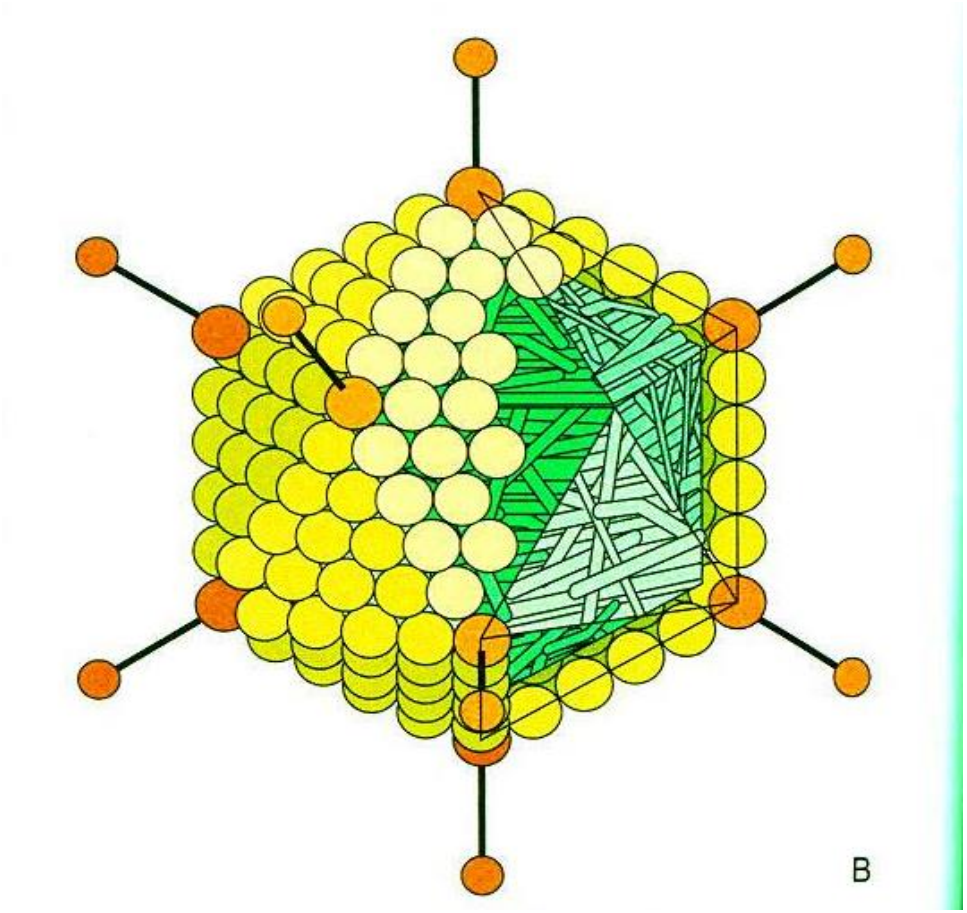
Virus

dr_irma_s@yahoo.co.id

Virus DNA

ADENOVIRUS

Adenovirus



Adenovirus

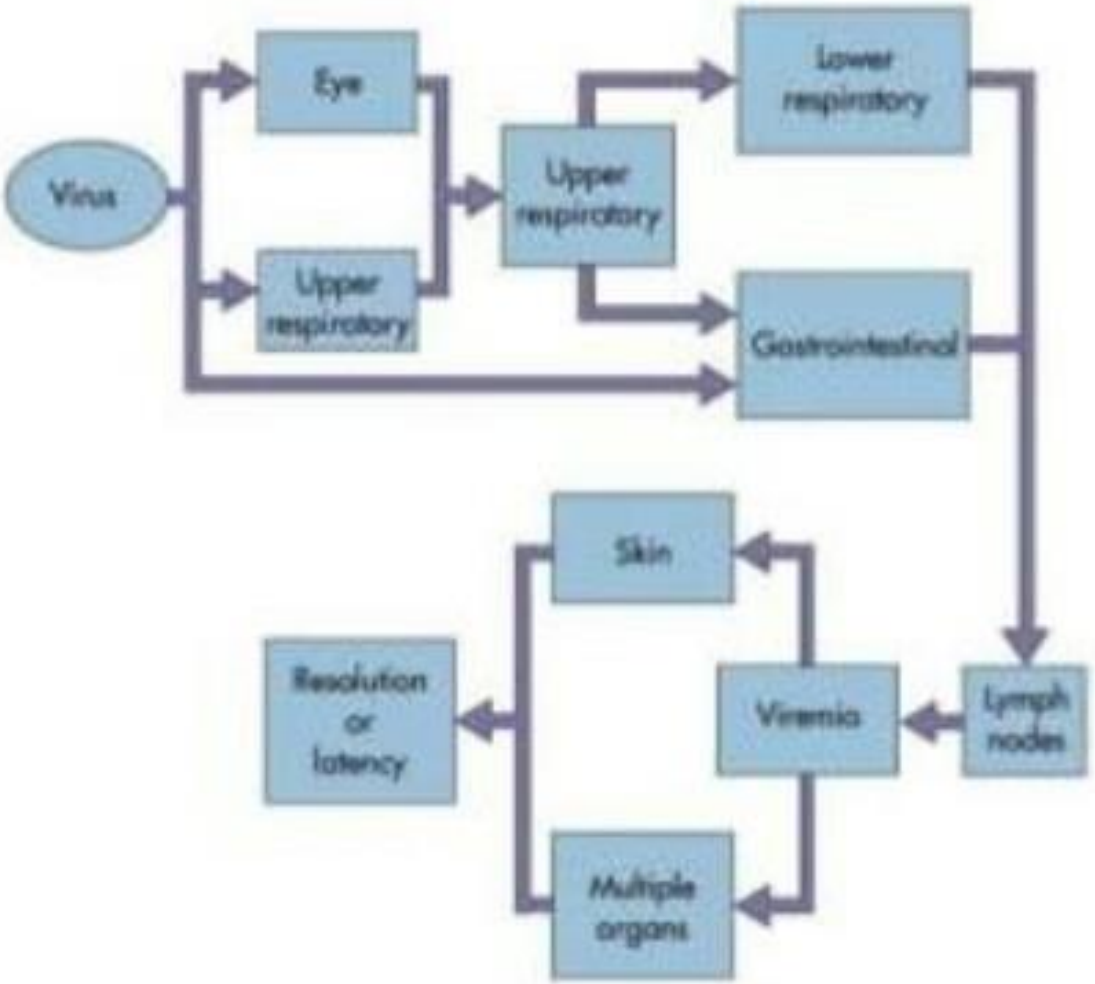
- **Non-enveloped, 70-90nm in size.**
- **Icosahedral capsid.**
- **Genome : double-stranded (ds) DNA dng 2 major proteins.**
- **Adenoviruses stabil : lingkungan dan pH rendah, empedu, dan enzim proteolitic**.

Adenovirus

- Adenoviridae

1. *Masadenovirus* : mamalian species (human)
2. *Aviadenovirus* : avian species

Adenovirus pathogenesis



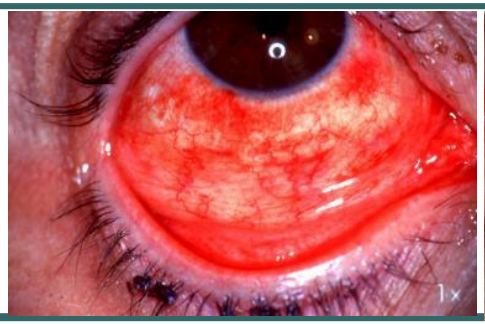
From Medical Microbiology, 5th ed., Murray, Rosenthal & Pfaller, Mosby Inc., 2005, Fig. 50-4.

Adenovirus

CLINICAL SYNDROMES

- **Respiratory system**
  - **Upper Respiratory Infections**
    - **common cold (rhinitis), pharyngitis (dengan /tanpa panas), tonsillitis dan pharyngoconjunctival fever.**
  - **Lower Respiratory Infections**
    - **bronchitis, acute respiratory disease, pertussis-like syndrome, dan pneumonia.**

Adenovirus



CLINICAL SYNDROMES

- **Eye:**
  - **Epidemic Keratoconjunctivitis (EKC), acute follicular conjunctivitis, pharyngoconjunctival fever.**
- **Gastrointestinal**
  - **Gastroenteritis, mesenteric adenitis, intussusception, hepatitis, dan appendicitis.**
  - **Diare lebih lama dibanding virus lain (m/ rotavirus)**

Adenovirus

CLINICAL SYNDROMES

- **Genitourinary**
  - **Acute hemorrhagic cystitis, urethritis, cervicitis, orchitis, nephritis, genital ulcers dan oculogenital syndrome.**
- **Lainnya (jarang)**
  - **Meningitis, encephalitis, arthritis, skin rash, myocarditis, pericarditis, hepatitis.**
  - **Penyakit fatal pada pasien immunocompromised.**

Adenovirus

DIAGNOSIS

- **Spesimen : swab (nasofaring,konjungtiva dll), kerokan kornea, tinja, urin, biopsy dan otopsi dll.**
- **Viral Isolation melalui culture sel**
  - **human embryonic kidney (HEK)**
  - **human fetal diploid cells (HDFL)**
- **Rapid detection**
  - **EIA or ELISA, immunofluorescence**
- **Electron Microscopy, PCR, dan nucleic acid probes.**
- **Serology- epidemiologic studies**

Adenovirus

THERAPY

- **Limited efficacy of antivirals (Ribavirin dan Cidofovir)**

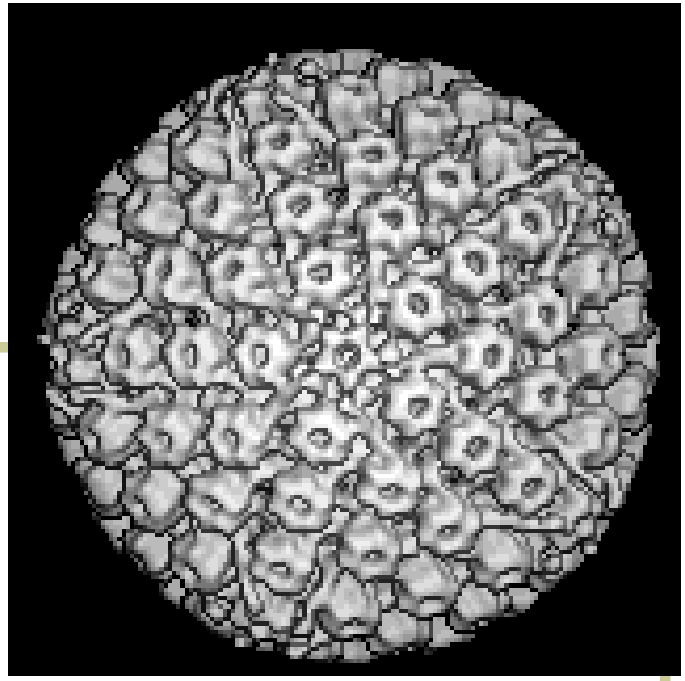
PREVENTION

- **Good hand washing**
- **Contact precautions, respiratory precautions in health care settings**
- **Adequate chlorination of swimming pools**
- **Sterilization and disinfection of ophthalmologic equipment and use of single dose vials of ophthalmic medications**
- **Vaccine- live enteric coated, oral vaccine**

