

26.08.2026

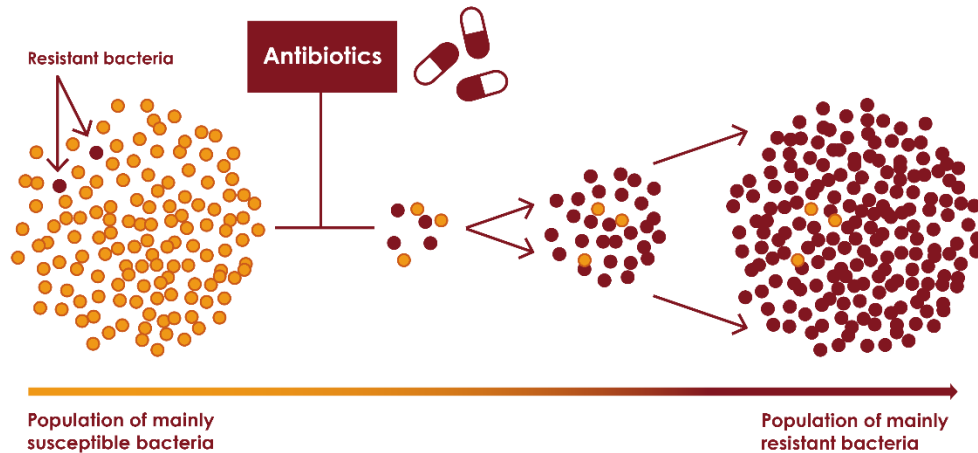
***NOVEL ANTIMICROBIAL COATINGS
REQUIRE NOVEL TESTING SOLUTIONS***
*from real-life efficacy testing to prediction of
resistance development*

Dr. Roberto Marano

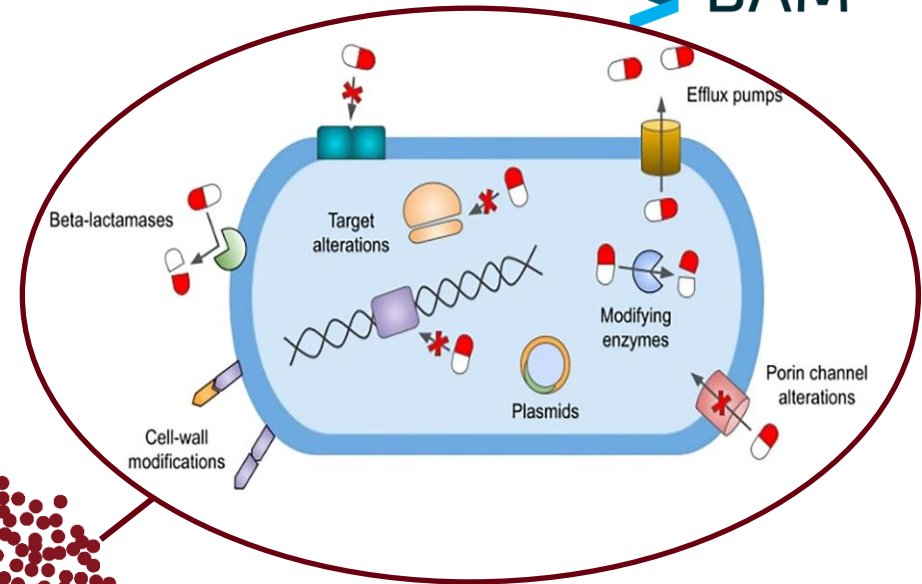
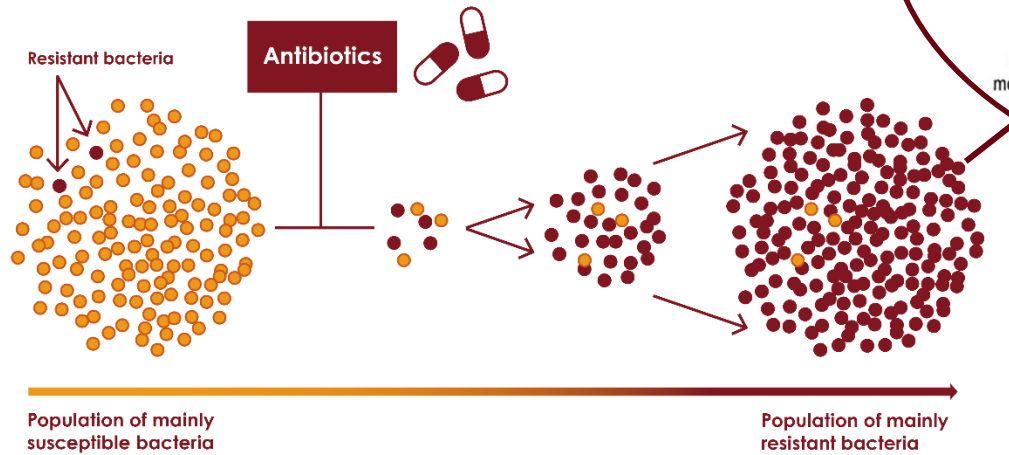


1. From a microbiological perspective, we ask:
What happens to the (e.g.) 0.1% bacteria that survive a disinfection strategy?
2. Antibiotic resistance vs biocide resistance
3. How can we test and predict **biocide+antibiotic resistance**

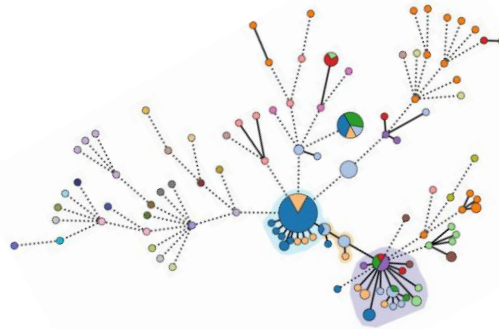
AMR: the broader context



AMR: the broader context



Resistance is the outcome of selection acting on **variation within a population**



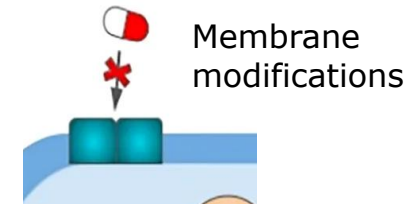
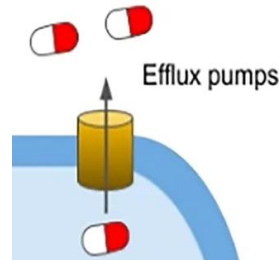
Genetic differences



or same genetics but temporary phenotypes

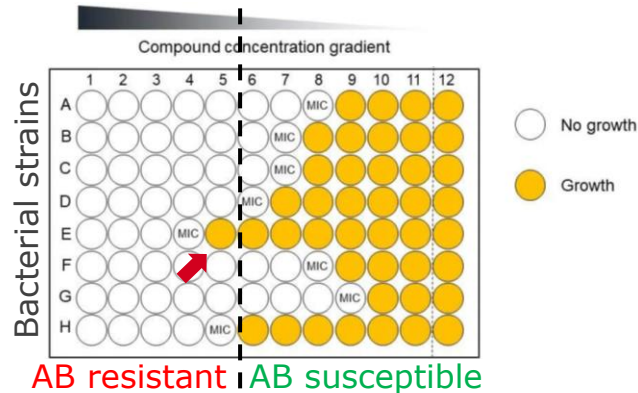
Antibiotic resistance $\neq$ biocide resistance

