

Meat, Monkeys, and Mosquitoes: A One Health Perspective on Emerging Diseases
Prof. Laura Kahn, Princeton University
A Webber Training Teleclass

**Meat, Monkeys, and Mosquitoes:
A One Health Perspective on
Emerging Diseases**

Prof. Laura H. Kahn, MD, MPH, MPP
Princeton University

Hosted by Prof. Jason Stull
The Ohio State University

www.webbertraining.com

September 12, 2019



- Human, animal and environmental health are linked.
- Complex subjects such as emerging diseases, food safety and security, chronic diseases must be addressed using an interdisciplinary "One Health" approach.
- <http://www.onehealthinitiative.com>

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Hippocrates (ca. 460 BCE--ca. 370 BCE)

Recognized the link between human health and the environment.

Malaria="mal" + "aria" means bad air.

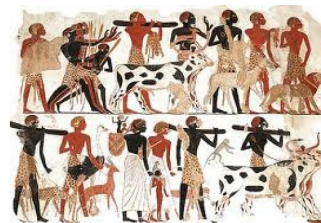


Relief from the sanctuary of Orpos, dedicated to the physician Asclepiades, showing Hippocrates treating a patient

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Domestication of Plants and Animals

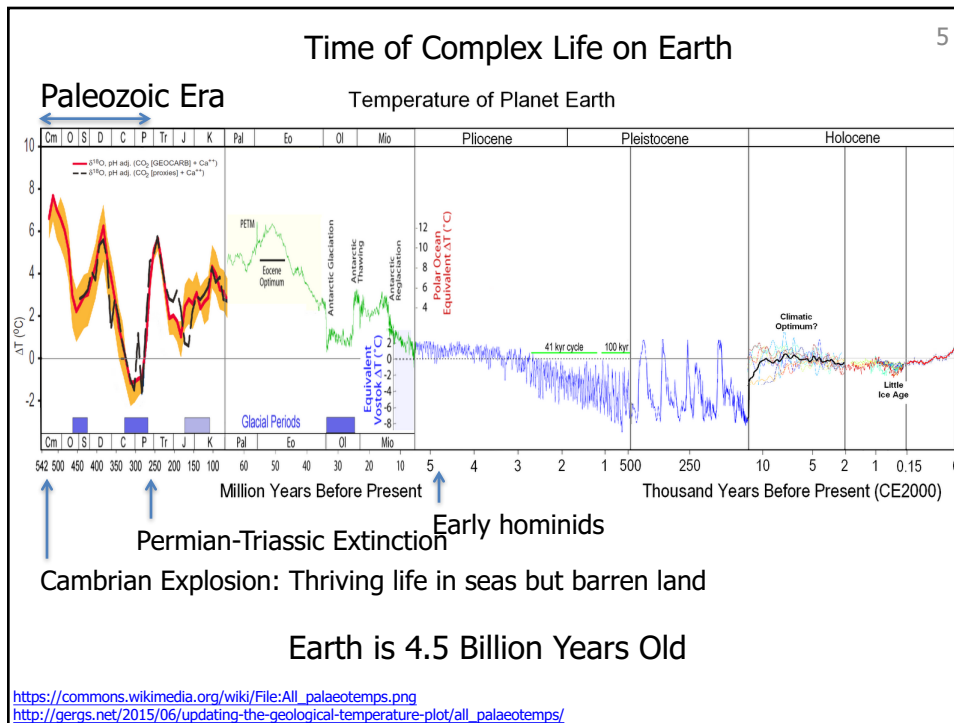
- Agriculture began about 10,000 years ago.
- Agriculture is foundation of civilization.
- Towns, cities, and nations flourished with secure food supplies..



<http://www.nature.com/nature/journal/v447/n7142/full/nature05775.html>

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Little Ice Age from 1300 to 1850