VIRUS DNA

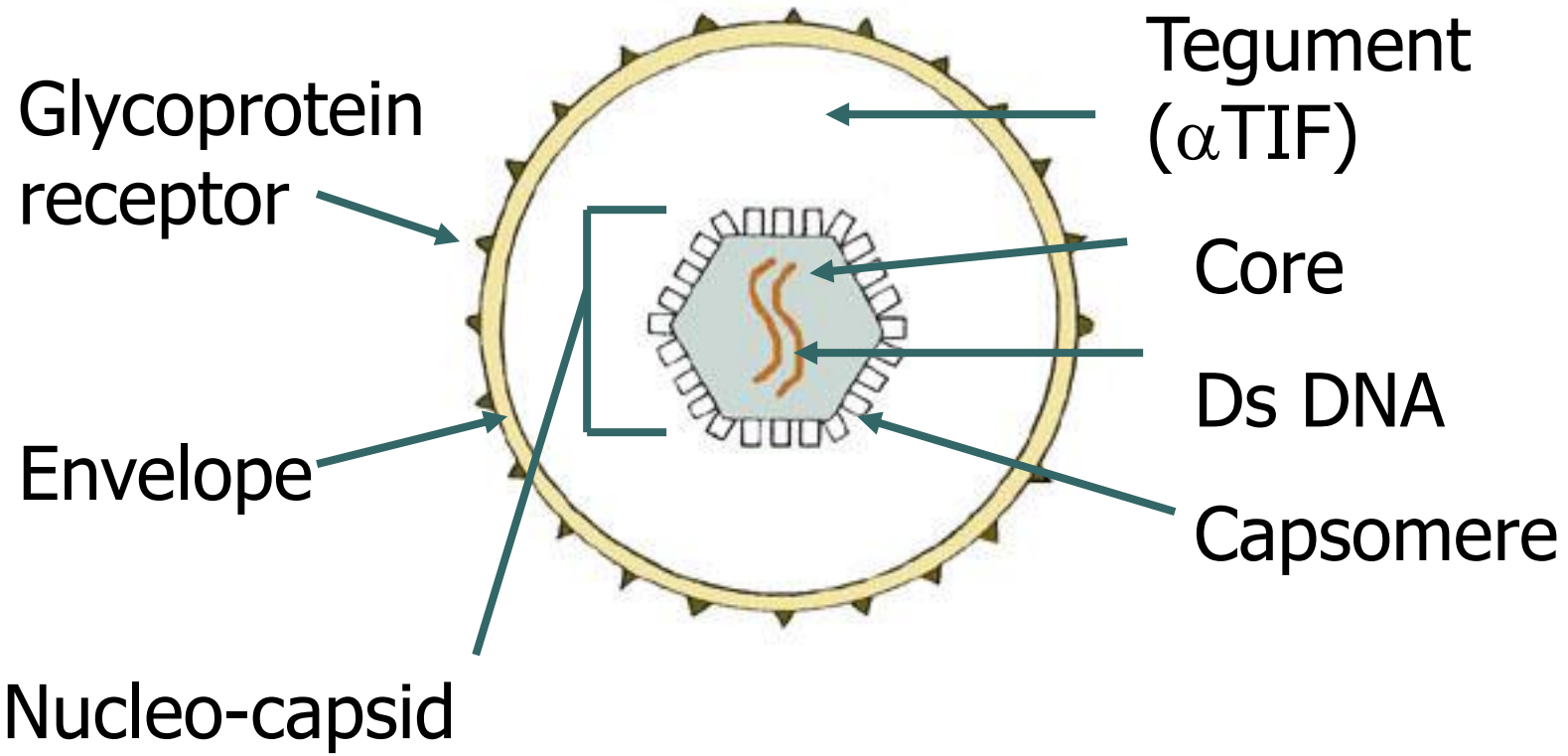
HERPES VIRUS

HERPESVIRUSES



Herpes simplex virus
Gross Anatomy

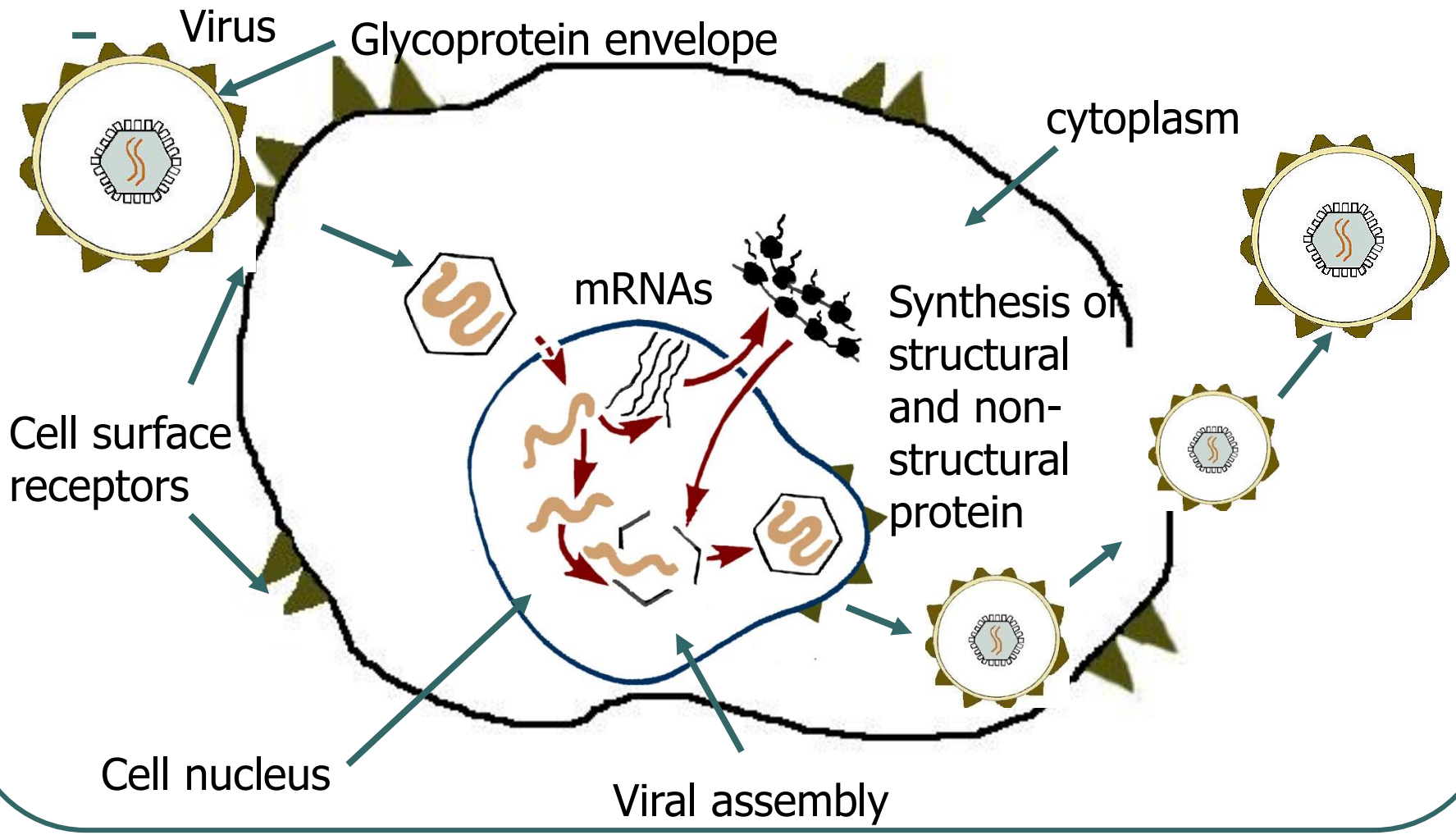
Structure



Herpes simplex virus

- **Family: *Herpesviridae***
- **120-200 nm in diameter**
- **Linear double-stranded (ds) DNA,**
- **Icosahedral capsid**
- **Envelope**
- **Viral DNA synthesis and capsid assembly occur in the nucleus**

Summary of HSV Replication



HSV

- Can cause lytic (productive), persistent and latent infection. Latent virus may undergo reactivation.

- Primary infection: (lytic infection)
  - High concentration of replicating virus at infection site
- Persistent infection: (latent infection)
  - Viral genomes keep hidden from host immune responses
- Intermittent reactivation: (lytic infection)
  - Caused by external stimuli (HSV, VZV) or impairment of the host's immune response (HSV, VZV, EBV, CMV)

HSV

1. Herpes simplex virus 1 (HSV-1)
2. Herpes simplex virus 2 (HSV-2)
3. Varicella-zoster virus (VZV)
4. Epstein-Barr virus (EBV)
5. Cytomegalivirus (CMV)
6. Human herpesvirus 6 (HHV-6 ; 6A and 6B)
7. Human herpesvirus 7 (HHV-7)
8. Human herpesvirus 8 (HHV-8)

HSV

Some herpesviruses are predominantly:

- Neurotropic (HSV and VZV)
- Lymphotropic (EBV, HHV-6 and HHV-7)

3 broad groups (subfamilies)

1. Alphaherpesviruses (HSV, VZV) : rapid growth, latency in sensory ganglia
2. Betaherpesviruses (CMV) : slow growth, restricted host range
3. Gammaherpesviruses (EBV) : growth in lymphoblastoid cells

Seroprevalence & Transmission

Human Herpesviruses		
Virus	**Seroprevalence Among Young, U.S. Adults (%)**	**Mode of Transmission**
HSV-1	50	secretions, especially oral
HSV-2	25	secretions, especially genital
VZV	100	infected skin lesions; respiratory route (chickenpox)
EBV	75	oral secretions, blood, transplanted organs
CMV	50	oral or genital secretions, urine, breast milk, blood, transplanted organs
HHV-6	100	oral secretions
HHV-7	100	oral secretions, breast milk
HHV-8	<10	bodily secretions

Adapted from: Prober C. *NEJM 2005;*352(8):753-5

Persistence & Infection

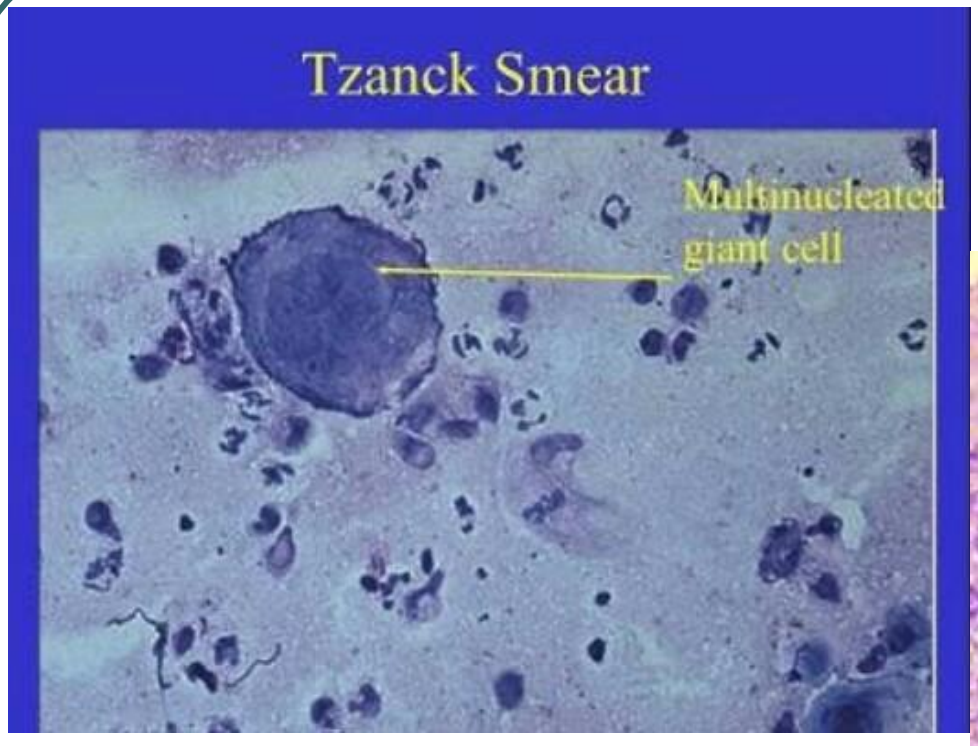
Human Herpesviruses		
Virus	**Site of Latency**	**Common Infections**
HSV-1	neuronal cells, especially trigeminal ganglia	herpes labialis, herpes whitlow, herpetic keratitis, herpes simplex encephalitis
HSV-2	neuronal cells, especially sacral dorsal root ganglia	herpes genitalis, herpes proctitis, neonatal herpes
VZV	neuronal cells, especially posterior root ganglia	chickenpox, herpes zoster (shingles)
EBV	B lymphocytes	infectious mononucleosis, prolonged fever, multiorgan manifestations
CMV	monocytes, macrophages	infectious mononucleosis, prolonged fever
HHV-6	T lymphocytes	febrile illness, roseola
HHV-7	T lymphocytes	febrile illness, roseola
HHV-8	not established	Kaposi's sarcoma

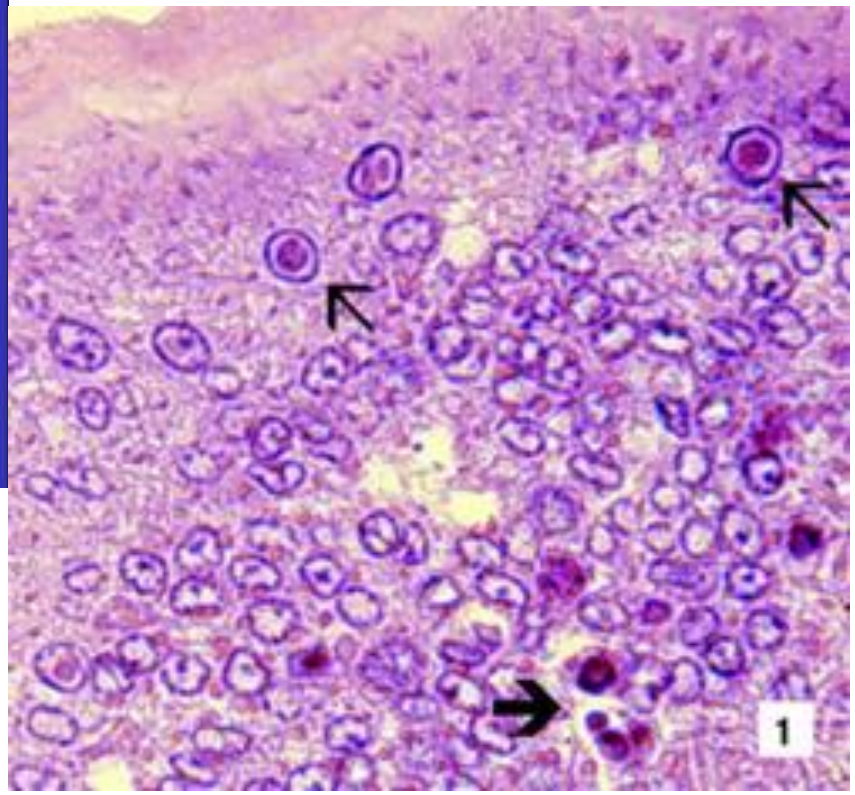
Adapted from: Prober C. *NEJM 2005;*352(8):753-5

