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(54) Title: ANTIBODY MOLECULES BINDING TO SARS-COV-2

(57) Abstract: Antibody molecules that specifically bind to a SARS-CoV-2 spike protein are disclosed. The antibody molecules can be used to treat, prevent, and/or diagnose disorders, such as COVID-19.

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ANTIBODY MOLECULES BINDING TO SARS-COV-2

RELATED APPLICATIONS

This application claims priority to U.S. Serial No.: 63/483,669, filed on February 7, 2023, the contents of which are hereby incorporated by reference in its entirety.

BACKGROUND

COVID-19 remains a healthcare burden worldwide. Monoclonal antibodies (mAbs) capable of neutralizing SARS-CoV-2 have proven to be a successful therapeutic modality for the treatment of and prophylaxis against COVID-19. However, due to the rapid evolution of the SARS-CoV-2 virus, currently available therapeutics have become ineffective. New mAbs are needed for preventing or treating SARS-CoV-2 infection.

SUMMARY

This disclosure provides, at least in part, antibody molecules that bind to a SARS-CoV-2 spike protein, and that comprise one or more functional and structural properties disclosed herein. In an embodiment, the antibody molecule binds to and/or reduces (e.g., inhibits, blocks, or neutralizes) one or more activities of the SARS-CoV-2 spike protein. In an embodiment, the antibody molecule is selected from **Table 2** or competes for binding to a SARS-CoV-2 spike protein with an antibody molecule selected from **Table 2**. In an embodiment, the antibody molecule binds to the same or overlapping epitope as the epitope recognized by an antibody molecule selected from **Table 2**. In an embodiment, the antibody molecule comprises one or more heavy chain variable regions and/or one or more light chain variable regions described in **Table 1 or 2**. In an embodiment, the antibody molecule comprises one or more heavy chain CDRs and/or one or more light chain CDRs described in **Table 1**. In an embodiment, nucleic acid molecules encoding the antibody molecules, expression vectors, host cells, compositions (e.g., pharmaceutical compositions), formulations, kits, containers, and methods for making the antibody molecules, are also provided. The antibody molecules disclosed herein can be used (alone or in combination with other agents or therapeutic modalities) to treat, prevent and/or diagnose SARS-CoV-2 infections. The antibody molecules disclosed herein can also be used to treat, prevent and/or diagnose disorders associated with a SARS-CoV-2, e.g., COVID-19.

Accordingly, in an aspect, this disclosure provides an antibody molecule (e.g., an antibody molecule described herein) having one or more (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, or all) of the following properties:

(i) binds to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, e.g., with a dissociation constant (K_D) of 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or

less, 0.1 nM or less, 0.09 nM or less, 0.08 nM or less, 0.07 nM or less, 0.06 nM or less, 0.05 nM or less, 0.04 nM or less, 0.03 nM or less, 0.02 nM or less, 0.01 nM or less, 0.005 nM or less, 0.002 nM or less, 0.001 nM or less, or 1pM or less, e.g., between 0.001 nM and 100 nM, between 0.01 nM and 100 nM, between 0.1 nM and 100 nM, between 1 nM and 100 nM, between 10 nM and 100 nM, between 0.001 nM and 1 nM, between 0.002 nM and 0.5 nM, between 0.005 nM and 0.2 nM, between 0.01 nM and 0.1 nM, between 0.02 nM and 0.05 nM, between 0.001 nM and 0.5 nM, between 0.001 nM and 0.2 nM, between 0.001 nM and 0.1 nM, between 0.001 nM and 0.05 nM, between 0.001 nM and 0.02 nM, between 0.001 nM and 0.01 nM, between 0.001 nM and 0.005 nM, between 0.5 nM and 1 nM, between 0.2 nM and 1 nM, between 0.1 nM and 1 nM, between 0.05 nM and 1 nM, between 0.02 nM and 1 nM, between 0.01 nM and 1 nM, between 0.005 nM and 1 nM, between 0.002 nM and 1 nM, between 0.002 nM and 0.01 nM, between 0.005 nM and 0.02 nM, between 0.01 nM and 0.05 nM, between 0.02 nM and 0.1 nM, between 0.05 nM and 0.2 nM, or between 0.1 nM and 0.5 nM, e.g., between 0.1 pM and 1 pM, between 0.01 pM and 0.1 pM, between 1 pM and 10 pM, between 10 pM and 100 pM, between 50 pM and 100 pM, between 0.1 nM and 1 nM, between 1 nM and 2 nM, between 2 nM and 3 nM, or between 3 nM and 4nM, e.g., 3.66 nM, 1.55 nM, or 90.8 pM, e.g., as determined by a method described herein (e.g., in the Examples);

(ii) binds to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, e.g., with a half maximal effective concentration (EC_{50}) of

(a) 10 μg/mL or less, e.g., 5 μg/mL or less, 2 μg/mL or less, 1 μg/mL or less, 0.5 μg/mL or less, 0.2 μg/mL or less, 100 ng/mL or less, 50 ng/mL or less, 20 ng/mL or less, 15 ng/mL or less, 10 ng/mL or less, 9 ng/mL or less, 8 ng/mL or less, 7 ng/mL or less, 6 ng/mL or less, 5 ng/mL or less, 4 ng/mL or less, 3 ng/mL or less, 2 ng/mL or less, 1 ng/mL or less, 0.5 ng/mL or less, 0.2 ng/mL or less, or 0.1 ng/mL or less, e.g., between 0.1 ng/mL to 10 μg/mL, between 1 ng/mL to 10 μg/mL, between 10 ng/mL to 10 μg/mL, between 100 ng/mL to 10 μg/mL, between 1 μg/mL to 10 μg/mL, between 0.1 ng/mL and 100 ng/mL, between 0.2 ng/mL and 50 ng/mL, between 0.5 ng/mL and 20 ng/mL, between 1 ng/mL and 10 ng/mL, between 2 ng/mL and 5 ng/mL, between 0.1 ng/mL and 50 ng/mL, between 0.1 ng/mL and 20 ng/mL, between 0.1 ng/mL and 10 ng/mL, between 0.1 ng/mL and 5 ng/mL, between 0.1 ng/mL and 2 ng/mL, between 0.1 ng/mL and 1 ng/mL, between 0.1 ng/mL and 0.5 ng/mL, between 0.1 ng/mL and 0.2 ng/mL, between 50 ng/mL and 100 ng/mL, between 20 ng/mL and 100 ng/mL, between 10 ng/mL and 100 ng/mL, between 5 ng/mL and 100 ng/mL, between 2 ng/mL and 100 ng/mL, between 1 ng/mL and 100 ng/mL, between 0.5 ng/mL and 100 ng/mL, between 0.2 ng/mL and 100 ng/mL, between 0.2 ng/mL and 1 ng/mL, between 0.5 ng/mL and 2 ng/mL, between 1 ng/mL and 5 ng/mL, between 2 ng/mL and 10 ng/mL, between 5 ng/mL and 20 ng/mL, or between 10 ng/mL and 50 ng/mL, e.g., between 0.03 μg/mL and 0.70 μg/mL, between 0.04 μg/mL and 0.61μg/mL, between 0.04 μg/mL and 0.1 μg/mL, between 0.1 μg/mL and 0.2 μg/mL, between 0.2 μg/mL and 0.3 μg/mL, between 0.3

μg/mL and 0.4 μg/mL, between 0.4 μg/mL and 0.5 μg/mL, between 0.5 μg/mL and 0.6 μg/mL, or between 0.6 μg/mL and 0.7 μg/mL, e.g., 0.11 μg/mL, 0.56 μg/mL, 0.23 μg/mL, 0.17 μg/mL, 0.12 μg/mL, 0.13 μg/mL, 0.21 μg/mL, 0.6 μg/mL, 0.15 μg/mL, 0.09 μg/mL, 0.07 μg/mL, 0.1 μg/mL, 0.169 μg/mL, 0.081 μg/mL, 0.05 μg/mL, 0.06 μg/mL, 0.105 μg/mL, 0.057 μg/mL, 0.055 μg/mL, 0.041 μg/mL, 0.089 μg/mL, 0.054 μg/mL, 0.042 μg/mL, 0.053 μg/mL, 0.096 μg/mL, 0.086 μg/mL, 0.052 μg/mL, or 0.072 μg/mL. e.g., as determined by a method described herein (e.g., in the Examples); or

(b) 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 500 pM or less, 200 pM or less, 100 pM or less, 50 pM or less, 20 pM or less, 10 pM or less, 5 pM or less, 2 pM or less, or 1 pM or less, e.g., between 1 pM and 100 nM, between 10 pM and 100 nM, between 0.1 nM and 100 nM, between 1 nM and 100 nM, between 10 nM and 100 nM, between 1 pM and 500 pM, between 2 pM and 200 pM, between 5 pM and 100 pM, between 10 pM and 50 pM, between 1 pM and 200 pM, between 1 pM and 100 pM, between 1 pM and 50 pM, between 1 pM and 20 pM, between 1 pM and 10 pM, between 1 pM and 5 pM, between 200 pM and 500 pM, between 100 pM and 500 pM, between 50 pM and 500 pM, between 20 pM and 500 pM, between 10 pM and 500 pM, between 5 pM and 500 pM, between 2 pM and 500 pM, between 2 pM and 10 pM, between 5 pM and 20 pM, between 10 pM and 50 pM, between 20 pM and 100 pM, or between 50 pM and 200 pM, e.g., as determined by a method described herein;

(iii) reduces (e.g., inhibits or blocks) the binding of a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), to an ACE receptor, at a half maximal inhibitory concentration (IC_{50}) of

(a) 100 μg/ml or less, e.g., 50 μg/ml or less, 20 μg/ml or less, 10 μg/ml or less, 9 μg/ml or less, 8 μg/ml or less, 7 μg/ml or less, 6 μg/ml or less, 5 μg/ml or less, 4 μg/ml or less, 3 μg/ml or less, 2 μg/ml or less, 1 μg/ml or less, 0.9 μg/ml or less, 0.8 μg/ml or less, 0.7 μg/ml or less, 0.6 μg/ml or less, 0.5 μg/ml or less, 0.4 μg/ml or less, 0.3 μg/ml or less, 0.2 μg/ml or less, 0.1 μg/ml or less, 0.05 μg/ml or less, 0.02 μg/ml or less, or 0.01 μg/ml or less, e.g., between 0.01 μg/ml and 100 μg/ml, between 0.02 μg/ml and 50 μg/ml, between 0.05 μg/ml and 20 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 0.2 μg/ml and 5 μg/ml, between 0.5 μg/ml and 2 μg/ml, between 0.02 μg/ml and 100 μg/ml, between 0.05 μg/ml and 100 μg/ml, between 0.1 μg/ml and 100 μg/ml, between 0.1 μg/ml and 50 μg/ml, between 0.1 μg/ml and 20 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 0.1 μg/ml and 5 μg/ml, between 0.1 μg/ml and 2 μg/ml, between 0.1 μg/ml and 1 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.1 μg/ml and 0.2 μg/ml, between 20 μg/ml and 100 μg/ml, between 10 μg/ml and 100 μg/ml, between 5 μg/ml and 100 μg/ml, between 2 μg/ml and 100 μg/ml, between 1 μg/ml and 100 μg/ml, between 0.5 μg/ml and 100 μg/ml, between 0.2 μg/ml and 100 μg/ml, between 0.1 μg/ml and 100 μg/ml, between 0.05 μg/ml and 100 μg/ml, 0.02

μg/ml and 100 μg/ml, between 0.02 μg/ml and 0.1 μg/ml, between 0.05 μg/ml and 0.2 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.2 μg/ml and 1 μg/ml, between 0.5 μg/ml and 2 μg/ml, between 1 μg/ml and 5 μg/ml, between 2 μg/ml and 10 μg/ml, between 5 μg/ml and 20 μg/ml, or between 10 μg/ml and 50 μg/ml, e.g., as determined by a method described herein; or

(b) 200 nM or less, e.g., 150 nM or less, 100 nM or less, 50 nM or less, 25 nM or less, 20 nM or less, 15 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or less, or 0.1 nM or less, e.g., between 0.1 nM and 200 nM, between 0.2 nM and 100 nM, between 0.5 nM and 50 nM, between 1 nM and 20 nM, between 2 nM and 10 nM, between 0.1 nM and 100 nM, between 0.1 nM and 50 nM, between 0.1 nM and 20 nM, between 0.1 nM and 10 nM, between 0.1 nM and 5 nM, between 0.1 nM and 2 nM, between 0.1 nM and 1 nM, between 0.1 nM and 0.5 nM, between 0.1 nM and 0.2 nM, between 100 nM and 200 nM, between 50 nM and 200 nM, between 20 nM and 200 nM, between 10 nM and 200 nM, between 5 nM and 200 nM, between 2 nM and 200 nM, between 1 nM and 200 nM, between 0.5 nM and 200 nM, between 0.2 nM and 200 nM, between 0.2 nM and 1 nM, between 0.5 nM and 2 nM, between 1 nM and 5 nM, between 2 nM and 10 nM, between 5 nM and 20 nM, between 10 nM and 50 nM, between 20 nM and 100 nM, e.g., as determined by a method described herein;

(iv) reduces (e.g., inhibits or neutralizes) a SARS-CoV-2 infection at a half maximal inhibitory concentration (IC_{50}) of

(a) 10 μg/ml or less, e.g., 5 μg/ml or less, 2 μg/ml or less, 1 μg/ml or less, 0.9 μg/ml or less, 0.8 μg/ml or less, 0.7 μg/ml or less, 0.6 μg/ml or less, 0.5 μg/ml or less, 0.4 μg/ml or less, 0.3 μg/ml or less, 0.2 μg/ml or less, 0.1 μg/ml or less, 0.05 μg/ml or less, 0.02 μg/ml or less, or 0.01 μg/ml or less, e.g., between 0.01 μg/ml and 10 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 1 μg/ml and 10 μg/ml, between 0.01 μg/ml and 5 μg/ml, between 0.02 μg/ml and 2 μg/ml, between 0.05 μg/ml and 1 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.01 μg/ml and 0.02 μg/ml, between 0.01 μg/ml and 0.05 μg/ml, between 0.01 μg/ml and 0.1 μg/ml, between 0.01 μg/ml and 0.2 μg/ml, between 0.01 μg/ml and 0.5 μg/ml, between 0.01 μg/ml and 1 μg/ml, between 0.01 μg/ml and 2 μg/ml, between 2 μg/ml and 5 μg/ml, between 1 μg/ml and 5 μg/ml, between 0.5 μg/ml and 5 μg/ml, between 0.2 μg/ml and 5 μg/ml, between 0.1 μg/ml and 5 μg/ml, between 0.05 μg/ml and 5 μg/ml, between 0.02 μg/ml and 5 μg/ml, between 0.02 μg/ml and 0.1 μg/ml, between 0.05 μg/ml and 0.2 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.2 μg/ml and 1 μg/ml, or between 0.5 μg/ml and 2 μg/ml, e.g., as determined by a method described herein; or

(b) 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 9 nM or less, 8 nM or less, 7 nM or less, 6 nM or less, 5 nM or less, 4 nM or less, 3 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or less, 0.1 nM or less, e.g., between 0.1 nM and 100

nM, between 1 nM and 100 nM, between 0.1 nM and 50 nM, between 0.2 nM and 20 nM, between 0.5 nM and 10 nM, between 1 nM and 5 nM, between 0.1 nM and 0.2 nM, between 0.1 nM and 0.5 nM, between 0.1 nM and 1 nM, between 0.1 nM and 2 nM, between 0.1 nM and 5 nM, between 0.1 nM and 10 nM, between 0.1 nM and 20 nM, between 20 nM and 50 nM, between 10 nM and 50 nM, between 5 nM and 50 nM, between 1 nM and 50 nM, between 0.5 nM and 50 nM, between 0.2 nM and 50 nM, between 0.2 nM and 1 nM, between 0.5 nM and 2 nM, between 1 nM and 5 nM, between 2 nM and 10 nM, or between 5 nM and 20 nM, e.g., as determined by a method described herein;

(v) reduces (e.g., inhibits, blocks, or neutralizes) one or more biological activities of a SARS-CoV-2 spike protein, *in vitro*, *ex vivo*, or *in vivo*;

(vi) binds specifically to an epitope on a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), e.g., the same, similar, or overlapping epitope as the epitope recognized by a monoclonal antibody described in **Table2**;

(vii) shows the same or similar binding affinity or specificity, or both, as a monoclonal antibody described in **Table 2**;

(viii) shows the same or similar binding affinity or specificity, or both, as an antibody molecule comprising one or more (e.g., two or three) heavy chain CDRs and/or one or more (e.g., two or three) light chain CDRs described in **Table 1**;

(ix) shows the same or similar binding affinity or specificity, or both, as an antibody molecule comprising a heavy chain variable region (VH) and/or a light chain variable region (VL) described in **Table 1 or 2**;

(x) inhibits, e.g., competitively inhibits, the binding of a second antibody molecule to a SARS-CoV-2 spike protein, or a fragment thereof, wherein the second antibody molecule is a monoclonal antibody described in **Table 2**;

(xi) competes for binding with a second antibody molecule to a SARS-CoV-2 spike protein, or a fragment thereof, wherein the second antibody molecule is a monoclonal antibody described in **Table 2**;

(xii) has one or more biological properties of a monoclonal antibody comprising the sequences described in **Tables 1 or 2**;

(xiii) has one or more structural properties of a monoclonal antibody described in **Table 2**;

(xiv) has one or more pharmacokinetic properties of a monoclonal antibody described in **Table 2**;

(xv) binds to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, wherein the SARS-CoV-2 spike protein comprises an amino acid sequence of SEQ ID NO: 321-323 or 336-340;

(xvi) binds specifically to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, wherein the SARS-CoV-2 spike protein comprises

one or more (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more) mutations, e.g., wherein the mutations are chosen from A67V, Δ69, Δ70, T95I, G142D, Δ143-145, N211I, Δ212, R214ins, G339D, S371L, S373P, S375F, K417N, N440K, G446S, S477N, T478K, E484A, Q493R, G496S, Q498R, N501Y, Y505H, T547K, D614G, H655Y, N679K, P681H, N764K, D796Y, N856K, Q954H, N969K, or L981F;

(xvii) reduces (e.g., inhibits or neutralizes) an infection caused by a SARS-CoV-2 or a SARS-CoV-2 variant, e.g., one or more of SARS-CoV-2 variants alpha (B.1.1.7, UK variant), beta (B.1.351, B.1.351.2, B.1.351.3, South Africa variant), gamma (P.1, P.1.1, P.1.2, Brazil variant), delta (B.1.617.2, AY.1, AY.2, AY.3, India variant), Eta (B.1.525), Iota (B.1.526), kappa (B.1.617.1), lambda (C.37), or omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB; or

(xviii) reduces (e.g., inhibits or neutralizes) an infection caused by a SARS-CoV-2 or a SARS-CoV-2 variant (e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB) comprising one or more (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more) mutations in the spike protein.

Exemplary variants of SARS-CoV-2 and mutations in the spike protein of a SARS-CoV-2 or a SARS-CoV-2 variant are described in www.who.int/activities/tracking-SARS-CoV-2-variants, incorporated herein by reference in its entirety.

In an aspect, the disclosure provides an antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising: a heavy chain variable region (VH) comprising an HCDR1 of a VH described in **Table 1**, an HCDR2 of a VH described in **Table 1**, and an HCDR3 of a VH described in **Table 1**; and/or a light chain variable region (VL) comprising an LCDR1 of a VL described in **Table 1**, an LCDR2 of a VL described in **Table 1**, and an LCDR3 of a VL described in **Table 1**.

In an embodiment, the HCDR1, HCDR2, and HCDR3 are chosen from the same VH described in **Table 1**. In an embodiment, the LCDR1, LCDR2, and LCDR3 are chosen from the same VL described in **Table 1**. In an embodiment, the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 are chosen from the VH and VL of the same row in **Table 2**.

In an embodiment, the antibody molecule comprises a VH comprising one or more (e.g., 2 or 3) HCDRs described in **Table 1** and/or a VL comprising one or more (e.g., 2 or 3) LCDRs described in **Table 1**.

In an embodiment, the antibody molecule comprises a VH comprising an HCDR1 comprising the amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201, an HCDR2 comprising the amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254, and an HCDR3 comprising the amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306; and a VL comprising an LCDR1 comprising the amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225, an LCDR2 comprising the amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267, and an LCDR3 comprising the amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises a VH comprising one or more (e.g., 2 or 3) HCDRs and/or and a VL comprising one or more (e.g., 2 or 3) LCDRs of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a VH and a VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**.

In an embodiment, the antibody molecule comprises a VL described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VL described in **Table 1 or 2**.

In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and a VL described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2** and a VL described in **Table 1 or 2**. In an embodiment, the VH and VL are chosen from the same row in **Table 2**.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%,

90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112 and a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises the VH and/or the VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises the VH and the VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a monoclonal antibody described in **Table 2**, e.g., mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises an antigen-binding fragment. In an embodiment, the antigen-binding fragment comprises a Fab, F(ab')2, Fv, scFv, or sc(Fv)2.

In an embodiment, the antibody molecule comprises a heavy chain constant region (e.g., one, two, or three of CH1, CH2, or CH3) chosen from the heavy chain constant regions of IgG1, IgG2, IgG3, or IgG4, e.g., a heavy chain constant region described herein (e.g., the amino acid sequence of

SEQ ID NO: 319 or 341, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom). In an embodiment, the antibody molecule comprises a light chain constant region (CL) chosen from the light chain constant regions of kappa or lambda, e.g., a light chain constant region described herein (e.g., the amino acid sequence of SEQ ID NO: 320, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom).

In an embodiment, the antibody molecule comprises an Fc region, e.g., an Fc region described herein. In an embodiment, the Fc region comprises a mutation.

In an embodiment, the antibody molecule is a humanized antibody molecule. In an embodiment, the antibody molecule is a monoclonal antibody molecule. In an embodiment, the antibody molecule is a synthetic antibody molecule. In an embodiment, the antibody molecule is an isolated antibody molecule. In an embodiment, the antibody molecule is a monospecific antibody molecule. In an embodiment, the antibody molecule is a multispecific antibody molecule, e.g., bispecific antibody molecule.

In an aspect, the disclosure provides an antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising:

(A) (a) a heavy chain variable region (VH) comprising:

(i) an HCDR1 comprising the amino acid sequence:

$GX_1X_2X_3X_4X_5YX_6$

wherein: X_1 is Y or F;
X_2 is P, D, S, T or N;
X_3 is F or Y;
X_4 is T or S;
X_5 is S, L, K, Q, R or Y; and
X_6 is G, L, R, Y or N;

(SEQ ID NO: 324);

(ii) an HCDR2 comprising the amino acid sequence:

$ISX_1X_2X_3GNT$

wherein: X_1 is T, N or D;
X_2 is Y, H or W; and
X_3 is N, D or T;

(SEQ ID NO: 325); and

(iii) an HCDR3 comprising the amino acid sequence:

$ARDYX_1X_2GX_3WX_4X_5EX_6LIGGFDN$

wherein: X_1 is N or T;

X_2 is R or Q;

X_3 is A, S, N or D;

X_4 is F or Y;

X_5 is G, Q, H, L or D; and

X_6 is S, T, H, E or Q;

(SEQ ID NO: 326); and

(b) a light chain variable region (VL) comprising:

(i) an LCDR1 comprising the amino acid sequence:

$QX_1X_2SX_3X_4X_5$

wherein: X_1 is T, Q, D, E or S;

X_2 is V or T;

X_3 is S, Q or M;

X_4 is T or E; and

X_5 is S or T;

(SEQ ID NO: 327);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2X_3$

wherein: X_1 is G, W, D, Y or F;

X_2 is A or S; and

X_3 is H, S, E, Y or Q;

(SEQ ID NO: 328); and

(iii) an LCDR3 comprising the amino acid sequence:

$QX_1HX_2X_3SLT$

wherein: X_1 is Q or E;

X_2 is D or E; and

X_3 is T, Q, E, K or R;

(SEQ ID NO: 329), or

(B) (a) a VH comprising:

(i) an HCDR1 comprising the amino acid sequence:

$X_1X_2X_3X_4X_5YX_6IG$

wherein: X_1 is Y, H, R, E, S or K;

X_2 is G or S;

X_3 is F or Y;

X_4 is I, Q or R;

X_5 is T or W; and

X_6 is W or Y;

(SEQ ID NO: 330);

(ii) an HCDR2 comprising the amino acid sequence:

GIIYX$_1$GX$_2$X$_3$EX$_4$RYS

wherein: X$_1$ is P, H or W;

X$_2$ is D or N;

X$_3$ is Q, S, L, H, N, G, K or R; and

X$_4$ is T or V;

(SEQ ID NO: 331); and

(iii) an HCDR3 comprising the amino acid sequence:

CAGX$_1$X$_2$X$_3$IX$_4$TPMDVW

wherein: X$_1$ is G, W, F, R or Y;

X$_2$ is S, G, K or D;

X$_3$ is G or R; and

X$_4$ is N, S, D, K, H, W, Y or R;

(SEQ ID NO: 332); and

(b) a VL comprising:

(i) an LCDR1 comprising the amino acid sequence:

KSSQSX$_1$LX$_2$X$_3$X$_4$IX$_5$X$_6$X$_7$YIX$_8$

wherein: X$_1$ is V or N;

X$_2$ is Y, R or W;

X$_3$ is S, T, N or H;

X$_4$ is S, R, H, W or N;

X$_5$ is N, E, K, Q, H, Y, L or K;

X$_6$ is K or R;

X$_7$ is N, E or D; and

X$_8$ is A or R;

(SEQ ID NO: 333);

(ii) an LCDR2 comprising the amino acid sequence:

X$_1$X$_2$SX$_3$X$_4$EX$_5$

wherein: X$_1$ is W or Y;

X$_2$ is A, S or G;

X$_3$ is T, K or R;

X$_4$ is R or P;

X$_5$ is S, Y, E, N, R, I or H;

(SEQ ID NO: 334); and

(iii) an LCDR3 comprising the amino acid sequence:

CQX$_1$YYX$_2$X$_3$PYTF

wherein: X$_1$ is E, Q or N;

X_2 is S, T, R, Q, K, W or E; and

X_3 is T or D;

(SEQ ID NO: 335).

In an embodiment, the antibody molecule comprises a VH comprising an HCDR1 of a VH described in **Table 1**, an HCDR2 of a VH described in **Table 1**, and an HCDR3 of a VH described in **Table 1**; and/or a VL comprising an LCDR1 of a VL described in **Table 1**, an LCDR2 of a VL described in **Table 1**, and an LCDR3 of a VL described in **Table 1**.

In an embodiment, the HCDR1, HCDR2, and HCDR3 are chosen from the same VH described in **Table 1**. In an embodiment, the LCDR1, LCDR2, and LCDR3 are chosen from the same VL described in **Table 1**. In an embodiment, the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 are chosen from the VH and VL of the same row in **Table 2**.

In an embodiment, the antibody molecule comprises a VH comprising one or more (e.g., 2 or 3) HCDRs described in **Table 1** and/or a VL comprising one or more (e.g., 2 or 3) LCDRs described in **Table 1**.

In an embodiment, the antibody molecule comprises a VH comprising an HCDR1 comprising the amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201, an HCDR2 comprising the amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254, and an HCDR3 comprising the amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306; and a VL comprising an LCDR1 comprising the amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225, an LCDR2 comprising the amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267, and an LCDR3 comprising the amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises a VH comprising one or more (e.g., 2 or 3) HCDRs and/or and a VL comprising one or more (e.g., 2 or 3) LCDRs of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a VH and a VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**.

In an embodiment, the antibody molecule comprises a VL described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VL described in **Table 1 or 2**.

In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and a VL described in **Table 1 or 2**, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH described in **Table 1 or 2** and a VL described in **Table 1 or 2**. In an embodiment, the VH and VL are chosen from the same row in **Table 2**. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence any of SEQ ID NOs: 1-37 or 68-112 and a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

In an embodiment, the antibody molecule comprises the VH and/or the VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30,

mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises the VH and the VL of a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises a monoclonal antibody described in **Table 2**, e.g., mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises an antigen-binding fragment. In an embodiment, the antigen-binding fragment comprises a Fab, F(ab')2, Fv, scFv, or sc(Fv)2.

In an embodiment, the antibody molecule comprises a heavy chain constant region (e.g., one, two, or three of CH1, CH2, or CH3) chosen from the heavy chain constant regions of IgG1, IgG2, IgG3, or IgG4, e.g., a heavy chain constant region described herein (e.g., the amino acid sequence of SEQ ID NO: 319 or 341, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom). In an embodiment, the antibody molecule comprises a light chain constant region (CL) chosen from the light chain constant regions of kappa or lambda, e.g., a light chain constant region described herein (e.g., the amino acid sequence of SEQ ID NO: 320, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom).

In an embodiment, the antibody molecule comprises an Fc region, e.g., an Fc region described herein. In an embodiment, the Fc region comprises a mutation.

In an embodiment, the antibody molecule is a humanized antibody molecule. In an embodiment, the antibody molecule is a monoclonal antibody molecule. In an embodiment, the antibody molecule is a synthetic antibody molecule. In an embodiment, the antibody molecule is an isolated antibody molecule. In an embodiment, the antibody molecule is a monospecific antibody molecule. In an embodiment, the antibody molecule is a multispecific antibody molecule, e.g., bispecific antibody molecule.

In an aspect, the disclosure provides an antibody molecule that competes for binding to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with an antibody molecule described herein.

In an embodiment, the antibody molecule described herein is a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an aspect, the disclosure provides an antibody molecule that binds to the same or overlapping epitope as the epitope recognized by an antibody molecule described herein.

In an embodiment, the antibody molecule described herein is a monoclonal antibody described in **Table 2**, e.g., any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an aspect, the disclosure provides a composition (e.g., pharmaceutical composition) comprising an antibody molecule described herein, and optionally a pharmaceutically acceptable carrier, excipient or stabilizer.

In an aspect, the disclosure provides a formulation comprising an antibody molecule described herein.

