

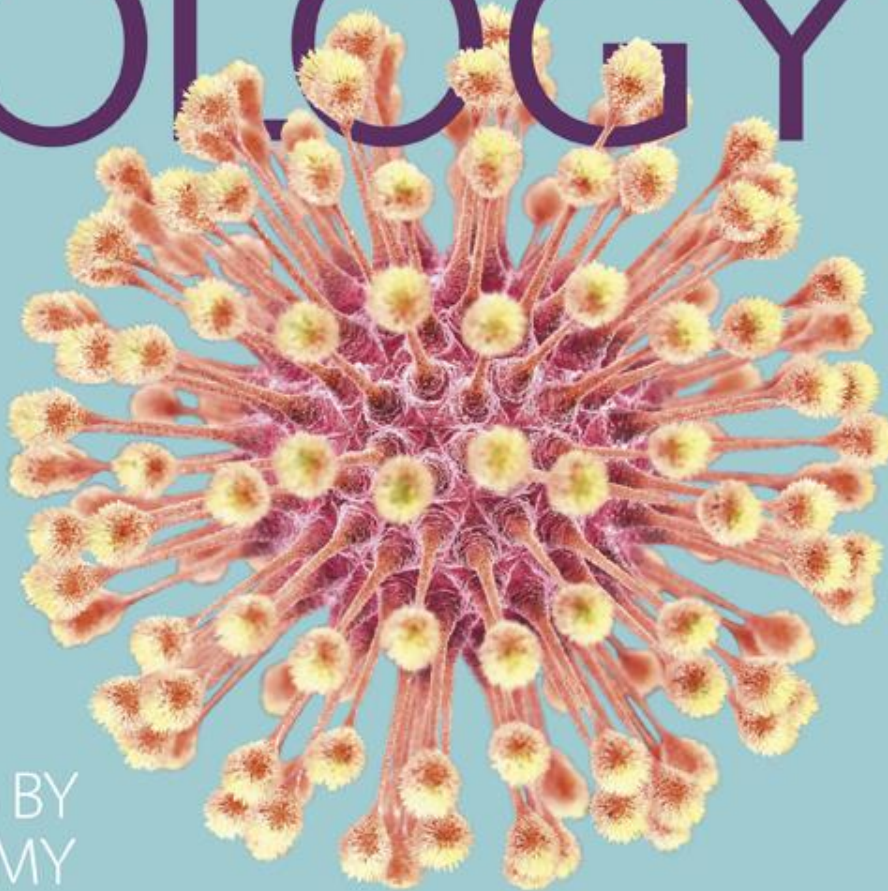
Chapter 25 – Pathogenic RNA Viruses

NIMESH PATEL | HLSC 2400

NOVEMBER 30, 2017

MICROBIOLOGY

5th Edition



WITH
DISEASES BY
TAXONOMY

ROBERT W. BAUMAN

PowerPoint® Lecture
Presentations prepared by
Mindy Miller-Kittrell,
North Carolina State
University

CHAPTER 25

Pathogenic RNA Viruses

Enveloped, Positive ssRNA Viruses with Reverse Transcriptase

- **Immunosuppressive Retroviruses (*Lentivirus*) and Acquired Immunodeficiency Syndrome**
 - Diagnosis, Treatment, and Prevention
 - Prevention
 - Behavioral changes slow progression of AIDS epidemics
 - **Abstinence, mutually faithful monogamy**, and safe sex
 - Use of clean needles
 - Providing antiviral drugs to infected pregnant women
 - Screening of blood products
 - Use of protective wear to prevent contact with blood
 - Circumcision reduces infection through sexual activity
 - Pre-exposure prophylaxis
 - Use of tenofovir gel vaginally before and after sex

Enveloped, Unsegmented Negative ssRNA Viruses

- *Paramyxoviridae*
 - Multinucleate syncytia enable virus to evade the immune system
 - Four genera infect humans:
 - *Morbillivirus* (measles virus)
 - *Respirovirus* (parainfluenza viruses)
 - *Rubulavirus* (mumps virus)
 - *Pneumovirus* (respiratory syncytial virus)
- *Rhabdoviridae*
 - Include a variety of plant and animal pathogens
 - Rabies is the most significant pathogen
- *Filoviridae*
 - Cause a number of emerging diseases

Enveloped, Unsegmented Negative ssRNA Viruses

- **Measles**
 - One of five classical childhood diseases
 - Also called *rubeola*
 - One of the more contagious childhood infections
 - Causes more serious disease than rubella

