Heystek et al., *J Immunol* 168:102-7 (2002)). These scavenging receptors, which are highly concentrated in the liver, recognize glycoproteins bearing incompletely sialylated N-linked glycans and remove them from circulation (Tomana et al., *Gastroenterology* 94:762-70 (1988) and Daniels et al., *Hepatology* 9:229-34 (1989)).

Accordingly, there is a need in the art for IgA antibodies that have a longer half-life and for production methods to improve expression levels and polymeric IgA generation.

## SUMMARY

The present disclosure relates to IgA antibodies and compositions comprising such antibodies, as well as methods of making and using such antibodies and compositions.

In certain examples, the present disclosure is directed to isolated IgA antibodies. For example, but not by way of limitation, an isolated IgA antibody, or a fragment thereof, of the present disclosure comprises a substitution at amino acid V458. In certain examples, amino acid V458 is substituted with an isoleucine (*i.e.*, V458I). In certain examples, the isolated IgA antibody is an IgA1, IgA2mn or IgA2m1 antibody.

In one aspect, the present disclosure provides an isolated IgA antibody comprising a substitution at amino acid V458 of a heavy chain constant region according to EU numbering, wherein the isolated IgA antibody is monomeric, and wherein the amino acid V458 is not substituted with a hydrophobic amino acid.

In another aspect, provided herein is an isolated IgA antibody comprising a substitution at amino acid I458 of a heavy chain constant region according to EU numbering, wherein the isolated IgA antibody is monomeric, and wherein the amino acid I458 is not substituted with a hydrophobic amino acid.

In another aspect, provided herein is an isolated nucleic acid encoding the IgA antibody as described herein.

In another aspect, provided herein is a host cell comprising the nucleic acid as described herein.

In another aspect, provided herein is a method of producing an IgA antibody culturing the host cell as described herein so that the IgA antibody is produced.

In another aspect, provided herein is a pharmaceutical composition comprising one or more IgA antibodies as described herein and a pharmaceutically acceptable carrier.

In yet another aspect, provided herein is use of the IgA antibody as described herein in the manufacture of a medicament for treatment of a disease.

In yet another aspect, provided herein is use of an isolated monomeric IgA antibody comprising a substitution at amino acid 458 of a heavy chain constant region according to EU numbering in the manufacture of a medicament for the treatment of a disease, wherein the disease is an inflammatory disease, an autoimmune disease or cancer.

In yet another aspect, provided herein is a method of increasing the production of IgA2m2 dimers comprising expressing, in an *in-vitro* first cell, an IgA2m2 antibody having a substitution at amino acid I458 of a heavy chain constant region according to EU numbering, wherein increased production is relative to the amount of IgA2m2 dimersproduced in an *in-vitro* second cell expressing an IgA2m2 antibody that does not have a substitution at amino acid I458 of a heavy chain constant region according to EU numbering.

In one example, the present disclosure provides an isolated IgA antibody, or a fragment thereof, of the present disclosure comprises a substitution at amino acid I458. In certain examples, amino acid I458 is substituted with a valine (*i.e.*, I458V). In certain examples, the isolated IgA antibody is an IgA2m2 antibody.

The present disclosure further provides an isolated IgA antibody that comprises a substitution at amino acid N459 and/or S461. In certain examples, amino acid N459 is substituted with a glutamine (*i.e.*, N459Q). In certain examples, amino acid S461 is substituted with an alanine (*i.e.*, S461A). In certain examples, IgA antibody is an IgA1 or IgA2m1 antibody.

