Timetable

Time	Monday September 8	Tuesday September 9	Wednesday September 10	Thursday September 11	Friday September 12
08:00 - 09:00	Registration				
09:00 - 09:45	McMeeking	Barocas	McHugh	McHugh	Barocas
09:45 - 10:30	Barocas	Barocas	McHugh	Barocas	McMeeking
Break					
11:00 - 11:45	McHugh	Holzapfel	Holmes	Holmes	Ogden
11:45 - 12:30	Holmes	Holzapfel	Barocas	Holmes	Holzapfel
Lunch					
14:30 - 15:15	Holzapfel	Ogden	Presentations from Participants*	McMeeking	Ogden
15:15 - 16:00	McMeeking	Holmes		McMeeking	Holzapfel
Break					
16:30 - 17:15	Ogden	McHugh		Ogden	
17:15 - 18:00	Ogden	McMeeking		Holzapfel	

*Participants are encouraged to present their work, ask questions and stimulate discussion. Please send a title of the presentation to bettina.srametz@tugraz.at by August 18.

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 560 €. 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; a welcome reception is also included.
Payment is required by August 11, 2014. The fee for payments after this date is 650 €. Arrangements for registration and payment are posted on the Summer School website.
www.summerschool.tugraz.at

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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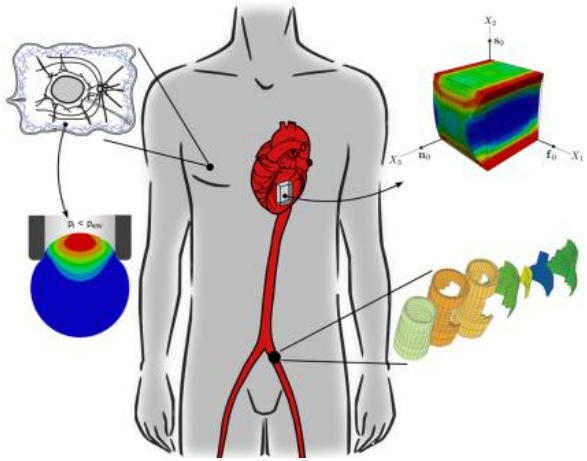
6th Summer School on

BIOMECHANICS:
TRENDS IN MODELING AND SIMULATION



GRAZ UNIVERSITY OF TECHNOLOGY
AUSTRIA
SEPTEMBER 8 – 12, 2014

Summer School coordinated by

Gerhard A. Holzapfel
Graz University of Technology, Austria

Ray W. Ogden
University of Glasgow, UK

WEBSITE:
www.summerschool.tugraz.at

Objectives

This is the 6th Summer School on Biomechanics presenting a state-of-the-art overview of biomechanical and mechanobiological modeling and simulation of soft biological tissues. The lecturers will discuss biomolecules, networks and cells as well as failure, multi-scale, agent-based, bio-chemo-mechanical, finite element and growth models appropriate for computational analysis. Applications include arteries, the heart, vascular stents and valve implants as well as adipose, brain, collagenous and engineered tissues.

We discuss the mechanics of the whole cell and sub-cellular components as well as the extracellular matrix structure and mechanotransduction that may contribute to the development of many diseases, including atherosclerosis and myocardial infarction, which are also elaborated in the course. In particular, the formation and remodeling of stress fibers, cytoskeletal contractility, cell adhesion and the mechanical regulation of fibroblast migration in healing myocardial infarcts are discussed. Emphasis is also put on the elasticity of biopolymer filaments and networks including their failure.

The essential ingredients of continuum mechanics are provided since they are key in the modeling of soft biological tissues. Constitutive models of fiber-reinforced materials with an emphasis on arterial walls and the myocardium are discussed and the important influence of residual stresses on material response emphasized. The mechanics and function of the heart, the brain and adipose tissues are discussed. Also experimental techniques for determining the mechanical properties of cells and tissues will be presented. Particular attention will be focused on microstructural and multi-scale modeling, finite element implementation and simulation of the (bio-chemo-) mechanics, electromechanics and electrophysiology of cells and tissues.

