PARAMYXO VIRUSES

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A new genus Metapnemovirus added in 2001: hMPV

Human Paramyxoviruses

Genus	Species	Distinguishing Properties
Paramyxovirus	Parainfluenza virus, types 1, 2, 3, 4A, and 4B, mumps virus	Contains neuraminidase and hemagglutinin; distinctive antigens
Pneumovirus	Respiratory syncytial virus	Lacks neuraminidase and hemagglutinin; morphology; distinctive antigens
Morbillivirus	Measles virus	Lacks neuraminidase; distinctive antigens

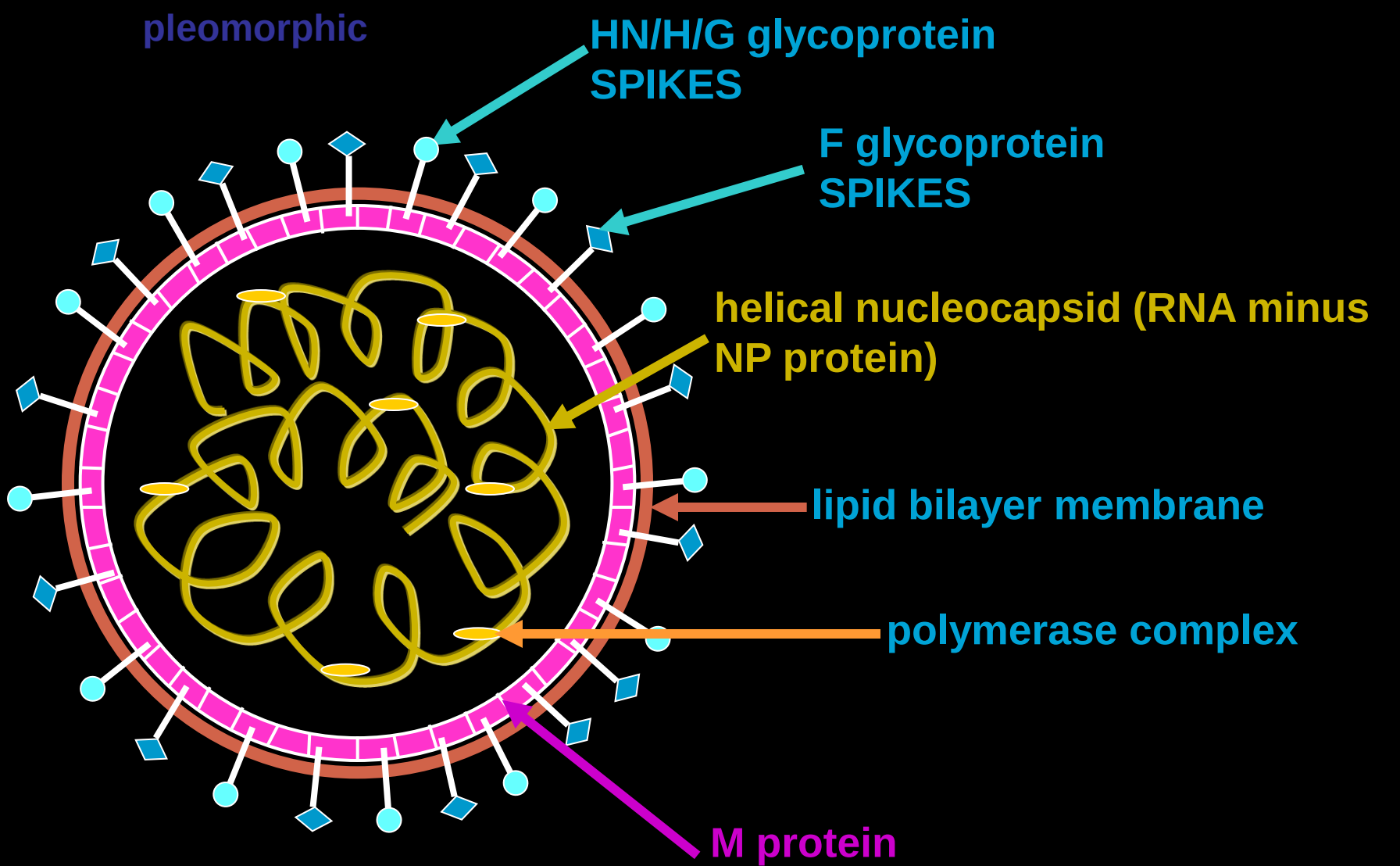
Table 14.1 General properties of the genera of the Family *Paramyxoviridae*

Characteristic	Genus		
	Paramyxovirus	*Morbillivirus*	*Pneumovirus*
Genome	Single-stranded negative-sense RNA of approximately 15 000 nucleotides		
Morphology	Quasispherical and filamentous particles with prominent filamentous fringe		
Nucleocapsid symmetry	Helical	Helical	Helical
Nucleocapsid diameter	18 nm	18 nm	13–14 nm
Nucleocapsid pitch	5.5 nm	5.5 nm	6.7–7.0 nm
Spike length	8 nm	8 nm	10–12 nm (RSV)
Spike spacing	8–10 nm	8–10 nm	7–10 nm
Virion RNA/RNA polymerase	+	+	+
Haemagglutinin	+	+	− (RSV) + (PVM)
Neuraminidase	+	−	−
Site of multiplication	Cytoplasm	Cytoplasm	Cytoplasm
Nuclear dependence	+	+	−
Structural proteins:*			
Large protein (polymerase?)	L (> 160 kD)	L (160–200 kD)	L (160–200 kD)
Attachment glycoprotein	HN (65–74 kD)	H (76–85 kD)	G‡ (84–90 kD)
Fusion glycoprotein	FO (60–68 kD)	FO (60–62 kD)	FO (66–70 kD)
(F subunits activated by proteolytic cleavage)	F1 (48–59 kD) F2 (10–15 kD)	F1 (40–41 kD) F2 (20–25 kD)	F1 (43–50 kD) F2 (19–24 kD)
Nucleocapsid protein	NP (56–61 kD)	NP (60 kD)	N (8–44 kD)
Phosphoprotein	P (44–84 kD)	P (70–73 kD)	P (31–34 kD)
Matrix protein	M (34–41 kD)	M (34–38 kD)	M (27–33 kD)
Non-structural **or** unknown function proteins	C† (24 kD) SH (5 kD)	C (18–20 kD) ...	... ... 1A (9.5 kD) (RSV) 1C (14 kD) (RSV) 1B (11 kD) (RSV) M2 (22–24 kD) (RSV)

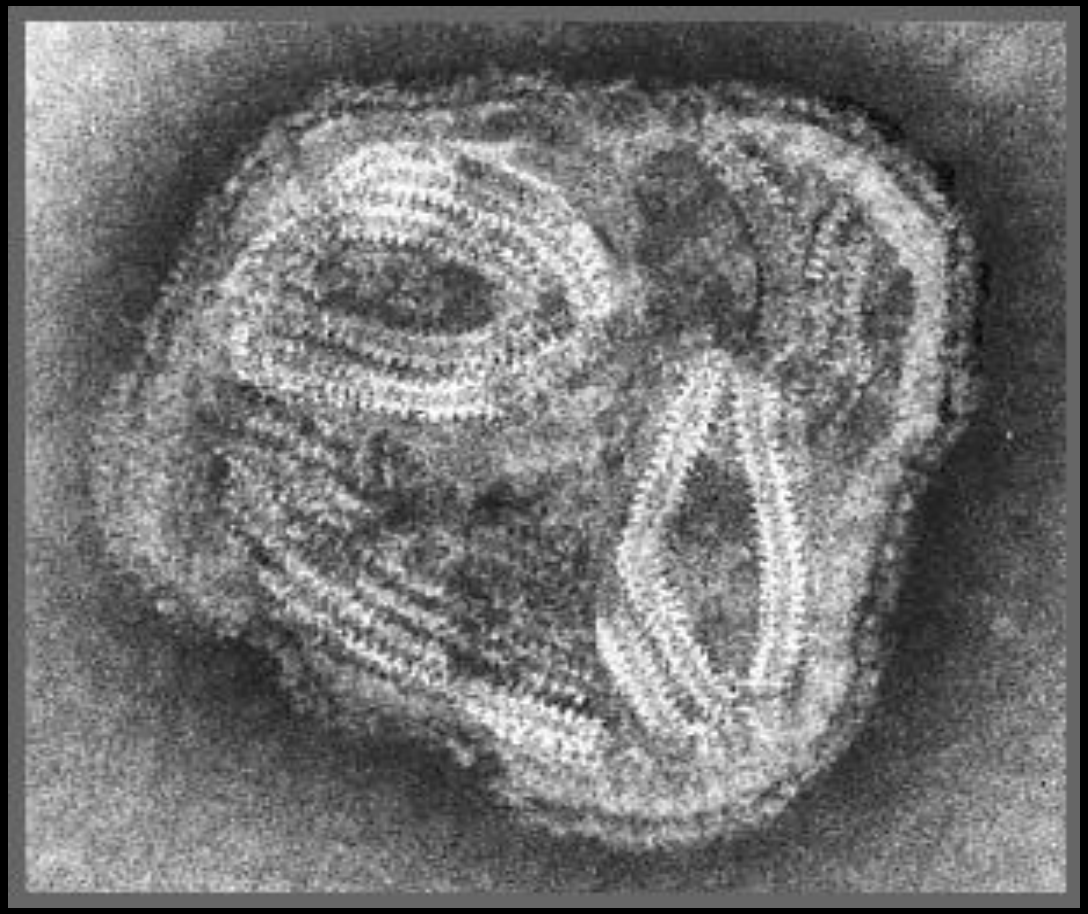
Structure of Paramyxoviruses

- Enveloped particles 150 to 300 nm in diameter, Tube like, helical symmetry
- Single-stranded, negative-sense RNA genome RNA-directed RNA polymerase of ~15000 nt
- Matrix protein (M) at the base of a double-layered lipid envelope
- envelope contains two glyco-proteins, a viral attachment protein, and a fusion protein

