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(12) **United States Patent**  
**Alderete**(10) **Patent No.: US 9,910,042 B2**  
(45) **Date of Patent: Mar. 6, 2018**(54) **STRINGS OF EPITOPES USEFUL IN  
DIAGNOSING AND ELICITING IMMUNE  
RESPONSES TO SEXUALLY TRANSMITTED  
INFECTIONS**(71) Applicant: **WASHINGTON STATE  
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UNIVERSITY**, Pullman, WA (US)(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 21 days.(21) Appl. No.: **14/774,158**(22) PCT Filed: **Mar. 13, 2014**(86) PCT No.: **PCT/US2014/025472**

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**G01N 33/571** (2006.01)  
**C07K 14/44** (2006.01)  
**A61K 39/002** (2006.01)  
**A61K 39/02** (2006.01)  
**A61K 39/095** (2006.01)  
**C07K 14/20** (2006.01)  
**C07K 14/22** (2006.01)  
**C07K 16/20** (2006.01)(52) **U.S. Cl.**CPC ..... **G01N 33/571** (2013.01); **A61K 39/002**  
(2013.01); **A61K 39/0225** (2013.01); **A61K**  
**39/095** (2013.01); **C07K 14/20** (2013.01);  
**C07K 14/22** (2013.01); **C07K 14/44** (2013.01);  
**C07K 16/20** (2013.01); **C07K 2319/40**  
(2013.01); **G01N 2333/20** (2013.01); **G01N**  
**2333/22** (2013.01); **G01N 2333/44** (2013.01)(58) **Field of Classification Search**

None

See application file for complete search history.

(56)

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(57)

**ABSTRACT**The invention provides methods and compositions for  
detecting and diagnosing sexually transmitted infections  
using a string of epitopes (SOE) specific for detection of  
causative microorganisms. The antigenic epitopes may be  
single epitope sequences a plurality of epitope sequences  
joined by repeats of glycine (-GG-) and/or lysine (-KK-) to  
form a series of epitopes (SOE), or nucleotide sequences  
encoding one or more SOEs and host cells harboring said  
SOE nucleotide sequences. SOEs specific for highly immu-  
nogenic regions of proteins from *Trichomonas*, *Treponema*  
and *Neisseria* species are provided. SOEs to detect the  
presence of *trichomonas* species comprise regions from  
*Trichomonas-sptcric* aldolase, GAPDH,  $\alpha$ -enolase and  
 $\alpha$ -actinin proteins. Pharmaceutical compositions comprising  
SOEs can also be used as vaccines or to elicit an immune  
response to specific microorganisms.**7 Claims, 14 Drawing Sheets**

FIGURE 1

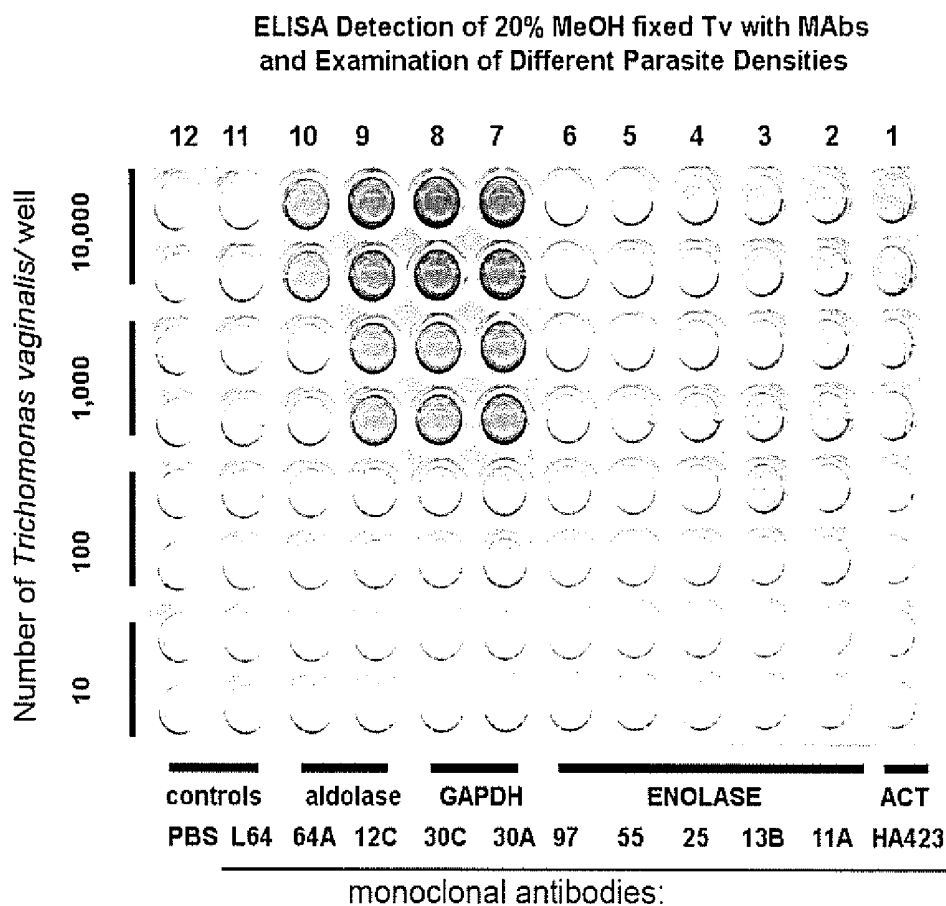
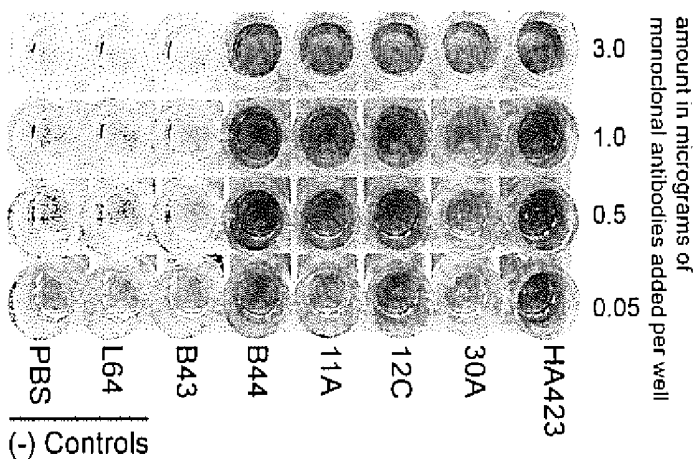


FIGURE 2

ELISA using a mixture of 3 *T. vaginalis* isolates detected by different amounts of monoclonal antibodies.



Spectroscopy readings of color intensity at 405-nm

.066	.133	.112	.789	.750	.642	.510	.577
.081	.092	.096	.758	.618	.648	.404	.534
.068	.074	.068	.699	.520	.600	.309	.529
.110	.113	.098	.317	.159	.332	.133	.420

FIGURE 3

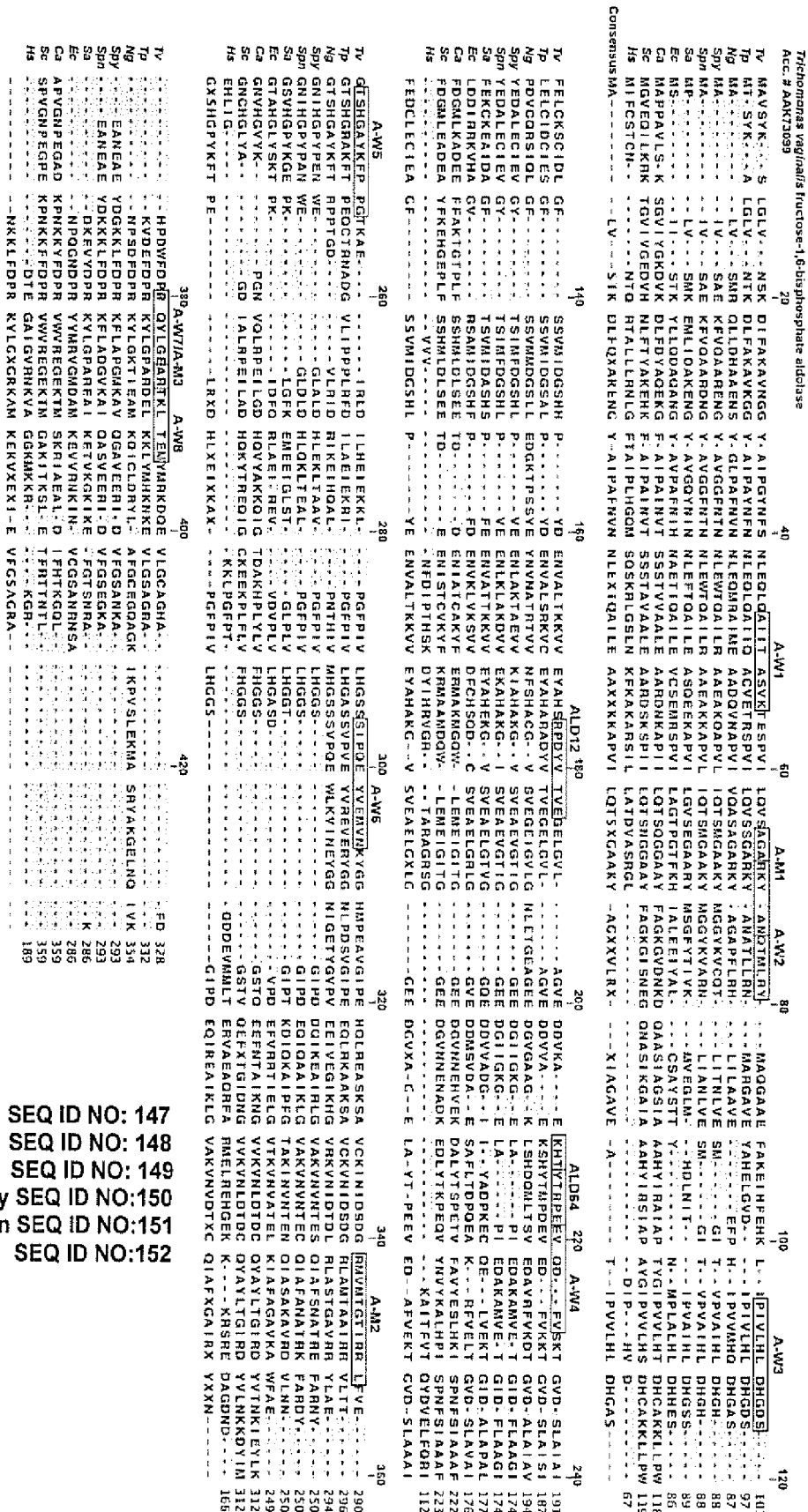
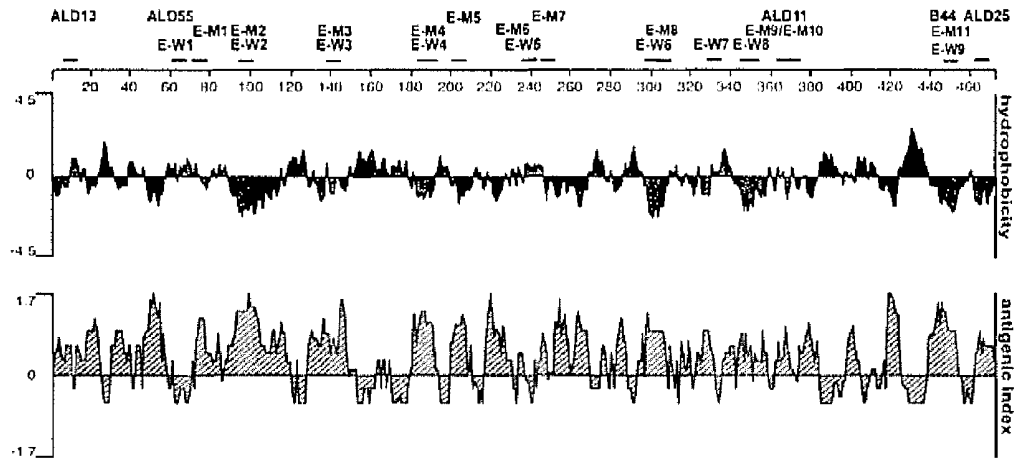
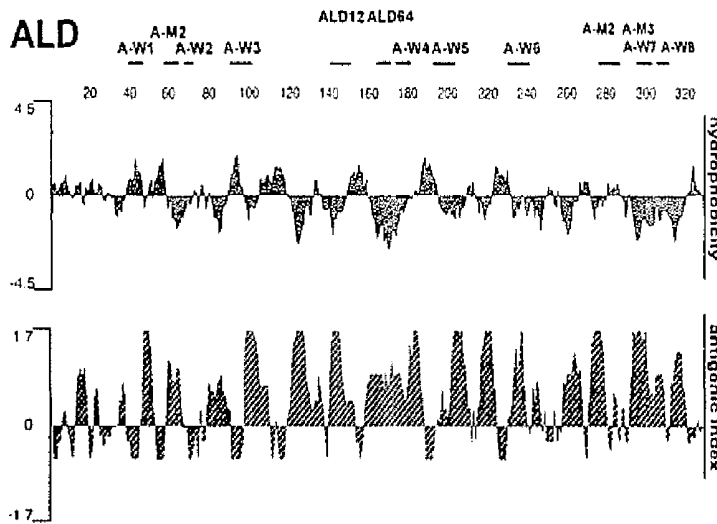


FIGURE 4

A. ENO



B. ALD



C. GAP

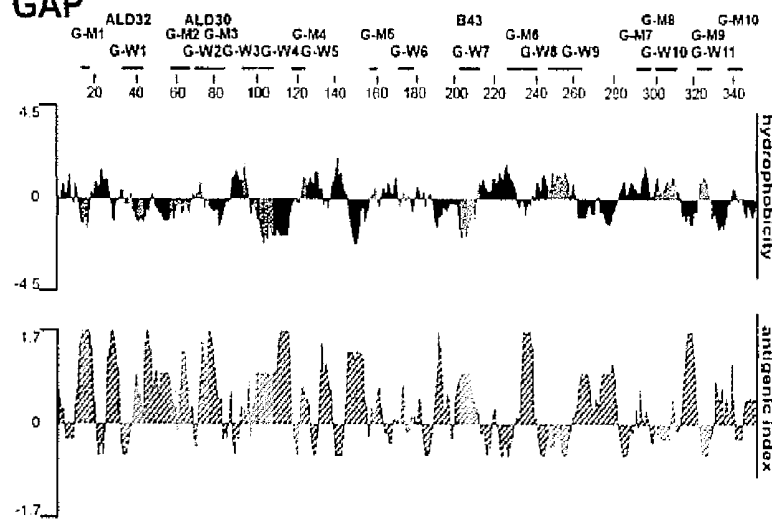


FIGURE 5

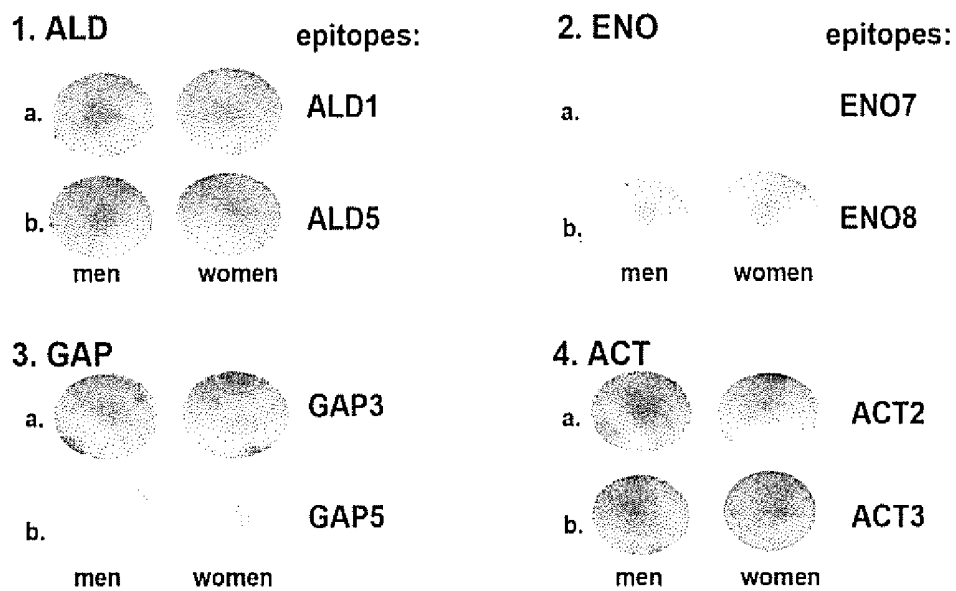
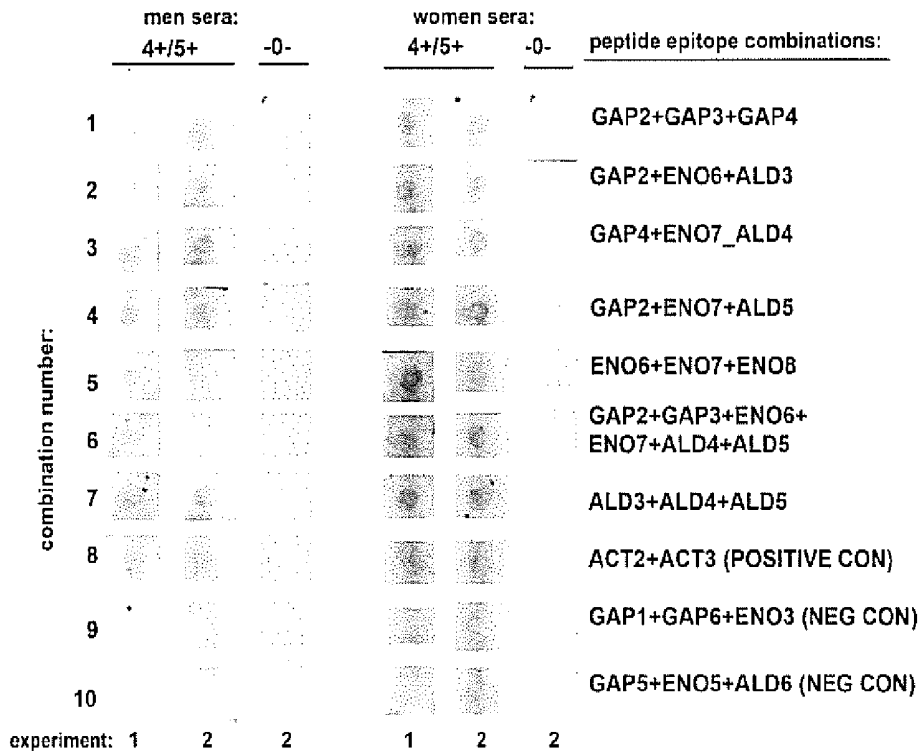


FIGURE 6

A. Dot-blot of combinations of 15-mer peptides



B. Densitometric scans of dot-blot

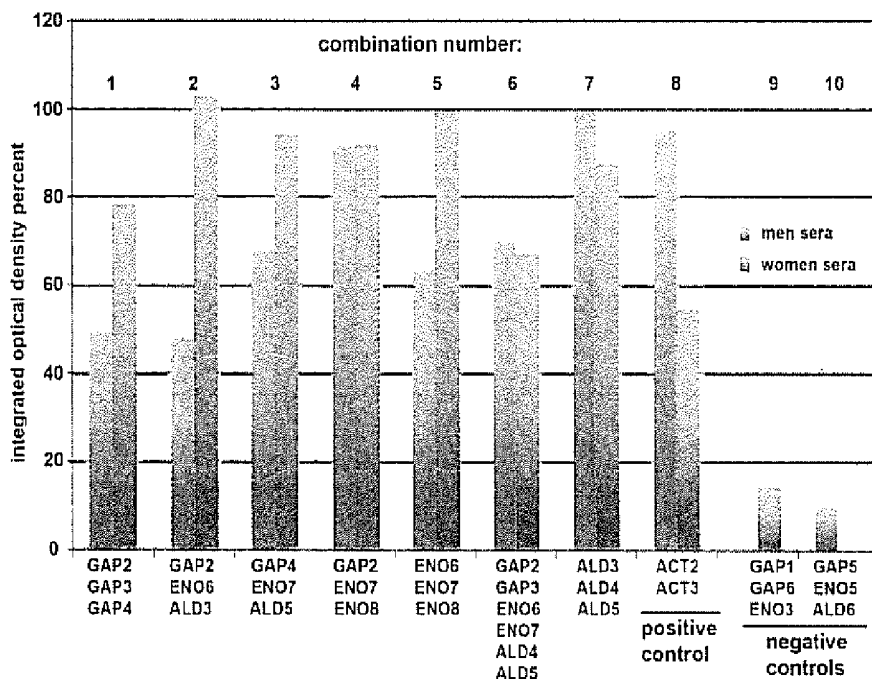
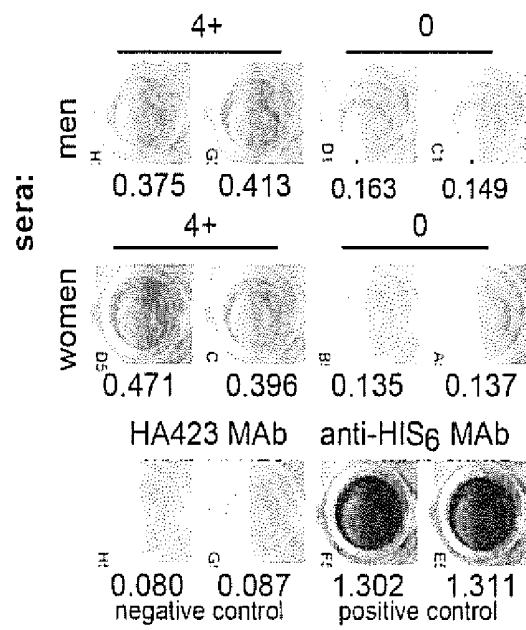


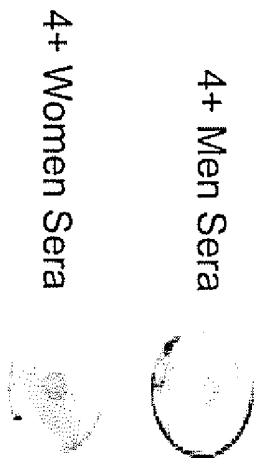


FIGURE 8

A. SOP ELISA



B1. Dot-blot



B2. Immunoblot

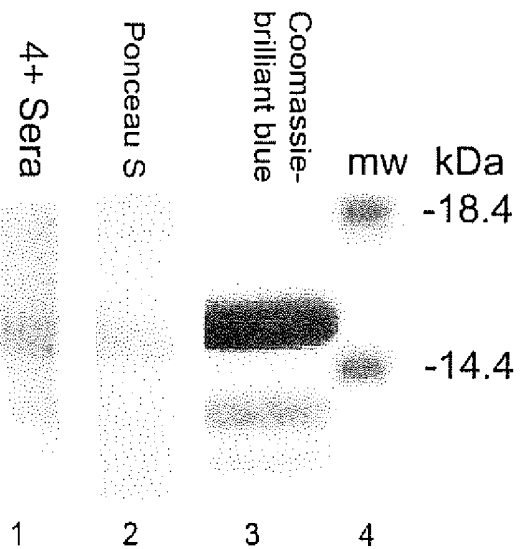


FIGURE 9

Recombinant SOP protein encoding sequential epitopes of the  $\alpha$ -actinin protein of *T. vaginalis* immunoreactive with women and men seropositive sera as a diagnostic target.

<b>ACT1</b>	<b>ACT2</b>	<b>ACT3</b>
GG- <u>SVRREGLLDDAWEKT</u> -GG-	<u>LARQIQFETIETDFE</u> -GG-	<u>PSKWHKQPKMMVQKR</u> -
<b>ACT4</b>	<b>ACT5</b>	<b>ACT6</b>
GG- <u>QGYEHVAVNNFTTSW</u> -GG-	<u>GIYVYLDPEDVIDTT</u> -GG-	<u>KIAAMADKIKRTVAI</u> -
<b>ACT7</b>	<b>ACT8</b>	<b>ACT9</b>
GG- <u>IPGIRGKLASVISYN</u> -GG-	<u>CKSGNRPIPEIPQGL</u> -GG-	<u>SVNRHHSQLITYIKH</u> -
<b>ACT10</b>	<b>ACT11</b>	<b>ACT12</b>
GG- <u>AQPLYDEAIAFKEEV</u> -GG-	<u>ELVEFKLNYKVITYTY</u> -GG-	<u>EFKLNKVTYTYSDA</u> -
<b>ACT13</b>		
GG- <u>FKDTFKYFDKKSNS</u> -GG-	HHHHHH	

general informaton: 229 amino acids  
25,198.23 daltons

SEQ ID NO:146

FIGURE 10

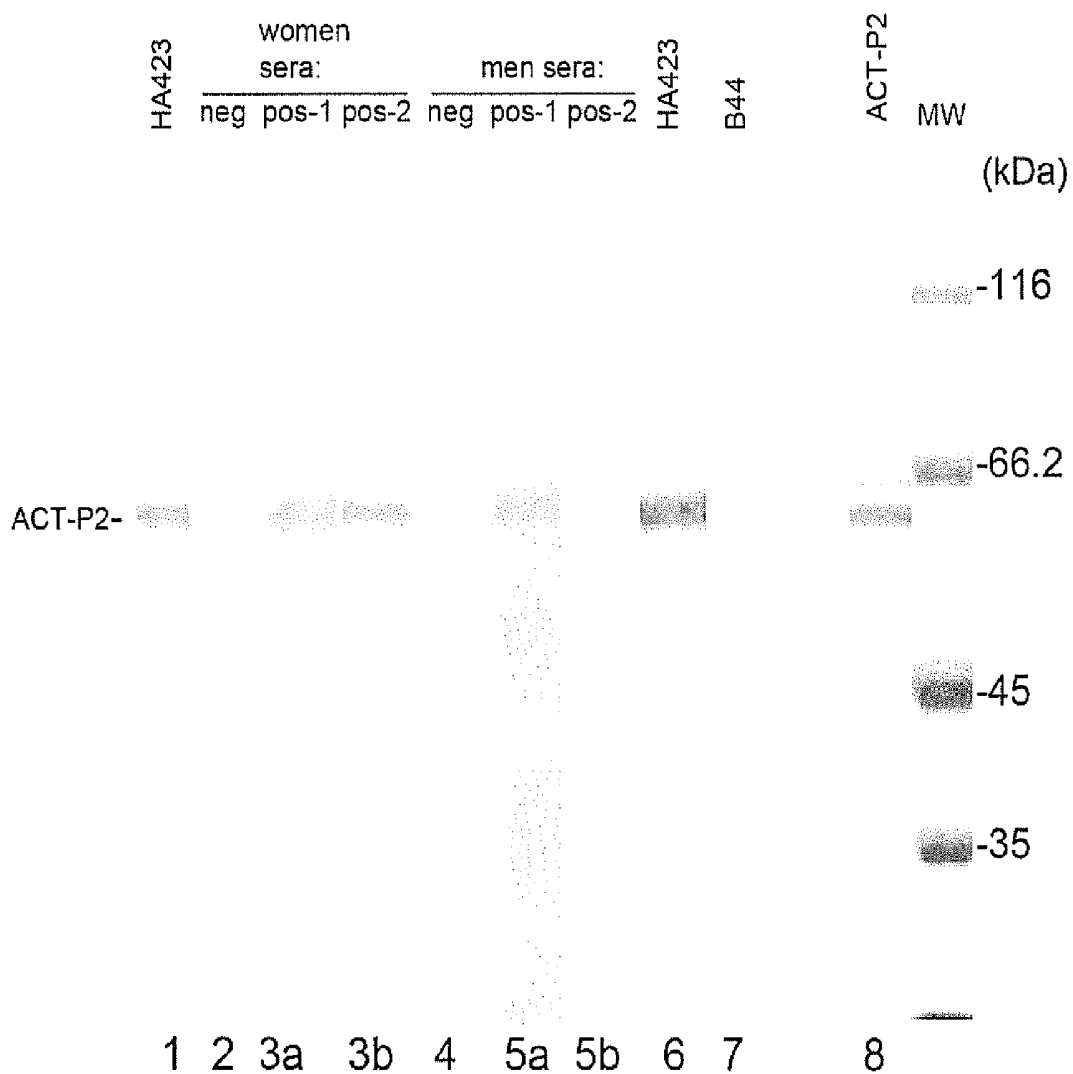


FIGURE 11

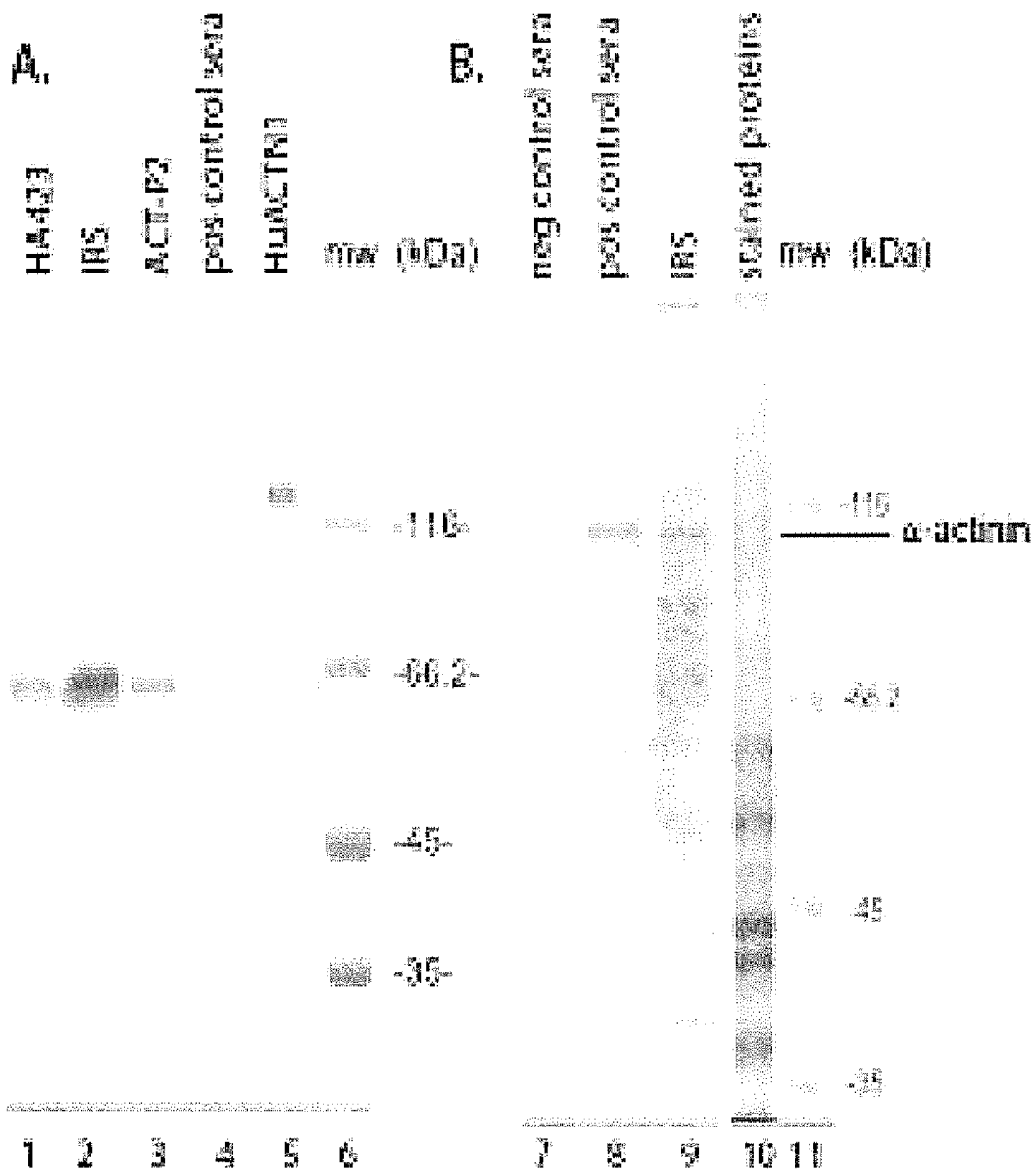


FIGURE 12

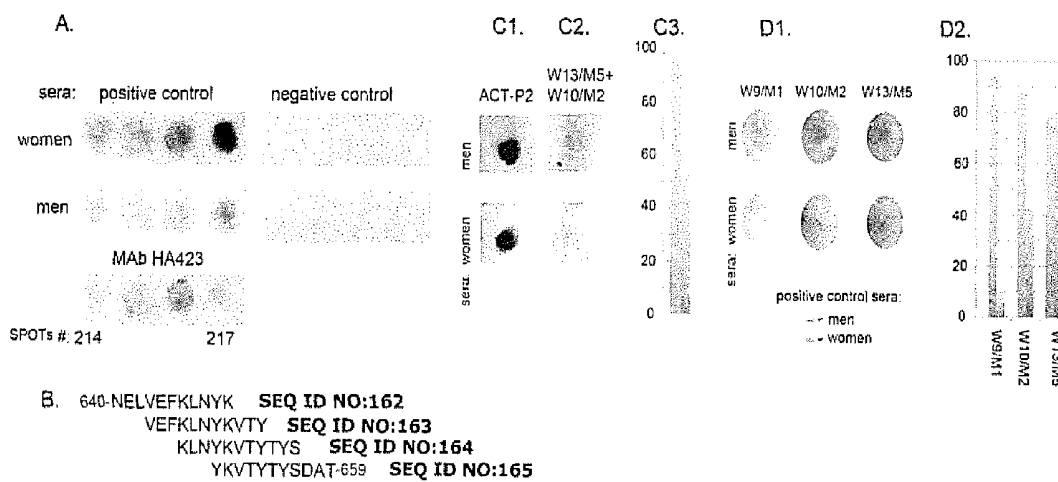
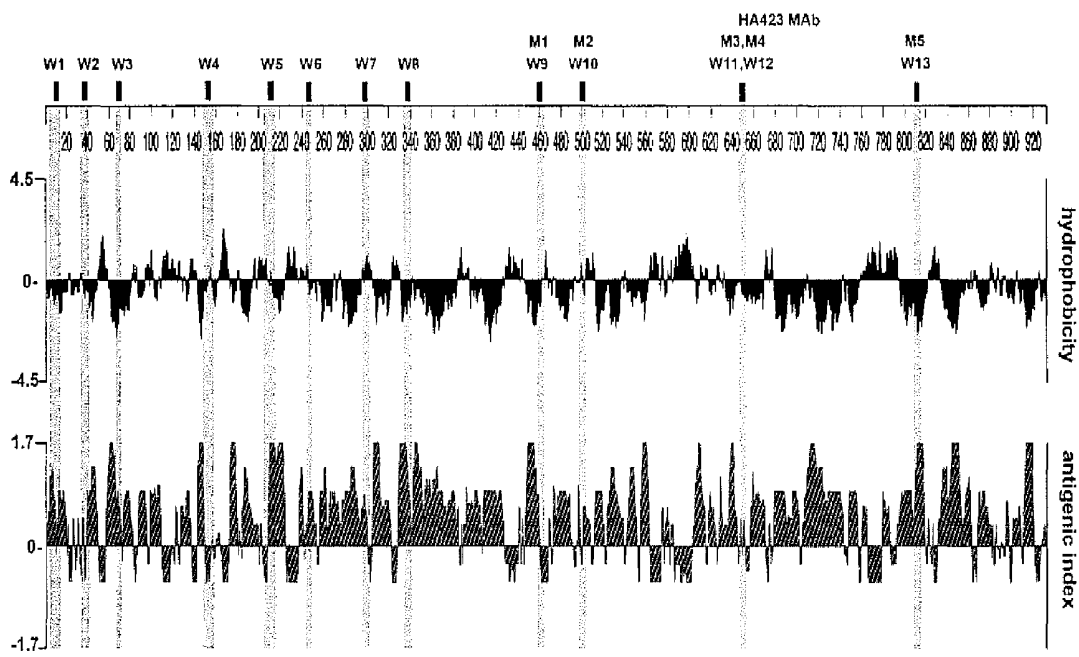


