ABCs of Vaccines

Part 2: MMR, Varicella, HepA, HepB, & Rotavirus

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PUBLIC HEALTH DIVISION
IMMUNIZATION UNIT

Overview

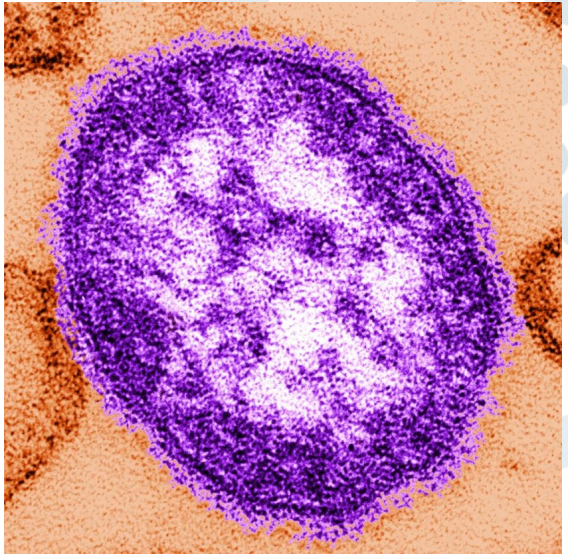
Disease causative agent, pathogenesis, and vaccination for:

- Measles
- Mumps
- Rubella
- Varicella
- Hepatitis A
- Hepatitis B
- Rotavirus

Measles

Measles virus

- Paramyxovirus of the genus *Morbillivirus*
  - Single-stranded RNA virus
  - Closely related to rinderpest and canine distemper viruses
- One antigenic type
- Rapidly inactivated by heat, sunlight, acidic pH, ether, and trypsin



Measles pathogenesis

- Two membrane envelope proteins are important
  - F (fusion) protein
    - Fusion of virus and host cell membranes, viral penetration, and hemolysis
  - H (hemagglutinin) protein
    - Binding of the virus to receptors on host cells
- Primary site of infection is alveolar macrophages or dendritic cells
- 2 to 3 days after replication in the lung, the virus spreads to regional lymphoid tissues, followed by a systemic infection
- Second viremia occurs 5 to 7 days after initial infection
  - Infected lymphocytes and dendritic cells migrate into the subepithelial cell layer and transmit the virus to epithelial cells
    - The virus is then released into the respiratory tract

Measles epidemiology

- Human disease
- Occurs worldwide
- Transmitted person-to-person via respiratory droplets
- Airborne in closed areas for up to 2 hours
- Occurs primarily in late winter and spring in temperate areas
- Communicable 4 days before through 4 days after rash onset

Measles clinical features

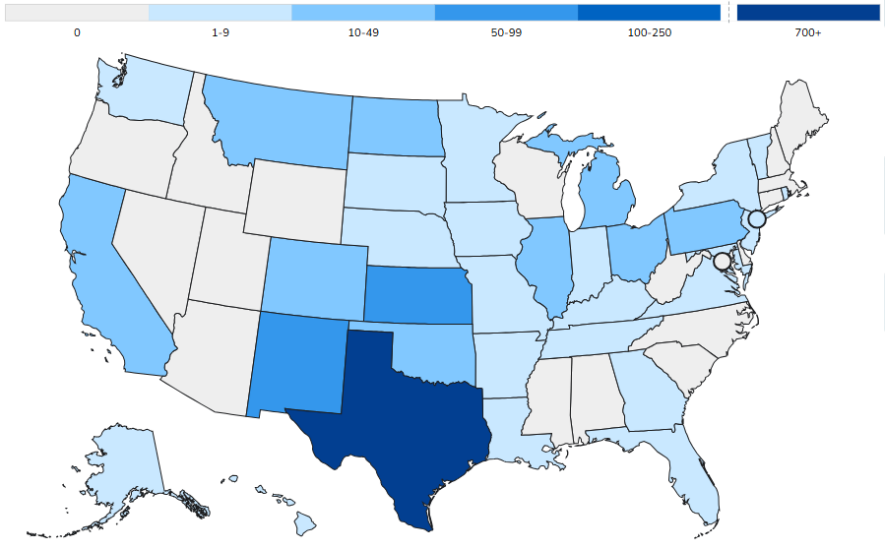
- Incubation period 11 to 12 days
  - Exposure to rash onset averages 14 days (range 7 to 21 days)
- Prodrome lasts 2 to 4 days
  - Stepwise increase in fever to 103-105
  - Cough, coryza, and conjunctivitis
  - Koplik spots on mucous membranes
- Rash
  - Persists for 5 to 6 days
  - Begins at the hairline, proceeding downward and outward
  - Severe areas peel off in scales
  - Fades in order of appearance

