Mathematical Biology: What Have You Done for Me Lately?

J. P. Keener

Department of Mathematics

University of Utah

Introduction

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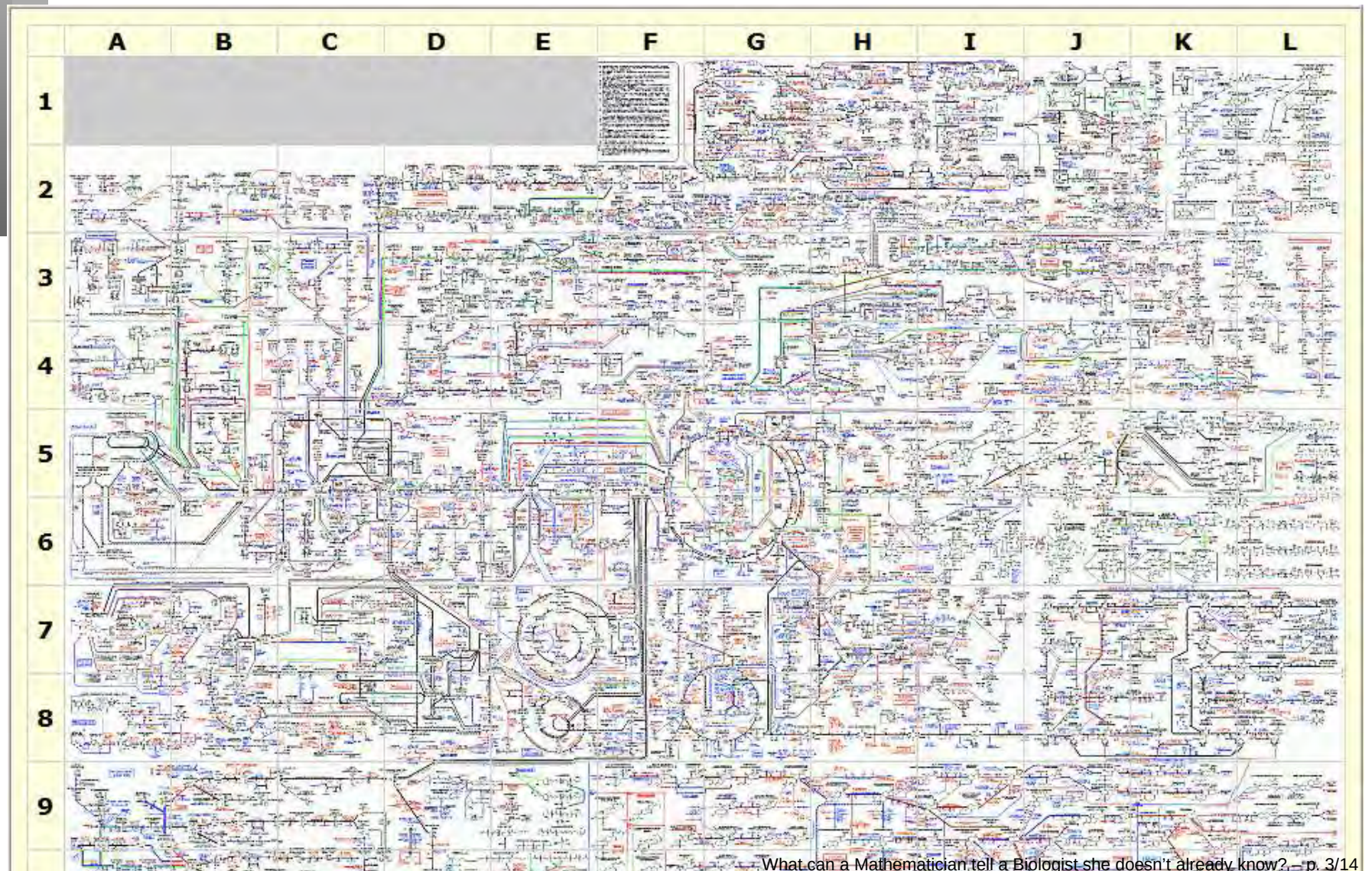
How can mathematics help?

- The search for general principles; organizing and describing the data in more comprehensible ways.
- Develop quantitative, predictive, mechanistic theories to replace qualitative, correlative, verbal explanations.

Biological Systems are Complex!!



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- Time scales: protein conformational changes $\rightarrow$ protein folding $\rightarrow$ action potentials $\rightarrow$ hormone secretion $\rightarrow$ protein translation $\rightarrow$ cell cycle $\rightarrow$ circadian rhythms $\rightarrow$ human disease processes $\rightarrow$ population changes $\rightarrow$ evolutionary scale adaptations

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- Populations and ecosystems - biodiversity, extinction, invasions.

The Need

Report from the Advisory Committee to the NIH Director on the Biomedical Workforce - 2012

"The NIH Biomedical Workforce report concluded that we probably have a serious oversupply in the pipeline of basic science PhD level investigators. BUT there is a serious shortage in one area, namely quantitative scientists..."

"The report challenged the NIH to initiate a serious and substantial training effort to close this gap. Thus, the two independent task forces came to one common conclusion that there is a serious shortage of trained quantitative scientists and the gap is widening."

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Recent Successes of Quantitative Approaches

- BioFire Diagnostics
- Merrimack Pharmaceuticals
- Tylenol overdose

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- Last month, BFD sold for $450M cash!

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- 6 compounds discovered this way are currently in stages of FDA approval.

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- Chris Remien and Fred Adler (UofU) built a (relatively simple) model (system of 7 differential equations) describing the dynamics of liver damage, glutathione and NAPQI concentrations, etc. that accurately predicts the outcome of antidote therapy.

