ALL ABOUT VACCINES

Training wheels for the immune system

When a disease-causing bug (**pathogen**) enters our bodies, our immune system will try to get rid of it by making special proteins (**antibodies**) or by directing specialized immune cells against it. We usually get sick the first time we are infected because it takes time for the protective response to be generated from scratch. Once we recover, our immune system remembers how the pathogen looks like and how to fight against it, protecting us from the same disease in the future. This feature of our immune system is called immune memory.

Vaccines help us generate immune memory in a safe, controlled setting. They contain a part of a pathogen (**antigen**) or a weakened form that mimics an initial infection without causing disease, which trains our immune system to defend against the real pathogen.

What's in a vaccine?

ANTIGENS
Component of pathogen

ADJUVANTS
Help boost the body's response

TRACE INGREDIENTS
Residual materials from the manufacturing process, like additional proteins (ex: egg), inactivating ingredients and antibiotics – in safe amounts that do not pose safety concerns

PRESERVATIVES
Prevent contamination and decay of the vaccine

STABILIZERS
Keep the vaccine effective after manufacturing and increase its shelf life

EFFECTIVENESS OF VACCINE-PREVENTABLE DISEASES IN CANADA

↓87% WHOOPING COUGH
Cases then: **17,777**
Cases now: **2,332**

↓99% DIPTHERIA
Cases then: **8,142**
Cases now: **1**

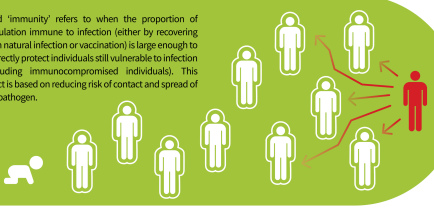
↓99% MEASLES, MUMPS, and RUBELLA
Cases then: **104,659**
Cases now: **396**

↓100% POLIO
Cases then: **2,545**
Cases now: **0**

From the Public Health Agency of Canada, 2018

MORE THAN YOU: HERD IMMUNITY

Herd 'immunity' refers to when the proportion of population immune to infection (either by recovering from natural infection or vaccination) is large enough to indirectly protect individuals still vulnerable to infection (including immunocompromised individuals). This effect is based on reducing risk of contact and spread of the pathogen.



CHALLENGES IN DESIGN

Difficulty in identifying immunogenic targets

Vaccine development efforts have not been successful in identifying targets for robust protective immune response. Recently, novel methods in understanding viral protein structures reveal promising insight for better design.
Example: respiratory syncytial virus (RSV), cytomegalovirus (CMV)

Variance for rapid mutation

Viral capacity for rapid mutation results in highly variable and diverse genetic composition that can enable the virus to escape.
Example: human immunodeficiency virus (HIV), Influenza

TYPES OF VACCINES

First licensing in North America

1914 Rabies vaccine — LIVE ATTENUATED

HOW	PRO	CON
Weakened (or attenuated) form of the pathogen	Creates a strong and long-lasting immune response	Cannot be given to immunocompromised individuals

1914 Typhoid vaccine — INACTIVATED

HOW	PRO	CON
Killed form of the pathogen	Fewer safety concerns than with live virus	Weaker immune response compared to live vaccine

1937 Tetanus vaccine — TOXOID

HOW	PRO	CON
Pathogen product (toxin) that causes disease	No risk of transmitting disease, easy to store long-term	May need booster, prevents disease but not infection

1986 Hepatitis B vaccine — VIRUS-LIKE PARTICLES (VLP)

HOW	PRO
Molecule that mimics a virus particle, but does not contain genetic material	No risk of transmitting disease, does not require an adjuvant

2021 COVID-19 vaccine (Moderna, Pfizer) — mRNA

HOW	PRO
mRNA (genetic instructions) to make a protein from the pathogen	No risk of transmitting disease, easy to manufacture

2021 COVID-19 vaccine (AstraZeneca) — VIRAL VECTOR

HOW	PRO	CON
Harmless virus modified to produce a pathogenic component	Does not require adjuvant	Limited efficacy if there is prior immunity against the "messenger" virus

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