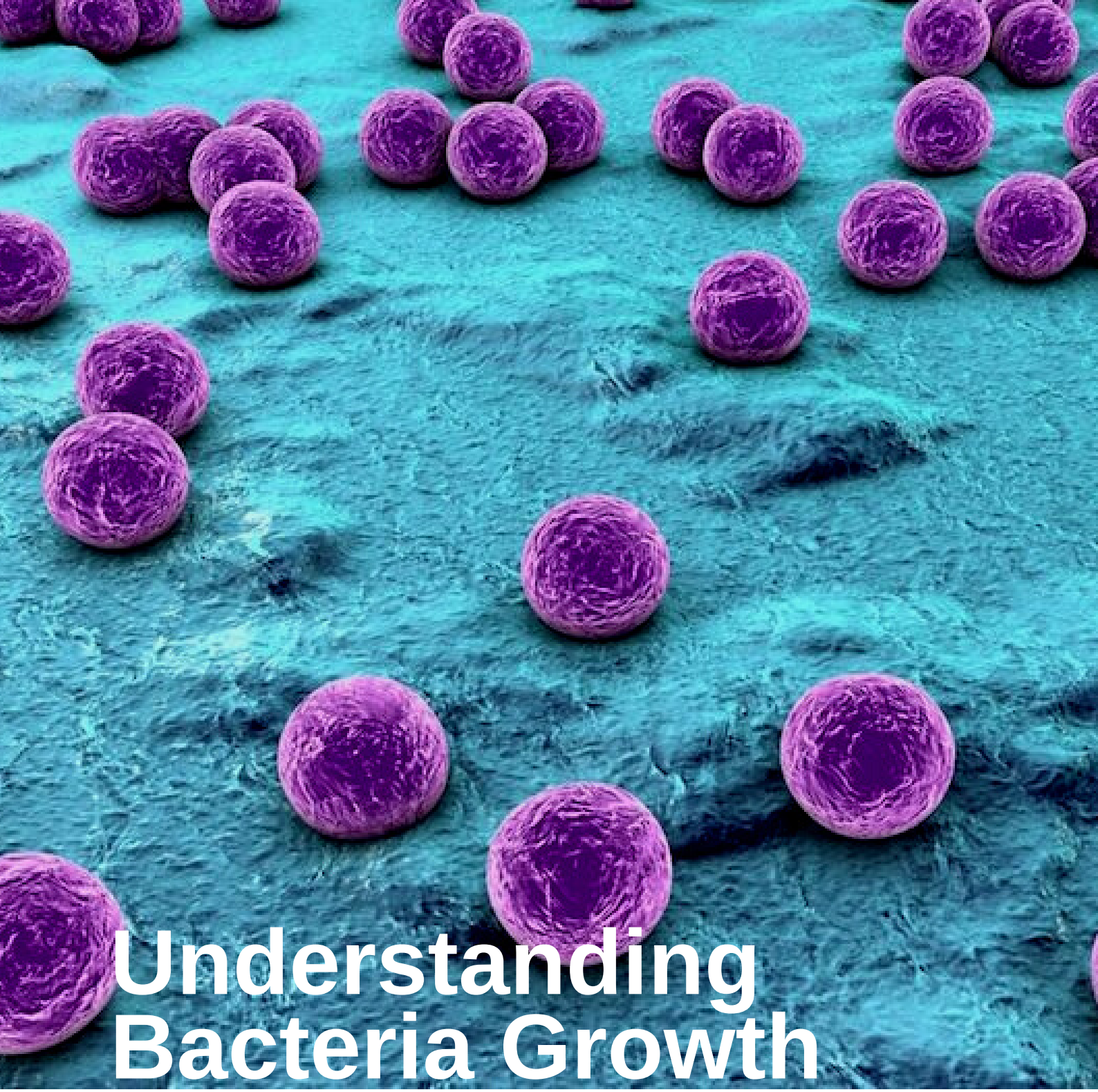

Understanding Bacteria Growth in the Food Manufacturing Industry

ALLIED FINISHES

Bacteria live in unbelievable mixtures of hundreds or thousands of species. Like on your teeth. There are 600 species of bacteria on your teeth every morning.

- Bonnie Bassler

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INTRODUCTION

From healthcare to food, various industries face a common problem – bacteria on floor surfaces. Cleanliness and controlling bacteria are crucial in large as well as small companies in these different fields. As bacteria is so commonly found, surface and floor cleanliness is consistently measured as a part of the quality system of such companies.