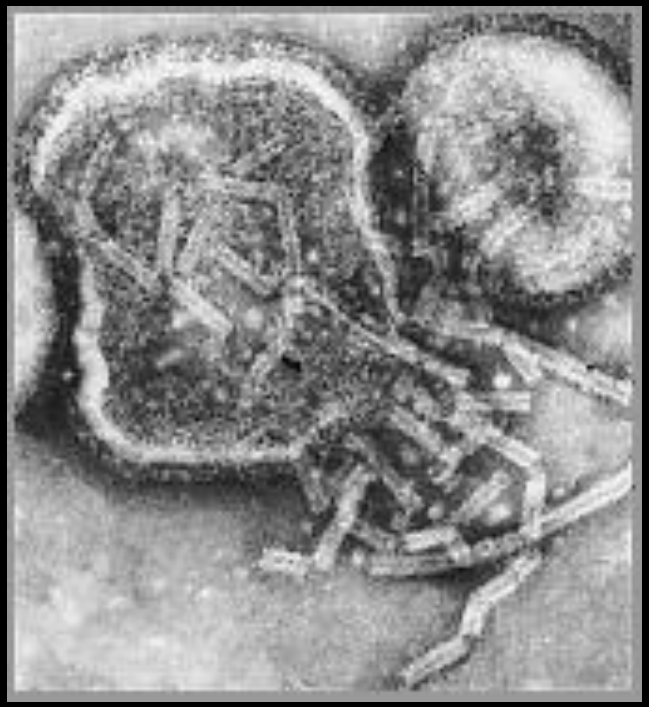
PARAMYXOVIRUSES



STRUCTURE-PARAMYXOVIRUSES

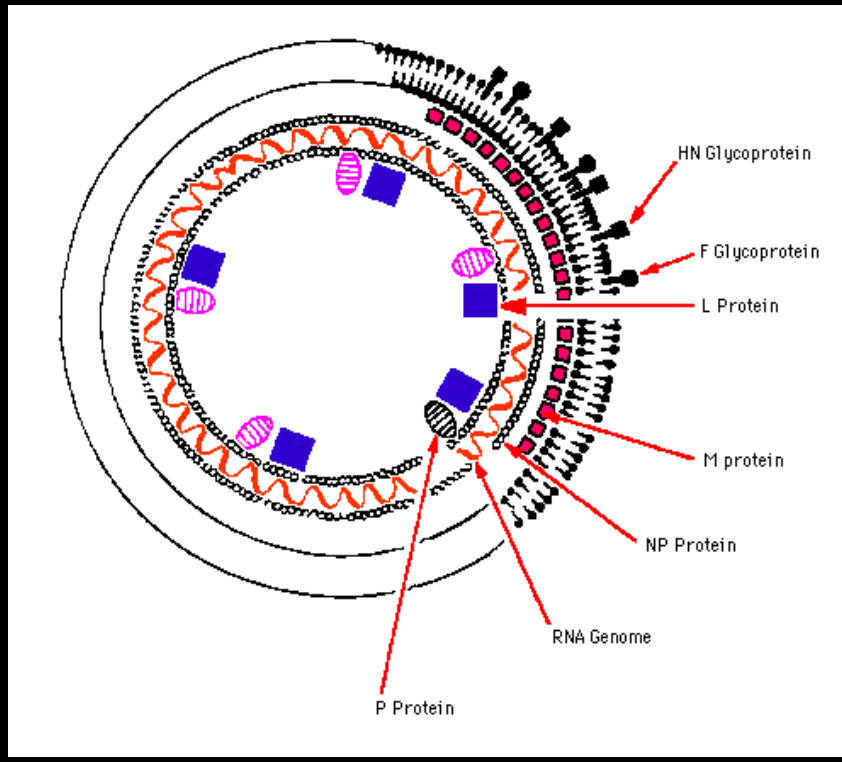


Parainfluenza Virus



PIV STRUCTURE

- 5 serotypes: 1, 2, 3, 4a, 4b
- No common group antigen
- Closely related to Mumps V
  - Possess Haemagglutination Neuraminidase surface proteins
- **F - F1 + F2** - responsible for cell fusion + haemolytic function.

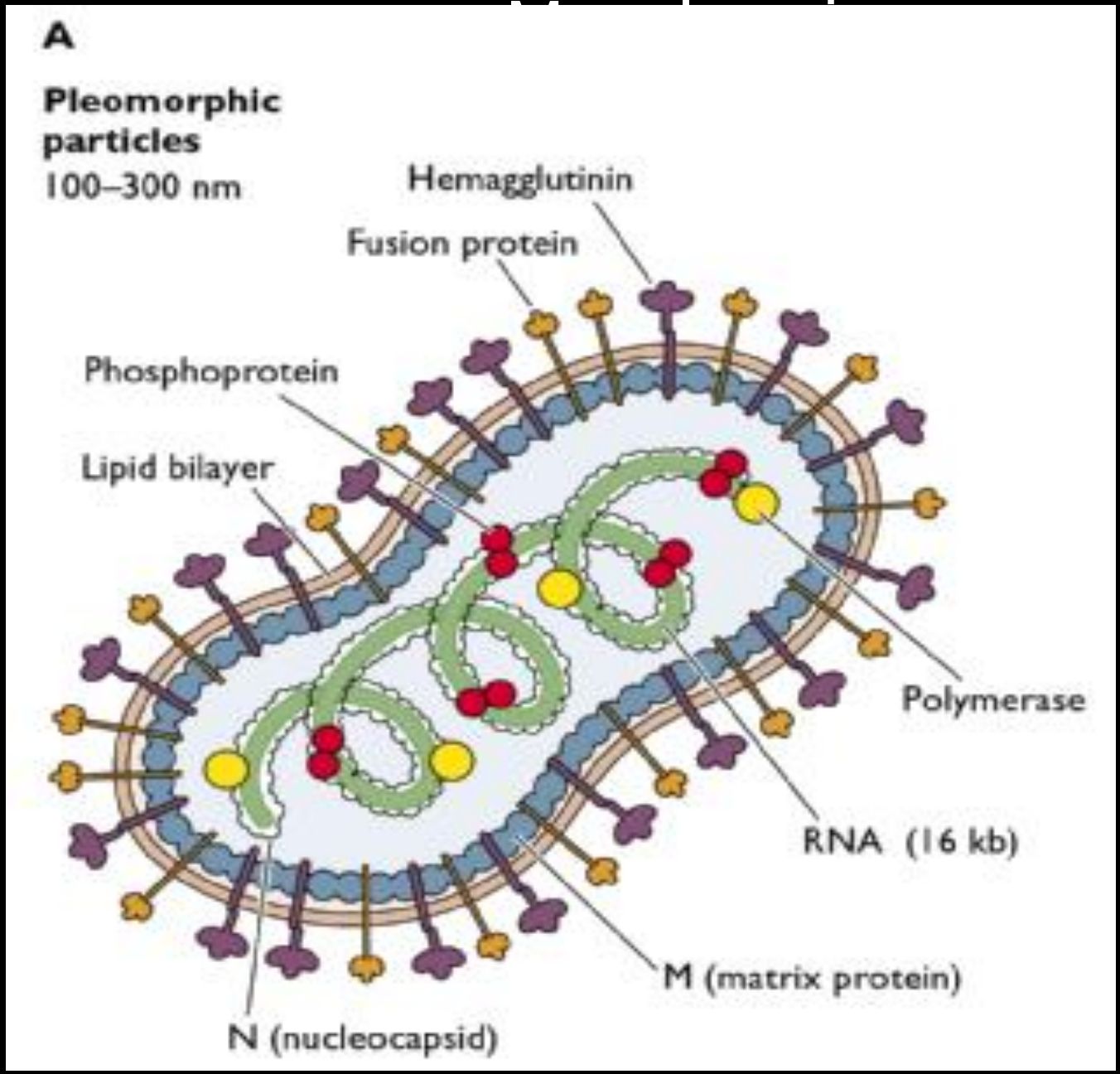


Mumps Virus

- One antigenic type
- Rapidly inactivated by chemical agents, heat and ultraviolet light
- Possess Haemagglutination Neuraminidase surface proteins

