Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 2814030 C 2019/04/30

(11)(21) **2 814 030**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(86) **Date de dépôt PCT/PCT Filing Date:** 2011/10/08

(87) **Date publication PCT/PCT Publication Date:** 2012/04/12

(45) **Date de délivrance/Issue Date:** 2019/04/30

(85) **Entrée phase nationale/National Entry:** 2013/04/08

(86) **N° demande PCT/PCT Application No.:** CN 2011/080538

(87) **N° publication PCT/PCT Publication No.:** 2012/045281

(30) **Priorités/Priorities:** 2010/10/08 (CN PCT/CN2010/077587); 2010/10/08 (CN PCT/CN2010/077589); 2010/10/08 (CN PCT/CN2010/077592); 2011/05/10 (CN PCT/CN2011/073881)

(51) **Cl.Int./Int.Cl.** ***A61K 38/02*** (2006.01), ***A61K 39/395*** (2006.01), ***A61P 7/00*** (2006.01), ***G01N 33/564*** (2006.01)

(72) **Inventeurs/Inventors:**
ZHANG, YUE, CN;
BAO, JUN, CN

(73) **Propriétaire/Owner:**
SHANGHAI KEXIN BIOTECH CO., LTD., CN

(74) **Agent:** MCCARTHY TETRAULT LLP

(54) **Titre : UTILISATIONS DIAGNOSTIQUES ET THERAPEUTIQUES DE FRAGMENTS DE LA MOESINE**
(54) **Title: DIAGNOSTIC AND THERAPEUTIC USES OF MOESIN FRAGMENTS**

(57) **Abrégé/Abstract:**
The present application provides compositions and methods for modulating the activity and quantity of platelets and preventing and treating disorders or diseases associated with abnormal activity and quantity of platelets.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 April 2012 (12.04.2012)

PCT

(10) International Publication Number
WO 2012/045281 A1

(51) International Patent Classification:
A61K 38/02 (2006.01) *G01N 33/564* (2006.01)
A61K 39/395 (2006.01) *A61P 7/00* (2006.01)

(21) International Application Number:
PCT/CN2011/080538

(22) International Filing Date:
8 October 2011 (08.10.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/CN2010/077592 8 October 2010 (08.10.2010) CN
PCT/CN2010/077589 8 October 2010 (08.10.2010) CN
PCT/CN2010/077587 8 October 2010 (08.10.2010) CN
PCT/CN2011/073881 10 May 2011 (10.05.2011) CN

(71) Applicant *(for all designated States except US)*: **SHANGHAI KEXIN BIOTECH CO., LTD.** [CN/CN]; Room 501, 1011 Halei Road, Zhangjiang High-Tech Park, Shanghai 201203 (CN).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ZHANG, Yue** [CN/CN]; Room 501, 1011 Halei Road, Zhangjiang High-Tech Park, Shanghai 201203 (CN). **BAO, Jun** [CN/CN]; Room 501, 1011 Halei Road, Zhangjiang High-Tech Park, Shanghai 201203 (CN).

(74) Agent: **WAN HUI DA INTELLECTUAL PROPERTY AGENCY**; Yiyuan Office Building, Friendship Hotel, No.1 Zhongguancun Street South, Haidian District, Beijing 100873 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report (Art. 21(3))*
— *with sequence listing part of description (Rule 5.2(a))*

WO 2012/045281 A1

(54) **Title**: DIAGNOSTIC AND THERAPEUTIC USES OF MOESIN FRAGMENTS

(57) **Abstract**: The present application provides compositions and methods for modulating the activity and quantity of platelets and preventing and treating disorders or diseases associated with abnormal activity and quantity of platelets.

DIAGNOSTIC AND THERAPEUTIC USES OF MOESIN FRAGMENTS

TECHNICAL FIELD

The present application relates to the field of molecular biology and medical study with respect to autoimmune diseases. More specifically, the present application concerns use of moesin fragments and antibodies against moesin fragments for modulating the activity and quantity of platelets.

BACKGROUND

Autoimmune diseases are diseases arising from aberrant response of the immune system against one's own substances and tissues. There are more than 80 different types of autoimmune diseases that, collectively, amount to the number two cause of chronic illness, and one of the top 10 leading causes of death in women of all age groups up to 64 years.

Significant medical research efforts have been devoted to understanding the mechanism of autoimmune diseases and finding effective diagnosis and treatments therefore. Many autoimmune diseases are now characterized by the presence and undesirable activities of autoantibodies. These autoantibodies recognize and bind to often normal and healthy self antigens, thereby causing significant damages and failures of relevant tissues and organs.

Immune thrombocytopenia is an autoimmune hematological disease that is characterized by an attack by the immune system that destroys platelets in the blood, resulting in an abnormally low platelet count. The platelet destruction is due to the presence of antiplatelet autoantibodies, which are antibodies directed against the patient's own platelets. This low platelet count can lead to easy bruising, bleeding gums or nose and, less commonly, to severe internal bleeding.

Thrombosis is the formation of a blood clot in a blood vessel, which may obstruct blood flow in the blood vessel and consequently severely interfere with the function of the cardiovascular system. It is believed that thrombosis is associated with abnormal activation and aggregation of platelets.

Antiphospholipid syndrome (APS) is characterized by the presence of antiphospholipid (aPL) antibodies, in particular, antibodies against cardiolipin and beta2 glycoproteins. APS can cause thrombosis in both arteries and veins as well as miscarriage and maternal and fetal morbidity. Two forms of APS have been described: primary antiphospholipid syndrome (PAPS) (Asherson, R. A., et al., (1989) Medicine 68: 366-374), wherein no evidence of any underlying disease is found, and secondary antiphospholipid syndrome (SAPS) (Alarcon-Segovia, D. et al., (1989) Medicine 68: 353-365), wherein APS is associated with other diseases such as systemic lupus erythematosus (SLE).

DISCLOSURE OF THE INVENTION

The present application provides compositions and methods for modulating the activity and quantity of platelets and preventing and treating disorders or diseases associated with abnormal activity and quantity of platelets. Furthermore, the present application provides compositions and methods for diagnosing disorders or diseases associated with abnormal activity and quantity of platelets. Certain relevant terms used below in this section are defined in the Definitions section of this application.

In one aspect, the present application provides a method for inhibiting the level (i.e. activity and/or quantity) of platelets in a sample comprising contacting the sample with a composition comprising a first antibody against a moesin fragment, wherein the moesin fragment consists essentially of the C-terminal tail domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for preventing and/or treating a disorder or disease associated with abnormal high level of platelets in a subject comprising administering to the subject a pharmaceutically effective amount of a pharmaceutical composition comprising a first antibody against a moesin fragment, wherein the moesin fragment consists essentially of the C-terminal tail domain of human moesin protein or a fragment thereof. In certain embodiments, the disorder or disease associated with abnormal high level of platelets is thrombosis, APS (e.g, PAPS or SAPS), miscarriage (e.g., habitual miscarriage), antiphospholipid (aPL) antibodies-mediated thrombosis (aPL-thrombosis), antiphospholipid-syndrome-related pregnancy complications (APS-related pregnancy complications), or thrombocythemia (e.g, primary thrombocythemia or secondary thrombocythemia).

In another aspect, the present application provides a method for modulating the level of platelets in a sample comprising contacting the sample with a first peptide comprising a moesin fragment, wherein the moesin fragment consists essentially of the C-terminal tail domain of human moesin protein or a fragment thereof. In certain embodiments, the sample contains or is suspected of containing autoantibodies against the C-terminal tail domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for preventing and/or treating a disorder or disease associated with abnormal low level of platelets in a subject comprising administering to the subject a pharmaceutically effective amount of a pharmaceutical composition comprising a first peptide comprising a moesin fragment, wherein the moesin fragment consists essentially of the C-terminal tail domain of human moesin protein or a fragment thereof. In certain embodiments, the subject has or is suspected of having autoantibodies against the C-terminal tail domain of human moesin protein or a fragment thereof. In certain embodiments, the disorder or disease associated with abnormal low level of platelets is immune thrombocytopenia, idiopathic thrombocytopenic purpura and secondary thrombocytopenic purpura (e.g., thrombotic thrombocytopenic purpura, or thrombotic thrombocytopenic purpura accompanied with hemolytic uremic syndrome), hemolysis, elevated liver enzymes and low platelets syndrome (HELLP syndrome), disseminated intravascular coagulation, systemic lupus erythematosis and aplastic anemia.

In another aspect, the present application provides a method for stimulating the level of platelets in a sample comprising contacting the sample with a composition comprising a second antibody against a moesin fragment, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for stimulating the level of platelets in a subject comprising administering to the subject a pharmaceutically effective amount of a pharmaceutical composition comprising a second antibody against a moesin fragment, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for inhibiting the level of platelets in a sample comprising contacting the sample with a second peptide comprising a moesin fragment, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof. In certain embodiments, the sample contains or is suspected of containing autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for inhibiting the level of platelets in a subject comprising administering to the subject a pharmaceutically effective amount of a pharmaceutical composition comprising a second peptide comprising a moesin fragment, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof. In certain embodiments, the subject has or is suspected of having autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment thereof.

In another aspect, the present application provides a method for preventing and/or treating a disorder or disease associated with abnormal high level of platelets in a subject comprising administering to the subject a pharmaceutically effective amount of a pharmaceutical composition comprising a second peptide comprising a moesin fragment, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof. In certain embodiments, the subject has or is suspected of having autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment thereof. In certain embodiments, the disorder or disease associated with abnormal high level of platelets is thrombosis, APS (e.g, PAPS or SAPS), miscarriage (e.g., habitual miscarriage), aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia (e.g, primary thrombocythemia or secondary thrombocythemia).

In another aspect, the present application provides a method for diagnosing a disorder or disease associated with abnormal low level of platelets comprising (i) contacting a sample from a subject suspected of having such disorders or diseases with a first peptide comprising a moesin fragment capable of binding to an anti-moesin autoantibody, wherein the moesin fragment consists essentially of the C-terminal tail domain of human moesin protein or a fragment thereof; (ii) detecting the binding of said first peptide to an anti-moesin autoantibody. Presence of the anti-moesin autoantibody binding to the first peptide in the sample at a level higher than the normal level obtained from a reference sample is indicative of high risk of a disorder or disease associated with abnormal low level of platelets in the subject.

In another aspect, the present application provides a method for diagnosing a disorder or disease associated with abnormal high level of platelets comprising (i) contacting a sample from a subject suspected of having such disorder or disease with a second peptide comprising a moesin fragment capable of binding to an anti-moesin autoantibody, wherein the moesin fragment consists essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof; (ii) detecting the binding of said second peptide to an anti-moesin autoantibody. Presence of the anti-moesin autoantibody binding to the second peptide in the sample at a level higher than the normal level obtained from a reference sample is indicative of high risk of a disorder or disease associated with abnormal high level of platelets in the subject.

In certain embodiments, the first peptide comprises at least eight consecutive amino acid residues of the C-terminal tail domain of human moesin protein. In certain embodiments, the first peptide comprises at least 10, 20, 30, 40, 50, 60, 70, 80, 90 or 100 consecutive amino acid residues of the C-terminal tail domain of human moesin protein. In certain embodiments, the first peptide comprises at least 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 consecutive amino acid residues of the C-terminal tail domain of human moesin protein.

In certain embodiments, the C-terminal tail domain of human moesin protein consists of amino acid residues from the region between about amino acid residues 471-577 of the human moesin protein. In certain embodiments, the C-terminal tail domain of human moesin protein contains amino acid residues from the region between amino acid residues 471-574, 471-575, 471-576, 471-577, 472-574, 472-575, 472-576, 472-577, 473-574, 473-575, 473-576 , 473-577, 474-574, 474-575, 474-576, or 474-577 of the human moesin protein. In certain embodiments, the C-terminal tail domain of human moesin protein contains amino acid residues selected from the group consisting of amino acid residues from the region between amino acid residues 471-487, 488-501, 502-577, and 471-577 of human moesin protein. In certain embodiments, the first peptide comprises the entire C-terminal tail domain of human moesin protein. In certain embodiments, the first peptide consists essentially of amino acid residues 471-577 of the human moesin protein or a fragment thereof. In certain embodiments, the first peptide does not contain any substantial portion of the N-terminal FERM domain of human moesin protein. As used herein, the term "substantial portion" refers to a portion of the relevant domain (Helical domain or N-terminal FERM domain or C-terminal tail domain) that can compete with such domain (Helical domain or N-terminal FERM domain or C-terminal tail domain) for specific binding to an antibody capable of binding to the entire relevant domain (Helical domain or N-terminal FERM domain or C-terminal tail domain).

In certain embodiments, the first peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 471-487 of the human moesin protein. In certain embodiments, the first peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 488-501 of the human moesin protein. In certain embodiments, the first peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 502-577 of the human moesin protein.

In certain embodiments, the first peptide shares at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% amino acid sequence identity with the C-terminal tail domain of human moesin protein or a fragment thereof. In certain embodiments, the first peptide shares at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% amino acid sequence identity with one of the amino acid sequences selected from the group consisting of amino acid residues 471-487, 488-501, 502-577, and 471-577 of human moesin protein.

In certain embodiments, the second peptide comprises at least eight consecutive amino acid residues of the N-terminal FERM domain of human moesin protein. In certain embodiments, the second peptide comprises at least 10, 20, 30, 40, 50, 60, 70, 80, 90, or 100 consecutive amino acid residues of the N-terminal FERM domain of human moesin protein. In certain embodiments, the second peptide comprises at least 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 consecutive amino acid residues of the N-terminal FERM domain of human moesin protein.

In certain embodiments, the N-terminal FERM domain of human moesin protein consists of amino acid residues from the region between about amino acid residues 1-297 of the human moesin protein. In certain embodiments, the N-terminal FERM domain of human moesin protein contains amino acid residues from the region between amino acid residues 1-294, 1-295, 1-296, 1-297, 2-294, 2-295, 2-296, 2-297, 3-294, 3-295, 3-296, 3-297, 4-294, 4-295, 4-296 or 4-297 of the human moesin protein. In certain embodiments, the second peptide comprises the entire N-terminal FERM domain of human moesin protein. In certain embodiments, the second peptide consists essentially of amino acid residues of the N-terminal FERM domain of the human moesin protein or a fragment thereof. In certain embodiments, the N-terminal FERM domain of human moesin protein contains amino acid residues selected from the group consisting of amino acid residues from the region between amino acid residues 1-94, 95-201, 202-297, and 1-297 of human moesin protein. In certain embodiments, the second peptide does not contain any substantial portion of the C-terminal tail domain of human moesin protein.

In certain embodiments, the second peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 1-94 of the human moesin protein. In certain embodiments, the second peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 95-201 of the human moesin protein. In certain embodiments, the second peptide comprises at least eight consecutive amino acid residues from the region between amino acid residues 202-297 of the human moesin protein.

In certain embodiments, the second peptide shares at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% amino acid sequence identity with the N-terminal FERM domain of human moesin protein or a fragment thereof. In certain embodiments, the second peptide shares at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% amino acid sequence identity with one of the amino acid sequences selected from the group consisting of amino acid residues 1-94, 95-201, 202-297, and 1-297 of human moesin protein.

In another aspect, the first and/or the second peptide described in the present application further comprises a carrier polypeptide. The term “carrier polypeptide” refers to any peptide or polypeptide that can be conjugated to the moesin fragment of the peptide of the present application. A carrier polypeptide can be beneficial to the peptide of the present application, e.g. to promote the stability, solubility, specific or non-specific binding affinity and/or function of the peptide of the present application. However, a carrier polypeptide is not required to provide any benefit or even biological function to the peptide of the present application. Commonly used carrier polypeptides include human serum albumin, bovine serum albumin, antibody fragments such as the antibody constant region.

In another aspect, the present application provides a method for diagnosing a disorder or disease associated with abnormal level of platelets, comprising contacting a sample from a subject suspected of such disorder or disease with a first and second peptides capable of binding to anti-moesin autoantibodies, wherein the first peptide comprises a first moesin fragment consisting essentially of the C-terminal tail domain of human moesin protein or a fragment thereof, the second peptide comprises a second moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof, and detecting the binding of the first and second peptide to the anti-moesin autoantibodies. The different levels of the anti-moesin autoantibodies binding to the first and second peptides, respectively, may be correlated with the different stages and degrees of severity of a disorder or disease associated with abnormal level of platelets in a subject. In certain embodiments, the sample is tested for binding of the first peptide to the anti-moesin antibodies before tested for binding of the second peptide to the anti-moesin antibodies. In certain embodiments, the sample is tested for binding of the first and second peptides to the anti-moesin antibodies at the same time. In certain embodiments, the sample is tested for binding of the second peptide to the anti-moesin antibodies before tested for binding of the first peptide to the anti-moesin antibodies.

In another aspect, the present application provides the use of a first antibody against a moesin fragment consisting essentially of the C-terminal tail domain of human moesin protein or a fragment thereof in the manufacture of a pharmaceutical composition for the prevention or treatment of a disorder or disease associated with abnormal high level of platelets in a subject.

In another aspect, the present application provides the use of a second antibody against a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof in the manufacture of a pharmaceutical composition for the prevention or treatment of a disorder or disease associated with abnormal low level of platelets in a subject.

In another aspect, the present application provides the use of a first peptide comprising a moesin fragment consisting essentially of the C-terminal tail domain of human moesin protein or a fragment thereof in the manufacture of a pharmaceutical composition for the prevention or treatment of a disorder or disease associated with abnormal low level of platelets in a subject.

In another aspect, the present application provides the use of a second peptide comprising a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof in the manufacture of a pharmaceutical composition for the prevention or treatment of a disorder or disease associated with abnormal high level of platelets in a subject.

In another aspect, the present application provides the use of a first peptide comprising a moesin fragment consisting essentially of the C-terminal tail domain of human moesin protein or a fragment thereof in the manufacture of a diagnostic composition for the diagnosis of a disorder or disease associated with abnormal low level of platelets in a subject.

