



THE UNIVERSITY OF
MELBOURNE

Mechanical Engineering

SEMINAR SERIES 2008

Dr Leo Hwa Liang

Research Fellow

Institute of Bioengineering and Nanotechnology,
ASTAR, Singapore.

Wednesday 22nd October, 2.45pm

IDTC Theatre, Gound Floor, Old Engineering,
Block A, Bldg 173

Applications of biofluid mechanics in the development of medical devices: from heart valve engineering to bio-artificial liver devices.

MORE INFORMATION

For more Mechanical Engineering seminar information contact:

Professor Ivan Marusic
Department of Mechanical Engineering

E: imarusic@unimelb.edu.au

Biofluid mechanics is an emerging field that plays an important role in development of many of today's medical devices. One of its main applications is in heart valve engineering. Each year there are over 180,000 heart valve replacement operations being performed worldwide. Despite four decades of use, heart valve prostheses are less than ideal and lead to many complications directly related to the fluid mechanics associated with the various mechanical and bioprosthetic valve designs. Using state-of-the-art experimental techniques to interrogate the critical regions of these prostheses, we are able to reveal that existing valves are still plagued by Reynolds shear stress (RSS) levels greater than 200 Pa (2000 dynes/cm²) far exceeding the threshold for platelet activation and hemolysis. The study showed that hinge geometry designs and hinge gap width tolerance governed the success of the bileaflet mechanical heart valves design, and the performance of the aortic polymeric heart valves is dependent on its commissural designs and leaflet thicknesses. Given the critical nature of the micro flow fields on the clinical outcome of the valve prostheses, this study highlight the importance of pre-clinical in vitro evaluation as an essential phase for all new MHV or PHVs.

Another important application of biofluid mechanics is in the development of bio-artificial liver (BAL) devices. Even though liver transplantation remains the main curative option for patients suffering from fulminant hepatic failure (FHF), it is constraint by cost, donor scarcity and donor compatibility. Recent years witness the advent of BAL as a promising therapeutic for the treatment of FHF. These BAL-type devices serve as an extracorporeal support for liver failure patients, either allowing the patient's liver to regenerate, or to act as a bridge for liver transplantation. In current study, our group proposes a BAL design that is based on sandwich culture configuration with the aim of addressing some of the persistent problems faced by the existing BAL prototypes, namely the supply of adequate oxygen to and the regulation of fluid shear on the cell surfaces, and the ease of scalability of the bioreactor. Our study showed that the bioreactor was able to maintain albumin production and urea synthesis over a period of 7 days. These results demonstrated that our novel bioreactor design is capable of maintaining long-term in vitro functions in the hepatocytes.