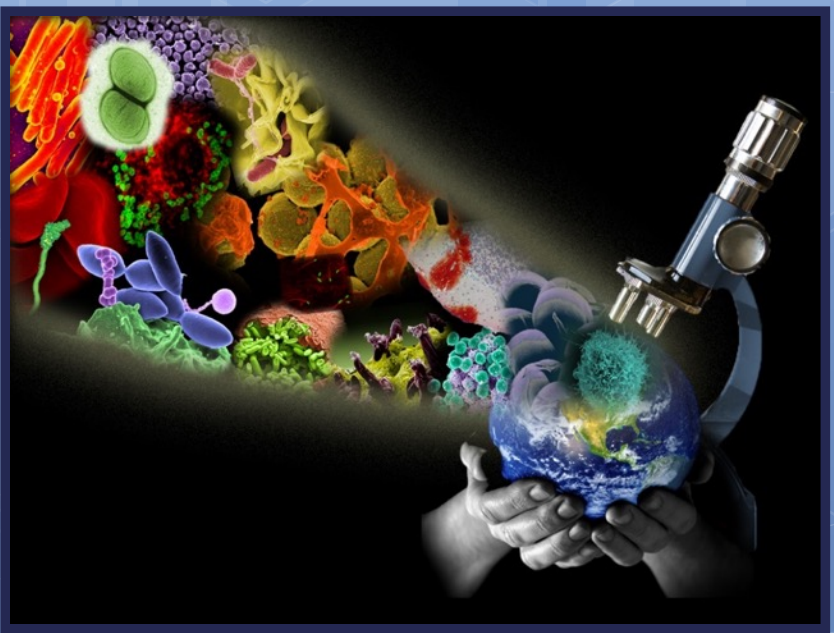
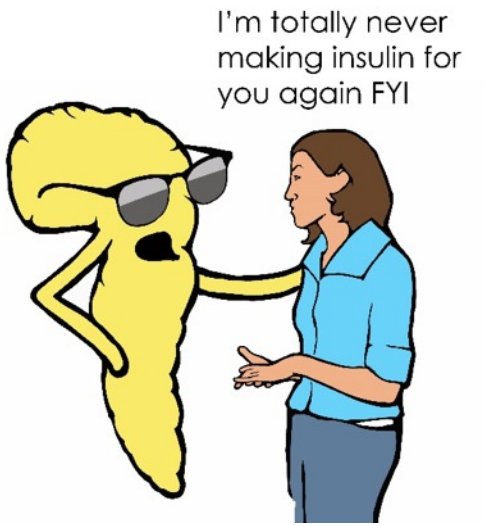


Infectious Diseases

Disease vs infectious disease

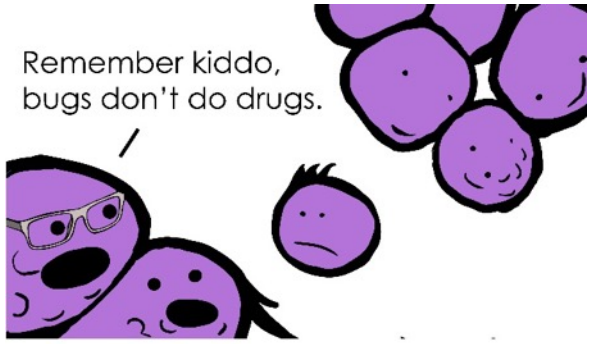
Disease

- A disorder of body function
  - Type 2 Diabetes



Infectious Disease

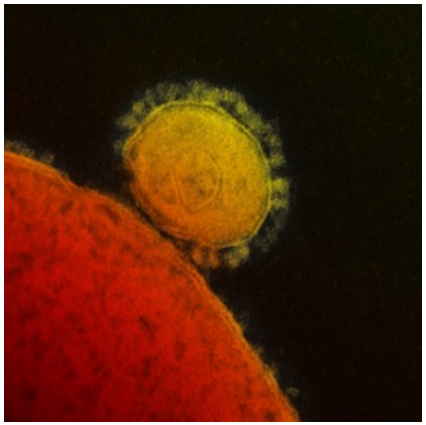
- A disorder of body function caused by the entry, growth, or multiplication of a microorganism



Advice from Mr. E. coli

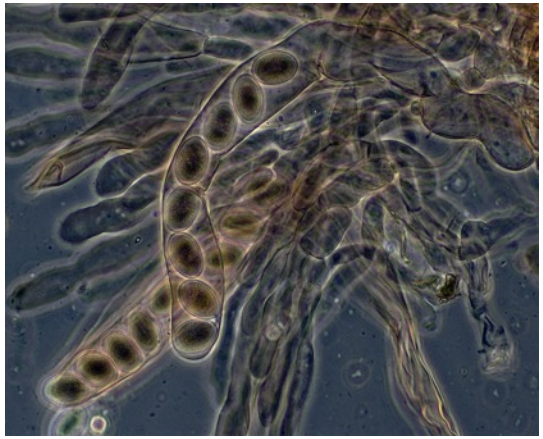
Microorganisms

Bacterium



Virus

Protozoa

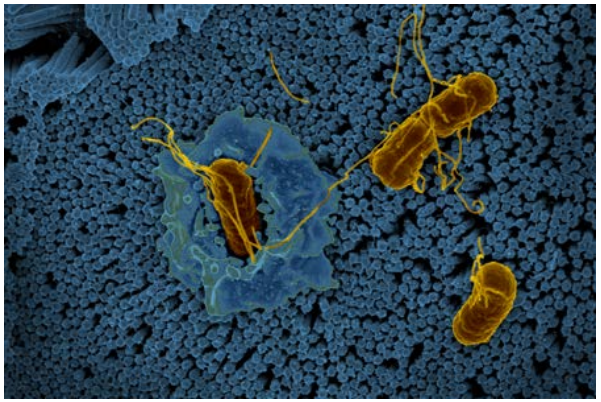


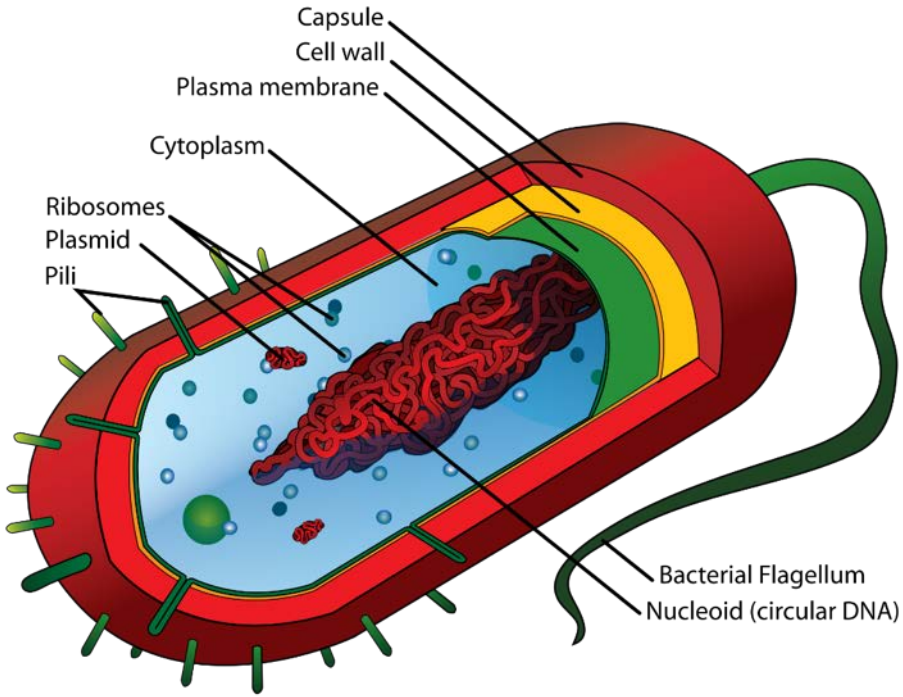
Fungus

Bacteria – what are they?

