



Biological and Bioorganic Chemistry

Some useful material

Kharkov V. N. Karazin National University
Institute for Chemistry

Department of Physical Organic Chemistry

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Teaching



Biological and Bioorganic Chemistry (Faculty of Medicine)

Lecturer: Dr. Denis Svechikarev

A semester-long introduction to organic, bioorganic and biological chemistry for first-year foreign students of the Faculty of Medicine is fully taught in English. The course comprises a small series of lectures, 10 seminars and 5 practice sessions and gives 2 credits according to ECTS.

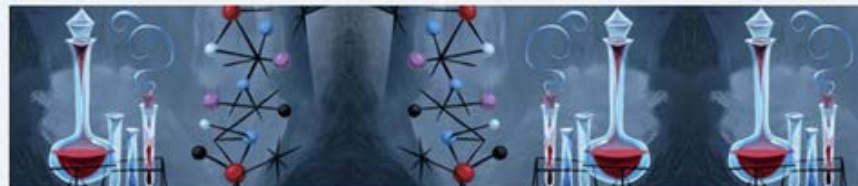
- [Lectures download \[PPT\]](#)
- [Material for seminars download \[PDF\]](#)
- [Calendar working plan \[PDF\]](#)
- [Rules and grading criteria for students \[PDF\]](#)

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will be announced ...

What shall we do?



Feb 19

Introduction to organic and biological chemistry. Classes and nomenclature of organic compounds. Saturated and unsaturated hydrocarbons. S_R and Ad_E reactions.

Mar 4

Aromatic hydrocarbons. Orientation in the aromatic ring. Halogen derivatives of hydrocarbons. S_N reactions. Alcohols, ethers. Polyhydric alcohols.

Mar 18

Carbonyl compounds – aldehydes and ketones. Carbohydrates.

Apr 1

Carboxylic acids and their derivatives: amides, nitriles, anhydrides. Esters, fats, lipids.

Apr 15

Amines, aminoacids, peptides. Heterocyclic compounds and their biological activity.

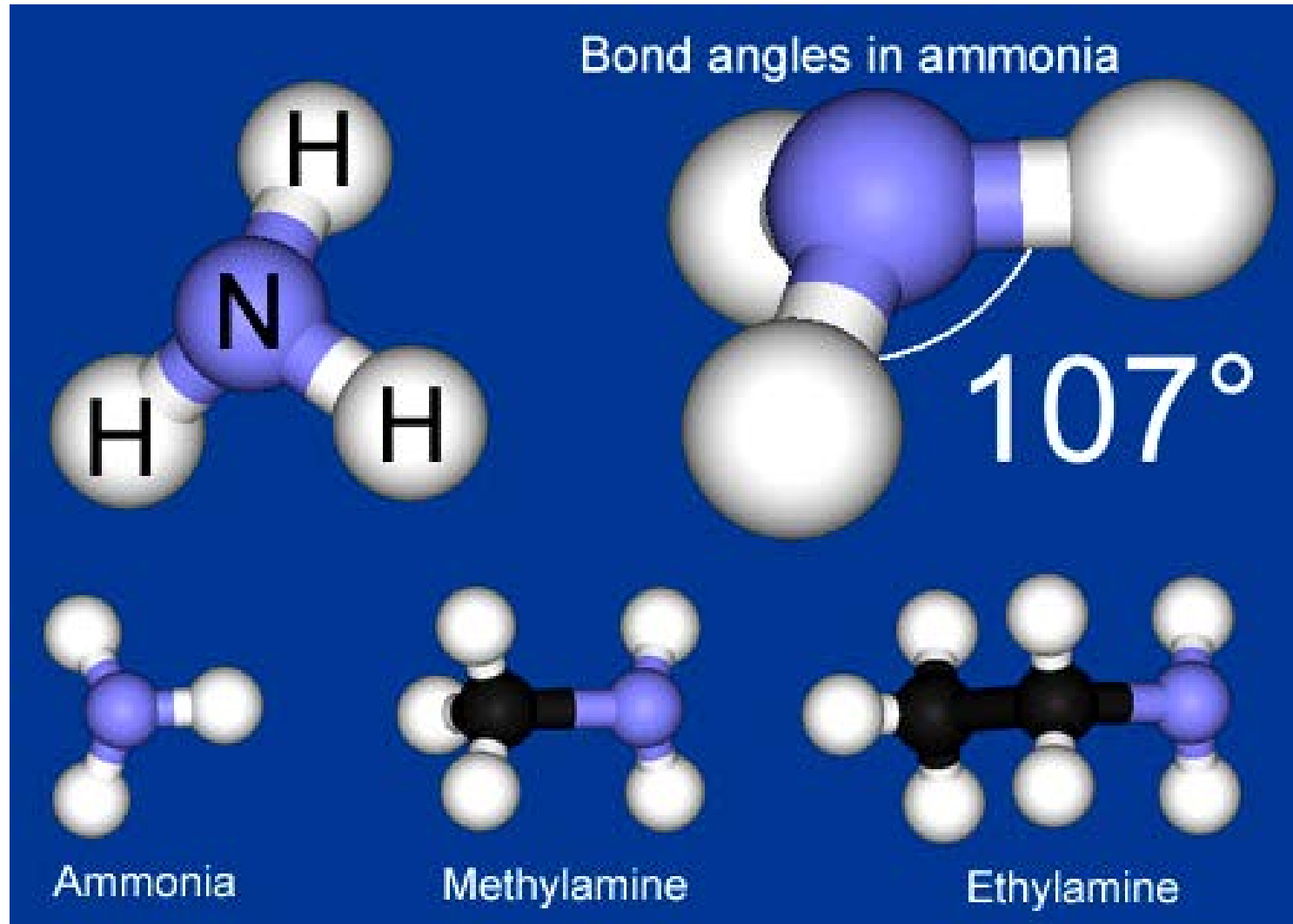


Amines

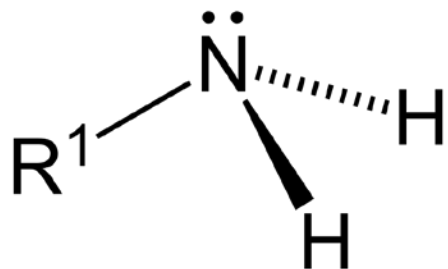
polar



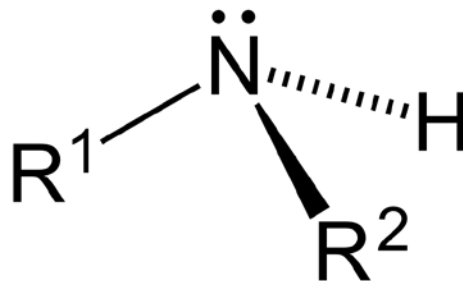
The amino group



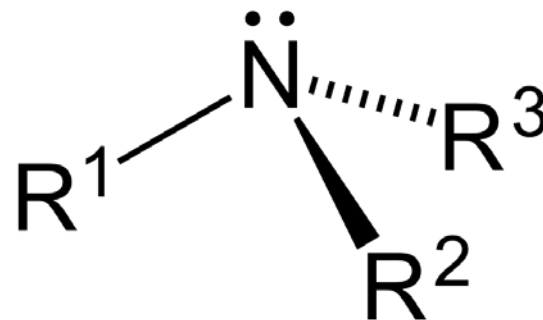
Amines classification



Primary amine



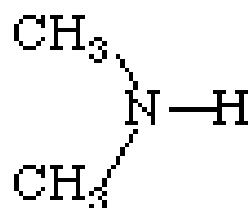
Secondary amine



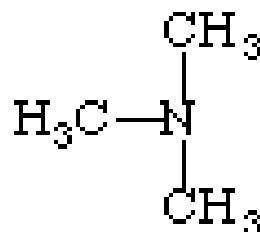
Tertiary amine

Amines are organic compounds and functional groups that contain a basic nitrogen atom with a lone electronic pair.

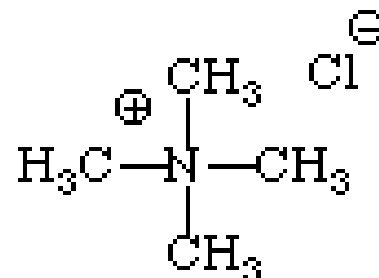
Amines classification



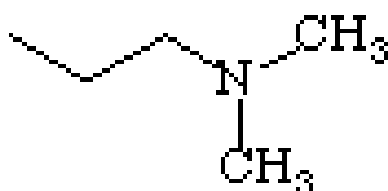
Secondary Amine



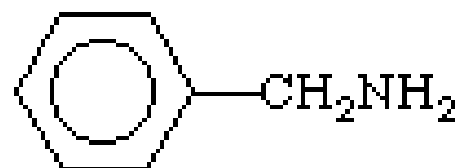
Tertiary Amine



**Quaternary Ammonium
Chloride**

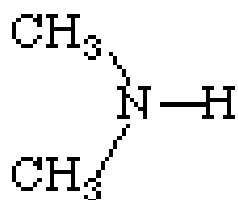


Secondary Amine

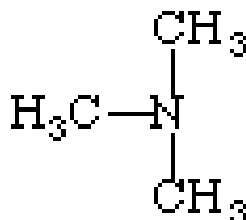


Primary Amine

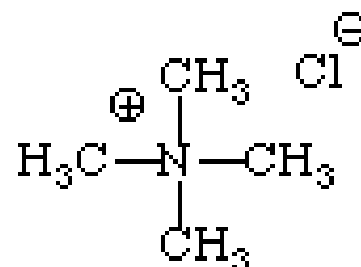
Naming aliphatic amines



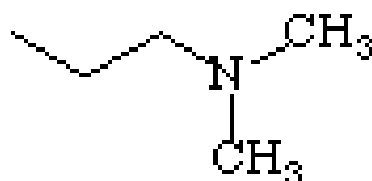
Dimethylamine



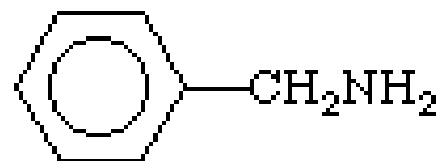
Trimethylamine



**Tetramethylammonium
Chloride**

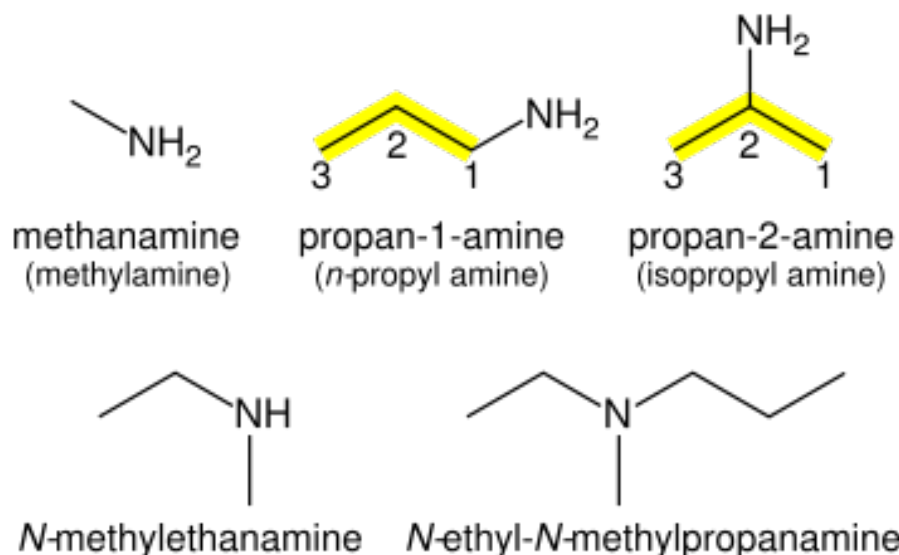


N,N-dimethylpropylamine



**Benzylamine
(phenylmethanamine)**

Naming aliphatic amines



Primary



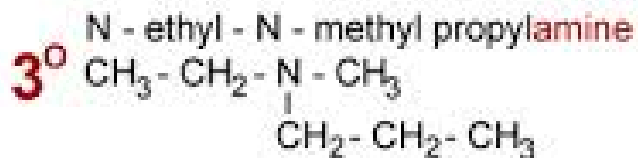
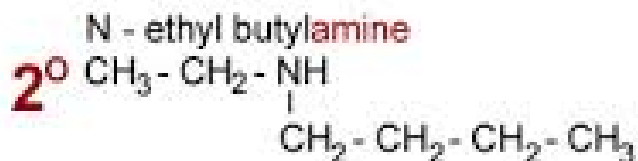
Secondary



Tertiary

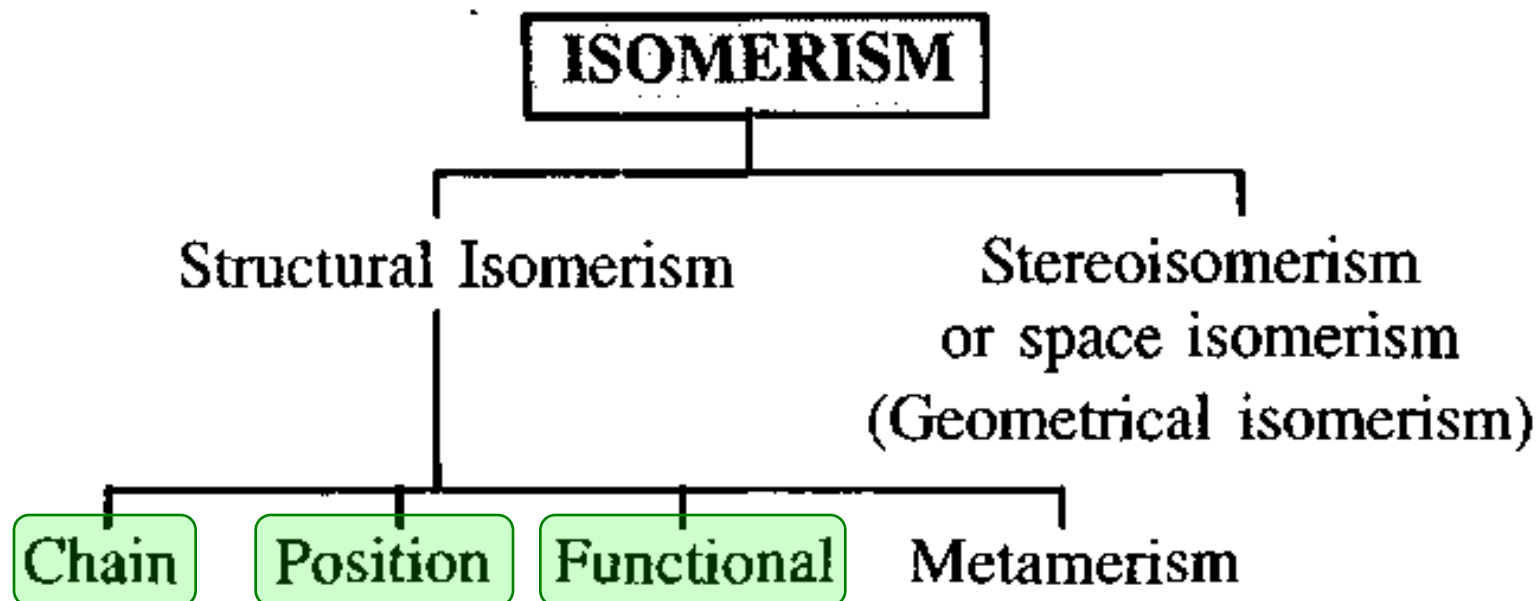


Naming amines...

