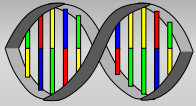


Mathematics and Medicine: Prescription for a Healthy Relationship

J. P. Keener

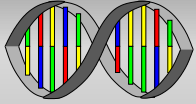
Mathematics Department

University of Utah



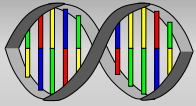
The Dilemma of Modern Medicine

- The amount of data being collected is staggering. Knowing what to do with the data is in its infancy.



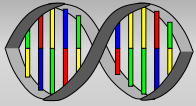
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- Much of what is "known" is correlative rather than mechanistic, historical rather than predictive, qualitative rather than quantitative.

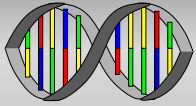


The Dilemma of Modern Medicine

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A Significant Modern Development

- The advent of fast, readily available computing. Question: What to do with all this computing power?

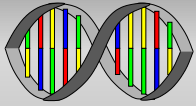


Can Math Help?

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.

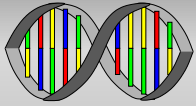


Will Math Help?

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?

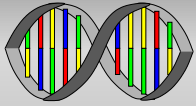
It is impossible to predict the impact of mathematics on medicine, however, if the past is an indicator of the future...



A few words about words

A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

Examples:

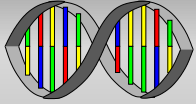


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Examples:

- to **divide** -

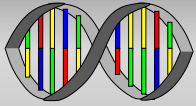


A few words about words

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Examples:

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

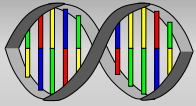


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Examples:

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

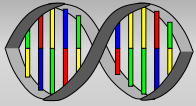


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Examples:

- to **divide** - replicate contents and split a cell into two
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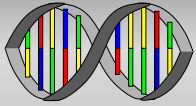


A few words about words

A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

Examples:

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

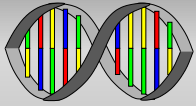


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- to **divide** - replicate contents and split a cell into two (Biologist)
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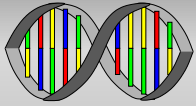


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Examples:

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

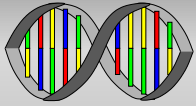


A few words about words

A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

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)

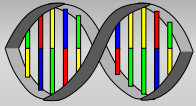


A few words about words

A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

Examples:

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



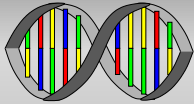
A few words about words

A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

Examples:

- to **divide** - replicate contents and split a cell into two (Biologist)
- to **differentiate** - change the function of a cell (Biologist)
- a **PDE** - Pennsylvania Department of Education (Google)

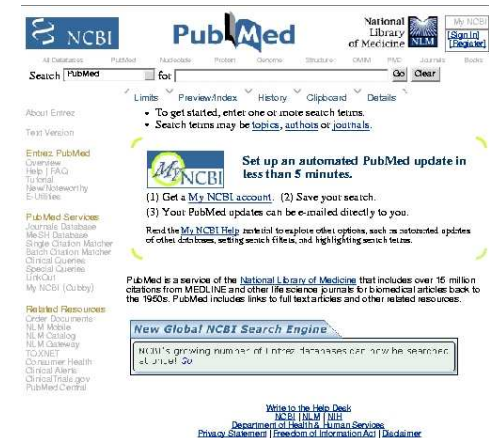
And so it goes with words like **germs** and **fiber bundles** (topologist or microbiologist), **cells** (numerical analyst or physiologist), **complex** (analysts or molecular biologists), **domains** (functional analysts or biochemists), and **rings** (algebraists or protein structure chemists)



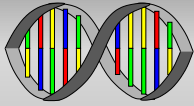
The Math in the Life of a Cardiologist

The patient's first visit:

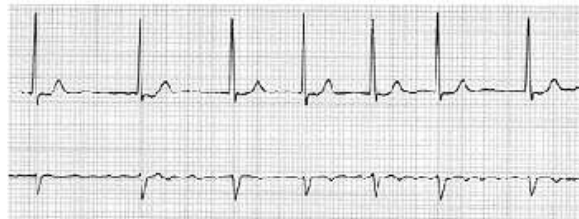
- Patient information system, retrieval of medical records
- Literature searches, database search engines



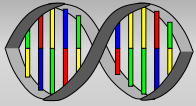
Search engines, database management, data mining, courtesy of mathematics.



