***eLife’s* transparent reporting form**

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* If no explicit power analysis was used, you should describe how you decided what sample (replicate) size (number) to use

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Systems of ordinary differential equations are available in a Mathematica notebook (.nb) and R files provided online at https://github.com/drmsmith/microbiomeR. These include code to reproduce all results from Part 1, i.e. Figures 1 to 3 and Figures S1-S7.