

# **VIRAL INFECTION**

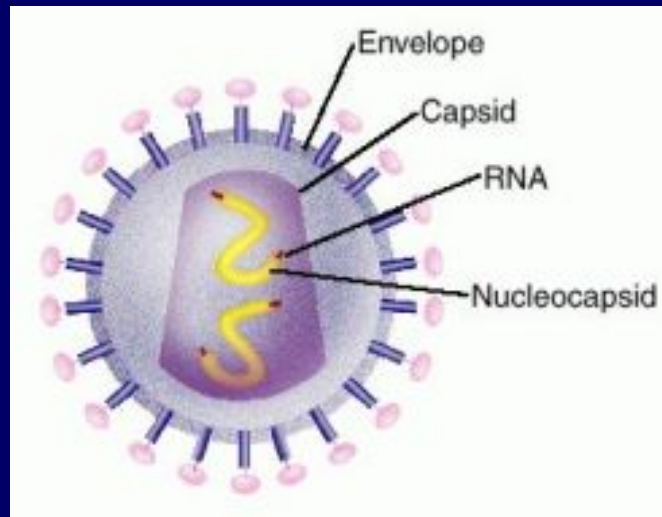
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## **Content of Viral disease**

- Respiratory system
- Digestive system
- Systemic with skin eruption
- Systemic with hematopoietic disorder
- Arbovirus and hemorrhagic fever
- Warty growths
- Central nervous system

## Viral structure



## Mechanism of viral infection

- Attachment
- Penetration
- Virus uncoating
- Replication and protein production
- Morphogenesis and maturation
- Release of virus

## Tissue change caused by viral infection

- Cell necrosis
- Cell swelling
- Inclusion body formation
- Giant cell formation
- Latent viral infection
- Oncogenesis

## Classification of viral disease

- **Respiratory system**
  - Adenovirus, Rhinovirus, Influenza, Respiratory syncytial virus
- **Digestive system**
  - Mumps virus, viral enteritis, hepatitis virus (A,B,C,D,E)

## Classification of viral disease

- **Systemic with skin eruption**
  - Measles virus, Rubella virus, Varicella zoster virus, Herpes simplex virus 1 and 2, Coxsackie Virus
- **Systemic with hematopoietic disorder**
  - Cytomegalovirus, EBV, HIV
- **Arbovirus and hemorrhagic fever**
  - Dengue virus 1-4

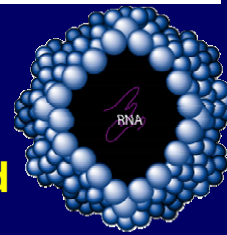
## Classification of viral disease

- **Warty growths**
  - Human papilloma virus, molluscum virus
- **Central nervous system**
  - Poliovirus, Rabies virus, Arbo viral encephalitis virus

## Respiratory system

### Rhinovirus

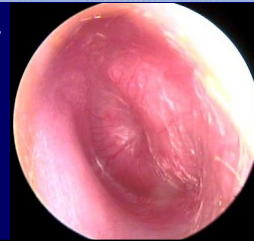
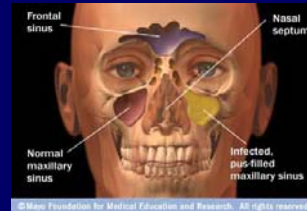
- Picornaviridae
- + single strand RNA
- Major cause of **common cold**
- More than 100 serotypes
- Binding to intercellular adhesion molecule-1 (ICAM-1) receptor on epithelial cells of URI
- Bradykinin from host response → mucous secretion



# Rhinovirus

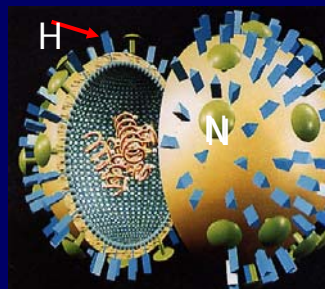
- **Clinical feature:**
  - rhinorrhea, nasal congestion, sore throat, cough, fever

- **Common complication:**
  - Adult:-sinusitis
  - Child:-otitis media, lower respiratory symptom (bronchopneumonia)



# Influenza virus

- Orthomyxoviruses
- Classify due to soluble (S) antigen of virion:
  - subtype A,B,C
- Classify due to glycoprotein envelope:
  - Hemagglutinin (H)
  - Neuraminidase (N)eg.H1N1, H3N2, H5N1



## Influenza Antigenic Changes

- **Antigenic Drift**
  - Minor change, same subtype
  - Caused by point mutations in gene
  - May result in epidemic
- **Antigenic Shift**
  - Major change, new subtype
  - Caused by exchange of gene segments
  - May result in pandemic

## Influenza virus

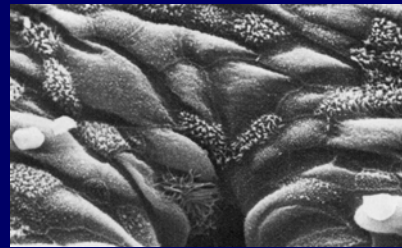
- Influenza
- Avian influenza (Bird flu)
- Mexico influenza or Swine influenza (2009 influenza)

# Influenza

- Self limited infection of upper airway, but can extend to lower airway
- Destroy mucociliary function followed by secondary bacterial infection

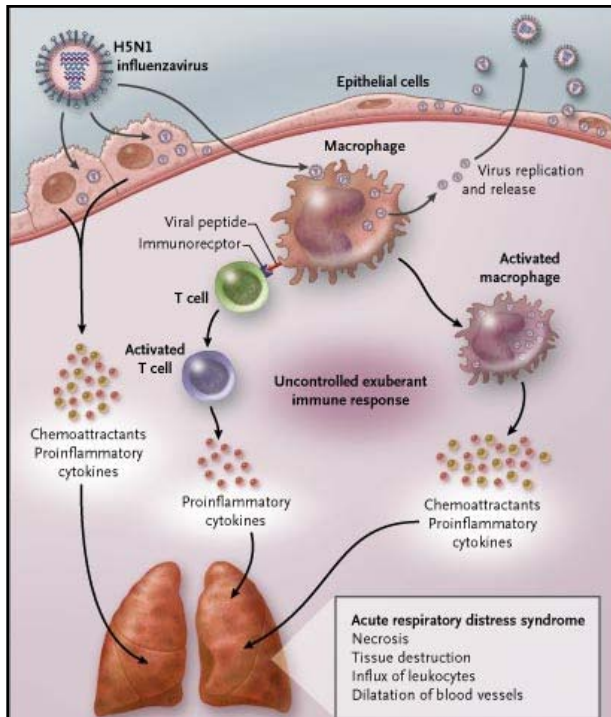


NORMAL TRACHEAL MUCOSA



7 DAYS POST-INFECTION

Lycke and Norby Textbook of Medical Virology 1993



## Mechanism of the Cytokine Storm Evoked by Influenza virus



# Influenza

- **Clinical feature:**

- rapid onset of fever, myalgia, headache, weakness, cough
- progressive symptom 3-5 day
- clinical subside 2 weeks



- **Complication:** pneumonia, lung hemorrhage, hyaline membrane disease
- Killed viral vaccine

