

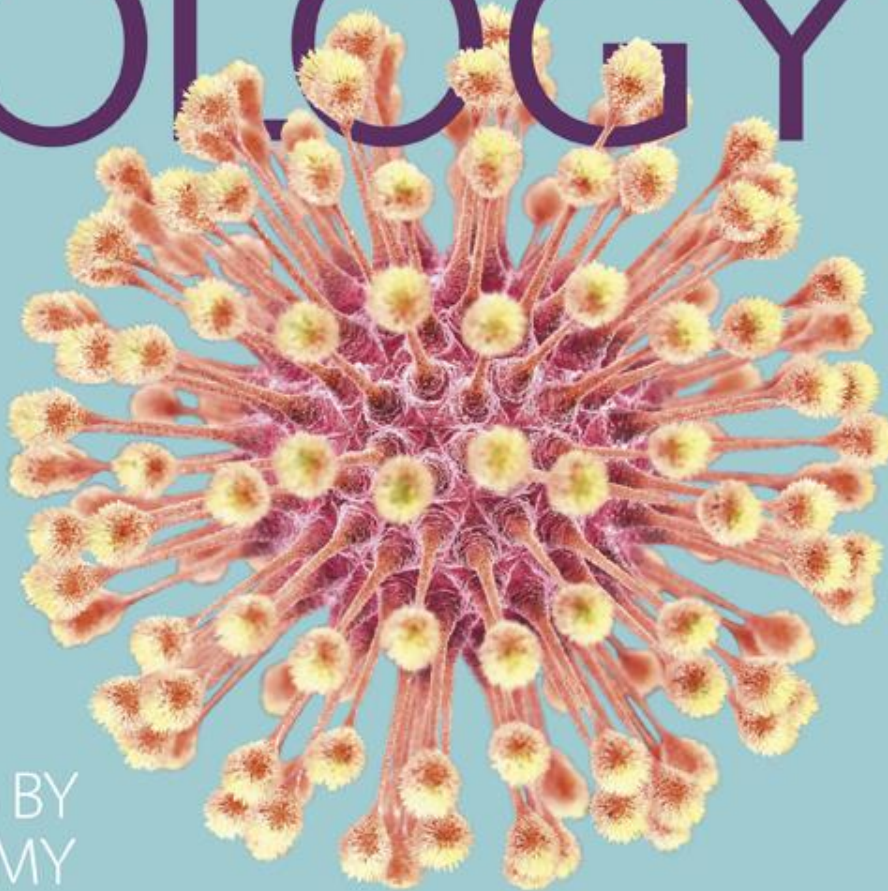
Chapter 24 – Pathogenic DNA Viruses

NIMESH PATEL | HLSC 2400

NOVEMBER 7, 2017

MICROBIOLOGY

5th Edition



WITH
DISEASES BY
TAXONOMY

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Presentations prepared by
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CHAPTER 24

