Viral Diseases of the Eye

Edited by RICHARD W. DARRELL, M.D., Dr. Med. Sci.

Viral Diseases of the Eye

Edited by

RICHARD W DARREIT, M.D., Dr. Med. Sci.

Associate P Columbia 1

Director,

Presbyteria New York,

thalmology

_se Clinics





Lea & Febiger Philadelphia 1985

Lea & Febiger 600 Washington Square Philadelphia, Pennsylvania 19106-4198 U.S.A. (215) 922-1330

Note: The original magnifications listed with each of the photographs of microscopic material represent the ratio between the size of the photographic image on the original negative and the size of the microscopic specimen itself. The magnifications should be used only as an approximate indication since they do not reflect subsequent magnifications and/or reductions in the final reproduction of the photographs.

Library of Congress Cataloging in Publication Data Main entry under title:

Viral diseases of the eye.

Includes index.

1. Virus diseases. 2. Eye—Infections. 3. Ocular manifestations of general diseases. I. Darrell, Richard W. [DNLM: 1. Eye Diseases. 2. Eye Manifestations. 3. Virus Diseases. WW 140 V813] RE901.V55V57 1984 617.7 84-7897 ISBN 0-8121-0943-0

Copyright © 1985 by Lea & Febiger. Copyright under the International Copyright Union. All rights reserved. This book is protected by copyright. No part of it may be reproduced in any manner or by any means without written permission of the publisher.

PRINTED IN THE UNITED STATES OF AMERICA

Print No. 5 4 3 2 1

Preface

Fourteen families of viruses include species capable of causing disease of the eyelids, conjunctiva, cornea, uvea, retina, optic nerve, and central or peripheral nervous systems. Several species have also been implicated in the development of ocular tumors.

The most common viral disease of the eye is an acute infection of the epithelial surface of the conjunctiva and cornea, which is characterized clinically by acute follicular conjunctivitis, epithelial keratitis, and preauricular lymphadenopathy; the causative agent is most often an adenovirus. A new viral type, enterovirus 70, has recently been identified as the cause of an acute follicular conjunctivitis with subconjunctival hemorrhage (acute hemorrhagic conjunctivitis) that affects individuals living in coastal tropical regions in a new epidemiologic pattern.

Immunosuppressed individuals are particularly vulnerable to viral infections of the retina, as is the case in cytomegalovirus infection. While human t-lymphotrophic retrovirus (HTLV-III) does not directly infect the retina, it so severely weakens the immune defense system in

acquired immune deficiency syndrome (AIDS) that cytomegalovirus infection of the retina can take place.

The optic nerve and central and peripheral nervous systems are also targets of viral disease, either by direct infection or through a secondary immune response, as in postinfectious encephalomeningitis. The peripheral sensory nerves are host to herpes simplex virus and varicella-zoster virus in their latent states. Multifocal leukoencephalopathy caused by polyomavirus, and subacute sclerosing panencephalitis caused by measles virus are chronic and progressive degenerative diseases of the central nervous system.

The contributors to this book have explored in depth the viral diseases of the eye, as well as the complex biologic problems of resistance to infection, virus latency, reactivation of disease, and the host immune response.

I would like to thank my colleagues, attendings and residents, at the Harkness Eye Institute of the Columbia Presbyterian Medical Center, for sharing with me so many challenging cases during the past 20 years.

Contributors

Daniel M. Albert, M.D.
Professor of Ophthalmology
Harvard University Medical School;
Director Eye Pathology Laboratory
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts

Terry J. Bergstrom, M.D.
Assistant Professor, Department of Ophthalmology
University of Michigan Medical School;
University of Michigan Hospitals and
Ann Arbor Veterans Administration Hospital
Ann Arbor, Michigan

Cated of Fernance man were parameter for the formule of Division of Medicalities for the son and Medicalities of Physical Alegacial Hospital

Helene M. Boisjoly, M.D.
Clinical Instructor of Ophthalmology
Université Laval;
Cornea Clinic Staff Member
Le Centre Hospitalier de L'Université Laval
Québec, Canada

John W. Chandler, M.D.
Clinical Associate Professor of Ophthalmology
University of Washington;
Ophthalmologist and Director, Corneal Disease
Research Laboratory
Swedish Hospital Medical Center
Seattle, Washington

S. Darougar, M.D.
Professor of Public Health Ophthalmology
Head of the Sub-Department of Virology
Institute of Ophthalmology
London, England

