

# Vaccines: The Basics

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# Vaccine Objectives

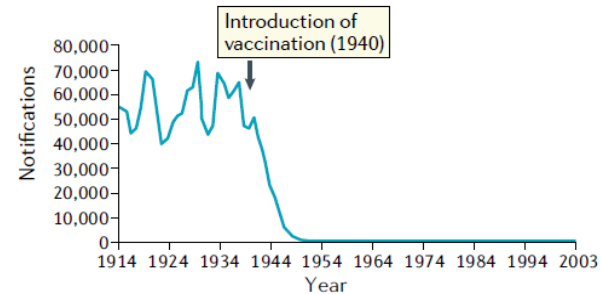
- What is a vaccine?
- Why are vaccines important?
- What are the different kinds of vaccines?
- What is herd or population immunity?
- Vaccine safety.

# What is a Vaccine

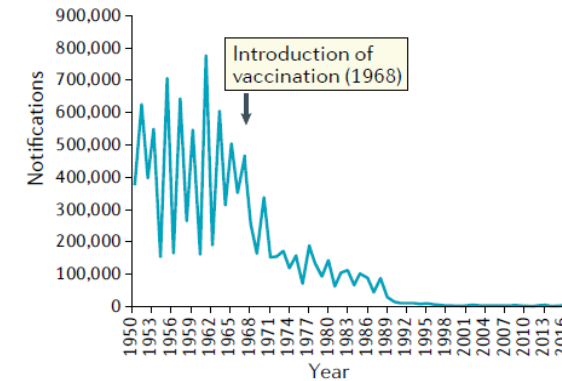
- A vaccine is a biological product that can safely lead to an immune response that protects a person against subsequent infection or disease.
  - Vaccines exploit the ability of the immune system to respond to and then remember encounters with various viruses and bacteria
- Vaccinations have reduced disease, disability, and death from a variety of infectious diseases.
- Vaccinations are safe and common.
  - Example: annual flu shots