In an embodiment, the formulation comprises one or more excipients, e.g., one, two, three, four, or all of a buffer, a salt, a surfactant, a carbohydrate, an amino acid, or an antioxidant. In an embodiment, the buffer comprises acetate, citrate, histidine, succinate, phosphate, or Tris. In an embodiment, the salt comprises sodium. In an embodiment, the surfactant comprises polysorbate 80, polysorbate 20, or poloxamer 188. In an embodiment, the carbohydrate comprises sucrose, mannitol, sorbitol, trehalose, or dextran 40. In an embodiment, the amino acid comprises glycine or arginine. In an embodiment, the antioxidant comprises ascorbic acid, methionine, or ethylenediaminetetraacetic acid (EDTA).

In an embodiment, the antibody molecule is present at a concentration of 1 mg/mL to 300 mg/mL. In an embodiment, the formulation has a pH of 5 to 8.

In an embodiment, the formulation is suitable for intravenous administration. In an embodiment, the formulation is suitable for subcutaneous administration. In an embodiment, the formulation is suitable for intramuscular administration. In an embodiment, the formulation is a liquid formulation. In an embodiment, the formulation is a lyophilized formulation. In an embodiment, the formulation is a reconstituted formulation.

In an aspect, the disclosure provides a kit comprising an antibody molecule described herein, or a composition or formulation described herein, and instructions for use.

In an aspect, the disclosure provides a container comprising an antibody molecule described herein, or a composition or formulation described herein.

In an embodiment, the container is a vial, e.g., a glass vial. In an embodiment, the container is suitable for storage at -20°C ± 5°C, e.g., for at least 3, 6, 9, 12, 15, 18, 21, 24, 30, or 36 months.

In an aspect, the disclosure provides a device (e.g., a syringe) comprising an antibody molecule described herein, or a composition or formulation described herein.

In an embodiment, the device is a pre-filled syringe.

In an aspect, the disclosure provides a nucleic acid encoding the VH, VL, or both, of an antibody molecule described herein.

In an aspect, the disclosure provides a vector (e.g., expression vector) comprising a nucleic acid described herein.

In an aspect, the disclosure provides a cell (e.g., host cell) comprising a nucleic acid described herein or a vector described herein.

In an aspect, the disclosure provides a method of producing an antibody molecule, comprising culturing a cell described herein under conditions that allow expression of the antibody molecule.

In an aspect, the disclosure provides a method of inhibiting a SARS-CoV-2, comprising contacting the SARS-CoV-2 with an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) or formulation described herein.

In an embodiment, the contacting step occurs *in vitro*, *ex vivo*, or *in vivo*. In an embodiment, the method further comprises contacting (e.g., sequentially or simultaneously contacting) the SARS-CoV-2 with a second therapeutic agent or modality. In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides a method of treating or preventing a SARS-CoV-2 infection, comprising administering to a subject in need thereof an effective amount of an antibody

molecule described herein, or a composition (e.g., pharmaceutical composition) or formulation described herein.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly. In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality. In an embodiment, the second therapeutic agent or modality is a second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides a method of treating or preventing COVID-19, or a symptom thereof, comprising administering to a subject in need thereof an effective amount of an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly. In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality. In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the COVID-19 is caused by a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein.

In an aspect, the disclosure provides a method of treating or preventing a disorder associated with a SARS-CoV-2, comprising administering to a subject in need thereof an effective amount of an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is

administered intramuscularly. In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality. In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, for use in a method of treating or preventing a SARS-CoV-2 infection in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly. In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality. In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, for use in a method of treating or preventing COVID-19, or a symptom thereof, in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly.

In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality (e.g., a second therapeutic agent or modality described herein). In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality

is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the COVID-19 is caused by a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, for use in a method of treating or preventing a disorder associated with a SARS-CoV-2 in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly.

In an embodiment, the method further comprises administering to the subject a second therapeutic agent or modality (e.g., a second therapeutic agent or modality described herein). In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides use of an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, in the manufacture of a medicament for treating or preventing a SARS-CoV-2 infection in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly.

In an embodiment, the use further comprises administering to the subject a second therapeutic agent or modality (e.g., a second therapeutic agent or modality described herein). In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an

embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides use of an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, in the manufacture of a medicament for treating or preventing COVID-19, or a symptom thereof, in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly.

In an embodiment, the use further comprises administering to the subject a second therapeutic agent or modality (e.g., a second therapeutic agent or modality described herein). In an embodiment, the second therapeutic agent or modality is second antibody molecule that is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second therapeutic agent or modality is administered prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the COVID-19 is caused by a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides use of an antibody molecule described herein, or a composition (e.g., pharmaceutical composition) described herein, in the manufacture of a medicament for treating or preventing a disorder associated with a SARS-CoV-2 in a subject.

In an embodiment, the antibody molecule is administered intravenously. In an embodiment, the antibody molecule is administered subcutaneously. In an embodiment, the antibody molecule is administered intramuscularly.

In an embodiment, the use further comprises administering to the subject a second therapeutic agent or modality (e.g., a second therapeutic agent or modality described herein). In an embodiment, the second therapeutic agent or modality is an antiviral drug, e.g., nirmatrelvir/ritonavir or molnupiravir, an immune modulator, e.g., anakinra, baricitinib, or tocilizumab, or a second antibody molecule, e.g., bebtelovimab, tixagevimab/cilgavimab, cairivimab/imdevimab, sotrovimab, or bamlanimvib/etsevimab. In an embodiment, the second therapeutic agent or modality is administered

prior to administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered concurrently with administration of the antibody molecule, composition, or formulation. In an embodiment, the second therapeutic agent or modality is administered after administration of the antibody molecule, composition, or formulation. In an embodiment, the SARS-CoV-2 is a SARS-CoV-2 variant, e.g., a SARS-CoV-2 variant described herein, e.g., omicron, e.g., omicron BA.1, BA.2. BA.4/5, BQ1.1 or XBB.

In an aspect, the disclosure provides a method of detecting a SARS-CoV-2, comprising (i) contacting a sample or a subject with an antibody molecule described herein under conditions that allow interaction of the antibody molecule and the SARS-CoV-2 or a spike protein from the SARS-CoV-2 to occur, and (ii) detecting formation of a complex between the antibody molecule and the sample or subject.

BRIEF DESCRIPTION OF THE DRAWINGS

The following detailed description of the embodiments of the disclosure will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the disclosure, there are shown in the drawing embodiments, which are presently exemplified. It should be understood, however, that the disclosure is not limited to the precise arrangement and instrumentalities of the embodiments shown in the drawings.

FIG. 1A is a graph depicting the binding of exemplary class 3 epitope antibodies to omicron BA.1 RBD, as determined using ELISA. Binding of reference antibody-2, mAb1, mAb4, mAb5, mAb10, mAb11, and mAb12 are shown. X -axis: concentration (µg/mL), y-axis: A450 absorbance units.

FIG. 1B is a graph depicting the binding of exemplary class 3 epitope antibodies to omicron BA.1 RBD, as determined using ELISA. Binding of reference antibody-2, mAb2, mAb3, mAb6, mAb7, mAb8, and mAb9 are shown. X -axis: concentration (µg/mL), y-axis: A450 absorbance units.

FIG. 1C is a table depicting the binding values (expressed as EC50 geometric mean; µg/mL) of exemplary class 3 epitope antibodies (reference antibody-2 and mAb1-mAb12) to omicron BA.1 RBD, as determined using ELISA.

FIG. 2A is a graph depicting the binding of exemplary class 4 epitope antibodies to omicron BA.1 RBD, as determined using ELISA. Binding of reference antibody-1, mAb17, mAb22, mAb23, mAb24, mAb33, mAb36, mAb45, mAb50, and mAb53 are shown. X -axis: concentration (µg/mL), y-axis: A450 absorbance units.

FIG. 2B is a graph depicting the binding of exemplary class 4 epitope antibodies to omicron BA.1 RBD, as determined using ELISA. Binding of reference antibody-1, mAb13, mAb14, mAb16, mAb20, mAb26, mAb29, mAb43, mAb48, and mAb49 are shown. X-axis: concentration (µg/mL), y-axis: A450 absorbance units.

FIG. 2C is a table depicting the binding values (expressed as EC50 geometric mean; μg/mL) of exemplary class 4 epitope antibodies (reference antibody-1, mAb13, mAb14, mAb16, mAb17, mAb20, mAb22, mAb23, mAb24, mAb26, mAb29, mAb33, mAb36, mAb43, mAb45, mAb48, mAb49, mAb50, and mAb53) to omicron BA.1 RBD, as determined using ELISA.

DETAILED DESCRIPTION

Disclosed herein are antibody molecules that bind to a SARS-CoV-2 spike protein with desired affinity and specificity. Advantageously, several of the antibody molecules describe herein have improved ability to reduce (e.g., inhibit, block, or neutralize) one or more biological activities of a SARS-CoV-2 spike protein or a fragment thereof. Nucleic acid molecules encoding the antibody molecules, expression vectors, host cells, compositions (e.g., pharmaceutical compositions), formulations, kits, use, and methods for making the antibody molecules, are also provided. The antibody molecules and pharmaceutical compositions disclosed herein can be used alone (or in combination with other agents or therapeutic modalities) to treat, prevent, and/or diagnose disorders and conditions, e.g., disorders and conditions associated with SARS-CoV-2 infection (e.g., COVID-19).

Definitions

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. All publications mentioned herein are incorporated herein by reference in their entirety.

As used herein, the articles "a" and "an" refer to one or to more than one (e.g., to at least one) of the grammatical object of the article.

The term "or" is used herein to mean, and is used interchangeably with, the term "and/or", unless context clearly indicates otherwise.

"About" and "approximately" shall generally mean an acceptable degree of error for the quantity measured given the nature or precision of the measurements. Exemplary degrees of error are within 20 percent (%), typically, within 10%, and more typically, within 5% (e.g., within 4%, 3%, 2%, or 1%) of a given value or range of values.

The terms "polypeptide", "protein" and "amino acid sequence" as used herein generally refer to a polymer of amino acid residues and are not limited to a minimum length of the product. Thus, peptides, oligopeptides, dimers, multimers, and the like, are included within the definition. Both full-length proteins and fragments thereof are encompassed by the definition. Minimum fragments of polypeptides useful in the disclosure can be at least 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15 amino acids. Typically, polypeptides useful in this disclosure can have a maximum length suitable for the

intended application. Generally, the maximum length is not critical and can easily be selected by one skilled in the art.

The compositions and methods disclosed herein encompass polypeptides and nucleic acids having the sequences specified, or sequences substantially identical or similar thereto, e.g., sequences at least 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% identical or higher to the sequence specified.

In the context of an amino acid sequence, the term "substantially identical" is used herein to refer to a first amino acid that contains a sufficient or minimum number of amino acid residues that are a) identical to, or b) conservative substitutions of aligned amino acid residues in a second amino acid sequence such that the first and second amino acid sequences can have a common structural domain and/or common functional activity. For example, amino acid sequences that contain a common structural domain having at least about 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% identity to a reference sequence, e.g., a sequence provided herein.

In the context of nucleotide sequence, the term "substantially identical" is used herein to refer to a first nucleic acid sequence that contains a sufficient or minimum number of nucleotides that are identical to aligned nucleotides in a second nucleic acid sequence such that the first and second nucleotide sequences encode a polypeptide having common functional activity or encode a common structural polypeptide domain or a common functional polypeptide activity. For example, nucleotide sequences having at least about 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% identity to a reference sequence, e.g., a sequence provided herein.

The term "functional variant" refers polypeptides that have a substantially identical amino acid sequence to the naturally occurring sequence, or are encoded by a substantially identical nucleotide sequence, and are capable of having one or more activities of the naturally-occurring sequence.

As used herein, the term "consensus sequence" refers to the sequence formed from the most frequently occurring amino acids (or nucleotides) in a family of related sequences (See e.g., Winnaker, From Genes to Clones (Verlagsgesellschaft, Weinheim, Germany 1987). In a family of proteins, each position in the consensus sequence is occupied by the amino acid occurring most frequently at that position in the family. If two amino acids occur equally frequently, either can be included in the consensus sequence. A "consensus framework" refers to the framework region in the consensus immunoglobulin sequence.

Calculations of homology or sequence identity between sequences (the terms are used interchangeably herein) are performed as follows.

To determine the percent identity of two amino acid sequences, or of two nucleic acid sequences, the sequences are aligned for optimal comparison purposes (e.g., gaps can be introduced in one or both of a first and a second amino acid or nucleic acid sequence for optimal alignment and non-homologous sequences can be disregarded for comparison purposes). In a typical embodiment,

the length of a reference sequence aligned for comparison purposes is at least 30%, e.g., at least 40%, 50%, 60%, 70%, 80%, 90%, or 100% of the length of the reference sequence. The amino acid residues or nucleotides at corresponding amino acid positions or nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding position in the second sequence, then the molecules are identical at that position.

The percent identity between the two sequences is a function of the number of identical positions shared by the sequences, taking into account the number of gaps, and the length of each gap, which need to be introduced for optimal alignment of the two sequences.

The comparison of sequences and determination of percent identity between two sequences can be accomplished using a mathematical algorithm. In an embodiment, the percent identify between two amino acid or nucleotide sequences is determined using Clustal Omega (Sievers *et al. Mol Syst Biol.* 2011; 7:539). In an embodiment, the percent identify between two amino acid or nucleotide sequences is determined using Kalign2 (Lassmann *et al. Nucleic Acids Res.* 2009; 37(3):858-65; Lassmann and Sonnhammer *BMC Bioinformatics.* 2005; 6:298). In an embodiment, the percent identify between two amino acid or nucleotide sequences is determined using MAFFT (Katoh and Standley *Mol Biol Evol.* 2013; 30(4):772-80). In an embodiment, the percent identify between two amino acid or nucleotide sequences is determined using MUSCLE (Edgar *Nucleic Acids Res.* 2004; 32(5):1792-7; Edgar *BMC Bioinformatics.* 2004; 5:113). In an embodiment, the percent identify between two amino acid or nucleotide sequences is determined using MView (Brown *et al. Bioinformatics.* 1998; 14(4): 380-1). Other methods for determining the percent identify between two sequences are also described, e.g., in Li *et al. Nucleic Acids Res.* 2015; 43(W1):W580-4; McWilliam *et al. Nucleic Acids Res.* 2013; 41(Web Server issue):W597-600.

In an embodiment, the percent identity between two amino acid sequences is determined using the Needleman and Wunsch (*J Mol Biol.* 1970; 48(3):443-53) algorithm which has been incorporated into the GAP program in the GCG software package (available at www.gcg.com), using either a Blossum 62 matrix or a PAM250 matrix, and a gap weight of 16, 14, 12, 10, 8, 6, or 4 and a length weight of 1, 2, 3, 4, 5, or 6. In an embodiment, the percent identity between two nucleotide sequences is determined using the GAP program in the GCG software package (available at www.gcg.com), using an NWSgapdna. CMP matrix and a gap weight of 40, 50, 60, 70, or 80 and a length weight of 1, 2, 3, 4, 5, or 6. One suitable set of parameters (and the one that should be used unless otherwise specified) are a Blossum 62 scoring matrix with a gap penalty of 12, a gap extend penalty of 4, and a frameshift gap penalty of 5.

The percent identity between two amino acid or nucleotide sequences can be determined using the algorithm of Meyers and Miller (*Comput Appl Biosci.* 1988; 4(1):11-7) which has been incorporated into the ALIGN program (version 2.0), using a PAM120 weight residue table, a gap length penalty of 12 and a gap penalty of 4.

The nucleic acid and protein sequences described herein can be used as a "query sequence" to perform a search against public databases, for example, to identify other family members or related sequences. Such searches can be performed using the NBLAST and XBLAST programs (version 2.0) of Altschul, *et al.* 1990; *J. Mol. Biol.* 215:403-10. BLAST nucleotide searches can be performed with the NBLAST program, score = 100, wordlength = 12 to obtain nucleotide sequences homologous to a nucleic acid as described herein. BLAST protein searches can be performed with the XBLAST program, score = 50, wordlength = 3 to obtain amino acid sequences homologous to protein molecules described herein. To obtain gapped alignments for comparison purposes, Gapped BLAST can be utilized as described in Altschul *et al.*, *Nucleic Acids Res.* 1997; 25:3389-3402. When utilizing BLAST and gapped BLAST programs, the default parameters of the respective programs (e.g., XBLAST and NBLAST) can be used. See www.ncbi.nlm.nih.gov.

As used herein, the term "hybridizes under low stringency, medium stringency, high stringency, or very high stringency conditions" describes conditions for hybridization and washing. Guidance for performing hybridization reactions can be found in *Current Protocols in Molecular Biology*, John Wiley & Sons, N.Y. (1989), 6.3.1-6.3.6, which is incorporated by reference. Aqueous and nonaqueous methods are described in that reference and either can be used. Specific hybridization conditions referred to herein are as follows: 1) low stringency hybridization conditions in 6X sodium chloride/sodium citrate (SSC) at about 45°C, followed by two washes in 0.2X SSC, 0.1% SDS at least at 50°C (the temperature of the washes can be increased to 55°C for low stringency conditions); 2) medium stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 60°C; 3) high stringency hybridization conditions in 6X SSC at about 45°C, followed by one or more washes in 0.2X SSC, 0.1% SDS at 65°C; and preferably 4) very high stringency hybridization conditions are 0.5M sodium phosphate, 7% SDS at 65°C, followed by one or more washes at 0.2X SSC, 1% SDS at 65°C. Very high stringency conditions 4) are suitable conditions and the ones that should be used unless otherwise specified.

It is understood that the molecules described herein may have additional conservative or non-essential amino acid substitutions, which do not have a substantial effect on their functions.

The term "amino acid" is intended to embrace all molecules, whether natural or synthetic, which include both an amino functionality and an acid functionality and capable of being included in a polymer of naturally occurring amino acids. Exemplary amino acids include naturally occurring amino acids; analogs, derivatives, and congeners thereof; amino acid analogs having variant side chains; and all stereoisomers of any of any of the foregoing. As used herein the term "amino acid" includes both the D- or L- optical isomers and peptidomimetics.

A "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a similar side chain. Families of amino acid residues having similar side chains 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).

The terms "polypeptide," "peptide" and "protein" (if single chain) are used interchangeably herein to refer to polymers of amino acids of any length. The polymer may be linear or branched, it may comprise modified amino acids, and it may be interrupted by non-amino acids. The terms also encompass an amino acid polymer that has been modified, for example, disulfide bond formation, glycosylation, lipidation, acetylation, phosphorylation, or any other manipulation, such as conjugation with a labeling component. The polypeptide can be isolated from natural sources, can be a produced by recombinant techniques from a eukaryotic or prokaryotic host, or can be a product of synthetic procedures.

The terms "nucleic acid," "nucleic acid sequence," "nucleotide sequence," or "polynucleotide sequence," and "polynucleotide" are used interchangeably. They refer to a polymeric form of nucleotides of any length, either deoxyribonucleotides or ribonucleotides, or analogs thereof. The polynucleotide may be either single-stranded or double-stranded, and if single-stranded may be the coding strand or non-coding (antisense) strand. A polynucleotide may comprise modified nucleotides, such as methylated nucleotides and nucleotide analogs. The sequence of nucleotides may be interrupted by non-nucleotide components. A polynucleotide may be further modified after polymerization, such as by conjugation with a labeling component. The nucleic acid may be a recombinant polynucleotide, or a polynucleotide of genomic, cDNA, semisynthetic, or synthetic origin which either does not occur in nature or is linked to another polynucleotide in a non-natural arrangement.

The term "isolated," as used herein, refers to material that is removed from its original or native environment (e.g., the natural environment if it is naturally occurring). For example, a naturally occurring polynucleotide or polypeptide present in a living animal is not isolated, but the same polynucleotide or polypeptide, separated by human intervention from some or all of the co-existing materials in the natural system, is isolated. Such polynucleotides could be part of a vector and/or such polynucleotides or polypeptides could be part of a composition, and still be isolated in that such vector or composition is not part of the environment in which it is found in nature.

As used herein, the term "treat", e.g., a disorder or infection, means that a subject (e.g., a human) who has a disorder, and/or experiences a symptom of a disorder or infection, will, in an embodiment, suffer less a severe symptom and/or recover faster when an antibody molecule is administered than if the antibody molecule were never administered. In an embodiment, when a SARS-CoV-2-associated disorder or SARS-CoV-2 infection is treated, the level of SARS-CoV-2 may be lower in a treated subject compared to a comparable untreated subject. For example, a diagnostic

assay using PCR or antigen test will detect a SARS-CoV-2 nucleic acid or protein in a biological sample of a subject after administration of an antibody molecule described herein for the effective treatment of the disorder or infection. Various assays can also be used to monitor treatment in a patient, or to detect the presence, e.g., decreased presence (or absence), of a symptom of the disorder or infection, after treatment of the disorder in the subject. Treatment can, e.g., partially or completely, alleviate, ameliorate, relieve, inhibit, or reduce the severity of, and/or reduce incidence, and optionally, delay onset of, one or more manifestations of the effects or symptoms, features, and/or causes of a disorder or infection. In an embodiment, treatment is of a subject who does not exhibit certain signs of a disorder or infection, and/or of a subject who exhibits only early signs of a disorder or infection. In an embodiment, treatment is of a subject who exhibits one or more established signs of a disorder or infection. In an embodiment, treatment is of a subject diagnosed as suffering from a disorder or infection. In an embodiment, the disorder is a SARS-CoV-2 infection or COVID-19.

As used herein, the term "prevent," a disorder, e.g., a complement-associated disorder, means that a subject (e.g., a human) is less likely to have the disorder or infection, if the subject receives the antibody molecule. In an embodiment, the subject is at risk of developing the disorder or infection. In an embodiment, the disorder is a SARS-CoV-2 infection or COVID-19.

As used herein, the term "effective amount" of an antibody molecule refers to a quantity sufficient to, when administered to a subject, including a mammal (e.g., a human), effect beneficial or desired results, including effects at the cellular level, tissue level, or clinical results, and, as such, an "effective amount" or synonym thereto depends upon the context in which it is being applied. For example, in the context of treating an infection it is an amount of the antibody molecule sufficient to achieve a treatment response (e.g., reduction of viral load) as compared to the response obtained without administration of the antibody molecule. The amount of a given antibody molecule described herein that will correspond to such an amount will vary depending upon various factors, such as the given agent, the pharmaceutical formulation, the route of administration, the type of disease or disorder, the identity of the subject (e.g., age, sex, weight) or host being treated, and the like, but can nevertheless be routinely determined by one skilled in the art. Dosage regimen may be adjusted to provide the optimum therapeutic response.

As used herein, the term "epitope" refers to moieties of an antigen that specifically interact with an antibody molecule. Such moieties, also referred to herein as epitopic determinants, typically comprise, or are part of, elements such as amino acid side chains or sugar side chains. An epitopic determinant can be defined by methods known in the art or disclosed herein, e.g., by crystallography or by hydrogen-deuterium exchange. At least one or some of the moieties on the antibody molecule that specifically interact with an epitopic determinant are typically located in a CDR(s). An epitope can have specific three-dimensional structural characteristics and/or specific charge characteristics. Some epitopes are linear epitopes while others are conformational epitopes.

Various aspects of the compositions and methods herein are described in further detail below. Additional definitions are set out throughout the specification.

SARS-Cov-2

SARS-CoV-2 is a single-stranded RNA-enveloped virus belonging to coronavirus family. The term "SARS-Cov-2" as used herein encompasses, e.g., naturally occurring (e.g. wild-type) SARS-CoV-2; naturally occurring SARS-CoV-2 variants (e.g., omicron, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB); and SARS-CoV-2 variants generated in the laboratory, e.g., variants generated by selection, variants generated by chemical modification, and genetically modified variants (e.g., SARS-CoV-2 modified in a laboratory by recombinant DNA methods).

SARS-CoV-2 has a genome size of about 30 kilobases, encoding about 9860 amino acids. Coronavirus genome encodes for multiple structural and non-structural proteins. The structural proteins include the spike (S) protein, the envelope (E) protein, the membrane (M) protein, and the nucleocapsid (N) protein. Without wising to be bound by theory, it is believed that S proteins are typically needed for interaction with the host cells. The spike protein is encoded by S gene and comprises an extracellular N-terminus, a transmembrane (TM) domain anchored in the viral membrane, and an intracellular C-terminal segment. The SARS-CoV-2 spike protein comprises a S1 subunit and a S2 subunit. The total length of SARS-CoV-2 spike protein is about 1273 amino acids and comprises a signal peptide (amino acids 1–13) located at the N-terminus, the S1 subunit (14–685 residues), and the S2 subunit (686–1273 residues. The S1 subunit comprises an N-terminal domain (14–305 residues) and a receptor-binding domain (RBD, 319–541 residues). The S2 subunit comprises the fusion peptide (FP) (788–806 residues), heptapeptide repeat sequence 1 (HR1) (912–984 residues), HR2 (1163–1213 residues), TM domain (1213–1237 residues), and cytoplasm domain (1237–1273 residues).

S1 proteins are important components in terms of infection. They possess two major domains named N-terminal domain (S1-NTD) and C-terminal domain (S1-CTD), both of which serve as the receptor-binding domains. S1-CTDs are responsible for recognizing different protein receptors such as angiotensin-converting enzyme 2 (ACE2), aminopeptidase N (APN), and dipeptidyl peptidase 4 (DPP4).

The amino acid sequence of an exemplary SARS-CoV-2 spike protein (NCBI Accession Number YP_009724390, encoded by the nucleic acid sequence according to NC_045512.2) is provided as follows:

MFVFLVLLPLVSSQCVNLTTRTQLPPAYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAI
HVSGTNGTKRFDNPVLPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFC
NDPFLGVYYHKNNKSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIY
SKHTPINLVRDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQP
RTFLLKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFGE

VFNATRFASVYAWNRKRISNCVADYSVLYNSASFSTFKCYGVSPTKLNDLCFTNVYADSFVIRGDEVR
QIAPGQTGKIADYNYKLPDDFTGCVIAWNSNNLDSKVGGNYNYLYRLFRKSNLKPFERDISTEIYQAG
STPCNGVEGFNCYFPLQSYGFQPTNGVGYQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFN
GLTGTGVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLY
QDVNCTEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEHVNNSYECDIPIGAGICASYQTQTNS
PRRARSVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTE
CSNLLLQYGSFCTQLNRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKDFGGFNFSQILPDPSKPSKRS
FIEDLLFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTDEMIAQYTSALLAGTITS
GWTFGAGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVV
NQNAQALNTLVKQLSSNFGAISSVLNDILSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRA
SANLAATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAH
FPREGVFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYF
KNHTSPDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGL
IAIVMVTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 321)

The amino acid sequence of an exemplary SARS-CoV-2 spike protein of a SARS-CoV-2 variant (e.g., omicron BA.1) is provided as follows:

MFVFLVLLPLVSSQCVNLTTRTQLPPAYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHVI
SGTNGTKRFDNPVLPFNDGVYFASIEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCND
PFLDHKNNKSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKHTP
IIVREPEDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQPRTF
LLKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFDEVFN
ATRFASVYAWNRKRISNCVADYSVLYNLAPFFTFKCYGVSPTKLNDLCFTNVYADSFVIRGDEVRQIA
PGQTGNIADYNYKLPDDFTGCVIAWNSNKLDSKVSGNYNYLYRLFRKSNLKPFERDISTEIYQAGNKP
CNGVAGFNCYFPLRSYSFRPTYGVGHQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLK
GTGVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQGV
NCTEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEYVNNSYECDIPIGAGICASYQTQTKSHRR
ARSVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTECSN
LLLQYGSFCTQLKRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKYFGGFNFSQILPDPSKPSKRSFIE
DLLFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFKGLTVLPPLLTDEMIAQYTSALLAGTITSGWT
FGAGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVVNHN
AQALNTLVKQLSSKFGAISSVLNDIFSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASAN
LAATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAHFPR
EGVFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNH
TSPDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGLIAI
VMVTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 336)

The amino acid sequence of an exemplary SARS-CoV-2 spike protein of a SARS-CoV-2 variant (e.g., omicron BA.2) is provided as follows:

MFVFLVLLPLVSSQCVNLITRTQSYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAIHVS
GTNGTKRFDNPVLPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCNDP
FLDVYYHKNNKSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKH
TPINLGRDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQPRTF
LLKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFDEVFN
ATRFASVYAWNRKRISNCVADYSVLYNFAPFFAFKCYGVSPTKLNDLCFTNVYADSFVIRGNEVSQIA
PGQTGNIADYNYKLPDDFTGCVIAWNSNKLDSKVGGNYNYLYRLFRKSNLKPFERDISTEIYQAGNKP
CNGVAGFNCYFPLRSYGFRPTYGVGHQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLT
GTGVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQGV
NCTEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEYVNNSYECDIPIGAGICASYQTQTKSHRR
ARSVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTECSN
LLLQYGSFCTQLKRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKYFGGFNFSQILPDPSKPSKRSFIE
DLLFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTDEMIAQYTSALLAGTITSGWT
FGAGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVVNHN
AQALNTLVKQLSSKFGAISSVLNDILSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASAN
LAATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAHFPR
EGVFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNH
TSPDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGLIAI
VMVTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 337)

The amino acid sequence of an exemplary SARS-CoV-2 spike protein of a SARS-CoV-2 variant (e.g., omicron BA.4) is provided as follows:

MFVFLVLLPLVSSQCVNLITRTQSYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAISGT
NGIKRFDNPVLPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCNDPFL
DVYYHKNNKSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKHTP
INLGRDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQPRTFLL
KYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFDEVFNAT
RFASVYAWNRKRISNCVADYSVLYNFAPFFAFKCYGVSPTKLNDLCFTNVYADSFVIRGNEVSQIAPG
QTGNIADYNYKLPDDFTGCVIAWNSNKLDSKVGGNYNYRYRLFRKSNLKPFERDISTEIYQAGNKPCN
GVAGVNCYFPLQSYGFRPTYGVGHQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLTGT
GVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQGVNC
TEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEYVNSSYECDIPIGAGICASYQTQTKSHRRAR
SVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTECSNLL
LQYGSFCTQLKRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKYFGGFNFSQILPDPSKPSKRSFIEDL
LFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTDEMIAQYTSALLAGTITSGWTFG

AGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVVNHNAQ
ALNTLVKQLSSKFGAISSVLNDILSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASANLA
ATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAHFPREG
VFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNHTS
PDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGLIAIVM
VTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 338)

The amino acid sequence of an exemplary SARS-CoV-2 spike protein of a SARS-CoV-2 variant (e.g., omicron BQ1.1) is provided as follows:

MFVFLVLLPLVSSQCVNLITRTQSYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAISGT
NGTKRFDNPVLPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCNDPFL
DVYYHKNNKSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKHTP
INLGRDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQPRTFLL
KYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFDEVFNAT
TFASVYAWNRKRISNCVADYSVLYNFAPFFAFKCYGVSPTKLNDLCFTNVYADSFVIRGNEVSQIAPG
QTGNIADYNYKLPDDFTGCVIAWNSNKLDSTVGGNYNYRYRLFRKSKLKPFERDISTEIYQAGNKPCN
GVAGVNCYFPLQSYGFRPTYGVGHQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLTGT
GVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQGVNC
TEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEYVNNSYECDIPIGAGICASYQTQTKSHRRAR
SVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTECSNLL
LQYGSFCTQLKRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKYFGGFNFSQILPDPSKPSKRSFIEDL
LFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTDEMIAQYTSALLAGTITSGWTFG
AGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVVNHNAQ
ALNTLVKQLSSKFGAISSVLNDILSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASANLA
ATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAHFPREG
VFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNHTS
PDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGLIAIVM
VTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 339)

The amino acid sequence of an exemplary SARS-CoV-2 spike protein of a SARS-CoV-2 variant (e.g., omicron XBB.1) is provided as follows:

MFVFLVLLPLVSSQCVNLITRTQSYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAIHVS
GTNGTKRFDNPALPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCNDP
FLDVYQKNNKSWMESEFRVYSSANNCTFEYVSQPFFMDLEGKEGNFKNLREFVFKNIDGYFKIYSKHT
PINLERDLPQGFSALEPLVDLPIGINITRFQTLLALHRSYLTPVDSSSGWTAGAAAYYVGYLQPRTFL
LKYNENGTITDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFHEVFNA
TTFASVYAWNRKRISNCVADYSVIYNFAPFFAFKCYGVSPTKLNDLCFTNVYADSFVIRGNEVSQIAP

GQTGNIADYNYKLPDDFTGCVIAWNSNKLDSKPSGNYNYLYRLFRKSKLKPFERDISTEIYQAGNKPC
NGVAGSNCYSPLQSYGFRPTYGVGHQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLTG
TGVLTESNKKFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQGVN
CTEVPVAIHADQLTPTWRVYSTGSNVFQTRAGCLIGAEYVNNSYECDIPIGAGICASYQTQTKSHRRA
RSVASQSIIAYTMSLGAENSVAYSNNSIAIPTNFTISVTTEILPVSMTKTSVDCTMYICGDSTECSNL
LLQYGSFCTQLKRALTGIAVEQDKNTQEVFAQVKQIYKTPPIKYFGGFNFSQILPDPSKPSKRSFIED
LLFNKVTLADAGFIKQYGDCLGDIAARDLICAQKFNGLTVLPPLLTDEMIAQYTSALLAGTITSGWTF
GAGAALQIPFAMQMAYRFNGIGVTQNVLYENQKLIANQFNSAIGKIQDSLSSTASALGKLQDVVNHNA
QALNTLVKQLSSKFGAISSVLNDILSRLDKVEAEVQIDRLITGRLQSLQTYVTQQLIRAAEIRASANL
AATKMSECVLGQSKRVDFCGKGYHLMSFPQSAPHGVVFLHVTYVPAQEKNFTTAPAICHDGKAHFPRE
GVFVSNGTHWFVTQRNFYEPQIITTDNTFVSGNCDVVIGIVNNTVYDPLQPELDSFKEELDKYFKNHT
SPDVDLGDISGINASVVNIQKEIDRLNEVAKNLNESLIDLQELGKYEQYIKWPWYIWLGFIAGLIAIV
MVTIMLCCMTSCCSCLKGCCSCGSCCKFDEDDSEPVLKGVKLHYT (SEQ ID NO: 340)

In an embodiment, an antibody molecule described herein binds to a SARS-CoV-2 spike protein comprising the amino acid sequence of SEQ ID NOs: 321 or 336-340, or a functional fragment thereof, or an amino acid sequence having at least 85, 90, 95, 99, or 100% identity thereto, or differing by no more than 1, 5, 10, 25, 50, 100, 150, or 150 amino acids therefrom.