Measles Virus

- Hemagglutinin - surface antigen
- One antigenic type

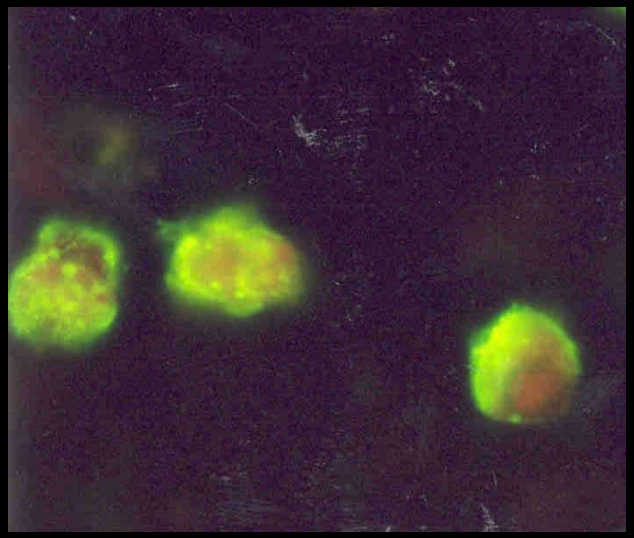

A
Pleomorphic particles
100–300 nm
Hemagglutinin
Fusion protein
Phosphoprotein
Lipid bilayer
Polymerase
RNA (16 kb)
M (matrix protein)
N (nucleocapsid)

Multiplication

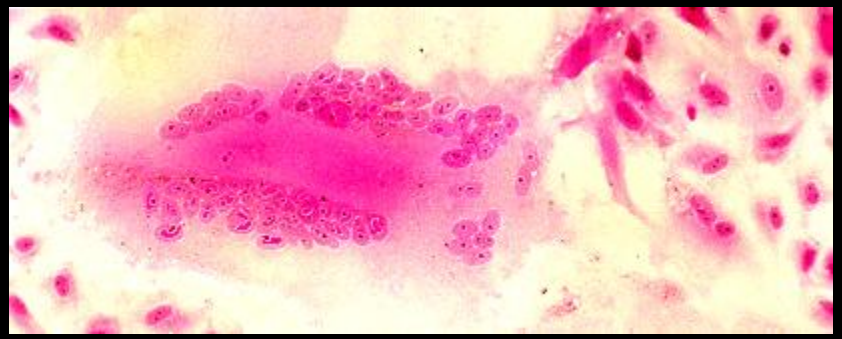
- Attach to host cell by hemagglutinin, which binds to host cell neuraminic acid receptor, and then penetrate cell by fusion with cell membrane mediated by F_1 and F_2 glycopeptides
- Virion transcriptase initiates transcription into 5-8 complementary messenger positive-sense RNA strands
- Direct viral protein synthesis and are copied into negative-sense RNA strands which are integrated in new virions
- For envelopment, virus-specific glycoproteins accumulate in cell membrane. Assembly is completed by budding of nucleocapsid through cell membrane studded with glycoproteins

Laboratory Diagnosis

- PCR
- Detection of Antigen - a rapid diagnosis -nasopharyngeal aspirates and throat washings.
- Urine can be a sample for measles
- Virus Isolation - virus may be readily isolated from nasopharyngeal aspirates and throat swabs. MDCK / LLCMK2/Vero/B95A cells - Haemadsorption
- Serology - a retrospective diagnosis may be made by serology.



Syncytia in vero cells



PARAINFLUENZA VIRUS

Clinical Manifestations (PIV)

- Croup (laryngotraheobroncitis)
  - most common manifestation.
  - However other viruses may induce croup e.g. influenza and RSV.
- Other conditions
  - Bronchiolitis,
  - Pneumonia
  - Flu-like tracheobronchitis
  - Corza-like illnesses.

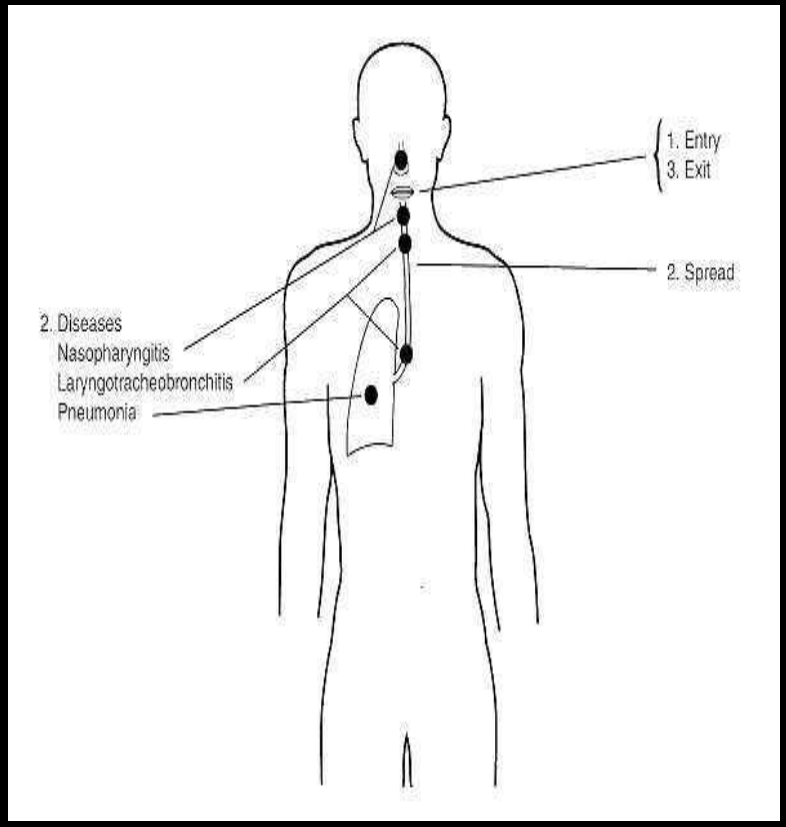
Clinical Manifestations (PIV)

- Types 1 to 3 most common cause of SARI in infants, responsible for 50-90% of Bronchiolitis and 5-40% of Bronchopneumonia
- Re-infection, causing milder upper respiratory illness, in older children & adults
- Type 4 causes usually only mild upper respiratory infection in children and adults, but severe symptoms can occur in infants

Pathogenesis

- First infect ciliated epithelial cells of nose and throat
- Infection may extend to paranasal sinuses, middle ear, and lower respiratory tract.
- Progeny viruses spread among cells both extracellularly and intracellularly
- Virus is shed in respiratory secretions for 3 to 16 days following primary infection and for 1 to 4 days following re-infection
- Shedding starts shortly before onset of disease and ends with development of local antibody
- Main pathogenic change is an inflammatory response in superficial layers of mucous membranes
- Development of croup is linked to IgE antibodies and release of histamine

Pathogenesis



- Generally initiate localized infections in upper and lower respiratory tracts without causing systemic infection
- Viremia may occur
- Local and serum antibodies develop after primary infection
- Resulting immunity is not adequate to prevent re-infection, but does provide some protection

Host Defences

- Immunologic events not well understood
- Nonspecific immunity may contribute to resistance
- Type-specific secretory and humoral immune responses occur, but protection does not last
- Reinfection with the same serotype may occur within 3 months to several years
- Degree of resistance to reinfection depend mainly on the concentration of secretory IgA antibodies
- Neutralizing IgA is found in infants and young children only for a short time
- Serum antibodies usually not significant in resistance to reinfection
- Passive maternal antibodies do not protect may influence disease manifestations with types 1 and 2 virus

Epidemiology

- Distributed worldwide
- endemic, sometimes epidemic proportions.
- types 1 and 2 peak in the winter months
- type 3 appears throughout the year
- source: humans
- incubation period: 2 to 6 (to 10) days
- transmitted by: direct person-to-person contact and by the airborne route
- labile and do not persist in environment

Management

- No specific antiviral chemotherapy available.
- Severe cases of croup should be admitted to hospital and placed in oxygen tents.
- No vaccine is available.

MUMPS

Mumps

- Acute viral illness
- Parotitis and orchitis described by Hippocrates in 5th century B.C.
- Viral etiology described by Johnson and Goodpasture in 1934
- Frequent cause of outbreaks among military personnel in pre-vaccine era

Mumps Pathogenesis

- Respiratory transmission of virus
- Replication in nasopharynx and regional lymph nodes
- Viremia 12-25 days after exposure with spread to tissues
- Multiple tissues infected during viremia

Virus enters respiratory tract

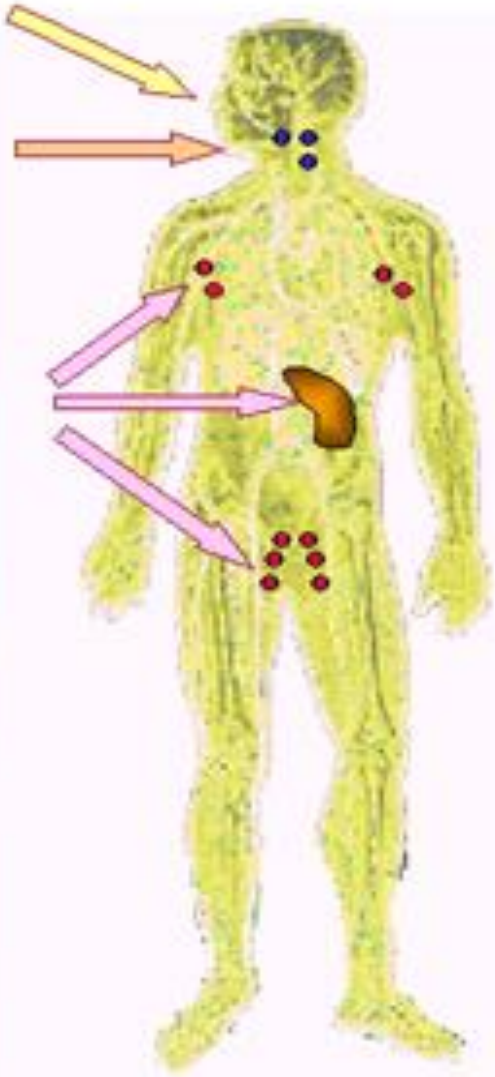
Virus grows in salivary glands and local lymphoid tissue

