(12) STANDARD PATENT (11) Application No. **AU 2014238363 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Methods and acellular compositions for treating inflammatory disorders

(51) International Patent Classification(s)
A61K 38/00 (2006.01) ***A61P 19/02*** (2006.01)
A61P 1/00 (2006.01) ***A61P 19/10*** (2006.01)
A61P 9/00 (2006.01) ***A61P 23/00*** (2006.01)
A61P 19/00 (2006.01) ***A61P 25/00*** (2006.01)

(21) Application No: **2014238363** (22) Date of Filing: **2014.02.14**

(87) WIPO No: **WO14/149266**

(30) Priority Data

(31) Number	(32) Date	(33) Country
13/837,005	**2013.03.15**	**US**

(43) Publication Date: **2014.09.25**
(44) Accepted Journal Date: **2018.07.05**

(71) Applicant(s)
Biomet Biologics, LLC

(72) Inventor(s)
Woodell-May, Jennifer E.;Higgins, Joel C.;Leach, Michael D.;O'Shaughnessey, Krista

(74) Agent / Attorney
Phillips Ormonde Fitzpatrick, PO Box 323, Collins Street West, VIC, 8007, AU

(56) Related Art
FEIGE U et al., 'Anti-interleukin-1 and anti-tumor necrosis factor-alpha synergistically inhibit adjuvant arthritis in Lewis rats', CMLS CELLULAR AND MOLECULAR LIFE SCIENCES. 2000, Vol. 57, pages 1457-1470
US 2009/0220482 A1

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 September 2014 (25.09.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/149266 A3

(51) **International Patent Classification**:
A61K 38/00 (2006.01) *A61P 25/00* (2006.01)
A61P 19/00 (2006.01) *A61P 23/00* (2006.01)
A61P 19/02 (2006.01) *A61P 9/00* (2006.01)
A61P 19/10 (2006.01) *A61P 1/00* (2006.01)

(21) **International Application Number**:
PCT/US2014/016384

(22) **International Filing Date**:
14 February 2014 (14.02.2014)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
13/837,005 15 March 2013 (15.03.2013) US

(71) **Applicant**: **BIOMET BIOLOGICS, LLC** [US/US]; 56 E. Bell Drive, Warsaw, Indiana 46582 (US).

(72) **Inventors**: **WOODELL-MAY, Jennifer E.**; 218 E. Dellview Dr., Warsaw, Indiana 46582 (US). **HIGGINS, Joel C.**; 8025 S. Beaver Dam Rd., Claypool, Indiana 46510 (US). **LEACH, Michael D.**; 2730 East Setter Lane, Warsaw, Indiana 46582 (US). **O'SHAUGHNESSEY, Krista**; 137 Ems B27 Lane, Pierceton, Indiana 46562 (US).

(74) **Agents**: **SUTER, David L.** et al.; Harness, Dickey & Pierce, P.L.C., P.O. Box 828, Bloomfield Hills, Michigan 48303 (US).

(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, BN, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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, 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, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) **Date of publication of the international search report**:
20 November 2014

WO 2014/149266 A3

(54) **Title**: METHODS AND ACELLULAR COMPOSITIONS FOR TREATING INFLAMMATORY DISORDERS

(57) **Abstract**: Acellular compositions for treating inflammation, comprising two or more of IL1-ra, sTNF-R1, sTNF-RII, IGF-I, EGF, HGF, PDGF-AB, PDGF-BB, VEGF, TGF-β1, and sIL-1RII. Components of the acellular compositions may be derived from biologic materials, such as blood clots and urine. Components may also be obtained from cell cultures.

METHODS AND ACELLULAR COMPOSITIONS FOR TREATING INFLAMMATORY DISORDERS

INTRODUCTION

[0001] The present technology relates to methods of treating inflammatory disorders, including osteoarthritis. In particular, methods comprise use of acellular solutions comprising cytokines.

[0002] Inflammation is a complex cellular and biochemical process that occurs in the affected blood vessels and adjacent tissues in response to an injury or abnormal stimulation caused by a physical, chemical, or biologic agent, such as a pathogen, allergen or irritant. The inflammatory process includes local reactions and resulting morphologic changes in tissue; the destruction or removal of the causative agent; and the responses that lead to repair and healing. In most instances, inflammation is a beneficial and transient process, which subsides as the body attacks and overcomes an infectious or other harmful agent. However, in some instances, inflammation can be chronic self-perpetuating process, for example, as part of an ongoing degenerative process (such as arthritis) or autoimmune disease, leading to destruction of tissue. Chronic inflammation is associated with a variety of disorders, including rheumatoid arthritis, atherosclerosis, ischemic heart disease, periodontitis, colitis, and some cancers.

[0003] An inflammatory response consists of a cascade of biochemical events, involving the local vascular system and immune system, and various cells within the injured tissue. The process involves the release of numerous cell-derived mediators, including histamine, interferon-gamma, interleukin-8, leukotriene, nitric oxide, prostaglandins, tumor necrosis factor-alpha, and interleukin-1. In particular, interleukin-1 (IL-1) includes a family of cytokines that can stimulate lymphocytes and macrophages, activate phagocytes, increase prostaglandin production, contribute to degeneration of bone joints, increase bone marrow cell proliferation, and are involved in many chronic inflammatory conditions. IL-1 can be generated by macrophages, monocytes, and dendritic cells, and can be part of the inflammatory response against infection.

[0004] The mode of action of IL-1 can be mediated by interleukin-1 receptor antagonist protein (IL-1ra; also known as "IRAP"). IL-1ra binds to the same receptor on the cell surface as IL-1, and thus prevents IL-1 from sending a signal to that cell. IL-1ra is secreted from white blood cells, including monocytes, macrophages, neutrophils,

polymorphonuclear cells (PMNs), and other cells, and can modulate a variety of IL-1 related immune and inflammatory responses, as described by Arend WP, Malyak M, Guthridge CJ, Gabay C (1998) "Interleukin-1 receptor antagonist: role in biology" Annu. Rev. Immunol. 16: 27-55. Production of IL-1ra is stimulated by several substances including adherent immunoglobulin G (IgG), other cytokines, and bacterial or viral components. IL-1ra, as well as other cytokines such as soluble tumor necrosis factor receptor 1 (sTNF-R1), soluble tumor necrosis factor receptor 2 (sTNF-R2) and (soluble interleukin receptor II (sIL-1RII), is an important natural anti-inflammatory protein in arthritis, colitis, and granulomatous pulmonary disease.

[0005] IL-1ra can be used in the treatment of rheumatoid arthritis, an autoimmune disease in which IL-1 plays a key role, reducing inflammation and cartilage degradation associated with the disease. For example, Kineret™ (anakinra) is a recombinant, non-glycosylated form of IL-1ra (Amgen Manufacturing, Ltd., Thousand Oaks, California). Various recombinant interleukin-1 inhibitors and methods of treatment are described in U.S. Patent No. 6,599,873, Sommer et al., issued July 29, 2003; U.S. Patent No. 5,075,222, Hannum et al., issued December 24, 1991; and U.S. Application Publication No. 2005/0197293, Mellis et al., published September 8, 2005 In addition, methods for producing IL-1ra from body fluids, including the use of autologous fluids, are described in U.S. Patent No. 6,623,472, Reinecke et al., issued September 23, 2003; U.S. Patent No. 6,713,246, Reinecke et al., issued March 30, 2004; and U.S. Patent No. 6,759,188, Reinecke et al., issued July 6, 2004.

[0006] Many such treatments for inflammation are known in the art. Therapies known in the art may be directed to removal of the underlying irritant or agent causing the inflammatory reaction, or by mediating one or more aspects of the inflammatory response. Examples include glucocorticoid steroids (such as hydrocortisone, cortisone, prednisone, and beclomethasone), non-steroidal anti-inflammatory drugs (such as aspirin, ibuprofen and naproxen), and immune selective anti-inflammatories. However, many such treatments present side effects, particularly during chronic administration, or have pharmacologic characteristics that limit their use. For example, while compositions and methods using IL-1ra are known in the art, they may be associated with issues regarding stability and half-life of IL-1ra as well as the amount and rate of IL-1ra provided. Moreover, many treatments do nothing to address the underlying causes of the inflammatory process. Accordingly, improved methods of

treating inflammation are needed, offering one or more of improved efficacy, reduced side effects, and improved dosing characteristics.

SUMMARY

[0007] The present technology provides methods for generating substantially acellular compositions comprising anti-inflammatory cytokines for use in treatment of inflammation and other disorders mediated by interleukin-1 and tumor necrosis factor-alpha. Such compositions comprise the following components:

(a) interleukin-1 receptor antagonist (IL-1ra);

(b) soluble tumor necrosis factor receptor I (sTNF-r1); and

(c) at least one protein selected from soluble interleukin-1 receptor II (sIL-1RII) and soluble tumor necrosis factor receptor II (sTNF-RII);

wherein at least one of the Il-1ra, sTNF-RI and the selected protein is isolated from urine, clotted blood, or tissue culture and wherein the composition is substantially free of viable cells.

[0007a] In various embodiments, the composition for the treatment of a disorder mediated by IL-1 comprises the following components:

(a) at least about 10,000 pg/ml IL-1ra;

(b) at least about 1,200 pg/ml sTNF-RI; and

(c) a protein selected from the group consisting of sTNF-RII, IGF-I, EGF, HGF, PDGF-AB, PDGF-BB, VEGF, TGF-β1, and sIL-1RII, and mixtures thereof, wherein the protein has a concentration in the composition greater than the concentration of the protein in normal blood; and

wherein at least one of the components is isolated from urine, clotted blood, or tissue culture.

