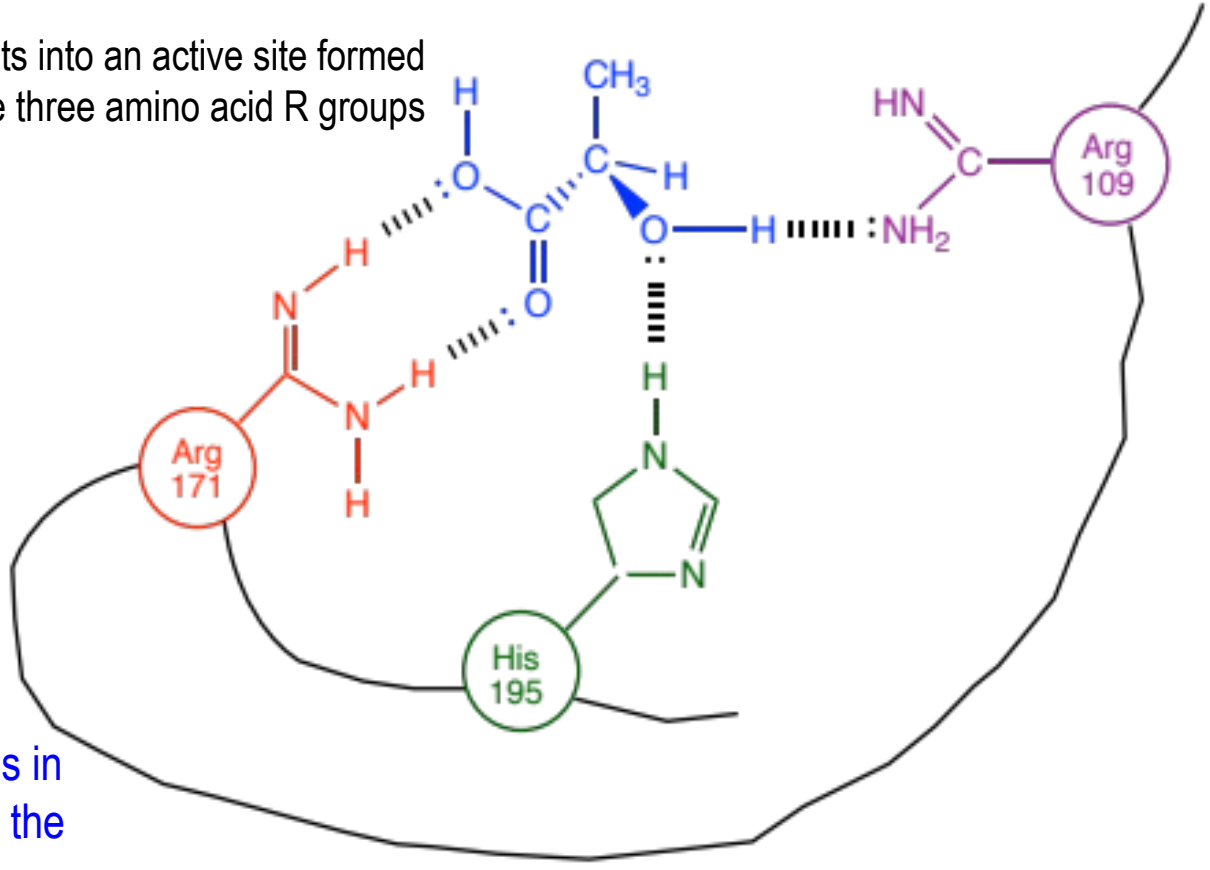
ENZYMES

- Enzymes are proteins that act as catalysts in biochemical reactions.
- Enzymes are highly effective and typically increase the rate of a reaction by factors of millions or more.
- Enzymes are also highly specific with each enzyme catalysing a specific reaction.
- They work by attracting a reactant (substrate) to an active site where the reaction occurs with a lower activation energy.



Example

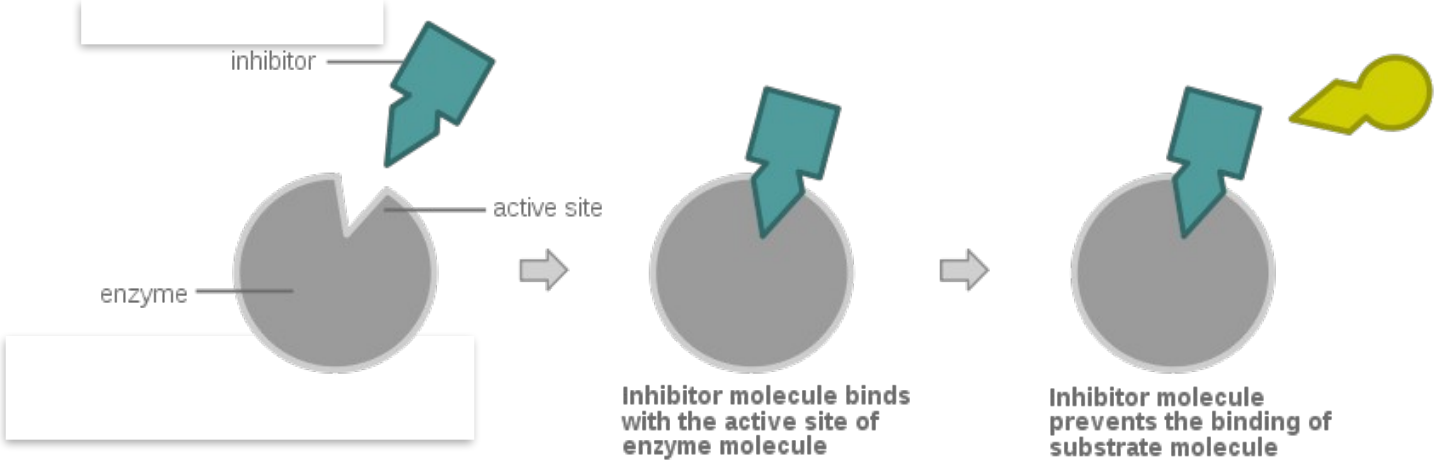
lactic acid fits into an active site formed from these three amino acid R groups



