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(54) Title: PRODUCTION OF VIRUS AND PURIFICATION OF VIRAL ENVELOPE PROTEINS FOR VACCINE USE

(57) Abstract

Immunogenic envelope glycoproteins are produced from enveloped virus, such as of the paramyxoviridae family, particularly PIV-3 and RSV, by culturing the virus in the substantial absence of exogenous serum proteins, isolating the virus from the tissue culture, solubilizing the envelope glycoproteins and isolating the solubilized envelope glycoproteins by chromatography.

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TITLE OF INVENTION

PRODUCTION OF VIRUS AND PURIFICATION OF VIRAL ENVELOPE PROTEINS FOR VACCINE USE

FIELD OF INVENTION

The present invention relates to the preparation and purification of envelope glycoproteins, particularly from the Paramyxoviridae family of human pathogenic viruses. The present invention also relates to the formulation of a mixture of the purified glycoproteins to give an efficacious and safe vaccine for use in infants and young children to protect against the diseases caused by the viruses.

BACKGROUND OF THE INVENTION

Human Parainfluenza type 3 (PIV-3) and Respiratory Syncytial subgroups A and B (RSV-A,B) viruses, which are members of the Paramyxoviridae, have been identified as major pathogens responsible for severe respiratory disease in infants and young children. It has been shown that both formaldehyde-inactivated and live-attenuated vaccines failed to provide adequate protection against these diseases in clinical trials. Currently, safe and effective vaccines for prevention against these viral infections are not available. Thus, the development of efficacious PIV-3 and RSV vaccines is urgently required.

The major immunogenic proteins of RSV and PIV-3 have been identified, thereby providing the scientific rationale for a sub-unit approach to vaccine development. It has been shown that an in vivo protective response is contingent on the induction of neutralizing antibodies against the major viral surface glycoproteins. For PIV-3, these protective immunogens are the HN protein, which has a M.W. of 72 kDa, and possesses both hemagglutinin and neuraminidase activities and the F (fusion) protein, which has a M.W. of 65 kDa, and is responsible for both fusion of the

virus to the host cell membrane and cell-to-cell spread of the virus. Immunogenicity studies in hamsters have shown that antibodies to both HN and F proteins were essential for protection against challenge with PIV-3. In addition, the presence of antibodies to both envelope glycoproteins was reported to correlate with protection in children naturally infected with PIV-3. For RSV, the two immunogenic surface glycoproteins are the 80-90 kDa glycoprotein (G) and the 70 kDa fusion (F) protein. The G and F proteins are thought to be functionally analogous to the PIV-3 HN and F proteins, respectively. In humans, antibodies to both PIV-3 viral surface glycoproteins are necessary for protection against PIV-3 infection, whereas anti-fusion protein antibodies are sufficient to elicit a cross-protective response against RSV infection.

SUMMARY OF INVENTION

In accordance with the present invention, the inventors have found a process for the production and purification of both PIV-3 and RSV viruses as well as a procedure for the purification of viral envelope surface glycoproteins generally. This process results in preparations that are potent PIV-3 immunogens in experimental animals and may be acceptable for use as vaccines in children. This procedure also is directly applicable for the production of virus and the purification of surface glycoproteins from any of the enveloped viruses, such as influenza, in which the major envelope proteins are important in eliciting an immunogenic response. The invention also includes the highly-purified immunogenic glycoproteins.

DESCRIPTION OF INVENTION

In the present invention, enveloped viruses, such as PIV-3 and RSV viruses, are grown in tissue culture on cell substrates that are readily acceptable for use in human vaccine production, such as the human diploid cell

line MRC-5, in a medium virtually free of exogenous serum proteins. Surprisingly, under these conditions the cells continue to produce PIV-3 for more than three weeks, entirely in the absence of exogenously added growth factors. This process enables multiple virus harvests of similar antigenic composition to be obtained from the same group of cells. The absence of exogenous serum proteins greatly facilitates the process of purification.

