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Testing Turing's Theory of Morphogenesis in Chemical Cells NATHAN TOMPKINS, NING LI, CAMILLE GIRABAWE, MICHAEL HEY-MANN, Brandeis University, G. BARD ERMENTROUT, University of Pittsburgh, IRVING EPSTEIN, SETH FRADEN, Brandeis University — Alan Turing's 1952 paper "The Chemical Basis of Morphogenesis" described how reaction-diffusion dynamics could create six spatiotemporal patterns including a stationary pattern that could lead to physical morphogenesis (which now bears his name). This stationary "Turing pattern" has been observed in continuous media of various chemical systems but never in diffusively coupled discrete reactors as Turing theorized. We have created a system of microfluidically produced chemical compartments containing the Belousov-Zhabotinsky reaction that are designed to fulfill the assumptions of Turing's theoretical system. This system demonstrates all six spatiotemporal patterns that Turing predicted. In particular, we observe the stationary case that bears Turing's name where the cells create a pattern of oxidized and reduced states. As Turing predicted, this chemical heterogeneity gives rise to physical heterogeneity by driving an osmotic flow, swelling the reduced cells and shrinking the oxidized cells. In addition to the six patterns and physical morphogenesis predicted by Turing we observe a seventh pattern of mixed stationary/oscillatory states that is not predicted by Turing. This seventh pattern requires modifying Turing's theory to include slight heterogeneity to match experiments.

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