

Biofilms: Impacts on Humans, the Environment, and Infrastructure

IMSA Institute Day
February 26, 2021
Liz Martinez
emartinez@imsa.edu

Biofilm Session

Growth

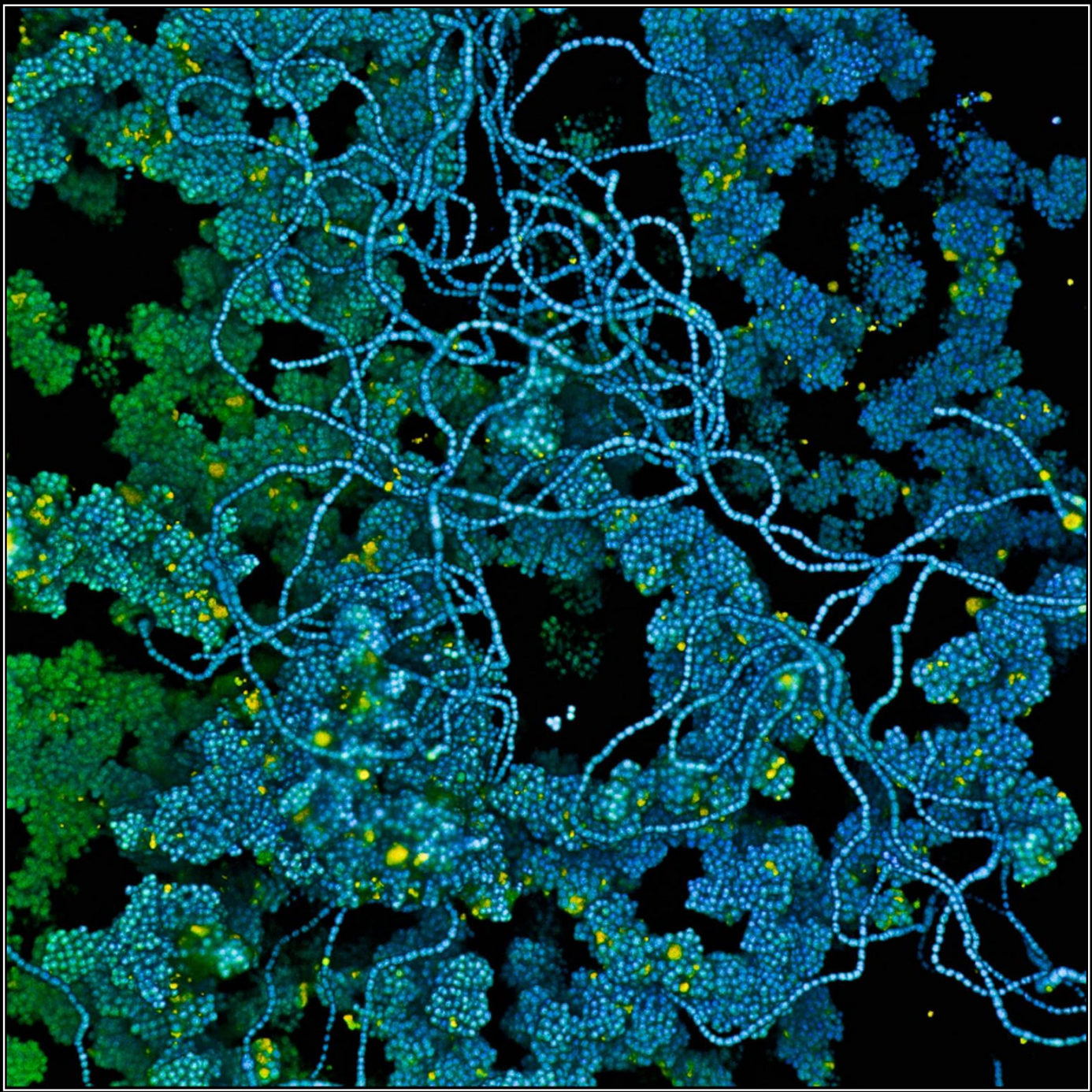
Traits

Impacts - Positive & Negative

Labs, Activities

Next Steps

References



MRSA

<https://www.nikonsmallworld.com/galleries/2017-photomicrography-competition/long-chains-of-s.-pyogenes-infecting-grape-like-clusters-of-mrsa-biofilm>

Biofilms

Where can biofilms be found?
(Put ideas in the chat box.)

- Nature
- Humans
- Industry

Humans: *Heart, Kidney, Bone, Teeth, Middle Ear Infections, Prosthetic Rejection*