Viral supernatants are either filtered or spun at low speed to remove cellular debris and concentrated by ultrafiltration, when necessary. The virus then is pelleted by ultracentrifugation. The virus also can be isolated by passage of the ultrafiltration retentate over an affinity matrix, such as Cellufine sulfate. The viral envelope glycoproteins then are solubilized with an appropriate detergent (eg. Triton X-100 or octylglucoside). Insoluble viral nucleocapsids are removed from the solubilized material by centrifugation. We have shown that this step, while useful, need not be performed. The viral surface glycoproteins are purified from the glycoprotein enriched fraction by affinity chromatography. Possible affinity matrixes include lentil-lectin and concanavalin A covalently coupled to cross-linked Sepharose or cellulosic microporous membranes. Contaminating cellular and residual viral matrix proteins are eliminated in the flow-through and high salt washes. Viral surface glycoproteins then are eluted from the column in the presence of an appropriate competing sugar, such as methyl α-D-mannopyranoside, in the presence or absence of salt. Highly purified glycoprotein preparations (as judged by Coomasie blue or silver stained SDS polyacrylamide gels) are obtained using this process. Viral surface glycoproteins also can be purified by immunoaffinity chromatography using glycoprotein-specific monoclonal antibodies.

In accordance with the present process, HN and F from PIV-3 and F and G proteins from RSV were affinity-purified. The PIV-3 HN and F proteins were found to be highly immunogenic when tested in three separate animal models, namely guinea pigs, hamsters and cotton rats. Immunization of animals with varying doses of HN and F elicited a strong anti-glycoprotein antibody response. When administered with the appropriate adjuvants such as Freund's or aluminum phosphate, the minimal immunoprotective dose can be significantly reduced. Thus the final vaccine preparation when formulated with aluminum phosphate as an adjuvant can be used as a readily injectable preparation for human use.

The effectiveness of the invention is not only limited to the preparation of the glycoproteins obtained from PIV-3 and RSV, but is applicable to coat proteins from all paramyxoviridae and other viruses. Our invention also covers the use of similar methods of isolation and the use of adjuvants other than those mentioned.

EXAMPLES

Methods of determining hemagglutination (HA), tissue culture infectious $dose_{50}$ ($TCID_{50}$), hemagglutination inhibition (HAI), neutralization and anti-fusion titres not explicitly described in this disclosure are amply reported in the scientific literature and are well within the scope of those skilled in the art.

EXAMPLE I:

This Example illustrates the production of PIV-3 by a mammalian cell line.

A stock of human PIV-3 virus was used to infect MRC-5 cells grown on microcarrier beads in a Bellco flask. A 35-litre culture of confluent MRC-5 cells grown in medium containing 10% fetal bovine serum was drained and the MRC-5 cells washed 3 times with 15

litres each of medium CMRL 1969 containing 0.14% $NaHCO_3$. The cells were then infected with PIV-3 virus in a final volume of 10 litres of CMRL 1969 containing 0.14% $NaHCO_3$ and the virus allowed to adsorb to the cells for 2 hours at 37°C with stirring. Following adsorption, an additional 25 litres of medium was added to the flask. These conditions reduced the serum proteins by an estimated 5,000 fold resulting in a final concentration of less than 0.002%. The cells were incubated at 37°C for 5 days and the virus supernatant was collected. Approximately 35 litres of medium CMRL 1969 containing 0.2% $NaHCO_3$ was added to the cells and the culture was incubated for an additional 3 days and a second virus harvest obtained. An additional 35 litres of medium was then added and the cells incubated a further 4 days prior to final harvest. Aliquots of all three virus supernatants were assayed for infectivity and HA activity. Infectivity was determined in a standard $TCID_{50}$ assay using VERO cells, while HA activity was determined using guinea pig red blood cells at 37°C. The results, summarized in Table 1 below, clearly demonstrate that MRC-5 cells produce substantial amounts of virus when cultured in the relative absence of exogenous serum proteins and that the same group of MRC-5 cells are capable of providing three virus harvests each containing substantial levels of virus. The process was also successfully scaled up to 150L bioreactors.

EXAMPLE II:

This Example illustrates the preparation of purified PIV-3.

PIV-3 supernatant #2, obtained as detailed above, was processed using techniques readily amenable to large-scale vaccine production. The virus supernatant was first clarified by filtration. Tangential flow filtration with a Sartorius Sartocon Mini unit

incorporating 0.3 m^2 of 0.45 um cellulose acetate membranes was used. Following clarification, virus was concentrated by tangential flow ultrafiltration using a Millipore Pellicon system incorporating 4 ft^2 of 100,000 nominal molecular weight cutoff PTHK membranes. The Pellicon retentate then was filtered through a 0.22 um Millipore Millipak 20 unit, and virus pelleted by ultracentrifugation at 100,000 x g for 1 hour at 4°C. The purified virus was resuspended in buffer. The HA and infectivity results are presented in Table 2 below. Essentially complete recovery of HA activity and substantial recovery of virus infectivity was observed following processing. These results demonstrate the suitability of this process for PIV-3 purification.

