A HISTORY OF CHEMISTRY

Bolded capitalized words are in the Glossary at the end.

I. Chemistry in Antiquity

Chemistry deals with the physical world of matter. At first thought, nothing could seem to be more ordinary than the material world, so why did modern chemistry develop so late in history? The truth is, however, that the chemical properties of matter are so startling that reflecting on them can seem like a dream - unreal and far removed from ordinary life. After all, who would think, just by looking at an ordinary glass of water, that in that one glass are uncountable numbers of water molecules?

When you drink a glass of water, you are drinking a number of water molecules far exceeding the cumulative human population since creation. Dividing these molecules evenly among all people who have ever lived would give each person beginning with Adam and Eve a trillion molecules of water!

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Did You Know?

Some of the water molecules you drink from a glass today may also have been drunk by Jesus Himself 2000 years ago, or by Alexander the Great, or by King David, or ... by Adam! The water molecules you drink today may have been part of the global Flood waters on which the Ark floated, or a small portion of the water gathered by the woman at the well in John 4.

Each molecule of water might have quite an interesting story to tell. However, none of this would be possible were water and matter generally not made of molecules.

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The incredibly tiny atoms and molecules making up all matter are a powerful testimony to the great and benevolent power of God. Who else but God could create, then organize, countless atoms and molecules into the earth and all of its life, not to mention the cosmos with its trillions of stars and galaxies? The atomic and molecular structure of matter is one way in which God shows us His awesome organizing and preserving power. Romans 1:20 alludes to this power by saying, "For the invisible things of him from the creation of the world are truly seen, even his eternal power . . ." **Through its discovery of the atomic and molecular structure of matter, chemistry has revealed the power of God in a marvelous way.**

Equally amazing is the fact that God today continues to preserve His creation. Even now He is governing the position and the motion of each atom and molecule in the universe. Indeed, Colossians 1:17 states, "By him [Christ] all things consist [are held together]." This is also what Hebrews 1:3 means by teaching that Christ is upholding all things "through the word of his power." **Chemistry of all the sciences is one of the greatest testimonies to the preserving power of God. It testifies to the power of God's word, since it is by His word that He maintains the organization of the cosmos.**

The intricacy of the creation revealed in chemistry also explains why chemistry was one of the last modern sciences to develop. **Ancient peoples knew much practical chemistry, but they understood little about the basic structure of matter.** They were skilled at making dyes, pigments, and concrete. They made metal alloys such as brass and steel which they used to produce analog computers and other ingenious implements. Many of these skills were so advanced that it is obvious that ancient peoples were not primitive.

Ancient skills reveal that man has always had technical abilities as part of his being made in the image of God. However, **only in recent centuries have scientists begun to unravel basic secrets of the nature of matter.** This knowledge has enabled modern chemistry to recreate in some parts of the world a level of comfort for living comparable to that of pre-Flood civilization.

As an example, people before the Flood often lived a very long time. To a small degree, modern chemistry applied to nutrition and medicine has enabled mankind to reach the highest life expectancies since the Flood. Because of these advances, people are living longer than they were a century ago.

Many of the sciences were well established in antiquity. The ancient Babylonians were skilled astronomers. They predicted solar eclipses years in advance. The Greek philosopher Aristotle more than 2,000 years ago performed biological dissections of plants and animals with a skill which would remain unmatched until centuries later. Greek inventors such as Archimedes discovered principles of physics such as the law of buoyancy, and Roman architects and engineers built roads and aqueducts so durable that many remain standing and usable today.

Nevertheless, chemistry did not develop in ancient times. At first it might seem puzzling why this was so, but ask yourself -- How long would you need to discover that matter is truly made of atoms and molecules? Though electron microscopes now make it possible to see these particles, the first scientists who taught that atoms and molecules are real acted on hunches from indirect evidence.

It is sometimes claimed that Greek philosophers first conceived of the modern idea of atoms. The philosopher Democritus, it is said, described atoms over 2,000 years ago. This claim is not really accurate. Democritus did little scientific research to back up his atomic idea. Like most Greek philosophers, Democritus believed that the universe had evolved out of chaos, a belief like that of modern evolution.

