# Advancement of Pathogen-Agnostic CLAROMER Peptoids as Deployable Countermeasures for Battlefield Wound Infection Treatment

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**Naval Medical Research Command | Militarily Relevant Bacterial Diseases Dept. | Combat Wounds Infection Division | MHSRS | 05 August 2026**

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Zachary Rivas has no conflicts of interest to report.

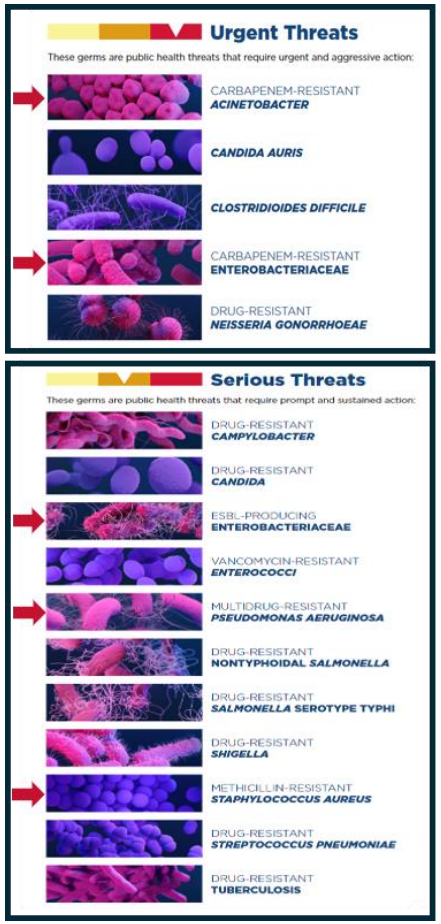
# NMRC – Combat Wounds Infections Divison

Conduct basic/translational research to develop and evaluate prevention and treatment solutions to mitigate complications from combat wound infections.

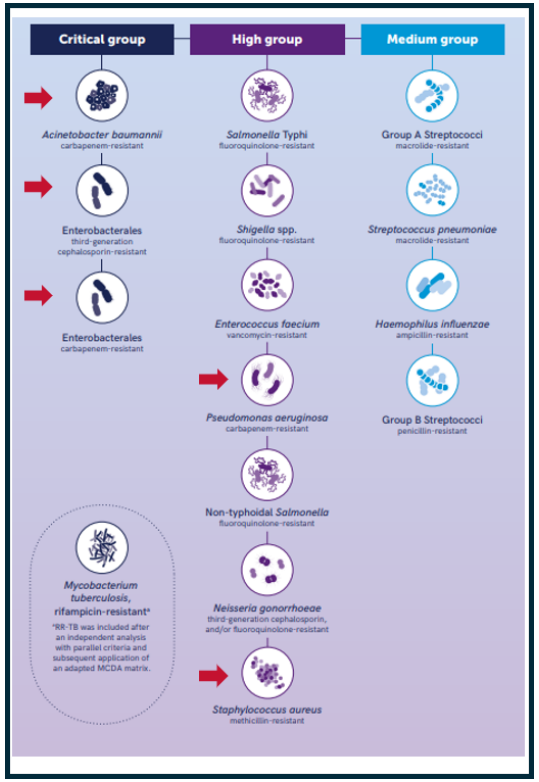
https://www.dvidshub.net/image/1355058/navy-medicine-field

https://www.dvidshub.net/image/1355070/navy-medicine-field

# The ESKAPE Pathogens




Adapted from www.cdc.gov/drugresistance/pdf/threats-report/2019




Adapted from WHO bacterial priority pathogens list, 2024

E Enterococci (*E. faecium, E. faecalis*)

S Staphylococci (*S. aureus, CoNS*)

K *Klebsiella pneumoniae*

A *Acinetobacter baumannii*

P *Pseudomonas aeruginosa*

E *Enterobacter* spp.

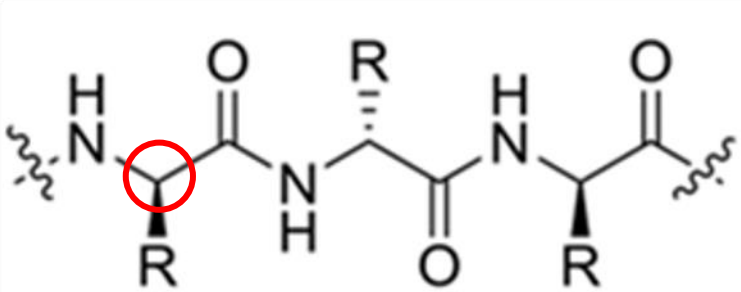
# Claromers – A Pathogen-Agnostic Solution