Pathogenic DNA Viruses

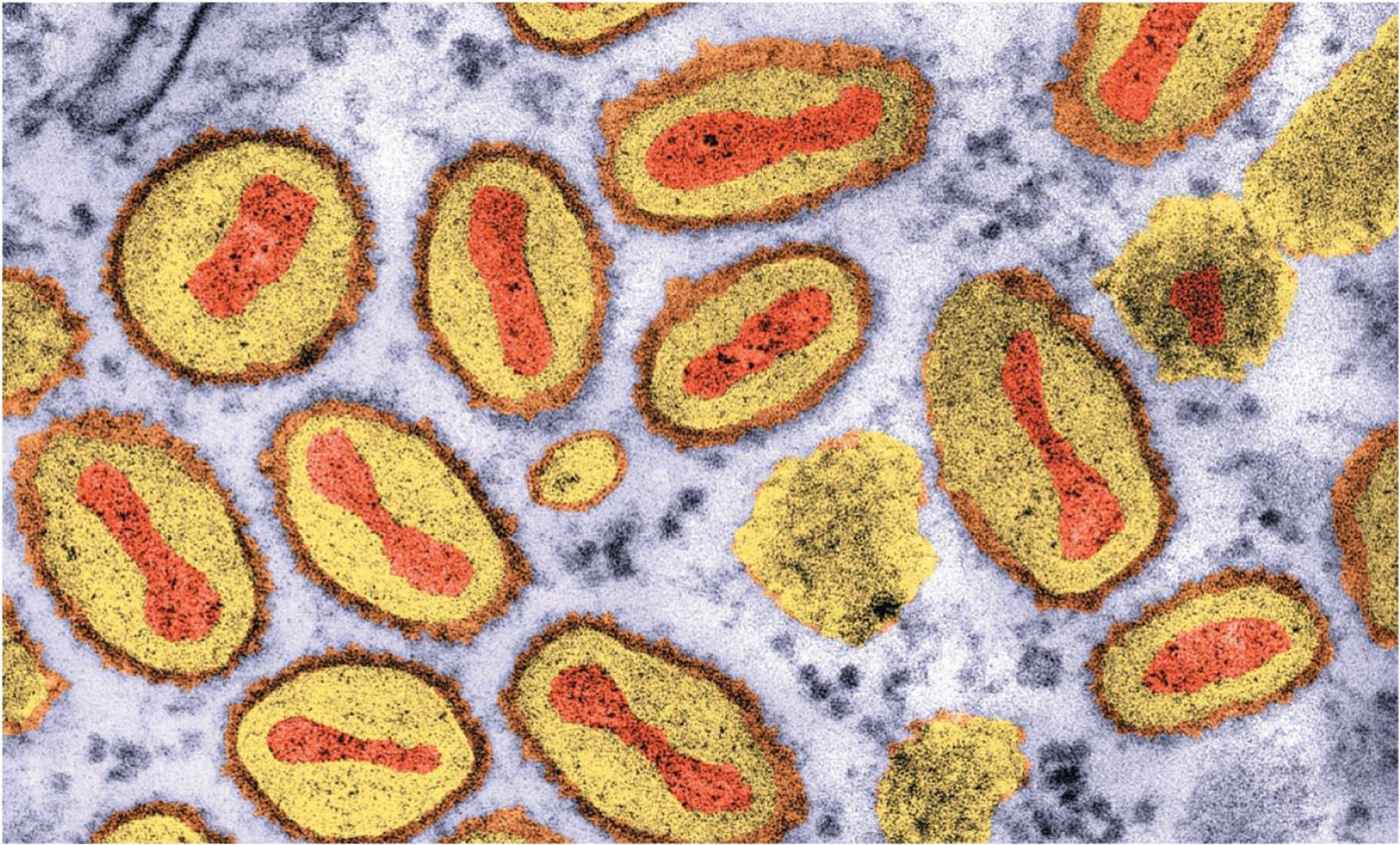
DNA Viruses

- DNA viruses causing human disease are grouped into seven families based on several factors
 - Type of DNA they contain
 - dsDNA
 - Pox, herpes, papilloma, polyoma, and adenoviridae
 - ssDNA
 - Parvoviridae
 - **Hepadnaviridae contain both dsDNA and ssDNA**
 - The presence or absence of an envelope
 - Size
 - The host cells they attack

Poxviridae

- Double-stranded DNA viruses
- Have complex capsids and envelopes
- Largest human pathogenic viruses
- Infect many mammals
- Most animal poxviruses are species specific
 - Unable to infect humans because cannot attach to human cells
- Infection occurs primarily through the inhalation of viruses
- Close contact is necessary for infection by poxviruses
- Smallpox and molluscum contagiosum are the main diseases of humans
- Some diseases of animals can be transmitted to humans
 - Orf [sheep and goat], cowpox, and monkeypox
- All poxviruses produce lesions that progress through stages

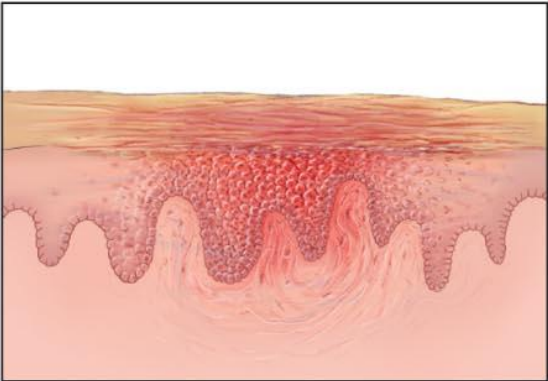
Figure 24.1 Poxviruses.



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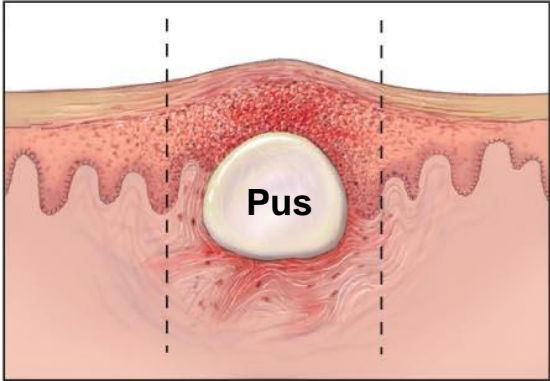
200 nm

Figure 24.2 The stages of the lesions in poxvirus infections.