## Avian influenza (Bird flu)

- **Caused by influenza virus type A, H5N1**
  - disease of bird, chicken, duck
  - transmitted to human by direct contact with affected animals
  - virus dies from heat (70 °C)

## Avian influenza

### - Disease in animals

low pathogenic  
highly pathogenic

### - Disease in humans (2-3 days)

fever, cough, sore throat,  
lymphopenia, severe pneumonia,  
res. failure, dead

## Mexico influenza

- Swine influenza or 2009 influenza
- Subtype A, H1N1
- Infected by respiratory system and direct contact to eye (infection between human)
- Clinical symptom : similar to influenza

## **Mexico influenza**

- People who work with poultry and swine, are increased risk of zoonotic infection
- In human, mutation of virus and transmitted between human

## **Influenza Antivirals**

- Use neuraminidase inhibitors
- Oseltamavir: chemoprophylaxis and treatment
- Zanamavir: treatment only

## Respiratory syncytial virus(RSV)

- Most common cause of self- limited respiratory tract infection in young children eg; bronchiolitis, pneumonia
- Transmitted by respiratory droplet and secretion

## Adenovirus

- Adenoviridae
- Incubation period 6-9 days
- Common cause in child :  
conjunctivitis, URIs, bronchitis,  
pharyngitis (exudate), bronchiolitis,  
pneumonia, myocarditis, cystitis,  
encephalitis
- Immunocompromised host:- high risk for  
severe pneumonia

## Digestive system

### Mumps virus

- Paramyxovirus family
- Cause of mumps with self limited disease in 2 weeks
- **Clinical:-** fever, malaise, headache, parotid swelling and pain
- Live attenuated vaccine



## Pathogenesis

Inhalation of respiratory droplet contains virus



dendritic cells at respiratory epithelium capture virus and drainage to lymph nodes



replication in lymph nodes



hematogeneous spread to parotid glands (parotitis), and other organs (CNS, pancreas, testis)

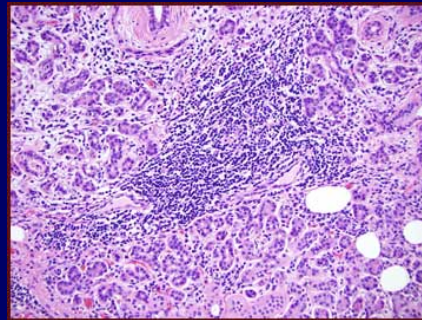
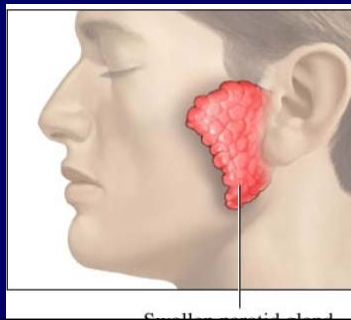
## Mumps

- **Extrasalivary gland complication:**
  - aseptic meningitis (most common)
  - orchitis
  - oophoritis
  - pancreatitis



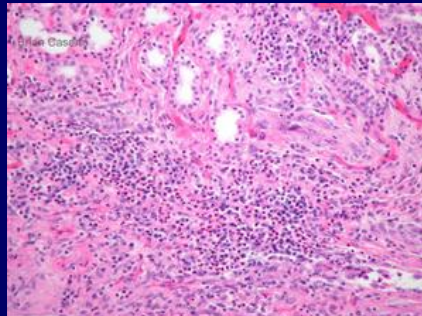
## Histology

- **Parotitis:** bilateral 75%
  - desquamation of ductal epithelial cells
  - interstitium edema with lymphocytes, and plasma cells infiltration



## Histology

- **Orchitis:**
  - testis edema, lymphocytes infiltration, hemorrhage
  - may be infarction → infertility (13%)



## Viral enteritis and diarrhea

- Rotavirus
- Norwalk virus
- Corona virus

## Rotavirus

- Reovirus family
- Most common cause of **gastroenteritis** in children < 1 year of age
- **Clinical** :- fever, rhinorrhea, vomiting, abdominal pain, watery non-bloody diarrhea
- **Pathogenesis**: reduce absorption of water and sodium from GI



## Rotavirus

- **Transmission** by fecal-oral route
- Persistent symptom about 1 week
- **Treatment:** conservative with fluid replacement



## Norwalk virus

- (+) ssRNA, nonenveloped virus
- Common in childhood
- Clinical , transmission, pathogenesis, clinical course and treatment are similar to Rotavirus

## Coronavirus

- Caused by respiratory tract infection and diarrhea
- Self limited disease
- Intermittent epidemiology

## Hepatitis virus

- Classified 6 types
  - Hepatitis virus types A, B, C, D, E, G

## Hepatitis A virus (HAV)

- Naked RNA virus
- Transmitted by fecal-oral route (food, water)
- Common cause of acute hepatitis
- **Clinical**:- fever, jaundice, nausea, vomiting
- Complete recovery
- No develop chronic hepatitis and hepatocellular carcinoma
- Diagnosis; HAV-IgM, IgG

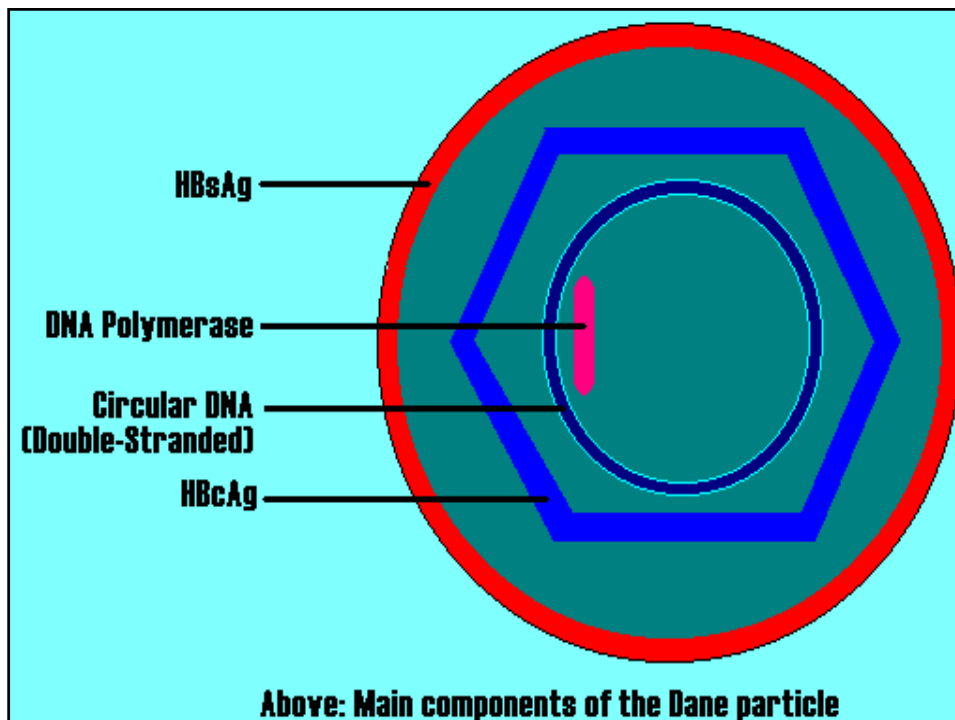
## Hepatitis B virus (HBV)

