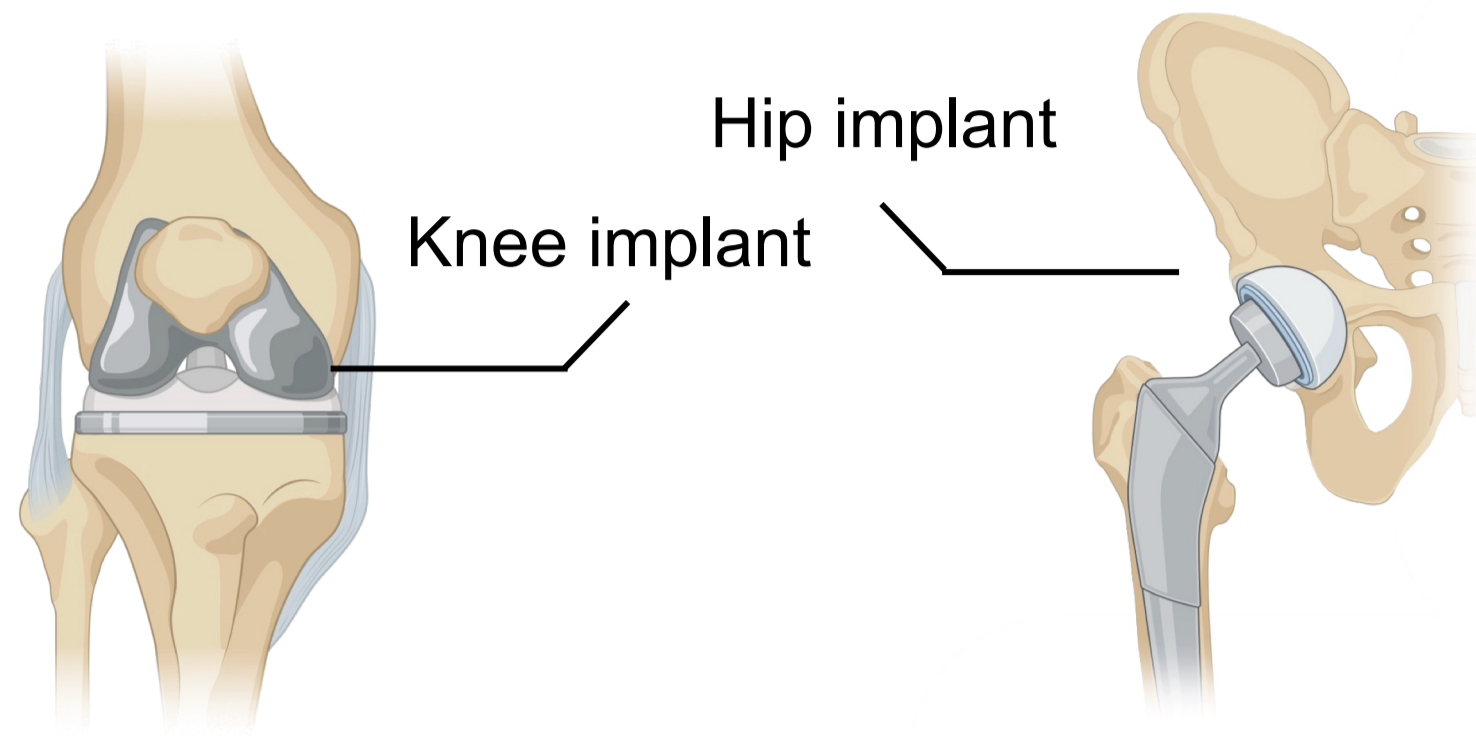


USING MATERIALS TO UNDERSTAND HOW TO DISRUPT SEPSIS-CAUSING BIOFILMS BY UNDERSTANDING HOW THEY TALK TO EACH OTHER

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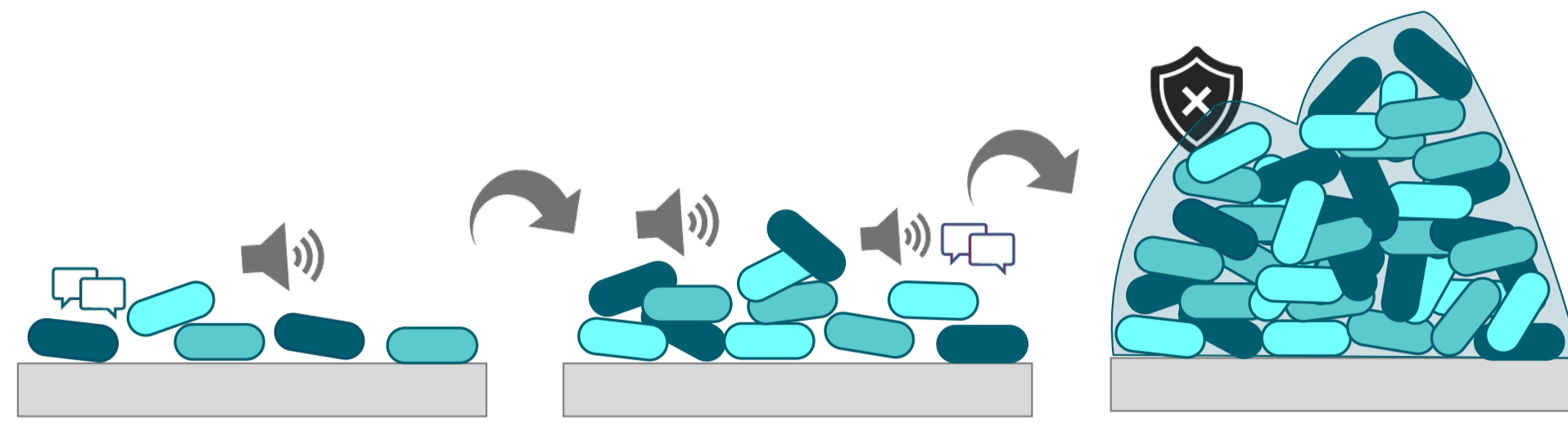