**NMRC**

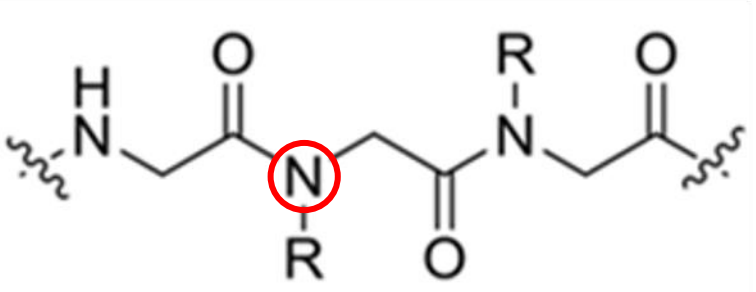
**WRAIR**

**Maxwell Biosciences**

**Peptide:**
Side groups appended to α-carbon backbone




**Peptoid:**
Side groups appended to a nitrogen backbone

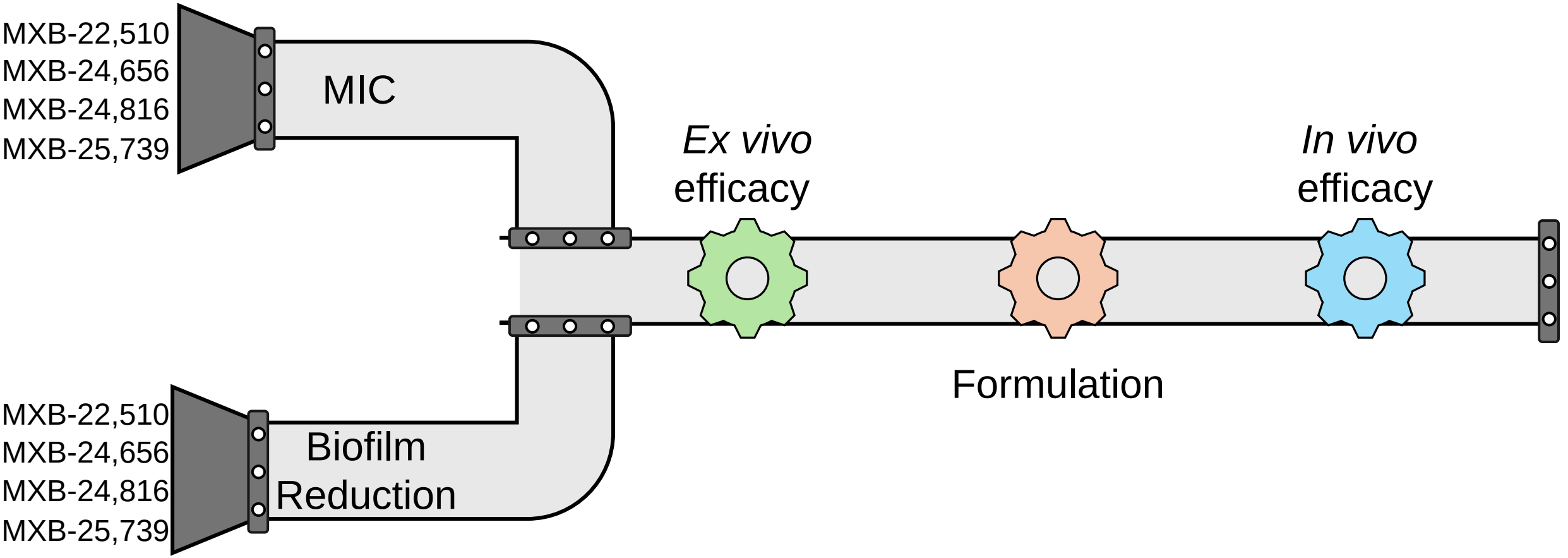



*Courtesy Maxwell Biosciences*

**Problem:** Combat wounds are vulnerable to colonization and infection by MDR pathogens

**Approach:** Evaluate CLAROMER peptoids as broad-spectrum antimicrobial candidates

# CWID's Pipeline for Candidate Evaluation




**Testing strategy:** Broad *in vitro* activity across SPAK pathogens, followed by validation in established safety & efficacy models

# Claromers Show Broad SPAK Coverage

| Pathogen | MXB-22,510 ($MIC_{50}$/$MIC_{90}$) | MXB-24,656 ($MIC_{50}$/$MIC_{90}$) | MXB-24,816 ($MIC_{50}$/$MIC_{90}$) | MXB-25,739 ($MIC_{50}$/$MIC_{90}$) | Levofloxacin ($MIC_{50}$/$MIC_{90}$) |
|---|---|---|---|---|---|
| *Acinetobacter baumannii* | 8 / 16 | 4 / 4 | 4 / 8 | 4 / 4 | 2 / 16 |
| *Staphylococcus aureus* | 2 / 2 | 4 / 4 | 2 / 2 | 2 / 4 | 0.25 - 128 |
| *Pseudomonas aeruginosa* | 4 / 8 | 8 / 8 | 4 / 4 | 4 / 8 | 4 / 64 |
| *Klebsiella pneumoniae* | 8 / 16 | 16 / 16 | 4 / 8 | 4 / 8 | 0.5 / 32 |

