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DEVELOPMENT OF METHODS TO IMPROVE THE EFFICIENCY OF ENERGY MANAGEMENT FOR BIOTECHNOLOGY SYSTEMS

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To improve the accuracy of energy management during the biotechnological process of laser embryo division, it is necessary to propose correct applied optimization mathematical models for finding local extremes of the temperature field. To justify the choice of thermal modes of laser action on the embryo during the development and implementation of boundary value problems with differential equations of thermal conductivity describing the state of the modeled system (embryo – source of laser action), it is necessary to consider the three-layer structure of the embryo, microscopic irregularities (microvilli) on the outer shell, and technical characteristics of laser emitters. It should be noted that an increase in the detail of the research object (embryo under laser action) during the implementation of computational and applied optimization mathematical models will complicate the calculation of the laser temperature and the search process of optimizing the time and power of laser action on the embryo. Using methods from the theory of pseudo-differential operators in the space of slowly increasing generalized functions, the authors substantiate the correctness of boundary value problems with systems of differential heat conduction equations modeling the state of an embryo under laser action. This guarantees the correctness not only of the above computational mathematical models, but also of a number of other computational mathematical models for many technical and biotechnological systems containing local, concentrated sources of thermal load [1, 2]. In addition, the research results were used to determine the conditions for the correctness of applied optimization mathematical models and the general optimization problem of finding the optimal values of power and time of laser exposure to embryos in order to improve the accuracy of energy management of these biotechnological systems by reducing embryo injury during laser fission [3].

By considering these features of the calculation and applied optimization mathematical models, a reasonable choice of methods was made to implement the search process of optimizing local extremes of the temperature field and ensuring energy management. To optimize the main parameters of laser emitters, the authors proposed a grid approach with discretization of the power and time of laser exposure to the embryo, which made it possible to obtain optimal values of these parameters. It should be noted that the research results can be used to improve the efficiency of energy management not only for technical and biotechnological systems containing thermal load sources, but also for other complex systems by increasing the accuracy of solving applied optimization problems for modeling processes in biotechnology, medicine, ophthalmology and metallurgy.

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