



Banish Biofilm for a Healthy Water System



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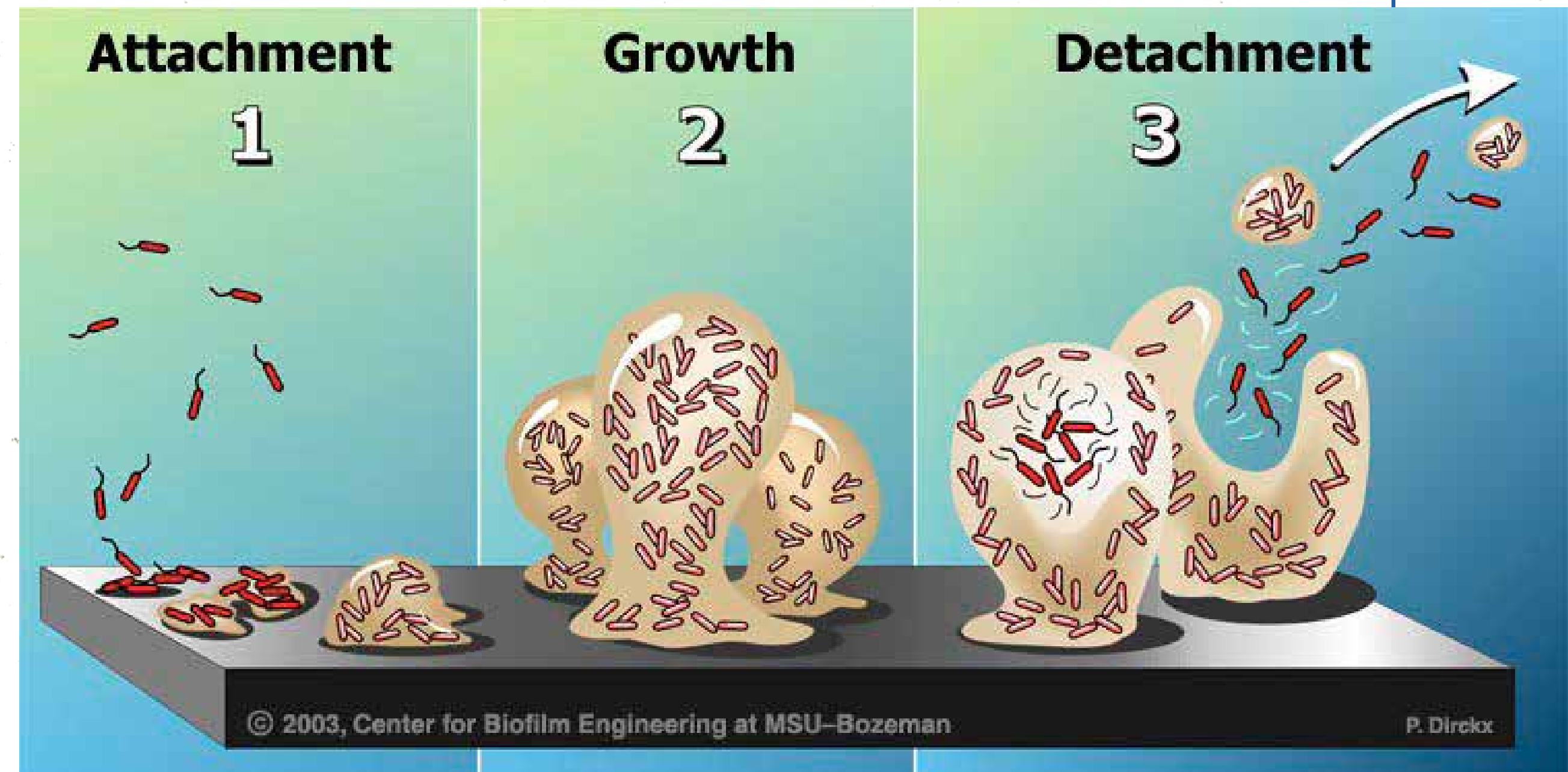


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What is a biofilm?