Nature: *Minerals, Metals, Thermal Vents, Plant Tissues*

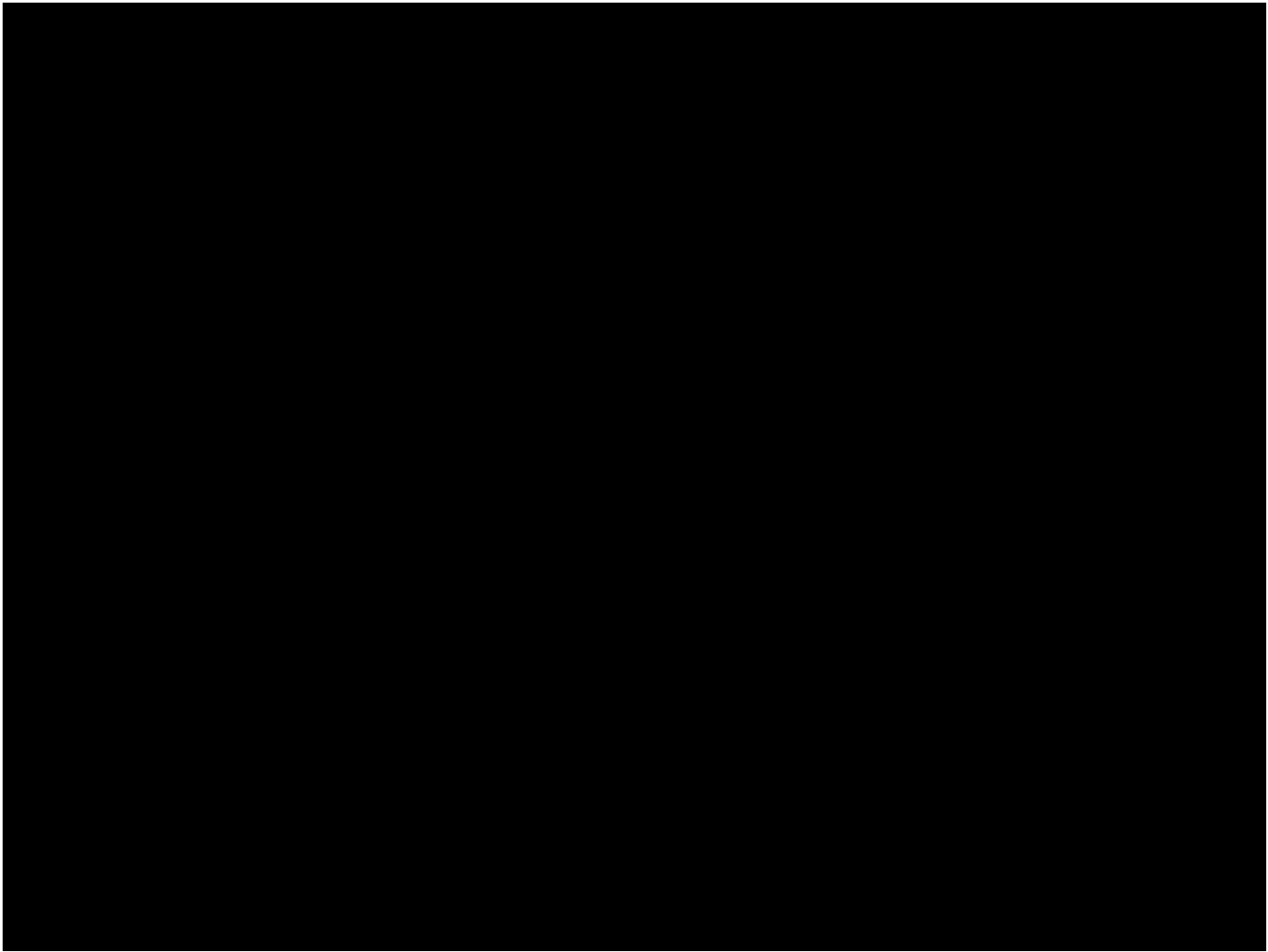
Infrastructure (Biofouling): *Water Treatment & Distribution, Food & Beverage Processing Plants, Ships*

\$94,000,000,000

If you could live for 94 billion minutes, you would live until you were
178,843 years old.

500,000 deaths

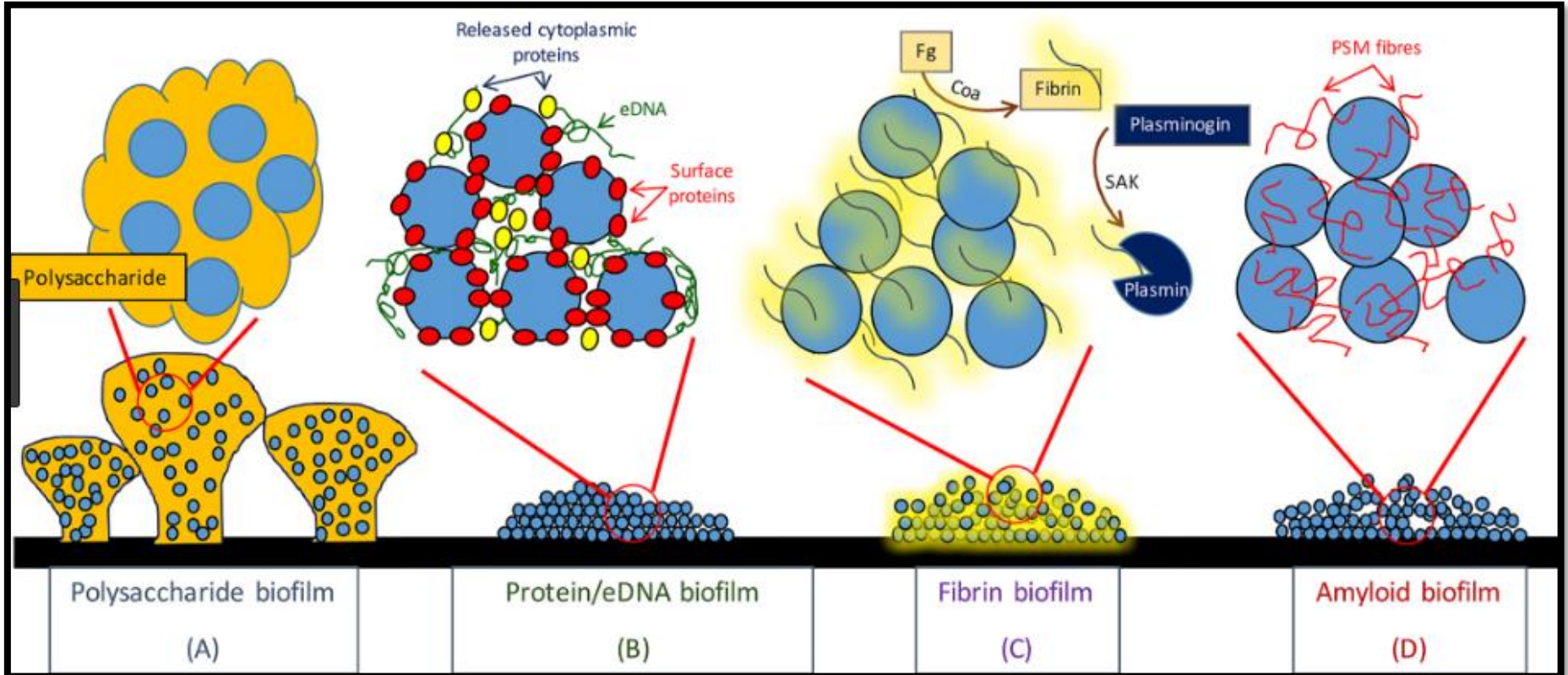
Annual impact of biofilm infections (2013)