Numerous organizations, laboratories, and industries have spent large amounts of time, energy, and money in researching and developing to find a solution to this critical bacteria problem. One such promising solution is antimicrobial flooring.

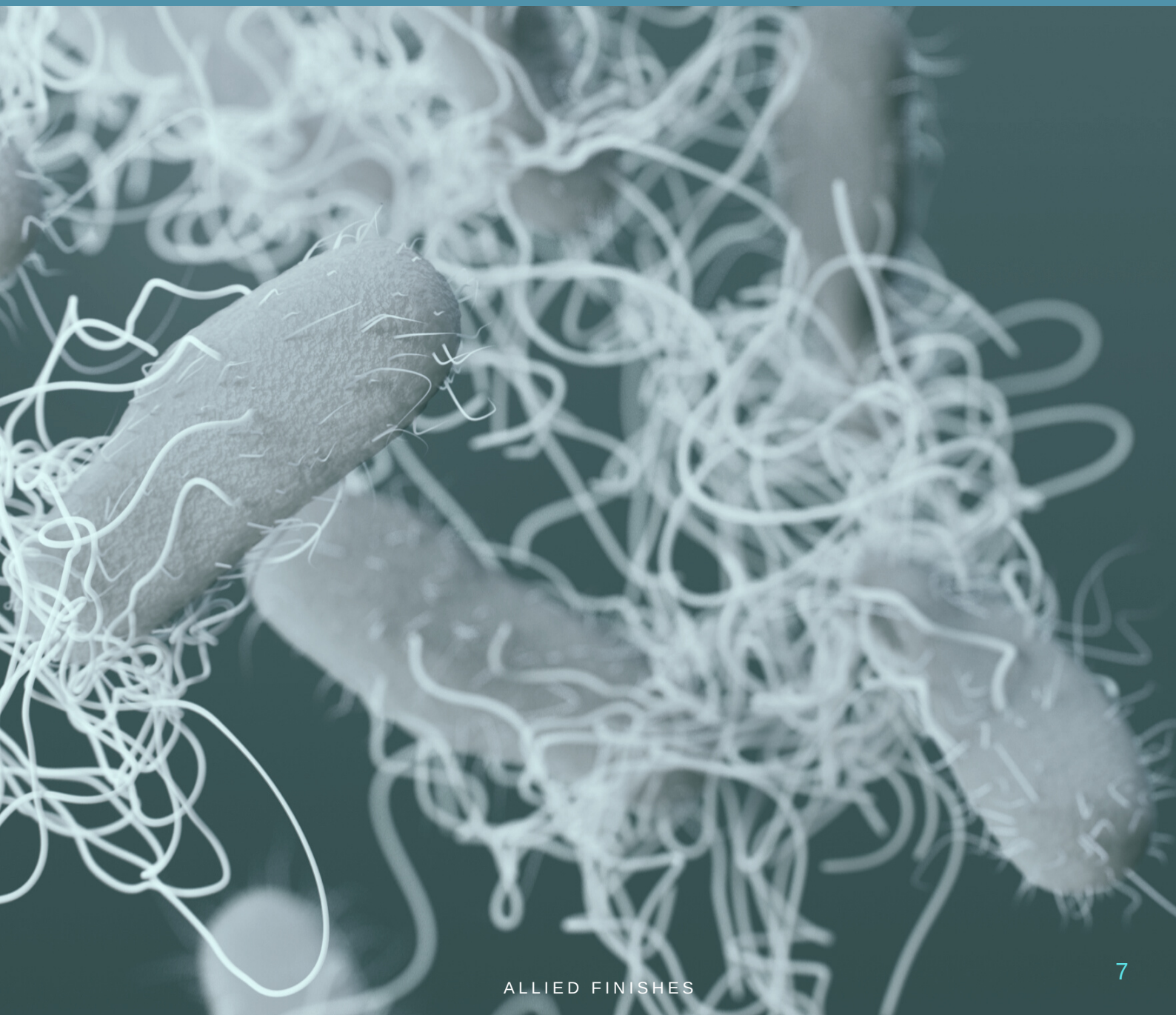
With the current global coronavirus pandemic, the importance of cleanliness and hygiene has never been more important. In hopes of slowing down the Covid-19 spread, healthcare facilities have increased their focus on this issue, including through antimicrobial flooring, leading to fast-tracked results.

Despite the attention the healthcare industry receives, antimicrobial flooring has been a minimal consideration for food and beverage manufacturing facilities. Even though they are constantly battling bacteria growth to deliver food with high-quality standards. While there is no one ultimate solution to eliminating bacteria growth in food manufacturing facilities, antimicrobial flooring along with on-site efforts to maintain cleanliness can go a long way in fighting and controlling bacteria.

