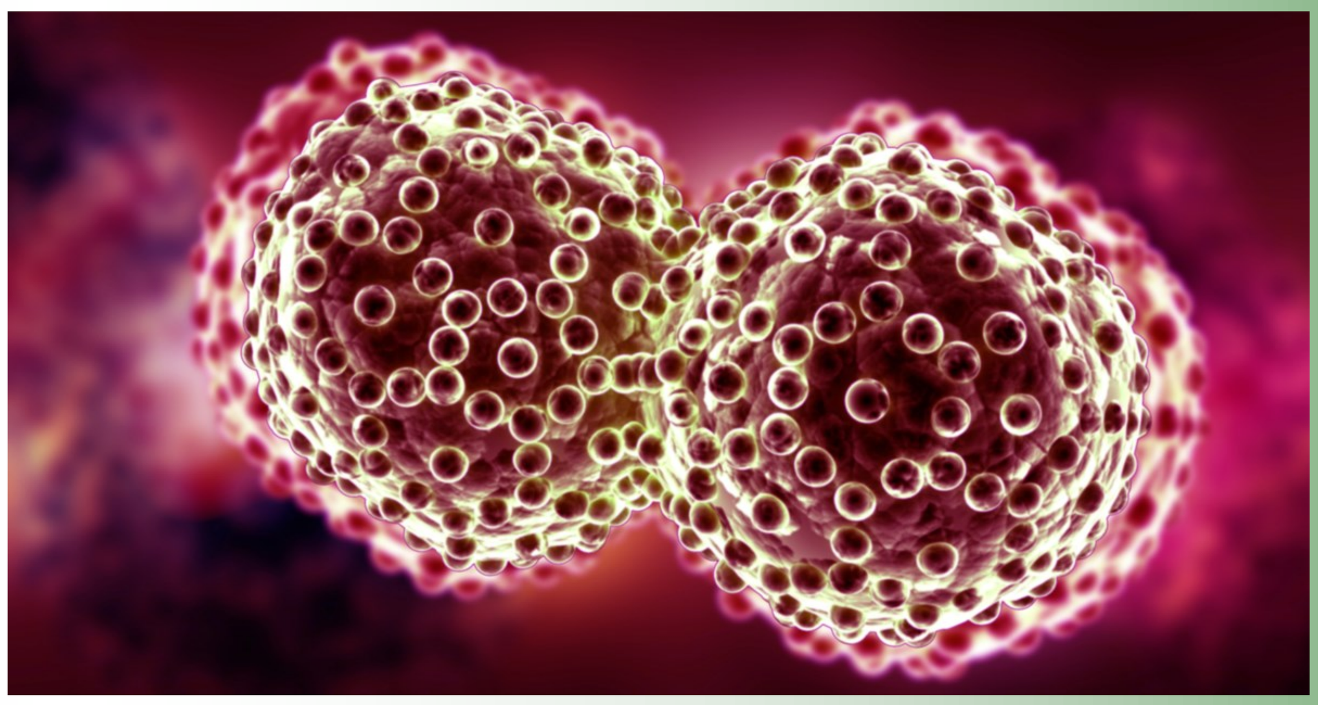
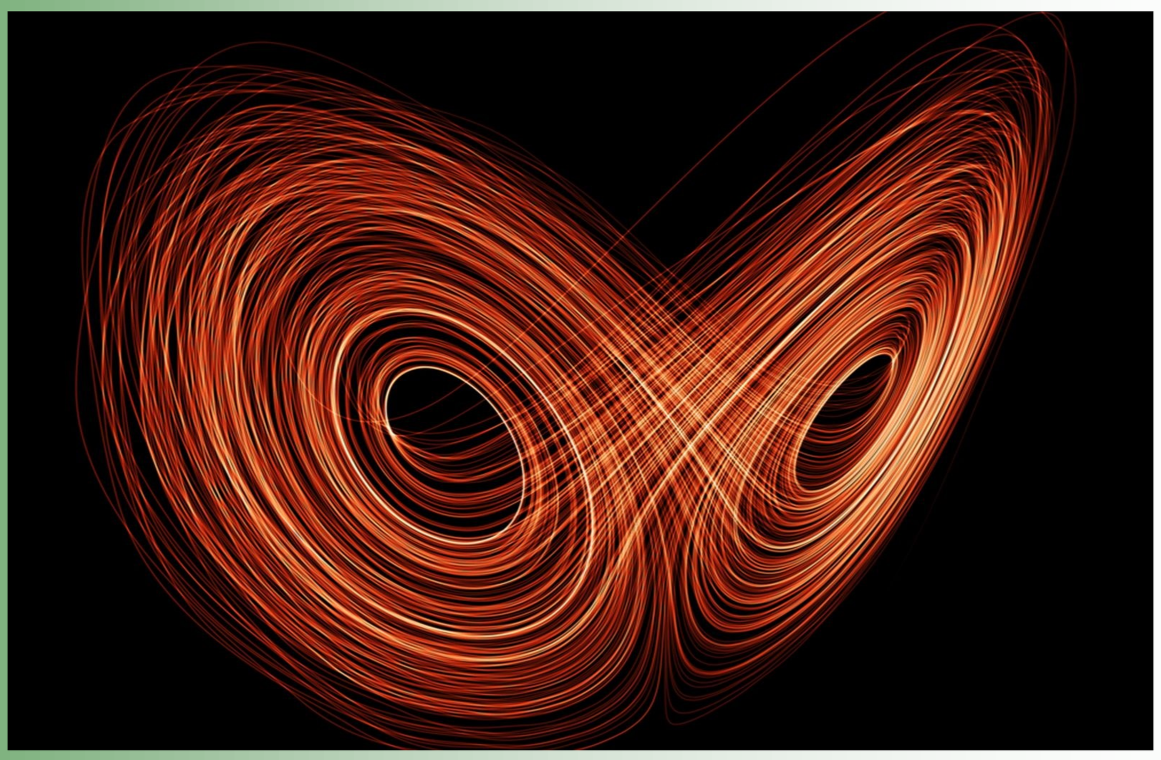
When *mathematics*

Meets Biology



During chemotherapy, there are two factors of concern: cancer eliminations and drug toxicity. An optimal treatment plan will need to balance both factors.



