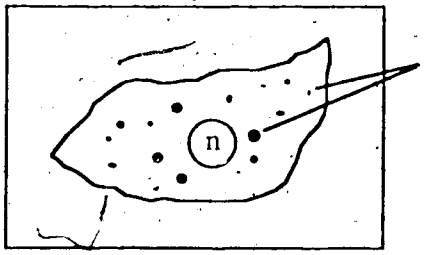
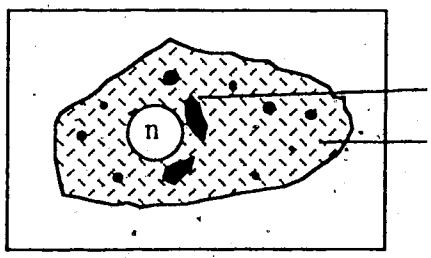
Figure 6

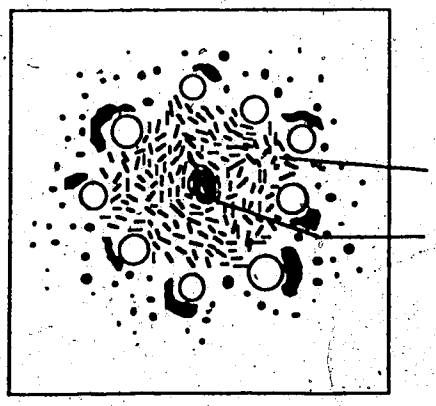
Progression of immunofluorescent staining obtained with NP and P protein monoclonal antibodies



refer to Fig. 9b



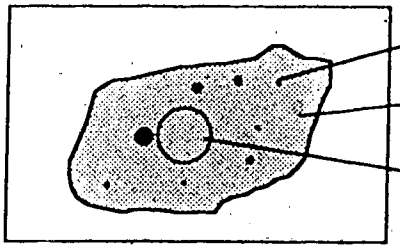
refer to Fig. 9c



refer to Fig. 10d

Figure 7

Progression of immunofluorescent staining obtained with M monoclonal antibody

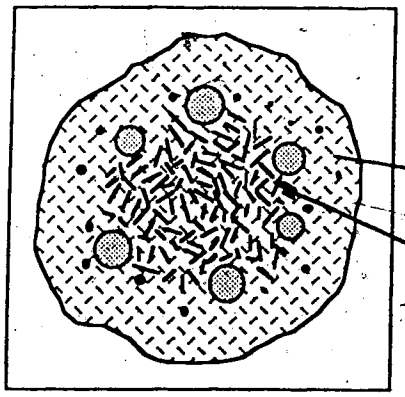


dots/globules

fine homogeneous

diffuse nuclear

refer to Fig. 11b



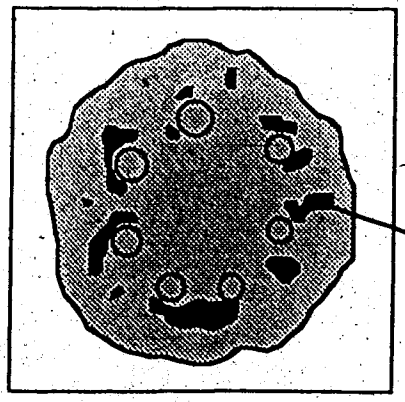
dots/globules

diffuse nuclear

flecks

fibrous

refer to Fig. 11c



fine homogeneous

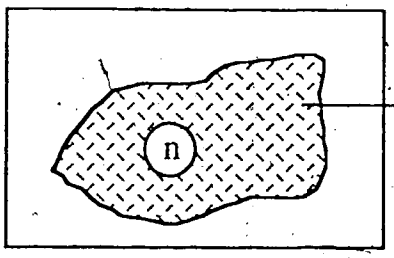
diffuse nuclear

pale globules

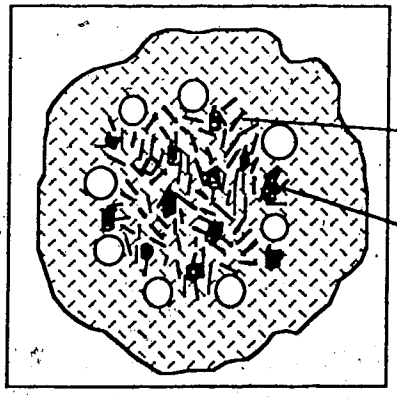
refer to Fig. 11e

Figure 8

Progression of immunofluorescent staining obtained with H and F monoclonal antibodies



flecks refer to Fig. 12b



flecks

fibrous refer to Fig. 13d

fibrous clusters

Figure 9.

Immunofluorescent staining of the NP protein in Vero cells infected with RP at 32°C

Figure 9a.

A photograph of a RP-infected cell fluorescing after immunofluorescent staining with the NP protein monoclonal antibody. Pin point dots were detected in the cytoplasm at 6 h pi. This and the following photographs of IF staining were taken using a Leitz incident light fluorescent microscope (section 2.7 and 2.10).
Magnification 512 X

Figure 9b.

Fluorescent dots in a variety of sizes detected in the cytoplasm at 14 h pi.

Figure 9c.

The appearance of flecks in addition to the bright dots and larger globules at 24 h pi.

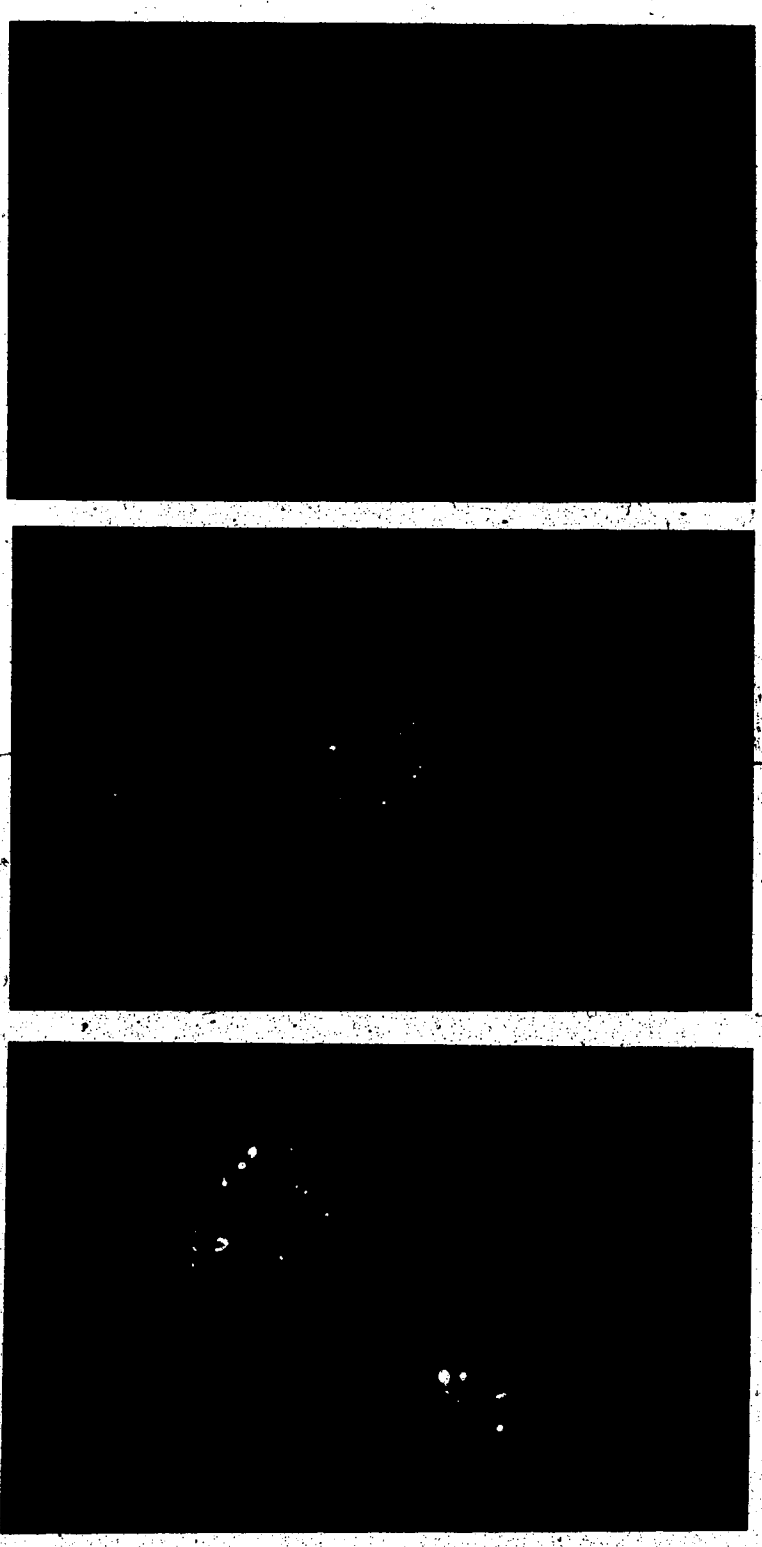
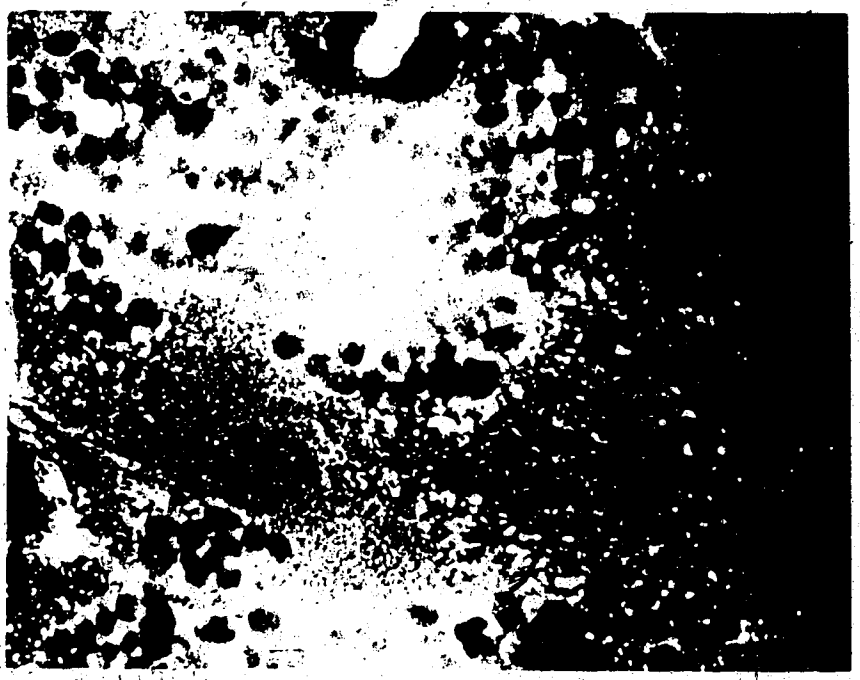


Figure 9d.

NP staining at 48 h pi showing extensive cytoplasmic staining. Magnification 320 X

Figure 9e.

NP staining at 72 h pi illustrating the fibrous type staining in the center of syncytia, perinuclear globular inclusions, and flecks and dots towards the periphery of the syncytia.



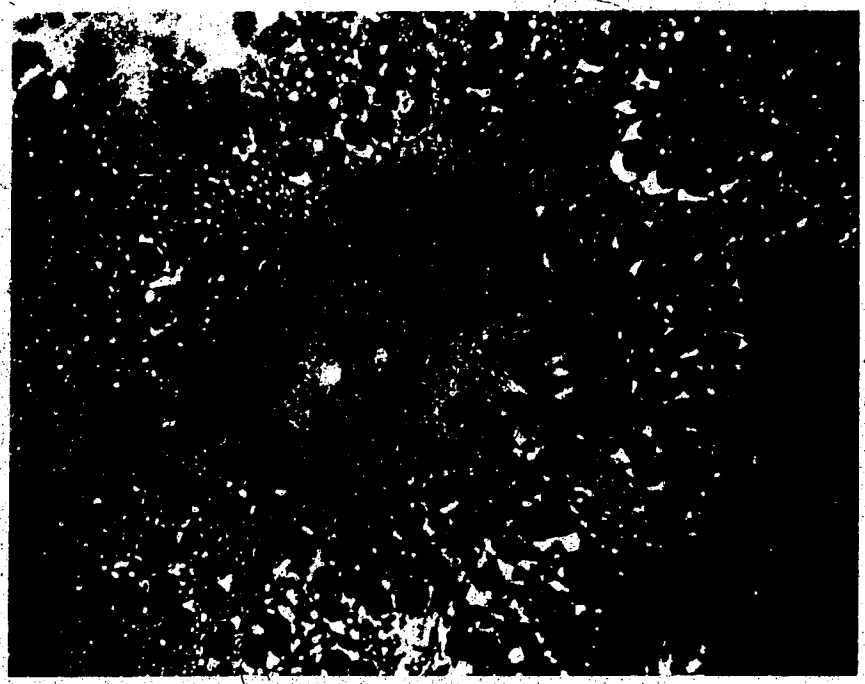


Figure 10.

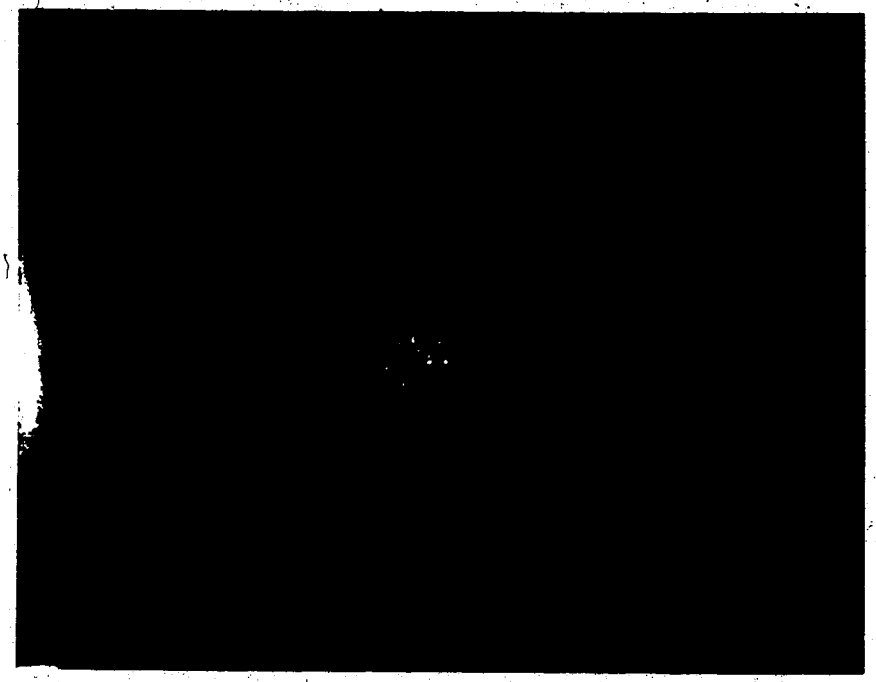
Immunofluorescent staining of the P protein in cells infected with RP at 32°C

Figure 10a.

Cytoplasmic dots of P protein seen at 10 h pi.

Figure 10b.

Flecks, bright dots and large globules of P protein seen at 24 h pi.



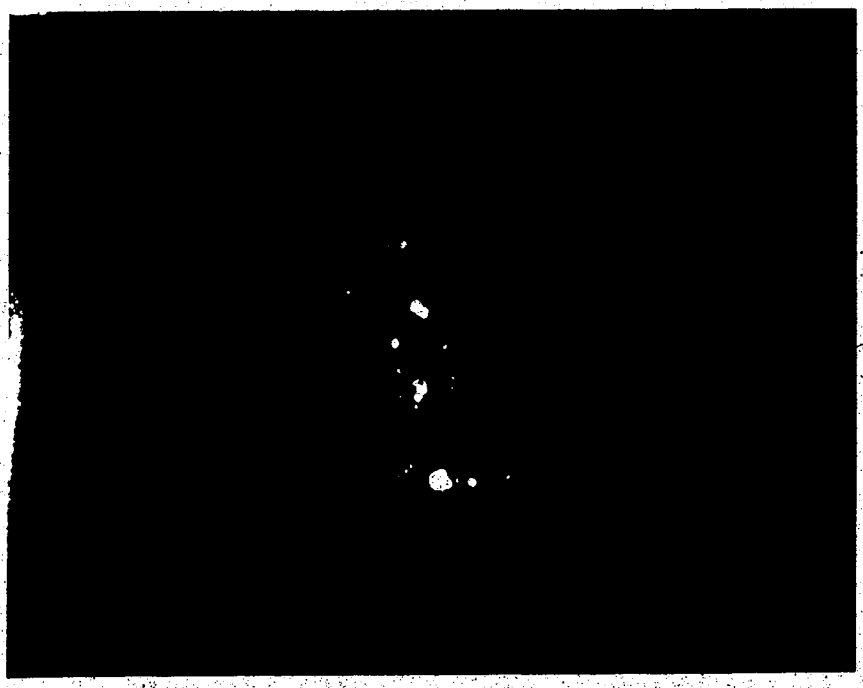


Figure 10c.

Appearance of P protein at 48 h pi showing flecks, bright dots and globules and some fibrous material.

Figure 10d.

A good example of the different types of cytoplasmic staining seen with P protein at 72 h pi. Present are dots/globules, flecks, fibrous material (f) and fibrous inclusions (i).

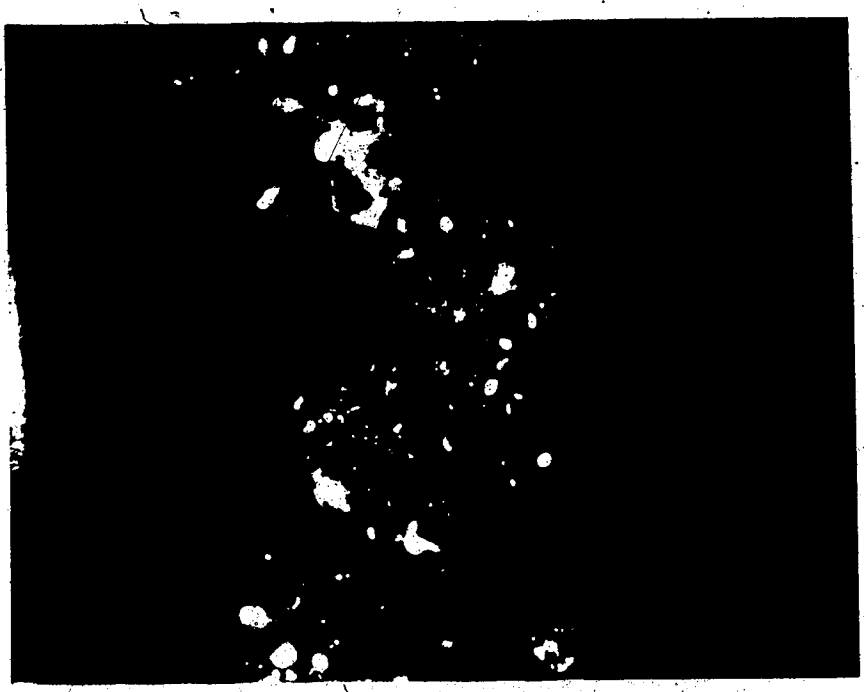


Figure 11.

Immunofluorescent staining of the M protein in cells infected with RP at 32°C

Figure 11a.

A faintly stained cell at 18 h pi showing pale diffuse nuclear staining, faint cytoplasmic staining with a few dots and globules of M protein.

Figure 11b.

An infected cell at 24 h pi showing the same features seen at 18 h pi but more intensely.

Figure 11c.

A small syncytia at 48 h pi characterized by flecks, fibrous material, a few globules and pale nuclear staining.

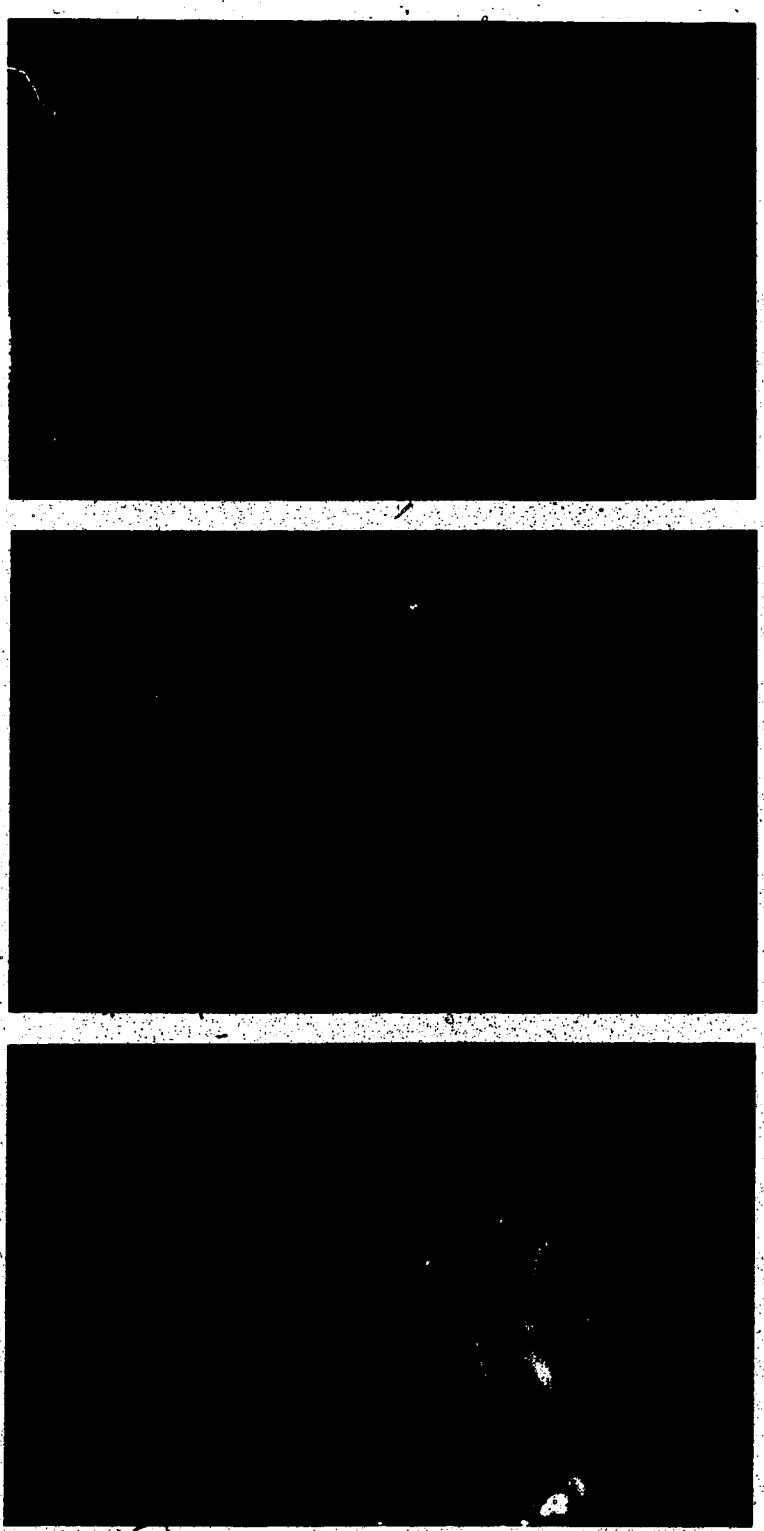
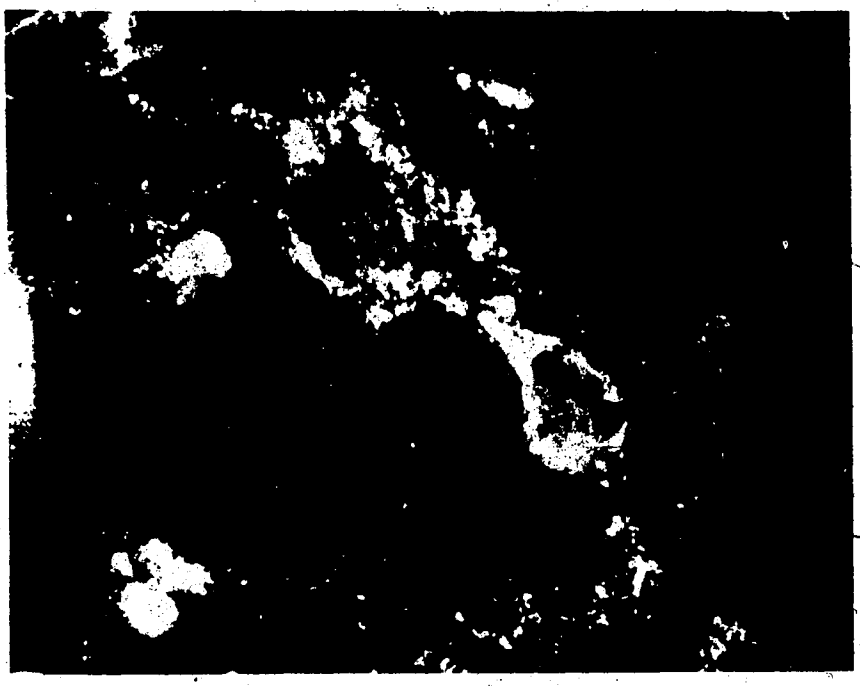


Figure 11d.

A brightly-staining flecked and fibrous type of syncytia seen at 72 h pi.

Figure 11e.

A pale-staining type of syncytia at 80 h pi characterized by a pale homogeneous cytoplasm containing weakly staining globular perinuclear inclusions and diffuse nuclear staining.



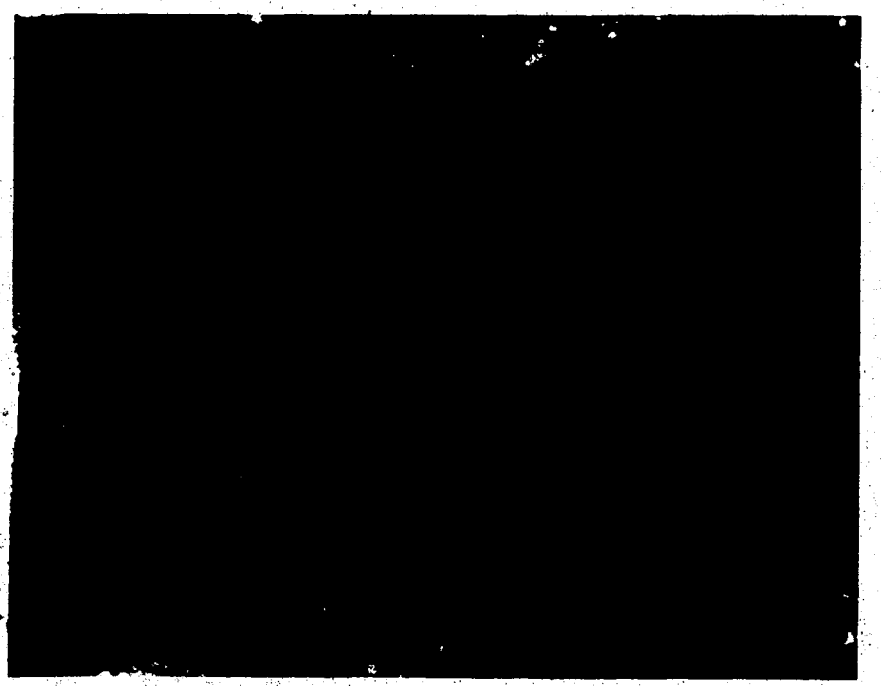


Figure 12.

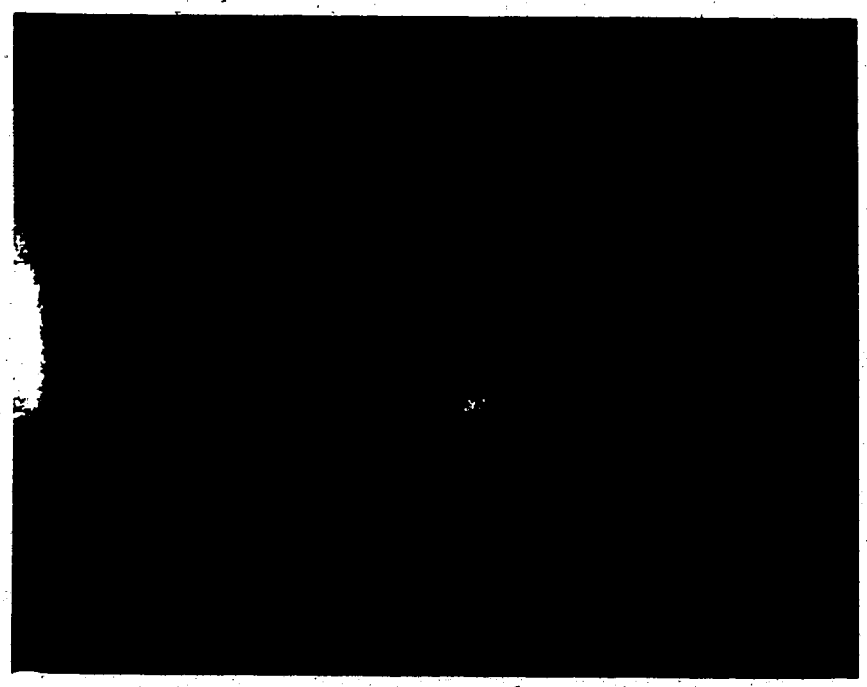
Immunofluorescent staining of the H protein in cells infected with RP at 32°C

Figure 12a.

An infected cell (20 h pi) showing diffuse homogeneous cytoplasmic staining, pale flecks and no nuclear staining with the anti-H monoclonal antibody.

Figure 12b.

Distinct flecking seen at 24 h pi.



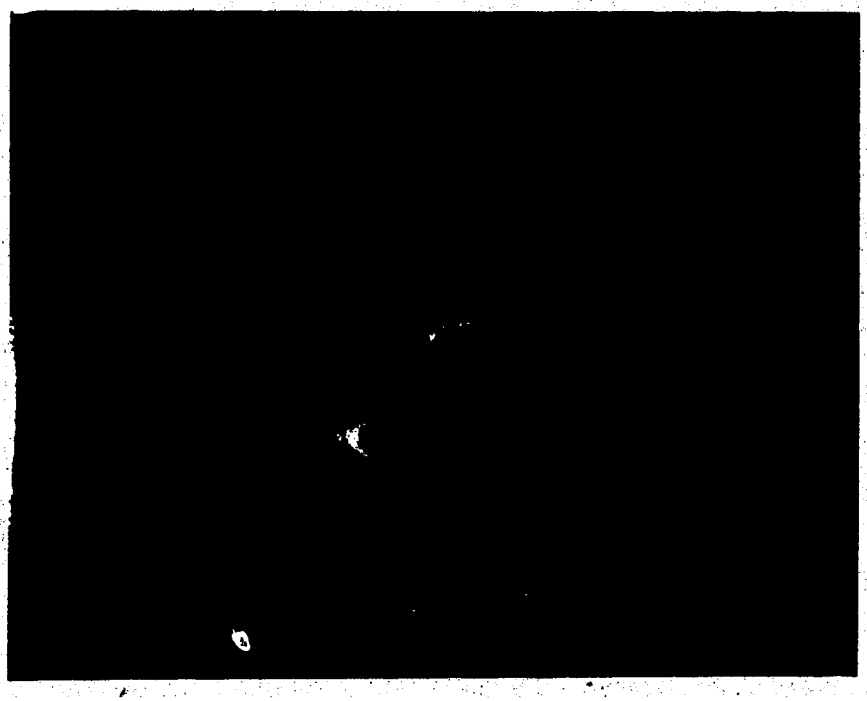


Figure 12c.

H protein at 40 h pi shows distinct flecks and fibrous material.

Figure 12d.

Fibrous clusters are a predominant feature of this syncytia at 56 h pi.

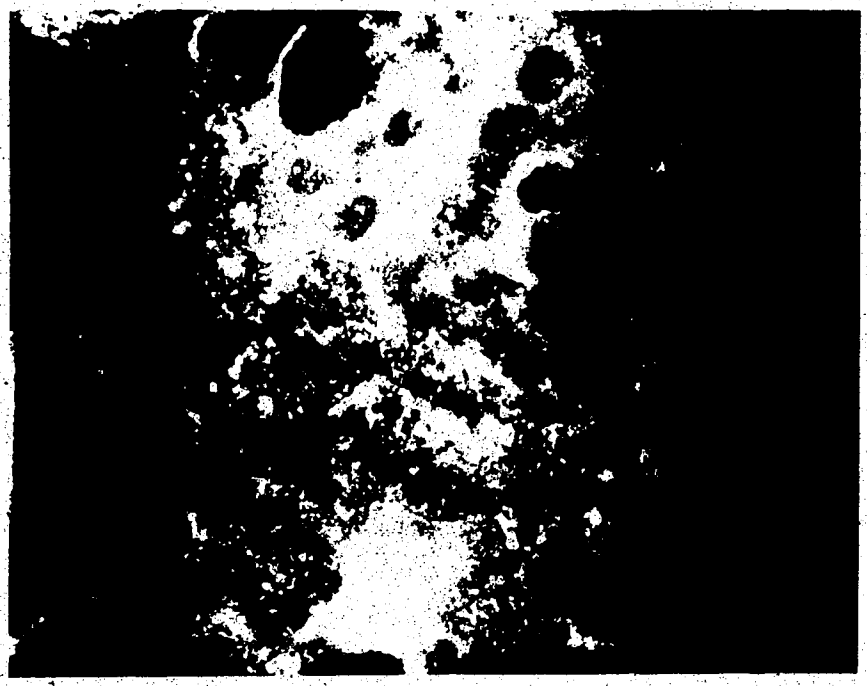


Figure 13.

Immunofluorescent staining of the F protein in cells infected with RP at 32°C

Figure 13a.

Pale cytoplasmic flecks of F protein detected at 21 h pi.

Figure 13b.

Pale flecking at 24 h pi.

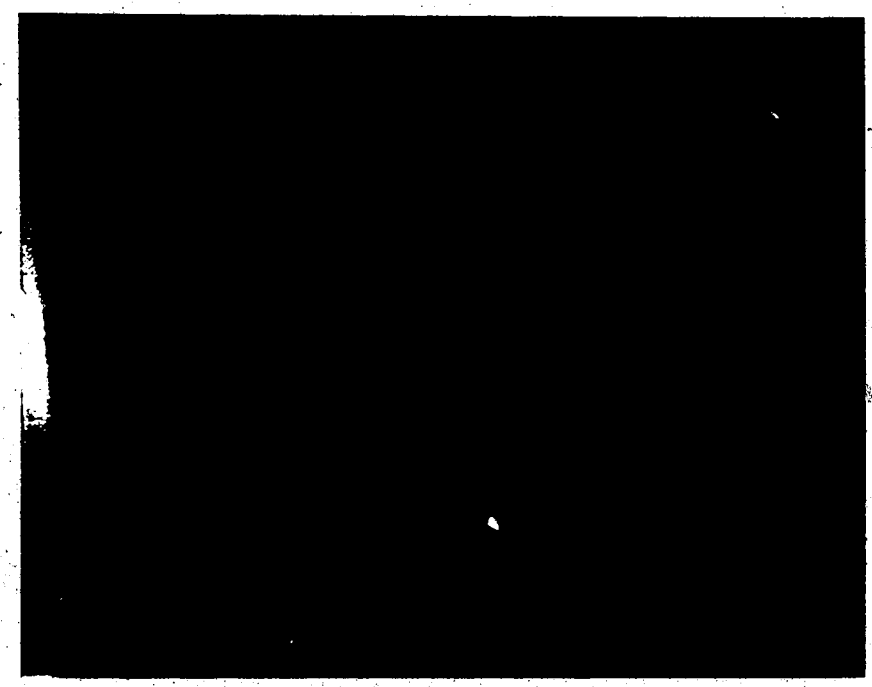


Figure 13c.

