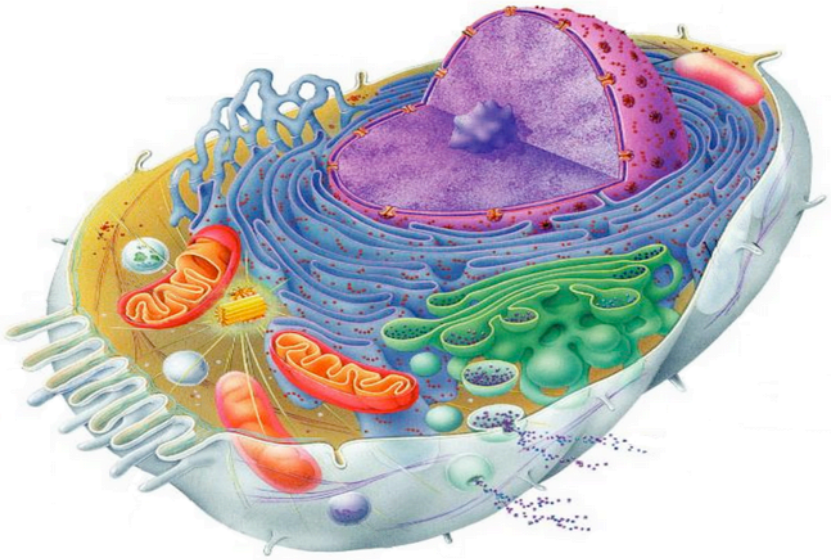
Super Models

THE BASIC UNIT OF STRUCTURE AND FUNCTION IN ALL LIVING THINGS...THE CELL



What's inside?
H_2O
Alcohols
Aldehydes
Amines
Amino Acids
Carboxylic Acids
Chemical Messengers
Esters
Ethers
Fatty Acids
Glycerides
Ketones
Lipids
Nucleic Acids
Peptides
Proteins
Salts
Sugars
Sulfhydryls
Vitamins

Chemistry of Life
Molecular Model Kit

Ryler Enterprises, Inc.

Recommended for ages 10-adult

⚠ **Caution:** Atom centers and vinyl tubing are a choking hazard. Do not eat or chew model parts.

Kit Contents:

20 white 1-peg hydrogen atom centers
4 green 1-peg halogen atom centers
4 blue 3-peg nitrogen atom centers
2 blue 4-peg nitrogen atom centers
2 purple 5-peg phosphorus atom centers
6 red 2-peg oxygen atom centers
15 black 4-peg carbon atom centers
7 black 3-peg carbon atom centers
40 clear, 1.25″single bonds
8 clear, 4 cm bonds (for double bonds)

Phone: 806-438-6865
E-mail: etishler@rylerenterprises.com
Website: www.rylerenterprises.com
Address: 5701 1st Street, Lubbock, Texas 79416

Chemistry of Life

General Information

The study of the materials that make up living things, biochemistry, is concerned with both inorganic and organic chemicals. Inorganic compounds usually do not include substances made from carbon. However, there are some exceptions to this generalization, namely carbon dioxide (CO_2), carbon monoxide (CO), carbonic acid (H_2CO_3) and its salts, and hydrocyanic acid (HCN) and its salts. All of these are considered to be inorganic. All other compounds containing the element carbon are organic.

One of the simplest compounds in living cells is the small, but indispensible water molecule (H_2O). Most cells are composed, by weight, of about 60% water. Why is water so important for life, as we know it, on Earth?

There are four major reasons:

1) Molecules are, in part, shaped by their interactions with water. Some molecules (e.g. proteins) have parts which are attracted to water and some areas which are repelled by water. The net result of the association with water is a folding of the interacting molecule, and since function follows form, biochemicals, such as proteins have their activity influenced by water;

2) Water itself is a reactant in many cellular reactions;

3) H^+ and OH^-, which are formed in the self ionization of water, affect the activity of molecules such as proteins;

4) Water provides for the easy transport of materials through cells and tissues.

By using this kit, you will learn about the organic and inorganic chemicals which are important to living things. They come in a dazzling number of varieties, some of which you will study by making molecular models.

General Instructions

1. Biology texts usually show structural diagrams of the organic chemicals which are being discussed. Therefore we should start our study of the chemistry of life with an explanation of how structural diagrams are written.