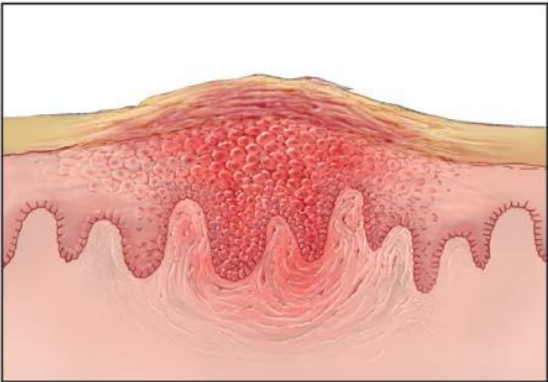


1 Macule

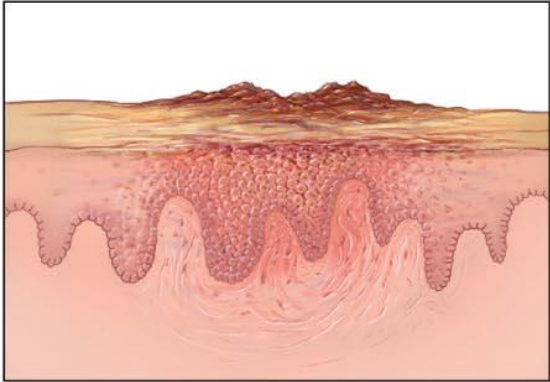
Epidermis
Dermis



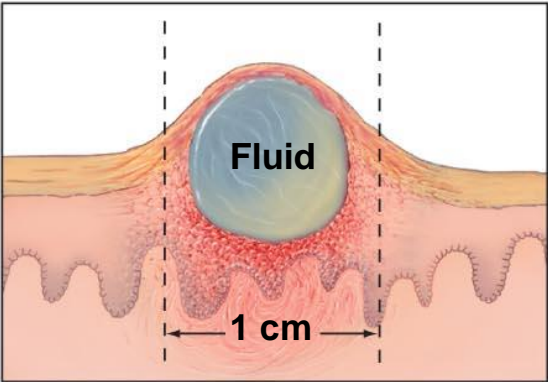
4 Pustule



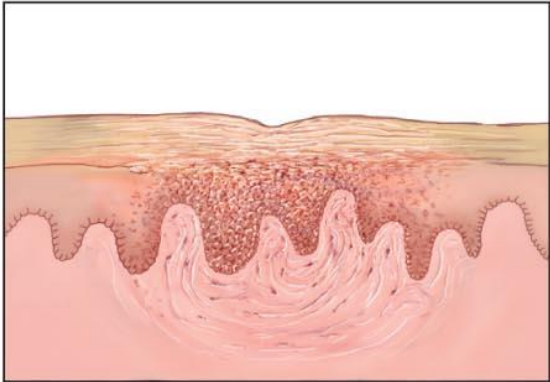
2 Papule



5 Crust



3 Vesicle



6 Scar

Poxviridae

- **Smallpox**
 - One of the most devastating diseases known to humanity
 - In the genus *Orthopoxvirus*
 - Commonly known as **variola**
 - Exists in two forms:
 - **Variola major**
 - Causes severe disease with a 20% mortality rate
 - **Variola minor**
 - Causes milder disease
 - **Variola** infects internal organs, causing fever, malaise, and delirium
 - The virus moves via the blood to the skin, where it produces pox
 - Scars result on the skin, especially on the face

Figure 24.3 Smallpox lesions.



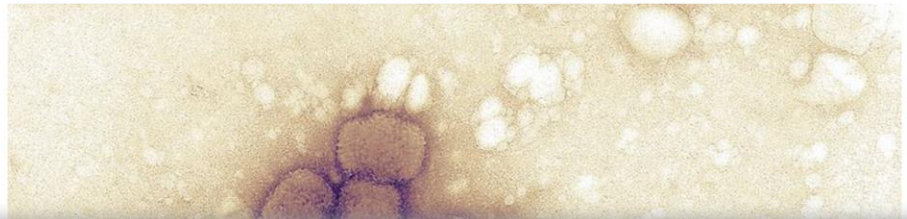
Poxviridae

- **Smallpox**

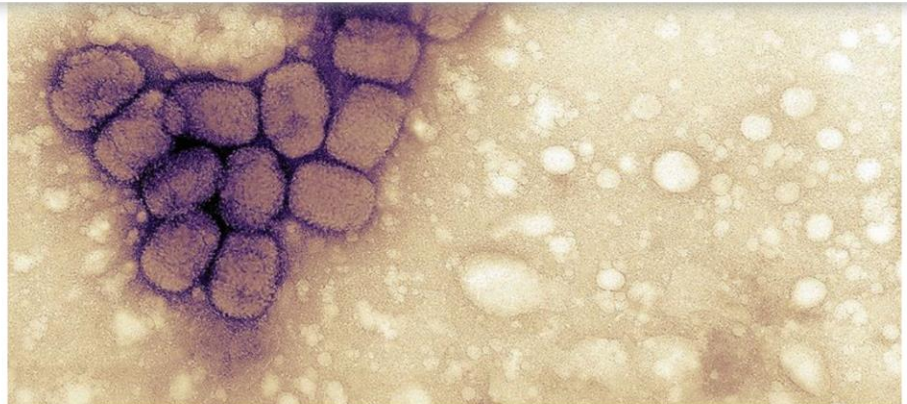
- Smallpox is the first human disease to be eradicated
- Several factors enabled the eradication of smallpox
 - Inexpensive, stable, and effective vaccine
 - No animal reservoirs
 - Obvious symptoms allow for quick diagnosis and quarantine
 - Lack of asymptomatic cases
 - Virus is only spread via close contact
- Routine vaccination has ceased in many concerns
 - Susceptible to accidental or deliberate release of smallpox
- Stocks of the virus are maintained in laboratories in the U.S. and Russia

Should We Destroy Our Last Living Samples of the Virus That Causes Smallpox?

Later this month, the World Health Organization will decide whether or not to get rid of two live virus repositories in the United States and Russia



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A cluster of variola viruses viewed under an electron microscope. Strains of the variola virus cause smallpox disease. (Photo: © Callista Images/Corbis)

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NEWS BLOG

WHO postpones decision on destruction of smallpox stocks — again

[28 May 2014](#) | [18:19 GMT](#) | Posted by [Declan Butler](#) | Category: [Biology & Biotechnology](#), [Drug discovery](#), [Health and medicine](#), [History](#), [Policy](#), [Politics](#), [Uncategorized](#)

The stalemate continues over the question of when to destroy the last stocks of the virus that causes smallpox, a killer disease that was eradicated in 1980. One of the World Health Organization's (WHO) two advisory committees on smallpox supports the stocks' destruction, and the other opposes it. Last weekend, health ministers of the WHO's 194 member states again postponed a decision and decided to set up a third WHO smallpox advisory committee in a bid to broker a consensus.

The issue came up again on the agenda of the annual meeting of the World Health Assembly, the WHO's top decision-making body, which was held in Geneva, Switzerland, from 19 to 24 May. It was last discussed at the 2011 assembly, which reaffirmed that the stocks of the variola virus should be destroyed but deferred to this year's meeting discussion on any date of destruction.



CIA believes four nations have secret smallpox virus stocks, report says

Filed Under: **Anthrax; Cholera; Plague; Smallpox**

Nov 07, 2002



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Nov 7, 2002 (CIDRAP News) – The CIA has good evidence that four nations—Iraq, North Korea, Russia, and France—have secret stores of smallpox virus, according to a *Washington Post* report based on comments from officials speaking anonymously.

The intelligence agency also thinks that Al Qaida has spent money to acquire biological weapons, but has been more interested in other agents than in smallpox, according to the report, published Nov 5. One official said there was no reason to believe that the organization actually has obtained smallpox virus.