To Democritus, the origin of the cosmos would have been most chaotic if it were made of innumerable atoms unpredictably careening in every conceivable direction. Occasionally, Democritus reasoned, atoms would unpredictably come together to form the different heavenly bodies, or to form living things. To Democritus, for evolution to be possible, matter must exist as atoms. This is a religious or philosophical position, not a scientific one. Thus it is not true to say that the modern concept of atoms originated with Democritus.

II. Alchemy vs. the Beginning of Modern Chemistry

In the Middle Ages, the study of matter was not called chemistry, but "alchemy." Sometimes it is claimed that the alchemy of the Middle Ages developed into modern chemistry. Like the misconception about Democritus, this is not really true either. Though the alchemists did invent some of the glassware and other laboratory equipment still in use today, modern chemistry did not begin with the alchemists. **The alchemists came no closer to discovering the basic structure of matter than did the ancient Greeks.** Modern chemistry did not begin its development until scientists had rejected the futile teachings of alchemy.

Modern chemistry developed in two major stages. The first stage was a direct result of the Reformation of the 1500s. The Reformation placed a high emphasis on Bible reading as the only source of true spiritual knowledge. Peoples' desire to read the Bible led to the desire to read and be educated about other matters as well. People began studying the physical world for themselves rather than trusting what ancient authorities such as Aristotle had taught. One such person was Robert Boyle, whose life overlapped with that of Martin Luther.

Born in England, Robert Boyle began life as many others in his time, with a strong belief in alchemy and the occult. Later Boyle was converted. He rejected the superstitions of alchemy and published The Skeptical Chymist, in which he described alchemical fallacies.

In a real sense, this book was the earliest modern chemistry text, because **Boyle for the first time defined an element as a substance which cannot be chemically decomposed.** Armed with this definition, scientists were able to test any substance to see if it could be decomposed by a chemical reaction. If it could not be decomposed, it was an element. In the two centuries following Boyle's death, chemists using this simple test discovered most of the known elements, many more than the few elements the alchemists had stumbled upon in the millennium before.

The second major stage in the development of chemistry was a result of the Industrial Revolution. The Industrial Revolution began somewhat before 1800. It was arguably an indirect result of the Reformation. A growing prosperity was one effect of the Reformation in the countries it affected most.

As already mentioned, a major emphasis of the Reformation was on reading and learning the Bible. The Bible, the Reformers taught, is the only right guide for the life to come. However, the Bible also teaches much about living wisely in this life.

As people in countries like England began applying biblical principles, they worked industriously, they saved part of their income, and they cared for their possessions. These patterns of life lead to prosperity. By the 1700s, prosperous people in England had accumulated money to spend. One of the items they were most willing to purchase was clothing. Up till then, the average person had only one set of clothes which he wore continuously until they wore out. Cloth and the thread to make it was extremely costly because it had to be tediously handmade.

In a large family, the mother would be continuously spinning thread of wool, cotton, or flax grown on the farm, then weaving cloth, and finally making clothes just in time to replace each person's worn out set. This was demanding, backbreaking labor. By the late 1700s, many English families had become prosperous enough to want to "buy" their way out of this endless drudgery. They were willing to pay to have other people make their clothes for them.

III. Effect of the Industrial Revolution on Chemistry

As a consequence, ingenious inventors searched for ways to make thread and cloth by machine instead of by hand. By 1800, huge factories were producing so much cloth that a moderately well-to-do family could buy material sufficient to make several sets of clothing for each family member. The Industrial Revolution had begun.

Now the old scarcity of clothing was replaced by a new problem: unless the family were very wealthy, most of the clothing had the same color -- white or off-white. With only one set of clothes, people didn't care what color they were. With many clothes, people desired different colors for variety.

This demand grew until by the mid-1800s, there was a huge demand for inexpensive colored cloth. Though the manufacture of cloth had been mechanized, the recovery of dyes from natural sources remained a slow and very expensive hand process. Anyone who could develop a chemical process to manufacture colorful pigments for dyeing textiles would become wealthy.

