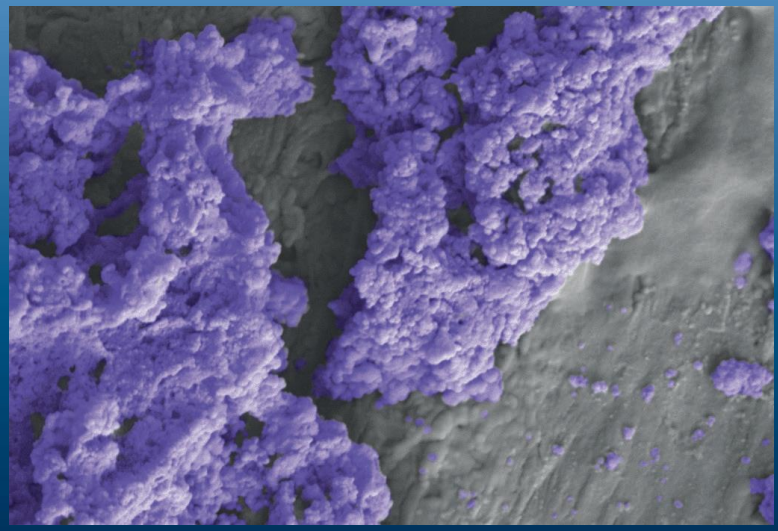
Dry Surface Biofilm



RESILIENCE RECOVERY THE PATH FORWARD

REUNITED 2023

IPAC Canada National Conference

Vancouver BC | May 28-31, 2023

Presented by:

Dr. Michelle Alfa, Ph.D., FCCM

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- Dr. Michelle Alfa is currently the President of AlfaMed Consulting Ltd.
- She has provided consulting services and/or been an invited speaker for; Olympus, Ofstead & Associates, Karl Storz, Kikkoman, 3M, STERIS, and Nanosonics. She also receives royalty payments from the University of Manitoba for licensing of a patent to Healthmark.
- None of the above are related to the topic of her presentation at IPAC 2023

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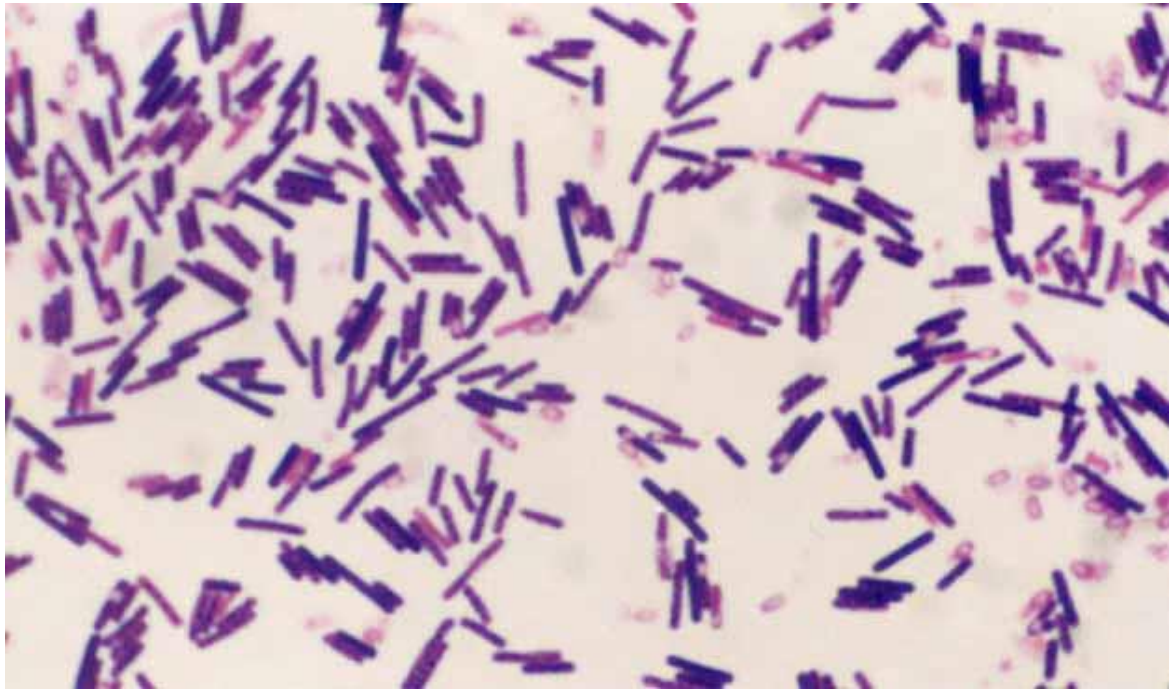
Objectives:

- What is Dry Surface Biofilm?
- Why is it important?
- What can be done to improve surface cleaning & disinfection in Healthcare?