Dictionary definition: “A biofilm comprises any syntrophic consortium of microorganisms in which cells stick to each other and often also to a surface. These adherent cells become embedded within a slimy extracellular matrix that is composed of extracellular polymeric substances.”

Practical definition: A biofilm is a sticky, slimy growth that clings to moist surfaces and creates an ideal environment for bacteria, fungi, and other microorganisms to live and reproduce. These include waterborne pathogens such as *Legionella*, *Pseudomonas*, Norovirus, *Giardia*, *Cryptosporidium*, and others.



There's more to worry about!

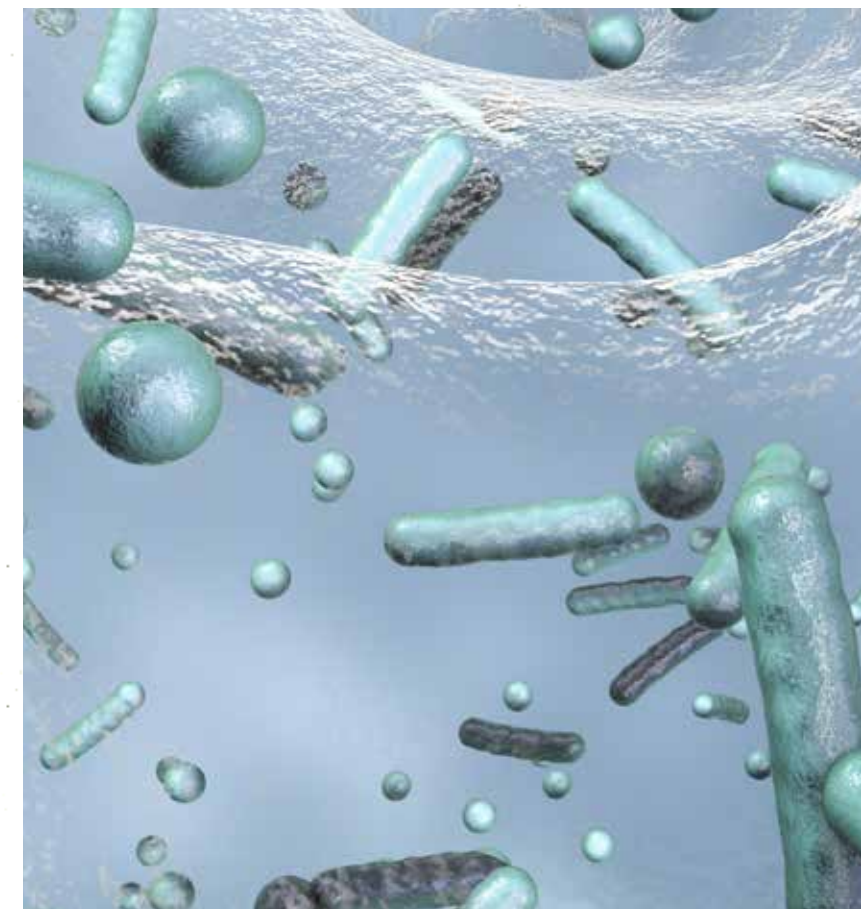
Bacterial biofilms function as “super organisms.” The sticky, slimy film encapsulating the microbes protects and grows microbes within it through a variety of mechanisms.

- + Incorporate free-floating bacteria, causing growth of the film
- + Create ideal breeding grounds for dangerous pathogens
- + Protect the pathogens by making them resistant to most disinfectants

Biofilms clog flow channels, insulate heat transfer surfaces*, contribute to microbiologically influenced corrosion (MIC)**, lose money, create a nuisance, and contribute to serious health conditions.

