Mathematics and Medicine: Prescription for a Healthy Relationship

J. P. Keener

Mathematics Department
University of Utah
The Dilemma of Modern Medicine

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Introduction

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A Significant Modern Development

- The advent of fast, readily available computing. Question: What to do with all this computing power?
Mathematical Medicine: Using mathematics (and this newfound computational power) to understand the complexities of the medical and life sciences.

- Organize and describe the data in more comprehensible ways.
- Provide predictive theories to replace verbal explanations.
- Cross the scales of space and time; Discover and understand emergent properties.
- Help you see things that couldn’t be seen otherwise.

Main Point: Mathematics can help you see and do things you could not have done otherwise.
There are numerous unanswered questions:

- What areas of medicine are most likely to yield to mathematical approaches?
- What mathematical tools are most likely to be useful?
- Can we overcome the cultural and language barriers?

It is impossible to predict the impact of mathematics on medicine, however, if the past is an indicator of the future...
A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

Examples:
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Examples:

- to divide -
A few words about words

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Examples:

- to divide - find the ratio of two numbers (Mathematician)
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Examples:

- to divide - replicate contents and split a cell into two (Biologist)
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Examples:

- **to divide** - replicate contents and split a cell into two
  (Biologist)
- **to differentiate** -
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Examples:

- to divide - replicate contents and split a cell into two (Biologist)
- to differentiate - find the slope of a function (Mathematician)
A few words about words

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Examples:

- to divide - replicate contents and split a cell into two (Biologist)
- to differentiate - change the function of a cell (Biologist)
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Examples:

- to *divide* - replicate contents and split a cell into two (Biologist)
- to *differentiate* - change the function of a cell (Biologist)
- a PDE -
A few words about words

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Examples:

- to divide - replicate contents and split a cell into two (Biologist)
- to differentiate - change the function of a cell (Biologist)
- a PDE - Partial Differential Equation (Mathematician)
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Examples:

- to divide - replicate contents and split a cell into two (Biologist)
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- a PDE - Phosphodiesterase (Biologist)
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Examples:

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- a PDE - Pennsylvania Department of Education (Google)

And so it goes with words like germs and fiber bundles (topologist or microbiologist), cells (numerical analyst or physiologist), complex (analysts or molecular biologists), domains (functional analysts or biochemists), and rings (algebraists or protein structure chemists).
The Math in the Life of a Cardiologist

The patient’s first visit:

- Patient information system, retrieval of medical records
- Literature searches, database search engines

Search engines, database management, data mining, courtesy of mathematics.
Interpretive EKG algorithms provided courtesy of mathematics.
Pacing and Cardioverter algorithms courtesy of mathematics.
Medical visualization and animation provided courtesy of mathematics.
Medical imaging (MRI, PET, CAT) provided courtesy of mathematics.
Fluid dynamics simulation courtesy of mathematics.
Electrical Activity of Cardiac Cells

Simulations of action potentials in cardiac cells provided courtesy of mathematics.
Simulations of cardiac arrhythmias provided courtesy of mathematics.
Summary

• This brief tour barely scratches the surface of the symbiotic relationship between mathematics and medicine.

• The coming years promise many dramatic new advances from this interaction.

• The Centre for Mathematics and Medicine is well-positioned to be at the forefront of this advance. Congratulations!
Credits

• Medtronic Inc. website
• Chris Johnson, University of Utah
• Charles Taylor, Stanford University
• Spencer Sherwin, Imperial College
• Charles Peskin, New York University
• Aaron Fogelson, University of Utah
• Yoram Rudy, Washington University
• Alexandre Panfilov, University of Utrecht