The Frozen Thames, Britain, 1677
Frost fairs lasted from 1607 to 1814

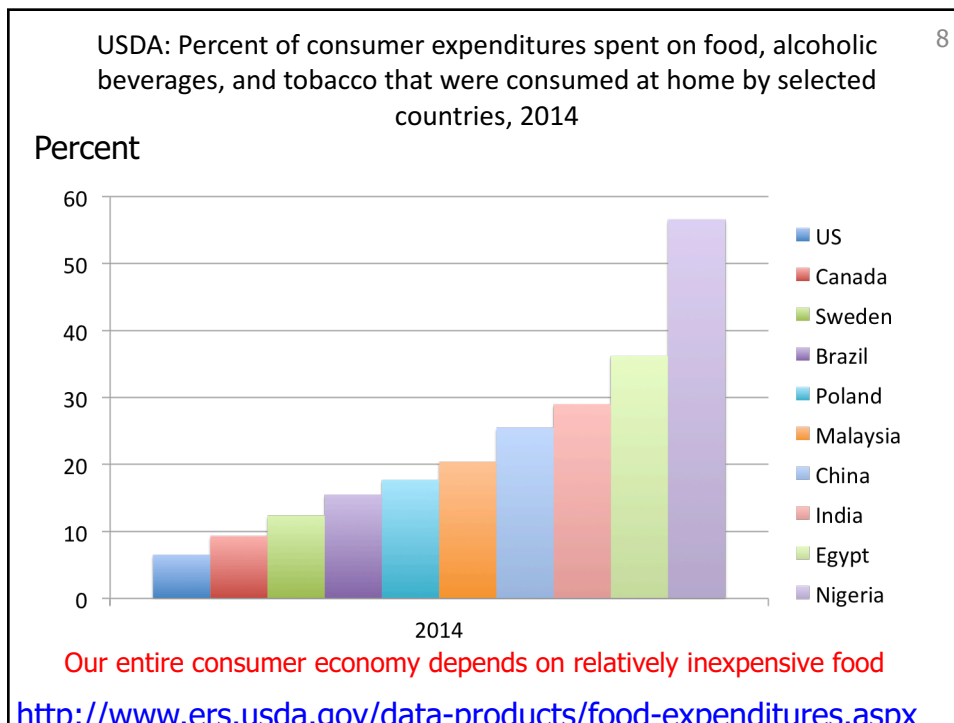
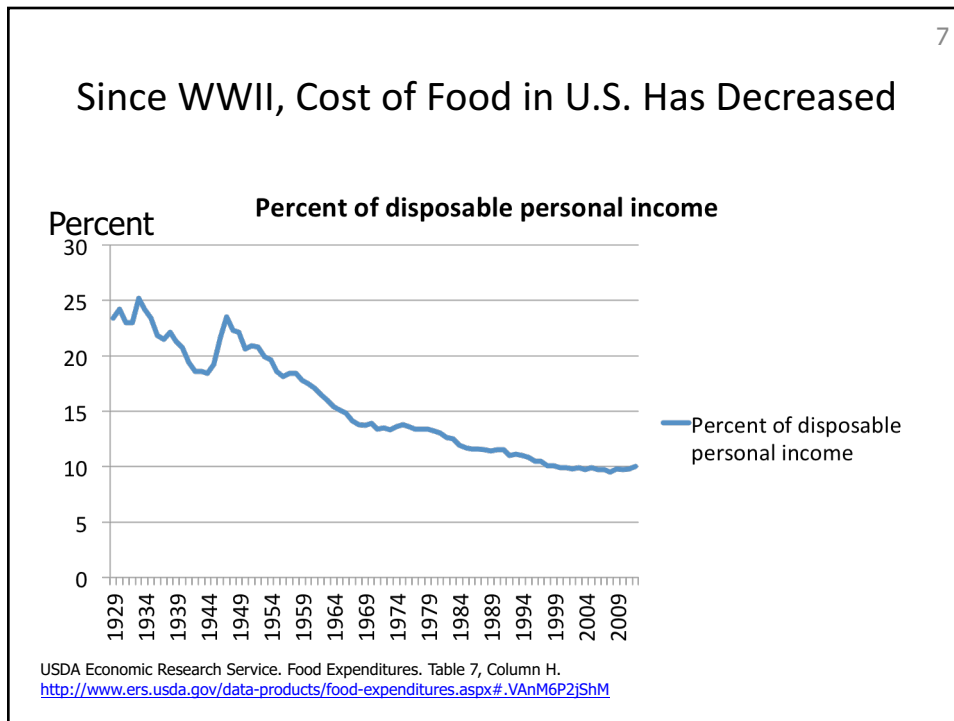
Ice skating on main canal of Pompenburg, Rotterdam, 1825.

The hunters in the snow, Pieter Brueghel the Elder, 1565

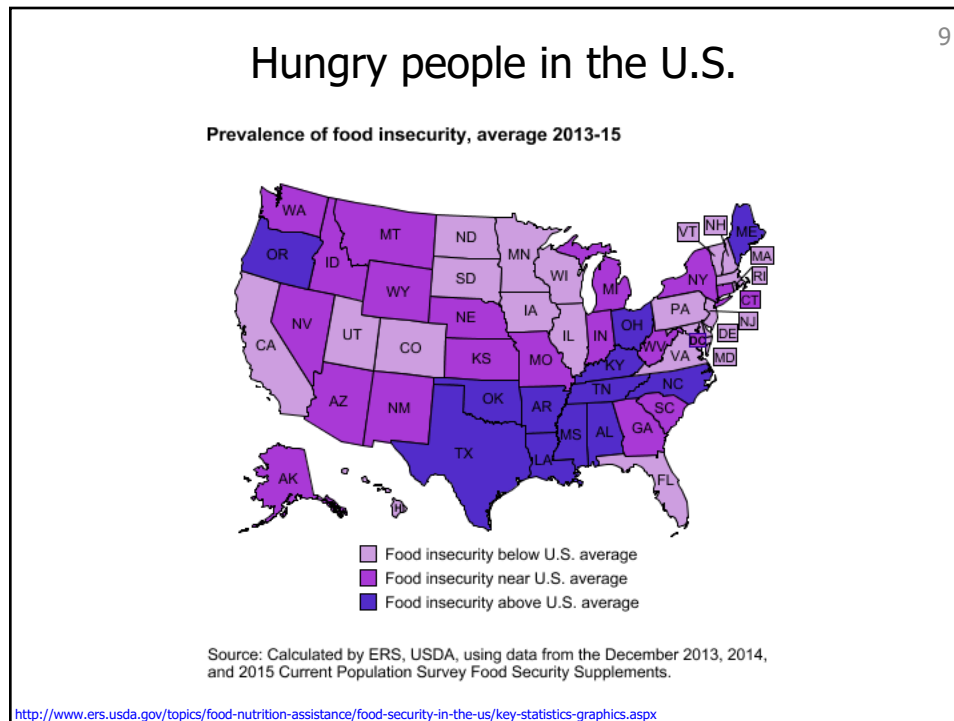
Little Ice Age noted for crop failures, famines and bread riots.

https://en.wikipedia.org/wiki/Little_Ice_Age

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Food Security Challenges in the 21st Century