[0008] Methods for producing compositions are also provided, including methods for making an acellular composition when used for the treatment of a disorder mediated by IL-1 comprising:

(a) culturing, in a growth medium, cells that produce IL-1ra and sIL-1RII or sTNF-RII;

(b) isolating the medium from the cells; and

(c) freeze drying the isolated medium to provide an acellular composition.

Culturing may be performed in a monolayer culture, a bioreactor, or a non-adherent culture, using cultured cells that are genetically engineered to overproduce IL-1ra. Methods may also comprise subjecting the cells to an electromagnetic field. Components of the acellular compositions may also be derived from biologic materials, such as blood clots and urine.

[0008a] In another aspect there is provided a method for treating a disorder mediated by IL-1 comprising administering the substantially acellular composition according to the invention to a subject in need thereof.

[0008b] In yet another aspect of the invention, there is provided a use of an acellular composition according to the invention in the preparation of a medicament for treating a disorder mediated by IL-1.

[0008c] A reference herein to a patent document or any other matter identified as prior art, is not to be taken as an admission that the document or other matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a diagram of a device for generating a blood clot.

[0010] Figure 2 shows a device for concentrating a blood clot extract to generate anti-inflammatory cytokines, before (Fig. 2A) and after (Fig. 2B) centrifugation.

[0011] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings. It should be noted that the figures set forth herein are intended to exemplify the general characteristics of materials, compositions, devices, and methods among those of the present technology, for the purpose of the description of certain embodiments. These figures may not precisely reflect the characteristics of any given embodiment, and are not necessarily intended to fully define or limit specific embodiments within the scope of this technology.

DESCRIPTION

[0012] The following description of technology is merely exemplary in nature of the composition, manufacture and use of one or more inventions, and is not intended to limit the scope, application, or uses of any specific invention claimed in this application or in such other applications as may be filed claiming priority to this application, or patents issuing therefrom. A non-limiting discussion of terms and phrases intended to aid understanding of the present technology is provided at the end of this Detailed Description.

[0013] The present technology relates to compositions, methods of making compositions, and methods of using compositions for the treatment of inflammatory disorders, and other disorders mediated by interleukin-1. Compositions comprise two or more cytokines, at least one of which is derived from urine, clotted blood or tissue culture.

Protein Compositions

[0014] The present technology provides methods for treating inflammatory disorders other disorders mediated by interleukin-1 in humans or other mammalian subjects using compositions (herein referred to as "Protein Solutions") comprising proteins dissolved, suspended or otherwise carried for delivery to a mammalian subject in a physiologically-acceptable medium. In various embodiments, such compositions

comprise proteins (e.g., cytokines) that are native to whole blood in normal mammal subjects.

[0015] Compositions of this technology are acellular. Such "acellular" compositions contain no, or are essentially free of, viable white blood cells, platelets, or other cells. Preferably, while compositions may contain proteins derived from cells, the compositions do not contain cellular fragments that are capable of creating an immunogenic response in a mammalian subject.

[0016] In various embodiments, the Protein Solution comprises at least two proteins selected from the group consisting of IL-1ra, sTNF-RI, sTNF-RII (soluble tumor necrosis factor-receptor 2), IGF-I (insulin-like growth factor 1), EGF (epidermal growth factor), HGF (hepatocyte growth factor), PDGF-AB (platelet-derived growth factor AB), PDGF-BB (platelet-derived growth factor BB), VEGF (vascular endothelial growth factor), TGF-β1 (transforming growth factor- β1, and sIL-1RII (soluble interleukin receptor II), wherein the concentration of each protein in the composition is greater than the concentration of the protein in normal blood. For the sake of clarity, the Protein Solution may contain three or more of the proteins from the recited group. While the concentration of every such protein in the composition may be greater than its respective concentrations in normal blood, it is not necessary that the concentration of more than two of the proteins be greater than their respective concentrations in normal blood.

[0017] In various embodiments, the protein solution comprises the following components.

Table 1. Protein Solution Exemplary Components

Component	Composition Concentration	Normal Whole Blood Concentration
IL-1ra	about 10,000 pg/ml or greater about 25,000 pg/ml or greater about 30,000 pg/ml or greater from about 25,000 to about 110,000 pg/ml from about 25,000 to about 40,000 pg/ml	about 4200 pg/ml

sTNF-RI	about 1,200 pg/ml or greater about 1,800 pg/ml or greater about 3,000 pg/ml or greater	about 630 pg/ml
sTNF-RII	about 3,000 pg/ml or greater about 5,000 pg/ml or greater about 7,000 pg/ml or greater about 9,000 pg/ml or greater	about 1200 pg/ml
sIL-1RII	about 15,000 pg/ml or greater about 20,000 pg/ml or greater about 25,000 pg/ml or greater	about 11,800 pg/ml
Growth factors		
EGF	about 800 pg/ml or greater about 1,000 pg/ml or greater about 1,200 pg/ml or greater	about 250 pg/ml
HGF	about 1,000 pg/ml or greater about 2,500 pg/ml or greater about 2,800 pg/ml or greater about 3,000 pg/ml or greater	about 500 pg/ml
PDGF-AB	about 35,000 pg/ml or greater about 50,000 pg/ml or greater about 70,000 pg/ml or greater	about 6,000 pg/ml
PDGF-BB	about 10,000 pg/ml or greater about 15,000 pg/ml or greater about 20,000 pg/ml or greater	about 1,500 pg/ml

TGF-β1	about 100,000 pg/ml or greater about 150,000 pg/ml or greater about 190,000 pg/ml or greater	about 10,000 pg/ml
IGF-1	about 130,000 pg/ml or greater about 150,000 pg/ml or greater about 160,000 pg/ml or greater	about 70,000 pg/ml
VEGF	about 500 pg/ml or greater about 600 pg/ml or greater about 800 pg/ml or greater	about 150 pg/ml
Component	Composition Concentration	Normal Whole Blood Concentration
IL-1ra	about 10,000 pg/ml or greater about 25,000 pg/ml or greater about 30,000 pg/ml or greater from about 25,000 to about 110,000 pg/ml from about 25,000 to about 40,000 pg/ml	about 8100 pg/ml
sTNF-RI	about 1,200 pg/ml or greater about 1,800 pg/ml or greater about 3,000 pg/ml or greater	about 630 pg/ml
sTNF-RII	about 5,000 pg/ml or greater about 7,000 pg/ml or greater about 9,000 pg/ml or greater	about 2500 pg/ml
sIL-1RII	about 15,000 pg/ml or greater about 20,000 pg/ml or greater	about 11,800 pg/ml

	about 25,000 pg/ml or greater	
Growth factors		
EGF	about 800 pg/ml or greater about 1,000 pg/ml or greater about 1,200 pg/ml or greater	about 250 pg/ml
HGF	about 2,500 pg/ml or greater about 2,800 pg/ml or greater about 3,000 pg/ml or greater	about 800 pg/ml
PDGF-AB	about 35,000 pg/ml or greater about 50,000 pg/ml or greater about 70,000 pg/ml or greater	about 24,000 pg/ml
PDGF-BB	about 10,000 pg/ml or greater about 15,000 pg/ml or greater about 20,000 pg/ml or greater	about 4,700 pg/ml
TGF-β1	about 100,000 pg/ml or greater about 150,000 pg/ml or greater about 190,000 pg/ml or greater	about 55 pg/ml
IGF-1	about 130,000 pg/ml or greater about 150,000 pg/ml or greater about 160,000 pg/ml or greater	about 115,000 pg/ml
VEGF	about 500 pg/ml or greater about 600 pg/ml or greater about 800 pg/ml or greater	about 370 pg/ml

[0018] Protein concentrations can be measured using the methods known in the art. For example, Quantikine Human Immunoassays (R&D Systems, Inc., Minneapolis, MN) may be used to assay for IL-1ra, IL-1β, IL-8, sTNF-RI, TNF-α, IL-6, sTNF-RII, IL-10, IL-13, and IL-4, according to the manufacturer's instructions. Immunoassays may perform for hepatocyte growth factor and soluble IL-1RII.

[0019] In various embodiments, the concentration of one or more of the proteins or other components in the Protein Solution is greater than the concentration of the component in normal blood. (Compositions with such higher concentrations of components are said to be "rich" in such components.) As referred to herein, the concentration of a component in "normal" blood or other tissue is the concentration found in the general population of mammalian subjects, e.g., in normal whole blood. It will be understood that this concentration is species specific.

[0020] Thus, in various embodiments, the concentration of one or more components of the Protein Solution is greater than about 1.5 times, about 2 times, or about 3 times, greater than the concentration of the component in normal blood. For example, components may have greater concentrations in the compositions, relative to normal (whole) blood, as follows:

- IL-1ra, at a concentration that is at least about 2.5, or at least about 3 or at least about 5, times greater;
- sTNF-RI, at a concentration that is at least about 2, or at least about 2.5 or at least about 3, times greater;
- sTNF-RII, at a concentration that is at least about 2, or at least about 2.5 or at least about 3, times greater;
- sIL-1RII, at a concentration that is at least about 1.5, or at least about 1.8 or at least about 2, times greater;
- EGF, at a concentration that is at least about 2, or at least about 3 or at least about 5, times greater;
- HGF, at a concentration that is at least about 2, or at least about 3 or at least about 4, times greater;
- PDGF-AB, at a concentration that is at least about 2, or at least about 3 or at least about 5, times greater;

- PDGF-BB, at a concentration that is at least about 2, or at least about 3 or at least about 5, times greater;
- TGF-β1, at a concentration that is at least about 3, or at least about 4 or at least about 6, times greater;
- IGF-1, at a concentration that is at least about 1.2, or at least about 1.4 or at least about 1.5, times greater; and
- VEGF, at a concentration that is at least about 2, or at least about 2.5 or at least about 3, times greater.