Around 1850, a chemist stumbled upon a chemical reaction for making a beautiful deep purple dye he called "mauve." He made his fortune quickly and retired at a young age. However, the demand for colorful clothing was not satisfied by the discovery of this one dye. **Other chemists got to work producing other pigments. This was the prelude to modern chemistry.** In the search for new pigments, chemists learned so much about new chemical reactions that by the late 1800s, modern chemistry was under way.

The search for pigments quickly expanded into a search for other luxuries that could be made inexpensively by chemical reactions. Mauve, the first "synthetic" dye, was made of chemicals obtained from coal, the most common fuel up to that time.

Coal must be mined at great danger and expense, however, whereas petroleum can be brought up fairly easily from the earth by drilling an oil well. Consequently, by the late 1800s petroleum was replacing coal as a fuel. Chemists began looking at petroleum to replace coal as a potential source of chemicals for their reactions.

After colored clothing became inexpensive, a demand grew for floor coverings like the ones in wealthy homes. Most homes were not well heated in the late 1800s. Bare floors were drafty and cold. Wealthy people had rugs or carpeting to make cold floors more comfortable.

Enterprising chemists looked for ways to make inexpensive floor coverings imitating the look of carpeting. The first such "synthetic carpeting" was marketed as "linoleum" and was hugely popular. Linoleum could be imprinted with the same patterns used on genuine carpeting, and it did make bare floors slightly less hard and cold.

Meanwhile, other chemists looked for ways to exploit petroleum as a fuel for gasoline-powered transportation. In 1903, Henry Ford founded the Ford Motor Company. He produced the first Model T in 1908, and went into mass production of the Model T in 1913. From 8,000 cars of all types in the United States in 1900, the number of cars had jumped to the millions worldwide after World War I.

Aside from using petroleum-derived gasoline, cars have always required many parts which only chemistry can make inexpensively. These parts include seat covers and paint for the body, plastic parts for the dashboard and rubber for the tires, as well as metal alloys for the engine and moving parts.

With the outbreak of World War II, there was a danger of natural sources for rubber and other materials being cut off. Chemists in America and Europe found ways of making synthetic rubber for tires and plastics for other vehicle parts, all from petroleum.

Cars are now mostly synthetics, as is most clothing and construction materials. If these synthetic items suddenly vanished, cars would have only a steel frame, houses would have only the wood and concrete frame but no roofs or walls, and our clothes would be in tatters. Most of us would *not* want to return to a pre-chemical age as hinted in the table below.

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Chemistry Makes Our Lives Better

Made by Chemistry	Living Before Chemistry
Soap	People weren't clean, diseases spread
Dyes, colorings	Clothing in drab shades
Gasoline	No gasoline-powered cars
Deodorant	Body odor after a long day
Teflon and silverstone	No non-stick kitchenware for cooking
Hairstyling chemicals	No hairstyling, no permanents
Refrigerants	No air conditioning
Better sports equipment*	Mediocre sports performance

*better racquets, golf balls and clubs, baseball bats, vaulting poles

We sometimes think of synthetic materials as inferior substitutes for the real thing. This perception is not accurate. **Most chemical synthetics are better than the originals.**

For example, tires before World War II were made from natural rubber. They went flat every few hundred miles, not because they wore out, but because natural rubber has microscopic pores allowing air molecules to slowly escape. A modern tire of synthetic rubber holds air pressure for thousands of miles unless punctured. Even thwn, some synthetic rubbers are capable of "self-sealing" small leaks.

IV. Prelude to Modern "Organic Chemistry"

There are about one billion automobiles in the world today. In 1900 by comparison, nearly all automobiles were in the United States, and there were only 8,000 in America then. People had used horses and other animals as transportation for millennia. In the late 1800s, New York City alone was home to thousands of horses. Worldwide, horses vastly outnumbered cars in 1900. Yet in the next century the horse as transportation passed into oblivion and the number of cars skyrocketed. **The 1900s were the first century in which animals were not the main transportation.** What happened so suddenly to make this possible?

