Nanoparticles make eye drops more effective

Drops are a common way of applying drugs for treating a wide range of eye diseases. Most of us have used eye drops at least once in our lives, but we are not usually aware that even if the drops are applied correctly, only one percent of the drug reaches the eye. The rest is flushed out by eyelid movement or with tear fluid. So very high drug concentrations are needed, and the downside of this is that it can cause substantial adverse effects. Research teams from the Universities of Tübingen and Groningen (Netherlands) have joined forces in a project called “nano-I-drops” and have developed DNA nanoparticles with a high affinity to the cornea, thus improving compliance and making most standard eye drugs more effective.

Dr. Sven Schnichels and his team from the University Eye Hospital in Tübingen have been working for a long time to find out whether nanoparticles can be used as carriers for drugs used to treat eye diseases. They were initially interested in this particular issue because 95 to 99 percent of drugs in eye drops are washed out of the eye by tear fluid and eyelid movement, irrespective of whether they are correctly applied or not. Only about one percent of the drug remains on the eye or enters the eye. Consequently, eye drops have to be highly concentrated and administered very frequently. "Some patients may have to use eye drops four times a day, along with tear substitutes eight times a day in some cases. Most patients find this difficult," says Schnichels, adding: "Eye drops therefore usually contain fairly high drug concentrations to compensate for the short retention time and ensure a greater effect." This often leads to adverse effects, ranging from simple irritations to life-threatening anaphylactic shocks in extreme cases. Some potent medicines have not even been brought to market because of the danger involved.
Researchers and physicians from the University Eye Hospital in Tübingen have therefore been looking for alternatives to conventional eye drops. Using nanoparticles has turned out a promising approach for improving compliance and drug effect. It was Prof. Dr. Andreas Herrmann, director of the Department of Polymer Chemistry at the Zernike Institute for Advanced Materials at the University of Groningen, who came up with the idea of using nanoparticles as drug carriers. Herrmann and his group have engineered nanoparticles from a broad range of biological materials.

Lipid DNA nanoparticles are loaded with drugs

Nanoparticles can be made of many different materials and are just one to one hundred nanometres in diameter: size-wise, they are to a football what a football is to the earth. Nanoparticles themselves have no therapeutic function; they are simply a vehicle for transporting active drug ingredients into the eye. Schnichels and his team were sent various materials by their colleagues in Groningen, and selected the ones with properties they thought were best suited for their purposes. Nanoparticles that consisted of lipid chains and DNA remained in the eye longest. "We tested eight different Lipid-DNA particle types to find out which ones had the optimal lipid and DNA ratios," says Schnichels. Drugs were subsequently linked to the various nanoparticles and their effect tested. This work was carried out jointly by Dr. Schnichels and his Dutch colleague, Dr. Jan Willem de Vries. The two scientists, along with Prof. Herrmann and Prof. Spitzer, have filed a patent for the invention.

Nanoparticle eye drops require less frequent application

Schnichels and de Vries were able to demonstrate that the drug-loaded nanoparticles remained in the eye for up to four hours. "We can thus considerably reduce drug concentration and the drops can be applied less frequently, which, in all probability, generates fewer side effects," says de Vries. Thanks to the universal properties of nanoparticles, the researchers can bind any kind of small molecules to the nanoparticles, including almost all drugs commonly used to treat eye diseases. "The final product looks like ordinary eye drops and feels like water," says the chemist. "Our experimental animals did not blink so often, indicating that the drops were much better tolerated." The scientists are now working on optimising the drugs so that they only need to be applied to the eye once a day.

After these positive results, the nano-I-drops team is now concentrating entirely on developing a drug delivery platform suitable for treating the most common eye diseases: infections, glaucoma
and retinal diseases. "We are not developing any new drugs at the moment, instead we are concentrating on loading nanoparticles with drugs already on the market," says Spitzer. These are then tested on pigs' eyes from abattoirs or human corneal tissue that is not needed for transplantations. And the project has been successful! "We now plan to initiate a large-scale efficiency study on animals with eye diseases. "If these investigations and the subsequent toxicity and stability studies work well, we would like to establish a company to drive forward clinical investigation of the new drug delivery systems," says Schnichels.

BIOPRO supports young company founders under the EXI High-tech Start-up Voucher programme

The team of researchers have had a lot of support as they concentrate on setting up their own company. The German Ministry for Economic Affairs and Energy provided assistance through its EXIST research transfer programme. "This helped us to bring the Groningen and Tübingen teams together," says the biologist, adding: "The EXI High-tech Start-up Vouchers are another excellent source of support." EXI High-tech Start-up Vouchers is a programme jointly offered by bwcon and BIOPRO. "The programme is fantastic," says Schnichels. The vouchers are designed to help people who want to set up their own businesses in high-tech areas and provide access to professional consultation at a preferential rate. BIOPRO Baden-Württemberg is involved in the programme, focussing specifically on support for life sciences companies. The programme supports potential business founders by giving them expert help to further develop their business idea.
"The EXI programme and BIOPRO's support are extremely helpful. For us scientists it is quite hard to find and pay for the services of a good coach. Many issues and challenges arise that scientists do not usually think of, which could lead to mistakes being made. It is good to be guided by an experienced coach," says Schnichels. And he adds: "I recommend everyone to apply for the vouchers at the earliest possible stage."

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- Nanobiotechnology
- company foundation
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- drug application