F protein stained at 48 h pi illustrating the bright flecks, fibrous material and some fibrous clusters

Figure 13d.

A good illustration of the F protein fibrous clusters (c) and fibrous material (f) seen at 72 h pi.

Figure 14.

Electron micrographs of cells infected with RP at 32°C

Figure 14a.

An electron micrograph of a RP-infected cell at 96 h pi illustrating a cytoplasmic inclusion of NC material. Refer to sections 2.8 and 2.9 for the methods used.
Magnification 25,500 X

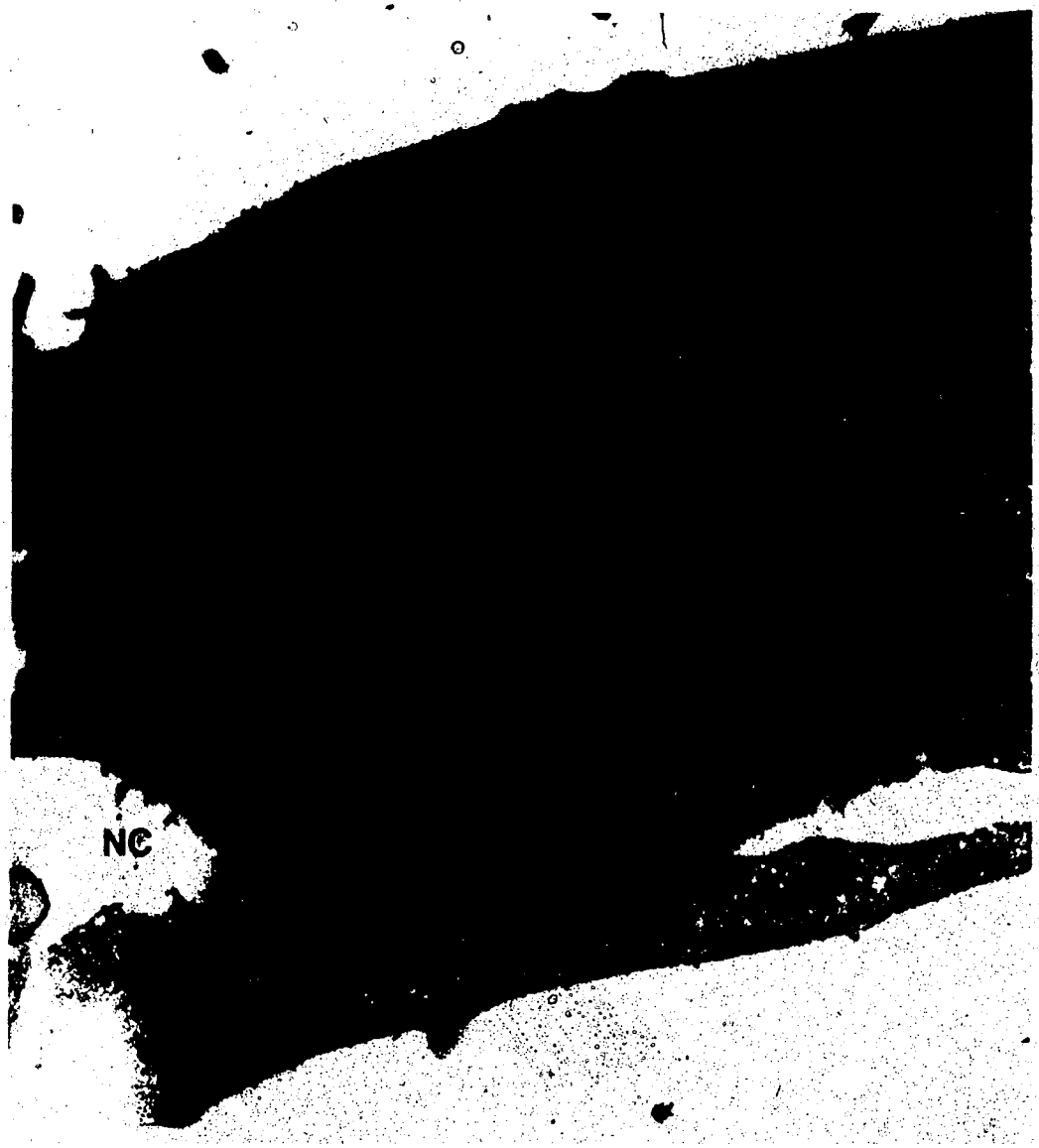

NC

Figure 14b.

Extracellular virus (v) seen at 72 h pi.
Magnification 51,000 X.

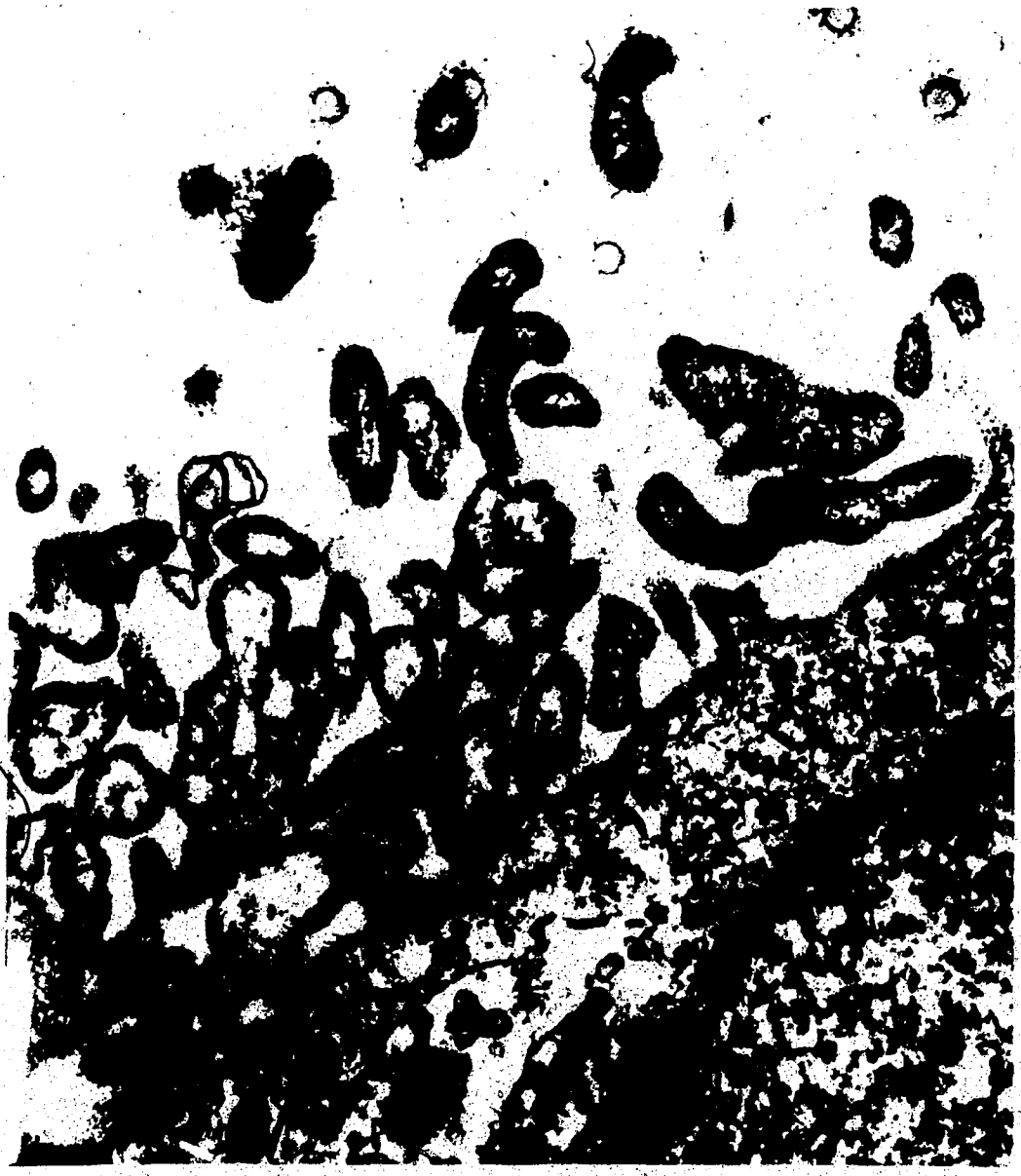


Figure 14c.

Infected cells at 96 h pi showing budding virus (bv) and simple nuclear bodies (sNB).
Magnification 25,500 X


bv

Figure 15.

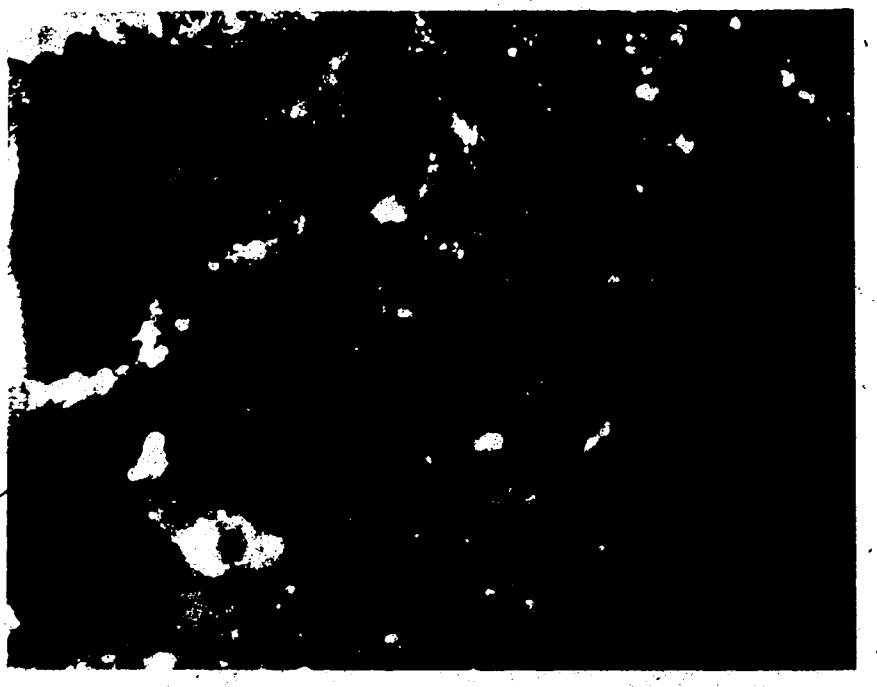
Immunofluorescent staining of Lec and mumps virus-infected cells with M monoclonal antibody (C1-144)

Figure 15a.

Lec-infected cells stained with the C1-144 clone showed diffuse nuclear staining

Figure 15b.

The uninfected control cells do not stain intranuclearly with the C1-144 clone.



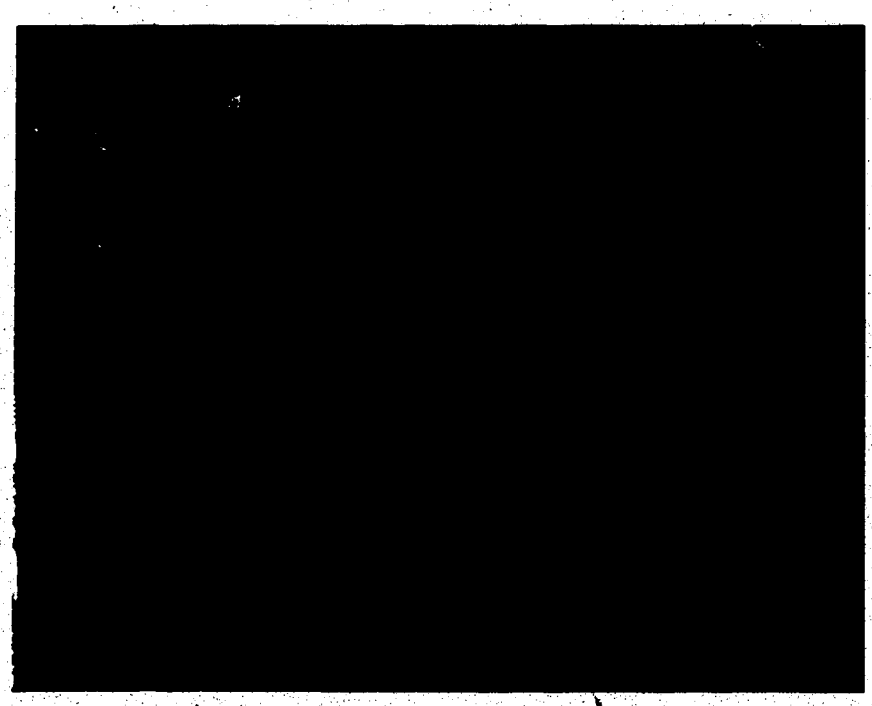
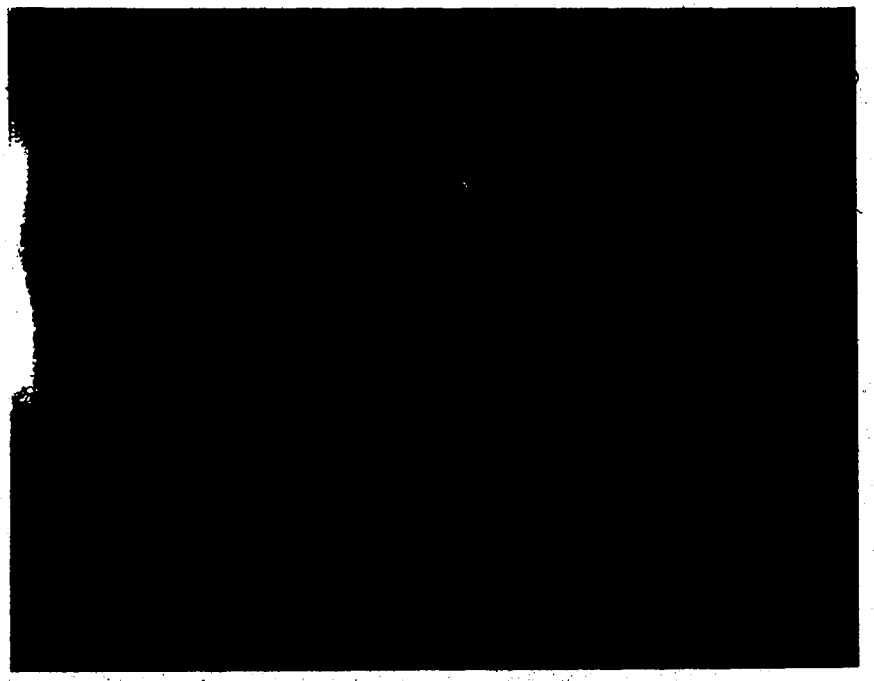


Figure 15c.

Mumps virus-infected cells do not stain with the C1-144 clone of M monoclonal antibody.

Figure 15d.

Nonstained uninfected control cells.



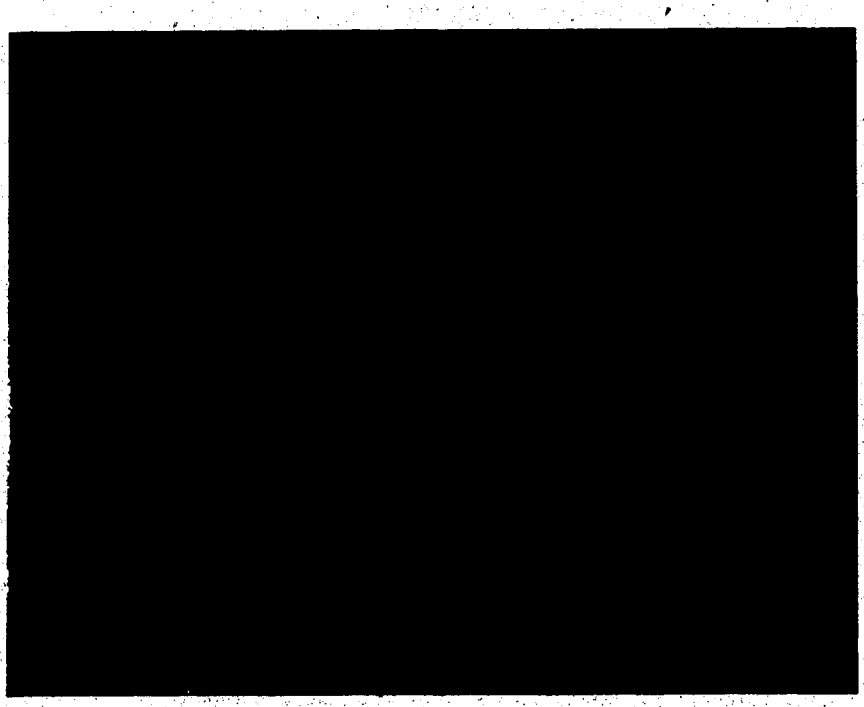


Figure 16.

Immunofluorescent staining of Halle UP-1 cells with polyclonal wild-type antiserum (MVR-3)

Figure 16a.

Brightly fluorescing infected cells at 32°C and 51 h pi showing primarily flecks, fibrous material and fine homogeneous cytoplasmic staining.

Figure 16b.

A syncytia at 39°C and 27 h pi illustrating the pale diffuse nuclear staining, fine cytoplasmic staining as well as bright dots/globules, flecks and fibrous staining.

Figure 17.

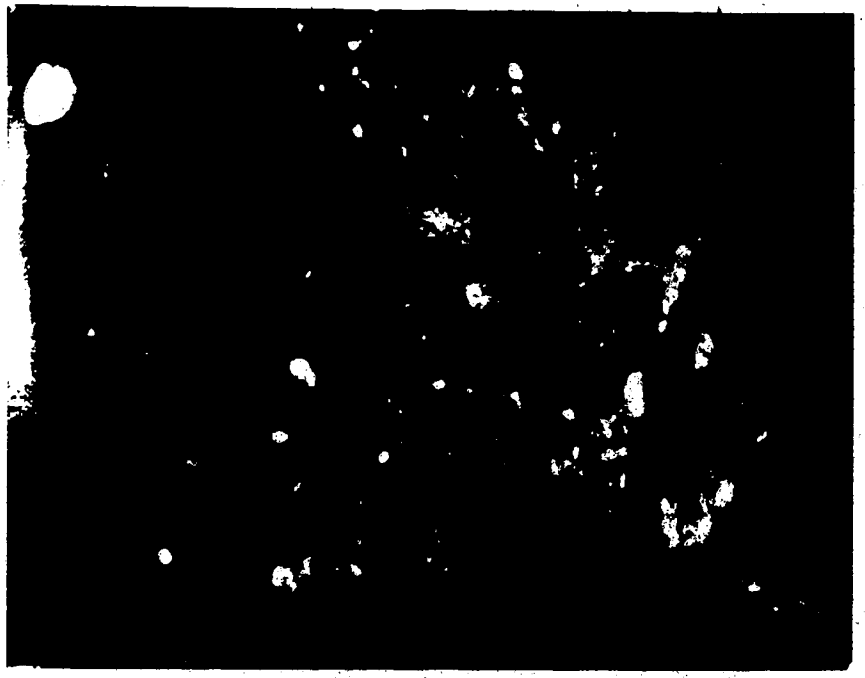
Immunofluorescent staining of Halle UP-1 cells with polyclonal nucleocapsid antiserum (MeNC-1)

Figure 17a.

Infected cells at 32°C and 51 h pi demonstrating diffuse and dotted nuclear staining and intense cytoplasmic staining.

Figure 17b.

A large syncytia at 39°C and 27 h pi illustrating nuclear diffuse staining and dots as well as bright cytoplasmic globular inclusions, dots and areas of only fine homogeneous staining.



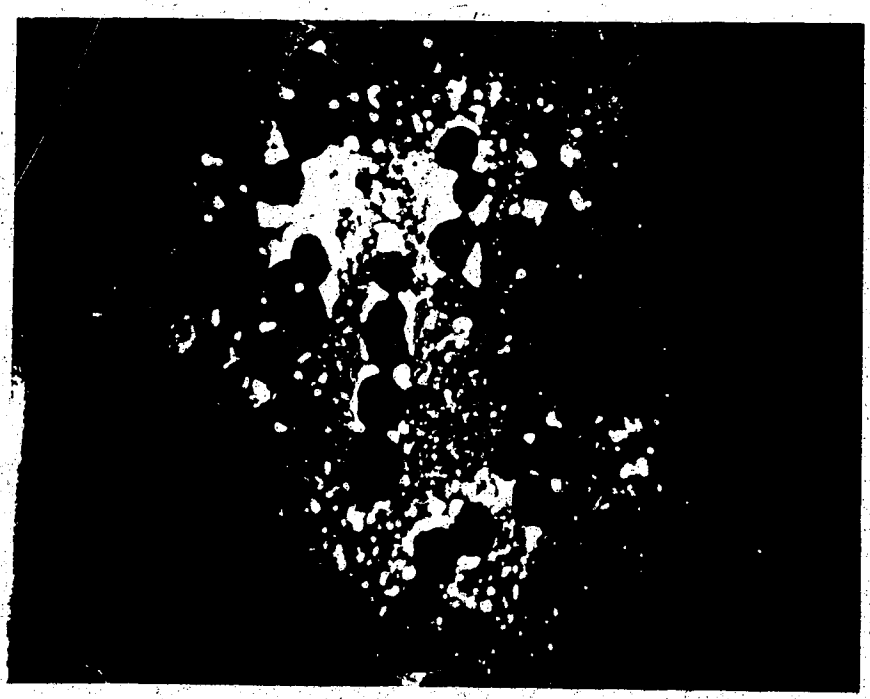


Figure 18.

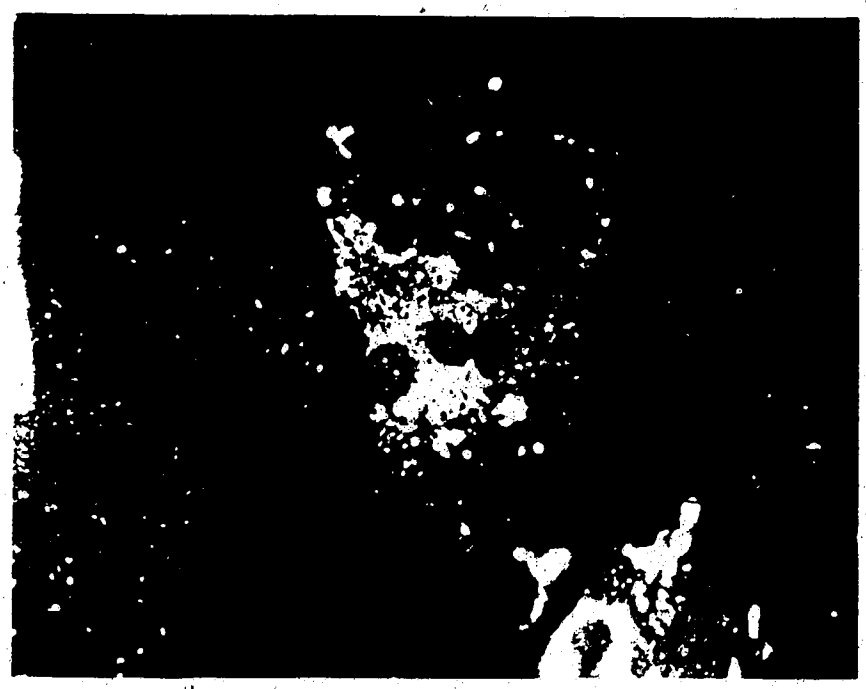
Immunofluorescent staining of Halle UP-1 cells with NP monoclonal antibody (16AC5)

Figure 18a.

The typical staining seen 51 h pi at 32°C with the flecks, fibrous material, dots and globules located cytoplasmically and the occasional nuclei with dots.

Figure 18b.

A similar-sized syncytia 27 h pi at 39°C showing many bright dots and globules and some flecking but less fibrous material as compared to fig. 18a.



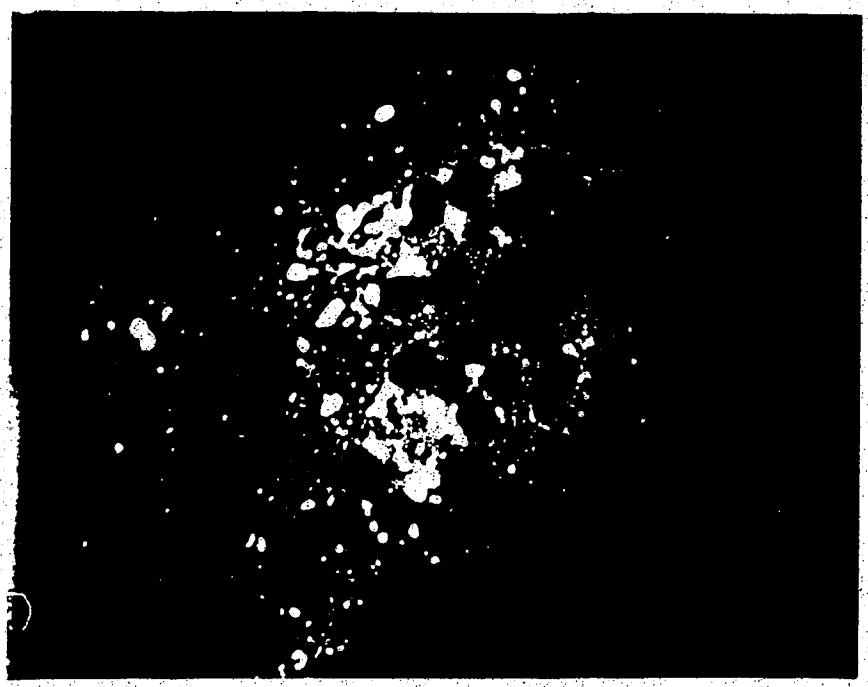


Figure 18c.

Distinct nuclear dots seen at 42 h pi and at 39°C.

Figure 18d.

A good example of the type of syncytia lacking flecks and fibrous material. This syncytia was observed 3 d pi at 39°C.

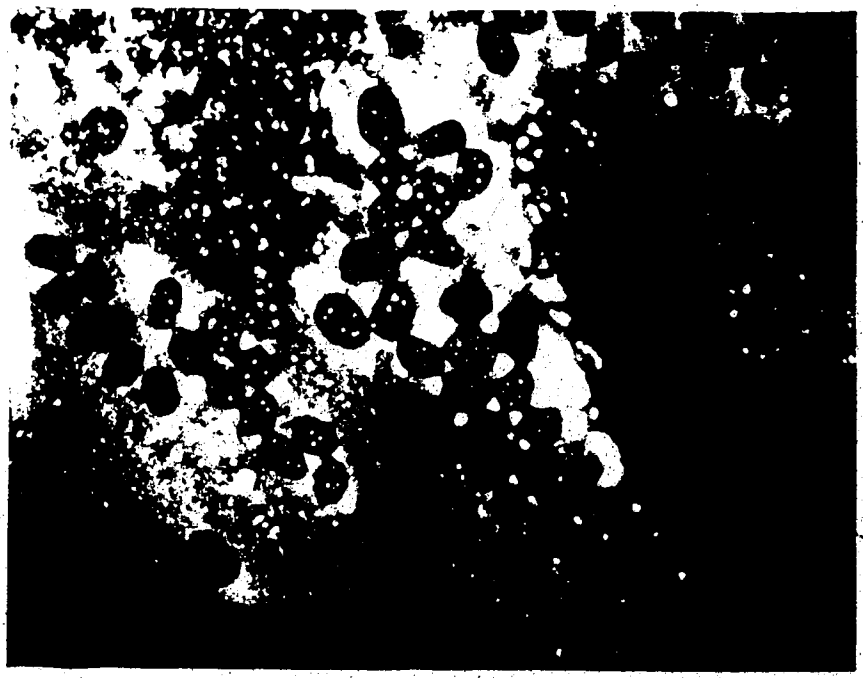


Figure 19.

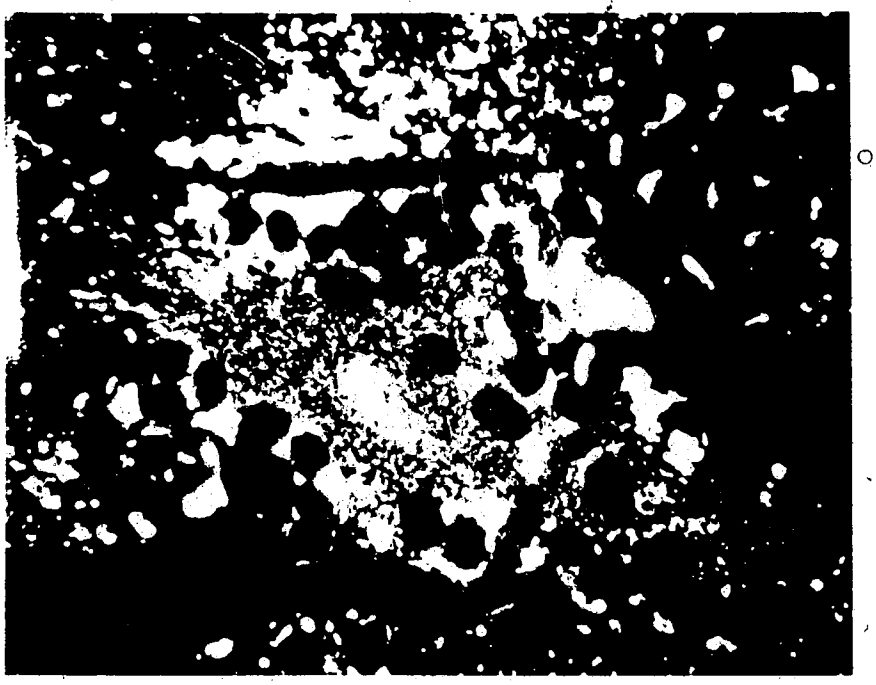
Immunofluorescent staining of Halle UP-1 cells with P monoclonal antibody (C1-105)

Figure 19a.

An intensely stained syncytia observed 51 h pi at 32°C showing types 1, 2, 3 and 4 cytoplasmic staining and a few nuclei with dots.

Figure 19b.

A less-flecked and less-fibrous type of syncytia at 42 h pi and 39°C showing tiny intranuclear fluorescing dots.



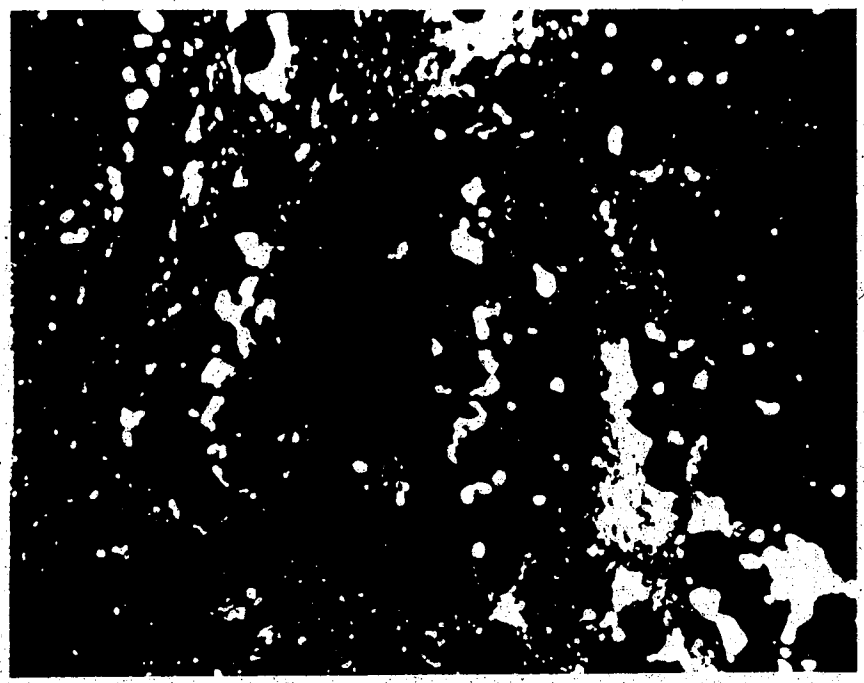


Figure 20.

Immunofluorescent staining of Halle UP-1 cells with CDV P protein monoclonal antibody

Figure 20a.

Distinct nuclear dots but very weak cytoplasmic staining observed 51 h pi at 32°C

Figure 20b.

A large syncytia demonstrating a nonstaining periphery and primarily type 1 cytoplasmic staining and type 7n nuclear staining at 42 h pi and 39°C.

Figure 21.

Immunofluorescent staining of Halle UP-1 cells with P monoclonal antibody (16AF10 or 16BD3)

Figure 21a.

Typical syncytia at 32°C and 51 h pi showing types 1, 2, 3 and 4 cytoplasmic staining but no nuclear staining.

Figure 21b.

Typical syncytia at 39°C, 27 h pi characterized by less-fibrous and less-flecked type of staining.

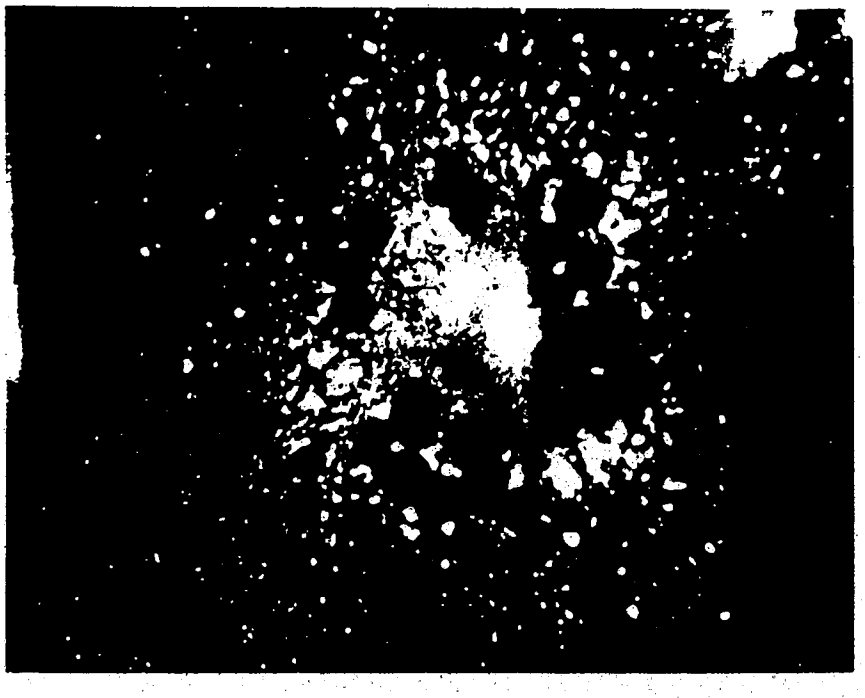


Figure 22.

Immunofluorescent staining of Halle UP-1 cells with M monoclonal antibody (C1-144)

Figure 22a.

A brightly stained syncytia at 51 h pi and 32°C demonstrating the typical appearance at this temperature. The nuclei are stained in addition to the cytoplasmic staining (types 2,3,4 and 6).

Figure 22b.

This large syncytia at 27 h pi and 39°C is like the 32°C type of syncytia without the flecks and fibrous material.

