ArrowBiome®

THE SCIENCE SERIES · NO. 01

Why Lysins Don’t Drive Resistance

A mechanistic, experimental and evolutionary answer to the question every investor asks

“If antibiotics drive resistance, won’t your lysins do the same?” The short answer is no — and this booklet explains exactly why, in plain language, grounded in peer-reviewed evidence.

CONFIDENTIAL · INVESTOR & PARTNER BRIEFING

Prepared with Aiden · June 2026

arrowbiome.com
Singapore · Brussels

A NOTE BEFORE YOU READ

Four words, four different claims

This is a science briefing written to be read at two levels at once: rigorous enough that a microbiologist cannot fault it, and plain enough that you can confidently repeat the argument in a meeting. Wherever the evidence is strong, we say so; wherever it is theoretical, we say that too.

WHAT LYSINS ARE

Bacteriolytic enzymes

Lysins are proteins that bacteriophages evolved to cut open the bacterial cell wall. ArrowBiome develops them as **INCI cosmetic actives** — not as drugs and not as antibiotics. ArcherZyme pops the target bacterium like a balloon; SmartArrow clears biofilm mechanically, without chemicals.

THE HONEST POSITION

Not “impossible” — just vanishingly unlikely

We never claim resistance is **impossible**. We claim it is **extremely unlikely**, has **not been observed** in lab studies, and has **never been clinically confirmed**. Those are three defensible claims; the fourth — impossibility — we deliberately do not make.

THE ONE THING TO REMEMBER

Antibiotics attack **processes inside the cell** that bacteria can re-route, slowly, over many generations. Lysins attack the **structural wall from the outside**, in seconds. Bacteria can evolve around a process. They cannot evolve away their own skeleton — **and they are not given the time to try.**

This document synthesises 50+ peer-reviewed sources. Every quantitative claim is traced to a primary source with a DOI, listed on each data page and consolidated in the closing references. Evidence strength is flagged throughout as **strong**, **moderate**, or **preliminary**.

01

THE PROBLEM WITH ANTIBIOTICS

The arms race bacteria keep winning

Antimicrobial resistance kills more people each year than HIV and malaria combined. To see why lysins are different, first understand precisely how and why antibiotics lose — reliably, predictably, and fast.

THE SCALE OF THE CRISIS

What resistance already costs

Antimicrobial resistance is not a future risk — it is a present-day mass-casualty event. These are the numbers that frame why a low-resistance antimicrobial modality matters.

1.27M
DEATHS DIRECTLY CAUSED BY AMR, 2019

4.95M
DEATHS ASSOCIATED WITH AMR, 2019

39M
PROJECTED AMR DEATHS 2025–2050

1 in 6
BACTERIAL INFECTIONS RESISTANT, 2023

MORE THAN THE HEADLINES

Bigger than HIV and malaria combined

The 1.27 million deaths directly attributable to bacterial AMR in 2019 exceeded global deaths from HIV (~680,000) and malaria (~627,000) put together — ranking AMR among the leading causes of death worldwide.

THE TRAJECTORY

A trillion-dollar problem, still growing

Forecasts project **8.2 million** AMR-associated deaths annually by 2050 and cumulative economic losses measured in the trillions. MRSA deaths alone more than doubled from 57,200 (1990) to 130,000 (2021).

WHY THIS IS THE RIGHT BACKDROP

Every one of these deaths traces to the same root cause: antibiotics give bacteria **time and an escapable target.** The rest of this booklet shows why lysins remove both.

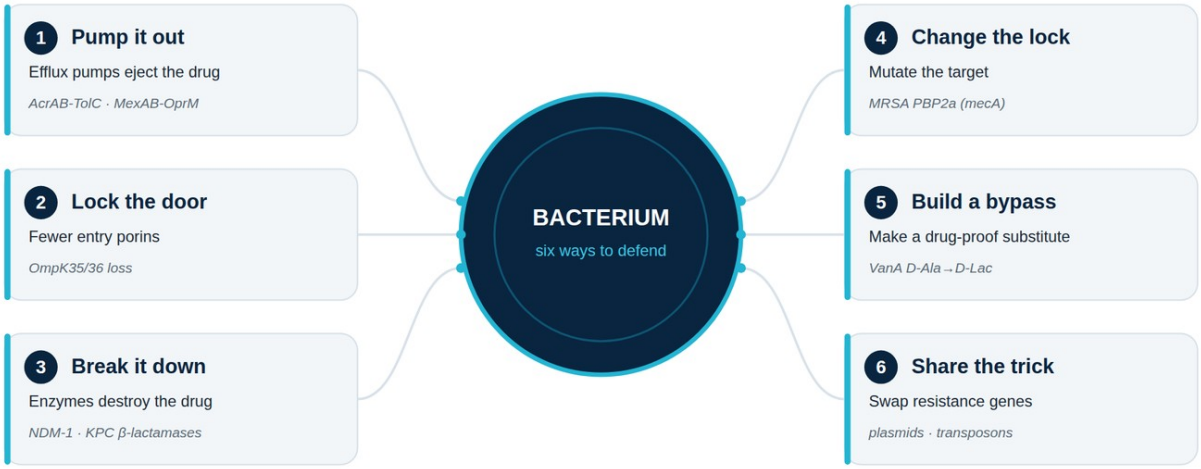
Sources: Murray et al. 2022, *The Lancet* 10.1016/S0140-6736(22)00087-3 [strong]; GRAM Collaborators 2024, *The Lancet* 10.1016/S0140-6736(24)01867-1 [strong]; WHO GLASS 2025; CDC AR Threats 2019.