Virus spreads to spleen and distant lymphoid tissue

Viremia

Virus spreads throughout body to testes, ovary, pancreas, thyroid, salivary glands

DISEASE



7-10 days

Approx 15 days

18 days and after

Host Defence

- Infection is followed by interferon production, specific cellular and humoral immunity
- Interferon limits virus spread and multiplication
- Production ceases as virus levels decrease and antibodies and CMI appear
- IgM class-specific antibodies develop within the first 3 days after onset of symptoms and persist for approximately 2 to 3 months
- IgG ab appear a few days later and persist for life
- Circulating ab provide lifelong protection
- IgG class is transplacentally transferred to newborn and persists in declining titers during first 6 months

Mumps Clinical Features

- Incubation period 14-18 days
- Nonspecific prodrome of low-grade fever, headache, malaise, myalgias
- Parotitis in 30%-40% (Unilateral or Bilateral)
- Up to 20% of infections asymptomatic
- May present as lower respiratory illness, particularly in preschool-aged children

Mumps Complications

CNS involvement	**15% of clinical cases**
Orchitis	**20% - 50% in post - pubertal males**
Pancreatitis	**2%-5%**
Deafness	**1/20,000**
Death	**1-3/10,000**

Epidemiology

- Worldwide, endemic
- Local outbreaks are in institutions, boarding schools, and military camps
- Epidemics in past used to occur every 2 to 3 years
- transmitted usually by direct and close person-to-person contact & less often by airborne route
- School children main source of spread
- 95 percent of individuals have abs by age 15
- 35 percent of these infections are subclinical

Mumps Epidemiology

- Reservoir — Human
- Transmission — Respiratory drop nuclei
  Subclinical infections may transmit
- Temporal pattern — Peak in late winter and spring
- Communicability — Three days before to four days after onset of active disease

Mumps Vaccine

- Composition — Live attenuated virus (L-Zagreb Mumps virus strain)
- Efficacy — 95% (Range, 90%-97%)
- Duration of Immunity — Life long
- Schedule — 1 Dose
- Usually given as MMR
- Also available as monovalent Mumps vaccine

RESPIRATORY SYNCYTIAL VIRUS

Respiratory Syncytial Virus (RSV)

- Most important respiratory viral pathogen among children.
- Considerable strain variation exists,
  - classified into subgroups A and B
- Both subgroups circulate in the community at any one time.
- Family: Paramyxoviridae
- Genus Pneumovirus
- ssRNA eveloped virus

Clinical Manifestations

- Most common cause of severe lower respiratory infection in Infants and small children
  - Bronchiolitis (RSV accounts for 50 – 90% cases)
  - Pneumonia / Bronchopneumonia (5-40%)
  - Upper respiratory tract infection
  - Croup
  - Apnoea
  - Otitis media
- Older Children / Adults
  - Upper respiratory tract infection
  - Bronchitis
  - Pneumonia (elderly)
- Notorious for causing outbreaks in hospitals

Infants at Risk of Severe Infection

1. Infants with congenital heart disease
2. Infants with underlying pulmonary disease
3. Immunocompromized infants

Pathogenesis

- initiates a localized infection in upper or lower respiratory tract
- virus infects ciliated mucosal epithelial cells of nose, eyes, and mouth.
- Generally is confined to epithelium of upper respiratory tract, but may involve lower respiratory tract
- Virus spreads both extra cellularly and by fusion of cells to form syncytia,
- Antibodies do not penetrate intra cellularly cannot completely restrict infection
- virus is shed in respiratory secretions usually for about 5 days – 20 days
- Shedding begins with onset of symptoms and declines with the appearance of local antibody

Pathogenesis

- pathogenesis of bronchiolitis may be immunologic or directly due to viral cytopathology
- bronchiolitis during the first year of life may be a risk factor for later development of asthma and sensitization to common allergens

Host Defence

- Nonspecific defence such as virus-inhibitory substances in secretions probably contribute to resistance and recovery
- Protective immunity elicited by F and G proteins.
- Secretory and serum antibody responses does not protect completely against re infection
- Resistance to re-infection depend on the presence of neutralizing antibody on mucosal surfaces

Epidemiology

- Source: respiratory tract of humans
- Incubation period: about 4 days.
- Prim infect are contagious from about 5 days to 3 wk
- Contagious periods become progressively shorter during re-infections
- Transmitted by direct person-to-person contact and by airborne route introduced by school children
- infects infants during the first few months of life despite the presence of maternal serum antibodies
- Sex and socioeconomic factors influence outcome of infection.

Epidemiology

- distributed worldwide,
- illness in infants and young children
- endemic, reaching epidemic proportions
- In temperate climates, epidemics occur each winter and last 4 to 5 months
- RSV subgroups A and B circulate during these epidemics
- about one-half of the susceptible infants undergo primary infection in each epidemic
- infection is almost universal by second birthday
- Reinfection may occur as early as a few weeks after recovery, but usually takes place during subsequent annual outbreaks, with a rate of 10 to 20 percent per epidemic throughout childhood
- In adults, the frequency of reinfection is lower.

Treatment and Prevention

- Aerosolised RIBAVIRIN can be used for infants with severe infection, and for those at risk of severe disease.
- There is no vaccine available.
- RSV immunoglobulin can be used to protect infants at risk of severe RSV disease.

MEASLES

Measles

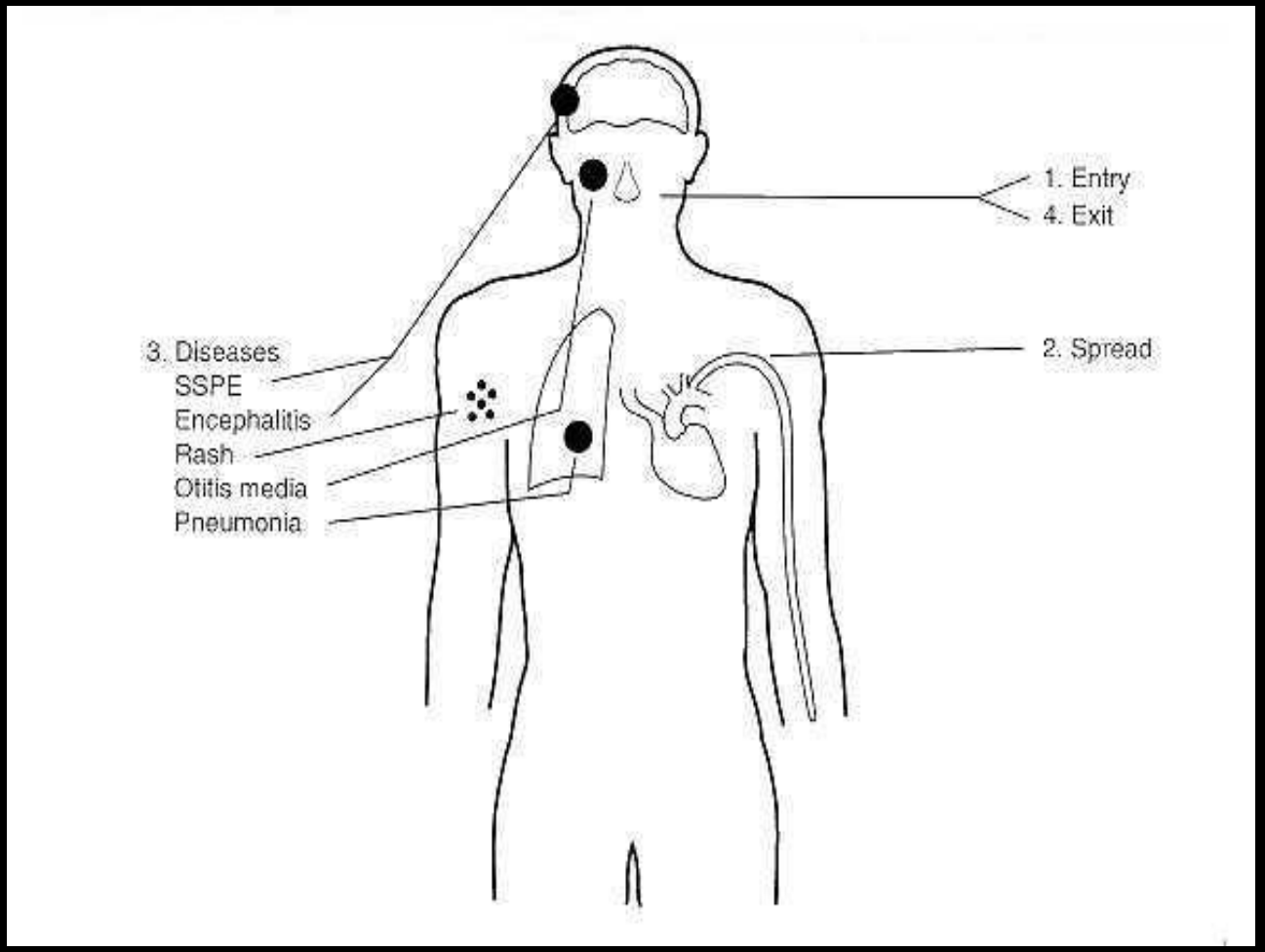
- Highly contagious viral illness
- First described in 7th century
- Near universal infection of childhood in prevaccination era
- Frequent and often fatal in developing areas
- Kills about 1.0 million children/year in developing countries