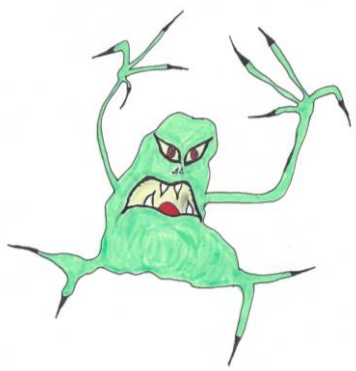
Microorganisms on Healthcare Surfaces

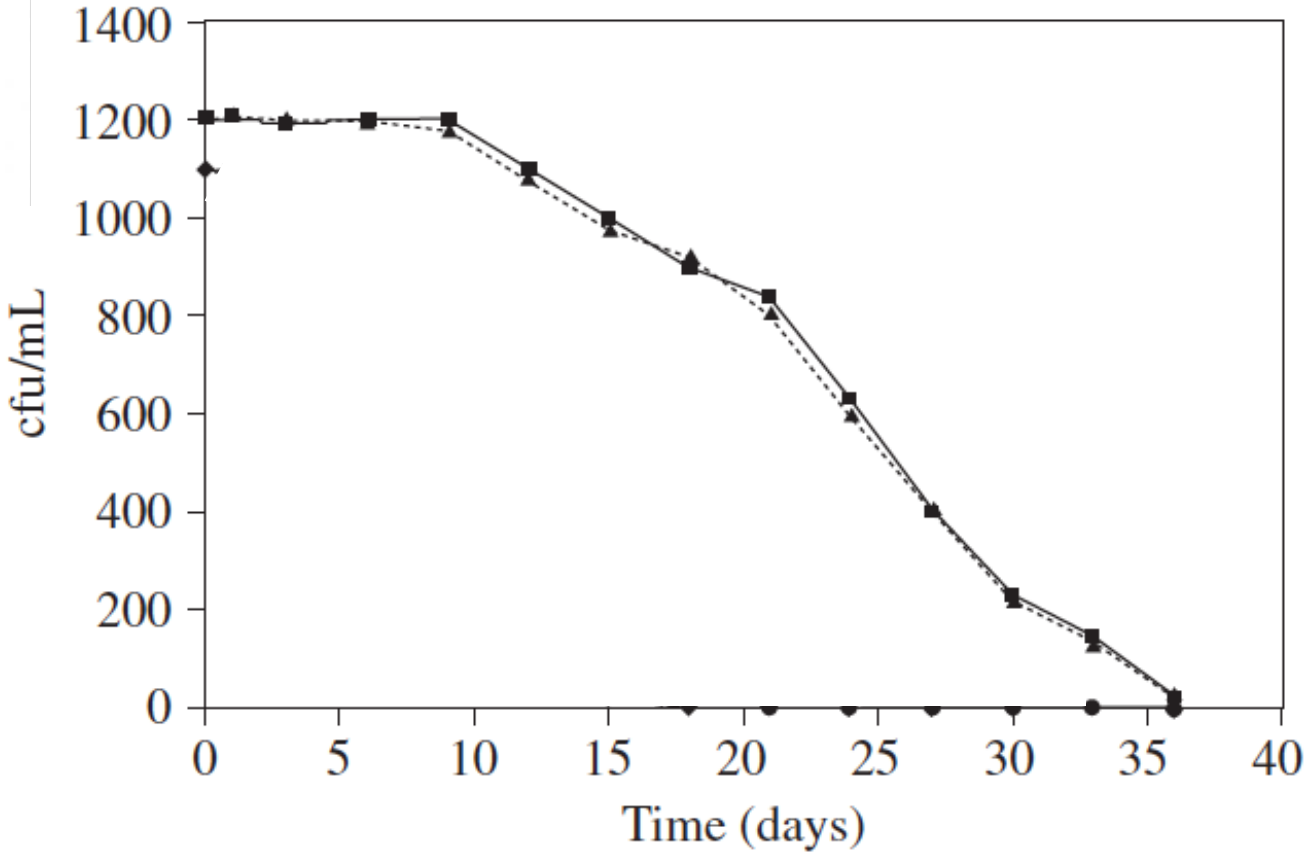


Many of the original cleaning and disinfection requirements were based on the assumption that only Planktonic organisms on surfaces needed to be eradicated

Planktonic: microorganisms adhere to dry surface

Planktonic *Acinetobacter baumannii* survives on environmental surfaces





Different microorganisms have differing ability to survive in planktonic form on environmental surfaces

Spore forms; survive for years

Espinal P et al Effect of biofilm formation on the survival of *Acinetobacter baumannii* on dry surfaces. J Hosp Infection 2012 http://dx.doi.org/10.1016/j.jhin.2011.08.013

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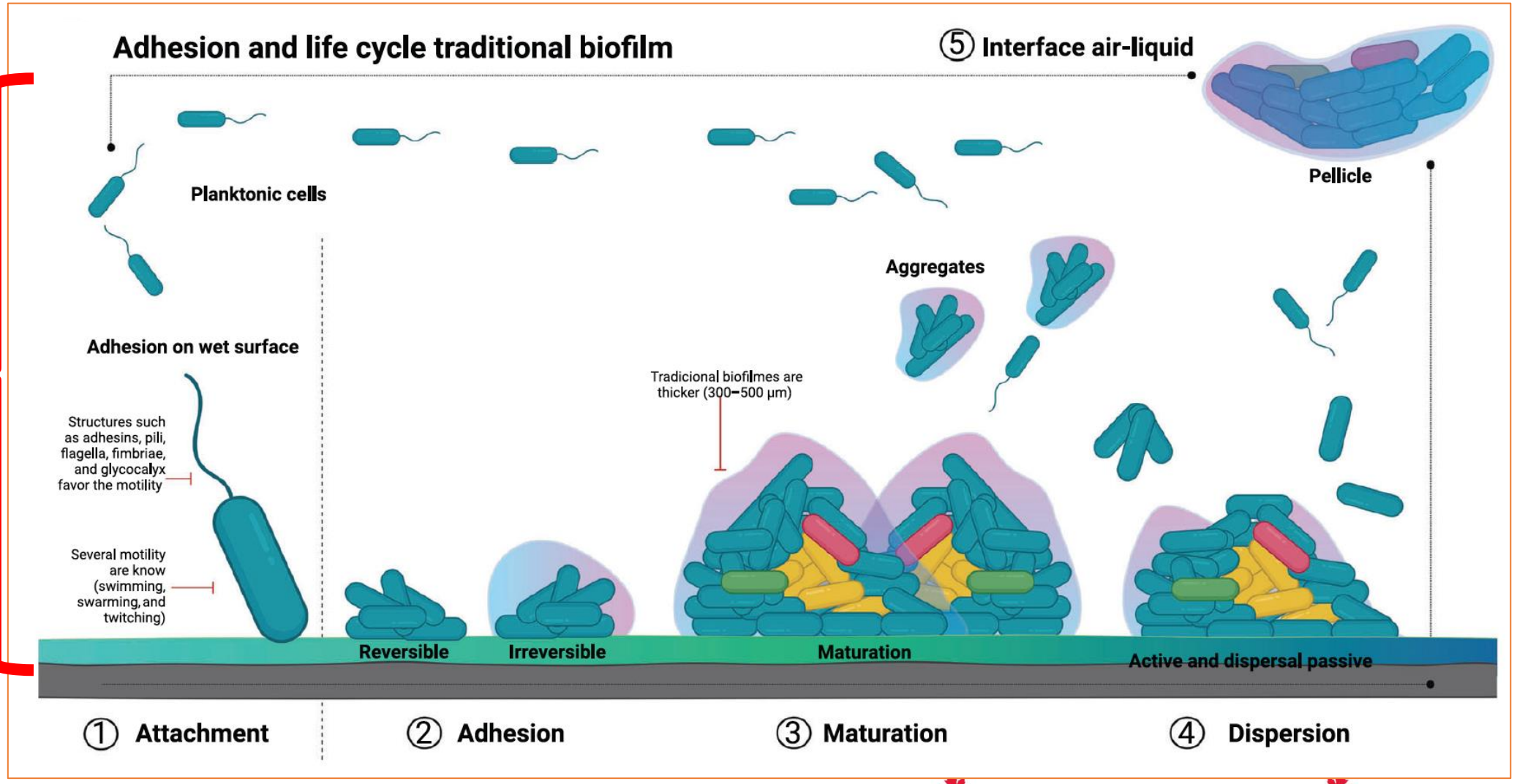
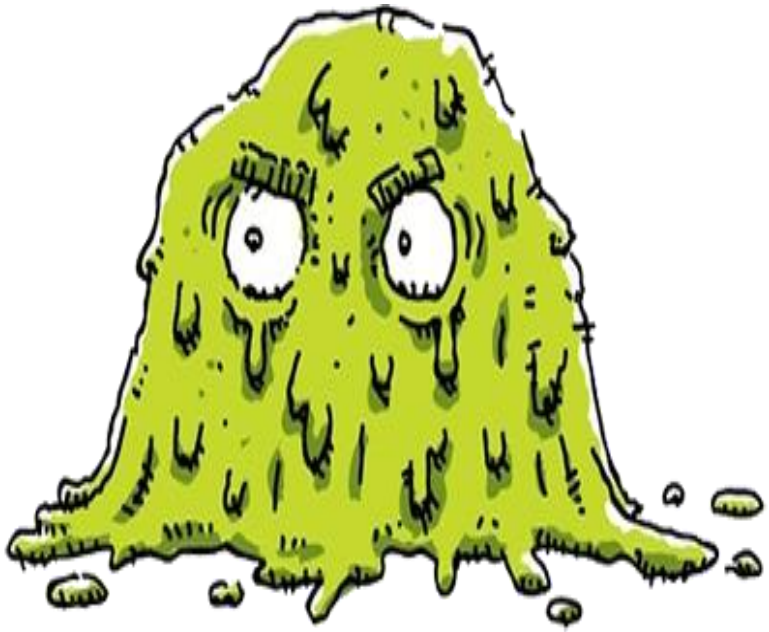
TRADITIONAL BIOFILM