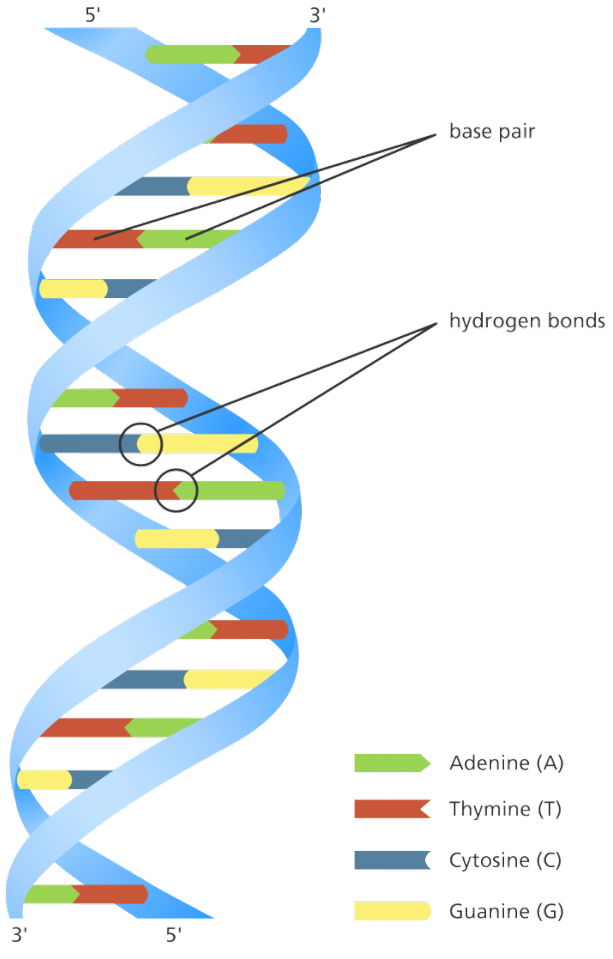
amino acid chain including Arg, His and Arg in positions 109, 171 and 195 in the sequence

- the specific shape and the atoms in an active site is often formed by the R groups on amino acids
- the enzyme LDH catalyses the oxidation of lactic acid to pyruvic acid - only one enantiomer of lactic acid fits this active site

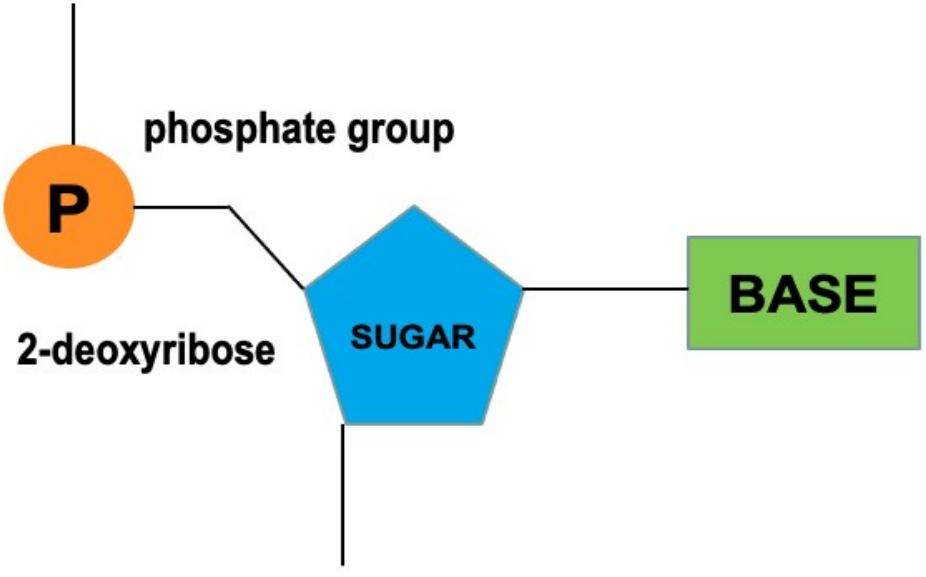
- Enzymes can be deactivated by other molecules that bind strongly to the active site and block it.
- Molecules that block active sites are called inhibitors.
- An as example, ibuprofen is a pain killer that works by blocking the active site that makes pain-causing prostaglandins.
- Computer modelling is used to design molecules to fit active sites



