Abstract:

The dream of personalized medicine is effectively the goal of customizing healthcare for the individual patient. Certain diseases, including many advanced stage cancers, exhibit such patient-to-patient variability that a true personalized medicine approach may be the only route to effective treatment. A prototypical disease example is the brain cancer glioblastoma multiforme (GBM). At the molecular level, it is rare for any two GBM patients to appear as if they have the same disease. Diseases such as GBM are not only heterogeneous across patient populations, but each tumor can also be highly heterogeneous at the cellular level—a trait that apparently contributes to the ability of such tumors to resist treatments. From a traditional biology perspective, this heterogeneity causes GBM to be viewed as a complex (or ‘hard to understand’) disease. However, a GBM tumor, as viewed by a physicist, might appear as a stable ‘organ’, with a stability that emerges exactly because of the heterogeneity of the cellular components. Consider, as an analogy, the robust nature of a diverse economy. That physical perspective implies that quantitatively capturing the cellular heterogeneity within the tumor can provide a route towards constructing the robust state of the tumor. That picture, in turn, can provide insight into how to disrupt that robust state by targeting the signaling networks essential for tumor maintenance, as well as anticipating mechanisms of resistance. I will discuss technology platforms and approaches we have developed for just this purpose, and how those platforms are beginning to be applied within the clinic for patient benefit.


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