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Zebrafish and their evolutionary relatives feature a range of colorful skin patterns, including, stripes, spots, and labyrinth curves. Zebrafish patterns form due to the interactions of pigment cells, and several models have been developed to describe or predict the cell behaviors that are involved. By adjusting parameters in these models, we can search for the cell interactions that produce different fish patterns. However, agent-based models have many parameters, and empirical descriptions of zebrafish patterns are largely qualitative and variable. To help address these challenges, we draw on topological data analysis to quantitatively describe pattern features in an interpretable, cell-based way. By applying our techniques to both simulated data and real fish images, we show how to model and quantitatively distinguish different cell-based patterns. (Received August 16, 2020)