# MolecModels3D™

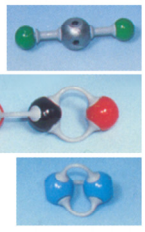
## Biochemistry (Student) Set
## Cat. No. 1021010

## Contents:

| Qty | Element | | Colour | Holes / Type | Dia mm |
|---|---|---|---|---|---|
| 12 | Carbon | C | Black | 4 tetra. sp3 | 23 |
| 9 | Carbon | C | Black | 3 trig. sp2 | 23 |
| 22 | Hydrogen | H | White | 1 | 17 |
| 3 | Hydrogen | H | White | 2 linear | 17 |
| 11 | Oxygen | O | Red | 2 angular | 23 |
| 2 | Oxygen | O | Red | 1 | 23 |
| 3 | Nitrogen | N | Blue | 4 tetra. | 23 |
| 2 | Nitrogen | N | Blue | 2 angular | 23 |
| 6 | Nitrogen | N | Blue | 3 trig. | 23 |
| 1 | Sulphur | S | Yellow | 2 angular | 23 |
| 1 | Phosphorus | P | Purple | 4 tetra sp3 | 23 |
| | | | | | |
| 40 | Link | | Grey | Medium | |
| 10 | Link | | Grey | Long flexible | |

### Links, Bond Types and Use

**Medium size links** are used for single covalent bonds.
**Long size links** are used for double or triple covalent bonds.

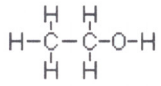


**Open models** are made using medium or long links, e.g. single double and triple bonds.

### Molecular and Structural Formulae

The Molecular formula shows the exact number of atoms of each element which are present in one molecule, e.g. ethanol $C_2H_6O$
2 carbon, 6 hydrogen, 1 oxygen

The Structural formula is a plan view of the arrangement of the atoms in a molecule using symbols for atoms and lines for the links, which represent the bonds between the atoms in the molecule.

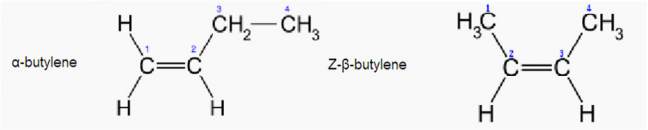


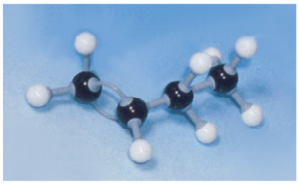
ethanol

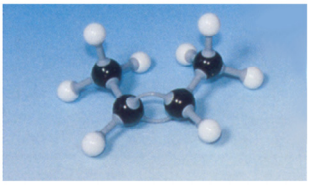
The Constitutional formula is an abbreviated version of a molecule and shows groups of atoms. For example, $CH_3.CH_2.OH$ is an abbreviated version for the formula of ethanol.

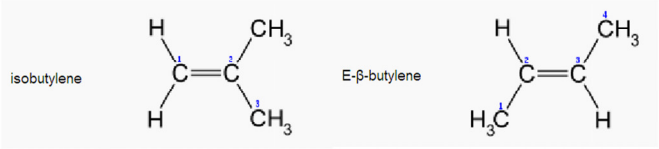
### Structural Isomerism

It is possible using the molecular formula $C_4H_8$ to make a different structures.
Four hydrocarbons have four Carbon atoms, eight Hydrogen atoms and one double bond in their molecules, but have different chemical structures.
When two or more substances have the same number and kind of atoms but different structures they are called Isomers.





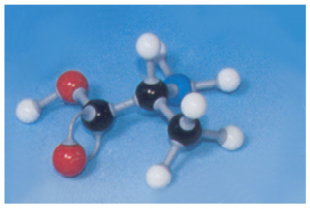



### Atoms Types

**In this set there are 2 types of Carbon atoms:**

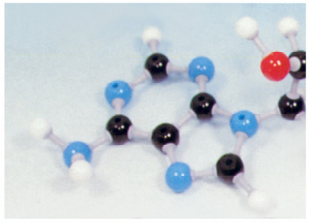
**sp3 tetrahedral 4-holes 109°**
This is the standard 4-hole atom used to make compounds containing carbon atoms. It can be converted into the sp2 and sp forms by using the long flexible links supplied to represent double and triple bonds.

*Example using 4-hole carbon atoms and the visible multiple bonds.*



**sp2 trigonal 3-holes 120°** This atom is used in planar models such as **ethene and benzene.**
**In this case one link is used to represent a multiple bond.**

*The same structure as above made using single links to represent multiple bonds.*



Similarly the 3 - and 2-hole nitrogen and 1-hole oxygen atoms maybe used with one link to represent multiple bonded situations.