HSV-1 & -2

LOCALIZED INFECTION

- **Primary infection**
  - **Masa inkubasi: 4-6 hari**
  - **Cell lysis, local inflammation → vesicles (Tzank cell dan eosinophilic inclusion bodies)**
  - **Regional lymphatics dan lymph nodes → penyakit disebarluaskan pada host yg susceptible**
  - **Masa infeksi: 10-14 hari**
  - **Virus menetap : latent infection**

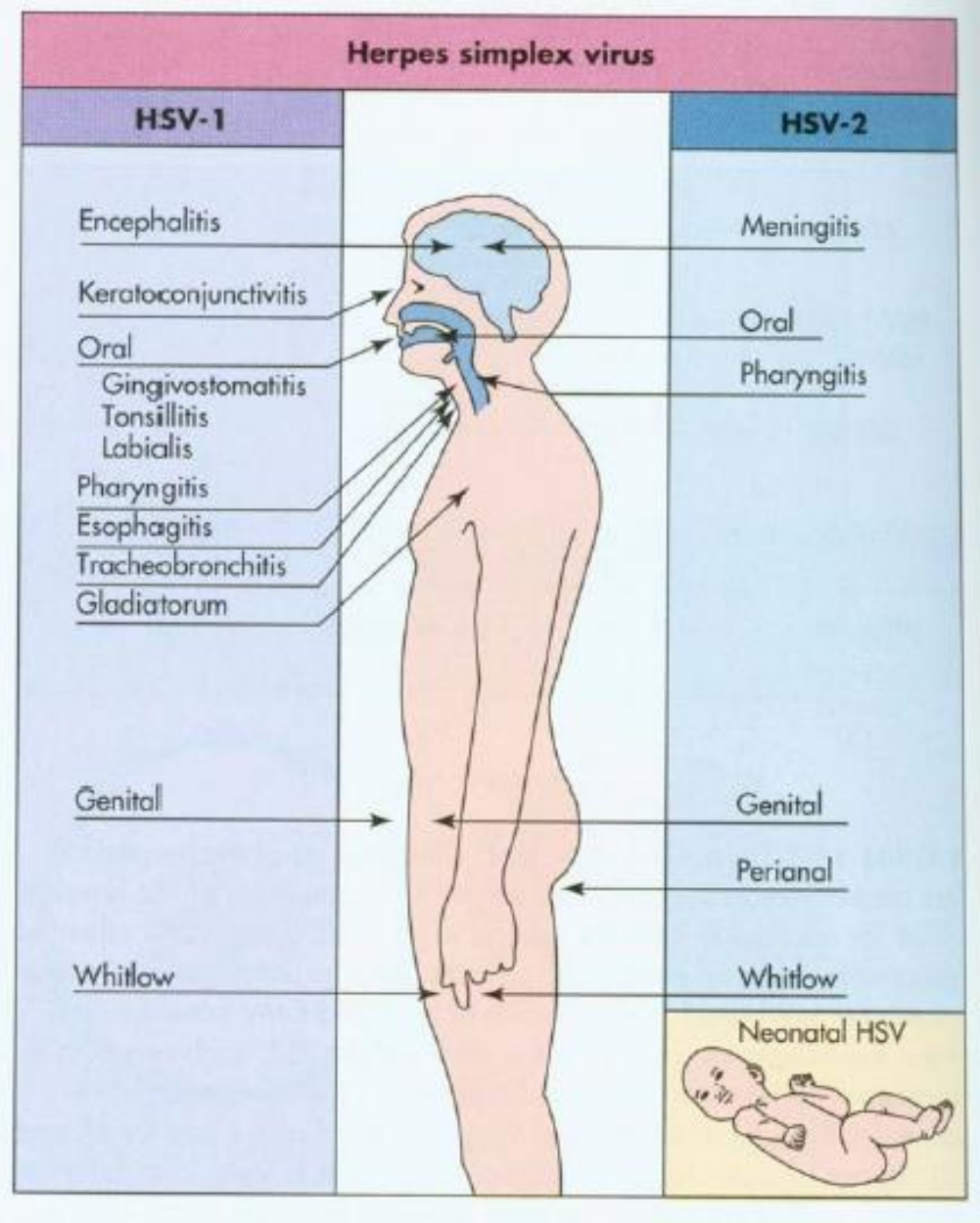

Tzanck Smear
Multinucleated
giant cell


1

HSV-1 & -2

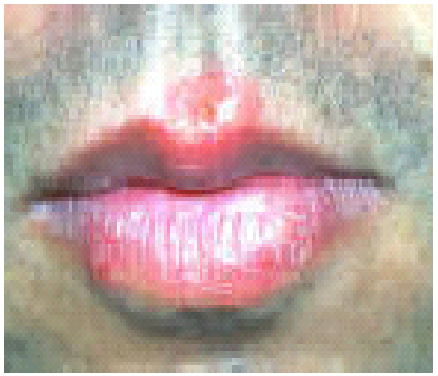
- **Reactivation disease**
  - **External stimuli – stress, menstruation, UV light, fever, trauma**
  - **Immunitas terganggu : infeksi HIV**
  - **Gejala prodromal : kesemutan, gatal, rasa terbakar**
  - **Lebih ringan dari infeksi primer/ asymtomatik**

Clinical features of HSV-1 and 2



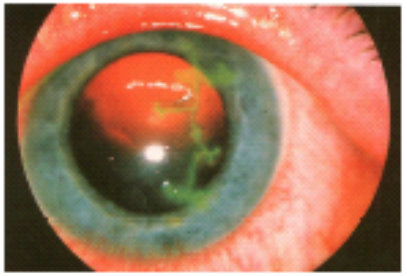
HSV-1 recurrent infection

- Herpes labialis
- Keratoconjunctivitis
- Encephalitis
- Herpetic Whitlow



HSV infection -complications-

- Erythema multiforme
- Blindness
- Encephalitis
- Disseminated HSV in immunocompromised
- Herpetic Whitlow
- Neonatal



HSV-2 primary infection

- Vulvovaginitis
- Neonatal infection

Skin lesions of a newborn with HSV-2 infection

HSV-2 recurrent infection

- Genital herpes
- Meningoencephalitis
- Herpetic Whitlow

HSV-1 & -2

DIAGNOSTIC

- **Viral DNA : PCR**
- **Electron microscopy**
- **Biopsy dan tissue culture**
- **Complement fixation tes (primary infection)**
- **Enzym imunoassay**

HSV

- Terapi
  - Aciclovir (topical, oral and intravenous)
    - Topical :
      - epitelial lesions
    - Oral and intravenous :
      - any deeper lesions,
      - disease in immunocompromised hosts,
      - central nervous system and other systemic infection, any of serious manifestations

HSV

Table 3. Recommended Regimens for Genital Herpes

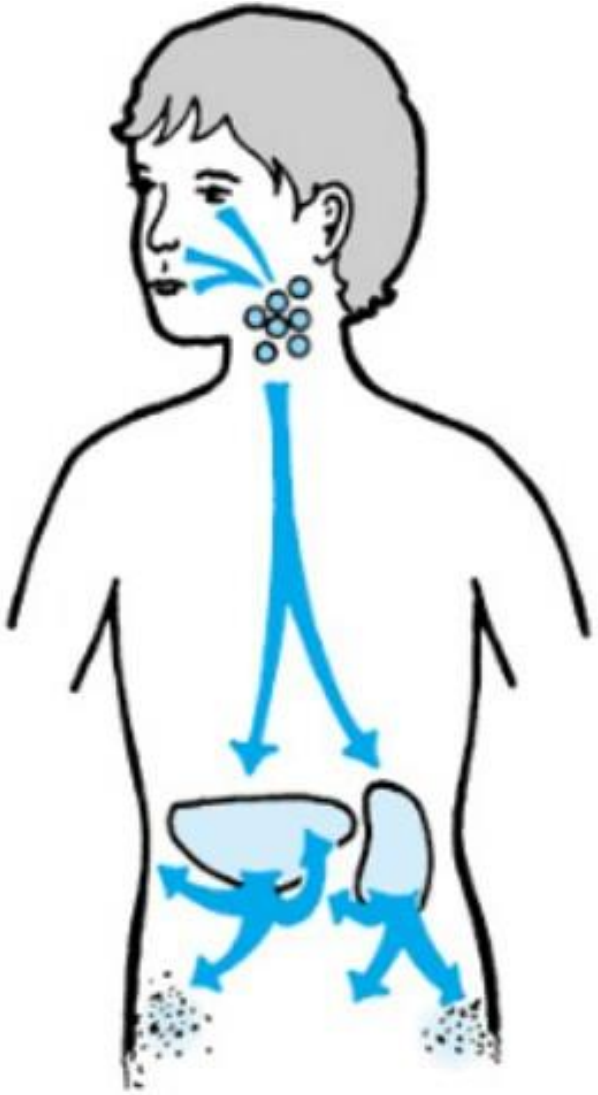
First Episode	Recurrent Episodes	Daily Suppressive Therapy
Acyclovir 400 mg po tid for 7-10 days	Acyclovir 400 mg po tid for 5 days	Acyclovir 400 mg po bid × 1 year
Acyclovir 200 mg po 5 times a day for 7-10 days	Acyclovir 800 mg po bid for 5 days	Famciclovir 250 mg po bid × 1 year
Famciclovir 250 mg po tid for 7-10 days	Acyclovir 800 mg po tid for 2 days	Valacyclovir 500 mg po daily × 1 year[a]
Valacyclovir 1 g po bid for 7-10 days	Famciclovir 125 mg po bid for 5 days	Valacyclovir 1 g po daily × 1 year
	Famciclovir 1 g po bid for 1 day	
	Famciclovir 500 mg po × 1 dose, then 250 mg po bid for 2 days	
	Valacyclovir 500 mg po bid for 3 days	
	Valacyclovir 1 g po once daily for 5 days	

[a] *May be less effective in those with ≥10 episodes per year. Source: Reference 2.*

Varicella-Zoster Virus

- Dua Bentuk

1. *Varicella* (chickenpox) : erupsi umum
2. *Zoster* (shingles) : infeksi reaktivasi dengan lokasi ke satu atau beberapa dermatome