HOW ANTIBIOTICS FAIL

Six ways bacteria fight back

An antibiotic must get inside the bacterium and disable a specific protein or process. That creates six well-mapped escape routes — and bacteria use all of them.

THE CANONICAL RESISTANCE TOOLKIT



WHY IT WORKS FOR BACTERIA

The target is reachable — and changeable

Each mechanism modifies something the bacterium can afford to change: a pump, a porin, an enzyme, a single amino acid in a protein. The cell keeps living; the drug stops working.

WHY IT SPREADS

Resistance genes travel between species

Plasmids, transposons and integrons let one resistance gene jump across species in real time. The *vanA* gene moved from enterococci into *S. aureus*; NDM-1 spread across continents within two years.

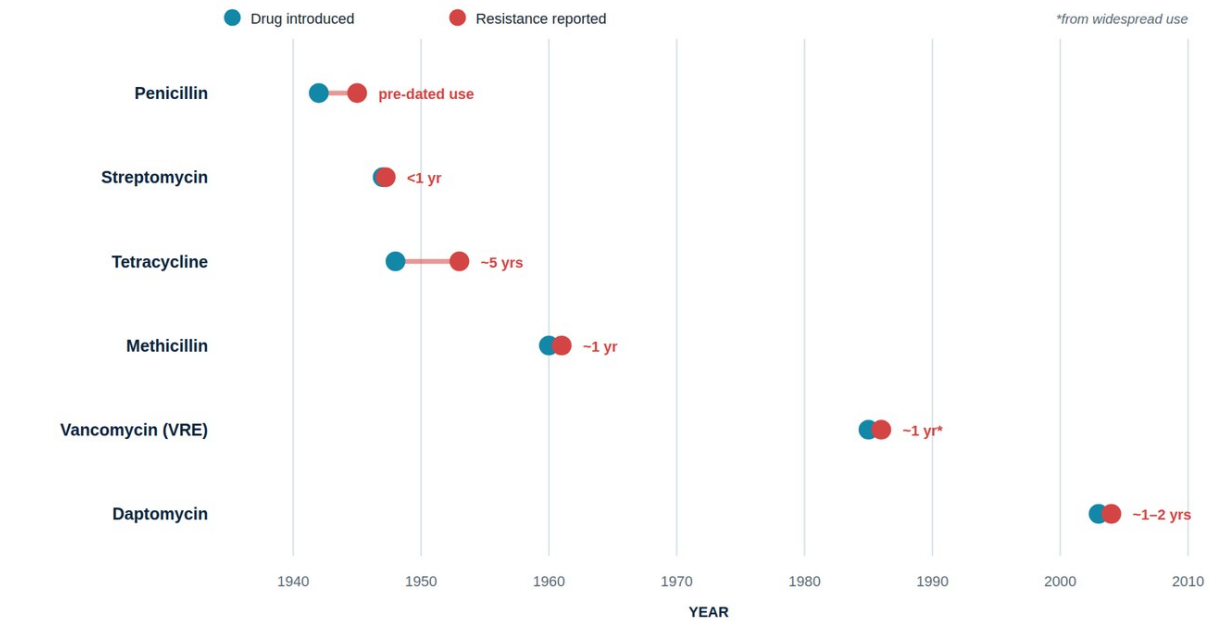
Sources: Baran et al. 2023, *IJMS* 10.3390/ijms24065777 [strong]; Varela et al. 2021, *Antibiotics* 10.3390/antibiotics10050593 [strong]; NDM-1 first report, *Emerg Infect Dis* 2010 10.3201/eid1611.100975.

THE ROLE OF TIME

A slow kill gives evolution room

Antibiotics rarely kill instantly. They block a process and let damage build over hours — many bacterial generations. That delay is the gift evolution needs: a rare resistant cell can multiply while the drug slowly clears the rest.

