Oxygen nanocarriers to help phototherapy combat tumors

Drug nanocarriers are created to deliver oxygen to the tumor in order to enhance the efficiency of phototherapy by increasing oxygen availability for therapy in solid cancers

The European OXIGENATED project, led by CIC biomaGUNE Research Professor Sergio Moya, has been recognized as a success story by the European Commission

Donostia-San Sebastian. 13 April, 2023. The effectiveness of photodynamic therapy is limited by the lack of oxygen in solid cancers. Now, researchers in the OXIGENATED EU-funded (€920,000) project, led by the CIC biomaGUNE research professor Sergio Moya, have created drug nanocarriers to deliver oxygen to the tumor. This strategy could improve the effectiveness of photodynamic therapy and contribute toward making the therapy more efficient in cancer patients. The project has also been recognized as a success story by the European Commission.

Photodynamic therapy (PDT) combines light with a photosensitive organic molecule known as a photosensitizer. “When photosensitizers are administered to a tumor and irradiated with light, they transfer energy to the oxygen,” explained the OXIGENATED project coordinator Sergio Moya. “This can induce a series of reactions that bring about the destruction of malignant cells and activate the immune system.” All of this can lead to the eradication of the tumor.

A key advantage of PDT is that it is highly specific. When light and photosensitizers are restricted to the tumor, much of the collateral damage to healthy tissue in other regions of the body can be avoided. However, the presence of oxygen is essential for PDT to be successful. “The difficulty here is that tumors are often characterized by limited oxygen availability,” said Moya. “If we could increase the availability of oxygen for the photosensitizer action, we could enhance the outcome of PDT.”

New ways of transporting oxygen

This was the main objective of the OXIGENATED project, launched in March 2019 and run with support from the Marie Skłodowska-Curie Actions program. “Our goal from the start was to find a new way of transporting both oxygen and photosensitizers to the malignant tumor,” as Moya pointed out. “We saw that when the availability of oxygen was increased in the environment of the photosynthesizing agent in order to initiate oxidation reactions, the effectiveness of photodynamic therapy would improve.”

To achieve this goal, the project team developed nanoparticles based on hemoglobin, the proteins present in erythrocytes or red blood cells responsible for naturally transporting oxygen throughout the body. Unmodified hemoglobin cannot be administered directly into the body, as it

may cause side effects. As Moya explained, “That is why our work has involved the design of nanoparticles with hemoglobin cores, which could be used to deliver oxygen safely and without unwanted effects.”

The team managed to trap hemoglobin in polymeric or protein matrixes, a technique that has been shown to prevent exposure of hemoglobin in the bloodstream while preserving its ability to carry and deliver oxygen.

Boosting non-invasive techniques to treat cancer

By making PDT more effective, Moya and his team hope to offer an attractive alternative to chemotherapy and other more aggressive anti-neoplastic methods. The project, scheduled for completion in August 2024, has already demonstrated that this is eminently possible. Until now, experiments have been carried out using *in vitro* cell cultures,” added Moya. “In the next phase of the project, we will conduct them *in vivo* as proof-of-concept to demonstrate the functionality of these nanoparticles.” Effective, minimally aggressive treatments, such as optimized photodynamic therapy, will not only improve clinical outcomes and quality of life for cancer patients, but will also reduce the financial burden on healthcare systems.

Through international exchanges and the participation of young researchers, the project has sought to ensure the long-term continuity of research in this promising field. “With the relaxation of restrictions due to COVID-19, we have been able to quickly resume researcher exchanges,” said Moya. “In the coming months, more researchers will be able to benefit from working abroad, while the project's main objective, which is to demonstrate the effectiveness of this new technique, will continue to be addressed.”

About CIC biomaGUNE

The Center for Cooperative Research in Biomaterials CIC biomaGUNE, member of the Basque Research and Technology Alliance (BRTA), conducts state-of-the-art research at the interface between Chemistry, Biology and Physics, devoting particular attention to studying the properties of biological nanostructures on a 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 level of competitiveness in its field of activity on the global scientific stage.