In another aspect, the present application provides the use of a second peptide comprising a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof in the manufacture of a diagnostic composition for the diagnosis of a disorder or disease associated with abnormal high level of platelets in a subject.

In another aspect, the present application provides a kit for diagnosing a disorder or disease associated with abnormal low level of platelets in a subject, comprising a first peptide comprising a moesin fragment consisting essentially of the C-terminal tail domain of human moesin protein or a fragment thereof, and a detecting reagent. In certain embodiments, the detecting reagent is an antibody capable of binding to the anti-moesin autoantibody. In certain embodiments, the peptide capable of binding to an anti-moesin autoantibody is bound to a solid phase.

In another aspect, the present application provides a kit for diagnosing a disorder or disease associated with abnormal high level of platelets in a subject, comprising a second peptide comprising a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof, and a detecting reagent.

In another aspect, the present application provides a method of determining the pathological state of a subject having APS (or thrombosis or other disease or disorder), comprising the following steps:

(i) contacting a sample from a subject suspected of having APS (or thrombosis or other disease or disorder) with a composition comprising a peptide capable of binding to an anti-moesin autoantibody, wherein the peptide comprises a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof;

(ii) detecting the binding of the peptide to an anti-moesin autoantibody and measuring the level of the anti-moesin autoantibody bound to the peptide; and

(iii) determining the pathological state of the subject according to a comparison of the level of the anti-moesin autoantibody to a reference database obtained from diseased reference samples correlating titers of the anti-moesin autoantibody to pathological states of APS (or thrombosis or other disease or disorder).

In certain embodiments, the reference database is a reference curve which shows the relationship between the titers of the anti-moesin autoantibodies and the levels of platelet counts in the subject.

In another aspect, the present application provides a method of monitoring treatment response in a subject undergoing a treatment for APS (or thrombosis or other disease or disorder), comprising:

(i) contacting a sample from a subject suspected of having APS (or thrombosis or other disease or disorder) with a peptide capable of binding to an anti-moesin autoantibody, wherein the peptide comprises a moesin fragment consisting essentially of the N-terminal FERM domain of human moesin protein or a fragment thereof;

(ii) detecting the binding of said peptide to an anti-moesin autoantibody and measuring the level of the anti-moesin autoantibody bound to the peptide; and

(iii) determining the pathological state of the subject according to a comparison of the level of the anti-moesin autoantibody to a reference database obtained from diseased reference samples correlating titers of the anti-moesin autoantibody to pathological states of the APS (or thrombosis or other disease or disorder), wherein a decrease in titer is indicative of positive response of the subject to the treatment.

In certain embodiments, the reference database contains data for the levels of the anti-moesin autoantibodies at different stages of the treatment.

In another aspect, the application provides a method of diagnosing APS (or thrombosis or other disease or disorder) in a subject, comprising the following steps: (i) contacting a peptide comprising at least eight consecutive amino acid residues of the N-terminal FERM domain of human moesin protein with a sample obtained from said subject; and (ii) determining whether the anti-moesin autoantibody is present in said sample at a level greater than the level of said anti-moesin autoantibody in a reference sample, thereby indicating that the subject has APS (or thrombosis or other disease or disorder).

BRIEF DESCRIPTION OF THE DRAWIINGS

Figure 1. Amino acid sequence of the full length human moesin protein (SEQ ID NO:1).

Figure 2. Amino acid sequence of moesin fragments: the N-terminal FERM domain (SEQ ID NO:2), the helical and C-terminal tail domains (SEQ ID NO:3), the helical domain (SEQ ID NO:4) and the C-terminal tail domain (SEQ ID NO:5).

Figure 3. cDNA sequence encoding for the full length human moesin protein (SEQ ID NO:6) (wherein the first underlined portion is the cDNA sequence encoding for the N-terminal FERM domain of moesin, and the second underlined portion is the cDNA sequence encoding for the C-terminal tail domain of moesin).

Figure 4. Cloning map of the pET32a(+) expression vector.

Figure 5. Cloning map of the pET28a(+) expression vector.

Figure 6 Graph illustrating the expression of CD62P and CD63 in the presence of anti-moesin N-terminal domain antibody, N-terminal FERM domain or ADP.

Figure 7 Graph illustrating the expression of CD62P and CD63 in the presence of anti-moesin N-terminal domain antibody, N-terminal FERM domain or ADP in combination with various inhibitors of platelet activation.

Figure 8 Graph illustrating the inhibition rate of platelet aggregation in the presence of N-terminal FERM domain, anti-moesin C-terminal tail domain antibody or RGDS in combination with ADP or anti-moesin N-terminal domain antibody.

Figure 9 Graph illustrating the presence of five different autoantibodies in sera of different patient groups.

MODES FOR CARRYING OUT THE INVETION

The practice of the present application will employ, unless otherwise indicated, conventional techniques of molecular biology (including recombinant techniques), microbiology, cell biology, biochemistry, and immunology, which are within the skill of the art. Such techniques are explained fully in the literature, such as, "Molecular Cloning: A Laboratory Manual", second edition (Sambrook et al., 1989); "Oligonucleotide Synthesis" (M. J. Gait, ed., 1984); "Animal Cell Culture" (R. I. Freshney, ed., 1987); "Methods in Enzymology" series (Academic Press, Inc.); "Current Protocols in Molecular Biology" (F. M. Ausubel et al., eds., 1987, and periodic updates); "PCR: The Polymerase Chain Reaction", (Mullis et al., eds., 1994).
Primers, polynucleotides and polypeptides employed in the present application can be generated using standard techniques known in the art.

Unless defined otherwise, technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Singleton et al., Dictionary of Microbiology and Molecular Biology 2nd ed., J. Wiley & Sons (New York, N.Y. 1994), and March, Advanced Organic Chemistry Reactions, Mechanisms and Structure 4th ed., John Wiley & Sons (New York, N.Y. 1992), provide one skilled in the art with a general guide to many of the terms used in the present application.

Definitions

The term "moesin" stands for membrane-organizing extension spike protein, as described in Lankes and Furthmayr (1991) Proc. Natl. Acad. Sci., 88:8297-8301. Full length human moesin protein is a 577 amino acid polypeptide having an amino acid sequence as set forth in Figure 1 (SEQ ID NO:1). The moesin protein consists of three domains: the N-terminal FERM domain, the helical domain, and the C-terminal tail domain, as further defined below. It belongs to the ERM (ezrin-radixin-moesin) family. The three ERM proteins, primarily expressed in cytoplasm right beneath the plasma membrane, share high degrees of sequence homology and act as linking proteins between the plasma membrane and the actin cytoskeleton. Furthermore, human moesin protein shares high degrees of sequence homology with moesins from other species such as mouse and bovine moesins. Sato et al. (1992) J. Cell Sci. 103:131-143.

The term "moesin fragment" refers to a portion of the moesin polypeptide that is shorter than the full length wild type moesin protein, and that is capable of binding to an anti-moesin autoantibody. Useful in the present application are such moesin fragments capable of binding to domain-specific anti-moesin autoantibodies. A "fragment" of the moesin fragment means a portion of the moesin fragment that is shorter than such moesin fragment, and that retains the ability of binding to an anti-moesin autoantibody.

The "N-terminal FERM domain" of human moesin protein refers to the globular portion of the wild type human moesin protein structurally proximate to the amino-terminal of the protein and functionally responsible for localizing the protein to the plasma membrane and interacting with adhesion molecules. The FERM domain, which stands for band four-point-one, ezrin, radixin, moesin homology domain because of its homology with the band 4.1 protein, defines members of the band 4.1 superfamily, which includes cytoskeletal proteins such as erythrocyte band 4.1, talin, and the ezrin-radixin-moesin (ERM) protein family, as well as several tyrosine kinases and phosphatases and the tumor suppressor protein merlin. Specifically, the term refers to the first about 297 amino acid residues of the mature form of human moesin protein (e.g., amino acid residues 1-297 (SEQ ID NO:2)). In certain literatures, the same domain is also known as N-ERM associated domain (N-ERMAD), which is included in the definition herein. Bretscher et al. (1995) Biochem. 34, 16830-7.

The "C-terminal tail domain" of human moesin protein refers to the portion of the wild type human moesin protein structurally proximate to the carboxy-terminal of the protein and functionally responsible for binding to and interacting with actin filaments. The tail domain of moesin is positively charged and adopts an extended, meandering structure. Specifically, the term refers to the last about 107 amino acid residues of human moesin protein (e.g., amino acid residues 471-577 (SEQ ID NO:5)). In certain literatures, the same domain is also known as C-ERM associated domain (C-ERMAD), which is included in the definition herein. Bretscher et al. (1995). The last 34 amino acid residues of the C-terminal tail domain are highly conserved amongst ERM proteins and forms the region for binding to F-actin. Within the F-actin binding region, there exists a threonine residue (Thr558 in wild type human moesin) that is phosphorylated during the activation of the protein.

The “helical domain” of human moesin protein refers to the central portion of the wild type human moesin resided in between the N-terminal FERM domain and the C-terminal tail domain. It adopts an extended alpha-helical structure, acting as a linker between the two terminal domains. Specifically, the term refers to the region encompassing about amino acid residues 298-470 of human moesin protein (SEQ ID NO:4).

The term “autoantibody” refers to any antibody produced by an individual’s immune system that recognizes and binds to such individual’s own intrinsic substance. The term “anti-moesin autoantibody” refers to an anti-moesin antibody produced by an individual’s immune system that recognizes and binds to such individual’s own moesin protein or fragments thereof. The presence of anti-moesin autoantibody can be associated with abnormal level of platelets, and the titer of such anti-moesin autoantibody in the body may correlate to the pathological state of the abnormal level of platelets.

The term “disorders or diseases associated with abnormal activity and quantity of platelets” or “disorders or diseases associated with abnormal high/low level of platelets” is used herein to refer to disorders or diseases either caused or facilitated by abnormal high or low level of platelets due to abnormal activation or destroy of platelets in a subject. Exemplary diseases associated with abnormal high level of platelets include, but not limited to, thrombosis, APS (e.g, PAPS or SAPS), miscarriage (e.g., habitual miscarriage), aPL-thrombosis, APS-related pregnancy complications, thrombocythemia (e.g, primary thrombocythemia or secondary thrombocythemia). Exemplary diseases associated with abnormal low level of platelets include, but not limited to, immune thrombocytopenia, idiopathic thrombocytopenic purpura and secondary thrombocytopenic purpura (e.g., thrombotic thrombocytopenic purpura, or thrombotic thrombocytopenic purpura accompanied with hemolytic uremic syndrome), hemolysis, elevated liver enzymes and low platelets syndrome

(HELLP syndrome), disseminated intravascular coagulation, systemic lupus erythematosis and aplastic anemia.

The term "diagnosis" is used herein to refer to the identification of a molecular or pathological state, disease or condition, such as the identification of an autoimmune disease, or to refer to identification of a patient with autoimmune disease who may benefit from a particular treatment regimen. In one embodiment, diagnosis refers to the identification of abnormal level of platelets. In yet another embodiment, diagnosis refers to the identification of abnormal level of platelets associated with higher than normal presence of anti-moesin autoantibodies in a subject. In yet another embodiment, diagnosis refers to the identification of APS in a subject. In yet another embodiment, diagnosis refers to the identification of the risk of habitual miscarriage in a subject.

The term "prognosis" is used herein to refer to the prediction of the likelihood of outcomes of disease symptoms, including, for example, recurrence, flaring, and drug resistance, of a disease. The term also refers to the prediction of the likelihood of clinical benefit from a therapy.

The term "prediction" is used herein to refer to the likelihood that a patient will respond either favorably or unfavorably to a drug or set of drugs or a particular therapy course. In one embodiment, the prediction relates to the extent of those responses. In one embodiment, the prediction relates to whether and/or the probability that a patient will survive or improve following treatment, for example treatment with a particular therapeutic agent, and for a certain period of time without disease recurrence. The predictive methods of the invention can be used clinically to make treatment decisions by choosing the most appropriate treatment modalities for any particular patient. The predictive methods of the present application are valuable tools in predicting if a patient is likely to respond favorably to a treatment regimen, such as a given therapeutic regimen, including for example, administration of a given therapeutic agent or combination, surgical intervention, steroid treatment, etc., or whether long-term survival of the patient, following a therapeutic regimen is likely.

The term “pharmaceutically effective amount” is used herein to refer to any amount of moesin fragments (e.g., the N-terminal FERM domain of human moesin protein, or C-terminal tail domain of human moesin protein) or anti-moesin antibodies (e.g., the antibody against the N-terminal FERM domain of human moesin protein, or antibody against the C-terminal tail domain of human moesin protein) or fragments thereof according to the present application (or a population thereof or a pharmaceutical composition thereof) that is sufficient to achieve the intended purpose (e.g, modulating abnormal high or low level of platelets).

The term “pharmaceutically acceptable” as used herein refers to any component (e.g., saline, solvents, dispersion media, coatings, antibacterial and antifungal agents, isotonic and absorption delaying agents) that is compatible with pharmaceutical administration.

The term “thrombosis” as used herein refers to formation of a thrombus (blood clot) inside a blood vessel. The term encompasses, without limitation, arterial and venous thrombosis, including deep vein thrombosis, portal vein thrombosis, jugular vein thrombosis, renal vein thrombosis, and cerebral venous sinus thrombosis. Diseases and conditions associated with thrombosis include, without limitation, acute venous thrombosis, pulmonary embolism, thrombosis during pregnancy, hemorrhagic skin necrosis, acute or chronic disseminated intravascular coagulation (DIC), clot formation from surgery, long bed rest, long periods of immobilization, venous thrombosis, fulminant meningococcemia, acute thrombotic stroke, acute coronary occlusion, acute peripheral arterial occlusion, massive pulmonary embolism, axillary vein thrombosis, massive iliofemoral vein thrombosis, occluded arterial cannulae, occluded venous cannulae, cardiomyopathy, venoocclusive disease of the liver, hypotension, decreased cardiac output, decreased vascular resistance, pulmonary hypertension, diminished lung compliance, leukopenia, and thrombocytopenia, stroke, myocardial infarction, Budd-Chiari syndrome, Paget-Schroetter disease.

The term “antiphospholipid antibodies-mediated thrombosis” or “aPL-thrombosis” as used herein refers to an immunic thrombosis which is mediated by or associated with antiphospholipid antibodies.

The term "antiphospholipid-syndrome-related pregnancy complications" or "APS-related pregnancy complications" as used herein refers to increased fetal morbidity, increased fetal growth restriction and/or increased miscarriage frequency in a female mammal with antiphospholipid syndrome. In humans, the criteria for classifying a patient as having APS-related pregnancy complications include the presence of antiphospholipid (aPL) antibodies and: (1) one or more unexplained deaths of morphologically normal fetuses at or after the 10th week of gestation; or (2) one or more premature births of morphologically normal fetuses at or before the 34th week of gestation; or (3) three or more unexplained consecutive spontaneous miscarriages before the 10th week of gestation (Levine et al., N. Eng. J. Med. 346:752-63 (2002)).

The term "antiphospholipid syndrome" or "APS" as used herein refers to a clinical association between antiphospholipid antibodies and a syndrome of hypercoagulability (Levine et al., N. Eng. J. Med. 346:752-63 (2002)). APS includes primary antiphospholipid syndrome (PAPS) wherein there is no evidence of any underlying disease, and secondary antiphospholipid syndrome (SAPS) wherein APS is associated with other diseases. APS can cause thrombosis or pregnancy-related complications or other diseases or conditions.

The term "miscarriage" as used herein refers to the natural or spontaneous end of a pregnancy at a stage where the embryo or the fetus is incapable of surviving, generally defined in humans at a gestation of prior to about 20 weeks. The term "habitual miscarriage" is defined broadly as recurrent miscarriage, and specifically refers to three or more consecutive miscarriages.

The term "thrombocytopenia" is used herein to refer to any disorder in which the platelet level in a subject fall below a normal range of platelet numbers for that individual, due to disturbance in the production or destruction of platelet. In one embodiment, normal blood platelet levels range from about 150.000 to 300.000 per microliter peripheral blood in humans. Thrombocytopenia as used herein also refers to a decrease in platelet number in an individual when compared to the platelet number measured at a certain reference point in that individual. The reference point mentioned can be, for instance, the start of a therapy such as a radiation therapy or chemotherapy.

The term "immune thrombocytopenia" is used herein to refer to any type of thrombocytopenia arising from an auto-immune response directed against an individual's own platelets. Immune thrombocytopenia includes primary immune thrombocytopenia, in which autoimmune response is the original cause for the decrease in the platelet counts. Immune thrombocytopenia includes, for example, idiopathic thrombocytopenic purpura. Furthermore, there is secondary immune thrombocytopenia, in which the decrease in platelet counts is associated with one or more other diseases such as aplastic anemia, iron deficiency anemia and autoimmune hemolytic anemia, leukemia, systemic lupus erythematosus, HIV-associated thrombocytopenia, Wiskott-Aldrich syndrome, Evans syndrome and the like. In secondary immune thrombocytopenia, those other diseases induce or trigger or otherwise cause an individual's body to generate an auto-immune response against its own platelets.

"Sample" or "test sample" herein refers to a composition that is obtained or derived from a subject of interest that contains a cellular and/or other molecular entity that is to be characterized and/or identified, for example based on physical, biochemical, chemical and/or physiological characteristics. In one embodiment, the definition encompasses blood and other liquid samples of biological origin and tissue samples such as a biopsy specimen or tissue cultures or cells derived there from or cell cultures. The source of the tissue sample may be solid tissue as from a fresh, frozen and/or preserved organ or tissue sample or biopsy or aspirate; blood or any blood constituents such as plasma or serum; bodily fluids; and cells from any time in gestation or development of the subject or plasma. In another embodiment, the sample is whole blood, serum or plasma obtained from a subject. A subject can be a human or an animal subject. In another embodiment, a subject has or is suspected of having an abnormal level of platelets. In another embodiment, the definition includes biological samples that have been manipulated in any way after their procurement, such as by treatment with reagents, solubilization, or enrichment for certain components, such as proteins or polynucleotides.