There were two factors: the development of gasoline and automobile engines designed to burn it. With all the news about air pollution today it may be surprising to know that **horses made more pollution than cars.** In New York City horses left thousands of pounds of droppings per day in their tracks. The droppings formed a dust in dry weather which blew with the wind into buildings and homes. Dead horses were often left to rot on the streets. These carcasses were taken to factories designed to boil the them down in a process called "rendering" which yielded glue and other products.

We tend to think of horse-and-buggy days as cleaner and perhaps "better" than life now. **In fact, even old-fashioned cars were not only faster but cleaner than horse-and-buggy transportation.** This is why people switched from horses to cars as quickly as they could afford to. Modern cars are cleaner still. **On average a modern vehicle in good repair produces less than four percent of the pollution of a car in 1970.**

The idea of automobile transportation was not new in 1900. Throughout the 1800s inventors first tried building steam-powered cars, then cars powered by massive electric batteries. Indeed, the first cars marketed in the 1890s were electric. They could not travel far before running out of electricity. They had low power and could not accelerate quickly. Steam-powered cars were even less practical. They required a huge, bulky engine.

Gasoline-powered cars were better. They could go long distances at high speed. Gasoline engines had more power than steam or electric engines. The first mass-produced car, the Ford Model T, was gasoline powered. It accelerated fast and maintained speeds of 70 miles per hour and more on the open road. What is this substance called "gasoline" that launched mankind into an unprecedented era of mechanized transportation?

Gasoline comes from PETROLEUM or "crude oil." Crude oil began forming in the Flood. In the Flood, untold numbers of creatures perished, many of them buried deep underground. Some of the remains fossilized, but others slowly decayed, especially the carcasses of marine dwellers like reptiles and fish, and possibly dinosaurs.

Deep underground in the absence of air, the remains turned into petroleum and natural gas (methane) over the years. **When we fuel up with gasoline, we are utilizing the remains of pre-Flood creatures.** Esso gasoline used to advertise, "Put a tiger in your tank!" Maybe Esso should have said, "Put an ichthyosuarus in your tank!"

Ancient peoples after the Flood used petroleum. Crude oil sometimes oozed from the depths to the surface. People called it "pitch" and used it like tar to waterproof boats. (The "pitch" mentioned in Genesis 6:14 which Noah used to waterproof the ark was a plant-like substance, not petroleum.) One of the world's largest deposits of pitch is in the Caribbean islands of Trinidad and Tobago. Pitch continues to ooze to the surface there.

It was known through the ages that crude oil would burn. It was used for torches. Ancient warriors used pitch in marine warfare, mixing it with other flammable substances to make a combination called "Greek fire." The mixture was molded into cannon-ball size bombs. Set ablaze and launched at enemy ships, Greek fire was one of the most lethal weapons of antiquity.

In Bible times, people had used olive oil or other vegetable oils as fuel for lanterns and indoor lighting. In the early 1800s, whale oil was popular, but by the mid-1800s, the price of whale oil was rising. Whales were being killed off too fast making whale oil scarce. People began looking to petroleum as a lantern fuel, and inventors began devising ways to drill for oil without waiting for it to come to the surface.

The first successful oil well was drilled in Pennsylvania in 1859. Crude oil spouted up from the depths like a fountain. This well was a "gusher." Inventors quickly realized that, unlike whale oil, petroleum deposits were seemingly unlimited. There were also untold numbers of people willing to buy it for their lanterns. Lots of money could be made. By the mid-1860s, many investors had "struck it rich" by drilling oil wells for themselves.

The most successful investor of them all was John D. Rockefeller, Sr. He founded the Standard Oil Company, known simply as Standard Oil or by its initials "S.O." It came to be called "Esso" and later, Exxon.

By 1890 Rockefeller had become the world's first billionaire. His search for oil spanned practically the entire planet by 1900. Every year Esso sold millions of gallons of "lantern oil" in China and other places then considered quite remote. Millions around the world now used petroleum.

Interest began waning in petroleum as a lantern fuel after Edison invented the light bulb in 1879. The stage was set for the global acceptance of gasoline and the gasoline-powered car. In 1875 German inventor Karl Benz had made the first practical gasoline-powered automobile. His model was the forerunner of the Mercedes-Benz make. The switch from petroleum as lantern fuel to petroleum as engine fuel happened quickly.

