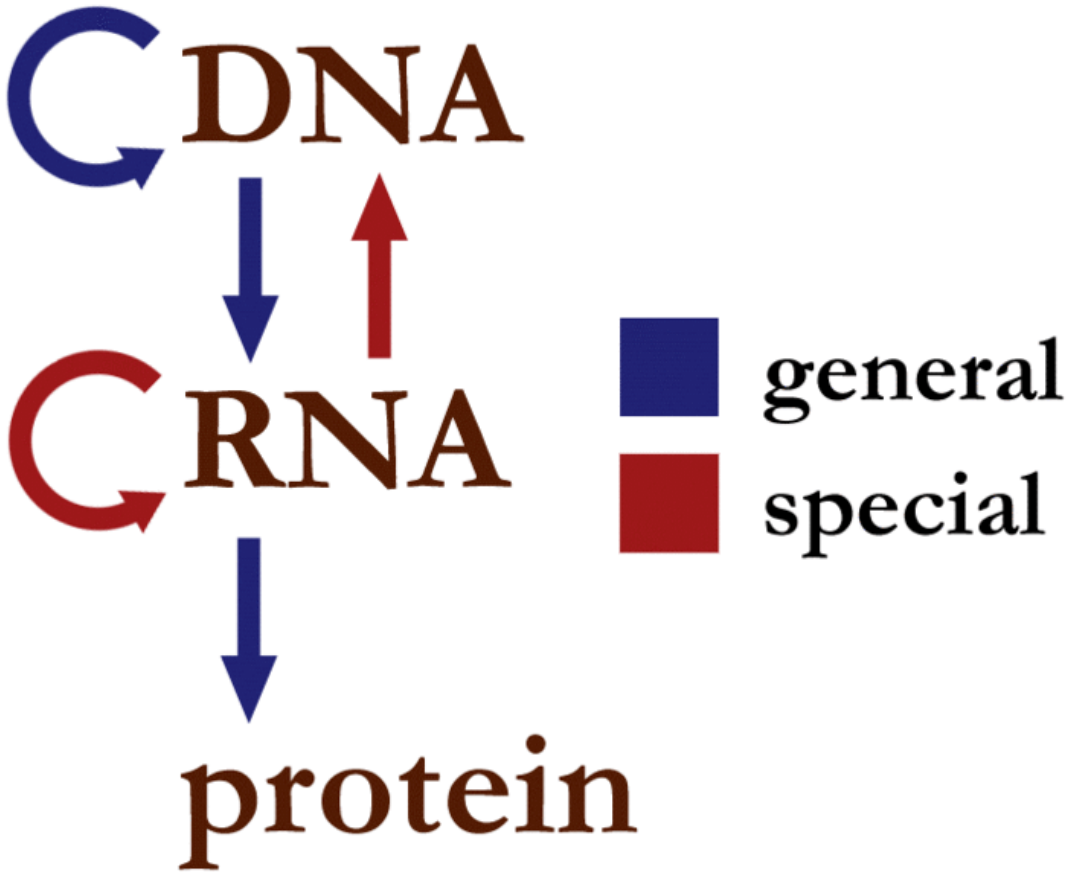
DNA, RNA, and Amino Acids

Ch. 26.1-10, 13, Ch. 21.1-4, 8, 13-17

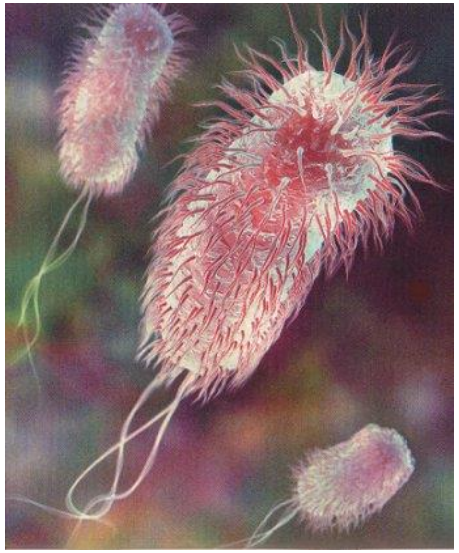
ChemV12B, Organic Chemistry II

Molecular Biology



Genes

- **<u>Gene</u>:**



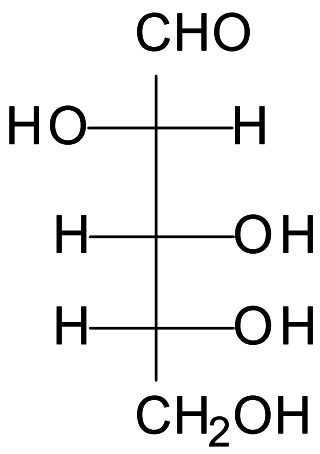
- **<u>Genome</u>:**

In perspective:

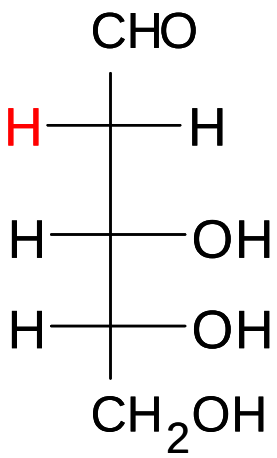
- *E. coli,* a bacteria, has 4,291 genes.
- *C. elegans,* a roundworm, has about 20,000 genes.
- Humans share 99% of their genes with mice.
- Almost 99.9% of all nucleotide bases are identical from person to person.
- Over 50% of human genes have no known function.

Structure of DNA

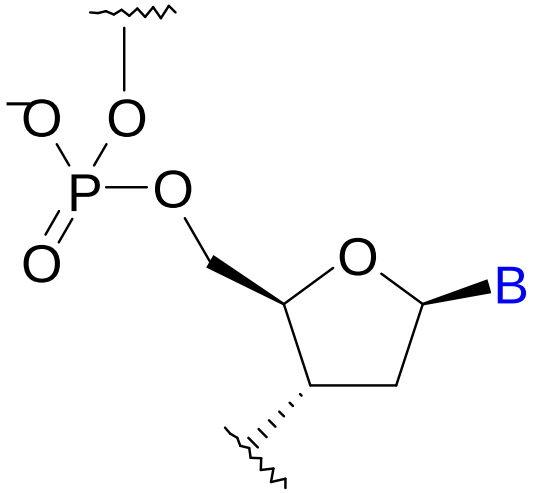
- **<u>DNA:</u>**
- **<u>Nucleotide</u>:**