**Heatmap Key (based on MIC90)**

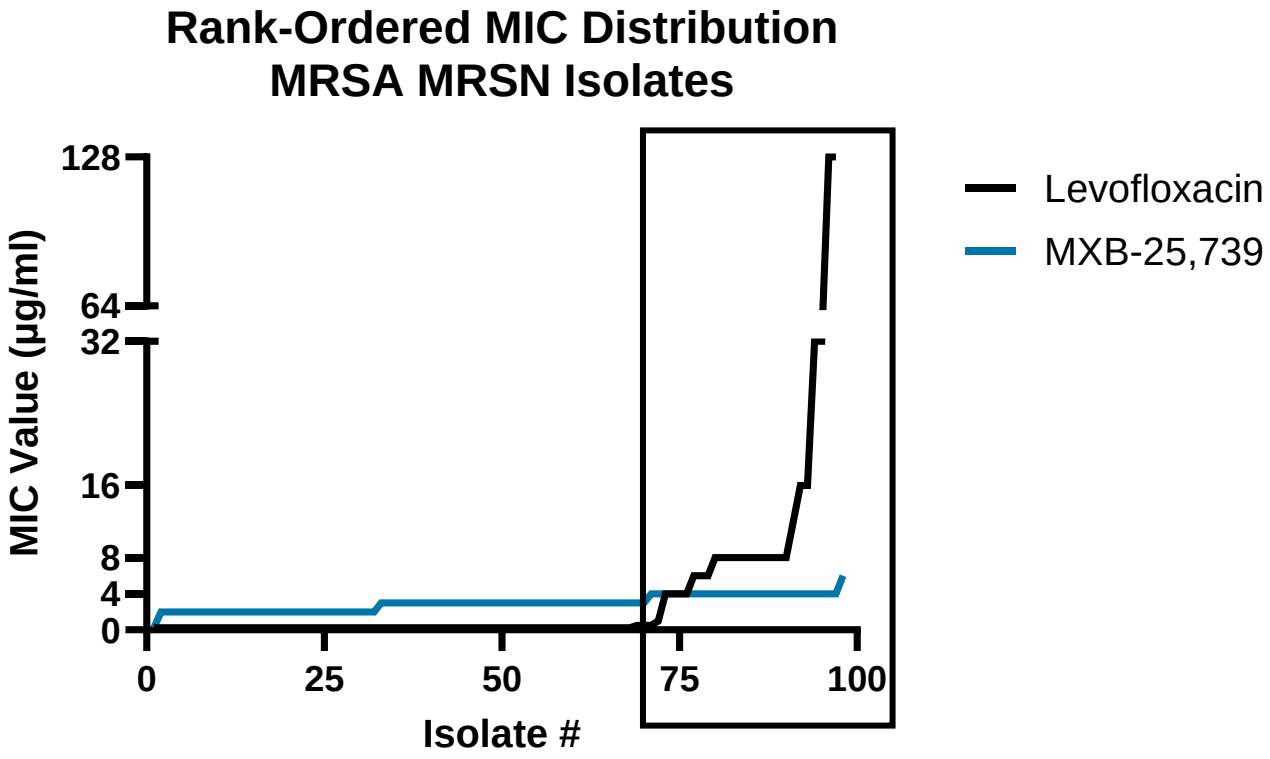
- ≤4
- 8
- 16
- 32
- 64
- 128

*Values shown in µg/ml; heatmap shading reflects MIC90*

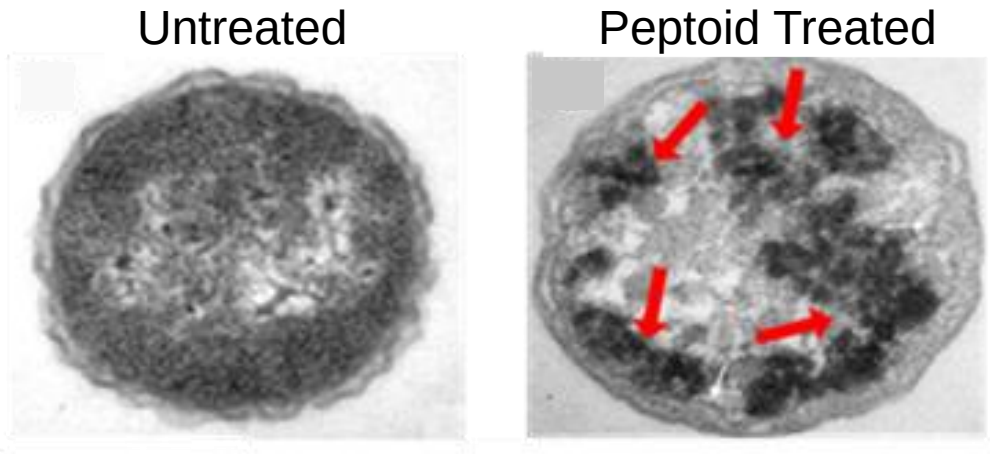
## Screening takeaway:

- Broad activity observed against SPAK pathogens
- Claromer peptoids show limited MIC50 → MIC90 shift compared to levofloxacin

# Claromers May Limit Escape Mechanisms




- Limited MIC shifts suggest activity is less dependent on a single mutable target than "traditional" antibiotics




- Peptoids have been reported to both disrupt bacterial membranes and associate with intracellular targets, including nucleic acids

*Adapted from Chongsiriwatana et al., 2017*

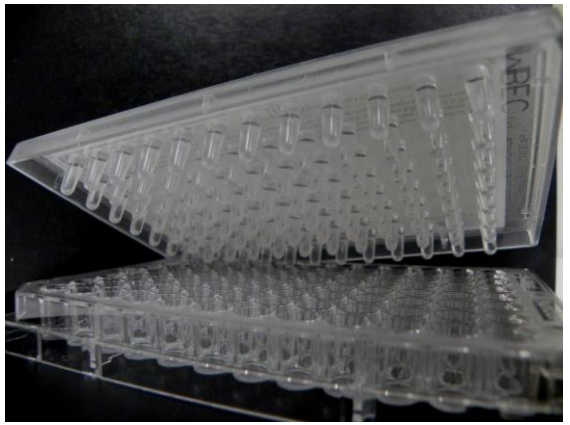
# MXB-22,510 Consistently Reduces Biofilms