CHAPTER ONE

Types of Bacteria in Food Manufacturing Facilities

Bacteria are microscopic organisms invisible to the naked eye that are present everywhere, including in food manufacturing facilities. Bacteria growth in food and beverage factories is a serious and common problem because it affects the quality of food/drink and in turn harms the consumers.



There are numerous bacteria or pathogens that grow in and affect the food manufacturing industry, but the 3 most common and arguably, most dangerous foodborne pathogens are:

- **Listeria** - a bacterium, which when present in foods, yields no difference in taste, smell or appearance, therefore making it especially dangerous and difficult to detect. It usually results in a rare bacterial disease called listeriosis.
- **Salmonella** - a type of bacterium that is also undetectable in food as it cannot be seen, smelt or tasted. It is prevalent in the gut of many animals such as poultry, pigs, cattle, and pets, as well as in insects and even humans. Salmonella is transferred into soil, water and food from the faeces of animals or people. The bacteria can enter and spread throughout food production facilities via raw ingredients, packaging, equipment, and workers' hands and clothing. Once introduced into a food production plant, Salmonella thrives in warm, moist environments. It causes salmonellosis infection that affects the intestinal tract and causes stomach ache, diarrhea, fever, pain and cramping.
- **E. coli** - or Escherichia coli consists of a number of strains of the bacterium that normally lives in the intestines of healthy humans and animals. While several types of E. coli are harmless and even necessary for certain proper bodily functions and to provide certain vitamins, few strains can cause severe illness, stomach cramps, bloody diarrhea and vomiting.

CHAPTER TWO

Flourishing Conditions for Bacteria

So where do bacteria grow? While we've established bacteria are present everywhere and are commonly found in factories and facilities of various industries, especially food manufacturing, we need to understand the conditions in which they flourish and thrive.

Warm Temperature

Temperature is a vital factor contributing to bacteria growth. Foodborne pathogens grow in temperatures between 5 and 57°C - a range known as the 'temperature danger zone' (TDZ) because of the dangers of food being at these temperatures for prolonged periods of time. Bacteria thrive better in the optimal temperature range of 21 to 40. It is therefore extremely important that food is stored, prepared, cooked, packaged and preserved at the right temperatures to ensure it is safe to eat.

Moisture

Like all living beings, water is essential for the survival and growth of bacteria. Foodborne pathogens grow in foods with a high “water activity” of 0.95 to 1.0. Water activity is a measure of how much water in foods is available for use and is measured on a scale of 0 to 1.
This is why foods that are dehydrated or freeze-dried with their moisture removed can be stored for longer periods of time. This is also the reason why Australian food regulations require water activity of 0.85 or lower for canned foods.