FIGURE 13





## STRINGS OF EPITOPES USEFUL IN DIAGNOSING AND ELICITING IMMUNE RESPONSES TO SEXUALLY TRANSMITTED INFECTIONS

The invention relates to compositions methods used to detect and/or diagnose infections caused by, for example, *Trichomonas*, *Treponema*, and *Neisseria* species. The invention further relates to compositions and methods for eliciting an immune response and/or vaccinating against infection by *Trichomonas*, *Treponema*, and *Neisseria* species

### BACKGROUND OF THE INVENTION

Sexually transmitted infections (STIs) are a major global cause of acute illness, infertility, long term disability and death, with severe medical and psychological consequences for millions of men, women and infants. WHO estimated that 340 million new cases of syphilis, gonorrhoea, *chlamydia* and trichomoniasis occurred throughout the world in 1999 in men and women aged 15-49 years, and incidence has risen steadily since then.

*Trichomonas vaginalis* causes vaginitis in women and non-gonococcal, non-chlamydial urethritis in men. Among men, the most recent findings indicate a relationship between seropositivity to *T. vaginalis* and prostate cancer. This parasite is now the number one, non-viral sexually transmitted disease agent. In 2013, the incidence of this sexually transmitted infection (STI) referred to as trichomonosis or trichomoniasis is estimated to be 10 million women in the United States and 270 to 350 million women worldwide. Health consequences to women include cervical cancer, pelvic inflammatory disease, infertility, increased HPV and herpes susceptibility, and adverse pregnancy outcomes accompanied with low-birth-weight infants. Significantly, 25% of HIV seroconversions are the direct result of trichomonosis, which is known to increase the portal of exit and entry of HIV infectious viral particles. Therefore, control of trichomonosis may be one of the most effective means of reducing HIV transmission risk and of preventing prostate and cervical cancers worldwide.

It is clear that the public health costs as a result of this STI are enormous, and interference strategies are needed. The most important interference strategy is the availability of rapid, accurate diagnostics with exceptional sensitivity and specificity toward this STI agent. Despite the impact of this STI to public health, fundamental aspects of *T. vaginalis* cell biology and mechanisms of pathogenesis remain unknown. As previously disclosed in U.S. Pat. No. 8,017,103 B2,  $\alpha$ -actinin is expressed by *Trichomonas* species and can be used to detect the presence of *Trichomonas* infection. However, the antibodies to parasite proteins available hitherto are inferior in their ability to detect the immunoreactive trichomonad protein antigens.

### SUMMARY OF THE INVENTION

The antibodies, proteins, and epitopes to the proteins detected by the human antibody of the present invention are novel and have increased utility for diagnostics to this STI. Antigenicity and specificity is increased with the microorganism-specific target protein antigens and epitopes of the present invention compared to previously available diagnostics. Furthermore, the present invention overcomes prior shortcomings in the art by providing epitopes for detecting antibody in sera of humans exposed to and/or infected with *T. vaginalis* and other microorganisms that cause STIs, such

as *Treponema pallidum* and *Neisseria gonorrhoeae*. In addition to compositions and methods relating to detection and diagnosis of STIs, the invention includes compositions and methods for eliciting an immune response and providing vaccines that can protect subjects from STIs.

An embodiment of the invention is a method of detecting the presence of a microorganism in a biological sample from a subject, comprising the steps of identifying at least one protein that is expressed by the microorganism of interest, determining regions of the protein that are highly immunogenic, and designing 15-mer epitopes encoding those regions. The invention is further directed to synthesizing a plurality of 15-mer epitopes in a linear array to form a series of epitopes (SOE), wherein the 15-mer epitopes are joined with amino acid repeats of glycine (-GG-) or lysine (-KK-). The SOE is then contacted with a biological sample under conditions whereby an antigen-antibody complex can form, and formation of at least one said antigen-antibody complex is an indication of the presence of the microorganism of interest. The SOE typically comprises at least six of said 15-mer epitopes, but may comprise fewer or greater numbers of 5-mer epitopes. A composition may comprise SOEs to detect multiple proteins from a single species or family of microorganisms, or from a group of unrelated microorganisms.

Sequences encoding 15-mer epitopes and SOEs are provided to detect, diagnose or treat infections caused by *Trichomonas*, *Treponema*, and *Neisseria* species. Aspects of the invention are applicable to other species. Exemplary SOEs detect *Trichomonas* species including *Trichomonas (T.) vaginalis*, *T. vaginalis* isolates T016, T068-II, UT40, and VB102, *Tritrichomonas (Tt.) foetus*, *T. foetus*, *Tt enteris*, *T. paviovi*, *Tt. suis*, *Tt. Rotunda*, *T. buttreysi*, *Tt. Ovis*, *Tt. Equi*, *T. equibuccalis*, *T. anatis*, *Tt. eberthi*, *T. gallinae*, *T. gallinarum*, *Tt. caviae*, *Tt muris*, *Tt. wenoni*, *Tt. Minula*, *T. microti*, *T. canistomae*, *T. felistomae*, *T. tenax*, *Tt. hominis*, and *T. macacovaginae*. Epitopes, 15-mer epitopes and SOE sequences are provided to detect diagnose or treat infections caused by *Treponema pallidum* and *Neisseria gonorrhoeae*.

Additional bacterial pathogens may be detected, diagnosed, or vaccinated against, with SOEs encoding highly immunogenic regions of one or more proteins expressed by a microorganism or bacterial pathogen of interest. Other microorganisms include, but are not limited to *Chlamydia trachomatis*, *Saccharomyces cerevisiae*, *Candida albicans*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*.

In one embodiment, detection is performed by immunoassay. A preferred immunoassay is an enzyme-linked immunosorbent assay (ELISA). The preferred biological sample can be saliva, urine, blood, serum or plasma, a lung lavage or sputum sample, and the subject may be male or female. Biological samples can also be vaginal fluid or washing, or semen or prostatic fluid.

In some embodiments, the biological sample is cerebrospinal fluid, joint fluid, body cavity fluid, whole cells, cell extracts, tissue, biopsy material, aspirates, exudates, pap smear samples, pap smear preparations, slide preparations, fixed cells, and tissue sections. The biological samples can be collected from a subject that may be human, non-human primate, dog, cat, cattle, sheep, swine, horse, bird, mouse and rat.

In one exemplary embodiment, a method of diagnosing a *Trichomonas* infection in a subject, comprises the steps of identifying at least one protein that is expressed by a *Trichomonas* species, determining one or more regions of at least one protein from *Trichomonas* that is/are highly immu-

nogenic, designing 15-mer epitopes encoding said regions of the protein, and synthesizing a plurality of 15-mer epitopes in a linear array to form a series of epitopes (SOE) wherein the 15-mer epitopes are joined with glycine (-GG-) and/or lysine (-KK-) repeats. Any SOE may contain a mixture of both -GG- and -KK- repeats. A biological sample from a subject is contacted with at least one SOE that binds an antibody to a *Trichomonas*-specific protein selected from the group consisting of aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin, under conditions whereby an epitope-antibody complex can form, and detecting formation of at least one epitope-antibody complex as an indication of *Trichomonas* infection. The biological sample typically is serum, plasma, blood, saliva, semen, cerebrospinal fluid, semen, prostatic fluid, urine, sputum, joint fluid, body cavity fluid, whole cells, cell extracts, tissue, biopsy material, aspirates, exudates, vaginal washings, pap smear samples, pap smear preparations, slide preparations, fixed cells, or tissue sections. The method of detecting the epitope-antibody is performed using an immunoassay. In one exemplary embodiment, the immunoassay is an enzyme-linked immunosorbent assay (ELISA). The *Trichomonas* species that can be identified include *Trichomonas (T.) vaginalis*, *T. vaginalis* isolates T016, T068-II, UT40, and VB102, *Tritrichomonas (Tt.) foetus*, *T. foetus*, *Tt enteris*, *T. paviovi*, *T. suis*, *Tt. Rotunda*, *T. buttrei*, *T. Ovis*, *Tt. Equi*, *T. equibuccalis*, *T. anatis*, *Tt. eberthi*, *T. gallinae*, *T. gallinarum*, *Tt. caviae*, *Tt muris*, *Tt. wenoni*, *T. Minuta*, *T. microti*, *T. canistomae*, *T. felistomae*, *T. tenax*, *Tt. hominis*, and *T. macacovaginae*. A subject in this invention is any animal that can be infected by trichomonads. In certain embodiments, the subject is human.

An exemplary embodiment includes a method of diagnosing in a subject a sexually transmitted infection (STI) selected from the group consisting of trichomoniasis, gonorrhoeae, and syphilis. This embodiment involves the steps of identifying at least one protein that is expressed by the microorganism of interest, determining regions of at least one protein that is highly immunogenic, designing 15-mer epitopes encoding the highly immunogenic regions of the protein, and synthesizing a plurality of said 15-mer epitopes in a linear array to form a series of epitopes (SOE) wherein the 15-mer epitopes are joined with amino acid repeats of glycine (-GG-) and/or lysine (-KK-). Variations on this method further comprise assaying biological samples from a subject that are collected at two different time points. The interval of time may be days, weeks, or months, as deemed appropriate by one of ordinary skill in the art of STI diagnosis. The assay can be an immunoassay, with at least one SOE encoding at least one protein specific to one or more microorganisms suspected of causing a STI, under conditions whereby an epitope-antibody or antigen-antibody complex can form; and detecting formation of at least one epitope-antibody complex in the two samples. Detection readout at the first time point is compared with detection readout of the second time point and the comparison is used to determine the status of a STI in said subject.

Embodiments of the invention include a monoclonal antibody selected from the group of ALDwsu-1, ALDwsu-2, ALD12A, ALD64A, B44, ENOWsu-2, ENOWsu-3, ENOWsu-4, ENOWsu-6, B43, GAPwsu-2, GAPwsu-3, and HA423 (Tables 1 and 2A).

Embodiments also include an epitope selected from the group consisting of SEQ ID NO:1-53, 66-78, 104-106, 121-126, 139-143 and 162-165; or 15-mer epitope selected from the group consisting of SEQ ID NO:79-102, 107-119, and 128-133. The invention is further a string of epitopes

(SOE), comprising a plurality of epitopes linked by glycine or lysine repeats (-GG- or -KK-), selected from the group consisting of SEQ ID NO: 120, 127, 134, 145, and 146.

Embodiments further include a nucleic acid encoding at least one epitope, or at least one 15-mer epitope, or at least one string of epitopes (SOE), wherein the protein product of the nucleic acid binds to at least one antibody type in a biological sample and at least one antibody type is reactive with at least one *Trichomonas* protein selected from the group consisting of aldolase, alpha-enolase, GAPDH, and alpha-actinin.

Embodiments also include a host cell comprising a transgene encoding a string of epitopes (SOE), wherein the SOE comprises a plurality of epitopes selected from NO:1-53, 66-78, 104-106, 121-126, AND 139-143, or a plurality of 15-mer epitopes selected from the group consisting of SEQ ID NO:79-102, 107-119, AND 128-133, wherein each SOE binds to at least one antibody type in a biological sample and the antibody type is reactive with at least one protein from a microorganism of interest. For *Trichomonas*, the protein is selected from the group consisting of aldolase, alpha-enolase, GAPDH, and alpha-actinin.

In addition, embodiments include a kit for diagnosis of a sexually transmitted infection (STI) in a subject, comprising at least one string of epitopes (SOE) able to bind at least one antibody type in a biological sample that is reactive with at least one protein from a microorganism selected from the group consisting of *Trichomonas*, *Treponema*, and *Neisseria* species. The kit comprises one or more reagents to perform an immunoassay of antibody-epitope or antibody-antigen complexes that form when the SOE of the kit contacts at least one antibody type in a biological sample, and may include a suitable vessel for performing said immunoassay, and a package insert describing steps required for performing said immunoassay, wherein detection of an antibody epitope or antibody-antigen complexes is diagnostic for a STI.

Embodiments also include eliciting an immune response to a microorganism in a subject. These involve identifying at least one protein that is expressed by the microorganism, determining regions of said at least one protein that are highly immunogenic, designing 15-mer epitopes encoding said regions of said at least one protein, and synthesizing a plurality of said 15-mer epitopes in a linear array to form a series of epitopes (SOE) wherein said 15-mer epitopes are joined with amino acid repeats selected from the group of glycine (-GG-) and lysine (-KK-). A pharmaceutical composition preferably includes at least one SOE with a suitable carrier and adjuvant, which is administered to a subject in an amount sufficient to stimulate formation of antibodies to the SOE by the immune system of the subject.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings are provided to assist in the understanding of the invention, but do not limit the invention and its uses.

FIG. 1 shows an ELISA assay of trichomonads to detect *T. vaginalis* aldolase, GAPDH, and  $\alpha$ -enolase.

FIG. 2 shows detection of *T. vaginalis* using different amounts of individual MAbs to show specificity of the MAbs.

FIG. 3 shows sequence alignment of fructose-1,6-bisphosphate aldolase sequences from *T. vaginalis*, *T. pallidum*, *N. gonorrhoeae*, *S. pyogenes*, *S. pneumoniae*, *S. aureus*, *E. coli*, *C. albicans*, *Saccharomyces cerevisiae* and *Homo sapiens*.

FIG. 4A shows hydrophobicity and antigenicity profile of *T. vaginalis*  $\alpha$ -enolase (ENO).

FIG. 4B shows hydrophobicity and antigenicity profile of *T. vaginalis* fructose-1,6-bisphosphate aldolase (ALD).

FIG. 4C shows hydrophobicity and antigenicity profile of *T. vaginalis*  $\alpha$ -glyceraldehyde-3-phosphate dehydrogenase (GAP).

FIG. 5 shows representative dot blots of individual 15-mer peptide epitopes.

FIG. 6A shows representative duplicate dot blots of combinations of 15-mer epitopes.

FIG. 6B shows densitometric scans of reactive dot blots from FIG. 4A.

FIG. 7A shows the 111 amino acid sequence of an rSOE encoding 15-mer epitopes of GAP (GAPDH), ENO (enolase) and ALD (aldolase) proteins from *T. vaginalis*. The sequence is that of SEQ ID NO: 145.

FIG. 7B shows SDS-PAGE and Coomassie-brilliant blue stained gels of recombinant *E. coli*, rSOE lysate, flow-through, washes and elution fractions.

FIG. 8A shows immunodetection of rSOE by ELISA.

FIG. 8B1 shows immunodetection of rSOE by dot blot.

FIG. 8B2 shows immunodetection of rSOE by immunoblotting after SDS-PAGE.

FIG. 9 is an example of an SOE comprising thirteen epitopes detected by women and men exposed to *T. vaginalis* are arranged sequentially within individual 15-mer peptides separated by a diglycine. The sequence is that of SEQ ID NO:146.

FIG. 10 shows immunoblot detection of ACT-P2 using IgG1 MAb HA423 and positive control sera from women and men.

FIGS. 11A and 11B are gels showing that pooled positive control sera from both women and men are unreactive with HuACTNa and have antibodies to numerous trichomonad proteins.

FIGS. 12A-12D2 show SPOTs analysis with positive control sera from women and men, detecting overlapping peptides on SPOTs membranes of a representative epitope and reactions with immobilized ACT-P2 and synthetic 15-mer peptides used in combination or singly. 12A shows IgG antibody detection of overlapping peptides from spots 214-217. 12B shows the corresponding amino acid sequences of the individual oligopeptides (SEQ ID NO:162-165). 12C1 and 12C2 show signal intensities obtained for 1 microgram of ACT-P2 or 2/13M5+W10/M2 immobilized on nitrocellulose membranes and detected by IgG of positive control sera. 12C3 shows densitometric scans of the dots shown in C2 to provide relative intensities. 12D1 shows relative reaction of 1  $\mu$ gram of 15-mer epitopes from Table 1, immobilized on nitrocellulose membranes. 12D2 shows densitometric scans to provide relative intensities of dots.

FIG. 13 shows a hydrophobicity plot for *T. vaginalis*  $\alpha$ -actinin.

FIG. 14 shows an amino acid sequence alignment of *T. vaginalis*  $\alpha$ -actinin (SEQ ID NO:157 with representative pathogenic organisms *T. suis*, *C. albicans*, *S. cerevisiae* and HuACTN1.

#### DETAILED DESCRIPTION

The present invention comprises peptide and nucleotide sequences encoding peptides that are highly immunogenic and may be used to detect the presence of microorganisms in a biological sample, or diagnose an infection of the microorganisms in a subject. The methods of the invention can comprise detection of one or more microorganism-

specific proteins in one or more biological samples, or detection of antibodies that a subject has produced in response to exposure or infection caused by microorganisms. The invention further comprises compositions and methods for eliciting an immune response in a subject, or vaccinating against a STI, such as trichomoniasis, gonorrhoea or syphilis.

The invention further comprises methods of arraying the highly immunogenic peptides in a linear macromolecule described herein as a series of epitopes (SOE), recombinant series of epitopes (rSOE), or string of pearls (SOP). In one embodiment, an SOE is synthetic DNA encoding a protein comprising sequential 15-mer peptides. The DNA encoding the SOE can be ligated into a plasmid and used to transform or transfect a suitable host cell that will express the SOE as a recombinant protein. In another embodiment, an SOE can be synthesized as a polypeptide sequence encoding sequential 15-mer peptides. Amino acid repeats of glycine (-GG-) or lysine (-KK-) are placed between the 15-mer peptides, either encoded as nucleotides in DNA, or as amino acid residues in a synthetic polypeptide. Typically, at least six 15-mer epitopes linked with -GG- or -KK- are used, however, more 15-mers may be added to a synthetic DNA construct or to a synthetic peptide. In another embodiment, several SOE species may be included in a composition. Each of the SOE species may differ in the identity of the 15-mer epitopes included in each, or they may further be 15-mer epitopes from different proteins or even different microorganisms.

The invention is based on the unexpected discovery that infection with *T. vaginalis* and other *Trichomonas* species can be diagnosed by detecting individually or in combination *T. vaginalis* or other *Trichomonas* species aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins or epitopes of the proteins either singly or in combination and/or antibodies to AGEA proteins or epitopes of the proteins either singly or in combination. Similar to embodiments relating to *T. vaginalis*, further embodiments of the invention are methods of detecting, diagnosing or preventing infection of *N. gonorrhoeae* and/or *T. pallidum*. These embodiments make use of highly immunogenic 15-mer peptides and SOEs that elicit an immune response to either *N. gonorrhoeae* or *T. pallidum*, and sequence listings are provided for each of the microorganisms of interest. Each of the embodiments of the invention may be practiced by substituting the SOE or antibodies specific to a microorganism of interest, such as a species of the *trichomonas*, *neisseria* or *treponema* families. Further, amino acid sequences of other sexually transmitted bacterial pathogens (*Chlamydia trachomatis*), of yeast (*Saccharomyces cerevisiae* and *Candida albicans*), and of other human bacterial pathogens (*Streptococcus pyogenes*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*) may be identified and incorporated into SOEs for detection and diagnosis, and may also be used to elicit immune response and provide protection from infection.

Thus, in some embodiments, the present invention provides a method of diagnosing a *T. vaginalis* infection in a subject. Highly immunogenic regions of microorganism-specific proteins selected from the group consisting of *T. vaginalis* aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin are identified and at least one SOE comprising 15-mer peptides encoding the highly immunogenic regions. The 15-mer peptides are linked with -GG- or -KK- amino acids. A biological sample from the subject suspected of having an infection caused by the *T. vaginalis* under conditions whereby an antigen/antibody complex can form; and b) detecting formation of an antigen/antibody complex, thereby

detecting *T. vaginalis* AGEA proteins or epitopes of the proteins either singly or in combination in the sample and thereby diagnosing a *T. vaginalis* infection in the subject.

Additionally provided is a method of identifying an acute *T. vaginalis* infection in a subject, comprising: a) at a first time point, contacting a first sample from the subject with a *T. vaginalis* protein selected from a) aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins or epitopes of proteins either singly or in combination, under conditions whereby an antigen/antibody complex can form; b) detecting the formation of an antigen/antibody complex in step a); c) at a second time point, contacting a second sample from the subject with a *T. vaginalis* protein or epitopes of proteins selected from aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins, under conditions whereby an antigen/antibody complex can form; d) detecting the formation of an antigen/antibody complex in step (c); and e) comparing the amount of antigen/antibody complex of step (b) with the amount of antigen/antibody complex of step (d), whereby a difference in the amount of antigen/antibody complex identifies an acute *T. vaginalis* infection in the subject.

Typically, the biological samples used in practicing the invention are vaginal washings, pap smear or other cell preparations, urine, blood or serum, or saliva samples. However, the sample in all the above various embodiments of the invention can be any biological fluid or tissue that can be used in an immunoassay that either detects antibody in the biological fluid or detects protein in the biological fluid with available polyclonal and/or monoclonal antibodies to the proteins of this invention, including but not limited to, lung aspirates, semen, cerebrospinal fluid, semen, prostatic fluid, sputum, joint fluid, body cavity fluid, whole cells, cell extracts, tissue, biopsy material, aspirates, exudates, vaginal washings, pap smear samples, pap smear preparations, slide preparations, fixed cells, or tissue sections from a subject, where the subject can be either female or male. Several recent reports examining infections in the lungs of immunocompromised individuals or patients with acute respiratory distress syndrome have shown the presence of *T. vaginalis* as primary or secondary infection. Therefore, it is understood that the invention may be useful for diagnosis and treatment of patients regardless of STI status, and that any biological sample may be used.

In the embodiment of identifying an acute infection in a subject, a first sample is taken at a first time point and a second sample is taken at a second time point and the amount of antibody or antigen and/or the type of antigen or antibody present in the two samples is compared. A change in the amount and/or type of antibody or antigen is indicative of an acute infection and no change in the amount and/or type of antibody or antigen is indicative of a past or chronic infection. For example, a decrease in the amount of antibody or antigen in the sample taken at the second time point (e.g., after treatment of the subject for a *T. vaginalis* infection) is indicative that the infection at the time the first sample was taken was an acute infection. Furthermore, if there is an increase in titer of antibody or amount of antigen, this would indicate an ongoing/active infection that was not diagnosed initially or that was not eliminated upon diagnosis and drug treatment. This would necessitate additional examination of body sites and tissues for the presence of organism or antigen or antibody.

Furthermore, a *T. vaginalis* protein of this invention can detect, but is not limited to, a recombinant  $\alpha$ -enolase, aldolase, GAPDH and/or  $\alpha$ -actinin protein as described in the EXAMPLES section set forth herein, as well as peptides of the reactive epitopes, fragments, and immunologically-

similar variants of such proteins, peptides and fragments. Such epitopes and recombinant proteins and peptides of this invention can be produced according to methods well known in the art and can also be produced by fractionation and/or isolation techniques, synthesis techniques, etc. that are known for producing proteins and peptides for use in immunoassays.

The term "*Trichomonas*" as used herein, includes, but is not limited to a protozoan parasite of the order Trichomonadida, genera *Ditrichomonas*, *Trichomonas*, *Tritrichomonas* and *Pentatrichomonas*, comprising multiple species that infects both humans and animals. "*Trichomonas*" refers to any *Trichomonas* species, e.g., *Tritrichomonas foetus* (also known as *Trichomonas foetus*, *Tt. fetus*), *Tt. enteris* and *T. paviovi*, which infect cattle; *Tt. suis*, *Tt. rotunda* and *T. buttrei*, which infect swine; *Dt. Ovis*, which infects sheep; *Tt. equi* and *T. equibuccalis*, which infect horses; *T. anatis*, *Tt. eberthi*, *T. gallinae* and *T. gallinarium*, which infect birds; *Tt. caviae*, *Tt. muris*, *Tt. wenoni*, *Tt. Minuta* and *T. microti*, which infect rodents; *T. canistomae* and *T. felistomae*, which infect dogs and cats; and *T. tenax*, *T. vaginalis*, *Pt. hominis*, and *T. macacovaginae*, which infect primates (including humans). *Trichomonas vaginalis* as described herein includes isolates T016, T068-II, UT40, and VB102, as well as any other *T. vaginalis* isolate now known or later identified.

The term "antibody" as used herein, includes, but is not limited to a polypeptide encoded by an immunoglobulin gene or immunoglobulin genes, or fragments thereof. An antibody may be produced in a species other than the species of the subject putatively affected by a *Trichomonas* infection. "Antibody" also includes, but is not limited to, a polypeptide encoded by an immunoglobulin gene or immunoglobulin genes, or fragments thereof, which specifically binds to and recognizes the antigen-specific binding region (idiotype) of an antibody produced by the host in response to exposure to *T. vaginalis* or other *Trichomonas* species antigen(s). Antibodies may also be produced using recombinant DNA gene engineering to generate synthetic linear or conformational antibodies that recognize and bind to their cognate antigen(s).

The term "epitope" means an antigenic determinant that is specifically bound by an antibody. Epitopes usually consist of surface groupings of molecules, such as amino acids and/or sugar side chains, and may be linear or have specific three-dimensional structural characteristics, as well as specific charge characteristics.

The term "15-mer epitope" and "15-mer amino acid sequences" are used interchangeably to describe the building blocks of a "series of epitopes" (see definition of series of epitopes below). A 15-mer epitope typically comprises are typically peptide 15-mers comprising 5 to 11 residues which are highly immunogenic. The epitope must have enough amino acid residues so that the peptide product is large enough to be recognized, which will generally be at least 4-5 amino acids, but can be up to 11, 12, 13, 14, or at least 15 amino acids. The peptide 15-mers encode highly immunogenic epitope regions (from a protein expressed by a pathogenic microorganism of interest), flanked by 3 to 5 amino acids of naturally occurring sequence in order to mimic the tertiary structure of protein folding to recapitulate the native protein domain. These sequences are also called 15-mer epitopes in order to distinguish them from the epitope within the native protein. However, they could easily be made small or larger, generally within the range of 5 to 30 amino acids, 10 to 25 amino acids, or 12 to 20 amino acids. Those of skill in the art will recognize that 15 amino acids is considered to

be a starting point or “default” size for designing short peptide sequences of epitopes. A 15-mer is thought to be sufficiently large enough to allow correct folding and presentation of an immunogenic site or protein domain, without having extraneous free ends that might hinder access to the site of interest. It can be easily understood that a 14-mer, 16-mer, or any other oligopeptide of about 5-30 amino acids could also be used in practicing the invention, so long as it comprises the essential core of the immunogenic amino acids provided in each sequence of the invention, shown in various tables herein, and is functionally immunogenic.

The terms “series of epitopes” or “string of epitopes” (SOE), “recombinant series of epitopes” (rSOE), and “string of pearls” (SOP) are used interchangeably to refer to a synthetic macromolecule encoding a plurality of epitopes. The epitopes encoded in the SOE, rSOE, or SOP macromolecules of the invention are typically peptide 15-mers (or 15-mer amino acid sequences) comprising 5 to 11 residues which are highly immunogenic. Selection of epitopes and/or 15-mer epitopes to be included in a SOE is based specificity of the sequence, i.e., having no identity to other proteins in databases. This is especially true with the SOEs that have epitopes and/or 15-mer epitopes from proteins expressed by other organisms. Thus, selecting unique sequences helps to eliminate false positives that may occur due to recognition of proteins or antibodies to proteins from other organisms. The plurality of epitopes are typically arrayed in a linear molecule linked with repeats of glycine (-GG-), lysine (-KK-), or a mixture of both. rSOE protein can be expressed in host cells transfected or transformed with a vector carrying a nucleic acid encoding SOE or SOP sequences.

The term “highly immunogenic” means that the amino acids encoded by the sequences indicated will selectively and specifically bind to antibodies raised against a particular sequence. For example, the epitopes, 15-mer epitopes, and SOEs of the invention from regions of *T. vaginalis*  $\alpha$ -actinin will detect the presence of *T. vaginalis* antibodies in in vitro detection assays. Accordingly, antibodies raised against the epitopes, 15-mer epitopes, and SOEs of the invention from regions of *T. vaginalis*  $\alpha$ -actinin will detect the presence of *T. vaginalis*  $\alpha$ -actinin protein or protein fragments.