# Impact of Vaccination on Disease

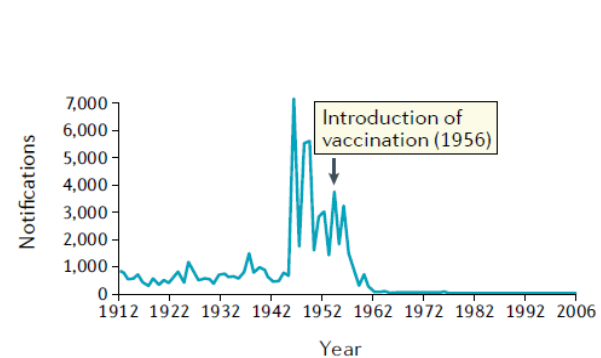
a Diphtheria



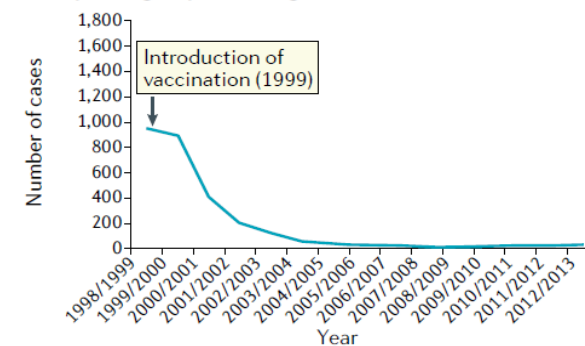
e Measles



c Polio



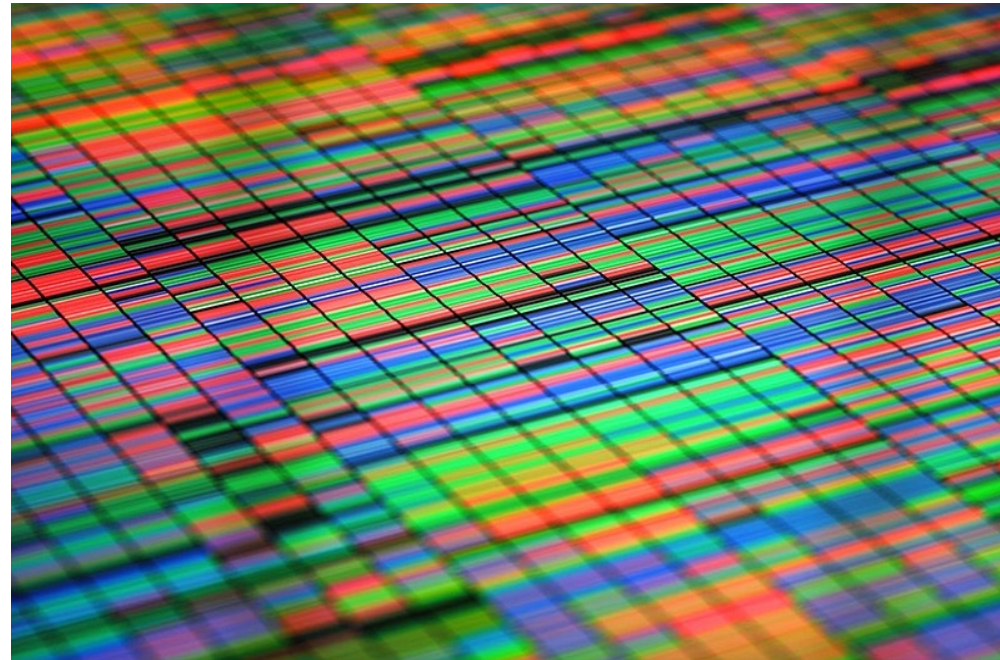
b Capsular group C meningococcus



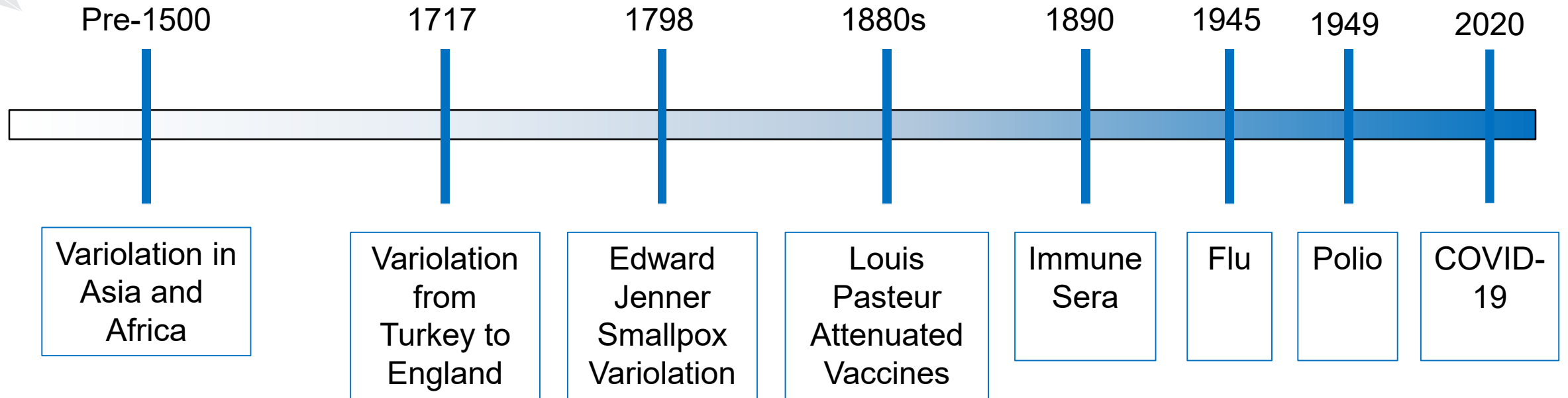
- 1980: Global eradication of smallpox
  - Previously 300 million deaths in the 20<sup>th</sup> century alone

# History of Vaccination

- 1500 and prior: Variolation used in parts of Europe, Africa and Asia
  - Variolation: Smallpox pustule scratched into recipient's skin to protect against smallpox
- 2020: COVID-19 vaccine: genetic sequence to vaccine candidate in a few days