## Biofilm Eradication Assay

| Mean $Log_{10}$ CFU Reduction (PBS vs. Claromer) | | | | |
|---|---|---|---|---|
| Pathogen | MXB-22,510 | MXB-24,656 | MXB-24,816 | MXB-25,739 |
| *A. baumannii* (AB5075) | 1.7 (+/- SD) | 0.6 (+/- SD) | 0.6 (+/- SD) | 0.3 (+/- SD) |
| MRSA (JE2) | 2.3 (+/- SD) | 2.3 (+/- SD) | 2.2 (+/- SD) | 1.3 (+/- SD) |
| ***P. aeruginosa* (PA01)** | **3.1 (+/- SD)** | **0.1 (+/- SD)** | **0.7 (+/- SD)** | **0.4 (+/- SD)** |
| *K. pneumoniae* (BIDMC 2A) | 0.4 (+/- SD) | 0.0 (+/- SD) | 0.2 (+/- SD) | 0.1 (+/- SD) |

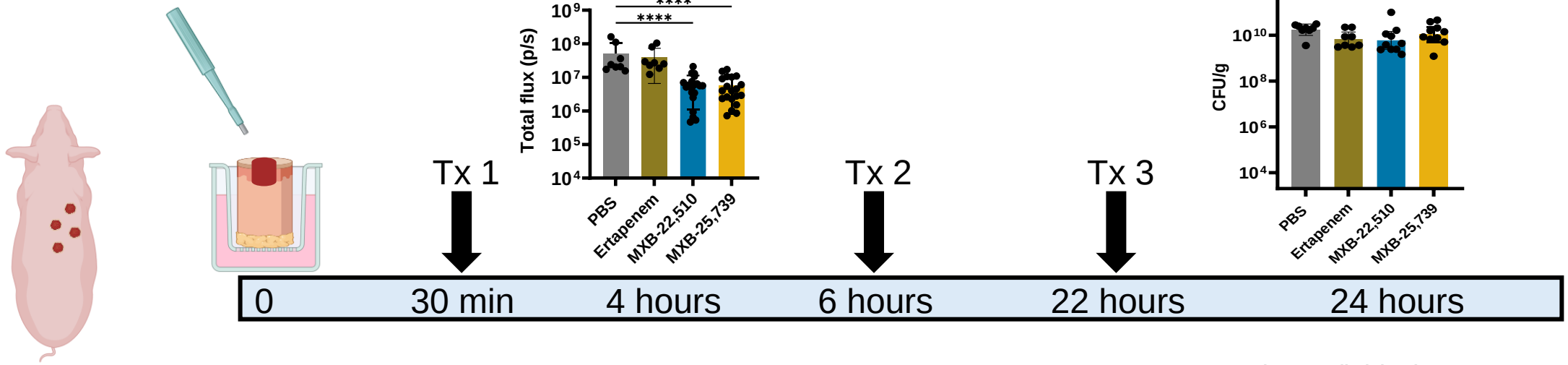
**$Log_{10}$ Reduction:** >3-log High | 3-2-log Strong | 2-1-log Moderate | 1-0.5-log Weak | <0.5-log None

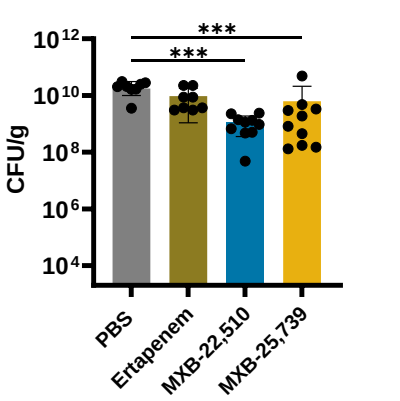
- MXB-22,510 showed the most robust reduction across both Gram-positive and Gram-negative bacteria



