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RESEARCH

- **Title:**

Design of extracorporeal detoxification stages by advanced simulation techniques

- **Description:**

The use of microfluidic devices and functionalized magnetic beads for extracorporeal toxin removal from flowing blood could prove to be a promising therapy for infectious illness patients. Due to the magnetic properties of the particles, once the target component is captured, their separation from the background stream can be performed in a continuous process using an external magnetic field. The suitable design of this system entails the maximization of toxin extraction while maintaining blood quality. For these requirements, several tasks must be fulfilled, which can be addressed by advanced simulation techniques:

- Selection of the material to functionalize the magnetic nanoparticles, i.e, one with high selectivity and affinity to the target as well as high capture capacity
- Determination of the geometry and dimensions of both the incubation and the separation stages to optimize toxin removal from blood
- Selection and location of the magnet to maximize particle recovery

Molecular Dynamics simulations can be employed for screening between potential candidates for particle functionalization and in the design of the incubation stage, while Computational Fluid Dynamics facilitates the design of both stages from a fluidodynamic point of view, as well as the maximization of the magnetic particle recovery.

- **Publications:**

J. Gómez-Pastora, C. González-Fernández, E. Real, A. Iles, E. Bringas, E.P Furlani and I. Ortiz. Computational modeling and fluorescence microscopy characterization of a two-phase magnetophoretic microsystem for continuous-flow blood detoxification, Lab on a Chip, 18, 1593-1606 (2018).

J. Gómez-Pastora, C. González-Fernández, M. Fallanza, E. Bringas and I. Ortiz. Flow patterns and mass transfer performance of miscible liquid-liquid flows in various

microchannels: Numerical and experimental studies, Chemical Engineering Journal, 344, 487-497 (2018).

J. Gómez-Pastora, C. González-Fernández, I.H. Karampelas, E. Bringas, E.P. Furlani and I. Ortiz. Design of Magnetic Blood Cleansing Microdevices through experimentally validated CFD modeling, TechConnect Briefs, Biotech, Biomaterials and Biomedical, 3, 170-173 (2018).

- **Congress contributions:**

J. Gómez-Pastora, C. González-Fernández, I.H. Karampelas, E. Bringas, E.P. Furlani, I.Ortiz. Design of magnetic blood cleansing microdevices through experimentally validated CFD modeling. Nanotech 2018 Conference & Expo, May 13-16, 2018, Anaheim (USA). Oral presentation.

J. Gómez-Pastora, C. González, J. Ramos-Vivas, E.P. Furlani, E. Bringas, I. Ortiz. Innovative microdevice for extracorporeal sepsis treatment. VI Doctorate Days and Scientific Dissemination of Group 9 of Universities (G-9), April 11-13, 2018, Santander (Spain). Poster presentation.

J. Gómez-Pastora, C. González-Fernández, A. Basauri, M. Fallanza, E. Bringas and I. Ortiz. Contribution to the design of magnetic blood cleansing microdevices. 10th World Congress of Chemical Engineering, October 1-5, 2017, Barcelona (Spain). Oral presentation.

C. González-Fernández, J. Gómez-Pastora, E. Bringas and I. Ortiz. Development of microfluidic-magnetophoretic devices for gram-negative sepsis treatment. 10th World Congress of Chemical Engineering, October 1-5, 2017, Barcelona (Spain). Poster presentation.

J. Gómez-Pastora, C. González-Fernández, A. Basauri, M. Fallanza, E. Bringas and I. Ortiz. Design and optimization of a multiphase microfluidic device for magnetic bead separation from biofluids. VII International Conference on Coupled Problems in Science and Engineering, June 12-14, 2017, Rhodes Island (Greece). Oral presentation.

- **R&D Projects:**

Title: Advanced separation applications. Mathematical modeling and proof of concept (CTQ2015-66078-R).
Participant entities: Ministry of Economy and Competitiveness
Duration, since 01/01/2016 to 31/12/2018.
Main researcher: Inmaculada Ortiz