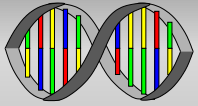


# ***Mathematics and Medicine: Prescription for a Healthy Relationship***

J. P. Keener

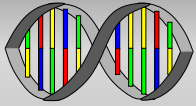
Mathematics Department

University of Utah



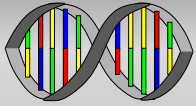
## The Dilemma of Modern Medicine

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



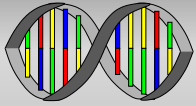
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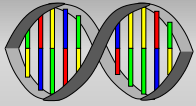


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## A Significant Modern Development

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

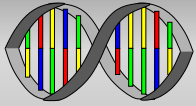


# *Can Math Help?*

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.

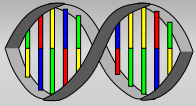


# *Will Math Help?*

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...



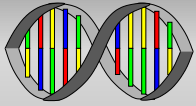
# ***A few words about words***

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

Examples:





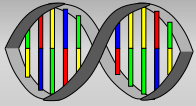
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- to **divide** -



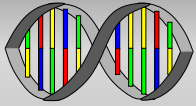
# *A few words about words*

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

Examples:

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



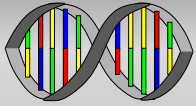
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Examples:

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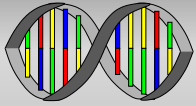


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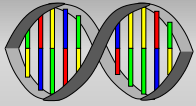


# ***A few words about words***

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)

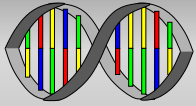


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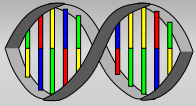


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Examples:

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



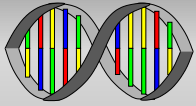
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Examples:

- 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)



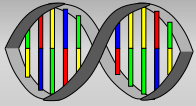


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A big difficulty in communication between Mathematicians and Life Scientists is because of different vocabulary.

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)



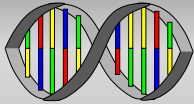
# ***A few words about words***

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)

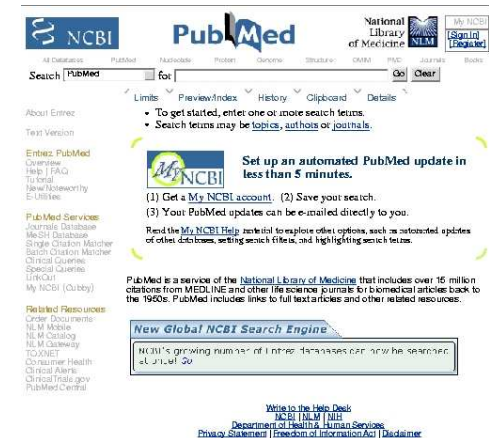
And so it goes with words like **germs** and **fiber bundles** (topologist or microbiologist), **cells** (numerical analyst or physiologist), **complex** (analysts or molecular biologists), **domains** (functional analysts or biochemists), and **rings** (algebraists or protein structure chemists)



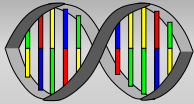
# The Math in the Life of a Cardiologist

The patient's first visit:

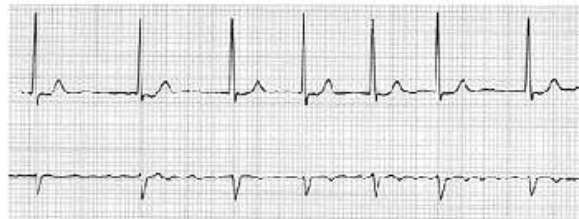
- Patient information system, retrieval of medical records
- Literature searches, database search engines



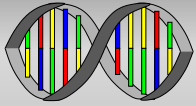
Search engines, database management, data mining, courtesy of mathematics.



# ***Diagnostics***



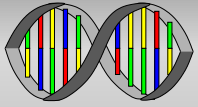
Interpretive EKG algorithms provided courtesy of mathematics.