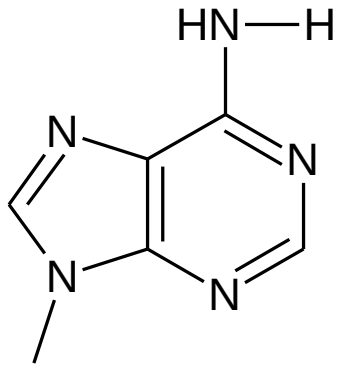
D-ribose



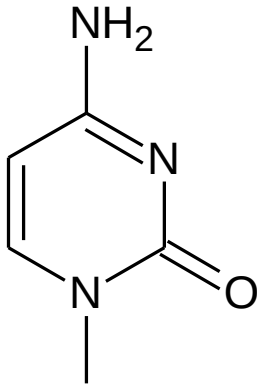
deoxyribose



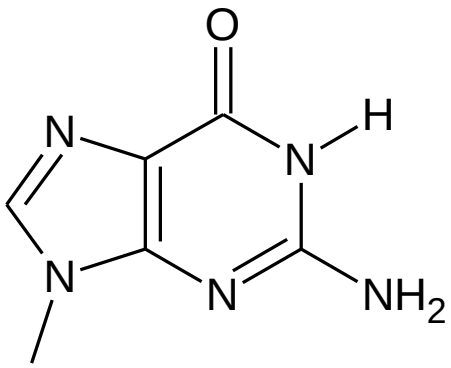
Nitrogenous Bases



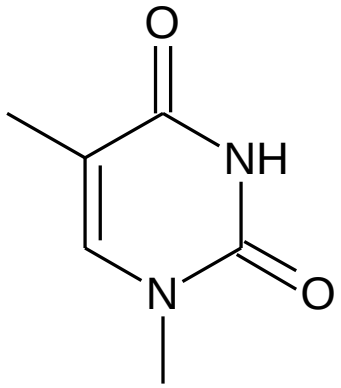
adenine



cytosine



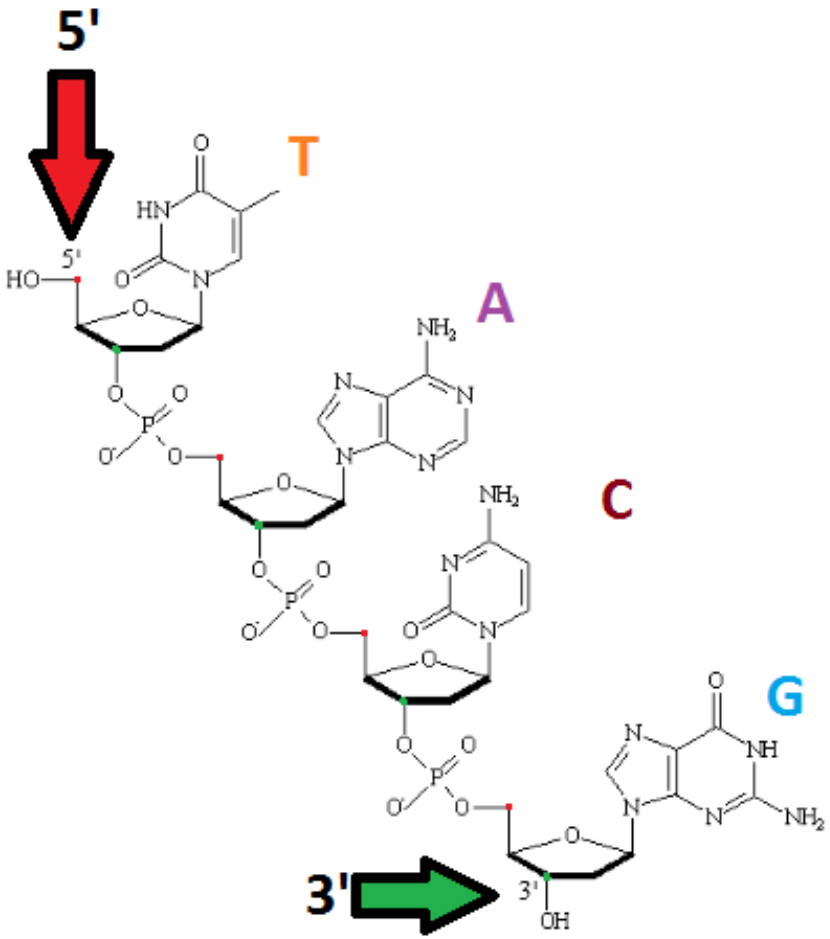
guanine



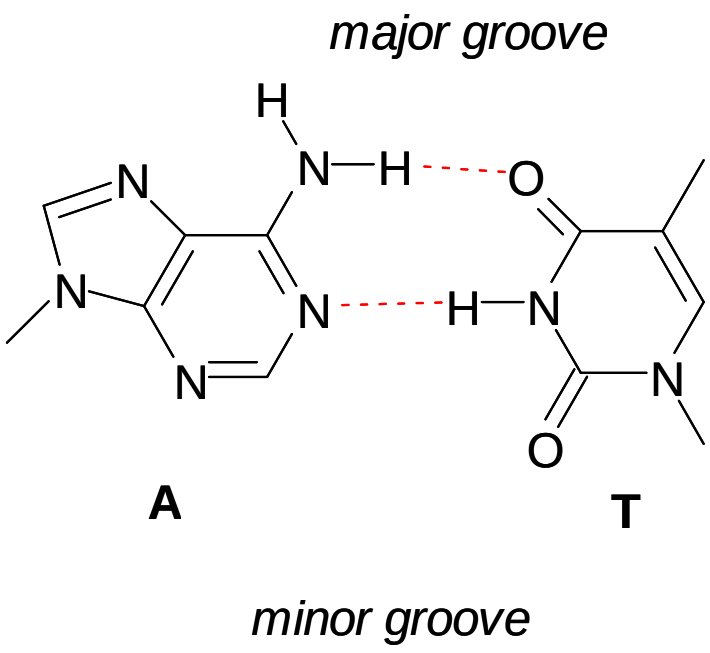
thymine

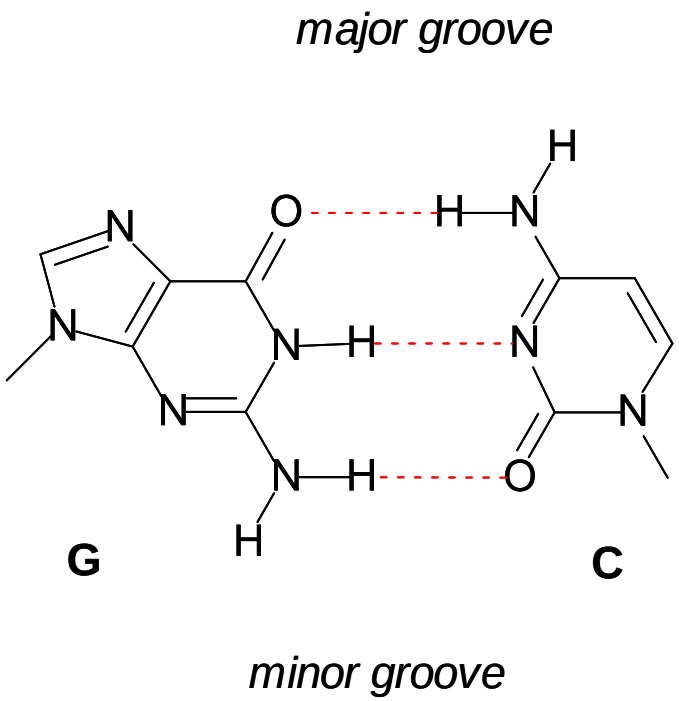
DNA Chains

- **<u>Nucleic acid:</u>**



Base Pairs

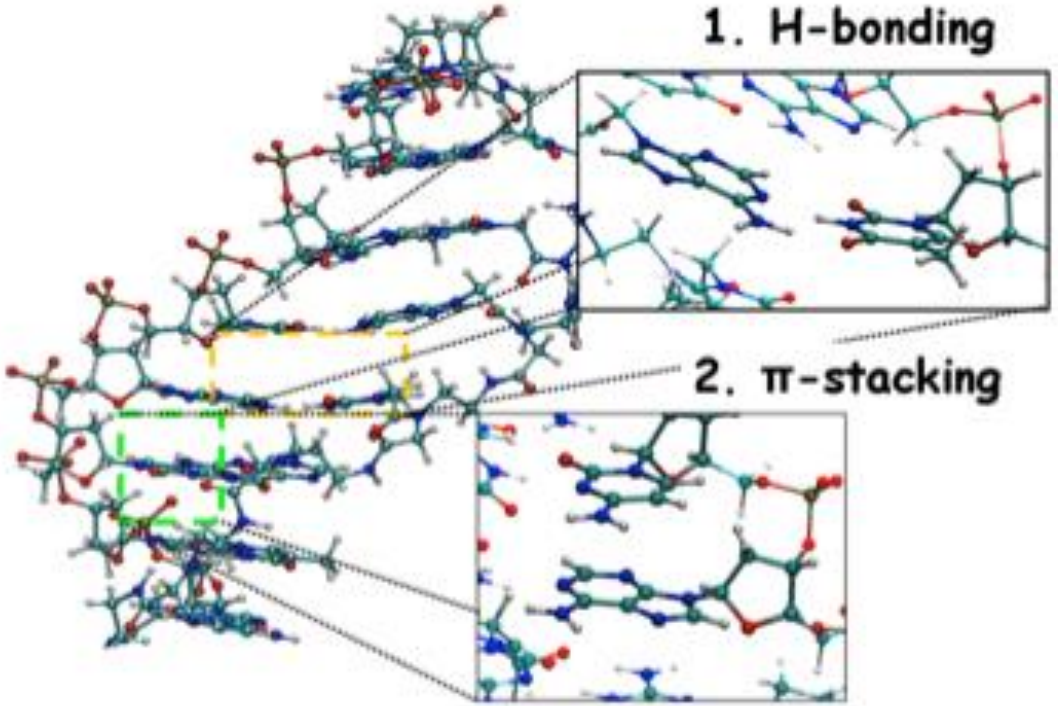

major groove
H
N
H
O
N
N