- **Transmitted** by blood transfusion, intravenous drug use, sexual activity, vertical transmission and contact body secretion eg. semen, saliva, breast milk
- **Clinical**:- fever, jaundice, nausea, vomiting

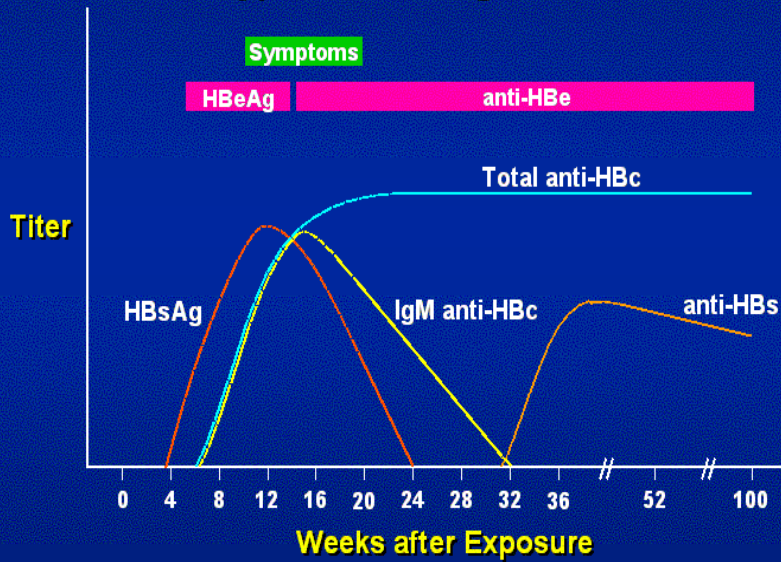
## Hepatitis B virus (HBV)

- **Cause of:**

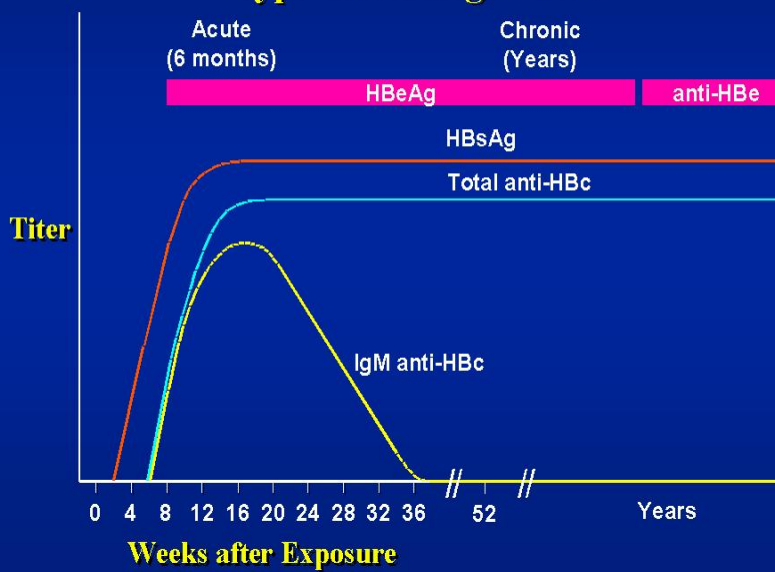
- acute hepatitis with resolution
- chronic hepatitis, cirrhosis and hepatocellular carcinoma
- fulminant hepatitis with massive liver necrosis
- result for hepatitis D virus infection
- carrier



## Acute Hepatitis B Virus Infection with Recovery Typical Serologic Course



## Progression to Chronic Hepatitis B Virus Infection Typical Serologic Course





## Interpretation serology of HBV

<u>HBsAg</u>	<u>Anti-HBs</u>	<u>Anti-HBc</u>	<u>Result</u>
-	-	-	ไม่เคยติดเชื้อ ไม่มีภูมิคุ้มกัน ควรฉีดวัคซีนป้องกัน
+	-	-	กำลังติดเชื้อ หรือเพิ่งเป็นโรคนี้นี้ ติดต่อให้ผู้อื่นได้
-	-	+	เคยติดเชื้อมานาน แต่ไม่มีเชื้อแล้ว และไม่ติดต่อไปยังผู้อื่น

## Interpretation serology of HBV

<u>HBsAg</u>	<u>Anti-HBs</u>	<u>Anti-HBc</u>	<u>Result</u>
+	-	+	กำลังติดเชื้อ อาจเป็นแบบเฉียบพลัน หรือเป็นพาหะเรื้อรัง สามารถติดต่อให้ผู้อื่นได้
-	+	+	เคยติดเชื้อมาก่อน และมีภูมิคุ้มกันแล้วจะไม่ติดเชื้อซ้ำอีก
-	+	-	เคยฉีดวัคซีนป้องกันโรค

## Hepatitis C virus (HCV)

- Transmitted by blood transfusion, intravenous drug use, sexual activity, and contact body secretion eg. semen, saliva
- Asymptomatic of acute illness

## Hepatitis C virus (HCV)

- **Cause of:**
  - persistent infection and chronic hepatitis
  - cirrhosis and hepatocellular carcinoma



## Hepatitis D virus (HDV)

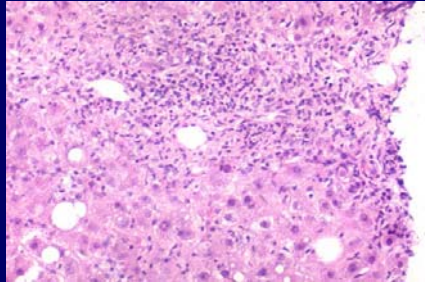
- **Transmitted** by blood transfusion, intravenous drug use, sexual activity, and contact body secretion
- **Infected with HBV:**
  - coinfection: expose to serum containing both HBV and HDV
  - superinfection: chronic carrier of HBV with new infection of HDV



## Hepatitis D virus (HDV)

- **Clinical:**

- acute hepatitis
- fulminant hepatitis
- chronic hepatitis with cirrhosis



## Hepatitis E virus (HEV)

- **Transmitted** by water-borne infection
- High mortality rate in pregnant women
- Self limited in most case
- Complete recovery
- No develop chronic hepatitis and hepatocellular carcinoma

	Hepatitis A Virus	Hepatitis B Virus	Hepatitis C Virus	Hepatitis D Virus	Hepatitis E Virus	Hepatitis G Virus*
Agent	Icosahedral capsid, ssRNA	Enveloped dsDNA	Enveloped ssRNA	Enveloped ssRNA	Unenveloped ssRNA	ssRNA virus
Transmission	Fecal-oral	Parenteral; close contact	Parenteral; close contact	Parenteral; close contact	Waterborne	Parenteral
Incubation period	2-6 wk	4-26 wk	2-26 wk	4-7 wk	2-8 wk	Unknown
Carrier state	None	0.1-1.0% of blood donors in U.S. and Western world	0.2-1.0% of blood donors in U.S. and Western world	1-10% in drug addicts and hemophiliacs	Unknown	1-2% of blood donors in U.S.
Chronic hepatitis	None	5-10% of acute infections	>50%	<5% coinfection, 80% upon superinfection	None	None
Hepatocellular carcinoma	No	Yes	Yes	No increase above HBV	Unknown, but unlikely	None