Diagnostics



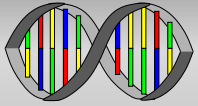
Interpretive EKG algorithms provided courtesy of mathematics.



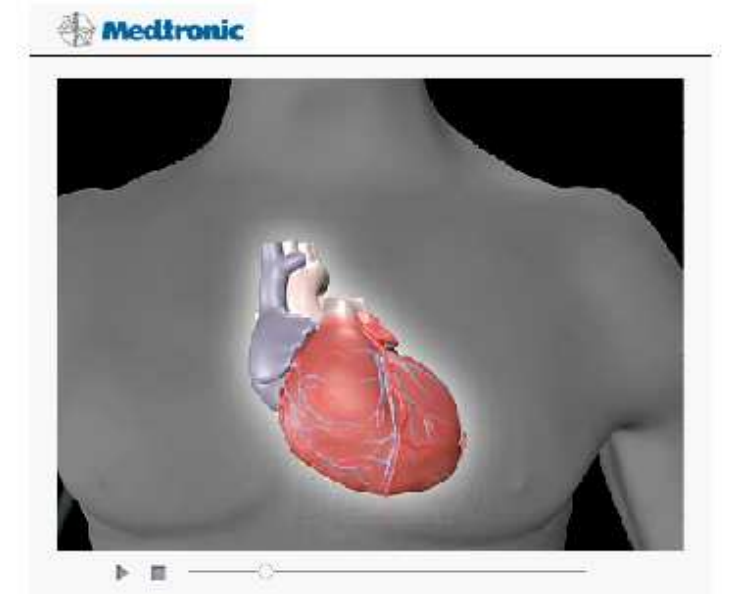
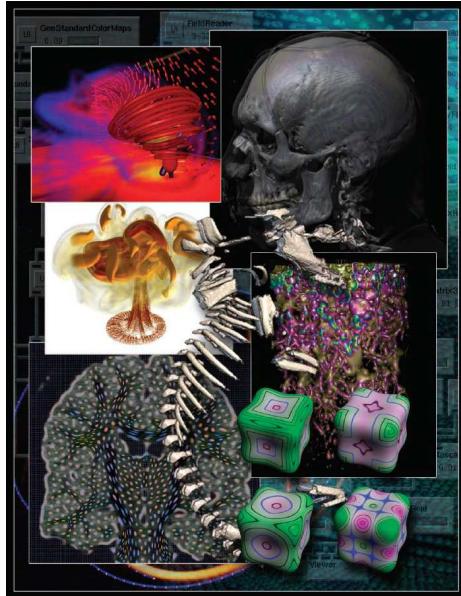
Medical Devices



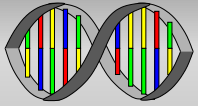
Pacing and Cardioverter algorithms courtesy of mathematics.



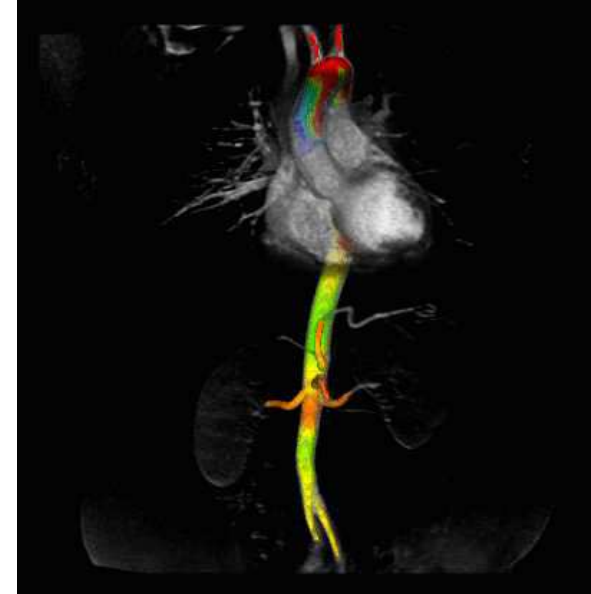
Visualization



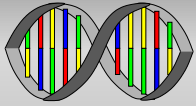
Medical visualization and animation provided courtesy of mathematics.



