Topic 9: Vaccines

- You develop immunity after illness
- Incidence of colds decrease with age
- Illness can do serious damage
    - Scarring
- Vaccines create a "fake" illness
    - Generate immunity without sickness
- Immune system uses many weapons to fight illness
    - Poisons
        - Defensins
        - Complement
    - Antibodies
        - Immobilize Invaders
        - Selectively destroy invaders
    - Macrophages
        - Specialized cells to eat foreign cells
        - Specialized cells to kill infected cells
- Innate immune system provides an immediate response
    - Non-specific reaction
        - All cells are targeted
        - Immediate maximum response
    - Cold symptoms are caused by innate immune system
    - Responds to damage
        - Releases cytokines
        - The cytokines stimulate
            - Inflammation
                - Gives easier access for immune cells
            - Leukocytes
                - Destroy invaders
- Adaptive immune system is selective but slow
    - Takes about 2 to 3 days from exposure to maximum response
    - Response is selective
        - Only invading cells are targeted
        - Immune system retains a memory of the infection
            - Next time the response is strong and immediate
    - Antibodies are the key recognition devices
        - Y shaped molecules
        - Has a "sticky" surface
            - Stick to epitopes
                - Tiny part of bacteria
        - Our bodies produce many different antibodies
            - With one is unique and will only "stick" to a specific molecule
        - Production is random
            - Can not store large amounts of antibodies
                - Make small amounts of many different types

            - No way to know with microbes will invade
            - Body stores small amounts of as many different antibodies as possible
                - Made randomly
            - Manufacture large quantities only when needed
- B Cells carry antibodies
    - Each one carries a different antibody
    - Carry many different types
        - Same as antibodies we do not know which one we will need
    - Immune response triggers replication of specific B Cell
    - After infection some B Cells become memory cells
        - As you get older, your body contains more memory cells
            - 5% of B Cells as an infant are memory cells
            - 50% fo B Cells in an adult are memory cells
        - Therefore you get sick less often
- Viruses live inside cells and escape B Cells
- T Cells are produced to kill viruses
    - Infected cells ‘display’ part of viruses
        - Viral protein fragments on MHC receptors
    - Killer T Cells recognize the MHC ‘display’
    - Helper T Cells send the kill signal
        - Two kill signals provide a failsafe
    - Viral infection triggers replication of specific T Cells
    - Some become memory cells
- Memory Cells give you immunity
    - Next time microbe invades you get an immediate and specific immune response
    - Microbes are killed quickly before infection develops
    - You don’t get sick
    - Most diseases only infect once
- To become immune without sickness you need to stimulate the manufacture of memory cells
    - Variolation was practiced by many cultures
        - Take a needle and collect puss from an infected persons, give it to an uninfected person
- Edward Jenner (1749-1823)
    - Wanted to make it safer
    - Noticed milkmaids who got cowpox didn't get smallpox
        - Cowpox is a less severe non fatal version of smallpox
    - So he infected children with the cowpox disease
    - This was safer than variolation
- Vaccination was an incredible success
    - By 1900 smallpox levels became very low in industrialized countries
    - Smallpox was eradicated from industrialized countries by 1950
    - Remained endemic in developing world
        - People were not vaccinated

- Today smallpox only exists at the CDC and in biological weapons
- Vaccine simulates a disease
    - Then our immune system produces memory cells to fight the disease in the future
- Jenner discovered cowpox (very similar but minor version of smallpox virus)
- Anthrax in livestock was a major issue and they were trying to find a way to fight it
    - Take the anthrax bacteria and "attenuated" it
        - Weaken it by heating it
    - This way when it is given to an animal they only develop a minor infection which they can fight and then when exposed to anthrax in the future
    - Had to give a booster shot, the first was not strong enough to completely protect the animal for life
- Because you are injecting a live organism into an animal there is still a small risk of a severe infection
    - Benefits out weight the risk because you are only dealing with a small number of infection
- Polio
    - You become paralyzed for a short period of time and then you would recover there could be long term effects
    - Fatal because it can paralyze your lungs
    - Example: President Roosevelt survived Polio, never regained his ability to walk properly
    - Salk Vaccine (1955) used dead virus
        - Required a booster
        - Tested in the largest clinical trial in 1954
        - 1.4 million children were injected in school
            - Since the vaccine was dead there was not a lot of risk
        - There was a defective batch produced, meaning there was live virus
            - Many people were then infected with polio and died
    - Sabin Vaccine used an attenuated virus
        - Could be given orally
        - No booster
        - Highly effect
            - Clinical trial in Russia
            - 77 million vaccinated
        - Used by most countries due to manufacturing problems with the Salk vaccine
    - Has almost been completely eradicated from the world due to vaccination
    - There was spike in cases of polio in 2009 in countries that were enduring civil war and politics intervened (religious leaders were blaming death on the westerners and their vaccines)
        - Therefore less people in theses places were getting vaccinated
    - 22 cases reported in 2017
        - Afghanistan
        - Pakistan
- Influenza

