DESCRIPTION

DEVICE FOR TRANSPORTING GRAFT

Technical Field

[0001]

The present invention relates to a device for transporting a graft.

Background Art

[0002]

In recent years, new regenerative medicine has been developed as a solution to the treatment of severe cardiac failure. As an example thereof, a method of applying a sheet-shaped cell culture prepared using a temperature-responsive culture dish devised by tissue engineering to the surface of a heart has been attempted to treat severe cardiac infarction, or the like. The method using a sheet-shaped cell culture is capable of safely transplanting a large amount of cells over a wide range, and is particularly effective for, for example, cardiac infarction (including chronic cardiac failure associated with cardiac infarction), dilated cardiomyopathy, ischemic cardiomyopathy, and cardiac diseases (e.g., cardiac failure, particularly, chronic cardiac failure) associated with systolic dysfunction (e.g., left ventricular systolic dysfunction).

[0003]

In order to clinically apply such a sheet-shaped cell culture, it is necessary to, for example, store the prepared sheet-shaped cell culture in a container together with a preservation solution and transport the container to an intensive care unit where transplantation is performed. However, the sheet-shaped cell culture inherently has a low physical strength, and thus, is susceptible to wrinkles, tears, damage, etc. that occur due to vibration during the transportation of the container. Therefore, transporting the container requires advanced technique and great care.

[0004]

In order to meet such needs, various methods and containers have been developed. For example, in a container for storing and transporting a membranous tissue disclosed in Patent Literature 1 below, a storage section is filled with a preservation solution to an extent that a gas layer is not formed in the storage section, whereby sloshing or movement of the preservation solution can be prevented. Thus, vibration is not transmitted to the membranous tissue, so that damage of the membranous tissue can be prevented.

[0005]

Patent Literature 2 below discloses a package for transporting a cultured cell sheet. When the package is sealed with a lid, air is discharged together with a little amount of liquid culture medium. Therefore, even if the cultured cell sheet package shakes during transportation, air bubbles do not move in

the liquid culture medium, which can prevent displacement and defect of the cultured cell sheet.

Citation List

Patent Literature

[0006]

Patent Literature 1: JP 2012-130311 A

Patent Literature 2: JP 2009-89715 A

Summary of Invention

Technical Problem

[0007]

As mentioned above, containers for safely transporting a fragile cell sheet have been developed. Further, such a container is designed to be liquid-tight so that air bubbles do not move in the container.

[0008]

However, a high level of technique is required to completely remove air bubbles from the inside of the container and achieve a liquid-tight state. Moreover, since a strong force is required to remove the lid from the liquid-tight container, the liquid may be wavy when the lid is attached and detached, which may damage the cell sheet.

Solution to Problem

[0009]

The present invention has been accomplished in view of the above points, and an object thereof is to provide a device capable of efficiently achieving a liquid-tight state by a simple operation.

[0010]

That is, the present invention involves the following.

[1] A device to be used in a state of being detachably attached to a container for storing a graft, the device including: a lid member for sealing the container; and an annular member for forming a first space by being interposed between the lid member and the container, wherein a second space is formed between the lid member and an inside surface of the container.

[2] The device according to [1], further including a sealing member interposed between the container and the lid member.

[3] The device according to [1] or [2], further including a protective member interposed between the annular member and the lid member to protect the first space.

[0011]

[4] The device according to [3], wherein the protective member is flexible.

[5] The device according to [1] or [3], wherein the protective member and/or the lid member is water repellent.

[6] The device according to any one of [1] to [5], wherein the graft is a sheet-shaped cell culture.

[7] The device according to [6], wherein the sheet-shaped cell

culture is a laminate.

[8] A gripping tool including: a cover member; and a base member, the gripping tool being configured to press and grip the device according to any one of [1] to [7] from above and below.

Advantageous Effects of Invention

[0012]

The device according to the present invention can efficiently achieve a liquid-tight state with a simple mechanism and a simple operation, thereby providing great advantages in terms of operability and manufacturing cost. Further, the device can bring the inside of the container into a complete liquid-tight state. Therefore, entry of air bubbles (gas) into the container can be prevented, and thus, a fragile object is not damaged due to the movement of air bubbles within the container caused by, for example, shaking of the container during transportation. Particularly when the fragile object is a laminate of sheet-shaped cell cultures, displacement or defect of the laminate due to the movement of air bubbles can be prevented. Therefore, the fragile object can be stored for a long time with the shape of the fragile object in the liquid being retained without being deformed.

[0013]

According to the device of the present invention, the liquid-tight state can be easily released. Therefore, vibration of the container and the movement of the liquid caused by, for example,

forced removal of the lid member by a worker can be minimized, and thus, damage of the fragile object can be prevented. In addition, since the device allows the worker to do the work without contaminating the surroundings, the device is suitable for use in a location where cleanliness is strictly controlled, such as a bio-clean room used for preparing a sheet-shaped cell culture and an intensive care unit where a sheet-shaped cell culture is used.

Brief Description of Drawings

[0014]

Fig. 1 is a conceptual diagram of a device 1 according to a first embodiment.

Fig. 2 is a sectional view of the device 1 shown in Fig. 1.

Fig. 3 is a perspective view of a gripping tool 7 according to a second embodiment.

Fig. 4 is a perspective view of a gripping tool 7A according to a third embodiment.

Fig. 5 is a perspective view of a gripping tool 7B according to a fourth embodiment.