The amino acid sequence of the S1 subunit of an exemplary SARS-CoV-2 spike protein is provided as follows:

QCVNLTTRTQLPPAYTNSFTRGVYYPDKVFRSSVLHSTQDLFLPFFSNVTWFHAIHVSGTNGTKRFDN
PVLPFNDGVYFASTEKSNIIRGWIFGTTLDSKTQSLLIVNNATNVVIKVCEFQFCNDPFLGVYYHKNN
KSWMESEFRVYSSANNCTFEYVSQPFLMDLEGKQGNFKNLREFVFKNIDGYFKIYSKHTPINLVRDLP
QGFSALEPLVDLPIGINITRFQTLLALHRSYLTPGDSSSGWTAGAAAYYVGYLQPRTFLLKYNENGTI
TDAVDCALDPLSETKCTLKSFTVEKGIYQTSNFRVQPTESIVRFPNITNLCPFGEVFNATRFASVYAW
NRKRISNCVADYSVLYNSASFSTFKCYGVSPTKLNDLCFTNVYADSFVIRGDEVRQIAPGQTGKIADY
NYKLPDDFTGCVIAWNSNNLDSKVGGNYNYLYRLFRKSNLKPFERDISTEIYQAGSTPCNGVEGFNCY
FPLQSYGFQPTNGVGYQPYRVVVLSFELLHAPATVCGPKKSTNLVKNKCVNFNFNGLTGTGVLTESNK
KFLPFQQFGRDIADTTDAVRDPQTLEILDITPCSFGGVSVITPGTNTSNQVAVLYQDVNCTEVPVAIH
ADQLTPTWRVYSTGSNVFQTRAGCLIGAEHVNNSYECDIPIGAGICASYQTQTNSPRRAR (SEQ ID NO: 322)

In an embodiment, an antibody molecule described herein binds to the S1 subunit of a SARS-CoV-2 spike protein comprising the amino acid sequence of SEQ ID NOs: 322, or an amino acid sequence having at least 85, 90, 95, 99, or 100% identity thereto, or differing by no more than 1, 5, 10, 25, 50, 75, or 100 amino acids therefrom.

The amino acid sequence of the RBD domain of an exemplary SARS-CoV-2 spike protein is provided as follows:

RVQPTESIVRFPNITNLCPFGEVFNATRFASVYAWNRKRISNCVADYSVLYNSASFSTFKCYGVSPTK
LNDLCFTNVYADSFVIRGDEVRQIAPGQTGKIADYNYKLPDDFTGCVIAWNSNNLDSKVGGNYNYLYR
LFRKSNLKPFERDISTEIYQAGSTPCNGVEGFNCYFPLQSYGFQPTNGVGYQPYRVVVLSFELLHAPA
TVCGPKKSTNLVKNKCVNF (SEQ ID NO: 323)

In an embodiment, an antibody molecule described herein binds to the RBD of a SARS-CoV-2 spike protein comprising the amino acid sequence of SEQ ID NOs: 323, or an amino acid sequence having at least 85, 90, 95, 99, or 100% identity thereto, or differing by no more than 1, 5, 10, 25, or 50 amino acids therefrom.

Variants

SARS-CoV-2 variants comprising one or more mutations in the spike protein may show one or more of following characteristics compared to the parental strain; increased transmission, reduced neutralization, decreased neutralization by antibodies generated during previous infection or vaccination, reduced vaccine-induced protection from severe disease, increased disease severity, or increased failure of diagnostics.

The antibody molecules described herein can bind to one or more SARS-CoV-2 variants with high affinity. The antibody molecules described herein can be used to treat or prevent an infection caused by a SARS-CoV-2 variant or a disorder associated with a SARS-CoV-2 variant, e.g., COVID-19.

Exemplary SARS-CoV-2 variants include, but are not limited to, variants alpha (B.1.1.7, UK variant), beta (B.1.351, B.1.351.2, B.1.351.3, South Africa variant), gamma (P.1, P.1.1, P.1.2, Brazil variant), delta (B.1.617.2, AY.1, AY.2, AY.3, India variant), eta (B.1.525), iota (B.1.526), kappa (B.1.617.1), lambda (C.37), epsilon (B.1.427, B.1.429), and omicron (B.1.1.529, BA.1, BA1.1, BA.2, BA.3, BA.4, BA.5, BA4/5, BQ1.1, XBB). Other exemplary SARS-CoV-2 variants include, e.g., EU1 strain, 21H strain, 20B/S:732A, 20B/S: 126A, 20A. EU2, 20A/S:439K, 20A/S:98F, 20C/S: 80Y, 20B/S:626S, and 20B/S:1122L.

In an embodiment, the SARS-CoV-2 variant comprises a mutation in the spike protein. In an embodiment, the SARS-CoV-2 spike protein comprises 2 or more (e.g., 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more) mutations, e.g., mutations described herein. In an embodiment, the mutation is a substitution. In an embodiment, the mutation is a deletion.

Exemplary SARS-CoV-2 spike protein mutations include, but are not limited to, A67V, Δ69, Δ70, T95I, G142D, Δ143-145, N211I, Δ212, R214ins, G339D, S371L, S373P, S375F, K417N, N440K, G446S, S477N, T478K, E484A, Q493R, G496S, Q498R, N501Y, Y505H, T547K, D614G, H655Y, N679K, P681H, N764K, D796Y, N856K, Q954H, N969K, L981F, or a combination thereof. Exemplary variants of SARS-CoV-2 and mutations in the spike protein of a SARS-CoV-2 or a SARS-CoV-2 variant are described in www.who.int/activities/tracking-SARS-CoV-2-variants, incorporated herein by reference in its entirety.

Epitope

The antibody molecule described herein can bind to an epitope on a SARS-CoV-2. For example, an epitope bound by an antibody molecule described herein can include one or more epitope contact points in a SARS-CoV-2 spike protein sequence, or a fragment thereof (e.g., a fragment comprising an RBD), as described herein. In an embodiment, the epitope is a conserved epitope.

Antibody molecules

Disclosed herein are antibody molecules that bind to a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein described herein, or a spike protein of a SARS-CoV-2 variant, e.g., a spike protein of a SARS-CoV-2 variant described herein, e.g., a spike protein of a SARS-CoV-2 omicron variant described herein, e.g., a spike protein of a SARS-CoV-2 omicron variant BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

As used herein, the term "antibody molecule" refers to a protein, e.g., an immunoglobulin chain or a fragment thereof, comprising at least one immunoglobulin variable domain sequence. The term "antibody molecule" includes, for example, a full-length antibody and an antigen-binding fragment of an antibody.

For example, an antibody molecule can include a heavy (H) chain variable domain sequence (abbreviated herein as VH), and a light (L) chain variable domain sequence (abbreviated herein as VL). In another example, an antibody molecule includes two heavy (H) chain variable domain sequences and two light (L) chain variable domain sequence, thereby forming two antigen binding sites, such as Fab, Fab', F(ab')2, Fc, Fd, Fd', Fv, single chain antibodies (scFv or sc(Fv)2, for example), single variable domain antibodies, diabodies (Dab) (bivalent and bispecific), and chimeric (e.g., humanized) antibodies, which may be produced by the modification of whole antibodies or those synthesized *de novo* using recombinant DNA technologies. These functional antibody fragments retain the ability to selectively bind with their respective antigen or receptor. Antibodies and antibody fragments can be from any class of antibodies including, but not limited to, IgG, IgA, IgM, IgD, and IgE, and from any subclass (e.g., IgG1, IgG2, IgG3, and IgG4) of antibodies. The antibody molecules can be monoclonal or polyclonal. In embodiments, the antibody molecule is a whole IgG antibody. The antibody molecule can also be a human, humanized, CDR-grafted, or *in vitro* generated antibody. The antibody molecule can have a heavy chain constant region chosen from, e.g., IgG1, IgG2, IgG3, IgG4, or a chimera of two or more isotypes. The antibody molecule can also have a light chain chosen from, e.g., kappa or lambda. The term "immunoglobulin" (Ig) is used interchangeably with the term "antibody" herein. In embodiments, the antibody molecule is a multispecific antibody molecule (e.g., a bispecific antibody molecule).

Examples of antigen-binding fragments include: (i) a Fab fragment, a monovalent fragment consisting of the VL, VH, CL and CH1 domains; (ii) a F(ab')2 fragment, a bivalent fragment

comprising two Fab fragments linked by a disulfide bridge at the hinge region; (iii) a Fd fragment consisting of the VH and CH1 domains; (iv) a Fv fragment consisting of the VL and VH domains of a single arm of an antibody, (v) a diabody (dAb) fragment, which consists of a VH domain; (vi) a camelid or camelized variable domain; (vii) a single chain Fv (scFv), see e.g., Bird *et al.* (1988) *Science* 242:423-426; and Huston *et al.* (1988) *Proc. Natl. Acad. Sci. USA* 85:5879-5883); (viii) a single domain antibody. These antibody fragments may be obtained using any suitable method, including several conventional techniques known to those with skill in the art, and the fragments can be screened for utility in the same manner as are intact antibodies.

The term "antibody" includes intact molecules as well as functional fragments thereof. Constant regions of the antibodies can be altered, e.g., mutated, to modify the properties of the antibody (e.g., to increase or decrease one or more of: Fc receptor binding, antibody glycosylation, the number of cysteine residues, effector cell function, or complement function).

In an embodiment, the antibody molecule is a single chain antibody. A single-chain antibody (scFv) may be engineered (*see*, for example, Colcher, D. *et al.* (1999) *Ann N Y Acad Sci* 880:263-80; and Reiter, Y. (1996) *Clin Cancer Res* 2:245-52). The single chain antibody can be dimerized or multimerized to generate multivalent antibodies having specificities for different epitopes of the same target protein.

In an embodiment, the antibody molecule is a single domain antibody. Single domain antibodies can include antibodies whose complementary determining regions are part of a single domain polypeptide. Examples include, but are not limited to, heavy chain antibodies, antibodies naturally devoid of light chains, single domain antibodies derived from conventional 4-chain antibodies, engineered antibodies and single domain scaffolds other than those derived from antibodies. Single domain antibodies may be any of the art, or any future single domain antibodies. Single domain antibodies may be derived from any species including, but not limited to mouse, human, camel, llama, fish, shark, goat, rabbit, and bovine. In an embodiment, a single domain antibody is a naturally occurring single domain antibody known as heavy chain antibody devoid of light chains. Such single domain antibodies are disclosed in WO 94/04678, for example. For clarity reasons, this variable domain derived from a heavy chain antibody naturally devoid of light chain is known herein as a VHH or nanobody to distinguish it from the conventional VH of four chain immunoglobulins. Such a VHH molecule can be derived from antibodies raised in *Camelidae* species, for example in camel, llama, dromedary, alpaca and guanaco. Other species besides *Camelidae* may produce heavy chain antibodies naturally devoid of light chain; such VHHs are also within the scope of the disclosure.

The VH and VL regions can be subdivided into regions of hypervariability, termed "complementarity determining regions" (CDR), interspersed with regions that are more conserved, termed "framework regions" (FR or FW). The terms "complementarity determining region," and "CDR," as used herein refer to the sequences of amino acids within antibody variable regions which

confer antigen specificity and binding affinity. In general, there are three CDRs in each heavy chain variable region (HCDR1, HCDR2, HCDR3) and three CDRs in each light chain variable region (LCDR1, LCDR2, LCDR3). As used herein, the terms "framework," "FW" and "FR" are used interchangeably.

The extent of the framework region and CDRs has been precisely defined by a number of methods (*see*, Kabat, E. A., *et al.* (1991) Sequences of Proteins of Immunological Interest, Fifth Edition, U.S. Department of Health and Human Services, NIH Publication No. 91-3242 ("Kabat" numbering scheme); Chothia, C. *et al.* (1987) *J. Mol. Biol.* 196:901-917 ("Chothia" numbering scheme); and the AbM definition used by Oxford Molecular's AbM antibody modeling software. *See*, generally, e.g., Protein Sequence and Structure Analysis of Antibody Variable Domains. In: Antibody Engineering Lab Manual (Ed.: Duebel, S. and Kontermann, R., Springer-Verlag, Heidelberg). As used herein, the CDRs defined according the "Chothia" number scheme are also sometimes referred to as "hypervariable loops." Under all definitions, each VH and VL typically includes three CDRs and four FRs, arranged from amino-terminus to carboxy-terminus in the following order: FR1, CDR1, FR2, CDR2, FR3, CDR3, FR4.

For example, under Kabat, the CDR amino acid residues in the heavy chain variable domain (VH) are numbered 31-35 (HCDR1), 50-65 (HCDR2), and 95-102 (HCDR3); and the CDR amino acid residues in the light chain variable domain (VL) are numbered 24-34 (LCDR1), 50-56 (LCDR2), and 89-97 (LCDR3). Under Chothia the CDR amino acids in the VH are numbered 26-32 (HCDR1), 52-56 (HCDR2), and 95-102 (HCDR3); and the amino acid residues in VL are numbered 26-32 (LCDR1), 50-52 (LCDR2), and 91-96 (LCDR3). By combining the CDR definitions of both Kabat and Chothia, the CDRs consist of amino acid residues 26-35 (HCDR1), 50-65 (HCDR2), and 95-102 (HCDR3) in human VH and amino acid residues 24-34 (LCDR1), 50-56 (LCDR2), and 89-97 (LCDR3) in human VL. Typically, antibody molecules can include any combination of one or more Kabat CDRs and/or Chothia hypervariable loops.

In an embodiment, the CDRs of the antibody molecules described herein are defined according to **Table 1** (e.g., as described in North et al. J Mol Biol. 2011 Feb 18;406(2):228-56, which is incorporated by reference in its entirety).

As used herein, an "immunoglobulin variable domain sequence" refers to an amino acid sequence which can form the structure of an immunoglobulin variable domain. For example, the sequence may include all or part of the amino acid sequence of a naturally-occurring variable domain. For example, the sequence may or may not include one, two, or more N- or C-terminal amino acids, or may include other alterations that are compatible with formation of the protein structure.

The term "antigen-binding region" refers to the part of an antibody molecule that comprises determinants that form an interface that binds to an antigen, e.g., a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein described herein, or an epitope thereof. With respect to proteins (or protein mimetics), the antigen-binding region typically includes one or more loops (of at least, e.g.,

four amino acids or amino acid mimics) that form an interface that binds to the antigen, e.g., a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein described herein. Typically, the antigen-binding region of an antibody molecule includes at least one or two CDRs and/or hypervariable loops, or more typically at least three, four, five or six CDRs and/or hypervariable loops.

The terms "compete" or "cross-compete" are used interchangeably herein to refer to the ability of an antibody molecule to interfere with binding of an anti-spike antibody molecule, e.g., an anti-spike antibody molecule provided herein, to a target, e.g., a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein described herein. The interference with binding can be direct or indirect (e.g., through an allosteric modulation of the antibody molecule or the target). The extent to which an antibody molecule is able to interfere with the binding of another antibody molecule to the target, and therefore whether it can be said to compete, can be determined using a competition binding assay, for example, a FACS assay, an ELISA, or a BIACORE assay. In an embodiment, a competition binding assay is a quantitative competition assay. In an embodiment, a first anti-spike antibody molecule is said to compete for binding to the target with a second anti-spike antibody molecule when the binding of the first antibody molecule to the target is reduced by 10% or more, e.g., 20% or more, 30% or more, 40% or more, 50% or more, 55% or more, 60% or more, 65% or more, 70% or more, 75% or more, 80% or more, 85% or more, 90% or more, 95% or more, 98% or more, 99% or more in a competition binding assay.

The terms "monoclonal antibody" or "monoclonal antibody composition" as used herein refer to a preparation of antibody molecules of single molecular composition. A monoclonal antibody composition displays a single binding specificity and affinity for a particular epitope. A monoclonal antibody can be made by hybridoma technology or by methods that do not use hybridoma technology (e.g., recombinant methods).

An "effectively human" protein is a protein that does not evoke a neutralizing antibody response, e.g., the human anti-murine antibody (HAMA) response. HAMA can be problematic in a number of circumstances, e.g., if the antibody molecule is administered repeatedly, e.g., in treatment of a chronic or recurrent disease condition. A HAMA response can make repeated antibody administration potentially ineffective because of an increased antibody clearance from the serum and potential allergic reactions (*see*, e.g., Saleh *et al.*, *Cancer Immunol. Immunother.*, 32:180-190 (1990); LoBuglio *et al.*, *Hybridoma*, 5:5117-5123 (1986)).

The antibody molecule can be a polyclonal or a monoclonal antibody. In an embodiment, the antibody can be recombinantly produced, e.g., produced by any suitable phage display or combinatorial methods.

Various phage display and combinatorial methods for generating antibodies are known in the art (as described in, e.g., Ladner *et al.* U.S. Patent No. 5,223,409; Kang *et al.* International Publication No. WO 92/18619; Dower *et al.* International Publication No. WO 91/17271; Winter *et al.* International Publication WO 92/20791; Markland *et al.* International Publication No. WO 92/15679;

Breitling *et al.* International Publication WO 93/01288; McCafferty *et al.* International Publication No. WO 92/01047; Garrard *et al.* International Publication No. WO 92/09690; Ladner *et al.* International Publication No. WO 90/02809; Fuchs *et al.* (1991) *Bio/Technology* 9:1370-1372; Hay *et al.* (1992) *Hum Antibod Hybridomas* 3:81-85; Huse *et al.* (1989) *Science* 246:1275-1281; Griffths *et al.* (1993) *EMBO J* 12:725-734; Hawkins *et al.* (1992) *J Mol Biol* 226:889-896; Clackson *et al.* (1991) *Nature* 352:624-628; Gram *et al.* (1992) *PNAS* 89:3576-3580; Garrad *et al.* (1991) *Bio/Technology* 9:1373-1377; Hoogenboom *et al.* (1991) *Nuc Acid Res* 19:4133-4137; and Barbas *et al.* (1991) *PNAS* 88:7978-7982, the contents of all of which are incorporated by reference herein).

In an embodiment, the antibody molecule is a fully human antibody (e.g., an antibody made in a mouse which has been genetically engineered to produce an antibody from a human immunoglobulin sequence), or a non-human antibody, e.g., a rodent (e.g., mouse or rat), goat, primate (e.g., monkey), camel antibody. In an embodiment, the non-human antibody is a rodent (e.g., mouse or rat antibody). Methods of producing rodent antibodies are known in the art.

Human monoclonal antibodies can be generated using transgenic mice carrying the human immunoglobulin genes rather than the mouse system. Splenocytes from these transgenic mice immunized with the antigen of interest are used to produce hybridomas that secrete human mAbs with specific affinities for epitopes from a human protein (*see e.g.*, Wood *et al.* International Application WO 91/00906, Kucherlapati *et al.* PCT publication WO 91/10741; Lonberg *et al.* International Application WO 92/03918; Kay et al. International Application 92/03917; Lonberg, N. *et al.* 1994 *Nature* 368:856-859; Green, L.L. et al. 1994 *Nature Genet.* 7:13-21; Morrison, S.L. *et al.* 1994 *Proc. Natl. Acad. Sci. USA* 81:6851-6855; Bruggeman *et al.* 1993 *Year Immunol* 7:33-40; Tuaillon *et al.* 1993 *PNAS* 90:3720-3724; Bruggeman *et al.* 1991 *Eur J Immunol* 21:1323-1326).

An antibody can be one in which the variable region, or a portion thereof, e.g., the CDRs, are generated in a non-human organism, *e.g.*, a rat or mouse. Chimeric, CDR-grafted, and humanized antibodies are within the disclosure. Antibodies generated in a non-human organism, e.g., a rat or mouse, and then modified, e.g., in the variable framework or constant region, to decrease antigenicity in a human are within the disclosure.

Chimeric antibodies can be produced by any suitable recombinant DNA technique. Several are known in the art (*see* Robinson *et al.*, International Patent Application Publication No. WO1987/002671; Akira, *et al.,* European Patent Application Publication No. 184,187; Taniguchi, M., European Patent Application Publication No. 171,496; Morrison *et al.*, European Patent Application Publication No. 173,494; Neuberger *et al.*, International Patent Application Publication No. WO 86/01533; Cabilly *et al.* U.S. Patent No. 4,816,567; Cabilly *et al.*, European Patent Application Publication No. 125,023; Better *et al.* (1988 *Science* 240:1041-1043); Liu *et al.* (1987) *PNAS* 84:3439-3443; Liu *et al.*, 1987, *J. Immunol.* 139:3521-3526; Sun *et al.* (1987) *PNAS* 84:214-218; Nishimura *et al.*, 1987, *Canc. Res.* 47:999-1005; Wood *et al.* (1985) *Nature* 314:446-449; and Shaw *et al.*, 1988, *J. Natl Cancer Inst.* 80:1553-1559).

A humanized or CDR-grafted antibody will have at least one or two but generally all three recipient CDRs (of heavy and or light immunoglobulin chains) replaced with a donor CDR. The antibody may be replaced with at least a portion of a non-human CDR or only some of the CDRs may be replaced with non-human CDRs. It is only necessary to replace the number of CDRs required for binding of the humanized antibody to lipopolysaccharide. In an embodiment, the donor will be a rodent antibody, e.g., a rat or mouse antibody, and the recipient will be a human framework or a human consensus framework. Typically, the immunoglobulin providing the CDRs is called the "donor" and the immunoglobulin providing the framework is called the "acceptor." In an embodiment, the donor immunoglobulin is a non-human (e.g., rodent). The acceptor framework is typically a naturally-occurring (e.g., a human) framework or a consensus framework, or a sequence about 85% or higher, e.g., 90%, 95%, 99% or higher identical thereto.

As used herein, the term "consensus sequence" refers to the sequence formed from the most frequently occurring amino acids (or nucleotides) in a family of related sequences (See e.g., Winnaker, From Genes to Clones (Verlagsgesellschaft, Weinheim, Germany 1987). In a family of proteins, each position in the consensus sequence is occupied by the amino acid occurring most frequently at that position in the family. If two amino acids occur equally frequently, either can be included in the consensus sequence. A "consensus framework" refers to the framework region in the consensus immunoglobulin sequence.

An antibody can be humanized by any suitable method, and several such methods known in the art (*see* e.g., Morrison, S. L., 1985, *Science* 229:1202-1207, by Oi *et al.*, 1986, *BioTechniques* 4:214, and by Queen *et al.* US 5,585,089, US 5,693,761 and US 5,693,762, the contents of all of which are hereby incorporated by reference).

Humanized or CDR-grafted antibodies can be produced by CDR-grafting or CDR substitution, wherein one, two, or all CDRs of an immunoglobulin chain can be replaced. *See e.g.*, U.S. Patent 5,225,539; Jones *et al.* 1986 *Nature* 321:552-525; Verhoeyan *et al.* 1988 *Science* 239:1534; Beidler *et al.* 1988 *J. Immunol.* 141:4053-4060; Winter US 5,225,539, the contents of all of which are hereby expressly incorporated by reference. Winter describes a CDR-grafting method which may be used to prepare humanized antibodies (UK Patent Application GB 2188638A, filed on March 26, 1987; Winter US 5,225,539), the contents of which is expressly incorporated by reference.

Also provided are humanized antibodies in which specific amino acids have been substituted, deleted or added. Criteria for selecting amino acids from the donor are described in, e.g., US 5,585,089, e.g., columns 12-16 of US 5,585,089, the contents of which are hereby incorporated by reference. Other techniques for humanizing antibodies are described in Padlan *et al.* EP 519596 A1, published on December 23, 1992.

In an embodiment, the antibody molecule has a heavy chain constant region chosen from, e.g., the heavy chain constant regions of IgG1, IgG2, IgG3, IgG4, IgM, IgA1, IgA2, IgD, and IgE; particularly, chosen from, e.g., the (e.g., human) heavy chain constant regions of IgG1, IgG2, IgG3,

and IgG4. In another embodiment, the antibody molecule has a light chain constant region chosen from, e.g., the (e.g., human) light chain constant regions of kappa or lambda. The constant region can be altered, e.g., mutated, to modify the properties of the antibody molecule (e.g., to increase or decrease one or more of: Fc receptor binding, antibody glycosylation, the number of cysteine residues, effector cell function, and/or complement function). In an embodiment, the antibody molecule has effector function and can fix complement. In another embodiment, the antibody molecule does not recruit effector cells or fix complement. In an embodiment, the antibody molecule has reduced or no ability to bind an Fc receptor. For example, it may be an isotype or subtype, fragment or other mutant, which does not support binding to an Fc receptor, e.g., it has a mutated or deleted Fc receptor binding region.

In an embodiment, a constant region of the antibody molecule is altered. Methods for altering an antibody constant region are known in the art. Antibody molecules with altered function, e.g. altered affinity for an effector ligand, such as FcR on a cell, or the C1 component of complement can be produced by replacing at least one amino acid residue in the constant portion of the antibody with a different residue (*see*, e.g., EP 388,151 A1, U.S. Pat. No. 5,624,821 and U.S. Pat. No. 5,648,260, the contents of all of which are hereby incorporated by reference). Amino acid mutations which stabilize antibody structure, such as S228P (EU nomenclature, S241P in Kabat nomenclature) in human IgG4 are also contemplated. Similar type of alterations could be described which if applied to the murine, or other species immunoglobulin would reduce or eliminate these functions.