Suitable pH

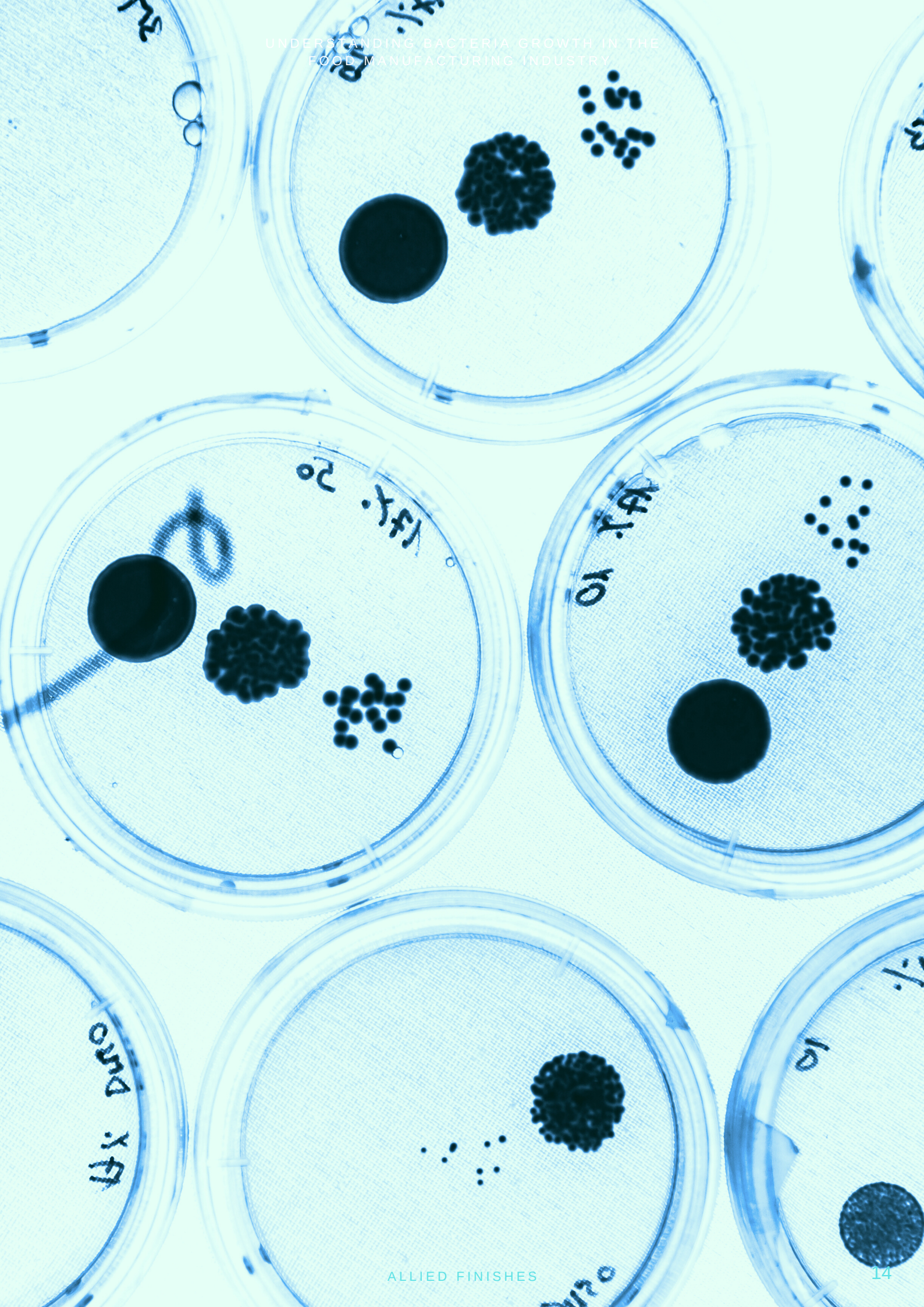
Though most bacteria reproduce best at a neutral pH level of 7, foodborne pathogens prefer a slightly acidic environment with a pH level of 4.6-7.5 and thrive in conditions with a pH of 6.6-7.5. To curb the growth of bacteria in food, food regulations for acid/acidified foods require that the food be brought to pH 4.5 or lower. Acidic foods with very low pH levels or alkaline foods with pH levels over 7 tend to stop or slow down the rate of bacterial growth.

Food - Food provides bacteria with energy and nutrients for growth. High-risk foods such as meat, fish, milk, eggs and other dairy products are rich in proteins and nutrients as well as moisture and promote bacterial growth.

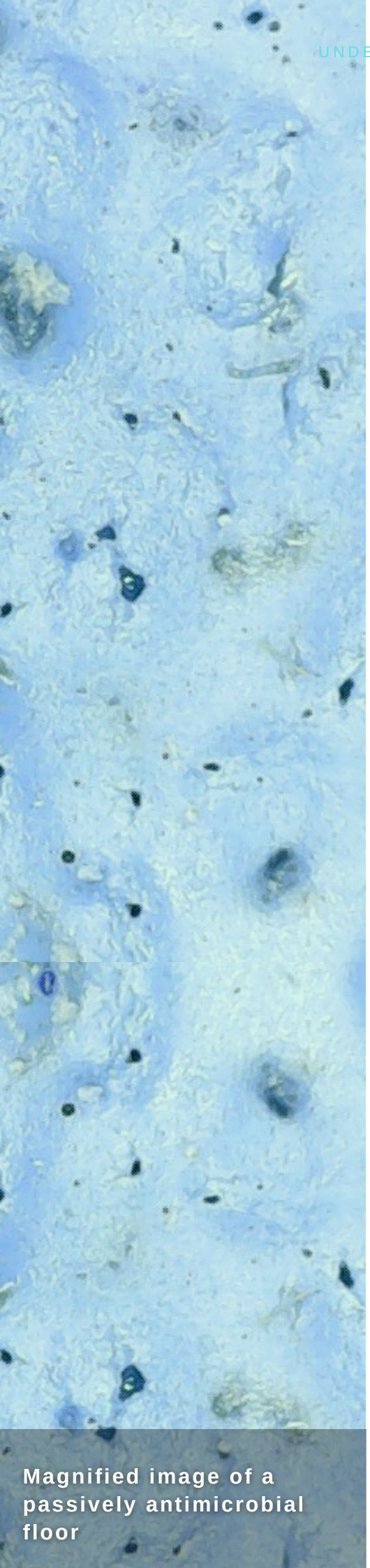
Oxygen - Most bacterial and foodborne pathogens are aerobic, that is they require oxygen to live and grow. Since oxygen is present in the air, this condition is hard to eliminate except through specific cleaning techniques such as steam sterilization.

