(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 385 280 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.10.2018 Bulletin 2018/41

(51) Int Cl.:
C07K 16/12 *(2006.01)* ***A61K 39/00*** *(2006.01)*

(21) Application number: **17205254.0**

(22) Date of filing: **08.06.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **10.06.2011 US 201161495460 P**
02.09.2011 US 201161530461 P
20.03.2012 US 201261613317 P

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
12796646.3 / 2 718 320

(71) Applicant: **MedImmune Limited**
Cambridge
Cambridgeshire CB21 6GH (GB)

(72) Inventors:
- **DIGIANDOMENICO, Antonio**
  Gaithersburg, Maryland 20878 (US)
- **WARRENER, Paul G.**
  Maryland, Gaithersburg 20878 (US)
- **STOVER, Charles K.**
  Gaithersburg, Maryland 20878 (US)
- **SELLMAN, Bret**
  Gaithersburg, Maryland 20878 (US)
- **GUILLARD, Sandrine**
  Cambridge, CB21 6GH (GB)
- **MINTER, Ralph**
  Cambridge, CB21 6GH (GB)
- **RUST, Steven**
  Cambridge, CB21 6GH (GB)
- **TOMICH, Mladen**
  Gaithersburg, Maryland 20878 (US)

(74) Representative: **AstraZeneca**
Milstein Building
Granta Park
Cambridge CB21 6GH (GB)

Remarks:
•Claims filed after the date of filing of the application/after the date of receipt of the divisional application (Rule 68(4) EPC).
•This application was filed on 04-12-2017 as a divisional application to the application mentioned under INID code 62.

(54) **ANTI-PSEUDOMONAS PSL BINDING MOLECULES AND USES THEREOF**

(57) This disclosure relates to an anti-*Pseudomonas* Psl binding molecules and uses thereof, in particular in prevention and treatment of *Pseudomonas* infection. Furthermore, the disclosure provides compositions and methods for preventing and treating *Pseudomonas* infection.

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Description

BACKGROUND

Field of the Disclosure

[0001] This disclosure relates to an *anti*-Pseudomonas Psl binding molecules and uses thereof, in particular in prevention and treatment of *Pseudomonas* infection. Furthermore, the disclosure provides compositions and methods for preventing and treating *Pseudomonas* infection.

Background of the Disclosure

[0002] *Pseudomonas aeruginosa* (*P. aeruginosa*) is a gram-negative opportunistic pathogen that causes both acute and chronic infections in compromised individuals (Ma et al., Journal of Bacteriology 189(22):8353-8356 (2007)). This is partly due to the high innate resistance of the bacterium to clinically used antibiotics, and partly due to the formation of highly antibioticresistant biofilms (Drenkard E., Microbes Infect 5:1213-1219 (2003); Hancokc & Speert, Drug Resist Update 3:247-255 (2000)).

[0003] *P. aeruginosa* is a common cause of hospital-acquired infections in the Western world. It is a frequent causative agent of bacteremia in burn victims and immune compromised individuals (Lyczak et al., Microbes Infect 2:1051-1060 (2000)). It is also the most common cause of nosocomial gram-negative pneumonia (Craven et al., Semin Respir Infect 11:32-53 (1996)), especially in mechanically ventilated patients, and is the most prevalent pathogen in the lungs of individuals with cystic fibrosis (Pier et al., ASM News 6:339-347 (1998)). Serious *P. aeruginosa* infections can become systemic, resulting in sepsis. Sepsis is characterized by severe systemic inflammation, often resulting in multiple organ failure and death.

[0004] *Pseudomonas* Psl exopolysaccharide is reported to be anchored to the surface of *P. aeruginosa* and is thought to be important in facilitating colonization of host tissues and in establishing/maintaining biofilm formation (Jackson, K.D., et al., J Bacteriol 186, 4466-4475 (2004)). Its structure comprises mannose-rich repeating pentasaccharide (Byrd, M.S., et al., Mol Microbiol 73, 622-638 (2009))

[0005] Due to increasing multidrug resistance, there remains a need in the art for the development of novel strategies for the identification of new *Pseudomonas*-specific prophylactic and therapeutic agents.

BRIEF SUMMARY

[0006] One embodiment is directed to an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, wherein the binding molecule (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote OPK of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote OPK of *P. aeruginosa.*

[0007] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the heavy chain variable region (VH) and light chain variable region (VL) region of WapR-004, Cam-003, Cam-004, or Cam-005.

[0008] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof as which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-004, Cam-003, Cam-004, or Cam-005.

[0009] Some embodiments include the present disclosure includes the binding molecule *e.g.,* an antibody or antigen-binding fragment thereof as described above, wherein the VH and VL of WapR-004 comprise SEQ ID NO:11 and SEQ ID NO:12, respectively, the VH and VL of Cam-003 comprise SEQ ID NO:1 and SEQ ID NO:2, respectively, the VH and VL of Cam-004 comprise SEQ ID NO:3 and SEQ ID NO:2, respectively, and the VH and VL of Cam-005 comprise SEQ ID NO:4 and SEQ ID NO:2, respectively.

[0010] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the VH and VL regions of WapR-001, WapR-002, or WapR-003.

[0011] Further disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-001, WapR-002, or WapR-003.

[0012] Some embodiments include the binding molecule *e.g.,* an antibody or antigen-binding fragment thereof as described above, wherein the VH and VL of WapR-001 comprise SEQ ID NO: 5 and SEQ ID NO: 6, respectively, the VH and VL of WapR-002 comprise SEQ ID NO: 7 and SEQ ID NO: 8, respectively, and the VH and VL of WapR-003

comprise SEQ ID NO: 9 and SEQ ID NO: 10, respectively.

[0013] Further provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the VH and VL regions of WapR-016.

[0014] Also provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-016.

[0015] Some embodiments include the binding molecule *e.g.,* an antibody or fragment thereof as described above, where the VH and VL of WapR-016 comprise SEQ ID NO: 15 and SEQ ID NO:16, respectively.

[0016] Also provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, where the VH comprises an amino acid sequence at least 90% identical or identical to SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, or SEQ ID NO: 15.

[0017] Some embodiments include an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, where the VL comprises an amino acid sequence at least 90% identical or identical to SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, and SEQ ID NO: 16.

[0018] Also provided is an isolated antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* psl, comprising VH and VL amino acid sequences at least 90% identical or identical to:(a) SEQ ID NO: 1 and SEQ ID NO: 2, respectively, (b) SEQ ID NO: 3 and SEQ ID NO: 2, respectively, (c) SEQ ID NO: 4 and SEQ ID NO: 2 , respectively, (d) SEQ ID NO: 5 and SEQ ID NO: 6 , respectively, (e) SEQ ID NO: 7 and SEQ ID NO: 8, respectively, (f) SEQ ID NO: 9 and SEQ ID NO: 10, respectively, (g) SEQ ID NO: 11 and SEQ ID NO: 12 , respectively, (h) SEQ ID NO: 13 and SEQ ID NO: 14, respectively; or (i) SEQ ID NO: 15 and SEQ ID NO: 16, respectively. In specific embodiments, the above-described antibody or antigen-binding fragment thereof comprises a VH with the amino acid sequence SEQ ID NO: 1 and a VL with the amino acid sequence of SEQ ID NO: 2. In other embodiments, the above-described antibody or antigen-binding fragment thereof comprises a VH with the amino acid sequence SEQ ID NO: 11 and a VL with the amino acid sequence of SEQ ID NO: 12.

[0019] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, where the VH comprises a VH complementarity determining region-1 (VHCDR1) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 17, SEQ ID NO: 23, SEQ ID NO: 26, SEQ ID NO: 29, SEQ ID NO: 35, SEQ ID NO: 41, SEQ ID NO: 47, SEQ ID NO: 53, or SEQ ID NO: 59.

[0020] Also provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, where the VH comprises a VH complementarity determining region-2 (VHCDR2) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 18, SEQ ID NO: 24, SEQ ID NO: 27, SEQ ID NO: 30, SEQ ID NO: 36, SEQ ID NO: 42, SEQ ID NO: 48, SEQ ID NO: 54, or SEQ ID NO: 60.

[0021] Further provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, where the VH comprises a VH complementarity determining region-3 (VHCDR3) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 19, SEQ ID NO: 25, SEQ ID NO: 28, SEQ ID NO: 31, SEQ ID NO: 37, SEQ ID NO: 43, SEQ ID NO: 49, SEQ ID NO: 55, or SEQ ID NO: 61.

[0022] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* psl comprising an antibody VL, where the VL comprises a VL complementarity determining region-1 (VLCDR1) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 20, SEQ ID NO: 32, SEQ ID NO: 38, SEQ ID NO: 44, SEQ ID NO: 50, SEQ ID NO: 56, or SEQ ID NO: 62.

[0023] Further provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, where the VL comprises a VL complementarity determining region-2 (VLCDR2) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 21, SEQ ID NO: 33, SEQ ID NO: 39, SEQ ID NO: 45, SEQ ID NO: 51, SEQ ID NO: 57, or SEQ ID NO: 63.

[0024] Some embodiments include an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, where the VL comprises a VL complementarity determining region-3 (VLCDR3) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 22, SEQ ID NO: 34, SEQ ID NO: 40, SEQ ID NO: 46, SEQ ID NO: 52, SEQ ID NO: 58, or SEQ ID NO: 64.

[0025] Also provided is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which

specifically binds to *Pseudomonas* Psl comprising an antibody VH, where the VH comprises VHCDR1, VHCDR2, and VHCDR3 amino acid sequences identical to, or identical except for four, three, two, or one amino acid substitutions in one or more of the VHCDRs to: SEQ ID NOs: 17, 18, and 19, SEQ ID NOs: 23, 24, and 25, SEQ ID NOs: 26, 27, and 28, SEQ ID NOs: 29, 30, and 31, SEQ ID NOs: 35, 36, and 37, SEQ ID NOs: 41, 42, and 43, SEQ ID NOs: 47, 48, and 49, SEQ ID NOs: 53, 54, and 55, or SEQ ID NOs: 59, 60, and 61, respectively.

[0026] Some embodiments include an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, where the VL comprises VLCDR1, VLCDR2, and VLCDR3 amino acid sequences identical to, or identical except for four, three, two, or one amino acid substitutions in one or more of the VHCDRs to: SEQ ID NOs: 20, 21, and 22, SEQ ID NOs: 32, 33, and 34, SEQ ID NOs: 38, 39, and 40, SEQ ID NOs: 44, 45, and 46, SEQ ID NOs: 50, 51, and 52, SEQ ID NOs: 56, 57, and 58, or SEQ ID NOs: 62, 63, and 64, respectively.

[0027] Also disclosed is an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, where the VL comprises VLCDR1, VLCDR2, and VLCDR3 amino acid sequences identical to, or identical except for four, three, two, or one amino acid substitutions in one or more of the VHCDRs to: SEQ ID NOs: 20, 21, and 22, SEQ ID NOs: 32, 33, and 34, SEQ ID NOs: 38, 39, and 40, SEQ ID NOs: 44, 45, and 46, SEQ ID NOs: 50, 51, and 52, SEQ ID NOs: 56, 57, and 58, or SEQ ID NOs: 62, 63, and 64, respectively.

[0028] Some embodiments include the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, which (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote OPK of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote OPK of *P. aeruginosa.*

[0029] Other embodiments include the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, where maximum inhibition of *P. aeruginosa* attachment to epithelial cells is achieved at an antibody concentration of about 50 μg/ml or less, 5.0μg/ml or less, or about 0.5μg/ml or less, or at an antibody concentration ranging from about 30 μg/ml to about 0.3 μg/ml, or at an antibody concentration of about 1 μg/ml, or at an antibody concentration of about 0.3 μg/ml.

[0030] Certain embodiments include the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, where the OPK EC50 is less than about 0.5 μg/ml, less than about 0.05μg/ml, or less than about 0.005μg/ml, or where the OPK EC50 ranges from about 0.001 μg/ml to about 0.5 μg/ml, or where the OPK EC50 is less than about 0.2 μg/ml, or wherein the OPK EC50 is less than about 0.02 μg/ml.

[0031] Also included is the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, which specifically binds to *P. aeruginosa* Psl with an affinity characterized by a dissociation constant (K_D) no greater than 5 x 10^{-2} M, 10^{-2} M, 5 x 10^{-3} M, 10^{-3} M, 5 x 10^{-4} M, 10^{-4} M, 5 x 10^{-5} M, 10^{-5} M, 5 x 10^{-6} M, 10^{-6} M, 5 x 10^{-7} M, 10^{-7} M, 5 x 10^{-8} M, 10^{-8} M, 5 x 10^{-9} M, 10^{-9} M, 5 x 10^{-10} M, 10^{-10} M, 5 x 10^{-11} M, 10^{-11} M, 5 x 10^{-12} M, 10^{-12} M, 5 x 10^{-13} M, 10^{-13} M, 5 x 10^{-14} M, 10^{-14} M, 5 x 10^{-15} M, or 10^{-15} M, or wherein K_D is in a range of about 1 x 10^{-10} to about 1 x 10^{-6} M. In one embodiment, an isolated antibody as described herein specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.18 x 10^{-7} M, as determined by the OCTET® binding assay. In another embodiment, an isolated antibody as described herein specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.44 x 10^{-7} M, as determined by the OCTET® binding assay.

[0032] In various embodiments, the above-described binding molecules are humanized.

[0033] In various embodiments, the above-described binding molecules are chimeric.

[0034] In various embodiments, the above-described binding molecules are fully human.

[0035] In certain embodiments, the above-described binding molecules are Fab fragments, Fab' fragments, $F(ab)_2$ fragments, or scFv fragments.

[0036] In certain embodiments, the above-described binding molecules comprise light chain constant regions consisting of a human kappa constant region or a human lambda constant region.

[0037] In certain embodiments, the above-described binding molecules comprise a heavy chain constant region or fragment thereof. In further embodiments, the heavy chain constant region or fragment thereof is a human IgG1.

[0038] In certain embodiments, the above-described binding molecules are monoclonal antibodies.

[0039] In some embodiments, the above described binding molecules *e.g.,* an antibodies or fragments thereof are conjugated to an agent selected from the group consisting of antimicrobial agent, a therapeutic agent, a prodrug, a peptide, a protein, an enzyme, a lipid, a biological response modifier, pharmaceutical agent, a lymphokine, a heterologous antibody or fragment thereof, a detectable label, polyethylene glycol (PEG), and a combination of two or more of any said agents. In further embodiments, detectable label is selected from the group consisting of an enzyme, a fluorescent label, a chemiluminescent label, a bioluminescent label, a radioactive label, or a combination of two or more of any said detectable labels.

[0040] Additional embodiments include compositions comprising the above-described binding molecules *e.g.,* antibodies or fragments thereof, and a carrier.

[0041] Certain embodiments include an isolated polynucleotide comprising a nucleic acid which encodes the above-

described VH. In some embodiments, the polynucleotide further comprises a nucleic acid which encodes the above-described VL, where a binding molecule or antigen-binding fragment thereof expressed by the polynucleotide specifically binds *Pseudomonas* Psl. In some embodiments the polynucleotide as described herein encodes an scFv molecule including VH and VL, comprising the nucleotide sequence SEQ ID NO: 65, SEQ ID NO: 66, SEQ ID NO: 67, SEQ ID NO: 68, SEQ ID NO: 69 or SEQ ID NO: 70. In other embodiments, the disclosure includes an isolated polynucleotide comprising a nucleic acid which encodes the above-described VL. In further embodiments, the polynucleotide further comprises a nucleic acid which encodes the above-described VH, where a binding molecule or antigen-binding fragment thereof expressed by the polynucleotide specifically binds *Pseudomonas* Psl.

[0042] Certain embodiments provide vectors comprising the above-described polynucleotides. In further embodiments, the polynucleotides are operably associated with a promoter. In additional embodiments, the disclosure provides host cells comprising such vectors. In further embodiments, the disclosure provides vectors where the polynucleotide is operably associated with a promoter, where vectors can express a binding molecule *e.g.,* an antibody or fragment thereof as described above which specifically binds *Pseudomonas* Psl in a suitable host cell.

[0043] Some embodiments provides a method of producing a binding molecule *e.g.,* an antibody or fragment thereof as described above which specifically binds *Pseudomonas* Psl, comprising culturing a host cell containing a vector comprising the above-described polynucleotides, and recovering said antibody, or fragment thereof. Further embodiments provide an isolated binding molecule or fragment thereof produced by the above-described method.

[0044] In some embodiments, the *Pseudomonas* species is *Pseudomonas aeruginosa.*

[0045] In further embodiments, the above-described binding molecules or fragments thereof, antibodies or fragments thereof, or compositions, bind to two or more, three or more, four or more, or five or more different *P. aeruginosa* serotypes, or to at least 80%, at least 85%, at least 90% or at least 95% of *P. aeruginosa* strains isolated from infected patients. In further embodiments, the *P. aeruginosa* strains are isolated from one or more of lung, sputum, eye, pus, feces, urine, sinus, a wound, skin, blood, bone, or knee fluid. *P. aeruginosa* serotypes are categorized according to an International Antigen Typing System (IATS) originally described in Liu, P.V. et al. Int. J. Syst. Bacteriol. 33:256-264 (1983), as supplemented, e.g., by Liu P.V., Wang S., J. Clin. Microbiol. 28:922-925 (1990).

[0046] Some embodiments are directed to a method of preventing or treating a *Pseudomonas* infection in a subject in need thereof, comprising administering to the subject an effective amount of the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein. In further embodiments, the *Pseudomonas* infection is a *P. aeruginosa* infection. In some embodiments, the subject is a human. In certain embodiments, the infection is an ocular infection, a lung infection, a burn infection, a wound infection, a skin infection, a blood infection, a bone infection, or a combination of two or more of said infections. In further embodiments, the subject suffers from acute pneumonia, burn injury, corneal infection, cystic fibrosis, or a combination thereof.

[0047] Some embodiments are directed to a method of blocking or preventing attachment of *P. aeruginosa* to epithelial cells comprising contacting a mixture of epithelial cells and *P. aeruginosa* with the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein.

[0048] Also disclosed is a method of promoting OPK of *P. aeruginosa* comprising contacting a mixture of phagocytic cells and *P. aeruginosa* with the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein. In further embodiments, the phagocytic cells are differentiated HL-60 cells or human polymorphonuclear leukocytes (PMNs).

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

[0049]

Figure 1 (A-F): Phenotypic whole cell screening with human antibody phage libraries identified *P. aeruginosa* functionally active specific antibodies. (A) Overview of complete antibody selection strategy. (B) Flow diagram describing the process to isolate antibody variable region genes from patients recently exposed to *P. aeruginosa.* (C) Characteristics of the scFv phage display libraries, indicating the size and diversity of the cloned antibody repertoire. (D) Comparison of the phage display selection efficiency using either the patient antibody library or a naïve antibody library, when selected on *P. aeruginosa* 3064 Δ WapR ([1]) or *P. aeruginosa* PAO1 MexAB OprM Δ WapR ([2]) in suspension. Bars indicate the output titers (in CFU) at each round of selection, and circles indicate the proportion of duplicated VH CDR3 sequences, an indication of clonal enrichment. (E) ELISA screen of scFv from phage display to test binding to multiple strains of *P. aeruginosa.* ELISA data (absorbance at 450 nm) are shown for eight individual phage-scFvs from selections and one irrelevant phage-scFv. (F) FACS binding of *P. aeruginosa* specific antibodies with representative strains from unique *P. aeruginosa* serotypes. For each antibody tested a human IgG negative control antibody is shown as a shaded peak.

Figure 2 (A-D): Evaluation of specific mAbs promoting OPK of *P. aeruginosa* (A) Opsonophagocytosis assay with luminescent *P. aeruginosa* serogroup O5 strain (PAO1.lux), with dilutions of purified monoclonal antibodies derived

from phage panning. (B) Opsonophagocytosis assay with luminescent *P. aeruginosa* serogroup O11 strain (9882-80.lux), with dilutions of purified WapR-004 and Cam-003 monoclonal antibodies derived from phage panning. In both A and B, R347, an isotype matched human monoclonal antibody that does not bind *P. aeruginosa* antigens, was used as a negative control. (A,B) Results are representative data from three independent experiments performed for each antibody. (C-D): Evaluation of Cam-003 promoting opsonophagocytic killing (OPK) of *P. aeruginosa* (C) Opsonophagocytosis assay with representative non-mucoid strains from clinically relevant O-antigen serotypes (6294 (O6 ExoU$^-$), 6077 (O11 ExoU$^+$), 9882-80.lux (O11 ExoU$^-$), 33356 (O9 ExoU$^-$), 2410.lux (O6) and 6206.lux (O11 ExoU$^+$)). (D) Opsonophagocytosis assay with representative mucoid strains that were engineered to be luminescent (A004.lux, A010.lux and A015.lux). The lines represent the mean percent killing and error bars represent the standard deviation. Percent killing was calculated relative to results obtained in assays run in the absence of antibody. (C,D) An R347 control was used within individual assays for each strain. For simplicity, the R347 control was not included in the figures. Results are representative data from three independent experiments performed for each strain.

Figure 3 (A-K): Identification of the *P. aeruginosa* Psl exopolysaccharide target of antibodies derived from phenotypic screening. Reactivity of antibodies was determined by indirect ELISA on plates coated with indicated *P. aeruginosa* strains: (A) wild type PAO1, PAO1Δ*wbpL*, PAO1Δ*rmlC* and PAO1Δ*galU.* (B) PAO1Δ*pslA*. The Genway antibody is specific to a *P. aeruginosa* outer membrane protein and was used as a positive control. (C) FACS binding analysis of Cam-003 to PAO1 and PAO1Δ*pslA*. Cam-003 is indicated by a solid black line and clear peak; an isotype matched non-*P. aeruginosa*-specific human IgG1 antibody was used as a negative control and is indicated by a gray line and shaded peak. (D) LPS purified from PAO1 and PAO1Δ*pslA* was resolved by SDS-PAGE and immunobloted with antisera derived from mice vaccinated with PAO1Δ*wapR*Δ*algD*, a mutant strain deficient in O-antigen transport to the outer membrane and alginate production. (E) Cam-003 ELISA binding data with isogenic mutants of PAO1. Lane 1: PAO1Δ*wbpL*Δ*algD*; Lane 2: PAO1Δ*wbpL*Δ*algD*Δ*pslA*; Lane 3: PAO1Δ*wbpL*Δ*algD*Δ*pelA*; Lane 4: PAO1Δ*wbpL*Δ*algD*Δ*pslA* + pUCP; Lane 5: PAO1Δ*wbpL*Δ*algD*Δ*pslA* + pPW145. pPW145 is a pUCP expression vector containing *pslA.*

* Indicates P<0.005 using the Mann-Whitney U-test when comparing Cam-003 vs. R347 binding. (F and G) Opsonophagocytosis assays indicating that Cam-003 only mediates killing of strains capable of producing Psl (wild type PAO1 and PAO1Δ*pslA* complemented *in trans* with the *pslA* gene). (H and I) ELISA data indicating reactivity of anti-Psl antibodies WapR-001, WapR-004, and WapR-016 with PAO1 Δ*wbpL*Δ*algD* and PAO1 Δ*wbpL*Δ*algD*Δ*pslA.* (J) Reactivity of antibodies was determined by indirect ELISA on plates coated with indicated *P. aeruginosa* strains: wild type PAO1, PAO1Δ*wbpL,* PAO1Δ*wbpL*Δ*algD*, PAO1Δ*rmlC* and PAO1Δ*galU.* R347 was used as a negative control in all experiments. (A, B, C, F, G, H, I, J). Each panel is a representative data set from three independent experiments.

(K) Anti-Psl antibody capture of enriched Psl isolated from whole *P. aeruginosa* cells as measured on a FORTEBIO® OCTET® 384 instrument. R347 was used as a negative control. Results are representative data from three independent experiments.

Figure 4: Anti-Psl mAbs inhibit cell attachment of luminescent *P. aeruginosa* strain PAO1.lux to A549 cells. Log-phase PAO1.lux were added to a confluent monolayer of A549 cells at an MOI of 10 followed by analysis of RLU after repeated washing to remove unbound *P. aeruginosa.* Results are representative of three independent experiments performed in duplicate for each antibody concentration.

Figure 5 (A-U): *In vivo* passaged *P. aeruginosa* strains maintain/increase expression of Psl. The Cam-003 antibody is shown by a solid black line and a clear peak; the human IgG negative control antibody is shown as a gray line and a shaded peak. (A) For the positive control, Cam-003 was assayed for binding to strains grown to log phase from an overnight culture (~5 x 10^8/ml). (B) The inocula for each strain were prepared to 5 x 10^8 CFU/ml from an overnight TSA plate grown to lawn and tested for reactivity to Cam-003 by flow cytometry. (C) Four hours post intraperitoneal challenge, bacteria was harvested from mice by peritoneal lavage and assayed for the presence of Psl with Cam-003 by flow cytometry. (D) Four hours and (E) twenty four hours post intranasal challenge, bacteria were harvested from mice by bronchoalveolar lavage (BAL) and assayed for the presence of Psl with Cam-003 by flow cytometry. Each flow cytometry panel is a representative data set from five independent experiments (F-U) The binding of *P. aeruginosa* specific antibodies (Cam-003, Cam-004 and Cam-005) to representative strains from unique *P. aeruginosa* serotypes (F) PAO1(O5), (G) 2135 (O1), (H) 2531 (O1), (I) 2410 (O6), (J) 2764 (O11), (K) 2757 (O11), (L) 33356 (O9), (M) 33348 (O1), (N) 3039 (NT), (O) 3061 (NT), (P) 3064 (NT), (Q) 19660 (NT), (R) 9882-80 (O11), (S) 6073 (O11), (T) 6077 (O11) and (U) 6206 (O11). Cam-003, Cam-004, and Cam-005 antibodies are shown by as gray line and a clear peak; the human IgG negative control antibody is shown as a solid black line and a shaded peak.

Figure 6 (A-G): Survival rates for animals treated with anti-Psl monoclonal antibodies Cam-003 or WapR-004 in a *P. aeruginosa* acute pneumonia model. (A-D) Animals were treated with Cam-003 at 45, 15, and 5mg/kg and R347 at 45mg/kg or PBS 24 hours prior to intranasal infection with (A) PAO1 (1.6 x 10^7 CFU), (B) 33356 (3 x 10^7 CFU),

(C) 6294 (7 x 10^6 CFU), (D) 6077 (1 x 10^6 CFU). (E-F) Animals were treated with WapR-004 at 5 and 1mg/kg as indicated followed by infection with 6077 at (E) (8 x 10^5 CFU), or (F) (6 x 10^5 CFU). Animals were carefully monitored for survival up to 72 hours (A-D) or for 120 hours (E-F). (G) Animals were treated with Cam-003 at 15 mg/kg or 5 mg/kg, or R347 at 15 mg/kg 24 hours prior to intranasal infection with PAO1 (4.4 x 10^7 CFU), and Cam-003 at 15 mg/kg 24 hours prior to intranasal infection with PAO1ΔpslA (3 x 10^7 CFU). In all experiments, PBS and R347 served as negative controls. Results are represented as Kaplan-Meier survival curves; differences in survival were calculated by the Log-rank test for Cam-003 vs. R347. (A) Cam-003 (45mg/kg - P<0.0001; 15mg/kg - P=0.0003; 5mg/kg - P=0.0033). (B) Cam-003 (45mg/kg - P=0.0012; 15mg/kg - P=0.0012; 5mg/kg - P=0.0373). (C) Cam-003 (45mg/kg - P=0.0007; 15mg/kg - P=0.0019; 5mg/kg - P=0.0212). (D) Cam-003 (45mg/kg - P<0.0001; 15mg/kg - P<0.0001; 5mg/kg - P=0.0001). Results are representative of at least two independent experiments. (E) [Cam-003 (5mg/kg) vs. R347 (5mg/kg): P=0.02; Cam-003 (1mg/kg) vs. R347 (5mg/kg): P=0.4848; WapR-004 (5mg/kg) vs. R347 (5mg/kg): P<0.0001; WapR-004 (1mg/kg) vs. R347 (5mg/kg): P=0.0886; WapR-004 (5mg/kg) vs. Cam-003 (5mg/kg): P=0.0017; WapR-004 (1mg/kg) vs. Cam-003 (1mg/kg): P=0.2468; R347 (5mg/kg) vs. PBS: P=0.6676] (F) [Cam-003 (5mg/kg) vs. R347 (5mg/kg): P=0.0004; Cam-003 (1mg/kg) vs. R347 (5mg/kg): P<0.0001; WapR-004 (5mg/kg) vs. R347 (5mg/kg): P<0.0001; WapR-004 (1mg/kg) vs. R347 (5mg/kg): P<0.0001; WapR-004 (5mg/kg) vs. Cam-003 (5mg/kg): P=0.0002; WapR-004 (1mg/kg) vs. Cam-003 (1mg/kg): P=0.2628; R347 (5mg/kg) vs. PBS: P=0.6676. (G) Cam-003 (15mg/kg - P=0.0028; 5mg/kg - P=0.0028)]. Results are representative of five independent experiments.

Figure 7 (A-F): Anti-Psl monoclonal antibodies, Cam-003 and WapR-004, reduce organ burden after induction of acute pneumonia. Mice were treated with Cam-003 antibody 24 hours prior to infection with (A) PAO1 (1.1 x 10^7 CFU), (B) 33356 (1 x 10^7 CFU), (C) 6294 (6.25 x 10^6 CFU) (D) 6077 (1 x 10^6 CFU), and WapR-004 antibody 24 hours prior to infection with (E) 6294 (~1 x 10^7 CFU), and (F) 6206 (~1 x 10^6 CFU). 24 hours post-infection, animals were euthanized followed by harvesting or organs for identification of viable CFU. Differences in viable CFU were determined by the Mann-Whitney U-test for Cam-003 or WapR-004 vs. R347. (A) Lung: Cam-003 (45mg/kg - P=0.0015; 15mg/kg - P=0.0021; 5mg/kg - P=0.0015); Spleen: Cam-003 (45mg/kg - P=0.0120; 15mg/kg - P=0.0367); Kidneys: Cam-003 (45mg/kg - P=0.0092; 15mg/kg - P=0.0056); (B) Lung: Cam-003 (45mg/kg - P=0.0010; 15mg/kg - P<0.0001; 5mg/kg - P=0.0045); (C) Lung: Cam-003 (45mg/kg - P=0.0003; 15mg/kg - P=0.0039; 5mg/kg - P=0.0068); Spleen: Cam-003 (45mg/kg - P=0.0057; 15mg/kg - P=0.0230; 5mg/kg - P=0.0012); (D) Lung: Cam-003 (45mg/kg - P=0.0005; 15mg/kg - P=0.0003; 5mg/kg - P=0.0007); Spleen: Cam-003 (45mg/kg - P=0.0015; 15mg/kg - P=0.0089; 5mg/kg - P=0.0089); Kidneys: Cam-003 (45mg/kg - P=0.0191; 15mg/kg - P=0.0355; 5mg/kg - P=0.0021). (E) Lung: WapR-004 (15mg/kg - P=0.0011; 5mg/kg - P=0.0004; 1mg/kg - P=0.0002); Spleen: WapR-004 (15mg/kg - P<0.0001; 5mg/kg - P=0.0014; 1mg/kg - P<0.0001); F) Lung: WapR-004 (15mg/kg - P<0.0001; 5mg/kg - P=0.0006; 1mg/kg - P=0.0079); Spleen: WapR-004 (15mg/kg - P=0.0059; 5mg/kg - P=0.0261; 1mg/kg - P=0.0047); Kidney: WapR-004 (15mg/kg - P=0.0208; 5mg/kg - P=0.0268.

Figure 8 (A-G): Anti-Psl monoclonal antibodies Cam-003 and WapR-004 are active in a *P. aeruginosa* keratitis model and thermal injury model. Mice were treated with a control IgG1 antibody or Cam-003 at 45mg/kg (A, B) or 15mg/kg (C, D) or PBS or a control IgG1 antibody or Cam-003 at 45mg/kg or WapR-004 at 45mg/kg or 15mg/kg or 5mg/kg (F, G) 24 hours prior to infection with 6077 (O11-cytotoxic - 2 x 10^6 CFU). Immediately before infection, three 1 mm scratches were made on the left cornea of each animal followed by topical application of *P. aeruginosa* in a 5 μl inoculum. 24 hours after infection, the corneal pathology scores were calculated followed by removal of the eye for determination of viable CFU. Differences in pathology scores and viable CFU were determined by the Mann-Whitney U-test. (A) P=0.0001, (B) P<0.0001, (C) P=0.0003, (D) P=0.0015. (F) and (G) Cam-003 (45mg/kg) vs. WapR-004 (45mg/kg): P=0.018; Cam-003 (45mg/kg) vs. WapR-004 (15mg/kg): P=0.0025; WapR-004 (45mg/kg) vs. WapR-004 (15mg/kg): P=0.1331; WapR-004 (5mg/kg) vs. Ctrl: P<0.0001. Results are representative of five independent experiments. (E) Survival analysis from Cam-003 and R347 treated CF-1 mice in a *P. aeruginosa* thermal injury model after 6077 infection (2 x 10^5 CFU) (log-rank: R347 vs. Cam-003 15mg/kg, P=0.0094; R347 vs. Cam-003 5mg/kg, P=0.0017). Results are representative of at least three independent experiments. (n) refers to number of animals in each group.

Figure 9 (A-E): A Cam-003 Fc mutant antibody, Cam-003-TM, has diminished OPK and *in vivo* efficacy but maintains anti-cell attachment activity. (A) PAO1.lux OPK assay with Cam-003 and Cam-003-TM, which harbors mutations in the Fc domain that prevents Fc interactions with Fcγ receptors (Oganesyan, V., et al., Acta Crystallogr D Biol Crystallogr 64, 700-704 (2008)). R347 was used as a negative control. Results are representative data from three independent experiments. (B) PAO1 cell attachment assay with Cam-003 and Cam-003-TM. Results are representative data from two independent experiments. (C-E) Acute pneumonia model comparing efficacy of Cam-003 vs. Cam-003-TM. *P. aeruginosa* strain 6077 acute pneumonia model using BALB/c mice inoculated with (C) 1.22 x 10^6 (D) 2.35 x 10^5 or (E) 1.07 x 10^6 comparing efficacy of Cam-003 versus Cam-003-TM. Mice were treated with antibody 24 hours before challenge. (C-E) Ten animals were used in each group. Results are representative data from two independent experiments.

Figure 10 (A-B): A: Epitope mapping and identification of the relative binding affinity for anti-Psl monoclonal anti-

bodies. Epitope mapping was performed by competition ELISA and confirmed using an OCTET® flow system with Psl derived from the supernatant of an overnight culture of *P. aeruginosa* strain PAO1. Relative binding affinities were measured on a FORTEBIO® OCTET® 384 instrument. Also shown are antibody concentrations where cell attachment was maximally inhibited and OPK EC50 values for each antibody. B. Relative binding affinities of various WapR-004 mutants as measured on a FORTEBIO® OCTET® 384 instrument. Also shown are OPK EC50 values for the various mutants.

Figure 11: (A-M): Evaluation of WapR-004 (W4) mutants clones in the *P. aeruginosa* OPK assay (A-M) Opsonophagocytosis assay with luminescent *P. aeruginosa* serogroup O5 strain (PAO1.lux), with dilutions of different W4 mutant clones in scFv-Fc format. In some instances, W4 IgG1 was included in the assay and is indicated as W4-IgG1. W4-RAD-Cam and W4-RAD-GB represent the same WapR-004RAD sequence described herein. "W4-RAD" is a shorthand name for WapR-004RAD, and W4-RAD-Cam and W4-RAD-GB designations in panels D through M represent two different preparations of WapR-004RAD. In all experiments, R347, a human IgG1 monoclonal antibody that does not bind *P. aeruginosa* antigens, was used as a negative control.

Figure 12: Method of site-directed conjugation of Polymyxin B (PMB) to mAbs in which a heterobifunctional SM-PEG_{12} linker (Pierce) was conjugated to a primary amine on PMB under conditions determined to favor conjugation of a single linker. Conjugation efficiency and levels free PMB-linker in the samples were determined by UPLC and mass spectrometry.

Figure 13 (A-B): PMB-mAb site-directed conjugates. Using the developed site-directed conjugation method, PMB was conjugated to CAM-003 and A7 (hIgG1 control) mAb variants with either one (SM, ND10), two (DM, ND10/19) or three (TM, ND4/10/19) cysteine engineered into the Fc region. A: Cam-003 and A7 Fc region mutated residues. B: The average number of PMB in PMB-mAb conjugates (single mutant (SM) > double mutant 1 (DM1) > double mutant 2 (DM2)).

Figure 14 (A-B): Evaluation of PMB-mAb conjugates binding to wild-type *P. aeruginosa* PAO1 cells by FACS analysis. A: Cam-003 (Cam-003-SM-PMB, Cam-003-DM1-PMB, Cam-003-DM2-PMB, mock-conjugated wild-type Cam-003 (Cam-003-Mock-PMB)). B: A7 control conjugates (A7-SM-PMB, A7-DM1-PMB, A7-DM2-PMB, mock-conjugated wild-type A7 (A7-Mock-PMB)). R347 was used as a negative control in all experiments.

Figure 15 (A-B): OPK activity of PMB-mAb conjugates against A: *P. aeruginosa* PAO1 wild-type strain and B: against the Δ*pslA P. aeruginosa* strain which does not express the Psl target.

Figure 16 (A-B): Neutralization of *P. aeruginosa* LPS by PMB-mAb conjugates. A: PMB-Cam-003 conjugates and mock-conjugated wild-type Cam-003 and B: PMB-A7 conjugates and mock-conjugated wild-type A7.

Figure 17: Structure showing polymyxin, a cyclic antibacterial lipopeptide that neutralize the proinflammatory effects of LPS and can be used for the treatment of Gram-negative MDR infections (colistin/polymyxin E). Polymyxins have 5 positively charged diamonbutyric acids (circled) that mediate interactions with negatively-charged Lipid A in LPS and neutralize its proinflammatory activity.

Figure 18 (A-B): OPK activity by human HL-60 neutrophil cell line in the presence of rabbit complement was evaluated using *P. aeruginosa* strain PAO1 expressing bacterial luciferase. A: % killing by CAM-003-PMB Conjugates. B: % killing by A7-PMB Conjugates.

Figure 19 (A-B): A. Percent Survival of C57B1/6 mice dosed with 45 mg/kg CAM-TM-PMB Conjugates. B: Percent Survival of C57B1/6 mice dosed with 45 mg/kg A7-TM-PMB Conjugates.

Figure 20 (A-B): A. Percent Survival of C57B1/6 mice dosed with 45 mg/kg, 15 mg/kg and 5 mg/kg CAM-TM-PMB Conjugates. B: Percent Survival of C57B1/6 mice dosed with 45 mg/kg, 15 mg/kg and 5 mg/kg A7-TM-PMB Conjugates.

Figure 21 (A-C): Percent survival of C57B1/6 mice dosed with mAb or PMB-mAb conjugates i.p A: 10 mg/kg. B: 1 mg/kg. C: 0.1 mg/kg.

DETAILED DESCRIPTION

I. DEFINITIONS

[0050] It is to be noted that the term "a" or "an" entity refers to one or more of that entity; for example, "a binding molecule which specifically binds to *Pseudomonas* Psl," is understood to represent one or more binding molecules which specifically bind to *Pseudomonas* Psl. As such, the terms "a" (or "an"), "one or more," and "at least one" can be used interchangeably herein.

[0051] As used herein, the term "polypeptide" is intended to encompass a singular "polypeptide" as well as plural "polypeptides," and refers to a molecule composed of monomers (amino acids) linearly linked by amide bonds (also known as peptide bonds). The term "polypeptide" refers to any chain or chains of two or more amino acids, and does not refer to a specific length of the product. Thus, peptides, dipeptides, tripeptides, oligopeptides, "protein," "amino acid chain," or any other term used to refer to a chain or chains of two or more amino acids, are included within the definition

of "polypeptide," and the term "polypeptide" can be used instead of, or interchangeably with any of these terms. The term "polypeptide" is also intended to refer to the products of post-expression modifications of the polypeptide, including without limitation glycosylation, acetylation, phosphorylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, or modification by non-naturally occurring amino acids. A polypeptide can be derived from a natural biological source or produced by recombinant technology, but is not necessarily translated from a designated nucleic acid sequence. It can be generated in any manner, including by chemical synthesis.

[0052] A polypeptide as disclosed herein can be of a size of about 3 or more, 5 or more, 10 or more, 20 or more, 25 or more, 50 or more, 75 or more, 100 or more, 200 or more, 500 or more, 1,000 or more, or 2,000 or more amino acids. Polypeptides can have a defined three-dimensional structure, although they do not necessarily have such structure. Polypeptides with a defined three-dimensional structure are referred to as folded, and polypeptides which do not possess a defined three-dimensional structure, but rather can adopt a large number of different conformations, and are referred to as unfolded. As used herein, the term glycoprotein refers to a *protein* coupled to at least one carbohydrate moiety that is attached to the protein via an oxygen-containing or a nitrogen-containing side chain of an amino acid residue, *e.g.,* a serine residue or an asparagine residue.

[0053] By an "isolated" polypeptide or a fragment, variant, or derivative thereof is intended a polypeptide that is not in its natural milieu. No particular level of purification is required. For example, an isolated polypeptide can be removed from its native or natural environment. Recombinantly produced polypeptides and proteins expressed in host cells are considered isolated as disclosed herein, as are native or recombinant polypeptides which have been separated, fractionated, or partially or substantially purified by any suitable technique.

[0054] Other polypeptides disclosed herein are fragments, derivatives, analogs, or variants of the foregoing polypeptides, and any combination thereof. The terms "fragment," "variant," "derivative" and "analog" when referring to a binding molecule such as an antibody which specifically binds to *Pseudomonas* Psl as disclosed herein include any polypeptides which retain at least some of the antigen-binding properties of the corresponding native antibody or polypeptide. Fragments of polypeptides include, for example, proteolytic fragments, as well as deletion fragments, in addition to specific antibody fragments discussed elsewhere herein. Variants of a binding molecule, *e.g.,* an antibody which specifically binds to *Pseudomonas* Psl as disclosed herein include fragments as described above, and also polypeptides with altered amino acid sequences due to amino acid substitutions, deletions, or insertions. Variants can occur naturally or be non-naturally occurring. Non-naturally occurring variants can be produced using art-known mutagenesis techniques. Variant polypeptides can comprise conservative or non-conservative amino acid substitutions, deletions or additions. Derivatives of a binding molecule, *e.g.,* an antibody which specifically binds to *Pseudomonas* Psl as disclosed herein are polypeptides which have been altered so as to exhibit additional features not found on the native polypeptide. Examples include fusion proteins. Variant polypeptides can also be referred to herein as "polypeptide analogs." As used herein a "derivative" of a binding molecule, *e.g.,* an antibody which specifically binds to *Pseudomonas* Psl refers to a subject polypeptide having one or more residues chemically derivatized by reaction of a functional side group. Also included as "derivatives" are those peptides which contain one or more naturally occurring amino acid derivatives of the twenty standard amino acids. For example, 4-hydroxyproline can be substituted for proline; 5-hydroxylysine can be substituted for lysine; 3-methylhistidine can be substituted for histidine; homoserine can be substituted for serine; and ornithine can be substituted for lysine.

[0055] The term "polynucleotide" is intended to encompass a singular nucleic acid as well as plural nucleic acids, and refers to an isolated nucleic acid molecule or construct, *e.g.,* messenger RNA (mRNA) or plasmid DNA (pDNA). A polynucleotide can comprise a conventional phosphodiester bond or a non-conventional bond (*e.g.,* an amide bond, such as found in peptide nucleic acids (PNA)). The term "nucleic acid" refer to any one or more nucleic acid segments, *e.g.,* DNA or RNA fragments, present in a polynucleotide. By "isolated" nucleic acid or polynucleotide is intended a nucleic acid molecule, DNA or RNA, which has been removed from its native environment. For example, a recombinant polynucleotide encoding a binding molecule, *e.g.,* an antibody which specifically binds to *Pseudomonas* Psl contained in a vector is considered isolated as disclosed herein. Further examples of an isolated polynucleotide include recombinant polynucleotides maintained in heterologous host cells or purified (partially or substantially) polynucleotides in solution. Isolated RNA molecules include *in vivo* or *in vitro* RNA transcripts of polynucleotides. Isolated polynucleotides or nucleic acids further include such molecules produced synthetically. In addition, polynucleotide or a nucleic acid can be or can include a regulatory element such as a promoter, ribosome binding site, or a transcription terminator.

[0056] As used herein, a "coding region" is a portion of nucleic acid which consists of codons translated into amino acids. Although a "stop codon" (TAG, TGA, or TAA) is not translated into an amino acid, it can be considered to be part of a coding region, but any flanking sequences, for example promoters, ribosome binding sites, transcriptional terminators, introns, and the like, are not part of a coding region. Two or more coding regions can be present in a single polynucleotide construct, *e.g.,* on a single vector, or in separate polynucleotide constructs, *e.g.,* on separate (different) vectors. Furthermore, any vector can contain a single coding region, or can comprise two or more coding regions, *e.g.,* a single vector can separately encode an immunoglobulin heavy chain variable region and an immunoglobulin light chain variable region. In addition, a vector, polynucleotide, or nucleic acid can encode heterologous coding regions, either fused or

unfused to a nucleic acid encoding an a binding molecule which specifically binds to *Pseudomonas* Psl, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof. Heterologous coding regions include without limitation specialized elements or motifs, such as a secretory signal peptide or a heterologous functional domain.

[0057] In certain embodiments, the polynucleotide or nucleic acid is DNA. In the case of DNA, a polynucleotide comprising a nucleic acid which encodes a polypeptide normally can include a promoter and/or other transcription or translation control elements operably associated with one or more coding regions. An operable association is when a coding region for a gene product, *e.g.,* a polypeptide, is associated with one or more regulatory sequences in such a way as to place expression of the gene product under the influence or control of the regulatory sequence(s). Two DNA fragments (such as a polypeptide coding region and a promoter associated therewith) are "operably associated" if induction of promoter function results in the transcription of mRNA encoding the desired gene product and if the nature of the linkage between the two DNA fragments does not interfere with the ability of the expression regulatory sequences to direct the expression of the gene product or interfere with the ability of the DNA template to be transcribed. Thus, a promoter region would be operably associated with a nucleic acid encoding a polypeptide if the promoter was capable of effecting transcription of that nucleic acid. The promoter can be a cell-specific promoter that directs substantial transcription of the DNA only in predetermined cells. Other transcription control elements, besides a promoter, for example enhancers, operators, repressors, and transcription termination signals, can be operably associated with the polynucleotide to direct cell-specific transcription. Suitable promoters and other transcription control regions are disclosed herein.

[0058] A variety of transcription control regions are known to those skilled in the art. These include, without limitation, transcription control regions which function in vertebrate cells, such as, but not limited to, promoter and enhancer segments from cytomegaloviruses (the immediate early promoter, in conjunction with intron-A), simian virus 40 (the early promoter), and retroviruses (such as Rous sarcoma virus). Other transcription control regions include those derived from vertebrate genes such as actin, heat shock protein, bovine growth hormone and rabbit β-globin, as well as other sequences capable of controlling gene expression in eukaryotic cells. Additional suitable transcription control regions include tissue-specific promoters and enhancers as well as lymphokine-inducible promoters (*e.g.,* promoters inducible by interferons or interleukins).

[0059] Similarly, a variety of translation control elements are known to those of ordinary skill in the art. These include, but are not limited to ribosome binding sites, translation initiation and termination codons, and elements derived from picornaviruses (particularly an internal ribosome entry site, or IRES, also referred to as a CITE sequence).

[0060] In other embodiments, a polynucleotide can be RNA, for example, in the form of messenger RNA (mRNA).

[0061] Polynucleotide and nucleic acid coding regions can be associated with additional coding regions which encode secretory or signal peptides, which direct the secretion of a polypeptide encoded by a polynucleotide as disclosed herein, *e.g.,* a polynucleotide encoding a binding molecule which specifically binds to *Pseudomonas* Psl, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof. According to the signal hypothesis, proteins secreted by mammalian cells have a signal peptide or secretory leader sequence which is cleaved from the mature protein once export of the growing protein chain across the rough endoplasmic reticulum has been initiated. Those of ordinary skill in the art are aware that polypeptides secreted by vertebrate cells generally have a signal peptide fused to the N-terminus of the polypeptide, which is cleaved from the complete or "full length" polypeptide to produce a secreted or "mature" form of the polypeptide. In certain embodiments, the native signal peptide, *e.g.,* an immunoglobulin heavy chain or light chain signal peptide is used, or a functional derivative of that sequence that retains the ability to direct the secretion of the polypeptide that is operably associated with it. Alternatively, a heterologous mammalian signal peptide, or a functional derivative thereof, can be used. For example, the wild-type leader sequence can be substituted with the leader sequence of human tissue plasminogen activator (TPA) or mouse β-glucuronidase.

[0062] Disclosed herein are certain binding molecules, or antigen-binding fragments, variants, or derivatives thereof. Unless specifically referring to full-sized antibodies such as naturally-occurring antibodies, the term "binding molecule" encompasses full-sized antibodies as well as antigen-binding fragments, variants, analogs, or derivatives of such antibodies, *e.g.,* naturally occurring antibody or immunoglobulin molecules or engineered antibody molecules or fragments that bind antigen in a manner similar to antibody molecules.

[0063] As used herein, the term "binding molecule" refers in its broadest sense to a molecule that specifically binds an antigenic determinant. A non-limiting example of an antigen binding molecule is an antibody or fragment thereof that retains antigen-specific binding.

[0064] The terms "antibody" and "immunoglobulin" can be used interchangeably herein. An antibody (or a fragment, variant, or derivative thereof as disclosed herein comprises at least the variable domain of a heavy chain and at least the variable domains of a heavy chain and a light chain. Basic immunoglobulin structures in vertebrate systems are relatively well understood. *See, e.g.,* Harlow et al., Antibodies: A Laboratory Manual, (Cold Spring Harbor Laboratory Press, 2nd ed. 1988).

[0065] As will be discussed in more detail below, the term "immunoglobulin" comprises various broad classes of polypeptides that can be distinguished biochemically. Those skilled in the art will appreciate that heavy chains are classified as gamma, mu, alpha, delta, or epsilon, (γ, μ, α, δ, ε) with some subclasses among them (*e.g.,* γ1-γ4). It is the

nature of this chain that determines the "class" of the antibody as IgG, IgM, IgA IgG, or IgE, respectively. The immunoglobulin subclasses (isotypes) *e.g.,* IgG_1, IgG_2, IgG_3, IgG_4, IgA_1, etc. are well characterized and are known to confer functional specialization. Modified versions of each of these classes and isotypes are readily discernible to the skilled artisan in view of the instant disclosure and, accordingly, are within the scope of this disclosure.

[0066] Light chains are classified as either kappa or lambda (κ, λ). Each heavy chain class can be bound with either a kappa or lambda light chain. In general, the light and heavy chains are covalently bonded to each other, and the "tail" portions of the two heavy chains are bonded to each other by covalent disulfide linkages or non-covalent linkages when the immunoglobulins are generated either by hybridomas, B cells or genetically engineered host cells. In the heavy chain, the amino acid sequences run from an N-terminus at the forked ends of the Y configuration to the C-terminus at the bottom of each chain.

[0067] Both the light and heavy chains are divided into regions of structural and functional homology. The terms "constant" and "variable" are used functionally. In this regard, it will be appreciated that the variable domains of both the light (VL) and heavy (VH) chain portions determine antigen recognition and specificity. Conversely, the constant domains of the light chain (CL) and the heavy chain (CH1, CH2 or CH3) confer important biological properties such as secretion, transplacental mobility, Fc receptor binding, complement binding, and the like. By convention the numbering of the constant region domains increases as they become more distal from the antigen binding site or amino-terminus of the antibody. The N-terminal portion is a variable region and at the C-terminal portion is a constant region; the CH3 and CL domains actually comprise the carboxy-terminus of the heavy and light chain, respectively.

[0068] As indicated above, the variable region allows the binding molecule to selectively recognize and specifically bind epitopes on antigens. That is, the VL domain and VH domain, or subset of the complementarity determining regions (CDRs), of a binding molecule, *e.g.,* an antibody combine to form the variable region that defines a three dimensional antigen binding site. This quaternary binding molecule structure forms the antigen binding site present at the end of each arm of the Y. More specifically, the antigen binding site is defined by three CDRs on each of the VH and VL chains.

[0069] In naturally occurring antibodies, the six "complementarity determining regions" or "CDRs" present in each antigen binding domain are short, non-contiguous sequences of amino acids that are specifically positioned to form the antigen binding domain as the antibody assumes its three dimensional configuration in an aqueous environment. The remainder of the amino acids in the antigen binding domains, referred to as "framework" regions, show less intermolecular variability. The framework regions largely adopt a β-sheet conformation and the CDRs form loops which connect, and in some cases form part of, the β-sheet structure. Thus, framework regions act to form a scaffold that provides for positioning the CDRs in correct orientation by inter-chain, non-covalent interactions. The antigen binding domain formed by the positioned CDRs defines a surface complementary to the epitope on the immunoreactive antigen. This complementary surface promotes the non-covalent binding of the antibody to its cognate epitope. The amino acids comprising the CDRs and the framework regions, respectively, can be readily identified for any given heavy or light chain variable region by one of ordinary skill in the art, since they have been precisely defined (*see*, "Sequences of Proteins of Immunological Interest," Kabat, E., et al., U.S. Department of Health and Human Services, (1983); and Chothia and Lesk, J. Mol. Biol., 196:901-917 (1987), which are incorporated herein by reference in their entireties).

[0070] In the case where there are two or more definitions of a term which is used and/or accepted within the art, the definition of the term as used herein is intended to include all such meanings unless explicitly stated to the contrary. A specific example is the use of the term "complementarity determining region" ("CDR") to describe the non-contiguous antigen combining sites found within the variable region of both heavy and light chain polypeptides. This particular region has been described by Kabat et al., U.S. Dept. of Health and Human Services, "Sequences of Proteins of Immunological Interest" (1983) and by Chothia et al., J. Mol. Biol. 196:901-917 (1987), which are incorporated herein by reference, where the definitions include overlapping or subsets of amino acid residues when compared against each other. Nevertheless, application of either definition to refer to a CDR of an antibody or variants thereof is intended to be within the scope of the term as defined and used herein. The appropriate amino acid residues which encompass the CDRs as defined by each of the above cited references are set forth below in Table I as a comparison. The exact residue numbers which encompass a particular CDR will vary depending on the sequence and size of the CDR. Those skilled in the art can routinely determine which residues comprise a particular CDR given the variable region amino acid sequence of the antibody.

TABLE 1: CDR Definitions[1]

	Kabat	Chothia
VH CDR1	31-35	26-32
VH CDR2	50-65	52-58
VH CDR3	95-102	95-102

(continued)

	Kabat	Chothia
VL CDR1	24-34	26-32
VL CDR2	50-56	50-52
VL CDR3	89-97	91-96
[1]Numbering of all CDR definitions in Table 1 is according to the numbering conventions set forth by Kabat *et al.* (see below).		

[0071] Kabat *et al.* also defined a numbering system for variable domain sequences that is applicable to any antibody. One of ordinary skill in the art can unambiguously assign this system of "Kabat numbering" to any variable domain sequence, without reliance on any experimental data beyond the sequence itself. As used herein, "Kabat numbering" refers to the numbering system set forth by Kabat et al., U.S. Dept. of Health and Human Services, "Sequence of Proteins of Immunological Interest" (1983). Unless otherwise specified, references to the numbering of specific amino acid residue positions in a binding molecule which specifically binds to *Pseudomonas* Psl, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof as disclosed herein are according to the Kabat numbering system.

[0072] Binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof include, but are not limited to, polyclonal, monoclonal, human, humanized, or chimeric antibodies, single chain antibodies, epitope-binding fragments, *e.g.,* Fab, Fab' and $F(ab')_2$, Fd, Fvs, single-chain Fvs (scFv), single-chain antibodies, disulfide-linked Fvs (sdFv), fragments comprising either a VL or VH domain, fragments produced by a Fab expression library. ScFv molecules are known in the art and are described, *e.g.,* in US patent 5,892,019. Immunoglobulin or antibody molecules encompassed by this disclosure can be of any type (*e.g.,* IgG, IgE, IgM, IgD, IgA, and IgY), class (*e.g.,* IgG1, IgG2, IgG3, IgG4, IgA1 and IgA2) or subclass of immunoglobulin molecule.

[0073] By "specifically binds," it is generally meant that a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof binds to an epitope via its antigen binding domain, and that the binding entails some complementarity between the antigen binding domain and the epitope. According to this definition, a binding molecule is said to "specifically bind" to an epitope when it binds to that epitope, via its antigen binding domain more readily than it would bind to a random, unrelated epitope. The term "specificity" is used herein to qualify the relative affinity by which a certain binding molecule binds to a certain epitope. For example, binding molecule "A" may be deemed to have a higher specificity for a given epitope than binding molecule "B," or binding molecule "A" may be said to bind to epitope "C" with a higher specificity than it has for related epitope "D."

[0074] By "preferentially binds," it is meant that the antibody specifically binds to an epitope more readily than it would bind to a related, similar, homologous, or analogous epitope. Thus, an antibody which "preferentially binds" to a given epitope would more likely bind to that epitope than to a related epitope, even though such an antibody can cross-react with the related epitope.

[0075] By way of non-limiting example, a binding molecule, *e.g.,* an antibody can be considered to bind a first epitope preferentially if it binds said first epitope with a dissociation constant (K_D) that is less than the antibody's K_D for the second epitope. In another non-limiting example, a binding molecule such as an antibody can be considered to bind a first antigen preferentially if it binds the first epitope with an affinity that is at least one order of magnitudeless than the antibody's K_D for the second epitope. In another non-limiting example, a binding molecule can be considered to bind a first epitope preferentially if it binds the first epitope with an affinity that is at least two orders of magnitude less than the antibody's K_D for the second epitope.

[0076] In another non-limiting example, a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof can be considered to bind a first epitope preferentially if it binds the first epitope with an off rate (k(off)) that is less than the antibody's k(off) for the second epitope. In another non-limiting example, a binding molecule can be considered to bind a first epitope preferentially if it binds the first epitope with an affinity that is at least one order of magnitude less than the antibody's k(off) for the second epitope. In another non-limiting example, a binding molecule can be considered to bind a first epitope preferentially if it binds the first epitope with an affinity that is at least two orders of magnitude less than the antibody's k(off) for the second epitope.

[0077] A binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof disclosed herein can be said to bind a target antigen, *e.g.,* a polysaccharide disclosed herein or a fragment or variant thereof with an off rate (k(off)) of less than or equal to 5×10^{-2} sec^{-1}, 10^{-2} sec^{-1}, 5×10^{-3} sec^{-1} or 10^{-3} sec^{-1}. A binding molecule as disclosed herein can be said to bind a target antigen, *e.g.,* a polysaccharide with an off rate (k(off)) less than or equal to 5×10^{-4} sec^{-1}, 10^{-4} sec^{-1}, 5×10^{-5} sec^{-1}, or 10^{-5} sec^{-1} 5×10^{-6} sec^{-1}, 10^{-6} sec^{-1}, 5×10^{-7} sec^{-1} or 10^{-7} sec^{-1}.

[0078] A binding molecule, *e.g.,* an antibody or antigen-binding fragment, variant, or derivative disclosed herein can be said to bind a target antigen, *e.g.,* a polysaccharide with an on rate (k(on)) of greater than or equal to 10^3 M^{-1} sec^{-1},

5×10^3 M^{-1} sec^{-1}, 10^4 M^{-1} sec^{-1} or 5×10^4 M^{-1} sec^{-1}. A binding molecule as disclosed herein can be said to bind a target antigen, *e.g.,* a polysaccharide with an on rate (k(on)) greater than or equal to 10^5 M^{-1} sec^{-1}, 5×10^5 M^{-1} sec^{-1}, 10^6 M^{-1} sec^{-1}, or 5×10^6 M^{-1} sec^{-1} or 10^7 M^{-1} sec^{-1}.