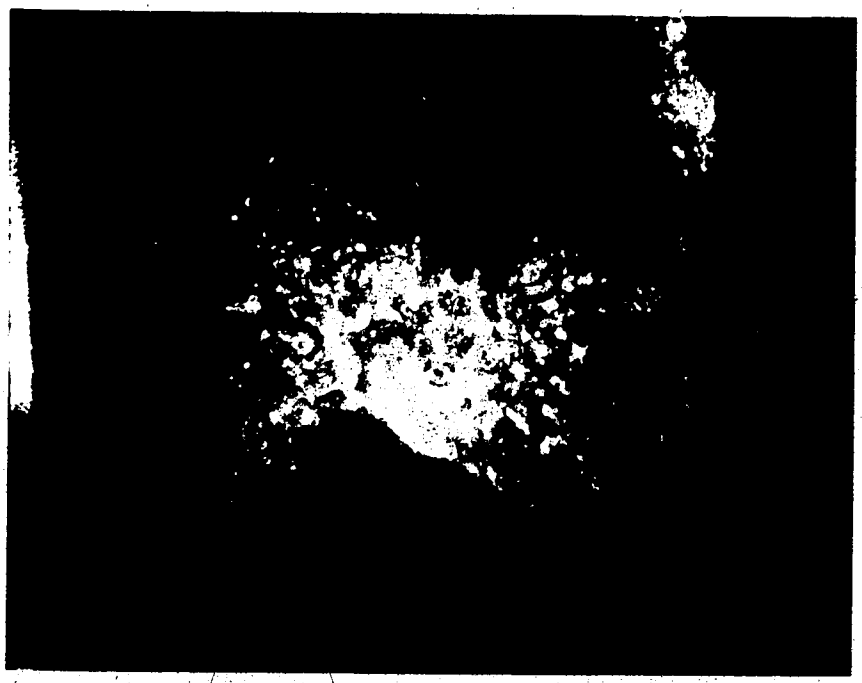


Figure 22c.

A good example of the pale perinuclear inclusions that are seen in 39°C syncytia at 42 h pi. Also the nuclear staining is quite strong and small fluorescing dots appear to be forming in the nuclei (arrow).

Figure 23.

Immunofluorescent staining of Halle UP-1 cells with H monoclonal antibody (C1-15)

Figure 23a.

The brightly stained type of syncytia seen at 32°C and 51 h pi characterized by flecks, fibrous material and fibrous clusters.

Figure 23b.

A syncytia at 39°C and 27 h pi illustrating very pale flecking.

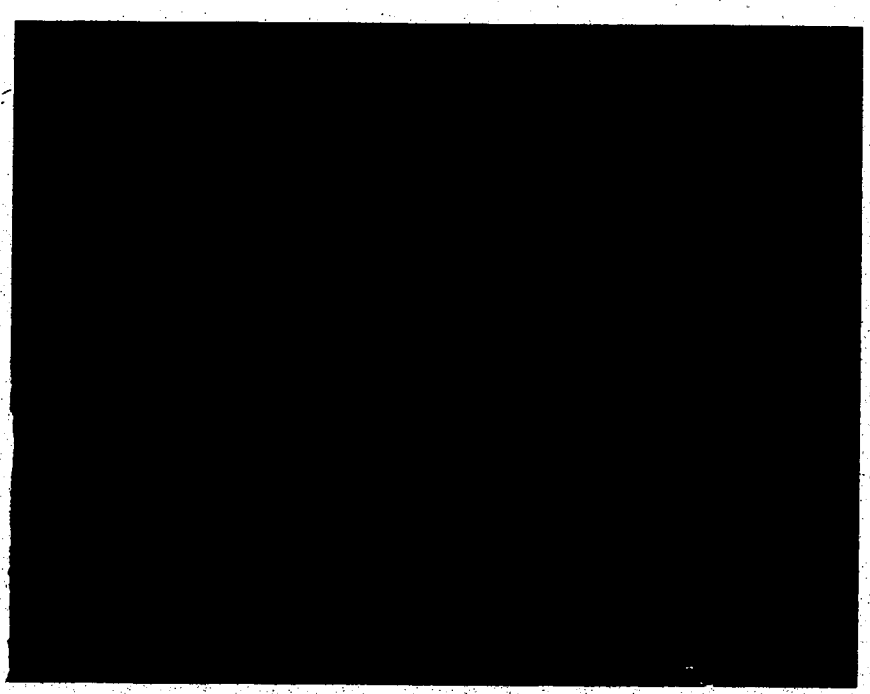


Figure 24.

Immunofluorescent staining of Halle UP-1 cells with F monoclonal antibody (19BG4)

Figure 24a.

A typical, brightly stained syncytia at 32°C and 51 h pi showing flecks, fibrous material and fibrous clusters.

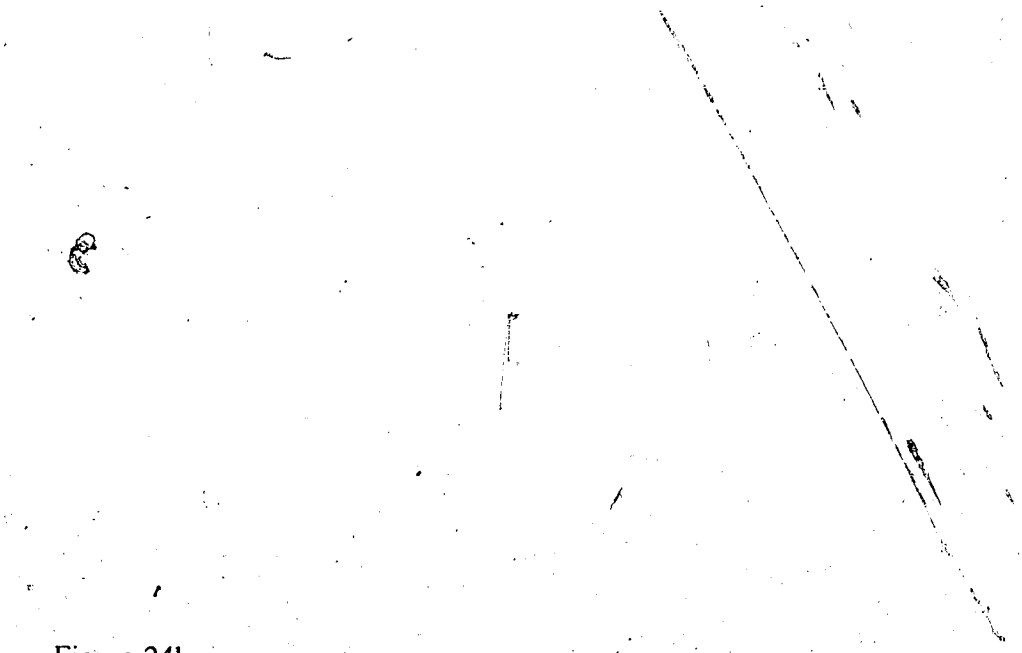
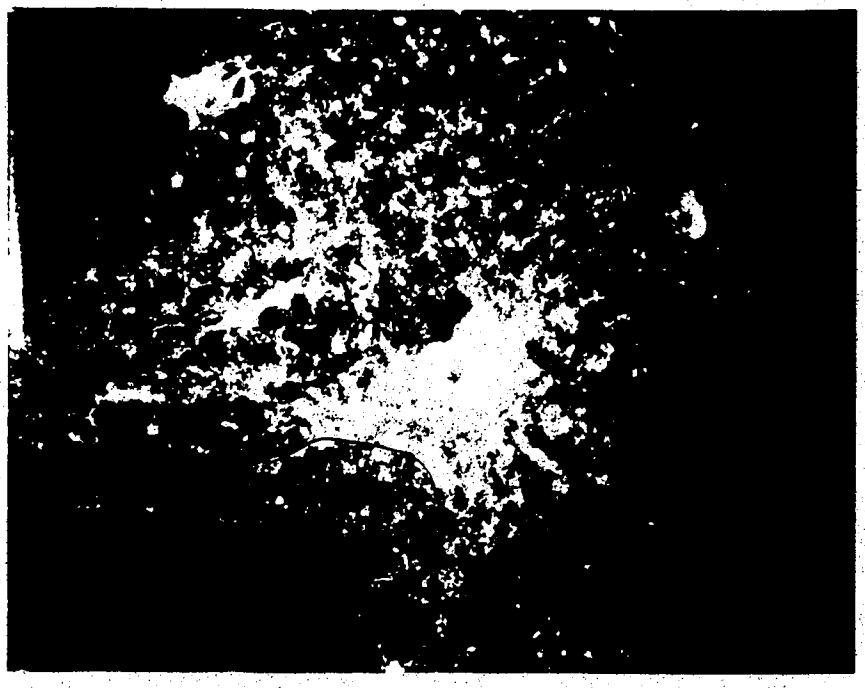


Figure 24b.

A typical weakly stained syncytia at 39°C and 27 h pi.



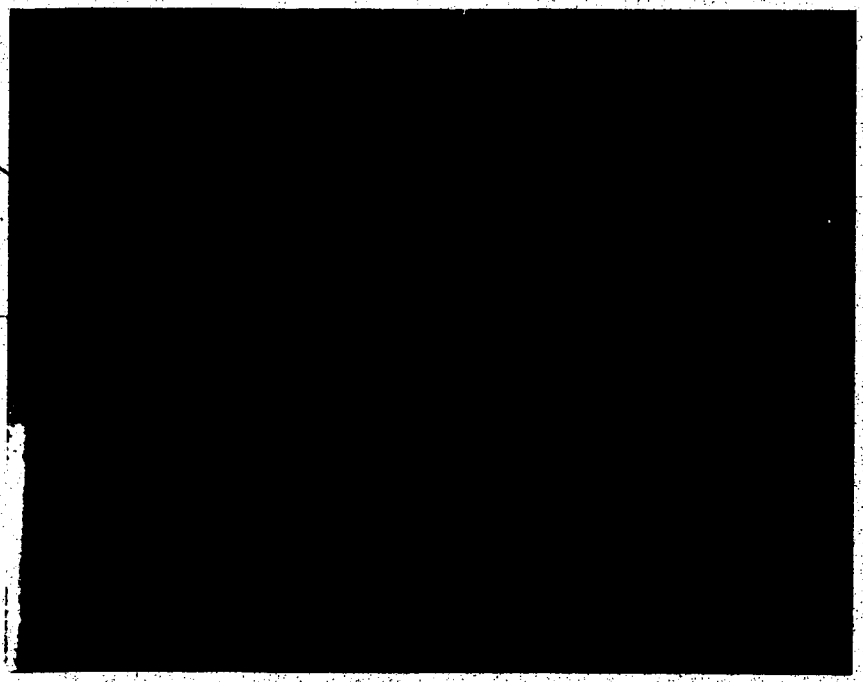


Figure 25.

Electron micrographs of Halle UP-1 cells

Figure 25a.

A section through a syncytia at 3 d pi and 39°C illustrating an inclusion body of tightly-packed NC tubules. Such an inclusion would probably correspond to the bright cytoplasmic dots or globules seen with immunofluorescence. Magnification 21,000 X

Figure 25b.

An infected cell 3 d pi in the UP-1(39) culture.
The infection process has advanced in this cell to the point where the entire cytoplasm is filled by nucleocapsid material.
Magnification 32,500 X

Figure 25c.

This micrograph of a UP-1(39) infected cell at 3 d pi illustrates three simple NB (sNB) in close proximity to one another and the beginning of nucleolar destruction (nd).
Magnification 41,500 X

Figure 26.

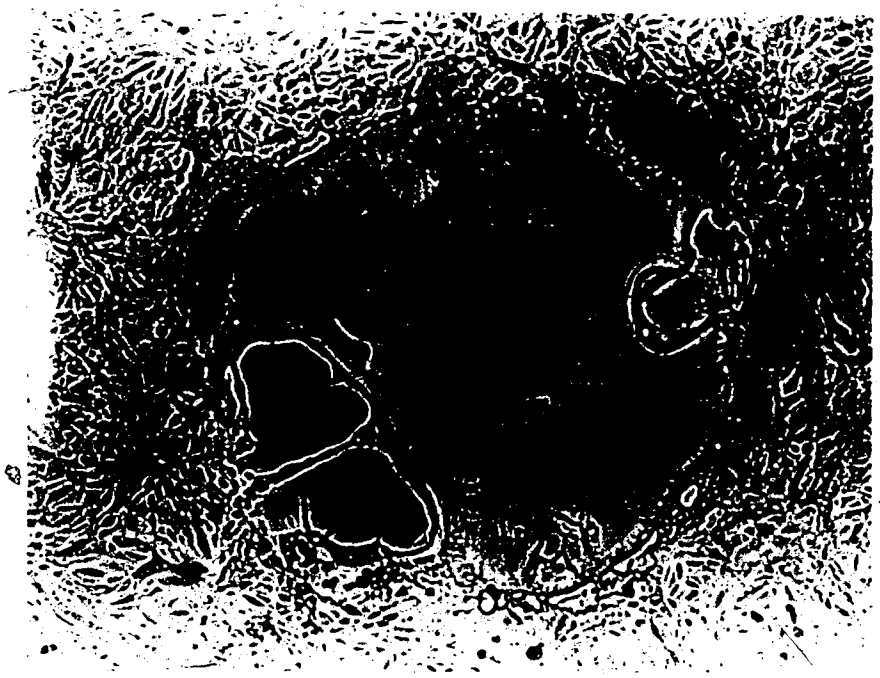
CPE and HAD observations on Halle UP-2 cells

Figure 26a.

An active syncytia seen 3 d pi at 39°C.
Magnification 80 X

Figure 26b.

Positive HAD on a syncytia at 39°C.



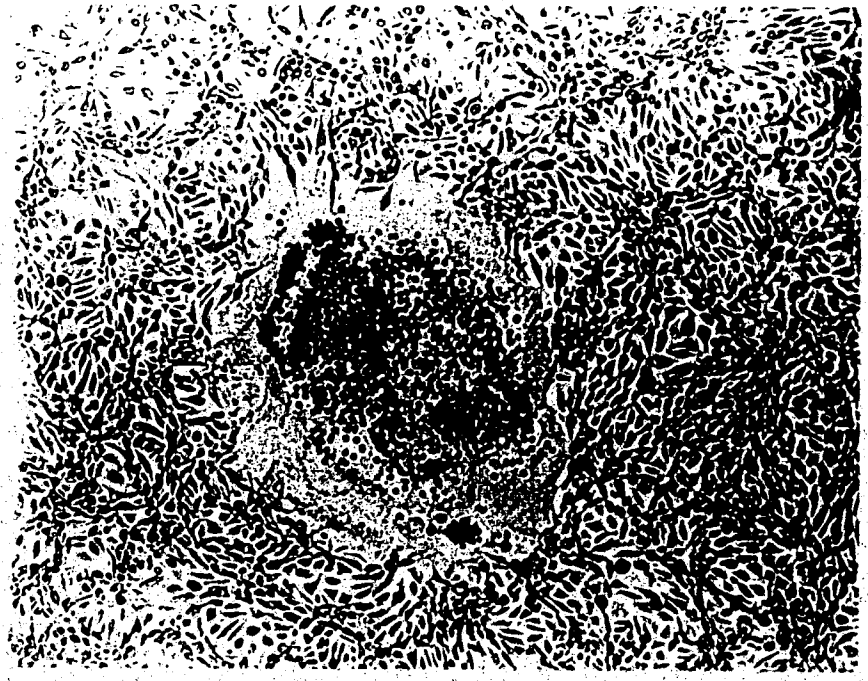
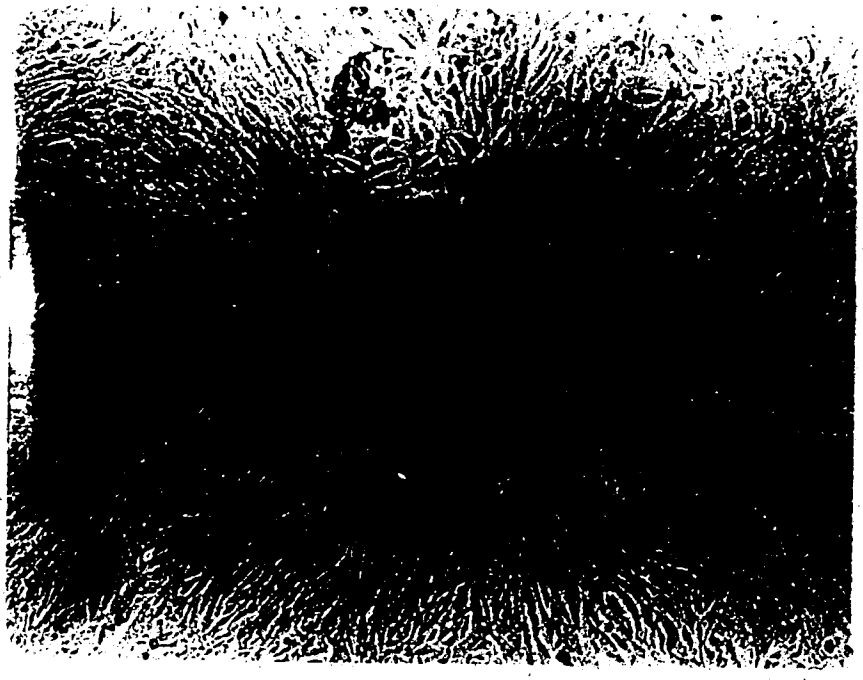


Figure 26c.

A healing syncytial hole observed 5 d pi at 39°C.

Figure 26d.

Weak HAD observed on a syncytial hole at 39°C.



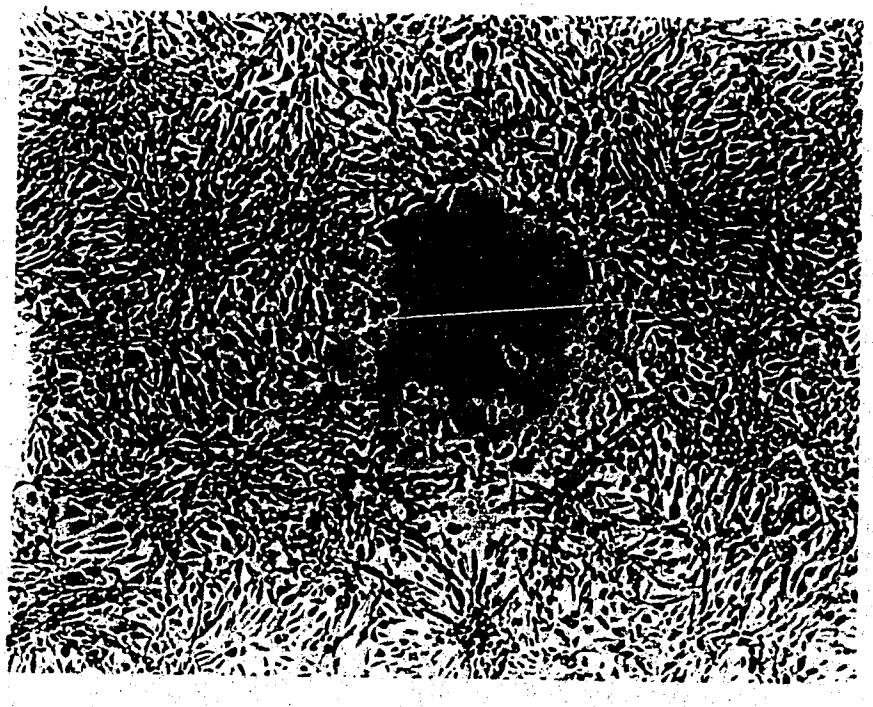
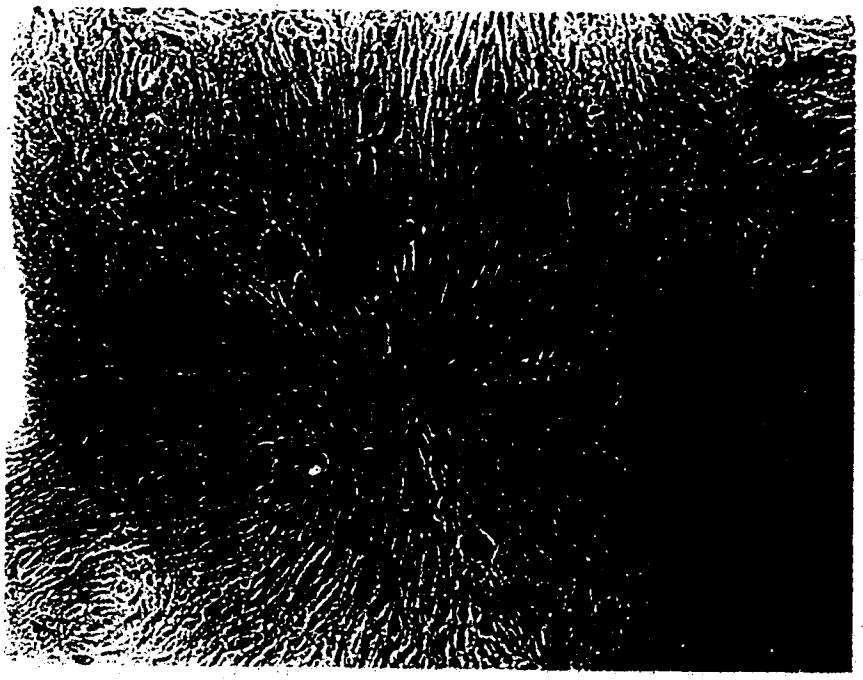


Figure 26e.

A completely healed hole seen 7 d pi at 39°C.

Figure 26f.

A healed plaque showing negative HAD.



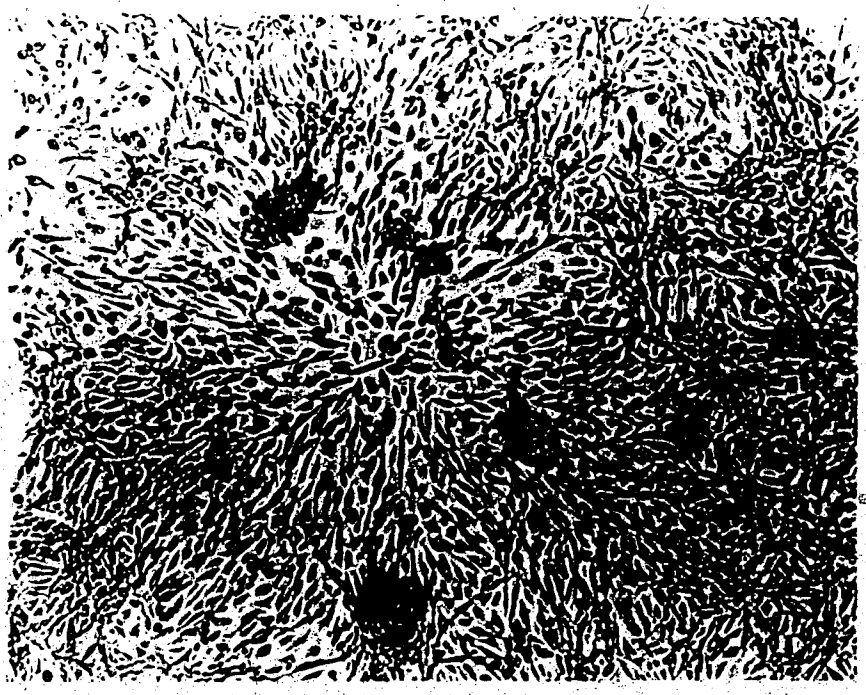


Figure 27.

Immunofluorescent staining of Halle UP-2 cells with P monoclonal antibody (16AF10). P protein staining of a 39°C culture illustrating the fine homogeneous cytoplasmic staining and the few dots/globules.

Figure 28.

Immunofluorescent staining of Halle UP-2 cells with NP monoclonal antibody (16AC5)

Figure 28a.

NP staining at 39°C illustrating an extreme example of the lack of bright dot or globule inclusions.

Figure 28b.

NP staining at 32°C showing both the intensely-stained type of syncytia and the weakly-stained type of syncytia.

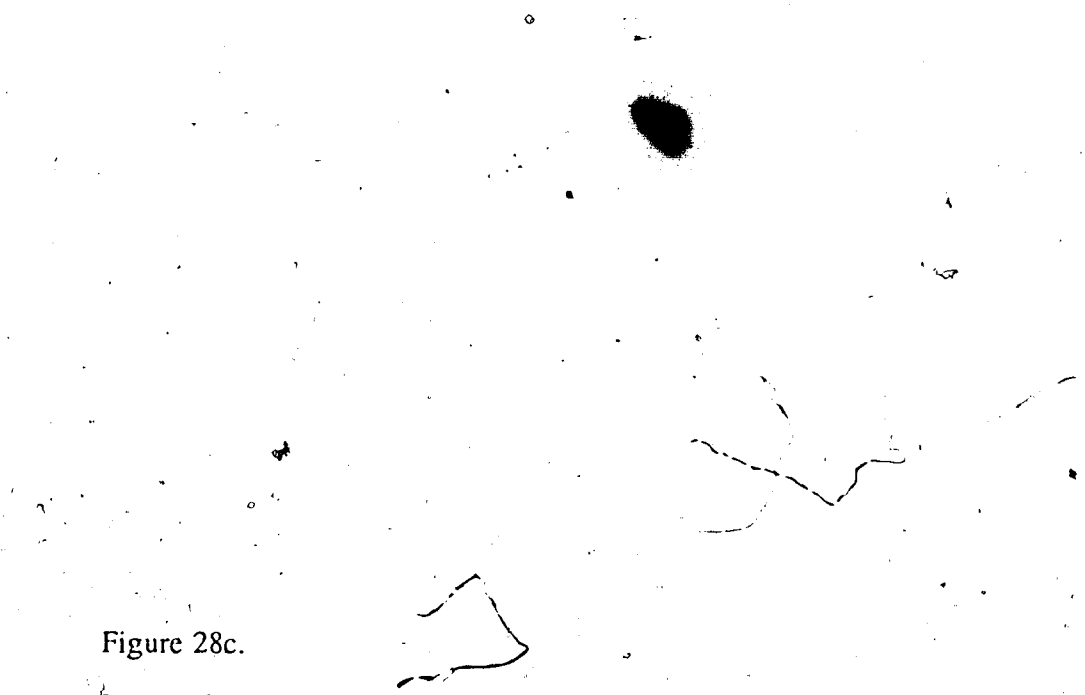


Figure 28c.

Intranuclear NP dots in a cell on the edge of a syncytial hole.

Figure 29.

Immunofluorescent staining of the UP-2(39) healing holes

Figure 29a.

The edge of a healing hole nonstained by the P monoclonal antibody.

Figure 29b.

The edge of a healing hole nonstained by the M monoclonal antibody.

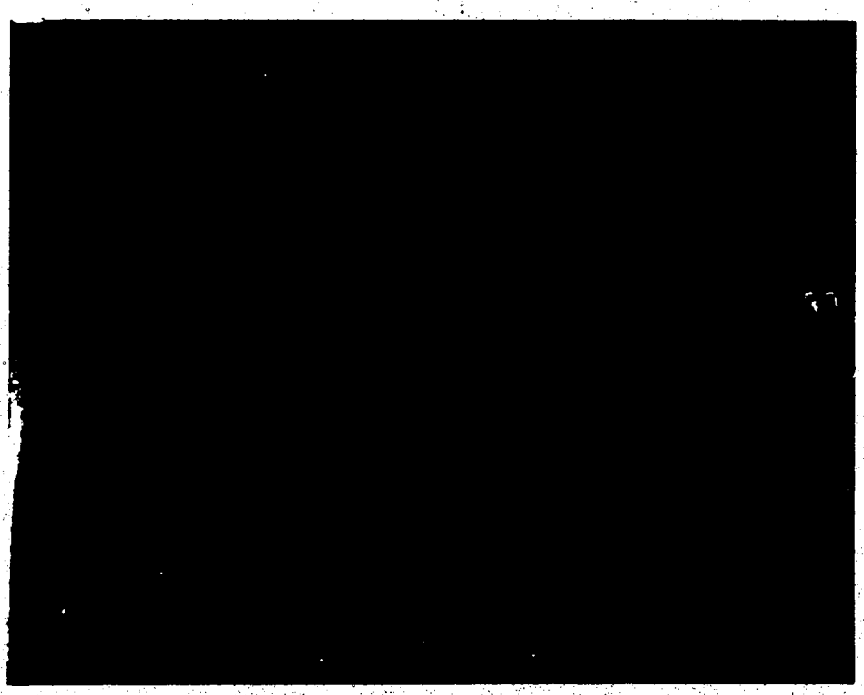


Figure 30.

Immunofluorescent staining of Halle UP-2 passages by M monoclonal antibody

Figure 30a.

Intense cytoplasmic staining and distinct nuclear dots seen in the p147 culture at 39°C.

Figure 30b.

Bright nuclear dots seen in the p147 culture at 39°C.

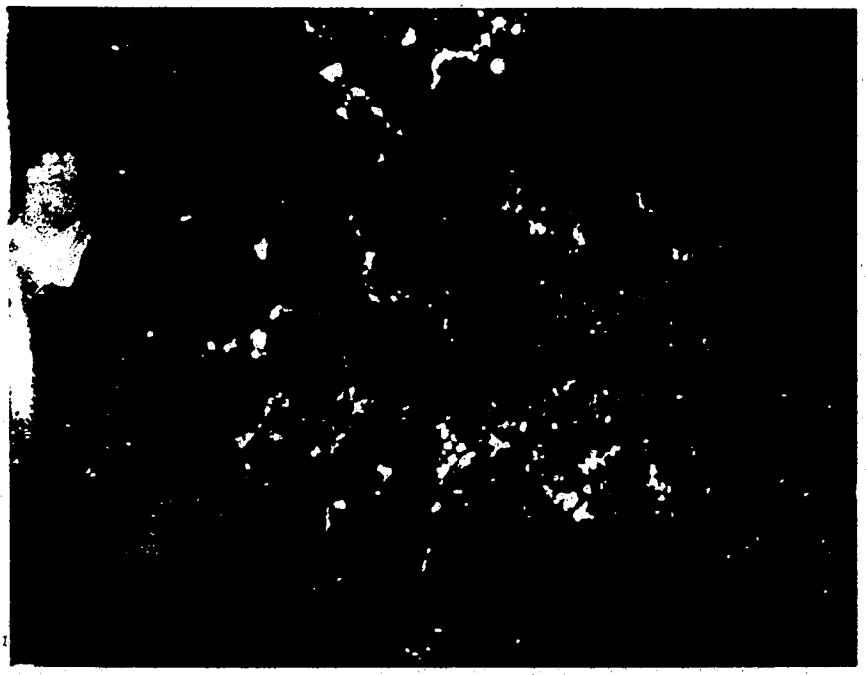
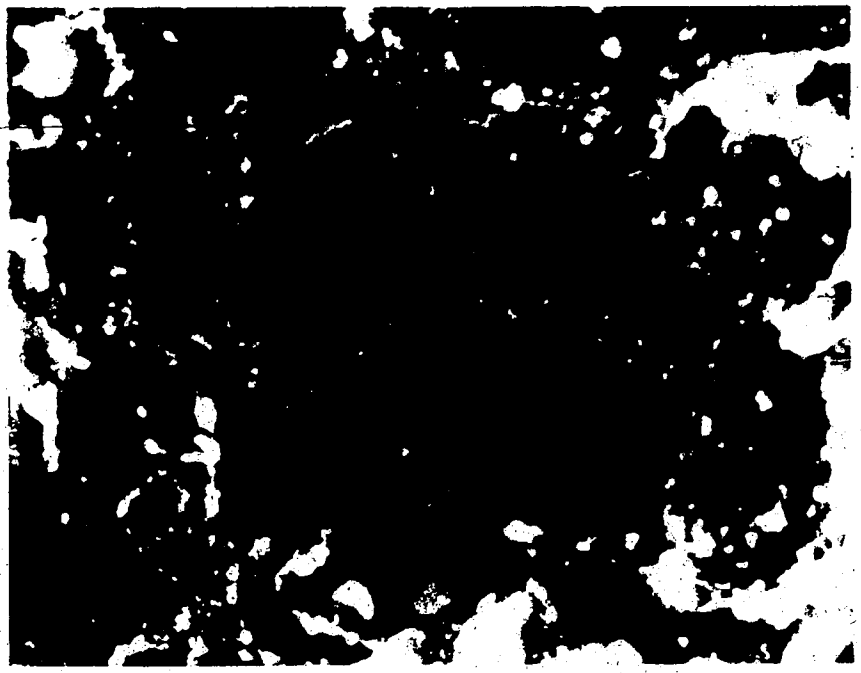


Figure 30c.

Bright cytoplasmic staining and nuclear dots of M protein seen in the p147 culture at 32°C.

Figure 30d.

A homogeneous, 8n type of syncytia seen in the p177 culture at 32°C. The diffuse nuclear staining is clearly seen.



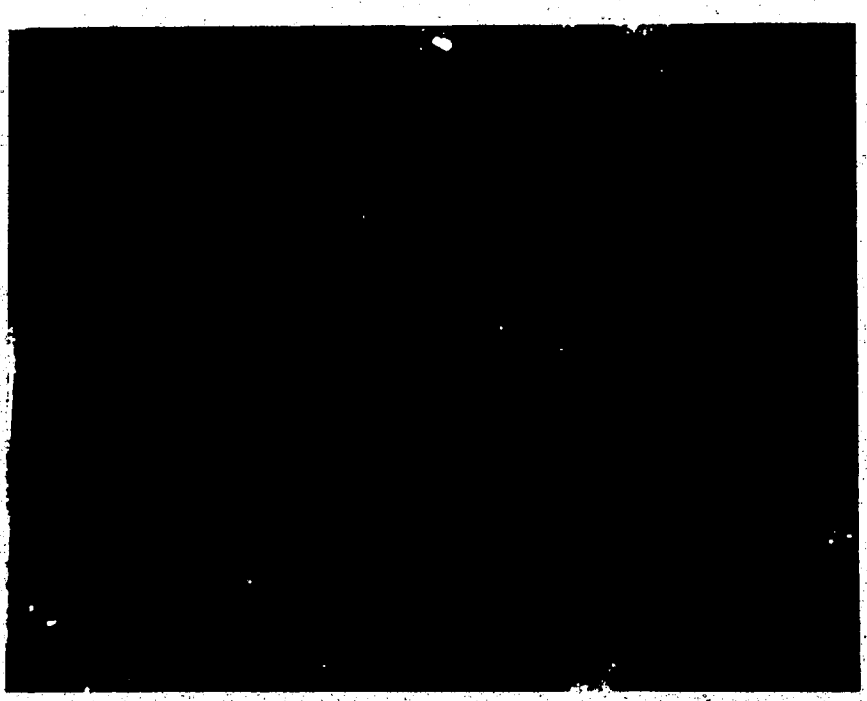


Figure 31.

Electron micrographs of Halle UP-2 cells

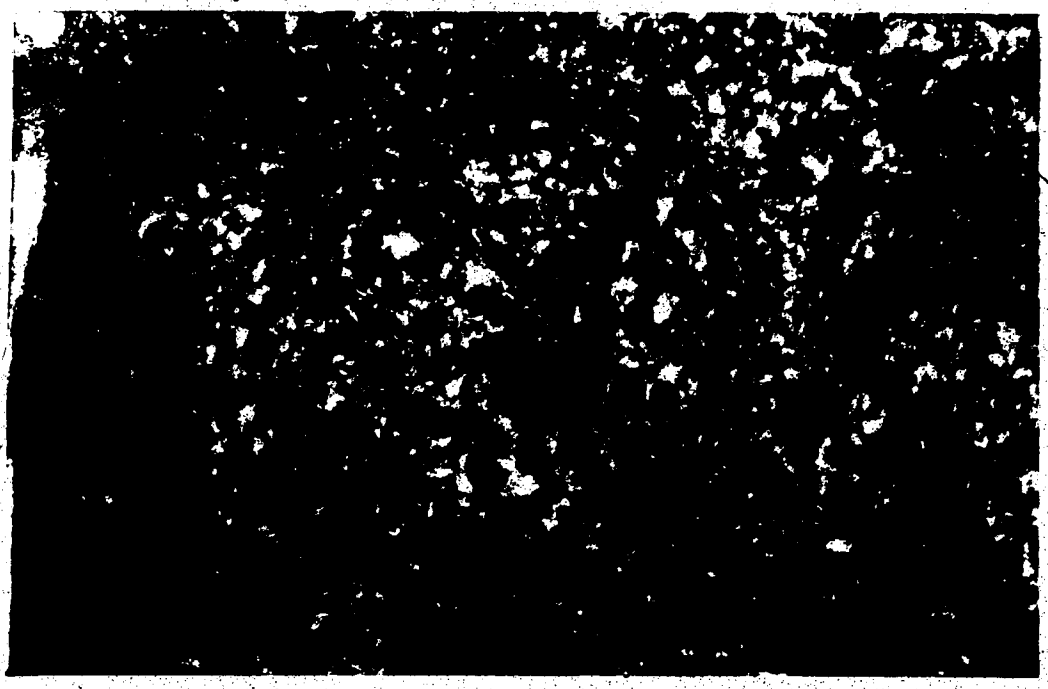
Figure 31a.