In one embodiment, a sample is obtained from a subject or patient prior to any treatment. In another embodiment, a test sample is obtained during or after treatment such as a therapy for modulating the abnormal level of platelets or a therapy for treating APS. In one embodiment, the test sample is a clinical sample. In another embodiment, the test sample is used in a diagnostic assay. In another embodiment, the sample is pre-tested with other known blood testing methods before being tested with the methods of the present application. These blood testing methods include, for example, full blood count, liver enzymes, renal function, vitamin B_{12} levels, folic acid levels, erythrocyte sedimentation rate, peripheral blood smear, bone marrow biopsy and the like.

A "reference sample", as used herein, refers to a sample from a source known, or believed, not to be afflicted with the disease or condition for which a method or composition of the present application is being used to identify. In one embodiment, a reference sample is obtained from a healthy part of the body of the same subject or patient in whom a disease or condition is being identified using a composition or method of the present application. In one embodiment, a reference sample is obtained from a healthy part of the body of an individual who is not the subject or patient in whom a disease or condition is being identified using a composition or method of the present application. In one embodiment, the reference sample is a sample from a healthy individual that has a normal platelet count.

A "disease reference sample", as used herein, refers to a sample from a source that is clinically identified as being afflicted with the disease or condition for which a method or composition of the present application is being used to identify. In one embodiment, the disease reference sample is a sample obtained from a subject or patient that has been clinically diagnosed with APS. In one embodiment, the subject or patient that has been clinically diagnosed with APS is under treatment for APS.

A "reference database", as used herein, refers to a collection of data, standard, or level from one or more reference samples or disease reference samples. In one embodiment, such collection of data, standard or level are normalized so that they can be used for comparison purpose with data from one or more sample. "Normalize" or "normalization" is a process by which a measurement raw data is converted into data that may be directly compared with other so normalized data. Normalization is used to overcome assay-specific errors caused by factors that may vary from one assay to another, for example, variation in loaded quantities, binding efficiency, detection sensitivity, and other various errors. In one embodiment, a reference database includes titers of anti-moesin autoantibodies, platelet counts, blood cell counts, and/or other laboratory and clinical data from one or more reference samples or disease reference samples. In one embodiment, a reference database includes levels of anti-moesin autoantibodies that are each normalized as a percent of the level of anti-moesin autoantibody of a control sample (e.g. a known amount of anti-moesin autoantibody) tested under the same conditions as the reference samples or disease reference samples. In order to compare with such normalized levels of anti-moesin autoantibodies, the level of anti-moesin autoantibody of a test sample is also measured and calculated as a percent of the level of anti-moesin autoantibody of a control sample tested under the same conditions as the test sample. In one embodiment, a reference database is established by compiling reference sample data from healthy subjects and/or non-diseased part of the body of the same subject or patient in whom a disease or condition is being identified using a composition or method of the present application. In one embodiment, a reference database is established by compiling data from disease reference samples from individuals under treatment for APS. In one embodiment, a reference database is established by compiling data from disease reference samples from individuals at different stages of APS as evidenced by, for example, different levels of platelet counts and other clinical indications.

In certain embodiments, the term "increase" refers to an overall increase of 5%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 60%, 70%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99% or greater, in the level of autoantibody, detected by standard art known methods such as those described herein, as compared to a reference sample or a disease reference sample. In certain embodiments, the term increase refers to the increase in the level of autoantibody in the sample wherein the increase is at least about 1.25X, 1.5X, 1.75X, 2X, 3X, 4X, 5X, 6X, 7X, 8X, 9X, 10X, 25X, 50X, 75X, or 100X the level of the autoantibody in the reference sample or the disease reference sample.

In certain embodiments, the term "decrease" herein refers to an overall reduction of 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, 99% or greater, in the level of autoantibody, detected by standard art known methods such as those described herein, as compared to a reference sample or a disease reference sample. In certain embodiments, the term decrease refers to the decrease in the level of autoantibody in the sample wherein the decrease is at least about 0.9X, 0.8X, 0.7X, 0.6X, 0.5X, 0.4X, 0.3X, 0.2X, 0.1X, 0.05X, or 0.01X the level of autoantibody in the reference sample or the disease reference sample.

The term "detection means" refers to a moiety or technique used to detect the presence of the detectable antibody in the ELISA herein and includes detection agents that amplify the immobilized label such as label captured onto a microtiter plate. In one embodiment, the detection means is a colorimetric detection agent such as avidin or streptavidin-HRP. In another embodiment, the detection means is a H_2O_2/TMB coloring system.

The term "capture reagent" refers to a reagent capable of binding and capturing a target molecule in a sample such that under suitable condition, the capture reagent-target molecule complex can be separated from the rest of the sample. Typically, the capture reagent is immobilized or immobilizable. In a sandwich immunoassay, the capture reagent is preferably an antibody or a mixture of different antibodies against a target antigen.

By "correlate" or "correlating" is meant comparing, in any way, the performance and/or results of a first analysis or protocol with the performance and/or results of a second analysis or protocol. For example, one may use the results of a first analysis or protocol in carrying out a second protocols and/or one may use the results of a first analysis or protocol to determine whether a second analysis or protocol should be performed. With respect to the embodiment of autoantibody detection, one may use the results of the detection analysis or protocol to determine whether a specific therapeutic regimen should be performed.

The word "label" when used herein refers to a compound or composition which is conjugated or fused directly or indirectly to a reagent such as a nucleic acid probe or an antibody and facilitates detection of the reagent to which it is conjugated or fused. The label may itself be detectable (e.g., radioisotope labels or fluorescent labels) or, in the case of an enzymatic label, may catalyze chemical alteration of a substrate compound or composition which is detectable.

An "isolated" polypeptide is one that has been identified and separated and/or recovered from contaminant components of its natural environment. Contaminant components of its natural environment are materials that would interfere with diagnostic or therapeutic uses for the polypeptide, and may include enzymes, hormones, and other proteinaceous or nonproteinaceous solutes. In certain embodiments, the polypeptide will be purified (1) to greater than 95% by weight of polypeptide as determined by the Lowry method, or more than 99% by weight, (2) to a degree sufficient to obtain at least 15 residues of N-terminal or internal amino acid sequence by use of a spinning cup sequenator, or (3) to homogeneity by SDS-PAGE under reducing or nonreducing conditions using Coomassie blue, or silver stain. Isolated polypeptide includes the polypeptide in situ within recombinant cells since at least one contaminant component of the polypeptide's natural environment will not be present. Ordinarily, however, isolated polypeptide will be prepared by at least one purification step.

"Percent (%) amino acid sequence identity" with respect to a moesin domain or fragment of the present application is defined as the percentage of amino acid residues in a sequence of interest that are identical with the amino acid residues in the moesin domain or fragment, after aligning the sequences and introducing gaps, if necessary, to achieve the maximum percent sequence identity, and not considering any conservative amino acid substitutions as part of the sequence identity.

Alignment for purposes of determining percent amino acid sequence identity can be achieved in various ways that are within the skill in the art, for instance, using publicly available computer software such as BLAST, BLAST-2, ALIGN or Megalign (DNASTAR) software. See, for example, Altschul et al., Nucleic Acids Res. 25:3389-3402 (1997); Altschul et al., Methods in Enzymology 266:460-480 (1996). Those skilled in the art can determine appropriate parameters for measuring alignment, including any algorithms needed to achieve maximal alignment over the full length of the sequences being compared.

The term "antibody" is used in the broadest sense and specifically covers monoclonal antibodies (including full length or intact monoclonal antibodies), polyclonal antibodies, multivalent antibodies, multispecific antibodies (e.g., bispecific antibodies) formed from at least two intact antibodies, and antibody fragments so long as they exhibit the desired antigen binding activity. The term "monoclonal antibody" as used herein refers to an antibody obtained from a population of substantially homogeneous antibodies, i.e., the individual antibodies comprising the population are identical except for possible mutations, e.g., naturally occurring mutations, that may be present in minor amounts.

"Treatment" refers to both therapeutic treatment and prophylactic or preventative measures. Those in need of treatment include those already with the disease or disorder as well as those in which the disease or disorder is to be prevented.

Responsiveness of a patient can be assessed using any endpoint indicating a benefit to the patient, including, without limitation, (1) inhibition, to some extent, of disease progression, including slowing down and complete arrest; (2) reduction in the number of disease episodes and/or symptoms; (3) reduction in lesion size; (4) inhibition (i.e., reduction, slowing down or complete stopping) of disease cell infiltration into adjacent peripheral organs and/or tissues; (5) inhibition (i.e. reduction, slowing down or complete stopping) of disease spread; (6) relief, to some extent, of one or more symptoms associated with the disorder; (7) increase in the length of disease-free presentation following treatment; (8) decrease of auto-immune response, which may, but does not have to, result in the regression or ablation of the disease lesion, e.g., progression-free survival; (9) increased overall survival; (10) higher response rate; and/or (11) decreased mortality at a given point of time following treatment. The term "benefit" is used in the broadest sense and refers to any desirable effect.

Typical Methods and Materials of the Invention

The present application provides compositions and methods for diagnosing, monitoring, preventing or treating disorders or diseases associated with abnormal level of platelets. Conventional methods known to the skilled in the art can be used to carry out the present application.

Vectors, Host Cells and Recombinant Methods

The polypeptides of the present application can be produced recombinantly, using techniques and materials readily obtainable. For recombinant production of a polypeptide of the present application, the nucleic acid encoding it is isolated and inserted into a replicable vector for further cloning (amplification of the DNA) or for expression. DNA encoding the polypeptide of the present application is readily isolated and sequenced using conventional procedures. For example, a DNA encoding a human moesin protein is isolated and sequenced, *e.g.*, by using oligonucleotide probes that are capable of binding specifically to genes encoding the protein. Many vectors are available. The vector components generally include, but are not limited to, one or more of the following: a signal sequence, an origin of replication, one or more selection genes, an enhancer element, a promoter, and a transcription termination sequence.

Signal Sequence Component

Polypeptides of the present application may be produced recombinantly not only directly, but also as a fusion polypeptide with a heterologous polypeptide, which is typically a signal sequence or other polypeptide having a specific cleavage site at the N-terminus of the mature protein or polypeptide. The heterologous signal sequence selected typically is one that is recognized and processed (*i.e.*, cleaved by a signal peptidase) by the host cell. For prokaryotic host cells, the signal sequence can be a prokaryotic signal sequence selected, for example, from the group of the alkaline phosphatase, penicillinase, lpp, or heat-stable enterotoxin II leaders. For yeast secretion, the signal sequence may be, *e.g.,* the yeast invertase leader, α factor leader (including *Saccharomyces* and *Kluyveromyces* α-factor leaders), or acid phosphatase leader, the *C. albicans* glucoamylase leader, or the signal described in WO 90/13646. In mammalian cell expression, mammalian signal sequences as well as viral secretory leaders, for example, the herpes simplex gD signal, are available.

The DNA for such precursor region is ligated in reading frame to DNA encoding the polypeptide of the present application.

Origin of Replication Component

Both expression and cloning vectors contain a nucleic acid sequence that enables the vector to replicate in one or more selected host cells. Generally, in cloning vectors this sequence is one that enables the vector to replicate independently of the host chromosomal DNA, and includes origins of replication or autonomously replicating sequences. Such sequences are well known for a variety of bacteria, yeast, and viruses. The origin of replication from the plasmid pBR322 is suitable for most Gram-negative bacteria, the 2μ plasmid origin is suitable for yeast, and various viral origins (SV40, polyoma, adenovirus, VSV or BPV) are useful for cloning vectors in mammalian cells. Generally, the origin of replication component is not needed for mammalian expression vectors (the SV40 origin may typically be used only because it contains the early promoter).

Selection Gene Component

Expression and cloning vectors may contain a selection gene, also termed a selectable marker. Typical selection genes encode proteins that (a) confer resistance to antibiotics or other toxins, *e.g.,* ampicillin, neomycin, methotrexate, or tetracycline, (b) complement auxotrophic deficiencies, or (c) supply critical nutrients not available from complex media, *e.g.,* the gene encoding D-alanine racemase for *Bacilli.*

One example of a selection scheme utilizes a drug to arrest growth of a host cell. Those cells that are successfully transformed with a heterologous gene produce a protein conferring drug resistance and thus survive the selection regimen. Examples of such dominant selection use the drugs neomycin, mycophenolic acid and hygromycin.

Another example of suitable selectable markers for mammalian cells are those that enable the identification of cells competent to take up nucleic acid, such as DHFR, thymidine kinase, metallothionein-I and -II, typically primate metallothionein genes, adenosine deaminase, ornithine decarboxylase, *etc.*

For example, cells transformed with the DHFR selection gene are first identified by culturing all of the transformants in a culture medium that contains methotrexate (Mtx), a competitive antagonist of DHFR. An appropriate host cell when wild-type DHFR is employed is the Chinese hamster ovary (CHO) cell line deficient in DHFR activity.

Alternatively, host cells (particularly wild-type hosts that contain endogenous DHFR) transformed or co-transformed with DNA sequences encoding a polypeptide of the present application, wild-type DHFR protein, and another selectable marker such as aminoglycoside 3'-phosphotransferase (APH) can be selected by cell growth in medium containing a selection agent for the selectable marker such as an aminoglycosidic antibiotic, *e.g.,* kanamycin, neomycin, or G418. See U.S. Patent No. 4,965,199.

A suitable selection gene for use in yeast is the *trp*1 gene present in the yeast plasmid Yrp7 (Stinchcomb *et al., Nature*, 282:39 (1979)). The *trp*1 gene provides a selection marker for a mutant strain of yeast lacking the ability to grow in tryptophan, for example, ATCC No. 44076 or PEP4-1. Jones, *Genetics*, 85:12 (1977). The presence of the *trp*1 lesion in the yeast host cell genome then provides an effective environment for detecting transformation by growth in the absence of tryptophan. Similarly, *Leu*2-deficient yeast strains (ATCC 20,622 or 38,626) are complemented by known plasmids bearing the *Leu*2 gene.

Promotor Component

Expression and cloning vectors usually contain a promoter that is recognized by the host organism and is operably linked to a nucleic acid encoding a polypeptide of the present application. Promoters suitable for use with prokaryotic hosts include the *phoA* promoter, β-lactamase and lactose promoter systems, alkaline phosphatase, a tryptophan (trp) promoter system, and hybrid promoters such as the tac promoter. However, other known bacterial promoters are suitable.

Promoters for use in bacterial systems also will contain a Shine-Dalgarno (S.D.) sequence operably linked to the DNA encoding the polypeptide of the present application.

Promoter sequences are known for eukaryotes. Virtually all eukaryotic genes have an AT-rich region located approximately 25 to 30 bases upstream from the site where transcription is initiated. Another sequence found 70 to 80 bases upstream from the start of transcription of many genes is a CNCAAT region where N may be any nucleotide. At the 3' end of most eukaryotic genes is an AATAAA sequence that may be the signal for addition of the poly A tail to the 3' end of the coding sequence. All of these sequences are suitably inserted into eukaryotic expression vectors.

Examples of suitable promoting sequences for use with yeast hosts include the promoters for 3-phosphoglycerate kinase or other glycolytic enzymes, such as enolase, glyceraldyhyde-3-phosphate dehydrogenase, hexokinase, pyruvate decarboxylase, phosphofructokinase, glucose-6-phosphate isomerase, 3-phosphoglycerate mutase, pyruvate kinase, triosephosphate isomerase, phosphoglucose isomerase, and glucokinase.

Other yeast promoters, which are inducible promoters having the additional advantage of transcription controlled by growth conditions, are the promoter regions for alcohol dehydrogenase 2, isocytochrome C, acid phosphatase, degradative enzymes associated with nitrogen metabolism, metallothionein, glyceraldehyde-3-phosphate dehydrogenase, and enzymes responsible for maltose and galactose utilization. Suitable vectors and promoters for use in yeast expression are further described in EP 73,657. Yeast enhancers also are advantageously used with yeast promoters.

Transcription of polypeptides of the present application from vectors in mammalian host cells is controlled, for example, by promoters obtained from the genomes of viruses such as polyoma virus, fowlpox virus, adenovirus (such as Adenovirus 2), bovine papilloma virus, avian sarcoma virus, cytomegalovirus, a retrovirus, hepatitis-B virus and Simian Virus 40 (SV40), from heterologous mammalian promoters, *e.g.,* the actin promoter or an immunoglobulin promoter, from heat-shock promoters, provided such promoters are compatible with the host cell systems.

The early and late promoters of the SV40 virus are conveniently obtained as an SV40 restriction fragment that also contains the SV40 viral origin of replication. The immediate early promoter of the human cytomegalovirus is conveniently obtained as a HindIII E restriction fragment. A system for expressing DNA in mammalian hosts using the bovine papilloma virus as a vector is disclosed in U.S. Patent No. 4,419,446. A modification of this system is described in U.S. Patent No. 4,601,978. See also Reyes *et al.*, *Nature* 297:598-601 (1982) on expression of human β-interferon cDNA in mouse cells under the control of a thymidine kinase promoter from herpes simplex virus. Alternatively, the rous sarcoma virus long terminal repeat can be used as the promoter.

Enhancer Element Component

Transcription of a DNA encoding a polypeptide of this application by higher eukaryotes is often increased by inserting an enhancer sequence into the vector. Many enhancer sequences are now known from mammalian genes (globin, elastase, albumin, α-fetoprotein, and insulin). Typically, one will use an enhancer from a eukaryotic cell virus. Examples include the SV40 enhancer on the late side of the replication origin (bp 100-270), the cytomegalovirus early promoter enhancer, the polyoma enhancer on the late side of the replication origin, and adenovirus enhancers. See also Yaniv, *Nature* 297:17-18 (1982) on enhancing elements for activation of eukaryotic promoters. The enhancer may be spliced into the vector at a position 5' or 3' to the polypeptide-encoding sequence, but is typically located at a site 5' from the promoter.

