Betty A. and Donald J. Baumann Family Scholarship Fund Application Form

1. **Name and NetID**

Emily Hanneken – emh08488

2. **Chemistry faculty research director**

Dr. James Fletcher

3. **Proposal title**

Photodegradable Antiseptic 1,2,3-Triazolium Salts: Exploring Structure-Activity Relationships

4. **Proposal description. Please limit the proposal to about 500 words and include figures as appropriate. Your proposal should briefly outline the overall project and its goal(s). If you have previous results related to your proposed project, concisely summarize those results and describe what you expect to accomplish during the time frame of the scholarship.**

Quaternary ammonium compounds (QACs) are widely recognized for their antiseptic properties, driven by the interplay of hydrophobicity and cationic charge that destabilizes microbial membranes. Recent studies in our group have shown that trisubstituted 1,2,3-triazolium salts, structural analogs of QACs, can exhibit tunable antiseptic activity depending on their substituent identity and molecular geometry. Building upon this foundation, my research will focus on designing photoresponsive triazolium salts that combine antimicrobial potency with the capacity for light-induced deactivation—a promising strategy to reduce environmental persistence of disinfectants after use.

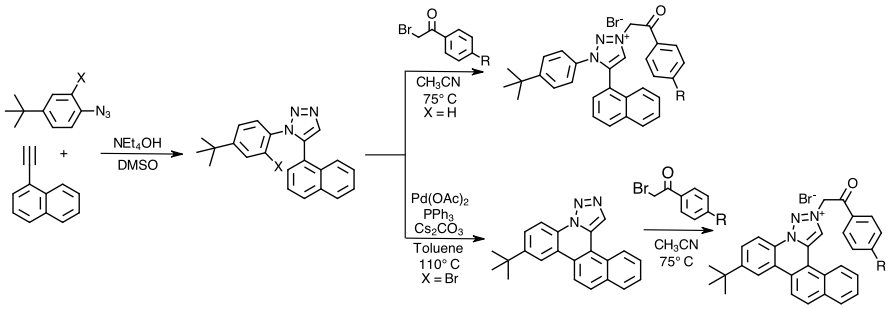

Figure 1. *General synthetic route to bridged and fused 1,2,3-triazolium salts derived from 1,5-diaryltriazole precursors. The naphthalene derivative is shown as a representative example.*

As summarized in Figure 1, target molecules will be synthesized via a modular base-catalyzed click chemistry approach, coupling azides (derived through Sandmeyer synthesis) with alkynes formed via Sonogashira coupling to yield 1,5-diaryl-1,2,3-triazoles. To probe the effect of

planarity and ring size, aryl substituents of varying size and geometry (phenyl, naphthyl, phenanthryl) will be incorporated. Bridged and fused analogs will be prepared using a palladium-catalyzed annulation reaction, providing an expanded library of triazole precursors with controlled rigidity and conjugation.

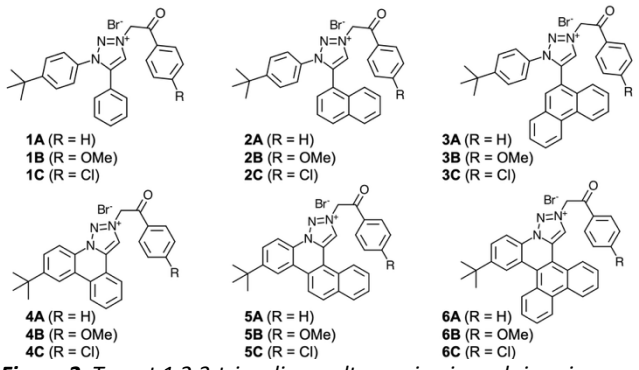

Figure 2*. Target 1,2,3-triazolium salts varying in aryl ring size, ring fusion or bridging, and substituent identity (R = H, OMe, or Cl).*

Each triazole will then be converted to its corresponding triazolium salt via N3-alkylation with photolabile protecting groups (PPGs) such as 2-bromoacetophenone, 2-bromo-4-chloroacetophenone, and 2-bromo-1-(4-methoxyphenyl)ethane (Figure 2). These PPG-modified salts will be characterized by ^{1}H NMR to confirm purity and substitution pattern. Photodeprotection kinetics will be monitored under 365 nm irradiation in d_6-DMSO using an LED photoreactor (Figure 3). The progression of dealkylation will be tracked by NMR spectroscopy, and half-lives will be determined to quantify the influence of both aryl substituent and PPG identity on photodeprotection efficiency.