In one example, the present disclosure further provides an isolated IgA antibody that comprises one or more substitutions at an amino acid selected from the group consisting of N166, T168, N211, S212, S213, N263, T265, N337, I338, T339, N459, S461 and a combination thereof. In certain examples, the IgA antibody has a substitution at amino acid N459 and is an IgA1, IgA2m1 or an IgA2m2 antibody. In certain examples, the IgA antibody has a substitution at amino acid N166 and is an IgA2m1 or an IgA2m2 antibody. In certain examples, the IgA antibody has a substitution at amino acid S212 and is an

IgA2m2 antibody. In certain examples, the IgA antibody has a substitution at amino acid N263 and is an IgA1, IgA2m1 or an IgA2m2 antibody. In certain examples, the IgA antibody has substitutions at amino acids N337, I338, T339 and is an IgA2m1 or an IgA2m2 antibody. In certain examples, the IgA antibody has substitutions at amino acids N337, I338, T339 and one or more substitutions at T168, N211, S212, S213, N263, T265, N459, S461 and a combination thereof. In certain examples, the IgA antibody is an IgA2m2 antibody and comprises substitutions at amino acids N166, S212, N263, N337, I338, T339 and N459. For example, but not by way of limitation, the substitutions at amino acids N166, S212, N263, N337, I338, T339 and N459 can be N166A, S212P, N263Q, N337T, I338L, T339S and N459Q.

The present disclosure further provides isolated IgG-IgA fusion molecules. In one example, the present disclosure provides an isolated IgG-IgA fusion molecule can comprise a full-length IgG antibody fused at its C-terminus to an Fc region of an IgA antibody, wherein the Fc region of the IgA antibody comprises a sequence comprising P221 or R221 through the C-terminus of the heavy chain of the IgA antibody and where IgG antibody further comprises a deletion of amino acid K447. In one example, the present disclosure provides an isolated IgG-IgA fusion molecule comprising a full-length IgG antibody fused at its C-terminus to an Fc region of an IgA antibody, wherein the Fc region of the IgA antibody comprises a sequence comprising C242 through the C-terminus of the heavy chain of the IgA antibody. In certain examples, the IgG antibody includes a deletion of amino acid K447. In certain examples, the IgG antibody is selected from the group consisting of an IgG1 antibody, an IgG2 antibody, an IgG3 antibody and an IgG4 antibody. For example, but not by way of limitation, the IgG antibody can be an IgG1 antibody. In certain examples, the IgA antibody is selected from the group consisting of an IgA1 antibody, an IgA2m1 antibody, an IgA2m2 antibody and an IgA2mn antibody. For example, but not by way of limitation, the IgA antibody is an IgA2m1 antibody.

In one example, the present disclosure further provides an isolated nucleic acid that encodes an IgA antibody or IgG-IgA fusion molecule disclosed herein and host cells that include such nucleic acids. In one example, the present disclosure further provides methods for producing an antibody that includes culturing a host cell disclosed herein so that the IgA antibody or IgG-IgA fusion molecule is produced. The method can further include recovering the IgA antibody or IgG-IgA fusion molecule from the host cell.

In one example, the present disclosure provides pharmaceutical compositions that include an IgA antibody or IgG-IgA fusion molecule disclosed herein and a

pharmaceutically acceptable carrier. In certain examples, the pharmaceutical composition can further include additional therapeutic agent.

The present disclosure further provides methods of treating an individual having a disease, where the method includes administering to the individual an effective amount of an IgA antibody or IgG-IgA fusion molecule disclosed herein. In certain examples, the disease is an inflammatory disease, an autoimmune disease or cancer.

In one example, the present disclosure provides methods of increasing the expression of IgA dimers. In certain examples, the method includes increasing the amount of DNA encoding a joining chain (JC) that is introduced into a first cell relative to the amount of DNA that encodes the light chain (LC) and the heavy chain (HC), wherein increased expression is relative to the amount of IgA dimers produced in a second cell introduced with equal amounts of JC, LC and HC DNA. For example, but not by way of limitation, the ratio of the amount of DNA encoding the HC to the amount of DNA encoding the LC to the amount of DNA encoding the JC (HC:LC:JC) that is introduced into the first cell is about from about 1:1:2 to about 1:1:5.

In one example, the present disclosure provides methods of increasing the expression of IgA dimers, trimers or tetramers. In certain examples, the method includes decreasing the amount of DNA encoding a joining chain (JC) introduced into a first cell relative to the amount of DNA that encodes the light chain (LC) and the heavy chain (HC), wherein increased expression is relative to the amount of IgA trimers or tetramers produced in a second cell introduced with greater amounts of HC and LC DNA relative to the amount of JC DNA. In certain examples, the ratio of the amount of DNA encoding the HC to the amount of DNA encoding the LC to the amount of DNA encoding the JC (HC:LC:JC) that is introduced into the first cell is from about 1:1:0.25 to about 1:1:0.5.