EXAMPLE III:

This Example illustrates the purification of PIV-3 HN and F proteins by lentil-lectin or concanavalin A Sepharose-4B affinity chromatography.

Pelleted virus, at a protein concentration of 1.5 mg/mL was treated at room temperature for 1.5 hours with 2% v/v Triton X-100. Alternately, other detergents, such as octylglucoside or a combination of detergents (2% Triton X-100 + 2% w/v octylglucoside), can be used for protein extraction. When necessary, these preparations are subsequently dialyzed against 0.02% Triton X-100. The insoluble nucleocapsid cores then were removed by centrifugation at 15000 x g for 1 hour at 4°C. HN and F proteins were purified from the glycoprotein-enriched supernatant by affinity chromatography on either a lentil-lectin or concanavalin A Sepharose column. The column first was washed with 10 bed volumes of PBS containing 0.02% v/v Triton X-100. Following sample loading, the column was washed with 10 volumes PBS containing 0.02% Triton X-100. This was followed by a high-salt wash consisting of 10 bed volumes of 0.35 M NaCl containing 0.02% v/v Triton X-100

in PBS. The HN and F proteins were eluted with 5 bed volumes of PBS containing 0.02% v/v Triton X-100 and 0.3 M methyl-α-D-mannopyranoside. The eluted surface glycoproteins were analyzed by SDS-PAGE and found to be ≥ 95% pure by Coomasie blue and silver staining of the polyacrylamide gels and scanning densitometry.

EXAMPLE IV:

This Example illustrates the purification of RSV F and G proteins by lentil-lectin or concanavalin A Sepharose-4B.

Pelleted RSV (Long strain), at a protein concentration of approximately 800 ug/mL, was treated at room temperature for 1.5 hours with 2% v/v Triton X-100. Insoluble nucleocapsid cores were removed by centrifugation at 15000 x g for 1 hour at 4°C. F and G proteins were purified from the glycoprotein-enriched supernatant by affinity chromatography on either lentil-lectin or concanavalin A Sepharose column. The procedure used for protein purification was essentially identical to that used for purifying the PIV-3 HN and F proteins, as detailed in Example III.

The eluted surface glycoproteins were analyzed by SDS-PAGE and found to be > 80% pure by silver staining of the polyacrylamide gels.

EXAMPLE V:

This Example illustrates the immunogenicity of the lentil-lectin purified PIV-3 glycoproteins in hamsters.

Four week old female hamsters (specific pathogen-free) were injected intramuscularly with either 1.0, 0.5 or 0.1 ug of lentil-lectin purified HN and F proteins, prepared as described in Example III, administered either alone or in combination with aluminium phosphate or Freund's adjuvants. Immediately after the 4 week bleed, animals were boosted with an equivalent dose of the antigen formulation. Sera samples also were taken 6 and 8 weeks after the primary injection. HAI,

neutralizing and anti-fusion titres were determined (summarized in Table 3 below). Data from the first bleed, (taken 4 weeks after the primary dose) demonstrated that all HN and F formulations tested can elicit a primary immune response. Inclusion of either aluminum phosphate or Freund's adjuvants increased the HAI and neutralizing antibody responses approximately 10 and 30 fold, respectively. Animals responded in a dose-dependent manner to immunization with 1.0, 0.5 or 0.1 ug of adjuvanted antigen. Boosting the animals at 4 weeks with an equivalent dose of the antigen formulation resulted in a substantial increase in the HAI, neutralizing and anti-fusion titres. At the 1 ug dose of antigen, the immunopotentiating effects of both aluminum phosphate and Freund's adjuvants were evident. Thus, the immunogenicity of the lentil-lectin purified HN and F proteins has been clearly demonstrated. Antibody responses in guinea pigs and cotton rats were similar.

EXAMPLE VI:

This Example illustrates the immunogenicity of the concanavalin A purified PIV-3 glycoproteins in hamsters.

Hamsters (specific pathogen-free) were injected with either 1.0, 0.1, 0.05, or 0.01 ug of concanavalin purified HN and F proteins, prepared as described in Example III, in the presence of aluminum phosphate. Animals were immunized according to the schedule outlined in Example IV. Animals immunized with adjuvanted concanavalin A purified proteins (the results are summarized in Table 4 below) responded in a dose-dependent manner to primary injection with 1.0, 0.1, 0.05 or 0.01 ug of antigen. The minimal immunogenic dose of adjuvanted concanavalin A purified proteins was 0.01 ug. These results confirm the immunogenicity of the concanavalin A purified HN and F

proteins.

