

The role of energy balance in the equilibrium of multicellular spheroids

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Irrespectively of the assumed mechanisms for nutrient consumption, replication rate, necrosis formation, the mathematical models for multicellular spheroid include some removal process of necrotic material, which is essential for reaching a steady state. An extreme assumption is that dead cells are removed instantly. However, the underlying physical mechanism has never been clarified. We propose a totally new approach in which in a spheroid at equilibrium there is no liquid leak to the exterior and the missing equation is instead provided on the basis of energy balance. Assuming the two-fluid scheme, in which the spheroid is viewed as a mixture of a cellular fluid and the extracellular fluid, we have calculated the power dissipated in the internal motion of the two components. Such a power has to be supplied by the proliferating cells. Equilibrium is reached when the size of the spheroid is such that the supplied power and the mechanical power dissipated balance each other. Numerical calculations based on this idea show a reasonable agreement with experiments performed in different environmental conditions. We believe this result is encouraging and we plan further studies in this direction.