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Total hip and knee replacements can fail in the first 10 years

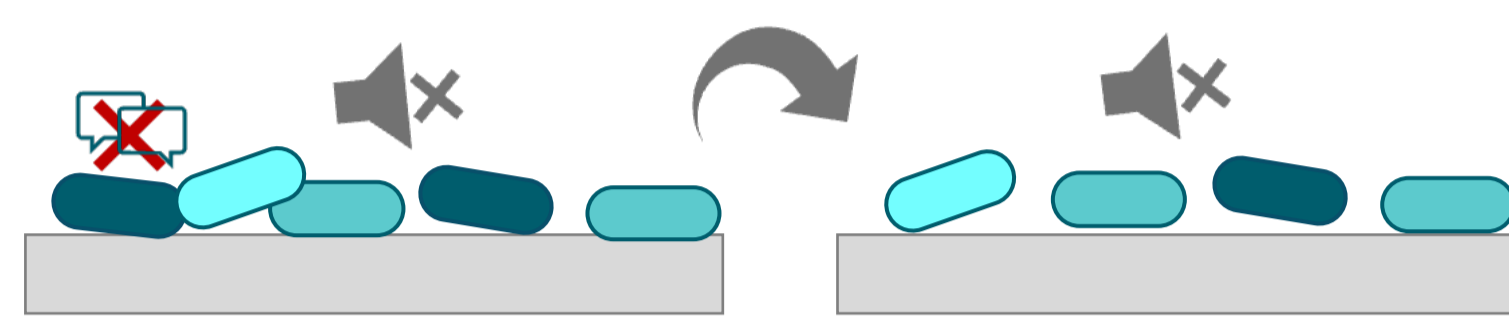


This due to lack of implant-bone integration (osteointegration) or infection, which can lead to sepsis.

