From Ebola to Zika - tracking large-scale outbreaks
Viruses and diseases we study

Lassa  
Ebola  
Zika
‘Classical’ Epidemiology

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This image illustrates a map of a particular area, highlighting a key location with an orange circle. The map shows streets labeled as Oxford Street and Ocean Street, with the axis marked for 200 yards and 200 meters. The map also indicates points of interest such as a pump and cholera deaths, with a particular focus on a contaminated pump in the center. The map provides a historical context for understanding the spread of cholera and the role of water sources in epidemic outbreaks.
'Genomic' Epidemiology

Origins
Spread
Timing
Evolution
Spread of Ebola across West Africa

Dudas et al., Nature 2017

www.nextstrain.org
Virus genomes provide detailed insights

Holmes et al., *Nature* 2016
Andersen et al., *Cell* 2015
Park et al., *Cell* 2015
Gire et al., *Science* 2014
‘Violation’ of molecular clock > sexual transmission

E.g., Blackley et al., Science Advances 2017
Massive collaboration
Zika virus spread across the world

1947: Discovered in Uganda
1977-78: Pakistan, Malaysia, Indonesia
2007: Yap, Micronesia
2013: French Polynesia
2014: Brazil

Source: Lancaster University
Undetected transmissions across the Americas

Grubaugh et al., *Nature* 2017
Metsky et al., *Nature* 2017
Faria et al., *Nature* 2017
Quick et al., *Nature Protocols* 2017

Figure from M. Worobey, *Nature* 2017
Zika virus outbreak in Florida

Map showing mosquito trap sites and ZIKV+ mosquitoes in different transmission zones. The map highlights Miami-Dade, Broward, Palm Beach, Pinellas, and Wynwood with varying numbers of local ZIKV cases. The number of ZIKV cases is indicated by different colors and symbols.
Zika virus outbreak in Florida

Was it mosquito-borne?
When did it arrive?
How many introductions?
Where did it come from? And how?
Why Miami? Why southern Florida?

Grubaugh et al., Nature 2017
Quick et al., Nature Protocols 2017
Killing mosquitos really works
Florida transmission started in Spring, 2016
Zika virus established itself repeatedly in Florida.
The Caribbean is the main source of Zika virus in Florida.
The Caribbean is the main source of Zika virus in Florida.
A lot of travel from the Caribbean

Estimated proportion of infected travelers

- Caribbean (cruises)
- Caribbean (flights)
- South America (combined travel)
- Central America (combined travel)

Month of 2016

Jan  Feb  Mar  Apr  May  Jun
Miami is unique

Introductions around this time
... and so is Florida
Future
Open Science critical

www.andersen-lab.com/data

www.bioRxiv.org
Real-time Science
Outbreak Response
Outbreak Prevention
Failure to diagnose rapidly

- Lassa endemic
- Ebola never seen before
- Poor healthcare infrastructure

~ three-month delay
Early detection
Test for everything

GTACTGACTACGTAGC
GACTGCTGACTGATCG
ATCGATGTATAGCTAC
TAGCTCGCTGCTAGAG
TCGTAGCTAGCATCGA
TCGATCGTACGTACGT
CGTAGCATCGATCGTA
CGATGCTAGCTACGAT
GTAGCTAGCTAGCTAC
GTAGCTACGTAGCTAC
ATCGTCGTAGTAGCCA
GCCGGCGCTGCCGCGA
CGATCGCCGCGATCGG