Richard W. Darrell, M.D., Dr. Med. Sci.
Associate Professor of Clinical Ophthalmology
Columbia University;
Director, Corneal and External Disease Clinics
Presbyterian Hospital
New York, New York

N.W.H.M. Dekkers, M.D. Ophthalmologist St. Elisabeth Hospital, Tilburg Tilburg, The Netherlands

Edmund C. Dunkel, Ph.D.
Research Instructor, Department of Ophthalmology
Harvard University Medical School
Cambridge, Massachusetts;
Assistant Scientist, Cornea Unit
Eye Research Institute of Retina Foundation
Boston, Massachusetts

John C. Harbotzeff, Ph. D.

Peter R. Egbert, M.D.
Associate Professor of Ophthalmology
Stanford University;
Eye Clinic, Division of Ophthalmology
Stanford University Medical Center
Stanford, California

Eugenia T. Gamboa, M.D.
Assistant Professor of Clinical Neurology
Columbia University College of Physicians and
Surgeons;
Assistant Attending Neurologist
Columbia Presbyterian Medical Center
New York, New York

J. Allen Gammon, M.D., M.P.H.
Assistant Professor of Ophthalmology
Emory University School of Medicine;
Chief of Ophthalmology
Henrietta Egleston Hospital for Children
Atlanta, Georgia

Anne A. Gershon, M.D.

Professor of Pediatrics, Department of Pediatrics

New York University Medical Center

New York, New York

Merrill L. Grayson, M.D.
Distinguished Professor and Acting Chairman of
Ophthalmology
Indiana University School of Medicine
Indianapolis, Indiana

Mary T. Green, M.D., Ph.D. Assistant Professor Cullen Eye Institute Baylor College of Medicine Houston, Texas

Milford H. Hatch, Sc.D.
Supervisory Research Microbiologist, Respiratory
and Enterovirus Branch
Division of Viral Diseases
Center for Disease Control
Atlanta, Georgia

John C. Hierholzer, Ph.D.
Supervisory Research Microbiologist, Respiratory
and Enterovirus Branch
Division of Viral Diseases
Center for Disease Control
Atlanta, Georgia

Jane R. Lubin, M.D.
Doctoral Candidate, Cancer Biology
Harvard University;
Fellow of Ophthalmic Pathology
Masschusetts Eye and Ear Infirmary
Boston, Massachusetts

James P. McCulley, M.D.

Professor and Chairman, Department of
Cophthalmology
Southwestern Medical School
University of Texas Health Science Center;
Chief of Service, Parkland Memorial Hospital
Chief of Service, Children's Medical Center
Dallas, Texas

Ronald J. Marsh, M.D. Professorial Unit Moorfields Eye Hospital; Consultant, Western Ophthalmic Hospital London, England

Alice Y. Matoba, M.D.
Assistant Professor of Ophthalmology, Department
of Ophthalmology
Southwestern Medical School
University of Texas Health Science Center
Parkland Memorial Hospital
Dallas, Texas

H. Cody Meissner, M.D.
Assistant Professor of Pediatrics
Tufts Medical School;
Attending Physician in Infectious Disease
Director, Immunoserology Laboratory
New England Medical Center
Boston, Massachusetts

Roger F. Meyer, M.D. Professor of Ophthalmology University of Michigan Medical School Ann Arbor, Michigan

Bartly J. Mondino, M.D.
Professor of Ophthalmology
Jules Stein Eye Institute
University of California, Los Angeles School of
Medicine
Los Angeles, California

André J. Nahmias, M.D., Ph.D.
Professor of Pediatrics and Associate Professor of
Community Health
Chief of Pediatric Infectious Disease and
Immunology Division
Emory University School of Medicine;
Attending Physician, Grady Memorial Hospital
Atlanta, Georgia

Jang O. Oh, M.D., Ph.D.
Research Microbiologist and Member, Frances I.
Proctor Foundation for Research in
Ophthalmology
University of California Medical Center
San Francisco, California

Deborah Pavan-Langston, M.D.
Associate Clinical Professor of Ophthalmology
Harvard University Medical School;
Associate Surgeon
Massachusetts Eye and Ear Infirmary
Boston, Massachusetts

T.F. Schlaegel, Jr., M.D.
Professor of Ophthalmology
Director of Uveitis Service
Indiana University School of Medicine
Indianapolis, Indiana

Alan Sugar, M.D.
Professor of Ophthalmology, Department of
Ophthalmology
University of Michigan Medical School
Ann Arbor, Michigan

Yukio Uchida, M.D.