Measles Epidemiology

- Reservoir Human
- Transmission Respiratory
  Airborne
- Communicability: 4 days before to 4 days after rash onset

Measles Pathogenesis

- Respiratory transmission of virus
- Replication in nasopharynx and regional lymph nodes
- Primary viremia 2-3 days after exposure
- Secondary viremia 5-7 days after exposure with spread to tissues


1. Entry
4. Exit
2. Spread
3. Diseases
SSPE
Encephalitis
Rash
Otitis media
Pneumonia

Measles Clinical Features

- Incubation period 10-12 days

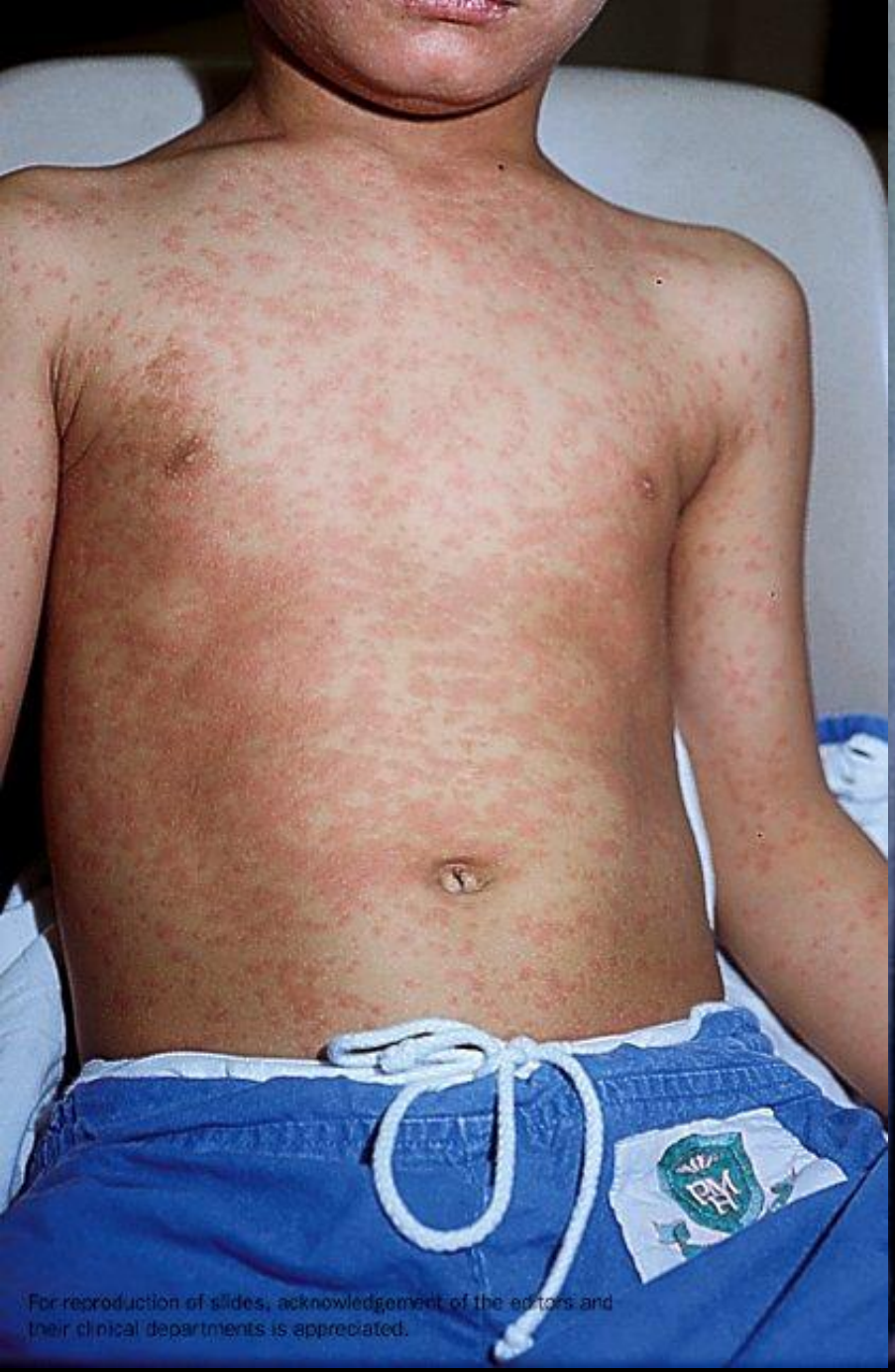
PRODROME

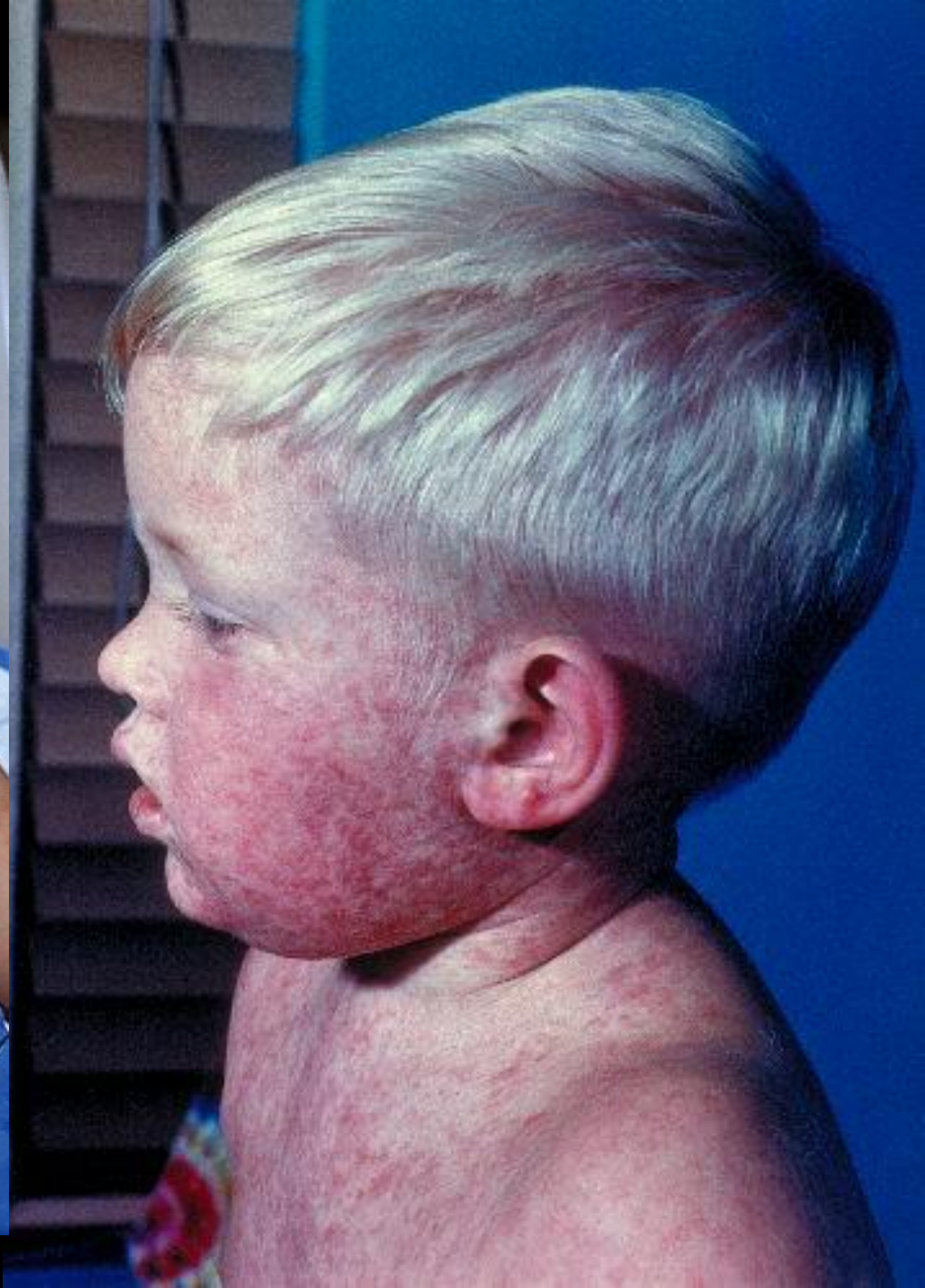
- Stepwise increase in fever to 103^{o} F or higher
- Cough, coryza, conjunctivitis
- Koplik spots