Antibiotics	Biocides
Specific cellular targets (e.g. Pennicillins)	Often multiple cellular targets (e.g. NaClO)
“low” concentrations	Often “high” concentrations
Resistance = failure	Reduced susceptibility $\neq$ product failure



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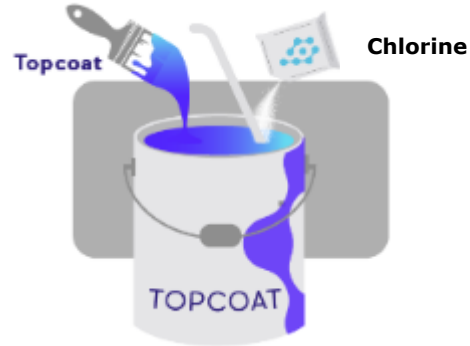


What does not select for resistance?



- High concentration
- Adequate contact time
- Multiple cellular targets or multiple biocides combined
 - low selective pressure, **low resistance selection**

Example of a „resistance-proof“ antimicrobial coating

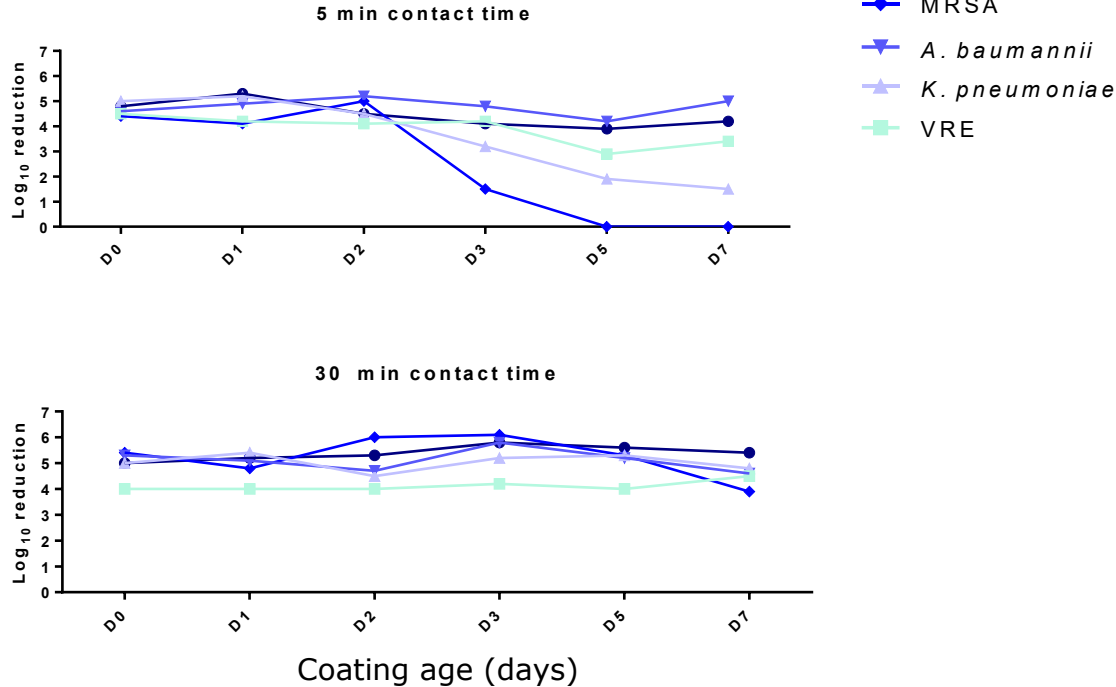


Evaluation of a novel surface-coating formulation with time-extended antimicrobial activity for healthcare environment disinfection

Research | [Open access](#) | Published: 23 November 2023

Roberto Bruno Maria Marano, Diana Merezko, Keren Anat Resnick, Jacob Moran-Gilad ✉ & Yonatan Oster

Fast killing

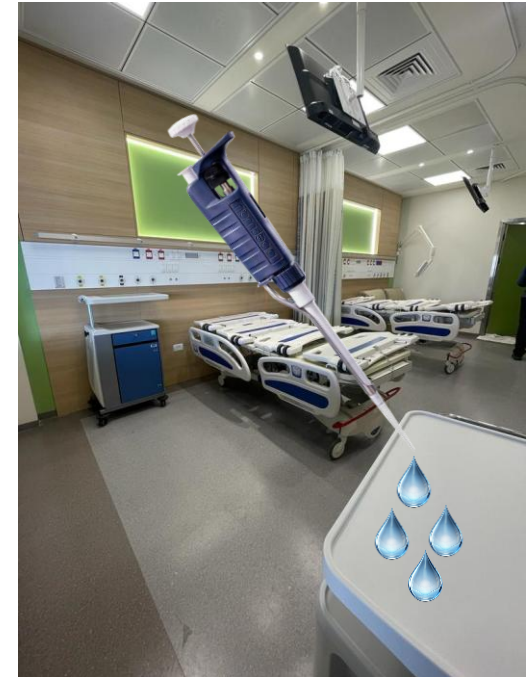
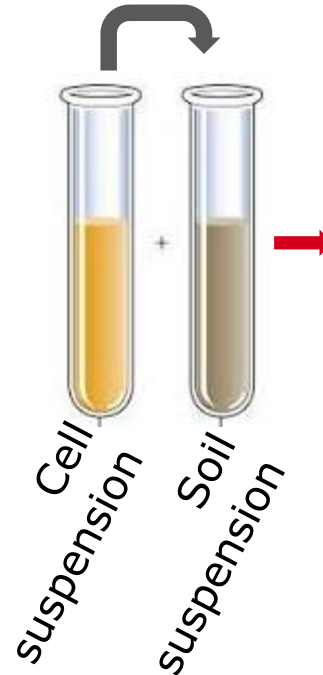


