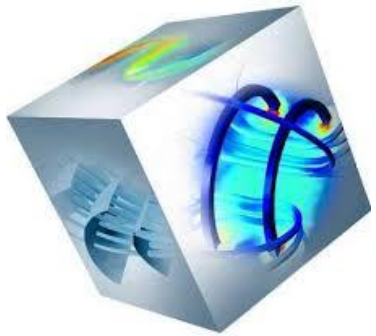
Modelling fluid flow using COMSOL Multiphysics

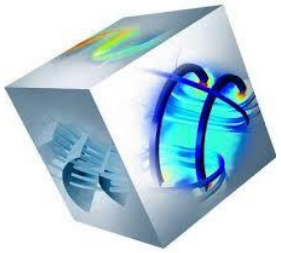
Giorgio MATTEI

giorgio.mattei@centropiaggio.unipi.it



Course: Fenomeni di trasporto biologico

Date: 10 Nov 2015



Blood flux in a vessel

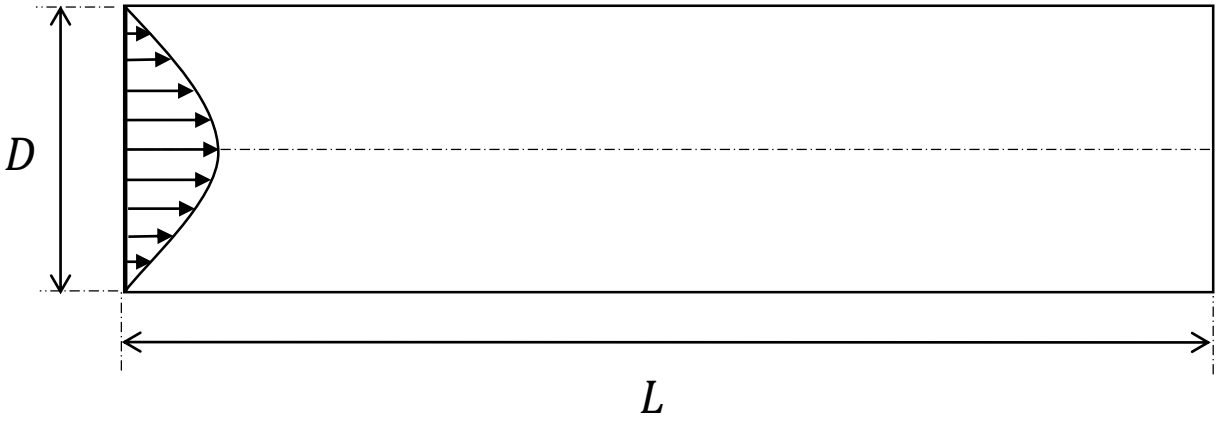
- Steady-state blood flux within a pipe

$$-\eta\nabla^2\boldsymbol{u} + \rho(\boldsymbol{u}\cdot\nabla)\boldsymbol{u} + \nabla p = \mathbf{F}$$

$$\nabla\cdot\boldsymbol{u} = 0$$

Incompressible Navier-Stokes equation for a Newtonian fluid

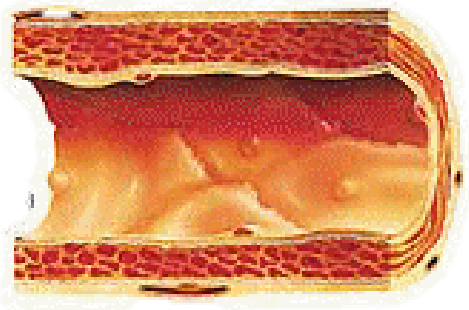
ρ → density = 1060 kg·m^{-3}
η → dynamic viscosity = 4·10^{-3} Pa·s
p → pressure (Pa)
F → volume force field such as gravity (N·m^{-3})