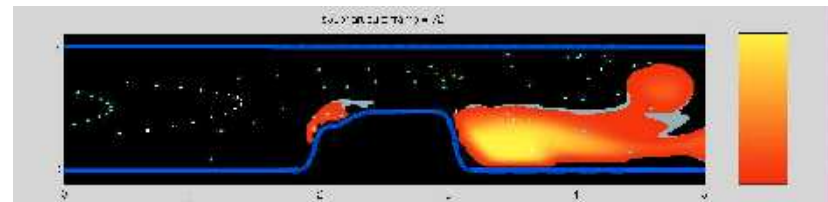
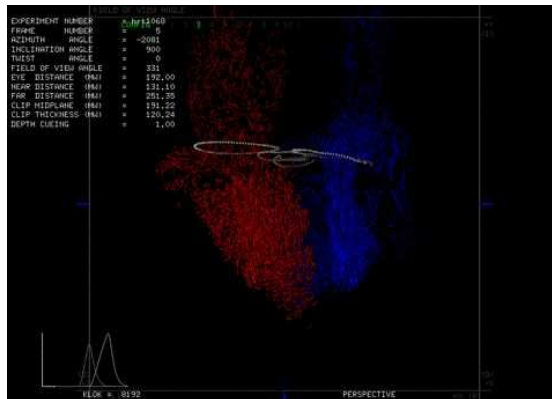
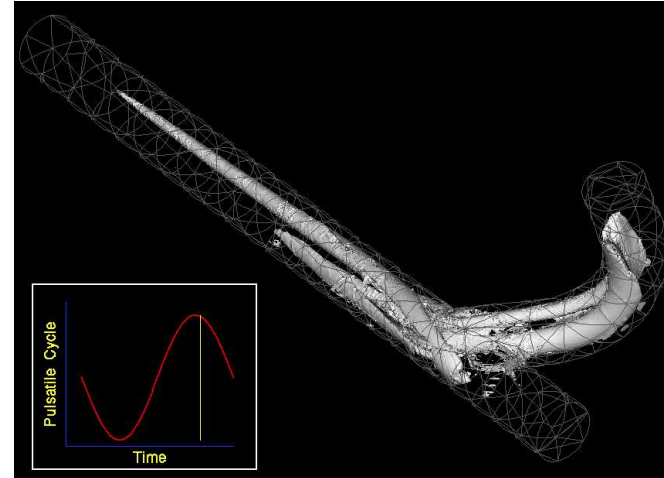
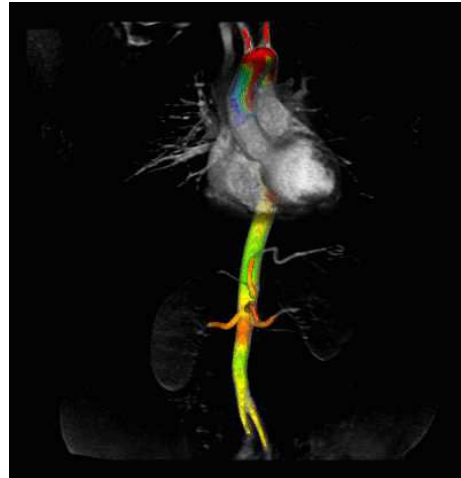
Medical Imaging



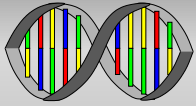
Medical imaging (MRI, PET, CAT) provided courtesy of mathematics.