Transcription Termination Component

Expression vectors used in eukaryotic host cells (yeast, fungi, insect, plant, animal, human, or nucleated cells from other multicellular organisms) will also contain sequences necessary for the termination of transcription and for stabilizing the mRNA. Such sequences are commonly available from the 5' and, occasionally 3', untranslated regions of eukaryotic or viral DNAs or cDNAs. These regions contain nucleotide segments transcribed as polyadenylated fragments in the untranslated portion of the mRNA encoding the polypeptide of the present application. One useful transcription termination component is the bovine growth hormone polyadenylation region. See WO94/11026 and the expression vector disclosed therein.

Selection and Transformation of Host Cells

Suitable host cells for cloning or expressing DNA encoding the polypeptides of the present application in the vectors herein are the prokaryote, yeast, or higher eukaryote cells described above. Suitable prokaryotes for this purpose include eubacteria, such as Gram-negative or Gram-positive organisms, for example, Enterobacteriaceae such as *Escherichia*, *e.g.*, *E. coli*, *Enterobacter*, *Erwinia*, *Klebsiella*, *Proteus*, *Salmonella*, *e.g.*, *Salmonella typhimurium*, *Serratia*, *e.g.*, *Serratia marcescans*, and *Shigella*, as well as *Bacilli* such as *B. subtilis* and *B. licheniformis* (*e.g.*, *B. licheniformis* 41P disclosed in DD 266,710 published 12 April 1989), *Pseudomonas* such as *P. aeruginosa* and *Streptomyces*. Typically, the *E. coli* cloning host is *E. coli* 294 (ATCC 31,446), although other strains such as *E. coli* B, *E. coli* BL21(DE3), *E. coli* X1776 (ATCC 31,537), and *E. coli* W3110 (ATCC 27,325) are suitable. These examples are illustrative rather than limiting.

In addition to prokaryotes, eukaryotic microbes such as filamentous fungi or yeast are suitable cloning or expression hosts for vectors encoding polypeptide of the present application. *Saccharomyces cerevisiae*, or common baker's yeast, is the most commonly used among lower eukaryotic host microorganisms. However, a number of other genera, species, and strains are commonly available and useful herein, such as *Schizosaccharomyces pombe*; *Kluyveromyces* hosts such as, *e.g.*, *K. lactis*, *K. fragilis* (ATCC 12,424), *K. bulgaricus* (ATCC 16,045), *K. wickeramii* (ATCC 24,178), *K. waltii* (ATCC 56,500), *K. drosophilarum* (ATCC 36,906), *K . thermotolerans*, and *K. marxianus; yarrowia* (EP 402,226); *Pichia pastoris* (EP 183,070); *Candida; Trichoderma reesia* (EP 244,234); *Neurospora crassa*; *Schwanniomyces* such as *Schwanniomyces occidentalis*; and filamentous fungi such as, *e.g., Neurospora, Penicillium*, *Tolypocladium*, and *Aspergillus* hosts such as *A. nidulans* and *A. niger.*

Suitable host cells for the expression of polypeptides of the present application can be derived from multicellular organisms. Examples of invertebrate cells include plant and insect cells. Numerous baculoviral strains and variants and corresponding permissive insect host cells from hosts such as *Spodoptera frugiperda* (caterpillar), *Aedes aegypti* (mosquito), *Aedes albopictus* (mosquito), *Drosophila melanogaster* (fruitfly), and *Bombyx mori* have been identified. A variety of viral strains for transfection are publicly available, *e.g.*, the L-1 variant of *Autographa californica* NPV and the Bm-5 strain of *Bombyx mori* NPV, and such viruses may be used as the virus herein according to the present application, particularly for transfection of *Spodoptera frugiperda* cells. Plant cell cultures of cotton, corn, potato, soybean, petunia, tomato, and tobacco can also be utilized as hosts.

However, interest has been greatest in vertebrate cells, and propagation of vertebrate cells in culture (tissue culture) has become a routine procedure. Examples of useful mammalian host cell lines are monkey kidney CV1 line transformed by SV40 (COS-7, ATCC CRL 1651); human embryonic kidney line (293 or 293 cells subcloned for growth in suspension culture, Graham *et al., J. Gen Virol.* 36:59 (1977)); baby hamster kidney cells (BHK, ATCC CCL 10); Chinese hamster ovary cells/-DHFR (CHO, Urlaub *et al., Proc. Natl. Acad. Sci. USA* 77:4216 (1980)); mouse sertoli cells (TM4, Mather, *Biol. Reprod.* 23:243-251 (1980)); monkey kidney cells (CV1 ATCC CCL 70); African green monkey kidney cells (VERO-76, ATCC CRL-1587); human cervical carcinoma cells (HELA, ATCC CCL 2); canine kidney cells (MDCK, ATCC CCL 34); buffalo rat liver cells (BRL 3A, ATCC CRL 1442); human lung cells (W138, ATCC CCL 75); human liver cells (Hep G2, HB 8065); mouse mammary tumor (MMT 060562, ATCC CCL51); TRI cells (Mather *et al., Annals N.Y. Acad. Sci.* 383:44-68 (1982)); MRC 5 cells; FS4 cells; and a human hepatoma line (Hep G2).

Host cells are transformed with the above-described expression or cloning vectors for production of polypeptide of the present application and cultured in conventional nutrient media modified as appropriate for inducing promoters, selecting transformants, or amplifying the genes encoding the desired sequences.

Culturing the Host Cells

The host cells used to produce polypeptides of the present application may be cultured in a variety of media. Commercially available media such as Ham's F10 (Sigma), Minimal Essential Medium ((MEM), (Sigma), RPMI-1640 (Sigma), and Dulbecco's Modified Eagle's Medium ((DMEM), Sigma) are suitable for culturing the host cells. In addition, any of the media described in Ham et al., Meth. Enz. 58:44 (1979), Barnes et al., Anal. Biochem.102:255 (1980), U.S. Pat. Nos. 4,767,704; 4,657,866; 4,927,762; 4,560,655; or 5,122,469; WO 90/03430; WO 87/00195; or U.S. Patent Re. 30,985 may be used as culture media for the host cells. Any of these media may be supplemented as necessary with hormones and/or other growth factors (such as insulin, transferrin, or epidermal growth factor), salts (such as sodium chloride, calcium, magnesium, and phosphate), buffers (such as HEPES), nucleotides (such as adenosine and thymidine), antibiotics (such as GENTAMYCIN™drug), trace elements (defined as inorganic compounds usually present at final concentrations in the micromolar range), and glucose or an equivalent energy source. Any other necessary supplements may also be included at appropriate concentrations that would be known to those skilled in the art. The culture conditions, such as temperature, pH, and the like, are those previously used with the host cell selected for expression, and will be apparent to the ordinarily skilled artisan.

Chemical Synthesis of Peptides

The peptides of the present application can also be produced by chemical synthesis, for example, the solid phase synthesis method described by Merrifield in J.A.C.S. 85: 2149-2154 (1963) or the standard solution synthesis method described in "Peptide Synthesis" by Bodanszky, et al, second edition, John Wiley and Sons, 1976.

The general procedure of the solid phase method of synthesis of a peptide involves initially attaching the protected C-terminal amino acid of the peptide to the resin. After attachment the resin is filtered, washed and the protecting group (e.g. t-butyloxycarbonyl) on the alpha amino group of the C-terminal amino acid is removed. The removal of this protecting group must take place, of course, without breaking the bond between that amino acid and the resin. To the resulting resin peptide is then coupled the penultimate C-terminal protected amino acid. This coupling takes place by the formation of an amide bond between the free carboxy group of the second amino acid and the amino group of the first amino acid attached to the resin. This sequence of events is repeated with successive amino acids until all amino acids of the peptide are attached to the resin. Finally, the protected peptide is cleaved from the resin and the protecting groups removed to obtain the desired peptide. The cleavage techniques used to separate the peptide from the resin and to remove the protecting groups depend upon the selection of resin and protecting groups and are known to those familiar with the art of peptide synthesis.

The resin mentioned above may be any suitable polymer and shall contain a functional group to which the first protected amino acid can be firmly linked by a covalent bond. Various polymers are suitable for this purpose, such as cellulose, polyvinyl alcohol, polymethylmethacrylate, and polystyrene. Appropriate protecting groups usable in solid phase synthesis include t-butyloxycarbonyl (BOC), benzyl (BZL), t-amyloxycarbonyl (AOC), tosyl (TOS), o-bromophenylmethoxycarbonyl (BrZ), 2,6-dichlorobenzyl (BZLCl.sub.2), and phenylmethoxycarbonyl (Z or CBZ). Additional protecting groups are also described in J. F. W. McOmie, "Protective Groups in Organic Chemistry", Plenum Press, New York, 1973.

The standard solution synthesis method can be performed by either stepwise or block coupling of amino acids or peptide fragments using chemical or enzymatic methods of amide bond formation. These solution synthesis methods are well known in the art.

Polypeptide Purification

A polypeptide or protein of the present application may be recovered from a subject. When using recombinant techniques, a polypeptide of the present application can be produced intracellularly, in the periplasmic space, or directly secreted into the medium. Polypeptides of the present application may be recovered from culture medium or from host cell lysates. If membrane-bound, it can be released from the membrane using a suitable detergent solution (e.g. Triton™ X-100) or by enzymatic cleavage. Cells employed in expression of a polypeptide of the present application can be disrupted by various physical or chemical means, such as freeze-thaw cycling, sonication, mechanical disruption, or cell lysing agents.

If a peptide is chemically synthesized, the peptide of the present application may be recovered from the reaction medium by any suitable techniques capable of separating the desired peptide from other components in the medium. For a solid phase synthesis, the protected peptide is firstly cleaved off the resin using a suitable cleaving solution. The selection of cleaving solution depends upon the properties of the resin and the amino acid bound thereto (such as trifluoroacetic acid for FMOC method). Cleaving is usually carried out under acid condition. Upon completion of cleaving, a dissociative peptide is then obtained and further purified using any suitable techniques (such as the methods described below).

The following procedures are exemplary of suitable protein purification procedures: by fractionation on an ion-exchange column; ethanol precipitation; reverse phase HPLC;

chromatography on silica, chromatography on heparin SEPHAROSETM, chromatography on an anion or cation exchange resin (such as a polyaspartic acid column, DEAE, etc.); chromatofocusing; SDS-PAGE; ammonium sulfate precipitation; gel filtration using, for example, Sephadex® G-75; protein A Sepharose columns to remove contaminants such as IgG; and metal chelating columns to bind epitope-tagged forms of polypeptides of the present application. Various methods of protein purification may be employed and such methods are known in the art and described for example in Deutscher, Methods in Enzymology, 182 (1990); Scopes, Protein Purification: Principles and Practice, Springer-Verlag, New York (1982). The purification step(s) selected will depend, for example, on the nature of the production process used and the particular polypeptide of the present application produced.

Detection Methods

In the methods of the present application, a biological sample is obtained from a subject suspected of having a disease associated with abnormal level of platelets (e.g., APS) and examined for expression of one or more anti-moesin autoantibodies (e.g. the antibody against the N-terminal FERM domain of moesin for detection of APS). Expression of various anti-moesin autoantibodies in a sample can be analyzed by a number of methodologies, many of which are known in the art and understood by the skilled artisan, including but not limited to, enzyme-linked immunosorbent assay (ELISA), enzyme-linked immuno-flow assay (ELIFA), immunoblotting, Western blot analysis, immunohistochemical analysis, immunoprecipitation, molecular binding assays and the like. Multiplexed immunoassays such as those available from Rules Based Medicine or Meso Scale Discovery (MSD) may also be used. These methods include both single-site and two-site or "sandwich" assays of the non-competitive types, as well as in the traditional competitive binding assays. Detection can be conducted in vitro, in vivo or ex vivo.

Sandwich assays are among the most useful and commonly used assays. A number of variations of the sandwich assay technique exist, and all are intended to be encompassed by the present application. Briefly, in a typical forward sandwich assay, an unlabelled capture reagent (e.g., a moesin fragment) is immobilized on a solid substrate, and the sample to be tested for the target protein (e.g., an anti-moesin autoantibody) is brought into contact with the bound molecule. After a suitable period of incubation, for a period of time sufficient to allow formation of an antibody-antigen complex, a detection antibody specific to the target protein (e.g., through binding to the Fc region of the anti-moesin autoantibody), labeled with a reporter molecule capable of producing a detectable signal is then added and incubated, allowing time sufficient for the formation of another complex of capture reagent-target protein- detection antibody. Any unreacted material is washed away, and the presence of the target protein is determined by observation of a signal produced by the reporter molecule. The results may either be qualitative, by simple observation of the visible signal, or may be quantitated by comparing with a control sample containing known amounts of the reporter molecules.

In a typical forward sandwich assay, a capture reagent having specificity for the target protein is either covalently or passively bound to a solid support. The solid support is typically glass or a polymer, the most commonly used polymers being cellulose, polyacrylamide, nylon, polystyrene, polyvinyl chloride or polypropylene. The solid supports may be in the form of tubes, beads, discs of microplates, or any other surface suitable for conducting an immunoassay.

Variations on the forward assay include a simultaneous assay, in which both the sample and detection antibody are added simultaneously to the capture reagent. These techniques are well known to those skilled in the art, including any minor variations as will be readily apparent. Another alternative method involves immobilizing the target proteins in the sample and then exposing the immobilized target proteins to the peptides of the present application which may or may not be labeled with a reporter molecule. Depending on the amount of target proteins and the strength of the reporter molecule signal, a bound target protein may be detectable by direct labeling with the capture reagent (e.g. a moesin fragment). Alternatively, a second detection antibody, specific to the capture reagent is exposed to the target protein-capture reagent complex to form a target protein-capture reagent-detection antibody tertiary complex. The complex is detected by the signal emitted by the reporter molecule.

The term "reporter molecule", as used herein, is meant a molecule which, by its chemical nature, provides an analytically identifiable signal which allows the detection of antigen-bound antibody. The most commonly used reporter molecules in this type of assay are either enzymes, fluorophores or radionuclide containing molecules (i.e. radioisotopes) and chemiluminescent molecules.

In certain embodiments, the reporter molecules are enzymes conjugated to the detection antibodies. The enzyme generally catalyzes a chemical alteration of the chromogenic substrate that can be measured using various techniques. For example, the enzyme may catalyze a color change in a substrate, which can be measured spectrophotometrically. Alternatively, the enzyme may alter the fluorescence or chemiluminescence of the substrate. When activated by illumination with light of a particular wavelength, the fluorochrome adsorbs the light energy, inducing a state to excitability in the molecule, followed by emission of the light at a characteristic color visually detectable with a light microscope. The chemiluminescent substrate becomes electronically excited by a chemical reaction and may then emit light which can be measured (using a chemiluminometer, for example) or donates energy to a fluorescent acceptor. Examples of enzymatic labels include luciferases (e.g., firefly luciferase and bacterial luciferase; U.S. Patent No. 4,737,456), luciferin, 2,3-dihydrophthalazinediones, malate dehydrogenase, urease, peroxidase such as horseradish peroxidase (HRPO), alkaline phosphatase, β-galactosidase, glucoamylase, lysozyme, saccharide oxidases (e.g., glucose oxidase, galactose oxidase, and glucose-6-phosphate dehydrogenase), heterocyclic oxidases (such as uricase and xanthine oxidase), lactoperoxidase, microperoxidase, and the like. Techniques for conjugating enzymes to antibodies are described in O'Sullivan et ah, Methods for the Preparation of Enzyme- Antibody Conjugates for use in Enzyme Immunoassay, in Methods in Enzym. (ed. J. Langone & H. Van Vunakis), Academic press, New York, 73:147-166 (1981).

Examples of enzyme-substrate combinations include, for example: (i) Horseradish peroxidase (HRPO) with hydrogen peroxidase as a substrate, wherein the hydrogen peroxidase oxidizes a dye precursor (e.g., orthophenylene diamine (OPD) or 3,3',5,5'-tetramethyl benzidine hydrochloride (TMB)); (ii) alkaline phosphatase (AP) with para-Nitrophenyl phosphate as chromogenic substrate; and (iii) β-D-galactosidase (β-D-Gal) with a chromogenic substrate (e.g., p-nitrophenyl-β- D-galactosidase) or fluorogenic substrate (e.g., 4-methylumbelliferyl-β-D-galactosidase). Numerous other enzyme-substrate combinations are available to those skilled in the art. For a general review of these, see U.S. Patent Nos. 4,275,149 and 4,318,980.

In certain embodiments, the reporter molecules are fluorophores including, but are not limited to, rare earth chelates (europium chelates), Texas Red, rhodamine, fluorescein, dansyl, Lissamine, umbelliferone, phycocrytherin, phycocyanin, or commercially available fluorophores such SPECTRUM ORANGE7 and SPECTRUM GREEN7 and/or derivatives of any one or more of the above. The fluorophores can be conjugated to the antibody using the techniques disclosed in Current Protocols in Immunology, Volumes 1 and 2, Coligen et al, Ed. Wiley-Interscience, New York, Pubs. (1991), for example. Fluorescence can be quantified using a fluorimeter.

In certain embodiments, the report molecules are radioisotopes, such as ^{35}S, ^{14}C, $^{125}1$, ^{3}H, and ^{131}I. The detection antibody or capture reagent can be labeled with the radioisotope using the techniques described in Current Protocols in Immunology, supra, for example and radioactivity can be measured using scintillation counting.

Sometimes, the label is indirectly conjugated with the detection antibody or capture reagent. The skilled artisan will be aware of various techniques for achieving this. For example, the detection antibody can be conjugated with biotin and the label can be conjugated with avidin, or vice versa. Biotin binds selectively to avidin and thus, the label can be conjugated with the detection antibody in this indirect manner. Alternatively, to achieve indirect conjugation of the label with the detection antibody, the detection antibody is conjugated with a small hapten and the label is conjugated with an anti-hapten antibody. Thus, indirect conjugation of the label with the antibody can be achieved.

