Timetable

Time	Monday July 5	Tuesday July 6	Wednesday July 7	Thursday July 8	Friday July 9
08:00 - 09:00	Registration				
09:00 - 09:45	Humphrey	Ogden	Vorp	MacKintosh	Humphrey
09:45 - 10:30	Ethier	Ogden	Ethier	MacKintosh	Miller
Break					
11:00 - 11:45	Ethier	Holzapfel	Miller	Ethier	Vorp
11:45 - 12:30	MacKintosh	Humphrey	Miller	Humphrey	Holzapfel
Lunch					
14:30 - 15:15	Holzapfel	MacKintosh	Presentations from Participants*	Vorp	
15:15 - 16:00	Vorp	MacKintosh	Presentations from Participants*	Ogden	
Break					
16:30 - 17:15	Vorp	Ethier	Presentations from Participants*	Ogden	
17:15 - 18:00	Miller	Humphrey	Presentations from Participants*	Holzapfel	

*Participants are encouraged to present their work, ask questions and stimulate discussion. Please send a title of the presentation to bettina.strametz@tugraz.at by June 15.

Audience

The Summer School is addressed to PhD students and postdoctoral researchers in biomedical engineering, (bio)physics, mechanical and civil engineering, applied mathematics, physiology and materials science and more senior scientists and engineers (including some from relevant industries) whose interests are in the area of biomechanics and mechanobiology.

Registration

The registration fee is 490 €. The fee covers the attendance at all lectures and a book of lecture notes. In addition light refreshments will be provided in the morning and afternoon breaks. Payment is required by May 31, 2010. The fee for payments after this date is 590 €. Arrangements for registration and payment are posted on the Summer School website.
www.biomech.tugraz.at/summerschool-2010

Accommodation

Participants are asked to make their own reservations. Rooms are pre-reserved for participants at some Student Hostels and Hotels around the venue of the Summer School. More detailed information about reservation modalities, including a list of accommodations and a map are available on the Summer School website.

Organization

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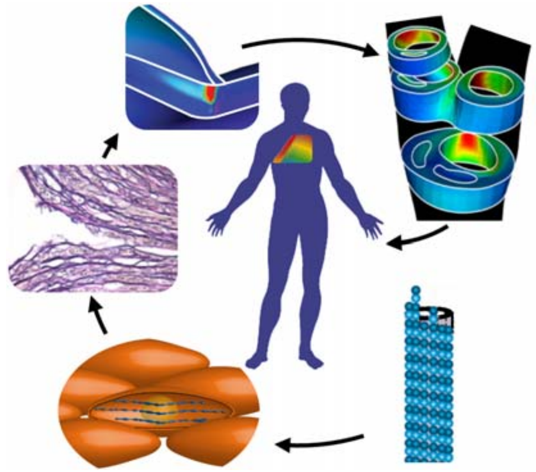
Summer School on

Modeling in Biomechanics and Mechanobiology at Different Length Scales



Graz University of Technology
Austria
July 5 – 9, 2010

TU Graz

Summer School coordinated by

Gerhard A. Holzapfel
Graz University of Technology, Austria
Ray W. Ogden
University of Glasgow, UK

WEBSITE:
www.biomech.tugraz.at/summerschool-2010

Objectives

The aim of the Summer School is to present a state-of-the-art introduction and overview of biomechanical and mechanobiological modeling at different length scales, with an emphasis on soft biological tissue. The lectures will discuss biomolecules and networks, the cytoskeleton and cells as well as macroscopic continuum models for soft tissues, including arteries, the heart, eyes and the brain.

The mechanics of the whole cell and sub-cellular components will be discussed with particular emphasis on endothelial cells and smooth muscle cells and their mechanochemical activation. This links to the discussion of growth and remodeling, which builds on the constituents of soft tissue, including smooth muscle, elastin and collagen. Applications of growth and remodeling that are considered include the response of arteries to hypertension and the analysis of mechanopathological changes such as aortic and cerebral aneurysm formation.

Experimental approaches for determining the mechanobiological properties of aneurismal tissue will be discussed along with diffusion and mass transport through the tissue. The discussion of arteries is underpinned by a detailed review of the fundamental structure of the arterial wall and related constitutive modeling, including the important effect of residual stresses. Models for cells and soft tissues are presented with particular reference to the collagen fiber structure. In addition, the fundamental biomechanics of brain tissues and the eye in health and disease are examined on the basis of experimental data and material and computational models.

