Academy of Romanian Scientists
Annals Series on Biological Sciences
Copyright ©2026 Academy of Romanian Scientists

Volume 15, No. 1, 2026, pp. 80 - 87
Online ISSN 2285 – 4177
ORIGINAL PAPERS

SYNTHON CHEMISTRY AND PREBIOTIC STAGE. FORMATION ON EARTH OF THE FIRST PROTEINOGENIC AMINO ACIDS AND THEIR POLYPEPTIDES WITH S (L) CONFIGURATION

Gheorghe SURPATEANU[1]

[1] Academy of Romanian Scientists (ARS), 3 Ilfov Street, District 5, Bucharest, Romania
*Corresponding author e-mail: gsurpa@gmail.com

Abstract: From three synthons: methylene, nitrene and carbon monoxide in nitrogen, at low temperatures, aziridinone is formed, asymmetrically compound under certain thermodynamic conditions. From aziridinone and methylene, under the influence of polarized light, the C-methyl-aziridinonyl radical, C(S) N(R), is preferably formed. From this radical and the same three syntones, 19 proteinogenic amino acids C(S) can be formed. Glycine, the only achiral proteinogenic amino acid, would be obtained from aziridinone or C-aziridinonyl radical. Part of the proteinogenic amino acid precursors by copolymerization forms the backbone polypeptide precursors, C(S). The first C(S) polypeptides would have formed from polypeptide precursors and not from amino acids. As scientific support for the above, we mention: a) in our experiments, from methylene and a mixture of: CO2, NH3 and H2O, at low temperatures, amino acids were formed; b) compounds: CH2, NH, CO, CO2, H2O, NH3, SH2, HNCO, •CH3, •CH, •SH, •SCH3 and glycine (ice comet), involved in the formation of proteinogenic precursors, are on the list of ''interstellar molecules" and c) our studies of thermodynamics and chemical reactivity, according to which at low temperatures, through interradical reactions, under the influence of polarized light, such asymmetric syntheses can take place.

Keywords: amino acids, polypeptides, S (L) configuration, synthons, aziridinone, precursors.

DOI 10.56082/annalsarscibio.2026.1.80

Introduction

Synthons are molecular fragments [1]. In many retrosynthetic diagrams, there are synthons that under certain thermodynamic conditions may exist as distinct molecular entities. When we refer to synthon chemistry, we take into account the reactions to which this type of synthons participates or could participate. Experiments [2] have shown that methylene at low temperatures (around 0 °C) forms a mixture of alcohols. Also, methylene, with carbon dioxide in water provides a complex mixture of carboxylic acids. Remarkable was the fact that methylene in contact with ammonia and carbon dioxide in water leads to a complex mixture of amino acids. Proteinogenic amino acids were also found among these amino acids.

Based on the experimental results previously mentioned and following theoretical studies of chemical reactivity, we proposed a new way of forming the first proteinogenic amino acids and their corresponding polypeptides [3-5].

In this paper, we propose a possible way after which the first proteinogenic amino acids and the first polypeptides of S (L) configuration, sinister or levo, would have formed on Earth.

General procedure

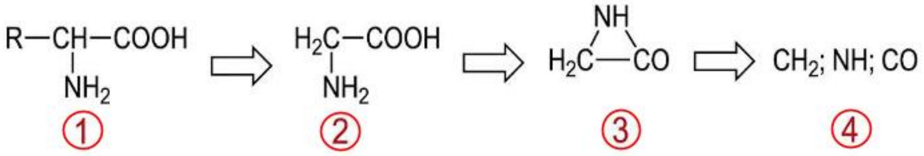
The structures of chemical sample were refined by performing an optimized geometry calculation in mechanic using successively: augmented MM3 parameters, MOPAC AM1 parameters and D-Gauss with B88-LYP, GGA functional with the DZVP basis sets [6, 7].

The structure corresponding to the reaction path, with all kinetic energy removed at every step, are calculated also in D-Gauss using B88-LYP, GGA, functional with DZVP sets. This calculation requires that input file by a transition state geometry [8, 9].

