

“Versatile Antimicrobial Coatings from Pulse Plasma Deposited Hydrogels and Hydrogel Composites”**Wen Chyan, Texas Academy of Mathematics and Science, Denton, TX – 2008 National Individual Winner**

Abstract: Every year, more than two million hospital patients contract nosocomial infections primarily from the formation of biofilms on invasive medical devices like I.V. needles, catheters, and breathing tubes. Antimicrobial coatings on such devices would inhibit the formation of bacterial biofilms and prevent most nosocomial infections. In this study, I utilized a novel class of materials, pulse plasma deposited hydrogels, to create polymer thin films that absorb and release Ag^+ , a potent antimicrobial. In the process of engineering the coatings, I resolved several structural difficulties, demonstrated the fine controllability of pulse plasma deposition, and developed a new electrochemical analytical method, Ultrasensitive Ag^+ Potentiometry, to test and prove the coating's effectiveness. Specific 1-amino-2-propanol hydrogel formulations exhibited important thermoresponsive accelerations of Ag^+ release at 40°C , which has important potential applications as a “smart” antimicrobial response to general infections that are usually accompanied by higher body temperatures. To further improve control of the Ag^+ release process, I designed a novel pulse plasma hydrogel-polymer composite that combines the excellent absorption properties of hydrogels with regulatory materials such as vinyl acetic acid and perfluorohexane. Pulse plasma deposited hydrogels and hydrogel composites represent a new class of versatile, finely-controllable antimicrobial coatings to reduce nosocomial infections.

Mentor: Dr. Richard B. Timmons

“Controlled Release of Nitric Oxide from Electrospun Biodegradable Fibers”**Camden Miller, Allen High School, Allen, TX and John Chen, Plano East Senior High School, Plano, TX – 2007 National Team Finalists**

Abstract: The importance of Nitric Oxide (NO) in several facets of human physiology has led to greater interests in producing materials that would release NO in a controlled manner; thus, provide a means to regulate physiological processes and preserve organs and tissues. This research attempts to create electrospun biodegradable fibers that would release NO in a controlled manner.

We synthesized DETA-NO from diazeniumdiolates and added it to a biodegradable polymer to produce an NO-releasing material. We used the electrospinning process to produce a free-standing paper material consisting of aligned fibers that are easily manipulated, thus permitting versatility for use in medical devices and transplants. Fiber morphology was evaluated using scanning electron microscopy. UV-Visible spectroscopy was used to quantify the formation of nitrite ions in water formed by NO. The PLA fibers containing the NO releasing agent was placed in a quartz cell and the UV-VIS spectrum recorded. So much nitrite was produced and the spectrum was off scale. This proves that NO can be released from the fibers upon exposure to water. Further experiments are in progress to determine the kinetics of NO release.

Mentor: Dr. Kenneth Balkus, Jr.

“FtsZ Inhibitors as Novel Chemotherapeutic Agents for Drug-Resistant Tuberculosis”

Janelle Schlossberger and Amanda Marinoff, Plainview-Old Bethpage John F. Kennedy High School, Plainview, NY – 2007 National Team Winners

Abstract: The recent emergence of multidrug-resistant (MDR) and extreme drug-resistant (XDR) strains of *Mycobacterium tuberculosis* (Mtb) has created a need for the development of antituberculosis agents with unique mechanisms of action.¹ In this study, two benzimidazole-based compounds are synthesized to yield novel antituberculosis agents. Unlike conventional antituberculosis drugs, these agents selectively target FtsZ, an essential bacterial cell division protein that is the prokaryotic homologue of tubulin.² Polymerization assays based on light scattering reveal that these compounds significantly inhibit the formation of FtsZ polymers. Determination of IC₅₀ values confirms that these agents exhibit considerably more potent activity against FtsZ than previously studied benzimidazole compounds. These results suggest that the benzimidazole-based compounds synthesized have the potential to act as effective antituberculosis agents capable of overcoming both drug-sensitive and drug-resistant strains of Mtb. After evaluating the activity of both anti-tuberculosis agents, benzimidazole and taxane-based photoaffinity labels are synthesized. These compounds are presently undergoing biological testing using MALDI mass spectrometric techniques to determine the specific amino acid sites of drug attachment to the FtsZ protein as a means of further drug optimization.

1. O'Brien, R.J.; Nunn, P., The need for new drugs against tuberculosis. Obstacles, opportunities, and next steps. *Am. J. Respir. Crit Care Med.* **2001**, 163, 1055-8.
2. Huang, Q.; Tonge, P. J.; Slayden, R. A.; Kirikae, T.; Ojima, I., FtsZ: a novel target for tuberculosis drug discovery. *Curr Top Med Chem* **2007**, 7, 527-43.

Mentor: Dr. Iwao Ojima