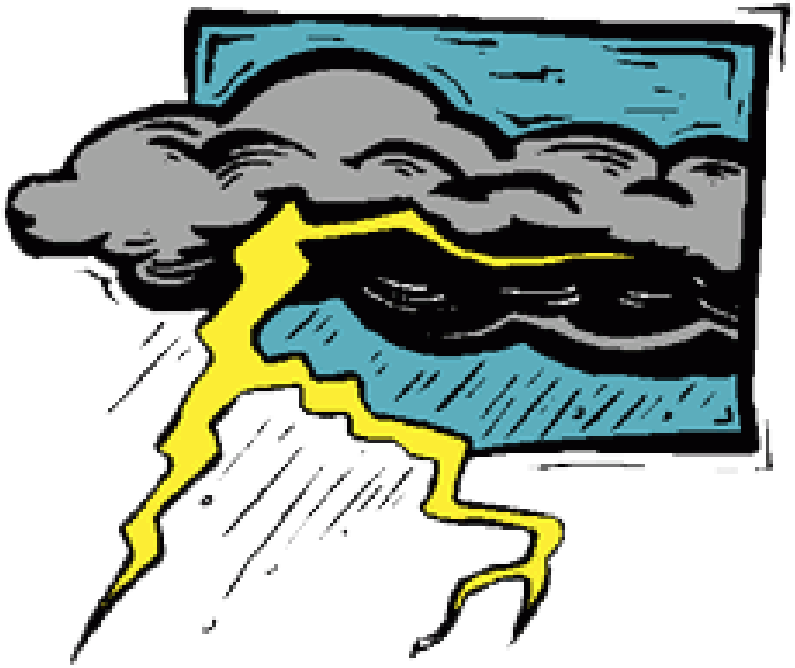
Bathed in liquid Flow



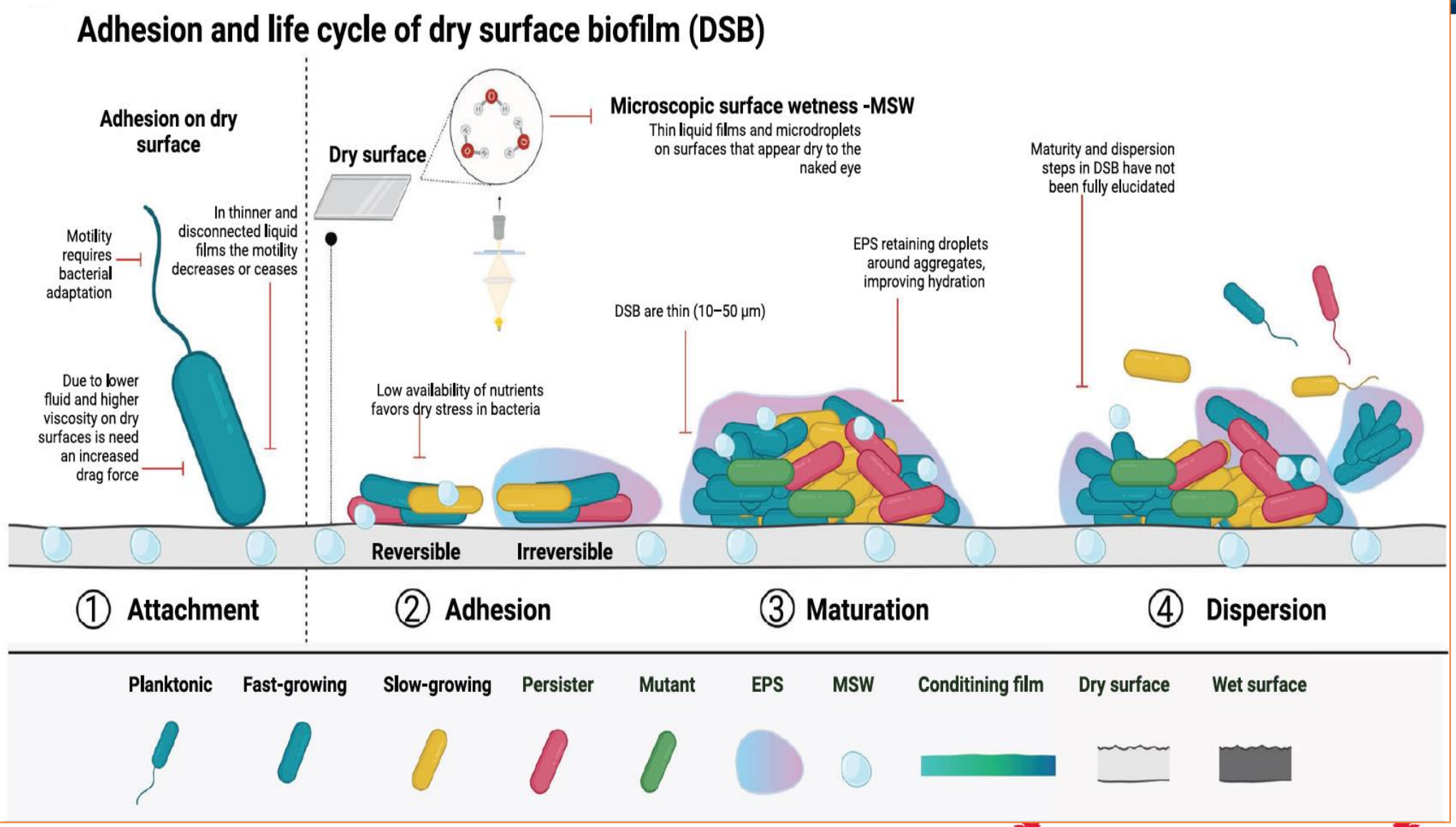
Alonso V. Dry surface biofilms in the food processing industry: An overview on surface characteristics, adhesion and biofilm formation, detection of biofilms, and dry sanitization methods. Compr Rev Food Sci Food Saf.2023;22:688–713

What more can happen…..?