**Systemic with skin eruption**

## **Measles (nine-day/rubeola)**

- Measles virus
- Infected by respiratory droplet
- Common in children
- Self limited disease
- Incubation period 9-10 days
- Vaccination is highly effective

## **Measles virus**

- Virus multiplies in upper respiratory epithelium, lymphoid tissue, and spread to blood
- Immunity protect reinfection

## Measles virus

- **Clinical:**

- conjunctivitis, cough, coryza, fever
- at day 2-3: "Koplik spot" at buccal mucosa
- at day 4-5: reddish-brown rash, enlarged cervical LN
- 1 week: subside

## Measles virus

- **Complication:**

- pneumonia
- encephalitis
- keratitis
- abnormal hemorrhage
- secondary bacterial infection

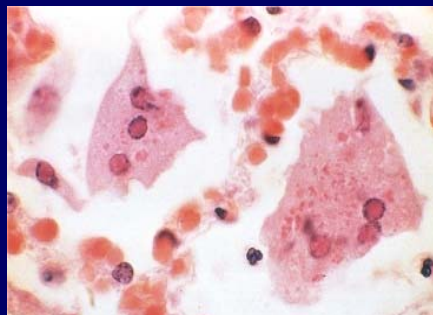
# Measles



Koplik spot

## Pathology of Measles

- Multinucleated giant cells with intranuclear and intracytoplasmic inclusion (**Warthin-Finkeldey cells**) in lymphoid organs and other organs



Warthin-Finkeldey cells

## Rubella (german measles)

- Caused by Rubella virus
- Incubation period 14-21 days
- Systemic infection : **rash**, fever, malaise, coryza, arthritis and arthralgias
- Exanthem - discrete, pinkish red, fine maculopapular eruption - begins on the face and spreads cephalocaudally
- Dx: serology testing

## Rubella (german measles)



## Congenital rubella syndrome

- Infected pregnant woman ( first 20<sup>th</sup> wks)
- Fetal death, premature delivery, congenital anomalies
- Heart defects: PDA, VSD, pulmonary valvular stenosis
- Eye and ear defects: cataract, glaucoma, deafness
- CNS defects: microcephaly, mental retard

## Rubella (german measles)

- **Complications** - arthritis, purpura, thrombocytopenia, encephalitis

# Herpes simplex infections

## ● HSV-1

- >90% of primary infections are subclinical
- Fever blister or cold sores at facial skin eg. lip, nose, gingivostomatitis



HSV-1 Cold sore

## ● HSV-2

- genital pathogen
- neonatal herpes



HSV-2 Genital Herpes

# Herpes simplex infection

- Transmitted by direct/sexual contact
- **Diagnosis:** clinically
  - scrap base of vesicle and a special stain - Giemsa-stained (Tzanck smear)
    - ballooned epithelial cells with **intranuclear inclusions and multinucleated giant**
- viral cultures take 24-72 hours



## Primary herpes simplex infections

### ● Herpetic gingivostomatitis

- high fever, irritability, anorexia, mouth pain, drooling in infants and toddlers
- gingiva becomes intensely erythematous, edematous, friable and tends to bleed
- small yellow ulcerations with red halos seen on buccal and labial mucosa, tongue, gingivae, palate, tonsils

## Primary herpes simplex infections

### ● Skin infections

- fever, malaise, localized lesions
- direct inoculation (usually cold sores) and genitalia
- painful vesicles on erythematous base - usually grouped

## Recurrent herpes simplex infection

- Triggers include fever, sunlight, local trauma, menses, emotional stress
- Seen most commonly as cold sores
- Prodrome of localized burning, itching before eruption of grouped vesicles

## Herpes simplex virus

- Gross:
  - group of intraepithelial vesicles (blisters) and frequently crust covering
  - may be ulcer
- Pathology:
  - pink to purple, glassy intranuclear inclusion (Cowdry type A)
  - mononucleated or **multinucleated cells**

## HSV (cold sores)



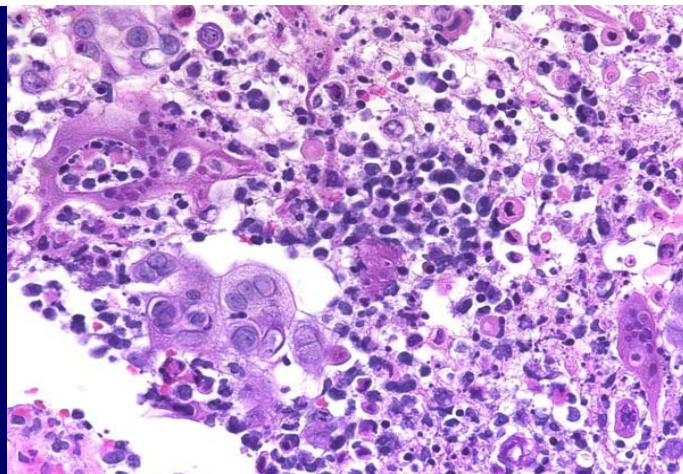
## HSV (gingivostomatitis)



## HSV (genital herpes)



## HSV



glassy intranuclear inclusion (mononucleated or multinucleated cells)

## Pathogenesis of HSV

Initial infection in skin or mucous membrane



travel along sensory nerve ending and retrograde axonal flow to neuron in dorsal root ganglia (latent infection)

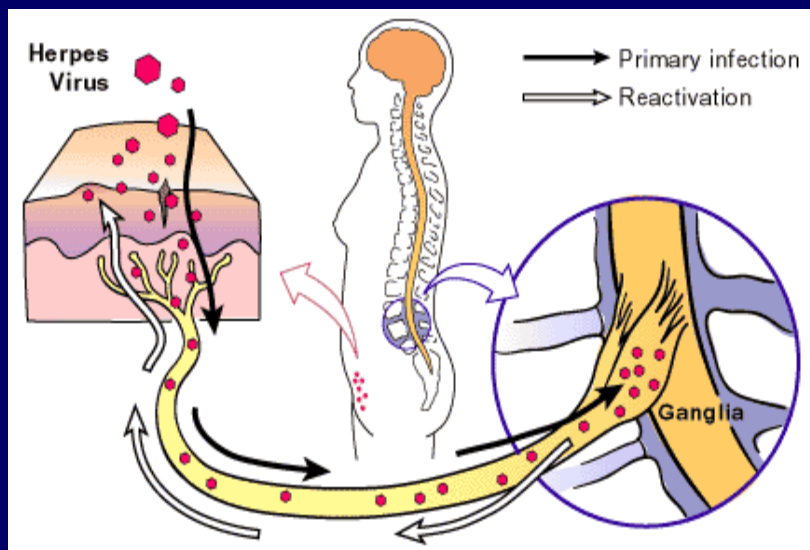


reactivate of latent infected neuron (eg. stress, fever, UV)



newly replicated virus is transported anterograde to a site at or near portal of entry into body causing localized vesicles