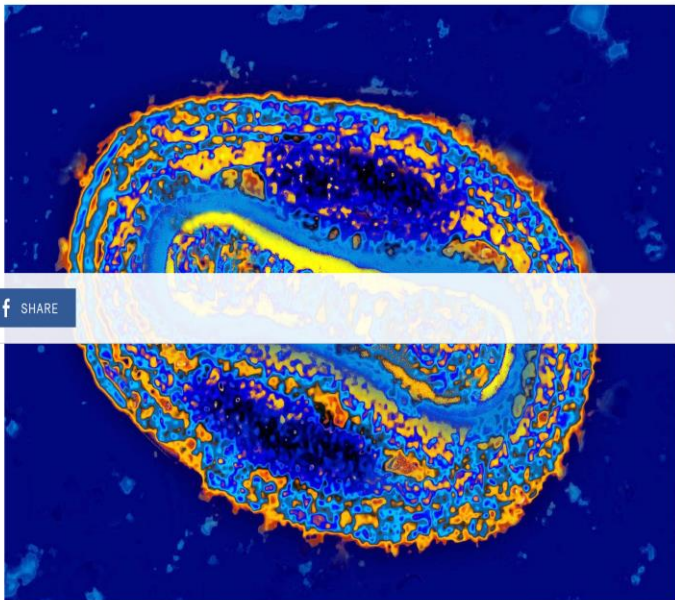
The anonymous officials based their information mainly on a briefing that the CIA's Weapons Intelligence, Nonproliferation and Arms Control Center (WINPAC) prepared last spring.

Why we'll never actually destroy the last samples of smallpox

Updated by Susannah Locke | @susannahlocke | May 22, 2014, 4:10pm EDT

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things to know about '



1) The US and Russia likely won't trust each other to destroy smallpox samples

2) There could still be unofficial stocks of smallpox out there

3) Smallpox could survive in dead bodies

4) Scientific curiosity may prevent the destruction of smallpox stocks

5) We could always recreate smallpox from genetic information

Poxviridae

- **Molluscum Contagiosum**

- Caused by *Molluscipoxvirus*
- Skin disease characterized by smooth, waxy **papules**
 - Typically on face, trunk, and external genitalia
- Spread by contact among infected individuals
 - Children
 - Sexually active individuals
 - AIDS patients
- Treatment involves removing the infected nodules
 - People with normal immunity heal without treatment
- Sexual abstinence prevents genital form of the disease

Figure 24.4 Lesions of molluscum contagiosum – pearly white to light pink, tumorlike lesions.



Poxviridae

- **Other Poxvirus Infections**

- Poxvirus infections also occur in animals
- Transmission to humans requires contact with infected animals
- Infections of humans are usually mild
- Can result in pox and scars but little other damage
- Edward Jenner used cowpox to immunize individuals against smallpox
- Increase in monkeypox cases in humans over the past decade
 - Changes in monkey habitats
 - Viral antigens
 - Cessation of smallpox vaccination