Table 25.7 A Comparison of Measles and Rubella

TABLE 25.7 A Comparison of Measles and Rubella					
Disease	Causative Agent	Primary Patient(s)	Complications	Skin Rash	Koplik's Spots
Measles (also known as rubeola and red measles)	Paramyxoviridae: Morbillivirus measles virus	Child	Pneumonia, encephalitis, subacute sclerosing panencephalitis	Extensive	Present
Rubella (also known as German measles and three-day measles)	Togaviridae: Rubivirus rubella virus	Child, fetus	Birth defects	Mild	Absent

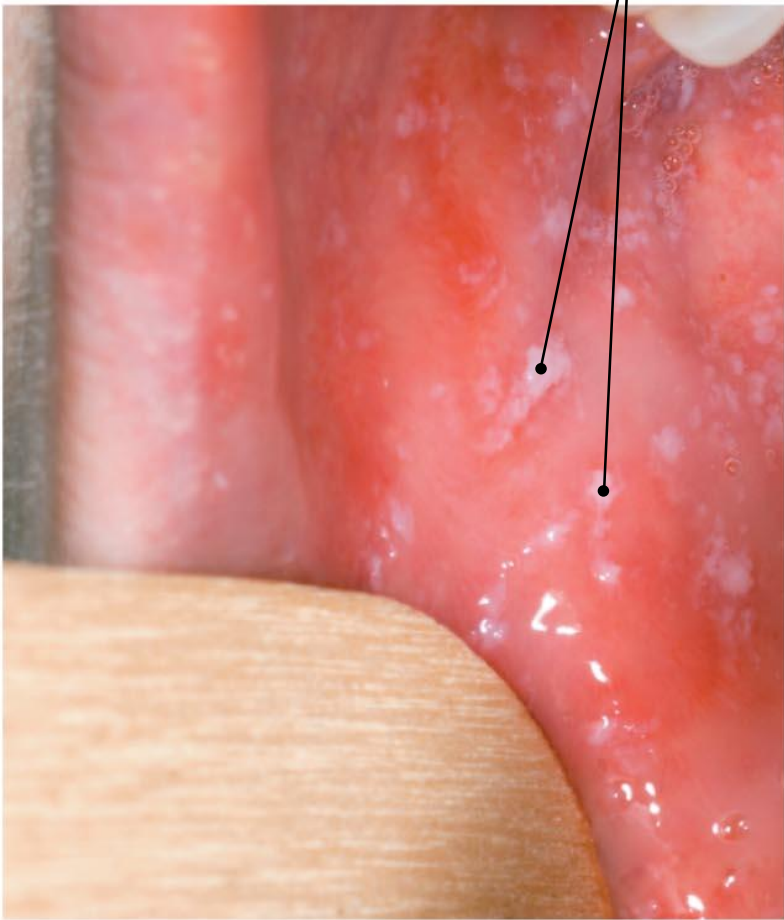
Enveloped, Unsegmented Negative ssRNA Viruses

- **Measles**

- Epidemiology
 - Spread in the air via respiratory droplets
 - Viral spread requires large, dense populations of people
 - Viruses infect the respiratory tract, then spread throughout body
 - **Koplik's spots** appear on the mucous membrane of the mouth
 - Provide a definitive sign of measles
 - Lesions then appear on the head and spread over the body
 - Rare complications of measles can result
 - Pneumonia, encephalitis, and **subacute sclerosing panencephalitis (SSPE)**
 - SSPE: Personality changes, memory loss, muscle spasm, blindness
 - Vaccine had eliminated endemic measles
 - Measles cases have recently reemerged

Figure 25.25 Signs of measles.