EXAMPLE VII:

This Example illustrates the ability of the various HN and F formulations to elicit a protective response in immunized hamsters and cotton rats.

Hamsters immunized with either 1.0, 0.5, 0.1, or 0.01 ug of the lentil-lectin purified HN and F preparations, prepared as described in Example III, were challenged with live PIV-3 virus immediately after the 8 week bleed in order to evaluate the ability of the various HN and F formulations to confer protective immunity. Hamsters were sacrificed 3 days after challenge and their lungs removed and homogenized. Virus lung titres are summarized in Table 5 below. Control animals injected with diluted elution buffer supported the replication of 5.0 $\log_{10}$ $TCID_{50}$ units of virus per gram of lung tissue. In the absence of adjuvant, 75% of animals immunized with 1 ug of HN and F proteins had a detectable level of virus in their lungs. When HN and F was administered with either aluminum phosphate or Freund's adjuvant, two 0.1 ug doses of antigen protected all hamsters against live virus challenge. Virus was not detected in the lung homogenates. Similar results were obtained in cotton rats.

Concanavalin A-purified HN and F proteins were also able to elicit a protective response in immunized hamsters. Two 0.01 ug doses of Concanavalin A purified proteins, prepared as described in Example III, (combined with aluminum phosphate) protected 80% of the animals against live virus challenge. These results demonstrate the ability of both the lentil-lectin and concanavalin A-purified HN and F proteins to protect the lower respiratory tract of animals against live virus challenge.

The ability of the affinity-purified HN and F

proteins to protect the upper respiratory tract of immunized animals against live virus challenge was also tested. Virus nasal wash titers are summarized in Table 6 below. The upper respiratory tract of animals immunized with two 1 ug doses of adjuvanted Concanavalin A purified proteins, prepared as described in Example III, was protected against PIV-3 infection. Virus was not detected in nasal washes from this group of animals. This was the only group of animals tested which showed significant protection in the upper respiratory tract following live virus challenge. Thus, concanavalin A-purified HN and F proteins, administered at a dose of 1 ug plus aluminum phosphate, can evoke an immunological response capable of protecting both the upper and lower respiratory tracts of hamsters against live virus challenge.

EXAMPLE VIII:

This Example illustrates that the various HN and F formulations do not cause "enhanced" histopathology in the lungs of immunized cotton rats following PIV-3 challenge.

Cotton rats were immunized with 1.0 or 0.1 ug of the lentil-lectin purified HN and F proteins, prepared as described in Example III, administered either alone or with aluminum phosphate. Animals were challenged intranasally with 100 median infectious doses of PIV-3 immediately after the 8 week bleed. Four days after virus challenge, cotton rats were sacrificed and lung sections were prepared for histopathological analysis. Lung sections from immunized and control animals were stained with hematoxylin and eosin, observed in a blinded fashion and evaluated for histopathology. The observed histopathological changes generally correlated with lung virus titers and varied conversely with HAI and neutralizing antibody levels. Animals immunized with placebo and then challenged with PIV-3 had the most

notable histopathological changes. Sections of lung from these animals exhibited moderate to marked peribronchial and peribronchiolar lymphocytic infiltration interspersed with polymorphonuclear leukocytes and macrophages. Many of the bronchi and bronchioles observed were partially desquamified and the lumen of these passageways often contained a mixture of debris, leukocytes and serous exudate. Scattered microareas of interstitial pneumonitis and perivascular cuffing were occasionally seen. In contrast, pathological changes were minimal in animals immunized with protective doses of antigen. Most importantly, there was no evidence of enhanced pathology in lung sections of any group of immunized animals when examined four days after virus challenge. In no instance was the histopathology greater in immunized, challenged animals than in control animals immunized with placebo then challenged with PIV-3. It can, therefore, be concluded that the affinity-purified HN and F subunit vaccine has no short term immunopathological effects.