DRY SURFACE BIOFILM



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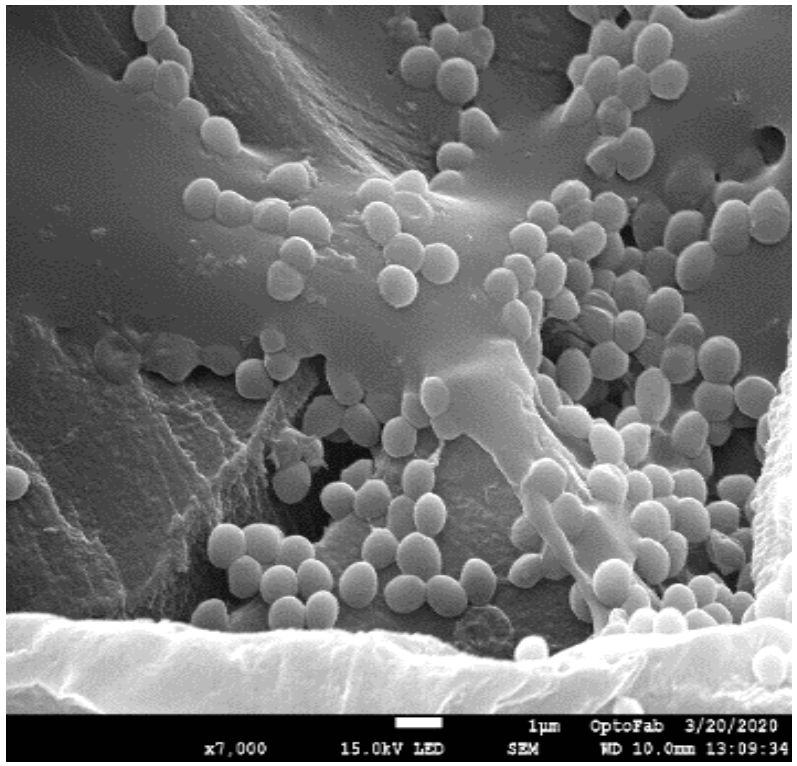
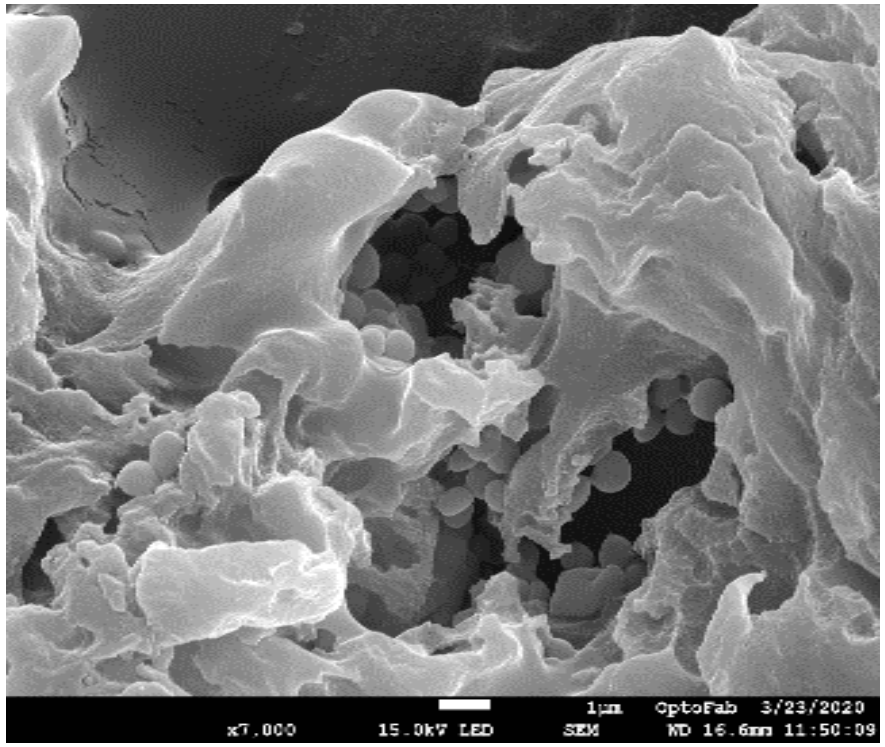
Staphylococcus aureus Biofilm versus Dry Surface biofilm??



12 Day hydrated Biofilm

Continuous hydration



12 Day Dry Surface Biofilm

Repeated rounds of hydration and dehydration

Hu H et. al. *Staphylococcus aureus* cell wall phenotypic changes associated with biofilm age and water stress: a key contributing factor for biocide resistance. 2023; https://doi.org/10.21203/rs.3.rs-2486620/v1

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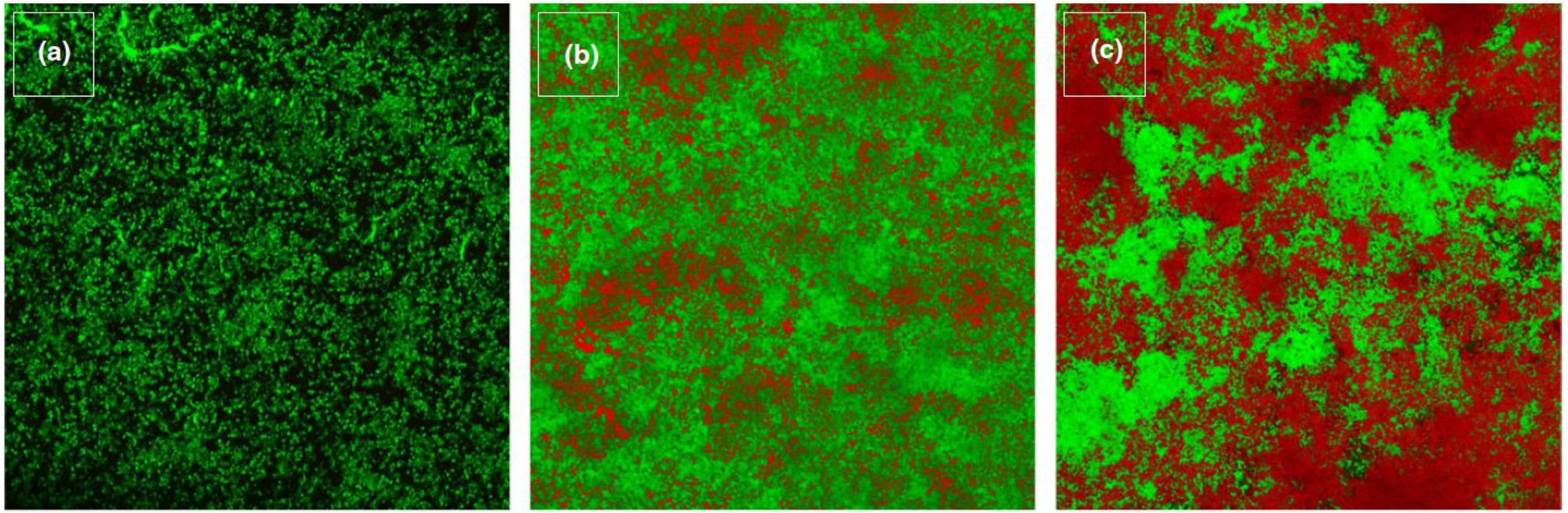
Dry Surface Biofilm Model: *S. aureus*

