tissuelike differentiation marker compounds, including villin, keratins, and specific lung epithelium marker compounds, and by the production of tissue mucin.

In a series of initial infection tests, TLA cultures were inoculated with human respiratory syncytial viruses and parainfluenza type 3 viruses. Infection was confirmed by photomicrographs that showed signs of damage by viruses and virus titers (see figure) that indicated large increases in the populations of viruses during the days following inoculation.

This work was done by Thomas J. Goodwin of Johnson Space Center. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-24164-1.

Isolation of Resistance-Bearing Microorganisms

NASA's Jet Propulsion Laboratory, Pasadena, California

Strategies were explored for inactivating resistance-bearing microorganisms, focusing on a new species (*Bacillus horneckii* sp. nov.) discovered on the surfaces of the Kennedy Space Center cleanroom facility in which the Phoenix lander was assembled. Two strains that belong to this novel species were isolated and subjected to a comprehensive, polyphasic analysis to characterize their taxonomic position.

Both phenotypic and genotypic analyses clearly indicate that these isolates belong to the genus *Bacillus*, and represent a novel species. In addition to the phylogenetic affiliation, structurally the spores of this novel bacterium possess an extraneous layer, which might be responsible for increased resistance to space radiation conditions. The chemical characterization of this novel, extraneous layer of spores will reveal the mechanisms behind radiation resistance.

This work was done by Kasthuri J. Venkateswaran, Alexander Probst, Parag A. Vaishampayan, and Sudeshna Ghosh of Caltech; and Shariff Osman of Lawrence Berkeley National Laboratory for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46337

Oscillating Cell Culture Bioreactor

This bioreactor is well suited to work with different biological specimens.

Lyndon B. Johnson Space Center, Houston, Texas

To better exploit the principles of gas transport and mass transport during the processes of cell seeding of 3D scaffolds and *in vitro* culture of 3D tissue engineered constructs, the oscillatory cell culture bioreactor provides a flow of cell suspensions and culture media directly through a porous 3D scaffold (during cell seeding) and a 3D construct (during subsequent cultivation) within a highly gas-permeable closed-loop tube. This design is simple, modular, and flexible, and its component parts are easy to assemble and operate, and are inexpensive. Chamber volume can be very low, but can be easily scaled up. This innovation is well suited to work with different biological specimens, particularly with cells having high oxygen requirements and/or shear sensitivity, and different scaffold structures and dimensions.

The closed-loop changer is highly gas permeable to allow efficient gas exchange during the cell seeding/culturing process. A porous scaffold, which may be seeded with cells, is fixed by means of a scaffold holder to the chamber wall with scaffold/construct orientation with respect to the chamber determined by the geometry of the scaffold holder. A fluid, with/without biological specimens, is added to the chamber such that all, or most, of the air is displaced (i.e., with or without an enclosed air bubble). Motion is applied to the chamber within a controlled environment (e.g., oscillatory motion within a humidified 37 °C incubator). Movement of the chamber induces relative motion of the scaffold/construct with respect to the fluid. In case the fluid is a cell suspension, cells will come into contact with the scaffold and eventually adhere to it. Alternatively, cells can be seeded on scaffolds by gel entrapment prior to bioreactor cultivation.

Subsequently, the oscillatory cell culture bioreactor will provide efficient gas exchange (i.e., of oxygen and carbon dioxide, as required for viability of metabolically active cells) and controlled levels of fluid dynamic shear (i.e., as required for viability of shear-sensitive cells) to the developing engineered tissue construct.

This bioreactor was recently utilized to show independent and interactive effects of a growth factor (IGF-I) and slow bidirectional perfusion on the survival, differentiation, and contractile performance of 3D tissue engineering cardiac constructs.

The main application of this system is within the tissue engineering industry. The ideal final application is within the automated mass production of tissue-engineered constructs. Target industries could be both life sciences companies as well as bioreactor device producing companies.

This work was done by Lisa E. Freed, Mingyu Cheng, and Matteo G. Moretti of Massachusetts Institute of Technology for Johnson Space Center. For further information, contact the Johnson Technology Transfer Office at (281) 483-3809.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Massachusetts Institute of Technology
Five Cambridge Center, Kendall Square
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Cambridge, MA 021142-1493

Refer to MSC-24270-1, volume and number of this Medical Design Briefs *issue, and the page number.*