
From Broad Street to Boston:

Tracking Infectious Disease Outbreaks Using Molecular Epidemiology

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Overview of today's talk:

- Broad Street Cholera Epidemic – London, 1854
- Current understanding of Cholera
- Impacts of modern Cholera – Haiti, 2010

Cholera

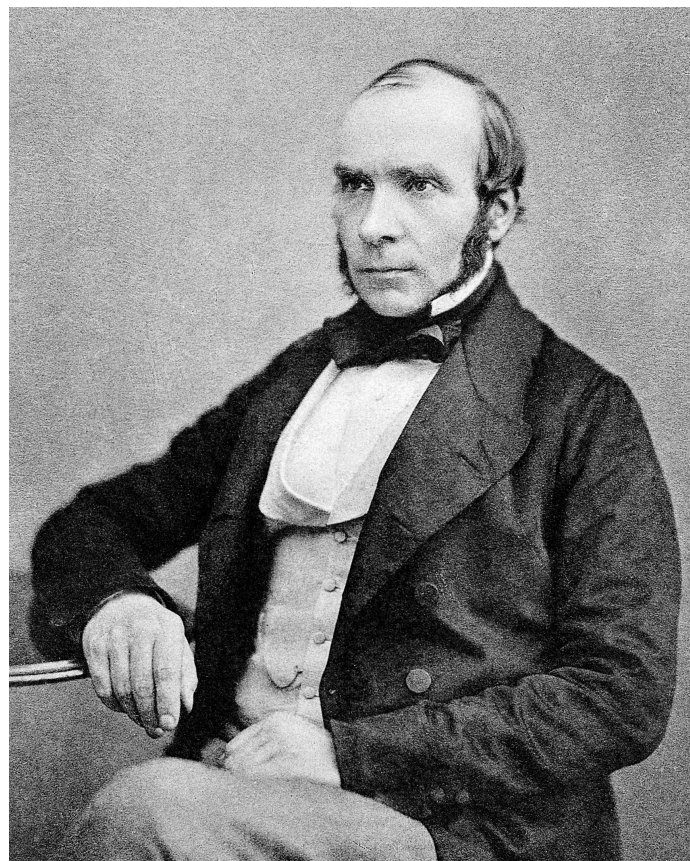


Cholera



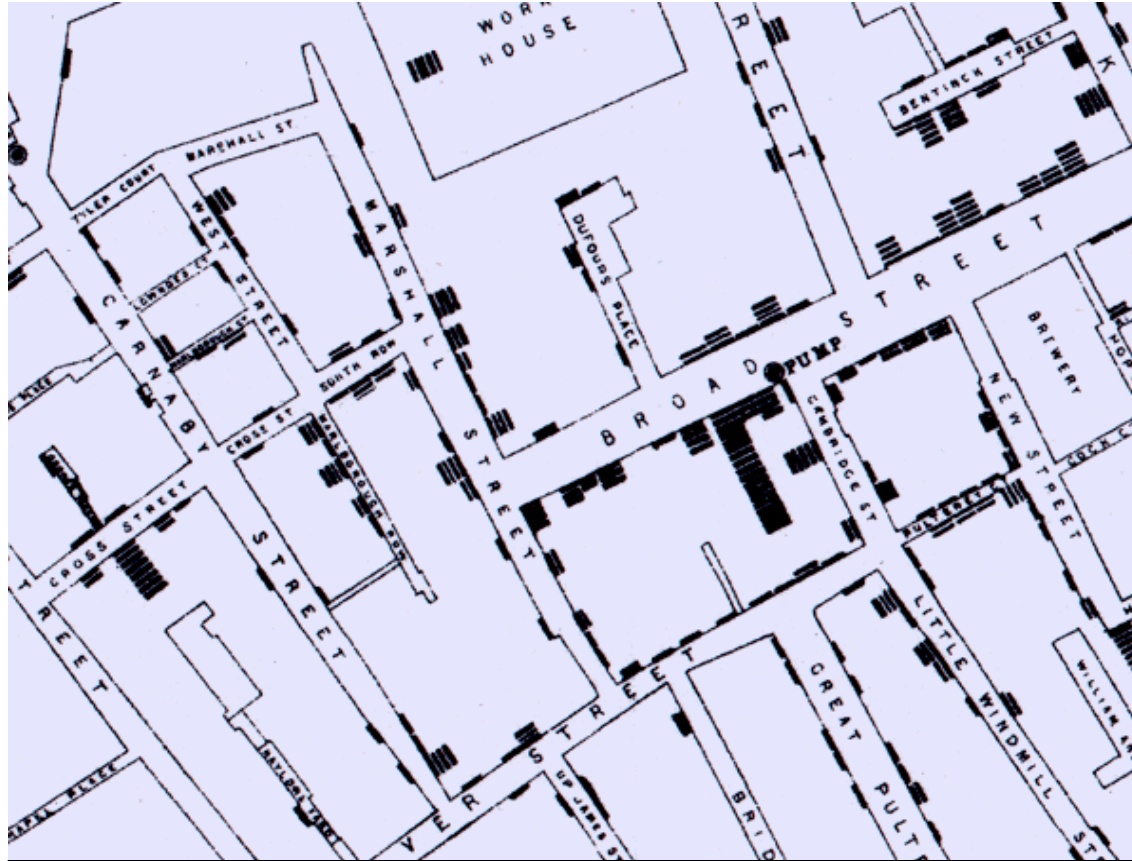
- 3-5 million cases and 100,000+ deaths annually

