Focal Points

the College of Arts & Sciences

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Chemistry Department

Special Issue: The College of Arts & Sciences Award for Research & Creative Activity

The award recognizes a significant research publication or creative project appearing during the previous two years and receiving expert critical review at the regional (i.e., multi-state), national, or international level. A faculty committee, chaired by the Associate Dean, selects the annual recipient, and this year the winner is Dr. Ed Lisic, In the following essay, Dr. Lisic describes the research upon which the award was based.

--Kurt Eisen, Interim Assoc. Dean

"What is the "Focal Point?" you may ask.

The answer is...Undergraduate Research. For me, one of the most enjoyable aspects of being a professor is the mentoring relationship with research students. This occurs specifically in my lab where undergraduates perform research projects that create and study new molecules. One such project was undertaken by several of my undergraduate researchers.

Undergraduate chemistry researchers Matt Stone, Kelly Monteen, Tiffaney Mathis, Kyle Ford, Rachel Huxford (a 4+1 major in our department), and I were authors of a paper that was published in the Journal of Undergraduate Chemistry Research in 2008. The title, "Synthesis and ^{1}H NMR Structural Characterization of a Series of 5-Substituted Isatin Thiosemicarbazone and Semicarbazone Compounds," describes the type of work we published.

The reason that we are so interested in the new isatin thiosemicarbazone compounds synthesized in this study is that many thiosemicarbazone compounds have antiviral activity. In particular, isatin thiosemicarbazone is a compound that has received much attention due to its medicinally important biological properties. Similarly, methylisatin-thiosemicarbazone (methisazone) has been well documented in the literature due to its use in the treatment of smallpox (D.J. Bauer. *Ann. N.Y. Acad. Sci.*, **1965**, 130, 110.). Isatin semicarbazone and thiosemicarbazone compounds also function as anticonvulsant agents and protease inhibitors. Several derivatives possess significant anticancer activity.

This paper focuses on the synthesis and solution structure of three series of 5-substituted isatin thiosemicarbazone compounds as determined by ^{1}H NMR spectroscopy. The compounds synthesized for this study are depicted in the figure on page 2. Of the 24 compounds synthesized by the undergrads, 20 had never been synthesized and reported in the literature. Our hope is that this information can be used in developing more potent antiviral agents.

In this paper, we show that ^{1}H NMR spectroscopy is sufficient to determine that the hydrazinic hydrogen of the thiosemicarbazone product is bound into a six membered ring through hydrogen bonding with the remaining carbonyl and may be used to infer the presence of an additional weak hydrogen bond in solution. The old adage in biochemistry is "structure determines function," and we seek to structurally characterize all of the new thiosemicarbazone compounds that undergrads are synthesizing in my lab.

To the non-chemists in the college who are reading this article, what this really means is that we are able to determine the structure of these chemical compounds with an instrument that the undergraduate researchers can be trained to use on an everyday basis. The instrument is called a nuclear magnetic resonance spectrometer (NMR), and Dr. Jeff Boles, Dr. Dan Swartling and I acquired it with a funded grant from the National Science Foundation a few years ago. My older undergraduate students train the younger students on the instrument. When they are ready, they are observed using the instrument by Dr. Dan, and cleared to use it by themselves. This promotes a type of mentoring system by the undergrads in my lab.

To me, the research paper represents a contribution to science and medicine, but it also represents an approach to education, via under-

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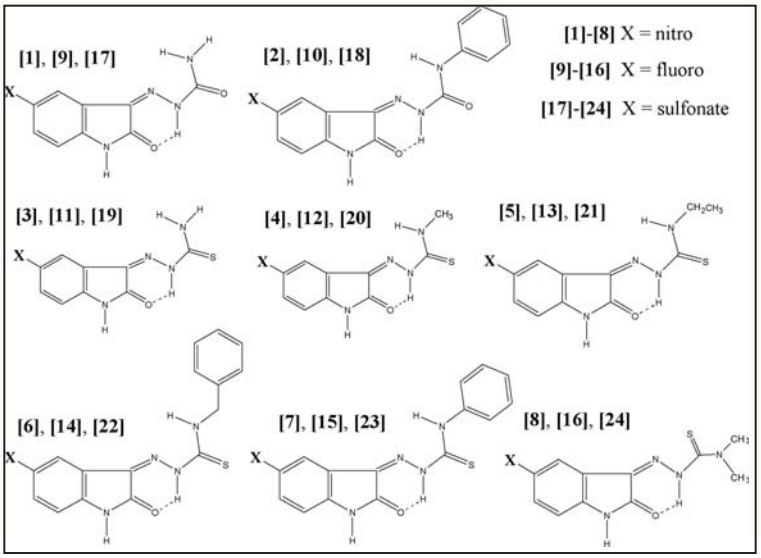

graduate research, that should be integral in training students in our professions. The process and experience of undergraduate research is extremely valuable to our students.

Undergraduate research in chemistry is fundamentally different than graduate research. Graduate students in chemistry have had laboratory training and classes in all areas of chemistry and supporting fields such as math , biology and physics, whereas undergraduate researchers don't have this experiential background from which to draw. I have found that it is better to take undergraduate research students as freshmen or sophomores instead of as juniors and seniors. This may seem counterintuitive since they have little training, but they need time to develop their skills and knowledge. They can develop those skills while doing meaningful research. The key is to spend time with them and discuss what they are doing and why, so I spend a lot of time with undergraduates.


2000 ACS meeting in San Francisco

I have also found by experience that undergraduate researchers work much better when they are a part of a group or a team. There are many reasons for this: they like a social network of friends, they are accountable for their efforts to each other, and they like to fit into a system that has a "culture of research". Individually, I discuss with them that they are NOT "working" for me, we work together on a research project for mutual benefit. If they present their research in venues such as Research Day at TTU, the Tennessee Academy of Sciences or in National and Regional American Chemical Society meetings, then these become items for their curriculum vitae and show that they have real experience.

Dissemination of research is one of the keys to success for undergraduate and graduate students. Here are two of my favorite American Chemical Society meeting photos of my students.

The first photo is from the 2000 ACS meeting in San Francisco, where all eight of my undergraduate students presented their research. Since then, four of those eight have acquired a PhD, two have acquired an M.D., and two have masters. Also, I should say that Dr. Dale Ensor collaborated with me on a project with two of those students. Dr. Ensor, along with Dr. Chris McGowan, Dr. Bob Swindell and Dr. Barbara Jackson were responsible for introducing me to the fun of undergraduate research when I arrived at TTU back in 1989, and I attribute some of my success to that atmosphere.


2007 ACS meeting in New Orleans

The second photo is from the 2007 ACS meeting in New Orleans and shows students who have worked in my lab. On the left, Rachel Huxford and second from the right, Kelly Monteen, were co-authors of this publication. Rachel is working on her PhD in chemistry at University of North Carolina, and Kelly is working on her PhD in Pharmacy in Memphis. Matt Stone, the first author on this paper, not shown in the photo, is now in medical school in Memphis. Richard Mayes, standing beside me in the photo, has just graduated with his PhD in chemistry from UT and is working at Oak Ridge National Lab. He performed undergrad research with me here at TTU. Seeing our alumni succeed, further their education and become professionals is one of the most meaningful and satisfying experiences that I have as a chemistry professor.

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