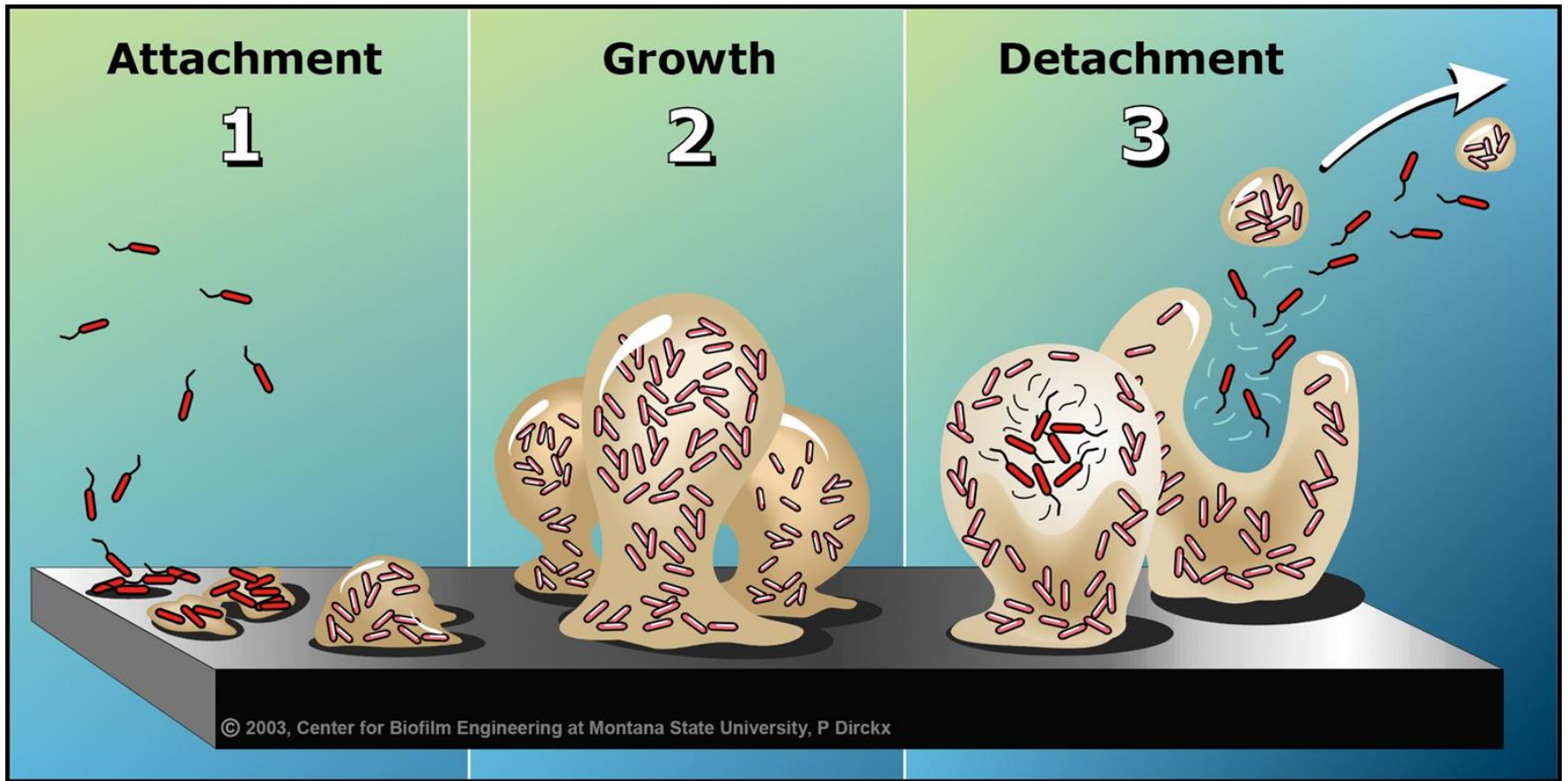
What Are Bacterial Biofilms? A Six Minute Montage.

Development

- Bacteria
- Surface
- Form Biofilm
- Extracellular Matrix
- Hydrophobic
- Nonplanktonic Relationship

