

TIME TABLE

TIME	Monday September 17	Tuesday September 18	Wednesday September 19	Thursday September 20	Friday September 21
9.00 - 9.45	Registration	Vico	Boccaccini	Vico	Komlev
9.45 - 10.30	Hellmich	Vico	Boccaccini	Vico	Komlev
11.00 - 11.45	Katti	Hellmich	Boccaccini	Vico	Lacroix
11.45 - 12.30	Katti	Hellmich	Katti	Lacroix	Lacroix
14.00 - 14.45	Boccaccini	Katti	Hellmich	Lacroix	
14.45 - 15.30	Boccaccini	Katti	Hellmich	Lacroix	
16.00 - 16.45	Komlev	Discussion	Discussion	Komlev	
16.45 - 17.30	Komlev	Discussion	Discussion	Discussion	

ADMISSION AND ACCOMMODATION

Applicants must contact CISM Secretariat at least one month before the beginning of the course. Application forms should be sent on-line through our web site: <http://www.cism.it> or by post.

A message of confirmation will be sent to accepted participants. If you need assistance for registration please contact our secretariat.

The 700,00 Euro registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday not included), hot beverages, on-line/downloadable lecture notes and wi-fi internet access.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered board and/or lodging in a reasonably priced hotel. Requests should be sent to CISM Secretariat by **July 17, 2012** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on our web site, or can be mailed upon request.

Please note that the centre will be closed for summer vacation the first three weeks in August.

For further information please contact:

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Piazza Garibaldi 18
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Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2012
The Nowacki Session



**SKELETAL TISSUE
ENGINEERING MECHANICS,
WITH LINKS TO BIOLOGY, CHEMISTRY,
AND MEDICINE**

Advanced School
coordinated by

Christian Hellmich
Vienna University of Technology,
Austria

Aldo R. Boccaccini
University of Erlangen-Nuremberg
Germany

supported by

KMM.VIN
www.kmm-vin.eu

Udine, September 17 - 21, 2012

SKELETAL TISSUE ENGINEERING MECHANICS, WITH LINKS TO BIOLOGY, CHEMISTRY, AND MEDICINE

Tissue engineering is the use of cells and bio-chemical substances, in combination with engineering and materials methods, in order to restore, maintain, or improve the functioning of biological tissue. The material scientific and cell biological technologies used in contemporary tissue engineering have reached breathtaking sophistication. On the contrary, the current design process of tissue engineering (TE) scaffolds is still a pure trial and error approach. We propose that this conceptual weakness explains why reliable, safe TE solutions for the daily clinical use are the exception, rather than the rule. In fact, it is very complicated (if not impossible), even with tremendous input gained from

sophisticated experimental work, to guess suitable combinations of the key design parameters (chemical composition, porosity, microstructural geometry, distribution of signalling factors and biological cells), which reflect a highly complex system of mutually coupled phenomena. This is where the field of applied mechanics is expected to be of enormous help – and recent developments in latest years are planned to be disseminated to an interdisciplinary audience from civil and mechanical engineering, material science, biology, and biomedicine. In more detail, the lectures of the proposed course will cover topics concerning the key challenges of contemporary tissue engineering strategies, which result from

(at least) two competing requirements: (i) the tissue engineering scaffolds must exhibit a sufficient mechanical competence, i.e. stiffness and strength comparable to natural bone. This relates to structural soundness; and (ii) within the living organism, it should be continuously resorbed and replaced by natural bone. This relates to the topic of bioresorbable scaffolds enabling internal growth of new tissue. Thereby, bone tissue will be the key focus, since in this field, great progress has been made, not only in the fields of materials science and biology, but in particular in the field of applied and computational mechanics. The course will gather experts from the fields of applied

mechanics, biology, and chemistry, in order to give, in an unprecedented transdisciplinary fashion (normally, applied mechanics are rather missing in the topic, than coordinating a joint educational effort), the cutting-edge view on what the up-to-date ingredients of tissue engineering for load-carrying organs are. The course is addressed to all doctoral students, researchers, engineers, physicists, chemists, biologists, and medical doctors interested in a novel, comprehensive approach to the understanding and improvement of the tissue engineering field, with special emphasis on mechanics of tissue engineering scaffolds and on the effect of mechanics on biological systems.

PRELIMINARY SUGGESTED READINGS

A.R. Boccaccini, J. Gough: Tissue engineering with ceramics and polymers, Woodhead Publishers (2007).

D.W. Hutmacher: Scaffolds in tissue engineering bone and cartilage, *Biomaterials* 21 (2000), 2529-2543.

St. Scheiner, R. Sinibaldi, B. Pichler, V. Komlev, C. Renghini, C. Vitale-Brovarone, F. Rustichelli, Ch. Hellmich: Micromechanics of bone tissue-engineering scaffolds, based on resolution error-cleared computer tomography, *Biomaterials*, 30 (2009), 2411-2419.

A. Fritsch, Ch. Hellmich, L. Dormieux: Ductile sliding between mineral crystals followed by rupture of collagen crosslinks: experimentally supported micromechanical explanation of bone strength, *Journal of Theoretical Biology*, 260 (2009), 230-252.