The Broad Street Cholera epidemic



~~Miasma – noxious air~~
Contagion – infectious particle

The Broad Street Cholera epidemic



Hypothesis: Cholera victims
drank contaminated water

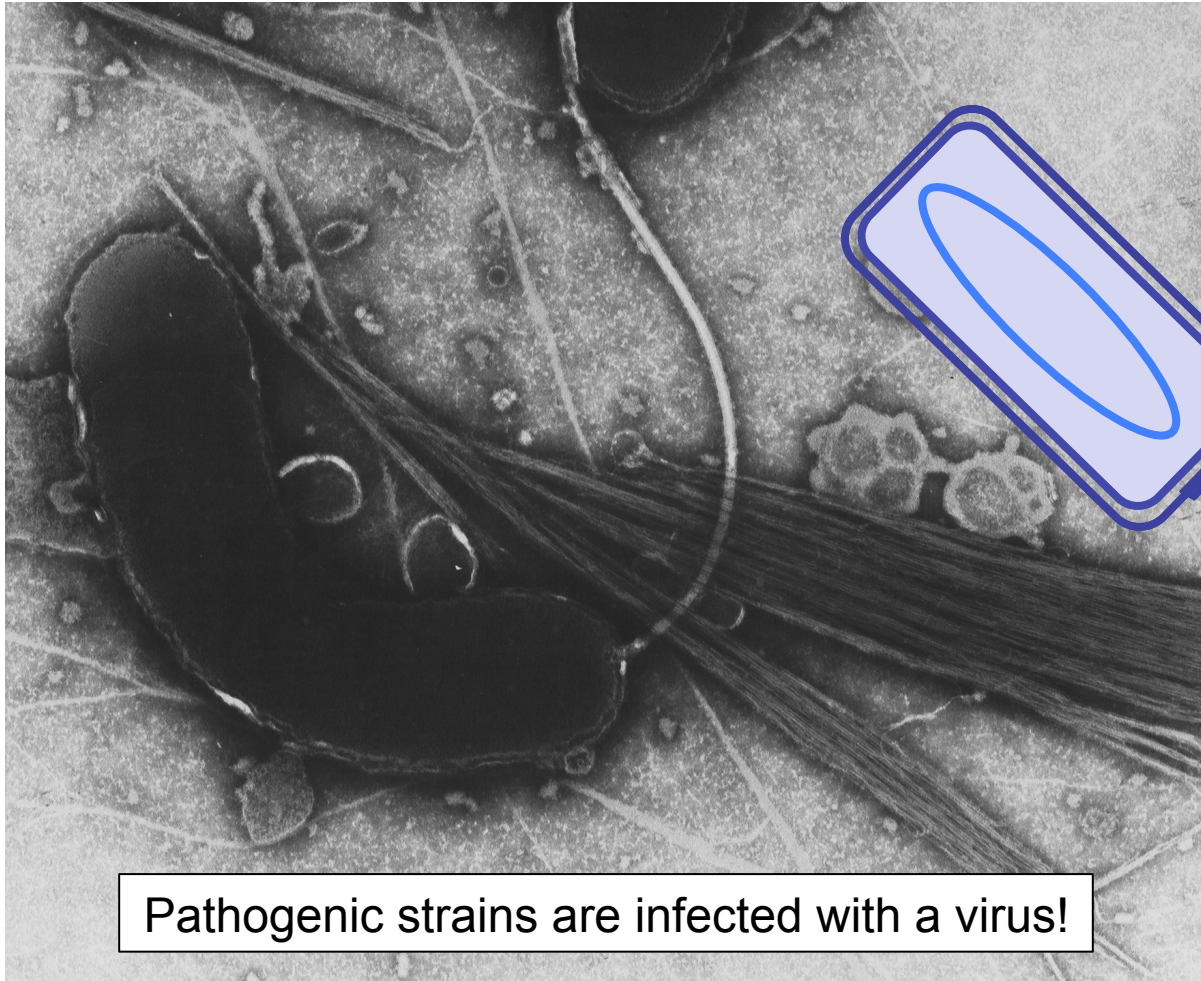


Snow, J. "On the Mode of Communication of Cholera," 1855

Snow's methods

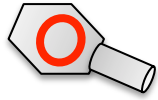
- Find cases of disease
- Identify connections between sick people
- Epidemiology – the study of the incidence, distribution, and potential control of disease
- **Stopped the epidemic without treating, or even identifying, the cause**

Vibrio cholerae: a bacterial pathogen

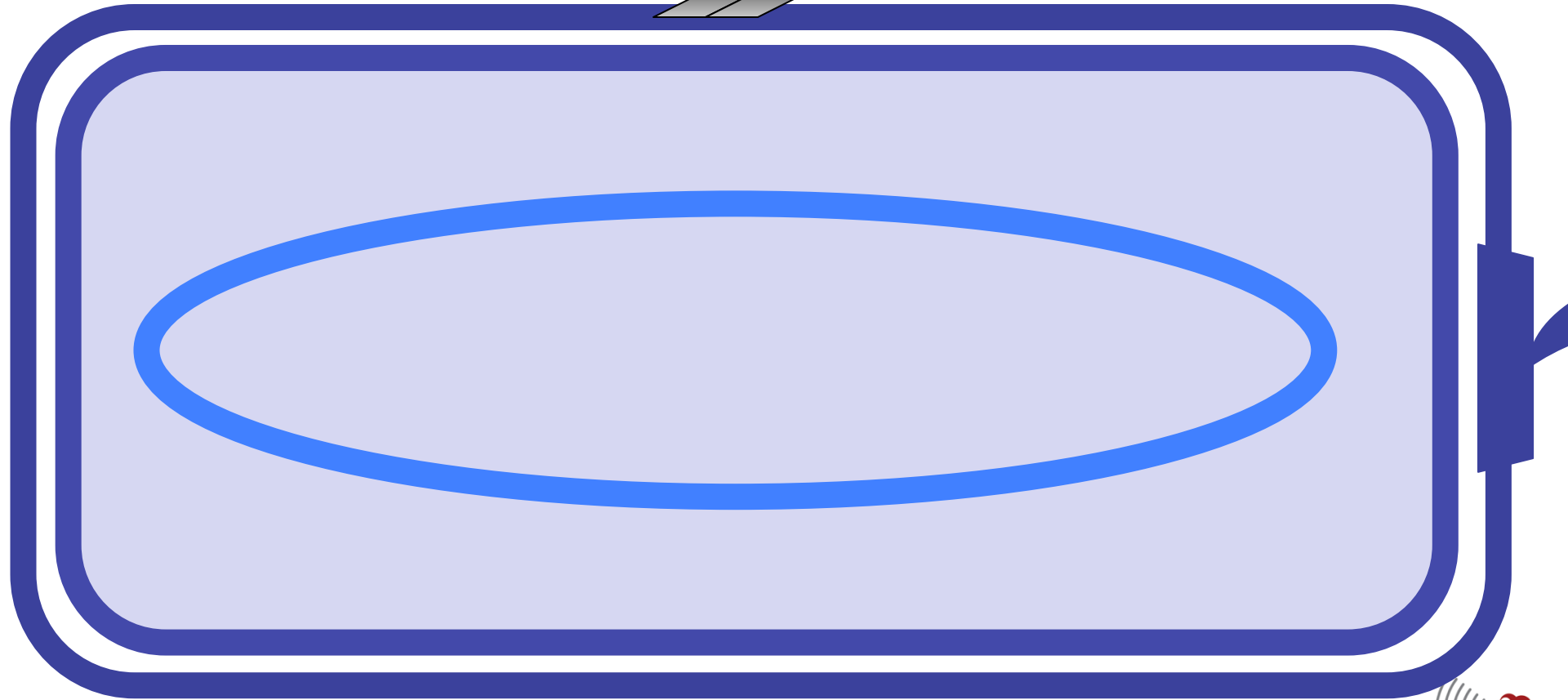
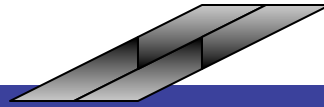


Pathogenic strains are infected with a virus!

