Available online at www.sciencedirect.com
ScienceDirect
Chinese Chemical Letters 21 (2010) 113–116
CHINESE CHEMICAL LETTERS
www.elsevier.com/locate/cclet

The role of nickel(II) on the homochirality of amino acids in living systems

Awni Khatib, Fathi Aqra *

Department of Chemistry, Faculty of Science and Technology, Hebron University, PO Box 40, Hebron, West Bank, Palestine

Received 1 June 2009

Abstract

The origin of homochirality in living organisms is controversial, stands out of being particularly important and a question which is still not satisfactorily answered. A mental picture of sequence of events that is thought to have preceded the existence of chirality in molecules is described. A chemical model to mimic the original abiotic conditions in an attempt to explain the preference of homochirality in living systems was tried. The effect which might have influenced this preference is presented. The surprising and unexpected results are indeed interesting, significant, repeatable and indicate that complexing alanine with nickel(II) ion alters the racemization rates of D and L isomers of the amino acid. However, why this difference happens is unclear and is difficult to explain.

Keywords: Homochirality; Living organisms; Chiral preference

The spontaneous generation of enantiomeric selectivity is an old topic in chemistry and is known to be difficult subject. In chemistry, an amino acid is an organic compound containing an amino group (NH_2), a carboxylic acid group (COOH), and any of various side groups, especially any of the 20 compounds that have the basic formula $NH_2CHRCOOH$, and that link together by peptide bonds to form proteins or that function as chemical messengers and as intermediates in metabolism. These molecules are particularly important in biochemistry, where this term refers to alpha-amino acids with the general formula $H_2NCHRCOOH$, where R is an organic substituent. In the alpha-amino acids, the amino and carboxylate groups are attached to the same carbon atom, which is called the α-carbon. The various alpha-amino acids differ in which side chain (R group) is attached to their alpha carbon. They can vary in size from just a hydrogen atom in glycine through a methyl group in alanine to a large heterocyclic group in tryptophan. Amino acids are critical to life, and have a variety of roles in metabolism. One particularly important function is as the building blocks of proteins, which are linear chains of amino acids. Amino acids are also important in many other biological molecules, such as forming parts of coenzymes, as in S-adenosylmethionine, or as precursors for the biosynthesis of molecules such as heme. Due to this central role in biochemistry, amino acids are very important in nutrition.

* Corresponding author.
E-mail address: fathiaqra2009@hotmail.com (F. Aqra).

1001-8417/$ – see front matter
doi:10.1016/j.cclet.2009.09.008

1. Experimental

The crystal structure, crystallographic data, isothermal calorimetry, ultraviolet–visible spectroscopy, gas chromatography and other physical data of the alaninato-nickel(II) complexes have been investigated [5–10].

2. Results and discussion

2.1. The first matter of the universe

The scientific hypothesis states that in the beginning there was an enormous amount of energy which transformed itself into matter and antimatter of equal proportions. At an instant and by a yet unknown process, matter became greater than antimatter. This matter formed quarks, leptons and other elementary particles, and these particles produced protons and neutrons. Thus, the first elemental nucleus, the hydrogen nuclei, was formed first. This explains why hydrogen is the most abundant element in the universe, at least 10 times as abundant as the second abundant element helium. Helium is the result of fusion between hydrogen isotopes: Deuterium (one proton and one neutron) and tritium (one proton and two neutrons). The origin of elements heavier than hydrogen in the interiors of stars is now an accepted fact, and is referred to as stellar nucleosynthesis. Two mechanisms are thought to be the vehicles of this evolution: The first is nuclear fusion by which the nuclei of lighter elements fuse to form larger and heavier nuclei. This mechanism is a continuous process in the stars. An example to this is what is known to take place in our solar system by which the sun produces enough energy for the solar system and sustains life on earth by the fusion of hydrogen isotopes nuclei into helium nuclei. In the early fifties of the twentieth century, man was able to perform nuclear fusion reaction by fusing deuterium and tritium to produce helium and releases a vast amount of energy. However, fusing heavier elements proves to be beyond the means of earth inhabitants but it takes place in the stars in the genesis of star formation. In this process (called Alpha process or atomic nucleosynthesis), lighter elements nuclei fuse to form larger nuclei. The chain of fusion events continue producing heavier elements up to the element iron that signifies the end of nuclear fusion. This is due to the fact that iron and nickel [1] have the most stable nuclei of all elements, and therefore, not possible to proceed fusion beyond nickel. The alphabets of the universe is composed of 88 primordial elements (not 28) from which the material universe is made. It is proposed that other elements heavier than iron and nickel are produced by neutron capture process or by beta emission.

2.2. The transformation of elements from nucleolus to atom

Atoms are not stable at the temperature of stellar interiors, because the high temperatures strip electrons away from nuclei to leave a gaseous plasma. Only when the nuclei escape from the star during the final stages of a star's lifetime, they cool enough to keep electrons and form atoms. It is believed that forming atoms at these relatively high temperatures make them highly reactive to form more stable entities which can stand the heat. A new form of energy, the chemical energy, is initiated after the existence of atoms. It can be said that in the beginning there was nuclear energy, and at this stage of evolution, chemical energy was introduced. It is fascinating to see that during the elemental chain of evolution and the transformation of nuclei to atoms, a new phenomenon is initiated ''the birth of chemical reactions'' thus, the start of compounds production, the alphabets of the universe are forming words (simple compounds). This happens only after the nuclei of the element is converted to atom as lowering of temperature takes place, and the ability of the nucleus to capture enough electrons to make it neutral, and the surrounding conditions to facilitate keeping these electrons orbiting around it. This development mark the birth of chemical reactions and the shift from nuclear to chemical reactions. It is worth noticing that the formation of simple ions would have come first on the chemical energy sequence (that is before the formation of covalent bonding). The energy required to remove an electron from a valence shell to form a positive ion which will initiate the formation of a negative ion to form a stable ionic compound is produced at high temperature. As temperature of the surroundings goes down, overlapping between the valences of atoms starts taking place making it possible for the formation of covalent compounds. So it is believed that the scenario of forming positive ions and negative ions have preceded the formation of covalent compounds. Thus, the formation of minerals and, thus, forming the crust of the earth must have preceded the formation of the reducing atmosphere which is made from covalent bonds between mainly two elements.