Three cycles of Hydration 2 days followed by Drying 2 days



4 days 8 days 12 days

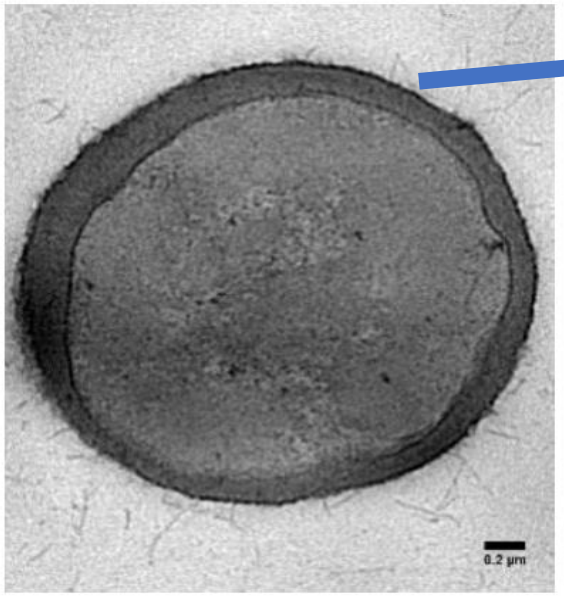
Live-Dead Stain:

GREEN: **Live** *Staphylococcus aureus*

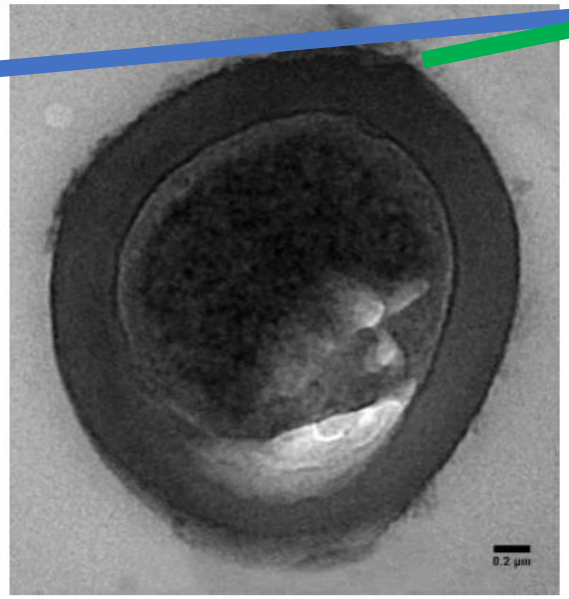
RED: **Dead** *Staphylococcus aureus*

Ledwoch K et al Artificial dry surface biofilm models for testing the efficacy of cleaning and disinfection. Letters Applied Microbiology 2019;68:329-336

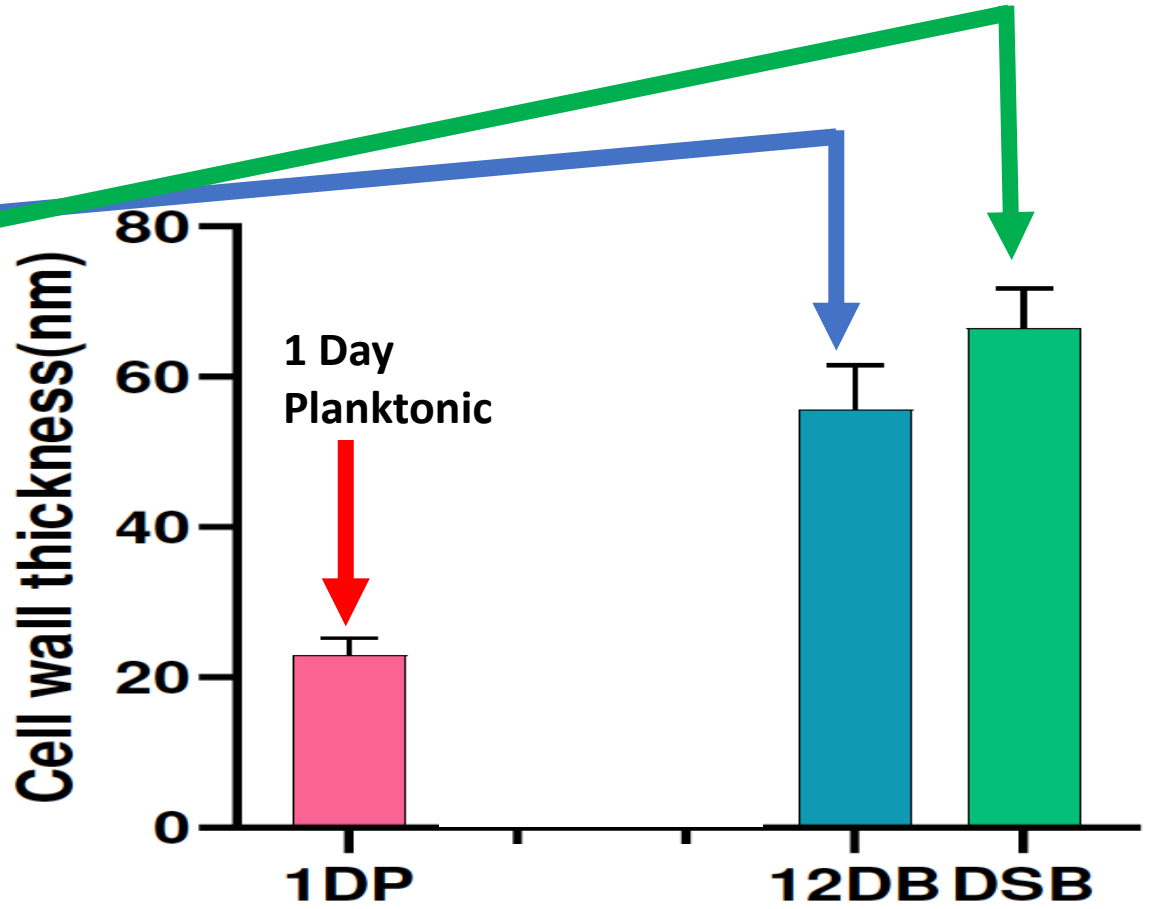
Staphylococcus aureus cell wall in Traditional Biofilm versus Dry Surface Biofilm



12 day Biofilm



12 day Dry Surface Biofilm



Hu H et. al. Staphylococcus aureus cell wall phenotypic changes associated with biofilm age and water stress: a key contributing factor for biocide resistance. 2023; https://doi.org/10.21203/rs.3.rs-2486620/v1