The most common microorganisms on earth

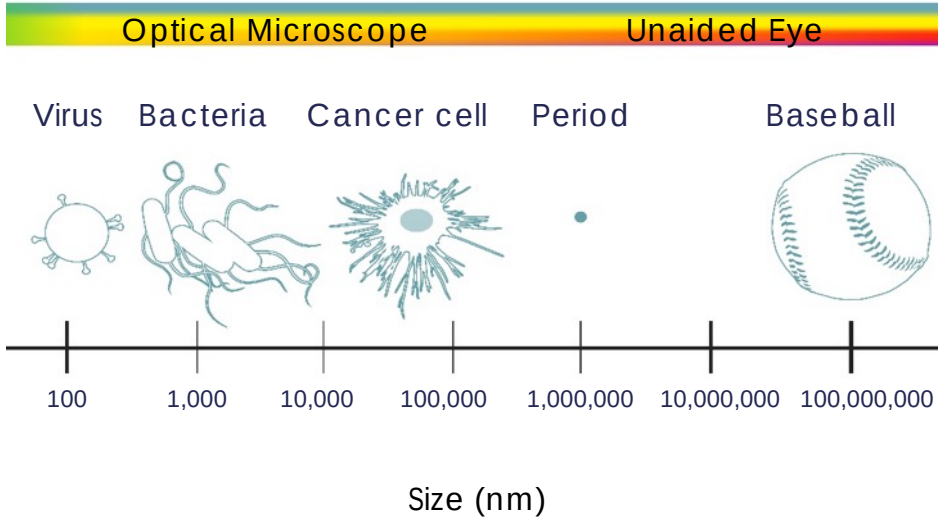
- Single cell organism
- Bacterial cells:
  - Lack internal membranes
  - Lack mitochondria
  - Have flagella





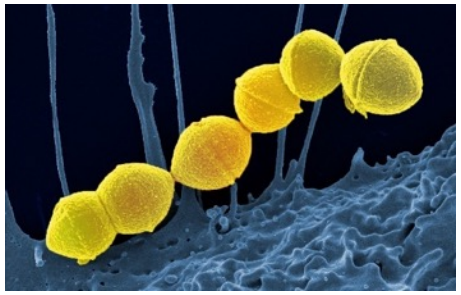
Bacteria – how big are they?

- Bacteria are generally 1-2 micrometers across
- 1/1000th the size of the head of a pin (~1 mm)
- 1/100th the width of human hair (~0.1 mm)



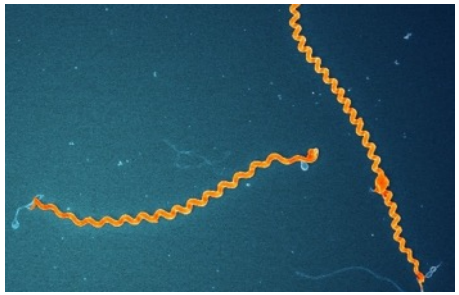
Bacteria morphology

- Coccus (Cocci) – round



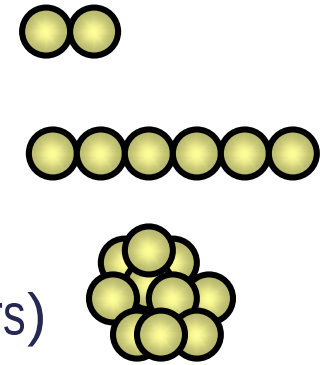
- Bacillus (Bacilli) – rod

- Spirillum (Spirilla) - corkscrew

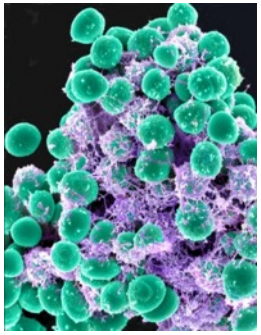


Coccus shaped bacteria

- Diplococci (pair)
- Streptococci (chain)
- Staphylococci (clusters)

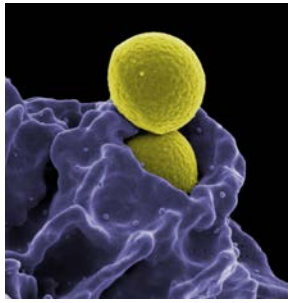


Staphylococcus aureus
(MRSA - Skin infection)



Staphylococcus epidermidis
(Skin – non pathogenic)

Streptococcus pneumoniae (purple)
(pneumonia)



Streptococcus pyogenes
(strep throat, scarlet fever, rheumatic fever, flesh eating disease)

Bacillus shaped bacteria

Single

Pair

Chain

Escherichia coli
(food poisoning)

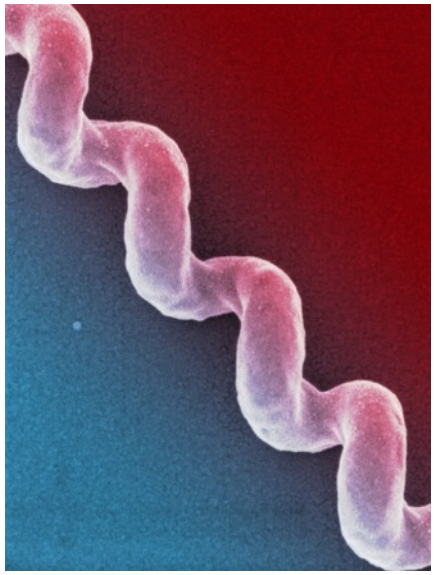
Clostridium difficille
(diarrhea)

Klebsiella pneumoniae
(pneumonia, meningitis)

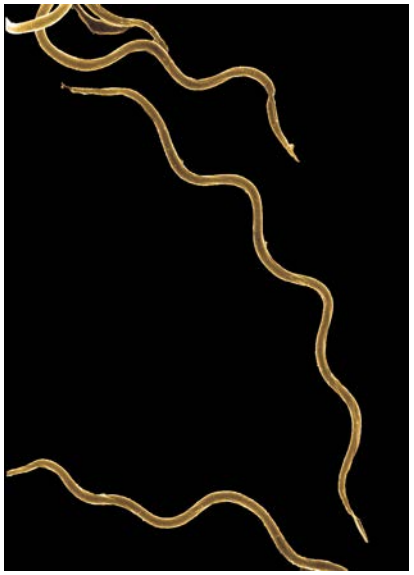
Salmonella enterica
(intestinal disease)

Bacillus anthracis
(anthrax)

Spirillium shaped bacteria



Leptospira
(Leptospirosis)



Borrelia burgdorferi
(Lyme Disease)

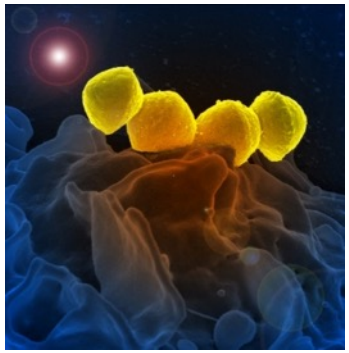
Bacteria – where are they?

- Bacteria are everywhere – they are ubiquitous
- Soil, air, water, mountaintops, ocean bottoms, polar regions, skin, & intestine

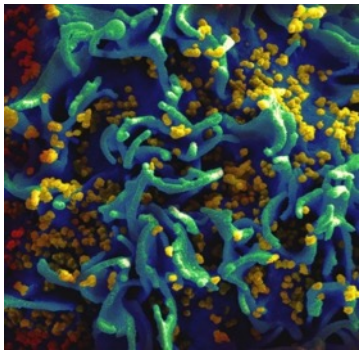
How much bacteria do people carry around?

Pathogens

- A microorganism that causes disease is called a pathogen
- Can be bacteria, virus, protozoa, fungus

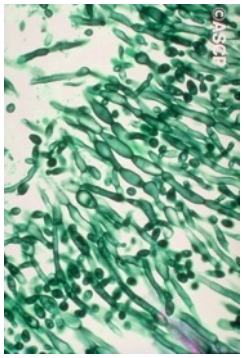


Methicillin-resistant *Staphylococcus aureus* (MRSA)

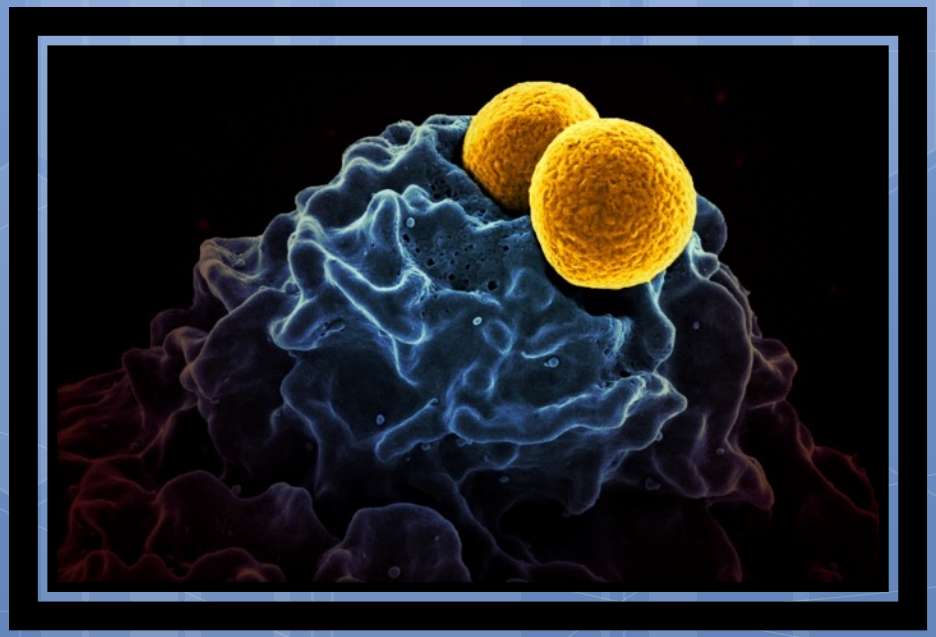


Human immunodeficiency virus (HIV)