An exemplary heavy chain constant region sequence (human IgG1) is provided below:

ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV
VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTLMI
SRTPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKC
KVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPEN
NYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK (SEQ ID
NO: 319)

An exemplary variant of a heavy chain constant region sequence (human IgG1) is provided below:

ASTKGPSVFPLAPSSKSTSGGTAALGCLVKDYFPEPVTVSWNSGALTSGVHTFPAVLQSSGLYSLSSV
VTVPSSSLGTQTYICNVNHKPSNTKVDKKVEPKSCDKTHTCPPCPAPELLGGPSVFLFPPKPKDTL**Y**I
TREPEVTCVVVDVSHEDPEVKFNWYVDGVEVHNAKTKPREEQYNSTYRVVSVLTVLHQDWLNGKEYKC
KVSNKALPAPIEKTISKAKGQPREPQVYTLPPSREEMTKNQVSLTCLVKGFYPSDIAVEWESNGQPEN
NYKTTPPVLDSDGSFFLYSKLTVDKSRWQQGNVFSCSVMHEALHNHYTQKSLSLSPGK (SEQ ID
NO: 341)

An exemplary light chain constant region sequence (human) is provided below:

RTVAAPSVFIFPPSDEQLKSGTASVVCLLNNFYPREAKVQWKVDNALQSGNSQESVTEQDSKDSTYSL
SSTLTLSKADYEKHKVYACEVTHQGLSSPVTKSFNRGEC (SEQ ID NO: 320)

In an embodiment, the only amino acids in the antibody molecule are canonical amino acids. In an embodiment, the antibody molecule comprises naturally-occurring amino acids; analogs, derivatives and congeners thereof; amino acid analogs having variant side chains; and/or all stereoisomers of any of any of the foregoing. The antibody molecule may comprise the D- or L- optical isomers of amino acids and peptidomimetics.

In an embodiment, the antibody molecule comprises a monoclonal antibody (e.g., a full-length antibody which has an immunoglobulin Fc region). In an embodiment, the antibody molecule comprises a full-length antibody or full length immunoglobulin chain. In an embodiment, the antibody molecule comprises an antigen binding or functional fragment of a full-length antibody or full-length immunoglobulin chain.

In an embodiment, the antibody molecule is a monospecific antibody molecule, e.g., it binds a single epitope. For example, a monospecific antibody molecule can have a plurality of immunoglobulin variable region sequences, each of which binds the same epitope.

In an embodiment, the antibody molecule is a multispecific antibody molecule, e.g., it comprises a plurality of immunoglobulin variable region sequences, wherein a first immunoglobulin variable region sequence of the plurality has binding specificity for a first epitope and a second immunoglobulin variable region sequence of the plurality has binding specificity for a second epitope. In an embodiment, the first and second epitopes are on the same antigen, e.g., the same protein (or subunit of a multimeric protein). In an embodiment, the first and second epitopes overlap. In an embodiment, the first and second epitopes do not overlap. In an embodiment, the first and second epitopes are on different antigens, e.g., the different proteins (or different subunits of a multimeric protein). In an embodiment, a multispecific antibody molecule comprises a third, fourth or fifth immunoglobulin variable domain. In an embodiment, a multispecific antibody molecule is a bispecific antibody molecule, a trispecific antibody molecule, or tetraspecific antibody molecule.

In an embodiment, a multispecific antibody molecule is a bispecific antibody molecule. A bispecific antibody has specificity for no more than two antigens. A bispecific antibody molecule is typically characterized by a first immunoglobulin variable domain sequence which has binding specificity for a first epitope and a second immunoglobulin variable domain sequence that has binding specificity for a second epitope. In an embodiment the first and second epitopes are on the same antigen, e.g., the same protein (or subunit of a multimeric protein). In an embodiment the first and second epitopes overlap. In an embodiment, the first and second epitopes do not overlap. In an embodiment, the first and second epitopes are on different antigens, e.g., the different proteins (or different subunits of a multimeric protein). In an embodiment, a bispecific antibody molecule comprises a heavy chain variable region sequence and a light chain variable region sequence which have binding specificity for a first epitope, and a heavy chain variable region sequence and a light chain variable region sequence which have binding specificity for a second epitope. In an embodiment, a bispecific antibody molecule comprises a half antibody having binding specificity for

a first epitope and a half antibody having binding specificity for a second epitope. In an embodiment, a bispecific antibody molecule comprises a half antibody, or a fragment thereof, having binding specificity for a first epitope, and a half antibody, or fragment thereof, having binding specificity for a second epitope. In an embodiment a bispecific antibody molecule comprises an scFv, or a fragment thereof, have binding specificity for a first epitope, and an scFv, or a fragment thereof, have binding specificity for a second epitope.

Protocols for generating bispecific or heterodimeric antibody molecules are known in the art; including but not limited to, for example, the "knob in a hole" approach described in, *e.g.*, US5731168; the electrostatic steering Fc pairing as described in, *e.g.*, WO 09/089004, WO 06/106905 and WO 2010/129304; Strand Exchange Engineered Domains (SEED) heterodimer formation as described in, *e.g.*, WO 07/110205; Fab arm exchange as described in, *e.g.*, WO 08/119353, WO 2011/131746, and WO 2013/060867; double antibody conjugate, *e.g.*, by antibody cross-linking to generate a bi-specific structure using a heterobifunctional reagent having an amine-reactive group and a sulfhydryl reactive group as described in, *e.g.*, US4433059; bispecific antibody determinants generated by recombining half antibodies (heavy-light chain pairs or Fabs) from different antibodies through cycle of reduction and oxidation of disulfide bonds between the two heavy chains, as described in, *e.g.*, US 4444878; trifunctional antibodies, *e.g.*, three Fab' fragments cross-linked through sulfhdryl reactive groups, as described in, *e.g.*, US5273743; biosynthetic binding proteins, *e.g.*, pair of scFvs cross-linked through C-terminal tails preferably through disulfide or amine-reactive chemical cross-linking, as described in, *e.g.*, US5534254; bifunctional antibodies, *e.g.*, Fab fragments with different binding specificities dimerized through leucine zippers (*e.g.*, c-fos and c-jun) that have replaced the constant domain, as described in, *e.g.*, US5582996; bispecific and oligospecific mono- and oligovalent receptors, *e.g.*, VH-CH1 regions of two antibodies (two Fab fragments) linked through a polypeptide spacer between the CH1 region of one antibody and the VH region of the other antibody typically with associated light chains, as described in, *e.g.*, US5591828; bispecific DNA-antibody conjugates, *e.g.*, crosslinking of antibodies or Fab fragments through a double stranded piece of DNA, as described in, *e.g.*, US5635602; bispecific fusion proteins, *e.g.*, an expression construct containing two scFvs with a hydrophilic helical peptide linker between them and a full constant region, as described in, *e.g.*, US5637481; multivalent and multispecific binding proteins, *e.g.*, dimer of polypeptides having first domain with binding region of Ig heavy chain variable region, and second domain with binding region of Ig light chain variable region, generally termed diabodies (higher order structures are also disclosed creating bispecific, trispecific, or tetraspecific molecules, as described in, *e.g.*, US5837242; minibody constructs with linked VL and VH chains further connected with peptide spacers to an antibody hinge region and CH3 region, which can be dimerized to form bispecific/multivalent molecules, as described in, *e.g.*, US5837821; VH and VL domains linked with a short peptide linker (*e.g.*, 5 or 10 amino acids) or no linker at all in either orientation, which can form dimers to form bispecific diabodies; trimers and tetramers, as described in, *e.g.*, US5844094;

String of VH domains (or VL domains in family members) connected by peptide linkages with crosslinkable groups at the C-terminus further associated with VL domains to form a series of FVs (or scFvs), as described in, *e.g.*, US5864019; and single chain binding polypeptides with both a VH and a VL domain linked through a peptide linker are combined into multivalent structures through non-covalent or chemical crosslinking to form, *e.g.*, homobivalent, heterobivalent, trivalent, and tetravalent structures using both scFV or diabody type format, as described in, *e.g.*, US5869620. The contents of the above-referenced applications are incorporated herein by reference in their entirety.

Additional methods of making multispecific or bispecific antibody molecules can be found, for example, in US5910573, US5932448, US5959083, US5989830, US6005079, US6239259, US6294353, US6333396, US6476198, US6511663, US6670453, US6743896, US6809185, US6833441, US7129330, US7183076, US7521056, US7527787, US7534866, US7612181, US2002/004587, US2002/076406, US2002/103345, US2003/207346, US2003/211078, US2004/219643, US2004/220388, US2004/242847, US2005/003403, US2005/004352, US2005/069552, US2005/079170, US2005/100543, US2005/136049, US2005/136051, US2005/163782, US2005/266425, US2006/083747, US2006/120960, US2006/204493, US2006/263367, US2007/004909, US2007/087381, US2007/128150, US2007/141049, US2007/154901, US2007/274985, US2008/050370, US2008/069820, US2008/152645, US2008/171855, US2008/241884, US2008/254512, US2008/260738, US2009/130106, US2009/148905, US2009/155275, US2009/162359, US2009/162360, US2009/175851, US2009/175867, US2009/232811, US2009/234105, US2009/263392, US2009/274649, EP346087, WO00/06605, WO02/072635, WO04/081051, WO06/020258, WO2007/044887, WO2007/095338A2, WO2007/137760A2, WO2008/119353, WO2009/021754, WO2009/068630, WO91/03493, WO93/23537, WO94/09131, WO94/12625, WO95/09917, WO96/37621, WO99/64460. The contents of the above-referenced applications are incorporated herein by reference in their entirety.

A polypeptide of an antibody molecule described herein may be linear or branched, it may comprise modified amino acids, and it may be interrupted by non-amino acids. The antibody molecule may also be modified; for example, by disulfide bond formation, glycosylation, lipidation, acetylation, phosphorylation, or any other manipulation, such as conjugation with a labeling component. The polypeptide can be isolated from natural sources, can be a produced by recombinant techniques from a eukaryotic or prokaryotic host, or can be a product of synthetic procedures.

The antibody molecule described herein can be used alone in unconjugated form, or can be bound to a substance, e.g., a toxin or moiety (e.g., a therapeutic drug; a compound emitting radiation; molecules of plant, fungal, or bacterial origin; or a biological protein (e.g., a protein toxin) or particle (e.g., a recombinant viral particle, e.g., via a viral coat protein). For example, the antibody molecule can be coupled to a radioactive isotope such as an α-, β-, or γ-emitter, or a β-and γ-emitter.

An antibody molecule can be derivatized or linked to another functional molecule (e.g., another peptide or protein). As used herein, a "derivatized" antibody molecule is one that has been modified. Methods of derivatization include but are not limited to the addition of a fluorescent moiety, a radionucleotide, a toxin, an enzyme or an affinity ligand such as biotin. Accordingly, the antibody molecules are intended to include derivatized and otherwise modified forms of the antibodies described herein, including immunoadhesion molecules. For example, an antibody molecule can be functionally linked (by chemical coupling, genetic fusion, noncovalent association or otherwise) to one or more other molecular entities, such as another antibody (e.g., a bispecific antibody or a diabody), a detectable agent, a toxin, a pharmaceutical agent, and/or a protein or peptide that can mediate association of the antibody or antibody portion with another molecule (such as a streptavidin core region or a polyhistidine tag).

Some types of derivatized antibody molecule are produced by crosslinking two or more antibodies (of the same type or of different types, e.g., to create bispecific antibodies). Suitable crosslinkers include those that are heterobifunctional, having two distinctly reactive groups separated by an appropriate spacer (e.g., m-maleimidobenzoyl-N-hydroxysuccinimide ester) or homobifunctional (e.g., disuccinimidyl suberate). Such linkers are available from Pierce Chemical Company, Rockford, Ill.

Useful detectable agents with which an anti-dengue antibody molecule may be derivatized (or labeled) to include fluorescent compounds, various enzymes, prosthetic groups, luminescent materials, bioluminescent materials, fluorescent emitting metal atoms, e.g., europium (Eu), and other anthanides, and radioactive materials (described below). Exemplary fluorescent detectable agents include fluorescein, fluorescein isothiocyanate, rhodamine, 5dimethylamine-1-napthalenesulfonyl chloride, phycoerythrin and the like. An antibody may also be derivatized with detectable enzymes, such as alkaline phosphatase, horseradish peroxidase, β-galactosidase, acetylcholinesterase, glucose oxidase and the like. When an antibody is derivatized with a detectable enzyme, it is detected by adding additional reagents that the enzyme uses to produce a detectable reaction product. For example, when the detectable agent horseradish peroxidase is present, the addition of hydrogen peroxide and diaminobenzidine leads to a colored reaction product, which is detectable. An antibody molecule may also be derivatized with a prosthetic group (e.g., streptavidin/biotin and avidin/biotin). For example, an antibody may be derivatized with biotin, and detected through indirect measurement of avidin or streptavidin binding. Examples of suitable fluorescent materials include umbelliferone, fluorescein, fluorescein isothiocyanate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride or phycoerythrin; an example of a luminescent material includes luminol; and examples of bioluminescent materials include luciferase, luciferin, and aequorin.

Labeled antibody molecules can be used, for example, diagnostically and/or experimentally in a number of contexts, including (i) to isolate a predetermined antigen by standard techniques, such as affinity chromatography or immunoprecipitation; (ii) to detect a predetermined antigen (e.g., in a

cellular lysate or cell supernatant) in order to evaluate the abundance and pattern of expression of the protein; (iii) to monitor protein levels in tissue as part of a clinical testing procedure, e.g., to determine the efficacy of a given treatment regimen.

An antibody molecule described herein can be conjugated to another molecular entity, typically a label or a therapeutic (*e.g.*, antimicrobial (e.g., antibacterial or bactericidal), immunomodulatory, immunostimularoty, cytotoxic, or cytostatic) agent or moiety. Radioactive isotopes can be used in diagnostic or therapeutic applications. Radioactive isotopes that can be coupled to the antibody molecules include, but are not limited to α-, β-, or γ-emitters, or β-and γ-emitters. Such radioactive isotopes include, but are not limited to iodine (^{131}I or ^{125}I), yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), praseodymium, astatine (^{211}At), rhenium (^{186}Re), bismuth (^{212}Bi or ^{213}Bi), indium (^{111}In), technetium (^{99}mTc), phosphorus (^{32}P), rhodium (^{188}Rh), sulfur (^{35}S) , carbon (^{14}C), tritium (^{3}H), chromium (^{51}Cr), chlorine (^{36}Cl), cobalt (^{57}Co or ^{58}Co), iron (^{59}Fe), selenium (^{75}Se), or gallium (^{67}Ga). Radioisotopes useful as therapeutic agents include yttrium (^{90}Y), lutetium (^{177}Lu), actinium (^{225}Ac), praseodymium, astatine (^{211}At), rhenium (^{186}Re), bismuth (^{212}Bi or ^{213}Bi), and rhodium (^{188}Rh). Radioisotopes useful as labels, e.g., for use in diagnostics, include iodine (^{131}I or ^{125}I), indium (^{111}In), technetium (^{99}mTc), phosphorus (^{32}P), carbon (^{14}C), and tritium (^{3}H), or one or more of the therapeutic isotopes listed above.

The present disclosure provides radiolabeled antibody molecules and methods of labeling the same. In an embodiment, a method of labeling an antibody molecule is disclosed. The method includes contacting an antibody molecule, with a chelating agent, to thereby produce a conjugated antibody. The conjugated antibody is radiolabeled with a radioisotope, e.g., ^{111}Indium, ^{90}Yttrium and ^{177}Lutetium, to thereby produce a labeled antibody molecule.

In an embodiment, the antibody molecule is conjugated to a therapeutic agent. Therapeutically active radioisotopes are disclosed herein. Examples of other therapeutic agents include, but are not limited to, taxol, cytochalasin B, gramicidin D, ethidium bromide, emetine, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicine, doxorubicin, daunorubicin, dihydroxy anthracin dione, mitoxantrone, mithramycin, actinomycin D, 1-dehydrotestosterone, glucocorticoids, procaine, tetracaine, lidocaine, propranolol, puromycin, maytansinoids, e.g., maytansinol (*see* e.g., U.S. Pat. No. 5,208,020), CC-1065 (*see* e.g., U.S. Pat. Nos. 5,475,092, 5,585,499, 5,846, 545) and analogs or homologs thereof. Therapeutic agents include, but are not limited to, antimetabolites (e.g., methotrexate, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-fluorouracil decarbazine), alkylating agents (e.g., mechlorethamine, thioepa chlorambucil, CC-1065, melphalan, carmustine (BSNU) and lomustine (CCNU), cyclothosphamide, busulfan, dibromomannitol, streptozotocin, mitomycin C, and cis-dichlorodiamine platinum (II) (DDP) cisplatin), anthracyclinies (e.g., daunorubicin (formerly daunomycin) and doxorubicin), antibiotics (e.g., dactinomycin (formerly actinomycin), bleomycin, mithramycin, and anthramycin (AMC)), and anti-mitotic agents (e.g., vincristine, vinblastine, taxol and maytansinoids).

In an embodiment, the anti-spike antibody molecule (e.g., a monospecific, bispecific, or multispecific antibody molecule) is covalently linked, e.g., fused, to another partner e.g., a protein, *e.g.*, as a fusion molecule (e.g., a fusion protein).

As used herein, a "fusion protein" and "fusion polypeptide" refer to a polypeptide having at least two portions covalently linked together, where each of the portions is a polypeptide. In an embodiment, each of the portions is a polypeptide that has a different property. The property can be a biological property, such as activity *in vitro* or *in vivo*. The property can also be simple chemical or physical property, such as binding to a target molecule, catalysis of a reaction, etc. The two portions can be linked directly by a single peptide bond or through a linker (e.g., peptide linker), but are in reading frame with each other.

In one aspect, the disclosure features a method of providing a target binding agent that specifically binds to a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein from a SARS-CoV-2 variant. For example, the target binding molecule is an antibody molecule. The method includes: providing a target protein that comprises at least a portion of non-human protein, the portion being homologous to (e.g., at least 70, 75, 80, 85, 87, 90, 92, 94, 95, 96, 97, 98% identical to) a corresponding portion of a human target protein, but differing by at least one amino acid (e.g., at least one, two, three, four, five, six, seven, eight, or nine amino acids); obtaining a binding agent (e.g., an antibody molecule) that specifically binds to the target protein; and evaluating efficacy of the binding agent in modulating an activity of the target protein. The method can further include administering the binding agent (*e.g.*, antibody molecule) or a derivative (*e.g.*, a humanized antibody molecule) to a subject (e.g., a human subject).

In another aspect, this disclosure provides a method of making an antibody molecule disclosed herein. The method includes: providing an antigen, e.g., a SARS-CoV-2 spike protein, a SARS-CoV-2 spike protein described herein, or a fragment thereof; obtaining an antibody molecule that specifically binds to the antigen; evaluating efficacy of the antibody molecule in modulating activity of the antigen and/or organism expressing the antigen, e.g., a SARS-CoV-2 spike protein, e.g., a SARS-CoV-2 spike protein described herein. The method can further include administering the antibody molecule, including a derivative thereof (e.g., a humanized antibody molecule) to a subject, e.g., a human.

This disclosure provides an isolated nucleic acid molecule encoding the above antibody molecule, vectors and host cells thereof. The nucleic acid molecule includes, but is not limited to, RNA, genomic DNA and cDNA.

Amino acid and nucleotide sequences of exemplary antibody molecules that are capable of biding to a SARS-CoV-2 spike protein are described in **Tables 1 and 2**.

Table 1. Amino acid sequences of heavy chain variable regions (VH), light chain variable regions (VL), and complementarity determining regions (CDR) of exemplary antibody molecules.

Variable Region	Sequence	SEQ ID NO.	CDR1	SEQ ID NO.	CDR2	SEQ ID NO.	CDR3	SEQ ID NO.
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYNRGAWFGESLIGGFDNWGQGTLVTVSS	1	GYPFTSYG	164	ISTYNGNT	226	ARDYNRGAWF GESLIGGFDN	268
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYL ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	2	GYPFTSYL	165	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFSSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	3	GYPFSSYG	166	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYDFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	4	GYDFTSYG	167	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYR ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	5	GYPFTSYR	168	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYDGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	6	GYPFTSYG	164	ISTYDGNT	227	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGFPFTSYGI SWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	7	GFPFTSYG	169	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYSFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	8	GYSFTSYG	170	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269

VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTHNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	9	GYPFTSYG	164	ISTHNGNT	228	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTLYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	10	GYPFTLYG	171	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTWNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	11	GYPFTSYG	164	ISTWNGNT	229	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYY ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	12	GYPFTSYY	172	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGSWFGESLIGGFDNWGQGTLVTVSS	13	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGSWF GESLIGGFDN	270
VH	QVQLVQSGAEVKKPGASVKVSCKASGYTFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	14	GYTFTSYG	173	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTKYG ISWVRQAPGQGLEWMGWISTYTGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGSWFGESLIGGFDNWGQGTLVTVSS	15	GYPFTKYG	174	ISTYTGNT	230	ARDYTRGSWF GESLIGGFDN	270
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGNWFGESLIGGFDNWGQGTLVTVSS	16	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGNWF GESLIGGFDN	271
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISNYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	17	GYPFTSYG	164	ISNYNGNT	231	ARDYTRGAWF GESLIGGFDN	269

VH	QVQLVQSGAEVKKPGASVKVSCKASGYPYTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	18	GYPYTSYG	175	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWYGESLIGGFDNWGQGTLVTVSS	19	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWY GESLIGGFDN	272
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYN ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	20	GYPFTSYN	176	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTQYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	21	GYPFTQYG	177	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGETLIGGFDNWGQGTLVTVSS	22	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF GETLIGGFDN	273
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISDYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	23	GYPFTSYG	164	ISDYNGNT	232	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFQESLIGGFDNWGQGTLVTVSS	24	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF QESLIGGFDN	274
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGDWFGESLIGGFDNWGQGTLVTVSS	25	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGDWF GESLIGGFDN	275
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYTGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	26	GYPFTSYG	164	ISTYTGNT	230	ARDYTRGAWF GESLIGGFDN	269

VH	QVQLVQSGAEVKKPGASVKVSCKASGYNFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	27	GYNFTSYG	178	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFHESLIGGFDNWGQGTLVTVSS	28	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF HESLIGGFDN	276
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGEHLIGGFDNWGQGTLVTVSS	29	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF GEHLIGGFDN	277
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTQGAWFGESLIGGFDNWGQGTLVTVSS	30	GYPFTSYG	164	ISTYNGNT	226	ARDYTQGAWF GESLIGGFDN	278
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGEELIGGFDNWGQGTLVTVSS	31	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF GEELIGGFDN	279
VH	QVQLVQSGSELKKPGSSVKVSCKASGYPFTKYGI SWVRQAPGQGLEWMGWISTYTGNTNYAQKFRG RVTMTTDTSTTTGYMELSSLGSEDTAVYYCARD YTRGSWFGESLIGGFDNWGQGTTVTVSS	32	GYPFTKYG	174	ISTYTGNT	230	ARDYTRGSWF GESLIGGFDN	270
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTKYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	33	GYPFTKYG	174	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGEQLIGGFDNWGQGTLVTVSS	34	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF GEQLIGGFDN	280
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFLESLIGGFDNWGQGTLVTVSS	35	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF LESLIGGFDN	281

VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTRYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFGESLIGGFDNWGQGTLVTVSS	36	GYPFTRYG	179	ISTYNGNT	226	ARDYTRGAWF GESLIGGFDN	269
VH	QVQLVQSGAEVKKPGASVKVSCKASGYPFTSYG ISWVRQAPGQGLEWMGWISTYNGNTNYAQKFQ GRVTMTTDTSTTTGYMELRRLRSDDTAVYYCAR DYTRGAWFDESLIGGFDNWGQGTLVTVSS	37	GYPFTSYG	164	ISTYNGNT	226	ARDYTRGAWF DESLIGGFDN	282
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGAHSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	38	QTVSSTS	180	GAH	233	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDQSLTFGGGTK VEIK	39	QTVSSTS	180	GAS	234	QQHDQSLT	284
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGSSSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	40	QTVSSTS	180	GSS	235	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYWASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	41	QTVSSTS	180	WAS	236	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQQVSSTSLA WYQQRPGQAPRLLIYGAESRATGIPDRFSGSGSG TDFTLSITRLEPEDFADYYCQQHDESLTFGPGTTV DIR	42	QQVSSTS	181	GAE	237	QQHDESLT	285
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYDASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	43	QTVSSTS	180	DAS	238	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYYASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	44	QTVSSTS	180	YAS	239	QQHDTSLT	283

VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGAESRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	45	QTVSSTS	180	GAE	237	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSQTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	46	QTVSQTS	182	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQEHDTSLTFGGGTK VEIK	47	QTVSSTS	180	GAS	234	QEHDTSLT	286
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	48	QTVSSTS	180	GAY	240	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQDVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	49	QDVSSTS	183	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSMTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	50	QTVSMTS	184	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQEVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	51	QEVSSTS	185	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQQVSSTSLA WYQQKPGQAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDESLTFGGGTK VEIK	52	QQVSSTS	181	GAY	240	QQHDESLT	285
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDESLTFGGGTK VEIK	53	QTVSSTS	180	GAS	234	QQHDESLT	285

VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGAQSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	54	QTVSSTS	180	GAQ	241	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTTSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	55	QTTSSTS	186	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYFASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	56	QTVSSTS	180	FAS	242	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGDRATLSCRASQQVSSTSLA WYQQRPGHAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLTVSRLEPEDFALYYCQQHDESLTFGQGTK LEIK	57	QQVSSTS	181	GAY	240	QQHDESLT	285
VL	EIVLTQSPGTLSLSPGERATLSCRASQQVSSTSLA WYQQRPGQAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLSITRLEPEDFADYYCQQHDKSLTFGPGTT VDIR	58	QQVSSTS	181	GAY	240	QQHDKSLT	287
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSESLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	59	QTVSSES	187	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHETSLTFGGGTK VEIK	60	QTVSSTS	180	GAS	234	QQHETSLT	288
VL	EIVLTQSPGTLSLSPGERATLSCRASQQVSSTSLA WYQQRPGQAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLSITRLEPEDFADYYCQQHDESLTFGPGTTV DIR	61	QQVSSTS	181	GAY	240	QQHDESLT	285
VL	EIVLTQSPGTLSLSPGERATLSCRASQSVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	62	QSVSSTS	188	GAS	234	QQHDTSLT	283

VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDKSLTFGGGTK VEIK	63	QTVSSTS	180	GAS	234	QQHDKSLT	287
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTTLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	64	QTVSSTT	189	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGERATLSCRASQQVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDTSLTFGGGTK VEIK	65	QQVSSTS	181	GAS	234	QQHDTSLT	283
VL	EIVLTQSPGTLSLSPGDRATLSCRASQEVSSTSLA WYQQRPGHAPRLLIYGAYSRATGIPDRFSGSGSG TDFTLTVSRLEPEDFALYYCQQHDESLTFGQGTK LEIK	66	QEVSSTS	185	GAY	240	QQHDESLT	285
VL	EIVLTQSPGTLSLSPGERATLSCRASQTVSSTSLA WYQQKPGQAPRLLIYGASSRATGIPDRFSGSGSG TDFTLTISRLEPEDFAVYYCQQHDRSLTFGGGTK VEIK	67	QTVSSTS	180	GAS	234	QQHDRSLT	289
VH	QVQLVQSGAEVRKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDQETRYSPSFQGR VTISADKSINTAYLQWSSLRAADSAIYYCAGGSG INTPMDVWGQGTLVTVSS	68	YGFITYWIG	190	GIIYPGDQE TRYS	243	CAGGSGINTPM DVW	290
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYYI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	69	YGFITYYIG	191	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDLETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	70	YGFITYWIG	190	GIIYPGDLE TRYS	245	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIDTPMDVWGQGTTVTVSS	71	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIDTPM DVW	292

VH	EVQLLQSGAEVKKPGESLTISCKGSGYGFITYWI GWVRQMPGRGLEWMGIIYPGDQETRYSPSFQGQ VAISADKSINTAYLQWTSLRASDTAIYYCAGGSG INTPMDVWGQGTLVTVSS	72	YGFITYWIG	190	GIIYPGDQE TRYS	243	CAGGSGINTPM DVW	290
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGNSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	73	YGFITYWIG	190	GIIYPGNSE TRYS	246	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFQTYW IGWVRQMPGKGLEWMGIIYPGDSETRYSPSFEG QVTISADKSISTAYLQWNTLKASDTAMYYCAGG SGISTPMDVWGQGTTVTVSS	74	YGFQTYWI G	192	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDHETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	75	YGFITYWIG	190	GIIYPGDHE TRYS	247	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSEVRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	76	YGFITYWIG	190	GIIYPGDSE VRYS	248	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIKTPMDVWGQGTTVTVSS	77	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIKTPM DVW	293
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIHTPMDVWGQGTTVTVSS	78	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIHTPM DVW	294
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGWS GISTPMDVWGQGTTVTVSS	79	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGWSGISTPM DVW	295
VH	QVQLVQSGAEVRKPGESLKISCKGSGYGFIWYWI GWVRQMPGKGLEWMGIIYPGDQETRYSPSFQGR VTISADKSINTAYLQWSSLRAADSAIYYCAGGSG IWTPMDVWGQGTLVTVSS	80	YGFIWYWI G	193	GIIYPGDQE TRYS	243	CAGGSGIWTPM DVW	296

VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIYTPMDVWGQGTTVTVSS	81	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIYTPM DVW	297
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYHGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	82	YGFITYWIG	190	GIIYHGDSE TRYS	249	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVRKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDQETRYSPSFQGR VTISADKSINTAYLQWSSLRAADSAIYYCAGGGG IWTPMDVWGQGTLVTVSS	83	YGFITYWIG	190	GIIYPGDQE TRYS	243	CAGGGGIWTP MDVW	298
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGFS GISTPMDVWGQGTTVTVSS	84	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGFSGISTPM DVW	299
VH	QVQLVQSGAEVKKPGESLKISCKGSGHGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	85	HGFITYWIG	194	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGK GISTPMDVWGQGTTVTVSS	86	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGKGISTPM DVW	300
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGYITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	87	YGYITYWI G	195	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDQETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	88	YGFITYWIG	190	GIIYPGDQE TRYS	243	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFIWYW IGWVRQMPGKGLEWMGIIYPGDSETRYSPSFEG QVTISADKSISTAYLQWNTLKASDTAMYYCAGG SGISTPMDVWGQGTTVTVSS	89	YGFIWYWI G	193	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291

VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDNETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	90	YGFITYWIG	190	GIIYPGDNE TRYS	250	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYWGDSETRYSPSFEG QVTISADKSISTAYLQWNTLKASDTAMYYCAGG SGISTPMDVWGQGTTVTVSS	91	YGFITYWIG	190	GIIYWGDSE TRYS	251	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGD GISTPMDVWGQGTTVTVSS	92	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGDGISTPM DVW	301
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFRTYW IGWVRQMPGKGLEWMGIIYPGDSETRYSPSFEG QVTISADKSISTAYLQWNTLKASDTAMYYCAGG SGISTPMDVWGQGTTVTVSS	93	YGFRTYWI G	196	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	EVQLLQSGAEVKKPGESLTISCKGSGYGFIWYWI GWVRQMPGRGLEWMGIIYPGDQETRYSPSFQGQ VAISADKSINTAYLQWTSLRASDTAIYYCAGGSG INTPMDVWGQGTLVTVSS	94	YGFIWYWI G	193	GIIYPGDQE TRYS	243	CAGGSGINTPM DVW	290
VH	QVQLVQSGAEVRKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDGETRYSPSFQGR VTISADKSINTAYLQWSSLRAADSAIYYCAGGSG IWTPMDVWGQGTLVTVSS	95	YGFITYWIG	190	GIIYPGDGE TRYS	252	CAGGSGIWTPM DVW	296
VH	QVQLVQSGAEVKKPGESLKISCKGSGRGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	96	RGFITYWIG	197	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGEGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	97	EGFITYWIG	198	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIWTPMDVWGQGTTVTVSS	98	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIWTPM DVW	296

VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GIRTPMDVWGQGTTVTVSS	99	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGIRTPM DVW	302
VH	QVQLVQSGAEVKKPGESLKISCKGSGSGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	100	SGFITYWIG	199	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVRKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDQETRYSPSFQGR VTISADKSINTAYLQWSSLRAADSAIYYCAGGSG IWTPMDVWGQGTLVTVSS	101	YGFITYWIG	190	GIIYPGDQE TRYS	243	CAGGSGIWTPM DVW	296
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDKETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	102	YGFITYWIG	190	GIIYPGDKE TRYS	253	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDRETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	103	YGFITYWIG	190	GIIYPGDRE TRYS	254	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGRS GISTPMDVWGQGTTVTVSS	104	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGRSGISTPM DVW	303
VH	QVQLVQSGAEVKKPGESLKISCKGSGKGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	105	KGFITYWIG	200	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYSFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	107	YSFITYWIG	201	GIIYPGDSE TRYS	244	CAGGSGISTPM DVW	291
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDGETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GISTPMDVWGQGTTVTVSS	108	YGFITYWIG	190	GIIYPGDGE TRYS	252	CAGGSGISTPM DVW	291

VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS RISTPMDVWGQGTTVTVSS	109	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSRISTPM DVW	304
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGS GINTPMDVWGQGTTVTVSS	110	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGSGINTPM DVW	290
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGYS GISTPMDVWGQGTTVTVSS	111	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGYSGISTPM DVW	305
VH	QVQLVQSGAEVKKPGESLKISCKGSGYGFITYWI GWVRQMPGKGLEWMGIIYPGDSETRYSPSFEGQ VTISADKSISTAYLQWNTLKASDTAMYYCAGGG GISTPMDVWGQGTTVTVSS	112	YGFITYWIG	190	GIIYPGDSE TRYS	244	CAGGGGISTPM DVW	306
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQEYYSTPYT FGQGTKLEIK	113	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQEYYSTPYTF	307
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYTSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	114	KSSQSVLY TSINKNYIA	203	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIE KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	115	KSSQSVLY SSIEKNYIA	204	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPASLAVTLGGRATINCKSSQSVLYSRIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF SGSGSATDFTLTISSLQAEDVAVYYCQNYYTTPY TFGQGTRVEIK	116	KSSQSVLY SRINKEYIA	205	WASTREY	256	CQNYYTTPYTF	309
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYRTPY TFGQGTKLEIK	117	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYRTPYTF	310

VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIRWYQQKPGQPPKLLIYWASTRESGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	118	KSSQSVLY SSINKNYIR	206	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIK KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	119	KSSQSVLY SSIKKNYIA	207	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYQTPY TFGQGTKLEIK	120	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYQTPYTF	311
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIQ KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	121	KSSQSVLY SSIQKNYIA	208	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYKTPY TFGQGTKLEIK	122	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYKTPYTF	312
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSHIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	123	KSSQSVLY SHINKNYIA	209	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KEYIAWYQQKPGQPPKLLIYWASTRESGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	124	KSSQSVLY SSINKEYIA	210	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIH KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	125	KSSQSVLY SSIHKNYIA	211	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYWTPY TFGQGTKLEIK	126	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYWTPYT F	313

VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSDPY TFGQGTKLEIK	127	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYSDPYTF	314
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIY KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	128	KSSQSVLY SSIYKNYIA	212	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWSSTRESGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	129	KSSQSVLY SSINKNYIA	202	WSSTRES	257	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASKRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	130	KSSQSVLY SSINKNYIA	202	WASKRES	258	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIL KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	131	KSSQSVLY SSILKNYIA	213	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPASLAVTLGGRATINCKSSQSVLYSSIK KEYIAWYQQKAGQPPKLLIYWASTREEGVPDRF SGSGSATDFTLTISSLQAEDVAVYYCQNYYSTPY TFGQGTRVEIK	132	KSSQSVLY SSIKKEYIA	214	WASTREE	259	CQNYYSTPYTF	315
VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLYSSIN KEYIAWYQQKAGQPPKLLIYWASTPEYGVPDRF TGSGSGTDFTLTINNVQAEDVAVYYCQNYYTTP YTFGQGTRVEIK	133	KSSQSVLY SSINKEYIA	210	WASTPEY	260	CQNYYTTPYTF	309
VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLYSSIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF TGSGSGTDFTLTINNVQAEDVAVYYCQNYYKTP YTFGQGTRVEIK	134	KSSQSVLY SSINKEYIA	210	WASTREY	256	CQNYYKTPYTF	316
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRENGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	135	KSSQSVLY SSINKNYIA	202	WASTREN	261	CQQYYSTPYTF	308

VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYTTPYT FGQGTKLEIK	137	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYTTPYTF	317
VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLYSSIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF TGSGSGTDFTLTINNVQAEDVAVYYCQNYYTTP YTFGQGTRVEIK	138	KSSQSVLY SSINKEYIA	210	WASTREY	256	CQNYYTTPYTF	309
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRERGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	139	KSSQSVLY SSINKNYIA	202	WASTRER	262	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLRSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	140	KSSQSVLRS SINKNYIA	215	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIF KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	141	KSSQSVLY SSIFKNYIA	216	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQNYYSTPYT FGQGTKLEIK	142	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQNYYSTPYTF	315
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTREYGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	143	KSSQSVLY SSINKNYIA	202	WASTREY	256	CQQYYSTPYTF	308
VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLYSSIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF TGSGSGTDFTLTINNVQAEDVAVYYCQNYYSTP YTFGQGTRVEIK	144	KSSQSVLY SSINKEYIA	210	WASTREY	256	CQNYYSTPYTF	315
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASRRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	145	KSSQSVLY SSINKNYIA	202	WASRRES	263	CQQYYSTPYTF	308

VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KDYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	146	KSSQSVLY SSINKDYIA	217	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWGSTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	147	KSSQSVLY SSINKNYIA	202	WGSTRES	264	CQQYYSTPYTF	308
VL	DIVMTQSPASLAVTLGGRATINCKSSQSVLYSRIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF SGSGSATDFTLTISSLQAEDVAVYYCQNYYSTPY TFGQGTRVEIK	148	KSSQSVLY SRINKEYIA	205	WASTREY	256	CQNYYSTPYTF	315
VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLYSSIK KEYIAWYQQKAGQPPKLLIYWASTREEGVPDRF TGSGSGTDFTLTINNVQAEDVAVYYCQNYYTTP YTFGQGTRVEIK	149	KSSQSVLY SSIKKEYIA	214	WASTREE	259	CQNYYTTPYTF	309
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSRIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	150	KSSQSVLY SRINKNYIA	218	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTREEGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	151	KSSQSVLY SSINKNYIA	202	WASTREE	259	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTREIGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	152	KSSQSVLY SSINKNYIA	202	WASTREI	265	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN RNYIAWYQQKPGQPPKLLIYWASTRESGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	153	KSSQSVLY SSINRNYIA	219	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYYASTRESGVPDRFS GSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYTF GQGTKLEIK	154	KSSQSVLY SSINKNYIA	202	YASTRES	266	CQQYYSTPYTF	308

VL	DVVLTQSPDSLAVSLGERATINCKSSQSVLWSSI NKEYIAWYQQKAGQPPKLLIYWASTREYGVPDR FTGSGSGTDFTLTINNVQAEDVAVYYCQNYYTT PYTFGQGTRVEIK	155	KSSQSVLW SSINKEYIA	220	WASTREY	256	CQNYYTTPYTF	309
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTREHGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	156	KSSQSVLY SSINKNYIA	202	WASTREH	267	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYNSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	157	KSSQSVLY NSINKNYIA	221	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSWI NKNYIAWYQQKPGQPPKLLIYWASTRESGVPDR FSGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPY TFGQGTKLEIK	158	KSSQSVLY SWINKNYI A	222	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYHSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	159	KSSQSVLY HSINKNYIA	223	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSNLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	160	KSSQSNLY SSINKNYIA	224	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSSIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYETPYT FGQGTKLEIK	161	KSSQSVLY SSINKNYIA	202	WASTRES	255	CQQYYETPYTF	318
VL	DIVMTQSPDSLAASLGERATINCKSSQSVLYSNIN KNYIAWYQQKPGQPPKLLIYWASTRESGVPDRF SGSGSGTDFTLTISSLQAEDVAIYYCQQYYSTPYT FGQGTKLEIK	162	KSSQSVLY SNINKNYIA	225	WASTRES	255	CQQYYSTPYTF	308
VL	DIVMTQSPASLAVTLGGRATINCKSSQSVLYSSIN KEYIAWYQQKAGQPPKLLIYWASTREYGVPDRF SGSGSATDFTLTISSLQAEDVAVYYCQNYYSTPY TFGQGTRVEIK	163	KSSQSVLY SSINKEYIA	210	WASTREY	256	CQNYYSTPYTF	315

Table 2. Heavy and light chain variable regions of exemplary antibody molecules.

Antibody	VH SEQ ID NO	VL SEQ ID NO
mAb1	15	58
mAb2	32	52
mAb3	32	42
mAb4	15	52
mAb5	15	61
mAb6	32	66
mAb7	32	57
mAb8	32	61
mAb9	32	58
mAb10	15	57
mAb11	15	66
mAb12	15	42
mAb13	72	148
mAb14	101	148
mAb15	83	133
mAb16	101	144
mAb17	68	132
mAb18	72	149
mAb19	95	134
mAb20	72	132
mAb21	94	132
mAb22	68	116
mAb23	68	138
mAb24	68	148
mAb25	94	149
mAb26	101	149
mAb27	101	155
mAb28	94	163
mAb29	72	163
mAb30	80	138
mAb31	94	138
mAb32	95	155
mAb33	68	144
mAb34	94	116
mAb35	83	134
mAb36	68	149
mAb37	72	144
mAb38	94	144
mAb39	72	138
mAb40	83	138

mAb41	83	155
mAb42	80	134
mAb43	101	138
mAb44	94	148
mAb45	68	163
mAb46	101	133
mAb47	80	133
mAb48	72	116
mAb49	101	116
mAb50	101	132
mAb51	95	133
mAb52	101	134
mAb53	101	163
mAb54	80	155
mAb55	95	138

In an embodiment, the antibody molecule comprises one or more (e.g., two, three, four, five, or all) of the CDRs of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

In an embodiment, the antibody molecule comprises:

(a) a heavy chain variable region (VH) comprising:

(i) an HCDR1 comprising the amino acid sequence:

$GX_1X_2X_3X_4X_5YX_6$

wherein: X_1 is Y or F;

X_2 is P, D, S, T or N;

X_3 is F or Y;

X_4 is T or S;

X_5 is S, L, K, Q, R or Y; and

X_6 is G, L, R, Y or N;

(SEQ ID NO: 324);

(ii) an HCDR2 comprising the amino acid sequence:

$ISX_1X_2X_3GNT$

wherein: X_1 is T, N or D;

X_2 is Y, H or W; and

X_3 is N, D or T;

(SEQ ID NO: 325); and

(iii) an HCDR3 comprising the amino acid sequence:

$ARDYX_1X_2GX_3WX_4X_5EX_6LIGGFDN$

wherein: X_1 is N or T;

X_2 is R or Q;

X_3 is A, S, N or D;

X_4 is F or Y;

X_5 is G, Q, H, L or D; and

X_6 is S, T, H, E or Q;

(SEQ ID NO: 326); and

(b) a light chain variable region (VL) comprising:

(i) an LCDR1 comprising the amino acid sequence:

$QX_1X_2SX_3X_4X_5$

wherein: X_1 is T, Q, D, E or S;

X_2 is V or T;

X_3 is S, Q or M;

X_4 is T or E; and

X_5 is S or T;

(SEQ ID NO: 327);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2X_3$

wherein: X_1 is G, W, D, Y or F;

X_2 is A or S; and

X_3 is H, S, E, Y or Q;

(SEQ ID NO: 328); and

(iii) an LCDR3 comprising the amino acid sequence:

$QX_1HX_2X_3SLT$

wherein: X_1 is Q or E;

X_2 is D or E; and

X_3 is T, Q, E, K or R;

(SEQ ID NO: 329).

In an embodiment, the antibody molecule comprises:

(a) a VH comprising:

(i) an HCDR1 comprising the amino acid sequence:

$X_1X_2X_3X_4X_5YX_6IG$

wherein: X_1 is Y, H, R, E, S or K;

X_2 is G or S;

X_3 is F or Y;

X_4 is I, Q or R;

X_5 is T or W; and

X_6 is W or Y;

(SEQ ID NO: 330);

(ii) an HCDR2 comprising the amino acid sequence:

$GIIYX_1GX_2X_3EX_4RYS$

wherein: X_1 is P, H or W;

X_2 is D or N;

X_3 is Q, S, L, H, N, G, K or R; and

X_4 is T or V;

(SEQ ID NO: 331); and

(iii) an HCDR3 comprising the amino acid sequence:

$CAGX_1X_2X_3IX_4TPMDVW$

wherein: X_1 is G, W, F, R or Y;

X_2 is S, G, K or D;

X_3 is G or R; and

X_4 is N, S, D, K, H, W, Y or R;

(SEQ ID NO: 332); and

(b) a VL comprising:

(i) an LCDR1 comprising the amino acid sequence:

$KSSQSX_1LX_2X_3X_4IX_5X_6X_7YIX_8$

wherein: X_1 is V or N;

X_2 is Y, R or W;

X_3 is S, T, N or H;

X_4 is S, R, H, W or N;

X_5 is N, E, K, Q, H, Y, L or K;

X_6 is K or R;

X_7 is N, E or D; and

X_8 is A or R;

(SEQ ID NO: 333);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2SX_3X_4EX_5$

wherein: X_1 is W or Y;

X_2 is A, S or G;

X_3 is T, K or R;

X_4 is R or P;

X_5 is S, Y, E, N, R, I or H;

(SEQ ID NO: 334); and

(iii) an LCDR3 comprising the amino acid sequence:

$CQX_1YYX_2X_3PYTF$

wherein: X_1 is E, Q or N;

X_2 is S, T, R, Q, K, W or E; and

X_3 is T or D;

(SEQ ID NO: 335).

In an embodiment, the antibody molecule comprises one or both of:

(i) a VH comprising one, two, or all of the following: (a) an HCDR1 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; (b) an HCDR2 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; or (c) an HCDR3 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306, or

(ii) a VL comprising one, two, or all of the following: (a) an LCDR1 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; (b) an LCDR2 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; or (c) an LCDR3 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises one or both of:

(i) a VH comprising: (a) an HCDR1 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; (b) an HCDR2 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; and (c) an HCDR3 comprising an amino acid sequence that differs by no more than 1, 2, or

3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306, or

(ii) a VL comprising: (a) an LCDR1 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; (b) an LCDR2 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; and (c) an LCDR3 comprising an amino acid sequence that differs by no more than 1, 2, or 3 amino acid residues from, or has at least 85, 90, 95, 99 or 100% homology with, an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises one or both of:

(i) a VH comprising: (a) an HCDR1 comprising an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; (b) an HCDR2 comprising an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; and (c) an HCDR3 comprising an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306, or

(ii) a VL comprising: (a) an LCDR1 comprising an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; (b) an LCDR2 comprising an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; and (c) an LCDR3 comprising an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises:

(i) a VH comprising: (a) an HCDR1 comprising an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; (b) an HCDR2 comprising an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; and (c) an HCDR3 comprising an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306, and

(ii) a VL comprising: (a) an LCDR1 comprising an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; (b) an LCDR2 comprising an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; and (c) an LCDR3 comprising an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of the LCDR1 of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 287.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid

sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 237; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 185; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO:

270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 287.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 185; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 240; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 174; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 230; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 270, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 181; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 237; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 285.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 298, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 260; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 252; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 316.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 220; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 252; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 220;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 298, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 316.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 298, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 298, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 220; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 316.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 260; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 260; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 290, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 205; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 214;

an LCDR2 comprising the amino acid sequence of SEQ ID NO: 259; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 252; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 260; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 316.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 315.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 193; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 243; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 220; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises: (i) a VH comprising: an HCDR1 comprising the amino acid sequence of SEQ ID NO: 190; an HCDR2 comprising the amino acid sequence of SEQ ID NO: 252; and an HCDR3 comprising the amino acid sequence of SEQ ID NO: 296, and (ii) a VL comprising: an LCDR1 comprising the amino acid sequence of SEQ ID NO: 210; an LCDR2 comprising the amino acid sequence of SEQ ID NO: 256; and an LCDR3 comprising the amino acid sequence of SEQ ID NO: 309.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs

by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 58. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 58. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 58.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 52. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 52. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 52.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 42. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 42. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 42.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least

85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 52. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 52. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 52.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 61. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 61. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 61.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 66. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 66. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 66.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 57. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 57. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 57.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 61. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 61. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 61.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 58. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 32; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 58. In an embodiment, the antibody

molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 32; and a VL comprising the amino acid sequence of SEQ ID NO: 58.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 57. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 57. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 57.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 66. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 66. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 66.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 42. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 15; and a VL comprising an amino acid sequence that differs by

no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 42. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 15; and a VL comprising the amino acid sequence of SEQ ID NO: 42.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 148.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 148.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10,

15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 83; and a VL comprising the amino acid sequence of SEQ ID NO: 133.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 144.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 132.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or

100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 149.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 95; and a VL comprising the amino acid sequence of SEQ ID NO: 134.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 132.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an

embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 132.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 116.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 148.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 149.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody

molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 149.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 155.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 163.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by

no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 163.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 80; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10,

15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 95; and a VL comprising the amino acid sequence of SEQ ID NO: 155.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 144.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 116.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or

100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 83; and a VL comprising the amino acid sequence of SEQ ID NO: 134.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 149. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 149.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 144.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an

embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 144. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 144.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 83; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 83; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 83; and a VL comprising the amino acid sequence of SEQ ID NO: 155.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 80; and a VL comprising the amino acid sequence of SEQ ID NO: 134.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody

molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 94; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 148. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 94; and a VL comprising the amino acid sequence of SEQ ID NO: 148.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 68; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 68; and a VL comprising the amino acid sequence of SEQ ID NO: 163.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs

by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 133.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 80; and a VL comprising the amino acid sequence of SEQ ID NO: 133.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 72; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 72; and a VL comprising the amino acid sequence of SEQ ID NO: 116.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10,

15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 116. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 116.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 132. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 132.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 133. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 95; and a VL comprising the amino acid sequence of SEQ ID NO: 133.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or

100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 134. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 134.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 101; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 163. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 101; and a VL comprising the amino acid sequence of SEQ ID NO: 163.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80. In an embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 80; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 155. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 80; and a VL comprising the amino acid sequence of SEQ ID NO: 155.

In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95. In an

embodiment, the antibody molecule comprises a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 95; and a VL comprising an amino acid sequence that differs by no more than 1, 5, 10, 15, or 20 amino acid residues from, or has at least 85%, 90%, 95%, 99%, or 100% homology with, the amino acid sequence of SEQ ID NO: 138. In an embodiment, the antibody molecule comprises a VH comprising the amino acid sequence of SEQ ID NO: 95; and a VL comprising the amino acid sequence of SEQ ID NO: 138.

In an embodiment, the antibody molecule comprises one or both of (a) a VH comprising an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; or (b) a VL comprising an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom. In an embodiment, the antibody molecule further comprises a heavy chain constant region (e.g., a heavy chain constant region described herein), a light chain constant region (e.g., a light chain constant region described herein), or both.

In an embodiment, the antibody molecule comprises one or both of the VH or VL of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55. In an embodiment, the antibody molecule further comprises a heavy chain constant region (e.g., a heavy chain constant region described herein), a light chain constant region (e.g., a light chain constant region described herein), or both.

In an embodiment, the antibody molecule further comprises a heavy chain constant region, e.g., a heavy chain constant region described herein. In an embodiment, the antibody molecule further comprises a light chain constant region, e.g., a light chain constant region described herein. In an embodiment, the antibody molecule further comprises a heavy chain constant region, e.g., a heavy chain constant region described herein, and a light chain constant region, e.g., a light chain constant region described herein.

In an embodiment, the antibody molecule binds to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, e.g., with a dissociation constant (K_D) of 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or less, 0.1 nM or less, 0.09 nM or less, 0.08 nM or less, 0.07 nM or less, 0.06 nM or less, 0.05 nM or less, 0.04 nM or less, 0.03 nM or less, 0.02 nM or less, 0.01 nM or less, 0.005 nM or less, 0.002 nM or less, 0.001 nM or less, or 1pM or less e.g., between 0.001 nM and 100 nM, between 0.01 nM and 100 nM, between 0.1 nM and 100 nM, between 1 nM and 100 nM, between 10 nM and 100 nM, between 0.001 nM and 1 nM, between 0.002 nM and 0.5 nM, between 0.005 nM and 0.2 nM, between 0.01 nM and 0.1 nM, between 0.02 nM and 0.05 nM, between 0.001 nM and 0.5 nM, between 0.001 nM and 0.2 nM, between 0.001 nM and 0.1 nM, between 0.001 nM and 0.05 nM, between 0.001 nM and 0.02 nM, between 0.001 nM and 0.01 nM, between 0.001 nM and 0.005 nM, between 0.5 nM and 1 nM, between 0.2 nM and 1 nM, between 0.1 nM and 1 nM, between 0.05 nM and 1 nM, between 0.02 nM and 1 nM, between 0.01 nM and 1 nM, between 0.005 nM and 1 nM, between 0.002 nM and 1 nM, between 0.002 nM and 0.01 nM, between 0.005 nM and 0.02 nM, between 0.01 nM and 0.05 nM, between 0.02 nM and 0.1 nM, between 0.05 nM and 0.2 nM, or between 0.1 nM and 0.5 nM, e.g., between 0.1 pM and 1 pM, between 0.01 pM and 0.1 pM, between 1 pM and 10 pM, between 10 pM and 100 pM, between 50 pM and 100 pM, between 0.1 nM and 1 nM, between 1 nM and 2 nM, between 2 nM and 3 nM, or between 3 nM and 4nM, e.g., 3.66 nM, 1.55 nM, or 90.8 pM, e.g., as determined by a method described herein (e.g., in Examples).

In an embodiment, the antibody molecule binds to a SARS-CoV-2 spike protein, or fragment thereof (e.g., a fragment comprising an RBD), with high affinity, e.g., with a half maximal effective concentration (EC_{50}) of 10 μg/mL or less, e.g., 5 μg/mL or less, 2 μg/mL or less, 1 μg/mL or less, 0.5 μg/mL or less, 0.2 μg/mL or less, 100 ng/mL or less, 50 ng/mL or less, 20 ng/mL or less, 15 ng/mL or less, 10 ng/mL or less, 9 ng/mL or less, 8 ng/mL or less, 7 ng/mL or less, 6 ng/mL or less, 5 ng/mL or less, 4 ng/mL or less, 3 ng/mL or less, 2 ng/mL or less, 1 ng/mL or less, 0.5 ng/mL or less, 0.2 ng/mL or less, or 0.1 ng/mL or less, e.g., less, 5 ng/mL or less, 4 ng/mL or less, 3 ng/mL or less, 2 ng/mL or less, 1 ng/mL or less, 0.5 ng/mL or less, 0.2 ng/mL or less, or 0.1 ng/mL or less, e.g., between 0.1 ng/mL to 10 μg/mL, between 1 ng/mL to 10 μg/mL, between 10 ng/mL to 10 μg/mL, between 100 ng/mL to 10 μg/mL, between 1 μg/mL to 10 μg/mL, between 0.1 ng/mL and 100 ng/mL, between 0.2 ng/mL and 50 ng/mL, between 0.5 ng/mL and 20 ng/mL, between 1 ng/mL and 10 ng/mL, between 2 ng/mL and 5 ng/mL, between 0.1 ng/mL and 50 ng/mL, between 0.1 ng/mL and 20 ng/mL, between 0.1 ng/mL and 10 ng/mL, between 0.1 ng/mL and 5 ng/mL, between 0.1 ng/mL and 2 ng/mL, between 0.1 ng/mL and 1 ng/mL, between 0.1 ng/mL and 0.5 ng/mL, between 0.1 ng/mL and 0.2 ng/mL, between 50 ng/mL and 100 ng/mL, between 20 ng/mL and 100 ng/mL, between 10 ng/mL and 100 ng/mL, between 5 ng/mL and 100 ng/mL, between 2 ng/mL and 100 ng/mL, between 1 ng/mL and 100 ng/mL, between 0.5 ng/mL and 100 ng/mL, between 0.2 ng/mL and 100 ng/mL,

between 0.2 ng/mL and 1 ng/mL, between 0.5 ng/mL and 2 ng/mL, between 1 ng/mL and 5 ng/mL, between 2 ng/mL and 10 ng/mL, between 5 ng/mL and 20 ng/mL, or between 10 ng/mL and 50 ng/mL, e.g., between 0.03 μg/mL and 0.70 μg/mL, between 0.04 μg/mL and 0.61μg/mL, between 0.04 μg/mL and 0.1 μg/mL, between 0.1 μg/mL and 0.2 μg/mL, between 0.2 μg/mL and 0.3 μg/mL, between 0.3 μg/mL and 0.4 μg/mL, between 0.4 μg/mL and 0.5 μg/mL, between 0.5 μg/mL and 0.6 μg/mL, or between 0.6 μg/mL and 0.7 μg/mL, e.g., 0.11 μg/mL, 0.56 μg/mL, 0.23 μg/mL, 0.17 μg/mL, 0.12 μg/mL, 0.13 μg/mL, 0.21 μg/mL, 0.6 μg/mL, 0.15 μg/mL, 0.09 μg/mL, 0.07 μg/mL, 0.1 μg/mL, 0.169 μg/mL, 0.081 μg/mL, 0.05 μg/mL, 0.06 μg/mL, 0.105 μg/mL, 0.057 μg/mL, 0.055 μg/mL, 0.041 μg/mL, 0.089 μg/mL, 0.054 μg/mL, 0.042 μg/mL, 0.053 μg/mL, 0.096 μg/mL, 0.086 μg/mL, 0.052 μg/mL, or 0.072 μg/mL, e.g., as determined by a method described herein (e.g., in Examples).

In an embodiment, the antibody molecule binds to a SARS-CoV-2 spike protein, or fragment thereof (e.g., a fragment comprising an RBD), with high affinity, e.g., with a half maximal effective concentration (EC_{50}) of 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 500 pM or less, 200 pM or less, 100 pM or less, 50 pM or less, 20 pM or less, 10 pM or less, 5 pM or less, 2 pM or less, or 1 pM or less, e.g., between 1 pM and 100 nM, between 10 pM and 100 nM, between 0.1 nM and 100 nM, between 1 nM and 100 nM, between 10 nM and 100 nM, between 1 pM and 500 pM, between 2 pM and 200 pM, between 5 pM and 100 pM, between 10 pM and 50 pM, between 1 pM and 200 pM, between 1 pM and 100 pM, between 1 pM and 50 pM, between 1 pM and 20 pM, between 1 pM and 10 pM, between 1 pM and 5 pM, between 200 pM and 500 pM, between 100 pM and 500 pM, between 50 pM and 500 pM, between 20 pM and 500 pM, between 10 pM and 500 pM, between 5 pM and 500 pM, between 2 pM and 500 pM, between 2 pM and 10 pM, between 5 pM and 20 pM, between 10 pM and 50 pM, between 20 pM and 100 pM, between 50 pM and 200 pM, , e.g., as determined by a method described herein.

In an embodiment, the antibody molecule reduces (e.g., inhibits or blocks) the binding of a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), to an ACE receptor, at a half maximal inhibitory concentration (IC_{50}) of 100 μg/ml or less, e.g., 50 μg/ml or less, 20 μg/ml or less, 10 μg/ml or less, 9 μg/ml or less, 8 μg/ml or less, 7 μg/ml or less, 6 μg/ml or less, 5 μg/ml or less, 4 μg/ml or less, 3 μg/ml or less, 2 μg/ml or less, 1 μg/ml or less, 0.9 μg/ml or less, 0.8 μg/ml or less, 0.7 μg/ml or less, 0.6 μg/ml or less, 0.5 μg/ml or less, 0.4 μg/ml or less, 0.3 μg/ml or less, 0.2 μg/ml or less, 0.1 μg/ml or less, 0.05 μg/ml or less, 0.02 μg/ml or less, or 0.01 μg/ml or less, e.g., between 0.01 μg/ml and 100 μg/ml, between 0.02 μg/ml and 50 μg/ml, between 0.05 μg/ml and 20 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 0.2 μg/ml and 5 μg/ml, between 0.5 μg/ml and 2 μg/ml, between 0.02 μg/ml and 100 μg/ml, between 0.05 μg/ml and 100 μg/ml, between 0.1 μg/ml and 100 μg/ml, between 0.1 μg/ml and 50 μg/ml, between 0.1 μg/ml and 20 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 0.1 μg/ml and 5 μg/ml, between 0.1 μg/ml and 2 μg/ml, between 0.1 μg/ml and 1 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.1 μg/ml and 0.2 μg/ml, between 20

μg/ml and 100 μg/ml, between 10 μg/ml and 100 μg/ml, between 5 μg/ml and 100 μg/ml, between 2 μg/ml and 100 μg/ml, between 1 μg/ml and 100 μg/ml, between 0.5 μg/ml and 100 μg/ml, between 0.2 μg/ml and 100 μg/ml, between 0.1 μg/ml and 100 μg/ml, between 0.05 μg/ml and 100 μg/ml, 0.02 μg/ml and 100 μg/ml, between 0.02 μg/ml and 0.1 μg/ml, between 0.05 μg/ml and 0.2 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.2 μg/ml and 1 μg/ml, between 0.5 μg/ml and 2 μg/ml, between 1 μg/ml and 5 μg/ml, between 2 μg/ml and 10 μg/ml, between 5 μg/ml and 20 μg/ml, or between 10 μg/ml and 50 μg/ml, e.g., between 0.1 μg/ml and 15 μg/ml, between 0.1 μg/ml and 2.5 μg/ml, between 1 μg/ml and 15 μg/ml, between 0.5 μg/ml and 3.5 μg/ml, between 0.3 μg/ml and 1.2 μg/ml, 1.2 μg/ml and 3 μg/ml, between 0.3 μg/ml and 0.4 μg/ml, between 0.9 μg/ml and 1 μg/ml, between 1 μg/ml and 1.2 μg/ml, between 2 μg/ml and 2.2 μg/ml, between 3.1 μg/ml and 3.2 μg/ml, e.g., as determined by a method described herein.