In one example, the present disclosure provides methods of increasing the production of an IgA1 or IgA2m1 polymer. In certain examples, the method comprises expressing, in a first cell, an IgA1 or IgA2m1 antibody having a substitution at amino acid V458, *e.g.*, V458I, wherein increased production is relative to the amount of IgA1 or IgA2m1 polymers produced in a second cell expressing an IgA1 or IgA2m1 antibody that does not have a substitution at amino acid V458. In one example, the present disclosure further provides methods of increasing the production of IgA2m2 dimers that comprise expressing, in a first cell, an IgA2m2 antibody having a substitution at amino acid I458, *e.g.*, I458V, wherein increased production is relative to the amount of IgA2m2 dimers produced in a second cell expressing an IgA2m2 antibody that does not have a substitution

at amino acid I458. In one example, methods for increasing the production of an IgA1 or IgA2m1 polymer includes expressing, in a first cell, an IgA1 or IgA2m1 antibody having a substitution at amino acid N459 and/or S461, *e.g.*, N459Q and/or S461A, wherein increased production is relative to the amount of IgA1 or IgA2m1 polymers produced in a second cell expressing an IgA1 or IgA2m1 antibody that does not have a substitution at amino acid N459 or S461. In one example, methods of decreasing the production of IgA2m2 polymers includes expressing, in a first cell, an IgA2m2 antibody with a substitution at amino acid C471, *e.g.*, C471S, wherein decreased production is relative to the amount of IgA2m2 polymers produced in a second cell expressing an IgA2m2 antibody that does not have a substitution at amino acid C471. In certain examples, IgA antibodies that include a substitution at amino acid C471, *e.g.*, C471S, can further include a substitution at P221, *e.g.*, P221R,

In one example, the present disclosure provides methods of increasing transient expression of an IgA2m2 antibody comprising expressing, in a first cell, an IgA2m2 antibody that comprises a substitution at an amino acid selected from the group consisting of N166, S212, N263, N337, I338, T339, N459 and a combination thereof, wherein increased transient expression is relative to the amount of transient expression produced in a second cell expressing an IgA2m2 antibody that does not have a substitution at an amino acid selected from the group consisting of N166, S212, N263, N337, I338, T339, N459 and a combination thereof.

In one example, the present disclosure further provides methods of expressing dimers of IgG-IgA fusion molecules that include expressing an IgG-IgA fusion molecule comprising a full-length IgG antibody fused at its C-terminus to an Fc region of an IgA antibody. In certain examples, the Fc region of the IgA antibody comprises a sequence comprising P221 or R221 through the C-terminus of the heavy chain of the IgA antibody, wherein the IgG antibody comprises a deletion of amino acid K447. In one example, the present disclosure provides methods of expressing dimers, trimers or tetramers of IgG-IgA fusion molecules that include expressing an IgG-IgA fusion molecule comprising a full-length IgG antibody fused at its C-terminus to an Fc region of an IgA antibody, wherein the Fc region of the IgA antibody comprises a sequence comprising C242 through the C-terminus of the heavy chain of the IgA antibody. In certain examples, the IgG antibody comprises a deletion of amino acid K447.

In one example, the present disclosure provides methods for purifying the IgA and IgG-IgA fusion molecules disclosed herein and/or for purifying a specific oligomeric state,

*e.g.*, dimer, trimer or tetramer, of the IgA and IgG-IgA fusion molecules disclosed herein. In certain examples, a method for purifying an IgA antibody from a mixture comprising an IgA antibody and at least one host cell protein includes applying the mixture to a column comprising Protein L to bind the IgA antibody, washing the Protein L column with a wash buffer comprising PBS and eluting the IgA antibody from the Protein L column by an elution buffer comprising phosphoric acid. In one example, a method for purifying an oligomeric state of an IgA antibody or an IgG-IgA fusion molecule from a mixture comprising an IgA antibody or an IgG-IgA fusion molecule and at least one host cell protein can include applying the mixture to an affinity purification column comprising Protein L or Protein A to bind the IgA antibody or IgG-IgA fusion molecule, washing the affinity purification column with a wash buffer, eluting the IgA antibody or IgG-IgA fusion molecule from the affinity purification column by an elution buffer to form a first eluate and applying the first eluate to a size exclusion chromatography column to separate different IgA oligomeric states and to obtain a flowthrough comprising an oligomeric state of the IgA antibody or IgG-IgA fusion molecule.