The terms “specifically binds to” and “specifically reactive with” refer to a binding reaction that is determinative of the presence of the antigen and antibody in the presence of a heterogeneous population of proteins and other biologics. Thus, under designated assay conditions, the specified antibodies and antigens bind to one another and do not bind in a significant amount to other components present in a sample. Specific binding to a target analyte under such conditions may require a binding moiety that is selected for its specificity for a particular target analyte. A variety of immunoassay formats may be used to select antibodies specifically reactive with a particular antigen. For example, solid-phase enzyme-linked immunosorbent assays (ELISA) are routinely used to select monoclonal antibodies specifically immunoreactive with an analyte. See Harlow and Lane (ANTIBODIES: A LABORATORY MANUAL, Cold Springs Harbor Publications, New York, (1988)) for a description of immunoassay formats and conditions that can be used to determine specific immunoreactivity. Typically a specific or selective reaction will be at least twice background signal to noise and more typically more than 10 to 100 times greater than background.

An “immunologically reactive fragment” of a protein refers to a portion of the protein or peptide that is immunologically reactive with a binding partner, e.g., an antibody, which is immunologically reactive with the protein itself.

As used herein, and “antibody-antigen complex” can refer to an immune complex that forms when an antibody binds to its preferred or recognized antigen. The antigen may be a full-length native protein, or it may be a protein fragment, either naturally occurring or synthetic. The antigen may further be an epitope, and that epitope may be synthetic. As practiced in the invention, and antigen may further be a 15-mer epitope or an SOE, as defined above. As disclosed herein, a discussion of antibody-epitope complex may further mean a complex of one or more 15-mer epitopes or SOEs and one or more antibody types. An immune complex comprising an antibody and an epitope may also be referred to as an antibody-epitope complex to distinguish if from an antibody-antigen complex, however, both antibody-epitope complexes and antibody-antigen complexes can be collectively referred to as immune complexes.

As used herein, the term “vaccine” refers to a composition that may be used to treat an individual to provide protection against challenge, and more specifically it provides protection against a challenge mounted by exposure to or infection with a microorganism. For example, an SOE composed of an array of *T. vaginalis* epitopes in a solution suitable for injection into a subject may provide protection from trichomoniasis. An SOE comprising an array of *N. gonorrhoeae* epitopes may provide protection from gonorrhoea, and an SOE comprising an array of *T. pallidum* epitopes may provide protection from syphilis.

As used herein, the term “immunogenic composition” refers to a composition comprising a SOE, rSOE, and/or SOP composed of epitopes that elicit an immune response. For example, an SOE composed of an array of *T. vaginalis* epitopes in a solution suitable for injection into a subject may elicit an immune response to *T. vaginalis* infection. An SOE comprising an array of *N. gonorrhoeae* epitopes may elicit an immune response to *N. gonorrhoeae* infection, and an SOE comprising an array of *T. pallidum* epitopes may elicit an immune response to *T. pallidum* infection.

Antibodies to *T. vaginalis* proteins can be generated using methods that are well known in the art. Such antibodies can include, but are not limited to, polyclonal, monoclonal, chimeric, humanized, single chain, Fab fragments, and fragments produced by an expression library, including phage display. (See, e.g., Paul, FUNDAMENTAL IMMUNOLOGY, 3rd Ed., 1993, Raven Press, New York, for antibody structure and terminology.)

Antibody fragments that contain specific binding sites for a *T. vaginalis* protein can also be generated. For example, such fragments include, but are not limited to, the F(ab')<sub>2</sub> fragments that can be produced by pepsin digestion of the antibody molecule, and the Fab fragments that can be generated by reducing the disulfide bridges of the F(ab')<sub>2</sub> fragments. Alternatively, Fab expression libraries can be constructed to allow rapid and easy identification of monoclonal antibody Fab fragments with the desired specificity (Huse et al., *Science* 254, 1275-1281 (1989)).

For the production of antibodies, various hosts including goats, rabbits, rats, mice, humans, and others, may be immunized by injection of chemically-stabilized whole organisms or any extract or lysate of organisms comprising total proteins or with a *T. vaginalis* protein (e.g., individual or a combination of aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins) or any fragment or oligopeptide or conjugate thereof that has immunogenic properties. In practicing the invention, one or more epitopes, 15-mer epitopes and/or SOEs may be used for injection into hosts for the production of antibodies. Depending on the host species, various adjuvants can be used to increase the immunological

response. Such adjuvants include, but are not limited to, Freund's complete and incomplete adjuvant, mineral gels such as aluminum hydroxide, and surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanin, and dinitrophenol. Examples of adjuvants used in humans include BCG (bacilli Calmette-Guerin) and *Corynebacterium parvum*.

Monoclonal antibodies (MAbs) to *Trichomonas vaginalis* proteins can be prepared using any technique that provides for the production of antibody molecules by continuous cell lines in culture. These include, but are not limited to, the hybridoma technique, the human B-cell hybridoma technique, and the EBV-hybridoma technique (Kohler, et al. (1975) *Nature* 256:495-497; Kozbor, et al. (1985) *J. Immunol. Methods* 81:31-42; Cote, et al. (1983) *Proc. Natl. Acad. Sci.* 80:2026-2030; Cole, et al. (1984) *Mol. Cell Biol.* 62:109-120). Briefly, the procedure is as follows: an animal is immunized with a *T. vaginalis* protein, such as individual or a combination of aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins, or immunogenic fragment or oligopeptide or conjugate thereof. For example, haptenic oligopeptides of a *T. vaginalis* protein can be conjugated to a carrier protein to be used as an immunogen. Lymphoid cells (e.g., splenic lymphocytes) are then obtained from the immunized animal and fused with immortal cells (e.g., myeloma or heteromyeloma) to produce hybrid cells. The hybrid cells are screened to identify those that produce the desired antibody.

Human hybridomas that secrete human MAb can be produced by the Kohler and Milstein technique. Although human antibodies are especially preferred for treatment of humans, in general, the generation of stable human-human hybridomas for long-term production of human MAb can be difficult. Hybridoma production in rodents, especially mouse, is a very well established procedure and thus, stable murine hybridomas provide an unlimited source of antibody of select characteristics. As an alternative to human antibodies, the mouse antibodies can be converted to chimeric murine/human antibodies by genetic engineering techniques. See Oi, et al., *Bio Techniques* 4(4):214-221 (1986); Sun, et al., *Hybridoma* 5 (1986).

The MAbs of this invention specific for *T. vaginalis* protein epitopes can also be used to produce anti-idiotypic (paratope-specific) antibodies. (See e.g., McNamara et al., *Science* 220, 1325-26 (1984); Kennedy et al., *Science* 232: 220 (1986).) These antibodies resemble the *T. vaginalis* protein epitope and thus can be used as an antigen to stimulate an immune response against the *T. vaginalis* protein.

In addition, techniques developed for the production of "chimeric antibodies," the splicing of mouse antibody genes to human antibody genes to obtain a molecule with appropriate antigen specificity and biological activity can be used (Morrison, et al., *Proc. Natl. Acad. Sci.* 81:6851-6855 (1984); Neuberger, et al. *Nature* 312:604-608 (1984); Takeda, et al., *Nature* 314:452-454 (1985)). Alternatively, techniques described for the production of single chain antibodies can be adapted, using methods known in the art, to produce *T. vaginalis* protein-specific single chain antibodies. Antibodies with related specificity, but of distinct idiotypic composition, can be generated by chain shuffling from random combinatorial immunoglobulin libraries (Burton, *Proc. Natl. Acad. Sci.* 88:11120-3 (1991)).

Antibodies can also be produced by inducing in vivo production in the lymphocyte population or by screening immunoglobulin libraries or panels of highly specific bind-

ing reagents as described in the literature (Orlandi, et al., *Proc. Natl. Acad. Sci.* 86:3833-3837 (1989)); Winter, et al., *Nature* 349:293-299 (1991)).

Various immunoassays can be used to identify antibodies of this invention having the desired specificity. Furthermore, a wide variety of immunoassays may be employed in the methods of this invention to detect antibodies and antigens of *T. vaginalis* proteins for diagnosis of *T. vaginalis* infection. Such immunoassays typically involve the measurement of antigen/antibody complex formation between a *T. vaginalis* protein or peptide and its specific antibody.

The immunoassays of the invention can be either competitive or noncompetitive. In competitive binding assays, *T. vaginalis* antigen or antibody competes with a detectably labeled *T. vaginalis* antigen or antibody for specific binding to a capture site bound to a solid surface. The concentration of labeled antigen or antibody bound to the capture agent is inversely proportional to the amount of free antigen or antibody present in the sample.

Noncompetitive assays can be, for example, sandwich assays, in which the sample analyte (target antibody) is bound between two analyte-specific binding reagents. One of the binding agents is used as a capture agent and is bound to a solid surface. The other binding agent is labeled and is used to measure or detect the resultant antigen/antibody complex by e.g., visual or instrument means. A number of combinations of capture agent and labeled binding agent can be used. For instance, antigens derived from the *T. vaginalis* can be used as the capture agent and labeled anti-human antibodies specific for the constant region of human antibodies can be used as the labeled binding agent to detect antibodies in a sample that bind the *T. vaginalis* antigen. Goat, sheep and other non-human antibodies specific for human immunoglobulin constant regions are well known in the art. Alternatively, the anti-human antibodies can be the capture agent and the antigen can be labeled. Other proteins capable of specifically binding human immunoglobulin constant regions, such as protein A, protein L or protein G can also be used as the capture agent or labeled binding agent. These proteins are normal constituents of the cell walls of streptococcal bacteria. They exhibit a strong non-immunogenic reactivity with immunoglobulin constant regions from a variety of species. (See, e.g., Kronval, et al., *J. Immunol.*, 111:1401-1406 (1973); Akerstrom, et al., *J. Immunol.*, 135: 2589-2542 (1985).)

The non-competitive assays need not be sandwich assays. For instance, the antibodies or antigens in the sample can be bound directly to the solid surface. The presence of antibodies or antigens in the sample can then be detected using labeled antigen or antibody, respectively.

In some embodiments, antibodies and/or *T. vaginalis* protein or epitopes of proteins either singly or in combination of aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins, can be conjugated or otherwise linked or connected (e.g., covalently or non-covalently) to a solid support (e.g., bead, plate, slide, dish, membrane or well) in accordance with known techniques. Further, a plasmid construct encoding a recombinant protein that contains the epitopes of aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins detected by human antibodies following infection by and exposure to *T. vaginalis* can be used. This protein comprised by a series of the epitope sequences is referred to as a SOE, rSOE, or SOP with each "pearl" representing an individual epitope, and the epitope can be separated by amino acid repeats, such as glycine (-GG-) or lysine (-KK-). Antibodies can also be conjugated or otherwise linked or connected to detectable groups such as radiolabels (e.g.,  $^{35}\text{S}$ ,  $^{125}\text{I}$ ,  $^{32}\text{P}$ ,

<sup>13</sup>H, <sup>14</sup>C, <sup>131</sup>I), enzyme labels (e.g., horseradish peroxidase, alkaline phosphatase), gold beads, chemiluminescence labels, ligands (e.g., biotin) and/or fluorescence labels (e.g., fluorescein isothiocyanate) in accordance with known techniques.

A variety of organic and inorganic polymers, both natural and synthetic can be used as the material for the solid surface. Non-limiting examples of polymers include polyethylene, polypropylene, poly(4-methylbutene), polystyrene, polymethacrylate, poly(ethylene terephthalate), rayon, nylon, poly(vinyl butyrate), polyvinylidene difluoride (PVDF), silicones, polyformaldehyde, cellulose, cellulose acetate, nitrocellulose, and the like. Other materials that can be used include, but are not limited to, include paper, glass, ceramic, metal, metalloids, semiconductive materials, cements and the like. In addition, substances that form gels, such as proteins (e.g., gelatins), lipopolysaccharides, silicates, agarose and polyacrylamides can be used. Polymers that form several aqueous phases, such as dextrans, polyalkylene glycols or surfactants, such as phospholipids, long chain (12-24 carbon atoms) alkyl ammonium salts and the like are also suitable. Where the solid surface is porous, various pore sizes can be employed depending upon the nature of the system.

A variety of immunoassay systems can be used, including but not limited to, radio-immunoassays (RIA), enzyme-linked immunosorbent assays (ELISA) assays, enzyme immunoassays (EIA), "sandwich" assays, gel diffusion precipitation reactions, immunodiffusion assays, agglutination assays, immunofluorescence assays, fluorescence activated cell sorting (FACS) assays, immunohistochemical assays, protein A immunoassays, protein G immunoassays, protein L immunoassays, biotin/avidin assays, biotin/streptavidin assays, immunoelectrophoresis assays, precipitation/flocculation reactions, immunoblots (Western blot; dot/slot blot); immunodiffusion assays; liposome immunoassay, chemiluminescence assays, library screens, expression arrays, etc., immunoprecipitation, competitive binding assays and immunohistochemical staining. These and other assays are described, among other places, in Hampton et al. (*Serological Methods, a Laboratory Manual*, APS Press, St Paul, Minn. (1990)) and Maddox, et al. (*J. Exp. Med.* 158:1211-1216 (1993)).

The methods of this invention can also be carried out using a variety of solid phase systems, such as described in U.S. Pat. No. 5,879,881, as well as in a dry strip lateral flow system, such as described, for example, in U.S. Patent Publication No. 20030073147, the entire contents of each of which are incorporated by reference herein.

A subject of this invention is any animal that can be infected by *Trichomonas vaginalis*. In certain embodiments, the subject is human.

In addition, a nucleic acid (DNA) having the nucleotide sequence or a substantially similar nucleotide sequence of the gene encoding the *T. vaginalis* protein of this invention can be used as a probe in a nucleic acid hybridization assay for the detection of a *T. vaginalis* protein in various tissues or body fluids of a subject of this invention. Further, DNA encoding the sequence of the epitopes, 15-mer epitopes, and/or SOEs of this invention detected by human serum following infection by and exposure to *T. vaginalis* can be used as a probe in a nucleic acid hybridization assay for the detection of a *T. vaginalis* protein in various tissues or body fluids of a subject of this invention. The probe can be used in any type of nucleic acid hybridization assay including Southern blots (Southern, 1975, *J. Mol. Biol.* 98:508), Northern blots (Thomas et al., 1980, *Proc. Natl Acad. Sci.*

*U.S.A.* 77:5201-05), colony blots (Grunstein, et al., 1975, *Proc. Natl Acad. Sci. U.S.A.* 72:3961-65), slot blots, dot blots, etc. Stringency of hybridization can be varied depending on the requirements of the assay according to methods well known in the art. Assays for detecting nucleic acid encoding a *T. vaginalis* protein in a cell, or the amount thereof, typically involve, first contacting the cells or extracts of the cells containing nucleic acids therefrom with an oligonucleotide probe that specifically binds to nucleic acid encoding a *T. vaginalis* protein or peptide as described herein (typically under conditions that permit access of the oligonucleotide to intracellular material), and then detecting the presence or absence of binding of the oligonucleotide probe thereto. Any suitable assay format can be employed (see, e.g., U.S. Pat. No. 4,358,535; U.S. Pat. Nos. 4,302,204; 4,994,373; 4,486,539; 4,563,419; and 4,868,104, the disclosures of each of which are incorporated herein by reference in their entirety).

The antibodies of this invention can be used in vitro, in vivo and/or in situ assays to detect a *T. vaginalis* protein or peptide of this invention.

Also as used herein, the terms peptide and polypeptide are used to describe a chain of amino acids, which correspond to those encoded by a nucleic acid (DNA). A peptide usually describes a chain of amino acids of from two to about 30 amino acids and polypeptide usually describes a chain of amino acids having more than about 30 amino acids. It is understood, however, that 30 is an arbitrary number with regard to distinguishing peptides and polypeptides and the terms may be used interchangeably for a chain of amino acids around 30. The peptides and polypeptides of the present invention are obtained by isolation and purification of the peptides and polypeptides from cells where they are produced naturally or by expression of a recombinant and/or synthetic nucleic acid encoding the peptide or polypeptide. The peptides and polypeptides of this invention can be obtained by chemical synthesis, by proteolytic cleavage of a polypeptide and/or by synthesis from nucleic acid encoding the peptide or polypeptide. The term polypeptide can refer to a linear chain of amino acids or it can refer to a chain of amino acids, which have been processed and folded into a functional protein. The term polypeptide can refer also the sequence of the epitopes. Using *T. vaginalis* as an example, the selected epitopes from the proteins of aldolase, GAPDH,  $\alpha$ -enolase, and/or  $\alpha$ -actinin are arranged so that each epitope is separated by amino acid repeats, such as glycine or lysine, in the form of an SOE, rSOE, or SOP.

It is also understood that the peptides and polypeptides of this invention may also contain conservative substitutions where a naturally occurring amino acid is replaced by one having similar properties and which does not alter the function of the peptide or polypeptide. Such conservative substitutions are well known in the art. Thus, it is understood that, where desired, modifications and changes may be made in the nucleic acid and/or amino acid sequence of the peptides and polypeptides of the present invention and still obtain a peptide or polypeptide having like or otherwise desirable characteristics. Such changes may occur in natural isolates or may be synthetically introduced using site-specific mutagenesis, the procedures for which, such as mismatch polymerase chain reaction (PCR), are well known in the art. One of skill in the art will also understand that polypeptides and nucleic acids that contain modified amino acids and nucleotides, respectively (e.g., to increase the half-life and/or the therapeutic efficacy of the molecule), can be used in the methods of the invention.

“Nucleic acid” as used herein refers to single- or double-stranded molecules which may be DNA, comprised of the nucleotide bases A, T, C and G, or RNA, comprised of the bases A, U (substitutes for T), C, and G. The nucleic acid may represent a coding strand or its complement. Nucleic acids may be identical in sequence to a sequence that is naturally occurring or may include alternative codons that encode the same amino acid as that which is found in the naturally occurring sequence. Furthermore, nucleic acids may include codons that represent conservative substitutions of amino acids as are well known in the art. The nucleic acids of this invention can also comprise any nucleotide analogs and/or derivatives as are well known in the art.

As used herein, the term “isolated nucleic acid” means a nucleic acid separated or substantially free from at least some of the other components of the naturally-occurring organism, for example, the cell structural components commonly found associated with nucleic acids in a cellular environment and/or other nucleic acids. The isolation of nucleic acids can therefore be accomplished by well-known techniques such as cell lysis followed by phenol plus chloroform extraction, followed by ethanol precipitation of the nucleic acids. The nucleic acids of this invention can be isolated from cells according to methods well known in the art for isolating nucleic acids. Alternatively, the nucleic acids of the present invention can be synthesized according to standard protocols well described in the literature for synthesizing nucleic acids. Modifications to the nucleic acids of the invention are also contemplated, provided that the essential structure and function of the peptide or polypeptide encoded by the nucleic acid are maintained.

The nucleic acid encoding the peptide or polypeptide of this invention can be part of a recombinant nucleic acid construct comprising any combination of restriction sites and/or functional elements as are well known in the art that facilitate molecular cloning and other recombinant DNA manipulations. Thus, the present invention further provides a recombinant nucleic acid construct comprising a nucleic acid encoding a peptide and/or polypeptide of this invention. The protein products of combinations of genetic sequences into a recombinant nucleic acid are sometimes referred to as chimeric proteins, polypeptides and/or peptides, and the SOEs of the invention can be called such.

The present invention further provides a vector comprising a nucleic acid encoding a peptide and/or polypeptide of this invention. The vector can be an expression vector which contains all of the genetic components required for expression of the nucleic acid in cells into which the vector has been introduced, as are well known in the art. The expression vector can be a commercial expression vector or it can be constructed in the laboratory according to standard molecular biology protocols. The expression vector can comprise, for example, viral nucleic acid including, but not limited to, vaccinia virus, adenovirus, retrovirus, alphavirus and/or adeno-associated virus nucleic acid. The nucleic acid or vector of this invention can also be in a liposome or a delivery vehicle, which can be taken up by a cell via receptor-mediated or other type of endocytosis.

The nucleic acid of this invention can be in a cell, which can be a cell expressing the nucleic acid whereby a peptide and/or polypeptide of this invention is produced in the cell. In addition, the vector of this invention can be in a cell, which can be a cell expressing the nucleic acid of the vector whereby a peptide and/or polypeptide of this invention is produced in the cell. It is also contemplated that the nucleic acids and/or vectors of this invention can be present in a host

(e.g., a bacterial cell, a cell line, a transgenic animal, etc.) that can express the peptides and/or polypeptides of the present invention.

In some embodiments, for recombinant production of the chimeric proteins, polypeptides and/or peptides of this invention in prokaryotes, there are numerous *Escherichia coli* (*E. coli*) expression vectors known to one of ordinary skill in the art useful for the expression of nucleic acid encoding proteins or peptides of this invention. Other microbial hosts suitable for use include bacilli, such as *Bacillus subtilis*, and other enterobacteria, such as *Salmonella*, *Shigella*, and *Serratia*, as well as various *Pseudomonas* species. These prokaryotic hosts can support expression vectors that will typically contain sequences compatible with the host cell (e.g., an origin of replication). In addition, any number of a variety of well-known promoters will be present, such as the lactose promoter system, a tryptophan (Trp) promoter system, a beta-lactamase promoter system, or a promoter system from phage lambda. The promoters will typically control expression, optionally with an operator sequence and have ribosome binding site sequences for example, for initiating and completing transcription and translation. If necessary, an amino terminal methionine can be provided by insertion of a Met codon 5' and in-frame with the coding sequence of the protein. Also, the carboxy-terminal extension of the protein can be removed using standard oligonucleotide mutagenesis procedures.

Additionally, yeast expression systems and baculovirus systems, which are well known in the art, can be used to produce the chimeric peptides and polypeptides of this invention.

The vectors of this invention can be transferred into a cell by well-known methods, which vary depending on the type of cell host. For example, calcium chloride transfection is commonly utilized for prokaryotic cells, whereas calcium phosphate treatment, lipofection or electroporation can be used for other cell hosts.

The present invention further provides a kit for detection of microorganism-specific proteins. In the case of *T. vaginalis*, at least one antibody is selected from the group consisting of aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin antibodies, as disclosed in the sequence listings and tables herein. Such a kit can comprise one or more proteins or antibodies of the invention, along with suitable buffers, wash solutions, dilution buffers, secondary antibodies, and detection reagents for the detection of antigen/antibody complex formation under various conditions. In another embodiment, a kit of this invention can comprise at least one amino acid sequence selected from the group consisting of SOE, polypeptide, a peptide, and antigenic fragment comprising the amino acid sequence (epitope) detected by the monoclonal antibody and/or a fusion protein or peptide comprising an individually or in combination the epitopes of interest, along with suitable buffers, wash solutions, dilution buffers, secondary antibodies, detection reagents, etc. for the detection of antigen/antibody complex formation under various conditions.

#### EXAMPLES OF THE INVENTION

The present invention is more particularly described in the Examples set forth below, which are not intended to be limiting of the embodiments of this invention.

Example 1. Monoclonal Antibodies (MAbs) that Specifically Bind a *Trichomonas vaginalis* Fructose-1,6-Biphosphate Aldolase (Aldolase), Glycerinaldehyde-3-Phosphate Dehydrogenase (GAPDH), and/or  $\alpha$ -Enolase Proteins

Detecting a *T. vaginalis* protein selected from aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins, in a sample, includes contacting a sample with an antibody that specifically binds a *T. vaginalis* protein or epitopes of proteins either singly or in combination selected from the group of aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin proteins, under conditions whereby an antigen/antibody complex can form, and detecting formation of an antigen/antibody complex, thereby detecting the protein in the sample. The method may be performed using an immunoassay, such as a dot blot, ELISA, or other high-throughput immunoassay, with ELISA being the preferred immunoassay.

generated MAbs readily detect the surface of trichomonads as evidenced by whole cell-enzyme-linked immunosorbent assay (WC-ELISA) and fluorescence of non-permeabilized organisms. The respective proteins are detected by immunoblot after SDS-PAGE blotting the proteins onto nitrocellulose after probing with individual MAbs. The amino acid sequences detected by the respective MAbs (epitopes) are provided, and it is noteworthy that the epitopes detected by the MAbs generated at WSU are different from that B44 and B43 MAbs.

In certain embodiments, an antibody of this invention is not cross-reactive with human epithelial cell extracts or other protozoan protein extracts (e.g., *G. lamblia*, *E. histolytica*, *A. castellanii*, *L. major*), fungi (*Candida* and pneumocystis), and bacteria (oral and vaginal bacterial flora). In yet other embodiments, an antibody of this invention does not bind or react with *T. vaginalis* adhesin proteins.

TABLE 1

New MAbs generated and reactive with aldolase (ALD), GAPDH (GAP), $\alpha$ -enolase (ENO), and $\alpha$ -actinin.							
SEQ ID NO:	protein	original name	WSU MAB designation <sup>1</sup>	amino acid numbers in protein	epitope sequence	surface detection	size (kDa)
1	ALD	ALD12A	ALDwsu-1	142-149	RPDYVTVE	yes	36.3
2	ALD	ALD64A	ALDwsu-2	166-173	KHTYTRPE	yes	"
3	ALD	B44	N/A	448-455	ERIQKYTR	yes	52
4	ALD	ALD11A	ENOWsu-2	364-371	DDLTTNP	yes	"
5	ALD	ALD13B	ENOWsu-3	7-14	AIVKECIA	yes	"
6	ALD	ALD25	ENOWsu-4	463-470	LKEHDMLA	yes	"
7	ENO	ALD55	ENOWsu-6	64-71	YLGRVTLA	yes	"
8	GAP	B43	N/A	205-212	RRARAAGM	yes	39.2
9	GAP	ALD30A	GAPwsu-2	70-77	KSIGGRLG	yes	"
10	GAP	ALD32C	GAPwsu-3	34-44	YLLKYDTAHR	yes	"
11	ACT	HA423	N/A	649-653	YKVTY	yes	106.2

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In particular embodiments of this invention, the antibody employed in the methods of this invention is an antibody that specifically binds a *T. vaginalis* protein or epitopes of the proteins either singly or in combination selected from aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins. A non-limiting example of an antibody that specifically binds the known amino sequence of the epitope of a *T. vaginalis* protein selected from aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin proteins is monoclonal antibody ALDwsu1 (aldolase), ALDwsu2 (aldolase), GAPwsu2 (GAPDH), GAPwsu3 (GAPDH), ENOWsu2 ( $\alpha$ -enolase), ENOWsu3 ( $\alpha$ -enolase), ENOWsu4 ( $\alpha$ -enolase), ENOWsu6 ( $\alpha$ -enolase) and HA423 ( $\alpha$ -actinin).

A library of new monoclonal antibodies (MAbs) was generated toward the *T. vaginalis* proteins aldolase, glyceraldehyde-3-phosphate-dehydrogenase, and  $\alpha$ -enolase proteins. The newly-generated MAbs are all IgG<sub>1</sub> isotype. MAbs B44, B43, and HA423 are included for comparative purposes and were generated at the University of Texas Health Science Center at San Antonio but the epitope amino acid sequences were unknown until now. All of the newly-

Detection of Fixed *Trichomonas vaginalis* Protein in Fixed Cell Preparations.

Pap smears were prepared using methanol (MeOH) as a fixative with MeOH in the range of 20% to 80%. Trichomonads are readily fixed by incubation in MeOH prepared in PBS buffer and retain integrity as visualized by darkfield microscopy. Surface-exposed epitopes are readily detected by MAbs as shown in Table 1.

The following ELISA protocol used for pap smear was used to show immunodetection of protein on MeOH-fixed trichomonads immobilized onto wells of microtiter plates.

- Overnight (o/n) cultures of *T. vaginalis* grown using standard protocols in medium were washed twice with ice-cold PBS.
- Trichomonads were fixed o/n at 4° C. (12 h to 18 h) using 20% MeOH (different concentrations of MeOH yield similar results) at a density of 10<sup>7</sup> per milliliter (ml).
- 100 microliters ( $\mu$ l) of different dilutions of parasites in MeOH fixative were added to individual wells of 96-well microtiter plates, and plates were placed in 37° C. incubator overnight.

4. To dried wells was added 100  $\mu$ l of a solution of 1% BSA in PBS-1% Tween (PBS-T) and incubated at 37° C. for 30 min.
5. Wells were then washed 3-times (3 $\times$ ) with PBS-T followed by addition of 100  $\mu$ l of each MAb (primary antibody) to wells. Negative controls included PBS (absence of primary MAb) and the addition of MAb L64, which detects a small-sized (17-kDa) cytoplasmic protein. (NOTE: This MAb of the same isotype (IgG<sub>1</sub>) does not detect the parasite surface showing the integrity of parasites by fixation.) Wells were incubated for 60 min at 37° C.
6. After washing 3 $\times$  with PBS-T, 100  $\mu$ l of a solution of secondary horseradish peroxidase-conjugated goat anti-mouse IgG antibody was added to wells followed by incubation at 37° C. for 30 min.
7. The wells were again washed 3 $\times$  with PBS-T prior to addition of 100  $\mu$ l of color development reagent. After 15 min, the microtiter well plates were read for intensity of optical density at 405 nm wavelength to measure absorbance values. A higher the absorbance value at 405 nm indicates strong immunoreactivity by MAb with the protein antigen on the surface of MeOH-fixed parasites.

Results are shown in FIGS. 1 and 2. Among noteworthy findings are the following:

- a) Sensitivity was  $\geq 1$  organism per  $\mu$ l of sample. Wells were incubated with 100  $\mu$ l of the parasite suspension  $\geq 10^3$ /ml. At the lowest density, this is equal to 100 organisms added to each well.
- b) All trichomonad isolates are readily detected.
- c) Parasite preparations made with a poly-bacterial contamination does not interfere with MAb detection.
- d) The presence of epithelial cells contaminating trichomonad preparations does not interfere with MAb detection.
- e) Newly-generated MAbs give higher signal compared to the HA423 MAb patented to the University of Texas system.
- f) Protein was detected using the range of MeOH for fixation.
- g) The signal was enhanced when a cocktail of three MAbs, one each for aldolase, GAPDH, and  $\alpha$ -enolase, was used.

#### Example 2. Detection of *Trichomonas vaginalis* Proteins and Antibodies in Saliva

*T. vaginalis* is a urogenital, mucosal parasite. Presently, there exists a point-of-care, antigen detection, lateral flow, immunochromatographic diagnostic that is used for women. This diagnostic is not useful for diagnosis in men. This diagnostic is invasive for women, because it requires obtaining a vaginal swab. Therefore, there is a need for a different, non-invasive diagnostic that will work for both men and women.

Both female and male patients make specific anti-trichomonad surface protein IgG antibody. This antibody is detectable in serum and vaginal washes in women and serum in males. Antibody at one mucosal site makes it possible to detect the antibody at distant mucosal sites. Patients are known to make antibody to the proteins aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin, making these proteins candidates for detection by saliva. Therefore, a diagnostic based on saliva antibody that detects these proteins or epitopes of the proteins either singly or in combination immobilized on a platform represents a diagnostic that is used for both female and male patients.

The availability of the MAbs to these proteins permits purification of recombinant proteins from cDNA expression libraries or by purification by MAb-affinity column chromatography. Alternatively, the epitopes known to be reactive by sera of both women and men represent targets that can be synthesized and immobilized for detection by saliva. Therefore, the individual or combination of aldolase, GAPDH, and  $\alpha$ -enolase proteins or the combination of reactive epitopes of the proteins aldolase, GAPDH, and  $\alpha$ -enolase are reagents used in a non-invasive, oral-saliva based diagnostic. Finally, the polypeptide either synthesized or derived from recombinant DNA that possess the sequence of the epitopes in the proteins of aldolase, GAPDH,  $\alpha$ -enolase, and/or  $\alpha$ -actinin whereby each epitope is separated by such amino acids as glycine or lysine (SOE) is a reagent used in a non-invasive, oral-saliva based diagnostic.