Professor and Chairman, Department of
Ophthalmology
Tokyo Women's Medical College
Tokyo, Japan

David W. Vastine, M.D.
Chief of Ophthalmology
Highland General Hospital
Oakland, California;
Consultant in External Ocular Disease and Corneal
Surgery, Department of Ophthalmology
Pacific Medical Center
San Francisco, California

Steven L. Wechsler, Ph.D.
Assistant Member, Department of Molecular
Virology
James N. Gamble Institute of Medical Research
Cincinnati, Ohio

Ocular intections of Herpes Supplier Virus Type , in Adults

Burton L. Wilner, Ph.D.
Orinda, California;
Formerly Assistant Scientist
Medical Research Institute
Pacific Medical Center
San Francisco, California

Stewart Mackay Wolff, M.D.

Associate Professor of Ophthalmology
Wilmer Institute
Johns Hopkins University School of Medicine
Johns Hopkins Hospital;
Greater Baltimore Medical Center
Baltimore, Maryland

Herpes Simplex Virus Infections: Latency and Reactivation	9
CHAPTER 2 Management of Herpes Simplex Virus Ocular Infections DEBORAH PAVAN-LANGSTON and HELENE M. BOISJOLY BET STATEMAN	
CHAPTER 3 Follicular Conjunctivitis and Keratoconjunctivitis Caused by Herpes Simplex Virus S. DAROUGAR	42
CHAPTER 4 Herpes Simplex Ocular Infections in the Newborn J. ALLEN GAMMON and ANDRÉ J. NAHMIAS	46
CHAPTER 5 Ocular Infections of Herpes Simplex Virus Type 2 in Adults JANG O. OH	59
CHAPTER 6 Varicella-Zoster Infections ANNE A. GERSHON	63
CHAPTER 7	
Varicella Dendritic Keratitis	73

Cytomegalovirus Qoular Infections (AND L

xiii

CHAPTER 8	
Ophthalmic Herpes Zoster	78
CHAPTER 9	
Corneal Manifestations of Herpes Zoster BARTLY J. MONDINO	90
CHAPTER 10	
Cytomegalovirus Ocular Infections	97
CHAPTER 11	
	4.4.00
Epstein-Barr Virus and Its Ocular Manifestations ALICE Y. MATOBA and JAMES P. McCULLEY	112
POXVIRIDAE	
CHAPTER 12	
Smallpox and Vaccinia	101
ALAN SUGAR and ROGER F. MEYER and remain some support and support support	
ARY T GREEN SAFEDWIND C. DUNGEL	
CHAPTER 13	
CHAPTER 13 Aloisios Maialrih 6 se Mottomal Mayorat Harouse Adenoviridae	
To the series of	
ear's fight filled the control of th	
CHAPTER 14	
Chronic Papillary Adenovirus Conjunctivitis	
PAPOVAVIRIDAE PAPOVAVIRIDAE PAPOVAVIRIDAE PAPOVAVIRIDAE	
Commence 15	
CHAPTER 15 Progressive Multifocal Leukoencephalopathy EUGENIA T. GAMBOA	153
PICORNAVIRIDAE NOSERRO A BANA	
CHAPTER 16	CHAPTER
Acute Hemorrhagic Conjunctivitis	165

TOGAVIRIDAE	
CHAPTER 17 Rubella Syndrome STEWART M. WOLFF	. 199
ORTHOMYXOVIRIDAE	
CHAPTER 18	
Orthomyxoviridae T.F. SCHLAEGEL, Jr. and MERRILL L. GRAYSON	. 211
PARAMYXOVIRIDAE	
CHAPTER 19 Newcastle Disease Virus Ocular Infections RICHARD W. DARRELL	
CHAPTER 20 Mumps Virus Ocular Disease RICHARD W. DARRELL	
CHAPTER 21 Measles Infection of the Eye TERRY J. BERGSTROM	. 233
CHAPTER 22 The Cornea in Measles N.W.H.M. DEKKERS	. 239
CHAPTER 23 Subacute Sclerosing Panencephalitis STEVEN L. WECHSLER and H. CODY MEISSNER	. 251
RESPONSE TO INFECTION	
CHAPTER 24 Immunologic Mechanisms in Viral Ocular Disease JOHN W. CHANDLER	. 265
CHAPTER 25 The Role of Viruses in Ocular Tumors DANIEL M. ALBERT and JANE R. LUBIN	. 283
CHAPTER 26 Follicular Conjunctivitis	. 296