## BRIEF DESCRIPTION OF THE FIGURES

Figure 1A-1D. Protein sequences of human IgA heavy chain constant domains and J chain. (A) Alignment of protein sequences for the human heavy chain constant domains $C_H1$, $C_H2$, $C_H3$, hinge (Brezski et al. *Curr Opin Immunol* 40:62–9 (2016)) and tailpiece of IgA1, IgA2m1 and IgA2m2 (Toraño et al. 75:966–9 (1978)). Mismatches relative to the IgA1 sequence are highlighted in gray, N-linked glycosylation motifs are boxed and asterisks indicate amino acid differences in IgA2m2 from IgA1 and IgA2m1 in

**WHAT IS CLAIMED IS:**

1. An isolated IgA antibody comprising a substitution at amino acid V458 of a heavy chain constant region according to EU numbering, wherein the isolated IgA antibody is monomeric, and wherein the amino acid V458 is not substituted with a hydrophobic amino acid.

2. The isolated IgA antibody of claim 1, wherein the IgA antibody is an IgA1, IgA2m1 or IgA2mn antibody.

3. An isolated IgA antibody comprising a substitution at amino acid I458 of a heavy chain constant region according to EU numbering, wherein the isolated IgA antibody is monomeric, and wherein the amino acid I458 is not substituted with a hydrophobic amino acid.

4. The isolated IgA antibody of claim 3, wherein the IgA antibody is an IgA2m2 antibody.

5. The isolated IgA antibody of any one of claims 1-4 further comprising a substitution at amino acid 467 of the heavy chain constant region according to EU numbering.

6. The isolated IgA antibody of any one of claims 1-5, wherein the IgA antibody is humanized, a chimeric antibody or human antibody.

7. An isolated nucleic acid encoding the IgA antibody of any one of claims 1-6.

8. A host cell comprising the nucleic acid of claim 7.

9. A method of producing an IgA antibody culturing the host cell of claim 8 so that the IgA antibody is produced.

10. The method of claim 9, further comprising recovering the IgA antibody from the host cell.

11. A pharmaceutical composition comprising one or more IgA antibodies of any one of claims 1-6 and a pharmaceutically acceptable carrier.

12. The pharmaceutical composition of claim 11, further comprising an additional therapeutic agent.

13. The IgA antibody of any one of claims 1-6 for use as a medicament.

14. Use of the IgA antibody of any one of claims 1-6 in the manufacture of a medicament for treatment of a disease.

15. The use of claim 14, wherein the disease is an inflammatory disease, an autoimmune disease or cancer.

16. The use of claim 15, wherein the disease is cancer.

17. Use of an isolated monomeric IgA antibody comprising a substitution at amino acid 458 of a heavy chain constant region according to EU numbering in the manufacture of a medicament for the treatment of a disease, wherein the disease is an inflammatory disease, an autoimmune disease or cancer.

18. The use of claim 17, wherein the disease in cancer.

19. The use of claim 17 or 18, wherein the IgA antibody is an IgA1, IgA2m1, IgA2m2 or IgA2mn antibody.

20. A method of increasing the production of IgA2m2 dimers comprising expressing, in an *in-vitro* first cell, an IgA2m2 antibody having a substitution at amino acid I458 of a heavy chain constant region according to EU numbering, wherein increased production is relative to the amount of IgA2m2 dimers produced in an *in-vitro* second cell expressing an IgA2m2 antibody that does not have a substitution at amino acid I458 of a heavy chain constant region according to EU numbering.

21. The method of claim 20, wherein amino acid is substituted with a valine (I458V).