Infection of conjunctivae and/or mucosa of upper respiratory tract — DAY 0

Viral replication in regional lymph nodes

Primary viremia — DAY 4-6

Viral replication in liver, spleen and (?) other organs

Secondary viremia

Infection of skin and appearance of vesicular rash — DAY 14

INCUBATION PERIOD

VZV

Clinical Presentations

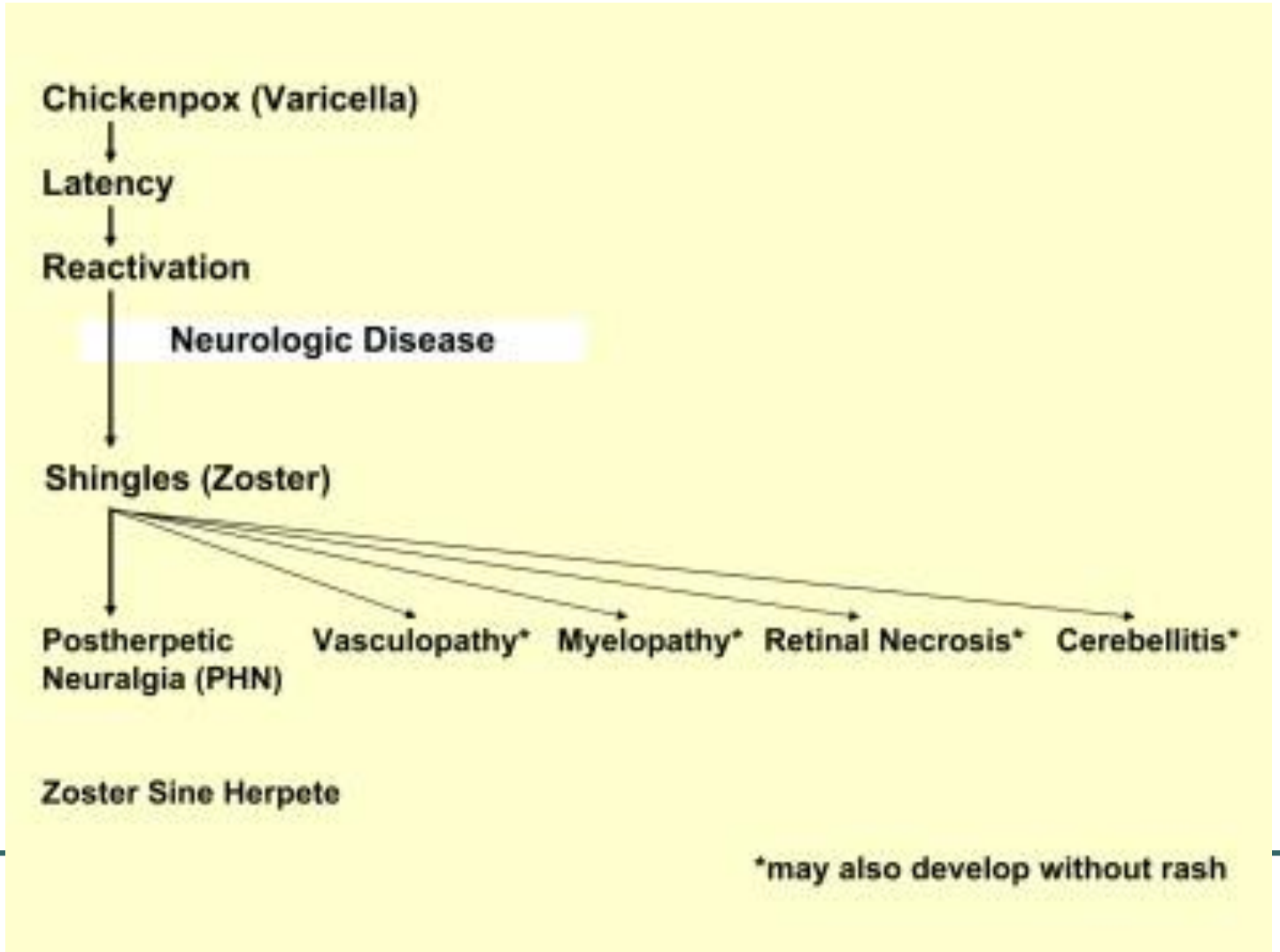
- **Primary infection = varicella (chickenpox)**
  - **≈ masa inkubasi 14 hari**
  - **Karakteristik : demam dan lesi vesicular, centripetal (dada dan kepala)**
  - **Anak : self-limiting**
  - **Lebih parah : dewasa dan immunocompromised**
  - **Mekanisme latensi belum diketahui dng pasti spt HSV**

VZV

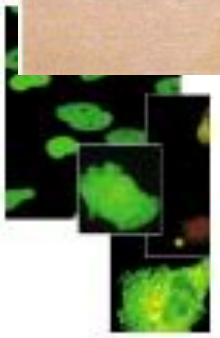
Clinical Presentations

- **Reactivation pada orang dewasa = zoster (shingles)**
  - **Nyeri unilateral vesicular rash**
  - **Dermatomally distribusi (T3-T12; L1-L2; V1)**
  - **Vesicles hilang 2-3 minggu – jaringan parut**
  - **Komplikasi: post-herpetic neuralgia**
  - **Lebih parah, pada penderita immunocompromised → encephalitis**

VZV


Chickenpox (Varicella)
Latency
Reactivation
Neurologic Disease
Shingles (Zoster)
Postherpetic Neuralgia (PHN)
Vasculopathy*
Myelopathy*
Retinal Necrosis*
Cerebellitis*
Zoster Sine Herpete
*may also develop without rash

Chickenpox (VZV)



Scraping/IFA
Culture
Serology
PCR

Shingles
-dermatomal distribution-

VZV

Laboratory diagnosis

- Antigen detection by PCR
- IgM VZV, IgG VZV

Antiviral Therapy for Herpes Zoster

Medication	Typical Dosing
Acyclovir (Zovirax®)	800 mg 5x/day, 7-10 days
Famciclovir (Famvir®)	500 mg 3x/day, 7 days
Valacyclovir (Valtrex®)	1000 mg 3x/day, 7 days

Zovirax Package Insert, GlaxoSmithKline.
Famvir Package Insert, Novartis Pharmaceuticals.
Valtrex Package Insert, GlaxoSmithKline.

CYTOMEGALOVIRUS

CLINICAL PRESENTATIONS

Normal host:

- **Primary infection - CMV mononucleosis**
  - **Terjadi pada anak-anak atau dewasa**
  - **Masa inkubasi : 20-60 hari**
  - **Penyakit 2-6 minggu**
    - **fever, chills, myalgias, malaise, lethargy, leukopenia, mild dyspnea**
  - **Pasien sembuh tanpa gejala sisa**
  - **Postviral asthenia dapat bertahan berbulan-bulan**
- **Primary infections: hepatitis, congenital**
- **Reactivation infection belum dapat dijelaskan dng baik**

CMV

Immunocompromised host:

- Primary & reactivation infection - invasive disease
  - Pneumonitis, esophagitis, colitis, hepatitis, pancreatitis, retinitis (can lead to blindness)
- Lethal Syndrome
  - Severe hypoxia, respiratory failure, hypotension, GI hemorrhages, superinfections
- Prolonged fever, malaise, fatigue, night sweats, arthralgias, myalgias
- Infeksi oportunistik dan dapat mengancam jiwa pd pasien AIDS

CMV

DIAGNOSTIC

- **PCR**
- **Culture**
- **Complement fixation tes**
- **Enzyme immunoassay**
- **Ig G**

EPSTEIN-BARR VIRUS

EBV primary infection is

- **Gejala paling sering asymtomatik dan terjadi pada usia dini**
- **Infectious mononucleosis klasik (*glandular fever*) pada remaja di Negara maju**

EBV

CLINICAL PRESENTATIONS

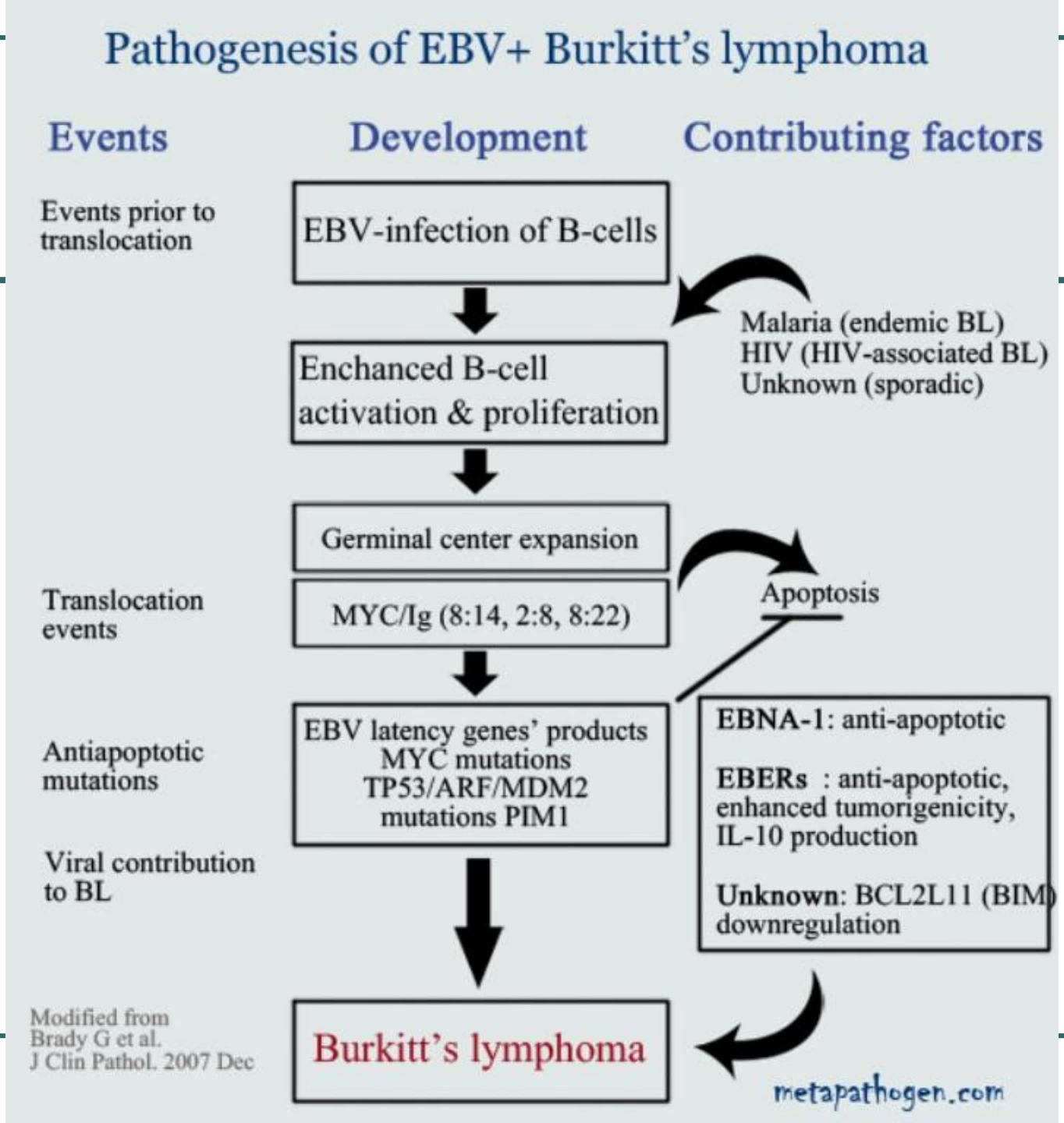
Normal host:

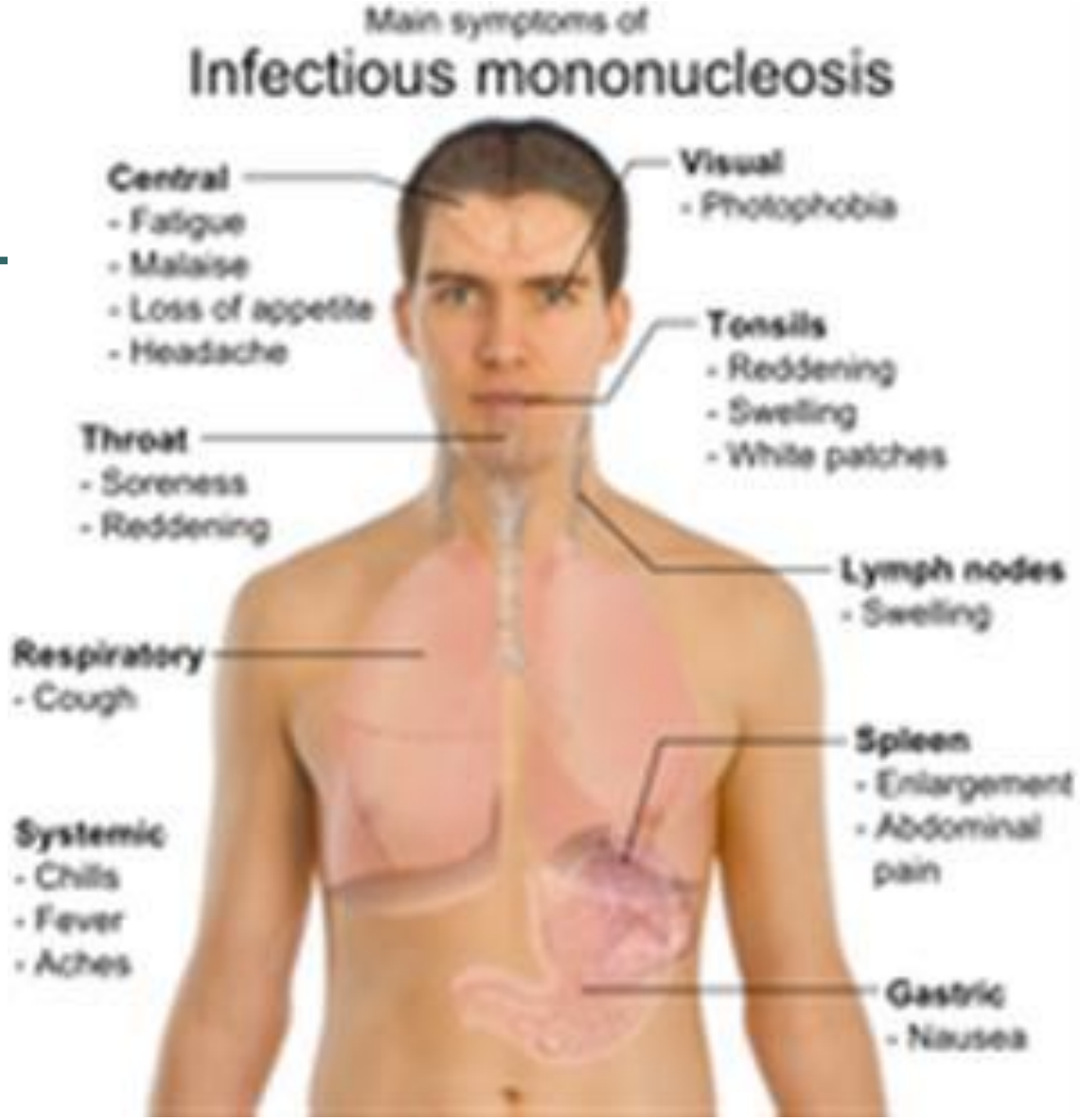
- **Primary infection - infectious mononucleosis – glandular fever**
  - **Sering pada remaja dan dewasa (15 – 25 tahun)**
  - **Infants & children : asymptomatic/nonspecific**
  - **Prodromal 7-hari; 4-hari sd 3-minggu acute illness**
  - **Fever, lymphadenopathy, tonsil membesar, pharyngitis (> 50%)**
  - **Splenomegaly, hepatomegaly, joundice (> 10%)**
  - **Leukocytosis**
  - **Proliferasi dan activasi CD4/CD8 sel yang merespon infeksi**