Biomechanical modeling of soft tissues requires application of continuum mechanics, and a summary of the key ingredients of this theory is therefore provided. The theory is then used to establish a framework for modeling the elasticity of the tissues and for characterizing their material properties.

Throughout the course the lecturers will point to future directions for research in the different areas of biomechanics and mechanobiology.

Invited Lecturers

C. Ross Ethier
Imperial College London, UK
Mechanics of the cell and the cytoskeleton; techniques for cell-scale biomechanical measurements; mechano-transduction; biomechanics of the human eye in health and disease.

Gerhard A. Holzapfel
Graz University of Technology, Austria and KTH Solid Mechanics, Stockholm, Sweden
Fundamental structure and constitutive modeling of arterial walls; residual stresses and their influence on the arterial response; modeling of smooth muscle activation; cerebral aneurysms including growth and remodeling.

Jay D. Humphrey
Texas A&M University, USA
Introduction to modeling in biomechanics and mechanobiology; biomechanical response due to elevated stress levels including hypertension; growth, remodeling and adaptation of arterial wall tissue; future directions for research in biomechanics and mechanobiology

Fred C. MacKintosh
Vrije Universiteit, The Netherlands
Fundamentals of elasticity and dynamics of biopolymers and the cytoskeletal networks they form in cells; collective effects of molecular motors in such networks; both experimental results and theoretical approaches will be discussed.

Karol Miller
University of Western Australia, Australia
Biomechanical modeling of the brain for surgical simulation, image-guided surgery and analysis of brain structural diseases; patient-specific models and computer simulations; real-time computations using finite element and meshless methods.

Ray W. Ogden
University of Glasgow, UK
Essential ingredients of continuum mechanics; kinematics, stress and constitutive modeling; elasticity, isotropy, transverse isotropy and orthotropy; application to fibrous tissue including the myocardial tissue.

David Vorp
University of Pittsburgh, USA
Biomechanics of aortic aneurysms; experimental approaches to determine the mechanobiological properties for aneurysmal tissues; diffusion of nutrients and mass transport through diseased arterial tissue; mechanobiology of stem cells.

Preliminary Suggested Readings

C.P. Brangwynne, G.H. Koenderink, F.C. MacKintosh and D.A. Weitz: Cytoplasmic diffusion: molecular motors mix it up. The Journal of Cell Biology, 183:583-587, 2008.

C.R. Ethier, M. Johnson and J. Ruberti: Ocular Biomechanics and Biotransport. Annual Review of Biomedical Engineering, 6:249-273, 2004.

P. Janmey and C. Schmidt: Experimental measurements of intracellular mechanics; Chapter 2 in R.D. Kamm and M.R.K. Mofrad (eds): Cytoskeletal Mechanics: Models and Measurements, Cambridge, 2006, pp. 18-49.

G.A. Holzapfel and R.W. Ogden (eds.): Biomechanical Modeling at the Molecular, Cellular and Tissue Levels, CISM Courses and Lectures No. 508. Springer: Wien, New York, 2009.

G.A. Holzapfel and R.W. Ogden: Constitutive modelling of passive myocardium. A structurally-based framework for material characterization. Philosophical Transactions of the Royal Society A, 367:3445–3475, 2009.

J.D. Humphrey: Cardiovascular Solid Mechanics: Cells, Tissues, and Organs. Springer-Verlag, NY, 2002.

J.D. Humphrey: Vascular adaptation and mechanical homeostasis at tissue, cellular, and sub-cellular levels. Cell Biochemistry and Biophysics, 50: 53-78, 2008.

G.R. Joldes, A. Wittek and K. Miller: Suite of finite element algorithms for accurate computation of soft tissue deformation for surgical simulation, Medical Image Analysis, in press.

F.C. MacKintosh: Polymer-based models of cytoskeletal networks; Chapter 8 in R.D. Kamm and M.R.K. Mofrad (eds): Cytoskeletal Mechanics: Models and Measurements, Cambridge, 2006, pp. 152-169.

K. Miller, A. Wittek, G. Joldes, A. Horton, T. Dutta Roy, J. Berger and L. Morriss: Modelling brain deformations for computer-integrated neurosurgery. Communications in Numerical Methods in Engineering, in press.

J.S. VanEpps and D.A. Vorp: Mechanopathobiology of Atherogenesis: A Review. Journal of Surgical Research, 142:202-17, 2007.

D.A. Vorp: Biomechanics of Abdominal Aortic Aneurysm. Journal of Biomechanics, 40:1887-902, 2007.