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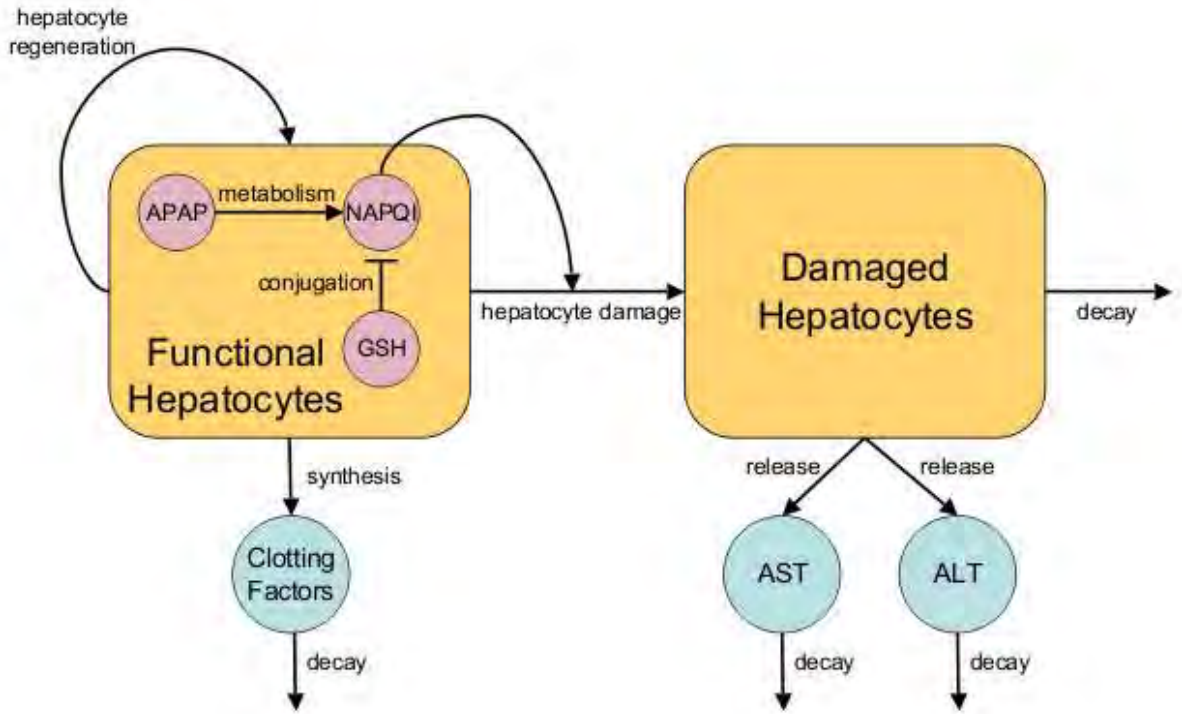

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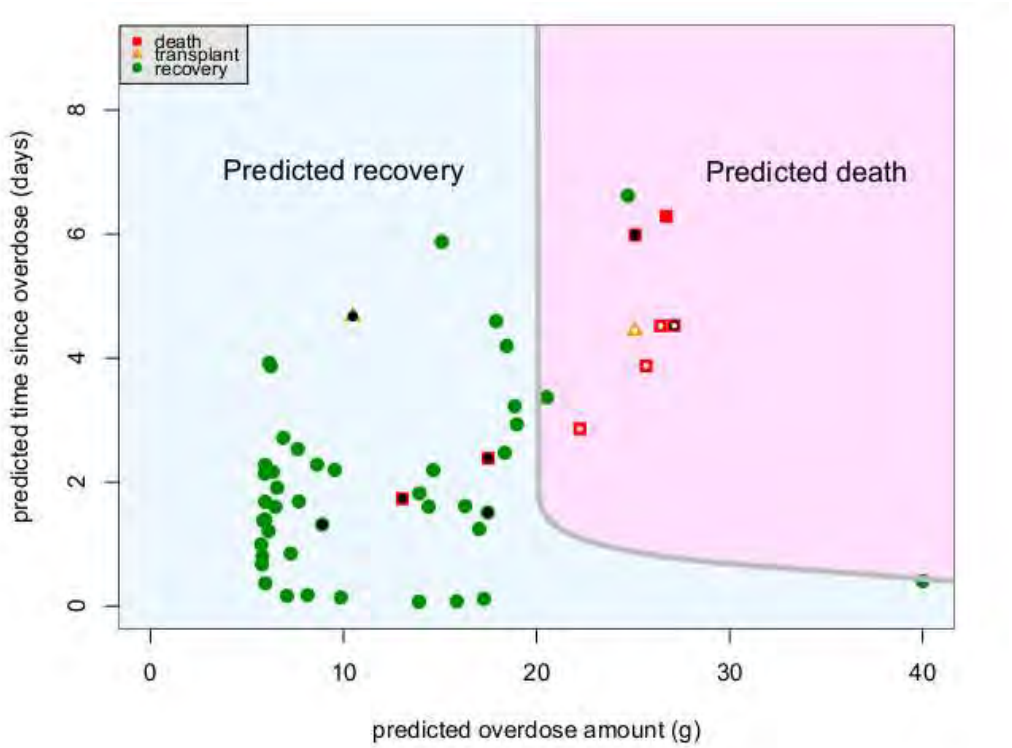

New treatment protocols are currently under investigation ...

The use of math in modern (i.e. post-genomic, data-driven) biology is relatively new. However, the complexity of biology demands that mathematical/quantitative approaches be encouraged.