# Summer Projects

**Students in the middle years of their degree may wish to undertake a summer project. This would usually be students at the end of their third year. Vacation bursaries are available. (Exceptionally students at the end of their 2nd year may be eligible). Undertaking a summer project is a useful way of discovering if you are interested in doing a research degree.**

**Possible Project Titles may** be found at the end of this document. Sources of funding are as follows:

## 1. EPSRC vacation bursaries

EPSRC has written to us to invite us to again participate in their Vacation Bursaries Programme. A total of £37,500 has been made available to MPLS Division to provide 15 bursaries to Oxford undergraduate students, to enable them to work in research laboratories for an average of 10 weeks during the 2010 summer vacation and gain first-hand practical experience of research. The funding provides £220 per week to the student, in addition to a total of £300 for allowable research expenses associated with the project. We anticipate that the scheme will run in the summer of 2010.

The scheme is restricted to EPSRC subject areas, and students that are in the middle years of their first degree. The research should fall within the identified "Robert's shortage areas" of Statistics and Operational Research, ICT, Engineering or Materials,

Students must satisfy the following criteria to be eligible for bursary funding:
(a) be registered for a first degree at the University of Oxford that falls within the remit of EPSRC;
(b) be in the middle years of their undergraduate course;
(c) be on track to receive at least a 2.1;
(d) be UK or EU Students who will have been resident in the UK for educational purposes for at least three years prior to graduating.

Please note that Overseas Students are not eligible, and neither are students visiting/working at Oxford from other universities.

**Application procedure**

Students interested in applying should ask their supervisor to submit their application by e-mail to Christopher Voyce, **voyce@maths.ox.ac.uk** 12th February 2010 . Results will be announced as soon as possible (date to be confirmed).

The application form for the EPSRC Vacation Bursaries can be found at:
https://www.maths.ox.ac.uk/current-students/undergraduates/projects

Successful Mathematics projects in the summer of 2009 can be found here:
https://www.maths.ox.ac.uk/current-students/undergraduates/projects

A review of the 2007 scheme is found at:
http://www.epsrc.ac.uk/PostgraduateTraining/VacationBursaries/Evaluation2007.htm

## 2. Wellcome Trust Bursaries

Oxford should be notified by the end of February 2010 of any bursaries that it is likely to receive for vacation bursaries. Information on the summer 2010 competition will be available on http://www.wellcome.ac.uk at the end of 2009.

## 3. Nuffield Science bursaries

Nuffield Undergraduate Research Bursaries offer up to 400 funded places a year, helping undergraduates across the UK to gain an insight into scientific research careers. Supervisors are invited to apply on behalf of a named student.

The awards provide support for the student at a rate of £180 per week, for a period of between 6 and 8 weeks.

The application form for the Nuffield Science Bursaries can be found through following: http://www.nuffieldfoundation.org/go/grants/nsbur/page400.html. The guidelines for applying can be found through following the link above. Contact Christopher Voyce if you wish to apply, preferably before **19th January 2010.**

The Nuffield deadline for this year is 5pm **Tuesday 9th February 2010.** Please see the link below for further information http://www.nuffieldfoundation.org/go/grants/nsbur/page400.html.

## 4. BBSRC Vacation Bursaries

**Purpose of the Scheme**

BBSRC Vacation Bursaries is a freestanding scheme that is designed to give promising undergraduates an opportunity to experience first-hand a period of time during the summer vacation in a research laboratory in a UK university or a BBSRC-sponsored research institute, to encourage them to consider a career in scientific research.

**Responsibilities of the Awarding Department**

The awarding department is responsible for administering all aspects of the award including:

- selecting a suitable undergraduate student
- identifying a suitable project
- ensuring that appropriate supervisory arrangements are in place for the student during the placement
- ensuring any necessary ethical committee approvals, animal licences and requirements of regulatory authorities are in place before the work begins and are maintained during the duration of the work
- the identification, protection and exploitation of any intellectual property rights arising from the work
- ensuring that all facilities, agreements about access and collaborations necessary for the work are obtained before the work commences and can be ensured through the period of the work
- ensuring that all support costs awarded under the bursary are used and accounted for appropriately

**Eligibility of the Student**

Selected students must be in the middle years of their first degree studies, be registered for a basic science or veterinary degree at a UK university, and be expected to obtain a first or upper second class UK honours degree. Preference should be given to students who have not had previous research experience.