TABLE 1

PI-3 Virus Production

SAMPLE	VOLUME (ml)	HA ACTIVITY		$TCID_{50}$ ACTIVITY	
		HAU\ 0.5ml	Total	Titer\ml	Total
Supernatant #1	34,000	32	2.2×10^7	$10^{6.0}$	5.4×10^{10}
Supernatant #2	34,000	32	2.2×10^7	$10^{7.0}$	3.4×10^{11}
Supernatant #3	25,000	16	8.0×10^6	$10^{6.2}$	4.0×10^{10}

TABLE 2

Purification of PI-3 Virus

SAMPLE	HA ACTIVITY		$TCID_{50}$ ACTIVITY	
	TOTAL UNITS	% RECOVERY	TOTAL	% RECOVERY
Supernatant	2.2×10^7	100	3.4×10^{11}	100
Clarified	2.2×10^7	100	2.1×10^{11}	62
Retentate	2.0×10^7	91	3.8×10^{10}	11
Filtered retentate	1.9×10^7	86	7.4×10^{10}	22
33k pellet	2.5×10^7	114	4.8×10^{10}	14

TABLE 3

Serum Antibody Response of Hamsters Immunised with Various Lentil Lectin affinity-purified HN and F Formulations[a]

Antigen Formulation	Dose	HAI[b]			Neutralisation[c]			Anti-Fusion[d]		
		Primary	Secondary		Primary	Secondary		Primary	Secondary	
		4 Week Bleed	6 Week Bleed	8 Week Bleed	4 Week Bleed	6 Week Bleed	8 Week Bleed	4 Week Bleed	6 Week Bleed	8 Week Bleed
Control	-	10	10	10	10	10	10	4	4	4
HN & F alone	1.0	11	80	47	10	37	24	4	4	4
HN & F + $AlPO_4$	1.0	100	640	640	79	645	457	8	16	8
	0.5	50	645	457	56	513	457	4	8	8
	0.1	28	575	575	28	407	407	4	8	4
HN & F + Freund's	1.0	380	1819	1819	380	2570	1513	8	32	8
	0.5	134	2560	1621	1123	2560	2041	4	64	32
	0.1	40	1071	758	28	912	912	4	64	32

a = Each value represents the reciprocal geometric mean titre from 6 animals

b = Serum dilution which inhibits erythrocyte agglutination by 4 hemagglutinating units of PIV-3

c = Serum dilution which blocks hemadsorption of 100 $TCID_{50}$ units of PIV-3

d = Serum dilution which blocks syncytia formation by 100 $TCID_{50}$ units of PIV-3

TABLE 4

Serum Antibody Response of Hamsters Immunised with Various Lentil Lectin affinity purified HN and F Formulations

Antigen Formulation	Dose	HAI[a]			Neutralisation[b]		
		Primary	Secondary		Primary	Secondary	
		4 Week Bleed	6 Week Bleed	8 Week Bleed	4 Week Bleed	6 Week Bleed	8 Week Bleed
HN & F alone	1.0	70	320	160	68	240	320
HN & F + $AlPO_4$	1.0	320	960	960	293	1920	1280
	0.1	50	480	240	55	480	480
	0.05	30	267	200	25	373	200
	0.01	35	256	224	28	288	176

a = Serum dilution which inhibits erythrocyte agglutination by 4 hemagglutination units of Para-3 virus

b = Serum dilution which blocks hemadsorption of 100 $TCID_{50}$ units of Para-3 virus

TABLE 5

Response of Immunized Hamsters to PIV-3 Challenge[a] (Lower Respiratory Tract)

HN & F Formulation	Dose of Antigen (ug)	% Animals With virus (b)	Mean Titre ± SEM $\log_{10}TCID_{50}$
Elution buffer		100	4.9
Lentil Lectin Purified			
HN and F alone	1.0	75	≤4.1
HN and F + Aluminium phosphate	1.0 0.5 0.1	0 0 0	≤1.9 ≤1.9 ≤1.9
HN and F + Freund's	1.0 0.5 0.1	0 0 0	≤1.9 ≤1.9 ≤1.9
Concanavilin A Purified			
HN and F alone	1.0	0	≤1.9
HN and F + Aluminium phosphate	1.0 .1 .01	0 0 20	≤1.9 ≤1.9 1.9

a = Animals were challenged with 10^6 $TCID_{50}$ units of PIV-3 and sacrificed 3 days later.

b = Minimum level of detectability was $10^{1.9}$ $TCID_{50}$/g of lung tissue. Each value represents the mean value of 6 animals.