Koplik's spots

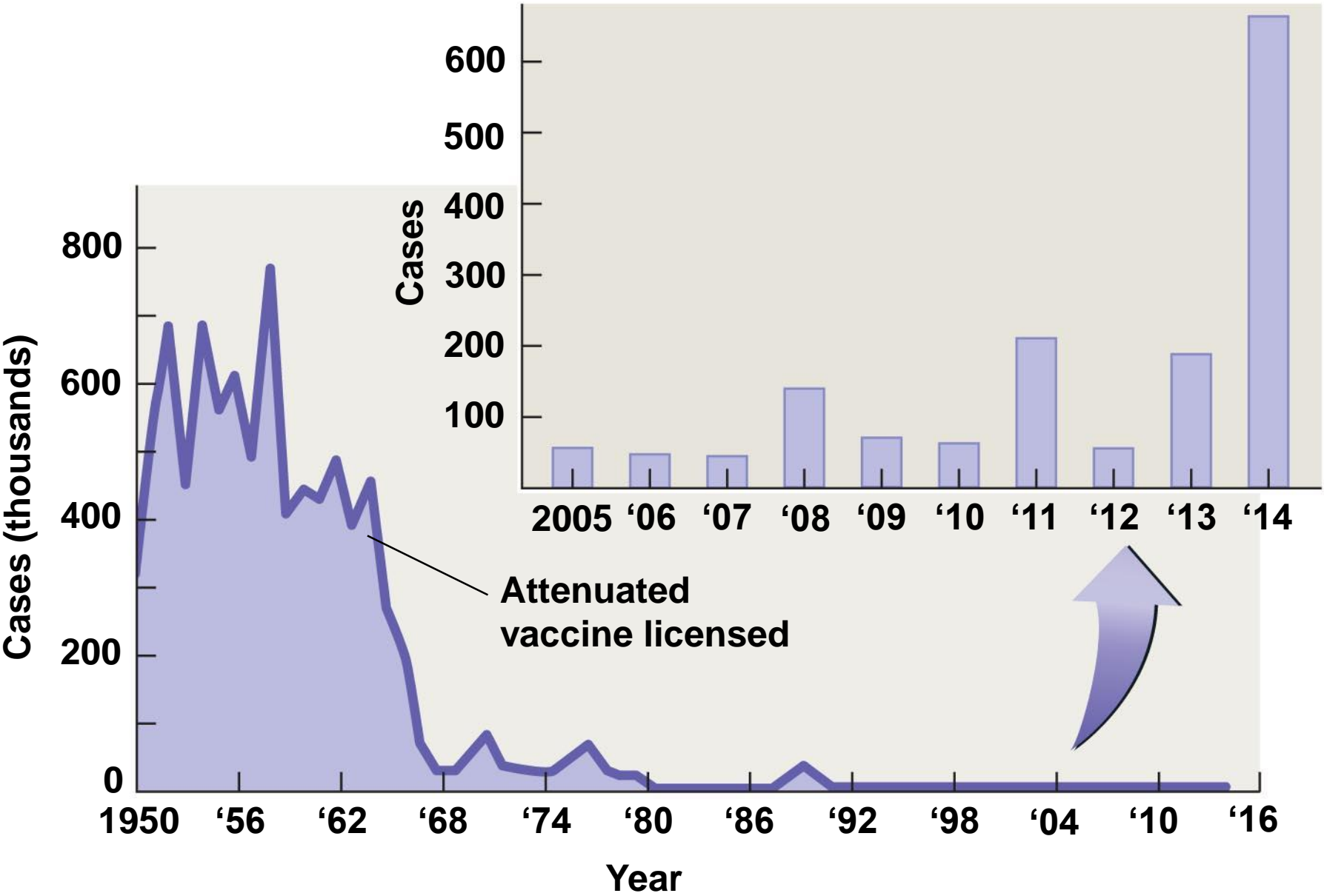


(a)



(b)

Figure 25.26 Measles cases in the United States since 1950.



Enveloped, Unsegmented Negative ssRNA Viruses

- **Measles**

- Diagnosis, Treatment, and Prevention

- Diagnosis

- Signs of measles, particularly Koplik's spots, are diagnostic

- Treatment

- Anti-measles immunoglobulin can prevent disease when administered soon after exposure

- Prevention

- Vaccine administered in infancy and again before grade school
 - Infective 4 days before to 4 days after the onset of rash

Enveloped, Unsegmented Negative ssRNA Viruses

- **Diseases of Parainfluenza Virus**

- Four parainfluenza viruses (HPIV) cause respiratory tract disease
- Children are particularly susceptible
- Transmitted via respiratory droplets and person-to-person contact
- HPIV-1, 2, and 3 associated with lower respiratory infections
- HPIV-4 causes mild upper respiratory tract infections