In certain embodiments, the detection method is a competitive binding assay in which a competing anti-moesin antibody is used. Such competing antibody is capable of competing with moesin auto-antibodies for binding to the peptides of the present application. In a competitive binding assay, the reduction of binding signals can be indicative of the existence and titer of the corresponding auto-antibodies.

Diagnostic Kits

For use in the applications described or suggested above, kits or articles of manufacture are also provided by the present application. Such kits may comprise a carrier means being compartmentalized to receive in close confinement one or more container means such as vials, tubes, and the like, each of the container means comprising one of the separate elements to be used in the method. For example, one of the container means may comprise a probe that is or can be detectably labeled. Such probe may be a moesin fragment specific for anti-moesin autoantibody.

The kits of the present application will typically comprise the container described above and one or more other containers comprising materials desirable from a commercial and user standpoint, including buffers, diluents, filters, needles, syringes, and package inserts with instructions for use. A label may be present on the container to indicate that the composition is used for a specific therapy or non-therapeutic application, and may also indicate directions for either in vivo or in vitro use, such as those described above.

The kits of the present application have a number of embodiments. A typical embodiment is a kit comprising a container, a label on said container, and a composition contained within said container; wherein the composition includes a peptide of the present application that can bind to an anti-moesin autoantibody, the label on said container indicates that the composition can be used to evaluate the presence of anti-moesin autoantibodies in a sample, and instructions for using the peptide of the present application for evaluating the presence of anti-moesin autoantibodies in a sample. The kit can further comprise a set of instructions and materials for preparing a sample and applying the peptide of the present application to the sample. The kit may include a secondary antibody, wherein the secondary antibody is conjugated to a label, e.g., an enzymatic label.

Other optional components in the kit include one or more buffers (e.g., block buffer, wash buffer, substrate buffer, etc), other reagents such as substrate (e.g., chromogen) which is chemically altered by an enzymatic label, epitope retrieval solution, control samples (positive and/or negative controls), control slide(s) etc.

Therapeutic or Preventative Applications

The moesin fragments and anti-moesin antibodies and compositions thereof of the present application can be used as a pharmaceutical composition for therapeutically modulating abnormal levels of platelets in vitro or in vivo.

In one aspect, the N-terminal FERM domain or fragments thereof and the antibody against the C-terminal tail domain or against fragments of the C-terminal tail domain and compositions thereof of the present applications can be used for inhibiting the level of platelets in a subject, thereby treating disorders or diseases associated with abnormal high level of platelets.

In another aspect, the C-terminal tail domain or fragments thereof and the antibody against the N-terminal FERM domain or against fragments thereof or compositions thereof of the present applications can be used for stimulating the level of platelets in a subject, thereby treating disorders or diseases associated with abnormal low level of platelets.

It is contemplated that the moesin fragments and anti-moesin antibodies and compositions thereof of the present application may be used to treat a mammal. In one embodiment, the moesin fragment or anti-moesin antibody or composition thereof of the present application is administered to a nonhuman mammal for the purposes of obtaining preclinical data, for example. Exemplary nonhuman mammals to be treated include nonhuman primates, dogs, cats, rodents and other mammals in which preclinical studies are performed. Such mammals may be established animal models for a disease to be treated with the moesin fragment or anti-moesin antibody or composition thereof of the present application or may be used to study toxicity of the moesin fragment or anti-moesin antibody or composition thereof of the present application of interest. In each of these embodiments, dose escalation studies may be performed in the mammal. In addition, or in the alternative, the moesin fragment or anti-moesin antibody or composition thereof of the present application is used to treat a human, e.g. a patient suffering from a disease or disorder who could benefit from administration of the composition.

Examples of disorders or diseases associated with abnormal high level of platelets include, but are not limited to thrombosis, APS (e.g, PAPS or SAPS), miscarriage (e.g., habitual miscarriage), aPL-thrombosis, APS-related pregnancy complications, thrombocythemia (e.g, primary thrombocythemia or secondary thrombocythemia). Examples of disorders or diseases associated with abnormal low level of platelets include, but are not limited to immune thrombocytopenia, idiopathic thrombocytopenic purpura and secondary thrombocytopenic purpura (e.g., thromboticthrombocytopenic purpura, or thrombotic thrombocytopenic purpura accompanied with hemolytic uremic syndrome), hemolysis, elevated liver enzymes and low platelets syndrome (HELLP syndrome), disseminated intravascular coagulation, systemic lupus erythematosis and aplastic anemia.

Pharmaceutical Formulations

Various substances or molecules (e.g., the moesin fragments or anti-moesin antibodies or compositions thereof of the present application) may be employed as therapeutic agents. These substances or molecules can be formulated according to known methods to prepare pharmaceutically useful compositions, whereby the product hereof is combined in admixture with a pharmaceutically acceptable carrier vehicle. Therapeutic formulations are prepared for storage by mixing the active ingredient having the desired degree of purity with optional physiologically acceptable carriers, excipients or stabilizers (Remington's Pharmaceutical Sciences 16th edition, Osol, A. Ed. (1980)), in the form of lyophilized formulations or aqueous solutions. Acceptable carriers, excipients or stabilizers are nontoxic to recipients at the dosages and concentrations employed, and include buffers such as phosphate, citrate and other organic acids; antioxidants including ascorbic acid; low molecular weight (less than about 10 residues) polypeptides; proteins, such as serum albumin, gelatin or immunoglobulins; hydrophilic polymers such as polyvinylpyrrolidone, amino acids such as glycine, glutamine, asparagine, arginine or lysine; monosaccharides, disaccharides and other carbohydrates including glucose, mannose, or dextrins; chelating agents such as EDTA; sugar alcohols such as mannitol or sorbitol; salt-forming counterions such as sodium; and/or nonionic surfactants such as TWEEN.TM., PLURONICS.TM. or PEG.

The formulations to be used for in vivo administration must be sterile. This is readily accomplished by filtration through sterile filtration membranes, prior to or following lyophilization and reconstitution.

Therapeutic compositions herein generally are placed into a container having a sterile access port, for example, an intravenous solution bag or vial having a stopper pierceable by a hypodermic injection needle.

It is contemplated that when used to treat various diseases such as APS and thrombosis, the substances or molecules of the present application can be combined with other therapeutic agents suitable for the same or similar diseases. When used for treating APS or thrombosis, the substances or molecules of the present application may be used in combination with conventional APS or thrombosis therapies.

In some other aspects, other therapeutic agents useful for combination therapy for thrombosis with the substances or molecules of the present application (e.g, the N-terminal FERM domain of moesin or antibody against the C-terminal tail domain of moesin) include, without limitation, platelet inhibitors 2a, low molecular weight heparins and heparinoids as well as unfractionated heparin 2b, factor Xa inhibitors 2c, combined thrombin/factor Xa inhibitors 2d, fibrinogen receptor antagonists (glycoprotein Ilb/IIa antagonists) 2e and Vitamin K antagonists 2f.

In some other aspects, other therapeutic agents useful for combination therapy for APS with the substances or molecules of the present application (e.g, the N-terminal FERM domain of moesin or antibody against the C-terminal tail domain of moesin) include, without limitation, heparin, low molecular weight heparin, aspirin and Warfarin.

The route of administration is in accord with known methods, e.g. injection or infusion by intravenous, intraperitoneal, intracerebral, intramuscular, intraocular, intraarterial or intralesional routes, topical administration, or by sustained release systems.

Dosages and desired drug concentrations of pharmaceutical compositions of the present application may vary depending on the particular use envisioned. The determination of the appropriate dosage or route of administration is well known within the skill of an ordinary physician. Animal experiments provide reliable guidance for the determination of effective doses for human therapy. Interspecies scaling of effective doses can be performed following the principles laid down by Mordenti, J. and Chappell, W. "The use of interspecies scaling in toxicokinetics" In Toxicokinetics and New Drug Development, Yacobi et al., Eds., Pergamon Press, New York 1989, pp. 42-96.

When in vivo administration of a substance or molecule of the present application is employed, normal dosage amounts may vary from about 10 ng/kg to up to 100 mg/kg of mammal body weight or more per day, preferably about 1 mg/kg/day to 10 mg/kg/day, depending upon the route of administration. Guidance as to particular dosages and methods of delivery is provided in the literature; see, for example, U.S. Pat. No. 4,657,760; 5,206,344; or 5,225,212. It is anticipated that different formulations will be effective for different treatment compounds and different disorders, that administration targeting one organ or tissue, for example, may necessitate delivery in a manner different from that to another organ or tissue.

Where sustained-release administration of a substance or molecule is desired in a formulation with release characteristics suitable for the treatment of any disease or disorder requiring administration of the substance or molecule, microencapsulation of the substance or molecule is contemplated. Microencapsulation of recombinant proteins for sustained release has been successfully performed with human growth hormone (rhGH), interferon- (rhIFN-), interleukin-2, and MN rgp120. Johnson et al., Nat. Med., 2:795-799 (1996); Yasuda, Biomed. Ther., 27:1221-1223 (1993); Hora et al., Bio/Technology, 8:755-758 (1990); Cleland, "Design and Production of Single Immunization Vaccines Using Polylactide Polyglycolide Microsphere Systems," in Vaccine Design: The Subunit and Adjuvant Approach, Powell and Newman, eds, (Plenum Press: New York, 1995), pp. 439462; WO 97/03692, WO 96/40072, WO 96/07399; and U.S. Pat. No. 5,654,010.

The sustained-release formulations can be developed using poly-lactic-coglycolic acid (PLGA) polymer due to its biocompatibility and wide range of biodegradable properties. The degradation products of PLGA, lactic and glycolic acids, can be cleared quickly within the human body. Moreover, the degradability of this polymer can be adjusted from months to years depending on its molecular weight and composition. Lewis, "Controlled release of bioactive agents from lactide/glycolide polymer," in: M. Chasin and R. Langer (Eds.), Biodegradable Polymers as Drug Delivery Systems (Marcel Dekker: New York, 1990), pp. 1-41.

The compositions (e.g., pharmaceutical compositions) can be included in a kit, container, pack, or dispenser together with instructions for administration. When supplied as a kit, the different components of the composition may be packaged in separate containers and admixed immediately before use. Such packaging of the components separately may permit long-term storage without losing the active components' functions. Kits may also include reagents in separate containers that facilitate the execution of a specific test, such as diagnostic tests or tissue typing.

The reagents included in kits can be supplied in containers of any sort such that the life of the different components are preserved and are not adsorbed or altered by the materials of the container. For example, sealed glass ampules may contain lyophilized modulator substance/molecule and/or buffer that have been packaged under a neutral, non-reacting gas, such as nitrogen. Ampules may consist of any suitable material, such as glass, organic polymers, such as polycarbonate, polystyrene, etc., ceramic, metal or any other material typically employed to hold reagents. Other examples of suitable containers include simple bottles that may be fabricated from similar substances as ampules, and envelopes, that may consist of foil-lined interiors, such as aluminum or an alloy. Other containers include test tubes, vials, flasks, bottles, syringes, or the like. Containers may have a sterile access port, such as a bottle having a stopper that can be pierced by a hypodermic injection needle. Other containers may have two compartments that are separated by a readily removable membrane that upon removal permits the components to mix. Removable membranes may be glass, plastic, rubber, etc.

Kits may also be supplied with instructional materials. Instructions may be printed on paper or other substrate, and/or may be supplied as an electronic-readable medium, such as a floppy disc, CD-ROM, DVD-ROM, Zip disc, videotape, laserdisc, audio tape, etc. Detailed instructions may not, be physically associated with the kit; instead, a user may be directed to an Internet web site specified by the manufacturer or distributor of the kit, or supplied as electronic mail.

In another embodiment of the present application, an article of manufacture containing materials useful for the treatment of the disorders described above is provided. The article of manufacture comprises a container and a label. Suitable containers include, for example, bottles, vials, syringes, and test tubes. The containers may be formed from a variety of materials such as glass or plastic. The container holds a composition which is effective for treating the condition and may have a sterile access port (for example the container may be an intravenous solution bag or a vial having a stopper pierceable by a hypodermic injection needle). The active agent in the composition is the antibody. The label on, or associated with, the container indicates that the composition is used for treating the condition of choice. The article of manufacture may further comprise a second container comprising a pharmaceutically-acceptable buffer, such as phosphate-buffered saline, Ringer's solution and dextrose solution. It may further include other materials desirable from a commercial and user standpoint, including other buffers, diluents, filters, needles, syringes, and package inserts with instructions for use.

The following are examples of the methods and compositions of the present application. It is understood that various other embodiments may be practiced, given the general description provided above.

EXAMPLES

Example 1. Generation of Anti-moesin Monoclonal Antibodies

Monoclonal antibody against the N-terminal FERM domain of moesin and monoclonal antibody against the C-terminal tail domain of moesin were prepared by using the conventional hybridoma methods. PRC technique was used to prepare the N-terminal FERM domain of moesin and C-terminal tail domain of moesin first.

To generate the N-terminal FERM domain having the sequence of SEQ ID NO:2, PCR was used to amplify cDNA fragments corresponding to the N-terminal FERM domain (see SEQ ID NO:6 shown in Figure 3, wherein the first underlined portion is the cDNA sequence of the N-terminal tail domain). To generate the C-terminal tail domain having the sequence of SEQ ID NO:5, PCR was used to amplify cDNA fragments corresponding to the C-terminal tail domain (see SEQ ID NO:6 shown in Figure 3, wherein the second underlined portion is the cDNA sequence of the C-terminal tail domain)

PCR-amplified moesin cDNA fragments (i.e., cDNA fragments of C-terminal tail domain, or cDNA fragments of N-terminal FERM domain) were cloned into expression vectors selected from pET32a(+) and pET28a(+). The constructed vectors were then used to transform E.coli host cell line BL21(DE3) for culturing and expression. The restriction and cloning maps of pET32a(+) and pET28a(+) are shown in Figures 4 and 5, respectively. The constructed expression systems for the moesin fragments were verified with restriction enzyme digestion followed by sequencing to confirm the correct reading frame for expression of the moesin fragments.

After sufficient culturing, host cells with expressed moesin fragments were harvested for collection and purification of the moesin fragments according to standard protein expression protocols. The resulting protein fragments were assayed with SDS-PAGE to confirm their identity and purity.

The expressed N-terminal FERM domain of moesin and C-terminal tail domain of moesin were then used to make the monoclonal antibody against the N-terminal FERM domain of moesin and the monoclonal antibody against the C-terminal tail domain of moesin, respectively, according to hybridoma methods by using BALB/C mice.

Hybridoma methods were first described by Kohler and Milstein, Nature, 256:495 (1975). In typical hybridoma methods, mice (e.g. BALB/C mice) are immunized with an antigen (e.g. N-terminal FERM domain or C-terminal tail domain) and spleen cells from the immunized mice are then fused with myeloma cells. The fused cells are harvested in a medium which selectively allows growth of hybridomas, and viable hybridoma colonies are grown out. After a sufficient time, supernatants are screened by ELISA testing and immunohistochemical assays using the antigen. Positive cells are selected for further sub-cloning. Selected clones are sub-cloned by limited dilution. Sub-cloning is performed until all clones are ELISA-positive. The positive clones are then selected to obtain hybridomas generating monoclonal antibodies against the antigens.

Example 2. Stimulation of Platelet Activation

The expressions of CD62P and CD63 are associated with platelet activation. Therefore, these two proteins can be used as indicators to characterize the profile of platelet activation. This experiment was performed in vitro to assess stimulation of platelet activation in the presence of various agents by detecting the expression levels of CD62P and CD63 using CD62P monoclonal antibody and CD63 monoclonal antibody.

Plasma samples were collected from 12 healthy individuals, and cultured at room temperature in the presence of various agents as described in Table 1 below for several minutes (e.g. 5 mins). The culture conditions were selected so that the platelets can be fully activated within about 10 mins. After that, CD62P monoclonal antibody and CD63 monoclonal antibody labeled with fluorescein isothiocyanate (FITC) were used to detect the expressed CD62P and CD63 in the plasma samples, and the fluorescence density ("FD") of the plasma samples was detected using flow cytometry of Beckman Coulter EPICS-XL. The expression levels of the CD62P and CD63 were represented by the average value of fluorescence density detected.

The agents being tested in this assay are listed in Table 1 below, including ADP which is known as an agent stimulating platelet activation (Group 1), the anti-moesin N-terminal domain antibody (Group 2) and the N-terminal FERM domain of moesin (Group 3) which were both prepared according to Example 1.

The concentration of an agent listed in Table 1 is a final concentration of the agent in the plasma sample. A plasma sample without any of the test agents was tested as a control group. The results are listed in Table 1 below and also illustrated in Figure 6.

Table 1. Effect of Various Agents on the Expression of CD62P and CD63

Group	Plasma (μl)	Agent		CD62P		CD63	
		Agent (μl)	Concentration	FD (Mnx)	SD (n=12)	FD (Mnx)	SD (n=12)
Group 1	450μl	ADP (50μl)	5μM	12.88	3.98	11.31	3.38
Group 2	450μl	Anti-moesin N-terminal domain antibody (50μl)	20μg/ml	19.23	5.01	22.88	6.12
Group 3	450μl	N-terminal FERM domain of moesin (50μl)	2mM	2.99	1.62	1.55	1.05
Control	500μl	/		3.34	1.21	5.16	1.91

The results in Table 1 and Figure 6 show that, the monoclonal antibody against N-terminal FERM domain of moesin results in the highest expression of CD62P (approximately 6 times of the expression level in the control group) and the highest expression of CD63 (approximately 4 times of the expression level in the control group). It indicates that the monoclonal antibody against the N-terminal FERM domain of moesin can significantly promote activation of platelets.

As shown in Table 1 and Figure 6, the N-terminal FERM domain of moesin results in an expression level of CD62P and CD63 similar to the expression level in the control group. It indicates that the N-terminal FERM domain of moesin does not stimulate platelet activation.