A beaded NB observed in the p147 UP-2(39) culture .
Magnification 55,500 X

Figure 31b.

A p147 UP-2(39) cell showing extensive nucleolar destruction (nd) and a complex NB (cNB).
Magnification 32,500 X

A higher magnification of this complex NB showing the fibrillar envelope and tubular (arrow) structures inside.
Magnification 81,000 X



6. Bibliography

ALKNATIB, G. and BRIEDIS, D. J. (1986). The predicted primary struture of the measles virus hemagglutinin. *Virology* 150, 000-000.

BACZKO, K., BILLETER, M., and ter MEULEN, V. (1983). Purification and molecular weight determination of measles virus genomic RNA. *J. Gen. Virol.* 64, 1409-1413.

BELLINI, W.J., ENGLUND, G., ROZENBLATT, S., ARNHEITER, H. and RICHARDSON, C.D. (1985). Measles virus P gene codes for two proteins. *J. Virol.* 53, 908-919.

BIRRER, M.J., BLOOM, B.R. and UDEM, S. (1981). Characterization of measles polypeptides by monoclonal antibodies. *Virology* 108,381-390.

BOUTEILLE, M., FONTAINE, C., VEDRENNE, C. and DELARUE, J. (1965). Sur un cas d'encephalite subclinique a inclusions. Etude anatomoclinique et ultrastructurale. *Rev. Neurol.* 113, 454-458.

BOUTEILLE, M., KALIFAT, S.R. and DELARUE, J. (1967). Ultrastructural variations of nuclear bodies in human diseases. *J. Ultrastruct. Res.* 19, 474-486.

BURNSTEIN, T., JACOBSEN, L.B., ZEMAN, W. and CHEN, T.T. (1974). Persistent infection of BSC-1 cells by defective measles virus derived from subacute sclerosing panencephalitis. *Infect. Immun.* 10, 1378-1382.

BYINGTON, D.P. and JOHNSON, K.P. (1972). Experimental subacute sclerosing panencephalitis in the hamster: Correlation of age with chronic inclusion-cell encephalitis. *J. Infect. Dis.* 126, 18-26.

CARLSEN, S.R., PELUSO, R.W. and MOYER, S.A. (1985). In vitro replication of Sendai virus wild-type and defective interfering particle genome RNAs. *J. Virol.* 54, 493-500.

CARTER, M.J., WILLCOCKS, M.M., LOFFLER, S. and ter MEULEN, V. (1982). Relationship between monoclonal antibody binding sites on the measles virus hemagglutinin. *J. Gen. Virol.* 63, 113-120.

CARTER, M.J., WILLCOCKS, M.M. and ter MEULEN, V. (1983). Defective translation of measles virus matrix protein in a subacute sclerosing panencephalitis cell line. *Nature* 305, 153-155.

CAVE, D.R., HENDRICKSON, F.M. and HUANG, A.S. (1985). Defective interfering virus

particles modulate virulence. *J. Virol.* 55, 366-373.

CENTERS FOR DISEASE CONTROL (1983). *Morbidity and Mortality Weekly Report* 31, No. 52.

CHOPPIN, P.W., RICHARDSON, C.D., MERZ, D.C., HALL, W.W. and SCHEID, A. (1981). The functions and inhibition of the membrane glycoproteins of paramyxoviruses and myxoviruses and the role of the measles virus M protein in subacute sclerosing panencephalitis. *J. Infect. Dis.* 143, 352-363.

COLLINS, P.L. and HIGHTOWER, L.E. (1982). Newcastle disease virus stimulates the cellular accumulation of stress (heat shock) mRNAs and proteins. *J. Virol.* 44, 703-707.

COLLINS, P.L., WERTZ, G.W., BALL, L.A. and HIGHTOWER, L. E. (1982). Coding assignments of the five smaller mRNAs of Newcastle disease virus. *J. Virol.* 43, 1024-1031.

CONNOLLY, J.H., ALLEN, I.V., HURWITZ, L.J. and MILLER, J.H.D. (1967). Measles virus antibody and antigen in subacute sclerosing panencephalitis. *Lancet* 1, 542-544.

COWDRY, E.V. (1934). The problem of intranuclear inclusions in virus diseases. *Arch. Path.* 18, 527-542.

CREMER, N.E., OSHIRO, L.S. and HAGENS, S.J. (1979). Cyclic expression of antigen and infectious virus in a BHK cell line (0-853) persistently infected with an SSPE strain of measles virus. *J. Gen. Virol.* 42, 637-640.

DAWSON, J.R. (1933). Cellular inclusions in cerebral lesions of lethargic encephalitis. *Am. J. Pathol.* 9, 7-16.

DE THÉ, G., RIVIERE, M. and BERNHARD, W. (1960) Examen au microscope électronique de la tumeur VX_2 du lapin domestique dérivée du papillome de Shope. *Bull. Assoc. Fr. Etude Cancer* 47, 570-584.

DOI, Y., SAMPE, T., NAKAJIMA, M., OKAWA, S., KATOG, T., ITOH, H., SATO, T., OGUCHI, K., KUMANISHI, T. and TSUBAKI, T. (1972). Properties of a cytopathic agent isolated from a patient with subacute sclerosing panencephalitis in Japan. *Jap. J. Med. Sci. Biol.* 25, 321-333.

DUBOIS-DALCQ, M., COBLENTZ, J.M. and PLEET, A.B. (1974). Subacute sclerosing panencephalitis. Unusual nuclear inclusions and lengthy clinical course. *Arch. Neurol.* 31, 355-363.

DUBOIS-DALCQ, M., HOLMES, K.V. and RENTIER, B. (1984). Assembly of Paramyxoviridae. In "Assembly of Enveloped RNA Viruses" (D.W. Kingsbury, ed.) pp. 44-65. Springer-Verlag, New York.

DUBOIS-DALCQ, M., HORTA-BARBOSA, L., HAMILTON, R. and SEVER, J.L. (1974). Comparison between productive and latent SSPE viral infection in vitro. *Lab. Invest.* 30, 241-250.

DUPUY-COIN, A.M. and BOUTEILLE, M. (1972). Developmental pathway of granular and beaded nuclear bodies from nucleoli. *J. Ultrastruct. Res.* 40, 55-67.

DUPUY-COIN, A.M., KALIFAT, S.R. and BOUTEILLE, M. (1972). Nuclear bodies as proteinaceous structures containing ribonucleoproteins. *J. Ultrastruct. Res.* 38, 174-187.

ENDERS, J.F., KATZ, S., MILOVANOVIC, M.C. and HALLOWAY, A. (1960). Studies on an attenuated measles virus vaccine I. Development and preparation of the vaccine: Techniques for assay of effects of vaccination. *N. Engl. J. Med.* 263, 153-169.

ENDERS, J.F. and PEEBLES, T.C. (1954). Propagation in tissue cultures of cytopathogenic agents from patients with measles. *Proc. Soc. Exp. Biol. Med.* 86, 277-286.

FOLLETT, E.A.C., PRINGLE, C.R., PENNINGTON, T.H. and SHIRODARIA, P. (1976). Events following the infection of enucleate cells with measles virus. *J. Gen. Virol.* 32, 163-175.

FOURNIER, J.G., PRIVAT, A. and BOUTEILLE, M. (1981). Structural changes in the cell nucleus during measles virus infection in cerebellar explants. *J. Ultrastruct. Res.* 77, 319-328.

GIRAUDON, P., GERALD, CH. and WILD, T.F. (1984). A study of measles virus antigens in acutely and persistently infected cells using monoclonal antibodies: Differences in the accumulation of certain viral proteins. *Intervirology* 21, 110-120.

GIRAUDON, P. and WILD, T.F. (1981). Monoclonal antibodies against measles virus. *J. Gen. Virol.* 54, 325-332.

GOULD, E.A., COSBY, S.L. and SHIRODARIA, P.V. (1976). Salt-dependent haemagglutinating measles virus in SSPE. *J. Gen. Virol.* 33, 139-142.

GOULD, E.A. and LINTON, P.E. (1975). The production of a temperature-sensitive persistent measles virus infection. *J. Gen. Virol.* 28, 21-28.

GRAVES, M.C. (1981). Measles virus polypeptides in infected cells studied by immune

precipitation and one dimensional peptide mapping. *J. Virol.* 38, 224-230.

HAASE, A.T., GANTZ, D., EBLE, B., WALKER, D., STOWRING, L., VENTURA, P., BLUM, H., WIETGREFE, S., ZUPANCIC, M., TOURTELLOTTE, W., GIBBS, C.J., NORRBY, E. and ROZENBLATT, S. (1985). Natural history of restricted synthesis and expression of measles virus genes in subacute sclerosing panencephalitis. *Proc. Natl. Acad. Sci. U.S.A.* 82, 3020-3024.

HALL, W.W. and CHOPPIN, P.W. (1979). Evidence for lack of synthesis of the M polypeptide of measles virus in brain cells in subacute sclerosing panencephalitis. *Virology* 99, 443-447.

HALL, W.W. and CHOPPIN, P.W. (1981). Measles virus proteins in the brain tissue of patients with subacute sclerosing panencephalitis. Absence of the M protein. *N. Engl. J. Med.* 304, 1152-1155.

HALL, W.W., LAMB, R.A. and CHOPPIN, P.W. (1979). Measles and SSPE virus protein: Lack of antibodies to the M protein in patients with subacute sclerosing panencephalitis. *Proc. Natl. Acad. Sci. U.S.A.* 76, 2047-2051.

HALL, W.W., LAMB, R.A. and CHOPPIN, P.W. (1980). The polypeptides of canine distemper virus. Synthesis in infected cells and relatedness to the polypeptides of other morbilliviruses. *Virology* 100, 433-449.

HALL, W.W. and MARTIN, S.J. (1973). Purification and characterization of measles virus. *J. Gen. Virol.* 19, 175-188.

HALL, W.W., MARTIN, S.J. and GOULD, E. (1974). Defective interfering particles produced during the replication of measles virus. *Med. Microbiol. Immunol.* 160, 155-164.

HAMILTON, R., BARBOSA, L. and DUBOIS, M. (1973). Subacute sclerosing panencephalitis measles virus: Study of biological markers. *J. Virol.* 12, 632-642.

HASPEL, M.V., KNIGHT, P.R., DUFF, R.G. and RAPP, F. (1973). Activation of a latent measles virus infection in hamster cells. *J. Virol.* 12, 690-695.

HINGLAIS-GUILLAUD, N., MORICARD, R. and BERNHARD, W. (1961). Ultrastructure des cancers pavimenteux invasifs du col utérin chez la femme. *Bull. Assoc. Fr. Etude Cancer* 48, 283-316.

HORTA-BARBOSA, L., FUCCILLO, D.A., SEVER, J.L. and ZEMAN, W. (1969). Subacute sclerosing panencephalitis: Isolation of measles virus from a brain biopsy. *Nature* 221, 974.

HORTA-BARBOSA, L., HAMILTON, R., WITTIG, B., FUCCILLO, D.A., SEVER, J.L. and VERNON, M.L. (1971). Subacute sclerosing panencephalitis: Isolation of suppressed measles virus from lymph node biopsies. *Science* 173, 840-841.

HSU,C.-H., RE, G.G., GUPTA, K.C., PORTNER, A. and KINGSBURY, D.W. (1985). Expression of Sendai virus defective-interfering genomes with internal deletions. *Virology* 146, 38-49.

HUANG, A.S. (1973). Defective interfering viruses. *Ann. Rev. Microbiol.* 27, 101-117.

HUANG, A.S. and BALTIMORE, D. (1970). Defective viral particles and viral disease processes. *Nature* 226, 325-327.

JENIS, E.H., KNIESER, M.R., ROTHOUSE, P.A., JENSEN, G.E. and SCOTT, R.M. (1973). Subacute sclerosing panencephalitis: Immunoultrastructural localization of measles-virus antigen. *Arch. Pathol.* 95, 81-89.

JOHNSON, K.P., NORRBY, E., SWOVELAND, P. and CARRIGAN, D.R. (1981). Experimental subacute sclerosing panencephalitis: Selective disappearance of measles virus matrix protein from the central nervous system. *J. Infect. Dis.* 144, 161-169.

JOHNSON, K.P., NORRBY, E., SWOVELAND, P. and CARRIGAN, D.R. (1982). Expression of five viral antigens in cells infected with wild-type and SSPE strains of measles virus: Correlation with cytopathic effects and productivity of infections. *Arch. Virol.* 73, 255-262.

JOHNSON, R.T. (1970). Subacute sclerosing panencephalitis. *J. Infect. Dis.* 121, 227-230.

KALLMAN, F., ADAMS, J.M., WILLIAMS, R.C. and IMAGAWA, D.T. (1959). Fine structure of cellular inclusions in measles virus infections. *J. Biophysic. Biochem. Cytol.* 6, 379-382.

KANDA, T. and SHIBUTA, H. (1982). Restricted viral RNA synthesis in establishment of persistent infection in Vero cells with a Sendai virus mutant. *Microbiol. Immunol.* 26, 1045-1055.

KANG, C.Y., SCHUBERT, M. and LAZZARINI, R.A. (1985). Frequent generation of new 3'- defective interfering particles of vesicular stomatitis virus. *Virology* 143, 630-635.

KILEY, M.P., GRAY, H. and PAYNE, F.E. (1974). Replication of measles virus: Distinct species of short nucleocapsids in cytoplasmic extracts of infected cells. *J. Virol.* 13, 721-728.

KNIGHT, P., DUFF, R., GLASER, R. and RAPP, F. (1974). Characteristics of the release

of measles virus from latently infected cells after cocultivation with BSC-1 cells. *Interviology* 2, 287-298.

KÖHLER, G. and MILSTEIN, C. (1975). Continous cultures of fused cells secreting antibody of predefined specificity. *Nature* 256, 495-497.

LIN, F.H. and THORMAR, H. (1980). Absence of M protein in a cell-associated subacute sclerosing panencephalitis virus. *Nature* 285,490-492.

MacDONALD, R.D. (1978). Ringed plague formation in infectious pancreatic necrosis virus correlates with defective interfering particle production. *J. Gen. Virol.* 41, 623-628.

MAKINO, S., SASAKI, K., NAKAGAWA, M., SAITO, M., SHINOHARA, Y., GOTOH, F. and OKABE, T. (1977). Isolation and biological characterization of a measles virus-like agent from the brain of an autopsied case of subacute sclerosing panencephalitis. *Microbiol. Immunol.* 21, 193-205.

MARTINEZ, A.J., OHYA, T., JABBOUR, J.T. and DUENAS, D. (1974). SSPE reappraisal of nuclear, cytoplasmic and axonal inclusions. Ultrastructural study of eight cases. *Acta Neuropath.* 28, 1-13.

MARUSYK, R.G. (1984). Measles: A continuing problem or eradication. *Appl. Virol.* 1, 211-219.

MAY, J.D. and MENNA, J.H. (1979). Changes in the virus-host cell relationship in a stable non-virogenic cell line persistently infected with measles virus (BGM/MV). *J. Gen. Virol.* 45, 185-194.

MILLER, C.A. (1980). Intranuclear polypeptides of measles and subacute sclerosing panencephalitis virus-infected cultures. *Virology* 101, 272-276.

MINAGAWA, T., SAKUMA, T., KUWAJIMA, S., YAMAMOTO, T.K. and IIDA, H. (1976). Characterization of measles virus in establishment of persistent infections in human lymphoid cell line. *J. Gen. Virol.* 33, 361-379.

MIRCHAMSY, H., BAHRAMI, S., SHAFYI, A., SHAHRABADY, M.S., KAMALY, M., AHOURAI, P., RAZAVI, J., NAZARI, P., DERAKHSHAW, J., LOTFI, J. and ABASSIOUN, K. (1978). Isolation and characterization of a defective measles virus from brain biopsies of three patients in Iran with subacute sclerosing panencephalitis. *Intervirology* 9, 106-118.

MOUNTCASTLE, W.E. and CHOPPIN, P.W. (1977). A comparison of the polypeptides of four measles virus strains. *Virology* 78, 463-474.

NAKAI, M. and IMAGAWA, D.T. (1969). Electron microscopy of measles virus replication. *J. Virol.* 3, 187-197.

NAKAI, T., SHAND, F.L. and HOWATSON, A.F. (1969). Development of measles virsus in vitro. *Virology* 38, 50-67.

NIVELEAU, A. and WILD, T.F. (1979). In vitro translation of measles virus-induced RNA. *Virology* 96, 295-298.

NORRBY, E., CHEN, S.-N., TOGASHI, T., SHESHBARADARAN, H. and JOHNSON, K.P. (1982). Five measles virus antigens demonstrated by use of mouse hybridoma antibodies in productively infected tissue culture cells. *Arch. Virol.* 71, 1-11.

NORRBY, E., CHIARINI, A. and MARUSYK, H. (1970). Measles virus variants; Intracellular appearance and biological characteristics of virus products. In "The Biology of Large RNA Viruses" (R.D. Barry, B.W.J. Mahy, eds.) pp. 141-152. Academic Press, New York.

NORRBY, E., ENDERS-RUCKLE, G., and ter MEULEN, V. (1975). Differences in the appearance of antibodies to structural components of measles virus after immunization with inactivated and live virus. *J. Infect. Dis.* 132, 262-269.

NORRBY, E., KRISTENSSON, K., BRZOSKO, W.J. and KAPSENBERG, J.G. (1985). Measles virus matrix protein detected by immune fluorescence with monoclonal antibodies in the brain of patients with subacute sclerosing panencephalitis. *J. Virol.* 56, 337-340.

OHARA, Y., TASHINO, M., TAKASE, S. and HOMMA, M. (1985). Detection of antibody to M protein of measles virus in patients with subacute sclerosing panencephalitis: A comparative study on immunoprecipitation. *Microbiol. Immunol.* 29, 709-723.

ÖRVELL, C. (1980). Structural polypeptides of canine distemper virus. *Arch. Virol.* 66, 193-206.

ÖRVELL, C. and NORRBY, E. (1974). Further studies on the immunologic relationships among measles, distemper and rinderpest viruses. *J. Immunol.* 113, 1850-1858.

ÖRVELL, C. and NORRBY, E. (1980). Immunological relationships between homologous structural polypeptides of measles and canine distemper virus. *J. Gen. Virol.* 50, 231-245.

ÖRVELL, C., SHESHBERADARAN, H. and NORRBY, E. (1985). Preparation and characterization of monoclonal antibodies directed against four structural components of canine distemper virus. *J. Gen. Virol.* 66, 443-456.

OYANAGI, S., ter MEULEN, V., KATZ, M. and KOPROWSKI, H. (1971). Comparison of subacute sclerosing panencephalitis and measles viruses: An electron microscope study. *J. Virol.* 7, 176-187.

OYANAGI, S., TER MEULEN, V., MÜLLER, D., KATZ, M. and KOPROWSKI, H. (1970). Electron microscopic observations in subacute sclerosing panencephalitis brain cell cultures: Their correlation with cytochemical and immunocytological findings. *J. Virol.* 6, 370-379.

PALMA, E.L. and HUANG, A. (1974). Cyclic production of vesicular stomatitis virus caused by defective interfering particles. *J. Infect. Dis.* 129, 402-410.

PAYNE, F.E., BAUBLIS, J.V. and ITABASHI, H.H. (1969). Isolation of measles virus from cell cultures of brain from a patient with subacute sclerosing panencephalitis. *N. Engl. J. Med.* 281, 585-589.

PÉRIER, O., VANDERHAEGEN, J.J. and PELC, S. (1967). Subacute sclerosing leuco-encephalitis: Electron microscopic findings in two cases with inclusion bodies. *Acta Neuropathol.* 8, 362-380.

PELUSO, R.W., LAMB, R.A. and CHOPPIN, P.W. (1978). Infection with paramyxoviruses stimulates synthesis of cellular polypeptides that are also stimulated in cells transformed by Rous sarcoma virus or deprived of glucose. *Proc. Natl. Acad. Sci. USA* 75, 6120-6124.

PFAU, C.J., WELSH, R.M. and TROWBRIDGE, R.S. (1973). Plaque assays and current concepts of regulation in arenavirus infections. In "Lymphocytic Choriomeningitis Virus and Other Arenaviruses" (F. Lehmann-Grube, ed.) Springer-Verlag, Berlin.

PREBLE, O.T. and YOUNGNER, J.S. (1975). Temperature-sensitive viruses and the etiology of chronic and inapparent infections. *J. Infect. Dis.* 131, 467-473.

RAINE, C.S., BYINGTON, D.P. and JOHNSON, K.P. (1974). Experimental subacute sclerosing panencephalitis in the hamster. Ultrastructure of the chronic disease. *Lab. Invest.* 31, 355-368.

RAINE, C.S., FELDMAN, L.A., SHEPPARD, R.D. and BORNSTEIN, M.B. (1969). Ultrastructure of measles virus in cultures of hamster cerebellum. *J. Virol.* 4, 169-181.

RE, G.G., MORGAN, E.M. and KINGSBURY, D.W. (1985). Nucleotide sequences responsible for generation of internally deleted Sendai virus defective interfering genomes. *Virology* 146, 27-37.

RENTIER, B., HOOGHE-PETERS, E.L. and DUBOIS-DALCQ, M. (1978). Electron microscopic study of measles virus infection: Cell fusion and hemadsorption. *J. Virol.*

28, 567-577.

RICHARDSON, C.D., BERKOVICH, A., ROZENBLATT, S. and BELLINI, W.J. (1985). Use of antibodies directed against synthetic peptides for identifying cDNA clones, establishing reading frames, and deducing the gene order of measles virus. *J. Virol.* 54, 186-193.

RIMA, B.K. (1983). The proteins of morbilliviruses. *J. Gen. Virol.* 64, 1205-1219.

RIMA, B.K., DAVIDSON, W.B. and MARTIN, S.J. (1977). The role of defective interfering particles in persistent infection of Vero cells by measles virus. *J. Gen. Virol.* 35, 89-97.

RIMA, B.K., LAPPIN, S.A., ROBERTS, M.W. and MARTIN, S.J. (1981). A study of phosphorylation of the measles membrane protein. *J. Gen. Virol.* 56, 447-450.

RIMA, B.K. and MARTIN, S.J. (1976). Persistent infection of tissue culture cells by RNA viruses. *Med. Microbiol. Immunol.* 162, 89-118.

ROBBINS, S.J. and EAGLE, J.P. (1985). Enhanced intranuclear expression of measles virus following exposure of persistently-infected cells to cyclic AMP. *J. Gen. Virol.* 66, 2065-2070.

ROUX, L. and WALDVOGEL, F.A. (1982). Instability of the viral M protein in BHK-21 cells persistently-infected with Sendai virus. *Cell* 28, 293-302.

RUSTIGIAN, R. (1962). A carrier state in HeLa cells with measles virus (Edmonston strain) apparently associated with non-infectious virus. *Virology* 16, 101-104.

RUSTIGIAN, R. (1966). Persistent infection of cells in cultures by measles virus. I. Development and characteristics of HeLa sublines persistently-infected with complete virus. *J. Bacteriol.* 92, 1792-1804.

SALMI, A.A., NORRBY, E. and PANELIUS, M. (1972). Identification of different measles virus-specific antibodies in the serum and cerebrospinal fluid from patients with subacute sclerosing panencephalitis and multiple sclerosis. *Infect. Immun.* 6, 248-254.

SATO, T.A., FUKUDA, A. and SUGIURA, A. (1985). Characterization of major structural proteins of measles virus with monoclonal antibodies. *J. Gen. Virol.* 66, 1397-1409.

SCHLUEDERBERG, A. and CHAVANICH, S. (1974). The role of the nucleus in measles virus replication. *Med. Microbiol. Immunol.* 160, 85-90.

SCHLUEDERBERG, A. and NAKAMURA, M. (1967). A salt-dependent haemagglutinating particle from measles-infected cells. *Virology* 33, 297-306.

SHAPSHAK, P., TOURTELLOTTE, W.W., NAKAMURA, S., GRAVES, M.C., DARVISH, M., HOFFMAN, D., WALSH, M.J., FAREED, G.C., SCHMID, P., HEINZMANN, C., SIDHU, K., BEDOWS, E., ROZENBLATT, S., BERRY, K. and HAWKINS, S. (1985). Subacute sclerosing panencephalitis: Measles virus matrix protein nucleic acid sequences detected by in situ hybridization. *Neurology* 35, 1605-1609.

SHEPPARD, R.D., RAINE, C.S., BORNSTEIN, M.B. and UDEM, S.A. (1985). Measles virus matrix protein synthesized in a subacute sclerosing panencephalitis cell line. *Science* 228, 1219-1221.

SHEPPARD, R.D., RAINE, C.S., FELDMAN, L.A., BURNSTEIN, T. and BORNSTEIN, M.B. (1975). A cell-associated strain of SSPE virus studied in organotypic CNS cultures. *J. Neuropathol. Exp. Neurol.* 34, 87.

SHESHBERADARAN, H., CHEN, S-N. and NORRBY, E. (1983). Monoclonal antibodies against five structural components of measles virus. I: Characterization of antigenic determinants on nine strains of measles virus. *Virology* 128, 341-353.

SHESHBERADARAN, H. and NORRBY, E. (1984). Three monoclonal antibodies against measles virus F protein cross-react with cellular stress proteins. *J. Virol.* 52, 995-999.

SHIRODARIA, P.V., DERMOTT, E. and GOULD, E.A. (1976). Some characteristics of salt-dependent haemagglutinating measles viruses. *J. Gen. Virol.* 33, 107-115.

STALLCUP, K.C., RAINE, C.S. and FIELDS, B. (1983). Cytochalasin B inhibits the maturation of measles virus. *Virology* 124, 59-74.

STALLCUP, K.C., WECHSLER, S.L. and FIELDS, B.N. (1979). Purification of measles virus and characterization of subviral components. *J. Virol.* 30, 166-176.

STEPHENSON, J.R., SIDDELL, S.G. and ter MEULEN, V. (1981). Persistent and lytic infections with SSPE virus: A comparison of the synthesis of virus-specific polypeptides. *J. Gen. Virol.* 57, 191-197.

TAJIMA, M. and USHIJIMA, T. (1971). The pathogenesis of rinderpest in the lymph nodes of cattle. *Am. J. Pathol.* 62, 221-236.

TELLEZ-NAGEL, I. and HARTER, D.H. (1966). Subacute sclerosing leukoencephalitis: Ultrastructure of intranuclear and intracytoplasmic inclusions. *Science* 154, 899-901.

ter MEULEN, V. and CARTER, M.J. (1984). Measles virus persistency and disease. *Prog.*

Med. Virol. 30, 44-61.

ter MEULEN, V., LÖFFLER, S., CARTER, M.J. and STEPHENSON, J.R. (1981). Antigenic characterization of measles and SSPE virus hemagglutinin by monoclonal antibodies. *J. Gen. Virol.* 57, 357-364.

THORMAR, H., ARNESEN, K. and MEHTA, P.D. (1977). Encephalitis in ferrets caused by a nonproductive strain of measles virus (D.R.) isolated from a patient with subacute sclerosing panencephalitis. *J. Infect. Dis.* 136, 229-238.

TOGASHI, T., ÖRVELL, C., VARTDAL, F. and NORRBY, E. (1981). Production of antibodies against measles virions by use of the mouse hybridoma technique. *Arch. Virol.* 67, 149-157.

TSANG, L. W.-L., CHANG, N. and MARUSYK, R.G. (1981). An interference phenomenon associated with a measles virus SSPE isolate (Halle). *J. Gen. Virol.* 56, 195-198.

TUCKER, J., RAMSINGH, A., LUND, G., SCRABA, D., LEUNG, W.C., and TYRRELL, D.L.T. (1984). Characterization of measles virus RNA. In "Negative Strand Virus" (D.H.L. Bishop, R.W. Compans, eds.) vol. 2, pp. 49-5[illegible]. Academic Press, New York.

TYRRELL, D.L.J. and EHRNST, A. (1979). Transmembrane communication in cells chronically infected with measles virus. *J. Cell Biol.* 81, 396-402.

TYRRELL, D.L.J. and NORRBY, E. (1978). Structural polypeptides of measles virus. *J. Gen. Virol.* 39, 219-229.

TYRRELL, D.L.J., RAFTER, D.J., ÖRVELL, C. and NORRBY, E. (1980). Isolation and immunological characterization of the nucleocapsid and membrane proteins of measles virus. *J. Gen. Virol.* 51, 307-315.

UCHIYAMA, T., TAKEDA, K. and YAMANOUCHI, K. (1985). Replication of measles virus and localization of the viral antigens in long-term infection in organotypic cultures of hamsters dosal-root gang[illegible]. *Jap. J. Exp. Med.* 55, 10[illegible]21.

VAINIONPÄÄ, R., ZIOLA, B. and SALMI, A.A. (1978). Measles virus polypeptides in purified virions and in infected cells. *Acta Pathol. Microbiol. Scand. (B)* 86, 379-385.

VON MAGNUS, P. (1954). Incomplete forms of influenza virus. *Adv. Virus Res.* 2, 59-79.

WATERS, D.J., HERSH, R.T. and BUSSELL, R.H. (1972). Isolation and characterization of measles nucleocapsid from infected cells. *Virology* 48, 278-281.

WECHSLER, S.L. and FIELDS, B.N. (1978). Intracellular synthesis of measles virus-specified polypeptides. *J. Virol.* 25, 285-297.

WECHSLER, S.L. and MEISSNER, H.C. (1982). Measles and SSPE viruses: Similarities and differences. *Prog. Med. Virol.* 28, 65-95.

WECHSLER, S.L., WEINER, H.L. and FIELDS, B.N. (1979). Immune response in subacute sclerosing panencephalitis: Reduced antibody response to the matrix protein of measles virus. *J. Immunol.* 123, 884-889.

WILD, T.F. (1981). Measles virus and chronic infections. *Pathol. Biol.* 29, 429-433.

WILD, T.F. and DUGRE, R. (1978). Establishment and characterization of a subacute sclerosing panencephalitis (measles) virus persistent infection in BGM cells. *J. Gen. Virol.* 39, 113-124.

YOSHIDA, T., NAGAI, Y., YOSHII, S., MAENO, K. and MATSUMOTO, T. (1976). Membrane (M) protein of HVJ (Sendai virus): Its role in virus assembly. *Virology* 71, 143-161.

YOUNG, K.K.Y., HEINEKE, B.F. and WECHSLER, S.L. (1985). M protein instability and lack of H protein processing associated with nonproductive persistent infection of HeLa cells by measles virus. *Virology* 143, 536-545.

7. Appendix

1. Modified Hucker's Crystal Violet

Solution A

crystal violet	2.0 grams
95% ethanol	20.0 mL

Solution B

ammonium oxalate	0.8 grams
distilled water	80.0 mL

Mix A and B, store for 24 h and filter.

2. LX-112 Embedding Resin

Mixture A

LX-112 resin[1]	36.4 grams
NMA[2]	33.6 grams

Mixture B

LX-112 resin	17.3 grams
DDSA[3]	22.7 grams

Mixture A and B are each mixed for 30 min with a magnetic stirrer. Mixture A is added to mixture B and while stirring, 3 mL of DMP-30[4] is gradually added at the level of the stirring bar using a disposable pipette. This mixture is stirred for 30 min, avoiding the incorporation of air bubbles. The resin is stored at -70°C in disposable 10 mL syringes.

[1] Ladd Research Industries Inc., Burlington, Vermont.
[2] Nadic methyl anhydride, Ladd Research Industries.
[3] Dodecenyl succinic anhydride, J. B. EM Services Inc., Pointe-Claire-Dorval, Quebec.
[4] 2, 4, 6 - tri (dimethylaminomethyl) phenol, Fisher Scientific Co..

3. Lead Citrate

lead citrate	0.01 - 0.04 grams
water	10 mL
10 M sodium hydroxide	0.1 mL

Add lead citrate to 10 mL of water in a screw-capped tube, add dropwise the sodium hydroxide and shake the tube vigorously until all the lead citrate is dissolved. Store in 1 mL syringes.

4. 0.1 M Phosphate Buffer, pH 7.2 - 7.4

Solution A

sodium phosphate, dibasic	7.1 grams
water	0.5 L

Solution B

potassium phosphate, monobasic	6.8 grams
water	0.5 L

Seven parts of A mixed with 3 parts of B gives a pH of 7.2 - 7.4.

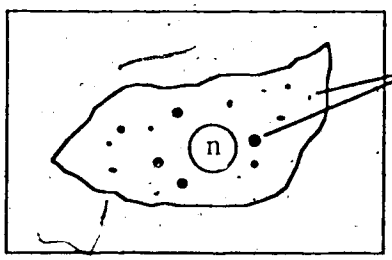
5. PBS

sodium chloride	8.00 grams
potassium chloride	0.2 grams
monobasic potassium phosphate	0.2 grams
dibasic sodium phosphate	1.14 grams

Dissolve the above in water to a final volume of 1 L.