[0079] A binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof is said to competitively inhibit binding of a reference antibody or antigen binding fragment to a given epitope if it preferentially binds to that epitope to the extent that it blocks, to some degree, binding of the reference antibody or antigen binding fragment to the epitope. Competitive inhibition can be determined by any method known in the art, for example, competition ELISA assays. A binding molecule can be said to competitively inhibit binding of the reference antibody or antigen binding fragment to a given epitope by at least 90%, at least 80%, at least 70%, at least 60%, or at least 50%.

[0080] As used herein, the term "affinity" refers to a measure of the strength of the binding of an individual epitope with the CDR of an immunoglobulin molecule. *See, e.g.,* Harlow et al., Antibodies: A Laboratory Manual, (Cold Spring Harbor Laboratory Press, 2nd ed. 1988) at pages 27-28. As used herein, the term "avidity" refers to the overall stability of the complex between a population of immunoglobulins and an antigen, that is, the functional combining strength of an immunoglobulin mixture with the antigen. *See, e.g.,* Harlow at pages 29-34. Avidity is related to both the affinity of individual immunoglobulin molecules in the population with specific epitopes, and also the valencies of the immunoglobulins and the antigen. For example, the interaction between a bivalent monoclonal antibody and an antigen with a highly repeating epitope structure, such as a polymer, would be one of high avidity.

[0081] Binding molecules or antigen-binding fragments, variants or derivatives thereof as disclosed herein can also be described or specified in terms of their cross-reactivity. As used herein, the term "cross-reactivity" refers to the ability of a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof, specific for one antigen, to react with a second antigen; a measure of relatedness between two different antigenic substances. Thus, a binding molecule is cross reactive if it binds to an epitope other than the one that induced its formation. The cross reactive epitope generally contains many of the same complementary structural features as the inducing epitope, and in some cases, can actually fit better than the original.

[0082] A binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof can also be described or specified in terms of their binding affinity to an antigen. For example, a binding molecule can bind to an antigen with a dissociation constant or K_D no greater than 5×10^{-2} M, 10^{-2} M, 5×10^{-3} M, 10^{-3} M, 5×10^{-4} M, 10^{-4} M, 5×10^{-5} M, 10^{-5} M, 5×10^{-6} M, 10^{-6} M, 5×10^{-7} M, 10^{-7} M, 5×10^{-8} M, 10^{-8} M, 5×10^{-9} M, 10^{-9} M, 5×10^{-10} M, 10^{-10} M, 5×10^{-11} M, 10^{-11} M, 5×10^{-12} M, 10^{-12} M, 5×10^{-13} M, 10^{-13} M, 5×10^{-14} M, 10^{-14} M, 5×10^{-15} M, or 10^{-15} M.

[0083] Antibody fragments including single-chain antibodies can comprise the variable region(s) alone or in combination with the entirety or a portion of the following: hinge region, CH1, CH2, and CH3 domains. Also included are antigen-binding fragments also comprising any combination of variable region(s) with a hinge region, CH1, CH2, and CH3 domains. Binding molecules, *e.g.,* antibodies, or antigen-binding fragments thereof disclosed herein can be from any animal origin including birds and mammals. The antibodies can be human, murine, donkey, rabbit, goat, guinea pig, camel, llama, horse, or chicken antibodies. In another embodiment, the variable region can be condricthoid in origin (*e.g.,* from sharks). As used herein, "human" antibodies include antibodies having the amino acid sequence of a human immunoglobulin and include antibodies isolated from human immunoglobulin libraries or from animals transgenic for one or more human immunoglobulins and that do not express endogenous immunoglobulins, as described *infra* and, for example in, U.S. Pat. No. 5,939,598 by Kucherlapati et al.

[0084] As used herein, the term "heavy chain portion" includes amino acid sequences derived from an immunoglobulin heavy chain. a binding molecule, *e.g.,* an antibody comprising a heavy chain portion comprises at least one of: a CH1 domain, a hinge (*e.g.,* upper, middle, and/or lower hinge region) domain, a CH2 domain, a CH3 domain, or a variant or fragment thereof. For example, a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof can comprise a polypeptide chain comprising a CH1 domain; a polypeptide chain comprising a CH1 domain, at least a portion of a hinge domain, and a CH2 domain; a polypeptide chain comprising a CH1 domain and a CH3 domain; a polypeptide chain comprising a CH1 domain, at least a portion of a hinge domain, and a CH3 domain, or a polypeptide chain comprising a CH1 domain, at least a portion of a hinge domain, a CH2 domain, and a CH3 domain. In another embodiment, a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof comprises a polypeptide chain comprising a CH3 domain. Further, a binding molecule for use in the disclosure can lack at least a portion of a CH2 domain (*e.g.,* all or part of a CH2 domain). As set forth above, it will be understood by one of ordinary skill in the art that these domains (*e.g.,* the heavy chain portions) can be modified such that they vary in amino acid sequence from the naturally occurring immunoglobulin molecule.

[0085] The heavy chain portions of a binding molecule, *e.g.,* an antibody as disclosed herein can be derived from different immunoglobulin molecules. For example, a heavy chain portion of a polypeptide can comprise a CH1 domain derived from an IgG1 molecule and a hinge region derived from an IgG3 molecule. In another example, a heavy chain portion can comprise a hinge region derived, in part, from an IgG1 molecule and, in part, from an IgG3 molecule. In another example, a heavy chain portion can comprise a chimeric hinge derived, in part, from an IgG1 molecule and, in part, from an IgG4 molecule.

[0086] As used herein, the term "light chain portion" includes amino acid sequences derived from an immunoglobulin light chain. The light chain portion comprises at least one of a VL or CL domain.

[0087] Binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof disclosed herein can be described or specified in terms of the epitope(s) or portion(s) of an antigen, *e.g.,* a target polysaccharide that they recognize or specifically bind. The portion of a target polysaccharide which specifically interacts with the antigen binding domain of an antibody is an "epitope," or an "antigenic determinant." A target antigen, *e.g.,* a polysaccharide can comprise a single epitope, but typically comprises at least two epitopes, and can include any number of epitopes, depending on the size, conformation, and type of antigen.

[0088] As previously indicated, the subunit structures and three dimensional configuration of the constant regions of the various immunoglobulin classes are well known. As used herein, the *term* "VH domain" includes the amino terminal variable domain of an immunoglobulin heavy chain and the term "CH1 domain" includes the first (most amino terminal) constant region domain of an immunoglobulin heavy chain. The CH1 domain is adjacent to the VH domain and is amino terminal to the hinge region of an immunoglobulin heavy chain molecule.

[0089] As used herein the term "CH2 domain" includes the portion of a heavy chain molecule that *extends, e.g.,* from about residue 244 to residue 360 of an antibody using conventional numbering schemes (residues 244 to 360, Kabat numbering system; and residues 231-340, EU numbering system; see Kabat EA *et al. op. cit.* The CH2 domain is unique in that it is not closely paired with another domain. Rather, two N-linked branched carbohydrate chains are interposed between the two CH2 domains of an intact native IgG molecule. It is also well documented that the CH3 domain extends from the CH2 domain to the C-terminal of the IgG molecule and comprises approximately 108 residues.

[0090] As used herein, the term "hinge region" includes the portion of a heavy chain molecule that joins the CH1 domain to the CH2 domain. This hinge region comprises approximately 25 residues and is flexible, thus allowing the two N-terminal antigen binding regions to move independently. Hinge regions can be subdivided into three distinct domains: upper, middle, and lower hinge domains (Roux et al., J. Immunol. 161:4083 (1998)).

[0091] As used herein the term "disulfide bond" includes the covalent bond formed between two sulfur atoms. The amino acid cysteine comprises a thiol group that can form a disulfide bond or bridge with a second thiol group. In most naturally occurring IgG molecules, the CH1 and CL regions are linked by a disulfide bond and the two heavy chains are linked by two disulfide bonds at positions corresponding to 239 and 242 using the Kabat numbering system (position 226 or 229, EU numbering system).

[0092] As used herein, the term "chimeric antibody" will be held to mean any antibody wherein the immunoreactive region or site is obtained or derived from a first species and the constant region (which can be intact, partial or modified) is obtained from a second species. In some embodiments the target binding region or site will be from a non-human source (*e.g.* mouse or primate) and the constant region is human.

[0093] As used herein, the term "engineered antibody" refers to an antibody in which the variable domain in either the heavy and light chain or both is altered by at least partial replacement of one or more CDRs from an antibody of known specificity and, if necessary, by partial framework region replacement and sequence changing. Although the CDRs can be derived from an antibody of the same class or even subclass as the antibody from which the framework regions are derived, it is envisaged that the CDRs will be derived from an antibody of different class and preferably from an antibody from a different species. An engineered antibody in which one or more "donor" CDRs from a non-human antibody of known specificity is grafted into a human heavy or light chain framework region is referred to herein as a "humanized antibody." It may not be necessary to replace all of the CDRs with the complete CDRs from the donor variable region to transfer the antigen binding capacity of one variable domain to another. Rather, it may only be necessary to transfer those residues that are necessary to maintain the activity of the target binding site. Given the explanations set forth in, *e.g.,* U. S. Pat. Nos. 5,585,089, 5,693,761, 5,693,762, and 6,180,370, it will be well within the competence of those skilled in the art, either by carrying out routine experimentation or by trial and error testing to obtain a functional engineered or humanized antibody.

[0094] As used herein the term "properly folded polypeptide" includes polypeptides (*e.g.,* anti-*Pseudomonas* Psl antibodies) in which all of the functional domains comprising the polypeptide are distinctly active. As used herein, the term "improperly folded polypeptide" includes polypeptides in which at least one of the functional domains of the polypeptide is not active. In one embodiment, a properly folded polypeptide comprises polypeptide chains linked by at least one disulfide bond and, conversely, an improperly folded polypeptide comprises polypeptide chains not linked by at least one disulfide bond.

[0095] As used herein the term "engineered" includes manipulation of nucleic acid or polypeptide molecules by synthetic means (*e.g.* by recombinant techniques, *in vitro* peptide synthesis, by enzymatic or chemical coupling of peptides or some combination of these techniques).

[0096] As used herein, the terms "linked," "fused" or "fusion" are used interchangeably. These terms refer to the joining together of two more elements or components, by whatever means including chemical conjugation or recombinant means. An "in-frame fusion" refers to the joining of two or more polynucleotide open reading frames (ORFs) to form a continuous longer ORF, in a manner that maintains the correct translational reading frame of the original ORFs. Thus,

a recombinant fusion protein is a single protein containing two or more segments that correspond to polypeptides encoded by the original ORFs (which segments are not normally so joined in nature.) Although the reading frame is thus made continuous throughout the fused segments, the segments can be physically or spatially separated by, for example, in-frame linker sequence. For example, polynucleotides encoding the CDRs of an immunoglobulin variable region can be fused, in-frame, but be separated by a polynucleotide encoding at least one immunoglobulin framework region or additional CDR regions, as long as the "fused" CDRs are co-translated as part of a continuous polypeptide.

[0097] In the context of polypeptides, a "linear sequence" or a "sequence" is an order of amino acids in a polypeptide in an amino to carboxyl terminal direction in which residues that neighbor each other in the sequence are contiguous in the primary structure of the polypeptide.

[0098] The term "expression" as used herein refers to a process by which a gene produces a biochemical, for example, a polypeptide. The process includes any manifestation of the functional presence of the gene within the cell including, without limitation, gene knockdown as well as both transient expression and stable expression. It includes without limitation transcription of the gene into messenger RNA (mRNA), and the translation of such mRNA into polypeptide(s). If the final desired product is a biochemical, expression includes the creation of that biochemical and any precursors. Expression of a gene produces a "gene product." As used herein, a gene product can be either a nucleic acid, *e.g.,* a messenger RNA produced by transcription of a gene, or a polypeptide which is translated from a transcript. Gene products described herein further include nucleic acids with post transcriptional modifications, *e.g.,* polyadenylation, or polypeptides with post translational modifications, *e.g.,* methylation, glycosylation, the addition of lipids, association with other protein subunits, proteolytic cleavage, and the like.

[0099] As used herein, the terms "treat" or "treatment" refer to both therapeutic treatment and prophylactic or preventative measures, wherein the object is to prevent or slow down (lessen) an undesired physiological change, infection, or disorder. Beneficial or desired clinical results include, but are not limited to, alleviation of symptoms, diminishment of extent of disease, stabilized (*i.e.,* not worsening) state of disease, clearance or reduction of an infectious agent such as P. *aeruginosa* in a subject, a delay or slowing of disease progression, amelioration or palliation of the disease state, and remission (whether partial or total), whether detectable or undetectable. "Treatment" can also mean prolonging survival as compared to expected survival if not receiving treatment. Those in need of treatment include those already with the infection, condition, or disorder as well as those prone to have the condition or disorder or those in which the condition or disorder is to be prevented, *e.g.,* in burn patients or immunosuppressed patients susceptible to P. *aeruginosa* infection.

[0100] By "subject" or "individual" or "animal" or "patient" or "mammal," is meant any subject, particularly a mammalian subject, for whom diagnosis, prognosis, or therapy is desired. Mammalian subjects include humans, domestic animals, farm animals, and zoo, sports, or pet animals such as dogs, cats, guinea pigs, rabbits, rats, mice, horses, cattle, cows, bears, and so on.

[0101] As used herein, phrases such as "a subject that would benefit from administration of an anti-*Pseudomonas* Psl antibody" and "an animal in need of treatment" includes subjects, such as mammalian subjects, that would benefit from administration of an anti-*Pseudomonas* Psl antibody used, *e.g.*, for detection of *Pseudomonas* Psl (*e.g.,* for a diagnostic procedure) and/or from treatment, *i.e.*, palliation or prevention of a disease, with an anti-*Pseudomonas* Psl antibody. As described in more detail herein, the anti-*Pseudomonas* Psl antibody can be used in unconjugated form or can be conjugated, *e.g.,* to a drug, prodrug, or an isotope.

II. BINDING MOLECULES

[0102] One embodiment is directed to an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, wherein the binding molecule (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote, mediate, or enhance opsonophagocytic killing (OPK) of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote, mediate, or enhance OPK of *P. aeruginosa.* In certain embodiments, the binding molecule or fragment thereof as described above can be antibody or antigen-binding fragment thereof such as Cam-003 or WapR-004.

[0103] As used herein, the term "antigen binding domain" includes a site that specifically binds an epitope on an antigen (*e.g.,* an epitope of *Pseudomonas* Psl). The antigen binding domain of an antibody typically includes at least a portion of an immunoglobulin heavy chain variable region and at least a portion of an immunoglobulin light chain variable region. The binding site formed by these variable regions determines the specificity of the antibody.

[0104] The disclosure is more specifically directed to an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the heavy chain variable region (VH) and light chain variable region (VL) region of WapR-004, Cam-003, Cam-004, or Cam-005.

[0105] Further included is an isolated binding molecule, *e.g.,* an antibody or fragment thereof which specifically binds to *Pseudomonas* Psl and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-004, Cam-003, Cam-004, or Cam-005.

[0106] One embodiment is directed to an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the VH and VL region of WapR-001, WapR-002, or WapR-003.

[0107] Also included is an isolated binding molecule, *e.g.,* an antibody or fragment thereof which specifically binds to *Pseudomonas* Psl and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-001, WapR-002, or WapR-003.

[0108] Further included is an isolated binding molecule, *e.g.,* an antibody or fragment thereof which specifically binds to *Pseudomonas* Psl and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-016.

[0109] Also included is an isolated binding molecule, *e.g.,* an antibody or fragment thereof which specifically binds to *Pseudomonas* Psl and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR16.

[0110] Methods of making antibodies are well known in the art and described herein. Once antibodies to various fragments of, or to the full-length *Pseudomonas* Psl without the signal sequence, have been produced, determining which amino acids, or epitope, of *Pseudomonas* Psl to which the antibody or antigen binding fragment binds can be determined by epitope mapping protocols as described herein as well as methods known in the art (*e.g.* double antibody-sandwich ELISA as described in "Chapter 11 - Immunology," Current Protocols in Molecular Biology, Ed. Ausubel et al., v.2, John Wiley & Sons, Inc. (1996)). Additional epitope mapping protocols can be found in Morris, G. Epitope Mapping Protocols, New Jersey: Humana Press (1996), which are both incorporated herein by reference in their entireties. Epitope mapping can also be performed by commercially available means (*i.e.* ProtoPROBE, Inc. (Milwaukee, Wisconsin)).

[0111] In certain aspects, the disclosure is directed to a binding molecule, *e.g.,* an antibody or fragment, variant, or derivative thereof which specifically binds to *Pseudomonas* Psl with an affinity characterized by a dissociation constant (K_D) which is less than the K_D for said reference monoclonal antibody.

[0112] In certain embodiments an anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody or antigen-binding fragment, variant or derivative thereof as disclosed herein binds specifically to at least one epitope of Psl, *i.e.*, binds to such an epitope more readily than it would bind to an unrelated, or random epitope; binds preferentially to at least one epitope of Psl, *i.e.*, binds to such an epitope more readily than it would bind to a related, similar, homologous, or analogous epitope; competitively inhibits binding of a reference antibody which itself binds specifically or preferentially to a certain epitope of Psl; or binds to at least one epitope of Psl with an affinity characterized by a dissociation constant K_D of less than about 5 x 10^{-2} M, about 10^{-2} M, about 5 x 10^{-3} M, about 10^{-3} M, about 5 x 10^{-4} M, about 10^{-4} M, about 5 x 10^{-5} M, about 10^{-5} M, about 5 x 10^{-6} M, about 10^{-6} M, about 5 x 10^{-7} M, about 10^{-7} M, about 5 x 10^{-8} M, about 10^{-8} M, about 5 x 10^{-9} M, about 10^{-9} M, about 5 x 10^{-10} M, about 10^{-10} M, about 5 x 10^{-11} M, about 10^{-11} M, about 5 x 10^{-12} M, about 10^{-12} M, about 5 x 10^{-13} M, about 10^{-13} M, about 5 x 10^{-14} M, about 10^{-14} M, about 5 x 10^{-15} M, or about 10^{-15} M.

[0113] As used in the context of binding dissociation constants, the term "about" allows for the degree of variation inherent in the methods utilized for measuring antibody affinity. For example, depending on the level of precision of the instrumentation used, standard error based on the number of samples measured, and rounding error, the term "about 10^{-2} M" might include, for example, from 0.05 M to 0.005 M.

[0114] In specific embodiments a binding molecule, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof binds *Pseudomonas* Psl with an off rate (k(off)) of less than or equal to 5 X 10^{-2} sec^{-1}, 10^{-2} sec^{-1}, 5 X 10^{-3} sec^{-1} or 10^{-3} sec^{-1}. Alternatively, an antibody, or antigen-binding fragment, variant, or derivative thereof binds *Pseudomonas* Psl with an off rate (k(off)) of less than or equal to 5 X 10^{-4} sec^{-1}, 10^{-4} sec^{-1}, 5 X 10^{-5} sec^{-1}, or 10^{-5} sec^{-1} 5 X 10^{-6} sec^{-1}, 10^{-6} sec^{-1}, 5 X 10^{-7} sec^{-1} or 10^{-7} sec^{-1}.

[0115] In other embodiments, a binding molecule, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof as disclosed herein binds *Pseudomonas* Psl with an on rate (k(on)) of greater than or equal to 10^3 M^{-1} sec^{-1}, 5 X 10^3 M^{-1} sec^{-1}, 10^4 M^{-1} sec^{-1} or 5 X 10^4 M^{-1} sec^{-1}. Alternatively, a binding molecule, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof as disclosed herein binds *Pseudomonas* Psl with an on rate (k(on)) greater than or equal to 10^5 M^{-1} sec^{-1}, 5 X 10^5 M^{-1} sec^{-1}, 10^6 M^{-1} sec^{-1}, or 5 X 106 M^{-1} sec^{-1} or 10^7 M^{-1} sec^{-1}.

[0116] In various embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof as described herein promotes opsonophagocytic killing of *Pseudomonas,* or inhibits *Pseudomonas* binding to epithelial cells. In certain embodiments described herein, the *Pseudomonas* Psl target is *Pseudomonas aeruginosa* Psl. In other embodiments, certain binding molecules described herein can bind to structurally related polysaccharide molecules regardless of their source. Such Psl-like molecules would be expected to be identical to or have sufficient structural relatedness to *P. aeruginosa* Psl to permit specific recognition by one or more of the binding molecules disclosed. For example, certain binding molecules described herein can bind to Psl-like molecules produced by other bacterial species, for example, Psl-like molecules produced by other *Pseudomonas* species, *e.g., Pseudomonas fluorescens, Pseudomonas putida, or Pseudomonas alcaligenes.* Alternatively, certain binding molecules as described herein can bind to Psl-like molecules produced synthetically or by host cells genetically modified to produce Psl-like molecules.

[0117] Unless it is specifically noted, as used herein a "fragment thereof" in reference to a binding molecule, *e.g.,* an antibody refers to an antigen-binding fragment, *i.e.*, a portion of the antibody which specifically binds to the antigen.

[0118] An anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof can comprise a constant region which mediates one or more effector functions. For example, binding of the C1 component of complement to an antibody constant region can activate the complement system. Activation of complement is important in the opsonization and lysis of pathogens. The activation of complement also stimulates the inflammatory response and can also be involved in autoimmune hypersensitivity. Further, antibodies bind to receptors on various cells via the Fc region, with a Fc receptor binding site on the antibody Fc region binding to a Fc receptor (FcR) on a cell. There are a number of Fc receptors which are specific for different classes of antibody, including IgG (gamma receptors), IgE (epsilon receptors), IgA (alpha receptors) and IgM (mu receptors). Binding of antibody to Fc receptors on cell surfaces triggers a number of important and diverse biological responses including engulfment and destruction of antibody-coated particles, clearance of immune complexes, lysis of antibody-coated target cells by killer cells (called antibody-dependent cell-mediated cytotoxicity, or ADCC), release of inflammatory mediators, placental transfer and control of immunoglobulin production.

[0119] Accordingly, certain embodiments disclosed herein include an anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody, or antigen-binding fragment, variant, or derivative thereof, in which at least a fraction of one or more of the constant region domains has been deleted or otherwise altered so as to provide desired biochemical characteristics such as reduced effector functions, the ability to non-covalently dimerize, increased ability to localize at the site of a tumor, reduced serum half-life, or increased serum half-life when compared with a whole, unaltered antibody of approximately the same immunogenicity. For example, certain binding molecules described herein are domain deleted antibodies which comprise a polypeptide chain similar to an immunoglobulin heavy chain, but which lack at least a portion of one or more heavy chain domains. For instance, in certain antibodies, one entire domain of the constant region of the modified antibody will be deleted, for example, all or part of the CH2 domain will be deleted.

[0120] Modified forms of anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof can be made from whole precursor or parent antibodies using techniques known in the art. Exemplary techniques are discussed elsewhere herein.

[0121] In certain embodiments both the variable and constant regions of anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments are fully human. Fully human antibodies can be made using techniques that are known in the art and as described herein. For example, fully human antibodies against a specific antigen can be prepared by administering the antigen to a transgenic animal which has been modified to produce such antibodies in response to antigenic challenge, but whose endogenous loci have been disabled. Exemplary techniques that can be used to make such antibodies are described in US patents: 6,150,584; 6,458,592; 6,420,140. Other techniques are known in the art. Fully human anti bodies can likewise be produced by various display technologies, *e.g.,* phage display or other viral display systems, as described in more detail elsewhere herein.

[0122] Anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof as disclosed herein can be made or manufactured using techniques that are known in the art. In certain embodiments, binding molecules or fragments thereof are "recombinantly produced," *i.e.*, are produced using recombinant DNA technology. Exemplary techniques for making antibody molecules or fragments thereof are discussed in more detail elsewhere herein.

[0123] In certain anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof described herein, the Fc portion can be mutated to decrease effector function using techniques known in the art. For example, the deletion or inactivation (through point mutations or other means) of a constant region domain can reduce Fc receptor binding of the circulating modified antibody thereby increasing tumor localization. In other cases it can be that constant region modifications moderate complement binding and thus reduce the serum half-life and nonspecific association of a conjugated cytotoxin. Yet other modifications of the constant region can be used to modify disulfide linkages or oligosaccharide moieties that allow for enhanced localization due to increased antigen specificity or antibody flexibility. The resulting physiological profile, bioavailability and other biochemical effects of the modifications, such as localization, biodistribution and serum half-life, can easily be measured and quantified using well known immunological techniques without undue experimentation.

[0124] In certain embodiments, anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof will not elicit a deleterious immune response in the animal to be treated, *e.g.,* in a human. In one embodiment, anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof are modified to reduce their immunogenicity using art-recognized techniques. For example, antibodies can be humanized, de-immunized, or chimeric antibodies can be made. These types of antibodies are derived from a non-human antibody, typically a murine or primate antibody, that retains or substantially retains the antigen-binding properties of the parent antibody, but which is less immunogenic in humans. This can be achieved by various methods, including (a) grafting the entire non-human variable domains onto human constant regions to generate chimeric antibodies; (b) grafting at least a part of one or more of the non-human complementarity determining regions (CDRs)

into a human framework and constant regions with or without retention of critical framework residues; or (c) transplanting the entire non-human variable domains, but "cloaking" them with a human-like section by replacement of surface residues. Such methods are disclosed in Morrison et al., Proc. Natl. Acad. Sci. 81:6851-6855 (1984); Morrison et al., Adv. Immunol. 44:65-92 (1988); Verhoeyen et al., Science 239:1534-1536 (1988); Padlan, Molec. Immun. 28:489-498 (1991); Padlan, Molec. Immun. 31:169-217 (1994), and U.S. Pat. Nos. 5,585,089, 5,693,761, 5,693,762, and 6,190,370, all of which are hereby incorporated by reference in their entirety.

[0125] De-immunization can also be used to decrease the immunogenicity of an antibody. As used herein, the term "de-immunization" includes alteration of an antibody to modify T cell epitopes (see, *e.g.,* WO9852976A1, WO0034317A2). For example, VH and VL sequences from the starting antibody are analyzed and a human T cell epitope "map" from each V region showing the location of epitopes in relation to complementarity-determining regions (CDRs) and other key residues within the sequence. Individual T cell epitopes from the T cell epitope map are analyzed in order to identify alternative amino acid substitutions with a low risk of altering activity of the final antibody. A range of alternative VH and VL sequences are designed comprising combinations of amino acid substitutions and these sequences are subsequently incorporated into a range of binding polypeptides, *e.g., Pseudomonas* Psl-specific antibodies or antigen-binding fragments thereof disclosed herein, which are then tested for function. Complete heavy and light chain genes comprising modified V and human C regions are then cloned into expression vectors and the subsequent plasmids introduced into cell lines for the production of whole antibody. The antibodies are then compared in appropriate biochemical and biological assays, and the optimal variant is identified.

[0126] Anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or antigen-binding fragments, variants, or derivatives thereof can be generated by any suitable method known in the art. Polyclonal antibodies to an antigen of interest can be produced by various procedures well known in the art. For example, an anti-*Pseudomonas* Psl antibody or antigen-binding fragment thereof can be administered to various host animals including, but not limited to, rabbits, mice, rats, chickens, hamsters, goats, donkeys, etc., to induce the production of sera containing polyclonal antibodies specific for the antigen. Various adjuvants can be used to increase the immunological response, depending on the host species, and include but are not limited to, Freund's (complete and incomplete), mineral gels such as aluminum hydroxide, surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanins, dinitrophenol, and potentially useful human adjuvants such as BCG (bacille Calmette-Guerin) and *Corynebacterium parvum.* Such adjuvants are also well known in the art.

[0127] Monoclonal antibodies can be prepared using a wide variety of techniques known in the art including the use of hybridoma, recombinant, and phage display technologies, or a combination thereof. For example, monoclonal antibodies can be produced using hybridoma techniques including those known in the art and taught, for example, in Harlow et al., Antibodies: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2nd ed. (1988)

[0128] DNA encoding antibodies or antibody fragments (*e.g.,* antigen binding sites) can also be derived from antibody libraries, such as phage display libraries. In a particular, such phage can be utilized to display antigen-binding domains expressed from a repertoire or combinatorial antibody library (*e.g.,* human or murine). Phage expressing an antigen binding domain that binds the antigen of interest can be selected or identified with antigen, *e.g.,* using labeled antigen or antigen bound or captured to a solid surface or bead. Phage used in these methods are typically filamentous phage including fd and M13 binding domains expressed from phage with scFv, Fab, Fv OE DAB (individual Fv region from light or heavy chains) or disulfide stabilized Fv antibody domains recombinantly fused to either the phage gene III or gene VIII protein. Exemplary methods are set forth, for example, in EP 368 684 B1; U.S. patent. 5,969,108, Hoogenboom, H.R. and Chames, Immunol. Today 21:371 (2000); Nagy et al. Nat. Med. 8:801 (2002); Huie et al., Proc. Natl. Acad. Sci. USA 98:2682 (2001); Lui et al., J. Mol. Biol. 315:1063 (2002), each of which is incorporated herein by reference. Several publications (*e.g.,* Marks et al., Bio/Technology 10:779-783 (1992)) have described the production of high affinity human antibodies by chain shuffling, as well as combinatorial infection and *in vivo* recombination as a strategy for constructing large phage libraries. In another embodiment, Ribosomal display can be used to replace bacteriophage as the display platform (*see, e.g.,* Hanes et al., Nat. Biotechnol. 18:1287 (2000); Wilson et al., Proc. Natl. Acad. Sci. USA 98:3750 (2001); or Irving et al., J. Immunol. Methods 248:31 (2001)). In yet another embodiment, cell surface libraries can be screened for antibodies (Boder et al., Proc. Natl. Acad. Sci. USA 97:10701 (2000); Daugherty et al., J. Immunol. Methods 243:211 (2000)). Such procedures provide alternatives to traditional hybridoma techniques for the isolation and subsequent cloning of monoclonal antibodies.

[0129] In phage display methods, functional antibody domains are displayed on the surface of phage particles which carry the polynucleotide sequences encoding them. For example, DNA sequences encoding VH and VL regions are amplified from animal cDNA libraries (*e.g.,* human or murine cDNA libraries of lymphoid tissues) or synthetic cDNA libraries. In certain embodiments, the DNA encoding the VH and VL regions are joined together by an scFv linker by PCR and cloned into a phagemid vector (*e.g.,* p CANTAB 6 or pComb 3 HSS). The vector is electroporated in *E. coli* and the *E. coli* is infected with helper phage. Phage used in these methods are typically filamentous phage including fd and M13 and the VH or VL regions are usually recombinantly fused to either the phage gene III or gene VIII. Phage expressing an antigen binding domain that binds to an antigen of interest (*i.e., Pseudomonas* Psl) can be selected or

identified with antigen, *e.g.,* using labeled antigen or antigen bound or captured to a solid surface or bead.

[0130] Additional examples of phage display methods that can be used to make the antibodies include those disclosed in Brinkman et al., J. Immunol. Methods 182:41-50 (1995); Ames et al., J. Immunol. Methods 184:177-186 (1995); Kettleborough et al., Eur. J. Immunol. 24:952-958 (1994); Persic et al., Gene 187:9-18 (1997); Burton et al., Advances in Immunology 57:191-280 (1994); PCT Application No. PCT/GB91/01134; PCT publications WO 90/02809; WO 91/10737; WO 92/01047; WO 92/18619; WO 93/11236; WO 95/15982; WO 95/20401; and U.S. Pat. Nos. 5,698,426; 5,223,409; 5,403,484; 5,580,717; 5,427,908; 5,750,753; 5,821,047; 5,571,698; 5,427,908; 5,516,637; 5,780,225; 5,658,727; 5,733,743 and 5,969,108; each of which is incorporated herein by reference in its entirety.

[0131] As described in the above references and in the examples below, after phage selection, the antibody coding regions from the phage can be isolated and used to generate whole antibodies, including human antibodies, or any other desired antigen binding fragment, and expressed in any desired host, including mammalian cells, insect cells, plant cells, yeast, and bacteria. For example, techniques to recombinantly produce Fab, Fab' and $F(ab')_2$ fragments can also be employed using methods known in the art such as those disclosed in PCT publication WO 92/22324; Mullinax et al., BioTechniques 12(6):864-869 (1992); and Sawai et al., AJRI 34:26-34 (1995); and Better et al., Science 240:1041-1043 (1988) (said references incorporated by reference in their entireties).

[0132] Examples of techniques which can be used to produce single-chain Fvs and antibodies include those described in U.S. Pat. Nos. 4,946,778 and 5,258,498; Huston et al., Methods in Enzymology 203:46-88 (1991); Shu et al., PNAS 90:7995-7999 (1993); and Skerra et al., Science 240:1038-1040 (1988). In certain embodiments such as therapeutic administration, chimeric, humanized, or human antibodies can be used. A chimeric antibody is a molecule in which different portions of the antibody are derived from different animal species, such as antibodies having a variable region derived from a murine monoclonal antibody and a human immunoglobulin constant region. Methods for producing chimeric antibodies are known in the art. *See, e.g.,* Morrison, Science 229:1202 (1985); Oi et al., BioTechniques 4:214 (1986); Gillies et al., J. Immunol. Methods 125:191-202 (1989); U.S. Pat. Nos. 5,807,715; 4,816,567; and 4,816397, which are incorporated herein by reference in their entireties. Humanized antibodies are antibody molecules from non-human species antibody that binds the desired antigen having one or more complementarity determining regions (CDRs) from the non-human species and framework regions from a human immunoglobulin molecule. Often, framework residues in the human framework regions will be substituted with the corresponding residue from the CDR donor antibody to alter, preferably improve, antigen binding. These framework substitutions are identified by methods well known in the art, *e.g.,* by modeling of the interactions of the CDR and framework residues to identify framework residues important for antigen binding and sequence comparison to identify unusual framework residues at particular positions. (See, *e.g.,* Queen et al., U.S. Pat. No. 5,585,089; Riechmann et al., Nature 332:323 (1988), which are incorporated herein by reference in their entireties.) Antibodies can be humanized using a variety of techniques known in the art including, for example, CDR-grafting (EP 239,400; PCT publication WO 91/09967; U.S. Pat. Nos. 5,225,539; 5,530,101; and 5,585,089), veneering or resurfacing (EP 592,106; EP 519,596; Padlan, Molecular Immunology 28(4/5):489-498 (1991); Studnicka et al., Protein Engineering 7(6):805-814 (1994); Roguska. et al., PNAS 91:969-973 (1994)), and chain shuffling (U.S. Pat. No. 5,565,332).

[0133] Fully human antibodies are particularly desirable for therapeutic treatment of human patients. Human antibodies can be made by a variety of methods known in the art including phage display methods described above using antibody libraries derived from human immunoglobulin sequences. See also, U.S. Pat. Nos. 4,444,887 and 4,716,111; and PCT publications WO 98/46645, WO 98/50433, WO 98/24893, WO 98/16654, WO 96/34096, WO 96/33735, and WO 91/10741; each of which is incorporated herein by reference in its entirety.

[0134] Human antibodies can also be produced using transgenic mice which are incapable of expressing functional endogenous immunoglobulins, but which can express human immunoglobulin genes. For example, the human heavy and light chain immunoglobulin gene complexes can be introduced randomly or by homologous recombination into mouse embryonic stem cells. In addition, various companies can be engaged to provide human antibodies produced in transgenic mice directed against a selected antigen using technology similar to that described above.

[0135] Fully human antibodies which recognize a selected epitope can be generated using a technique referred to as "guided selection." In this approach a selected non-human monoclonal antibody, *e.g.,* a mouse antibody, is used to guide the selection of a completely human antibody recognizing the same epitope. (Jespers et al., Bio/Technology 12:899-903 (1988). *See also*, U.S. Patent No. 5,565,332.)

[0136] In another embodiment, DNA encoding desired monoclonal antibodies can be readily isolated and sequenced using conventional procedures (*e.g.,* by using oligonucleotide probes that are capable of binding specifically to genes encoding the heavy and light chains of murine antibodies). Isolated and subcloned hybridoma cells or isolated phage, for example, can serve as a source of such DNA. Once isolated, the DNA can be placed into expression vectors, which are then transfected into prokaryotic or eukaryotic host cells such as *E. coli* cells, simian COS cells, Chinese Hamster Ovary (CHO) cells or myeloma cells that do not otherwise produce immunoglobulins. More particularly, the isolated DNA (which can be synthetic as described herein) can be used to clone constant and variable region sequences for the manufacture antibodies as described in Newman et al., U.S. Pat. No. 5,658,570, filed January 25, 1995, which is

incorporated by reference herein. Transformed cells expressing the desired antibody can be grown up in relatively large quantities to provide clinical and commercial supplies of the immunoglobulin.

[0137] In one embodiment, an isolated binding molecule, *e.g.,* an antibody comprises at least one heavy or light chain CDR of an antibody molecule. In another embodiment, an isolated binding molecule comprises at least two CDRs from one or more antibody molecules. In another embodiment, an isolated binding molecule comprises at least three CDRs from one or more antibody molecules. In another embodiment, an isolated binding molecule comprises at least four CDRs from one or more antibody molecules. In another embodiment, an isolated binding molecule comprises at least five CDRs from one or more antibody molecules. In another embodiment, an isolated binding molecule of the description comprises at least six CDRs from one or more antibody molecules.

[0138] In a specific embodiment, the amino acid sequence of the heavy and/or light chain variable domains can be inspected to identify the sequences of the complementarity determining regions (CDRs) by methods that are well-known in the art, *e.g.,* by comparison to known amino acid sequences of other heavy and light chain variable regions to determine the regions of sequence hypervariability. Using routine recombinant DNA techniques, one or more of the CDRs can be inserted within framework regions, *e.g.,* into human framework regions to humanize a non-human antibody. The framework regions can be naturally occurring or consensus framework regions, and preferably human framework regions (see, *e.g.,* Chothia et al., J. Mol. Biol. 278:457-479 (1998) for a listing of human framework regions). The polynucleotide generated by the combination of the framework regions and CDRs encodes an antibody that specifically binds to at least one epitope of a desired antigen, *e.g.,* Psl. One or more amino acid substitutions can be made within the framework regions, and, the amino acid substitutions improve binding of the antibody to its antigen. Additionally, such methods can be used to make amino acid substitutions or deletions of one or more variable region cysteine residues participating in an intrachain disulfide bond to generate antibody molecules lacking one or more intrachain disulfide bonds. Other alterations to the polynucleotide are encompassed by the present disclosure and are within the capabilities of a person of skill of the art.

[0139] Also provided are binding molecules that comprise, consist essentially of, or consist of, variants (including derivatives) of antibody molecules (*e.g.,* the VH regions and/or VL regions) described herein, which binding molecules or fragments thereof specifically bind to *Pseudomonas* Psl. Standard techniques known to those of skill in the art can be used to introduce mutations in the nucleotide sequence encoding a binding molecule or fragment thereof which specifically binds to *Pseudomonas* Psl, including, but not limited to, site-directed mutagenesis and PCR-mediated mutagenesis which result in amino acid substitutions. The variants (including derivatives) encode polypeptides comprising less than 50 amino acid substitutions, less than 40 amino acid substitutions, less than 30 amino acid substitutions, less than 25 amino acid substitutions, less than 20 amino acid substitutions, less than 15 amino acid substitutions, less than 10 amino acid substitutions, less than 5 amino acid substitutions, less than 4 amino acid substitutions, less than 3 amino acid substitutions, or less than 2 amino acid substitutions relative to the reference VH region, VHCDR1, VHCDR2, VHCDR3, VL region, VLCDR1, VLCDR2, or VLCDR3. A "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a side chain with a similar charge. Families of amino acid residues having side chains with similar charges have been defined in the art. These families include amino acids with basic side chains (*e.g.,* lysine, arginine, histidine), acidic side chains (*e.g.,* aspartic acid, glutamic acid), uncharged polar side chains (*e.g.,* glycine, asparagine, glutamine, serine, threonine, tyrosine, cysteine), nonpolar side chains (*e.g.,* alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), beta-branched side chains (*e.g.,* threonine, valine, isoleucine) and aromatic side chains (*e.g.,* tyrosine, phenylalanine, tryptophan, histidine). Alternatively, mutations can be introduced randomly along all or part of the coding sequence, such as by saturation mutagenesis, and the resultant mutants can be screened for biological activity to identify mutants that retain activity (*e.g.,* the ability to bind an *Pseudomonas* Psl).

[0140] For example, it is possible to introduce mutations only in framework regions or only in CDR regions of an antibody molecule. Introduced mutations can be silent or neutral missense mutations, *i.e.*, have no, or little, effect on an antibody's ability to bind antigen. These types of mutations can be useful to optimize codon usage, or improve a hybridoma's antibody production. Alternatively, non-neutral missense mutations can alter an antibody's ability to bind antigen. The location of most silent and neutral missense mutations is likely to be in the framework regions, while the location of most non-neutral missense mutations is likely to be in CDR, though this is not an absolute requirement. One of skill in the art would be able to design and test mutant molecules with desired properties such as no alteration in antigen binding activity or alteration in binding activity (*e.g.,* improvements in antigen binding activity or change in antibody specificity). Following mutagenesis, the encoded protein can routinely be expressed and the functional and/or biological activity of the encoded protein, (*e.g.,* ability to bind at least one epitope of *Pseudomonas* Psl) can be determined using techniques described herein or by routinely modifying techniques known in the art.

III. ANTIBODY POLYPEPTIDES

[0141] The disclosure is further directed to isolated polypeptides which make up binding molecules, *e.g.,* antibodies

or antigen-binding fragments thereof, which specifically bind to *Pseudomonas* Psl and polynucleotides encoding such polypeptides. Binding molecules, *e.g.,* antibodies or fragments thereof as disclosed herein, comprise polypeptides, *e.g.,* amino acid sequences encoding, for example, Psl-specific antigen binding regions derived from immunoglobulin molecules. A polypeptide or amino acid sequence "derived from" a designated protein refers to the origin of the polypeptide. In certain cases, the polypeptide or amino acid sequence which is derived from a particular starting polypeptide or amino acid sequence has an amino acid sequence that is essentially identical to that of the starting sequence, or a portion thereof, wherein the portion consists of at least 10-20 amino acids, at least 20-30 amino acids, at least 30-50 amino acids, or which is otherwise identifiable to one of ordinary skill in the art as having its origin in the starting sequence.

[0142] Also disclosed is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an immunoglobulin heavy chain variable region (VH) amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0143] Further disclosed is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VH amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions to one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0144] Some embodiments include an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VH, where one or more of the VHCDR1, VHCDR2 or VHCDR3 regions of the VH are at least 80%, 85%, 90%, 95% or 100% identical to one or more reference heavy chain VHCDR1, VHCDR2 or VHCDR3 amino acid sequences of one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0145] Further disclosed is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VH, where one or more of the VHCDR1, VHCDR2 or VHCDR3 regions of the VH are identical to, or identical except for four, three, two, or one amino acid substitutions, to one or more reference heavy chain VHCDR1, VHCDR2 and/or VHCDR3 amino acid sequences of one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2. Thus, according to this embodiment the VH comprises one or more of a VHCDR1, VHCDR2, or VHCDR3 identical to or identical except for four, three, two, or one amino acid substitutions, to one or more of the VHCDR1, VHCDR2, or VHCDR3 amino acid sequences shown in Table 3.

[0146] Also disclosed is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an immunoglobulin light chain variable region (VL) amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0147] Some embodiments disclose an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VL amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions, to one or more of SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0148] Also provided is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VL, where one or more of the VLCDR1, VLCDR2 or VLCDR3 regions of the VL are at least 80%, 85%, 90%, 95% or 100% identical to one or more reference light chain VLCDR1, VLCDR2 or VLCDR3 amino acid sequences of one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0149] Further provided is an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VL, where one or more of the VLCDR1, VLCDR2 or VLCDR3 regions of the VL are identical to, or identical except for four, three, two, or one amino acid substitutions, to one or more reference heavy chain VLCDR1, VLCDR2 and/or VLCDR3 amino acid sequences of one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2. Thus, according to this embodiment the VL comprises one or more of a VLCDR1, VLCDR2, or VLCDR3 identical to or identical except for four, three, two, or one amino acid substitutions, to one or more of the VLCDR1, VLCDR2, or VLCDR3 amino acid sequences shown in Table 3.

[0150] In other embodiments, an isolated antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, comprises, consists essentially of, or consists of VH and VL amino acid sequences at least 80%, 85%, 90% 95% or 100% identical to:

(a) SEQ ID NO: 1 and SEQ ID NO: 2, respectively,(b) SEQ ID NO: 3 and SEQ ID NO: 2, respectively,(c) SEQ ID

NO: 4 and SEQ ID NO: 2, respectively,(d) SEQ ID NO: 5 and SEQ ID NO: 6 , respectively,(e) SEQ ID NO: 7 and SEQ ID NO: 8, respectively,(f) SEQ ID NO: 9 and SEQ ID NO: 10, respectively,(g) SEQ ID NO: 11 and SEQ ID NO: 12, respectively,(h) SEQ ID NO: 13 and SEQ ID NO: 14, respectively; (i) SEQ ID NO: 15 and SEQ ID NO: 16, respectively; or (j) SEQ ID NO: 74 and SEQ ID NO: 12 , respectively. In certain embodiments, the above-described antibody or antigen-binding fragment thereof comprises a VH with the amino acid sequence SEQ ID NO: 11 and a VL with the amino acid sequence of SEQ ID NO: 12. In some embodiments, the above-described antibody or antigen-binding fragment thereof comprises a VH with the amino acid sequence SEQ ID NO: 1 and a VL with the amino acid sequence of SEQ ID NO: 2. In other embodiments, the above-described antibody or antigen-binding fragment thereof comprises a VH with the amino acid sequence SEQ ID NO: 11 and a VL with the amino acid sequence of SEQ ID NO: 12.

[0151] In certain embodiments, an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof as described herein specifically binds to *Pseudomonas* Psl with an affinity characterized by a dissociation constant (K_D) no greater than 5 x 10^{-2} M, 10^{-2} M, 5 x 10^{-3} M, 10^{-3} M, 5 x 10^{-4} M, 10^{-4} M, 5 x 10^{-5} M, 10^{-5} M, 5 x 10^{-6} M, 10^{-6} M, 5 x 10^{-7} M, 10^{-7} M, 5 x 10^{-8} M, 10^{-8} M, 5 x 10^{-9} M, 10^{-9} M, 5 x 10^{-10} M, 10^{-10} M, 5 x 10^{-11} M, 10^{-11} M, 5 x 10^{-12} M, 10^{-12} M, 5 x 10^{-13} M, 10^{-13} M, 5 x 10^{-14} M, 10^{-14} M, 5 x 10^{-15} M, or 10^{-15} M.

[0152] In specific embodiments, an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof as described herein specifically binds to *Pseudomonas* Psl, with an affinity characterized by a dissociation constant (K_D) in a range of about 1 x 10^{-10} to about 1 x 10^{-6} M. In one embodiment, an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof as described herein specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.18 x 10^{-7} M, as determined by the OCTET® binding assay described herein. In another embodiment, an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof as described herein specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.44 x 10^{-7} M, as determined by the OCTET® binding assay described herein.

[0153] Some embodiments include the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, which (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote OPK of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote OPK of *P. aeruginosa.*

[0154] In some embodiments the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, where maximum inhibition of *P. aeruginosa* attachment to epithelial cells is achieved at an antibody concentration of about 50 μg/ml or less, 5.0μg/ml or less, or about 0.5μg/ml or less, or at an antibody concentration ranging from about 30 μg/ml to about 0.3 μg/ml, or at an antibody concentration of about 1 μg/ml, or at an antibody concentration of about 0.3 μg/ml.

[0155] Certain embodiments include the isolated binding molecule *e.g.,* an antibody or fragment thereof as described above, where the OPK EC50 is less than about 0.5 μg/ml, less than about 0.05μg/ml, or less than about 0.005μg/ml, or where the OPK EC50 ranges from about 0.001 μg/ml to about 0.5 μg/ml, or where the OPK EC50 ranges from about 0.02 μg/ml to about 0.08 μg/ml, or where the OPK EC50 ranges from about 0.002 μg/ml to about 0.01 μg/ml or where the OPK EC50 is less than about 0.2 μg/ml, or wherein the OPK EC50 is less than about 0.02 μg/ml. In certain embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* antibody or fragment, variant or derivative thereof described herein specifically binds to the same Ps1 epitope as monoclonal antibody WapR-004, WapR-004RAD, Cam-003, Cam-004, or Cam-005, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl. WapR-004RAD is identical to WapR-004 except for an amino acid substitution G98A of the VH amino acid sequence of SEQ ID NO:11.

[0156] Some embodiments include WapR-004 (W4) mutants comprising an scFv-Fc molecule amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions to one or more of: SEQ ID NO: 78, SEQ ID NO: 79, SEQ ID NO: 80, SEQ ID NO: 81, SEQ ID NO: 82, SEQ ID NO: 83, SEQ ID NO: 84, SEQ ID NO: 85, SEQ ID NO: 86, SEQ ID NO: 87, SEQ ID NO: 88, SEQ ID NO: 89, SEQ ID NO: 90, SEQ ID NO: 91, SEQ ID NO: 92, SEQ ID NO: 93, SEQ ID NO: 94, SEQ ID NO: 95, SEQ ID NO: 96, SEQ ID NO: 97, SEQ ID NO: 98, SEQ ID NO: 99, SEQ ID NO: 100, SEQ ID NO: 101, SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104, SEQ ID NO: 105, SEQ ID NO: 106, SEQ ID NO: 107, SEQ ID NO: 108, SEQ ID NO: 109, SEQ ID NO: 110, SEQ ID NO: 111, SEQ ID NO: 112, SEQ ID NO: 113, SEQ ID NO: 114, SEQ ID NO: 115, SEQ ID NO: 116, SEQ ID NO: 117, SEQ ID NO: 118, SEQ ID NO: 119, SEQ ID NO: 120, SEQ ID NO: 121, SEQ ID NO: 122, SEQ ID NO: 123, SEQ ID NO: 124, SEQ ID NO: 125, SEQ ID NO: 126, SEQ ID NO: 127, SEQ ID NO: 128, SEQ ID NO: 129, SEQ ID NO: 130, SEQ ID NO: 131, SEQ ID NO: 132, SEQ ID NO: 133, SEQ ID NO: 134, SEQ ID NO: 135, SEQ ID NO: 136, SEQ ID NO: 137, SEQ ID NO: 138, SEQ ID NO: 139, SEQ ID NO: 140, SEQ ID NO: 141, SEQ ID NO: 142, SEQ ID NO: 143, SEQ ID NO: 144, SEQ ID NO: 145; or SEQ ID NO: 146.

[0157] Other embodiments include WapR-004 (W4) mutants comprising an scFv-Fc molecule amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of: SEQ ID NO: 78, SEQ ID NO: 79, SEQ ID NO: 80, SEQ ID NO: 81, SEQ ID NO: 82, SEQ ID NO: 83, SEQ ID NO: 84, SEQ ID NO: 85, SEQ ID NO: 86, SEQ ID NO: 87,

SEQ ID NO: 88, SEQ ID NO: 89, SEQ ID NO: 90, SEQ ID NO: 91, SEQ ID NO: 92, SEQ ID NO: 93, SEQ ID NO: 94, SEQ ID NO: 95, SEQ ID NO: 96, SEQ ID NO: 97, SEQ ID NO: 98, SEQ ID NO: 99, SEQ ID NO: 100, SEQ ID NO: 101, SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104, SEQ ID NO: 105, SEQ ID NO: 106, SEQ ID NO: 107, SEQ ID NO: 108, SEQ ID NO: 109, SEQ ID NO: 110, SEQ ID NO: 111, SEQ ID NO: 112, SEQ ID NO: 113, SEQ ID NO: 114, SEQ ID NO: 115, SEQ ID NO: 116, SEQ ID NO: 117, SEQ ID NO: 118, SEQ ID NO: 119, SEQ ID NO: 120, SEQ ID NO: 121, SEQ ID NO: 122, SEQ ID NO: 123, SEQ ID NO: 124, SEQ ID NO: 125, SEQ ID NO: 126, SEQ ID NO: 127, SEQ ID NO: 128, SEQ ID NO: 129, SEQ ID NO: 130, SEQ ID NO: 131, SEQ ID NO: 132, SEQ ID NO: 133, SEQ ID NO: 134, SEQ ID NO: 135, SEQ ID NO: 136, SEQ ID NO: 137, SEQ ID NO: 138, SEQ ID NO: 139, SEQ ID NO: 140, SEQ ID NO: 141, SEQ ID NO: 142, SEQ ID NO: 143, SEQ ID NO: 144, SEQ ID NO: 145; or SEQ ID NO: 146.

[0158] In some embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* antibody or fragment, variant or derivative thereof described herein specifically binds to the same epitope as monoclonal antibody WapR-001, WapR-002, or WapR-003, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl.

[0159] In certain embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* antibody or fragment, variant or derivative thereof described herein specifically binds to the same epitope as monoclonal antibody WapR-016, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl.

TABLE 2: Reference VH and VL amino acid sequences*

Antibody Name	VH	VL
Cam-003	QVRLQQSGPGLVKPSETLSLTCTVSGGSTS**PYFWS**WLRQPPGKGLEWIG**YIHSNGGTNYNPSLKS**RLTISGDTSKNQFSLNLSFVTAADTALYYCAR**TDYDVYGPAFDI**WGQGTMVTV SEQ ID NO:1	SSELTQDPAVSVALGQTVRITC**QGDSLRSYYAS**WYQQKPGQAPVLVIY**GKNNRPS**GIPDRFSGSSSGNTASLTITGAQAEDEADYYC**NSRDSSGNHVV**FGGGTKLTVL SEQ ID NO:2
Cam-004	QVQLQQSGPGRVKPSETLSLTCTVSGYSVS**SGYYWG**WIRQSPGTGLEWIG**SISHSGSTYYNPSLKS**RVTISGDASKNQFFLRLTSVTAADTAVYYCAR**SEATANFDS**WGRGTLVTVSS SEQ ID NO:3	SSELTQDPAVSVALGQTVRITC**QGDSLRSYYAS**WYQQKPGQAPVLVIY**GKNNRPS**GIPDRFSGSSSGNTASLTITGAQAEDEADYYC**NSRDSSGNHVV**FGGGTKLTVL SEQ ID NO:2

(continued)

Antibody Name	VH	VL
Cam-005	QVQLQQSGPGLVKPSETLSLTCTVSGGSVS**SSGYYWT**WIRQPPGKGLEWIG**SIYSSGSTYYSPSLKS**RVTISGDTSKNQFSLKLSSVTAADTAVYYCAR**LNWGTVSAFDI**WGRGTLVTV SEQ ID NO:4	SSELTQDPAVSVALGQTVRITC**QGDSLRSYYAS**WYQQKPGQAPVLVIY**GKNNRPS**GIPDRFSGSSSGNTASLTITGAQAEDEADYYC**NSRDSSGNHVV**FGGGTKLTVL SEQ ID NO:2
WapR-001	EVQLLESGGGLVQPGGSLRLSCSASGFTFS**RYPMH**WVRQAPGKGLEYVS**DIGTNGGSTNYADSVKG**RFTISRDNSKNTVYLQMSSLRAEDTAVYHCVA**GIAAAYGFDV**WGQGTMVTVSS SEQ ID NO:5	QAGLTQPASVSGSPGQSITISC**TGTSSDIATYNYVS**WYQQHPGKAPKLMIY**EGTKRPS**GVSNRFSGSKSGNTASLTISGLQAEDEADYYC**SSYARSYTYV**FGTGTELTVL SEQ ID NO:6
WapR-002	QVQLVQSGGGLVQPGGSLRLSCSASGFTFS**SYPMH**WVRQAPGKGLDYVS**DISPNGGSTNYADSVKG**RFTISRDNSKNTLFLQMSSLRAEDTAVYYCVM**GLVPYGFDI**WGQGTLVTVSS SEQ ID NO:7	QTVVTQPASVSGSPGQSITISC**TGTSSDVGGYNYVS**WYQQHPGKAPKLMIY**EVSNRPS**GVSNHFSGSKSGNTASLTISGLQAEDEADYYC**SSYTTSSTYV**FGTGTKVTVL SEQ ID NO:8

(continued)

Antibody Name	VH	VL
WapR-003	QMQLVQSGGGLVQPGG SLRLSCSASGFTFS**SYP MH**WVRQAPGKGLDYV S**DISPNGGATNYADSV KG**RFTISRDNSKNTVYL QMSSLRAEDTAVYYCV M**GLVPYGFDN**WGQGT MVTVSS SEQ ID NO:9	QTVVTQPASVSASPGQSITISC**AGTSG DVGNYNFVS**WYQQHPGKAPKLLIY**E GSQRPS**GVSNRFSGSRSGNTASLTIS GLQAEDEADYYC**SSYARSYTYV**FGT GTKLTVL SEQ ID NO:10
WapR-004	EVQLLESGPGLVKPSET LSLTCNVAGGSIS**PYYW T**WIRQPPGKGLELIG**YI HSSGYTDYNPSLKS**RV TISGDTSKKQFSLHVSS VTAADTAVYFCAR**GD WDLLHALDI**WGQGTL VTVSS SEQ ID NO:11	EIVLTQSPSSLSTSVGDRVTITC**RASQ SIRSHLN**WYQQKPGKAPKLLIY**GAS NLQS**GVPSRFSGSGSGTDFTLTISSLQ PEDFATYYC**QQSYSFPLT**FGGGTKLE IK SEQ ID NO:12
WapR-007	EVQLVQSGADVKKPGA SVRVTCKASGYTFT**GH NIH**WVRQAPGQGLEW MG**WINPDSGATSYAQ KFQG**RVTMTRDTSITT AYMDLSRLRSDDTAVY YCAT**DTLLSNH**WGQGT LVTVSS SEQ ID NO:13	SSELTQDPAVSVALGQTVRITC**QGDS LRSYYTN**WFQQKPGQAPLLVVY**AK NKRPP**GIPDRFSGSSSGNTASLTITGA QAEDEADYYC**HSRDSSGNHVV**FGG GTKLTVL SEQ ID NO:14

(continued)

Antibody Name	VH	VL
WapR-016	EVQLVESGGGLVQPGGSL RLSCAASGYTFS**SYATS**WV RQAPGKGLEWVA**GISGSG DTTDYVDSVKG**RFTVSRD NSKNTLYLQMNSLRADDT AVYYCAS**RGGLGGYYRG GFDF**WGQGTMVTVSS SEQ ID NO:15	QSVLTQPASVSGSPGQSITISC**TGTSSDVG GYNYVS**WYQQHPGKAPKLMIY**EVSNRPS** GVSNRFSGSKSGNTASLTISGLQAEDEAD YC**SSYSSGTVV**FGGGTELTVL SEQ ID NO:16
WapR-004RAD	EVQLLESGPGLVKPSET LSLTCNVAGGSIS**PYYW T**WIRQPPGKGLELIG**YI HSSGYTDYNPSLKS**RV TISGDTSKKQFSLHVSS VTAADTAVYFCAR**AD WDLLHALDI**WGQGTL VTVSS SEQ ID NO:74	EIVLTQSPSSLSTSVGDRVTITC**RASQ SIRSHLN**WYQQKPGKAPKLLIY**GAS NLQS**GVPSRFSGSGSGTDFTLTISSLQ PEDFATYYC**QQSYSFPLT**FGGGTKLE IK SEQ ID NO:12
*VH and VL CDR1, CDR2, and CDR3 amino acid sequences are underlined		

TABLE 3: Reference VH and VL CDR1, CDR2, and CDR3 amino acid sequences

Antibody Name	VHCDR1	VHCDR2	VHCDR3	VLCDR1	VLCDR2	VLCDR3
Cam-003	PYFWS SEQ ID NO:17	YIHSNGGTNYNPSLKS SEQ ID NO:18	TDYDVYGPAFDI SEQ ID NO:19	QGDSLRSYYAS SEQ ID NO:20	GKNNRPS SEQ ID NO:21	NSRDSSGNHVV SEQ ID NO:22
Cam-004	SGYYWG SEQ ID NO:23	SISHSGSTYYNPSLKS SEQ ID NO:24	SEATANFDS SEQ ID NO:25	QGDSLRSYYAS SEQ ID NO:20	GKNNRPS SEQ ID NO:21	NSRDSSGNHVV SEQ ID NO:22
Cam-005	SSGYYWT SEQ ID NO:26	SIYSSGSTYYSPSLKS SEQ ID NO:27	LNWGTVSAFDI SEQ ID NO:28	QGDSLRSYYAS SEQ ID NO:20	GKNNRPS SEQ ID NO:21	NSRDSSGNHVV SEQ ID NO:22
WapR-001	RYPMH SEQ ID NO:29	DIGTNGGSTNYADSVKG SEQ ID NO:30	GIAAAYGFDV SEQ ID NO:31	TGTSSDIATYNYVS SEQ ID NO:32	EGTKRPS SEQ ID NO:33	SSYARSYTYV SEQ ID NO:34

(continued)

Antibody Name	VHCDR1	VHCDR2	VHCDR3	VLCDR1	VLCDR2	VLCDR3
WapR-002	SYPMH SEQ ID NO:35	DISPNGGSTNYADSVKG SEQ ID NO:36	GLVPYGFDI SEQ ID NO:37	TGTSSDVGGYNYVS SEQ ID NO:38	EVSNRPS SEQ ID NO:39	SSYTTSSTYV SEQ ID NO:40
WapR-003	SYPMH SEQ ID NO:41	DISPNGGATNYADSVKG SEQ ID NO:42	GLVPYGFDN SEQ ID NO:43	AGTSGDVGNYNFVS SEQ ID NO:44	EGSQRPS SEQ ID NO:45	SSYARSYTYV SEQ ID NO:46
WapR-004	PYYWT SEQ ID NO:47	YIHSSGYTDYNPSLKS SEQ ID NO:48	GDWDLLHALDI SEQ ID NO:49	RASQSIRSHLN SEQ ID NO:50	GASNLQS SEQ ID NO:51	YSFPLT SEQ ID NO:52
WapR-007	GHNIH SEQ ID NO:53	WINPDSGATSYAQKFQG SEQ ID NO:54	DTLLSNH SEQ ID NO:55	QGDSLRSYYTN SEQ ID NO:56	AKNKRPP SEQ ID NO:57	HSRDSSGNHVV SEQ ID NO:58

(continued)

Antibody Name	VHCDR1	VHCDR2	VHCDR3	VLCDR1	VLCDR2	VLCDR3
WapR-016	SYATS SEQ ID NO:59	GISGSGDT TDYVDSV KG SEQ ID NO:60	RGGLGG YYRGGF DF SEQ ID NO:61	TGTSSDVG GYNYVS SEQ ID NO:62	EVSNRPS SEQ ID NO:63	SSYSSGTVV SEQ ID NO:64
WapR-004RAD	PYYWT SEQ ID NO:47	YIHSSGY TDYNPSL KS SEQ ID NO:48	ADWDL LHALDI SEQ ID NO:75	RASQSIRS HLN SEQ ID NO:50	GASNLQS SEQ ID NO:51	YSFPLT SEQ ID NO:52

[0160] Any anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof described herein can further include additional polypeptides, *e.g.,* a signal peptide to direct secretion of the encoded polypeptide, antibody constant regions as described herein, or other heterologous polypeptides as described herein. Additionally, binding molecules or fragments thereof of the description include polypeptide fragments as described elsewhere. Additionally anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof described herein can be fusion polypeptides, Fab fragments, scFvs, or other derivatives, as described herein.