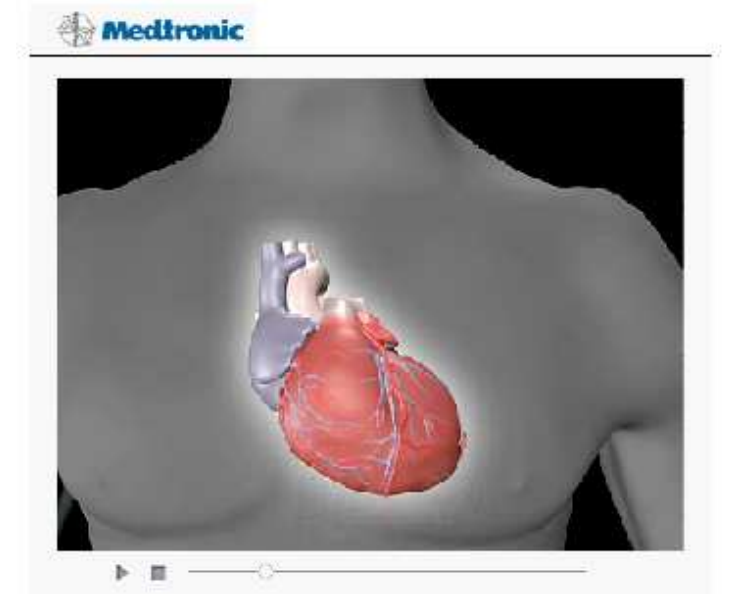
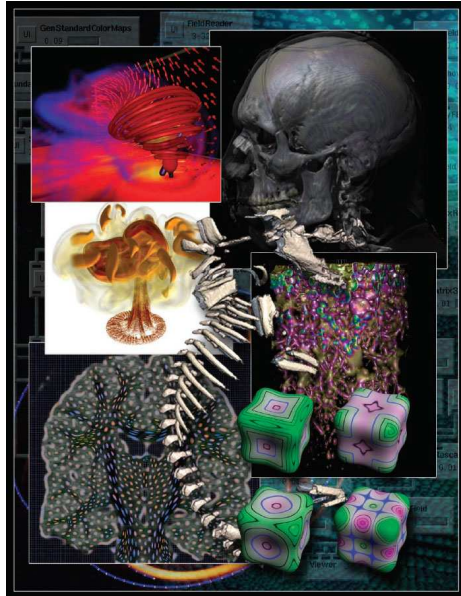
# Medical Devices



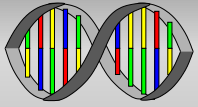
Pacing and Cardioverter algorithms courtesy of mathematics.



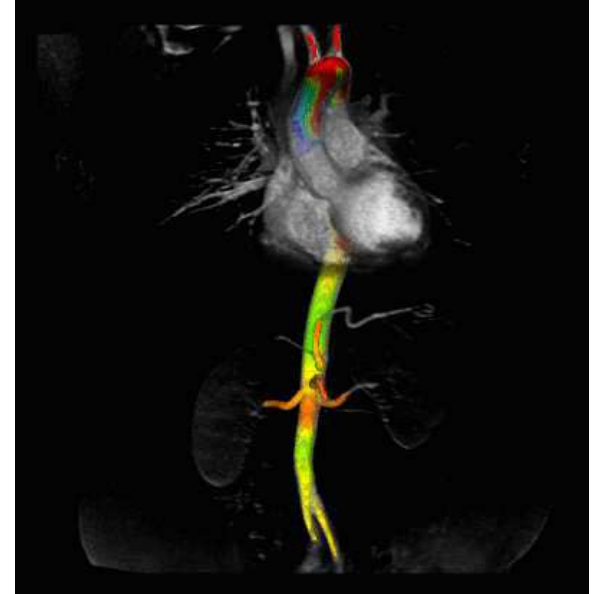
# Visualization



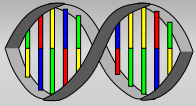
Medical visualization and animation provided courtesy of mathematics.