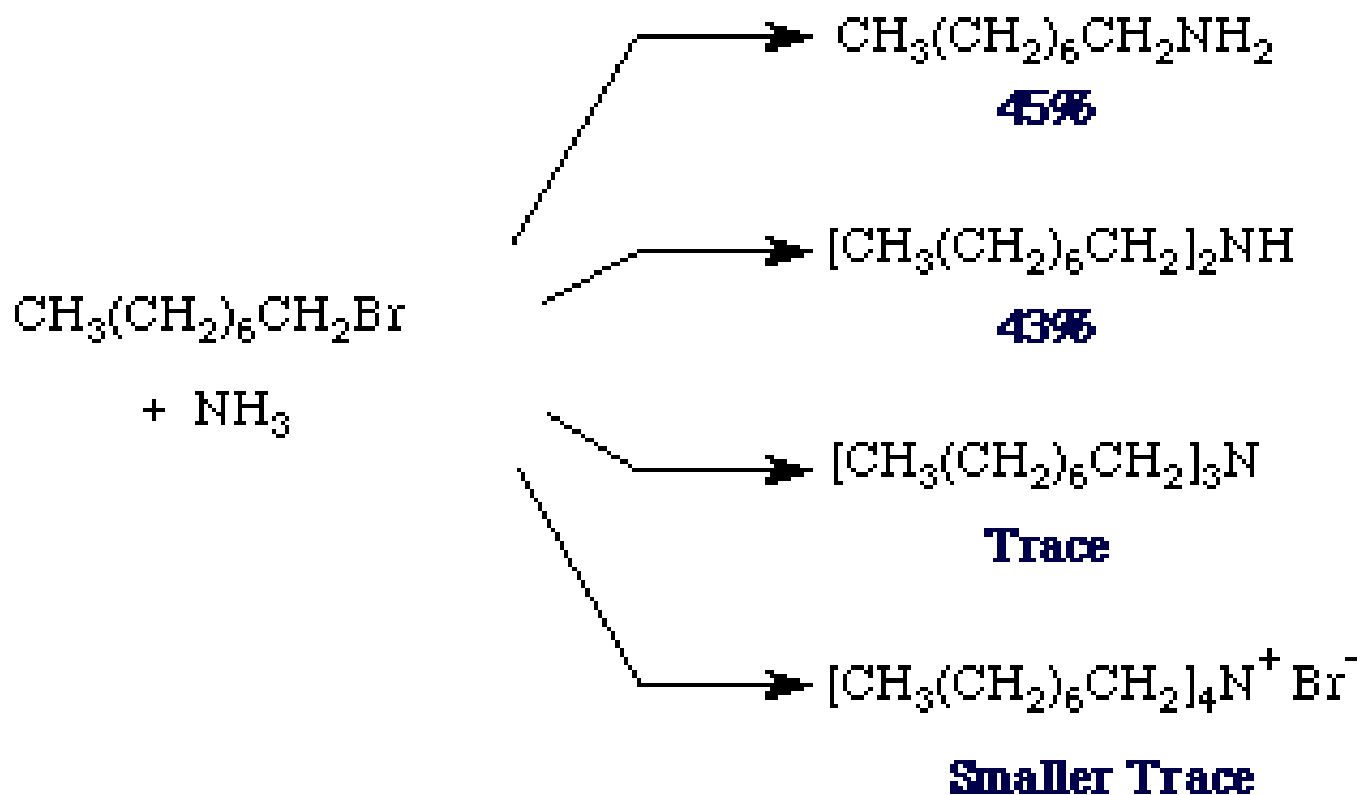


IUPAC nomenclature

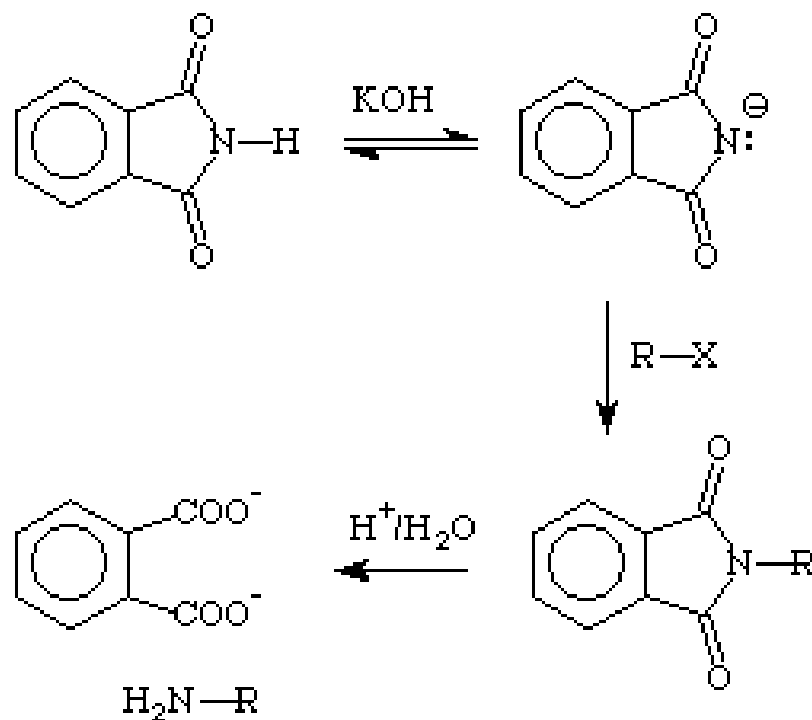
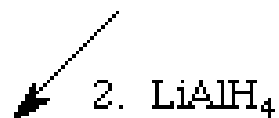
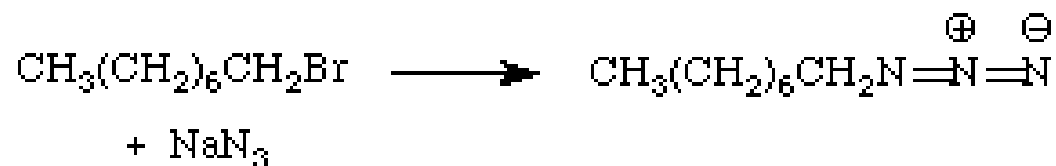
Isomerism of amines



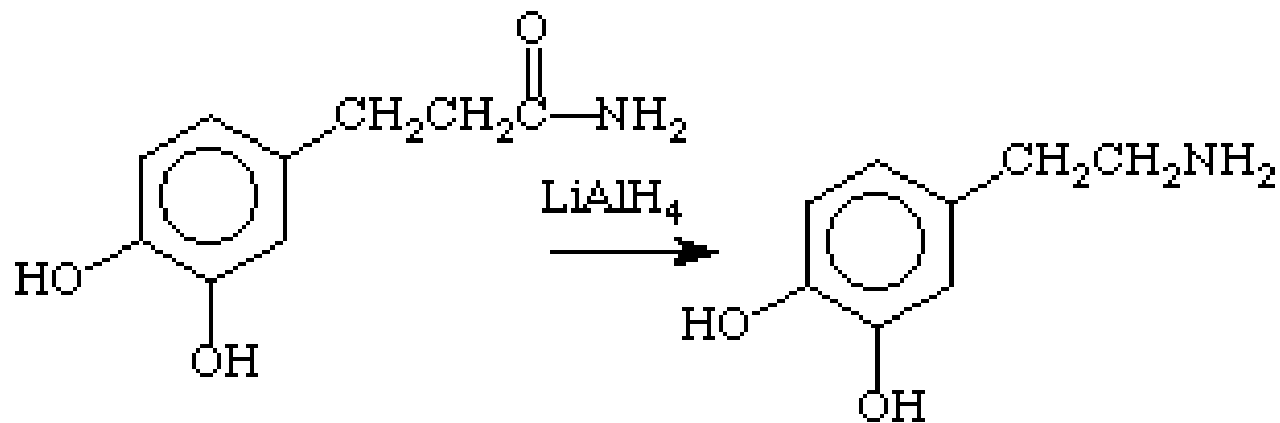
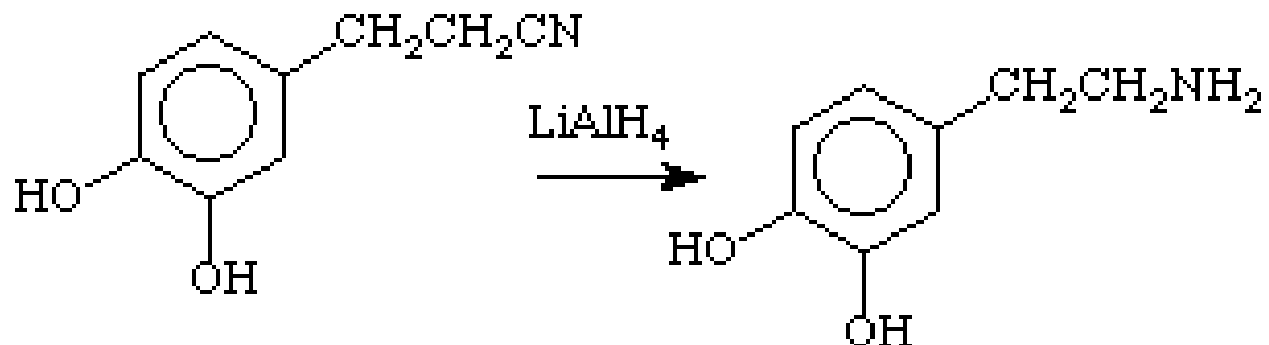
Synthesis of amines



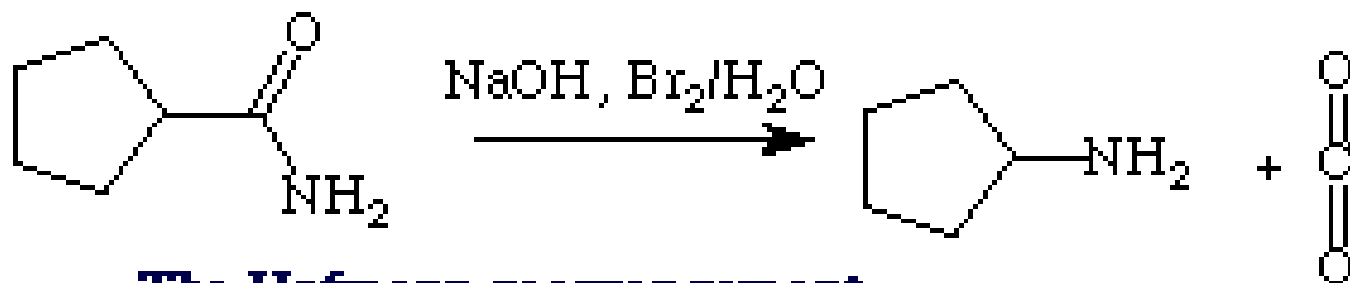
Synthesis of amines



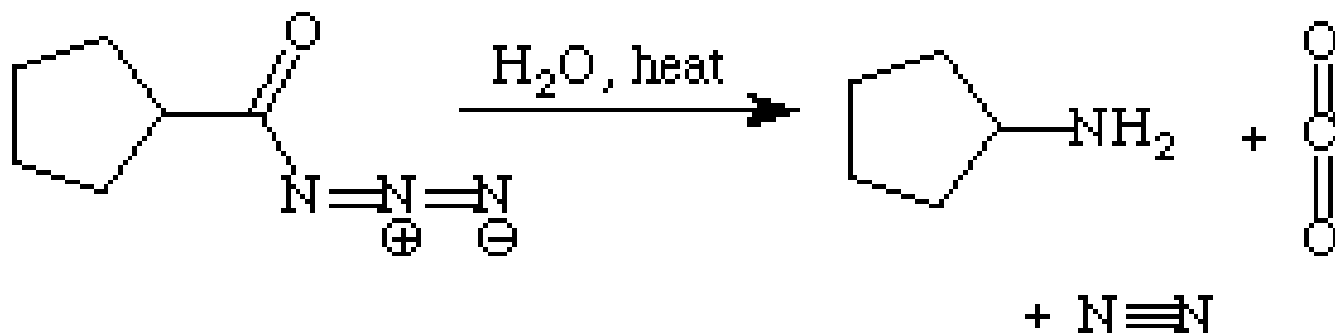
Synthesis of amines



Synthesis of amines

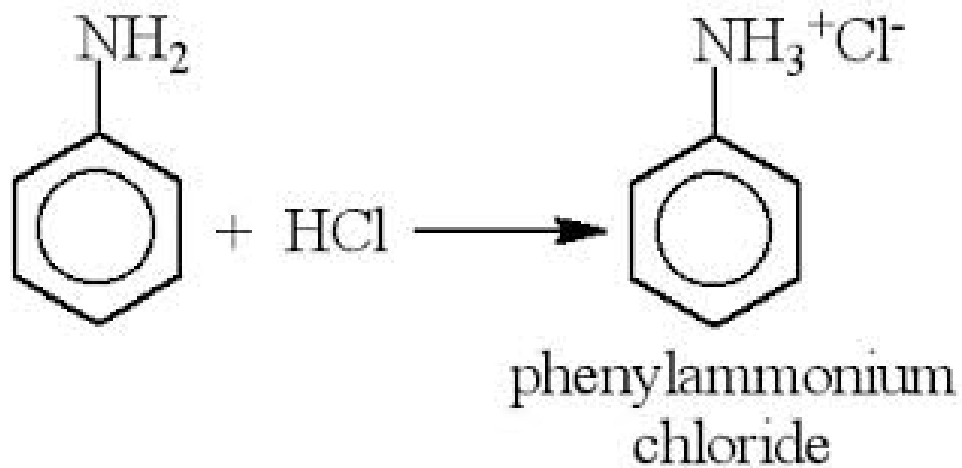


The Hofmann rearrangement...