For example, a Protein Solution may comprise:

(a) at least about 10,000 pg/ml IL1-ra;

(b) at least about 1,200 pg/ml sTNF-RI; and

(c) a protein selected from the group consisting of sTNF-RII, IGF-I, EGF, HGF, PDGF-AB, PDGF-BB, VEGF, TGF-β1, and sIL-1RII, and mixtures thereof, wherein the protein has a concentration higher than the protein's baseline concentration in normal blood. In another example, a Protein Solution comprises:

(a) interleukin-1 receptor antagonist (IL-1ra), at a concentration of from at least 3 times greater than the concentration of IL-1ra in normal blood;

(b) soluble tissue necrosis factor-r1 (sTNF-r1), at a concentration at least 2 times greater than the concentration of IL-1ra in normal blood.

Methods of Making Protein Solutions

[0021] Protein Solutions may be made by any of a variety of methods, including admixture of individual components and processes wherein one or more components are derived from a source material. In various embodiments, the Protein Solution is made by admixture of components obtained from natural or synthetic sources. Without limiting the scope, mechanism or function of the present technology, such acellular anti-inflammatory cytokine compositions may offer advantages in certain applications, insofar as they may not create an immunogenic response in subjects to whom they are administered.

[0022] In particular, by way of example, a Protein Solution may comprise interleukin-1 receptor antagonist (IL-1ra) that is synthetic or recombinant, or isolated

from autologous, allogeneic or xenogeneic blood or other biologic sources, aside from the methods described above. For example, Kineret™ (anakinra) is a recombinant, non-glycosylated form of IL-1ra, sold by Amgen Manufacturing, Ltd. (Thousand Oaks, California). Various recombinant interleukin-1 inhibitors and methods of treatment are described in U.S. Patent No. 6,599,873, Sommer et al., issued July 29, 2003; U.S. Patent No. 5,075,222, Hannum et al., issued December 24, 1991; and U.S. Application Publication No. 2005/0197293, Mellis et al., published September 8, 2005. In addition, methods for producing IL-1ra from body fluids, including the use of autologous fluids, are described in U.S. Patent No. 6,623,472, Reinecke et al., issued September 23, 2003; U.S. Patent No. 6,713,246, Reinecke et al., issued March 30, 2004; and U.S. Patent No. 6,759,188, Reinecke et al., issued July 6, 2004. When an allogeneic anti-inflammatory cytokine composition is to be generated, multiple sources of IL-1ra from multiple subjects may be pooled together.

[0023] Components of the acellular Protein Solutions may also be derived from biologic materials, such as blood clots and urine. Components may also be obtained from cell cultures.

Obtaining Components from Blood Clots

[0024] In particular, methods include obtaining one or more Protein Solution components from a liquid ("clot extract") trapped in a blood clot. A liquid (cell releasate) can be obtained by compression ("squeezing"), clot disruption, or centrifugation. Blood useful in making clots may be autologous (i.e., obtained from the subject to be treated using the Protein Solution) or from allogeneic sources (i.e., from subjects of the same species as the subject to whom the solution is to be administered) or xenogeneic sources (i.e., from animal sources other than the species to whom the solution is to be administered). In some embodiments, allogeneic blood is obtained from a plurality of donors.

[0025] The blood clot can be made with or without anticoagulant and with or without exogenous thrombin by combining blood or a blood fraction with a clotting agent. Suitable clotting agents include thrombin (e.g., bovine, recombinant human, pooled human, or autologous), autologous clotting protein, and polyethylene glycol. Calcium may be in the form of a calcium salt, such as calcium chloride.

[0026] In some embodiments, the clotting agent comprises a clotting protein. A suitable clotting fraction can be obtained by a process of: loading whole blood or plasma with a calcium solution (e.g., calcium chloride in ethanol) into a blood isolation device; heating the whole blood or plasma for at least about 20 minutes, at a temperature of at least about 20° C; and isolating the clotting fraction. The isolating may be performed by centrifuging the heated whole blood or plasma. A suitable isolation device is commercially available as the Clotalyst™ Autologous Thrombin Collection System (hereinafter "Clotalyst System"), sold by Biomet Biologics LLC, Warsaw, Indiana, USA.

[0027] An exemplary device 100 for producing a clotting agent is shown in Figure 1. A process for making the clotting agent begins with injecting a reagent comprising calcium chloride and ethanol into the main chamber 105 through the first port 110. Glass beads are also placed in the main chamber 105. After the reagent has been injected, the first port 110 is closed using the first replacement cap 115. Blood with anticoagulant is injected into the main chamber 105 through the second port 120. After the blood has been injected, the second port 120 is closed using the second replacement cap 125. Optionally, the syringes and blood separation device 400 are pre-heated to a temperature of about 25°C.

[0028] The contents of the device 100 are mixed by repeatedly inverting the device 100, e.g. about twelve times, so as to contact the blood with the glass beads. After mixing, the device is incubated The incubation process can be at a temperature and for a duration that will permit the contents of the device 100 to be heated at about 25°C for about 15 minutes. Upon completion of the incubation period, a clotted mass of red blood cells, blood plasma, and glass beads forms at a second end 106 of the main chamber 105. After incubation is complete, the device 100 is shaken enough to dislodge and break-up any gel that may be present.

[0029] The clot extract may be otherwise contacted with a solid extraction material to produce a protein-containing liquid. This liquid is then isolated from the solid extraction material, as a Protein Solution of the present technology. Without limiting the scope, mechanism or function of the present technology, solid extraction materials useful herein concentrate cytokines or other proteins in the clot extract.

[0030] The solid extraction material can include various materials that provide a particular surface area to contact the cells. The solid extraction material may be a continuous material or may be discontinuous and comprise a plurality of separate

particles. For example, the solid extraction material may be in the form of a plurality of beads, fibers, powder, a porous material, or a surface of a container comprising the clot extract. The solid extraction material may comprise geometric forms having various cross-sectional shapes, such as spherical, oval, or polygonal, among others. The solid extraction material can also comprise a continuous porous network, similar to a sponge, or can include a plurality of individual porous particles. The solid extraction material may also provide a larger surface area by being porous in comparison to a non-porous material.

[0031] In some embodiments, the solid extraction material includes particles having a large aspect ratio, for example, where the particles are needle-like in shape. The solid extraction material may also be formed as long fibers and may be or take a form similar to glass wool.

[0032] In some cases, the solid extraction material can comprise the internal walls of a container holding the liquid comprising white blood cells. For example, the solid extraction material may comprise the lumen of a syringe that contains the clot extract. Other containers include tubes, such as centrifuge tubes, or a blood fractionation device or concentrator assembly as described elsewhere herein.

[0033] Where the solid extraction material is a continuous material, such as a porous sponge-like material, the solid extraction material can be used in an amount sufficient to absorb or adsorb or include substantially the entire clot extract within the pores or interstices of the solid extraction material. Where the solid extraction material is a discontinuous material, such as a plurality of particles, the solid extraction material can be combined with the liquid containing the cells to form a slurry-like composition. The slurry can vary in consistency from paste-like, having a high-solids fraction, to a readily flowable slurry having a low-solids fraction.

[0034] The solid extraction material can provide a large surface area with which to contact clot extract. However, in some cases, the solid extraction material can be further treated to increase its surface area, for example, by physically or chemically etching or eroding the surface of the solid extraction material. With respect to chemical etching, a corrosive agent can be used to modify the surface of the solid extraction material depending on the nature of the material. The modified surface may be produced by employing an alkali or an acid, for example chromosulphonic acid, in particular about 20% to about 80% in strength, preferably about 50% chromosulphonic acid. The solid

extraction material can be incubated with the corrosive agent for about 5 min to about 30 min in order to chemically etch the surface and increase the surface area. The solid extraction material can then be washed to remove the corrosive agent. For example, the solid extraction material can include the internal walls of a container for holding the clot extract where the internal walls are etched to subsequently increase the surface area in contact with the clot extract.

[0035] Various polymers, metals, ceramics, and glasses can be used as the solid extraction material. In some embodiments, the solid extraction material comprises a hygroscopic material. Examples of suitable solid extraction material materials include glasses, minerals, polymers, metals, and polysaccharides. Minerals include corundum and quartz. Polymers include polystyrene, polyethylene, polyvinyl chloride, polypropylene, and polyacrylamide. Metals include titanium. Polysaccharides include dextran and agarose. A preferred solid extraction material comprises, or consists essentially of, polyacrylamide, as further described below.

[0036] The solid extraction material may comprise, for example, continuous solid extraction material of glass or a plurality of glass particles, glass wool, a continuous solid extraction material of metal such as titanium, a plurality of metal beads, metal powder, and combinations thereof. A continuous solid extraction material of metal can include a block or other three-dimensional shape formed of porous metal or metal alloys with an open cell structure. The solid extraction material may include various beads or particles of various sizes including substantially spherical beads. Beads include polystyrene beads, polyacrylamide beads, glass beads, metal (e.g., titanium) beads, or any other appropriate beads. Beads may be any size appropriate for the container and the amount of liquid comprising white blood cells being used. In some instances, bead sizes can range from about 0.001 millimeters to about 3 millimeters in diameter. Where the bead size is sufficiently small, the beads can appear more like a powder.