Tested with ISO22196

Fast killing, even in dirty conditions

“Real life” testing

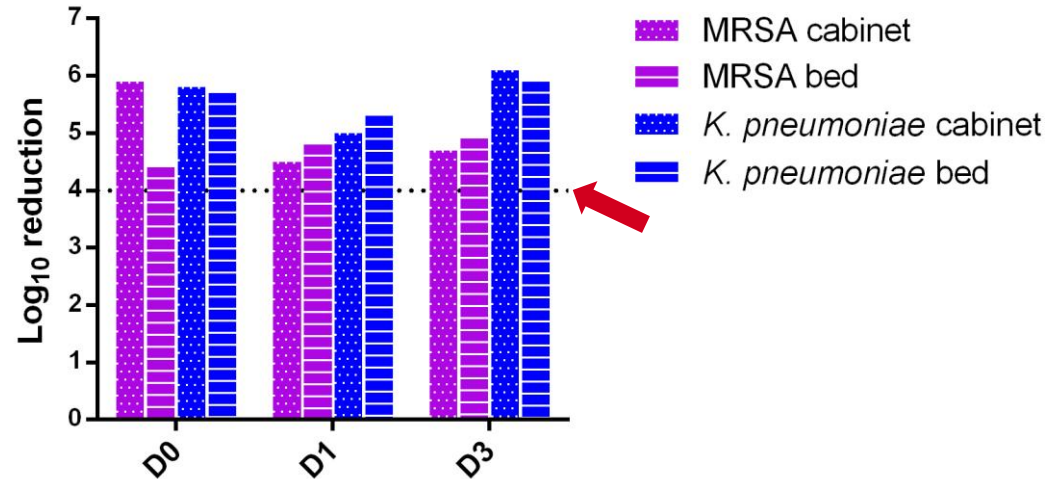
- 2 species
- Cells + artificial soil (dirt)
- 1 contact times (60 min)
- “semidry” inoculum



Fast killing, even in dirty conditions

“Real life” testing

- 2 species
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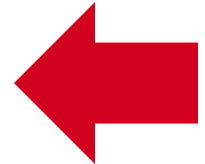
What actually does select for resistance?



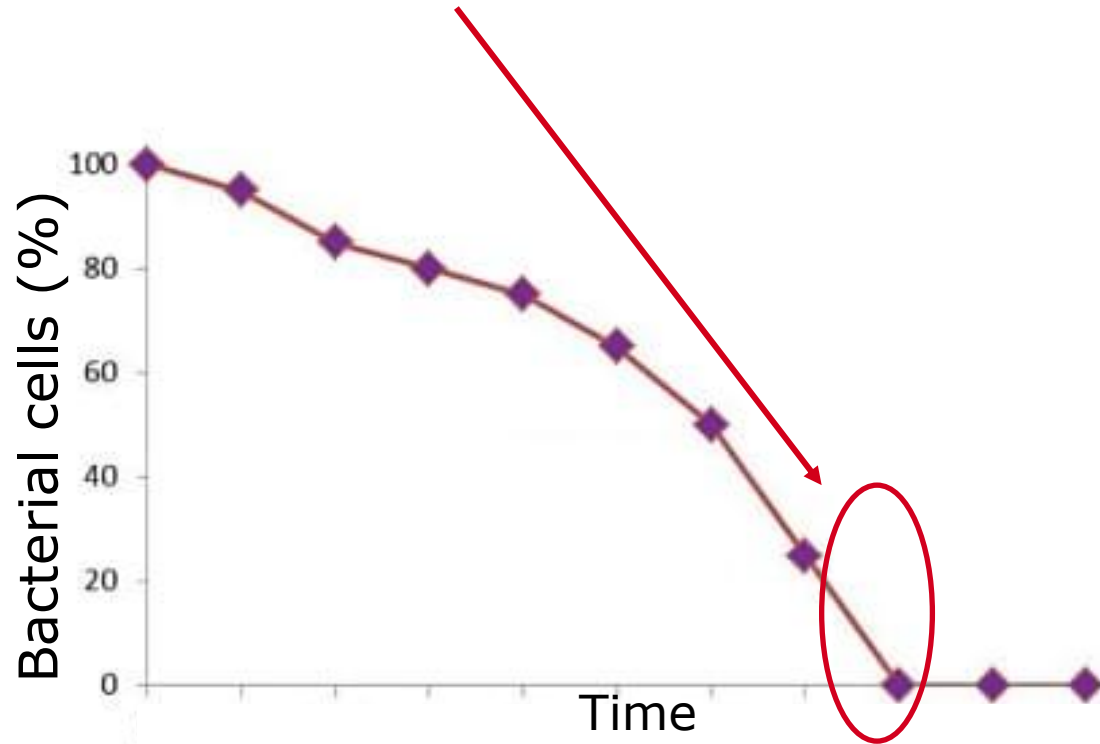
- High concentration
- Adequate contact time
- Multiple cellular targets or multiple biocides combined
 - low selective pressure, **low resistance selection**



- **Low (subinhibitory) concentrations of biocides**
- **Inadequate contact time**
 - higher selective pressure,
 - **possible enrichment/ evolution**



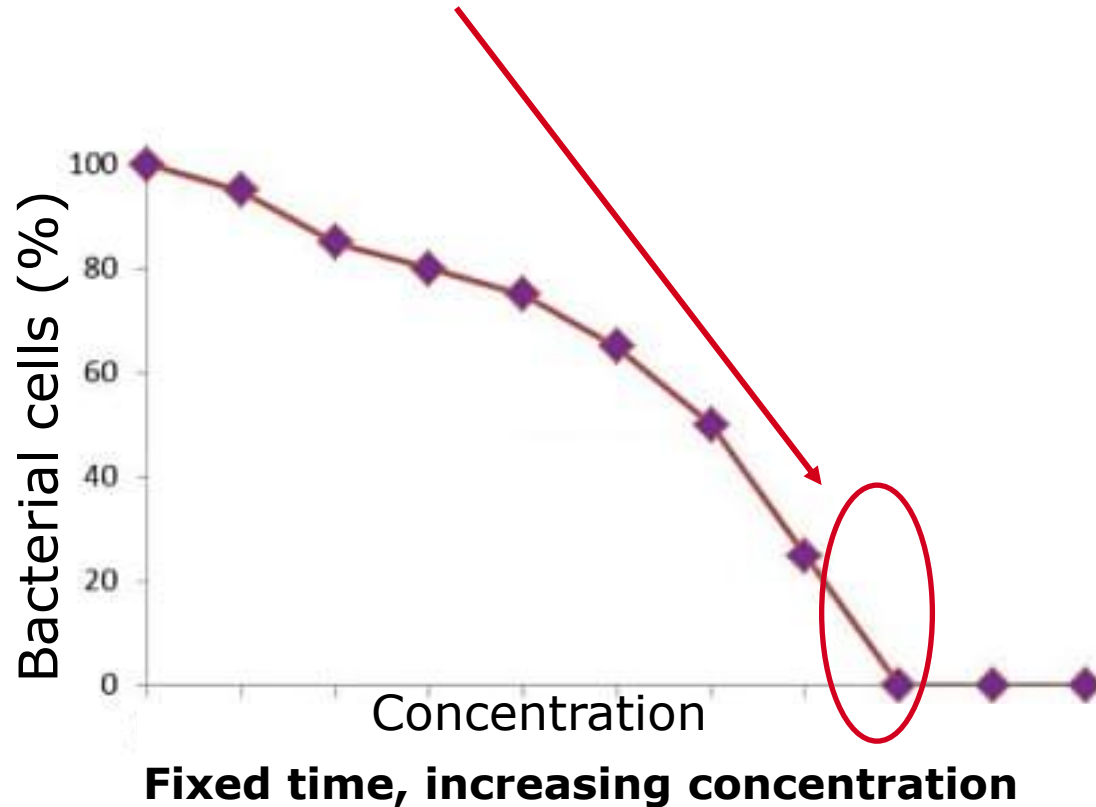
The “window of opportunity” for AMR selection