Снарт	Thygeson's Superficial Punctate Keratitis: Natural History and Assotion with HLA-DR3	
	RICHARD W. DARRELL	Action of the Contract
INDEX		335
1145221	DRTHOMYXOVIRIDAE COMMON OF THE PROPERTY OF TH	
	TA- Inhomy xovindae L'SCHLASCEL, is and MERICLE is CRAYSON TO STAND THE TO STAND	
		q'
	Special Barr of the wife the Orolan Manufestations	
	lowcastle Disease Virus Oqular Infections " To the Fifth M. Y. M. I.	
	CHARD W DARKIL	
	Lumps Virus Oqular Disease	
	CHARD W DARREL	
	he Cornea in Measles	
	Consult Papillary Adenovirus Consultati voco in bas serridaw il sovat s passouras	
	menunologic Mechanisms in Viral Ocular Disease	
	Plantane trultilocal Leukoen sphalopathy SERVARS WIRE	
	FILCONIA 7, CAMBIOA	
	Apply Bemorchagic Community itis	

Introduction (Taxonomy of Viruses)

Specials Country Transfer of the But

RICHARD W. DARRELL

Viruses are essentially molecules of nucleic acid capable of penetrating living cells and of redirecting the host's cellular machinery to create additional copies of both viral nucleic acid and protein. Within this framework, viruses are a very diverse group of infectious agents. They contain either DNA or RNA as their nucleic acid, vary greatly in size, from 22 nm (parvovirus) to 250 × 300 nm (poxvirus), are coded for different enzymes, and differ in the complexity and geometry of their electron micrographic appearance.1,2 The nucleic acid of the virus is called the genome and is surrounded by a protective protein shell, or capsid; genome and capsid together comprise the nucleocapsid. Capsids are constructed of repeating subunits arranged in geometric or otherwise precise patterns, as, for example, the icosahedral symmetry of adenovirus or the helical symmetry of orthomyxoviruses and paramyxoviruses (Table 1).

Viruses also differ in their host ranges, both in the living animal and in tissue culture. The latter is important because several different types of tissue culture cells must be used to isolate an unknown virus that may grow well in one but not in other types of cells. Within the living host, different virus species also display a preference for different types of tissue. For ex-

ample, herpes simplex virus infects sensory nerves and becomes latent in nerve ganglia, whereas adenovirus is usually limited to epithelial and adjacent subepithelial tissues.

Révalendamen et not trains

The sequelae of virus infection of the eye and visual system can be divided clinically into four general patterns (1) acute conjunctivitis, keratitis, and blepharitis following infection of the ocular surface, (2) chorioretinitis and uveitis following infection of the retina and uvea, (3) optic neuritis, papillitis, papilledema, oculomotor paresis, and meningoencephalitis following infection of the central and peripheral nervous system, and (4) the induction of tumors (Table 2). That viruses could cause ocular tumors was a matter of conjecture until recently, but new evidence has implicated several viruses in the development of cancer (e.g., melanoma).

Infection of the epithelial surface of the cornea, conjunctiva, and eyelids is the most commonly encountered virus disease in clinical practice. The hallmarks are follicular conjunctivitis, variable epithelial keratitis, and enlargement of the preauricular lymph nodes. Herpes simplex virus and adenovirus infections are the usual causes, although in tropical regions, coxsackievirus A24 and enterovirus

Table 1. Characteristics of Virus Families Causing Diseases of the Eye

Family	Nucleic Acid	Morphology	Diameter of Naked Nucleocapsid (nm)
Herpesviridae	DNA		
		Enveloped icosahedral nucleocapsid	100
Poxviridae	DNA	Complex	225×300
Adenoviridae	DNA	Naked icosahedral nucleocapsid	75
Papovaviridae	DNA	Naked icosahedral nucleocapsid	4555
Picornaviridae	RNA	Naked icosahedral nucleocapsid	25-30
Togaviridae	RNA	Enveloped icosahedral nucleocapsid	40-70
Bunyaviridae	RNA	Enveloped coiled circular nucleocapsids	100
Reoviridae	RNA	Naked double-shelled icosahedral nucleocapsid	75
Orthomyxoviridae	RNA	Enveloped helical nucleocapsid	80-120
Paramyxoviridae	RNA	Enveloped helical nucleocapsid	150
Rhabdoviridae	RNA	Enveloped helical nucleocapsid	75 × 180
Retroviridae	RNA	Enveloped coiled nucleocapsid	150
Arenaviridae	RNA	Enveloped coiled nucleocapsid	80-130
Coronaviridae	RNA	Enveloped helical nucleocapsid	100