Time - In optimal conditions, bacteria can multiply and grow to millions in a short period of time through binary fission. Bacteria divide themselves into two every 4-20 minutes, and therefore when exposed to favourable conditions for sufficient amounts of time, they grow in large numbers and contaminate their surrounding environment.

It is advised that food is to be removed from such optimal conditions (also known as the danger zone) within two to four hours, either by heating or cooling. Since bacteria flourish in a warm, moist, protein-rich environment that is pH neutral or contains low acid, such conditions are collectively referred to as the 'danger zone'.



CHAPTER THREE



Magnified image of a passively antimicrobial floor

How do Antimicrobial Agents play a role?

To understand the role of antimicrobial agents, we need to familiarise ourselves with what they are. Antimicrobial agents are a mixture of chemical compounds and physical materials that kill and destroy microorganisms like pathogenic bacteria. By killing bacteria or reducing their metabolic activity, antimicrobial agents minimise bacteria's pathogenic effect in biological environments.

Antimicrobial flooring hinders the growth of bacteria on its surface. The most common additives used to manufacture antimicrobial flooring include isothiazolinone, zinc pyrithione, thiabendazole, and silver antimicrobial treatments.

Antimicrobial Agents and their Properties

Several materials exhibit antimicrobial properties, and many types of antimicrobial agents can be incorporated into floor coatings.
Metals such as silver, copper, zinc, titanium, and cobalt have antimicrobial properties. When these remain on surfaces, their biocidal properties are gradually released onto the surface through a process of ion exchange. They, thereby, provide the surfaces with continuous and lasting antimicrobial properties.

Silver Ions:

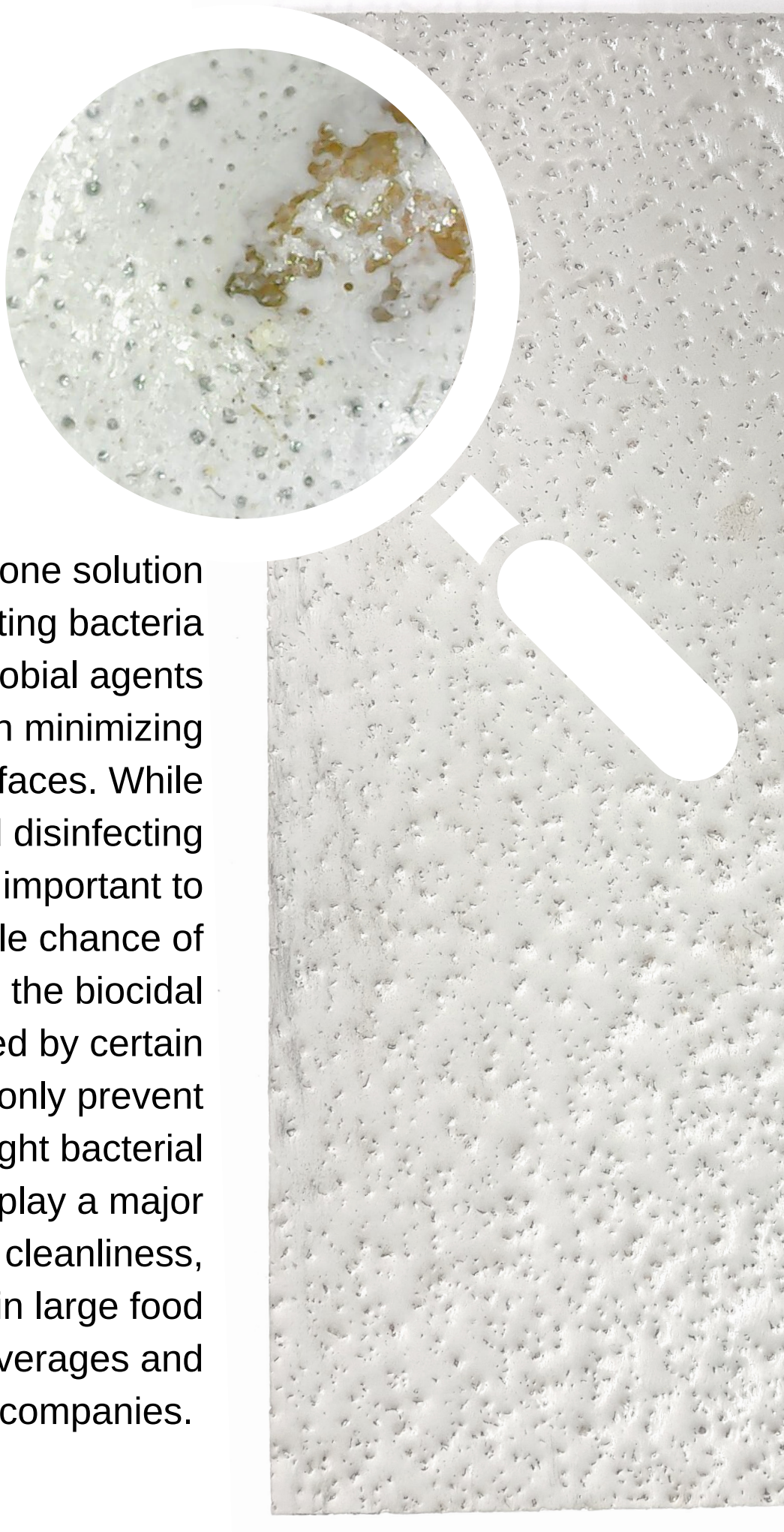
Silver Ion is a metal antimicrobial agent that is commonly used in floor coatings. Silver is known for its antimicrobial properties that can kill a wide spectrum of bacteria, fungi and even certain viruses. The positively charged silver ions (Ag+) possess an antimicrobial effect. These silver ions target the bacteria through a series of actions, starting with damaging the protein in the bacterial cell wall to enter the microorganism. The structural damage to the bacteria cell wall, as seen on page 22, helps easy entry of the particles into the bacteria cell's interior, preventing replication and destroying the bacteria.