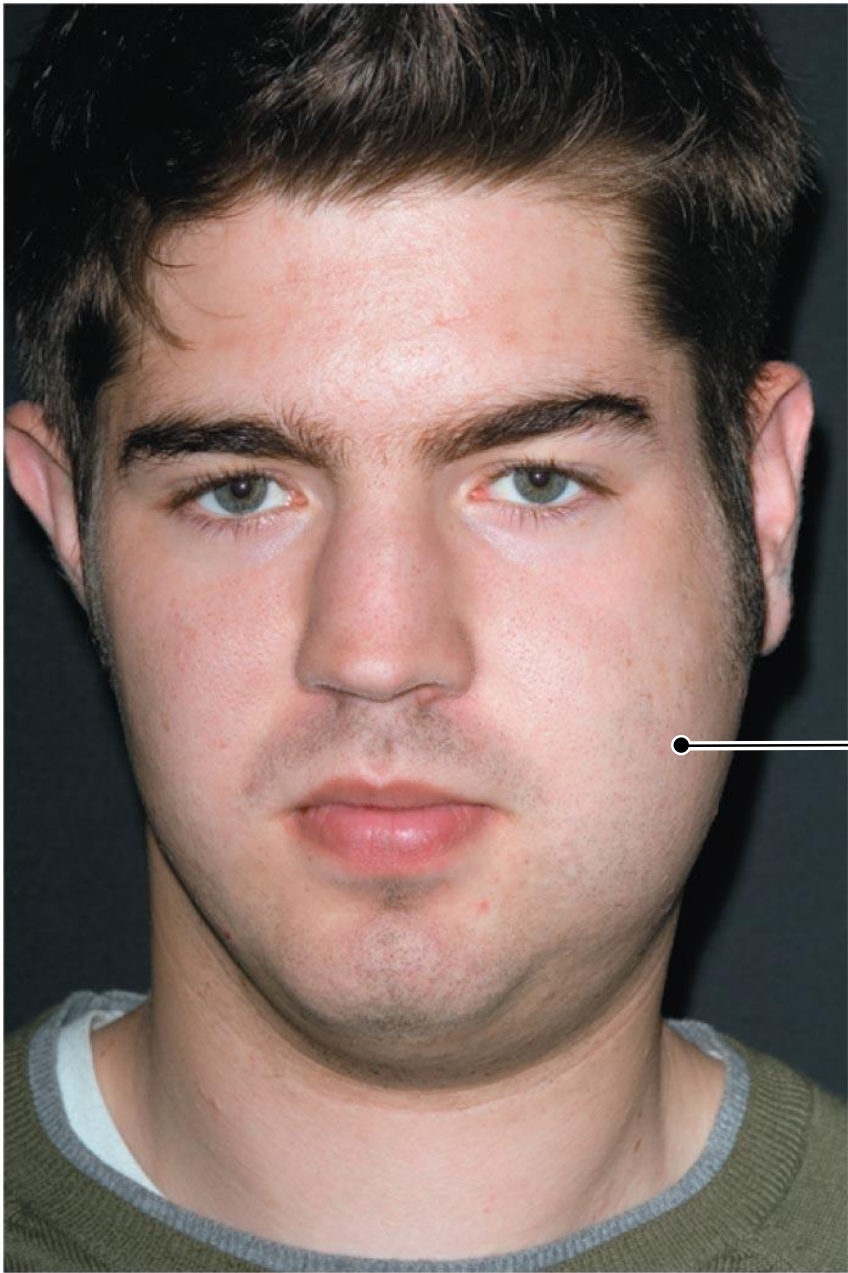
- **Croup**

- Severe condition caused by HPIV-1 and HPIV-2
 - Characterized by inflammation of larynx, trachea, and bronchi
- Most patients recover from infection within two days
- No antiviral treatment available
- *Intubation* may be needed if airways become occluded

Enveloped, Unsegmented Negative ssRNA Viruses

- **Mumps**
 - Mumps virus is the causative agent
 - Transmission occurs via **respiratory** secretions
 - Viruses infect upper respiratory system and spread to other organs
 - **Parotitis** results
 - Painful enlargement of the parotid salivary glands
 - Orchitis, **meningitis, pancreatitis, or deafness in one ear** can occur
 - Infection may also be asymptomatic
 - Recovery is typically complete
 - **No specific treatment** is available
 - **Vaccine** has almost eradicated mumps in the industrialized world

Figure 25.27 Parotitis.