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

Invited Lecturers

Victor Barocas
University of Minnesota, USA
Microstructural and multi-scale modeling; collagenous tissues; engineered tissues; failure of networks and tissues

Jeffrey W. Holmes
University of Verginia, USA
Heart function; myocardial infarction; myocardial material properties; biaxial mechanical testing; anisotropy; compartmental models; agent-based models; finite-element mode

Gerhard A. Holzapfel
Graz University of Technology, Austria
Artery walls in health and disease; constitutive modeling of cross-linked actin networks; mechanics/modeling of the myocardium and the adipose tissue; mechanics of brain tissue

Peter McHugh
National University of Ireland, Galway
Atherosclerotic plaque; permanent and biodegradable vascular stents; pulmonary and heart valve implants; cell mechanics

Robert McMeeking
University of California, Santa Barbara
Bio-chemo-mechanical cell models; stress fiber formation and remodeling; cytoskeletal contractility; actomyosin cross-bridging; cell adhesion; focal adhesion formation and growth; signaling

Ray W. Ogden
University of Glasgow, UK
The essential ingredients of continuum mechanics; constitutive modeling of fiber-reinforced materials; residual stresses and their influence on material response, with particular reference to arteries; elasticity of biopolymer filaments and networks

Preliminary Suggested Readings

C. Conway, F. Sharif, J.P. McGarry, P.E. McHugh: A computational test-bed to assess coronary stent implantation mechanics using a population-specific approach. *Cardiovascular Engineering and Technology*, 3:374–387, 2012.

K.D. Costa, J.W. Holmes, A.D. McCulloch: Modelling cardiac mechanical properties in three dimensions. *Phil Trans R Soc Lond A*, 359:1233–1250, 2001.

V.S. Deshpande, R.M. McMeeking, A.G. Evans: A model for the contractility of the cytoskeleton including the effects of stress-fibre formation and dissociation. *Proc R Soc A*, 463:787–815, 2007.

V.S. Deshpande, M. Mrksich, R.M. McMeeking, A.G. Evans: A bio-mechanical model for coupling cell contractility with focal adhesion formation. *J Mech Phys Solids*, 56:1484–1510, 2008.

E.P. Dowling, W. Ronan, G. Ofek, V.S. Deshpande, R.M. McMeeking, K.A. Athanasiou, J.P. McGarry: The effect of remodelling and contractility of the actin cytoskeleton on the shear resistance of single cells: a computational and experimental investigation. *J R Soc Interface*, 9:3469–3479, 2012.

J.A. Grogan, B.J. O'Brien, S.B. Leen, P.E. McHugh: A corrosion model for bioabsorbable metallic stents. *Acta Biomaterialia*, 7:3523–3533, 2011.

M.F. Hadi, E.A. Sander, V.H. Barocas: Multiscale model predicts tissue-level failure from collagen fiber-level damage. *J Biomech Eng*, 134:091005, 2012.

G.A. Holzapfel, E. Kuhl (eds): Computer Models in Biomechanics: From Nano to Macro. Springer, 2013.

G.A. Holzapfel, R.W. Ogden: Constitutive modelling of arteries. *Proc R Soc Lond A*, 466:1551–1597, 2010.

G.A. Holzapfel, R.W. Ogden: Constitutive modelling of passive myocardium: a structurally based framework for material characterization. *Phil Trans R Soc Lond A*, 367:3445–3475, 2009.

G.A. Holzapfel, R.W. Ogden: Constitutive modelling of arteries. *Proc R Soc Lond A*, 466:1551–1597, 2010.

G.A. Holzapfel, R.W. Ogden: Elasticity of biopolymer filaments. *Acta Biomat*, 9:7320–7325, 2013.

A.D. Rouillard, J.W. Holmes: Mechanical regulation of fibroblast migration and collagen remodelling in healing myocardial infarcts. *J Physiol*, 590:4585–4602, 2012.

G. Sommer, M. Eder, L. Kovacs, H. Pathak, L. Bonitz, C. Mueller, P. Regitnig, G.A. Holzapfel: Multiaxial mechanical properties and constitutive modeling of human adipose tissue: A basis for preoperative simulations in plastic and reconstructive surgery. *Acta Biomat*, 9:9036–9048, 2013.

L. Zhang, S.P. Lake, V.K. Lai, C.R. Picu, V.H. Barocas, M.S. Shepard: A coupled fiber-matrix model demonstrates highly inhomogeneous microstructural interactions in soft tissues under tensile load. *J Biomech Eng*, 135:011008, 2013.