

Airborne Viral Diseases

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Airborne Diseases

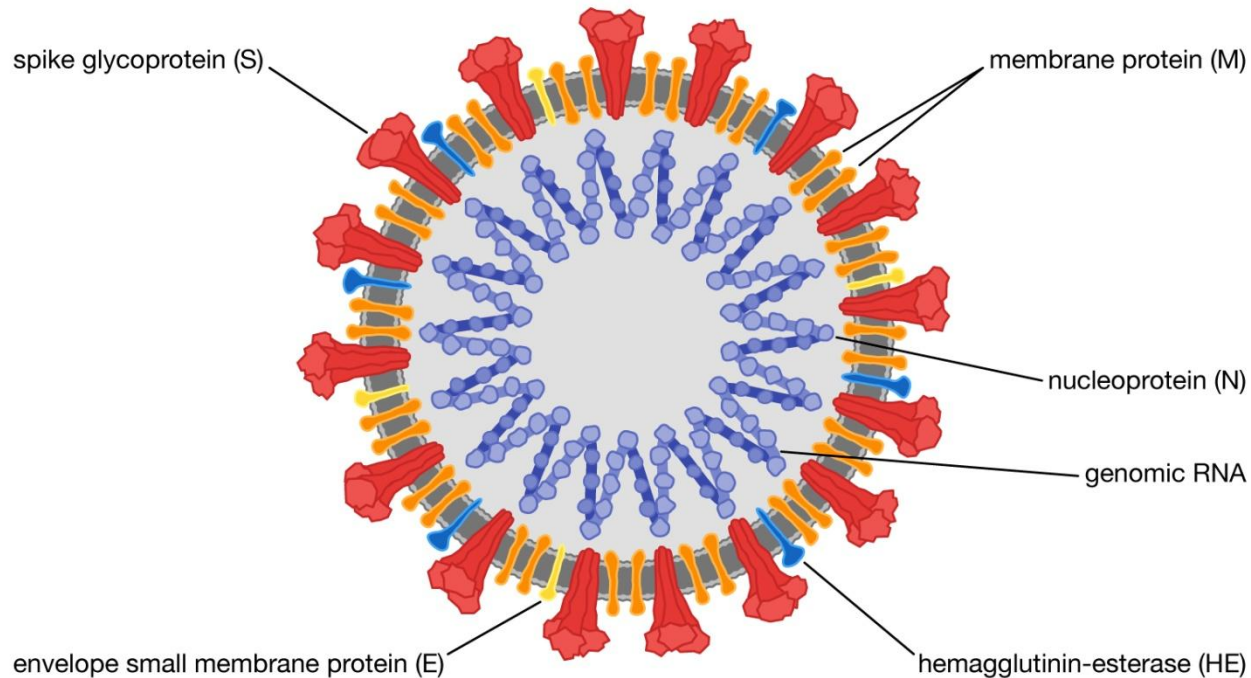
- Because air does not support virus growth, any virus that is airborne must have originated from a source such as another human.
- When humans are the source of the airborne virus, it usually is propelled from the respiratory tract by an individual's coughing, sneezing, or vocalizing.
- Examples:
 - COVID-19
 - Chickenpox (Varicella) and Shingles (Zoster)
 - Influenza (Flu)
 - Measles (Rubeola)
 - Mumps
 - Respiratory Syndromes and Viral Pneumonia
 - Rubella (German Measles)
 - Smallpox (Variola)

COVID-19

Caused by: a novel coronavirus, SARS-CoV-2 (formerly called 2019-nCoV) reported in December 31, 2019 from Wuhan, China

- Corona viruses are a large family of viruses that causes illness ranges from common cold to more severe diseases such as **Severe Acute Respiratory Syndrome (SARS-CoV)**, transmitted from civet cats, reported in 2003) and **Middle East Respiratory Syndromes (MERS-CoV)**, transmitted from dromedary camels, reported in 2012).

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)



COVID-19

Transmission: possible modes of transmission for SARS-CoV-2, including contact, droplet, airborne, fomite, fecal-oral, bloodborne, mother-to-child, and animal-to-human transmission.