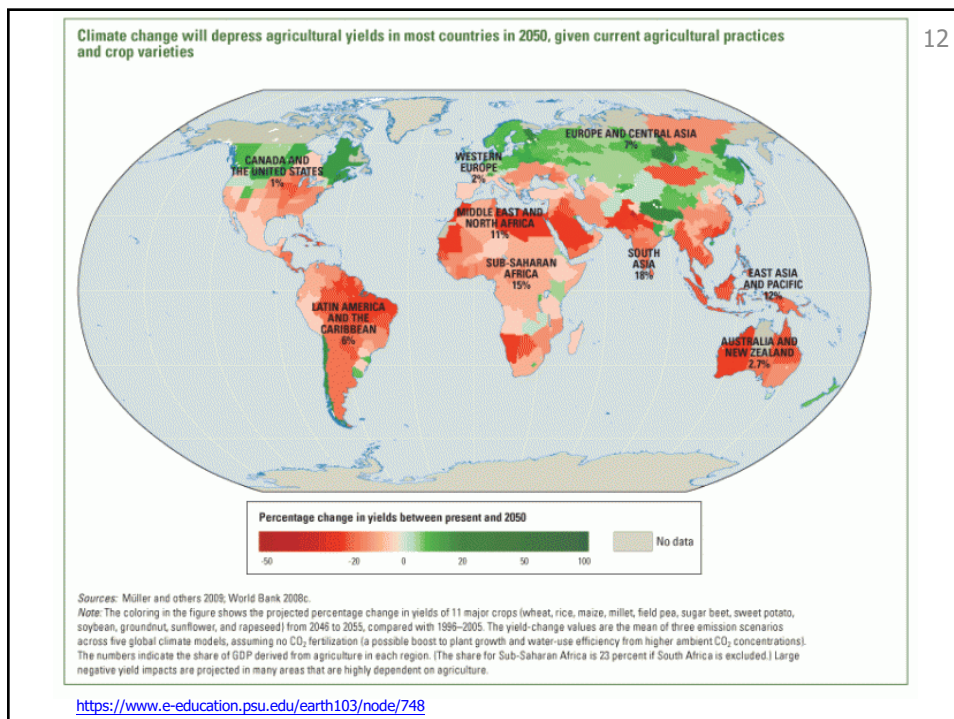
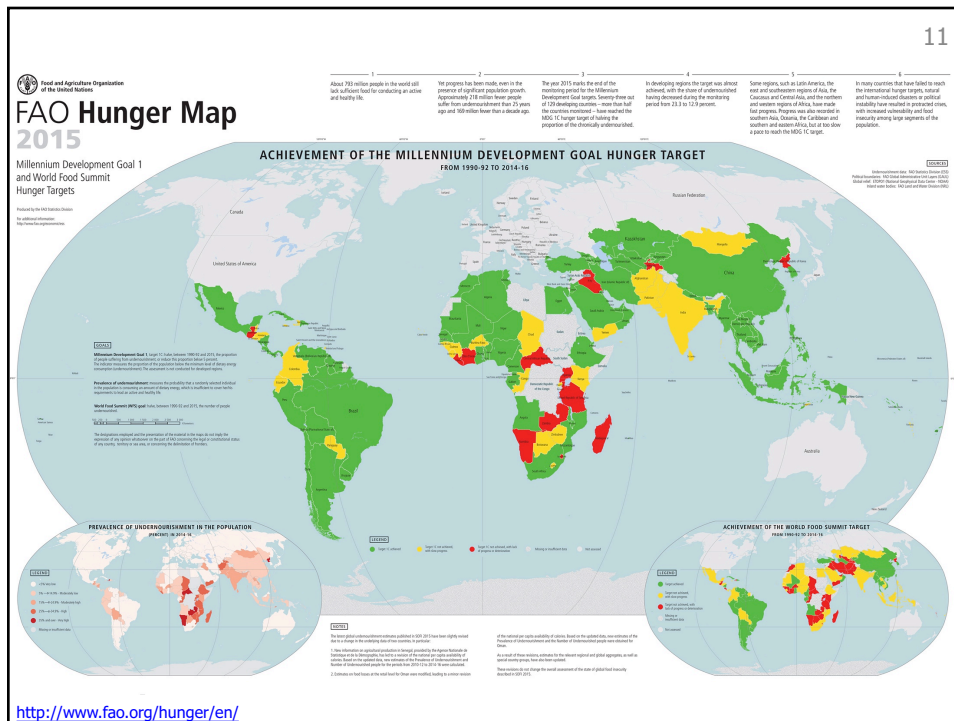
- What impact will climate change have on food production?
- What policies can governments implement to maximize food security? (And food safety?)
- Governments have an incentive to ensure food security to minimize risk of civil unrest or possibly even revolution.
- How can everyone be fed without destroying the planet's biosphere (global sum of all ecosystems)?

Crash Course on Drought and Famine: <https://www.youtube.com/watch?v=Sgae8SA-rcI>

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What's the difference between food safety and food security?

Food Safety



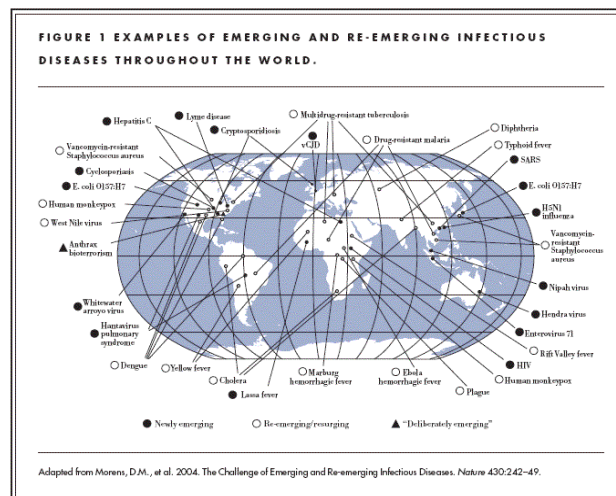
Food free from harmful bacteria, viruses, parasites or chemical substances.

Food Security

- Food Security = No Hungry People
- UN FAO estimates 795 million people out of 7.3 billion (1 in 9) suffer from chronic undernourishment in 2014-2016.
- Prevention of hunger
 - Food availability
 - Food affordability
 - Food use/waste

<http://www.worldhunger.org/2015-world-hunger-and-poverty-facts-and-statistics/>

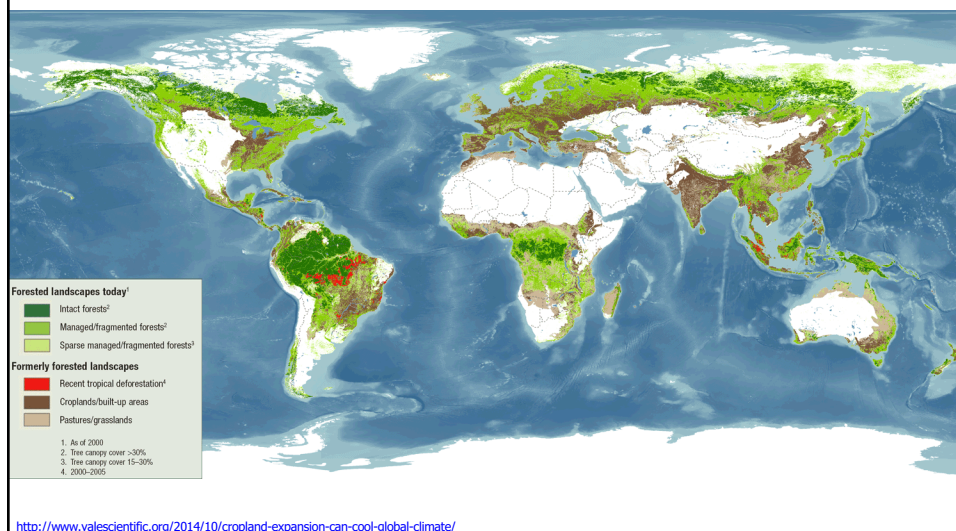
Newly emerging diseases beginning in the mid-20th century



Why are these diseases emerging?