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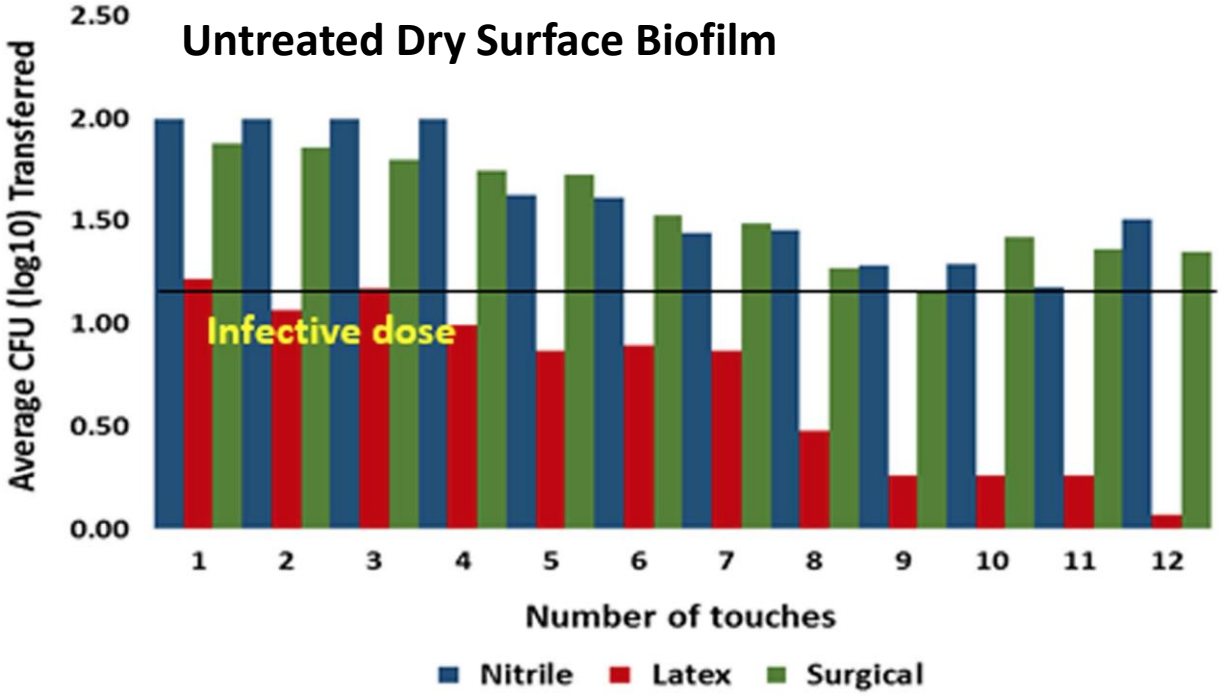
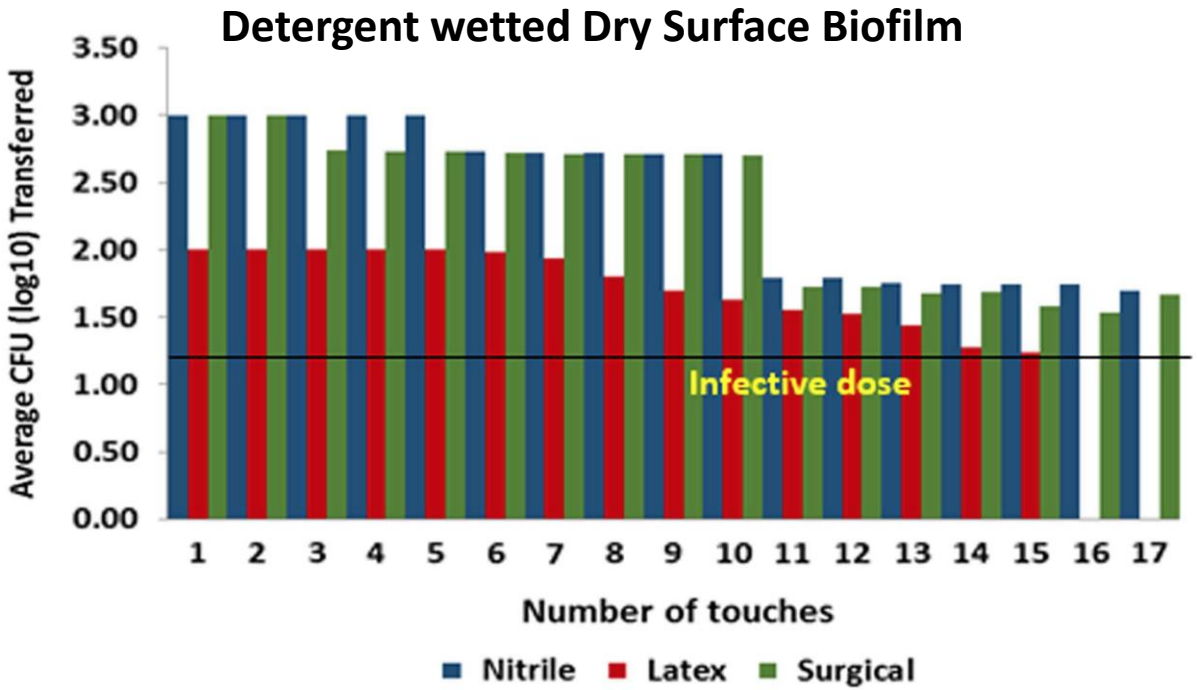
Transmission of *S. aureus* from Dry Surface Biofilm by gloved hand contact





Tahir S et. al. Transmission of *Staphylococcus aureus* from dry surface biofilm (DSB) via different types of gloves. Infection Control & Hospital Epidemiology 2019, 40, 60–64. doi: 10.1017/ice.2018.285

