Immunisation
How vaccines work

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Presentation Outline

- An understanding of the following principles
- Overview of immunity
- Different types of vaccines and vaccine contents
- Vaccine failures
- Time intervals between vaccine doses
- Vaccine overload
- Adverse reactions
- Herd immunity

Immunity

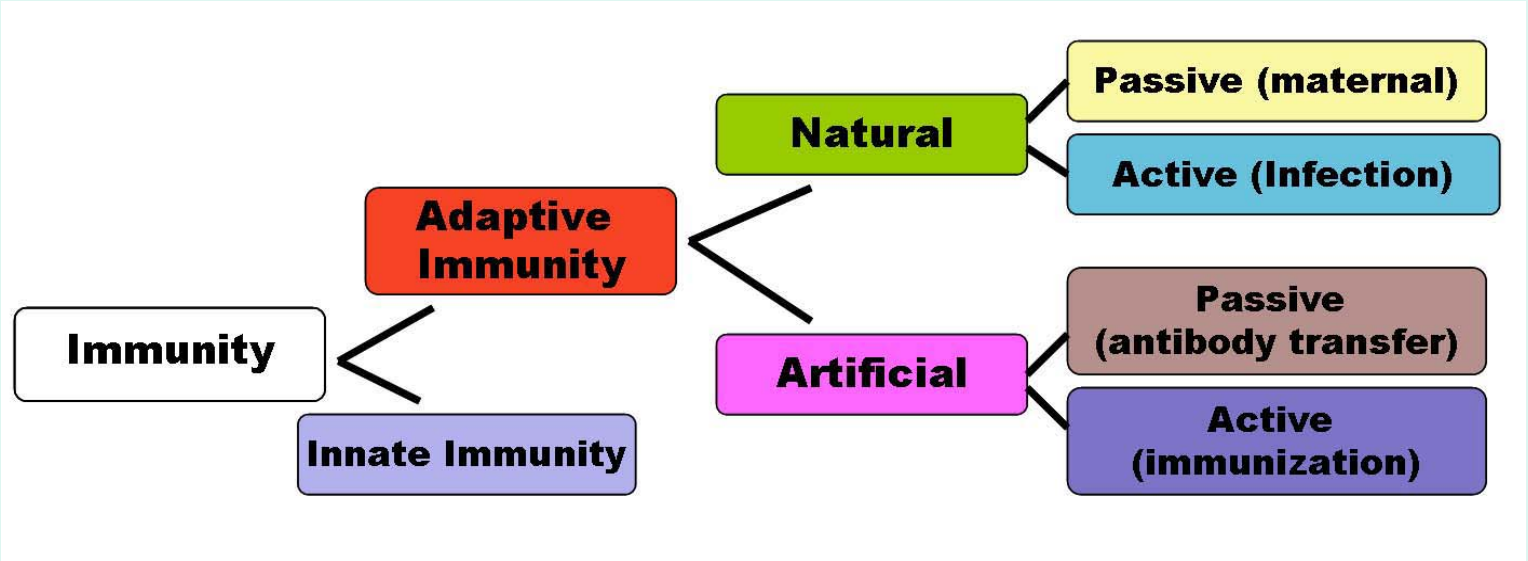
Immunity

- – The ability of the human body to protect itself from infectious disease

The immune system

- Cells with a protective function in the
  - bone marrow
  - thymus
  - lymphatic system of ducts and nodes
  - spleen
  - blood

