Microbecide™

Silver Ions – Nature's Health Defense

World Changing Technologies Pte Ltd - Singapore
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http://www.microbecide.com

Executive Summary

Silver Ions - The new standard in medicine and industry

Twenty-first century technology is giving us a new perspective of an old friend. Silver - in a new form, *ionic silver* - is emerging as the new antimicrobial wonder in dealing with bacterial, as well as viral and fungal conditions, in both medicine and industry.

Ionic silver is proving to be a remarkably effective defense, not only against an enormous range of infectious diseases that are a very real part of our world today, but also against the increasing number of dangerous superbugs like MRSA (Methicillin-resistant *Staphylococcus aureus* with its growing number of strains) and newly emerging pandemic threats, such as bird flu (H5N1 virus) and SARS (Severe Acute Respiratory Syndrome).

A Respected Antimicrobial and More

Since early civilization, silver has been known to have exceptional antimicrobial properties. Long before the advent of modern antibiotics, which only attack bacteria and are becoming disturbingly impotent against resistant super germs, silver was a commonly-used antimicrobial agent. Today, ionic silver is increasingly being recognized for its broad spectrum antimicrobial qualities and the fact that it presents virtually none of the side-effects related to antibiotics.

Ionic silver is friendly and non-toxic to the environment, safe for plants, pets and humans. A powerful tissue-healing agent, ionic silver applications currently represent one of the fastest growing sectors - if not the fastest growing sector - in wound care today. While safe and gentle to humans or animals, ionic silver is brutal and deadly to bacteria, viruses and fungi. Research in the United States at Washington University School of Medicine in St. Louis, Missouri confirms studies that resistant strains of pathogenic microbes cannot develop with ionic silver the way that they will with antibiotics.

The fact that silver is an effective agent against a very broad range of microorganisms is well established. Recent advances in the stabilization and delivery of ionic silver, together with the problems associated with antibiotics, are propelling ionic silver technology usage in a rapidly growing range of medical, industrial and dietary-supplement products. Illustrating how serious this trend is, in a report published in April 2006 by Chemical & Engineering News about a new method from Nexxion for applying ionic-silver coating to catheters, IV needles, and other medical devices, the chief technical officer of the company is quoted as saying, "To date, no pathogens have been able to survive contact with silver."[1]

A Growing Body Of Evidence

AcryMed, a nanotechnology company, recently announced FDA approval of its product SilvaGard, a silver-nanotechnology coating to protect medical devices

from bacteria. The company stated, "Ionic silver has been long recognized and used as a highly effective antimicrobial."[2]

Covalon is a manufacturer that has introduced an antimicrobial silver-ion releasing, collagen-based sheet dressing for wound care. In January 2006, the president of the company was quoted as having said, "In the wound dressings market, silver dressings growth outperforms all others in the category."[3]

Curad and Johnson & Johnson bandages are now available to the consumer with ionic silver actually impregnated into the gauze so as to destroy bacteria.[4] In the medical field, another company, AgION has stated that, "Today silver is a key ingredient in new high-tech, powder coated finishes that hospitals and doctors' offices are using to protect walls, counters and other germ-gathering surfaces."

Other manufacturers are introducing ionic silver technology based products. **Microbecide™** silver ion complex is an example of an ionic silver based agent used in diverse applications from food contact surfaces, clinical work surfaces to medical disinfectant wipes and water treatment systems.

Samsung recently introduced a clothes-washing machine that they claim kills 99% of bacteria in cold water by using silver ions.[5] Adidas, and Polartec have licensed silver coated nylon fabric known as X-Static[13] to incorporate antimicrobial silver in athletic and outdoor clothing for their ability to kill odors and promote thermal properties.

ARC Outdoors uses silver infused fabric from NanHorizon Inc. to produce antimicrobial thermals and socks for the U.S. military. SmartSilver[14] is a brand of odor-eliminating underwear, stocking caps and gloves that kills bacteria on contact using ionic silver. ARC sells to Wal-Mart, Bass ProShops and Cabelas.

Sharper Image has a line of slippers and pillows that have ionic silver compounds incorporated into the fabric to prevent odor-causing bacteria. Containers for food storage are now being impregnated with ionic silver releasing compounds to prevent bacterial growth that contributes to spoilage. Writing pens, bath mats, cutting boards, and door knobs are being coated with silver compounds to prevent bacteria from being spread.

Closed populations, such as prisons where stubbornly resistant staph infections are becoming increasingly problematic, are turning to ionic silver for a solution. Ionic silver compounds are presently being used in 15 different correctional facilities in 9 states in the United States, including Oklahoma, Kansas, Tennessee, Ohio, Minnesota, Louisiana, Pennsylvania, Florida and Texas.[11]

Water treatment facilities that service hospitals use silver ions as antimicrobial agents. And that is still just the tip of the iceberg. The list goes on and on, and is growing faster every week.

Overcomes Bacterial Resistance

Although researchers have known of ionic silver's germ-fighting effects for decades, it wasn't until 2000 that scientists began to unlock the mystery of ions and understand why ionic silver worked so well. Germs have three vulnerable targets:

(1) the germ's outer membrane
(2) its internal components
(3) its delicate gene pool

When a microorganism becomes resistant to an antimicrobial agent, it has learned how to fortify the specific target that the agent attacks. Ionic silver attacks all three vulnerable areas simultaneously. This multimodal action is what makes ionic silver such an effective and broad spectrum antimicrobial, effective even against resistant strains of microbes.

A press release by Curad quoted Philip M. Tierno, Ph.D., Director of Clinical Microbiology and Immunology at New York University Medical Center and author of The Secret Life of Germs (Atria Books 2004), as stating, "Silver is a natural antibacterial that works by killing bacteria, fungi and yeast by interfering with the metabolism necessary for respiration of these microbes. It fights germs with much less fear of developing antibiotic resistance."[8]

A representative of AgION stated in a recent press release, "Silver has multiple mechanisms of action. Use of silver as an antimicrobial [agent] is therefore unlikely to promote antibiotic resistance."

Antimicrobial vs Antibacterial

Ionic silver is often referred to as having "antimicrobial" qualities, rather than just "antibacterial" qualities. This is a very important distinction because many diseases that affect human beings today - bird flu and SARS if they should become pandemic in the future - all involve "viral" pathogens, not bacterial. And the medical community truly has nothing that will reliably combat viral pathogens.

A 2003 study by the Chinese Center for Disease Control and Prevention found ionic silver to be highly effective against the human **SARS** virus.[6] In the United States, a recent study at the University of Arizona showed ionic silver to be effective against the coronavirus that researchers use as the surrogate for SARS.[6]

A 2009 evaluation by the Faculty of Veterinary Medicine at Kasetsart University Kamphaengsaen Campus, Thailand documented **Microbecide™** silver ion complex completely deactivated the **H5N1** avian influenza A virus.[12]

The U.S. Environmental Protection Agency quotes on its website “[The EPA] believes based on available scientific information that the currently registered avian influenza A products, when applied in strict accordance with label directions, will be effective against the H5N1 strain.” Ionic silver complexes have proven to be very effective against the Avian Influenza A (ATCC VR-544, Hong Kong Strain) virus.

A study out of the United States University of Texas suggested ionic silver may be effective against HIV-1, and researchers expect it will be effective against other viruses and bacteria as well. "We're testing against other viruses and the super bug (Methicillin resistant *staphylococcus aureus*)," said Miguel Jose Yacaman, from University of Texas, Department of Engineering and one of the study's authors.[7]

Tests conducted in 2006 by independent laboratories in Frankfurt, Germany in the European Union demonstrated that Microbecide™ ionic silver complex, "fulfilled European Standard EN1040 required log reduction (> 5 log ie >99.999% reduction) against *Staphylococcus aureus*, *Candida albicans*, *Corynebacterium minutissimum* and *Escherichia coli*."

Independent Nelson laboratories in Salt Lake, Utah in the United States confirmed the kill of Methicillin resistant *staphylococcus aureus* (MRSA) and Vancomycin Resistant *Enterococcus faecium* (VRE) bacteria within two minutes of contact with an ionic silver complex.

In St. Paul, Minnesota in the United States, AppTec Laboratory Services reported "complete inactivation" of Human Immunodeficiency Virus type 1 in less than one minute of contact with an ionic silver complex.

The "antimicrobial" effect of ionic silver has long been recognized. Ionic silver is extremely broad spectrum when applied to bacterial, viral and fungal pathogens, including mold and yeast. Ionic silver is clearly recognized to be highly effective against essentially every known class of pathogen. Phrases like "antimicrobial" and "no pathogens survive" are intended to be quite broad in scope. And the mechanisms of action that make ionic silver effective as an antimicrobial agent are unique enough to support such claims.

