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Infectious cDNA Clone of the Modified Live Virus Vaccine Strain of *Equine Arteritis* Virus

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Balasuriya et al.

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(54) **INFECTIOUS CDNA CLONE OF THE MODIFIED LIVE VIRUS VACCINE STRAIN OF *EQUINE ARTERITIS* VIRUS**

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C12N 7/00 (2006.01)
C12N 15/63 (2006.01)
C12N 15/85 (2006.01)
(52) **U.S. Cl.** **435/235.1**; 435/320.1; 435/325
(58) **Field of Classification Search** .... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,500,662	B1	12/2002	Calvert et al.
7,232,680	B2	6/2007	Calvert et al.
2003/0157689	A1	8/2003	Calvert et al.
2005/0070700	A1	3/2005	Giese
2007/0003570	A1	1/2007	Murtaugh et al.

OTHER PUBLICATIONS

Balasuriya et al (Journal of General Virology, 2007. vol. 88, pp. 918-924).*

AAT70125 (Sep. 24, 1997 first entry) Equine arteritis virus genome.* http://vir.sgmjournals.org/cgi/content/abstract/80/8/1949 Journal of General Virology (1999), 80, 1949-1958 © 1999 Society for General Microbiology "Genetic stability of equine arteritis virus during horizontal and vertical transmission in an outbreak of equine viral arteritis" Udeni B. R. Balasuriya, Jodi F. Hedges, Steven A. Nadler, William H. McCollum, Peter J. Timoney and N. James MacLachlan. http://www.ncbi.nlm.nih.gov/pubmed/17267078 Vaccine; Jul. 26, 2007;25(30):5577-82. Epub Jan. 16, 2007 "Experiences with new generation vaccines against equine viral arteritis, West Nile disease and African horse sickness." MacLachlan NJ, Balasuriya UB, Davis NL, Collier M, Johnston RE, Ferraro GL, Guthrie AJ.
http://jvi.asm.org/cgi/reprint/70/3/1981.pdf Journal of Virology, Mar. 1996, p. 1981-1989 Copyright 1996, American Society for Microbiology "Deduced consensus sequence of Sindbis virus strain AR339: mutations contained in laboratory strains which affect cell culture and in vivo phenotypes" Kevin L. McKnight, Dennis A. Simpson, Seh-Ching Lin, Travis A. Knott, John M. Polo, David F. Pence, Diana B. Johannsen, Hans W. Heidner, Nancy L. Davis, and Robert E. Johnston.
"Development and evolution of three equine vaccines" Bobby O. Moore Irish Veterinary Journal [IR. VET. J.]. vol. 40, No. 5-6, pp. 105-107. 1986.
Zhang, J. et al.; "Equine arteritis virus strain ARVAC, complete genome"; Gen Bank Accession No. EU586275.1 (Aug. 29, 2008). Balasuriya, U.B., et al.; "Cloning vector pEAVrVBS, complete sequence"; Gen Bank Accession No. DQ846751.1 (Mar. 1, 2007).