Measles complications

- ~30% of U.S. measles causes were reported to have one or more complications
  - Diarrhea
  - Otitis media
  - Pneumonia
  - Encephalitis
  - Subacute sclerosing panencephalitis
  - Death
- Complications most common in children <5 years and adults

Measles secular trends

- Nationally notifiable disease
- Pre-vaccine era, more than 50% of persons had measles by age 6 years, 90% by 15 years
  - 3 to 4 million annual cases with 500 deaths
- After vaccine introduction, cases declined by more than 95%
- Last Wyoming case in 2010
- As of June 6, 1168 cases in the U.S. in 2025
  - 95% unvaccinated or unknown vaccine status
  - 12% of cases were hospitalized
  - 3 deaths



Measles vaccination

- First vaccines licensed in 1963
  - Inactivated vaccine was withdrawn in 1967 as it did not protect against measles
- 1971 first combined measles, mumps, and rubella (MMR) vaccine was licensed
- In the U.S., always in combination with mumps and rubella
- Live, attenuated
- 2-dose series given at 12-15 months and 4-6 years
- Except for health care personnel, birth before 1957 generally can be considered acceptable evidence of immunity
- Vaccine efficacy for measles is 99% after two doses
- Immunity is probably lifelong in most persons

Measles vaccines

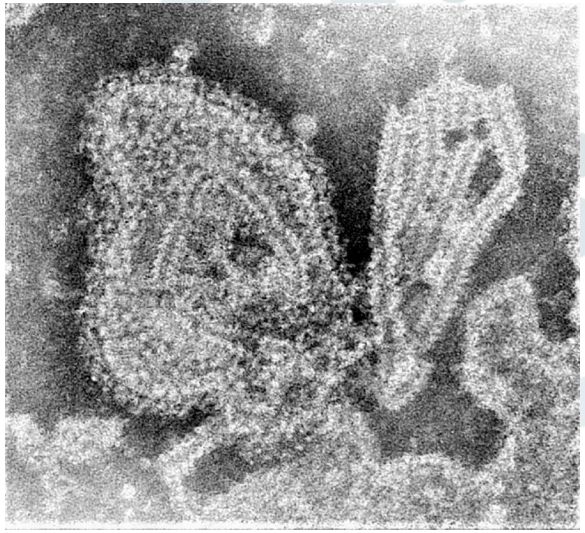
- MMR (MMR-II and Priorix)
  - MMR-II: Subcutaneous (SC) or intramuscular (IM) injection
  - Priorix: SC injection
- MMRV (ProQuad)
  - SC or IM injection

Questions?

Mumps

Mumps virus

- Paramyxovirus
  - Closely related to parainfluenza and Newcastle disease virus
- Single-stranded RNA virus
- Virus has been recovered from the saliva, cerebrospinal fluid, urine, blood, semen, breastmilk, and infected tissues of patients with mumps
- Rapidly inactivated by formalin, ether, chloroform, heat, and UV light



Mumps pathogenesis

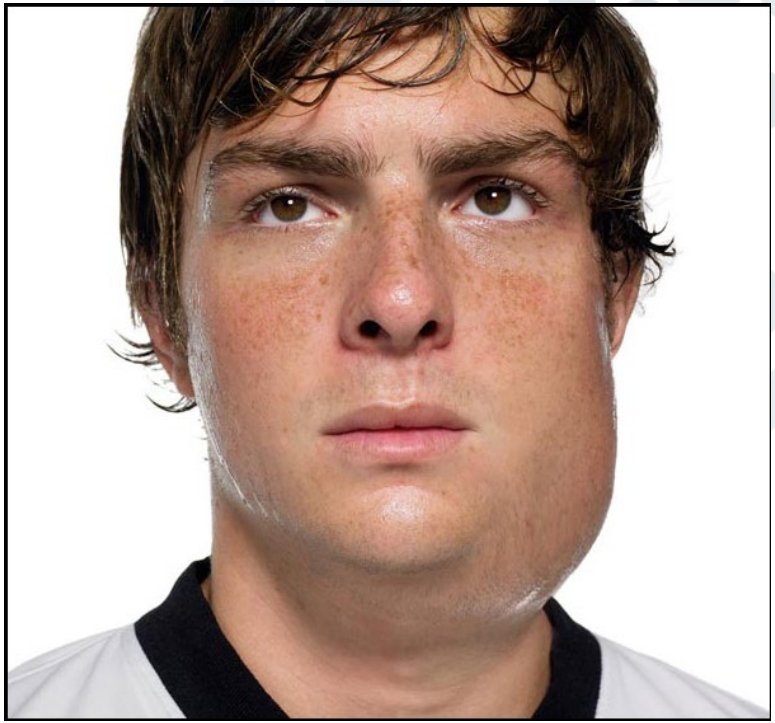
- Virus replicates in the nasopharynx and regional lymph nodes
- During viremia, it spreads to multiple tissues
  - Meninges, salivary glands, pancreas, testes, and ovaries
- Inflammation of infected tissues leads to characteristic symptoms of parotitis and complications as orchitis and aseptic meningitis

