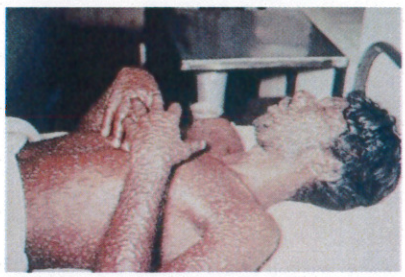
Lecture 18 – Immunization & Vaccines

The production of a state of immunity in a subject - a way of preventing infectious disease **symptoms** by boosting the immune response.

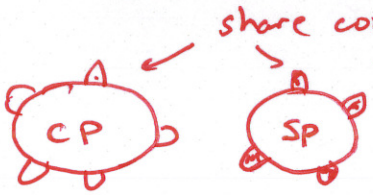
1. **Passive immunization**: provides transient immune protection by transfer of antibodies or lymphocytes, or other means of assisting the immune response
   - natural: placental transfer (IgG) and breastfeeding (IgA)
   - artificial: antibody/serum therapy (snake bite/diptheria). These antibodies are typically obtained from horses. *What the advantages and disadvantages of this source of Ab?*

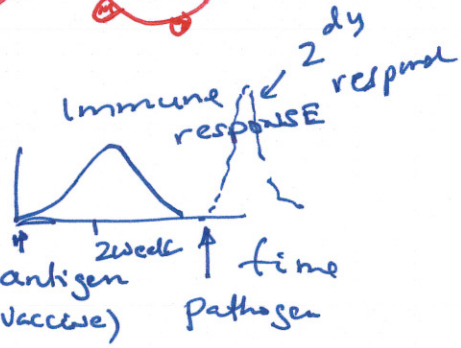
2. **Active immunization**: provides long-lasting immunity (memory)
   - natural
   - artificial – Vaccination (vacca = latin for cow).



Case Study - Small pox (Variola virus) Lethality rate 30% (European) - 90% (Native American).

1000 BC – documented cases.
1567 AD – Powdered small pox scabs used intra-nasally as vaccine.
1721 AD – Variolation introduced in England – scratching skin with sample from scabs (1/1000 mortality rate)
1800 AD – Jenner uses cowpox to vaccinate against smallpox
1940 AD - Vaccinia virus (similar to variola virus) used in current vaccines (1/10^6 mortality)
1977 AD – Smallpox eradicated globally.





2. Vaccination

Vaccine: a vehicle containing a **form of an antigen** that is administered to induce memory B and T cells specific for that antigen. Generally protect against disease, not infection.

B-cell vaccine: Introduction of a B-cell epitope to produce antibodies that interfere with pathogen life-cycle (neutralizing antibodies). Note this also requires the formation of T_H cells.

T-cell vaccine: Presentation of antigens on MHC I to stimulate formation of T_C memory cells.

Adjuvant: Increase immunogenicity of the antigen by causing inflammation.

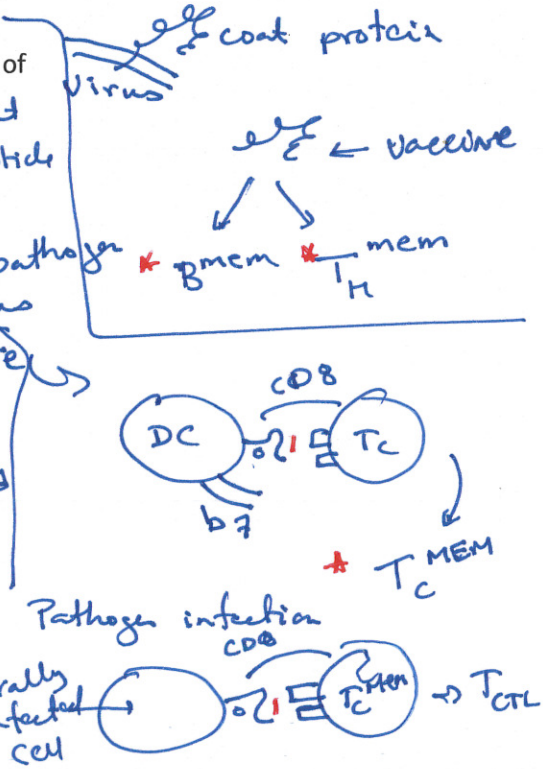
i. Aluminum salts (Alum)
ii. MF59: oil-water emulsion
iii. AS04: Alum + lipopolysaccharides.

Booster shots - Measles 9 months 15 months 5 yrs.

What do booster shots do?

Properties of a Useful Vaccine?

- immunogenic.
- Safe
- cheap.
- Stable
- one dose
- no needle



Some theoretical considerations for vaccine development:

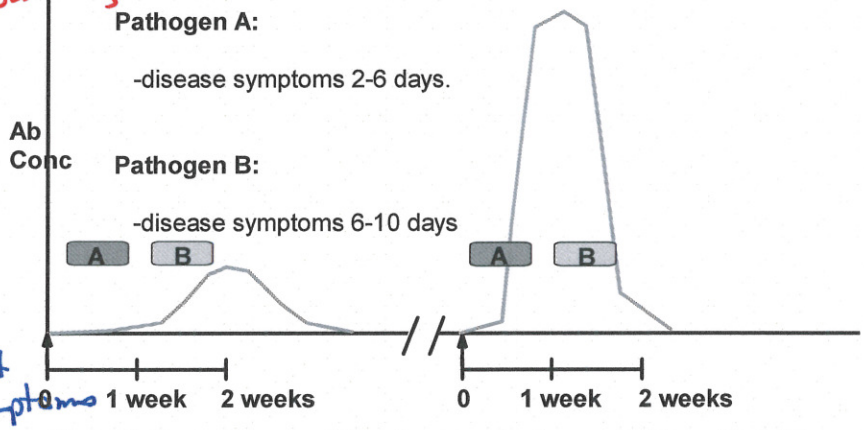
i) Acute versus chronic disease.