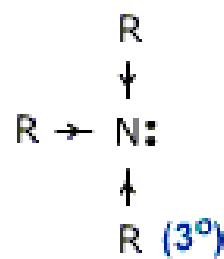
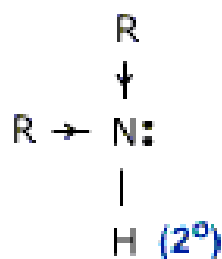
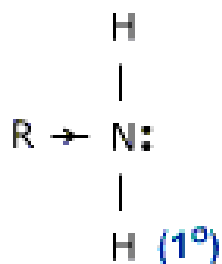


The Curtius rearrangement...

Basicity of amines

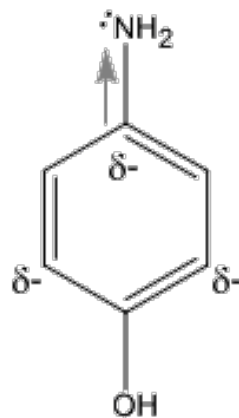


Basicity of amines



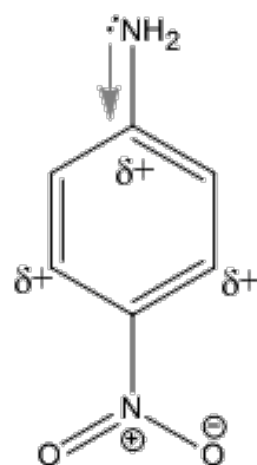
→ basic character increases

More basic



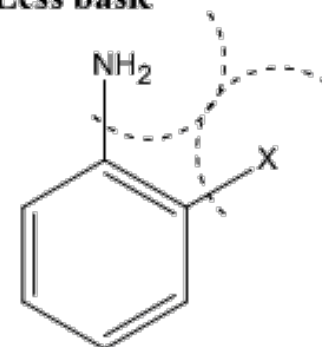
e^- donating group

Less basic



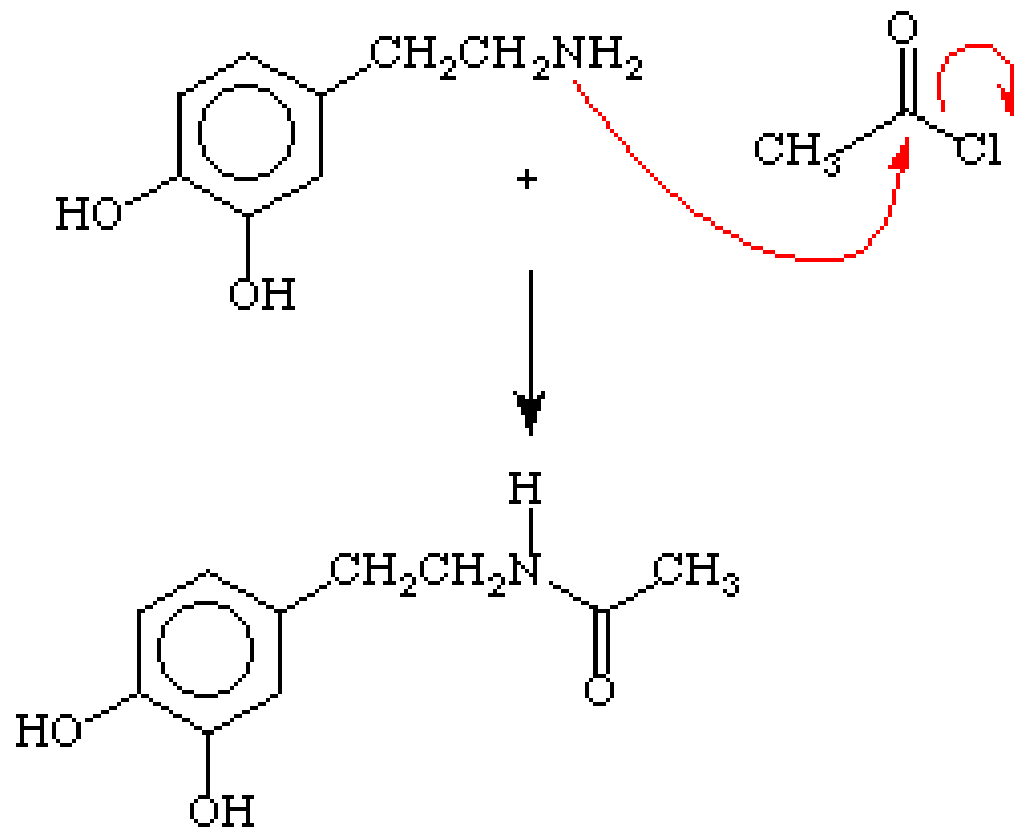
e^- withdrawing group

Less basic

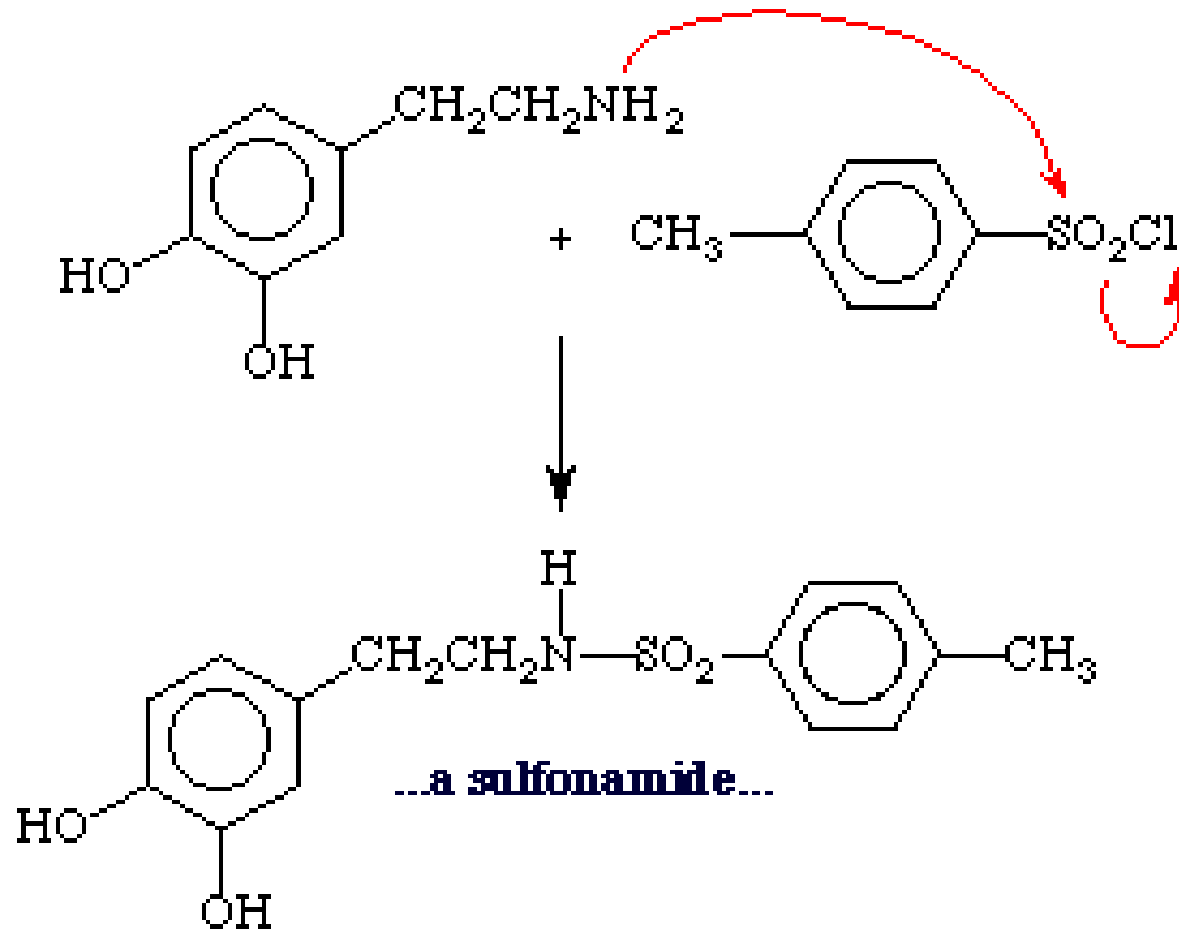


ortho effect

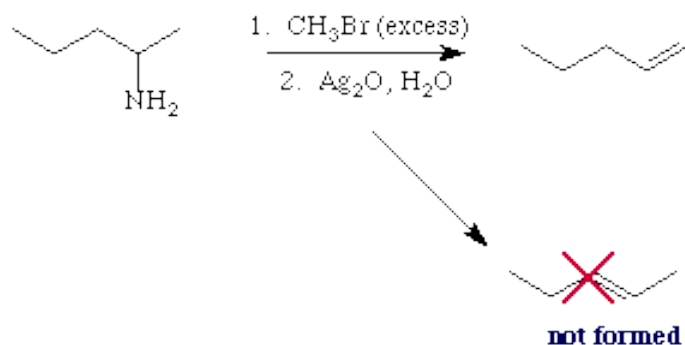
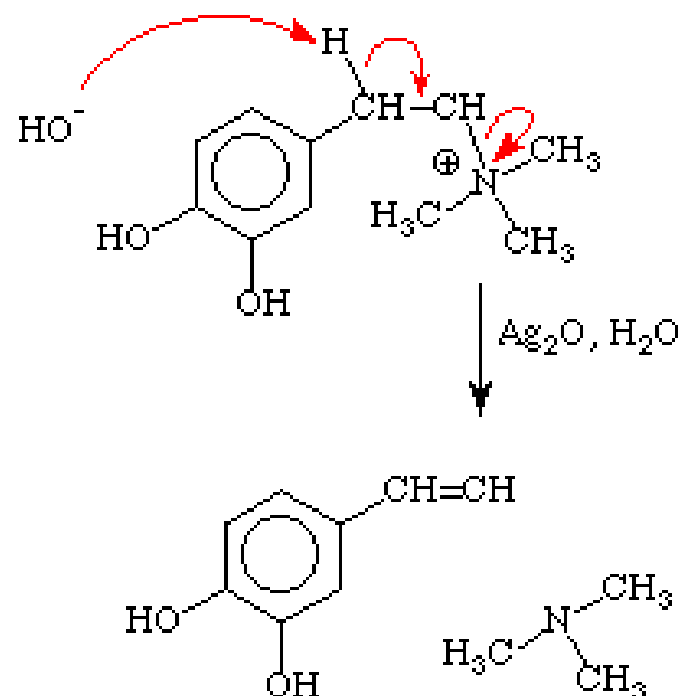
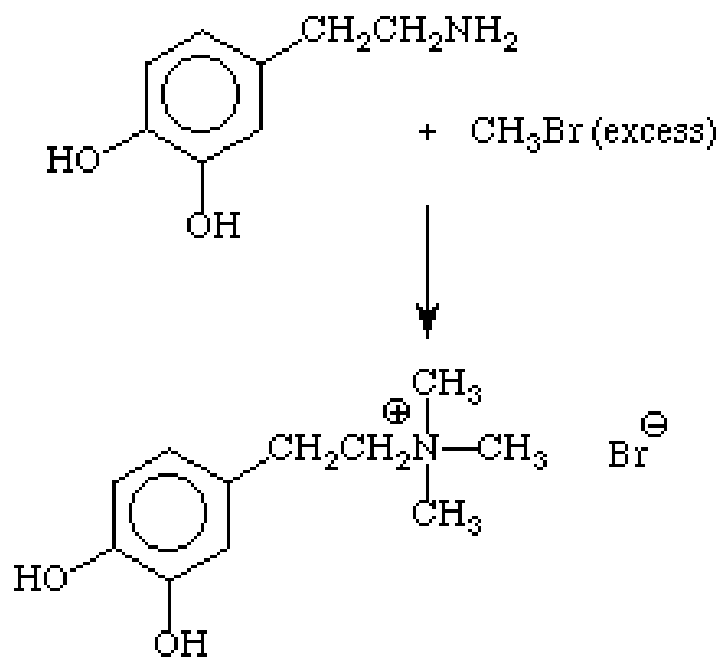
Reactions of amines