Mumps epidemiology

- Human virus
- Occurs worldwide
- Transmitted through respiratory droplets and saliva
- No temporal pattern
- Communicable 2 days before through 5 days after the onset of parotitis

Mumps clinical features

- Incubation period of 16 to 18 days (range 12 to 25 days)
- Nonspecific prodrome
  - Myalgia, malaise, headache, low-grade fever
- Typically presents as parotitis or other salivary gland swelling
  - Lasts about 5 days
  - May be unilateral or bilateral
- May present with nonspecific respiratory symptoms or be subclinical

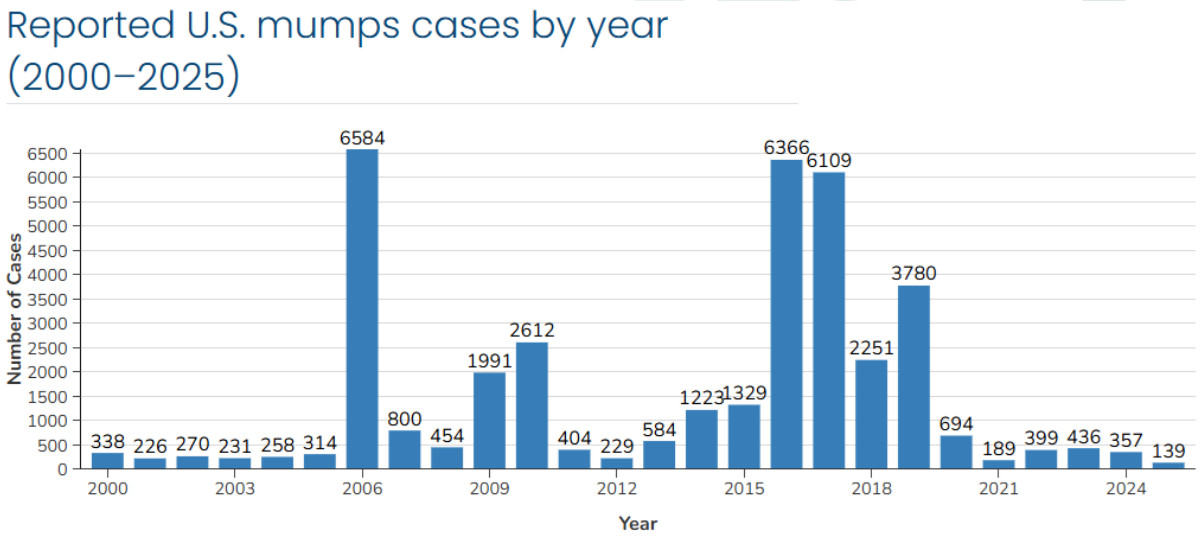


Mumps complications

- More common among adults than children
- Complications
  - Orchitis
  - Oophoritis
  - Mastitis
  - Pancreatitis
  - Hearing loss
  - Meningitis
  - Encephalitis
- Permanent sequelae and death are very rare

Mumps secular trends

- Nationally notifiable disease
- In pre-vaccine era, most children got mumps by adolescence
- Cases decreased by more than 99% after vaccination began
- 139 cases in the U.S. as of May 22 in 2025