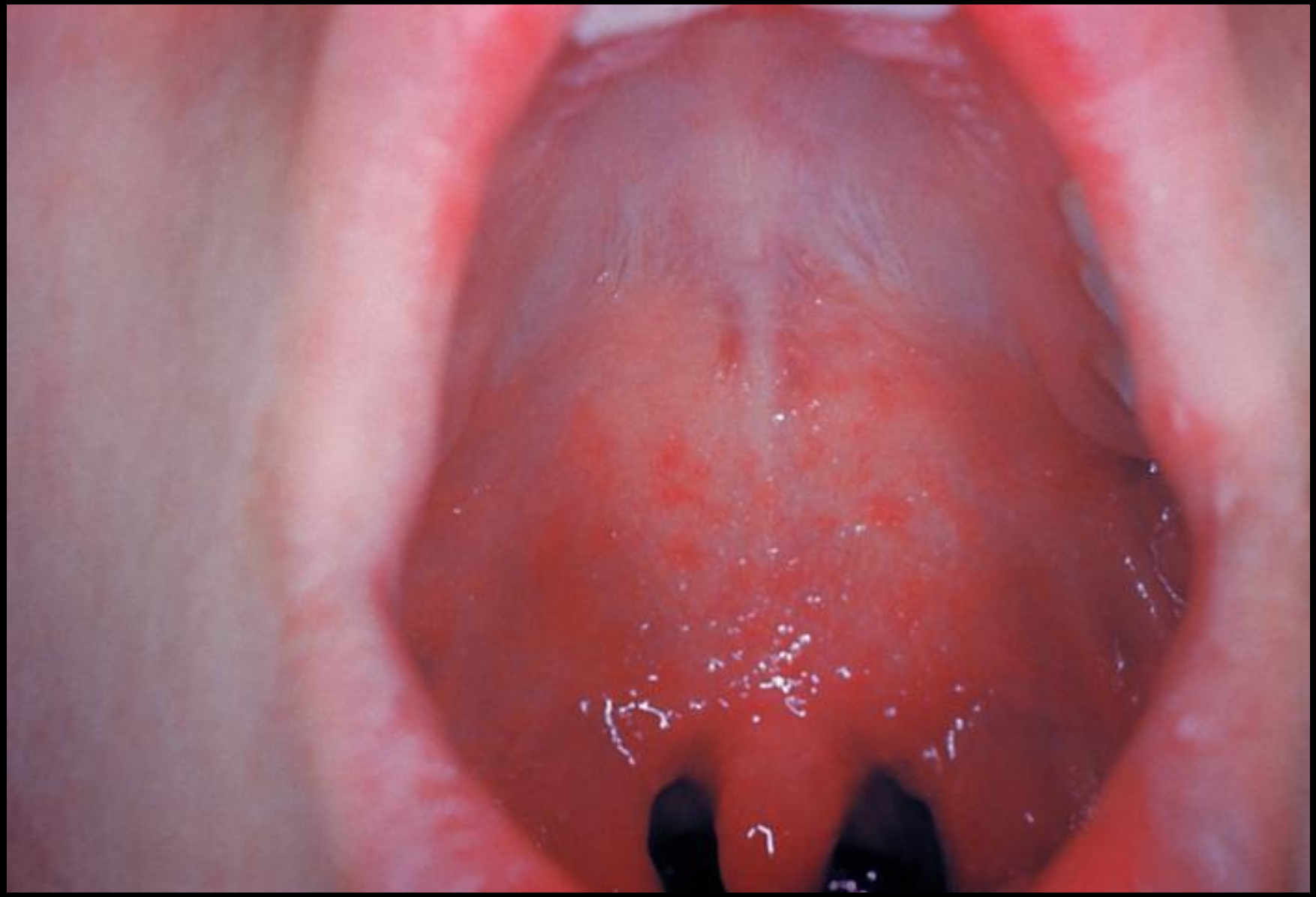
Measles Clinical Features

Rash

- 2-4 days after prodrome, 14 days after exposure
- Maculopapular, becomes confluent
- Begins on face and head
- Persists 5-6 days
- Fades in order of appearance







Measles Complications

Pneumonia
Otitis media
Diarrhea
Encephalitis

Measles Complications

- Subacute sclerosing pan encephalitis (SSPE): Rare complication of measles infection
- slowly progressing, fatal neurodegenerative disease of CNS affecting children and young adults.
- due to the persistence of defective Measles virus in brain cells.
- Manifested usually after 7 to 15 years following Primary Measles.
- Affects all parts of the brain: pan encephalitis.
- Incidence of 1:300,000 to 1:1000,000 cases of Measles.
- Exact pathogenic mechanism of SSPE remains unclear.
- SSPE patients will have high levels of Measles specific antibody in blood and CSF.
- Measles before one year of age - significant risk of developing SSPE
- Invariably fatal disease

Measles Vaccine

- 1968 — Live further attenuated vaccine (Edmonston-Enders strain)
- Efficacy — 95% (range, 90%-98%)
- Duration of Immunity — Lifelong
- Schedule — Developing Countries -9th Month
  Developed Countries – 12th Month
- Vaccine given before 9 / 12 months should not be counted as a valid dose
- Also administered as MMR
- Second dose may be given at the school entry age (4-6 yrs

Human Metapneumoviruses

- In 2001, researchers in Netherlands reported unidentified pathogen associated with ARTI in Europe, America, Asia, Australia and South Africa in individuals of all ages
- Avian pneumovirus (aMPV, Turkey rhinotracheitis virus) and human metapneumovirus (hMPV) are pathogens of birds and humans, associated with respiratory tract infections
- aMPV and hMPV have been classified into a new genus referred to as Metapneumovirus

Metapneumoviruses

- Incidence varies from 1.5% to 25%
- Plays important role in pediatric URTI/ LRTI with epidemiological & clinical features similar to RSV & Influenza
- Socio-economic impact considerable on families
- May be associated with significant morbidity and mortality in pre-term infants and children with underlying clinical conditions
  - Many fundamental questions concerning the pathogenesis of hMPV disease and the host's specific immune response remain to be answered.

MMR vaccine

- Measles, Mumps and Rubella Vaccine (Live) freeze-dried
- live attenuated strains of
  - Edmonston-Zagreb Measles virus propagated on human diploid cell culture
  - L-Zagreb Mumps virus propagated on chick embryo fibroblast cells
  - Wistar RA 27/3 Rubella virus propagated on human diploid cell culture
- The reconstituted vaccine contains, in single dose of 0.5 ml not less than
  - 1000 $CCID_{50}$ of Measles virus
    5000 $CCID_{50}$ of Mumps virus
    1000 $CCID_{50}$ of Rubella virus.
    Diluent : Sterile water for injection.

INDICATIONS

- children of 12 months to 10 years of age
- children above 10 years and susceptible non pregnant adult individuals,
- The IAP Committee of Immunisation recommends two doses of MMR vaccine to every child at 15 to 18 months and 5 years. The second dose of MMR vaccine can be given at any time 4 to 8 weeks after the first dose. can also be given to adults at any age in case they have missed the vaccination in childhood and or there is no vaccination record available, by giving 2 doses of MMR with an interval of minimum 4 weeks.
- in adults can cause higher percentage of adverse reactions as compared to childhood vaccination.
- commonly encountered side reactions are unilateral or bilateral parotitis and fever. MMR vaccine can be safely and effectively given simultaneously with DTP, DT, TT, Td, BCG, Polio vaccine (OPV and IPV), Haemophilus influenzae type b, Hepatitis B, Yellow fever vaccine and vitamin A supplementation.

ADMINISTRATION AND DOSAGE

- reconstituted with the entire contents of the diluent supplied (Sterile water for injections) using a sterile syringe and needle. With gentle shaking the dried cake is easily dissolved. After reconstitution the vaccine should be used immediately. A single dose of 0.5 ml should be administered by deep subcutaneous injection into the anterolateral aspect of upper thigh in toddlers and upper arm in older children. If the vaccine is not used immediately then it should be stored in the dark at 2° - 8°C for no longer than 6 hours.
  The diluent and reconstituted vaccine should be inspected visually for any foreign particulate matter and / or variation of physical aspects prior to administration. In the event of either being observed, discard the diluent or reconstituted vaccine.

ADVERSE REACTIONS

- measles vaccine may cause within 24 hours of vaccination mild pain and tenderness at the injection site. In most cases, they spontaneously resolve within two to three days without further medical attention. A mild fever can occur in 5-15% of vaccinees 7 to 12 days after vaccination and last for 1-2 days.
  Rash occurs in approximately 2% of recipients, usually starting 7-10 days after vaccination and lasting 2 days. The mild side effects occur less frequently after the second dose of a measles-containing vaccine and tend to occur only in person not protected by the first dose. Encephalitis has been reported following measles vaccination at a frequency of approximately one case per million doses administered although a causal link is not proven.
  The mumps component may result in parotitis and low grade fever. Febrile seizures and orchitis may also occur. However, moderate fever occurs rarely and aseptic meningitis has been reported very rarely. Vaccine-associated meningitis resolves spontaneously in less than 1 week without any sequelae. The onset of aseptic meningitis is delayed, which may limit the ability to detect these cases by passive surveillance. Vaccine associated aseptic meningitis is observed between 15-35 days post immunization.
  The rubella component may commonly result in joint symptoms manifested as arthralgias (25%) and arthritis (10%) among adolescent and adult females that usually last from a few days to 2 weeks. However, such adverse reactions are very rare in children and in men receiving MMR vaccine (0%-3%). Symptoms typically begin 1-3 weeks after vaccination and last 1 day to 2 weeks. These transient reactions seem to occur in non-immunes only, for whom the vaccine is important. Low-grade fever and rash, lymphadenopathy, myalgia and paraesthesiae are commonly reported. Thrombocytopenia is rare and has been reported in less than 1 case per 30 000 doses administered. Anaphylactic reactions are also rare. Clinical experience has exceptionally recorded isolated reactions involving the CNS. These more serious reactions have however, not been directly linked to vaccination.