In transition state structure of the chemical sample is refined by performing a transition state calculation using B88-PW91, GGA energy functional with the DZVP basis sets [10, 11].

Results and discussion

Formally, all proteinogenic amino acids S (L) can be considered as glycine derivatives, the only optically inactive. As a result, we have considered a retrosynthetic diagram that links proteinogenic amino acids to three synthons: methylene, nitrene and carbon monoxide.



Retrosynthetic diagram 1.
Relationship between proteinogenic amino acids and synthons.”

Glycine and aziridinone appear in this diagram as intermediaries. Interestingly, in the structure of aziridinone, according to D-Gauss calculations with B88-LYP CGA energy functional, the hydrogen bound of nitrogen, a pyramidal position outside the lactamic cycle would occupy. In this situation the nitrogen atom of aziridinone would be asymmetrical. Aziridione, a chiral compound, would become the "key" intermediary in the formation of the first proteinogenic amino acids S (L) and of the first polypeptides with back-bone S (L).

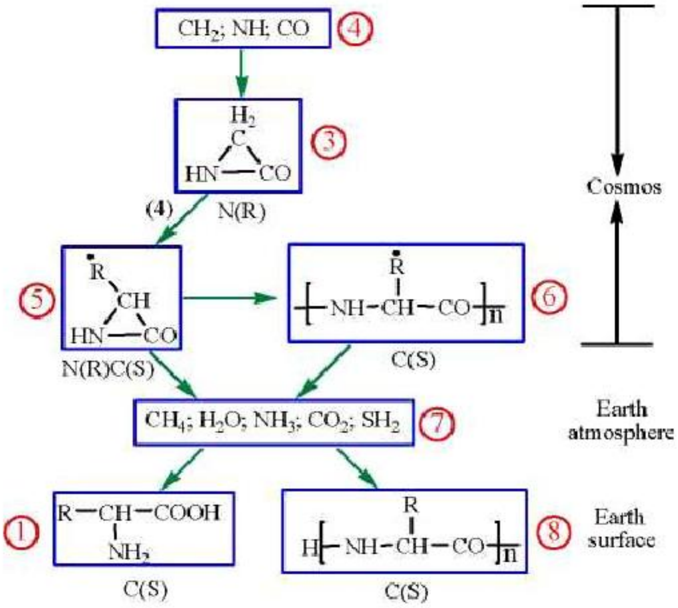


Diagram 2. Formation of proteinogenic amino acids and polypeptides

5 - aziridinonyl radicals; 6 - polypeptide radicals; 7 - primary atmosphere components; 8 -polypeptides

The three synthons carried by nitrogen, such as: diazomethane (CH2N2), hydrazoic acid (HN3) and diazocarbonyl (N2CO), at very low temperatures (why not, inside comets) would form aziridinone. It has been previously specified [3] that a multitude of other reactions can occur between the three synthons. Consequently, many compounds identified as interstellar molecules would form [12, 13].

In order to finally reach the proteinogenic acids S (L) and polypeptide with back-bone S (L), due to steric considerations it was necessary to involve aziridinone N(R) in Diagram 2. The existence of aziridinone in its N(R), N(S) enantiomeric forms seem plausible. The asymmetric structure of aziridinone with hydrogen bound of nitrogen outside the cycle plane is more stable by 3.4 kcal than that in which the same hydrogen would be coplanar to the lactam cycle. Temperature plays an important role in this asymmetric induction.

The asymmetrical synthesis between aziridinone N(R) and synthons, after which the precursors of proteinogenic amino acids would form, would have taken place at low temperatures too, outside the Earth's primary atmosphere, under the influence of polarized light. Specifically, polarized light has been identified in cosmic background radiation [14].

Next, we studied in detail the interaction between aziridinone N(R) and methylene (CH2) (Diagram 3).

