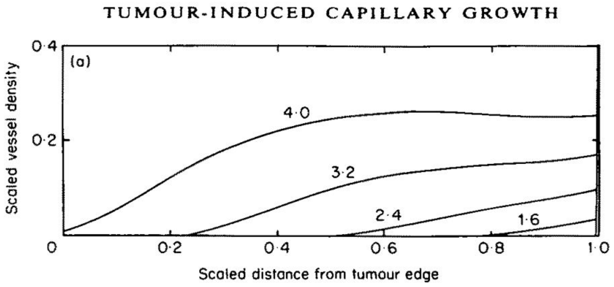
1985

Balding, D. & McElwain, D. L. S

Dr. Balding - Professor of Mathematics, Statistics, and Computer Science at the University of Newcastle

Dr. McElwain -Professor of Mathematics, Statistics, and Computer Science at the University of Newcastle

This chart shows one of the results from the experiment. It shows what levels of vessel density resulted in the largest distance from the tumor's edge.



Angiogenesis: the physiological process by which new blood vessels form from existing vessels.

Balding and McElwain performed an experiment where limbal vessels of an animal host responds to a Tumor Antigenesis Factor (TAF) planted in the cornea by forming new capillaries that then grow into the source. The mathematical model created from this experiment produces graphs to show the numerical values that lead the mathematicians to develop certain strategies that help heal and develop tools to study the anti-angiogenesis further.

2000

Levine, H.A, Sleeman, B.D, & Nilsen-Hamilton, M

Dr. Levine - Department of Mathematics at Iowa State
Dr. Sleeman - Department of Applied Mathematics at the University of Leeds
Dr. Nilsen-Hamilton - Department of Biochemistry, Biophysics, & Molecular Biology at Iowa State

These doctors created a mathematical model that described the introduction of capillaries in tumor angiogenesis as it is extended to pericytes and macrophages in regulating angiogenesis.

Pericytes: contractile cells that wrap around the endothelial cells

2003

Fister, R. & Panetta, J.C

Dr. Panetta - Mathematics program at Penn State and mathematician serving as a biomedical modeler at Pharmacokinetics Shared Resource.
Dr. Fister - Mathematician at Murray State University in Kentucky

Fister and Panetta Equation:
N represents the tumor volume
The parameter r is a growth rate
Θ represents a maximum size of the tumor
$u(t)$ represents the physician-prescribed treatment

The equation below tracks how certain medications react to tumor growth or shrinkage

$$\frac{dN}{dt} = rN\ln\left(\frac{\theta}{N}\right) - G(N, u(t))$$

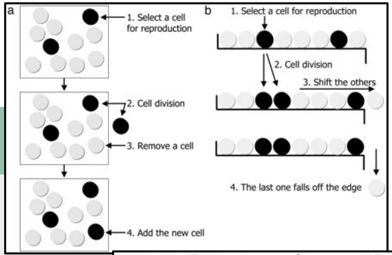
2003

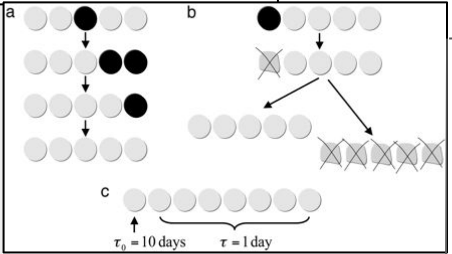
Nowak, M. A., Michor, F. & Iwasa, Y

Dr. Nowak - Professor of Biology and Mathematics at Harvard University

Dr. Michor - Professor of Computational Biology in the Department of Biostatistics

Dr. Iwasa - Associate Professor of Mathematics at the University of South Carolina at Beaufort.





This mathematical model and design has the potential to slow the rate of somatic evolution ("the accumulation of mutations and epimutations in the cells of a body during a lifetime") which would delay the onset of cancer

$$\rho = 1 \Big/ \left[1 + \sum_{k=1}^{N-1} \frac{1}{S^k} \prod_{i=1}^{k} \left(1 - \frac{i}{N}\right) \right]$$

This equation shows the *probability* that a single mutant cell starting in position one takes of the whole compartment.

connects to consumer statistics and probability

2014

The Cost of Cancer

Cancer patients were paying nearly $4 billion out of pocket for different cancer treatments. A large portion of the $87.8 billion spent on cancer-related healthcare in 2014 was paid through employers, insurance companies, and publicly funded programs.

connects to finance

Anderson, A. R. A

Dr. Anderson - Chair of the Integrated Mathematical Oncology (IMO) department and Senior member at Moffitt Cancer Center.

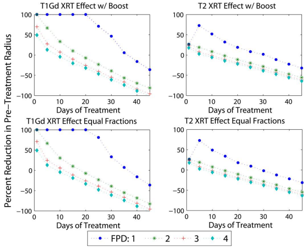
Dr. Anderson completed a mathematical model examine how the geometry of a growing tumor is affected by tumour cell heterogeneity caused by genetic mutations.