Description of Embodiments

[0015]

The term “fragile object” as used in the present invention denotes any object which has such low physical strength as to tear, break, deform, or the like when a liquid moves. Examples of such

objects include an object having a thin-walled part, a band-shaped object, and a sheet-shaped object. Examples of the sheet-shaped object include, but are not limited to, a sheet-shaped structural object, for example, a flat membranous tissue formed from a biologically derived material such as a sheet-shaped cell culture, and various kinds of films formed from plastic, paper, woven cloth, unwoven cloth, metal, polymer, lipid, etc. Among these, objects that hardly decompose or disintegrate in a liquid are preferable. The sheet-shaped structural object may have, for example, a polygonal shape or a circular shape, and may vary in width, thickness, diameter, etc. The sheet-shaped structural object in the present invention may be used in a monolayer form or as a laminate in which the two or more sheet-shaped structural objects are laminated. When the sheet-shaped structural objects are used as a laminate, layers of the object laminate may be joined together or separated from one another. If the layers are joined together, overlapped parts of the layers may be entirely or partially joined to one another. Further, in the present invention, the term "fragile" means that it is difficult or substantially impossible to evaluate tensile properties of an object due to its fragility with, for example, a conventional tensile tester (for example, a tester specified in JIS K 7161 etc.) in which the object is fixed to a gripping tool outside the liquid. Examples of such a fragile object include an object whose tensile properties are difficult to be accurately measured by a conventional tensile tester because

values associated with the tensile properties are small. Examples of such fragile objects include those that exhibit a breaking load of less than 10 N (Newton), less than 5 N, less than 2 N, less than 1 N, less than 0.5 N, less than 0.1 N, and less than 0.05 N when subjected to a tensile test. Further, the measurement limit of the conventional tensile test regarding a breaking load is generally about 1 N, and therefore, in one aspect of the present invention, an object exhibiting a breaking load lower than 1 N (for example, less than 0.5 N) is preferable as a fragile object.

[0016]

In the present invention, the term “graft” denotes a biologically derived fragile object having a relatively low physical strength. The graft includes cultured cells (for example, cell cultures, etc.) and harvested cells. The graft may further include products produced by cells. The graft may also include a material (filling material or supporting material) for filling and/or supporting a predetermined part of the living body (for example, a diseased part), in addition to cells and/or cell products. The graft may have various shapes such as a sheet shape, a membranous shape, a lump shape, and a column shape. The graft is used for transplantation into a living body. Examples of the graft include three-dimensional cell tissues (organoids, spheroids, etc.), and two-dimensional cell tissues (sheet-shaped cell cultures, etc.).

The term “sheet-shaped cell culture” as used in the present invention denotes a cell culture which resembles a sheet having

cells joined together. The cells may be joined together directly (including the case where the cells are joined together with cellular elements such as adhesion molecules therebetween) and/or via an intervening substance therebetween. The intervening substance is not particularly limited so long as it is capable of joining cells together at least physically (mechanically). Examples thereof include an extracellular matrix. Preferably, the intervening substance is derived from cells, particularly derived from cells constituting the sheet-shaped cell culture. The cells can be joined together at least physically (mechanically) and may be further joined together functionally, for example chemically or electrically. The sheet-shaped cell culture may consist of one layer of cells (may have a monolayer form), or two or more layers of cells (may have a multilayer form). Further, the sheet-shaped cell culture may have a three-dimensional structure having a thickness exceeding the thickness of one cell without the cells exhibiting a clear layered structure. For example, in the vertical cross section of the sheet-shaped cell culture, the cells may be present in a state of being arranged nonuniformly (for example, in a mosaic) without being uniformly aligned in the horizontal direction. The sheet-shaped cell culture may be a single sheet-shaped cell culture which is independently formed, or may be a laminate formed by laminating two or more independent sheet-shaped cell cultures. The laminate may have two, three, four, five, or six layers of sheet-shaped cell cultures.

[0017]

The sheet-shaped cell culture involved in the present invention includes any cells capable of forming the above-mentioned structure. Non-limiting examples of such cells include adherent cells. The adherent cells include, for example, adherent somatic cells and stem cells. Examples of the somatic cells include cardiac muscle cells, fibroblasts, epithelial cells, endothelial cells, hepatic cells, pancreatic cells, kidney cells, adrenal cells, periodontal ligament cells, gingival cells, periosteal cells, dermal cells, synovial cells, and cartilage cells. Examples of the stem cells include myoblasts, tissue stem cells such as cardiac stem cells, embryonic stem cells, pluripotent stem cells such as induced pluripotent stem (iPS) cells, and mesenchymal stem cells. The somatic cells may be those that are obtained by differentiation from stem cells, especially iPS cells. Non-limiting examples of the cells capable of forming the sheet-shaped cell culture include myoblasts (for example, skeletal myoblasts), mesenchymal stem cells (for example, those which are derived from bone marrow, fat tissues, peripheral blood, skin, hair root, muscle tissues, endometrium, placenta, and cord blood), cardiac muscle cells, fibroblasts, cardiac stem cells, embryonic stem cells, iPS cells, synovial cells, cartilage cells, epithelial cells (for example, oral mucosal epithelial cell, retinal pigment epithelial cells, and nasal mucosal epithelial cells), endothelial cells (for example, vascular endothelial cells), hepatic cells (for example, hepatic parenchymal

cells), pancreatic cells (for example, islet cells), kidney cells, adrenal cells, periodontal ligament cells, gingival cells, periosteal cells, and dermal cells. In the present specification, cells which form mono-layered cell cultures, such as myoblast or cardiac muscle cells, are preferable, and most preferable cells are skeletal myoblasts or iPS cell-derived cardiac muscle cells.

[0018]

The cells can be derived from any living organism that can be cured with the help of cell culture. Such living organisms are not particularly limited, and examples thereof include human, primate, dog, cat, pig, horse, goat, and sheep. The sheet-shaped cell culture may be prepared from one species of cells or more than one species of cells. According to a preferred embodiment of the present invention, in a case where the cell culture is prepared from more than one species of cells, the major cells account for 65% or more, preferably 70% or more, and more preferably 75% or more of the total cells in the cell culture (in the case of using, for example, skeletal myoblasts), when the cell culture is prepared completely. The percentage represents purity.