Zinc Oxide:

Zinc Oxide (ZnO) showcases antimicrobial activities when its particle size is reduced to a nanometer range. In such a state, zinc oxide can effortlessly interact with the contaminated surface and the bacteria. Zinc oxide particles enter the bacteria and exhibit a distinct bactericidal mechanism. However, zinc oxide is only effective on specific types of bacteria.

Triclosan:

Triclosan is a chemical antimicrobial agent that is widely effective against many gram-positive and gram-negative bacteria. Triclosan works by blocking bacterial fatty acid biosynthesis. Originally developed in the early 1960s, Triclosan is a phenoxy phenol antimicrobial agent used as an antibacterial and an antifungal agent. Though it is safe to add in floor coatings, it would require a significantly higher strength for it to impactfully control bacteria growth on floor surfaces.



Though there is no one solution to completely eliminating bacteria growth, antimicrobial agents significantly assist in minimizing bacteria on floor surfaces. While regular cleaning and disinfecting schedules are just as important to prevent any possible chance of bacterial growth, the biocidal properties exhibited by certain floor coatings not only prevent but also actively fight bacterial growth and therefore play a major role in maintaining cleanliness, hygiene and safety in large food manufacturing, beverages and pharmaceutical companies.

Though there is no one solution to completely eliminating bacteria growth, antimicrobial agents *significantly* assist in minimizing bacteria growth on floor surfaces.

CHAPTER FOUR

Antimicrobial Flooring - Passive Vs Active

With sanitation standards and cleanliness ever so important, hygiene and antimicrobial properties has become a major factor of consideration when selecting new floor finishes.
Many flooring companies claim to have antimicrobial floors, even without reengineering their coatings to incorporate antimicrobial agents. This is because certain materials like epoxy and polyurethane cement floors, with hardwearing resin systems, naturally do not encourage bacterial growth. As long as the flooring has no gaps, cracks or pinholes, such coated floors do not assist bacterial growth and make the floor somewhat antimicrobial. Therefore, such claims by certain flooring companies are somewhat true. However, it is not enough.

Such floors are only passively antimicrobial. This means that while they naturally hinder bacterial growth, wear and tear in a busy food plant through heavy equipment and processing can damage the floor finish and coat and lead to an increased risk of unwanted bacteria.

To prevent such risks, Allied Finishes emphasizes the importance of using active antimicrobial agents.