H
N
N
N
O
A
T
minor groove


major groove
H
O
H
N
N
N
H
N
N
N
N
H
O
H
G
C
minor groove

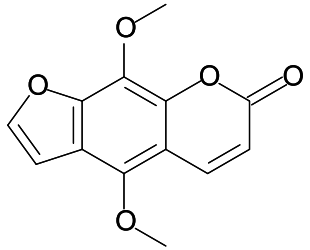
Structures of DNA

- **<u>Primary structure:</u>**

- **<u>Secondary structure:</u>**

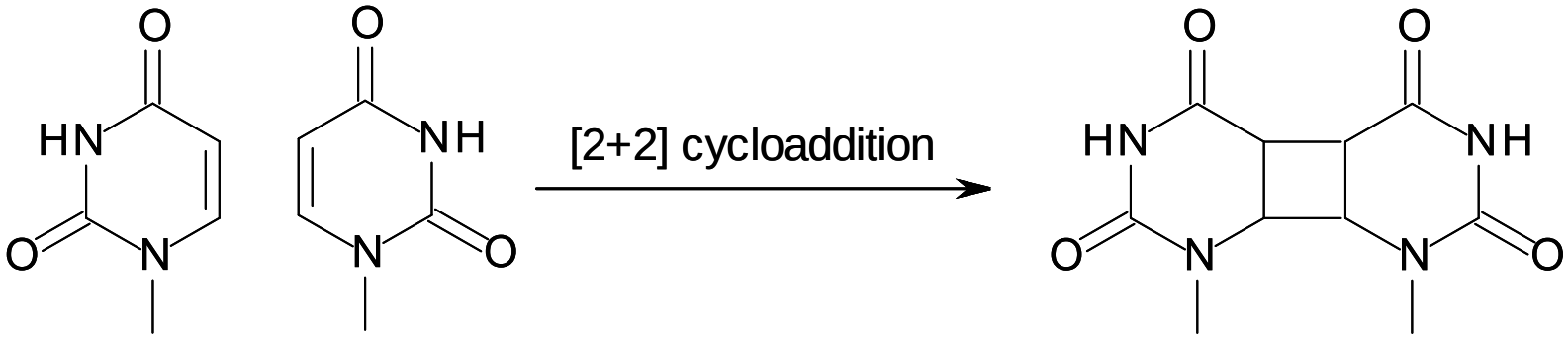


The Case of the Limes



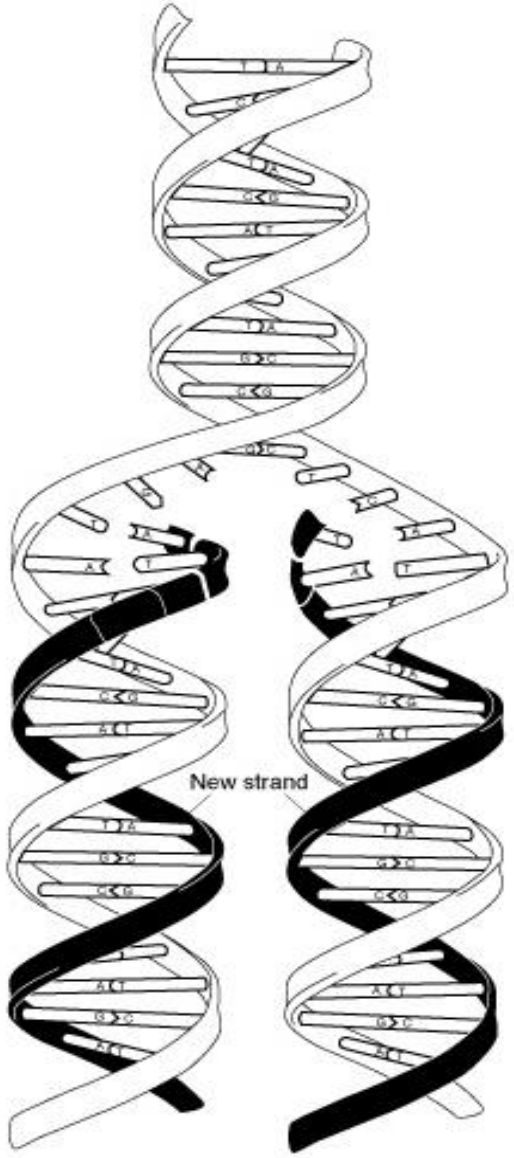
5,6-dimethoxypsoralen

- **<u>Intercalation:</u>**



Replication

- **Replication:**
- **DNA helicase:**
- **DNA polymerase:**
- **Leading strand:**
- **Lagging strand:**



