CLAIMS

1. A binding domain that binds a MUC1 peptide comprising the amino acid sequence as set forth in SEQ ID NO: 249, wherein the threonine (T) residue at position 14 of the MUC1 peptide comprises α-GalNAc glycosylation or Neu5Ac-α(2-6)-GalNAc glycosylation.

2. The binding domain according to claim 1, wherein in addition the serine (S) residue at position 15 of the MUC1 peptide comprises α-GalNAc glycosylation or Neu5Ac-α(2-6)-GalNAc glycosylation.

3. The binding domain according to claim 1 or 2, which does not bind to a MUC1 peptide comprising the amino acid sequence as set forth in SEQ ID NO: 249 not comprising α-GalNAc glycosylation or Neu5Ac-α(2-6)-GalNAc glycosylation.

4. The binding domain according to any one of claims 1-3, wherein the binding to the MUC-1 peptide is determined in a glycopeptide array.

5. A binding domain that specifically binds to cancer-associated MUC-1, wherein the binding domain binds to an epitope on MUC1 comprising the VTSA motif of the N-terminal domain of MUC1, wherein the threonine (T) residue is α-GalNAc glycosylated or Neu5Ac-α(2-6)-GalNAc glycosylated.

6. The binding domain according to claim 5, wherein in addition the serine (S) residue is α-GalNAc glycosylated or Neu5Ac-α(2-6)-GalNAc glycosylated.

7. The binding domain according to claim 5 or 6, wherein the binding to the epitope on MUC1 is determined in a glycopeptide array.

8. A binding domain having binding specificity for cancer-associated MUC1, wherein the binding domain comprises a heavy chain variable region comprising:

a) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 2, SEQ ID NO: 3, and SEQ ID NO: 4, respectively;

b) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 6, SEQ ID NO: 7, and SEQ ID NO: 8, respectively;

c) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 10, SEQ ID NO: 11, and SEQ ID NO: 12, respectively;

d) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 14, SEQ ID NO: 15, and SEQ ID NO: 16, respectively;

e) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 18, SEQ ID NO: 19, and SEQ ID NO: 20, respectively;

f) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 22, SEQ ID NO: 23, and SEQ ID NO: 24, respectively;

g) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 26, SEQ ID NO: 27, and SEQ ID NO: 28, respectively;

h) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 30, SEQ ID NO: 31, and SEQ ID NO: 32, respectively;

i) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 34, SEQ ID NO: 35, and SEQ ID NO: 36, respectively;

j) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 38, SEQ ID NO: 39, and SEQ ID NO: 40, respectively;

k) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 42, SEQ ID NO: 43, and SEQ ID NO: 44, respectively;

l) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 46, SEQ ID NO: 47, and SEQ ID NO: 48, respectively;

m) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 50, SEQ ID NO: 51, and SEQ ID NO: 52, respectively;

n) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 54, SEQ ID NO: 55, and SEQ ID NO: 56, respectively;

o) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 58, SEQ ID NO: 60, and SEQ ID NO: 61, respectively;

p) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 63, SEQ ID NO: 64, and SEQ ID NO: 65, respectively;

q) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 67, SEQ ID NO: 68, and SEQ ID NO: 69, respectively;

r) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 71, SEQ ID NO: 72, and SEQ ID NO: 73, respectively;

s) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 75, SEQ ID NO: 76, and SEQ ID NO: 77, respectively;

t) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 79, SEQ ID NO: 80, and SEQ ID NO: 81, respectively;

u) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 83, SEQ ID NO: 84, and SEQ ID NO: 85, respectively;

v) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 87, SEQ ID NO: 88, and SEQ ID NO: 89, respectively;

w) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 91, SEQ ID NO: 92, and SEQ ID NO: 93, respectively;

x) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 95, SEQ ID NO: 96, and SEQ ID NO: 97, respectively;

y) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 99, SEQ ID NO: 100, and SEQ ID NO: 101, respectively;

z) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 103, SEQ ID NO: 104, and SEQ ID NO: 105, respectively;

aa) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 107, SEQ ID NO: 108, and SEQ ID NO: 109, respectively;

bb) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 111, SEQ ID NO: 112, and SEQ ID NO: 113, respectively;

cc) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 115, SEQ ID NO: 116, and SEQ ID NO: 117, respectively;

dd) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 119, SEQ ID NO: 120, and SEQ ID NO: 121, respectively;

ee) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 123, SEQ ID NO: 124, and SEQ ID NO: 125, respectively;

ff) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 127, SEQ ID NO: 128, and SEQ ID NO: 129, respectively;

gg) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 131, SEQ ID NO: 132, and SEQ ID NO: 133, respectively;

hh) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 135, SEQ ID NO: 136, and SEQ ID NO: 137, respectively;

ii) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 139, SEQ ID NO: 140, and SEQ ID NO: 141, respectively;

jj) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 143, SEQ ID NO: 144, and SEQ ID NO: 145, respectively;

kk) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 147, SEQ ID NO: 148, and SEQ ID NO: 149, respectively;

ll) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 151, SEQ ID NO: 152, and SEQ ID NO: 153, respectively;

mm) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 155, SEQ ID NO: 156, and SEQ ID NO: 157, respectively;