Patient saliva has antibody specific to whole cell *T. vaginalis* and to trichomonad proteins of aldolase, GAPDH,  $\alpha$ -enolase, and/or  $\alpha$ -actinin. A whole cell-ELISA was carried out, in which microtiter wells were coated with whole *T. vaginalis* cells. Saliva of individual *T. vaginalis*-infected patients and pooled saliva of healthy, uninfected individuals were then tested for reactive IgG using horse radish peroxidase-conjugated anti-human IgG secondary antibody. Each patient shows elevated absorbance values compared to the control pooled saliva of uninfected individuals. This study demonstrates the presence of IgG antibody reactive to whole *T. vaginalis* proteins. Wells coated with whole cells tested separately using rabbit anti-*T. vaginalis* serum or with a MAb served as positive controls and were also used for standardization to show similar reactions among wells. Non-reactive serum of men and women and prebleed normal rabbit serum served as negative controls.

In separate experiments, the individual sera of women and men highly reactive with the whole cell-ELISA and with each of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins above were each reacted with overlapping, synthetically-made dodecapeptides comprising the entire amino acid sequence of the aldolase, GAPDH,  $\alpha$ -enolase proteins and  $\alpha$ -actinin proteins. The overlapping dodecapeptides were spotted (immobilized) onto a membrane that was then probed individually with 10% dilution of highly WC-ELISA reactive sera of women or men. The sera detected all of the epitopes to which antibody was present. No dodecapeptides were detected by negative control, unreactive sera of women and men. This study demonstrates the existence and immunoreactivity of sera of both women and men to various epitopes and also demonstrated that the women and men sera detected the same epitopes recognized by the MAbs included in Table 1 to the aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin proteins.

In yet another experiment, the individual sera of women and men highly reactive with *T. vaginalis* organisms and with each of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins above were each reacted with synthetic 15-mer peptides possessing the epitopes of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins either singly or in combination were immobilized onto a membrane that was then probed individually with 10% dilution of highly WC-ELISA reactive sera of women or men. The sera detected all of the epitopes to epitopes singly and in combination. No peptides singly or in combination were detected by negative control, unreactive sera of women and men. This study demonstrates the existence and immunoreactivity of sera of both women and men to various epitopes and also demonstrated that the women and men sera detected the same epitopes recognized

by the MAbs included in Table 1 to the aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin proteins.

In yet another experiment, the individual sera of women and men highly reactive with *T. vaginalis* organisms and with each of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins above were each reacted with a recombinant polypeptide possessing the epitopes of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins (SOE) immobilized onto a membrane that was then probed individually with 10% dilution of highly WC-ELISA reactive sera of women or men. The sera detected all of the epitopes this recombinant polypeptide possessing the epitopes of the aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin proteins. No peptides singly or in combination were detected by negative control, unreactive sera of women and men. This study demonstrates the existence and immunoreactivity of sera of both women and men to various epitopes and also demonstrated that the women and men sera detected the same epitopes recognized by the MAbs included in Table 1 to the aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin proteins.

No crossreactivity of saliva antibody between *T. vaginalis* and the opportunistic oral *T. tenax*. Saliva of humans uninfected with *T. vaginalis* has no detectable antibody using any of the ELISA assays mentioned above. Thus, the existence of immunocrossreactive antibodies in saliva of patients to *T. tenax*, the oral trichomonad will be non-existent. *T. tenax* organisms are not readily apparent in the oral cavity and are not detectable in individuals even if there is severe periodontitis.

Demonstration of Specific Anti-*T. vaginalis* Antibody in Saliva of Patients.

Standard ELISA can demonstrate the existence of saliva antibody in all patients. The assays can be optimized to minimize any crossreactive antibody to *T. tenax* and to monitor the level of saliva antibody among the patients, although, as just mentioned above, there is no evidence of salivary antibody crossreactivity with *T. tenax*. Three different assays provide a basis by which to determine the level of antibody to trichomonad proteins in saliva. ELISA protocols that bind non-specific sites on the coated wells with irrelevant proteins, such as BSA and/or or skim milk, can be employed. The first ELISA has whole intact trichomonads coated onto 96-well microtiter plates as antigen for saliva antibody detection, and this whole cell-ELISA employs standard conditions. For this whole cell ELISA, MeOH-fixed trichomonads can be used, or, alternatively, PBS-washed organisms can be added to wells and allowed to dry o/n. Then ethanol is added to the dried wells, and wells allowed to dry and fix the trichomonads onto the wells. The second ELISA has purified IgG of high-titered rabbit antisera to total trichomonad proteins coated onto microtiter wells. Then, trichomonad protein antigens from a detergent extract of *T. vaginalis* will bind to the IgG-coated wells after incubation. The bound trichomonad proteins provide antigen detectable by saliva antibody. Similarly, the third assay has a cocktail of MAbs to aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin-coated onto microtiter wells. These MAbs-coated wells bind protein antigen from the trichomonad extract. These parasite proteins bound to MAbs will now serve as antigen for saliva antibody. The second and third sandwich-ELISAs take advantage of the knowledge that women and men make serum antibody to various epitopes of each protein (Table 1). It is expected that saliva antibody, like serum antibody, is directed to epitopes different from those of rabbit antiserum and that we have now shown are detected by serum antibody of women and men infected and exposed to *T. vaginalis*.

After treatment of freshly prepared ELISA plates with skim milk to decrease non-specific interactions, select samples of saliva from patients and from uninfected control individuals can be diluted in PBS without or with a *T. tenax* detergent extract prior to addition of standard 100  $\mu$ l volumes to microtiter wells. PBS without *T. tenax* extract provides duplicates of the same saliva. Initial data shows that saliva does not have any antibody to *T. tenax*, and data suggests that any concern of crossreactivity is nonexistent. Experiments indicate that a 60 min to 120 min incubation at 37° C. is optimal. After washing, horseradish peroxidase-conjugated secondary goat anti-human IgG, anti-IgA, or Ig (IgG+IgA+IgM) Ab is added, followed by color development with substrate. In these assays, purified trichomonad protein called P230 that is a prominent immunogen eliciting a vaginal IgG antibody response will serve as a positive control for saliva IgG antibody.

Saliva antibody from women infected with *T. vaginalis* and after treatment is tested. Saliva can be obtained on at least two occasions post-treatment to assess the nature of the antibody response following removal of trichomonads from the urogenital tract through drug treatment. Saliva from male partners of infected women can also be examined to confirm the validity of this diagnostic for both infected partners.

#### Example 3. *Trichomonas vaginalis* Proteins Detected in Urine by MAbs

The numerous proteins that are increased in expression during infection, found in secretions of patients, and are readily secreted by trichomonads have been identified and include aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin. Both women and men patients infected with *T. vaginalis* have trichomonads in urine. This means that many proteins and/or intact organisms may be detected in urine samples for both women and men. Among the many secreted proteins found in large amounts are those to which the new MAbs have been generated, and these proteins are aldolase, GAPDH, and/or  $\alpha$ -enolase. These proteins are readily detected by immunoblots with the MAbs to aldolase, GAPDH,  $\alpha$ -enolase and/or  $\alpha$ -actinin. Therefore, these proteins in soluble form in urine can be immobilized through filtration and can then be detected by the MAbs. Therefore, the MAbs are reagents that are critical for this urine-based diagnostic. Although the present invention has been described with reference to specific details of certain embodiments thereof, it is not intended that such details should be regarded as limitations upon the scope of the invention except as and to the extent that they are included in the accompanying claims. Throughout this application, various patents, patent publications and non-patent publications are referenced. The disclosures of these patents, patent publications, and non-patent publications in their entireties are incorporated by reference into this application in order to more fully describe the state of the art to which this invention pertains.

#### Overview of Examples 4 Through 7: Identification of Diagnostic Immunogenic Epitopes of Aldolase, GAPDH, $\alpha$ -Enolase, and $\alpha$ -Actinin that are Reactive with Sera of Female and Male Patients and Monoclonal Antibodies (MAbs) and are Unique to *Trichomonas vaginalis*

We have identified epitopes of the *T. vaginalis* proteins aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin with little or no identity to other sexually transmitted microorganisms

[*Treponema pallidum* (syphilis), *Chlamydia trachomatis* (chlamydia), *Neisseria gonorrhoeae* (gonorrhea), and *Candida albicans* (yeast)], normal flora bacteria (*E. coli*), yeast (*Saccharomyces cerevisiae*), and humans (*Homo sapiens*) and are, therefore, unique targets to diagnose infection and exposure to *T. vaginalis*. These peptide epitopes have significance for diagnosis of infection with *T. vaginalis*. The experimental approach likewise identified epitopes in the trichomonad GAPDH and  $\alpha$ -enolase proteins with significant identity to peptide epitopes in the human proteins to which individuals infected with *T. vaginalis* make antibody. Such antibody during a *T. vaginalis* infection may have consequences for autoimmunity. The GAPDH peptide epitopes were found to have high sequence identity to the GAPDH protein of *Trichomonas suis* parasite of porcine, which is a synonym for *Trichomonas foetus*—bovine, the causative agent of fetal wastage in cattle, *Trichomonas foetus*—cat, causative agent for chronic large-bowel diarrhea, and *Trichomonas mobilensis*, enteric protozoan of squirrel monkeys (Lun, Z.-R., et al., Trends in Parasitol., 21:122-125, 2005; Reinmann, K., et al., Veterinary Parasitol., published ahead of print, doi: 10.1016/j.vet-par.2011.09.032.). Therefore, these epitope characterization experiments have identified diagnostic epitopes of the important pathogenic porcine, cattle, cat, and squirrel monkey trichomonads (*Trichomonas suis*, *T. foetus*—bovine, *T. foetus*—cat, and *T. mobilensis*).

Overlapping dodecapeptides of each of the aldolase, GAPDH,  $\alpha$ -enolase and  $\alpha$ -actinin proteins were examined for immunoreactivity with the sera of women and men patients and MAbs. The overlapping dodecapeptides for each of the proteins were immobilized in succeeding spots on a template that permitted detection by antibodies. This procedure is standard for identification of epitopes immunogenic during infection or that react with serum antibody and MAbs. This approach permits analysis of the antibody responses that are similar and distinct between the sera of women and men patients in addition to localizing the epitopes detected by MAbs. Further, it is possible to perform comparative analysis of the amino acid sequences of similar

functional proteins of humans (*Homo sapiens*), of other sexually transmitted bacterial pathogens (*Neisseria gonorrhoeae*, *Treponema pallidum* subsp. *pallidum* strain Nichols, and *Chlamydia trachomatis*), of yeast (*Saccharomyces cerevisiae* and *Candida albicans*), and of other human bacterial pathogens (*Streptococcus pyogenes*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*). Alignment of the amino acid sequences reveals whether the peptide sequences are unique to *Trichomonas vaginalis*, are identical and common to other *Trichomonas* sp. (*T. suis* and synonyms *T. foetus*—bovine, *T. foetus*—cat, and *T. mobilensis*), and share high or identical sequence identity with humans (*H. sapiens*) that may have significance for autoimmune reactions.

Accompanying each of the following experiments are tables showing the diagnostic immunogenic sequences reactive with female and male sera and MAbs that are unique to *T. vaginalis*. Other tables illustrate the extent of sequence identity between the *T. vaginalis* amino acid sequences with those of other bacteria, yeast, and human. These alignments were obtained from BLAST amino acid sequence alignments of proteins. Spot numbers on the overlapping peptides and the numbers of amino acids in the *T. vaginalis* peptide epitopes reactive with female (F) and male (M) sera and MAbs and that are unique to *T. vaginalis* are provided under the column labeled “unique Tv epitope for diagnosis” and given a positive (+) sign. *T. vaginalis* peptide epitopes with high sequence identity to *Trichomonas suis* (synonym with *T. foetus*—bovine, *T. foetus*—cat, and *T. mobilensis*) protein epitope sequences are also disclosed. These peptides are reactive with female or male sera or both, and illustrate their utility also for diagnosis of porcine, cattle, cat, and squirrel monkey trichomonads. The peptides of the proteins  $\alpha$ -enolase and GAPDH with high sequence identity to human protein epitopes and with possible autoimmune crossreactivity are listed, and the *T. vaginalis* (Tv) peptide sequences are aligned with the human sequences (Hu).

Example 4. Identification of Diagnostic Immunogenic Epitopes of Aldolase Unique to *T. vaginalis*

TABLE 2

Identification of diagnostic immunogenic epitopes of fructose-1,6-biphosphate aldolase protein that are unique to <i>T. vaginalis</i> (Tv).							
	no. amino acid sequence	amino acid epitope sequence	female patient sera reactivity	male patient sera reactivity	Mab reactivity	unique To Tv	
SEQ ID NO: 12	40-47	AIITASVK	F1				
SEQ ID NO: 13	58-65	AGARKYAN		M1			
SEQ ID NO: 14	61-71	RKYANQTMLRY	F2				
SEQ ID NO: 15	91-101	PIVLHLDHGDS	F3				
SEQ ID NO: 1	142-149	RPDYVTVE			ALD12A		
SEQ ID NO: 2	166-173	KHYTYTRPE			ALD64A	+	
SEQ ID NO: 16	169-179	YTRPEEVQDFV	F4				
SEQ ID NO: 17	193-203	TSHGAYKFPPG	F5				
SEQ ID NO: 18	231-241	SIPQEYVEMVN	F6				
SEQ ID NO: 19	277-287	RMVMGTIRRL		M2			

TABLE 2-continued

Identification of diagnostic immunogenic epitopes of fructose-1,6-biphosphate aldolase protein that are unique to <i>T. vaginalis</i> (Tv).											
no. amino acid sequence	epitope sequence	female patient sera reactivity	male patient sera reactivity	Mab reactivity	unique To Tv						
SEQ ID NO: 20	298-305 RQYLGEAR	F7	M3								
SEQ ID NO: 21	304-311 ARTKLTEM	F8			+						

The range of percent identity of these peptide epitopes with selected pathogens and humans is illustrated in the sequence alignment data of FIG. 3. Abbreviations F and M refer to female and male patient sera reactive with corresponding epitopes. The plus (+) sign refers to the epitope sequences that are unique to *T. vaginalis*, as evidenced by absence of sequence identity shown in FIG. 3.

Sequence Alignment of the *T. vaginalis* Fructose-1,6-Bisphosphate Aldolase (ALD) Protein with ALD Proteins of Other Representative Organisms and *H. sapiens*.

FIG. 3 shows the amino acid sequence comparison of *T. vaginalis* (Tv, SEQ ID NO:147) ALD with the homolog proteins from *Treponema pallidum* (Tp, SEQ ID NO:148),

*Neisseria gonorrhoeae* (Ng, SEQ ID NO:149), *Streptococcus pyogenes* (Spy, SEQ ID NO:150), *Streptococcus pneumoniae* (Spn, SEQ ID NO: 151), *Staphylococcus aureus* (Sa, SEQ ID NO:152), *Escherichia coli*, *Candida albicans*, *Saccharomyces cerevisiae*, and *Homo sapiens*. The boxed amino acids contained in the *T. vaginalis* sequence are the epitopes presented in Table 2. The order from top to bottom of the sequences is based on from highest to lowest percent identity compared to *T. vaginalis* ALD sequence. All microorganisms represented are pathogens, and 15-mer epitopes and/or SOEs derived from the ALD or other proteins may be used to practice the invention.

TABLE 3

Organism	Epitope											
	F1	M1	F2	F3	ALD12A	ALD64A	F4	F5	F6	M2	M3	F8
<i>T. vaginalis</i>	100	100	100	100	100	100	100	100	100	100	100	100
<i>T. pallidum</i>	62.5	87	72.7	100	87	50	72.7	63.6	54.5	54.5	75	37.5
<i>N. gonorrhoeae</i>	37.5	87.5	54.5	63.6	37.5	0	28.57	72.7	45.4	45.4	50	0
<i>S. pyogenes</i>	37.5	44.4	16.7	54.5	37.5	0	14.3	27.3	0	9.1	25	0
<i>S. pneumoniae</i>	37.5	44.4	25	54.5	25.00	0	14.29	27.3	0	9.1	25	0
<i>S. aureus</i>	50	33.3	8.3	63.6	37.5	25	45.4	45.4	0	9.1	75	37.5
<i>E. coli</i>	25	33.3	16.7	63.6	25	25	41.7	45.4	0	9.1	25	12.5
<i>C. albicans</i>	25	33.3	16.7	54.5	12.5	50	35.7	36.4	0	18.2	25	0
<i>S. cerevisiae</i>	25	33.3	16.7	54.5	12.5	50	35.7	27.3	0	18.2	25	0
<i>Homo sapiens</i>	0	12.5	9.1	27.3	0	0	0	9	0	9.1	12.5	0

Hydrophobicity and Antigenicity Profiles of the ALD, ENO, and GAP Sequences.

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FIG. 4 presents analyses of hydrophobicity and antigenicity alignments in reference to epitopes along the protein. Of interest is that with few exceptions the epitopes represent hydrophilic regions contained within the protein, perhaps consistent with presentation of amino acids for antibody synthesis and recognition.

Based on the features of the epitopes, 7 epitopes for ALD, 8 for ENO, and 6 for GAP were selected for synthesis of 15-mer peptides encoding in an SOE. The individual amino acid sequence encoding the epitope is bold and underlined.

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Example 5. Identification of Diagnostic Immunogenic Epitopes of  $\alpha$ -Enolase Unique to *Trichomonas vaginalis*

TABLE 4

Identification of diagnostic immunogenic epitopes of  $\alpha$ -enolase protein unique to *T. vaginalis* (Tv). Epitope amino acid sequences unique to the *T. vaginalis* protein are based on percent identity shown in Table 5.

SEQ ID NO:	amino acid sequence	epitope sequence	female patient sera reactivity	male patient sera reactivity	MAb reactivity	unique to Tv
22	6-14	AIVKECIA			ALD13A	+
23	64-71	YLGRVTLA	F1		ALD55	+
24	70-77	LAARSSAP		M1		+
25	94-101	DKARYGGK	F2	M2		
26	139-146	TVLKKNIG	F3	M3		+
27	184-194	VPKKFKLPSPF	F4	M4		+
28	238-246	GGLLVKKY	F5			+
29	245-252	KYGLSAKN		M7		+
30	298-305	FYDEEKKL		M8		+
31	328-338	KKHPAIVSIED	F6			
32	343-362	ENWTKLNARLG	F7			
33	364-371	DDLTYTNP			ALD11A	
34	448-455	ERIQKYTR	F9	M11	B44	
35	463-471	LKEHDMLA			ALD25	+

TABLE 5

The extent of sequence identity of the *T. vaginalis*  $\alpha$ -enolase with the protein sequences of bacteria, yeasts, and human. The epitopes are indicated by F1 through F9, M1 through M7, and the MAbs ALD13A/B, ALD55, ALD11A, and ALD25 are as listed in the Table.

Organism	Epitope													
	ALD13A	F1 ALD55	M1	F2 M2	F3 M3	F4 M4	F5	M5	F6 M6	F7	F8	ALD11A	F9 M7 B44	ALD25
<i>T. vaginalis</i>	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>T. pallidum</i>	0.00	0.00	25	71.4	37.5	27.3	37.5	0	25	63.6	27.3	50	37.5	5.5
<i>N. gonorrhoeae</i>	0	0	25	71.4	50	27.3	25	12.5	25	54.5	45.4	75	37	10.5
<i>C. trachomatis</i>	0	0	12.5	57.1	37.5	27.3	12.5	0	37.5	54.5	45.4	62.5	75	0
<i>S. pyogenes</i>	0	0	25	71.4	37.5	27.3	12.5	12.5	37.5	54.5	45.4	50	50	10.5
<i>S. pneumoniae</i>	0	0	25	85.7	37.5	27.3	12.5	12.5	37.5	54.5	45.4	50	50	10.5
<i>S. aureus</i>	0	0	25	71.4	37.5	27.3	25	12.5	25	54.5	36.4	62.5	50	10.5
<i>E. coli</i>	0	0	25	57.1	37.5	36.4	25	25	25	72.7	18.3	62.5	37.5	10
<i>C. albicans</i>	0	12.5	50	42.8	37.5	54.5	50	75	37.5	63.6	27.3	75	37.5	6.3
<i>S. cerevisiae</i>	0	0	37.5	42.8	37.5	36.4	37.5	62.5	25	73.7	27.3	75	37.5	6.3
<i>Homo sapiens</i>	0	12.5	37.5	71.4	37.5	27.3	37.5	62.5	37.5	54.5	36.4	75	50	6.3

Abbreviations:

F, female antibody reacting with epitope;

M, male antibody reacting with epitope;

ALD refers to MAbs.

TABLE 6

Identification of epitopes of <i>Trichomonas vaginalis</i> (Tv) $\alpha$ -enolase reactive with human sera. <sup>1</sup>								
SEQ ID NO:	spots number on membrane	amino acid sequence	epitope sequence	female patient sera	pooled reactive male sera	MAb reactions	unique to Tv	% identity with human sequence
SEQ ID NO: 22	2, 3	6-14	AIVKECIA			ALD13A	+	
SEQ ID NO: 23	21-23	64-71	YLGRVTLA	F1		ALD55	+	
SEQ ID NO: 24	23-15	70-77	LAARSSAP		M1		+	
SEQ ID NO: 25	31-33	94-101	DKARYGGK	F2	M2			71%
SEQ ID NO: 26	46-47	139-146	TVLKKNIG	F3	M3		+	
SEQ ID NO: 27	62	184-194	VPKKFKLPSPF	F4	M4		+	
SEQ ID NO: 135	67	199-209	NGGKHAGGNLK		M5			
SEQ ID NO: 136	76	226-236	OLRMVAEYQK		M6			
SEQ ID NO: 28	79-81	238-246	GGLLVKKY	F5			+	
SEQ ID NO: 29	81-82	245-252	KYGLSAKN		M7			62.5%
SEQ ID NO: 30	99-100	298-305	FYDEEKKL		M8		+	
SEQ ID NO: 31	110	328-338	KKHPAIVSIED	F6			+	
SEQ ID NO: 32	115-118	343-362	ENWTKLNARLG	F7			+	
SEQ ID NO: 137	117-118	352-359	NARLGQRV		M9			
SEQ ID NO: 33	121-123	364-371	DDLTYTNP			ALD11A		75%
SEQ ID NO: 138	123-124	370-377	NPITIKKG	F8	M10			
SEQ ID NO: 34	149-151	448-455	ERIQKYTR	F9	M11	B44	+	
SEQ ID NO: 35	154-155	463-471	LKEHDMLA			ALD25	+	

Example 6. Identification of Diagnostic Immunogenic Epitopes of GAPDH Unique to *Trichomonas vaginalis*, and Diagnostic Epitopes Identical to or with High Sequence Identity to *Tritrichomonas suis* (Synonym with *T. foetus* Bovine, *T. foetus* Cat, and *T. mobilensis*)

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TABLE 7

Identification of diagnostic immunogenic epitopes of GAPDH protein unique to <i>T. vaginalis</i> .							
SEQ ID NO:	no. amino acid sequence	epitope sequence	female patient sera	patient reactivity	male patient sera reactivity	MAB reactivity	unique to Tv
SEQ ID NO: 36	13-17	LYPKD			M1		+
SEQ ID NO: 37	34-44	YLLKYDTAHR	F1			ALD32C	+
SEQ ID NO: 38	58-68	FTVGEADKWV			M2		+
SEQ ID NO: 39	70-77	KSIGGRLG	F2			ALD30A	+
SEQ ID NO: 40	94-101	STGIFRTK	F3				+
SEQ ID NO: 41	106-113	AEGKIKKD	F4				+
SEQ ID NO: 42	118-125	HLVSGAKK	F5		M4		
SEQ ID NO: 43	157-161	SNASC			M5		

TABLE 7-continued

Identification of diagnostic immunogenic epitopes of GAPDH protein unique to <i>T. vaginalis</i> .						
SEQ ID NO:	no. amino acid sequence	epitope sequence	female patient sera reactivity	male patient sera reactivity	MAb reactivity	unique to Tv
44	175-182	NAFGIRNG	F6			+
45	205-212	RRARAAGM	F7		B43	
46	217-224	TSTGAAIA	F8			
47	229-233	CHGLP		M6		
48	250-260	SLVDLTVNVNA	F9			
49	292-299	VSSDIIGC		M7		
50	298-305	GCQYSSIV		M8		
51	301-311	YSSIVDALSTK	F10			
52	325-335	VSWYDNEWMY	F11	M9		
53	337-341	CRCAD		M10		

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TABLE 8

The extent of sequence identity of the *T. vaginalis* GAPDH with the protein sequences of bacteria, yeasts, and human from alignment shown in FIG. 3.

Organism	Epitope											
	M1	F1 ALD32	M2	F2 ALD30	M3	F3	F4	M4	F5	M5	F6	F7 B43
<i>T. vaginalis</i>	100	100	100	100	100	100	100	100	100	100	100	100
<i>T. suis</i>	80	55	73	63	100	75	38	75	100	100	75	88
<i>C. albicans</i>	0	45	9	25	40	50	13	56	100	100	50	38
<i>S. cerevisiae</i>	0	45	9	13	60	50	13	56	100	100	63	38
<i>C. trachomatis</i>	0	55	0	0	60	50	13	67	100	100	50	38
<i>T. pallidum</i>	40	45	9	44	100	38	0	56	100	100	38	50
<i>N. gonorrhoeae</i>	0	45	9	13	60	38	13	78	100	100	38	50
<i>S. pneumoniae</i>	0	55	9	25	40	38	25	67	80	80	38	63
<i>S. pyogenes</i>	0	55	9	25	20	38	25	67	80	80	63	63
<i>S. aureus</i>	0	45	0	25	60	38	13	56	100	100	75	50
<i>E. coli</i>	0	55	9	13	40	38	0	56	100	100	50	38
<i>Homo sapiens</i>	0	45	0	0	60	38	0	33	36	36	50	38

Organism	Epitope									
	F8	M6	F9	M7	M8	F10	F11 M9	M10	Overall	
<i>T. vaginalis</i>	100	100	100	100	100	100	100	100	100	
<i>T. suis</i>	100	20	64	88	63	73	100	100	70	
<i>C. albicans</i>	75	20	55	50	63	45	64	40	40	
<i>S. cerevisiae</i>	75	20	64	63	50	45	64	40	39	
<i>C. trachomatis</i>	75	20	55	88	75	55	55	40	38	
<i>T. pallidum</i>	63	0	45	50	63	55	82	40	40	
<i>N. gonorrhoeae</i>	75	20	45	38	13	45	64	20	41	
<i>S. pneumoniae</i>	75	20	18	75	38	55	73	0	40	
<i>S. pyogenes</i>	75	20	27	75	38	55	73	0	40	
<i>S. aureus</i>	88	20	55	38	25	55	73	40	40	
<i>E. coli</i>	75	20	55	50	25	27	64	20	40	
<i>Homo sapiens</i>	75	20	45	50	50	45	64	40	30	

TABLE 9

Identification of epitopes of <i>Trichomonas vaginalis</i> (Tv) GAPDH reactive with human sera and MAb and with identity to human and <i>T. suis</i> .									
SEQ ID NO:	SPOTS peptide no	amino acid sequence	epitope sequence	female patient serum	pooled reactive male sera	MAb reactions	unique Tv epitope for diagnosis	% identity with human peptide sequence	% identity with <i>T. suis</i> peptide sequence
SEQ ID NO: 36	3-5	13-17	LYPKD		M1		+		80
SEQ ID NO: 37	12	34-44	YLLKYDTAHRA	F1		ALD32C	+		55
SEQ ID NO: 38	20	58-68	FTVGEGADKVV		M2		+		73
SEQ ID NO: 39	23-24	70-77	KSIGGRLG	F2		ALD30A	+		63
SEQ ID NO: 139	25-27	79-83	SQLPW		M3			60	100
SEQ ID NO: 40	31-33	94-101	STGIFRTK	F3			+		75
SEQ ID NO: 41	35-37	106-113	AEGKIKKD	F4			+		25
SEQ ID NO: 42	39-41	118-125	HLVSGAKK	F5	M4				75
SEQ ID NO: 43	51-53	157-161	SNASC		M5			50	100
SEQ ID NO: 44	57-59	175-182	NAFGIRNG	F6				50	75
SEQ ID NO: 45	67-69	205-212	RRARAAGM	F7		B43			88
SEQ ID NO: 46	72-74	217-224	TSTGAAIA	F8				75	100
SEQ ID NO: 47	75-77	229-233	CHGLP		M6		+		20
SEQ ID NO: 48	84	250-260	SLVDLTVNVNA	F9			+		64
SEQ ID NO: 49	97-98	292-299	VSSDHGC		M7			50	88
SEQ ID NO: 50	99-100	298-305	GCQYSSIV		M8			50	63
SEQ ID NO: 51	101	301-311	YSSIVDALSTK	F10			+		73
SEQ ID NO: 52	109	325-335	VLSWYDNEWMY	F11	M9			64	100
SEQ ID NO: 53	111-113	337-341	CRCAD		M10		+		100

TABLE 10

Identification of <i>T. vaginalis</i> (Tv) GAPDH peptide epitopes that have high sequence identity to GAPDH of and are diagnostic for <i>Trichomonas suis</i> (Ts). Only peptide epitopes of <i>T. vaginalis</i> with $\geq 50\%$ identity were selected.					
SEQ ID NO:	no. amino acid sequence	(Tv) epitope sequence	SEQ ID NO:	(Ts) epitope sequence	Ts percent identity
SEQ ID NO: 36	13-17	LYPKD	54	<u>LYPKE</u>	80
SEQ ID NO: 37	34-44	YLLKYDTAHRA	55	<u>HLLNYDSAHOQ</u>	55
SEQ ID NO: 38	58-68	FTVGEGADKVV	56	<u>FEVGTGSDKVV</u>	73
SEQ ID NO: 39	70-77	KSIGGRLG	57	<u>KNLTGRLG</u>	62.5
SEQ ID NO: 40	94-101	STGIFRTK	58	<u>STGLPRTK</u>	75
SEQ ID NO: 41	118-125	HLVSGAKK	59	<u>HLLAGAKK</u>	75
SEQ ID NO: 43	157-161	SNASC	60	SNASC	100
SEQ ID NO: 140	172-179	TLNNAFGI	61	<u>VLNDTFGI</u>	57
SEQ ID NO: 141	202-212	KDLRRARAAGM	62	RRARAAGM	100

TABLE 10-continued

Identification of *T. vaginalis* (Tv) GAPDH peptide epitopes that have high sequence identity to GAPDH of and are diagnostic for *Trichomonas suis* (Ts). Only peptide epitopes of *T. vaginalis* with  $\geq 50\%$  identity were selected.

SEQ ID NO:	no. amino acid sequence	(Tv) epitope sequence	SEQ ID NO:	(Ts) epitope sequence	Ts percent identity
SEQ ID NO: 142	247-257	ITGSLVDLTVN	63	ITGSLVDITVN	91
SEQ ID NO: 51	301-311	YSSIVDALSTKV	64	HSSIVDSLSTMV	75
SEQ ID NO: 143	322-329	LVKVLSWY	65	LVKVLSWY	100

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Additional noteworthy evidence of the GAPDH cross-reactivity between *T. vaginalis* and *T. suis* (*T. foetus*) is evidenced by data obtained by detection on nitrocellulose of the *T. foetus* GAPDH after SDS-PAGE and immunoblotting of total proteins of different *T. foetus* isolates. The MAbs generated to the *T. vaginalis* GAPDH (Table 1) were used as probes to detect the *T. foetus* protein.

Example 7. Identification of Diagnostic Immunogenic Epitopes of  $\alpha$ -Actinin Unique to *Trichomonas vaginalis*

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TABLE 11

Identification of diagnostic immunogenic epitopes of  $\alpha$ -actinin protein unique to *T. vaginalis* (Tv).