*Courtesy Innovotech Inc.*

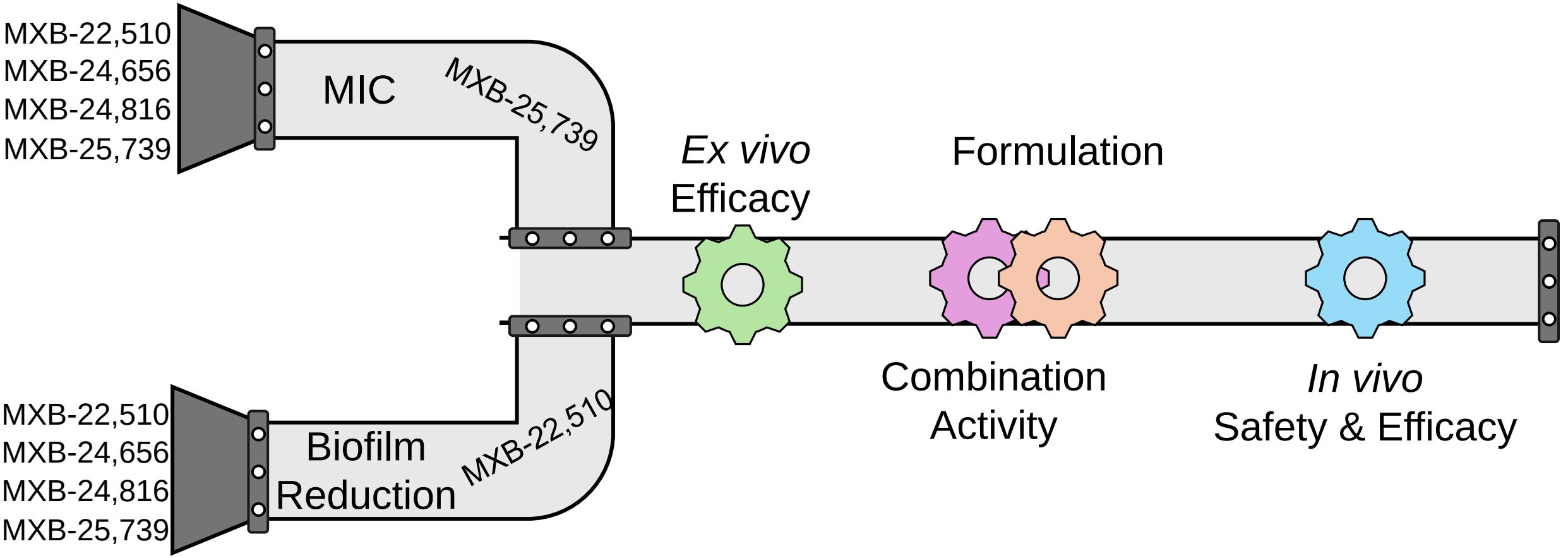
# Peptoids Reduce *A. baumannii* in Pig Skin



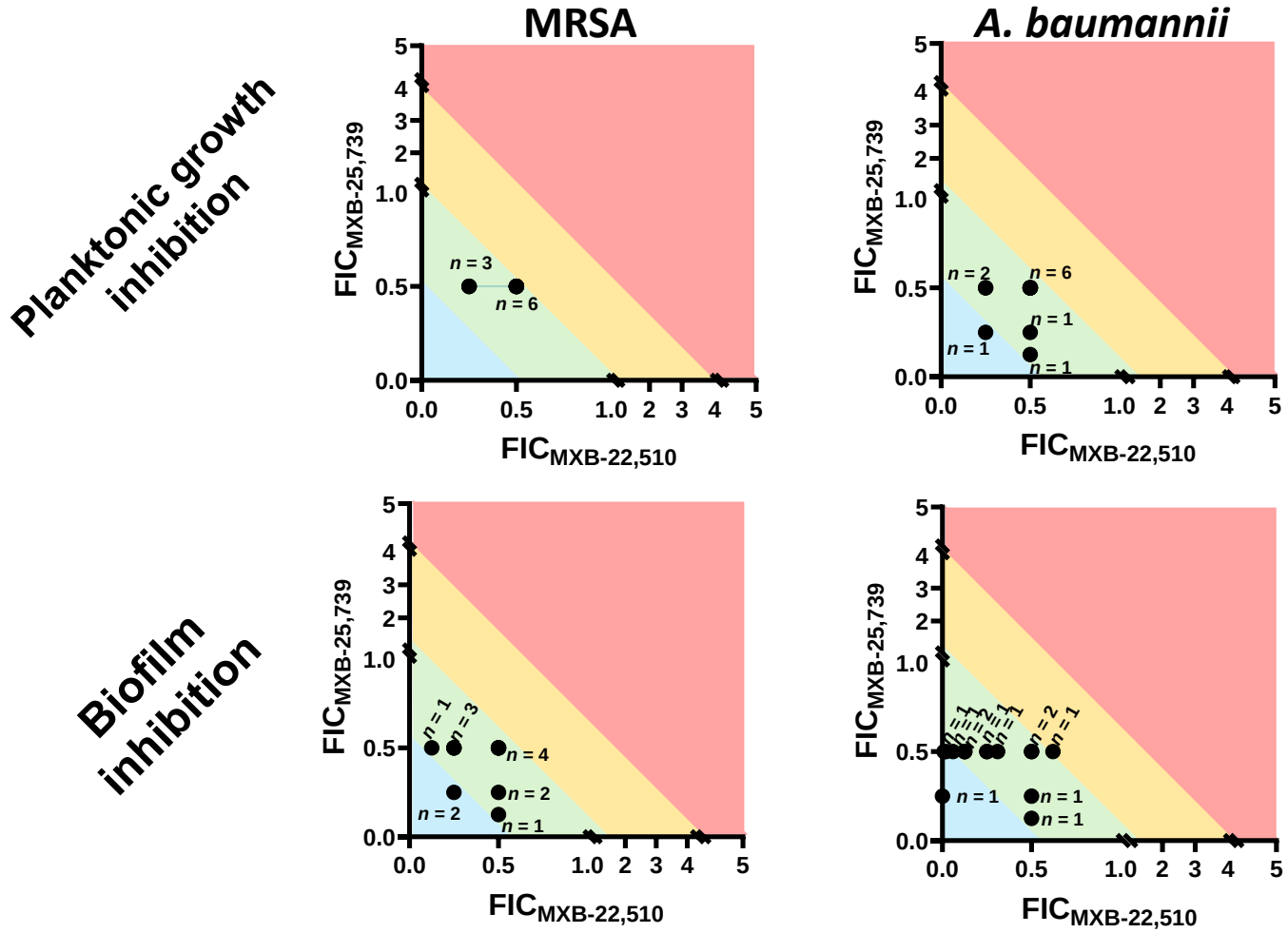

- Lead peptoids significantly reduces *A. baumannii* load at early infection timepoint
- Repeated dosing improves *A. baumannii* bacterial reduction at 24 hours