Ionic Silver Stabilization Technology

Back 100 years ago, major pharmaceutical firms made silver products in the form of what is loosely referred to as "colloidal" silver, a process that did the job of delivering silver ions decently for its time. But after the advent of far more profitable antibiotics, silver fell out of favor.

In recent decades, colloidal silver has seen a resurgence in popularity, but primarily in the alternative or natural medicine field, or when sold as a dietary supplement. Meanwhile, important advances in the field of ionic silver stabilization are rapidly rendering colloidal silver products obsolete. New, patented technologies in the stabilization of ionic silver and unique, innovative methods of delivery represent a major breakthrough in antimicrobial technology.

All of the products on the market today that utilize ionic silver for its antimicrobial qualities incorporate a technology to stabilize the silver ions making the product commercially viable. The delivery mechanism varies relative to the environment where the ionic silver is being delivered and to some extent, so too the stabilization methodology employed.

Our growing understanding of stabilization techniques and controlled delivery mechanisms has contributed greatly to the increase in the number of products using ionic silver as an antimicrobial agent. The New York Times stated in a December 2005 article, "Silver, one of humankind's first weapons against bacteria, is receiving new respect for its antiseptic powers, thanks to the growing ability of researchers to tinker with its molecular structure."[9]

The same article goes on to say, "But silver's time-tested - if poorly understood - versatility […] was overshadowed in the latter half of the 20th century by the rise of antibiotics. Now, with more and more bacteria developing resistance to antibiotic [agents], some researchers and healthcare entrepreneurs have returned to silver for another look. This time around, they are armed with nanotechnology, a fast-developing collection of products and skills that helps researchers deploy silver compounds in ways that maximize the availability of silver ions - the element's most potent form. Scientists also now have a better understanding of the weaknesses of their microbial adversaries."

Silver May Outshine the Threat of Bird Flu and SARS

Perhaps a possible solution to a SARS or bird flu pandemic, if it were to develop, may already exist today in ionic silver based applications. And it may be the solution for a lot of things that really need an answer today.

Based upon the proliferation of products coming out in the medical field that use ionic silver, it is evident this is a technology that may prove to be the answer to not only MRSA strains, bird flu and SARS, but also for a wide range of infectious diseases that are very real and present threats to the health of the public today.

Using **Microbecide™** silver ion complex as a preventative, a treatment or a disinfectant may very well prove to be a major stride in shifting the tide in our favor.

1. Introduction

Two hundred thousand germs could easily lurk under the top half of this semicolon;

A single bacterium – a **microbe** - is only about three microns long. With a tough, armored, outer cell wall, it is shaped somewhat like a railway tank car. **Viruses** are even smaller and are the most basic of all microorganisms. They contain only nucleic acid (DNA or RNA) and a protein coat cover. Some more complex viruses are enclosed in a protective envelope derived from infected microbes own cell membrane. Viruses require the help of other microbes to reproduce.

Bacteria, fungi, chlamydia are more complex and have a nuclear body (DNA or RNA) and cytoplasm that contain components that convert nutrients into energy to drive the microbe's functions. These microorganisms can reproduce on their own.

An **antimicrobial agent** is a substance that kills or inhibits the growth of microbes (antibacterial, antifungal and antiviral actions). Disinfectants are antimicrobial agents that are applied to non-living objects while antiseptics are agents which destroy microorganisms on living tissue. Antibiotics are agents that destroy microorganisms within the body.

The length of time that an antimicrobial agent remains active after it has been applied is called the **residual effect**. Some agents remain active for hours or minutes, while others have no residual activity.

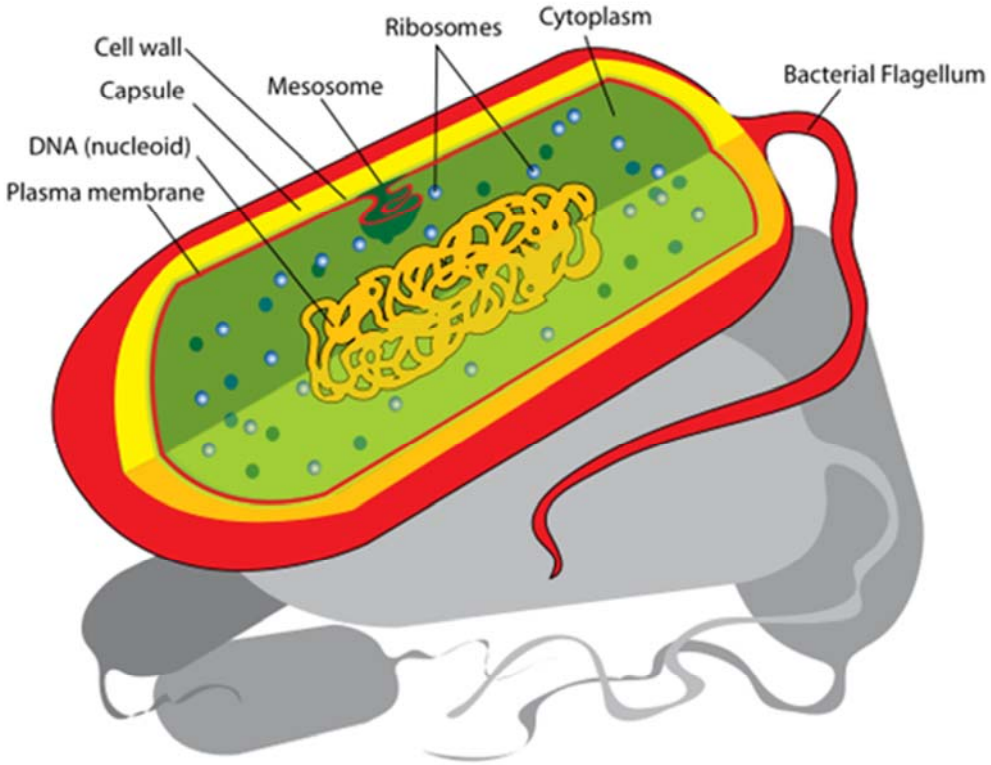
The nucleus of a microbe can be viewed as the control center and the cytoplasm the factory. Viruses have a control center but no cytoplasm, a virus is dependent on the microbe it infects to provide the factory it needs to produce energy or reproduce itself.

Microbes live anywhere damp. In water. In mud. In the air, as spores and on dust specks. In melting snow, in boiling volcanic springs. In the soil, in fantastic numbers. All over the planet's ecosystem, any liquid with organic matter, or any solid foodstuff with a trace of damp in it, anything not salted, mummified, pickled, poisoned, scorching hot or frozen solid, will swarm with microbes if exposed to air.

Microbes live on and inside human beings. They creep onto us in the first instants in which we are held in our mother's arms. They live on us, and especially inside us, for as long as we live. And when we die, then other microbes break down our remains into raw materials for the microbe factory.

1.1 Tank Car Size Microbes

Let us imagine (for the purpose of exploring the world of microorganisms) that a microbe is about the size and shape of a real railway tank car. Now, we can peer inside, examine how microbes survive and replicate, learn how they mutate and adapt to defend against attacks by antimicrobial agents and most importantly, understand how **Microbecide™** silver ion complex overcomes all their defenses.



The first thing we notice about our tank car microbe is the long, powerful whips that are corkscrewing at a blistering 12,000 revolutions per minute. When it's got room and a reason to move, the microbe can swim ten body-lengths every second. The human equivalent would be sprinting at forty miles an hour.

The butt-ends of these spinning whips are firmly socketed inside rotating, proton-powered, motor-hubs. It seems very unnatural for a living creature to use rotating wheels as organs, but microbes are untroubled by ideas of what is natural.

The microbe, constantly chugging away with powerful interior metabolic factories, is surrounded by a cloud of its own greasy mucus. The rotating spines, known as **flagella**, are firmly embedded in the microbe's outer hide, a slimy, lumpy, armored bark. The outer cell wall is a double-sided network of interlocking polymers, two regular, almost crystalline layers of macromolecular armor.

The netted armor, wrinkled into warps and bumps, is studded with hundreds of busily sucking and spewing orifices. These are the microbe's "**porins**," pores made from wrapped-up protein membrane, something like damp rolled-up newspapers that protrude through the armor into the world outside.

On our scale of existence, it would be very hard to drink through a waterlogged rolled-up newspaper, but in the tiny world of a microbe, osmosis is a powerful force. The osmotic pressure inside the microbe can reach 70 pounds per square inch, five times atmospheric pressure.

