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THE PARTNER



In this edition we feature two researchers conducting "out of the box" research....

Science fiction becomes reality with Dr. Anastassia Voronova, a recent graduate from the University of Ottawa with a PhD in Biology who tells us about the first ever in vitro hamburger--Steak in a petrie dish anybody?

Dr. Robert Smith? from the University of Ottawa (Yes, the question mark is part of his name) explains how he uses Zombies to get students excited about mathematical modeling of disease. His research is a perfect complement to our new video podcast series, *Why Math?*, launching October 2012. In this series we answer the Why Math? question by showcasing incredible careers, like Dr. Smith's, for students that stick it out in math class.

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I am happy to announce our new partnership with the Canadian Medical Hall of Fame (CMHF).

CMHF honours many Canadian medical heroes with the hope of inspiring the pursuit of careers in medicine and health science. Among their many programs CMHF runs Discovery Days, an exciting one-day workshop that allows teachers and students to explore diverse careers in medicine and health science. These hands on interactive workshops give students a true glimpse of what it would be like to be a health researcher.

Partners In Research's (PIR) Virtual Researcher On Call (VROC) program will be partnering with Discovery Days to offer virtual learning sessions for students to interact with experts and researchers. Dr. Thomas Merritt, Tier 2 Canada Research Chair in Genomics and Bioinformatics at Laurentian University is the first expert to sign up for virtual Discovery Days. He will be hosting a gameshow style genetics lesson for students at the University of Manitoba via video conference.

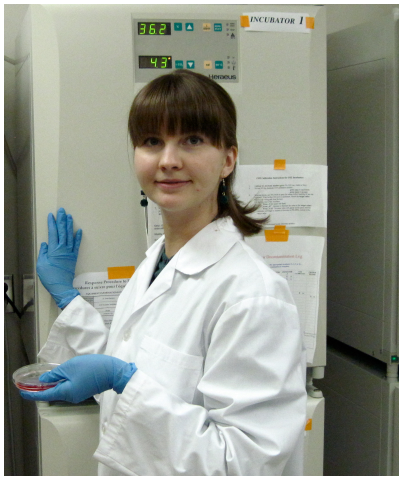
We are pleased to welcome CMHF as a partner and look forward to the creation of more opportunities for students to interact with experts and explore career paths they had never considered.

Kevin Cougler, *Executive Director*

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Meat, Shmeat…



By Anastassia Voronova, stem cell scientist and recent graduate from the University of Ottawa with a Ph.D. degree in Biochemistry.

The month of October is typically associated with the world-famous beer festival, Oktoberfest. In October of this year, however, the spotlight will be on Maastricht, Netherlands, where the team of Dr. Mark Post will be cooking up something that can be regarded as science fiction – the first ever in vitro burger grown in a laboratory from muscle cells [1]. As absurd as it sounds, this type of meat production might become an everyday reality within the next 40 years.

With our life expectancy becoming increasingly longer and fertility rates more successful, there is no wonder that the world population rose from 1 billion in 1825 to 7 billion in 2011. By 2050, we are expected to hit a 9 billion mark, an unprecedented amount of people living on Earth. In accordance, it is predicted that meat consumption will double by 2050. However, with the capacity of conventional meat production through livestocks reaching its maximum, we face an insurmountable challenge that must be overcome in this Century. According to Dr. Post, one of the possible solutions to this problem is the production of laboratory-grown meat [2].

While the idea of in vitro meat seems novel and perhaps shocking, it was actually introduced as early as 1897 by Kurd Lasswitz in "Two Planets" (original German title: Auf Zwei Planeten), where "synthetic meat" was brought in by the Martians. Later in the 1930-s Winston Churchill said "Fifty years hence, we shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium." Seventy years later, in 2002, the first edible muscle was created from goldfish cells resembling fish fillets and was suggested to represent an alternative food supply for astronauts [3].