* Reduces heat transfer by up to 50% and costs by up to 35%

** Responsible for > \$100 million annually in costs

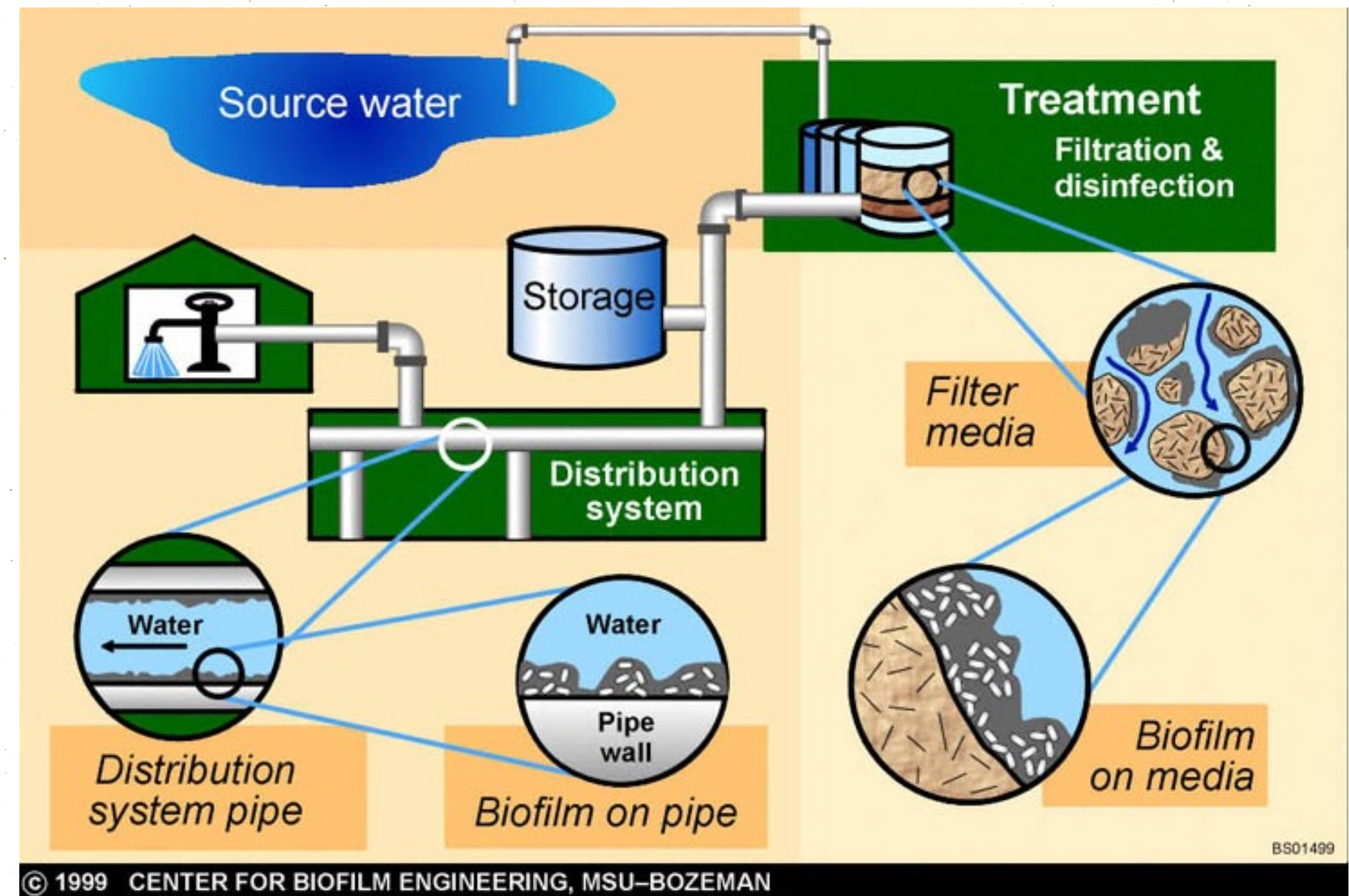


Where are biofilms found?

Water system biofilms inhabit nearly 6 million miles of piping found inside of U.S. buildings, including hospitals, nursing facilities, outpatient facilities, residential buildings, and office complexes. Biofilms present in piping can support and accelerate the growth of pathogens because the systems have:

- Long residence times
- Inadequate biocide dosing
- Water warm enough to encourage growth without being hot enough to sanitize the piping

In addition, biofilms and the pathogens within them can develop immunity to common biocides such as bleach and other common treatments.



