CHEMISTRY & BIOCHEMISTRY DEPARTMENT STUDENT SEMINAR

Probing triazine-based lipid head group modifications for nucleic acid delivery

by Maximilian Alves, '26 BMB

11:30 a.m. **April 9, 2026** **Darrah Auditorium**
McCreary Hall Room 101

Abstract:
Nucleic acids have great potential as therapeutic agents, but their size, charge, immunogenicity, and instability must be addressed in clinical applications. Lipid nanoparticles (LNPs) have emerged as a way to protect them from decomposition and to transport them through plasma membranes. LNP formulations typically contain a mixture of at least four types of lipids: a zwitterionic phospholipid, cholesterol, a PEG-ligated lipid, and a cationic or ionizable lipid. The cationic/ionizable lipids electrostatically interact with the phosphate backbone of nucleic acids to encapsulate them in LNPs, and they also play a critical role in fusing with the cell membrane and in the disruption of the endosomal membrane to release the nucleic acid cargo into the cytoplasm. The cationic/ionizable lipids play an important role in determining the physical and biological properties of the nucleic acid-LNPs, including tissue specificity. Many classes of cationic/ionizable lipids have been prepared, and with so many potential therapeutic applications of nucleic acids across different diseases, it is useful to have many lipid classes so the optimal formulation can be developed for each application.

We are preparing a library of triazine-based, ionizable lipids using cyanuric chloride as a functionalizable core. The introduction of hydrophilic head groups and hydrophobic tails to the triazine is controlled by the reaction temperature of the nucleophilic aromatic substitution reactions. Our lipids have two hydrophilic headgroups, and due to the selective, sequential nature of the synthesis, we can introduce both symmetrical and unsymmetrical headgroups. In this study, triazine-based ionizable lipids were synthesized and characterized, with emphasis on hydrophilic head group modifications. Specifically, two classes of lipids were synthesized—those with asymmetric primary amine/tertiary amine head groups and those with asymmetric tertiary amine/alcohol head groups. *In vitro* analysis at the University of Kentucky College of Pharmacy demonstrated the superior transfection of imidazole tertiary amine groups as well as improved efficiency with the utilization of 14 carbon tails (as opposed to 12 carbon tails). Additionally, lipids with asymmetric tertiary amine/alcohol head groups performed better than those with primary amine/tertiary amine head groups. Ultimately, this transfection data is able to provide a blueprint for future design and synthesis of triazine-based ionizable lipids.

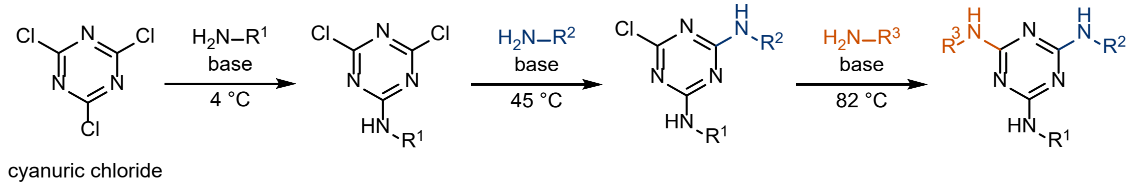

Figure 1. General synthesis of triazine-based lipids from cyanuric chloride.

CHEMISTRY & BIOCHEMISTRY DEPARTMENT STUDENT SEMINAR

Development of a non-invasive liquid biopsy for prostate cancer detection

by Savarna Goutam, ’26 Chemistry

11:30 a.m. **April 9, 2026** **Darrah Auditorium**
McCreary Hall Room 101

Abstract:
Prostate cancer remains a leading cause of cancer-related mortality, particularly in its metastatic castration-resistant form where traditional biomarkers such as prostate-specific antigen (PSA) lose reliability. PSA levels in the body reflects tumor burden up until the third recurrence of prostate cancer. However, after the third recurrence, PSA levels are no longer representative of the tumor burden, making it unreliable to detect prostate cancer. This limitation highlights the need for novel biomarkers capable of detecting disease progression during treatment-resistant stages. The Abelson Interactor 1 (ABI1) gene, a tumor suppressor involved in cytoskeletal regulation and cell motility, has been shown to exhibit altered expression during prostate cancer progression. More importantly, the exon 4–containing splice variant of AbI1 is upregulated in this disease, suggesting that it could be a potential biomarker during the post-AR phase.

Last summer, I aimed to develop a non-invasive method to detect this isoform in saliva by establishing an enzyme-linked immunosorbent assay (ELISA). This work has exciting implications for the future of cancer diagnostics by moving toward a model that is rapid, non-invasive, and accessible to a much broader population. The bigger-picture goal is to translate these findings into a COVID-like test strip using a lateral flow assay (LFA), where individuals could simply swab their mouth and receive a quick readout indicating the presence of prostate cancer–associated biomarker, in this case being ABI1. This non-invasive approach would eliminate the need for frequent blood draws, specialized laboratory equipment, and complex clinical visits, making screening and disease monitoring far more practical and scalable. By simplifying the logistics of testing, this strategy has the potential to enable earlier detection of treatment-resistant disease, improve patient compliance, and ultimately shift prostate cancer management toward a more proactive and personalized model.