In an embodiment, the antibody molecule reduces (e.g., inhibits or blocks) the binding of a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), to an ACE receptor, at a half maximal inhibitory concentration (IC_{50}) of 200 nM or less, e.g., 150 nM or less, 100 nM or less, 50 nM or less, 25 nM or less, 20 nM or less, 15 nM or less, 10 nM or less, 5 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or less, or 0.1 nM or less, e.g., between 0.1 nM and 200 nM, between 0.2 nM and 100 nM, between 0.5 nM and 50 nM, between 1 nM and 20 nM, between 2 nM and 10 nM, between 0.1 nM and 100 nM, between 0.1 nM and 50 nM, between 0.1 nM and 20 nM, between 0.1 nM and 10 nM, between 0.1 nM and 5 nM, between 0.1 nM and 2 nM, between 0.1 nM and 1 nM, between 0.1 nM and 0.5 nM, between 0.1 nM and 0.2 nM, between 100 nM and 200 nM, between 50 nM and 200 nM, between 20 nM and 200 nM, between 10 nM and 200 nM, between 5 nM and 200 nM, between 2 nM and 200 nM, between 1 nM and 200 nM, between 0.5 nM and 200 nM, between 0.2 nM and 200 nM, between 0.2 nM and 1 nM, between 0.5 nM and 2 nM, between 1 nM and 5 nM, between 2 nM and 10 nM, between 5 nM and 20 nM, between 10 nM and 50 nM, between 20 nM and 100 nM, e.g., as determined by a method described herein.

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) a SARS-CoV-2 infection at a half maximal inhibitory concentration (IC_{50}) of 10 μg/ml or less, e.g., 5 μg/ml or less, 2 μg/ml or less, 1 μg/ml or less, 0.9 μg/ml or less, 0.8 μg/ml or less, 0.7 μg/ml or less, 0.6 μg/ml or less, 0.5 μg/ml or less, 0.4 μg/ml or less, 0.3 μg/ml or less, 0.2 μg/ml or less, 0.1 μg/ml or less, 0.05 μg/ml or less, 0.02 μg/ml or less, or 0.01 μg/ml or less, e.g., between 0.01 μg/ml and 10 μg/ml, between 0.1 μg/ml and 10 μg/ml, between 1 μg/ml and 10 μg/ml, between 0.01 μg/ml and 5 μg/ml, between 0.02 μg/ml and 2 μg/ml, between 0.05 μg/ml and 1 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.01 μg/ml and 0.02 μg/ml, between 0.01 μg/ml and 0.05 μg/ml, between 0.01 μg/ml and 0.1 μg/ml, between 0.01 μg/ml and 0.2 μg/ml, between 0.01 μg/ml and 0.5 μg/ml, between 0.01 μg/ml and 1 μg/ml, between 0.01 μg/ml and 2 μg/ml, between 2 μg/ml and 5 μg/ml, between 1 μg/ml and 5 μg/ml, between 0.5 μg/ml and 5 μg/ml, between 0.2 μg/ml and 5 μg/ml, between 0.1 μg/ml and 5 μg/ml, between 0.05 μg/ml and 5 μg/ml, between 0.02 μg/ml and 5 μg/ml, between 0.02 μg/ml and

0.1 μg/ml, between 0.05 μg/ml and 0.2 μg/ml, between 0.1 μg/ml and 0.5 μg/ml, between 0.2 μg/ml and 1 μg/ml, or between 0.5 μg/ml and 2 μg/ml, as determined by a method described herein.

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) a SARS-CoV-2 infection at a half maximal inhibitory concentration (IC_{50}) of 100 nM or less, e.g., 50 nM or less, 20 nM or less, 10 nM or less, 9 nM or less, 8 nM or less, 7 nM or less, 6 nM or less, 5 nM or less, 4 nM or less, 3 nM or less, 2 nM or less, 1 nM or less, 0.5 nM or less, 0.2 nM or less, 0.1 nM or less, e.g., between 0.1 nM and 100 nM, between 1 nM and 100 nM, between 0.1 nM and 50 nM, between 0.2 nM and 20 nM, between 0.5 nM and 10 nM, between 1 nM and 5 nM, between 0.1 nM and 0.2 nM, between 0.1 nM and 0.5 nM, between 0.1 nM and 1 nM, between 0.1 nM and 2 nM, between 0.1 nM and 5 nM, between 0.1 nM and 10 nM, between 0.1 nM and 20 nM, between 20 nM and 50 nM, between 10 nM and 50 nM, between 5 nM and 50 nM, between 1 nM and 50 nM, between 0.5 nM and 50 nM, between 0.2 nM and 50 nM, between 0.2 nM and 1 nM, between 0.5 nM and 2 nM, between 1 nM and 5 nM, between 2 nM and 10 nM, or between 5 nM and 20 nM, as determined by a method described herein;

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) a SARS-CoV-2 infection at a $PRNT_{50}$ of 100 μg/mL or less, e.g., 20 μg/mL or less, 10 μg/mL or less, 9 μg/mL or less, 8 μg/mL or less, 7 μg/mL or less, 6 μg/mL or less, 5 μg/mL or less, 4 μg/mL or less, 3 μg/mL or less, 2 μg/mL or less, 1 μg/mL or less, 0.5 μg/mL or less, 0.2 μg/mL or less, 0.1 μg/mL or less, e.g., between 0.1 μg/mL and 100 μg/mL, between 1 μg/mL and 100 μg/mL, between 10 μg/mL and 100 μg/mL, between 0.1 μg/mL and 50 μg/mL, between 0.2 μg/mL and 20 μg/mL, between 0.5 μg/mL and 10 μg/mL, between, 1 μg/mL and 5 μg/mL, between 0.1 μg/mL and 20 μg/mL, between 0.1 μg/mL and 10 μg/mL, between 0.1 μg/mL and 5 μg/mL, between 0.1 μg/mL and 2 μg/mL, between 0.1 μg/mL and 1 μg/mL, between 0.1 μg/mL and 0.5 μg/mL, between 0.1 μg/mL and 0.2 μg/mL, between 20 μg/mL and 50 μg/mL, between 10 μg/mL and 50 μg/mL, between 5 μg/mL and 50 μg/mL, between 2 μg/mL and 50 μg/mL, between 1 μg/mL and 50 μg/mL, between 0.5 μg/mL and 50 μg/mL, between 0.2 μg/mL and 50 μg/mL, between 0.2 μg/mL and 1 μg/mL, between 0.5 μg/mL and 2 μg/mL, between 1 μg/mL and 5 μg/mL, between 2 μg/mL and 10 μg/mL, between 5 μg/mL and 20 μg/mL, e.g., as determined by a plaque reduction neutralization test (PRNT).

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) a SARS-CoV-2 infection at a $PRNT_{50}$ of 500 nM or less, e.g., 200 nM or less, 100 nM or less, 50 nM or less, 40 nM or less, 30 nM or less, 20 nM or less, 10 nM or less, 5 nm or less. 2 nM or less, or 1 nM or less, e.g., between 1 nM and 500 nM, between 10 nM and 500 nM, between 100 nM and 500 nM, between 1 nM and 200 nM, between 2 nM and 100 nM, between 5 nM and 50 nM, between 10 nM and 20 nM, between 1 nM and 100 nM, between 1 nM and 50 nM, between 1 nM and 20 nM, between 1 nM and 10 nM, between 1 nM and 5 nM, between 1 nM and 2 nM, between 100 nM and 200 nM, between 50 nM and 200 nM, 20 nM and 200 nM, 10 nM and 200 nM, 5 nM and 200 nM, 2 nM and 200 nM, 2 nM

and 10 nM, 5 nM and 20 nM, 10 nM and 50 nM, 20 nM and 100 nM, as determined by a plaque reduction neutralization test (PRNT).

In an embodiment, the antibody molecule reduces (e.g., inhibits, blocks, or neutralizes) one or more biological activities of a a SARS-CoV-2 spike protein, *in vitro*, *ex vivo*, or *in vivo*.

In an embodiment, the antibody molecule binds specifically to an epitope on a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), e.g., the same, similar, or overlapping epitope as the epitope recognized by a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule shows the same or similar binding affinity or specificity, or both, as a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule shows the same or similar binding affinity or specificity, or both, as an antibody molecule comprising one or more (e.g., two or three) heavy chain CDRs and/or one or more (e.g., two or three) light chain CDRs described in **Table 1**.

In an embodiment, the antibody molecule shows the same or similar binding affinity or specificity, or both, as an antibody molecule comprising a heavy chain variable region (VH) and/or a light chain variable region (VL) described in **Table 1**.

In an embodiment, the antibody molecule inhibits, e.g., competitively inhibits, the binding of a second antibody molecule to a SARS-CoV-2 spike protein, or a fragment thereof, wherein the second antibody molecule is a monoclonal antibody described in **Tables 1 or 2**.

In an embodiment, the antibody molecule competes for binding with a second antibody molecule to a SARS-CoV-2 spike protein, or a fragment thereof, wherein the second antibody molecule is a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule has one or more biological properties of a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule has one or more structural properties of a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule has one or more pharmacokinetic properties of a monoclonal antibody described in **Table 2**.

In an embodiment, the antibody molecule binds to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, wherein the SARS-CoV-2 spike protein comprises an amino acid sequence of SEQ ID NO: 321-323 or 336-340.

In an embodiment, the antibody molecule binds specifically to a SARS-CoV-2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD), with high affinity, wherein the SARS-CoV-2 spike protein comprises one or more (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more) mutations chosen from A67V, Δ69, Δ70, T95I, G142D, Δ143-145, N211I, Δ212, R214ins, G339D, S371L, S373P, S375F, K417N, N440K, G446S, S477N, T478K, E484A, Q493R, G496S, Q498R, N501Y, Y505H, T547K, D614G, H655Y, N679K, P681H, N764K, D796Y, N856K, Q954H, N969K, or L981F.

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) an infection caused by a SARS-CoV-2 variant, e.g., one or more of SARS-CoV-2 variants alpha (B.1.1.7, UK variant), beta (B.1.351, B.1.351.2, B.1.351.3, South Africa variant), gamma (P.1, P.1.1, P.1.2, Brazil variant), delta (B.1.617.2, AY.1, AY.2, AY.3, India variant), eta (B.1.525), Iota (B.1.526), kappa (B.1.617.1), lambda (C.37), or omicron (B.1.1.529, BA.1, BA1.1, BA.2, BA.3, BA.4, BA.5, BA.4/5, BQ1.1, XBB).

In an embodiment, the antibody molecule reduces (e.g., inhibits or neutralizes) an infection caused by a SARS-CoV-2 variant comprising one or more (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, or more) mutations in the spike protein chosen from A67V, Δ69, Δ70, T95I, G142D, Δ143-145, N211I, Δ212, R214ins, G339D, S371L, S373P, S375F, K417N, N440K, G446S, S477N, T478K, E484A, Q493R, G496S, Q498R, N501Y, Y505H, T547K, D614G, H655Y, N679K, P681H, N764K, D796Y, N856K, Q954H, N969K, or L981F.

Animal Models

The antibody molecules described herein can be evaluated *in vivo*, e.g., using various animal models. For example, an animal model can be used to test the efficacy of an antibody molecule described herein in inhibiting binding of a SARS-CoV-2 spike protein, in treating or preventing a SARS-CoV-2 infection, and/or in treating or preventing a disorder associated with a SARS-CoV-2, e.g., COVID-19.

Exemplary animal models that can be used for evaluating an antibody molecule described herein are known in the art, e.g., as described in Muñoz-Fontela et al., Nature. 2020 Oct; 586(7830):509-515, which is incorporated by reference in its entirety. For example, the suitable animal models include, but are not limited to, mouse models, Syrian hamster model, ferret models, and non-human-primate models. Additional exemplary animal models include, e.g., mink, cats, dogs, pigs, chickens, ducks, and fruit bats.

Pharmaceutical Compositions

The antibody molecules described herein can be included in pharmaceutical compositions.

In an aspect, this disclosure provides a composition, e.g., a pharmaceutically acceptable composition, which includes an antibody molecule described herein, formulated together with a pharmaceutically acceptable carrier.

Therapeutic compositions in accordance with the disclosure can comprise one or more antibody molecules, e.g., an antibody molecule as disclosed herein, with suitable carriers, excipients, and other agents that are incorporated into formulations to provide improved transfer, delivery, tolerance, and the like. These formulations include, for example, powders, pastes, ointments, jellies, waxes, oils, lipids, lipid (cationic or anionic) containing vesicles (such as LIPOFECTIN™), DNA

conjugates, anhydrous absorption pastes, oil-in-water and water-in-oil emulsions, emulsions carbowax (polyethylene glycols of various molecular weights), semi-solid gels, and semi-solid mixtures containing carbowax. See, e.g., Remington's Pharmaceutical Sciences, Mack Publishing Company, Easton, Pa.; and Powell et al. "Compendium of excipients for parenteral formulations" PDA (1998) J Pharm Sci Technol 52:238-311.

As used herein, "pharmaceutically acceptable carrier" includes any and all solvents, dispersion media, isotonic and absorption delaying agents, and the like that are physiologically compatible. The carrier can be suitable for intravenous, intramuscular, subcutaneous, parenteral, rectal, spinal or epidermal administration (e.g., by injection or infusion). In an embodiment, less than about 5%, e.g., less than about 4%, 3%, 2%, or 1% of the antibody molecules in the pharmaceutical composition are present as aggregates. In other embodiments, at least about 95%, e.g., at least about 96%, 97%, 98%, 98.5%, 99%, 99.5%, 99.8%, or more of the antibody molecules in the pharmaceutical composition are present as monomers. In an embodiment, the level of aggregates or monomers is determined by chromatography, e.g., high performance size exclusion chromatography (HP-SEC).

The compositions set out herein may be in a variety of forms. These include, for example, liquid, semi-solid and solid dosage forms, such as liquid solutions (e.g., injectable and infusible solutions), dispersions or suspensions, liposomes, and suppositories. A suitable form depends on the intended mode of administration and therapeutic application. Typical suitable compositions are in the form of injectable or infusible solutions. One suitable mode of administration is parenteral (e.g., intravenous, subcutaneous, intraperitoneal, intramuscular). In an embodiment, the antibody molecule is administered by intravenous infusion or injection. In an embodiment, the antibody is administered by intramuscular or subcutaneous injection.

The phrases "parenteral administration" and "administered parenterally" as used herein means modes of administration other than enteral and topical administration, usually by injection, and includes, without limitation, intravenous, intramuscular, intraarterial, intrathecal, intracapsular, intraorbital, intracardiac, intradermal, intraperitoneal, transtracheal, subcutaneous, subcuticular, intraarticular, subcapsular, subarachnoid, intraspinal, epidural and intrasternal injection and infusion.

Therapeutic compositions typically should be sterile and stable under the conditions of manufacture and storage. The composition can be formulated as a solution, microemulsion, dispersion, liposome, or other ordered structure suitable to high antibody concentration. Sterile injectable solutions can be prepared by incorporating the active compound (i.e., antibody or antibody portion) in the required amount in an appropriate solvent with one or a combination of ingredients enumerated above, as required, followed by filtered sterilization. Generally, dispersions are prepared by incorporating the active compound into a sterile vehicle that contains a basic dispersion medium and the required other ingredients from those enumerated above. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation are vacuum drying and

freeze-drying that yields a powder of the active ingredient plus any additional desired ingredient from a previously sterile-filtered solution thereof. The proper fluidity of a solution can be maintained, for example, by the use of a coating such as lecithin, by the maintenance of the required particle size in the case of dispersion and by the use of surfactants. Prolonged absorption of injectable compositions can be brought about by including in the composition an agent that delays absorption, for example, monostearate salts and gelatin.

The antibody molecules described herein can be administered by a variety of methods. Several are known in the art, and for many therapeutic, prophylactic, or diagnostic applications, an appropriate route/mode of administration is intravenous injection or infusion. For example, the antibody molecules can be administered by intravenous infusion at a rate of less than 10mg/min; preferably less than or equal to 5 mg/min to reach a dose of about 1 to 100 mg/m^2, preferably about 5 to 50 mg/m^2, about 7 to 25 mg/m^2 and more preferably, about 10 mg/m^2. As will be appreciated by the skilled artisan, the route and/or mode of administration will vary depending upon the desired results. In an embodiment, the active compound may be prepared with a carrier that will protect the compound against rapid release, such as a controlled release formulation, including implants, transdermal patches, and microencapsulated delivery systems. Biodegradable, biocompatible polymers can be used, such as ethylene vinyl acetate, polyanhydrides, polyglycolic acid, collagen, polyorthoesters, and polylactic acid. Many methods for the preparation of such formulations are patented or generally known to those skilled in the art. See, e.g., Sustained and Controlled Release Drug Delivery Systems, J. R. Robinson, ed., Marcel Dekker, Inc., New York, 1978.

In an embodiment, an antibody molecule can be orally administered, for example, with an inert diluent or an assimilable edible carrier. The antibody molecule (and other ingredients, if desired) may also be enclosed in a hard- or soft-shell gelatin capsule, compressed into tablets, or incorporated directly into the subject's diet. For oral therapeutic administration, the antibody molecule may be incorporated with excipients and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. To administer an antibody molecule by other than parenteral administration, it may be necessary to coat the compound with, or co-administer the compound with, a material to prevent its inactivation. Therapeutic, prophylactic, or diagnostic compositions can also be administered with medical devices, and several are known in the art.

Dosage regimens are adjusted to provide the desired response (e.g., a therapeutic, prophylactic, or diagnostic response). For example, a single bolus may be administered, several divided doses may be administered over time or the dose may be proportionally reduced or increased as indicated by the exigencies of the therapeutic situation. It is especially advantageous to formulate parenteral compositions in dosage unit form for ease of administration and uniformity of dosage. Dosage unit form as used herein refers to physically discrete units suited as unitary dosages for the subjects to be treated; each unit contains a predetermined quantity of active compound calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. The

specification for the dosage unit forms are dictated by and directly dependent on (a) the unique characteristics of the antibody molecule and the particular therapeutic, prophylactic, or diagnostic effect to be achieved, and (b) the limitations inherent in the art of compounding such an antibody molecule for the treatment of sensitivity in individuals.

An exemplary, non-limiting range for a therapeutically, prophylactically, or diagnostically effective amount of an antibody molecule is about 0.1-200 mg/kg body weight of a subject, e.g., about 0.1-100 mg/kg, e.g., about 0.1-50, 0.2-40, 0.3-30, 0.4-20, 0.5-15, 1-30, 1-15, 1-10, 1-5, 5-10, or 1-3 mg/kg, e.g., about 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50, 100, or 200 mg/kg. The antibody molecule can be administered by intravenous infusion at a rate of less than 10 mg/min, e.g., less than or equal to 5 mg/min to reach a dose of about 1 to 100 mg/m^2, e.g., about 5 to 50 mg/m^2, about 7 to 25 mg/m^2, e.g., about 10 mg/m^2.

In an embodiment, a therapeutically, prophylactically, or diagnostically effective amount of an antibody molecule is between 5 mg to 10,000 mg, e.g., between 10 mg to 9,000 mg, 15 mg to 8,500 mg, 20 mg to 8,250 mg, 25 mg to 8,000 mg, 30 mg to 7,500 mg, 35 mg to 7,000 mg, 40 mg to 6,500 mg, 50 mg to 8, 000 mg, 75 mg to 8,000 mg, 100 mg to 8,000 mg, 150 mg to 6,000 mg, 100 mg to 9,000 mg, 150 mg to 8,500 mg, 200 mg to 8,000 mg, 250 mg to 7,500 mg, 300 mg to 7,000 mg, 350 mg to 7, 000 mg, 400 mg to 6,500 mg, 450 mg to 6,000 mg, 500 mg to 5,500 mg, 100 mg to 5,000 mg, 150 mg to 4,500 mg, 200 mg to 4,000 mg, 200 mg to 3,500 mg, 200 mg to 2,000 mg, 200 mg to 1000 mg, 50 mg to 900 mg, 100 mg to 850 mg, 125 mg to 800 mg, 150 mg to 750 mg, 175 mg to 700 mg, 200 mg to 600 mg, 150 mg to 500 mg, or 200 mg to 400 mg.

It is to be noted that dosage values may vary with the type and severity of the condition to be alleviated. It is to be further understood that for any particular subject, specific dosage regimens should be adjusted over time according to the individual need and the professional judgment of the person administering or supervising the administration of the compositions, and that dosage ranges set forth herein are exemplary only and are not intended to limit the scope or practice of the claimed compositions.

A "prophylactically effective amount" refers to an amount effective, at dosages and for periods of time necessary, to achieve the desired prophylactic result. Typically, since a prophylactic dose is used in subjects prior to or at an earlier stage of disease, the prophylactically effective amount will be less than the therapeutically effective amount.

A "diagnostically effective amount" refers to an amount effective, at dosages and for periods of time necessary, to achieve the desired diagnostic result. Typically, a diagnostically effective amount is one in which a disorder, e.g., a disorder described herein, e.g., IgA nephropathy, can be diagnosed *in vitro, ex vivo,* or *in vivo.*

Formulations

The antibody molecules described herein can be formulated into various formulations for therapeutic and/or prophylactic use.

In an aspect, the disclosure provides a formulation comprises an antibody molecule described herein.

In an embodiment, the formulation is a drug substance formulation. In an embodiment, the formulation is a liquid formulation. In an embodiment, the formulation is a lyophilized formulation. In an embodiment, the formulation is a reconstituted formulation.

In an embodiment, the formulation is suitable for intravenous administration. In an embodiment, the formulation is suitable for subcutaneous administration. In an embodiment, the formulation is suitable for intramuscular administration.

In an embodiment, the formulation further comprises one or more excipients, e.g., one, two, three, four, or all of a buffer, a salt, a surfactant, a carbohydrate, an amino acid, or an antioxidant. In an embodiment, the buffer comprises acetate, citrate, histidine, succinate, phosphate, or Tris. In an embodiment, the salt comprises sodium. In an embodiment, the surfactant comprises polysorbate 80, polysorbate 20, or poloxamer 188. In an embodiment, the carbohydrate comprises sucrose, mannitol, sorbitol, trehalose, or dextran 40. In an embodiment, the amino acid comprises glycine or arginine. In an embodiment, the antioxidant comprises ascorbic acid, methionine, or ethylenediaminetetraacetic acid (EDTA).

In an embodiment, the antibody molecule is present at a concentration of 1 mg/mL to 300 mg/mL. In an embodiment, the formulation has a pH of 5 to 8.

Kits

The antibody molecules described herein can also be placed in kits.

In an aspect, the disclosure provides kit that comprises an antibody molecule described herein or a composition (e.g., pharmaceutical composition) described herein. The kit can include one or more other elements including: instructions for use; other reagents, e.g., a label, a therapeutic agent, or an agent useful for chelating, or otherwise coupling, an antibody molecule to a label or therapeutic agent, or a radioprotective composition; devices or other materials for preparing the antibody molecule for administration; pharmaceutically acceptable carriers; and devices or other materials for administration to a subject.

Nucleic Acids

The disclosure also features nucleic acids comprising nucleotide sequences that encode the antibody molecules (e.g., heavy and/or light chain variable regions, CDRs of the antibody molecules), as described herein.

For example, the present disclosure features a first and second nucleic acid encoding heavy and light chain variable regions, respectively, of an antibody molecule chosen from one or more of the antibody molecules disclosed herein, e.g., an antibody molecule of **Table 2**, or a portion of an antibody molecule, e.g., the variable regions of **Table 1 or 2**. The nucleic acid can comprise a nucleotide sequence encoding any one of the amino acid sequences in the tables herein, or a sequence substantially identical thereto (e.g., a sequence at least about 85%, 90%, 95%, 99% or more identical thereto, or which differs by no more than 3, 6, 15, 30, or 45 nucleotides from the sequences shown in the tables herein).

In an embodiment, the nucleic acid can comprise a nucleotide sequence encoding at least one, two, or three CDRs from a heavy chain variable region having an amino acid sequence as set forth in **Table 1**, or a sequence substantially homologous thereto (e.g., a sequence at least about 85%, 90%, 95%, 99% or more identical thereto, and/or having one or more substitutions, e.g., conserved substitutions). In an embodiment, the nucleic acid can comprise a nucleotide sequence encoding at least one, two, or three CDRs from a light chain variable region having an amino acid sequence as set forth in the tables herein, or a sequence substantially homologous thereto (e.g., a sequence at least about 85%, 90%, 95%, 99% or more identical thereto, and/or having one or more substitutions, e.g., conserved substitutions). In an embodiment, the nucleic acid can comprise a nucleotide sequence encoding at least one, two, three, four, five, or six CDRs from heavy and light chain variable regions having an amino acid sequence as set forth in the tables herein, or a sequence substantially homologous thereto (e.g., a sequence at least about 85%, 90%, 95%, 99% or more identical thereto, and/or having one or more substitutions, e.g., conserved substitutions).

In an embodiment, the nucleic acid may encode, for example, a variable region (e.g., VH or VL); one, two, or three or more CDRs; or one, two, three, or four or more framework regions.

The nucleic acids disclosed herein include deoxyribonucleotides or ribonucleotides, or analogs thereof. The polynucleotide may be either single-stranded or double-stranded, and if single-stranded may be the coding strand or non-coding (antisense) strand. A polynucleotide may comprise modified nucleotides, such as methylated nucleotides and nucleotide analogs. The sequence of nucleotides may be interrupted by non-nucleotide components. A polynucleotide may be further modified after polymerization, such as by conjugation with a labeling component. The nucleic acid may be a recombinant polynucleotide, or a polynucleotide of genomic, cDNA, semisynthetic, or synthetic origin which either does not occur in nature or is linked to another polynucleotide in a non-natural arrangement.

In an aspect, the application features host cells and vectors containing the nucleic acids described herein. The nucleic acids may be present in a single vector or separate vectors present in the same host cell or separate host cell, as described in more detail below.

Vectors

The disclosure also provides vectors that comprise a nucleotide sequence encoding an antibody molecule described herein.

In an embodiment, the vector comprises a nucleotide sequence encoding an antibody molecule described herein, e.g., as described in **Table 2**. The vectors include, but are not limited to, a virus, plasmid, cosmid, lambda phage or a yeast artificial chromosome (YAC).

Numerous vector systems can be employed. For example, vectors can utilize DNA elements or RNA elements derived from animal viruses. Exemplary viral vectors include, but are not limited to, those derived from bovine papilloma virus, polyoma virus, adenovirus, adeno-associated virus, vaccinia virus, baculovirus, retrovirus, lentivirus, SV40 virus, Semliki Forest virus, eastern equine encephalitis virus, and flaviviruses.

Additionally, cells which have stably integrated the DNA into their chromosomes may be selected by introducing one or more markers which allow for the selection of transfected host cells. The marker may provide, for example, prototropy to an auxotrophic host, biocide resistance (e.g., antibiotics), or resistance to heavy metals such as copper, or the like. The selectable marker gene can be either directly linked to the DNA sequences to be expressed or introduced into the same cell by cotransformation. Additional elements may also be needed for optimal synthesis of mRNA. These elements may include splice signals, as well as transcriptional promoters, enhancers, and termination signals.

Once the expression vector or DNA sequence containing the constructs has been prepared for expression, the expression vectors may be transfected or introduced into an appropriate host cell. Various techniques may be employed to achieve this, such as, for example, protoplast fusion, calcium phosphate precipitation, electroporation, retroviral transduction, viral transfection, gene gun, lipid based transfection or other conventional techniques. In the case of protoplast fusion, the cells are grown in media and screened for the appropriate activity.

Methods and conditions for culturing the resulting transfected cells and for recovering the antibody molecule produced are known to those skilled in the art and may be varied or optimized depending upon the specific expression vector and mammalian host cell employed, based upon the present description.

Cells

The present disclosure also provides cells (e.g., host cells) comprising a nucleic acid encoding an antibody molecule as described herein. In some embodiments, the cell comprises a nucleic acid described herein. Additionally, the cells may comprise a nucleic acid molecule encoding an amino acid sequence of **Table 1**, a sequence substantially homologous thereto (e.g., a sequence at least about 80%, 85%, 90%, 95%, 99% or more identical thereto), or a portion of one of said sequences. The disclosure also provides cells comprising a vector described herein.

In an embodiment, the cell is an isolated cell. In an embodiment, the cell is genetically engineered to comprise a nucleic acid encoding an antibody molecule described herein. In an embodiment, the cell is genetically engineered by using an expression cassette. The phrase "expression cassette," refers to nucleotide sequences, which are capable of affecting expression of a gene in hosts compatible with such sequences. Such cassettes may include a promoter, an open reading frame with or without introns, and a termination signal. Additional factors necessary or helpful in effecting expression may also be used, such as, for example, an inducible promoter.