WHEN do biofilm pathogens create health problems?

Pathogens released from the biofilm can be inhaled or ingested through

Showerheads



Cooling Towers



Decorative water features



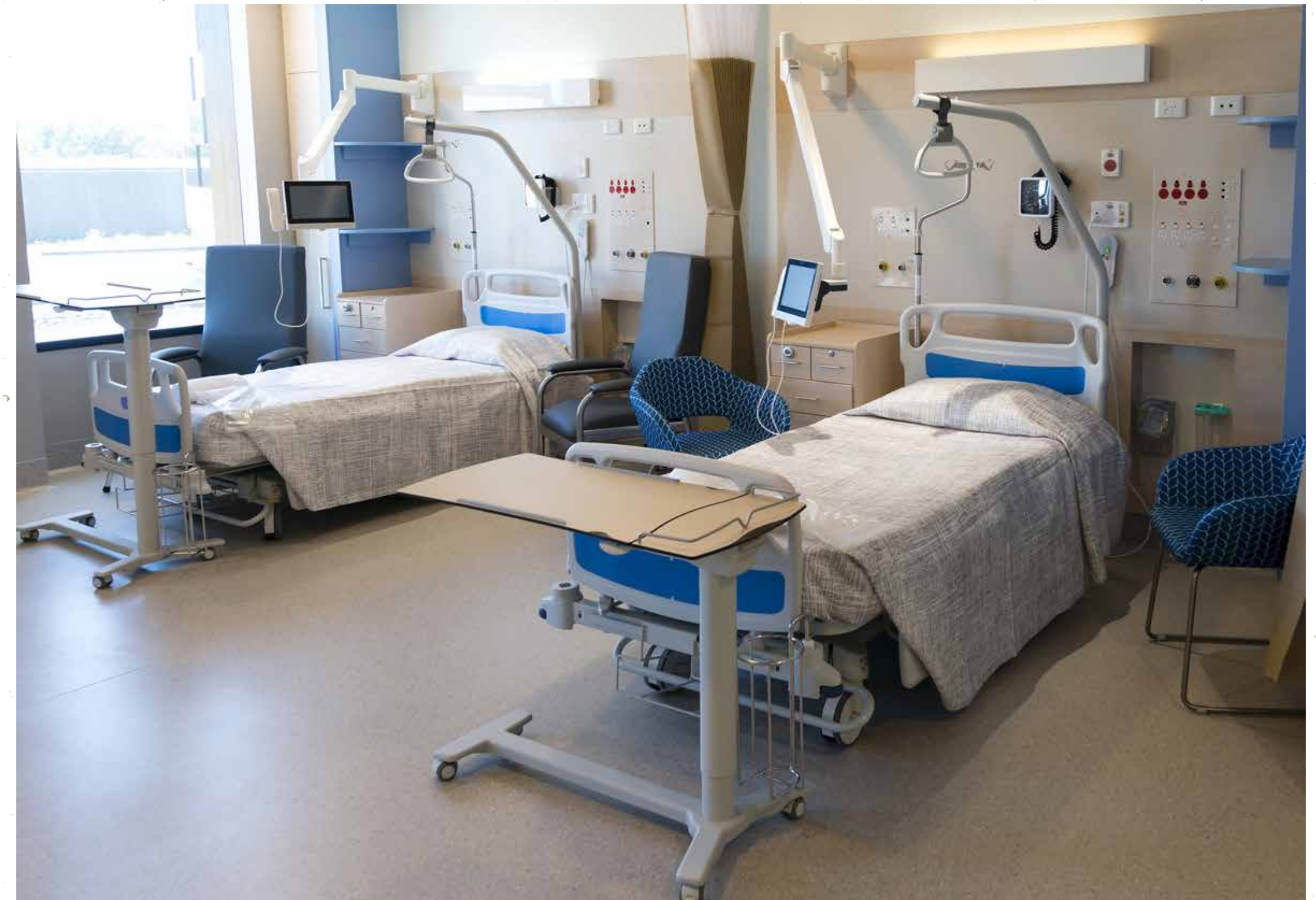
Other Aerosolizing Environments



Why are biofilms harmful?

