The Immune System and Immunisation



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Offaly is famous for....



Great Musicians...





World Record Holders...



The Ancestral Home....



We've Been Around a Long Time! Old Croghan Man

Found near Croghan Hill in 2003

Over 2000 years old.

Died from a stab wound to his chest, was decapitated and his body was cut in half.



Thankfully, less dangerous nowadays...



The Immune System



The Immune System

- Array of organs, cells and chemicals that:
- Determine self from "non-self"
- Identify potential dangers to the body
- Eliminate them by mounting an immune response



The Infant's Immune System

- Naive needs exposure to foreign antigen in order to develop normally
- Maternally acquired immunity is temporary and does not protect against all infections.
- The infant immune system has the capacity to cope with a vast array of antigens at any one time.



Immune System Components



Source: <u>http://www.webmd.com/a-to-z-guides/components-of-the-immune-system</u>

Organisation of the Immune System



The Pathogen's Journey





Will Sickness Occur?

Getting sick or remaining well when exposed to a germ is a balance. It depends on the virulence of the germ and the ability of the person to resist the infection.

Both of these things are variable.

www.nrvs.info

The Consequences of Infection...

- Lifelong immunity (most of the time!)
- May be innocuous

BUT....

- May cause serious disease
- May cause permanent damage to the host
- May cause death



The Pathogen soon encounters the first level of defence

- Physical barriers (intact skin, intact mucous membranes, cilia etc....)
- Physiological factors (eg pH, temp)
- Protein secretions (complement, interferons)
- Phagocytes macrophages and PMNLs



Defining characteristic of innate immunity - **NO MEMORY PERSISTS.**

Macrophages



Macrophage surrounds/"eats" the virus

- Digest most of the micro-organism
- Regurgitate the antigens
 - Display antigens on their surface so that another type of white blood cell (lymphocytes) can take over.

What is an antigen?



Microbe

Fragments of Microbe = antigen

"Anything that can be bound by an antibody"

The Pathogen Next Encounters the Second Level of Defence

- Adaptive immunity
- The foreign agent is recognised in a specific manner e.g
- B Cells
- T Cells

THE IMMUNE SYSTEM ACQUIRES MEMORY

Cell-Mediated Immune Response



What is an Antibody?



- Produced to one specific epitope (ie is antigen specific)
- Neutralises toxins
- Blocks adhesion/ cell entry
- Kills via complement
- Neutralises viral infectivity and prevents replication.

Immune System Superheroes!



Memory Cells

- Once infection has been eliminated, some B and T cells become memory cells
- These retain memory of the antigen
- On re-exposure, powerful immune response.
- This ability of the immune system to have a memory for previous antigens is the basis for vaccination.



Vaccines and How They Work



The Ideal Vaccine

- Produces the same immune protection as an infection without causing disease
- Generates long-lasting immunity
- Interrupts spread of infection



How Soon After Immunisation are we Protected?

- Immune response is generated after 4-7/7
- >7/7 get Primary immune response (IgM), lasts 3 weeks, memory cells made.
- Secondary/subsequent immune response, IgG, faster
- It takes 2 weeks to get optimum immune response after vaccination.



In Simple Terms....

Vaccines work by making us produce antibodies to fight disease without actually infecting us with the disease. If the vaccinated person then comes into contact with the disease itself, their immune system will recognise it and immediately produce the antibodies they need to fight it.



Vaccines can be divided into two types

Live attenuated

Inactivated







Basic Differences

Live Attenuated

- A version of the living microbe that has been weakened in the lab so it can't cause disease.
- These vaccines are good "teachers" of the immune system: They elicit strong cellular and antibody responses, and often confer lifelong immunity with only one or two doses.
- "weak pathogen"

Inactive

- Produced by killing the disease-causing microbe with chemicals, heat, or radiation.
- Such vaccines are more stable and safer than live vaccines: The dead microbes can't mutate back to their diseasecausing state.
- Inactivated vaccines can be easily stored and transported.
- "dead pathogen"

Inactivated Vaccines

Whole

- viruses
- bacteria

Fractional

- protein-based
 - toxoid
 - subunit
- polysaccharide-based
 - pure
 - conjugate

Live Attenuated Vaccine

- Vaccines are longer lasting and require fewer boosters
- However the disease could mutate back to the pathogenic strain
- Harder to make for bacteria
- eg BCG/ MMR/ Rotavirus/ Varicella/ Yellow fever