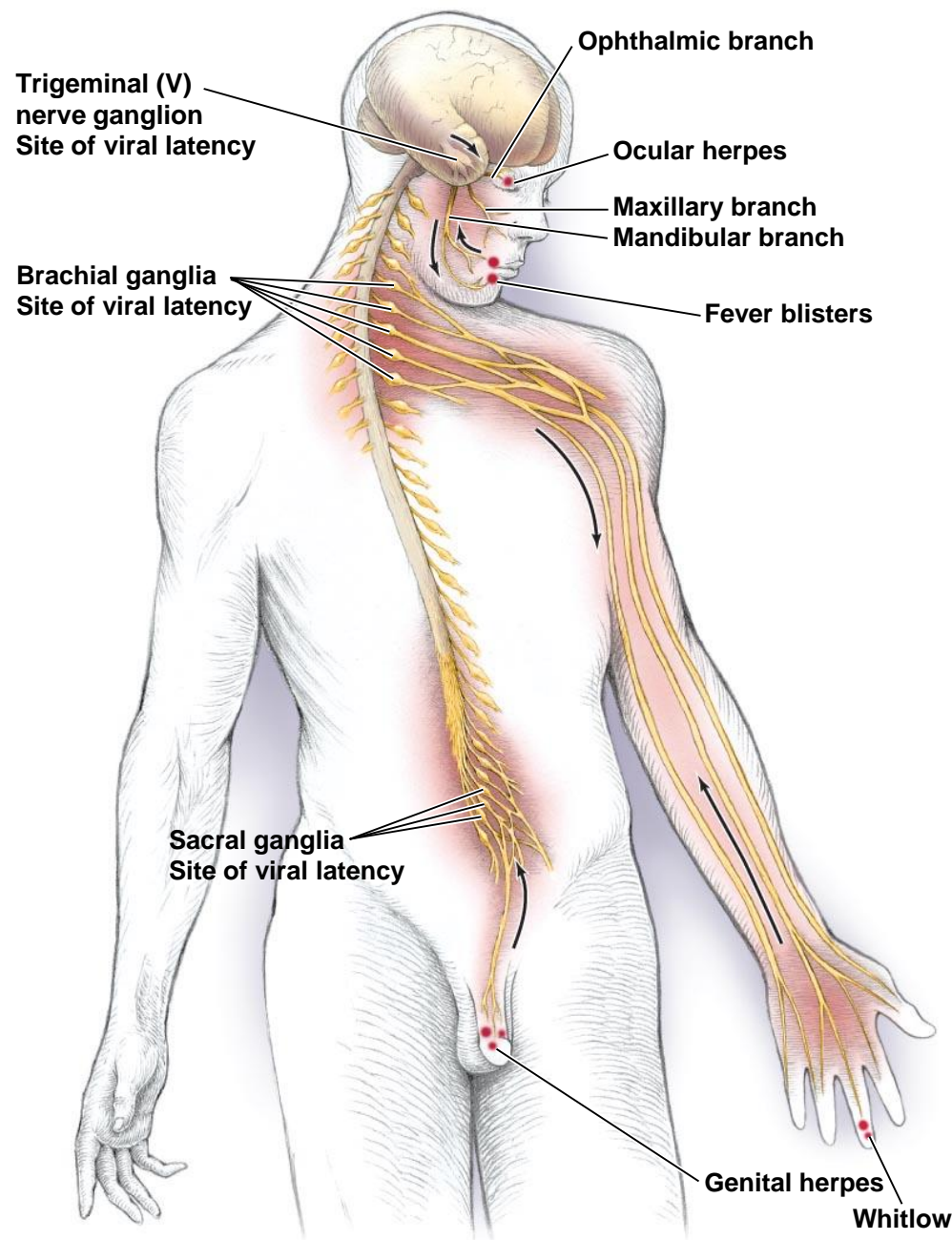
Herpesviridae

- Linear dsDNA viruses
- Have enveloped polyhedral capsids
 - Viral envelope acquired from the host cell's nuclear membrane
- Viral envelope fuses with the cell membrane to facilitate entry into cell
- **Most prevalent DNA viruses**
- **Often latent**
 - Remain inactive inside infected cells
 - Reactivation causes recurrence of the disease manifestations
- Species names combine "HHV" and a number indicating order in which they were discovered

Herpesviridae

- **Infections of *Human Herpesvirus 1* and *2***
 - Often result in slow-spreading skin lesions
 - **Formerly known as herpes simplex virus or HSV**
 - Two species:
 - *Human herpesvirus 1* (HHV-1)
 - *Human herpesvirus 2* (HHV-2)
 - After a primary infection, viruses remain latent in ganglia
 - MC sites: Trigeminal, sacral, and other ganglia
 - Latent viruses may reactivate later in life, in about 2/3 of the patients

Figure 24.5 Sites of events in herpesvirus infections.



Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Types of HHV-1 and HHV-2 Infections
 - Oral herpes
 - Genital herpes
 - Ocular herpes
 - Whitlow
 - Neonatal herpes

Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Types of HHV-1 and HHV-2 Infections
 - Oral herpes
 - **HHV-1** can cause lesions called fever blisters or cold sores
 - Painful, itchy lesions on lips
 - Herpetic gingivostomatitis can occur if the infection extends into the oral cavity
 - Herpetic pharyngitis can also occur

Figure 24.6 Oral herpes lesions.



Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Types of HHV-1 and HHV-2 Infections
 - Genital herpes
 - **HHV-2** causes the majority of genital herpes infections
 - Painful lesions develop on the genitalia
 - **Transmitted sexually**
 - HHV-2 can also cause oral lesions
 - Transmitted to the oral region via oral sex

Figure 24.7 Genital herpes lesions.



Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Types of HHV-1 and HHV-2 Infections
 - Ocular herpes
 - Occurs when latent viruses reactivate and infect the eye
 - Symptoms and signs usually occur in only one eye
 - Include gritty feeling, conjunctivitis, pain, and sensitivity to light
 - Corneal lesions may also occur – may result in blindness

Figure 24.8a Two manifestations of herpesvirus infections.



(a)

Herpesviridae

- **Infections of *Human Herpesvirus 1* and *2***
 - Types of HHV-1 and HHV-2 Infections
 - Whitlow
 - Inflamed blister on the finger
 - **Occurs when HHV-1 or HHV-2 enters the skin of a finger**
 - Potential source of infection among **children** and **healthcare workers**

Figure 24.8b Two manifestations of herpesvirus infections.



(b)

Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Types of HHV-1 and HHV-2 Infections
 - Neonatal herpes
 - Babies most often infected during birth
 - Infections can be severe and have a high mortality rate
 - 30% for cutaneous or oral infections
 - 80% for nervous system infections
 - Other herpes simplex infections
 - *Herpes gladiatorum* can occur in athletes
 - Contact with HHV-1 lesions on the skin from wrestling
 - HHV-1 and HHV-2 may also cause encephalitis, meningitis, and pneumonia in immunosuppressed individuals

Table 24.1 Comparative Epidemiology and Pathology of Human Herpesvirus 1 and 2 Infections

TABLE 24.1 Comparative Epidemiology and Pathology of Human Herpesvirus 1 and 2 Infections		
	HHV-1 (HSV-1)	HHV-2 (HSV-2)
Usual Diseases	90% of cold sores/fever blisters; whitlow	85% of genital herpes cases
Mode of Transmission	Close contact	Sexual intercourse
Site of Latency	Trigeminal and brachial ganglia	Sacral ganglia
Locations of Lesions	Face, mouth, and rarely trunk	External genitalia and less commonly thighs, buttocks, and anus
Other Complications	15% of genital herpes cases; pharyngitis; gingivostomatitis; ocular/ophthalmic herpes; herpes gladiatorum; 30% of neonatal herpes cases	10% of oral herpes cases; 70% of neonatal herpes cases

Herpesviridae

- **Infections of *Human Herpesvirus 1 and 2***
 - Epidemiology and Pathogenesis
 - Active lesions are the usual source of infection
 - **Asymptomatic carriers shed HHV-2 genitally**
 - Transmission occurs through close body contact
 - Enter body through cracks or cuts in mucous membranes
 - Viral replication in epithelial cells leads to lesion formation
 - Virus spreads from cell to cell through syncytia formation
 - Infected cells fuse with uninfected cells producing *syncytia*
 - HHV-1 infections typically occur via casual contact in children
 - HHV-2 infections occur between ages of 15 and 29 from sexual activity
 - One of the more common STI

Herpesviridae

- **Infections of *Human Herpesvirus 1* and *2***
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Characteristic lesions are often diagnostic
 - Treatment
 - Infections can be controlled with chemotherapeutic agents (Valaciclovir, iododeoxyrubicine, and trifluridine)
 - Limit duration of the lesions and reduce viral shedding
 - **Don't cure the disease or eliminate latent virus**
 - Prevention
 - Use of gloves can reduce exposure in health care workers
 - Abstinence, monogamy, & proper condom use can help prevent spread of genital infections
 - **Acyclovir during late pregnancy may prevent transmission**

