11:09AM GA.00004 Osmotically driven pipe flows[1] , EMMANUELLE RIO, RASMUS HANSEN, KAARE JENSEN, TOMAS BOHR, The Technical University of Denmark, CHRISTOPHE CLANET, IRPHE, Marseille — The mechanism for the transport of sugar in plants is a key issue for the understanding of their growth. Since the 1930'ies the dominant model has been the so-called Münch model (Münch 1930) where the transport of sugar in the phloem of plants is viewed as a purely passive hydrodynamical process. According to Münch, differences in osmotic pressure caused by differences in sugar concentration create a mean flow, transporting sugar from high concentration regions (e.g. leaves) to low concentration regions (e.g. new shoots or roots). We have performed experiments and numerical solutions for such flows under various conditions, to explore the nature of the ensuing rich fluid dynamics. Experiments are performed with solutions of dextran of various molecular weights and in channels of widths ranging from centimetric down to micrometric.

[1]Supported by the Danish Natural Science Foundation

11:22AM GA.00005 Injection From Side Holes on a Generic Catheter Tip , JASON FOUST, DONALD ROCKWELL, Lehigh University — Central venous catheters (CVC), typically positioned within the superior vena cava (SVC), play an important role in the process of hemodialysis. Simultaneous extraction and injection of blood typically occur through one or more side holes at the catheter tip. High-image-density particle image velocimetry is employed, in conjunction with a scaled-up water facility, to characterize the structure of single and multiple jets. The injection jets that penetrate the steady crossflow generate complex, but deterministic, flow patterns. Significant interaction between multiple jets generates flow features that are more pronounced than those of a single jet, including increased jet penetration and elevated levels of turbulent shear stresses. In addition, the effects of a pulsatile throughflow on the structure of an isolated, single jet are determined as a function of phase of the systole-diastole cycle, corresponding to actual blood flow in a normal adult.

11:35AM GA.00006 Direct Numerical Simulations of transitional pulsatile flow through stenotic vessels[1] , NIKOLAOS BERATLIS, ELIAS BALARAS, Dept. Mechanical Engineering, University of Maryland, College Park, MD 20742 — A series of direct numerical simulations of pulsatile flows in pipes with a constriction are presented here. Results capture the flow features reported in earlier experiments in the literature and confirm a qualitatively similar multi-step process to transition to turbulence observed in planar configurations. In particular, an instability of the shear layer leads to the formation of an array of vortices rings. Transition to turbulence takes place as these vortex rings undergo three-dimensional instabilities. We will present a systematic study of the effects of: 1. geometry of the constriction; 2. percent occlusion; 3. inflow conditions, to the above transition process. In addition, the effects of blood rheology on the results will be explored via numerical experiments with a variety of non-Newtonian models.

[1]Research supported by the National Science Foundation (CTS-0347011)

11:48AM GA.00007 Blockage effects on steady and pulsatile flows in stenotic geometries , MARTIN GRIFFITH, IRPHE, France/ FLAIR Monash University, Australia, THOMAS LEWEKE, IRPHE, France, MARK THOMPSON, KERRY HOURIGAN, FLAIR Monash University, Australia — Steady and pulsatile flows through a locally constricted circular tube are studied numerically and experimentally. The geometry, a simplified model of an arterial stenosis, consists of a long straight tube with an axi-symmetric constriction, the size of which is varied. The Reynolds number is varied between 50 and 1400 and the blockage ratio by area between 0.2 and 0.95. For pulsatile flow – a steady Poiseuille flow with an added sinusoidal pulsation – a single frequency is examined, corresponding to a Womersley number of 14. The amplitude of the pulsation is varied between 0 and 1.5. For steady flow, stability analysis of our numerical results reveals a boundary for absolute linear stability, with the mode numbers and structures varying across the blockage range. However, experimental results reveal that strong convective shear layer instabilities occur at much lower Reynolds numbers. For pulsatile flow, experiments again indicate that shear layer instability seems to be of the most importance. However, flows of waveforms of large amplitude, or those possessing a negative velocity component during the pulse cycle, show a period-doubling phenomenon, with successive vortex rings tilting and breaking-up in opposite directions.

12:01PM GA.00008 Experimental Study of the Effect of a Skewed Inlet Flow Profile on Stenotic Flow Development , SEAN PETERSON, MICHAEL PLESNIAK, Purdue University — Blood flows through a constricted artery, or stenosis, are known to be sensitive to geometric and velocity perturbations. The effect of a skewed mean inlet velocity on the flow development distal to an axisymmetric stenosis (modeling a diseased carotid artery) driven by a physiological forcing waveform is studied. In the physiological environment, a skewed mean velocity profile (plus a secondary flow) can be produced, e.g. by vessel curvature. This study attempts to decouple the mean flow profile and the secondary flow in order to ascertain the impact of each disturbance individually. The skewed inlet profile is produced by a porous insert designed to replicate the mean flow profile downstream of a bend. LDV and PIV data are acquired to assess the impact of the skewed velocity profile on flow features. The skewed velocity profile was observed to promote earlier reattachment of the stenotic jet by deflecting it towards the wall sooner than in a baseline study. In a second experiment, the impact of secondary flow on the stenotic jet development is investigated by the introduction of a 180° bend upstream of the stenosis. The mean flow profile is similar in character to that produced by the porous insert.

12:14PM GA.00009 Period doubling during Liebau pumping in the displacement mode , DAVID AUERBACH, Medical University Graz, MAXIMILIAN MOSER, Joanneum Research, Weiz, Austria — Liebau Pumping is the often strong unidirectional flow obtained when a more or less elastic tube containing a fluid is periodically squeezed. It is a ubiquitous non-peristaltic feature in many interactions between tubes and fluids contained in them, and has been invoked to explain numerous biological flows. These include promoting blood flow in early vertebrate embryos, in animals with valveless hearts and lymph flow in the eye. It has also been discussed in connection with power-optimization of blood flow. One of the most popular setups is the circular geometry with two in-series interconnected pipes joined at their ends. This system has a zero head: All power is used to bring the fluid into flow, the flow mode. A beaten U-tube, on the other hand, has no steady flow component, what I call the pressure mode. A partially filled horizontally oriented tube allows the fluid displacement for each beat to be measured. This mode is what I call the displacement mode. A period doubling is the most ubiquitous feature of operation in this mode. Even single beats without any wave interaction between beats gives rise to this behaviour.

12:27PM GA.00010 Towards PIV measurements around the breathing zones of two Thermal Breathing Manikins , KALIGOTLA SRIKAR, MARK GLAUSER, Syracuse University — This work includes the transport processes in indoor environments for assessing personal exposure in connection with human health. Airflow within indoor spaces, around human bodies in ventilated spaces and within the human airways is complex due to the vast range of length and velocity scales. Breathing zones of two thermal breathing manikins seated around a table are studied in a cubicle (6 ft X 8 ft X 8 ft). To quantify the facility with the simple table geometry/ventilation system and to provide a quality Particle Image Velocimetry (PIV) flow field database for the computational validation, measurements are made in a cubicle configuration without manikins. Stereo PIV flow field measurements are acquired near the floor inlet vent, continuing up to and at various locations around and above the table. Future work will include PIV measurements utilizing two breathing manikins seated around the table to study two body interaction problems. These measurements of the airflow will be made with the manikins breathing in phase and 180 out of phase.

Monday, November 20, 2006 10:30AM - 12:40PM –
Session GB Computational Fluid Dynamics II Tampa Marriott Waterside Hotel and Marina Grand Salon F