Reactions of amines



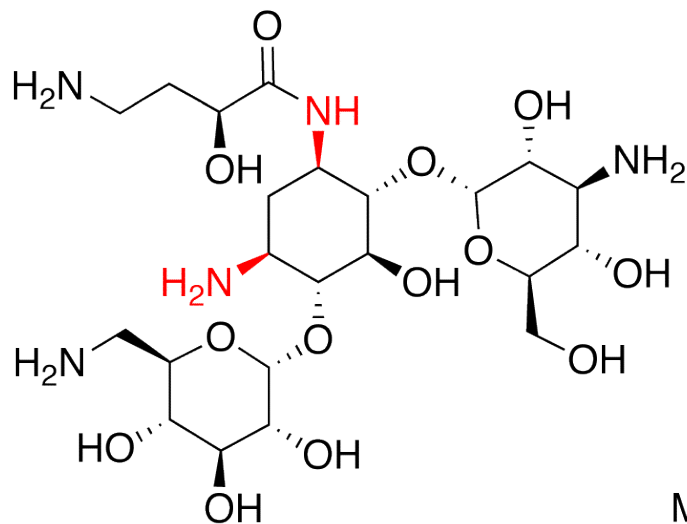
Reactions of amines



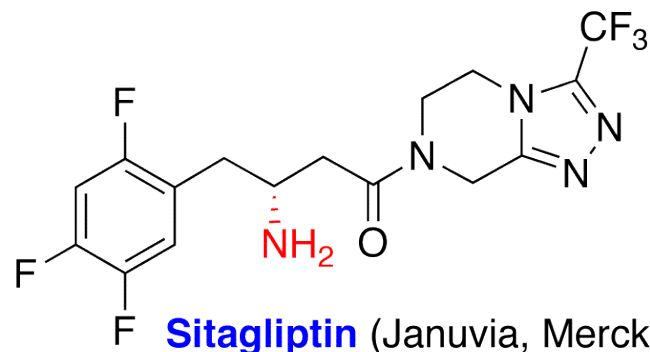
Hofmann elimination

Biologically active amines

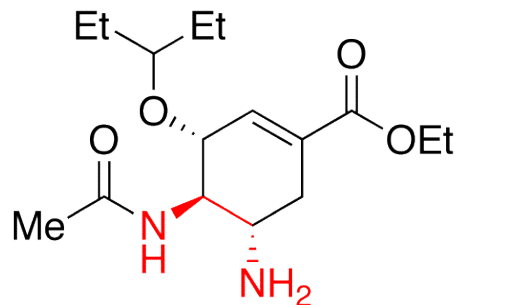
Examples of Pharmaceuticals Containing α -Chiral Amines



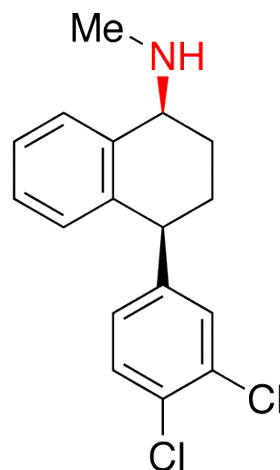
Amikacin (Amikin, BMS)
antibiotic



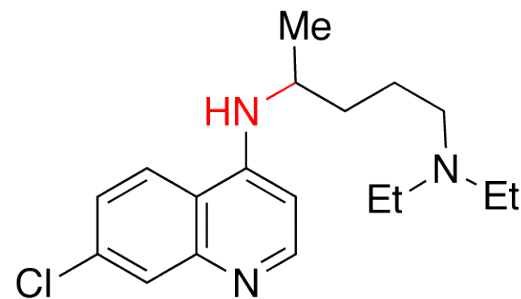
Sitagliptin (Januvia, Merck)
type 2 diabetes



Oseltamivir (Tamiflu, Gilead)
anti-viral



Sertraline (Zoloft, Pfizer)
Serotonin Reuptake Inhibitor

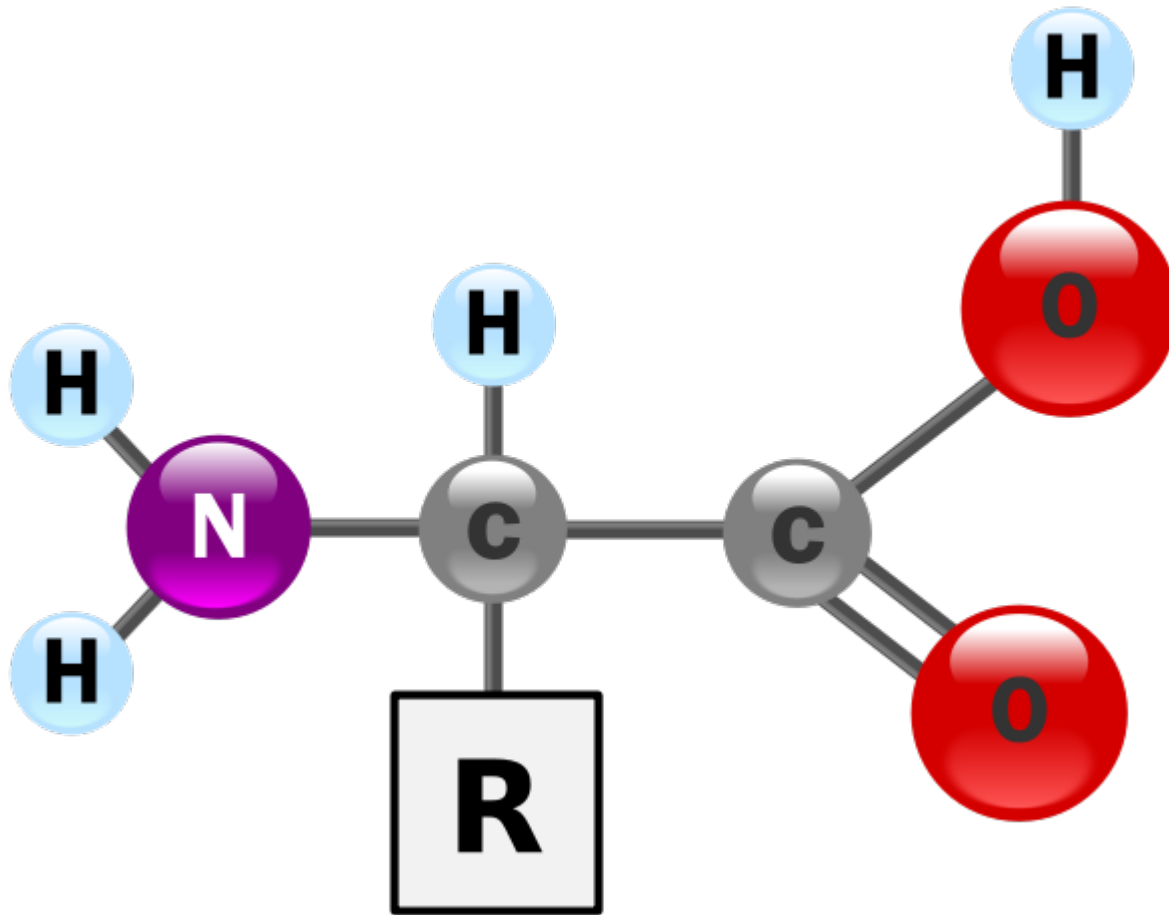


Chloroquine (Aralen)
anti-malarial

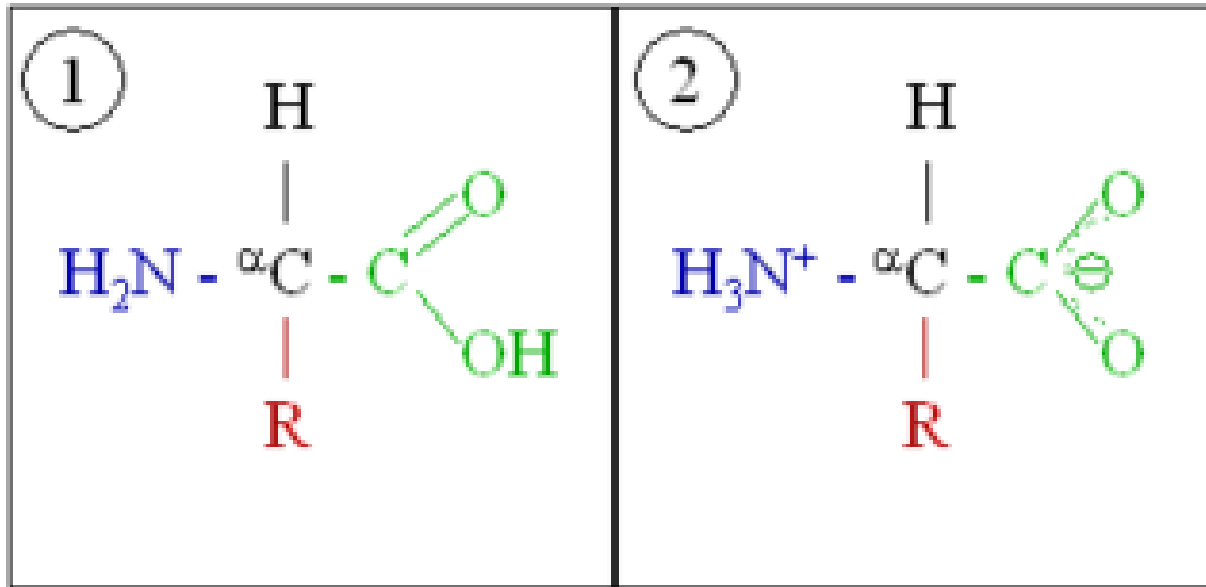
A 3D molecular model of a protein structure is shown against a black background. The protein is composed of several distinct regions, each rendered in a different color: a large pink/red region at the top left, a blue region at the top center, a green region at the top right, a yellow region in the center, and a light blue region at the bottom left. The protein backbone is represented by thin lines, and the side chains are shown as small spheres. A semi-transparent white rectangular box with rounded corners is centered over the protein, containing the text "Amino acids and peptides" in a bold, black, sans-serif font.

**Amino acids
and peptides**

Amino acids structure

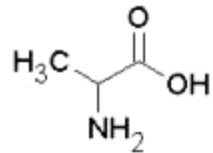


Amino acids structure

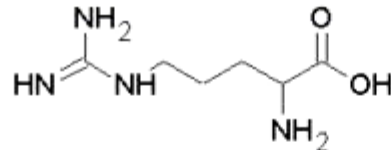


Unionized (1) and zwitterionic (2) structures of amino acids

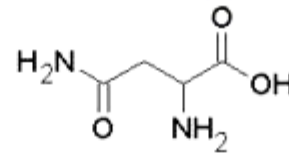
Standard amino acids



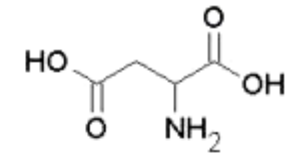
Alanin (Ala)



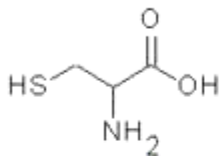
Arginin (Arg)



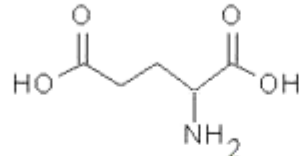
Asparagin (Asn)



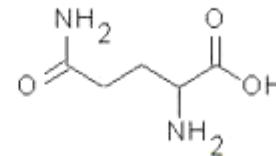
Asparaginsäure (Asp)



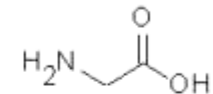
Cysteine (Cys)



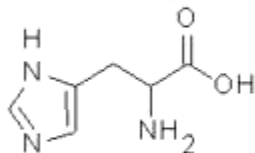
Glutaminsäure (Glu)



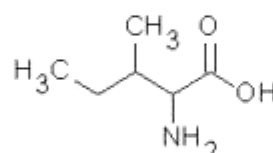
Glutamin (Gln)



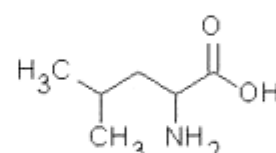
Glycin (Gly)



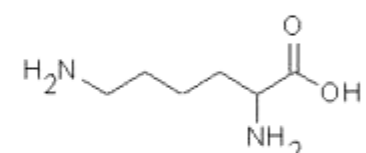
Histidin (His)



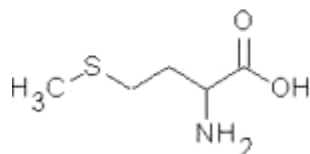
Isoleucin (Ile)



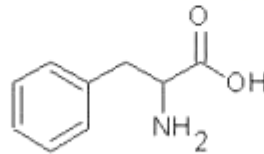
Leucin (Leu)



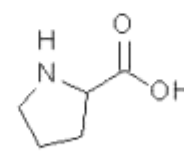
Lysin (Lys)



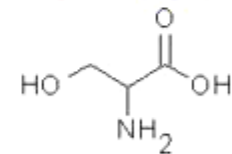
Methionin (Met)



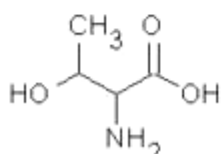
Phenylalanin (Phe)



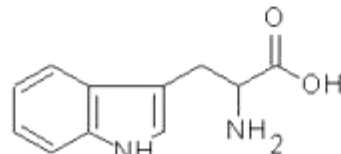
Prolin (Pro)



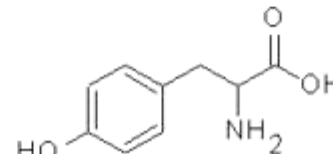
Serin (Ser)



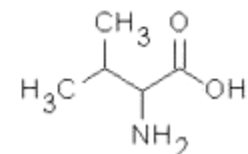
Threonin (Thr)



Tryptophan (Trp)