    - Occasional severe pandemics
        - This happens when the virus changes
    - Flu vaccine uses dead virus
        - New vaccine every year
        - Excellent safety record
        - Takes 21 for full protection to take effect
    - Reason for low stats on vaccine
        - Vaccines become available in late november, but flu season starts in october
        - Takes 21 days for the vaccine to be most effective
        - Researchers must anticipate which strains will become prevalent
            - Vaccine manufacture starts in spring
            - Flu season starts in october
            - Make an educated guess about which type will become important
        - Still worth it to get he shot because you will be protected from those sub types in the future
    - Side Effects
        - Egg allergy
            - Make it using eggs
            - The bacteria is grown inside an egg and contains some of its proteins
- Have been able to almost eradicate some diseases due to vaccines
    - Measles
    - Mumps
    - Chicken poxs (only more recent)
- Number of adverse events exceeds number of illness
    - Adverse event: any complaint that a patient makes after receiving a vaccine
        - Usually minor like a sore arm or fever
- Some people have created an anti vaccine movement
    - Not getting children vaccinated against diseases can be dangerous
        - Leads to them possibly contracting the disease that could possibly turn fatal
- Vaccines do not cause Autism
    - Autism symptoms appear around the age of 2
        - It is human nature for us to look for patterns, to look around for a cause
        - Vaccinations happen around the same age
    - Wakefield study appeared to back up theses claims
        - Published some papers that seems to show a link between measles vaccinations
        - Caused a decrease in vaccinations in england against measles, which caused an increase in the number of cases
        - The study was a fraud
            - Wakefield manipulated much of the data
            - Wakefield stripped of his medical license in 2011 and his paper s were retracted

    - Preservatives in H1N1 (Thimerosal)
        - There was a preservative that had mercury in it
        - Mercury is a neurotoxin
        - And autism in a neural disease
        - It was a very common preservative, used for a very long period of time, used in antibiotics as well
        - There is less mercury in a shot than in one piece of fish
    - Went over the medical records of people in the Neverlands (they have a universal health care system where everyone receives the exact same care)
        - Some people had been vaccinated, some were vaccinated with a vaccine with the Thimerosal, and some with a vaccine without
        - They found the autistic population was the same in all three groups
        - Proving there is no link
    - Adjuvants
        - Ingredient added to vaccines which prevents the need for booster shots
        - Makes them more effective the first time
        - Alum is used as a adjuvant
            - A type of rock
            - They grind it up and put it in the vaccine
        - In the 1970s they switched to using fats
        - Squalene (MF59) was used in the influenza vaccine
            - Blamed for gulf war syndrome
            - Soldiers received a bunch of vaccines from the military vaccines
            - People blamed they syndrom on the Squalene
                - There was no squalene in the vaccines given to the military
            - Our bodies naturally make this compound, steroids are made from it so we produce large amounts everyday
            - Can be purchased as a dietary supplement
- Vaccines occasionally cause adverse effects
    - Most are minor:
        - Fevor
        - Swelling, redness, soreness
        - Dizziness (psychological)
    - Allergic reactions (rare)
    - Disease (extremely rare)
        - Only with live or attenuated organisms
            - Example: 69 cases of polio between 1978 & 1983
- Why vaccinate if a country is free of disease
    - Need to keep vaccinating as long as the disease exists on the planet
    - Herd immunity
        - Need to have a significant amount of the population vaccinated to protect the herd and prevent the disease from recirculating

- Cervical Cancer
    - 25000 women killed world wide
    - This is a viral disease
    - Only exists in sexually active women
    - Caused by HPV (genital warts)
        - The warts can translocate and cause tumors on the cervix
        - More than 200 types of HPV
            - Each is specific to one tissue in one area on your body
            - Warts on the bottom of your feet won't grow anywhere else on your body
            - Only a few cause cancer
                - These strains target p53
                - By doing this the virus ensures its survival and that tumors can be produced
    - To vaccinated you only need a part of a protein from the virus
        - Guarasil
        - Vaccine only works if you have not been previously infected
        - Thus it is typically administered before people become sexually active
        - A serious side effect if GBS
            - Of 8,600,000 vaccinated, 69 cases of GBS and 12 resulted in disability
- Recombinant Vaccine
    - Don't use the live virus
    - Only use a little piece of the protein
    - There is no danger of the person contracting the disease