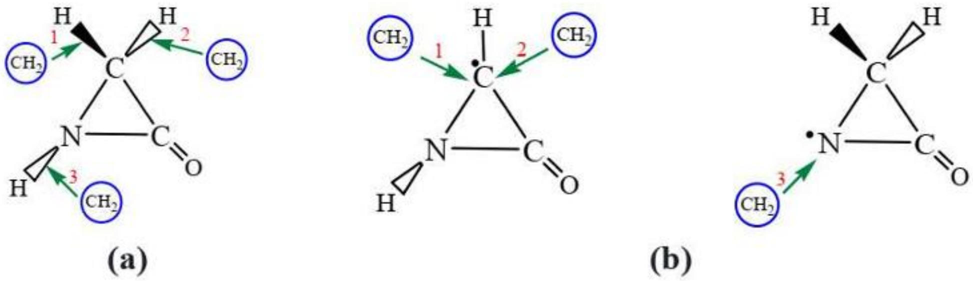


Diagram 3. Sterical attacks

(a) - formation of methyl-aziridinones; (b) - formation of methyl-aziridinone radicals

As a process we explored the entire conformational space around the carbon and nitrogen atoms of aziridinone by approaching methylene. In order to better highlight the quantitative results, the possible reaction pathways and energy states in the formation of methyl-aziridinones and methyl- one radical are suggested in Figure 1.

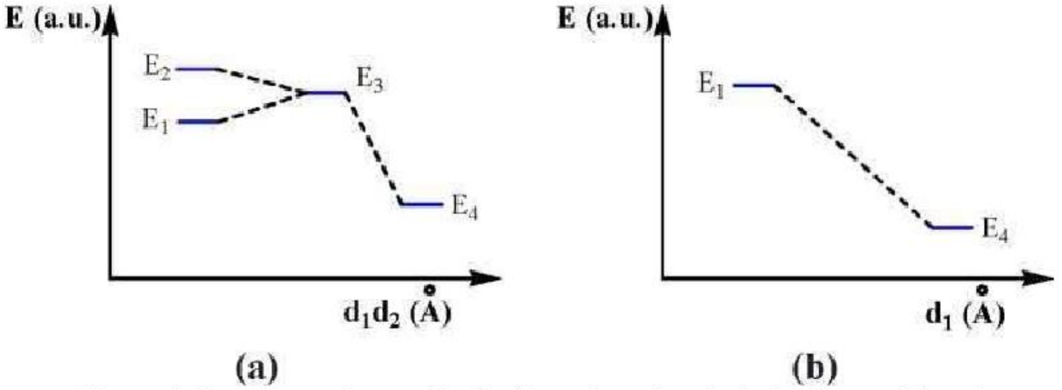


Figure 1. Reaction pathways for the formation of methylaziridinones (a) and methylaziridinone radicals (b)

In the case of methyl-aziridinones formation, after the lowest value, $\Delta E\neq$ = 1.92 kcal/mol, the anti-attack is energetically and sterically favored. This attack corresponds to the formation of the C-methyl-aziridinone precursor N(R) C(S) (Table 1). We refer to the E1 state (Fig. 1a) with the involvement of triplet methylene. A participation of the singlet methylene (initial state E2 in Figure 1a), would cause the fact that the same transformation will follow a photochemical pathway reaction (without classical transition state).

Table 1. Free energies ΔG and activation energies $\Delta E^{\neq}$. Formation of methyl-aziridinones

No	**Attack**	**ΔG (a.u.)**	**$\Delta E^{\neq}$**
1	sin	-247.15955	2.54
2	anti	-247.16191*	1.92*
3	N	-247.15501	3.17

The presence of this activation in the case of triplet methylene made us consider the involvement of the methylene radicals of aziridinone as precursors of alanine (13 - Diagram 4).

According to the ΔG values (Table 2), anti-attack would be favored too.

