Diverse interactions among species within bacterial colonies often lead to intricate spatiotemporal dynamics. The spatial structure can determine the growth and survival of different species, but the mechanisms driving formation of these structures are not fully understood. Here, we describe the emergence of complex structures in a colony grown from a mixture of motile and non-motile strains of bacteria on a semi-solid agar surface. Time-lapse imaging shows that non-motile bacteria “hitchhike” with the motile bacteria as the latter grow and expand. The non-motile bacteria accumulate at the moving colony boundary and trigger a mechanical instability of the colony boundary that leaves behind striking flower-like patterns. The mechanism of the front instability governing this pattern formation can be qualitatively elucidated by a mathematical model describing frictional interface motion where friction depends on the local concentration of the non-motile strain at the interface. We also developed a two-dimensional phase-field model that explicitly accounts for the interplay between mechanical stress from the motile species and effective friction provided by the non-motile species and reproduces the observed phenomenology. Our findings highlight the importance of mechanical interactions in shaping the spatial structure of multi-strain biofilms.