[0037] Polyacrylamide beads used as the solid extraction material can be formed by polymerizing acrylamide monomer using controlled and standardized protocols as known in the art to produce relatively uniform beads formed of polyacrylamide gel. In general, polyacrylamide is formed by polymerizing acrylamide with a suitable bifunctional crosslinking agent, most commonly N,N'-methylenebisacrylamide (bisacrylamide). Gel polymerization is usually initiated with ammonium persulfate and the reaction rate is accelerated by the addition of a catalyst,

such as N,N,N',N'-tetramethylethylenediamine (TEMED). In various embodiments, polyacrylamide beads comprise 0.5 micromole of carboxyl groups per milliliter of beads, imparting a slight anionic character (negative charge). The beads are also typically resistant to changes in pH, and are stable in many aqueous and organic solutions. By adjusting the total acrylamide concentration, the polyacrylamide gel can be formed in a wide range of pore sizes. Moreover, the polyacrylamide beads can be formed in many sizes and can have relatively uniform size distributions. Bead size may range from several micrometers in diameter to several millimeters in diameter. For example, various types of Bio-Gel™ P polyacrylamide gel beads (Bio-Rad Laboratories, Hercules, California, USA) have particle sizes ranging from less than about 45 μm up to about 180 μm. Polyacrylamide beads are also available from SNF Floerger (Riceboro, Georgia, USA), Pierce Biotechnology, Inc. (Rockford, Illinois, USA), and Polymers, Inc. (Fayetteville, Arkansas, USA).

[0038] Once polymerized, polyacrylamide beads can be dried and stored in a powder-like form. The dry beads are insoluble in water but can swell considerably upon being rehydrated. Rehydration returns the polyacrylamide beads to a gel consistency that can be from about two to about three times the dry state size. Thus, dry polyacrylamide beads (i.e., desiccating polyacrylamide beads) may be used to absorb a portion of a liquid volume, including solutes smaller than the bead pore size, and can serve to concentrate IL-1ra and other proteins produced by the white blood cells. For example, combining dry polyacrylamide beads with the blood and/or platelet-rich plasma activates production of IL-1ra by the white blood cells and also reduces the total liquid volume as the dry beads rehydrate and swell.

[0039] The solid extraction material is preferably sterilized, using techniques among known in the art, in order to prevent contamination of the clot extract. For example, heat and pressure sterilization methods, such as autoclaving, may be used depending on the particular composition of the solid extraction material. Alternative methods, such as chemical sterilization or irradiation, can be used where the solid extraction material may be adversely affected by the autoclaving process.

[0040] In some embodiments, the clot extract is incubated with solid extraction material for a time effective to remove a portion of the liquid. For example, the incubation may be 24 hours or less, 10 hours or less, 5 hours or less, 2 hours or less, 1 hour or less, 30 minutes or less, 15 minutes or less 10 minutes or less, 5 minutes or

less, 4 minutes or less, 3, minutes or less, or 2 minutes or less. Incubation may be at least about 15 seconds, at least about 30 seconds, at least about 1 minutes, at least about 90 seconds, at least about 2 minutes, at least about 10 minutes, or at least about 30 minutes. In some embodiments, incubation s from about 1 minute to about 3 minutes. In some embodiments, the incubation is conducted at about 37°C. In some embodiments the liquid is not incubated, but is contacted with the solid extraction material for only so long as necessary to perform subsequent processing. The contacting may occur at ambient conditions, e.g., at a temperature of about 20-25°C.

[0041] In some embodiments, the clot extract and the solid extraction material are agitated to more thoroughly mix these components during contact. The agitation may be accomplished by inverting, shaking, rocking, stirring, or vortexing the liquid and solid extraction material. Agitation may increase contact of the clot extract with the solid extraction material. Agitation may be performed once, repeated multiple times, repeated periodically, or may be continuous. Additional aspects and features relating to producing protein-rich solutions using polyacrylamide beads and other solid extraction materials are described in: U.S. Patent Application Publication No. 2009/0220482, Higgins et al., published September 3, 2009; U.S. Patent Application Publication No. 2010/0055087, Higgins et al., published March 4, 2010; U.S. Patent Application Publication 2011/0052561, Hoeppner, published March 3, 2011; International Application Publication 2012/030593, Higgins et al., published March 8, 2012; and U.S. Patent Application Publication 2012/0172836, Higgins et al., published July 5, 2012.

[0042] Contacting of clot extract with the solid extraction material may be performed using a suitable container or other apparatus to affect the contact. Contacting may be performed in a continuous process wherein a flow of the clot extract is passed over or through the solid extraction material, or the clot extract and solid extraction material may be contained in a vessel. As discussed above, the vessel may comprise the solid extraction material, or may merely serve as a container holding the beads or other forms of the material. Containers useful in the present technology include those known in the art, such as the Plasmax™ Plus Plasma Concentrator, commercially available from Biomet Biologics, LLC (Warsaw, Indiana, USA) and may include those devices and methods of use as described in U.S. Patent No. 7,553,413, Dorian et al., issued June 30, 2009; and U.S. Patent No. 7,694,828, Swift et al., issued April 13, 2010.

[0043] Such a device is shown in Figures 2A and 2B, for exemplary use with a polyacrylamide gel bead solid extraction material. The device 200 has an upper chamber 205 and a lower chamber 210. The upper chamber 205 has an end wall 215 through which the agitator stem 220 of a gel bead agitator 225 extends. The device 200 also has an inlet port 230 that extends through the end wall 215 and into the upper chamber 205. The device 200 also includes an outlet port 235 that communicates with a plasma concentrate conduit 240. The floor of upper chamber 205 includes a filter 245, the upper surface of which supports desiccated concentrating polyacrylamide beads 250.

[0044] During use, a fluid 255 containing the clot extract is injected to the upper chamber 205 via the inlet port 230 and mixed with the polyacrylamide beads 250. The fluid 255 and polyacrylamide beads 250 may be mixed by rotating the agitator stem 220 and the gel bead agitator 225, to help mix the fluid 255 and beads 250. The mixed fluid 255 and polyacrylamide beads 250 are then incubated for the desired time at the desired temperature. The device 200 is then centrifuged so that liquid passes to the lower chamber 210 while the polyacrylamide beads 250 are retained by a filter 245, thereby separating the polyacrylamide beads 250 from the resulting solution 260 of IL-1ra and other proteins that collects in the lower chamber 210. The solution 260 may be removed from the device via outlet port 235.

Obtaining Components from Tissue Cultures

[0045] Methods for making acellular Protein Solutions can comprise culturing cells in a cell culture that either naturally produce anti-inflammatory cytokines, such as IL-1ra, or cells that are engineered to produce such cytokines. Non-limiting examples of cells that naturally produce anti-inflammatory cytokines include adipose tissue cells, adipocytes, adipose-derived stem cells, stromal cells, bone marrow cells, mesenchymal stem cells, and blood cells.

[0046] In various embodiments, cell lines can be engineered to overproduce an anti-inflammatory cytokine. Non-limiting examples of anti-inflammatory cytokines include VEGF, TNF-α, IL-1ra, sTNF-RI, sTNF-RII, PGDF-AB, PDGF-BB, IGF-I, EGF, TGF-β1, sIL-1RII, and HGF. Stable eukaryotic cell lines can be generated that overexpress an anti-inflammatory cytokine by transfecting eukaryotic cells, such as mammalian cells, with recombinant DNA comprising a gene encoding an anti-inflammatory cytokine and a selectable marker. Alternatively, prokaryotes and yeast can

be engineered to overexpress an anti-inflammatory cytokine by transformation with recombinant DNA comprising a gene encoding an anti-inflammatory cytokine and a selectable marker. Transformations and transfections can be performed with recombinant DNA molecules comprising a DNA sequencing encoding an anti-inflammatory cytokine, such as IL-1ra, and a selectable marker. Eukaryotic and prokaryotic cells can be engineered to overexpress the anti-inflammatory cytokine constitutively or by induction. Methods for expressing anti-inflammatory cytokines, such as IL-1ra, sTNF-RI, and sTNF-RII, and sIL1-RII in eukaryotic and prokaryotic cells are described in U.S. Patent No. 6,337,072, Ford et al., issued January 8, 2002; and U.S. Application Publication No. 2001/0053764, Sims et al., published December 20, 2001.

[0047] When a IL-1ra gene is transcribed in humans, the mRNA can be spliced into four variants, resulting in four isoforms of translated IL-1ra. SEQ ID NOs: 1, 3, 5, and 7 are the cDNAs for IL-1ra isoforms 1-4 respectively, and SEQ ID NOs: 2, 4, 6, and 8 are the amino acid sequences of IL-1ra isoforms 1-4 respectively. Collectively, the IL-1ra isoforms are referred to as "IL-1ra." SEQ ID NO: 9 is the cDNA sequence for sTNF-RI and SEQ ID NO:10 is the amino acid sequence for sTNF-RI. SEQ ID NO:11 is the cDNA sequence for sTNF-RII and SEQ ID NO:12 is the amino acid sequence for sTNF-RII. SEQ ID NO:13 is the cDNA sequence for sIL-1RI and SEQ ID NO:14 is the amino acid sequence for sIL-1RI. SEQ ID NOs 15 and 17 are the cDNAs for sIL-1RIIv1and sIL-1RIIv3 respectively, and SEQ ID NOs:16 and 18 are the amino acid sequences for sIL-1RIIv1and sIL-1RIIv3 respectively. The cDNA sequence for IL-1RIIv2 is a non-coding sequence; therefore, it is not included.