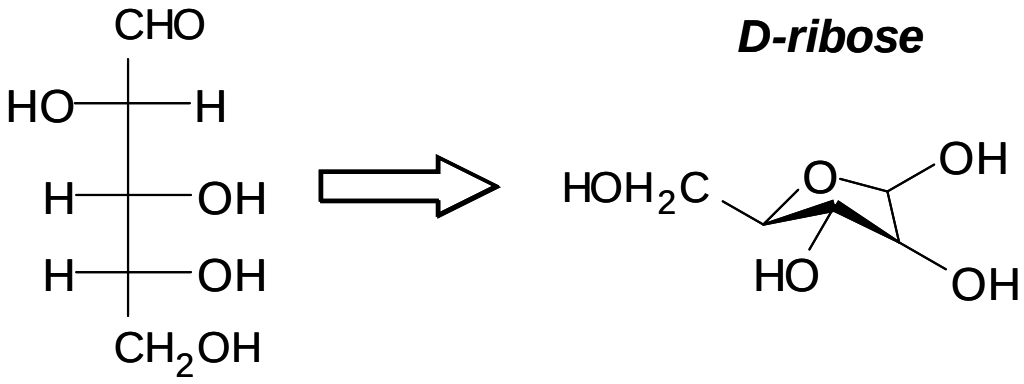
Transcription

- **<u>Transcription:</u>**

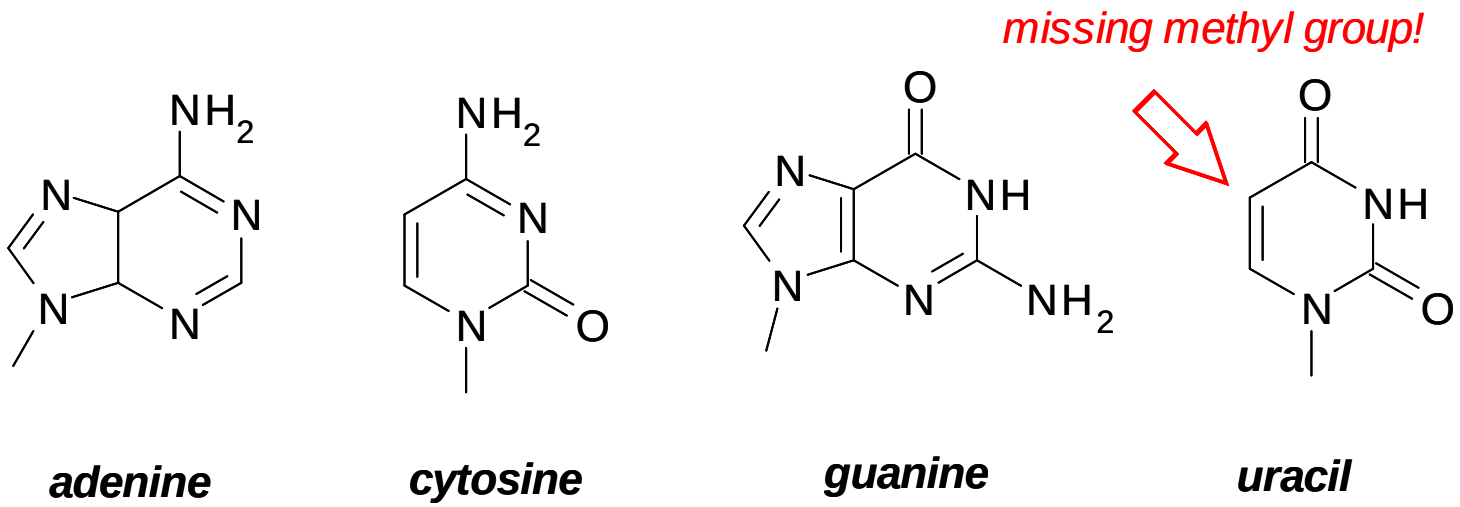
- **<u>RNA:</u>**

RNA

- **D-Ribose:**



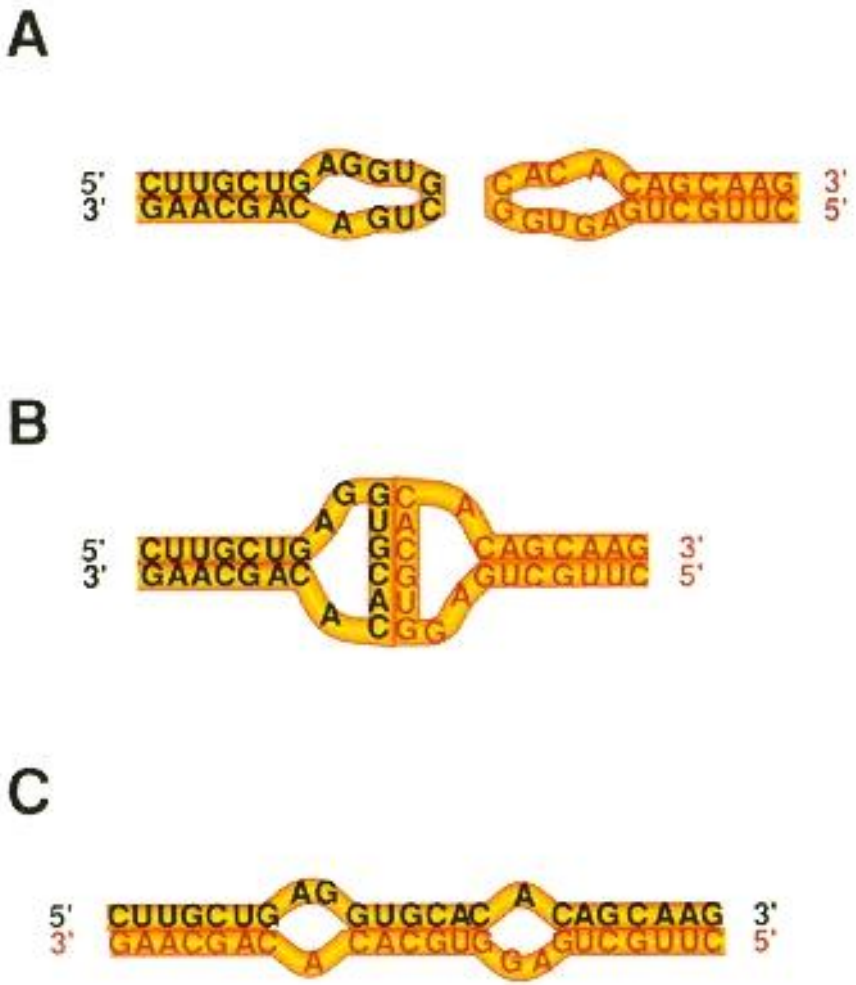
- **Uracil:**



Structures of RNA

- **<u>Primary structure:</u>**

- **<u>Secondary structure:</u>**



Types of RNA

- **Messenger RNA (mRNA):**
- **Transfer RNA (tRNA):**
- **Ribosomal RNA (rRNA):**
- **Small nuclear RNA (snRNA):**
- **Micro RNA (miRNA):**
- **Small Interfering RNA (siRNA):**