The first thing to keep in mind is the habit of each carbon atom to form four bonds with other atoms, so always make sure that you see four dashes around each carbon atom. However, in some diagrams you will not see the four dashes, and there are some formulas that do not even show the carbon atoms. In Fig.1, a molecule of a substance called pentane shows all of the carbon atoms, hydrogen atoms, and bonds in a). The same molecule in b) is displayed in a condensed form, and it is assumed that with experience, you will be able to count the number of bonds to each carbon atom. In part c), the molecule is condensed even further, and you again are expected to make the correct bond count. It is unlikely that you will see a diagram as in d) in a biology book, but we added it for interest sake. Notice that the carbon atoms are not even shown.

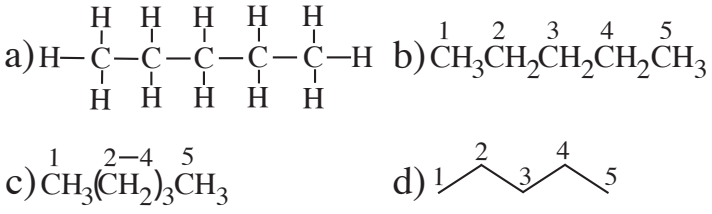


Fig.1 Four methods of drawing pentane.

Another example of how to condense structural formulas is given in Fig. 2, below.

2. The symbols R, R′, and R″ in the formulas you will see represent either –H, $–CH_3$, a straight chain of hydrocarbons, e.g. $–(CH_2)_XCH_3$ (where X = 1 or some small number), a branched carbon chain, or a ring of carbon atoms. The R symbols mean "residual group," and they save the time it would take to write out the complete structure.

3. Four ways of drawing a benzene ring, from most complex to simplest, are shown below in Fig. 2.

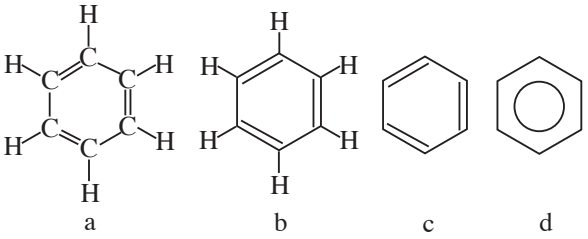


Fig. 2 A benzene ring.

The forms labeled "c," and "d," are called skeleton diagrams, and the presence of a carbon atom at each of the corners in "b," "c," and "d," is understood.

Since benzene is highly toxic, it is not found as a free chemical in living things. However, by bonding benzene, minus one hydrogen, to another molecule the benzene, then called a phenyl group, is not harmful. The phenyl group is illustrated as a part of the amino acid phenylalanine in Fig. 3. The phenyl group is in red.

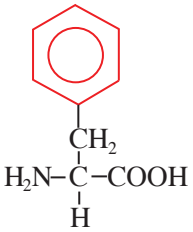


Fig. 3 Benzene, lacking one hydrogen, incorporated as a phenyl group into the amino acid, phenylalanine.

When you make a model of the phenyl group, use the 3-peg carbon atoms in order to avoid having to make double bonds, but do not omit the H atoms.

4. In order to make a double (or triple) bond between any two atoms, join two (or three) of the pegs of one atom to two (or three) of the pegs of the other atom with two (or three) of the long, thin plastic tubes. See Fig. 4.

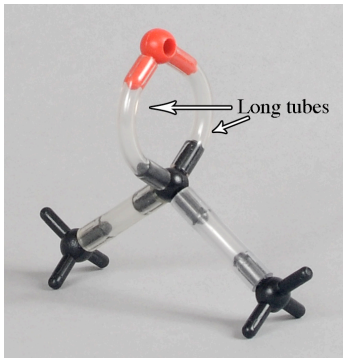


Fig. 4 Making a double bond.

Part I-Learning Functional Groups.

1. The common elements found in biochemicals are C, H, O, N, S, and P, but this lab is concerned only with a few compounds containing C, H, O, N and P.

Because there is such a vast number of biologically important compounds, this lab facilitates learning about them by

categorizing them according to their functional groups, some with oxygen, some with nitrogen, and some of a miscellaneous nature.

2. The lab begins with an explanation of the general form of each functional group. The tables in **Part 1** deal with oxygen, nitrogen, and miscellaneous functional groups. We include a few inorganic ions and molecules as well. Students will learn the formula and name of a specific example of a molecule containing the functional group, make a model of it, and show it to the instructor.

Part II-Identifying Functional Groups in Specific Biochemicals.