However, **crude oil cannot be used as is to power a car. Coming out of the ground, petroleum is a black, gummy liquid.** It must be modified for use as an engine fuel in an "oil refinery." The process of making useful fuel and other products from petroleum is called "oil refining."

Drilling for petroleum and refining it became a global multi-billion dollar enterprise called the "oil industry." Petroleum is one of the world's most important commodities. It comes closer to dominating the global economy than any other single substance. No wonder it has been nicknamed "black gold." This important substance called petroleum is also an organic substance. That is, it is a mixture of compounds containing carbon. **The science of carbon compounds is ORGANIC CHEMISTRY and is closely related to the petroleum industry.**

V. Wohler Shows that Organic Compounds Are Not Living

Petroleum is the source of most man-made or "synthetic" organic compounds. Thus we can trace most organic chemicals back to a once-living source, since petroleum formed from creatures buried in the Flood. **Generally, a compound originating from a once-living source contains carbon and is therefore organic.** As an example, all types of plastic are organic because they come from petroleum which contains carbon from pre-Flood creatures. Table 7-1 contrasts some organic and inorganic substances.

Many inorganic compounds are not associated with plants or animals. However, the real mark of an inorganic compound is that it has no carbon. Water is certainly associated with living things; all life needs it. Yet water has no carbon, so it is not organic. We say it is "inorganic."

The modern definition of an organic compound as one containing carbon is fairly new. Before the 1800s, an "organic" substance was defined as one that would burn. Thus, oil, wood, and coal were "organic," but iron, granite, and sand were not. Scientists assumed that all substances involved in biological processes were flammable. Thus, substances associated with living things were flammable and therefore organic.

In the last half of the 1700s, however, scientists realized that water, which does not burn, is also intimately involved in biological processes. In 1807 prominent Swedish chemist Jön Jakob Berzelius re-defined organic compounds as those produced by biological organisms. With the Berzelius definition, water was considered organic though it does not burn.

Scientists knew that organic substances decompose into inorganic compounds, but they had been unable to make an organic compound from an inorganic source. Then in 1828, German chemist Friedrich Wohler synthesized urea from an inorganic compound. Living creatures make urea as a waste product excreted in urine.

Wohler's discovery showed that urea could be made without a plant or animal source. Therefore, living things were not the only possible source of organic compounds. Berzelius' definition was given up. Further experiments revealed that carbon is the element distinguishing most biological compounds from non-biological ones. This realization led to the modern definition of organic compounds.

Wohler showed that, at least in theory, any organic compound can be made from inorganic chemicals. However, plants and animals are still the least costly source of most organic compounds. Plants are the main source of organic compounds in the form of billions of tons of food consumed annually by the world's animals and people. Even petroleum, the main source of man-made synthetic organic chemicals, is from an animal source.

Scientists have tried to synthesize organic compounds from plants without growing the plants themselves. For example, some plants produce sucrose (table sugar). Scientists have tried to make sucrose in the laboratory. It can be done, but simply growing the plants for sucrose is cheaper.

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Something to Think About

Carbon is the essential element in all organic compounds. Without organic compounds life would not exist. Yet carbon is rare element in the universe. It is not abundant even on earth. It ranks seventeenth by weight (about 0.03%) of the elements in the earth's crust. It makes up less than 0.2% of the gases in the atmosphere. **Almost all the earth's carbon is concentrated at the surface in plants and in limestone deposits.**

The supply of carbon at or near the surface of the earth may be the highest concentration of carbon anywhere in the cosmos. No other place is known with such a supply. The Bible says of the earth, and no place else, that God "formed it to be inhabited" (Isaiah 45:18). If evolution were true, how is it that no other planet or place has surface supplies of carbon like the earth? Rather than believing in evolution, it is easier to believe that the Creator designed the earth for life, and that He placed an abundance of carbon at the surface where He intended for life to live.

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The final three sections of this paper discuss three special topics related to the history of organic chemistry: (1) the discovery of benzene structure; (2) the discovery of Teflon; and (3) implications of genetic engineering.