The following 3 pages contain examples of important Biochemical structures, some (BUT NOT ALL) may be made with this set.

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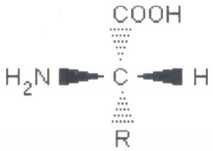
# Amino-acids

**Classification of amino-acids** based upon chemical composition of the R group.

1. Aliphatic, 2. Hydroxyl, 3. Sulphur,
4. Acidic (and amides), 5. Imino,
6. Basic, 7. Aromatic

**Configuration of natural Amino-acids**

Every amino-acid except glycine has a chiral centre with a configuration about the carbon atom carrying the alpha amino group



**L-amino acid**

**Dipolar structure of amino-acids**

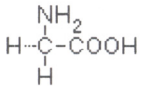
$^{+}H_3N-CHR-COO^{-}$

The tetrahedral nitrogen atom should be used for the amine group to enable hydrogen-ion transfer.

## Aliphatic

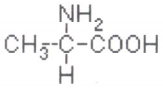
Glycine (gly)

*polar*
*neutral*
*nonessential*



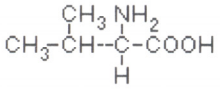
Alanine (ala)

*nonpolar*
*neutral*
*nonessential*



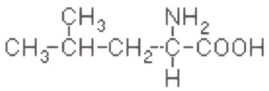
Valine (val)

*nonpolar*
*neutral*
*essential*



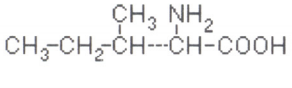
Leucine (leu)

*nonpolar*
*neutral*
*essential*



Isoleucine (ile)

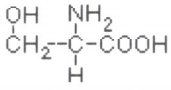
*nonpolar*
*neutral*
*essential*



## Hydroxyl

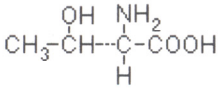
Serine (ser)

*polar*
*neutral*
*nonessential*



Threonine (thr)

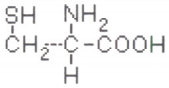
*polar*
*neutral*
*essential*



## Sulphur

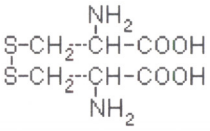
Cysteine (cys)

*polar*
*nonessential*



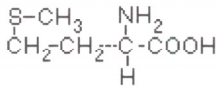
Cystine (cys/2)

*nonpolar*
*neutral*
*nonessential*



Methionine (met)

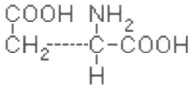
*nonpolar*
*neutral*
*essential*



## Acidic

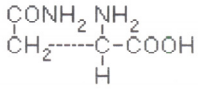
Aspartic acid (asp)

*polar*
*acidic*
*nonessential*



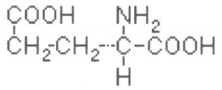
Asparagine (asn)

*polar*
*neutral*
*nonessential*



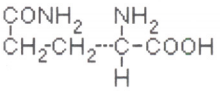
Glutamic acid (glu)

*polar*
*acidic*
*nonessential*



Glutamine (gln)

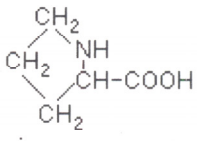
*polar*
*neutral*
*nonessential*



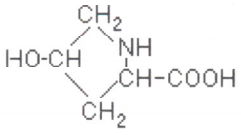
## Imino

Proline (pro)

*nonpolar*
*neutral*
*nonessential*



Hydroxyproline

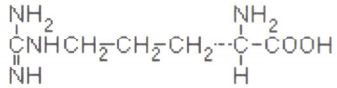


**Note:** Not all the amino-acids can be made at the same time, but it is possible to make one amino-acid of each type.

## Basic

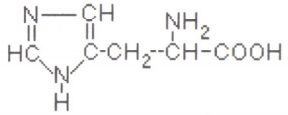
Arginine (arg)

*polar, basic, essential*



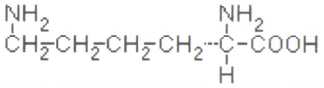
Histidine (his)

*polar, weakly basic, essential*



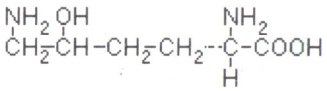
Lysine (lys)

*polar, basic, essential*



Hydroxylysine

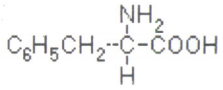
*Found in collagen*



## Aromatic

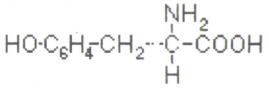
Phenylalanine (phe)

*nonpolar*
*neutral*
*essential*

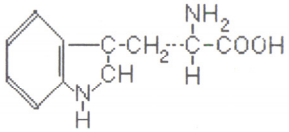


Tyrosine (tyr)

polar
nonessentia



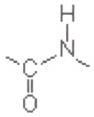
Tryptophan (trp)



*nonpolar, neutral, essential*

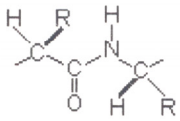
## Peptides

**The Peptide Bond** is an amide linkage formed by the condensation reaction between the carboxy group of one amino-acid and the amino group of another.