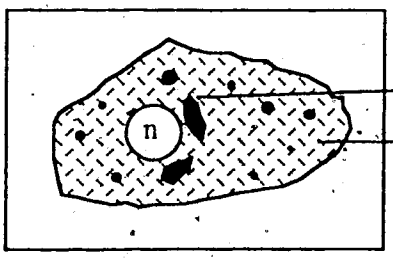
Figure 6

Progression of immunofluorescent staining obtained with NP and P protein monoclonal antibodies



dots of various sizes

refer to Fig. 9b

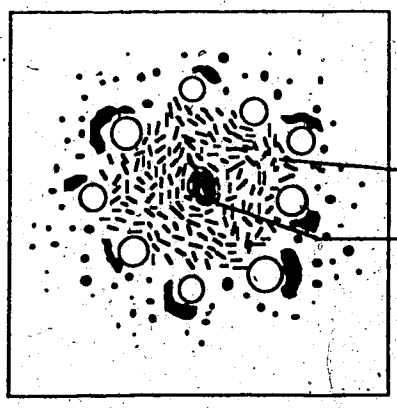


dots

globules

flecks

refer to Fig. 9c



dots/globules

flecks

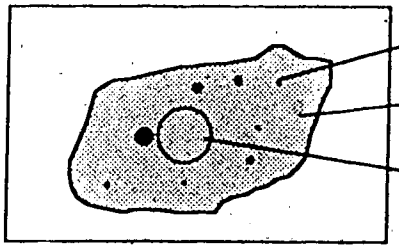
fibrous

fibrous inclusion

refer to Fig. 10d

Figure 7

Progression of immunofluorescent staining obtained with M monoclonal antibody

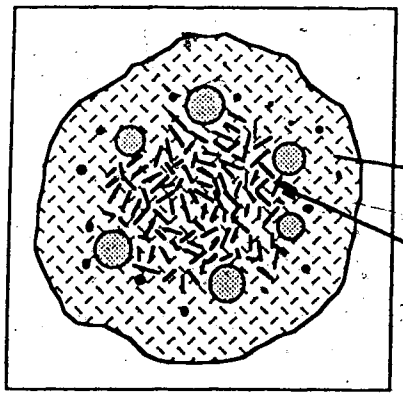


dots/globules

fine homogeneous

diffuse nuclear

refer to Fig. 11b



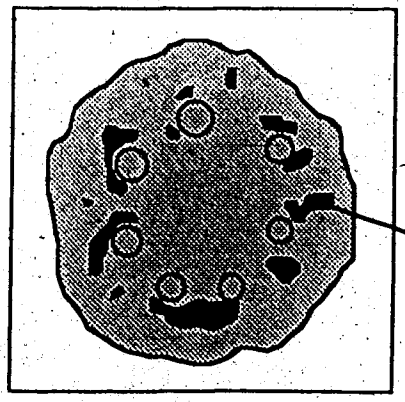
dots/globules

diffuse nuclear

flecks

fibrous

refer to Fig. 11c



fine homogeneous

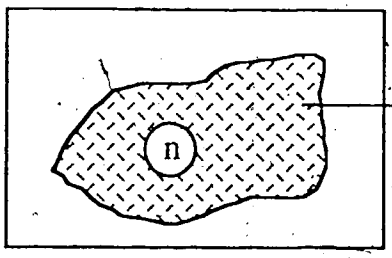
diffuse nuclear

pale globules

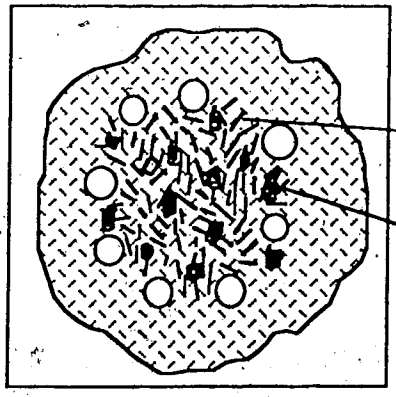
refer to Fig. 11e

Figure 8

Progression of immunofluorescent staining obtained with H and F monoclonal antibodies



flecks refer to Fig. 12b



flecks

fibrous refer to Fig. 13d

fibrous clusters

Figure 9.

Immunofluorescent staining of the NP protein in Vero cells infected with RP at 32°C

Figure 9a.

A photograph of a RP-infected cell fluorescing after immunofluorescent staining with the NP protein monoclonal antibody. Pin point dots were detected in the cytoplasm at 6 h pi. This and the following photographs of IF staining were taken using a Leitz incident light fluorescent microscope (section 2.7 and 2.10).
Magnification 512 X

Figure 9b.

Fluorescent dots in a variety of sizes detected in the cytoplasm at 14 h pi.

Figure 9c.

The appearance of flecks in addition to the bright dots and larger globules at 24 h pi.

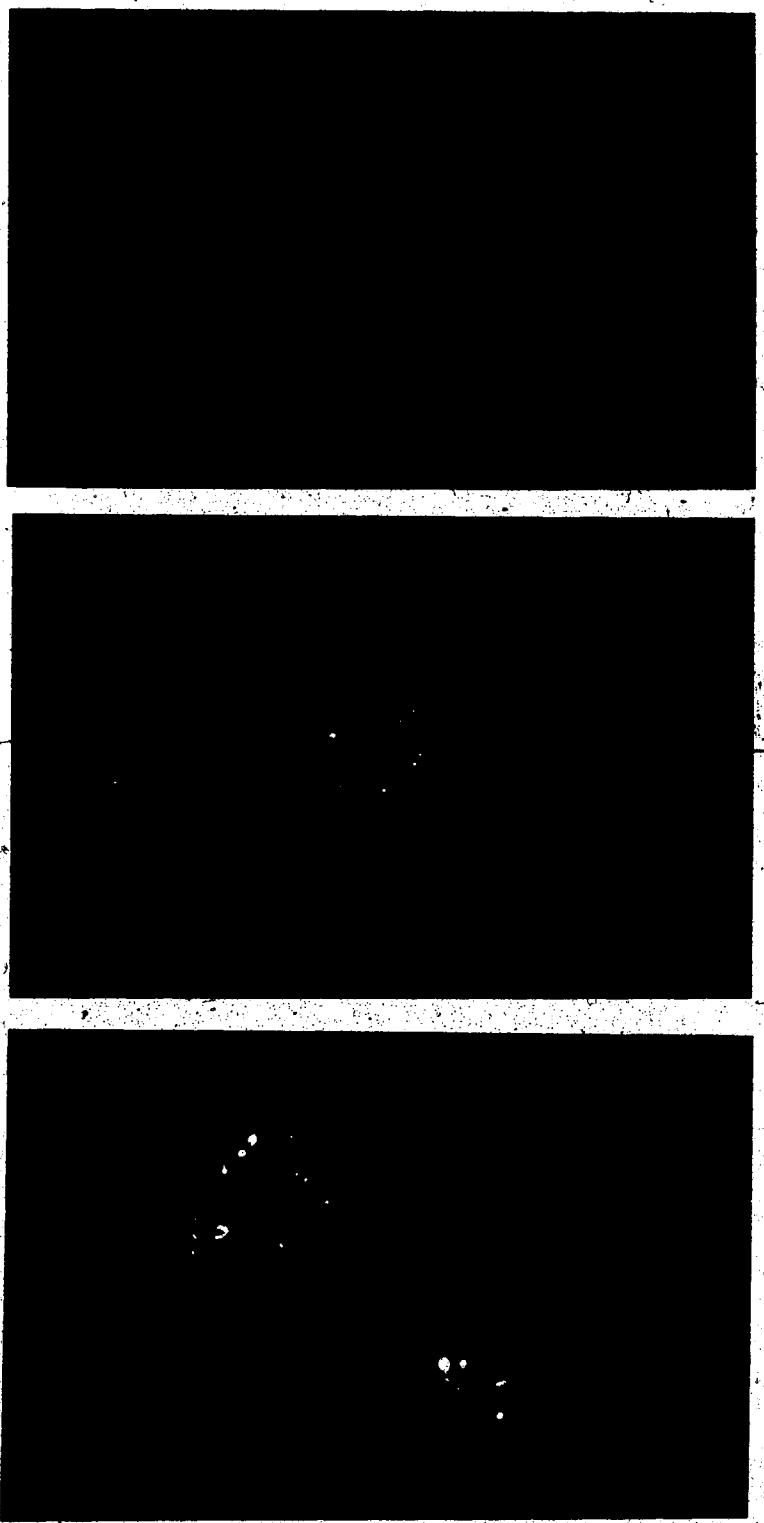


Figure 9d.

NP staining at 48 h pi showing extensive cytoplasmic staining. Magnification 320 X

Figure 9e.

NP staining at 72 h pi illustrating the fibrous type staining in the center of syncytia, perinuclear globular inclusions, and flecks and dots towards the periphery of the syncytia.

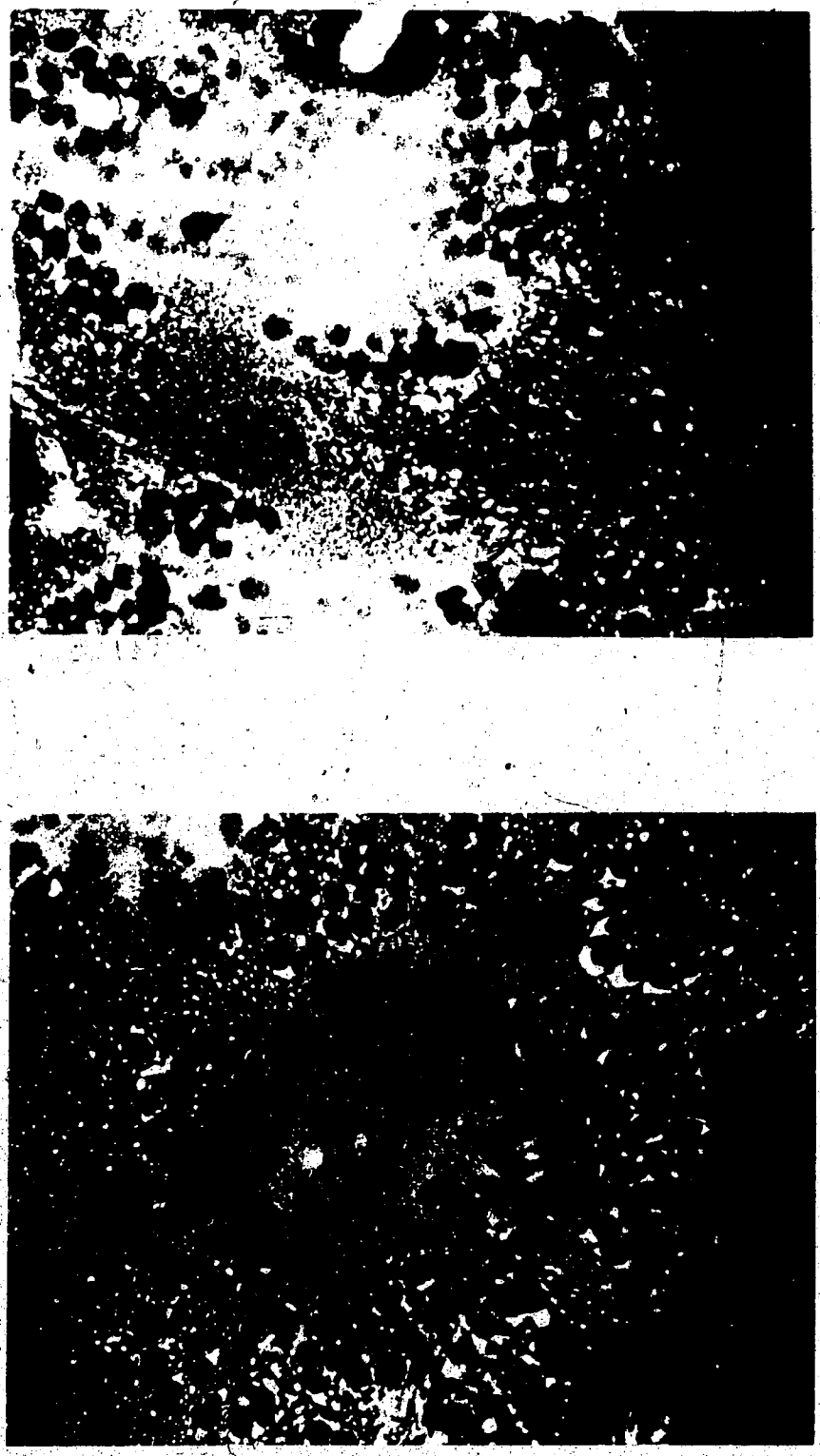


Figure 10.

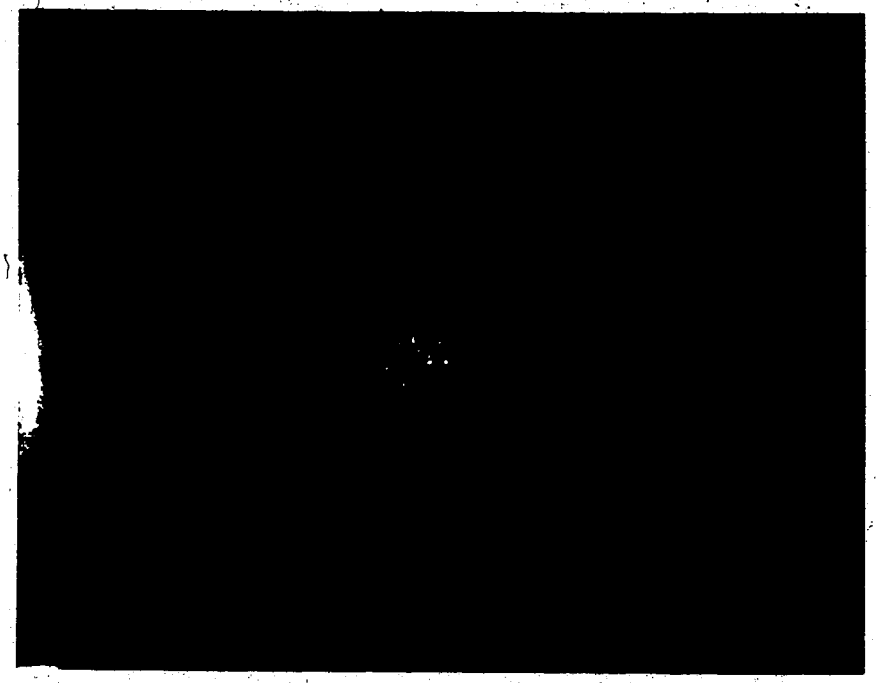
Immunofluorescent staining of the P protein in cells infected with RP at 32°C

Figure 10a.

Cytoplasmic dots of P protein seen at 10 h pi.

Figure 10b.

Flecks, bright dots and large globules of P protein seen at 24 h pi.



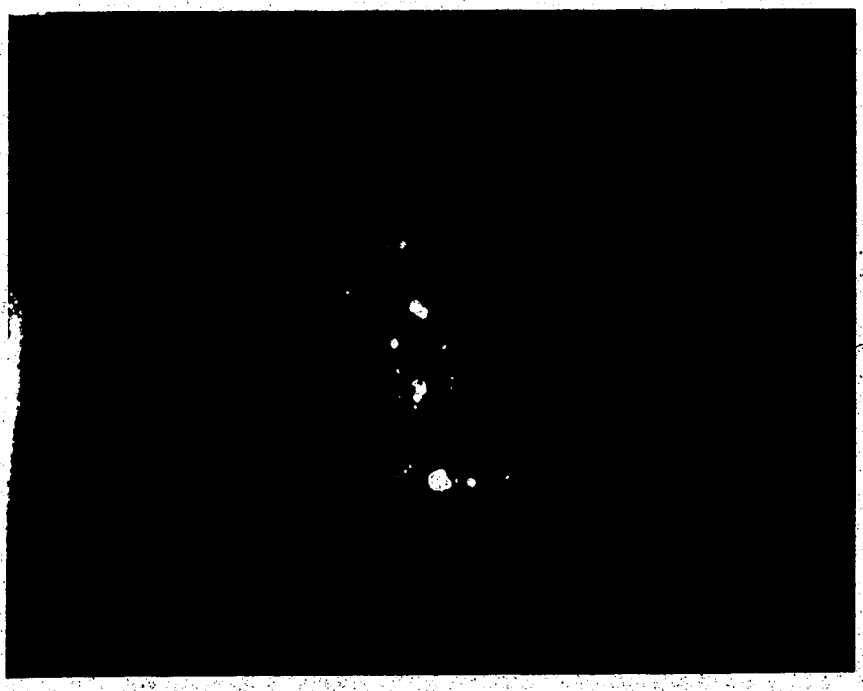


Figure 10c.

Appearance of P protein at 48 h pi showing flecks, bright dots and globules and some fibrous material.

Figure 10d.

A good example of the different types of cytoplasmic staining seen with P protein at 72 h pi. Present are dots/globules, flecks, fibrous material (f) and fibrous inclusions (i).

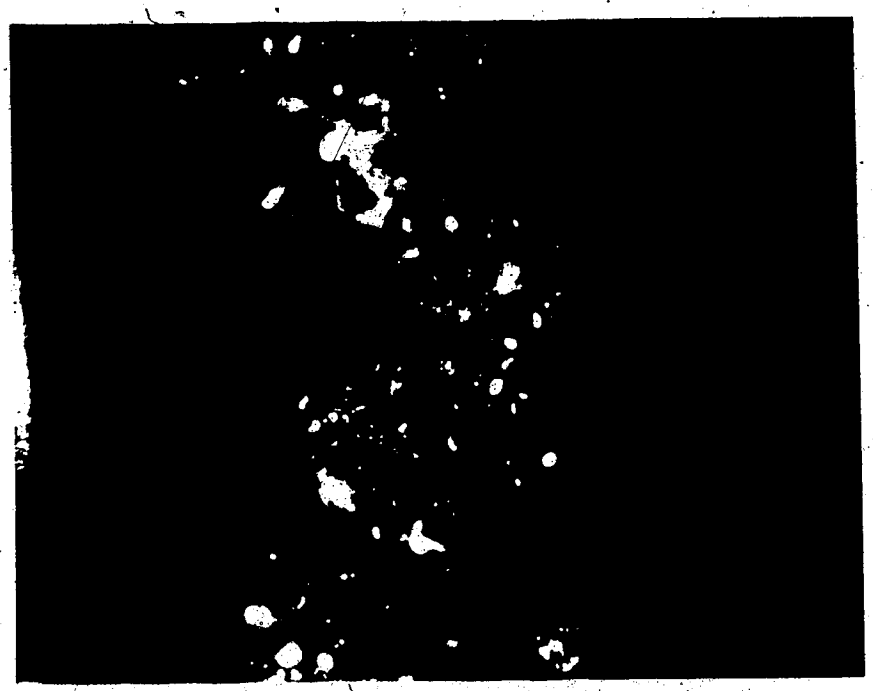


Figure 11.

Immunofluorescent staining of the M protein in cells infected with RP at 32°C

Figure 11a.

A faintly stained cell at 18 h pi showing pale diffuse nuclear staining, faint cytoplasmic staining with a few dots and globules of M protein.

Figure 11b.

An infected cell at 24 h pi showing the same features seen at 18 h pi but more intensely.

Figure 11c.

A small syncytia at 48 h pi characterized by flecks, fibrous material, a few globules and pale nuclear staining.

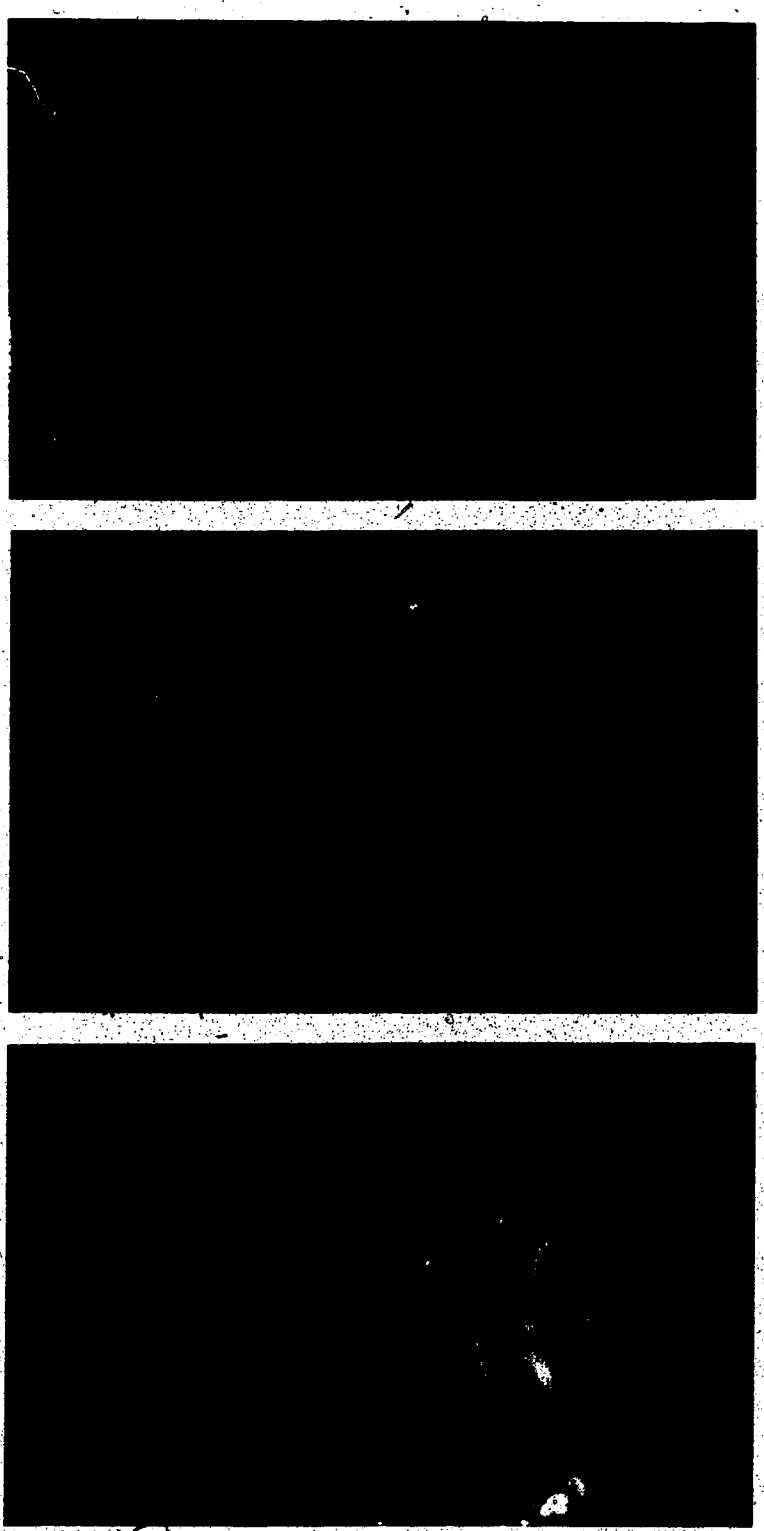
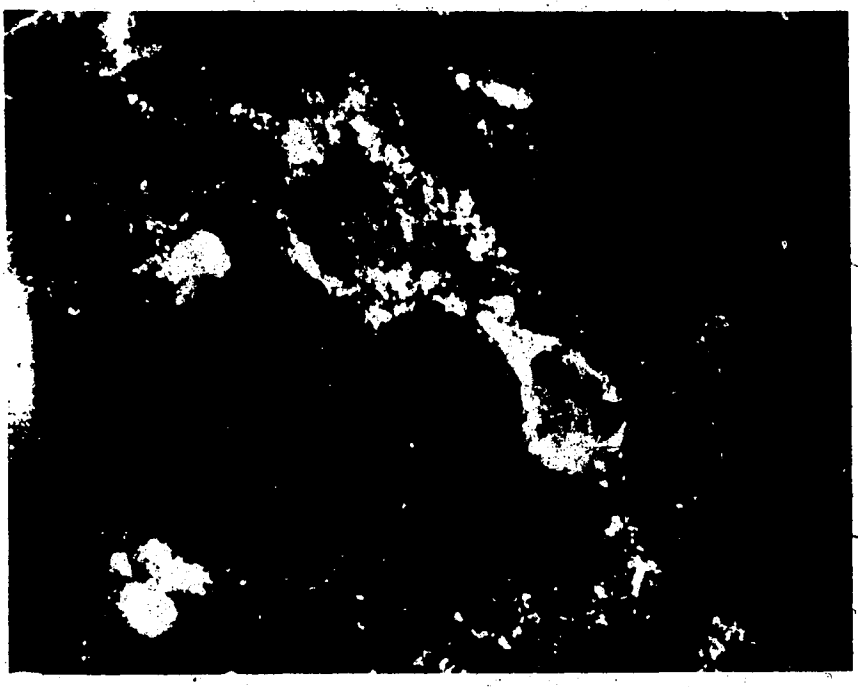


Figure 11d.

A brightly-staining flecked and fibrous type of syncytia seen at 72 h pi.

Figure 11e.

A pale-staining type of syncytia at 80 h pi characterized by a pale homogeneous cytoplasm containing weakly staining globular perinuclear inclusions and diffuse nuclear staining.



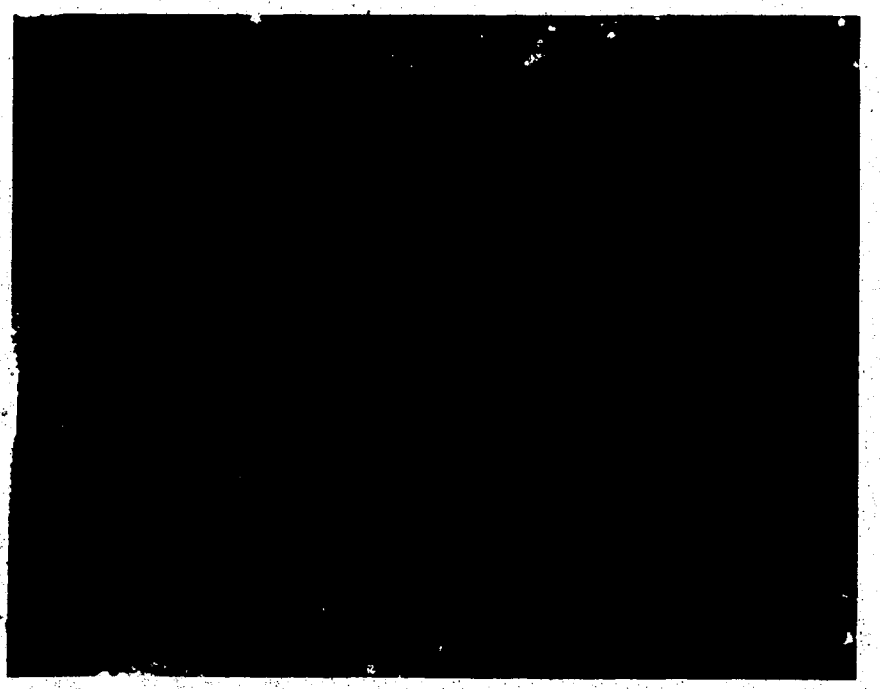


Figure 12.

Immunofluorescent staining of the H protein in cells infected with RP at 32°C

Figure 12a.

An infected cell (20 h pi) showing diffuse homogeneous cytoplasmic staining, pale flecks and no nuclear staining with the anti-H monoclonal antibody.

Figure 12b.

Distinct flecking seen at 24 h pi.

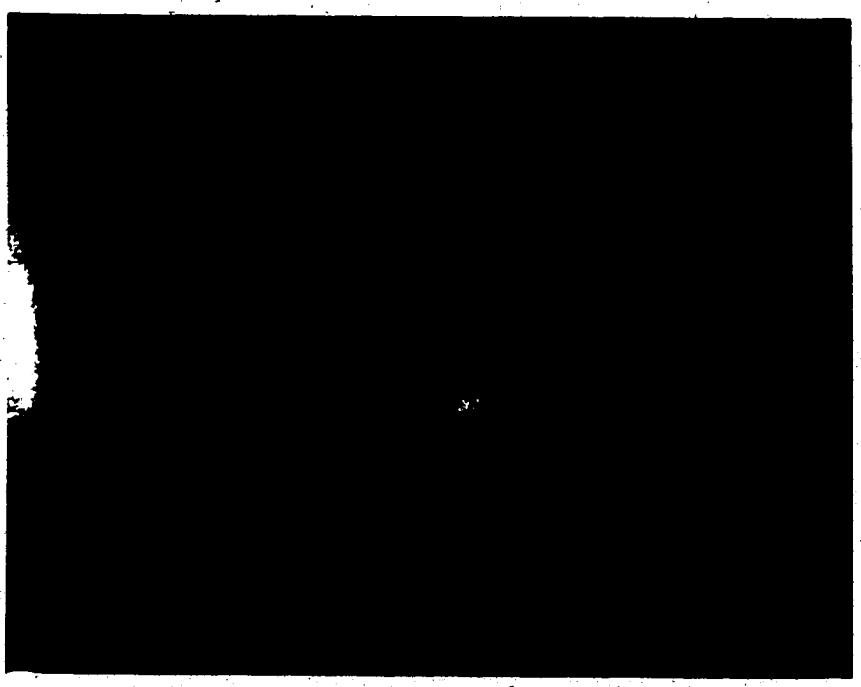


Figure 12c.

H protein at 40 h pi shows distinct flecks and fibrous material.

Figure 12d.

Fibrous clusters are a predominant feature of this syncytia at 56 h pi.

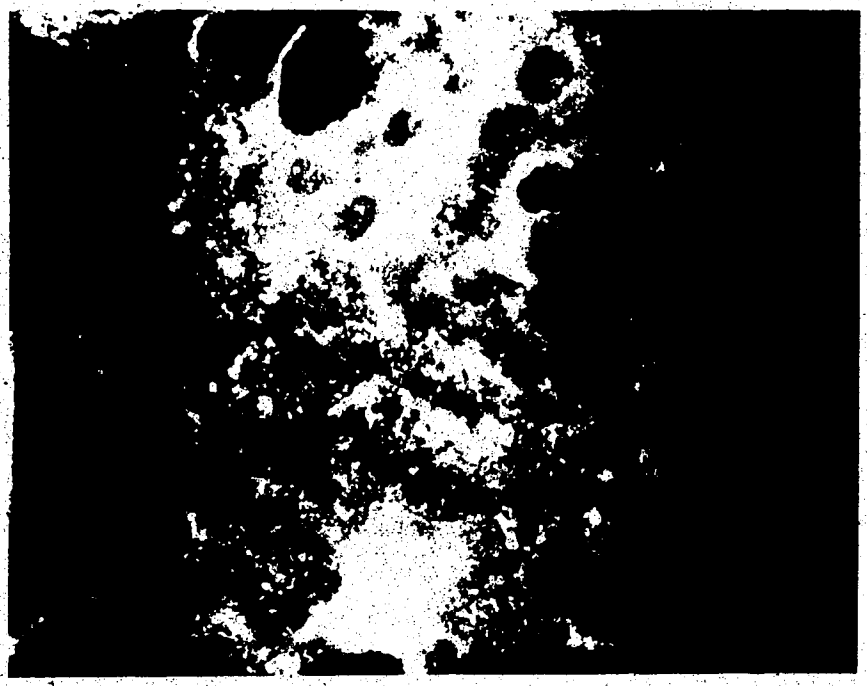


Figure 13.

Immunofluorescent staining of the F protein in cells infected with RP at 32°C

Figure 13a.

Pale cytoplasmic flecks of F protein detected at 21 h pi.

Figure 13b.

Pale flecking at 24 h pi.

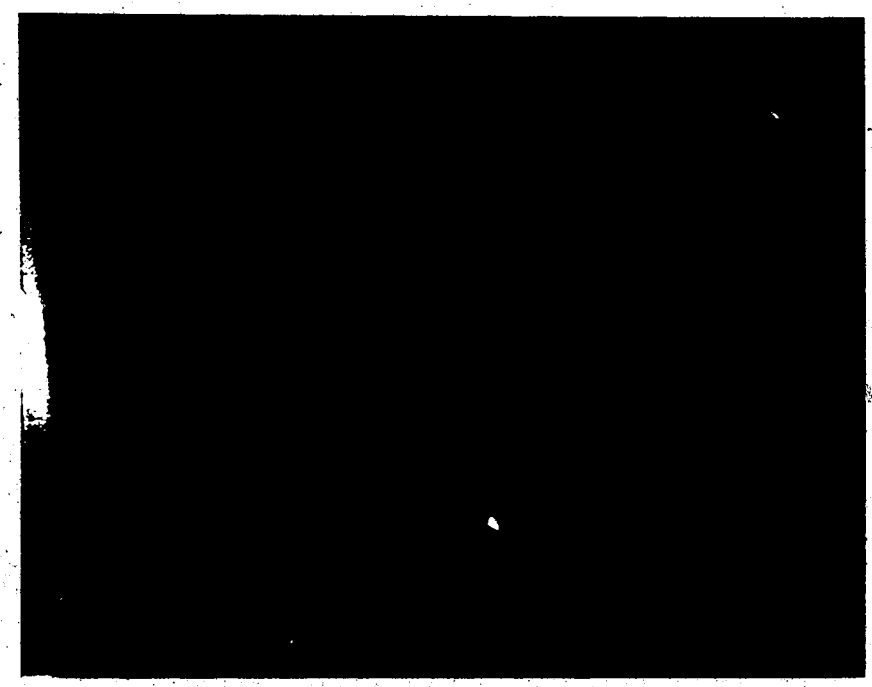


Figure 13c.

F protein stained at 48 h pi illustrating the bright flecks, fibrous material and some fibrous clusters

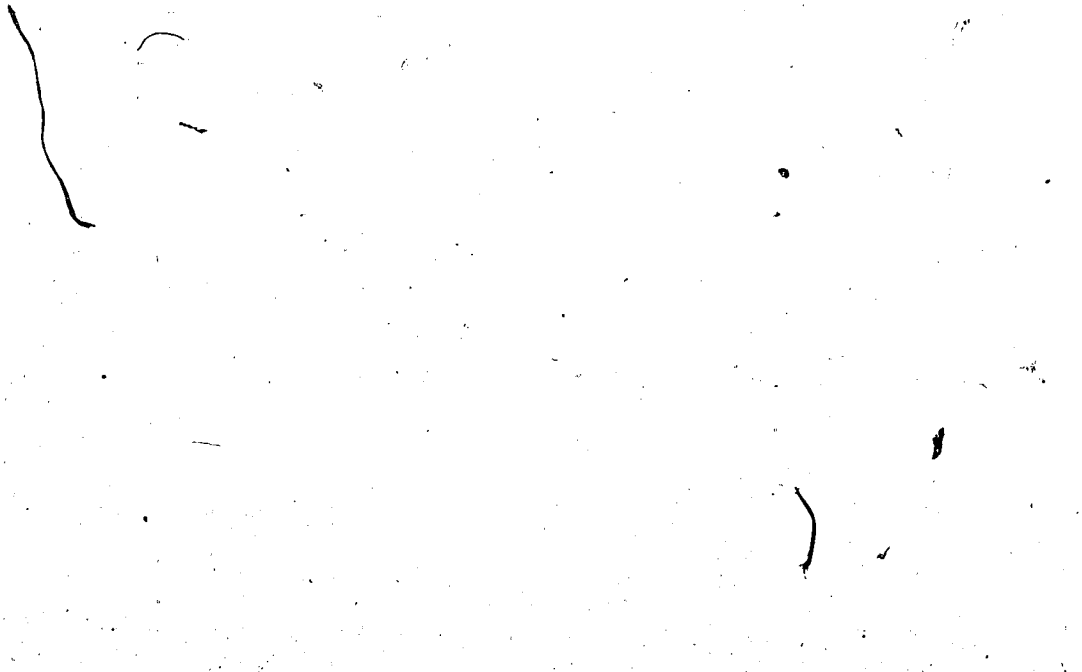


Figure 13d.

A good illustration of the F protein fibrous clusters (c) and fibrous material (f) seen at 72 h pi.

Figure 14.

Electron micrographs of cells infected with RP at 32°C

Figure 14a.