EBV

Immunocompromised host:

- **Primary & reactivation infection**
  - **Polyclonal & monoclonal lymphoproliferative disorders (post-transplantation)**
  - **Oral Hairy Leukoplakia - nonmalignant hyperplastic lesion of epithelial cells (tongue) usually seen in HIV/AIDS**
- **Association with human cancers:**
  - **Burkitt's lymphoma, nasopharyngeal carcinoma, Non-Hodgkin's lymphoma, CNS lymphoma**


Pathogenesis of EBV+ Burkitt's lymphoma
Events
Development
Contributing factors
Events prior to translocation
EBV-infection of B-cells
Malaria (endemic BL)
HIV (HIV-associated BL)
Unknown (sporadic)
Enchanced B-cell activation & proliferation
Germinal center expansion
Translocation events
MYC/Ig (8:14, 2:8, 8:22)
Apoptosis
Antiapoptotic mutations
EBV latency genes' products
MYC mutations
TP53/ARF/MDM2 mutations PIM1
EBNA-1: anti-apoptotic
EBERs : anti-apoptotic, enhanced tumorigenicity, IL-10 production
Unknown: BCL2L11 (BIM) downregulation
Viral contribution to BL
Burkitt's lymphoma
Modified from Brady G et al. J Clin Pathol. 2007 Dec
metapathogen.com


Main symptoms of
Infectious mononucleosis
Central
- Fatigue
- Malaise
- Loss of appetite
- Headache
Visual
- Photophobia
Tonsils
- Reddening
- Swelling
- White patches
Throat
- Soreness
- Reddening
Lymph nodes
- Swelling
Respiratory
- Cough
Spleen
- Enlargement
- Abdominal pain
Systemic
- Chills
- Fever
- Aches
Gastric
- Nausea

EBV

Terapi :

- Acyclovir (acute)
- Immunoterapy
- Reducing immnosuppression in transplant recipients
- Monoclonal antibody CD20 (a marker for the B cell immunoblast) : tumour

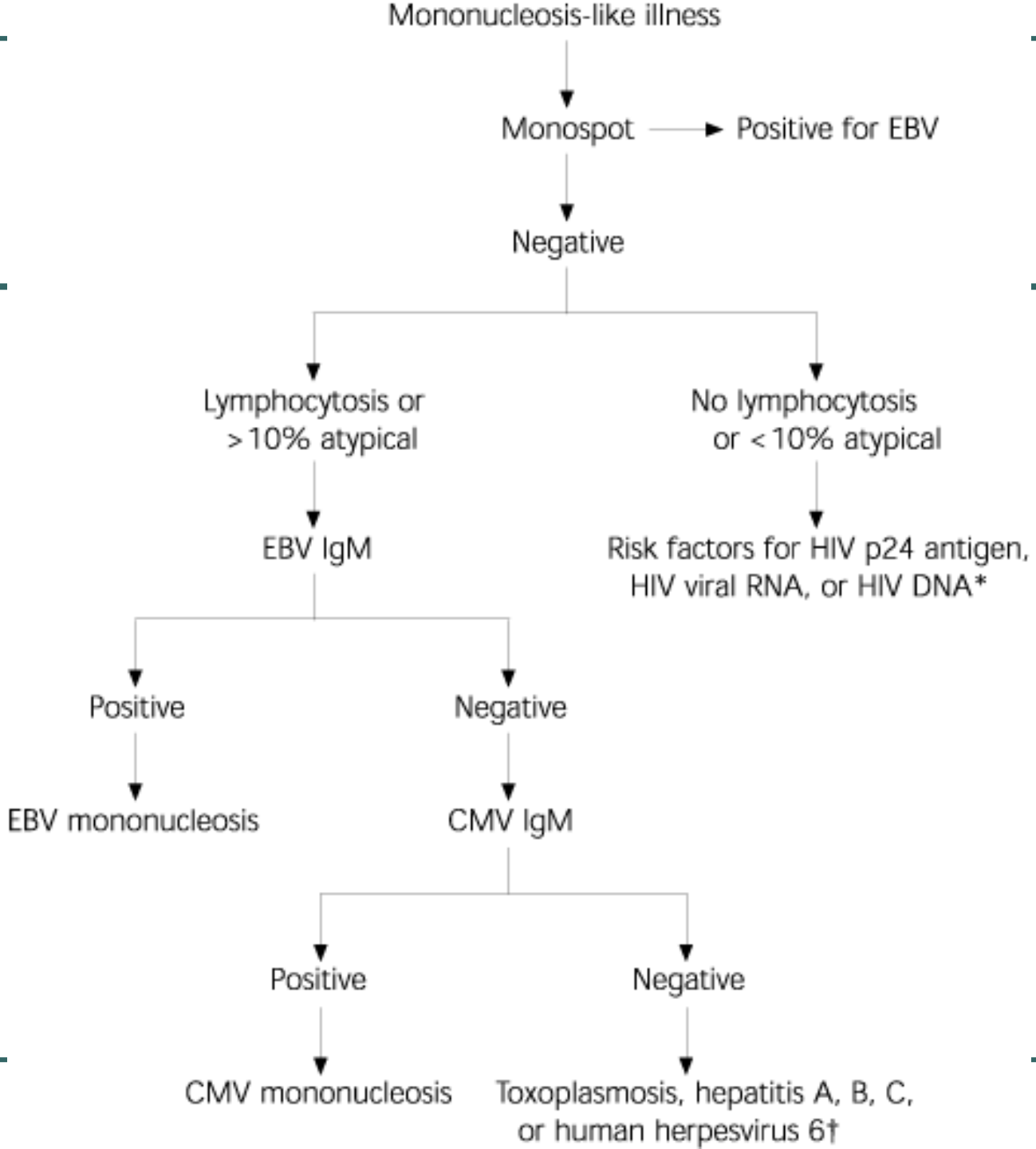
EBV

Table 1

Clinical and Laboratory Manifestations of Infectious Mononucleosis

Clinical (Frequency)	Laboratory (Frequency)
Fever (76%)	Atypical lymphocytes (>10%)
Hepatomegaly (12%)	Heterophile antibodies (90% in adolescents and adults)
Lymphadenopathy (94%)	Lymphocytosis (>50%)
Malaise, fatigue (57%)	Mild thrombocytopenia (25%-50%)
Pharyngitis, sore throat (82%)	Permanent antibodies to Epstein-Barr virus (100%)
Rash (10%)	
Splenomegaly (52%)	

Source: References 1, 5, 19.


Mononucleosis-like illness
Monospot
Positive for EBV
Negative
Lymphocytosis or >10% atypical
No lymphocytosis or <10% atypical
EBV IgM
Risk factors for HIV p24 antigen, HIV viral RNA, or HIV DNA*
Positive
Negative
EBV mononucleosis
CMV IgM
Positive
Negative
CMV mononucleosis
Toxoplasmosis, hepatitis A, B, C, or human herpesvirus 6†

Human herpes virus 6 dan 7

- HHV 6 – 7 : persisten in saliva and female genital secretion
- HHV 7 : in breast milk
- Roseola infantum (exanthem subium)
  - Acut febril 39,4-39,7˚C (20% childhood) selama 3 hari, macular rash
  - Troat congestion
  - Cervical lymadenopathy
  - Kadang : respiratory symptoms dng kejang demam

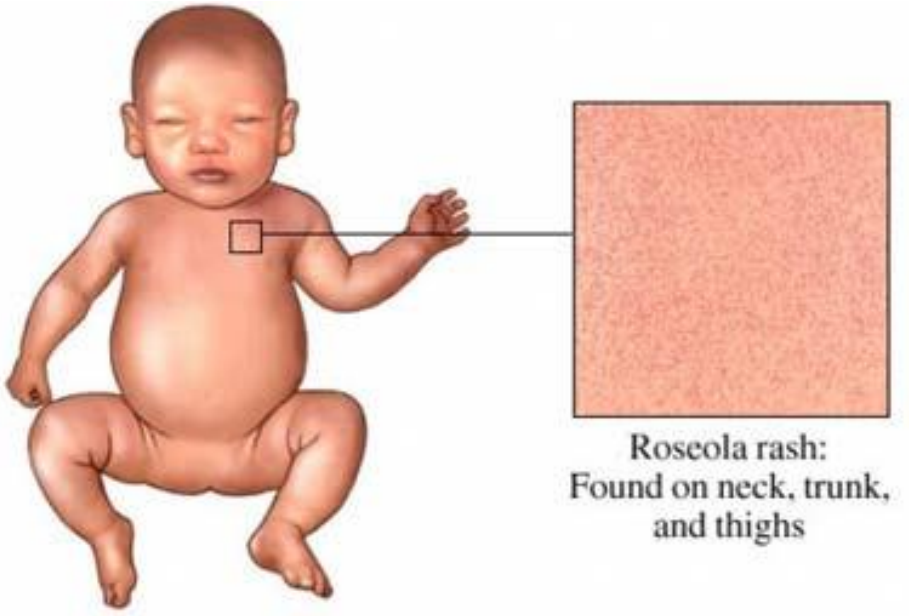
HHV 6 – 7

Laboratory

- PCR
- IgG

Terapy

- Geniciclovir
- Cidofovir



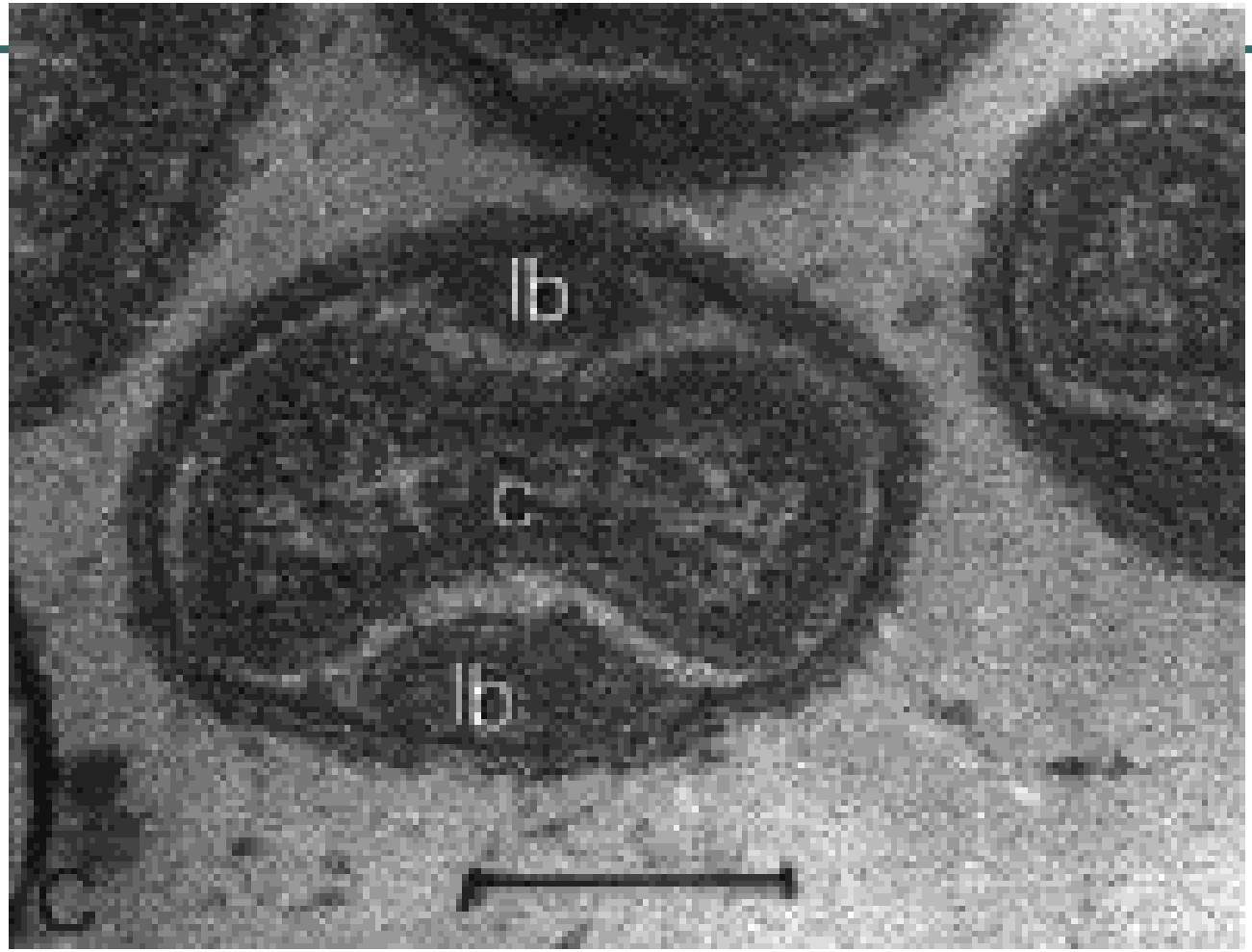
HHV 8

- *Kaposi's sarcoma-associated herpesvirus*
- Mucocutaneus neoplasma (the commonest tumour in one group o HIV)
- Transmitted : sexsual, rarely by blood
- Laboratory : PCR

