immunoreactive to antibodies specific for PPV5A. Preferred polypeptides of the disclosure include the sequences of SEQ ID NO:2 or SEQ ID NO:4, in particular SEQ ID NO:4. Preferably those polypeptides, or fragments thereof, are immunoreactive to antibodies specific for PPV5A.

[0011] The disclosure provides nucleic acid sequences that encode one or more polypeptides, antibody constructs, or antibody conjugates. The gene sequences coding for the polypeptides comprise a nucleic acid sequence that is at least 95%, 90%, 85%, or even 80% homologous to and/or identical with the sequence of SEQ ID NO: 1, in particular, nucleotide sequences 2845-5547 of SEQ ID NO:1 (the capsid protein), or fragments of SEQ ID NO:1 coding for a polypeptide that is immunoreactive to antibodies specific for PPV5A. Exemplary nucleic acid sequences of the disclosure include any one of the sequences of nucleotides 1975-2844 of SEQ ID NO:1, and nucleotides 2845-5547 of SEQ ID NO:1, and fragments thereof, that encode a polypeptide that is immunoreactive to an antibody specific for PPV5A. Preferably, the nucleic acid sequences, or genes, are those coding for a polypeptide or peptide that is immunoreactive to an antibody specific for PPV5A.

[0011a] In one aspect, there is provided an isolated antibody that specifically binds to a porcine parvovirus polypeptide encoded by a porcine parvovirus polynucleotide having a sequence of SEQ ID NO:1, said polypeptide having an amino acid sequence of SEQ ID NO:2 or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO: 1, and wherein said antibody does not bind to a polypeptide encoded by a different parvovirus. In another aspect, there is provided a hybridoma that expresses an antibody as defined herein.

[0012] Moreover a polypeptide of the disclosure as used herein includes but is not limited to a polypeptide that comprises:

i) a polypeptide comprising the amino acid sequence of SEQ ID NO: 2 or SEQ ID NO:4;

ii) a polypeptide that is at least 80% homologous to and/or identical with a polypeptide of i);

iii) a fragment of the polypeptides of i) and/or ii);

included in the sequences of nucleotides 1975-2844 of SEQ ID NO:1, or nucleotides 2845-5547 of SEQ ID NO:1.

[0012a] In another aspect, there is provided a polynucleotide, comprising a polynucleotide

a) having the nucleic acid sequence of SEQ ID NO:1;

b) having a nucleic acid sequence that encodes

- a polypeptide of SEQ ID NO:2,
- a polypeptide SEQ ID NO:3, or
- a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO. 1; or

c) having a nucleic acid sequence at least 95% identical to SEQ ID NO:1, which encodes a polypeptide having a biological or immunologically-effective activity of a polypeptide of SEQ ID NO:2, or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

[0012b] In another aspect, there is provided a polypeptide, comprising a polypeptide

a) having the amino acid sequence of SEQ ID NO:2, or SEQ ID NO:3, or that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1; or

b) having an amino acid sequence at least 95% identical to SEQ ID NO:2, SEQ ID NO:3, or to a sequence of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO. 1, and having an immunologically-effective activity of a polypeptide encoded by SEQ ID NO:2, or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

[0012c] In another aspect, there is provided a porcine parvovirus, comprising

a) a nucleic acid sequence of SEQ ID NO:1, or

b) a nucleic acid sequence at least 95% identical to SEQ ID NO:1, which encodes a polypeptide having an immunologically-effective activity of a polypeptide of SEQ ID NO:2, or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

[0013] Immunogenic compositions of the disclosure which comprise at least one or more PPV5A polypeptides as defined herein may further comprise a physiologically-acceptable vehicle such as a pharmaceutically or veterinary-acceptable carrier, adjuvant, or combination thereof.

[0014] Any of the PPV5A polypeptides provided herewith or any immunogenic compositions comprising one or more of these PPV5A polypeptides provided herewith can be used as a medicament, preferably as a vaccine or immunogenic composition, most preferably for the prophylaxis or treatment of a subject against a PPV5A infection.

[0014a] In another aspect, there is provided a vaccine for treating or preventing an infection by a virulent PPV5A, comprising a killed or attenuated form of a PPV5A as defined herein. In another aspect, there is provided a vaccine for treating or preventing an infection by a virulent PPV5A, comprising a subunit of a killed or attenuated form of a PPV5A as defined herein. In another aspect there is provided a pharmaceutical composition comprising the porcine parvovirus as defined herein for generating an immune response in a mammal. In another aspect, there is provided a pharmaceutical composition comprising the polypeptide as defined herein for generating an immune response in a mammal. In another aspect, there is provided a vaccine for use in treating or preventing an infection by a virulent porcine parvovirus, comprising a killed or attenuated form of a porcine parvovirus as defined herein. In another aspect, there is provided a vaccine for use in treating or preventing an infection by a virulent porcine parvovirus, comprising a subunit of a killed or attenuated form of a porcine parvovirus as defined herein. In another aspect there is provided a pharmaceutical composition comprising the porcine parvovirus as defined herein for use in generating an immune response in a mammal. In another aspect,

there is provided a pharmaceutical composition comprising the polypeptide as defined herein for use in generating an immune response in a mammal.