Incubation period: 1-27 days

Recovery time: 3 to 6 weeks

Symptoms: Infection with SARS-CoV-2 primarily causes respiratory illness ranging from mild to severe disease and death, and some infected people never develop symptoms.

- The most common symptoms of COVID-19 include:
 - Fever (77-98%),
 - Cough (46%-82%),
 - Myalgia or fatigue (11-52%)
 - shortness of breath (3-31%)
- Less common symptoms – sore throat, headache, cough with sputum production and/or haemoptysis

Chickenpox (Varicella) and Shingles (Zoster)

- Chickenpox (varicella) is a highly contagious skin disease primarily of children 2 to 7 years of age.
- **Caused by:** varicella-zoster virus, a member of the family *Herpesviridae*
- **Transmission:** acquired by droplet inhalation into the respiratory system.
- **Symptoms:** Following an incubation period of from 10 to 23 days, small vesicles erupt on the face or upper trunk, fill with pus, rupture, and become covered by scabs .
- Healing of the vesicles occurs in about 10 days.
- **Treatment:** Chickenpox can be prevented or the infection shortened with an attenuated varicella vaccine (Varivax) or the drug acyclovir (Zovirax or Valtrex).

Chickenpox Pathogenesis & Symptom

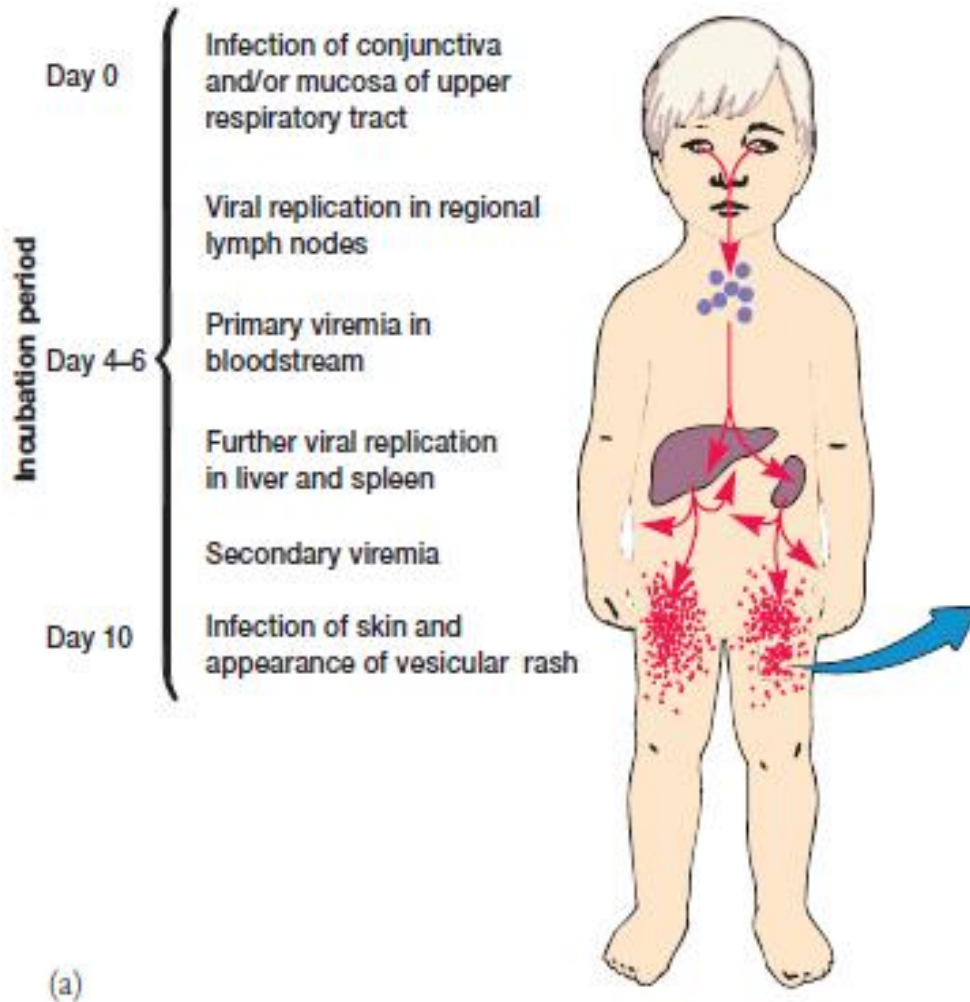


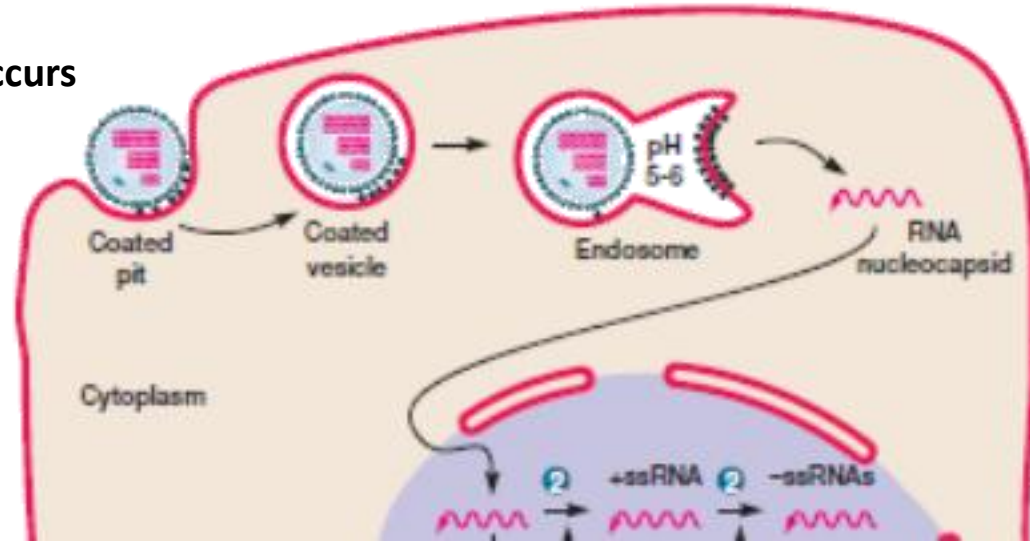
Figure Chickenpox (Varicella). (a) Pathogenesis. (b) Typical vesicular skin rash. This rash occurs all over the body, but is heaviest on the trunk and diminishes in intensity toward the periphery.

Influenza (Flu)

- **Caused by:** orthomyxoviruses.
- Influenza viruses are classified into A, B, and C groups based on the antigens (H and N) of their protein coats.
- One unique feature of the influenza viruses is the frequency with which changes in antigenicity occur.
- These changes are called antigenic variation.
