Percorso Autonomo Autorizzato

Title (Titolo)	**Mathematical and physical modelling for biomedicine** **(Modellistica matematico-fisica per la biomedicina)**
Coordinator	(DMAT, PoliMi): prof. Davide Ambrosi
Supporting coordinators	(DMAT, PoliMi): prof. Maurizio Vianello, prof. Pasquale Ciarletta, prof. Paolo Zunino (DFIS, PoliMi): prof. Paolo Biscari
Scientific collaborations and partnerships	· (École Politechnique, Paris): prof. Lev Truskinovsky · (Universita' Roma III): prof. Luciano Teresi · (Dip. Matematica, PoliTo): prof. Luigi Preziosi · (EPFL, Losanna): prof. Alfio Quarteroni, prof. Fabio Nobile · (University of Oxford, UK): prof. Helen Byrne, prof. Alain Goriely · (University College of London, UK): dr. Rebecca Shipley · (Yale University, US): prof. Jay Humphrey
Description and aims	This track of MSc in Mathematical Engineering develops inside the framework M*ajor* in "Computational Sciences for Engineering" and provides the students with the basis of the mathematical and physicals model that describe the behaviour of biological systems at the cell scale, tissue and organ scale. Mathematical models in engineering are a tool to theoretically analyse the experimental results, predict new dynamics and support the design of devices. In recent years mathematics, with the support of computing, has demonstrated to be an effective tool also for engineering applications in biology and medicine The track in "Mathematical and physical modelling for biomedicine" is in particular devoted to the methodological issues in deducing and analyse qualitatively the mathematical models. The natural theoretical framework is continuum mechanics: on the basis of experimental evidence, exploiting balance laws and conservation and dissipation principles, mathematical models are derived in a rational way, with the aim to explain the observed phenomena, provide a quantitative prediction and possibly support the design of medical devices. Specific examples of mechanobiological systems that are studied in the course of this track comprise the growth and modelling of soft biological tissues, the propagation of electrical signals in muscles, the blood flow in large and small vessels, the cardiac mechanics, cell mechanobiology and methods for imaging data inversion. Engineering and biomedical applications encompass the design of valves, stents and scaffolds, optimization of drug delivery and therapies, biomedical imaging analyses.
Study plan	Beyond the courses that are mandatory for the Major in "*Computational Sciences*", this track is characterized by the following courses: *1) 097725 – Mathematical and physical modelling in engineering* (10 CFU) *2) 088928 – Biomathematical modelling* (8 CFU) *3) 098444 – Tecnologie per la medicina rigenerativa (10 CFU)* *4) 096253 – Fenomeni di trasporto nei sistemi biologici (10 CFU)* *5)* optional choice between *073588 – Laboratorio di elaborazione di immagini* (5 CFU) and 0*97660 – Methods and models for statistical mechanics* (8 CFU)
Past thesis	· S. Scotton (Ing. Mtm.), *Modelli bifase a rilascio controllato di farmaco*, 2012 · M.C. Colombo (Ing. Mtm.) *A mathematical model to predict Glioblastoma invasion: use of patient-specific diffusion tensor imaging data in simulation*, 2014 · N. Colombo (ing Mtm), *Numerical Modelling of Ventricular Mechanics: Role of the Myofibre Architecture,* 2014 · M. Vassallo (Ing Mtm) *Unstable dynamics of polar bacteria near surfaces, 2014*
Ongoing thesis	· V.Sicuro (Ing Biomed) *Accoppiamento tra sforzo meccanico e crescita in uno sferoide tumorale*

Available thesis	• *Cell migration: the inner mechanism of cell motility* • *Stress state and mechanobiological feedback in glioblastoma invasion* • *The role of fibres in cardiac torsion: optimal orientation to maximize the power stroke* • *The stress produced by a migrating cell on the matrix: the inverse problem* • *The generation of shape and in living organisms as prosuced by growth and instability*
Job opportunities	Research and Development in the companies that design and produce new technological tools in biomedical engineering.