1. In part two of this lab procedure, the student will complete three lab sheets that show the names, formulas, and descriptions of several interesting biochemical compounds.

2. The student will then observe the structural formulas for the compounds, and then fill in the appropriate boxes on the lab sheet with the names of the functional groups found in each molecule.

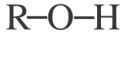
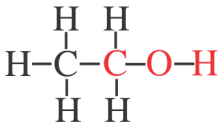
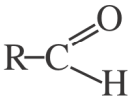
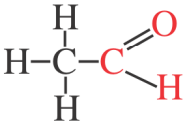
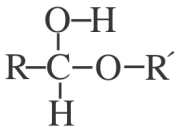
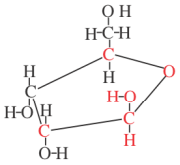
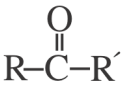
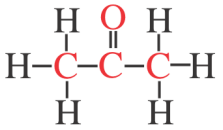
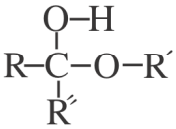
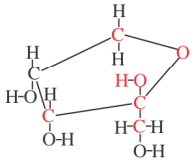
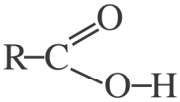
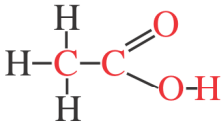
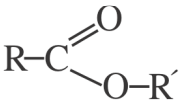
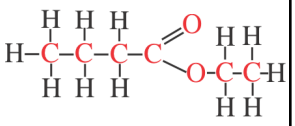
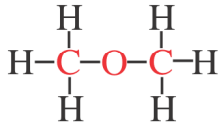
3. Students will build a model of the compound, and then present the lab sheet and model to the instructor for approval.

CHEMISTRY OF LIFE LABORATORY

PART 1-Learning Functional Groups

NAME_____ CLASS_____ DATE_____

FUNCTIONAL GROUPS CONTAINING OXYGEN

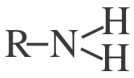
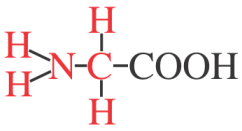
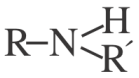
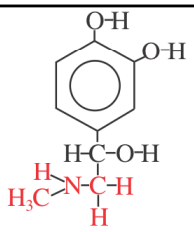
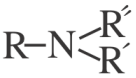
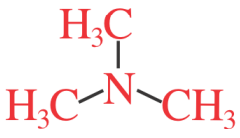
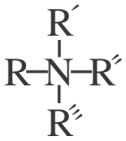
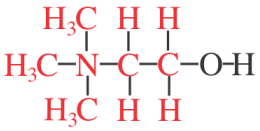
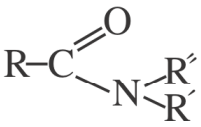
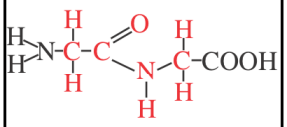
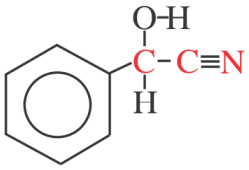
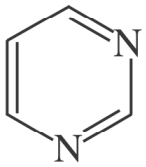
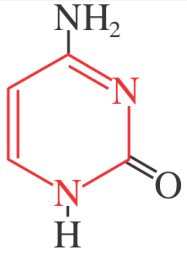
General		Specific Example		Practice model
Name	Formula	Name	Formula	made and checked
alcohol		ethyl alcohol (ethanol) (drinking alcohol)		
aldehyde		acetaldehyde (ethanal)		
hemiacetal		ribose (cyclic form) (the sugar of RNA)		
ketone		acetone (propanone) (nail polish remover)		
hemiketal		ribulose (cyclic form)(one of the most important chemicals on earth)		
carboxylic acid		acetic acid (ethanoic acid) (water + acetic acid = vinegar)		
ester		ethyl butyrate (odor of banana, pineapple, strawberry)		
ether		dimethyl ether (used to freeze warts)		