[0019]

The sheet-shaped cell culture in the present invention may be a cultured tissue in a sheet form which is obtained by inoculating cells onto a scaffold (support for cell culturing) and culturing the cells. However, it is preferable that the sheet-shaped cell culture is composed solely of substances derived from

the cells constituting the cell culture, and does not contain other substances.

The sheet-shaped cell culture may be prepared by any known method.

[0020]

In one aspect of the present invention, the sheet-shaped cell culture is a sheet-shaped cell culture of skeletal myoblasts. The sheet-shaped cell culture of skeletal myoblasts may be vulnerable to breaking by its own weight even when a part of the sheet-shaped cell culture is pinched. Thus, the sheet-shaped cell culture cannot be transported in its isolated form. Moreover, it is extremely difficult to restore the sheet-shaped cell culture into its original form once it is folded. Consequently, keeping the sheet form in a liquid can be of great significance.

[0021]

In the present invention, the container is not particularly limited so long as it is capable of holding inside a fragile object, a liquid, or the like and is capable of preventing the liquid from leaking form the container. Any container, including commercially available containers, may be used. Examples of the material of the container include, but are not limited to, polyethylene, polypropylene, Teflon (registered trademark), polyethylene terephthalate, polymethyl methacrylate, nylon 6,6, polyvinyl alcohol, cellulose, silicone, polystyrene, glass, polyacrylamide, polydimethylacrylamide, and metal (for example, iron, stainless

steel, aluminum, copper, or brass). In addition, the container preferably has at least one flat bottom surface for keeping the shape of the fragile object. Examples of such container include, but are not limited to, a petri dish, a cell culture dish, and a cell culture bottle. The area of the flat bottom surface is not particularly limited, but is typically 9.1 to 78.5 cm^2, 1.13 to 78.5 cm^2, preferably 12.6 to 78.5 cm^2, and more preferably 9.1 to 60.8 cm^2.

[0022]

In the present invention, the liquid in the container is composed of at least one component which is not particularly limited. Examples of the liquid include water, aqueous solution, non-aqueous solution, suspension, and emulsion.

Moreover, the “solution” or “liquid” used in the present specification may be a fluid having fluidity as a whole, and may contain any other non-liquid components including solids such as a scaffold and air bubbles.

[0023]

The liquid in the container may be composed of any components that have little effect on the fragile object. In a case where the fragile object is a membrane composed of materials derived from a living organism, biocompatible components, that is, components that cause no or at least little undesirable effects such as inflammatory reaction, immune reaction, or toxic reaction on the living organism and cells are preferably used as the

components constituting the liquid in the container from a viewpoint of biological stability and long-term storage stability. Examples of such components include water, saline, biological buffer (such as HBSS, PBS, EBSS, Hepes, and sodium bicarbonate), culture medium (such as DMEM, MEM, F12, DMEM/F12, DME, RPMI1640, MCDB, L15, SkBM, RITC80-7, and IMDM), sugar solution (such as sucrose solution and Ficoll-paque (registered trademark) PLUS), sea water, serum-containing solution, Renografin (registered trademark) solution, metrizamide solution, meglumine solution, glycerin, ethylene glycol, ammonia, benzene, toluene, acetone, ethyl alcohol, benzole, oil, mineral oil, animal oil, vegetable oil, olive oil, colloidal solution, liquid paraffin, turpentine oil, linseed oil, and castor oil.

[0024]

In a case where the fragile object is a sheet-shaped cell culture, the liquid in the container is preferably composed of components that can ensure stable cell storage, contain minimal oxygen and nutrients required for cell existence, and have an osmotic pressure low enough not to break cells. Examples of the components to meet these requirements include, but are not limited to, saline, biological buffer (such as HBSS, PBS, EBSS, Hepes, and sodium bicarbonate), culture medium (such as DMEM, MEM, F12, DMEM/F12, DME, RPMI1640, MCDB, L15, SkBM, RITC80-7, and IMDM), and sugar solution (such as sucrose solution and Ficoll-paque PLUS (registered trademark)).

[0025]

The amount of the liquid in the container is not particularly limited, as long as the fragile object can be retained with the lid member being attached to the container, and the liquid level present between the bottom part of the container and the top part of the lid member is high enough to prevent the fragile object from moving (shaking) in the liquid. That is, when a space is created between the liquid surface and the lid member, the liquid (liquid surface) moves, and the fragile object easily moves in the liquid. Therefore, it is preferable to adjust the liquid level so that there is no space between the liquid surface and the lid member. In one aspect of the present invention, the sheet-shaped cell culture has a diameter of about 35 to 55 mm and an area of 6 cm^2 or more, or 10 cm^2 or more. The liquid level can be set to, for example, 1.0 mm to 20.0 mm regardless of the diameter of the sheet-shaped cell culture.

[0026]

In the present invention, the lid member is not particularly limited as long as it can seal the container. Examples of the material of the lid member include, but are not limited to, polyethylene, polypropylene, Teflon (registered trademark), polyethylene terephthalate, polymethyl methacrylate, nylon 6,6, polyvinyl alcohol, cellulose, silicone, polystyrene, glass, polyacrylamide, polydimethylacrylamide, and metal (for example, iron, stainless steel, aluminum, copper, or brass).

[0027]

In the present invention, the shapes of the lid member and the container are not particularly limited as long as the lid member and the container can be engaged with each other and a closed space can be formed by such engagement. For example, in a case where the container is a general-purpose petri dish, the lid member preferably has a circular shape. Further, the lid member and/or the container may be made of a light-transmissive material so that the state of the fragile object contained in the container and the presence or absence of air bubbles in the liquid can be confirmed.