Herpesviridae

- ***Human Herpesvirus 3 (Varicella-Zoster Virus)***
Infections
 - In the genus *Varicelovirus*
 - Causes two diseases:
 - **Varicella**
 - Often called **chickenpox**
 - Typically occurs in **children**
 - **Herpes zoster**
 - Also called **shingles**
 - Usually occurs in **adults**

Herpesviridae

- ***Human Herpesvirus 3 (Varicella-Zoster Virus) Infections***
 - Epidemiology and Pathogenesis
 - Chickenpox is highly infectious disease
 - Virus enters body through the respiratory tract or eyes
 - Virus travels via the blood from infection site throughout body
 - Causing fever, malaise
 - Characteristic skin lesions appear 2–3 weeks after infection
 - Progress from macules to papules, to vesicles to crust

Herpesviridae

- **Human Herpesvirus 3 (Varicella-Zoster Virus) Infections**
 - Epidemiology and Pathogenesis
 - The disease is usually mild in children
 - Chickenpox in adults is typically more severe
 - Latent virus can reactivate (about 15% of the infected people), producing a rash known as **shingles** or **herpes zoster**
 - Painful skin rash near the distal end of the nerve
 - Lesions occur along band of skin called a dermatome, associated with infected nerve
 - May occur in eye, ear, or elsewhere on the head or torso
 - Some may experience long-term nerve pain
 - Recurrences usually occur only once or twice, typically after age 45

Figure 24.9 Characteristic chickenpox lesions – thin walled, fluid-filled vesicles on red bases.



Figure 24.10 Latency and reactivation of varicella-zoster virus.

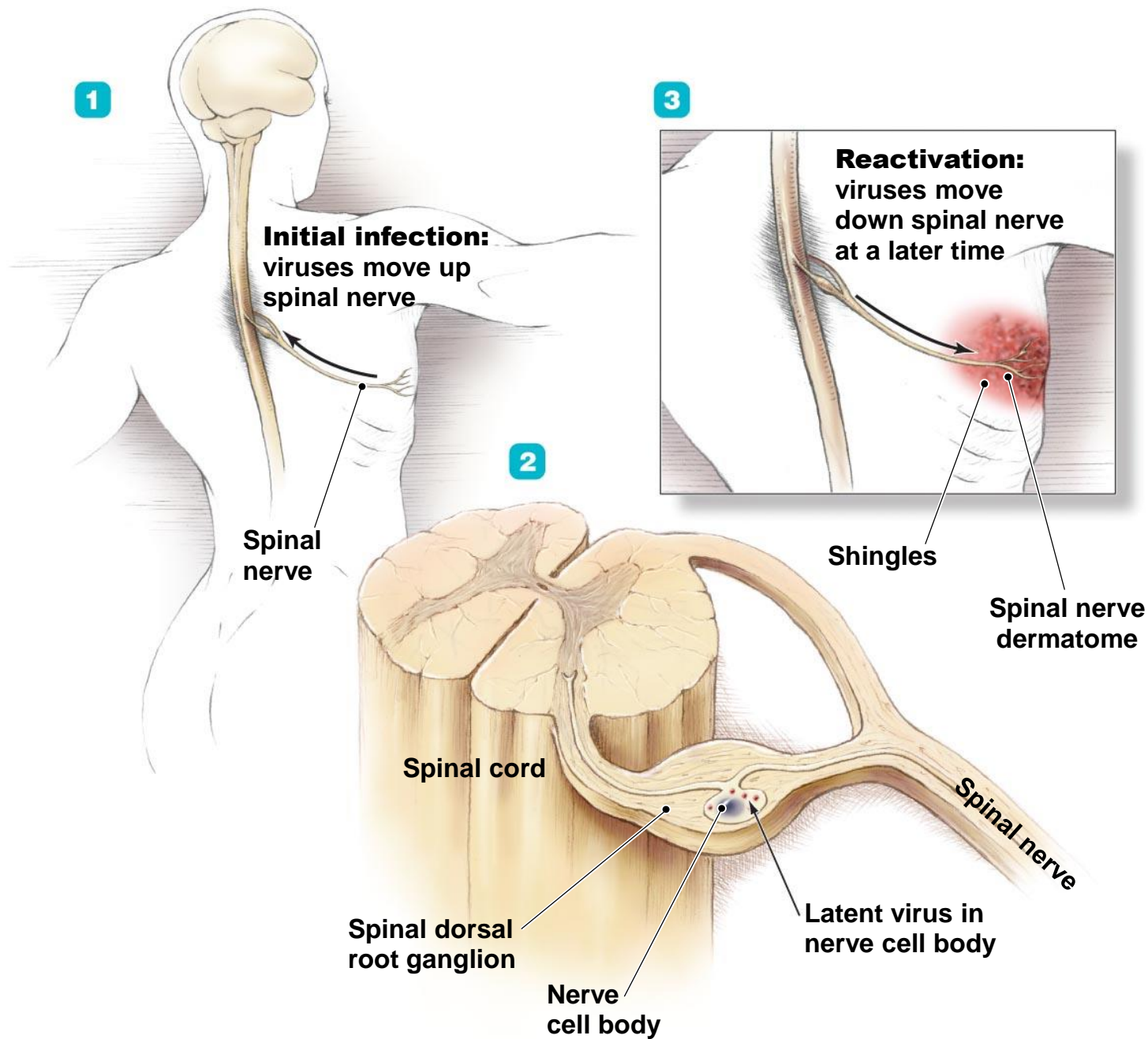


Figure 24.11 Shingles, a rash caused by *Varicellovirus*.