CHEMISTRY OF LIFE LABORATORY

PART 1-Learning Functional Groups

NAME_____ CLASS_____ DATE_____

FUNCTIONAL GROUPS CONTAINING NITROGEN

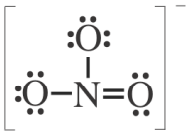
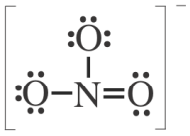
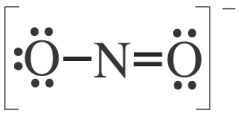
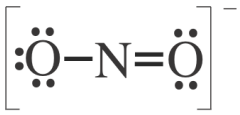
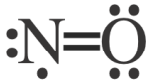
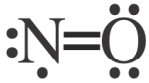
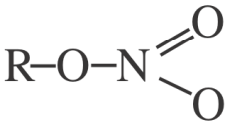
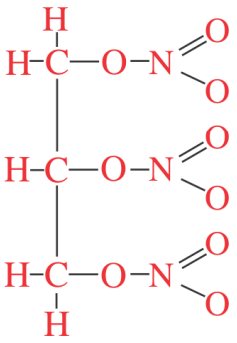
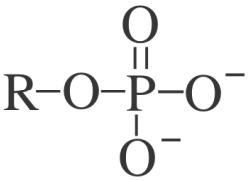
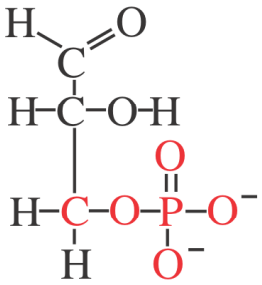
General Name	Formula	Specific Example Name	Formula	Practice model made
primary amine (1° amine)		glycine (the simplest amino acid)		
secondary amine (2° amine)		epinephrine (adrenaline)		
tertiary amine (3° amine)		trimethylamine (causes foul odor of decaying flesh)		
quaternary amine (4° amine)		choline		
amide		a dipeptide (two bonded amino acids)		
nitrile		mandelonitrile (in pits of some fruits)		
cyclic amine		cytosine (from DNA & RNA)		

CHEMISTRY OF LIFE LABORATORY

PART 1-Learning Functional Groups

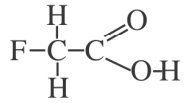
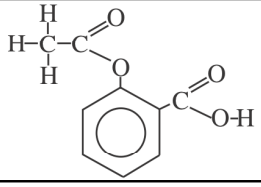
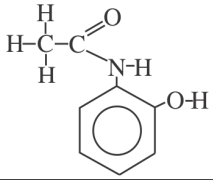
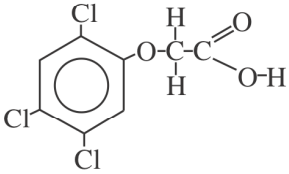
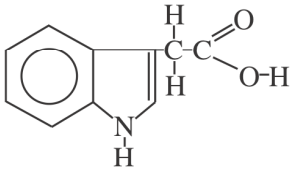
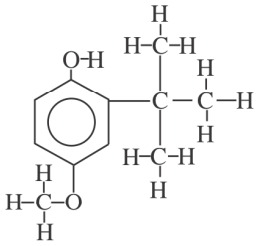
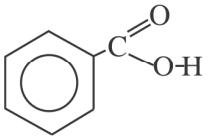
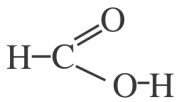
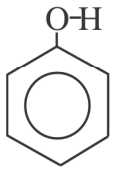
NAME_____ CLASS_____ DATE_____

MISCELLANEOUS SUBSTANCES OF IMPORTANCE

General		Specific Example		Practice
Name	Formula	Name	Formula	model made
nitrate ion		nitrate ion (source of nitrogen for plants)		
nitrite ion		nitrite ion		
nitric oxide		nitric oxide (increases blood flow)		
nitro group		nitroglycerine (explosive & treats heart disease)		
phosphate ester		phosphoglyceride (product of glucose break down)		
carbon dioxide		carbon dioxide (involved in respiration & photosynthesis)		

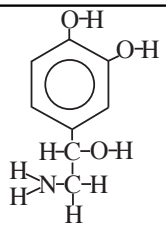
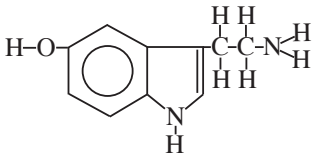
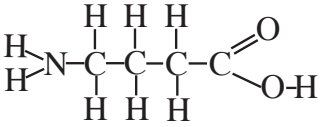
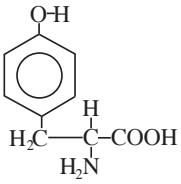
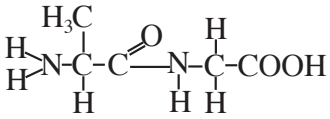
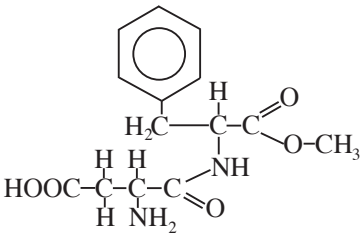
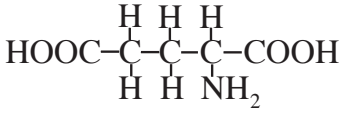
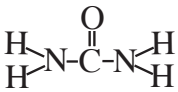
PART 2-Identifying Functional Groups in Biochemicals