Example 3. Inhibition of Platelet Activation

This experiment is performed to assess the blocking effect of various inhibitors (i.e. test agents) on the platelet activation induced by various different activators.

The plasma samples were collected from 12 healthy individuals, and cultured in the presence of an inhibitor as described in Table 2 below for several minutes (e.g. 5mins), and thereafter an activator of platelet activation was added therein and the plasma samples were further cultured for another several minutes (e.g. 5mins). The culture conditions were the same as

Example 2. After that, CD62P monoclonal antibody and CD63 monoclonal antibody labeled with FITC were used to detect the expressed CD62P and CD63 in the plasma samples, and the fluorescence density of the plasma samples was detected using flow cytometry of Beckman Coulter EPICS-XL. The expression levels of the CD62P and CD63 were represented by the average value of fluorescence density detected. A control group using 0.01M PBS instead of any inhibitor was also tested.

The inhibitors and activators of platelet activation being tested in this experiment are listed in Table 2 below. The peptide RGDS is known as an inhibitor of platelet activation that inhibits platelet's activation by competing with platelet activator combined-1 (PAC-1) to bind to glycoprotein (GP) Ⅱb/Ⅲa complex on the surface of platelets. The RGDS was prepared according to a conventional peptide synthesis in solid phase and used herein with a concentration of 10mg/ml in 0.01 M PBS. The moesin fragments and anti-moesin antibodies used in this experiment were prepared according to Example 1. As used in this experiment, the anti-moesin N-terminal domain antibody has a concentration of 20μg/ml in 0.01M PBS, the N-terminal FERM domain has a concentration of 2mM in 0.01M PBS, and the anti-moesin C-terminal domain has a concentration of 20μg/ml in 0.01M PBS. The ADP used herein has a concentration of 5μM in 0.01M PBS. The results are listed in Table 2 below and also illustrated in Figure 7.

Table 2. Effect of Various Inhibitors on the Expression of CD62P and CD63

Group	Plasma (μl)	Inhibitor (μl)	Activator (μl)	CD62P		CD63	
				FD (Mnx)	SD (n=12)	FD (Mnx)	SD (n=12)
Group 1	445μl	RGDS (5μl)	ADP (50μl)	7.04	2.91	5.61	1.09
Group 2	445μl	RGDS (5μl)	Anti-moesin N-terminal domain (50μl)	17.98	6.08	20.13	7.83
Group 3	400μl	N-terminal FERM domain (50μl)	Anti-moesin N-terminal domain (50μl)	5.79	2.01	6.30	2.55
Group 4	400μl	Anti-moesin C-terminal domain (50μl)	ADP (50μl)	9.99	2.89	8.23	3.88
Group 5	400μl	N-terminal FERM domain (50μl)	ADP (50μl)	11.38	0.81	7.23	2.81
Control	445μl	PBS (5μl)	ADP (50μl)	13.04	4.09	11.98	3.56

The results of Table 2 and Figure 7 show that, as expected, RGDS can substantially inhibit platelet activation induced by ADP (see Group 1); however, the RGDS has no blocking effect on the platelet's activation induced by the antibody against the N-terminal FERM domain of moesin (see Group 2). In contrast, the N-terminal FERM domain of moesin can significantly block the platelet's activation induced by the antibody against the N-terminal FERM domain of moesin (see Group 3). It indicates that the antibody against the N-terminal FERM domain of moesin and RGDS inhibits platelet activation via different pathways.

It is also shown that the antibody against the C-terminal tail domain of moesin (i.e., anti-moesin C-terminal domain) has inhibiting effect on platelet activation (see Group 4). This suggests that the C-terminal tail domain and N-terminal tail domain of moesin have opposite effect on platelet activation.

On the other hand, the N-terminal FERM domain has no significant effect on platelet activation induced by ADP (see Group 5) when compared with the control group.

Example 4. Platelet Aggregation Assay

Plasma samples were collected from 6 healthy individuals and mixed with 3.8% sodium citrate in the ratio of 9:1 (v/v) to prevent solidification of the plasma. The mixed plasma samples were then centrifuged to obtain a portion of platelet-rich plasma ("PRP") and another portion of platelet-poor plasma ("PPP"). The PRP was diluted with PPP to obtain a plasma sample having a platelet count of 5×10^8 per milliliter as a testing plasma sample for later use.

The testing plasma sample was incubated in the presence of an inhibitor of platelet activation as described in Table 3 below for several minutes, and thereafter an activator of platelet activation as described in Table 3 below was added therein and the plasma sample was further incubated for another several minutes to obtain a final mixture. The final mixture was detected for blood aggregation by measuring the transparency of the sample using TYXN-91 Intelligent Blood Agglutometer according to the Born methods. The transparency of PRP in the presence of either ADP or antibody against the N-terminal domain of moesin was also detected as positive controls. A negative control containing no inhibitor was also tested.

The testing results which was shown as platelet aggregation rate ("PAR") and platelet aggregation inhibition rate ("PAIR") are listed in Table 3 below.

PAR is calculated by, 1) subtracting PPP's transparency with the testing group's transparency, and 2) dividing the result of step 1) by PPP's transparency and then multiplying 100%. PAIR is calculated by, 1) subtracting the PRP group's PAR with the testing group's PAR, and 2) dividing the result of step 1) by the PRP group's PAR and then multiplying 100%.

The RGDS was prepared according to a conventional peptide synthesis in solid phase and used herein with a concentration of 10ug/ml in 0.01M PBS. The moesin fragments and anti-moesin antibodies used in this experiment were prepared according to Example 1. The concentration regarding an inhibitor as described in Table 3 below is a final concentration of the inhibitor in the testing plasma sample, and the concentration regarding the activator of ADP and the antibody against N-terminal FERM domain of moesin also refers to a final concentration in the testing plasma sample.

The results represented by PAR and PAIR are listed in Table 3 below. Figure 8 also illustrates the PAIR for the testing groups 1-3 and negative control group.

Table 3. Inhibition Rate of Various Inhibitors in the presence of Different Activators (n=6)

Testing Group	Inhibitor	ADP (5μM)			Anti-moesin N-terminal domain antibody (2μg/mL)		
		PAR		PAIR	PAR		PAIR
		PAR (%)	SD		PAR (%)	SD	
PRP	/	45.62	21.63	/	61.56	24.2	/
Negative Control	/	44.52	22.18	2.41	60.79	23.41	1.25
Group 1	RGDS (10μg/ml)	11.12	5.56	75.62	55.55	25.37	9.77
Group 2	N-terminal domain (0.2mM)	27.55	19.73	39.61	6.03	3.45	90.21
Group 3	Anti-moesin C-terminal domain antibody (2μg/ml)	17.55	5.21	61.53	/	/	/

The results of Table 3 show that, the N-terminal FERM domain of moesin can significantly inhibit the platelet aggregation induced by the antibody against N-terminal FERM domain of moesin (PAIR is approximately 90%) whereas its ability to inhibit the platelet aggregation induced by ADP is much less (see Group 2). The antibody against C-terminal tail domain of moesin can significantly inhibit the ADP-induced platelet aggregation (PAIR is approximately 62%) (see Group 3). In contrast, the RGDS can significantly inhibit the ADP-induced platelet aggregation (PAIR is approximately 76%) but has much less inhibiting effect on platelet aggregation induced by the antibody against the N-terminal FERM domain of moesin (see Group 1).

The test results suggest that the N-terminal FERM domain of moesin can be used to modulate abnormal platelet aggregation (e.g., thrombosis) which is induced by abnormal high level of the antibody against N-terminal FERM domain of moesin; and the antibody against C-terminal tail domain of moesin also can be used to modulate abnormal platelet aggregation.

Example 5. Detection and Measurement of Specific Autoantibodies in Sera of Patient Groups.

Sera samples were collected from patients having various diseases with abnormal level of platelets and tested for the presence of various autoantibodies that are associated with such diseases. Patients' profiles and clinical information were used to categorize them based on types and stages of their diseases.

The autoantibodies that were tested for the presence in the sera samples include, 1) anti-moesin N-terminal domain antibody, 2) anti-platelets antibody, 3) anti-cardiolipin antibody (including the subgroups of IgM, IgG and IgA), 4) anti-beta2 glycoprotein 1 antibody (including the subgroups of IgM, IgG, and IgA), and 5) anti-dsDNA antibody. The antibodies 2), 3) and 4) are all known indicators associated with the selected diseases for testing.

The anti-platelet antibody was tested by using PAIG ELISA Kit which was commercially obtained from Shanghai Jiemen Bio-Tech Co., Ltd., PRC. The anti-cardiolipin antibody was tested by using Zeus Anti-Cardiolipin IgG/IgA/IgM ELISA Kits which were all commercially obtained from ZEUS Scientific, Inc. The anti-beta2 glycoprotein 1 antibody was tested by using Anti-beta2 Glycoprotein 1 ELISA Kit (IgG/IgA/IgM) which was commercially obtained from Euroimmun Medizinische Labordiagnostika AG. The anti-dsDNA antibody was tested by using ELISA Kit for Anti-Double Stranded DNA (Anti-DsDNA) which was commercially available from Shanghai Kexin Biotech Co., Ltd., PRC. The testing was performed according to the respective instructions of the kits provided by the manufacturer. The anti-moesin N-terminal domain antibody was tested for the presence according to ELISA assays as described below.

The N-terminal FERM domain of moesin obtained from Example 1 was used as an antigen in ELISA assays for anti-moesin N-terminal domain antibodies. Specifically, each micro well of the ELISA plate was coated with about 400ng of the N-terminal FERM domain of moesin at 2^{o}C to 8^{o}C for 12-16 hours, and then washed with PBS once before being blocked with blocking solution and vacuum dried for storage and later use. So a highly purified antigen (i.e., the N-terminal FERM domain of moesin) was bound to the wells of a polystyrene microwell plate under conditions that would preserve the antigen in its native state.

Sera samples were collected from 3 patient groups, including 180 patients that were clinically diagnosed with APS (among the 180 patients, 100 patients were clinically diagnosed with PAPS and 80 patients were clinically diagnosed with SAPS), 50 patients that were diagnosed with aPL-thrombosis, 20 patients that were diagnosed with APS-related pregnancy complications. Sera samples were also collected from 100 healthy individuals and tested as healthy controls.

The controls and patient sera were diluted using PBS-T buffer (i.e. PBS buffer containing 0.05% (v/v) of Tween-20), and 100μl of such diluted controls and diluted patient sera were then added to separate wells, allowing the anti-moesin N-terminal domain antibodies present to bind to the immobilized antigen. Unbound sample was washed away using PBS-T buffer and an enzyme labeled anti-human IgG conjugate was added to each well. A second incubation allowed the enzyme labeled anti-human IgG to bind to any antibodies which have become attached to the micro wells. After washing away any unbound enzyme labeled anti-human IgG, the remaining enzyme activity was measured by adding a chromogenic substrate (H_2O_2/TMB) and measuring the intensity of the color that develops. 100μl of HRP Stop Solution (e.g. 2M H_2SO_4) were then added to each well. Sequence and timing of adding and maintaining HRP Stop Solution were according to TMB Chromogen. Each ELISA plate was gently tapped with fingers to thoroughly mix the wells.

The assay was evaluated using a spectrophotometer to measure and compare the color intensity that developed in the patient wells with the color in the control wells. Specifically, bichromatic measurements are used to measure and compare the color intensity, wherein both OD_{450} value and OD_{630} value (as a reference) of each well were read within 15mins of stopping the reaction. The OD value of each test or control sample was calculated by subtracting the OD_{450} value with the OD_{630} value.

The ELISA low positive control, the ELISA high positive control and the ELISA negative control were run with every batch of samples to ensure that all reagents and procedures performed properly. The ELISA negative control was sera collected from healthy individuals. The OD values of sera collected from 100 healthy individuals were each measured and the average OD value (the "Control OD Value") and the standard deviation (the "Control Standard Deviation") from those 100 samples were calculated. Such Control OD Value and Control Standard Deviation were used to determine the concentrations of the ELISA low positive control and high positive control. The ELISA low positive control contains sera from patients with PAPS or SAPS that were diluted enough to show an OD value which equals to the Control OD Value plus three times of the Control Standard Deviation. The ELISA high positive control contains sera from patients with PAPS or SAPS that was diluted to show an OD value which equals to three times of the OD value of the ELISA low positive control. The dilution was done using 0.01M PBS-T buffers.

The average OD value for each set of duplicates of a sample was first determined, and the sample was determined positive if its average OD value was higher than the average OD value of the ELISA low positive control (as shown in Table 4).

As the skilled artisan will appreciate, the step of correlating a marker level to the presence or absence of PAPS and SAPS can be performed and achieved in different ways. In general a reference population is selected and a normal range established. It is fairly routine to establish the normal range for anti-moesin N-terminal domain antibodies using an appropriate reference population. It is generally accepted that the normal range depends, to a certain but limited extent, on the reference population in which it is established. In one aspect, the reference population is high in number, e.g., hundreds to thousands, and matched for age, gender and optionally other variables of interest. The normal range in terms of absolute values, like a concentration given, also depends on the assay employed and the standardization used in producing the assay.

The levels for anti-moesin N-terminal domain antibodies can be measured and established with the assay procedures given in the examples section. It has to be understood that different assays may lead to different cut-off values.

The clinical performance of a laboratory test depends on its diagnostic accuracy, or the ability to correctly classify subjects into clinically relevant subgroups. Diagnostic accuracy measures the test's ability to correctly distinguish different conditions of the subjects investigated. Such conditions are for example health and disease or benign versus malignant disease. That is, a significant higher value obtained from certain patient population indicates the positive presence of the corresponding anti-moesin N-terminal domain autoantibody.

The results of the experiments are illustrated in Figure 9 and also listed in the following Table 4 comparing the positive presences of different autoantibodies in various patients groups:

Table 4. Comparison of the Positive Presence of Various Autoantibodies in Sera of Patient Groups and Control Group

Group		Patient Number	Antibody				
			Anti-moesin N-terminal domain	Anti-platelets	Anti-cardiolipin	Anti-beta2 glycoprotein 1	Anti-dsDNA
APS	PAPS	80	53 (66.3%)	64 (80.0%)	11 (11.0%)	13 (16.3%)	27 (33.8%)
	SAPS	100	62 (62.0%)	39 (39.0%)	38(38.0%)	21 (21.0%)	57 (75.0%)
aPL-thrombosis		50	38 (76.0%)	23 (46.0%)	31(62.0%)	28 (56.0%)	6 (12.0%)
APS-related pregnancy complications		20	13 (65.0%)	8 (40.0%)	3 (15.0%)	2 (10.0%)	6 (3.0%)
Healthy Individuals		100	3 (3.0%)	12 (12.0%)	9 (9.0%)	8 (4.0%)	2 (2.0%)

The results of Table 4 show that, the positive presence of anti-moesin N-terminal domain is significantly high both in PAPS and SAPS subgroups (approximately 66% and 62%, respectively) and it is the second highest positive presence both in PAPS and SAPS subgroups among the five tested autoantibodies. Therefore, it is indicated that the anti-moesin N-terminal domain is significantly correlated with the incidence of APS.

The positive presence of anti-moesin N-terminal domain is the highest both in aPL-thrombosis group and APS-related pregnancy complications group among the five tested autoantibodies. It is indicated that the anti-moesin N-terminal domain is also significantly correlated with the incidence of aPL-thrombosis and APS-related pregnancy complications.

CLAIMS

What is claimed is:

1. A method for inhibiting the activation of platelets in a sample, comprising contacting the sample with a composition comprising an antibody against a moesin fragment, wherein the moesin fragment consists of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain.

2. The method of claim 1, wherein the moesin fragment comprises at least eight consecutive amino acid residues of the C-terminal tail domain of human moesin protein.

3. The method of claim 2, wherein the C-terminal tail domain of human moesin protein comprises amino acid residues 471-487, 488-501, 502-577, or 471-577 of human moesin protein.

4. Use of an antibody against a moesin fragment in the manufacture of a medicament for preventing or treating a disorder or disease associated with abnormally high level of platelets in a subject, wherein the moesin fragment consists of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain, and wherein the disorder or disease associated with the abnormally high level of platelets is thrombosis, antiphospholipid syndrome (APS), miscarriage, aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia.

5. A method for stimulating activation of platelets in a sample, comprising contacting the sample with a peptide comprising a moesin fragment, wherein the moesin fragment consists of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain.

6. The method of claim 5, wherein the sample contains or is suspected of containing autoantibodies against the C-terminal tail domain of human moesin protein or a fragment of the

C-terminal tail domain.

7. Use of a peptide comprising a moesin fragment in the manufacture of a medicament for preventing or treating a disorder or disease associated with abnormally low level of platelets in a subject, wherein the moesin fragment consists of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain, and wherein the disorder or disease associated with abnormally low level of platelets is thrombocytopenic purpura, HELLP syndrome, disseminated intravascular coagulation, or systemic lupus erythematosis.

8. The use of claim 7, wherein the subject has or is suspected of having autoantibodies against the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain.

9. A method for stimulating activation of platelets in a sample, comprising contacting the sample with a composition comprising an antibody against a moesin fragment, wherein the moesin fragment consists of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain.

10. The method of claim 9, wherein the moesin fragment contains at least eight consecutive amino acid residues of the N-terminal FERM domain of human moesin protein.

11. The method of claim 10, wherein the N-terminal FERM domain of human moesin protein contains amino acid residues 1-94, 95-201, 202-297, or 1-297 of human moesin protein.

12. Use of an antibody against a moesin fragment in the manufacture of a medicament for stimulating activation of platelets in a subject, wherein the moesin fragment consists of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain.

13. A method for inhibiting activation of platelets in a sample, comprising contacting the sample with a peptide comprising a moesin fragment, wherein the moesin fragment consists

of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain, and wherein the sample contains or is suspected of containing autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain.