* cited by examiner

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(57) **ABSTRACT**

An isolated polynucleotide molecule includes a DNA sequence encoding an infectious RNA molecule encoding a modified live viral strain of an Equine arteritis virus, wherein the DNA sequence is SEQ ID NO:1 or a degenerate variant thereof. Also provided are transformed or transfected host cells including that sequence, vectors including the sequence, and isolated infectious RNA molecules encoded by the sequence. Further, a modified DNA sequence encoding an infectious RNA molecule encoding a modified live viral strain of an Equine arteritis virus is provided wherein the DNA sequence is SEQ ID NO:2 or a degenerate variant thereof, including a silent point mutation allowing distinguishing the modified sequence from the parent and other strains of Equine arteritis virus.
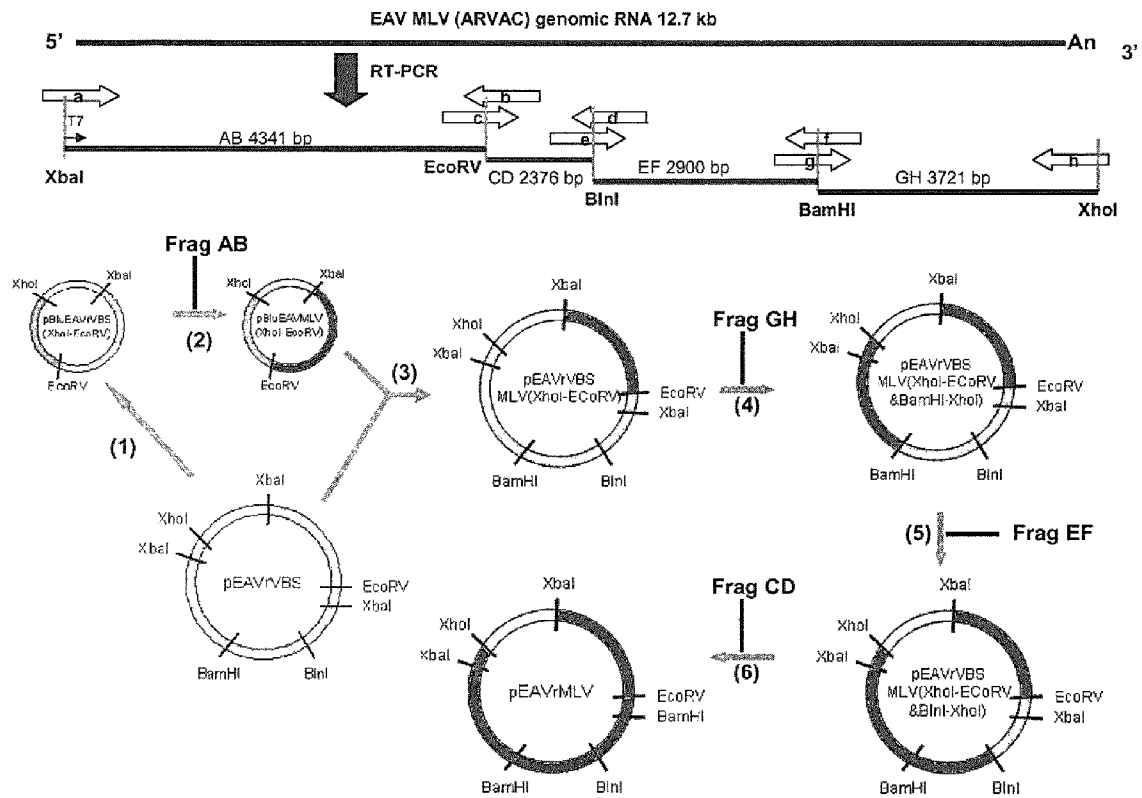
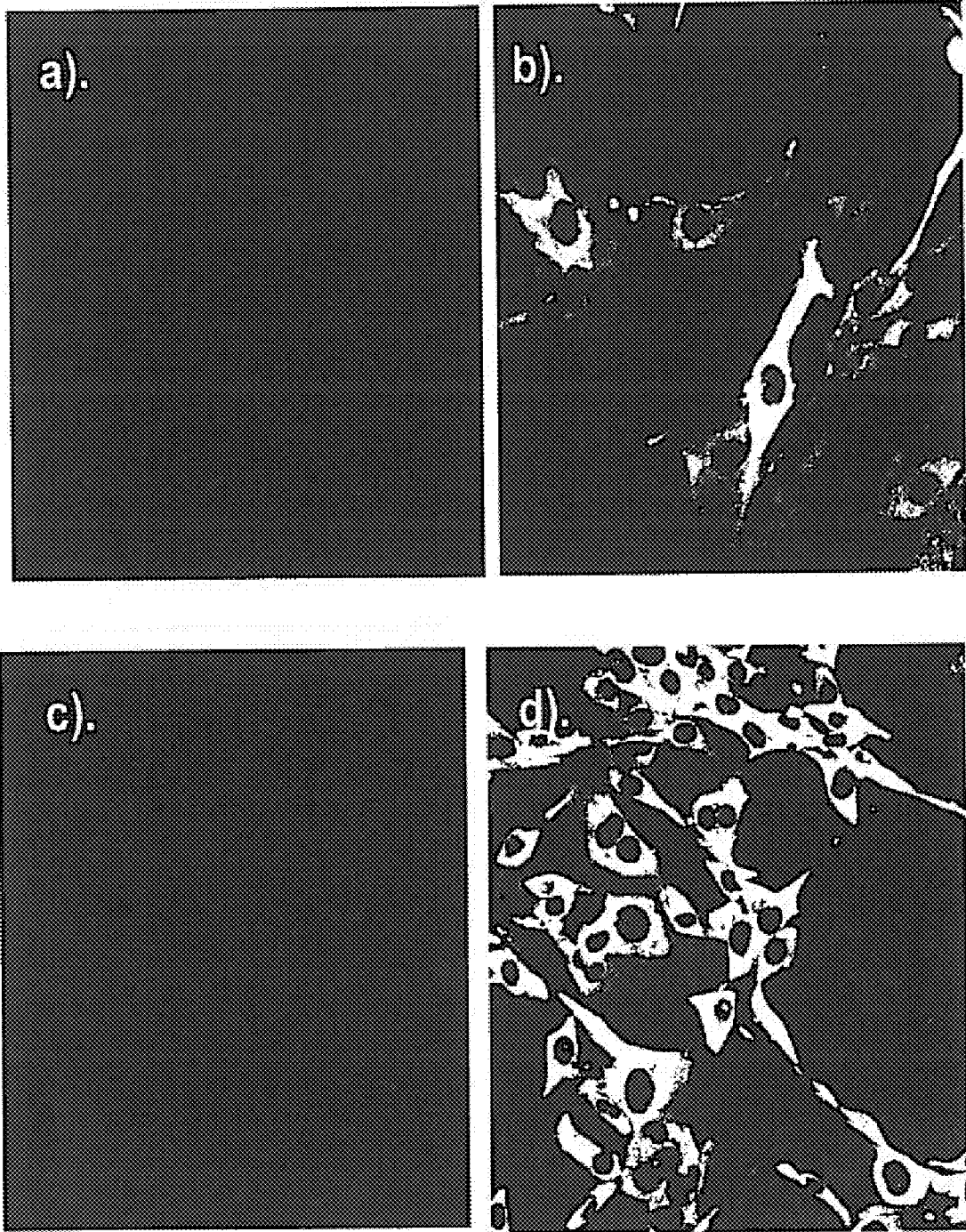**9 Claims, 2 Drawing Sheets**