The cell can be, but is not limited to, a eukaryotic cell, a bacterial cell, an insect cell, or a human cell. Suitable eukaryotic cells include, but are not limited to, Vero cells, HeLa cells, COS cells, CHO cells, HEK293 cells, BHK cells and MDCKII cells. Suitable insect cells include, but are not limited to, Sf9 cells. In an embodiment, the cell (e.g., host cell) is an isolated cell.

Uses of Antibody Molecules

The antibody molecules disclosed herein, as well as the pharmaceutical compositions disclosed herein, have *in vitro*, *ex vivo*, and *in vivo* therapeutic, prophylactic, and/or diagnostic utilities.

In an embodiment, the antibody molecule reduces (e.g., inhibits, blocks, or neutralizes) one or more biological activities of a SARS-CoV2 spike protein, or a fragment thereof (e.g., a fragment comprising an RBD). For example, these antibodies molecules can be administered to cells in culture, *in vitro* or *ex vivo*, or to a subject, e.g., a human subject, e.g., *in vivo*, to reduce (e.g., inhibits, blocks, or neutralizes) an infection caused by a SARS-CoV-2. In an embodiment, the antibody molecule inhibits, or substantially inhibit, binding of e.g., a SARS-CoV-2 spike protein to an ACE receptor expressed in a cell surface, e.g., mammalian cell surface, e.g., human cell surface. Accordingly, in an aspect, the disclosure provides a method of treating, preventing, or diagnosing a disorder, e.g., a disorder described herein (e.g., COVID-19), in a subject, comprising administering to the subject an antibody molecule described herein, such that the disorder is treated, prevented, or diagnosed. For example, the disclosure provides a method comprising contacting the antibody molecule described herein with cells in culture, e.g., *in vitro* or *ex vivo*, or administering the antibody molecule described herein to a subject, e.g., *in vivo*, to treat, prevent, or diagnose a disorder, e.g., a disorder described herein (e.g., COVID-19).

As used herein, the term "subject" is intended to include human and non-human animals. In an embodiment, the subject is a human subject, e.g., a human patient having a SARS-CoV-2-associated disorder, or at risk of having a SARS-CoV-2-associated disorder. The term "non-human animals" includes mammals and non-mammals, such as non-human primates. In an embodiment, the subject is a human.

The antibody molecules and pharmaceutical compositions described herein are suitable for treating various SARS-CoV-2-associated disorders in subjects (e.g., human subjects). SARS-CoV-2-

associated disorders include, e.g., disorders that caused by SARS-CoV-2 directly or indirectly. For example, SARS-CoV-2-associated disorders can include SARS-CoV-2 infections or disorders following SARS-CoV-2 infections. Subjects (e.g., patients) having a SARS-CoV-2-associated disorder include those who have developed the disorder, but are (at least temporarily) asymptomatic, patients who have exhibited a symptom of the disorder, or patients having another disorder related to or associated with the disorder.

In an embodiment, the subject has, or is at risk of having, a SARS-CoV-2 infection. In an embodiment, the subject has, or is at risk of having, COVID-19. Subjects that are at risk of having a SARS-CoV-2 infection include, but are not limited to, subjects with compromised immune systems, subjects with forms of anemia that deplete or destroy white blood cells, subjects afflicted with human immunodeficiency syndrome (HIV) or acquired immune deficiency syndrome (AIDS), subjects receiving immunosuppressive therapy (e.g., following organ transplant), subjects afflicted with a neoplasia disorder, subjects afflicted with a respiratory disorder, e.g., asthma, subjects receiving radiation or chemotherapy, or subjects afflicted with an inflammatory disorder. In an embodiment, subjects of young age (e.g., 5 years of age or younger) or old age (e.g., 65 years of age or older) may be at increased risk. In an embodiment, a subject may be at risk of contracting a SARS-CoV-2 infection due to proximity to an outbreak of the disease, e.g., subject resides in a densely-populated location or in close proximity to subjects having confirmed or suspected infections of a SARS-CoV-2, or choice of employment (e.g., hospital worker, pharmaceutical researcher, traveler to infected area, or frequent flier).

In an embodiment, the subject has, is at risk of having, a disorder following a SARS-CoV-2 infection. Exemplary disorders that may follow a SARS-CoV-2 infection include, but are not limited to, multisystem inflammatory syndrome (IMS), e.g., pediatric inflammatory syndrome (PIMS), Guillain–Barré Syndrome, Kawasaki disease, autoimmune diseases, inflammatory diseases, and central nervous system complications.

Methods of Treating or Preventing Disorders

The antibody molecules described herein can be used to treat or prevent a SARS-CoV-2 infection, or a SARS-CoV-2-associated disorder, e.g., COVID-19), or a symptom thereof.

In an aspect, the disclosure provides a method of treating or preventing a SARS-CoV-2 infection or a symptom thereof. The method comprises administering to a subject in need thereof an effective amount of an antibody molecule described herein.

In an embodiment, the subject has a SARS-CoV-2 infection. In an embodiment, the subject is at risk of having a SARS-CoV-2 infection. In an embodiment, the subject has exhibited a symptom of a SARS-CoV-2 infection. In an embodiment, the subject has not exhibited a symptom of a SARS-CoV-2 infection.

In an aspect, the disclosure provides a method of treating or preventing a SARS-CoV-2-associated disorder, e.g., COVID-19, or a symptom thereof. The method comprises administering to a subject in need thereof an effective amount of an antibody molecule described herein.

In an embodiment, the subject has a SARS-CoV-2-associated disorder, e.g., COVID-19. In an embodiment, the subject is at risk of having a a SARS-CoV-2-associated disorder, e.g., COVID-19. In an embodiment, the subject has exhibited a symptom of a SARS-CoV-2-associated disorder, e.g., COVID-19. In an embodiment, the subject has not exhibited a symptom of a SARS-CoV-2-associated disorder, e.g., COVID-19.

Exemplary symptoms of a SARS-CoV-2 infection, or a SARS-CoV-2-associated disorder, e.g., COVID-19, include, but are not limited to, fever or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, and diarrhea.

Exemplary SARS-CoV-2-associated disorders include, but are not limited to, multisystem inflammatory syndrome (IMS), e.g., pediatric inflammatory syndrome (PIMS), Guillain–Barré Syndrome, Kawasaki disease, acute respiratory distress syndrome (ARDS), lung injuries (e.g., diffuse alveolar damage in the lung, lung fibrosis, dilated pulmonary vessels), pneumonias, autoimmune diseases, inflammatory diseases, and central nervous system complications.

The antibody molecules described herein are typically administered at a frequency that keeps a therapeutically effective level of antibody molecules in the patient's system until the patient recovers. For example, the antibody molecules may be administered at a frequency that achieves a serum concentration sufficient for at least about 1, 2, 5, 10, 20, 30, or 40 antibody molecules to bind each SARS-CoV-2 spike protein. In an embodiment, the antibody molecules are administered every 1, 2, 3, 4, 5, 6, or 7 days, every 1, 2, 3, 4, 5, or 6 weeks, or every 1, 2, 3, 4, 5, or 6 months.

Methods of administering antibody molecules are known in the art. Suitable dosages of the antibody molecules used typically depend on the age and weight of the subject and the particular drug used.

In an embodiment, the antibody molecule is administered to the subject (e.g., a human subject) intravenously. In an embodiment, the antibody molecule is administered to the subject at a dose between 0.01 mg/kg and 500 mg/kg, e.g., between 0.05 mg/kg and 200 mg/kg, between 0.1 mg/kg and 100 mg/kg, between 0.2 mg/kg and 50 mg/kg, between 0.5 mg/kg and 20 mg/kg, 1 mg/kg and 10 mg/kg, between 2 mg/kg and 5 mg/kg, between 1 mg/kg and 10 mg/kg, between 1 mg/kg and 5 mg/kg, between 0.5 mg/kg and 30 mg/kg, between 2.5 mg/kg and 15 mg/kg, between 5 mg/kg and 7.5 mg/kg, between 0.2 mg/kg and 1 mg/kg, between 2 mg/kg and 3 mg/kg, between 2 mg/kg and 10 mg/kg, between 5 mg/kg and 10 mg/kg, between 10 mg/kg and 20 mg/kg, between 25 mg/kg and 35 mg/kg, e.g., 0.5 mg/kg, 1 mg/kg, 2.5 mg/kg, 5 mg/kg, 7.5 mg/kg, 10 mg/kg, 15 mg/kg, 20 mg/kg, 25 mg/kg, or 30 mg/kg. In an embodiment, the antibody molecule is administered once a day, once a week, twice a week, once every two weeks, once every three weeks, once every four weeks, once

every eight weeks, once a month, once every two months, or once every three months, or on as needed basis based on subject condition.

In an embodiment, the antibody molecule may be administered at an initial dose, followed by one or more secondary doses. In certain embodiments, the initial dose may be followed by administration of a second or a plurality of subsequent doses of antibody molecule in an amount that can be approximately the same or less than that of the initial dose, wherein the subsequent doses are separated by at least 1 day to 3 days, at least one week, at least 2 weeks, at least 3 weeks, at least 4 weeks, at least 5 weeks, at least 6 weeks, at least 7 weeks, at least 8 weeks, at least 9 weeks, at least 10 weeks, at least 12 weeks, or at least 14 weeks.

The antibody molecules described herein can be used by themselves or conjugated to a second agent, e.g., a bacterial agent, toxin, or protein, e.g., a second antibody molecule. This method includes: administering the antibody molecule, alone or conjugated to a second agent, to a subject requiring such treatment. The antibody molecules described herein can be used to deliver a variety of therapeutic agents, e.g., a toxin, or mixtures thereof.

In an embodiment, a method described herein reduces one or more symptoms of a SARS-CoV-2 infection, or a SARS-CoV-2-associated disorder, e.g., COVID-19 in a subject for 12 hours, 15 hours, 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, or longer, compared to a subject who has not been treated by a method described herein.

Combination Therapies

The antibody molecules described herein can be used in combination with other therapies.

In an aspect, the disclosure provides a combination therapy comprising an antibody molecule described herein and a second therapeutic agent or modality. In an embodiment, the antibody molecule is administered or used in combination with a second therapeutic agent or modality to treat or prevent e.g., a SARS-CoV-2 infection or a SARS-CoV-2-associated disorder, e.g., COVID-19.

In an embodiment, the combination therapy comprises an antibody molecule described herein co-formulated with, and/or co-administered with, one or more additional therapeutic agents or modalities e.g., one or more additional therapeutic agents or modalities described herein. Such combination therapies may advantageously utilize lower dosages of the administered or used therapeutic agents or modalities, thus avoiding possible toxicities or complications associated with the various monotherapies.

Administered "in combination", as used herein, means that two (or more) different treatments are delivered to the subject before, or during the course of the subject's affliction with a disorder. In an embodiment, two or more treatments are delivered prophylactically, e.g., before the subject has the disorder or is diagnosed with the disorder. In another embodiment, the two or more treatments are delivered after the subject has developed or diagnosed with the disorder. In an embodiment, the delivery of one treatment is still occurring when the delivery of the second begins, so that there is

overlap. This is sometimes referred to herein as "simultaneous" or "concurrent delivery." In other embodiments, the delivery of one treatment ends before the delivery of the other treatment begins. This is sometimes referred to herein as "sequential delivery." In an embodiment of either case, the treatment is more effective because of combined administration. For example, the second treatment is more effective, e.g., an equivalent effect is seen with less of the second treatment, or the second treatment reduces symptoms to a greater extent, than would be seen if the second treatment were administered in the absence of the first treatment, or the analogous situation is seen with the first treatment. In an embodiment, delivery is such that the reduction in a symptom, or other parameter related to the disorder is greater than what would be observed with one treatment delivered in the absence of the other. The effect of the two treatments can be partially additive, wholly additive, or greater than additive. The delivery can be such that an effect of the first treatment delivered is still detectable when the second is delivered.

In an embodiment, the additional agent is a second antibody molecule, e.g., an antibody molecule different from a first antibody molecule. Exemplary antibody molecules that can be used in combination include, but are not limited to, any combination of the antibody molecules described in **Table 2** or antibody molecules comprising any of the sequences described in **Table 1**. In an embodiment, the first and second antibody molecules are described in **Table 2**.

In an embodiment, the second antibody molecule is capable of binding to a SARS-CoV-2 spike protein. In an embodiment, the second antibody molecule comprises one or more of bamlanivimab (LY-CoV555, LY3819253), etesevimab (LY-CoV016, JS016), bamlanivimab/etesevimab, casirivimab (REGN10933), imdevimab (REGN10987), casirivimab/imdevimab (REGEN-COV®), sotrovimab (VIR-7831), bebtelovimab (LY-CoV1404, LY3853113), tixagevimab (AZD8895, COV2-2196), cilgavimab (AZD1061), tixagevimab/cilgavimab (AZD442, EVUSHELD®), or a combination thereof.

In an embodiment, the additional agent is a small molecule. Exemplary small molecules that can be used in combination with an antibody molecule described herein include, but are not limited to, an RdRp inhibitor (e.g., remdesivir (GS-5734, VEKLURY®), molnupiravir (LAGEVRIO®), favipiravir (T-705), ribavirin, penciclovir), a $3CL^{pro}$ inhibitor (e.g., nirmatrelvir (PF-07321332), ritonavir, nirmatrelvir-ritonavir (PAXLOVID®), PF-00835231, AG7088, AG7404, lopinavir, darunavir, cobicistat, ASC09 F), a PL^{pro} inhibitor (e.g., 6-mercaptopurine (6MP), 6-thioguanine (6TG), biltricide, cinacalcet, procainamide, terbinafine, pethidine, labetalol, tetrahydrozoline, ticlopidine, ethoheptazine, formoterol, amitriptyline, naphazoline, levamisole, benzylpenicillin, CQ, HCQ, chlorothiazide), a selective serotonin reuptake inhibitor (e.g., fluvoxamine), a dihydroorotate dehydrogenase (DHODH) inhibitor (e.g., S312, S416), thalidomide, pentoxifylline, oxypurinol, an S-phase kinase-associated protein 2 (SKP2) inhibitor, a TMPRSS2 inhibitor (e.g., camostat mesylate, namostat mesylate, MI-432, MI-1900), a furin inhibitor (MI-1851, MI-1148, diminazene, CMK), an S protein inhibitor (e.g., arbidol), a corticosteroid, or a combination thereof. Other small molecule

therapeutics are described, e.g., in Tian et al. Biomed Pharmacother. 2021; 137:111313, and Puhl et al. Front. Drug. Discov. 2022; 2:837587, which are incorporated by reference in their entirety.

In an embodiment, the additional agent is an anti-inflamatory agent. Exemplary anti-inflamatory agents that can be used in combination with an antibody molecule described herein include, but are not limited to, anakinra (KINERET®), tocilizumab (ACTEMRA®) and baricitinib (OLUMIANT®).

Other exemplary second therapeutic agents or modalities that can be used in the combination therapies described herein include, but are not limited to, vaccine (e.g., a COVID-19 vaccine, e.g., an mRNA vaccine), convalescent plasma, pyronaridine, paracetamol, NSAID, fluid therapy, oxygen support, prone positioning, glucocorticoid dexamethasone, noninvasive ventilation, mechanical ventilation, extracorporeal membrane oxygenation (ECMO), and hydroxychloroquine (PLAQUENIL®).

Methods of Diagnosis

The antibody molecules described herein can be used to detect a SARS-CoV-2 infection and/or to diagnose a SARS-CoV-2-associated disorder.

In an aspect, the disclosure provides a method for detecting the presence of a SARS-CoV-2 *in vitro* (e.g., in a sample) or *in vivo* (e.g., *in vivo* imaging in a subject). The method includes: (i) contacting a sample with an antibody molecule described herein, or administering to a subject an antibody molecule described herein; (optionally) (ii) contacting a reference sample with the antibody molecule, or administering to a reference subject the antibody molecule; and (iii) detecting formation of a complex between the antibody molecule and the SARS-CoV2 in the sample or subject, or in the control sample or subject, wherein a change, e.g., a statistically significant change, in the formation of the complex in the sample or subject relative to the control sample or subject is indicative of the presence of the SARS-CoV2 in the sample or subject.

In another aspect, the disclosure provides a diagnostic method for detecting the presence of a SARS-CoV2 spike protein or a fragment thereof (e.g., a fragment comprising an RBD) *in vitro* (e.g., in a sample) or *in vivo* (e.g., *in vivo* imaging in a subject). The method includes: (i) contacting a sample with an antibody molecule described herein, or administering to a subject an antibody molecule described herein; (optionally) (ii) contacting a reference sample with the antibody molecule, or administering to a reference subject the antibody molecule; and (iii) detecting formation of a complex between the antibody molecule and the SARS-CoV2 spike protein or a fragment thereof (e.g., a fragment comprising an RBD) in the sample or subject, or in the control sample or subject, wherein a change, e.g., a statistically significant change, in the formation of the complex in the sample or subject relative to the control sample or subject is indicative of the presence of the SARS-CoV2 spike protein or a fragment thereof (e.g., a fragment comprising an RBD) in the sample or subject.

Complex formation can be detected by measuring or visualizing either the bound or unbound antibody molecule. Any suitable detection assays can be used, and conventional detection assays include, e.g., an enzyme-linked immunosorbent assays (ELISA), a radioimmunoassay (RIA) or tissue immunohistochemistry. The antibody molecule can be directly or indirectly labeled with a detectable substance to facilitate detection of the bound or unbound antibody. Suitable detectable substances include various enzymes, prosthetic groups, fluorescent materials, luminescent materials, and radioactive materials.

Alternative to labeling the antibody molecule, a competition immunoassay utilizing a standard labeled with a detectable substance and an unlabeled antibody molecule can be used. In this assay, the sample, labeled standard, and antibody molecule are combined, and the amount of labeled standard bound to the unlabeled antibody molecule is determined. The amount of SARS-CoV-2, or SARS-CoV-2 spike protein or a fragment thereof (e.g., a fragment comprising an RBD), in the sample is inversely proportional to the amount of labeled standard bound to the antibody molecule.

Various samples can be used in accordance with the detection and diagnosis methods described herein. In an embodiment, the sample is a biological sample. The biological samples can include, e.g., body fluids, cells, cell lysates, cell extracts, proteins, or a mixture thereof. In an embodiment, the sample is obtained from a subject (e.g., a subject described herein). In an embodiment, the subject has, or is at risk of having, a SARS-CoV2 infection. In an embodiment, the subject has, or is at risk of having a SARS-CoV2-associated disorder. Exemplary samples include, but are not limited to, a swap sample (e.g., a sample from the nose or throat, e.g., anterior nares, mid-turbinate, nasopharyngeal, or oropharyngeal), a saliva sample, and a blood sample.

The detection and diagnostic methods described herein can further include a second test for diagnosing a SARS-CoV-2 infection, e.g., a PCR test or an antigen test.

The antibody molecules described herein can be used to diagnose a disorder at can be treated or prevented by the antibody molecules described herein. The detection or diagnostic methods described herein can be used in combination with other methods described herein to treat or prevent a disorder described herein.

Enumerated Embodiments

1. An antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising a heavy chain variable region (VH) and a light chain variable region (VL),

wherein the VH comprises three heavy chain complementarity determining regions (HCDR1, HCDR2, and HCDR3), wherein the VL comprises three light chain complementarity determining regions (LCDR1, LCDR2, and LCDR3), and

wherein the HCDR1 comprises an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; the HCDR2 comprises an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; the HCDR3 comprises an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306; the

LCDR1 comprises an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; the LCDR2 comprises an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; and the LCDR3 comprises an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

2. The antibody molecule of embodiment 1, comprising the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

3. The antibody molecule of embodiment 1 or 2, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

4. The antibody molecule of any of embodiments 1-3, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112.

5. The antibody molecule of any of embodiments 1-4, wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

6. The antibody molecule of any of embodiments 1-5, wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163.

7. The antibody molecule of any of embodiments 1-6, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

8. The antibody molecule of any of embodiments 1-7, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112; and wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163.

9. The antibody molecule of any of embodiments 1-8, comprising the VH and the VL of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34,

mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

10. An antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising:

(A) (a) a heavy chain variable region (VH) comprising:

(i) an HCDR1 comprising the amino acid sequence:

$GX_1X_2X_3X_4X_5YX_6$

wherein: X_1 is Y or F;

X_2 is P, D, S, T or N;

X_3 is F or Y;

X_4 is T or S;

X_5 is S, L, K, Q, R or Y; and

X_6 is G, L, R, Y or N;

(SEQ ID NO: 324);

(ii) an HCDR2 comprising the amino acid sequence:

$ISX_1X_2X_3GNT$

wherein: X_1 is T, N or D;

X_2 is Y, H or W; and

X_3 is N, D or T;

(SEQ ID NO: 325); and

(iii) an HCDR3 comprising the amino acid sequence:

$ARDYX_1X_2GX_3WX_4X_5EX_6LIGGFDN$

wherein: X_1 is N or T;

X_2 is R or Q;

X_3 is A, S, N or D;

X_4 is F or Y;

X_5 is G, Q, H, L or D; and

X_6 is S, T, H, E or Q;

(SEQ ID NO: 326); and

(b) a light chain variable region (VL) comprising:

(i) an LCDR1 comprising the amino acid sequence:

$QX_1X_2SX_3X_4X_5$

wherein: X_1 is T, Q, D, E or S;

X_2 is V or T;

X_3 is S, Q or M;

X_4 is T or E; and

X_5 is S or T;

(SEQ ID NO: 327);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2X_3$

wherein: X_1 is G, W, D, Y or F;

X_2 is A or S; and

X_3 is H, S, E, Y or Q;

(SEQ ID NO: 328); and

(iii) an LCDR3 comprising the amino acid sequence:

$QX_1HX_2X_3SLT$

wherein: X_1 is Q or E;

X_2 is D or E; and

X_3 is T, Q, E, K or R;

(SEQ ID NO: 329), or

(B) (a) a VH comprising:

(i) an HCDR1 comprising the amino acid sequence:

$X_1X_2X_3X_4X_5YX_6IG$

wherein: X_1 is Y, H, R, E, S or K;

X_2 is G or S;

X_3 is F or Y;

X_4 is I, Q or R;

X_5 is T or W; and

X_6 is W or Y;

(SEQ ID NO: 330);

(ii) an HCDR2 comprising the amino acid sequence:

$GIIYX_1GX_2X_3EX_4RYS$

wherein: X_1 is P, H or W;

X_2 is D or N;

X_3 is Q, S, L, H, N, G, K or R; and

X_4 is T or V;

(SEQ ID NO: 331); and

(iii) an HCDR3 comprising the amino acid sequence:

$CAGX_1X_2X_3IX_4TPMDVW$

wherein: X_1 is G, W, F, R or Y;

X_2 is S, G, K or D;

X_3 is G or R; and

X_4 is N, S, D, K, H, W, Y or R;

(SEQ ID NO: 332); and

(b) a VL comprising:

(i) an LCDR1 comprising the amino acid sequence:

$KSSQSX_1LX_2X_3X_4IX_5X_6X_7YIX_8$

wherein: X_1 is V or N;

X_2 is Y, R or W;

X_3 is S, T, N or H;

X_4 is S, R, H, W or N;

X_5 is N, E, K, Q, H, Y, L or K;

X_6 is K or R;

X_7 is N, E or D; and

X_8 is A or R;

(SEQ ID NO: 333);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2SX_3X_4EX_5$

wherein: X_1 is W or Y;

X_2 is A, S or G;

X_3 is T, K or R;

X_4 is R or P;

X_5 is S, Y, E, N, R, I or H;

(SEQ ID NO: 334); and

(iii) an LCDR3 comprising the amino acid sequence:

$CQX_1YYX_2X_3PYTF$

wherein: X_1 is E, Q or N;

X_2 is S, T, R, Q, K, W or E; and

X_3 is T or D;

(SEQ ID NO: 335).

11. The antibody molecule of embodiment 10, comprising the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

12. The antibody molecule of embodiment 10 or 11, comprising the VH and the VL of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34,

mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

13. The antibody molecule of any of the preceding embodiments, which comprises an antigen-binding fragment.

14. The antibody molecule of embodiment 13, wherein the antigen-binding fragment comprises a Fab, F(ab')2, Fv, scFv, or sc(Fv)2.

15. The antibody molecule of any of the preceding embodiments, which comprises a heavy chain constant region chosen from the heavy chain constant regions of IgG1, IgG2, IgG3, or IgG4.

16. The antibody molecule of any of the preceding embodiments, which comprises a light chain constant region chosen from the light chain constant regions of kappa or lambda.

17. The antibody molecule of any of the preceding embodiments, which comprises an Fc region.

18. The antibody molecule of embodiment 17, wherein the Fc region comprises a mutation.

19. The antibody molecule of any of the preceding embodiments, wherein said antibody molecule is a monoclonal antibody molecule, an isolated antibody molecule, a humanized antibody molecule, or a synthetic antibody molecule.

20. The antibody molecule of any of the preceding embodiments, wherein said antibody molecule is a monospecific antibody molecule or a multispecific antibody molecule, e.g., a bispecific antibody molecule.

21. An antibody molecule that competes for binding to a SARS-CoV-2 spike protein with an antibody molecule of any of embodiments 1-20.

22. An antibody molecule that binds to the same or overlapping epitope as the epitope recognized by an antibody molecule of any of embodiments 1-20.

23. A composition (e.g., pharmaceutical composition) comprising an antibody molecule of any of embodiments 1-20, and optionally a pharmaceutically acceptable carrier, excipient or stabilizer.

24. A container (e.g., a vial) comprising an antibody molecule of any of embodiments 1-22, or the composition of embodiment 23.

25. A kit comprising an antibody molecule of any of embodiments 1-20, or the composition of embodiment 23, and instructions for use.

26. A nucleic acid encoding the VH, VL, or both, of an antibody molecule of any of embodiments 1-22.

27. A vector (e.g., expression vector) comprising the nucleic acid of embodiment 26.

28. A cell (e.g., host cell) comprising the nucleic acid of embodiment 26 or the vector of embodiment 27.

29. A method of producing an antibody molecule, comprising culturing the cell of embodiment 28 under conditions that allow expression of the antibody molecule.

30. A method of inhibiting SARS-CoV-2, comprising contacting SARS-CoV-2 with an antibody molecule of any of embodiments 1-22, or the composition of embodiment 23.

31. The method of embodiment 30, wherein the contacting step occurs *in vitro*, *ex vivo*, or *in vivo*.

32. A method of treating or preventing a SARS-CoV-2 infection, comprising administering to a subject in need thereof an effective amount of an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23.

33. A method of treating or preventing COVID-19, or a symptom thereof, comprising administering to a subject in need thereof an effective amount of an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23.

34. A method of treating or preventing a disorder associated with SARS-CoV-2, comprising administering to a subject in need thereof an effective amount an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23.

35. An antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, for use in a method of treating or preventing a SARS-CoV-2 infection in a subject.

36. An antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, for use in a method of treating or preventing COVID-19, or a symptom thereof, in a subject.

37. An antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, for use in a method of treating or preventing a disorder associated with SARS-CoV-2 in a subject.

38. Use of an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, in the manufacture of a medicament for treating or preventing a SARS-CoV-2 infection in a subject.

39. Use of an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, in the manufacture of a medicament for treating or preventing COVID-19, or a symptom thereof, in a subject.

40. Use of an antibody molecule of any of embodiments 1-22 or the composition of embodiment 23, in the manufacture of a medicament for treating or preventing a disorder associated with SARS-CoV-2 in a subject.

41. The method of any of embodiments 32-34, the antibody molecule or composition for use of any of embodiments 35-37, or the use of any of embodiments 38-40, wherein the antibody molecule or composition is administered intravenously, subcutaneously, or intramuscularly.

42. The method of any of embodiments 32-34 or 41, the antibody molecule or composition for use of any of embodiments 35-37 or 41, or the use of any of embodiments 38-41, wherein the antibody molecule or composition is administered at a dose of 0.5 mg/kg to 30 mg/kg.

43. The method of any of embodiments 32-34, 41, or 42, the antibody molecule or composition for use of any of embodiments 35-37, 41, or 42, or the use of any of embodiments 38-42, wherein the antibody molecule or composition is administered or used in combination with a second therapeutic agent or modality.

44. The method, the antibody molecule or composition for use, or the use of embodiment 43, wherein the antibody molecule or composition is administered or used prior to, concurrently with, or after the administration or use of the second therapeutic agent or modality.

45. The method, the antibody molecule or composition for use, or the use of embodiment 43 or 44, wherein the second therapeutic agent or modality comprises an antiviral drug, e.g., nirmatrelvir/ritonavir or molnupiravir, an immune modulator, e.g., anakinra, baricitinib, or tocilizumab, or a second antibody molecule, e.g., bebtelovimab, tixagevimab/cilgavimab, cairivimab/imdevimab, sotrovimab, or bamlanimvib/etsevimab.

46. The method of any of embodiments 32-34 or 41-45, the antibody molecule or composition for use of any of embodiments 35-37 or 41-45, or the use of any of embodiments 38-45, wherein the SARS-CoV-2 is a SARS-CoV-2 variant, or wherein the COVID-19 is caused by a SARS-CoV-2 variant, optionally wherein the SARS-CoV-2 variant is an alpha variant, a beta variant, a gamma variant, a delta variant, or an omicron variant, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

47. A method of detecting SARS-CoV-2, comprising (i) contacting a sample or a subject with an antibody molecule of any of embodiments 1-22 under conditions that allow interaction of the antibody molecule and SARS-CoV-2 to occur, and (ii) detecting formation of a complex between the antibody molecule and the sample or subject.

48. The method of embodiment 47, further comprising (i) contacting a reference sample or subject with the antibody molecule under conditions that allow interaction of the antibody molecule and SARS-CoV-2 to occur, and (ii) detecting formation of a complex between the antibody molecule and the reference sample or subject.

EXAMPLES

Example 1: Engineering and Screening of Expressed Recombinant Antibodies

This Example describes engineering and screening of monoclonal antibodies binding to SARS-CoV-2. Computational engineering of monoclonal antibodies binding to SARS-CoV-2 involved selection of orthogonal, conserved, target epitopes on the SARS-CoV-2 receptor binding domain and use of machine learning and existing datasets in combination with experimental screening.