The microbe boasts strong, highly sophisticated electrochemical pumps working through specialized fauceted porins that can slurp up and spew out just the proper mix of materials. An efficient factory, the microbe can pump enough materials to double in size in a mere twenty minutes. In that same twenty minutes, the microbe can also build an entire duplicate of itself from scratch.

Inside the outer wall of protective bark is a greasy space full of chemically reactive ooze. It's the **periplasm**. Periplasm is a treacherous mass of bonding proteins and digestive enzymes, which can pull fragments of building materials right through the exterior hide, and break them up for further assimilation, rather like chemical teeth. The periplasm also features chemoreceptors, the microbial equivalent of nostrils or taste-buds.

Beneath the periplasmic ooze is the interior cell membrane, a tender and very lively place full of elaborate chemical scaffolding, where pump and assembly-work goes on.

Inside the interior membrane is the **cytoplasm**, a rich ointment of salts, sugars, vitamins, proteins, and fats, the microbe's factory and treasure-house.

1.2 Plasmids

If our microbe is lucky, it has some handy plasmids in its custody. A **plasmid** is an alien DNA ring, a kind of genetic franchise which sets up work in the midst of somebody else's sheltering cytoplasm. If the microbe is unlucky, it's afflicted with a **bacteriophage**, a virus with the modus operandi of a plasmid but its own predatory agenda.

And the microbe has its own native genetic material. **Eukaryotic** cells -- we humans are made from eukaryotic cells -- possess a neatly defined nucleus of DNA, firmly coated in a membrane shell. Microbes are **prokaryotic** cells, the oldest known form of life. Microbial DNA simply sprawls out amid the cytoplasmic ooze in a series of circular double-helix snarled and knotted configurations.

1.3 Transposons

Any plasmid or transposon (**transposons** are sequences of DNA that can move around to different positions within the genome of a single microbe, cause mutations, and change the amount of DNA in the genome, also called "jumping genes") wandering by with a pair of genetic shears and a zipper is welcome to snip off some data or zip in some data. A microbe usually has 200,000 or so clone microbial sisters around within the space of a pencil dot, who are also cloning themselves every twenty minutes.

Microbes share enormous amounts of DNA. They not only share DNA among members of their own species, through conjugation and transduction, but they will encode DNA in plasmids and transposons and transmit it to other species. They can even find loose DNA from the burst bodies of other microbes, and take in that DNA like food and then make it work like information. Pieces of stray DNA can be swept into the molecular syringes of viruses, and injected randomly into other microbes.

Microbes do extremely strange and highly inventive things with DNA. This property of microbes is very unique. For example, if your lungs were damaged, and you asked your dog for a spare lung, and your dog produced a lung and gave it to you, that would be quite an unlikely event. It would be even more miraculous if you could swallow a dog's lung and then breathe with it just fine, while your dog calmly grew himself a new one. But in the world of microbes this kind of miracle is commonplace.

Microbes are both primitive and highly sophisticated -- and vastly different from us multicellular mammals. When an antimicrobial agent is introduced into an environment, mass death of microbes will result. But any bug that is resistant will swiftly multiply by millions of times, thriving enormously in the power-vacuum caused by the destruction of other germs. The genes that gave the lucky winner its resistance will also increase by millions of times, becoming far more generally available. And that’s not all, often the resistance is carried by plasmids, and one single microbe can contain as many as a thousand plasmids, and produce them and spread them at will.

1.4 Cassettes

A resistance plasmid (familiarly known to researchers as "R-plasmids," because they've become so common) doesn't have to specialize. There's plenty of room inside a ring of plasmid DNA for information on a lot of different products and processes. Moving data on and off the plasmid, scissors-and-zippers units, transposons, can knit plasmid DNA right into the microbe’s DNA -- or they can transpose new knowledge onto a plasmid. These segments of loose DNA are aptly known as "**cassettes**."

So when a microbe is under assault and acquires a resistance plasmid, it can suddenly find an entire arsenal of defenses in its possession. Not just resistance to the one agent that provoked the response, but a whole library of resistance to a wide array of agents.

That genetic knowledge, once spread, will likely remain for some time. Microbes don't die of old age. Unless they are killed, microbes just keep splitting and doubling. The same microbial "individual" can spew copies of itself every twenty minutes, basically forever. After billions of generations, and trillions of variants, there are still likely to be a few random microbes around identical to ancestors from some much earlier epoch. Furthermore, spores of microbes can remain dormant for centuries, then sprout in seconds and carry on as if nothing had happened. This gives the microbial gene-pool an enormous depth and range.

Some of the best and cleverest information-traders are some of the worst and most noxious microbes. Such as *Staphylococcus* (boils), *Haemophilus* (ear infections), *Neisseria* (gonorrhea), *Pseudomonas* (abcesses, surgical infections). Even *Escherichia*, a very common human commensal microbe.

An adult human being carries about a solid pound of commensal microbes in his or her body; about a hundred trillion of them. Humans have a whole garden of specialized human-dwelling microbes -- tank-car *E. coli*, balloon-shaped *staphylococcus, streptococcus, corynebacteria, micrococcus*, and so on. Although microbes can be profoundly destructive to the human body, normally these do us little harm. On the contrary, our normal human-dwelling microbes act as a kind of protection, monopolizing the available nutrients and forcing out other rival microbes that might be harmful or dangerous.

1.5 Today's Battleground

The greatest battlegrounds of microbial warfare today are hospitals. Increasingly, to enter a hospital can make people sick. This is known as "**nosocomial infection**," from the Latin for hospital. About five percent of patients who enter hospitals nowadays pick up an infection from inside the hospital itself.

Staphylococcus aureus, a common hospital **superbug** which causes boils and ear infections, is now present in super-strains highly resistant to every known antibiotic except vancomycin. *Enterococcus* is resistant to vancomycin, and it has been known to swap genes with *staphylococcus*. *Staphylococcus* often lurks harmlessly in the nose and throat.

Staphylococcus epidermis, a species which lives naturally on human skin, rarely causes any harm, but this harmless species may serve as a reservoir of DNA data for the microbial resistance of other, truly lethal microbes. Certain species of staph cause boils, others impetigo. Staph attacking a weakened immune system can kill, attacking the lungs (pneumonia) and brain (meningitis). Staph is thought to cause toxic shock syndrome in women, and toxic shock in post-surgical patients.

An epidemic of acquired immune deficiency has come at a particularly bad time. The patients are just one aspect of the problem, though healthy doctors and nurses show no symptoms, they can carry strains of hospital superbugs from bed to bed on their hands, deep in the pores of their skin, and in their nasal passages. Superbugs show up in food, fruit juices, bedsheets, even in bottles and buckets of antiseptics.

Nowadays half of nosocomial infections are either surgical infections, or urinary tract infections from contaminated catheters. Microbes attack us where we are weakest and most vulnerable, and where their own populations are the toughest and most battle-hardened. From hospitals, resistant superbugs travel to old-age homes and day-care centers, predating on the old and the very young.

1.6 Agents, Tactics and Defenses

When the cell wall of a microbe bursts from osmotic pressure, the effect is known as "l**ysing**." Microbes lyse because of a chemical structure called "**beta-lactam**". Beta-lactam is produced in nature by certain molds and fungi.

Beta-lactam is a four-membered cyclic amide ring, a molecular ring which bears a fatal resemblance to the chemical mechanisms a microbe uses to build its cell wall.

Microbe cell walls are mostly made from **peptidoglycan**, a plastic-like molecule chained together to form a tough, resilient network. Peptidoglycan serves a structural role in the microbial cell wall, giving the wall shape and structural strength, as well as counteracting the osmotic pressure of the cytoplasm. Peptidoglycan is also involved in binary fission during microbial reproduction. A microbe is almost always growing, repairing damage, or reproducing, so there are almost always raw spots in its cell wall that require construction work.

It's a sophisticated process. First, fragments of not-yet-peptided glycan are assembled inside the cytoplasm. Then the glycan chunks are hauled out to the cell wall by a chemical scaffolding of lipid carrier molecules, and they are fitted in place. Lastly, the peptidoglycan is busily knitted together by catalyzing enzymes and set to cure.

Beta-lactam attacks the enzyme which links chunks of peptidoglycan together. The result is like building a wall of bricks without mortar; the unlinked chunks of glycan break open under osmotic pressure, and the cell spews out its innards and dies.

Gram-negative microbes, of the sort we have been describing, have a double cell wall, with an outer armor plus the inner cell membrane, rather like a rubber tire with an inner tube. They can sometimes survive a beta-lactam attack, if they don't leak to death. But **gram-positive** microbes are more lightly built and rely on a single wall only, and for them a beta-lactam puncture is a swift kiss of death.