Giardia lamblia

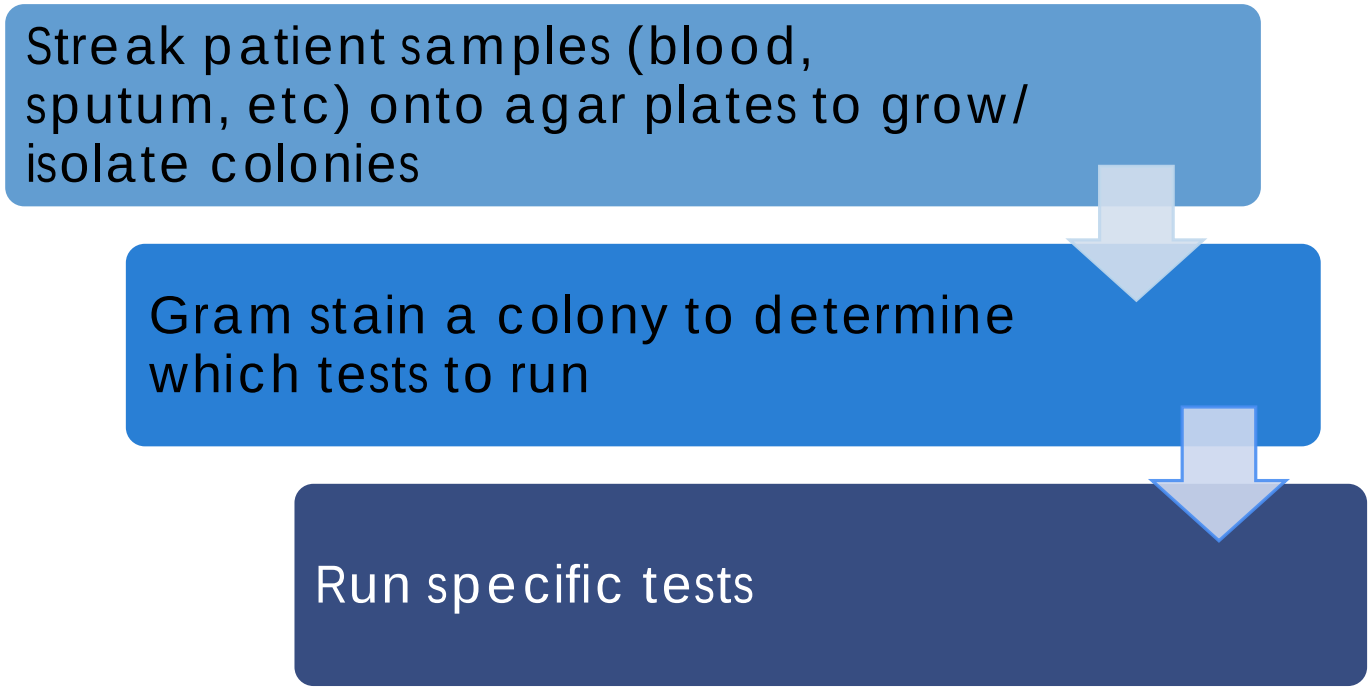


Candida albicans



Identification of Pathogenic (Disease Causing) Bacteria

Steps to bacterial identification



Types of tests

- Differential/Selective Tests
- Biochemical
- Immunological
- Genetic

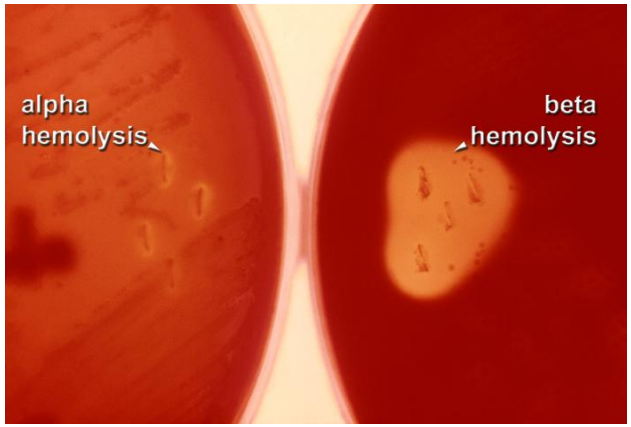
Biochemical vs. differential/selective tests

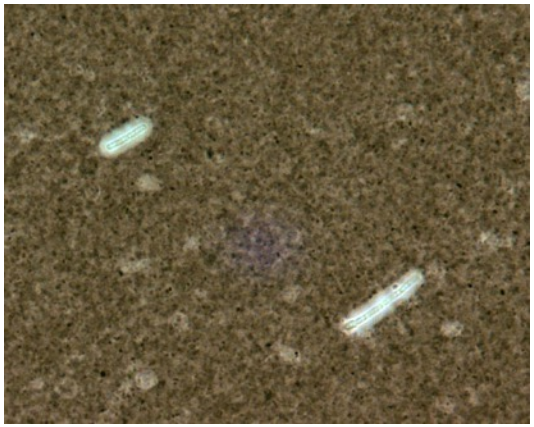
Biochemical tests

- depend on an enzyme's metabolic activity.

Differential/Selective tests

- can indicate specific genus/species without relying on enzymatic function.

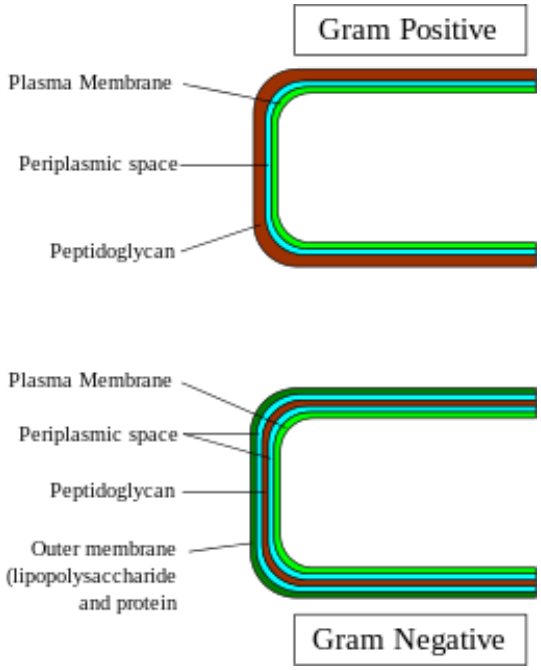




Differential test: gram stain

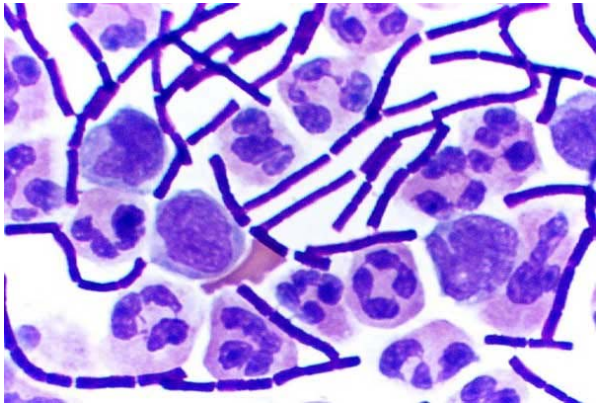
Bacteria stain differently because of differences between their cell walls:

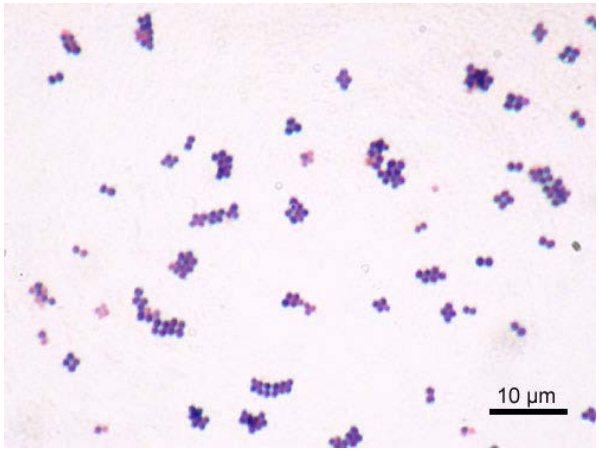
- The outer Peptidoglycan layer of Gram positive bacteria retains the primary stain (Crystal violet), making it appear purple.
- Alcohol washes the primary stain off of Gram negative bacteria allowing them to pick up the secondary stain (Safranin), appearing red.