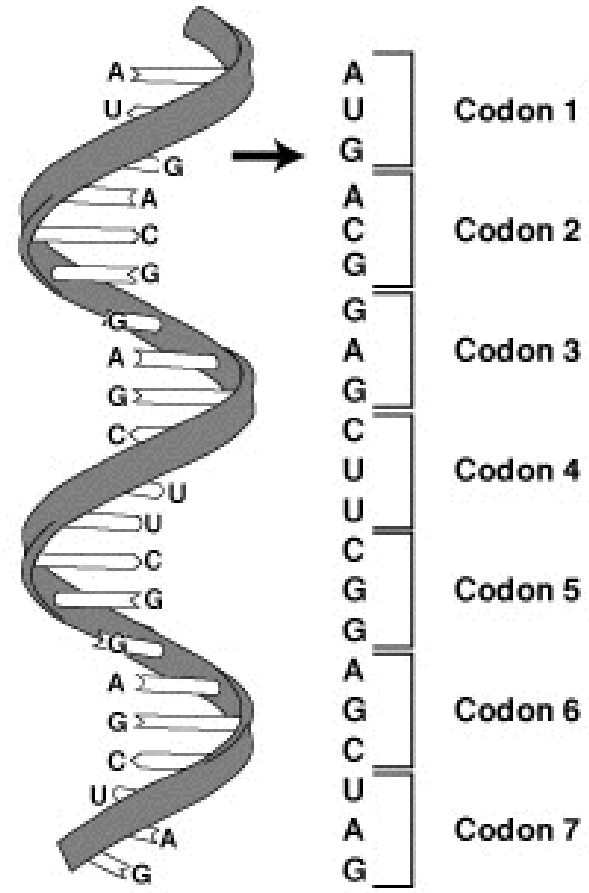
Translation

- **Translation:**

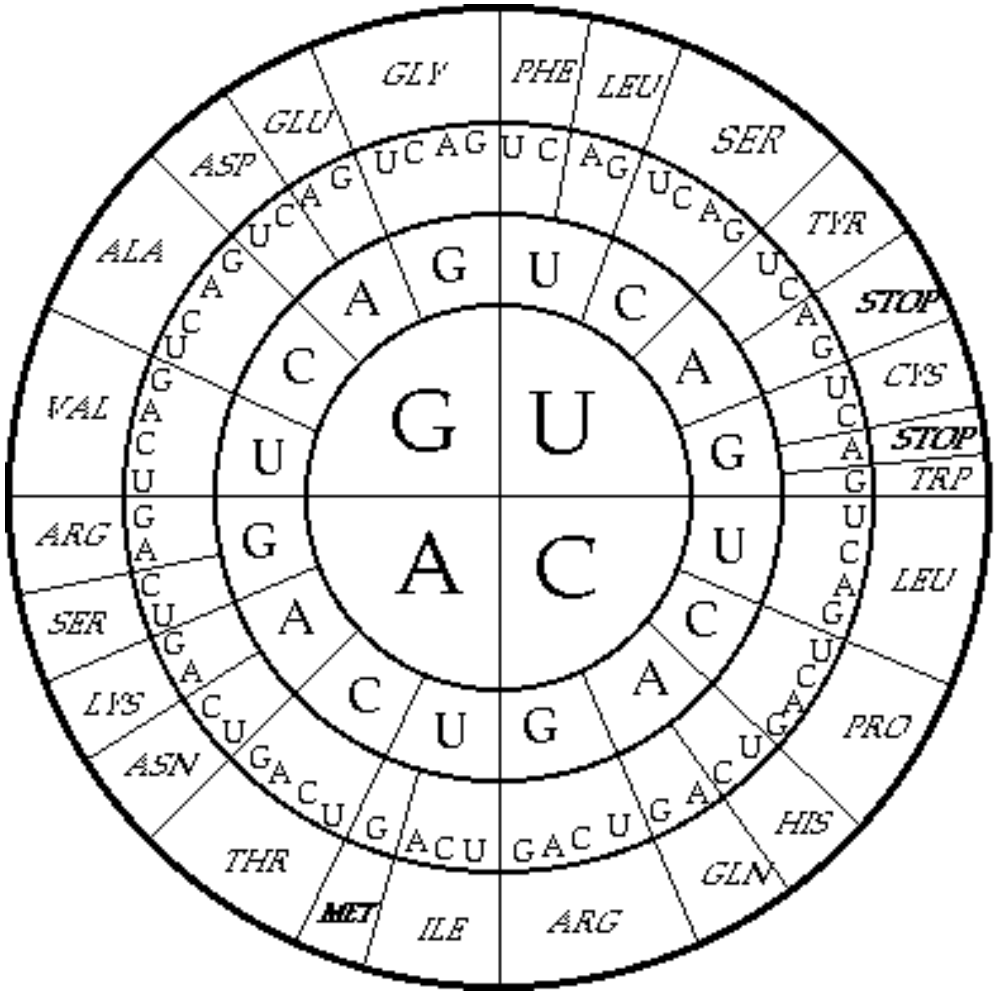
- **Codon:**

- **Initiation:**

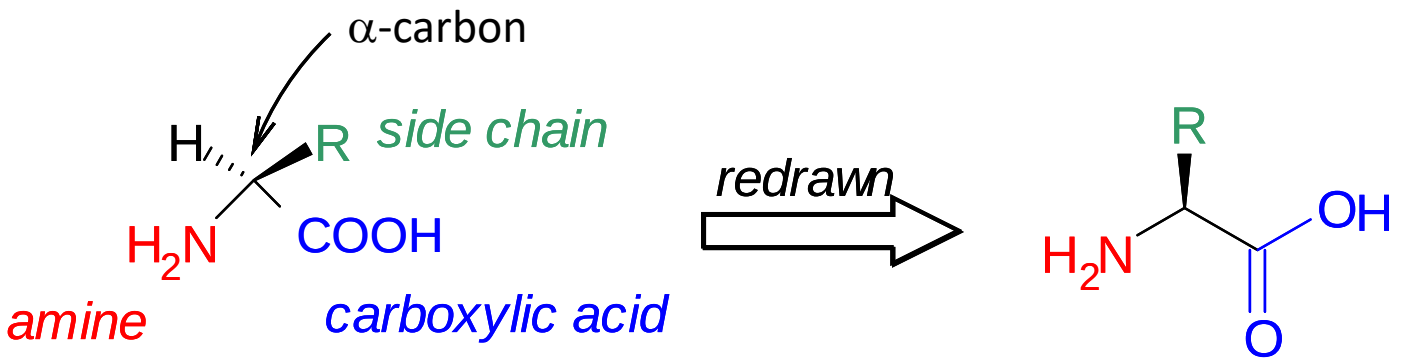
- **Termination:**



Genetic Code



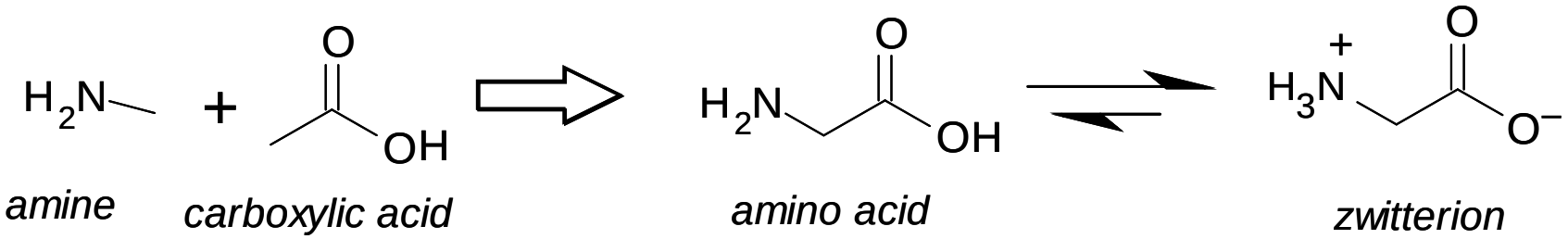
Amino Acids



- **Amino acid:**

- **Zwitterion:**

- **Isoelectric point:**



The List of Amino Acids

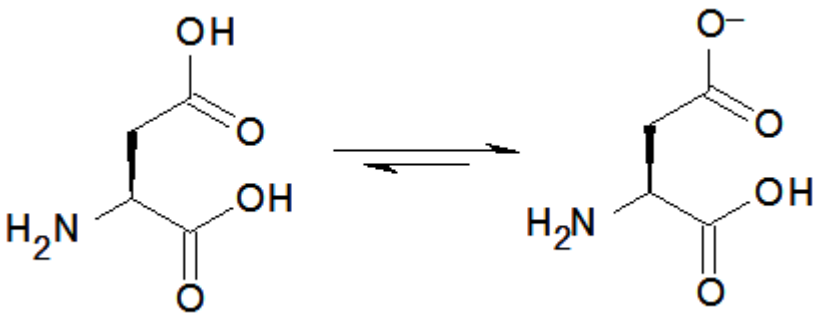
NAME	3-LETTER	1-LETTER	NAME	3-LETTER	1-LETTER
Alanine	Ala	**A**	Methionine	Met	**M**
Cysteine	Cys	**C**	Asparagine	Asn	**N**
Aspartic Acid	Asp	**D**	Proline	Pro	**P**
Glutamic Acid	Glu	**E**	Glutamine	Gln	**Q**
Phenylalanine	Phe	**F**	Arginine	Arg	**R**
Glycine	Gly	**G**	Serine	Ser	**S**
Histidine	His	**H**	Threonine	Thr	**T**
Isoleucine	Ile	**I**	Valine	Val	**V**
Lysine	Lys	**K**	Tryptophan	Trp	**W**
Leucine	Leu	**L**	Tyrosine	Tyr	**Y**