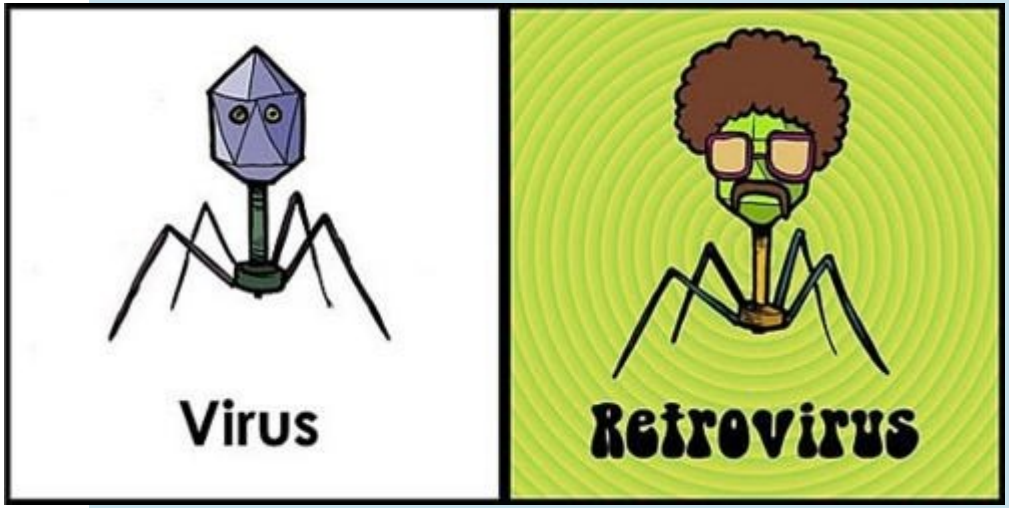
Mumps vaccination

- First vaccine for mumps licensed in 1967
- 1971 first combined measles, mumps, and rubella (MMR) vaccine was licensed
- In the U.S., always in combination with measles and rubella
- Live, attenuated
- 2-dose series given at 12-15 months and 4-6 years
- Except for health care personnel, birth before 1957 generally can be considered acceptable evidence of immunity
- Vaccine effectiveness for mumps is 78% after one dose, 88% after two doses

Mumps vaccines

- MMR (MMR-II and Priorix)
  - MMR-II: SC or IM injection
  - Priorix: SC injection
- MMRV (ProQuad)
  - SC or IM injection

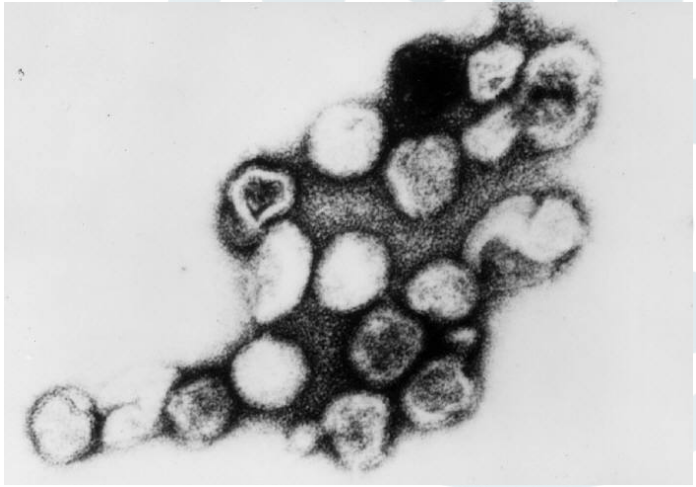
Questions?



Rubella

Rubella virus

- Sole member of the genus Rubivirus, in the family Matonaviridae
- Enveloped, single-stranded RNA virus
- One antigenic type



Rubella pathogenesis

- Virus replicates in the nasopharynx and regional lymph nodes
- Placental infection can occur during viremia and lead to transplacental fetal infection
  - Fetal damage occurs through cell destruction and disruption of cell division
  - Persistent infection occurs, leading to hearing impairment, ocular, and cardiovascular abnormalities

Rubella epidemiology

- Endemic rubella was eliminated in the U.S. in 2004 and the Americas region in 2009
- U.S. cases since 2012 have been imported
- Humans are only reservoir
- Person-to-person transmission via droplets
- No known temporal pattern
- Communicable 7 days before to 7 days after rash onset
- Infants with CRS shed large quantities of virus from body secretions for up to 1 year

Rubella clinical features

- Incubation period 12-23 days
- Rash first symptom in children
- Prodrome with low-grade fever, malaise, lymphadenopathy, and upper respiratory symptoms before rash in older children and adults
- Maculopapular rash 14-17 days after exposure
- Arthralgia is common in adult women

Congenital Rubella Syndrome (CRS)

- Prevention of CRS is the main objective of rubella vaccination programs
- Infection is most consequential in early gestation
  - CRS risk is highest in the first 12 weeks of gestation
  - Miscarriage, stillbirth, and severe birth defects may occur
- CRS is a constellation of birth defects
  - Deafness
  - Eye abnormalities (cataracts, glaucoma, retinopathy, microphthalmia)
  - Congenital heart diseases

Rubella secular trends

- Nationally notifiable disease
- 1964-1965 epidemic in the U.S. (pre-vaccine era)
  - 12.5 million cases
  - 11,000 miscarriages
  - 2,100 newborn deaths
  - 20,000 newborns with CRS
- Currently <10 cases annually in U.S.