Beta-lactam can not only mimic, subvert and destroy the assembly enzymes, but it can even eat away peptide-chain mortar already in place. And since mammalian cells never use any peptidoglycans, beta-lactam is non-toxic to humans and animals.

Agents such as tetracycline, streptomycin, gentamicin, and chloramphenicol break-up or jam-up the microbe's protein synthesis. These agents creep through the porins deep inside the cytoplasm and lock onto the various vulnerable sites in the RNA protein factories. This RNA sabotage brings the cell's basic metabolism to a halt, and the microbe chokes and dies.

The final major method of attack is an assault on microbial DNA. These compounds, such as the sulphonamides, the quinolones, and the diaminopyrimidines, gum up microbial DNA itself, or break its strands, or destroy the template mechanism that reads from the DNA and helps to replicate it. Or,

they can ruin the DNA's nucleotide raw materials before those nucleotides could be plugged into the genetic code.

Antimicrobial agents break open cell walls, choke off the life-giving flow of proteins, and smash or poison microbial DNA, the microbe's central command and control center.

1.7 Antimicrobial (Bacterial) Resistance

Microbes have evolved to defend against these attacks. It begins outside the cell, where certain microbes have learned to eject defensive enzymes into the cloud of enzymes that surrounds them -- enzymes called **beta-lactamases**, specifically adapted to destroy beta-lactam. At the cell wall itself, microbes have evolved walls that are tougher and thicker. Other microbes have lost certain vulnerable porins, or have changed the shape of their porins so that antimicrobial agents will be excluded instead of inhaled.

Inside the cell wall, microbes make permanent stores of beta-lactamases in the outer mass of periplasm, which will chew up and digest the agent before it ever reaches the vulnerable core of the cell. Other enzymes have evolved that will crack or chemically smother it.

In the pump-factories of the inner cell membrane, new pumps have evolved that specifically latch on to an antimicrobial agent and spew it back out of the cell before it can kill. Other microbes have mutated their interior protein factories so that the assembly-line no longer offers any sabotage-sites for a protein-busting agent.

Yet another strategy is to build excess production capacity, so that instead of two or three assembly lines for protein, a mutant cell will have ten or fifty, requiring ten or fifty times as much agent for the same effect. Other microbes have come up with immunity proteins that will lock-on to an antimicrobial agent and make it a useless inert lump.

2. Microbecide™ Silver Ion Complex

2.1 Ionic Silver - A Superweapon

A silver ion is a different form of matter than an atom of silver and has entirely different physical properties. An ion of silver is formed when a single electron is removed from a silver atom causing the ion to have a positive charge. Silver ions diffuse through a solution due to the mutual repulsion they have for each other caused by their ionic charge.

Since antiquity, Silver ions (Ag+) have been known for their ability to destroy bacteria, fungus and viruses. Manufacturers have long sought to harness the extraordinary microbiocidal properties of ionic silver. Historically, the principal limitation of ionic silver products has been the propensity of the silver ions to "**precipitate**" or "fall" out of the solute phase, resulting in a rapid reduction of ionic concentration, rendering the products ineffective.

2.2 Advanced Silver Ion Technology

The advanced technology employed in the manufacture of **Microbecide™** silver ion complex overcomes this limitation allowing silver ions to remain in solution for time periods extending into years. Ionic silver based products formulated using this patented technology have been **proven stable for over two years** under actual warehouse conditions.

2.3 Increased Bio-Availability

This advanced molecular technology results in the formation of unique antimicrobial molecules. The molecular properties of these uniquely created molecules allow us to engineer **Microbecide™** with higher stability and efficacy as compared to traditional antimicrobial products on the market today. This advanced picotechnology creates a weak molecular bond which makes the silver ions more bio-available, increasing their antimicrobial action.

The increased biological availability of these silver ions in solution contributes to the outstanding effectiveness of **Microbecide™** against a wide range of **gram negative** and **gram positive** bacteria and fungus as well as viruses.

2.4 Overcomes Bacterial Resistance

Organically engineered antimicrobial agents are designed to attack a specific target within a microorganism. Each agent has a unique technique or action it employs against specific enzymes or functions within the microbe. Microorganisms have evolved to resist these attacks, becoming strain resistant to many scientifically engineered agents. **Microbecide™** is a stabilized ionic silver complex, no known pathogenic organism has developed immunity to silver ions. Ionic silver is unique in its actions against microorganisms.

2.5 Multiple Modes of Attack

Unlike organic agents, ionic silver attacks in multiple ways, simultaneously. This multimodal action is what makes ionic silver such an effective and broad spectrum antimicrobial and what makes **Microbecide™** effective even against resistant strains of microorganisms.

Microbes view the molecules of **Microbecide™** as a food source, taking in the silver ions through **porins**. Uptake of silver ions by a microbe occurs by several mechanisms, including passive diffusion and active transport by systems that normally transport essential ions.

The silver ions may bind non-specifically to cell surfaces, causing disruptions in cellular membrane functions, but it is the ionic binding within the microorganism that results in ionic silver's exceptional antimicrobial properties.

Once inside the microbe, silver ions begin to interrupt the critical functions of the microorganism. Silver ions are highly reactive and readily bind to electron donor groups containing sulphur, oxygen and nitrogen, as well as negatively charged groups such as phosphates and chlorides.

A prime molecular target for the silver ion resides in cellular thiol (-SH) groups, commonly found in critical proteins, the **enzymes**. Enzymes become denatured because of conformational changes in the microbe that result from silver ion binding. Many of the enzymes that silver ions denature are necessary in the cellular generation of energy.

When the energy source of the microorganism is incapacitated, the microbe cannot maintain osmotic pressure and the microbe **lyses** or bursts. Necessary substrates leak out of the microorganism and the microbe will quickly die.

In addition to the well-known reaction of silver ions and proteins, silver ions react with the base pairs of the microbe's DNA, interfering with DNA replication and the microbe is unable to replicate itself.

The ionic silver of **Microbecide™** blocks the cell respiration pathway, interferes with components of the microbial electron transport system, binds DNA and inhibits DNA replication. **Microbecide™** is unique in its actions as a disinfectant, a preventative or a treatment.

2.6 Superior Disinfection Properties

Microbecide™ disinfection claims are based on challenge tests designed to determine the kill activity of an antimicrobial agent against specific microorganisms.

The tests were performed by recognized independent laboratories under official AOAC (Association of Official Analytical Chemists) procedures and in accordance

with Good Laboratory Practices and protocols.

Testing in the US was conducted in accordance with U.S. Environmental Protection Agency (U.S. EPA) regulations.

Testing in the EU was conducted according to the European Standard EN 1040 (Chemical disinfectants and antiseptics / Basic bactericidal activity / Test method and requirements phase 1).

Microbecide™ Silver Ion Complex Disinfection Claims

BACTERIA	KILL TIME
Proprionibacterium acnes[15] ATCC 6921	15-seconds
Pseudomonas aeruginosa[16] ATCC 15422†	30-seconds
Staphylococcus aureus[16] ATCC 6538†	30-seconds
Salmonella cholerasuis[17] ATCC 10708†	30-seconds
Listeria monocytogenes[18] ATCC 19111†	30-seconds
E. coli 0157[18] ATCC 43888†	2-minute
Enterococcus facium[18] (VRE) ATCC 700221†	2-minute
Staphylococcus aureus[18] (MRSA) *ATCC 700698*†	2-minute
VIRUS	**KILL TIME**
Human Immunodeficiency Virus[19] type 1, Strain HTLV-III$_B$	30-seconds
Herpes simplex[20] type I ATCC VR-733 Strain F(1) ±	1-minute
Rhinovirus[21] type R37 ATCC VR-1147 Strain 151-1±	10-minute
Influenza A[22] ATCC VR-544, Hong Kong Strain±	10-minute
Poliovirus[23] type 2 ATCC VR-1002 Strain Lansing±	10-minute
FUNGUS	**KILL TIME**
Trichophyton mentagrophytes[24] *ATCC 9533*	10-minute

†Evaluated in the presence of 5% organic soil ±Evaluated in the presence of 1% organic soil

2.7 Residual Action - 24 Hours Protection

The length of time that an antimicrobial agent remains active after it has been applied to a surface is called the residual effect. Some agents remain active for hours or minutes, while others have no residual activity.