# Advance Both Claromers as a Combination




**Testing strategy:** Broad *in vitro* activity across SPAK pathogens, followed by validation in established safety & efficacy models

# Lead Peptoids Show an Additive Interaction



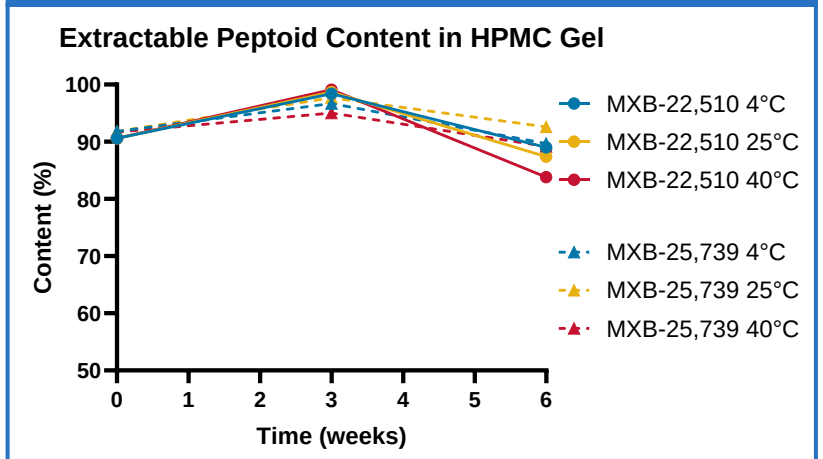

| Antagonism | Indifference | Additive | Synergy |
|---|---|---|---|
| > 4 | >1 to ≤ 4 | >0.5 to ≤ 1 | ≤ 0.5 |
| 1 + 1 = <1 | 1 + 1 = 1 | 1 + 1 = 2 | 1 + 1 = >2 |
| The combination is less effective than either drug alone. Overall antimicrobial effect is reduced. | The combination is similar to what would be expected from either drug alone | The combination is more effective than either drug alone but the effect is equal to individual effects. | The combination is significantly more effective than the sums of individual effects |

| $FIC_A$ = MIC of drug A in combination / MIC of drug A alone | $FIC_B$ = MIC of drug B in combination / MIC of drug B alone | FIC Index (FICI) = $FIC_A + FIC_B$ |
|---|---|---|

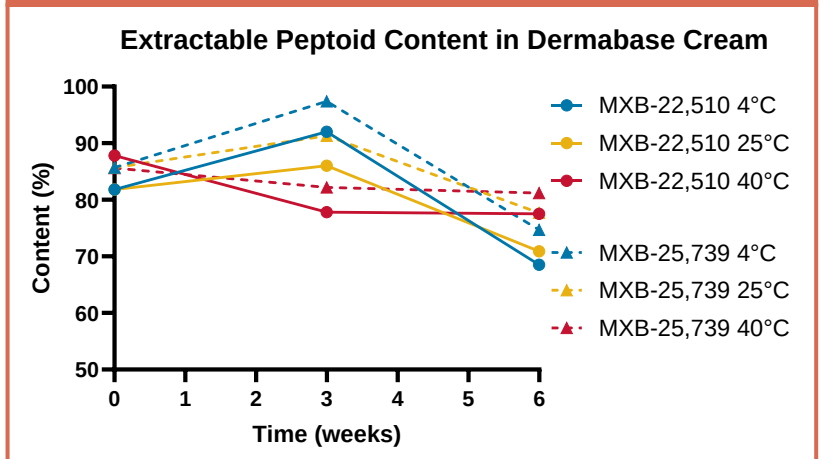
- MXB-22,510 + MXB-25,739 show no evidence of antagonism
- Interaction profiles were primarily additive, supporting further testing of the combination product