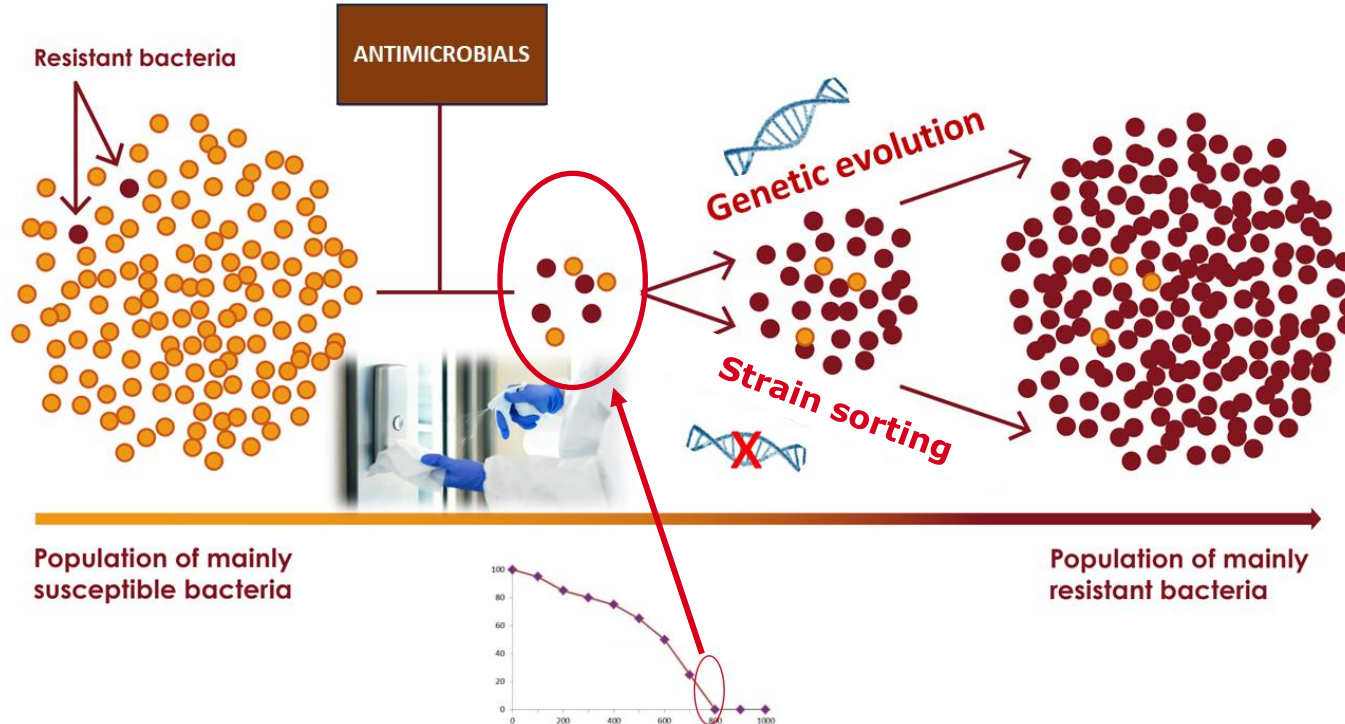
Fixed concentration, increasing contact time



The “window of opportunity” for AMR selection



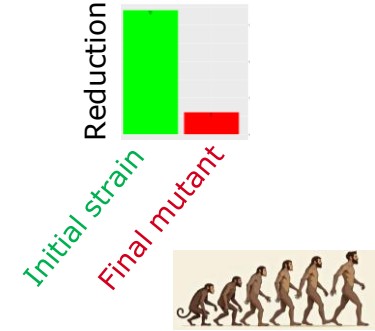
Two selective phenomena require two surveillance approaches



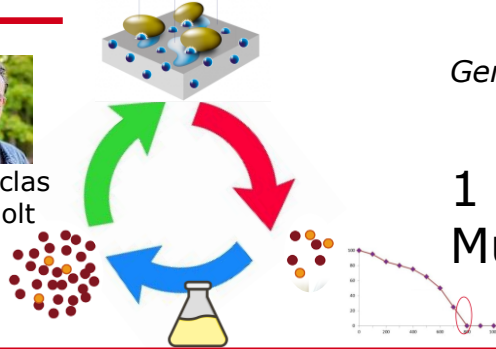
How did we developed protocols for predicting resistance evolution OR selection?

Genetic mutations + repeated exposure = selection?

1 strain
Multiple exposure cycles



Dr. Niclas Nordholt

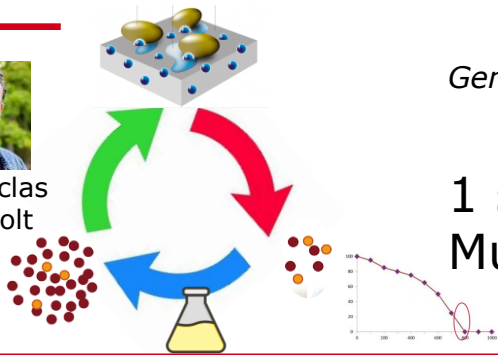


How did we develop protocols for predicting resistance evolution OR selection?

Evolution

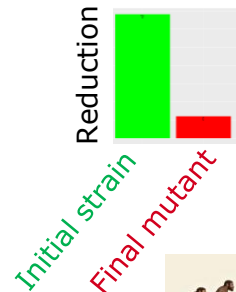


Dr. Niclas Nordholt



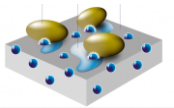
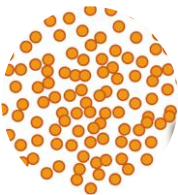
Genetic mutations + repeated exposure = selection?

1 strain
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Selection

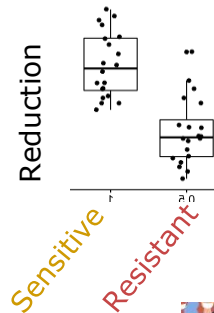
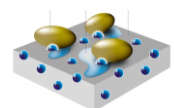
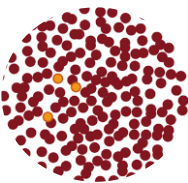
Antibiotic susceptible