- Increasing global population pressures
- Widespread deforestation
- Environmental destruction
- Intensive agriculture
- Livestock and bushmeat (wild animal) consumption
- Global trade and travel
- Probably climate change

Deforestation for Expanding Agriculture



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Where are they emerging from? Mostly from animals (wild and domestic) **“Zoonoses”**



Bats: SARS, Nipah virus, Ebola (probably), Hendra, Rabies

<http://www.batworlds.com/fruit-bat/>



Rodents: Leptospirosis, Hantavirus, Plague, Rat-Bite Fever, South American Arenaviruses

About 75% of newly emerging diseases are zoonoses.

<http://www.telegraph.co.uk/news/health/news/9793580/Haemorrhagic-fever-carried-by-UK-rats-scientists.html>
<http://www.cdc.gov/rodents/diseases/direct.html>
<http://www.cdc.gov/importation/bringing-an-animal-into-the-united-states/monkeys.html>



Monkeys: Cercopithecine herpesvirus 1 (B virus), monkeypox, SIV, Tb, yellow fever host.

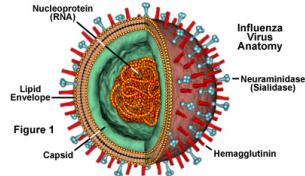
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Zoonotic Diseases (Zoonoses)

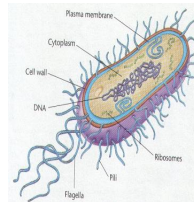
- Diseases of animals that can spread to people.
- **Virus**
- Bacteria
- Fungus
- Parasite
- Prions

What's the difference between...

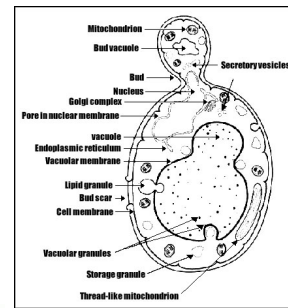
A virus...a bacteria...a fungus...a parasite and a prion?



Virus



Bacteria



Fungus

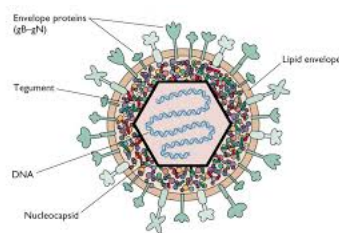


Parasite



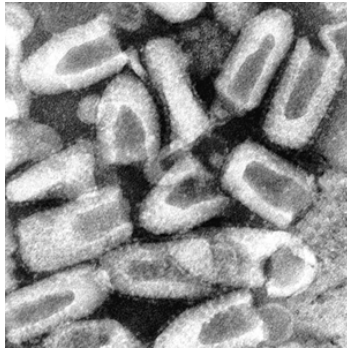
Prion

Viruses



- Protein coat
- Genetic material
- Technically not “alive”
- Why?

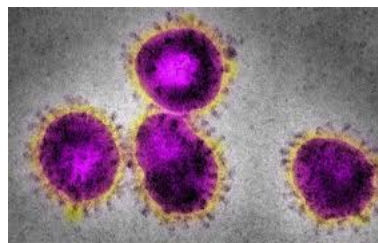
Viruses are parasites



Rabies



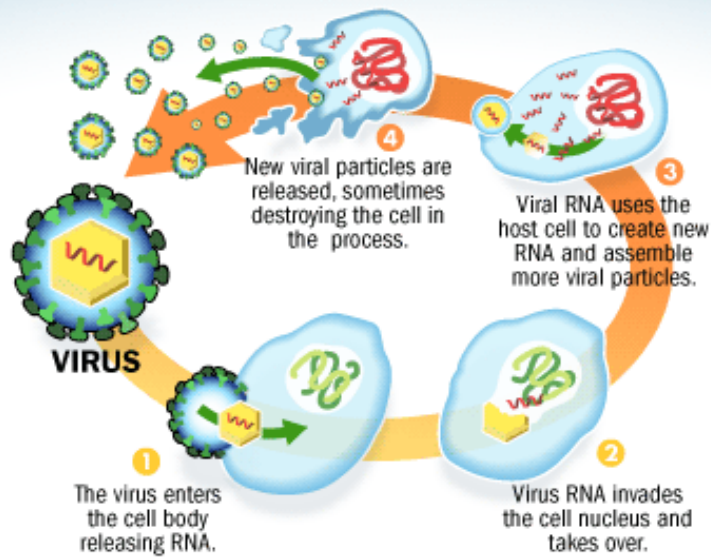
Ebola



SARS

How a Virus Works

©2010 HowStuffWorks



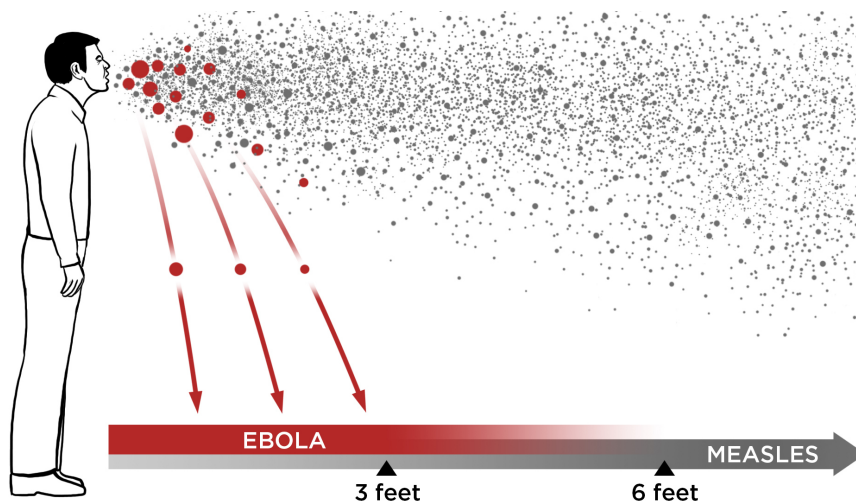
Because viruses are not alive...