SEQ ID NO:	SPOTS numbers	amino acid sequence	epitope name	sequence	woman patient serum	reactive men serum	MAb	unique to Tv
SEQ ID NO: 66	2	4-14	ACT1	RREGLDDAWE	F1			+
SEQ ID NO: 67	11-12	34-41	ACT2	IQFETIET	F2			+
SEQ ID NO: 68	21-23	67-71	ACT3	KQPKM	F3			+
SEQ ID NO: 69	50	148-158	ACT4	YEHVAVNNFTT	F4			+
SEQ ID NO: 70	69	205-215	ACT5	YVYLDPEDVID	F5			+
SEQ ID NO: 71	80-82	244-248	ACT6	ADKIK	F6			+
SEQ ID NO: 72	97-99	295-302	ACT7	RGKLASVI	F7			+
SEQ ID NO: 73	111-112	334-341	ACT8	NRPIPEIP	F8			+
SEQ ID NO: 74	152-153	457-464	ACT9	HHSQLITY	F9	M1		+
SEQ ID NO: 75	165-166	496-503	ACT10	YDEAIAFK	F10	M2		+
SEQ ID NO: 76	214-216	646-650	ACT11	KLNYK	F11	M3		+
SEQ ID NO: 77	215-217	649-653	ACT12	YKVTY	F12	M4	HA423	+
SEQ ID NO: 78	268-270	808-812	ACT13	KYFDK	F13	M5		+

TABLE 12

The extent of sequence identity of the *T. vaginalis*  $\alpha$ -actinin with the protein sequences of bacteria, yeasts, and human.

Epitope	<i>T. suis</i>	<i>C. albicans</i>	<i>S. cerevisiae</i>	HuACTN1
ACT-F1 (W1)	9	9	11	21
ACT-F2 (W2)	0	0	0	50
ACT-F3 (W3)	0	20	20	40
ACT-F4 (W4)	9	18	9	46

TABLE 12-continued

The extent of sequence identity of the *T. vaginalis*  $\alpha$ -actinin with the protein sequences of bacteria, yeasts, and human.

Epitope	<i>T. suis</i>	<i>C. albicans</i>	<i>S. cerevisiae</i>	HuACTN1
ACT-F5 (W5)	0	18	0	36
ACT-F6 (W6)	14	14	20	40
ACT-F7 (W7)	0	0	13	25
ACT-F8 (W8)	0	0	25	38

60

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TABLE 12-continued

The extent of sequence identity of the <i>T. vaginalis</i> $\alpha$ -actinin with the protein sequences of bacteria, yeasts, and human.				
Epitope	<i>T. suis</i>	<i>C. albicans</i>	<i>S. cerevisiae</i>	HuACTN1
ACT-F1/M1 (W9/M1)	11	22	11	13
ACT-F10/M2 (W10/M2)	0	0	13	13
ACT-F11/M3 (W11/M3)	20	0	20	20
ACT-F12/M4 (W12/M4/HA423)	20	20	20	0
ACT-F13/M5 (W13/M5)	0	20	0	40

Note absence of sequence identity with all proteins for representative organisms shown in Table 12. There is no identity of epitopes with other proteins of bacteria, fungi, protists, and humans in databanks.

Example 8. Synthesis of 15-Mer Peptide Epitopes of ALD, ENO, GAP, and ACT Unique to *Trichomonas Vaginalis* to Demonstrate Immunoreactivity with Women and Men Sera

Based examination of the sequences with algorithms for hydrophobicity and antigenicity, we then selected 7 epitopes for ALD, 8 for ENO, and 6 for GAP, and the 13 for ACT (taken from Table 11) for synthesis of 15-mer peptides

encoding the epitopes. Table 13 shows the epitopes and includes 3 for ACT to which data are presented below. The individual amino acid sequence encoding the epitope within each 15-mer peptide is shown in bold and underlined.

Peptide epitopes from each protein were selected based on low percent identity and solubility. The 15-mer amino acid sequences were sent to Sigma-Aldrich (The Woodlands, Tex.) and synthesized using their Custom PepScreen Peptide service. Each individual 15-mer peptide contained was acetylated at the amino-terminus and was amidylated at the carboxy-terminus. Each 15-mer peptide was screened by mass spectrometry to determine yield and purity of each product. Peptide epitopes were received with a pass/fail designation and the amount provided. Three  $\alpha$ -actinin 15-mer peptides of ACT were used as positive controls in the experiments presented below. These peptides were designated ACT2, ACT3, and ACT1 and corresponded to the amino acid sequences

AQPLYDEAIAFKEEV, (SEQ ID NO: 101)  
 FKDTFKYFDKDKSNS (SEQ ID NO: 102)  
 and  
 SVNRHHSQLITYIKH, (SEQ ID NO: 100)

respectively (shown in Table 13).

TABLE 13

List of synthetic 15-mer peptides of representative epitopes of ALD, ENO, GAP, and ACT for reactivity with immunoreactive women and men sera.				
	women/men epitope designation	peptide name	amino acid numbers	amino acid sequence
SEQ ID NO: 79	A-W1	ALD1	36-50	EQLQ <b><u>AIITASV</u></b> KTES
SEQ ID NO: 80	A-ALD12	ALD2	138-152	EAHSR <b><u>PDYVT</u></b> VEGEL
SEQ ID NO: 81	A-ALD64	ALD3	159-173	EDDVKA <b><u>EKHITYTR</u></b> PE
SEQ ID NO: 82	A-W4	ALD4	167-181	HTY <b><u>TRPEE</u></b> VODFVSK
SEQ ID NO: 83	A-W6	ALD5	230-244	SS <b><u>SIPQEV</u></b> EMVVKY
SEQ ID NO: 84	A-M2	ALD6	275-289	DGR <b><u>MVTGT</u></b> IRRLFV
SEQ ID NO: 85	A-W8	ALD7	301-315	LGE <b><u>ARTKLT</u></b> EMYMRK
SEQ ID NO: 86	E-W1	ENO1	57-71	V <b><u>KYLGRV</u></b> TLAARSSA
SEQ ID NO: 87	E-M1	ENO2	70-84	V <b><u>TLAARSS</u></b> APSGAST
SEQ ID NO: 88	E-W3, E-M3	ENO3	136-150	TD <b><u>GTVLK</u></b> KKINIGGNAC
SEQ ID NO: 89	E-F4/M4	ENO4	182-196	DK <b><u>VPKKFK</u></b> LPSPFKN
SEQ ID NO: 90	E-W5	ENO5	236-250	KL <b><u>GLLVKK</u></b> YGLSAK
SEQ ID NO: 91	E-M8	ENO6	295-309	SSE <b><u>FYDEEK</u></b> LYEVE
SEQ ID NO: 92	E-W7/M9	ENO7	344-358	D <b><u>YENWTK</u></b> LNARLGQR
SEQ ID NO: 93	E-W8, E-M10	ENO8	366-380	LY <b><u>TTNPIT</u></b> IKKGLLEG
SEQ ID NO: 94	G-M1	GAP1	8-22	RACR <b><u>KLYPKD</u></b> IQVVA
SEQ ID NO: 95	G-M2	GAP2	56-70	Q <b><u>EFTVGE</u></b> GADKWVVK
SEQ ID NO: 96	G-W2	GAP3	67-81	WV <b><u>VKSIGGR</u></b> LGPSQL

TABLE 13-continued

List of synthetic 15-mer peptides of representative epitopes of ALD, ENO, GAP, and ACT for reactivity with immunoreactive women and men sera.

SEQ ID NO:	women/men designation	epitope peptide name	amino acid numbers	amino acid sequence
97	G-W4	GAP4	104-118	KDA <u>EGKIK</u> KKDDGYDGH
98	G-M6	GAP5	224-238	ALPKV <u>CHGLP</u> PKSLD
99	G-M10	GAP6	332-346	EWMYSC <u>RCAD</u> IFHRL
100	ACT-W9,M1	ACT1	463-467	SVNR <u>HHSQ</u> LITYIKH
101	ACT-W10,M2	ACT2	492-506	AQPL <u>YDEA</u> IAPKEEV
102	ACT-W13,M5	ACT3	803-817	FKDTF <u>KYFD</u> KDKSNS

Approximately 1 µg of individual and/or a combination of synthetic peptides were dot-blotted onto a nitrocellulose membrane and allowed to air dry for 30 min at 37° C. These dot-blots were fit into individual wells of a 96-well microtiter ELISA plate. Then, 100 µl of 2% ELISA-grade BSA (Sigma-Aldrich, St. Louis, Mo.) in PBS (eBSA-PBS), pH 7.4, was added and incubated for 2 h at RT, after which 5 µl of a 1:1 dilution (v/v) of *T. vaginalis* negative- and positive-control women or men sera in PBS, pH 7.4, was added and incubated for 30 min at RT. The remainder of the procedure is as detailed above. Densitometric scans were produced using the ImageJ software (rsbweb.nih.gov/ij).

FIG. 5 presents results from representative dot-blot reactions using positive control sera of women and men of 15-mer peptides for ALD (1a and 1b), ENO (2a and 2b), GAP (3a and 3b), and ACT (4a and 4b) as a positive control (XX). Reactivity was detected for each 15-mer peptide, albeit at different levels of spot intensities. No peptides were detectable using negative control sera for both women and men that were determined to be unreactive with the full-length proteins. These data suggest that some peptide-epitopes have potential as serodiagnostic targets.

We next wanted to perform dot-blots (FIG. 6A) using random combinations of the 15-mer peptides to determine whether an increased extent of reactivity was seen for women and men sera. We further wanted combinations of

peptides that might give equal reactivity for both sera. FIG. 6B presents in duplicate the intensity of signal for each combination with the positive control women and men sera (labeled 4+/5+), and no detection of the peptide cocktails was evident with negative control sera (labeled -0-). Densitometric scan (bars 1 through 7) revealed overall better extent of reactions with combination of peptides compared to the individual peptides for both women and men sera (data not shown). The combined peptides ACT2 and ACT3 (bars 8) served as positive controls with known sera of men and women reactive with α-actinin, and the pooled peptides GAP1, GAP6 and ENO3 (bars 9) as well as GAP5, ENO5, and ALD6 (bars 10) showed no reactivity with negative control sera of both women and men sera.

#### Example 8. Identification of Immunogenic Epitopes of α-Enolase and GAPDH with High Sequence Identity to Human Protein Sequences

From Tables 6 and 9 it was possible to identify three epitopes of α-enolase and one epitope of GAPDH with 62.5% to 78% identity to the human peptide sequences, as illustrated in Table 14. The peptide sequences were considered high identity if there was a difference in sequence by only two to three amino acids in an eight to nine linear amino acid sequence.

TABLE 14

Identification of *Trichomonas vaginalis* (Tv) peptide epitopes with high sequence identity to human (Hu) protein epitopes and with possible immune crossreactivity.

SEQ ID NO:	amino acid protein sequence	amino acid epitope sequence	female patient sera reaction	male patient sera reaction	MAb reactivity	identity (%)
25	ENO	94-101 (Tv) DKARYGGK	+	+		78
103		(Hu) DKQRYLGK				
29	ENO	245-252 (Tv) KYGLSAKN		+		62.5
104		(Hu) KYGKD <del>A</del> TN				
4	ENO	364-371 (Tv) DDLYTTNP			+	75
105		(Hu) DDLT <del>V</del> TNP				
144	GAP	322-329 (Tv) LVKVL <del>S</del> WY	+	+		62.5
106		(Hu) FVKLI <del>S</del> WY				

Example 9. Production of Recombinant Protein  
Encoding Sequential Epitope Sequences of  
Aldolase, GAPDH,  $\alpha$ -Enolase, and  $\alpha$ -Actinin  
Separated by Amino Acid Spacers for Use in  
Serodiagnosis

In this example, the epitopes identified in Tables 2-11 that are immunoreactive with seropositive sera of women and men for the proteins aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin are encoded within a plasmid construct so that the individual epitopes are within 15-mer peptides of the trichomonad protein. The epitopes may be in any random order so that, for example, the sequence of epitopes may include one for aldolase followed by one for  $\alpha$ -actinin followed by one for  $\alpha$ -enolase followed by one for aldolase, etcetera. Further, the number of epitopes may be just one each representative of each protein or as many as deemed necessary for each protein for optimal antibody detection in a serodiagnostic. The plasmid construct is then expressed in recombinant *E. coli*, and a recombinant protein is then made upon induction. This type of recombinant protein containing a series or an array of epitopes is referred to here as a String of Pearls (SOP) where each "pearl" is representative of the amino acid sequence within which is found an epitope as described. This recombinant protein can also be referred to interchangeably as a SOE or rSOE.

FIG. 7A presents a simple example of an SOP encoding sequentially two epitopes of GAPDH, two epitopes of  $\alpha$ -enolase, and two epitopes of aldolase. The sequences of these individual epitopes and 15-mer epitopes are among those listed in Table 13 above. The SOP sequence identity is also provided in SEQ ID NO:145. This and other recombinant SOP arrays of epitopes of the *T. vaginalis* proteins aldolase, GAPDH,  $\alpha$ -enolase, and  $\alpha$ -actinin purified similarly can then be immobilized on surfaces for probing and detection by immunoreactive sera of women and men. FIG. 7B shows purification of an SOP, with lysate, flow-through, washes, and elution fractions in SDS-PAGE gel with Coomassie-brilliant blue stain.

The SOP encoding for an array of six 15-mer amino acid sequences, two each of which contained epitopes for ALD, ENO, and GAP was 111 amino acids for an Mr of 13.35-kDa. The DNA encoding for the SOP with a His<sub>6</sub> tag at the carboxy terminus was cloned into a pET23b expression plasmid construct that was transformed into *E. coli* B121 DE3. Recombinant *E. coli* (*rE. coli*) was stored as glycerol stocks at  $-70^{\circ}$  C. until used, which were thawed and streaked onto Luria Broth (LB) agar plates containing 25  $\mu$ g ampicillin (amp). Isolated colonies were inoculated into 200 ml fresh LB containing amp and incubated in a shaker incubator at  $37^{\circ}$  C. and 220 rpm. Following overnight growth, *rE. coli* were inoculated into fresh LB medium with amp and incubated for 3 h at  $37^{\circ}$  C. at 220 rpm prior to addition of 1 mM IPTG and incubation an additional 3 h. The *rE. coli* were centrifuged using a Sorvall SLA-1500 rotor at 8,000 rpm and  $4^{\circ}$  C. for 15 min. Supernatant was decanted, and the pellet was stored at  $-80^{\circ}$  C. until used. At various time intervals, prior to and after IPTG addition, 1 ml of *rE. coli* were microfuged at 10,000 rpm for 15 min and pellets prepared for SDS-PAGE (34, 35) for analysis of recombinant SOP::His<sub>6</sub> fusion protein (12.2-kDa) expression after IPTG addition. Immunoblot analysis after SDS-PAGE, shown in FIG. 8, confirmed the synthesis of SOP::His<sub>6</sub> using as probe positive control sera of women and men that were seropositive to  $\alpha$ -actinin as defined above.

ELISA was performed by immobilizing purified SOP protein onto 96-well, flat-bottom Nunc polystyrene plates.

Each well was coated with 100  $\mu$ l containing 1  $\mu$ g of SOP diluted in carbonate/bicarbonate buffer, pH 9.6, and the plates were incubated o/n at RT with gentle agitation. Each plate was then washed 3 $\times$  with PBS-T. On the third wash the plates were incubated in PBS-T for 5 min at RT with gentle agitation prior to removing the PBS-T. The plates were then incubated upside down o/n on at RT on paper towels before being covered with plastic wrap and stored at  $4^{\circ}$  C. until used. For testing, plates were washed twice with PBS-T. On the second wash the plates were incubated in PBS-T at RT for 5 min with gentle agitation and slap-dried. Each well was then blocked with 200  $\mu$ l of eBSA-PBS for 2 h at  $37^{\circ}$  C. Plates were then washed twice with PBS-T. On the second wash the plates were incubated in PBS-T at RT for 5 min with gentle agitation followed by removing the PBS-T. Next, 100  $\mu$ l of a 1:25 dilution in eBSA-PBS of women and men sera was added to each well in duplicate and incubated at RT for 5 min with gentle agitation before incubation for 4 h at  $37^{\circ}$  C. The plates were washed three times with PBS-T. On the third wash the plates were incubated in PBS-T for 5 min at RT with gentle agitation. After removal of the PBS-T, 100  $\mu$ l of secondary horseradish peroxidase-conjugated goat-anti-human IgG (Fc-specific) diluted 1:1, 500 in eBSA-PBS was added to each well and incubated at RT with gentle agitation for 5 min before incubation for 1 h at  $37^{\circ}$  C. The plates were washed 3 $\times$  with PBS-T, as above, prior to addition of 100  $\mu$ l of color development solution, prepared according to the manufacturer's instructions well and incubated at RT with gentle agitation for 15 min. Absorbance values at 405-nm were obtained using Bio-Tek plate reader (Bio-Tek Instruments, Inc).

We performed assays to assess whether this novel recombinant protein is detectable with positive control sera of women and men, as above. FIG. 8A shows representative reactions by ELISA with SOP arrays immobilized onto individual wells of 96-well microtiter plates. Negative control sera of women and men had little to no reactivity as evidenced by low  $A_{405nm}$  with the SOP in comparison to the strong signals (high  $A_{450nm}$ ) obtained with positive sera of women and men. The SOP was undetectable when using an irrelevant MAb HA423 to  $\alpha$ -actinin of *T. vaginalis* (XX) compared to the very strong reaction seen with a positive control MAb to hexa-histidine in the fusion recombinant protein.

Further, FIGS. 8B and 8C demonstrates that antibodies in positive sera of women and men react with the SOP array and are detected by dot-blots (FIG. 8B1) and by immunoblot after SDS-PAGE and immunoblotting onto nitrocellulose (FIG. 8B2). The Coomassie-brilliant blue stained gel is a duplicate from the SDS-PAGE used for immunoblotting of the SOP, and the Ponceau S-stained nitrocellulose is a duplicate included to show the transfer of the SOP protein onto nitrocellulose.

Example 9. Epitopes of Highly Immunogenic *T. vaginalis*  $\alpha$ -Actinin Used as Serodiagnostic Targets for Both Women and Men

Highly immunogenic  $\alpha$ -actinin protein and protein fragments were characterized to further establish utility as a target for serodiagnosis of trichomonosis for both women and men. It is known that the sera of women with trichomonosis possess antibody reactive with numerous trichomonad proteins, including  $\alpha$ -actinin (referred to as positive control women sera). Epitope mapping identified 13 peptide epitopes within  $\alpha$ -actinin reactive to the positive control sera of women. Men sera highly-seropositive to the

trichomonad parent  $\alpha$ -actinin and the truncated version called ACT-P2 (positive control men sera) identified 5 epitopes that were a subset of those detected by positive control women sera. The amino acid sequences of the epitopes had little or no sequence identity to the human  $\alpha$ -actinin homolog and to proteins of other microbial pathogens, including a related *Tritrichomonas suis* and yeasts *Candida albicans* and *Saccharomyces cerevisiae*. Further, immobilized 15-mer peptides of representative epitopes are reactive to both positive control women and men sera.

A plasmid was constructed to encode an SOP array of all thirteen epitopes of  $\alpha$ -actinin as shown in FIG. 9 (SEQ ID NO:146). This actinin SOP is expressed in *E. coli* as is the SOP presented above expressing epitopes of ALD, ENO, and GAP. In this case, the thirteen epitopes detected antibodies in the sera of women and men exposed to *T. vaginalis* are arranged sequentially within individual 15-mer peptides, which were separated from each other by a diglycine (-GG-) recombinant *E. coli* with the plasmid construct with the DNA sequence encoding this recombinant SOP of  $\alpha$ -actinin is induced for expression of the protein. The  $\alpha$ -actinin epitope protein is a fusion protein with a hexa-histidine sequence at the carboxy-terminus for purification as above by nickel-affinity chromatography. Purified  $\alpha$ -actinin SOP can be immobilized for detection antibodies in the sera of women and men.

#### Materials and Methods

##### $\alpha$ -Actinin-P2 (ACT-P2) Expression and Purification.

The natural *T. vaginalis*  $\alpha$ -actinin protein consists of 931-amino acids and is 106.2-kDa. This full-length highly immunogenic protein is used for examining the relation between seropositivity in men and prostate cancer. Subclones of the trichomonad  $\alpha$ -actinin gene are made to determine the region of the protein most reactive with men sera. This subclone encoded a protein of 558-amino acid protein from the amino terminus, called ACT-P2. The coding region of ACT-P2 corresponding to amino acids 375 to 932 is PCR amplified and cloned in pET23b expression vector with the kanamycin resistance gene (Kan<sup>r</sup>) for transformation of *E. coli* BL21DE3 cells. The resulting recombinant 558-amino acid sequence further comprises a C-terminal His<sub>6</sub> tag fusion protein of 63.5-kDa. Bacteria are grown on Luria Broth (LB) agar plates containing 25  $\mu$ g/ml Kan, and *rE. coli* is incubated for 3 h at 37° C. at 220 rpm prior to addition of 1 mM isopropylthiogalactoside and incubated for an additional 3 h. The *rE. coli* are centrifuged using a Sorvall SLA-1500 rotor at 8,000 rpm and 4° C. for 15 min. and pellets stored at -80° C. until used. Synthesis of ACT-P2 is confirmed using as probe the murine monoclonal antibody (MAb) HA423 (27-29) to trichomonad  $\alpha$ -actinin or MAb to His<sub>6</sub> (Advanced Targeting Systems, San Diego, Calif., USA).

For purification of ACT-P2, pellets of *rE. coli* are thawed for 15 min on ice and suspended in 10-ml lysis buffer (50 mM Tris, pH 8.0, 300 mM NaCl, 10 mM  $\beta$ -mercaptoethanol ( $\beta$ -ME), and 0.1% Triton-X100), and lysates are sonicated 10 times each at room temperature (RT) for 30 seconds (sec). Sonicates are centrifuged using a Sorvall SS-34 rotor at 8,000 rpm and 4° C. for 20 minutes (min), and supernatant is applied to a Ni<sup>2+</sup>-NTA superflow affinity column according to the manufacturer's instructions (Qiagen Inc., Valencia, Calif., USA). Purified ACT-P2 protein is confirmed by SDS-PAGE and immunoblot using as probe MAb HA423, as above.

##### The Human ACTN1 Homolog.

The purified full-length human ACTN1  $\alpha$ -actinin homolog used in this study is the isoform B protein of 892

amino acids (~103-kDa) (Novus Biologicals, Littleton, Colo., USA). The soluble protein is in 74 mM Tris-HCl, pH 8.0, containing 10 mM reduced glutathione. For ELISA and immunoblot assays 1  $\mu$ g of ACT-P2 and ACTN1 is used. ELISA is performed using wells of microtiter plates coated with ACT-P2 or ACTN1 as detailed below. SDS-PAGE for immunoblotting onto nitrocellulose for both ACT-P2 and ACTN1 is carried out using 7.5% acrylamide gels, as before (36, 37).

##### 10 Positive Control Sera of Women and Men and Detection of Antibody to ACT-P2.

During the course of our research on *T. vaginalis* we have examined ~1,000 sera of women patients with trichomonosis and, more recently, up to 20,000 sera of men for seropositivity to trichomonad proteins and particularly  $\alpha$ -actinin. We, therefore, were able to determine the extent of serum antibody to total *T. vaginalis* proteins,  $\alpha$ -actinin, and ACT-P2 by ELISA (27-29). Individual,  $\alpha$ -actinin-seropositive sera of women and men had identical or very similar reactivities to trichomonad proteins and  $\alpha$ -actinin. This permitted us to pool the sera to have sufficient amounts for conducting epitope mapping experiments, as outlined below, and was considered positive control sera. Likewise, pooled seronegative sera of both women and men were considered negative control sera for parallel experiments conducted throughout.

##### Trichomonad Natural $\alpha$ -Actinin SPOTs Membrane Synthesis for Epitope Mapping.

Oligopeptides derived from the sequences of *T. vaginalis*  $\alpha$ -actinin (GenBank accession number AAC72899) were synthesized on activated membranes using the SPOTs system (Sigma-Genosys, The Woodlands, Tex., USA). Five to 10 nmol of each peptide was covalently bound to a Whatman 50 cellulose support (Whatman, Maidstone, England) by the C-terminus using Fmoc-L amino acid chemistry and had an acetylated N-terminus. The oligopeptides were 11-mer amino acids in length and had a sequential overlap of eight amino acids. The SPOTs spanned the entire sequence of the protein.

##### 40 Probing the $\alpha$ -Actinin SPOTs Membrane with Positive and Negative Control Sera and MAb HA423.

The membrane was initially washed with a small volume of 100% MeOH for 5 min to avoid precipitation of hydrophobic peptides during the following procedure. After washing 3 $\times$  each for 10 min in 25 ml of TBS buffer (50 mM Tris-HCl, pH 8.0, 137 mM NaCl, and 2.7 mM KCl), the SPOTs membrane was incubated in Blocking Buffer (TBS containing 5% BSA) at RT for 2 h. The membrane was incubated with a 1:10 dilution of negative or positive control sera of women and men, respectively, and incubated o/n at 4° C. The membrane was also probed with the MAb HA423 that detects  $\alpha$ -actinin. After washing 3 $\times$  each for 5 min each in TBS, the membrane was incubated with a 1:1,500 dilution of secondary anti-human antibody as above or anti-mouse IgG Fab (IgG fraction) prepared in Blocking Buffer. After washing 3 $\times$  each in TBS at RT for 5 min each, bound antibodies were detected using color development reagent.

Immediately following color development and SPOT analysis, the membrane was regenerated by washing 3 $\times$  with water with each wash for 10 min at RT with agitation. Bound antibody was stripped from the membrane by washing at least 4 times with each wash for 30 min with Regeneration Buffer 1 (62.5 mM Tris-HCl, pH 6.7, 2% SDS, and 100 mM  $\beta$ -ME) at 50° C. with agitation. The membrane was washed three times each for 20 min with 10 $\times$ PBS at RT with agitation, after which the membrane was washed 3 $\times$  each for 20 min with T-TBS buffer (TBS, pH 8.0, containing 0.05%

Tween 20) at RT with agitation. This was followed by washing 3× each for 10 min with TBS at RT with agitation. The presence of any visible spots resulted in repeating the regeneration steps. As a control to show that the primary antibody was completely removed, the membrane was re-incubated with the appropriate secondary antibody and substrate solution and developed. Regeneration was continued until no reactivity was seen with secondary antibody.

The epitope amino acid sequences were determined based on reactivities of overlapping peptides, as shown above in Table 11. Epitope sequences were compared with other proteins by using the protein-protein basic local alignment search tool found on a page of the NCBI website. Amino acid sequence alignments of the proteins were performed with CLC Protein Workbench (Muehlthal, Germany). Hydrophobicity plots and antigenicity plots were constructed using Lasergene MegAlign (DNASTAR, Madison, Wis.).

Synthesis and Reactivity of Individual  $\alpha$ -Actinin Epitopes.

Three 15-mer peptide epitopes identified from SPOT membrane epitope mapping with low percent identity to other human pathogens as well as the  $\alpha$ -actinin human homolog were synthesized in PEPscreen format (Sigma-Genosys). The reactivity of each peptide was tested with representative negative and positive control sera either individually or in combination. Approximately 10  $\mu$ g of peptide was blotted onto nitrocellulose membranes and air dried o/n at RT. The epitope blots were then blocked with 2% e-BSA in PBS at 37 C for 2 h followed by incubation with 1:25 dilution in PBS of negative or positive control women and men sera for ACT-P2 and incubated o/n at RT. This was followed by secondary antibody and color development, as above. All assays were performed in duplicate and repeated at least three times.

#### Results

Positive Control Sera of Women and Men does not Detect the Human  $\alpha$ -Actinin Homolog Protein.

Negative and positive control sera of women and men were used to probe immunoblots of ACT-P2. As can be seen in FIG. 10 positive (pos) control sera of women (lanes 3a and 3b) and of men (lanes 5a, and 5b) detected ACT-P2 in two separate experiments done at different times under identical experimental conditions. Negative (neg) control sera of women and of men gave no detectable bands (lanes 2 and 4, respectively). The IgG<sub>1</sub> MAb HA423 to the trichomonad  $\alpha$ -actinin used as probe gave strong reactivity in separate experiments (lanes 1 and 6), and, not unexpectedly, an irrelevant IgG<sub>1</sub> MAb B44 reactive with trichomonad  $\alpha$ -enolase as a negative control detected no protein band. We next tested for immuno-crossreactivity purified, commercially-available human  $\alpha$ -actinin (HuACTN1) with pooled positive control sera of women and men used in FIG. 10. FIG. 11A (lane 5) shows the intense stained band of 1  $\mu$ g HuACTN1. Gels with the same amount of HuACTN1 were transferred onto nitrocellulose for immunoblotting. A duplicate blot with HuACTN1 was stained to insure transfer of the protein (not shown). The HuACTN1 was neither detected by the positive control sera (lane 4) nor HA423 (not shown). As above, 1  $\mu$ g of ACT-P2 (lane 3) was readily detected by MAb HA423 (lane 1) and rabbit antiserum to total *T. vaginalis* proteins (IRS, lane 2). We then tested by immunoblot using total proteins of *T. vaginalis* (lane 10), as before, whether the pooled positive control sera of both women and men detected numerous other trichomonad proteins. FIG. 11B shows that pooled negative control sera did not detect any trichomonad proteins by immunoblot (lane 7) whereas pooled positive control sera recognized numerous proteins (lane 8). As a control and not surpris-

ingly, many trichomonad proteins in the total protein preparation were evident when blots were probed with IRS (lane 9). As with negative control sera of women and men (lane 7), no proteins were detected by control, prebleed normal rabbit serum. Finally, we tested for detection of non-denatured HuACTN1 coated onto wells of microtiter plates. Again, neither positive control sera of women and men nor MAb HA423 reacted to the HuACTN1-coated wells (not shown).

$\alpha$ -Actinin Epitopes React with Positive Control Sera of Women and Men and MAb HA423.

We next tested the positive control sera of women and men strongly reactive with ACT-P2 for IgG antibody to overlapping 11-mer peptides on a Custom SPOTs membrane (Materials and Methods). Table 5A of Example 7 lists the 13 epitopes and corresponding amino acid sequences labeled W1 through W13 recognized by women sera. M1 through M5 represent the subset of epitopes detected by men sera. The IgG<sub>1</sub> MAb HA423 detected the same epitope as W12/M4. Negative control sera of women and men and the MAbs B43 and B44 to trichomonad GAPDH and  $\alpha$ -enolase, respectively, which were the same isotype as HA423, were unreactive with the SPOTs membrane.

FIG. 12A shows a representative reaction for epitope detection of 11-mer overlapping peptides (SEQ ID NO:162-165) for spots numbered 214 through 217. The highly reactive SPOTs 214 through 217 for positive control sera of women indicates the epitope sequence of 643-VEFKLNYKVTY-653 (SEQ ID NO:163). (FIG. 12B). Likewise, the 216 and 217 peptides reactive with positive control sera of men suggest the sequence 649-YKVTYS-653 as the epitope. No reactivity was seen with negative control sera of either women or men. The MAb HA423 epitope is 643-VEFKLNYKVTY-653 (SEQ ID NO:163). FIG. 12C1 shows the strong dot-blot reaction by positive control sera of women and men to ACT-P2 immobilized on nitrocellulose. We then synthesized 15-mer peptides overlapping W10/M2 (AQPLYDEAIAFKKEEV) (SEQ ID NO:101) and W13/M5 (FKDTFKYFDKDKSNS) (SEQ ID NO:102), epitopes from Table 11 (epitopes underlined), and immobilized 1  $\mu$ g of each peptide together and probed with positive control sera. The sera of both women and men reacted with the combined 15-mer peptide epitopes (FIG. 12C2). FIG. 12C3 presents densitometric scans of the reactive spots and shows the elevated level of detection by men sera compared to women sera. Finally, FIG. 12D1 shows the reactivity of individual 15-mer peptides containing the epitopes of W9/M1 (SVNRHHSOLITYIKH) (SEQ ID NO:100), W10/M2, and W13/M5 with positive control sera. FIG. 12D2 illustrates the densitometric scans that show men sera giving elevated intensities to W9/M1 and W10/M2 compared to women sera. The extent of detection was identical for both sera of women and men to the epitope W13/M5. Negative control sera of both women and men showed no reactions in these dot-blots of epitopes.

Hydrophobicity and Antigenicity Profiles of the Natural  $\alpha$ -Actinin Sequence.

