

Contents

Preface

xii

Part I: What is a virus?

1	Towards a definition of a virus	1
1.1	Discovery of viruses	3
1.2	Development of virus assays	4
1.3	Multiplication of viruses	6
1.4	The virus multiplication cycle	8
1.5	Viruses can be defined in chemical terms	9
1.6	Multiplication of bacterial and animal viruses is fundamentally similar	10
1.7	Viruses can be manipulated genetically	13
1.8	Properties of viruses	14
1.9	Origin of viruses	15
	Key points	15
	Further reading	16
2	Some methods for studying animal viruses	17
2.1	Selection of a culture system	18
2.2	Identification of viruses using antibodies (serology)	18
2.3	Detection, identification, and cloning of virus genomes using PCR and RT-PCR	23
	Key points	27
	Further reading	28
3	The structure of virus particles	29
3.1	Virus particles are constructed from subunits	30
3.2	The structure of filamentous viruses and nucleoproteins	30
3.3	The structure of isometric virus particles	32
3.4	Enveloped (membrane-bound) virus particles	32
3.5	Virus particles with head–tail morphology	42
3.6	Frequency of occurrence of different virus particle morphologies	45
3.7	Principles of disassembly: virus particles are metastable	47
	Key points	47
	Further reading	47

4	Classification of viruses	49
4.1	Classification on the basis of disease	49
4.2	Classification on the basis of host organism	50
4.3	Classification on the basis of virus particle morphology	51
4.4	Classification on the basis of viral nucleic acids	52
4.5	Classification on the basis of taxonomy	54
4.6	Satellites, viroids, and prions	55
	Key points	58
	Further reading	58
Part II: Virus growth in cells		59
5	The process of infection: I. Attachment of viruses and the entry of their genomes into the target cell	61
5.1	Infection of animal cells – attachment to the cell	62
5.2	Infection of animal cells – entry into the cell	65
5.3	Infection of plants	70
5.4	Infection of bacteria	71
5.5	Prevention of the early stages of infection	75
	Key points	77
	Questions	77
	Further reading	78
6	The process of infection: IIA. The replication of viral DNA	79
6.1	The universal mechanism of DNA synthesis	80
6.2	Replication of circular double-stranded DNA genomes	83
6.3	Replication of linear double-stranded DNA genomes that can form circles	86
6.4	Replication of linear double-stranded DNA genomes that do not circularize	89
6.5	Replication of circular single-stranded DNA genomes	92
6.6	Replication of linear single-stranded DNA genomes	93
6.7	Dependency versus autonomy among DNA viruses	95
	Key points	96
	Questions	96
	Further reading	96
7	The process of infection: IIB. Genome replication in RNA viruses	97
7.1	Nature and diversity of RNA virus genomes	98
7.2	Regulatory elements for RNA virus genome synthesis	99
7.3	Synthesis of the RNA genome of Baltimore class 3 viruses	102
7.4	Synthesis of the RNA genome of Baltimore class 4 viruses	104
7.5	Synthesis of the RNA genome of Baltimore class 5 viruses	107
7.6	Synthesis of the RNA genome of viroids and hepatitis delta virus	110
	Key points	111
	Questions	111
	Further reading	112

8	The process of infection: IIC. The replication of RNA viruses with a DNA intermediate and vice versa	113
8.1	The retrovirus replication cycle	114
8.2	Discovery of reverse transcription	115
8.3	Retroviral reverse transcriptase	116
8.4	Mechanism of retroviral reverse transcription	117
8.5	Integration of retroviral DNA into cell DNA	120
8.6	Production of retrovirus progeny genomes	122
8.7	Spumaviruses: retrovirus with unusual features	122
8.8	The hepadnavirus replication cycle	123
8.9	Mechanism of hepadnavirus reverse transcription	123
8.10	Comparing reverse transcribing viruses	126
	Key points	127
	Questions	127
	Further reading	127
9	The process of infection: IIIA. Gene expression in DNA viruses and reverse-transcribing viruses	128
9.1	The DNA viruses and retroviruses: Baltimore classes 1, 2, 6, and 7	129
9.2	Polyomaviruses	130
9.3	Papillomaviruses	132
9.4	Adenoviruses	136
9.5	Herpesviruses	139
9.6	Poxviruses	141
9.7	Parvoviruses	142
9.8	Retroviruses	143
9.9	Hepadnaviruses	146
9.10	DNA bacteriophages	147
	Key points	147
	Questions	148
	Further reading	148
10	The process of infection: IIIB. Gene expression and its regulation in RNA viruses	149
10.1	The RNA viruses: Baltimore classes 3, 4, and 5	150
10.2	Reoviruses	151
10.3	Picornaviruses	157
10.4	Alphaviruses	158
10.5	Coronaviruses	160
10.6	Negative sense RNA viruses with segmented genomes	162
10.7	Orthomyxoviruses	163
10.8	Arenaviruses	167
10.9	Negative sense RNA viruses with nonsegmented, single-stranded genomes: rhabdoviruses and paramyxoviruses	167
	Key points	171
	Questions	171
	Further reading	171

