

Nanoparticles inspired by lung fluid improve therapies targeting respiratory system

A CIC biomaGUNE team has managed to retain 90% of an antifibrotic nanomedicine in the lungs in mice, thereby reducing its side effects

The synthesis method used is simple, automated and reproducible, and opens up new avenues for drug encapsulation and its use in inhaled pulmonary therapy

Donostia. 4 June, 2026. The CIC biomaGUNE Center for Cooperative Research in Biomaterials has developed pulmonary surfactant nanoparticles (the blend of lipids and proteins that lines the alveoli and enables breathing), which are encapsulated in a drug used to treat pulmonary fibrosis. It was shown that these nanoparticles are highly capable of remaining trapped in the diseased tissue after being administered via the pulmonary pathway. This allows the doses of antifibrotic medication to be cut, and thus reduces the potential side effects associated with conventional therapies. Tests carried out on mice display a therapeutic effect on pulmonary fibrosis.

The study, published in the *Advanced Healthcare Materials* journal by the [Molecular and Functional Biomarkers](#) group at CIC biomaGUNE, presents a simple, automated and reproducible synthesis method that ensures effective drug encapsulation, appropriate distribution by particle size and high stability by means of microfluidics, a technique that allows fluids to be managed at microscopic scale with great precision.

Pulmonary fibrosis is a relatively common chronic disease in which lung tissue forms scars in an uncontrolled, progressive way. The most common risk factors include smoking, occupational exposure to dust and chemicals, exposure to drugs such as chemotherapy, or radiotherapy, and viral diseases such as COVID-19. This thickened, stiff tissue prevents the lungs from functioning properly, thus making breathing progressively more difficult. Conventional treatment for pulmonary fibrosis (administered orally) frequently has adverse effects, so there is great interest in improving the treatment.

Although administering drugs via inhalation makes the targeted treatment of the lungs possible, their clinical efficacy is often limited by inflammation, uneven distribution and physiological barriers. "To reduce the side effects caused by drugs used to treat pulmonary fibrosis, the best thing is to target the diseased tissue, directly," explained Dr [Susana Carregal](#), an Ikerbasque Research Fellow. "Inhalation is a very direct way of delivering medicines to the lungs. However, as the lungs are designed to protect themselves against inhaled pathogens, the very mechanisms that help defend the body also make this type of administration through inhalation more complicated."

Further information:
Elhuyar Komunikazio-zerbitzuak
Alaitz Imaz
747 400 121

The power of mimicry

Currently, to ensure that these types of therapies work effectively, there is extensive research that focuses on finding ways of evading the immune system, in other words, so that the lungs cannot recognize the drugs as pathogens or foreign substances, thereby allowing them to reach their target. In this respect, the research team led by Dr. Carregal has developed a biomimetic platform based on pulmonary surfactant nanoparticles “which preserves the native proteins and lipids of the surfactant and its biophysical functionality, thereby improving pulmonary delivery”, said Dr. Carregal, the lead researcher in the study.

“The lung is filled with pulmonary surfactant; this is the interface where the exchange between air and fluid takes place,” she explained. “Encapsulating drugs designed to treat lung diseases in pulmonary surfactant can improve distribution throughout the lung, due to its surface properties. In other words, using an endogenous material can help to ensure that, when administered by inhalation, the drug is distributed more effectively in the lung.”

The CIC biomaGUNE research team has found that “90% of the administered nanomedicine is retained in the lungs in mouse models. Retention is very high, and this means that, with this treatment, the amount of drug reaching the liver is much lower than with conventional treatments, thereby reducing the side effects,” pointed out Carregal. It is important for a drug to act only where it should, in order to reduce the dose administered as well as the side effects.

The synthesis method developed at CIC biomaGUNE has the potential to drive forward the use of inhaled medicines. “The synthesis of these nanoparticles has been greatly simplified and can help standardize the product, as it produces materials or nanomedicines with a highly controlled size and direct encapsulation of the drug. It is a highly homogeneous and reproducible system. It opens up new avenues for developing inhaled treatments for lung diseases,” said Dr Carregal.

This study, carried out by the research group led by the Ikerbasque Research Professor [Jesús Ruiz-Cabello](#), involved collaboration with the team from the Department of Biochemistry and Molecular Biology, led by Professor Jesús Pérez-Gil, at the Complutense University of Madrid.

About CIC biomaGUNE

The Center for Cooperative Research in Biomaterials [CIC biomaGUNE](#), member of the Basque Research and Technology Alliance ([BRTA](#)), is a not-for-profit research center located in Donostia. It conducts state-of-the-art research at the interface between Chemistry, Biology and Physics, devoting particular attention to studying the properties of biological nanostructures at the molecular scale, and their biomedical applications. It was recognized in 2018 as a “María de Maeztu” Unit of Excellence for meeting requirements of excellence, which are characterized by a high impact and degree of competitiveness in its field of activity on the global scientific stage.

Further information:
Elhuyar Komunikazio-zerbitzuak
Alaitz Imaz
747 400 121

Bibliographic reference

Laura Fernández-Méndez, Marina Piñol-Cancer, Itziar Souto-Riobó, Ainhize Urkola-Arsuaga, Elena González-Lozano, Irene Fernández-Folgueral, Claudia Miranda-Pérez de Alejo, Mikel Azkargorta, Felix Elortza, Alberto Tagliaferro-Quiñonero, Desire Di Silvio, Olga Cañadas, Jon Maiz, Jesús Pérez-Gil, Pedro Ramos-Cabrer, Jesús Ruíz-Cabello, Susana Carregal-Romero

Pulmonary Surfactant Nanoparticles for Lung-Targeted and Dose-Efficient Delivery

Advanced Healthcare Materials

DOI: [10.1002/adhm.202505871](https://doi.org/10.1002/adhm.202505871)