**Research Project**
The proposed research project must have a clearly defined objective, be within the remit of BBSRC and be suitable for a student to sensibly complete within the timescale of the award. The project should not be part of the normal degree course or propose that the student undertakes the research outside of the UK. The project should give scope for thought and initiative on the part of the student and should not use the student as a general assistant.

**Duration**
Each bursary is for up to ten weeks duration, for take up during the summer vacation in 2009.

**Support Costs**
The value of a bursary is £2,500 to cover a minimum stipend of £200 per week to the student and a contribution towards research expenses during the placement.

**Reporting and Payments**
The student and the awarding department will be required to submit a brief report on the outcome of the bursary to BBSRC by **31 October**. Payment will be released by BBSRC on receipt of the final report.

## 5. OxPDE Student Summer Projects

The **Oxford Centre for Nonlinear PDE** is offering bursaries to undergraduates in the middle years of their degree to work on a research project for a period of up to 10 weeks during the summer vacation. It's an excellent opportunity for you to gain first hand research experience and find out whether you might be suited to a career in academia. You will receive a bursary of £180 per week as well as up to £200 for allowable research expenses associated with the project.

The scheme will be open to applicants from any UK or EU institution they will be given a bursary of £180 per week and £200 for research consumables. Deadline for applications to be confirmed.

Please refer to https://www.maths.ox.ac.uk/node/7746 for further details.

Seven students were funded for projects of 6 weeks duration in the summer of 2009.

### Possible Project Titles

### The titles below are from Professor Mason Porter

The general area of projects being offered would be in applied mathematics and/or theoretical physics. Please contact mason.porter@some.ox.ac.uk for further discussion.

Available projects include:

1. Various topics in network science (applied graph theory), such as community structure in social and other networks, development of ranking systems, etc.

2. Various projects in nonlinear waves, including applications in materials science and Bose-Einstein condensation

3. Various projects in other areas of nonlinear science, including billiard systems, Hamiltonian systems, quantum chaos, and synchronization

I'd be delighted to meet with any interested students. To get some additional idea of the flavour of some of these possibilities, go to
http://people.maths.ox.ac.uk/~porterm/synopsis.html

Summer projects
Dr Sarah Waters (OCIAM)
Contact: waters@maths.ox.ac.uk

- Mathematical modelling of arterial disease

The most common arterial disease is atherosclerosis, which is characterised by atherosclerotic plaques. Figure 1a shows the cross-section of a healthy artery, in which there is a wide open lumen through which the blood can flow, and a healthy arterial wall. Figure 1b shows the cross-section of a diseased artery, in which there is significant plaque deposit in the artery wall, and the lumen has significantly narrowed.

It is now widely accepted that the sites at which plaques are initiated, and their subsequent development, is correlated with the wall shear stress exerted by the flowing blood on the artery wall. In particular, plaques tend to develop where the shear stress is low or where it changes direction during the course of a cardiac cycle.

A feature of large arteries is that they have significant curvature. To understand the flow in curved arteries, and the associated shear stress distribution, we have modelled the artery as a tube of uniform circular cross-section, having a centreline which lies on the arc of a circle [1]. To mimic pumping of blood by the heart, the flow is driven by a prescribed pulsatile pressure gradient [2]. The flow is governed by four key dimensionless parameters: the curvature, steady and unsteady effective Reynolds numbers, and the amplitude of the pressure gradient.

The aim of this project will be to determine how the wall shear stress distribution depends on the key parameters. In certain parameter regimes, it will be possible to construct asymptotic solutions. These will be complemented by numerical solutions (an existing code is available that can be developed as necessary) in regions of parameter space where it is not possible to obtain analytical solutions.