[0161] Also, as described in more detail elsewhere herein, the disclosure includes compositions comprising anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof described herein.

[0162] It will also be understood by one of ordinary skill in the art that anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof described herein can be modified such that they vary in amino acid sequence from the naturally occurring binding polypeptide from which they were derived. For example, a polypeptide or amino acid sequence derived from a designated protein can be similar, *e.g.,* have a certain percent identity to the starting sequence, *e.g.,* it can be 60%, 70%, 75%, 80%, 85%, 90%, or 95% identical to the starting sequence.

[0163] The term "percent sequence identity" between two polynucleotide or polypeptide sequences refers to the number of identical matched positions shared by the sequences over a comparison window, taking into account additions or deletions (*i.e.*, gaps) that must be introduced for optimal alignment of the two sequences. A matched position is any position where an identical nucleotide or amino acid is presented in both the target and reference sequence. Gaps presented in the target sequence are not counted since gaps are not nucleotides or amino acids. Likewise, gaps presented in the reference sequence are not counted since target sequence nucleotides or amino acids are counted, not nucleotides or amino acids from the reference sequence.

[0164] The percentage of sequence identity is calculated by determining the number of positions at which the identical amino-acid residue or nucleic acid base occurs in both sequences to yield the number of matched positions, dividing the number of matched positions by the total number of positions in the window of comparison and multiplying the result by 100 to yield the percentage of sequence identity. The comparison of sequences and determination of percent sequence identity between two sequences may be accomplished using readily available software both for online use and for download. Suitable software programs are available from various sources, and for alignment of both protein and nucleotide sequences. One suitable program to determine percent sequence identity is bl2seq, part of the BLAST suite of program available from the U.S. government's National Center for Biotechnology Information BLAST web site (blast.ncbi.nlm.nih.gov). Bl2seq performs a comparison between two sequences using either the BLASTN or BLASTP algorithm. BLASTN is used to compare nucleic acid sequences, while BLASTP is used to compare amino acid sequences. Other suitable programs are, *e.g.,* Needle, Stretcher, Water, or Matcher, part of the EMBOSS suite of bioinformatics programs and also available from the European Bioinformatics Institute (EBI) at www.ebi.ac.uk/Tools/psa.

[0165] Different regions within a single polynucleotide or polypeptide target sequence that aligns with a polynucleotide or polypeptide reference sequence can each have their own percent sequence identity. It is noted that the percent sequence identity value is rounded to the nearest tenth. For example, 80.11, 80.12, 80.13, and 80.14 are rounded down to 80.1, while 80.15, 80.16, 80.17, 80.18, and 80.19 are rounded up to 80.2. It also is noted that the length value will always be an integer.

[0166] One skilled in the art will appreciate that the generation of a sequence alignment for the calculation of a percent sequence identity is not limited to binary sequence-sequence comparisons exclusively driven by primary sequence data. Sequence alignments can be derived from multiple sequence alignments. One suitable program to generate multiple sequence alignments is ClustalW2, available from www.clustal.org. Another suitable program is MUSCLE, available from www.drive5.com/muscle/. ClustalW2 and MUSCLE are alternatively available, *e.g.,* from the EBI.

[0167] It will also be appreciated that sequence alignments can be generated by integrating sequence data with data from heterogeneous sources such as structural data (*e.g.*, crystallographic protein structures), functional data (*e.g.*, location of mutations), or phylogenetic data. A suitable program that integrates heterogeneous data to generate a multiple sequence alignment is T-Coffee, available at www.tcoffee.org, and alternatively available, *e.g.,* from the EBI. It will also be appreciated that the final alignment used to calculated percent sequence identity may be curated either automatically or manually.

[0168] Whether any particular polypeptide is at least about 70%, 75%, 80%, 85%, 90% or 95% identical to another polypeptide can also be determined using methods and computer programs/software known in the art such as, but not limited to, the BESTFIT program (Wisconsin Sequence Analysis Package, Version 8 for Unix, Genetics Computer Group, University Research Park, 575 Science Drive, Madison, WI 53711). BESTFIT uses the local homology algorithm of Smith and Waterman, Advances in Applied Mathematics 2:482-489 (1981), to find the best segment of homology between two sequences. When using BESTFIT or any other sequence alignment program to determine whether a particular sequence is, for example, 95% identical to a reference sequence, the parameters are set, of course, such that the percentage of identity is calculated over the full length of the reference polypeptide sequence and that gaps in homology of up to 5% of the total number of amino acids in the reference sequence are allowed.

[0169] Furthermore, nucleotide or amino acid substitutions, deletions, or insertions leading to conservative substitutions

or changes at "non-essential" amino acid regions can be made. For example, a polypeptide or amino acid sequence derived from a designated protein can be identical to the starting sequence except for one or more individual amino acid substitutions, insertions, or deletions, *e.g.,* one, two, three, four, five, six, seven, eight, nine, ten, fifteen, twenty or more individual amino acid substitutions, insertions, or deletions. In certain embodiments, a polypeptide or amino acid sequence derived from a designated protein has one to five, one to ten, one to fifteen, or one to twenty individual amino acid substitutions, insertions, or deletions relative to the starting sequence.

[0170] An anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody or fragment, variant or derivative thereof described herein can comprise, consist essentially of, or consist of a fusion protein. Fusion proteins are chimeric molecules which comprise, for example, an immunoglobulin antigen-binding domain with at least one target binding site, and at least one heterologous portion, *i.e*., a portion with which it is not naturally linked in nature. The amino acid sequences can normally exist in separate proteins that are brought together in the fusion polypeptide or they can normally exist in the same protein but are placed in a new arrangement in the fusion polypeptide. Fusion proteins can be created, for example, by chemical synthesis, or by creating and translating a polynucleotide in which the peptide regions are encoded in the desired relationship.

[0171] The term "heterologous" as applied to a polynucleotide, polypeptide, or other moiety means that the polynucleotide, polypeptide, or other moiety is derived from a distinct entity from that of the rest of the entity to which it is being compared. In a non-limiting example, a "heterologous polypeptide" to be fused to a binding molecule, *e.g.,* an antibody or an antigen-binding fragment, variant, or derivative thereof is derived from a non-immunoglobulin polypeptide of the same species, or an immunoglobulin or non-immunoglobulin polypeptide of a different species.

IV. FUSION PROTEINS AND ANTIBODY CONJUGATES

[0172] In some embodiments, the anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof can be administered multiple times in conjugated form. In still another embodiment, the anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof can be administered in unconjugated form, then in conjugated form, or vice versa.

[0173] In specific embodiments, the anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof can be conjugated to one or more antimicrobial agents, for example, Polymyxin B (PMB). PMB is a small lipopeptide antibiotic approved for treatment of multidrug-resistant Gram-negative infections. In addition to its bactericidal activity, PMB binds lipopolysaccharide (LPS) and neutralizes its proinflammatory effects. (Dixon, R.A. & Chopra, I. J Antimicrob Chemother 18, 557-563 (1986)). LPS is thought to significantly contribute to inflammation and the onset of Gram-negative sepsis. (Guidet, B., et al., Chest 106, 1194-1201 (1994)). Therapies that neutralize and/or clear LPS from circulation have the potential to prevent or delay the onset of sepsis and improve clinical outcome. Polymyxin B (PMB) is a lipopeptide antibiotic approved for treatment of multidrug-resistant Gram-negative infections. In addition to its bactericidal activity, PMB binds LPS and neutralizes its proinflammatory effects. Conjugates of PMB to carrier molecules have been shown to neutralize LPS and mediate protection in animal models of endotoxemia and infection. (Drabick, J.J., et al. Antimicrob Agents Chemother 42, 583-588 (1998)). Also disclosed is a method for attaching one or more PMB molecules to cysteine residues introduced into the Fc region of monoclonal antibodies (mAb) of the disclosure. For example, the Cam-003-PMB conjugates retained specific, mAb-mediated binding to *P. aeruginosa* and also retained OPK activity. Furthermore, mAb-PMB conjugates bound and neutralized LPS *in vitro.*

[0174] In certain embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody or fragment, variant or derivative thereof described herein can comprise a heterologous amino acid sequence or one or more other moieties not normally associated with an antibody (*e.g*., an antimicrobial agent, a therapeutic agent, a prodrug, a peptide, a protein, an enzyme, a lipid, a biological response modifier, pharmaceutical agent, a lymphokine, a heterologous antibody or fragment thereof, a detectable label, polyethylene glycol (PEG), and a combination of two or more of any said agents). In further embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.,* an antibody or fragment, variant or derivative thereof can comprise a detectable label selected from the group consisting of an enzyme, a fluorescent label, a chemiluminescent label, a bioluminescent label, a radioactive label, or a combination of two or more of any said detectable labels.

V. POLYNUCLEOTIDES ENCODING BINDING MOLECULES

[0175] Also provided herein are nucleic acid molecules encoding the anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof described herein.

[0176] One embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding an immunoglobulin heavy chain variable region (VH) amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ IS NO: 74 as shown in Table 2.

[0177] Another embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of

a nucleic acid encoding a VH amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions to one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0178] Further embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding a VH, where one or more of the VHCDR1, VHCDR2 or VHCDR3 regions of the VH are identical to, or identical except for four, three, two, or one amino acid substitutions, to one or more reference heavy chain VHCDR1, VHCDR2 and/or VHCDR3 amino acid sequences of one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0179] Another embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VH, where one or more of the VHCDR1, VHCDR2 or VHCDR3 regions of the VH are identical to, or identical except for four, three, two, or one amino acid substitutions, to one or more reference heavy chain VHCDR1, VHCDR2 and/or VHCDR3 amino acid sequences of one or more of: SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, or SEQ ID NO: 74 as shown in Table 2.

[0180] A further embodiment provides an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment comprising the VH encoded by the polynucleotide specifically or preferentially binds to *Pseudomonas* Psl.

[0181] Another embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding an immunoglobulin light chain variable region (VL) amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0182] A further embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding a VL amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions to one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0183] Another embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding a VL, where one or more of the VLCDR1, VLCDR2 or VLCDR3 regions of the VL are at least 80%, 85%, 90%, 95% or 100% identical to one or more reference light chain VLCDR1, VLCDR2 or VLCDR3 amino acid sequences of one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0184] A further embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding an isolated binding molecule, *e.g.,* an antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an VL, where one or more of the VLCDR1, VLCDR2 or VLCDR3 regions of the VL are identical to, or identical except for four, three, two, or one amino acid substitutions, to one or more reference heavy chain VLCDR1, VLCDR2 and/or VLCDR3 amino acid sequences of one or more of: SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, or SEQ ID NO: 16 as shown in Table 2.

[0185] In another embodiment, an isolated binding molecule *e.g.,* an antibody or antigen-binding fragment comprising the VL encoded by the polynucleotide specifically or preferentially binds to *Pseudomonas* Psl.

[0186] One embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid which encodes an scFv molecule including a VH and a VL, where the scFv is at least 80%, 85%, 90% 95% or 100% identical to one or more of SEQ ID NO:65, SEQ ID NO:66, SEQ ID NO:67, SEQ ID NO:68, SEQ ID NO:69, or SEQ ID NO:70 as shown in Table 4.

TABLE 4: Reference scFv nucleic acid sequences

Antibody Name	scFv nucleotide sequences
Cam-003	CAGCCGGCCATGGCCCAGGTACAGCTGCAGCAGTCAGGCCCAGG ACTGGTGAAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCTCT GGTGGCTCCACCAGTCCTTACTTCTGGAGCTGGCTCCGGCAGCCC CCAGGGAAGGGACTGGAGTGGATTGGTTATATCCATTCCAATGGG GGCACCAACTACAACCCCTCCCTCAAGAGTCGACTCACCATATCA GGAGACACGTCCAAGAACCAATTCTCCCTGAATCTGAGTTTTGTG ACCGCTGCGGACACGGCCCTCTATTACTGTGCGAGAACGGACTAC GATGTCTACGGCCCCGCTTTTGATATCTGGGGCCAGGGGACAATG GTCACCGTCTCGAGTGGTGGAGGCGGTTCAGGCGGAGGTGGCAG CGGCGGTGGCGGATCGTCTGAGCTGACTCAGGACCCTGCTGTGTC TGTGGCCTTGGGACAGACAGTCAGGATCACATGCCAAGGAGACA GCCTCAGAAGCTATTATGCAAGCTGGTACCAGCAGAAGCCAGGA CAGGCCCCTGTACTTGTCATCTATGGTAAAAACAACCGGCCCTCA GGGATCCCAGACCGATTCTCTGGCTCCAGCTCAGGAAACACAGCT TCCTTGACCATCACTGGGGCTCAGGCGGAAGATGAGGCTGACTAT TACTGTAACTCCCGGGACAGCAGTGGTAACCATGTGGTATTCGGC GGAGGGACCAAGCTGACCGTCCTAGGTGCGGCCGCA SEQ ID NO:65

(continued)

Antibody Name	scFv nucleotide sequences
Cam-004	CAGCCGGCCATGGCCCAGGTACAGCTGCAGCAGTCAGGCCCAGG ACGGGTGAAGCCTTCGGAGACGCTGTCCCTCACCTGCACTGTCTC TGGTTACTCCGTCAGTAGTGGTTACTACTGGGGCTGGATCCGGCA GTCCCCAGGGACGGGGCTGGAGTGGATTGGGAGTATCTCTCATAG TGGGAGCACCTACTACAACCCGTCCCTCAAGAGTCGAGTCACCAT ATCAGGAGACGCATCCAAGAACCAGTTTTTCCTGAGGCTGACTTC TGTGACCGCCGCGGACACGGCCGTTTATTACTGTGCGAGATCTGA GGCTACCGCCAACTTTGATTCTTGGGGCAGGGGCACCCTGGTCAC CGTCTCTTCAGGTGGAGGCGGTTCAGGCGGAGGTGGCAGCGGCG GTGGCGGATCGTCTGAGCTGACTCAGGACCCTGCCGTGTCTGTGG CCTTGGGACAGACAGTCAGGATCACATGCCAAGGAGACAGCCTC AGAAGCTATTATGCAAGCTGGTACCAGCAGAAGCCAGGACAGGC CCCTGTACTTGTCATCTATGGTAAAAACAACCGGCCCTCAGGGAT CCCAGACCGATTCTCTGGCTCCAGCTCAGGAAACACAGCTTCCTT GACCATCACTGGGGCTCAGGCGGAAGATGAGGCTGACTATTACTG TAACTCCCGGGACAGCAGTGGTAACCATGTGGTATTCGGCGGAGG GACCAAGCTGACCGTCCTAGGTGCGGCCGCA SEQ ID NO:66

(continued)

Antibody Name	scFv nucleotide sequences
Cam-005	CAGCCGGCCATGGCCCAGGTACAGCTGCAGCAGTCAGGCCCAGG ACTGGTGAAGCCTTCGGAGACCCTGTCCCTCACCTGCACTGTCTCT GGTGGCTCCGTCAGCAGTAGTGGTTATTACTGGACCTGGATCCGC CAGCCCCCAGGGAAGGGGCTGGAGTGGATTGGGAGTATCTATTCT AGTGGGAGCACATATTACAGCCCGTCCCTCAAGAGTCGAGTCACC ATATCCGGAGACACGTCCAAGAACCAGTTCTCCCTCAAGCTGAGC TCTGTGACCGCCGCAGACACAGCCGTGTATTACTGTGCGAGACTT AACTGGGGCACTGTGTCTGCCTTTGATATCTGGGGCAGAGGCACC CTGGTCACCGTCTCGAGTGGTGGAGGCGGTTCAGGCGGAGGTGGC AGCGGCGGTGGCGGATCGTCTGAGCTGACTCAGGACCCTGCTGTG TCTGTGGCCTTGGGACAGACAGTCAGGATCACATGCCAAGGAGAC AGCCTCAGAAGCTATTATGCAAGCTGGTACCAGCAGAAGCCAGG ACAGGCCCCTGTACTTGTCATCTATGGTAAAAACAACCGGCCCTC AGGGATCCCAGACCGATTCTCTGGCTCCAGCTCAGGAAACACAGC TTCCTTGACCATCACTGGGGCTCAGGCGGAAGATGAGGCTGACTA TTACTGTAACTCCCGGGACAGCAGTGGTAACCATGTGGTATTCGG CGGAGGGACCAAGCTGACCGTCCTAGGTGCGGCCGCA SEQ ID NO:67

(continued)

Antibody Name	scFv nucleotide sequences
WapR-001	TCTATGCGGCCCAGCCGGCCATGGCCGAGGTGCAGCTGTTGGAGT CTGGGGGAGGTTTGGTCCAGCCTGGGGGGTCCCTGAGACTCTCCT GTTCAGCCTCTGGGTTCACCTTCAGTCGGTATCCTATGCATTGGGT CCGCCAGGCTCCAGGGAAGGGACTGGAATATGTTTCAGATATTGG TACTAATGGGGGTAGTACAAACTACGCAGACTCCGTGAAGGGCA GATTCACCATCTCCAGAGACAATTCCAAGAACACGGTGTATCTTC AAATGAGCAGTCTGAGAGCTGAGGACACGGCTGTGTATCATTGTG TGGCGGGTATAGCAGCCGCCTATGGTTTTGATGTCTGGGGCCAAG GGACAATGGTCACCGTCTCGAGTGGAGGCGGCGGTTCAGGCGGA GGTGGCTCTGGCGGTGGCGGAAGTGCACAGGCAGGGCTGACTCA GCCTGCCTCCGTGTCTGGGTCTCCTGGACAGTCGATCACCATCTCC TGCACTGGAACCAGCAGTGACATTGCTACTTATAACTATGTCTCCT GGTACCAACAGCACCCAGGCAAAGCCCCCAAACTCATGATTTATG AGGGCACTAAGCGGCCCTCAGGGGTTTCTAATCGCTTCTCTGGCT CCAAGTCTGGCAACACGGCCTCCCTGACAATCTCTGGGCTCCAGG CTGAGGACGAGGCTGATTATTACTGTTCCTCATATGCACGTAGTT ACACTTATGTCTTCGGAACTGGGACCGAGCTGACCGTCCTAGCGG CCGC SEQ ID NO:68

(continued)

Antibody Name	scFv nucleotide sequences
WapR-002	CTATGCGGCCCAGCCGGCCATGGCCCAGGTGCAGCTGGTGCAGTC TGGGGGAGGCTTGGTCCAGCCTGGGGGGTCCCTGAGACTCTCCTG TTCAGCCTCTGGATTCACCTTCAGTAGCTATCCTATGCACTGGGTC CGCCAGGCTCCAGGGAAGGGACTGGATTATGTTTCAGACATCAGT CCAAATGGGGGTTCCACAAACTACGCAGACTCCGTGAAGGGCAG ATTCACCATCTCCAGAGACAATTCCAAGAACACACTGTTTCTTCA AATGAGCAGTCTGAGAGCTGAGGACACGGCTGTGTATTATTGTGT GATGGGGTTAGTACCCTATGGTTTTGATATCTGGGGCCAAGGCAC CCTGGTCACCGTCTCGAGTGGAGGCGGCGGTTCAGGCGGAGGTGG CTCTGGCGGTGGCGGAAGTGCACAGACTGTGGTGACCCAGCCTGC CTCCGTGTCTGGGTCTCCTGGACAGTCGATCACCATCTCCTGCACT GGAACCAGCAGTGACGTTGGTGGTTATAACTATGTCTCCTGGTAC CAACAGCACCCAGGCAAAGCCCCCAAACTCATGATTTATGAGGTC AGTAATCGGCCCTCAGGGGTTTCTAATCACTTCTCTGGCTCCAAGT CTGGCAACACGGCCTCCCTGACCATCTCTGGGCTCCAGGCTGAGG ACGAGGCTGATTATTACTGCAGCTCATATACAACCAGCAGCACTT ATGTCTTCGGAACTGGGACCAAGGTCACCGTCCTAGCGGCCG SEQ ID NO:69

(continued)

Antibody Name	scFv nucleotide sequences
WapR-003	CGGCCCAGCCGGCCATGGCCCAGATGCAGCTGGTGCAGTCGGGG GGAGGCTTGGTCCAGCCTGGGGGGTCCCTGAGACTCTCCTGTTCA GCCTCTGGATTCACCTTCAGTAGCTATCCTATGCACTGGGTCCGCC AGGCTCCAGGGAAGGGACTGGATTATGTTTCAGACATCAGTCCAA ATGGGGGTGCCACAAACTACGCAGACTCCGTGAAGGGCAGATTC ACCATCTCCAGAGACAATTCCAAGAACACGGTGTATCTTCAAATG AGCAGTCTGAGAGCTGAAGACACGGCTGTCTATTATTGTGTGATG GGGTTAGTGCCCTATGGTTTTGATAACTGGGGCCAGGGGACAATG GTCACCGTCTCGAGTGGAGGCGGCGGTTCAGGCGGAGGTGGCTCT GGCGGTGGCGGAAGTGCACAGACTGTGGTGACCCAGCCTGCCTCC GTGTCTGCATCTCCTGGACAGTCGATCACCATCTCCTGCGCTGGA ACCAGCGGTGATGTTGGGAATTATAATTTTGTCTCCTGGTACCAA CAACACCCAGGCAAAGCCCCCAAACTCCTGATTTATGAGGGCAGT CAGCGGCCCTCAGGGGTTTCTAATCGCTTCTCTGGCTCCAGGTCTG GCAACACGGCCTCCCTGACAATCTCTGGGCTCCAGGCTGAGGACG AGGCTGATTATTACTGTTCCTCATATGCACGTAGTTACACTTATGT CTTCGGAACTGGGACCAAGCTGACCGTCCTAGCGGCCGCA SEQ ID NO:70

(continued)

Antibody Name	scFv nucleotide sequences
WapR-004	TATGCGGCCCAGCCGGCCATGGCCGAGGTGCAGCTGTTGGAGTCG GGCCCAGGACTGGTGAAGCCTTCGGAGACCCTGTCCCTCACCTGC AATGTCGCTGGTGGCTCCATCAGTCCTTACTACTGGACCTGGATCC GGCAGCCCCCAGGGAAGGGCCTGGAGTTGATTGGTTATATCCACT CCAGTGGGTACACCGACTACAACCCCTCCCTCAAGAGTCGAGTCA CCATATCAGGAGACACGTCCAAGAAGCAGTTCTCCCTGCACGTGA GCTCTGTGACCGCTGCGGACACGGCCGTGTACTTCTGTGCGAGAG GCGATTGGGACCTGCTTCATGCTCTTGATATCTGGGGCCAAGGGA CCCTGGTCACCGTCTCGAGTGGAGGCGGCGGTTCAGGCGGAGGTG GCTCTGGCGGTGGCGGAAGTGCACTCGAAATTGTGTTGACACAGT CTCCATCCTCCCTGTCTACATCTGTAGGAGACAGAGTCACCATCA CTTGCCGGGCAAGTCAGAGCATTAGGAGCCATTTAAATTGGTATC AGCAGAAACCAGGGAAAGCCCCTAAACTCCTGATCTATGGTGCAT CCAATTTGCAAAGTGGGGTCCCATCAAGGTTCAGTGGCAGTGGAT CTGGGACAGATTTCACTCTCACCATTAGTAGTCTGCAACCTGAAG ATTTTGCAACTTACTACTGTCAACAGAGTTACAGTTTCCCCCTCAC TTTCGGCGGAGGGACCAAGCTGGAGATCAAAGCGGCCGC SEQ ID NO:71

(continued)

Antibody Name	scFv nucleotide sequences
WapR-007	GCGGCCCAGCCGGCCATGGCCGAAGTGCAGCTGGTGCAGTCTGG GGCTGACGTAAAGAAGCCTGGGGCCTCAGTGAGGGTCACCTGCA AGGCTTCTGGATACACCTTCACCGGCCACAACATACACTGGGTGC GACAGGCCCCTGGACAAGGGCTTGAATGGATGGGATGGATCAAC CCTGACAGTGGTGCCACAAGCTATGCACAGAAGTTTCAGGGCAGG GTCACCATGACCAGGGACACGTCCATCACCACAGCCTACATGGAC CTGAGCAGGCTGAGATCTGACGACACGGCCGTATATTACTGTGCG ACCGATACATTACTGTCTAATCACTGGGGCCAAGGAACCCTGGTC ACCGTCTCGAGTGGTGGAGGCGGTTCAGGCGGAGGTGGCAGCGG CGGTGGCGGATCGTCTGAGCTGACTCAGGACCCTGCTGTGTCTGT GGCCTTGGGACAGACAGTCAGGATCACTTGCCAAGGAGACAGTCT CAGAAGCTATTACACAAACTGGTTCCAGCAGAAGCCAGGACAGG CCCCTCTACTTGTCGTCTATGCTAAAAATAAGCGGCCCCCAGGGA TCCCAGACCGATTCTCTGGCTCCAGCTCAGGAAACACAGCTTCCT TGACCATCACTGGGGCTCAGGCGGAAGATGAGGCTGACTATTACT GTCATTCCCGGGACAGCAGTGGTAACCATGTGGTATTCGGCGGAG GGACCAAGCTGACCGTCCTAGGTGCGGCCGCA SEQ ID NO:72

(continued)

Antibody Name	scFv nucleotide sequences
WapR-016	CAGCCGGCCATGGCCGAGGTGCAGCTGGTGGAGTCTGGGGGAGG CTTGGTACAGCCTGGGGGGTCCCTGAGACTCTCCTG TGCAGCCTCTGGATACACCTTTAGCAGCTATGCCACGAGCTGGGT CCGCCAGGCTCCAGGGAAGGGGCTGGAGTGGGTCG CAGGTATTAGTGGTAGTGGTGATACCACAGACTACGTAGACTCCG TGAAGGGCCGGTTCACCGTCTCCAGAGACAATTCC AAGAACACCCTATATCTGCAAATGAACAGCCTGAGAGCCGACGA CACGGCCGTGTATTACTGTGCGTCGAGAGGAGGTTT AGGGGGTTATTACCGGGGCGGCTTTGACTTCTGGGGCCAGGGGAC AATGGTCACCGTCTCGAGTGGAGGCGGCGGTTCAG GCGGAGGTGGCTCTGGCGGTGGCGGAAGTGCACAGTCTGTGCTGA CGCAGCCTGCCTCCGTGTCTGGGTCTCCTGGACAG TCGATCACCATCTCCTGCACTGGAACCAGCAGTGACGTTGGTGGT TATAACTATGTCTCCTGGTACCAACAGCACCCAGG CAAAGCCCCCAAACTCATGATTTATGAGGTCAGTAATCGGCCCTC AGGGGTTTCTAATCGCTTCTCTGGCTCCAAGTCTG GCAACACGGCCTCCCTGACCATCTCTGGGCTCCAGGCTGAGGACG AGGCTGATTATTACTGCAGCTCATATACAAGCAGC GGCACTGTGGTATTCGGCGGAGGGACCGAGCTGACCGTCCTAGCG GCCGCA SEQ ID NO:73

[0187] In some embodiments, an isolated antibody or antigen-binding fragment thereof encoded by one or more of the polynucleotides described above, which specifically binds to *Pseudomonas* Psl, comprises, consists essentially of, or consists of VH and VL amino acid sequences at least 80%, 85%, 90% 95% or 100% identical to:

(a) SEQ ID NO: 1 and SEQ ID NO: 2, respectively, (b) SEQ ID NO: 3 and SEQ ID NO: 2, respectively, (c) SEQ ID NO: 4 and SEQ ID NO: 2 , respectively, (d) SEQ ID NO: 5 and SEQ ID NO: 6 , respectively, (e) SEQ ID NO: 7 and SEQ ID NO: 8, respectively, (f) SEQ ID NO: 9 and SEQ ID NO: 10, respectively, (g) SEQ ID NO: 11 and SEQ ID NO: 12 , respectively, (h) SEQ ID NO: 13 and SEQ ID NO: 14, respectively; (i) SEQ ID NO: 15 and SEQ ID NO: 16, respectively; or (j) SEQ ID NO: 74 and SEQ ID NO: 12 , respectively.

[0188] In certain embodiments, an isolated binding molecule, *e.g.*, an antibody or antigen-binding fragment thereof encoded by one or more of the polynucleotides described above, specifically binds to *Pseudomonas* Psl with an affinity characterized by a dissociation constant (K_D) no greater than 5×10^{-2} M, 10^{-2} M, 5×10^{-3} M, 10^{-3} M, 5×10^{-4} M, 10^{-4} M, 5×10^{-5} M, 10^{-5} M, 5×10^{-6} M, 10^{-6} M, 5×10^{-7} M, 10^{-7} M, 5×10^{-8} M, 10^{-8} M, 5×10^{-9} M, 10^{-9} M, 5×10^{-10} M, 10^{-10} M, 5×10^{-11} M, 10^{-11} M, 5×10^{-12} M, 10^{-12} M, 5×10^{-13} M, 10^{-13} M, 5×10^{-14} M, 10^{-14} M, 5×10^{-15} M, or 10^{-15} M.

[0189] In specific embodiments, an isolated binding molecule, *e.g.*, an antibody or antigen-binding fragment thereof encoded by one or more of the polynucleotides described above, specifically binds to *Pseudomonas* Psl, with an affinity characterized by a dissociation constant (K_D) in a range of about 1×10^{-10} to about 1×10^{-6} M. In one embodiment, an

isolated binding molecule, *e.g.*, an antibody or antigen-binding fragment thereof encoded by one or more of the polynucleotides described above, specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.18 x 10^{-7} M, as determined by the OCTET® binding assay described herein. In another embodiment, an isolated binding molecule, *e.g.*, an antibody or antigen-binding fragment thereof encoded by one or more of the polynucleotides described above, specifically binds to *Pseudomonas* Psl, with an affinity characterized by a K_D of about 1.44 x 10^{-7} M, as determined by the OCTET® binding assay described herein.

[0190] In certain embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof encoded by one or more of the polynucleotides described above, specifically binds to the same Ps1 epitope as monoclonal antibody WapR-004, WapR-004RAD, Cam-003, Cam-004, or Cam-005, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl. WapR-004RAD is identical to WapR-004 except for a nucleic acid substitution G293C of the VH nucleic acid sequence encoding the VH amino acid sequence of SEQ ID NO:11 (a substitution of the nucleotide in the VH-encoding portion of SEQ ID NO:71 at position 317). The nucleic acid sequence encoding the WapR-004RAD VH is presented as SEQ ID NO 76.

[0191] Some embodiments provide an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding a W4 mutant scFv-Fc molecule amino acid sequence identical to, or identical except for one, two, three, four, five, or more amino acid substitutions to one or more of: SEQ ID NO: 78, SEQ ID NO: 79, SEQ ID NO: 80, SEQ ID NO: 81, SEQ ID NO: 82, SEQ ID NO: 83, SEQ ID NO: 84, SEQ ID NO: 85, SEQ ID NO: 86, SEQ ID NO: 87, SEQ ID NO: 88, SEQ ID NO: 89, SEQ ID NO: 90, SEQ ID NO: 91, SEQ ID NO: 92, SEQ ID NO: 93, SEQ ID NO: 94, SEQ ID NO: 95, SEQ ID NO: 96, SEQ ID NO: 97, SEQ ID NO: 98, SEQ ID NO: 99, SEQ ID NO: 100, SEQ ID NO: 101, SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104, SEQ ID NO: 105, SEQ ID NO: 106, SEQ ID NO: 107, SEQ ID NO: 108, SEQ ID NO: 109, SEQ ID NO: 110, SEQ ID NO: 111, SEQ ID NO: 112, SEQ ID NO: 113, SEQ ID NO: 114, SEQ ID NO: 115, SEQ ID NO: 116, SEQ ID NO: 117, SEQ ID NO: 118, SEQ ID NO: 119, SEQ ID NO: 120, SEQ ID NO: 121, SEQ ID NO: 122, SEQ ID NO: 123, SEQ ID NO: 124, SEQ ID NO: 125, SEQ ID NO: 126, SEQ ID NO: 127, SEQ ID NO: 128, SEQ ID NO: 129, SEQ ID NO: 130, SEQ ID NO: 131, SEQ ID NO: 132, SEQ ID NO: 133, SEQ ID NO: 134, SEQ ID NO: 135, SEQ ID NO: 136, SEQ ID NO: 137, SEQ ID NO: 138, SEQ ID NO: 139, SEQ ID NO: 140, SEQ ID NO: 141, SEQ ID NO: 142, SEQ ID NO: 143, SEQ ID NO: 144, SEQ ID NO: 145; or SEQ ID NO: 146.

[0192] Other embodiments provide an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid encoding a W4 mutant scFv-Fc molecule amino acid sequence at least 80%, 85%, 90% 95% or 100% identical to one or more of: SEQ ID NO: 78, SEQ ID NO: 79, SEQ ID NO: 80, SEQ ID NO: 81, SEQ ID NO: 82, SEQ ID NO: 83, SEQ ID NO: 84, SEQ ID NO: 85, SEQ ID NO: 86, SEQ ID NO: 87, SEQ ID NO: 88, SEQ ID NO: 89, SEQ ID NO: 90, SEQ ID NO: 91, SEQ ID NO: 92, SEQ ID NO: 93, SEQ ID NO: 94, SEQ ID NO: 95, SEQ ID NO: 96, SEQ ID NO: 97, SEQ ID NO: 98, SEQ ID NO: 99, SEQ ID NO: 100, SEQ ID NO: 101, SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104, SEQ ID NO: 105, SEQ ID NO: 106, SEQ ID NO: 107, SEQ ID NO: 108, SEQ ID NO: 109, SEQ ID NO: 110, SEQ ID NO: 111, SEQ ID NO: 112, SEQ ID NO: 113, SEQ ID NO: 114, SEQ ID NO: 115, SEQ ID NO: 116, SEQ ID NO: 117, SEQ ID NO: 118, SEQ ID NO: 119, SEQ ID NO: 120, SEQ ID NO: 121, SEQ ID NO: 122, SEQ ID NO: 123, SEQ ID NO: 124, SEQ ID NO: 125, SEQ ID NO: 126, SEQ ID NO: 127, SEQ ID NO: 128, SEQ ID NO: 129, SEQ ID NO: 130, SEQ ID NO: 131, SEQ ID NO: 132, SEQ ID NO: 133, SEQ ID NO: 134, SEQ ID NO: 135, SEQ ID NO: 136, SEQ ID NO: 137, SEQ ID NO: 138, SEQ ID NO: 139, SEQ ID NO: 140, SEQ ID NO: 141, SEQ ID NO: 142, SEQ ID NO: 143, SEQ ID NO: 144, SEQ ID NO: 145; or SEQ ID NO: 146.

[0193] One embodiment provides an isolated polynucleotide comprising, consisting essentially of, or consisting of a nucleic acid which encodes a W4 mutant scFv-Fc molecule, where the nucleic acid is at least 80%, 85%, 90% 95% or 100% identical to one or more of SEQ ID NO: 147, SEQ ID NO: 148, SEQ ID NO: 149, SEQ ID NO: 150, SEQ ID NO: 151, or SEQ ID NO: 152, SEQ IS NO: 153, SEQ ID NO: 154, SEQ ID NO: 155, SEQ ID NO: 156, SEQ ID NO: 157, SEQ ID NO: 158, SEQ ID NO: 159, SEQ ID NO: 160, SEQ ID NO: 161, SEQ ID NO: 162, SEQ ID NO: 163, SEQ ID NO: 164, SEQ ID NO: 165, SEQ ID NO: 166, SEQ ID NO: 167, SEQ ID NO: 168, SEQ ID NO: 169, SEQ ID NO: 170, SEQ ID NO: 171, SEQ ID NO: 172, SEQ ID NO: 173, SEQ ID NO: 174, SEQ ID NO: 175, SEQ ID NO: 176, SEQ ID NO: 177, SEQ ID NO: 178, SEQ ID NO: 179, SEQ ID NO: 180, SEQ ID NO: 181, SEQ ID NO: 182, SEQ ID NO: 183, SEQ ID NO: 184, SEQ ID NO: 185, SEQ ID NO: 186, SEQ ID NO: 187, SEQ ID NO: 188, SEQ ID NO: 189, SEQ ID NO: 190, SEQ ID NO: 191, SEQ ID NO: 192, SEQ ID NO: 193, SEQ ID NO: 194, SEQ ID NO: 195, SEQ ID NO: 196, SEQ ID NO: 197, SEQ ID NO: 198, SEQ ID NO: 199, SEQ ID NO: 200, SEQ ID NO: 201, SEQ ID NO: 202, SEQ ID NO: 203, SEQ ID NO: 204, SEQ ID NO: 205, SEQ ID NO: 206, SEQ ID NO: 207, SEQ ID NO: 208, SEQ ID NO: 209, SEQ ID NO: 210, SEQ ID NO: 211, SEQ ID NO: 212, SEQ ID NO: 213, SEQ ID NO: 214; or SEQ ID NO: 215.

[0194] In other embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof encoded by one or more of the polynucleotides described above, specifically binds to the same epitope as monoclonal antibody WapR-001, WapR-002, or WapR-003, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl.

[0195] In certain embodiments, an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof encoded by one or more of the polynucleotides described above, specifically binds to the same epitope

as monoclonal antibody WapR-016, or will competitively inhibit such a monoclonal antibody from binding to *Pseudomonas* Psl.

[0196] The disclosure also includes fragments of the polynucleotides as described elsewhere herein. Additionally polynucleotides which encode fusion polynucleotides, Fab fragments, and other derivatives, as described herein, are also provided.

[0197] The polynucleotides can be produced or manufactured by any method known in the art. For example, if the nucleotide sequence of the antibody is known, a polynucleotide encoding the antibody can be assembled from chemically synthesized oligonucleotides (*e.g.*, as described in Kutmeier et al., BioTechniques 17:242 (1994)), which, briefly, involves the synthesis of overlapping oligonucleotides containing portions of the sequence encoding the antibody, annealing and ligating of those oligonucleotides, and then amplification of the ligated oligonucleotides by PCR.

[0198] Alternatively, a polynucleotide encoding an anti-*Pseudomonas* Psl binding molecule, *e.g.,* antibody or fragment, variant or derivative thereof can be generated from nucleic acid from a suitable source. If a clone containing a nucleic acid encoding a particular antibody is not available, but the sequence of the antibody molecule is known, a nucleic acid encoding the antibody can be chemically synthesized or obtained from a suitable source (*e.g.*, an antibody cDNA library, or a cDNA library generated from, or nucleic acid, preferably poly A+RNA, isolated from, any tissue or cells expressing the antibody or such as hybridoma cells selected to express an antibody) by PCR amplification using synthetic primers hybridizable to the 3' and 5' ends of the sequence or by cloning using an oligonucleotide probe specific for the particular gene sequence to identify, *e.g.*, a cDNA clone from a cDNA library that encodes the antibody. Amplified nucleic acids generated by PCR can then be cloned into replicable cloning vectors using any method well known in the art.

[0199] Once the nucleotide sequence and corresponding amino acid sequence of an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof is determined, its nucleotide sequence can be manipulated using methods well known in the art for the manipulation of nucleotide sequences, *e.g.*, recombinant DNA techniques, site directed mutagenesis, PCR, etc. (see, for example, the techniques described in Sambrook et al., Molecular Cloning, A Laboratory Manual, 2d Ed., Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y. (1990) and Ausubel et al., eds., Current Protocols in Molecular Biology, John Wiley & Sons, NY (1998), which are both incorporated by reference herein in their entireties), to generate antibodies having a different amino acid sequence, for example to create amino acid substitutions, deletions, and/or insertions.

[0200] A polynucleotide encoding an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof can be composed of any polyribonucleotide or polydeoxribonucleotide, which can be unmodified RNA or DNA or modified RNA or DNA. For example, a polynucleotide encoding an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof can be composed of single- and double-stranded DNA, DNA that is a mixture of single- and double-stranded regions, single- and double-stranded RNA, and RNA that is mixture of single- and double-stranded regions, hybrid molecules comprising DNA and RNA that can be single-stranded or, more typically, double-stranded or a mixture of single- and double-stranded regions. In addition, a polynucleotide encoding an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof can be composed of triple-stranded regions comprising RNA or DNA or both RNA and DNA. A polynucleotide encoding an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof can also contain one or more modified bases or DNA or RNA backbones modified for stability or for other reasons. "Modified" bases include, for example, tritylated bases and unusual bases such as inosine. A variety of modifications can be made to DNA and RNA; thus, "polynucleotide" embraces chemically, enzymatically, or metabolically modified forms.

[0201] An isolated polynucleotide encoding a non-natural variant of a polypeptide derived from an immunoglobulin (*e.g.*, an immunoglobulin heavy chain portion or light chain portion) can be created by introducing one or more nucleotide substitutions, additions or deletions into the nucleotide sequence of the immunoglobulin such that one or more amino acid substitutions, additions or deletions are introduced into the encoded protein. Mutations can be introduced by standard techniques, such as site-directed mutagenesis and PCR-mediated mutagenesis. Conservative amino acid substitutions are made at one or more non-essential amino acid residues.

VI. EXPRESSION OF ANTIBODY POLYPEPTIDES

[0202] As is well known, RNA can be isolated from the original hybridoma cells or from other transformed cells by standard techniques, such as guanidinium isothiocyanate extraction and precipitation followed by centrifugation or chromatography. Where desirable, mRNA can be isolated from total RNA by standard techniques such as chromatography on oligo dT cellulose. Suitable techniques are familiar in the art.

[0203] In one embodiment, cDNAs that encode the light and the heavy chains of the anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof can be made, either simultaneously or separately, using reverse transcriptase and DNA polymerase in accordance with well-known methods. PCR can be initiated by consensus constant region primers or by more specific primers based on the published heavy and light chain DNA and amino acid sequences. As discussed above, PCR also can be used to isolate DNA clones encoding the antibody light

and heavy chains. In this case the libraries can be screened by consensus primers or larger homologous probes, such as mouse constant region probes.

[0204] DNA, typically plasmid DNA, can be isolated from the cells using techniques known in the art, restriction mapped and sequenced in accordance with standard, well known techniques set forth in detail, *e.g.*, in the foregoing references relating to recombinant DNA techniques. Of course, the DNA can be synthetic according to the present disclosure at any point during the isolation process or subsequent analysis.

[0205] Following manipulation of the isolated genetic material to provide an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof of the disclosure, the polynucleotides encoding anti-*Pseudomonas* Psl binding molecules, are typically inserted in an expression vector for introduction into host cells that can be used to produce the desired quantity of anti-*Pseudomonas* Psl binding molecules.

[0206] Recombinant expression of an antibody, or fragment, derivative or analog thereof, *e.g.*, a heavy or light chain of an antibody which binds to a target molecule described herein, *e.g.*, Psl, requires construction of an expression vector containing a polynucleotide that encodes the antibody. Once a polynucleotide encoding an antibody molecule or a heavy or light chain of an antibody, or portion thereof (containing the heavy or light chain variable domain), of the disclosure has been obtained, the vector for the production of the antibody molecule can be produced by recombinant DNA technology using techniques well known in the art. Thus, methods for preparing a protein by expressing a polynucleotide containing an antibody encoding nucleotide sequence are described herein. Methods which are well known to those skilled in the art can be used to construct expression vectors containing antibody coding sequences and appropriate transcriptional and translational control signals. These methods include, for example, *in vitro* recombinant DNA techniques, synthetic techniques, and *in vivo* genetic recombination. The disclosure, thus, provides replicable vectors comprising a nucleotide sequence encoding an antibody molecule of the disclosure, or a heavy or light chain thereof, or a heavy or light chain variable domain, operably linked to a promoter. Such vectors can include the nucleotide sequence encoding the constant region of the antibody molecule (see, *e.g.*, PCT Publication WO 86/05807; PCT Publication WO 89/01036; and U.S. Pat. No. 5,122,464) and the variable domain of the antibody can be cloned into such a vector for expression of the entire heavy or light chain.

[0207] The term "vector" or "expression vector" is used herein to mean vectors used in accordance with the present disclosure as a vehicle for introducing into and expressing a desired gene in a host cell. As known to those skilled in the art, such vectors can easily be selected from the group consisting of plasmids, phages, viruses and retroviruses. In general, vectors compatible with the instant disclosure will comprise a selection marker, appropriate restriction sites to facilitate cloning of the desired gene and the ability to enter and/or replicate in eukaryotic or prokaryotic cells.

[0208] For the purposes of this disclosure, numerous expression vector systems can be employed. For example, one class of vector utilizes DNA elements which are derived from animal viruses such as bovine papilloma virus, polyoma virus, adenovirus, vaccinia virus, baculovirus, retroviruses (RSV, MMTV or MOMLV) or SV40 virus. Others involve the use of polycistronic systems with internal ribosome binding sites. Additionally, cells which have integrated the DNA into their chromosomes can be selected by introducing one or more markers which allow selection of transfected host cells. The marker can provide for prototrophy to an auxotrophic host, biocide resistance (*e.g.*, antibiotics) or resistance to heavy metals such as copper. The selectable marker gene can either be directly linked to the DNA sequences to be expressed, or introduced into the same cell by cotransformation. Additional elements can also be needed for optimal synthesis of mRNA. These elements can include signal sequences, splice signals, as well as transcriptional promoters, enhancers, and termination signals.

[0209] In some embodiments the cloned variable region genes are inserted into an expression vector along with the heavy and light chain constant region genes (*e.g.*, human) synthetic as discussed above. Of course, any expression vector which is capable of eliciting expression in eukaryotic cells can be used in the present disclosure. Examples of suitable vectors include, but are not limited to plasmids pcDNA3, pHCMV/Zeo, pCR3.1, pEF1/His, pIND/GS, pRc/HCMV2, pSV40/Zeo2, pTRACER-HCMV, pUB6/V5-His, pVAX1, and pZeoSV2 (available from Invitrogen, San Diego, CA), and plasmid pCI (available from Promega, Madison, WI). In general, screening large numbers of transformed cells for those which express suitably high levels if immunoglobulin heavy and light chains is routine experimentation which can be carried out, for example, by robotic systems.

[0210] More generally, once the vector or DNA sequence encoding a monomeric subunit of the anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof of the disclosure has been prepared, the expression vector can be introduced into an appropriate host cell. Introduction of the plasmid into the host cell can be accomplished by various techniques well known to those of skill in the art. These include, but are not limited to, transfection (including electrophoresis and electroporation), protoplast fusion, calcium phosphate precipitation, cell fusion with enveloped DNA, microinjection, and infection with intact virus. *See,* Ridgway, A. A. G. "Mammalian Expression Vectors" Vectors, Rodriguez and Denhardt, Eds., Butterworths, Boston, Mass., Chapter 24.2, pp. 470-472 (1988). Typically, plasmid introduction into the host is via electroporation. The host cells harboring the expression construct are grown under conditions appropriate to the production of the light chains and heavy chains, and assayed for heavy and/or light chain protein synthesis. Exemplary assay techniques include enzyme-linked immunosorbent assay (ELISA), radioim-

munoassay (RIA), or fluorescence-activated cell sorter analysis (FACS), immunohistochemistry and the like.

[0211] The expression vector is transferred to a host cell by conventional techniques and the transfected cells are then cultured by conventional techniques to produce an antibody for use in the methods described herein. Thus, the disclosure includes host cells containing a polynucleotide encoding anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof, or a heavy or light chain thereof, operably linked to a heterologous promoter. In some embodiments for the expression of double-chained antibodies, vectors encoding both the heavy and light chains can be co-expressed in the host cell for expression of the entire immunoglobulin molecule, as detailed below.

[0212] Certain embodiments include an isolated polynucleotide comprising a nucleic acid which encodes the above-described VH and VL, wherein a binding molecule or antigen-binding fragment thereof expressed by the polynucleotide specifically binds *Pseudomonas* Psl. In some embodiments the polynucleotide as described encodes an scFv molecule including VH and VL, at least 80%, 85%, 90% 95% or 100% identical to one or more of SEQ ID NO: 65, SEQ ID NO: 66, SEQ ID NO: 67, SEQ ID NO: 68, SEQ ID NO: 69, or SEQ ID NO: 70 as shown in Table 4.

[0213] Some embodiments include vectors comprising the above-described polynucleotides. In further embodiments, the polynucleotides are operably associated with a promoter. In additional embodiments, the disclosure provides host cells comprising such vectors. In further embodiments, the disclosure provides vectors where the polynucleotide is operably associated with a promoter, wherein vectors can express a binding molecule which specifically binds *Pseudomonas Psl* in a suitable host cell.

[0214] Also provided is a method of producing a binding molecule or fragment thereof which specifically binds *Pseudomonas* Psl, comprising culturing a host cell containing a vector comprising the above-described polynucleotides, and recovering said antibody, or fragment thereof. In further embodiments, the disclosure provides an isolated binding molecule or fragment thereof produced by the above-described method.

[0215] As used herein, "host cells" refers to cells which harbor vectors constructed using recombinant DNA techniques and encoding at least one heterologous gene. In descriptions of processes for isolation of antibodies from recombinant hosts, the terms "cell" and "cell culture" are used interchangeably to denote the source of antibody unless it is clearly specified otherwise. In other words, recovery of polypeptide from the "cells" can mean either from spun down whole cells, or from the cell culture containing both the medium and the suspended cells.

[0216] A variety of host-expression vector systems can be utilized to express antibody molecules for use in the methods described herein. Such host-expression systems represent vehicles by which the coding sequences of interest can be produced and subsequently purified, but also represent cells which can, when transformed or transfected with the appropriate nucleotide coding sequences, express an antibody molecule of the disclosure *in situ.* These include but are not limited to microorganisms such as bacteria (*e.g.*, *E. coli, B. subtilis*) transformed with recombinant bacteriophage DNA, plasmid DNA or cosmid DNA expression vectors containing antibody coding sequences; yeast (*e.g.*, *Saccharomyces, Pichia*) transformed with recombinant yeast expression vectors containing antibody coding sequences; insect cell systems infected with recombinant virus expression vectors (*e.g.*, baculovirus) containing antibody coding sequences; plant cell systems infected with recombinant virus expression vectors (*e.g.*, cauliflower mosaic virus, CaMV; tobacco mosaic virus, TMV) or transformed with recombinant plasmid expression vectors (*e.g.*, Ti plasmid) containing antibody coding sequences; or mammalian cell systems (*e.g.,* COS, CHO, BLK, 293, 3T3 cells) harboring recombinant expression constructs containing promoters derived from the genome of mammalian cells (*e.g.*, metallothionein promoter) or from mammalian viruses (*e.g.*, the adenovirus late promoter; the vaccinia virus 7.5K promoter). Bacterial cells such as *Escherichia coli,* or eukaryotic cells, especially for the expression of whole recombinant antibody molecule, are used for the expression of a recombinant antibody molecule. For example, mammalian cells such as Chinese hamster ovary cells (CHO), in conjunction with a vector such as the major intermediate early gene promoter element from human cytomegalovirus is an effective expression system for antibodies (Foecking et al., Gene 45:101 (1986); Cockett et al., Bio/Technology 8:2 (1990)).

[0217] The host cell line used for protein expression is often of mammalian origin; those skilled in the art are credited with ability to determine particular host cell lines which are best suited for the desired gene product to be expressed therein. Exemplary host cell lines include, but are not limited to, CHO (Chinese Hamster Ovary), DG44 and DUXB11 (Chinese Hamster Ovary lines, DHFR minus), HELA (human cervical carcinoma), CVI (monkey kidney line), COS (a derivative of CVI with SV40 T antigen), VERY, BHK (baby hamster kidney), MDCK, 293, WI38, R1610 (Chinese hamster fibroblast) BALBC/3T3 (mouse fibroblast), HAK (hamster kidney line), SP2/O (mouse myeloma), P3x63-Ag3.653 (mouse myeloma), BFA-1c1BPT (bovine endothelial cells), RAJI (human lymphocyte) and 293 (human kidney). Host cell lines are typically available from commercial services, the American Tissue Culture Collection or from published literature.

[0218] In addition, a host cell strain can be chosen which modulates the expression of the inserted sequences, or modifies and processes the gene product in the specific fashion desired. Such modifications (*e.g.*, glycosylation) and processing (*e.g.*, cleavage) of protein products can be important for the function of the protein. Different host cells have characteristic and specific mechanisms for the post-translational processing and modification of proteins and gene products. Appropriate cell lines or host systems can be chosen to ensure the correct modification and processing of the foreign protein expressed. To this end, eukaryotic host cells which possess the cellular machinery for proper processing

of the primary transcript, glycosylation, and phosphorylation of the gene product can be used.

[0219] For long-term, high-yield production of recombinant proteins, stable expression is preferred. For example, cell lines which stably express the antibody molecule can be engineered. Rather than using expression vectors which contain viral origins of replication, host cells can be transformed with DNA controlled by appropriate expression control elements (*e.g.*, promoter, enhancer, sequences, transcription terminators, polyadenylation sites, etc.), and a selectable marker. Following the introduction of the foreign DNA, engineered cells can be allowed to grow for 1-2 days in an enriched media, and then are switched to a selective media. The selectable marker in the recombinant plasmid confers resistance to the selection and allows cells to stably integrate the plasmid into their chromosomes and grow to form foci which in turn can be cloned and expanded into cell lines. This method can advantageously be used to engineer cell lines which stably express the antibody molecule.

[0220] A number of selection systems can be used, including but not limited to the herpes simplex virus thymidine kinase (Wigler et al., Cell 11:223 (1977)), hypoxanthine-guanine phosphoribosyltransferase (Szybalska & Szybalski, Proc. Natl. Acad. Sci. USA 48:202 (1992)), and adenine phosphoribosyltransferase (Lowy et al., Cell 22:817 1980) genes can be employed in tk-, hgprt- or aprt-cells, respectively. Also, antimetabolite resistance can be used as the basis of selection for the following genes: dhfr, which confers resistance to methotrexate (Wigler et al., Natl. Acad. Sci. USA 77:357 (1980); O'Hare et al., Proc. Natl. Acad. Sci. USA 78:1527 (1981)); gpt, which confers resistance to mycophenolic acid (Mulligan & Berg, Proc. Natl. Acad. Sci. USA 78:2072 (1981)); neo, which confers resistance to the aminoglycoside G-418 Clinical Pharmacy 12:488-505; Wu and Wu, Biotherapy 3:87-95 (1991); Tolstoshev, Ann. Rev. Pharmacol. Toxicol. 32:573-596 (1993); Mulligan, Science 260:926-932 (1993); and Morgan and Anderson, Ann. Rev. Biochem. 62:191-217 (1993);, TIB TECH 11(5):155-215 (May, 1993); and hygro, which confers resistance to hygromycin (Santerre et al., Gene 30:147 (1984). Methods commonly known in the art of recombinant DNA technology which can be used are described in Ausubel et al. (eds.), Current Protocols in Molecular Biology, John Wiley & Sons, NY (1993); Kriegler, Gene Transfer and Expression, A Laboratory Manual, Stockton Press, NY (1990); and in Chapters 12 and 13, Dracopoli et al. (eds), Current Protocols in Human Genetics, John Wiley & Sons, NY (1994); Colberre-Garapin et al., J. Mol. Biol. 150:1 (1981), which are incorporated by reference herein in their entireties.

[0221] The expression levels of an antibody molecule can be increased by vector amplification (for a review, *see* Bebbington and Hentschel, The use of vectors based on gene amplification for the expression of cloned genes in mammalian cells in DNA cloning, Academic Press, New York, Vol. 3. (1987)). When a marker in the vector system expressing antibody is amplifiable, increase in the level of inhibitor present in culture of host cell will increase the number of copies of the marker gene. Since the amplified region is associated with the antibody gene, production of the antibody will also increase (Crouse et al., Mol. Cell. Biol. 3:257 (1983)).

[0222] *In vitro* production allows scale-up to give large amounts of the desired polypeptides. Techniques for mammalian cell cultivation under tissue culture conditions are known in the art and include homogeneous suspension culture, *e.g.* in an airlift reactor or in a continuous stirrer reactor, or immobilized or entrapped cell culture, *e.g.* in hollow fibers, microcapsules, on agarose microbeads or ceramic cartridges. If necessary and/or desired, the solutions of polypeptides can be purified by the customary chromatography methods, for example gel filtration, ion-exchange chromatography, chromatography over DEAE-cellulose or (immuno-)affinity chromatography, *e.g.,* after preferential biosynthesis of a synthetic hinge region polypeptide or prior to or subsequent to the HIC chromatography step described herein.