RESISTANCE FOLLOWS INTRODUCTION — OFTEN WITHIN A YEAR



THE MATHS OF SELECTION

A resistant mutant is already there

With ~10^8 bacteria at an infection site and a mutation rate near 10^{-8}, a resistant cell is statistically **present before treatment begins**. Slow killing simply lets it win.

SUB-MIC MAKES IT WORSE

Low doses train bacteria

At concentrations below the killing threshold, antibiotics switch on the bacterial SOS response — raising mutation rates ~10-fold and boosting gene transfer. The drug becomes a teacher, not a weapon.

Sources: Holden et al. 2017, *Genome Biology* 10.1186/s13059-017-1252-9 [strong]; principles of bactericidal kinetics, *mBio* 2025 10.1128/mbio.02089-24 [strong]; SOS & sub-MIC, *FEMS Microbiol Rev* 2014 10.1111/1574-6976.12042.

02

A FUNDAMENTALLY DIFFERENT TOOL

How lysins actually work

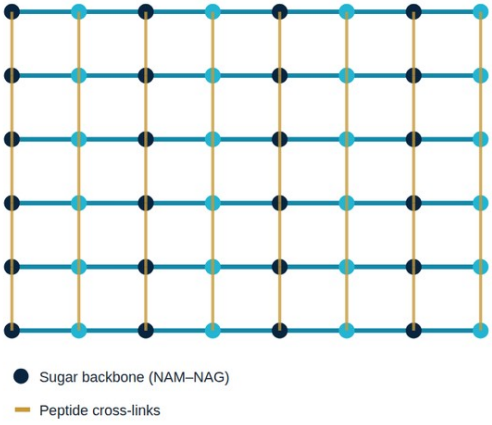
Lysins are not small-molecule drugs that sneak inside the cell. They are enzymes that cut the wall from the outside — targeting the one structure a bacterium cannot live without and cannot quickly change.

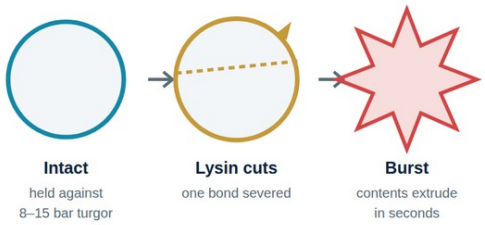
THE TARGET

The wall is the skeleton

Peptidoglycan is the mesh that holds a bacterium together against enormous internal pressure. It is a single, continuous, covalently woven molecule — the bacterial exoskeleton. Lysins cut its load-bearing bonds.

ONE WOVEN MOLECULE · CUT IT AND THE CELL BURSTS





You cannot remove your own skeleton and keep standing.

THE ANALOGY THAT STICKS

Popping a balloon

A bacterium holds **8–15 bar** of internal turgor — more than a car tyre. A lysin cuts one structural bond and the cell extrudes its contents in seconds. ArrowBiome describes ArcherZyme exactly this way: it **pops bacteria like a balloon.**

WHY IT CANNOT BE SWAPPED OUT

No substitute exists

Unlike a drug-target protein, peptidoglycan cannot be replaced with a “resistant” version — any cell that abandons it loses osmotic integrity, shape and the ability to divide. The fix is fatal.

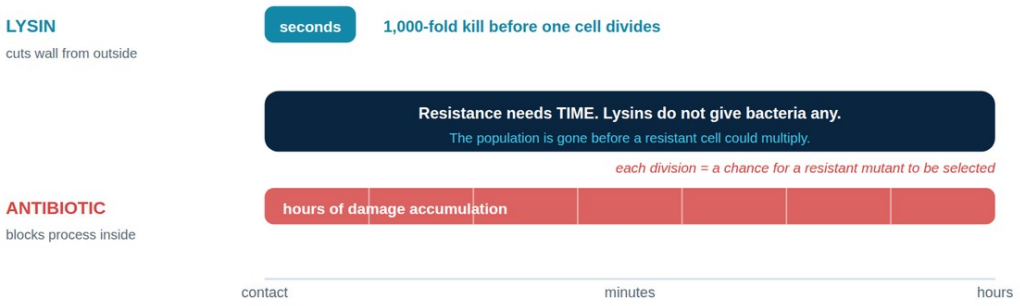
Sources: peptidoglycan structure & function, *EcoSal Plus* 2021 10.1128/ecosalplus.esp-0010-2020 [strong]; Fischetti 2018, *Viruses* 10.3390/v10060310 [strong].