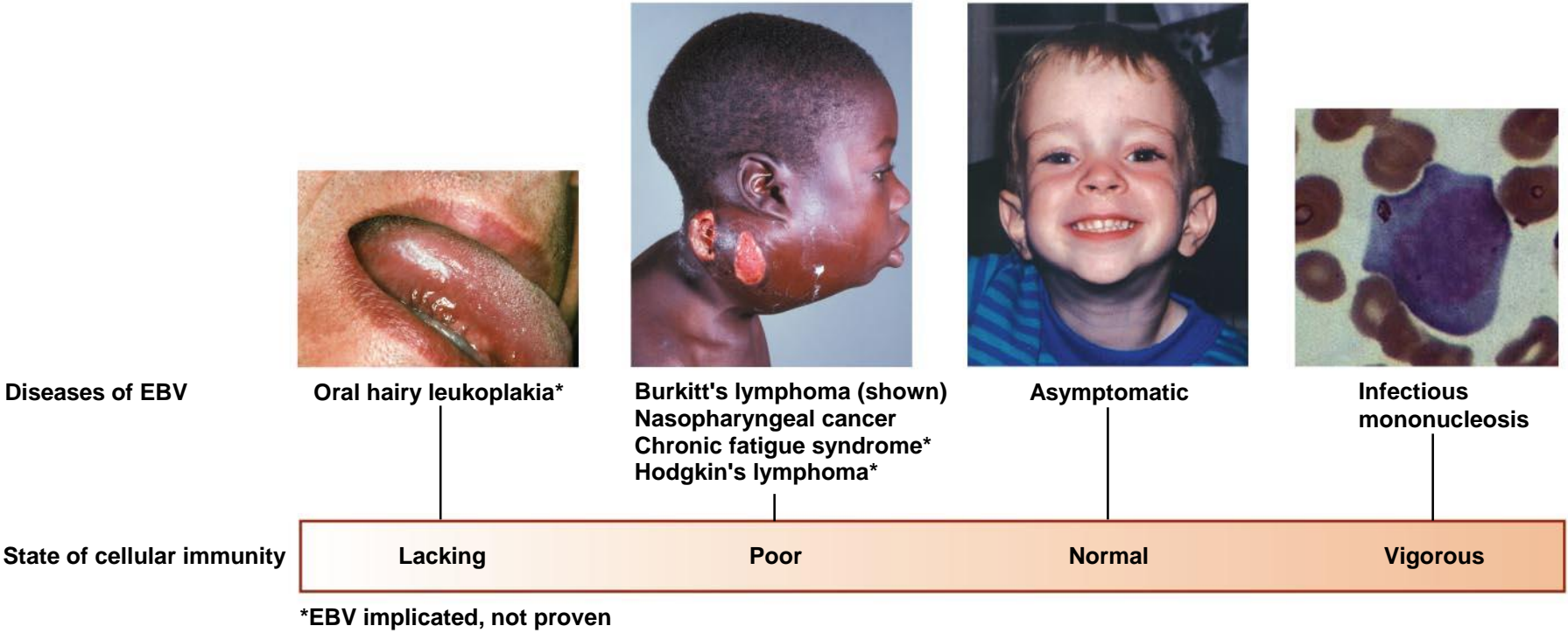
Herpesviridae

- ***Human Herpesvirus 3 (Varicella-Zoster Virus)***
Infections
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Chickenpox is diagnosed from the characteristic lesions
 - Shingles lesions can be more difficult to diagnose
 - Treatment
 - Chickenpox is usually self-limiting
 - Shingles treatment involves management of symptoms
 - Prevention
 - Difficult to prevent exposure, since virus is shed before obvious signs appear
 - Vaccines against chickenpox and shingles are available

Herpesviridae

- ***Human Herpesvirus 4 (Epstein-Barr Virus)***
Infections
 - Also referred to as EBV
 - Can cause a number of different diseases

Figure 24.12 Diseases associated with Epstein-Barr virus.



Herpesviridae

- ***Human Herpesvirus 4 (Epstein-Barr Virus)***
Infections
 - Epidemiology and Pathogenesis
 - Transmission usually occurs via saliva
 - Initially infect epithelium of pharynx and parotid salivary glands
 - Virus enters the bloodstream and invades B lymphocytes
 - Becomes latent and suppresses apoptosis of B cells
 - Immune response causes infectious mononucleosis symptoms
 - Results from a “civil war” between humoral (antibody) and cellular branches of immunity
 - Cytotoxic T cells kill virus-infected B lymphocytes

Herpesviridae

- ***Human Herpesvirus 4 (Epstein-Barr Virus)***
Infections

- Epidemiology and Pathogenesis
 - Infection in children is usually asymptomatic
 - 70% adults over age 30 have antibodies to EBV
 - Infection in adults produces more serious signs and symptoms
 - Cancer development appears to depend on various cofactors
 - Extreme diseases arise in individuals with T-cell deficiency

Herpesviridae

- ***Human Herpesvirus 4 (Epstein-Barr Virus)***
Infections
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Some diseases diagnosed by their characteristic signs
 - Treatment
 - Burkitt's lymphoma responds well to chemotherapy
 - Hodgkin's lymphoma is treated with radiation and chemotherapy
 - Mono patients are treated to relieve the symptoms
 - Other conditions have no effective treatment
 - Prevention
 - Hard or nearly impossible because virus is widespread and transmitted by saliva

Herpesviridae

- ***Human Herpesvirus 5 (Cytomegalovirus)***
Infections
 - Infected cells become enlarged
 - One of the more common infections of humans
 - 50% of the adult population in the U.S. is infected
 - 100% of the population of some countries test positive for antibodies against Cytomegalovirus (CMV)

