Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Subject
Multiscale modelling of fluid and solute transport in normal and pathological peritoneal tissues

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Project Description
In intraperitoneal therapies the peritoneal cavity with the surrounding peritoneal tissues are used to remove excess water and waste metabolic products from the patient (peritoneal dialysis) or to deliver drugs to the tumors (intraperitoneal chemotherapy). The efficiency of the intraperitoneal treatment is strictly related to the local, physiological properties of the peritoneal tissue. The special role in the transport processes plays interstitium, whose role had not been recognized until recently. It serves as a medium for fluid and solute peritoneal exchange. Its transport properties and structure are dynamically changing – influencing efficiency of the treatment and whole body status. The complexity of the relationship between structure and function leads to the highly nonlinear transport phenomena. Currently applied mathematical models for peritoneal transport consider the interstitium (tissue) with capillary and lymphatics beds and other structures, as uniformly distributed with phenomenologically described transport characteristics. The goal of the proposed PhD project is to develop a quantitative mathematical framework to model peritoneal fluid and solute transport. Such model should take into account description of the tissue structure on multiscale level linking existing models on macroscopic level with the description on mesoscopic (such as discreet structure of capillaries, differences in the local tissue anatomy), and microscopic level (such as two phase structure of the interstitium, cell/tissue exchange). The mathematical framework should also take into account impact of different osmotic agents such as glucose, or Icodextrin (polyglucose), typically applied in intraperitoneal therapies, and their impact on the transport properties of the peritoneal barrier and treatment efficiency. The framework will include description of the transport phenomenon in normal tissue (with relatively regular structure). It will be further extended to cover pathological changes of the tissue structure and properties as observed in peritoneal dialysis and in tumor tissue. The developed model will be calibrated with the available experimental and clinical data on the local physiology, its structure and transport properties as well as with treatment kinetics and its efficiency.

Bibliography

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