In the lab, in vitro meat is grown from animal stem cells, which can be of embryonic or adult origin. Skeletal muscle fibres contain stem, or satellite, cells that are responsible for the repair of muscle after injury. Although these satellite cells can be relatively easily obtained, their propagation in vitro – i.e. in a petri dish - is limited [1]. Thus, there will still be a need on a regular basis to acquire muscle satellite cells from animals. The embryonic stem cells, on the other hand, can be extensively propagated in the lab, however, there are many ethical issues associated with the their use. Both of these stem cell types can be differentiated, or developed, into sheets of muscle in vitro, and matured by the application of force and electrical stimuli [2].

While it is possible to produce meat sheets, or "shmeat" (combination of words "sheet" and "meat"), in a lab; there is the contentious issue of its taste. After all, a steak, or a beef patty, is not solely composed from muscle. In addition to muscle fibres, there is also a considerable amount of fat and blood cells. As a result, scientists are also developing ways to grow these tissues from stem cells. Whilst we probably will never match the appearance of steak in a petri dish, it is possible that we will be able to use ground in vitro sheets of meat and fat in sausages, beef patties and chicken nuggets. With the latest PETA (People for the Ethical Treatment of Animals) $1 million dollar prize announcement for the first in vitro chicken meat [4], those in vitro chicken nuggets might not be that far away from reality!

Apart from economical and demand benefits that cultured meat can have, it is also a valid point in the environmental debate. Conventional cattle farming is responsible for 18% of greenhouse gases resulting in greater damage to the environment than the combined effects on the world transportation system. Even a combination of meat produced by livestock with an in vitro meat may lower our impact on the environment [2].

Despite the facts speaking in favor of "shmeat", there might be a resistance from the world population to adopt an idea of eating cultured meat, perhaps due to the possible association with genetically modified food. While in vitro meat does not have to be genetically modified, the mere concept of a lab-based solution to a global problem may lead to an outcry. This was seen in the 1970s when the first test tube baby, Louise Brown, was essentially conceived in a petri dish.

The backlash at first was tremendous with concerns over genetic modification and the development of designer babies but over the coming decades, the practice was adopted worldwide as a miracle in reproductive technology. It may only be a matter of time – and taste – before the same can be said for "shmeat".

The success of "shmeat" may be in doubt but Dr. Post has worked to increase the odds for success. He has tentatively enlisted celebrated chef and "molecular gastronomist" Heston Blumenthal to cook the Maastricht burgers next month. Depending on Blumenthal's ability to turn the lab meat into a gourmet treat, the future of in vitro foods may indeed be bright. Even so, it may still be a while before Gordon Ramsay's cookbook on "shmeat" ends up on a bookshelf in your local bookstore.

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What can Zombies Teach us about Mathematics?

by Robert Smith?, Department of Mathematics, University of Ottawa



In 2009, I published an article I thought would amuse me and no one else: a mathematical model of zombies. The idea was to examine a hypothetical zombie apocalypse through the lens of disease modeling: that is, using the same types of differential equations I use every day to examine the spread of infections such as HIV, malaria, human papilloma virus and a variety of tropical diseases. What we found was that zombies would overwhelm a mid-sized city like Ottawa in just four days.

Much to my surprise, the media appeared to share my sense of humour. The zombie paper was the #1 story on the BBC, stories about it appeared in the Wall Street Journal, the UK Daily Telegraph, Dutch and Finnish papers, on television (TVO's The Agenda with Steve Paikin) and on radio, such as CBC and NPR. To this day, it remains the #1 pdf on Google. (Simply by typing "pdf" into Google, it comes up as the first pdf that's listed).

What this did was raise enormous awareness for disease modeling as a concept. Many people who had never heard of disease modeling became aware of it through this paper. High school teachers reported that their students became interested in mathematics for the first time as a result of reading the zombie paper. Popular science books on mathematics (The Calculus Diaries: How Math Can Help You Lose Weight, Win At Vegas and Survive a Zombie Apocalypse) were written that showcased both my zombie modeling and also my more serious work on AIDS.