→ poor immune response ∴ vaccine ineffective

↳ because decent immune response chance of preventing symptoms

ii) Time course of disease versus timing of secondary response: shorter incubation period of the disease may not allow rapid memory response and, therefore, disease may not be inhibited.

Which pathogen A, or B should you make a vaccine against?

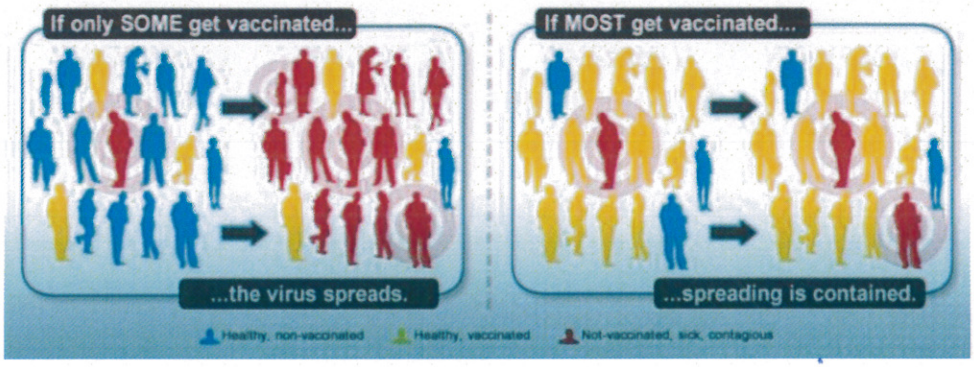


B - 2dy response is fast enough to prevent symptoms

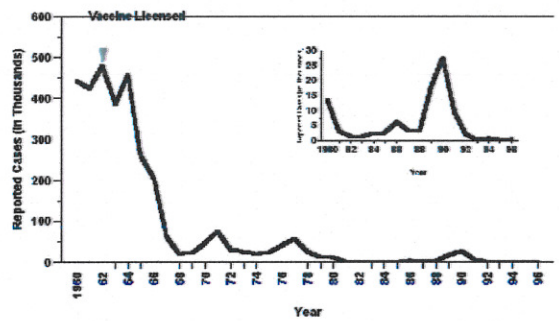
How would you provide protective immunity against a pathogen with a short incubation period (e.g. Ebola)?

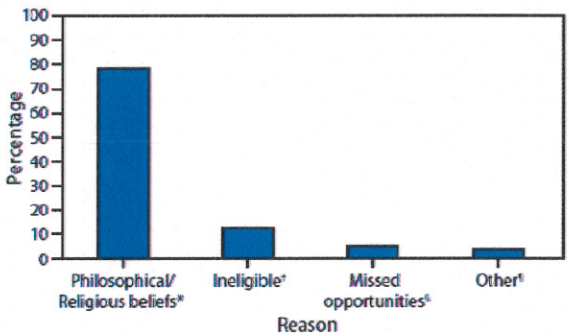
Many booster shots ⇒ circulating Ab. ⇒ inactivate "fast" pathogen

Importance of High Levels of Vaccination - Herd Immunity.



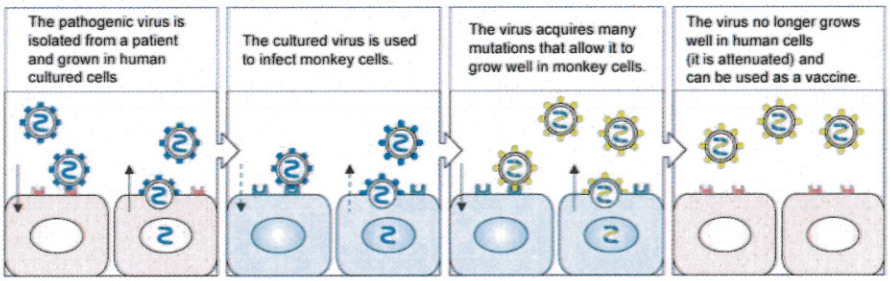
Reported Measles Cases, United States, 1960-1996





Cervical Cancer – Herpes Papillomavirus (HPV) 99% of cases. Vaccine Cervarix – 99% effective.
Historical Rates of one dose (3 recommended)

2007– 25%
2011 – 53%
2012 – 53%

Vaccine	Target	Strengths (+) and Weaknesses (-)
Denatured (inactive) toxins/sub-units	Toxin (e.g. diphtheria, tetanus)	⊖ Not as effective ⊖ 100% inactivation, reproducible.
Killed organism	Bacteria (Typhoid) & Viruses (Salk polio)	⊖ 100% inactivation required.
Surface carbohydrate + carrier protein (conjugate vaccine)	Bacteria (H. influenza)	⊖ reproducible - stable carrier protein - produce Ab response against carrier.
Capsid proteins purified or recombinant	Virus (HepB, HPV)	T_C response required. - weak antigen presentation (DC only) - limited production of antigen.
Attenuated virus i) natural non-infectious virus *e.g. cowpox*	Virus (Sabin polio, mumps, measles)	 Figure 14.2 The Immune System, 3ed. (© Garland Science 2009)
ii) passage on non-human host.		⊖ revert back to original pathogenic virus
iii) recombinant		make deletions. very difficult to revert.
Viral vector encoded	Virus (HepB)	Virus & insert antigen from pathogen (safe) → vaccine.

live vaccine virus more effective
- antigen present
- infection

dead bacteria vaccine safer (No poss. of getting disease.)