VI. A Fortunate Dream: Discovery of Benzene Structure

Not all scientists have known the Lord, and even those who walked with Him have sometimes struggled with anxiety. Michael Faraday, active in the 1800s, was one of the greatest chemists of all time and knew the Lord devoutly. Yet over the years he became anxious and overwrought with scientific work to the point of suffering several nervous breakdowns.

Friedrich Kekule was another chemist of the 1800s. Trying to work out the structure of a certain organic molecule, his anxiety mounted until visions of the molecule invaded his sleep. In a dream, he saw the molecule curling around on itself like a snake swallowing its tail.

Suddenly awaking, he realized that in his dream he had seen the structure of benzene, a compound of six carbon atoms linked in a ring. Benzene was the first known "carbon-ring" compound. Its existence, however, was not a new discovery. Faraday had discovered it some forty years earlier in 1825.

We are frail creatures. We succumb to failings such as anxiety. However, God knows we are weak. "For he knoweth our frame; he remembereth that we are dust" (Psalm 103:14). As in the lives of Faraday and Kekule, the history of science shows that God uses our weaknesses for good.

What type of substance is benzene with its mysterious snake-like ring of carbon atoms? The structure of benzene is a ring of six carbons shaped like a hexagon, a six-sided figure. Benzene is a liquid with a strong odor. A term describing anything with a strong aroma is the word "aromatic."

Chemists in the 1800s described benzene as an aromatic substance. **The term "aromatic hydrocarbon" eventually came to signify any molecule with a benzene ring in its structure.** Many aromatic hydrocarbons have pleasant aromas; others have unpleasant odors. Some are odorless. The benzene ring in their structure makes them aromatic hydrocarbons.

There are compounds containing a benzene ring and other atoms besides carbon and hydrogen. These are not hydrocarbons because hydrocarbons have only carbon and hydrogen. These substances are called **AROMATIC COMPOUNDS**. Some aromatic compounds are well-known flavorings. Aromatic compounds include vitamins required for life. Niacin and vitamin B-6 are both aromatic compounds. The chart below lists some common aromatic compounds.

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Some Common Aromatic Compounds

Chemical	Use
Almond Oil	Flavoring for baking cookies and pastries
Benzene	Solvent
Mothballs	Killing moths in woolen clothes
Niacin	Vitamin required by humans
Spearmint oil	Flavoring in ice cream, chewing gum
Toluene	Model airplane glue
Vanilla	Flavoring for baking
Vitamin B-6	Vitamin required by humans

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VII. A Fortunate Accident: The Discovery of Teflon

Non-stick cook ware prevents food from sticking during cooking. The inside is coated with a special **POLYMER**. Teflon is one such polymer. Teflon is inert and stable. Hardly any solvent dissolves it. It does not burn or corrode even at extreme temperatures. It forms such weak bonds with other molecules that few things stick to it, including most kinds of glue. It's nearly impossible to glue anything to Teflon.

The discovery of this unusual substance was an accident. In 1938, scientist Roy Plunkett and a technician were experimenting with a gas called tetrafluoroethylene (TFE). A few moments into the experiment, the TFE gas stopped flowing out of its pressurized container. Thinking that the valve might be clogged, Plunkett cleaned out the valve with a wire. Still no gas. The researchers could have concluded that the container was empty and simply discarded it, but their curiosity was aroused.

The two men were astonished when they shook the container and realized that something solid was inside. Plunkett cut open the container with a hacksaw. Inside was a white powdery solid. The TFE gas had spontaneously become the polymer now known as Teflon. An accident, an observant technician, and a curious chemist all worked together to bring about a fortunate discovery. **The occurrence of an unexpected but beneficial discovery is sometimes called "serendipity."**

If hardly anything sticks to Teflon, what makes Teflon stick to the inside of a Teflon pan? Before applying Teflon to the pan, the metal is roughened. The Teflon is heated with a special solvent to liquify it, then sprayed on the metal. The solvent evaporates, the Teflon cools, but the roughened surface holds the Teflon in place like a person gripping the rungs of a ladder. As Teflon cookware grows old with use, the Teflon peels off and the cook ware loses its non-stick feature.