Expressed recombinant antibodies were screened using enzyme linked immunosorbant assays (ELISAs). The antibodies purified from a 1mL transient transfection were tested for binding against BA.1 receptor-binding domain (RBD) (Acro# SPD C522e) protein on an ELISA. Briefly, 2ug/mL of SARS-CoV-2 BA.1 RBD protein were coated on 96-well ELISA plates (Nunc Maxisorp) and left overnight at 4°C. The wells were blocked with 5% Blotto (Santa Cruz) in 1xPBST for 1hr at room temperature. Using the Opentron OT-2 benchtop liquid handler, the purified variant recombinant antibodies were diluted to either 12 and 0.3ug/mL or 12 and 0.06ug/mL respectively and added to the plates and incubated on a rocker platform for 2hrs at room temperature. After rinsing the plates three times with 1x PBST, a rabbit anti-human IgG conjugated to horseradish peroxidase (Jackson Immuno Research) was added to each well. The plates were incubated for 1hr at room temperature followed by washing with 1xPBST and addition of TMB substrate. The reaction was stopped by adding 1N sulphuric acid and the absorbance was read at 450nm.

Select antibody candidates were serially diluted and tested for binding against BA.1 RBD (Acro# SPD C522e) protein on an ELISA to determine apparent K_D values. Briefly, 0.5ug/mL of BA.1 RBD protein were coated on 96-well ELISA plates (Nunc Maxisorp) and left overnight at 4°C. The wells were blocked with 5% Blotto (Santa Cruz) in 1xPBST for 1hr at room temperature. Using the Opentron OT-2 benchtop liquid handler, a three-fold serial dilution of select antibodies from 9ug/mL to 0.152ng/ul was made and added to the plates and incubated on a rocker platform for 2hrs at room temperature. After rinsing the plates three times with 1x PBST a rabbit anti-human IgG conjugated to horseradish peroxidase (Jackson Immuno Research) was added to each well. The plates were incubated for 1hr at room temperature followed by washing with 1xPBST and addition of TMB substrate. The reaction was stopped by adding 1N sulphuric acid and the absorbance was read at 450nm. Binding curves and binding affinity values are shown in **FIGs. 1A-1C** and **2A-2C**. The affinity of the antibodies to BA.1 RBD (Acro# SPD C522e) was determined using the Octet (biolayer interferometry). The Pro A sensors were presoaked in 20mM HEPES with 150mM NaCl and 0.05% tween 20, pH 7.4 or assay buffer and then loaded with 0.5ug/mL of select recombinant monoclonal antibody. A two-fold dilution of the different RBDs from 60nM to 1.875nM in assay buffer was made and the antibody coated Pro A sensors were then incubated in the various dilutions followed by dissociation in assay buffer. The K_D values were calculated using the global fit method on the Octet Red96(Sartorius) instrument. Binding affinity values are shown in **Table 3**.

Table 3. K_D estimates by Octet BLI for exemplary class 3 and class 4 epitope antibodies

Antibody	K_D (M)	K_D Error	k_a (1/Ms)	k_a Error	k_{dis} (1/s)	k_{dis} Error
reference antibody – 1	3.66E-09	4.89E-11	6.79E+05	5.69E+03	2.49E-03	2.58E-05
reference antibody – 2	1.55E-09	1.96E-11	7.92E+04	2.35E+02	1.22E-04	1.51E-06
mAb11	<1.0E-12	<1.0E-12	3.35E+05	3.28E+02	1.85E-07	<1.0E-07

mAb43	9.80E-11	<1.0E-12	5.89E+05	2.24E+03	5.77E-05	5.13E-07

As shown in **Table 3**, **FIGs. 1A-1C**, and **FIGs. 2A-2C**, the engineered mAbs (**Tables 1 and 2**) reached sufficient binding affinities against circulating SARS-CoV-2 variants of concerns (VOCs), leading to effective neutralization either as monotherapies or in combination. The engineered antibodies showed subnanomolar affinities to the receptor binding domain of the circulating Omicron BA.1 receptor binding domain (RBD), on par or better than reference therapeutic antibodies (**Table 3**, **FIGs. 1A-1C**, and **FIGs. 2A-2C**).

INCORPORATION BY REFERENCE

All publications, patents, and accession numbers mentioned herein are hereby incorporated by reference in their entirety as if each individual publication or patent was specifically and individually indicated to be incorporated by reference.

EQUIVALENTS

While specific embodiments of the subject invention have been discussed, the above specification is illustrative and not restrictive. Many variations of the invention will become apparent to those skilled in the art upon review of this specification and the claims below. The full scope of the invention should be determined by reference to the claims, along with their full scope of equivalents, and the specification, along with such variations.

CLAIMS

What is claimed is:

1. An antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising a heavy chain variable region (VH) and a light chain variable region (VL).

wherein the VH comprises three heavy chain complementarity determining regions (HCDR1, HCDR2, and HCDR3), wherein the VL comprises three light chain complementarity determining regions (LCDR1, LCDR2, and LCDR3), and

wherein the HCDR1 comprises an amino acid sequence of any of SEQ ID NOs: 164-179 or 190-201; the HCDR2 comprises an amino acid sequence of any of SEQ ID NOs: 226-232 or 243-254; the HCDR3 comprises an amino acid sequence of any of SEQ ID NOs: 268-282 or 290-306; the LCDR1 comprises an amino acid sequence of any of SEQ ID NOs: 180-189 or 202-225; the LCDR2 comprises an amino acid sequence of any of SEQ ID NOs: 233-242 or 255-267; and the LCDR3 comprises an amino acid sequence of any of SEQ ID NOs: 283-289 or 307-318.

2. The antibody molecule of claim 1, comprising the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

3. The antibody molecule of claim 1 or 2, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

4. The antibody molecule of any of claims 1-3, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112.

5. The antibody molecule of any of claims 1-4, wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

6. The antibody molecule of any of claims 1-5, wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163.

7. The antibody molecule of any of claims 1-6, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom; and wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163, or an amino acid sequence that is at least 85%, 90%, 95%, 96%, 97%, 98%, or 99% identical thereto, or differs by no more than 1, 2, 3, 4, 5, 10, 15, 20, or 25 amino acids therefrom.

8. The antibody molecule of any of claims 1-7, wherein the VH comprises an amino acid sequence of any of SEQ ID NOs: 1-37 or 68-112; and wherein the VL comprises an amino acid sequence of any of SEQ ID NOs: 38-67 or 113-163.

9. The antibody molecule of any of claims 1-8, comprising the VH and the VL of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

10. An antibody molecule capable of binding to a SARS-CoV-2 spike protein, comprising:

(A) (a) a heavy chain variable region (VH) comprising:

(i) an HCDR1 comprising the amino acid sequence:

$GX_1X_2X_3X_4X_5YX_6$

wherein: X_1 is Y or F;

X_2 is P, D, S, T or N;

X_3 is F or Y;

X_4 is T or S;

X_5 is S, L, K, Q, R or Y; and

X_6 is G, L, R, Y or N;

(SEQ ID NO: 324);

(ii) an HCDR2 comprising the amino acid sequence:

$ISX_1X_2X_3GNT$

wherein: X_1 is T, N or D;

X_2 is Y, H or W; and

X_3 is N, D or T;

(SEQ ID NO: 325); and

(iii) an HCDR3 comprising the amino acid sequence:

$ARDYX_1X_2GX_3WX_4X_5EX_6LIGGFDN$

wherein: X_1 is N or T;

X_2 is R or Q;

X_3 is A, S, N or D;

X_4 is F or Y;

X_5 is G, Q, H, L or D; and

X_6 is S, T, H, E or Q;

(SEQ ID NO: 326); and

(b) a light chain variable region (VL) comprising:

(i) an LCDR1 comprising the amino acid sequence:

$QX_1X_2SX_3X_4X_5$

wherein: X_1 is T, Q, D, E or S;

X_2 is V or T;

X_3 is S, Q or M;

X_4 is T or E; and

X_5 is S or T;

(SEQ ID NO: 327);

(ii) an LCDR2 comprising the amino acid sequence:

$X_1X_2X_3$

wherein: X_1 is G, W, D, Y or F;

X_2 is A or S; and

X_3 is H, S, E, Y or Q;

(SEQ ID NO: 328); and

(iii) an LCDR3 comprising the amino acid sequence:

$QX_1HX_2X_3SLT$

wherein: X_1 is Q or E;

X_2 is D or E; and

X_3 is T, Q, E, K or R;

(SEQ ID NO: 329), or

(B) (a) a VH comprising:

(i) an HCDR1 comprising the amino acid sequence:

$X_1X_2X_3X_4X_5YX_6IG$

wherein: X_1 is Y, H, R, E, S or K;

X_2 is G or S;

X_3 is F or Y;

X_4 is I, Q or R;

X_5 is T or W; and

X_6 is W or Y;

(SEQ ID NO: 330);

(ii) an HCDR2 comprising the amino acid sequence:

GIIYX$_1$GX$_2$X$_3$EX$_4$RYS

wherein: X_1 is P, H or W;

X_2 is D or N;

X_3 is Q, S, L, H, N, G, K or R; and

X_4 is T or V;

(SEQ ID NO: 331); and

(iii) an HCDR3 comprising the amino acid sequence:

CAGX$_1$X$_2$X$_3$IX$_4$TPMDVW

wherein: X_1 is G, W, F, R or Y;

X_2 is S, G, K or D;

X_3 is G or R; and

X_4 is N, S, D, K, H, W, Y or R;

(SEQ ID NO: 332); and

(b) a VL comprising:

(i) an LCDR1 comprising the amino acid sequence:

KSSQSX$_1$LX$_2$X$_3$X$_4$IX$_5$X$_6$X$_7$YIX$_8$

wherein: X_1 is V or N;

X_2 is Y, R or W;

X_3 is S, T, N or H;

X_4 is S, R, H, W or N;

X_5 is N, E, K, Q, H, Y, L or K;

X_6 is K or R;

X_7 is N, E or D; and

X_8 is A or R;

(SEQ ID NO: 333);

(ii) an LCDR2 comprising the amino acid sequence:

X$_1$X$_2$SX$_3$X$_4$EX$_5$

wherein: X_1 is W or Y;

X_2 is A, S or G;

X_3 is T, K or R;

X_4 is R or P;

X_5 is S, Y, E, N, R, I or H;

(SEQ ID NO: 334); and

(iii) an LCDR3 comprising the amino acid sequence:

$CQX_1YYX_2X_3PYTF$

wherein: X_1 is E, Q or N;

X_2 is S, T, R, Q, K, W or E; and

X_3 is T or D;

(SEQ ID NO: 335).

11. The antibody molecule of claim 10, comprising the HCDR1, HCDR2, HCDR3, LCDR1, LCDR2, and LCDR3 of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

12. The antibody molecule of claim 10 or 11, comprising the VH and the VL of any of mAb1, mAb2, mAb3, mAb4, mAb5, mAb6, mAb7, mAb8, mAb9, mAb10, mAb11, mAb12, mAb13, mAb14, mAb15, mAb16, mAb17, mAb18, mAb19, mAb20, mAb21, mAb22, mAb23, mAb24, mAb25, mAb26, mAb27, mAb28, mAb29, mAb30, mAb31, mAb32, mAb33, mAb34, mAb35, mAb36, mAb37, mAb38, mAb39, mAb40, mAb41, mAb42, mAb43, mAb44, mAb45, mAb46, mAb47, mAb48, mAb49, mAb50, mAb51, mAb52, mAb53, mAb54, or mAb55.

13. The antibody molecule of any of the preceding claims, which comprises an antigen-binding fragment.

14. The antibody molecule of claim 13, wherein the antigen-binding fragment comprises a Fab, F(ab')2, Fv, scFv, or sc(Fv)2.

15. The antibody molecule of any of the preceding claims, which comprises a heavy chain constant region chosen from the heavy chain constant regions of IgG1, IgG2, IgG3, or IgG4.

16. The antibody molecule of any of the preceding claims, which comprises a light chain constant region chosen from the light chain constant regions of kappa or lambda.

17. The antibody molecule of any of the preceding claims, which comprises an Fc region.

18. The antibody molecule of claim 17, wherein the Fc region comprises a mutation.

19. The antibody molecule of any of the preceding claims, wherein said antibody molecule is a monoclonal antibody molecule, an isolated antibody molecule, a humanized antibody molecule, or a synthetic antibody molecule.

20. The antibody molecule of any of the preceding claims, wherein said antibody molecule is a monospecific antibody molecule or a multispecific antibody molecule, e.g., a bispecific antibody molecule.

21. An antibody molecule that competes for binding to a SARS-CoV-2 spike protein with an antibody molecule of any of claims 1-20.

22. An antibody molecule that binds to the same or overlapping epitope as the epitope recognized by an antibody molecule of any of claims 1-20.

23. A composition (e.g., pharmaceutical composition) comprising an antibody molecule of any of claims 1-20, and optionally a pharmaceutically acceptable carrier, excipient or stabilizer.

24. A container (e.g., a vial) comprising an antibody molecule of any of claims 1-22, or the composition of claim 23.

25. A kit comprising an antibody molecule of any of claims 1-20, or the composition of claim 23, and instructions for use.

26. A nucleic acid encoding the VH, VL, or both, of an antibody molecule of any of claims 1-22.

27. A vector (e.g., expression vector) comprising the nucleic acid of claim 26.

28. A cell (e.g., host cell) comprising the nucleic acid of claim 26 or the vector of claim 27.

29. A method of producing an antibody molecule, comprising culturing the cell of claim 28 under conditions that allow expression of the antibody molecule.

30. A method of inhibiting SARS-CoV-2, comprising contacting SARS-CoV-2 with an antibody molecule of any of claims 1-22, or the composition of claim 23.

31. The method of claim 30, wherein the contacting step occurs *in vitro*, *ex vivo*, or *in vivo*.

32. A method of treating or preventing a SARS-CoV-2 infection, comprising administering to a subject in need thereof an effective amount of an antibody molecule of any of claims 1-22 or the composition of claim 23.

33. A method of treating or preventing COVID-19, or a symptom thereof, comprising administering to a subject in need thereof an effective amount of an antibody molecule of any of claims 1-22 or the composition of claim 23.

34. A method of treating or preventing a disorder associated with SARS-CoV-2, comprising administering to a subject in need thereof an effective amount an antibody molecule of any of claims 1-22 or the composition of claim 23.

35. An antibody molecule of any of claims 1-22 or the composition of claim 23, for use in a method of treating or preventing a SARS-CoV-2 infection in a subject.

36. An antibody molecule of any of claims 1-22 or the composition of claim 23, for use in a method of treating or preventing COVID-19, or a symptom thereof, in a subject.

37. An antibody molecule of any of claims 1-22 or the composition of claim 23, for use in a method of treating or preventing a disorder associated with SARS-CoV-2 in a subject.

38. Use of an antibody molecule of any of claims 1-22 or the composition of claim 23, in the manufacture of a medicament for treating or preventing a SARS-CoV-2 infection in a subject.

39. Use of an antibody molecule of any of claims 1-22 or the composition of claim 23, in the manufacture of a medicament for treating or preventing COVID-19, or a symptom thereof, in a subject.

40. Use of an antibody molecule of any of claims 1-22 or the composition of claim 23, in the manufacture of a medicament for treating or preventing a disorder associated with SARS-CoV-2 in a subject.

41. The method of any of claims 32-34, the antibody molecule or composition for use of any of claims 35-37, or the use of any of claims 38-40, wherein the antibody molecule or composition is administered intravenously, subcutaneously, or intramuscularly.

42. The method of any of claims 32-34 or 41, the antibody molecule or composition for use of any of claims 35-37 or 41, or the use of any of claims 38-41, wherein the antibody molecule or composition is administered at a dose of 0.5 mg/kg to 30 mg/kg.

43. The method of any of claims 32-34, 41, or 42, the antibody molecule or composition for use of any of claims 35-37, 41, or 42, or the use of any of claims 38-42, wherein the antibody molecule or composition is administered or used in combination with a second therapeutic agent or modality.

44. The method, the antibody molecule or composition for use, or the use of claim 43, wherein the antibody molecule or composition is administered or used prior to, concurrently with, or after the administration or use of the second therapeutic agent or modality.

45. The method, the antibody molecule or composition for use, or the use of claim 43 or 44, wherein the second therapeutic agent or modality comprises an antiviral drug, e.g., nirmatrelvir/ritonavir or molnupiravir, an immune modulator, e.g., anakinra, baricitinib, or tocilizumab, or a second antibody molecule, e.g., bebtelovimab, tixagevimab/cilgavimab, cairivimab/imdevimab, sotrovimab, or bamlanimvib/etsevimab.

46. The method of any of claims 32-34 or 41-45, the antibody molecule or composition for use of any of claims 35-37 or 41-45, or the use of any of claims 38-45, wherein the SARS-CoV-2 is a SARS-CoV-2 variant, or wherein the COVID-19 is caused by a SARS-CoV-2 variant, optionally wherein the SARS-CoV-2 variant is an alpha variant, a beta variant, a gamma variant, a delta variant, or an omicron variant, e.g., omicron BA.1, BA.2, BA.4/5, BQ1.1 or XBB.

47. A method of detecting SARS-CoV-2, comprising (i) contacting a sample or a subject with an antibody molecule of any of claims 1-22 under conditions that allow interaction of the antibody molecule and SARS-CoV-2 to occur, and (ii) detecting formation of a complex between the antibody molecule and the sample or subject.

48. The method of claim 47, further comprising (i) contacting a reference sample or subject with the antibody molecule under conditions that allow interaction of the antibody molecule and SARS-CoV-2 to occur, and (ii) detecting formation of a complex between the antibody molecule and the reference sample or subject.

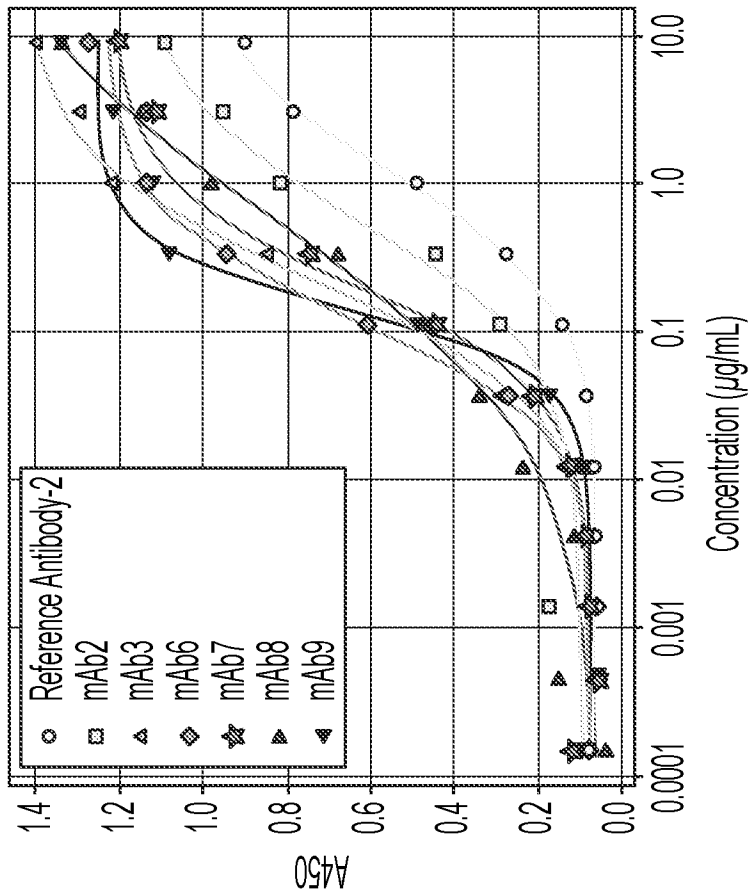
A450
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0001
0.001
0.01
0.1
1.0
10.0
Concentration (µg/mL)
Reference Antibody-2
mAb2
mAb3
mAb6
mAb7
mAb8
mAb9

FIG. 1B

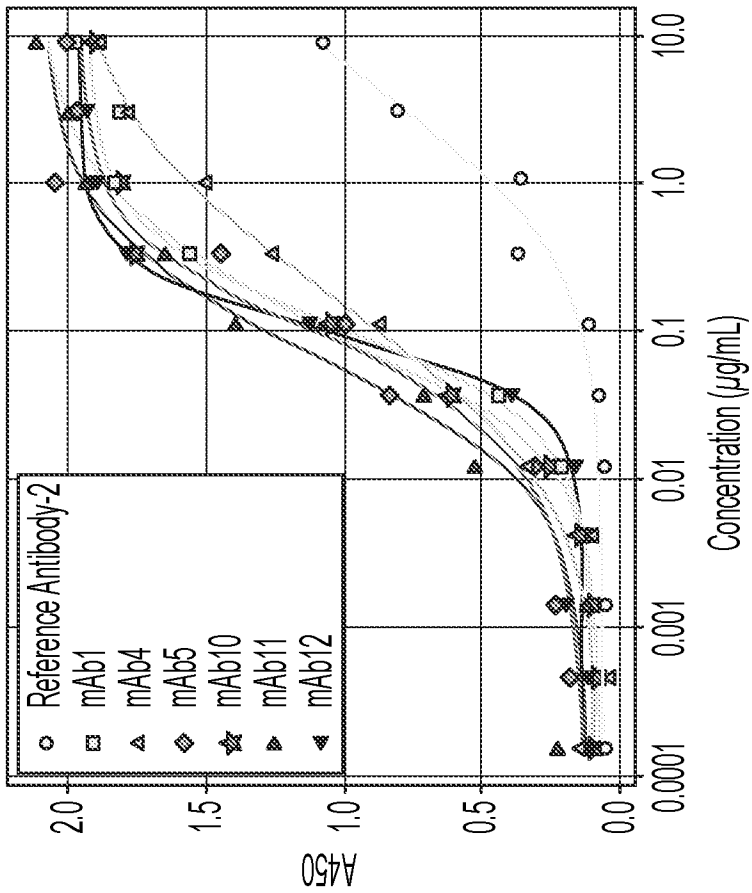
A450
2.0
1.5
1.0
0.5
0.0
0.0001
0.001
0.01
0.1
1.0
10.0
Concentration (µg/mL)
Reference Antibody-2
mAb1
mAb4
mAb5
mAb10
mAb11
mAb12

FIG. 1A

Antibody	EC50 Geometric Mean (ug/mL)
Reference Antibody-2	2.07
mAb1	0.11
mAb2	0.56
mAb3	0.23
mAb4	0.17
mAb5	0.12
mAb6	0.13
mAb7	0.21
mAb8	0.6
mAb9	0.15
mAb10	0.09
mAb11	0.07
mAb12	0.1

FIG. 1C

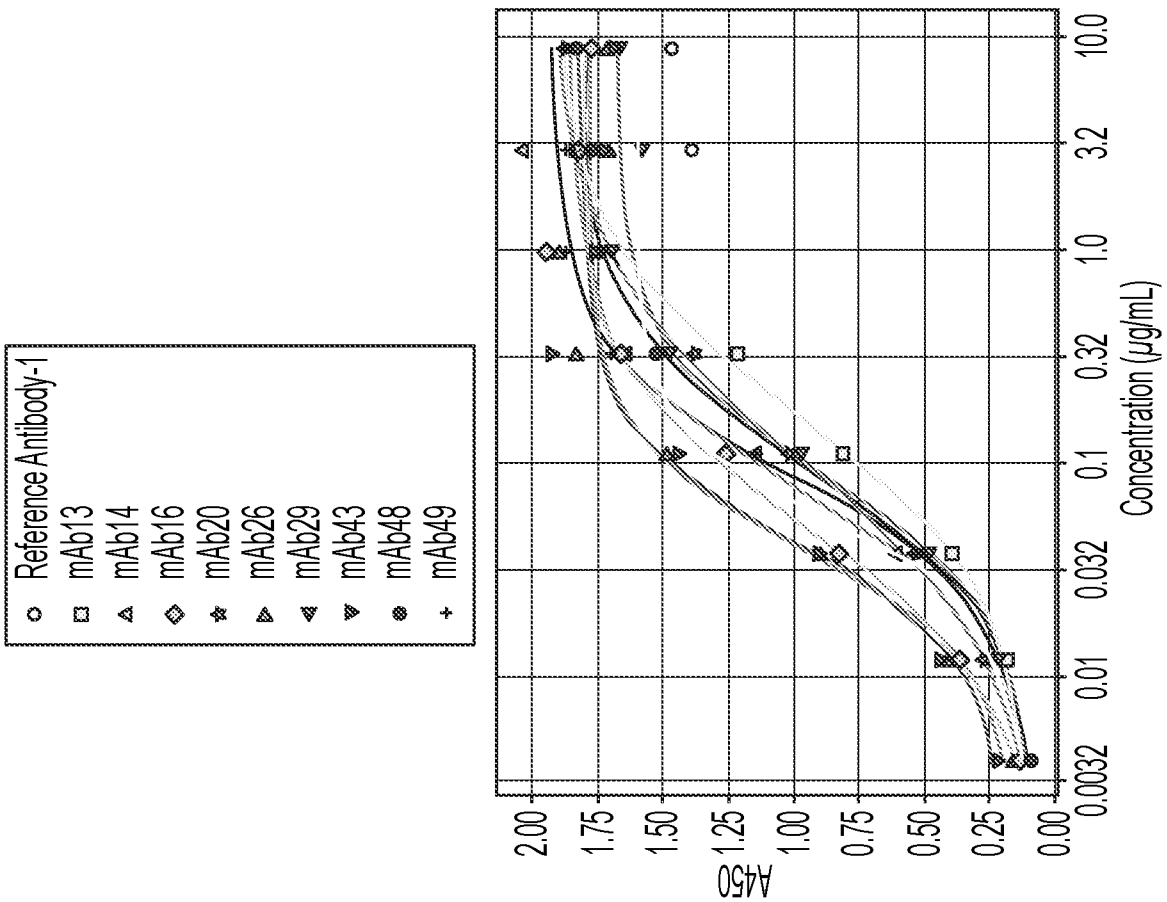
Reference Antibody-1
mAb13
mAb14
mAb16
mAb20
mAb26
mAb29
mAb43
mAb48
mAb49
A450
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.0032
0.01
0.032
0.1
0.32
1.0
3.2
10.0
Concentration (µg/mL)

FIG. 2B

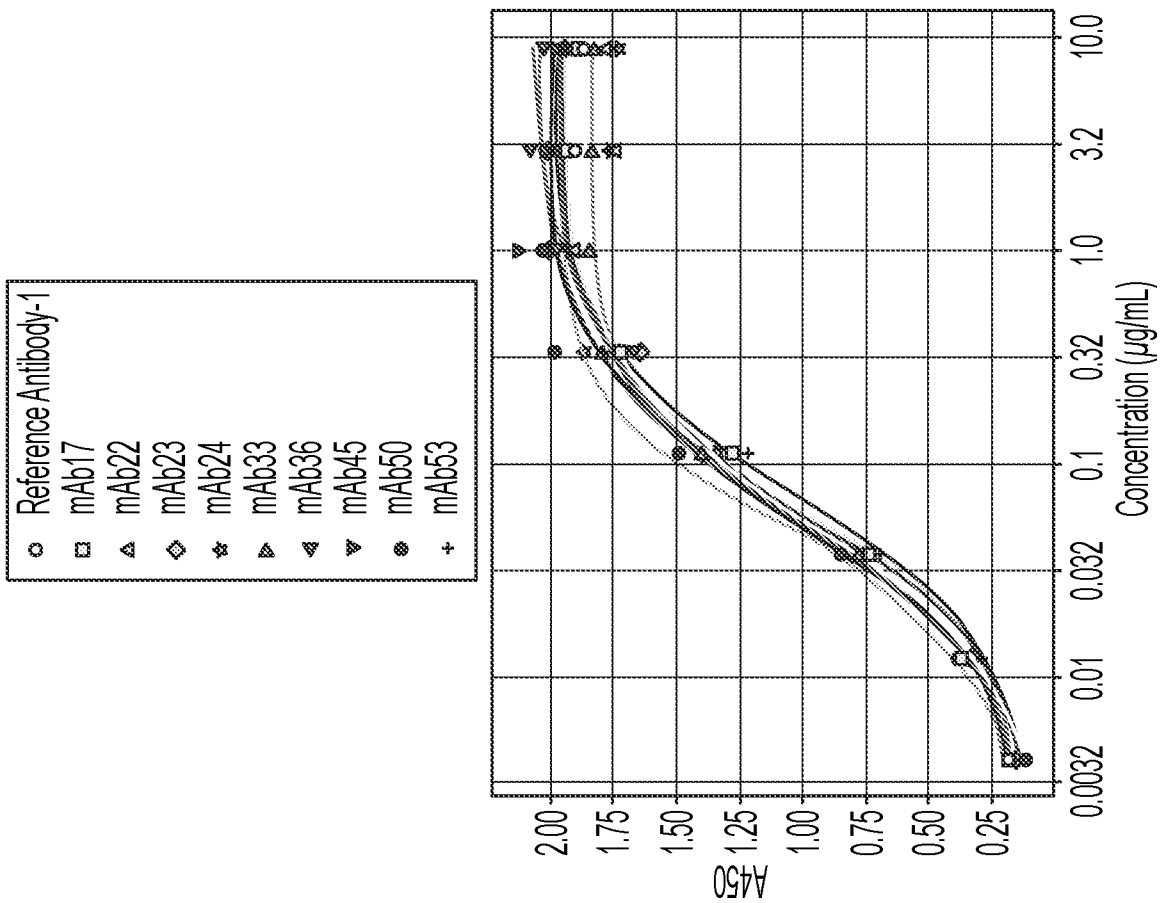
Reference Antibody-1
mAb17
mAb22
mAb23
mAb24
mAb33
mAb36
mAb45
mAb50
mAb53
A450
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.0032
0.01
0.032
0.1
0.32
1.0
3.2
10.0
Concentration (µg/mL)

FIG. 2A

Antibody	EC50 Geometric Mean (ug/mL)	Antibody	EC50 Geometric Mean (ug/mL)
reference antibody-1	0.059	mAb29	0.089
mAb13	0.169	mAb33	0.054
mAb14	0.081	mAb36	0.054
mAb16	0.05	mAb43	0.042
mAb17	0.06	mAb45	0.053
mAb20	0.105	mAb48	0.096
mAb22	0.057	mAb49	0.086
mAb23	0.055	mAb50	0.052
mAb24	0.055	mAb53	0.072
mAb26	0.041		

FIG. 2C