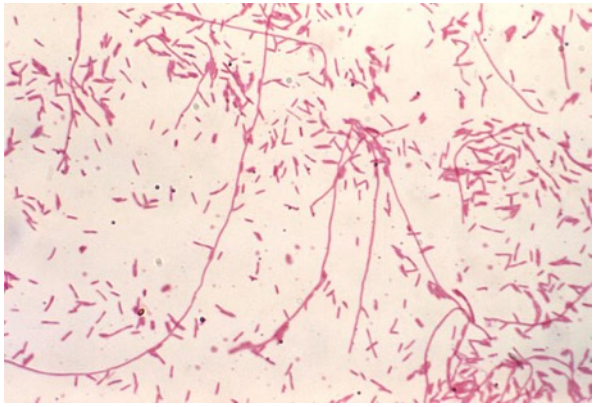
Gram stain examples

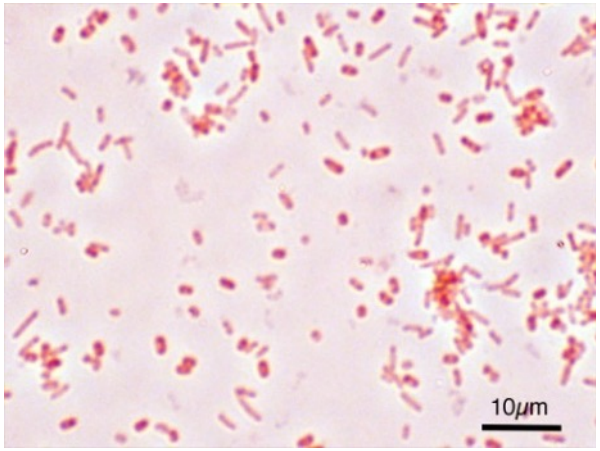
Gram Positive





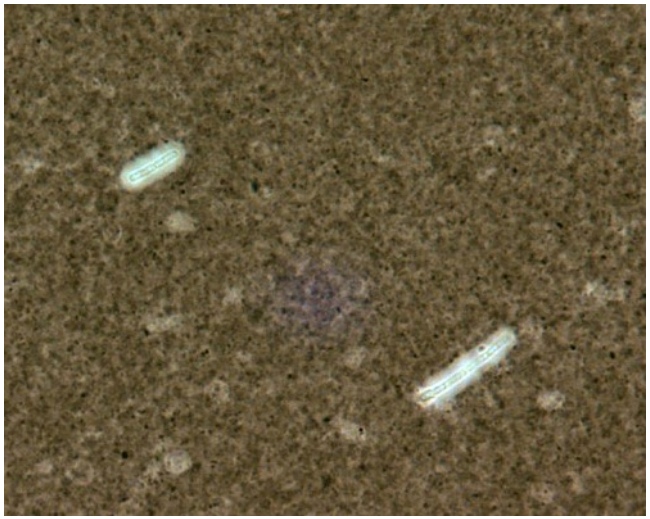
Gram Negative





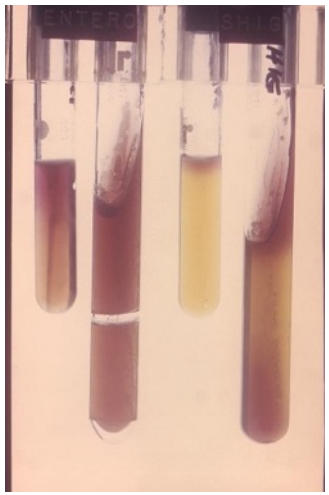
Differential tests: capsule stain

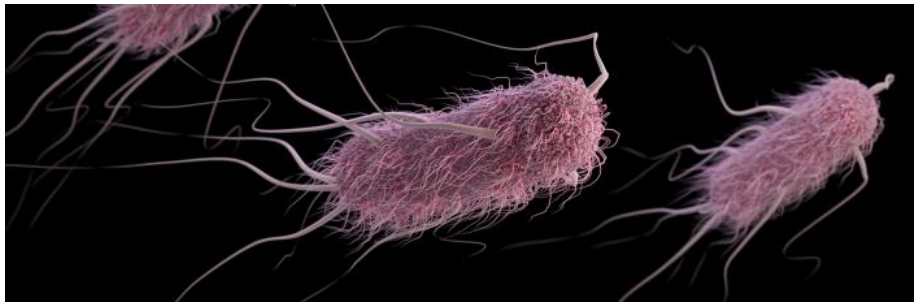
- Crystal violet stain for a few minutes, then flood slide with 20% copper sulfate ($CuSO_4$) and blot dry.
- If there is a capsule (polysaccharides & lipoproteins) it will appear like a “halo”.



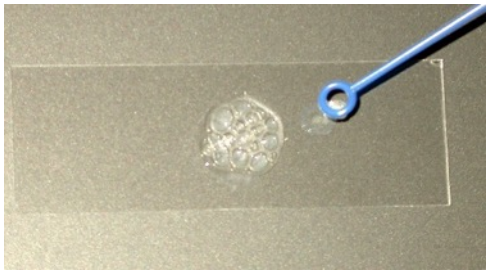
Differential test: motility

- Using a straight wire or inoculating loop, bacteria is stabbed through semisolid media and incubated overnight
- If bacteria have flagella for motility, there will be growth all over the tube, rather than just at the stab site





Biochemical tests

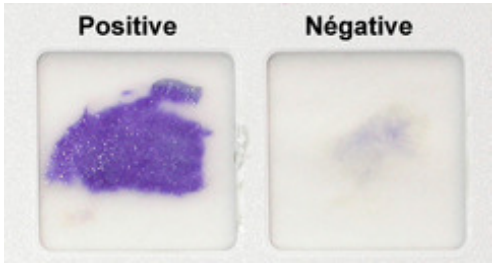


Catalase Test

- Differentiates between streptococcus & staphylococcus
- Indicates catalase production
- Positive result – causes bubbles

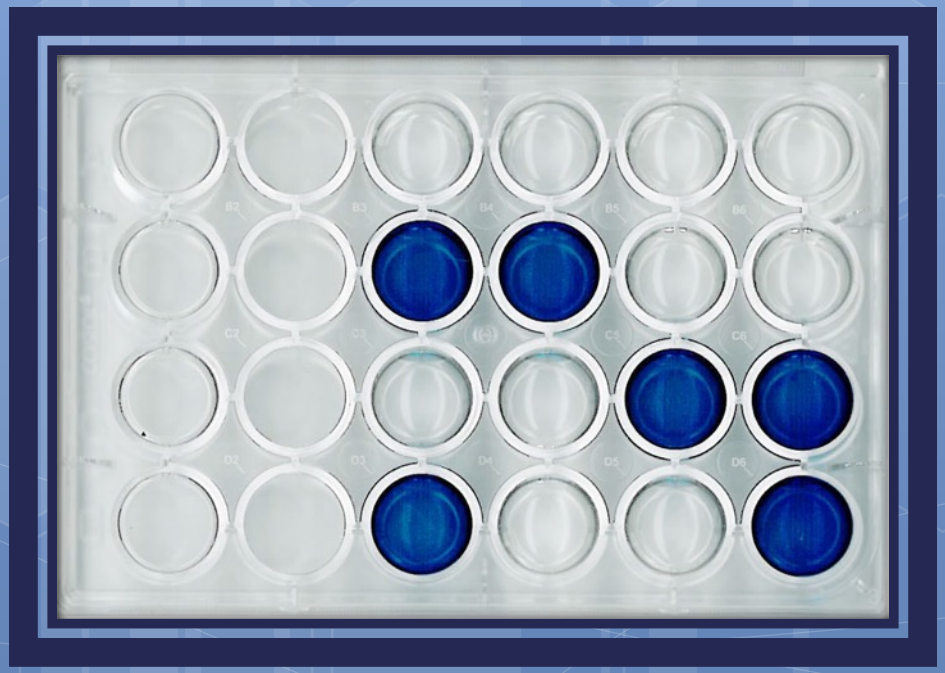
Methyl Red Test

- Tests fermentation of glucose
- Glucose byproducts are acidic (pH <7)
- Positive result-pH change