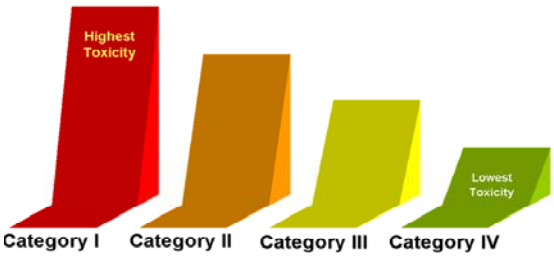
The residual activity of an antimicrobial agent is tested by application to a hard non-porous surface, contaminated with standard indicator organisms (*Staphylococcus aureus* ATCC 6538, *Pseudomonas aeruginosa* ATCC 15442 and *Salmonella choleraesuis* ATCC 10708).

Quantitative residual results at **24 hours after initial application** of the ionic silver complex of **Microbecide™** showed a 99.99% reduction in all three bacteria tested.[25]

Microbecide™ provides 24 hours of continuous protection after application.

2.8 Non-Toxic – Category IV Toxicity Rating (US EPA)

Microbecide™ silver ion complex's high efficacy and low toxicity set a new industry benchmark**.** Harsh chemicals, such as ammonium chloride, have been the standard means of disinfection for the past three decades. **Microbecide™**, both less toxic and more powerful, does not contain any quaternary ammonium salts, phenols, glutaraldehyde, chlorine or bromine compounds, is non-caustic, colorless, odorless and does not produce toxic fumes.



While highly toxic to bacteria, fungi and viruses, the ionic silver molecules of **Microbecide™** are non-toxic to humans and animals.

With a toxicity rating of Category IV, it is in the lowest category of the US Environmental Protection Agency's (EPA) toxicity categorization of antimicrobial agents. The EPA categories range from Category I (highest toxicity) down to Category IV, (lowest toxicity).

	Microbecide™ Silver Ion Complex	Leading brands
Class	Ionic Silver	Alcohol/Quaternary Ammonium compounds
U.S. EPA Toxicity Category	IV	II
Standard Bacteria Kill Time	30 Seconds	10 Minutes
Resistant Bacteria Kill Time	2 Minutes	None
Fungal/Virus Kill Time	10 Minutes	10 Minutes
Residual Protection	24 hours	None
Rinse Required	No	Yes
Irritating Fumes	No	Yes
Skin Irritation	No	Yes
Flammable	No	Yes

2.9 Toxicity and Dermal Sensitization Studies

The ionic silver complex of **Microbecide™** has been assessed in extensive laboratory testing, including acute toxicity tests and dermal sensitization studies.

Summary of Results

Acute Dermal LD50 (rat) : >5000 mg/kg
Skin Irritation: Non-irritating
Oral Toxicity: >5000 mg/kg
Eye Irritation: Practically non-irritating, Category IV
Dermal Sensitization: Not a contact sensitizer
Carcinogenicity: Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Epidemiology: N/A
Teratogenicity: N/A
Neurotoxicity: N/A

2.10 Specially Formulated For Safe Use

Child Safety Network (CSN) has recognized the Silver Ion Complex as a child safe product. For more than 16 years, CSN has been working to build awareness of and solve child safety issues. In 2005 CSN began issuing challenges to companies to manufacture and sell products that were safer for use near children. CSN encourages companies to invest money in research and development to create, re-engineer or reformulate commonly used yet dangerous products into safe products for use where children may come into contact with them.

Based on advanced technology, **Microbecide™** silver ion complex is a safe and effective answer to CSN's call for a child safe product. **Microbecide™** is formulated and marketed for use in childcare facilities and family homes with children.

Microbecide™ is specially formulated for safe use to disinfect and deodorize:

- Children's toys
- Toy boxes
- Jungle gyms
- Playhouses
- Desks
- Strollers
- Cribs
- Playpens
- Play tables
- Activity centres
- Diaper pails
- Changing tables
- Child car seats

Microbecide™ can be used in Taxis, Busses, Trains, Airplanes, Ships, Preschools, Schools, Restaurants, Offices, Homes and Medical Facilities.

Microbecide™ is specially formulated for safe use to disinfect and deodorize:

- Hospitals
- Nursing homes
- Restaurants
- Schools
- Offices
- Homes
- Day Care centres
- Subways
- Trains
- Airplanes
- Ships
- Busses
- Taxis
- School busses
- Beauty shops
- Barber shops
- Kitchens
- Bathrooms
- Locker rooms
- Veterinary clinics
- Exercise facilities
- Public restrooms
- Nursery houses
- Animal shelters
- Poultry houses

2.11 A Platform Technology

Microbecide™ Applications

Commercial / Institutional
- Disinfectants / Sanitizers
- Wipes / Towelettes
- Hand Sanitizer
- Hand Soap
- Food Processing
- Bandages / Dressings
- Medical / Dental Pre-Clean
- Fruit and Vegetable Wash

Pharmaceutical
- Acne Care
- Athletes Foot Control
- Nail Fungus Control
- Intravaginal / Perineal
- Wound / Burn Care
- Diabetic Ulcer Care
- Diaper Dermatitis
- Toothpaste / Mouthwash
- Cold / Canker Sores

Odor Control
- Carpets
- Mops
- Cleaning Aids
- Garbage Cans
- Landfills

Industrial
- Mold Remediation
- Cooling Towers
- Bio-Film Control
- Industrial Fluid Treatment

Veterinary
- Vet Spray – Parvo
- Kennel / Stall Wash
- Teat Wash
- Feeders / Drinkers
- Egg Laying Cages
- Poultry House Extraction Fans
- Wipes / Towelettes
- Hand Soap

Environmental
- Drinking Water Purification
- Swimming Pool Treatment

Bio-Terrorism Assistance
- Mass Transit Disinfection
- Public Decon Stations

Microbecide™ is a highly effective broad spectrum, non-corrosive and odorless antimicrobial agent with unparalleled performance and significant residual activity. Incorporating stabilized ionic silver technology, Microbecide™ can serve as the technology platform for practically any given application.

2.12 Manufacturing Capability

Microbecide™ silver ion complex is manufactured at our state-of-the-art, 5,000 square feet, manufacturing facility at Kallang Basin Industrial Estate, Singapore.

The plant is Good Manufacturing Practices (GMP) compliant; with clean room facilities certified to ISO 14644-1 Class 7 (U.S. FED STD 209E Class 10,000) Cleanroom Standards.

The 5,000 square feet facility, designed for maximum efficiency, is equipped with rooms for mixing, filling and packaging as well as a testing laboratory. The plant can scale from a single product to multiple product lines; from reception of raw materials to formulation, production, storage and shipment of finished product.

We conduct ongoing, continuous Product Development, combining the latest in chemical technology and ingredient trends to bring cutting-edge products to market. Our Quality Assurance program is among the most comprehensive in the industry.

3. Application and Use Instructions

When used as directed, **Microbecide**™ provides protection from *Pseudomonas aeruginosa, Staphylococcus aureus* and *Salmonella choleraesuis* up to **24 hours** after initial application.

3.1 General Disinfection:

For general disinfection and control of the bacteria *Pseudomonas aeruginosa*, *Staphylococcus aureus, Salmonella choleraesuis, Listeria monocytogenes*, Vancomycin Resistant *Enterococcus faecium* (VRE), Methicillin Resistant *Staphylococcus aureus*, (MRSA) and *Escherichia coli* 0157:H7 the surface must be completely wet with **Microbecide™** for **2 minutes**. The surface may then be wiped dry with a clean towel.

3.2 Fungus Control:

For effective control of the fungus Trichophyton mentagrophytes, the surface must be completely wet with **Microbecide**™ for **10 minutes**. The surface may then be wiped dry with a clean towel. Re-apply when cleaning or when new growth appears.

3.3 Viral Control:

To kill Herpes Simplex Type 1 F(1) Strain, Influenza A Virus, Hong Kong strain, Rhinovirus R37 Strain 151-1, Polio Virus Type 2 Lansing Strain the surface must be completely wet with **Microbecide**™ for **10 minutes**. The surface may then be wiped dry with a clean towel.

3.4 Instructions for Cleaning and Decontamination Against HIV:

On pre-cleaned environmental surfaces/objects previously soiled with blood/body fluids:

- Kills HIV-1 on pre-cleaned environmental surfaces/objects previously soiled with blood/body fluids in health care settings (or other settings in which there is an expected likelihood of soiling of inanimate surfaces/objects with blood or body fluids, and in which the surfaces/objects likely to be soiled with blood or body fluids can be associated with the potential for transmission of HIV).

- Personal Protection: When handling items soiled with blood or body fluids, use appropriate barrier protection such as latex gloves, gowns, masks or eye coverings.

- Cleaning Procedure: Blood and other body fluids must be thoroughly cleaned from surfaces and objects before application of this product.