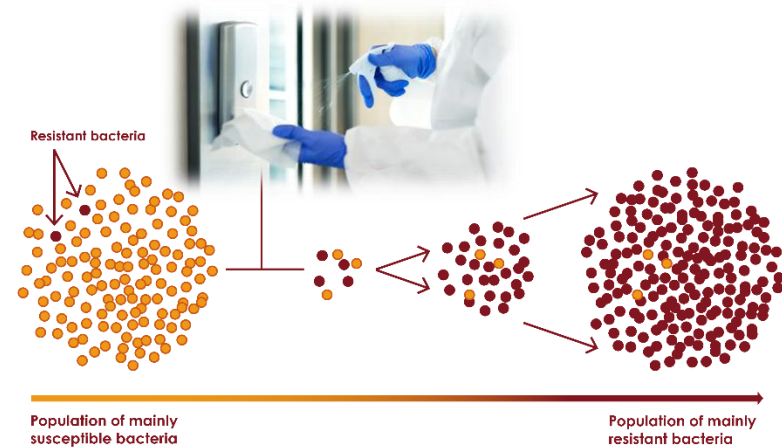
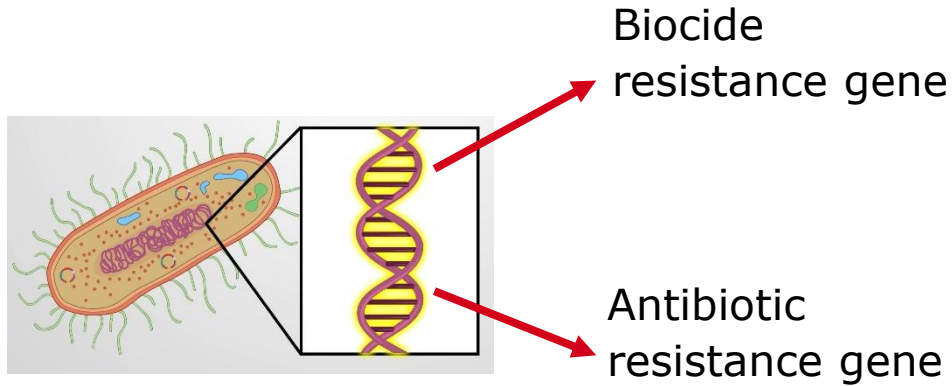
Genetic variations + single exposure = selection?

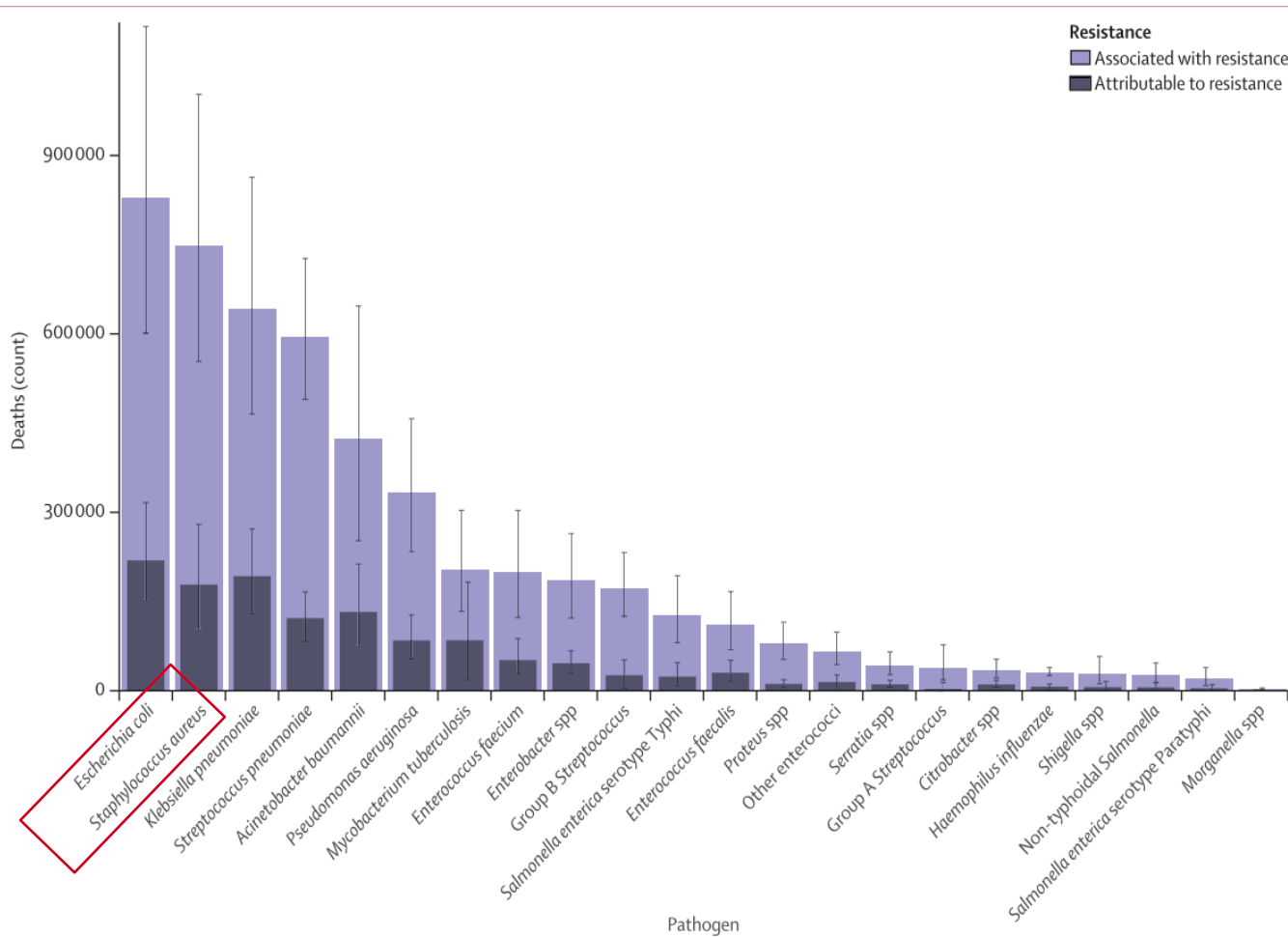
Multiple strains
1 single exposure

Antibiotic resistant



The principle: “co-selection”





