MATHEMATICAL MODELING of CANCER TUMOR ANGIOGENESIS

Fact!
Unless furnished with an adequate blood supply and a means of disposing of waste products by a mechanism other than diffusion, a solid tumor cannot grow beyond a few millimetres in diameter and remains in an “avascular” state. This type of tumor cannot metastasize.

Definition
Transition from this dormant avascular state to the vascular state, wherein the tumor possesses the ability to invade surrounding tissue, induce new blood vessels from the surrounding blood vessels to sprout towards it and then gradually penetrate the tumor, thus providing it with an adequate blood supply and microcirculation, is called “Angiogenesis”

Mathematical Models of Angiogenesis

1-D PDE Models

\[
\begin{align*}
\frac{\partial J_x}{\partial t} &= \frac{\partial}{\partial x} [D \frac{\partial J_x}{\partial x} + \sigma J_x] \\
\frac{\partial \rho}{\partial t} &= -n \nu - d \\
\end{align*}
\]

Surface Averaged Quantities
- \(v(x,y)\), velocity of tips
- \(\nu(x,y)\), net tip creation rate
- \(\sigma(x,y)\), tip death rate
- \(n\), number of tips
- \(\rho\), vascular content
- \(c\), TAF concentration
- \(\mu\), tip flux
- \(\gamma\), secondary threshold
- \(\alpha\), proliferation rate (sec.)
- \(\lambda\), decay rate
- \(D\), diffusion constant
- \(\frac{\partial c}{\partial t} = -n \frac{\partial c}{\partial x} + \frac{\partial}{\partial x} [D \frac{\partial c}{\partial x}] - \gamma c
\]

Research Areas
- Machine Learning in Healthcare
- Quantitative methods, techniques and software tools in the field of MRI
- Mathematical modeling
- Computational methods for Partial Differential Equations
- Computational Plasma Flows
- Multi-phase Flows

Mathematical modeling

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