# Vaccination Timeline



# Types of Vaccines

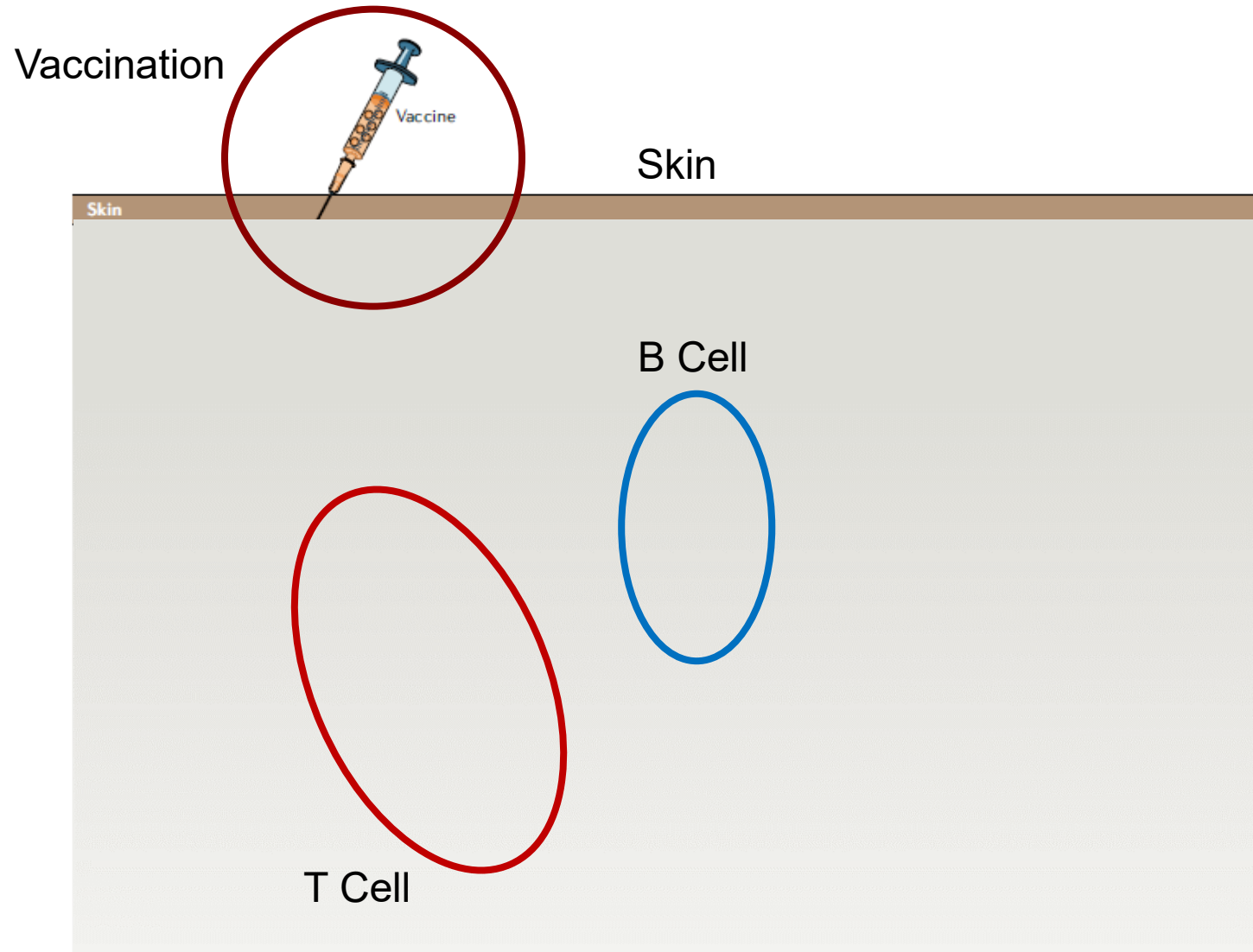
- Live attenuated vaccines can replicate in the recipient
  - Limits their use in immunocompromised people
    - Old shingles (varicella zoster), measles/mumps/rubella (MMR)
- Non-live vaccines cannot replicate in the recipient
  - No disease risk to immunocompromised people
  - Non-live vaccines are usually combined with an adjuvant
    - Adjuvant is an agent which enhances the immune response to the vaccine
- Live vaccines are not generally given to immunocompromised recipients