-COOH + $NH_2$ - → -CO.NH- + $H_2O$

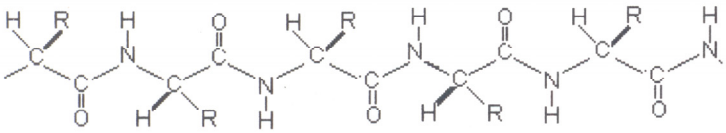
**Peptide Group** -CO.NH-
The four atoms of the peptide group are Planar, and the two adjacent alpha carbon atoms are also in the same spatial plane.



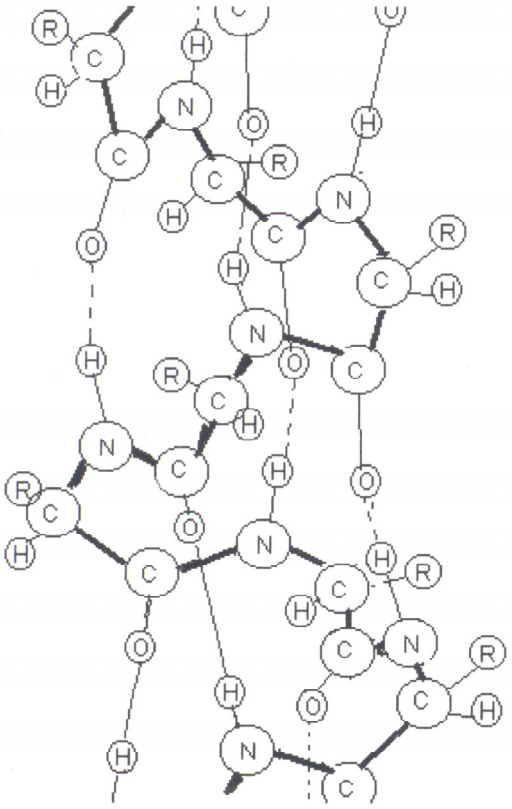
**Notes**
1. The H and R groups are projected out of the plane.
2. The O and N atoms are in a trans geometric position to each other.

**Model making:**
A trigonal Nitrogen should be used in the peptide group. Linear 2-hole hydrogen and oxygen will be necessary for secondary peptides (e.g. alpha-helix).

**A 5-unit polypeptide chain** (a primary structure)



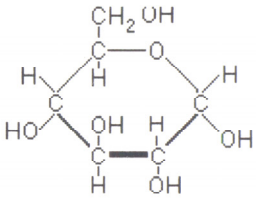
## Alpha-helix (a secondary structure)



## Polysaccharides

**Monosaccharide**

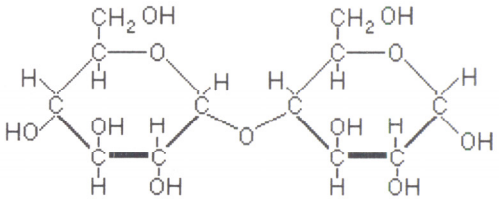
Glucose $C_6H_{12}O_6$



**Disaccharide**

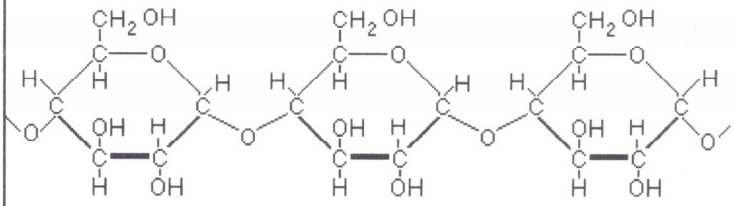
Maltose

$C_{12}H_{22}O_{11}$



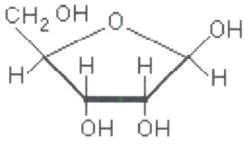
**Polysaccharide**

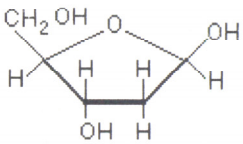
Starch (amylose)



