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Image analysis of germplasm behaviour reveals complex distribution patterns in early zebrafish embryos.

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The germline is a unique line of cells responsible for reproduction and loss of germline cells can lead to sterility and in extreme cases, loss of the species. This shows how vital the germline is for the continuation of species and hence how crucial early specification of the germline is in early embryogenesis. The precise mechanisms by which the germline is formed are seemingly species-dependent, for instance, zebrafish use a maternally derived ribonucleoprotein complex called germplasm to specify germ cells, but the mechanism is poorly understood. In particular, how germplasm is segregated into four clusters which are inherited by four cells at the 1000-cell stage, is not known. To understand the behaviour of germplasm we used live imaging across early embryonic cell divisions and tested whether germplasm is inherited asymmetrically through early embryonic cell divisions. Through fluorescence microscopy, live cell imaging and combining image analysis tools together with manual tracking, we find that germplasm distribution is largely asymmetric during early cell divisions. However, we also found evidence for symmetric cleavage of germplasm in some cells and cells with small aggregates undergo clearance. These observations were then tested statistically. Based on these results, we propose a new model to account for the behaviour of germplasm, "the SHARP (Stochastic Hereditary of Aggregated Ribonucleoprotein Particle) eraser model". Our model can be used to understand the mechanisms underpinning germplasm movement and localisation, and germline development and can potentially provide insights into how ribonucleoproteins across a range of contexts and cell types.