100% (Husain et al., *Clin Infect Dis* 37:221-29 (2003)). Because of this unacceptably high mortality rate, and the extreme morbidity of highly disfiguring surgical therapy, it has been imperative to develop new strategies to treat and prevent invasive mucormycosis.

One of the underlying factors in predisposition to fungal infection is elevated serum iron levels. Subjects who have elevated available serum iron are hypersusceptible to mucormycosis. Iron is required by virtually all microbial pathogens for growth and virulence. In mammalian hosts, very little serum iron is available to microorganisms because it is highly bound to carrier proteins such as transferrin. Although sequestration of serum iron is a major host defense mechanism against pathogenic fungi, subjects treated with exogenous iron chelators e.g., deferoxamine have a markedly increased incidence of invasive mucormycosis, which is associated with a mortality of >80%. While deferoxamine is a chelator from the perspective of the human host, it predisposes subjects to mucormycosis by acting as a siderophore, supplying previously unavailable iron to the pathogenic fungi.

Therefore, there exists a need for compounds and methods that can reduce the risk of mucormycosis pathogenesis and provide effective therapies without adverse effects. The present invention satisfies this need and provides related advantages as well.

SUMMARY OF THE INVENTION

In a first aspect~~accordance with the embodiments outlined in this disclosure~~, the present invention refers to~~provides~~ a vaccine composition, comprising~~including~~ an *FTR* polypeptide, or an antigenic fragment of the polypeptide, and a pharmaceutically acceptable carrier. In a second aspect~~addition~~, the present invention refers to~~provides~~ a vaccine composition, comprising~~including~~ a vector comprising~~having~~ a nucleotide sequence that is substantially complimentary to at least 18 contiguous nucleotides of *FTR* sequence, a transcription promoter, and a transcription terminator; wherein the promoter is operably linked to the *FTR* nucleotide sequence, and wherein the *FTR* nucleotide sequence is operably linked to the transcription terminator, and a pharmaceutically acceptable carrier. The vaccine compositions of the present invention can further include an adjuvant.

In addition, the invention describes~~provides~~ a pharmaceutical composition for treating or preventing a fungal condition in a subject in need thereof, including an antisense, a small interfering RNA or an antibody inhibitor of *FTR* selected from the group consisting of a nucleotide sequence that is substantially complimentary to a portion of an *FTR* sequence; a nucleotide sequence that is substantially complimentary to at least 12 contiguous nucleotide bases of *FTR* sequence; a nucleotide RNAi sequence that is substantially complimentary to at least 18

contiguous nucleotide bases of *FTR* sequence; an antibody or antibody fragment thereof that specifically binds to an *FTR* polypeptide or a fragment thereof; and a pharmaceutically acceptable excipient or carrier.

In a third aspect, the present invention refers to the use of an antisense, a small interfering RNA or an antibody inhibitor of *FTR* selected from the group consisting of a nucleotide sequence that is substantially complimentary to a portion of an *FTR* sequence encoding for *FTR* polypeptide as defined above; a nucleotide sequence that is substantially complimentary to at least 12 contiguous nucleotide bases of *FTR* sequence encoding for *FTR* polypeptide as defined above and a pharmaceutically acceptable excipient or carrier in the manufacture of a vaccine for treating or preventing a fungal condition in a subject in need thereof.

In a fourth aspect, the present invention refers to the use of an immunogenic amount of an *FTR* polypeptide, or an immunogenic fragment thereof in the manufacture of a vaccine for treating or preventing a fungal condition, wherein said vaccine is to be administered to a subject having, or susceptible to having, a fungal condition, wherein said fungal condition comprises zygomycosis.

In a fifth aspect, the present invention refers to the use of an antisense, a small interfering RNA or an antibody (polyclonal or monoclonal) inhibitor of *FTR* nucleotide sequence encoding for *FTR* polypeptide as defined above in the manufacture of a vaccine for treating or preventing a fungal condition in a subject in need thereof, wherein the use comprises exposing said fungi to said vaccine, wherein said fungal condition comprises zygomycosis.

In addition, the invention describesprovides a method of treating or preventing a fungal condition, including administering to a subject having, or susceptible to having, a fungal condition an immunogenic amount of an *FTR* polypeptide, or an immunogenic fragment thereof. In addition, the invention provides a method for treating or preventing a fungal condition in a subject in need thereof, including exposing said fungi to an antisense, a small interfering RNA or an antibody inhibitor of *FTR*.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows Rhizopus *oryzae* high affinity iron permease nucleotide sequence (SEQ ID NO: 1), with Genbank cDNA accession NO. AY344587.

Figure 2 shows Rhizopus *oryzae* high affinity iron permease polypeptide sequence (SEQ ID NO:2), with Genbank protein ID. No. AAQ24109.1.

Figure 3 shows amino acid sequence alignment (a) and dendrogram (b) for *FTR* of *R. oryzae* having 46% and 44% identity with *FTR* of *C. albicans* and *S. cerevisiae*, respectively. Box on amino acid sequence alignment indicates the conserved REGLE motif involved in a direct interaction with iron.

Figure 4 shows mechanisms of iron uptake by *Zygomycetes* in conditions of elevated available serum iron.

Figure 5 shows the *FTR* expression in *R. oryzae* grown in media with varying concentrations of iron.

Figure 6 shows the growth of *S. cerevisiae ftr1* mutant transformed with vector expressing *FTR*.

Figure 7 shows high affinity iron uptake by *S. cerevisiae ftr1* mutant transformed with vector expressing *FTR* as compared with iron uptake by wild-type *S. cerevisiae* and *S. cerevisiae ftr1* mutant transformed with empty vector. $^{*}P < 0.05$.

Figure 8 shows the percent survival of diabetic mice (n = 10) infected with *R. oryzae* as compared with non-diabetic infected and diabetic uninfected mice.