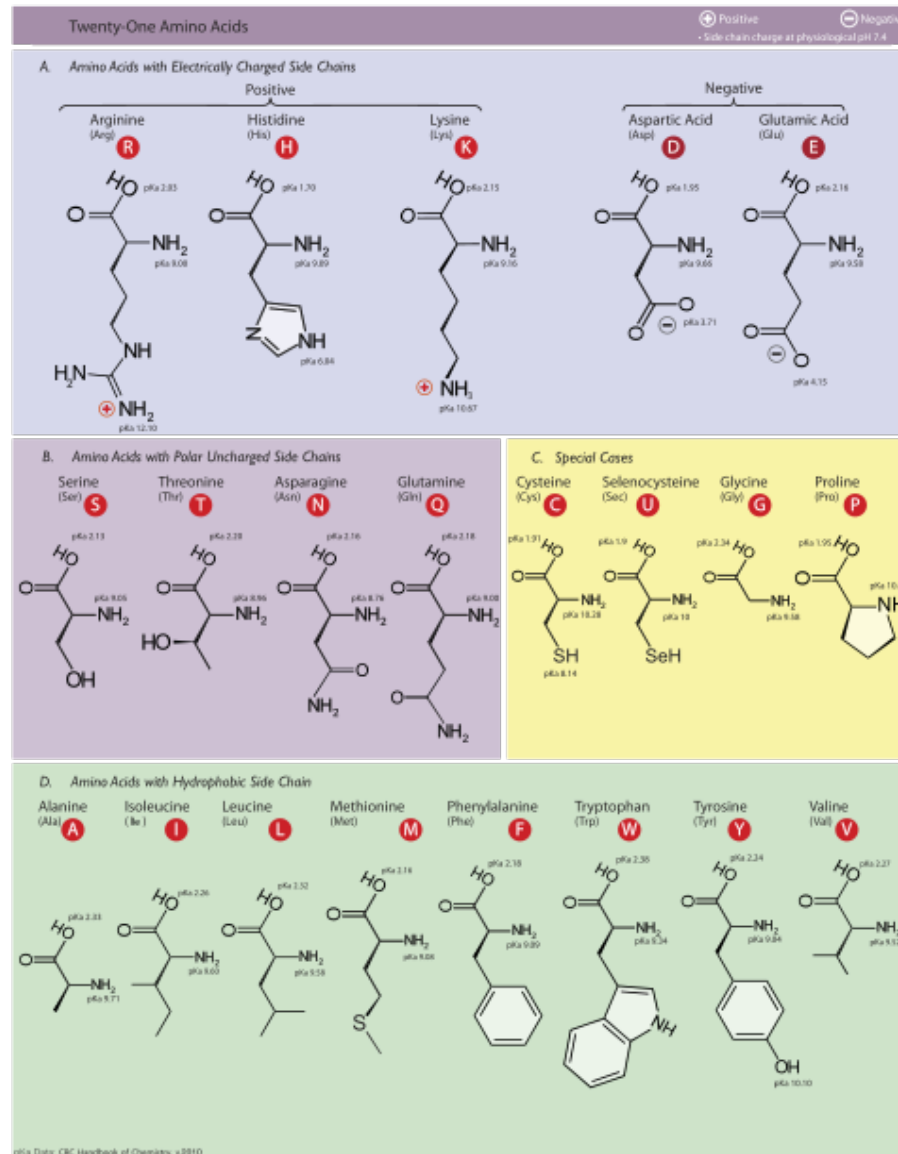


Tyrosin (Tyr)

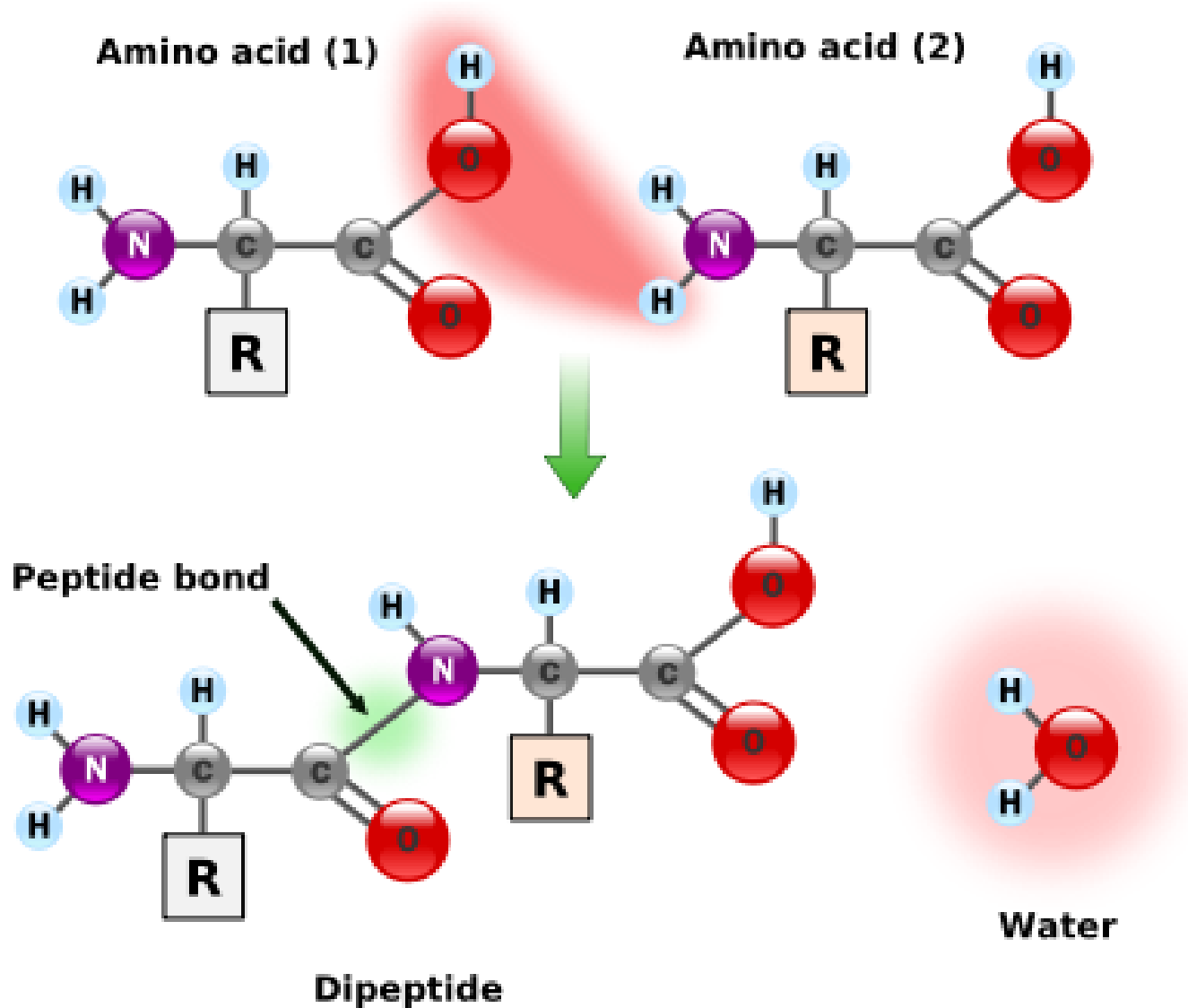


Valin (Val)

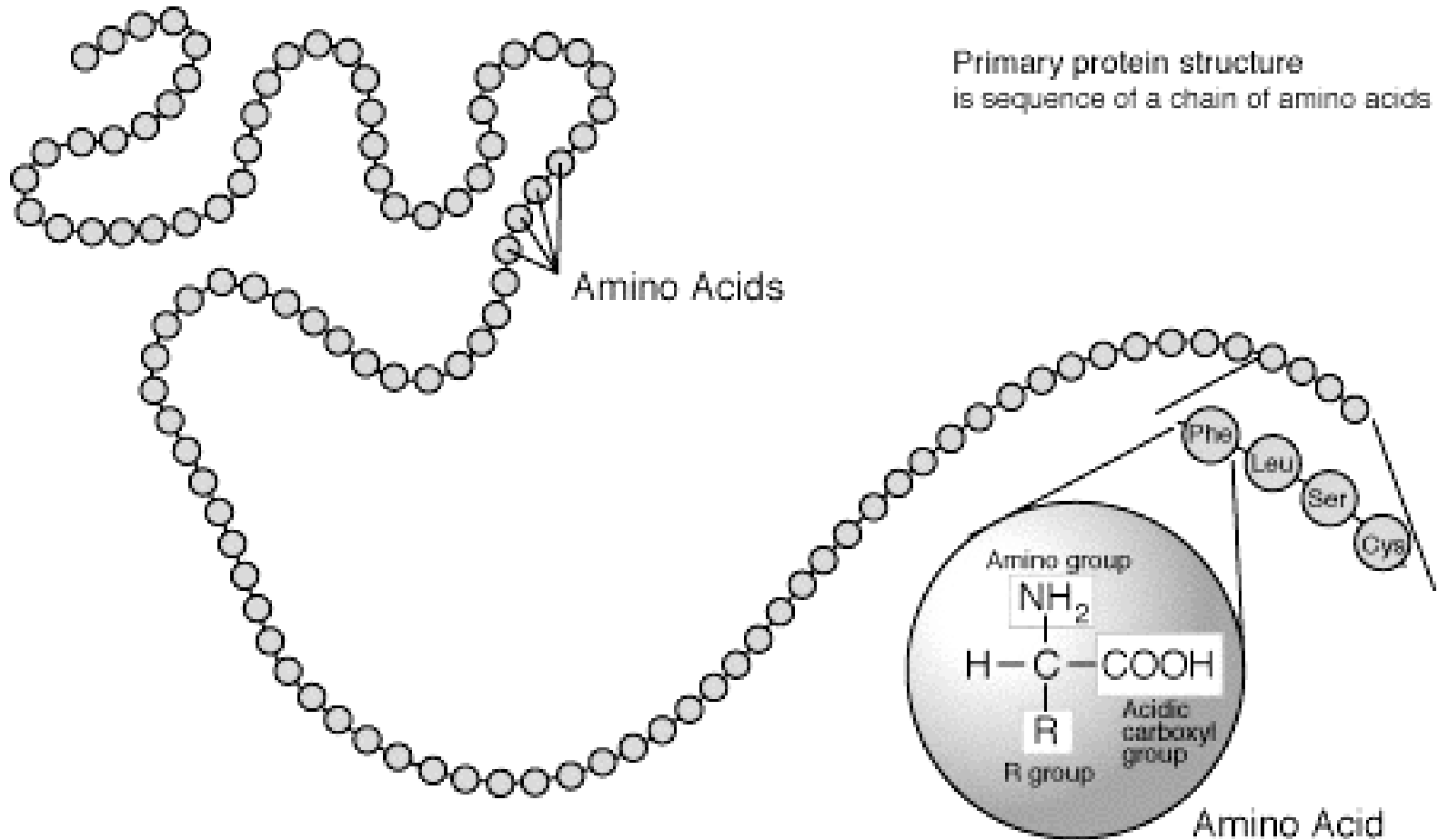
Standard amino acids



Peptide bond formation

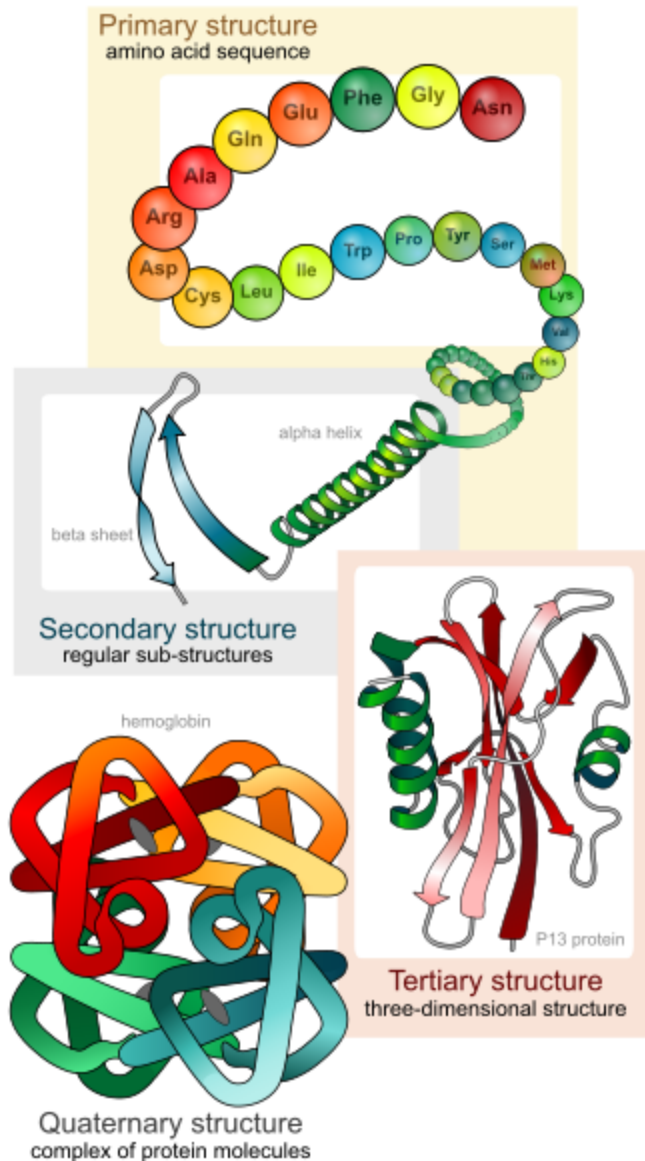


Polypeptides



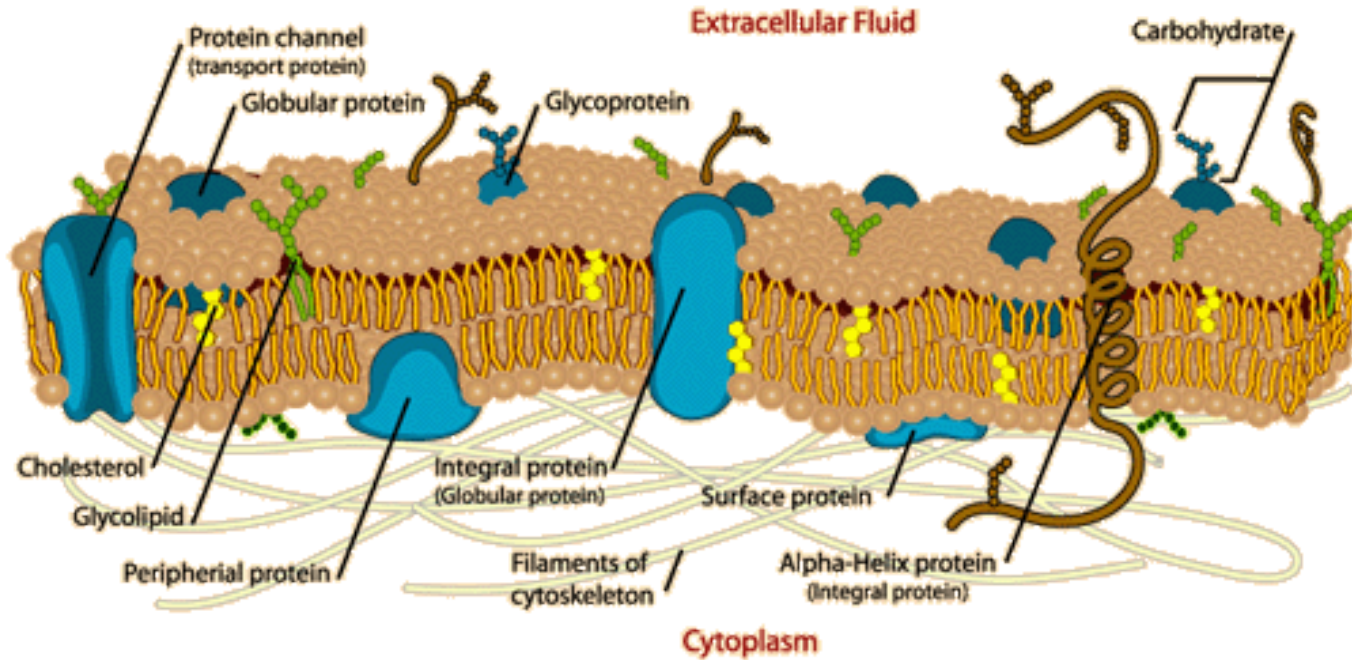
Peptides - are short chains of [amino acid monomers](#) (< 20) linked by [peptide \(amide\)](#) bonds

