عنوان مقاله:

Mathematical Model of Fluid Flow and Solute Transport in Converging-diverging Permeable Tubes

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خلاصه مقاله:

This article presents a mathematical model for fluid and solute transport in an ultra-filtered glomerular capillary. Capillaries are assumed to be converging-diverging tubes with permeable boundaries. According to Starling's hypothesis, ultrafiltration is related to the variations in hydrostatic and osmotic pressures in the capillary and Bowman's space and takes place along the length of the capillary. The governing equations of fluid flow for the case of axisymmetric motion of viscous incompressible Newtonian fluid have been considered along with the solute transfer equation. The non-uniform geometry has been mapped into a finite regular computational domain via a coordinate transformation. Correspondingly, the governing equations are transformed to the computational space and solved to get the velocity and pressure values. The solute transfer equation is also solved numerically using a finite difference scheme. The solutions provide the predictions of the axial distribution of hydrostatic pressure and osmotic pressure, velocities, and concentration profiles at various points along the axis and solute clearance quantities along the capillary. The current results are in good agreement with the earlier findings in limiting cases of cylindrical tubes with a constant radius. It is found that there is a significant effect of osmotic pressure on the solute concentration. Using a set of data, the influence of various physiological parameters on the velocity components and solute concentration are presented and discussed through graphs to correlate with physiological situations. The generic structure of the current model also provides an acceptable approach to exploring fluid exchange in organs apart from the glomerular capillary.

کلمات کلیدی:

Glomerular capillary, Finite difference method, Ultrafiltration, Converging-diverging tubes, Permeable wall