[0048] To express either IL-1ra, sTNF-RI, or sTNF-RII (generically referred to as a "protein of interest") in a prokaryotic culture, for example in a particular bacteria, a cDNA sequence (SEQ ID NOs: 1, 3, 5, 7, 9, 11, 13, 15, or 17) is cloned into an expression vector suitable for the bacteria. The expression vector should comprise a strong promoter, and a selectable marker, such as antibiotic resistance. Non-limiting examples of antibiotics capable of killing bacteria cells include ampicillin, tetracycline, kanamycin, and chloramphenicol. The expression vector should further comprise elements that result in constitutive or inducible expression of the protein of interest. Optionally, a DNA sequence corresponding to a tag functionally coupled to the protein of interest that allows for identification and purification of the protein can be present in the vector adjacent to the gene for the protein of interest. For example, an N or C-

terminal His tag can be used to detect proteins with anti-His antibodies, and they allow for purification on nickel columns. When the expression vector comprising a gene expressing a protein of interest is prepared, a bacteria cell, for example E. coli, can be transformed with the expression vector. The selectable marker ensures that only cells transformed with the vector will survive in LB broth supplemented with an antibiotic corresponding to the selectable marker. The bacteria can then be grown in LB broth supplemented with the antibiotic for expression and purification. Expression vectors, methods for cloning a protein of interest into an expression vector, methods for transforming prokaryotic cells, methods for expressing protein from transformed prokaryotic cells, and protein purification methods are commonly known by those with ordinary skill in the art.

[0049] To express a protein of interest in a eukaryotic culture, for example in mammalian cells, a cDNA sequence (SEQ ID NOs: 1, 3, 5, 7, 9, 11, 13, 15, or 17) is cloned into an expression vector suitable for a particular mammalian cell. The expression vector should comprise a strong promoter, and a selectable marker, such as antibiotic resistance. Non-limiting examples of antibiotics capable of killing mammalian cells include geneticin and gentamicin. The expression vector should further comprise elements that result in constitutive or inducible expression of the protein of interest. Optionally, a DNA sequence corresponding to a tag functionally coupled to the protein of interest that allows for identification and purification of the protein can be present in the vector adjacent to the gene for the protein of interest. When the expression vector comprising a gene expressing a protein of interest is prepared, a mammalian cell, such as a human cell, can be transfected with the expression vector. Transfected cells can be grown in a cell culture medium supplemented with an antibiotic corresponding to the selectable marker. The presence of the antibiotic allows for the isolation of stable cell lines. Stable cell lines can then be grown in cell culture medium supplemented with antibiotic for expression and purification. Expression vectors, methods for cloning a protein of interest into an expression vector, methods for transfecting eukaryotic cells and developing stable cell lines, methods for expressing protein from transfected eukaryotic cells, and protein purification methods are commonly known by those with ordinary skill in the art.

[0050] Alternatively, eukaryotic cells that have not been genetically altered by DNA transfection can be cultured. The eukaryotic cells can be primary cultures, i.e. cells grown directly from a eukaryotic donor, such as a human, or the eukaryotic cells can be established cell lines. Many established cell lines are available commercially from American Type Culture Collection, Inc. (Manassas, VA, USA). The cells can be grown with or an exogenous signal, such as a recombinant protein. Eukaryotic cells are often cultured in culture flasks with cell culture medium. The cell culture medium can be recovered from the flasks, and centrifuged to remove any non-adherent cells.

[0051] A cell culture can be a monolayer culture, a non-adherent culture, or a bioreactor. A monolayer culture comprises anchorage-dependent cells that are cultured on a suitable substrate that allows cell adhesion and spreading, such as cell culture flasks and cell culture dishes. A non-adherent culture comprises cells that are maintained in a suspension. Suitable cells are either not anchorage-dependent, or they are anchorage-dependent cells that have been adapted for culture in a suspension. Many cell lines, for example many insect cells, can be grown in either a monolayer or a suspension. A bioreactor is a device that can support a biologically active environment in which chemical processes are carried out and/or biochemically active substances are derived. Bioreactors can include suspended or immobilized cells. Monolayer cultures, non-adherent cultures, and bioreactors can be maintained by methods commonly used in the art.

[0052] In some embodiments, the cell culture is subjected to an electromagnetic field, so as to stimulate the production of one or more proteins. Stimulating the culture with an electromagnetic field may involve various forms of electromagnetic stimulation, such as a pulsed electromagnetic field or a capacitively coupled electromagnetic field. In some embodiments, the culture is stimulated using a power source coupled to a stimulation coil. The current passing through the coil produces a pulsing magnetic field which induces in the liquid a pulsing electric field. The coil may partially surround the culture as it is held within a container. The coil may be integrated into to the container holding the culture or may be removable. For example, a plastic tube can be formed with an integrated coil or the coil can be temporarily coupled to the container or placed within the container; for example, the tube can be configured so that the coil can be snapped onto the container. The power source can be coupled to the coil as needed to perform the stimulation.

[0053] Stimulation of the culture with an electromagnetic field may also include placing at least two electrodes across the liquid. Electrical energy may then be applied to the electrodes so as to capacitively couple the electrodes and generate the electromagnetic field there between. The electromagnetic field is therefore able to pass through the culture so as to increase the rate and/or amount of cytokine production. In other embodiments, electrodes can be used to produce a direct current or one or more coils can be used to produce a pulsed electromagnetic field.

[0054] The strength of the electromagnetic field during stimulation can be at least about 0.5 microvolts per centimeter, whether produced by direct current, capacitively coupled current, or pulsed electromagnetic field. In the case of a direct current electrode, the amplitude of the current can be from about 1 to about 200 microamperes, and in some embodiments, the amplitude may be from about 20 to about 100 microamperes. In still further embodiments, the current may be about 20, about 60, or about 100 microamperes. It should be understood, however, that the amplitude of the current may be of other suitable magnitudes.

[0055] The electromagnetic field applied during stimulation may be constant or vary over time. For example, a sinusoidal time varying electromagnetic field can be applied using the electrodes placed across the liquid. Such a sinusoidal time varying electromagnetic field can have a peak voltage across the electrodes from about 1 volt to about 10 volts, and in some embodiments, the peak voltage can be about 5 volts. The corresponding electric field produced can have an amplitude of from about 0.1 millivolt per centimeter (mV/cm) to about 100 mV/cm, and in some embodiments can be about 20 mV/cm. The sinusoidal time varying electric field may have a frequency of from about 1,000 Hz to about 200,000 Hz, and in some embodiments the frequency may be about 60,000 Hz.

[0056] The electromagnetic field applied to the culture may also be a pulsed electromagnetic field. The pulsed electromagnetic field can be induced using an external coil and a pulse generator. In this regard, a pulsed electromagnetic field may have a pulse duration of from about 10 microseconds per pulse to about 2000 microseconds per pulse. The pulse duration in one embodiment can be about 225 microseconds. The pulses may include electromagnetic bursts, in which a burst can comprise from 1 pulse to about 200 pulses. Alternatively, the electromagnetic field may have bursts that comprise

from about 10 pulses to about 30 pulses. In this regard, in one embodiment each burst may comprise about 20 pulses.

[0057] The frequency at which bursts in the pulsed electromagnetic are applied may vary. In this regard, bursts can be repeated at a frequency of from about 1 Hz to about 100 Hz in some embodiments, and can be repeated at a frequency of about 10 Hz to about 20 Hz in other embodiments. Furthermore, bursts can repeat at a frequency of about 1.5 Hz, about 15 Hz or about 76 Hz. A burst can have a duration from about 10 microseconds up to about 40,000 microseconds. In this regard, a burst can have a duration of about 4.5 milliseconds.

[0058] Suitable devices for generating a capacitively coupled electromagnetic field include SpinalPak® spinal stimulator (EBI, L.P., Parsippany, New Jersey) or a DC stimulation device such as an SpF® XL IIb spinal fusion stimulator (EBI, L.P., Parsippany, New Jersey). Pulsed electromagnetic fields can be produced using various known methods and apparatuses, such as using a single coil or a pair of Helmholtz coils. For example, a suitable apparatus includes the EBI Bone Healing System® Model 2001 (EBI, L.P., Parsippany, New Jersey) and the BTBS stimulation coil. With respect to direct current, an electric field may be generated using any known device for generating a direct current electric field, such as for example, the Osteogen™ implantable bone growth stimulator (EBI, L.P., Parsippany, New Jersey). Other suitable devices for generating electromagnetic fields may be used.

[0059] Cell cultures can either release anti-inflammatory cytokines into culture medium naturally, or the cultures can be induced to release the anti-inflammatory cytokines into the culture medium. The culture medium can be isolated by aspiration, centrifugation or filtration for use in forming the acellular anti-inflammatory cytokine composition.

Obtaining Components from Urine

[0060] In some embodiments, an anti-inflammatory cytokine is isolated from urine, for use in producing a Protein Solution of the present technology. Proteins can be isolated from urine by methods among those known in the art. One such method is employed in the ProteoSpinTM Urine Protein Concentration Maxi Kit sold by Norgen Biotek Corp. (Thorold, Ontario, Canada). This kit utilizes an ion exchange resin integrated into a spin column. Briefly, a urine sample is obtained and its pH adjusted to

3.5. The urine is then transferred to a spin column containing the ion exchange resin, which is placed in a collection tube. The column is then centrifuged, wherein the proteins attach to the resin, and the remaining fluids and salts flow into the collection tube and are discarded. The proteins are then washed by applying supplied column activation and wash buffer followed by centrifugation. The flow through is discarded and the wash procedure is repeated. An elution buffer (10 mM sodium phosphate, pH 12.5) is added to the column and neutralizer is added to an elution tube. The spin column containing the elution buffer is placed in the elution tube and centrifuged, whereby the proteins are eluted and captured in the elution tube containing neutralizer.