Polypeptides and proteins



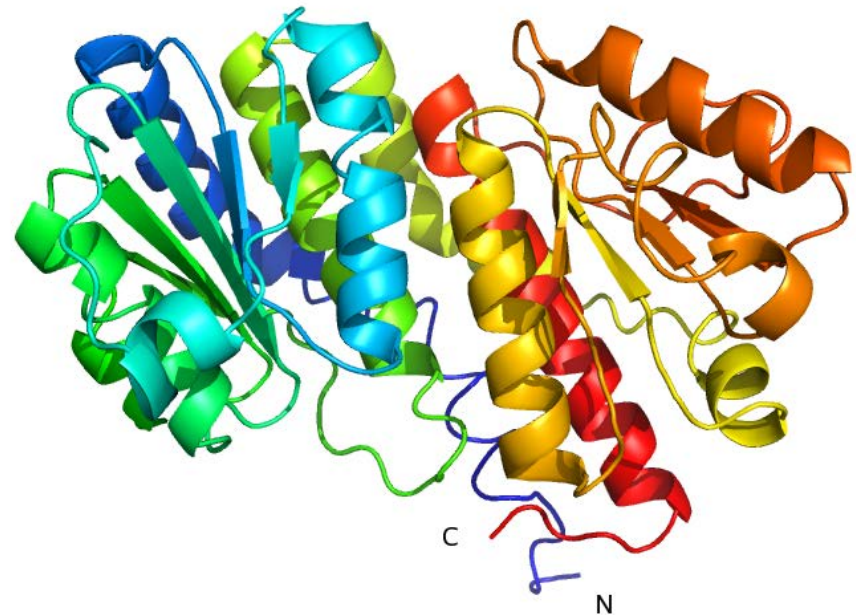
Like other biological macromolecules such as polysaccharides and nucleic acids, proteins are essential parts of organisms and participate in virtually every process within cells. Many proteins are enzymes that catalyze biochemical reactions and are vital to metabolism. Proteins also have structural or mechanical functions, such as actin and myosin in muscle and the proteins in the cytoskeleton, which form a system of scaffolding that maintains cell shape. Other proteins are important in cell signaling, immune responses, cell adhesion, and the cell cycle. Proteins are also necessary in animals' diets, since animals cannot synthesize all the amino acids they need and must obtain essential amino acids from food. Through the process of digestion, animals break down ingested protein into free amino acids that are then used in metabolism.

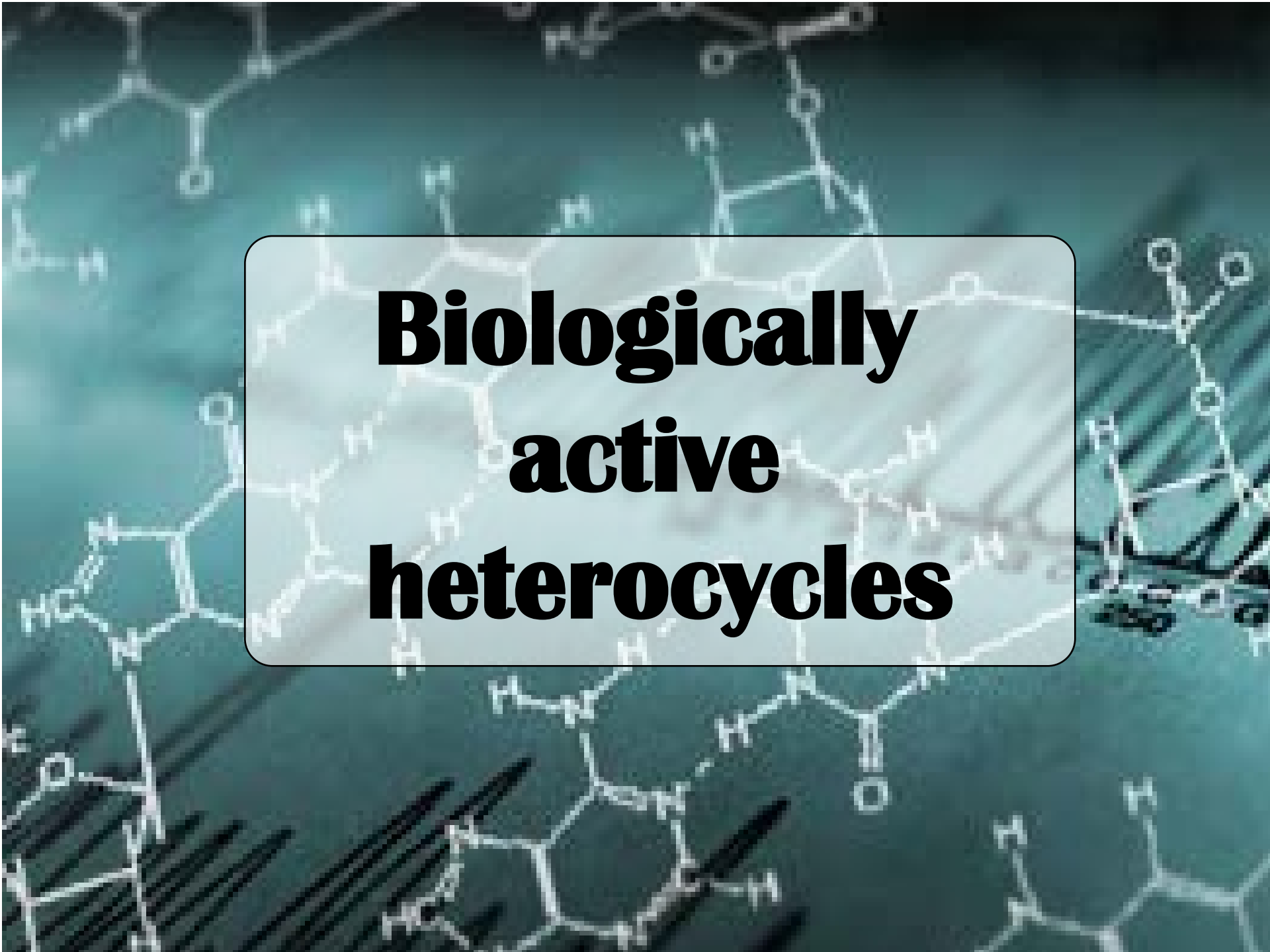
Cell Membrane



Proteins

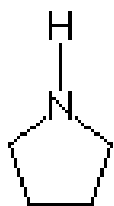
Proteins - are large [biological molecules](#), or [macromolecules](#), consisting of one or more chains of [amino acid](#) residues.



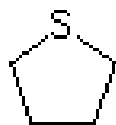
The background of the slide is a dark teal color with a pattern of white chemical structures, including various rings and chains, representing heterocyclic compounds.