Bacteria can form a mucus matrix where they can hide from antibiotics, creating a long-lasting infection, this is called a bacterial biofilm. These are formed when they talk to each other using 'quorum sensing'.



By interrupting quorum sensing we can avoid biofilms.



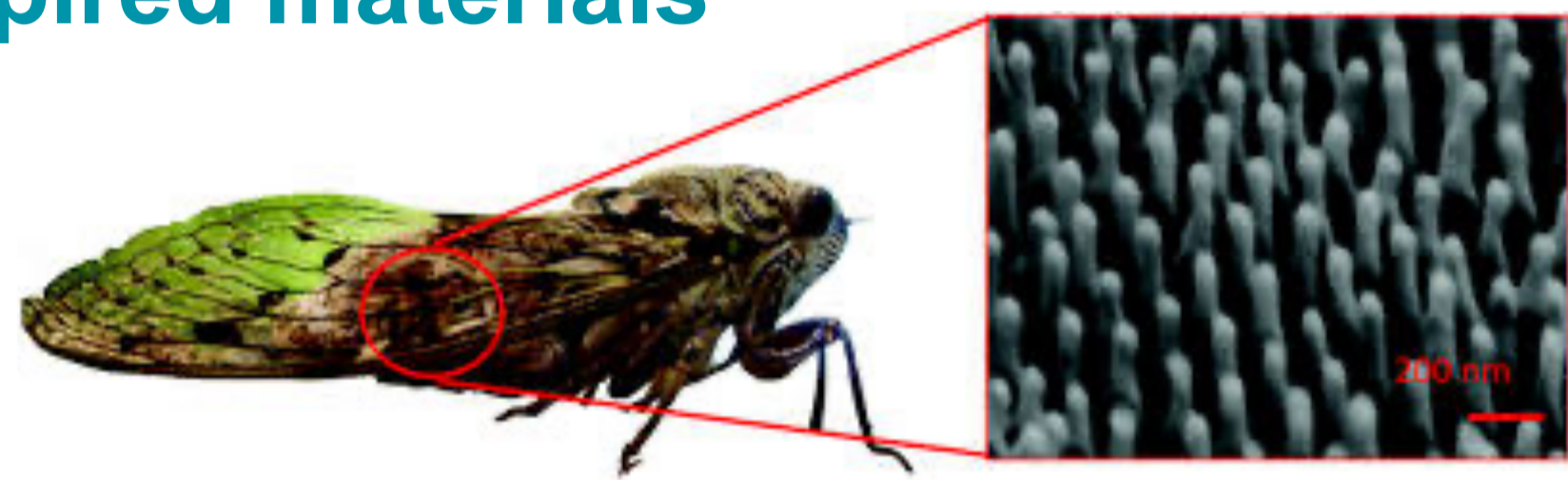
Infections and lack of osteointegration, can cost over the next decade up to

£5 billion pa

to the NHS (including surgeries, follow ups, and drugs).^{1,2,3} We studied *Pseudomonas aeruginosa* that are responsible for 20% of orthopaedic infections.⁴

