INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **A MATHEMATICAL STUDY ON THE IMPACTS OF OXYGEN HETEROGENEITY ON TUMOR GROWTH AND EMT DYNAMICS**

Name of Thesis Supervisor(s)	:	Prof. Durga Charan Dalal
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SHORT ABSTRACT

Oxygen heterogeneity in a tumor microenvironment—arising from disorganized vasculature and irregular blood flow—leads to non-uniform oxygen distribution, which significantly influences tumor necrosis, metabolic shifts and invasive behavior. Under hypoxic stress, tumor cells switch from aerobic to anaerobic glycolysis, producing lactate and H^+ ions that contribute to acidification and promote tumor progression. This heterogeneous oxygen environment not only drives necrosis and metabolic adaptation but also facilitates processes like epithelial-mesenchymal transition (EMT), enabling invasion and metastasis. To study these phenomena, this thesis employs a continuum mathematical modeling approach involving coupled partial and ordinary differential equations with appropriate boundary and initial conditions. The models are solved using finite difference schemes such as FTCS and pressure-velocity coupling methods. The models capture in vivo and in vitro tumor environments and help understand how asymmetric oxygen at tumor boundaries affects necrotic core evolution, how lactate accumulation correlates with oxygen stress, and how initial tumor shapes and oxygen fluctuations influence growth dynamics. The work also incorporates the role of exosomes—whose secretion increases in acidic environments—in promoting tumor cell proliferation, angiogenesis, EMT and immune evasion. Lastly, the model investigates how cyclic hypoxia regulates EMT and MET processes and highlights the role of mesenchymal motility. Overall, the thesis provides a comprehensive mathematical framework to understand how oxygen heterogeneity governs key aspects of tumor development and progression.