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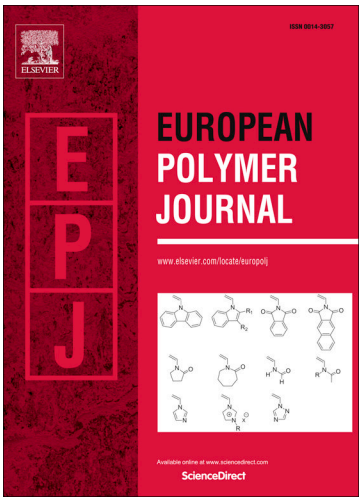

Prebiotic Macromolecules and Today's Biomacromolecules in the Light of Polymerology

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Prebiotic Macromolecules and Today's Biomacromolecules in the Light of Polymerology

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Abstract:

The appearance of life and thus of biomacromolecules on Earth is related to the presence of small organic molecules, polymerized under prebiotic environmental conditions. However, none of proteins, polynucleotides or polysaccharides taken individually is a true biomacromolecule, because biomacromolecules result from mutual involvements in complex biological processes. Logically, the biomacromolecules involved in the first living cells were first macromolecules formed under early Earth environmental conditions. The appearance of such living cells required macromolecules with fundamental features like controlled synthesis and structures, compatibility with aqueous media, chirality, memory, replication, and recycling that had to respect corresponding fundamentals of polymer science referred to as polymerology. After a recall of relevant basics of chemical reactions, the prebiotic appearance of macromolecules is critically compared with today's polymer science including chirality, stability, degradation, and recycling. Instead of providing arguments in favor of consistent routes to the first biomacromolecules, the reference to polymerology emphasizes obstacles that complement those occasionally found in the origin of life literature. In front of this conclusion, the discussion is extended to the other ends of these routes, i.e. today's biomacromolecules. The comparison with polymerology emphasizes the pertinence of the natural choices that led to the outstanding smartness of biomacromolecules. Polymerology is still in its cradle after less than a century of existence. For the future, it is suggested to pay increasing attention to chiral, multimeric multifunctional macromolecules to enrich the population of smart polymers, to solve the problem of plastic pollution, and, maybe, to enlighten the mystery of biomacromolecules emergence under unfavorable conditions.

Keywords: prebiotic chemistry, origin of macromolecules, chirality, polymer science, biomacromolecules, origin of life.

1. Introduction

"Bang", a sudden event that may have occurred about 13.7 billion years ago is the favorite vision of the birth of the Universe proposed by astrophysicists under the form of a huge condensed energy that started evolving towards particles, atoms and matter to finally form galaxies, stars, and planets [1]. The origin of the Universe is still a matter of debate. Anyhow, the Universe is definitely very old compared with the formation of our planet, about 4.5 billion years ago [2]. Earth comes from extremely hot condensed matter. Only temperature-resistant inorganic compounds existed until environmental conditions became compatible with organic matter [3-4]. Chemical elements were available individually or combined as inorganic compounds: sulfur as depot from volcanos, carbon and oxygen probably as carbonates, phosphor and oxygen as phosphates, nitrogen and oxygen as nitrates, nitrogen and hydrogen as ammonium salts, for instance. In the early times, there was no oxygen gas and no water on Earth [5]. The origin of oxygen is often assigned to the activity of newly-formed protobacteria [6]. However such assignment faces a dilemma since these protobacteria and