Can Artificial Intelligence Beat Superbugs?





How ProteoGPT is helping scientists discover the next generation of antibiotics

1 INTRODUCTION

Antibiotic resistance is one of the greatest threats to global health. Superbugs like methicillin-resistant *Staphylococcus aureus* (MRSA) and carbapenem-resistant *Acinetobacter baumannii* (CRAB) are becoming harder to treat, leading to longer hospital stays, higher costs and more deaths.

AMR causes **~1.27 million** deaths annually worldwide

Up to **10 million** deaths projected by 2050

Few new antibiotics have been approved in the last 30 years

2 AIM



Can artificial intelligence design brand-new antimicrobial peptides (AMPs) that kill drug-resistant bacteria effectively and safely?

The researchers developed a pre-trained protein language model – ProteoGPT – and used it to mine nature's protein sequences and generate entirely new peptides. They then tested the best candidates in the lab and in mice.

3 HOW DID THEY DO IT?



1. BIG DATA
ProteoGPT was trained on over 600,000 protein sequences from the UniProt database.

2. AI LEARNS
The AI learns the "language of proteins" – patterns of amino acids that create useful functions.

3. DISCOVERY
Two strategies were used:
- Data mining – find hidden AMPs in natural proteins
- Text generation – design brand-new peptides

4. SMART FILTERING
AI models predicted which peptides are antimicrobial and non-toxic, narrowing millions to a few hundred.

5. LAB TESTING
The best peptides were tested against superbugs in the lab and in mouse infection models.

4 KEY FINDINGS



STRONG ANTIBACTERIAL ACTIVITY

AI-designed peptides killed drug-resistant bacteria, including:
- MRSA
- Carbapenem-resistant *A. baumannii* (CRAB)
- *E. coli*
- *C. albicans* (fungus)

MIC as low as 1–8 µg/mL



LOW TOXICITY

Most top peptides showed low toxicity towards human cells and red blood cells.



EFFECTIVE IN MICE

Selected peptides significantly reduced bacterial load in infected mouse thighs – similar or better than existing antibiotics.



RESISTANCE DEVELOPS SLOWLY

After 20 days of repeated exposure, AI peptides showed much smaller increases in MIC compared to common antibiotics.

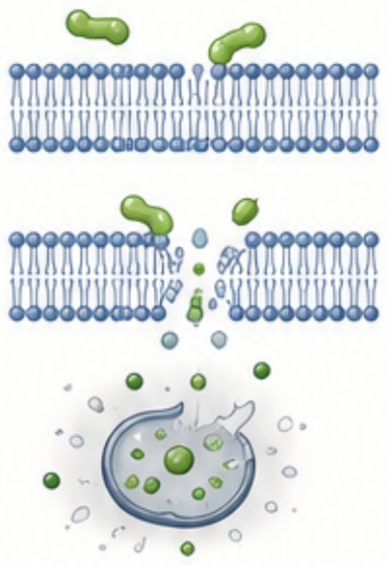
Increase in MIC after 20 days (example)

AI-designed peptides	2–8 fold increase
Traditional antibiotics	32–128 fold increase

5 HOW DO THESE PEPTIDES WORK?

They act like tiny torpedoes on bacteria.

1. Peptide binds to the bacterial membrane.
2. It disrupts the membrane and causes leakage.
3. The cell loses its contents and dies quickly.



6 WHY IT MATTERS

AI allows scientists to explore millions of possibilities in days instead of decades. This approach could fast-track the discovery of safe, effective antibiotics – a critical need as superbugs continue to rise.

- Faster discovery
- Smarter candidates
- Better outcomes for patients

7 TAKE-HOME MESSAGE

Artificial intelligence is not replacing scientists – it is giving them a powerful new way to discover life-saving antibiotics.

The future of infectious disease treatment may be written in code.

REFERENCE
Wang, Y., Zhao, L., Li, Z., Xi, Y., Pan, Y., Zhao, G. & Zhang, L. (2025). A generative artificial intelligence approach for the discovery of antimicrobial peptides against multidrug-resistant bacteria. *Nature Microbiology*, 10, 2997–3012. https://doi.org/10.1038/s41564-025-02114-4

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