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BONE BANK AND METHOD OF PRESERVING
BONES FOR TRANSPLANTATION

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This invention relates to a method of obtaining bones from living bodies or from recently expired bodies, and preserving such bones under conditions to maintain them viable for transplantation at later times into other living bodies.

It is an object of this invention to provide a bone supply or bone bank consisting of viable and transplantable bones which are classified as to blood types.

It is another object of this invention to provide a bone bank of viable and transplantable bones so selected as to preclude the inclusion of any bones which might communicate syphilis and other communicable diseases in transplantation.

It is also an object of this invention to provide a bone bank of this class consisting of viable bones classified into Rh-positive and Rh-negative groups, thereby providing against attempts to graft bones from bodies of one type of Rh factor onto bones in bodies of an opposite factor.

It is also an object of this invention to provide a bone bank of transplantable bones which are kept viable through nutrition derived from a culture of blood serum or plasma in which the bones are maintained.

It is yet another object of this invention to provide a bone bank of this class in which the bones are kept in cultures containing a sufficient volume of sulfa-thiazole or other anti-biotic substance to inhibit the growth of bacteria or other organisms therein.

It is also an object of this invention to provide a bone bank of this class in which the bones and culture are maintained in a substantially refrigerated state at such temperatures below normal body temperature as to effectively reduce the rate of absorption by the bones of nutrient from the culture thereby materially lengthening the period during which a culture may nourish without replenishment the bones kept therein.

It is also an object of this invention to provide a bone bank of this class in which the culture may be changed or replenished from time to time to indefinitely prolong the preservation of bones therein.

Other and further objects of this invention will be apparent upon considering the specification herein set forth.

The medical profession has long considered that autogenous bones are best adapted for grafting primarily because the blood cells of such bones are of the same blood type as the bones forming the "bed" of the graft. This

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insures against adverse reactions within the red blood cells of the bone portion to be grafted or within the bone portion of the body forming the "bed."

Human blood has been separated by medical analysis into four types, O, A, B, and AB, the basis of classification being whether or not successful transfusion can be carried out between these groups. It has been found that, for purposes of transfusion, blood of type O can be transfused into bodies of types A, B, and AB, whereas blood of type AB cannot be transfused into any other type. Also, whereas blood of types A and B cannot be inter-transfused nor transfused into a type O body, both types can be transfused into type AB bodies. Such relations apply to the grafting of bones as well as to transfusions, and it is necessary to know what type of bone is to be grafted into what type of "bed" wherever homologous bones are not available.

It has also been determined by the profession that human beings have in the blood certain other factors which oppose the transfusion and intermingling between bloods of opposite types and for purposes of classification such factors are termed Rh-positive and Rh-negative factors. The incompatibility of these factors is most apparent in operations where it is endeavored to graft bones from bodies having blood of one Rh factor onto bones in bodies having blood of the opposite Rh factors. In such cases unfavorable reactions result which oppose the knitting together of the bones to be inter-grafted.

The bone supply contemplated by this invention may be obtained from several sources. Permission may be obtained to use the bones of persons after they expire, the operation therefor being of similar nature as in cases of autopsy. A second source may be bones acquired from larger bone portions amputated from living persons, as when a whole leg may have to be amputated as the result of a wreck or accident, in which case the victim may contribute the usable and unfractured portions to the bone bank. In every case the most careful sterile technique must be employed in removing the bones donated from any source of bone supply.

The source of autopsy should be the best source, and could be developed by educating public concepts thereof in view of the humanitarian results to be obtained. When autopsies are granted, practically all of the bones of the expired person may be obtained for the bone bank, and the fact that the donors may have expired of certain dis-

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eases rather than by accident does not ordinarily lessen the value of the bones contributed. It is only necessary that the bones be healthy and that they be obtained promptly after respiration ceases, while the bones are still viable and before necrosis sets in.

However, in both the cases of donated amputated bones, and bones obtained by autopsy, it is necessary to test the bodies of the donors to eliminate obtaining donations from bodies having certain communicable diseases, particularly syphilis which is carried in the blood stream. This is necessary since the conditions under which the bones are maintained in the bank, to be hereinafter described, could not with certainty exterminate the germs of these certain diseases, as the spirochete of syphilis without possibly also affecting the viability of the bones.

The viable and healthy bones obtained and classified by the above described methods are placed in vitro in prepared cultures of blood plasma of blood serum to which has been added a sufficient volume of anti-biotic substance, as sulfa-thiazole, to inhibit the growth of bacteria and other organisms therein.

Plasma is essentially the liquid portion of the blood which has been separated without clotting, and contains in solution albumin, globulin, and fibrinogen. Serum, on the other hand, is the liquid constituent of the blood remaining after coagulation, and as such has had separated therefrom those components of the blood which combine in the substance of blood clots. Both plasma and serum may be optionally selected as the culture media for sustaining in vitro bone cells of any blood type, since both these substances contain therein the nutritive constituents of the blood for maintaining the bones viable. The fact that neither plasma nor serum contain therein blood cell matter which differentiates blood as to types makes it possible to use either plasma or serum without consideration as to the types of blood from which these derivatives have been obtained.

