

1 **Chapter 13**

Viruses, Viroids, and Prions

2 **General Characteristics of Viruses**3 **General Characteristics of Viruses**

- Obligatory intracellular parasites
- Contain DNA or RNA
- Contain a protein coat
- Some are enclosed by an envelope
- Some viruses have spikes
- Most viruses infect only specific types of cells in one host
- Host range is determined by specific host attachment sites and cellular factors

4 **Virus Sizes**5

- ✓ How could the small size of viruses have helped researchers detect viruses before the invention of the electron microscope? 13-1

✓

✓

6 **Viral Structure**7 **Virion Structure**

- Nucleic acid
 - DNA or RNA
- Capsid
 - Capsomeres
- Envelope
- Spikes

8 **Morphology of a Polyhedral Virus**9 **Polyhedral Viruses**10 **Morphology of an Enveloped Virus**11 **Enveloped Viruses**12 **Morphology of a Helical Virus**13 **Morphology of a Complex Virus**14

- ✓ Diagram a nonenveloped polyhedral virus that has spikes. 13-2

✓

✓

✓

15 **Taxonomy of Viruses**16 **Taxonomy of Viruses**

- Family names end in *-viridae*.
- Genus names end in *-virus*.
- Viral species: A group of viruses sharing the same genetic information and ecological niche (host). Common names are used for species.
- Subspecies are designated by a number.

17 **Taxonomy of Viruses**

- 1 **Herpesviridae**
 - *Herpesvirus*
 - Human herpes virus HHV-1, HHV-2, HHV-3
- 2 **Retroviridae**
 - *Lentivirus*
 - Human immunodeficiency virus HIV-1, HIV-2

18

- ✓ How does a virus species differ from a bacterial species? 13-3
- ✓ Attach the proper endings to *Papilloma*- to show the family and genus that includes HPV, the cause of cervical cancer. 13-4
- ✓
- ✓
- ✓
- ✓

19 **Isolation, Cultivation, and Identification**20 **Growing Viruses**

- Viruses must be grown in living cells
 - Bacteriophages form plaques on a lawn of bacteria

21 **Growing Viruses**

- Animal viruses may be grown in living animals or in embryonated eggs

22 **Growing Viruses**

- Animal and plant viruses may be grown in cell culture
 - Continuous cell lines may be maintained indefinitely

23 **Virus Identification**

- Cytopathic effects
- Serological tests
 - Detect antibodies against viruses in a patient
 - Use antibodies to identify viruses in neutralization tests, viral hemagglutination, and Western blot
- Nucleic acids
 - RFLPs: Restriction fragment length polymorphisms
 - PCR

24 **Virus Identification**25

- ✓ What is the plaque method? 13-5
- ✓ Why are continuous cell lines of more practical use than primary cell lines for culturing viruses? 13-6
- ✓ What tests could you use to identify influenza virus in a patient? 13-7
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

26 **Viral Multiplication**

- 27 **The Lytic Cycle**
- Attachment: Phage attaches by tail fibers to host cell
 - Penetration: Phage lysozyme opens cell wall; tail sheath contracts to force tail core and DNA into cell
 - Biosynthesis: Production of phage DNA and proteins
 - Maturation: Assembly of phage particles
 - Release: Phage lysozyme breaks cell wall
- 28 **Lytic Cycle of a T-Even Bacteriophage**
- 29 **Lytic Cycle of a T-Even Bacteriophage**
- 30 **Results of Multiplication of Bacteriophages**
- Lytic cycle
 - Phage causes lysis and death of host cell
 - Lysogenic cycle
 - Prophage DNA incorporated in host DNA
 - Phage conversion
 - Specialized transduction
- 31 **The Lysogenic Cycle**
- 32 **Generalized Transduction**
- 33 **Specialized Transduction**
- 34 **Specialized Transduction**
- 35
- ✓ How do bacteriophages get nucleotides and amino acids if they don't have any metabolic enzymes? 13-8
 - ✓ *Vibrio cholerae* produces toxin and is capable of causing cholera only when it is lysogenic. What does this mean? 13-9
- 36 **Viral Multiplication**
- 37 **Multiplication of Animal Viruses**
- Attachment: Viruses attach to cell membrane
 - Penetration by endocytosis or fusion
 - Uncoating by viral or host enzymes
 - Biosynthesis: Production of nucleic acid and proteins
 - Maturation: Nucleic acid and capsid proteins assemble
 - Release by budding (enveloped viruses) or rupture
- 38 **Attachment, Penetration, Uncoating**
- By pinocytosis
- 39 **Attachment, Penetration, Uncoating**
- By fusion
- 40 **Budding of an Enveloped Virus**
- 41 **Budding of an Enveloped Virus**
- 42 **Multiplication of DNA Virus**
- 43 **Sense Strand (+ Strand) RNA Virus**