Selection prediction on multi-strain testing



Genomic data

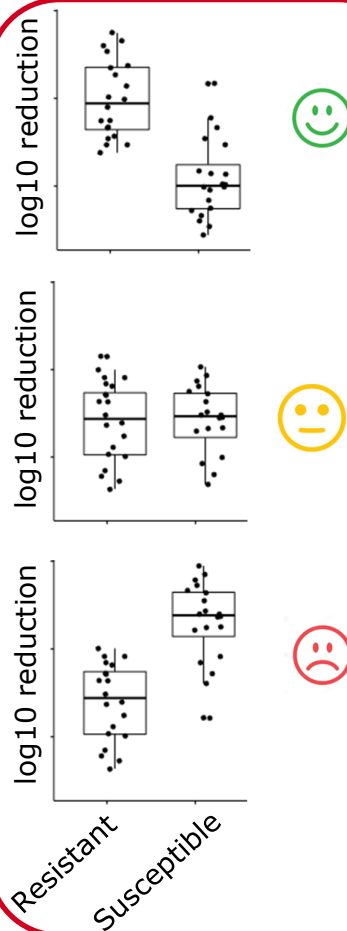


AST

E. coli library



ISO 22196



Genomic data

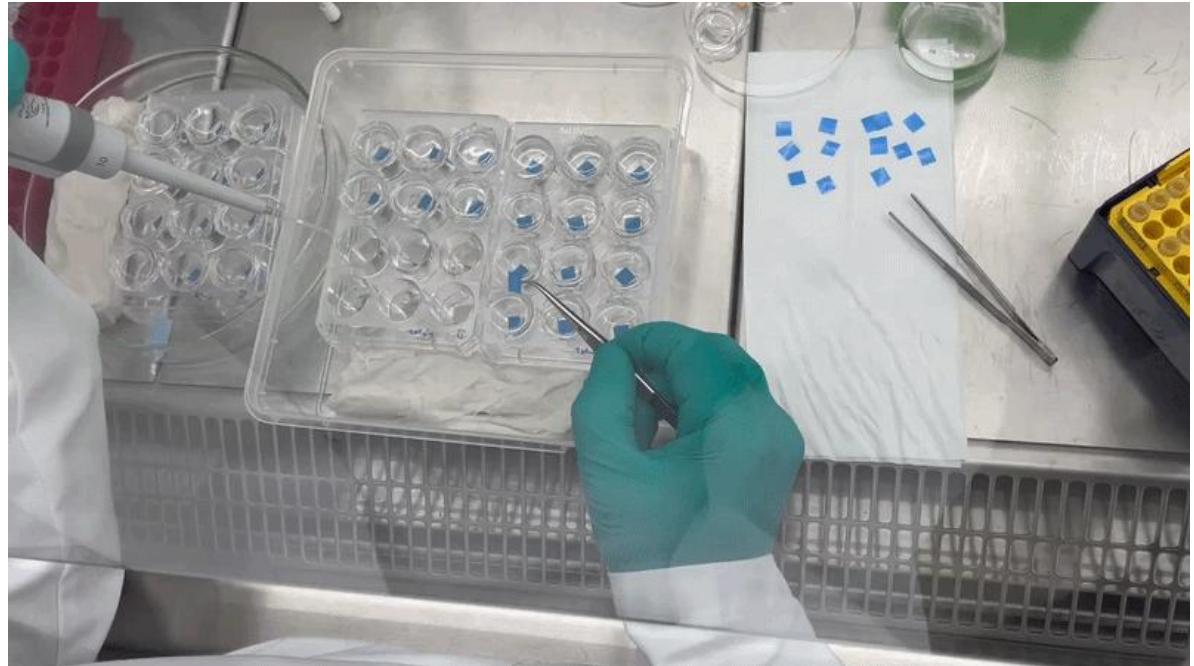


AST

S. aureus library

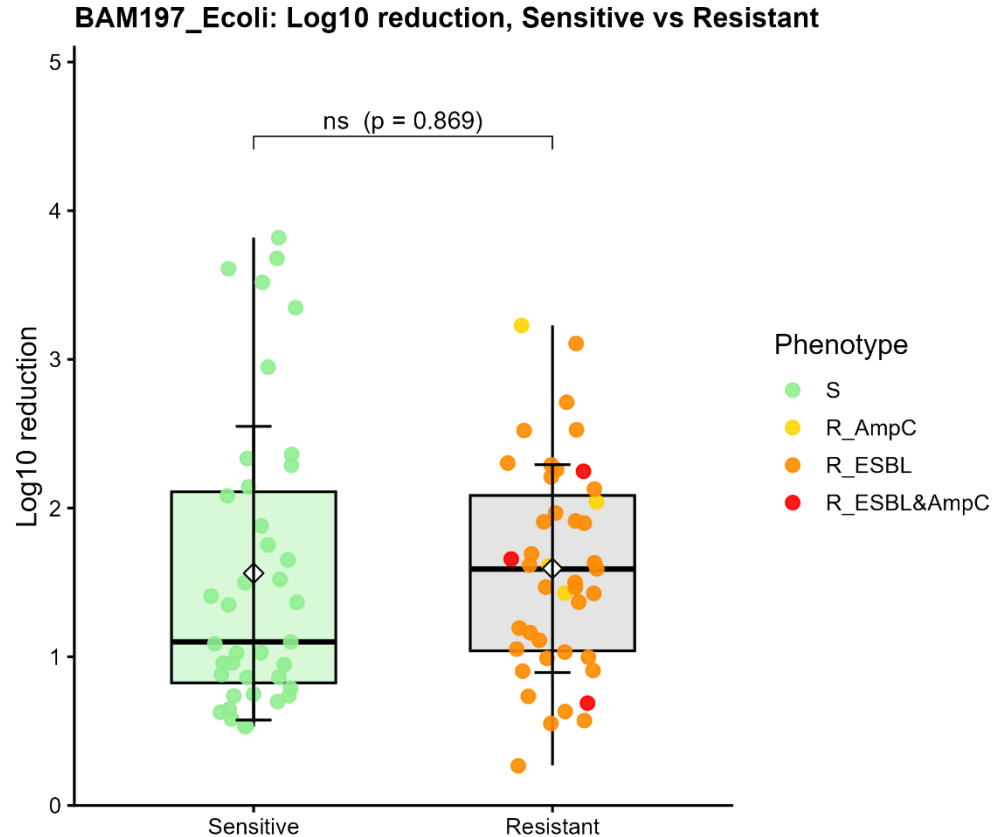
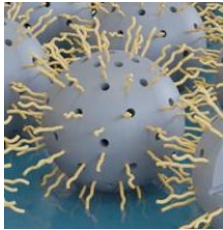


The chosen strategy



Results: STOP coating (BAM197)

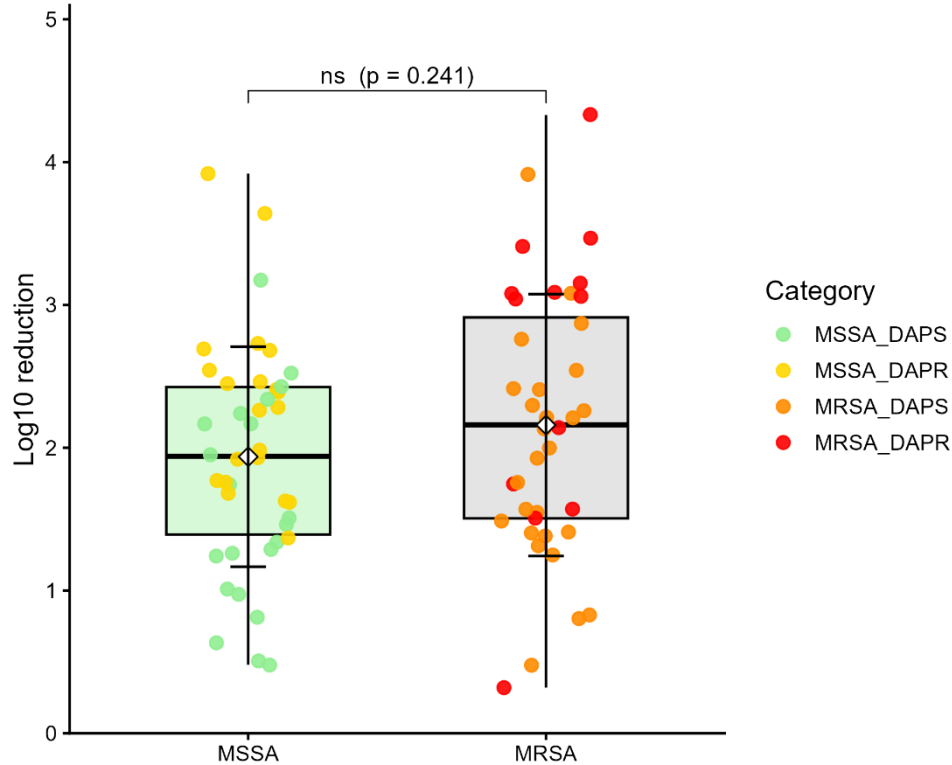
N= 80
E. coli strains
(3rd gen.
cephalosporine
resistant/susceptible)