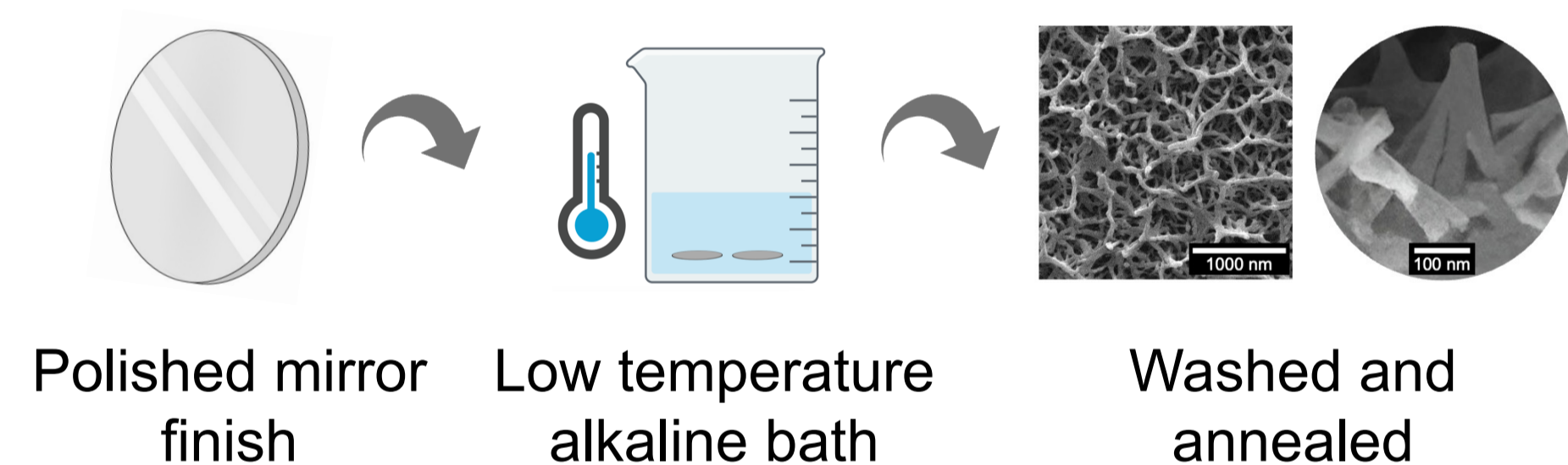
We need new biomaterials that can inhibit infections and promote bone integration

1 Bioinspired materials



Cicada wings have high aspect ratio nanopillars that create an unfavourable environment for bacteria to adhere, making them antimicrobial.⁵