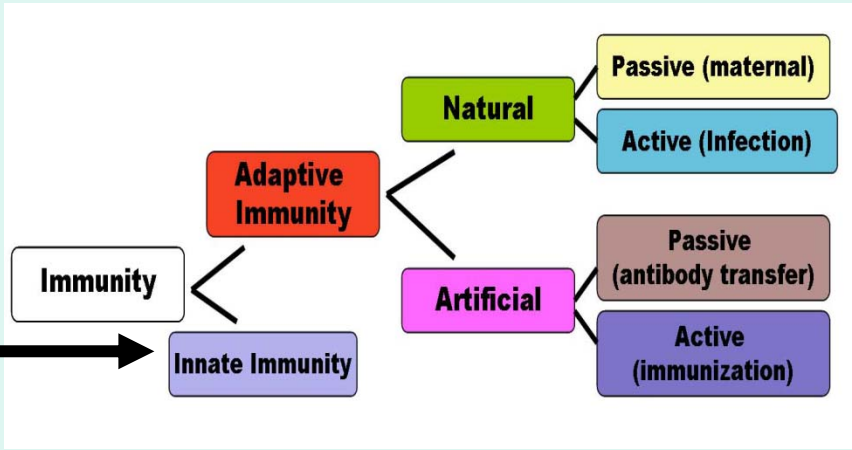
Types of immunity



Source: **http://en.wikipedia.org/wiki/Immunological_memory**

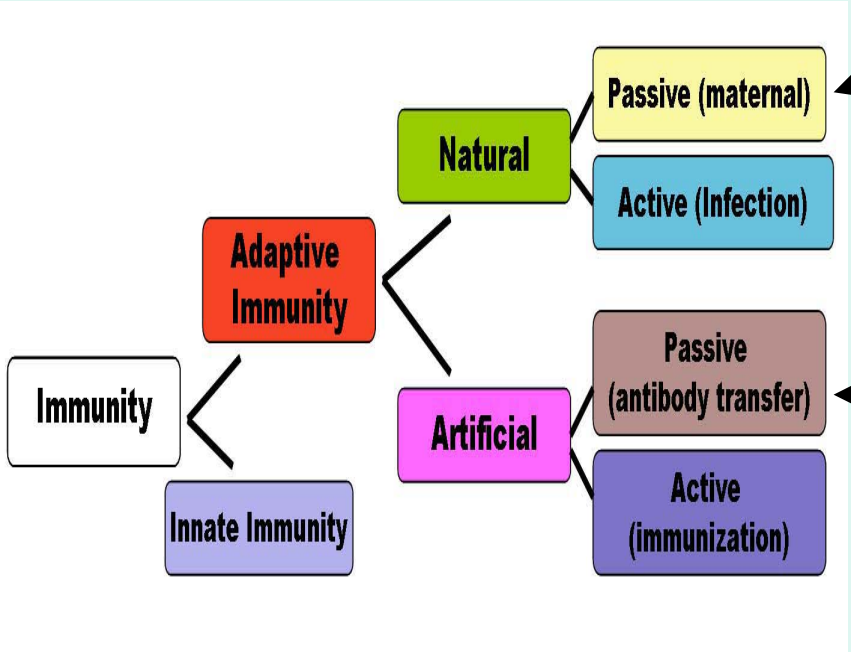
Natural (innate) immunity

Non-specific mechanisms
- – Physical barriers
  - • skin and mucous membranes
- – Chemical barriers
  - • gastric and digestive enzymes
- – Cellular and protein secretions
  - • phagocytes, macrophages, complement system



** No “memory” of protection exists afterwards **

Passive immunity – adaptive mechanisms



Natural

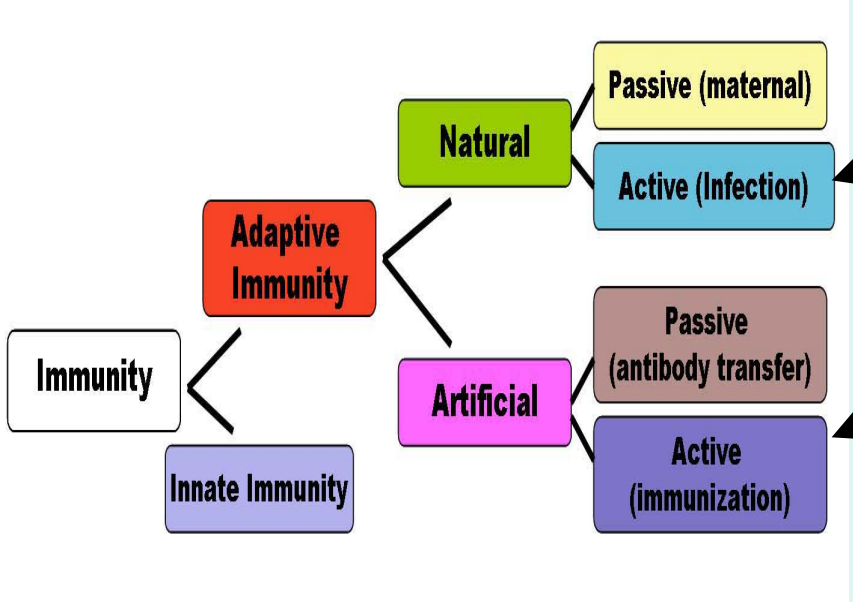
- maternal transfer of antibodies to infant via placenta

Artificial

- administration of pre-formed substance to provide immediate but short-term protection (anti-toxin, antibodies)