44 **Antisense Strand (– Strand) RNA Virus**45 **Double-Stranded RNA Virus**46 **Multiplication of RNA-Containing Viruses**47 **Multiplication of a Retrovirus**48 49

✓ Describe the principal events of attachment, entry, uncoating, biosynthesis, maturation, and release of an enveloped DNA-containing virus. 13-10

✓

✓

50 **Viruses and Cancer**51 **Cancer**

- Activated oncogenes transform normal cells into cancerous cells
- Transformed cells have increased growth, loss of contact inhibition, tumor-specific transplant antigens, and T antigens
- The genetic material of oncogenic viruses becomes integrated into the host cell's DNA

52 **Oncogenic Viruses**

- 1 ▪ Oncogenic DNA viruses
 - Adenoviridae
 - Herpesviridae
 - Poxviridae
 - Papovaviridae
 - Hepadnaviridae
- 2 ▪ Oncogenic RNA viruses
 - Retroviridae
 - Viral RNA is transcribed to DNA, which can integrate into host DNA
 - HTLV-1
 - HTLV-2

53

✓ What is a provirus? 13-11

✓ How can an RNA virus cause cancer if it doesn't have DNA to insert into a cell's genome? 13-12

✓

✓

✓

54 **Latent and Persistent Viral Infections**55 **Latent Viral Infections**

- Virus remains in asymptomatic host cell for long periods
 - Cold sores, shingles

56 **Persistent Viral Infections**

- Disease processes occurs over a long period; generally is fatal
 - Subacute sclerosing panencephalitis (measles virus)

57

- ✓ Is shingles a persistent or latent infection? 13-13, 13-14
- ✓
- ✓
- ✓

58 **Prions, Viroids, and Plant Viruses**

59 **Prions**

- *Proteinaceous Infectious* particle
- Inherited and transmissible by ingestion, transplant, and surgical instruments
 - Spongiform encephalopathies: Sheep scrapie, Creutzfeldt-Jakob disease, Gerstmann-Sträussler-Scheinker syndrome, fatal familial insomnia, mad cow disease
-

60 **Prions**

- PrP^C: Normal cellular prion protein, on cell surface
- PrP^{Sc}: Scrapie protein; accumulates in brain cells, forming plaques

61 **How a Protein Can Be Infectious**

62 **Plant Viruses and Viroids**

- Plant viruses: Enter through wounds or via insects
- Viroids: Infectious RNA; e.g., potato spindle tuber disease

63

- ✓ Contrast viroids and prions, and for each name a disease it causes. 13-15, 13-16
- ✓ How do plant viruses enter host cells? 13-17
- ✓
- ✓
- ✓
- ✓
- ✓

64 **Virus Families That Affect Humans**

65 **Parvoviridae**

- Single-stranded DNA, nonenveloped viruses
 - Fifth disease
 - Anemia in immunocompromised patients

66 **Adenoviridae**

- Double-stranded DNA, nonenveloped viruses
 - Respiratory infections in humans
 - Tumors in animals