Therapeutic Compositions

[0061] The present technology also provides compositions comprising a Protein Solution and a second component comprising active materials, physiological carriers, and combinations thereof. In some embodiments, compositions comprise a safe and effective amount of the Protein Solution and a safe and effective amount of a second active. A "safe and effective" amount of a component is an amount that is sufficient to have the desired therapeutic effect in the human or other mammalian subject, without undue adverse side effects (such as toxicity, irritation, or allergic response), commensurate with a reasonable benefit/risk ratio when used in the manner of this technology. The specific safe and effective amount of the component will, obviously, vary with such factors as the particular condition being treated, the physical condition of the patient, the nature of concurrent therapy (if any), the specific components used, the specific route of administration and dosage form, the carrier (if any) employed, and the desired dosage regimen.

[0062] Active materials among those useful herein include biologics and pharmaceutical actives. Biologics include blood fractions, such as PRP, blood products, and concentrated bone marrow aspirate (cBMA). Accordingly, in some embodiments, the present technology provides compositions comprising a safe and effective amount of a Protein Solution and a safe and effective amount of cBMA. An autologous therapeutic composition comprises APS and cBMA in an APS:cBMA ratio of about 1:1, about 1:2, about 1:3, about 1:4, about 1:5, about 1:6, about 1:7, about 1:8, about 1:9 or about 1:10. Alternatively, the APS:cBMA ratio can be about 2:1, about 3:1, about 4:1, about 5:1, about 6:1, about 7:1, about 8:1, about 9:1 or about 10:1. cBMA can include

hematopoietic, stem cells, stromal stem cells, mesenchymal stem cells, endothelial progenitor cells, red blood cells, white blood cells, fibroblasts, reticulocytes, adipose cells, or endothelial cells. Methods for producing cBMA among those useful herein are described in U.S. Application Publication No. 2006/0278588, Woodell-May, published December 14, 2006.

[0063] Pharmaceutical actives among those useful herein include herein include organic molecules, proteins, peptides, peptidomimetics, nucleic acids, nucleoproteins, antisense molecules, polysaccharides, glycoproteins, lipoproteins, carbohydrates and polysaccharides, botanical extracts, and synthetic and biologically engineered analogs thereof, living cells (other than white blood cells stromal cells) such as chondrocytes, bone marrow cells, viruses and virus particles, natural extracts, and combinations thereof. Specific non-limiting examples of bioactive materials include hormones, antibiotics and other anti-infective agents, hematopoietics, thrombopoietics, antiviral agents, antitumor agents (chemotherapeutic agents), antipyretics, analgesics, anti-inflammatory agents, antiallergy agents, vasodilators, cytokines, growth factors, gene regulators, vitamins, minerals and other nutritionals, nutraceuticals and combinations thereof. In particular, actives include bronchodilators (such as albuterol, levabuterol, irbuterol, ipatropium, salmeterol, and formoterol), glucocorticosteroids (such as mometasone, fluticasone, budesonide, and beclomethosone), antibiotics, antivirals, and combinations thereof. In some embodiments, compositions may comprise growth factors in addition to those present in the Protein Solution, such Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor Beta (TGF-β), Insulin-Like Growth Factor (IGF), Fibroblast Growth Factor (FGF), Epidermal Growth Factor (EGF), Vascular Endothelial Growth Factor (VEGF), and Bone Morphogenetic Proteins (BMPs).

[0064] In some embodiments, Protein Solutions comprise one or more cytokines derived from a tissue comprising white blood cells, by contacting a liquid comprising white blood cells with a solid extraction material. Liquids comprising white blood cells include blood, adipose tissue, bone marrow, and fractions thereof, such as platelet-rich plasma. Solid extraction materials include those described above. Devices for making blood fractions by centrifugation of whole blood are described in U.S. Patent No. 7,992,725, Leach et al., issued August 9, 2011, U.S. Patent No. 7,374,678, Leach, issued May 20, 2008; U.S. Patent No. 7,179,391 to Leach et al., issued February 20,

2007; U.S. Patent No. 7,992,725, Leach et al., issued August 9, 2011; U.S. Patent No. 7,806,276, Leach et al., issued October 5, 2010; and U.S. Patent No. 8,048,297, Leach et al., issued November 1, 2011. Methods for making solutions rich in cytokines are described in U.S. Patent Application Publication No. 2009/0220482, Higgins et al., published September 3, 2009; U.S. Patent Application Publication No. 2010/0055087, Higgins et al., published March 4, 2010; U.S. Patent Application Publication 2011/0052561, Hoeppner, published March 3, 2011; International Application Publication 2012/030593, Higgins et al., published March 8, 2012; and U.S. Patent Application Publication 2012/0172836, Higgins et al., published July 5, 2012. Compositions and methods useful in aspects of the present technology are also described in the following applications filed concurrently with this disclosure: U.S. Patent Application Serial Number 13/840562, Binder et al., Methods and Non-Immunugenic Compositions for Treating Inflammatory Diseases; U.S. Patent Application Serial Number 13/841083, Landrigan, et al., Treatment of Inflammatory Respiratory Disease Using Protein Solutions; U.S. Patent Application Serial Number 13/837480, O'Shaughnessey, et al., Treatment of Pain Using Protein Solutions; U.S. Patent Application Serial Number 13/839280, Leach et al., Methods for Making Cytokine Compositions from Tissue Using Non-Centrifugal Methods; U.S. Patent Application Serial Number 13/840129, Matusuka, et al., Treatment of Collagen Defects Using Protein Solutions; and U.S. Patent Application Serial Number 13/841103, Landrigan, et al., Treatment of Peripheral Vascular Disease Using Protein Solutions, all of which are incorporated by reference herein.

[0065] The compositions may comprise a carrier material, in addition to any liquid comprising the Protein Solution. It should be understood that in various embodiments of the present technology, methods of treatment employ the Protein Solution as comprised and made above, without further carrier, by direct injection or other application to the site of treatment. However, in other embodiments, an additional carrier material may be used for such reasons as for ease of administration, to facilitate administration using a particular delivery device, enhancing activity, an increasing the length of time the Protein Solution remains at the site of administration. Carriers among those useful herein include saline, hyaluronic acid, collagen, buffers (such as Hank's Buffer), cell culture media, blood products (such as PRP and platelet poor plasma), bone marrow aspirate, concentrated bone marrow aspirate, and mixtures thereof.

[0066] Protein Solutions, and compositions comprising Protein Solutions may be sterilized prior to administration, by any suitable method. For example, a Protein Solution may be sterilized by including a sterile filter to process the product made by the processes described above. In some embodiments, an antibiotic may be included in the solid extraction material during the contacting step described above, or may be added at one or more of the various steps in the methods and treatments described herein. Alternatively, or in addition, the Protein Solution may be produced asceptically.

[0067] Protein Solutions and compositions comprising Protein Solutions may also be lyophilized (freeze drying, or cryodesiccation) after production, using methods among those known in the art. When freeze dried, the anti-inflammatory cytokine composition can be hydrated at a time before administration or at a time of administration. Hydration may be accomplished by mixing the composition with a solution including saline, buffers, blood, blood fractions, bone marrow aspirate, concentrated bone marrow aspirate, and combinations thereof.

[0068] The present technology provides compositions comprising components derived from blood or other tissue that are suitable for allogeneic administration. In particular, such compositions may comprise proteins and other components isolated from a mammalian subject, or a plurality of mammalian subjects, other than the subject to whom the composition is to be administered in a method of this technology. In some embodiments, Protein Solutions comprise components isolated from the subject to be treated and components isolated from one or more subjects other than the subject to be treated.

Methods of Treatment

[0069] The present technology provides methods for the treatment of an inflammatory disorder or other disorder mediated by IL1-ra in a human or other mammalian subject, comprising administration of a Protein Solution of the present technology to the subject. Such diseases may be characterized by elevated neutrophil counts. Without limiting the mechanism, utility or function of the present technology, the methods and treatments of this technology mediate the effects of interleukin-1 and its role in the inflammation cascade. As generally discussed above, interleukin-1 (IL-1) includes a family of cytokines that can stimulate lymphocytes, neutrophils, and macrophages, activate phagocytes, increase airway fibrosis, promote lymphocyte nodules

in the airways, increase production of both MMP-9 and MMP-12, and are involved in many chronic inflammatory conditions. IL-1 can be generated by macrophages, monocytes, and dendritic cells, and can be part of the inflammatory response against infection. See, Lappalainen et al., "Interleukin-1β Causes Pulmonary Inflammation, Emphysema, and Airway Remodeling in the Adult Murine Lung" American Journal of Respiratory Cell and Molecular Biology, vol. 32, no. 4, pages 311-318 (April 2005).

[0070] The mode of action of IL-1 can be mediated by IL-1ra. IL-1ra binds to the same receptor on the cell surface as IL-1, and thus prevents IL-1 from sending a signal to that cell. IL-1ra is secreted from white blood cells, including monocytes, macrophages, neutrophils, polymorphonuclear cells (PMNs), and other cells, and can modulate a variety of IL-1 related immune and inflammatory responses, as described by Arend WP, Malyak M, Guthridge CJ, Gabay C (1998) "Interleukin-1 receptor antagonist: role in biology" Annu. Rev. Immunol. 16: 27-55. Production of IL-1ra is stimulated by several substances including adherent immunoglobulin G (IgG), other cytokines, and bacterial or viral components. Likewise, the mode of action of TNF-α can be mediated by sTNF-RI and sTNF-RII, which prevent TNF-α from binding to membrane bound TNF-RI and/or TNF-RII.