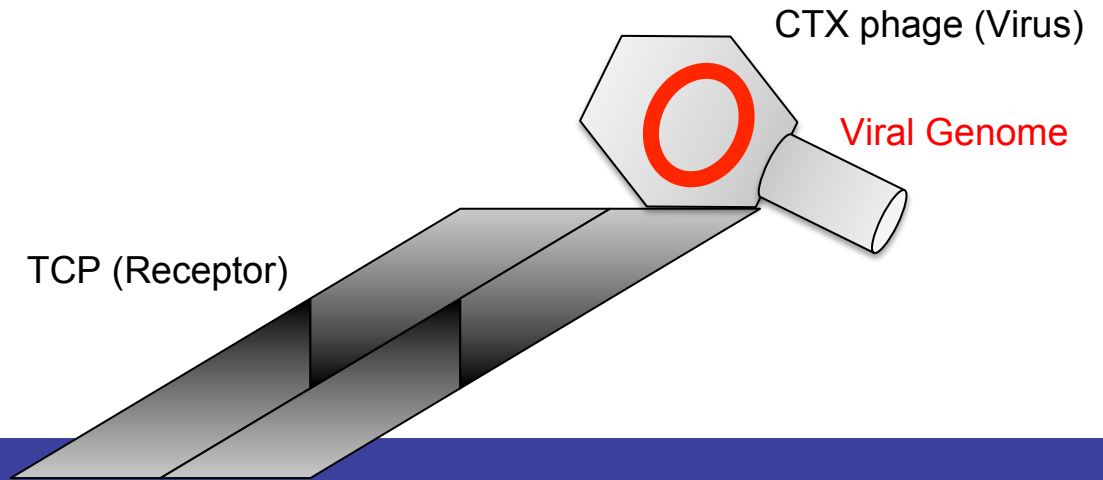
CTX Phage (Virus)



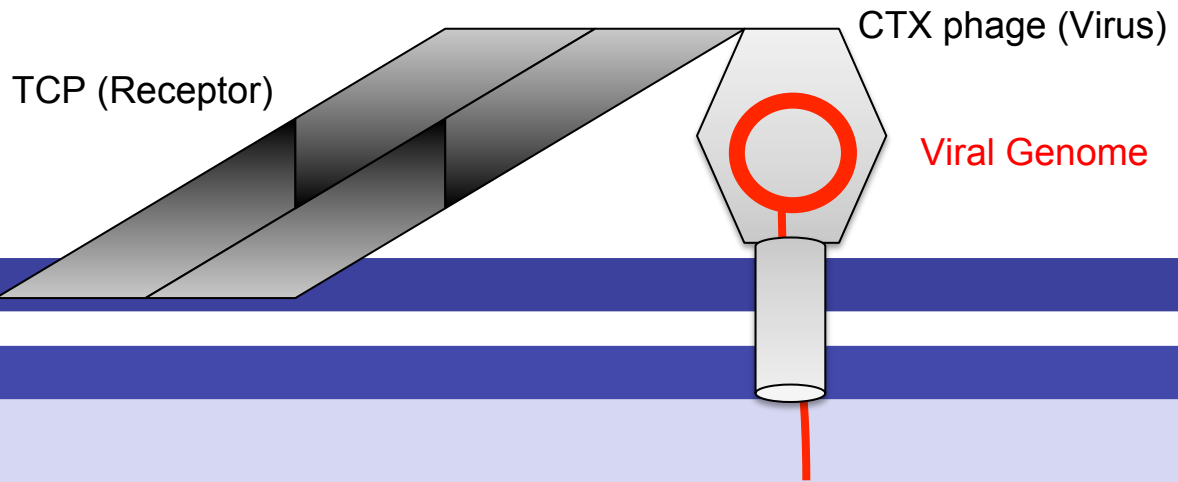
TCP



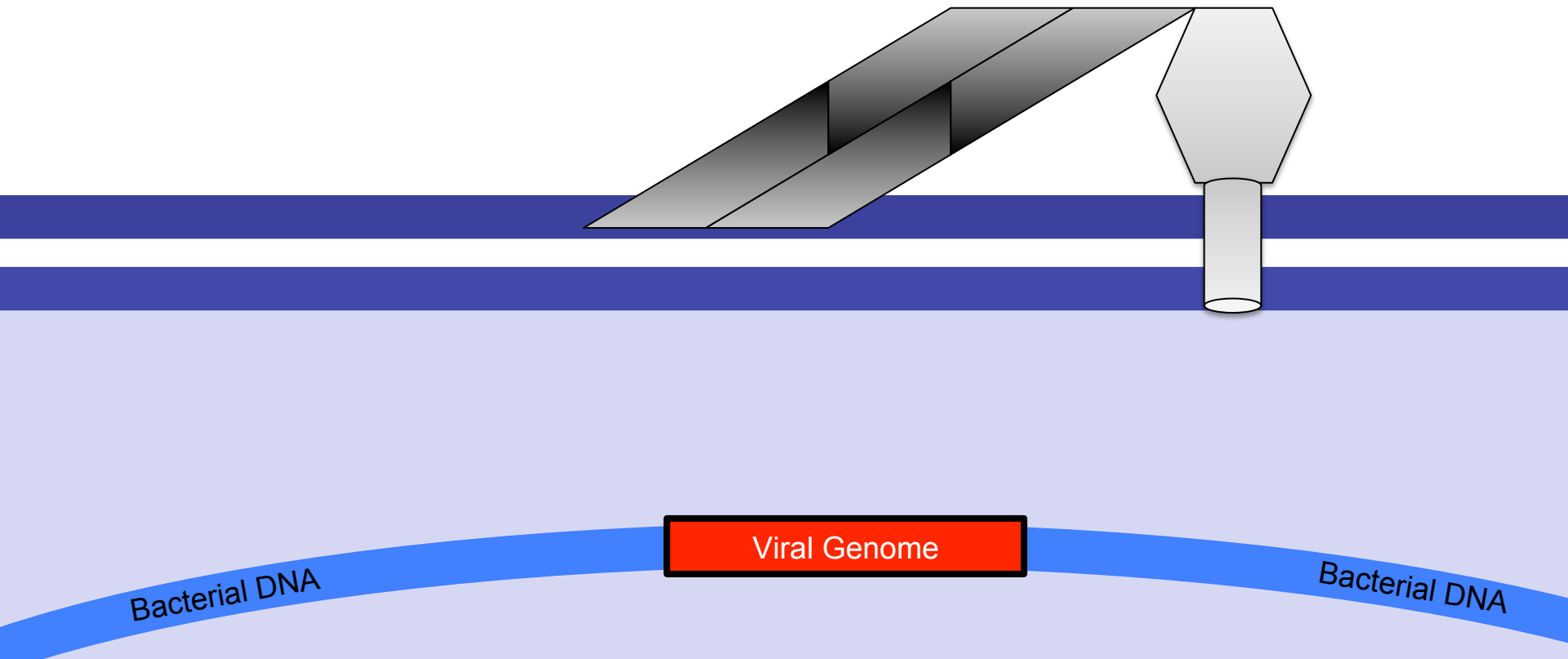
Vibrio cholerae is infected with a virus