We then analyzed the immunoreactive epitopes of Table 11 for hydrophobicity and antigenicity. FIG. 13 demonstrates the mapping of the epitopes with the respective profiles and shows that most epitopes were hydrophilic and corresponded with predicted antigenicity. As representative examples, epitopes W3, W4, W8, HA423/M4/W12, and M5/W13 each gave prominent hydrophilic and antigenic characteristics that were not inconsistent with serum antibody detection.

Sequence Alignment of the *T. vaginalis*  $\alpha$ -Actinin with Proteins of Other Representative Organisms and of the HuACTN1.

BLAST of *T. vaginalis*  $\alpha$ -actinin amino acid sequence (SEQ ID NO:157) is presented in FIG. 14 and shows little amino acid percent identity with  $\alpha$ -actinin-like proteins of different species. The low percent identity of amino acids is particularly noteworthy for the boxed epitope sequences indicated above the *T. vaginalis* amino acid sequence detected by both positive control sera of women and men. Table 12 summarizes the percent amino acid sequence identity comparisons for the individual epitopes compared with sequences for *T. suis*, a related trichomonad, and the yeasts *C. albicans*, and *S. cerevisiae*.

The organisms shown in FIG. 14 and Table 12 were chosen because of their relation to STIs and/or eukaryotic pathogens. The range of amino acid percent identity was from 0% to 25%. The percent amino acid identity for  $\alpha$ -actinin of *T. vaginalis* compared with the HuACTN1 was 0% to 50%. Not unexpectedly, the seemingly high percent sequence identity of any epitope with the corresponding region of HuACTN1 decreased when neighboring amino acids were analyzed. Specific synthesized peptide epitopes of  $\alpha$ -actinin with low to no amino acid sequence identity with other proteins were reactive with positive control sera of both women and men, as shown for representative epitopes in FIG. 12.

#### Discussion

Research in our laboratory led to the development of the lateral flow, immunochromatographic diagnostic for detection of trichomonad protein in female patients, and this diagnostic was commercialized and is currently in use in the United States and other countries (OSOM® *Trichomonas* Rapid Test, Sekisui Diagnostics, San Diego, Calif.). This diagnostic, developed in our laboratory, works on neither urine nor secretions obtained from male patients nor on urine spiked with lysates of total *T. vaginalis* proteins based on our analysis in the laboratory. Reports suggesting a relation between seropositivity to the ACT-P2 of *T. vaginalis* and prostate cancer reveal the need for a serum-based point-of-care diagnostic that utilizes a highly specific target. Our data show that the 558-amino acid ACT-P2 is a good target for detection of antibody in both women and men seropositive to *T. vaginalis*. This region of ACT-P2 was found to possess less homology with other  $\alpha$ -actinin-related proteins, further reinforcing its diagnostic value. The fact that the epitopes detected by the positive control sera of men are located toward the C-terminus revealed why ACT-P2 was a good target for our earlier screening for serum antibody. It is noteworthy that there is absent or little identity between the peptide-epitope sequences with other proteins in databanks and among proteins for *T. suis*, *C. albicans*, and *S. cerevisiae* and the HuACTN1 of humans (Table 12 and FIG. 14). This suggests strongly that high seropositivity is the result of exposure to *T. vaginalis*. Furthermore, of particular interest is that 15-mer synthetic peptide-epitopes found within ACT-P2 immobilized onto nitrocellulose were detected by sera of both positive control sera women and men reactive to  $\alpha$ -actinin (FIG. 12). Perhaps not surprisingly, most of the peptide epitope amino acid sequences represented portions of the protein that were hydrophilic and antigenic (FIG. 4). The representative 15-mer synthetic peptides corresponding to W10/M2 and W13/M5 that were readily detected on immobilized surfaces were in fact highly hydrophilic (FIG. 12). This further suggests that the reactive 15-mer epitopes represent linear, readily detectable epitopes.

A cocktail of or a recombinant protein encoding for a series of highly-reactive epitopes, such as a rSOE or SOP, represents diagnostic targets.

It is not surprising that  $\alpha$ -actinin represents a target for serodiagnostic. This is one of the most immunogenic proteins of *T. vaginalis*. Its function is to associate with actin, which is important because of the dramatic and rapid morphologic transformation that this organism undergoes immediately following contact with vaginal epithelial cells, prostate epithelial cells (unpublished data), and extracellular matrix proteins, such as laminin and fibronectin. Indeed, recent transcriptomic and proteomic analyses has revealed the dramatic increased expression levels of  $\alpha$ -actinin required for cytoskeletal rearrangements for morphological changes upon adherence to vaginal epithelial cells and binding to fibronectin. Further, equally elevated amounts of mRNA encoding for trichomonad GAPDH and  $\alpha$ -enolase were found, and both of these proteins are surface ligands for binding fibronectin. There are four  $\alpha$ -actinin human homologs, none of which are crossreactive with the MAb HA423 to the trichomonad  $\alpha$ -actinin (FIG. 9 and Table 15) and with positive control sera of women and men. These human  $\alpha$ -actinin proteins are known to have a less conserved central region, as is the case for all actin-binding proteins of the spectrin family.

Equally noteworthy is that the epitopes detected by MAb HA423 and positive control sera of women and men are invariant. Laboratory-adapted *T. vaginalis* isolates grown in batch culture for >20 years possess the MAb 423-immunoreactive  $\alpha$ -actinin with the same Mr. Further, more than fifty fresh clinical isolates, one-half of which are the Type II P270 phenotypically-varying isolates with the dsRNA virus, all possess  $\alpha$ -actinin detected by MAb and positive control sera of women and men. We have seen no relation between *T. vaginalis* with or without *mycoplasma* and changes with  $\alpha$ -actinin. Thus, this invariant and stable immunogenic protein appears suitable for a rapid serodiagnostic test for trichomonosis.

Of interest is the number of epitopes detected by the positive control sera of women patients compared to sera of men. This may be the result of different presentation of the protein(s) during immune surveillance that results from the unique urogenital regions of women in contrast to men. It is known to those of ordinary skill in the art that women patients with trichomonosis possess IgG antibody in the serum and vagina to numerous trichomonad proteins, perhaps indicating a more vigorous antibody response during infection compared to men. Studies by others demonstrated the highly immunogenic nature of and serum antibody response by women to  $\alpha$ -actinin. Nonetheless, these data show that men respond to exposure to *T. vaginalis* by producing serum IgG antibody, especially to the epitopes located toward the carboxy-terminal region with the least identity to other known proteins. Importantly, what remains unknown is the temporal relationship between seropositivity with initial exposure to this STI, and this critical absence of clinical information perhaps may be corrected through future availability of a serodiagnostic for women and men. What is known, however, albeit in only a small sample size is that one week after treatment of women with trichomonosis the vaginal antibody to proteinases was not detected.

The literature is replete with examples of peptide epitopes utilized for diagnostics of infectious diseases. For example, rapid diagnostics for *Plasmodium falciparum* employ epitopes of histidine-rich proteins. Diagnosis of visceral leishmaniasis is performed with rapid antigen-based tests, and specific epitopes of the proteins p120 and p140 are used

for detection of *Ehrlichia claffeensis* and *E. canis*, respectively. This shows the value of characterization of immunogenic epitopes for developing specific targets for serodiagnosis. In summary, our results present evidence for the validity of  $\alpha$ -actinin and the truncated ACT-P2 as a target for serodiagnosis in both women and men exposed to *T. vaginalis*. This is important not only for screening men possibly exposed to this STI in relation to the possibility of prostate cancer development but for a more rapid, non-invasive test for women as well. This approach highlights the methods by which peptide epitopes of immunogens may be identified as targets for antibody detection for determining exposure to and infection by this significant STD pathogen.

Example 10.  $\alpha$ -Actinin String-of-Pearls (KK-ACT-SOP) Epitopes, and SOE Sequences

Sequences are shown in Table 15, comprising 229 amino acids; pI=9.93; MW=27,207 Da.

TABLE 15

<i>T. vaginalis</i> $\alpha$ -Actinin epitopes, and SOE sequences			
	EPITOPE #	NAME	AA SEQUENCE
SEQ ID NO: 107	1	W1	SVRREGLLDDAWEKT
SEQ ID NO: 108	2	W2	LARQIQFETIETDFE
SEQ ID NO: 109	3	W3	PSKWHKQPKMMVTQKR
SEQ ID NO: 110	4	W4	QGYEHVAVNNFTTSW
SEQ ID NO: 111	5	W5	GIYVYLDPEDVIDTT
SEQ ID NO: 112	6	W6	KIAAMADKIKRTVAI
SEQ ID NO: 113	7	W7	IPGIRGLASVISYN
SEQ ID NO: 114	8	W8	CKSGNRPIPEIQGL
SEQ ID NO: 100	9	W9/M1	SVNRHHSQLITYIKH
SEQ ID NO: 101	10	W10/M2	AQPLYDEAIAFKEEV
SEQ ID NO: 117	11	W11/M3	ELVEFKLNYKVTTY
SEQ ID NO: 118	12	W12/M4/ HA423	EPKLNKVTYTYSDA
SEQ ID NO: 102	13	W13/M5	FKDTFKYFDKDKSNS
SEQ ID NO: 120			KK-SVRREGLLDDAWEKT-KK-LARQIQFETIETDFE-KK-PSKWHKQPKMMVTQKR-KK-QGYEHVAVNNFTTSW-KK-GIYVYLDPEDVIDTT-KK-KIAAMADKIKRTVAI-KK-IPGIRGLASVISYN-KK-CKSGNRPIPEIQGL-KK-SVNRHHSQLITYIKH-KK-AQPLYDEAIAFKEEV-KK-ELVEFKLNYKVTTY-KK-EPKLNKVTYTYSDA-KK-FKDTFKYFDKDKSNS-KK-HHHHHH
SEQ ID NO: 120			KKSVRREGLLDDAWEKTKKLARQIQFETIETDFEKPSKWHKQPKMMVTQKRKQGYEHVAVNNFTTSWKKGIYVYLDPEDVIDTTKKKIAAMADKIKRTVAIKKIPGIRGLASVISYNKKCKSGNRPIPEIQGLKKS VNRHHSQLITYIKHKAQPLYDEAIAFKEEVKKELVEFKLNYKVTTYKKEFKLNYKVTTYSDAKKFKDTFKYFDKDKSNSKHHHHHH
SEQ ID NO: 12			KKSVRREGLLDDAWEKTKKLARQIQFETIETDFEKPSKWHKQPKMMVTQKRKQGYEHVAVNNFTTSWKKGIYVYLDPEDVIDTTKKKIAAMADKIKRTVAIKKIPGIRGLASVISYNKKCKSGNRPIPEIQGLKKS VNRHHSQLITYIKHKAQPLYDEAIAFKEEVKKEL

TABLE 15-continued

<i>T. vaginalis</i> $\alpha$ -Actinin epitopes, and SOE sequences		
EPITOPE #	NAME	AA SEQUENCE
		VEFKLNYKVTTYKKEFKLNYKVTTYSDAKKFKDTFKYFDKDKSNSKHHHHHH

Example 11. Examples of *T. pallidum* Highly Immunogenic Peptides, 15-Mer Epitopes, and SOE as Targets for Serodetection, Shown in Table 16

As taught by Brinkman, epitope sequences identified as SEQ ID NO:121-124 are highly immunogenic. Antoni teaches that the epitope sequence identified as SEQ ID NO:125 is highly immunogenic, and Liu teaches that sequences of SEQ ID NO:126 are also highly immunogenic. Additional immunogenic protein sequences for *T. pallidum* are provided in SEQ ID NO: 161-164. Based on this information, and using the methods of the invention, the SOE of SEQ ID NO: 127 was designed and synthesized. Experimental evidence shows that it is able to detect *T. pallidum* in a biological sample, and to elicit an immune response when injected into a subject. The H<sub>6</sub> (also referred to as hexa-His) at the amino terminal end of the SOE polypeptide is for purification of the SOE using Ni-NTA (nickel) affinity chromatography.

TABLE 16

<i>T. pallidum</i> epitopes and SOE sequences	
SEQ ID NO:	AA SEQUENCE
SEQ ID NO: 121	LSTSLTTCDFTGIFA
SEQ ID NO: 122	IQSEVPIK
SEQ ID NO: 123	LLIGGSRGYGEIKLE
SEQ ID NO: 124	RPDLYAAVGE
SEQ ID NO: 125	ASGAKEEAEKKAEEQRALL
SEQ ID NO: 126	EVEDVPKVVPEASEREGGER
SEQ ID NO: 127	KK-LSTSLTTCDFTGIFA-KK-IQSEVPIK-KK-LLIGGSRGYGEIKLE-KK-RPDLYAAVGE-KK-ASGAKEEAEKKAEEQRALL-KK-EVEDVPKVVPEASEREGGER-KK-HHHHHH

Brinkman, M B, et al., 2008. A novel *Treponema pallidum* antigen, TP0136 . . . Infect. Immun. 76:1848-1857.  
 Antoni, G., et al., 1996. Detection of antigen determinants in the *Treponema pallidum* . . . 189:137-140.  
 Liu, H., et al., 2007. Molecular characterization and analysis of a gene . . . 56:715-721.

Example 12. Examples of *N. gonorrhoeae* Highly Immunogenic Peptides, 15-Mer Epitopes, and SOE as Targets for Serodetection, Shown in Table 17

Epitope sequences, SEQ ID NO:128-133, were derived from Cooke et al., 1997; 143:1415-1422. Additional immunogenic protein sequence for *N. gonorrhoeae* is provided in SEQ ID NO:165. Based on this information, SOE with sequence provided in SEQ ID NO: 134 was designed and synthesized. Experimental evidence shows that it is able to

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detect *N. gonorrhoeae* in a biological sample, and to elicit an immune response when injected into a subject. The H<sub>6</sub> at the amino terminal end of the SOE polypeptide sequence is for purification of the SOE using Ni-NTA (nickel) affinity chromatography.

TABLE 17

<i>N. gonorrhoeae</i> highly immunogenic peptides encoded in 15-mer epitopes, and SOE.	
AA SEQUENCE	
SEQ ID NO: 128	FGSKIGFKGQEDLGN
SEQ ID NO: 129	GFSGSVQYAPKDNSG
SEQ ID NO: 130	GFFAQYAGLFQRYGE

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TABLE 17-continued

<i>N. gonorrhoeae</i> highly immunogenic peptides encoded in 15-mer epitopes, and SOE.	
AA SEQUENCE	
5	SEQ ID NO: 131 VEKLQVHRLVGGYDN
10	SEQ ID NO: 132 NSHNSQTEVAATAAY
10	SEQ ID NO: 133 NTYDQVVVGAEYDFS
15	SEQ ID NO: 134 KK-FGSKIGFKGQEDLGN-KK-GFSGSVQYAPKDNS G-KK-GFFAQYAGLFQRYGE-KK-VEKLQVHRLVGG YDG-KK-N-KK-NSHNSQTEVAATAAY-KK-NTYDQ VVVGAEYDFS-KK-HHHHHH

SEQUENCE LISTING

<160> NUMBER OF SEQ ID NOS: 165

<210> SEQ ID NO 1  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: *Trichomonas vaginalis*

<400> SEQUENCE: 1

Arg Pro Asp Tyr Val Thr Val Glu  
 1 5

<210> SEQ ID NO 2  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: *Trichomonas vaginalis*

<400> SEQUENCE: 2

Lys His Thr Tyr Thr Arg Pro Glu  
 1 5

<210> SEQ ID NO 3  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: *Trichomonas vaginalis*

<400> SEQUENCE: 3

Glu Arg Ile Gln Lys Tyr Thr Arg  
 1 5

<210> SEQ ID NO 4  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: *Trichomonas vaginalis*

<400> SEQUENCE: 4

Asp Asp Leu Tyr Thr Thr Asn Pro  
 1 5

<210> SEQ ID NO 5  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: *Trichomonas vaginalis*

<400> SEQUENCE: 5

Ala Ile Val Lys Glu Cys Ile Ala  
 1 5

-continued

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<210> SEQ ID NO 6  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 6

Leu Lys Glu His Asp Met Leu Ala  
1 5

<210> SEQ ID NO 7  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 7

Tyr Leu Gly Arg Val Thr Leu Ala  
1 5

<210> SEQ ID NO 8  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 8

Arg Arg Ala Arg Ala Ala Gly Met  
1 5

<210> SEQ ID NO 9  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 9

Lys Ser Ile Gly Gly Arg Leu Gly  
1 5

<210> SEQ ID NO 10  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 10

Tyr Leu Leu Lys Tyr Asp Thr Ala His Arg Ala  
1 5 10

<210> SEQ ID NO 11  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 11

Tyr Lys Val Thr Tyr  
1 5

<210> SEQ ID NO 12  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 12

Ala Ile Ile Thr Ala Ser Val Lys  
1 5

<210> SEQ ID NO 13

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<211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 13

Ala Gly Ala Arg Lys Tyr Ala Asn  
 1 5

<210> SEQ ID NO 14  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 14

Arg Lys Tyr Ala Asn Gln Thr Met Leu Arg Tyr  
 1 5 10

<210> SEQ ID NO 15  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 15

Pro Ile Val Leu His Leu Asp His Gly Asp Ser  
 1 5 10

<210> SEQ ID NO 16  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 16

Tyr Thr Arg Pro Glu Glu Val Gln Asp Phe Val  
 1 5 10

<210> SEQ ID NO 17  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 17

Thr Ser His Gly Ala Tyr Lys Phe Pro Pro Gly  
 1 5 10

<210> SEQ ID NO 18  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 18

Ser Ile Pro Gln Glu Tyr Val Glu Met Val Asn  
 1 5 10

<210> SEQ ID NO 19  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 19

Arg Met Val Met Thr Gly Thr Ile Arg Arg Leu  
 1 5 10

<210> SEQ ID NO 20  
 <211> LENGTH: 8  
 <212> TYPE: PRT

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<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 20

Arg Gln Tyr Leu Gly Glu Ala Arg  
1 5

<210> SEQ ID NO 21

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 21

Ala Arg Thr Lys Leu Thr Glu Met  
1 5

<210> SEQ ID NO 22

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 22

Ala Ile Val Lys Glu Cys Ile Ala  
1 5

<210> SEQ ID NO 23

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 23

Tyr Leu Gly Arg Val Thr Leu Ala  
1 5

<210> SEQ ID NO 24

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 24

Leu Ala Ala Arg Ser Ser Ala Pro  
1 5

<210> SEQ ID NO 25

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 25

Asp Lys Ala Arg Tyr Gly Gly Lys  
1 5

<210> SEQ ID NO 26

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 26

Thr Val Leu Lys Lys Asn Ile Gly  
1 5

<210> SEQ ID NO 27

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

-continued

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<400> SEQUENCE: 27

Val	Pro	Lys	Lys	Phe	Lys	Leu	Pro	Ser	Pro	Phe
1				5					10	

<210> SEQ ID NO 28

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 28

Gly	Gly	Leu	Leu	Val	Lys	Lys	Tyr
1				5			

<210> SEQ ID NO 29

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 29

Lys	Tyr	Gly	Leu	Ser	Ala	Lys	Asn
1				5			

<210> SEQ ID NO 30

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 30

Phe	Tyr	Asp	Glu	Glu	Lys	Lys	Leu
1				5			

<210> SEQ ID NO 31

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 31

Lys	Lys	His	Pro	Ala	Ile	Val	Ser	Ile	Glu	Asp
1				5					10	

<210> SEQ ID NO 32

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 32

Glu	Asn	Trp	Thr	Lys	Leu	Asn	Ala	Arg	Leu	Gly
1				5					10	

<210> SEQ ID NO 33

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 33

Asp	Asp	Leu	Tyr	Thr	Thr	Asn	Pro
1				5			

<210> SEQ ID NO 34

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 34

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Glu Arg Ile Gln Lys Tyr Thr Arg  
1 5

<210> SEQ ID NO 35  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 35

Leu Lys Glu His Asp Met Leu Ala  
1 5

<210> SEQ ID NO 36  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 36

Leu Tyr Pro Lys Asp  
1 5

<210> SEQ ID NO 37  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 37

Tyr Leu Leu Lys Tyr Asp Thr Ala His Arg Ala  
1 5 10

<210> SEQ ID NO 38  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 38

Phe Thr Val Gly Glu Gly Ala Asp Lys Trp Val  
1 5 10

<210> SEQ ID NO 39  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 39

Lys Ser Ile Gly Gly Arg Leu Gly  
1 5

<210> SEQ ID NO 40  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 40

Ser Thr Gly Ile Phe Arg Thr Lys  
1 5

<210> SEQ ID NO 41  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 41

Ala Glu Gly Lys Ile Lys Lys Asp  
1 5

-continued

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<210> SEQ ID NO 42  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 42

His Leu Val Ser Gly Ala Lys Lys  
1 5

<210> SEQ ID NO 43  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 43

Ser Asn Ala Ser Cys  
1 5

<210> SEQ ID NO 44  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 44

Asn Ala Phe Gly Ile Arg Asn Gly  
1 5

<210> SEQ ID NO 45  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 45

Arg Arg Ala Arg Ala Ala Gly Met  
1 5

<210> SEQ ID NO 46  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 46

Thr Ser Thr Gly Ala Ala Ile Ala  
1 5

<210> SEQ ID NO 47  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 47

Cys His Gly Leu Pro  
1 5

<210> SEQ ID NO 48  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 48

Ser Leu Val Asp Leu Thr Val Asn Val Asn Ala  
1 5 10

-continued

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<210> SEQ ID NO 49  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 49

Val Ser Ser Asp Ile Ile Gly Cys  
1 5

<210> SEQ ID NO 50  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 50

Gly Cys Gln Tyr Ser Ser Ile Val  
1 5

<210> SEQ ID NO 51  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 51

Tyr Ser Ser Ile Val Asp Ala Leu Ser Thr Lys  
1 5 10

<210> SEQ ID NO 52  
<211> LENGTH: 10  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 52

Val Ser Trp Tyr Asp Asn Glu Trp Met Tyr  
1 5 10

<210> SEQ ID NO 53  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 53

Cys Arg Cys Ala Asp  
1 5

<210> SEQ ID NO 54  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis

<400> SEQUENCE: 54

Leu Tyr Pro Lys Glu  
1 5

<210> SEQ ID NO 55  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis

<400> SEQUENCE: 55

His Leu Leu Asn Tyr Asp Ser Ala His Gln Arg  
1 5 10

<210> SEQ ID NO 56  
<211> LENGTH: 11

-continued

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<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 56  
  
Phe Glu Val Gly Thr Gly Ser Asp Lys Trp Val  
1           5                   10

<210> SEQ ID NO 57  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 57

Lys Asn Leu Thr Gly Arg Leu Gly  
1           5

<210> SEQ ID NO 58  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 58

Ser Thr Gly Leu Phe Arg Thr His  
1           5

<210> SEQ ID NO 59  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 59

His Leu Leu Ala Gly Ala Lys Lys  
1           5

<210> SEQ ID NO 60  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 60

Ser Asn Ala Ser Cys  
1           5

<210> SEQ ID NO 61  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 61

Val Leu Asn Asp Thr Phe Gly Ile  
1           5

<210> SEQ ID NO 62  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis  
  
<400> SEQUENCE: 62

Arg Arg Ala Arg Ala Ala Gly Met  
1           5

<210> SEQ ID NO 63  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas suis

-continued

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&lt;400&gt; SEQUENCE: 63

Ile Thr Gly Ser Leu Val Asp Ile Thr Val Asn  
1           5                   10

&lt;210&gt; SEQ ID NO 64

&lt;211&gt; LENGTH: 12

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas suis

&lt;400&gt; SEQUENCE: 64

His Ser Ser Ile Val Asp Ser Leu Ser Thr Met Val  
1           5                   10

&lt;210&gt; SEQ ID NO 65

&lt;211&gt; LENGTH: 8

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas suis

&lt;400&gt; SEQUENCE: 65

Leu Val Lys Val Leu Ser Trp Tyr  
1           5

&lt;210&gt; SEQ ID NO 66

&lt;211&gt; LENGTH: 11

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 66

Arg Arg Glu Gly Leu Leu Asp Asp Ala Trp Glu  
1           5                   10

&lt;210&gt; SEQ ID NO 67

&lt;211&gt; LENGTH: 8

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 67

Ile Gln Phe Glu Thr Ile Glu Thr  
1           5

&lt;210&gt; SEQ ID NO 68

&lt;211&gt; LENGTH: 5

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 68

Lys Gln Pro Lys Met  
1           5

&lt;210&gt; SEQ ID NO 69

&lt;211&gt; LENGTH: 11

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 69

Tyr Glu His Val Ala Val Asn Asn Phe Thr Thr  
1           5                   10

&lt;210&gt; SEQ ID NO 70

&lt;211&gt; LENGTH: 11

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 70

-continued

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Tyr Val Tyr Leu Asp Pro Glu Asp Val Ile Asp  
1 5 10

<210> SEQ ID NO 71  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 71

Ala Asp Lys Ile Lys  
1 5

<210> SEQ ID NO 72  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 72

Arg Gly Lys Leu Ala Ser Val Ile  
1 5

<210> SEQ ID NO 73  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 73

Asn Arg Pro Ile Pro Glu Ile Pro  
1 5

<210> SEQ ID NO 74  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 74

His His Ser Gln Leu Ile Thr Tyr  
1 5

<210> SEQ ID NO 75  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 75

Tyr Asp Glu Ala Ile Ala Phe Lys  
1 5

<210> SEQ ID NO 76  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 76

Lys Leu Asn Tyr Lys  
1 5

<210> SEQ ID NO 77  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis  
  
<400> SEQUENCE: 77

Tyr Lys Val Thr Tyr

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1 5

<210> SEQ ID NO 78  
 <211> LENGTH: 5  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 78

Lys Tyr Phe Asp Lys  
 1 5

<210> SEQ ID NO 79  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 79

Glu Gln Leu Gln Ala Ile Ile Thr Ala Ser Val Lys Thr Glu Ser  
 1 5 10 15

<210> SEQ ID NO 80  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 80

Glu Ala His Ser Arg Pro Asp Tyr Val Thr Val Glu Gly Glu Leu  
 1 5 10 15

<210> SEQ ID NO 81  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 81

Glu Asp Asp Val Lys Ala Glu Lys His Thr Tyr Thr Arg Pro Glu  
 1 5 10 15

<210> SEQ ID NO 82  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 82

His Thr Tyr Thr Arg Pro Glu Glu Val Gln Asp Phe Val Ser Lys  
 1 5 10 15

<210> SEQ ID NO 83  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 83

Ser Ser Ser Ile Pro Gln Glu Tyr Val Glu Met Val Asn Lys Tyr  
 1 5 10 15

<210> SEQ ID NO 84  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 84

Asp Gly Arg Met Val Met Thr Gly Thr Ile Arg Arg Leu Phe Val  
 1 5 10 15

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<210> SEQ ID NO 85  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 85  
 Leu Gly Glu Ala Arg Thr Lys Leu Thr Glu Met Tyr Met Arg Lys  
 1            5                    10                    15

<210> SEQ ID NO 86  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 86  
 Val Lys Tyr Leu Gly Arg Val Thr Leu Ala Ala Arg Ser Ser Ala  
 1            5                    10                    15

<210> SEQ ID NO 87  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 87  
 Val Thr Leu Ala Ala Arg Ser Ser Ala Pro Ser Gly Ala Ser Thr  
 1            5                    10                    15

<210> SEQ ID NO 88  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 88  
 Thr Asp Gly Thr Val Leu Lys Lys Asn Ile Gly Gly Asn Ala Cys  
 1            5                    10                    15

<210> SEQ ID NO 89  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 89  
 Asp Lys Val Pro Lys Lys Phe Lys Leu Pro Ser Pro Phe Phe Asn  
 1            5                    10                    15

<210> SEQ ID NO 90  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 90  
 Lys Leu Gly Gly Leu Leu Val Lys Lys Tyr Gly Leu Ser Ala Lys  
 1            5                    10                    15

<210> SEQ ID NO 91  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
 <400> SEQUENCE: 91  
 Ser Ser Glu Phe Tyr Asp Glu Glu Lys Lys Leu Tyr Glu Val Glu  
 1            5                    10                    15

<210> SEQ ID NO 92

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<211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 92  
  
 Asp Tyr Glu Asn Trp Thr Lys Leu Asn Ala Arg Leu Gly Gln Arg  
 1 5 10 15

<210> SEQ ID NO 93  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 93  
  
 Leu Tyr Thr Thr Asn Pro Ile Thr Ile Lys Lys Gly Leu Glu Gly  
 1 5 10 15

<210> SEQ ID NO 94  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 94  
  
 Arg Ala Cys Arg Lys Leu Tyr Pro Lys Asp Ile Gln Val Val Ala  
 1 5 10 15

<210> SEQ ID NO 95  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 95  
  
 Gln Glu Phe Thr Val Gly Glu Gly Ala Asp Lys Trp Val Val Lys  
 1 5 10 15

<210> SEQ ID NO 96  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 96  
  
 Trp Val Val Lys Ser Ile Gly Gly Arg Leu Gly Pro Ser Gln Leu  
 1 5 10 15

<210> SEQ ID NO 97  
 <211> LENGTH: 16  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 97  
  
 Lys Asp Ala Glu Gly Lys Ile Lys Lys Asp Asp Gly Tyr Asp Gly His  
 1 5 10 15

<210> SEQ ID NO 98  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide  
  
 <400> SEQUENCE: 98  
  
 Ala Leu Pro Lys Val Cys His Gly Leu Pro Pro Lys Ser Leu Asp  
 1 5 10 15

<210> SEQ ID NO 99  
 <211> LENGTH: 15  
 <212> TYPE: PRT

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<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 99

Glu Trp Met Tyr Ser Cys Arg Cys Ala Asp Ile Phe His Arg Leu  
 1 5 10 15

<210> SEQ ID NO 100

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 100

Ser Val Asn Arg His His Ser Gln Leu Ile Thr Tyr Ile Lys His  
 1 5 10 15

<210> SEQ ID NO 101

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 101

Ala Gln Pro Leu Tyr Asp Glu Ala Ile Ala Phe Lys Glu Glu Val  
 1 5 10 15

<210> SEQ ID NO 102

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 102

Phe Lys Asp Thr Phe Lys Tyr Phe Asp Lys Asp Lys Ser Asn Ser  
 1 5 10 15

<210> SEQ ID NO 103

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 103

Asp Lys Gln Arg Tyr Leu Gly Lys  
 1 5

<210> SEQ ID NO 104

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 104

Lys Tyr Gly Lys Asp Ala Thr Asn  
 1 5

<210> SEQ ID NO 105

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 105

Asp Asp Leu Thr Val Thr Asn Pro  
 1 5

<210> SEQ ID NO 106

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

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<400> SEQUENCE: 106

Phe Val Lys Leu Ile Ser Trp Tyr  
 1 5

<210> SEQ ID NO 107

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 107

Ser Val Arg Arg Glu Gly Leu Leu Asp Asp Ala Trp Glu Lys Thr  
 1 5 10 15

<210> SEQ ID NO 108

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 108

Leu Ala Arg Gln Ile Gln Phe Glu Thr Ile Glu Thr Asp Phe Glu  
 1 5 10 15

<210> SEQ ID NO 109

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 109

Pro Ser Lys Trp His Lys Gln Pro Lys Met Met Val Gln Lys Arg  
 1 5 10 15

<210> SEQ ID NO 110

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 110

Gln Gly Tyr Glu His Val Ala Val Asn Asn Phe Thr Thr Ser Trp  
 1 5 10 15

<210> SEQ ID NO 111

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 111

Gly Ile Tyr Val Tyr Leu Asp Pro Glu Asp Val Ile Asp Thr Thr  
 1 5 10 15

<210> SEQ ID NO 112

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 112

Lys Ile Ala Ala Met Ala Asp Lys Ile Lys Arg Thr Val Ala Ile  
 1 5 10 15

<210> SEQ ID NO 113

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 113

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Ile	Pro	Gly	Ile	Arg	Gly	Lys	Leu	Ala	Ser	Val	Ile	Ser	Tyr	Asn
1			5						10					15