[0071] Examples of inflammatory disorders treated by the methods of this technology include rheumatoid arthritis, osteoarthritis, osteolytis, tendonitis, synovitis, peripheral vascular disease, and inflammatory respiratory diseases (such as chronic obstructive pulmonary disease, fibrosis, emphysema, acute respiratory distress syndrome, and pneumonia). Treatment methods also include the prevention, reduction or elimination of pain associated with various disorders, such as pain associated with traumatic injury, muscle strain, arthritis (rheumatoid arthritis and osteoarthritis), synovitis, sacroiliac joint disorders, back disorders, post-surgical injections, tendon injections, sports medicine procedure (for example, ACL repair, MCL repair, BTB repair, patella repair, or cartilage repair), contusions, muscle strains, post traumatic osteoarthritis. Methods also include stimulation of chondrocyte production at the site of a collagen defect, such as defects at joints associated with arthritis, injuries or surgical procedures.

[0072] In some embodiments, methods of the present technology comprise administration of a Protein Solution to the site of a tissue defect to prevent or treat a disorder associated with IL-1ra. As referred to herein, such "tissue defects" include any

condition involving tissue which is inadequate for physiological or cosmetic purposes. Examples of such defects include those that are congenital, those that result from or are symptomatic of disease, disorder, or trauma, and those that are consequent to surgical or other medical procedures. Embodiments include treatment for vascular, bone, skin, nerve, and organ tissue defects. Examples of such defects include those resulting from osteoporosis, spinal fixation procedures, hip and other joint replacement procedures, chronic wounds, fractures, sclerosis of tissues and muscles, and spinal cord or other nerve injury. In various embodiments, the compositions and methods of this invention may be used in methods associated with the repair bone or cartilage defects.

[0073] In various embodiments, methods are for the treatment of inflammatory disorders in a human. In other embodiments, treatment is for non-human mammals, such as companion, working, and sports animals. For example, such methods of this technology may be used for the treatment of inflammatory disorders in horses.

[0074] In various embodiments, methods of the present technology comprise a point-of-care method for making a Protein Solution. As referred to herein, a "point-of-care method" wherein the processes of the present technology, e.g., production of a Protein Solution from blood clots or urine, are performed at a time proximate to the administration of the Protein Solution to the subject being treated. Such methods may be performed at a location proximate, such as in the same room (for example, bed side) or otherwise immediately adjacent, to the mammalian subject to be transfused with the RBCs. In various embodiments, a "proximate time" may be, for example, within 12 hours, within 8 hours, within 2 hours, within 1 hour or within 30 minutes of administration of the Protein Solution to the subject.

[0075] In some embodiments, the Protein Solution is administered with a concomitant therapy. Such therapies include, for example, the administration of pharmaceutical actives or biologics, as described above. In some embodiments, concomitant therapies are administered concurrently with a Protein Solution. For example, methods may comprise administration of a Protein Solution with a safe and effective amount of an active selected from the group consisting of glucocorticosteroids, non-steroidal anti-inflammatories, antibiotics, antivirals, and combinations thereof.

[0076] In some embodiments, methods comprise administration of a Protein Solution with concentrated bone marrow aspirate, as described above. For example, cBMA and a Protein Solution may be administered concomitantly.

[0077] Methods of the present technology generally comprise administration of a Protein Solution to the site of inflammation in a mammalian subject. Administration of the Protein Solution can be performed with any suitable device, including such devices known in the art for topical delivery of compositions to the muscle, joint, vascular, lung or other tissue. For example, topical delivery for treatment of inflammation or pain associated with joint disorders may comprise injection of a Protein Solution at or near the joint. Treatment for inflammatory respiratory diseases may comprise delivery of a Protein Solution by endotracheal tubes, inhalers and nebulizers.

Non-limiting Discussion of Terminology

[0078] The headings (such as "Introduction" and "Summary") and sub-headings used herein are intended only for general organization of topics within the present disclosure, and are not intended to limit the disclosure of the technology or any aspect thereof. In particular, subject matter disclosed in the "Introduction" may include novel technology and may not constitute a recitation of prior art. Subject matter disclosed in the "Summary" is not an exhaustive or complete disclosure of the entire scope of the technology or any embodiments thereof. Classification or discussion of a material within a section of this specification as having a particular utility is made for convenience, and no inference should be drawn that the material must necessarily or solely function in accordance with its classification herein when it is used in any given composition.

[0079] The disclosure of all patents and patent applications cited in this disclosure are incorporated by reference herein.

[0080] The description and specific examples, while indicating embodiments of the technology, are intended for purposes of illustration only and are not intended to limit the scope of the technology. Equivalent changes, modifications and variations of specific embodiments, materials, compositions and methods may be made within the scope of the present technology, with substantially similar results. Moreover, recitation of multiple embodiments having stated features is not intended to exclude other embodiments having additional features, or other embodiments incorporating different combinations of the stated features. Specific examples are provided for illustrative purposes of how to make and use the compositions and methods of this technology and,

unless explicitly stated otherwise, are not intended to be a representation that given embodiments of this technology have, or have not, been made or tested.

[0081] As used herein, the words "prefer" or "preferable" refer to embodiments of the technology that afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the technology.

[0082] As used herein, the word "include," and its variants, is intended to be non-limiting, such that recitation of items in a list is not to the exclusion of other like items that may also be useful in the materials, compositions, devices, and methods of this technology. Similarly, the terms "can" and "may" and their variants are intended to be non-limiting, such that recitation that an embodiment can or may comprise certain elements or features does not exclude other embodiments of the present technology that do not contain those elements or features.

[0083] Although the open-ended term "comprising," as a synonym of non-restrictive terms such as including, containing, or having, is used herein to describe and claim embodiments of the present technology, embodiments may alternatively be described using more limiting terms such as "consisting of" or "consisting essentially of." Thus, for any given embodiment reciting materials, components or process steps, the present technology also specifically includes embodiments consisting of, or consisting essentially of, such materials, components or processes excluding additional materials, components or processes (for consisting of) and excluding additional materials, components or processes affecting the significant properties of the embodiment (for consisting essentially of), even though such additional materials, components or processes are not explicitly recited in this application. For example, recitation of a composition or process reciting elements A, B and C specifically envisions embodiments consisting of, and consisting essentially of, A, B and C, excluding an element D that may be recited in the art, even though element D is not explicitly described as being excluded herein. Further, as used herein the term "consisting essentially of" recited materials or components envisions embodiments "consisting of" the recited materials or components.

[0084] A" and "an" as used herein indicate "at least one" of the item is present; a plurality of such items may be present, when possible. "About" when applied to values indicates that the calculation or the measurement allows some slight imprecision in the value (with some approach to exactness in the value; approximately or reasonably close to the value; nearly). If, for some reason, the imprecision provided by "about" is not otherwise understood in the art with this ordinary meaning, then "about" as used herein indicates at least variations that may arise from ordinary methods of measuring or using such parameters.

[0085] As referred to herein, ranges are, unless specified otherwise, inclusive of endpoints and include disclosure of all distinct values and further divided ranges within the entire range. Thus, for example, a range of “from A to B” or “from about A to about B” is inclusive of A and of B. Disclosure of values and ranges of values for specific parameters (such as temperatures, molecular weights, weight percentages, etc.) are not exclusive of other values and ranges of values useful herein. It is envisioned that two or more specific exemplified values for a given parameter may define endpoints for a range of values that may be claimed for the parameter. For example, if Parameter X is exemplified herein to have value A and also exemplified to have value Z, it is envisioned that Parameter X may have a range of values from about A to about Z. Similarly, it is envisioned that disclosure of two or more ranges of values for a parameter (whether such ranges are nested, overlapping or distinct) subsume all possible combination of ranges for the value that might be claimed using endpoints of the disclosed ranges. For example, if Parameter X is exemplified herein to have values in the range of 1–10, or 2–9, or 3–8, it is also envisioned that Parameter X may have other ranges of values including 1–9, 1–8, 1–3, 1–2, 2–10, 2–8, 2–3, 3–10, and 3–9.

The claims defining the invention are as follows:

1. A substantially acellular anti-inflammatory cytokine composition comprising the following components:

(a) interleukin-1 receptor angagonist (IL-1ra);

(b) soluble tumor necrosis factor receptor I (sTNF-RI); and

(c) at least one protein selected from soluble interleukin-1 receptor II (sIL-1RII) and soluble tumor necrosis factor receptor II (sTNF-RII);

wherein at least one of the IL-1ra, sTNF-RI and the selected protein is isolated from urine, clotted blood, or tissue culture and wherein the composition is substantially free of viable cells.

2. The anti-inflammatory composition according to Claim 1, wherein the IL-1ra has a concentration of at least about 10,000 pg/ml, and the sTNF-RI has a concentration of at least about 1,200 pg/ml.

3. The anti-inflammatory composition according to Claim 1 or 2, further comprising a cytokine selected from the group consisting of platelet derived growth factors AB and BB (PDGF-AB and PDGF-BB), epidermal growth factor (EGF), hepatocyte growth factor (HGF), and mixtures thereof.

4. The anti-inflammatory composition according to any one of Claims 1 to 3, wherein the at least one protein comprises sIL1-RII at a concentration of at least about 15,000 pg/ml.

5. The anti-inflammatory composition according to any one of Claims 1 to 4, wherein at least one protein comprises sTNF-RII at a concentration of at least about 3,000 pg/ml.

6. The anti-inflammatory composition according to any one of Claims 1 to 5, wherein the anti inflammatory cytokine composition is freeze dried.