**Biologically
active
heterocycles**

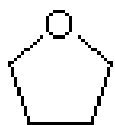
Carboxylic acids derivatives



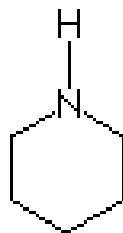
Pyrrolidine



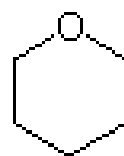
Tetrahydrothiophene



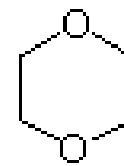
Tetrahydrofuran



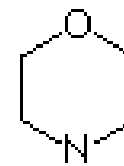
Piperidine



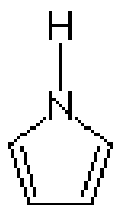
Pyran



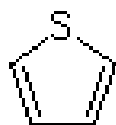
Dioxan



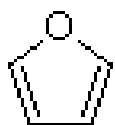
Morpholine



Pyrrole



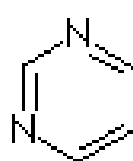
Thiophene



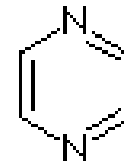
Furan



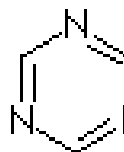
Pyridine



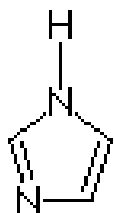
Pyrimidine



Pyrazine



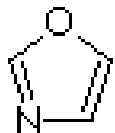
Triazine



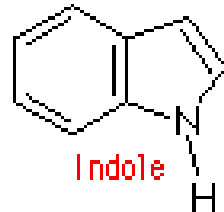
Imidazole



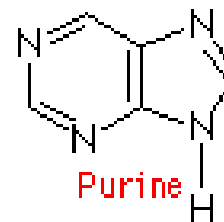
Thiazole



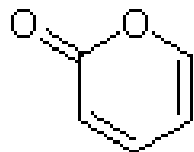
Oxazole



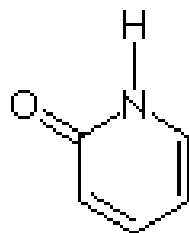
Indole



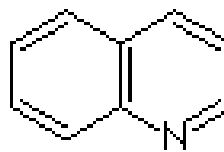
Purine



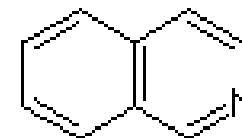
Pyrone



Pyridone

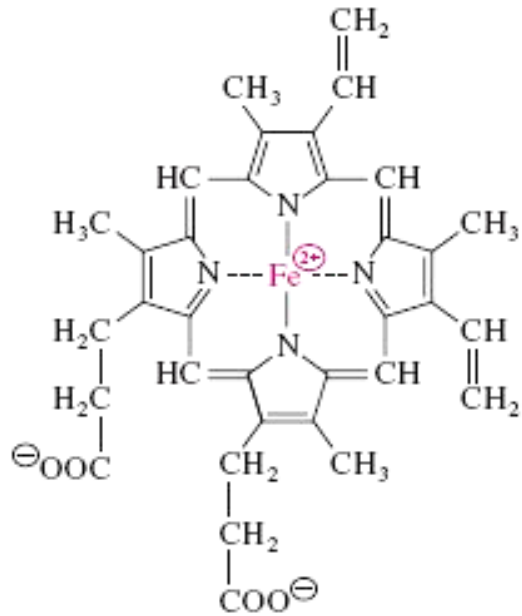


Quinoline



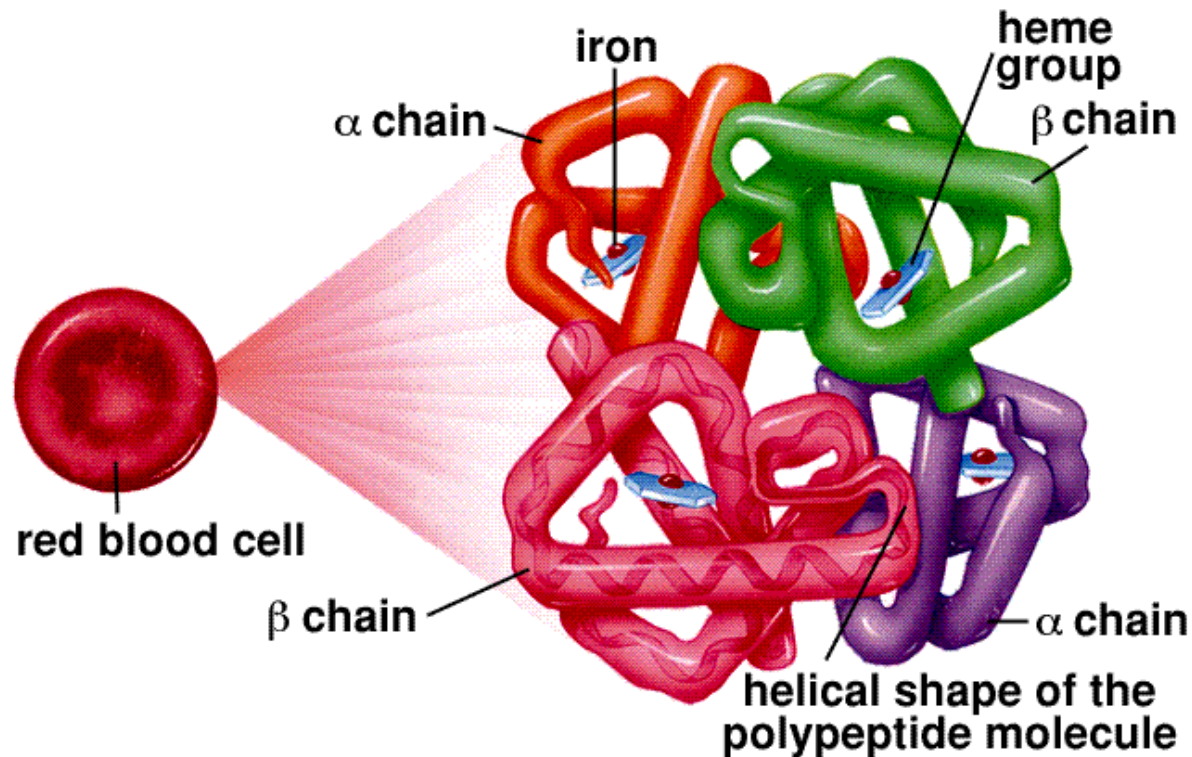
Isoquinoline

Pyrrole derivatives - porphyrins

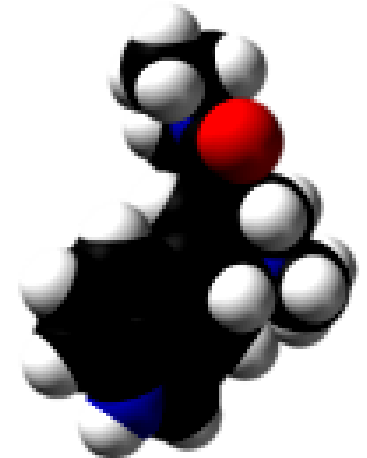
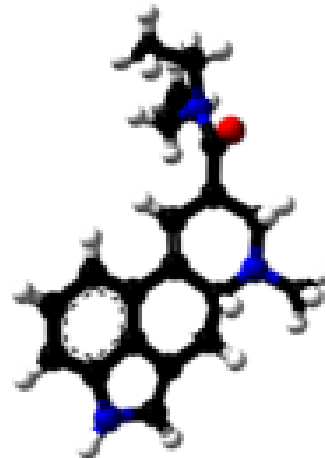
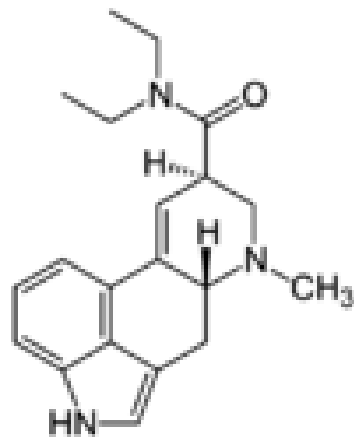
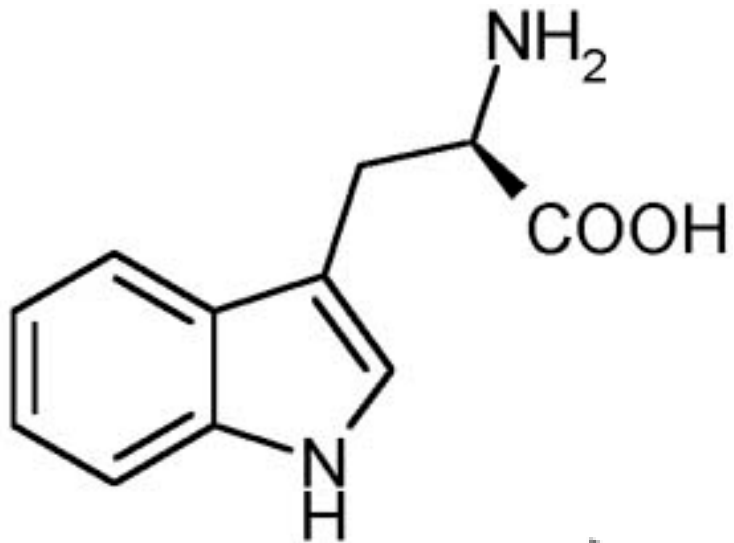


Chemical structure of the Fe(II)-protoporphyrin IX heme group in myoglobin and hemoglobin.

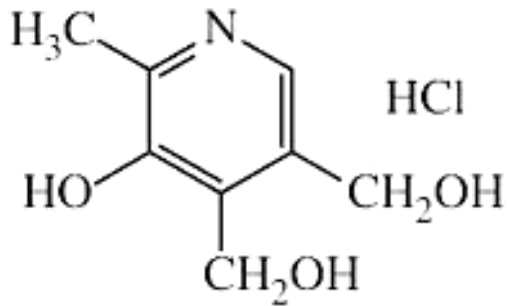
Hemoglobin Molecule



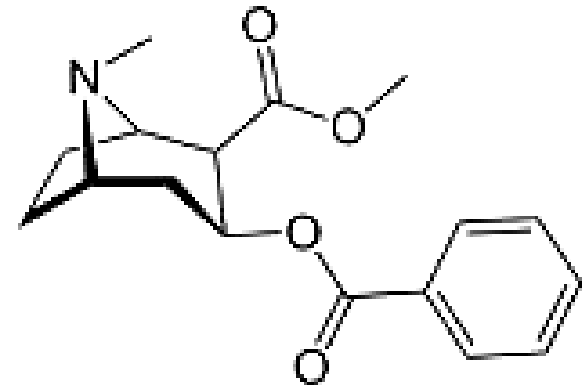
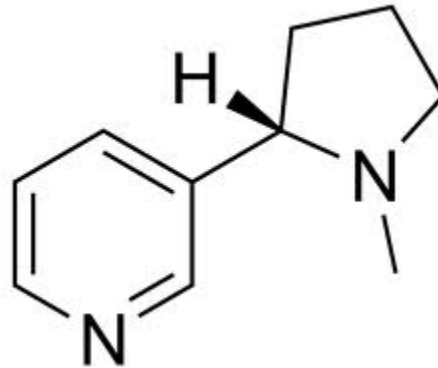
Indole derivatives – tryptophan and LSD



Pyridine derivatives – vitamin B6, nicotine, cocaine

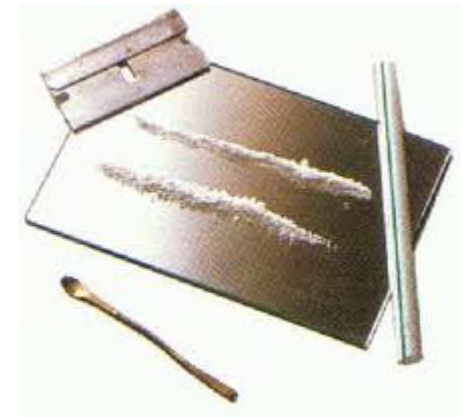


PYRIDOXINE

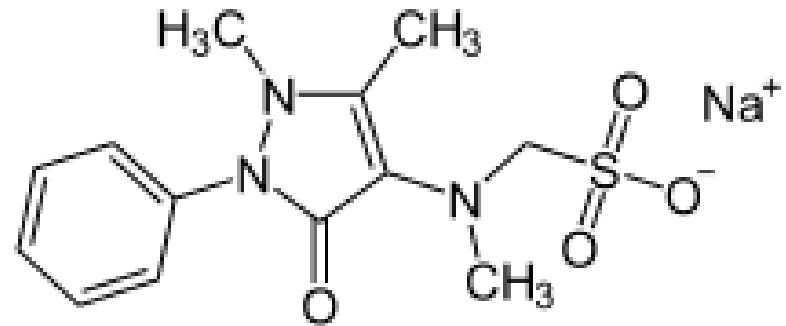
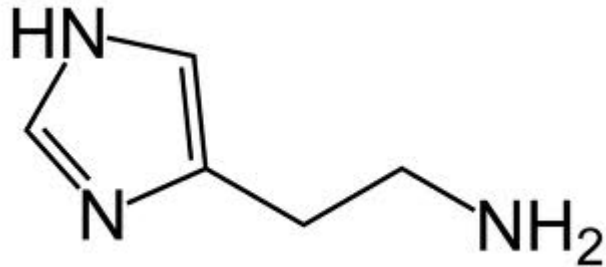


Vitamin **B6**

Food sources of vitamin B6 (pyridoxine) include beans, legumes, nuts, eggs, meats, fish breads and cereals

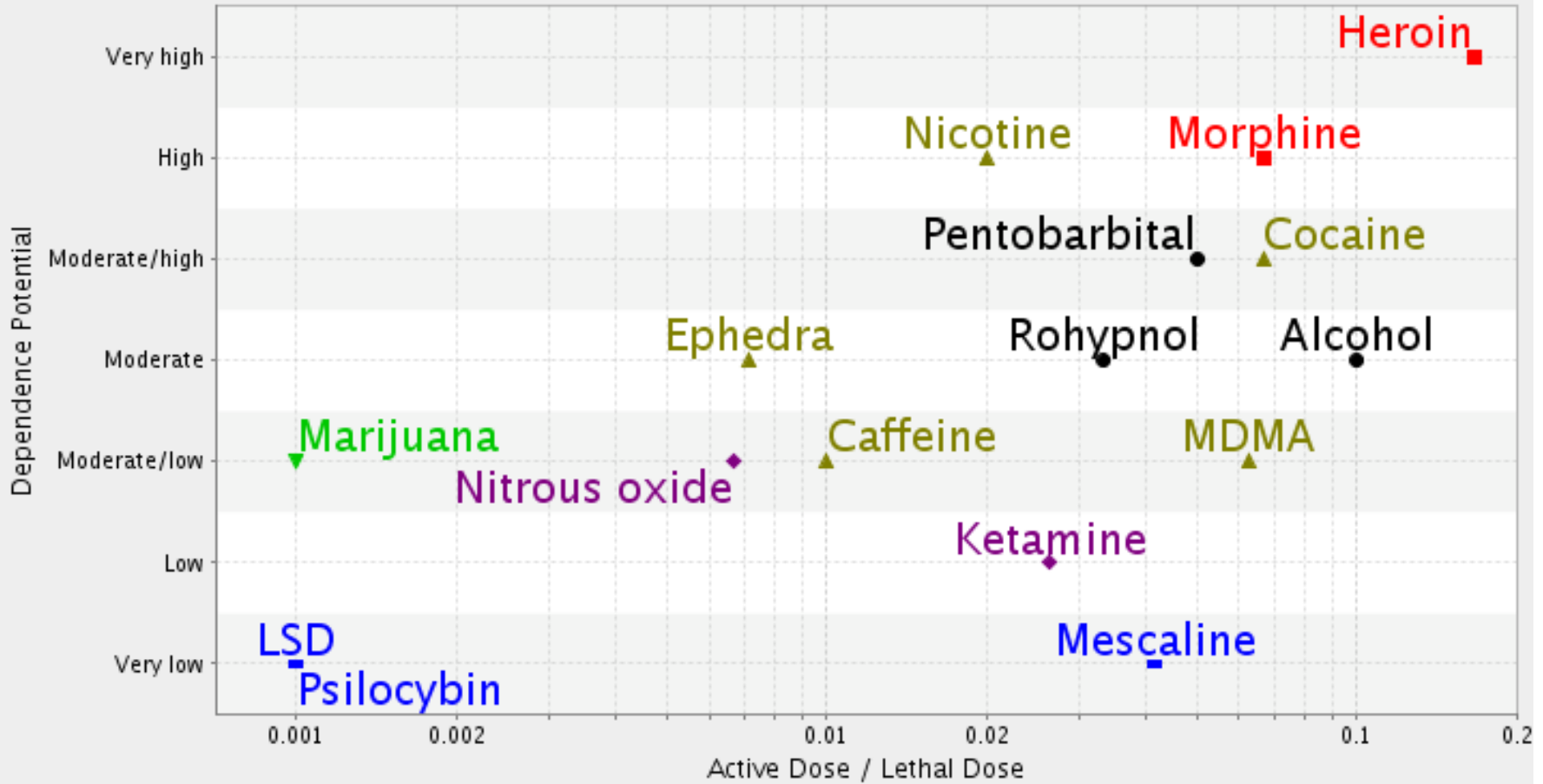


Imidazole and pyrazole derivatives – histamine, analgin



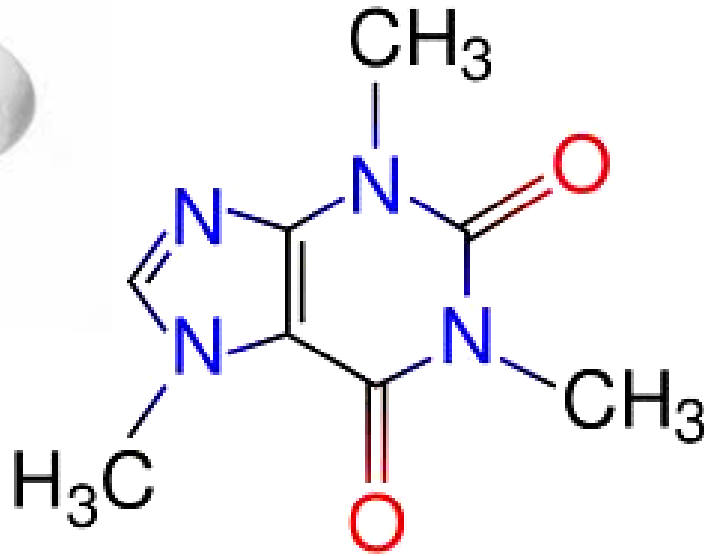
Drugs activity and danger

Active/Lethal Dose Ratio and Dependence Potential of Psychoactive Drugs



- Narcotics
- Depressants
- ▲ Stimulants
- ◆ Anesthetics
- Hallucinogens
- ▼ Cannabis