CONTRAINDICATIONS

- Pregnancy
- Leukaemia, lymphomatoses and other Malignant diseases.
- Severe febrile diseases.
- Therapy with Corticosteroids, radiation, cytostatic drugs and Gammaglobulins 3 months prior to vaccination and one and half to three months post-vaccination.
- History of febrile convulsions or impairment of CNS.
- History of known hypersensitivity to egg protein.
- The vaccine may contain traces of neomycin. Anaphylactic or anaphylactoid reactions to neomycin
- **HIV INFECTION**
  Tresivac may be used in children with known or suspected HIV infection. The vaccine is contraindicated in persons who are severely immunocompromised as a result of congenital disease, HIV infection, advanced leukaemia or lymphoma, serious malignant disease, or treatment with high-dose steroids, alkylating agents or anti-metabolites, or in persons who are receiving immunosuppressive therapeutic radiation

PRECAUTIONS

- Do not administer intravenously.
- **STORAGE**
  Store between +2°C and +8°C. Protect from light, for long term storage a temperature of -20°C is recommended for the vaccine. The diluent should not be frozen, but should be kept cool

THANK YOU

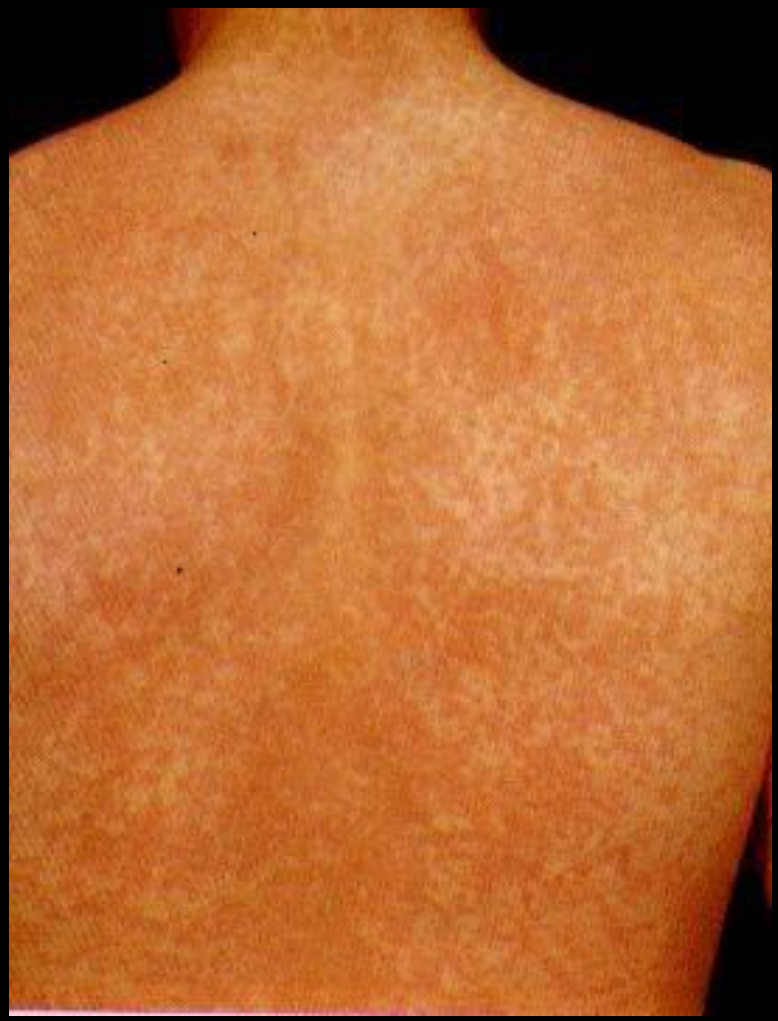
Rubella

- Acute Viral exanthematous disease
- Discovered in 18th century - thought to be variant of measles
- From Latin meaning "little red"
- First described in German literature
  - German Measles
  - Third Disease
  - Three day fever
- World wide in distribution
- Congenital rubella syndrome described by Gregg in 1941
- Teratogenic Virus

Rubella

Characterized by

- Acute onset of generalized maculopapular rash
- Fever &
- Arthralgia or arthritis, or lymph-adenopathy, or conjunctivitis



Rubella Epidemiology

- Reservoir — Human
- Transmission — Respiratory
  Subclinical cases may transmit
- Communicability — 7 days before to 14 days after rash onset

  Infants with CRS may shed virus for a year or more

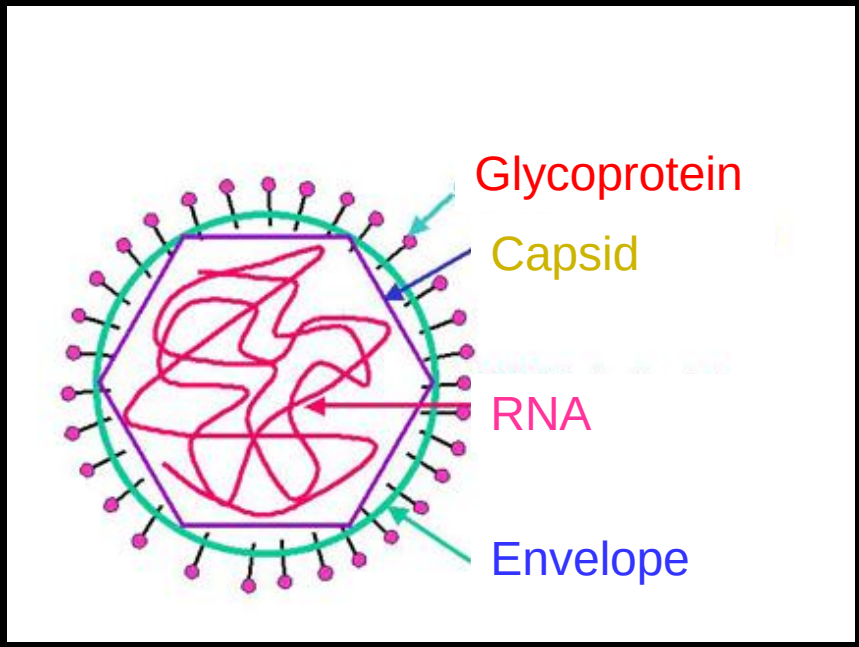
In developing Countries more than 95% of Children exposed to Rubella by 5 years of age

Ideal candidate for global eradication

Eradicated from most of the developed countries

Rubella Virus

- Family :Togaviridae
- Genus: Rubivirus
- Species: Rubella Virus



- Positive Strand ssRNA virus
- Icosahedral Symmetry
- One antigenic type

Rubella Virus

- Rapidly inactivated by chemical agents, low pH, heat and ultraviolet light.
- Grows in Vero and BHK cells
- DO not Produce CPE
- Identified by IFA / Interference assay
- Strictly Human Pathogen