 - If the variation is small, it is called antigenic drift
 - if it is large, it is called antigenic shift. Recombination between human and avian strains thus occurs in pigs, leading to major antigenic shifts.
- Antigenic variation occurs almost yearly with the influenza A virus, less frequently with the B virus, and has not been demonstrated with the C virus.

... Influenza (Flu)

- **Pathogenesis:** The virus *is acquired by inhalation* or ingestion of virus-contaminated respiratory secretions.
- During an incubation period of 1 to 2 days, the virus adheres to the epithelium of the respiratory system (the neuraminidase present in envelope spikes may hydrolyze the mucus that covers the epithelium).
- The virus attaches to the epithelial cell by its hemagglutinin spike protein, causing part of the cell's plasma membrane to bulge inward, seal off, and form a vesicle (receptor-mediated endocytosis). This encloses the virus in an endosome.
- The hemagglutinin molecule in the virus envelope undergoes a dramatic conformational change when the endosomal pH decreases.
- The hydrophobic ends of the hemagglutinin spring outward and extend toward the endosomal membrane.
- After they contact the membrane, fusion occurs and the RNA nucleocapsid is released into the cytoplasmic matrix.



...Influenza (Flu)

Symptoms: chills, fever, headache, malaise, and general muscular aches and pains.

- These symptoms arise from the death of respiratory epithelial cells, probably due to attacks by activated T cells.
- Recovery usually occurs in 3 to 7 days, during which coldlike symptoms appear as the fever subsides.
- Influenza alone usually is not fatal. However, death may result from pneumonia caused by secondary bacterial invaders such as *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Haemophilus influenzae*.