<210> SEQ ID NO 114  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 114

Cys	Lys	Ser	Gly	Asn	Arg	Pro	Ile	Pro	Glu	Ile	Pro	Gln	Gly	Leu
1			5					10						15

<210> SEQ ID NO 115  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 115

Ser	Val	Asn	Arg	His	His	Ser	Gln	Leu	Ile	Thr	Tyr	Ile	Lys	His
1			5					10						15

<210> SEQ ID NO 116  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 116

Ala	Gln	Pro	Leu	Tyr	Asp	Glu	Ala	Ile	Ala	Phe	Lys	Glu	Glu	Val
1			5					10						15

<210> SEQ ID NO 117  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 117

Glu	Leu	Val	Glu	Phe	Lys	Leu	Asn	Tyr	Lys	Val	Thr	Tyr	Thr	Tyr
1			5					10						15

<210> SEQ ID NO 118  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 118

Glu	Phe	Lys	Leu	Asn	Tyr	Lys	Val	Thr	Tyr	Thr	Tyr	Ser	Asp	Ala
1			5					10						15

<210> SEQ ID NO 119  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 119

Phe	Lys	Asp	Thr	Phe	Lys	Tyr	Phe	Asp	Lys	Asp	Lys	Ser	Asn	Ser
1			5					10						15

<210> SEQ ID NO 120  
 <211> LENGTH: 229  
 <212> TYPE: PRT  
 <213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 120

Lys	Lys	Ser	Val	Arg	Arg	Glu	Gly	Leu	Leu	Asp	Asp	Ala	Trp	Glu	Lys
1			5					10							15

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Thr Lys Lys Leu Ala Arg Gln Ile Gln Phe Glu Thr Ile Glu Thr Asp  
                   20                                  25                                  30  
 Phe Glu Lys Lys Pro Ser Lys Trp His Lys Gln Pro Lys Met Met Val  
           35                                  40                                  45  
 Gln Lys Arg Lys Lys Gln Gly Tyr Glu His Val Ala Val Asn Asn Phe  
           50                                  55                                  60  
 Thr Thr Ser Trp Lys Lys Gly Ile Tyr Val Tyr Leu Asp Pro Glu Asp  
   65                                  70                                  75                                  80  
 Val Ile Asp Thr Thr Lys Lys Lys Ile Ala Ala Met Ala Asp Lys Ile  
                   85                                  90                                  95  
 Lys Arg Thr Val Ala Ile Lys Lys Ile Pro Gly Ile Arg Gly Lys Leu  
                  100                                 105                                 110  
 Ala Ser Val Ile Ser Tyr Asn Lys Lys Cys Lys Ser Gly Asn Arg Pro  
                  115                                 120                                 125  
 Ile Pro Glu Ile Pro Gln Gly Leu Lys Lys Ser Val Asn Arg His His  
          130                                 135                                 140  
 Ser Gln Leu Ile Thr Tyr Ile Lys His Lys Lys Ala Gln Pro Leu Tyr  
  145                                 150                                 155                                 160  
 Asp Glu Ala Ile Ala Phe Lys Glu Glu Val Lys Lys Glu Leu Val Glu  
          165                                 170                                 175  
 Phe Lys Leu Asn Tyr Lys Val Thr Tyr Thr Tyr Lys Lys Glu Phe Lys  
          180                                 185                                 190  
 Leu Asn Tyr Lys Val Thr Tyr Thr Tyr Ser Asp Ala Lys Lys Phe Lys  
          195                                 200                                 205  
 Asp Thr Phe Lys Tyr Phe Asp Lys Asp Lys Ser Asn Ser Lys Lys His  
  210                                 215                                 220  
 His His His His His  
 225

<210> SEQ ID NO 121  
 <211> LENGTH: 16  
 <212> TYPE: PRT  
 <213> ORGANISM: Treponema pallidum

<400> SEQUENCE: 121

Leu Ser Thr Ser Leu Leu Thr Thr Cys Asp Phe Thr Gly Ile Phe Ala  
 1                  5                                  10                                  15

<210> SEQ ID NO 122  
 <211> LENGTH: 8  
 <212> TYPE: PRT  
 <213> ORGANISM: Treponema pallidum

<400> SEQUENCE: 122

Ile Gln Ser Glu Val Pro Ile Lys  
 1                  5

<210> SEQ ID NO 123  
 <211> LENGTH: 15  
 <212> TYPE: PRT  
 <213> ORGANISM: Treponema pallidum

<400> SEQUENCE: 123

Leu Leu Ile Gly Gly Ser Arg Gly Tyr Gly Glu Ile Lys Leu Glu  
 1                  5                                  10                                  15

<210> SEQ ID NO 124  
 <211> LENGTH: 10

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&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Treponema pallidum*

&lt;400&gt; SEQUENCE: 124

Arg Pro Asp Leu Tyr Ala Ala Val Gly Glu  
 1 5 10

&lt;210&gt; SEQ ID NO 125

&lt;211&gt; LENGTH: 19

&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Treponema pallidum*

&lt;400&gt; SEQUENCE: 125

Ala Ser Gly Ala Lys Glu Glu Ala Glu Lys Lys Ala Ala Glu Gln Arg  
 1 5 10 15

Ala Leu Leu

&lt;210&gt; SEQ ID NO 126

&lt;211&gt; LENGTH: 20

&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Treponema pallidum*

&lt;400&gt; SEQUENCE: 126

Glu Val Glu Asp Val Pro Lys Val Val Glu Pro Ala Ser Glu Arg Glu  
 1 5 10 15

Gly Gly Glu Arg  
 20

&lt;210&gt; SEQ ID NO 127

&lt;211&gt; LENGTH: 108

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Synthetic Peptide

&lt;400&gt; SEQUENCE: 127

Lys Lys Leu Ser Thr Ser Leu Leu Thr Thr Cys Asp Phe Thr Gly Ile  
 1 5 10 15

Phe Ala Lys Lys Ile Gln Ser Glu Val Pro Ile Lys Lys Lys Leu Leu  
 20 25 30

Ile Gly Gly Ser Arg Gly Tyr Gly Glu Ile Lys Leu Glu Lys Lys Arg  
 35 40 45

Pro Asp Leu Tyr Ala Ala Val Gly Glu Lys Lys Ala Ser Gly Ala Lys  
 50 55 60

Glu Glu Ala Glu Lys Lys Ala Ala Glu Gln Arg Ala Leu Leu Lys Lys  
 65 70 75 80

Glu Val Glu Asp Val Pro Lys Val Val Glu Pro Ala Ser Glu Arg Glu  
 85 90 95

Gly Gly Glu Arg Lys Lys His His His His His His  
 100 105

&lt;210&gt; SEQ ID NO 128

&lt;211&gt; LENGTH: 15

&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Neisseria gonorrhoeae*

&lt;400&gt; SEQUENCE: 128

Phe Gly Ser Lys Ile Gly Phe Lys Gly Gln Glu Asp Leu Gly Asn  
 1 5 10 15

&lt;210&gt; SEQ ID NO 129

&lt;211&gt; LENGTH: 15

&lt;212&gt; TYPE: PRT

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<213> ORGANISM: Neisseria gonorrhoeae

<400> SEQUENCE: 129

Gly	Phe	Ser	Gly	Ser	Val	Gln	Tyr	Ala	Pro	Lys	Asp	Asn	Ser	Gly
1				5					10					15

<210> SEQ ID NO 130

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Neisseria gonorrhoeae

<400> SEQUENCE: 130

Gly	Phe	Phe	Ala	Gln	Tyr	Ala	Gly	Leu	Phe	Gln	Arg	Tyr	Gly	Glu
1				5				10						15

<210> SEQ ID NO 131

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Neisseria gonorrhoeae

<400> SEQUENCE: 131

Val	Glu	Lys	Leu	Gln	Val	His	Arg	Leu	Val	Gly	Gly	Tyr	Asp	Asn
1				5				10						15

<210> SEQ ID NO 132

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Neisseria gonorrhoeae

<400> SEQUENCE: 132

Asn	Ser	His	Asn	Ser	Gln	Thr	Glu	Val	Ala	Ala	Thr	Ala	Ala	Tyr
1				5					10					15

<210> SEQ ID NO 133

<211> LENGTH: 15

<212> TYPE: PRT

<213> ORGANISM: Neisseria gonorrhoeae

<400> SEQUENCE: 133

Asn	Thr	Tyr	Asp	Gln	Val	Val	Val	Gly	Ala	Glu	Tyr	Asp	Phe	Ser
1				5					10					15

<210> SEQ ID NO 134

<211> LENGTH: 110

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 134

Lys	Lys	Phe	Gly	Ser	Lys	Ile	Gly	Phe	Lys	Gly	Gln	Glu	Asp	Leu	Gly
1				5					10					15	

Asn	Lys	Lys	Gly	Phe	Ser	Gly	Ser	Val	Gln	Tyr	Ala	Pro	Lys	Asp	Asn
			20					25					30		

Ser	Gly	Lys	Lys	Gly	Phe	Phe	Ala	Gln	Tyr	Ala	Gly	Leu	Phe	Gln	Arg
		35					40					45			

Tyr	Gly	Glu	Lys	Lys	Val	Glu	Lys	Leu	Gln	Val	His	Arg	Leu	Val	Gly
	50				55						60				

Gly	Tyr	Asp	Asn	Lys	Lys	Asn	Ser	His	Asn	Ser	Gln	Thr	Glu	Val	Ala
65					70					75					80

Ala	Thr	Ala	Ala	Tyr	Lys	Lys	Asn	Thr	Tyr	Asp	Gln	Val	Val	Val	Gly
				85				90							95

Ala	Glu	Tyr	Asp	Phe	Ser	Lys	Lys	His	His	His	His	His	His	His
			100					105						110

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<210> SEQ ID NO 135  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 135

Asn Gly Gly Lys His Ala Gly Gly Asn Leu Lys  
1 5 10

<210> SEQ ID NO 136  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 136

Gln Leu Arg Met Val Ala Glu Val Tyr Gln Lys  
1 5 10

<210> SEQ ID NO 137  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 137

Asn Ala Arg Leu Gly Gln Arg Val  
1 5

<210> SEQ ID NO 138  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 138

Asn Pro Ile Thr Ile Lys Lys Gly  
1 5

<210> SEQ ID NO 139  
<211> LENGTH: 5  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 139

Ser Gln Leu Pro Trp  
1 5

<210> SEQ ID NO 140  
<211> LENGTH: 8  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 140

Thr Leu Asn Asn Ala Phe Gly Ile  
1 5

<210> SEQ ID NO 141  
<211> LENGTH: 11  
<212> TYPE: PRT  
<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 141

Lys Asp Leu Arg Arg Ala Arg Ala Ala Gly Met  
1 5 10

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<210> SEQ ID NO 142

<211> LENGTH: 11

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 142

Ile Thr Gly Ser Leu Val Asp Leu Thr Val Asn  
1                   5                   10

<210> SEQ ID NO 143

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 143

Leu Val Lys Val Leu Ser Trp Tyr  
1                   5

<210> SEQ ID NO 144

<211> LENGTH: 8

<212> TYPE: PRT

<213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 144

Leu Val Lys Val Leu Ser Trp Tyr  
1                   5

<210> SEQ ID NO 145

<211> LENGTH: 111

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 145

Met Lys Lys Gln Glu Phe Thr Val Gly Glu Gly Ala Asp Lys Trp Val  
1                   5                   10                   15

Val Lys Lys Lys Trp Val Val Lys Ser Ile Gly Gly Arg Leu Gly Pro  
20                   25                   30

Ser Gln Leu Lys Lys Ser Ser Glu Phe Tyr Asp Glu Glu Lys Lys Leu  
35                   40                   45

Tyr Glu Val Glu Lys Lys Asp Tyr Glu Asn Trp Thr Lys Leu Asn Ala  
50                   55                   60

Arg Leu Gly Gln Arg Lys Lys His Thr Tyr Thr Arg Pro Glu Glu Val  
65                   70                   75                   80

Gln Asp Phe Val Ser Lys Lys Lys Ser Ser Ser Ile Pro Gln Glu Tyr  
85                   90                   95

Val Glu Met Val Asn Lys Tyr Lys Lys His His His His His His  
100                   105                   110

<210> SEQ ID NO 146

<211> LENGTH: 229

<212> TYPE: PRT

<213> ORGANISM: Synthetic Peptide

<400> SEQUENCE: 146

Gly Gly Ser Val Arg Arg Glu Gly Leu Leu Asp Asp Ala Trp Glu Lys  
1                   5                   10                   15

Thr Gly Gly Leu Ala Arg Gln Ile Gln Phe Glu Thr Ile Glu Thr Asp  
20                   25                   30

Phe Glu Gly Gly Pro Ser Lys Trp His Lys Gln Pro Lys Met Met Val  
35                   40                   45

Gln Lys Arg Gly Gly Gln Gly Tyr Glu His Val Ala Val Asn Asn Phe

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50          55          60
Thr Thr Ser Trp Gly Gly Gly Ile Tyr Val Tyr Leu Asp Pro Glu Asp
65          70          75          80
Val Ile Asp Thr Thr Gly Gly Lys Ile Ala Ala Met Ala Asp Lys Ile
85          90          95
Lys Arg Thr Val Ala Ile Gly Gly Ile Pro Gly Ile Arg Gly Lys Leu
100         105         110
Ala Ser Val Ile Ser Tyr Asn Gly Gly Cys Lys Ser Gly Asn Arg Pro
115
Ile Pro Glu Ile Pro Gln Gly Leu Gly Gly Ser Val Asn Arg His His
130         135         140
Ser Gln Leu Ile Thr Tyr Ile Lys His Gly Gly Ala Gln Pro Leu Tyr
145         150         155         160
Asp Glu Ala Ile Ala Phe Lys Glu Glu Val Gly Gly Glu Leu Val Glu
165         170         175
Phe Lys Leu Asn Tyr Lys Val Thr Tyr Thr Tyr Gly Gly Glu Phe Lys
180         185         190
Leu Asn Tyr Lys Val Thr Tyr Thr Tyr Ser Asp Ala Gly Gly Phe Lys
195         200         205
Asp Thr Phe Lys Tyr Phe Asp Lys Asp Lys Ser Asn Ser Gly Gly His
210         215         220
His His His His His
225

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&lt;210&gt; SEQ ID NO 147

&lt;211&gt; LENGTH: 328

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Trichomonas vaginalis

&lt;400&gt; SEQUENCE: 147

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Met Ala Val Ser Tyr Lys Ser Leu Gly Leu Val Asn Ser Lys Asp Ile
1          5          10          15
Phe Ala Lys Ala Val Asn Gly Gly Tyr Ala Ile Pro Gly Tyr Asn Phe
20         25         30
Ser Asn Leu Glu Gln Leu Gln Ala Ile Ile Thr Ala Ser Val Lys Thr
35         40         45
Glu Ser Pro Val Ile Leu Gln Val Ser Ala Gly Ala Arg Lys Tyr Ala
50         55         60
Asn Gln Thr Met Leu Arg Tyr Met Ala Gln Gly Ala Ala Glu Phe Ala
65         70         75         80
Lys Glu Ile His Pro Glu His Lys Leu Ile Pro Ile Val Leu His Leu
85         90         95
Asp His Gly Asp Ser Phe Glu Leu Cys Lys Ser Cys Ile Asp Leu Gly
100        105        110
Phe Ser Ser Val Met Ile Asp Gly Ser His His Pro Tyr Asp Glu Asn
115        120        125
Val Ala Leu Thr Lys Lys Val Val Glu Tyr Ala His Ser Arg Pro Asp
130        135        140
Tyr Val Thr Val Glu Gly Glu Leu Gly Val Leu Ala Gly Val Glu Asp
145        150        155        160
Asp Val Lys Ala Glu Lys His Thr Tyr Thr Arg Pro Glu Glu Val Gln
165        170        175
Asp Phe Val Ser Lys Thr Gly Val Asp Ser Leu Ala Ile Ala Ile Gly
180        185        190

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Val Glu Tyr Val Arg Glu Val Glu Arg Tyr Gly Gly Asn Leu Pro Asp  
 245 250 255

Ser Val Gly Ile Pro Glu Glu Gln Leu Arg Lys Ala Ala Lys Ser Ala  
 260 265 270

Val Cys Lys Val Asn Ile Asp Ser Asp Gly Arg Leu Ala Met Thr Ala  
 275 280 285

Ala Ile Arg Arg Val Leu Thr Thr Lys Val Asp Glu Phe Asp Pro Arg  
 290 295 300

Lys Tyr Leu Gly Pro Ala Arg Asp Glu Leu Lys Lys Leu Tyr Met His  
 305 310 315 320

Lys Asn Lys Glu Val Leu Gly Ser Ala Gly Arg Ala  
 325 330

&lt;210&gt; SEQ ID NO 149

&lt;211&gt; LENGTH: 354

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Neisseria gonorrhoeae

&lt;400&gt; SEQUENCE: 149

Met Ala Leu Val Ser Met Arg Gln Leu Leu Asp His Ala Ala Glu Asn  
 1 5 10 15

Ser Tyr Gly Leu Pro Ala Phe Asn Val Asn Asn Leu Glu Gln Met Arg  
 20 25 30

Ala Ile Met Glu Ala Ala Asp Gln Val Asn Ala Pro Val Ile Val Gln  
 35 40 45

Ala Ser Ala Gly Ala Arg Lys Tyr Ala Gly Ala Pro Phe Leu Arg His  
 50 55 60

Leu Ile Leu Ala Ala Val Glu Glu Phe Pro His Ile Pro Val Val Met  
 65 70 75 80

His Gln Asp His Gly Ala Ser Pro Asp Val Cys Gln Arg Ser Ile Gln  
 85 90 95

Leu Gly Phe Ser Ser Val Met Met Asp Gly Ser Leu Leu Glu Asp Gly  
 100 105 110

Lys Thr Pro Ser Ser Tyr Glu Tyr Asn Val Asn Ala Thr Arg Thr Val  
 115 120 125

Val Asn Phe Ser His Ala Cys Gly Val Ser Val Glu Gly Glu Ile Gly  
 130 135 140

Val Leu Gly Asn Leu Glu Thr Gly Glu Ala Gly Glu Glu Asp Gly Val  
 145 150 155 160

Gly Ala Ala Gly Lys Leu Ser His Asp Gln Met Leu Thr Ser Val Glu  
 165 170 175

Asp Ala Val Arg Phe Val Lys Asp Thr Gly Val Asp Ala Leu Ala Ile  
 180 185 190

Ala Val Gly Thr Ser His Gly Ala Tyr Lys Phe Thr Arg Pro Pro Thr  
 195 200 205

Gly Asp Val Leu Arg Ile Asp Arg Ile Lys Glu Ile His Gln Ala Leu  
 210 215 220

Pro Asn Thr His Ile Val Met His Gly Ser Ser Ser Val Pro Gln Glu  
 225 230 235 240

Trp Leu Lys Val Ile Asn Glu Tyr Gly Gly Asn Ile Gly Glu Thr Tyr  
 245 250 255

Gly Val Pro Val Glu Glu Ile Val Glu Gly Ile Lys His Gly Val Arg  
 260 265 270

Lys Val Asn Ile Asp Thr Asp Leu Arg Leu Ala Ser Thr Gly Ala Val



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290

<210> SEQ ID NO 151  
 <211> LENGTH: 293  
 <212> TYPE: PRT  
 <213> ORGANISM: Streptococcus pneumoniae  
 <400> SEQUENCE: 151

Met Ala Ile Val Ser Ala Glu Lys Phe Val Gln Ala Ala Arg Asp Asn  
 1 5 10 15  
 Gly Tyr Ala Val Gly Gly Phe Asn Thr Asn Asn Leu Glu Trp Thr Gln  
 20 25 30  
 Ala Ile Leu Arg Ala Ala Glu Ala Lys Lys Ala Pro Val Leu Ile Gln  
 35 40 45  
 Thr Ser Met Gly Ala Ala Lys Tyr Met Gly Gly Tyr Lys Val Ala Arg  
 50 55 60  
 Asn Leu Ile Ala Asn Leu Val Glu Ser Met Gly Ile Thr Val Pro Val  
 65 70 75 80  
 Ala Ile His Leu Asp His Gly His Tyr Glu Asp Ala Leu Glu Cys Ile  
 85 90 95  
 Glu Val Gly Tyr Thr Ser Ile Met Phe Asp Gly Ser His Leu Pro Val  
 100 105 110  
 Glu Glu Asn Leu Lys Leu Ala Lys Glu Val Val Glu Lys Ala His Ala  
 115 120 125  
 Lys Gly Ile Ser Val Glu Ala Glu Val Gly Thr Ile Gly Gly Glu Glu  
 130 135 140  
 Asp Gly Ile Ile Gly Lys Gly Glu Leu Ala Pro Ile Glu Asp Ala Lys  
 145 150 155 160  
 Ala Met Val Glu Thr Gly Ile Asp Phe Leu Ala Ala Gly Ile Gly Asn  
 165 170 175  
 Ile His Gly Pro Tyr Pro Val Asn Trp Glu Gly Leu Asp Leu Asp His  
 180 185 190  
 Leu Gln Lys Leu Thr Glu Ala Leu Pro Gly Phe Pro Ile Val Leu His  
 195 200 205  
 Gly Gly Ser Gly Ile Pro Asp Glu Gln Ile Gln Ala Ala Ile Lys Leu  
 210 215 220  
 Gly Val Ala Lys Val Asn Val Asn Thr Glu Cys Gln Ile Ala Phe Ala  
 225 230 235 240  
 Asn Ala Thr Arg Lys Phe Ala Arg Asp Tyr Glu Ala Asn Glu Ala Glu  
 245 250 255  
 Tyr Asp Lys Lys Lys Leu Phe Asp Pro Arg Lys Phe Leu Ala Asp Gly  
 260 265 270  
 Val Lys Ala Ile Gln Ala Ser Val Glu Glu Arg Ile Asp Val Phe Gly  
 275 280 285  
 Ser Glu Gly Lys Ala  
 290

<210> SEQ ID NO 152  
 <211> LENGTH: 286  
 <212> TYPE: PRT  
 <213> ORGANISM: Staphylococcus aureus  
 <400> SEQUENCE: 152

Met Pro Leu Val Ser Met Lys Glu Met Leu Ile Asp Ala Lys Glu Asn  
 1 5 10 15  
 Gly Tyr Ala Val Gly Gln Tyr Asn Ile Asn Asn Leu Glu Phe Thr Gln

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20				25				30							
Ala	Ile	Leu	Glu	Ala	Ser	Gln	Glu	Glu	Asn	Ala	Pro	Val	Ile	Leu	Gly
		35					40					45			
Val	Ser	Glu	Gly	Ala	Ala	Arg	Tyr	Met	Ser	Gly	Phe	Tyr	Thr	Ile	Val
	50					55					60				
Lys	Met	Val	Glu	Gly	Leu	Met	His	Asp	Leu	Asn	Ile	Thr	Ile	Pro	Val
65					70					75				80	
Ala	Ile	His	Leu	Asp	His	Gly	Ser	Ser	Phe	Glu	Lys	Cys	Lys	Glu	Ala
			85						90					95	
Ile	Asp	Ala	Gly	Phe	Thr	Ser	Val	Met	Ile	Asp	Ala	Ser	His	Ser	Pro
		100						105					110		
Phe	Glu	Glu	Asn	Val	Ala	Thr	Thr	Lys	Lys	Val	Val	Glu	Tyr	Ala	His
	115						120					125			
Glu	Lys	Gly	Val	Ser	Val	Glu	Ala	Glu	Leu	Gly	Thr	Val	Gly	Gly	Gln
	130					135					140				
Glu	Asp	Asp	Val	Val	Ala	Asp	Gly	Ile	Ile	Tyr	Ala	Asp	Pro	Lys	Glu
145					150					155					160
Cys	Gln	Glu	Leu	Val	Glu	Lys	Thr	Gly	Ile	Asp	Ala	Leu	Ala	Pro	Ala
			165					170						175	
Leu	Gly	Ser	Val	His	Gly	Pro	Tyr	Lys	Gly	Glu	Pro	Lys	Leu	Gly	Phe
		180						185					190		
Lys	Glu	Met	Glu	Glu	Ile	Gly	Leu	Ser	Thr	Gly	Leu	Pro	Leu	Val	Leu
	195					200						205			
His	Gly	Gly	Thr	Gly	Ile	Pro	Thr	Lys	Asp	Ile	Gln	Lys	Ala	Ile	Pro
	210					215					220				
Phe	Gly	Thr	Ala	Lys	Ile	Asn	Val	Asn	Thr	Glu	Asn	Gln	Ile	Ala	Ser
225					230					235				240	
Ala	Lys	Ala	Val	Arg	Asp	Val	Leu	Asn	Asn	Asp	Lys	Glu	Val	Tyr	Asp
			245						250					255	
Pro	Arg	Lys	Tyr	Leu	Gly	Pro	Ala	Arg	Glu	Ala	Ile	Lys	Glu	Thr	Val
			260						265					270	
Lys	Gly	Lys	Ile	Lys	Glu	Phe	Gly	Thr	Ser	Asn	Arg	Ala	Lys		
	275						280					285			

&lt;210&gt; SEQ ID NO 153

&lt;211&gt; LENGTH: 350

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 153

Met	Thr	Asp	Ile	Ala	Gln	Leu	Leu	Gly	Lys	Asp	Ala	Asp	Asn	Leu	Leu
1				5					10					15	
Gln	His	Arg	Cys	Met	Thr	Ile	Pro	Ser	Asp	Gln	Leu	Tyr	Leu	Pro	Gly
			20						25					30	
His	Asp	Tyr	Val	Asp	Arg	Val	Met	Ile	Asp	Asn	Asn	Arg	Pro	Pro	Ala
		35					40						45		
Val	Leu	Arg	Asn	Met	Gln	Thr	Leu	Tyr	Asn	Thr	Gly	Arg	Leu	Ala	Gly
	50					55					60				
Thr	Gly	Tyr	Leu	Ser	Ile	Leu	Pro	Val	Asp	Gln	Gly	Val	Glu	His	Ser
65					70					75				80	
Ala	Gly	Ala	Ser	Phe	Ala	Ala	Asn	Pro	Leu	Tyr	Phe	Asp	Pro	Lys	Asn
			85						90					95	
Ile	Val	Glu	Leu	Ala	Ile	Glu	Ala	Gly	Cys	Asn	Cys	Val	Ala	Ser	Thr
			100						105					110	

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Tyr Gly Val Leu Ala Ser Val Ser Arg Arg Tyr Ala His Arg Ile Pro  
 115 120 125  
 Phe Leu Val Lys Leu Asn His Asn Glu Thr Leu Ser Tyr Pro Asn Thr  
 130 135 140  
 Tyr Asp Gln Thr Leu Tyr Ala Ser Val Glu Gln Ala Phe Asn Met Gly  
 145 150 155 160  
 Ala Val Ala Val Gly Ala Thr Ile Tyr Phe Gly Ser Glu Glu Ser Arg  
 165 170 175  
 Arg Gln Ile Glu Glu Ile Ser Ala Ala Phe Glu Arg Ala His Glu Leu  
 180 185 190  
 Gly Met Val Thr Val Leu Trp Ala Tyr Leu Arg Asn Ser Ala Phe Lys  
 195 200 205  
 Lys Asp Gly Val Asp Tyr His Val Ser Ala Asp Leu Thr Gly Gln Ala  
 210 215 220  
 Asn His Leu Ala Ala Thr Ile Gly Ala Asp Ile Val Lys Gln Lys Met  
 225 230 235 240  
 Ala Glu Asn Asn Gly Gly Tyr Lys Ala Ile Asn Tyr Gly Tyr Thr Asp  
 245 250 255  
 Asp Arg Val Tyr Ser Lys Leu Thr Ser Glu Asn Pro Ile Asp Leu Val  
 260 265 270  
 Arg Tyr Gln Leu Ala Asn Cys Tyr Met Gly Arg Ala Gly Leu Ile Asn  
 275 280 285  
 Ser Gly Gly Ala Ala Gly Gly Glu Thr Asp Leu Ser Asp Ala Val Arg  
 290 295 300  
 Thr Ala Val Ile Asn Lys Arg Ala Gly Gly Met Gly Leu Ile Leu Gly  
 305 310 315 320  
 Arg Lys Ala Phe Lys Lys Ser Met Ala Asp Gly Val Lys Leu Ile Asn  
 325 330 335  
 Ala Val Gln Asp Val Tyr Leu Asp Ser Lys Ile Thr Ile Ala  
 340 345 350

&lt;210&gt; SEQ ID NO 154

&lt;211&gt; LENGTH: 359

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Candida albicans

&lt;400&gt; SEQUENCE: 154

Met Ala Pro Pro Ala Val Leu Ser Lys Ser Gly Val Ile Tyr Gly Lys  
 1 5 10 15  
 Asp Val Lys Asp Leu Phe Asp Tyr Ala Gln Glu Lys Gly Phe Ala Ile  
 20 25 30  
 Pro Ala Ile Asn Val Thr Ser Ser Thr Val Val Ala Ala Leu Glu  
 35 40 45  
 Ala Ala Arg Asp Asn Lys Ala Pro Ile Ile Leu Gln Thr Ser Gln Gly  
 50 55 60  
 Gly Ala Ala Tyr Phe Ala Gly Lys Gly Val Asp Asn Lys Asp Gln Ala  
 65 70 75 80  
 Ala Ser Ile Ala Gly Ser Ile Ala Ala Ala His Tyr Ile Arg Ala Ile  
 85 90 95  
 Ala Pro Thr Tyr Gly Ile Pro Val Val Leu His Thr Asp His Cys Ala  
 100 105 110  
 Lys Lys Leu Leu Pro Trp Phe Asp Gly Met Leu Lys Ala Asp Glu Glu  
 115 120 125  
 Phe Phe Ala Lys Thr Gly Thr Pro Leu Phe Ser Ser His Met Leu Asp  
 130 135 140

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Leu Ser Glu Glu Thr Asp Asp Glu Asn Ile Ala Thr Cys Ala Lys Tyr  
 145 150 155 160  
 Phe Glu Arg Met Ala Lys Met Gly Gln Trp Leu Glu Met Glu Ile Gly  
 165 170 175  
 Ile Thr Gly Gly Glu Glu Asp Gly Val Asn Asn Glu His Val Glu Lys  
 180 185 190  
 Asp Ala Leu Tyr Thr Ser Pro Glu Thr Val Phe Ala Val Tyr Glu Ser  
 195 200 205  
 Leu His Lys Ile Ser Pro Asn Phe Ser Ile Ala Ala Ala Phe Gly Asn  
 210 215 220  
 Val His Gly Val Tyr Lys Pro Gly Asn Val Gln Leu Arg Pro Glu Ile  
 225 230 235 240  
 Leu Gly Asp His Gln Val Tyr Ala Lys Lys Gln Ile Gly Thr Asp Ala  
 245 250 255  
 Lys His Pro Leu Tyr Leu Val Phe His Gly Gly Ser Gly Ser Thr Gln  
 260 265 270  
 Glu Glu Phe Asn Thr Ala Ile Lys Asn Gly Val Val Lys Val Asn Leu  
 275 280 285  
 Asp Thr Asp Cys Gln Tyr Ala Tyr Leu Thr Gly Ile Arg Asp Tyr Val  
 290 295 300  
 Thr Asn Lys Ile Glu Tyr Leu Lys Ala Pro Val Gly Asn Pro Glu Gly  
 305 310 315 320  
 Ala Asp Lys Pro Asn Lys Lys Tyr Phe Asp Pro Arg Val Trp Val Arg  
 325 330 335  
 Glu Gly Glu Lys Thr Met Ser Lys Arg Ile Ala Glu Ala Leu Asp Ile  
 340 345 350  
 Phe His Thr Lys Gly Gln Leu  
 355