70 cause acute hemorrhagic conjunctivitis. Vesicle formation on the lids or conjunctiva suggests infection by herpes simplex or varicella-zoster virus. Such vesicles are also seen in variola and varicella virus infections, but these diseases have been eliminated almost completely by vaccination. Similarly, the eradication of smallpox has reduced the need for vaccinia virus as a source of vaccination against the disease; therefore, the extreme blepharitis and conjunctivitis seen in vaccinia virus ocular infection is also observed rarely today.

Most virus families contain species capable of causing external ocular disease, for example, herpes simplex virus type 1 and 2, varicella-zoster virus, and Epstein-Barr virus among the herpesviridae; smallpox, chickenpox, vaccinia, and molluscum contagiosum viruses among the poxviridae; numerous adenovirus types among the adenoviridae; the virus that causes papilloma among the papovaviridae; coxsackievirus, enterovirus, and human rhinovirus among the picornaviridae; rubella virus among the togaviridae; influenza, parainfluenza, Newcastle disease, mumps, measles, and respiratory syncytial viruses among the orthomyxoviridae and paramyxoviridae families; and the coronaviruses among the coronaviridae. All of these can produce variable signs of virus infection of the ocular surfaces.

Virus infection of the retina and uvea causes chorioretinitis and uveitis with variable inflammation of the optic nerve and retinal vessels. All members of the herpesviridae family are capable of producing this clinical pattern, particularly in individuals whose immune system has been suppressed. Rubella virus infection (togaviridae) also affects the choroid and retina, and a retinitis is seen in the rarer bunyaviridae infections (Rift Valley fever). human T-lymphotrophic retroviruses (HTLV-III) have been isolated from patients with AIDS (acquired immune deficiency syndrome).3-6 While these viruses do not directly infect the eye, they can so weaken the T-cell immune system that secondary infections can colonize the retina and choroid.

Virus infection of the central and peripheral nervous system is manifested clinically by optic neuritis, papillitis, papilledema, oculomotor paresis, and meningoencephalitis. Most members of the togaviridae, bunyaviridae, and reoviridae families cause encephalitis and are transferred by insects. Many members of the herpesviridae family can cause meningitis and encephalitis, particularly in immu-

Table 2. Virus Species Causing Disease of the Eye

Family	Subfamily or Genus	Species Species	Clinical Disease
Herpesviridae	Alphaherpesvirinae	Herpes simplex virus type	Herpetic ocular disease
higs por	pp sid tenhilor of celocal	Herpes simplex virus type	Genital herpes with ocular infection in newborn and adults
ohalidise ini sare i disea namigidensis by done mast aparajilant A disea bata	ponthnevic, bd. Ciliacutae salty an of a subgroup at total a rovinus a (HTLV HI)	Varicella zoster virus	Chickenpox ocular disease in nonimmune, herpes zoster ocular disease in immune individuals
		B virus	Encephalitis
Serional n	Betaherpesvirinae	Human cytomegalovirus	Retinitis
	Gammaherpesvirinae	Epstein-Barr virus	Infectious mononucleosis
Poxviridae	Orthopoxvirus	Variola major	Cmallagy
	o tinopontinuo	Variola minor	Smallpox
	nocytic Wenit	Vaccinia	Chickenpox September A
	Parapoxvirus		Vaccinia
		Orf virus	Contagious pustular dermatitis
	Ungrouped	Molluscum contagiosum	Molluscum of lids
Adenoviridae	Mastadenovirus Mastadenovirus	Human adenovirus	Follicular conjunctivitis, keratitis
Papovaviridae	Papillomavirus	Human papillomavirus	Papillomas on lid or conjunctiva
nas T-lympho-		DAR Virus	Progressive multifocal leukoencephalopathy
Picornaviridae	Enterovirus	Poliovirus 1–3;	Meningitis; acute hemorrhagic conjunctivitis in
	ner viruses remain laten	50 (38DI)F	coxsackievirus A24 and
ecome latent but tree, of destruc-	Rhinovirus	Human rhinovirus	enterovirus 70 infection Common cold
Togaviridae	Alphavirus; Flavivirus	Insect-borne viruses named for geography of disease	Encephalitis
	Rubrivirus	Rubella virus	Rubella ocular disease
Attanton Interes		tol	
	Bunyavirus de la financius de	disease	Encephalitis; retinitis in Rift Valley fever
	Orbivirus di ai listab	Colorado tick fever virus	Encephalitis The Encephalitis
Orthomyxoviridae	Influenzavirus	Influenza virus A,B,C	Conjunctivitis
Paramyxoviridae	Paramyxovirus	Parainfluenza virus 1–4	Conjunctivitis (type 1);
	Virology, Edited by WK. Jo	Newcastle disease virus	
	pleton-Century-Crofts, 1989 Popovic, M., Samperthaten,	Mumps virus	Conjunctivitis Dacryoadenitis
	Morbillivirus	Measles virus	Conjugativitie
	and the state of t	Micasics VIIUS 1911 931138 II	Conjunctivitis; keratitis

