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Cryogenic storage strategy - Green storage - Protecting the environment and maximizing the integrity of stored biologicals for viability and analytics

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A key aspect of biological research revolves around the gathering and collection of samples and their preservation for examination and analysis at a future date. Since time elapses between when a sample is collected and when it is analyzed, and biological samples often degrade over time, it is imperative to have a process of storage (short and long term) that is efficient and preserves sample integrity over time. Today, billions of biological specimens and samples collected by researchers in academia, research institutes, hospitals and commercial organizations are often stored in cold environments (refrigeration @ -40°C, low- and ultralow- temperature freezers @ -50°C to -80°C)

This article will highlight some of the shortcomings in the use of cold-temperature-based sample storage, describe the new and innovative technologies available today that mitigate these shortcomings, and offer suggestions on the convergence of these technologies in meeting the global challenge to be faced as bio-specimen collection increases in research labs as well as in bio-banks.

Current best practices of cold storage of biological samples

In the United States alone, there are more than 40,000 individual research laboratories located on university campuses that are advancing the field of biological and biomedical sciences. Researchers within these laboratories have assembled a very large collection of biological samples from clinical and field studies, some irreplaceable, all representing enormous scientific and financial value for the researcher and the organization (universities, research institutes, biotechnology/pharmaceutical companies, biobanks, etc.). The cost per sample collected can range from a few dollars up to $10,000. There are currently over a billion samples (DNA, RNA, cells, clones, tissue organs, blood, buccal swabs, etc.) collected and warehoused in thousands of research labs and bio-banks globally. These samples are of high value to researchers, and current research trends are driving growth of these collections at an escalating rate.

To preserve these important research assets, organizations and individual researchers engaged in biological and biomedical research invest a huge sum of money in capital equipment purchases and maintenance of cold storage facilities to stabilize and store their large inventory of samples. However, there are increasing disadvantages to this method. For example, mechanical refrigeration/freezers produce hydrofluorocarbons, which are some of the most potent greenhouse gas pollutants with a deleterious impact on the environment. Quantitatively, according to a report in The Economist, the typical ultra-low-temperature freezer consumes about 7,665 kWh per year while releasing 54,805 pounds of carbon dioxide. This is equal to the emission from about four cars.

Additional challenges to the use of cold storage are highlighted below:

- Purchase costs, maintenance costs and energy costs of mechanical refrigerators/freezers add up as sample collection grows, and accelerate as the cost of energy increases.
- Heat generated from refrigerators/freezers further adds demands to facility requirements, costs and planning to stabilize environmental conditions at lower temperatures than would be required without the equipment.
- Freezers take up an increasingly large amount of lab space, potentially inhibiting current and new facility/ research space needs.
- Multiple freeze-thaw cycles can lead to sample quality degradation.
- Power failure or freezer failure can place samples at risk for degradation and loss.

Biography

Ian M. Pope has worked in the field of cryogenics for more than 25 years, as VP and President of Planer PLC and Chart Industries Biomedical Division, as Principal of Core Cryolab Inc. and currently VP of Business and Market Development for Cryo Associates Inc. Ian has designed facilities for critical storage for CDC, NIH and many organizations throughout the world, has lectured at scientific meetings globally and consulted with leading organizations

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