Planning Next-Gen Biological Repositories Cheat Sheet

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Introduction

Today, there are more than 300 million biological samples in the world stored at temperatures below -80 C. Few of these samples have a storage strategy associated with them. A recent U.S. National Institutes of Health (NIH) discussion group estimated that up to 70 percent of all the sample material stored at -80 C and below is unusable because of its lack of provenance. In other words, these samples do not have histories, they can't be traced, their origins are unknown, and environmental storage records don't exist.. Effective planning will produce two important benefits for your sample library. The first is sample value and viability. If an organization doesn't develop a long-term storage plan, then 90 percent of the time the potential use of the material will be compromised.

The second benefit is cost reduction. Unless there is thought about the reasons behind sample storage, a lot of money can go to waste. Strategic planning results in creating a cold space that fits a purpose, and then controls its use in a way that provides maximum efficiency and minimal operating expense.

Explore the five critical elements in planning next-generation biologic repositories, their implications on storage conditions in the preservation protocol, and their benefits for an organization

Source: https://www.laboratoryequipment.com/article/2017/02/how-plan-next-generation-biological-repositories

Five Key Elements

There are two types of cryogenic storage. The first is transactional storage. This covers material that typically will be used for 3 to 12 months. It could include a collection that a researcher may want to repurpose, such as genetic information. If an individual is managing a drug discovery project, he or she may have cryopreservation systems to store material that is used again and again. That's known as transactional storage—there is a transactional reason to manage samples for a given period of time.. For long-term storage, which is referred to as archival storage, the decisions are completely different. There are five key elements that must be addressed when planning archival cold space.

1. Storage objective

Why are the samples being stored? At first glance, that might appear to be a stupid question. The reason behind sample storage is important however, because one never really knows the true potential value of the material. The effort required to store the samples in a way that is regulated, tracked (with the correct information), and creates provenance represents very little additional effort compared to the generation of the samples in the first place. That little bit of effort is what instills all of the value in an organization's research material.. In addition, an organization needs to know how many samples it wants to store. One caveat: no one ever throws anything away. Take the number of samples planned for storage and triple it.

2. Biological viability

The reasons for storing biological material can vary widely and will play a major role in developing a sound sample management strategy. There are serious implications for the usability of the material associated with the temperature at which it is stored. Therefore, part of the planning process must be to understand the implications of the storage strategy on long-term cell viability. How long will the samples be stored? In the vast majority of cases, this question is never asked. If the samples must thrive when removed from a cold environment, the storage temperature will have a profound effect on how long the material can be kept: -135 C is considered the normal transition point for cryogenic storage media. All of the research demonstrates that if the samples have been prepared properly, and stored below -135 C, it is possible to keep the material infinitely and still have biofunction when removed.. Once the storage temperature rises above -135 C, however, this is no longer the case. At that point, it is a question of how long the material can be archived before it degrades. So it is important to know what temperature is appropriate for the lifetimes of the samples. That modality choice must be driven by whether the samples are being stored for transactional or archival purposes.

An organization must also decide what it is going to store, and know what it is going to store it in. It doesn't matter what type of biocryogenic storage is being considered—an under-bench refrigerator, a biostore that holds two million samples or a liquid nitrogen dewar. Unless these questions can be answered, chances are an organization will not create the right environment for said material.

3. Thermal performance

When an organization begins to develop these strategies, the creation and management of the storage systems are key issues. One thing worth remembering when creating cold space is that the real investment is in insulation. The method by which heat energy is removed is almost irrelevant. For example, the reason a liquid nitrogen storage dewar is so much more efficient than an -80 C mechanical freezer has nothing to do with the fact that one uses liquid nitrogen and the other uses a mechanical compressor. Instead, it is because one has 100x better insulation than the other.. For example, if you compared a Vario liquid nitrogen-based storage system to a mechanically cooled storage box, the difference in thermal performance would have little to do with the systems' cooling technologies. The difference between the two boxes is that one has 3 inches of expanded polyurethane foam and the other has a sub-5--micron vacuum system with super insulation. The amount of heat energy that gets into the Vario's space is less than the energy that will penetrate the mechanical box. Any cold space, no matter how it is powered or cooled or sized, will increase its thermal performance and efficiency most effectively by improving the insulation..

4. Environmental impact

The environmental impact of a large biological repository can be substantial due to its cooling requirements and energy consumption. For example, three -80 C freezers have the same environmental footprint as a typical family car. Five freezers have the same impact as a domestic dwelling's annual power consumption. Insulation can make a dramatic difference in environmental impact. If the cooling capacity shuts off in an ultra-high efficiency cold space, the temperature will be maintained for about one week. In a mechanically cooled box, the temperature will start to rise in about one hour after cooling stops. Organizations that value environmental sustainability must consider energy efficiency and insulation types when planning their sample storage and management systems..

5. Cost

When evaluating cost, it is important to consider holistic cost, or the total cost of ownership. Typically, when a lab runs out of -80 C storage space, it buys another $10,000 freezer and plugs it into the wall. The lab may not consider the cost of electricity because it gets paid from a different budget. The organization also must pay for the air conditioning that removes the excess heat generated by the freezer. There are also costs associated with maintenance and repairs. All of these expenses should be considered when planning a sample storage strategy..