[0015] Particularly preferred PPV5A polypeptides include those with immunogenic epitopes that induce an immunological response that is specific for PPV5A. Preferred PPVA polypeptides include those having an amino acid sequences predicted in related PPV1 to be surface antigens (Simpson et al. JMB 315, 2002) and include, but is not limited to residues 141-156, 272-278, and 329-339 of SEQ ID NO:4.

[0016] Those of skill in the art will understand that the compositions used herein may incorporate known injectable, physiologically acceptable sterile solutions. For preparing a ready-to-use solution for parenteral injection or infusion, aqueous isotonic solutions, e.g. saline or plasma protein solutions, are readily available. In addition, the immunogenic and vaccine compositions of the present disclosure can include veterinary-acceptable carriers, diluents, isotonic agents, stabilizers, or adjuvants.

[0016a] In another aspect, there is provided an immunogenic preparation comprising a polypeptide as defined herein.

[0017] Methods of the disclosure include, but are not limited to, a method of provoking an immune response against a PPV5A infection in a subject comprising the step of administering to the subject an immunogenic composition comprising one or more PPV5A polypeptides as defined herein. Preferably, the immune response is provoked against more than one serotype or strain of PPV5A. Compositions of the disclosure may be used to treat or alternatively to prevent a PPV5A infection. Preferably, such immune response reduces the incidence of or severity of one or more clinical signs associated with or caused by the infection with one or more PPV5A serotypes.

[0024] The disclosure provides a method of diagnosing a PPV5A infection in a subject. That method comprises providing one or more PPV5A peptides; contacting the one or more PPV5A peptides with a sample obtained from the subject; and identifying the subject as having a PPV5A infection if an antibody capable of binding the one or more PPV5A peptides is detected in the sample.

[0025] In another respect, the disclosure provides a method of ascertaining that a subject has been previously exposed to a PPV5A infection and is able to express an immune response to PPV5A. That method comprises providing one or more PPV5A peptides; contacting the one or more PPV5A peptides with a sample obtained from the subject; and identifying the subject as having a PPV5A infection if an antibody capable of binding the one or more PPV5A peptides is detected in the sample. In another aspect, there is provided a method of identifying the presence of porcine parvovirus in a biological sample, comprising (a) contacting the biological sample with an antibody as defined herein, (b) detecting the formation of a complex between the antibody and a porcine parvovirus polypeptide, wherein the presence of said complex indicates the presence of porcine parvovirus in the biological sample.

[0026] The disclosure also provides kits that comprise an immunogenic composition that comprises one or more PPV5A peptides, preferably together with a carrier molecule; a container for packaging the immunogenic composition; a set of printed instructions; and a dispenser capable of administering the immunogenic composition to an animal. Optionally, the one or more PPV5A peptides and the carrier molecule may be packaged as a conjugate or as separate compounds. When supplied separately, a means of conjugating the one or more PPV5A peptides and carrier molecule, as well as appropriate printed instructions, is also supplied. In another aspect, there is provided a diagnostic kit for identifying the presence of porcine parvovirus in a biological sample, comprising (a) an antibody as defined herein, and (b) reagents for detecting the formation of a complex between the antibody and a porcine parvovirus polypeptide.

[0027] The disclosure also provides kits for vaccinating an animal comprising a set of printed instructions; a dispenser capable of administering the immunogenic composition provided herewith comprising one or more PPV5A peptides to an animal; and wherein at least one of PPV5A peptides effectively immunizes the animal against at least one disease associated

with PPV5A infection. Preferably, the one or more PPV5A peptides are selected from those provided herewith. Kits of the disclosure may further comprise a veterinary acceptable carrier, adjuvant, or combination thereof. In another aspect, there is provided an immunogenic kit, comprising (a) at least one immunogenic porcine parvovirus peptide as defined herein which is effective to immunize an animal against at least one disease associated with porcine parvovirus infection; (b) at least one carrier or adjuvant molecule; (c) a container for packaging the immunogenic composition containing the peptide of a) and the carrier or adjuvant molecule of b); (d) a set of printed instructions; and (e) a dispenser capable of administering the immunogenic composition to an animal.

[0028] The dispenser in a kit of the disclosure is capable of dispensing its contents as droplets; and the immunogenic composition comprises the PPV5A peptides as provided herewith included in the kit is capable of reducing the severity of at least one clinical sign of a PPV5A infection when administered intranasally, orally, intradermally, or intramuscularly to an animal.

