What are the properties of silver ($Ag_{(n)}^{1+}$ or Ag^{1+}) and its methods of action?

- Promotes accelerated wound healing while improving cosmetic appearance on recovery (no scarring)[1]
- Positive effects exerted through antimicrobial properties, reduction in wound inflammation, and modulation of fibrogenic cytokines[1]
- In human physiology, silver plays an important role. It is literally an essential trace element for the peripheral nervous system. Science has now identified receptor sites for silver in myelin neural tissue.[2] [3]
- Positive silver ions stimulates de-differentiation and redifferentiation of stem cells in vivo, accelerating healthy regenerative events wherever there is inflammation, infection or injury.[4]
- Oligodynamic silver improves the body's internal colloidal milieu by facilitating oxidative reactions central to immunity.[5] [6] [7]

What are the antimicrobial properties of silver?

Like bacteria and fungi, infectious viral organisms may have multiple susceptibilities when encountering oligodynamic Ag^{1+}. On the other hand, evidence suggests that oligodynamic Ag^{1+} will not interfere with normal white blood cell (WBC) activity, and may even enhance WBC activity.[8] [9] Feng et al.[10] concluded that oligodynamic Ag^{1+} offered profound immune benefits because of its ability to intervene with select bacteria in three key ways almost simultaneously. Central to all three is the ability of oligodynamic Ag1 to denature (dose-dependent permanent inactivation) essential microorganisms' protein and DNA:

1. One type of essential protein maintains the integrity of the cell's membranes and boundaries. Once the membranes become unstable, the cell begins to rupture.
2. Simultaneously, the smallest sizes of Ag^{1+} may more easily penetrate the membrane pores of the bacteria. Once penetration occurs, life-essential enzyme reactions governing cell metabolism go into partial or full arrest.
3. As the silver further penetrates the most interior recesses of the cell, the genetic building blocks (nucleic acids) of the germs are paralyzed, ending the ability of the invaders to replicate.

How does silver eradicate bacteria, viruses and fungus?

- Ag^{1+} at the nano and picoscale denatures the protein coat of a virus, can penetrate the cell wall of a bacteria and fungus and enter the mitochondria, binding with RNA and DNA rendering them unable to replicate (in the case of viral particles) or reproduce.
- The antiseptic activity of silver compounds results from the reaction of Ag^{1+} with proteins of the microorganism, such as structural proteins and enzymes. Chambers *et al* have shown

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[1] Jun Tian, Dr. *et al.* Topical Delivery of Silver Nanoparticles Promotes Wound Healing 31 Oct 2006 ChemMedChem Vol. 2 Issue 1, P. 129-136
[2] Gallyas, F., "Physico-Chemical Mechanism of the Argyrophil I Reaction," *Histochemistry* (1982) 74:393.
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[4] Becker, RO, "Induced De-differentiation; A Possible Alternative to Embryonic Stem Cell Transplants." *Neurorehabilitation* 17 (2002):23-31.
[5] Gan X, Liu T, Zhong J, Liu X, Li G. Effect of silver nanoparticles on the electron transfer reactivity and the catalytic activity of myoglobin. Chembiochem. 2004 Dec 3;5(12):1686-91.
[6] Samuni A, et al. On the Cytotoxicity of Vitamin C and metal ions. Eur J Biochem. 1983;99:562.
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[9] Jansson G, Harms-Ringdahl M. Stimulating effects of mercuris and silver ions on the superoxide anion production in human polymorphonuclear leukocytes. Free Radic Res Commun 1993; 18(2):87–98.
[10] Feng QL, Wu J, Chen GO, et al. A mechanistic study of the antibacterial effect of silver ions on Escherichia coli and Staphylococcus aureus. J Biomed Mater Res 2000; 52: 662–8.

that the activity of a specified amount of silver is related to the concentration of Ag^{1+} ion, which is in an unbound state, rather than to the chemical or physical nature of its source.[11]

- With all prokaryotes, there is a destructive translocation of silver hydrosol particles through their biological membrane or cell wall. There is a destructive translocation of silver hydrosol particles across some simple eukaryotes of various fungal species. The Zeta potential of Ag_n^{1+} in the organized water molecules contributes to an electroporation event, which further destabilizes the bacterial cell wall.[12]
- Silver (Ag^{1+}) ions have been tested extensively for their antibacterial efficacy on both gram negative and gram positive bacteria.[13]
- Feng *et al* were able to elaborate on the changes in bacteria via x-ray microanalysis and the inactivation of DNA replication in these bacteria.[14]

What form or species of silver is its true active state?

Positive silver ions (Ag^{1+}or Ag_n^{1+}) are the only active state of silver for use within the body. Acél[15] was perhaps the first to observe that the oligodynamic action of silver was due to liberated Ag^{1+} as opposed to metallic (neutral) Ag. Eichorn *et al*[16] emphasized that the charge significantly facilitates electron displacement. The Ag^{1+} structure of silver hydrosol has been shown to have the greatest antimicrobial activity at or near the picoscalar level[17] due to the fact that it enjoys the greatest surface presentation (~6km^2 per gram Ag).[18]

Why is Particle Charge important in the action of silver hydrosol?

The term oligodynamic is only applicable to extremely low concentrations of metal ions (Ag^{1+}). Ace´l[19] was perhaps the first to observe that the oligodynamic action of silver was due to liberated Ag^{1+} as opposed to metallic (neutral) Ag. Eichorn et al.[20] emphasized that the charge significantly facilitates electron displacement. The oligodynamic metal charge effectively yanks electrons away from a molecule, in essence weakening the molecular bond and rendering it susceptible to cleavage. Goetz[21] observed that silver is microcidal only if it is in the ionic state, and this was later characterized further by Rochart and Uzdins[22] [59] who observed that cells selectively bond only with Ag^{1+}.

What is the metabolic pathway of elimination?

The normal physiologic pathway in humans and animals for the metabolism and elimination of ingested silver occurs in phase II liver glutathione conjugation, which leads to normal excretion as solid waste through the colon.[23]

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