Vibrio cholerae is infected with a virus

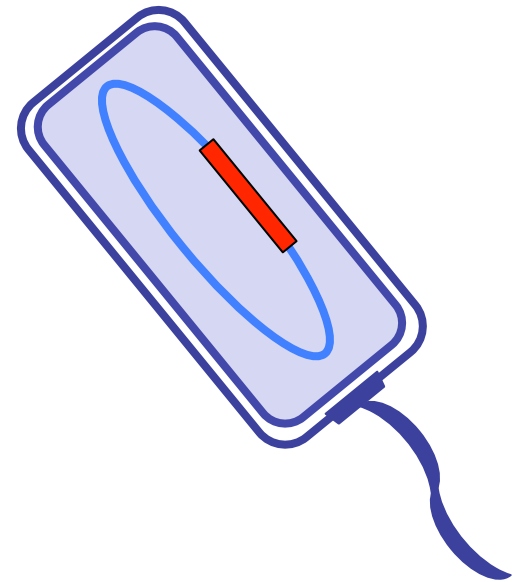


Vibrio cholerae is infected with a virus

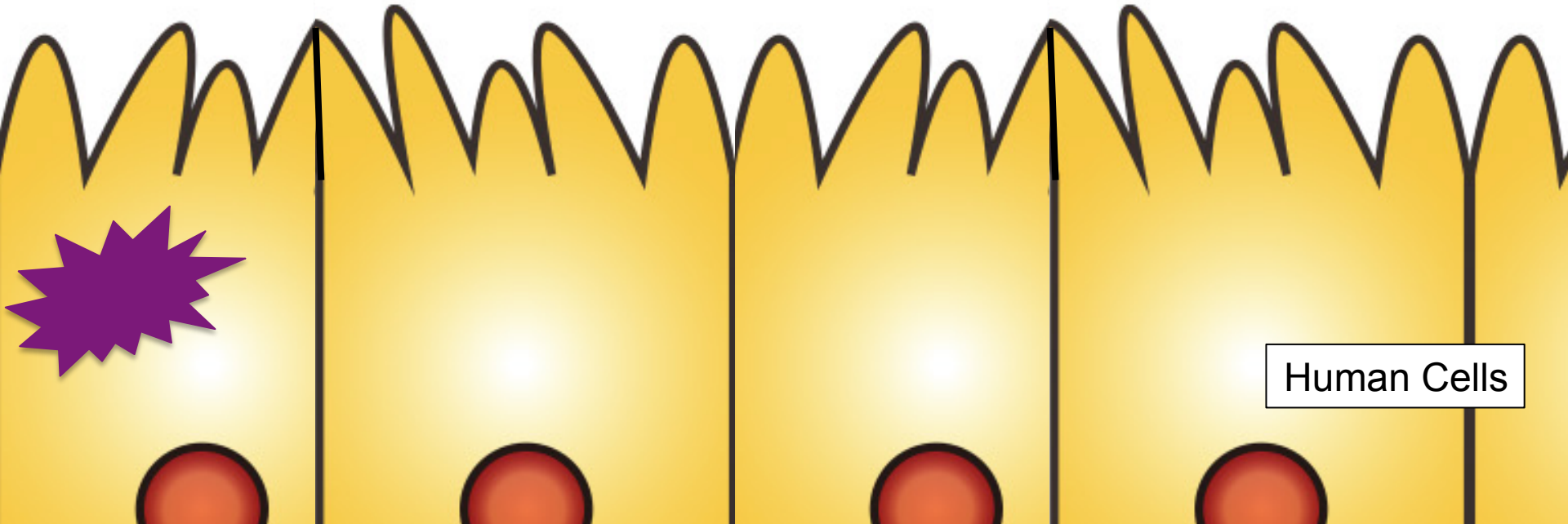
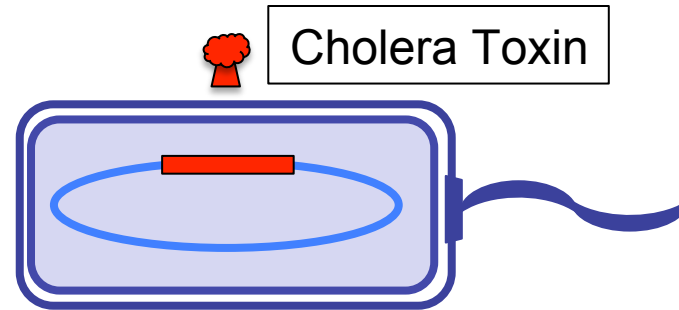