VIRUS DNA

POXVIRUS

POXVIRUSES

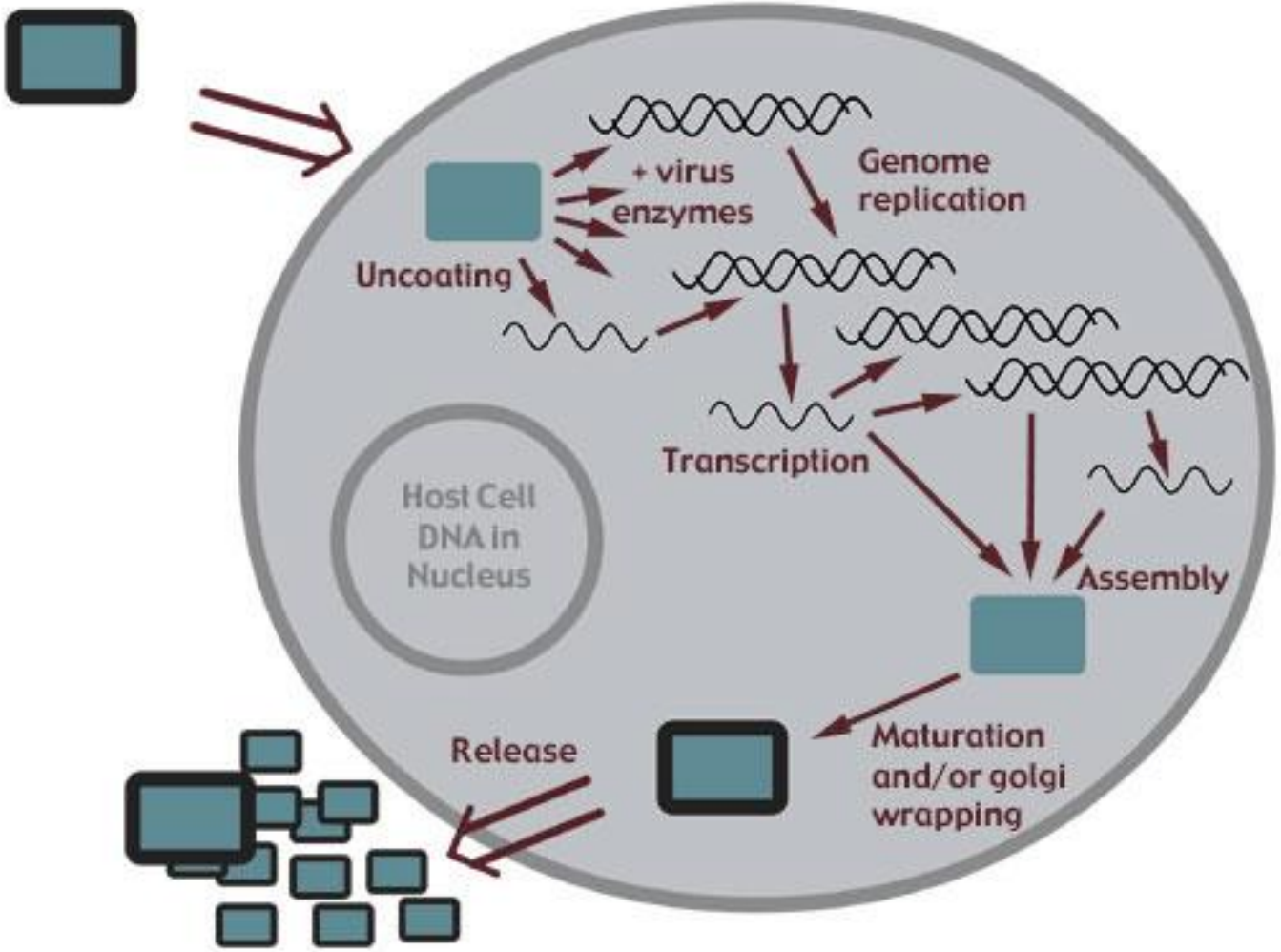


POXVIRUSES

Characteristics

- Large virus 200-300nm
- Brick shape
- Double stranded DNA
- Enveloped
- Cytoplasmic site of replication
- Encodes own multi-subunit RNA polymerase

Replication of Poxviruses



POXVIRUSES

Variola (Smallpox)

- Two variants ; variola major (mortality 15% to 40%) dan variola minor (mortality 1%)
- Variola (Smallpox) : infeksi tractus respiratory dan local lymph glands, menyebabkan viremia
- Inkubasi; 5-17 hari rata-rata 12 hari

POXVIRUSES

Variola (Smallpox)

- **Smallpox : acute exanthematous disease disebabkan infeksi poxvirus /variola.**
- **Gambaran klinis:**
  - **Prodromal 3 hari (fever, headache, backache dan vomiting).**
  - **Centrifugal rash dimulai central – ekstremitas – muka**
  - **Papules, vesicles, pustules, umbilication, dan krusta selama 14-hari.**

Variola (Smallpox)

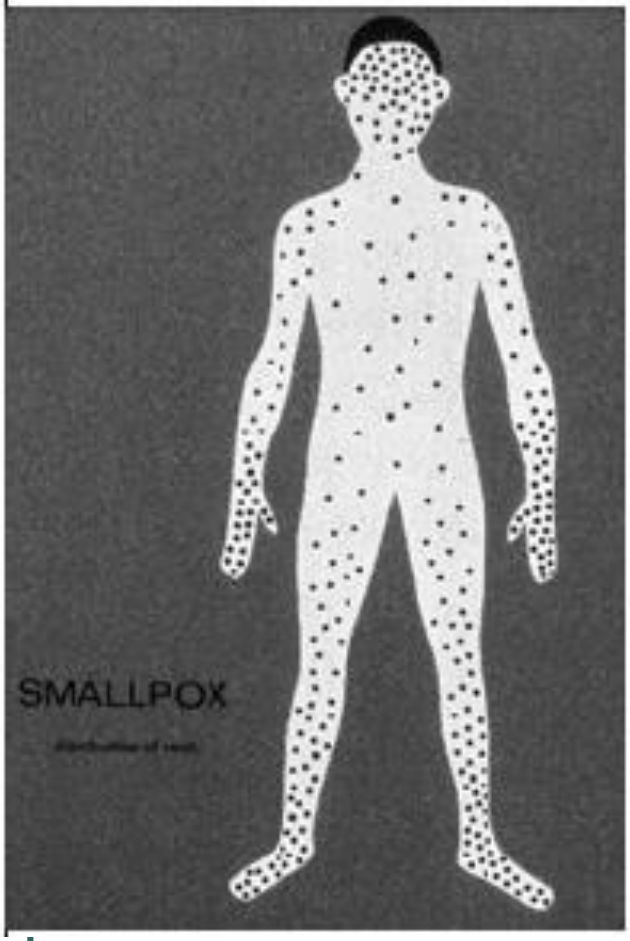
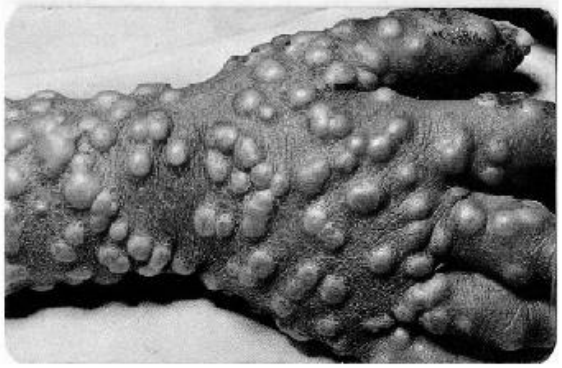


Chart from the Center for Disease Control and Prevention showing the characteristic distribution of smallpox lesions.

(From Creager JG et al., Microbiology Principles and Applications, 1990, P. 279)

Variola (Smallpox)



Smallpox on the hand: Notice how these lesions have become confluent.

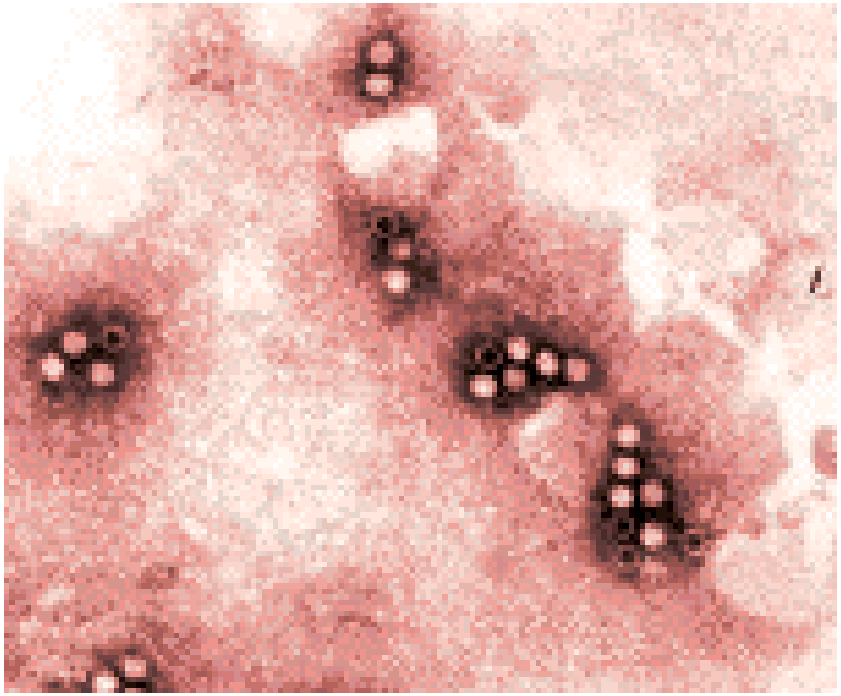
Variola (Smallpox)

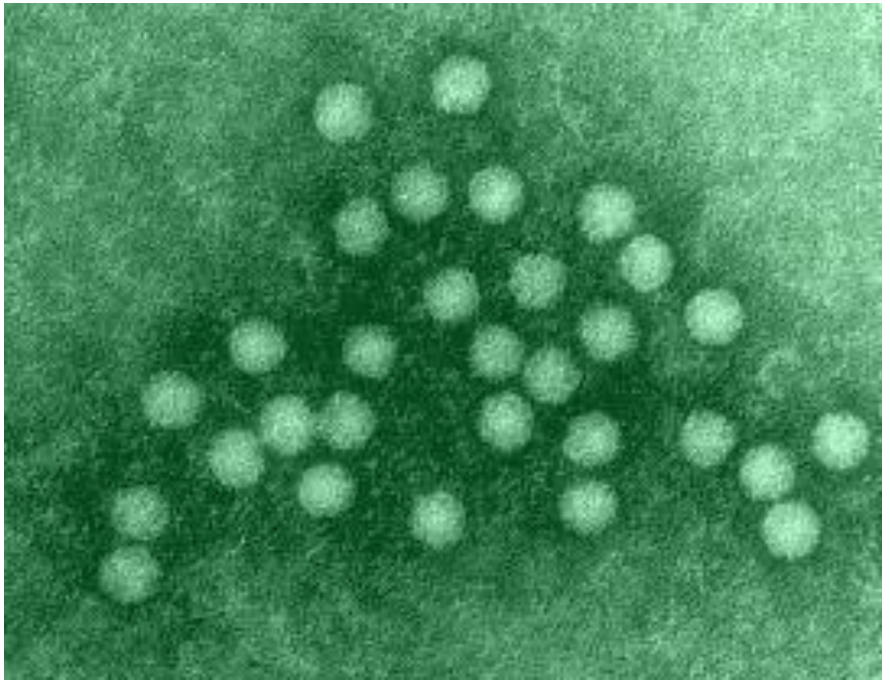
Smallpox in a child: Notice the characteristic distribution of the lesions, more concentrated on the distal extremities and face and less concentrated on the trunk.