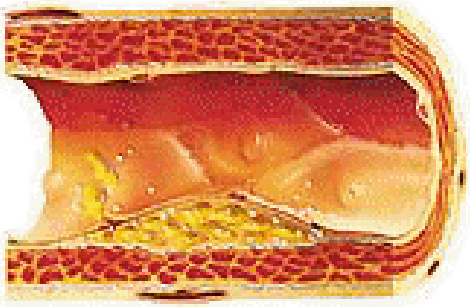
$D = 25\ mm$
$L = 110\ mm$

$Q_{in} = 5\ L/min$

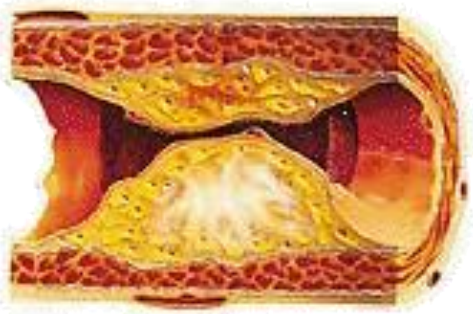
Atherosclerotic artery



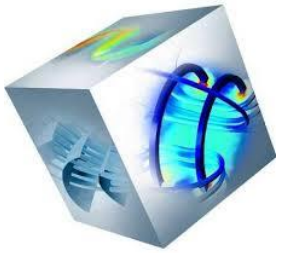
Artery with
no deposits



Artery with
atherosclerotic plaque

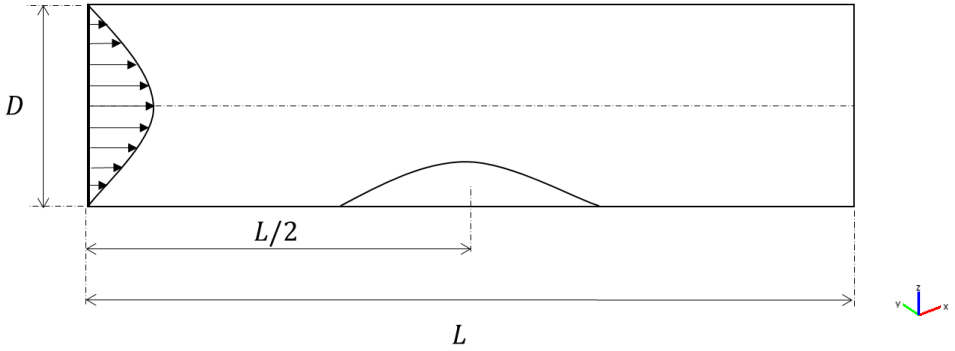


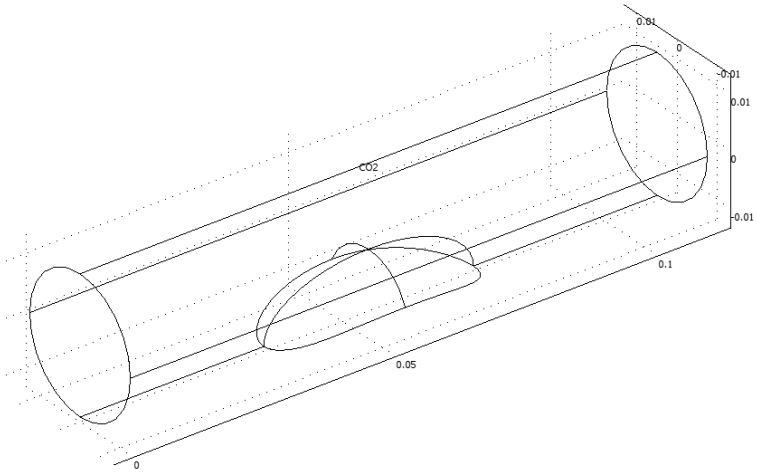
Stenotic artery with big
atherosclerotic plaques