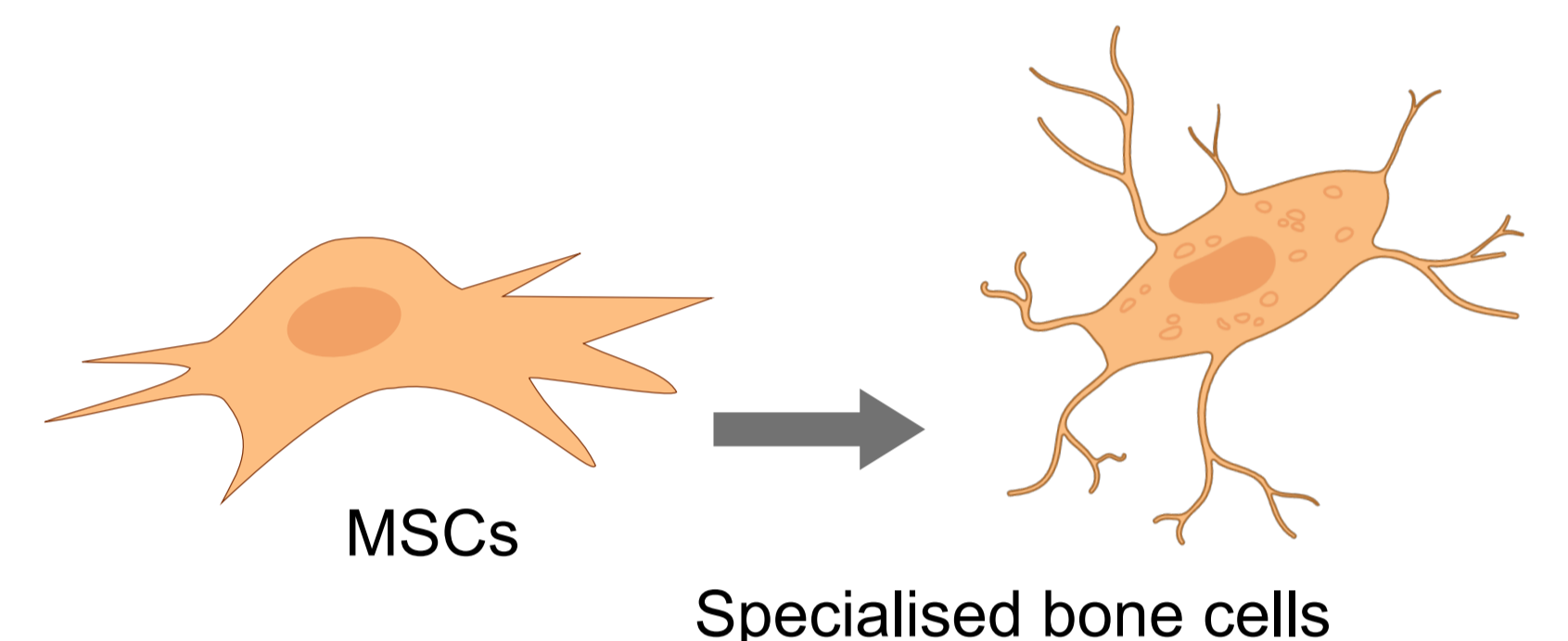
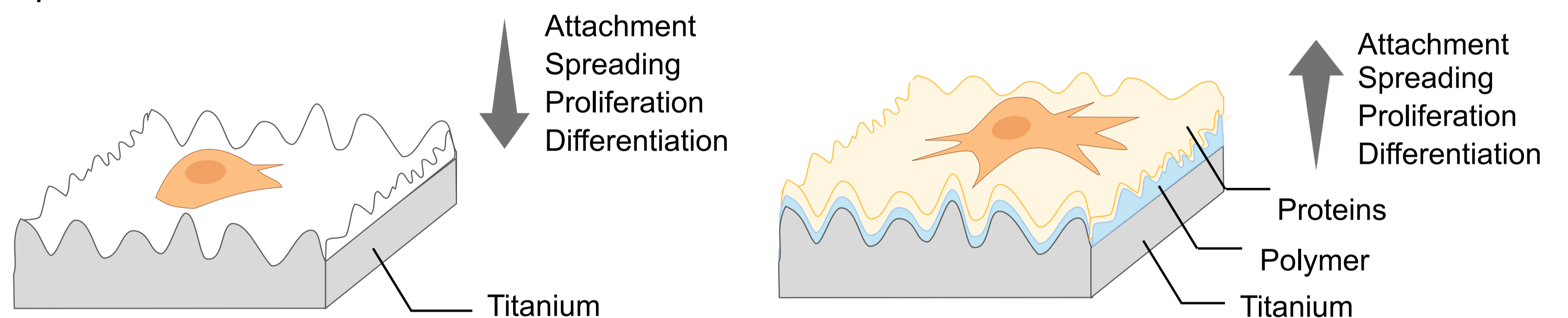
Inspired by this, we created similar high aspect ratio nanotopography structures in titanium, the same material used in implants



2 Biocompatibility

Human mesenchymal stromal cells (MSCs) are responsible for producing bone forming cells (differentiation). MSCs are also antimicrobial when they properly attach and spread onto materials.

We tested MSCs on plain titanium nanotopographies, but they detached. When the surfaces were coated using proteins, the cell attachment, spreading, proliferation, and differentiation improved.