# Peptoids Exhibit High Recovery in Topicals

## HPMC Gel

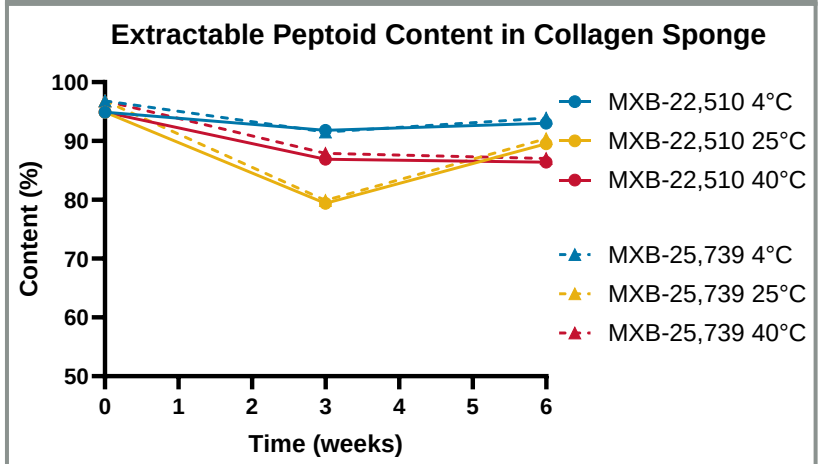


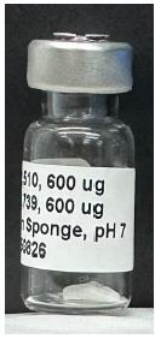

## Dermabase Cream





## Collagen Sponge

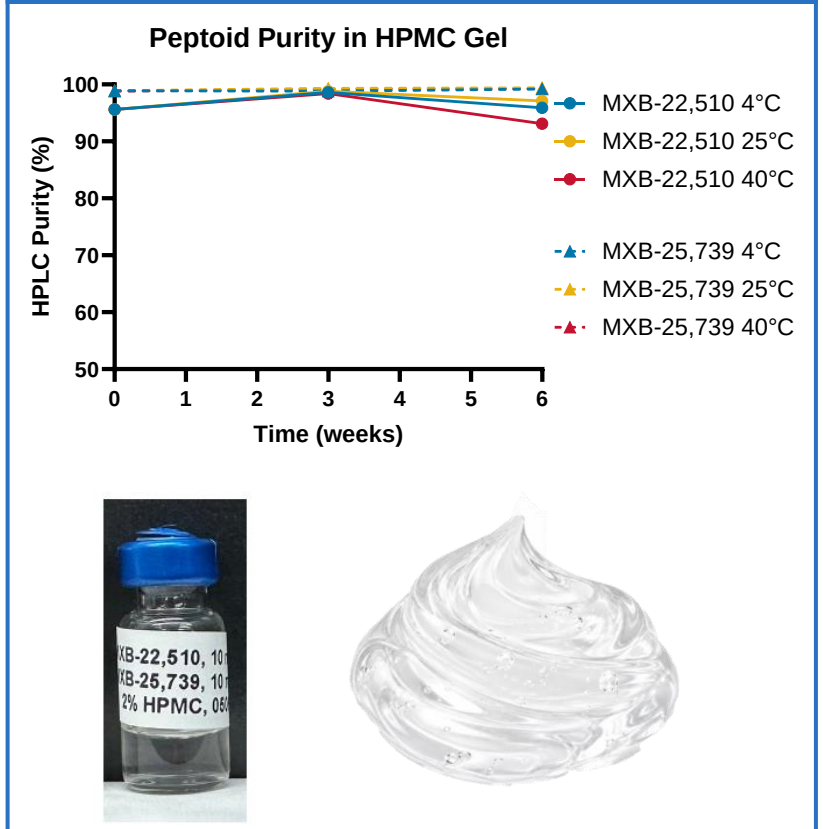



Peptoids were recoverable in all three formulations after 6 weeks, supporting continued development in all formats