## Pathogenesis of HSV



## Neonatal herpes infection

- Infected fetus by contact vaginal secretion contains viruses
- **Clinical features**
  - mucocutaneous vesicles
  - virus spread to other organs eg. brain, liver, lung
- High mortality rate

## Varicella zoster virus (VZV)

- Cause of chickenpox, herpes zoster (shingles)
- Incubation period ranges from 10-20 days
- Transmitted by inhalation of airborne respiratory droplets from an infected host or direct contact

## Varicella zoster virus (VZV)

- Primary acute infection of VZV: “chickenpox”
- Reactivation of latent VZV: “shingles or herpes zoster” distributes to sensory nerves

## Varicella (chickenpox)

- Clinical : fever, diffuse vesicle on skin and mucous membrane
- Complications : secondary bacterial skin infections, pneumonia, hepatitis, encephalitis, Reye syndrome
- Severe in the immunocompromised host
- Tx: Varicella-zoster immunoglobulin

## Herpes zoster (shingles)

- After primary infection, virus lies dormant in genome of sensory nerve root cell
- Postulated triggers include mechanical and trauma, infection, immunosuppression
- Lesions are grouped, thin-walled vesicles on erythematous base distributed along dermatome

## Pathogenesis of VZV

Primary infection ( chickenpox)



VZV spread from mucosal and epidermal lesions to local sensory nerves



VZV remains latent in dorsal ganglion cells of sensory nerves



Reactivation of VZV results in syndrome of herpes zoster (shingles)



## Varicella zoster virus (VZV)

- Gross:
  - chickenpox: diffuse, scattered vesicles
  - shingles: vesicles distribution along the peripheral nerve (dermatome)
- Histology:
  - Intranuclear inclusion of infected cells (multinucleated cells)

## Varicella (chickenpox)



🌻 lesions in multi-stages

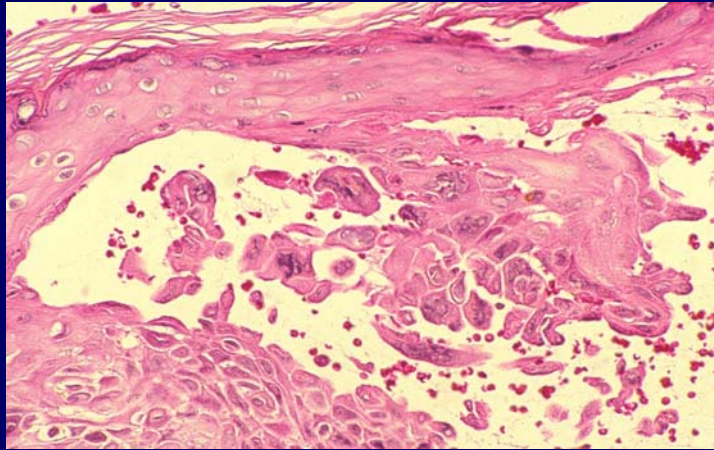
# Shingles



# Shingles



## VZV



Intranuclear inclusion

## Coxsackie Virus

- **Type A**
  - Causes herpangina and hand- foot-and mouth disease
- **Type B**
  - Causes Plerodinia
- **Both**
  - Causes meningitis, myocarditis and pericarditis, also can cause juvenile diabetes

## Hand-Foot-and Mouth disease

- ☀️ Coxsackie Virus A, B or Enterovirus71
- ☀️ Common in child
- ☀️ Prodrome : low-grade fever, malaise, sore mouth, anorexia
- ☀️ 1-2 days later :
  - oral lesions (tongue, throat, gum) : shallow, yellow ulcers surrounded by red halos
  - painful red blister on hand and foot
- ☀️ Rx : supportive treatment

## Hand-foot-and-mouth disease



# Herpangina

- Coxsackie Virus A
- Common in child
- Infection of the throat
- Causes red-ringed blisters or ulcers on tonsils, roof of mouth and tongue



**Systemic with  
hematopoietic disorder**

## Cytomegalovirus (CMV)

- Produce a variety of disease depend on age, immune status
- Cause of asymptomatic in healthy person or severe systemic infection in neonates and immunocompromised host (opportunistic infection)

## Cytomegalovirus (CMV)

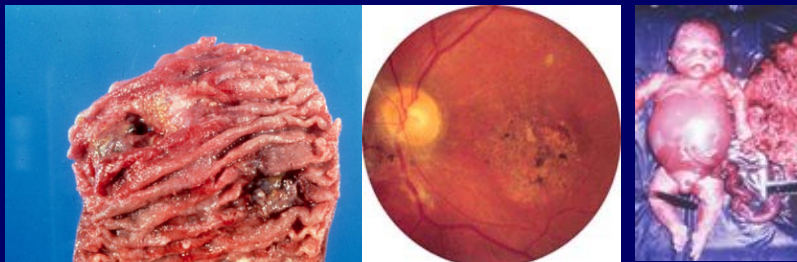
- Transmitted by:
  - intrauterine transmission
  - perinatal transmission
  - breast milk
  - respiratory droplets
  - semen and vaginal fluid
  - blood transfusion
  - organs transplantation

## Cytomegalovirus (CMV)

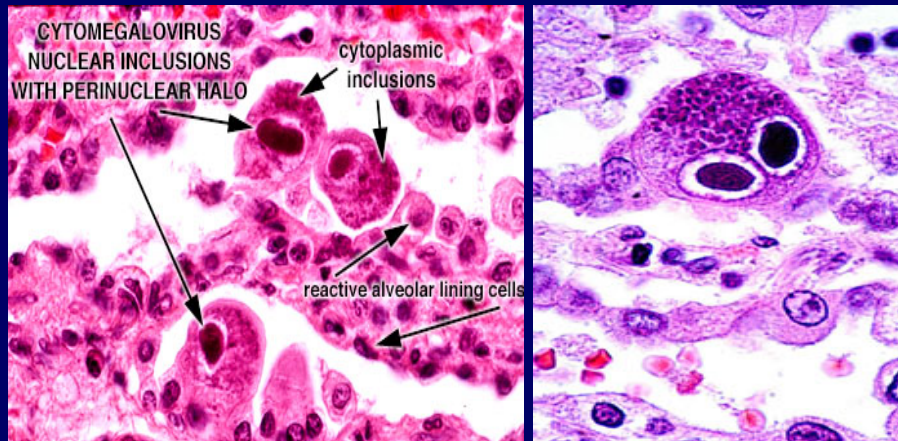
- Clinical feature depends on infected organs
- Congenital CMV infection
  - 90% asymptomatic
  - 10% symptomatic eg. hemolytic anemia, jaundice, thrombocytopenia, pneumonia, hepatosplenomegaly, retinitis, brain damage, mental retard or dead

## Histology of CMV

- **Large purple intranuclear inclusion** surrounded by clear halo and smaller basophilic **intracytoplasmic inclusion**
- Organ involvement: salivary glands, kidney, liver, pancreas, brain, ect.



