ORGANIC CHEMISTRY REFLECTS GOD'S INFINITE KNOWLEDGE

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The structure of organic chemical molecules is reviewed briefly from the alkanes through and including the steroids. For each class of compounds the number of different molecules that may be synthesized is truly immense. Such versatility of design and construction is seen as a tribute to the infinite wisdom of the Creator.

Introduction

All knowledge comes from God.
. . . for the Lord is a God of all knowledge.[1]
Mighty is our Lord and great his power, and his wisdom beyond all telling.[2]

The particular part of knowledge that concerns us in this article is Organic Chemistry. Although it is hard to quantify, knowledge dealing with chemistry is now said to double every ten years.

Organic Chemistry

Organic chemistry is the chemistry of carbon compounds. Although most any of the active elements may be incorporated in an organic compound, those most commonly associated with carbon are hydrogen, oxygen, nitrogen, sulfur, chlorine, bromine, iodine and fluorine.

It is very fortunate for us that God invented the carbon compounds because organic chemistry or carbon compounds include foods, fuels, and clothing. The simple foods—fats, proteins and carbohydrates—are all carbon compounds. For health, besides foods, we need vitamins and hormones, which are organic compounds too.

Other organic compounds that touch our daily lives are clothing such as cotton, wool, silk, and many synthetic fibers.

To these are added soaps, perfumes, dyestuffs, flavors, plastics, photographic films, explosives, synthetic rubbers, artificial flavors and many medicinals. Organic fuels are coal, natural gas, gasolines, fuel oils, and lubricating oils.

The organic compounds are infinite in number. In the Bible to represent very great numbers the author mentioned the "sands of the sea." The number of possible organic compounds far exceeds the "sands of the sea."

In the days of Columbus the exciting thing for a young man to do was to discover new lands. Now that has practically all been done. Around the end of the Nineteenth Century the exciting adventure was hunting gold. Now that type of search has practically been exhausted. One field will never be exhausted and that is organic chemistry. The organic chemist will never run out of things to do and much of his work is very exciting such as discovering new medicinals to cure other diseases.

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The Simpler Organic Compounds,

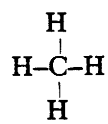
In inorganic chemistry a pair of elements are known to make only a few compounds, usually one or two. For instance, hydrogen and oxygen form only two compounds—water (H_20) and hydrogen peroxide (H_2O_2). Carbon and hydrogen, however, can form trillions of compounds.

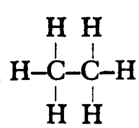
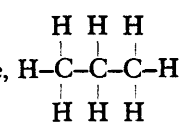
The general name of the carbon and hydrogen compounds is *hydrocarbons.* There are many series of hydrocarbons.

The Alkanes[3]

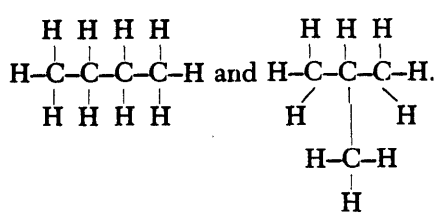
The simplest series of hydrocarbons is known as the "Alkanes." The alkanes start with one carbon, two carbons, three carbons, four carbons, on up to 94 carbons and probably many more. The molecule with 94 carbon atoms is the largest one synthesized by the chemists, but we have every reason to believe that this is not the end of the series.

A series of compounds of the same elements differing from the next by one carbon is called an *homologous series.* The series of alkanes is built up on the fact that carbon has four valences or bonds by which it can attach to other elements including carbon atoms. The smallest molecules in the alkane series are gases, then liquids of increasing density and finally solids.

The simpler alkanes are methane, ;

ethane, ; and propane, .