According to the Center for Disease Control (CDC), 17 waterborne infectious diseases can result from biofilm pathogens. These pathogens are responsible for:

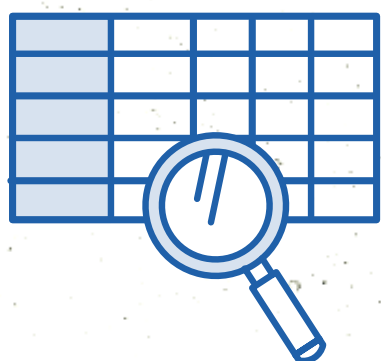
- Over 7 million cases every year
- \$2.39 billion in health care costs associated with the diseases
- 600,000 emergency department admissions
- Nearly 120,000 hospital admissions
- More than 6,000 deaths annually



Tragically, most of these happen in health care facilities.

How do you get rid of biofilms?

CHLORINE DIOXIDE EFFECTIVELY PENETRATES AND REMOVES BIOFILMS¹



Traditional disinfectants such as chlorine and chloramine, while effective on free-floating (planktonic) organisms, do not effectively penetrate biofilms.

Chlorine dioxide effectively penetrates and removes biofilms¹

	CHLORINE	CHLORAMINE	COPPER	CHLORINE DIOXIDE
EPA Approved / ANSI 60 Approved	✓	✓	✓	✓
Dosing	High	High	Not Established	LOW
Efficiency	pH Dependent	Less effective than Chlorine	Not Established	Rapid
THM by products	✓	✓	NO	NO
Special Considerations	Corrosive	May lead to nitrification	Low efficacy on <i>Legionella</i> biofilm	Requires training to handle

Additional Benefits

Chlorine dioxide is a water-soluble gas that can easily diffuse through cell membranes of microorganisms. It has been found to be superior in penetrating biofilms as compared to chlorine (Lin et al., 2011b). Studies have shown that chlorine dioxide is an effective disinfectant (when used correctly) for inactivating certain bacterial pathogens (e.g., E. coli, Salmonella), viruses (e.g., poliovirus, coxsackie virus) and protozoan pathogens (e.g., Giardia) (USEPA, 1999c). It has a high oxidation potential. Its use as a biocide can be maintained over a wider pH range than can the use of chlorine or Copper Silver Ionization (CSI) (Lin et al., 2011b).ⁱⁱⁱ

Fast acting

2.6 times the oxidizing power of waterborne chlorine from bleach

Not easily consumed by non-biological organics such as amines

6 to 10 log reduction in microorganismsⁱⁱ

Microorganisms do not generally develop resistance to chlorine dioxide

Effective over a wide pH range

Who can help you with your biofilm control?

Contact your local Garratt-Callahan service representative to learn more about how we can help you banish the biofilm and maintain a healthy water treatment system!