Vibrio cholerae: a bacterial pathogen

- Cause of Cholera:
 - Ingestion of contaminated food or water

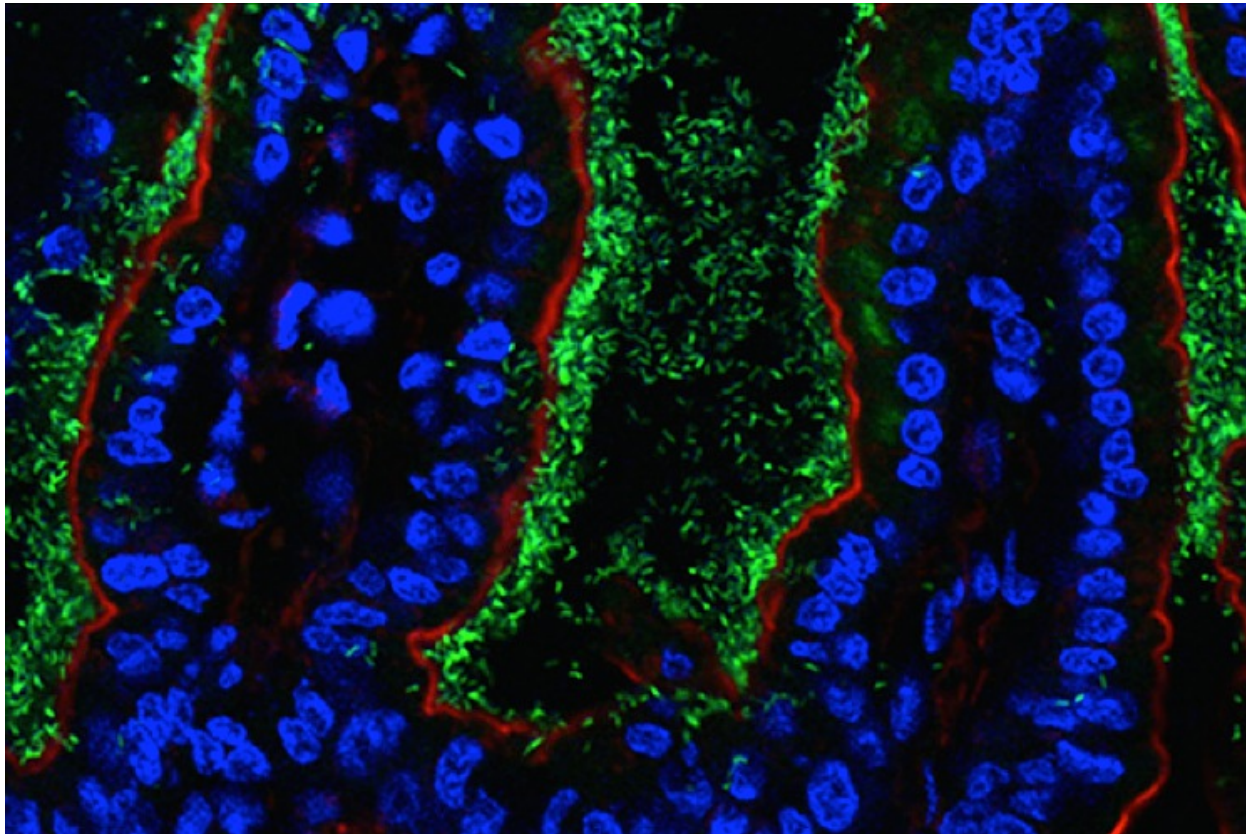


Vibrio cholerae produces Cholera Toxin

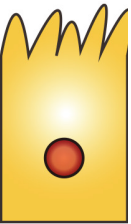


Vibrio cholerae intestinal colonization

Vibrio cholerae = green

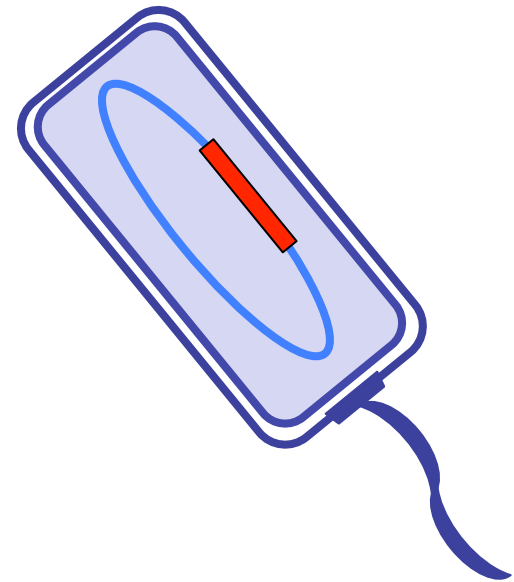


Intestinal cell = blue/red



Vibrio cholerae: a bacterial pathogen

- Cause of Cholera:
 - Ingestion of contaminated food or water
- Spread of Cholera:
 - Infected humans produce ~20L of stool containing ~10,000,000,000,000 bacteria each day



Cholera treatment

- Rehydration with intravenous fluids
- Cholera salts to restore lost electrolytes
- Antibiotics for extremely severe cases
- Moderately effective short-term Cholera vaccines

Recap

- John Snow's study of the Broad Street epidemic serves as the foundation of epidemiology
- Pathogenic strains of *Vibrio cholerae* are infected with a virus
- Humans contract Cholera by ingesting food or water contaminated with a pathogenic strain
- Cholera is extremely rare in the developed world

The earthquake in Haiti

- January, 2010
- ~100,000 killed, millions homeless
- Significant damage to infrastructure



Center for Disease Control (CDC)

“An outbreak of Cholera is very unlikely at this time... While the current water, sanitation, and hygiene infrastructure in Haiti would certainly facilitate transmission of Cholera, Cholera is not circulating in Haiti, and the risk of Cholera introduction to Haiti is low. Most current travelers to Haiti are relief workers from countries without endemic Cholera, and they are likely to have access to adequate sanitation and hygiene facilities within Haiti.” – March, 2010

Center for Disease Control (CDC)