FROM OUTSIDE, IN SECONDS

Speed changes the rules

An antibiotic inhibits a process and waits for damage to accumulate over hours. A lysin cleaves the wall on contact and the cell bursts immediately. That difference — seconds versus hours — rewrites the evolutionary maths.

TIME TO KILL, AND WHY IT MATTERS



THE MEASURED KINETICS

A 1,000-fold kill in 30 minutes

Exebacase, the most advanced therapeutic lysin, delivers a **≥3-log (1,000-fold) kill within 30 minutes** at therapeutic concentration — faster than *S. aureus* can complete a single division. Streptococcal lysins drop bacterial counts by >6 logs in seconds.

THE EVOLUTIONARY CONSEQUENCE

No generations, no selection

Resistance requires the susceptible majority to die slowly while a rare mutant multiplies. If the whole population is gone before one division, that selection window **never opens.**

Sources: Oh & Schuch 2023, *Microbiology Spectrum* 10.1128/spectrum.01906-23 [strong]; Nelson et al. kinetics reviewed in *Int J Med Microbiol* 2010 (PMC3666336) [moderate]; Qian & Zheng 2026, *Front Microbiol* 10.3389/fmicb.2026.1762768.

OUTSIDE THE CELL

Every defence aims inward

The six antibiotic-resistance mechanisms all operate inside the cell or at its membrane. A lysin attacks the wall from the outside and never enters — so each internal shield is simply pointed the wrong way.

WHY THE RESISTANCE TOOLKIT DOESN'T APPLY

A lysin attacks the wall from the outside and never enters the cell — so every internal shield is irrelevant.

- **Efflux pumps** — nothing to pump — lysin never enters
- **Enzyme inactivation** — lysis is over in seconds, before degradation
- **Reduced uptake / porin loss** — no entry needed; binds surface directly
- **Dormancy / persisters** — wall is present; killing is metabolism-independent
- **Target mutation (e.g. PBP2a)** — target is the external wall, not a protein
- **Gene transfer of resistance** — no 'lysin-resistance gene' exists to share

THE ARCHITECTURE ARGUMENT

Efflux pumps have nothing to pump. Porin loss blocks an entry the lysin never uses. Target mutations protect an interior the lysin never reaches. Even dormant "persister" cells — invisible to most antibiotics — still have a wall, so **lysins kill them too.** The only theoretical escape is to rebuild peptidoglycan itself, which we address honestly in Section 05.

Sources: Qian & Zheng 2026, *Front Microbiol* 10.3389/fmicb.2026.1762768 [strong]; Danis-Wlodarczyk et al. 2021, *Antibiotics* 10.3390/antibiotics10121497 [moderate]; Murray et al. 2021, *Viruses* 10.3390/v13040680.

03

THE EVOLUTIONARY CASE

Why bacteria can’t escape

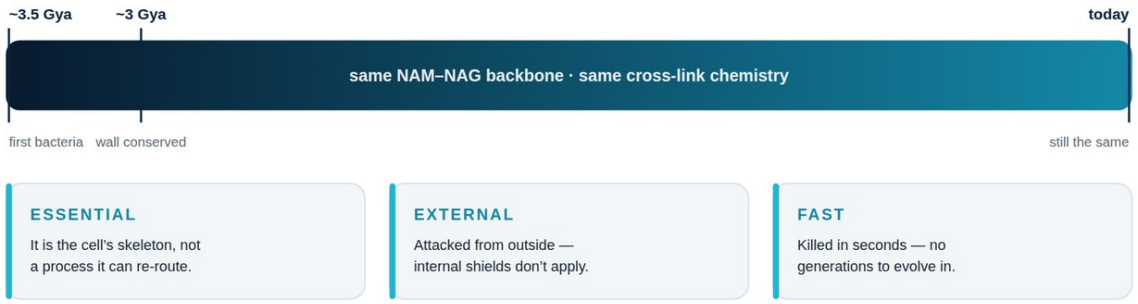
Three billion years of evolution have not changed the bacterial wall — not because bacteria never tried, but because they cannot change it and survive. This is the deepest reason resistance to lysins is so improbable.

THREE BILLION YEARS

Essential, external, and fast

The case against lysin resistance rests on three reinforcing pillars. Peptidoglycan is essential, it is attacked from outside, and the kill is so fast there is no time to adapt. Each pillar alone is strong; together they compound.

THE SAME WALL, UNCHANGED ACROSS DEEP TIME



ESSENTIAL
It is the cell's skeleton, not a process it can re-route.

EXTERNAL
Attacked from outside — internal shields don't apply.

FAST
Killed in seconds — no generations to evolve in.

