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Stem cell photostimulation mediated by organic bio-interface

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Optical modulation of living cells activity by light-absorbing exogenous materials is gaining increasing interest, due to the possibility both to achieve high spatial and temporal resolution with a minimally invasive and reversible technique. In this context, conjugated polymers represent ideal candidates for photo-transduction, due to their excellent optoelectronic and biocompatibility properties.

In this work, we consider a well-established polymer, i.e., poly(3-hexylthiophene) (P3HT). We use it in the form of a thin film, as a cell culturing and stimulating substrate for human adipose stem cells (hASCs). ASCs are a subset of mesenchymal stem cells (MSCs) that can be obtained easily from adipose tissues and possess many of the same regenerative properties as other MSCs, including the capacity to differentiate into multiple cell lineages, offering the potential to repair, maintain, or enhance various tissues.1 In particular, a link between differentiation and intracellular calcium modulation is known from literature.2

Here, we successfully seed hASCs on top of P3HT substrates and we investigate their possible use as biocompatible, cell culturing substrates. Proliferation assays confirm the good biocompatibility properties of the substrates as compared to controls. We carry out patch clamp experiments, both in voltage- and in current-clamp configuration, and we observe a change of the cell membrane potential triggered by optical excitation of the polymer (both depolarizing and hyperpolarizing, depending on the stimuli duration). Moreover, we study the effect of prolonged, pulsed photostimulation (light pulses of 400 ms and 20 ms, followed by 4000 ms and 200 ms recovery in dark, respectively, repeated for 6 hours) on intracellular calcium dynamics. Interestingly, we observe an increase in the intracellular calcium concentration, deterministically related to polymer photoexcitation, together with an enhanced responsivity of cells plated on polymer substrates.
Our results represent a first step in the use of light stimuli for controlling stem cells physiological pathways, and may reveal themselves interesting for optical modulation of differentiation or stemness maintenance.

References

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