containing 1 wt % SeaKem ® ME agarose and 0.7 wt % aqueous sodium chloride (to prevent lysing of the whole blood cells in aqueous solution), at approximately 55° C. The matrix used in this example was rigid, porous (medium pore, approximately 70 μm) polyethylene plastic. A small, plug-shaped piece of the porous polyethylene plastic was saturated with the blood-containing hot agarose solution and the rigid plastic matrix containing the gel solution was cooled to cause gel formation.

The gel-containing porous plastic matrix was placed in a test tube that had been fitted with a spacer to keep the gel-in-matrix at a distance from the bottom of the tube. The test tube was placed in a laboratory centrifuge and spun at about 2000 rpm for approximately minutes. This centrifuge treatment caused about 30–40% of the liquid originally contained in the gel within the plug matrix to be expressed into the reservoir the bottom of the test tube.

The expressed liquid was pale yellow in appearance and evidenced only slight amounts of red blood cell contamination. Despite expression of a substantial proportion of the gel liquid, the red blood cells remained immobilized within the partially-dewatered gel-in-matrix structure in substantially intact form. Since the rigid plug retained its original volume and shape following centrifugation, this evidenced a void volume in the porous plug of approximately ⅓.

EXAMPLE 4

The procedure described in this Example 4 suggests that entrapment or immobilization of fragile cells within the hydrogel contained in a foam matrix allows the cells to withstand partial dewatering of the gel via compression or squeezing without appreciable fracturing of the cells.

Plug-shaped pieces of reticulated open-cell (100 ppi) flexible polyurethane foam were used as the matrix in this Example. A hot solution containing 10% whole human blood containing EDTA and 0.7 wt % NaCl and also containing 1 wt % SeaPlaque ® agarose was used to saturate the foam pieces. The gel pieces were then refrigerated at a temperature of 4° C. for a few hours to cool the solution within the gel pieces and thereby form a gel.

One of these gel-containing foam plugs, a cylindrical plug approximately 2"×½" in diameter, was manually stretched along its longitudinal axis to fracture the gel within the foam matrix. During the stretching treatment, liquid was expressed from the gel within the foam matrix. After the stretching treatment, the partially-dewatered gel-containing plug regained its original size and shape.

The stretched gel-containing plug was then inserted into the barrel of a 5 ml syringe. An aqueous wash solution containing 0.7 wt % NaCl was then run through the syringe to wash the gel-containing plug, in order to flush out loose red blood cells and gel particles from the column. The wash solution flowed through the column with little resistance and after a few minutes the washed solution exiting from the syringe was clear and virtually free of any visible solid contaminants.

Following the washing step, the partially-dewatered gel-in-matrix was subjected to a procedure that illustrates the existence of a network of fracture channels within the partially-dewatered gel-in-matrix. After the washing treatment with saline solution, distilled water was then flowed through the syringe. Almost immediately after this treatment was begun, the exiting fluid appeared bright red, indicating that the whole red blood cells had been lysed by the distilled water. The rapidity with which the cells can be lysed in the partially dewatered gel-in-foam (when contacted with distilled water) indicates that the entrapped cells are readily accessible to contact with an aqueous or other liquid medium via the fracture channel network in the partially-dewatered gel-in-matrix.

EXAMPLE 5

This Example illustrates freeze/thaw as the means for creating a mechanically-fractured hydrogel within a porous matrix.

Small blocks of reticulated open cell (100 ppi) ible polyurethane foam, about 1"×½"×½ in size, were used as the three dimensional matrix. A hot solution containing 2 wt % SeaKem ® ME agarose was used to saturate the foam blocks, which were thereafter cooled to effect formation of a gel. The gel-containing foam blocks were placed in a freezer at a temperature of −20° C. overnight and then removed and allowed to thaw at room temperature.

This freeze/thaw cycle caused the gel-containing foam blocks to exhibit good porosity since water could be flowed through the treated gel-containing foam blocks with ease. Water poured on top of the block flowed freely through the block and out the bottom, demonstrating the network of fracture channels that existed throughout the gel-in-matrix.

EXAMPLE 6

This Example illustrates the use of a partially dewatered gel-in-foam matrix to immobilize yeast cells which are then employed to make ethanol from a dextrose feed solution contacted with the immobilized cells within the gel-in-matrix.

Dry baker's yeast (14 grams) was dissolved in an aqueous agarose solution containing 1 wt % SeaKem ® LE agarose (120 ml) at 45° C. A cylindrical plug (2"×9/16") of reticulated open-cell (100 ppi) flexible polyurethane foam was saturated with :he agarose solution and thereafter placed in a refrigerator to cause gelation of the solution by cooling.

The gel-containing foam plug was removed from the refrigerator and manually squeezed between two plates of acrylic plastic to fracture the gel within the foam and express water. After fracturing, the partially-dewatered gel-in-foam was contacted with distilled water; the gel-containing plug was then squeezed and recontacted with distilled water two more times.

The rehydrated, gel-in-foam plug was then inserted into the barrel of a 10 μml syringe, fitted with inlet and outlet tubes to allow passage of a liquid medium through the gel-containing plug in the syringe barrel. Distilled water was flowed through the gel-containing plug in the syringe until the outlet fluid was observed to be clear and free of any visible yeast cells. This required approximately 150 ml distilled water.

A sterile solution of dextrose (10 wt %) was flowed through the gel-containing plug in the syringe barrel at a rate of approximately 2.2 ml per minute. The evolution of gas was evident almost immediately. Dextrose solution contained in a 300 ml reservoir was recirculated through the gel-containing plug in the syringe barrel for about 3¾ hours. Samples of the outlet fluid were periodically collected and the ethanol concentration in these samples was measured.