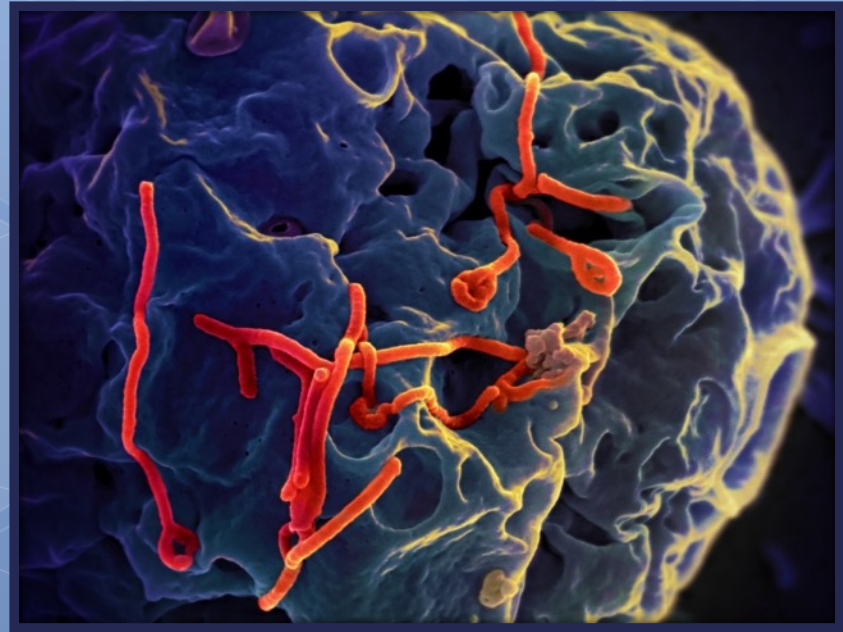
Oxidase Test

- Identifies cytochrome oxidase
- Positive result - color change due to oxidation of the test reagent.



Activity 1: Bacterial Identification

Patient Case Studies

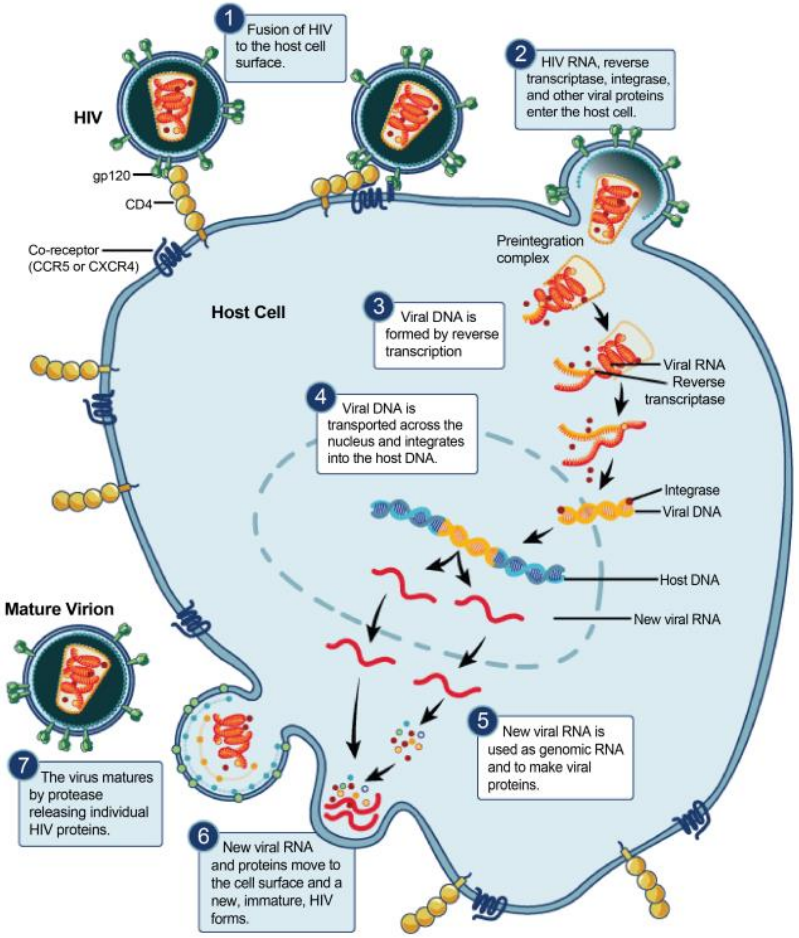


Virology

What is a virus?

A virus is an obligate intracellular parasite

- Requires a host cell to replicate

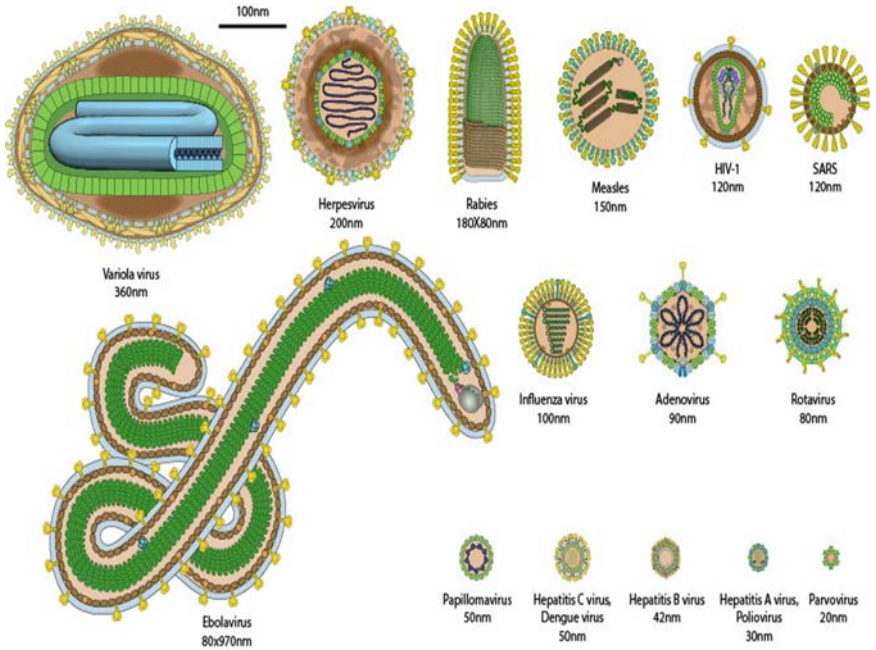


Viruses are the most abundant biological entity

- There are millions of viruses in a single drop of water
- There are roughly 10^{31} total viruses on Earth
- If lined up end to end, all of Earth's viruses would stretch over 100 light years into space.

How big are viruses?

Most viruses range from 20-300 nm in diameter

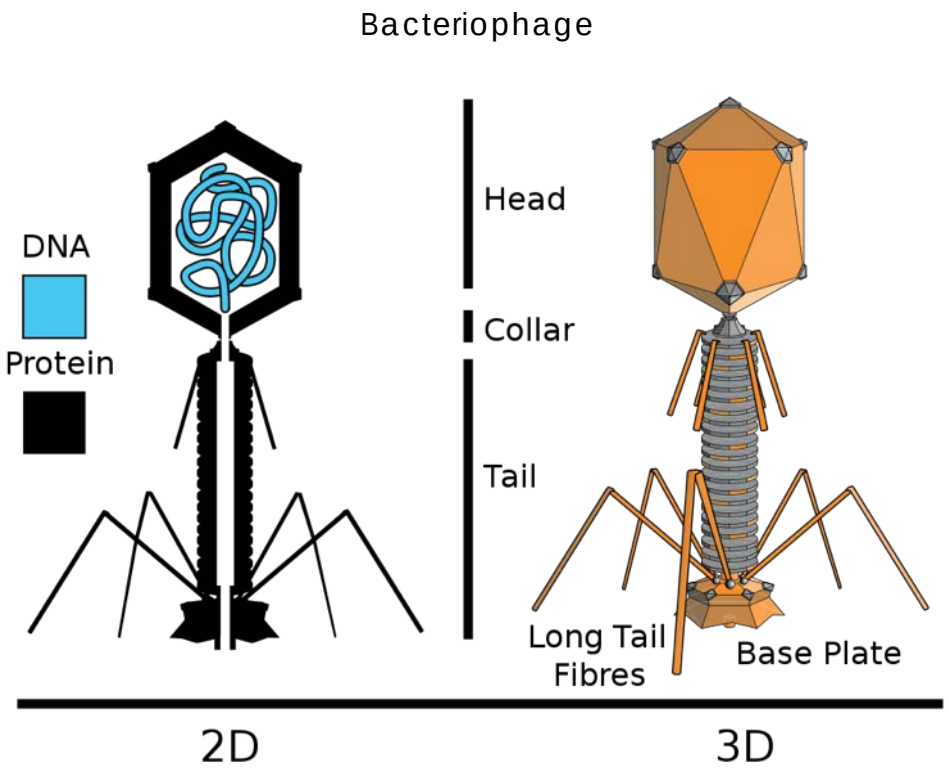


Source: ViralZone: www.expasy.org/viralzone,
SIB Swiss Institute of Bioinformatics

What makes up a virus?