- Can't be killed.
- Antibiotics do not work.
- Antivirals work.
- Best option is vaccination.
- Vaccines against viral diseases are made from weakened or deactivated viruses.
- Prime immune system to fight invasion.



**No cure for the common cold.
Almost 100 rhinovirus strains.**

How do viruses spread?



<http://www.northcountrypublicradio.org/news/npr/364749313/ebola-in-the-air-what-science-says-about-how-the-virus-spreads>

Viruses can also spread by...



Contaminated water (and food)



Mosquitoes and other insects



Blood and Other Body Fluids



Contaminated Surfaces

So How Does Agriculture Fit in The Picture of Zoonoses?

- Food animals (livestock) help microbes jump from wild animals into humans.
- In 2012, a World Bank study found that of the 11 major pandemics that have afflicted the world since the 1980's, 8 (such as avian influenza) involved domesticated food animals.
- Diseases jumping from domesticated animals to humans isn't a new phenomenon...

Price of Agriculture

- Measles (Rinderpest) Cattle
- Brucellosis Goats/Sheep
- Q fever Goats/Sheep
- Tularemia Rabbit/Squirrels
- BSE ("Mad Cow") Cattle

http://www.nhbs.com/beasts_of_the_earth_tefno_141345.html

There are increasing numbers of domestic animals and humans

- 96 to 98 percent of the planet's mammalian zoomass is made up of domesticated animals and humans.
- Approximately 40 billion food animals provide meat, milk, and eggs to an ever growing human population (7+ billion and counting).
- Intensive livestock systems provide excellent conditions for disease transmission...

<https://howwegettonext.com/pandemic-proofing-the-world-98222a38782#.fwwutac03>

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**Intensive food
animal production**



https://en.wikipedia.org/wiki/Intensive_animal_farming
http://www.stoprac.org/index.php?mact=News,cntnt01,detail_0&cntnt01articleid=273&cntnt01origid=93&cntnt01returnid=93
<http://www.fis.com/fis/techno/printable.asp?id=55672&l=e&nb=1&print=yes>

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Without Agriculture

- People eat wild animals/bushmeat (e.g. bats, rodents, and monkeys)
- Danger of zoonotic disease transmission
 - HIV/AIDS
 - SARS
 - MERS
 - Ebola
 - What's next?

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African Bushmeat Market



<http://midwestdiplomacy.com/category/sub-saharan-africa/>

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Fruit Bats for Sale in Democratic Republic of Congo



<http://www.pri.org/stories/2014-08-13/ebola-crisis-rages-west-african-villagers-are-warned-away-fruit-bats>

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Bushmeat for sale in Laos



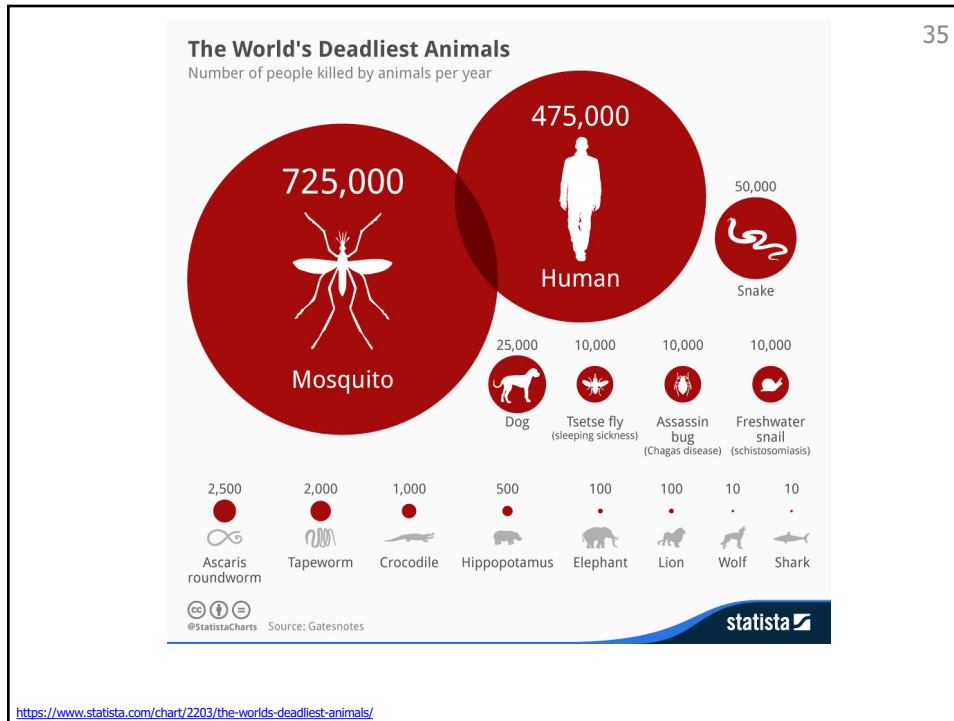
<https://news.mongabay.com/2013/08/scientists-discover-new-flying-mammal-in-bushmeat-market/>

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Let's turn to mosquito-borne
zoonoses...



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Mosquito evolution

- Specimen found in Cretaceous Canadian amber 79 million years old.*
- Some feed on birds and monkeys in rain forest canopies; others feed on ground-dwelling mammals, some on amphibians and reptiles. (Crocodiles get sick from West Nile virus.)
- More than 3,500 species of mosquitoes; >176 species in the U.S.
- Increasing subset of mosquito species that have adapted to humans (30 Anopheles species, Culex species, Aedes aegypti, Aedes albopictus, and Aedes japonicus...and a few others).

