# Georgia Tech Awarded a $20M Center for Chemical Innovation

Georgia Institute of Technology

A team of institutions led by the Georgia Institute of Technology has been awarded a $20 million grant from the National Science Foundation and the National Aeronautics and Space Administration to pursue research that could lead to a better understanding of how life started on Earth. Researchers will focus their efforts on exploring chemical processes that enable the spontaneous formation of functional polymers -- such as proteins and DNA -- from much smaller and simpler starting materials.

“Our research team seeks to understand how certain molecules in a complex mixture can work together to form highly ordered assemblies that exhibit chemical properties similar to those associated with biological molecules,” said Nicholas V. Hud, a professor in the Georgia Tech School of Chemistry and Biochemistry. “Such a process was likely an essential and early stage of life, so we are also working to understand what chemicals were present on the prebiotic Earth and what processes helped these chemicals form the complex substances ultimately needed for life.”

Hud will direct the effort, which is known as the Center for Chemical Evolution. The five-year grant will support research in more than 15 laboratories at institutions including Georgia Tech, Emory University, the Scripps Research Institute, the Scripps Institution of Oceanography, Jackson State University, Spelman College, Furman University and the SETI Institute.

All of the researchers will work together to accomplish the Center for Chemical Evolution’s three main research goals:

- To identify potential biological building blocks among the products of model prebiotic reactions,
- To investigate the chemical components and conditions that promote the spontaneous assembly of increasingly complex multi-component structures, and
- To prepare and characterize highly-ordered chemical assemblies, and to study their potential to function like biological substances.

“We will work backward from the complex substances found in living organisms today, such as proteins and DNA, and make materials that are a little bit different and simpler in chemical structure,” explained Hud. “We will then strive to determine if there were possibly chemicals and conditions on the early Earth that would have given rise to these and similar substances.”

In addition, the researchers will translate technological developments into

commercially viable products. Facundo Fernandez, an associate professor in the Georgia Tech School of Chemistry and Biochemistry, is leading the Center's commercialization efforts.

For the first research theme, which is being led by Georgia Tech chemistry professor Thomas Orlando, creating a model inventory of the chemicals present on the early Earth will require the development of new tools and approaches for analyzing and sorting complex mixtures.

"Complex mixtures are found in many chemical industries -- including petroleum, food and pharmaceuticals," said Fernandez. "The instruments and protocols we develop to sort through the complex mixtures that result from model prebiotic chemical reactions are going to be valuable to these industries too."

Charles Liotta, a Regents professor in the Georgia Tech School of Chemistry and Biochemistry, is leading the second research theme, which involves exploring alternative media that could have facilitated the assembly of complex substances in the prebiotic world. This research could produce environmentally-friendly procedures leading to new chemical processes, according to the team.

In the third research theme, led by David Lynn, chair of the Department of Chemistry at Emory University, and Ram Krishnamurthy, an associate professor of chemistry at the Scripps Research Institute, methods will be developed to create polymers and assemblies that mimic natural macromolecules, such as DNA and proteins. The resulting methods could be used as a platform to create a range of substances with broad commercial applications across the spectrum of therapeutics, diagnostics and drug delivery materials. Lynn will also lead the Center's education and public outreach programs.

The research efforts of the Center will build on the knowledge and results gained during the past three years, during which time a smaller group of laboratories were funded by the National Science Foundation to conduct collaborative research projects and to develop a larger center.

Research progress made during the initial phase of funding includes a paper published June 14 in the journal ChemBioChem. Center laboratories showed for the first time that guanine, a component of DNA, could be produced from formamide (H2NCOH), a simple chemical known to exist in outer space.

Previous research had shown that the other three building blocks of nucleic acids -- cytosine, adenine and uracil -- could be synthesized by heating formamide in the presence of mineral catalysts, but not guanine.

Center researchers produced guanine from formamide by subjecting the sample to ultraviolet light during the heating process. The results also demonstrated that guanine, adenine and another building block called hypoxanthine could be produced at lower temperatures than previously reported.

"Our ultimate goal is to create a complete chemical pathway showing how relatively

simple substances can interact with the environment and each other to spontaneously produce complex assemblies that exhibit properties normally associated with biological substances, and perhaps shed some light on the earliest stages of life on Earth," noted Hud.

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