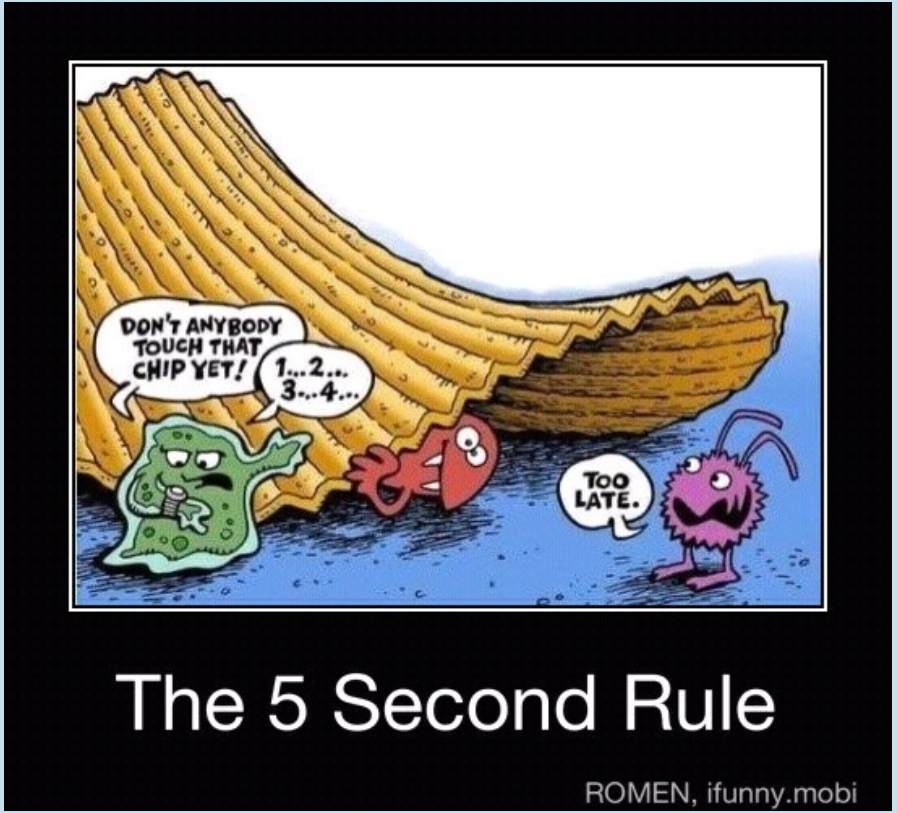
Rubella vaccination

- 1971 first combined measles, mumps, and rubella (MMR) vaccine was licensed
- In the U.S., always in combination with measles and mumps
- Live, attenuated
- 2-dose series given at 12-15 months and 4-6 years
- Except for health care personnel, birth before 1957 generally can be considered acceptable evidence of immunity
- Vaccine efficacy for rubella is 95% after a single dose
- Immunity is probably lifelong

Rubella vaccines

- MMR (MMR-II and Priorix)
  - MMR-II: SC or IM injection
  - Priorix: SC injection
- MMRV (ProQuad)
  - SC or IM injection

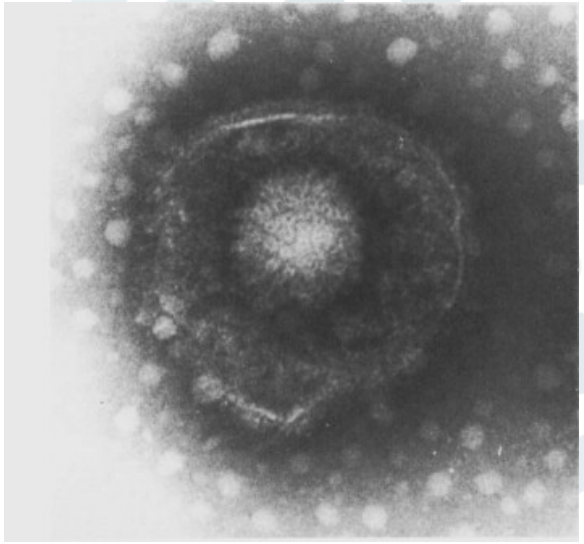
Questions?


DON'T ANYBODY TOUCH THAT CHIP YET!
1...2...3...4...
TOO LATE.
The 5 Second Rule
ROMEN, ifunny.mobi

Varicella

Varicella

- Varicella-zoster virus (VZV)
- Herpesvirus
- Persists in the body as a latent infection after the primary infection
- Short survival in the environment



Varicella pathogenesis

- Virus enters through the respiratory tract and the conjunctiva
- Replicates in the nasopharynx and regional lymph nodes
- Primary viremia occurs 4-6 days after infection
  - Disseminates virus to other organs, such as the liver, spleen, and sensory ganglia
- Secondary viremia occurs with viral infection of the skin