[0028]

In the present invention, the fragile object is held in the liquid in the container containing the liquid. Although the position of the fragile object in the liquid is not particularly limited, the fragile object is placed at a position where the lid member and the fragile object do not come into contact with each other (or may come into contact with each other) while the lid member is attached to the container to form a closed space. Preferably, the fragile object is placed on the bottom surface of the container, near the bottom surface, or the like in the liquid in the container.

[0029]

In the present invention, the term “water-repellent treatment” means that a solid surface is treated so that the

contact angle, which is the angle formed by a liquid surface and the solid surface, is 90° or more at the boundary line where the solid surface and the liquid contact. For example, on a water-repellent solid surface that has been subjected to Teflon (registered trademark) coating or the like, the contact angle is nearly 180°, and the droplets are almost spherical. Therefore, even if a liquid is present between the water-repellent solid surfaces, the solid surfaces do not stick to each other. Examples of the water-repellent treatment method include a coating method for coating the solid surface with a resin such as Teflon (registered trademark), silicone, a fluorine-based water repellent agent, wax, alumina soap, pyridinium salt, or gelatin. Further, the water-repellent treatment may be a method for forming irregularities on the solid surface without using a coating agent, such as forming irregularities on the solid surface with laser, like a super water-repellent treatment.

[0030]

In the present invention, the annular member indicates a member having a space inside a ring formed by rotating a rectangle around an axis parallel to one side of the rectangle. The height of the annular member is not particularly limited, but is typically 1 to 20 mm, preferably 3 to 15 mm, more preferably 5 to 10 mm so that the liquid and the fragile object can be contained in such a space. The inner diameter of the annular member is not particularly limited, but is typically 1 to 15 cm, preferably 3 to

15 cm, more preferably 3 to 10 cm.

[0031]

In the present invention, the sealing member indicates a member that is interposed between the container and the lid member to enhance the hermeticity of the container, and examples thereof include a packing ring.

The annular member and/or the sealing member can be made of an elastic material in order to absorb manufacturing tolerances of the container and the lid member and improve the hermeticity of the container. Examples of the elastic material include, but are not limited to, natural rubber, elastomer, nitrile rubber, and silicone rubber.

[0032]

[First Embodiment]

One aspect of the present invention relates to a device to be used in a state of being detachably attached to a container for storing a graft, the device including: a lid member for sealing the container; and an annular member for forming a first space by being interposed between the lid member and the container, wherein a second space is formed between the lid member and an inside surface of the container.

[0033]

Preferred embodiments of the present invention will now be described in detail with reference to the drawings.

First, a first embodiment of the present invention will be

described.

Fig. 1 is a conceptual diagram of a device 1 according to the first embodiment of the present invention, and Fig. 2 is a sectional view of the device 1 shown in Fig. 1. In the drawings of the present application, the dimensions of the various components are exaggerated, as appropriate, for facilitating the understanding of the description, and they may differ from the actual dimensions.

[0034]

As shown in Fig. 1, the device 1 according to the first embodiment of the present invention includes a lid member 3 for sealing a container 2, an annular member 4, a protective member 5, and a sealing member 6. The container 2 is a commercially available petri dish having an end part 21 that surrounds an opening, and constitutes a storage space that can store a liquid L, a fragile object S, or the like. The lid member 3 includes a top part 32, a protruding part 31 extending downward from the top part 32, and a cylindrical skirt wall 34 hanging from the peripheral edge of the top part 32. The protruding part 31 has a bottomed cylindrical shape having a bottom surface 33, and protrudes toward the internal space of the container 2 with the lid member 3 attached to the container 2. The outer diameter of the protruding part 31 is smaller than the inner diameter of the container 2, so that a space G (second space) is formed between the protruding part 31 and the inside surface of the container 2 when the lid member 3 is attached to the container 2. The cylindrical skirt wall 34 has

an inner diameter larger than the outer diameter of the container 2, and functions as a guide mechanism for guiding the position of the protruding part 31 to the center of the container 2 when the lid member 3 is attached to the container 2.

[0035]

The annular member 4 is a member having a space (first space) inside a ring formed by rotating a rectangle around an axis parallel to one side of the rectangle. The annular member 4 has an outer diameter substantially the same as or slightly larger than the inner diameter of the container 2 so that it can be placed on the bottom surface of the container 2 without displacement. The inner diameter of the annular member 4 is smaller than the outer diameter of the protruding part 31 so that, when the protruding part 31 is placed on the annular member 4, the protruding part 31 can be placed on the upper surface of the annular member 4 without entering the space inside the annular member 4. The annular member 4 has a rectangular cross section, and is configured so that there is no space into which air bubbles will enter when the annular member 4 is immersed in the liquid. The annular member 4 is made of an elastic material. Therefore, when held between the lid member 3 and the container 2, the annular member 4 absorbs manufacturing tolerances of the container 2 and/or the lid member 3 to improve adhesion.

[0036]

The protective member 5 is a member that is placed on the

annular member 4 to protect the space inside the annular member 4. The diameter of the protective member 5 is larger than the inner diameter of the annular member 4 so that, when the protective member 5 is placed on the annular member 4, the protective member 5 can be placed on the upper surface of the annular member 4 without entering the space inside the annular member 4. The protective member 5 is made of a fluid impermeable material so that gas and liquid do not pass therethrough. The protective member 5 is a flexible transparent film member, and thus, has strength enough to prevent damage once it is rolled, bent, or unrolled. The sealing member 6 is an annular elastic member that is interposed between the end part 21 of the container 2 and the top part 32 of the lid member 3 to enhance the adhesion. The inner diameter of the sealing member 6 is larger than the protruding part 31, and the outer diameter thereof is slightly larger than the inner diameter of the cylindrical skirt wall 34. Thus, when attached to the lid member 3, the sealing member 6 enters between the protruding part 31 and the cylindrical skirt wall 34 and is held between the top part 32 and the end part 21.