*Acta Geologica Hispanica 2000; 35: 119-128
 Dina M. Fonseca, PhD, Director, Center for Vector Biology, Rutgers University, SEBS

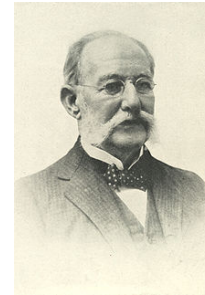
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Drs. Walter Reed, Carlos Finley, and Colleagues
Discovered Mosquitoes spread Yellow Fever



Aedes mosquito



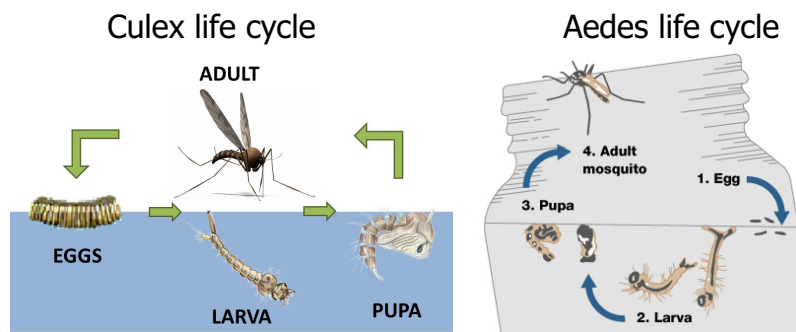
Maj. Walter Reed (1851-1902)
 Headed U.S. Army Yellow Fever Board.
 Carried out experiments in 1900
 proving Dr. Finlay's hypothesis
 correct. Infected human volunteers.

Cuban Dr. Carlos Finlay
 (1833-1915) Proposed and
 identified *Aedes* mosquito as
 transmitter of yellow fever. More
 U.S. troops died from yellow
 fever than battle wounds in
 Spanish-American war.

https://en.wikipedia.org/wiki/Carlos_Finlay
https://en.wikipedia.org/wiki/Walter_Reed
<http://indianapublicmedia.org/amomentofscience/yellow-fever-vaccine-temporarily-disappears-clear-answer/>

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Mosquito life cycle



<http://fayetteville.mosquitosquad.com/blog/2015/11/6/mosquito-life-cycle/>
<https://www.amazon.com/Mosquito-Story-Mans-Deadliest-Foe/dp/0786886676>
 Dina M. Fonseca, PhD, Director, Center for Vector Biology, Rutgers University School of Environmental and Biological Sciences

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Mosquitoes and Their Diseases



Aedes aegypti



Aedes albopictus
Asian "Tiger" mosquito



Anopheles gambiae



Culex pipiens
"House Mosquito"

Chikungunya
Dengue
Yellow Fever
Zika

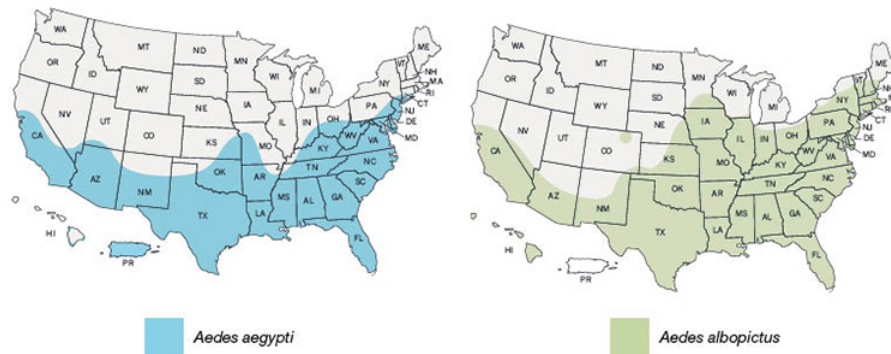
Malaria
Filariasis

Avian malaria
Filariasis
Japanese encephalitis
St. Louis encephalitis
West Nile virus

<https://www.vectorbase.org/organisms/aedes-aegypti>
https://en.wikipedia.org/wiki/File:Anopheles_gambiae_Mosquito.jpg
http://entnemdept.ufl.edu/creatures/aquatic/southern_house_mosquito.htm

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Estimated Range of *Aedes aegypti* and *Aedes albopictus* in U.S. 2016



<http://www.cdc.gov/zika/vector/range.html>

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Mosquitoes on the Move



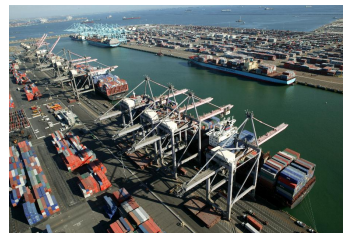
Used tires: Perfect Mosquito Breeding Grounds



