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Exploring an autoimmune hair loss condition through mathematical modeling and sensitivity analysis

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Alopecia areata is a hair loss disease caused by an autoimmune response which disrupts the natural constantly repeating cycle of hair follicles. The cycle consists of three main phases - growth, regression, and rest, and alopecia areata considerably shortens the stage of hair growth. We will first present a model that captures the disease dynamics over time in a small cluster of homogeneous cycling follicles. The model couples equations that reflect the behavior of autoreactive immune cells with a dynamical system for the hair cycle. We will present our results from applying sensitivity analysis to determine how different cellular and molecular processes influence the duration of hair growth in healthy follicles versus follicles affected by alopecia areata. Finally, we will discuss our efforts to construct a PDE model that describes the distinctive spatio-temporal disease dynamics.