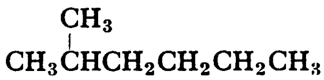
The next member in the alkane series is called butane. The surprising thing about butane is that there are two butanes. This is explained by the two structures:

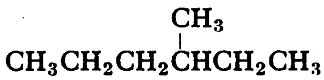


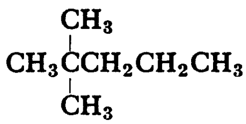
The two or more forms of an alkane are called isomers. As the number of carbons in the molecule increase, the number of possible isomers increases. For instance, heptane with seven carbons exists in nine isomers.

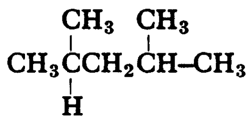
The Heptanes

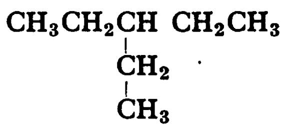
1. $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$

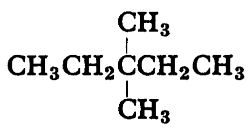
2. 

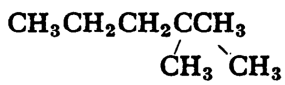
3. 

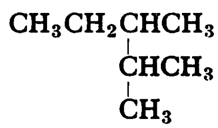
4. 

5. 

6. 

7. 

8. 

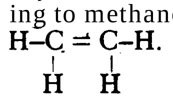
9. 

Any particular alkane can be represented by the formula C_nH_{2n+2}. The number of isomers soon begin to increase rapidly with the number of carbons in the molecule as follows:

7 Carbons—9 isomers.
10 " -75 isomers.
20 " -366,319 isomers.
30 " -4,111,846,763 isomers.
40 " -6.25 X 10^{13} isomers.

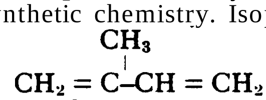
No one has tried to estimate how many isomers there could be of the alkane with 94 carbons in the molecule. Now we are getting beyond man's limit of comprehension into a level conceivable only to God. Yet we have hardly begun to estimate the possible number of known organic compounds.

The Alkenes[4]

Another homologous series of hydrocarbons is the alkenes. The general formula for the alkenes with 1 double bond is C_nH_{2n}. This means that any alkene molecule has two fewer hydrogen atoms than the corresponding alkane. This is explained by assuming a double bond between two adjacent carbons. There is no alkene corresponding to methane. The series must start with ethene,  Beginning with ethene, there is one or more alkene for every alkane.

The alkanes are not very reactive at laboratory temperatures, but the alkenes take part in many reactions. They react readily by addition, where the double bond is broken and part of the adding molecule joins each of the carbons where the double bond was.

As soon as the molecule reaches a chain of four carbons there can be two double bonds to form a diene. For instance, butadiene, CH_2=CH-CH=CH_2, is a very useful compound in synthetic chemistry. Isoprene,



is the fundamental unit in natural rubber, and is also important in synthetic rubber.

Since a double bond can be put between any two adjacent carbons in an alkane molecule there can be many times as many alkenes as alkanes. As soon as a chain gets four carbons long there can be dienes, and as soon as it reaches six carbons long there can be trienes, then tetrenes, etc. If there can be trillions of alkanes there can be many times as many trillions of alkenes. Man cannot think in terms of such numbers; and, therefore, we shall have to turn the counting over to God.

The Alkyne[5]

Another hydrocarbon series is the alkynes. The alkynes are characterized by triple bonds between adjacent carbons. Their reactions are similar to those of the alkenes. The number of alkynes is comparable to that of the alkenes, so they add about another billion billion to the total number of hydrocarbons.

There are several other classes of hydrocarbons but let us hold them in abeyance until we have discussed the addition of some other atom to the hydrocarbon molecule.

The Alcohol[6]

Two generally known alcohols are methanol, commonly called wood alcohol (CH_3OH) and ethanol (C_2H_5OH) commonly known as grain alcohol. The numbers of alcohols are very large since there can be one OH on most of the carbons in the alkanes.