Varicella epidemiology

- Human reservoir
- Occurs worldwide
- Temporal pattern
  - Vaccination in the U.S. has eliminated discernible seasonality of disease
- Person-to-person transmission by direct contact with vesicular fluid or inhalation of aerosols from vesicular fluid of skin lesions, or respiratory tract secretions
  - Transmission of VZV causes varicella, not zoster (shingles), in a VZV-naïve person
- Communicable from 1-2 days before the onset of rash until all lesions have formed crusts
- Highly contagious
  - Secondary attack rates among susceptible household contacts are 61-100%

Varicella clinical features

- Incubation period 10-21 days
- Rash is often the first sign of disease in children
  - Generalized and pruritic rash progresses quickly from macules to vesicles
  - Usually first appears on the scalp, face, or trunk, then spreads to the extremities
  - Vesicules can also occur on mucous membranes
- Recovery from infection usually results in lifelong immunity
- Breakthrough varicella may occur more than 42 days after varicella vaccination
  - Less severe, usually fewer than 50 lesions
- VZV stays in sensory ganglia permanently
  - Can reactivate to cause zoster (shingles)

Varicella complications

- Bacterial infection of skin lesions
- Pneumonia
- Central nervous system manifestations
- Reye syndrome
- Disseminated disease with multiple organ involvement
- Maternal varicella 5 days before and 2 days after delivery may result in overwhelming infection in the neonate

Varicella secular trends

- Notifiable disease
  - Varicella only, not zoster (shingles) cases
- In the pre-vaccine era, virtually all persons acquired varicella by adulthood
- Incidence has declined 97% since vaccine introduction
- In Wyoming, 9 cases in 2023

Varicella vaccination

- First vaccine developed in Japan in the 1970s
  - Licensed in the U.S. in 1995
- Live, attenuated
- 2-dose series given at 12-15 months and 4-6 years
- Except for health care personnel, pregnant women, and immunocompromised persons, birth in the U.S. before 1980 generally can be considered acceptable evidence of immunity
- Vaccine effectiveness is 82% for dose 1, 92% after dose 2
- Immunity is probably lifelong

Varicella vaccines

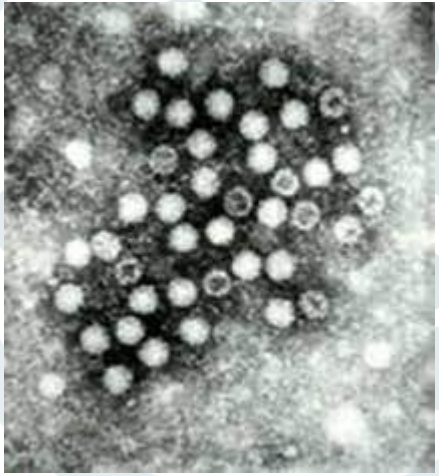
- Varivax
  - SC or IM injection
- MMRV (ProQuad)
  - SC or IM injection

Questions?


Bacteria: you've killed %99.99 of us why do you let that %0.01 live?
cleaning products:
No need to fear me, boy. I always leave one man behind to tell the tale.

Hepatitis A

Hepatitis A virus



- Picornavirus
- First isolated in 1979
- RNA virus
- Stable at low pH and frozen temperatures
- Stable in the environment for months, depending on conditions
- Inactivated by heat, chlorine

Hepatitis A pathogenesis

- Virus acquired through ingestion
- Viral replication in the liver
- After 10-12 days, the virus is present in blood and feces
- Viral excretion may continue for up to 3 weeks after the onset of symptoms

Hepatitis A epidemiology

- Humans are the only natural reservoir
- Fecal-oral transmission
  - Contaminated food or water
  - Direct contact with an infectious person
- Occurs worldwide
  - Highly endemic in Central and South America, Africa, the Middle East, Asia, and the Western Pacific
- No temporal pattern
- Most infectious 1-2 weeks before onset of illness

Hepatitis A clinical features

- Incubation period 15-50 days
- Clinical course indistinguishable from other types of viral hepatitis
- Symptoms:
  - Abrupt onset of fever, malaise, anorexia, nausea, abdominal discomfort, dark urine, jaundice
- Clinical illness usually does not last longer than 2 months
  - 10-15% of persons have prolonged or relapsing signs and symptoms for up to 6 months
- Children usually have asymptomatic or unrecognized illness
  - Important source of infection
- Chronic infections have not been reported

Hepatitis A complications & medical management

- Severe clinical complications are rare
- Fulminant hepatitis is the most severe complication
- No specific treatment for infection
  - Supportive treatment

Hepatitis A secular trends

- Nationally notifiable disease
- Large, nationwide epidemics during pre-vaccine era
- Children 2-18 had the highest rates historically
- Rates declined 95.5% since vaccine introduction in the U.S.
- 3 cases in 2023 in Wyoming