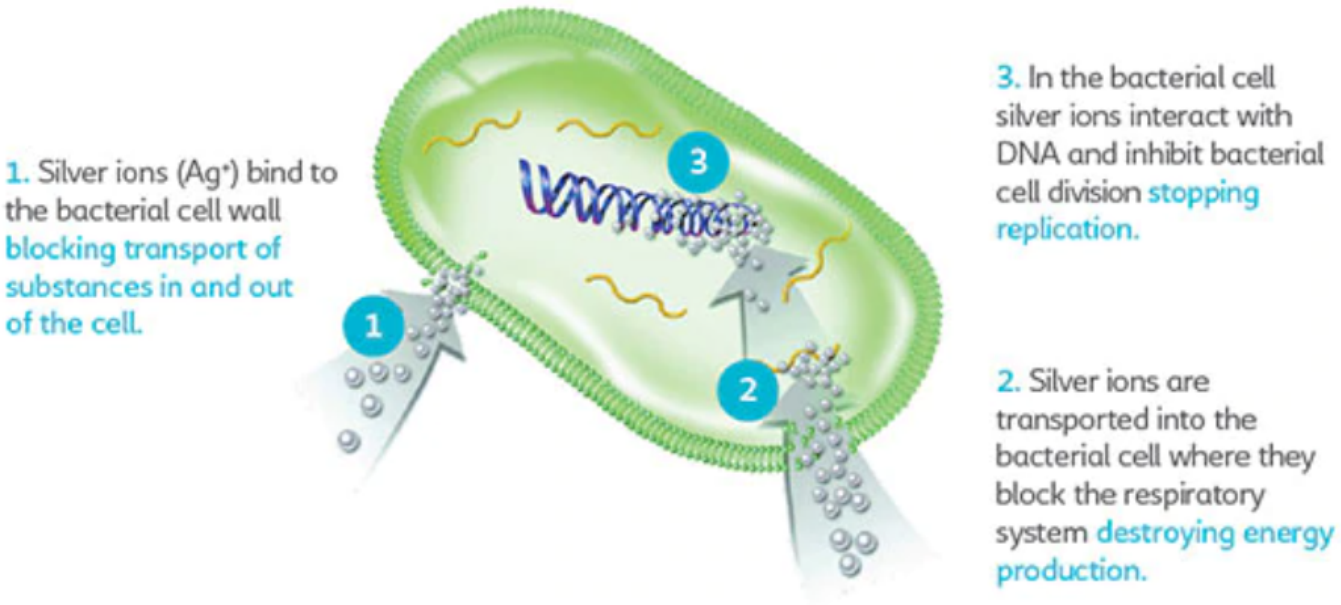
Difference between Active and Passive

In our fast-paced, quality-focused food manufacturing industry, a passively antimicrobial floor is not enough. A **passively** antimicrobial floor only discourages bacteria growth and that isn't enough in Australia's food manufacturing industry.

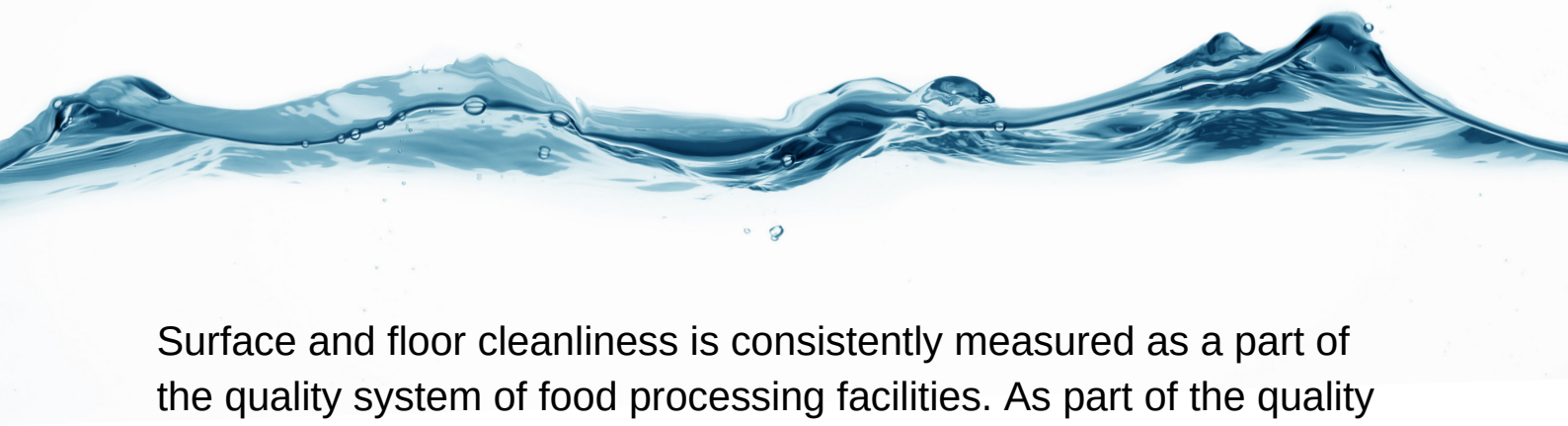
An **actively** antimicrobial floor is a floor that has the right level of antimicrobial agents and additives, incorporated at the right time, and therefore actively fights against bacteria growth.