We noted previously that there can be over four billion alkanes with up to 30 carbons in the molecule. Since most of the hydrogens in the alkanes can be replaced by an OH, the number of alcohols becomes extremely large. Even now we have hardly begun to estimate the number of organic compounds.

The Aldehydes and Ketones[7]

If we try to put two OH's on the end of a carbon chain, water splits off and we get an aldehyde. The simplest one is formaldehyde (HCHO). If we try to put two oxygens on a carbon within a chain, again water splits off and we get a ketone such as acetone ($CH_3-\overset{O}{\overset{\|}{C}}-CH_3$).

In the complicated molecules wherever there is an end to a chain, the last carbon can become an aldehyde group. Any carbon within the chain having two hydrogens can become a ketone. It is almost impossible to estimate how many compounds the aldehydes and ketones represent.

But let us think of a ketone as being $\begin{matrix}R_1\\R_2\end{matrix}> CO$. Now either R_1 or R_2 can be any one of the four billion radicals in the alkanes with 30 carbons. The ketones can start with R_1 as CH_3 and go through the whole four billion R_2 radicals. Then R_1 can be changed to C_2H_5 and then repeat the four billion radicals for R_2. This will add up to four billion squared or 16×10^{18}. The possible aldehydes will not be so many but the number will be large.

The Ethers[8]

If we took an alcohol and replaced the hydrogen of the OH by an alkyl radical, we would have an ether. Diethyl ether ($C_2H_5O\ C_2H_5$) is the ordinary anesthetic ether. We could consider the ethers in the same way we did the ketones, by looking at an ether as R_1OR_2. Then, if we let R_1 be CH_3, while we went through all the four billion R_2's, then go to C_2H_5 and go through the four billion R_2's, we would come out with 16×10^{18} again.

The Organic Acids[9]

If an aldehyde is oxidized, an organic acid is formed. The acid is characterized by the radical $-CO_2H$. There are as many possible organic acids as there are aldehydes which is a very large number.

The Esters[10]

If a molecule of water is split off between an acid radical of the acid and the OH radical of an alcohol an ester results, such as ethyl acetate ($CH_3CO_2C_2H_5$). If we represent the part that comes from the alcohol as R_1 as $CH_3CO_2\ R_1$, then for every acid there can be as many esters as there are alcohols. Since the number of acids and alcohols are approximately the same, the number of esters can be, for the molecules up to 30 carbons, something less than 16×10^{18}.

Amines[11]

Now let us turn to the nitrogen organic compounds. We first think of the amines. These compounds can be looked upon as an alcohol with the OH replaced by NH_2. The first of the series is methyl amine (CH_3NH_2). This type of amine is called a primary amine. Thus for every alcohol there can be a corresponding primary amine.

There are also secondary amines such as $(CH_3)_2NH$. We can represent the secondary amines by $\begin{matrix}R_1\\R_2\end{matrix}> NH$. Then the situation becomes the same as the ketones; the ethers and the esters and the number of possible compounds approaches 16×10^{18} for the molecules up to 30 carbons in each R.

Another series of amines is the tertiary amines such as $(CH_3)_3N$. Calculation of the possible numbers is too complicated. One can think of the number as extremely large, much larger than the number of secondary amines.

Nitrogen can have a valence of five as well as three. This makes the possibility of compounds such as $(CH_3)_4NOH$. This possibility multiplies the possible numbers many times.

The Nitro Compounds[12]

Another more or less common type of nitrogen organic compound is the nitro compound such as CH_3NO_2. There can be as many of these as there are alcohols, which is a very large number.

The Sulfur Organic Compounds[13]

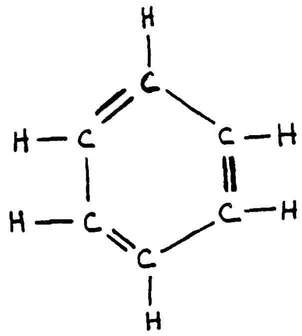
For every organic compound containing oxygen, a corresponding compound of sulfur is possible. These are the thiol, thiacids, thiesters, the thialdehydes, the sulfides, thiethers, and the thisulfates. The number of these compounds is too large to estimate.