CLAIMS

What is claimed is:

1. A polynucleotide, comprising a polynucleotide

   a) having the nucleic acid sequence of SEQ ID NO:1;

   b) having a nucleic acid sequence that encodes

   - a polypeptide of SEQ ID NO:2,
   - a polypeptide SEQ ID NO:3, or
   - a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO. 1; or

   c) having a nucleic acid sequence at least 95% identical to SEQ ID NO:1, which encodes a polypeptide having a biological or immunologically-effective activity of a polypeptide of SEQ ID NO:2 or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

2. A polypeptide, comprising a polypeptide

   a) having the amino acid sequence of SEQ ID NO:2 or SEQ ID NO:3, or that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1; or

   b) having an amino acid sequence at least 95% identical to SEQ ID NO:2, SEQ ID NO:3, or to a sequence of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO. 1, and having an immunologically-effective activity of a polypeptide encoded by SEQ ID NO:2 or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

3. A porcine parvovirus comprising

a) a nucleic acid sequence of SEQ ID NO:1, or

b) a nucleic acid sequence at least 95% identical to SEQ ID NO:1, which encodes a polypeptide having an immunologically-effective activity of a polypeptide of SEQ ID NO:2 or SEQ ID NO:3 or of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO:1.

4. The porcine parvovirus of claim 3, comprising an attenuated, non-virulent form of a porcine parvovirus.

5. A vaccine for treating or preventing an infection by a virulent porcine parvovirus, comprising a killed or attenuated form of a porcine parvovirus of claim 3.

6. A vaccine for treating or preventing an infection by a virulent porcine parvovirus, comprising a subunit of a killed or attenuated form of a porcine parvovirus of claim 3.

7. A vaccine of claim 6, wherein the subunit is a capsid protein, wherein said capsid protein is a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO: 1.

8. An immunogenic preparation comprising a polypeptide of claim 2.

9. A pharmaceutical composition comprising the porcine parvovirus of claim 3 for generating an immune response in a mammal.

10. A pharmaceutical composition comprising the polypeptide of claim 2 for generating an immune response in a mammal.

11. The pharmaceutical composition of claim 9 or 10 or the vaccine of any one of claims 5 to 7, wherein the mammal is a swine, and the immune response provides protective immunity to disease caused by porcine parvovirus infection.

12. An antibody that specifically binds to a porcine parvovirus polypeptide encoded by a porcine parvovirus polynucleotide having a sequence of SEQ ID NO:1, said polypeptide having an amino acid sequence of SEQ ID NO:2 or SEQ ID NO:3 or

of a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO: 1, and wherein said antibody does not bind to a polypeptide encoded by a different parvovirus.

13. A method of identifying the presence of porcine parvovirus in a biological sample, comprising

a) contacting the biological sample with an antibody of claim 12,

b) detecting the formation of a complex between the antibody and a porcine parvovirus polypeptide,

wherein the presence of said complex indicates the presence of porcine parvovirus in the biological sample.

14. A vector or plasmid that comprises a polynucleotide of claim 1.

15. A host cell comprising a vector of claim 14.

16. A hybridoma that expresses an antibody of claim 12.

17. A diagnostic kit for identifying the presence of porcine parvovirus in a biological sample, comprising

a) an antibody of claim 12, and

b) reagents for detecting the formation of a complex between the antibody and a porcine parvovirus polypeptide.

18. An immunogenic kit, comprising

a) at least one immunogenic porcine parvovirus peptide of claim 2 which is effective to immunize an animal against at least one disease associated with porcine parvovirus infection;

b) at least one carrier or adjuvant molecule;

c) a container for packaging the immunogenic composition containing the peptide of a) and the carrier or adjuvant molecule of b);

d) a set of printed instructions; and

e) a dispenser capable of administering the immunogenic composition to an animal.

19. The immunogenic kit of claim 18, further comprising at least one immunogenic protein which is effective to immunize said animal against at least one other porcine pathogenic virus or bacteria which causes a disease associated with an infection with said virus or bacteria.

20. A vaccine for use in treating or preventing an infection by a virulent porcine parvovirus, comprising a killed or attenuated form of a porcine parvovirus of claim 3.

21. A vaccine for use in treating or preventing an infection by a virulent porcine parvovirus, comprising a subunit of a killed or attenuated form of a porcine parvovirus of claim 3.

22. The vaccine for use of claim 21, wherein the subunit is a capsid protein, wherein said capsid protein is a polypeptide that is encoded by a polynucleotide comprising the sequence of nucleotides 2845-5547 of SEQ ID NO: 1.

23. A pharmaceutical composition comprising the porcine parvovirus of claim 3 for use in generating an immune response in mammal.

24. A pharmaceutical composition comprising the polypeptide of claim 2 for use in generating an immune response in a mammal.

25. The pharmaceutical composition for use of claim 23 or 24 or the vaccine for use of any one of claims 20 to 22, wherein the mammal is a swine, and the immune response provides protective immunity to disease caused by porcine parvovirus infection.