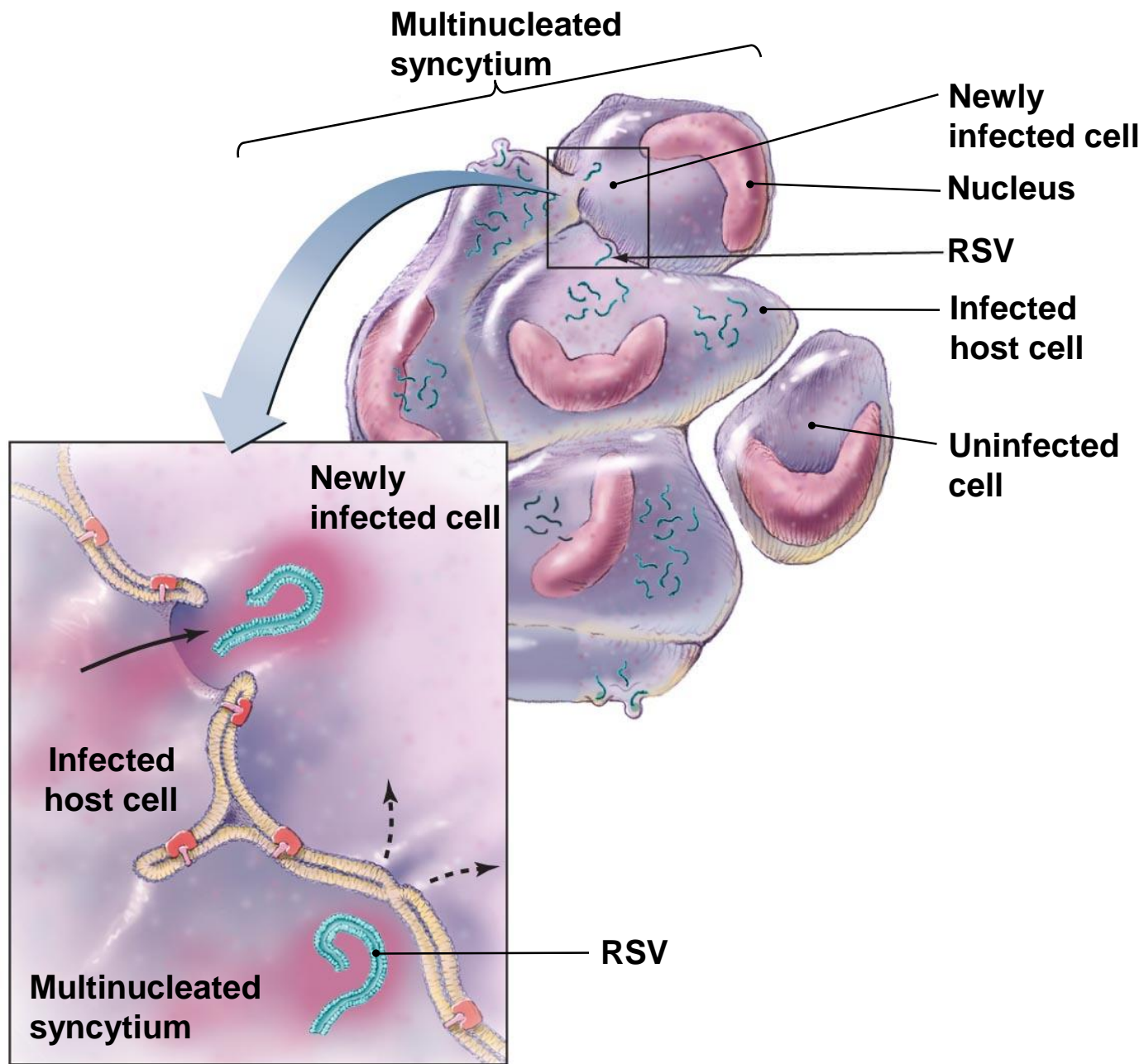


Parotid salivary gland

Enveloped, Unsegmented Negative ssRNA Viruses

- **Disease of Respiratory Syncytial Virus (RSV)**
 - RSV causes a disease of the lower respiratory tract
 - The virus causes syncytia formation in the lungs
 - Infection can also result in difficult breathing known as *dyspnea*
 - Leading cause of fatal respiratory disease in infants and children
 - Infection is asymptomatic or a mild cold in older children and adults
 - Immune response contributes to the damage to the lungs

Figure 25.29 A syncytium forms when RSV triggers infected cells to fuse with uninfected cells.