Diagnosis: A commercially available identification technique is Directigen FLU-A (an enzyme immunoassay [EIA] rapid test).

Treatment: As with many other viral diseases, only the symptoms of influenza usually are treated.

- However, the antiviral drugs have been shown to reduce the duration and symptoms of type influenza if administered during first two days of illness:
 - amantadine (Symmetrel),
 - rimantadine (Flumadine),
 - zanamivir (Relenza),
 - oseltamivir (Tamiflu)

Respiratory Syndromes and Viral Pneumonia

- **Caused by:** The infectious agents are called the acute respiratory viruses (The adenoviruses, coxsackievirus A, coxsackievirus B, echovirus, influenza viruses, parainfluenza viruses, poliovirus, respiratory syncytial virus, and reovirus)
- **Symptoms:** collectively produce a variety of clinical manifestations, including rhinitis (inflammation of the mucous membrane of the nose), tonsillitis, laryngitis, and bronchitis.
- **Respiratory syncytial virus (RSV)** often is described as the most dangerous cause of lower respiratory infections in young children.

RSV and Viral Pneumonia

- The **RSV** is a member of the RNA virus family, *Paramyxoviridae*.
- It is a negative single-stranded RNA virus that is enveloped with two virally specific glycoproteins as part of the structure.
 - the large glycoprotein or G, is responsible for the binding of the virus to the host cell.
 - The other, the fusion protein or F, permits fusion of the viral envelope with the host cell plasma membrane, leading to entry of the virus.
- The F protein also induces the fusion of the plasma membranes of infected cells.
- RSV thus gets its name from the resulting formation of a syncytium or multinucleated mass of fused cells.
- The multinucleated syncytia are responsible for inflammation, alveolar thickening, and the filling of alveolar spaces with fluid.
- The source of the RSV is hand contact and respiratory secretions of humans.
- **Symptoms:** an acute onset of fever, cough, rhinitis, and nasal congestion.
- In infants and children, often progresses to severe bronchitis and viral pneumonia.
- **Diagnosis** is by either Directigen RSV or Test-Pack RSV rapid test kits.
- **Treatment** is with inhaled ribavirin (Virazole).
- A recently developed series of antibody (RSV-immune globulin) injections has been shown to reduce the severity of this disease in infants by 75%.
- Prevention and control consists of isolation for RSV-infected individuals.

Smallpox (variola)

Causal organism: The variola virus belongs to the family *Poxviridae*.

- The virion is large, brick-shaped, and contains a dumbbell-shaped core.
- The genome consists of a single linear molecule of double-stranded DNA.

Transmission: Variola was transmitted between humans by aerosol or contact.

Symptoms: The virus produced a severe fever, prostration, and rash.

- Toxemia and septic shock led to case fatality rates of up to 30%.
- The infection progressed from a skin rash that developed through stages of macule, papule, vesicle, and pustule .

Fully eradicated: Since the advent of immunization with the vaccinia virus, and because of concerted efforts by the World Health Organization, the disease smallpox has been eradicated throughout the world. (The last case from a natural infection occurred in Somalia in 1977.)

- This was possible because a disease such as smallpox has obvious clinical features, virtually no asymptomatic carriers, only a human reservoir, and a short period of infectivity (3 to 4 weeks).
- The virus, however, is still kept in two locations: the CDC in Atlanta, Georgia, and the Russian State Center for Research on Virology and Biotechnology, Koltsovo, Novosibirsk region, Russia.

Water borne viral disease

Gastroenteritis (Viral)

Caused by: four major categories of viruses: rotaviruses, Norwalk and Norwalk-like viruses, other caliciviruses, and astroviruses.

Transmission: The viruses responsible for gastroenteritis are probably transmitted by the fecal-oral route.

- Infection is most common during the cooler months in contrast to bacteria-caused diarrheal diseases, which usually occur in the warmer months of the year.

Pathogenesis: seen most frequently in infants 1 to 11 months of age.

- The virus attacks the upper intestinal epithelial cells of the villus, causing malabsorption, impairment of sodium transport, and diarrhea.

Symptoms: The clinical manifestations range from asymptomatic to a relatively mild diarrhea with headache and fever to a severe and occasionally fatal dehydrating disease.

