UGRL Scholarship Learning Contract

This document provides the framework for the project to be undertaken by the UGRL Scholar. It provides an outline of the larger research project to which the Scholar will contribute and the detail of that contribution, including timing, duties, outcomes and supervision arrangements.

It will be considered by the Faculty/School Scholarship Committee and if a Scholarship is awarded for the project should be signed by the Faculty Academic Lead, the project supervisor and the scholar.

1. **Title of Overarching Research Project**: Human Clinical Cardiac Electrophysiology
2. **Research Project Leader:** Arun Holden
3. **Scholarship Project Supervisor:** Arun Holden
4. **Working title of Scholarship Project:** Analysis and modelling of human cardiac electrophysiology
5. **Period of Scholarship Project Work** *(see note i)***:** 6 Weeks FTE during each summer vacations of 2016 and 2017, not necessarily in one block, and dates flexible. Ideally, will include European Working Group on Cellular Cardiac Electrophysiology meeting in (probably end of June) 2017, or Computing in Cardiology Sep 2017.
6. **Summary of the research to which the Scholar will contribute (200 words):** We have developed a series of cardiac cell, tissue, chamber and whole heart computational electrophysiology models that have been adapted for the normal foetal (gestational age 16 weeks to full term) and adult human heart, and applied to some cardiac pathologies. Application, pharmacological modification and validation of this family of models is by a portfolio of small projects that interrelate numerical solutions of the computational models with clinical recordings that have been obtained either during normal treatment or IRAS approved clinical studies. The clinical data is in the form of (moving) geometry, from non-invasive magnetic resonance imaging, or electrophysiological multiple time series V(t). These time series are recorded either noninvasively , from the body surface (maternal abdomen for foetal ECG, limb leads for neonatal ECG, torso for adult ECG and body surface potential mapping; or invasively, either from intracardiac electrodes during invasive procedures, or exported from implanted devices (eg ICDs, pacemakers).Projects currently underway, with data from Warwick, Nottingham, Bradford and Leeds, include arrhythmogenic right ventricular cardiomyopathy, atrial fibrillation, inherited and acquired LQT syndrome, ventricular fibrillation and defibrillation, neonatal sepsis, pre- and peri-natal congenital heart block and normal prenatal and paediatric development.
7. **Summary of the work to be undertaken by the Scholar (200 words) :**
   (to be used to advertise the Scholarship)

   We have developed cardiac computational electrophysiology models for the normal foetal and adult human heart, and applied them to some cardiac pathologies. We also have clinical

electrophysiological recordings from patients, either as noninvasive ECGs or via implanted devices, or from electrodes inside the heart during clinical procedure, together with clinical magnetic resonance imaging data on heart geometry, motion, fibrosis and blood flow. We use the models to aid in the interpretation of clinical data , and to use clinical data to validate and adapt the models.

In the summer of 2016 you will produce (from simulations) and extract from clinical recordings data as V(t) that will be graphically analysed using Origin, producing figures for publication/presentation in 2017. In the summer of 2017 you will visualise, analyse and quantify 3D datasets obtained by magnetic resonance imaging, producing figures for publication during the 2017-8 academic year. During the summer placements you will need to interact with clinicians and other healthcare professionals. You will not have any direct patient contact but may be able to observe some procedures. You would be expected to present a poster at a European meeting

8. Detail of the work to be undertaken by the Scholar (500 words) *(see note ii)***:**

The two 6 week research periods (not necessarily continuous, dates to be mutually agreed) will be in the computational biology laboratory, Garstang building. Local simulation software (C code), visualisation (some of ITKsnap, Volview, Paraview, DSI, Osirix) and university supported graphing and analysis tools (OriginPro), will be used. We have used these with L3 undergraduates, year 3-5 medics (ESREP) and MSc students, and they soon learn how to use the new software.

Summer 2016: Scholar will run cell and 1D human tissue models for propagation within heart, that output V(t) for all major cardiomyocyte types at up to several hundred locations, from which graphs of action potential characteristics and ECG intervals will be extracted. Scholar will also analyse related endocardial or body surface ECG recordings. These will form a series of graphs as a technical report, from which I will construct the abstract/powerpoint/paper, to be submitted by

January 2017 for June 2017 EWGCCE/CARDIOSTIM-EHRA Europace location tba

April 2017 for Sep 2017 Computing in Cardiology, Rennes, France

The choice of topic (AF/VF/pre- or neo-natal) will be determined by which project is most appropriate for the scholar to be able to complete within the six weeks.

During this time the scholar will also be responsible for organising the literature and data sets: this involves meeting with clinicians and healthcare professionals.