TABLE 6

Response of Immunized Hamsters to PIV-3 Challenge[a] (Upper Respiratory Tract)

HN & F Formulation	Dose of Antigen (ug)	% Animals With virus (b)	Mean Titre ± SEM $\log_{10}TCID_{50}$
Elution buffer		100	5.0
Lentil Lectin Purified			
HN and F alone	1.0 0.1 0.01	100 100 100	4.0 3.6 3.5
HN and F + Aluminium phosphate	0.1 0.01	100 100	4.2 4.2
HN and F + Freund's	0.1 0.01	100 100	2.4 4.7
Concanavalin A Purified			
HN and F alone	1.0	100	4.0
HN and F + Aluminium phosphate	1.0 .1 .01	0 100 100	≤1.5 2.7 3.9

a = Animals were challenged with 10^6 $TCID_{50}$ units of PIV-3 and sacrificed 3 days later.

b = Minimum level of detectability was $10^{1.9}$ $TCID_{50}$/ml of nasal wash. Each value represents the mean value of 6 animals.

SUMMARY OF DISCLOSURE

In summary of this disclosure, the present invention provides a novel procedure for preparing immunogenic envelope glycoproteins as well as the glycoproteins themselves. Modifications are possible within the scope of this invention.

CLAIMS

What we claim is:

1. A method of isolating an immunogenic glycoprotein, which comprises:

growing an enveloped virus, in which at least one envelope glycoprotein is capable of eliciting an immunogenic response, in a tissue culture on a suitable cell substrate,

isolating the virus from tissue culture,

solubilizing said at least one envelope glycoprotein from said virus, and

isolating said at least one envelope glycoprotein.

2. The method of claim 1 wherein said tissue culture is substantially free from exogenous serum proteins.

3. The method of claim 2 wherein said cell substrate is the human diploid cell line MRC-5.

4. The method of claim 1 wherein said virus is PIV-3.

5. The method of claim 4 wherein said at least one envelope glycoprotein is glycoprotein HN and glycoprotein F, which are separately isolated.

6. The method of claim 1 wherein said virus is RSV.

7. The method of claim 6 wherein said at least one envelope glycoprotein is glycoprotein F and glycoprotein G, which are separately isolated.

8. The method of claim 1, 2, 3, 4, 5, 6 or 7 wherein said at least one viral envelope glycoprotein is isolated by affinity chromatography.

9. The method of claim 1, 2, 3, 4, 5, 6 or 7 wherein said at least one viral envelope glycoprotein is isolated by immunoaffinity chromatography.

10. An immunogenically-active purified viral envelope glycoprotein.

11. The glycoprotein of claim 10 which is glycoprotein HN from PIV-3.

12. The glycoprotein of claim 10 which is glycoprotein F from PIV-3.

13. The glycoprotein of claim 10 which is glycoprotein F from RSV.

14. The glycoprotein of claim 10 which is glycoprotein G from RSV.

15. A method of growing an enveloped virus in which at least one envelope glycoprotein is capable of eliciting an immunogenic response, which comprises:

growing said virus in a tissue culture comprising a diploid cell line substantially free from exogenous serum proteins.

16. the method of claim 15 wherein said diploid cell line is a human diploid cell line.

17. The method of claim 16 wherein said human diploid cell line is MRC-5.

18. The method of claim 15, 16 or 17 wherein said virus is one from the paramyxoviridae family.

19. The method of claim 15, 16 or 17 wherein said virus is PIV-3.

20. The method of claim 15, 16 or 17 wherein said virus is RSV.

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 90/00205

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: A 61 K 39/155

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	A 61 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	J. Gen. Virol., volume 68, 1987, SGM, (GB), R. Ray et al.: "Glycoproteins of human parainfluenza virus type 3: affinity purification, antigenic characterization and reconstitution into lipid vesicles" pages 409-418 see the whole article	1-20
Y	Biological Abstracts, volume 78, 1984, (Philadelphia, PA, US), E.E. Walsh et al.: "Purification and characterization of GP90, one of the envelope glycoproteins of respiratory syncytial virus", see page 5426, abstract 48223, & J. Gen. Virol. 65(4): 761-768, 1984	1-20
Y	Chemical Abstracts, volume 111, no. 5, 31 July 1989, (Columbus, Ohio, US), R.G. Arumugham et al.: "Interprotein disulfide bonding betweeen F and G glycoproteins of human respiratory ./.	1-20

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10th October 1990	31 OCT 1990
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Mme N. KUIPER

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	syncytial virus", see page 235, abstract 35325x, & Arch. Virol. 1989, 105(1-2), 65-79 --	
Y	Chemical Abstracts, volume 107, no. 13, 28 September 1987, (Columbus, Ohio, US), E.E. Walsh et al.: "Immunological differences between the envelope glycoproteins of two strains of human respiratory syncytial virus", see page 485, abstract 113935e, & J. Gen. Virol. 1987, 68(8), 2169-78 ----------	1-20