## CMV



## Epstein-Barr Virus (EBV)

- Cause of infectious mononucleosis
- Self-limiting illness of children & young
- EBV associated with hairy leukoplakia, lymphoma, and nasopharyngeal carcinoma
- Transmitted by contact saliva



## Epstein-Barr Virus (EBV)

- Clinical of infectious mononucleosis:
  - fever
  - generalized lymphadenopathy
  - hepatosplenomegaly
  - sore throat (patch on tonsil)
  - may be CNS lesion
  - may be hepatitis, pneumonia

## Pathogenesis

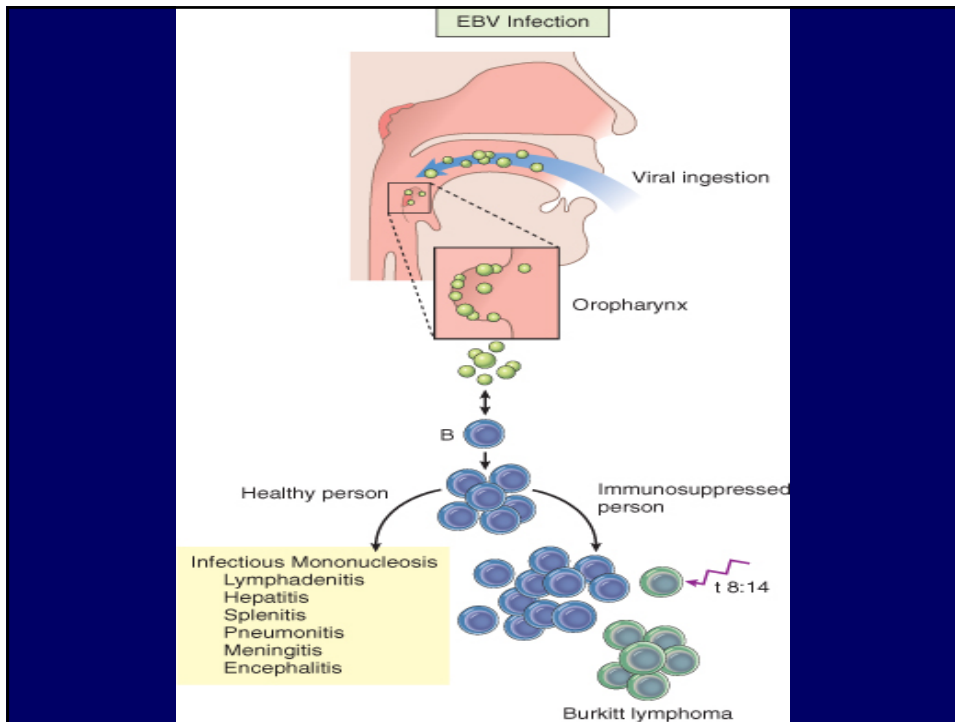
EBV replicates in B-lymphocytes in tonsil



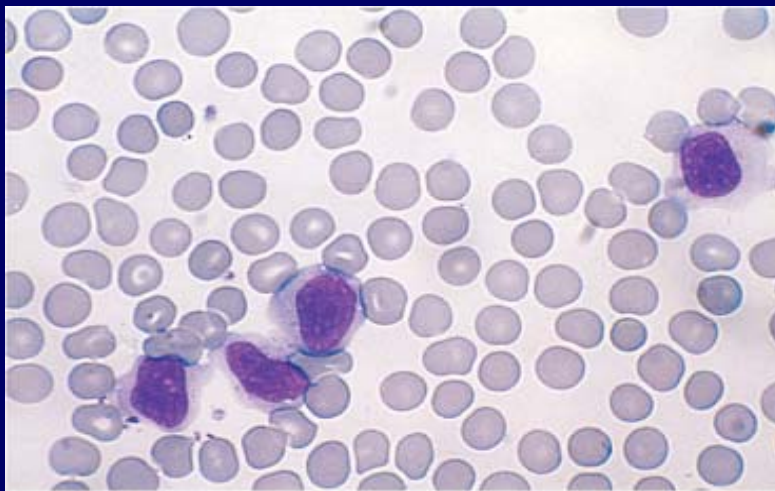
B-lymphocytes disseminates in circulation



Atypical T lymphocytes in blood circulation



## Atypical T lymphocytes



## **Human Immunodeficiency Virus (HIV)**

- single-stranded, enveloped RNA viruses
- HIV 1, HIV 2
- can lead to acquired immunodeficiency syndrome (AIDS)

## **Human Immunodeficiency Virus (HIV)**

- Infection occurs by transfer of blood, semen, vaginal fluid, or breast milk
- 4 major routes of transmission
  - sexual intercourse
  - contaminated needles
  - breast milk
  - vertical transmission

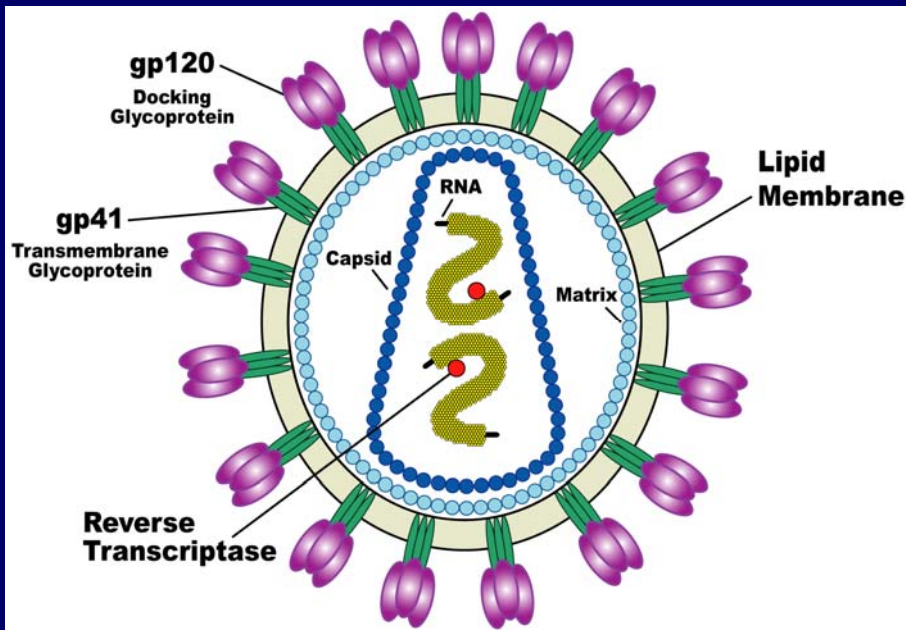
## Human Immunodeficiency Virus (HIV)

- Primarily infects in helper T cells (CD4+ T cells), macrophages, and dendritic cells
- HIV infection leads to low levels of CD4+ T cells by 3 main mechanisms
  - direct viral killing of infected CD4+ T cells
  - increased rates of apoptosis in infected CD4+ T cells
  - killing of infected CD4+ T cells by CD8 cytotoxic lymphocytes that recognize infected cells