Caffeine – an everyday narcotic

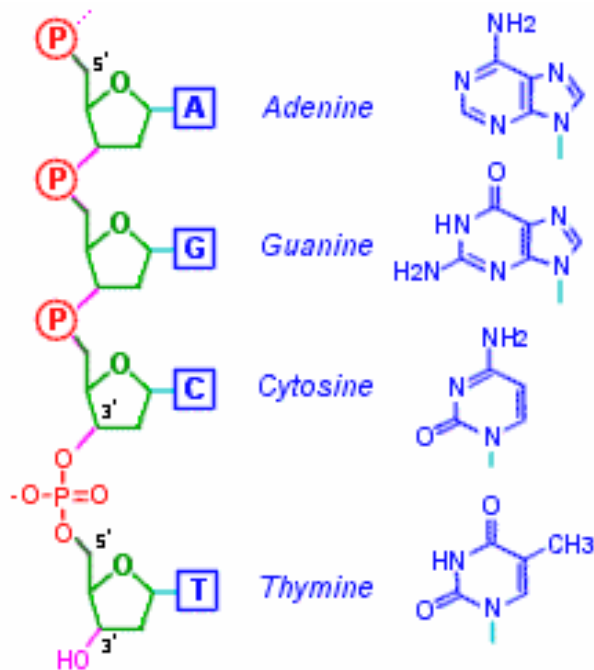


I've gotta cut back on the caffeine



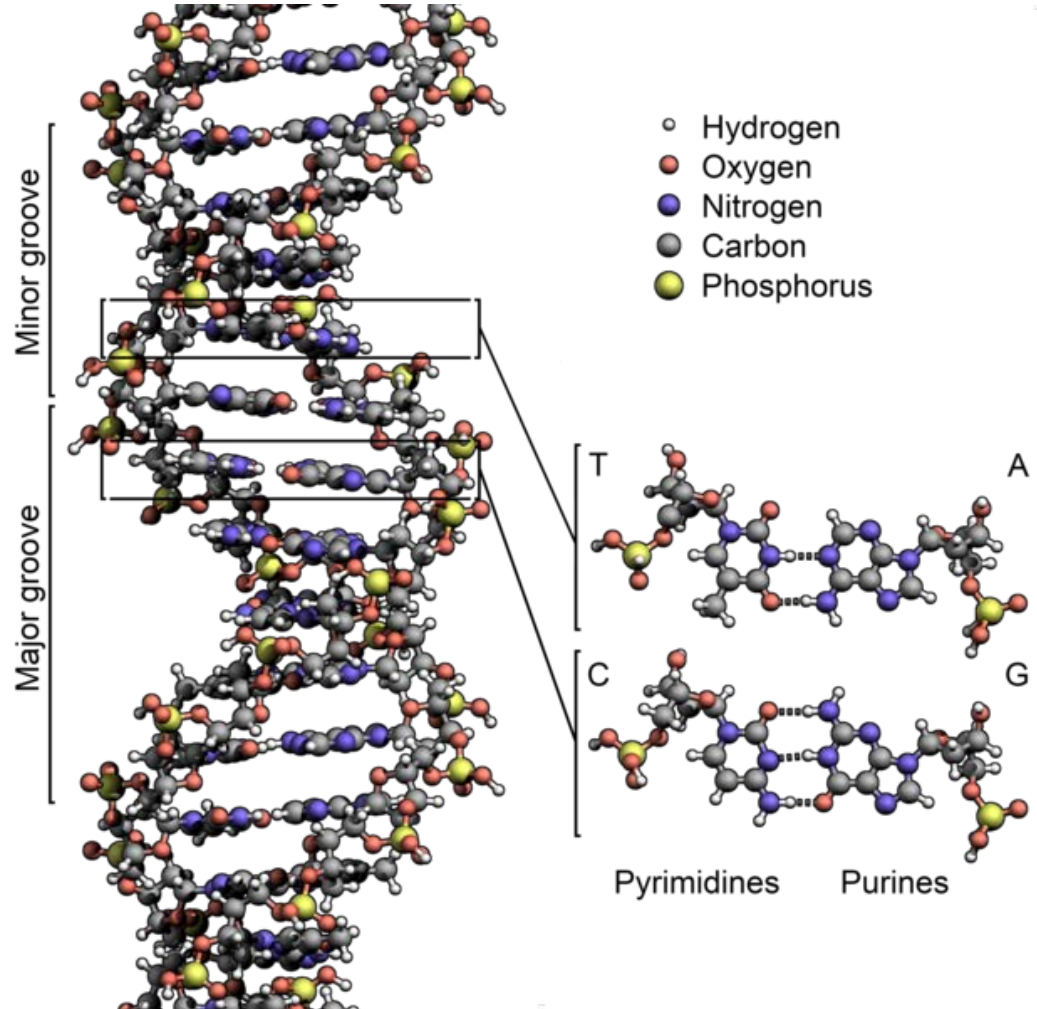
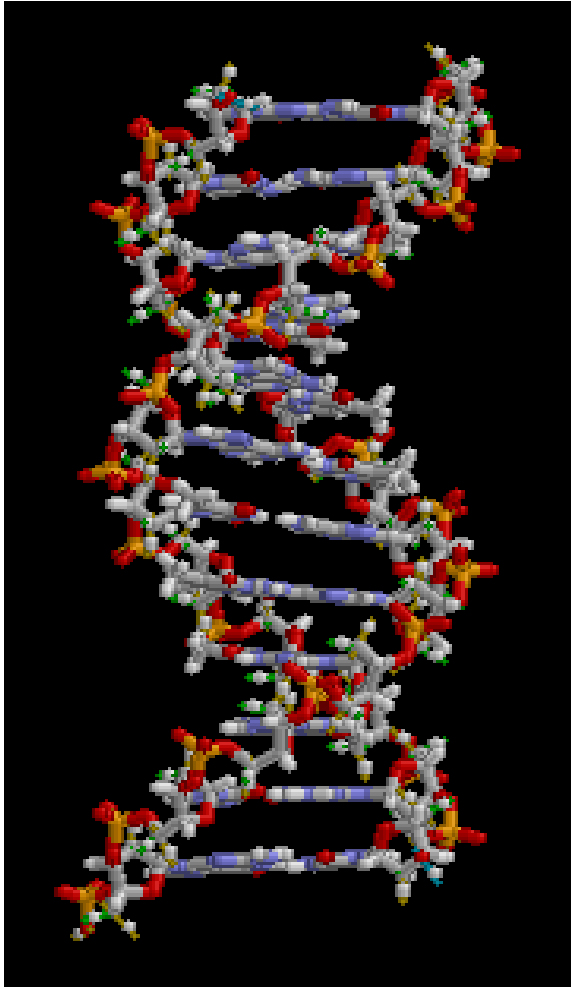
Nucleic Acids

Nucleic acids are polymeric macromolecules, or large biological molecules, essential for all known forms of life

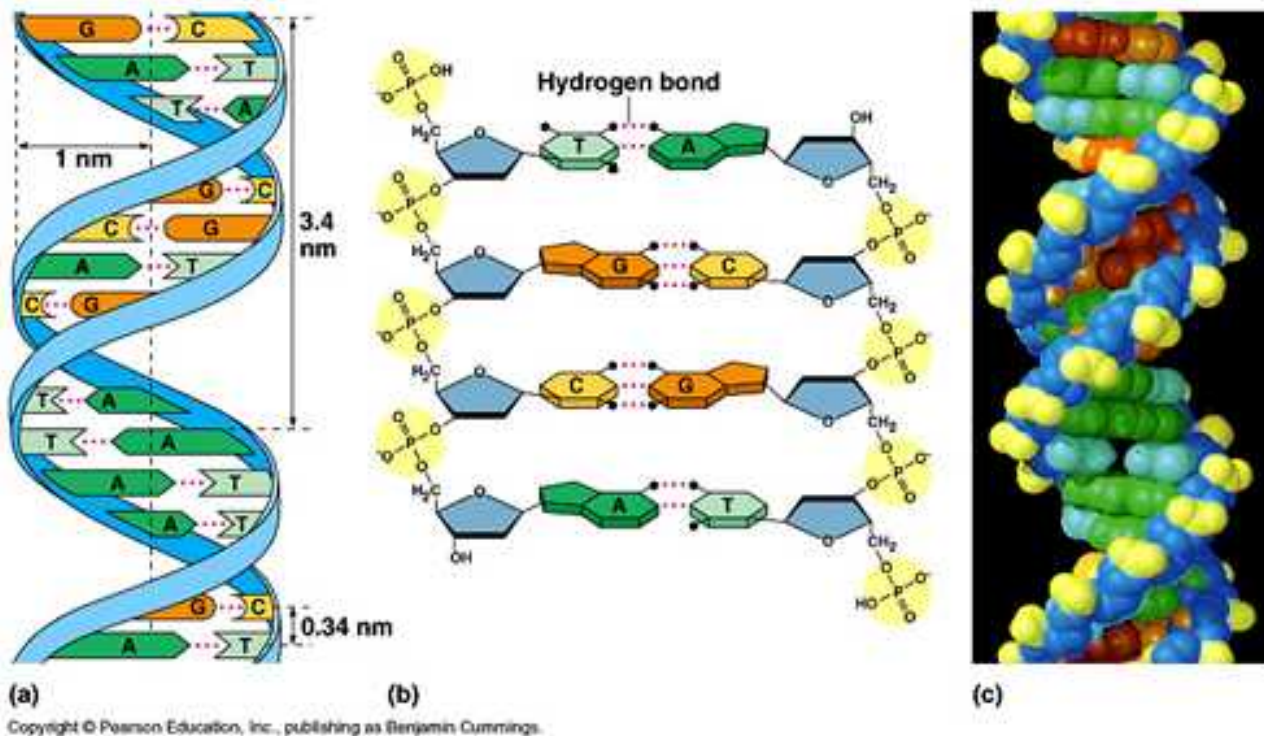


The Swiss scientist Friedrich Miescher discovered nucleic acids (DNA) in 1869. Later, he raises the idea that they could be involved in heredity.

Deoxyribonucleic acid (DNA)

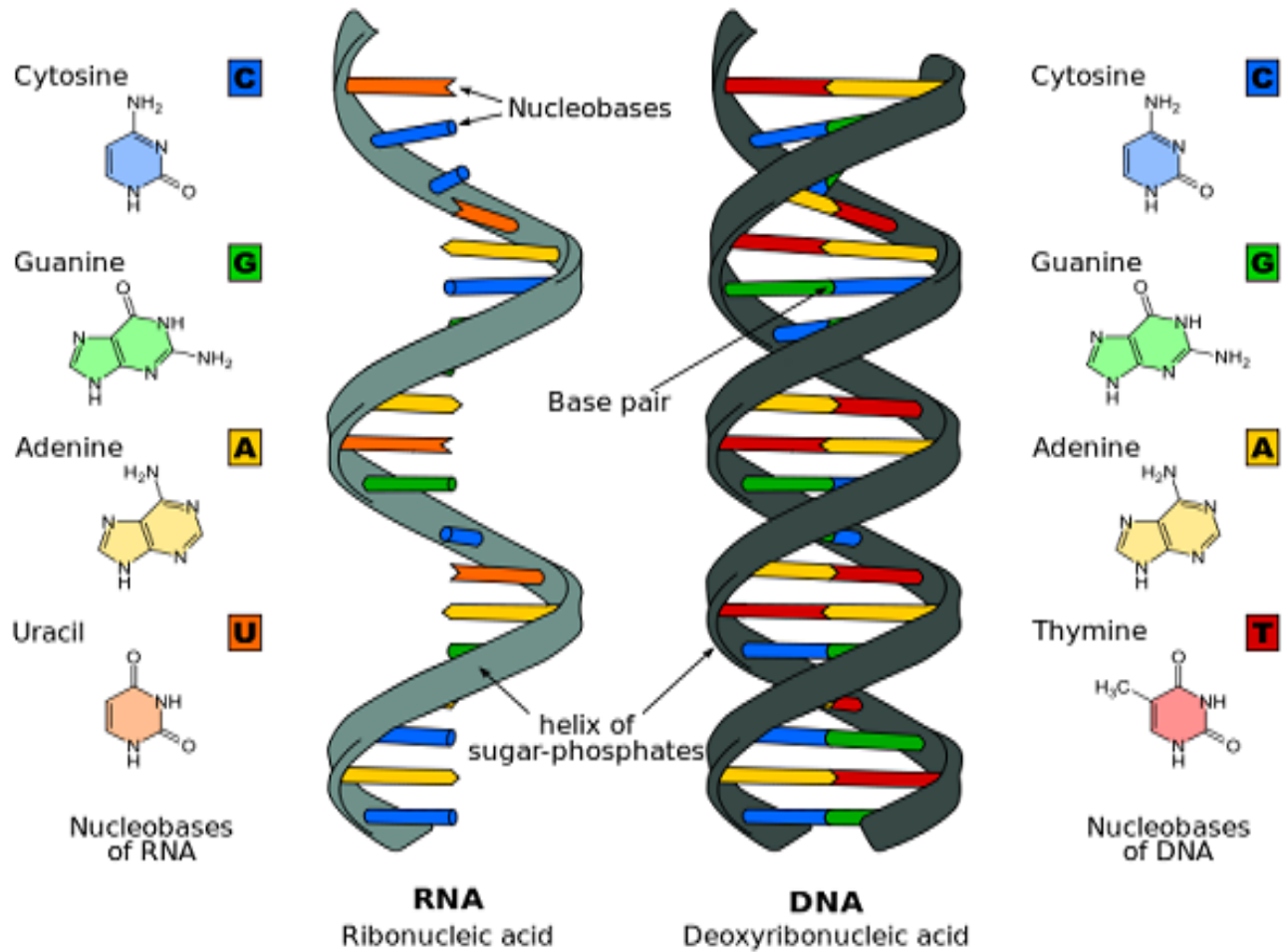


DNA



Deoxyribonucleic acid (DNA) is a molecule that encodes the genetic instructions used in the development and functioning of all known living organisms and many viruses. DNA is a nucleic acid

DNA



Thank you for your attention !