- Contact Time: Apply **Microbecide**™ to area to be treated. The surface must be completely wet with **Microbecide**™ for 30 seconds. The surface may then be wiped dry with a clean towel. This contact time will

not control all organisms listed. Refer to above application instructions for other organisms.

Disposal of Infectious Materials: Blood and other body fluids should be autoclaved and disposed of according to governmental regulations for infectious waste disposal.

3.5 Choosing And Using A Disinfectant

Ideally, a disinfectant will rapidly kill a large variety of pathogens, be totally safe for use on all inanimate objects, and nontoxic to humans and animals.

All of us have probably used some sort of disinfectant at one time. Many people think that if a product just says on the label that it "kills germs" it's doing a good job of protecting them from diseases. Unfortunately, choosing a disinfectant isn't that easy.

There are many diseases--bacterial, viral, fungal and parasitical--which can affect our lives. While many microorganisms are necessary for life, some are very dangerous. Even normal bacteria can become deadly if they get a chance to grow out of control. It's not practical to maintain a fully sterile environment, but it is possible to keep things as clean as possible to prevent contamination. Many of the most common diseases are easily spread on skin, hair, clothing, shoes, and inanimate objects such as doorknobs, light switches, counter tops, playgrounds, toys and dishes.

Some, such as *Pseudomonas* bacteria and *Salmonella*, can even be spread through the water supply, via contaminated water pipes or dirty dishes. It is common sense that we should do everything we can to keep ourselves from becoming infected with preventable illnesses.

Good hygiene is very important. If you prevent diseases from gaining access to your environment, it is much easier than treating illnesses after the fact.

You can easily carry pathogens into your environment. Plain soap and water will clean, but if you need to kill germs, you must use a disinfectant!

When you pick a disinfectant, it's a much harder task than just grabbing a bottle off a shelf. You need to know what specific pathogens (germs) you want to destroy or deactivate. You then need to find out which disinfectant(s) will act on those pathogens. That is the first step in choosing--most disinfectants do not kill everything. Pick a product which takes care of the majority of your most worrisome pathogens, or at least the one most troublesome to you.

But once you have bought a product, you can't just start washing indiscriminately. Educate yourself in how to use the product before you start. You need to know if the disinfectant you choose will work in the presence of organic matter (dirt), or whether you need to pre-wash the items to be disinfected before you apply the disinfecting substance. And you must know if the product you choose is toxic, how to use it properly, and under what circumstances. A disinfectant which is

used improperly can either be totally useless, or very dangerous to you and/or your environment. Reading the entire label on the product is very important before beginning to use the disinfectant. Always follow the manufacturer's directions exactly, to avoid problems.

Few disinfectants work well in the presence of organic debris. To maximize the effects of a disinfectant, the item must be thoroughly clean first. The easier it is to clean, the more likely it will be to be disinfected adequately. Once you've cleaned an item, it must be rinsed thoroughly before disinfecting to avoid chemical reactions between the two solutions which could possibly inactivate the disinfectant product.

It is good to be patient when using a disinfectant. No disinfectant is instantaneous. To kill pathogens and do a thorough job of it, many disinfectants must remain in contact with the item being disinfected from several minutes to several hours! **Nothing works with a wipe on-wipe off approach.** Again, read the label and use the product properly. If left for too short a time, the product won't do its job, and if left too long, some products may damage the surface of the item being disinfected.

Finding a disinfectant that will battle viruses is even more confusing, because virus-killing disinfectants are very virus specific. There are two kinds of viruses--lipophilic and hydrophilic. Lipophilic viruses combine with lipids (Fats) such as cholesterol; hydrophilic viruses do not combine with lipids. Lipophilic viruses, such as herpes and influenza, are very easy to destroy, while hydrophilic viruses such as reoviruses, polyomaviruses and parvoviruses are very difficult to kill. You must read the labels of disinfectants very carefully to find out if the product you are considering is a virucide against the virus you need to kill.

So--which disinfectant do you pick? There are literally hundreds out on the market, under as many brand names. It is not uncommon to need more than one kind of disinfectant to combat different types of pathogens. Hospitals, on the average, have over 14 different types of disinfectants in use at any given time; your environment may not need 14, but just one may not be enough!

Good hygiene goes a long way toward keeping your environment healthy--if you wash things down with soap and water more often, you will need to use strong disinfectants less often.

Washing items thoroughly of all organic debris (food, blood, dirt) will assist the activity of any disinfectant you choose.

Read ALL instructions thoroughly before beginning to disinfect an object.

Use the best possible disinfectant for your specific situation--read about which pathogens it will kill, how difficult it is to use, and any special requirements. Don't buy a bottle of a disinfectant if you won't be able to use it properly for some reason (does it require protective clothing you don't have? Will it create toxic fumes in a room you cannot ventilate?). Take all required proper precautions before starting a disinfecting project.

4. Classes Brands Advantages Disadvantages

The efficacy (capacity of an active ingredient to produce a desired result or effect as compared to comparable substances) of an antimicrobial product is directly proportional to the antimicrobial properties of the active ingredient of the product. Many products contain one or more active ingredients or antimicrobial agents. Products containing various combinations (compounds or complexes) of antimicrobial agents are typically marketed under multiple brand names. Each agent has advantages as well as disadvantages in its usage. It is not uncommon to need more than one class of microbial agent to combat different types of pathogens. Hospitals, on the average, have several different classes in use at any given time.

Table 1: Properties of Antimicrobial Agents

Agent	Significant Residual Action	Toxicity	Non-Flammable	Non-Corrosive	No Skin Irritation	No Fumes	Effective Against Bacteria	Effective Against Viruses	Effective Against Fungi
Silver ion complex	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alcohol > 60% concentrations	✗	⚠	✗	⚠	⚠	⚠	✓	✓	✓
Glutaraldehyde compounds	⚠	⚠	⚠	⚠	⚠	⚠	✓	✓	✓
Chlorhexidine gluconate	⚠	⚠	✓	✓	⚠	✓	✓	✓	⚠
Iodine compounds	✗	⚠	✓	⚠	✗	⚠	✓	✓	✓
Phenol derivatives	✗	⚠	✓	⚠	✗	⚠	✓	✓	✓
Chloroxylenol complex	✗	✗	✓	✓	⚠	⚠	✓	⚠	⚠
Quaternary ammonium compounds	✗	✗	✗	✗	✗	✗	⚠	⚠	✗
Chlorinated compounds	✗	✗	✗	✗	✗	✗	✓	✓	✓
Hydrogen peroxide compounds	⚠	⚠	✓	⚠	⚠	⚠	✓	✓	✓
Wood tar derivatives	✗	⚠	✓	✓	⚠	⚠	✗	✗	✗

✓ Good or Category IV ⚠ Fair or Category III ✗ No Activity or Category I or II

Source: U.S. CDC – Guidelines for Hand Hygiene in Healthcare Settings
U.S. EPA – Precautionary Labelling Guidelines
Manufacturer / Product Material Safety Data Sheet (MSDS)

Table 2: Brand Names

Agent	Brand Names	Effective Against Bacteria	Effective Against Viruses	Effective Against Fungi
Silver ion complex	Microbecide™, Staph Attack, CleanKill, SilverClene24	✓	✓	✓
Alcohol > 60% concentrations	Viraguard	✓	✓	✓
Glutaraldehyde compounds	Wavecide, Cidex, Sporcide, Banacide, Sterol	✓	✓	✓
Chlorhexidine gluconate	Nolvasan, Phisohex, Virosan, Hibitane	✓	✓	⚠
Iodine compounds	Vanodine, Betadyne, Providone, Scrubodyne	✓	✓	✓
Phenol derivatives	Lysol, Stericol, O-Syl Staphene, 1-Stroke Environ	✓	✓	✓
Chloroxylenol complex	Dettol	✓	⚠	⚠
Quaternary ammonium compounds	Roccal-D, Quintacide, Parvosol, Hitor Merquat, Cetylcide	⚠	⚠	✗
Chlorinated compounds	Clorox, Purex	✓	✓	✓
Hydrogen peroxide compounds	Virox	✓	✓	✓
Wood tar derivatives	Pine-Sol, Hexol	✗	✗	✗

✓ Good or Category IV ⚠ Fair or Category III ✗ No Activity or Category I or II

Source: U.S. CDC – Guidelines for Hand Hygiene in Healthcare Settings
U.S. EPA – Precautionary Labelling Guidelines
Manufacturer / Product Material Safety Data Sheet (MSDS)

Microbecide™ rapidly kills a large variety of pathogens, is totally safe for use on all inanimate objects, and is nontoxic to humans and animals.