[0037]

As shown in Fig. 2A, when the device 1 is used, the annular member 4 is placed on the bottom surface of the container 2 that contains the liquid L and the fragile object S, and the liquid L and the fragile object S are put into the space (first space) inside the annular member 4. Then, when the liquid level of the

liquid L is lower than the height of the annular member 4, the liquid is further poured so that the liquid level is adjusted to be equal to or slightly higher than the height of the annular member 4. Since the cross section of the annular member 4 is rectangular and there is no space in which gas is accumulated, the first space is filled with the liquid L. Then, the protective member 5 is put so as to close the opening of the annular member 4, whereby the liquid surface of the liquid L contained in the first space is covered. Due to the film shape, the protective member 5 can cover the liquid surface without disturbing the liquid surface while gradually increasing the contact area with the liquid surface. Further, since the protective member 5 is transparent, the presence or absence of air bubbles can be visually confirmed, and the air bubbles can be easily removed by, for example, pushing the protective member 5 with finger. As a result, a complete liquid-tight space surrounded by the bottom surface of the container 2, the annular member 4, and the protective member 5 can be formed.

[0038]

Next, as shown in Fig. 2B, the lid member 3 is attached to the container 2, and the protective member 5 is held (fixed) between the protruding part 31 and the annular member 4. This prevents the protective member 5 from displacing from the liquid surface. At this time, even if air bubbles enter between the protruding part 31 and the protective member 5, the air bubbles do not enter the first space because the protective member 5 is fluid

impermeable. Further, the liquid L expelled by the protruding part 31 is held in the space G between the protruding part 31 and the container 2, and the sealing member 6 increases the hermeticity between the end part 21 of the container 2 and the top part 32 of the lid member 3. Thus, even if the liquid L contained in the space G is moved during transportation of the device 1, any problem such as leakage of the liquid L to the outside of the container 2 is unlikely to occur. Then, since the first space is completely liquid-tight and the liquid L is incompressible, the liquid L does not move even if the device 1 vibrates during transportation, so that an external force that deforms the fragile object S is not generated.

[0039]

When the fragile object S is used, the lid member 3 is removed from the container 2 at the destination of transportation. In the device 1, the protruding part 31 does not enter the liquid-tight space (first space), and therefore, it is unlikely that a worker forcibly removes the lid member. Further, since the liquid surface in the liquid-tight space is protected by the protective member 5, it is unlikely that the fragile object S is damaged due to the wavy liquid surface when the lid member 3 is removed from the container 2. Since the film-shaped protective member 5 sticks to the liquid L by surface tension, it is unlikely that it sticks to the protruding part 31. The contact area between the protective member 5 and the liquid surface can be gradually decreased by

pinching the protective member 5 at its end with tweezers or the like and rolling it up, whereby the surface waviness of the liquid can be minimized. Then, the fragile object S contained in the first space is taken out and used.

[0040]

As described above, the device 1 according to the first embodiment of the present invention can efficiently achieve a liquid-tight state with a simple mechanism and a simple operation, thereby providing great advantages in terms of operability and manufacturing cost. Further, the device 1 can bring the inside of the container into a complete liquid-tight state. Therefore, entry of air bubbles (gas) into the container can be prevented, and thus, the fragile object is not damaged due to the movement of air bubbles within the container caused by, for example, shaking of the container during transportation. Particularly when the fragile object is a laminate of sheet-shaped cell cultures, displacement or defect of the laminate due to the movement of air bubbles can be prevented. Therefore, the fragile object can be stored for a long time with the shape of the fragile object in the liquid being retained without being deformed.

[0041]

Further, according to the device 1 of the first embodiment of the present invention, the liquid-tight state can be easily released. Therefore, vibration of the container and the movement of the liquid caused by, for example, forced removal of the lid

member by the worker can be minimized, and thus, damage of the fragile object can be prevented. In addition, since the device 1 allows the worker to do the work without contaminating the surroundings, the device 1 is suitable for use in a location where cleanliness is strictly controlled, such as a bio-clean room used for preparing a sheet-shaped cell culture and an intensive care unit where a sheet-shaped cell culture is used.

[0042]

The device 1 according to the present invention has been described above on the basis of the first embodiment, but the present invention is not limited thereto, and may have various modifications. For example, the protective member 5 and/or the lid member 3 may be water repellent. That is, the portion where the protective member 5 and the lid member 3 contact, for example, the bottom surface of the protruding part 31 of the lid member 3, may be water repellent. This configuration can prevent the liquid L from sticking to the protective member 5 and the lid member 3, even when the liquid L enters between the protective member 5 and the lid member 3. Further, the protective member 5 may not be provided. That is, the device 1 according to the present invention is not configured such that the protruding part 31 of the lid member 3 enters the space (liquid-tight space) inside the annular member 4, whereby it is less likely that excessive force is applied during removal of the lid member 3. Therefore, problems such as surface waviness of the liquid is less likely to occur even if the

protective member 5 is not provided. Further, due to the bottom surface of the protruding part 31 being water repellent, the liquid surface is prevented from being pulled by the protruding part 31, which can suppress the surface waviness of the liquid.