Figure 1

Figure 2

INFECTIOUS CDNA CLONE OF THE MODIFIED LIVE VIRUS VACCINE STRAIN OF *EQUINE ARTERITIS* VIRUS

This utility patent application claims the benefit of priority in U.S. Provisional Patent Application Ser. No. 61/156,595 filed on Mar. 2, 2009, the entirety of the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to an infectious clone of the modified live virus (MLV) vaccine strain of Equine arteritis Virus (EAV). In particular, the invention relates to an infectious cDNA clone of the MLV vaccine strain allowing generation of full length, infectious transcripts of MLV EAV. Use of the functional, infectious recombinant virion of EAV derived from an attenuated vaccine strain in marker vaccines, companion diagnostic tests, and the like is contemplated.

BACKGROUND OF THE INVENTION

Equine arteritis virus (EAV) is a member of the genus *Arterivirus*, family Arteriviridae in the order Nidovirales (Cavanagh, 1997), and is the causative agent of equine viral arteritis (EVA) of horses (Doll et al., 1957a). Outbreaks of EVA are characterized by any combination of systemic illness of adult horses, abortion of pregnant mares, interstitial pneumonia of young foals and persistent infection of stallions (Doll et al., 1957a; Doll et al., 1957b; Golnik et al., 1981; Timoney et al. 1986; Timoney et al., 1987; Timoncy et al., 1992; Carman et al., 1988; Vaala et al., 1992; Del Piero et al., 1995; Del Piero et al., 1997). EAV is horizontally transmitted either by aerosol during outbreaks of EVA or venerally via the breeding of an infected stallion to susceptible mares, and vertically through congenital infection of foals born to mares infected late in gestation (Timoney et al., 1987; Timoney et al., 1992; Vaala et al., 1992; Timoney and McCollum, 1993; Glaser et al., 1996).

Dissemination of EAV by fomites such as vehicles, twitches, artificial vaginas and shanks can be an important source of infection in some outbreaks (Collins et al. 1987; Timoney and McCollum, 1988; Timoney and McCollum, 1993). The persistently infected carrier stallion clearly plays an important role in perpetuation and sexual dissemination of EAV. The persistence of EAV in the male reproductive tract is testosterone-dependent (Timoney and McCollum, 1993). It was recently shown that EAV behaves as a quasi-species during persistent infection of carrier stallions, with regular emergence of novel genotypic and phenotypic viral variants (Hedges et al., 1999).

The EAV genome is 12.7 kb and contains 5' and 3' untranslated regions and nine functional open reading frames [ORFs; (Snijder and Meulenberg, 1998. Snijder et al., 1999)]. ORFs 1a and 1b encode two replicase polyproteins [pp1a and pp1ab; (de Vries et al., 1997; Snijder and Spaan, 2006; Snijder and Meulenberg, 1998)], and the remaining seven ORFs (2a, 2b and 3-7) encode structural proteins of the virus. These include four membrane glycoproteins GP2 (25 kDa), GP3 (3642 kDa), GP4 (28 kDa) and GP5 (30-44 kDa), respectively encoded by ORFs 2b, 3, 4, and 5, two unglycosylated membrane proteins E (8 kDa) and M (17 kDa) encoded by ORFs 2a and 6, and the phosphorylated nucleocapsid protein N (14 kDa) encoded by ORF7 (de Vries et al., 1992; Snijder et al., 1999; Wieringa et al, 2002).