nn) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 159, SEQ ID NO: 160, and SEQ ID NO: 161, respectively;

oo) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 163, SEQ ID NO: 164, and SEQ ID NO: 165, respectively;

pp) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 167, SEQ ID NO: 168, and SEQ ID NO: 169, respectively;

qq) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 171, SEQ ID NO: 172, and SEQ ID NO: 173, respectively;

rr) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 175, SEQ ID NO: 176, and SEQ ID NO: 177, respectively;

ss) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 179, SEQ ID NO: 180, and SEQ ID NO: 181, respectively;

tt) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 183, SEQ ID NO: 184, and SEQ ID NO: 185, respectively;

uu) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 187, SEQ ID NO: 188, and SEQ ID NO: 189, respectively;

vv) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 191, SEQ ID NO: 192, and SEQ ID NO: 193, respectively;

ww) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 195, SEQ ID NO: 196, and SEQ ID NO: 197, respectively;

xx) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 199, SEQ ID NO: 200, and SEQ ID NO: 201, respectively;

yy) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 203, SEQ ID NO: 204, and SEQ ID NO: 205, respectively; or

zz) heavy chain CDR1 (HCDR1), heavy chain CDR2 (HCDR2), and heavy chain CDR3 (HCDR3), having an amino acid sequence as set forth in SEQ ID NO: 207, SEQ ID NO: 208, and SEQ ID NO: 209, respectively;

wherein each of the HCDRs may comprise at most three, two, or one amino acid substitutions.

9. The binding domain according to claim 8, wherein the binding domain comprises a heavy chain variable region having an amino acid sequence as set forth in any one of SEQ ID NO: 1; 5; 9; 13; 17; 21; 25; 29; 33; 37; 41; 45; 49; 53; 57; 62; 66; 70; 74; 78; 82; 86; 90; 94; 98; 102; 106; 110; 114; 118; 122; 126; 130; 134; 138; 142; 146; 150; 154; 158; 162; 166; 170; 174; 178; 182; 186; 190; 194; 198; 202; or 206, or having at least 80%, or 85%, or 90%, or 95% sequence identity thereto.

10. The binding domain according to claim 8 or 9, wherein the binding domain comprises a light chain variable region comprising light chain CDR1 (LCDR1), light chain CDR2 (LCDR2), and light chain CDR3 (LCDR3), having an amino acid sequence as set forth in SEQ ID NO: 219, SEQ ID NO: 220, and SEQ ID NO: 221, respectively, wherein each of the LCDRs may comprise at most three, two, or one amino acid substitutions.

11. The binding domain according to any one of claims 8-10, wherein the binding domain comprises a light chain variable region having an amino acid sequence as set forth in SEQ ID NO: 218, or having at least 80%, or 85%, or 90%, or 95% sequence identity thereto.

12. The binding domain according to any one of claims 1-11, wherein the binding domain is a Fab.

13. A binding moiety comprising two binding domains according to any one of claims 1-12.

14. The binding moiety according to claim 13, wherein the binding moiety is an IgG1 or IgG4 antibody.

15. The binding moiety according to claim 13 or 14, wherein the binding of the binding moiety to an Fc receptor is eliminated or reduced, or wherein the binding of the binding moiety to an Fc receptor is enhanced.

16. The binding moiety according to any one of claims 13-15, wherein the binding moiety shows a higher binding signal than a reference antibody comprising two heavy chains having an amino acid sequence as set forth in SEQ ID NO: 210 and a light chain having an amino acid sequence as set forth in SEQ ID NO: 211.

17. A pharmaceutical composition comprising an effective amount of a binding domain according to any one of claims 1-12, or a binding moiety according to any one of claims 13-16, and a pharmaceutically acceptable carrier.

18. The binding domain according to any one of claims 1-12, the binding moiety according to any one of claims 13-16, or the pharmaceutical composition according to claim 17, for use in therapy, in particular for use in the treatment of cancer.

19. Use of an effective amount of a binding domain according to any one of claims 1-12, a binding moiety according to any one of claims 13-16, or a pharmaceutical composition according to claim 17 in the manufacture of a medicament for treating a disease in an individual in need thereof.

20. A nucleic acid comprising a nucleic acid sequence encoding a heavy chain variable region as defined in claim 8 or 9, in particular wherein the nucleic acid further comprises a nucleic acid sequence encoding a CH1 region and optionally a hinge, CH2 and CH3 region.

21. A cell comprising a nucleic acid sequence encoding a heavy chain variable region as defined in claim 8 or 9, in particular wherein the cell further comprises a nucleic acid sequence encoding a CH1 region and optionally a hinge, CH2 and CH3 region.

22. The cell according to claim 21, wherein the cell further comprises at least one nucleic acid sequence encoding a light chain variable region, in particular wherein the light chain variable region a light chain variable region as defined in claim 10 or 11, and optionally a CL region.

23. A cell producing a binding domain as claimed in any one of claims 1-12, or a binding moiety as claimed in any one of claims 13-16.

24. A kit comprising a container comprising a binding domain as claimed in any one of claims 1-12, or a binding moiety as claimed in any one of claims 13-16, and optionally instructions for use.