Results: STOP coating (BAM197)



BAM197_Saureus: Log10 reduction, MSSA vs MRSA



N= 80
S. aureus
strains

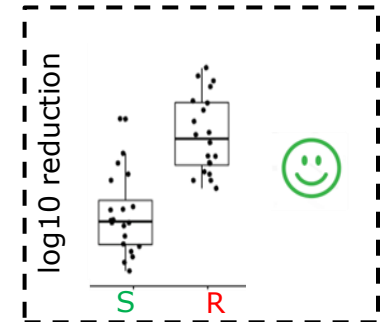
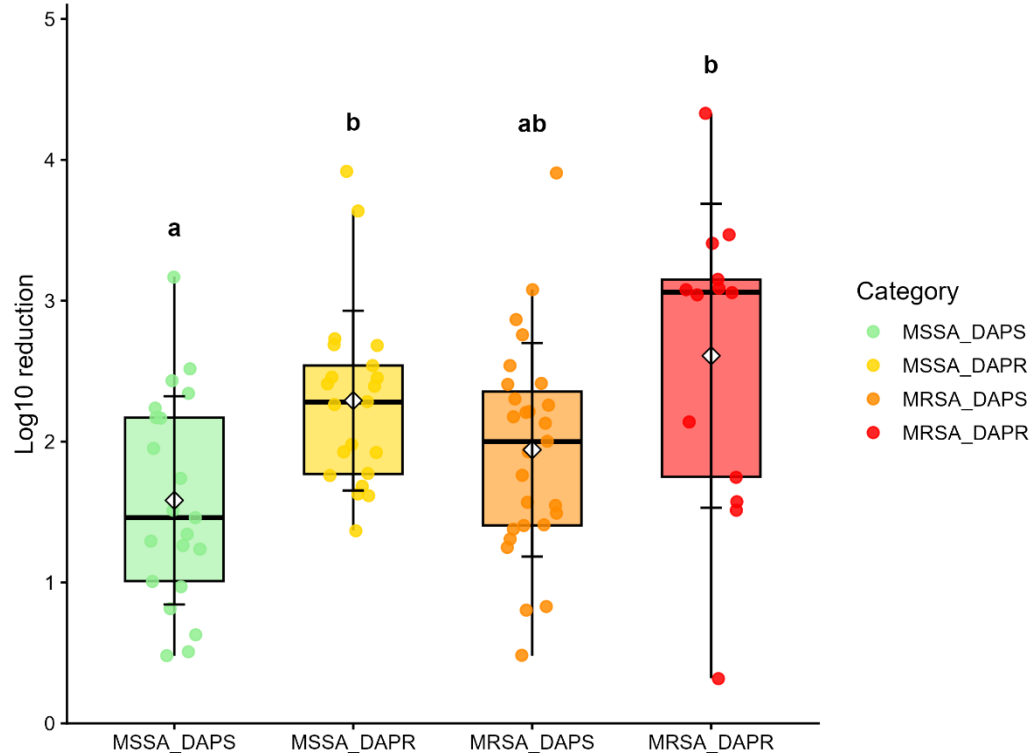
Methicillin
Resistant/**S**usceptible
S.
aureus

DAPtomycin
Resistant/**S**usceptible

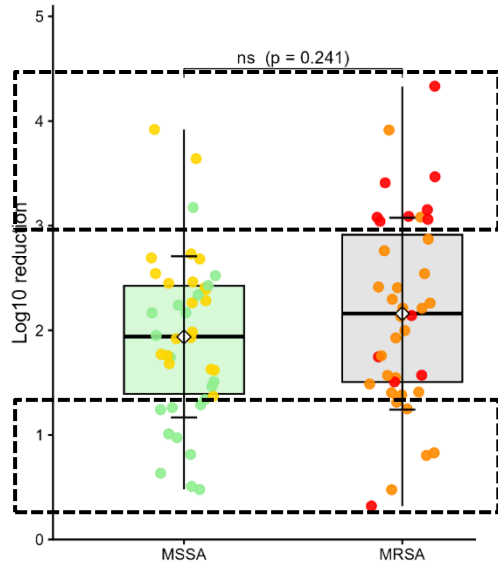
Results: STOP coating (BAM197)

BAM197_Saureus: Log10 reduction by MRSA/MSSA x DAP category

Welch ANOVA: $F(3, 36.3) = 4.92, p = 0.006$



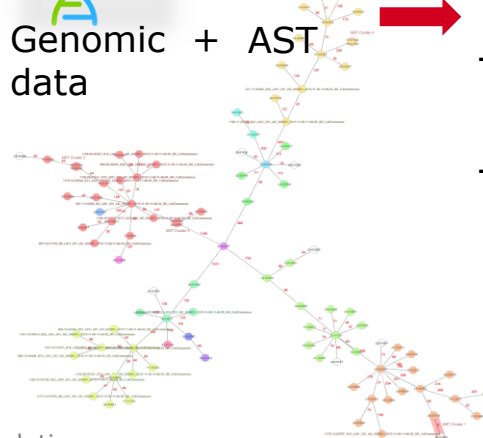
Outlook: scavanging for predictors of resistance and/or associated mechanisms



Genomic data



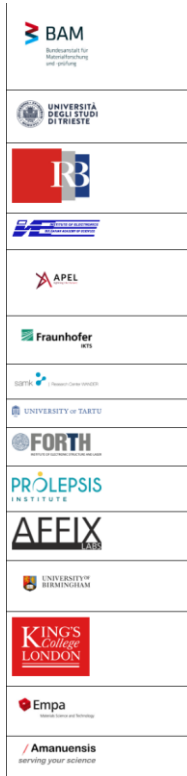
+ AST



- Other resistance profiles associated with high/low reduction
- Mode of action insights
- **Suggestions** for improvements of developed materials

-
- Antimicrobial materials are being developed, but **no test exists** that complements this development with **AMR** safety.
 - AMR selection is a phenomenon based on **variation within bacterial populations**, therefore...
 - **Multi-strain testing** should complement current tests that only use single strains.
 - Suggestions for **improvements** of developed materials (e.g. recommendations on use, mode-of-action).