Table 2. Free energies ΔG. Formation of methyl-aziridinone radicals

No	**Attack**	**ΔG (200/300 K) (a.u.)**
1	sin	-246.53825 -246.54849
2	anti	-246.53946* -246.54964
3	N	-246.51876 -246.52906

The consequence would be the formation of the 13.N(R) C(S) radical with the same configuration as C-methyl-aziridinone 14.N(R)C(S).

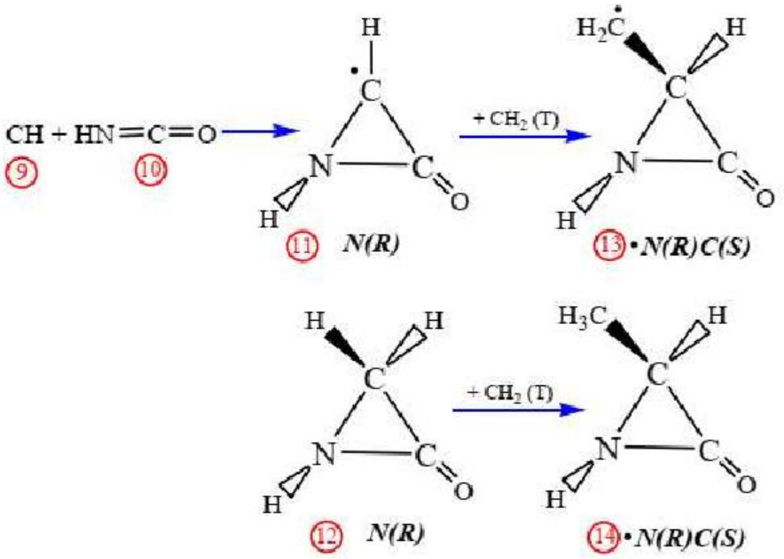


Diagram 4. Formation of C-methyl-aziridinone and of C-methylene-aziridinonyl radical

Subsequently, by interradical reactions between aziridinone and the three synthons: methylene, nitrene and carbon monoxide, we constructed all precursors corresponding to the 20 proteinogenic amino acids [15-17]. The mixture of precursors 5 (Diagram 2), by copolymerization would lead to polypeptide precursors 6 with back-bone N(R) C(S) [3].

Both amino acid and polypeptidic precursors, of radical structures, carried by nitrogen, anywere in the cosmos, in reactions with the earliest atmosphere components [18], would form at the same time the proteinogenic amino acids S (L) and polypeptides with backbone S (L). The hydrolysis reaction in the lactamic cycle destroys asymmetry at the nitrogen level. In addition, other reactions between radical precursors and components of earliest atmosphere form the proteinogenic amino acids and polypeptides with: -OH, -COOH, -NH2, S-H, S-CH3 functional groups.

In the construction of precursors, we identified many types of reactions: chaining, isomerization, cyclization, elimination, hydrolysis, ammonolysis, thiolysis, hydrogen bond insertion. Their summation leads to a so-called reaction number (Nr). Also, we summed the number of reaction components: CH2, NH, CO, H2O, NH3, SH2 as (Nc). The sum of these two numbers could be considered as a factor of structural complexity of each proteinogenic amino acid. Next, we introduced a term, the participation coefficient Cp, in the sense of measuring the ability of each proteinogenic amino acid to polypeptides formation: Cp = 5-1/Fc (5 is the Fc value for glycine). Finally,the values of the reaction enthalpies corresponding to the most difficult stages in formation of each proteinogenic amino acid precursor were correlated with characters: nonessential, conditioned essential and essential of all proteinogenic amino acids

We recall that the first polypeptides would be obtained from polypeptide precursors and not from proteinogenic amino acids. All these compounds would have remained in the water when we talk that evolution had taken place. Nitrogen remained in the atmosphere where it accompanies us today. At the contact between precursors and water,the molecular oxygen would have formed.

Conclusions

1.According to our results, the C-methylene-aziridinonyl radical C(S) N(R) would be responsible for the appearance of the first proteinogenic amino acids S(L) and of the first polypeptides with backbone S(L) on Earth.

