

BM5063 Mathematical Physiology and Systems Medicine

Exam 3

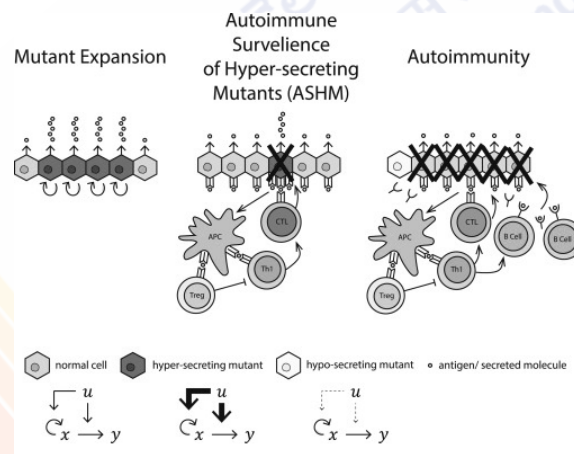
Instructions

1. This exam is open notes where you can use any hand-written material. Photocopies/prints/books/electronic devices are not permitted to be used.
2. You are expected to work on these problems on your own. **Any reasonable signs of 'copying/plagiarism' will attract penalties.**

Questions

1. This question is based on the research paper *Endocrine Autoimmune Disease as a Fragility of Immune Surveillance against Hypersecreting Mutants* by Kohanim et al., 2020 in the journal *Immunity*.

The “autoimmune surveillance of hypersecreting mutants” (ASHM) hypothesis suggests that autoreactive T cells are present in healthy individuals and that self-antigens are derived from peptides within the hormone secretion pathway. ASHM T cells recognize antigens in the secretion pathway to selectively eliminate cells that secrete more than their neighbors. When overactivated, the same cells can set off a persistent immune response including B cell activation that kills much of the tissue, except for hypo-secreting clones. See the figure below (taken from the research paper).



- (a) Identify key variables in the system. **(10)**
- (b) Write down equations describing the mechanism of ASHM (middle panel in the figure above). **(15)**
- (c) Describe the changes in the system (either in equations or parameters) that can lead ASHM to an autoimmune disorder (right most panel in the figure above). **(10)**