Dimensional advantage: How 3D organoids are re-shaping the oncology research

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Traditional *in vitro* 2D cell culture-based models have limitations in cancer research, as they do not accurately reflect the complex 3D architecture and interactions we find in tumors. Cell–cell communications are vital for cancer growth and proliferation.[1] Cancer cells communicate with each other and surrounding cells through various pathways, sending signals that promote their growth, survival, and proliferation through autocrine, paracrine, and endocrine.[2] Fundamentally, this communication forms the basis of cancer survival.[3] This can involve growth factors, cytokines, and other molecules that activate essential signaling pathways for tumor growth.[4] Cancer cells need constant blood and nutrients to sustain such massive growth. This is again achieved by communication with endothelial cells to stimulate the formation of new blood vessels to sustain their energy and metabolic needs.[5] Conventional 2D and 3D cultures play a role in oncology research, but each has its strengths and weaknesses when it comes to studying cancer.[6] While 2D culture systems are simple, easier, and inexpensive to set up and maintain, 3D cultures are more realistic representations of actual tumors due to their 3D structure and cell–cell interactions.[7] They can capture the genetic and functional heterogeneity of patient-derived tumors, thereby allowing for modeling the tumor microenvironment with various cell types and signaling and immune molecules.[8] 2D culture fails to accurately reflect the complex 3D architecture and interactions of cells as seen *in vivo* due to their limited ability to model cell–cell interactions and the tumor microenvironment.[9] 3D culture-derived organoids behave like miniature, simplified organs *in vitro*, which can be used for drug testing, disease modeling, and regenerative medicine applications.[10,11] By creating conditions mimicking embryonic development, 3D culture can be used to study organogenesis and tissue morphogenesis. 3D culture models can also be used to study the interaction between pathogens and host cells, providing a more accurate representation of *in vivo* conditions than traditional 2D cultures.[12,13]

Therefore, the use of 3D culture is multidimensional and spans multiple avenues, contributing to our advancements in understanding biology, disease mechanisms, oncology research, and the development of novel therapeutic strategies.[14,15]

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Ruby Dhar[1], Arun Kumar[2], Subhradip Karmakar[3]

[1]Scientist, Room 3020, Department of Biochemistry, [3]Additional Professor, Department of Biochemistry, All India Institute of Medical Sciences, New Delhi, [2]Professor, Department of Biochemistry, Narayan Medical College, Gopal Narayan Singh University, Sasaram, Bihar, India

Address for Correspondence:
Dr. Subhradip Karmakar, Additional Professor, Department of Biochemistry, All India Institute of Medical Sciences, New Delhi, India. **Mobile:** +91-9999612564. **E-mail:** subhradipaiims@gmail.com

Dr. Arun Kumar, Professor, Department of Biochemistry, Narayan Medical College, Gopal Narayan Singh University, Sasaram, Bihar, India. **Mobile:** +91-7584089886. **E-mail:** profdrarunk@gnsu.ac.in

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RD, AK, and SK- Contributed equally toward the scripting of this editorial.

Work attributed to:
Department of Biochemistry, All India Institute of Medical Sciences, New Delhi, India and Department of Biochemistry, Narayan Medical College, Gopal Narayan Singh University, Sasaram, Bihar, India.

Orcid ID:
Dr. Ruby Dhar - https://orcid.org/0000-0003-3600-6554
Dr. Arun Kumar - https://orcid.org/0000-0002-8800-0296
Dr. Subhradip Karmakar - https://orcid.org/0000-0002-4757-8729

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