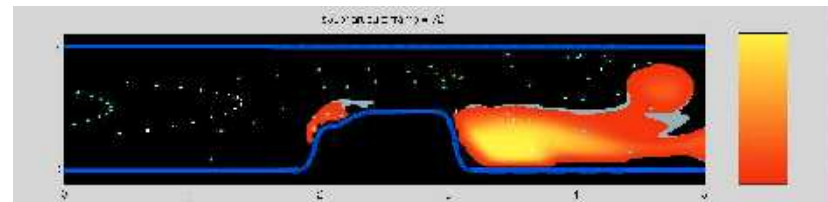
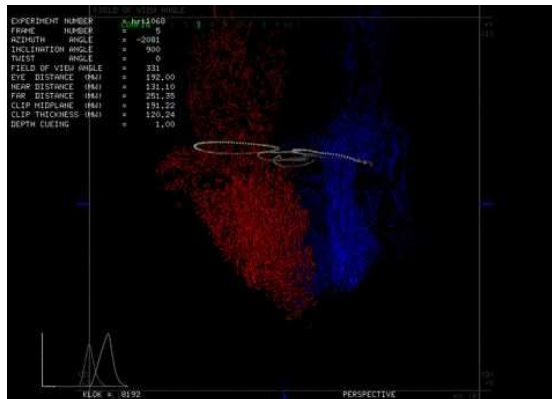
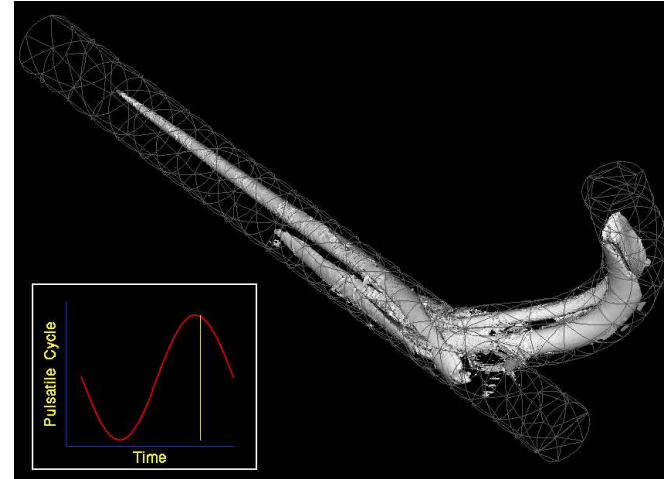
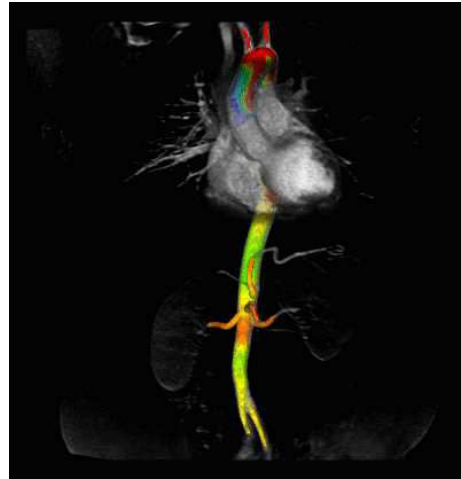
# *Medical Imaging*