Prevention and control of EVA in North America is achieved by vaccination of horses with the modified live virus vaccine strain of EAV (ARVAC®, Fort Dodge Animal Health; Moore, 1986). Although the current modified live virus (MLV) vaccine against EVA is safe and efficacious, there is resistance to using it in horses in many countries (e.g. European Union) regardless of the seroprevalence of EAV infec-

tion. One of the major concerns is the safety of the current MLV vaccine in pregnant mares, in particular the ability of the attenuated virus to cross the placenta and infects the unborn foal. The vaccine is only recommended for use in stallions and nonpregnant mares. It is not recommended for use in pregnant mares, especially during the last two months of gestation, or in foals less than 6 weeks of age, unless they are at high risk of natural exposure. Furthermore, horses that are vaccinated with the current MLV cannot be distinguished from naturally infected animals. Following the recent multistate EVA occurrence in the United States there is a strong industry demand for a marker vaccine to distinguish vaccinated animals from the naturally infected animals, as well as to develop a MLV vaccine that is totally safe for use in pregnant mares. Thus, there remains a need in the art for novel means for control of outbreaks of EAV. The advent of recombinant DNA technology has helped to develop new generation vaccines against a number of veterinary pathogens. These include live-vectored vaccines, gene deletion mutants and DNA vaccines.

SUMMARY OF THE INVENTION

To solve the aforementioned problems, there is provided an isolated polynucleotide molecule comprising a DNA sequence which encodes an infectious RNA molecule encoding a modified live virus vaccine strain of an Equine arteritis virus. That polynucleotide sequence is derived from an Equine arteritis virus modified live virus vaccine strain (ARVAC®, Fort Dodge Animal Health). In one embodiment, the polynucleotide sequence is SEQ ID NO:1 or a degenerate variant thereof. Vectors, including plasmid vectors, comprising the polynucleotide molecule are provided. Still further, an isolated infectious RNA molecule encoded by the isolated polynucleotide molecule is provided, which encodes a modified live virus vaccine strain of the Equine arteritis virus.

In another aspect, there is provided an isolated polynucleotide molecule comprising a DNA sequence which encodes an infectious RNA molecule encoding an Equine arteritis virus, wherein the DNA sequence is SEQ TD NO:2 or a degenerate variant thereof. In this embodiment, a silent point mutation is introduced, allowing recognition and distinguishing the sequence from the parent strain Equine arteritis virus or other strains of the virus. Vectors, host cells transfected with the polynucleotide molecule, and infectious RNA molecules encoded by the polynucleotide molecule are provided also.

These and other embodiments, aspects, advantages, and features of the present invention will be set forth in the description which follows, and in part will become apparent to those of ordinary skill in the art by reference to the following description of the invention and referenced drawings or by practice of the invention. The aspects, advantages, and features of the invention are realized and attained by means of the instrumentalities, procedures, and combinations particularly pointed out in the appended claims. Various patent and non-patent citations are discussed herein. Unless otherwise indicated, any such citations are specifically incorporated by reference in their entirety into the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings incorporated in and forming a part of the specification, illustrate several aspects of the present invention, and together with the description serve to explain the principles of the invention. In the drawings:

FIG. 1 presents a schematic in flow diagram form of a cloning strategy for constructing a full-length infectious cDNA clone of the Equine arteritis virus modified live vaccine strain (ARVAC®); and

FIG. 2 shows immunofluorescent staining of BHK-21 cells transfected with in vitro transcribed RNA from the cDNA clone shown in FIG. 1.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

In the following detailed description of the illustrated embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration, specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Also, it is to be understood that other embodiments may be utilized and that process, reagent, software, and/or other changes may be made without departing from the scope of the present invention.

EXAMPLE 1

FIG. 1 shows in flow diagram the strategy employed for construction of a full-length infectious cDNA clone of EAV MLV. The experimental details for this strategy have been previously set forth (Balasuriya et al., 2007; incorporated herein by reference). Briefly, the pTRSB plasmid sequence (McKnight et al., 1996) used in making in the virulent pEAVrVBS infectious cDNA clone (Balasuriya et al., 2007; GenBank accession no. DQ846751) was used as the backbone to construct the EAV MLV clone.