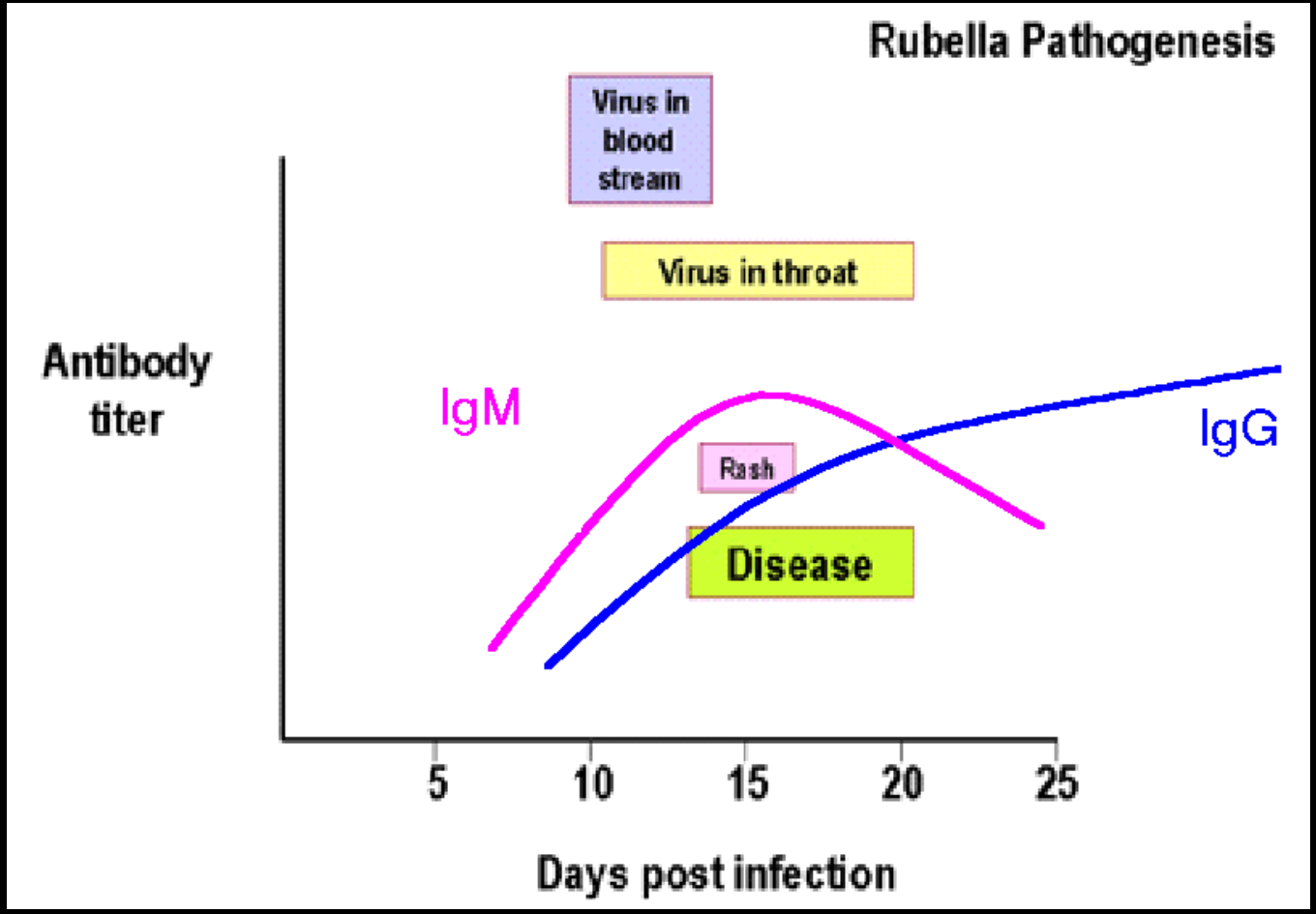
Rubella Pathogenesis

- Mode of Transmission – Respiratory Aerosol (Droplet Infection)
- Portal of Entry : Respiratory tract
- (Not arthropod borne viral disease)
- Incubation Period: 14 days (range 12-23 days)
- Communicable period: 7 days before onset of rash to 14 days post rash.

Rubella Pathogenesis

- Replication in nasopharynx and regional lymph nodes
- Viremia 5-7 days after exposure with spread to tissues
- Placenta and fetus infected during viremia
- Prodrome of low grade fever
- Lymphadenopathy in second week
- Maculopapular rash 14-17 days after exposure.
- Rash start from behind the ear and spread to face and downwards
- Subclinical infection in 90% cases
- Severe in Adults

Pathogenesis of Rubella



Rubella Complications

Arthralgia or arthritis	
children	**rare**
adult female	**up to 70%**
Thrombocytopenic purpura	**1/3000 cases**
Encephalitis	**1/6,000 cases**
Neuritis	**rare**
Orchitis	**rare**

Congenital Rubella Syndrome

- Infection may affect all organs
- May lead to fetal death or premature delivery
- Severity of damage to fetus depends on gestational age
- Up to 85% of infants affected if infected during first trimester
- Cellular destruction by Rubella virus
- Mitotic arrest – leads to Genetic defects

Congenital Rubella Syndrome

- Deafness (Sensorineural)
- Cataracts
- Heart defects
- Microcephaly
- Mental retardation
- Bone alterations
- Liver and spleen damage

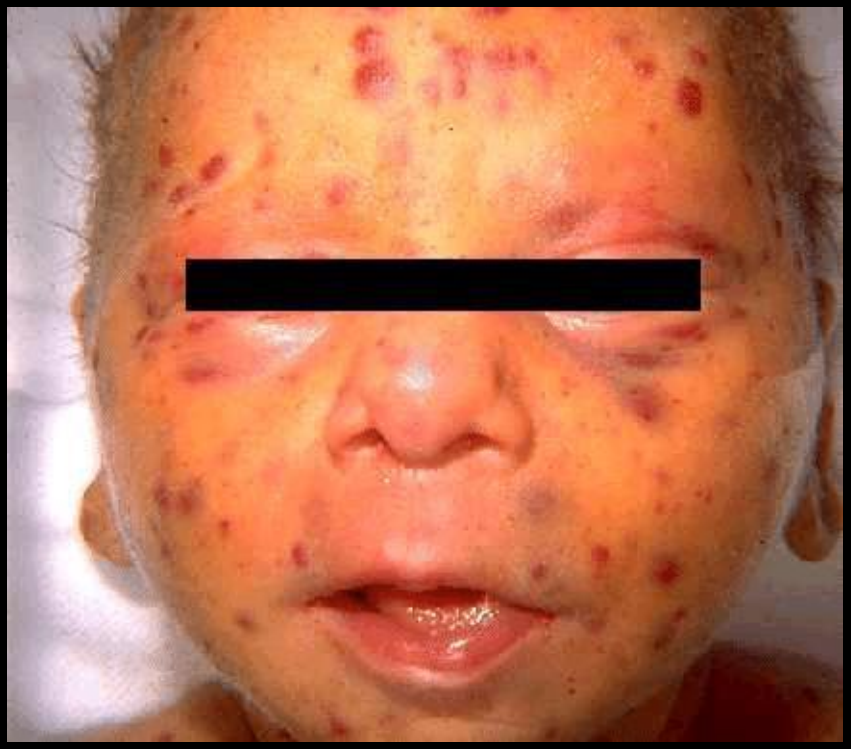
Classical triad

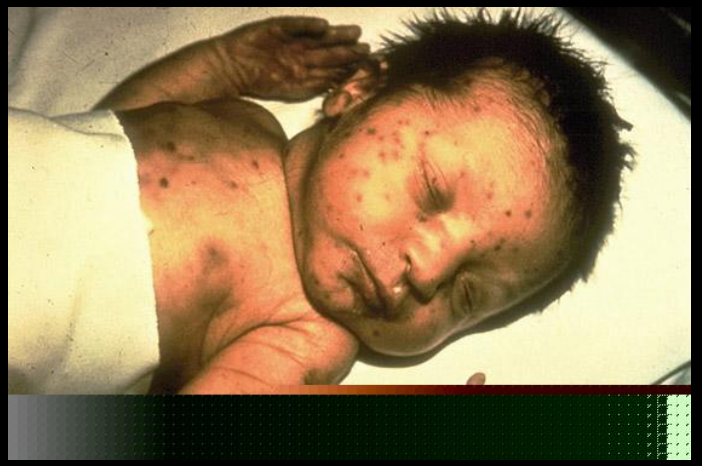
cataracts

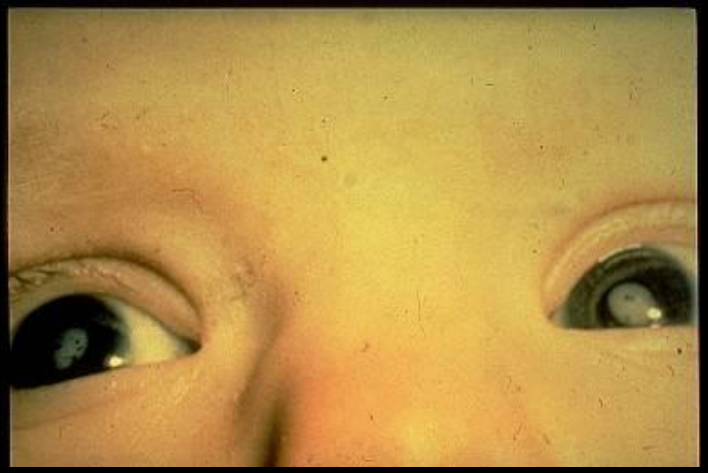
heart defects &

sensorineural deafness

Congenital Rubella Syndrome







Risks of rubella infection during pregnancy

Preconception	minimal risk
0-12 weeks	100% risk major congenital abnormalities. Spontaneous abortion - 20% of cases.
13-16 weeks	deafness and retinopathy 15%
after 16 weeks	normal development, slight risk of deafness and retinopathy

Laboratory Diagnosis

- Isolation of rubella virus from clinical specimen (e.g., nasopharynx, urine)
- Positive serologic test for rubella IgM antibody by ELISA
- Significant rise in rubella IgG by ELISA

Rubella Vaccine

- Available since 1969
- Live virus (RA 27/3 strain)

- Efficacy — 95% (Range, 90%-97%)
- Duration of Immunity — Lifelong
- Schedule — ≥1 Dose
- Should be administered with measles and mumps as MMR
- All infants >12 months of age
- Susceptible adolescents and adults
- Women of childbearing age

Viruses Associated with Respiratory Infections

Syndrome	Commonly Associated Viruses	Less Commonly Associated Viruses
Coryza	Rhinoviruses, Coronaviruses	Influenza and parainfluenza viruses, enteroviruses, adenoviruses
Influenza	Influenza viruses	Parainfluenza viruses, adenoviruses
Croup	Parainfluenza viruses	Influenza virus, RSV, adenoviruses
Bronchiolitis	RSV	Influenza and parainfluenza viruses, adenoviruses
Bronchopneumonia	Influenza virus, RSV, Adenoviruses	Parainfluenza viruses, measles, VZV, CMV