67 **Papovaviridae**

- Double-stranded DNA, nonenveloped viruses
 - *Papillomavirus*
 - Human wart virus
 - *Polyomavirus*
 - Cause tumors; some cause cancer

68 **Poxviridae**

- Double-stranded DNA, enveloped viruses
 - *Orthopoxvirus* (vaccinia and smallpox viruses)
 - *Molluscipoxvirus*

- Smallpox
- Molluscum contagiosum
- Cowpox

69  **Herpesviridae**

- Double-stranded DNA, enveloped viruses
 - *Simplexvirus* (HHV-1 and HHV-2)
 - *Varicellovirus* (HHV-3)
 - *Lymphocryptovirus* (HHV-4)
 - *Cytomegalovirus* (HHV-5)
 - *Roseolovirus* (HHV-6)
 - HHV-7
 - Kaposi's sarcoma (HHV-8)
- Some herpesviruses can remain latent in host cells

70  **Hepadnaviridae**

- Double-stranded DNA, enveloped viruses
 - Hepatitis B virus
 - Use reverse transcriptase

71  **Picornaviridae**

- Single-stranded RNA, + strand, nonenveloped
 - *Enterovirus*
 - Poliovirus and coxsackievirus
 - *Rhinovirus*
 - Hepatitis A virus

72  **Caliciviridae**

- Single-stranded RNA, + strand, nonenveloped
 - Hepatitis E virus
 - *Norovirus* causes gastroenteritis

73  **Togaviridae**

- Single-stranded RNA, + strand, enveloped
 - *Alphavirus*
 - Transmitted by arthropods
 - *Rubivirus* (rubella virus)

74  **Flaviviridae**










- Single-stranded RNA, + strand, enveloped
 - Arboviruses can replicate in arthropods; include yellow fever, dengue, SLE (systemic lupus erythematosus), and West Nile viruses
 - Hepatitis C virus

75  **Coronaviridae**

- Single-stranded RNA, + strand, enveloped
 - Upper respiratory infections
 - *Coronavirus*
 - SARS

76  **Rhabdoviridae**

- Single-stranded RNA, – strand, one RNA strand
 - *Vesiculovirus*
 - *Lyssavirus* (rabies virus)
 - Cause numerous animal diseases

- 77  **Filoviridae**
- Single-stranded RNA, – strand, one RNA strand
 - *Filovirus*
 - Enveloped, helical viruses
 - Ebola and Marburg viruses
- 78  **Paramyxoviridae**
- Single-stranded RNA, – strand, one RNA strand
 - *Paramyxovirus*
 - *Morbillivirus*
 - Parainfluenza
 - Mumps
 - Newcastle disease (chickens)
- 79  **Deltaviridae**
- Single-stranded RNA, – strand, one RNA strand
 - Hepatitis D virus
 - Depends on coinfection with hepadnavirus
- 80  **Orthomyxoviridae**
- Single-stranded RNA, – strand, multiple RNA strands
 - Envelope spikes can agglutinate RBCs
 - *Influenzavirus* (influenza viruses A and B)
 - Influenza C virus
- 81  **Avian Influenza**
- 82  **Bunyaviridae**
- Single-stranded RNA, – strand, multiple RNA strands
 - *Bunyavirus* (CE virus)
 - *Hantavirus*
- 83  **Arenaviridae**
- Single-stranded RNA, – strand, multiple RNA strands
 - Helical capsids contain RNA-containing granules
 - Lymphocytic choriomeningitis
 - VEE (Venezuelan Equine Encephalitis) and Lassa fever
- 84  **Retroviridae**
- Single-stranded RNA, 2 RNA strands, produce DNA
 - Use reverse transcriptase to produce DNA from viral genome
 - *Lentivirus* (HIV)
 - Oncogenic viruses
 - Includes all RNA tumor viruses
- 85  **Reoviridae**
- Double-stranded RNA, nonenveloped
 - *Reovirus* (respiratory enteric orphan)
 - *Rotavirus* (mild respiratory infections and gastroenteritis)
 - Colorado tick fever