The viral RNA of EAV MLV strain (ARVAC®, Fort Dodge Animal Health) was RT-PCR amplified using four pairs of synthetic oligonucleotide primers (a & b, c & d, e & f, and g & h), designed according to the EAV MLV nucleotide sequence (GenBank accession no. EU586275) to obtain four overlapping fragments (termed AB, CD, EF, and GH). Long PCR was carried out according to the manufacturers instructions with the Expand Long Template PCR system (Boehringer Mannheim). The primers used are set forth in Table 1.

With reference to FIG. 1, in step 1 a shuttle vector pBluEAVrVBS(XhoI-EcoRV) was constructed by replacing the fragment XhoI-EcoRV of the plasmid pBlu2SKP with the fragment XhoI-EcoRV of the full-length clone pEAVrVBS. Next (step 2), the fragment AB was digested with restriction enzymes XbaI and EcoRV and then cloned into the shuttle vector pBluEAVrVBS(XhoI-EcoRV) which was also cut with the same restriction enzymes, to obtain the recombinant plasmid pBluEAVMLV(XhoI-EcoRV). In step 3, the plasmid pBluEAVMLV(XhoI-EcoRV) was digested with restriction enzymes XhoI and EcoRV and then cloned into the full-length clone pEAVrVBS which was also cut with the same restriction enzymes, to obtain the recombinant plasmid pEAVrVBSMLV(XhoI-EcoRV).

The fragment GH was digested (step 4) with restriction enzymes BamHI and XhoI and then cloned into the plasmid pEAVrVBSMLV (XhoI-EcoRV) which was also digested with the same restriction enzymes, to obtain the recombinant plasmid pEAVrVBSMLV(XhoI-EcoRV&BamHI-XhoI). Following, (step 5) the fragment EF was digested with restriction enzymes BlnI and BamHI and then cloned into the plasmid pEAVrVBSMLV(XhoI-EcoRV&BamHI-XhoI) which was also digested with the same restriction enzymes, to obtain the recombinant plasmid pEAVrVBSMLV(XhoI-EcoRV&BlnI-XhoI). Finally, in step 6, the fragment CD was digested with restriction enzymes EcoRV and BlnI and then cloned into the plasmid pEAVrVBSMLV(XhoI-EcoRV&BlnI-XhoI) which was also cut with the same restriction enzymes, to obtain the full-length clone pEAVrMLV. Following assembly, the EAV MLV cDNA (SEQ ID NO:1) was immediately downstream of a T7 promoter for generation of full-length in vitro transcripts of EAV MLV.

EXAMPLE 2

Once assembly of the full-length clone was complete, its authenticity was confirmed by sequencing. That sequence is

TABLE 1

Primers used for reverse transcription and PCR
amplification of the EAV MLV (ARVAC) fragments AB, CD, EF and GH.
Table 1. Primers for RT-PCR amplification of the
EAV MLV vaccine strain (ARVACC)

Fragment	Primers for reverse transcription	Primers for PCR Forward Primer	Reverse Primer	Digested with restriction enzymes
Fragment AB	5'GTCATCATCAGTGAG GGCAG3' (SEQ ID NO: 5)	Primer a GATTAATACGACTCACT ATAGCTCGAAGTGTGTA TGGTG3' (SEQ ID NO: 6)	Primer b CAGCGGCAGTGAT GTAG3' (SEQ ID NO: 7)	XbaI + EcoRV
Fragment CD	5'CCCCCGCGTTTGGTGA ATGC3' (SEQ ID NO: 8)	Primer c 5'TGCTTGTTCCATCTGG TCTG3' (SEQ ID NO: 9)	Primer d 5'TCTCCAGGTCTGT TTCAAGG3' (SEQ ID NO: 10)	EcoRV + Blnl
Fragment EF	5'ACTTCTGTTGAGCTGA GGAG3' (SEQ ID NO: 11)	Primer e 5'ATTAGGAGCATTCTGG GCACC3' (SEQ ID NO: 12)	Primer f 5'ACGCGACTCAGT GTCTCAGG3' (SEQ ID NO: 13)	Blnl + BamHI
Fragment GH	5'GCACTCAGCTAGTAG ACATCCTCGAGTTTTTT TTTTTTTTTTTTTGGTT CCTGGGTGGCTAATAAC (SEQ ID NO: 14)	Primer g 5'TATTCTCGTCCGGTAG GTTCG3' (SEQ ID NO: 15)	Primer h 5'GCACTCAGCTAG TAGACATCCTCG3' (SEQ ID NO: 16)	BamHI + XhoI

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set forth herein as SEQ ID NO: 1. The cloned virus sequence (EAVrMLV) had 100% nucleotide identity to the master sequence of the parental MLV vaccine strain (GenBank accession no. EU586275).