2.We consider that the polarized light favored the formation of the C-methylene-aziridinonyl- radical C(S)N(R) as a result of an asymmetric reaction between the C-aziridinonyl radical N(R) and the methylene triplet.

3.The C-aziridinonyl radical C(S) N(R) may be obtained from aziridinone and methylene singlet or from a reaction between nitrene and isocyanic acid, both known as" interstellar molecules".

4. Molecular nitrogen plays a dual role: as synthons carrier and as reaction medium.

5. At the contact of the synthon mixture with water wouid have generated the molecular oxygen in water.

Remarks. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

[1] Corey E. J., (1988) - *Retrosynthetic Thinking - Essentials and Examples*. Chem. Soc. Rev. 17, 111-133.

[2] Surpateanu G. & Lungu N. C., (2011) - *Chemical behaviour of methilene in the presence of ammonia, carbon monoxide and water*. Rev. Chim. 62, 1107-1110.

[3] Surpateanu G., (2018) - *Syntone chemistry and prebiotic stage in life evolution 1. Aziridinone, a key compound in formation of the first proteinogenic amino acids and polypeptides*. Int. J. Astrobiology 17, 361-379.

[4] Surpateanu G. & Ghiorghita G., (2019) - *Syntone Chemistry and Prebiotic Stage*. LAP, Lambert academic Publishing, ISBN 978-620-0-11527-0

[5] Ghiorghita G. & Surpateanu G., (2019) - *The prebiotic stage and the evolution of life on Earth*, Environ. Nat. Resour. Res. 9, 86-101.

[6] Stewart J. J. P., (1989) - *Optimization of Parameters for Semi-Empirical Methods I-Method*. J. Comp. Chem., 10, 209-220.

[7] Dewar M. J. S., Healy E. F., Stewart J. J. P., (1984) - *Location of Transition States in Reaction Mechanisms*, J. Chem. Soc., Faraday Trans. II, 80 (3), 227-233

[8] Parr R. G., Yang W., (1989) - Density-functional theory of atoms and molecules, Oxford University Press, New York.

[9] Salahub D. R., (1987) - in *Ab initio Methods in Quantum Methods in Quantum Chemistry-II*, Ed. Lawly, K. P., Wiley & Sons, New York, 447.

[10] Solomons T. W. G. & Fryhle C. B., (2004) - *Organic Chemistry*, 8th ed., John Wiley & Sons, Inc. ISBN 0471-41799-8.

[11] Atkins P. & Paula J. D., (2006) - *Physical Chemistry* 8th et., W. H. Freeman and Company, New York, ISBN 0-7167-8759-8, 809.

[12] Shu Frank H., (1982) - *The Physical Universe. An introduction to astronomy*. University Science Books, ISBN 978-0-935-702-05-7.

[13] Dalgado A., (2006) - *Interstelar chemistry special feature. The galactic cosmic ray ionization rate. Proceeding on the National Academy of Science*, 103, 12269-12273.

[14] Luminet J. P., (2014) - *100 questions sur l'Univers*, Edition la Boetie, p. 36.

[15] Surpateanu G., Nistor I. D., Georgescu A. M., Lungu N. C., (2019) - *Syntone chemistry. Theoretical study on the formation of glycine, alanine and serine*. Rev. Chim., 70, 1707-1711.

[16] Surpateanu G., Nistor I. D., Georgescu A. M., Lungu N. C., (2020) - *Syntone chemistry. Theoretical study on the formation of cysteine, aspartic acid, asparagine and threonine*. Rev. Chim. (submitted, manuscript ID 20.0051).

[17] Surpateanu G., Nistor I. D., Georgescu A. M., Lungu N. C., (2020) - *Synthon chemistry. Theoretical study on the formation of valine, leucine, isoleucine and methionine*. Rev. Chim. (accepted, manuscript ID 20.0113).

[18] Zahnle K., Schaefer L., Fegley B., (2010) - *Earth's Earliest Atmospheres*. Cold Spring-HarbPrspect. Biol. 2, a004895.