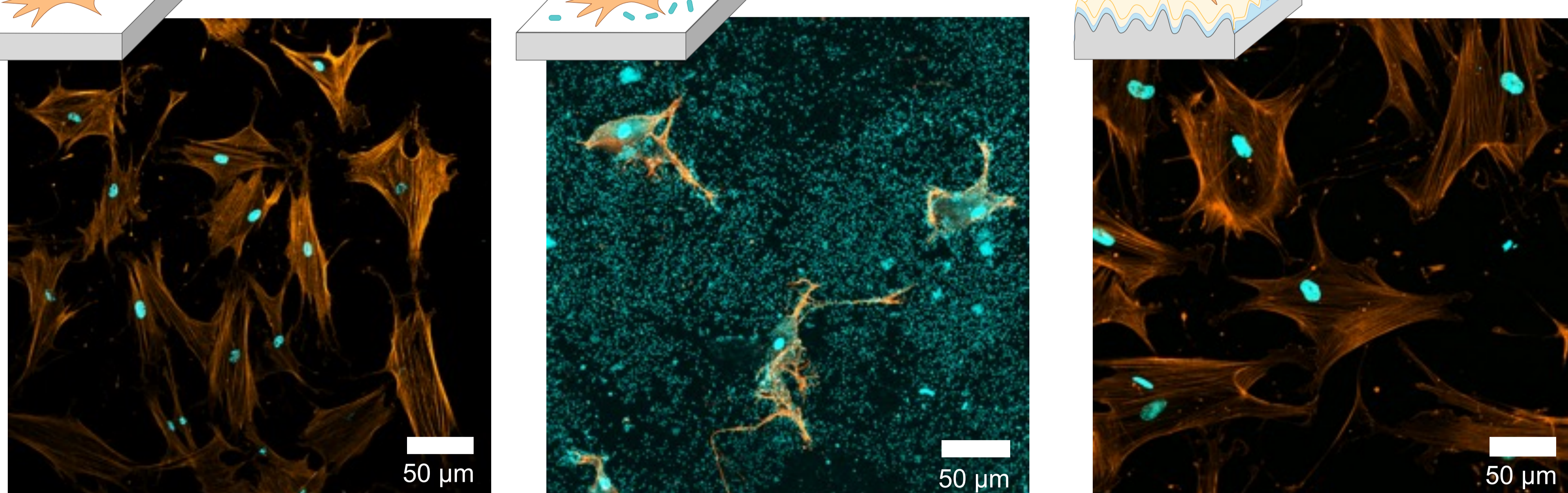


3 MSC adhesion and antibacterial action

Flat surface + MSC

Flat surface + MSC + bacteria

Nanotopography + MSC + bacteria

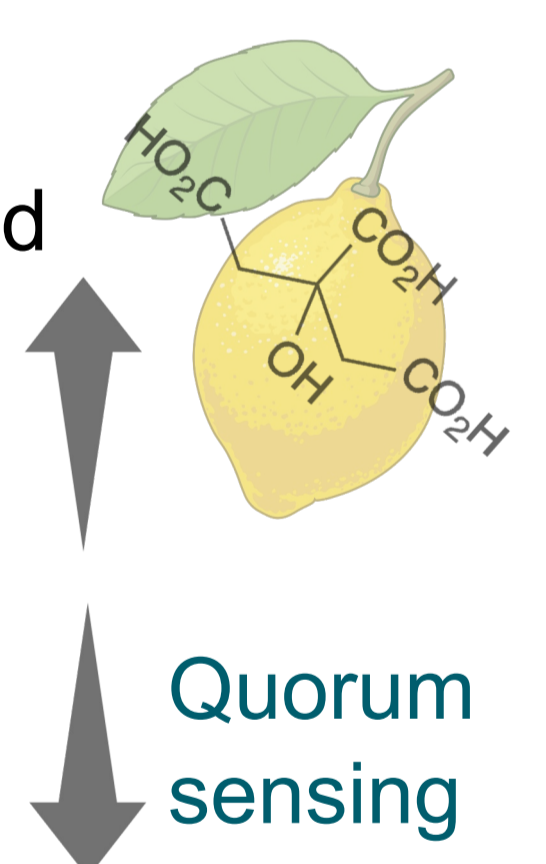


We tested the different conditions and incubated at 37°C overnight. We then stained MSCs and bacteria and observed them with a fluorescence microscope. The MSCs on the coated nanotopographies inhibited biofilm formation.

