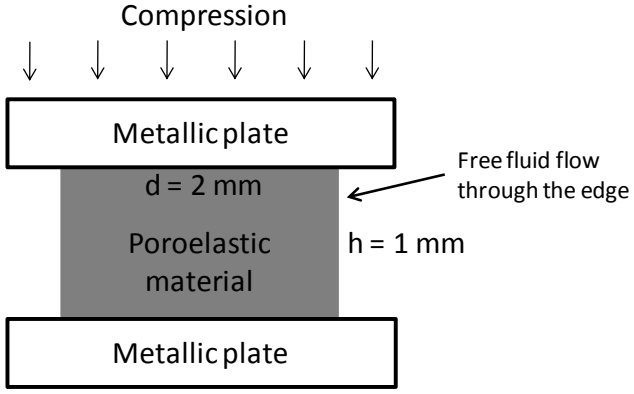
iBIOMEP 29.4.2009
TBGS

BIOMECHANICAL MODELLING OF BONE AND CARTILAGE
22.-24.4.2009

Examination
(answer either to questions 1-4 or do only exercise 5 or 6)

1. Explain composition, structure and function of articular cartilage and bone. Present mechanical testing and imaging techniques that can be used to characterize these properties.
2. Present the workflow when creating a biomechanical model from an image stack. Give two examples for each step of the model creation and analysis.
3. It is known that the incidence of wrist fractures temporarily increases during adolescent years. Assume that you were carrying out a study which would employ finite element modeling approach to evaluate the influence of bone growth on the forearm fragility. Which imaging method would you choose and on what grounds? Describe also the main specifications of the imaging protocol you would apply in this study.
4. Explain the term mechanobiology and the main uses of computational models in studying mechanoregulated processes. Give 3 examples of mechanoregulatory processes that are studied with computational models.
5. Analyze the stress relaxation response (reaction force as a function of time) of a poroelastic (void ratio = 4), isotropic material that is compressed 5% of its thickness (10s compression, 1000s relaxation). Assume that the Young's modulus and Poisson's ratio are 0.5MPa and 0.1, respectively, and permeability 1 x 10^{-15} m^4/Ns (remember that the permeability is implemented in Abaqus in m/s and the specific weight of wetting liquid is 9810 N/m^3). The geometry of the problem is shown below. Use Abaqus or Calculix to create the model and simulate the relaxation response. ***Give a short report of the model creation (Introduction and Methods), show fluid pressure distribution at time 50s and show the stress-relaxation curve (Results and Discussion)***
   (hint 1: create axisymmetric model, hint 2: reaction force is the sum of RF2:s of the nodes at the material surface).



6. See the separate appendix.