# Peptoids Remain Intact after Recovery

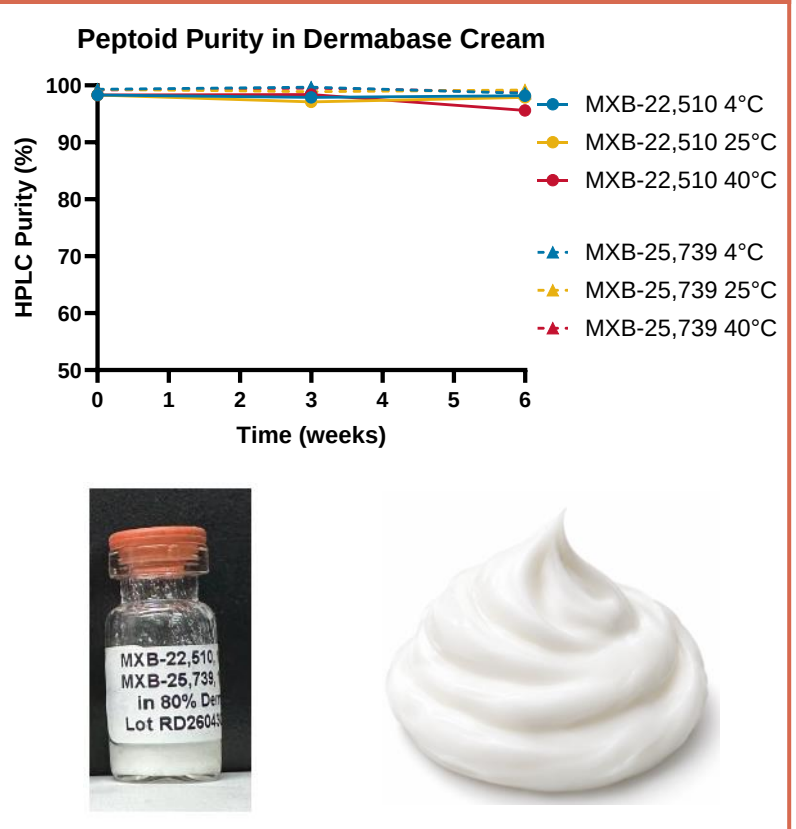
## HPMC Gel








## Dermabase Cream





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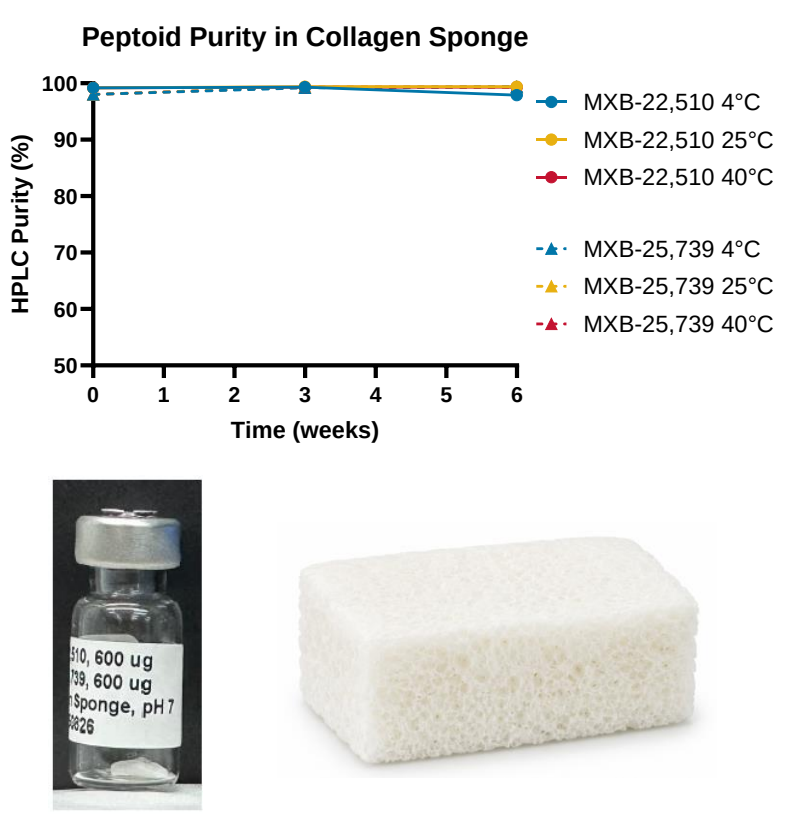






Peptoids in HPMC gel, Dermabase cream, and Collagen sponge maintain >90% purity throughout 6-week stability study

# Conclusions and Future Directions

## Conclusions

- Claromers demonstrate broad antibacterial activity against Tier-1 pathogens
- MXB-22,510 and MXB-25,739 being advanced as a combination topical product
- Early topical formulation data show product feasibility with recoverable content and purity for 6 weeks

## Future Directions

- Optimize lead topical formulations for combat wound application in models
- Define local tolerability, dosing regimen, and wound-site exposure
- Confirm efficacy in animal wound models

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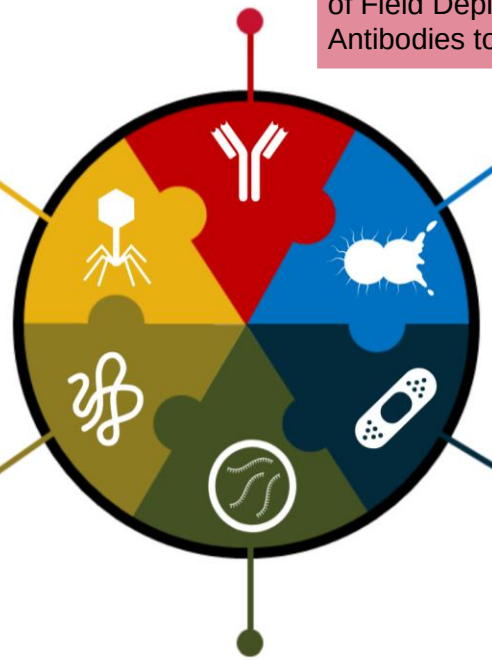
# Thank You For Your Attention

## Monoclonal Antibodies

**Dr. Lucas Brown: MHSRS-26-5513 (poster):** Evaluation of Field Deployable Broadly Neutralizing Monoclonal Antibodies to Counter MRSA Infections in Combat Wounds.



## Bacteriophages

## Anti-Biofilm Agents

**Dr. John Vitucci: MHSRS-26-3821 (poster):** Efficacy of a Novel Antimicrobial Peptide in Eradicating Multidrug-Resistant Bacterial Infections and Biofilms in Preclinical Mouse and Porcine Models.

## Antimicrobial Proteins/Peptides

## Enhanced Dressings

## mRNA Medicine

**Dr. Yoann Le Breton: MHSRS-26-4190 (talk):** Novel Cell-Mediated RNA-Based Antimicrobial Solutions to Prevent Combat Wound Infections Suited for Austere Conditions

**Dr. Corley Bernstein: MHSRS-26-3702 (poster):** Illuminating *Klebsiella pneumoniae* Infections: A Bioluminescent Platform for Longitudinal Assessment of Antibacterial Efficacy

**Dr. Mackenzie Ryan: MHSRS-26-4729 (poster):** Engineering Antimicrobial RNA Therapeutics to Combat *Staphylococcus aureus* in Human Cell Models of Combat Wound Infections.