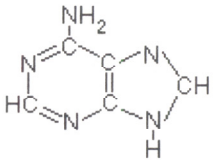
**Pentoses**

Ribose Deoxyribose

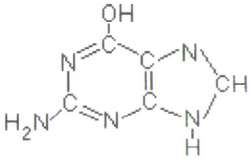




## Purines

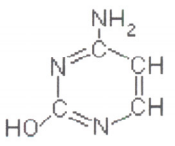


Adenine

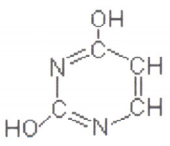


Guanine

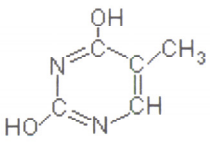
## Pyrimidines



Cytosine

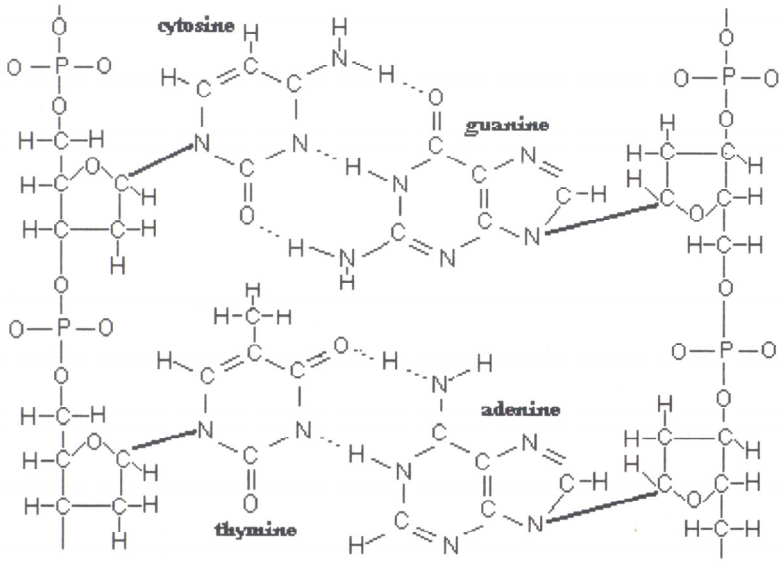


Uracil



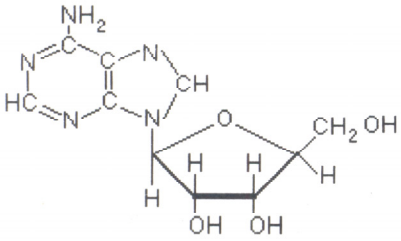
Thymine

## Deoxyribose Nucleic Acid D.N.A.

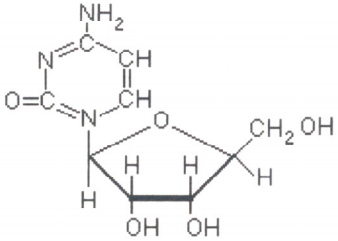



## Nucleosides, Nucleotides & Coenzymes

### Nucleosides

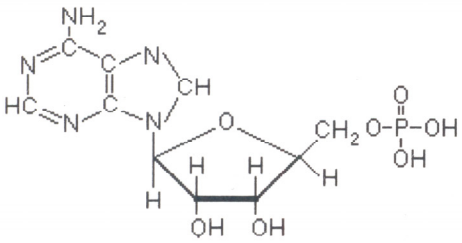


Adenosine



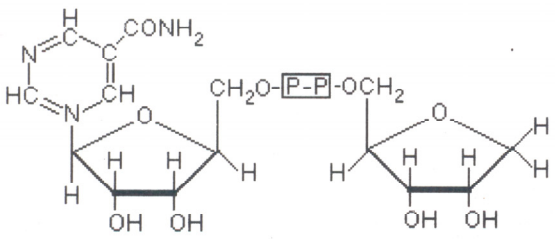
Cytidine

### Nucleotide



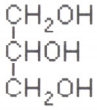
AMP
adenosine
monophosphate

### Coenzyme

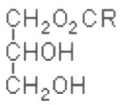


NAD
nicotinamide adenine dinucleotide

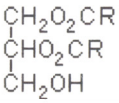
## Glycerides and Phospholipids



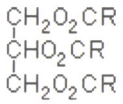
Glycerol



Monoglyceride



Diglyceride



Triglyceride

**R** is a long chain e.g. Palmitic $C_{15}H_{31}$

Stearic $C_{17}H_{35}$ Oleic $C_{17}H_{33}$

Stearic acid $CH_3.(CH_2)_{16}.COOH$

Oleic acid

$CH_3(CH_2)_7.CH{=}CH.(CH_2)_7.COOH$

**Phospholipids** are 1, 2 –diglycerides with a phosphate group and another group usually a base attached to the 3 position of the glycerol.

e. g. Lecithin