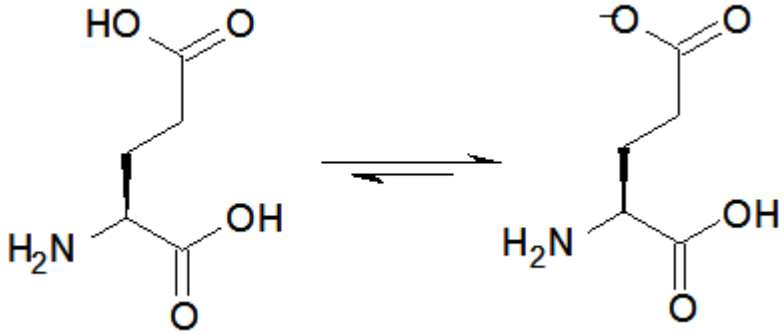
* Non-intuitive abbreviations

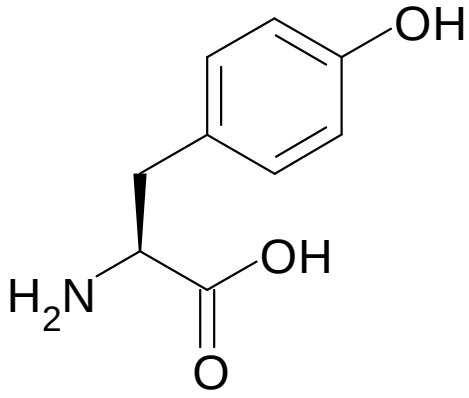
Categories of Amino Acids

- **Essential/Non-essential:**
- **Acidic:**
- **Basic:**
- **Aromatic:**
- **Aliphatic:**
- **Polar:**
- **Sulfur:**
- **Twisty:**

Acidic Amino Acids







Basic Amino Acids

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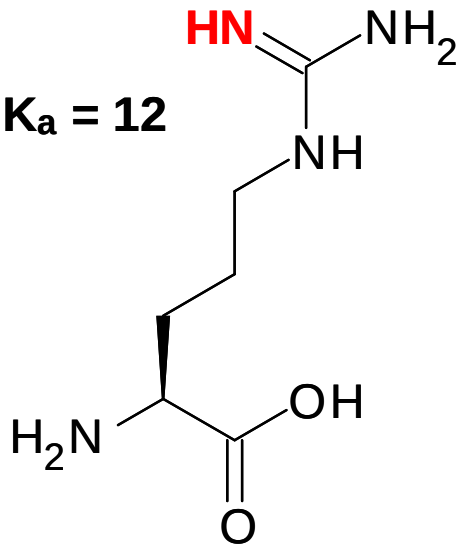
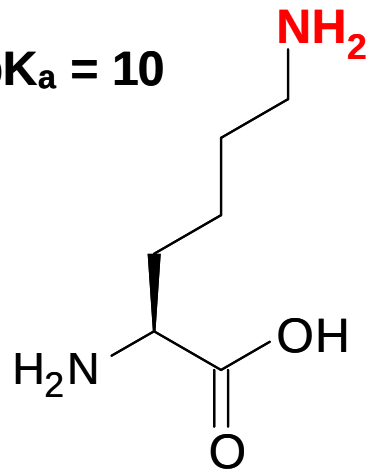
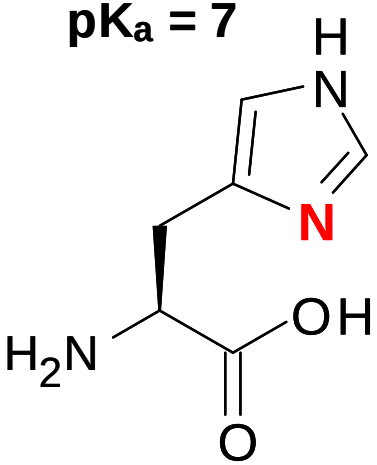