Summer 2017: Scholar will visualise and quantify MRI datasets (MRI, late delayed Gd-enhanced for fibrosis, cineMRI, DT-MRI for architecture , 4D+t for blood flow velocity) , and construct figures using some of ITKsnap, Volview, Paraview, DSI, Osirix. Choice of dataset and problem will be determined by where the scholar could achieve enough to complete part of an ongoing paper within the six weeks; paper to be completed by me during the 2017-18 academic year. The scholar will also be responsible for the submission process of a paper for Computing in Cardiology 2017 that includes material from the work done in the previous summer.

During this time the scholar may, if interested, and if I think suitable, and if my clinical colleagues are willing, observe some clinical procedures. In the past some medical and medical science summer students have done this, and valued the experience.

I would expect (but do not guarantee) the scholar to end up, before the end of their final year, as coauthors on a couple of papers and conferences papers, and to have attended and contributed to at least one European meeting. This is consistent with the outputs from my previous summer students . During the 2017-18 academic year the scholar should not do a laboratory project with me.

9. Detail of the Leadership development to be undertaken as part of the project *(see note iii)*

The anonymized clinical data is held on password protected devices within my office , with a remote backup: the scholar will be responsible for downloading and analysing data from this archive. This archive is intermittently updated, the scholar will also be responsible for meeting with clinical colleagues, to obtain the anonymised on CD, and incorporating the new data in the archive.

All the clinical data analysis by the scholar will require forensic tracking, so that the source of any point on an output graph can be traced back, from Origin through spreadsheets to the original raw data files.

I am legally responsible for these processes and their audit trial, so the scholar will have the lead role for these processes within an isolated file system, that I will then incorporate into the archive after verification

Organising meetings with clinicians (finding mutually acceptable time, booking room, re-arranging at short notice due to clinical events) is an iterative ongoing process that will develop management skills.

Meeting with clinical colleagues, and the possible observer role at some clinical interventions (eg catheter ablation) provides experience of leadership processes in collaborative working groups where different individuals have different key role and responsibilities.

Abstract preparation and submission deadlines are in term time, but in July/August 2017 the camera ready Computing in Cardiology paper will need to be prepared and submitted through their website, and the scholar will have the leadership role for this web-based submission process.

10. Outputs expected of the Scholar (200 words) including the final report *(see note iv)*

Summer 2016: Weekly meetings will define what has been done, and plan the next weeks work: a summary of these will form the first report of ~1000 words to be produced before the beginning of the Autumn term . Numerical solutions and time series analysis results will be produced and archived. Publication quality figures will be organised in a series of in .ppt files, with legend, notes and data source locations in notes section . These will form an appendix to the first report , which I will use in early 2017 to draft the abstracts for presentations in the summer of 2017

Summer 2017: The final report of ~1000 words to be produced before the beginning of the Autumn term. MRI data analysis will be produced and archived . Publication quality figures/presentation quality movies will be organised in a series of in .ppt files, with legend, notes and data source locations in notes section This will form the appendix to the final report. If suitable, figures from the .ppt will be incorporated into papers to be submitted by me during the 2017-8 academic year.

11. Details of supervision arrangements *(see note v)*

The scholar will be working within Computational Biology labspace ie deskspace with iMacs and PCs, and so will have daily interaction with me, postgraduates (MD, MSc), and ESREP project students and summer visitors.

There will be formal meetings at the beginning of each working week, to evaluate progress and define objectives for the week.

12. Resources required for the Scholar to undertake the project *(see note vi):*

Clinical electrophysiology and MRI imaging data is obtained during treatment/clinical research, and so the only costs associated are media and reprographic consumables. Say <£150/year.

High resolution imaging DT-MRI of ex vivo clinical samples is charged at £190/day by Physics; say 2 days/year £380/year .

The scholar would benefit from accompanying me on a visit to one or two collaborating sites (Warwick, Edinburg, Manchester, Bradford, London) –say <£100 /year.

I would expect the scholar to attend and present a poster one European meeting(EWGCCE or Computing in Cardiology) or page charges for open access publication (PloS/Frontiers in..), <£700

	2016	2017	Upper limit
Media and reprographics	150	150	300
DTMRI imaging : 2 days/year	380	380	760
Local travel to UK collaborators	100	100	200
Conference registration, travel and accommodation		700	700

Total < £1960

(to be completed if a Scholarship is awarded)

Project Leaders – please tick to confirm the following:

Consideration of Health and Safety context and appropriate risk assessment and risk management exercises have been completed ☐

Relevant ethical clearance has been sought ☐

Scholar and project leader are aware that any additional expenses or equipment costs are the responsibility of project leader to plan for and approve (if approved, students must provide receipts) ☐

Signature of Scholar _____ Date: ____/____/____

Signature of Project Leader _____ Date: ____/____/____