EXAMPLE 3

Plasmid containing the full-length sequence of the MLV vaccine (pEAVrMLV; SEQ ID NO: 3; GenBank Accession No. FJ798195) was XhoI-linearized and in vitro transcribed (IVT) RNA was generated for electroporation into baby hamster kidney cells (BHK 21; ATCC CCL10) according to published methods (Balasuriya et al., 1999). The electroporated cells were seeded onto culture plates and incubated at 37° C. until complete cytopathic effect (CPE) was observed to confirm infectivity. When 100% CPE was observed the tissue culture fluid was harvested and stored at −80° C.

EXAMPLE 4

The infectivity of the IVT RNA was confirmed also by indirect immunofluorescence (IFA; FIG. 2; see Balasuriya et al., 2007) to detect viral protein synthesis in BHK-21 cells transfected with synthetic full-length RNA. Electroporated cells were plated directly onto chamber slides and incubated. The cells were labeled with anti-nsp1 monoclonal antibody 12A1 (Mab; FIG. 2b) and anti-nucleocapsid MAb 3E2 (FIG. 2d) at 24 hours post transfection. Mock-transfected cells were also stained with the same MAbs as controls (FIG. 2a, c).

EXAMPLE 5

To distinguish the cloned virus from the parental strain and from other field and laboratory EAV strains, a silent point mutation (bp12,423 C→G) was introduced into the cDNA clone described in Example 1, providing another infectious cDNA clone termed pEAVrMLVB (SEQ ID NO:4; GenBank Accession No.: FJ798196). The silent point mutation was introduced using QuikChange II site-directed mutagenesis kit (Stratagene) and the mutagenesis primers EAV12423Pmut (5'-GATGCGGGTCCGGAAACCGC-CCGCG-3': SEQ ID NO: 17) and EAV12423Nmut (5'-CGCGGGCGGTTTCCGGACCCATC-3': SEQ ID NO:18). This clone contained a unique restriction site Bsp EI (5'-TCCGGA-3') at positions 12.419-12,424. This restriction site is lacking in pEAVrMLV.

EXAMPLE 6

A vaccine is formulated according to conventional methods, incorporating virus, plasmid, or other vectors comprising SEQ ID NO:1 and including acceptable carriers, including standard buffers, stabilizers, diluents, preservatives, and the like, and may be formulated for extended release. Adjuvants or other immunomodulators may be included, such as Freund's complete or incomplete adjuvants and the like. An effective dosage of vaccine can be determined conventionally by methods known to the skilled artisan, such as administering sequentially increasing doses of virus, plasmid, or vector comprising SEQ ID NO:1 and other additives as described to ascertain proper dosages and any side effects. Single or multiple administrations of vaccine are contemplated. Immune response to the vaccine is monitored by conventional methods, such as seroconversion and antibody titer post-vaccination.

EXAMPLE 7

A marker vaccine is formulated according to conventional methods, incorporating virus, plasmid, or other vectors com-

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prising SEQ ID NO:2 and including acceptable carriers, including standard buffers, stabilizers, diluents, preservatives, and the like, and may be formulated for extended release. Adjuvants or other immunomodulators may be included, such as Freund's complete and incomplete adjuvant and the like. An effective amount of vaccine can be determined conventionally by methods known to the skilled artisan, such as administering sequentially increasing doses of virus, plasmid, or vector comprising SEQ ID NO:1 and other additives as described to ascertain proper dosages and any side effects. Single or multiple administrations of vaccine are contemplated. Immune response to the vaccine is monitored by conventional methods, such as seroconversion and antibody titer post-vaccination. The presence of the marker vaccine is detected by the presence of the unique restriction site Bsp EI (Example 5). This allows monitoring successful vaccination, even in the presence of antibody to wild-type Equine arteritis virus. Even more, it is possible to differentiate vaccinated animals (by the described marker vaccine) from experimentally or naturally infected animals by detecting the mutation.