An electron micrograph of a RP-infected cell at 96 h pi illustrating a cytoplasmic inclusion of NC material. Refer to sections 2.8 and 2.9 for the methods used.
Magnification 25,500 X

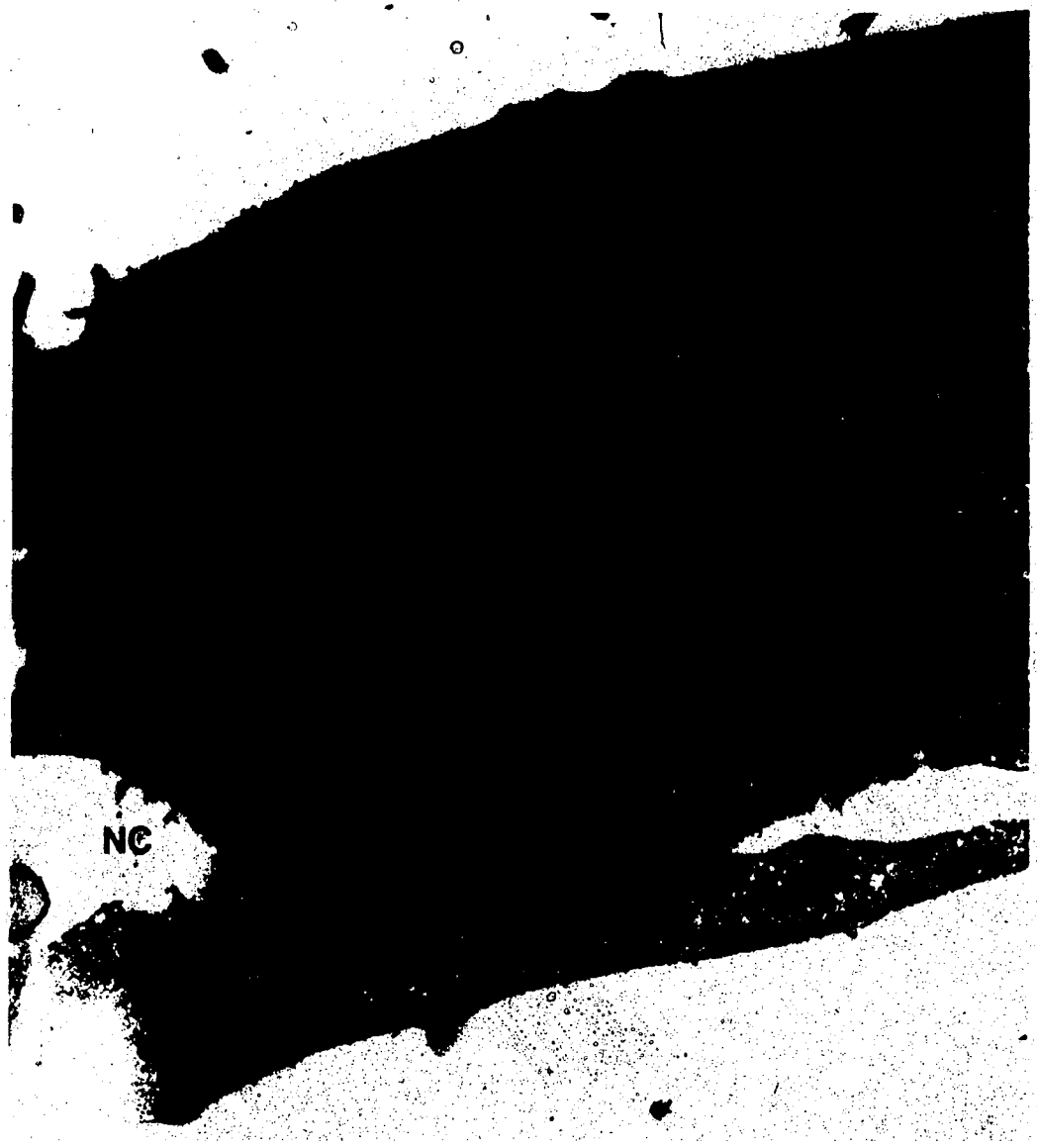

NC

Figure 14b.

Extracellular virus (v) seen at 72 h pi.
Magnification 51,000 X.

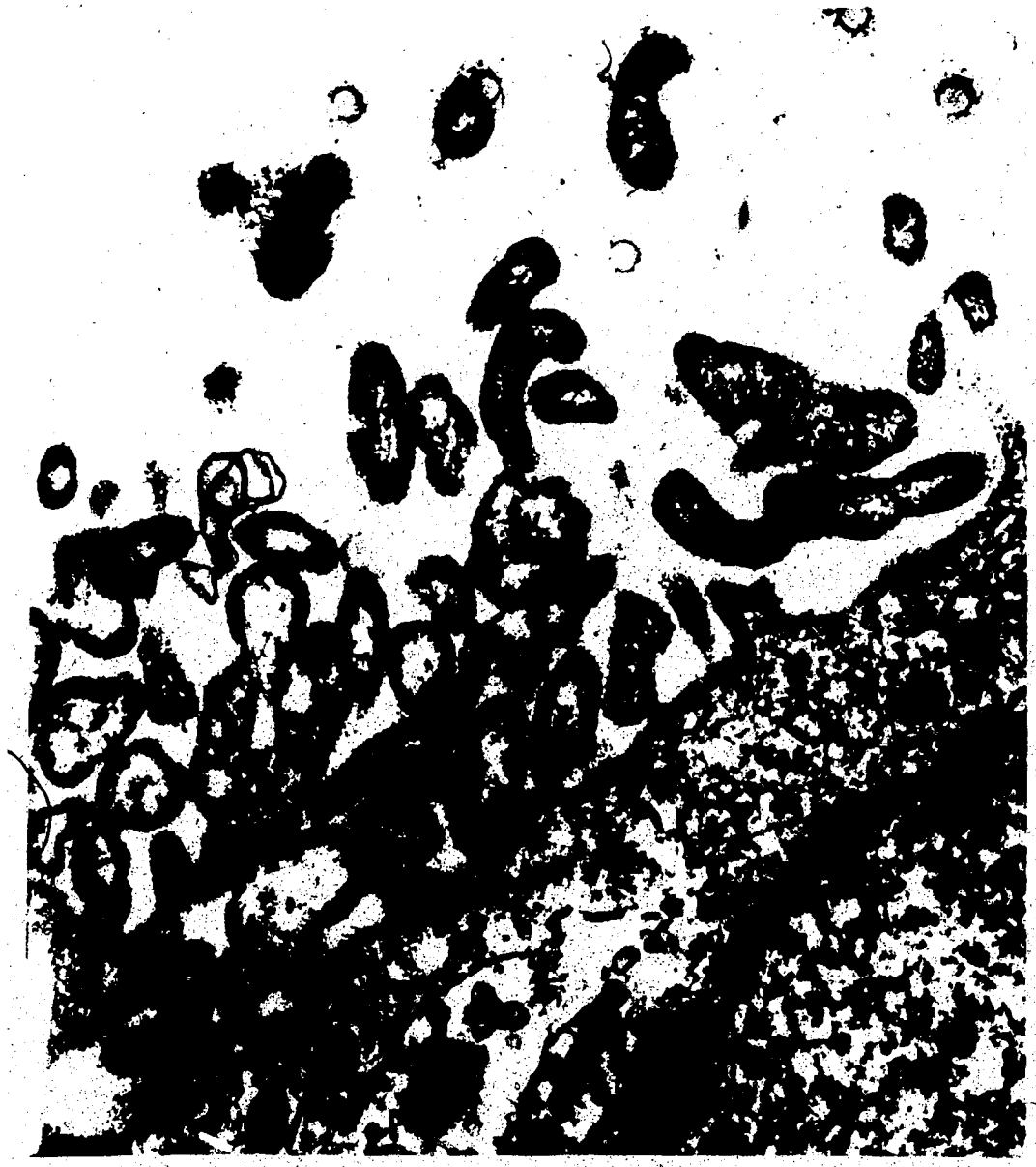


Figure 14c.

Infected cells at 96 h pi showing budding virus (bv) and simple nuclear bodies (sNB).
Magnification 25,500 X


DV

Figure 15.

Immunofluorescent staining of Lec and mumps virus-infected cells with M monoclonal antibody (C1-144)

Figure 15a.

Lec-infected cells stained with the C1-144 clone showed diffuse nuclear staining.

Figure 15b.

The uninfected control cells do not stain intranuclearly with the C1-144 clone.

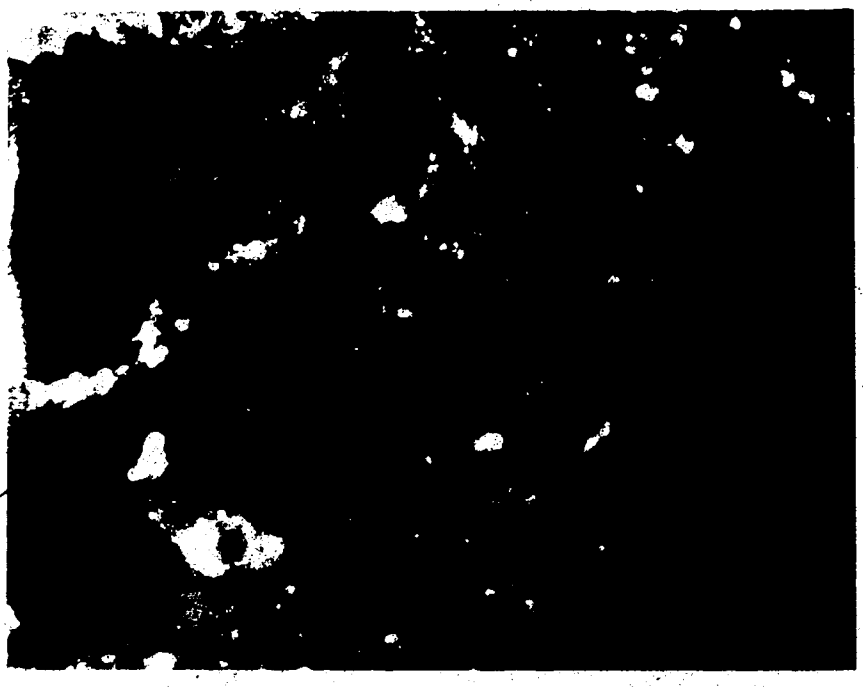
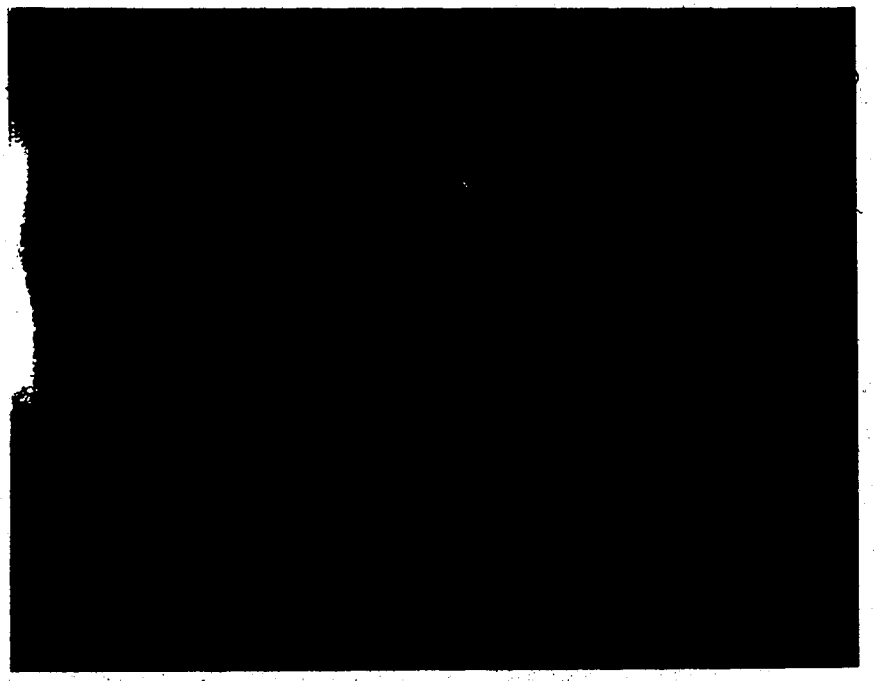


Figure 15c.

Mumps virus-infected cells do not stain with the C1-144 clone of M monoclonal antibody.

Figure 15d.

Nonstained uninfected control cells.



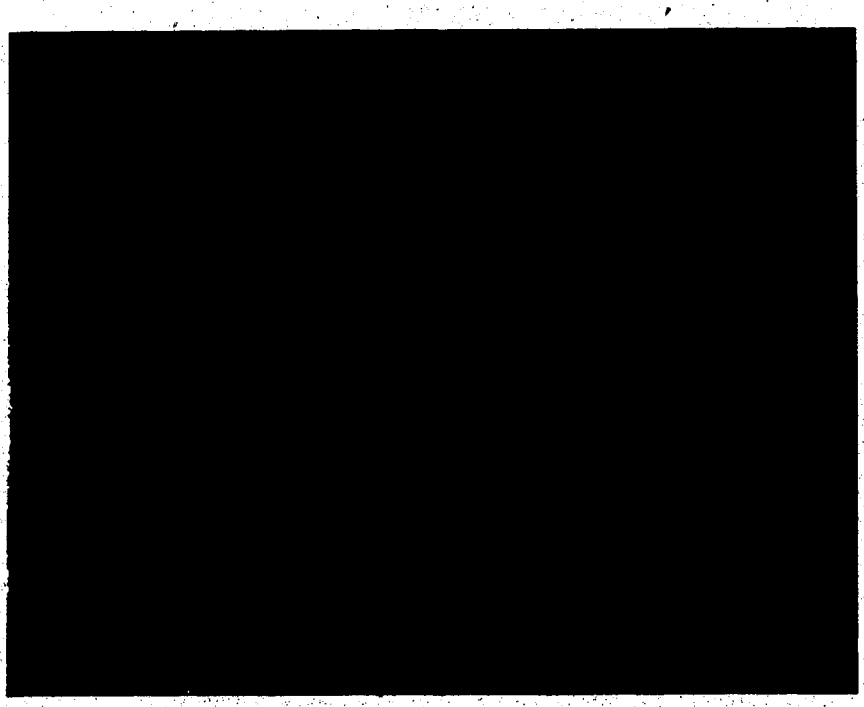


Figure 16.

Immunofluorescent staining of Halle UP-1 cells with polyclonal wild-type antiserum (MVR-3)

Figure 16a.

Brightly fluorescing infected cells at 32°C and 51 h pi showing primarily flecks, fibrous material and fine homogeneous cytoplasmic staining.

Figure 16b.

A syncytia at 39°C and 27 h pi illustrating the pale diffuse nuclear staining, fine cytoplasmic staining as well as bright dots/globules, flecks and fibrous staining.

Figure 17.

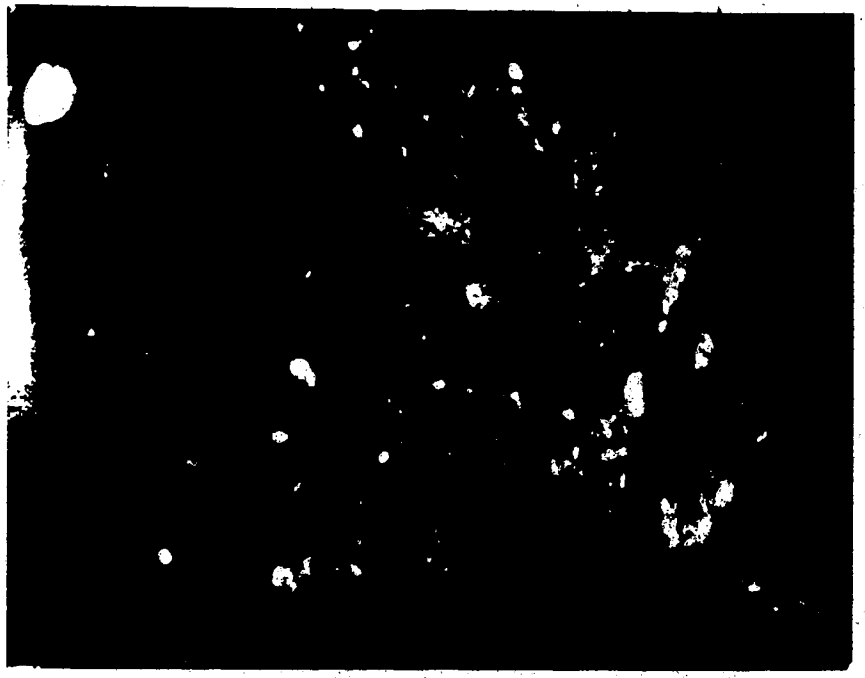
Immunofluorescent staining of Halle UP-1 cells with polyclonal nucleocapsid antiserum (MeNC-1)

Figure 17a.

Infected cells at 32°C and 51 h pi demonstrating diffuse and dotted nuclear staining and intense cytoplasmic staining.

Figure 17b.

A large syncytia at 39°C and 27 h pi illustrating nuclear diffuse staining and dots as well as bright cytoplasmic globular inclusions, dots and areas of only fine homogeneous staining.



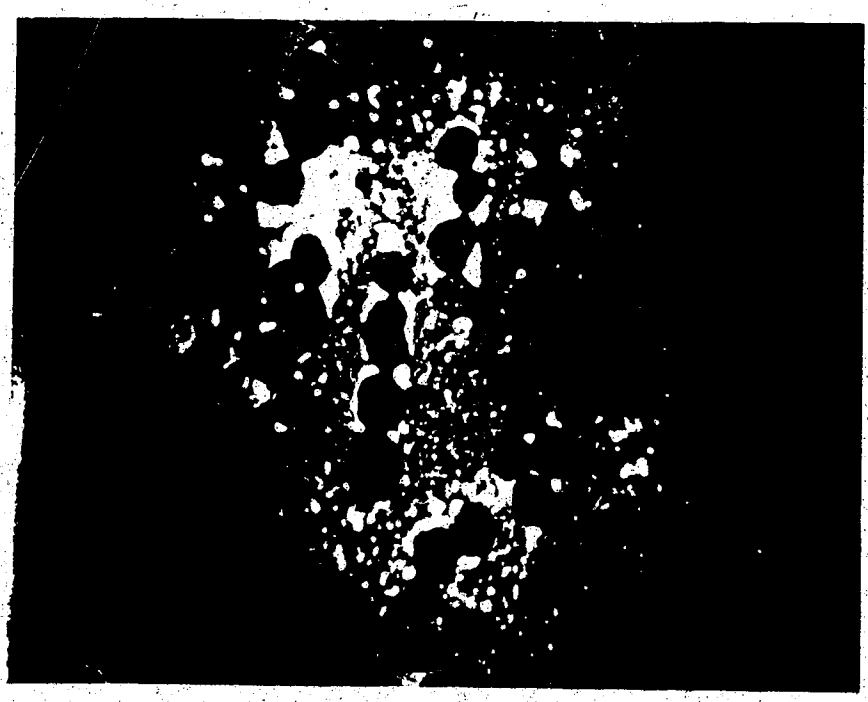


Figure 18.

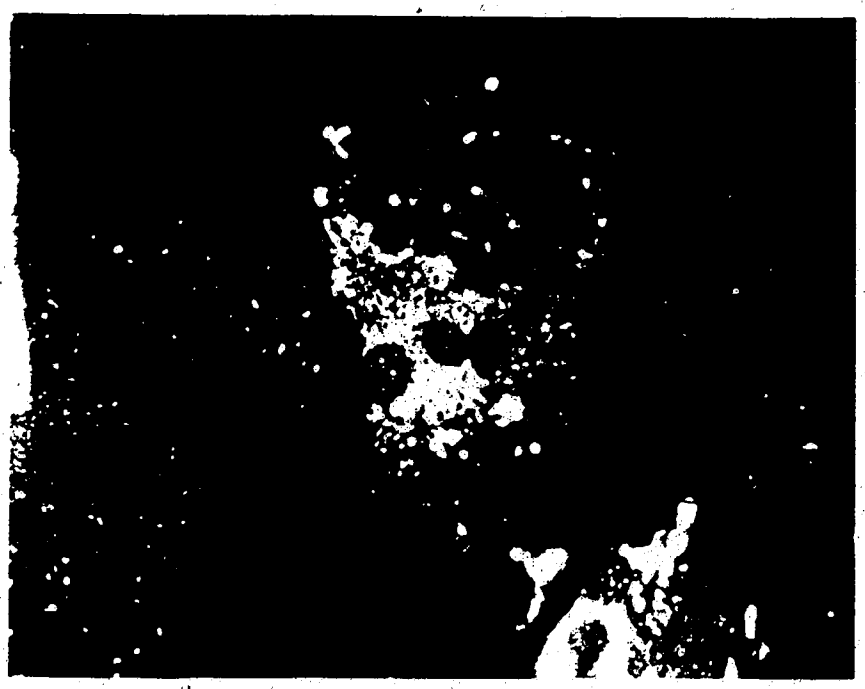
Immunofluorescent staining of Halle UP-1 cells with NP monoclonal antibody (16AC5)

Figure 18a.

The typical staining seen 51 h pi at 32°C with the flecks, fibrous material, dots and globules located cytoplasmically and the occasional nuclei with dots.

Figure 18b.

A similar-sized syncytia 27 h pi at 39°C showing many bright dots and globules and some flecking but less fibrous material as compared to fig. 18a.



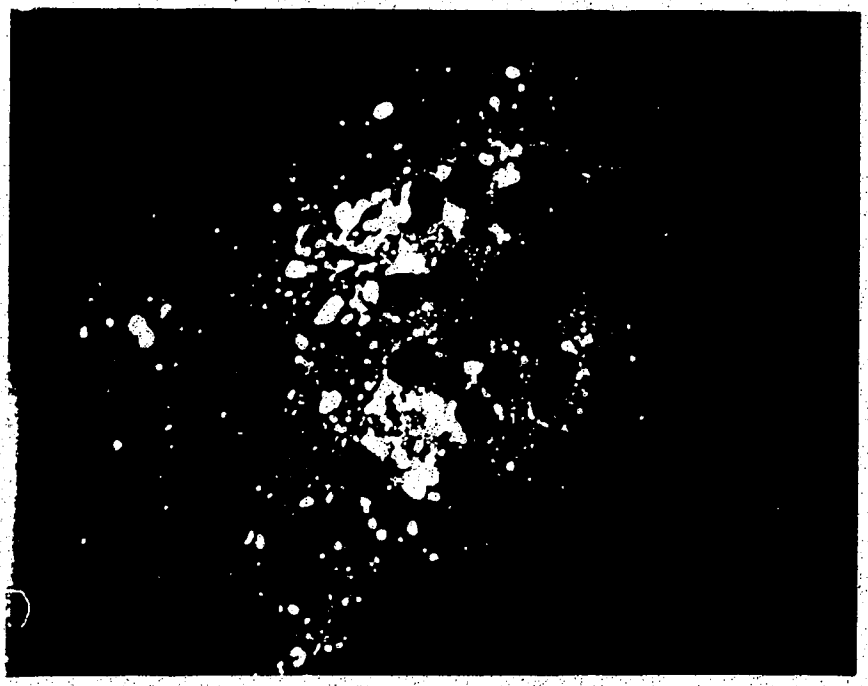


Figure 18c.

Distinct nuclear dots seen at 42 h pi and at 39°C.

Figure 18d.

A good example of the type of syncytia lacking flecks and fibrous material. This syncytia was observed 3 d pi at 39°C.

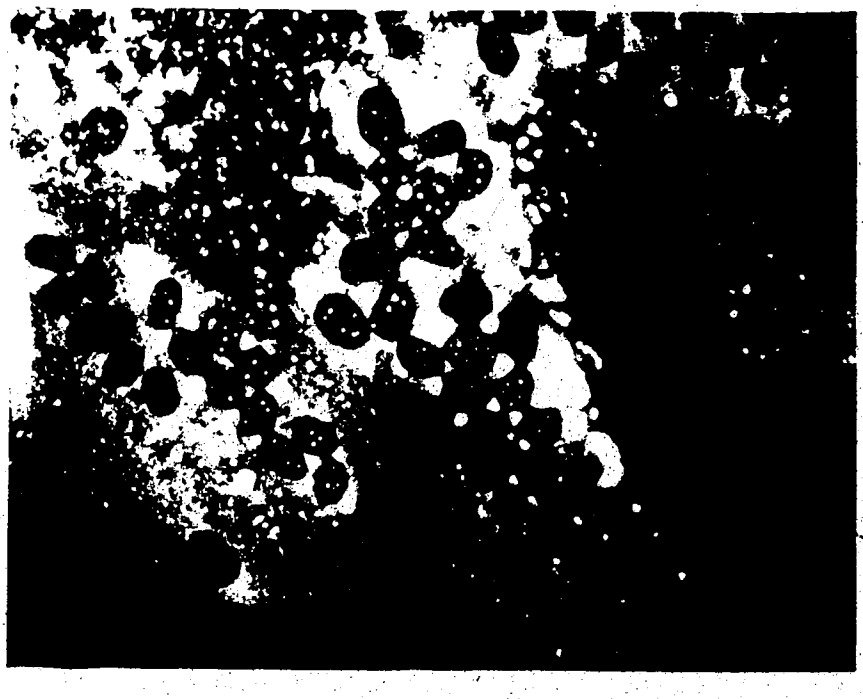


Figure 19.

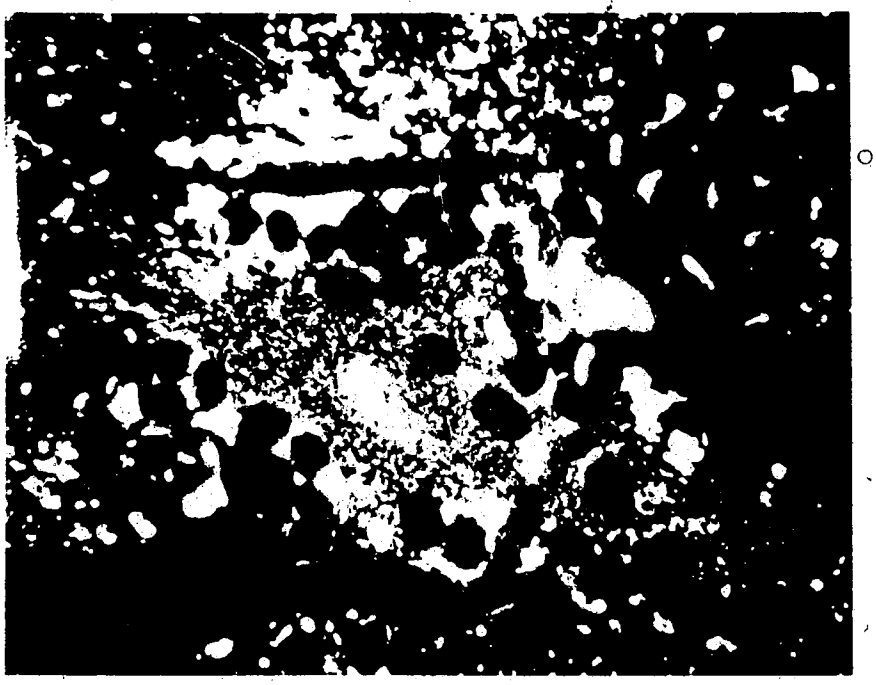
Immunofluorescent staining of Halle UP-1 cells with P monoclonal antibody (C1-105)

Figure 19a.

An intensely stained syncytia observed 51 h pi at 32°C showing types 1, 2, 3 and 4 cytoplasmic staining and a few nuclei with dots.

Figure 19b.

A less-flecked and less-fibrous type of syncytia at 42 h pi and 39°C showing tiny intranuclear fluorescing dots.



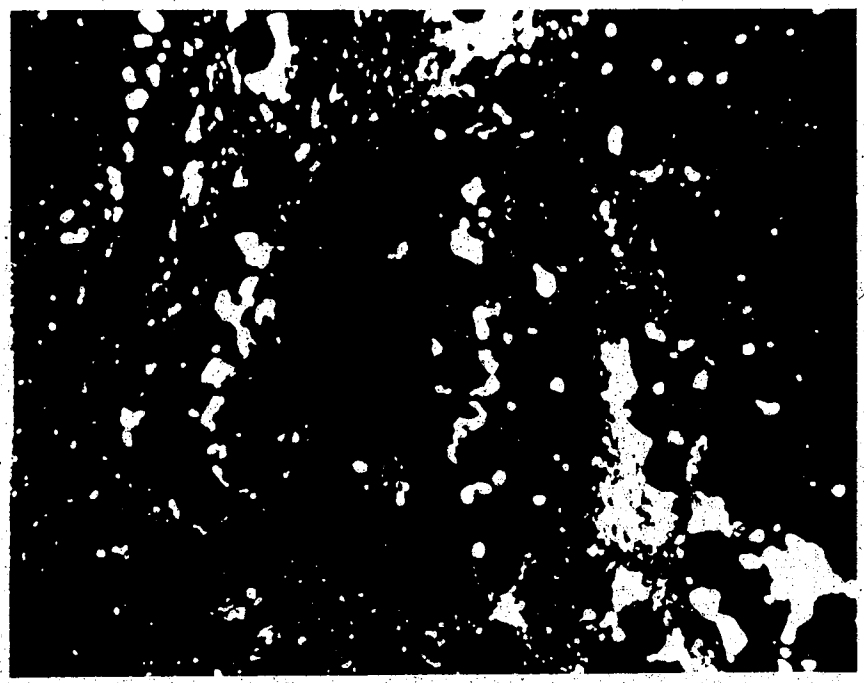


Figure 20.

Immunofluorescent staining of Halle UP-1 cells with CDV P protein monoclonal antibody

Figure 20a.

Distinct nuclear dots but very weak cytoplasmic staining observed 51 h pi at 32°C.

Figure 20b.

A large syncytia demonstrating a nonstaining periphery and primarily type 1 cytoplasmic staining and type 7n nuclear staining at 42 h pi and 39°C.

Figure 21.

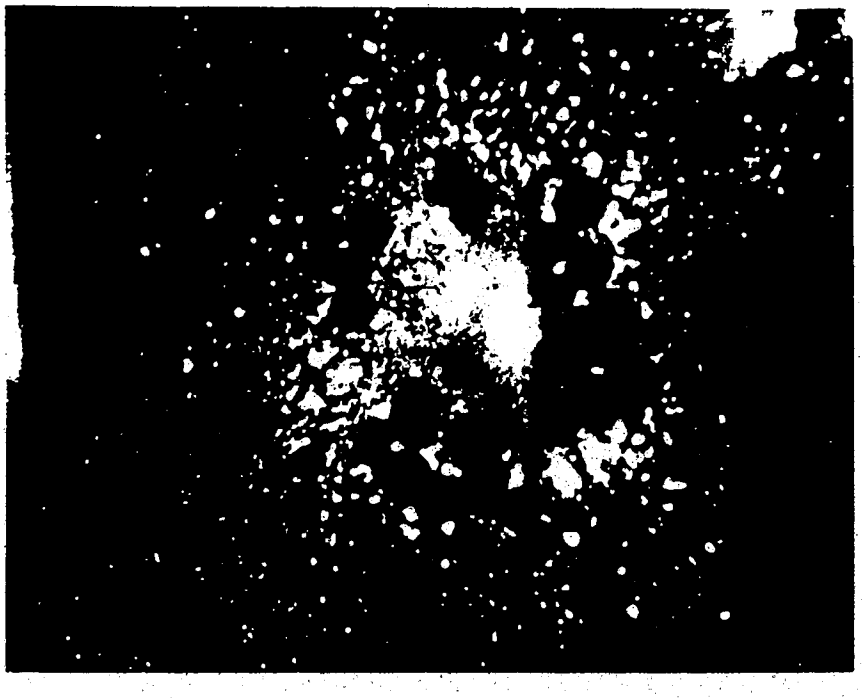
Immunofluorescent staining of Halle UP-1 cells with P monoclonal antibody (16AF10 or 16BD3)

Figure 21a.

Typical syncytia at 32°C and 51 h pi showing types 1, 2, 3 and 4 cytoplasmic staining but no nuclear staining.

Figure 21b.

Typical syncytia at 39°C, 27 h pi characterized by less-fibrous and less-flecked type of staining.



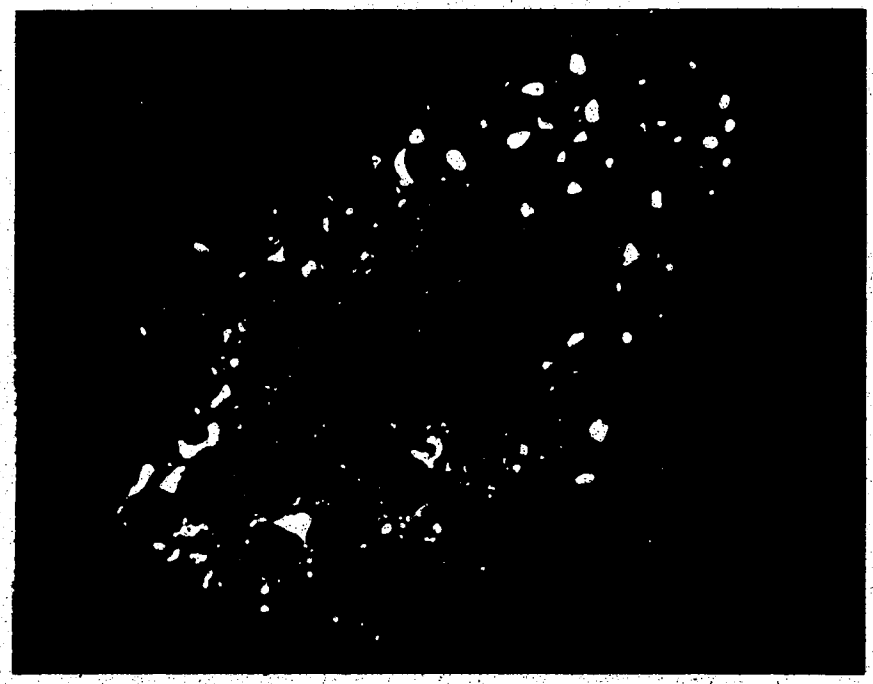


Figure 22.

Immunofluorescent staining of Halle UP-1 cells with M monoclonal antibody (C1-144)

Figure 22a.

A brightly stained syncytia at 51 h pi and 32°C demonstrating the typical appearance at this temperature. The nuclei are stained in addition to the cytoplasmic staining (types 2,3,4 and 6).

Figure 22b.

This large syncytia at 27 h pi and 39°C is like the 32°C type of syncytia without the flecks and fibrous material.

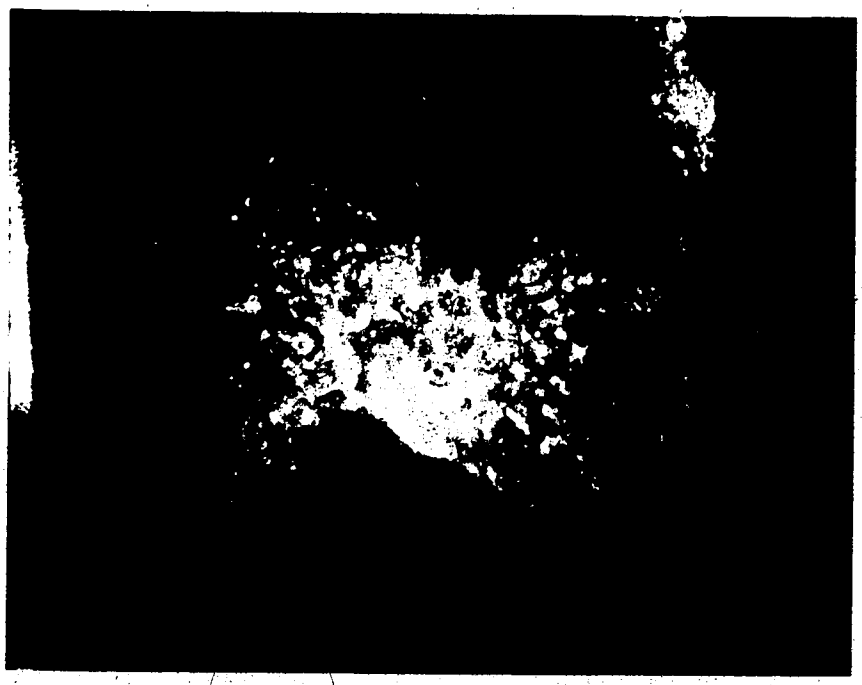


Figure 22c.

A good example of the pale perinuclear inclusions that are seen in 39°C syncytia at 42 h pi. Also the nuclear staining is quite strong and small fluorescing dots appear to be forming in the nuclei (arrow).

Figure 23.

Immunofluorescent staining of Halle UP-1 cells with H monoclonal antibody (C1-15)

Figure 23a.

The brightly stained type of syncytia seen at 32°C and 51 h pi characterized by flecks, fibrous material and fibrous clusters.

Figure 23b.

A syncytia at 39°C and 27 h pi illustrating very pale flecking.