Table 2. Virus Species Causing Disease of the Eve Continued

Family Property of the Propert	Subfamily or Genus	Species	Clinical Disease
Control ocular disease	off egyl auriv xeightlis enn Nachels Adid Monneckey ave seeden virus bygdyn, ave	Subacute sclerosing panencephalitis	Chronic degeneration of the central nervous system
integran ni noticelni	Pneumovirus	Respiratory syncytial virus	Common cold
Rhabdoviridae	Lyssavirus	Rabies virus	Encephalitis; in rare cases transmission is by dono corneal transplant
Retroviridae	Oncovirinae	RNA tumor viruses	Benign tumors and leukemia
ections regionalisaments et discourse et dis	HAI RAIS CURSTAGE GROWN THE RAIS CONTRACTOR OF THE RAISE CONTRACTOR OF THE RAI	HTLV-III	Acquired Immune Deficiency Syndrome
Arenaviridae	Arenavirus	Lymphocytic choriomeningitis virus	Meningitis 134
Coronaviridae	Coronavirus	Human coronavirus	Upper respiratory disease
Unclassified viruses and viruselike agents	CHINA agents (chronic- infectious neuropathic agents)	Agents of Kuru and Creutzfeldt-Jakob disease	Degenerative disorder of the central nervous system

nocompromised individuals. Poliovirus, coxsackievirus, echovirus, and enterovirus (picornaviridae) are all capable of causing meningitis, as are rabies and lymphocytic choriomeningitis viruses (rhabdoviridae and arenaviridae).

Progressive multifocal leukoencephalopathy, a slowly progressive degenerative disease of the central nervous system, is associated with DAR and JC viruses (papovaviridae). Subacute sclerosing panencephalitis, also a progressive degenerative infection of the central nervous system, has been linked to the measles virus (paramyxoviridae). Creutzfeldt-Jakob disease and rabies have both been transferred to a healthy individual by a corneal graft taken from a donor not known at the time to have these diseases.⁷⁻¹⁰

Viruses continue to present surprises to us in their relationship to cancer as well as to acute infectious disease. Occasionally, a new virus will appear in the context of a new epidemic disease, as is the case with enterovirus 70 in acute hemorrhagic conjunctivitis, and human T-lymphotrophic retroviruses (HTLV-III) in acquired immune deficiency syndrome (AIDS). Whereas most viruses cause an acute disease from which the patient recovers. other viruses remain latent with the body. Still other viruses do not become latent but continue a relentless course of destruction, as is evident in progressive multifocal leukoencephalopathy, subacute sclerosing panencephalitis, and Creutzfeldt-Jakob disease. A few virus species are instrumental in altering the normal growth controls within cells, thus causing cancerous growth. The broad spectrum of virus diseases of the eye will be discussed in detail in the following chapters.

REFERENCES

- Matthews, R.E.F.: Classification and nomenclature of viruses. Intervirology, 17:27-181, 1982.
- Joklik, W.K.: The nature, isolation and measurement of animal viruses. In Principles of Animal Virology. Edited by W.K. Joklik. New York, Appleton-Century-Crofts, 1980.
- 3. Popovic, M., Sarngadharan, M.G., Read, E., et al.: Detection, isolation, and continuous production

of cytopathic retroviruses (HTLV-III) from patients with AIDS and pre-AIDS. Science, 224:497-500, May 4, 1984.