Email: watersafetygroup@g-c.com

Phone: 650.466.7912



Do No Harm

Chlorine dioxide is relatively non-corrosive to piping at typical use levels

Chlorine dioxide breaks down into simple, harmless materials - water and salt



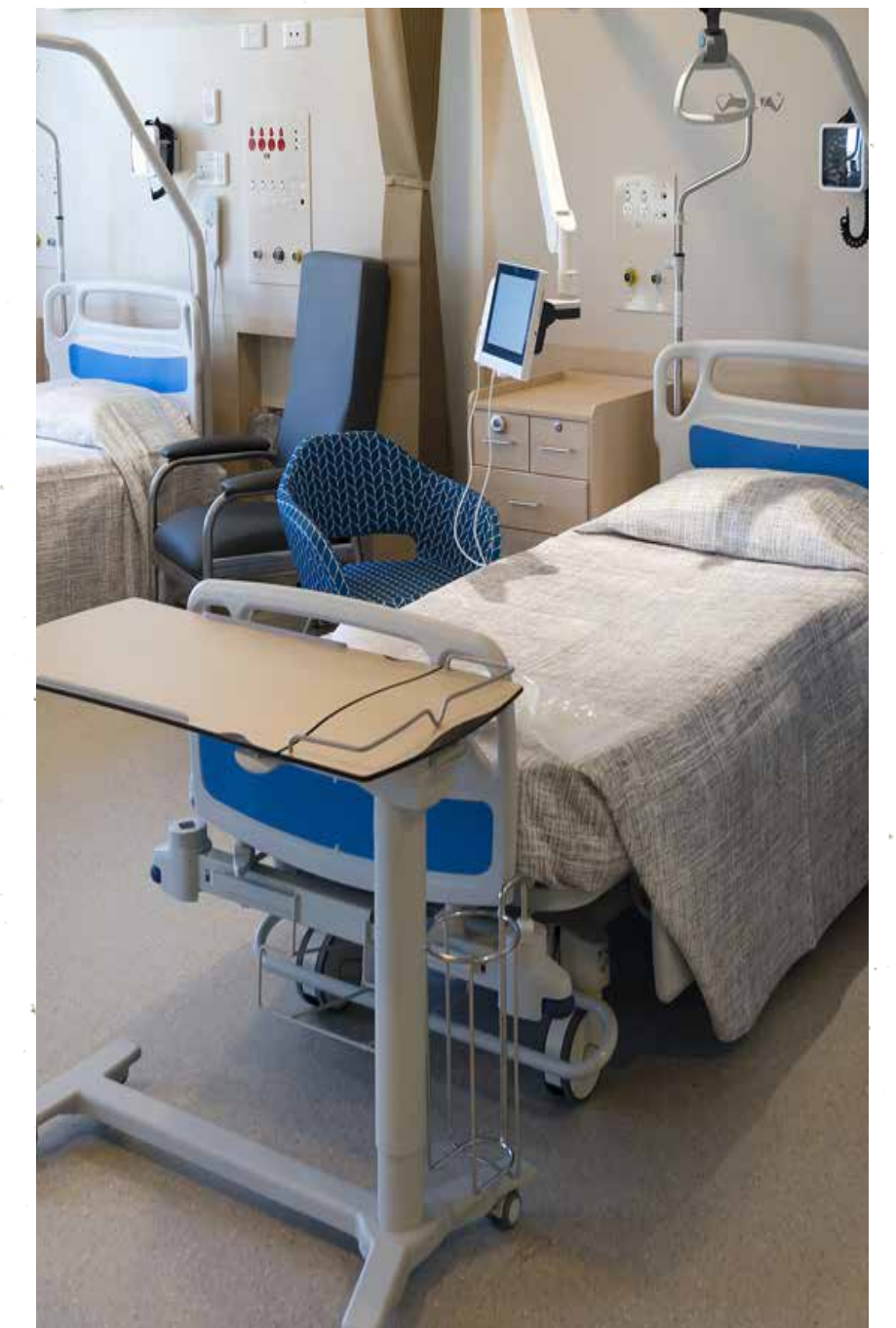
So safe, it's used in wound care^{iv}



Chlorine dioxide is effective at low dosage levels, making it budget friendly



Chlorine dioxide has no known carcinogenic by-products



A dynamic splash of water in various shades of blue, with many small bubbles and droplets, creating a sense of movement and freshness. The water is splashing upwards and outwards from the center, filling the entire frame.

Banish Biofilm with
Chlorine Dioxide

Safe Effective Cost Conscious

Need We Say More?

REFERENCES

ⁱ 10 Reasons Why You Should Be Using Chlorine Dioxide, Food Safety Magazine, February 2005)

ⁱⁱ Impact of Chlorine Dioxide Gas Sterilization on Nosocomial Organism Viability in a Hospital Room

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EPA Office of Water EPA 810-R-16-001 September 2016 Office of Water EPA 810-R-16-001 September 2016

^{iv} Activated chlorine dioxide solution can be used as a biocompatible antiseptic wound irrigant

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Corrosivity of Chlorine Dioxide Used as Sanitizer in Ultrafiltration Systems

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Journal of Dairy Science Vol. 74. No. 10, 1991