WHY IT NEVER CHANGED

The fitness cost is lethal

Any mutation that meaningfully alters peptidoglycan chemistry weakens the wall, distorts cell shape, or blocks division. The mutant is outgrown and outcompeted — so evolution has held the structure constant for eons.

WHY PHAGES CHOSE IT

Aimed at the unchangeable

Over the same three billion years, bacteriophages evolved lysins to target the most conserved, most essential bonds in the wall — precisely because a target the host cannot change is a target it cannot escape.

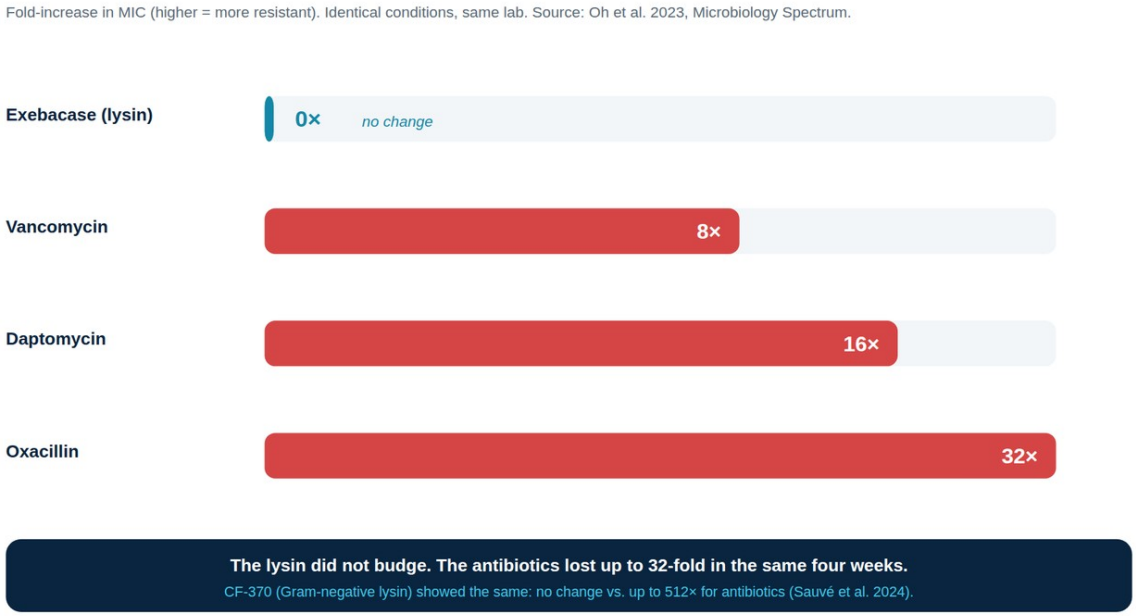
Sources: Fischetti 2018, *Viruses* 10.3390/v10060310 [strong]; peptidoglycan conservation, *Mol Microbiol* 2017 (PMC5720918) [strong]; *EcoSal Plus* 2021 10.1128/ecosalplus.esp-0010-2020.

THE DECISIVE EXPERIMENT

Head-to-head, same lab

Mechanism and theory are persuasive; data settles it. In a 28-day serial-passage study — the gold standard for measuring how fast resistance emerges — a lysin and three antibiotics were pushed under identical conditions. The result is stark.

FOLD-INCREASE IN MIC OVER 28 DAYS · LOWER IS BETTER



WHAT MIC MEANS

The dose needed to stop growth

A rising MIC means the bug is becoming harder to kill. Over 28 days the antibiotics needed 8×, 16× and 32× more drug. The lysin needed exactly the same dose on day 28 as on day 1: **zero drift.**

IT HOLDS IN THE REAL WORLD

A decade of stability

Surveillance of exebacase against staphylococci from 2011–2025 found its activity **unchanged over a decade**, with no difference between methicillin-susceptible and methicillin-resistant strains.

Sources: Oh et al. 2023, *Microbiology Spectrum* 10.1128/spectrum.05261-22 [strong]; Sauvé et al. 2024, *J Infect Dis* 10.1093/infdis/jiae027 [strong]; Souche et al. 2025, *J Antimicrob Chemother* 10.1093/jac/dkaf435.

MORE THAN NEUTRAL

Lysins suppress resistance

The most striking finding is not that lysins resist resistance — it is that they actively prevent antibiotics from developing it. Add a trace of lysin to a passaging antibiotic and the resistance that normally appears simply does not.