18.5	Acute viral infection 1: gastrointestinal infections	301
18.6	Acute viral infection 2: respiratory infections	303
18.7	Acute viral infection 3: infections of the liver	305
18.8	Acute viral infection 4: systemic spread	306
18.9	Acute viral disease: conclusions	308
	Key points	308
	Questions	309
	Further reading	309
19	HIV and AIDS	310
19.1	The biology of HIV infection	311
19.2	Molecular biology of HIV-1	315
19.3	HIV transmission	320
19.4	Course of HIV infection and disease	321
19.5	Death and AIDS	323
19.6	Immunological abnormalities	324
19.7	Why is the incubation period of AIDS so long?	325
19.8	Prevention and control of HIV infection	327
19.9	The cost of the HIV pandemic	337
19.10	Unresolved issues	338
	Key points	338
	Questions	339
	Further reading	339
20	Carcinogenesis and tumor viruses	341
20.1	Immortalization, transformation, and tumorigenesis	343
20.2	Oncogenic viruses	345
20.3	Polyomaviruses, papillomaviruses, and adenoviruses: the small DNA tumor viruses as experimental models	347
20.4	Papillomaviruses, SV40, and human cancer	352
20.5	Herpesvirus involvement in human cancers	354
20.6	Retroviruses as experimental model tumor viruses	356
20.7	Retroviruses and naturally occurring tumors	358
20.8	Hepatitis viruses and liver cancer	359
20.9	Prospects for the control of virus-associated cancers	360
	Key points	362
	Questions	362
	Further reading	362
21	Vaccines and antivirals: the prevention and treatment of virus diseases	364
21.1	Principal requirements of a vaccine	365
21.2	Advantages, disadvantages, and difficulties associated with live and killed vaccines	370
21.3	Peptide vaccines	375
21.4	Genetically engineered vaccines	377

21.5	Infectious disease worldwide	381
21.6	Elimination of virus diseases by vaccination	381
21.7	Clinical complications with vaccines and immunotherapy	388
21.8	Prophylaxis and therapy with antiviral drugs	390
	Key points	399
	Questions	399
	Further reading	400
22	Prion diseases	401
22.1	The spectrum of prion diseases	401
22.2	The prion hypothesis	403
22.3	The etiology of prion diseases	405
22.4	Prion disease pathogenesis	407
22.5	Bovine spongiform encephalopathy (BSE)	409
22.6	BSE and the emergence of variant CJD	411
22.7	Unresolved issues	413
	Key points	414
	Questions	414
	Further reading	415
23	Horizons in human virology	416
23.1	Technical advances	417
23.2	Recombinant viruses as gene therapy vectors	422
23.3	Subtle and insidious virus–host interactions	428
23.4	Emerging virus infections	433
23.5	Virology and society: for good or ill	441
	Key points	442
	Questions	442
	Further reading	442
	Appendixes: Survey of virus properties	444
1	Viruses that multiply in vertebrate and invertebrate animals	445
2	Viruses that multiply in plants	460
3	Viruses that multiply in algae, fungi, and protozoa	469
4	Viruses (phages) that multiply in <i>Archaea</i> , bacteria, <i>Mycoplasma</i> , and <i>Spiroplasma</i>	472
5	Satellite viruses and satellite nucleic acids of viruses of animals, plants, and bacteria	476
6	Viroids (genome unclassified as they synthesize no mRNA)	478
7	Further reading	479
	Index	480