- Gallo, R., Salahuddin, S., Popovic, M., et al.: Frequent detection and isolation of cytopathic retroviruses (HTLV-III) from patients with AIDS and at risk for AIDS. Science, 24:500-503, May 4, 1984.
- Schupbach, J., Popovic, M., Gilden, R., et al.: Serological analysis of a subgroup of human T-lymphotropic retroviruses (HTLV-III) associated with AIDS. Science, 224:503-505, May 4, 1984.
- Sarngadharan, M.G., Popovic, M., Bruch, L., et al.: Antibodies reactive with human

- T-lymphotropic retroviruses (HTLV-III) in the serum of patients with AIDS. Science, 224:506-508, May 4, 1984.
- Centers for Disease Control. Human-to-human transmission of rabies via a corneal transplant— Idaho. MMWR, 28:109-111, 1979.
- Centers for Disease Control. Human-to-human transmission of rabies via a corneal transplant— France. MMWR, 29:25-26, 1980.
- Centers for Disease Control. Human-to-human transmission of rabies via a corneal transplant— Thailand. MMWR, 30:473-474, 1981.
- Duffy, P., Wolf, J., Collins, G., et al.: Possible person-to-person transmission of Creutzfeldt-Jakob disease. N. Engl. J. Med., 290:692, March 21, 1974.

Tymphestopia ectroviness (ETLV-UI) in the second by patheats with AIDS. Science.

Lecture 90, the 4, 1954.

Cachic 90, the 4, 1954.

trademission of phies via a comeal transplant — iddee verifyR, 20 108-111, 1979.

8. Camers for Differen Control. Human co-human

Hense laston of moles via a corneal transplust—
President MMVR. 1915-26, 1980 Centers for Nacest Control. Parameter in himse

Teneralise of relates via a conneal transplant
Transmission of relates via a conneal transplant
Trailend MMWR, 30:473-474, 1987.

40. Duffy P. Wolf, Collins, C., et al. Possible
Connection of County List.

person to gersan transmission of Greutzluddtlakeb disease. N. Engl. J. Med., 2500682, March 21, 1974.

H-Verffiy ye COA-Had		
	1,000,10	
by to nells		menb
		and a

seasy Schapbells W. Coldens M. ardell are dell' service No. Coldens M. Schapping of human 13.5 gasphotopin settoviruses (HTAM III) associated with AIDS. Science. 22 0503-505, May 4.

6. Sarngadharais, M.G. Popovic, M. Brach, L. et al., Antibodies reschive with human

Deficiency Synarces

k soprificae arecentos	vmolecce z	Reministra	
2 constant county			
Lispasindas Coronisvirus			
pages to appearable		system	

processor and arena varieties and enterovities (picernavirsus) are air capable of constigues ingitis, as are ratios and gree processor chomomentagitis viruses (resocapable of arena varieties).

Prepressive multifical in a cencernal relative stores of the central nervous system, is checked with DAR and it veryons functive intection of the contral nervous system intection of the contral nervous system has been linked to the measure virus to remain the interteller, a some horn been tracked to the measure wirds to remain relative and rabies have both been trees even to a healthy individual by a contrast goal taken from a donor and known as the trees to be veryone a donor and known as the trees to be veryone a donor and known as the trees to be veryone a donor and known as the trees to be veryone at the trees to be veryone.

Viruses confinue to present surprises
to la their relationship to cancer as well
as to acute infections disagrae. Caccasin
alty a new spaceance the case as is the case
the anterovirus 70 in acute. Shortbasic

communicativities and burnan T-lymphotomonic retrievers (ITTV III) in acquired immunication of virtues cause an acute disease/fight, which the patient recovers, the current remain latent with the body. Still other viruses are in recome latent burn gontione a releations course of destruction, as is avident in propagative multifocult leukachrophalopatity, subsects are instrumental in altering the normal growth controls within calls thus causing cancers within calls thus causing cancers are within calls thus causing cancers arowits. The broad spectrum of virus diseases of the eye will be discussed in data to the following brenters.

ESPERANCES

- by March R.J. e. Classification and morninglerate of crosses. Interpreting, 17:27-183, 1892. March W.K. The nature backers and metalenal and committee of Committee of America. Virusing Edited by W. Joseph Mer York, Apples of Committy-Cookse 1980.
- Determine the second transfer of the second second