4.1 Silver Ion Complex

Ionic silver is an excellent antimicrobial, with low toxicity against non-target organisms. Ionic silver solutions are increasingly an alternative to traditional disinfectants; besides having fast acting disinfectant properties, ionic silver solutions provide a residual effect lasting up to 24 hours. Silver ions disrupt transport functions in cell walls, interrupt cell metabolism and prevent cell

division in microorganisms. Ionic silver technology reduces the potential for the development of antimicrobial resistance commonly encountered with many traditional disinfectants. This is especially important in healthcare environments where microbial mutation and antibiotic resistance are major concerns in fighting disease.

An ionic silver complex is colorless, odorless, tasteless, and non-caustic. Some manufactures add fragrance and cleaning agents to their products, as ionic silver solutions formulate well with other compounds. Ionic silver has a broad range of commercial, industrial and consumer applications including restaurants, homes and medical facilities. The US EPA toxicity categorization of antimicrobial products range from Category I (highest toxicity) down to Category IV (lowest toxicity), ionic silver solutions are in the EPA Category IV.

Brand Names: Microbecide™, AgION, Alagon, Axenhol, Axen30, CleanKill, Conval PAg-40TM, Staph Attack, SilverClene24, Silverlon, Tetrasil

Advantages

- ✔ Broad spectrum protection as a disinfectant, fungicide and virucide
- ✔ Kills germs in 30 seconds
- ✔ Provides residual protection for 24 hours
- ✔ Effective against resistant bacteria such as MRSA and VRE
- ✔ Effective against H5N1 virus
- ✔ Effective against SARS
- ✔ Lowest toxicity rating available
- ✔ Safe for use in diverse environments
- ✔ Short contact time
- ✔ Non flammable
- ✔ Non corrosive
- ✔ Not irritating to the skin
- ✔ No irritating fumes
- ✔ Long shelf life
- ✔ Powerful deodorizer
- ✔ Readily available, medium cost

Disadvantages

- ⚠ Stability may be altered by specific chemicals
- ⚠ Susceptible to ultra violet light
- ⚠ May stain marble surfaces

4.2 Alcohols

Alcohols are the base ingredient for many other disinfectants. When used as a surface spray or solution on inanimate objects, alcohol is an excellent pathogen destroyer. But it must be left in contact with the item to be disinfected for long periods to do its job--20 minutes contact time is considered proper for disinfection with ethyl alcohol. The higher the "proof" of an alcohol product, the better antimicrobial it is, but the more volatile and evaporative it will be. Isopropyl alcohol is not considered to be an

antimicrobial--its main use is as a skin wipe to remove loose organic debris from the site of a wound or injection.

Brand Names: Disaptic, Lysol I.C. Spray, Lysol II Spray, Metriguard, Virahol

Advantages

- ✔ Low cost
- ✔ Effective against many pathogens with correct contact time

Disadvantages

- ⚠ Long contact time required for disinfecting action
- ⚠ May irritate respiratory system if not used in extremely well-ventilated areas
- ⚠ Only certain types of alcohol contain true antimicrobial properties
- ⚠ May dissolve synthetic surfaces
- ⚠ Not effective against some viruses
- ⚠ Evaporates quickly, so items being disinfected must be physically soaked in alcohol to obtain disinfection

4.3 Chlorhexidine Gluconates

Chlorhexidine products are often used as disinfectants for inanimate objects or antiseptics for cleaning skin wounds. Some chlorhexidine compounds contain alcohol, and these have been found to have superior antimicrobial properties to those containing only chlorhexidine. Chlorhexidine is effective against many bacteria, and yeast (especially Candida). It is not effective against most viruses, *mycobacteria* spores and *Pseudomonas*. Hexachlorophene has been suggested to be a potent carcinogenic. Some aviculturists use chlorhexidine as a water additive for control of pathogens, although this is not recommended by the manufacturers, as these products were never meant for ingestion.

Brand Names: Dispatch, Hibitane, Hibistat, MicroStat, Nolvasan, Virosan

Advantages

- ✔ Effective as a water pan additive in incubators and brooders for control of aspergillus fungus
- ✔ Effective against Newcastle virus
- ✔ Not corrosive to equipment
- ✔ Readily available, medium cost

Disadvantages

- ⚠ Poor efficiency against most viruses and many gram-negative bacteria including *Pseudomonas* (Virosan is the exception--it is effective against *Pseudomonas*)
- ⚠ Must be discarded and re-mixed daily
- ⚠ Not effective in the presence of organic debris
- ⚠ Not effective against bacterial spores or *mycobacterium*

4.4 Chlorine

The best known member of this class is sodium hypochlorite (bleach). Bleaches are very harsh but effective. They attack pathogens, organic debris

and living tissues equally well. Bleach can create toxic fumes which can lead to chemical pneumonia, skin and eye irritation or burns. It is recommended to wear protective clothing and eye gear when using bleach.

Brand Names: Clorox, Purex

Advantages

- ✔ Inexpensive
- ✔ Easily available without a license
- ✔ Depending on the concentration at which it is mixed it can kill most bacteria, viruses, and mycoplasmas
- ✔ Potent deodorizer, works best in the presence of sunlight which releases more free radicals

Disadvantages

- ⚠ Caustic to tissues and equipment
- ⚠ Loses its effectiveness quickly while still on the shelf in the bottle
- ⚠ Not all brands of bleach, and not all production lots are the same concentration
- ⚠ Prolonged contact may be required for heavy sterilization
- ⚠ Solution may require freshening every few hours
- ⚠ Produces carcinogenic by-products, and must be used in a well-ventilated area
- ⚠ All objects treated with bleach must be well rinsed and allowed to dry before use
- ⚠ Rapidly inactivated by organic debris (any dirt left on the object being disinfected will interfere with the action of the free radicals, up to the point where no chlorine is left to act on the actual pathogens)

4.5 Stabilized Chlorine Dioxide

Stabilized chlorine dioxide is a chlorine derivative which is a powerful oxidizing agent. It can destroy many pathogens, including bacteria, viruses, fungi and protozoa. Many studies have suggested that stabilized chlorine dioxide is a superior disinfecting agent to sodium hypochlorite (bleach). It is used in Europe to treat drinking water because it does not form carcinogenic by-products like sodium hypochlorite does.

A detergent product containing stabilized chlorine dioxide is a good washing/soaking product for syringes, dishes and other hard surfaces, and can also be safely used on the skin. Chlorine dioxide is an excellent deodorizer; the oxidizing properties destroy odor-causing molecules.

Brand Names: Oxyfresh Dent-a-gene (full strength stabilized chlorine dioxide), Oxyfresh Cleansing Gele' (detergent with stabilized chlorine dioxide added) ***Advantages***

- ✔ Safe for use around humans at recommended working dilutions
- ✔ Deactivates avian polyoma virus in 1 minute contact time
- ✔ Diluted solution creates no harmful fumes and is safe to use on skin or other surfaces

Disadvantages

- ⚠ In undiluted form, fumes of stabilized chlorine dioxide may be toxic to living tissue
- ⚠ Rapidly deactivated by organic debris and exposure to sunlight

4.6 Glutaraldehydes

This is a relatively new class of antimicrobial which has come out within the past 25 years. The chemical action is to deactivate DNA and RNA proteins. They will deactivate most bacteria (including mycobacteria), viruses, and chlamydia. They are very stable and most work well even in the presence of organic debris. When mixed up in solution, they last a long time, making the cost per use fairly low. They are expensive to purchase initially compared to other antimicrobials, and have many possible side effects, including tissue toxicity, irritation to the eyes, mucous membranes, respiratory tract and skin. Some glutaraldehyde formulas are corrosive to metals, others are not; read the label of a particular product to find the corrosive properties of that product. Never, ever mix glutaraldehydes with any other cleaning or disinfectant product.

Brand Names: Banacide, Cidex, Cetylcide, Metricide, ProCide, Sporcide, Sterol, Wavecide

Advantages

- ✔ Equally effective in water of any temperature or hardness
- ✔ Effective against essentially any pathogen, even in presence of organic debris
- ✔ Solutions are good for longer periods than most other antimicrobials available
- ✔ Speed of killing pathogens is very fast compared to many other antimicrobials
- ✔ Available in many forms, including sprays, concentrates and bulk volumes

Disadvantages

- ⚠ May require a medical license to purchase from some suppliers
- ⚠ May irritate respiratory system if not used in extremely well-ventilated areas
- ⚠ May cause eye, skin or mucous membrane irritation or damage with some brands
- ⚠ May cause skin irritation, yellowing or peeling
- ⚠ Concentrated forms not available in some regions
- ⚠ Some forms/brands of product may be more corrosive/caustic than others - read all labels carefully before using these products

4.7 Iodines

Iodine solutions are frequently used as antiseptics for cleaning wounds and skin. Most iodine-containing disinfectants also contain a detergent, and are called "iodophors".