Lysin & setting	Lysin resistance	What happened to the antibiotic alongside it
Exebacase + oxacillin (MRSA/MSSA, 28 days)	**none (0-fold)**	Oxacillin's usual 32-fold resistance climb was **completely suppressed** when sub-MIC exebacase was present.
CF-370 + antibiotics (*P. aeruginosa*)	**none (0-fold)**	Tobramycin and levofloxacin resistance fully suppressed; meropenem held to 2-fold (vs. 32-fold alone).
SAL200 (*S. aureus*, 30 passages at ½ MIC)	**none**	No resistant mutant could be generated across 30 repeated exposures.
PlyG (*B. anthracis*)	**$<5\times10^{-9}$**	Below the detection limit — even after chemical mutagenesis — versus 10^{-7}–10^{-9} for antibiotics.

WHY THIS MATTERS COMMERCIALLY

A modality that **protects the antibiotics we still have** is not just defensible against the resistance question — it is an answer to it. In combination, lysins make conventional drugs harder for bacteria to defeat.

Sources: Oh et al. 2023 10.1128/spectrum.05261-22 [strong]; ContraFect ECCMID 2022 (CF-370) [strong]; SAL200 in Rahman et al. 2021, *Antibiotics* 10.3390/antibiotics10111277; Schuch et al., *PLoS ONE* 10.1371/journal.pone.0060754.

INTELLECTUAL HONESTY

The non-zero chance

Sophisticated investors trust candour over absolutes. So we state it plainly: there is a non-zero chance of lysin resistance. What the structural biology and the data show is that it is orders of magnitude less probable than antibiotic resistance — not that it is impossible.

FOUR CLAIMS · WE MAKE ONLY THE DEFENSIBLE ONES

a	**Resistance is IMPOSSIBLE** Overstates the case — modification is theoretically conceivable.	✗ NOT claimed
b	**Resistance is EXTREMELY UNLIKELY** Orders of magnitude rarer than antibiotics; mechanistically grounded.	✓ supported
c	**Resistance has NOT been observed** True across endolysin serial-passage studies to date.	✓ supported
d	**Resistance has NEVER been CLINICALLY confirmed** Confirmed by multiple 2021–2026 reviews.	✓ supported

THE THEORETICAL ESCAPE ROUTES

Known, and each self-limiting

Cell-wall thickening, teichoic-acid charge changes, capsule masking and sugar O-acetylation are all conceivable. Each yields only modest **tolerance** (2–4-fold), targets a single enzyme class, or carries a real fitness penalty — none reaches clinically meaningful resistance.

TWO LOCKS, NOT ONE

Multi-domain architecture

Most therapeutic lysins bind one conserved target *and* cut another. Escaping both at once multiplies the odds: roughly $10^{-9} \times 10^{-9} \approx 10^{-18}$ — beyond any practical evolutionary reach.

Sources: Qian & Zheng 2026, *Front Microbiol* 10.3389/fmicb.2026.1762768 [strong]; Moghadam et al. 2025, *MedComm* 10.1002/mco2.70280 [moderate]; Translational barriers review, *Front Antibiotics* 2026 (PMC13111215).

THE CLOSEST REAL-WORLD TEST

Even resistance is a dead end

Lysostaphin — a bacterial enzyme with a single cutting site — is the one peptidoglycan-targeting agent for which resistance has been forced in the lab. It is the honest worst case, and even it ends badly for the bacterium.

WHEN LYSOSTAPHIN RESISTANCE DOES EMERGE, THE MUTANT PAYS FOR IT

Lysostaphin-resistant MRSA (the closest real-world model). Source: Kusuma et al. 2006, AAC.

4–5×	5×+	MRSA→MSSA	0
slower growth	less virulent	re-sensitised	compensatory fixes
than wild-type	needs 10× dose to infect	oxacillin MIC >32 to 0.25	none in 14 days

A resistant mutant that is slower, weaker, and treatable cannot win.

WHY LYSOSTAPHIN IS THE EXCEPTION

A single, non-essential site

Lysostaphin cuts only the pentaglycine bridge — a feature bacteria can truncate. Therapeutic phage lysins (exebacase, CF-370) carry extra catalytic domains hitting essential bonds, and show **no detectable resistance** in the same kind of study.

THE SELF-DEFEATING TRADE

Resistance re-opens the antibiotic door

The very mutation that resists lysostaphin also abolishes methicillin resistance — turning MRSA back into easily treatable MSSA. A bacterium escaping one weapon walks straight into another.

Source: Kusuma et al. 2006, *Antimicrob Agents Chemother* 10.1128/aac.00786-06 [strong]; Climo et al. 2001, *AAC* 10.1128/AAC.45.6.1800-1805.2001; Rodriguez-Rubio et al. 2013, *PLoS ONE* 10.1371/journal.pone.0064671.