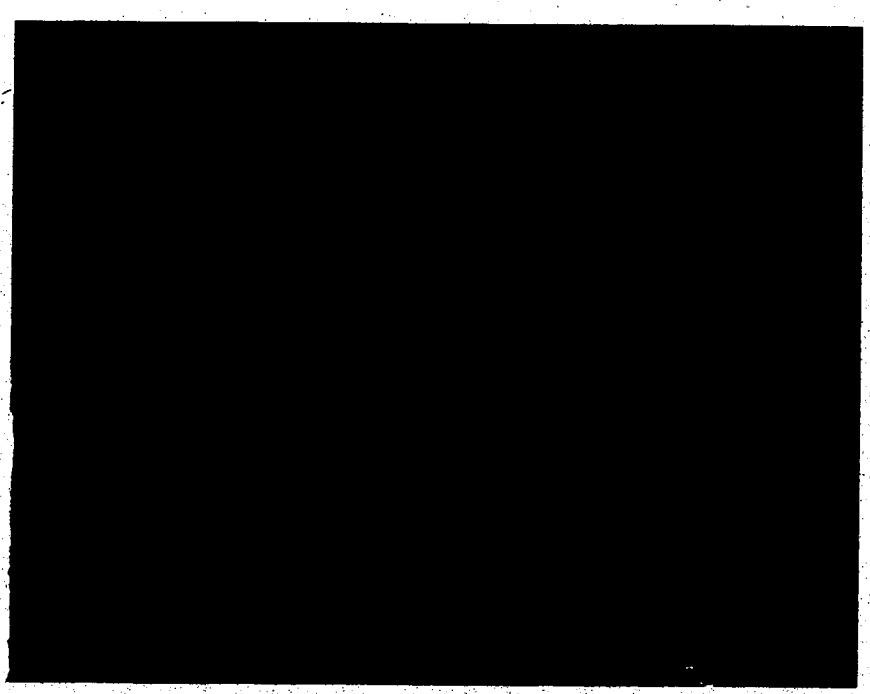


Figure 24.

Immunofluorescent staining of Halle UP-1 cells with F monoclonal antibody (19BG4)

Figure 24a.

A typical, brightly stained syncytia at 32°C and 51 h pi showing flecks, fibrous material and fibrous clusters.

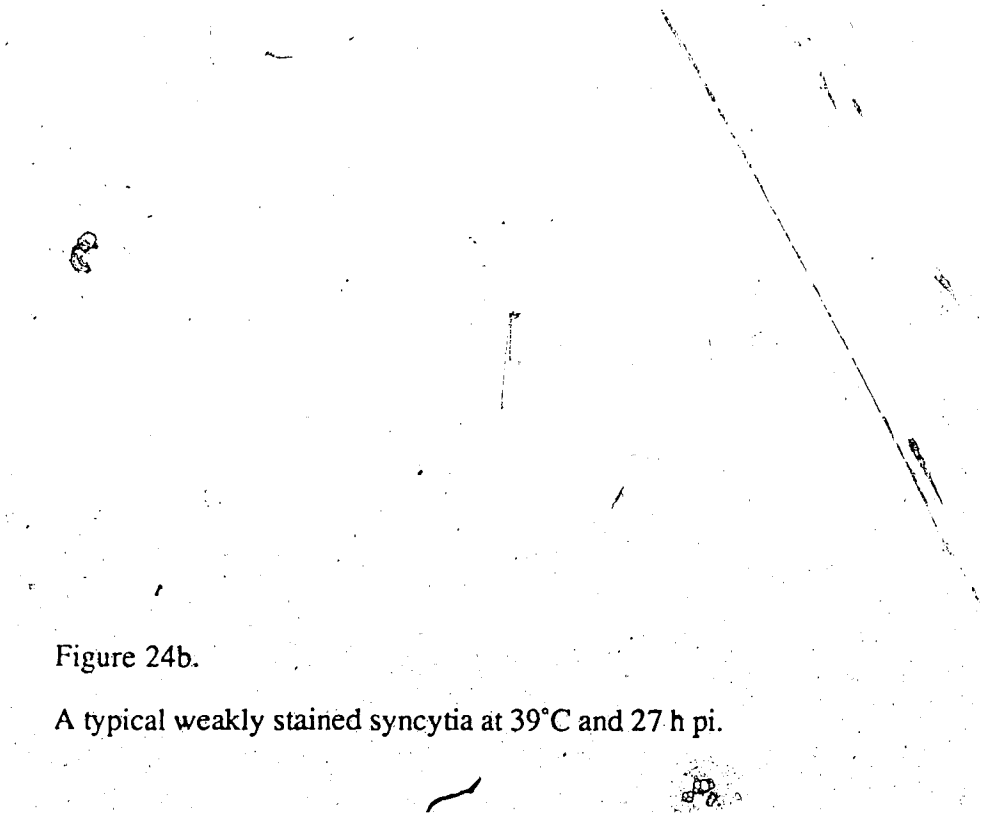
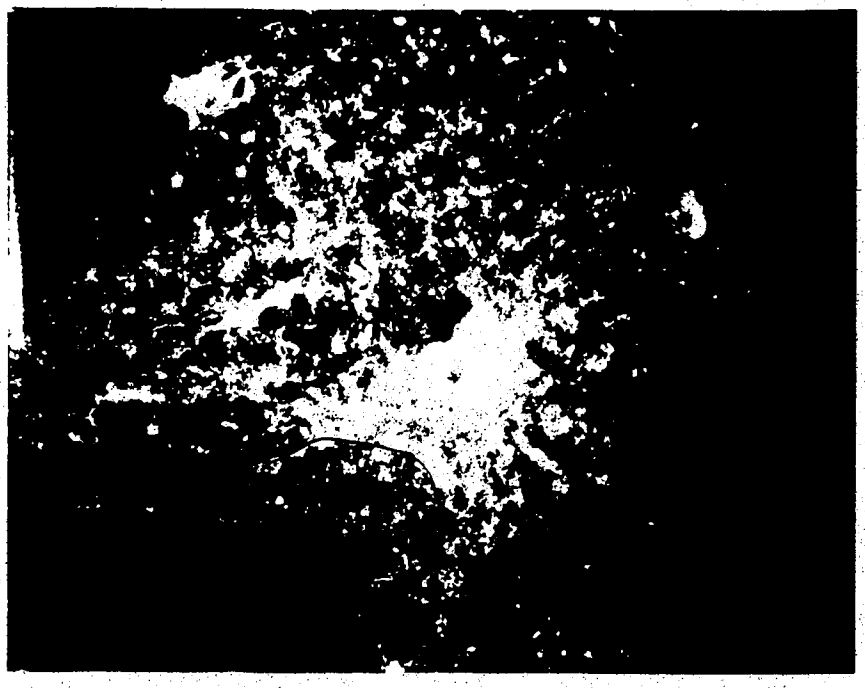


Figure 24b.

A typical weakly stained syncytia at 39°C and 27 h pi.



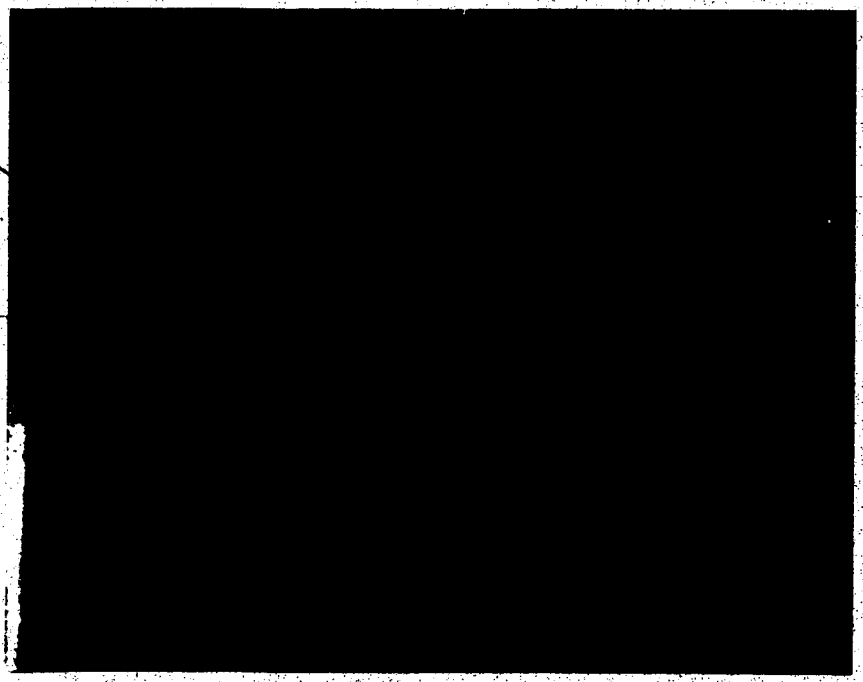


Figure 25.

Electron micrographs of Halle UP-1 cells

Figure 25a.

A section through a syncytia at 3 d pi and 39°C illustrating an inclusion body of tightly-packed NC tubules. Such an inclusion would probably correspond to the bright cytoplasmic dots or globules seen with immunofluorescence. Magnification 21,000 X

Figure 25b.

An infected cell 3 d pi in the UP-1(39) culture.
The infection process has advanced in this cell to the point where the entire cytoplasm is filled by nucleocapsid material.
Magnification 32,500 X

Figure 25c.

This micrograph of a UP-1(39) infected cell at 3 d pi illustrates three simple NB (sNB) in close proximity to one another and the beginning of nucleolar destruction (nd).
Magnification 41,500 X

Figure 26.

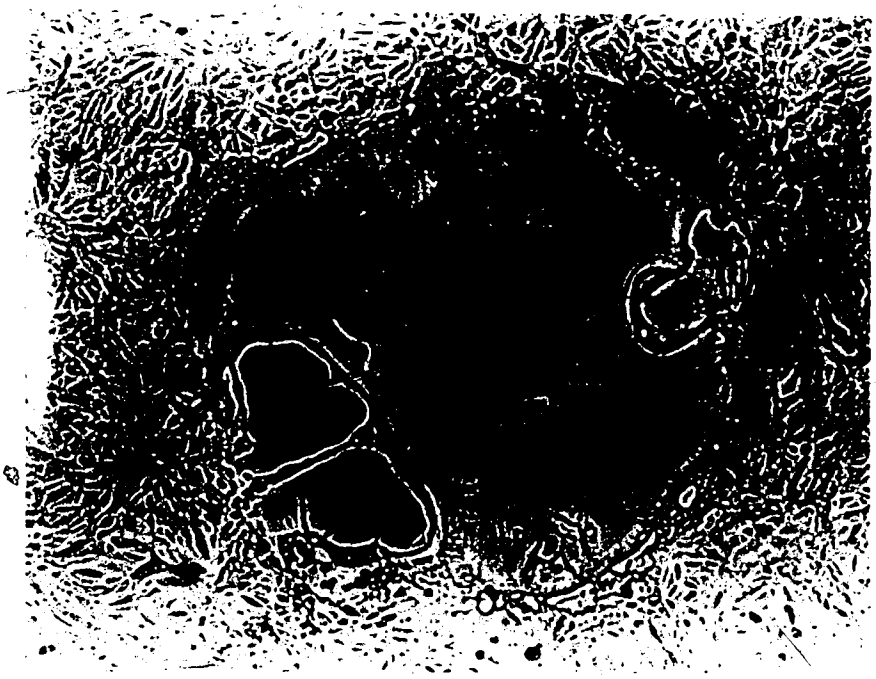
CPE and HAD observations on Halle UP-2 cells

Figure 26a.

An active syncytia seen 3 d pi at 39°C.
Magnification 80 X

Figure 26b.

Positive HAD on a syncytia at 39°C.



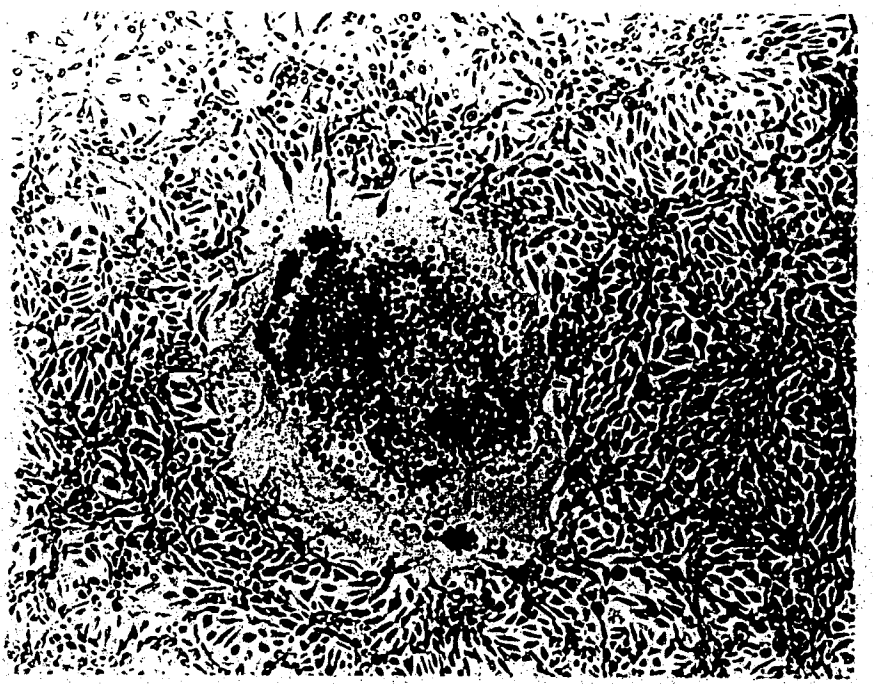
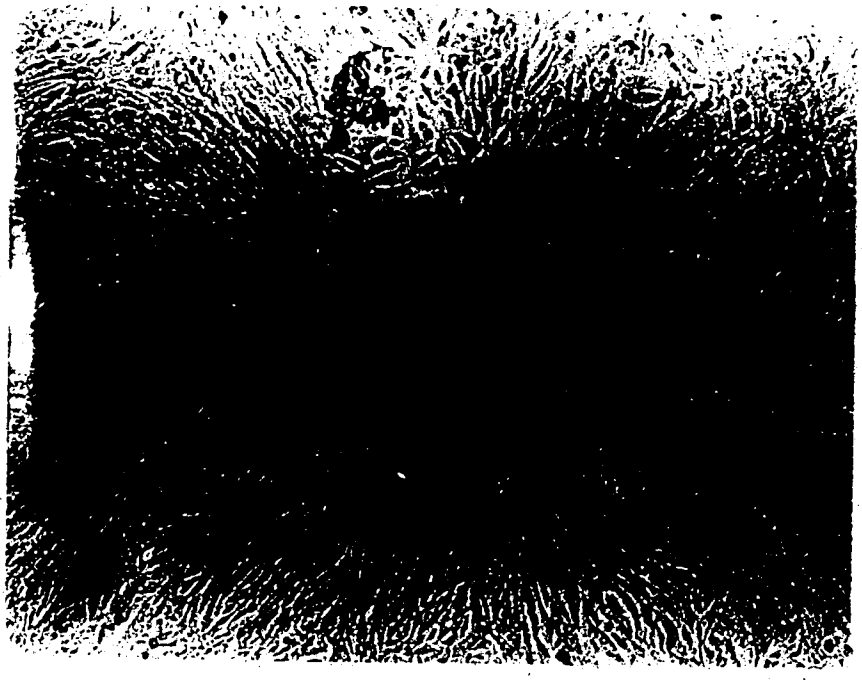


Figure 26c.

A healing syncytial hole observed 5 d pi at 39°C.

Figure 26d.

Weak HAD observed on a syncytial hole at 39°C.



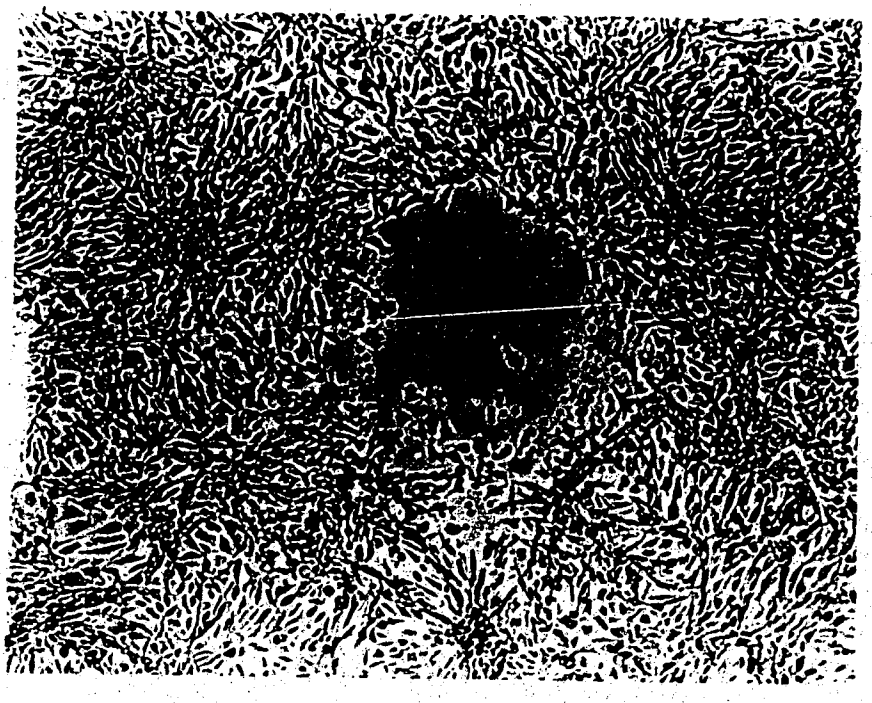
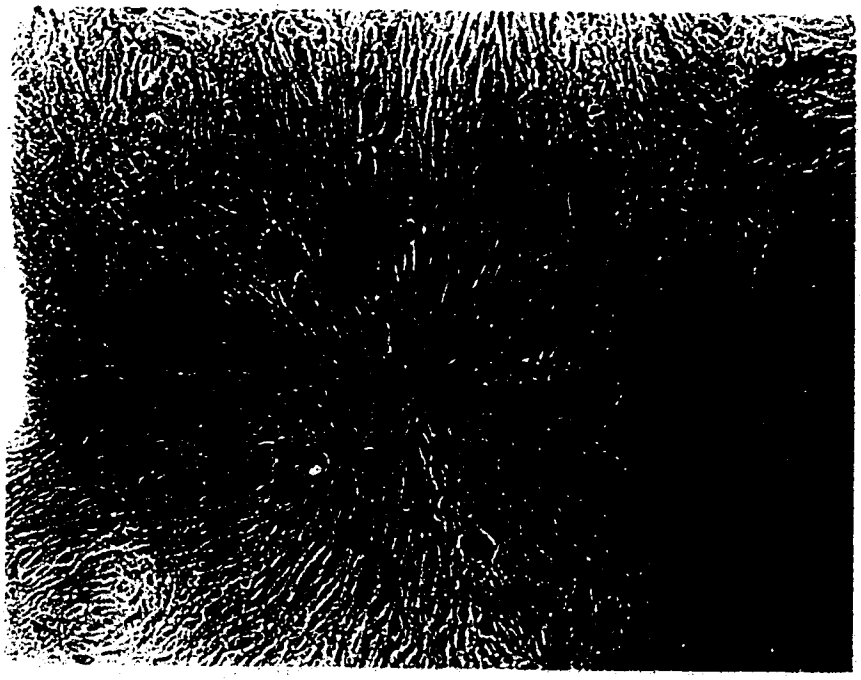


Figure 26e.

A completely healed hole seen 7 d pi at 39°C.

Figure 26f.

A healed plaque showing negative HAD.



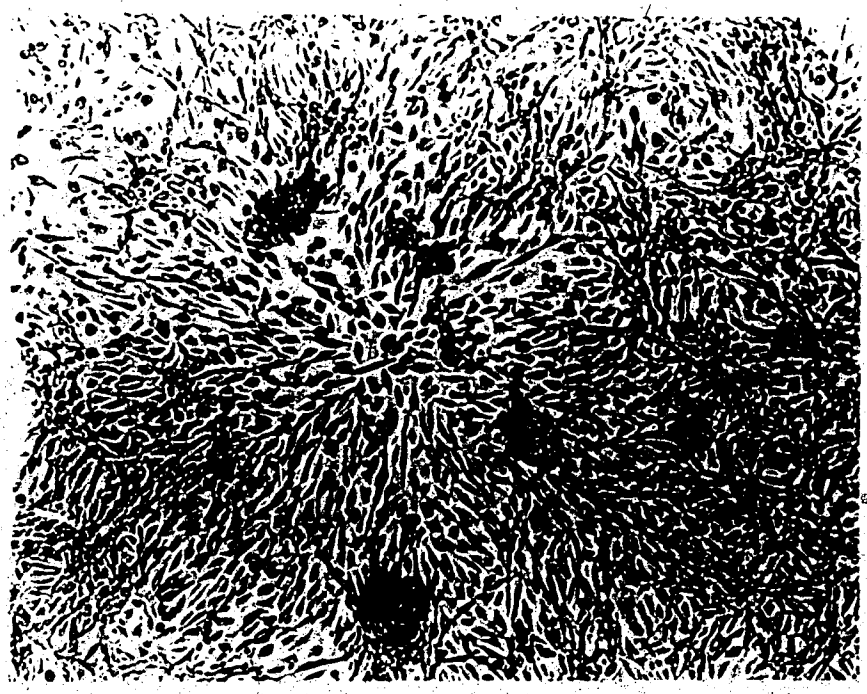


Figure 27.

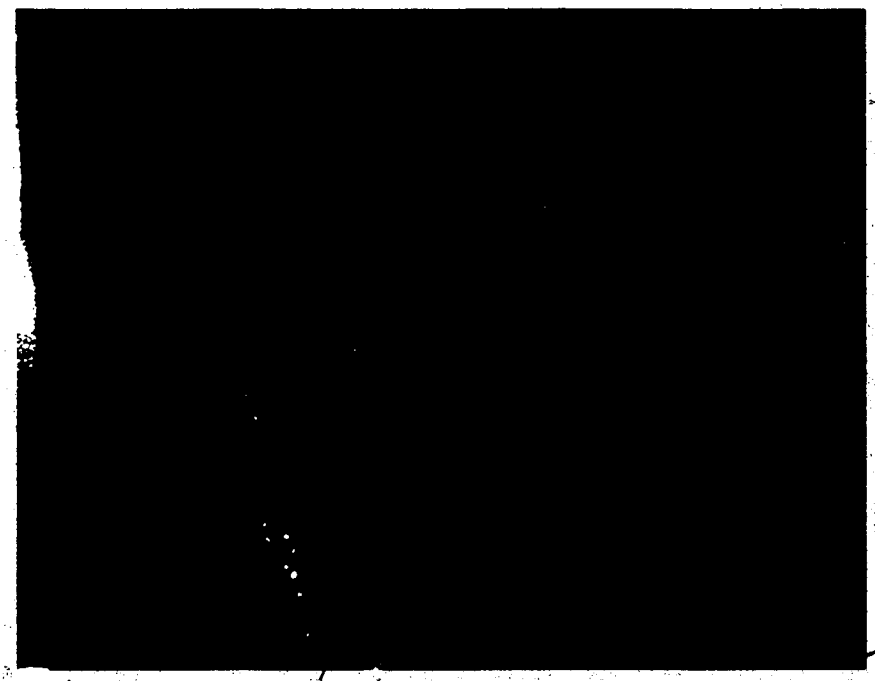
Immunofluorescent staining of Halle UP-2 cells with P monoclonal antibody (16AF10). P protein staining of a 39°C culture illustrating the fine homogeneous cytoplasmic staining and the few dots/globules.

Figure 28.

Immunofluorescent staining of Halle UP-2 cells with NP monoclonal antibody (16AC5)

Figure 28a.

NP staining at 39°C illustrating an extreme example of the lack of bright dot or globule inclusions.



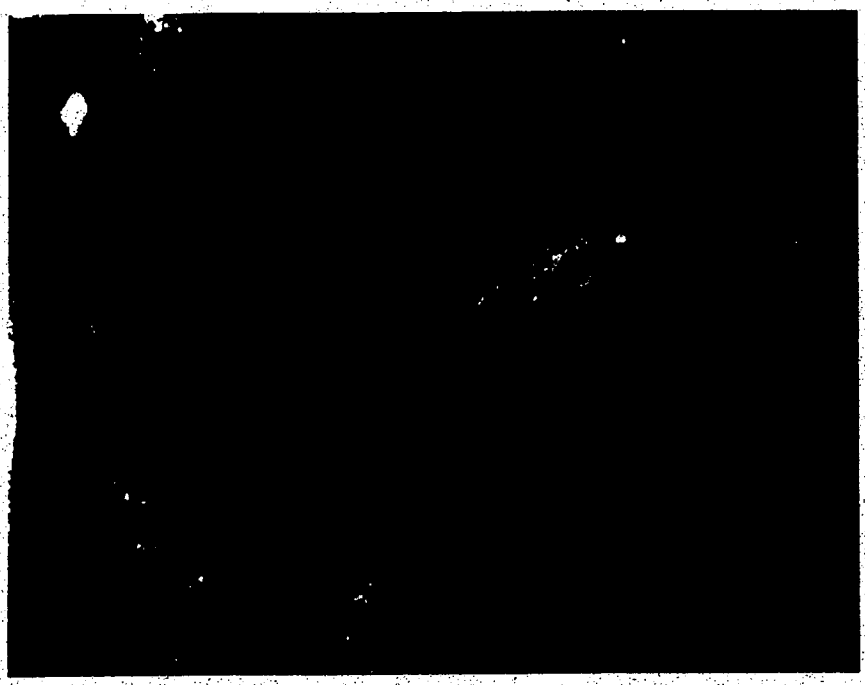


Figure 28b.

NP staining at 32°C showing both the intensely-stained type of syncytia and the weakly-stained type of syncytia.

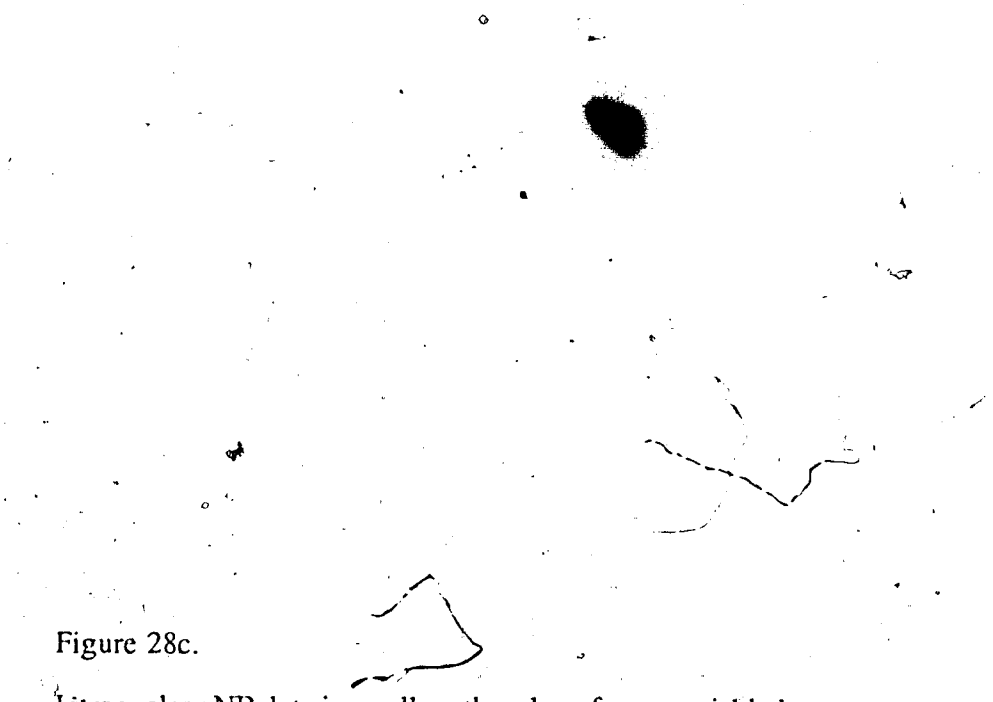


Figure 28c.

Intranuclear NP dots in a cell on the edge of a syncytial hole.

Figure 29.

Immunofluorescent staining of the UP-2(39) healing holes

Figure 29a.

The edge of a healing hole nonstained by the P monoclonal antibody.

Figure 29b.

The edge of a healing hole nonstained by the M monoclonal antibody.

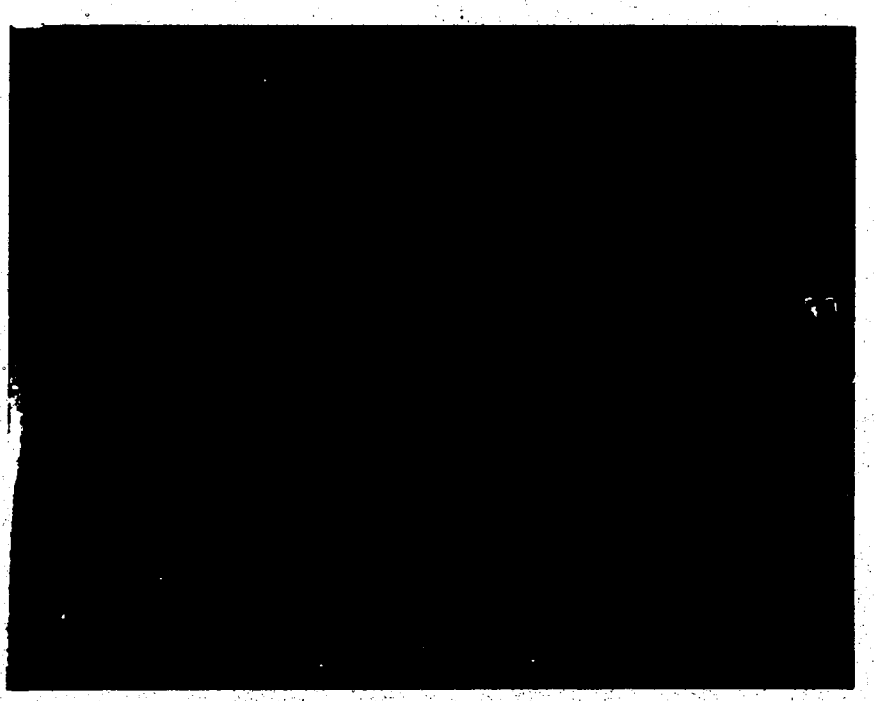


Figure 30.

Immunofluorescent staining of Halle UP-2 passages by M monoclonal antibody

Figure 30a.

Intense cytoplasmic staining and distinct nuclear dots seen in the p147 culture at 39°C.

Figure 30b.

Bright nuclear dots seen in the p147 culture at 39°C.

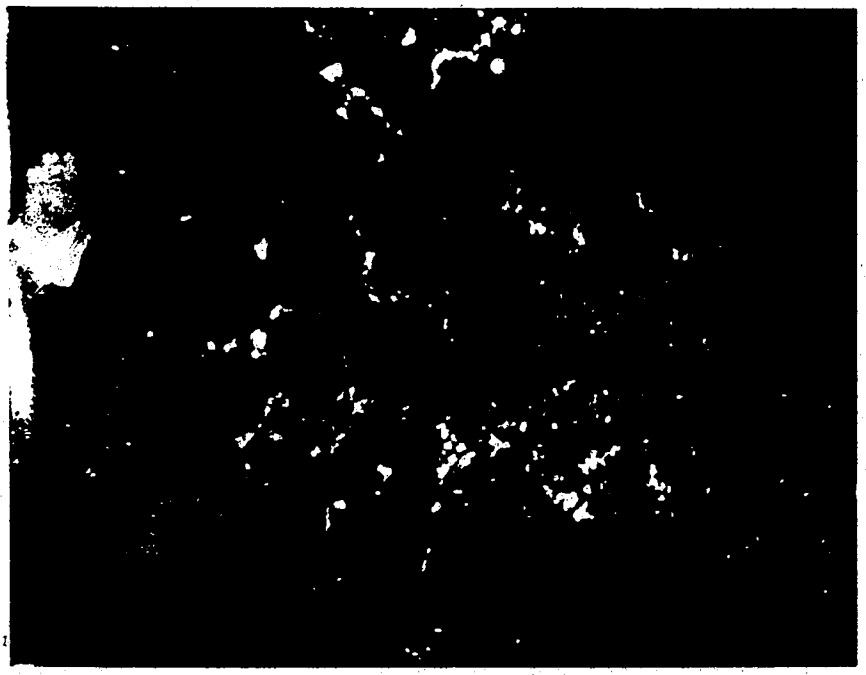
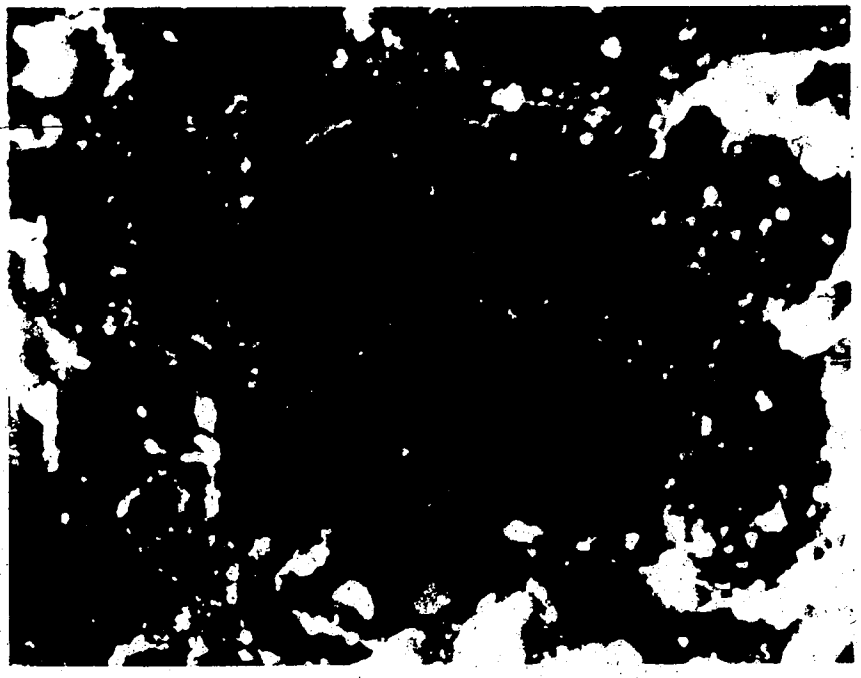


Figure 30c.

Bright cytoplasmic staining and nuclear dots of M protein seen in the p147 culture at 32°C.

Figure 30d.

A homogeneous, 8n type of syncytia seen in the p177 culture at 32°C. The diffuse nuclear staining is clearly seen.



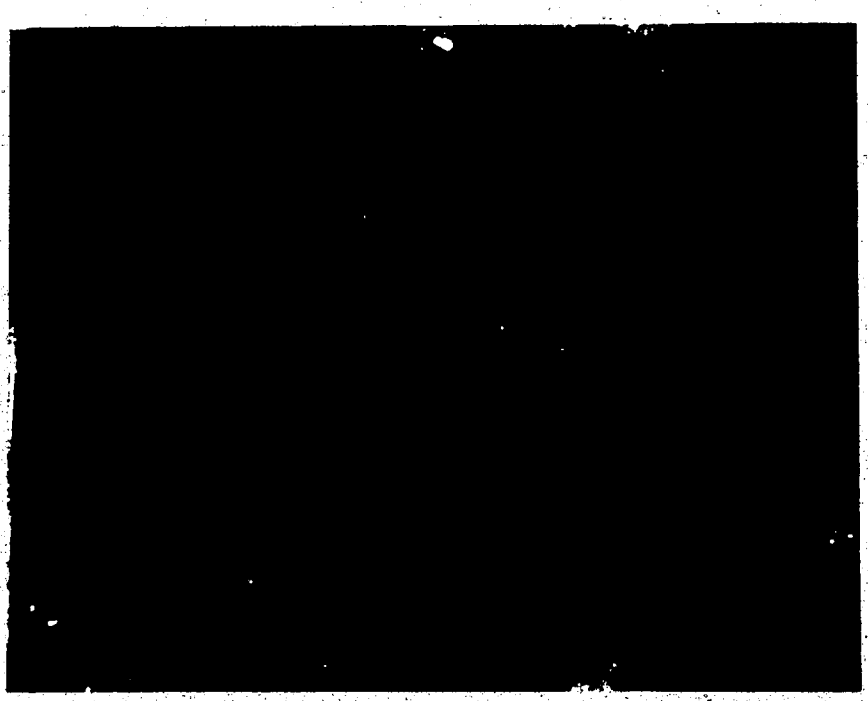


Figure 31.

