Wireless Monitoring System For Cell Culture Processes
Abdel Hafiz M Rabi1, Melissa L Mather1, David E Morris1, Amit Chandra2, John A Crowe1
Corresponding Author: john.crowe@nottingham.ac.uk
1Electrical Systems and Optics Research Division, University of Nottingham, Nottingham, UK, 2Centre for Biological Engineering, Loughborough University, Loughborough, UK.

Introduction
Cellular feedstocks are at the core of many regenerative therapies. For a therapeutic effect vast numbers of high quality cells are required. Currently, cell culture processes are used to expand cell numbers. This is a complicated process particularly due to the sensitivity of cells to their environmental conditions. The design and consistency of cell culture processes would benefit significantly from in-process monitoring of key environmental parameters such as temperature, humidity, carbon dioxide (CO₂), oxygen (O₂) and vibration. This work describes the development and use of a wireless monitoring system capable of in-process sensing in a cell culture environment.

Materials and Methods
The device was designed to be integrated into commercially available culture vessels, including a T-175 culture flask and a 6 well culture plate. An integrated circuit was fabricated to incorporate commercially available sensors (temperature, humidity, CO₂, O₂ accelerometer, gyroscope). Wireless data transfer was achieved through use of a Jennic Zigbee system. The device was interfaced with a computer to enable the sensing protocol to be customised remotely. The device was then placed in an incubator and used to monitor the environmental conditions.

Results
The effect of opening the incubator door on temperature, humidity, CO₂ and O₂ can be seen through inspection of Figure 1. The figure shows that the environmental conditions were stable prior to the door being opened. The door was first opened for 30 seconds which can be seen by a sharp drop in temperature, humidity and CO₂ and a rise in O₂. The incubator was then left shut for several hours. Results show humidity took approximately 3 hours to recover, temperature 10 minutes, CO₂ 30 minutes and O₂ 20 minutes. This effect was found to be repeatable when the incubator door was again opened. The device was also used to monitor the vibrations experienced by the flask whilst stationary in the incubator and also whilst undergoing standard maneuvers used in cell culture including shaking and swirling.

Fig. 1. The effect of opening the incubator door on environmental parameters.

Discussion and Conclusions
The device developed enables quantitative monitoring of environmental parameters during cells culture processes. This will be of significant value to both research scientists and manufacturers of cell-based products as it will aid in the optimisation of cell culture protocols and overall improve product quality.

References

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