[0223] Constructs encoding anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof, as disclosed herein can also be expressed non-mammalian cells such as bacteria or yeast or plant cells. Bacteria which readily take up nucleic acids include members of the enterobacteriaceae, such as strains of *Escherichia coli* or *Salmonella*; Bacillaceae, such as *Bacillus subtilis*; *Pneumococcus*; *Streptococcus,* and *Haemophilus influenzae.* It will further be appreciated that, when expressed in bacteria, the heterologous polypeptides typically become part of inclusion bodies. The heterologouspolypeptides must be isolated, purified and then assembled into functional molecules. Where tetravalent forms of antibodies are desired, the subunits will then self-assemble into tetravalent antibodies (WO02/096948A2).

[0224] In bacterial systems, a number of expression vectors can be advantageously selected depending upon the use intended for the antibody molecule being expressed. For example, when a large quantity of such a protein is to be produced, for the generation of pharmaceutical compositions of an antibody molecule, vectors which direct the expression of high levels of fusion protein products that are readily purified can be desirable. Such vectors include, but are not limited, to the *E. coli* expression vector pUR278 (Ruther et al., EMBO J. 2:1791 (1983)), in which the antibody coding sequence can be ligated individually into the vector in frame with the lacZ coding region so that a fusion protein is produced; pIN vectors (Inouye & Inouye, Nucleic Acids Res. 13:3101-3109 (1985); Van Heeke & Schuster, J. Biol. Chem. 24:5503-5509 (1989)); and the like. pGEX vectors can also be used to express foreign polypeptides as fusion proteins with glutathione S-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption and binding to a matrix glutathione-agarose beads followed by elution in the presence of free glutathione. The pGEX vectors are designed to include thrombin or factor Xa protease cleavage sites so that the cloned target gene product can be released from the GST moiety.

[0225] In addition to prokaryotes, eukaryotic microbes can also be used. *Saccharomyces cerevisiae,* or common baker's yeast, is the most commonly used among eukaryotic microorganisms although a number of other strains are commonly available, *e.g.*, *Pichia pastoris.*

[0226] For expression in *Saccharomyces,* the plasmid YRp7, for example, (Stinchcomb et al., Nature 282:39 (1979); Kingsman et al., Gene 7:141 (1979); Tschemper et al., Gene 10:157 (1980)) is commonly used. This plasmid already contains the TRP1 gene which provides a selection marker for a mutant strain of yeast lacking the ability to grow in tryptophan, for example ATCC No. 44076 or PEP4-1 (Jones, Genetics 85:12 (1977)). The presence of the trpl lesion as a characteristic of the yeast host cell genome then provides an effective environment for detecting transformation by growth in the absence of tryptophan.

[0227] In an insect system, *Autog*rapha californica nuclear polyhedrosis virus (AcNPV) is typically used as a vector to express foreign genes. The virus grows in Spodoptera *frugiperda* cells. The antibody coding sequence can be cloned individually into non-essential regions (for example the polyhedrin gene) of the virus and placed under control of an AcNPV promoter (for example the polyhedrin promoter).

[0228] Once the anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof, as disclosed herein has been recombinantly expressed, it can be purified by any method known in the art for purification of an immunoglobulin molecule, for example, by chromatography (*e.g.*, ion exchange, affinity, particularly by affinity for the specific antigen after Protein A, and sizing column chromatography), centrifugation, differential solubility, or by any other standard technique for the purification of proteins. Another method for increasing the affinity of antibodies of the disclosure is disclosed in US 2002 0123057 A1.

VII. IDENTIFICATION OF SEROTYPE-INDIFFERENT BINDING MOLECULES

[0229] The disclosure encompasses a target indifferent whole-cell approach to identify serotype independent therapeutic binding molecules *e.g.*, antibodies or fragments thereof with superior or desired therapeutic activities. The method can be utilized to identify binding molecules which can antagonize, neutralize, clear, or block an undesired activity of an infectious agent, *e.g.*, a bacterial pathogen. As is known in the art, many infectious agents exhibit significant variation in their dominant surface antigens, allowing them to evade immune surveillance. The identification method described herein can identify binding molecules which target antigens which are shared among many different *Pseudomonas* species or other Gram-negative pathogens, thus providing a therapeutic agent which can target multiple pathogens from multiple species. For example, the method was utilized to identify a series of binding molecules which bind to the surface of *P. aeruginosa* in a serotype-independent manner, and when bound to bacterial pathogens, mediate, promote, or enhance opsonophagocytic (OPK) activity against bacterial cells such as bacterial pathogens, *e.g.* opportunistic *Pseudomonas* species (*e.g., Pseudomonas aeruginosa, Pseudomonas fluorescens, Pseudomonas putida, and Pseudomonas alcaligenes*) and/or inhibit the attachment of such bacterial cells to epithelial cells.

[0230] Certain embodiments disclose a method of identifying serotype-indifferent binding molecules comprising: (a) preparing naive and/or convalescent antibody libraries in phage, (b) removing serotype-specific antibodies from the library by depletion panning, (c) screening the library for antibodies that specifically bind to whole cells independent of serotype, and (d) screening of the resulting antibodies for desired functional properties.

[0231] Certain embodiments provide a whole-cell phenotypic screening approach as disclosed herein with antibody phage libraries derived from either naive or *P. aeruginosa* infected convalescing patients. Using a panning strategy that initially selected against serotype-specific reactivity, different clones that bound *P. aeruginosa* whole cells were isolated. Selected clones were converted to human IgG1 antibodies and were confirmed to react with *P. aeruginosa* clinical isolates regardless of serotype classification or site of tissue isolation (See Examples). Functional activity screens described herein indicated that the antibodies were effective in preventing *P. aeruginosa* attachment to mammalian cells and mediated opsonophagocytic (OPK) killing in a concentration-dependent and serotype-independent manner.

[0232] In further embodiments, the above-described binding molecules or fragments thereof, antibodies or fragments thereof, or compositions, bind to two or more, three or more, four or more, or five or more different *P. aeruginosa* serotypes, or to at least 80%, at least 85%, at least 90% or at least 95% of *P. aeruginosa* strains isolated from infected patients. In further embodiments, the *P. aeruginosa* strains are isolated from one or more of lung, sputum, eye, pus, feces, urine, sinus, a wound, skin, blood, bone, or knee fluid.

VIII. PHARMACEUTICAL COMPOSITIONS COMPRISING ANTI- *PSEUDOMONAS* PSL BINDING MOLECULES

[0233] The pharmaceutical compositions used in this disclosure comprise pharmaceutically acceptable carriers well known to those of ordinary skill in the art. Preparations for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, and emulsions. Certain pharmaceutical compositions as disclosed herein can be orally administered in an acceptable dosage form including, *e.g.*, capsules, tablets, aqueous suspensions or solutions. Certain pharmaceutical compositions also can be administered by nasal aerosol or inhalation. Preservatives and other additives

can also be present such as for example, antimicrobials, antioxidants, chelating agents, and inert gases and the like. Suitable formulations for use in the therapeutic methods disclosed herein are described in Remington's Pharmaceutical Sciences, Mack Publishing Co., 16th ed. (1980).

[0234] The amount of an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof, that can be combined with the carrier materials to produce a single dosage form will vary depending upon the host treated and the particular mode of administration. Dosage regimens also can be adjusted to provide the optimum desired response (*e.g.,* a therapeutic or prophylactic response). The compositions can also comprise the anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof dispersed in a biocompatible carrier material that functions as a suitable delivery or support system for the compounds.

IX. TREATMENT METHODS USING THERAPEUTIC BINDING MOLECULES

[0235] Methods of preparing and administering an anti-*Pseudomonas* Psl binding molecule, *e.g.*, an antibody or fragment, variant or derivative thereof, as disclosed herein to a subject in need thereof are well known to or are readily determined by those skilled in the art. The route of administration of the anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof, can be, for example, oral, parenteral, by inhalation or topical. The term parenteral as used herein includes, *e.g.*, intravenous, intraarterial, intraperitoneal, intramuscular, or subcutaneous administration. A suitable form for administration would be a solution for injection, in particular for intravenous or intraarterial injection or drip. However, in other methods compatible with the teachings herein, an anti-*Pseudomonas* Psl binding molecule, *e.g.*, antibody or fragment, variant or derivative thereof, as disclosed herein can be delivered directly to the site of the adverse cellular population *e.g.*, infection thereby increasing the exposure of the diseased tissue to the therapeutic agent. For example, an anti-*Pseudomonas* Psl binding molecule can be directly administered to ocular tissue, burn injury, or lung tissue.

[0236] Anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof, as disclosed herein can be administered in a pharmaceutically effective amount for the *in vivo* treatment of *Pseudomonas* infection. In this regard, it will be appreciated that the disclosed binding molecules will be formulated so as to facilitate administration and promote stability of the active agent. For the purposes of the instant application, a pharmaceutically effective amount shall be held to mean an amount sufficient to achieve effective binding to a target and to achieve a benefit, *e.g.*, treat, ameliorate, lessen, clear, or prevent *Pseudomonas* infection.

[0237] Some embodiments are directed to a method of preventing or treating a *Pseudomonas* infection in a subject in need thereof, comprising administering to the subject an effective amount of the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein. In further embodiments, the *Pseudomonas* infection is a *P. aeruginosa* infection. In some embodiments, the subject is a human. In certain embodiments, the infection is an ocular infection, a lung infection, a burn infection, a wound infection, a skin infection, a blood infection, a bone infection, or a combination of two or more of said infections. In further embodiments, the subject suffers from acute pneumonia, burn injury, corneal infection, cystic fibrosis, or a combination thereof.

[0238] Certain embodiments are directed to a method of blocking or preventing attachment of *P. aeruginosa* to epithelial cells comprising contacting a mixture of epithelial cells and *P. aeruginosa* with the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein.

[0239] Also disclosed is a method of enhancing OPK of *P. aeruginosa* comprising contacting a mixture of phagocytic cells and *P. aeruginosa* with the binding molecule or fragment thereof, the antibody or fragment thereof, the composition, the polynucleotide, the vector, or the host cell described herein. In further embodiments, the phagocytic cells are differentiated HL-60 cells or human polymorphonuclear leukocytes (PMNs).

[0240] In keeping with the scope of the disclosure, anti-*Pseudomonas* Psl binding molecules, *e.g.,* antibodies or fragments, variants or derivatives thereof, can be administered to a human or other animal in accordance with the aforementioned methods of treatment in an amount sufficient to produce a therapeutic effect. The anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof, disclosed herein can be administered to such human or other animal in a conventional dosage form prepared by combining the antibody of the disclosure with a conventional pharmaceutically acceptable carrier or diluent according to known techniques.

[0241] Effective doses of the compositions of the present disclosure, for treatment of *Pseudomonas* infection vary depending upon many different factors, including means of administration, target site, physiological state of the patient, whether the patient is human or an animal, other medications administered, and whether treatment is prophylactic or therapeutic. Usually, the patient is a human but non-human mammals including transgenic mammals can also be treated. Treatment dosages can be titrated using routine methods known to those of skill in the art to optimize safety and efficacy.

[0242] Anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof can be administered multiple occasions at various frequencies depending on various factors known to those of skill in the art.. Alternatively, anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof can be administered as a sustained release formulation, in which case less frequent administration is required. Dosage

and frequency vary depending on the half-life of the antibody in the patient.

[0243] The compositions of the disclosure can be administered by any suitable method, *e.g.*, parenterally, intraventricularly, orally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. The term "parenteral" as used herein includes subcutaneous, intravenous, intramuscular, intra-articular, intra-synovial, intrasternal, intrathecal, intrahepatic, intralesional and intracranial injection or infusion techniques.

X. IMMUNOASSAYS

[0244] Anti-*Pseudomonas* Psl binding molecules, *e.g.*, antibodies or fragments, variants or derivatives thereof can be assayed for immunospecific binding by any method known in the art. The immunoassays which can be used include but are not limited to competitive and non-competitive assay systems using techniques such as western blots, radioimmunoassays, ELISA (enzyme linked immunosorbent assay), "sandwich" immunoassays, immunoprecipitation assays, precipitin reactions, gel diffusion precipitin reactions, immunodiffusion assays, agglutination assays, complement-fixation assays, immunoradiometric assays, fluorescent immunoassays, protein A immunoassays, to name but a few. Such assays are routine and well known in the art (*see, e.g.,* Ausubel et al., eds, Current Protocols in Molecular Biology, John Wiley & Sons, Inc., New York, Vol. 1 (1994), which is incorporated by reference herein in its entirety). Exemplary immunoassays are described briefly below (but are not intended by way of limitation).

[0245] There are a variety of methods available for measuring the affinity of an antibody-antigen interaction, but relatively few for determining rate constants. Most of the methods rely on either labeling antibody or antigen, which inevitably complicates routine measurements and introduces uncertainties in the measured quantities. Antibody affinity can be measured by a number of methods, including OCTET®, BIACORE®, ELISA, and FACS.

The OCTET® system uses biosensors in a 96-well plate format to report kinetic analysis. Protein binding and dissociation events can be monitored by measuring the binding of one protein in solution to a second protein immobilized on the FortéBio biosensor. In the case of measuring binding of anti-Psl antibodies to Psl, the Psl is immobilized onto OCTET® tips followed by analysis of binding of the antibody, which is in solution. Association and disassociation of antibody to immobilized Psl is then detected by the instrument sensor. The data is then collected and exported to GraphPad Prism for affinity curve fitting.

[0246] Surface plasmon resonance (SPR) as performed on BIACORE® offers a number of advantages over conventional methods of measuring the affinity of antibody-antigen interactions: (i) no requirement to label either antibody or antigen; (ii) antibodies do not need to be purified in advance, cell culture supernatant can be used directly; (iii) real-time measurements, allowing rapid semi-quantitative comparison of different monoclonal antibody interactions, are enabled and are sufficient for many evaluation purposes; (iv) biospecific surface can be regenerated so that a series of different monoclonal antibodies can easily be compared under identical conditions; (v) analytical procedures are fully automated, and extensive series of measurements can be performed without user intervention. BIAapplications Handbook, version AB (reprinted 1998), BIACORE® code No. BR-1001-86; BIAtechnology Handbook, version AB (reprinted 1998), BIACORE® code No. BR-1001-84.

[0247] SPR based binding studies require that one member of a binding pair be immobilized on a sensor surface. The binding partner immobilized is referred to as the ligand. The binding partner in solution is referred to as the analyte. In some cases, the ligand is attached indirectly to the surface through binding to another immobilized molecule, which is referred as the capturing molecule. SPR response reflects a change in mass concentration at the detector surface as analytes bind or dissociate.

[0248] Based on SPR, real-time BIACORE® measurements monitor interactions directly as they happen. The technique is well suited to determination of kinetic parameters. Comparative affinity ranking is extremely simple to perform, and both kinetic and affinity constants can be derived from the sensorgram data.

[0249] When analyte is injected in a discrete pulse across a ligand surface, the resulting sensorgram can be divided into three essential phases: (i) Association of analyte with ligand during sample injection; (ii) Equilibrium or steady state during sample injection, where the rate of analyte binding is balanced by dissociation from the complex; (iii) Dissociation of analyte from the surface during buffer flow.

[0250] The association and dissociation phases provide information on the kinetics of analyte-ligand interaction (k_a and k_d, the rates of complex formation and dissociation, $k_d/k_a = K_D$). The equilibrium phase provides information on the affinity of the analyte-ligand interaction (K_D).

[0251] BIAevaluation software provides comprehensive facilities for curve fitting using both numerical integration and global fitting algorithms. With suitable analysis of the data, separate rate and affinity constants for interaction can be obtained from simple BIACORE® investigations. The range of affinities measurable by this technique is very broad ranging from mM to pM.

[0252] Epitope specificity is an important characteristic of a monoclonal antibody. Epitope mapping with BIACORE®, in contrast to conventional techniques using radioimmunoassay, ELISA or other surface adsorption methods, does not require labeling or purified antibodies, and allows multi-site specificity tests using a sequence of several monoclonal

antibodies. Additionally, large numbers of analyses can be processed automatically.

[0253] Pair-wise binding experiments test the ability of two MAbs to bind simultaneously to the same antigen. MAbs directed against separate epitopes will bind independently, whereas MAbs directed against identical or closely related epitopes will interfere with each other's binding. These binding experiments with BIACORE® are straightforward to carry out.

[0254] For example, one can use a capture molecule to bind the first Mab, followed by addition of antigen and second MAb sequentially. The sensorgrams will reveal: 1. how much of the antigen binds to first Mab, 2. to what extent the second MAb binds to the surface-attached antigen, 3. if the second MAb does not bind, whether reversing the order of the pair-wise test alters the results.

[0255] Peptide inhibition is another technique used for epitope mapping. This method can complement pair-wise antibody binding studies, and can relate functional epitopes to structural features when the primary sequence of the antigen is known. Peptides or antigen fragments are tested for inhibition of binding of different MAbs to immobilized antigen. Peptides which interfere with binding of a given MAb are assumed to be structurally related to the epitope defined by that MAb.

[0256] The practice of the disclosure will employ, unless otherwise indicated, conventional techniques of cell biology, cell culture, molecular biology, transgenic biology, microbiology, recombinant DNA, and immunology, which are within the skill of the art. Such techniques are explained fully in the literature. *See,* for example, Molecular Cloning A Laboratory Manual, 2nd Ed., Sambrook et al., ed., Cold Spring Harbor Laboratory Press: (1989); Molecular Cloning: A Laboratory Manual, Sambrook et al., ed., Cold Springs Harbor Laboratory, New York (1992), DNA Cloning, D. N. Glover ed., Volumes I and II (1985); Oligonucleotide Synthesis, M. J. Gait ed., (1984); Mullis et al. U.S. Pat. No: 4,683,195; Nucleic Acid Hybridization, B. D. Hames & S. J. Higgins eds. (1984); Transcription And Translation, B. D. Hames & S. J. Higgins eds. (1984); Culture Of Animal Cells, R. I. Freshney, Alan R. Liss, Inc., (1987); Immobilized Cells And Enzymes, IRL Press, (1986); B. Perbal, A Practical Guide To Molecular Cloning (1984); the treatise, Methods In Enzymology, Academic Press, Inc., N.Y.; Gene Transfer Vectors For Mammalian Cells, J. H. Miller and M. P. Calos eds., Cold Spring Harbor Laboratory (1987); Methods In Enzymology, Vols. 154 and 155 (Wu et al. eds.); Immunochemical Methods In Cell And Molecular Biology, Mayer and Walker, eds., Academic Press, London (1987); Handbook Of Experimental Immunology, Volumes I-IV, D. M. Weir and C. C. Blackwell, eds., (1986); Manipulating the Mouse Embryo, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y., (1986); and in Ausubel et al., Current Protocols in Molecular Biology, John Wiley and Sons, Baltimore, Maryland (1989).

[0257] Standard reference works setting forth general principles of immunology include Current Protocols in Immunology, John Wiley & Sons, New York; Klein, J., Immunology: The Science of Self-Nonself Discrimination, John Wiley & Sons, New York (1982); Roitt, I., Brostoff, J. and Male D., Immunology, 6th ed. London: Mosby (2001); Abbas A., Abul, A. and Lichtman, A., Cellular and Molecular Immunology, Ed. 5, Elsevier Health Sciences Division (2005); and Harlow and Lane, Antibodies: A Laboratory Manual, Cold Spring Harbor Press (1988).

[0258] Having now described the disclosure in detail, the same will be more clearly understood by reference to the following examples, which are included herewith for purposes of illustration only and are not intended to be limiting of the disclosure. All patents and publications referred to herein are expressly incorporated by reference in their entireties.

EXAMPLES

Example 1: Construction and screening of human antibody phage display libraries

[0259] This example describes a target indifferent whole cell panning approach with human antibody phage libraries derived from both naive and *P. aeruginosa* infected convalescing patients to identify novel protective antigens against *Pseudomonas* infection (Figure 1A). Assays included in the *in vitro* functional screens included opsonophagocytosis (OPK) killing assays and cell attachment assays using the epithelial cell line A549. The lead candidates, based on superior *in vitro* activity, were tested in *P. aeruginosa* acute pneumonia, keratitis, and burn infection models.

[0260] Figure 1B shows construction of patient antibody phage display library. Whole blood was pooled from 6 recovering patients 7-10 days post diagnosis followed by RNA extraction and phage library construction as previously described (Vaughan, T.J., et al., Nat Biotechnol 14, 309-314 (1996); Wrammert, J., et al., Nature 453, 667-671 (2008)). Figure 1C shows that the final cloned scFv library contained 5.4 x 10^8 transformants and sequencing revealed that 79% of scFv genes were full-length and in frame. The VH CDR3 loops, often important for determining epitope specificity, were 84% diverse at the amino acid level prior to library selection.

[0261] In addition to the patient library, a naive human scFv phage display library containing up to $1x10^{11}$ binding members (Lloyd, C., et al., Protein Eng Des Sel 22, 159-168 (2009)) was used for antibody isolation (Vaughan, T.J., et al., Nat Biotechnol 14, 309-314 (1996)). Heat killed *P.aeruginosa* ($1x10^9$) was immobilized in IMMUNO™ Tubes (Nunc; MAXISORP™) followed for phage display selections as described (Vaughan, T.J., et al., Nat Biotechnol 14, 309-314 (1996)) with the exception of triethanolamine (100nM) being used as the elution buffer. For selection on *P. aeruginosa*

in suspension, heat killed cells were blocked followed by addition of blocked phage to cells. After washing, eluted phage was used to infect *E. coli* cells as described (Vaughan, 1996). Rescue of phage from *E. coli* and binding to heat-killed *P. aeruginosa* by ELISA was performed as described (Vaughan, 1996).

[0262] Following development and validation of the whole-cell affinity selection methodology, both the new convalescing patient library and a previously constructed naive library (Vaughan, T.J., et al., Nat Biotechnol 14, 309-314 (1996)) underwent affinity selection on suspensions of *P. aeruginosa* strain 3064 possessing a complete O-antigen as well as an isogenic *wapR* mutant strain which lacked surface expression of O-antigen. Figure ID shows that output titers from successive patient library selections were found to increase at a greater rate for the patient library than for the naive library ($1x10^7$ vs $3x10^5$ at round 3, respectively). In addition, duplication of VH CDR3 loop sequences in the libraries (a measure of clonal enrichment during selection), was also found to be higher in the patient library, reaching 88-92%, compared to 15-25% in the naive library at round 3 (Figure 1D). Individual scFv phage from affinity selections were next screened by ELISA for reactivity to *P. aeruginosa* heterologous serotype strains (Figure 1E). ELISA plates (Nunc; MAXISORP™) were coated with *P. aeruginosa* strains from overnight cultures as described (DiGiandomenico, A., et al., Infect Immun 72, 7012-7021 (2004)). Diluted antibodies were added to blocked plates for 1 hour, washed, and treated with HRP-conjugated anti-human secondary antibodies for 1 hour followed by development and analysis as described (Ulbrandt, N.D., et al., J Virol 80, 7799-7806 (2006)). The dominant species of phage obtained from whole cell selections with both libraries yielded serotype specific reactivity (data not shown). Clones exhibiting serotype independent binding in the absence of nonspecific binding to *E. coli* or bovine serum albumin were selected for further evaluation.

[0263] For IgG expression, the VH and VL chains of selected antibodies were cloned into human IgG1 expression vectors, co-expressed in HEK293 cells, and purified by protein A affinity chromatography as described (Persic, L., et al., Gene 187, 9-18 (1997)). Human IgG1 antibodies made with the variable regions from these selected serotype independent phage were confirmed for *P. aeruginosa* specificity and prioritized for subsequent analysis by whole cell binding to dominant clinically relevant serotypes by FACS analysis (Figure 1F), since this method is more stringent than ELISA. For the flow cytometry based binding assays mid-log phase *P. aeruginosa* strains were concentrated in PBS to an OD_{650} of 2.0. After incubation of antibody (10 μg/mL) and bacteria (~1 x 10^7 cells) for 1 hr at 4°C with shaking, washed cells were incubated with an ALEXA FLUOR 647® goat anti- human IgG antibody (Invitrogen, Carlsbad, CA) for 0.5 hr at 4°C. Washed cells were stained with BACLIGHT™ green bacterial stain as recommended (Invitrogen, Carlsbad, CA). Samples were run on a LSR II flow cytometer (BD Biosciences) and analyzed using BD FacsDiva (v. 6.1.3) and FlowJo (v. 9.2; TreeStar). Antibodies exhibiting binding by FACS were further prioritized for functional activity testing in an opsonophagocytosis killing (OPK) assay.

Example 2: Evaluation of mAbs promoting OPK of *P. aeruginosa*

[0264] This example describes the evaluation of prioritized human IgG1 antibodies to promote OPK of *P. aeruginosa.* Figure 2A shows that with the exception of WapR-007 and the negative control antibody R347, all antibodies mediated concentration dependent killing of luminescent *P. aeruginosa* serogroup O5 strain (PAO1.lux). WapR-004 and Cam-003 exhibited superior OPK activity. OPK assays were performed as described in (DiGiandomenico, A., et al., Infect Immun 72, 7012-7021 (2004)), with modifications. Briefly, assays were performed in 96-well plates using 0.025 ml of each OPK component; *P. aeruginosa* strains; diluted baby rabbit serum; differentiated HL-60 cells; and monoclonal antibody. In some OPK assays, luminescent *P. aeruginosa* strains, which were constructed as described (Choi, K.H., et al., Nat Methods 2, 443-448 (2005))., were used. Luminescent OPK assays were performed as described above but with determination of relative luciferase units (RLUs) using a Perkin Elmer ENVISION Multilabel plate reader (Perkin Elmer).

[0265] The ability of the WapR-004 and Cam-003 antibodies to mediate OPK activity against another clinically relevant O-antigen serotype strain, 9882-80.lux, was evaluated. Figure 2B shows that enhanced WapR-004 and Cam-003 OPK activity extends to strain 9882-80 (O11).

[0266] The ability of Cam-003 to mediate OPK activity against representative non-mucoid strains from clinically relevant O-antigen serotypes and against mucoid *P. aeruginosa* strains which were derived from cystic fibrosis patients was evaluated. Cam-003 mediated potent OPK of all non-mucoid clinical isolates tested (Figure 2C). In addition, Cam-003 mediated potent killing of all mucoid *P. aeruginosa* isolates that were tested (Figure 2D).

[0267] In addition, this example describes the evaluation of WapR-004 (W4) mutants in scFv-Fc format to promote OPK of *P. aeruginosa.* One mutant, Wap-004RAD (W4-RAD), was specifically created through site-directed mutagenesis to remove an RGD motif in VH. Other W4 mutants were prepared as follows. Nested PCR was performed as described (Roux, K.H., PCR Methods Appl 4, S185-194 (1995)), to amplify W4 variants (derived from somatic hypermutation) from the scFv library derived from the convalescing P. aeruginosa infected patients , for analysis. This is the library from which WapR-004 was derived. W4 variant fragments were subcloned and sequenced using standard procedures known in the art. W4 mutant light chains (LC) were recombined with the WapR-004 heavy chain (HC) to produce W4 mutants in scFv-Fc format. In addition WapR-004 RAD heavy chain (HC) mutants were recombined with parent LCs of M7 and

M8 in the scFv-Fc format. Constructs were prepared using standard procedures known in the art. Figures 11 (A-M) show that with the exception of the negative control antibody R347, all WapR-004 (W4) mutants mediated concentration dependent killing of luminescent *P. aeruginosa* serogroup O5 strain (PAO1.lux).

Example 3: Serotype independent anti-*P. aeruginosa* antibodies target the Psl exopolysaccharide

[0268] This example describes identification of the target of anti-*P. aeruginosa* antibodies derived from phenotypic screening. Target analysis was performed to test whether the serotype independent antibodies targeted protein or carbohydrate antigens. No loss of binding was observed in ELISA to PAO1 whole cell extracts exhaustively digested with proteinase K, suggesting that reactivity targeted surface accessible carbohydrate residues (data not shown). Isogenic mutants were constructed in genes responsible for O-antigen, alginate, and LPS core biosynthesis; *wbpL* (O-antigen-deficient); *wbpL*/*algD* (O-antigen and alginate deficient); *rmlC* (O-antigen-deficient and truncated outer core); and *galU* (O-antigen-deficient and truncated inner core). *P. aeruginosa* mutants were constructed based on the allele replacement strategy described by Schweizer (Schweizer, H.P., Mol Microbiol 6, 1195-1204 (1992); Schweizer, H.D., Biotechniques 15, 831-834 (1993)). Vectors were mobilized from *E. coli* strain S17.1 into *P. aeruginosa* strain PAO1; recombinants were isolated as described (Hoang, T.T., et al., Gene 212, 77-86 (1998)). Gene deletion was confirmed by PCR. *P. aeruginosa* mutants were complemented with pUCP30T-based constructs harboring wild type genes. Reactivity of antibodies was determined by indirect ELISA on plates coated with above indicated *P. aeruginosa* strains: Figures 3A and 3J show that Cam-003 binding to the *wbpL* or the *wbpL*/*algD* double mutant was unaffected, however binding to the *rmlC* and *galU* mutants were abolished. While these results were consistent with binding to LPS core, reactivity to LPS purified from PAO1 was not observed. The *rmlC* and *galU* genes were recently shown to be required for biosynthesis of the Psl exopolysaccharide, a repeating pentasaccharide polymer consisting of D-mannose, L-rhamnose, and D-glucose. Cam-003 binding to an isogenic *pslA* knockout PAO1Δ*pslA,* was tested, as *pslA* is required for Psl biosynthesis (Byrd, M.S., et al., Mol Microbiol 73, 622-638 (2009)). Binding of Cam-003 to PAO1Δ*pslA* was abolished when tested by ELISA (Figure 3B) and FACS (Figure 3C), while the LPS molecule in this mutant was unaffected (Figure 3D). Binding of Cam-003 was restored in a PAO1Δ*wbpL*/*algD*/*pslA* triple mutant complemented with *pslA* (Figure 3E) as was the ability of Cam-003 to mediate opsonic killing to complemented PAO1Δ*pslA* in contrast to the mutant (Figure 3F and 3G). Binding of Cam-003 antibody to a Pel exopolysaccharide mutant was also unaffected further confirming Psl as our antibody target (Figure 3E). Binding assays confirmed that the remaining antibodies also bound Psl (Figure 3H and 3I).

[0269] To confirm that all of the antibodies bound to the same antigen, a Psl capture binding assay was performed using a FORTEBIO® OCTET® 384 instrument as described above. The antigen was proteinase K-treated enriched carbohydrate purified from PAO1Δ*wbpL*/*algD*/*pelA* (O-antigen-, alginate- and Pel exopolysaccharide-deficient). Individual antibodies were bound to aminopropylsilane biosensors followed by blocking and the addition of the enriched carbohydrate antigen. After washing to remove unbound antigen, binding of unlabelled mAbs to captured antigen was assessed. All bound antibodies (Cam-003, Cam-004, Cam-005, WapR-001, WapR-002, WapR-003, WapR-007 and WapR-016), with the exception of the control mAb R347, were capable of capturing antigen that reacted with each of Cam-003, WapR-001, WapR-002, WapR-003, and WapR-016 (Figure 3K). Minimal reactivity to captured Psl was observed with Cam-004, Cam-005 and WapR-007 even though all three of these antibodies captured sufficient Psl to potently react with Cam-003, WapR-001, WapR-002, WapR-003, and WapR-016 (Figure 3K). These results suggest that all of the mAbs derived by phenotypic screening that bound *P. aeruginosa* independently of serotype, targeted epitopes associated with Psl exopolysaccharide.

Example 4: Anti-Psl mAbs block attachment of *P. aeruginosa* to cultured epithelial cells.

[0270] This example shows that anti-Psl antibodies blocked *P. aeruginosa* association with epithelial cells. Anti-Psl antibodies were added to a confluent monolayer of A549 cells (an adenocarcinoma human alveolar basal epithelial cell line) grown in opaque 96-well plates (Nunc Nunclon Delta). Log-phase luminescent *P. aeruginosa* PAO1 strain (PAO1.lux) was added at an MOI of 10. After incubation of PAO1.lux with A549 cells at 37°C for 1 hour, the A549 cells were washed, followed by addition of LB+0.5% glucose. Bacteria were quantified following a brief incubation at 37°C as performed in the OPK assay described in Example 2. Measurements from wells without A549 cells were used to correct for non-specific binding. Figure 4 shows that with the exception of Cam-005 and WapR-007, all antibodies reduced association of PAO1.lux to A549 cells in a dose-dependent manner. The mAbs which performed best in OPK assays, WapR-004 and Cam-003 (see Figures 2A-B, and Example 2), were also most active at inhibiting *P. aeruginosa* cell attachment to A549 lung epithelial cells, providing up to ~80% reduction compared to the negative control. WapR-016 was the third most active antibody, showing similar inhibitory activity as WapR-004 and Cam-003 but at 10-fold higher antibody concentration.

Example 5: *In vivo* passaged *P. aeruginosa* strains maintain/increase expression of Psl

[0271] To test if Psl expression *in vivo* is maintained, mice were injected intraperitoneally with *P. aeruginosa* isolates followed by harvesting of bacteria by peritoneal lavage four hours post-infection. The presence of Psl was analyzed with a control antibody and Cam-003 by flow cytometry as conditions for antibody binding are more stringent and allow for quantification of cells that are positive or negative for Psl expression. For *ex vivo* binding, bacterial inocula (0.1ml) was prepared from an overnight TSA plate and delivered intraperitoneally to BALB/c mice. At 4 hr. following challenge, bacteria were harvested, RBCs lysed, sonicated and resuspended in PBS supplemented with 0.1% Tween-20 and 1% BSA. Samples were stained and analyzed as previously described in Example 1. Figure 5 shows that bacteria harvested after peritoneal lavage with three wild type *P. aeruginosa* strains showed strong Cam-003 staining, which was comparable to log phase cultured bacteria (compare Figures 5A and 5C). *In vivo* passaged wild type bacteria exhibited enhanced staining when compared to the inoculum (compare Figures 5B and 5C). Within the inocula, Psl was not detected for strain 6077 and was minimally detected for strains PAO1 (O5) and 6206 (O11-cytotoxic). The binding of Cam-003 to bacteria increased in relation to the inocula indicating that Psl expression is maintained or increased *in vivo.* Wild type strains 6077, PAO1, and 6206 express Psl after *in vivo* passage, however strain PAO1 harboring a deletion of *pslA* (PAO1Δ*pslA*) is unable to react with Cam-003. These results further emphasize Psl as the target of the monoclonal antibodies.

[0272] The level of Psl expression/accessibility on the surface of *P. aeruginosa* strains PAO1 and 6206 in the acute pneumonia model was also assessed. Bacteria prepared from overnight-incubated, confluent plates, as described above, were intranasally administered to BALB/c mice. At 4 and 24 hours post-infection, bacteria were recovered from the lungs by bronchoalveolar lavage. Samples were stained and analyzed as previously described in Example 1. Strong Cam-003 staining was observed for PAO1 at 4 hours post-infection, but was minimal for 6206 at this time point (Figure 5D). However, for both strain PAO1 and 6206, strong Cam-003 staining was observed at 24 hours post-infection (Figure 5E).

[0273] The binding of *P. aeruginosa* specific antibodies (Cam-003, Cam-004 and Cam-005) to representative strains from unique *P. aeruginosa* serotypes (PAO1(O5) (Figure 5F), 2135 (O1) (Figure 5G), 2531 (O1) (Figure 5H), 2410 (O6) (Figure 5I), 2764 (O11) (Figure 5J), 2757 (O11) (Figure 5K), 33356 (O9) (Figure 5L), 33348 (O1) (Figure 5M), 3039 (NT) (Figure 5N), 3061 (NT) (Figure 5O), 3064 (NT) (Figure 5P), 19660 (NT) (Figure 5Q), 9882-80 (O11) (Figure 5R), 6073 (O11) (Figure 5S), 6077 (O11) (Figure 5T) and 6206 (O11) (Figure 5U), was evaluated by flow cytometry as generally described above.

Example 6: Survival rates for animals treated with anti-Psl monoclonal antibodies Cam-003 and WapR-004 in a *P. aeruginosa* acute pneumonia model

[0274] Antibodies or PBS were administered 24 hours before infection in each model. *P. aeruginosa* acute pneumonia, keratitis, and thermal injury infection models were performed as described (DiGiandomenico, A., et al., Proc Natl Acad Sci U S A 104, 4624-4629 (2007)), with modifications. In the acute pneumonia model, BALB/c mice (The Jackson Laboratory) were infected with *P. aeruginosa* strains suspended in a 0.05 ml inoculum. In the thermal injury model, CF-1 mice (Charles River) received a 10% total body surface area burn with a metal brand heated to 92°C for 10 seconds. Animals were infected subcutaneously with *P. aeruginosa* strain 6077 at the indicated dose. For organ burden experiments, acute pneumonia was induced in mice followed by harvesting of lungs, spleens, and kidneys 24 hours post-infection for determination of CFU.

[0275] Monoclonal antibodies Cam-003 and WapR-004 were evaluated in an acute lethal pneumonia model against *P. aeruginosa* strains representing the most frequent serotypes associated with clinical disease. Figures 6A and 6C show significant concentration-dependent survival in Cam-003-treated mice infected with strains PAO1 and 6294 when compared to controls. Figures 6B and 6D show that complete protection from challenge with 33356 and cytotoxic strain 6077 was afforded by Cam-003 at 45 and 15 mg/kg while 80 and 90% survival was observed at 5mg/kg for 33356 and 6077, respectively. Figures 6E and 6F show significant concentration-dependent survival in WapR-004-treated mice in the acute pneumonia model with strain 6077 (O11) (8×10^5 CFU) (Figure 6E), or 6077 (011) (6×10^5 CFU) (Figure 6F). Figure 6G shows that at 120 hours Cam-003 provided 100 % survival following infection with strain PAO1. Increased survival was not observed against the Psl mutant strain, PAO1Δ*pslA*, used as a negative control in the PAO1 acute pneumonia study (Figure 6G), confirming the lack of Cam-003 activity against strains deficient in Psl expression.

[0276] Cam-003 and WapR-004 were next examined for their ability to reduce *P. aeruginosa* organ burden in the lung and spread to distal organs, and later the animals were treated with various concentrations of WapR-004, Cam-003, or control antibodies at several different concentrations. Cam-003 was effective at reducing *P. aeruginosa* lung burden against all four strains tested. Cam-003 was most effective against the highly pathogenic cytotoxic strain, 6077, where the low dose was as effective as the higher dose (Figures 7D). Cam-003 also had a marked effect in reducing dissemination to the spleen and kidneys in mice infected with PAO1 (Figure 7A), 6294 (Figure 7C), and 6077 (Figure 7D), while dissemination to these organs was not observed in 33356 infected mice (Figure 7B). Figures 7E and 7F show that

similarly, WapR-004 reduced organ burden after induction of acute pneumonia with 6294 (O6) and 6206 (O11). Specifically, WapR-004 was effective at reducing *P. aeruginosa* dissemination to the spleen and kidneys in mice infected.

Example 7: Survival rates for animals treated with anti-Psl monoclonal antibodies Cam-003 and WapR-004 in a *P. aeruginosa* corneal infection model

[0277] Cam-003 and WapR-004 efficacy was next evaluated in a *P. aeruginosa* corneal infection model which emphasizes the pathogens ability to attach and colonize damaged tissue. Figures 8 A-D and 8 F-G show that mice receiving Cam-003 and WapR-004 had significantly less pathology and reduced bacterial counts in total eye homogenates than was observed in negative control-treated animals. Figure 8E shows that Cam-003 was also effective when tested in a thermal injury model, providing significant protection at 15 and 5mg/kg when compared to the antibody-treated control.

Example 8: A Cam-003 Fc mutant antibody, Cam-003-TM, has diminished OPK and *in vivo* efficacy but maintains anti-cell attachment activity.

[0278] Given the potential for dual mechanisms of action, a Cam-003 Fc mutant, Cam-003-TM, was created which harbors mutations in the Fc domain that reduces its interaction with Fcγ receptors (Oganesyan, V., et al., Acta Crystallogr D Biol Crystallogr 64, 700-704 (2008))., to identify if protection was more correlative to anti-cell attachment or OPK activity. *P. aeruginosa* mutants were constructed based on the allele replacement strategy described by Schweizer (Schweizer, H.P., Mol Microbiol 6, 1195-1204 (1992); Schweizer, H.D., Biotechniques 15, 831-834 (1993)). Vectors were mobilized from *E. coli* strain S17.1 into *P. aeruginosa* strain PAO1; recombinants were isolated as described (Hoang, T.T., et al., Gene 212, 77-86 (1998)). Gene deletion was confirmed by PCR. *P. aeruginosa* mutants were complemented with pUCP30T-based constructs harboring wild type genes. Figures 9A shows that Cam-003-TM exhibited a 4-fold drop in OPK activity compared to Cam-003 (EC_{50} of 0.24 and 0.06, respectively) but was as effective in the cell attachment assay (Figure 9B). Figure 9C shows that Cam-003-TM was also less effective against pneumonia suggesting that optimal OPK activity is necessary for optimal protection. OPK and cell attachment assays were performed as previously described in Examples 2 and 4, respectively. When tested in the mouse acute pneumonia model, Cam-003-TM was similar in potency to Cam-003 at a low infectious inoculum of 6077 ($2.4x10^5$ CFU) (Figure 9D). However, further titration of the antibody dose followed by challenge with a larger infectious inoculum ($1.07x10^6$) revealed Cam-003 activity was superior to Cam-003-TM, suggesting OPK activity significantly contributes to optimal protection *in vivo* (Figure 9E).

Example 9: Epitope mapping and relative affinity for anti-Psl antibodies

[0279] Epitope mapping was performed by competition ELISA and confirmed using an OCTET® flow system with Psl derived from the supernatant of an overnight culture of *P. aeruginosa* strain PAO1. For competition ELISA, antibodies were biotinylated using the EZ-Link Sulfo-NHS-Biotin and Biotinylation Kit (Thermo Scientific). Antigen coated plates were treated with the EC_{50} of biotinylated antibodies coincubated with unlabeled antibodies. After incubation with HRP-conjugated streptavidin (Thermo Scientific), plates were developed as described above. Competition experiments between anti-Psl mAbs determined that antibodies targeted at least three unique epitopes, referred to as class 1, 2, and 3 antibodies (Figure 10A). Class 1 and 2 antibodies do not compete for binding, however the class 3 antibody, WapR-016, partially inhibits binding of the Class 1 and 2 antibodies.

[0280] Antibody affinity was determined by the OCTET® binding assays using Psl derived from the supernatant of overnight PAO1 cultures. Antibody K_D was determined by averaging the binding kinetics of seven concentrations for each antibody. Affinity measurements were taken with a FORTEBIO® OCTET® 384 instrument using 384 slanted well plates. The supernatant from overnight PAO1 cultures $\pm$ the *pslA* gene were used as the Psl source. Samples were loaded onto OCTET® AminoPropylSilane (hydrated in PBS) sensors and blocked, followed by measurement of anti-Psl mAb binding at several concentrations, and disassociation into PBS + 1% BSA. All procedures were performed as described (Wang, X., et al., J Immunol Methods 362, 151-160). Association and disassociation raw ΔnM data were curve-fitted with GraphPad Prism. Figure 10A shows the relative binding affinities of anti-Psl antibodies characterized above. Class 2 antibodies had the highest affinities of all the anti-Psl antibodies. Figure 10A also shows a summary of cell attachment and OPK data experiments. Figure 10B shows the relative binding affinities and OPK EC50 values of the Wap-004RAD (W4RAD) mutant as well as other W4 mutants prepared as described in Example 1.

Example 10: Binding of Polymyxin B (PMB)-mAb conjugates to *P. aeruginosa* PAO1 cells was evaluated by FACS

[0281] In this Example, PMB conjugated to an opsonic monoclonal antibody (mAb) that was capable of mediating bacterial clearance was evaluated to determine whether the conjugate would improve and/or expand mAb functionality, while also reducing the toxicity of PMB. CAM-003, a mAb targeting the *P. aeruginosa* Psl surface exopolysaccharide,

which mediates potent opsonophagocytic killing (OPK) activity and protection *in vivo,* was selected for conjugate evaluation.

[0282] This example evaluates binding of various Polymyxin B (PMB)-mAbs conjugates to *P. aeruginosa* PAO1 cells. Using a two-step site-directed conjugation method (Figure 12), Polymyxin B (PMB) was conjugated to the Cam-003 and A7 (hIgG1 control) mAb variants with either a single or double cysteine engineered into the Fc region. Cam-003 and A7 mAbs Fc variants were prepared using standard protocols as described in (Dimasi, N. et al., J Mol Biol. 393(3):672-92 (2009)). The heterobifunctional $SM(PEG)_{12}$ linker (Pierce) was initially conjugated to one of the primary amines in PMB via the NHS group in the linker under conditions determined to favor conjugation of a single linker. Polymyxin B sulfate (Sigma) was dissolved in PBS pH 7.2 at 2 mg/ml and reacted with $SM(PEG)_{12}$ linker at a 4:1 PMB:linker ratio. The reaction was carried out at room temperature for 30 min and stopped with 50 mM glycine. The efficiency of $SM(PEG)_{12}$ linker conjugation to PMB was approximately 25%. Crude preparations of PMB-PEG_{12} were then reacted with deprotected Fc cysteine mAb variants and conjugated via maleamide in the PEG_{12} linker (see, *e.g.*, WO 2011/005481 and WO 2009/092011). The PMB-mAb conjugates were purified by extensive dialysis. The conjugates were initially dialyzed in 3.3X PBS pH 7.2 with 0.7% CHAPS with four buffer exchanges, followed by dialysis in IX PBS pH 7.2 with additional four buffer exchanges. Conjugation efficiency and levels free PMB-linker in the samples were determined by UPLC and mass spectrometry.

[0283] CAM-003 is specific for the *P. aeruginosa* Psl surface exopolysaccharide and mediates potent OPK activity and protection in multiple *in vivo* models. Figure 13A shows Cam-003 and A7 Fc region mutated residues. SM (A339C), DM1 (T289C/A339C), DM2 (A339C/S442C). Conjugation efficiency of PMB-mAbs variants was determined by mass spectrometry analysis of heavy chains in purified conjugates. (see, *e.g.*, WO 2011/005481 and WO 2009/092011). The overall conjugation efficiency was 75-85%. Purity of constructs was >95% relative to conjugated vs. free PMB-linker. Figure 13B shows the average number of PMB in PMB-Cam-003 and PMB-A7 conjugates (double mutant 2 (DM2) > double mutant 1 (DM1) > single mutant (SM)). A7 conjugates exhibited greater conjugation efficiency compared to Cam-003 conjugates. Contamination with free PMB in the purified preparations was determined to be negligible. Binding of PMB-Cam-003 and PMB-A7 conjugates to *P. aeruginosa* PAO1 cells was evaluated by FACS. R347 was used as a negative control in all experiments. Samples were stained and analyzed as previously described in Example 1. No significant difference in binding of Cam-003 conjugates compared to unconjugated or mock-conjugated Cam-003 was observed (Figure 14A). Binding of A7 control conjugates was proportional to the number of PMB molecules per conjugate (Figure 14B). This analysis indicates that conjugation of PMB to Cam-003 does not significantly impact whole-cell binding and that conjugated PMB can mediate direct binding to cells, presumably by binding LPS.

Example 11: Evaluation of PMB-mAb conjugates promoting OPK of P. aeruginosa

[0284] This example describes two series of experiments evaluating the ability of PMB-mAb conjugates to promote OPK of *P. aeruginosa.* In the first experiments (Figures 15A-B), conjugate-mediated OPK activity by human HL-60 neutrophil cell line in the presence of rabbit complement was evaluated using *P. aeruginosa* strains expressing bacterial luciferase as described in Example 2. R347 was used as a negative control in these experiments. The CAM-003 conjugates retained potent OPK activity, although it diminished with increasing number of PMB per conjugate (SM > DM1 > DM2) (Figure 15A). The CAM-003 conjugates did not exhibit OPK activity against the *ΔpslA P. aeruginosa* strain which does not express the Psl target, indicating that mAb-mediated binding was required for killing (Figure 15B). In the second series of experiments, reduction in luminescence following 2 h incubation relative to control lacking mAb was used to determine % killing. Figure 18A shows that the CAM-003 conjugates retained OPK activity, although it diminished with increasing number of PMB per conjugate, particularly in DM and TM constructs (WT>SM>DM>TM). The CAM-003 conjugates did not exhibit OPK activity against the PAO! *ΔpslA* strain which does not express the Psl target (not shown). Figure 18B shows that A7-PMB conjugates did not mediate OPK indicating that mAb-mediated binding was required for killing.

Example 12: Neutralization of *P. aeruginosa* LPS by PMB-mAb conjugates

[0285] Neutralization of *P. aeruginosa* O10 LPS activity was evaluated by preincubating the PMB-mAb conjugates or PMB alone with LPS for 1h, followed by stimulation of murine RAW 264.7 macrophages and quantification of TNF secretion. Final concentration of LPS was 2ng/ml. TNF was quantified by the FACS-based BD™ Cytometric Bead Array (CBA) method (BD Biosciences) after 6h stimulation. LPS neutralization was measured by a decrease in TNF production relative to the LPS maximal response. PMB-Cam-003 conjugates, but not mock-conjugated wild-type Cam-003 exhibited LPS neutralization. Efficiency of neutralization was directly proportional to the average number of PMB in the conjugate (DM2 > DM1 > SM) (Figure 16A). PMB-A7 conjugates, but not mock-conjugated wild-type A7 exhibited LPS neutralization (Figure 16B). A7 conjugates exhibited better neutralization than CAM-003 conjugates. A7 conjugates exhibited better neutralization than CAM-003 conjugates likely due to greater conjugation efficiency achieved with these molecules.

Approximately 2 conjugated PMB molecules/mAb are required to neutralize the amount of LPS neutralized by a free PMB molecule.

Example 13: Evaluation of Cam-003-PMB site-directed conjugates in murine models

[0286] The efficacy of Cam-003-PMB conjugates were evaluated in two types of murine models: 1) endotoxemia (LPS) challenge model, to determine the ability of the conjugates to neutralize and/or detoxify LPS *in vivo*; and 2) in *P. aeruginosa* sepsis model, to evaluate if Cam-003-PMB conjugates effect improved protection against bacterial challenge relative to the antibody alone through PMB-mediated LPS neutralization and/or clearance, in addition to the antibody-mediated bacterial clearance. Other *P. aeruginosa* challenge models can also be used to test the efficacy of Cam-003-PMB conjugates (see below).

A. Endotoxemia model

[0287] It is well established that PMB can bind and neutralize LPS *in vivo,* and mediate protection against LPS challenge (Morrison, DC. et al. J. Immunochemistry 13(10):813-818 (1976), Drabick, JJ. et al., Antimicrob Agents Chemother. 42(3):583-588 (1998)). In the endotoxemia model, Cam-003-PMB conjugates will be evaluated for their ability to protect animals from LPS challenge. Purified LPS from Gram-negative bacteria, including *P. aeruginosa* and *E. coli,* will be used to challenge mice at the established minimal lethal doses (LD100). As mice are relatively resistant to LPS, D-galactosamine may also be coadministered, as it greatly increases the sensitivity of mice to LPS to roughly that of humans (Galanos, C. et al., Proc Natl Acad Sci U S A. 76(11):5939-5943 (1979)). Such models have been widely used for preclinical efficacy evaluation of LPS neutralizing molecules, including antibodies and polymyxin-protein conjugates (Bailat, S. et al., Infect Immun. 65(2):811-814 (1997), Birkenmeier, G. et al., J Pharmacol Exp Ther. 318(2):762-771 (2006), Drabick, JJ. et al., Antimicrob Agents Chemother. 42(3):583-588 (1998)). Cam-003-PMB conjugates, control conjugates and unconjugated Cam-003 can be administered either therapeutically or prophylactically, and their ability to protect animals from LPS challenge can be evaluated. The extent of protection mediated by PMB conjugates can be correlated with levels of proinflammatory cytokines and chemokines measured in sera or plasma, including TNF, KC and IL-6.

B. *P. aeruginosa* challenge models

[0288] Several murine models of *P. aeruginosa* infection can be used to evaluate the ability of Cam-003-PMB conjugates to mediate protection. *P. aeruginosa* can be administered to mice intraperitoneally (sepsis model), intravenously (bacteremia model) or intranasally (pneumonia model) at the determined LD100 doses. These models have previously been used for preclinical efficacy studies of passive or active vaccines (Frank, DW. et al., J Infect Dis. 186(1):64-73. (2002), Secher, T. et al., J Antimicrob Chemother. 66(5):1100-1109 (2011), Miyazaki, S. et al., J Med Microbiol. 43(3):169-175 (1995), Dunn, DL. et al., Surgery 96(2):440-446 (1984)).

[0289] As in the endotoxemia model, it may also be necessary to sensitize mice with D-galactosamine prior to bacterial challenge to overcome their innate resistance to LPS toxicity and to be able to evaluate the contribution of LPS neutralization and/or clearance to *in vivo* efficacy of the PMB conjugates. D-galactosamine has been demonstrated to reduce the LD100 of Gram-negative bacteria, likely by increasing sensitivity to LPS shed during infection (Bucklin, SE. et al., J Infect Dis. 172(6):1519-27 (1995)).

[0290] Cam-003-PMB conjugates, control conjugates and unconjugated Cam-003 can be administered either therapeutically or prophylactically. The ability of CAM-003 conjugates to effect increased protection over Cam-003 alone by neutralizing and/or clearing the bacterial LPS via the conjugated PMB moiety can be determined in survival studies. The efficacy of Cam-003-PMB conjugates in mediated bacterial clearance can also be evaluated by quantifying *P. aeruginosa* bacteria in serum and organs, including spleen, kidneys and lungs, following infection. Serum or plasma LPS levels can also be quantified to evaluate the extent of bacterial clearance and LPS clearance and/or neutralization by the Cam-003-PMB conjugates and compare it to those of unconjugated Cam-003 and control antibody-PMB conjugates.

C. Endotoxemia Model Data

[0291] In particular, C57B1/6 mice (10 per group) were dosed i.p. with mAb or PMB-mAb conjugate 6h prior to challenge with *P. aeruginosa* PAO10 LPS (Sigma) and D-galactosamine. PMB control was dosed i.p. 2 h prior to challenge at 0.2 mg/kg and typically provides 80-100% protection. Control mice dosed with unconjugated CAM-003 all died within 18h. Figures 19A and B show that, at 45 mg/kg, DM and TM conjugates of CAM-003 and A7 provided 90-100% protection, while the SM conjugates were not protective.

[0292] TM conjugates were dosed at 45, 15 and 5 mg/kg. As shown in Figures 20A and B, loss of protective activity

was more rapid with CAM-003-TM-PMB than with A7-TM-PMB, which retained 80% protection at 5 mg/kg. These differences suggest that unique structural features of a mAb can impact LPS neutralization activity of conjugated PMB, as previously seen *in vitro.*

D. Sepsis Model Data

[0293] C57B1/6 mice (10 per group) were dosed with mAb or PMB-mAb conjugates i.p (10, 1 and 0.1 mg/kg) 6 h prior to i.p. challenge with LD_{80-100} dose of *P. aeruginosa* strain 6294 (4E7 CFU). Data from two studies was combined in this analysis. Survival was monitored over 72h. Combined results of two studies are shown in Figures 21A-C: . Most control mice dosed with A7 or buffer died by 24 h. Unconjugated CAM-003 showed 50-90% protection. Protective activity appeared to be inversely correlated with dose. CAM-003-PMB conjugates conferred better protection than unconjugated mAb at the high dose of 10 mg/kg, suggesting that neutralization of LPS shed during infection contributed to survival. The A7-DM-PMB control conjugate exhibited 50% protective activity at 10 mg/kg, suggesting that LPS neutralization can provide a survival benefit. Conversely, the conjugates were less protective than CAM-003 at the low dose of 0.1mg/kg, and protective activity correlated with *in vitro* OPK activity of the conjugates (WT>SM>DM>TM). Together the results indicate that conjugated PMB can confer added protective activity to an opsonic antibody by mediating neutralization of LPS and complement its bacterial clearance function.

[0294] High conjugation efficiency of PMB to engineered Fc cysteine residues was achieved using the SM-PEG12 heterobifunctional linker. A series of site-directed PMB conjugates of CAM-003, a potent opsonic and protective mAb targeting *P. aeruginosa* Psl exopolysaccharide, was evaluated *in vitro* and *in vivo.* CAM-003-PMB conjugates retained in vitro OPK activity. However the OPK activity was impacted by the increase in the average number of PMB per mAb. DM and TM PMB-mAb conjugates conferred protection in mouse *P. aeruginosa* endotoxemia model, demonstrating that LPS neutralization function of PMB was conferred onto the mAb. CAM-003-PMB conjugates showed greater protective activity than unconjugated CAM-003 mAb in the *P. aeruginosa* sepsis model at high doses (10 mg/kg), and reduced activity at low dose (0.1 mg/kg). These data suggest that conjugated PMB can complement bacterial clearance mediated by the opsonic CAM-003 mAb and improve protection by LPS neutralization. The improvement in protective activity by CAM-003-PMB conjugates in the sepsis model is lost at lower doses, where levels of conjugated PMB are too low to neutralize LPS, and the primary mode of protection is likely mAb-mediated bacterial clearance. The loss of protective activity of the CAM-003-PMB conjugates at lower doses is consistent with the reduction in in vitro OPK activity as a result of PMB conjugation. These studies show that conjugated PMB on an opsonic mAb can confer LPS neutralization activity and result in increased protective activity in a systemic *P. aeruginosa* infection model. Optimization of conjugation sites to reduce the negative impact on OPK activity may further improve the protective activity of PMB conjugates relative to unconjugated opsonic mAb.

[0295] The disclosure is not to be limited in scope by the specific embodiments described which are intended as single illustrations of individual aspects of the disclosure, and any compositions or methods which are functionally equivalent are within the scope of this disclosure. Indeed, various modifications of the disclosure in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Such modifications are intended to fall within the scope of the appended claims and embodiments.

[0296] All publications and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporated by reference.

Embodiments:

[0297]

Embodiment 1. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, wherein the binding molecule (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote opsonophagocytic killing (OPK) of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote OPK of *P. aeruginosa.*

Embodiment 2. The binding molecule or fragment thereof of embodiment 1, which comprises an antibody or antigen-binding fragment thereof.

Embodiment 3. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the heavy chain variable region (VH) and light chain variable region (VL) region of WapR-004, Cam-003, Cam-004, or Cam-005.

Embodiment 4. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-004, Cam-003, Cam-004, or Cam-005.

Embodiment 5. The binding molecule or fragment thereof of embodiment 3 or embodiment 4, wherein the VH and VL of WapR-004 comprise SEQ ID NO:11 and SEQ ID NO:12, respectively, the VH and VL of Cam-003 comprise SEQ ID NO:1 and SEQ ID NO:2, respectively, the VH and VL of Cam-004 comprise SEQ ID NO:3 and SEQ ID NO:2, respectively, and the VH and VL of Cam-005 comprise SEQ ID NO:4 and SEQ ID NO:2, respectively.

Embodiment 6. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the VH and VL regions of WapR-001, WapR-002, or WapR-003.

Embodiment 7. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-001, WapR-002, or WapR-003.

Embodiment 8. The binding molecule or fragment thereof of embodiment 6 or embodiment 7, wherein the VH and VL of WapR-001 comprise SEQ ID NO:5 and SEQ ID NO:6, respectively, the VH and VL of WapR-002 comprise SEQ ID NO:7 and SEQ ID NO:8, respectively, and the VH and VL of WapR-003 comprise SEQ ID NO:9 and SEQ ID NO:10, respectively.

Embodiment 9. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the VH and VL regions of WapR-016.

Embodiment 10. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, and competitively inhibits *Pseudomonas* Psl binding by an antibody or antigen-binding fragment thereof comprising the VH and VL of WapR-016.

Embodiment 11. The binding molecule or fragment thereof of embodiment 9 or embodiment 10, wherein the VH and VL of WapR-016 comprise SEQ ID NO: 15 and SEQ ID NO: 16, respectively.

Embodiment 12. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, wherein the VH comprises an amino acid sequence at least 90% identical to SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, or SEQ ID NO: 15.

Embodiment 13. The binding molecule or fragment thereof of embodiment 12, wherein the VH comprises SEQ ID NO: 1, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 5, SEQ ID NO: 7, SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, or SEQ ID NO: 15.

