Project Details	
Project Code	MRC22NMHBa Reis
Title	Implantable microchips for real-time monitoring of endocrine disorders
Research Theme	Neuroscience & Mental Health
Summary	Measuring endocrine hormones is very challenging as the level of these hormones in blood can change very rapidly. This limits the ability to correctly diagnose patients with endocrine disorders and to research the interlinks between endocrine system, stress response and onset of chronic diseases. This project will use novel supramolecular chemistry embedded in a novel microchip to enable non-invasive real-time monitoring of key endocrine hormones.
Description	Decades of intense research on neurophysiology and psychology identified the mechanisms of response to stress. The theory of "allostatic load" suggests an accumulated physiological 'wear and tear' leading to dysregulation and poor health. Current procedures for measuring endocrine hormones and inflammatory cytokines are too laborious relying on expensive and bulky sophisticated lab equipment and complex sample preparation. We hypothesise that an implantable microchip would offer real-time monitoring of hormones and inflammatory biomarkers with the assistance of a smartphone, speeding up diagnosis of endocrine disorders; reducing cost of intervention for patients undergoing therapeutics; enabling health psychologists to make more rational decisions; enabling neuroendocrine researchers to study more effectively the links of neuroendocrine system with chronic diseases; and providing clinically important information in areas of the world with poor laboratory services. This project brings together a world-class supervisory team from Biomedical Engineering, Neuroendocrinology, Supermolecular Chemistry and Health Psychology with a track record of supervision of multidisciplinary research projects for delivering a transformative biosensing methodology tuned to Neurosciences and Mental Health. The project would suit a creative student with background in Biomedical Sciences, Chemistry, Chemical Engineering, Biomedical Engineering or any other relevant science, interested in working in the leading frontiers of novel biosensing applied to the understanding of mechanism of nervous system diseases. To validate the research hypotheses, the project will focus on 3 main activities: 1. Supramolecular chemistry: We will synthesise and screen new biosensing reporter molecules generating a signal through one-step quantitation of hormones. We will prioritise 'switch-on' fluorescence reporters that can be easily incorporated in a disposable device and provide optimum signal-to-noise ratio; however a 'switch-off' reporter can be incorporated into non-invasive devices (e.g. a patch for continuous monitoring of hormone from sweat). The targeted hormones and biomarker's panel will be based on a SWOT analysis, NHS statistics data and expertise of supervisory team, but the initial focus will be a bioassay for quantitation of cortisol and C-reactive protein. We will characterise the probes using molecular and spectrophotometer imaging techniques and in-flow NMR. 2. Implantable microchips: We will integrate the new bioassays into implantable microchips. The design of the devices will be driven by the targeted sample to be measured and sensitivity of the test, as hormones are present at very distinct

	concentrations in different human body fluids. For example, the "Lab-on-a-stick" approach pioneered by Reis et al (Lab on a Chip, 2016) can be quickly adapted to one-step quantitation of hormones from saliva, urine and a finger-prick, and other microchip devices implantable or embedded within a 'skin patch' will be fast-prototyped for quantitation from sweat, for which a microfluidic device embedded within a 'skin patch'. We will access state-of-the-art nano- and micro-fabrication facility, surface characterisation and microscopy and imaging facilities. Manufacturing and performance of the devices can be assisted by CAD and Computational Fluid Dynamics (CFD) simulation tools, depending on the interests of the candidate. Optical and fluorescence imaging including confocal microscopy are all available on-site. 3. Gathering proof-of-concept data in neurophysiology and health psychology: We aim at testing the methodology in endocrinology and health psychology, and benchmark against current bioanalytical methodologies (ELISA and MS). This will include testing the methodology with healthy patient samples and carry out testing in a small group of volunteers in order to deliver impact during the time scale of the PhD project.
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