NAME_____ CLASS_____ DATE_____

Compound Name	Compound Structure	Miscellaneous info. Use, source, etc.	Make model and name functional groups	Teacher check box
1.1 Fluoroacetic acid		Poison made by a South American plant species.		
1.2 Aspirin (use the 3-peg carbons for the phenyl group)		Also calld acetylsalicylic acid, the salicylic acid part of the molecule is made by a plant (in the barks of willows).		
1.3 Tylenol (Acetominophen)		Like aspirin this chemical is a pain reliever and antipyretic.		
1.4 2, 4, 5-T (2, 4, 5-trichloro-phenoxyacetic acid)		This synthetic chemical is used as an herbicide. 2, 4, 5-T does not degrade well in the environment due to the chlorine atoms.		
1.5 IAA (Indoleacetic acid)		Naturally existing plant hormone. 2, 4, 5-T works like IAA and tricks the plant into uncontrolled growth, followed by death.		
1.6 BHA (Butylated hydroxy-anisole)		This preservative is put into many foods (such as dry cereals) as an antioxidant. A related compound, BHT, is also frequently used.		
1.7 Benzoic acid		A very common antibacterial preservative used in drinks, pickles, jams, pie fillings, etc.		
1.8 Formic acid		In ant bites, bee and wasp stings. Also used to make perfume. Forms in body when one drinks methyl alcohol.		
1.9 Phenol		Also called carbolic acid, it is used as a mild anesthetic and antimicrobial agent in mouth and throat medi-cations.		

PART 2-Identifying Functional Groups in Biochemicals

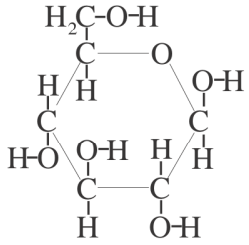
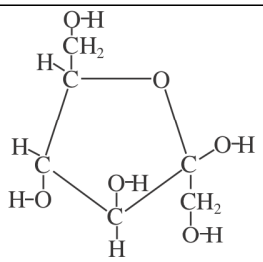
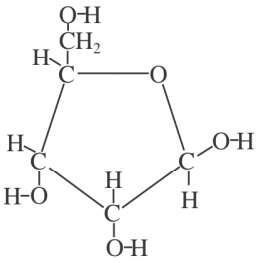
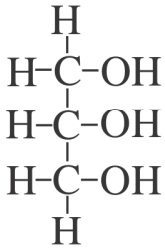
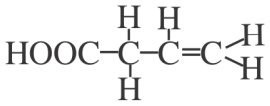
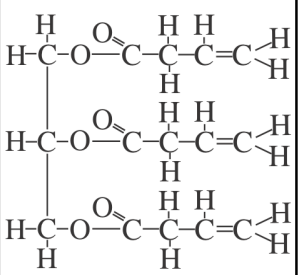
NAME_____ CLASS_____ DATE_____

Compound Name	Compound Structure	Miscellaneous info. Use, source, etc.	Make model and name functional groups	Teacher check box
2.1 Norepinephrine (Noradrenaline)		A chemical messenger, used as a hormone released from adrenal glands and a neuro-humor released from nerve cells. Made from the amino acid tyrosine.Similar to adrenaline.		
2.2 Serotonin		Like IAA this comes from the amino acid tryptophan. But in the human brain, serotonin is a powerful chemical messenger.		
2.3 GABA (Gamma amino butyric acid)		When released from a nerve cell, this chemical will in-hibit other nerve cells that the substance comes in contact with.		
2.4 Tyrosine		This amino acid is made into adrenaline,noradrenaline, and melanin which is the brown pigment of skin, hair, eyes, etc.		
2.5 Dipeptide		A peptide bond is formed between 2 amino acids as the two molecules lose a molecule of water. Proteins are made this way.		
2.6 Aspartame		This dipeptide, made from 2 amino acids, aspartic acid and phenylalanine, and methyl alcohol is 180x as sweet as sugar, but has very few calories. It is an artificial sweetener.		
2.7 Glutamic acid		When combined with a base forms monosodium glutamate (MSG). Used as flavor en-hancer. Causes some people to have allergic reactions.		
2.8 Urea		The main chemical the body uses to get rid of nitrogen-ous waste. Found in blood, sweat, urine. Once used as an antiseptic.		

