USING EDIBLE MODELS TO COMMUNICATE PRINCIPLES OF COMET SCIENCE: ASSEMBLING AMINO ACIDS FROM SIMPLER MOLECULES. L. Arino de la Rubia[1], J. Butler[2], T. Gary[3] S. Kuner[4] and M. Mumma[5], [1,3]Tennessee State University (3500 John A. Merritt Blvd, Research & Sponsored Programs Building, Nashville, TN 37209), [2]Dragonfly Enterprises, Nashville, TN [4]Topaz Canyon Group, LLC, Alameda, CA [5]Goddard Center for Astrobiology, GSFC, Greenbelt, MD

Introduction. When teaching science there are a variety of different activities from which an instructor can choose. Often what determines the use of an activity in a classroom are the materials required and the match of the activity to the student context and concept. This presentation outlines the ways in which edible models can be used to demonstrate principles of astrochemistry while assessing student concepts of basic chemistry.

In this activity, student makes ball-and-stick methane, ammonia, H_2 gas, and H_2O using marshmallows, bubble gum, gumdrops, and toothpicks during the first class meeting. Each student then saves his/her newly made molecules in zipper baggies for use in the next class period. During the second class period the students use the existing molecules in their baggies to construct amino acids according to a drawing of the amino acid. Each student's amino acid can then be linked with another student's, modeling a dehydration reaction which forms a peptide bond. The activity begins with individual atoms and guides students through the steps that can occur to build amino acids in nature. The steps that students take with their models can then be connected to when and where those steps occur in nature and what this process means in the context of astrobiology.

This activity reviews simple concepts in chemistry in a fun way and serves as an assessment of student knowledge of bonding patterns, elements, conservation of matter, and molecules. The activity can be completed during two separate class periods, or at one time. Both parts of the activity take approximately 1.5 hours to complete. This activity has been implemented as an outreach activity and as a high school science classroom activity nearly 50 times since its' development in 2005.

Use of Candy Models. There are many ways in which models improve student learning of science concepts, especially on the molecular level [1,2]. These models can take the form of software that allows students to control variables and see the ways in which molecules behave, or a website where students can visit demonstrations or manipulate models themselves. There are also the lower-tech plastic molecular models available from science supply companies. There are many research studies which have shown the effectiveness of these various types of molecular models with student understanding of chemistry.

Why we use edible models. The cost and upkeep of plastic molecular models can be cumbersome and software that allows students to build models requires technology that can be prohibitive in many settings. By using marshmallows, candies, and toothpicks to make ball-and-stick models students can participate individually rather than in small groups. The materials are disposable, edible, and require no special technology. The materials are also easy to move from place to place and only need purchased as-needed from a local grocery store.

Appropriate audiences for this activity. This activity can be easily modified to fit the needs of a middle school classroom, high school classroom, after school groups, or the undergraduate laboratory setting. Because of the diversity of amino acids formed in nature, students can be instructed to make only glycine molecules for a simpler version, or those students who build the model quickly can be asked to re-form another amino acid, for example phenylalanine. The level of detail provided is differentiated for the audience. This activity models not only the original Miller-Urey experiment but also allows the instructor to discuss the recent reanalysis of those results. We have also used this activity to provide an understanding of current research in comet science, making it a great outreach activity for astrobiologists to use during outreach sessions.

Informal assessment of chemistry principles. During the progression of this activity, it becomes apparent what chemistry facts (bonding patterns, nomenclature, etc.) students recall. A handout guide has been developed for the purposes of summarizing these chemistry principles, to be used at the discretion of the instructor. By noting the areas of confusion and misunderstanding expressed by students then instructor can not only determine the level of the students but also adjust future activities.

More information about this activity. This activity is contained in the Astrobiology in the Secondary Classroom activity guide. The goal of the Astrobiology in the Secondary Classroom (ASC) curriculum development project is to establish a successful model for increasing the use of authentic scientific data to connect diverse groups of high school students to the real world of science and scientists. The ASC modules are being developed by Tennessee State University in partnership with the Minority Institution Astrobiology Collaborative and the NASA Astrobiology Institute to create a high-quality curriculum available for free via the Internet. All of the curriculum implementation sites are in public schools or after-school programs in which 90% or more of the participants are African American, Hispanic, and/or Native American. The curriculum is being field-tested at eight sites: two after-school programs and high schools in six school districts around the country. Three of the seven sites are designated as NASA Science, Engineering, Mathematics and Aerospace Academies (SEMAA).

The ASC curriculum emphasizes interdisciplinary connections in astronomy, biology, chemistry, geoscience, physics, mathematics, and ethics for students and teachers to better understand scientific endeavors. During this last year of the project we are continuing to pilot-test the ASC curriculum with diverse audiences, finalize activities and data sets, and prepare the curriculum for the NASA review process in order to become an official NASA educational product.

References. [1] Harrison A & Treagust D (1996) *Sci Ed, 80*(5), 509-534. [2] Copolo C. & Hounshell P. (1995) *J Sci Ed & Tech., 4(4),* 295-205.