Claims

Claim 1. An *in vitro* method of detecting phosphorylation of a Rubicon protein comprising:

isolating proteins from a sample;

contacting the isolated proteins with an antibody that binds a phosphorylated threonine at 166 of a Rubicon protein to form a complex;

detecting the complex wherein detection of the complex that varies from a predetermined value indicates that the sample comes from a subject having a disease associated with Leucine-rich repeat kinase 2 (LRRK2) comprising Parkinson's disease, or chronic inflammation, or mycobacterial infections,

wherein the antibody is capable of binding to SEQ ID NO. 2 at a titer at least 4 times higher than the antibody binds SEQ ID NO. 14.

Claim 2. The *in vitro* method according to claim 1, wherein the disease associated with Leucine-rich repeat kinase 2 (LRRK2) is Parkinson's disease.

Claim 3. The *in vitro* method according to claim 1 or 2, wherein the antibody is a chimeric humanised antibody or a monoclonal antibody.

Claim 4. The *in vitro* method according to any one of the preceding claims, wherein the complex is detected with an enzyme linked immunosorbent assay.

Claim 5. An antibody which is capable of binding to phosphorylated threonine 166 of a Rubicon protein wherein the antibody is capable of binding to SEQ ID NO. 2 at a titer at least 4 times higher than the antibody binds SEQ ID NO. 14.

Claim 6. The antibody according to claim 5, comprising at least one variable region incorporating a CDR selected from amino acid sequences i) to vi):

i) LC-CDR1: RSSQSLVHSNGNTYLH (SEQ ID NO. 4);

ii) LC-CDR2: KLSNRFS (SEQ ID NO. 5);

iii) LC-CDR3: SQSTHVPLT (SEQ ID NO. 6);

iv) HC-CDR1: NYGVS (SEQ ID NO. 7);

v) HC-CDR2: TINSNGGSKYYPDSVKG (SEQ ID NO. 8);

vi) HC-CDR3: DVWLRRQWYFDV (SEQ ID NO. 9); and

a functional variant with 99% amino acid sequence identity to any one of amino acid sequences i) to vi).

Claim 7. The antibody according to claim 5, comprising amino acid sequences set forth in SEQ ID NO. 10 and SEQ ID NO. 11 or SEQ ID NO. 12 and SEQ ID NO. 13; or a functional variant with 99% amino acid sequence identity to any one of amino acid sequences set forth in SEQ ID NO. 10, SEQ ID NO. 11, SEQ ID NOS. 12 and SEQ ID NO. 13.

Claim 8. The antibody according to any one of claims 5 to 7, wherein the antibody is a chimeric humanised antibody or is a monoclonal antibody.

Claim 9. The antibody according to any one of claims 5 to 8, for use in the detection or treatment of a disease associated with Leucine-rich repeat kinase 2 (LRRK2) comprising Parkinson's disease, or chronic inflammation, or mycobacterial infections.

Claim 10. The antibody for use according to claim 9, wherein the disease associated with Leucine-rich repeat kinase 2 (LRRK2) is Parkinson's disease.

Claim 11. An inhibitor of Rubicon interaction with Leucine-rich repeat kinase 2 (LRRK2) comprising an antibody able to block interaction of LRRK2 with threonine 166 of the Rubicon protein wherein the antibody comprises amino acid sequences set forth in SEQ ID NOS. 4 to 9 or a functional variant with 99% amino acid sequence identity to any one of amino acid sequences set forth in SEQ ID NOS. 4 to 9.

Claim 12. The inhibitor according to claim 11, wherein the antibody comprises a monoclonal antibody or a chimeric humanised antibody.

Claim 13. The inhibitor according to claim 11 or 12, for use in the treatment of a disease wherein, the disease is Parkinson's disease.

Claim 14. Use of an antibody according to any one of claims 5 to 8 or an inhibitor according to claim 11 or 12, in the manufacture of a medicament for the treatment of a disease associated with Leucine-rich repeat kinase 2 (LRRK2) comprising Parkinson's disease, or chronic inflammation, or mycobacterial infections.

Claim 15. Use according to the claim 14, wherein the disease associated with Leucine-rich repeat kinase 2 (LRRK2) is Parkinson's disease.

Claim 16. A kit comprising an antibody according to any one of claims 6 to 9, and detection reagents for detecting a disease associated with Leucine-rich repeat kinase 2

(LRRK2) comprising Parkinson’s disease, or chronic inflammation, or mycobacterial infections.

Claim 17. The Kit according to claim 14, wherein the disease associated with Leucine-rich repeat kinase 2 (LRRK2) is Parkinson’s disease.