[0043]

Further, the sealing member 6 can also be variously modified. For example, the upper surface of the sealing member 6 may be fixed to the top part 32 of the lid member 3, and a circular groove may be provided in the lower surface. With this configuration, when the lid member 3 is attached to the container 2, the end part 21 of the container 2 is engaged with the circular groove, so that the airtightness of the second space is further increased, and the lid member 3 is less likely to be detached from the container 2. In addition, the sealing member 6 simultaneously pulls the lid member 3 downward, which increases the force to press the protruding part 31 of the lid member 3 against the annular member 4. Thus, the liquid-tightness of the first space is further enhanced. Furthermore, any addition or modification may be freely provided to the sealing member 6. For example, the sealing member 6 may be provided between the cylindrical skirt wall 34 of the lid member 3 and the outer peripheral surface of the container 2, or between the protruding part 31 of the lid member 3 and the inner peripheral surface of the container 2.

In addition, the annular member 4 can also be variously modified. For example, when the container is a commercially

available petri dish, the inner peripheral surface of the petri dish is slightly inclined. Therefore, at least the outer peripheral surface of the annular member 4 may be tapered. With this configuration, the annular member 4 can be in close contact with the inner peripheral surface of the petri dish. In this case, a mark such as a marker or a small protrusion (raised dot) may be provided on the upper surface of the annular member 4 so that the upper and lower sides of the annular member 4 can be discriminated. In a case where the protrusion is provided, the worker can discriminate the upper side from the lower side only by touching the annular member 4 by his/her hand. However, when the protective member 5 is placed on the protrusion, the protective member 5 may rise. In view of this, a cutout may be formed in the protective member 5 at a position corresponding to the protrusion. This configuration can prevent the protective member 5 from rising.

The components used in the present invention may be substituted by arbitrary components which can function in the same way or may be added with arbitrary structure.

[0044]

The device according to the present invention can be used according to following steps, for example.

(1) Prepare the container containing the fragile object and the liquid.

(2) Place the annular member on the bottom surface of the container.

(3) Place the protective member on the annular member.

(4) Attach the lid member to the container to form a liquid-tight state.

(5) Transport the device.

(6) Remove the lid member.

(7) Remove the protective member to release the liquid-tight state.

(8) Take out the fragile object for use.

[0045]

Hereinafter, embodiments of gripping tools suitable for pressing and gripping the device 1 (container 2 and lid member 3) according to the present invention will be described in detail with reference to the drawings.

Fig. 3 is a perspective view of a gripping tool 7 according to a second embodiment of the present invention, Fig. 4 is a perspective view of a gripping tool 7A according to a third embodiment of the present invention, and Fig. 5 is a perspective view of a gripping tool 7B according to a fourth embodiment of the present invention. In the drawings of the present application, the dimensions of the various components are exaggerated, as appropriate, for facilitating the understanding of the description, and they may differ from the actual dimensions.

[0046]

[Second Embodiment]

As shown in Fig. 3, the gripping tool 7 according to the

present embodiment includes a base member 8 and a cover member 9. The gripping tool 7 can press and grip the device 1 including the container 2 (not shown) and the lid member 3 (not shown) for sealing the container 2 from above and below.

[0047]

The base member 8 and the cover member 9 both have a circular shape, and can press the device 1, as appropriate, from above and below. The base member 8 includes an opening 81, a bottom part 82, a screw part (engagement part) 83, a placement part 84, and a ridge part 85. In the present embodiment, the engagement is achieved by screwing. The placement part 84 has, on its upper surface, a placement surface on which the container 2 can be placed, and is provided with the opening 81 in the central portion. The placement part 84 has the annular ridge part 85 (elongated ridge) that surrounds the lower end of the container 2 when the container 2 is placed on the placement surface. Thus, the mounting position of the container 2 with respect to the base member 8 can be defined. The placement part 84 has a disk shape protruding upward from the bottom part 82, and the screw part 83 is provided on the side peripheral surface thereof. The bottom part 82 has an outer diameter larger than that of the placement part 84, and serves as a bottom when the base member 8 is placed on a table or the like.

[0048]

The cover member 9 includes an opening 91, a top part 92, a screw part (engagement part) 93, a cylindrical skirt wall 94, and a

grip part 95. The top part 92 has a cover surface that can cover the upper surface of the lid member 3, and is provided with the opening 91 in the central portion. The top part 92 includes the cylindrical skirt wall 94 hanging from the peripheral edge of the top part 92. The device 1 can be gripped by being surrounded by the top part 92, the cylindrical skirt wall 94, and the placement part 84. The screw part 93 (not shown) is provided on the inner peripheral surface of the lower end of the cylindrical skirt wall 94. The cover member 9 can be screwed to the base member 8 by screwing the screw part 93 into the screw part 83 of the base member 8. Optionally, the inner diameter of at least a part (for example, the inner peripheral surface of the upper end of the cylindrical skirt wall 94) of the cylindrical skirt wall 94 may be set equal to the outer diameter of the lid member 3. With this configuration, the mounting position of the lid member 3 with respect to the gripping tool 7 can be defined.

[0049]

When the gripping tool 7 is used, the lid member 3 is put on the container 2 containing an object S. At this time, a closed space (liquid-tight space) can also be formed by optionally putting the lid member 3 on the container 2 filled with the liquid L. Further, optionally, the sealing member 6 is provided between the container 2 and the lid member 3 to enhance the hermeticity, or the annular member is provided between the container 2 and the lid member 3 as described above to form a liquid-tight space. Next,

the container 2 is placed on the base member 8. At this time, the container 2 can be positioned at the center of the placement part 84 using the ridge part 85. Further, the screw part 83 of the base member 8 is provided below the placement part 84, that is, the screw part 83 does not surround the side surface of the container 2. Therefore, when the container 2 is mounted/removed on/from the placement part 84, vibration can be suppressed by sliding the container 2 in the lateral direction. Next, the cover member 9 is attached to the base member 8. At this time, the lid member 3 can be positioned at the center of the cover member 9 (and the base member 8) using the cylindrical skirt wall 94.