Enveloped, Unsegmented Negative ssRNA Viruses

- **Disease of Respiratory Syncytial Virus**
 - Epidemiology
 - RSV is prevalent in the U.S.
 - Virus transmitted via fomites, hands, and respiratory droplets
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Diagnosis based on the signs of respiratory distress
 - Verified by serological testing
 - Treatment
 - Treatment is supportive
 - Prevention
 - Frequent handwashing by nursery and health care workers

Enveloped, Unsegmented Negative ssRNA Viruses

- **Rabies**

- Rabies virus is the causative agent
- Virus attaches to nerve cells and travels to central nervous system
 - Infection causes spinal cord and brain degeneration
 - Develop neurological manifestations characteristic of rabies
 - **Hydrophobia**, seizures, disorientation, hallucination, and paralysis
- Death results from respiratory paralysis and other complications

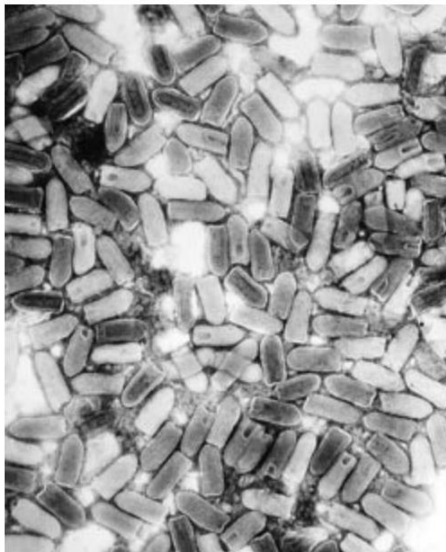
Enveloped, Unsegmented Negative ssRNA Viruses

- **Rabies**

- Epidemiology
 - Classical zoonotic disease of mammals
 - Primary reservoir of rabies in urban areas is the dog
 - Bats are the source of most cases of rabies in humans
 - Transmission usually occurs via a bite
 - Virus sometimes introduced through break in the skin or inhalation



Rabies



Rabies is also known as hydrophobia, because one of the symptoms is paralysis of the throat muscles leading to a fear of water. This viral encephalitis is spread by infected mammals. Dogs are responsible for most of the cases worldwide; in B.C., bats are currently the only known reservoir. Bats and other wild animals deserve our respect, and should not be touched or bothered, which can lead to potentially harmful contacts. The disease can be

prevented by vaccination, but the best prevention is avoidance.

Enveloped, Unsegmented Negative ssRNA Viruses

- **Rabies**

- Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Neurological symptoms of rabies are usually sufficient
 - Too late to intervene once symptoms and antibodies occur
 - Postmortem tests can identify **Negri bodies** in the brain
 - Treatment
 - Treatment of the site of infection
 - Injection of *human rabies immune globulin (HRIG)*
 - Vaccination with *human diploid cell vaccine (HDCV)*
 - Prevention
 - Vaccination of domestic dogs and cats helps control rabies

Enveloped, Segmented Negative ssRNA Viruses

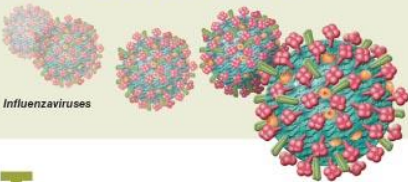
- **Influenza**

- Caused by orthomyxovirus types A and B
- Genome consists of eight different ssRNA molecules
- Envelope studded with two glycoproteins important for attachment
 - Neuraminidase (NA)
 - Provides virus access to cell surface by hydrolyzing mucus in the lungs
 - Hemagglutinin (HA)
 - Attaches to pulmonary epithelial cells and triggers endocytosis
- Mutations in HA and NA result in new influenzavirus strains

DISEASE
IN DEPTH

SIGNS & SYMPTOMS

INFLUENZA

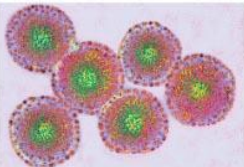


Two strains of orthomyxoviruses, designated types A and B, cause influenza. The flu is a common respiratory disease, second in prevalence only to common colds, yet it has characteristics that can produce devastating epidemics.

VIRULENCE FACTORS

Each flu virion is segmented, having eight different $-ssRNA$ molecules, and is surrounded by an envelope studded with prominent glycoprotein spikes composed of either hemagglutinin (HA) or neuraminidase (NA). Both HA and NA play roles in attachment: NA spikes provide the virus access to cell surfaces by hydrolyzing mucus in the lungs, whereas HA spikes bind to pulmonary epithelial cells and trigger endocytosis.