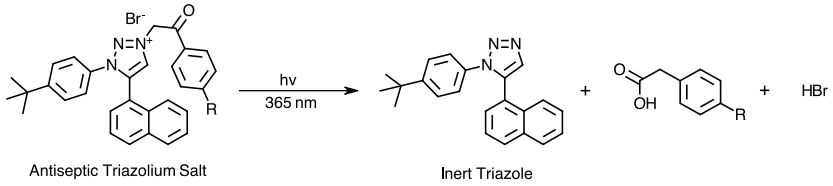

Figure 3. *Photodeprotection pathway illustrating UV-induced cleavage of the photolabile protecting group from 1,2,3-triazolium salts, resulting in formation of the corresponding 1,5-diaryl-1,2,3-triazole and loss of antiseptic activity.*

Antimicrobial testing will be conducted through minimum inhibitory concentration (MIC) assays against Gram-positive and Gram-negative bacteria, as well as yeast. Based on preliminary results, I anticipate observing clear trends linking larger, more conjugated arene systems to enhanced baseline antiseptic activity. Photolabile triazolium salts are expected to show measurable loss of activity following UV exposure, demonstrating the successful deactivation of antimicrobial function via light-triggered cleavage. These experiments will establish how both steric and electronic characteristics of the aryl substituent—along with PPG composition—affect antiseptic strength and photodeprotection kinetics. Following UV illumination studies, photodeprotection studies will be done on select analogs using a white light LED to model potential long-term deactivation of such compounds in the environment.

Overall, this project aims to establish design principles for programmable antiseptic agents that retain potency during use but can be safely neutralized afterward via light stimulation. The study will contribute to a growing body of research at the interface of synthetic organic chemistry and public health, addressing the environmental persistence and resistance concerns associated with conventional disinfectants. The final stage of this project will focus on

completing antimicrobial testing of remaining PPG-containing analogs and refining structure–activity correlations to better guide future design of photoresponsive antiseptic compounds.

5. Presentation of research results (past and future conferences, publications, seminars, etc.)

Publications

Lathrum, K., Hanneken, E., Grzelak, K., Fletcher, J. Pentacyclic aromatic heterocycles from Pd-catalyzed annulation of 1,5-diaryl-1,2,3-triazoles. 2025. *Beilstein Journal of Organic Chemistry*. Accepted for publication.

National and Regional Presentations

Hanneken, E., Lathrum, K., Fletcher, J. *Influence of arene size and geometry in antiseptic 1,2,3-triazolium salts*. Poster Presentation at ACS Midwest Regional Meeting, Omaha, NE, October 14th, 2024.
***Outstanding Poster Award in Organic Chemistry**

Hanneken, E., Lathrum, K., Fletcher, J. *Influence of arene size and geometry in antiseptic 1,2,3-triazolium salts*. Poster Presentation at ACS Spring 2025 National Meeting, San Diego, CA, March 24th, 2025.

Hanneken, E., Onyschuk, Z., Fletcher, J. *Impact of arene group identity, annulation and photolabile protecting group on photodeprotection rates of 1,2,3-triazolium salts*. Poster Presentation at ACS Midwest Regional Meeting, Columbia, MO, October 12th, 2025.

State and Local Presentations

Hanneken, E., Lathrum, K., Fletcher, J. *Influence of arene size and geometry in antiseptic 1,2,3-triazolium salts*. Poster Presentation at Creighton University Research Week, Omaha, NE, April 1st, 2025.

Hanneken, E., Lathrum, K., Fletcher, J. *Influence of arene size and geometry in antiseptic 1,2,3-triazolium salts*. Oral Presentation at Nebraska Academy of Sciences Annual Spring Meeting, Lincoln, NE, April 25th, 2025.

Future Presentations

Oral Presentation at Nebraska Academy of Sciences Annual Spring Meeting, Lincoln, NE, April 2026.

Poster Presentation at Creighton University Research Week, Omaha, NE, April 2026.

6. Post-graduate plans (job market, graduate school, medical school, etc.)

Following my graduation from Creighton University, I intend to pursue a Ph.D. in organic chemistry, beginning in Fall 2026. After completing my Ph.D. and subsequent postdoctoral work, I plan to pursue a career in academia.

7. Number of semesters involved in research, including current semester (summers count as two semesters)

8 Semesters

8. Anticipated graduation date

May 2026