Metabolite discovery

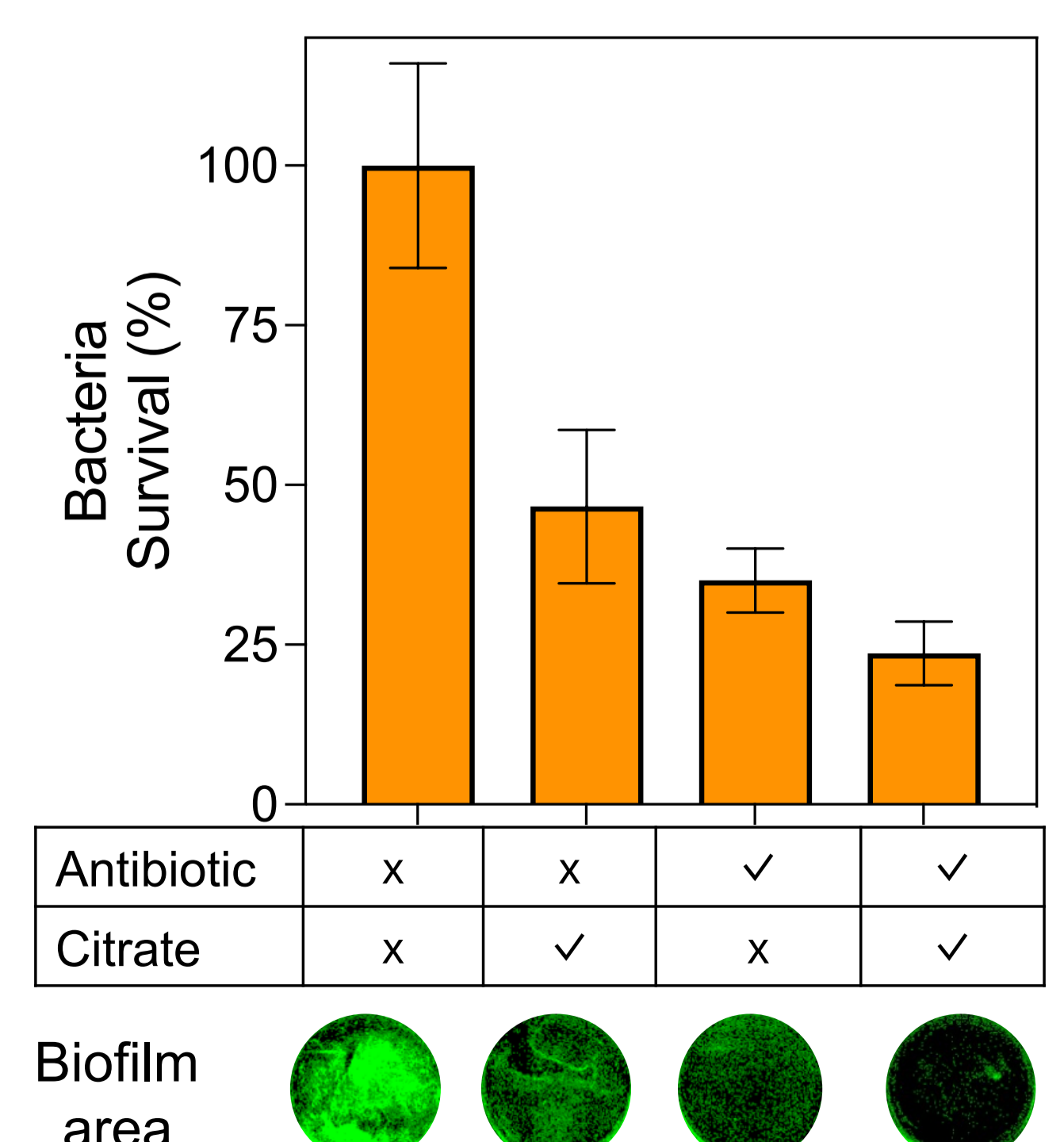
The molecules present in the different conditions were investigated using mass spectrometry.

It was found that citrate was increased in the MSCs in the presence of bacteria, and quorum sensing was reduced in bacteria.



4 Biofilm inhibition

We tested *P. aeruginosa* in the presence of citrate and a common antibiotic to investigate the antimicrobial performance.



Bacteria population was reduced up to 75% when citrate was used as adjuvant to antibiotics.
We can reduce the use of antibiotics and tackle antimicrobial resistance.