Acknowledgements

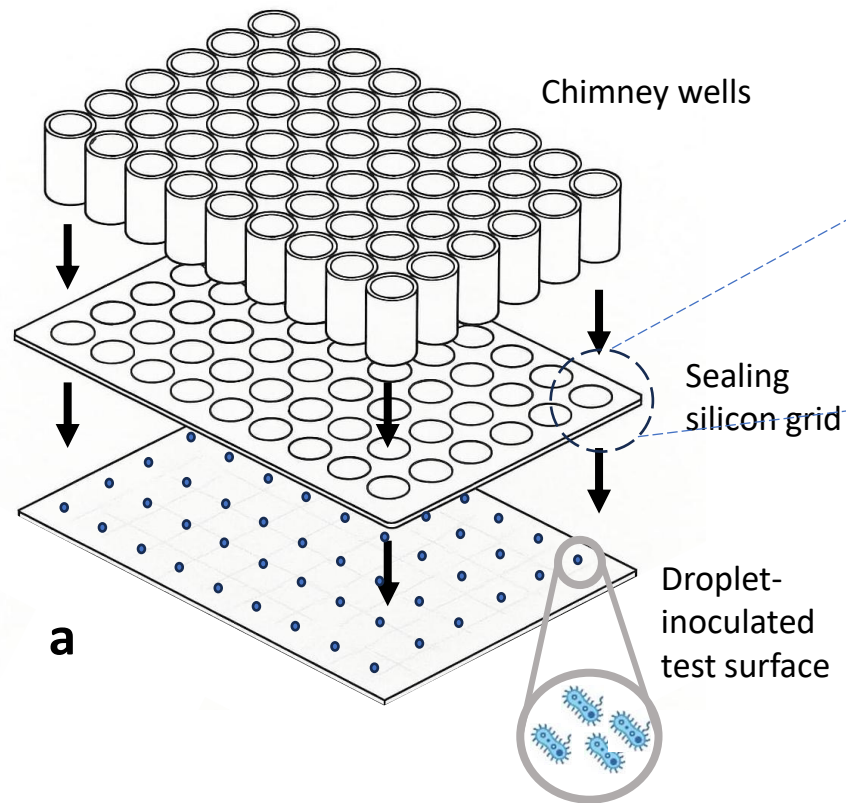


- **Maximilian Schmitt**
- **Linus Wäschle**
- Susann Wiltner
- Niclas Nordholt
- Birgit Strommenger (RKI)

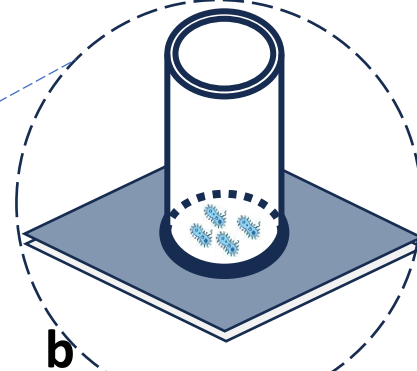


Thanks for your attention!

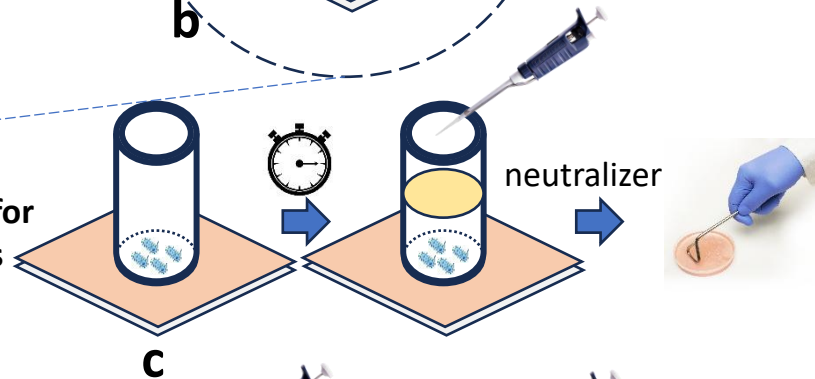




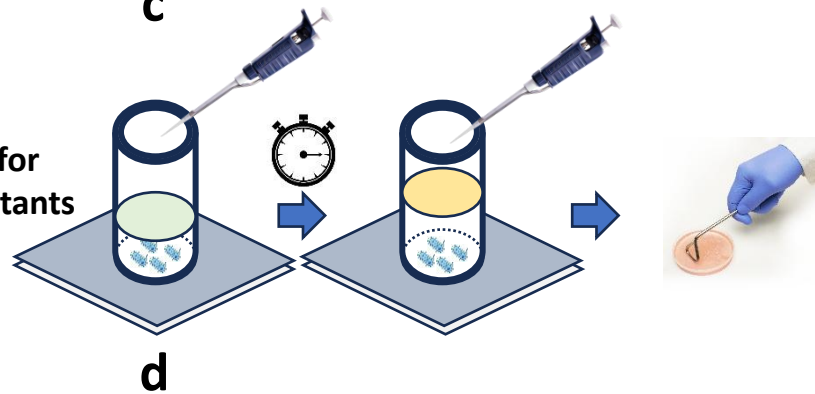
Detail on
Assembled
components



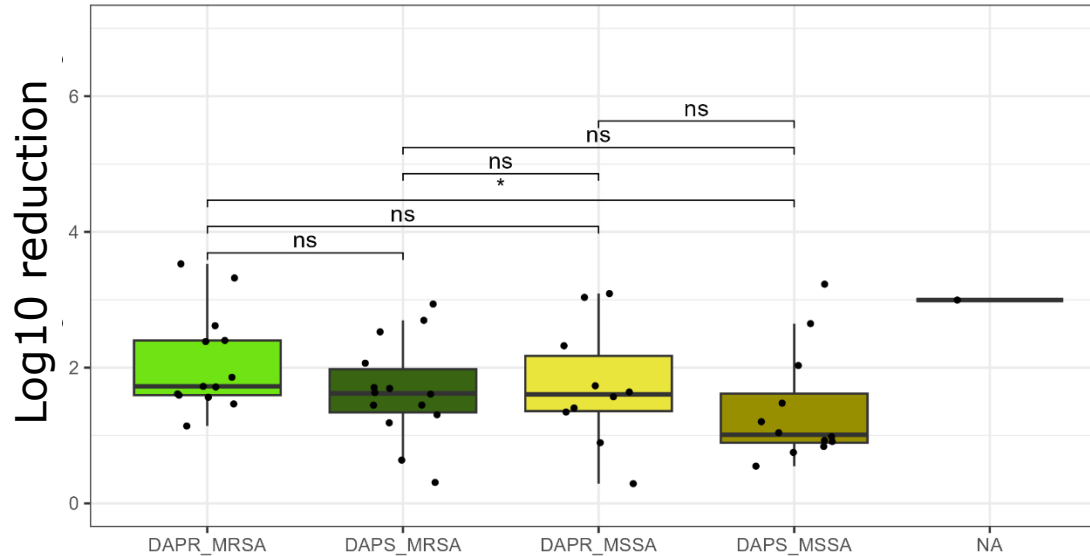
Testing for
coatings



Testing for
disinfectants



Example of *S. aureus* library testing on copper (1 hour)



calibration of contact time (proxy for killing time)