The bones and the blood culture may not necessarily be kept in vitro but substances other than glass may be employed for the containers; however, glass is especially suitable because of its durability, transparency, opposition to absorption, and because of the ease with which it can be sterilized when the contents thereof may be removed.

The maintaining of the culture and bones at refrigerated temperatures serves to materially reduce the rate at which the bones derive nutriment from the culture, and thus the period during which a culture may nourish bones therein is materially extended.

Mean temperatures of 46 degrees Fahrenheit are indicated as suitable for maintaining the bones at a reduced rate of absorption of nutriment and in a substantially refrigerated state, and a temperature range of 5 degrees may be set on the refrigerative means in which the bank is kept. However, these temperatures are not critical except as they are near a lower limit at which the processes in bones and culture may be materially and adversely affected by further reduced temperatures.

Microscopic tests, taken of the bones in the bank at necessary intervals will reveal if they have begun to atrophy or will show whether or not necrosis may have set in. Upon the slightest indication of either of these symptoms the cul-

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ture may be replenished with fresh ingredients of proper amounts of sulfa-thiazole, and of either plasma or serum. It also may be preferable to completely replace a culture partially depleted of nutriment by an entirely new culture and such may be done promptly without adversely affecting the existing viability of the bones in the bank.

The transplantable character of bones maintained by this invention appears to be due in part to the fact that the plasma or serum medium in which the bones are kept partially absorbs the calcium and phosphorus from the bones, and thereby accomplishes in advance part of a step preceding the amalgamation of the bone to be grafted with the bone of the body. Thus it can be seen that bones maintained by the steps of this invention are even more adaptable for transplanting than bones which are obtained from a donor or other source and immediately thereafter employed for transplantation.

This invention is not limited in its scope to the elimination from the bank of only bones which could transmit syphilis or other communicable diseases, but it is further limited to the elimination of bones of any type and having any factors or characteristics which could adversely affect the bodies on which such bones might be grafted.

The classification of bones by two Rh factors and four blood types also does not limit the multiples of sub-classes into which the bones of the bank may be sub-divided, but this invention broadly considers further beneficial bases of classification and sub-classification which may be developed by medical research.

Broadly, this invention considers the provision of a bank of viable and pre-selected bones by obtaining such bones in a viable state and maintaining them in a culture to sustain their viability over indefinitely extended periods.

What is claimed is:

1. A method of providing a viable bone of a desired Rh factor and blood type comprising the steps of, testing donors to eliminate the use of bones from those donors having diseases communicable by bone grafting, testing donors not thus eliminated to identify a donor of desired Rh factor and blood type, removing the desired bone from such donor, placing the bone in a container having therein a blood plasma culture containing sulfa-thiazole as an anti-biotic agent, maintaining the container contents at temperatures below normal body temperatures, testing the bone at intervals to observe for indications of atrophy and necrosis, replenishing the culture when indicated, thereby indefinitely maintaining the bone viable for transplantation.

2. A method of providing a viable bone of a desired Rh factor and blood type comprising the steps of, testing donors to eliminate the use of bones from those donors having syphilis communicable by bone grafting, testing the remaining donors not thus eliminated to identify a donor of desired Rh factor and blood type, removing the desired bone from such donor, placing the bone in a container having therein a blood plasma culture containing sulfa-thiazole as an anti-biotic agent, maintaining the container contents at temperatures substantially below normal body temperatures, testing the bone at intervals to observe for decreasing viability, replenishing the culture when indicated, thereby indefinitely maintaining the bone viable for transplantation.

3. A method of providing a viable bone of a desired Rh factor and blood type comprising the steps of, testing donors to eliminate the use of

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bones from those donors having diseases communicable by bone grafting, testing the donors not thus eliminated to identify a donor of desired Rh factor and blood type, removing the desired bone from such donor, placing the bone into a container having therein a blood serum culture containing sulfa-thiazole as an anti-biotic agent, maintaining the container contents thereof at temperatures below normal body temperatures, testing the bone at intervals to observe for indications of atrophy and necrosis, and replenishing the culture when indicated, thereby indefinitely maintaining the bone viable for transplantation.

4. A method of maintaining a bone or segment thereof in viable state for transplantation, which comprises testing donors to eliminate the use of bones from those having diseases communicable

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by bone grafting, testing donors not thus eliminated to identify a donor of desired Rh factor and blood type, removing the desired bone from such donor under careful sterile technique, placing the bone thus removed in containing means having therein a culture of protein blood components containing an anti-biotic agent, and maintaining the contents of the container at temperatures below normal body temperature.

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REFERENCES CITED

The following references are of record in the file of this patent:

"American Druggist" for January 1948, pp. 72-73, 112, 114, 116 and 118.