

Quiescent or Senescent? Research Helps Identify Cancer That Is More Likely to Recur

Colorado University Cancer Center's Sabrina Spencer and Brianna Fernandez explore when cells divide and when they're dormant.

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In a study that could have implications for more effective cancer therapies and preventing cancer recurrence, University of Colorado Anschutz Cancer Center member [Sabrina Spencer](#), PhD, working with graduate student Brianna Fernandez, used single-cell RNA sequencing to investigate the cell-cycle state of cells following chemotherapy.

Specifically, the researchers were looking to characterize cells in one of two arrested states: quiescence, a reversible state of cell-cycle arrest, and senescence, an irreversible state of cell-cycle arrest. Their research was [published](#) in January 2026 in the journal Nature Communications.

"People always talk about quiescence and senescence as binary, distinct states, but there wasn't good data to support that model, or any other model," says Spencer, associate professor of biochemistry at CU Boulder. "People don't understand senescence very well, and since we've become pretty good at understanding quiescence in my lab, I thought we could make an important contribution to understanding the relationship between quiescence and senescence: What makes senescence irreversible, meaning the cells will never divide again, and what allows quiescence to be reversible?"

On the continuum

The ultimate goal of chemotherapy is to kill cancer cells completely, but when that doesn't happen, a senescent state is preferable, Fernandez explains, although it can cause chronic inflammation if the senescent cells aren't destroyed by the immune system.

"There was originally some interest in senescence as a therapeutic outcome, because it induces

an inflammatory response that recruits the immune system to clear the cells,” she says. “There’s also the fact that senescent cells will be arrested from the cell cycle, which will block tumor growth.”

Quiescent cells, on the other hand, are “dormant” cancer cells that have the ability to start dividing again at some point. The researchers were hoping to find biomarkers that could distinguish between the two distinct states, but the RNA sequencing revealed instead that chemotherapy-treated cancer cells are spread along on a continuum between quiescence and senescence.

“We confirmed that there’s a gradient between quiescence and senescence,” Fernandez explains. “All of the phenotypes that go along with senescence start to manifest as soon as cells exit the cell cycle after chemotherapy, just at a weak level. We couldn’t find a binary molecular distinction between quiescent and senescent cells in our data. Senescent cells have similar phenotypes as chemotherapy-induced quiescent cells; the senescent cells are just more extreme.”

To reoccur or not to reoccur

Though quiescence and senescence aren’t as cut and dry as the field believes or as the researchers hoped, the findings can help identify which cancer cells need further treatment after chemotherapy, Spencer says.

“One of the things I’m excited about is that this continuum of gene expression will allow us to create a marker panel to identify a cell’s depth of withdrawal,” she says. “If we could characterize where on the continuum a dormant cancer cell is, we may be able to say, ‘This cell has a very low likelihood of waking back up, so no further treatment is needed.’ But in another case, the cells may be in a shallow quiescence, and further treatment would be beneficial to avoid tumor recurrence.”

The research is also applicable to aging, where there’s an increase in senescent cells that are no longer able to divide.

“There’s a lot of interest in developing waypoints to characterize cell-cycle withdrawal — identifying where cells are on the continuum — then trying to push cells to be either more senescent or more proliferative,” Fernandez says.

Adds Spencer: “In the case of aging, you may want to rejuvenate the cells and push them away

from senescence back towards proliferation for tissue and wound healing. But in cancer, you want to push them the other way.”

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