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

Recognized the link between human health and the environment.

Malaria = “mal” + “aria” means bad air.

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.

[Image of ancient mural showing domestication]

http://www.nature.com/nature/journal/v447/n7142/full/nature05775.html
## Time of Complex Life on Earth

**Paleozoic Era**

<table>
<thead>
<tr>
<th>Period</th>
<th>Temperature of Planet Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambrian Explosion</td>
<td>Thriving life in seas but barren land</td>
</tr>
<tr>
<td>Permian-Triassic Extinction</td>
<td></td>
</tr>
<tr>
<td>Early hominids</td>
<td></td>
</tr>
</tbody>
</table>

Earth is 4.5 Billion Years Old

---

## 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.**

Little Ice Age noted for crop failures, famines and bread riots.
Since WWII, Cost of Food in U.S. Has Decreased

Our entire consumer economy depends on relatively inexpensive food

USDA: Percent of consumer expenditures spent on food, alcoholic beverages, and tobacco that were consumed at home by selected countries, 2014

Hungry people in the U.S.

Prevalence of food insecurity, average 2013-15


[Map showing food insecurity in the U.S.]

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
FAO Hunger Map
2015
Millennium Development Goal 1
And World Food Summit Hunger Target

Achievement of the Millennium Development Goal Hunger Target
from 1990 to 2015

Climate change will depress agricultural yields in most countries in 2050, given current agricultural practices and crop varieties.

Percentage change in yields between present and 2050

Source: Müller et al. (2009), World Bank (2009).

Note: The coloring in the figure shows the projected percentage change in yields of 11 major crops (barley, rice, maize, millet, soybean, sorghum, wheat, sugar beet, sweet potatoes, potato, groundnuts, and soybeans) from 1990 to 2050, compared with 1980–2000. The yield change values are the mean of the six emission scenarios across four global climate models, assuming no CO₂ fertilization (a possible boost to plant growth and water-use efficiency from higher ambient CO₂ concentrations). The number of indices indicates the share of GDP derived from agriculture in each region. (The share for Sub-Saharan Africa is 22 percent, if South Africa is excluded.) Large negative yield impacts are projected in many areas that are highly dependent on agriculture.

https://www.e-education.psu.edu/earth103/node/748

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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


Newly emerging diseases beginning in the mid-20th century

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

- Rodents: Leptospirosis, Hantavirus, Plague, Rat-Bite Fever, South American Arenaviruses
- Bats: SARS, Nipah virus, Ebola (probably), Hendra, Rabies
- Monkeys: Cercopithecine herpesvirus 1 (B virus), monkeypox, SIV, Tb, yellow fever host.

About 75% of newly emerging diseases are zoonoses.

Zoonotic Diseases (Zoonoses)

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

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www.webbertraining.com
What’s the difference between...

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

Viruses

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

- Ebola
- Rabies
- SARS

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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?

- Ebola
- Measles


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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

<table>
<thead>
<tr>
<th>Disease</th>
<th>Host</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles (Rinderpest)</td>
<td>Cattle</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>Goats/Sheep</td>
</tr>
<tr>
<td>Q fever</td>
<td>Goats/Sheep</td>
</tr>
<tr>
<td>Tularemia</td>
<td>Rabbit/Squirrels</td>
</tr>
<tr>
<td>BSE (“Mad Cow”)</td>
<td>Cattle</td>
</tr>
</tbody>
</table>

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

Intensive food animal production  

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?
African Bushmeat Market

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

Fruit Bats for Sale in Democratic Republic of Congo

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Bushmeat for sale in Laos

[Image of bushmeat]


Let’s turn to mosquito-borne zoonoses...
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
Drs. Walter Reed, Carlos Finley, and Colleagues Discovered Mosquitoes spread Yellow Fever

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.


Mosquito life cycle

Culex life cycle  Aedes life cycle

http://fayetteville.mosquitoquad.com/blog/2015/11/6/mosquito-life-cycle/
http://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
Mosquitoes and Their Diseases

Aedes aegypti  Aedes albopictus  Anopheles gambiae  Culex pipiens

Chickungunya  Dengue  Malaria  Avian malaria
Dengue  Yellow Fever  Filariasis  Filarisis
Zika  

https://www.vectorbase.org/organisms/aedes-aegypti
http://entnemdept.ufl.edu/creatures/aquatic/southern_house_mosquito.htm

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

Mosquitoes on the Move

- Used tires: Perfect Mosquito Breeding Grounds
- Air Travel
- Deforestation
- Shipping

1999 West Nile Virus Outbreak in NYC

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Two Simultaneous Outbreaks

WNV TRANSMISSION CYCLE

Bird to Mosquito
Mosquito to Bird
Insect Vector
Reservoir Host: Birds
Accidental Hosts: People and Animals

(Not spread by person to person or by animal to human contact)

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
- fever
- red eyes
- pale skin rash
- muscle pain, arthralgia
- headache
- diarrhea

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

Zika-related microcephaly

https://www.youtube.com/watch?v=XaqRR1I0zes

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

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CT Scan of Baby with Severe Microcephaly

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

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.


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

- 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

- 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).
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.

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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http://www.onehealthinitiative.com/about.php

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

• 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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<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 22, 2019</td>
<td>Cottrell Lecture — CHALLENGES AND OPPORTUNITIES IN INFECTION</td>
<td>Prof. Brett Mitchell, University of Newcastle, Australia</td>
</tr>
<tr>
<td></td>
<td>PREVENTION AND CONTROL</td>
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<tr>
<td>September 24, 2019</td>
<td>Aylliffe Lecture — PNEUMOCYSTIS — AN IMPORTANT HEALTHCARE-ASSOCIATED</td>
<td>Prof. Tim Boswell, Nottingham University Hospitals NHS Trust, UK</td>
</tr>
<tr>
<td></td>
<td>INFECTION?</td>
<td></td>
</tr>
<tr>
<td>September 24, 2019</td>
<td>Live broadcast sponsored by Schülke</td>
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</tbody>
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