REAL-WORLD EVIDENCE

Tested in people

Six lysins have entered human clinical trials; exebacase was the first to reach Phase III. Across hundreds of patients and years of dosing, the safety profile is clean — and not a single case of lysin resistance has been recorded.

Lysin	Indication	Furthest phase	Resistance seen
Exebacase (CF-301)	*S. aureus* bacteraemia / MRSA	**Phase III**	None
SAL200 / tonabacase	*S. aureus* bacteraemia	Phase IIa	None
XZ.700 (Micreos)	Atopic dermatitis (topical)	Phase I/IIa	None
LMN-201	*C. difficile* (oral)	Phase II	None
P128 / HY-133	Nasal decolonisation	Phase I/II	None

THE DISTINCTION THAT MATTERS MOST

Exebacase's Phase III was stopped for **futility on the efficacy endpoint** — a trial-design and placebo-response problem in a notoriously hard bacteraemia setting. **It was never a resistance or safety failure.** Phase II had shown a 74% vs 31% MRSA response. No resistance to exebacase emerged in any patient, in either trial.

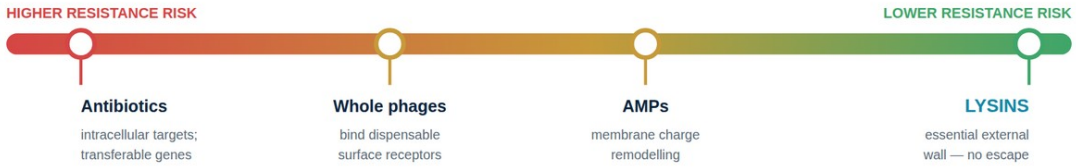
Sources: Fowler et al. 2020, *J Clin Invest* 10.1172/JCI136577 [strong]; Fowler et al. 2024, *Clin Infect Dis* 10.1093/cid/ciae043 [strong]; Vander Elst 2026, *Eur J Med Res* 10.1186/s40001-025-03655-4.

THE LANDSCAPE

Where lysins sit

Placed against the other antimicrobial modalities, lysins occupy the low-risk end for a structural reason: only they target an essential, external, conserved polymer with no transferable resistance gene.

RESISTANCE RISK ACROSS MODALITIES



Same family, opposite risk

Phages and lysins both come from bacteriophages — but phages bind a receptor bacteria can drop, while lysins cut a wall they cannot live without.

Why it matters for ArrowBiome

Topical, species-selective lysins sit at the safest end of this spectrum — and preserve the helpful microbiome.

Dimension	Antibiotics	Whole phages	AMPs	Lysins
Target location	Inside cell	Surface receptor	Membrane	**External wall**
Target conserved & essential	Variable	Low	Moderate	**Highest**
Speed of kill	Hours	Hours–days	Seconds	**Seconds**
Clinical resistance documented	Extensive	~75% of trials	Yes	**None**
Cross-resistance / gene transfer	High	Low	Moderate	**None**

Sources: Roach & Fischetti 2018 (PMC6070868) [moderate]; AMP resistance, *Phil Trans R Soc B* 2016 10.1098/rstb.2015.0292; Cui et al. 2025, *Virulence* 10.1080/21505594.2025.2562634 [strong].

ARROWBIOME'S CONTEXT

Topical means lower still

ArrowBiome's lysins are INCI cosmetic actives applied to skin — not systemic drugs. Every factor that drives resistance in hospitals is weaker or absent in a rinse-off, species-selective topical. The use-case lowers an already-low risk.

NO SELECTION WINDOW

Applied, then gone

Resistance is driven by sustained sub-MIC exposure. A rinse-off product leaves no lingering low dose, never reaches the bloodstream, and never touches the gut — the body's main reservoir of resistance genes.

MICROBIOME-FRIENDLY

Hits one species, spares the rest

Lysins can kill *S. aureus* while leaving beneficial *S. epidermidis* untouched — the most selective topical antimicrobial yet. Broad-spectrum antibacterials flatten the whole skin community; lysins do not.

AMR risk dimension	Triclosan (banned biocide)	Bacteriophage lysin
Target	A metabolic enzyme — mutatable	**Structural wall — mutation is lethal**
Resistance mechanism	Point mutation; efflux pumps	**None validated**
Environmental persistence	Stable; persists in water & soil	**Protein — rapidly degraded**
Regulatory status	Banned (FDA 2016/17, EU, Canada)	**Breakthrough & QIDP designations**

THE REGULATORY PRECEDENT WORKS FOR US

Triclosan was restricted because it had a *real, mechanistic* resistance pathway. Regulators apply mechanism-based scrutiny — and a structural enzyme with no escape route **passes exactly the test triclosan failed.**

Sources: Bunce et al. 2021, *AAC* (PMC8092865) [strong]; Schirmeier et al. 2022, *AAC* 10.1128/aac.02273-21; EC SCCS Opinion on triclosan [strong]; personal-care AMR review (PMC8463082).