Embodiment 14. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, wherein the VL comprises an amino acid sequence at least 90% identical to SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, and SEQ ID NO: 16.

Embodiment 15. The binding molecule or fragment thereof of embodiment 14, wherein the VL comprises SEQ ID NO: 2, SEQ ID NO: 4, SEQ ID NO: 6, SEQ ID NO: 8, SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, and SEQ ID NO: 16.

Embodiment 16. The binding molecule or fragment thereof of any one of embodiments 3 to 15, which comprises an antibody or antigen-binding fragment thereof.

Embodiment 17. An isolated antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl, comprising VH and VL amino acid sequences at least 90% identical to:

(a) SEQ ID NO: 1 and SEQ ID NO: 2, respectively,
(b) SEQ ID NO: 3 and SEQ ID NO: 2, respectively,
(c) SEQ ID NO: 4 and SEQ ID NO: 2 , respectively,
(d) SEQ ID NO: 5 and SEQ ID NO: 6 , respectively,
(e) SEQ ID NO: 7 and SEQ ID NO: 8, respectively,
(f) SEQ ID NO: 9 and SEQ ID NO: 10, respectively,
(g) SEQ ID NO: 11 and SEQ ID NO: 12, respectively,
(h) SEQ ID NO: 13 and SEQ ID NO: 14, respectively; or
(i) SEQ ID NO: 15 and SEQ ID NO: 16, respectively.

Embodiment 18. The antibody or fragment thereof of embodiment 17, comprising the VH and VL amino acid sequences:

(a) SEQ ID NO: 1 and SEQ ID NO: 2, respectively,
(b) SEQ ID NO: 3 and SEQ ID NO: 2, respectively,
(c) SEQ ID NO: 4 and SEQ ID NO: 2 , respectively,
(d) SEQ ID NO: 5 and SEQ ID NO: 6 , respectively,

(e) SEQ ID NO: 7 and SEQ ID NO: 8, respectively,
(f) SEQ ID NO: 9 and SEQ ID NO: 10, respectively,
(g) SEQ ID NO: 11 and SEQ ID NO: 12, respectively,
(h) SEQ ID NO: 13 and SEQ ID NO: 14, respectively; or
(i) SEQ ID NO: 15 and SEQ ID NO: 16, respectively.

Embodiment 19. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, wherein the VH comprises a VH complementarity determining region-1 (VHCDR1) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 17, SEQ ID NO: 23, SEQ ID NO: 26, SEQ ID NO: 29, SEQ ID NO: 35, SEQ ID NO: 41, SEQ ID NO: 47, SEQ ID NO: 53, or SEQ ID NO: 59.

Embodiment 20. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, wherein the VH comprises a VH complementarity determining region-2 (VHCDR2) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 18, SEQ ID NO: 24, SEQ ID NO: 27, SEQ ID NO: 30, SEQ ID NO: 36, SEQ ID NO: 42, SEQ ID NO: 48, SEQ ID NO: 54, or SEQ ID NO: 60.

Embodiment 21. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, wherein the VH comprises a VH complementarity determining region-3 (VHCDR3) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 19, SEQ ID NO: 25, SEQ ID NO: 28, SEQ ID NO: 31, SEQ ID NO: 37, SEQ ID NO: 43, SEQ ID NO: 49, SEQ ID NO: 55, or SEQ ID NO: 61.

Embodiment 22. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, wherein the VL comprises a VL complementarity determining region-1 (VLCDR1) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 20, SEQ ID NO: 32, SEQ ID NO: 38, SEQ ID NO: 44, SEQ ID NO: 50, SEQ ID NO: 56, or SEQ ID NO: 62.

Embodiment 23. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, wherein the VL comprises a VL complementarity determining region-2 (VLCDR2) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 21, SEQ ID NO: 33, SEQ ID NO: 39, SEQ ID NO: 45, SEQ ID NO: 51, SEQ ID NO: 57, or SEQ ID NO: 63.

Embodiment 24. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, wherein the VL comprises a VL complementarity determining region-3 (VLCDR3) amino acid sequence identical to, or identical except for four, three, two, or one amino acid substitutions to: SEQ ID NO: 22, SEQ ID NO: 34, SEQ ID NO: 40, SEQ ID NO: 46, SEQ ID NO: 52, SEQ ID NO: 58, or SEQ ID NO: 64.

Embodiment 25. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VH, wherein the VH comprises VHCDR1, VHCDR2, and VHCDR3 amino acid sequences identical to, or identical except for four, three, two, or one amino acid substitutions in one or more of the VHCDRs to: SEQ ID NOs: 17, 18, and 19, SEQ ID NOs: 23, 24, and 25, SEQ ID NOs: 26, 27, and 28, SEQ ID NOs: 29, 30, and 31, SEQ ID NOs: 35, 36, and 37, SEQ ID NOs: 41, 42, and 43, SEQ ID NOs: 47, 48, and 49, SEQ ID NOs: 53, 54, and 55, or SEQ ID NOs: 59, 60, and 61, respectively.

Embodiment 26. An isolated binding molecule or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising an antibody VL, wherein the VL comprises VLCDR1, VLCDR2, and VLCDR3 amino acid sequences identical to, or identical except for four, three, two, or one amino acid substitutions in one or more of the VHCDRs to: SEQ ID NOs: 20, 21, and 22, SEQ ID NOs: 32, 33, and 34, SEQ ID NOs: 38, 39, and 40, SEQ ID NOs: 44, 45, and 46, SEQ ID NOs: 50, 51, and 52, SEQ ID NOs: 56, 57, and 58, or SEQ ID NOs: 62, 63, and 64, respectively.

Embodiment 27. The binding molecule of any one of embodiments 19 to 26, wherein the binding molecule or fragment thereof comprises an antibody or antigen binding fragment thereof.

Embodiment 28. An isolated antibody or antigen-binding fragment thereof which specifically binds to *Pseudomonas* Psl comprising a VH and a VL comprising VHCDR1, VHCDR2, VHCDR3, VLCDR1, VLCDR2 and VLCDR3 amino acid sequences identical or identical except for four, three, two, or one amino acid substitutions in one or more CDRs to: SEQ ID NOs: 17, 18, 19, 20, 21, and 22, SEQ ID NOs: 23, 24, 25, 20, 21, and 22, SEQ ID NOs: 26, 27, 28, 20, 21, and 22, SEQ ID NOs: 29, 30, 31, 32, 33, and 34, SEQ ID NOs: 35, 36, 37, 38, 39, and 40, SEQ ID NOs: 41, 42, 43, 44, 45, and 46, SEQ ID NOs: 47, 48, 49, 50, 51, and 52, SEQ ID NOs: 53, 54, 55, 56, 57, and 58, or SEQ ID NOs: 59, 60, 61, 62, 63, and 64, respectively

Embodiment 29. The antibody or fragment thereof of any one of embodiments 2,16-18, 27, or 28, which (a) can inhibit attachment of *Pseudomonas aeruginosa* to epithelial cells, (b) can promote OPK of *P. aeruginosa,* or (c) can inhibit attachment of *P. aeruginosa* to epithelial cells and can promote OPK of *P. aeruginosa.*

Embodiment 30. The antibody or fragment thereof of embodiment 29, wherein maximum inhibition of *P. aeruginosa* attachment to epithelial cells is achieved at an antibody concentration of about 50 μg/ml or less, 5.0 μg/ml or less,

or about 0.5 μg/ml or less.

Embodiment 31. The antibody or fragment thereof of embodiment 29, wherein maximum inhibition of *P. aeruginosa* attachment to epithelial cells is achieved at an antibody concentration ranging from about 30 μg/ml to about 0.3 μg/ml.

Embodiment 32. The antibody or fragment thereof of embodiment 29, wherein the OPK EC50 is less than about 0.5 μg/ml, less than about 0.05 μg/ml, or less than about 0.005 μg/ml.

Embodiment 33. The antibody or fragment thereof of embodiment 29, wherein the OPK EC50 ranges from about 0.001 μg/ml to about 0.5 μg/ml.

Embodiment 34. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-33, which specifically binds to *P. aeruginosa* Psl with an affinity characterized by a dissociation constant (K_D) no greater than 5×10^{-2} M, 10^{-2} M, 5×10^{-3} M, 10^{-3} M, 5×10^{1} M, 10^{-4}M, 5×10^{-5} M, 10^{-5} M, 5×10^{-6} M, 10^{-6} M, 5×10^{-7} M, 10^{-7} M, 5×10^{-8} M, 10^{-8} M, 5×10^{-9} M, 10^{-9} M, 5×10^{-10} M, 10^{-10} M, 5×10^{-11} M, 10^{-11} M, 5×10^{-12} M, 10^{-12} M, 5×10^{-13} M, 10^{-13} M, 5×10^{-14} M, 10^{-14} M, 5×10^{-15} M, or 10^{-15} M.

Embodiment 35. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, wherein the affinity is characterized by a dissociation constant (K_D) in a range of about 1×10^{-10} to about 1×10^{-6} M.

Embodiment 36. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is humanized.

Embodiment 37. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is chimeric.

Embodiment 38. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is fully human.

Embodiment 39. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is an Fab fragment.

Embodiment 40. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is an Fab' fragment.

Embodiment 41. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is an F(ab)2 fragment.

Embodiment 42. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-35, which is a single chain Fv (scFv) fragment.

Embodiment 43. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-41, which comprises a light chain constant regions selected from the group consisting of a human kappa constant region and a human lambda constant region.

Embodiment 44. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-41, which comprises at a heavy chain constant region or fragment thereof.

Embodiment 45. The antibody or fragment thereof of embodiment 44, wherein said heavy chain constant region or fragment thereof is human IgG1.

Embodiment 46. The antibody or a fragment thereof of any one of embodiments 2, 16-18, or 27-45, which is monoclonal.

Embodiment 47. The antibody or fragment thereof of embodiment 18, comprising a VH with the amino acid sequence SEQ ID NO:11 and a VL with the amino acid sequence of SEQ ID NO:12.

Embodiment 48. The antibody or fragment thereof of embodiment 47, further comprising a human kappa light chain constant region or fragment thereof and a human IgG1 heavy chain constant region or fragment thereof.

Embodiment 49. The antibody or fragment thereof of embodiment 47 or embodiment 48, which specifically binds to *P. aeruginosa* with an affinity characterized by a K_D of about 1.18×10^{-7} M, as determined by the OCTET® binding assay.

Embodiment 50. The antibody or fragment thereof of any one of embodiments 47 to 49, wherein maximum inhibition of attachment to epithelial cells is achieved at an antibody concentration of about 0.3 μg/ml.

Embodiment 51. The antibody or fragment thereof of any one of embodiments 47 to 50, wherein the OPK EC50 is less than about 0.02 μg/ml.

Embodiment 52. The antibody or fragment thereof of embodiment 18, comprising a VH with the amino acid sequence SEQ ID NO: 1 and a VL with the amino acid sequence of SEQ ID NO:2.

Embodiment 53. The antibody or fragment thereof of embodiment 52, further comprising a human lambda light chain constant region or fragment thereof and a human IgG1 heavy chain constant region or fragment thereof.

Embodiment 54. The antibody or fragment thereof of embodiment 51 or embodiment 52, which specifically binds to *P. aeruginosa* with an affinity characterized by a K_D of about 1.44×10^{-7} M, as determined by the OCTET® binding assay.

Embodiment 55. The antibody or fragment thereof of any one of embodiments 51 to 54, wherein maximum inhibition of attachment to epithelial cells is achieved at an antibody concentration of about 1.0 μg/ml.

Embodiment 56. The antibody or fragment thereof of any one of embodiments 52 to 55, wherein the OPK EC50 is less than about 0.2 μg/ml.

Embodiment 57. The antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-56, wherein the antibody is conjugated to an agent selected from the group consisting of antimicrobial agent, a therapeutic agent,

a prodrug, a peptide, a protein, an enzyme, a lipid, a biological response modifier, pharmaceutical agent, a lymphokine, a heterologous antibody or fragment thereof, a detectable label, polyethylene glycol (PEG), and a combination of two or more of any said agents.

Embodiment 58. The antibody or fragment thereof of embodiment 57, wherein said detectable label is selected from the group consisting of an enzyme, a fluorescent label, a chemiluminescent label, a bioluminescent label, a radioactive label, or a combination of two or more of any said detectable labels.

Embodiment 59. A composition comprising the antibody or a fragment thereof of any one of embodiments 2, 16-18, or 27-58, and a carrier.

Embodiment 60. An isolated polynucleotide comprising a nucleic acid encoding the VH of any one of embodiments 3-13, 16-21, 25, or 27-59.

Embodiment 61. The polynucleotide of embodiment 60, further comprising a nucleic acid encoding the VL of any one of embodiments 3-11, 14-18, 22-24, or 26-59, wherein a binding molecule or antigen-binding fragment thereof expressed by the polynucleotide specifically binds *Pseudomonas* Psl.

Embodiment 62. The polynucleotide of embodiment 61 which encodes an scFv molecule including VH and VL, comprising the nucleotide sequence SEQ ID NO:65, SEQ ID NO: 66, SEQ ID NO: 67, SEQ ID NO: 68, SEQ ID NO: 69, or SEQ ID NO: 70.

Embodiment 63. An isolated polynucleotide comprising a nucleic acid encoding the VL of any one of embodiments 3-11, 14-18, 22-24, or 26-59.

Embodiment 64. The polynucleotide of embodiment 63, further comprising a nucleic acid encoding the VH of any one of embodiments 3-13, 16-21, 25, or 27-59, wherein a binding molecule or antigen-binding fragment thereof expressed by the polynucleotide specifically binds *Pseudomonas* Psl.

Embodiment 65. A vector comprising the polynucleotide of embodiment 60.

Embodiment 66. The vector of embodiment 65, further comprising a promoter operably associated with said polynucleotide.

Embodiment 67. A vector comprising the polynucleotide of embodiment 63.

Embodiment 68. The vector of embodiment 67, further comprising a promoter operably associated with said polynucleotide.

Embodiment 69. A vector comprising the polynucleotide of any one of embodiments 61, 62, or 64.

Embodiment 70. The vector of embodiment 69, comprising one or more promoters operably associated with said polynucleotide, wherein the vector can express a binding molecule which specifically binds *Pseudomonas Psl* in a suitable host cell.

Embodiment 71. A host cell comprising the polynucleotide of any one of embodiments 60 to 64 or the vector of any one of embodiments 65 to 70.

Embodiment 72. A method of producing a binding molecule or antigen-binding fragment thereof which specifically binds *Pseudomonas* Psl, comprising culturing the host cell of embodiment 71, and recovering the binding molecule or fragment thereof.

Embodiment 73. A binding molecule or antigen-binding fragment thereof which specifically binds *Pseudomonas* Psl, produced by the method of embodiment 72.

Embodiment 74. The binding molecule or fragment thereof of any one of embodiments 1-16 or 19-27, the antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-58, the composition of embodiments 59, the polynucleotide of any one of embodiments 60 to 64, the vector of any one of embodiments 65 to 70, or the host cell of embodiment 71, wherein the *Pseudomonas* species is *Pseudomonas aeruginosa.*

Embodiment 75. The binding molecule or fragment thereof, antibody or fragment thereof, or composition of embodiment 74, which binds to two or more, three or more, four or more, or five or more different *P. aeruginosa* serotypes.

Embodiment 76. The binding molecule or fragment thereof, antibody or fragment thereof, or composition of embodiment 74 or embodiment 75, which binds to at least 80%, at least 85%, at least 90% or at least 95% of *P. aeruginosa* strains isolated from infected patients.

Embodiment 77. The binding molecule or fragment thereof, antibody or fragment thereof, or composition of embodiment 76, wherein the *P. aeruginosa* strains are isolated from one or more of lung, sputum, eye, pus, feces, urine, sinus, a wound, skin, blood, bone, or knee fluid.

Embodiment 78. A method of preventing or treating a *Pseudomonas* infection in a subject in need thereof, comprising administering to the subject an effective amount of the binding molecule or fragment thereof of any one of embodiments 1-16 or 19-27, the antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-58, the composition of embodiment 59, the polynucleotide of any one of embodiments 60 to 64, the vector of any one of embodiments 65 to 70, or the host cell of embodiment 71.

Embodiment 79. The method of embodiment 78, wherein the *Pseudomonas* infection is a *P. aeruginosa* infection.

Embodiment 80. The method of embodiment 78 or embodiment 79, wherein the subject is a human.

Embodiment 81. The method of any one of embodiments 78 to 80, wherein the infection is an ocular infection, a

lung infection, a burn infection, a wound infection, a skin infection, a blood infection, a bone infection, or a combination of two or more of said infections.

Embodiment 82. The method of any one of embodiments 78 to 81, wherein the subject suffers from acute pneumonia, burn injury, corneal infection, cystic fibrosis, or a combination thereof.

Embodiment 83. A method of blocking or preventing attachment of *P. aeruginosa* to epithelial cells comprising contacting a mixture of epithelial cells and *P. aeruginosa* with the binding molecule or fragment thereof of any one of embodiments 1-16 or 19-27, the antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-58, the composition of embodiment 59, the polynucleotide of any one of embodiments 60 to 64, the vector of any one of embodiments 65 to 70, or the host cell of embodiment 71.

Embodiment 84. A method of enhancing OPK of *P. aeruginosa* comprising contacting a mixture of phagocytic cells and *P. aeruginosa* with the binding molecule or fragment thereof of any one of embodiments 1-16 or 19-27, the antibody or fragment thereof of any one of embodiments 2, 16-18, or 27-58, the composition of embodiment 59, the polynucleotide of any one of embodiments 60 to 64, the vector of any one of embodiments 65 to 70, or the host cell of embodiment 71.

Embodiment 85. The method of embodiment 84, wherein the phagocytic cells are differentiated HL-60 cells or human polymorphonuclear leukocytes (PMN).

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35 40 45

Gly Tyr Ile His Ser Asn Gly Gly Thr Asn Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Leu Thr Ile Ser Gly Asp Thr Ser Lys Asn Gln Phe Ser Leu
65 70 75 80

Asn Leu Ser Phe Val Thr Ala Ala Asp Thr Ala Leu Tyr Tyr Cys Ala
85 90 95

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20 25 30

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35 40 45

Gly Lys Asn Asn Arg Pro Ser Gly Ile Pro Asp Arg Phe Ser Gly Ser
50 55 60

Ser Ser Gly Asn Thr Ala Ser Leu Thr Ile Thr Gly Ala Gln Ala Glu
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35 40 45

Ile Gly Ser Ile Ser His Ser Gly Ser Thr Tyr Tyr Asn Pro Ser Leu

50 55 60

Lys Ser Arg Val Thr Ile Ser Gly Asp Ala Ser Lys Asn Gln Phe Phe
65 70 75 80

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Leu Val Thr Val Ser Ser
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35 40 45

Trp Ile Gly Ser Ile Tyr Ser Ser Gly Ser Thr Tyr Tyr Ser Pro Ser
50 55 60

Leu Lys Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Asn Gln Phe
65 70 75 80

Ser Leu Lys Leu Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Tyr
85 90 95

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100 105 110

Arg Gly Thr Leu Val Thr Val
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20 25 30

Pro Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Tyr Val
35 40 45

Ser Asp Ile Gly Thr Asn Gly Gly Ser Thr Asn Tyr Ala Asp Ser Val
50 55 60

Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Val Tyr
65 70 75 80

Leu Gln Met Ser Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr His Cys
85 90 95

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20 25 30

Asn Tyr Val Ser Trp Tyr Gln Gln His Pro Gly Lys Ala Pro Lys Leu
35 40 45

Met Ile Tyr Glu Gly Thr Lys Arg Pro Ser Gly Val Ser Asn Arg Phe

50 55 60

Ser Gly Ser Lys Ser Gly Asn Thr Ala Ser Leu Thr Ile Ser Gly Leu
65 70 75 80

Gln Ala Glu Asp Glu Ala Asp Tyr Tyr Cys Ser Ser Tyr Ala Arg Ser
85 90 95

Tyr Thr Tyr Val Phe Gly Thr Gly Thr Glu Leu Thr Val Leu
100 105 110

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20 25 30

Pro Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Asp Tyr Val
35 40 45

Ser Asp Ile Ser Pro Asn Gly Gly Ser Thr Asn Tyr Ala Asp Ser Val
50 55 60

Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Leu Phe
65 70 75 80

Leu Gln Met Ser Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
85 90 95

Val Met Gly Leu Val Pro Tyr Gly Phe Asp Ile Trp Gly Gln Gly Thr
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Leu Val Thr Val Ser Ser
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        35                  40                  45

Met Ile Tyr Glu Val Ser Asn Arg Pro Ser Gly Val Ser Asn His Phe
    50                  55                  60

Ser Gly Ser Lys Ser Gly Asn Thr Ala Ser Leu Thr Ile Ser Gly Leu
65                  70                  75                  80

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Pro Met His Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Asp Tyr Val
        35                  40                  45

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    50                  55                  60

Lys Gly Arg Phe Thr Ile Ser Arg Asp Asn Ser Lys Asn Thr Val Tyr
65                  70                  75                  80

Leu Gln Met Ser Ser Leu Arg Ala Glu Asp Thr Ala Val Tyr Tyr Cys
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85 90 95

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Asn Phe Val Ser Trp Tyr Gln Gln His Pro Gly Lys Ala Pro Lys Leu
35 40 45

Leu Ile Tyr Glu Gly Ser Gln Arg Pro Ser Gly Val Ser Asn Arg Phe
50 55 60

Ser Gly Ser Arg Ser Gly Asn Thr Ala Ser Leu Thr Ile Ser Gly Leu
65 70 75 80

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20 25 30

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35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
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35 40 45

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50 55 60

Ser Gly Ser Gly Thr Asp Phe Thr Leu Thr Ile Ser Ser Leu Gln Pro
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20 25 30

Asn Ile His Trp Val Arg Gln Ala Pro Gly Gln Gly Leu Glu Trp Met
35 40 45

Gly Trp Ile Asn Pro Asp Ser Gly Ala Thr Ser Tyr Ala Gln Lys Phe
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Gln Gly Arg Val Thr Met Thr Arg Asp Thr Ser Ile Thr Thr Ala Tyr
65 70 75 80

Met Asp Leu Ser Arg Leu Arg Ser Asp Asp Thr Ala Val Tyr Tyr Cys
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Ala Lys Asn Lys Arg Pro Pro Gly Ile Pro Asp Arg Phe Ser Gly Ser
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Ala Thr Ser Trp Val Arg Gln Ala Pro Gly Lys Gly Leu Glu Trp Val
        35                  40                  45

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    50                  55                  60

Lys Gly Arg Phe Thr Val Ser Arg Asp Asn Ser Lys Asn Thr Leu Tyr
65                  70                  75                  80

Leu Gln Met Asn Ser Leu Arg Ala Asp Asp Thr Ala Val Tyr Tyr Cys
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35 40 45

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50 55 60

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Ser Ser Tyr Thr Thr Ser Ser Thr Tyr Val
1 5 10

<210> 41
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<213> Artificial

<220>
<223> WapR-003 VHCDR1

<400> 41

Ser Tyr Pro Met His
1 5

<210> 42
<211> 17
<212> PRT
<213> Artificial

<220>
<223> WapR-003 VHCDR2

<400> 42

Asp Ile Ser Pro Asn Gly Gly Ala Thr Asn Tyr Ala Asp Ser Val Lys
1 5 10 15

Gly

<210> 43
<211> 9
<212> PRT
<213> Artificial

<220>
<223> WapR-003 VHCDR3

<400> 43

Gly Leu Val Pro Tyr Gly Phe Asp Asn
1 5

<210> 44
<211> 14
<212> PRT
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<220>
<223> WapR-003 VLCDR1

<400> 44

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

<210> 45
<211> 7
<212> PRT
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<220>
<223> WapR-003 VLCDR2

<400> 45

Glu Gly Ser Gln Arg Pro Ser
1 5

<210> 46
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<212> PRT
<213> Artificial

<220>
<223> WapR-003 VLCDR3

<400> 46

Ser Ser Tyr Ala Arg Ser Tyr Thr Tyr Val
1 5 10

<210> 47
<211> 5
<212> PRT
<213> Artificial

<220>
<223> WapR-004 & WapR-004RAD VHCDR1

<400> 47

Pro Tyr Tyr Trp Thr
1 5

<210> 48
<211> 16
<212> PRT
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<220>
<223> WapR-004 & WapR-004RAD VHCDR2

<400> 48

Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys Ser
1 5 10 15

<210> 49
<211> 11
<212> PRT
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<220>

<223> WapR-004 VHCDR3

<400> 49

Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile
1 5 10

<210> 50
<211> 11
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<220>
<223> WapR-004 & WapR-004RAD VLCDR1

<400> 50

Arg Ala Ser Gln Ser Ile Arg Ser His Leu Asn
1 5 10

<210> 51
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<220>
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<400> 51

Gly Ala Ser Asn Leu Gln Ser
1 5

<210> 52
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<220>
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<400> 52

Tyr Ser Phe Pro Leu Thr
1 5

<210> 53
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<220>
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<400> 53

Gly His Asn Ile His
1 5

<210> 54
<211> 17
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<220>
<223> WapR-007 VHCDR2

<400> 54

Trp Ile Asn Pro Asp Ser Gly Ala Thr Ser Tyr Ala Gln Lys Phe Gln
1 5 10 15

Gly

<210> 55
<211> 7
<212> PRT
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<220>
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<400> 55

Asp Thr Leu Leu Ser Asn His
1 5

<210> 56
<211> 11
<212> PRT
<213> Artificial

<220>
<223> WapR-007 VLCDR1

<400> 56

Gln Gly Asp Ser Leu Arg Ser Tyr Tyr Thr Asn
1 5 10

<210> 57
<211> 7
<212> PRT
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<220>
<223> WapR-007 VLCDR2

<400> 57

Ala Lys Asn Lys Arg Pro Pro
1 5

<210> 58
<211> 11

<212> PRT
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<220>
<223> WapR-007 VLCDR3

<400> 58

His Ser Arg Asp Ser Ser Gly Asn His Val Val
1 5 10

<210> 59
<211> 5
<212> PRT
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<220>
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<400> 59

Ser Tyr Ala Thr Ser
1 5

<210> 60
<211> 17
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<400> 60

Gly Ile Ser Gly Ser Gly Asp Thr Thr Asp Tyr Val Asp Ser Val Lys
1 5 10 15

Gly

<210> 61
<211> 14
<212> PRT
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<220>
<223> WapR-016 VHCDR3

<400> 61

Arg Gly Gly Leu Gly Gly Tyr Tyr Arg Gly Gly Phe Asp Phe
1 5 10

<210> 62
<211> 14
<212> PRT
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<220>
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<400> 62

Thr Gly Thr Ser Ser Asp Val Gly Gly Tyr Asn Tyr Val Ser
1 5 10

<210> 63
<211> 7
<212> PRT
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<220>
<223> WapR-016 VLCDR2

<400> 63

Glu Val Ser Asn Arg Pro Ser
1 5

<210> 64
<211> 9
<212> PRT
<213> Artificial

<220>
<223> WapR-016 VLCDR3

<400> 64

Ser Ser Tyr Ser Ser Gly Thr Val Val
1 5

<210> 65
<211> 753
<212> DNA
<213> Artificial

<220>
<223> Cam-003 scFv

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gagaccctgt ccctcacctg cactgtctct ggtggctcca ccagtcctta cttctggagc 120

tggctccggc agcccccagg gaagggactg gagtggattg gttatatcca ttccaatggg 180

ggcaccaact acaacccctc cctcaagagt cgactcacca tatcaggaga cacgtccaag 240

aaccaattct ccctgaatct gagttttgtg accgctgcgg acacggccct ctattactgt 300

gcgagaacgg actacgatgt ctacggcccc gcttttgata tctggggcca ggggacaatg 360

gtcaccgtct cgagtggtgg aggcggttca ggcggaggtg gcagcggcgg tggcggatcg 420

tctgagctga ctcaggaccc tgctgtgtct gtggccttgg gacagacagt caggatcaca 480

tgccaaggag acagcctcag aagctattat gcaagctggt accagcagaa gccaggacag 540

gcccctgtac ttgtcatcta tggtaaaaac aaccggccct cagggatccc agaccgattc 600

tctggctcca gctcaggaaa cacagcttcc ttgaccatca ctggggctca ggcggaagat 660

gaggctgact attactgtaa ctcccgggac agcagtggta accatgtggt attcggcgga 720

gggaccaagc tgaccgtcct aggtgcggcc gca 753

<210> 66
<211> 747
<212> DNA
<213> Artificial

<220>
<223> Cam-004 scFv

<400> 66
cagccggcca tggcccaggt acagctgcag cagtcaggcc caggacgggt gaagccttcg 60

gagacgctgt ccctcacctg cactgtctct ggttactccg tcagtagtgg ttactactgg 120

ggctggatcc ggcagtcccc agggacgggg ctggagtgga ttgggagtat ctctcatagt 180

gggagcacct actacaaccc gtccctcaag agtcgagtca ccatatcagg agacgcatcc 240

aagaaccagt ttttcctgag gctgacttct gtgaccgccg cggacacggc cgtttattac 300

tgtgcgagat ctgaggctac cgccaacttt gattcttggg gcaggggcac cctggtcacc 360

gtctcttcag gtggaggcgg ttcaggcgga ggtggcagcg gcggtggcgg atcgtctgag 420

ctgactcagg accctgccgt gtctgtggcc ttgggacaga cagtcaggat cacatgccaa 480

ggagacagcc tcagaagcta ttatgcaagc tggtaccagc agaagccagg acaggcccct 540

gtacttgtca tctatggtaa aaacaaccgg ccctcaggga tcccagaccg attctctggc 600

tccagctcag gaaacacagc ttccttgacc atcactgggg ctcaggcgga agatgaggct 660

gactattact gtaactcccg ggacagcagt ggtaaccatg tggtattcgg cggagggacc 720

aagctgaccg tcctaggtgc ggccgca 747

<210> 67
<211> 756
<212> DNA
<213> Artificial

<220>
<223> Cam-005 scFv

<400> 67
cagccggcca tggcccaggt acagctgcag cagtcaggcc caggactggt gaagccttcg 60

gagaccctgt ccctcacctg cactgtctct ggtggctccg tcagcagtag tggttattac 120

tggacctgga tccgccagcc cccagggaag gggctggagt ggattgggag tatctattct 180

agtgggagca catattacag cccgtccctc aagagtcgag tcaccatatc cggagacacg 240

tccaagaacc agttctccct caagctgagc tctgtgaccg ccgcagacac agccgtgtat 300

tactgtgcga gacttaactg gggcactgtg tctgcctttg atatctgggg cagaggcacc 360

ctggtcaccg tctcgagtgg tggaggcggt tcaggcggag gtggcagcgg cggtggcgga 420

tcgtctgagc tgactcagga ccctgctgtg tctgtggcct tgggacagac agtcaggatc 480

acatgccaag gagacagcct cagaagctat tatgcaagct ggtaccagca gaagccagga 540

caggcccctg tacttgtcat ctatggtaaa aacaaccggc cctcagggat cccagaccga 600

ttctctggct ccagctcagg aaacacagct tccttgacca tcactggggc tcaggcggaa 660

gatgaggctg actattactg taactcccgg gacagcagtg gtaaccatgt ggtattcggc 720

ggagggacca agctgaccgt cctaggtgcg gccgca 756

<210> 68
<211> 769
<212> DNA
<213> Artificial

<220>
<223> WapR-001 scFv

<400> 68
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tccagcctgg ggggtccctg agactctcct gttcagcctc tgggttcacc ttcagtcggt 120

atcctatgca ttgggtccgc caggctccag ggaagggact ggaatatgtt tcagatattg 180

gtactaatgg gggtagtaca aactacgcag actccgtgaa gggcagattc accatctcca 240

gagacaattc caagaacacg gtgtatcttc aaatgagcag tctgagagct gaggacacgg 300

ctgtgtatca ttgtgtggcg ggtatagcag ccgcctatgg ttttgatgtc tggggccaag 360

ggacaatggt caccgtctcg agtggaggcg gcggttcagg cggaggtggc tctggcggtg 420

gcggaagtgc acaggcaggg ctgactcagc ctgcctccgt gtctgggtct cctggacagt 480

cgatcaccat ctcctgcact ggaaccagca gtgacattgc tacttataac tatgtctcct 540

ggtaccaaca gcacccaggc aaagccccca aactcatgat ttatgagggc actaagcggc 600

cctcaggggt ttctaatcgc ttctctggct ccaagtctgg caacacggcc tccctgacaa 660

tctctgggct ccaggctgag gacgaggctg attattactg ttcctcatat gcacgtagtt 720

acacttatgt cttcggaact gggaccgagc tgaccgtcct agcggccgc 769

<210> 69
<211> 764
<212> DNA
<213> Artificial

<220>
<223> WapR-002 scFv

<400> 69
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ccagcctggg gggtccctga gactctcctg ttcagcctct ggattcacct tcagtagcta 120

tcctatgcac tgggtccgcc aggctccagg gaagggactg gattatgttt cagacatcag 180

tccaaatggg ggttccacaa actacgcaga ctccgtgaag ggcagattca ccatctccag 240

agacaattcc aagaacacac tgtttcttca aatgagcagt ctgagagctg aggacacggc 300

tgtgtattat tgtgtgatgg ggttagtacc ctatggtttt gatatctggg gccaaggcac 360

cctggtcacc gtctcgagtg gaggcggcgg ttcaggcgga ggtggctctg gcggtggcgg 420

aagtgcacag actgtggtga cccagcctgc ctccgtgtct gggtctcctg gacagtcgat 480

caccatctcc tgcactggaa ccagcagtga cgttggtggt tataactatg tctcctggta 540

ccaacagcac ccaggcaaag cccccaaact catgatttat gaggtcagta atcggccctc 600

aggggtttct aatcacttct ctggctccaa gtctggcaac acggcctccc tgaccatctc 660

tgggctccag gctgaggacg aggctgatta ttactgcagc tcatatacaa ccagcagcac 720

ttatgtcttc ggaactggga ccaaggtcac cgtcctagcg gccg 764

<210> 70
<211> 761
<212> DNA
<213> Artificial

<220>
<223> WapR-003 scFv

<400> 70
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ctgggggggtc cctgagactc tcctgttcag cctctggatt caccttcagt agctatccta 120

tgcactgggt ccgccaggct ccagggaagg gactggatta tgtttcagac atcagtccaa 180

atgggggtgc cacaaactac gcagactccg tgaagggcag attcaccatc tccagagaca 240

attccaagaa cacggtgtat cttcaaatga gcagtctgag agctgaagac acggctgtct 300

attattgtgt gatggggtta gtgccctatg gttttgataa ctggggccag gggacaatgg 360

tcaccgtctc gagtggaggc ggcggttcag gcggaggtgg ctctggcggt ggcggaagtg 420

cacagactgt ggtgacccag cctgcctccg tgtctgcatc tcctggacag tcgatcacca 480

tctcctgcgc tggaaccagc ggtgatgttg ggaattataa ttttgtctcc tggtaccaac 540

aacacccagg caaagccccc aaactcctga tttatgaggg cagtcagcgg ccctcagggg 600

tttctaatcg cttctctggc tccaggtctg gcaacacggc ctccctgaca atctctgggc 660

tccaggctga ggacgaggct gattattact gttcctcata tgcacgtagt tacacttatg 720

tcttcggaac tgggaccaag ctgaccgtcc tagcggccgc a 761

<210> 71
<211> 761
<212> DNA
<213> Artificial

<220>
<223> WapR-004 scFv

<400> 71
tatgcggccc agccggccat ggccgaggtg cagctgttgg agtcgggccc aggactggtg 60

aagccttcgg agaccctgtc cctcacctgc aatgtcgctg gtggctccat cagtccttac 120

tactggacct ggatccggca gcccccaggg aagggcctgg agttgattgg ttatatccac 180

tccagtgggt acaccgacta caacccctcc ctcaagagtc gagtcaccat atcaggagac 240

acgtccaaga agcagttctc cctgcacgtg agctctgtga ccgctgcgga cacggccgtg 300

tacttctgtg cgagaggcga ttgggacctg cttcatgctc ttgatatctg gggccaaggg 360

accctggtca ccgtctcgag tggaggcggc ggttcaggcg gaggtggctc tggcggtggc 420

ggaagtgcac tcgaaattgt gttgacacag tctccatcct ccctgtctac atctgtagga 480

gacagagtca ccatcacttg ccgggcaagt cagagcatta ggagccattt aaattggtat 540

cagcagaaac cagggaaagc ccctaaactc ctgatctatg gtgcatccaa tttgcaaagt 600

ggggtcccat caaggttcag tggcagtgga tctgggacag atttcactct caccattagt 660

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actttcggcg gagggaccaa gctggagatc aaagcggccg c 761

<210> 72
<211> 747
<212> DNA
<213> Artificial

<220>
<223> WapR-007 scFv

<400> 72
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cctggggcct cagtgagggt cacctgcaag gcttctggat acaccttcac cggccacaac 120

atacactggg tgcgacaggc ccctggacaa gggcttgaat ggatgggatg gatcaaccct 180

gacagtggtg ccacaagcta tgcacagaag tttcagggca gggtcaccat gaccagggac 240

acgtccatca ccacagccta catggacctg agcaggctga gatctgacga cacggccgta 300

tattactgtg cgaccgatac attactgtct aatcactggg gccaaggaac cctggtcacc 360

gtctcgagtg gtggaggcgg ttcaggcgga ggtggcagcg gcggtggcgg atcgtctgag 420

ctgactcagg accctgctgt gtctgtggcc ttgggacaga cagtcaggat cacttgccaa 480

ggagacagtc tcagaagcta ttacacaaac tggttccagc agaagccagg acaggcccct 540

ctacttgtcg tctatgctaa aaataagcgg cccccaggga tcccagaccg attctctggc 600

tccagctcag gaaacacagc ttccttgacc atcactgggg ctcaggcgga agatgaggct 660

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aagctgaccg tcctaggtgc ggccgca 747

<210> 73
<211> 771
<212> DNA
<213> Artificial

<220>
<223> WapR-016 scFv

<400> 73
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gggtccctga gactctcctg tgcagcctct ggatacacct ttagcagcta tgccacgagc 120

tgggtccgcc aggctccagg gaaggggctg gagtgggtcg caggtattag tggtagtggt 180

gataccacag actacgtaga ctccgtgaag ggccggttca ccgtctccag agacaattcc 240

aagaacaccc tatatctgca aatgaacagc ctgagagccg acgacacggc cgtgtattac 300

tgtgcgtcga gaggaggttt aggggttat taccggggcg gctttgactt ctggggccag 360

gggacaatgg tcaccgtctc gagtggaggc ggcggttcag gcggaggtgg ctctggcggt 420

ggcggaagtg cacagtctgt gctgacgcag cctgcctccg tgtctgggtc tcctggacag 480

tcgatcacca tctcctgcac tggaaccagc agtgacgttg gtggttataa ctatgtctcc 540

tggtaccaac agcacccagg caaagccccc aaactcatga tttatgaggt cagtaatcgg 600

ccctcagggg tttctaatcg cttctctggc tccaagtctg gcaacacggc ctccctgacc 660

atctctgggc tccaggctga ggacgaggct gattattact gcagctcata tacaagcagc 720

ggcactgtgg tattcggcgg agggaccgag ctgaccgtcc tagcggccgc a 771

<210> 74
<211> 119
<212> PRT
<213> Artificial

<220>
<223> WapR-004RAD VH

<400> 74

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser
115

<210> 75
<211> 11
<212> PRT
<213> Artificial

<220>
<223> WapR-004RAD VHCDR3

<400> 75

Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile
1 5 10

<210> 76
<211> 351
<212> DNA
<213> Artificial

<220>
<223> WapR-004RAD VH

<400> 76
gaggtgcagc tgttggagtc gggcccagga ctggtgaagc cttcggagac cctgtccctc 60

acctgcaatg tcgctggtgg ctccatcagt ccttactact ggacctggat ccggcagccc 120

ccagggaagg gcctggagtt gattggttat atccactcca gtgggtacac cgactacaac 180

ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt c 351

<210> 77
<211> 321

<212> DNA
<213> Artificial

<220>
<223> WapR-004RAD VL

<400> 77
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atcacttgcc gggcaagtca gagcattagg agccatttaa attggtatca gcagaaacca 120

gggaaagccc ctaaactcct gatctatggt gcatccaatt tgcaaagtgg ggtcccatca 180

aggttcagtg gcagtggatc tgggacagat ttcactctca ccattagtag tctgcaacct 240

gaagattttg caacttacta ctgtcaacag agttacagtt tccccctcac tttcggcgga 300

gggaccaagc tggagatcaa a 321

<210> 78
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-M1 scFv-Fc

<400> 78

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro

130 135 140

Ser Ser Leu Ser Ala Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Thr Pro Gln Thr Phe Gly Gln Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 79
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M5 scFv-Fc

<400> 79

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Ser Val Val Thr Gln Pro Ala Ser
130 135 140

Val Ser Gly Ser Leu Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Ala Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
165 170 175

Pro Gly Lys Ala Pro Lys Leu Ile Ile Tyr Asp Val Asn Asn Arg Pro
180 185 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Asn Ser Tyr Gly Gly Ser Ser Thr Trp Leu Phe Gly Gly Gly Thr
225 230 235 240

Lys Leu Thr Val Leu
245

<210> 80
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M6 scFv-Fc

<400> 80

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Ser Tyr Glu Leu Met Gln Pro Pro
130 135 140

Ser Val Ser Gly Thr Pro Gly Gln Arg Val Thr Ile Ser Cys Ser Gly
145 150 155 160

Ser Ser Ser Asn Ile Gly Ser Asn Thr Val Asn Trp Tyr Gln Gln Leu
165 170 175

Pro Gly Thr Ala Pro Lys Leu Leu Ile Tyr Ser Asn Asn Gln Arg Pro
180 185 190

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

Ser Leu Ala Ile Ser Gly Leu Gln Ser Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Ala Ala Trp Asp Asp Ser Leu Asn Val Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 81
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M7 scFv-Fc

<400> 81

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 82
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M8 scFv-Fc

<400> 82

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205
```

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 83
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M9 scFv-Fc

<400> 83

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Ser Val Leu Thr Gln Pro Ala Ser
130 135 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Thr Ser Asp Val Gly Ala Phe Gly Phe Val Ser Trp Tyr Gln Gln Lys

165 170 175

Pro Gly Glu Val Pro Lys Leu Met Ile Tyr Asp Val Ser Asp Arg Pro
180 185 190

Ser Gly Val Ser Asp Arg Phe Ser Gly Ser Lys Ser Gly Ser Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Gly Ser Tyr Thr Ser Thr Ser Thr Trp Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Leu Thr Val Leu
245

<210> 84
<211> 246
<212> PRT
<213> Artificial

<220>
<223> W4-M11 scFv-Fc

<400> 84

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Ser Tyr Glu Leu Met Gln Pro Ala
130 135 140

Ser Val Ser Gly Ser Leu Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly
145 150 155 160

Thr Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln
165 170 175

His Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg
180 185 190

Pro Ser Gly Val Pro Asp Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr
195 200 205

Ala Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr
210 215 220

Tyr Cys Ser Ser Tyr Ala Arg Ser Tyr Thr Tyr Val Phe Gly Thr Gly
225 230 235 240

Thr Lys Val Thr Val Leu
245

<210> 85
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M12 scFv-Fc

<400> 85

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

```
His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Gly Asp Ile Gly Ala Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Ile Ile Tyr Asp Val Asn Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Ser Ser Tyr Thr Ser Ser Asn Thr Tyr Leu Phe Gly Thr Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 86
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M14 scFv-Fc

<400> 86

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30
```

```
Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Ser Val Leu Thr Gln Pro Pro Ser
    130                 135                 140

Ala Phe Gly Thr Pro Gly Gln Ser Leu Thr Ile Ser Cys Ser Gly Ser
145                 150                 155                 160

Asn Ser Asn Ile Gly Arg Asn Thr Val Thr Trp Tyr Gln His Leu Pro
                165                 170                 175

Gly Thr Ala Pro Lys Leu Leu Ile Tyr Ser Ser Asn Gln Arg Pro Ser
            180                 185                 190

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

Leu Ala Ile Ser Gly Leu Gln Ser Glu Asp Glu Ala His Tyr Tyr Cys
    210                 215                 220

Ala Ala Trp Asp Asp Ser Leu His Gly Met Ile Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 87
<211> 245
<212> PRT
<213> Artificial

<220>

<223> W4-M15 scFv-Fc

<400> 87

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Leu Thr Gln Pro Pro Ser
    130                 135                 140

Ala Phe Gly Thr Pro Gly Gln Ser Leu Thr Ile Ser Cys Ser Gly Ser
145                 150                 155                 160

Asn Ser Asn Ile Gly Arg Asn Thr Val Thr Trp Tyr Gln His Leu Pro
                165                 170                 175

Gly Thr Ala Pro Lys Leu Leu Ile Tyr Ser Ser Asn Gln Arg Pro Ser
            180                 185                 190

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

Leu Ala Ile Ser Gly Leu Gln Ser Glu Asp Glu Ala His Tyr Tyr Cys
    210                 215                 220

Ala Ala Trp Asp Asp Ser Leu His Gly Met Ile Phe Gly Gly Gly Thr
225                 230                 235                 240
```

Lys Val Thr Val Leu
245

<210> 88
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M16 scFv-Fc

<400> 88

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Ser Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Leu Thr Gln Pro Pro Ser
130 135 140

Ala Phe Gly Thr Pro Gly Gln Ser Leu Thr Ile Ser Cys Ser Gly Ser
145 150 155 160

```
Asn Ser Asn Ile Gly Arg Asn Thr Val Thr Trp Tyr Gln His Leu Pro
                165                 170                 175

Gly Thr Ala Pro Lys Leu Leu Ile Tyr Ser Ser Asn Gln Arg Pro Ser
            180                 185                 190

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

Leu Ala Ile Ser Gly Leu Gln Ser Glu Asp Glu Ala His Tyr Tyr Cys
    210                 215                 220

Ala Ala Trp Asp Asp Ser Leu His Gly Met Ile Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 89
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M17 scFv-Fc

<400> 89

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
```

115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Pro Ser
130 135 140

Ala Phe Gly Thr Pro Gly Gln Ser Leu Thr Ile Ser Cys Ser Gly Ser
145 150 155 160

Ser Ser Asn Ile Gly Gly Asn Thr Val Asn Trp Tyr Gln Gln Leu Pro
165 170 175

Gly Thr Ala Pro Arg Leu Leu Ile Tyr Ser Asn Ser Gln Arg Pro Ser
180 185 190

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

Leu Ala Ile Ser Gly Leu Gln Ser Glu Asp Glu Ala Asp Tyr Tyr Cys
210 215 220

Ala Ala Trp Asp Asp Ser Leu Asn Gly Val Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Leu Thr Val Leu
245

<210> 90
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M19 scFv-Fc

<400> 90

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

```
His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Leu Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ala Tyr Asn Tyr Val Ser Trp Phe Gln Gln His
                165                 170                 175

Pro Gly Lys Val Pro Lys Leu Ile Ile Trp Glu Val Ile Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Ser Ser Tyr Thr Ser Ser Asn Thr Tyr Val Phe Gly Thr Gly Thr
225                 230                 235                 240

Lys Leu Thr Val Leu
                245
```

<210> 91
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M20 scFv-Fc

<400> 91

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30
```

```
Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Ser Ala Leu Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Ser Gly Ser
145                 150                 155                 160

Ser Ser Asn Ile Gly Asn Asn Tyr Val Ser Trp Tyr Leu Gln Leu Pro
                165                 170                 175

Gly Thr Ala Pro Lys Leu Leu Ile Tyr Asp Asn Asn Gly Arg Pro Ser
            180                 185                 190

Gly Ile Pro Asp Arg Phe Ser Gly Ser Lys Ser Gly Thr Ser Ala Thr
        195                 200                 205

Leu Gly Ile Thr Gly Leu Gln Thr Gly Asp Glu Ala Asp Tyr Tyr Cys
    210                 215                 220

Ala Thr Trp Asp Ser Ser Leu Ser Ala Gly Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 92
<211> 244
<212> PRT
<213> Artificial

<220>

<223> W4-M4 scFv-Fc

<400> 92

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Leu Ser Tyr Glu Leu Met Gln Asp Pro
    130                 135                 140

Ala Val Ser Val Ala Leu Gly Gln Thr Val Arg Ile Thr Cys Arg Gly
145                 150                 155                 160

Asp Ser Leu Ser Ser Phe Tyr Thr Ser Trp Tyr Gln Gln Lys Pro Gly
                165                 170                 175

Gln Ala Pro Leu Leu Val Ile Tyr Gly Lys Asn Asn Arg Pro Ser Gly
            180                 185                 190

Ile Pro Asp Arg Phe Ser Gly Ser Ser Ser Gly Asn Thr Ala Ser Leu
        195                 200                 205

Thr Ile Thr Gly Ala Gln Ala Glu Asp Glu Ala Asp Tyr Tyr Cys Asn
    210                 215                 220

Ser Arg Asp Ser Ser Asp Asn Tyr Val Leu Phe Gly Gly Gly Thr Lys
225                 230                 235                 240
```

Leu Thr Val Leu

<210> 93
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-M10 scFv-Fc

<400> 93

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Lys Gly Val Ser Trp Tyr Gln Gln Pro
                165                 170                 175

Pro Gly Thr Ala Pro Lys Leu Leu Ile Tyr Asn Asp Asn Gln Arg Pro
            180                 185                 190
```

Ser Gly Ile Pro Gly Arg Phe Ser Gly Ser Asn Ser Gly Asn Thr Ala
195 200 205

Ile Leu Thr Ile Ser Gly Thr Gln Ala Met Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Gln Ala Trp Asp Ser Ser Asn His Val Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Leu Thr Val Leu
245

<210> 94
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-HC1-LCP

<400> 94

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg

145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 95
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-HC1-LC7 scFv-Fc

<400> 95

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

```
Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 96
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-HC2-LC7 scFv-Fc

<400> 96

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60
```

```
Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Thr Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 97
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-HC3-LCP scFv-Fc

<400> 97

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15
```

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Phe Asp Ile Trp Gly Gln Gly
100 105 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 98
<211> 243
<212> PRT

<213> Artificial

<220>
<223> W4-HC4-LCP scFv-Fc

<400> 98

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Gly Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220
```

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 99
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-HC5-LCP scFv-Fc

<400> 99

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Pro Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser

180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 100
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-HC5-LC7 scFv-Fc

<400> 100

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Pro Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
130 135 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
165 170 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
180 185 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 101
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-HC7-LCP scFv-Fc

<400> 101

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

```
Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Val Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 102
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH1-VL8 scFv-Fc

<400> 102

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45
```

```
Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 103
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH2-VLP scFv-Fc

<400> 103

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
```

```
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Thr Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 104
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH2-VL8 scFv-Fc

<400> 104

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Thr Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
```

210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 105
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH3-VL7 scFv-Fc

<400> 105

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Phe Asp Ile Trp Gly Gln Gly
100 105 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
130 135 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
165 170 175

```
Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 106
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH3-VL8 scFv-Fc

<400> 106

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Phe Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125
```

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
130 135 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
165 170 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
180 185 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 107
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH5-VL8 scFv-Fc

<400> 107

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

```
His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Pro Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
```

<210> 108
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH6-VL7 scFv-Fc

<400> 108

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
```

35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Met Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
130 135 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
165 170 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
180 185 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 109
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH6-VL8 scFv-Fc

<400> 109

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Met Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
    130                 135                 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
```

245

<210> 110
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH6-VLP scFv-Fc

<400> 110

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Met Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 111
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH7-VLP scFv-Fc

<400> 111

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Val Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 112
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH7-VL7 scFv-Fc

<400> 112

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Val Trp Gly Gln Gly
100 105 110

```
Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Ser Gly Ser Ala Gln Thr Val Val Thr Gln Pro Ala Ser
    130                 135                 140

Val Ser Gly Ser Pro Gly Gln Ser Ile Thr Ile Ser Cys Thr Gly Thr
145                 150                 155                 160

Ser Ser Asp Ile Gly Gly Tyr Asn Tyr Val Ser Trp Tyr Arg Gln His
                165                 170                 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Asp Val Ser Asn Arg Pro
            180                 185                 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
        195                 200                 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
    210                 215                 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225                 230                 235                 240

Lys Val Thr Val Leu
                245
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<210> 113
<211> 245
<212> PRT
<213> Artificial

<220>
<223> W4-VH7-VL8 scFv-Fc

<400> 113

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
```

65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Val Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Gln Ser Val Val Thr Gln Pro Pro Ser
130 135 140

Val Ser Ala Ala Pro Gly Gln Lys Val Thr Ile Ser Cys Thr Gly Thr
145 150 155 160

Ser Ser Asp Val Gly Ser Tyr Asn Phe Val Ser Trp Tyr Gln Gln His
165 170 175

Pro Gly Lys Ala Pro Lys Leu Met Ile Tyr Glu Gly Thr Lys Arg Pro
180 185 190

Ser Gly Val Ser Asn Arg Phe Ser Gly Ser Lys Ser Gly Asn Thr Ala
195 200 205

Ser Leu Thr Ile Ser Gly Leu Gln Ala Glu Asp Glu Ala Asp Tyr Tyr
210 215 220

Cys Thr Ser Tyr Thr Ser Asp Ser Thr Leu Val Phe Gly Gly Gly Thr
225 230 235 240

Lys Val Thr Val Leu
245

<210> 114
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH9-VLP scFv-Fc

<400> 114

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Val Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 115
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH10-VLP scFv-Fc

<400> 115

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Phe His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240
```

Glu Ile Lys

<210> 116
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH11-VLP scFv-Fc

<400> 116

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Pro His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190
```

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 117
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH12-VLP scFv-Fc

<400> 117

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu Arg Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

```
Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 118
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH15-VLP scFv-Fc

<400> 118

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Gly Asn Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
```

100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 119
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH16-VLP scFv-Fc

<400> 119

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asn Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 120
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH20-VLP scFv-Fc

<400> 120

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Thr Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 121
<211> 243

<212> PRT
<213> Artificial

<220>
<223> W4-VH31-VLP scFv-Fc

<400> 121

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Glu Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 122
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH37-VLP scFv-Fc

<400> 122

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Phe Asp Met Trp Gly Gln Gly
100 105 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 123
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH41-VLP scFv-Fc

<400> 123

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Ala Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro

130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 124
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH42-VLP scFv-Fc

<400> 124

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Arg Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Met Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 125
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH35-VLP scFv-Fc

<400> 125

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Thr
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 126
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH36-VLP scFv-Fc

<400> 126

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Val
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 127
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH52-VLP scFv-Fc

<400> 127

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Gly Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 128
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH53-VLP scFv-Fc

<400> 128

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Pro Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro

```
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 129
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH54-VLP scFv-Fc

<400> 129

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Asn Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125
```

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 130
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH55-VLP scFv-Fc

<400> 130

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Thr His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

```
His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 131
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH56-VLP scFv-Fc

<400> 131

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30
```

```
Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Ala Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 132
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH57-VLP scFv-Fc

<400> 132

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Gly Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240
```

Glu Ile Lys

<210> 133
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH58-VLP scFv-Fc

<400> 133

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Arg Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr

195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 134
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH60-VLP scFv-Fc

<400> 134

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Ser Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

```
Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 135
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH61-VLP scFv-Fc

<400> 135

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Phe Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110
```

```
Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 136
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH62-VLP scFv-Fc

<400> 136

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Arg Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60
```

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 137
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH63-VLP scFv-Fc

<400> 137

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr

20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Gly Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 138
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH64-VLP scFv-Fc

<400> 138

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                  10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile Arg Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
```

225 230 235 240

Glu Ile Lys

<210> 139
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH65-VLP scFv-Fc

<400> 139

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Asn Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 140
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH66-VLP scFv-Fc

<400> 140

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp His Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

```
Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 141
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH67-VLP scFv-Fc

<400> 141

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Phe Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
    50                  55                  60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65                  70                  75                  80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
                85                  90                  95
```

```
Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
            100                 105                 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
        115                 120                 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
    130                 135                 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145                 150                 155                 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
                165                 170                 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
            180                 185                 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
        195                 200                 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
    210                 215                 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225                 230                 235                 240

Glu Ile Lys
```

<210> 142
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH69-VLP scFv-Fc

<400> 142