CHEMISTRY OF LIFE LABORATORY

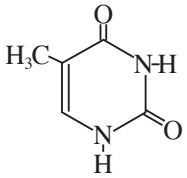
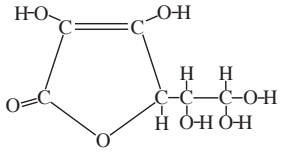
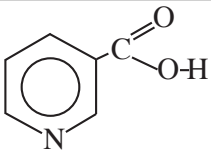
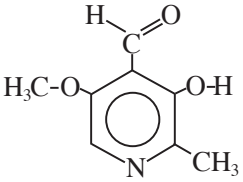
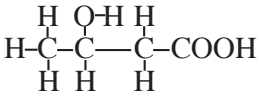
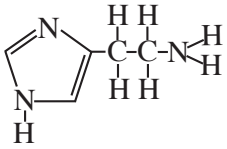
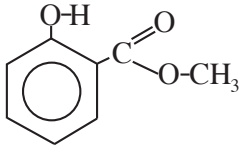
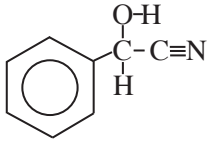
PART 2-Identifying Functional Groups in Biochemicals

NAME_____ CLASS_____ DATE_____

Name	Compound Structure	Miscellaneous info. Use, source, etc.	Make model and name functional groups	Teacher check box
3.1 Glucose (Dextrose) (Ring structure)		The main source of energy in most living things. Also part of sucrose (with fructose), lactose, starch, cellulose, chitin (material of insect exoskeletons), etc.		
3.2 Fructose (Ring structure)		The sweetest sugar. Like glucose, one of several hexoses that exist in nature. Also called fruit sugar, it is used as a sweetener in many foods. It is a ketose sugar.		
3.3 Ribose		This aldopentose is found in RNA, where it is bonded to a phosphate ion and a nitrogenous base. The same sugar less the oxygen on the second carbon (then called deoxyribose), is found in DNA.		
3.4 Glycerol (Glycerin)		A part of fats and oils, used commercially as a constituent of lotions, etc.		
3.5 Mono-unsaturated fatty acid		Fatty acids usually contain many more carbons. Fatty acids that have lost H atoms and have double bonds are said to be unsaturated.		
3.6 Triglyceride		In general: Fats and oils are triglycerides. Fats are solid at room temp. and come from animals, while oils are liquids at room temp. and come from plants. Mono-unsaturated oils are best nutritionally.		

PART 2-Identifying Functional Groups in Biochemicals

NAME_____ CLASS_____ DATE_____

Compound Name	Compound Structure	Miscellaneous info. Use, source, etc.	Make model and name functional groups	Teacher check box
4.1 Thymine		One of the 4 bases found in DNA. In DNA it is found opposite the base adenine, held to it by 2 hydrogen bonds. It resenbles the bases uracil and cytosine.		
4.2 Ascorbic acid		Also called vitamin C. Only 4 animals do not make ascorbic acid, among them, man. Used as an antioxidant in the body and in foods.		
4.3 Niacin		Also called nicotinic acid, or vitamin B-3. It is incorporated into a coenzyme called NAD which aids in the transfer of hydride ions.		
4.4 Pyridoxal		One of the 3 forms of vitamin B-6, it is important in the metabolism of fats in cells.		
4.5 β-hydroxybutyric acid (β means beta)		One of the 3 ketone bodies formed from fatty acids. If fat rather than sugar is the main source of energy, excess ketone bodies form.		
4.6 Histamine		When histidine, an amino acid, loses a carboxylic acid group, histamine is formed. It causes the symptoms of hay fever, allergies, asthma, etc.		
4.7 Methyl salicylate		Also called oil of wintergreen, it is used as a topical medication for muscle pain in animals and humans. It is also used to flavor candies.		
4.8 Mandelonitrile		Made by some millipedes. When attacked, the animal releases HCN, a cyanide (poisonous) gas by breaking off the nitrile group.		