- Vomiting is almost always present.

Treatments: Viral gastroenteritis is usually self-limited.

- Treatment is designed to provide relief through the use of oral fluid replacement with isotonic liquids, analgesics, and antiperistaltic agents.

Hepatitis A

Caused by: the hepatitis A virus (HAV).

- HAV has recently been reclassified as the type species of a new genus (Hepatovirus) in the family Picornaviridae.
- The hepatitis A virus is an icosahedral, single-stranded linear, positive-sense RNA virus that lacks an envelope.

Transmission: by fecal-oral contamination of food, drink, or shellfish that live in contaminated water and contain the virus in their digestive system.

Pathogenesis: Once in the digestive system, the viruses multiply within the intestinal epithelium.

- Usually only mild intestinal symptoms result.
- Occasionally viremia (the presence of viruses in the blood) occurs and the viruses may spread to the liver.
- The viruses reproduce in the liver, enter the bile, and are released into the small intestine.

... Hepatitis A

Symptoms: Symptoms last from 2 to 20 days and include anorexia, general malaise, nausea, diarrhea, fever, and chills.

- If the liver becomes infected, jaundice ensues.
- Most cases resolve in 4 to 6 weeks and yield a strong immunity.

Diagnosis: by detection of the hepatitis A antibody.

Treatments: Control of infection is by simple hygienic measures, the sanitary disposal of excreta, and the killed HAV vaccine (Havrix).

- This vaccine is recommended for travelers going to regions with high evidence rates of hepatitis A.

Hepatitis E

Caused by: The genomic organization suggests it is the prototype human pathogen for a new class of single-stranded linear RNA viruses or perhaps a separate genus within the family *Caliciviridae*.

Transmission: Infection usually is associated with feces-contaminated drinking water.

Pathogenesis: Presumably HEV enters the blood from the gastrointestinal tract.

- Replicates in the liver, is released from hepatocytes into the bile, and is subsequently excreted in the feces.

... Hepatitis E

Symptoms: Like hepatitis A, an HEV infection usually runs a benign course and is self-limiting.

- One exception is that at least 10% of women infected in their last 3 months of pregnancy die of fulminant hepatic failure.

Diagnosis: Antibody assay systems using HEV cDNA products.

Treatments: There are no specific measures for preventing HEV infections other than those aimed at improving the level of health and sanitation in affected areas.

Poliomyelitis

- **Caused by:** Poliomyelitis [Greek *polios*, *gray*, and *myelos*, *marrow or spinal cord*], polio, or infantile paralysis is caused by the poliovirus, a member of the family *Picornaviridae*.
- The poliovirus is a plus-stranded RNA virus with three different serotypes—1, 2, and 3.
- **Transmission:** The virus is very stable and can remain infectious for relatively long periods in food and water—its main routes of transmission.
- **Pathogenesis & Symptoms:** Once ingested, the virus multiplies in the mucosa of the throat and/or small intestine.
- From these sites the virus invades the tonsils and lymph nodes of the neck and terminal portion of the small intestine.
- Generally, there are either no symptoms or a brief illness characterized by fever, headache, sore throat, vomiting, and loss of appetite.
- The virus sometimes enters the bloodstream and causes a viremia.
- In most cases (> 99%), the viremia is transient and clinical disease does not result.
- In the minority of cases (less than 1%), the viremia persists and the virus enters the central nervous system and causes paralytic polio.
- The virus has a high affinity for anterior horn motor nerve cells of the spinal cord.
- Once inside these cells, it multiplies and destroys the cells; this results in motor and muscle paralysis.

... Poliomyelitis

Treatments: Since the arrival of the formalin-inactivated Salk vaccine (1954) and the attenuated virus Sabin vaccine (1962), the incidence of polio has decreased markedly.

- There are fewer than 10 cases per year, and no endogenous reservoir of polioviruses exists in the United States.
- However, there is a continuing need for vaccination programs in all population groups to limit the spread of poliovirus when it is introduced from other countries.
- In developing countries, 4 of every 1,000 children born annually have paralytic disease caused by the poliovirus.
- Prevention and control is by vaccination;
- Global eradication of polio is possible in the next few years.