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How frog embryos replicate their DNA reliably JOHN BECHHOEFER, BRANDON MARSHALL, Dept. of Physics, Simon Fraser University — Frog embryos contain three billion base pairs of DNA. In early embryos (cycles 2-12), DNA replication is extremely rapid, about 20 min., and the entire cell cycle lasts only 25 min., meaning that mitosis (cell division) takes place in about 5 min. In this stripped-down cell cycle, there are no efficient checkpoints to prevent the cell from dividing before its DNA has finished replication - a disastrous scenario. Even worse, the many origins of replication are laid down stochastically and are also initiated stochastically throughout the replication process. Despite the very tight time constraints and despite the randomness introduced by origin stochasticity, replication is extremely reliable, with cell division failing no more than once in 10,000 tries. We discuss a recent model of DNA replication that is drawn from condensed-matter theories of 1d nucleation and growth. Using our model, we discuss different strategies of replication: should one initiate all origins as early as possible, or is it better to hold back and initiate some later on? Using concepts from extreme-value statistics, we derive the distribution of replication times given a particular scenario for the initiation of origins. We show that the experimentally observed initiation strategy for frog embryos meets the reliability constraint and is close to the one that requires the fewest resources of a cell.

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