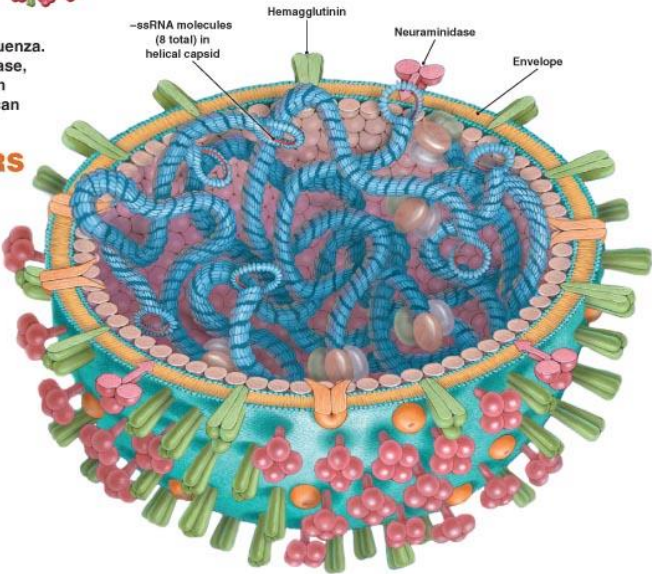
Scientists name influenza A viruses for the type of glycoproteins they have. For example, influenzavirus H5N1 has hemagglutinin subtype five and neuraminidase subtype one.



Avian influenzaviruses



Following infection, influenza has an incubation period of about one day. The signs and symptoms of influenza usually include sudden fever between 39°C and 41°C ($102\text{--}106^{\circ}\text{F}$), pharyngitis, congestion, dry cough, malaise, headache, and myalgia. Fever distinguishes a flu from a common cold. Most people recover in one to two weeks.

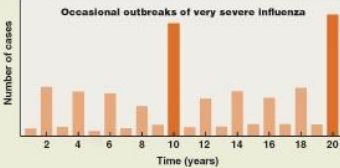


EPIDEMIOLOGY

INVESTIGATE IT!

Scan this QR code to watch Dr. Bauman's Video Tutor explore influenza. Then go to *MasteringMicrobiology* to investigate further and record your research findings on the following question:

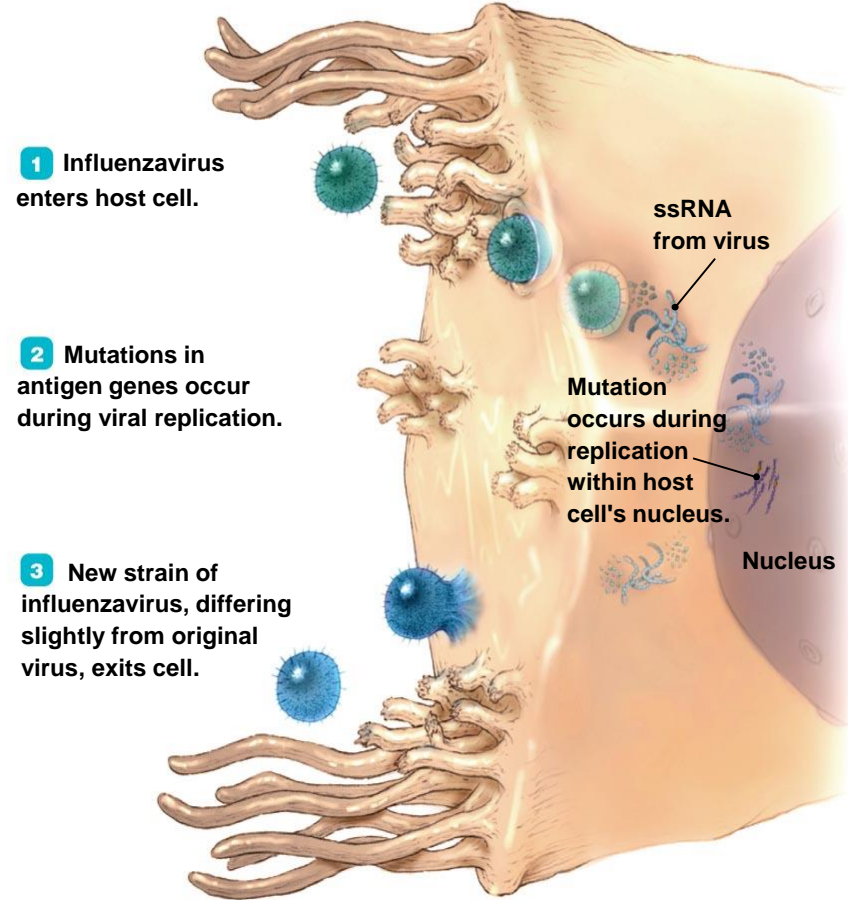
How can a student distinguish the flu from a common cold?