Protection is temporary and wanes with time (usually few months)

Active immunity – adaptive mechanisms



Natural
- following contact with organism

Artificial
- administration of agent to stimulate immune response (immunisation)

Acquired through contact with an micro-organism
Protection produced by individual's own immune system
Protection often life-long but may need boosting

How vaccines work

- Induce active immunity
  - Immunity and immunologic memory similar to natural infection but without risk of disease
- Immunological memory allows
  - Rapid recognition and response to pathogen
  - Prevent or modify effect of disease

Live attenuated vaccines

Weakened viruses /bacteria

- – Achieved by growing numerous generations in laboratory
- – Produces long lasting immune response after one or two doses
- – Stimulates immune system to react as it does to natural infection
- – Can cause mild form of the disease (e.g. mini measles which is non transmissible)
- – CANNOT be given to immuno-compromised persons

e.g. BCG/ MMR/ Varicella/ Yellow fever

Inactivated vaccine and toxoids

- Cannot cause disease they are designed to protect against
- Doses
  - Two of more doses plus booster doses usually required
- Inactivated
  - e.g. pertussis, Hib, Pneumococcal, Men C, influenza
- Toxoids
  - e.g. tetanus, diphtheria

Vaccine Components

- Conjugating agents
- – Carrier proteins which combine with antigens to improve immunogenicity
- E.g. Men C, PCV, Hib
- Suspension fluid
  - Fluid (water, saline, tissue-culture mixture)
- Preservatives, stabilisers, antimicrobial agents
  - Trace amounts used to stabilise vaccine
  - May cause allergic reaction

Vaccine Components

- Adjuvants
  - Aluminium salt used to increase immunogenicity of vaccines containing inactivated micro-organisms or their products
- e.g.
    - Hepatitis B vaccine
    - Tetanus toxoid
    - Diphtheria toxoid

Vaccine Failure

- Primary
  - Inadequate immune response to vaccine (e.g.MMR1)
  - Infection possible any time post vaccination
- Secondary
  - Adequate antibody response immediately after vaccination
  - Level of antibodies decrease with time
  - Booster doses usually required
  - Feature of many inactivated vaccines

Time intervals between vaccine doses

Antigen combination	Recommended minimal interval between doses
≥2 killed antigens	No minimum interval
Killed and live antigens	No minimum interval
≥2 live antigens	Four-week minimum interval if not administered simultaneously

Time intervals between vaccine doses

- 2 Live vaccines - Minimum one month interval required
  - Allows **each immune response to develop**
  - Diminishes immune interference
- Interval between doses
  - Allows the next response to be a true secondary response – i.e. faster and bigger and with higher affinity IgG

Time Interval between vaccine doses

- Exceptions include
  - Yellow fever and MMR
    - Ideally separate by 1 month as may be suboptimal response to both if given together.
  - Rotavirus no interval needed
    - Anytime before or after other live vaccine
  - Influenza and PCV vaccine in those aged 12-23 months separate by at least 1 week due to slight increased risk of fever if given together

Can vaccines overload the immune system?

- The human body is composed of 10 trillion cells and contains 100 trillion bacteria
- On average there are
  - 1000 bacteria on each cm2 of skin
  - 1,000,000 bacteria on each cm2 of the scalp
  - 100,000,000 bacteria per gram of saliva
- The maximum number of antigens in a vaccine was ~3000 (DTwP, most from wP)
- With the new vaccines this number is much lower still
- No evidence that vaccines can overload the immune system

Adverse Events

Live vaccines:

- Frequency of adverse events falls with number of doses
- If antibody is made -> neutralises small amount of vaccine virus in any subsequent vaccine dose
- E.g. MMR

Inactivated vaccines

- Frequency of adverse events increases with number of doses
- Good antibody levels ->good secondary immune response
- May be inflammatory (i.e. produce a sore arm)
- E.g. tetanus, pertussis

Herd Immunity

Only applies to diseases which are passed from person to person

- For each disease
  - a certain level of immunity in the population which protects the whole population because the disease stops spreading in the community
- Provides indirect protection of unvaccinated as well as vaccinated individuals.
- May be the most important aspect of how vaccines work
  - MMR given to infants protects pregnant women from rubella.
  - Can eradicate disease even if some people remain susceptible

Vaccination: It works

REDPEN/
BLACKPEN

Hey guys - I don't even feel any rain. Why are we doing this again? Just put down the stupid umbrellas - they're bad for your arms anyway.