Hepatitis A vaccination

- First vaccine licensed in 1995
- Inactivated vaccines given by IM injection
- 2-dose series at 12-23 months
- >97% of children and adolescents will be seropositive within 1 month of the first vaccine dose

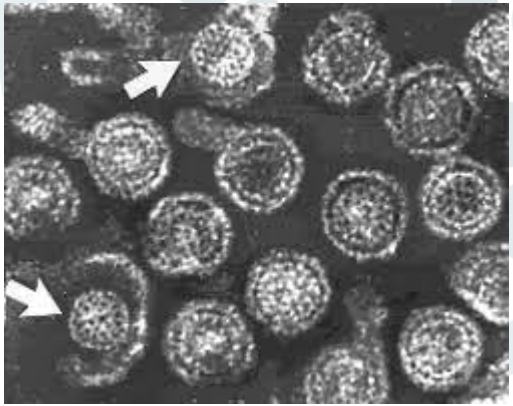
Hepatitis A vaccines

- HepA (Havrix and Vaqta)
  - Pediatric and adult formulations
- HepA-HepB (Twinrix)
  - Adult only

Hepatitis B

Hepatitis B virus

- Hepadnaviridae family
- Double-stranded DNA virus
- Multiple serologic markers for infection
- Infectious for at least 7 days on environmental surfaces
- Transmissible in the absence of visible blood



Hepatitis B pathogenesis

- Transmission by parenteral or mucosal exposure to the virus in infected body fluids
- Virus replicates in hepatocytes through a unique reverse transcription process

Hepatitis B epidemiology

- Reservoirs are humans and some primates
- Transmission through parenteral or mucosal exposure to HBsAg-positive body fluids
  - Highest concentrations in blood and serous fluids
- No temporal pattern
- Occurs worldwide
  - Most common in some countries in Asia, Africa, South America, and the Caribbean
- Persons with acute or chronic HBV infection are infectious at any time HBsAg is present in the blood
- Persons with acute infection can have HBsAg in blood 1-2 months before and after the onset of symptoms

Hepatitis B clinical features

- Incubation period 60 to 90 days
- Clinical signs and symptoms are more common in adults
  - Infants and young children are usually asymptomatic
- Three stages:
  - Prodromal: 3-10 days
    - Abrupt onset of fever, malaise, anorexia, nausea, abdominal discomfort, dark urine
  - Icteric: 1-3 weeks
    - Jaundice, light or gray stools, hepatic tenderness, hepatomegaly
  - Convalescent: weeks to months
    - Malaise and fatigue persist

Hepatitis B clinical features

- 90% of HBV infections in infants progress to chronic infection
- Perinatal transmission is highly efficient
- Complications:
  - Fulminant hepatitis
  - Liver cancer

Hepatitis B secular trends

- Nationally notifiable disease
- Cases decreased by 90% after vaccine introduction
- Incidence is greatest for persons 40-49 years, and lowest for those <19 years
- Estimated 850,000-2.2 million persons chronically infected in the U.S.
- 10 cases in Wyoming in 2023

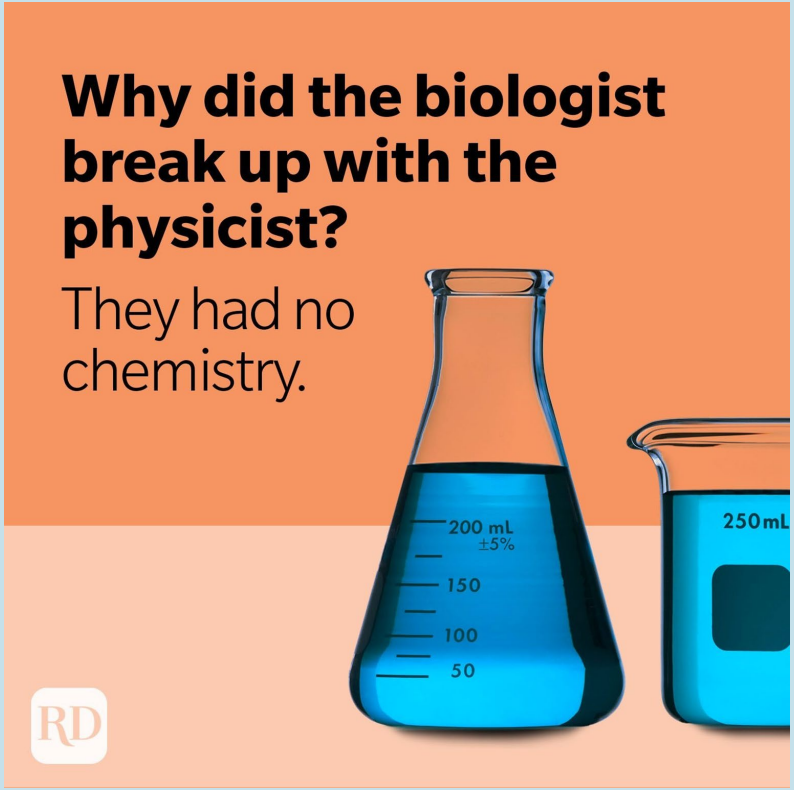
Hepatitis B vaccination

- First vaccine licensed in 1986
- Inactivated vaccines given by IM injection
- 3-dose series at 0 (birth), 1, 6 months
- Vaccine effectiveness 80-100%