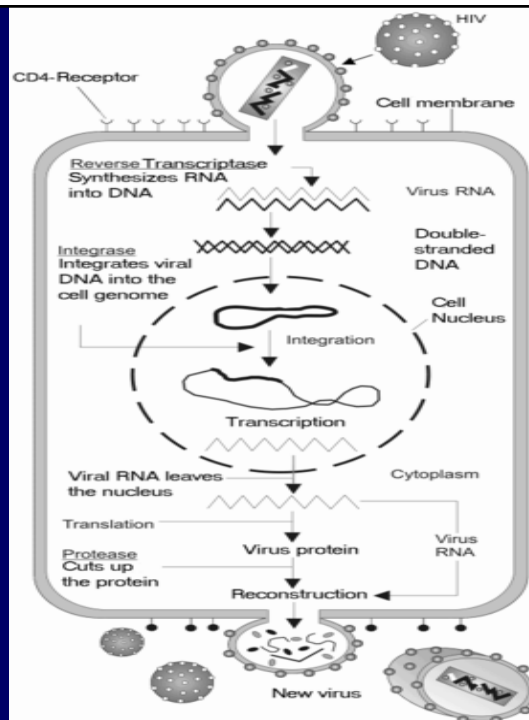
## Human Immunodeficiency Virus (HIV)

- CD4+ T cell numbers decline below a critical level, cell-mediated immunity (CMI) is lost, and the body becomes progressively more susceptible to opportunistic infections

# HIV structure



# Replication cycle



## HIV infection 4 stages

- Incubation period
  - asymptomatic , 2-4 weeks after infection
- Acute infection
  - rapid viral replication
  - fever, lymphadenopathy
  - pharyngitis (sore throat)
  - rash, myalgia, malaise
  - mouth and esophageal sores

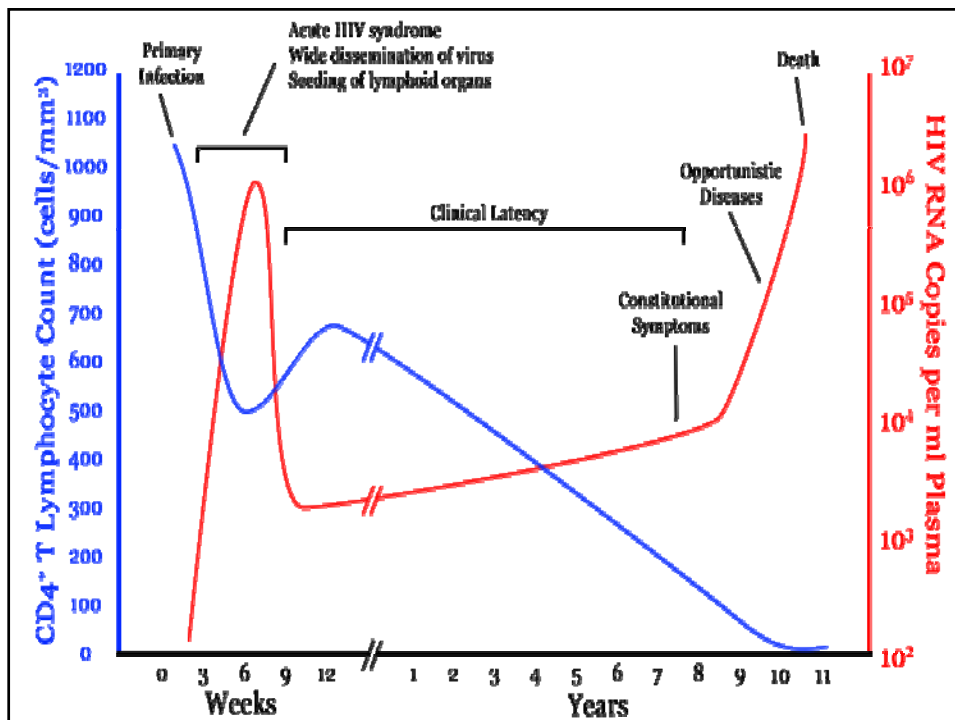
## HIV infection 4 stages

- Latency stage
  - shows few or no symptoms
  - low level viral particle in blood stream
  - duration 2 weeks -20 years

## HIV infection 4 stages

- **AIDS**

- symptoms of various opportunistic infections
- early : oral candidiasis (thrush) and tuberculosis
- later : recurrences of HSV, shingles and pneumonia caused by *Pneumocystis jirovecii*
- final stages : CMV, Mycobacterium avium complex (MAC) and EBV induced B-cell lymphomas or Kaposi 's sacroma



## Arbovirus and hemorrhagic fever

### Dengue virus

- Dengue virus 1-4
- Dengue fever is a vector-borne disease
- transmitted via bite of mosquitoes  
eg. *Aedes aegypti*, *Aedes albopictus*
- Symptoms of dengue include:
  - high fever, headache
  - rash
  - nausea and vomiting
  - myalgia
  - leukopenia (neutropenia), thrombocytopenia



## Dengue virus

- Infection with one serotype provides lifelong immunity to that particular serotype but not to the other three
- Previous infection with simple dengue fever greatly increases risk of developing DHF

## Warty growths

## Human papilloma virus (HPV)

- Most common causes of sexually transmitted infection (STI) in the world
- HPV types cause benign skin wart, anogenital warts, anogenital cancer
- Warts: proliferative squamous epithelium producing nodules or flat lesions

## Human papilloma virus (HPV)

- **Skin warts**
  - HPV types 1,2
  - common warts (verruca vulgaris): hands, trunk, extremities
  - plantar warts: plantar
  - no associated with cancer

## Human papilloma virus (HPV)

- **Anogenital warts** (condyloma acuminatum)
  - HPV types 6,11
  - warts at penis, vulva, vagina, anus
  - no associated with cancer
- **Anogenital cancer** (squamous cell carcinoma)
  - HPV types 16,18,31,45
  - cause of cancer of anus, vulva, cervix and penis

## Human papilloma virus (HPV)

- Transmitted by skin-to-skin contact during sexual intercourse
- Treated by electrocautery, laser treatment
- Histology : **koilocytosis** of infected cells

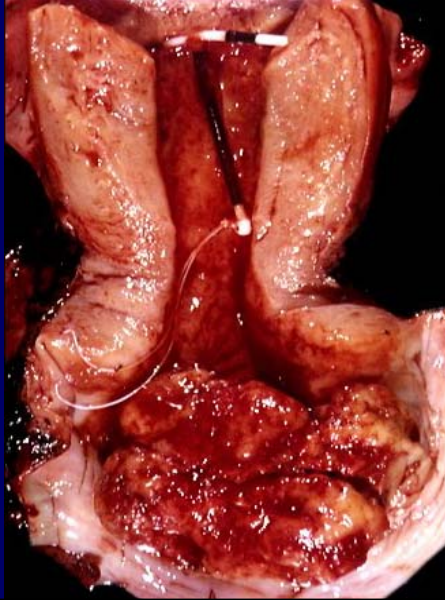
## Skin warts



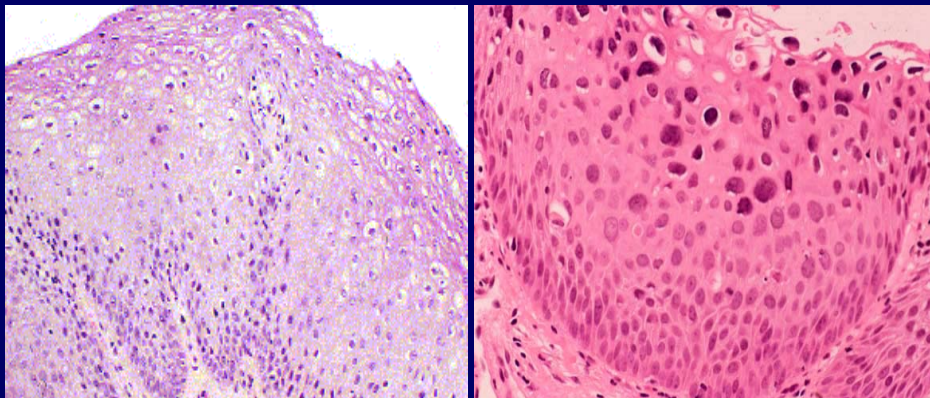
## Anogenital warts (condylomata acuminata)