Electron micrographs of Halle UP-2 cells

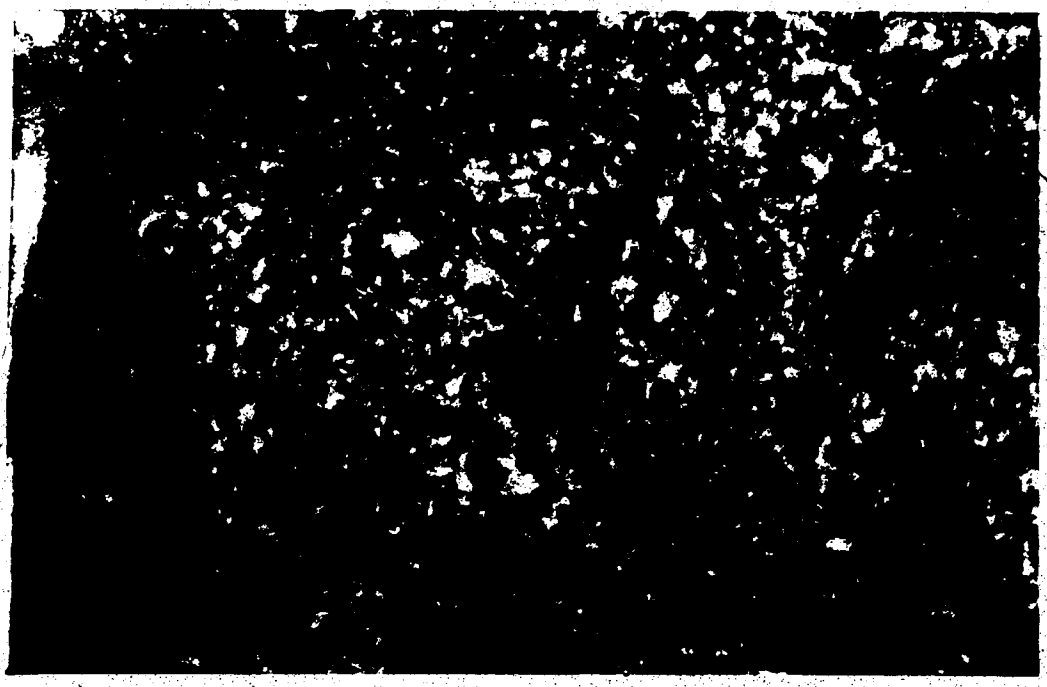
Figure 31a.

A beaded NB observed in the p147 UP-2(39) culture .
Magnification 55,500 X

Figure 31b.

A p147 UP-2(39) cell showing extensive nucleolar destruction (nd) and a complex NB (cNB).
Magnification 32,500 X

A higher magnification of this complex NB showing the fibrillar envelope and tubular (arrow) structures inside.
Magnification 81,000 X



6. Bibliography

ALKNATIB, G. and BRIEDIS, D. J. (1986). The predicted primary struture of the measles virus hemagglutinin. *Virology* 150, 000-000.

BACZKO, K., BILLETER, M., and ter MEULEN, V. (1983). Purification and molecular weight determination of measles virus genomic RNA. *J. Gen. Virol.* 64, 1409-1413.

BELLINI, W.J., ENGLUND, G., ROZENBLATT, S., ARNHEITER, H. and RICHARDSON, C.D. (1985). Measles virus P gene codes for two proteins. *J. Virol.* 53, 908-919.

BIRRER, M.J., BLOOM, B.R. and UDEM, S. (1981). Characterization of measles polypeptides by monoclonal antibodies. *Virology* 108,381-390.

BOUTEILLE, M., FONTAINE, C., VEDRENNE, C. and DELARUE, J. (1965). Sur un cas d'encephalite subclinique a inclusions. Etude anatomoclinique et ultrastructurale. *Rev. Neurol.* 113, 454-458.

BOUTEILLE, M., KALIFAT, S.R. and DELARUE, J. (1967). Ultrastructural variations of nuclear bodies in human diseases. *J. Ultrastruct. Res.* 19, 474-486.

BURNSTEIN, T., JACOBSEN, L.B., ZEMAN, W. and CHEN, T.T. (1974). Persistent infection of BSC-1 cells by defective measles virus derived from subacute sclerosing panencephalitis. *Infect. Immun.* 10, 1378-1382.

BYINGTON, D.P. and JOHNSON, K.P. (1972). Experimental subacute sclerosing panencephalitis in the hamster: Correlation of age with chronic inclusion-cell encephalitis. *J. Infect. Dis.* 126, 18-26.

CARLSEN, S.R., PELUSO, R.W. and MOYER, S.A. (1985). In vitro replication of Sendai virus wild-type and defective interfering particle genome RNAs. *J. Virol.* 54, 493-500.

CARTER, M.J., WILLCOCKS, M.M., LOFFLER, S. and ter MEULEN, V. (1982). Relationship between monoclonal antibody binding sites on the measles virus hemagglutinin. *J. Gen. Virol.* 63, 113-120.

CARTER, M.J., WILLCOCKS, M.M. and ter MEULEN, V. (1983). Defective translation of measles virus matrix protein in a subacute sclerosing panencephalitis cell line. *Nature* 305, 153-155.

CAVE, D.R., HENDRICKSON, F.M. and HUANG, A.S. (1985). Defective interfering virus

particles modulate virulence. *J. Virol.* 55, 366-373.

CENTERS FOR DISEASE CONTROL (1983). *Morbidity and Mortality Weekly Report* 31, No. 52.

CHOPPIN, P.W., RICHARDSON, C.D., MERZ, D.C., HALL, W.W. and SCHEID, A. (1981). The functions and inhibition of the membrane glycoproteins of paramyxoviruses and myxoviruses and the role of the measles virus M protein in subacute sclerosing panencephalitis. *J. Infect. Dis.* 143, 352-363.

COLLINS, P.L. and HIGHTOWER, L.E. (1982). Newcastle disease virus stimulates the cellular accumulation of stress (heat shock) mRNAs and proteins. *J. Virol.* 44, 703-707.

COLLINS, P.L., WERTZ, G.W., BALL, L.A. and HIGHTOWER, L. E. (1982). Coding assignments of the five smaller mRNAs of Newcastle disease virus. *J. Virol.* 43, 1024-1031.

CONNOLLY, J.H., ALLEN, I.V., HURWITZ, L.J. and MILLER, J.H.D. (1967). Measles virus antibody and antigen in subacute sclerosing panencephalitis. *Lancet* 1, 542-544.

COWDRY, E.V. (1934). The problem of intranuclear inclusions in virus diseases. *Arch. Path.* 18, 527-542.

CREMER, N.E., OSHIRO, L.S. and HAGENS, S.J. (1979). Cyclic expression of antigen and infectious virus in a BHK cell line (0-853) persistently infected with an SSPE strain of measles virus. *J. Gen. Virol.* 42, 637-640.

DAWSON, J.R. (1933). Cellular inclusions in cerebral lesions of lethargic encephalitis. *Am. J. Pathol.* 9, 7-16.

DE THÉ, G., RIVIERE, M. and BERNHARD, W. (1960) Examen au microscope électronique de la tumeur VX_2 du lapin domestique dérivée du papillome de Shope. *Bull. Assoc. Fr. Etude Cancer* 47, 570-584.

DOI, Y., SAMPE, T., NAKAJIMA, M., OKAWA, S., KATOG, T., ITOH, H., SATO, T., OGUCHI, K., KUMANISHI, T. and TSUBAKI, T. (1972). Properties of a cytopathic agent isolated from a patient with subacute sclerosing panencephalitis in Japan. *Jap. J. Med. Sci. Biol.* 25, 321-333.

DUBOIS-DALCQ, M., COBLENTZ, J.M. and PLEET, A.B. (1974). Subacute sclerosing panencephalitis. Unusual nuclear inclusions and lengthy clinical course. *Arch. Neurol.* 31, 355-363.

DUBOIS-DALCQ, M., HOLMES, K.V. and RENTIER, B. (1984). Assembly of Paramyxoviridae. In "Assembly of Enveloped RNA Viruses" (D.W. Kingsbury, ed.) pp. 44-65. Springer-Verlag, New York.

DUBOIS-DALCQ, M., HORTA-BARBOSA, L., HAMILTON, R. and SEVER, J.L. (1974). Comparison between productive and latent SSPE viral infection in vitro. *Lab. Invest.* 30, 241-250.

DUPUY-COIN, A.M. and BOUTEILLE, M. (1972). Developmental pathway of granular and beaded nuclear bodies from nucleoli. *J. Ultrastruct. Res.* 40, 55-67.

DUPUY-COIN, A.M., KALIFAT, S.R. and BOUTEILLE, M. (1972). Nuclear bodies as proteinaceous structures containing ribonucleoproteins. *J. Ultrastruct. Res.* 38, 174-187.

ENDERS, J.F., KATZ, S., MILOVANOVIC, M.C. and HALLOWAY, A. (1960). Studies on an attenuated measles virus vaccine I. Development and preparation of the vaccine: Techniques for assay of effects of vaccination. *N. Engl. J. Med.* 263, 153-169.

ENDERS, J.F. and PEEBLES, T.C. (1954). Propagation in tissue cultures of cytopathogenic agents from patients with measles. *Proc. Soc. Exp. Biol. Med.* 86, 277-286.

FOLLETT, E.A.C., PRINGLE, C.R., PENNINGTON, T.H. and SHIRODARIA, P. (1976). Events following the infection of enucleate cells with measles virus. *J. Gen. Virol.* 32, 163-175.

FOURNIER, J.G., PRIVAT, A. and BOUTEILLE, M. (1981). Structural changes in the cell nucleus during measles virus infection in cerebellar explants. *J. Ultrastruct. Res.* 77, 319-328.

GIRAUDON, P., GERALD, CH. and WILD, T.F. (1984). A study of measles virus antigens in acutely and persistently infected cells using monoclonal antibodies: Differences in the accumulation of certain viral proteins. *Intervirology* 21, 110-120.

GIRAUDON, P. and WILD, T.F. (1981). Monoclonal antibodies against measles virus. *J. Gen. Virol.* 54, 325-332.

GOULD, E.A., COSBY, S.L. and SHIRODARIA, P.V. (1976). Salt-dependent haemagglutinating measles virus in SSPE. *J. Gen. Virol.* 33, 139-142.

GOULD, E.A. and LINTON, P.E. (1975). The production of a temperature-sensitive persistent measles virus infection. *J. Gen. Virol.* 28, 21-28.

GRAVES, M.C. (1981). Measles virus polypeptides in infected cells studied by immune

precipitation and one dimensional peptide mapping. *J. Virol.* 38, 224-230.

HAASE, A.T., GANTZ, D., EBLE, B., WALKER, D., STOWRING, L., VENTURA, P., BLUM, H., WIETGREFE, S., ZUPANCIC, M., TOURTELLOTTE, W., GIBBS, C.J., NORRBY, E. and ROZENBLATT, S. (1985). Natural history of restricted synthesis and expression of measles virus genes in subacute sclerosing panencephalitis. *Proc. Natl. Acad. Sci. U.S.A.* 82, 3020-3024.

HALL, W.W. and CHOPPIN, P.W. (1979). Evidence for lack of synthesis of the M polypeptide of measles virus in brain cells in subacute sclerosing panencephalitis. *Virology* 99, 443-447.

HALL, W.W. and CHOPPIN, P.W. (1981). Measles virus proteins in the brain tissue of patients with subacute sclerosing panencephalitis. Absence of the M protein. *N. Engl. J. Med.* 304, 1152-1155.

HALL, W.W., LAMB, R.A. and CHOPPIN, P.W. (1979). Measles and SSPE virus protein: Lack of antibodies to the M protein in patients with subacute sclerosing panencephalitis. *Proc. Natl. Acad. Sci. U.S.A.* 76, 2047-2051.

HALL, W.W., LAMB, R.A. and CHOPPIN, P.W. (1980). The polypeptides of canine distemper virus. Synthesis in infected cells and relatedness to the polypeptides of other morbilliviruses. *Virology* 100, 433-449.

HALL, W.W. and MARTIN, S.J. (1973). Purification and characterization of measles virus. *J. Gen. Virol.* 19, 175-188.

HALL, W.W., MARTIN, S.J. and GOULD, E. (1974). Defective interfering particles produced during the replication of measles virus. *Med. Microbiol. Immunol.* 160, 155-164.

HAMILTON, R., BARBOSA, L. and DUBOIS, M. (1973). Subacute sclerosing panencephalitis measles virus: Study of biological markers. *J. Virol.* 12, 632-642.

HASPEL, M.V., KNIGHT, P.R., DUFF, R.G. and RAPP, F. (1973). Activation of a latent measles virus infection in hamster cells. *J. Virol.* 12, 690-695.

HINGLAIS-GUILLAUD, N., MORICARD, R. and BERNHARD, W. (1961). Ultrastructure des cancers pavimenteux invasifs du col utérin chez la femme. *Bull. Assoc. Fr. Etude Cancer* 48, 283-316.

HORTA-BARBOSA, L., FUCCILLO, D.A., SEVER, J.L. and ZEMAN, W. (1969). Subacute sclerosing panencephalitis: Isolation of measles virus from a brain biopsy. *Nature* 221, 974.

HORTA-BARBOSA, L., HAMILTON, R., WITTIG, B., FUCCILLO, D.A., SEVER, J.L. and VERNON, M.L. (1971). Subacute sclerosing panencephalitis: Isolation of suppressed measles virus from lymph node biopsies. *Science* 173, 840-841.

HSU,C.-H., RE, G.G., GUPTA, K.C., PORTNER, A. and KINGSBURY, D.W. (1985). Expression of Sendai virus defective-interfering genomes with internal deletions. *Virology* 146, 38-49.

HUANG, A.S. (1973). Defective interfering viruses. *Ann. Rev. Microbiol.* 27, 101-117.

HUANG, A.S. and BALTIMORE, D. (1970). Defective viral particles and viral disease processes. *Nature* 226, 325-327.

JENIS, E.H., KNIESER, M.R., ROTHOUSE, P.A., JENSEN, G.E. and SCOTT, R.M. (1973). Subacute sclerosing panencephalitis: Immunoultrastructural localization of measles-virus antigen. *Arch. Pathol.* 95, 81-89.

JOHNSON, K.P., NORRBY, E., SWOVELAND, P. and CARRIGAN, D.R. (1981). Experimental subacute sclerosing panencephalitis: Selective disappearance of measles virus matrix protein from the central nervous system. *J. Infect. Dis.* 144, 161-169.

JOHNSON, K.P., NORRBY, E., SWOVELAND, P. and CARRIGAN, D.R. (1982). Expression of five viral antigens in cells infected with wild-type and SSPE strains of measles virus: Correlation with cytopathic effects and productivity of infections. *Arch. Virol.* 73, 255-262.

JOHNSON, R.T. (1970). Subacute sclerosing panencephalitis. *J. Infect. Dis.* 121, 227-230.

KALLMAN, F., ADAMS, J.M., WILLIAMS, R.C. and IMAGAWA, D.T. (1959). Fine structure of cellular inclusions in measles virus infections. *J. Biophysic. Biochem. Cytol.* 6, 379-382.

KANDA, T. and SHIBUTA, H. (1982). Restricted viral RNA synthesis in establishment of persistent infection in Vero cells with a Sendai virus mutant. *Microbiol. Immunol.* 26, 1045-1055.

KANG, C.Y., SCHUBERT, M. and LAZZARINI, R.A. (1985). Frequent generation of new 3'- defective interfering particles of vesicular stomatitis virus. *Virology* 143, 630-635.

KILEY, M.P., GRAY, H. and PAYNE, F.E. (1974). Replication of measles virus: Distinct species of short nucleocapsids in cytoplasmic extracts of infected cells. *J. Virol.* 13, 721-728.

KNIGHT, P., DUFF, R., GLASER, R. and RAPP, F. (1974). Characteristics of the release

of measles virus from latently infected cells after cocultivation with BSC-1 cells. *Interviology* 2, 287-298.

KÖHLER, G. and MILSTEIN, C. (1975). Continous cultures of fused cells secreting antibody of predefined specificity. *Nature* 256, 495-497.

LIN, F.H. and THORMAR, H. (1980). Absence of M protein in a cell-associated subacute sclerosing panencephalitis virus. *Nature* 285,490-492.

MacDONALD, R.D. (1978). Ringed plague formation in infectious pancreatic necrosis virus correlates with defective interfering particle production. *J. Gen. Virol.* 41, 623-628.

MAKINO, S., SASAKI, K., NAKAGAWA, M., SAITO, M., SHINOHARA, Y., GOTOH, F. and OKABE, T. (1977). Isolation and biological characterization of a measles virus-like agent from the brain of an autopsied case of subacute sclerosing panencephalitis. *Microbiol. Immunol.* 21, 193-205.

MARTINEZ, A.J., OHYA, T., JABBOUR, J.T. and DUENAS, D. (1974). SSPE reappraisal of nuclear, cytoplasmic and axonal inclusions. Ultrastructural study of eight cases. *Acta Neuropath.* 28, 1-13.

MARUSYK, R.G. (1984). Measles: A continuing problem or eradication. *Appl. Virol.* 1, 211-219.

MAY, J.D. and MENNA, J.H. (1979). Changes in the virus-host cell relationship in a stable non-virogenic cell line persistently infected with measles virus (BGM/MV). *J. Gen. Virol.* 45, 185-194.

MILLER, C.A. (1980). Intranuclear polypeptides of measles and subacute sclerosing panencephalitis virus-infected cultures. *Virology* 101, 272-276.

MINAGAWA, T., SAKUMA, T., KUWAJIMA, S., YAMAMOTO, T.K. and IIDA, H. (1976). Characterization of measles virus in establishment of persistent infections in human lymphoid cell line. *J. Gen. Virol.* 33, 361-379.

MIRCHAMSY, H., BAHRAMI, S., SHAFYI, A., SHAHRABADY, M.S., KAMALY, M., AHOURAI, P., RAZAVI, J., NAZARI, P., DERAKHSHAW, J., LOTFI, J. and ABASSIOUN, K. (1978). Isolation and characterization of a defective measles virus from brain biopsies of three patients in Iran with subacute sclerosing panencephalitis. *Intervirology* 9, 106-118.

MOUNTCASTLE, W.E. and CHOPPIN, P.W. (1977). A comparison of the polypeptides of four measles virus strains. *Virology* 78, 463-474.

NAKAI, M. and IMAGAWA, D.T. (1969). Electron microscopy of measles virus replication. *J. Virol.* 3, 187-197.

NAKAI, T., SHAND, F.L. and HOWATSON, A.F. (1969). Development of measles virsus in vitro. *Virology* 38, 50-67.

NIVELEAU, A. and WILD, T.F. (1979). In vitro translation of measles virus-induced RNA. *Virology* 96, 295-298.

NORRBY, E., CHEN, S.-N., TOGASHI, T., SHESHBARADARAN, H. and JOHNSON, K.P. (1982). Five measles virus antigens demonstrated by use of mouse hybridoma antibodies in productively infected tissue culture cells. *Arch. Virol.* 71, 1-11.

NORRBY, E., CHIARINI, A. and MARUSYK, H. (1970). Measles virus variants; Intracellular appearance and biological characteristics of virus products. In "The Biology of Large RNA Viruses" (R.D. Barry, B.W.J. Mahy, eds.) pp. 141-152. Academic Press, New York.

NORRBY, E., ENDERS-RUCKLE, G., and ter MEULEN, V. (1975). Differences in the appearance of antibodies to structural components of measles virus after immunization with inactivated and live virus. *J. Infect. Dis.* 132, 262-269.

NORRBY, E., KRISTENSSON, K., BRZOSKO, W.J. and KAPSENBERG; J.G. (1985). Measles virus matrix protein detected by immune fluorescence with monoclonal antibodies in the brain of patients with subacute sclerosing panencephalitis. *J. Virol.* 56, 337-340.

OHARA, Y., TASHINO, M., TAKASE, S. and HOMMA, M. (1985). Detection of antibody to M protein of measles virus in patients with subacute sclerosing panencephalitis: A comparative study on immunoprecipitation. *Microbiol. Immunol.* 29, 709-723.

ORVELL, C. (1980). Structural polypeptides of canine distemper virus. *Arch. Virol.* 66, 193-206.

ORVELL, C. and NORRBY, E. (1974). Further studies on the immunologic relationships among measles, distemper and rinderpest viruses. *J. Immunol.* 113, 1850-1858.

ORVELL, C. and NORRBY, E. (1980). Immunological relationships between homologous structural polypeptides of measles and canine distemper virus. *J. Gen. Virol.* 50, 231-245.

ORVELL, C., SHESHBERADARAN, H. and NORRBY, E. (1985). Preparation and characterization of monoclonal antibodies directed against four structural components of canine distemper virus. *J. Gen. Virol.* 66, 443-456.

OYANAGI, S., ter MEULEN, V., KATZ, M. and KOPROWSKI, H. (1971). Comparison of subacute sclerosing panencephalitis and measles viruses: An electron microscope study. *J. Virol.* 7, 176-187.

OYANAGI, S., TER MEULEN, V., MÜLLER, D., KATZ, M. and KOPROWSKI, H. (1970). Electron microscopic observations in subacute sclerosing panencephalitis brain cell cultures: Their correlation with cytochemical and immunocytological findings. *J. Virol.* 6, 370-379.

PALMA, E.L. and HUANG, A. (1974). Cyclic production of vesicular stomatitis virus caused by defective interfering particles. *J. Infect. Dis.* 129, 402-410.

PAYNE, F.E., BAUBLIS, J.V. and ITABASHI, H.H. (1969). Isolation of measles virus from cell cultures of brain from a patient with subacute sclerosing panencephalitis. *N. Engl. J. Med.* 281, 585-589.

PÉRIER, O., VANDERHAEGEN, J.J. and PELC, S. (1967). Subacute sclerosing leuco-encephalitis: Electron microscopic findings in two cases with inclusion bodies. *Acta Neuropathol.* 8, 362-380.

PELUSO, R.W., LAMB, R.A. and CHOPPIN, P.W. (1978). Infection with paramyxoviruses stimulates synthesis of cellular polypeptides that are also stimulated in cells transformed by Rous sarcoma virus or deprived of glucose. *Proc. Natl. Acad. Sci. USA* 75, 6120-6124.

PFAU, C.J., WELSH, R.M. and TROWBRIDGE, R.S. (1973). Plaque assays and current concepts of regulation in arenavirus infections. In "Lymphocytic Choriomeningitis Virus and Other Arenaviruses" (F. Lehmann-Grube, ed.) Springer-Verlag, Berlin.

PREBLE, O.T. and YOUNGNER, J.S. (1975). Temperature-sensitive viruses and the etiology of chronic and inapparent infections. *J. Infect. Dis.* 131, 467-473.

RAINE, C.S., BYINGTON, D.P. and JOHNSON, K.P. (1974). Experimental subacute sclerosing panencephalitis in the hamster. Ultrastructure of the chronic disease. *Lab. Invest.* 31, 355-368.

RAINE, C.S., FELDMAN, L.A., SHEPPARD, R.D. and BORNSTEIN, M.B. (1969). Ultrastructure of measles virus in cultures of hamster cerebellum. *J. Virol.* 4, 169-181.

RE, G.G., MORGAN, E.M. and KINGSBURY, D.W. (1985). Nucleotide sequences responsible for generation of internally deleted Sendai virus defective interfering genomes. *Virology* 146, 27-37.

RENTIER, B., HOOGHE-PETERS, E.L. and DUBOIS-DALCQ, M. (1978). Electron microscopic study of measles virus infection: Cell fusion and hemadsorption. *J. Virol.*

28, 567-577.

RICHARDSON, C.D., BERKOVICH, A., ROZENBLATT, S. and BELLINI, W.J. (1985). Use of antibodies directed against synthetic peptides for identifying cDNA clones, establishing reading frames, and deducing the gene order of measles virus. *J. Virol.* 54, 186-193.

RIMA, B.K. (1983). The proteins of morbilliviruses. *J. Gen. Virol.* 64, 1205-1219.

RIMA, B.K., DAVIDSON, W.B. and MARTIN, S.J. (1977). The role of defective interfering particles in persistent infection of Vero cells by measles virus. *J. Gen. Virol.* 35, 89-97.

RIMA, B.K., LAPPIN, S.A., ROBERTS, M.W. and MARTIN, S.J. (1981). A study of phosphorylation of the measles membrane protein. *J. Gen. Virol.* 56, 447-450.

RIMA, B.K. and MARTIN, S.J. (1976). Persistent infection of tissue culture cells by RNA viruses. *Med. Microbiol. Immunol.* 162, 89-118.

ROBBINS, S.J. and EAGLE, J.P. (1985). Enhanced intranuclear expression of measles virus following exposure of persistently-infected cells to cyclic AMP. *J. Gen. Virol.* 66, 2065-2070.

ROUX, L. and WALDVOGEL, F.A. (1982). Instability of the viral M protein in BHK-21 cells persistently-infected with Sendai virus. *Cell* 28, 293-302.

RUSTIGIAN, R. (1962). A carrier state in HeLa cells with measles virus (Edmonston strain) apparently associated with non-infectious virus. *Virology* 16, 101-104.

RUSTIGIAN, R. (1966). Persistent infection of cells in cultures by measles virus. I. Development and characteristics of HeLa sublines persistently-infected with complete virus. *J. Bacteriol.* 92, 1792-1804.

SALMI, A.A., NORRBY, E. and PANELIUS, M. (1972). Identification of different measles virus-specific antibodies in the serum and cerebrospinal fluid from patients with subacute sclerosing panencephalitis and multiple sclerosis. *Infect. Immun.* 6, 248-254.

SATO, T.A., FUKUDA, A. and SUGIURA, A. (1985). Characterization of major structural proteins of measles virus with monoclonal antibodies. *J. Gen. Virol.* 66, 1397-1409.

SCHLUEDERBERG, A. and CHAVANICH, S. (1974). The role of the nucleus in measles virus replication. *Med. Microbiol. Immunol.* 160, 85-90.

SCHLUEDERBERG, A. and NAKAMURA, M. (1967). A salt-dependent haemagglutinating particle from measles-infected cells. *Virology* 33, 297-306.

SHAPSHAK, P., TOURTELLOTTE, W.W., NAKAMURA, S., GRAVES, M.C., DARVISH, M., HOFFMAN, D., WALSH, M.J., FAREED, G.C., SCHMID, P., HEINZMANN, C., SIDHU, K., BEDOWS, E., ROZENBLATT, S., BERRY, K. and HAWKINS, S. (1985). Subacute sclerosing panencephalitis: Measles virus matrix protein nucleic acid sequences detected by in situ hybridization. *Neurology* 35, 1605-1609.

SHEPPARD, R.D., RAINE, C.S., BORNSTEIN, M.B. and UDEM, S.A. (1985). Measles virus matrix protein synthesized in a subacute sclerosing panencephalitis cell line. *Science* 228, 1219-1221.

SHEPPARD, R.D., RAINE, C.S., FELDMAN, L.A., BURNSTEIN, T. and BORNSTEIN, M.B. (1975). A cell-associated strain of SSPE virus studied in organotypic CNS cultures. *J. Neuropathol. Exp. Neurol.* 34, 87.

SHESHBERADARAN, H., CHEN, S-N. and NORRBY, E. (1983). Monoclonal antibodies against five structural components of measles virus. I: Characterization of antigenic determinants on nine strains of measles virus. *Virology* 128, 341-353.

SHESHBERADARAN, H. and NORRBY, E. (1984). Three monoclonal antibodies against measles virus F protein cross-react with cellular stress proteins. *J. Virol.* 52, 995-999.

SHIRODARIA, P.V., DERMOTT, E. and GOULD, E.A. (1976). Some characteristics of salt-dependent haemagglutinating measles viruses. *J. Gen. Virol.* 33, 107-115.

STALLCUP, K.C., RAINE, C.S. and FIELDS, B. (1983). Cytochalasin B inhibits the maturation of measles virus. *Virology* 124, 59-74.

STALLCUP, K.C., WECHSLER, S.L. and FIELDS, B.N. (1979). Purification of measles virus and characterization of subviral components. *J. Virol.* 30, 166-176.

STEPHENSON, J.R., SIDDELL, S.G. and ter MEULEN, V. (1981). Persistent and lytic infections with SSPE virus: A comparison of the synthesis of virus-specific polypeptides. *J. Gen. Virol.* 57, 191-197.

TAJIMA, M. and USHIJIMA, T. (1971). The pathogenesis of rinderpest in the lymph nodes of cattle. *Am. J. Pathol.* 62, 221-236.

TELLEZ-NAGEL, I. and HARTER, D.H. (1966). Subacute sclerosing leukoencephalitis: Ultrastructure of intranuclear and intracytoplasmic inclusions. *Science* 154, 899-901.

ter MEULEN, V. and CARTER, M.J. (1984). Measles virus persistency and disease. *Prog.*

Med. Virol. 30, 44-61.

ter MEULEN, V., LÖFFLER, S., CARTER, M.J. and STEPHENSON, J.R. (1981). Antigenic characterization of measles and SSPE virus hemagglutinin by monoclonal antibodies. *J. Gen. Virol.* 57, 357-364.

THORMAR, H., ARNESEN, K. and MEHTA, P.D. (1977). Encephalitis in ferrets caused by a nonproductive strain of measles virus (D.R.) isolated from a patient with subacute sclerosing panencephalitis. *J. Infect. Dis.* 136, 229-238.

TOGASHI, T., ÖRVELL, C., VARTDAL, F. and NORRBY, E. (1981). Production of antibodies against measles virions by use of the mouse hybridoma technique. *Arch. Virol.* 67, 149-157.

TSANG, L. W.-L., CHANG, N. and MARUSYK, R.G. (1981). An interference phenomenon associated with a measles virus SSPE isolate (Halle). *J. Gen. Virol.* 56, 195-198.

TUCKER, J., RAMSINGH, A., LUND, G., SCRABA, D., LEUNG, W.C., and TYRRELL, D.L.T. (1984). Characterization of measles virus RNA. In "Negative Strand Virus" (D.H.L. Bishop, R.W. Compans, eds.) vol. 2, pp. 49-5[illegible]. Academic Press, New York.

TYRRELL, D.L.J. and EHRNST, A. (1979). Transmembrane communication in cells chronically infected with measles virus. *J. Cell Biol.* 81, 396-402.

TYRRELL, D.L.J. and NORRBY, E. (1978). Structural polypeptides of measles virus. *J. Gen. Virol.* 39, 219-229.

TYRRELL, D.L.J., RAFTER, D.J., ÖRVELL, C. and NORRBY, E. (1980). Isolation and immunological characterization of the nucleocapsid and membrane proteins of measles virus. *J. Gen. Virol.* 51, 307-315.

UCHIYAMA, T., TAKEDA, K. and YAMANOUCHI, K. (1985). Replication of measles virus and localization of the viral antigens in long-term infection in organotypic cultures of hamsters dosal-root gang[illegible]. *Jap. J. Exp. Med.* 55, 10[illegible]21.

VAINIONPÄÄ, R., ZIOLA, B. and SALMI, A.A. (1978). Measles virus polypeptides in purified virions and in infected cells. *Acta Pathol. Microbiol. Scand. (B)* 86, 379-385.

VON MAGNUS, P. (1954). Incomplete forms of influenza virus. *Adv. Virus Res.* 2, 59-79.

WATERS, D.J., HERSH, R.T. and BUSSELL, R.H. (1972). Isolation and characterization of measles nucleocapsid from infected cells. *Virology* 48, 278-281.

WECHSLER, S.L. and FIELDS, B.N. (1978). Intracellular synthesis of measles virus-specified polypeptides. *J. Virol.* 25, 285-297.

WECHSLER, S.L. and MEISSNER, H.C. (1982). Measles and SSPE viruses: Similarities and differences. *Prog. Med. Virol.* 28, 65-95.

WECHSLER, S.L., WEINER, H.L. and FIELDS, B.N. (1979). Immune response in subacute sclerosing panencephalitis: Reduced antibody response to the matrix protein of measles virus. *J. Immunol.* 123, 884-889.

WILD, T.F. (1981). Measles virus and chronic infections. *Pathol. Biol.* 29, 429-433.

WILD, T.F. and DUGRE, R. (1978). Establishment and characterization of a subacute sclerosing panencephalitis (measles) virus persistent infection in BGM cells. *J. Gen. Virol.* 39, 113-124.

YOSHIDA, T., NAGAI, Y., YOSHII, S., MAENO, K. and MATSUMOTO, T. (1976). Membrane (M) protein of HVJ (Sendai virus): Its role in virus assembly. *Virology* 71, 143-161.

YOUNG, K.K.Y., HEINEKE, B.E. and WECHSLER, S.L. (1985). M protein instability and lack of H protein processing associated with nonproductive persistent infection of HeLa cells by measles virus. *Virology* 143, 536-545.

7. Appendix

1. Modified Hucker's Crystal Violet

Solution A

crystal violet	2.0 grams
95% ethanol	20.0 mL

Solution B

ammonium oxalate	0.8 grams
distilled water	80.0 mL

Mix A and B, store for 24 h and filter.

2. LX-112 Embedding Resin

Mixture A

LX-112 resin[1]	36.4 grams
NMA[2]	33.6 grams

Mixture B

LX-112 resin	17.3 grams
DDSA[3]	22.7 grams

Mixture A and B are each mixed for 30 min with a magnetic stirrer. Mixture A is added to mixture B and while stirring, 3 mL of DMP-30[4] is gradually added at the level of the stirring bar using a disposable pipette. This mixture is stirred for 30 min, avoiding the incorporation of air bubbles. The resin is stored at -70°C in disposable 10 mL syringes.

[1] Ladd Research Industries Inc., Burlington, Vermont.
[2] Nadic methyl anhydride, Ladd Research Industries.
[3] Dodecenyl succinic anhydride, J. B. EM Services Inc., Pointe-Claire-Dorval, Quebec.
[4] 2, 4, 6 - tri (dimethylaminomethyl) phenol, Fisher Scientific Co..

3. Lead Citrate

lead citrate	0.01 - 0.04 grams
water	10 mL
10 M sodium hydroxide	0.1 mL

Add lead citrate to 10 mL of water in a screw-capped tube, add dropwise the sodium hydroxide and shake the tube vigorously until all the lead citrate is dissolved. Store in 1 mL syringes.

4. 0.1 M Phosphate Buffer, pH 7.2 - 7.4

Solution A

sodium phosphate, dibasic	7.1 grams
water	0.5 L

Solution B

potassium phosphate, monobasic	6.8 grams
water	0.5 L

Seven parts of A mixed with 3 parts of B gives a pH of 7.2 - 7.4.

5. PBS

sodium chloride	8.00 grams
potassium chloride	0.2 grams
monobasic potassium phosphate	0.2 grams
dibasic sodium phosphate	1.14 grams

Dissolve the above in water to a final volume of 1 L.