VIRUS DNA

PARVOVIRUS

PARVOVIRUSES





PARVOVIRUSES

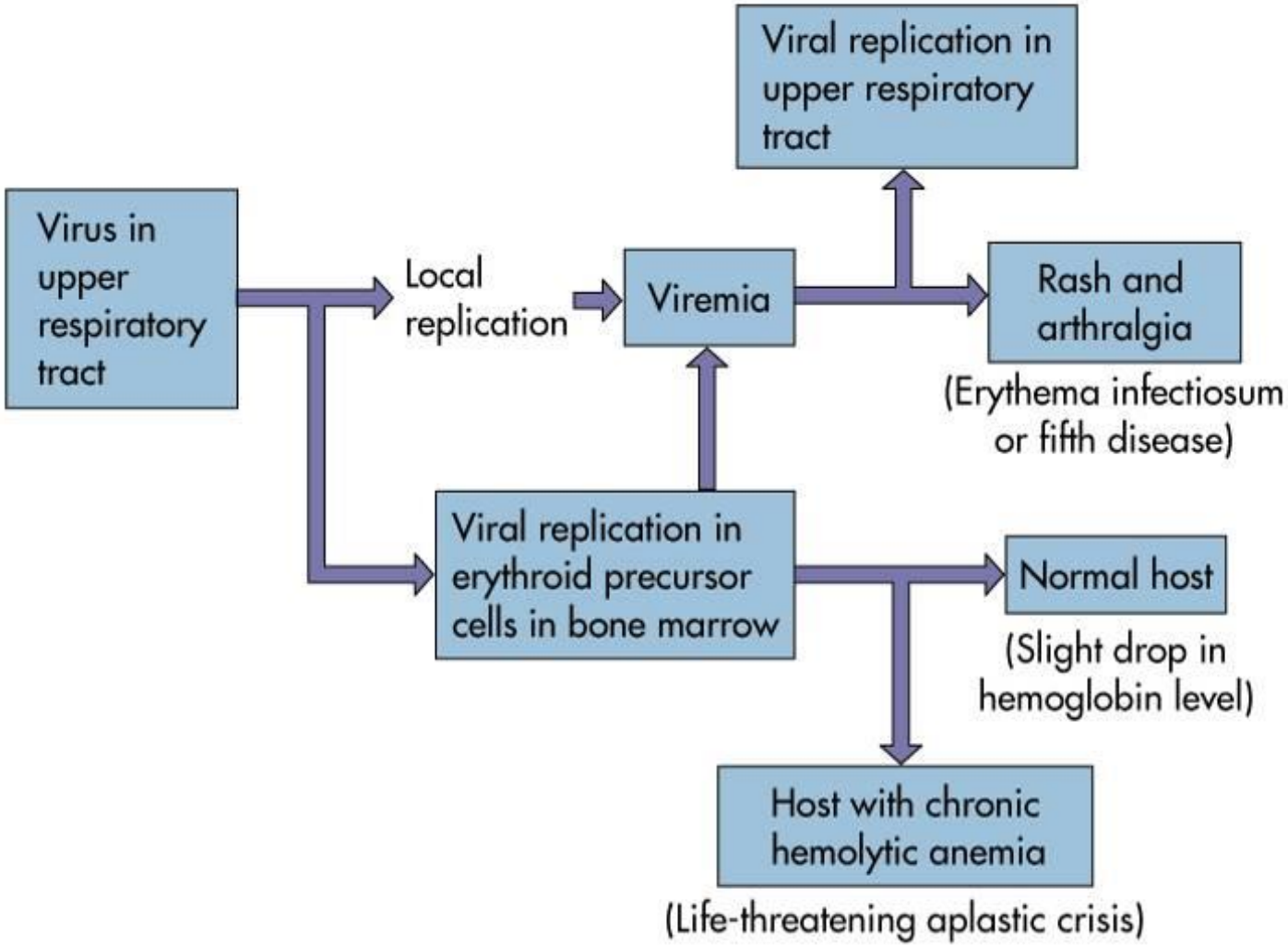
Characteristics

- Very small (22nm)
- Non-enveloped
- Icosahedral
- Single-stranded DNA virus

PARVOVIRUSES

- **Pathogenesis**
  - **Transmisi mll respiratori**
  - **replication di nucleus**
  - **viremia**
  - **Kekebalan : antibody**

Parvovirus pathogenesis



From Medical Microbiology, 5th ed., Murray, Rosenthal & Pfaller, Mosby Inc., 2005, Fig. 56-3.

PARVOVIRUSES

- **Pathogenesis**

  Targets erythroid lineage cells;

  a. erythrema infectiosum atau fifth disease; self-limited febrile illness pada anak dengan rash dimuka ("slapped cheek" syndrome)– sering pd 4-15 tahun

  - **mild rash, acute arthritis**

  b. Replikasi di sel darah merah

  - **Anemia kronis, immune suppression (idiopathic anemia aplasia pada pasien AIDS), transient aplastic crisis, sickle-cell anemia**

PARVOVIRUSES

- **Pathogenesis**

  c. Dapat menyebabkan spontaneous abortion;

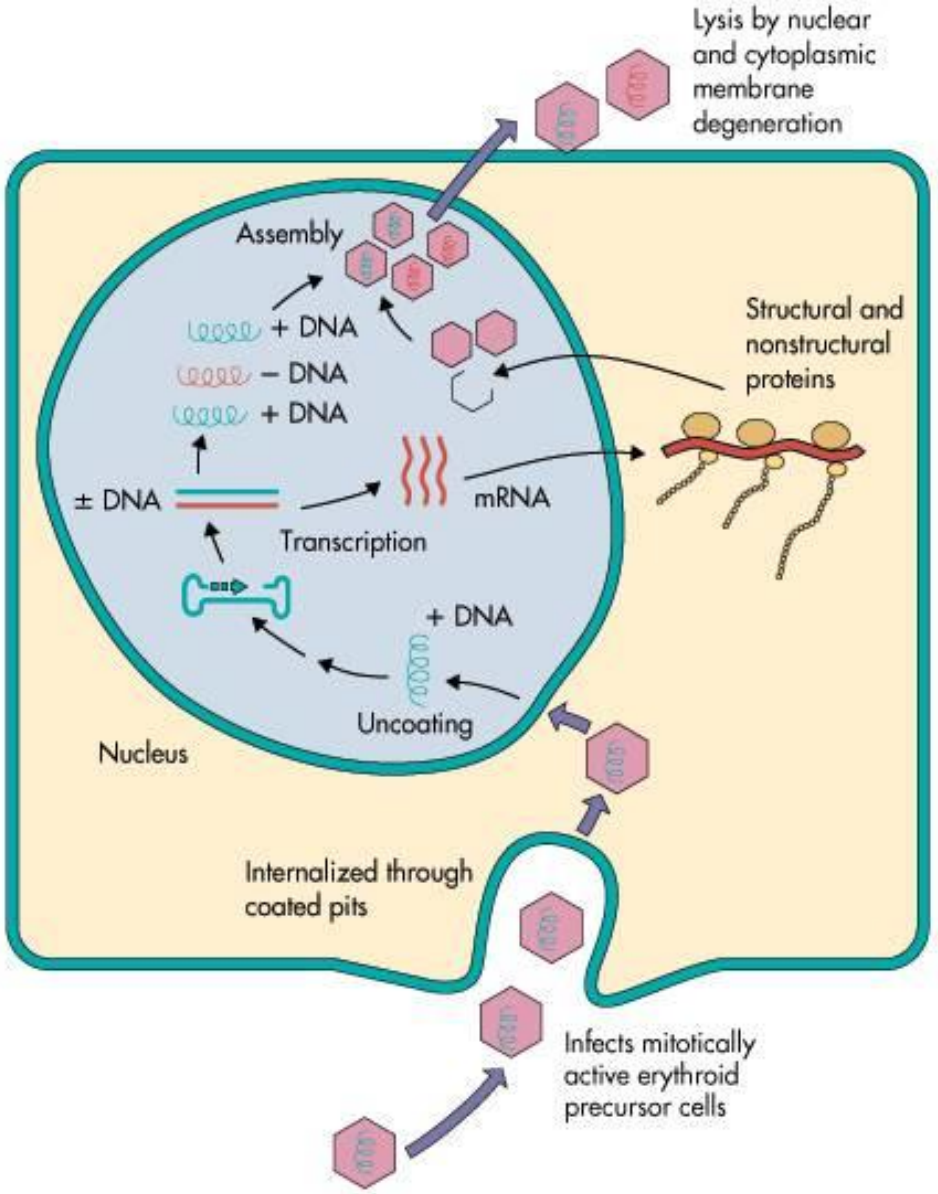
  - **hydrops fetalis; severe anaemia, congestive heart failure, generalized edema and fetal death**

  d. Jarang : rheumatoid arthritis pada dewasa muda atau hepatitis pada anak

PARVOVIRUSES

- **Diagnosis**
  - **serology, viral nucleic acid**
- **Treatment/prevention**
  - **antivirals dan normal human immunoglobulin (Neutralizing abtibodi)**
  - **none**

Autonomous parvovirus replication



SLAPPED-CHEEK SYNDROME

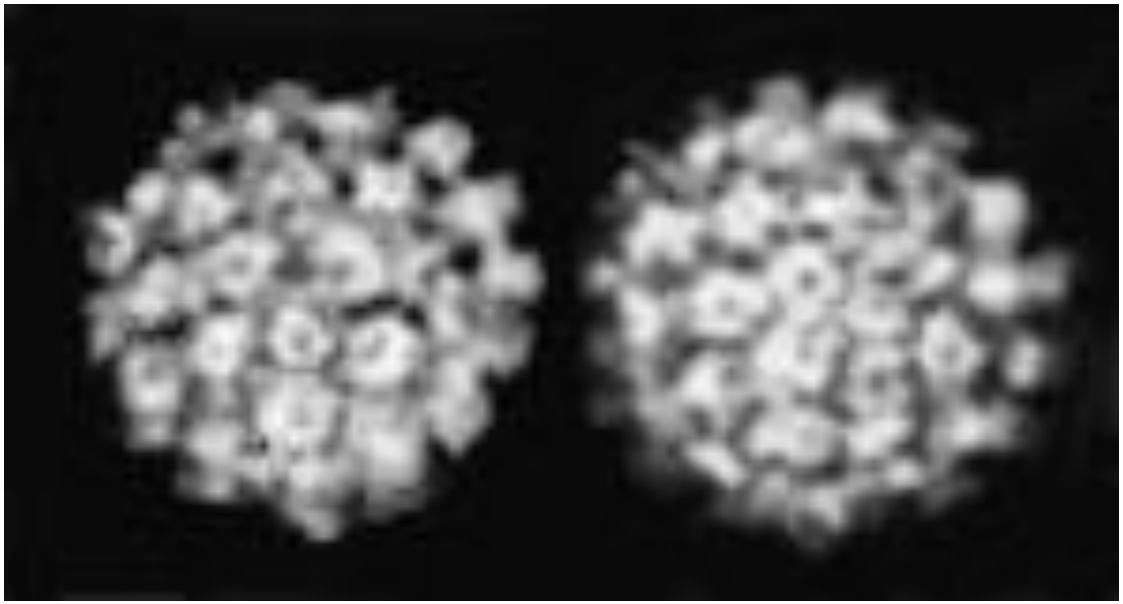
Click on image to see a close-up of a child with fifth disease.

A "slapped-cheek" appearance is typical of the rash for erythema infectiosum.(From Medical Microbiology, 5th ed., Murray, Rosenthal & Pfaller, Mosby Inc., 2005, Fig. 56-5.)