In Winter 2012, I taught a class called "Mathematical Modeling of Zombies", which illustrated a variety of disease-modeling techniques through the angle of a zombie apocalypse. It received significant attention, with CBC coming to class to film the lectures and also interview students for a news segment. The fact that zombie modeling

received so much attention, despite involving mathematics -- one of the most impenetrable disciplines and one which engenders fear-based reactions in many people -- is still astonishing to me. But zombies aren't just a piece of frivolity. There are important lessons to be learned that can help us understand just how useful mathematics can be -- and which could potentially save our lives someday.

No, really! When the next pandemic comes, what happens? First we need to understand the biology, then create accurate mathematical models that simulate the mechanics of the spread of disease. Once we have these models in place, we use mathematical analysis to develop a conclusion. The great thing about mathematics is that the conclusion is absolutely robust, based on the premise (ie the model). This gives us a way to see through the darkness that avoids the messiness and uncertainty of the real world. Every step of the process involved in developing a zombie model is conceptually the same step we want to take when the next pandemic comes (as it surely will).

Furthermore, by using pop culture and social media, mathematics can be made accessible to non-mathematicians. Where physics has a popular following -- concepts such as the Higgs Boson, black holes or quarks excite the popular imagination, even among people who may never understand the details -- mathematics struggles to make its concepts similarly appealing beyond a niche audience. Zombies break this trend, allowing people who will never solve an equation to be engaged and excited by mathematical modeling.

Zombies also have inherent properties that lend themselves very nicely to various mathematical techniques. They swarm, they act together without being conscious of it and they move about pseudo-randomly. There are also an enormous number of them! On the flipside, when faced with an outbreak, there are things we need to do that also lend themselves to mathematics: we need to estimate parameters, make decisions based on imperfect information and develop government policy that needs to evolve as the situation changes.

Swarming can be modeling via integro-differential equations, which helps us understand how people (or zombies) cluster together and what the effects of that are on an infectious disease. Pseudo-random movement (of a staggering zombie or an airborne virus) can be described by diffusion, which requires partial differential equations. With so many zombies, each with specific desires (to eat our braaaiiinnnsss), individual-based modeling can step in to numerically simulate the effects of many individuals in an urban environment. Then there are networks, which describe the interactions that people and zombies may have (for example, infection can only spread to those nearby), showing how a disease might spread in a neighbourhood or via international travel.

As for our own response, to estimate parameters we use statistical inference (filling in the gaps when we have some information, but not everything we'd like). We can also use fuzzy decision-making to make logical choices even when information is only "somewhat" true (for example, if we spy three zombies does that mean there's an epidemic underway or not?). There are also techniques to develop an evolvable linear system to simulate government responses to an emergency. Some of these techniques are analytical, some computational and others involve a combination of the two. All of them apply both to the fun thought experiment of a zombie outbreak and to the more serious possibility of a major infection sweeping across the globe.

Thus, what we learn from zombies is how to cope with the unknown. A pandemic might be terrifying, but if we know how many vaccines to stockpile in advance (or very quickly after it begins), then it becomes manageable. Knowing how a disease spreads through a population -- which requires knowing the makeup of that population and how it might change -- is immensely valuable information for knowing when to intervene. Mathematics can help us determine which control efforts might be most useful (and when to apply them) or it might tell us that a particular intervention will be functionally useless, thus saving lives, money and valuable time in an emergency.

So there you have it. Everything you ever needed to know to survive the next outbreak is right at hand. Just wait till the depraved undead arise from their graves and start munching on society's brains, unaware of the power of modelling to predict and thwart their every move. You'll be glad you took all those math classes then.

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VROC Programming Update

VROC has a new website and promotional video!

Watch HERE



This October we interviewed researchers from: The University of Waterloo, Ryerson University, Confederation College Aviation School and the University of Ottawa for our new video podcast series!

You can preview these new series that explore career opportunities in STEM by clicking on the links below.

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