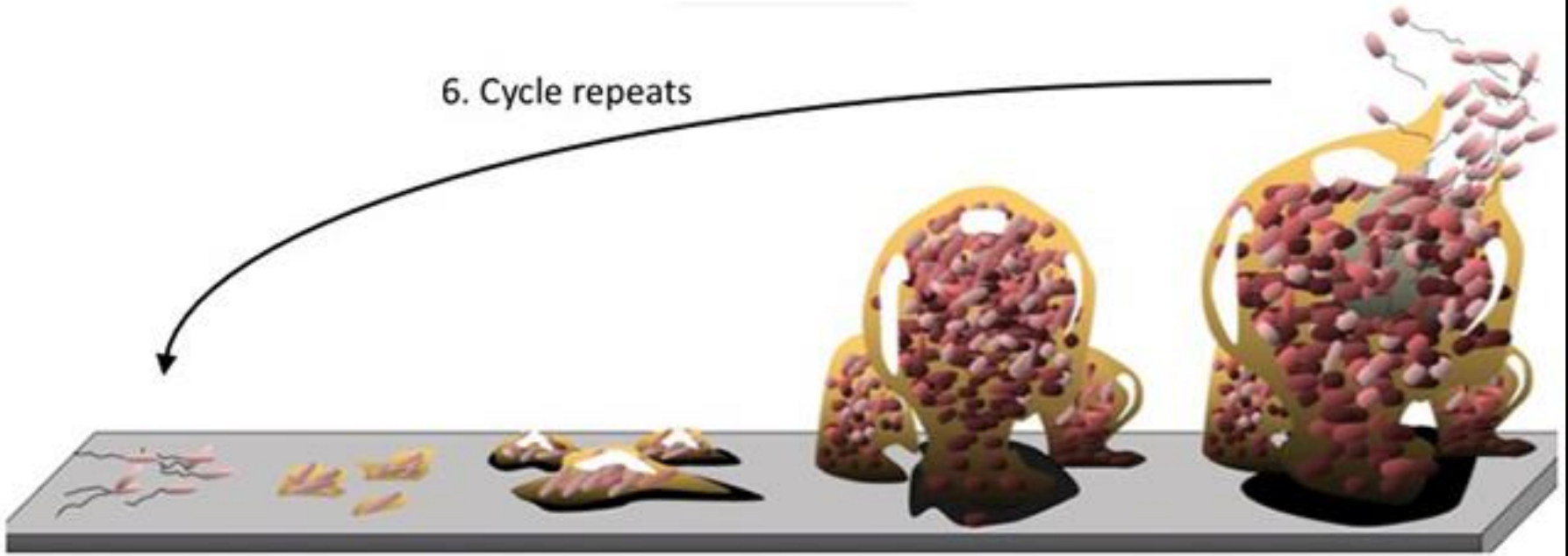


<https://socratic.org/questions/where-is-biofilm-found>



http://www.biofilm.montana.edu/biofilm-basics/what_are_biofilms.html

6. Cycle repeats



1. Single free floating bacteria land on surface

2. Bacterial cells aggregate and attach

3. Growth and division of bacteria for biofilm formation

4. Mature biofilm formation

5. Part of biofilm disperses to release free floating bacteria for further colonization

