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Commentary

Molecular Structure and Antibiotic Activity of Streptomycin

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DESCRIPTION

Streptomycin was the first antibiotic discovered to treat Tuberculosis, but scientists did not fully understand how it functions at the molecular level until recently. They knew streptomycin inhibits a vital step, protein synthesis by ribosomes, which leads to bacterial cell death, but some characteristics of the interaction remained unknown. Streptomycin belongs to a class of antibiotics that functions by interfering with the activity of ribosomes, the complex molecular mechanism that binds amino acids together to form proteins in bacterium cells. Streptomycin is a bactericidal antibiotic with a wide range. It kills both gram-positive and gram-negative bacteria. Streptomycin inhibits various Mycobacterium species and is an effective antibiotic for TB caused by M. *tuberculosis*. Streptomycin is hazardous to humans and other animals, causing allergic reactions, hearing loss, nausea, and kidney damage. Highly pure streptomycin is harmless when administered in tiny quantities, but it appears to have a cumulative negative effect on the nervous system when used as a drug over time. Streptomycin is classified as an aminoglycoside antibiotic. It is consisting of three components that are linked glycosidically. Streptidine (inositol with two guanidino groups), Streptose (methyl pentose), and Streptoscamine (N-methyl-L-glycosamine). Both guanidino groups of streptavidin are required for antibiotic action, and removing one group lowers antibiotic activity by up to 90%.

Ribosomes, which are a major target for antibiotics that work by inhibiting protein synthesis, are composed of two major portions, or subunits. The larger subunit builds the protein, directed by a specific type of RNA known as messenger RNA (mRNA), which binds to it. The tiny subunit "reads" the mRNA and identifies the corresponding Transfer RNA (tRNA) molecule, which identifies and delivers the next amino acid to the ribosome. This is where streptomycin shows its action. It attaches near to the tiny subunit, leading it to read the sequence incorrectly. This causes the bacteria to produce random proteins, which eventually kill them. The researchers created numerous detailed "photographs" of the interaction by producing an ordered structure of identical units. The small ribosomal subunit coupled to mRNA in the presence of streptomycin, finally shows how streptomycin affects the subunit's function. They employed an x-ray crystallography technique at NSLS beamline X25, in which an x-ray beam is directed towards the crystal, interacts with the molecules, and produces a complicated diffraction pattern. The scientists used computer software to create visual representations of the subunit-mRNA-streptomycin complex based on the pattern. As a result of all of these minor alterations, streptomycin destabilizes the subunit's binding to the right tRNA while concurrently stabilizing the subunit's binding to the wrong tRNA, essentially erasing the distinction between the correct and incorrect tRNA. This disrupts the bacterial supply chain for new proteins, interfering with bacterial reproduction and the life cycle.

Streptomycin-susceptible bacteria can become resistant to the antibiotic by a single-step mutation, according to recent studies. This mutation causes a structural change in the 30S subunit, resulting in a lack of affinity for streptomycin, preventing the antibiotic from binding to its recognition site and inhibiting protein synthesis. Streptomycin dependency is a very intriguing discovery observed in several streptomycin-resistant mutants. Streptomycin dependency is hypothesized to emerge as a result of another mutation that produces an opposite deformation of the 305 subunit's recognition site. Protein synthesis in streptomycin-dependent mutants of bacterial pathogens fails in the absence of streptomycin.

CONCLUSION

Streptomycin is injected into a muscle. A healthcare practitioner can educate on how to use the drug appropriately on their own. Other drugs may be prescribed to help treat the infection. Streptomycin does not treat viral infections like the flu or the common cold. Streptomycin can cause the following serious side effects: headache, nausea, vomiting; severe dizziness, spinning sensation, balance problems; hearing loss, a feeling of fullness in your ears, and a ringing or roaring sound in your ears (during or after streptomycin treatment); vision problems, eye pain; memory or concentration problems, changes in personality or behavior; muscle weakness, weak or shallow breathing; tremors, muscle twitching, seizure; pain, numbness.

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