DNA

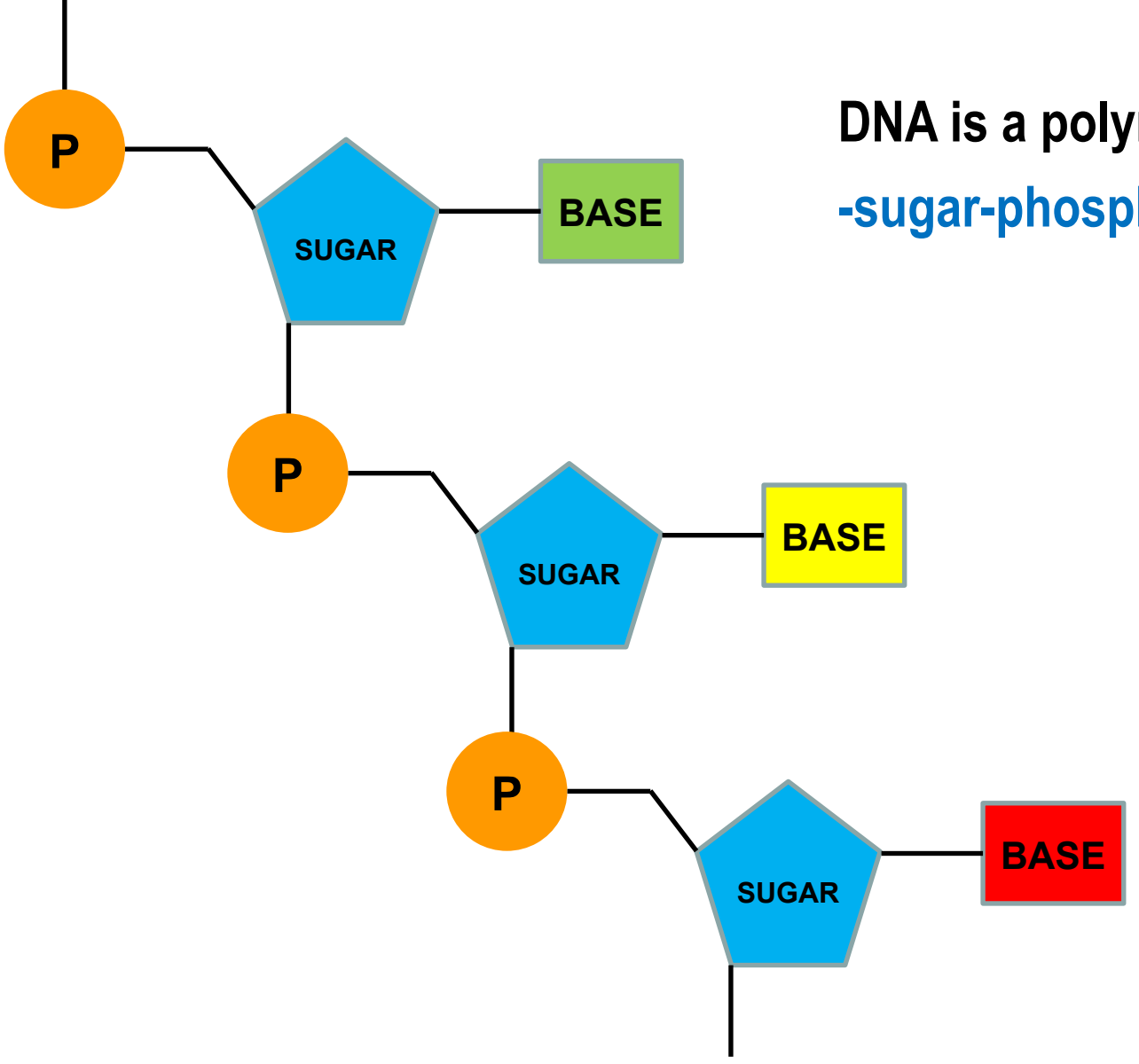


- DNA is made up of two strands held together in a double helix by hydrogen bonds.
- Each strand of DNA is made up from four different nucleotides. Each DNA strand contains thousands of these nucleotides in a specific sequence.



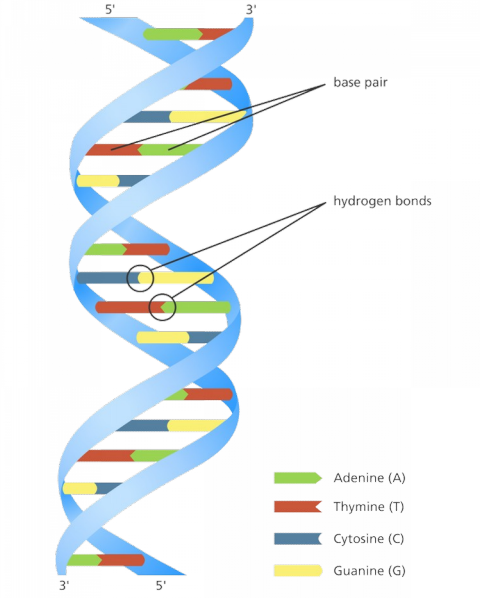
Nucleotides are made from one

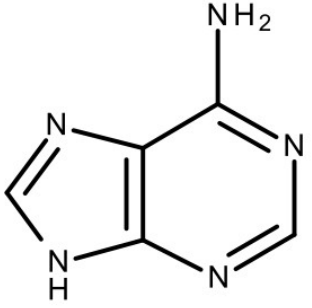
- phosphate group
- deoxyribose group (a sugar)
- one of these four bases:
  - adenine (A)
  - cytosine (C)
  - guanine (G)
  - thymine (T)



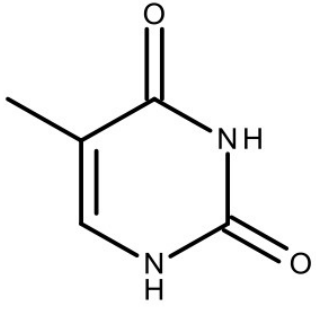
DNA is a polymer made of:

-sugar-phosphate-sugar-phosphate-

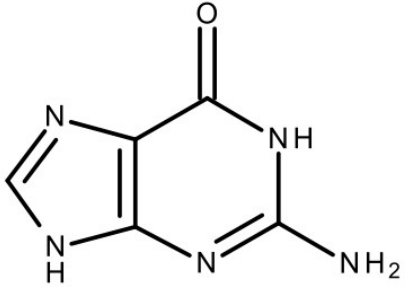




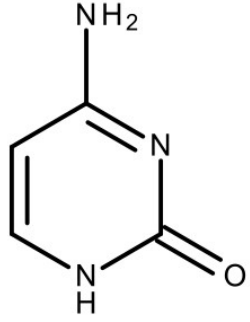
adenine (A)



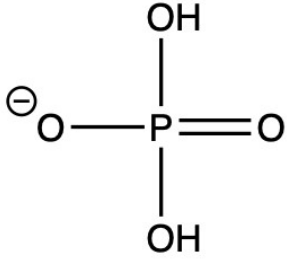
thymine (T)



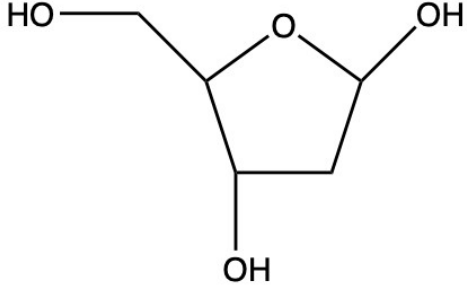
guanine (G)



cytosine (C)