## Squamous cell carcinoma of cervix



## Koilocytosis of infected cells



## Molluscum virus

- Cause of molluscum contagiosum
- Self-limited viral disease of skin
- Transmitted by skin or sexual contact
- **Gross:** raised, umbilicated, cutaneous nodules at skin (most perineum)
- **Histology:** intracytoplasmic inclusion bodies (molluscum bodies)

## Pathogenesis

transmitted primarily through direct skin contact with an infected individual



virus infects epidermis causing hyperplasia, hypertrophy and central degeneration of the epidermis

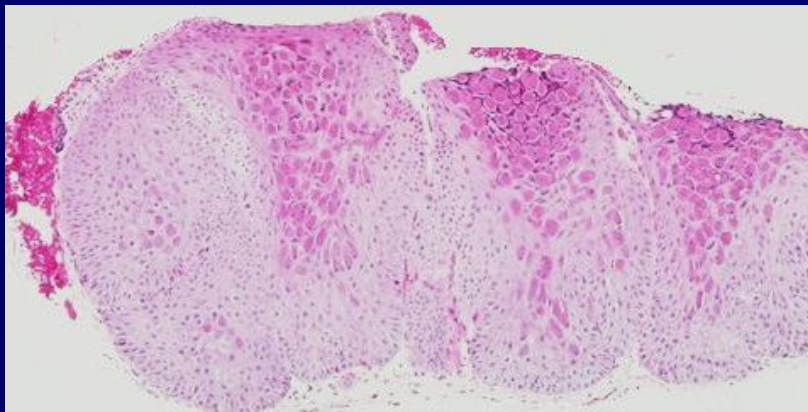


epidermis has molluscum bodies contain large numbers of maturing virions

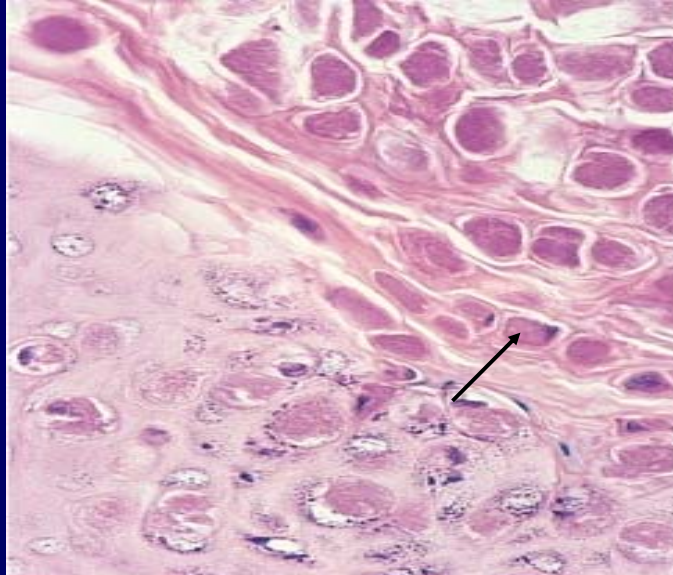
## Molluscum contagiosum



intracytoplasmic inclusion bodies  
(molluscum bodies)



**Intracytoplasmic inclusion bodies  
(molluscum bodies)**



**Central nervous system**



## Poliovirus

- Causes poliomyelitis
- Transmitted by fecal-oral route
- Most asymptomatic
- 1/100 of infected patients → disease (spinal poliomyelitis, bulbar poliomyelitis)

## Pathogenesis

Poliovirus infects oropharynx secreted in saliva and swallow



Multiplies in intestinal mucosa and lymph nodes



Hematogenous spreading



Invade to CNS and replicate in spinal cord (spinal poliomyelitis), or brain stem (bulbar poliomyelitis)

\* Virus destroys motor neuron in anterior horn of spinal cord or brain stem\*

## Poliomyelitis

- **Clinical features**

- flaccid paralysis
- muscle atrophy
- hyporeflexia



## Rabies virus

- Cause of rabies (encephalitis)
- Transmitted by saliva of dog or cat bites
- **Clinical:**
  - malaise, headache, fever, dysphagia followed by period of acute neurologic symptom including disorientation, hallucination, seizure, coma and dead from res. failure

## Rabies virus

- Post-exposure prophylaxis: combined immune serum and vaccine
- High mortality rate



## Pathogenesis

Rabies virus multiplies at site of local bite



travel to CNS through the peripheral nerves

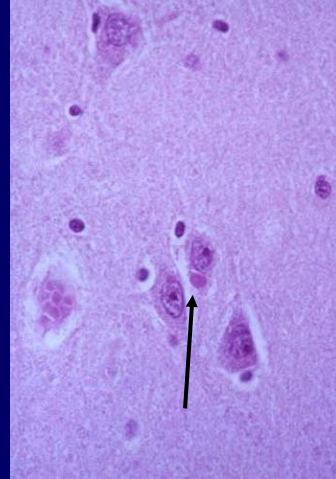
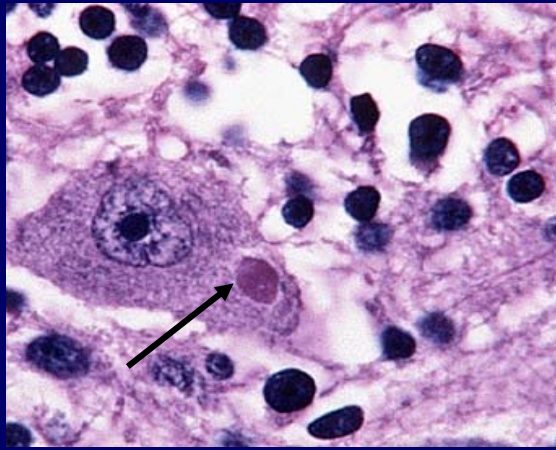


replicates in neurons of CNS



Clinical symptom

## Negri bodies



Intracytoplasmic inclusion in neuron

## Arbo viral encephalitis virus

- Japanese B caused by encephalitis
- Animal host : pig
- Carrier : Culex mosquitoes
- **Clinical** : confusion, seizure, coma
- **Pathology** : mononuclear cells around vessels, necrosis of neuron and brain tissue



**THE END**