Brand Names: Aspect, Biocide, Betadyne, Iodo Five, Povidone, Scrubodyne, Vanodine

Advantages

- ✔ Limited vapor production
- ✔ Not usually affected by hard water
- ✔ Long shelf life
- ✔ Works well in hot or cold water
- ✔ Effective against many bacteria, some fungi and viruses

Disadvantages

- ⚠ May stain surfaces and tissues brown
- ⚠ Toxic if ingested (may cause iodine overdose)
- ⚠ May dry and crack skin
- ⚠ Corrosive to metal surfaces with prolonged exposure
- ⚠ Easily deactivated by contact with organic debris
- ⚠ Not effective against hydrophylic viruses such as polyoma
- ⚠ Not effective against all strains of Pseudomonas bacteria

4.8 Phenols

Phenols are produced by coal distillation. Sodium orthophenol is the active ingredient in most phenol disinfectants. Phenols are effective against many bacteria, including Pseudomonas and mycobacteria, fungi and some viruses. They may not work well in the presence of organic material. Some phenols are inexpensive, and are readily available in the marketplace.

Brand Names: Dettol, Birex SE, Discide, Lysol Brand Disinfecting Spray, One Stroke Environ, O-Syl, Sporicidin

Advantages

- ✔ Kills many pathogens, including bacteria such as Salmonella and Pseudomonas, mycobacteria, fungi and lipophilic viruses
- ✔ Effective even in hard water
- ✔ Doesn't stain surfaces or leave residual odors, low cost
- ✔ Easy to rinse off objects

Disadvantages

- ⚠ Toxic to many tissues including skin, eyes, and respiratory tract
- ⚠ VERY toxic to cats and reptiles
- ⚠ may not work well if organic debris is present
- ⚠ Not effective against bacterial spores or hydrophilic viruses
- ⚠ Must be used with adequate ventilation
- ⚠ Must be rinsed off cleaned surfaces before use

4.9 Quaternary Ammonium Compounds

"Quats" are a large class of antimicrobials which add organic compounds to ammonia. Many quats also function as a detergent, and help remove organic debris from objects. The presence of organic debris, however, may deactivate the antimicrobial in the quat compound. Difficult to rinse off completely, and residue can cause respiratory paralysis and even death! Quats are effective

against many types of bacteria, some viruses, and chlamydia; they are not effective against spores, mycobacteria or fungi, Pseudomonas, and hydrophylic viruses such as Polyoma.

Brand Names: Barquat, Cavicide, Cetylcide II, Discide Ultra, Envirocide, Hitor, Merquat, Omega, Parvosol, Quintacide, Roccal-D

Advantages

- ✔ Contains detergent for action against organic debris
- ✔ Pleasant scent in most forms
- ✔ Good antimicrobial against many bacteria, a few viruses, and chlamydia

Disadvantages

- ⚠ Not effective against bacterial spores, Pseudomonas, fungi or mycobacteria, hydrophylic viruses
- ⚠ High levels of organic debris may inactivate the product
- ⚠ Hard water may inactivate the quat product
- ⚠ May leave slimy residue on objects which won't rinse off
- ⚠ Ingestion and inhalation of products or residue may cause respiratory paralysis and even death

4.10 Wood Tar Distillates

Wood tar distillates are a by-product of the lumber industry. They include such products as creosotes, turpentine and pine oils. Pine oils are the only member of this group with any antimicrobial applications, and only when mixed with soap. They are very safe, but have very low levels of effectiveness against any pathogens. Very inexpensive, and readily available in the marketplace.

Brand Names: Pine-Sol, Hexol

Advantages

- ✔ Easily available
- ✔ Low cost
- ✔ Pleasant fragrance
- ✔ Low toxicity
- ✔ Detergent ingredients make them good cleaning products for removing organic debris

Disadvantages

- ⚠ Very poor effectiveness against any pathogens
- ⚠ Hard to rinse off surfaces, may leave floors slick

Fire

Flame is an excellent antimicrobial. Gas torches will kill any known living organism; remember, the solution to cleaning up after epidemics has been to burn down anything that was contaminated! But flame is obviously limited in its uses--it's hard to disinfect wood and plastic objects with flame, and it will often discolor metal surfaces.

Freezing

Freezing temperatures will deactivate some infectious organisms, but many, including viruses will survive. The longer the freezing time, the lower the survival rate for most organisms, but it won't kill everything.

Steam

Pressurized steam directed into cracks and corners is an excellent sterilant. However, it can be costly due to equipment rental/purchase charges. It is best to thoroughly wash all equipment prior to steaming it.

Soaps/Detergents

Soaps and detergents do not disinfect. But they help remove surface organic debris so it does not interfere with the function of antimicrobials. Always rinse soap or detergent off completely before disinfecting, and never mix with other antimicrobial products unless the instructions specifically state that it is safe. Avoid oral ingestion of these products, as they can cause intestinal upset, and can irritate mucous membranes.

5. Background

Silver (Ag) has an atomic number of 47. It is the 47th element in the periodic table by atomic weight and contains 47 electrons. It has four filled valence shells and a fifth shell with one electron. In fluids, silver can exist in four basic forms - as a compound, a neutral particle (as in ground silver), a negatively charged aggregate (particle), and a positively charged ion.

While silver's importance as a bactericide has been documented only since the late 1800s, its use in purification has been known throughout the ages. Silver has been used as a medicine and preservative by many cultures throughout history. Early records indicate that the Phoenicians and Greeks used silver vessels to keep water, wine and vinegar pure during their long voyages. In ancient Greece, Rome, Phoenicia and Macedonia, silver was used extensively to control infections and spoilage.

It is widely thought that during the Middle Ages, silver utensils and goblets may have contributed to health as well as wealth. The wealthy were noted to have obtained a measure of protection from the rampant plagues common to Europe in those centuries. The use of silver to provide bacteria-free tableware, pacifiers and storage vessels has been practiced throughout history.

Pioneers of the American West would drop silver coins in their barrels of drinking water to combat bacteria and algae. Settlers in the Australian outback still suspend silverware in their water tanks to retard spoilage.

During the wars with Napoleon, the armies of Tsar Alexander used water casks lined with silver to clean drinking water from rivers and streams. This practice by the Imperial Russian army was common through World War I and continued to be incorporated by some units in the Soviet Army during World War II.

Throughout the last centuries silver has been used as an antimicrobial agent and the efficacy and safety of silver has been well established. In 1861, Thomas Graham found that certain solutions would pass through a membrane and others would not. Graham found a stable, intermediate state of matter and was able to describe it.

Graham discovered that substances could enter a solution in such a manner that they would exhibit characteristics quite different from those of a true solution. He applied the term "colloidal" (from kolla = glue) to this intermediate state, since glue, gelatin, and related substances were the most obvious to him as being in this unique state.

The Swiss botanist von Nageli recorded one of the amazing discoveries of the 19th Century in 1869. Von Nageli coined the term "oligodynamic" to describe the microbiocidal properties of a metal hydrosol (solution) at minute concentrations. In the same year, Raulin recorded the first clinical description

of the water-cleansing effect by silver. He observed that Aspergillus niger could not grow in silver vessels.

By 1910, Henry Crookes had documented that certain metals, when in a colloidal state, had strong germicidal action, but were harmless to human beings. Silver solutions were approved in the 1920s by the US Food and Drug Administration for use as antibacterial agents. Specifically silver sulfadiazine is used by every hospital in North America to prevent bacterial infections in burn victims and allow the body to restore naturally the burnt tissue. It is used worldwide under the trade name "Silvadiene."

Increasingly, wound dressings and other wound care products incorporate a layer of fabric containing silver for prevention of secondary infections. Hospitals and other medical facilities use climate control system components and ductwork with a coating containing silver to prevent the transmission of bacteria that cause Legionnaires disease. Surgical gowns and draperies include silver to prevent microbial transmission. Other medical products containing silver are catheters and stethoscope diaphragms. Silver is being increasingly tapped for its biocidal properties.

Research initiated in the 1990's by the Chinese government through the Department of Materials Science and Engineering, Tsinghua University, Beijing, studied the reaction between bacteria and silver ions. Their goal was to develop an effective antiseptic that would sanitize almost any surface. They developed a silver / zircon phosphate complex that proved to be an excellent disinfectant with stable, long-term sterilization effects. This silver complex also maintained perfect safety with no toxicity to humans. The Science and Technology Ministry of China certified the new antimicrobial as a "National Key New Product".

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