[0050]

In this way, the gripping tool 7 can define the relative position between the container 2 and the lid member 3 using the ridge part 85 of the base member 8 and the cylindrical skirt wall 94 of the cover member 9. When the device 1 is gripped using the gripping tool 7, the screw part 83 of the base member 8 and the screw part 93 of the cover member 9 are screwed together. During the screwing operation, the worker grips the grip part 95 provided on the outer peripheral surface of the cylindrical skirt wall 94 as a projecting part (or may be a groove). Thus, the container 2 and the lid member 3 can be tightened from above and below with a strong force. This is highly versatile, and is suitable for, for example, the case where the container 2 does not have a screw part, such as a general-purpose petri dish. Further, the lid member 3

can be configured not to rotate with respect to the container 2 (not to be screwed to the container 2). This configuration prevents the protective member 5 interposed between the container 2 and the lid member 3 from receiving a rotational force of the lid member 3, and thus is particularly advantageous. Further, particularly in a case where the elastic sealing member 6 or the annular member 4 is interposed, these members are accurately compressed between the container 2 and the lid member 3 which are accurately positioned relative to each other, whereby hermeticity is improved. Thus, this configuration is advantageous. The cover member 9 only needs to be screwed to the base member 8 by an amount corresponding to the height of the screw part 83. Therefore, the gripping operation is facilitated, and the gripping force can be easily adjusted. Thus, problems such as destruction of the device 1 can be prevented.

[0051]

The base member 8 and the cover member 9 have the opening 81 and the opening 91, respectively, in the central portion. Therefore, the fixing position of the device 1 and the state of the liquid L, the object S, etc. contained in the device 1 can be constantly observed. This is particularly advantageous when the container 2 and the lid member 3 are made of a light-transmissive material. Even if a less visible object such as a sheet-shaped cell culture is used as the graft, light is emitted through one of the openings and the sheet-shaped cell culture can be viewed

through the other opening. Thus, this configuration is advantageous. Further, in a case where the liquid-tight space is formed as described above, it is possible to press the lid member 3 against the container 2 while confirming that air bubbles, foreign matters, etc. do not enter the container 2 through the opening 91. Next, the device 1 is transported. Since the device 1 is firmly gripped by the gripping tool 7, problems such as detachment of the lid member 3 from the container 2 due to shaking during transportation can be prevented. Further, since the device 1 is surrounded by the gripping tool 7, it is protected from external impact. Finally, the gripping tool 7 is removed from the device 1 at the destination of transportation, and the device 1 is used there.

[0052]

While the present invention has been described with reference to the illustrated embodiment, the present invention is not limited thereto. For example, the screw parts 83 and 93 may be replaced with other engagement means having a function of pressing the device 1 from above and below, such as sliding engagement (for example, see JP 2006-315757 A), flange fitting (for example, see JP 2006-001582 A), and engagement using a ridge (for example, JP 2016-203985 A). The annular ridge part 85 can be replaced with other means capable of positioning the container 2 on the placement surface, such as a plurality of annularly arranged protrusions. For example, a fragile object (for example, a laminate of sheet-

shaped cell cultures) can be contained as the object S. In that case, the fragile object can be transported with the shape thereof being retained by establishing a liquid-tight state in the container 2.

[0053]

[Third Embodiment]

Next, the third embodiment of the present invention will be described. The different point from the second embodiment will be described in detail below, and the description of similar matters will be omitted. In the drawings of the present application, the dimensions of the various components are exaggerated, as appropriate, for facilitating the understanding of the description, and they may differ from the actual dimensions.

[0054]

As shown in Fig. 4, a gripping tool 7A according to the present embodiment includes a base member 8A and a cover member 9A. In the present embodiment, the base member 8A further includes protruding walls 86, a groove 87, and a cutout part 88. The protruding walls 86 are a plurality of walls that is provided outside the ridge part 85 and that protrudes from the placement part 84 beyond the height of the container 2. The groove 87 is formed in the lower surface of the bottom part 82 of the base member 8A so as to prevent the base member 8A from sticking to a working surface when the base member 8A is placed on a table or the like.

[0055]

When the gripping tool 7A is used, the container 2 (not shown) is positioned at the center of the base member 8 using the ridge part 85. Next, the lid member 3 (not shown) is put on the container 2 along the protruding walls 86, whereby the lid member 3 can be positioned at the center of the base member 8. That is, the worker can define the relative position between the container 2 and the lid member 3 using the ridge part 85 and the protruding walls 86 of the base member 8A. This is particularly advantageous when the annular sealing member 6 and the annular member 4 are interposed between the container 2 and the lid member 3, because these members can be accurately pressed due to this configuration.

[0056]

Next, the device 1 (not shown) is gripped. When gripping the device 1, the worker grips the grip part 95 provided as a projecting part projecting radially from the cover member 9A and the cutout part 88 formed in the side surface of the bottom part 82 of the base member 8A. Thus, the worker can easily perform the screwing operation. When the device 1 is used, the cover member 9A is unscrewed to remove the device 1 from the base member 8A. During the removal, the device 1 is exposed from gaps between the plurality of protruding walls 86, so that the device 1 is easily gripped. Further, since the plurality of protruding walls 86 is arranged so as to surround the container 2, the lid member 3 can be accurately positioned with respect to the container 2.

[0057]

[Fourth Embodiment]

Next, the fourth embodiment of the present invention will be described. The different point from the second embodiment and the third embodiment will be described in detail below, and the description of similar matters will be omitted. In the drawings of the present application, the dimensions of the various components are exaggerated, as appropriate, for facilitating the understanding of the description, and they may differ from the actual dimensions.