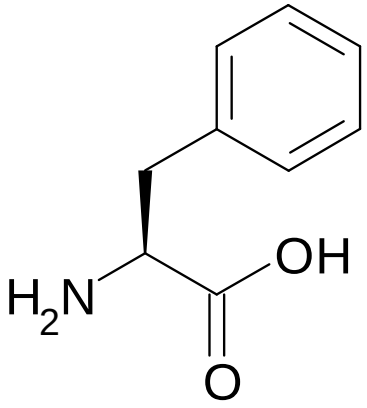
pK_a = 10

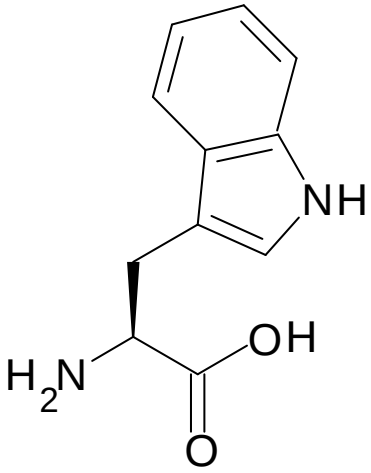


pK_a = 7

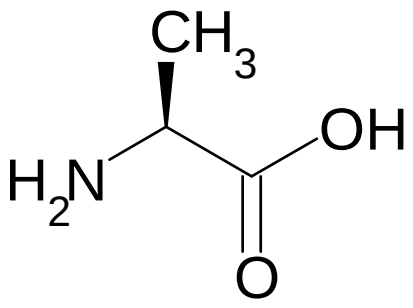


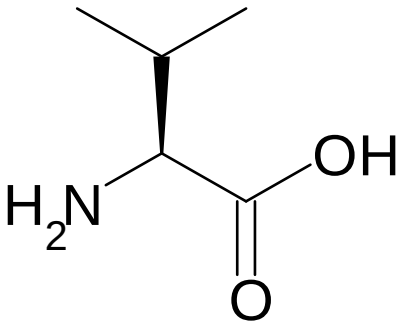
Aromatic Amino Acids

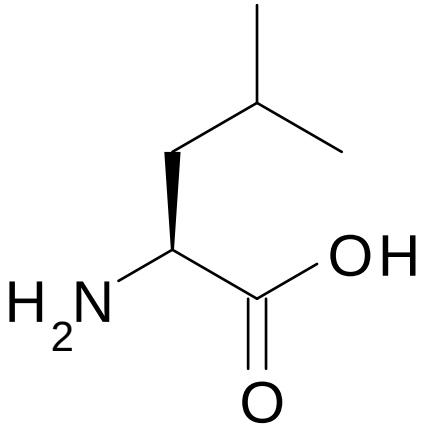


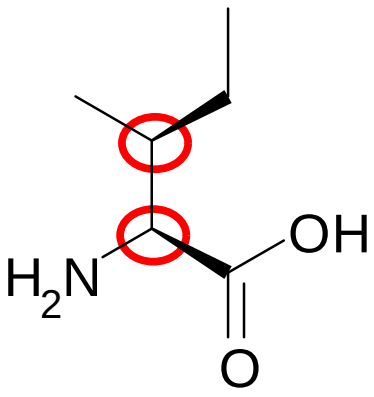


Aliphatic Amino Acids

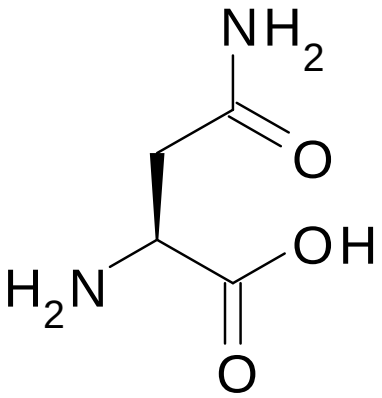


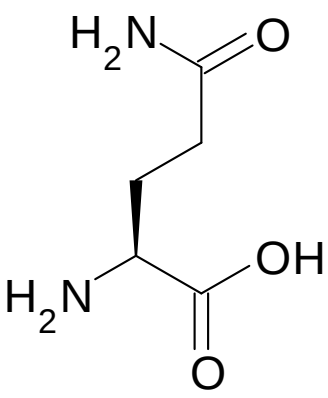


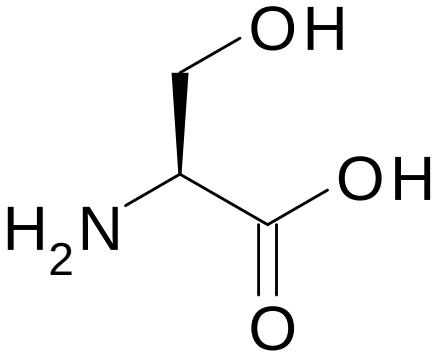


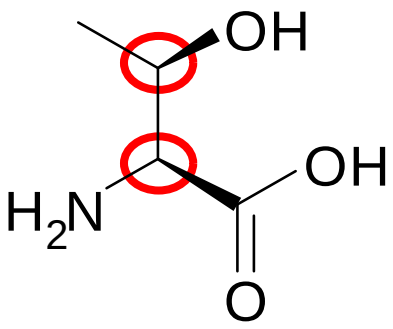


Polar Amino Acids

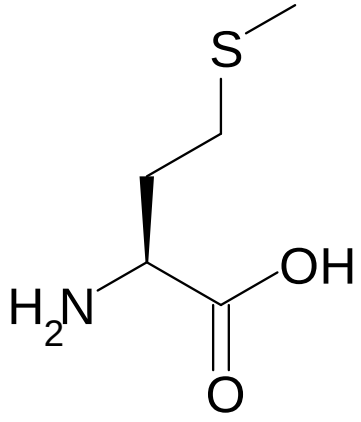








Sulfur Amino Acids



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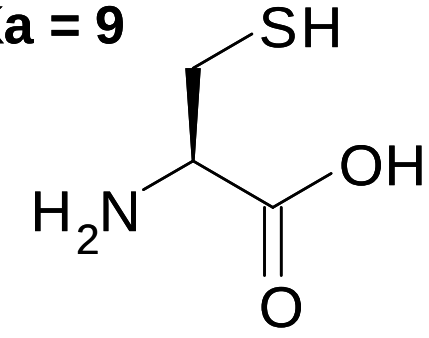
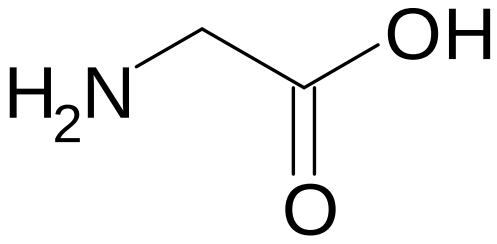
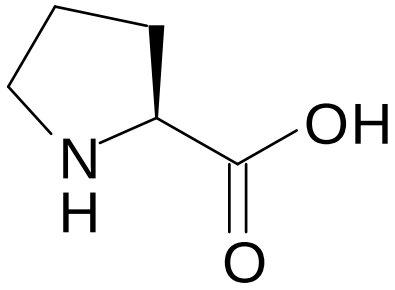
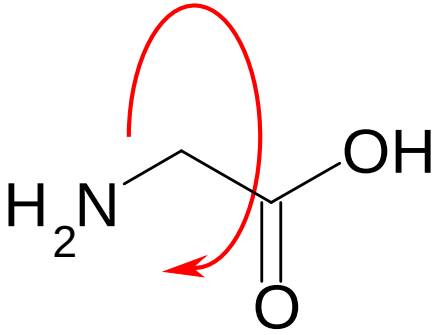