Non Live Vaccine

- Cannot cause disease
- Cannot replicate
- Immune response mainly antibody based
- Antibody titre falls with time
- 3-5 doses required
- Classified as whole inactivated/conjugate/recombinant/subunit

Whole Inactivated Vaccine

- Organisms are killed or inactivated by heat or chemicals but remain antigenic.
- They are usually safe but less effective than live attenuated vaccines.
- Larger doses and more boosters are required.
- Eg polio virus



Toxoid Vaccine

- A purified toxin produced by the antigen is used to elicit a response
- Eg tetanus, diphtheria



Sub unit Vaccine

- Contains only specific antigentic proteins of an infectious agent.
- Antigens have been separated from the rest of the vaccine
- Eg acellular pertussis and some influenza.



Recombinant Vaccine (a type of Subunit)

- Recombinant DNA technology
- Eg HPV and Hep B



Conjugate Vaccine

- Some bacteria are encapsulated making it difficult for the immune system to respond
- Carrier proteins are used which combine with antigens to improve immunogenicity
- Their efficacy and safety appear to be high.
- Men C , PCV, Hib.

"Other Ingredients" needed to make a Vaccine



COMMON COMPONENTS OF VACCINES

As well as the active components, vaccines contain a number of other substances. This graphic examines these and the reasons for their inclusion.

ACTIVE COMPONENTS



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STABILISERS

Vaccine Components

- Suspension fluid (water, saline etc)
- Preservatives, stabilisers, antimicrobial agents
- a) Trace amounts
- b) May cause allergic reaction
- Adjuvants
- a) Aluminium salts to increase immunogenicity
- b) Eg hep B, tet, diphth



Thiomersal

- Mercury containing compound used as a preservative and an inactivating agent
- In 1999 EU and US manufacturers decided to decrease thiomersal levels in vaccines as a precaution and to retain trust in vaccine supply
- WHO state that there is no evidence of toxicity
- All vaccines in the infant immunisation programme are thiomersal free

Timing of Vaccines and their Side Effects!



Why are Gaps Needed Between Doses?

- To allow each immune response to develop eg primary immunisation
- To avoid immune interference if another live vaccine is given while the immune system is making a primary immune response, the activation of the innate immune system may neutralise the second vaccine. Hence we wait 4 weeks.

Timing of Primary Immunisation Course

- Maternal IgG is transferred across the placenta
- Passively acquired IgG can suppress response to DTP, Polio, Men C and Hib for 2 months
- Maternal antibody to measles may interfere for 1 year.



Can Vaccines Overload the Immune System?

- We are exposed to countless antigens every day, in the food we eat, in the air we breathe, in the water we drink.
- The human body contains 100 trillion bacteria.
- The immune system is capable of responding to 100,000,000,000 antigens at a given time
- The MMR contains only 24 antigens.

NO EVIDENCE THAT VACCINES OVERLOAD THE IMMUNE SYSTEM

Arguing that vaccines will overwhelm a child's immune system



is like arguing that a tablespoon will make an Olympic swimming pool overflow thelogicofscience.com

Vaccine failures

- Primary failure when an individual fails to respond to the initial vaccine (eg 10% MMR)
- Secondary failure responds initially but response wanes over time (most inactivated vaccines)



Timing of Vaccine Reactions

- Inactivated generally within 48h
- Live vaccine according to time taken for virus to replicate
- Eg MMR vaccine
- a) Reactions to measles (malaise, fever, rash) occur in 1st week
- b) Rubella (pain, joint swelling) in 2nd week
- c) Mumps (parotid swelling) in 3rd week

Adverse events

- Live vaccine frequency of adverse events falls with number of doses
- Inactivated vaccines frequency of adverse events increases with number of doses...

if antibody levels are good, this binds to antigen in subseq dose, producing an immune response which, if big enough, is inflammatory

Susceptible populations

- Not everyone produces an immune response
- Not everyone can get certain vaccinations
- Other factors eg immunosuppression can cause susceptibility

Herd Immunity

HERD IMMUNITY

- If enough of the population is immunized, even those that aren't are protected
- Who relies on herd immunity?
 - Infants
 - Elderly
 - Those with weakened immune systems
 - Those who are allergic to the vaccine



http://www.vaccines.gov/basics/protection/

Thanks!

