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Precision and Reproducibility in Biological Patterning THOMAS GREGOR, ERIC F. WIESCHAUS, WILLIAM BIALEK, DAVID W. TANK, Princeton University — During embryonic development, information about spatial location is represented by the concentration of various morphogen molecules. The reproducibility and precision of biological pattern formation thus is limited by the accuracy with which these concentration profiles can be established and "read out" by their target pathways. We consider four measures of precision for the Bicoid morphogen in the Drosophila embryo: The concentration differences that distinguish neighboring cells, the limits set by the random arrival of Bcd molecules at their targets (which depends on the absolute concentration), the noise in readout of Bcd by the activation of Hunchback, and the reproducibility of Bcd concentration at corresponding positions in multiple embryos. We show, through a combination of different experiments, that all of these quantities are $\sim$10%. This agreement among different measures of accuracy, which depend on very different molecular mechanisms, indicates that the embryo is not faced with sloppy input signals and noisy readout mechanisms; rather we have to understand how the embryo exerts precise control over absolute concentrations and responds reliably to small changes in these concentrations, down to the limits set by basic physical principles.

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