14. Use of a peptide comprising a moesin fragment in the manufacture of a medicament for inhibiting activation of platelets in a subject, wherein the moesin fragment consists of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain, and wherein the subject has or is suspected of having autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain.

15. Use of a peptide comprising a moesin fragment in the manufacture of a medicament for preventing or treating a disorder or disease associated with abnormally high level of platelets in a subject, wherein:

the moesin fragment consists of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain,

the disorder or disease associated with abnormally high level of platelets is thrombosis, APS, miscarriage, aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia, and

the subject has or is suspected of having autoantibodies against the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain.

16. A method for diagnosing a disorder or disease associated with abnormally low level of platelets, comprising (i) contacting a sample from a subject suspected of having such disorder or disease with a peptide comprising a moesin fragment capable of binding to an anti-moesin autoantibody, wherein the moesin fragment consists of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain; (ii) detecting the binding of said peptide to an anti-moesin autoantibody, wherein the disorder or disease associated with abnormally low level of platelets is thrombocytopenic purpura, HELLP syndrome, disseminated intravascular coagulation, or systemic lupus erythematosis.

17. A method for diagnosing a disorder or disease associated with abnormally high level of platelets, comprising (i) contacting a sample from a subject suspected of having such disorder or disease with a peptide comprising a moesin fragment capable of binding to an anti-moesin autoantibody, wherein the moesin fragment consists of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain; (ii) detecting the binding of said peptide to an anti-moesin autoantibody, wherein the disorder or disease associated with abnormally high level of platelets is thrombosis, APS, miscarriage, aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia.

18. A method for diagnosing a disorder or disease associated with abnormal level of platelets, comprising contacting a sample from a subject suspected of such disorder or disease with first and second peptides capable of binding to anti-moesin autoantibodies, wherein the first peptide comprises a first moesin fragment consisting of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain, and the second peptide comprises a second moesin fragment consisting of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain, and detecting the binding of the first and second peptides to the anti-moesin autoantibodies, wherein the disorder or disease associated with abnormal level of platelets is thrombocytopenic purpura, HELLP syndrome, disseminated intravascular coagulation, systemic lupus erythematosis, thrombosis, APS, miscarriage, aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia.

19. A kit for diagnosing a disorder or disease associated with abnormally low level of platelets in a subject, comprising a peptide comprising a moesin fragment consisting of the C-terminal tail domain of human moesin protein or a fragment of the C-terminal tail domain, and a detecting reagent, wherein the disorder or disease associated with abnormally low level of platelets is thrombocytopenic purpura, HELLP syndrome, disseminated intravascular coagulation, or systemic lupus erythematosis.

20. A kit for diagnosing a disorder or disease associated with abnormally high level of platelets in a subject, comprising a peptide comprising a moesin fragment consisting of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain,

and a detecting reagent, wherein the disorder or disease associated with abnormally high level of platelets is thrombosis, APS, miscarriage, aPL-thrombosis, APS-related pregnancy complications, or thrombocythemia.

21. A method of determining the pathological state of a subject having APS, comprising the following steps:

(i) contacting a sample from a subject suspected of having APS with a composition comprising a peptide capable of binding to an anti-moesin autoantibody, wherein the peptide comprises a moesin fragment consisting of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain;

(ii) detecting the binding of the peptide to an anti-moesin autoantibody and measuring the level of the anti-moesin autoantibody bound to the peptide; and

(iii) determining the pathological state of the subject according to a comparison of the level of the anti-moesin autoantibody to a reference database obtained from diseased reference samples correlating titers of the anti-moesin autoantibody to pathological states of APS.

22. A method of monitoring treatment response in a subject undergoing a treatment for APS, comprising:

(i) contacting a sample from a subject suspected of having APS with a peptide capable of binding to an anti-moesin autoantibody, wherein the peptide comprises a moesin fragment consisting of the N-terminal FERM domain of human moesin protein or a fragment of the N-terminal FERM domain;

(ii) detecting the binding of said peptide to an anti-moesin autoantibody and measuring the level of the anti-moesin autoantibody bound to the peptide; and

(iii) determining the pathological state of the subject according to a comparison of the level of the anti-moesin autoantibody to a reference database obtained from diseased reference samples correlating titers of the anti-moesin autoantibody to pathological states of the APS, wherein a decrease in titer is indicative of positive response of the subject to the treatment.

DRAWINGS

Amino Acid Sequence of the Full Length Human Moesin Protein

MPKTISVRVT TMDAELEFAI QPNTTGKQLF DQVVKTIGLR EVWFFGLQYQ
DTKGFSTWLK LNKKVTAQDV RKESPLLFKF RAKFYPEDVS EELIQDITQR
LFFLQVKEGI LNDDIYCPPE TAVLLASYAV QSKYGDFNKE VHKSGYLAGD
KLLPQRVLEQ HKLNKDQWEE RIQVWHEEHR GMLREDAVLE YLKIAQDLEM
YGVNYFSIKN KKGSELWLGV DALGLNIYEQ NDRLTPKIGF PWSEIRNISF
NDKKFVIKPI DKKAPDFVFY APRLRINKRI LALCMGNHEL YMRRRKPDTI
EVQQMKAQAR EEKHQKQMER AMLENEKKKR EMAEKEKEKI EREKEELMER
LKQIEEQTKK AQQELEEQTR RALELEQERK RAQSEAEKLA KERQEAEEAK
EALLQASRDQ KKTQEQLALE MAELTARISQ LEMARQKKES EAVEWQQKAQ
MVQEDLEKTR AELKTAMSTP HVAEPAENEQ DEQDENGAEA SADLRADAMA
KDRSEEERTT EAEKNERVQK HLKALTSELA NARDESKKTA NDMIHAENMR
LGRDKYKTLR QIRQGNTKQR IDEFESM (SEQ ID NO.1)

Figure 1

1-297 AA (N-terminal FERM domain of human moesin protein)

MPKTISVRVTTMDAELEFAIQPNTTGKQLFDQVVKTIGLREVWFFGLQYQDTKGFSTWLK
LNKKVTAQDVRKESPLLFKFRAKFYPEDVSEELIQDITQRLFFLQVKEGILNDDIYCPPETA
VLLASYAVQSKYGDFNKEVHKSGYLAGDKLLPQRVLEQHKLNKDQWEERIQVWHEEHR
GMLREDAVLEYLKIAQDLEMYGVNYFSIKNKKGSELWLGVDALGLNIYEQNDRLTPKIGF
PWSEIRNISFNDKKFVIKPIDKKAPDFVFYAPRLRINKRILALCMGNHELYMRRRKP (SEQ
ID NO:2)

298-577 AA (helical and C-terminal tail domains of human moesin protein)

DTIEVQQMKAQAREEKHQKQMERAMLENEKKKREMAEKEKEKIEREKEELMERLKQIEE
QTKKAQQELEEQTRRALELEQERKRAQSEAEKLAKERQEAEEAKEALLQASRDQKKTQE
QLALEMAELTARISQLEMARQKKESEAVEWQQKAQMVQEDLEKTRAELKTAMSTPHVA
EPAENEQDEQDENGAEASADLRADAMAKDRSEEERTTEAEKNERVQKHLKALTSELANA
RDESKKTANDMIHAENMRLGRDKYKTLRQIRQGNTKQRIDEFESM (SEQ ID NO:3)

298-470 AA (helical domain of human moesin protein)

DTIEVQQMKAQAREEKHQKQMERAMLENEKKKREMAEKEKEKIEREKEELMERLKQIEE
QTKKAQQELEEQTRRALELEQERKRAQSEAEKLAKERQEAEEAKEALLQASRDQKKTQE
QLALEMAELTARISQLEMARQKKESEAVEWQQKAQMVQEDLEKTRAELKTAMSTP (SEQ
ID NO:4)

471-577 AA (C-terminal tail domain of human moesin protein)

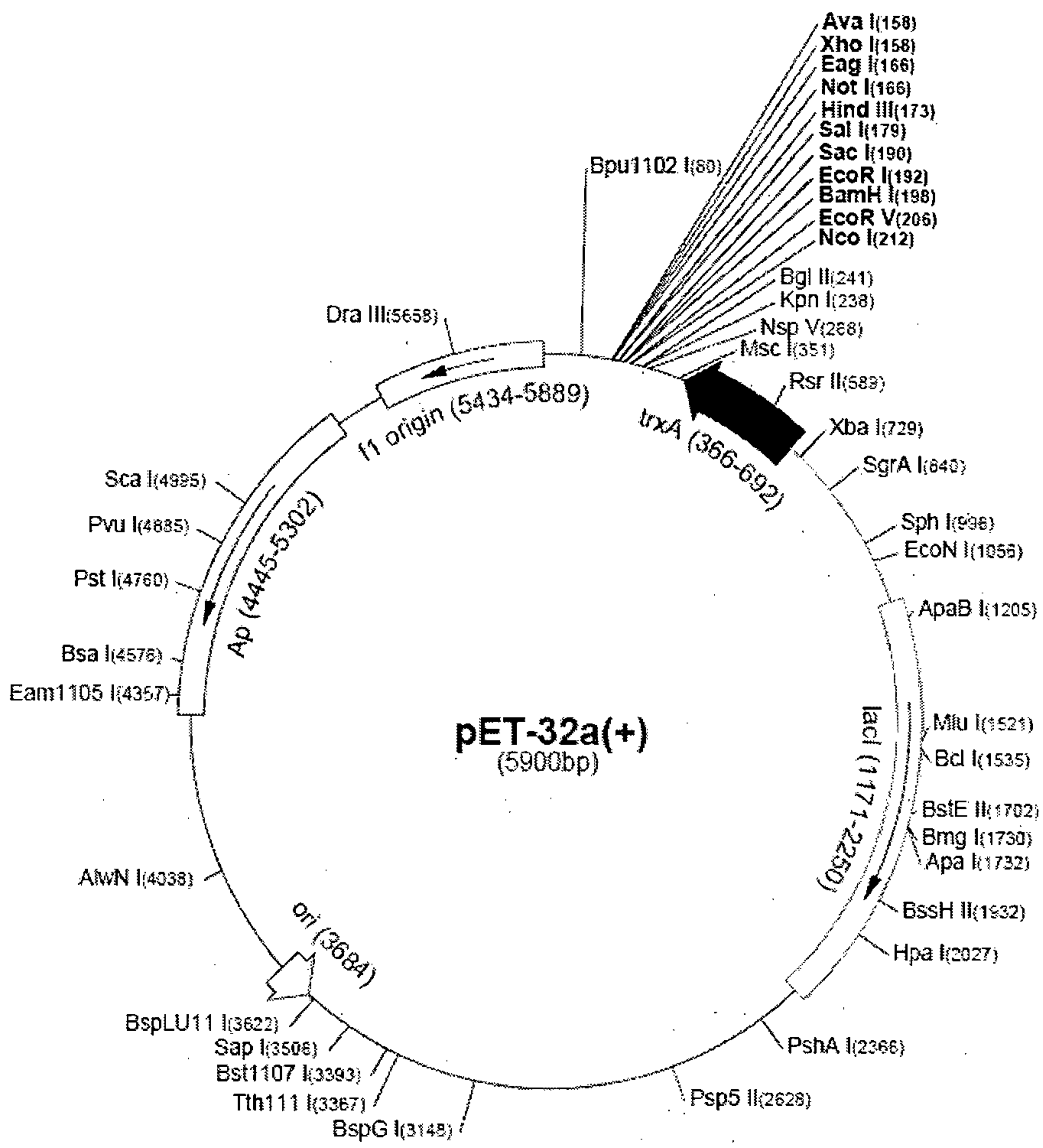
HVAEPAENEQDEQDENGAEASADLRADAMAKDRSEEERTTEAEKNERVQKHLKALTSEL
ANARDESKKTANDMIHAENMRLGRDKYKTLRQIRQGNTKQRIDEFESM (SEQ ID NO:5)

Figure 2

cDNA Sequence encoding for the Full Length Human Moesin Protein

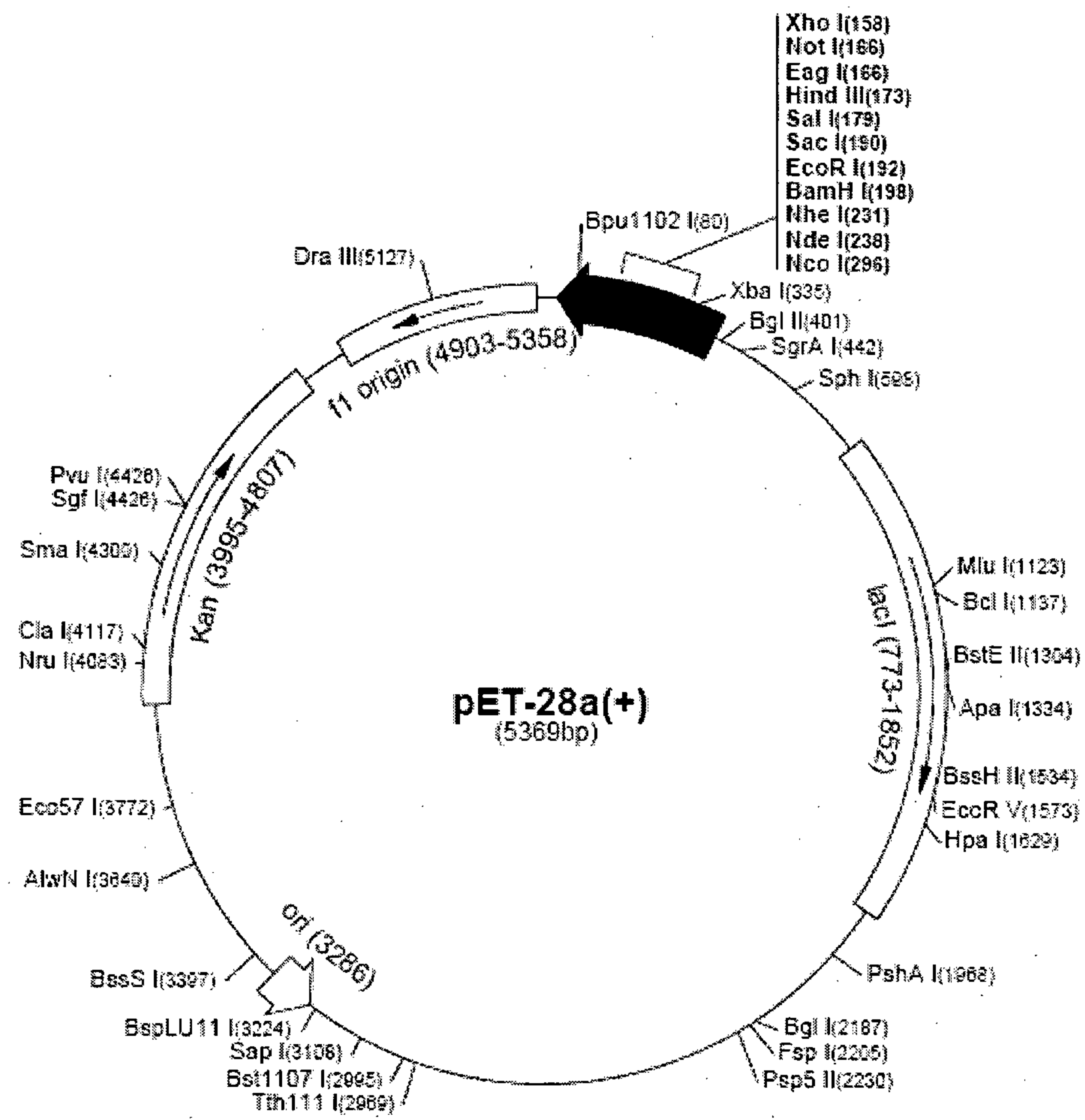
ATGCCCAAAACGATCAGTGTGCGTGTGACCACCATGGATGCAGAGCTGGAGTTTGCCATCCAGC
CCAACACCACCGGGAAGCAGCTATTTGACCAGGTGGTGAAAACTATTGGCTTGAGGGAAGTTTG
GTTCTTTGGTCTGCAGTACCAGGACACTAAAGGTTTCTCCACCTGGCTGAAACTCAATAAGAAG
GTGACTGCCCAGGATGTGCGGAAGGAAAGCCCCCTGCTCTTTAAGTTCCGTGCCAAGTTCTACC
CTGAGGATGTGTCCGAGGAATTGATTCAGGACATCACTCAGCGCCTGTTCTTTCTGCAAGTGAA
AGAGGGCATTCTCAATGATGATATTTACTGCCCGCCTGAGACCGCTGTGCTGCTGGCCTCGTAT
GCTGTCCAGTCTAAGTATGGCGACTTCAATAAGGAAGTGCATAAGTCTGGCTACCTGGCCGGAG
ACAAGTTGCTCCCGCAGAGAGTCCTGGAACAGCACAAACTCAACAAGGACCAGTGGGAGGAGCG
GATCCAGGTGTGGCATGAGGAACACCGTGGCATGCTCAGGGAGGATGCTGTCCTGGAATATCTG
AAGATTGCTCAAGATCTGGAGATGTATGGTGTGAACTACTTCAGCATCAAGAACAAGAAAGGCT
CAGAGCTGTGGCTGGGGGTGGATGCCCTGGGTCTCAACATCTATGAGCAGAATGACAGACTAAC
TCCCAAGATAGGCTTCCCCTGGAGTGAAATCAGGAACATCTCTTTCAATGATAAGAAATTTGTC
ATCAAGCCCATTGACAAAAAAGCCCCGGACTTCGTCTTCTATGCTCCCCGGCTGCGGATTAACA
AGCGGATCTTGGCCTTGTGCATGGGGAACCATGAACTATACATGCGCCGTCGCAAGCCTGATAC
CATTGAGGTGCAGCAGATGAAGGCACAGGCCCGGGAGGAGAAGCACCAGAAGCAGATGGAGCGT
GCTATGCTGGAAAATGAGAAGAAGAAGCGTGAAATGGCAGAGAAGGAGAAAGAGAAGATTGAAC
GGGAGAAGGAGGAGCTGATGGAGAGGCTGAAGCAGATCGAGGAACAGACTAAGAAGGCTCAGCA
AGAACTGGAAGAACAGACCCGTAGGGCTCTGGAACTTGAGCAGGAACGGAAGCGTGCCCAGAGC
GAGGCTGAAAAGCTGGCCAAGGAGCGTCAAGAAGCTGAAGAGGCCAAGGAGGCCTTGCTGCAGG
CCTCCCGGGACCAGAAAAAGACTCAGGAACAGCTGGCCTTGGAAATGGCAGAGCTGACAGCTCG
AATCTCCCAGCTGGAGATGGCCCGACAGAAGAAGGAGAGTGAGGCTGTGGAGTGGCAGCAGAAG
GCCCAGATGGTACAGGAAGACTTGGAGAAGACCCGTGCTGAGCTGAAGACTGCCATGAGTACAC
CTCATGTGGCAGAGCCTGCTGAGAATGAGCAGGATGAGCAGGATGAGAATGGGGCAGAGGCTAG
TGCTGACCTACGGGCTGATGCTATGGCCAAGGACCGCAGTGAGGAGGAACGTACCACTGAGGCA
GAGAAGAATGAGCGTGTGCAGAAGCACCTGAAGGCCCTCACTTCGGAGCTGGCCAATGCCAGAG
ATGAGTCCAAGAAGACTGCCAATGACATGATCCATGCTGAGAACATGCGACTGGGCCGAGACAA
ATACAAGACCCTGCGCCAGATCCGGCAGGGCAACACCAAGCAGCGCATTGACGAATTTGAGTCT
ATGTAA (SEQ ID NO:6)

