current *Eimeria*-based vaccines produces substantial vaccine-reaction morbidity and economic losses in vaccinated flocks. Thus an effective low-virulence vaccine against *Eimeria* is needed. An effective vaccine for *Eimeria* based on conserved immunogenic targets may also prove useful as a vaccine against other apicomplexan parasites.

SUMMARY

A vaccine vector comprising a first polynucleotide sequence encoding an Apicomplexan Rhomboid polypeptide and methods of using the same are provided herein.

In one aspect, provided herein is a vaccine vector comprising a first polynucleotide sequence encoding an Apicomplexan Rhomboid polypeptide optionally expressed on the surface of the vaccine vector, wherein the Rhomboid polypeptide consists of SEQ ID NO: 2, SEQ ID NO: 37, or an immunogenic fragment of SEQ ID NO: 2 comprising amino acids 1-11, 18-27, or 31-43 of SEQ ID NO: 2 and further comprising a second polynucleotide sequence encoding an immunostimulatory polypeptide, wherein the immunostimulatory polypeptide is expressed on the surface of the vaccine vector, wherein the vaccine vector effects an immune response against an Apicomplexan parasite in a subject, and wherein the immune response is a protective immune response.

In another aspect, provided herein is a pharmaceutical composition comprising the vaccine vector described herein and a pharmaceutically acceptable carrier.

In another aspect, provided herein is the use of a vaccine vector described herein or a pharmaceutical composition described herein in the manufacture of a medicament for enhancing the immune response against an Apicomplexan parasite in a subject, wherein the vaccine vector or the pharmaceutical composition is to be administered to the subject, and optionally wherein the Apicomplexan parasite is selected from the group consisting of *Eimeria, Plasmodium, Toxoplasma*, *Neospora* and *Cryptosporidium*.

In another aspect, provided herein is the use of a vaccine vector described herein or a pharmaceutical composition described herein in the manufacture of a medicament for reducing morbidity associated with infection with an Apicomplexan parasite in a subject, wherein the vaccine vector or the pharmaceutical composition is to be administered to the subject, and optionally wherein the Apicomplexan parasite is selected from the group consisting of *Eimeria, Plasmodium, Toxoplasma*, *Neospora* and *Cryptosporidium*.

In another aspect, provided herein is a vaccine vector described herein or a pharmaceutical composition described herein for use in therapy.

In one aspect, a vaccine vector comprising a first polynucleotide encoding an Apicomlexan Rhomboid polypeptide or an immunogenic fragment thereof and a second polypeptide sequence encoding an immunostimulatory polypeptide is disclosed. The Apicomplexan Rhomboid polypeptide and the immunostimulatory polypeptide are suitably expressed on the surface of the vaccine vector. The Apicomplexan Rhomboid polypeptide may comprise SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, SEQ ID NO: 38, an immunogenic fragment of at least one of SEQ ID NO: 1-4, 37-38 or combinations of SEQ ID NO: 1-4 and 37-38. The immunostimulatory polypeptide may be a CD154 polypeptide capable of binding CD40 or an HMGB1 polypeptide. The CD154 polypeptides include fewer than 50 amino acids and comprise amino acids 140-149 of CD154 or a homolog thereof.

In another aspect, a vaccine vector comprising a first polynucleotide encoding an Apicomlexan Rhomboid polypeptide of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, SEQ ID NO: 38, an immunogenic fragment of at least one of SEQ ID NO: 1-4 or 37-38 or combinations of SEQ ID NO: 1-4 or 37-38. The Apicomplexan Rhomboid polypeptide may be expressed on the surface of the vaccine vector.

Vaccine vectors according to the present invention may be a virus, yeast, bacterium, or liposome vector. Pharmaceutical compositions may be comprised of the vaccine vectors described herein and a pharmaceutically acceptable carrier.

In still another aspect, methods of enhancing the immune response against an Apicomplexan parasite in a subject by administering a vaccine vector described herein to the subject are provided. The enhanced immune response may be an enhanced antibody response, an enhanced T cell response or a combination thereof.

In a still further aspect, methods of reducing morbidity and mortality associated with infection with an apicomplexan parasite in a subject by administering a vaccine vector as