One of ordinary skill in the art will recognize that additional embodiments of the invention are also possible without departing from the teachings herein. For example, the skilled artisan will appreciate that it is now possible, using the described cDNA clone of the modified live virus of Equine arteritis virus, to provide a validated repository of seed virus for live virus vaccine production, ensuring a genetically homogenous virus stock. Further, the clone finds utility in development of mutations such as disable infectious single cycle (DISC) mutant, allowing a combination of the safety of inactivated vaccines with the immunogenic activity of live viral vaccines. Still further, the cDNA marker clone (SEQ ID NO:4; Example 5) allows development of not only marker vaccines (Example 7), but also diagnostic assays for differentiation of vaccinated animals from naturally infected animals.

This detailed description, and particularly the specific details of the exemplary embodiments, is given primarily for clarity of understanding, and no unnecessary limitations are to be imported, for modifications will become obvious to those skilled in the art upon reading this disclosure and may be made without departing from the spirit or scope of the invention. Relatively apparent modifications, of course, include combining the various features of one or more figures or examples with the features of one or more of other figures or examples.

REFERENCES

Cavanagh, D. 1997. Nidovirales: a new order comprising Coronaviridae and Arteriviridae. *Archives of Virology* 142: 629-633.

Doll, E. R., Bryans, J. T., McCollum, W. H. and Crowe, M. E. W. 1957a. Isolation of a filterable agent causing arteritis of horses and abortion by mares. Its differentiation from the equine abortion (influenza) virus. *Cornell Vet.* 47: 3-41.

Doll, E. R., Knappenberger, R. E., and Bryans, J. T. 1957b. An outbreak of abortion caused by the equine arteritis virus. *Cornell Vet.* 47: 69-75.

Golnik, W., Michalska, Z., and Michalak, T. 1981. Natural equine viral arteritis in foals. *Schweizer Archiv für Tierheilkunde* 123: 523-533.

Timoncy, P. J., McCollum, W. H., Roberts, A. W., and Murphy, T. W. 1986. Demonstration of the carrier state in naturally acquired equine arteritis virus infection in the stallion. *Res. Vet. Sci.* 41: 279-280.

Timoney. P. J., McCollum, W. H., Murphy, T. W., Roberts, A. W., Willard, J. G., and Carswell, G. D. 1987. The carrier state in equine arteritis virus infection in the stallion with specific emphasis on the venereal mode of virus transmission. *J. Reprod. & Fertility Supplementum* 35: 95-102.

Timoney, P. J., McCollum, W. H. and Murphy, T. W. 1992. A longitudinal study of equine arteritis virus infection in standard bred stallions with special reference to occurrence of the carrier state. In: *Proceedings of the Sixth International Conference on Equine Infectious Diseases, Cambridge,* 1991, pp. 231-237.

Calman, S., Rae, C., and Dubovi, E. J. 1988. Equine arteritis virus isolated from a standard bred foal with pneumonia. *Canadian Vet. J.* 29: 937.

Vaala, W. E., Hamir, A. N., Dubovi, E. J., Timoney, P. J., and Ruiz, B. 1992. Fatal, congenitally acquired infection with equine arteritis virus in a neonatal thoroughbred. *Equine Vet. J.* 24: 155-158.

Del Piero, F., Lopez, J., Glaser, A. L. Dubovi, E. J., Schlafer, D., Wilkins, P. and Lein, D. 1995. Histopathology and immunoperoxidase histochemistry of equine arteritis virus in newborn foals: a retrospective study of formalin fixed tissue from natural cases. *Vet. Patrol.* 32, 565.

Del Piero, F., Wilkins, P. A., Lopez, J., W., Glaser, A. L., Dubovi, E. J., Schlafer, D. H., and Lein, D. H. 1997. Equine viral arteritis in newborn foals: clinical, pathological, serological, microbiological and immunohistochemical observations. *Equine Vet. J.* 29: 178-185.

Timoney, P. J. and McCollum, W. H. 1993. Equine viral arteritis. *Veterinary Clinics of North America Equine Practice* 9: 54-59.

Glaser, A. L., Rottier, P. J. M., Horzinek, M. C., and Colenbrander, B. 1996. Equine arteritis virus: a review of clinical features and management aspects. *Vet. Quarterly* 18: 95-99.

Collins, J. K., Kari, S., Ralston, S. L., Bennet, D. G., Traub-Dargatz, J. L., and McKinnon. A. O. 1987. Equine viral arteritis in a veterinary teaching hospital. *Preventative Vet. Med* 4: 389-397.

Timoney, P. J. and McCollum, W. H. 1988. Equine viral arteritis: epidemiology and control. *J. Equine Vet. Sci.* 9: 54-59.