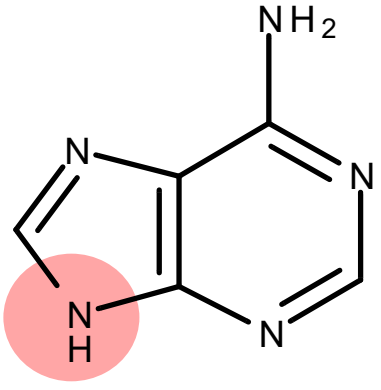


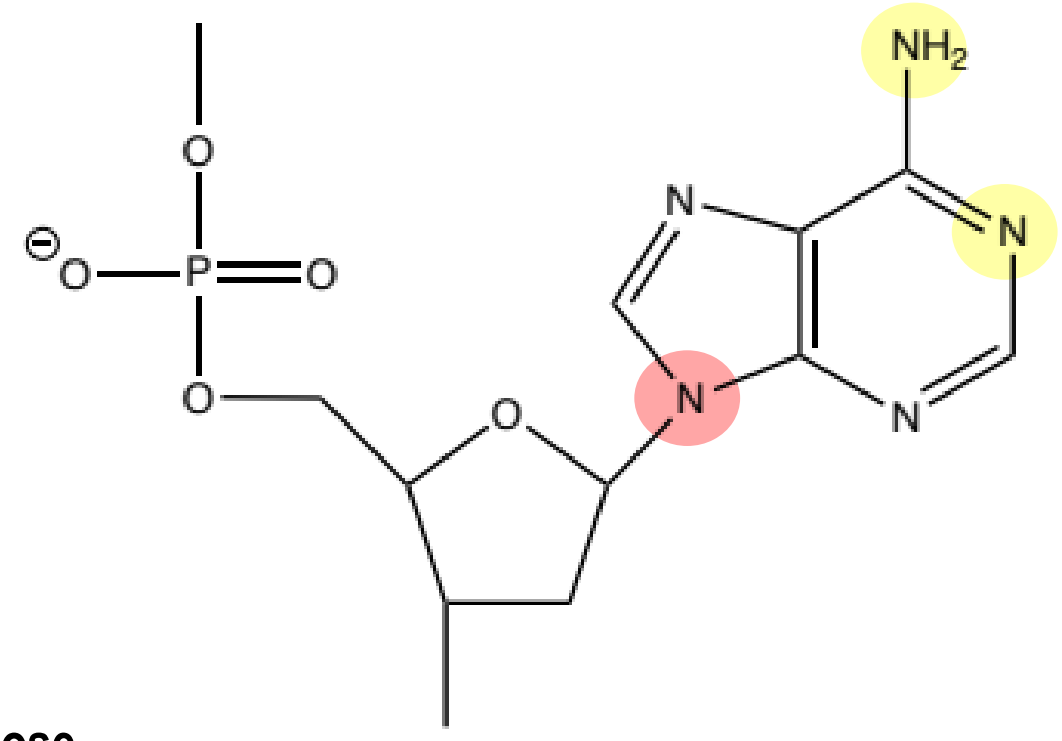
phosphate group



2-deoxyribose

adenine

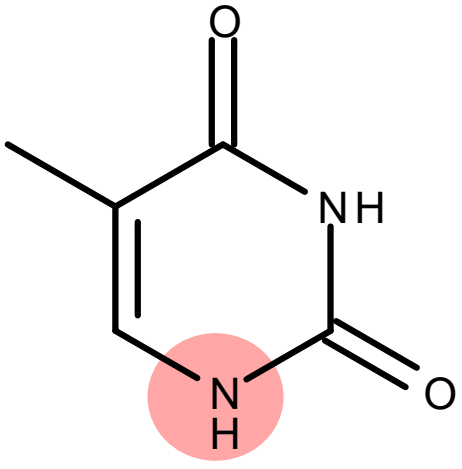


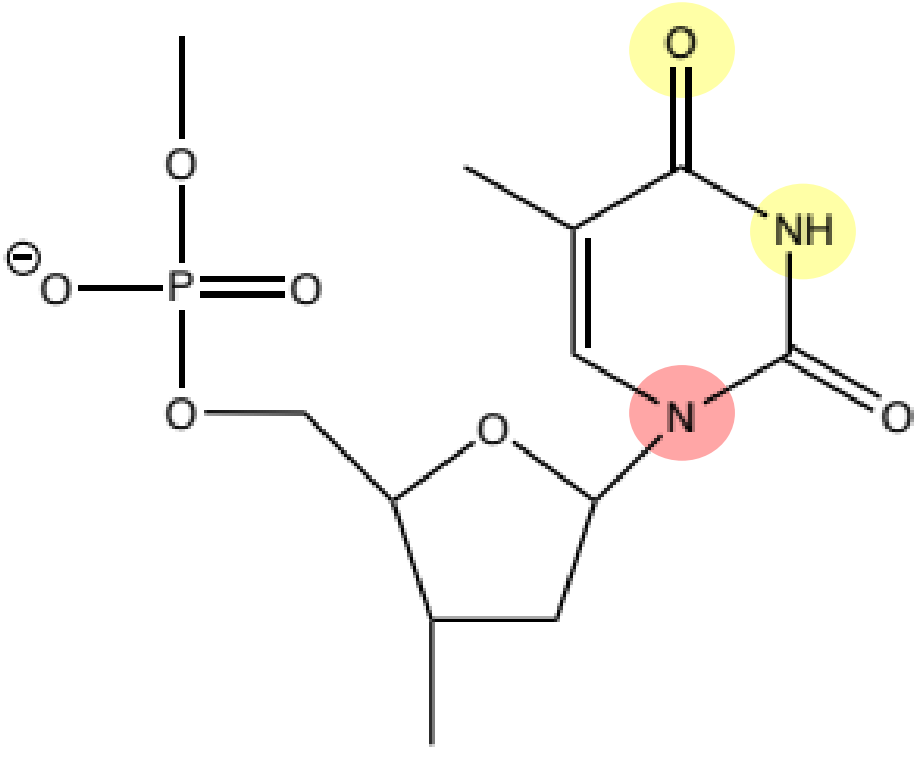


bonding site to deoxyribose

H bonding site to base partner

thymine

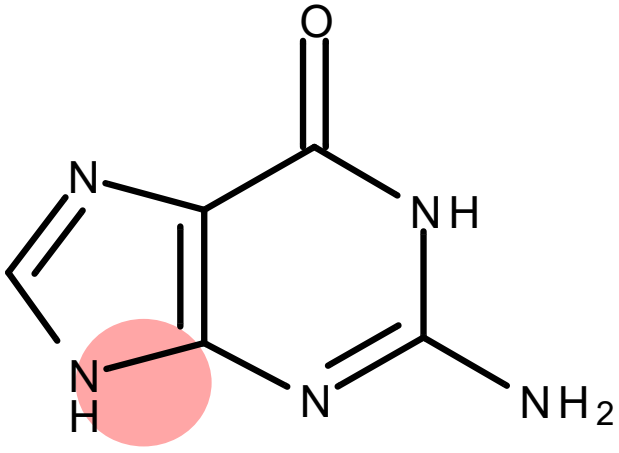


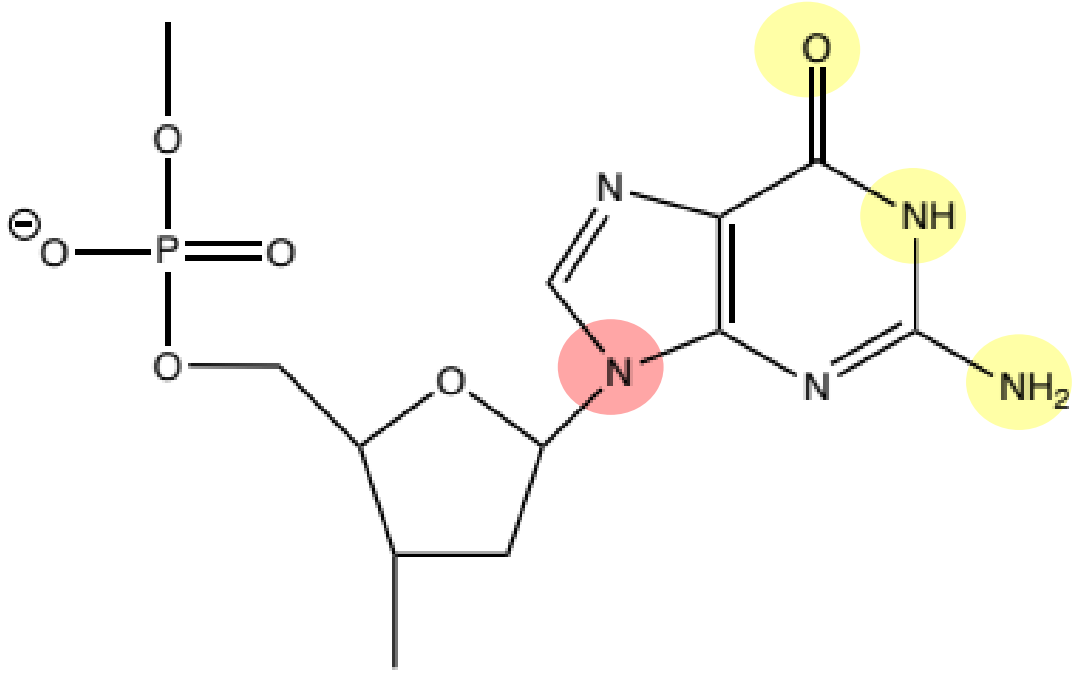


bonding site to deoxyribose

H bonding site to base partner

guanine

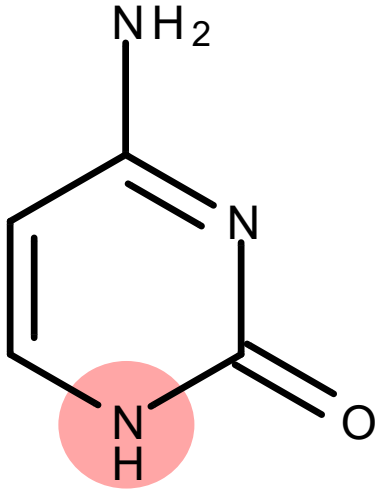


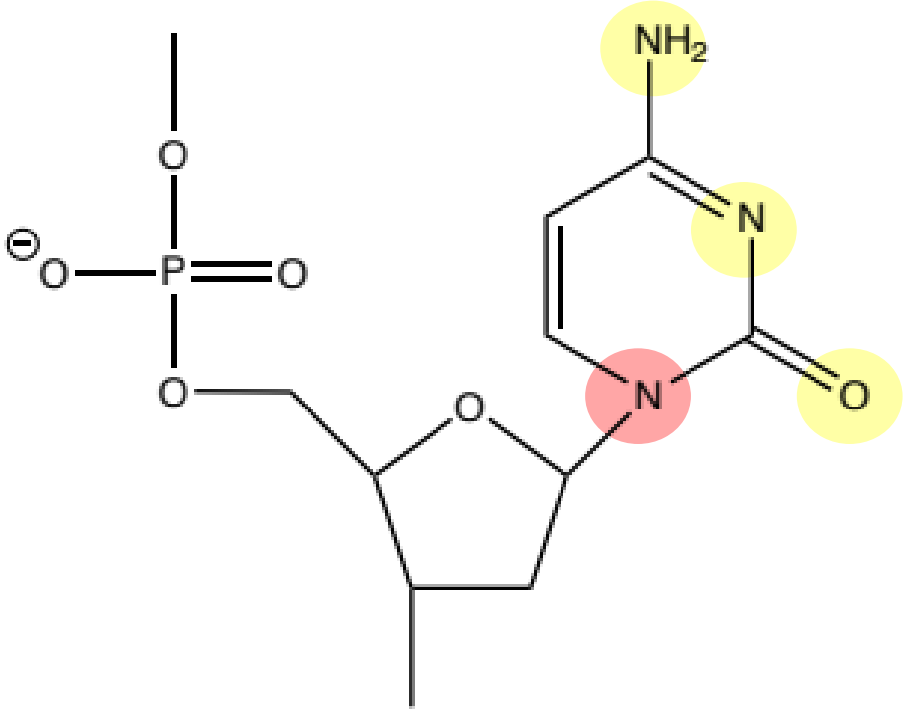


