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# Professor Ihab Farag, Department of Chemical Engineering

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## mentor highlights

### Ihab Farag

Ihab Farag is a professor in the Department of Chemical Engineering at UNH. He initiated the Biodiesel Group at UNH, the Bio-Oil Team and the NH Pollution Prevention Partnership, and the Pollution Prevention Internship Program. He also initiated the International Pollution Prevention Partnership (IP3) in Thailand.

Below is our correspondence with Professor Farag about his own research and his mentoring experiences with undergraduate students.

**Inquiry:** What is the current focus of your research activities? What interests you most about it?

**IF:** My research focuses on biofuels, specifically the production of biodiesel and enhancing the quality of bio-oil. Biodiesel research in our lab focused initially on converting local waste vegetable oil into environmentally friendly biodiesel fuel that can be blended with diesel fuel and used in any diesel engine. This work started in 2003, and I was blessed with excellent undergraduate students from chemical engineering, mechanical engineering, environmental conservation, biology and biochemistry. Their research showed the economic limitations of getting biodiesel from vegetable oils (virgin or waste) and the problems with using a food feedstock to produce it. We shifted our research direction to the use of microalgae feedstock. Early studies by my graduate and undergraduate students had shown the advantages of using microalgae feedstock to produce biodiesel. The undergraduate studies also showed a heavy usage of fresh water in growing microalgae. This pointed us toward the use of impaired water, (e.g., wastewater, sea water), which we are currently experimenting with. Recent undergraduate studies by Brian McConnell, Gina Chaput, Kyle Charmanski and Seth Tremblay showed the high expense of chemical nutrients in microalgae growth. This pointed us to the idea of nutrient recycle, which we are experimenting with now. We want to show that microalgae reduce the land, water and carbon footprints of producing biodiesel. What really interests me is that our projects are not just scientifically challenging and academically rewarding, but they have important national implication: to reduce the U.S. dependence on imported petroleum-based fuel, create local jobs and prepare an excellent UNH-educated workforce.



*Professor Ihab Farag and student Brian McConnell in the UNH Biodiesel Lab.*

**Inquiry:** What are some of the benefits of including undergraduate students in your research?

**IF:** Undergraduate students got involved in my research through the Hamel Center for Undergraduate Research programs INCO 590/790: Student Research Experience, the Research Experience and Apprenticeship Program (REAP), Summer Undergraduate Research Fellowships (SURF), and the International Research Opportunities Program (IROP) along with the NH Pollution Prevention internship program. These programs provide our undergraduates with opportunities for research-based learning. While they enhance education and career

development of the student, they also benefit the faculty mentor. I am excited to exchange ideas with my undergraduate students, learn from their experiences, and make joint discoveries, some of which have resulted in grant proposals to national organizations.

**Inquiry:** What is the purpose of a mentoring relationship? What should the student and you gain from it?

**IF:** Mentoring has been around for a long time. The word *mentor* appears as a proper name in “The Odyssey” by the Greek poet Homer. Odysseus, the king of Ithaca, sailed off with his army to fight in the Trojan War. He knew that his son, Telemachus, needed someone to educate and care for him. He turned to his trusted friend Mentor. Now, *mentor* means a trusted advisor, teacher, role model and friend.

As a mentor, I guide each student through the research project. This process not only develops the student’s research skills but also helps me sharpen my mentoring and teaching skills. There are different ways of mentoring. These include supporting (use of praise to promote cooperation—this is more relationship- than task-oriented); coaching (demonstrating appropriate behaviors); delegating (giving the student responsibility—this promotes toleration of ambiguity and freedom of choice); and directing. Traditionally, I use the directing mentoring approach, in which I specify exactly what needs to be done and when and how it needs to be done. In this mentoring style, task completion and performance outcomes are emphasized. When I have a well-motivated student, I use a mix of the different mentoring approaches. I think this helps me provide each student with a strong learning and research experience.