Herpesviridae

- ***Human Herpesvirus 5 (Cytomegalovirus)***
Infections
 - Epidemiology and Pathogenesis
 - Transmission occurs through bodily secretions
 - Requires close contact and a large exchange of secretion
 - Usually occurs via sexual intercourse
 - Also transmitted by *in utero* exposure, vaginal birth, blood transfusions, and organ transplants

Herpesviridae

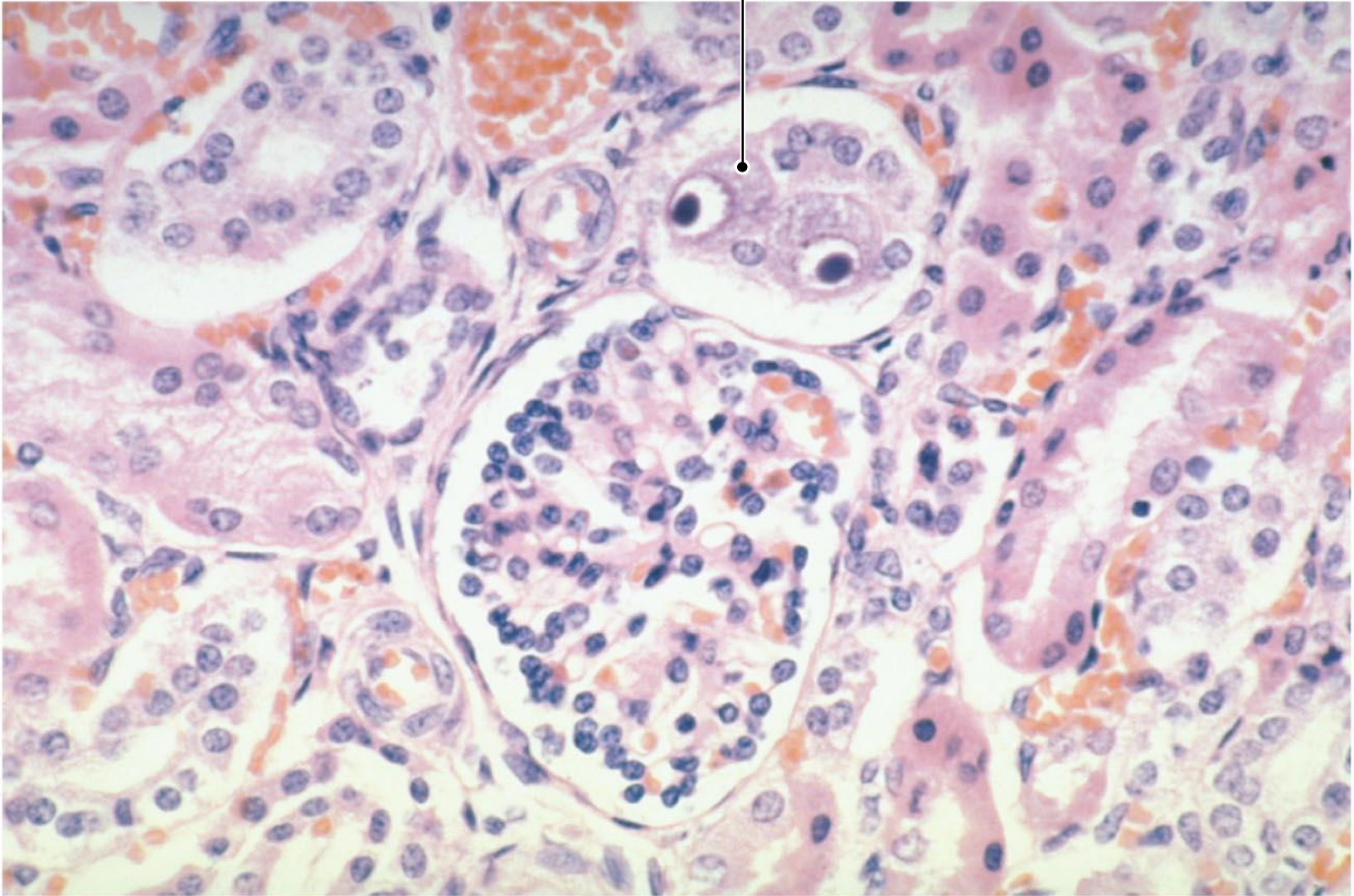
- ***Human Herpesvirus 5 (Cytomegalovirus)***
Infections
 - Epidemiology and Pathogenesis
 - Most CMV infections are asymptomatic
 - Complications in fetuses, newborns, and immunodeficient patients
 - Newborns may develop signs of infection, mental retardation, or hearing and visual damage
 - AIDS patients or immunosuppressed adults may develop pneumonia, blindness, or mononucleosis

Herpesviridae

- ***Human Herpesvirus 5 (Cytomegalovirus) Infections***
 - Diagnosis, Treatment, and Prevention
 - Diagnosis
 - Detection of enlarged cells and cellular inclusions
 - Virus can be detected by enzyme-linked immunosorbent assay (ELISA) tests or DNA probes
 - Treatment
 - Treatment of fetuses and newborns is difficult
 - Damage usually occurs before infection is discovered
 - Fomivirsen is used to treat CMV eye infections
 - Prevention
 - Abstinence and safe sex can reduce chance of infection

Figure 24.13 An owl's eyes cell.

"Owl's eyes" cell



LM

100 μ m

Herpesviridae

- **Other Herpesvirus Infections**

- *Human herpesvirus 6 (HHV-6)*
 - In the genus *Roseolovirus*
 - Causes roseola
 - Characterized by pink rash on face, neck, trunk, and thighs
 - May be linked to multiple sclerosis
 - Can cause mononucleosis-like symptoms
 - HHV-6 may make individuals more susceptible to AIDS
- *Human herpesvirus 8 (HHV-8, Rhadinovirus)*
 - Causes Kaposi's sarcoma
 - Cancer often seen in AIDS patients