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Bio-electronic Cell Based Implant for Multiple Sclerosis Treatment

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The implementation of electronic systems in the human body has led to numerous medical progresses. New emerging therapies invest in this area supporting advances and benefits stemming from genetics and cell-based therapy for addressing unmet needs for the caregivers and the patient. The present device developed within the framework of Optogenerapy Project represents an innovative and effective therapeutic delivery with an impact on slowing the disease progression and increasing the Multiple Sclerosis patients' quality of life. This implant is based on wireless powered optogenetics technology which combines genetics and optics techniques to control and monitor activities of cells in a living tissue with light to directly and remotely control cells using Near Infrared Light (NIR) to produce themselves the necessary IFN- β drug. The cells are confined within a chamber sealed by a porous membrane for safe drug release, replacing standard intravenous IFN- β delivery by subcutaneous delivery prevents the side effects of current cellular therapies and efficiency-losses related to drug peaks and discontinuation, while saving non-adherence costs.

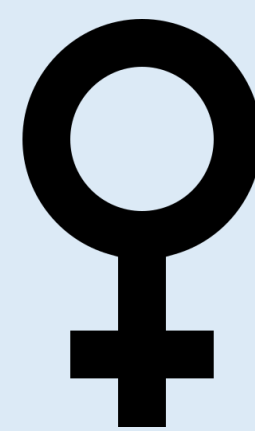
The technology developed in this work can be used as a multifunctional platform to revolutionize the therapeutic protein delivery in several clinical conditions focusing on the emerging field of theranostics.

Multiple sclerosis

Multiple sclerosis is a chronic disease in which the body's immune system attacks myelin forming scar tissue (sclerosis) and distorting or interrupting the nerve impulses travelling to and from the brain and spinal cord. This can lead to a wide range of symptoms including muscle atrophy, lack of coordination, cognitive impairment, dysphagia, fatigue, incontinence, vision loss and hyperalgesia among others. In many countries is the leading cause of non-traumatic disability in young adults affecting most frequently people between the ages of 20 and 40. Treatments attempt to improve function after an attack and prevent new attacks. Therapy with **interferon beta** leads to a reduction of neuron inflammation.



2.3 million people affected worldwide



2/3 of the people affected are women



MS disease-modifying therapies market to reach \$25 billion by 2026

Consortium

The therapeutic optogenetic cell-line are developed (ETHZ and INSERM) for long term delivery of a recombinant glycosylated form of IFN- β . Manufacturing aspects of the implant integrating the cell chamber, the optoelectronics and the injection moulding are addressed (EURECAT, BOSTON SCIENTIFIC) together with the suitable sterilization protocol (TUL, Lodz University of Technology) including materials modelling and a clear business case for exploitation (BOSTON SCIENTIFIC).

Concept

Optoelectronics module
A micro-power energy harvesting antenna and rectifying circuit controlling a NIR-LED, packaged in long term hermetic and stable material and then embedded in moulded polymer

Drug delivery cell chamber

Composed of a frame of biocompatible optical polymer with the upper and lower surfaces closed by flat membranes, and a lateral filling port to load cells in the cell chamber.

Goal

The Optogenerapy team will use **optogenetics** technology to develop an implant with light-sensitive cells with the mission to create and release IFN- β protein once activated by light.

Benefits

Save the costs of non-adherence to the healthcare system: direct and indirect

Reliable **ON/OFF switch** to externally start and interrupt the drug delivery

Steady drug flow eliminating drug peaks

Cell-produced IFN- β **not causing immune reaction** in the long-term.

Electromagnetic antenna: the external controller device to activate the electronics encapsulated in the implant by electromagnetic energy. It is related to the matching circuit and acts as the secondary coil to collect the generated signal by emitter plate.

Optoelectronic unit: compact and flexible low-resistance screen-printed NFC antennas of high quality factor, as well as the footprint and interconnections, on which the components are hybridized electronic which controls the generation of the IFN- β drug

The Functional Printing & Embedded Devices Department at Eurecat is in charge of designing the flexible optoelectronic module of the implant



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