Hedges, J. F., Balasuriya, U. B. R., Timoney, P. J., McCollum, W. H. and MacLachlan, N. J. 1999. Genetic divergence with emergence of phenotypic variants of equine arteritis virus during persistent infection of stallions. *J. Virol.* 73: 3672-3681.

Snijder, E. J., and Meulenberg, J. J. (1998). The molecular biology of *arteriviruses. J Gen Virol* 79 (Pt 5), 961-79.

Snijder, E. J., van Tol, H., Pedersen, K. W., Raamsman, M. J., and de Vries, A. A. (1999). Identification of a novel structural protein of *arteriviruses. J Virol* 73(8), 6335-45.

de Vries, A. A. F., Horzinek, M. C., Rottier, P. J. M., and de Groot, R. J. 1997. The genome organization of the Nidovirales: similarities and differences between arteri-, toro- and coronaviruses. *Seminars in Virology* 8: 33-47.

Snijder, E. J., and Spaan, W. J. (2006). "*Arteriviruses.*" 5th ed. Fields Virology (D. M. Knipe, and Howley, P. M., Ed.) Lippincott Williams & Wilkins, Philadelphia, pp 1337-1355.

de Vries, A. A. F., Chirmside, E. D., Horzinek, M. C., and Rottier, P. J. M. 1992. Structural proteins of equine arteritis virus. *J. Virol.* 66: 6294-6303.

Wiering a, R., A. A. de Vries, M. J. Raamsman, and P. J. Rottier. 2002. Characterization of two new structural glycoproteins, GP(3) and GP(4), of equine arteritis virus. *J Virol* 76:10829-40.

Moore, 1986. Development and Evolution of Three Equine Vaccines. Irish Vet. J. 40: 105-107.

Balasuriya, U. B. R., Snijder, E. J., Heidner, H. W., Zhang, J., Zevenhoven-Dobbe, J. C.; Boone, J. D., McCollum, W. H., Tinoney, P. J., and MacLachlan, N. J. 2007. Development and characterization of an infectious cDNA clone of the virulent Bucymus strain of Equine arteritis virus. *J. Gen. Virol.* 88: 918-924.

McKnight, K. L., Simpson, D. A., Lin, S. C., Knott, T. A., Polo, J. M., Pence, D. F., Johannsen, D. B., Heidner, H. W., Davis, N. L., and Johnston, R. E. 1996. Deduced consensus sequence of Sindbis virus strain AR339; mutations contained in laboratory strains which affect cell culture and in vivo phenotypes. *J. Virol.* 70: 1981-1989.

Balasuriya, U. B., Snijder, E. J., van Dinten, L. C., Heidner, H. W., Wilson, W. D., Hedges, J. F., Hullinger, P. J., and MacLachlan, N. J. 1999. Equine arteritis virus derived from an infectious cDNA clone is attenuated and genetically stable in infected stallions. *Virology* 260: 201-208.

SEQUENCE LISTING

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<213> ORGANISM: Equine arteritis virus

<400> SEQUENCE: 1

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tcgttagata acggcaagtt ccctttctta ctatcctatt ttcatcttgt ggcttgacgg       180

gtcactgcca tcgtcgtcga tctctatcaa ctacccttgc gactatggca accttctccg       240

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What is claimed is:

1. An isolated polynucleotide molecule comprising a DNA sequence encoding an infectious RNA molecule encoding a modified live viral strain of an Equine arteritis virus, wherein said DNA sequence is SEQ ID NO:1.

2. An isolated transformed or transfected host cell comprising the DNA sequence of claim **1**.

3. A plasmid vector comprising the isolated polynucleotide molecule of claim **1** operatively linked to a suitable promoter.

4. The vector of claim **3**, consisting of SEQ ID NO: 3.

5. An isolated infectious RNA molecule encoded by the isolated polynucleotide molecule of claim **1**, wherein the infectious RNA molecule encodes a modified live viral strain of an Equine arteritis virus.

6. An isolated polynucleotide molecule comprising a DNA sequence encoding an infectious RNA molecule encoding a modified live viral strain of an Equine arteritis virus, wherein the DNA sequence is SEQ ID NO:2.

7. An isolated transformed or transfected host cell comprising the DNA sequence of claim **6**.

8. A plasmid vector comprising the isolated polynucleotide molecule of claim **6** operatively linked to a suitable promoter.

9. An isolated infectious RNA molecule encoded by the isolated polynucleotide molecule of claim **6**, wherein the infectious RNA molecule encodes a modified live viral strain of an Equine arteritis virus.

* * * * *