bonding site to deoxyribose

H bonding site to base partner

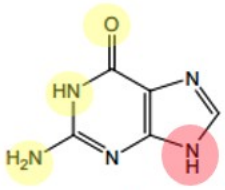
cytosine

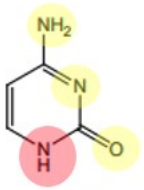


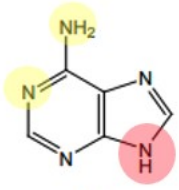


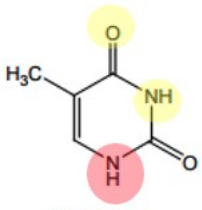
bonding site to deoxyribose

H bonding site to base partner



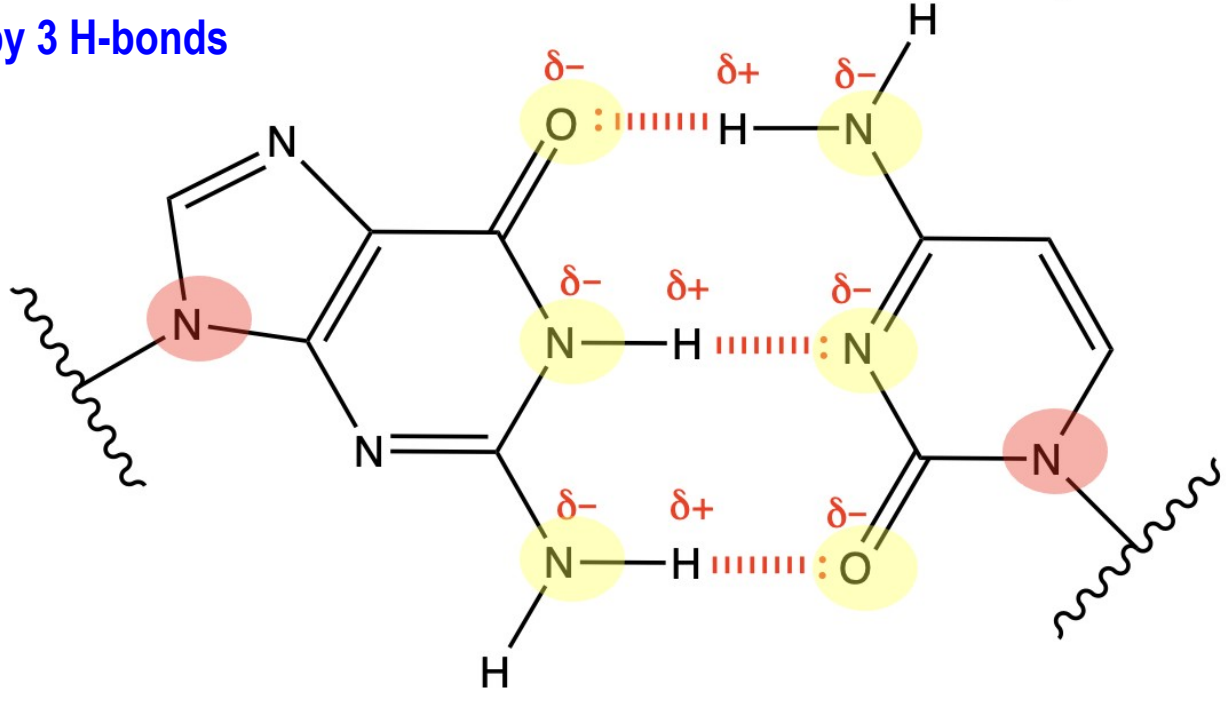




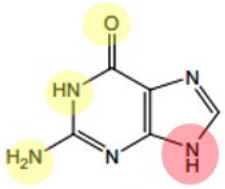


C & G held together by 3 H-bonds

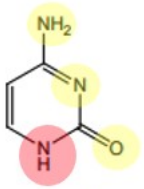
cytosine



guanine

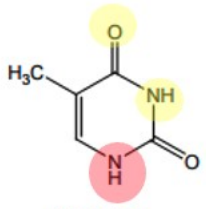