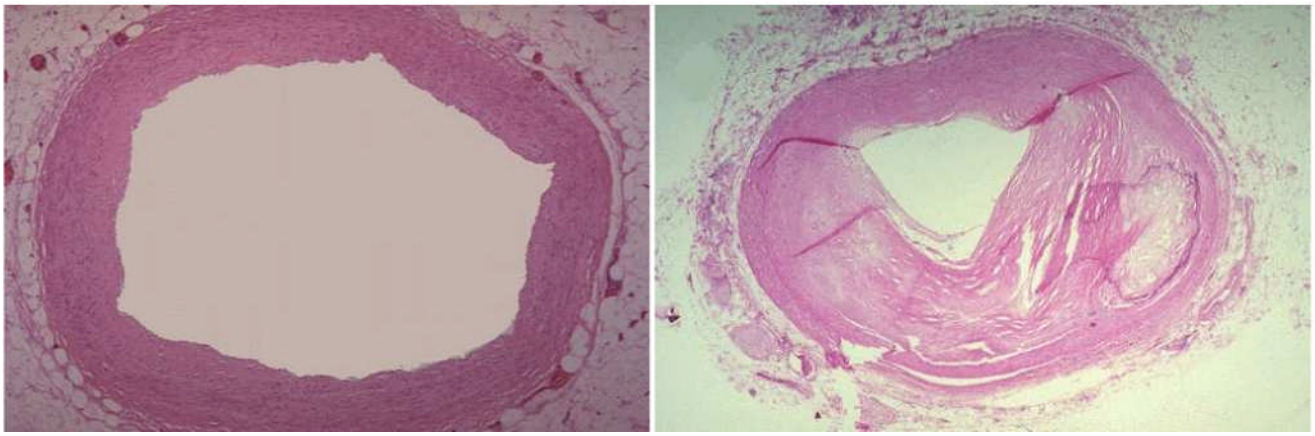

Figure 1: (a) Cross-section of a healthy artery. (b) Cross-section of an artery with significant atherosclerotic plaque. Images from http://www-medlib.med.utah.edu

No previous biological knowledge is required for this project. This work will be in collaboration with Dr Jennifer Siggers, Bioengineering, Imperial College London.

- Particle transport in curved pipe flows

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The aim of this project will be to understand how particles are transported by such flows. The project will involve both analytical and numerical work, and will provide insight into how sites of disease in arteries are correlated with the flows within arteries.

No previous biological knowledge is required for this project. This work will be in collaboration with Professor Peter Hydon, Mathematics, University of Surrey, and Dr Jennifer Siggers, Bioengineering, Imperial College London.

- Mathematical modelling for tissue engineering

The aim of tissue engineering is to grow tissues in the laboratory that can be used to replace tissues in the body that have become damaged through age or disease, or can be used in drug screening applications. When engineering tissues, it is desirable to culture cells within three-dimensional, multicellular aggregates, as this has been shown to be advantageous in improving cell viability and functionality compared to traditional monolayer culture techniques.

In this project, we will examine an existing simple mathematical model for the early stages of the aggregation process, when cells start to form small clusters. In particular, we will determine under what conditions an initially spatially uniform distribution of cells forms clusters, using both linear and weakly nonlinear stability theory. The results will be applied to liver tissue engineering.

No previous biological knowledge is required for this project. This work is in collaboration with Professor Helen Byrne, Mathematics, University of Nottingham.

## References

[1] Siggers, J. H. & Waters, S. L. (2005) Steady flows in pipes with finite curvature. Phys. Fluids. 17, 077102.

[2] Siggers, J. H. & Waters, S. L. (2007) Unsteady flows in pipes with finite curvature J. Fluid Mech. Accepted.

# SUMMER VACATION STUDENTSHIP IN BIO-MATHEMATICAL MODELLING

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One salaried vacation studentship will be available for up to 8 weeks over the summer to suitable candidates to work on research on the mathematical modelling of neural stem cells.

The aim of the project is to develop and implement a mathematical model of the migration, proliferation and differentiation of neural stem cells. The model will be a system of partial differential equations, hence experience with the analyses of such models is highly desirable. Knowledge of optimisation techniques and parameter studies would be an asset since not all of the model parameters can be derived from the literature and therefore their impact on the final simulation outcomes needs to be investigated. Furthermore, the successful applicant must have experience of using Matlab and ideally writing programs in Matlab, preferably with some knowledge or understanding of the implementation of partial differential equations using Matlab. A strong interest in biology will be indispensable as the applicant will have to derive the necessary input for the creation of the model from the experimental literature. Additional information and background reading for the successful applicant will be provided by the project supervisor.

Applications are sought from Mathematics *Third Years* who are doing a 4-year degree course (this is a specific condition of the grant) with an aptitude for computing and using Matlab code in order to assist with this project.

For information and further details, interested applicants should contact Dr Jo Ashbourn by email at: jashb@herald.ox.ac.uk and send a copy of their CV and programming experience *AS SOON AS POSSIBLE* and before the application deadline of Monday 18th January 2010.