General thoughts/ideas

* Who is the target audience?
* What kind of book would have the biggest reach & impact?
* Should it have more of an infectious disease or an immunology angle?
* What level do we aim at?
* We would need to focus on dynamic mechanistic models. I’m not expert enough to cover much other topics (genetic models, etc.)
* Should it be a “classical” book with a companion webpage that provides R scripts? Or a more modern form, e.g. e/multimedia-book with integrated exercises (e.g. like ActiveEpi)?
* Any good existing examples (even if only small aspects of a whole book) that we want to emulate?
* Should we touch on within-cell/molecular dynamical models? There are a ton, but we don’t really do those.
* How much stats ideas (e.g. along the lines of the T-cell repertoire analysis) should we include?

Related work

* “Killer Cell dynamics” by Dominik Wodarz, Springer
* “Virus Dynamics” by Nowak and May

Title Ideas

* Mechanistic modeling in immunology and virology

Ideas for structure

* Structure it along pathogens, with each pathogen being used to introduce a new modeling approach (like SISMID).
* Structure it along modeling topics, with specific pathogens as “worked examples” at the appropriate locations (like a “Keeling and Rohani” for within-host modeling).
* A combination of the 2 previous ones. 1st part introduces immunology and modeling basics, 2nd part gives case studies for specific pathogen.

Sketch of a possible outline (not very good)

Part 1:

1. General Introduction (what is this book (not), what prerequisites, etc.)
2. Overview of Modeling (what is modeling, why do it, etc.)
3. Immunology Primer
4. Simple difference and differential equation models for an acute viral infection
5. Primer of the innate response
6. ODE models with innate responses. Case studies (with biology background) for some pathogens.
7. Primer of adaptive response.
8. ODE models with adaptive response. Case studies.

Part 2:

1. Stochastic models. Case studies for some pathogens.
2. Spatial models & case studies
3. …

Part 3:

1. Fitting data introduction
2. Fitting data case studies.
3. Fitting data advanced topics.

Biology – Topics and Objectives

* T-cells:
* B-cells:
* HIV
* HCV
* Influenza
* Dengue
* Malaria
* TB

Modeling – Topics and Objectives

* Show a discrete time model and its continuous equivalent
* Show and explain a simple virus model
* Show and explain a simple bacteria model
* Show what simple models can do
* Show how model formulation can affect outcome
* Show how to deal with parameter uncertainty
* How to fit models to data

List of individual modules/units

|  |  |  |  |
| --- | --- | --- | --- |
| **Module Name** | **Biology Content** | **Modeling Content** | **Notes** |
| Basic bacteria/IR model | Complement? | Simple compartmental model |  |
|  |  |  |  |
|  | Cytokines |  |  |
|  | Innate cells |  |  |
|  | B-cells |  |  |
|  | T-cells |  |  |
| HCV treatment | HCV and treatment | How to model drug treatment |  |
|  |  |  |  |

Sketch of a possible outline (not very good)

Part 1: General Introductory Stuff

1. General Introduction (what is this book (not), what prerequisites, etc.)

2. Overview of Modeling (what is modeling, why do it, etc.)

3. General Immunology Comments

Part 2: Brief introduction to basic immunology and basic modeling

4. Simple difference and differential equation models for an acute viral infection

5. Primer of the innate response

6. ODE models with innate responses. Case studies (with biology background) for some pathogens.

7. B-cells. Primer of adaptive response.

8. T-cells. ODE models with adaptive response. Case studies.

Part 3: Specific pathogens and specific models

9. Stochastic models. Case studies for some pathogens.

10. Spatial models & case studies

11. Fitting data

Biology – Topics and Objectives

- T-cells:

- B-cells:

- Innate response

- HIV

- HCV

- Influenza

- Dengue

- Malaria

- TB

- Co-infection

Model structure/flow:

Introduction:

* Show some basic models
* Discrete time, ODE, compartmental
* Simple bacteria model, simple virus model

Model Use 1 - Understanding/exploration

* Building and exploring a simple ODE model
* Importance of model term formulation (HIV model)
* Models with memory (Alun Lloyd paper, Catherine flu work)

Model Use 2 - Making predictions

* Using a model to make predictions
* Assessing parameter uncertainty in predictions (U/S analysis)
* Assessing process uncertainty in predictions (stochastic models)

Model Use 3 - Hypothesis testing/inference/parameter estimates

* Simple/qualitative hypothesis testing (HCV)
* Fitting/inference (influenza)

Further topics

* Evolutionary dynamics
* Spatial structure
* Co-infections (Amber and Pej work)

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|  | B-cells |  |  |
|  | T-cells |  |  |
| HCV treatment | HCV and treatment | How to model drug treatment |  |
| HCV & IFN |  | “qualitative fitting” |  |