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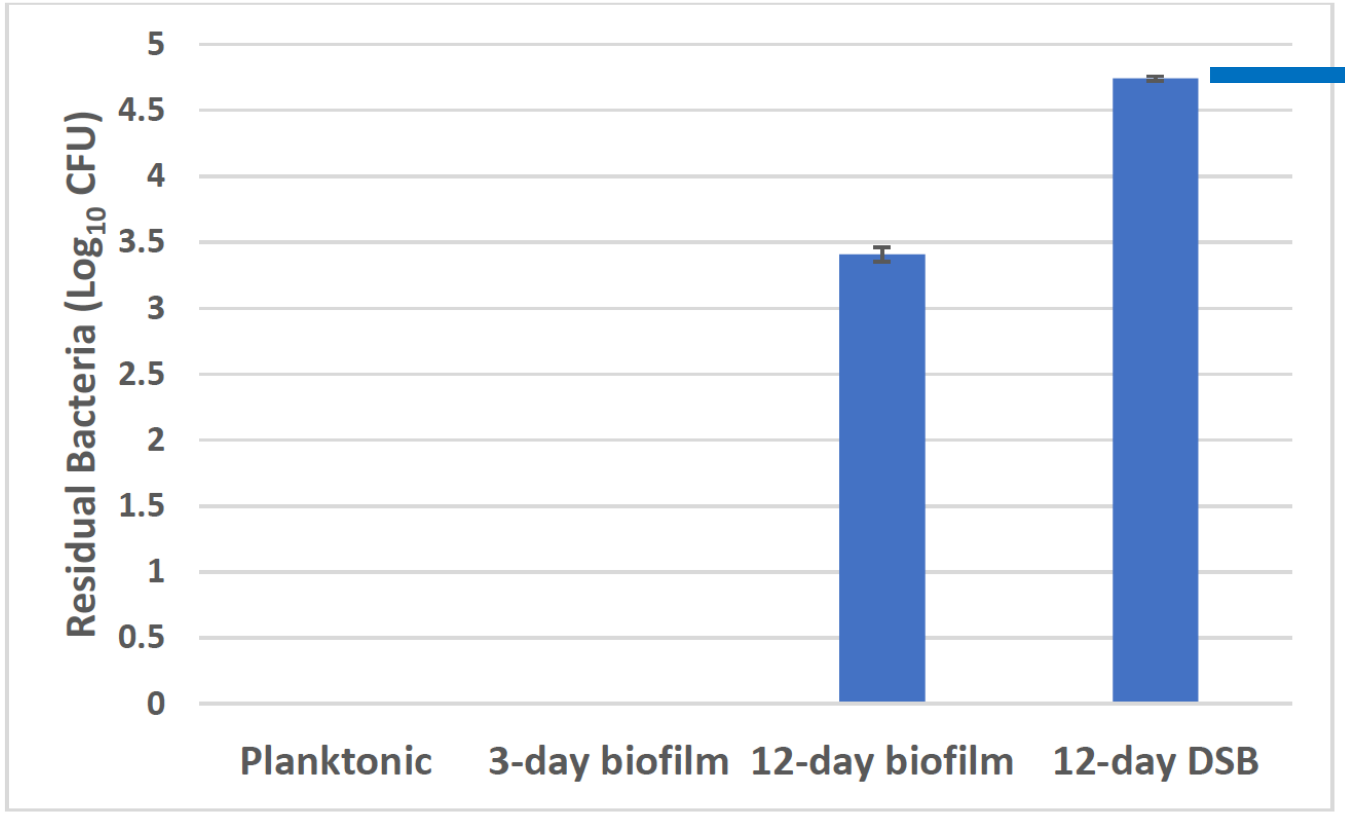
Difficult to eradicate *S. aureus* in Dry Surface Biofilm using Bleach (5 min contact time)



Eradication of 12-day DSB only achieved with 5000 ppm Bleach, 5 min contact time

1000 ppm Chlorine on planktonic vs biofilm vs Dry Surface Biofilm (DSB)

Hu H et. al. Staphylococcus aureus cell wall phenotypic changes associated with biofilm age and water stress: a key contributing factor for biocide resistance. 2023; https://doi.org/10.21203/rs.3.rs-2486620/v1

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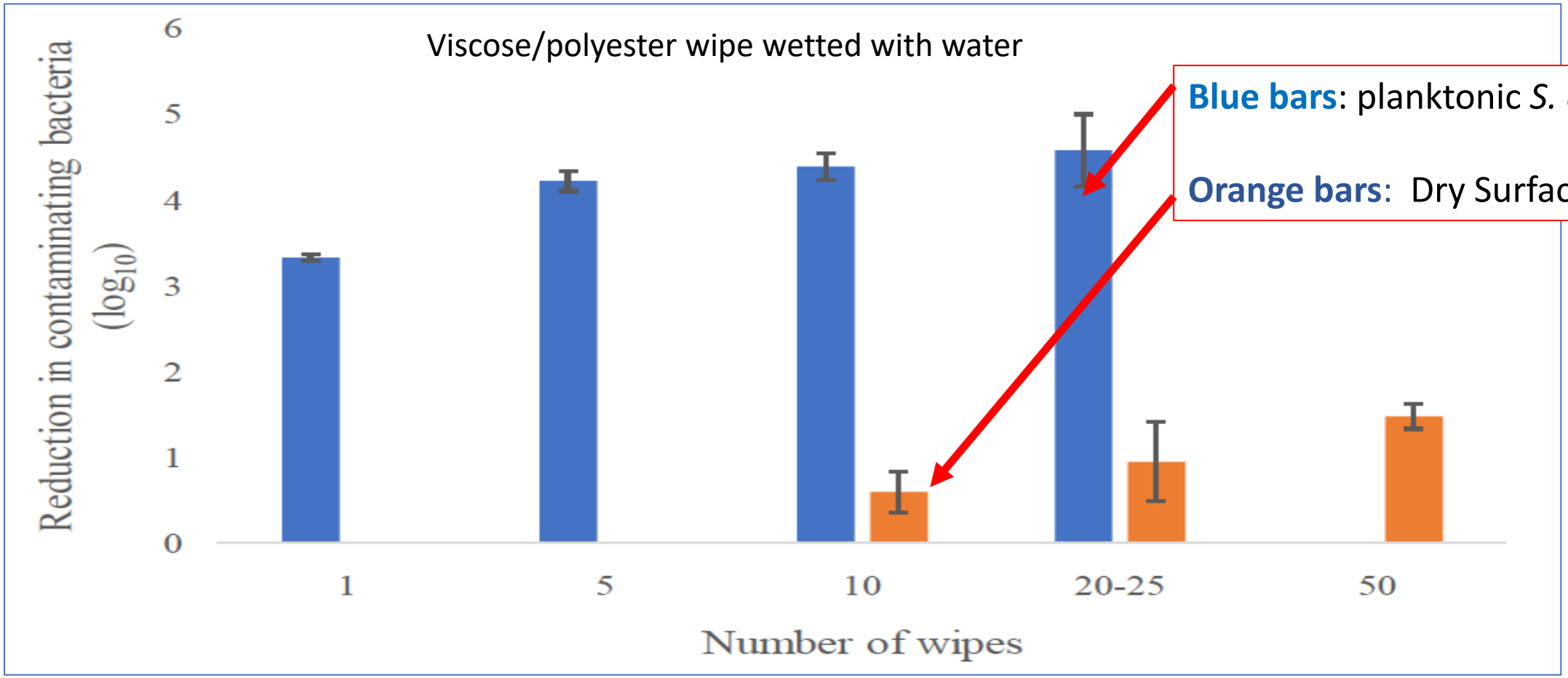
Impact of linear wiping action on different growth cultures of *Staphylococcus aureus*

Abrasion Tester

- Scrub testing device with a mechanical arm, set at 1000 g downward pressure (equivalent to 28 g/cm^2)
- 60 cm/second in a linear motion
- Provides a linear two-way wiping process
  (Elcometer 1720 Abrasion Tester, Phillro Industries, Moorabin, Australia).