READY FOR THE MEETING

The five objections

Short, jargon-free answers to the questions that come up most often. Each can be delivered in under thirty seconds.

Q1 Don't lysins drive resistance just like antibiotics?

> No. Antibiotics block a process **inside** the cell that bacteria can re-route over many generations. Lysins cut the structural wall from **outside**, in seconds. The wall is essential and unchangeable, and the kill is too fast to allow selection — so the resistance machinery never engages.

Q2 Have you ever seen lysin resistance in the lab?

> In a 28-day head-to-head study, exebacase showed **zero** change in potency while oxacillin, daptomycin and vancomycin became 8–32× harder to use. Across multiple lysins and 40+ passage cycles, no stable resistance has been generated (Oh et al. 2023).

Q3 What if bacteria do evolve to resist your lysins?

> The one peptidoglycan-targeting enzyme where resistance was forced — lysostaphin — produced mutants that grow 4–5× slower, are 5× less virulent, and revert to being treatable by ordinary antibiotics. Even the worst case is a self-limiting dead end (Kusuma et al. 2006).

Q4 Is lysin resistance impossible, or just unlikely?

> Unlikely — we never say impossible. There is a **non-zero** chance, but the structural biology and the data make it orders of magnitude rarer than antibiotic resistance. Honesty here is the strongest position, not the weakest.

Q5 How is your topical use different from hospital resistance?

> A rinse-off, species-selective topical leaves no lingering sub-lethal dose, never reaches the gut, and spares beneficial skin bacteria. Every driver of hospital resistance is weaker or absent — making an already-low risk lower still.

Full evidence and citations for each answer appear in the preceding sections and the references on the final page.

HAND-OUT

One page, five points

- **Different target.** Antibiotics hit changeable processes inside the cell; lysins cut the essential structural wall from outside.
- **No time to adapt.** Lysins kill in seconds — faster than a bacterium can divide — so the window resistance needs never opens.
- **Proven in data.** Zero resistance drift over 28 days versus 8–32× for three antibiotics in the same experiment.
- **Honest, not absolute.** The chance is non-zero but orders of magnitude lower; even forced resistance is a self-limiting dead end.
- **Topical lowers it further.** Rinse-off, species-selective use removes the drivers of hospital resistance and preserves the microbiome.

0×
LYSIN MIC CHANGE OVER 28 DAYS

32×
OXACILLIN, SAME EXPERIMENT

0
CLINICAL LYSIN-RESISTANCE CASES EVER

THE ANALOGY TO REMEMBER

An antibiotic picks a lock the bacterium can re-key. A lysin **pops the balloon.** You cannot evolve resistance to losing your own skeleton — and you are not given the time to try.

	Antibiotics	Lysins
Where they act	Inside the cell	**Outside, on the wall**
Speed	Hours	**Seconds**
Resistance documented	Extensive	**None**

Full report: *Why Lysins Don't Drive Antibiotic-Equivalent Resistance*, ArrowBiome Science Series No. 01 (June 2026). Citations within.

THE BOTTOM LINE

Resistance needs what lysins never give

1. **The target cannot change.** Peptidoglycan is the bacterial skeleton — conserved for three billion years because altering it is fatal.
2. **The attack comes from outside.** All six antibiotic defences face inward; a lysin never enters the cell, so none of them apply.
3. **The kill is instant.** Seconds, not hours — the population is gone before a resistant cell could multiply.
4. **The evidence agrees.** Zero resistance in 28-day studies, none in any clinic, and even forced resistance is weak and treatable.

> *"Antibiotics drive resistance because they give bacteria a changeable target and the time to change it. Lysins give them neither."*

ArrowBiome®

Why Lysins Don't Drive Antibiotic-Equivalent Resistance

CONFIDENTIAL · INVESTOR & PARTNER BRIEFING

METHOD & CONFIDENCE

Synthesised from 50+ peer-reviewed sources across molecular mechanism, head-to-head experiment, evolutionary biology, clinical translation and the topical use-case. Claims are graded strong / moderate / preliminary in-text. We state resistance as *extremely unlikely, unobserved and clinically unconfirmed* — never as impossible.

KEY REFERENCES

Murray et al. 2022, *The Lancet* — 10.1016/S0140-6736(22)00087-3
GRAM Collaborators 2024, *The Lancet* — 10.1016/S0140-6736(24)01867-1
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Kusuma et al. 2006, *Antimicrob Agents Chemother* — 10.1128/aac.00786-06
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