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ANALYTICAL THEORY OF BIOHEAT TRANSPORT

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ABSTRACT Macroscale models of bioheat transport can be developed either by the mixture theory of continuum mechanics or by the porous-media theory. The former approach down-scales the global balance equations. The latter, instead, up-scales both conservation and constitutive equations from the microscale. Compared with the continuum approach, the porous-media approach is more powerful in offering connections between microscale and macroscale properties and accurately describing the rich blood-tissue interaction in biological tissues. We previously developed a general bioheat transfer model using the volume averaging method. The model shows that both blood and tissue temperatures satisfy the dual-phase-lagging (DPL) energy equations at the macroscale. The solution of the DPL bioheat equation often relies on numerical simulation. Systematic analytical approaches have been rarely reported in this field. In this paper I will present two case studies of (a) heat conduction in the stratified skin tissue and (b) magnetic hyperthermia in the spherical tumor tissue. We analytically solve three types of bioheat transfer models and compare the results with those from numerical simulation. The results evidence the efficiency and accuracy of the analytical approach that we developed.