# Types of Vaccines

| Live Vaccines                    | Example                | Booster | Introduced         |
|----------------------------------|------------------------|---------|--------------------|
| Live attenuated                  | MMR, yellow fever      | yes     | 1798 smallpox      |
| Non-Live Vaccines                |                        |         |                    |
| Killed                           | polio (Salk)           | yes     | 1896 typhoid       |
| Toxoid                           | tetanus                | yes     | 1923 diphtheria    |
| Recombinant subunit              | hepatitis, zoster, flu | yes     | 1970 anthrax       |
| Viral-like Particles             | HPV                    | yes     | 1986 hepatitis B   |
| Protein Polysaccharide Conjugate | pneumococcal           | yes     | 1987 meningococcal |
| Outer Membrane                   | meningococcal          | yes     | 1987 influenza     |
| Viral vectored (single gene)     | Ebola                  | no      | 2019 ebola         |
| Nucleic Acid (mRNA)              | COVID-19               | yes     | 2020 COVID-19      |



# Vaccination: An Immune Response is Required

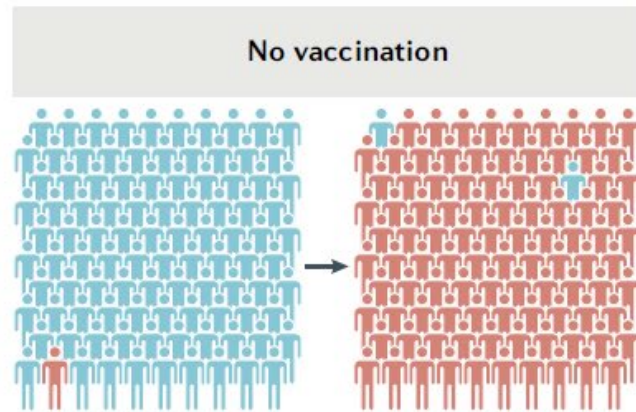


Nature Rev Immunol. <https://doi.org/10.1038/s41577-020-00479-7>

# Population Immunity

- Vaccines provide individual protection for those persons vaccinated
- Vaccines also provide population (herd) protection by reducing the spread of disease within a population

# What is Population or Herd Immunity



Infection passes from individuals with disease to susceptible individuals and spreads throughout the population

# Vaccine Safety

- Existing data indicate that vaccines are very safe
- Common side effects of many vaccines
  - Injection site pain, redness and swelling
  - Systemic symptoms such as fever, malaise and headache.
- Serious side effects from vaccines are very rare
  - Anaphylaxis (a potentially severe allergic reaction) occurs less than one in a million doses.
- People often learn about real or perceived vaccine adverse events through social media platforms

# Vaccination Challenges

- Vaccines only work if they are used
- A vaccine that remains in the vial is 0% effective.
- The greatest challenge protection against serious infectious disease remains vaccine access.
- Communication is crucial to building confidence
  - Explaining how vaccines work
  - Explaining how vaccines are developed based on safety and efficacy

