Growing Together: How viruses have shaped human evolution

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Introduction

Think of a virus, and you'll likely think of an infection - Ebola, HIV, mononucleosis. But in actuality, the viruses that infect humans make up an infinitesimally small percentage of the total number on Earth, now estimated to be in the range of 10^{31}. Neither truly "alive" nor "dead," viruses are miniscule but complex pieces of machinery whose evolution has become intricately entwined with ours. In this lecture, we will explore the benefits viruses have on their hosts, as well as how we can manipulate their abilities to benefit human health. Shirlee will begin with an introduction to viruses: she will describe what viruses are, where they are located within the human body, and the viral life cycle. She will then focus on retroviruses, a specific type of virus used for gene therapy. Next, Katie will introduce the human virome, which consists of all the viruses in the human body, and how these viruses possibly benefit their hosts. She will then talk about two types of viral technologies, phage therapy and the recently developed diagnostic test VirScan. Following the lecture, there will be a tour of the lab of Dr. Eric Rubin, who conducts research on *Mycobacterium tuberculosis,* the bacterium responsible for tuberculosis. The lab does not intrinsically focus on viruses, but many of the techniques used in this lab are similar to those used to study viruses.

Speakers

Shirlee Wohl grew up in Vermont and received her B.S. in Molecular Biophysics & Biochemistry from Yale University. She is currently a 3rd year PhD student in the Systems Biology program and works in Dr. Pardis Sabeti's laboratory. Her research focuses on understanding the evolution and transmission of the Ebola virus during the 2013-2015 epidemic in Western Africa. More specifically, she studies variation in viruses within a single infected human host. Shirlee is enthusiastic about science communication and has given numerous talks and seminars to a variety of scientific and non-scientific audiences. Outside the lab, she is an avid Ultimate Frisbee player and reader of fiction.

Katherine Wu grew up in Southern California, and received her B.A. in Human Biology and M.S. in Biology from Stanford University. She is currently a 2nd year PhD student in the Biological and Biomedical Sciences (BBS) program. Her thesis work is in Dr. Eric Rubin's laboratory, which focuses on the life cycle and antibiotic resistance mechanisms of the causative agent of tuberculosis. Specifically, Katie's research looks into how *Mycobacterium tuberculosis* regulates its protein levels over the course of the cell cycle. She is enthusiastic about science communication and outreach, and is involved in several aspects of Science in the News. In the future, she hopes to incorporate aspects of outreach and education into her work. Outside of the lab, she also enjoys running marathons and cooking.

Glossary of Important Terms

Virus: A particle consisting of DNA or RNA enclosed within a protein coat (capsid).

Central dogma of biology: The central dogma assumes that **DNA** codes for **RNA**, which codes for **proteins**. DNA can be thought of as the blueprint for all the processes within the cell. RNA is the intermediary: it transcribes all the information from DNA and is used to make proteins. Proteins are the workhorse: they perform the processes within the cell.

Genome: The entire set of DNA that belongs to a single organism. This consists of all its genes and non-coding sequence (DNA that is not genes).

Retrovirus: A type of virus that converts RNA (the genetic material inside its protein coat) into DNA. After the virus invades the host cell, the DNA is then inserted into the host genome.

Gene therapy: The artificial insertion of genes into a patients' body as an alternative to drug therapy.

Human virome: All the viruses present in and on the human body. This is a subset of the human microbiome, which is all the microorganisms present in and on the human body.

Bacteriophage: A virus that exclusively infects bacteria.

Phage therapy: The use of bacteriophages to selectively kill pathogenic bacteria.

Antibody: A protein generated by B cells and used to fight infections. These proteins attach to antigens, neutralizing the negative effects of the target or marking them for destruction by other immune cells.

Antigen: Any substance that attracts the attention of the immune system. They are often pieces of infectious agents (bacteria, virus, parasites), but can also come from the environment (dust, pollen) and cause allergies.

Memory B cell: An immune cell generated in response to an infection and maintained to respond more quickly to subsequent infections by the same antigen.

Resources to learn more

Virology Blog: About Viruses and Disease, http://www.virology.ws/, This blog is written by Vincent Racaniello Ph.D., Professor of Microbiology & Immunology at Columbia University.
Repurposing Virus Proteins for a Positive Role in the Placenta, http://sitn.hms.harvard.edu/flash/2015/repurposing-virus-proteins-for-a-positive-role-in-the-placenta/, This article provides more detail on the way retroviruses work, as well as gene therapy.
About Phage Therapy, http://www.phagoburn.eu/about-phage-therapy.html, Phagoburn is a project funded by the European Union to explore phage therapy for burn victims.
Viral History in a Single Drop of Blood, https://hms.harvard.edu/news/viral-history-drop-blood, Harvard Medical School's description of VirScan.