VIRUS DNA

PAPOVAVIRUS

HUMAN PAPOVAVIRUSES



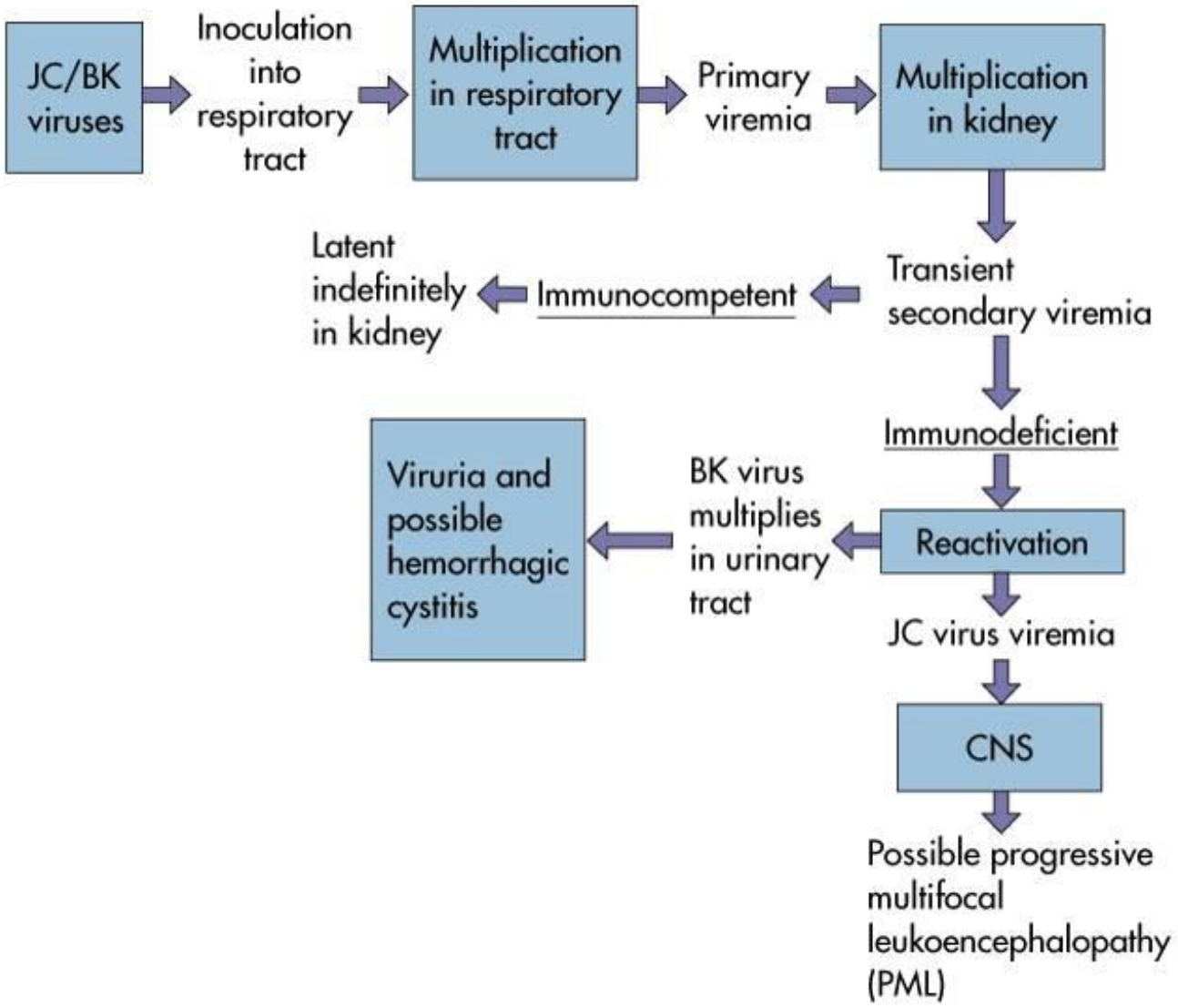
HUMAN PAPOVAVIRUSES

- Papilloma Polyoma Vacuolating agent
- Two subfamilies: Papillomavirinae, Polyomavirinae
- Penyebab warts dan cancer
- Viral STD
- Small (40-55 nm)
- Icosahedral
- ds DNA
- Non-enveloped

Major papovavirus diseases

- **Papillomavirus:**
  - **Genital warts, dan cancer**
- **Polyomaviruses:**
  - **JC (John Cunningham) Virus**
    - **Infeksi pd manusia**
    - **immunosuppressed**
  - **BK (Burger King) Virus**
    - **immunosuppressed**
    - **JC dan BK : cancer**
  - **Peran SV40 penyebab kanker pada manusia masih diperdebatkan**

Polyomavirus pathogenesis



From Medical Microbiology, 5th ed., Murray, Rosenthal & Pfaller, Mosby Inc., 2005, Fig.52-8.

Polyomavirus

Clinical syndromes

- **Infeksi primar : asymptomatis**
- **BK/JC virus; ekskresi di urine (40% pasien immunocompromised)**
- **Progressive multifocal leukoencephalophaty (jarang)**

Polyomavirus

Diagnosis

- **Biopsy or autopsy**
- **Electron microscopy**
- **PCR or DNA probe analysis**
- **Urine cytological tests**

Treatment

- **No specific treatment**

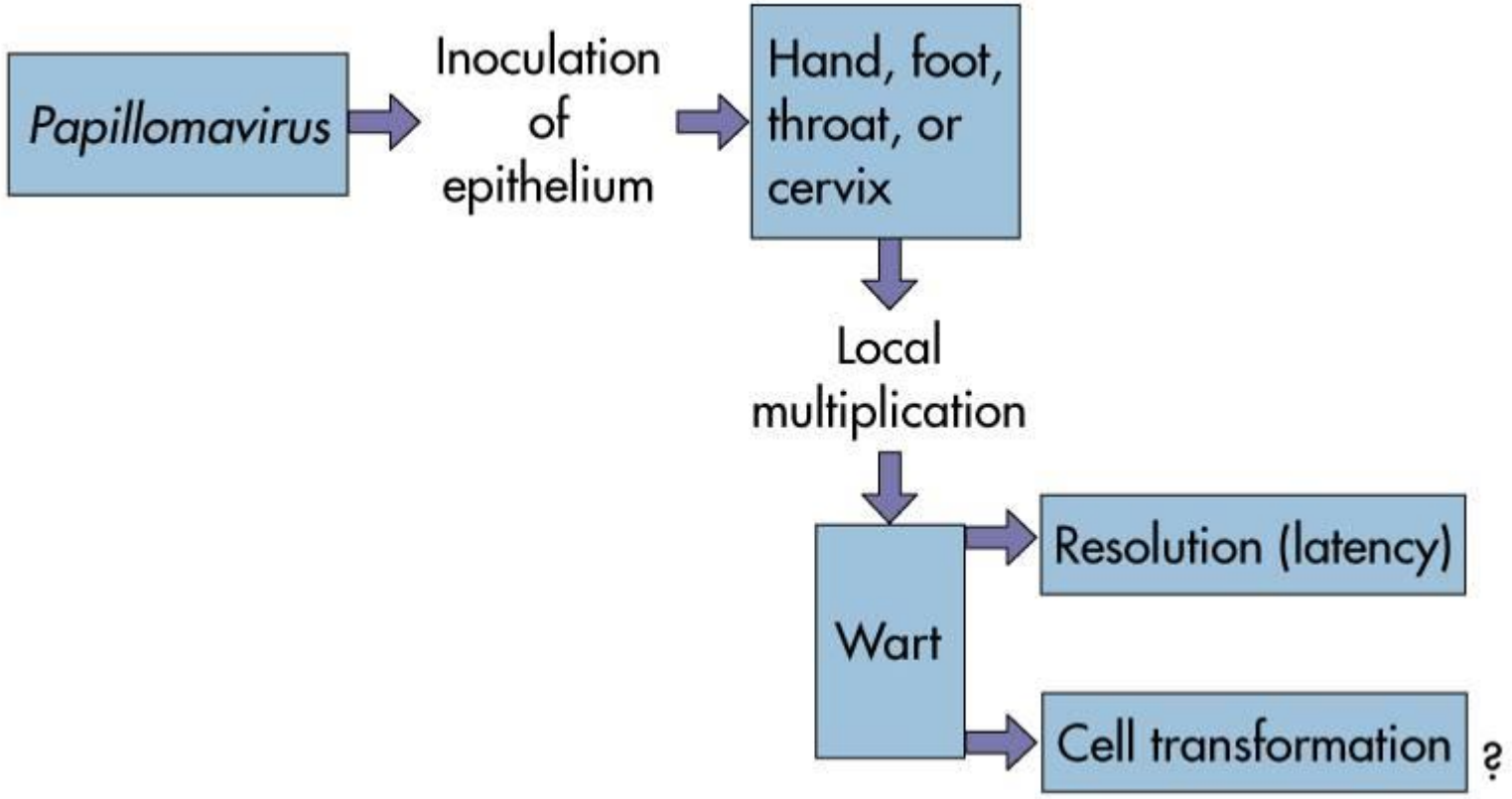
Papillomaviruses

- **Tropisme pada epithelium squamous**
  - **Warts dan papillomas**
- **Tempat infeksi**
  - **Cutaneous: Keratinized squamous epithelium**
  - **Mucosal: Non-keratinized squamous epithelium**

Papillomavirus

- **Pathogenesis**
  - **Transmisi : direct contact atau sexual; kulit, mucosa**
  - **replication di nucleus sel basal epithelium**
  - **no spread**
  - **Respon imun sel primer**
  - **Warts adalah tumor; cervical carcinoma (anogenital wart = *condylomata accuminata*)**

Papillomavirus pathogenesis



From Medical Microbiology, 5th ed., Murray, Rosenthal & Pfaller, Mosby Inc., 2005, Fig. 52-3.

Human Papillomaviruses (HPVs)

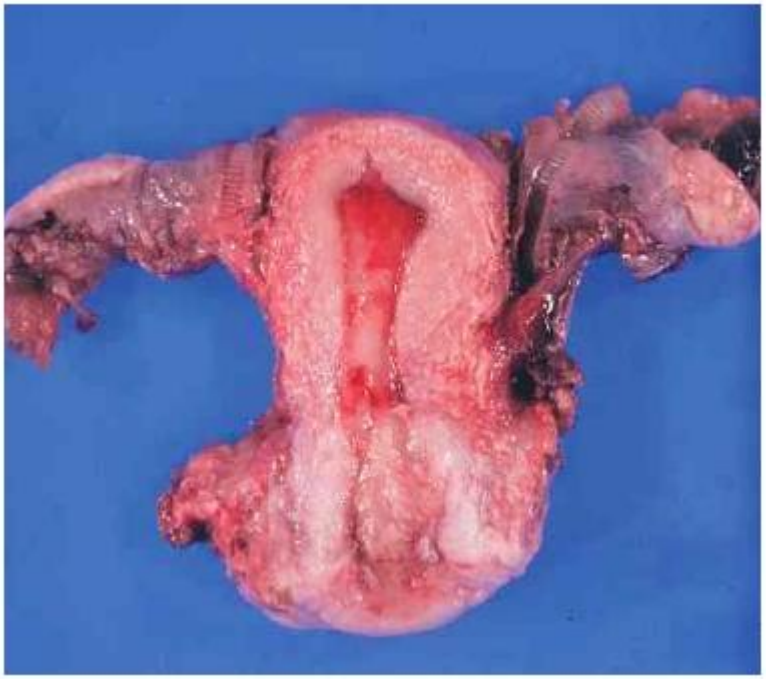
- HPV-1 — Plantar warts
- HPV-2, -4, .. — Common warts
- HPV-5, 8 … — Epidermodysplasia verruchiformis
- HPV-6, 11 — Genital warts
  40, 42, 53, 54, 66 . . } Low Risk
- HPV- 16, 18 — Cervical cancer
  31, 33, 35, 39, 45
  51, 52, 56, 58, 59, 66 ... } High Risk

Over 100 HPV types, ~ 30 infect the genital tract

Common warts/plantar warts

Condyloma acuminata

Cervical carcinoma



Anal carcinoma

Oral cancer

Papillomavirus

- **Diagnosis**
  - **cytology (PAP smear; koilocytosis)**
  - **immunohistochemistry**
  - **nucleic acid**
  - **electron microscopy**
- **Treatment/prevention**
  - **surgery**
  - **recombinant subunit (VLP) vaccine**

VIRUS DNA

HEPADNAVIRUS

Hepadnavirus – virus DNA

- ds DNA
- Disebut juga virus hepatitis B
- Hepatothropic
- Resiko berkembang menjadi liver carcinoma

Hepadnavirus – virus DNA

- **Incubation period:** Average 60-90 days
Range 45-180 days
- **Clinical illness (jaundice):** <5 yrs, <10%
5 yrs, 30%-50%
- **Acute case-fatality rate:** 0.5%-1%
- **Chronic infection:** <5 yrs, 30%-90%
5 yrs, 2%-10%
- **Premature mortality from chronic liver disease:** 15%-25%

Hepadnavirus – virus DNA

Spectrum of Chronic Hepatitis B Diseases

1. **Chronic Persistent Hepatitis – asymptomatic**
2. **Chronic Active Hepatitis - symptomatic exacerbations of hepatitis**
3. **Cirrhosis of Liver**
4. **Hepatocellular Carcinoma**

Hepadnavirus – virus DNA

Diagnosis : Serological test

- **HBsAg – antigen hepatitis serum.**
- **HBsAb – antibodi hepatitis serum : penyembuhan / kekebalan**
- **anti-HBc IgM – marker infeksi akut.**
- **anti-HBcIgG – marker infeksi kronis.**

Hepadnavirus – virus DNA

- **HBeAg – virus replikasi aktif.**
- **Anti-Hbe - virus tidak replikasi dalam waktu yang panjang.**
- **HBV-DNA – virus replikasi aktif, lebih akurat dibanding HBeAg, untuk kasus yang mengalami mutasi. Monitoring respon terapi.**

Hepadnavirus – virus DNA

Treatment

- **Interferon**
- **Lamivudine**
- **Adefovir**
- **Entecavir**

Hepadnavirus – virus DNA

Prevention

- **Vaccination**
- **Hepatitis B Immunoglobulin**
- **Other measures - screening of blood donors, blood and body fluid precautions.**

Wassalam