guanine



cytosine

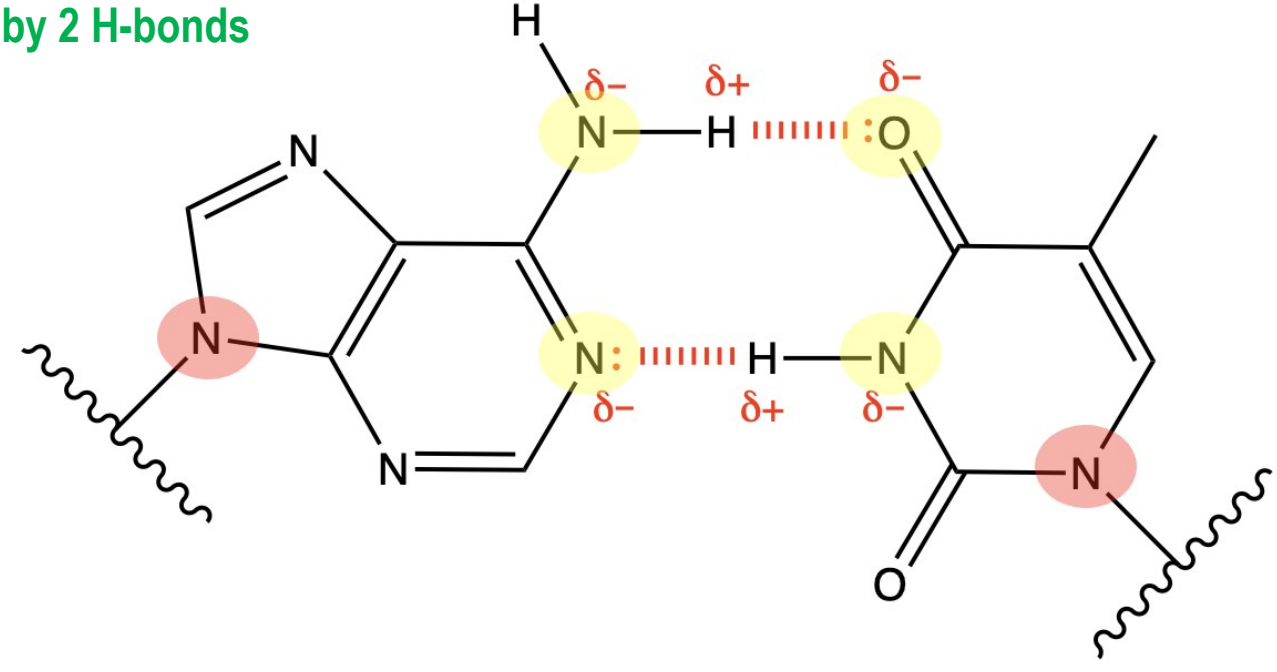
adenine



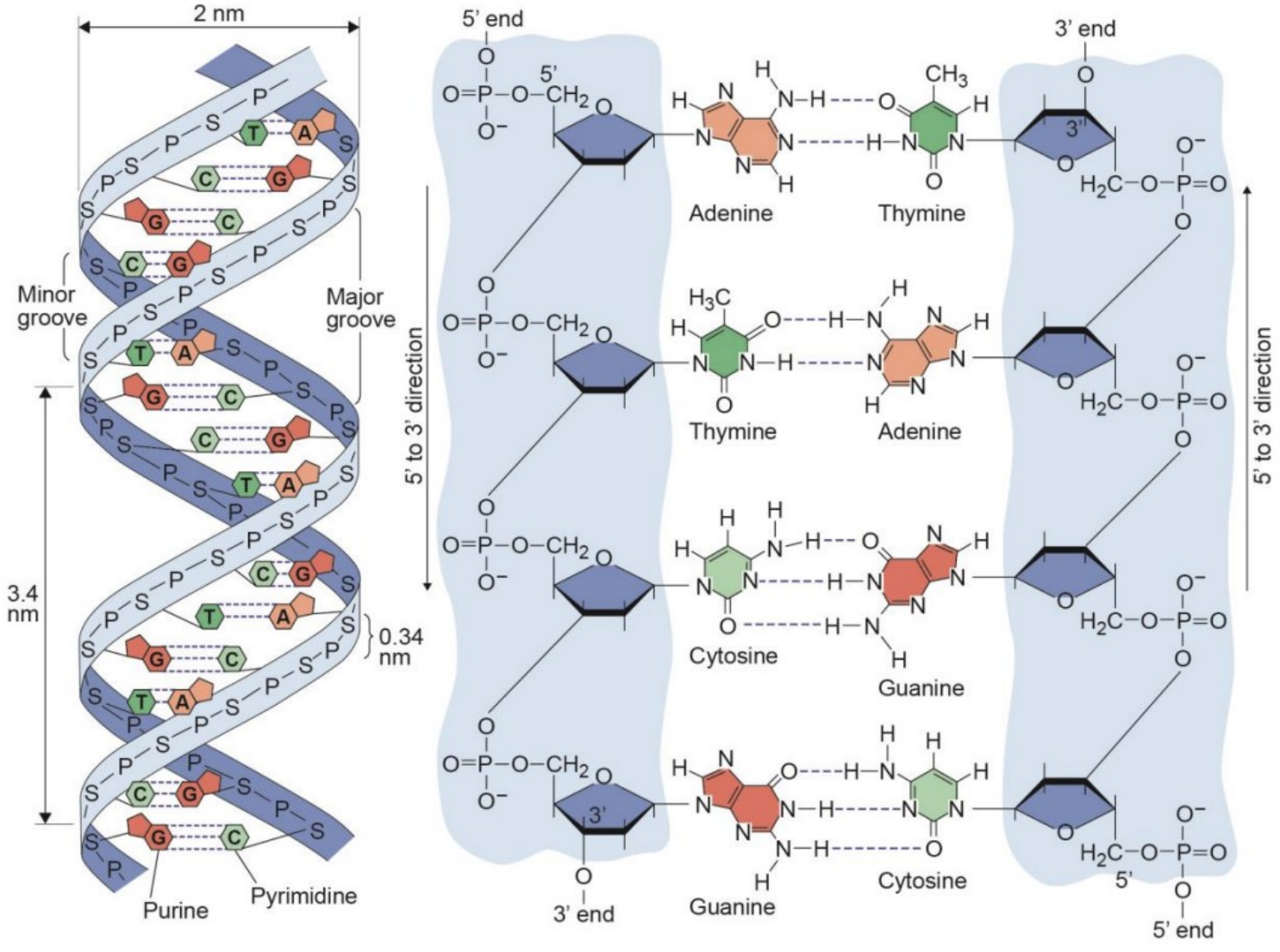
thymine

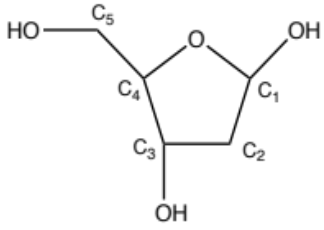
A & T held together by 2 H-bonds

thymine



ademine

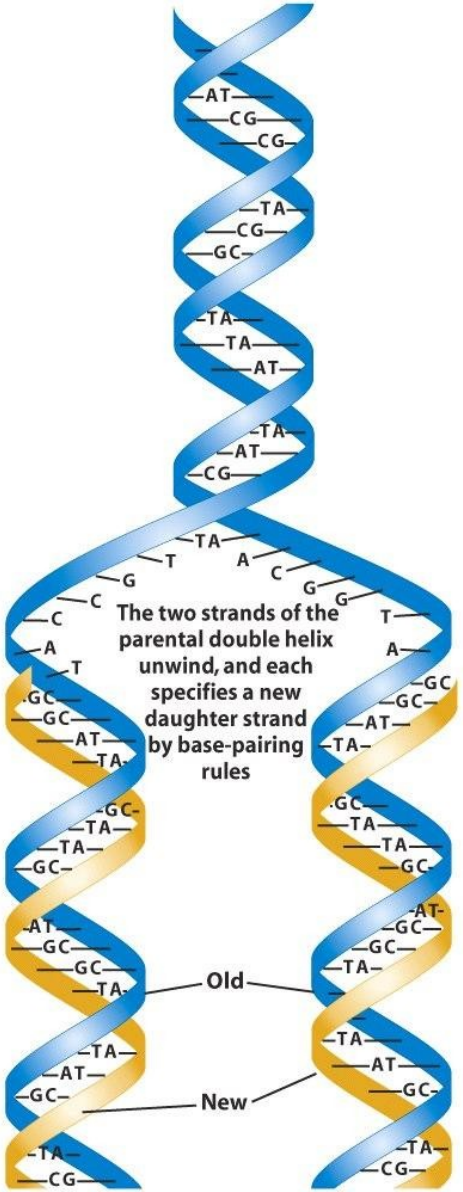




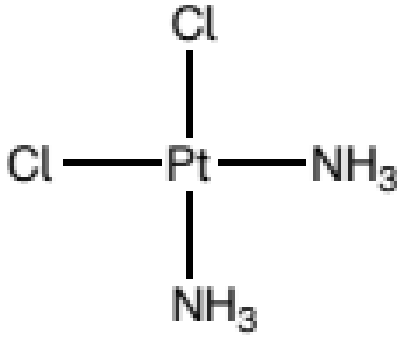
3' and 5' refer to whether C3 or C5 is closest to the end of the chain.

One strand runs in the 3' to 5' direction and one in the 5' to 3' direction

- The two DNA strands are only held together by hydrogen bonds.