Parvin F et al., Difficulty in removing biofilm from dry surfaces, Journal of Hospital Infection, https://doi.org/10.1016/j.jhin.2019.07.005

Impact of linear wiping action on different growth cultures of *Staphylococcus aureus*



Parvin F et al., Difficulty in removing biofilm from dry surfaces, Journal of Hospital Infection, https://doi.org/10.1016/j.jhin.2019.07.005

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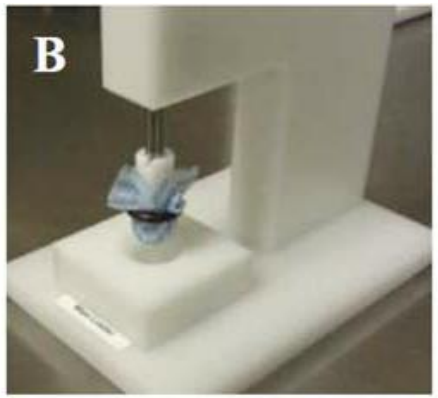
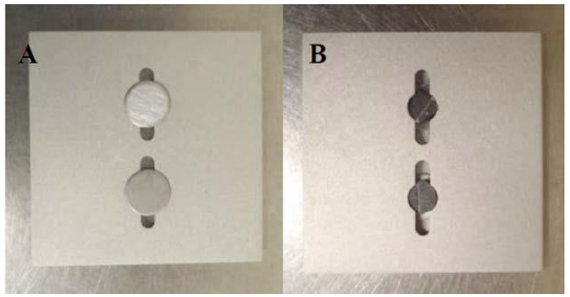
ASTM: E2967 – 15 Standard Test Method for Assessing the Ability of Pre-wetted Towelettes to Remove and Transfer Bacterial Contamination on Hard, Non-Porous Environmental Surfaces Using the Wiperator





Orbital motion:

1 orbit/second
(5 – 45 orbits total)

150 g pressure

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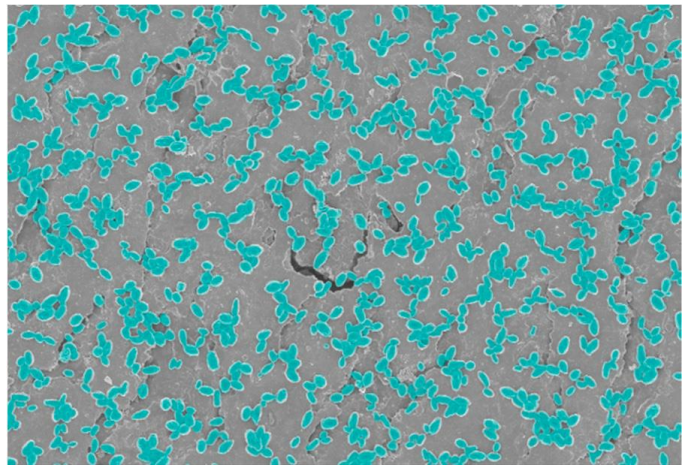
Candida auris Dry Surface Biofilm

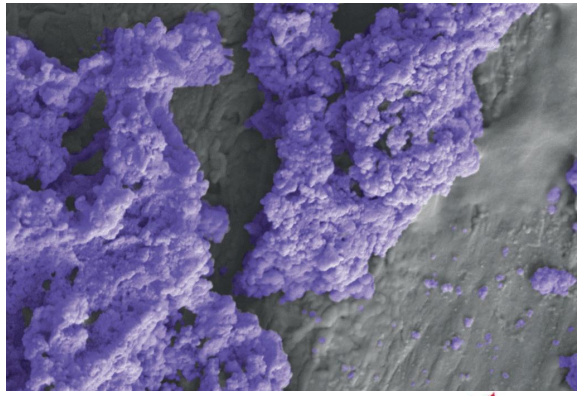


- ASTM E2967-15: Wiperator used to determine efficacy of eleven wipe-based disinfectants
- Quaternary disinfectant not effective
- Commercial formulations of; Sodium hypochlorite 1000 ppm & Peracetic acid at 3500 ppm were most effective
  - 7 $\log_{10}$ reduction in CFU and
  - prevented subsequent transfer of *C. auris* from the treated surface

Ledwoch K & Maillard JV *Candida auris* Dry Surface Biofilm (DSB) for Disinfectant Efficacy Testing. Materials 2019;12:18;doi:10.3390/ma12010018

What does this mean for Cleaning and Disinfection in Healthcare Facilities??

- **Dry surface biofilm (DSB):**
  - widespread (up to 95%) on dry surfaces in healthcare settings
  - can harbor multidrug resistant organisms
  - less susceptible to disinfection
  - after cleaning & disinfection pathogens in DSB can be transferred by direct or indirect contact (gloves)
- **Effective elimination requires:**
  - Cleaning: adequate friction
  - Effective disinfectant
  - Use of UV-C/Pulsed light technology?*



Ledwoch K, et. al. Br J Hosp Med. 2022. https://doi.org/10.12968/hmed.2022.0274
*Alonso V. et. al. Compr Rev Food Sci Food Saf.2023;22:688–713

SUMMARY:

- **What is Dry Surface Biofilm (DSB)?**
  - accumulated (dry) matrix containing viable organisms
- **Why is it important?**
  - current cleaning & disinfection methods not as effective against organisms embedded in DSB
- **What can be done to improve surface cleaning & disinfection in Healthcare?**
  - Friction is crucial for physical removal of DSB
  - Use an effective disinfectant that prevents transfer post exposure
  - Cleaning plus UV-C or Pulsed light disinfection??

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I Despise Dry Surface Biofilm!!

REFERENCES

1. Espinal P et al Effect of biofilm formation on the survival of *Acinetobacter baumannii* on dry surfaces. J Hosp Infection 2012 http://dx.doi.org/10.1016/j.jhin.2011.08.013
2. Alonso V. Dry surface biofilms in the food processing industry: An overview on surface characteristics, adhesion and biofilm formation, detection of biofilms, and dry sanitization methods. Compr Rev Food Sci Food Saf.2023;22:688–713
3. Hu H et. al. *Staphylococcus aureus* cell wall phenotypic changes associated with biofilm age and water stress: a key contributing factor for biocide resistance. 2023; https://doi.org/10.21203/rs.3.rs-2486620/v1
4. Ledwoch K et al Artificial dry surface biofilm models for testing the efficacy of cleaning and disinfection. Letters Applied Microbiology 2019;68:329-336
5. Tahir S et. al. Transmission of *Staphylococcus aureus* from dry surface biofilm (DSB) via different types of gloves. Infection Control & Hospital Epidemiology 2019, 40, 60–64. doi: 10.1017/ice.2018.285
6. Parvin F et al., Difficulty in removing biofilm from dry surfaces, Journal of Hospital Infection, https://doi.org/10.1016/j.jhin.2019.07.005
7. Ledwoch K, Vickery K, Maillard J-Y. Dry surface biofilms: what you need to know. Br J Hosp Med. 2022. https://doi.org/10.12968/hmed.2022.0274