

UCLA Center for Biological Physics Seminar

How the Immune System Learns through Physical Constraints

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Throughout life, the adaptive immune system must continually learn to protect against an evolving world of micro-invaders (pathogens). A key challenge is how to generalize from limited examples under pressure for speed—unlike the way machines often learn. This challenge is met by an accelerated Darwinian process within us: through cycles of somatic mutation and positive selection, a finite repertoire of immune cells improves antigen recognition while assembling a diverse immunological memory.

Despite increasingly resolved views of molecules, cells, and tissues during immune responses, the principles underlying robust and efficient immune learning remain elusive. In this talk, I propose rethinking the basis of learning on the fly by considering the inherent physical capabilities of evolving systems. By describing the unexpected impact of modest

cellular forces and possible origins of rugged yet navigable fitness landscapes, I will show how generic physical constraints can enhance discrimination and enable efficient search through vast state spaces.

This framework bridges statistical physics and evolutionary biology to address long-standing puzzles in immunology and suggests new ways to detect physical imprints of learning..

**Monday, June 1st at 3pm
4-330 PAB**

Hosted by Shenshen Wang