VIII. Genetic Engineering and Its Implications

The body contains about 10,000 different proteins. Each of these proteins must be synthesized in the body from the foods we eat. The directions for making each protein -- and all the other chemicals the body requires -- are contained in molecules called the **NUCLEIC ACIDS** -- DNA and RNA.

Chemists have learned much over the past several decades about how DNA and RNA work. Until a few decades ago, the structure of DNA was unknown. Now scientists have learned to work with DNA in the science called **GENETIC ENGINEERING.**

Each DNA molecule is like a long video tape. RNA in the cell reads instructions from the DNA "video tape" much like we would watch a video tape by running it through a tape player. With video tape, it is possible to cut out certain pieces of the tape. We can use scissors to cut a piece of tape out. Then we can "splice" the video tape back together with sticky tape. Scientists have learned how to do the same thing with DNA molecules in the cell.

We can also add new video images to a video tape. We find the place in the video tape where we want the added portion. We cut the tape with scissors, then insert the new portion, "splicing" both ends with sticky tape. Scientists have also learned how to do this with DNA.

Instead of scissors for cutting and splicing DNA, genetic engineers use chemical reactions. As an example, the only source of insulin for people with diabetes used to be natural insulin from animal sources. The supply was limited and expensive. With genetic engineering, techniques scientists make insulin in the laboratory with special microorganisms. The DNA of the microorganisms have the instructions for making insulin spliced in.

With the explosion of knowledge about DNA, evolutionists have wanted to make life in the laboratory. They believe that making "life in a test tube" would prove that God did not create it in the beginning.

Genetic engineering techniques are complex. The equipment is costly. The techniques can take hours or days to carry out. Even if scientists ever do make life in the laboratory, how would this prove that no intelligence was needed to create life in the beginning? Evolution believes that life developed by chance, but the scientist in the genetic engineering laboratory is using anything but chance to get the result he wants.

Even more importantly, scientists have never made life in the lab anyway. All that genetic engineers have done is to rearrange pre-existing cell parts. Even cloning experiments have used pre-existing parts of cells. Man has not made life from "scratch."

Furthermore, he never will. The "Human Genome Project" sought to "map" the DNA sequence of the entire human genetic code. Scientists thought that they might unravel secrets to help them truly create life. Instead, the Human Genome Project revealed that the genetic code is much more complex than scientists had thought. There are many basic things scientists still do not understand about DNA.

Though man will never create life in the lab, genetic engineering has the power -- like any technology -- to be used for good or evil. Unlike other creatures, man is made in the image of God, so the Bible gives a moral code for man which does not apply to any other creature.

For example, Genesis 2:24 sets out the condition under which human beings may have children. **The condition is that a husband and wife come together to have a family. For humans, this means that making human offspring by genetic engineering methods is wrong.** Cloning humans is wrong for the same reason. Cloning animals is not wrong, because they are not made in God's image.

The Bible also prohibits murder of human beings. Killing animals is not wrong because they are not made in the image of God. Killing human beings is wrong because man is made in God's image. Abortion of human babies for "tissue harvesting" is also wrong for the same reason -- even if the intention of tissue harvesting is to save other lives.

Except in the case of Jesus Christ Who sacrificed His life for us, the sacrifice of one human life for another is never condoned in the Bible. God prevented Abraham from offering Isaac as a sacrifice (Genesis 22:12). Neither did He allow Moses to suffer in place of the Israelites (Exodus 32:31-33). Neither should we sacrifice the lives of the unborn even with the intention of saving other lives. God has not given us that right.

The Christian must remember that not every technological possibility is permissible according to the Bible. The opportunities offered by technology should not rule our lives. The Bible must be the rule book for our lives. Yet for any of us who has misused technology, there is always God's forgiveness for the sin and wrong acts we have committed.

Glossary

aromatic compound = a compound containing a benzene ring
genetic engineering = genetics applied to technological problems
nucleic acid = DNA or any form of RNA
organic chemistry = study of carbon compounds
petroleum = crude oil; oil from the earth before refining
polymer = a molecule composed of many repeating units