Key components

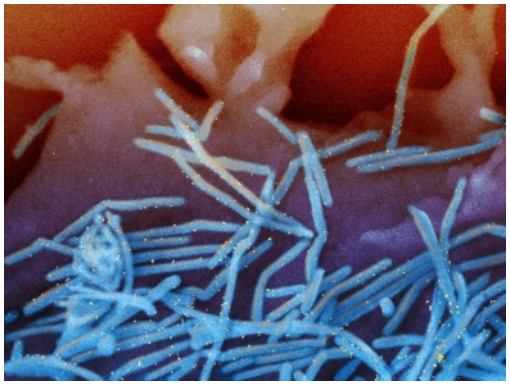
- Genetic material
- Protein coating (capsid)
- Receptor binding element



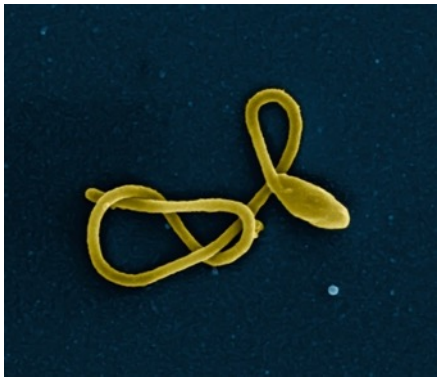
Genetic material

- Viruses can use all types of nucleic acids as their genetic material
- Most genomes range in size from 1.7kb - 600kb
- The human genome is 100,000 – 1,000,000 times larger than most viral genomes!