Air Travel

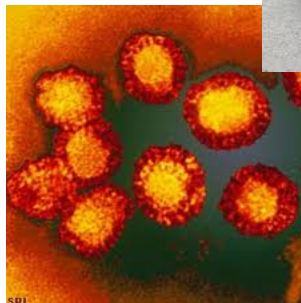


Deforestation

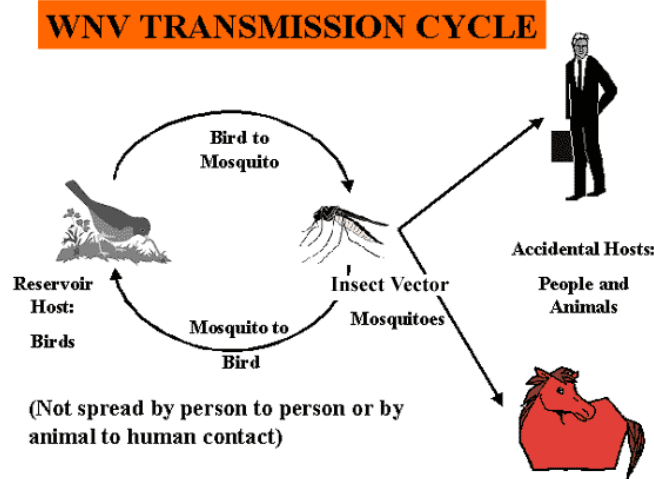


Shipping

1999 West Nile Virus Outbreak in NYC



Two Simultaneous Outbreaks



Solving the Mystery

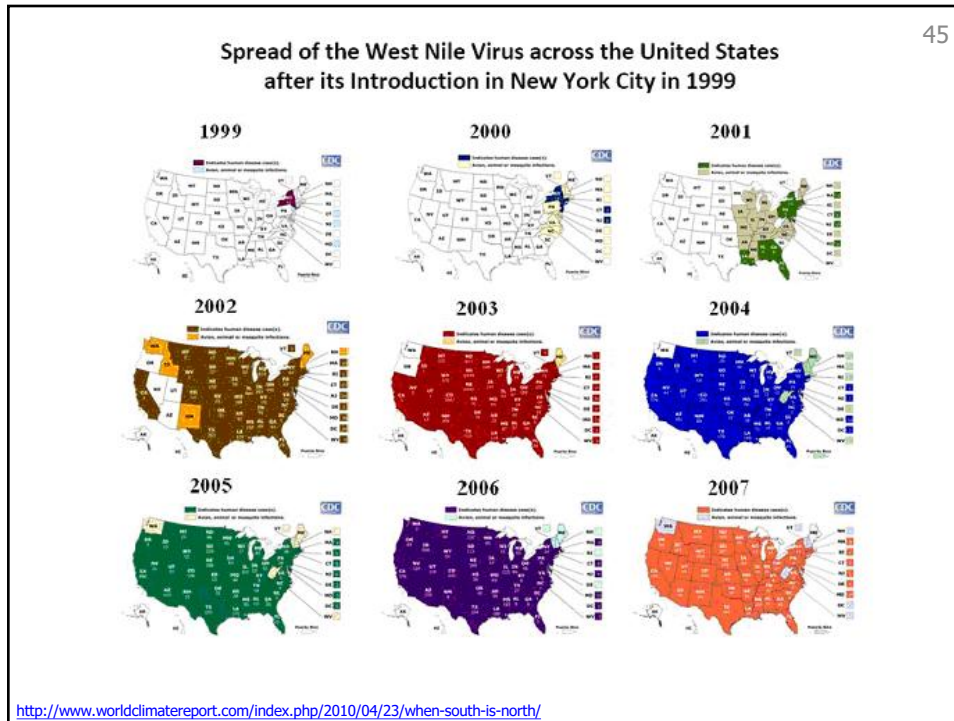


Dr. Tracey McNamara, Chief Veterinary Pathologist, Bronx Zoo



Birds native to North America

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Zika Virus

- First discovered in April 1947 in Zika Forest, Uganda.
- Rhesus monkey got sick during a research study on yellow fever.
- Obscure virus stayed in equatorial region in Africa and Asia for decades. (Asian and African strains)
- Host animals were primarily monkeys.
- April 2007, Zika virus appeared on Yap Island, Micronesia.
- Late 2014, Brazil experienced explosive Zika virus epidemic.

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ZIKA VIRUS

Symptoms

The infographic features a central illustration of a mosquito. Surrounding it are seven circular icons, each representing a symptom: a thermometer for fever, a woman with red eyes for red eyes, a woman with a skin rash for pale, skin rash, a joint with a red spot for muscle pain, arthralgia, a woman with a headache for headache, and a human digestive tract for diarrhea.

<http://www.treatmentabroad.com/about-medical-tourism/articles/zika-virus-all-you-need-know>

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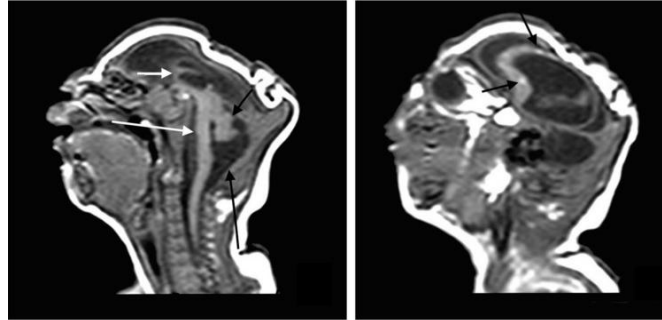
Zika-related microcephaly

The image shows two side-profile illustrations of a baby's head. The head on the left is significantly smaller than the head on the right, which is of normal size. A dashed white circle highlights the smaller head.

<https://www.youtube.com/watch?v=XaqRRI0zes>

<https://en.wikipedia.org/wiki/Microcephaly>

CT Scan of Baby with Severe Microcephaly



Total lifetime cost of a Zika-infected individual: \$1 to \$10 million

<http://www.latimes.com/science/sciencenow/la-sci-sn-zika-microcephalic-brain-scans-20160414-story.html>
<http://www.wired.com/2016/08/price-zika-4-million-per-child/>

Guillain-Barre Syndrome (GBS)

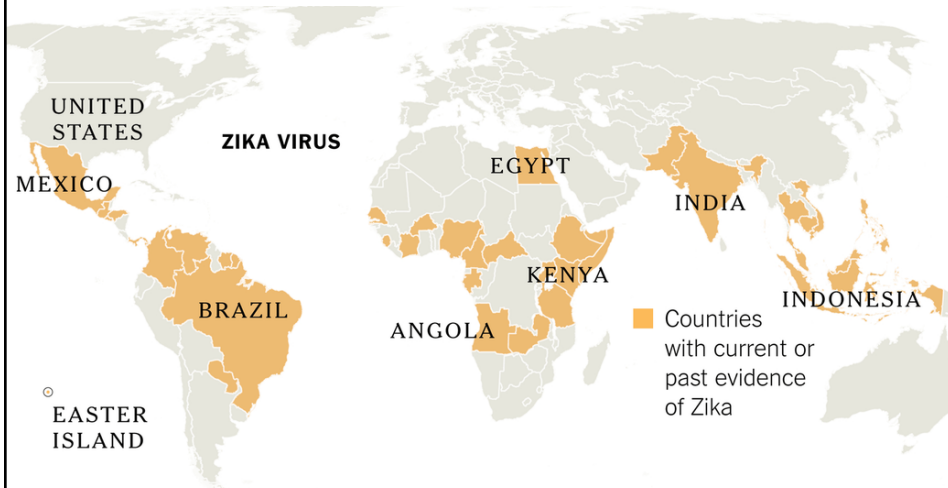
- Immune system attacks and damages nervous system causing muscle weakness and sometimes paralysis.
- Triggered by an infection, very rarely vaccination (1976 Swine flu vaccine).
- Most cases—no known cause.
- Zika infections have triggered GBS.
- 1-2 cases per 100,000 people per year in U.S.