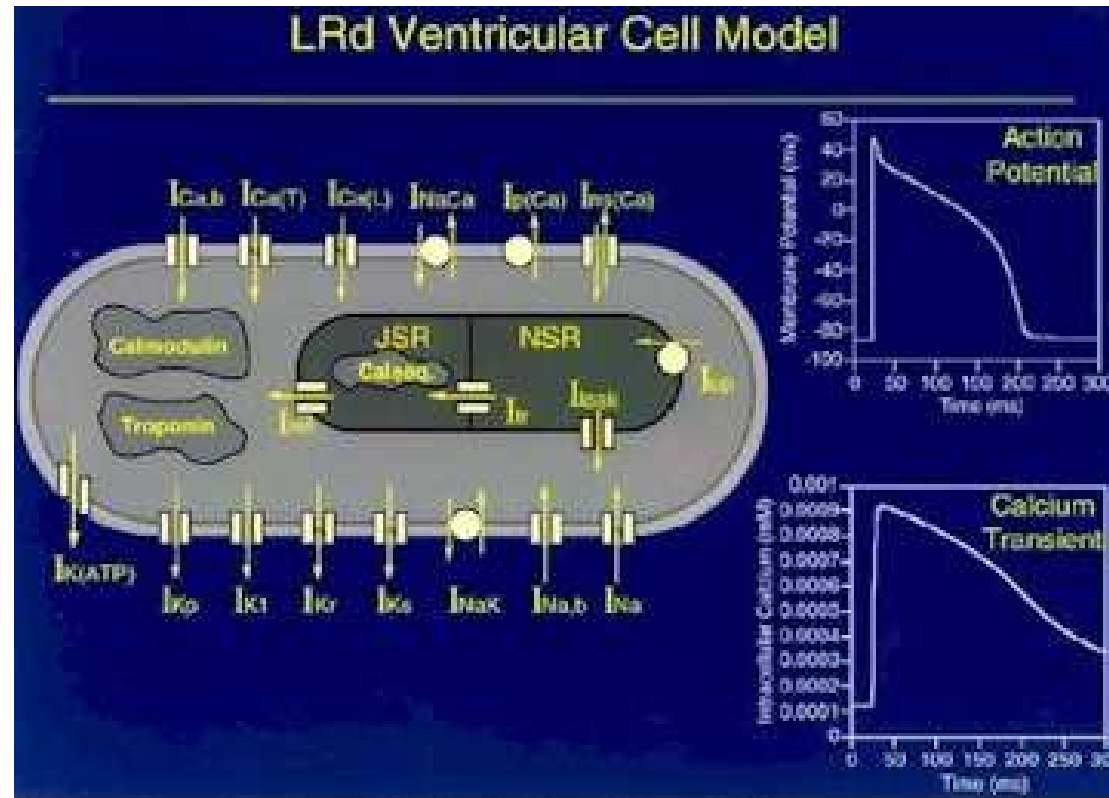
Blood Flow



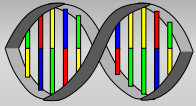
Fluid dynamics simulation courtesy of mathematics.



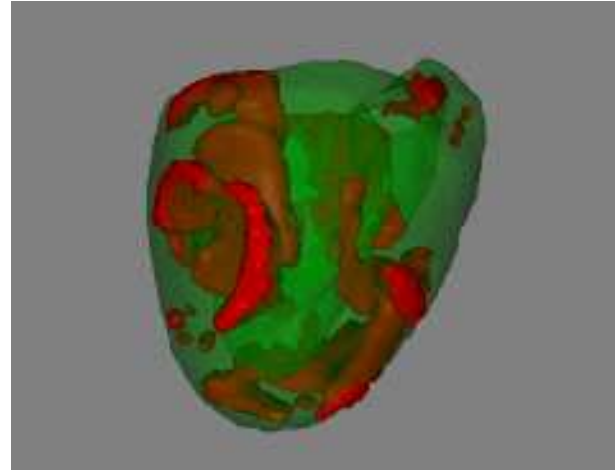
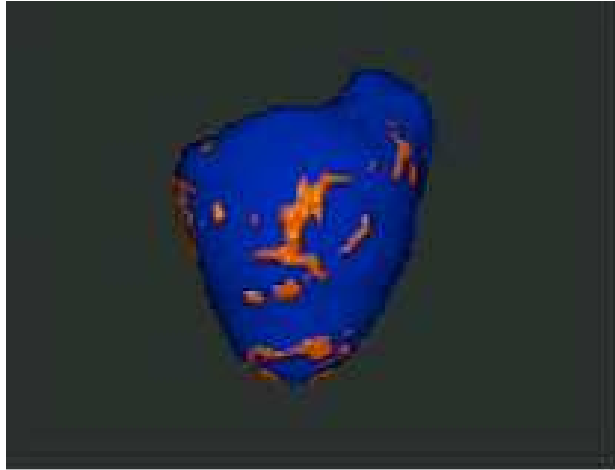
Electrical Activity of Cardiac Cells



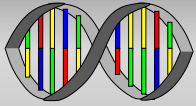
Simulations of action potentials in cardiac cells provided courtesy of mathematics.



Dynamics of Cardiac Arrhythmias

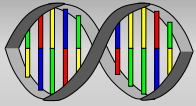


Simulations of cardiac arrhythmias provided courtesy of mathematics.



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