Twisty Amino Acids



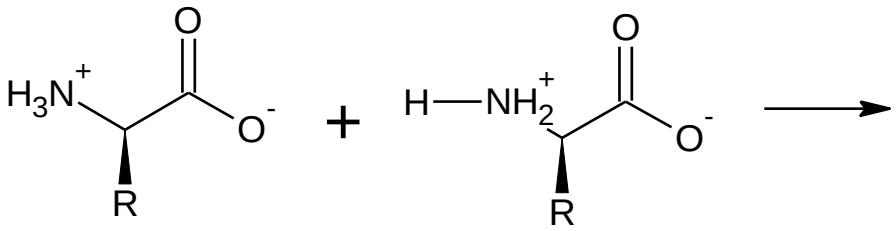




Proteins

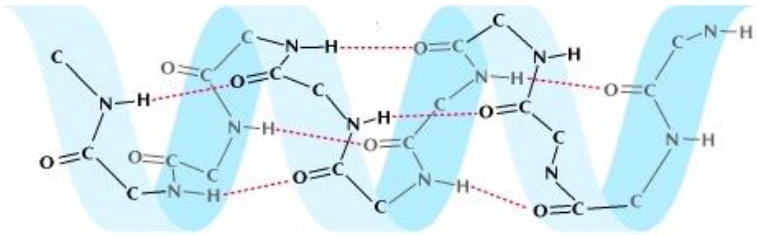
- **<u>Peptide:</u>**

- **<u>Peptide bond:</u>**

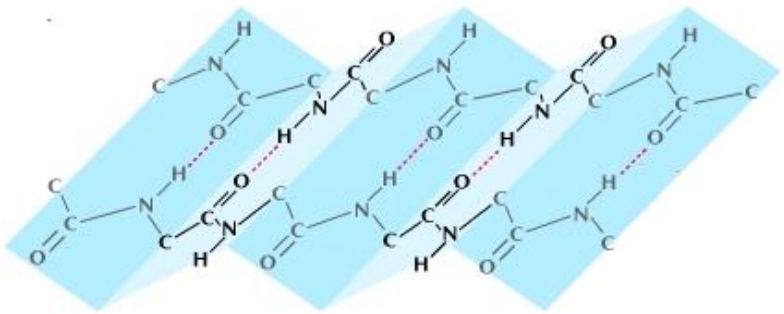


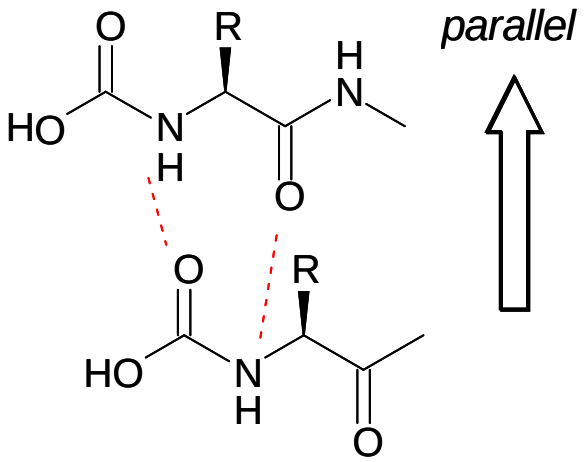
Structures of Proteins

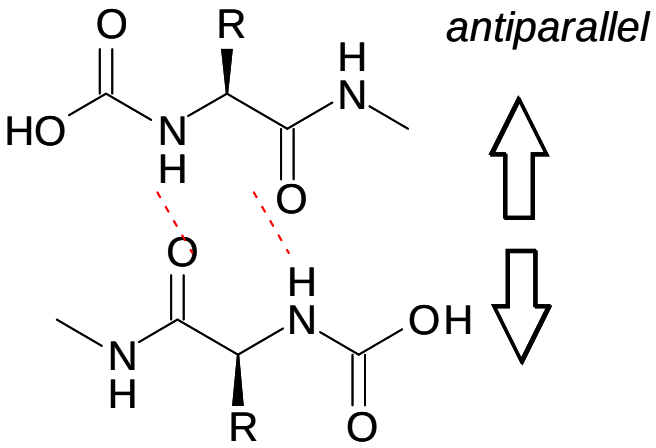
- **<u>Primary structure:</u>**



- **<u>Secondary structure:</u>**

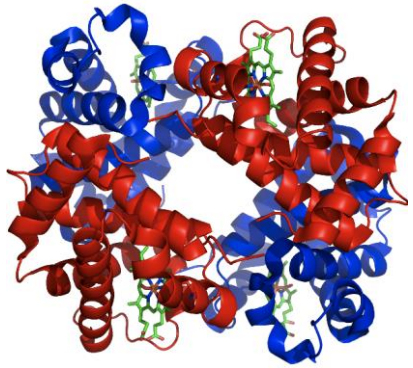




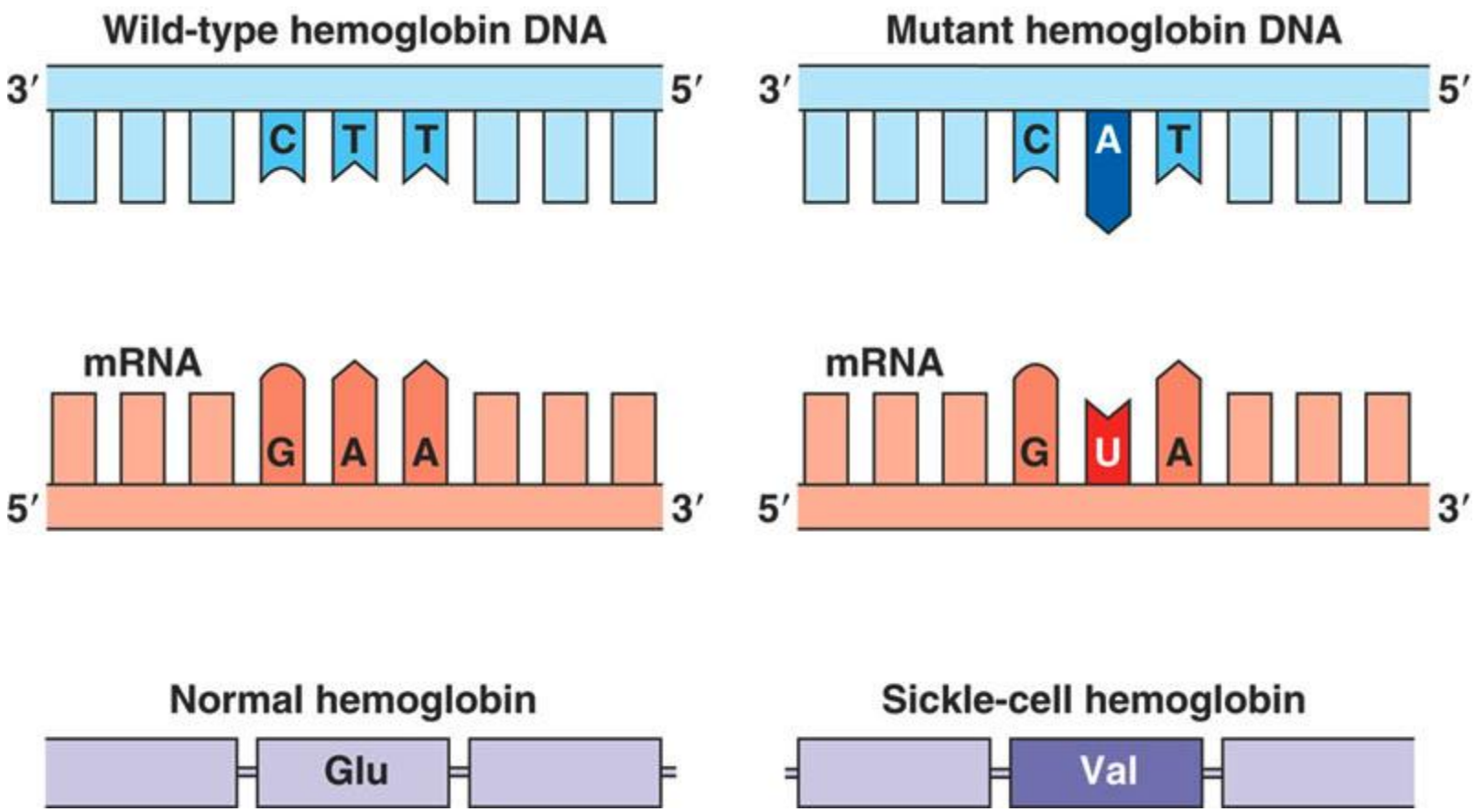


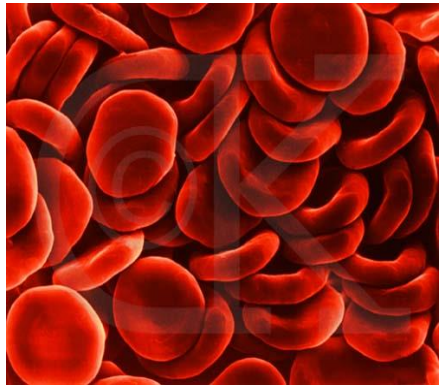
Structures of Proteins

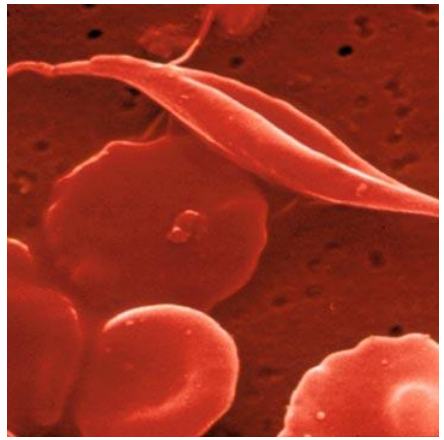
- **Tertiary structure:**
  - **Covalent bonds:**
  - **Hydrogen bonding:**
  - **Salt bridges:**
  - **Metallic ion coordination:**
  - **Hydrophobic interactions:**
- **Quaternary structure:**



Sickle Cell Anemia







Genetic Modification

galacturonase gene

DNA

5'-GTGTGTGT-3'
3'...**CACACACA**-5'

transcription

5'-**GUGUGUGU**-3'

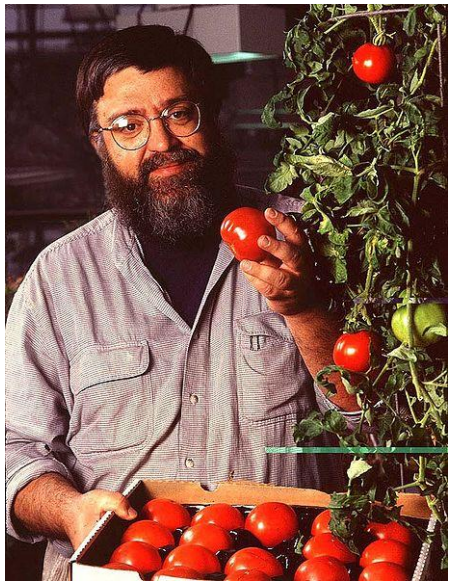
antisense gene

5'-**GTGTGTGT**...-3'
3'-CACACACA-5'

DNA

transcription

3'-**CACACACA**-5'

5'-**GUGUGUGU**-3'
3'-**CACACACA**-5'

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