Quest for a Creatorless Origin of Life - 16

Shape Matters - We noted earlier that each of the more than 5,000 biochemicals called catalysts must have a unique physical shape in order for it to be able to perform its function - to enable a chemical reaction.

In the case of the catalyst called sucrase, it is used to combine the 12-carbon sugar called sucrose with water to produce two 6-carbon sugars, glucose and fructose. The catalyst sucrase will act only on sucrose, and rejects any similar molecules. It does this by its shape. Since sucrase, like other enzymes, are proteins, they are macromolecules with their own particular 3-dimensional shape.

One particular region of the enzyme, called the active site, is a pocket or groove on the surface of that molecule. The groove acts like a hand, ready to receive the sucrose molecule. As the sucrose molecule enters the active site of the enzyme, it causes the enzyme to change the shape of its groove slightly, to make a snug fit between the two molecules.

The adjoining branches of the amino acids in the catalyst position the internal chemical bonds in the sucrose which then enables the sucrose to split into the two 6-carbon sugar molecules. These then leave the groove, which is ready to receive another sucrose molecule every 1/1000th of a second. There is no chemical change in the catalyst, and no change in the amount present at the end of the process.

It is not only in catalysts that the precise shape of the molecule is very important. Molecular shape determines how most biological molecules respond to one another. In the case of brain cells involved in the sensing of pain, the signal molecules which are released by the transmitting cell have a unique shape that specifically fits together with the shape of the receptor molecules on the surface of the receiving cell, very like a key fitting in a lock.

The attachment of the signal molecule to the receptor molecule stimulates activity in the receptor cell. In reaction to pain, natural signal molecules called endorphin attach to the endorphin receptors to relieve pain. A molecule similarly shaped to the endorphin, such as morphine, mimic the endorphin to reduce pain perception

Variation in the architecture of organic molecules can be seen in isomers. These are chemical compounds which have the same molecular formula - kind and numbers of atoms, but they are interconnected differently to give them different physical shapes. These differing structures give the isomers different attributes.

One kind of isomer is the enantiomer, where each is a mirror image of the other, like right hand and left hand. Usually one isomer is biologically active and the other is inactive. For example, the left-handed L-Dopa is useful in the treatment of Parkinson’s disease, but the right-hand R-Dopa has no effect.

More serious is the effect of thalidomide, first used as a mixture of both left and right forms to treat morning sickness in pregnant women. It was later discovered that one form of the drug worked well and caused no harm, while the other caused the birth defects. Unfortunately, after the good type is taken, the body tends to convert it to the harmful kind. But back to the main topic. As it happens, the living cell is very choosy about right-handed and left-handed molecules.