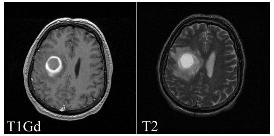
connects to geometry

2005

Rockne, R., Alvord, E. C., Rockhill, J. K. & Swanson, K. R.

Dr. Rockne - Assistant professor in the Department of Information Sciences within Beckman Research Institute
Dr. Alvord - Scientist at University of Washington at Seattle
Dr. Rockhill - Radiation Oncologist at UWMC Neuro Oncology Clinic
Dr. Swanson - Director, Mathematical NeuroOncology; Professor and Vice Chair, Neurosurgery, at the Mayo Clinic





connects to geometry

2009

These four scientists completed a mathematical model which presented an extension to a reaction-diffusion model. The scientists explored different therapy options with a virtual tumor to see how it would react.

Maggie Hooks and Syd Shadrick
Annotated Bibliography
Math 1010: Sarah Greenwald

Blading, David, McElwain, D.L. Sean. "A Mathematical Model of Tumor-Induced Capillary Growth." *Journal of Theoretical Biology,* Volume 114, Issue 1, pp. 53-72, 21 August 1984.

A scholarly article discussing the experimental research done by Dr. David Balding and Dr. D.L Sean McElwain, two mathematicians from Australia that researched the effects of capillary implantation to tumor growth. The two doctors implanted vessels from animal cells into the cornea causing new capillaries to grow and form. They then examined how tumors grew or shrunk based on certain capillary growth and if certain vessel density caused the largest scaled distance from the tumor's edge. The experimentation used math when applied to cancer through various equations and graphs. Their experiments worked to develop research on ways to help heal cancer victims and establish tools to develop the study of anti-angiogenesis further.

Byrne, Halen M. "Dissecting cancer through mathematics: from the cell to the animal model." *Nature Reviews*, Macmillan Publishers Limited, 1 Mar. 2010, www.nature.com/articles/nrc2808. A timeline highlighting 84 mathematical breakthroughs in cancer throughout the most recent 50 years. We chose six of these articles to highlight in our paper. Many of these breakthroughs were very important, and it was very interesting to see the span of time these breakthroughs have occurred over. It was very cool to see how much cancer research has progressed along with mathematics and technology.

Levine, Howard A., Sleeman, Brian D., Nilsen-Hamilton, M. "A Mathematical Model for the Roles of Pericytes and Macrophages in the Initiation of Angiogenesis." *Mathematical Biosciences*, Volume 168, Issue 1, pp. 77-115, November 2000.

This entry in the scholarly journal *Mathematical Biosciences* covers the research done by doctors Howard Levine, Brian Sleeman, and Marit Nilsen-Hamilton, two mathematicians and one biology expert's research into tumor angiogenesis as applied to capillary induction and the regulation of pericytes and macrophages in the cancer cells. These doctors used mathematical models to track the cell growth of cells that further cause cancer like pericytes, cells that wrap around endothelial cells, and macrophages, cells that are important in fighting infection. Their research helped discover more information about minimizing cells that both cause cancer and prolong it in already existing cancer patients. They were able to use a combination of math and science to help cancer research.

Mackenzie, Dana. “Mathematical Modeling and Cancer.” *Siam News*, Volume 37, Number 1, January/February 2004.

This article covers information about Dr. Renee Fister’s life and her work with Dr. Carl Panetta to develop a mathematical equation that could measure a patient’s reaction to certain prescription drugs and how those reactions affected tumor growth. The article goes into detail about Fister’s life and why she chose cancer research as a career. Her younger brother died at a young age from cancer and she chose to dedicate her passion for math to cancer research. Along with the help of Dr. Panetta, a researcher at the St. Jude’s Hospital for Cancer Research, they created an equation with variables such as tumor volume, drug prescribed by a doctor, and growth rate. This work has been used for doctors to help give appropriate drugs to appropriate patients depending on their diagnosis and their own tumor.

Nowak, Martin A, et al. “The linear process of somatic evolution.” *PNAS*, HighWire Press, 16 Oct. 2003, www.pnas.org/content/100/25/14966.full.

A web article that outlines the findings of Dr. Nowak, Dr. Michor and Dr. Iwasa. Provides detailed photos and analyses of how these scientists designed a mathematical model that could potentially delay the onset of cancer. These authors used the process of evolutionary dynamics including the rate of evolution and linear processes in order to come to their conclusion. In the end, they found different tumor suppressor genes which which then delay the onset of cancer.

Singleterry, Jennifer. “The Costs of Cancer.” *Ascan.org*, American Cancer Society, Apr. 2017, www.acscan.org/sites/default/files/Costs%20of%20Cancer%20-%20Final%20Web.pdf.

An article/booklet addressing the cost of cancer treatments for patients. Clearly outlines the costs with and without insurance, along with graphs and photos for explanation. Because cancer is currently one of the leading causes of death, prices of treatments are skyrocketing. The cost of cancer depends on the type of treatment one receives as well as the insurance and public aid one has.