<https://socratic.org/questions/where-is-biofilm-found>

Figure A: Bacteria

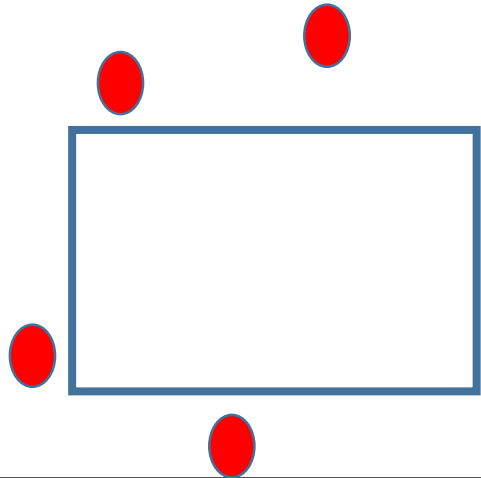


Figure B: Bacteria
Attach to Surface

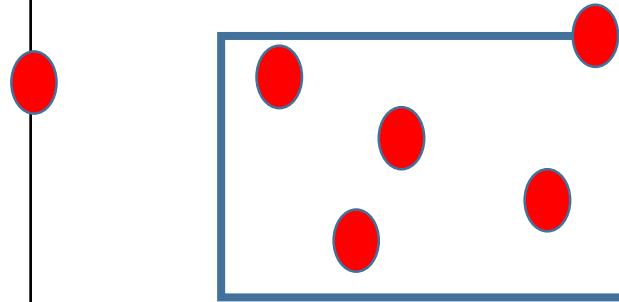


Figure C: Biofilm Production

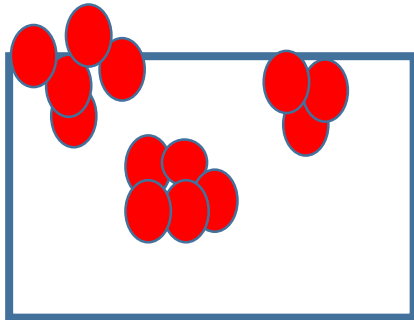
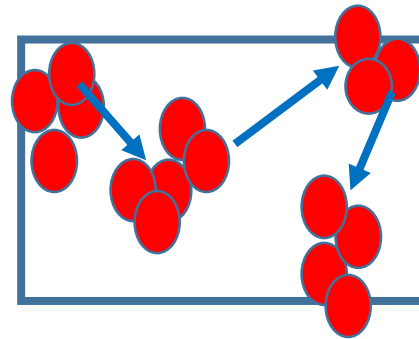
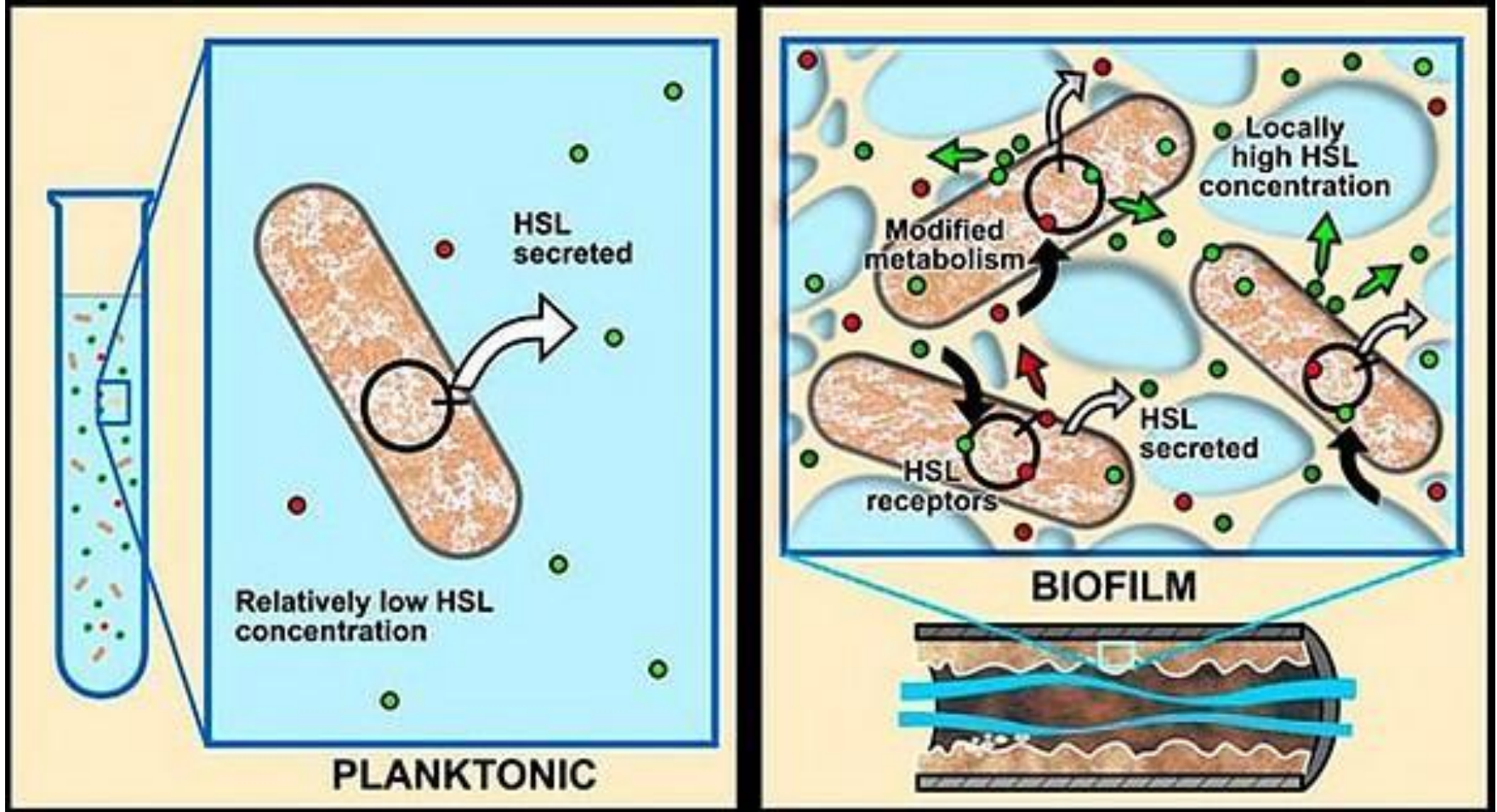
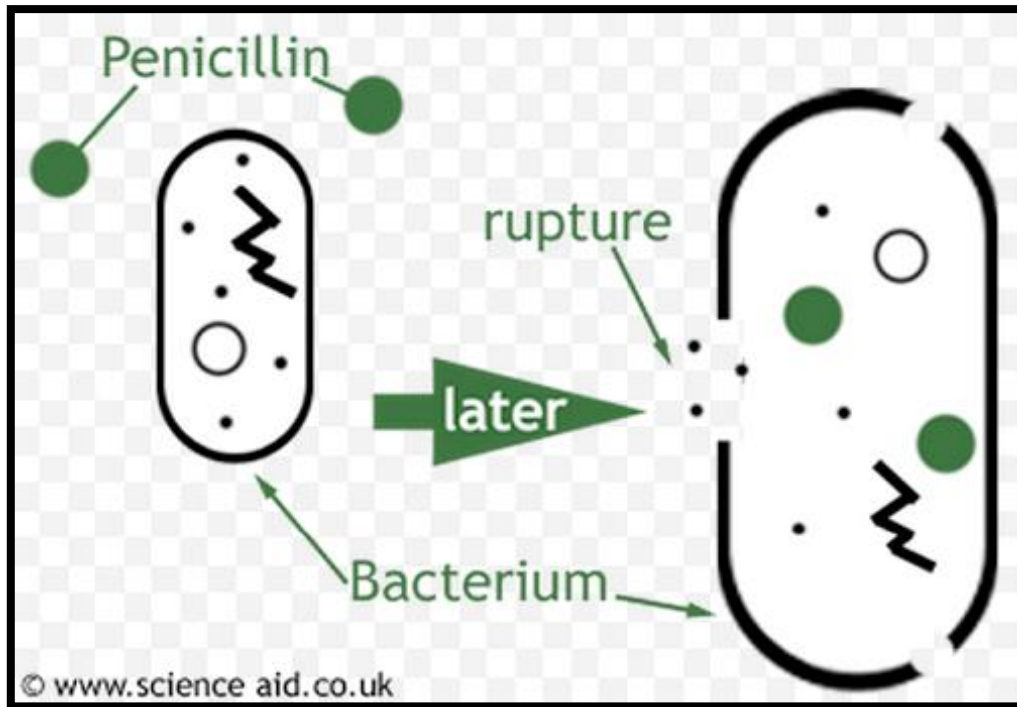
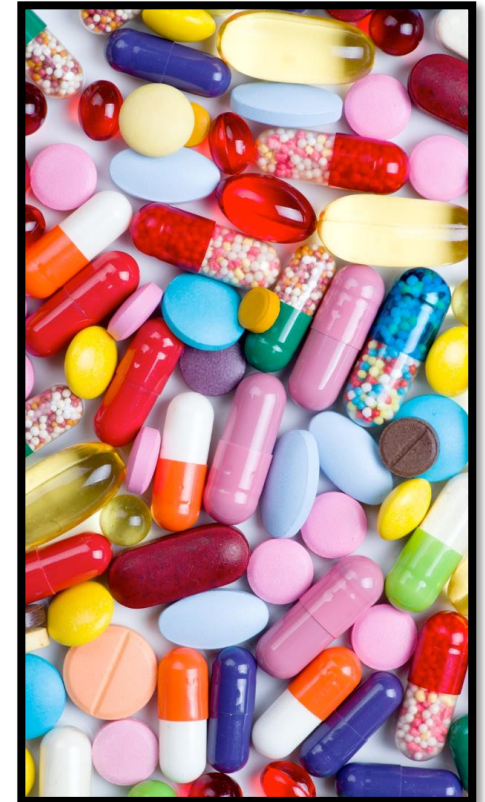
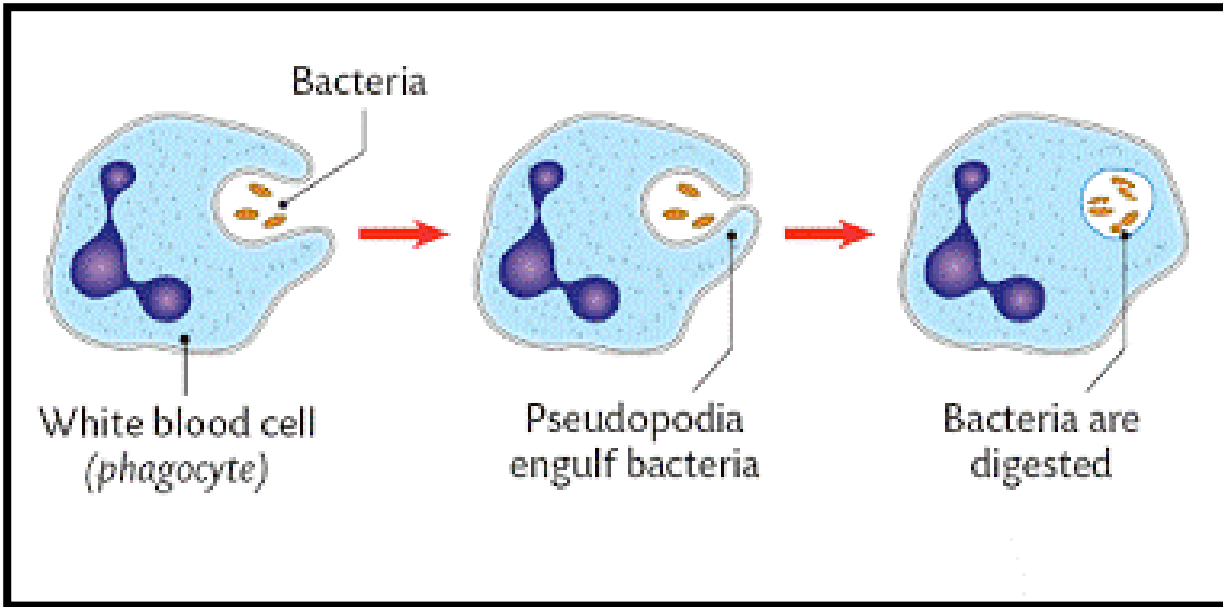