Mathematics, notably dynamical systems and control theory, can help us find the optimal solution that maximise cancer elimination while minimising drug toxicity

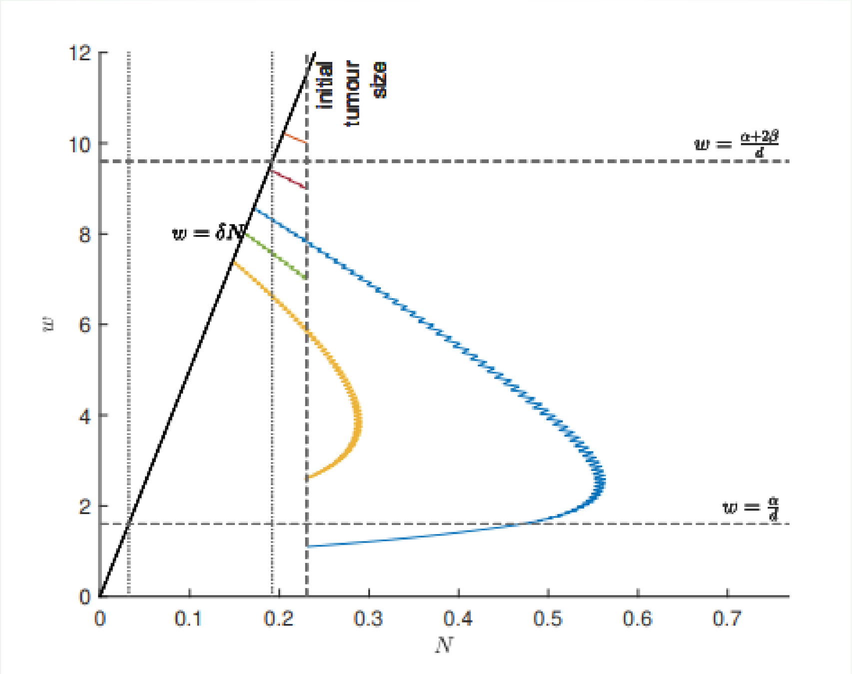
Studies have found that drug toxicity varies with our circadian rhythm. We can exploit this fact and provide a treatment plan accordingly, known as chronotherapy.

What did I do exactly?

1. Construct an ordinary differential equation model and a cost function. We want to find the treatment plan that minimises the cost.

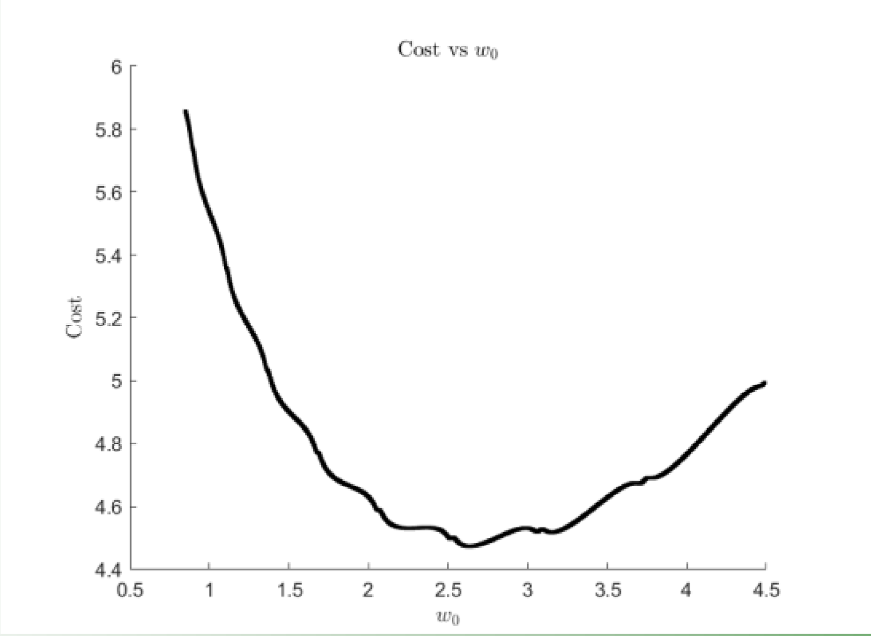
$$\frac{\mathrm{d}N}{\mathrm{d}t} = \lambda(t)\left(1 - \frac{N(t)}{K}\right)N - du(t)N(t)$$

$$J[N,u] = \delta N(T) + \int_0^T (\alpha + \beta h(t))u(t)\mathrm{d}t$$



2. Apply Pontryagin's Minimum Principle, obtain a family of optimal trajectories.

3. For each trajectory, compute the cost numerically, and find the minimum, thus obtain theoretically the best treatment plan.



Project Outcome: My project successfully analysed two one-dimensional logistic models by categorising the trajectories and finding the minimum cost. I also proposed two potential methods to analyse two-dimensional models (with delayed drug effect): asymptotic expansions and backward integration.