

MATH 495: Mathematics of Cancer

Quiz 4

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Answer the following question on this sheet of paper. No calculators or other electronic devices are permitted.

Consider a tumor that is **growing exponentially**. Answer the following questions related to growth and treatment of such a tumor.

- (a) In the absence of treatment, suppose that it takes  $\tau = 2 \ln 2$  days for the tumor mass to double in size. Find the growth rate  $\lambda$  of the population.
- (b) Now assume that treatment is applied to the **same tumor**. We experimentally observe **log-kill** dynamics in response to therapy. If the treatment is represented with efficacy  $u(t)$  at time  $t$  (i.e. its per-capita induced-death rate), write down a differential equation describing the dynamics of the tumor population during treatment.
- (c) Similarly to (b), write down a differential equation describing tumor growth **post-treatment**. How would you connect the dynamics of pre- and post-treatment? That is, how do the ODEs from (b) and (c) relate to one another?
- (d) Suppose we apply the following treatment strategy:

$$u(t) = \begin{cases} 1, & \text{for } 0 \leq t \leq 2 \\ 0, & \text{for } t > 2, \end{cases}$$

where  $t$  is measured in days. If (in some units, say  $10^7$  cells) the initial tumor had size  $N_0 = 10$ , find its size **four days after treatment**.