7. A substantially acellular composition for the treatment of a disorder mediated by IL-1 comprising the following components:

(a) at least about 10,000 pg/ml IL-1ra;

(b) at least about 1,200 pg/ml sTNF-RI; and

(c) a protein selected from the group consisting of sTNF-RII, IGF-I, EGF, HGF, PDGF-AB, PDGF-BB, VEGF, TGF-β1, and sIL-1RII, and mixtures thereof, wherein the protein has a concentration in the composition greater than the concentration of the protein in normal blood; and

wherein at least one of the components is derived from urine, clotted blood, or tissue culture.

8. The composition according to Claim 7, wherein at least one component is isolated from urine, clotted blood, or tissue culture.

9. The composition according to Claim 7 or 8, wherein at least one component is obtained from culture medium from a monolayer cell culture, a bioreactor, or a non-adherent cell culture.

10. A method for making an acellular composition when used for the treatment of a disorder mediated by IL-1 comprising:

(a) culturing, in a growth medium, cells that produce IL- 1ra and sIL-1RII or sTNF-RII;

(b) isolating the medium from the cells; and

(c) freeze drying the isolated medium to provide an acellular composition.

11. The method according to Claim 10, wherein the culturing is performed in a monolayer culture, a bioreactor, or a non-adherent culture.

12. The method according to Claim 10 or 11, wherein the cultured cells are genetically engineered to overproduce IL-1ra.

13. The method according to Claim 12, wherein the cultured cells that are engineered to overproduce IL-1ra are mammalian cells transfected with a recombinant DNA molecule comprising a DNA sequence encoding IL-1ra.

14. The method according to any one of Claims 10 to 13, wherein the cultured cells are cells derived from blood, bone marrow, adipose tissue, bone marrow-derived stem cells, or adipose-derived stem cells.

15. The method according to any one of Claim 10 to 14, wherein the cells are subjected to an electromagnetic field or a solid extraction material during the culturing.

16. A method for treating a disorder mediated by IL-1 comprising administering the substantially acellular composition according to any one of Claims 1 to 9 to a subject in need thereof.

17. The method according to Claim 16, wherein the disorder is arthritis, osteolytis, tendonitis, synovitis, pain, traumatic injury, muscle strain, peripheral vascular disease, or an inflammatory respiratory disease.

18. The method according to Claim 16 or 17, further comprising administering to the subject a pharmaceutical active ingredient selected from the group consisting of steroids, analgesics, and combinations thereof.

19. A method for treating a disorder mediated by IL-1 in a mammalian subject comprising administering to the subject the substantially acellular composition according to Claim 6.

20. The method according to Claim 19, wherein composition is reconstituted in a solution prior to the administering, the solution being selected from the group consisting of saline, buffers, blood, blood fractions, bone marrow aspirate, concentrated bone marrow aspirate, and combinations thereof.

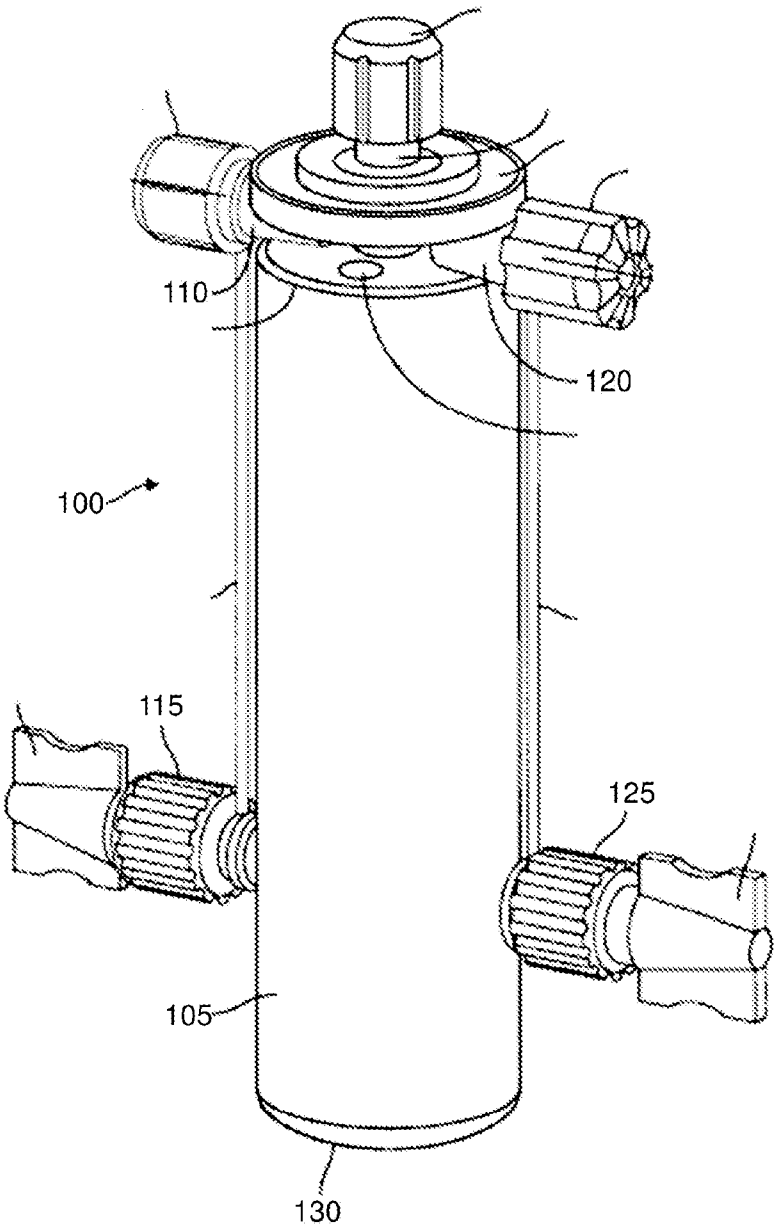


Fig. 1

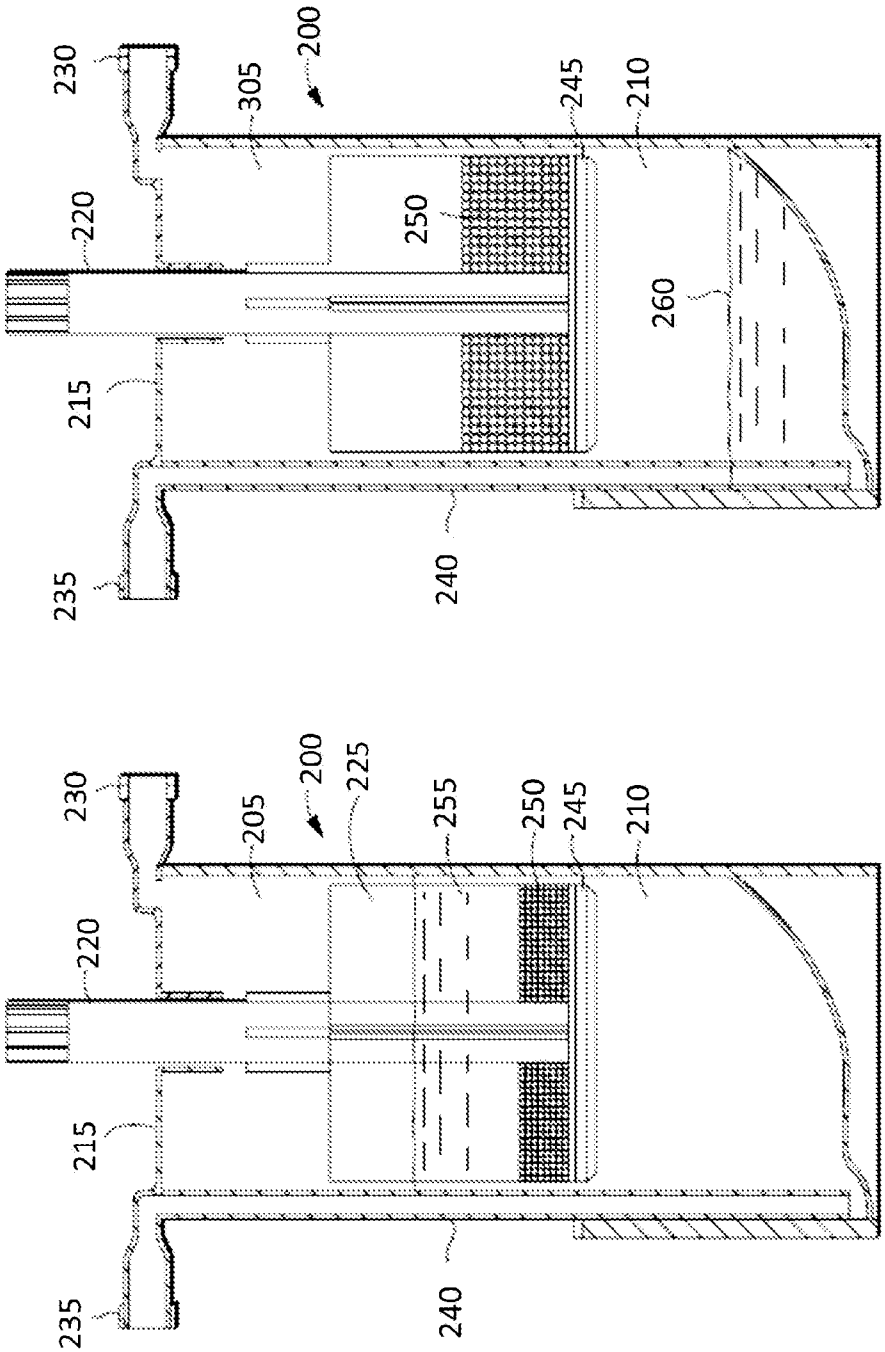


Fig. 2B

Fig. 2A

Fig. 2