[0058]

As shown in Fig. 5, a gripping tool 7B according to the present embodiment includes a cover member (not shown) and a base member 8B. The base member 8B includes a placement part 84B, a ridge part 85B, and a protruding wall 86B (the description of other components will be omitted). The ridge part 85B is arranged on the placement part 84B in a semi-annular shape. The protruding wall 86B is arranged in a semi-annular shape on the outside of the ridge part 85B, and a cutout (gap) C is provided in a part thereof (two or more protruding walls 86B may be provided in a semi-annular shape with a gap therebetween). That is, in the present embodiment, a half (the side reverse to the side where the ridge part 85B and the protruding wall 86B are provided) of the placement surface of the placement part 84B is flat.

[0059]

When the gripping tool 7B is used, the container 2 (not

shown) is set such that the container 2 slides in the lateral direction (toward the ridge part 85B and the protruding wall 86B) from the side reverse to the side where the ridge part 85B and the protruding wall 86B are provided. At this time, the worker slides the container 2 on the flat surface of the placement part 84B, by which careless vibration of the container 2 can be suppressed. Next, the lid member 3 (not shown) is put on the container 2 while being pressed against the protruding wall 86B of the base member 8B, whereby the lid member 3 can be accurately positioned with respect to the container 2. When the device 1 (not shown) is used, the device 1 is removed from the base member 8A. When the device is removed, the side surface of the device 1 (the container 2 and/or the lid member 3) exposed from the cutout C is pressed, by which the device 1 slides on the flat surface. Thus, the device 1 can be removed. A protrusion 89 serving as a mark may be provided on the side facing the cutout C on the placement part 84B so that the sliding direction for sliding the device 1 on the base member 8A can be easily recognized. Accordingly, the device 1 can be accurately positioned on the placement part 84B simply by sliding the device 1 between the protrusion 89 and the cutout C. Further, the protrusion 89 may be provided on an extension of the ridge part 85B so as to face the cutout C so that the side surface of the device 1 abuts the protrusion 89. With this configuration, displacement of the device 1 can be prevented.

[0060]

As described above, the gripping tools according to the second to fourth embodiments efficiently enable the container and the lid member to be in tight contact with each other with a simple mechanism and a simple operation, thereby providing great advantages in terms of operability and manufacturing cost. Further, the object contained in the container can be visually recognized from the outside, and thus, it is possible to easily confirm the state of the contained object, intrusion of foreign matters, and the like. Furthermore, the container and the lid member can be relatively positioned with high accuracy, whereby hermeticity is improved. In particular, when the elastic sealing member 6 and the annular member 4 are interposed between the container and the lid member, these members can be accurately pressed, so that the hermeticity is further improved.

[0061]

Further, according to the gripping tool of the present invention, the container and the lid member can be reliably fixed in tight contact with each other, whereby problems such as detachment of the lid member from the container during transportation can be prevented. Particularly when the contained object is a laminate of sheet-shaped cell cultures, the object can be transported with the container being reliably brought into a liquid-tight state. Therefore, displacement or defect of the laminate due to air bubbles entering the container and moving in the container can be prevented. Accordingly, the object can be

stored for a long time with its shape being retained without deformation.

[0062]

The present invention is not limited to the abovementioned embodiments, and those skilled in the art could implement a gripping tool having different configurations and shapes by appropriately combining the configurations and shapes of the gripping tools according to the second to fourth embodiments. For example, the cover member 9 or the cover member 9A may be combined with the base member 8, the base member 8A, or the base member 8B, or the ridge part 85, the ridge part 85B, the protruding wall 86, or the protruding wall 86B may be combined with the base member 8, the base member 8A, or the base member 8B.

The components used in the present invention may be substituted by arbitrary components which can function in the same way or may be added with arbitrary structure.

Reference Signs List

[0063]

1 Device

2 Container

21 End part

3 Lid member

31 Protruding part

32 Top part

33 Bottom surface

34 Cylindrical skirt wall

4 Annular member

5 Protective member

6 Sealing member

[0064]

7, 7A, 7B Gripping tool

8, 8A, 8B Base member

81 Opening

82 Bottom part

83 Engagement part

84 Placement part

85, 85B Ridge part

86, 86B Protruding wall

87 Groove

88 Cutout part

89 Protrusion

[0065]

9, 9A Cover member

91 Opening

92 Top part

93 Engagement part

94 Cylindrical skirt wall

95 Grip part

CLAIMS

1. A device to be used in a state of a lid member being detachably attached to a container for storing a graft, the device comprising:

a lid member for sealing the container; and

an annular member for forming a first space by being interposed between the lid member and the container,

wherein a second space is formed between the lid member and an inside surface of the container,

wherein the lid member includes a top part and a protruding part extending downward from the top part,

wherein the protruding part has an outer diameter smaller than the inner diameter of the container, so that the second space is formed between the protruding part and the inside surface of the container when the lid member is attached to the container,

wherein the annular member is made of elastic material, and

wherein the annular member has an outer diameter substantially the same as or slightly larger than the inner diameter of the container and the inner diameter of the annular member is smaller than the outer diameter of the protruding part.

2. The device according to claim 1, further comprising a sealing member interposed between the container and the lid member.

3. The device according to claim 1 or 2, further comprising a protective member interposed between the annular member and the lid member to protect the first space.

4. The device according to claim 3, wherein the protective member is flexible.

5. The device according to claim 3 or 4, wherein the protective member and/or the lid member is water repellent.

6. The device according to any one of claims 1 to 5, wherein the graft is a sheet-shaped cell culture.

7. The device according to claim 6, wherein the sheet-shaped cell culture is a laminate.

8. The device according to any one of claims 1 to 7, further comprising a gripping tool comprising:

a cover member; and

a base member,

the gripping tool being configured to press and grip the device.