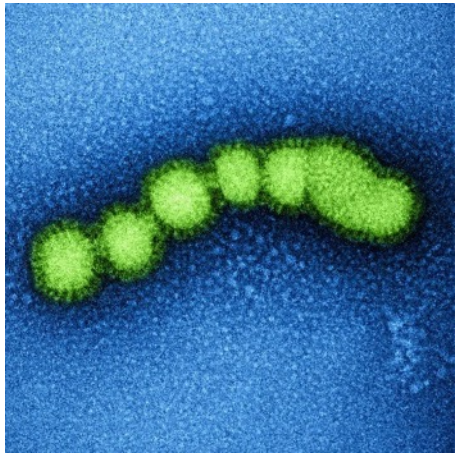
Virus shapes and diversity



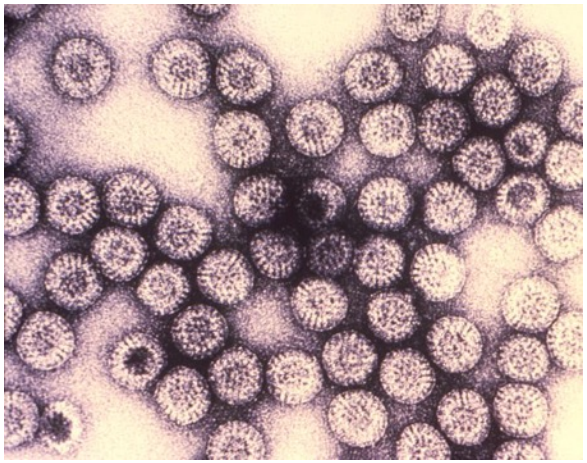
RSV



Ebola



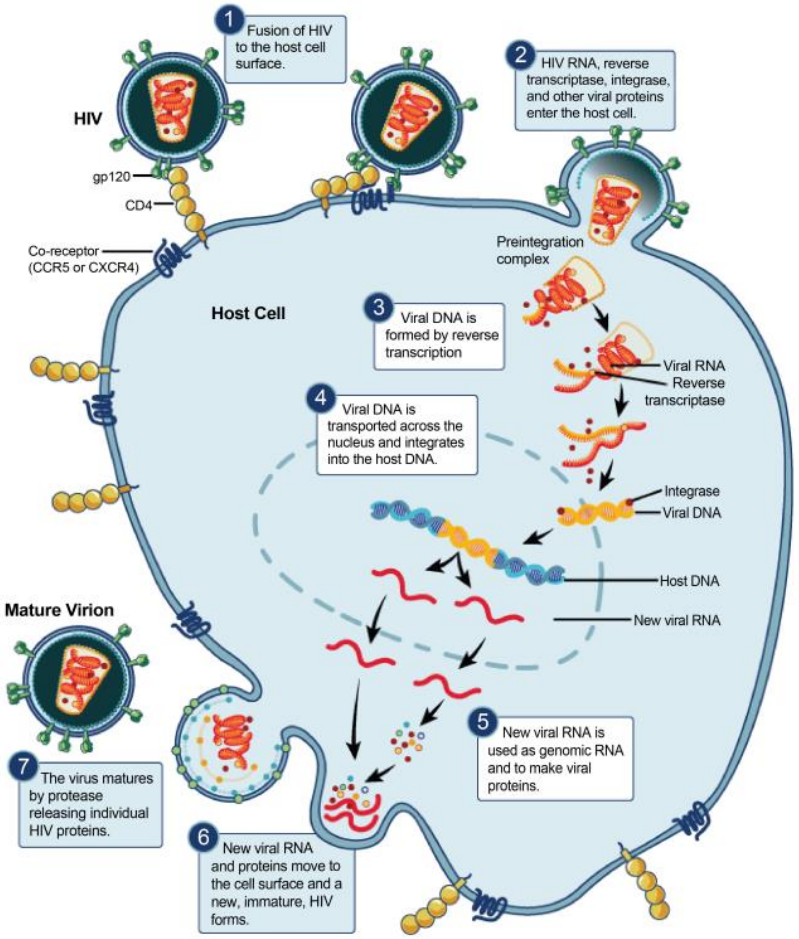
Swine flu



Rotavirus

Viral life cycle

1) Attachment
2) Entry
3) Uncoating
4) Replication
5) Assembly
6) Release



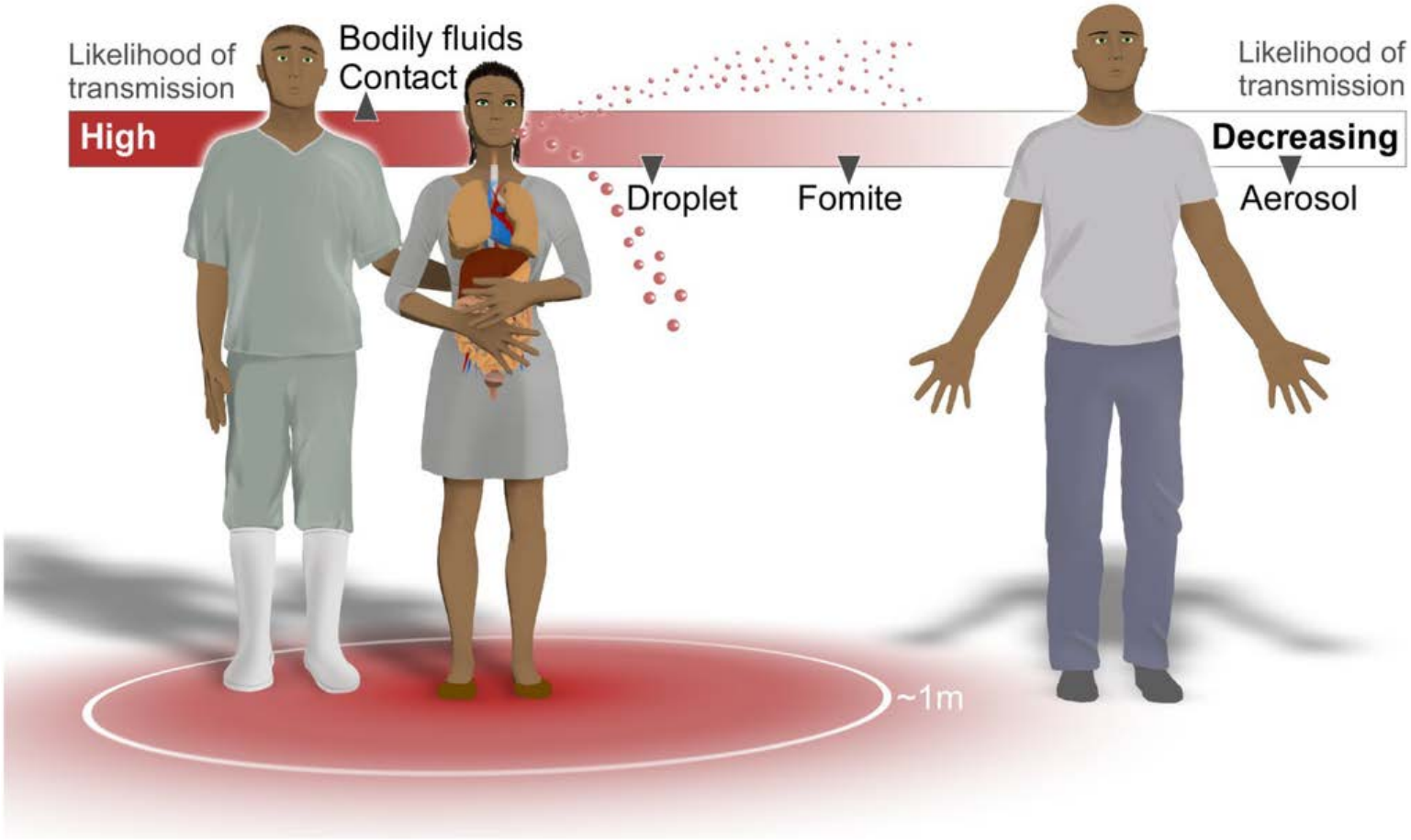
Transmission

How infectious diseases spread

Routes of transmission

- Person to Person
- Food
- Water
- Insects
- Fomites

Likelihood of transmission



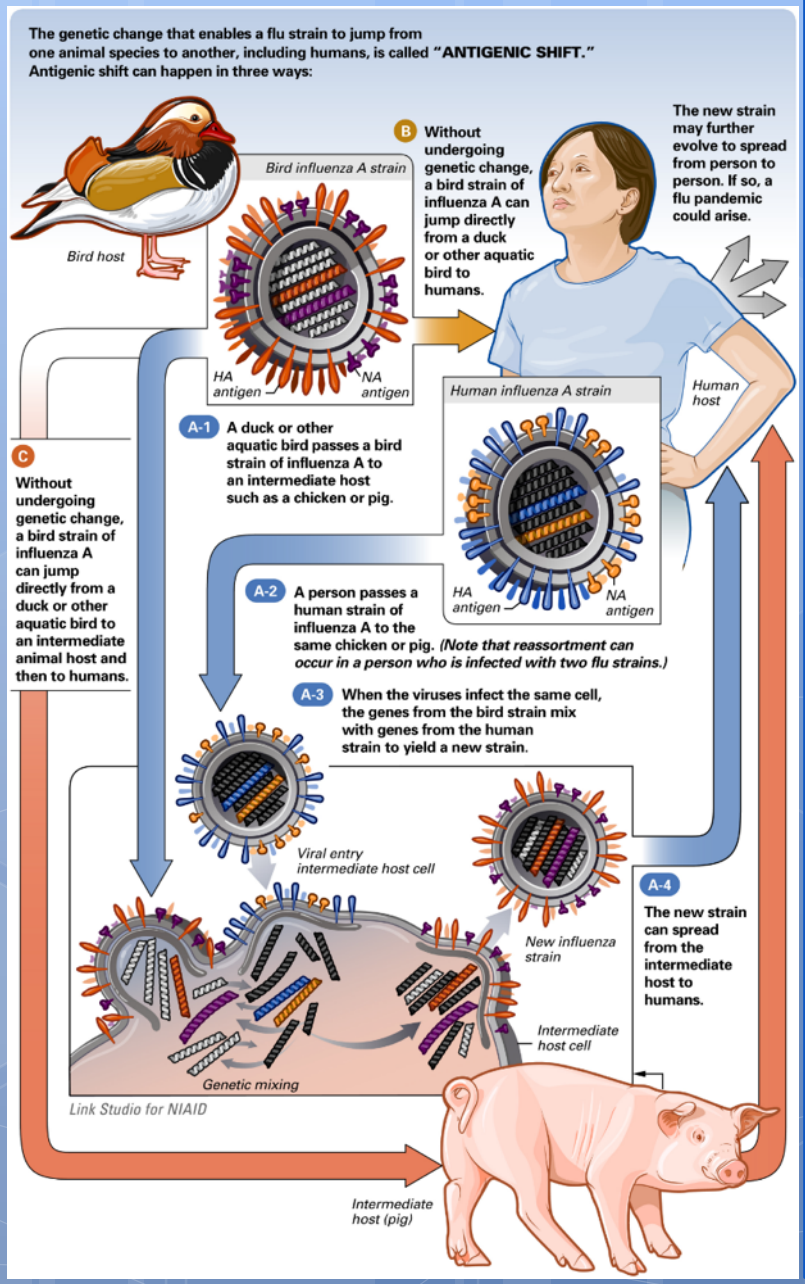
R_0 (r naught)

The number of people that one sick person will infect (on average) is called R_0 (r naught). The higher the value, the more contagious the virus.

Average R_0:

- Hepatitis C = 2
- Ebola = 2
- HIV= 4
- SARS= 4
- Mumps = 5
- Measles = 15

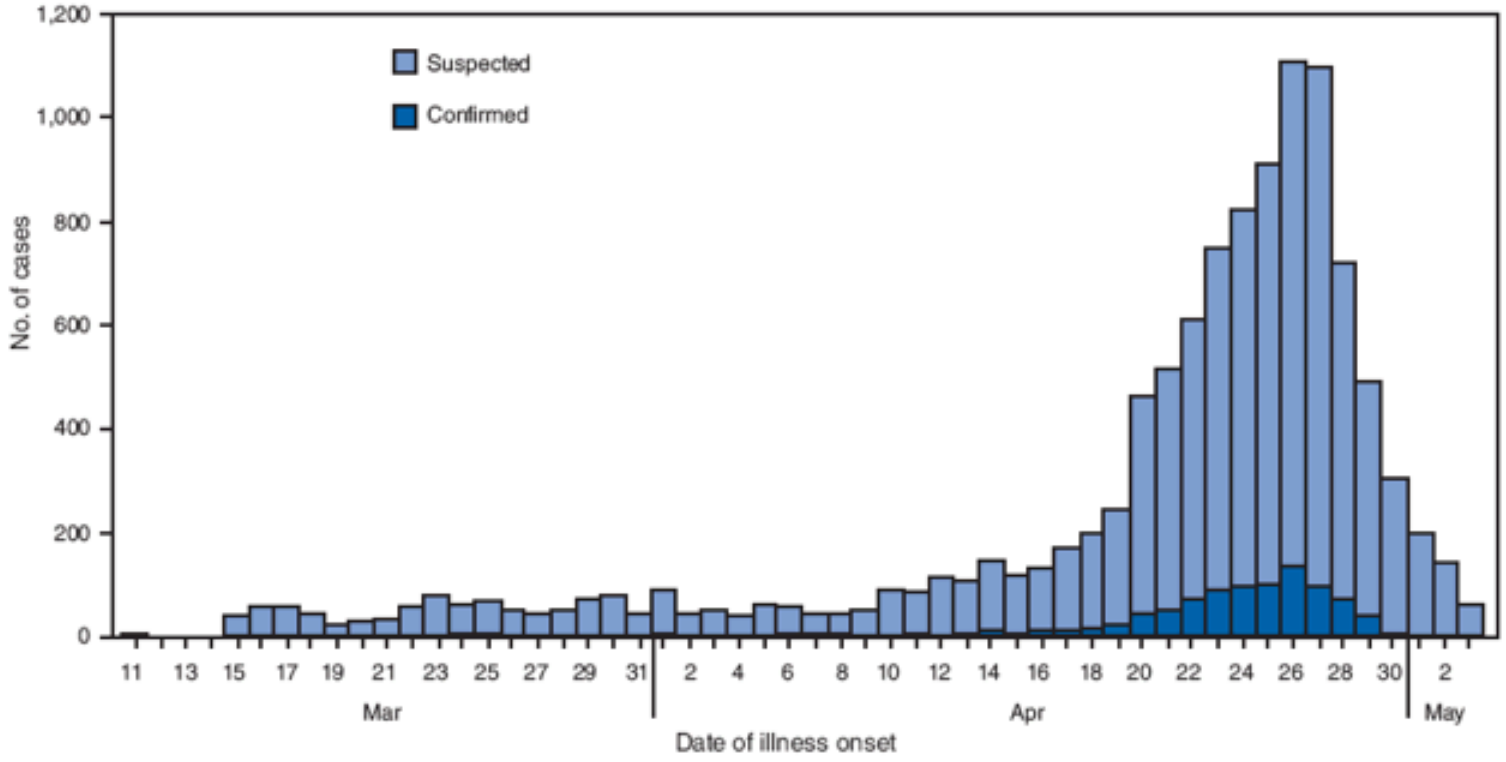
2009 H1N1 influenza pandemic

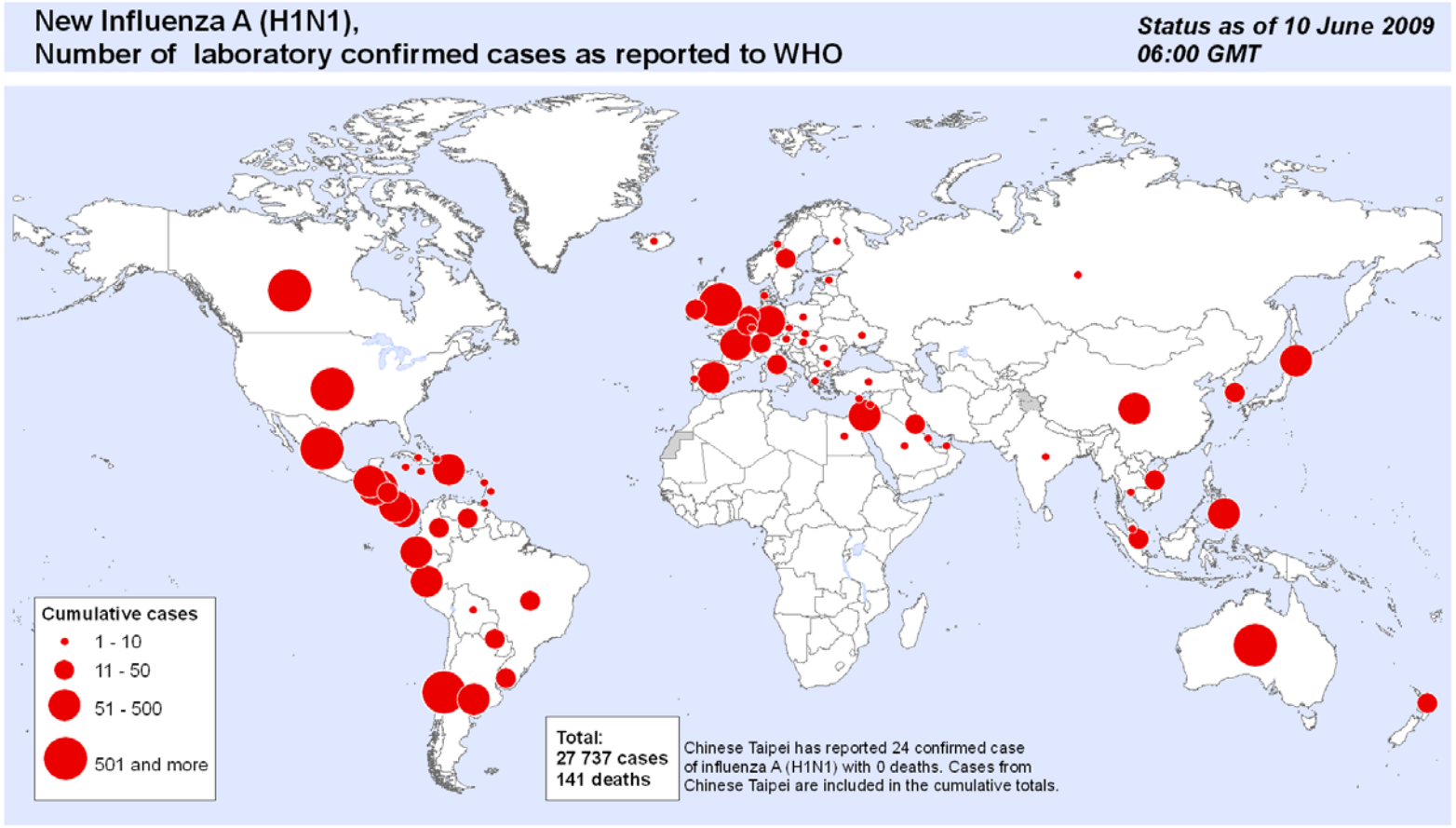


Story of the outbreak

- Novel combination of human, bird, and pig influenza A
- R_0 = 1.4-1.6

Laboratory-confirmed cases of H1N1 virus in Mexico (March - May 2009)




New Influenza A (H1N1),
Number of laboratory confirmed cases as reported to WHO
Status as of 10 June 2009
06:00 GMT
Cumulative cases
1 - 10
11 - 50
51 - 500
501 and more
Total:
27 737 cases
141 deaths
Chinese Taipei has reported 24 confirmed case of influenza A (H1N1) with 0 deaths. Cases from Chinese Taipei are included in the cumulative totals.
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.
Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization
World Health Organization
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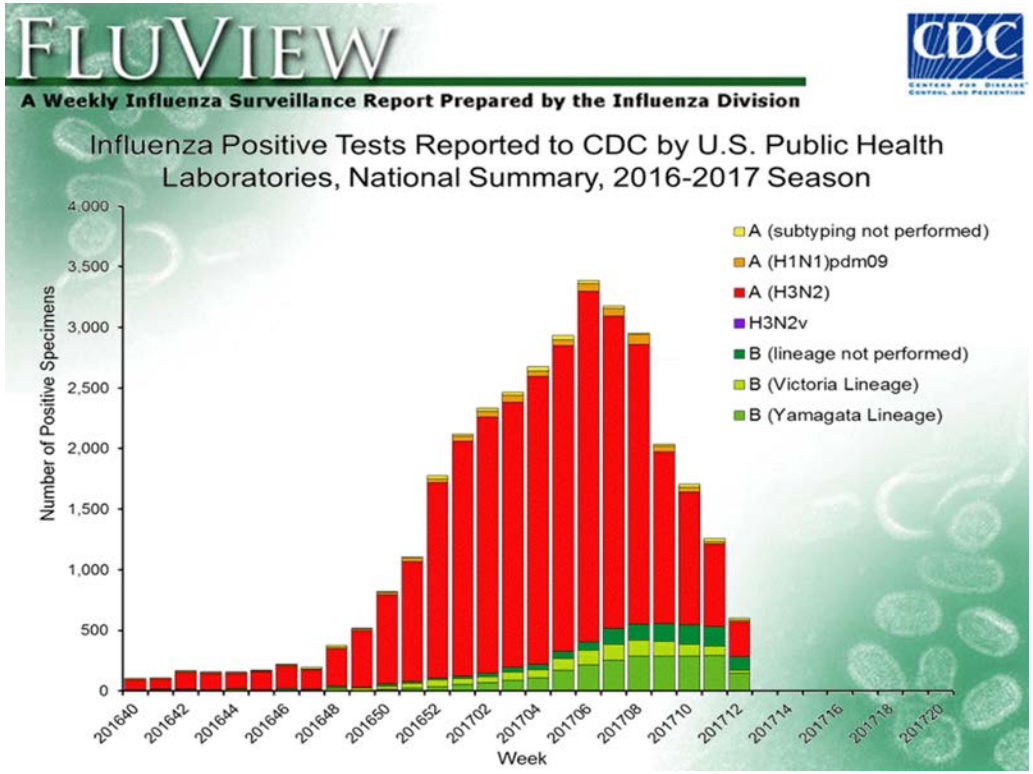
Map produced: 10 June 2009 10:22 GMT

H1N1 is still around

Most commonly seen during the normal season for influenza



Activity 2: Outbreak Simulation

Rules:

- You will give to two people and receive from two people.
- If you give/receive from someone, do not exchange with that person again.
- Record each interaction so that patient zero can be determined.