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

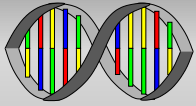


# Blood Flow

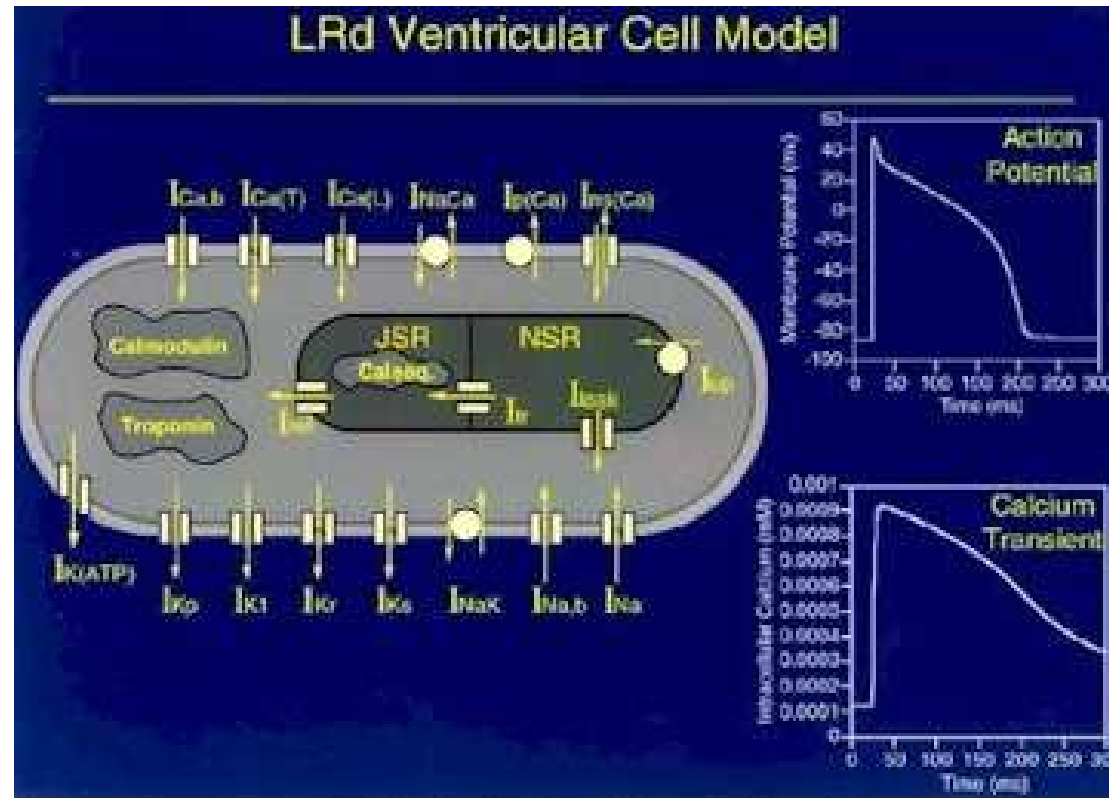


Fluid dynamics simulation courtesy of mathematics.

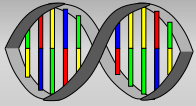




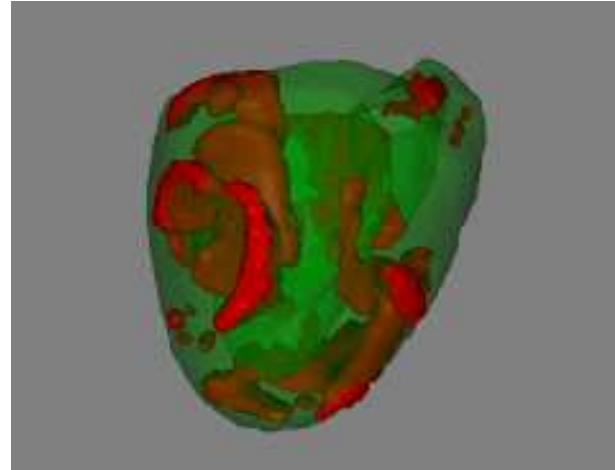
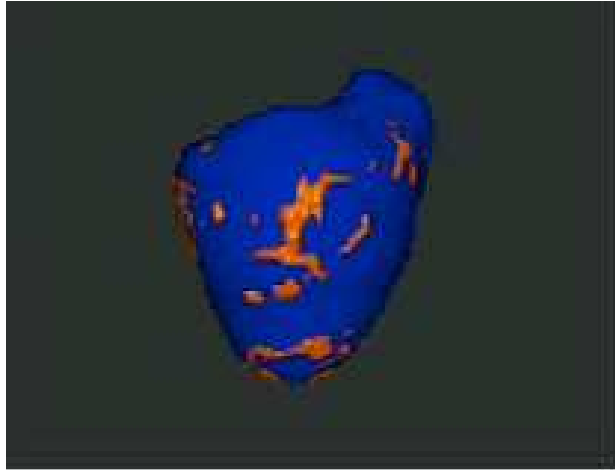
# Electrical Activity of Cardiac Cells



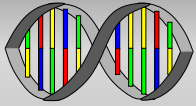
Simulations of action potentials in cardiac cells provided courtesy of mathematics.



# *Dynamics of Cardiac Arrhythmias*



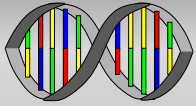
Simulations of cardiac arrhythmias provided courtesy of mathematics.



# *Summary*

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- 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