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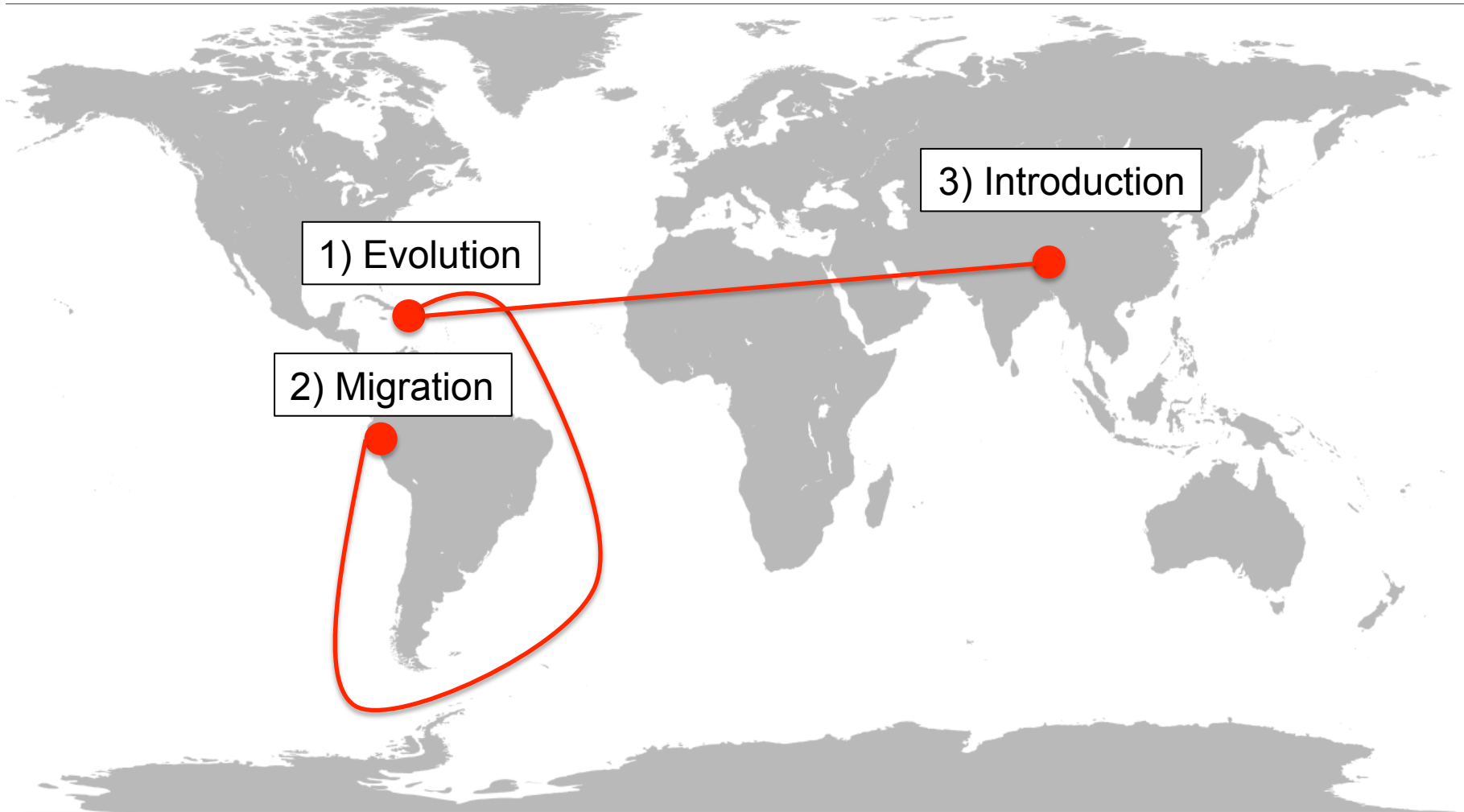
700,000+ cases

8,000+ deaths

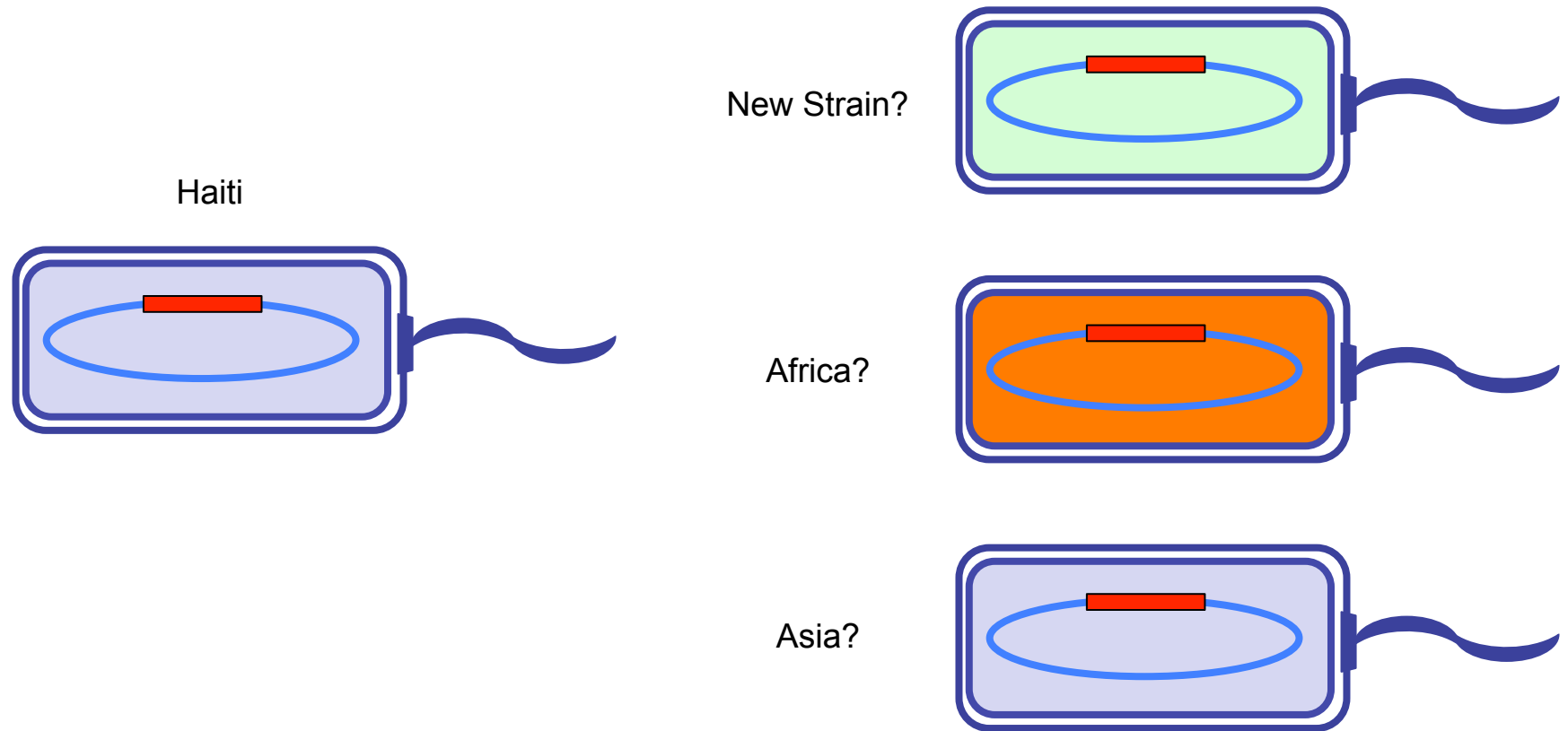