**Inquiry:** Please tell us about some of your most memorable mentoring experiences.

**IF:** One enjoyable aspect is introducing “newcomers” to biofuels research. Newcomers are gradually “engaged” with the help, support, and hands-on experience of an “old-timer,” or a “master.” It is gratifying to witness the progress of the students as they move from “novice” to “old timer.” They acquire the skills, the habits of mind, the confidence to think for themselves and are then ready to share their knowledge and experience with a new “newcomer.”

Gina Chaput started with us as a freshman, learned all the techniques and started giving tours to lab visitors and introducing new students to the techniques of microalgae growth. She was selected to accompany UNH President Huddleston to the State House in Concord to take questions from the Legislature about the value of funding UNH. She was also selected to discuss our biodiesel work and the value of research opportunities for undergraduates during a visit by the USNH Board of Trustees. After her presentation Dr. John Aber, UNH Provost, asked Gina, “Are you sure you are only a sophomore, and not a graduate student?” What a memorable moment.

Another recent mentee is Brian McConnell, who started as a REAP fellow in our Biodiesel Lab in 2010. He did an excellent job and published a research article about his experience in the 2011 edition of *Inquiry*. He continued working with me through INCO 590, and in 2011 received a SURF award to pursue the idea of growing microalgae off-shore in wastewater. Brian and Zlatan Zuka, a McNair fellow who worked in our Biodiesel Group the summer of 2010, recently had a paper published in the *Journal of American Science* (2012;8(2):392-398). It was so gratifying when both Brian’s and Gina’s accomplishments were acknowledged by a 2012 Greater Research Opportunities fellowship from the U.S. Environmental Protection Agency’s National Center for Environmental Research.

Thad Webster also started with us as a freshman. Based on his INCO experience he received a 2008 SURF award to investigate the growth of microalgae in sea water. As a junior he was teaching new students how to start an algae run and monitor its growth. In his junior year he received an IROP to study the growth of microalgae in the warm climate of Cairo, Egypt. He did his senior Honors thesis on the temperature stressing/lipid triggering of salt water algae for enhanced lipid production. Thad also introduced a new graduate student to the subject area.

Becky Wilson started as a sophomore doing INCO 590. She received a 2010 SURF award to study the production of biodiesel in a bench-top reactor. In 2011 Becky received an IROP award to investigate the cultivation of microalgae in Qatar's hot and sunny environment using the seawater in the Gulf around Qatar. She educated students and faculty in Qatar about the concepts of microalgae growth to produce the environmentally-friendly biodiesel liquid fuel. Becky just published a paper in the *International Journal of Oil, Gas and Coal Technology* (2012: Vol. 5, No.1, pp.92-105).



*Professor Farag with student Becky Wilson in the UNH Biodiesel Lab.*

I encourage my student researchers to submit their projects to professional meetings and journals. I enjoy seeing their excitement when they receive a note accepting their presentation or paper. More exciting for me is to be present at their conference presentation and see how they respond to challenging questions; and to observe the happiness in their eyes when they are congratulated by the session chair and the audience for a job well done.

Through these experiences, the student researchers realize that research is not just a report on what someone else has already discovered, but that research is their own discovery of knowledge. It makes all the time, effort, frustration (yes, research is not smooth—there are bumps) and challenges worthwhile.

***Inquiry:*** Have you had any difficulties or problems mentoring undergraduates?

**IF:** Sometimes a novice student searches the literature or the Internet to find related articles. His or her hope is to find two or three sources that say exactly what to do and possibly what to write in a report. These students get dismayed when they do not find such sources, and they may start losing interest in the project. The role of the mentor is crucial in explaining that their projects are often original and that research is discovery.

***Inquiry:*** What advice or tips would you give a faculty member new to undergraduate mentoring?

**IF:** The term *mentor* is often used to mean a faculty adviser. In fact, mentoring is much more gratifying than advising. It is a personal and professional relationship that takes time to develop. One of the challenges is that the needs of the student and the nature of the relationship may change over time. The mentorship experience will become stronger when the faculty mentor varies the degree and type of attention, help, advice, information, and encouragement that he or she provides. It is quite rewarding to see the growth of a student under the mentor's guidance, and this may provide opportunities to apply for grants that require training undergraduates in research—a win-win situation. Happy mentoring!