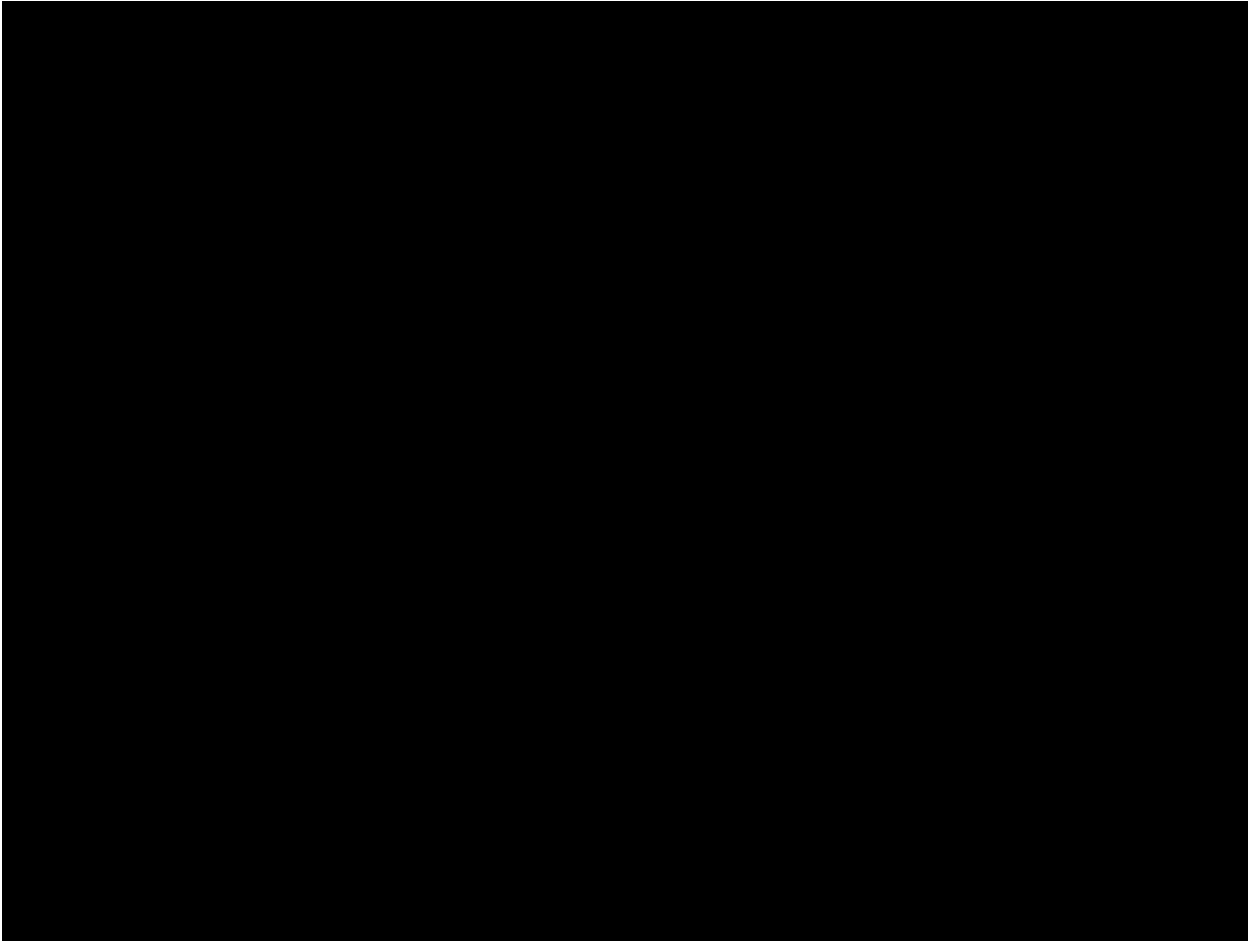
Figure D: Quorum Sensing
Group Behavior, Regulate Gene
Expression, Defensive, Difficulty
Treating



Quorum Sensing







Bonnie Bassler: How bacteria “talk”

Impacts

Positive

- Nutrient requirement
- Protection to antibiotic, antiseptics
- Gene regulation
- Protection
- Wastewater treatment
- Drinking water treatment
- Contaminated soil treatment
- Leaching precious metals
- Important link food web

Negative

- Immunocompromised
- Chronic infections
- Antibiotic & antiseptic resistance
- Quantity of medication needed
- Waste accumulation
- Prevalence

Classroom Resources

Articles:

Biofilms as Biobarriers

[IT'S ALIVE! Biofilm at water-air \(NSTA\)](#)

Stop the Microbial Chatter

Where are all the antibiotics?

Case Study:

What's wrong with Maria?

Labs:

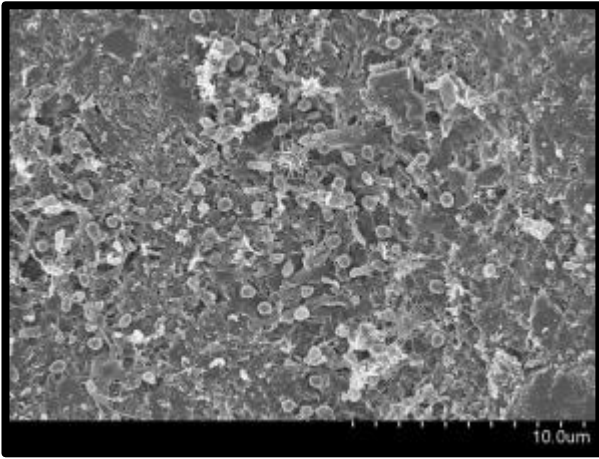
Biofilm Lab

[Blast a Biofilm Modeling Traits](#)