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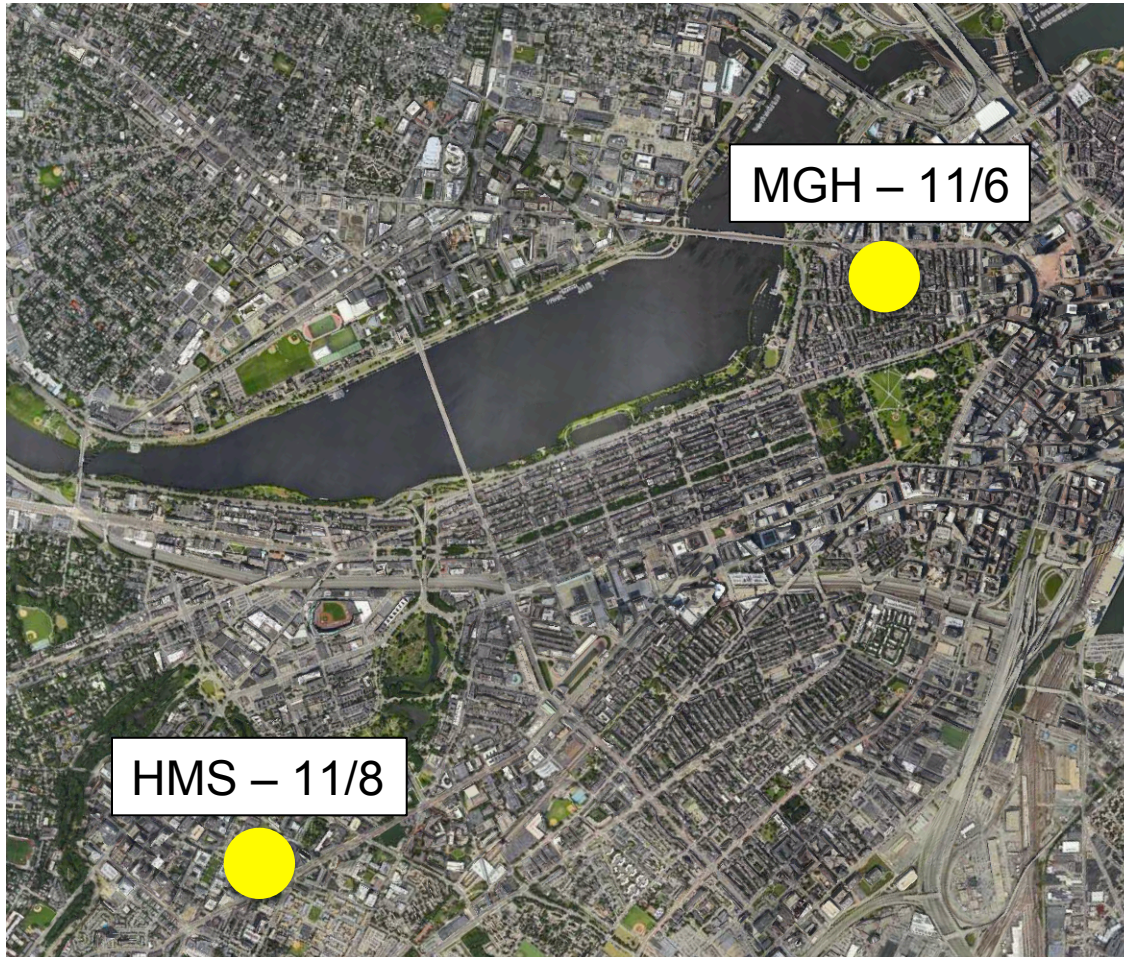
How did Cholera get to Haiti?