Zika virus: Treatment and Prevention

- No specific anti-viral medications are available.
- No vaccines are currently available for preventing the disease.
- Treatment is strictly supportive.
- Best approach to Zika virus is preventing it by reducing mosquito breeding sites, sanitation, larvicides, wearing protective clothing, screen windows and doors, and insect repellent.

<http://www.cdc.gov/zika/prevention/index.html>

Global Zika Virus Distribution



http://www.nytimes.com/2016/01/05/health/us-becomes-more-vulnerable-to-tropical-diseases-like-zika.html?_r=0

Vector-borne diseases and climate change

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- Arthropods (i.e. insects) transmit many diseases.
- They are very sensitive to temperature changes and thrive in warm, tropical climates.
- Malaria and dengue are being reported at higher elevations around the world.
- We must anticipate more emergence and spread of these diseases.

<http://climate.org/archive/topics/health.html>

Agriculture, Diseases, Climate Change

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- We rely on agriculture for a safe and secure food supply.
- Food safety and food security are the foundation of civilization.
- Yet, intensive agriculture comes with risks—
- Contributes to emerging diseases by deforestation and environmental degradation and contamination.
- Contributes to climate change by emitting greenhouse gases (e.g. methane and nitrous oxide).

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We must figure out how to feed ourselves and maintain civilization without destroying the natural world



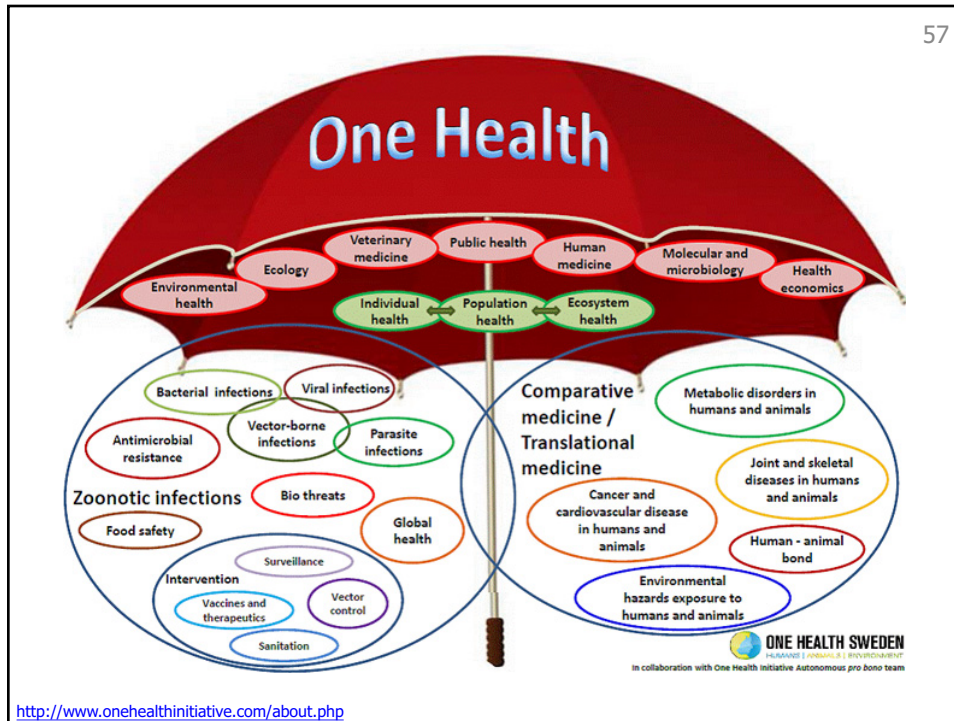
We need to integrate our efforts to benefit humans, animals, and the environment

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How can health care professionals get involved in One Health?

- Hold interdisciplinary One Health conferences and invite veterinarians, human health care professionals, and environmental health specialists.
- Join One Health venues on Facebook, LinkedIn, and various websites.
- Discuss the importance of One Health with policymakers at the local, regional, and national levels.

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Spreading the word about One Health

https://www.onehealthcommission.org/en/eventscalendar/one_health_day/about_one_health_day/

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One Health Day Map of Events



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- Acknowledgements
- Collaborators:
 - Bruce Kaplan DVM, Dipl. AVES (Hon)
 - Tom Monath MD, Dipl. AVES (Hon)
 - Lisa Conti, DVM, MPH, Dip. AVES (Hon)

<http://www.onehealthinitiative.com>

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www.webbertraining.com/schedule1.php

(FREE European Teleclass – Broadcast live from the Infection Prevention Society conference)

September 22, 2019 **Cottrell Lecture ... CHALLENGES AND OPPORTUNITIES IN INFECTION PREVENTION AND CONTROL**

Speaker: **Prof. Brett Mitchell**, University of Newcastle, Australia

(FREE European Teleclass – Broadcast live from the Infection Prevention Society conference)

September 24, 2019 **Ayliffe Lecture ... PNEUMOCYSTIS - AN IMPORTANT HEALTHCARE-ASSOCIATED INFECTION?**

Speaker: **Prof. Tim Boswell**, Nottingham University Hospitals NHS Trust, UK

(FREE South Pacific Teleclass – Broadcast live from the New Zealand Infection Prevention & Control Nurses College conference)

September 24, 2019 **IPC EDUCATION: DEVELOPMENT OF PROGRAMMES**

Speaker: **Prof. Shaheen Mehtar**, Stellenbosch University, South Africa

Live broadcast sponsored by Schulke

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POSITIVE DEVIANCE AND HAND HYGIENE: WHAT CAN WE LEARN FROM THE BEST?

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