Blood flux in a stenotic vessel

- Steady-state blood flux within a pipe



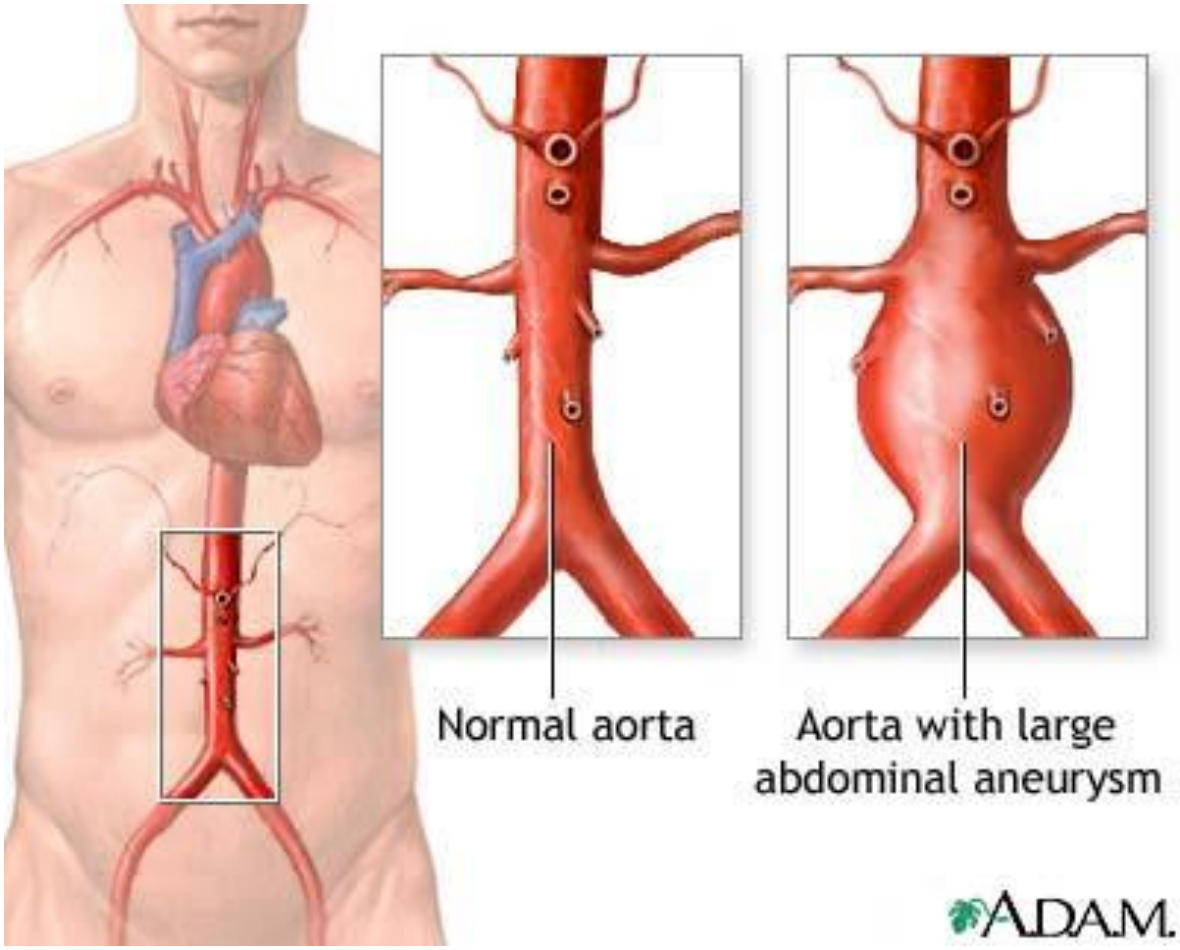


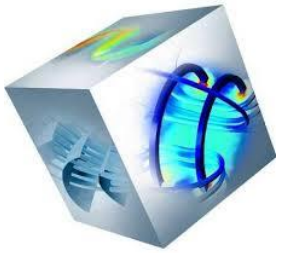
$D = 25\ mm$ $L = 110\ mm$ $Q_{in} = 5\ L/min$

Atherosclerotic plaque → ellipsoid (semiaxes: x = 20 mm, y = 10 mm, z = 10 mm)

- Solve the problem considering Poiseuille inflow profile
- Evaluate wall shear stress
- Evaluate pressure

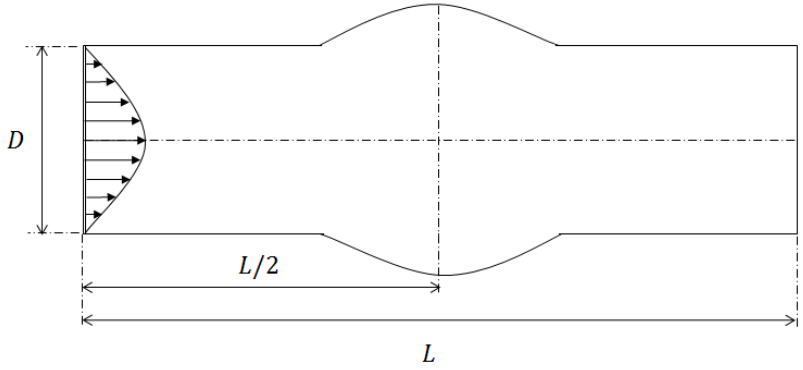
Aneurysm

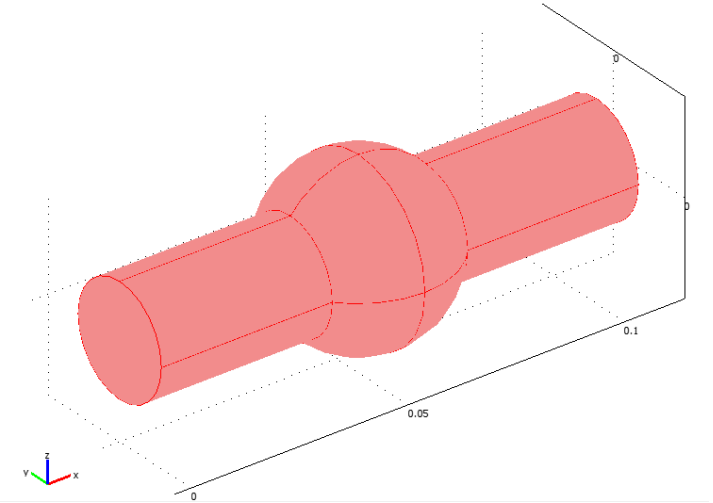




Blood flux with aneurysm

- Steady-state blood flux within a pipe





$D = 25\ mm$ $L = 110\ mm$ $Q_{in} = 5\ L/min$

Aneurysm → sphere (radius 20 mm)

- Solve the problem considering Poiseuille inflow profile
- Evaluate wall shear stress
- Evaluate average pressure on aneurysm wall (what happens in presence of a bigger aneurysm? Increase sphere radius to *30 mm.*