Figure 3



pET32a(+)

Figure 4



pET28a(+)

Figure 5

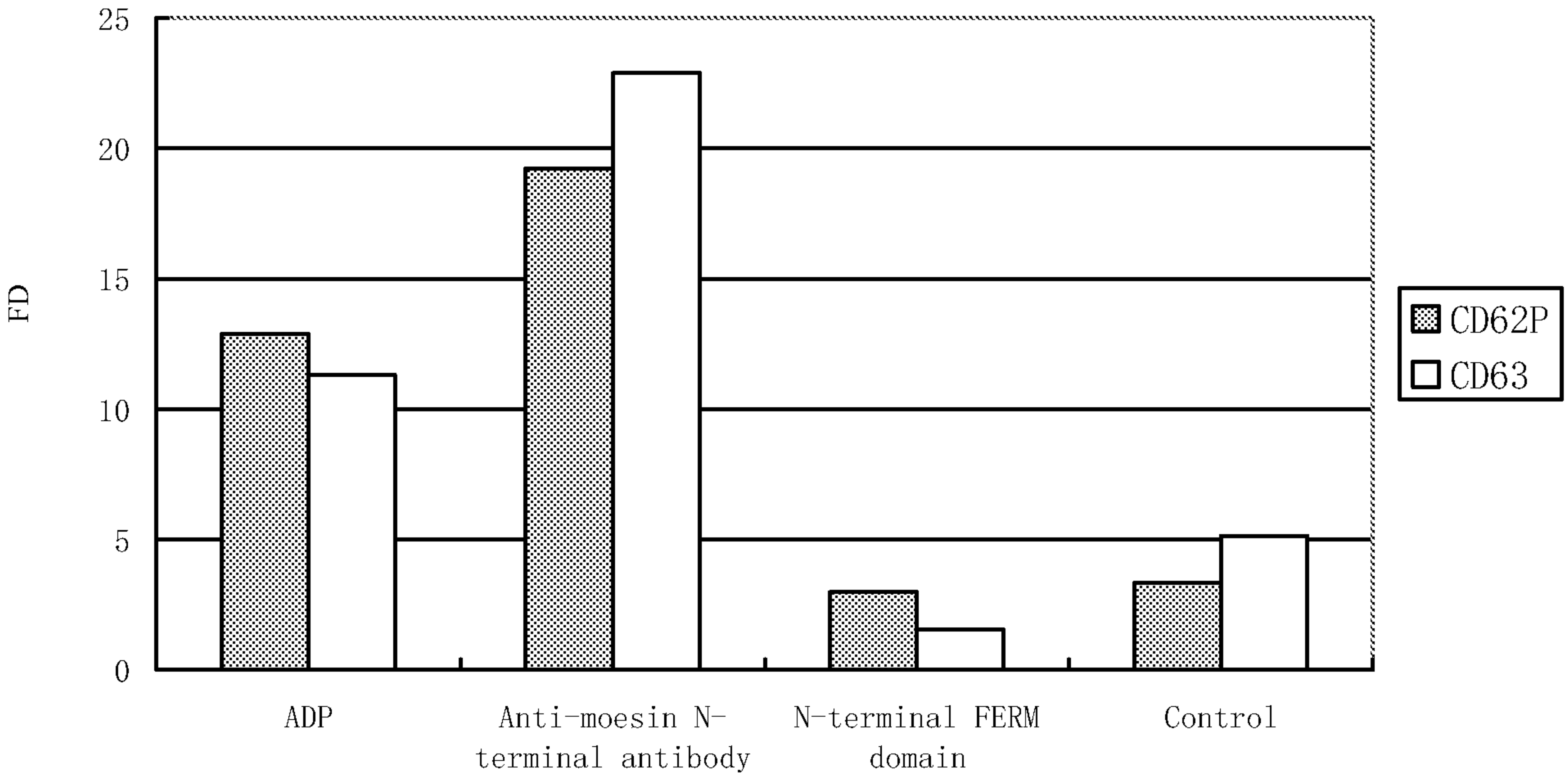

25
20
15
10
5
0
FD
CD62P
CD63
ADP
Anti-moesin N-terminal antibody
N-terminal FERM domain
Control

Figure 6

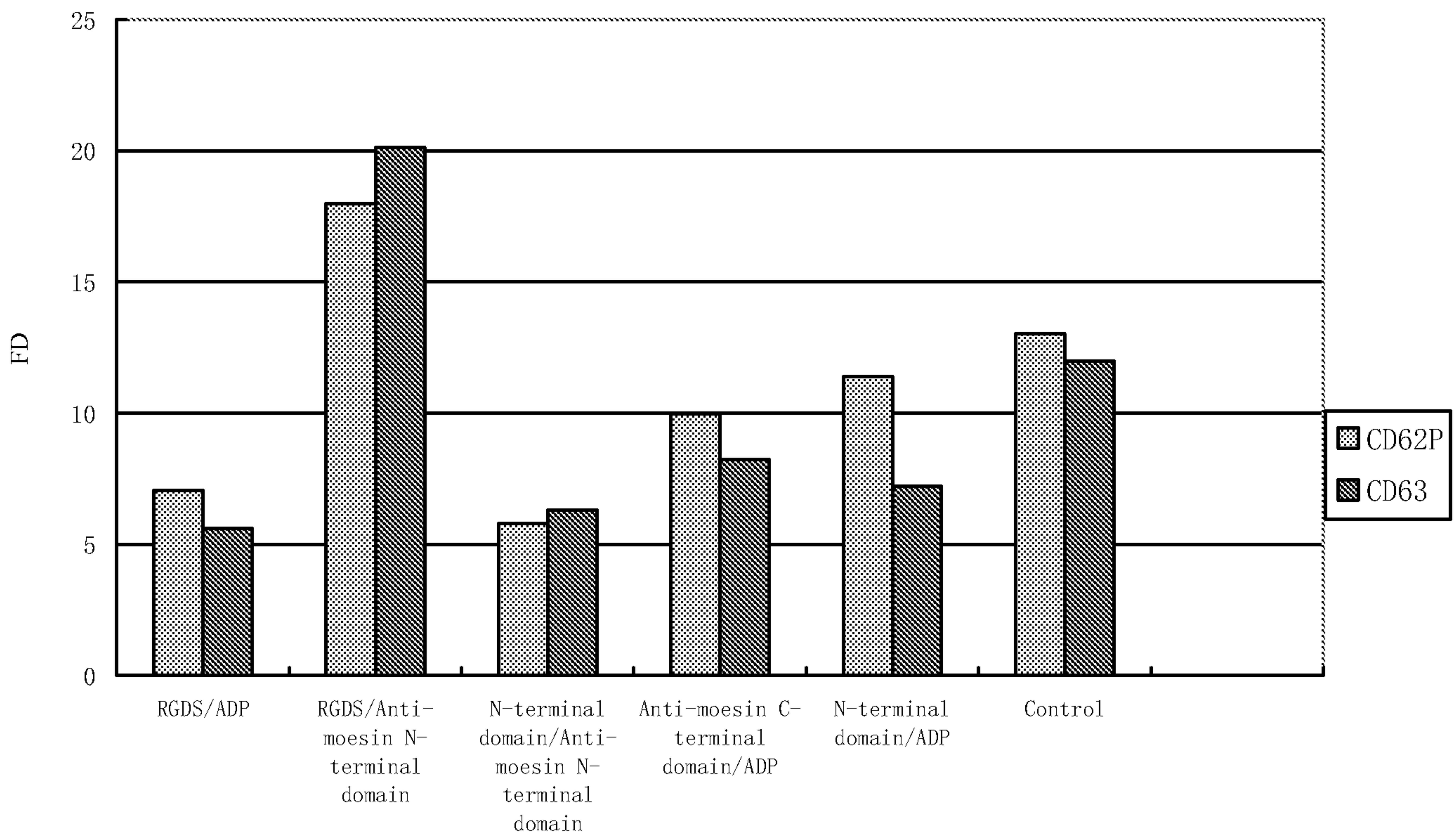

25
20
15
10
5
0
FD
CD62P
CD63
RGDS/ADP
RGDS/Anti-moesin N-terminal domain
N-terminal domain/Anti-moesin N-terminal domain
Anti-moesin C-terminal domain/ADP
N-terminal domain/ADP
Control

Figure 7

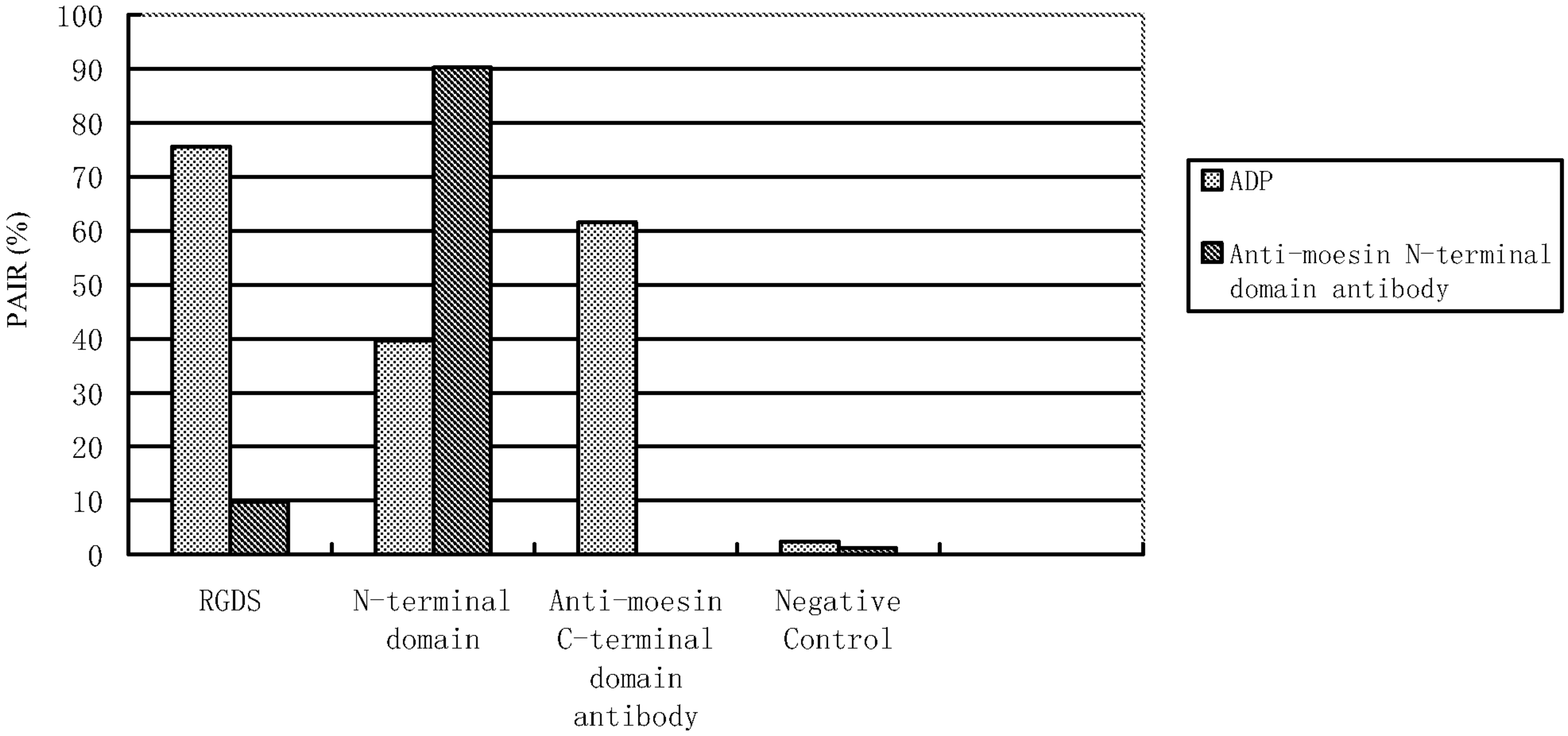

100
90
80
70
60
50
40
30
20
10
0
PAIR (%)
RGDS
N-terminal domain
Anti-moesin C-terminal domain antibody
Negative Control
ADP
Anti-moesin N-terminal domain antibody

Figure 8

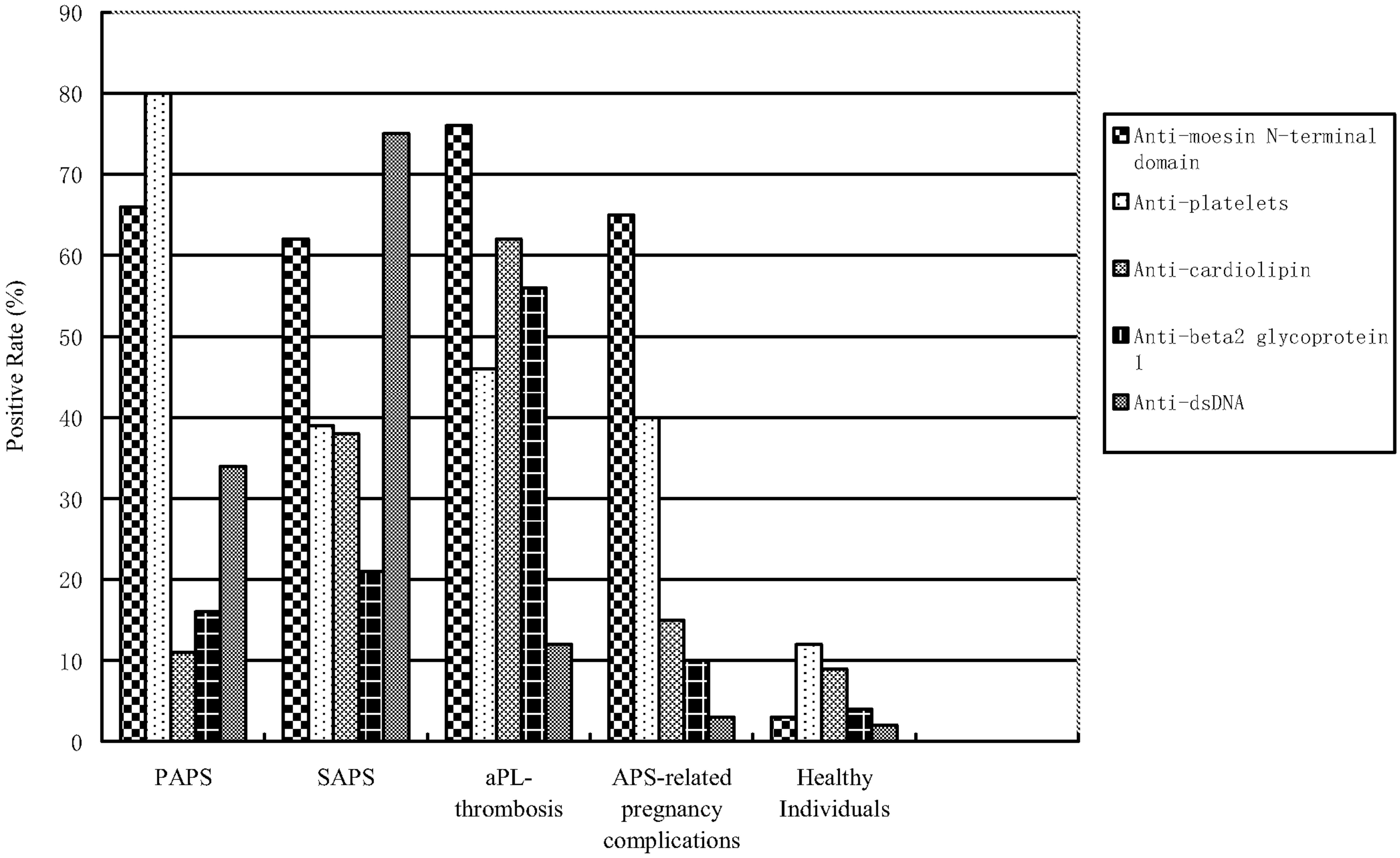

90
80
70
60
50
40
30
20
10
0
Positive Rate (%)
PAPS
SAPS
aPL-
thrombosis
APS-related
pregnancy
complications
Healthy
Individuals
Anti-moesin N-terminal domain
Anti-platelets
Anti-cardiolipin
Anti-beta2 glycoprotein 1
Anti-dsDNA

Figure 9