- When a cell replicates by **mitosis**, the two DNA strands separate.
- Two new complementary strands are built up by connecting the appropriate nucleotides to match the sequence on the other strand. This leads to two DNA double helices made from one DNA double helix, each being identical to the original.



- Cancer cells contain incorrect DNA sequences
- Chemotherapy uses medicines to stop cells replicating
- Cis-platin is an effective chemotherapy drug



1) $Pt(NH_3)_2Cl_2$ reacts with water in cell with H_2O replacing one Cl^- ligand:

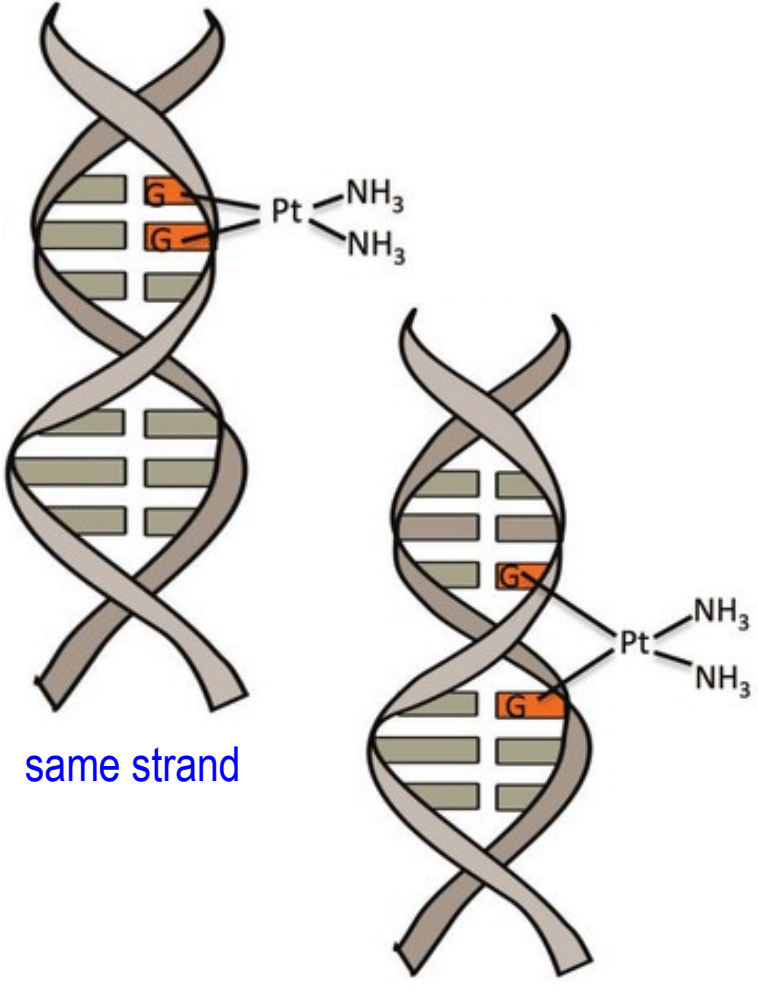
$$Pt(NH_3)_2Cl_2 + H_2O \rightarrow Pt(NH_3)_2(H_2O)Cl^+ + Cl^-$$

2) guanine bonds to the Pt via an N atom replacing the H_2O

3) second guanine bonds to the Pt via an N atom replacing the Cl^-

4) if the two guanines are on different DNA strands then the **two strands cannot separate** preventing replication of the DNA, or

   if the two guanines are on the same DNA strand, then the **strand becomes kinked** and cannot replicate



same strand

different strands