Sequencing the Haitian outbreak strain

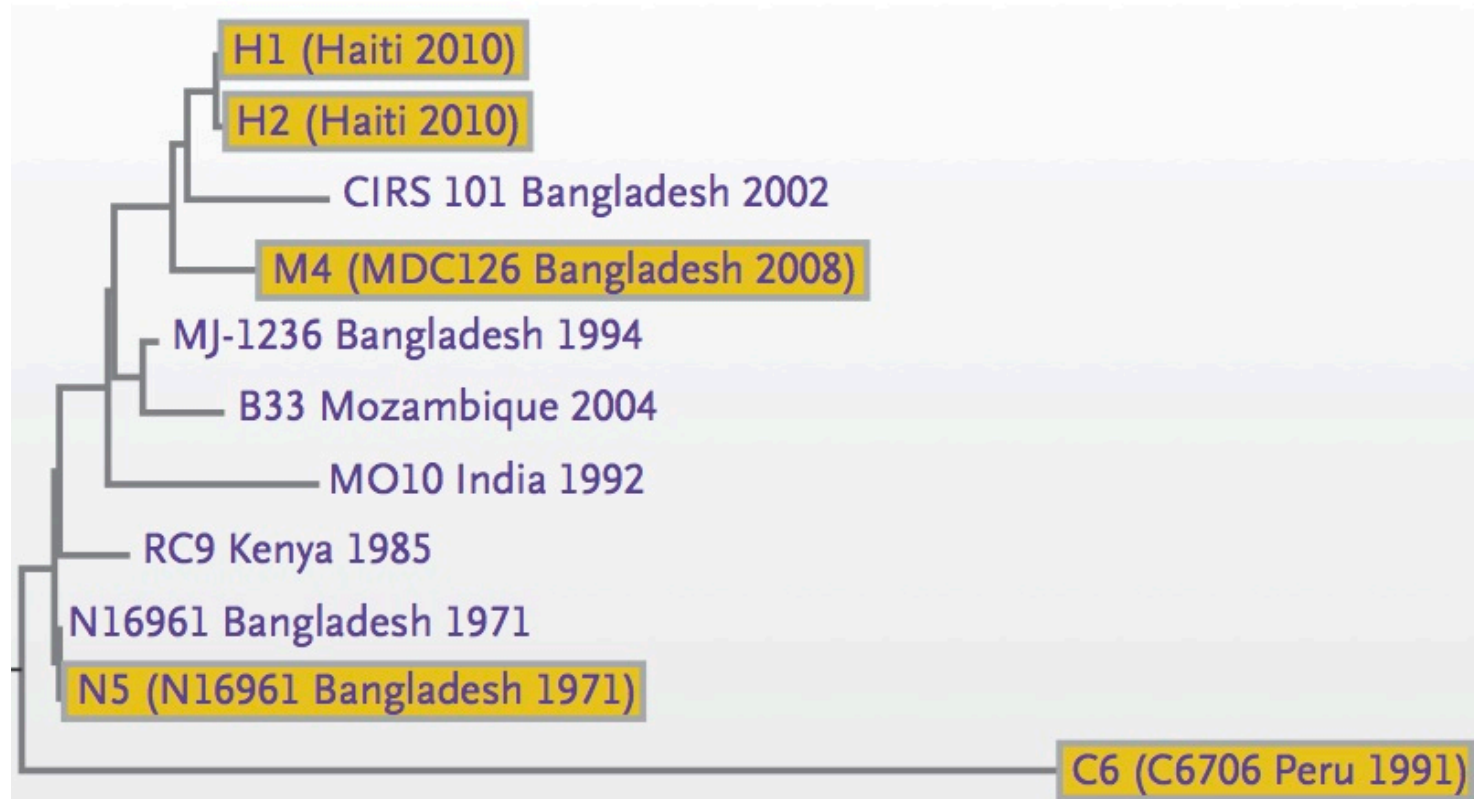


Sequencing the Haitian outbreak strain

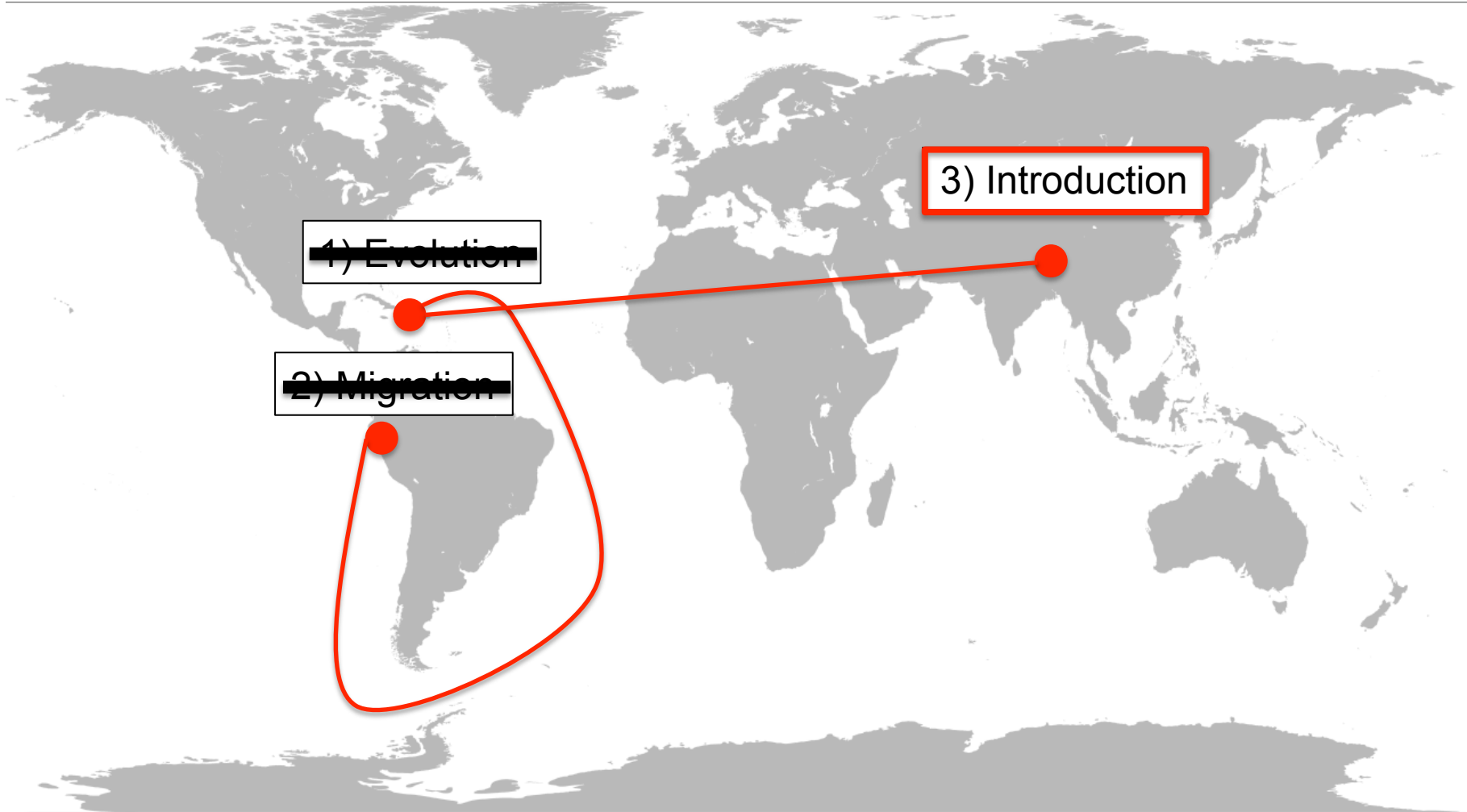


- DNA isolated, 4 am – 11/9
- Sequencing, 10 pm – 11/9
- Preliminary conclusions, 11/11

Haitian outbreak genome



How did Cholera get to Haiti?



Cholera epidemic in Haiti



- UN aid workers identified as the source of Cholera in Haiti
- Rioting directed against UN peacekeepers

Response to the Haiti outbreak

- Provide vaccination or preventative care for aid workers from Cholera-endemic areas
- Stockpile Cholera vaccines for rapid deployment
- Calls for the UN to pay reparations to Haiti

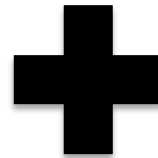
Conclusions:

- Social context to outbreaks of infectious disease
- Curing a disease is only the first step
- Responding to Cholera outbreaks requires a comprehensive approach...

“A comprehensive, integrated strategy for Cholera prevention and care”



Access to quality care

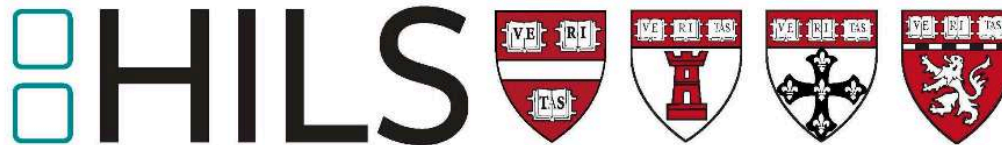


Access to quality infrastructure

Thank you!

SITN would like to acknowledge the following organizations for their generous support of this event.

Harvard Integrated Life Sciences



The nonprofit plasmid repository



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