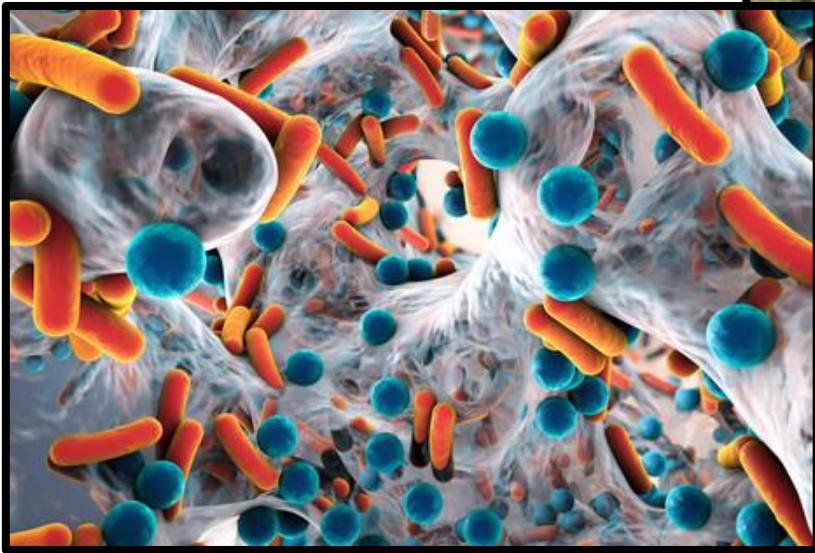
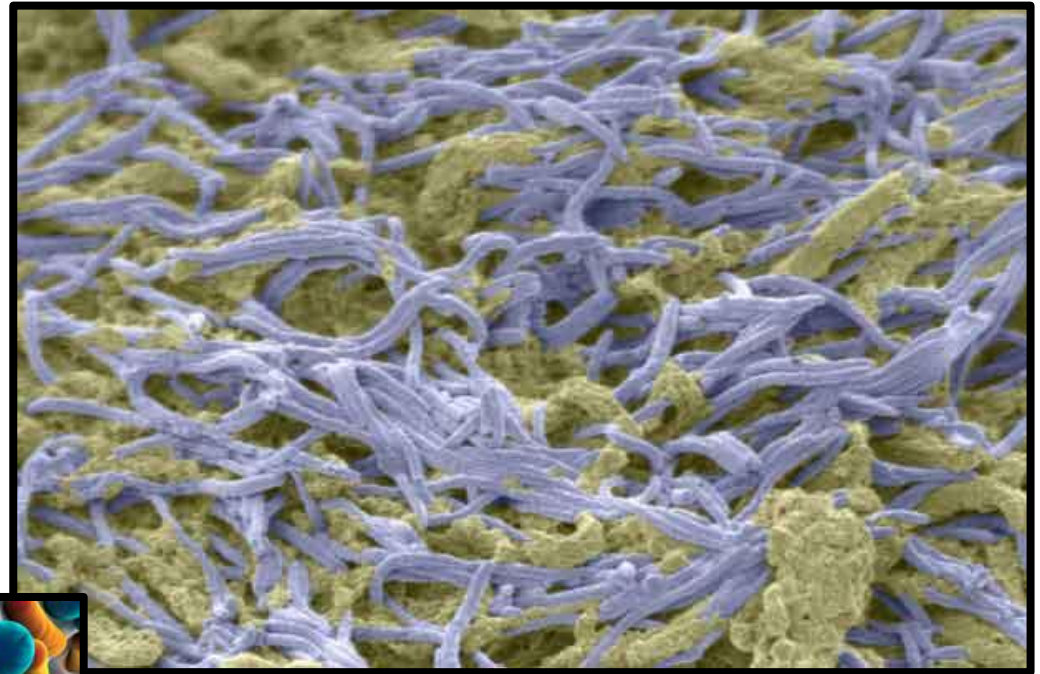
Videos:

[Bonnie Bassler: How bacteria "talk"](#)

[What are bacterial biofilms?](#)



<https://bitesizebio.com/37911/amazing-world-biofilms/>



<https://www.cancer.gov/news-events/cancer-currents-blog/2015/bacterial-biofilms-provide-clues>

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<https://courses.lumenlearning.com/ivytech-bio1-1/chapter/prokaryotic-diversity-2/>



<https://www.atac.cc/blog/solving-the-film-mystery/>



<https://www.clspectrum.com/issues/2008/january-2008/cultivating-compliance>



<https://bestshowercurtainsblog.wordpress.com/2017/11/15/how-to-maintain-and-keep-your-shower-curtain-liner-clean/>



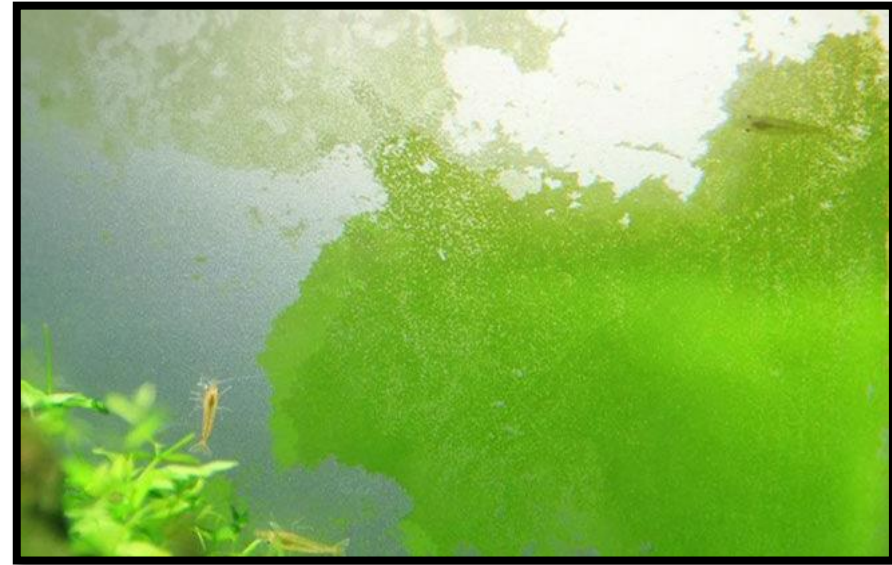
<https://sites.google.com/a/nsix.org.uk/obhs-science/home/year-11/triple-science/triple-chemistry/topic-2/hard-and-soft-water>