The Halogen Organic Compounds[14]

Most of the hydrogens in all of the alkanes can be replaced by chlorine, bromine, fluorine, or iodine. This means that if in the large molecule alkanes there are almost an infinite number of compounds, then the possible organic compounds represent approximately five times that infinite number!

Organic Ring Compounds[15]

So far in this discussion we have been considering many of the simpler organic compounds, but not all of them by any means. Now let us turn to the ring compounds of Carbon. Benzene is the best known and the simplest:



Each and every one of the six hydrogens can be replaced by any of the common radicals, OH, F, Cl, Br, I, CHO, CH_2OH, CO_2H, CO_2R, SH, SO_2H, $CH = CH_2$, or one at a time, or any number of them up to six. There are an equal number of less common, but well known radicals that may replace the hydrogens of benzene. It must be remembered that as long as a ring has one carbon in it, it is an organic compound.

This edition of the ring index gives just the bare rings. Any radical can be attached, at any corner where there can be a hydrogen. The Ring Index lists 4000 rings of various complexity, up to 19 rings in a molecule. (See Reference 15.)

Besides carbon at the joints of the rings there may be N, S, O, and various metals. The common elements N, S, and O may occur several times in any of the rings. A single ring may vary in size up to 18 atoms. At every joint there will be a substitutable hydrogen to build up the valence of Carbon to four, and nitrogen to three. No one could afford the time to try to estimate the number of possible ring compounds. As far as man is concerned it is a fully infinite number. God has all of it in His mind.

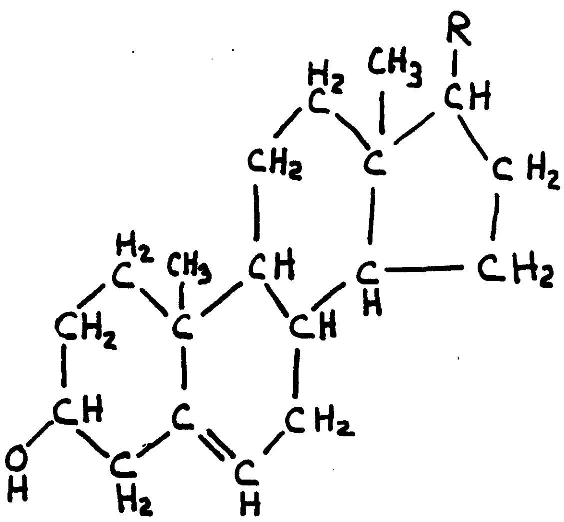


Figure 1. Steroids and cholesterol-like compounds are built on this 4-ring system. R is the varying and distinctive portion of the molecule making it, for example, cholesterol, vitamin D, a bile salt, or a sex hormone.

Chemists are presently specializing on certain ring compounds because of their great physiological properties. We have in mind the steroids and cholesterol-like compounds. These are built on a 4-ring system.

Chemists are patenting about 200 derivatives of this ring system every month. This can go on to "Dooms Day" without more than sampling the possibilities.

What we have pointed out so far is only the beginning of the possible organic compounds. One would be foolish to try to estimate the numbers of possible compounds in the more complex systems. Such complicated classes are the alkaloids[16], the proteins[17], carbohydrates[18], cellulose[19], polyesters[20], and dyes.

Only God fully understands all of organic chemistry. What he has revealed to man is only a small part of what He in his infinite wisdom knows. Each new discovery of man leads to many avenues that are unexplored and we see the truth of Ecclesiastes 8:17 illustrated in the field of organic chemistry: "Then I beheld all the work of God, that a man cannot find out the work that is done under the Sun: because though a man labour to seek it out, yet he shall not find it; yea further, though a wise man think to know it, yet shall he not be able to find it out."

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