```
Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1               5                   10                  15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
            20                  25                  30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
        35                  40                  45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Ser Ser Leu Lys
```

50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 143
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH70-VLP scFv-Fc

<400> 143

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Arg
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 144

<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH72-VLP scFv-Fc

<400> 144

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly His Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 145
<211> 243
<212> PRT
<213> Artificial

<220>
<223> W4-VH79-VLP scFv-Fc

<400> 145

Glu Val Gln Leu Leu Glu Ser Gly Pro Gly Leu Val Lys Pro Ser Glu
1 5 10 15

Thr Leu Ser Leu Thr Cys Asn Val Ala Gly Gly Ser Ile Ser Pro Tyr
20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Tyr His Pro Ser Gly Tyr Thr Asp Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

<210> 146
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<223> W4-VH80-VLP scFv-Fc

<400> 146

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20 25 30

Tyr Trp Thr Trp Ile Arg Gln Pro Pro Gly Lys Gly Leu Glu Leu Ile
35 40 45

Gly Tyr Ile His Ser Ser Gly Phe Thr Ser Tyr Asn Pro Ser Leu Lys
50 55 60

Ser Arg Val Thr Ile Ser Gly Asp Thr Ser Lys Lys Gln Phe Ser Leu
65 70 75 80

His Val Ser Ser Val Thr Ala Ala Asp Thr Ala Val Tyr Phe Cys Ala
85 90 95

Arg Ala Asp Trp Asp Leu Leu His Ala Leu Asp Ile Trp Gly Gln Gly
100 105 110

Thr Leu Val Thr Val Ser Ser Gly Gly Gly Gly Ser Gly Gly Gly Gly
115 120 125

Ser Gly Gly Gly Gly Ser Ala Leu Glu Ile Val Leu Thr Gln Ser Pro
130 135 140

Ser Ser Leu Ser Thr Ser Val Gly Asp Arg Val Thr Ile Thr Cys Arg
145 150 155 160

Ala Ser Gln Ser Ile Arg Ser His Leu Asn Trp Tyr Gln Gln Lys Pro
165 170 175

Gly Lys Ala Pro Lys Leu Leu Ile Tyr Gly Ala Ser Asn Leu Gln Ser
180 185 190

Gly Val Pro Ser Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
195 200 205

Leu Thr Ile Ser Ser Leu Gln Pro Glu Asp Phe Ala Thr Tyr Tyr Cys
210 215 220

Gln Gln Ser Tyr Ser Phe Pro Leu Thr Phe Gly Gly Gly Thr Lys Leu
225 230 235 240

Glu Ile Lys

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ccagggaagg gcctggagtt gattggttat atccactcca gtgggtacac cgactacaac 180

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agtggatctg ggacagattt cactctcacc atcagcagtc tgcaacctga ggattttgca 660

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gagatcaaa 729

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cagcctgcct ccgtgtctgg gtctcttgga cagtcgatca ccatctcctg cactggaacc 480

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ggctccaagt ctggcaacac ggcctccctg accatctctg gcctccaggc tgaggacgag 660

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aagctgaccg tccta 735

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ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

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ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag aggcgattgg 300

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<400> 152

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Gly Gly Thr Gly Ala Ala Gly Cys Cys Thr Thr Cys Gly Gly Ala Gly
35 40 45

Ala Cys Cys Cys Thr Gly Thr Cys Cys Cys Thr Cys Ala Cys Cys Thr
50 55 60

Gly Cys Ala Ala Thr Gly Thr Cys Gly Cys Thr Gly Gly Thr Gly Gly
65 70 75 80

Cys Thr Cys Cys Ala Thr Cys Ala Gly Thr Cys Cys Thr Thr Ala Cys
85 90 95

Thr Ala Cys Thr Gly Gly Ala Cys Cys Thr Gly Gly Ala Thr Cys Cys
100 105 110

Gly Gly Cys Ala Gly Cys Cys Cys Cys Cys Ala Gly Gly Gly Ala Ala
115 120 125

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Gly Gly Gly Cys Cys Thr Gly Gly Ala Gly Thr Thr Gly Ala Thr Thr
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Gly Gly Thr Thr Ala Thr Ala Thr Cys Cys Ala Cys Thr Cys Cys Ala
145                 150                 155                 160

Gly Thr Gly Gly Gly Thr Ala Cys Ala Cys Cys Gly Ala Cys Thr Ala
                165                 170                 175

Cys Ala Ala Cys Cys Cys Cys Thr Cys Cys Cys Thr Cys Ala Ala Gly
            180                 185                 190

Ala Gly Thr Cys Gly Ala Gly Thr Cys Ala Cys Cys Ala Thr Ala Thr
        195                 200                 205

Cys Ala Gly Gly Ala Gly Ala Cys Ala Cys Gly Thr Cys Cys Ala Ala
    210                 215                 220

Gly Ala Ala Gly Cys Ala Gly Thr Thr Cys Thr Cys Cys Cys Thr Gly
225                 230                 235                 240

Cys Ala Cys Gly Thr Gly Ala Gly Cys Thr Cys Thr Gly Thr Gly Ala
                245                 250                 255

Cys Cys Gly Cys Thr Gly Cys Gly Gly Ala Cys Ala Cys Gly Gly Cys
            260                 265                 270

Cys Gly Thr Gly Thr Ala Cys Thr Thr Cys Thr Gly Thr Gly Cys Gly
        275                 280                 285

Ala Gly Ala Gly Gly Cys Gly Ala Thr Thr Gly Gly Gly Ala Cys Cys
    290                 295                 300

Thr Gly Cys Thr Thr Cys Ala Thr Gly Cys Thr Cys Thr Thr Gly Ala
305                 310                 315                 320

Thr Ala Thr Cys Thr Gly Gly Gly Gly Cys Cys Ala Ala Gly Gly Gly
                325                 330                 335

Ala Cys Cys Cys Thr Gly Gly Thr Cys Ala Cys Cys Gly Thr Cys Thr
            340                 345                 350

Cys Gly Ala Gly Thr Gly Gly Ala Gly Gly Cys Gly Gly Cys Gly Gly
        355                 360                 365

Thr Thr Cys Ala Gly Gly Cys Gly Gly Ala Gly Gly Thr Gly Gly Cys
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370 375 380

Thr Cys Thr Gly Gly Cys Gly Gly Thr Ala Gly Cys Gly Gly Ala Ala
385 390 395 400

Gly Thr Gly Cys Ala Cys Ala Gly Thr Cys Thr Gly Thr Gly Cys Thr
405 410 415

Gly Ala Cys Thr Cys Ala Gly Cys Cys Thr Gly Cys Cys Thr Cys Cys
420 425 430

Gly Thr Gly Thr Cys Cys Gly Gly Gly Thr Cys Ala Cys Cys Thr Gly
435 440 445

Gly Ala Cys Ala Gly Thr Cys Gly Ala Thr Cys Ala Cys Cys Ala Thr
450 455 460

Ala Thr Cys Cys Thr Gly Cys Ala Cys Thr Gly Gly Cys Ala Cys Cys
465 470 475 480

Ala Cys Cys Ala Gly Cys Gly Ala Cys Gly Thr Thr Gly Gly Thr Gly
485 490 495

Cys Thr Thr Thr Thr Gly Gly Cys Thr Thr Thr Gly Thr Cys Thr Cys
500 505 510

Cys Thr Gly Gly Thr Ala Cys Cys Ala Ala Cys Ala Gly Ala Ala Gly
515 520 525

Cys Cys Ala Gly Gly Cys Gly Ala Ala Gly Thr Cys Cys Cys Cys Ala
530 535 540

Ala Ala Cys Thr Cys Ala Thr Gly Ala Thr Thr Thr Ala Thr Gly Ala
545 550 555 560

Thr Gly Thr Cys Ala Gly Thr Gly Ala Thr Cys Gly Gly Cys Cys Cys
565 570 575

Thr Cys Ala Gly Gly Gly Gly Thr Thr Thr Cys Thr Gly Ala Thr Cys
580 585 590

Gly Cys Thr Thr Cys Thr Cys Thr Gly Gly Cys Thr Cys Cys Ala Ala
595 600 605

Gly Thr Cys Thr Gly Gly Cys Ala Gly Cys Ala Cys Gly Gly Cys Cys
610 615 620

Thr Cys Cys Cys Thr Gly Ala Cys Cys Ala Thr Cys Thr Cys Thr Gly
625 630 635 640

Gly Gly Cys Thr Cys Cys Ala Gly Gly Cys Thr Gly Ala Gly Gly Ala
645 650 655

Cys Gly Ala Gly Gly Cys Thr Gly Ala Thr Thr Ala Thr Thr Ala Cys
660 665 670

Thr Gly Cys Gly Gly Cys Thr Cys Ala Thr Ala Thr Ala Cys Ala Ala
675 680 685

Gly Cys Ala Cys Cys Ala Gly Cys Ala Cys Thr Thr Gly Gly Gly Thr
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705 710 715 720

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ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

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gcccccaaac tcatgattta tgagggcact aagcggccct caggggtccc tgaccgattc 600

tctggctcca agtctggcaa cacggcctcc ctgacaatct ctgggctcca ggctgaggac 660

gaggctgatt attactgttc ctcatatgca cgtagttaca cttatgtctt cggaactggc 720

accaaggtga ccgtcctc 738

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cccaaactca tcatttatga tgtcaataat cggccctcag gggtttctaa tcgcttctct 600

ggctccaagt ctggcaacac ggcctccctg accatctctg ggctccaggc tgaggacgag 660

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aaggtcaccg tccta 735

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cagccgccct cagtgtctgc ggccccagga cagaaggtca ccatctcctg ctctggaagc 480

agctccaaca ttgggaacaa ttatgtctcc tggtatctgc agctcccagg aacagccccc 540

aaactcctca tttatgacaa taatgggcga ccctcaggga ttcctgaccg attctctggc 600

tccaagtctg gcacgtcagc caccctgggc atcaccggac tccagactgg ggacgaggcc 660

gattattact gcgcaacatg ggatagcagc ctgagtgctg gggtgttcgg cggagggacc 720

aaggtcaccg tccta 735

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tattactgta actcccggga cagcagtgat aactatgtgt tattcggcgg agggaccaag 720

ctgaccgtcc ta 732

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gctgactatt actgtcaggc gtgggacagc agtaatcatg tggttttcgg cggagggacc 720

aagctgaccg tccta 735

<210> 163
<211> 729
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<213> Artificial

<220>
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gagatcaaa 729

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aaggtgaccg tcctc 735

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<220>
<223> W4-HC2-LC7 scFv-Fc

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aaggtgaccg tcctc 735

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<220>
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agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

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gagatcaaa 729

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gagatcaaa 729

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aaggtgaccg tcctc 735

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gagatcaaa 729

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aaggtgaccg tcctc 735

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aaggtgaccg tcctc 735

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aaggtgaccg tcctc 735

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<400> 182
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gagatcaaa 729

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<213> Artificial

<220>
<223> W4-VH67-VLP scFv-Fc

<400> 210
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ccagggaagg gcctggagtt gattggttat atccacttca gtgggtacac cgactacaac 180

ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagccct 540

aaactcctga tctatggtgc atccaatttg caaagtgggg tcccatcaag gttcagtggc 600

agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

<210> 211
<211> 729
<212> DNA
<213> Artificial

<220>
<223> W4-VH69-VLP scFv-Fc

<400> 211
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ccagggaagg gcctggagtt gattggttat atccactcca gtgggtacac cgactacaac 180

tcctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagccct 540

aaactcctga tctatggtgc atccaatttg caaagtgggg tcccatcaag gttcagtggc 600

agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

<210> 212
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<212> DNA
<213> Artificial

<220>
<223> W4-VH70-VLP scFv-Fc

<400> 212
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ccagggaagg gcctggagtt gattggttat atccactcca gtgggtacac cgactacaac 180

ccctccctca ggagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagccct 540

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agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

<210> 213
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<212> DNA
<213> Artificial

<220>
<223> W4-VH72-VLP scFv-Fc

<400> 213
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ccagggaagg gcctggagtt gattggttat atccactcca gtgggcacac cgactacaac 180

ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagcccct 540

aaactcctga tctatggtgc atccaatttg caaagtgggg tcccatcaag gttcagtggc 600

agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

<210> 214
<211> 729
<212> DNA
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<220>
<223> W4-VH79-VLP scFv-Fc

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ccagggaagg gcctggagtt gattggttat taccacccca gtgggtacac cgactacaac 180

ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagcccct 540

aaactcctga tctatggtgc atccaatttg caaagtgggg tcccatcaag gttcagtggc 600

agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

<210> 215
<211> 729
<212> DNA
<213> Artificial

<220>
<223> W4-VH80-VLP scFv-Fc

<400> 215
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acctgcaatg tcgctggtgg ctccatcagt ccttactact ggacctggat ccggcagccc 120

ccagggaagg gcctggagtt gattggttat atccactcca gtgggttcac cagctacaac 180

ccctccctca agagtcgagt caccatatca ggagacacgt ccaagaagca gttctccctg 240

cacgtgagct ctgtgaccgc tgcggacacg gccgtgtact tctgtgcgag agccgattgg 300

gacctgcttc atgctcttga tatctggggc caagggaccc tggtcaccgt ctcgagtgga 360

ggcggcggtt caggcggagg tggctctggc ggtggcggaa gtgcactcga aattgtgttg 420

acacagtctc catcctccct gtctacatct gtaggagaca gagtcaccat cacttgccgg 480

gcaagtcaga gcattaggag ccatttaaat tggtatcagc agaaaccagg gaaagcccct 540

aaactcctga tctatggtgc atccaatttg caaagtgggg tcccatcaag gttcagtggc 600

agtggatctg ggacagattt cactctcacc attagtagtc tgcaacctga agattttgca 660

acttactact gtcaacagag ttacagtttc cccctcactt tcggcggagg gaccaagctg 720

gagatcaaa 729

Claims

1. An antibody or antigen-binding fragment thereof which specifically binds to the same *Pseudomonas* Psl epitope as an antibody or antigen-binding fragment thereof comprising the heavy chain variable region (VH) and light chain variable region (VL) region selected from the group consisting of:

   SEQ ID NO: 1 and SEQ ID NO: 2 (Cam-003),
   SEQ ID NO: 3 and SEQ ID NO: 2 (Cam-004),
   SEQ ID NO: 4 and SEQ ID NO: 2 (Cam-005),
   SEQ ID NO: 5 and SEQ ID NO: 6 (WapR-001),
   SEQ ID NO: 7 and SEQ ID NO: 8 (WapR-002),
   SEQ ID NO: 9 and SEQ ID NO: 10 (WapR-003),
   SEQ ID NO: 11 and SEQ ID NO: 12 (WapR-004),
   SEQ ID NO: 74 and SEQ ID NO: 12 (WapR-004RAD), and
   SEQ ID NO: 15 and SEQ ID NO: 16 (WapR-016).

2. The antibody or antigen-binding fragment thereof of claim 1, which is humanized, chimeric or fully human.

3. The antibody or antigen-binding fragment thereof of any one of claims 1-2, which is an Fab fragment, an Fab' fragment, an F(ab)2 fragment or a single chain Fv (scFv) fragment.

4. The antibody or antigen-binding fragment thereof of any one of claims 1-3, which is monoclonal.

5. A composition comprising the antibody or antigen-binding fragment thereof of any one of claims 1-4, and a carrier.

6. An isolated polynucleotide encoding the antibody or antigen-binding fragment thereof of any one of claims 1-4.

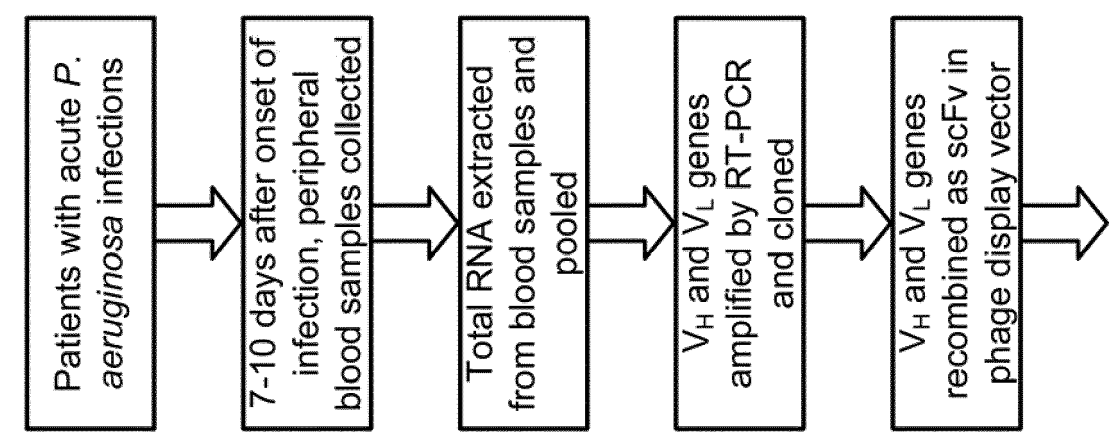
7. A method of producing an antibody or antigen-binding fragment thereof, comprising culturing a host cell comprising the polynucleotide of claim 6, and recovering the antibody or antigen-binding fragment thereof.

8. An antibody or antigen-binding fragment thereof produced by the method of claim 7.

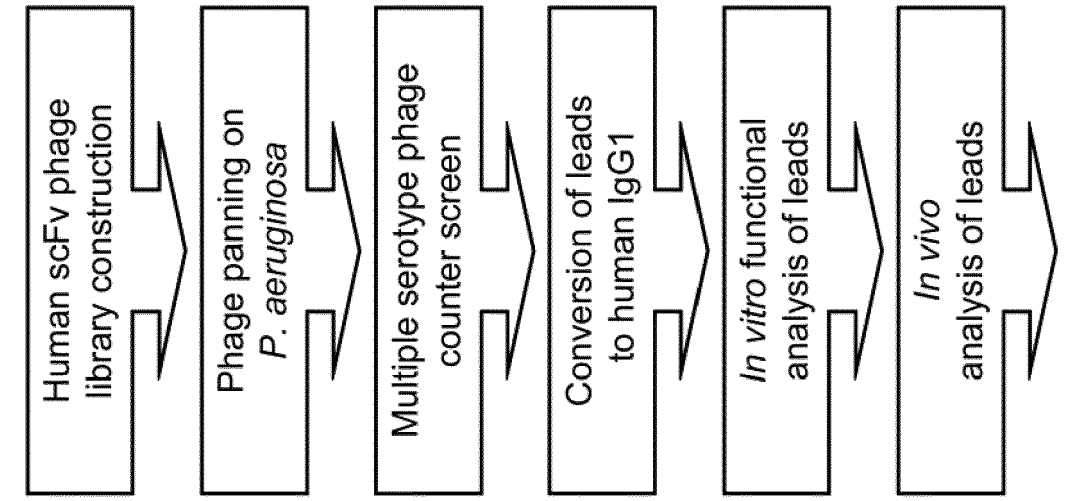
9. The antibody or antigen-binding fragment thereof of any one of claims 1-4 and 8, the composition of claim 5, or the polynucleotide of claim 6 for use in preventing or treating a *Pseudomonas* infection in a subject in need thereof, optionally wherein the *Pseudomonas* infection is a *P. aeruginosa* infection,
optionally wherein the subject is a human,
optionally wherein the infection is an ocular infection, a lung infection, a burn infection, a wound infection, a skin infection, a blood infection, a bone infections, or a combination of two or more of said infections.

10. The antibody or antigen-binding fragment thereof of any one of claims 1-4 and 8, the composition of claim 5, or the polynucleotide of claim 6 for use in blocking or preventing attachment of *P. aeruginosa* to epithelial cells, wherein a mixture of epithelial cells and *P. aeruginosa* are contacted with said antibody or antigen-binding fragment, said composition or said polynucleotide.

11. The antibody or antigen-binding fragment thereof of any one of claims 1-4 and 8, the composition of claim 5, or the polynucleotide of claim 6 for use in enhancing opsonophagocytic killing (OPK) of *P. aeruginosa*, wherein a mixture of phagocytic cells and *P. aeruginosa* are contacted with said antibody or antigen-binding fragment, said composition or said polynucleotide, optionally wherein the phagocytic cells are differentiated HL-60 cells or human polymorphonuclear leukocytes (PMN).


Patients with acute P. aeruginosa infections
7-10 days after onset of infection, peripheral blood samples collected
Total RNA extracted from blood samples and pooled
VH and VL genes amplified by RT-PCR and cloned
VH and VL genes recombined as scFv in phage display vector

1B.


Human scFv phage library construction
Phage panning on P. aeruginosa
Multiple serotype phage counter screen
Conversion of leads to human IgG1
In vitro functional analysis of leads
In vivo analysis of leads

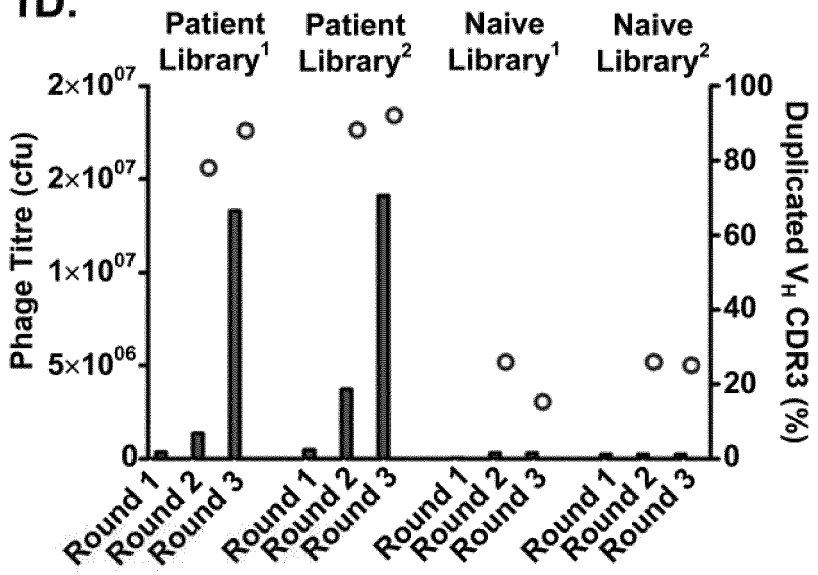
1A.

FIG. 1

1C.

Patient Library Data	
V_H library size:	5.2×10^8
V_κ library size:	1.6×10^7
V_λ library size:	3.5×10^7
scFv library size:	5.4×10^8
Full length, in-frame scFv:	279/352 (79%)
Unique V_HCDR3 sequences:	234/279 (84%)

1D.



1E.

	P. aeruginosa 3039	*P. aeruginosa* 3064	*P. aeruginosa* PA01	*P. aeruginosa* 33356	*P. aeruginosa* 33359	*E. coli* TG1	BSA
CAM-003 scFv	1.28	1.46	1.22	1.06	1.31	0.09	0.07
CAM-004 scFv	0.91	1.15	0.84	0.82	1.03	0.06	0.08
CAM-005 scFv	0.33	0.55	0.27	0.23	0.33	0.07	0.08
CAM-006 scFv	0.51	0.65	0.47	0.45	0.62	0.05	0.06
CAM-007 scFv	0.99	1.12	0.77	0.76	1.06	0.05	0.06
CAM-008 scFv	0.17	0.25	0.13	0.16	0.17	0.07	0.06
CAM-009 scFv	0.99	1.15	0.88	0.87	1.02	0.08	0.07
CAM-010 scFv	0.74	1.03	0.68	0.68	0.91	0.07	0.07
Irrelevant scFv	0.06	0.06	0.07	0.06	0.06	0.07	0.05

FIG. 1

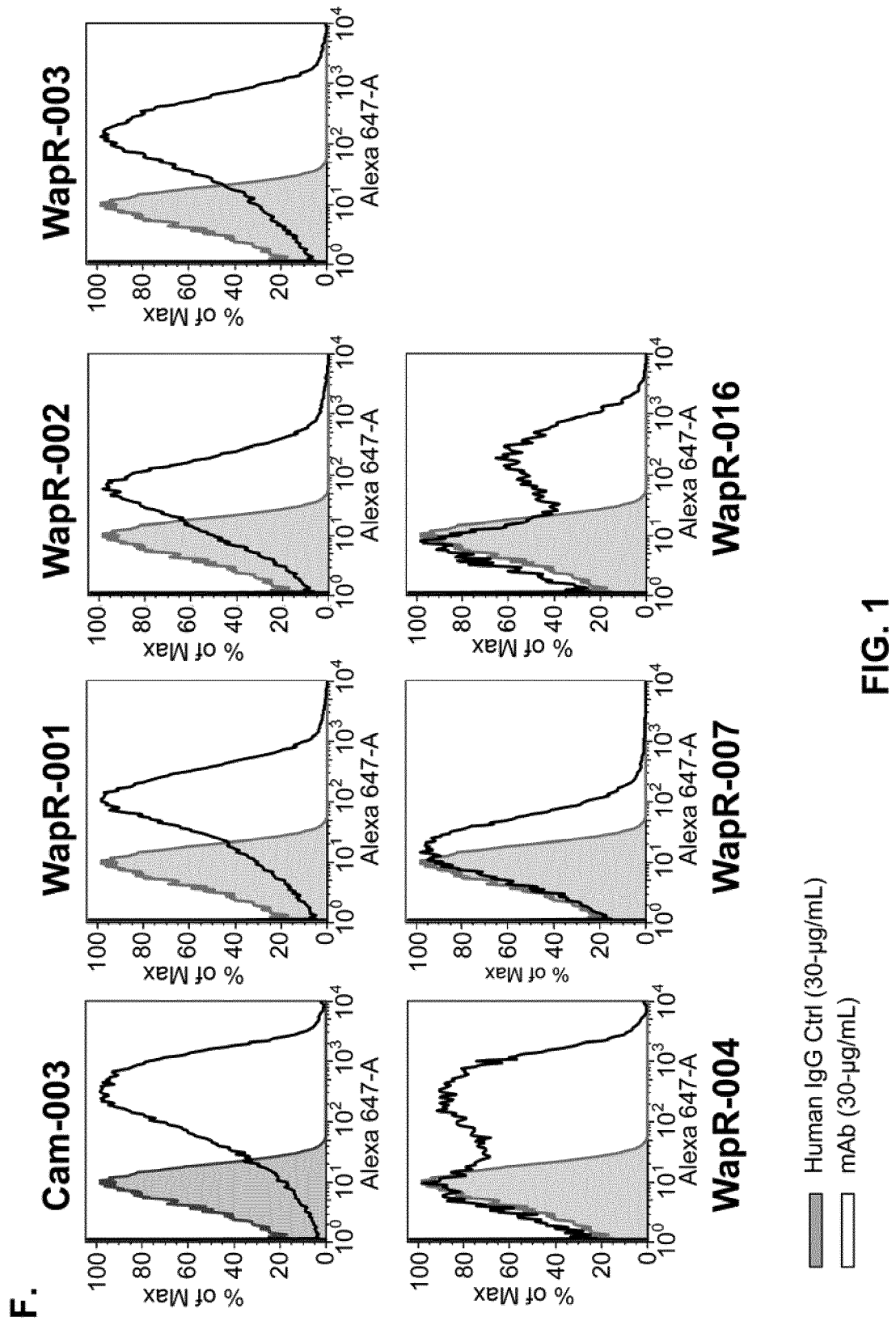

1F.
Cam-003
WapR-001
WapR-002
WapR-003
WapR-004
WapR-007
WapR-016
% of Max
Alexa 647-A
Human IgG Ctrl (30-µg/mL)
mAb (30-µg/mL)

FIG. 1

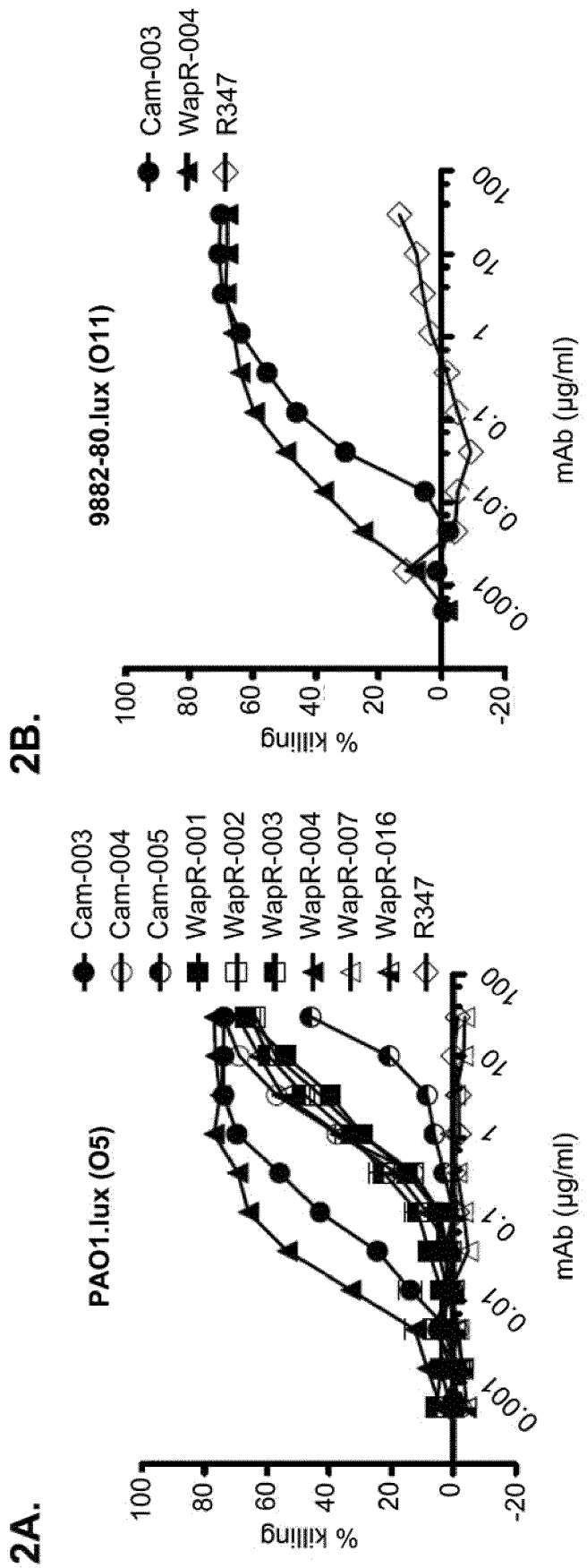
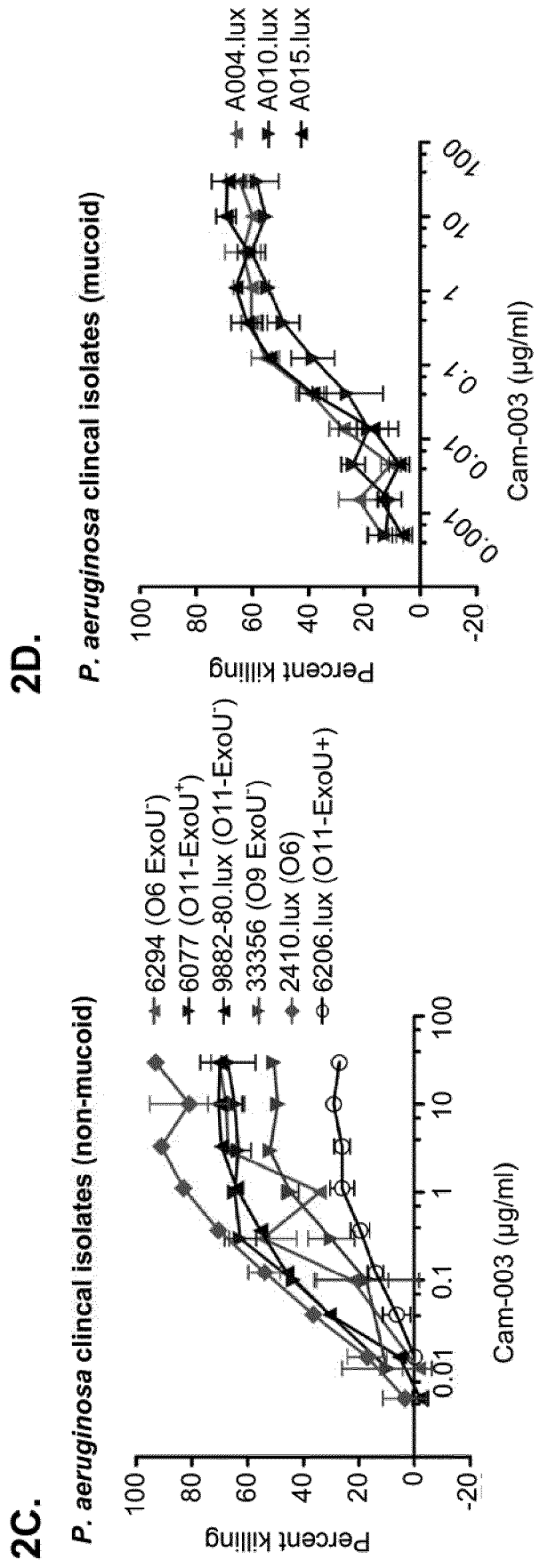

2A.
PAO1.lux (O5)
Cam-003
Cam-004
Cam-005
WapR-001
WapR-002
WapR-003
WapR-004
WapR-007
WapR-016
R347
% killing
100
80
60
40
20
0
-20
mAb (µg/ml)
100
10
1
0.1
0.01
0.001
2B.
9882-80.lux (O11)
Cam-003
WapR-004
R347
% killing
100
80
60
40
20
0
-20
mAb (µg/ml)
100
10
1
0.1
0.01
0.001

FIG. 2


2C.
P. aeruginosa clincal isolates (non-mucoid)
6294 (O6 ExoU-)
6077 (O11-ExoU+)
9882-80.lux (O11-ExoU-)
33356 (O9 ExoU-)
2410.lux (O6)
6206.lux (O11-ExoU+)
Percent killing
Cam-003 (µg/ml)
2D.
P. aeruginosa clincal isolates (mucoid)
A004.lux
A010.lux
A015.lux
Percent killing
Cam-003 (µg/ml)

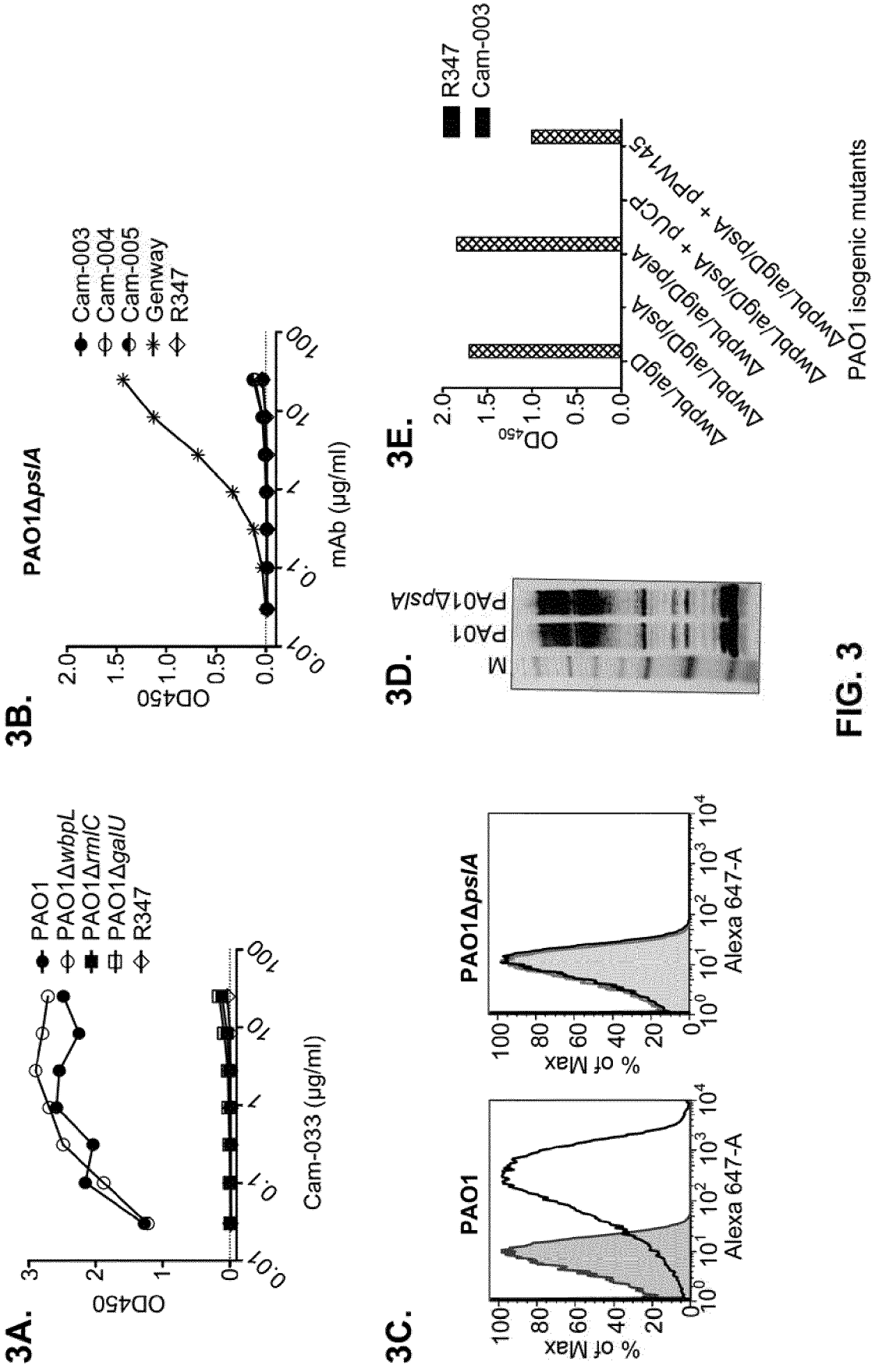

3A.
PAO1
PAO1ΔwbpL
PAO1ΔrmlC
PAO1ΔgalU
R347
OD450
Cam-033 (μg/ml)
3B.
PAO1ΔpslA
Cam-003
Cam-004
Cam-005
Genway
R347
OD450
mAb (μg/ml)
3C.
PAO1
PAO1ΔpslA
% of Max
Alexa 647-A
3D.
M
PA01
PA01ΔpslA
3E.
R347
Cam-003
OD450
ΔwpbL/algD
ΔwpbL/algD/psiA
ΔwpbL/algD/pelA
ΔwpbL/algD/psiA + pUCP
ΔwpbL/algD/psiA + pPW145
PAO1 isogenic mutants

FIG. 3

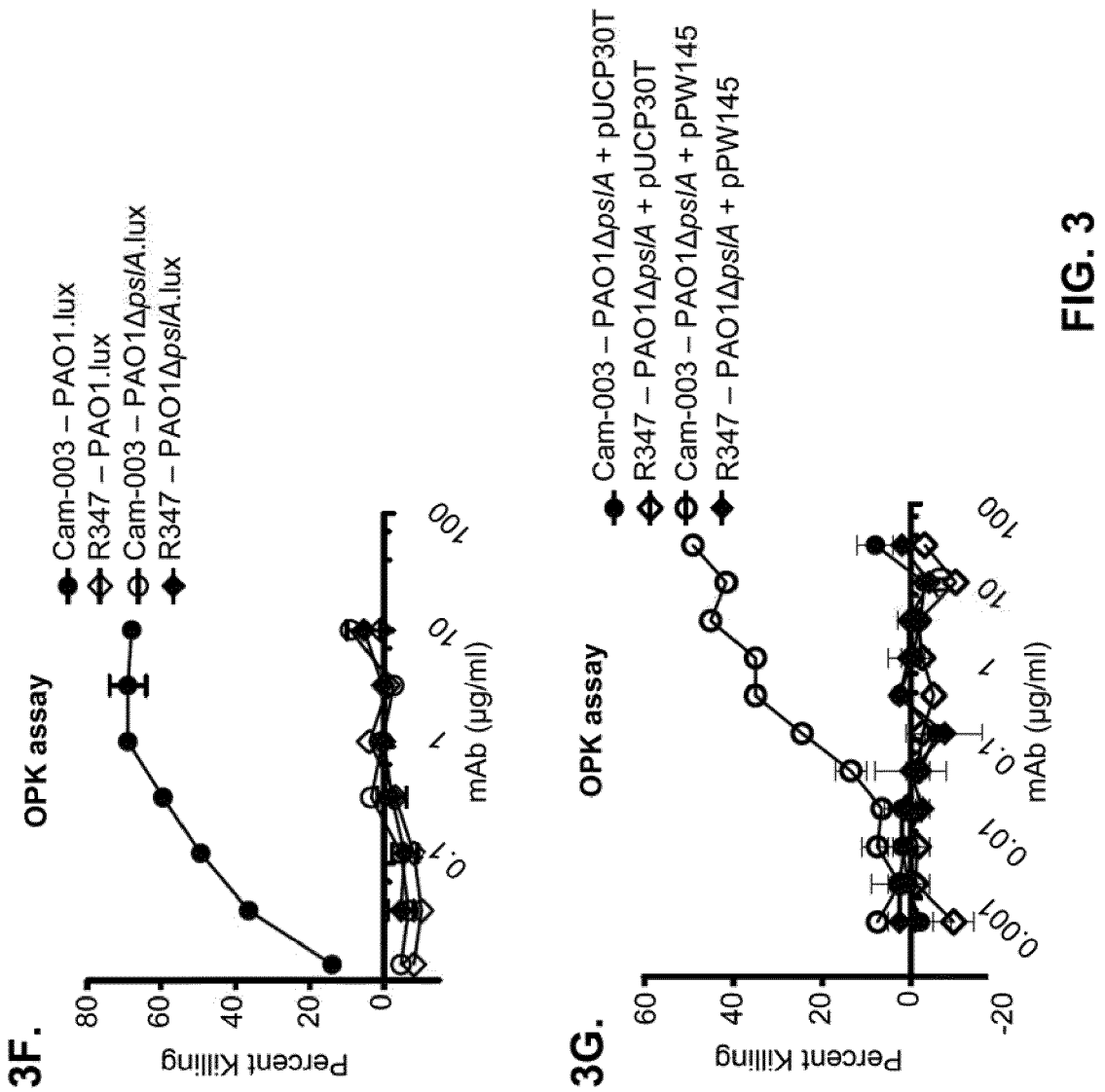
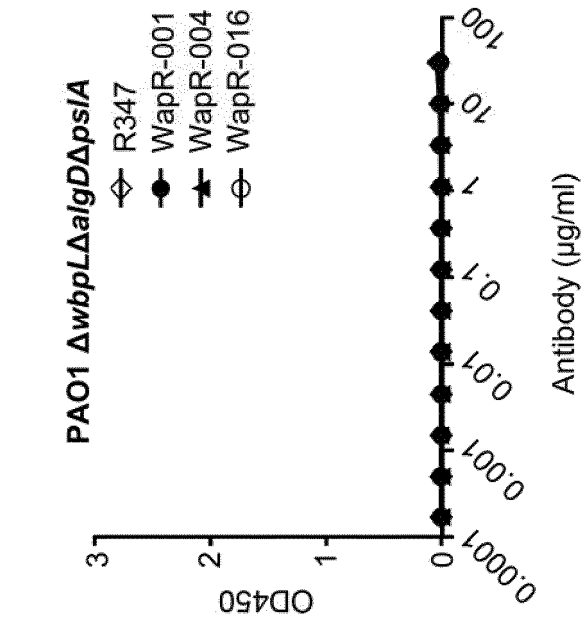

3F.
OPK assay
Cam-003 – PAO1.lux
R347 – PAO1.lux
Cam-003 – PAO1ΔpslA.lux
R347 – PAO1ΔpslA.lux
Percent Killing
80
60
40
20
0
0.1
1
10
100
mAb (µg/ml)
3G.
OPK assay
Cam-003 – PAO1ΔpslA + pUCP30T
R347 – PAO1ΔpslA + pUCP30T
Cam-003 – PAO1ΔpslA + pPW145
R347 – PAO1ΔpslA + pPW145
Percent Killing
60
40
20
0
-20
0.001
0.01
0.1
1
10
100
mAb (µg/ml)

FIG. 3


3I.
PAO1 ΔwbpLΔalgDΔpslA
R347
WapR-001
WapR-004
WapR-016
OD450
Antibody (µg/ml)
0.0001
0.001
0.01
0.1
1
10
100
0
1
2
3

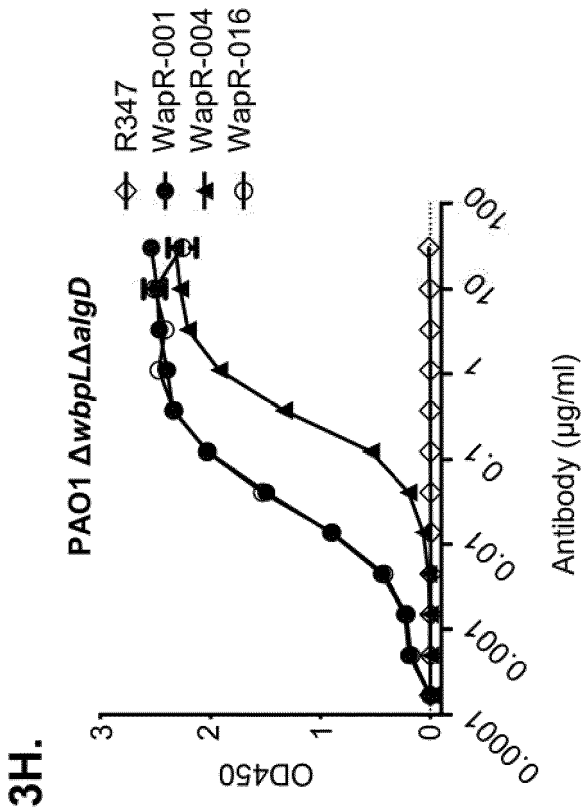

3H.
PAO1 ΔwbpLΔalgD
R347
WapR-001
WapR-004
WapR-016
OD450
Antibody (µg/ml)
0.0001
0.001
0.01
0.1
1
10
100
0
1
2
3

FIG. 3

3J.

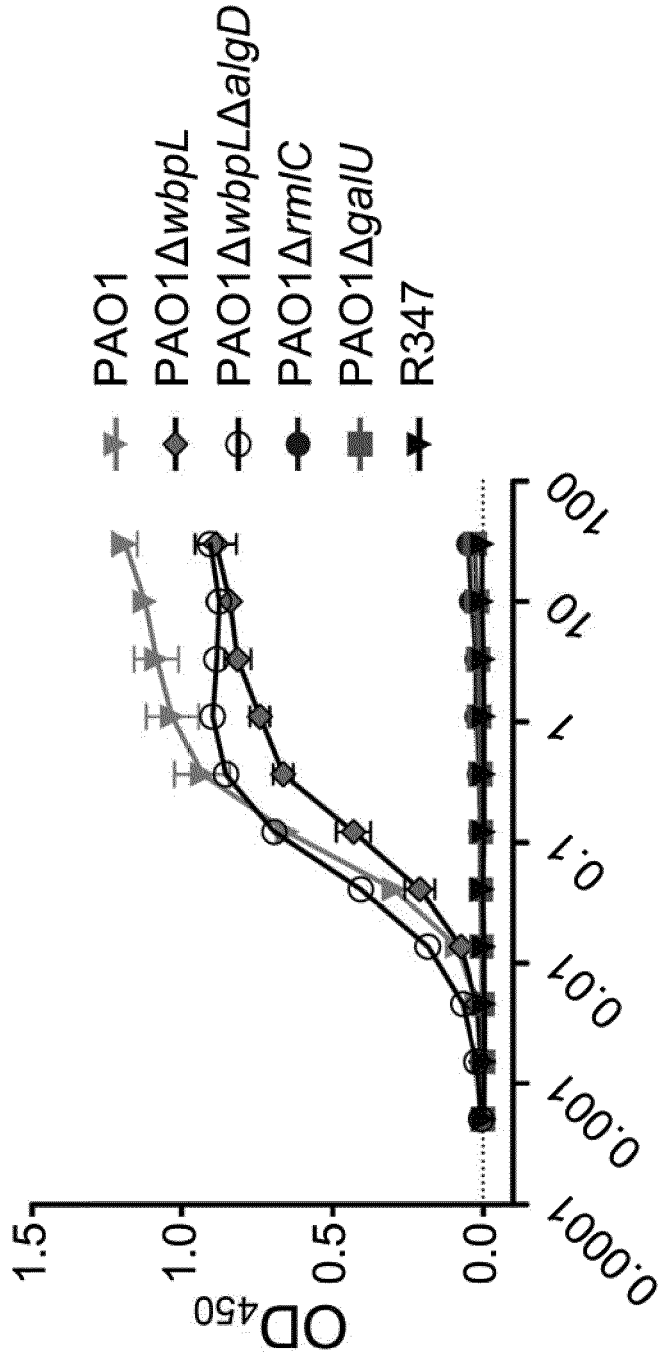

PAO1
PAO1ΔwbpL
PAO1ΔwbpLΔalgD
PAO1ΔrmlC
PAO1ΔgalU
R347
OD450
1.5
1.0
0.5
0.0
0.0001
0.001
0.01
0.1
1
10
100
Cam-003 (µg/ml)

FIG. 3

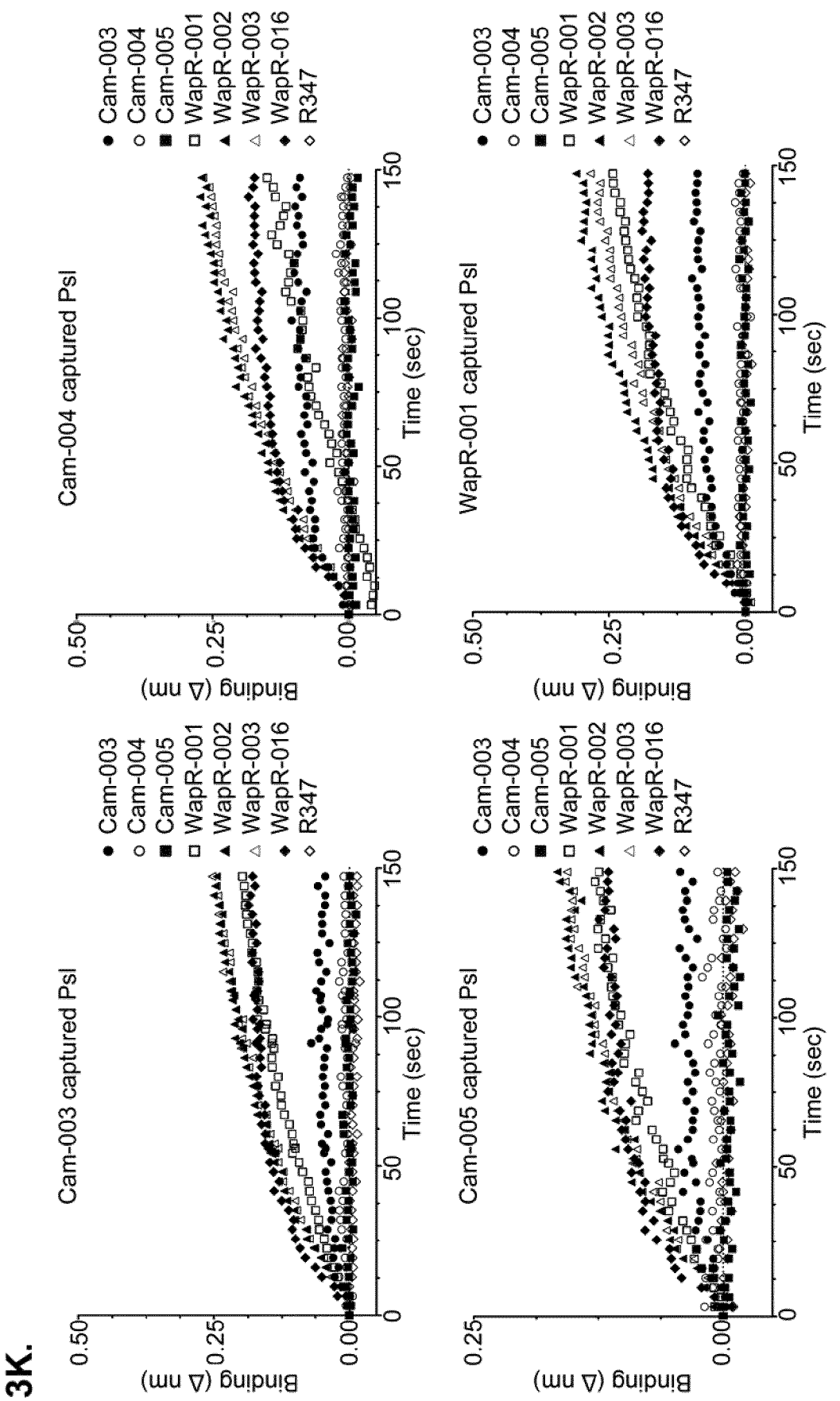

3K.
Cam-003 captured Psl
Cam-004 captured Psl
WapR-001 captured Psl
Cam-005 captured Psl
Binding (Δ nm)
Time (sec)
Cam-003
Cam-004
Cam-005
WapR-001
WapR-002
WapR-003
WapR-016
R347

FIG. 3

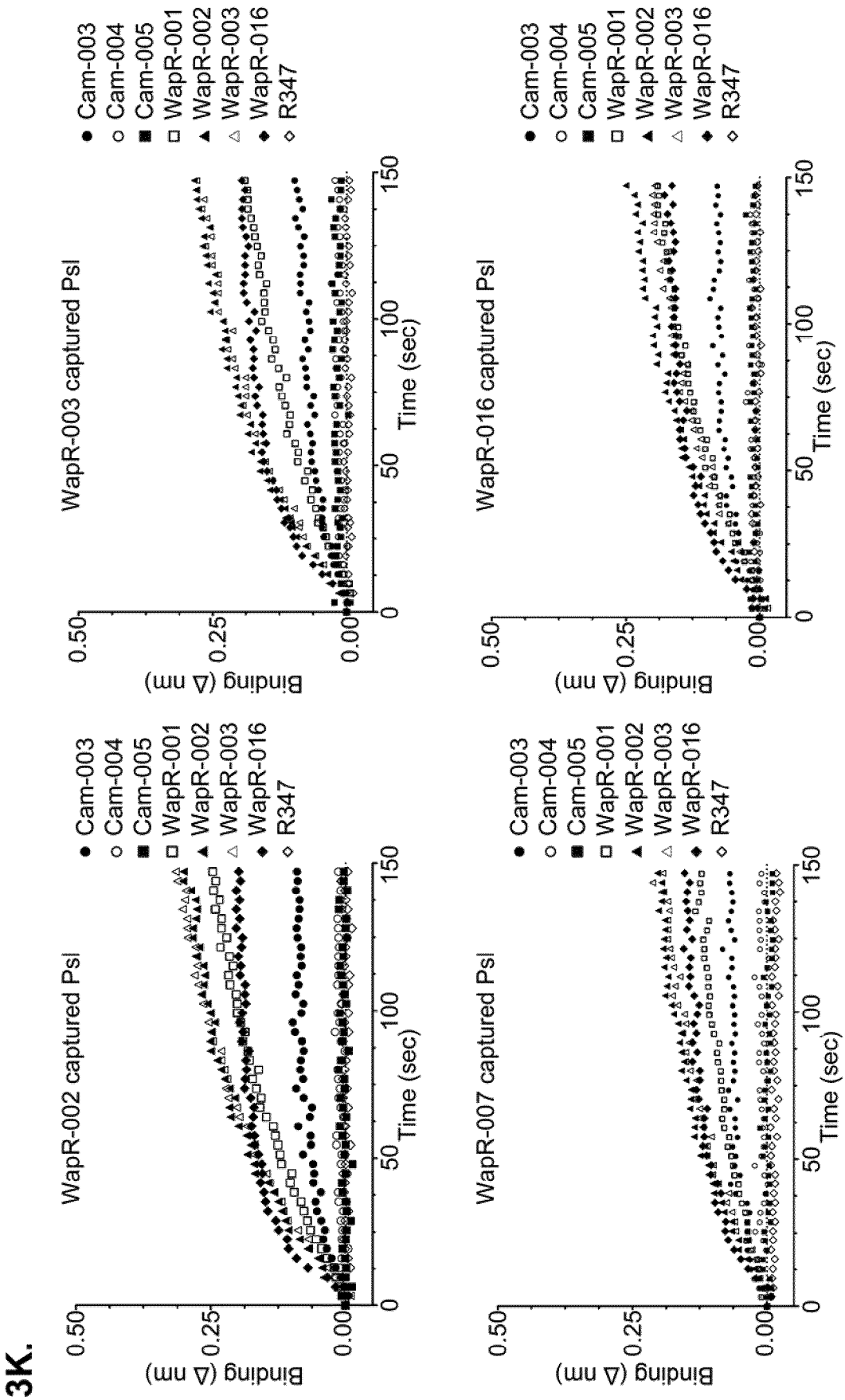

3K.
WapR-003 captured Psl
WapR-016 captured Psl
WapR-002 captured Psl
WapR-007 captured Psl
Binding (Δ nm)
Time (sec)
0.00
0.25
0.50
0
50
100
150
Cam-003
Cam-004
Cam-005
WapR-001
WapR-002
WapR-003
WapR-016
R347

FIG. 3

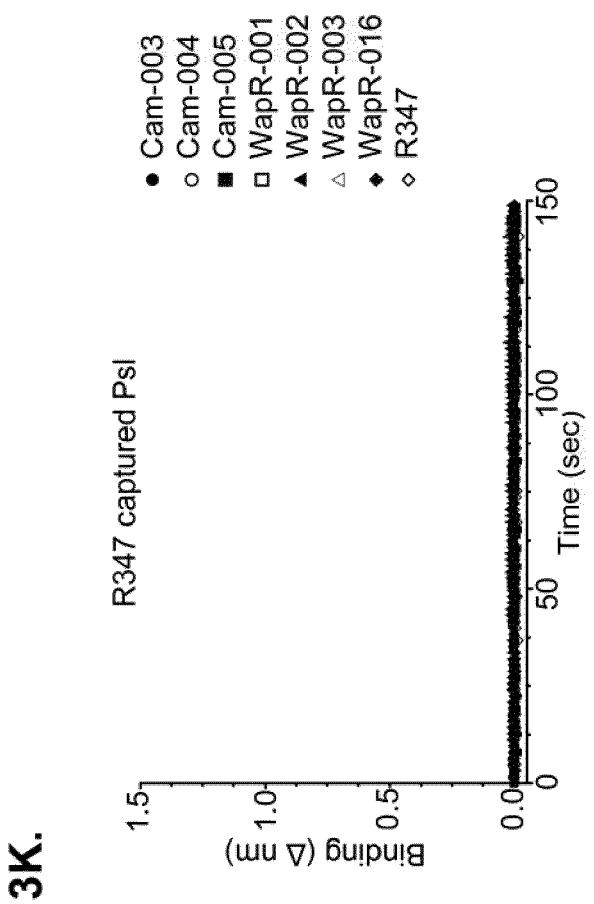

3K.
R347 captured PsI
Cam-003
Cam-004
Cam-005
WapR-001
WapR-002
WapR-003
WapR-016
R347
Binding (Δ nm)
1.5
1.0
0.5
0.0
0
50
100
150
Time (sec)

FIG. 3

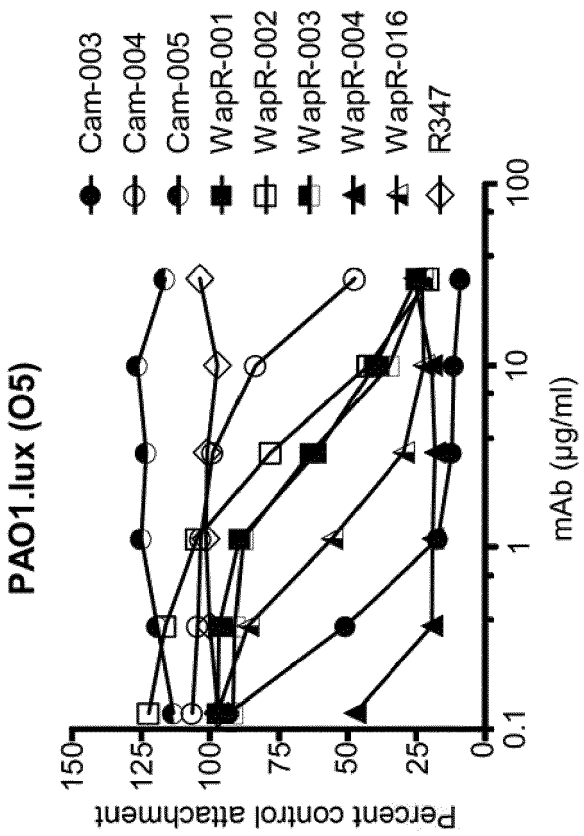

PAO1.lux (O5)
Cam-003
Cam-004
Cam-005
WapR-001
WapR-002
WapR-003
WapR-004
WapR-016
R347
Percent control attachment
150
125
100
75
50
25
0
0.1
1
10
100
mAb (µg/ml)

FIG. 4

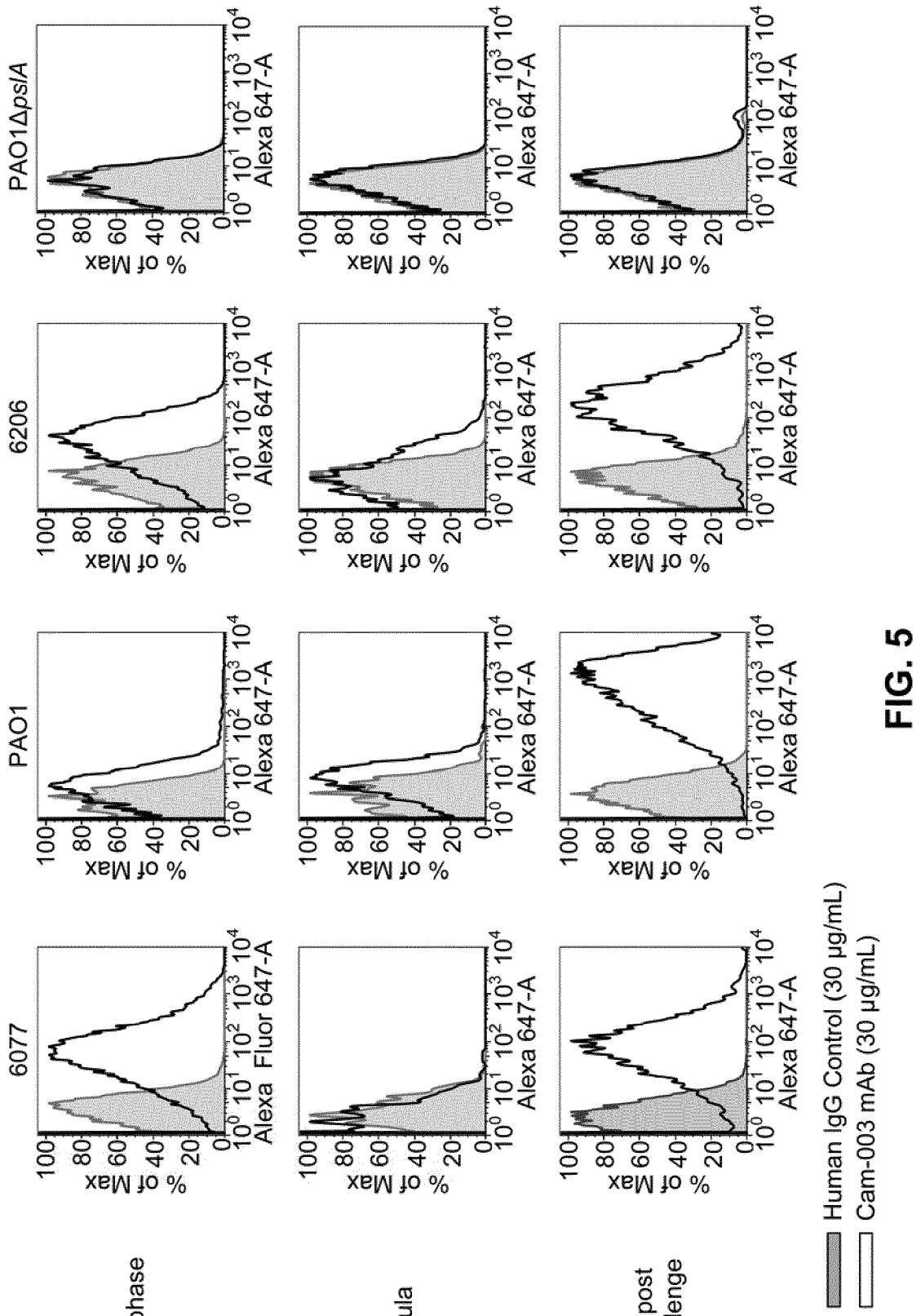

6077
PAO1
6206
PAO1Δpsl A
a. log phase
b. inocula
c. 4 hr post challenge
% of Max
Alexa Fluor 647-A
Alexa 647-A
Human IgG Control (30 µg/mL)
Cam-003 mAb (30 µg/mL)

FIG. 5

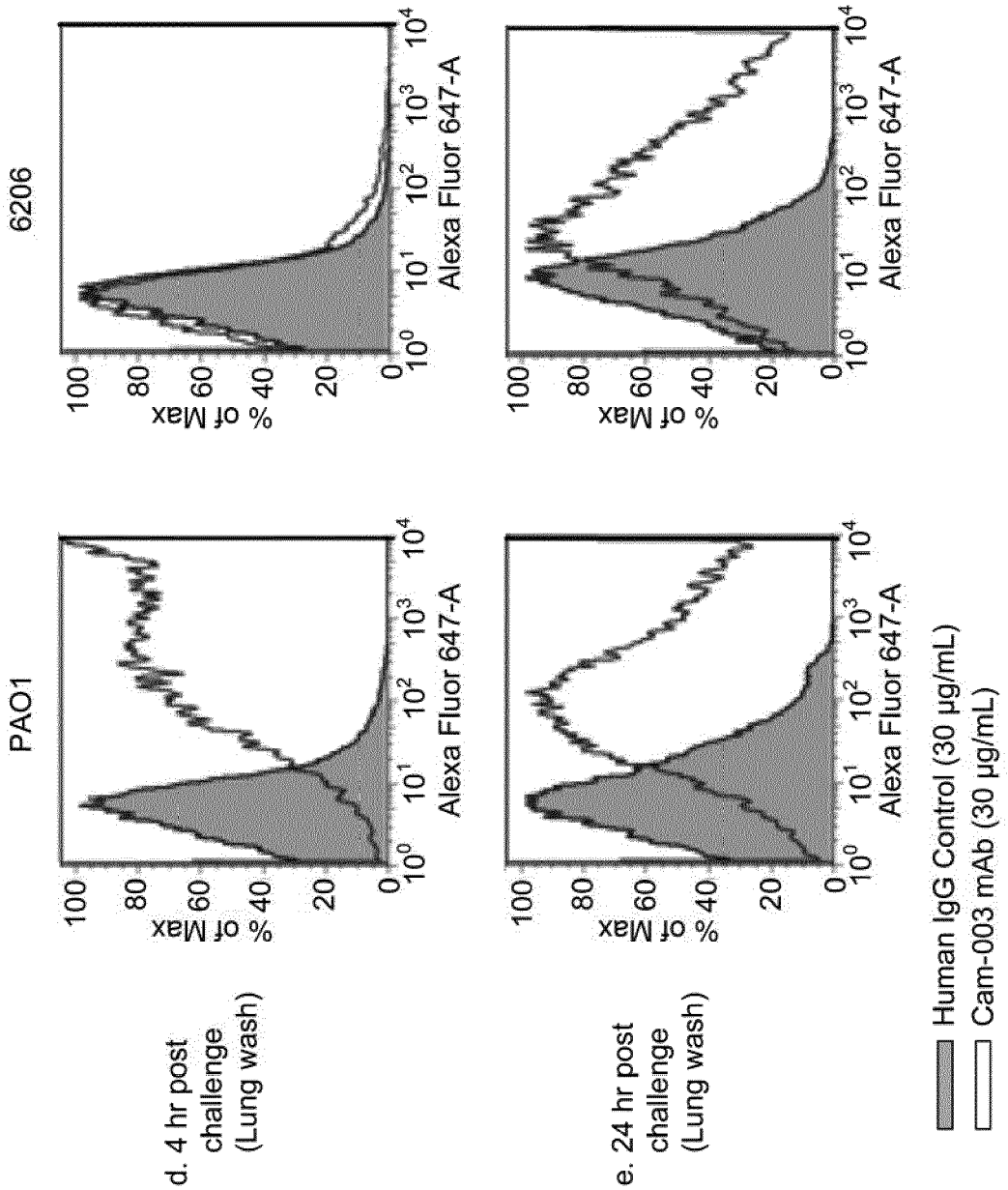

PAO1
6206
d. 4 hr post challenge (Lung wash)
e. 24 hr post challenge (Lung wash)
% of Max
Alexa Fluor 647-A
Human IgG Control (30 µg/mL)
Cam-003 mAb (30 µg/mL)

FIG. 5

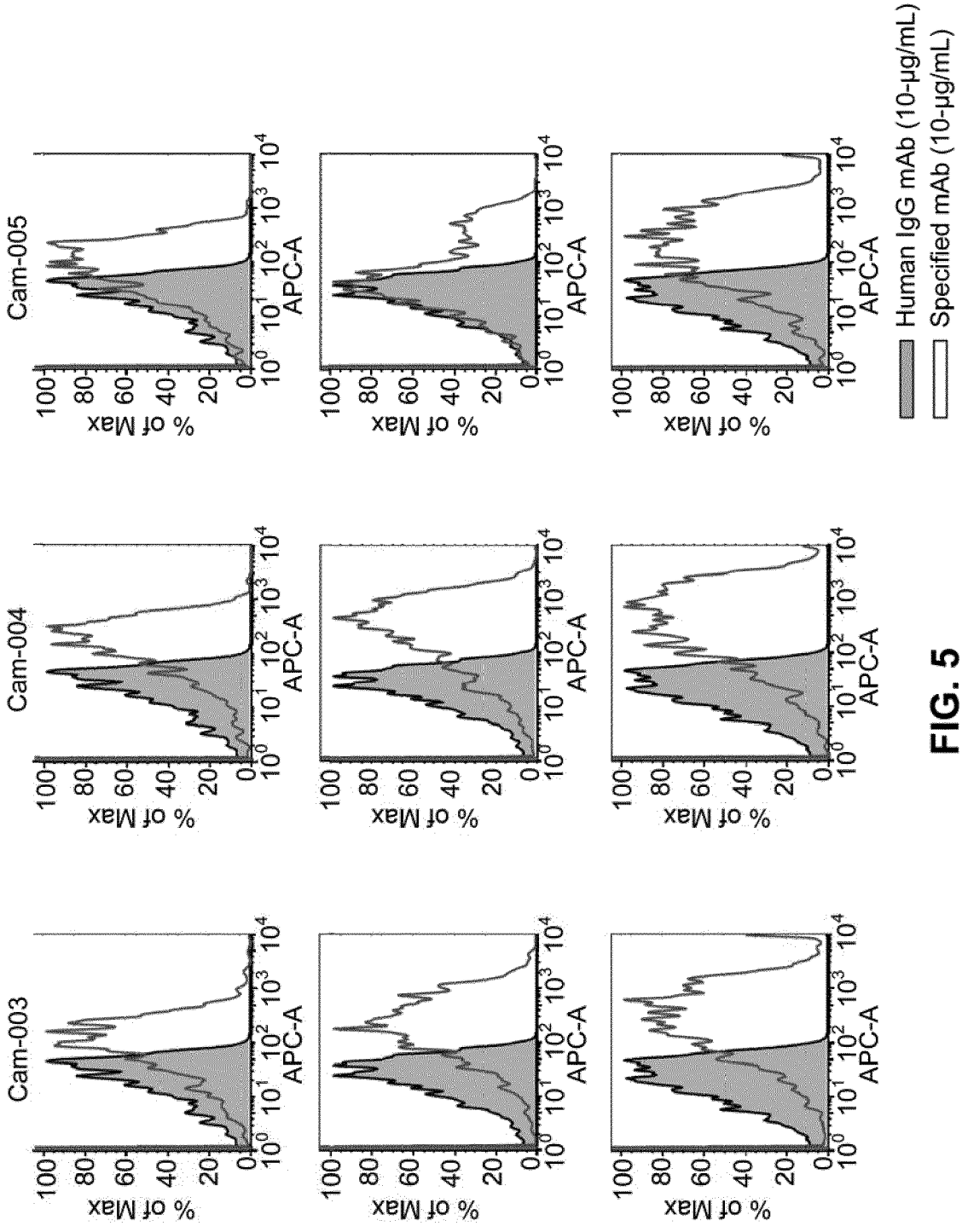

Cam-003
Cam-004
Cam-005
% of Max
APC-A
f. PAO1(O5)
g. 2135 (O1)
h. 2531 (O1)