Hepatitis B vaccines

- DTaP-HepB-IPV (Pediarix)
- DTaP-IPV-Hib-HepB (Vaxelis)
- HepA-HepB (Twinrix - adults only in U.S.)
- HepB (Engerix-B, RecombivaxHB, Heplisav-B)
    - Heplisav-B is 18+ years

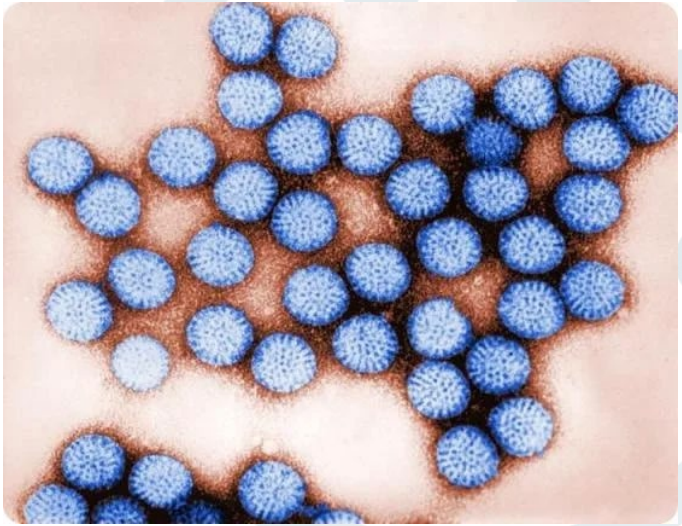
Questions?


Why did the biologist break up with the physicist?
They had no chemistry.
200 mL ±5%
150
100
50
250mL
RD

Rotavirus

Rotavirus

- Double-stranded RNA virus of the Reoviridae family
- Very stable, and may remain viable in the environment for weeks or months if disinfection does not occur



Rotavirus pathogenesis

- Virus enters through the mouth
- Replicates in the epithelium of the small intestine
- Infection results in decreased intestinal absorption and may lead to isotonic diarrhea
- Recovery does not lead to permanent immunity, and reinfection can occur at any age

Rotavirus epidemiology

- Occurs worldwide
- Humans are the only reservoir
- Fecal-oral, person-to-person, and fomite transmission
- Most prevalent in fall and winter in temperate climates
- Highly communicable
  - Nearly universal infection of children by age 5 years in the pre-vaccine era

Rotavirus clinical features

- Short incubation period
  - Usually less than 48 hours
- May be asymptomatic or result in severe dehydrating diarrhea with fever and vomiting
- Virus shed in stool beginning 2 days before onset of diarrhea and for several days after onset of symptoms
- First infection after age 3 months is generally most severe
- GI symptoms generally resolve in 3-7 days

Rotavirus secular trends

- Not a notifiable disease
- Pre-vaccine era:
  - 2.7 million cases annually in the U.S.
  - 95% of children are infected by 5 years of age
  - Accounted for 30-50% of all hospitalizations for gastroenteritis among children <5 years

Rotavirus vaccines

- First vaccine licensed in 1998
  - Withdrawn from the U.S. market within 1 year after post-marketing surveillance detected an association with intussusception
- Vaccination resumed in 2006 with two new vaccines
  - Both are administered orally
  - Live, attenuated

Rotavirus vaccines

- RV5 (RotaTeq)
  - Contains five strains
  - 3-dose series at 2, 4, and 6 months
- RV1 (Rotarix)
  - Contains one strain
  - 2-dose series at 2 and 4 months
- Maximum age for first dose is 14 weeks 6 days
- Maximum age for any dose is 8 months 0 days

Questions?


I COULD BE ROUND.
COCCUS
I COULD BE ROD.
BACILLUS
@amoebasisters
I COULD BE SPIRALED
SPIRILLUM
AND DYED.
CRYSTAL VIOLET
I COULD BE HURTFUL.
MWAHAHA
I COULD BE HELPFUL.
@amoebasisters
I COULD BE ANYTHING YOU LIKE.
WHAT BACTERIAL TRANSFORMATION DO YOU WANT?!

Thank you!!

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