V.S. Komlev, I.V. Fadeeva, S.M. Barinov, J.V. Rau, M. Fosca, A.N. Gurin, N.A. Gurin: Phase development during setting and hardening of a bone cement based on a-tricalcium- and octacalcium phosphates, *Journal of Biomaterial Applications*

(2011), in print, <http://dx.doi.org/10.1177/0885328210390403>.

C. Sandino, S. Checa, P.J. Prendergast, D. Lacroix: Simulation of angiogenesis and cell differentiation in a CaP scaffold subjected to compressive strains using a lattice modeling approach. *Biomaterials*, 31 (2010), 2446-2452.

C. Faure, L. Vico, P. Tracqui, N. Laroche, A. Vanden-Bossche, M.T. Linossier, A. Rattner, A. Guignandon: Functionalization of matrices by cyclically stretched osteoblasts

through matrix targeting of VEGF. *Biomaterials*. 31 (2010), 6477-6484.

R. Bhowmik, K.S. Katti, D.R. Katti: Mechanisms of load-deformation behavior of molecular collagen in hydroxyapatite-tropocollagen molecular system: steered molecular dynamics study, *Journal of Engineering Mechanics*, 135 (2009), 413-421.

INVITED LECTURERS

Aldo R. Boccaccini - University of Erlangen-Nuremberg, Germany
5 lectures on biomaterial classifications (permanent, bioresorbable, bioinert, bioactive); basics of ceramics, metals, polymers, and composites and their relevance in tissue engineering; tissue scaffolds (requirements, processing, structure-mechanical property relations, topography); applications (bone, cartilage, angiogenesis).

Christian Hellmich - Vienna University of Technology, Austria
5 lectures on basics of continuum micromechanics; upscaling of elasticity, poroelasticity, creep, and strength; multiscale mechanics of bone; multiscale mechanics of tissue engineering scaffolds; merging Computer Tomography with micromechanics as new clinical tool.

Kalpana Katti - North Dakota State University, USA
5 lectures on basics of steered molecular dynamics, on modeling hydroxyapatite-collagen interfaces, on molecular simulation of full length collagen, on bone tissue engineering scaffolds (based on nanoclay, chitosan, unnatural amino-acids) and cell culturing.

Vladimir Komlev - Russian Academy of Sciences, Russia
5 lectures on structure of calcium orthophosphates and isomorphous substitutions; synthesis and sintering methods, including nanoparticles; calcium phosphate-based materials such as granules, ceramics, composites, and cements; phase formation characterization through energy-dispersive X-ray diffraction; 3D imaging techniques.

Damien Lacroix - Institute for Bioengineering Catalonia, Spain
5 lectures on Finite Element modeling of skeletal organs (including annulus fibrosus of lumbar spine), computer-aided design of biomaterial scaffolds, Computational Fluid Dynamic modeling of bioreactor, bioreactor applications (including human cartilage), mechanical stimuli and tissue differentiation.

Laurence Vico - Université St. Etienne, France
5 lectures on basics of experimental mechanobiology, skeletal effects of space flight, microgravity exposure, mechanical effects on cell differentiation (dependence on frequency and magnitude) and on growth factor expression, dynamic 3D bioreactors.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from CISM web site, instructions will be sent to accepted participants.

**KMM-VIN - SKELETAL TISSUE ENGINEERING MECHANICS,
WITH LINKS TO BIOLOGY, CHEMISTRY, AND MEDICINE**

Udine, September 17 - 21, 2012

Application Form

(Please print or type)

Surname _____

Name _____

Affiliation _____

Address _____

E-mail _____

Phone _____ Fax _____

Method of payment upon receipt of confirmation (Please check the box)

The fee of Euro 700,00 includes IVA/VAT tax and excludes bank charges

I shall send a check of Euro _____

*Payment will be made to CISM - Bank Account N° 094570210900,
VENETO BANCA - Udine (CAB 12300 - ABI 05035 - SWIFT/BIC VEBHIT2M -
IBAN CODE IT46 N 05035 12300 09457 0210900).
Copy of the receipt should be sent to the secretariat*

*I shall pay at the registration counter with check, cash or VISA
Credit Card (Mastercard/Eurocard, Visa, CartaSi)*

IMPORTANT: CISM is obliged to present an invoice for the above sum. Please indicate to whom the invoice should be addressed.

Name _____

Address _____

C.F.* _____

VAT/IVA* No. _____

(*) Only for EU residents or foreigners with a permanent business activity in Italy.

Only for Italian Public Companies

I ask for IVA exemption (ex law n. 537/1993 - art. 14 comma 10).

Privacy policy: I understand that data received via this form will be used only to provide information about CISM and its activities, within the limits set by the Italian legislative decree no. 196/2003 and subsequent amendments.

Complete information on CISM's privacy policy is available at http://www.cism.it/courses/privacy_statement/

I have read the "Admission and Accommodation" terms and conditions and agree.

Date _____ Signature _____