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5

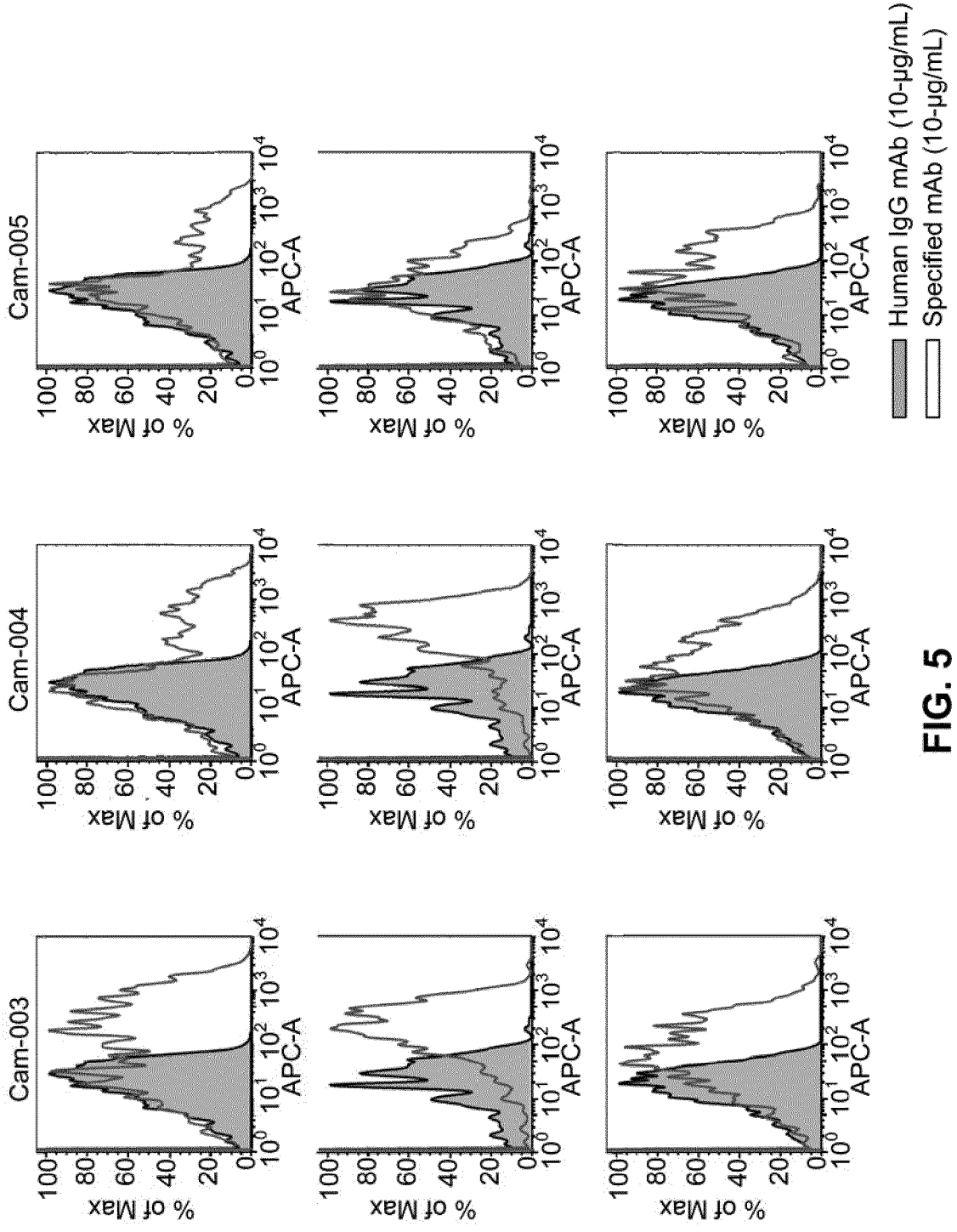

Cam-003
Cam-004
Cam-005
% of Max
APC-A
i. 2410 (O6)
j. 2764 (O11)
k. 2757 (O11)
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5

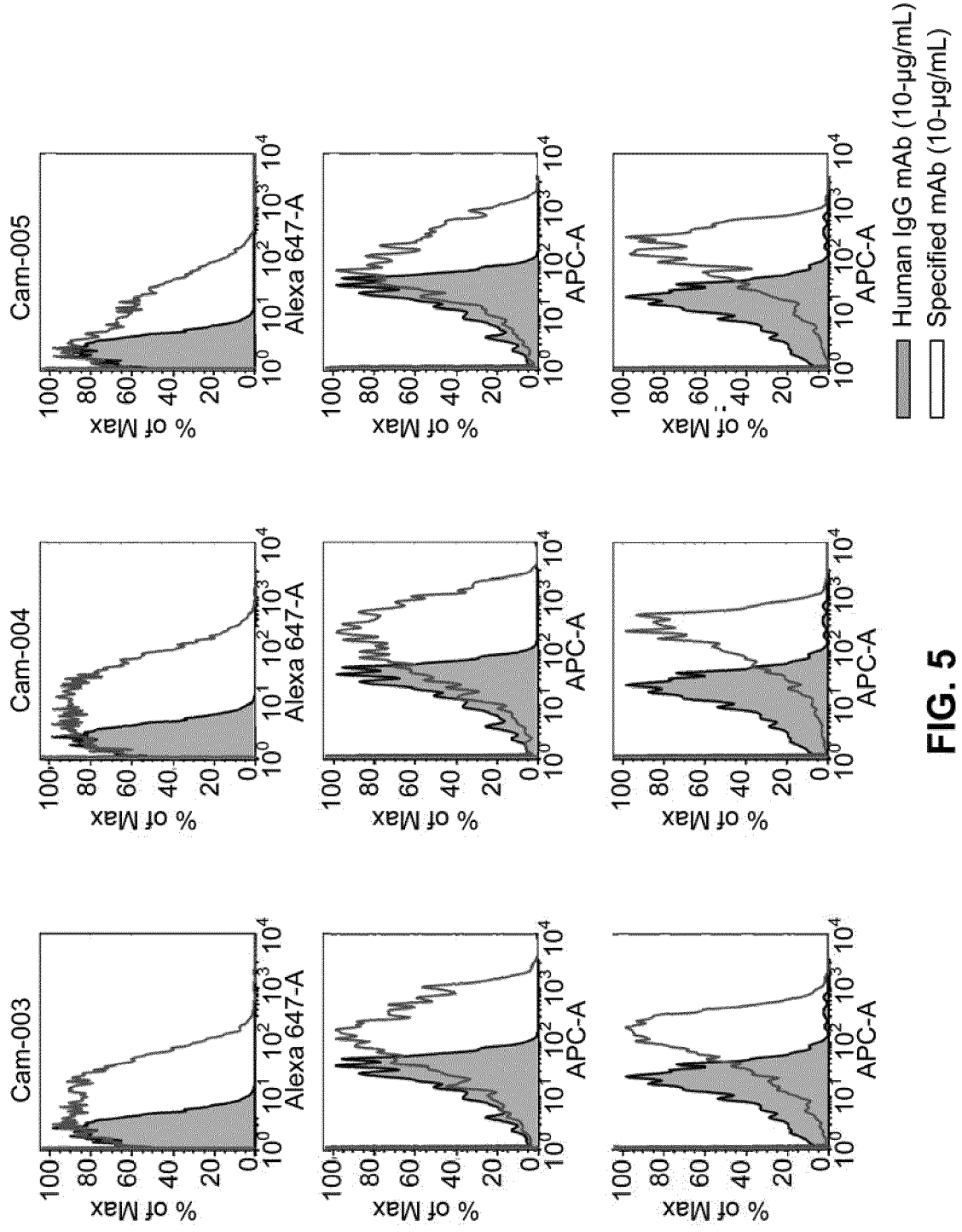

Cam-003
Cam-004
Cam-005
Alexa 647-A
APC-A
% of Max
l. 33356 (O9)
m.33348 (O1)
n. 3039 (NT)
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5

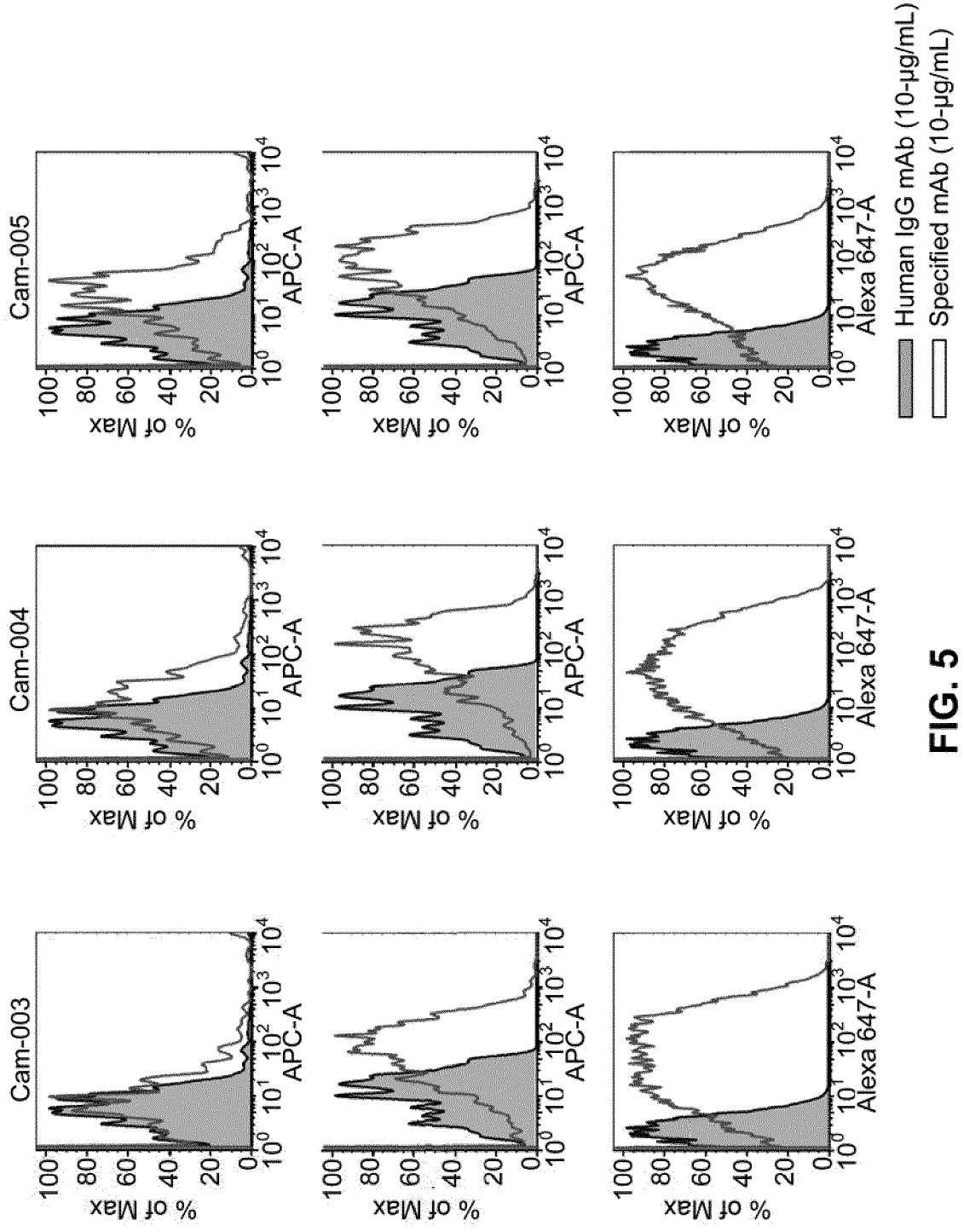

Cam-003
Cam-004
Cam-005
% of Max
APC-A
Alexa 647-A
o. 3061 (NT)
p. 3064 (NT)
q. 19660 (NT)
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5

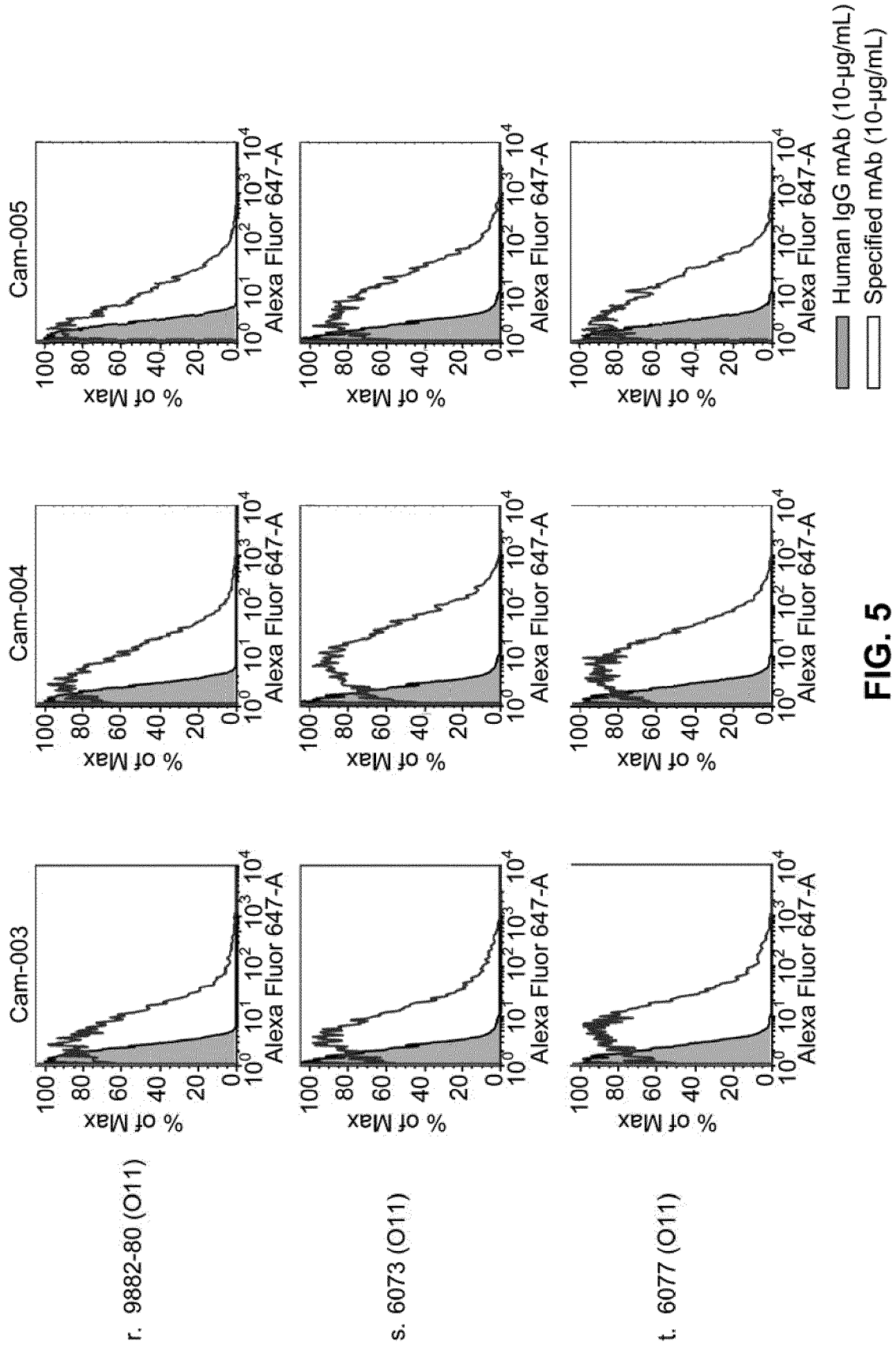

Cam-003
Cam-004
Cam-005
% of Max
Alexa Fluor 647-A
r. 9882-80 (O11)
s. 6073 (O11)
t. 6077 (O11)
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5

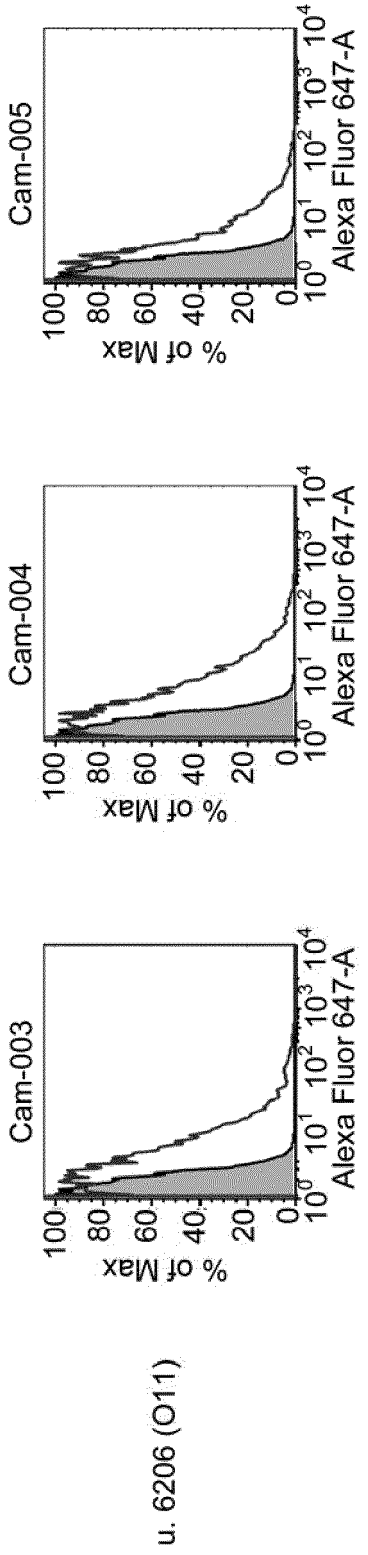
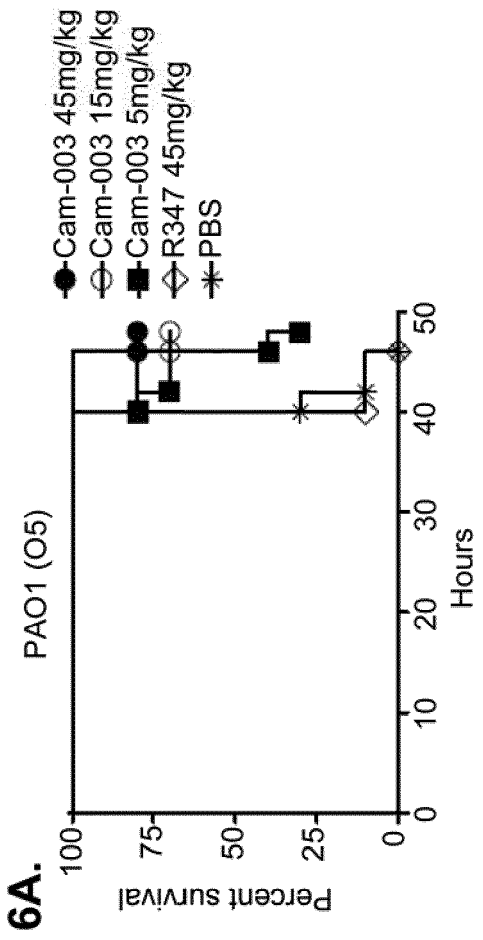

u. 6206 (O11)
Cam-003
Cam-004
Cam-005
% of Max
Alexa Fluor 647-A
Human IgG mAb (10-µg/mL)
Specified mAb (10-µg/mL)

FIG. 5


6A.
PAO1 (O5)
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg
R347 45mg/kg
PBS
Percent survival
100
75
50
25
0
0
10
20
30
40
50
Hours

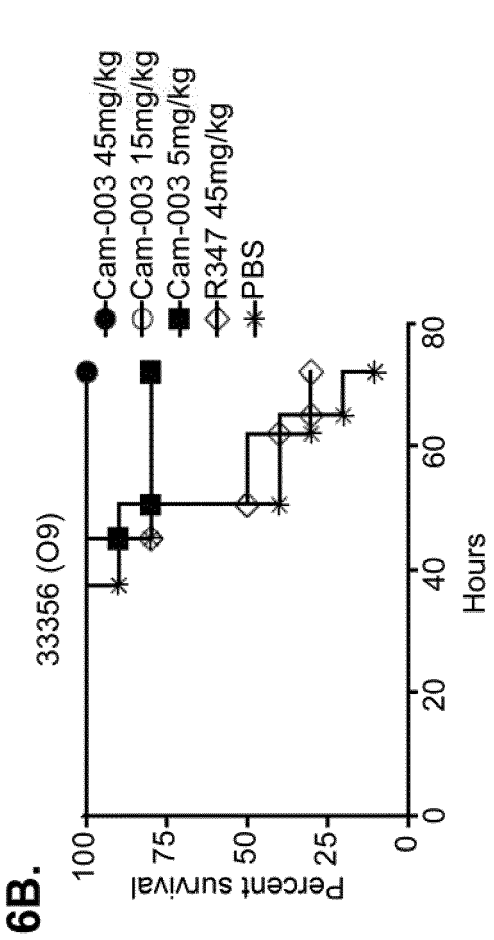

6B.
33356 (O9)
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg
R347 45mg/kg
PBS
Percent survival
100
75
50
25
0
0
20
40
60
80
Hours

FIG. 6

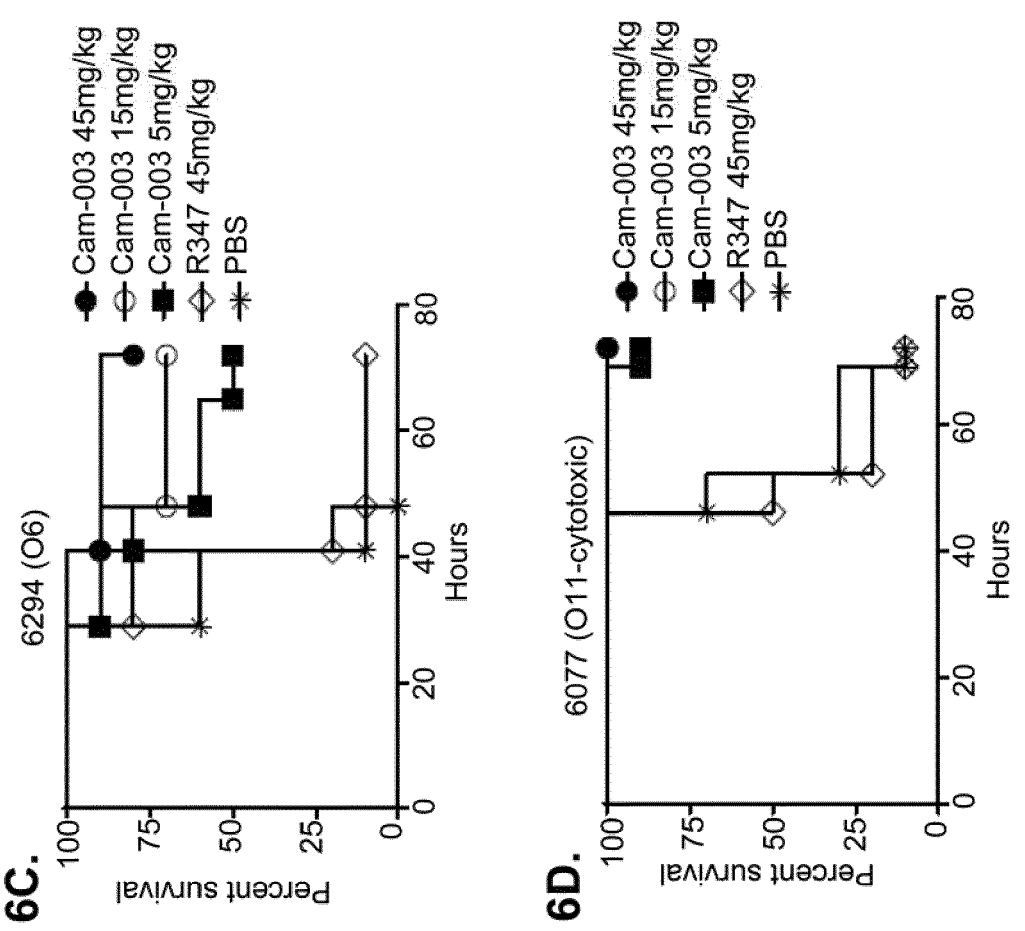

6C.
6294 (O6)
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg
R347 45mg/kg
PBS
Percent survival
100
75
50
25
0
0
20
40
60
80
Hours
6D.
6077 (O11-cytotoxic)
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg
R347 45mg/kg
PBS
Percent survival
100
75
50
25
0
0
20
40
60
80
Hours

FIG. 6

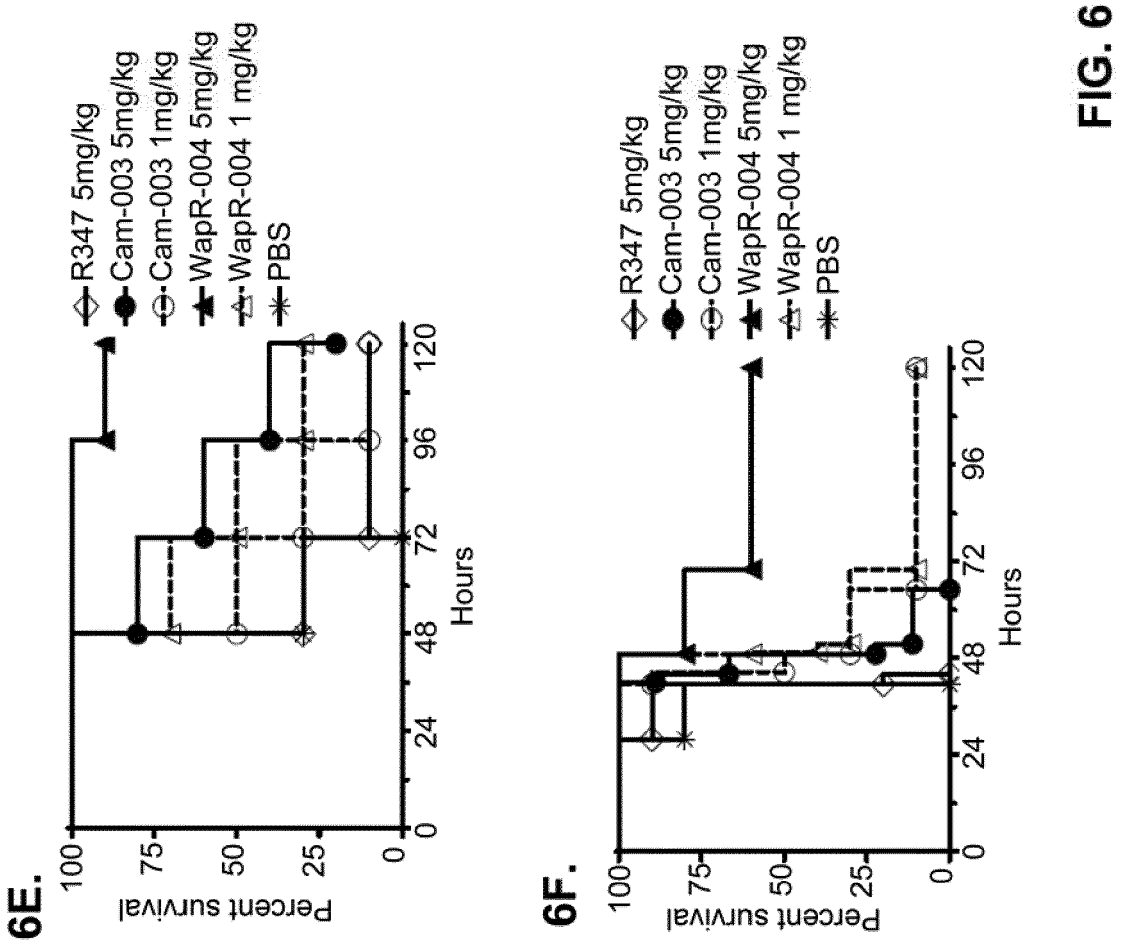

6E.
R347 5mg/kg
Cam-003 5mg/kg
Cam-003 1mg/kg
WapR-004 5mg/kg
WapR-004 1 mg/kg
PBS
Percent survival
100
75
50
25
0
0
24
48
72
96
120
Hours
6F.
R347 5mg/kg
Cam-003 5mg/kg
Cam-003 1mg/kg
WapR-004 5mg/kg
WapR-004 1 mg/kg
PBS
Percent survival
100
75
50
25
0
0
24
48
72
96
120
Hours

FIG. 6

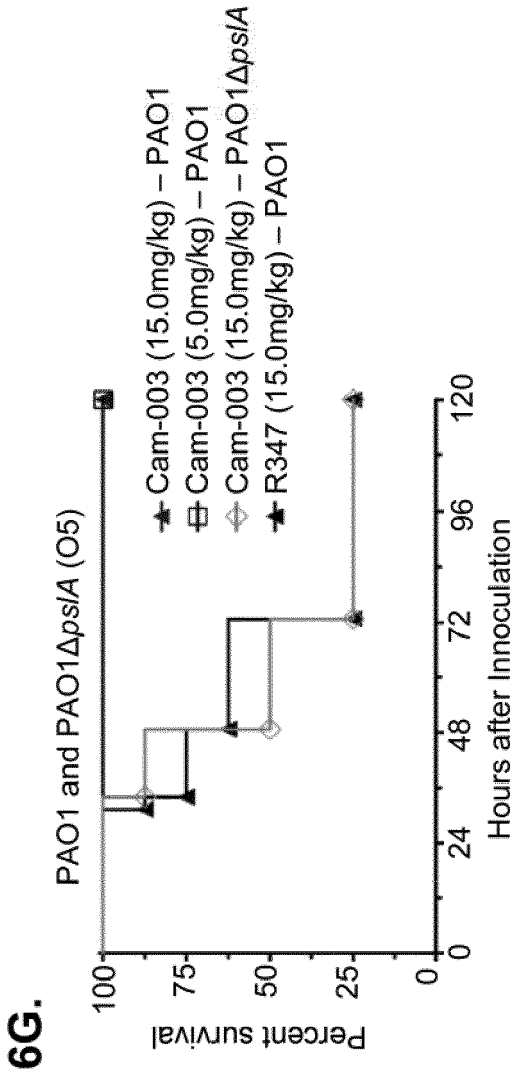

6G.
PAO1 and PAO1Δpsl A (O5)
Cam-003 (15.0mg/kg) – PAO1
Cam-003 (5.0mg/kg) – PAO1
Cam-003 (15.0mg/kg) – PAO1Δpsl A
R347 (15.0mg/kg) – PAO1
Percent survival
100
75
50
25
0
0
24
48
72
96
120
Hours after Innoculation

FIG. 6

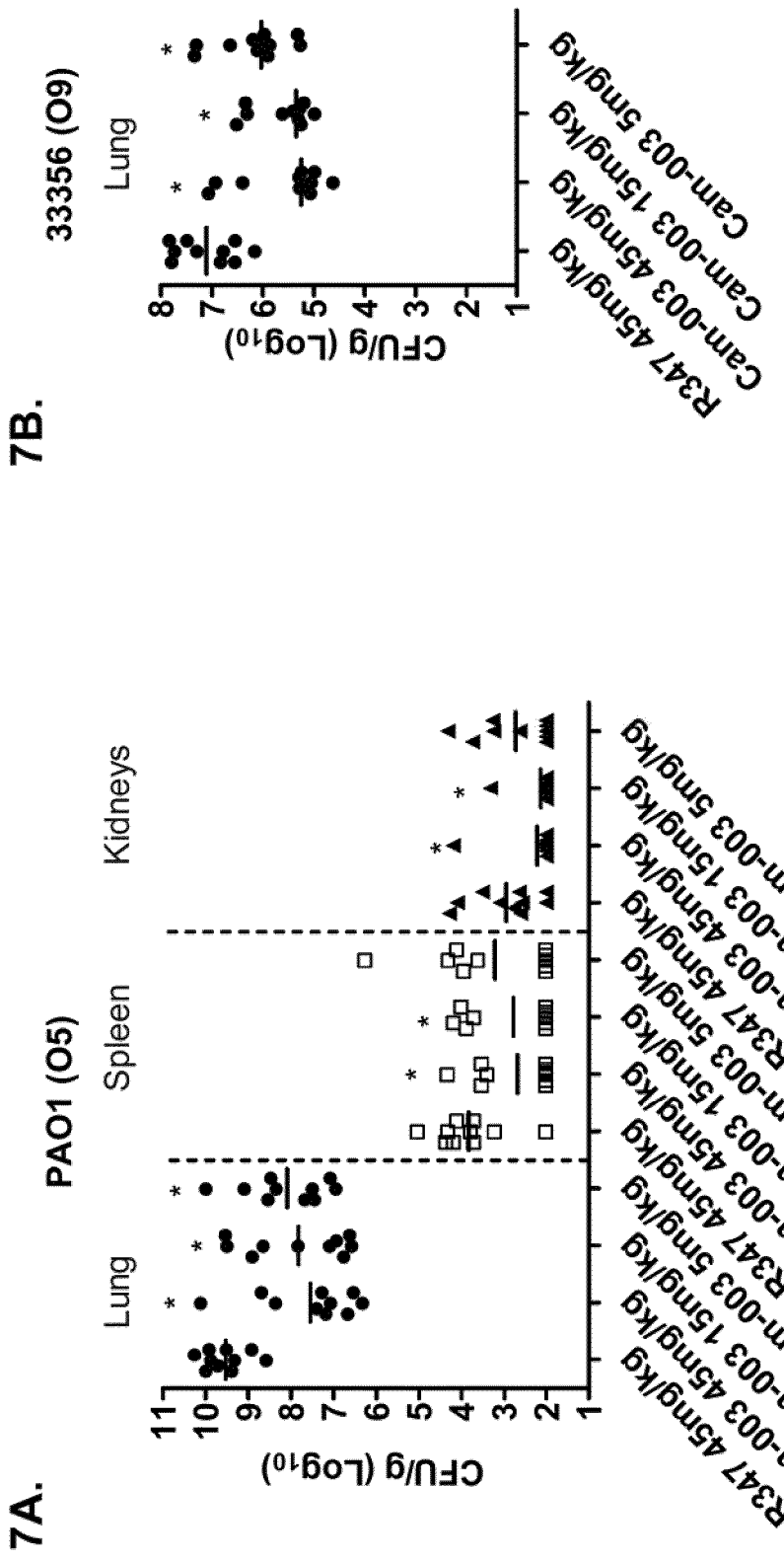

7A.
PAO1 (O5)
Lung
Spleen
Kidneys
CFU/g (Log10)
11
10
9
8
7
6
5
4
3
2
1
R347 45mg/kg
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg
7B.
33356 (O9)
Lung
CFU/g (Log10)
8
7
6
5
4
3
2
1
R347 45mg/kg
Cam-003 45mg/kg
Cam-003 15mg/kg
Cam-003 5mg/kg

FIG. 7

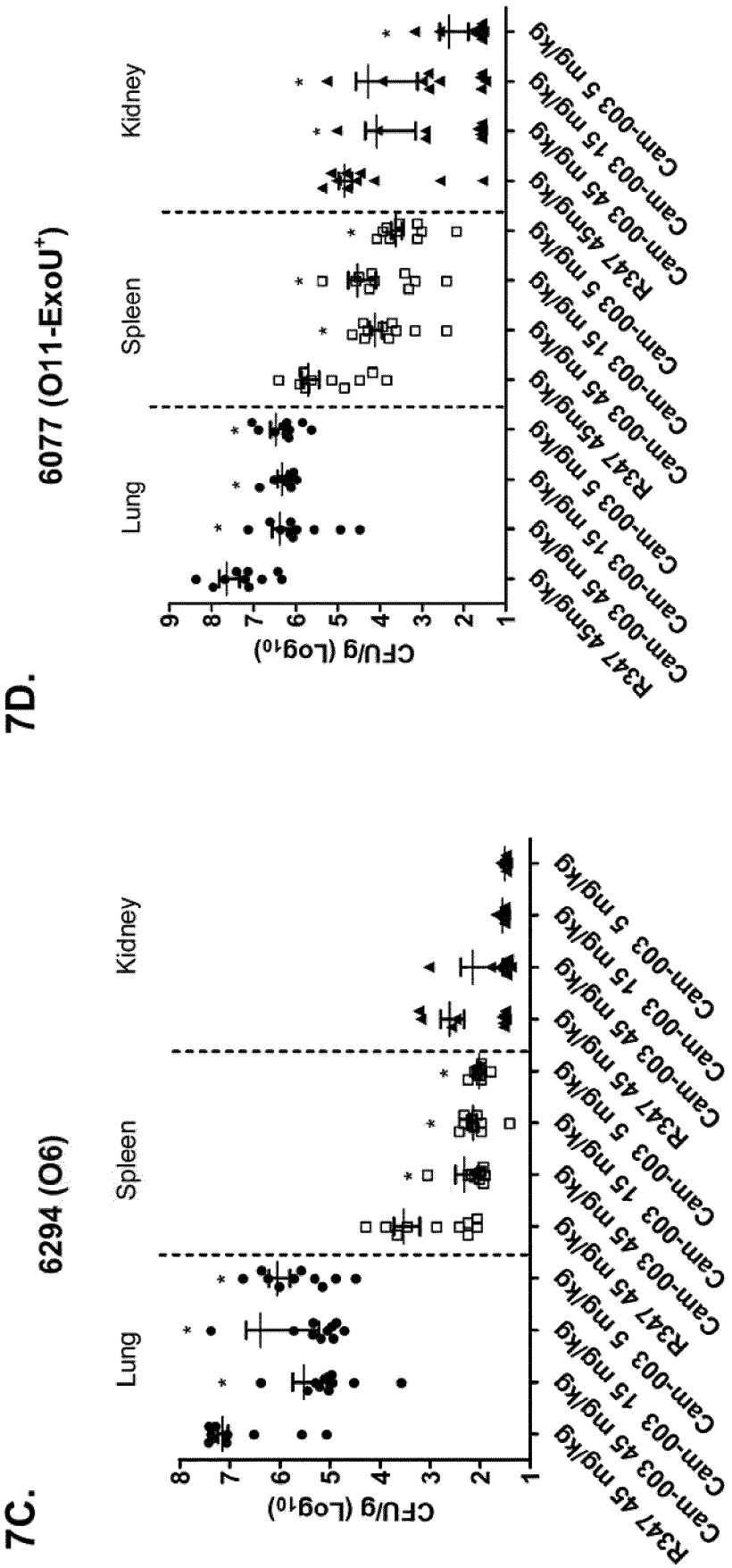

7C.
6294 (O6)
Lung
Spleen
Kidney
CFU/g (Log10)
8
7
6
5
4
3
2
1
R347 45 mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg
R347 45 mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg
R347 45 mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg
7D.
6077 (O11-ExoU+)
Lung
Spleen
Kidney
CFU/g (Log10)
9
8
7
6
5
4
3
2
1
R347 45mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg
R347 45mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg
R347 45mg/kg
Cam-003 45 mg/kg
Cam-003 15 mg/kg
Cam-003 5 mg/kg

FIG. 7

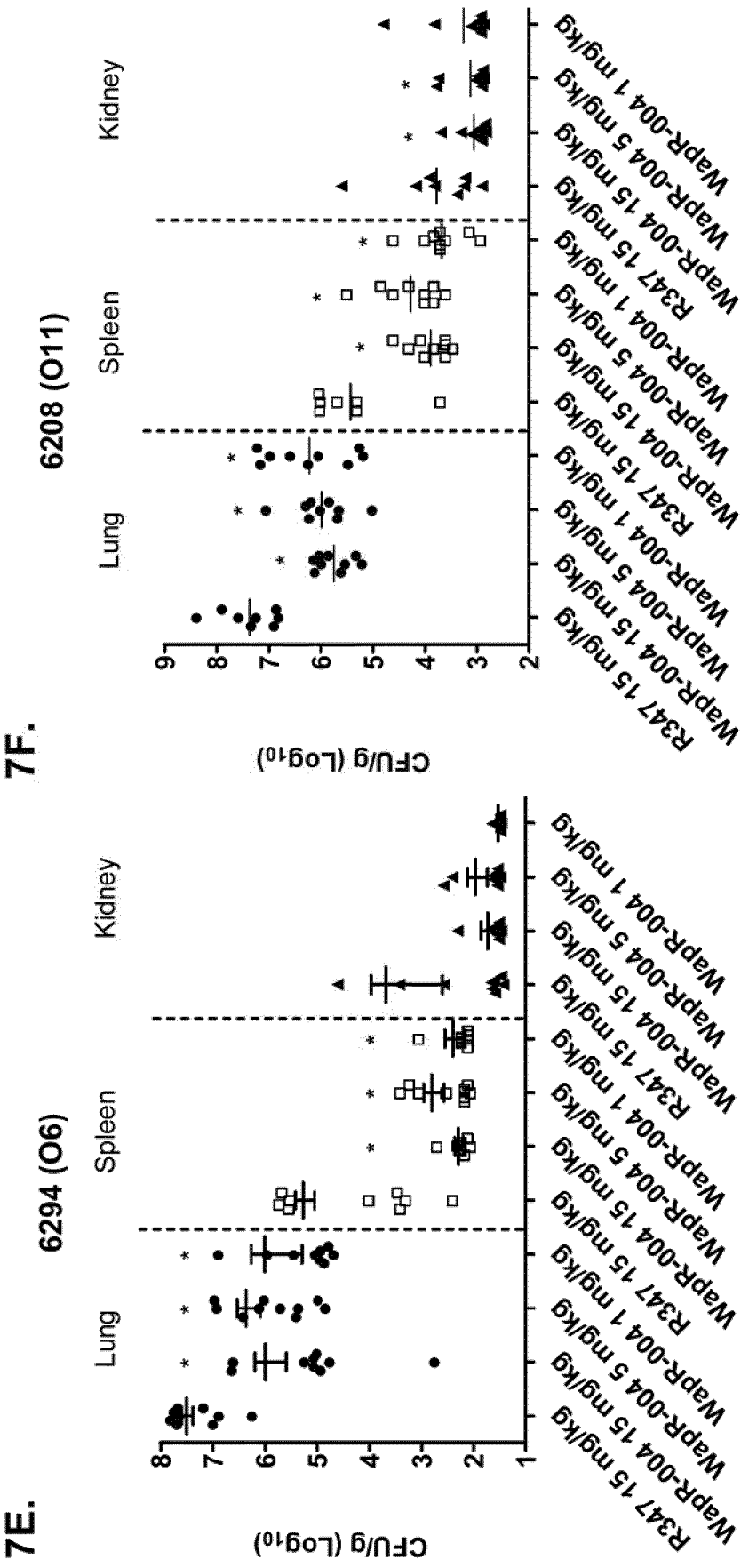

7F.
6208 (O11)
Lung
Spleen
Kidney
CFU/g (Log10)
9
8
7
6
5
4
3
2
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg
7E.
6294 (O6)
Lung
Spleen
Kidney
CFU/g (Log10)
8
7
6
5
4
3
2
1
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg
R347 15 mg/kg
WapR-004 15 mg/kg
WapR-004 5 mg/kg
WapR-004 1 mg/kg

FIG. 7

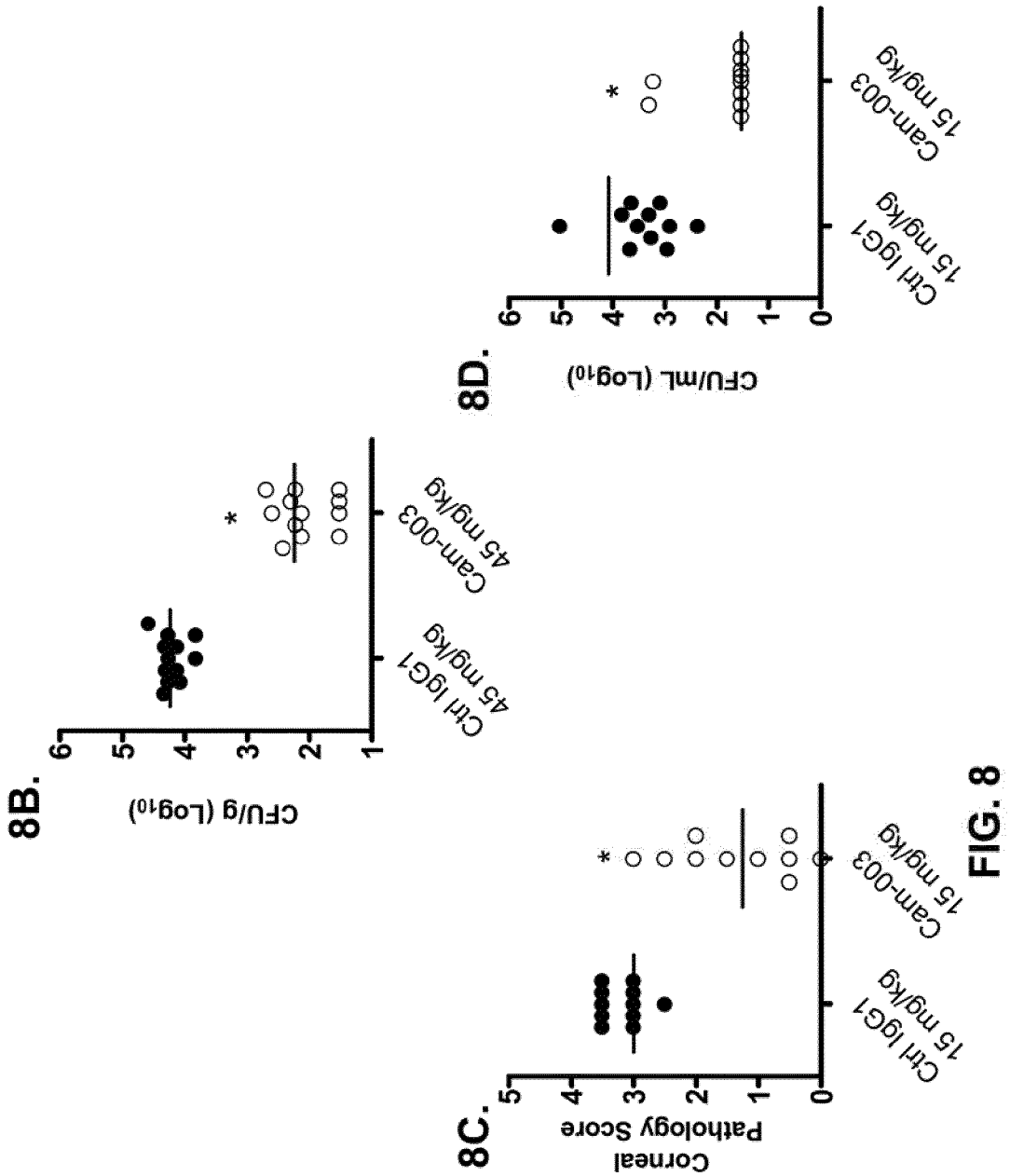

8A.
Corneal Pathology Score
0
1
2
3
4
5
Ctrl IgG1 45 mg/kg
Cam003 45 mg/kg
*
8B.
CFU/g (Log10)
1
2
3
4
5
6
Ctrl IgG1 45 mg/kg
Cam-003 45 mg/kg
*
8C.
Corneal Pathology Score
0
1
2
3
4
5
Ctrl IgG1 15 mg/kg
Cam-003 15 mg/kg
*
8D.
CFU/mL (Log10)
0
1
2
3
4
5
6
Ctrl IgG1 15 mg/kg
Cam-003 15 mg/kg
*

FIG. 8

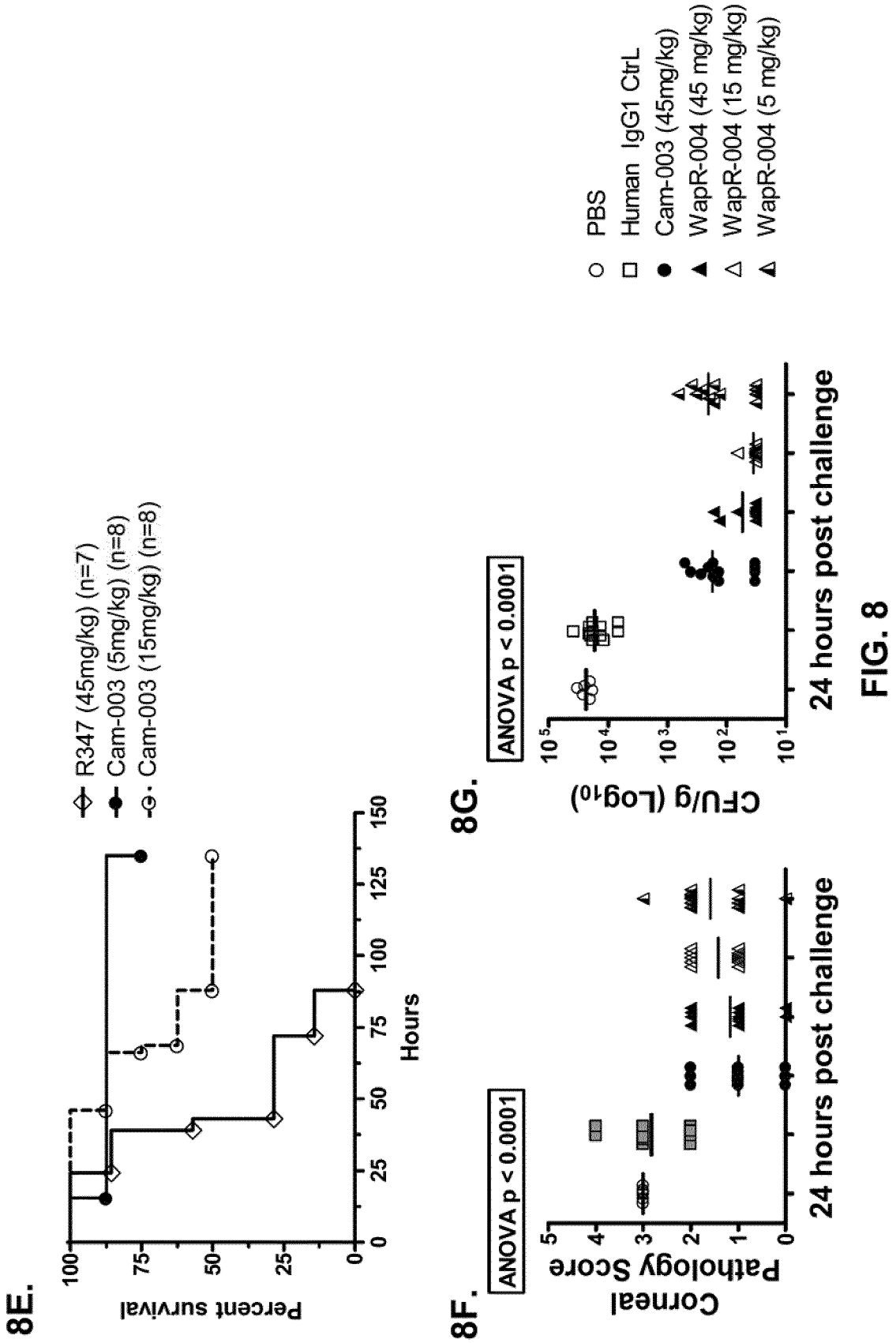

8E.
R347 (45mg/kg) (n=7)
Cam-003 (5mg/kg) (n=8)
Cam-003 (15mg/kg) (n=8)
Percent survival
Hours
8F.
ANOVA p < 0.0001
Corneal Pathology Score
24 hours post challenge
8G.
ANOVA p < 0.0001
CFU/g (Log10)
24 hours post challenge
PBS
Human IgG1 CtrL
Cam-003 (45mg/kg)
WapR-004 (45 mg/kg)
WapR-004 (15 mg/kg)
WapR-004 (5 mg/kg)

FIG. 8

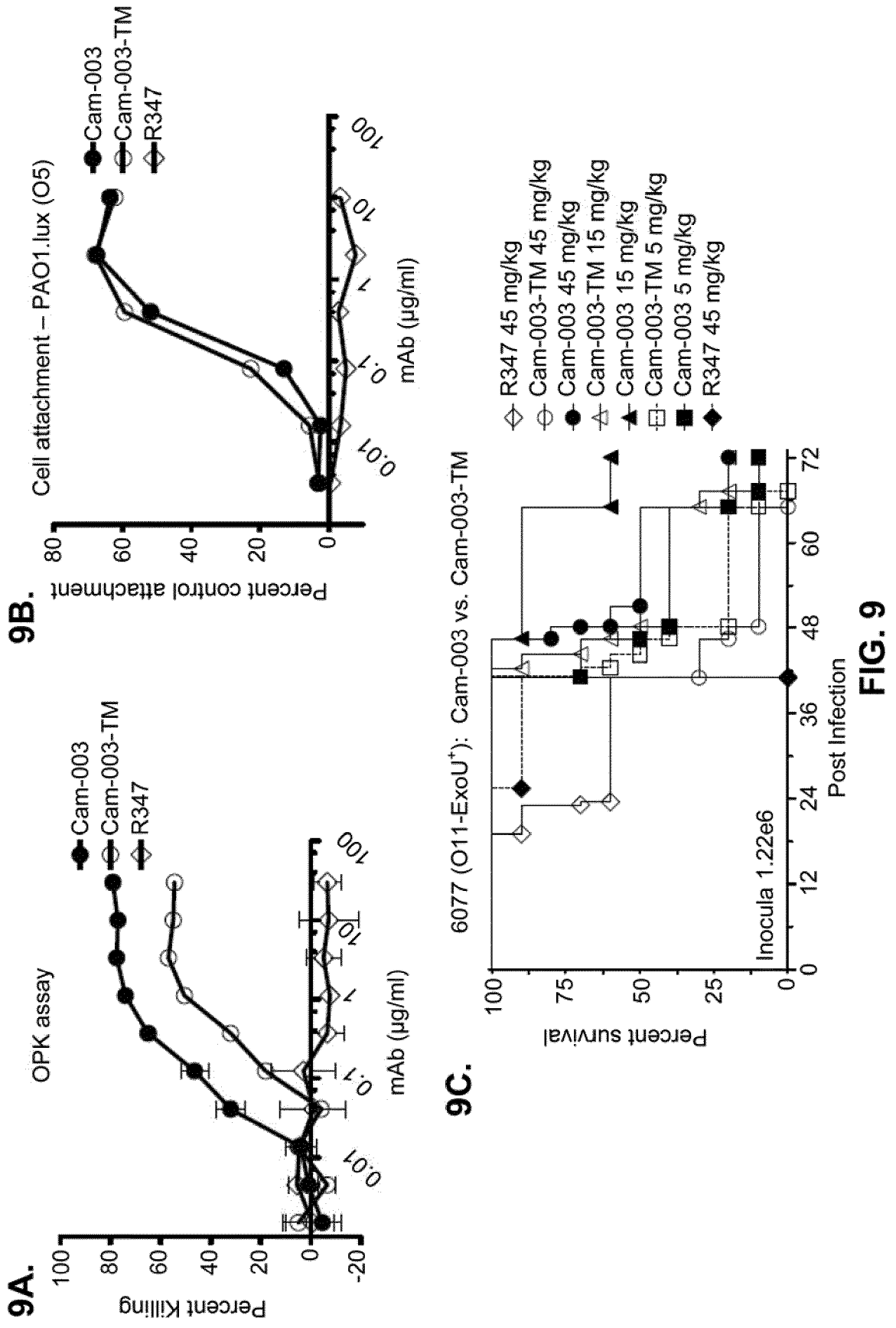

9A.
OPK assay
Percent Killing
100
80
60
40
20
0
-20
Cam-003
Cam-003-TM
R347
100
10
1
0.1
0.01
mAb (µg/ml)
9B.
Cell attachment – PAO1.lux (O5)
Percent control attachment
80
60
40
20
0
Cam-003
Cam-003-TM
R347
100
10
1
0.1
0.01
mAb (µg/ml)
9C.
6077 (O11-ExoU+): Cam-003 vs. Cam-003-TM
Percent survival
100
75
50
25
0
Inocula 1.22e6
0
12
24
36
48
60
72
Post Infection
R347 45 mg/kg
Cam-003-TM 45 mg/kg
Cam-003 45 mg/kg
Cam-003-TM 15 mg/kg
Cam-003 15 mg/kg
Cam-003-TM 5 mg/kg
Cam-003 5 mg/kg
R347 45 mg/kg

FIG. 9

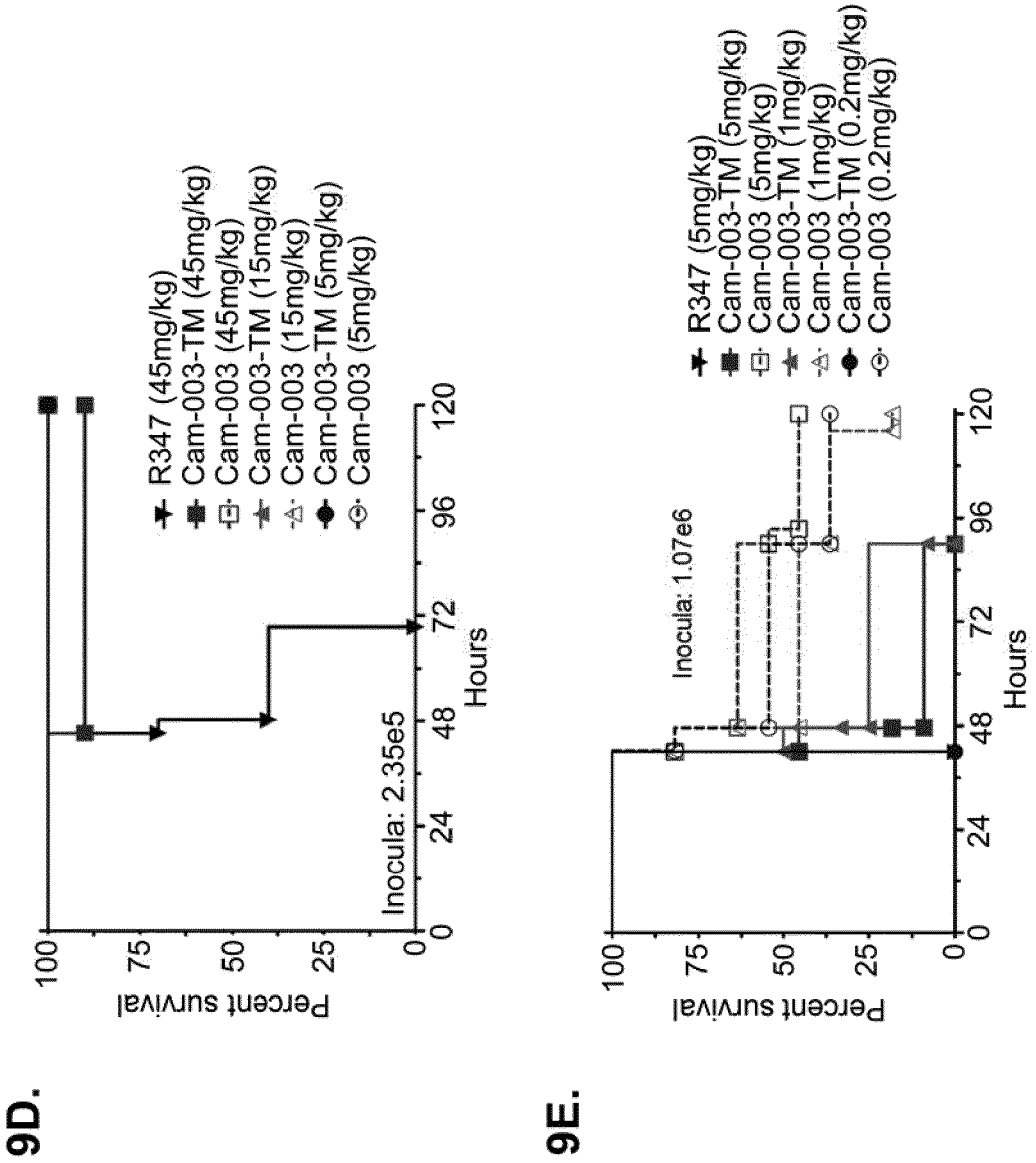

9D.
Percent survival
100
75
50
25
0
0
24
48
72
96
120
Hours
Inocula: 2.35e5
R347 (45mg/kg)
Cam-003-TM (45mg/kg)
Cam-003 (45mg/kg)
Cam-003-TM (15mg/kg)
Cam-003 (15mg/kg)
Cam-003-TM (5mg/kg)
Cam-003 (5mg/kg)
9E.
Percent survival
100
75
50
25
0
0
24
48
72
96
120
Hours
Inocula: 1.07e6
R347 (5mg/kg)
Cam-003-TM (5mg/kg)
Cam-003 (5mg/kg)
Cam-003-TM (1mg/kg)
Cam-003 (1mg/kg)
Cam-003-TM (0.2mg/kg)
Cam-003 (0.2mg/kg)

FIG. 9

Epitope	mAb	K_D(nM)	Cell attachment max. inhibition (µg/ml)	OPK EC50 (µg/ml)
Class 1	WapR-004	118.00	0.3	0.0027
	Cam-003	144.00	1.0	0.0220
	Cam-004	2100.00	>30.0	0.2771
	Cam-005	8400.00	NA	NA
Class 2	WapR-001	0.84	30.0	0.3100
	WapR-003	12.20	30.0	0.2778
	WapR-002	12.60	ND	0.3960
Class 3	WapR-016	75.00	ND	0.2417

FIG. 10A

scFv-Fc	k_{off}	k_{on}	K_D (nM)	OPK EC50
W4 RAD	1.30E-02	5.39E+04	241	0.0068
W4-M1	8.18E-02	1.69E+05	483	0.0475
W4-M7	1.28E-02	6.49E+04	196	0.0060
W4-M8	1.90E-02	1.54E+05	124	0.0056
W4-M9	1.66E-02	1.98E+05	84	0.0167
W4-M11	8.50E-03	1.25E+05	68	0.0045
W4-M12	9.10E-03	1.26E+05	72	0.0085
W4-M17	1.91E-01	9.60E+04	1990	1.3935

FIG. 10B

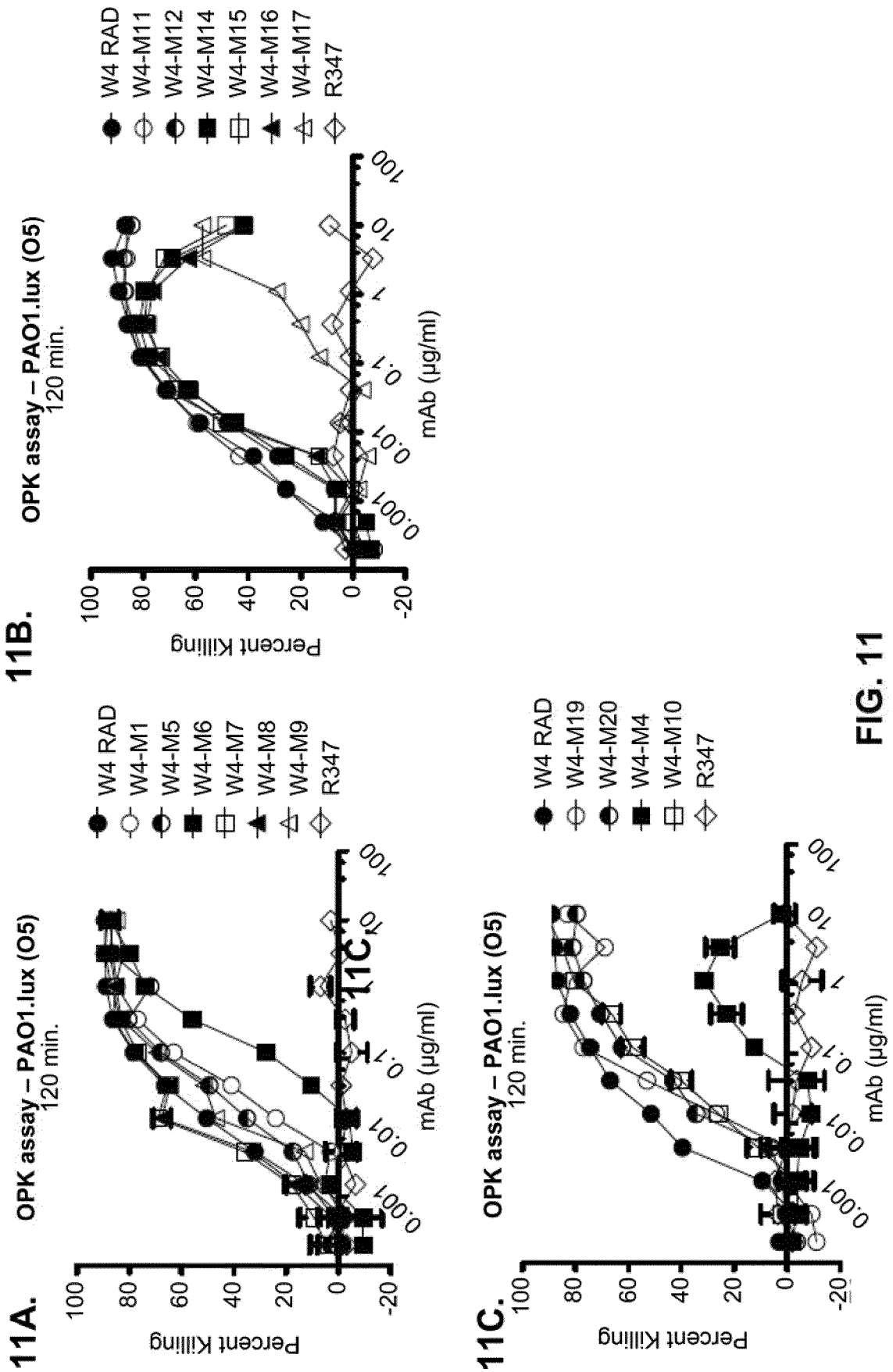

11A.
OPK assay – PAO1.lux (O5)
120 min.
Percent Killing
mAb (µg/ml)
W4 RAD
W4-M1
W4-M5
W4-M6
W4-M7
W4-M8
W4-M9
R347
11B.
OPK assay – PAO1.lux (O5)
120 min.
Percent Killing
mAb (µg/ml)
W4 RAD
W4-M11
W4-M12
W4-M14
W4-M15
W4-M16
W4-M17
R347
11C.
OPK assay – PAO1.lux (O5)
120 min.
Percent Killing
mAb (µg/ml)
W4 RAD
W4-M19
W4-M20
W4-M4
W4-M10
R347

FIG. 11

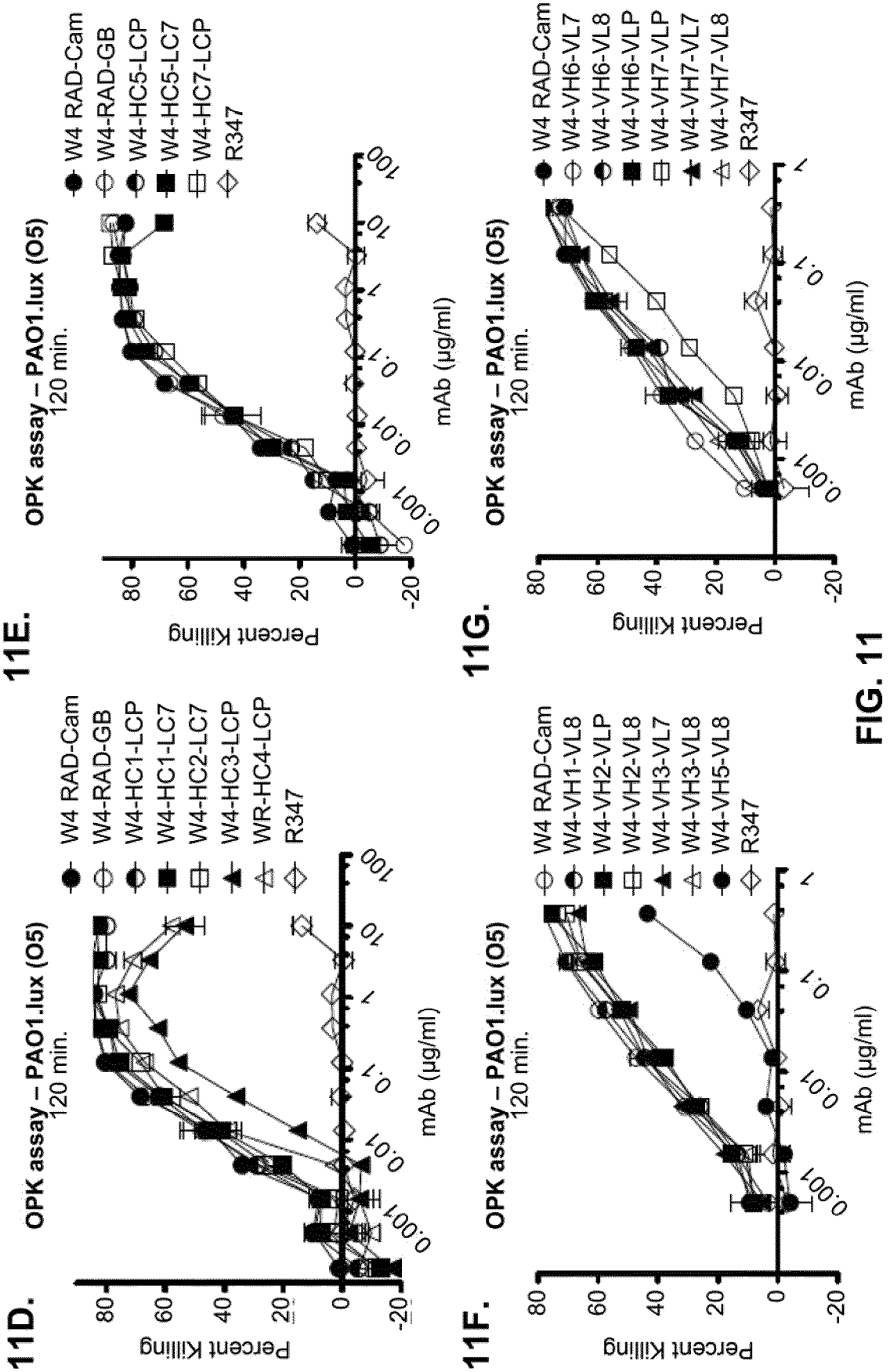

11D.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-RAD-GB
W4-HC1-LCP
W4-HC1-LC7
W4-HC2-LC7
W4-HC3-LCP
WR-HC4-LCP
R347
Percent Killing
mAb (µg/ml)
11E.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-RAD-GB
W4-HC5-LCP
W4-HC5-LC7
W4-HC7-LCP
R347
Percent Killing
mAb (µg/ml)
11F.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH1-VL8
W4-VH2-VLP
W4-VH2-VL8
W4-VH3-VL7
W4-VH3-VL8
W4-VH5-VL8
R347
Percent Killing
mAb (µg/ml)
11G.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH6-VL7
W4-VH6-VL8
W4-VH6-VLP
W4-VH7-VLP
W4-VH7-VL7
W4-VH7-VL8
R347
Percent Killing
mAb (µg/ml)

FIG. 11

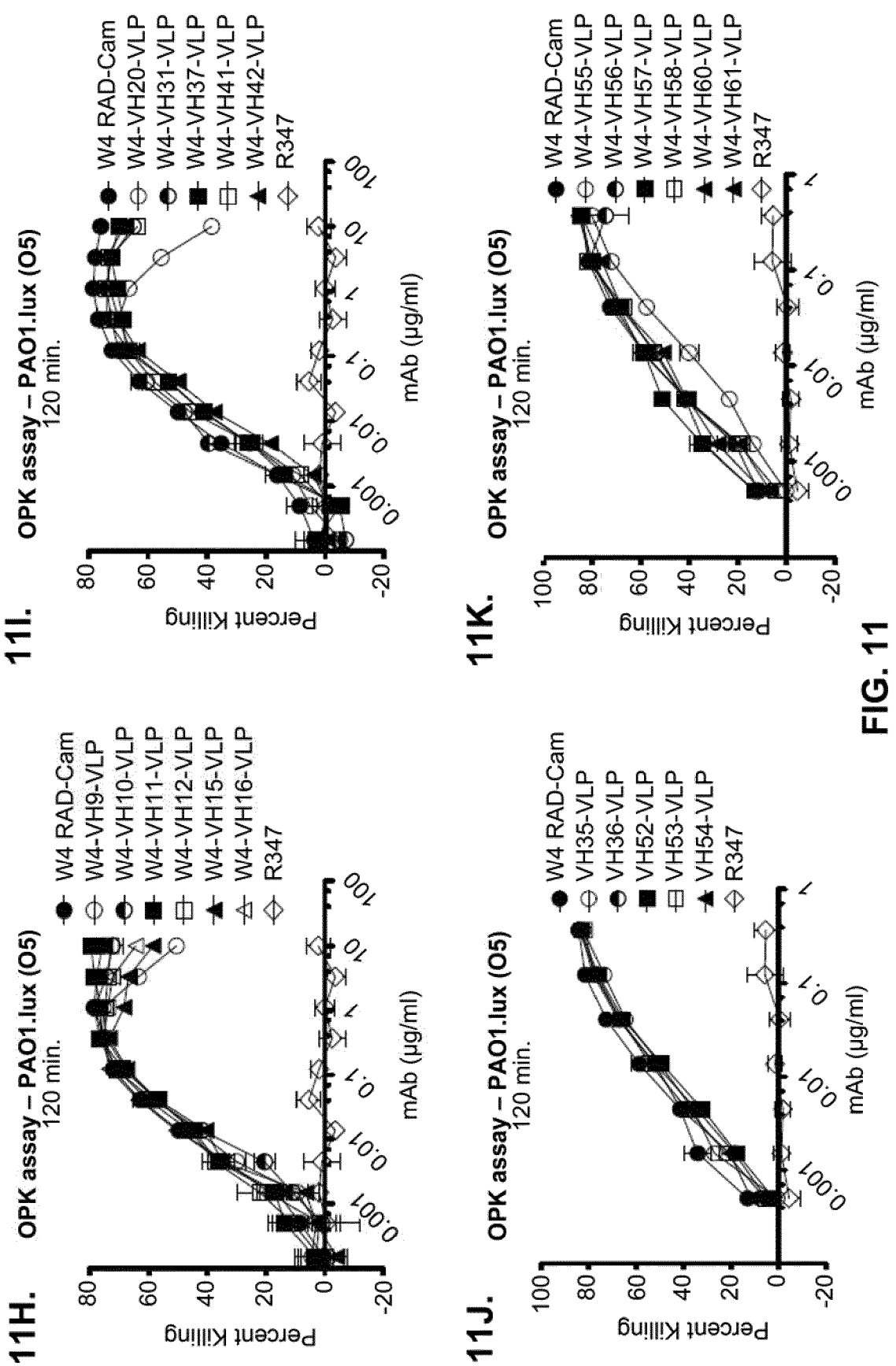
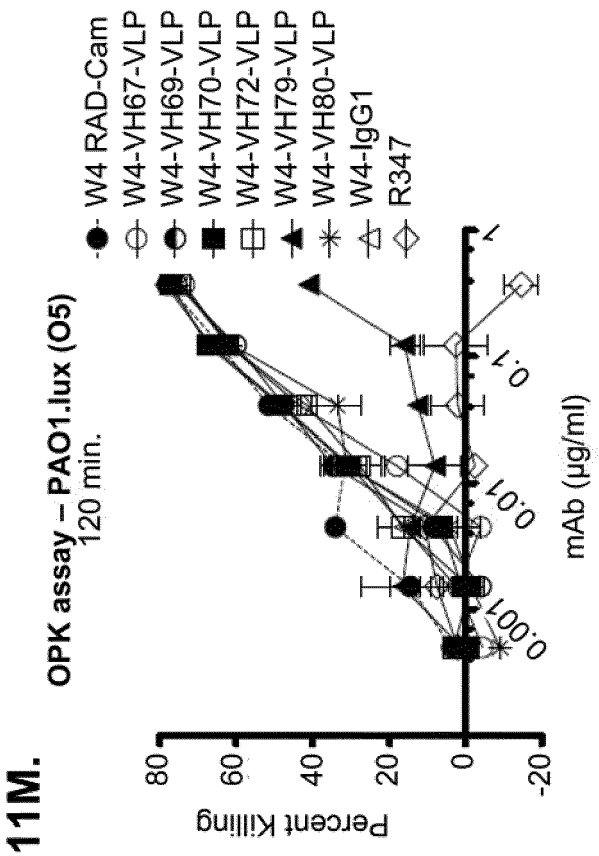

11H.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH9-VLP
W4-VH10-VLP
W4-VH11-VLP
W4-VH12-VLP
W4-VH15-VLP
W4-VH16-VLP
R347
Percent Killing
mAb (µg/ml)
11I.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH20-VLP
W4-VH31-VLP
W4-VH37-VLP
W4-VH41-VLP
W4-VH42-VLP
R347
Percent Killing
mAb (µg/ml)
11J.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
VH35-VLP
VH36-VLP
VH52-VLP
VH53-VLP
VH54-VLP
R347
Percent Killing
mAb (µg/ml)
11K.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH55-VLP
W4-VH56-VLP
W4-VH57-VLP
W4-VH58-VLP
W4-VH60-VLP
W4-VH61-VLP
R347
Percent Killing
mAb (µg/ml)

FIG. 11


11M.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH67-VLP
W4-VH69-VLP
W4-VH70-VLP
W4-VH72-VLP
W4-VH79-VLP
W4-VH80-VLP
W4-IgG1
R347
Percent Killing
80
60
40
20
0
-20
mAb (µg/ml)
1
0.1
0.01
0.001

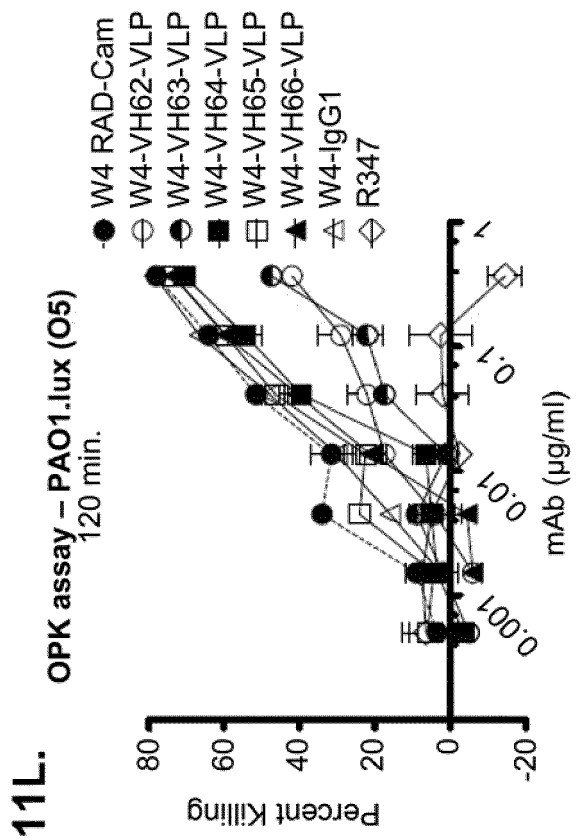

11L.
OPK assay – PAO1.lux (O5)
120 min.
W4 RAD-Cam
W4-VH62-VLP
W4-VH63-VLP
W4-VH64-VLP
W4-VH65-VLP
W4-VH66-VLP
W4-IgG1
R347
Percent Killing
80
60
40
20
0
-20
mAb (µg/ml)
1
0.1
0.01
0.001

FIG. 11

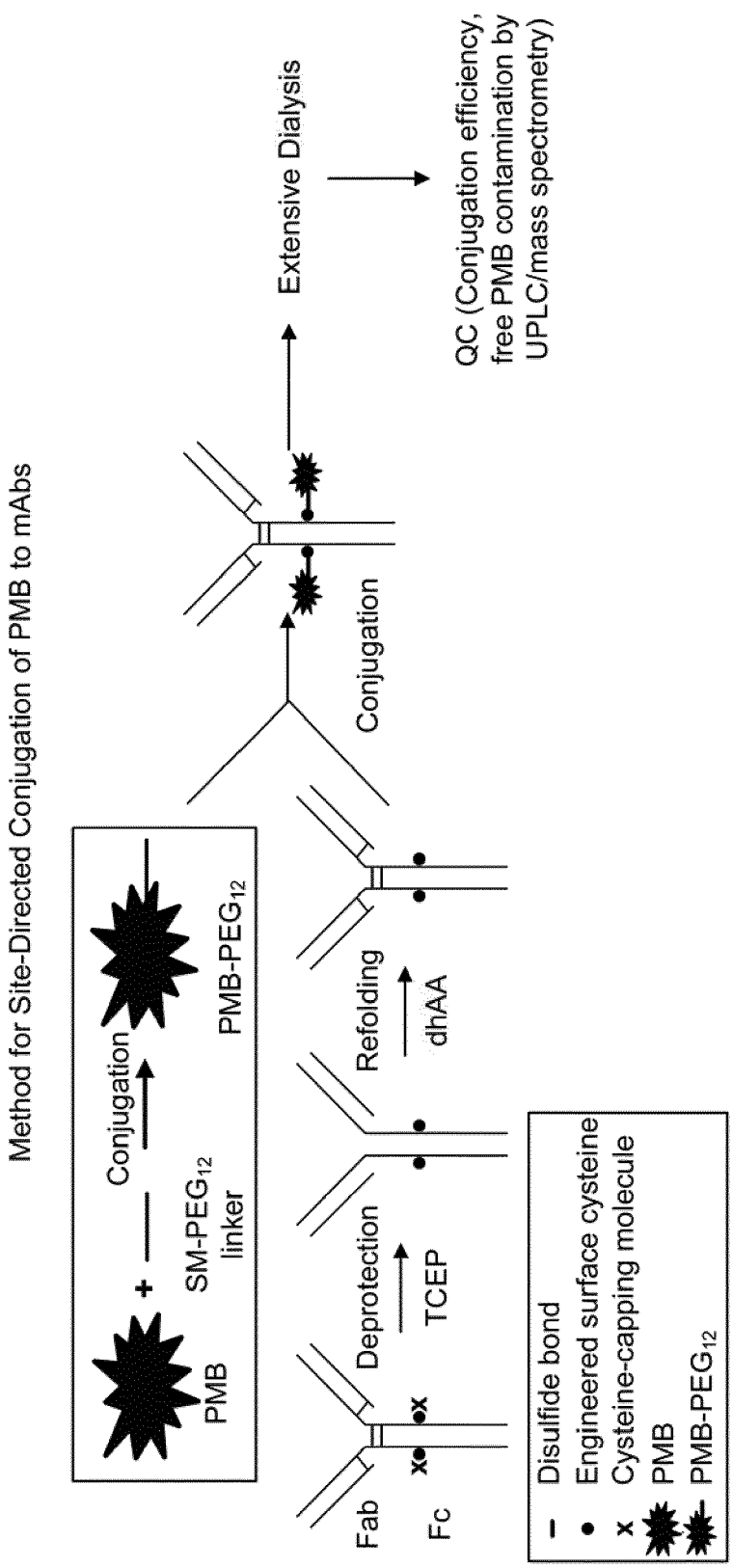
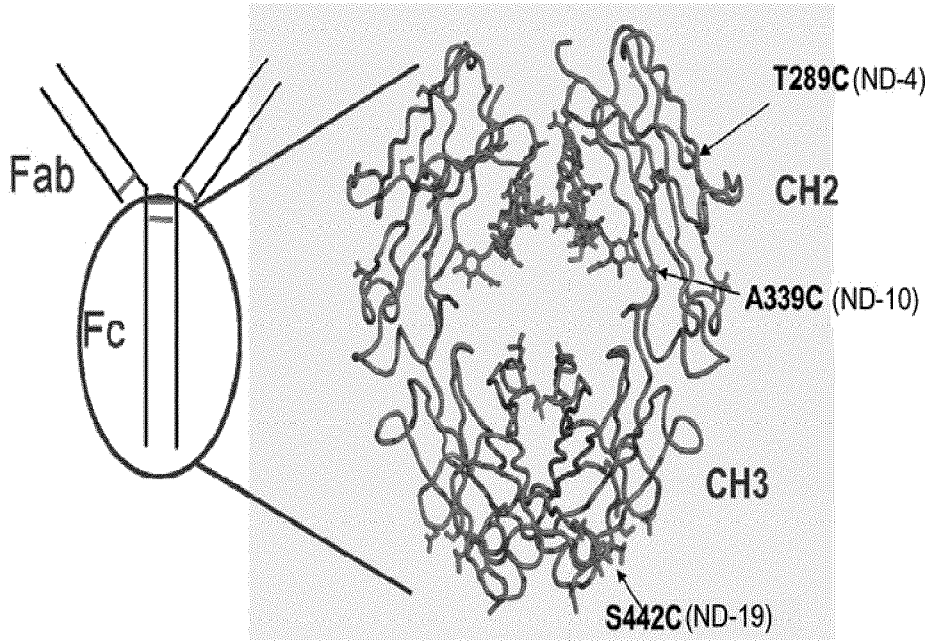

Method for Site-Directed Conjugation of PMB to mAbs
PMB
SM-PEG12 linker
Conjugation
PMB-PEG12
Fab
Fc
Deprotection
TCEP
Refolding
dhAA
Conjugation
Extensive Dialysis
QC (Conjugation efficiency, free PMB contamination by UPLC/mass spectrometry)
Disulfide bond
Engineered surface cysteine
Cysteine-capping molecule
PMB
PMB-PEG12

FIG. 12

13A.



13B.

Construct	PMB/mAb	% Conjugated PMB
A7-SM-PMB	1.5 / 2 (75%)	98.9
CAM-003-SM-PMB	1.5 / 2 (75%)	95.5
A7-DM-PMB	3.4 / 4 (85%)	99.5
CAM-003-DM-PMB	3.3 / 4 (82%)	98.8
A7-TM-PMB	5.0 / 6 (83%)	99.0
CAM-003-TM-PMB	5.1 / 6 (85%)	99.0

FIG. 13

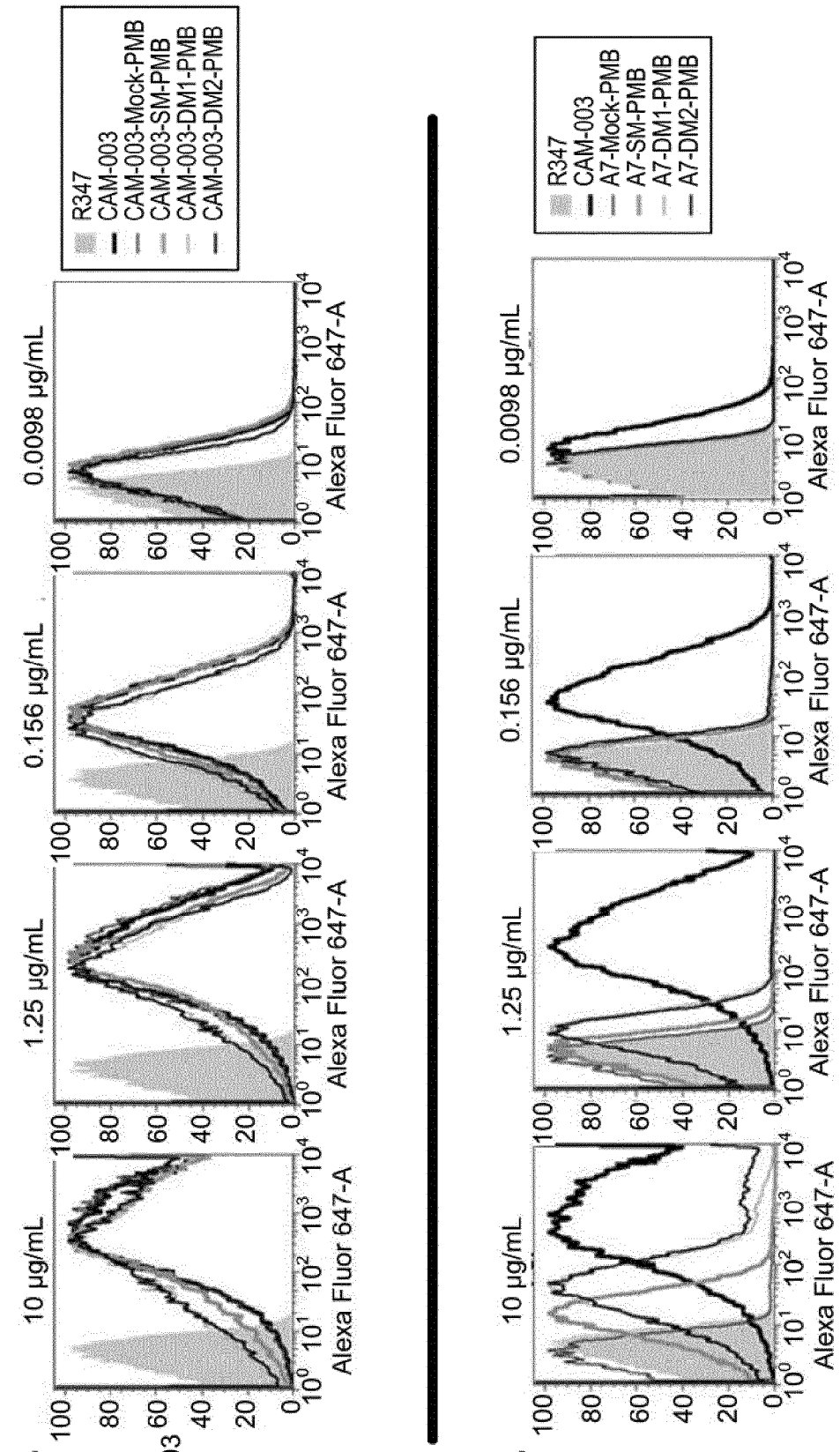
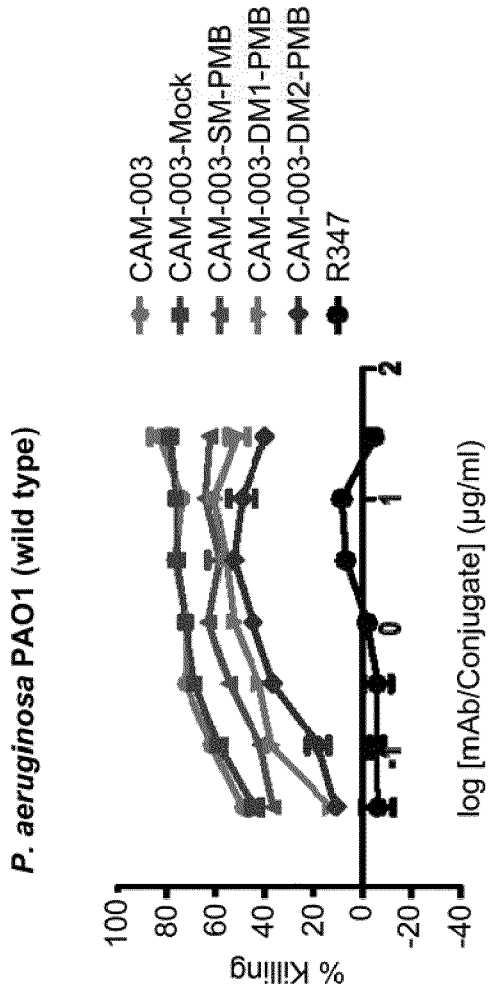

14A.
14B.
CAM-003
A7
10 µg/mL
1.25 µg/mL
0.156 µg/mL
0.0098 µg/mL
Alexa Fluor 647-A
R347
CAM-003
CAM-003-Mock-PMB
CAM-003-SM-PMB
CAM-003-DM1-PMB
CAM-003-DM2-PMB
A7-Mock-PMB
A7-SM-PMB
A7-DM1-PMB
A7-DM2-PMB

FIG. 14

15A.



15B.

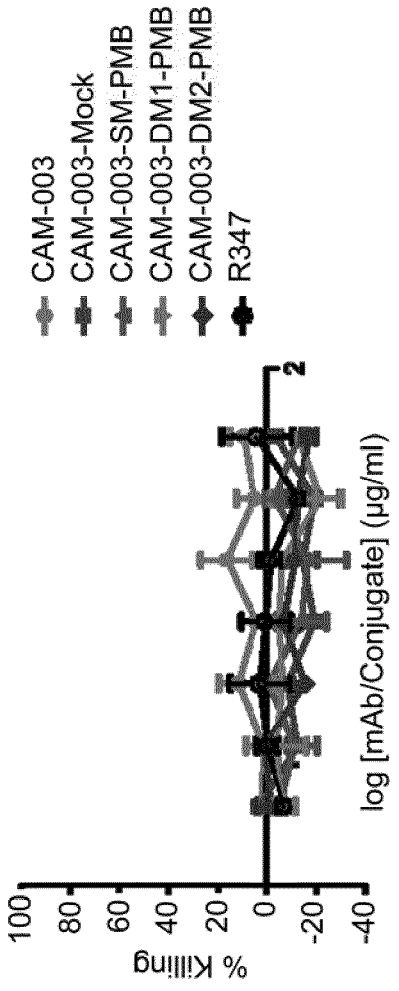


FIG. 15

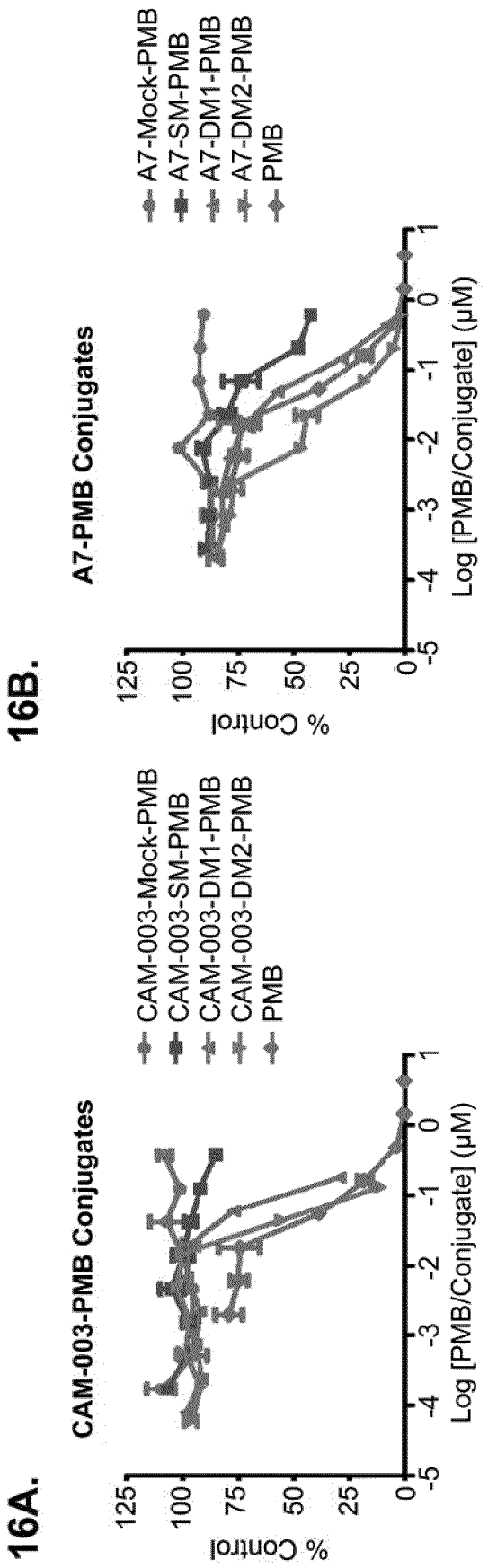

16A.
CAM-003-PMB Conjugates
CAM-003-Mock-PMB
CAM-003-SM-PMB
CAM-003-DM1-PMB
CAM-003-DM2-PMB
PMB
% Control
125
100
75
50
25
0
-5
-4
-3
-2
-1
0
1
Log [PMB/Conjugate] (µM)
16B.
A7-PMB Conjugates
A7-Mock-PMB
A7-SM-PMB
A7-DM1-PMB
A7-DM2-PMB
PMB
% Control
Log [PMB/Conjugate] (µM)

FIG. 16

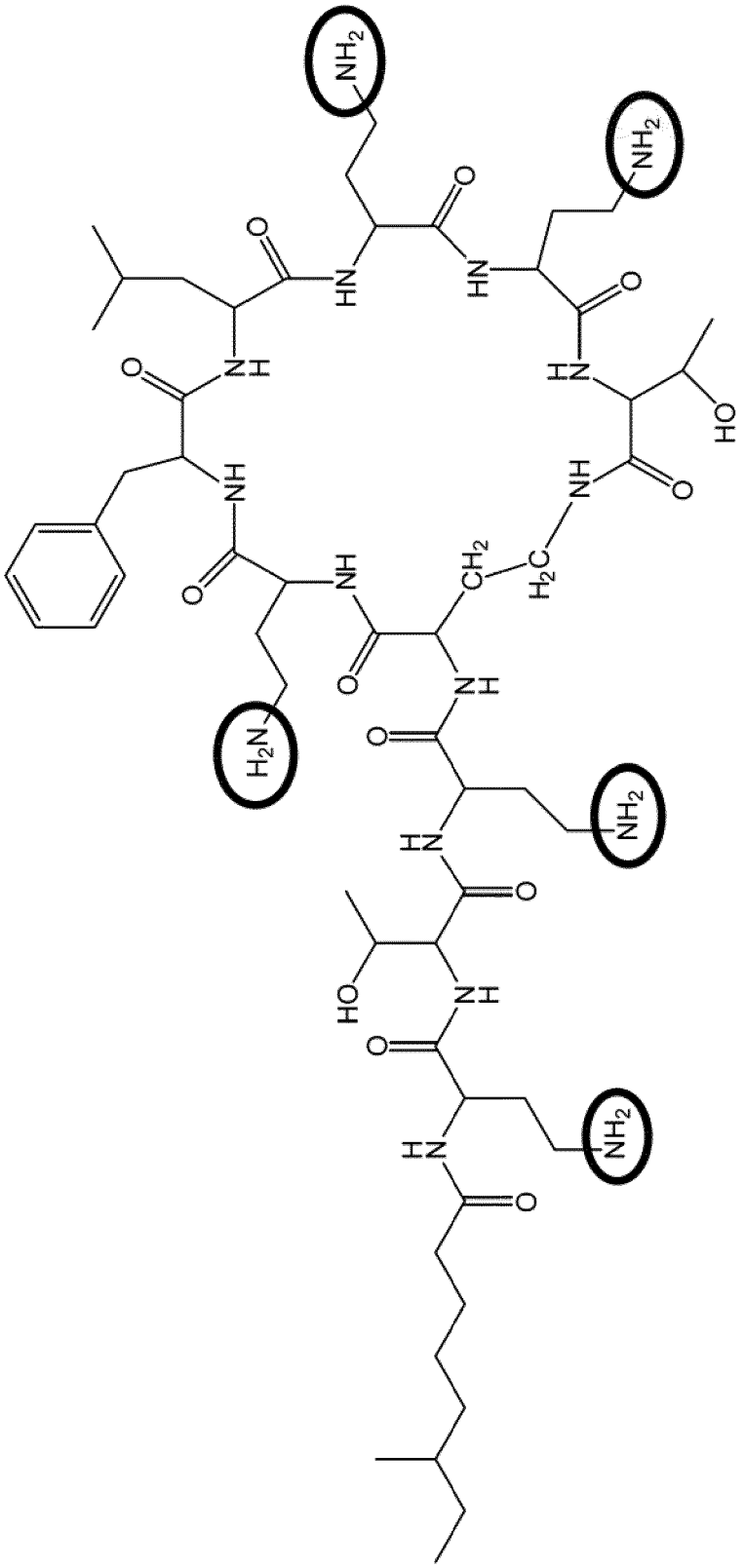
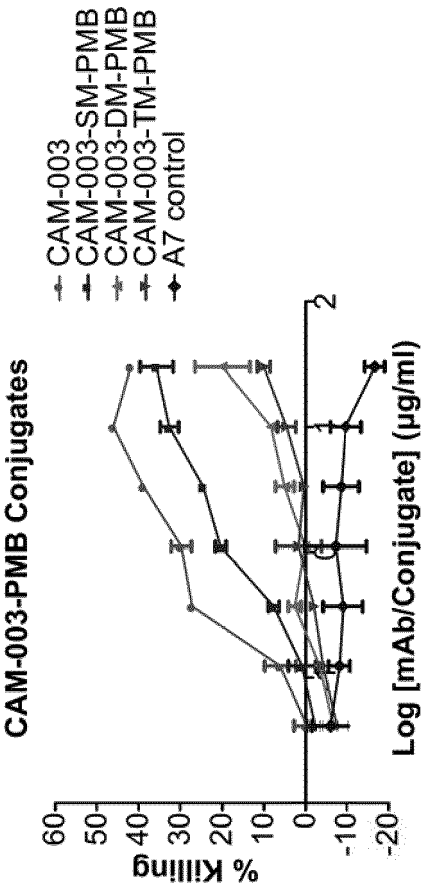


FIG. 17

18A.



18B.

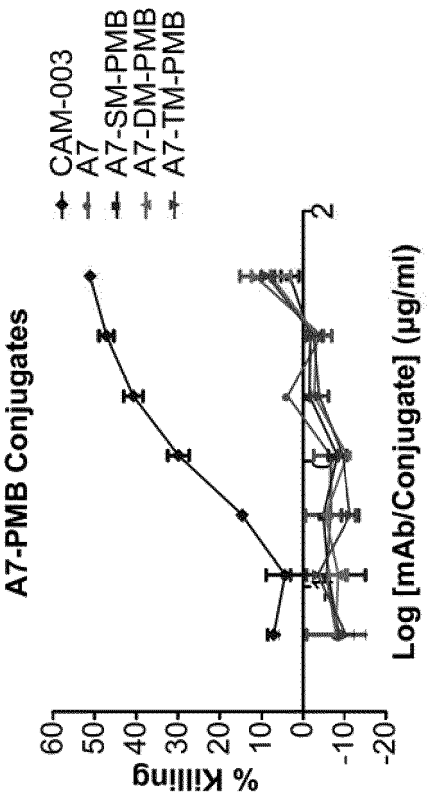
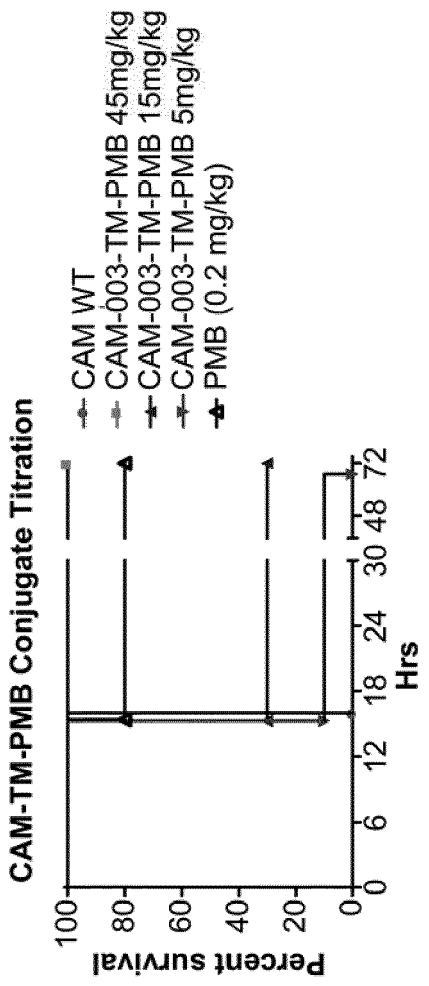


FIG. 18

19A.



19B.

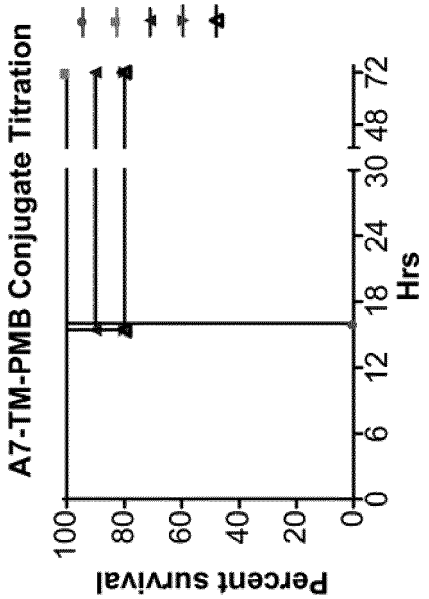
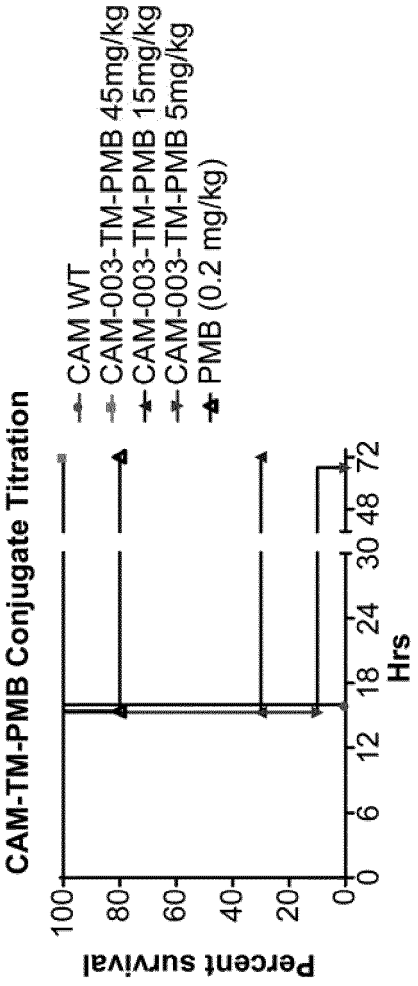


FIG. 19

20A.



20B.

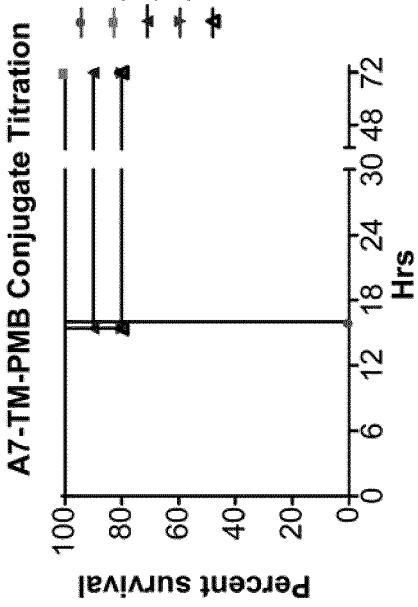


FIG. 20

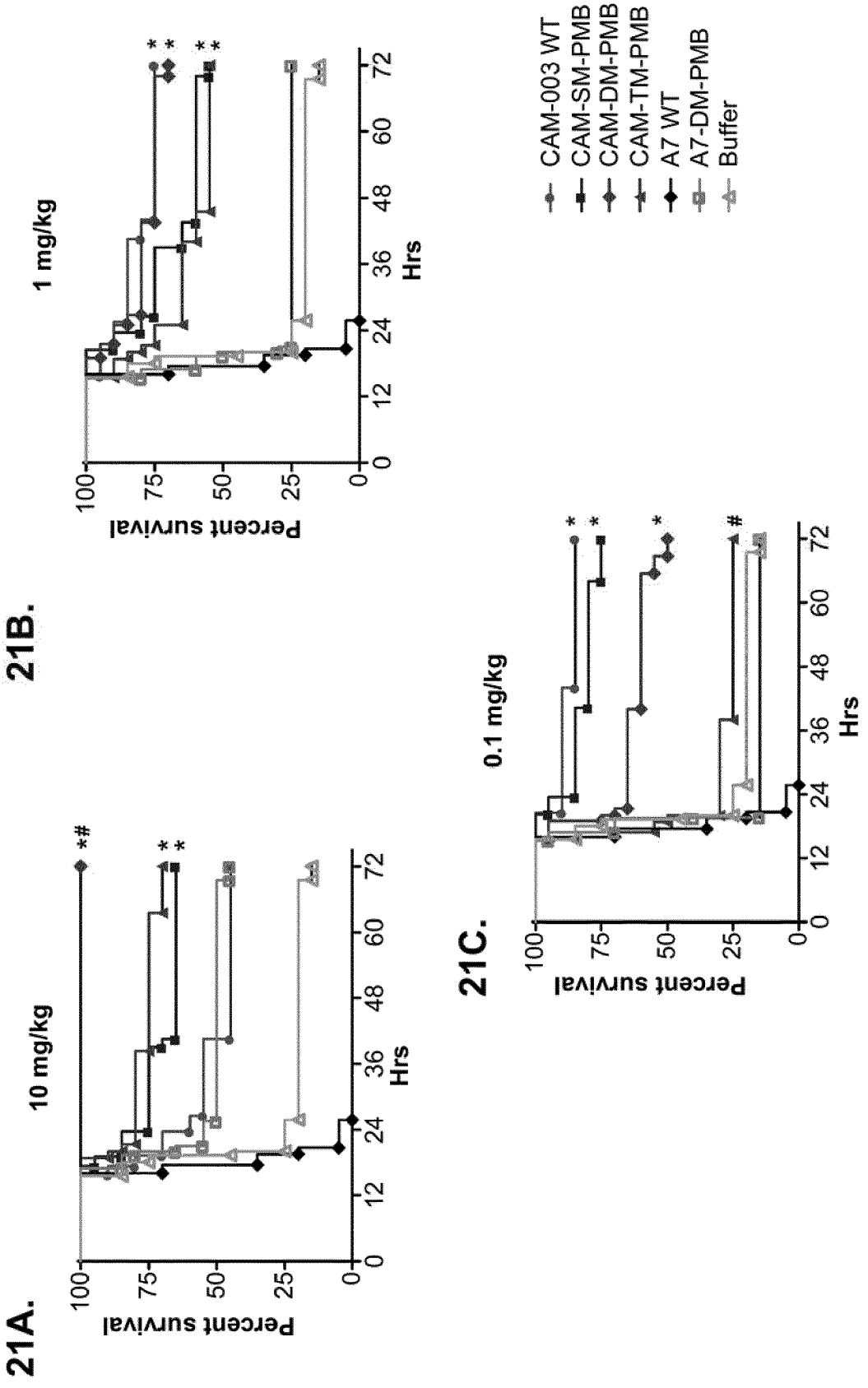

21A.
10 mg/kg
Percent survival
Hrs
21B.
1 mg/kg
Percent survival
Hrs
21C.
0.1 mg/kg
Percent survival
Hrs
CAM-003 WT
CAM-SM-PMB
CAM-DM-PMB
CAM-TM-PMB
A7 WT
A7-DM-PMB
Buffer

FIG. 21

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 5254

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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T	WO 2014/186358 A2 (DIGIANDOMENICO ANTONIO [US]; STOVER CHARLES K [US]; WANG QUN [US]; BOO) 20 November 2014 (2014-11-20) * paragraph [0007] *		

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 June 2018	Wagner, René

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
Munich	26 June 2018	Wagner, René

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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摘要：

本发明涉及抗假单胞菌 Psl 结合分子及其用途，特别是在预防和治疗假单胞菌感染中的用途。此外，本披露提供了用于预防和治疗假单胞菌感染的组合物和方法。