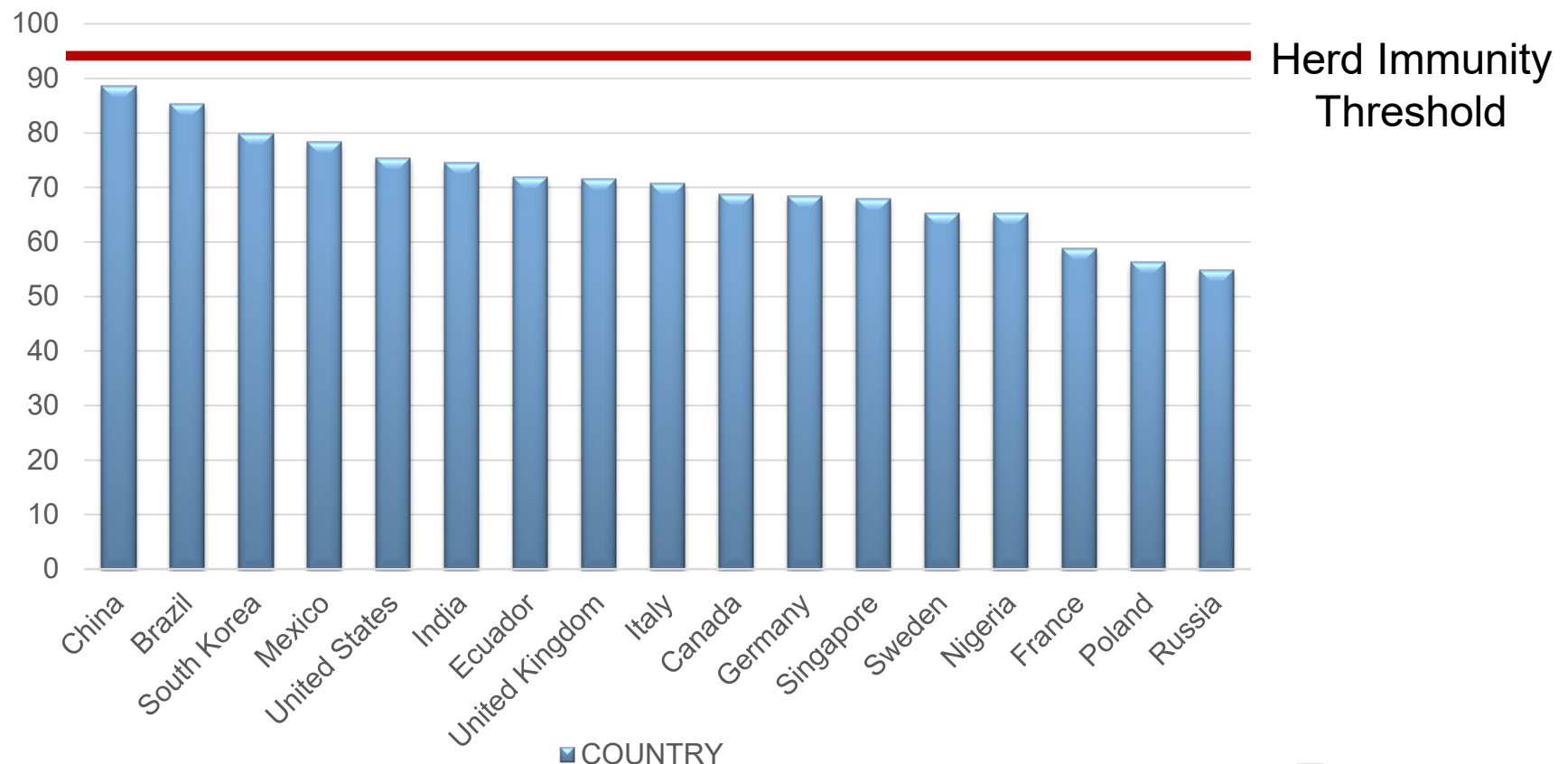


# Challenges: The Anti-Vaccination Movement

- Decreasing vaccine coverage has led to outbreaks of infectious diseases such as measles
- There may be philosophical or religious objections to vaccination
- Survey data suggest that a substantial proportion of adults may be unlikely to accept the COVID-19 vaccine.
- 2020 multi-country survey of potential COVID-19 vaccination acceptance:
  - 13,426 randomly selected individuals across 19 countries
    - 71.5% would be likely to take COVID-19 vaccine
    - 61.4% would get vaccinated if their employer recommended it.

# Survey: Potential Acceptance of COVID-19 Vaccine

- For highly transmissible pathogens 92-94% of the population must be vaccinated to prevent disease.



# Summary

- Vaccinations have been in use for hundreds of years
- Vaccines are very safe and have reduced disease, disability, and death from a variety of infectious diseases.
- There are several types of vaccines in use
  - Current COVID-19 vaccines are mRNA vaccines
- Vaccines only work if they are used