As discussed in Chapter Three, not all antimicrobial agents fight all or most bacteria. Silver ions are known for their ability to fight many species of bacteria, including the main three - Listeria, Salmonella, and E. Coli. Silver attacks each type of bacteria differently.

As seen in the image below, silver ions not only attack the bacteria's cell walls but also interact with the DNA, to inhibit bacterial cell division and stop replication and bacterial growth.



CONCLUSION



Surface and floor cleanliness is consistently measured as a part of the quality system of food processing facilities. As part of the quality control system, most food facilities regularly clean and disinfect the production environments to remove any food, moisture (water), and microbial contaminants that accumulate on surfaces during production. Using biocidal disinfection aims to reduce the bacteria level to ensure safe food production and higher food shelf-life.

While regular cleaning processes are important in reducing bacteria levels, these sanitation processes do not completely sterilize the surfaces, and bacteria continue to survive on surfaces of floors, equipment and machinery. Bacteria on surfaces can easily be transferred from floors, panels and equipment such as slicers and conveyor onto the food during the production process.

Bacteria in food production facilities obviously pose a threat to food quality and safety. They require conditions similar to those required to produce food such as similar temperature, nutrient, water and preservatives. This gives them the ability to not only survive but also grow in food production and storage environments.

In addition to the role of bacteria as food contaminants, they can influence food production processes by deteriorating surface materials or by producing biofouling. Fouling and deterioration of process surfaces increases costs due to increased energy consumption, need for more heavy cleaning processes, and extensive maintenance.

These reasons make bacterial growth a serious problem in the food and beverage industry. But there is no one final solution to deal with the ongoing bacterial problem. Antimicrobial coatings are just one of the agents to help mitigate bacterial growth. Continual control systems, the cohesion of on-site teams and external partners can collectively minimize bacteria growth in food manufacturing facilities.

Additional research and development are required on the flooring front to find new technology and techniques that can assist food manufacturing facilities in their quest to eliminate bacteria growth. However, antimicrobial agents are an excellent start to tackling bacterial growth, ensuring food quality safety and standards and can certainly save site and quality control managers both time and money in eliminating bacteria growth.

While we emphasize the importance of specialized antimicrobial agents and flooring, we remind you this is only the start - a crucial first step to dealing with a critical issue.

Allied Finishes & SteriFloor

Allied Finishes is an Australia-based company that specialises in antimicrobial, fast-curing flooring and drainage solutions for the food, beverage, healthcare and pharmaceutical sectors. We supply and install premium flooring that is durable, safe, and compliant. We also offer fast and efficient delivery of our advanced antimicrobial flooring that saves our customers both time and money. With our specialised antimicrobial floors, we help reduce production downtime and offer uptime to our valued clients as well as their end customers.

Our team of innovative individuals and specialists strives to develop premium and advanced flooring solutions for our clients in the food manufacturing and pharmaceutical industries.

SteriFloor
ANTIMICROBIAL FLOORING

SteriFloor is a unique suite of antimicrobial flooring solutions that have been specially designed to reduce bacteria growth specifically in the food and beverage manufacturing industry.

Jayanti Mendhi

A PhD student from the Queensland University of Technology, Jayanti Mendhi has been a recent and valuable addition to our dedicated team.

Jayanti has been working on antimicrobial coatings for the last 3 years and thoroughly understands the types of antimicrobial agents currently available in the industry. She has extensively studied and researched the importance of antimicrobial floorings. With her skilled experience and a strong background in antimicrobial coatings, she can offer informed advice on the best types of antimicrobial agents to use with each floor and the coating level required to successfully eliminate bacteria growth on the floor.

Jayanti's professional expertise, as well as our team's relentless support, showcase our commitment to this industry by minimizing bacterial growth to become leaders in our industry.

Additional Reading:

Visit www.alliedfinishes.com/resources to view the following:

- Compendium of Microbiological Criteria for Food
- Safe Food Australia Standard 3.2.3