People who get the flu one year are immunologically protected the next year from similar strains resulting from antigenic drift; thus, the total number of cases is typically lower every other year. However, antigenic shift results in major changes in antigens every ten years, so epidemics occur about once a decade. Epidemiologists are concerned that a deadly pandemic of influenza A virus could reoccur if genes for antigens similar to those of the 1918 flu virus should combine in a new virus by antigenic shift. A virus of concern is H5N1, which kills more than 60% of people who contract the virus from birds. Another virus, H7N9, is resistant to all anti-flu drugs approved by the U.S. Food and Drug Administration.

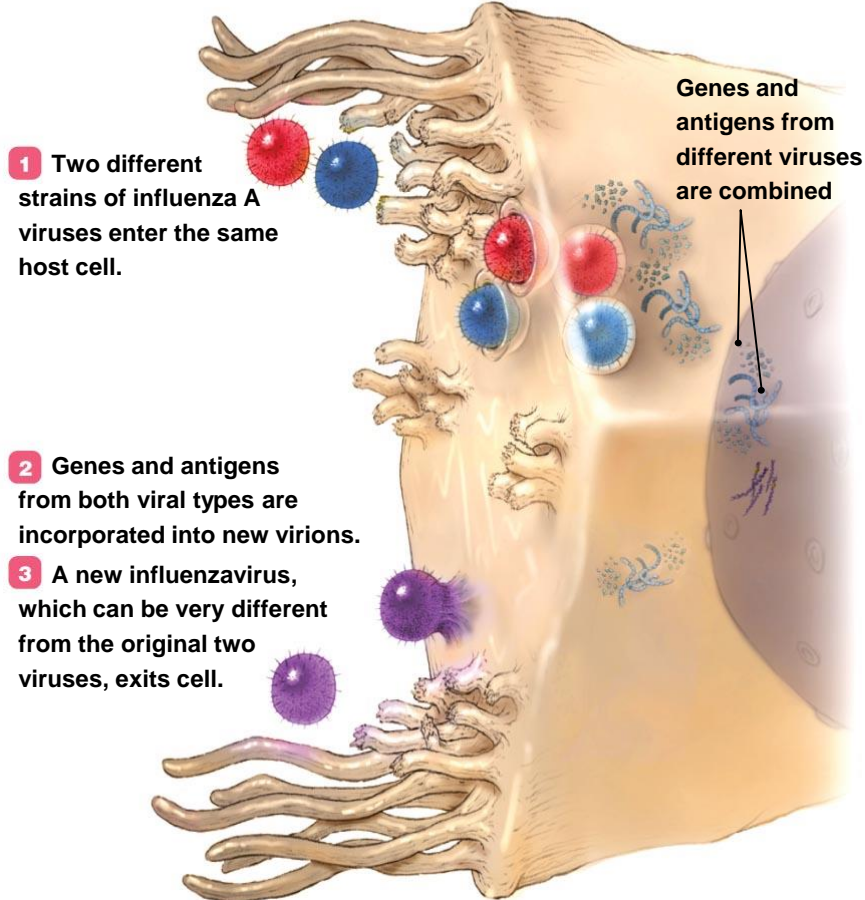
ANTIGENIC DRIFT

Mutations and recombinations in the genes coding for HA and NA spikes are responsible for the production of new strains of influenza A and B viruses via processes known as antigenic drift and antigenic shift.



ANTIGENIC SHIFT

Antigenic shift by influenza A virus occurs about once a decade. Influenza B virus does not undergo antigenic shift.



Enveloped, Segmented Negative ssRNA Viruses

- **Influenza**

- Signs and Symptoms
 - Symptoms include fever, malaise, headache, and myalgia
- Pathogenesis
 - Influenzaviruses enter the body via the respiratory route
 - Incubation period is about one day
 - Viruses multiply in epithelial cells lining the lung
 - Death of infected epithelial cells eliminate the lungs' epithelial lining
 - Patients more susceptible to secondary bacterial infections

Enveloped, Segmented Negative ssRNA Viruses

- **Influenza**

- Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Signs and symptoms during community-wide outbreak
 - Laboratory tests can distinguish between virus strains
 - Treatment
 - Oseltamivir or zanamivir inhibit type A and type B neuraminidase
 - Prevention
 - Immunization with multivalent vaccines
 - Protect only against the strains included in the vaccine