<https://fastplumbers.net.au/a-guide-on-clearing-clogs-from-galvanized-pipes/>



<https://preservationscience.wordpress.com/2019/07/10/biofilm-attack/>



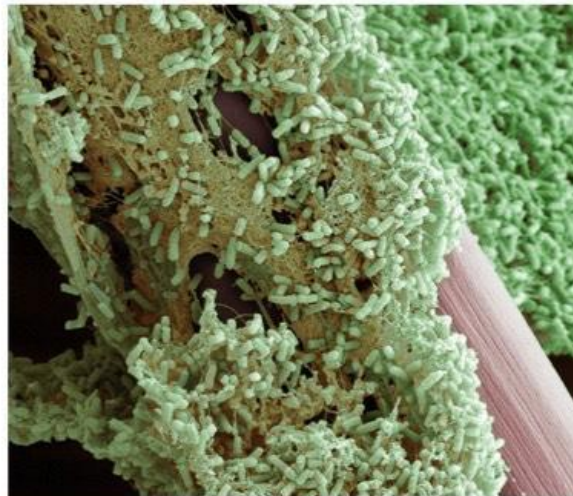
<https://fishlab.com/green-dust-algae/>



<https://me.dental-tribune.com/clinical/plaque-bacteria-prove-no-match-for-guided-biofilm-therapy/>



Biofilm on a toothbrush bristle



Biofilm on a toothbrush bristle (higher magnification)

Biofilm Lab

Tips:

- Use mouthwash brands that do not list alcohol as an active ingredient.
- These 4 bacteria species work well: *Escherichia coli*, *Lactobacillus lactis*, *Staphylococcus epidermidis*, *Staphylococcus salivarius*
- Have students fill out a well plate diagram before Day One with exactly what goes in each well.

Equipment:

- Plate reader
- Spec 20
- Visual

Title

- Include the scientific name of the organism, the independent variable, and the dependent variable.

Introduction

- What question/s are you answering in this lab?
- Give a brief overview of how you answered this question in this activity.
- What is your hypothesis?

Abstract

- What are biofilms?
- Connect this lab with to we learned in class.
- What organism/s are you using? Why?
- What mouthwash are you using? Why?

Methodology

- Write a detailed step-by-step procedure.

Materials

- List all the materials and quantities needed.

Results

- Include any pictures, tables, or graphs that demonstrate your outcome. Include captions for each. **For this lab you must include a computer generated graph of results!
- Explain what the data shows and identify any patterns.

Discussion

- Discuss your results.
- Are your results what you did or did not expect? Explain why/why not.
- What do your results mean to the scientific community and general public?
- Draw a conclusion.
- How would you improve this experiment if you were to do it again?
- What would you explore next to further support your research in this area?

Available Materials

96uL of bacteria species #1

94uL of bacteria species #2

100uL of water

.2mL of ethanol

15.4mL of LB broth

9mL of mouthwash (maximum)

Pipets and tips

Saran wrap

Rubber band

37°C incubator

96 Well plate

Considerations

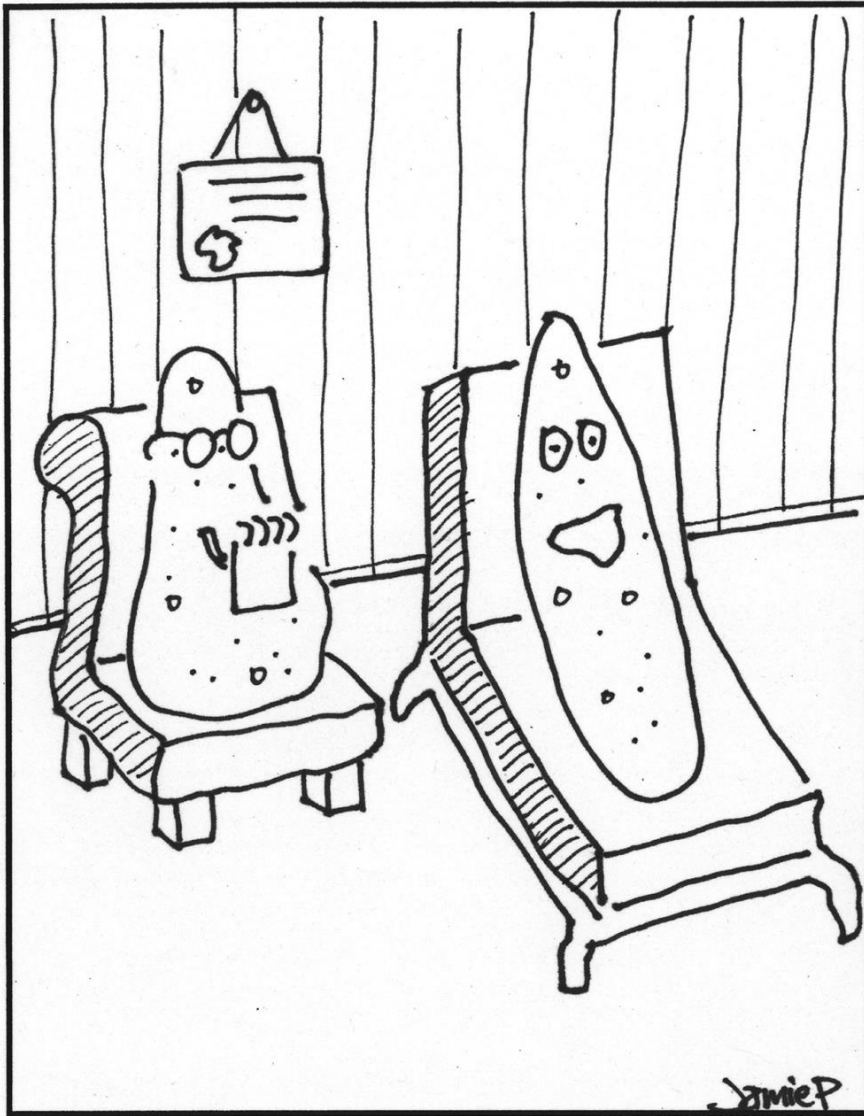
Antibiotic development

- 1987
- 10-15 years
- ~ \$2,000,000,000
- Resilience

Knowledge

Applications

Careers



**I just can't go with the flow anymore.
I've been thinking about joining a biofilm.**

http://www.biofilm.montana.edu/biofilm-basics/what_are_biofilms.html

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