&lt;210&gt; SEQ ID NO 155

&lt;211&gt; LENGTH: 359

&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Saccharomyces cerevisiae*

&lt;400&gt; SEQUENCE: 155

Met Gly Val Glu Gln Ile Leu Lys Arg Lys Thr Gly Val Ile Val Gly  
 1 5 10 15  
 Glu Asp Val His Asn Leu Phe Thr Tyr Ala Lys Glu His Lys Phe Ala  
 20 25 30  
 Ile Pro Ala Ile Asn Val Thr Ser Ser Ser Thr Ala Val Ala Ala Leu  
 35 40 45  
 Glu Ala Ala Arg Asp Ser Lys Ser Pro Ile Ile Leu Gln Thr Ser Asn  
 50 55 60  
 Gly Gly Ala Ala Tyr Phe Ala Gly Lys Gly Ile Ser Asn Glu Gly Gln  
 65 70 75 80  
 Asn Ala Ser Ile Lys Gly Ala Ile Ala Ala His Tyr Ile Arg Ser  
 85 90 95  
 Ile Ala Pro Ala Tyr Gly Ile Pro Val Val Leu His Ser Asp His Cys  
 100 105 110  
 Ala Lys Lys Leu Leu Pro Trp Phe Asp Gly Met Leu Glu Ala Asp Glu  
 115 120 125  
 Ala Tyr Phe Lys Glu His Gly Glu Pro Leu Phe Ser Ser His Met Leu  
 130 135 140  
 Asp Leu Ser Glu Glu Thr Asp Glu Glu Asn Ile Ser Thr Cys Val Lys



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Asn Thr Gly Leu Ala Phe Ala Ala Leu Ile Asn Lys Phe Arg Pro Asn  
 165 170 175

Leu Leu Asp Tyr Ser Ala Leu Asp Tyr Asn Asp His Lys Gly Ala Cys  
 180 185 190

Glu Lys Ala Phe Ala Ala Cys Lys Glu Leu Gly Ile Tyr Val Tyr Leu  
 195 200 205

Asp Pro Glu Asp Val Ile Asp Thr Thr Pro Asp Glu Lys Ser Val Val  
 210 215 220

Thr Gln Val Ala Glu Phe Phe His Phe Phe Ala Ser Glu Ser Lys Ile  
 225 230 235 240

Ala Ala Met Ala Asp Lys Ile Lys Arg Thr Val Ala Ile Gln Lys Gln  
 245 250 255

Ile Asp Glu Leu Lys Asn Thr Tyr Ile Glu Asp Ala Lys Ala Ala Ile  
 260 265 270

Glu Lys Met Thr Val Glu Asp Glu Lys Leu Lys Ala Asp Asp Tyr Glu  
 275 280 285

Lys Thr Ile Pro Gly Ile Arg Gly Lys Leu Ala Ser Val Ile Ser Tyr  
 290 295 300

Asn Arg Asp Ile Arg Pro Glu Ile Val Asp His Arg Ala Lys Ala Met  
 305 310 315 320

Arg Ser Trp Ala Ala Leu Val Thr Lys Cys Lys Ser Gly Asn Arg Pro  
 325 330 335

Ile Pro Glu Ile Pro Gln Gly Leu Glu Pro Glu Ala Leu Thr Asn Lys  
 340 345 350

Phe Asn Glu Ile Glu Gln Thr Ser Thr Thr Arg Arg Asp Glu Leu Thr  
 355 360 365

Gln Glu Leu Asn Asp Met Ile Lys Lys Lys Val Glu Asp Phe Met Ala  
 370 375 380

Lys Cys Met Asp Ile Ile Asn Lys Cys Asp Ala Ile His Glu Glu Val  
 385 390 395 400

Lys Thr Ile Glu Gly Thr Thr Ala Glu Lys Lys Asp Lys Val Glu Gln  
 405 410 415

Lys Leu His Glu Ala Glu Asp Leu Gln Pro Ala Leu Ala Glu Leu Thr  
 420 425 430

Pro Leu Phe Gln Glu Leu Val Glu Leu Arg Ile Asn Thr Leu Ser Ser  
 435 440 445

Gln Thr Asp Asp Ser Val Asn Arg His His Ser Gln Leu Ile Thr Tyr  
 450 455 460

Ile Lys His Leu Leu Glu Gln Leu Asn Gly Lys Leu Phe Glu Glu Thr  
 465 470 475 480

Asn Glu Ala Arg Ile Asn Glu Tyr Asn Ala Leu Ala Gln Pro Leu Tyr  
 485 490 495

Asp Glu Ala Ile Ala Phe Lys Glu Glu Val Leu Ala Ile Ser Gly Glu  
 500 505 510

Leu Arg Glu Arg Arg Thr Gln Phe Leu Ala Lys Gln Ala Glu Ala Pro  
 515 520 525

Thr Lys Arg Glu His Val Asn Glu Ile Asp Pro Ile Phe Asp Gly Leu  
 530 535 540

Glu Lys Asp Ser Leu His Leu Arg Val Asn His Ser Pro Thr Glu Ile  
 545 550 555 560

Arg Asn Val Tyr Ala Val Thr Leu Gln His Ile Ile Thr Glu Leu Asn  
 565 570 575

Lys Ile Phe Glu Glu Met Val Ala Asn Phe Asp Ala Thr Ala Val Pro

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580					585					590					
Ile	Ile	Asp	Gly	Ile	Thr	Ala	Leu	Val	Thr	Ser	Ser	His	Gln	Ile	Pro
		595					600					605			
Gly	Asp	Ala	Ala	Ala	Val	Lys	Ala	Gln	Val	Glu	Glu	Asn	Leu	Ala	Ser
	610					615						620			
Leu	Asp	Gly	Phe	Ala	Glu	Lys	Ile	Gln	Ala	Leu	Gln	Asp	Pro	Tyr	Asn
	625					630						635			640
Glu	Leu	Val	Glu	Phe	Lys	Leu	Asn	Tyr	Lys	Val	Thr	Tyr	Thr	Tyr	Ser
				645					650					655	
Asp	Ala	Thr	Gly	Glu	Leu	Asp	Gln	Ala	Arg	Leu	Asp	Leu	Lys	Gln	Ile
				660					665					670	
Ile	Leu	Ala	Lys	Lys	Thr	Phe	Leu	Glu	Glu	Glu	Glu	Arg	Lys	Ala	Arg
				675					680					685	
Ile	Asn	Asn	Tyr	Thr	Val	Lys	Ala	Asp	Glu	His	Met	Asn	Glu	Ala	His
				690					695					700	
Ala	Leu	Asp	Gly	Lys	Ile	Asn	Ser	Val	Asp	Gly	Glu	Leu	Glu	Pro	Lys
				705					710					715	
Arg	Gln	Lys	Leu	Tyr	Glu	Val	Arg	Glu	Glu	Val	Asn	Ala	Lys	Lys	Glu
				725					730					735	
Lys	Ala	Ala	Glu	Glu	Leu	Thr	Pro	Ile	Tyr	Glu	Asp	Leu	Glu	Lys	Asp
				740					745					750	
Gln	Leu	His	Leu	Glu	Ile	Thr	Ser	Thr	Pro	Ala	Ser	Ile	Asn	Ile	Phe
				755					760					765	
Phe	Glu	Asn	Leu	Ile	Ala	His	Ile	Asp	Thr	Leu	Val	Lys	Glu	Ile	Asp
				770					775					780	
Ala	Ala	Ile	Ala	Ala	Ala	Lys	Gly	Leu	Glu	Ile	Ser	Glu	Glu	Glu	Leu
				785					790					795	
Asn	Glu	Phe	Lys	Asp	Thr	Phe	Lys	Tyr	Phe	Asp	Lys	Asp	Lys	Ser	Asn
				805					810					815	
Ser	Leu	Glu	Tyr	Phe	Glu	Leu	Lys	Ala	Cys	Leu	Thr	Ala	Leu	Gly	Glu
				820					825					830	
Asp	Ile	Thr	Asp	Gly	Gln	Ala	Lys	Glu	Tyr	Cys	Lys	Lys	Tyr	Asn	Ser
				835					840					845	
Lys	Gly	Glu	Gly	Thr	Ala	Leu	Glu	Phe	Asp	Asp	Tyr	Val	Arg	Phe	Met
				850					855					860	
Leu	Asp	His	Phe	Ser	Lys	Ala	Glu	Thr	Thr	Glu	Thr	Thr	Met	Glu	Ala
				865					870					875	
Phe	Lys	Ala	Ile	Ala	Gln	Asn	Gln	Pro	Val	Leu	Thr	Asp	Ala	Gln	Leu
				885					890					895	
Asp	Gln	Tyr	Phe	Ser	Ala	Glu	Asp	Ala	Ala	Tyr	Leu	Arg	Ser	Gln	Leu
				900					905					910	
Lys	Gln	Gly	Glu	Asn	Gly	Tyr	Glu	Phe	Ala	Asp	Trp	Val	Asn	Ser	Leu
				915					920					925	
Tyr	Asn	His													
				930											
<210> SEQ ID NO 157															
<211> LENGTH: 894															
<212> TYPE: PRT															
<213> ORGANISM: Homo sapiens															
<400> SEQUENCE: 157															
Met	Asn	Gln	Ile	Glu	Pro	Gly	Val	Gln	Tyr	Asn	Tyr	Val	Tyr	Asp	Glu
1				5					10					15	

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Asp Glu Tyr Met Ile Gln Glu Glu Glu Trp Asp Arg Asp Leu Leu Leu  
 20 25 30  
 Asp Pro Ala Trp Glu Lys Gln Gln Arg Lys Thr Phe Thr Ala Trp Cys  
 35 40 45  
 Asn Ser His Leu Arg Lys Ala Gly Thr Gln Ile Glu Asn Ile Glu Glu  
 50 55 60  
 Asp Phe Arg Asn Gly Leu Lys Leu Met Leu Leu Leu Glu Val Ile Ser  
 65 70 75 80  
 Gly Glu Arg Leu Pro Lys Pro Asp Arg Gly Lys Met Arg Phe His Lys  
 85 90 95  
 Ile Ala Asn Val Asn Lys Ala Leu Asp Tyr Ile Ala Ser Lys Gly Val  
 100 105 110  
 Lys Leu Val Ser Ile Gly Ala Glu Glu Ile Val Asp Gly Asn Val Lys  
 115 120 125  
 Met Thr Leu Gly Met Ile Trp Thr Ile Ile Leu Arg Phe Ala Ile Gln  
 130 135 140  
 Asp Ile Ser Val Glu Glu Thr Ser Ala Lys Glu Gly Leu Leu Leu Trp  
 145 150 155 160  
 Cys Gln Arg Lys Thr Ala Pro Tyr Arg Asn Val Asn Ile Gln Asn Phe  
 165 170 175  
 His Thr Ser Trp Lys Asp Gly Leu Gly Leu Cys Ala Leu Ile His Arg  
 180 185 190  
 His Arg Pro Asp Leu Ile Asp Tyr Ser Lys Leu Asn Lys Asp Asp Pro  
 195 200 205  
 Ile Gly Asn Ile Asn Leu Ala Met Glu Ile Ala Glu Lys His Leu Asp  
 210 215 220  
 Ile Pro Lys Met Leu Asp Ala Glu Asp Ile Val Asn Thr Pro Lys Pro  
 225 230 235 240  
 Asp Glu Arg Ala Ile Met Thr Tyr Val Ser Cys Phe Tyr His Ala Phe  
 245 250 255  
 Ala Gly Ala Glu Gln Ala Glu Thr Ala Ala Asn Arg Ile Cys Lys Val  
 260 265 270  
 Leu Ala Val Asn Gln Glu Asn Glu Arg Leu Met Glu Glu Tyr Glu Arg  
 275 280 285  
 Leu Ala Ser Glu Leu Leu Glu Trp Ile Arg Arg Thr Ile Pro Trp Leu  
 290 295 300  
 Glu Asn Arg Thr Pro Glu Lys Thr Met Gln Ala Met Gln Lys Lys Leu  
 305 310 315 320  
 Glu Asp Phe Arg Asp Tyr Arg Arg Lys His Lys Pro Pro Lys Val Gln  
 325 330 335  
 Glu Lys Cys Gln Leu Glu Ile Asn Phe Asn Thr Leu Gln Thr Lys Leu  
 340 345 350  
 Arg Ile Ser Asn Arg Pro Ala Phe Met Pro Ser Glu Gly Lys Met Val  
 355 360 365  
 Ser Asp Ile Ala Gly Ala Trp Gln Arg Leu Glu Gln Ala Glu Lys Gly  
 370 375 380  
 Tyr Glu Glu Trp Leu Leu Asn Glu Ile Arg Arg Leu Glu Arg Leu Glu  
 385 390 395 400  
 His Leu Ala Glu Lys Phe Arg Gln Lys Ala Ser Thr His Glu Thr Trp  
 405 410 415  
 Ala Tyr Gly Lys Glu Gln Ile Leu Leu Gln Lys Asp Tyr Glu Ser Ala  
 420 425 430  
 Ser Leu Thr Glu Val Arg Ala Leu Leu Arg Lys His Glu Ala Phe Glu

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435				440				445							
Ser	Asp	Leu	Ala	Ala	His	Gln	Asp	Arg	Val	Glu	Gln	Ile	Ala	Ala	Ile
450						455					460				
Ala	Gln	Glu	Leu	Asn	Glu	Leu	Asp	Tyr	His	Asp	Ala	Val	Asn	Val	Asn
465				470						475					480
Asp	Arg	Cys	Gln	Lys	Ile	Cys	Asp	Gln	Trp	Asp	Arg	Leu	Gly	Thr	Leu
				485					490						495
Thr	Gln	Lys	Arg	Arg	Glu	Ala	Leu	Glu	Arg	Met	Glu	Lys	Leu	Leu	Glu
				500					505					510	
Thr	Ile	Asp	Gln	Leu	His	Leu	Glu	Phe	Ala	Lys	Arg	Ala	Ala	Pro	Phe
				515					520					525	
Asn	Asn	Trp	Met	Glu	Gly	Ala	Met	Glu	Asp	Leu	Gln	Asp	Met	Phe	Ile
				530			535				540				
Val	His	Ser	Ile	Glu	Glu	Ile	Gln	Ser	Leu	Ile	Thr	Ala	His	Glu	Gln
545					550					555					560
Phe	Lys	Ala	Thr	Leu	Pro	Glu	Ala	Asp	Gly	Glu	Arg	Gln	Ser	Ile	Met
				565					570						575
Ala	Ile	Gln	Asn	Glu	Val	Glu	Lys	Val	Ile	Gln	Ser	Tyr	Asn	Ile	Arg
				580					585					590	
Ile	Ser	Ser	Ser	Asn	Pro	Tyr	Ser	Thr	Val	Thr	Met	Asp	Glu	Leu	Arg
				595			600					605			
Thr	Lys	Trp	Asp	Lys	Val	Lys	Gln	Leu	Val	Pro	Ile	Arg	Asp	Gln	Ser
				610			615				620				
Leu	Gln	Glu	Glu	Leu	Ala	Arg	Gln	His	Ala	Asn	Glu	Arg	Leu	Arg	Arg
625					630						635				640
Gln	Phe	Ala	Ala	Gln	Ala	Asn	Ala	Ile	Gly	Pro	Trp	Ile	Gln	Asn	Lys
				645					650						655
Met	Glu	Glu	Ile	Ala	Arg	Ser	Ser	Ile	Gln	Ile	Thr	Gly	Ala	Leu	Glu
				660					665					670	
Asp	Gln	Met	Asn	Gln	Leu	Lys	Gln	Tyr	Glu	His	Asn	Ile	Ile	Asn	Tyr
				675					680					685	
Lys	Asn	Asn	Ile	Asp	Lys	Leu	Glu	Gly	Asp	His	Gln	Leu	Ile	Gln	Glu
				690			695				700				
Ala	Leu	Val	Phe	Asp	Asn	Lys	His	Thr	Asn	Tyr	Thr	Met	Glu	His	Ile
					710					715					720
Arg	Val	Gly	Trp	Glu	Leu	Leu	Leu	Thr	Thr	Ile	Ala	Arg	Thr	Ile	Asn
				725					730						735
Glu	Val	Glu	Thr	Gln	Ile	Leu	Thr	Arg	Asp	Ala	Lys	Gly	Ile	Thr	Gln
				740					745					750	
Glu	Gln	Met	Asn	Glu	Phe	Arg	Ala	Ser	Phe	Asn	His	Phe	Asp	Arg	Arg
				755			760					765			
Lys	Asn	Gly	Leu	Met	Asp	His	Glu	Asp	Phe	Arg	Ala	Cys	Leu	Ile	Ser
				770			775				780				
Met	Gly	Tyr	Asp	Leu	Gly	Glu	Ala	Glu	Phe	Ala	Arg	Ile	Met	Thr	Leu
				785		790				795					800
Val	Asp	Pro	Asn	Gly	Gln	Gly	Thr	Val	Thr	Phe	Gln	Ser	Phe	Ile	Asp
				805					810					815	
Phe	Met	Thr	Arg	Glu	Thr	Ala	Asp	Thr	Asp	Thr	Ala	Glu	Gln	Val	Ile
				820					825					830	
Ala	Ser	Phe	Arg	Ile	Leu	Ala	Ser	Asp	Lys	Pro	Tyr	Ile	Leu	Ala	Glu
				835			840					845			
Glu	Leu	Arg	Arg	Glu	Leu	Pro	Pro	Asp	Gln	Ala	Gln	Tyr	Cys	Ile	Lys
				850			855				860				

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Arg Met Pro Ala Tyr Ser Gly Pro Gly Ser Val Pro Gly Ala Leu Asp  
865 870 875 880

Tyr Ala Ala Phe Ser Ser Ala Leu Tyr Gly Glu Ser Asp Leu  
885 890

<210> SEQ ID NO 158

<211> LENGTH: 482

<212> TYPE: PRT

<213> ORGANISM: Treponema pallidum

<400> SEQUENCE: 158

Met Arg Arg Arg Val Cys Thr Val Val Arg Ala Val Val Cys Leu Leu  
1 5 10 15

Ser Thr Ser Leu Leu Thr Thr Cys Asp Phe Thr Gly Ile Phe Ala Ala  
20 25 30

Ile Gln Ser Glu Val Pro Ile Lys Thr Pro Ser Ile Pro Gly Ala Ile  
35 40 45

Tyr Gly Leu Val Lys Ala Gly Ser Lys Leu Tyr Ala Thr Asn Gly Arg  
50 55 60

Leu Trp Glu Lys Glu Leu Asn Gly Thr Glu Ser Trp Gln Lys Val Ser  
65 70 75 80

Ser Ser Ser Val Pro Thr Asp Ser Asp Lys Lys Val Met Ser Ile Ala  
85 90 95

Thr Asp Gly Thr Asn Phe Val Leu Ala Cys Val Pro Gly Thr Gly Val  
100 105 110

Tyr Lys His Cys Val Asn Gly Ala Val Gly Ser Ser Ser Thr Ala Ala  
115 120 125

Ser Gly Ser Thr Glu Thr Cys Ser Asn His Ala Thr Leu Val Gly Gly  
130 135 140

Thr Ser Thr Pro Phe Trp Ile Val Pro Gly Gly Thr Gly Ser Asn Gly  
145 150 155 160

Asn Cys Gly Cys Gly Ala Gly Gly Gly Gly Ser Ser Ser Ser Ser Ser  
165 170 175

Ser Cys Ile His Ile Trp Leu Val Pro Ala Gly Thr Gly Ser Asn Gly  
180 185 190

Asn Cys Gly Cys Gly Ala Gly Gly Gly Gly Ser Ser Ser Ser Ser Ser  
195 200 205

Ser Cys Ile His Ile Lys Lys Glu Asp Thr Gly Glu Gln Phe Leu Asp  
210 215 220

Arg Gly Glu Gly Tyr Val Val Thr Thr Lys His Leu Tyr Thr Lys Asn  
225 230 235 240

Gly Ser Ser Ser Ala Gly Pro Ala Pro Cys Pro Gly Gly Gly Gly Gly  
245 250 255

Ser Ser Gly Gly Gly Gly Ser Ser Gln Tyr Thr Lys Asp Ser Cys Phe  
260 265 270

Phe Ser Thr Pro Ile Leu Ala Ser Val Ser Asp Gly Cys Tyr His Tyr  
275 280 285

Ile Leu Thr Lys Glu Lys Val Tyr Cys Arg Lys Gln Asn Ala Ala Ser  
290 295 300

Ser Ala Ala Ser Ser Pro Ala Ser Cys Pro Ser Ser Pro Ser Ser Ser  
305 310 315 320

Ser Ser Ser Ser Thr Asn Ala Gly Cys Glu Val Glu His Gly Val Asp  
325 330 335

Asp Pro Leu Cys Leu Ala Ile Phe Lys His Asn Gly Cys Glu Tyr Leu



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225                230                235                240
Gly Lys Val Val Arg Leu Lys Lys Thr Glu Ala Glu Lys Ala Leu Gln
      245                250                255
Ser Ala Lys Thr Lys Gln Lys Ala Ser Ser Asp Leu Ala Arg Ser Ala
      260                265                270
Asp Lys Ser Ala Pro Leu Pro Glu Asn Ala Gln Gly Phe Ser Lys Glu
      275                280                285
Pro Ile Glu Val Glu Pro Leu Pro Asn Asp Arg Leu Asn Thr Thr Gln
      290                295                300
Ala Asp Glu Ser Ala Pro Ile Pro Ile Ser Asp Thr Ser Ser Pro Ser
      305                310                315                320
Arg Val Gln Ser Arg Gly Val Glu Asp Gly Gly Arg Ser Pro Lys Ser
      325                330                335
Ser Met Asn Glu Glu Gly Ala Ser Arg
      340                345

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&lt;210&gt; SEQ ID NO 160

&lt;211&gt; LENGTH: 320

&lt;212&gt; TYPE: PRT

<213> ORGANISM: *Treponema pallidum*

&lt;400&gt; SEQUENCE: 160

```

Arg Asp Pro Leu Ser Ser Pro Pro Ala Gly His Thr Val Pro Glu Tyr
1          5          10          15
Arg Asp Thr Val Ile Phe Asp Asp Pro Arg Leu Val Ser Pro Leu Ser
      20          25          30
Arg Glu Val Glu Asp Ala Pro Lys Val Val Glu Pro Ala Ser Glu Arg
      35          40          45
Glu Gly Gly Glu Arg Glu Val Glu Asp Ala Pro Lys Val Val Glu Pro
      50          55          60
Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu Asp Val Pro Lys
      65          70          75          80
Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu
      85          90          95
Asp Ala Pro Lys Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu
      100         105         110
Arg Glu Val Glu Asp Val Pro Lys Val Val Glu Pro Ala Ser Glu Arg
      115         120         125
Glu Gly Gly Glu Arg Glu Val Glu Asp Val Pro Lys Val Val Glu Pro
      130         135         140
Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu Asp Ala Pro Lys
      145         150         155         160
Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu
      165         170         175
Asp Ala Pro Lys Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu
      180         185         190
Arg Glu Val Glu Asp Val Pro Lys Val Val Glu Pro Ala Ser Glu Arg
      195         200         205
Glu Gly Gly Glu Arg Glu Val Glu Asp Val Pro Lys Val Val Glu Pro
      210         215         220
Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu Asp Val Pro Lys
      225         230         235         240
Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu Arg Glu Val Glu
      245         250         255

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Asp Val Pro Lys Val Val Glu Pro Ala Ser Glu Arg Glu Gly Gly Glu
      260                      265                      270

Arg Glu Val Glu Asp Val Pro Gly Val Val Glu Pro Ala Ser Gly His
      275                      280                      285

Glu Gly Gly Glu Arg Glu Val Glu Asp Val Pro Gly Val Val Glu Pro
      290                      295                      300

Ala Ser Gly His Glu Gly Gly Glu Arg Glu Val Ala Ser Gln His Thr
      305                      310                      315                      320

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&lt;210&gt; SEQ ID NO 161

&lt;211&gt; LENGTH: 348

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Neisseria gonorrhoeae

&lt;400&gt; SEQUENCE: 161

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Met Lys Lys Ser Leu Ile Ala Leu Thr Leu Ala Ala Leu Pro Val Ala
  1      5      10      15

Ala Thr Ala Asp Val Thr Leu Tyr Gly Ala Ile Lys Ala Gly Val Gln
      20                      25                      30

Thr Tyr Arg Ser Val Glu His Arg Glu Gly Lys Val Val Gly Val Glu
      35                      40                      45

Thr Gly Ser Glu Ile Ser Asp Phe Gly Ser Lys Ile Gly Phe Lys Gly
      50                      55                      60

Gln Glu Asp Leu Gly Asn Gly Leu Lys Ala Val Trp Gln Leu Glu Gln
      65                      70                      75                      80

Gly Ala Ser Val Ala Gly Thr Asn Thr Gly Trp Gly Asn Lys Gln Ser
      85                      90                      95

Phe Val Gly Leu Lys Gly Gly Phe Gly Thr Ile Arg Val Gly Ser Leu
      100                     105                     110

Asn Ser Pro Leu Lys Asn Thr Gly Ala Asn Val Asn Ala Trp Glu Ser
      115                     120                     125

Gly Lys Tyr Thr Gly Glu Phe Leu Glu Ile Ser Lys Met Ala Gly Arg
      130                     135                     140

Glu His Arg Tyr Leu Ser Ala Arg Tyr Asp Ser Pro Glu Phe Ala Gly
      145                     150                     155                     160

Phe Ser Gly Ser Val Gln Tyr Ala Pro Lys Asp Asn Ser Gly Ser Asn
      165                     170                     175

Gly Glu Ser Tyr His Val Gly Leu Asn Tyr Arg Asn Gly Gly Phe Phe
      180                     185                     190

Ala Gln Tyr Ala Gly Leu Phe Gln Arg Tyr Gly Glu Gly Thr Lys Lys
      195                     200                     205

Ile Glu Tyr Asn Ser Gln Ser Tyr Ser Ile Pro Ser Leu Phe Val Glu
      210                     215                     220

Lys Leu Gln Val His Arg Leu Val Gly Gly Tyr Asp Asn Asn Ala Leu
      225                     230                     235                     240

Tyr Ala Ser Val Ala Ala Gln Gln Gln Asp Ala Lys Leu Tyr Gly Thr
      245                     250                     255

Trp Arg Ala Asn Ser His Asn Ser Gln Thr Glu Val Ala Ala Thr Ala
      260                     265                     270

Ala Tyr Arg Phe Gly Asn Leu Thr Pro Arg Val Ser Tyr Ala His Gly
      275                     280                     285

Phe Lys Gly Ser Val His Ser Ala Asp Tyr Asp Asn Thr Tyr Asp Gln
      290                     295                     300

Val Val Val Gly Ala Glu Tyr Asp Phe Ser Lys Arg Thr Ser Ala Leu
      305                     310                     315                     320

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Val Ser Ala Gly Trp Leu Gln Glu Gly Lys Gly Ala Glu Lys Ile Val  
 325 330 335

Ser Thr Ala Ser Ala Val Val Leu Arg His Lys Phe  
 340 345

<210> SEQ ID NO 162  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 162

Asn Glu Leu Val Glu Phe Lys Leu Asn Tyr Lys  
 1 5 10

<210> SEQ ID NO 163  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 163

Val Glu Phe Lys Leu Asn Tyr Lys Val Thr Tyr  
 1 5 10

<210> SEQ ID NO 164  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 164

Lys Leu Asn Tyr Lys Val Thr Tyr Thr Tyr Ser  
 1 5 10

<210> SEQ ID NO 165  
 <211> LENGTH: 11  
 <212> TYPE: PRT  
 <213> ORGANISM: Trichomonas vaginalis

<400> SEQUENCE: 165

Tyr Lys Val Thr Tyr Thr Tyr Ser Asp Ala Thr  
 1 5 10

What is claimed is:

1. A method for detecting the presence of one or more *Trichomonas vaginalis* microorganisms in a biological sample of a subject, comprising the steps of:

combining said biological sample with a polypeptide including a series of epitopes (SOE) which includes at least a plurality of SEQ ID NO: 2, SEQ ID NO: 21, SEQ ID NO: 22, SEQ ID NO: 23, SEQ ID NO: 24, SEQ ID NO: 26, SEQ ID NO: 27, SEQ ID NO: 28, SEQ ID NO: 29, SEQ ID NO: 30, SEQ ID NO: 35, SEQ ID NO: 36, SEQ ID NO: 37, SEQ ID NO: 38, SEQ ID NO: 39, SEQ ID NO: 40, SEQ ID NO: 41, and SEQ ID NO: 44, said epitopes being arranged as a linear array with each of said epitopes being connected by one or more repeats of amino acid linkers selected from the group consisting of glycine-glycine (-GG-) and lysine (-KK-), wherein said combining is performed under conditions whereby antigen-antibody complexes are permitted to form; and

detecting formation of at least one antigen-antibody complex as an indication of a presence of at least one microorganism of said one or more *Trichomonas* microorganisms in said biological sample.

2. The method of claim 1, wherein said *Trichomonas vaginalis* microorganisms are selected from the group consisting of *Trichomonas (T.) vaginalis*, *T. vaginalis* isolates T016, T068-II, UT40, and VB102.

3. The method of claim 1, wherein said detecting step is performed using an immunoassay.

4. The method of claim 3, wherein said immunoassay is an enzyme-linked immunosorbent assay (ELISA).

5. The method of claim 1, wherein said biological sample is selected from the group consisting of serum, plasma, blood, saliva, semen, cerebrospinal fluid, semen, prostatic fluid, urine, sputum, joint fluid, body cavity fluid, whole cells, cell extracts, tissue, biopsy material, aspirates, exudates, vaginal washings, pap smear samples, pap smear preparations, slide preparations, fixed cells, and tissue sections.

6. The method of claim 1, wherein said subject is selected from the group of human, non-human primate, dog, cat, cattle, sheep, swine, horse, bird, mouse and rat.

7. The method of claim 1, wherein said SOE includes each of SEQ ID NO: 2, SEQ ID NO: 21, SEQ ID NO: 22, SEQ ID NO: 23, SEQ ID NO: 24, SEQ ID NO: 26, SEQ ID NO:

27, SEQ ID NO: 28, SEQ ID NO: 29, SEQ ID NO: 30, SEQ ID NO: 35, SEQ ID NO: 36, SEQ ID NO: 37, SEQ ID NO: 38, SEQ ID NO: 39, SEQ ID NO: 40, SEQ ID NO: 41, and SEQ ID NO: 44.

\* \* \* \* \*

专利名称(译)	表位的串可用于诊断和引发对性传播感染的免疫应答		
公开(公告)号	<a href="#">US9910042</a>	公开(公告)日	2018-03-06
申请号	US14/774158	申请日	2014-03-13
[标]申请(专利权)人(译)	华盛顿州立大学		
申请(专利权)人(译)	华盛顿州立大学		
当前申请(专利权)人(译)	华盛顿州立大学		
[标]发明人	ALDERETE JOHN F		
发明人	ALDERETE, JOHN F.		
IPC分类号	G01N33/53 C07K14/44 C07K16/20 A61K39/02 A61K39/095 C07K14/20 C07K14/22 G01N33/571 A61K49/00 A61K39/002		
CPC分类号	G01N33/571 A61K39/002 A61K39/0225 A61K39/095 C07K14/20 C07K14/44 C07K16/20 C07K14/22 G01N2333/44 C07K2319/40 G01N2333/20 G01N2333/22		
优先权	61/779166 2013-03-13 US		
其他公开文献	US20160041169A1		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

摘要(译)

本发明提供了使用特异于检测致病微生物的一串表位 (SOE) 来检测和诊断性传播感染的方法和组合物。抗原表位可以是单个表位序列, 多个表位序列通过甘氨酸 (-GG-) 和/或赖氨酸 (-KK-) 的重复连接形成一列表位 (SOE), 或编码一个或多个SOE的核苷酸序列。和携带所述SOE核苷酸序列的宿主细胞。提供了对来自毛滴虫, 密螺旋体和奈瑟氏球菌属的蛋白质的高免疫原性区域特异的SOE。检测毛滴虫物种存在的SOE包括来自毛滴虫 - 醛缩酶醛缩酶, GAPDH,  $\alpha$ -烯醇酶和 $\alpha$ -辅肌动蛋白的区域。包含SOE的药物组合物也可用作疫苗或引发对特定微生物的免疫应答。

FIGURE 1

