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Robustness in multicellular systems

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Cells and organisms cope with the task of maintaining their phenotypes in the face of numerous challenges. Much attention has recently been paid to questions of how cells control molecular processes to ensure robustness. However, many biological functions are multicellular and depend on interactions, both physical and chemical, between cells. We use a combination of mathematical modeling and molecular biology experiments to investigate the features that convey robustness to multicellular systems. Cell populations must react to external perturbations by sensing environmental cues and acting coordinately in response. At the same time, they face a major challenge: the emergence of conflict from within. Multicellular traits are prone to cells with exploitative phenotypes that do not contribute to shared resources yet benefit from them. This is true in populations of single-cell organisms that have social lifestyles, where conflict can lead to the emergence of social “cheaters,” as well as in multicellular organisms, where conflict can lead to the evolution of cancer. I will describe features that diverse multicellular systems can have to eliminate potential conflicts as well as external perturbations.