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Recommendations for the energy-saving use of -80°C ultra-low temperature freezers

Ultra-low temperature (ULT) freezers operating at -80°C are widely used for the storage of human biospecimens – both in biobanks and outside of them. This form of storage requires a high amount of energy: a -80°C ULT consumes an average of 20 kWh per day, depending on the cooling volume, age and state of maintenance. This means that a single unit consumes one and a half times as much electricity as an average three-person household in a year. [1] In this document, the German Biobank Node (GBN) has compiled recommendations for the energy-saving use of -80°C ULT – the following checklist provides a compact overview to get started.

Checklist

- Do not increase the temperature of the ULT (exception: back-up units)
- Follow ULT guideline with rules of conduct for correct use
- Store biosamples compactly, share ULT across working groups if necessary
- Store certain samples, e.g. DNA, at -30°C
- Discard unusable samples
- Reduce the number of ULT (especially older equipment with high consumption)
- When purchasing new ULT, consider energy demand
- Use (central) biobanks for sample storage
- Before setting up new collections, check whether suitable samples are available in other biobanks

Temperature increase endangers biosamples

For many liquid biospecimens, a temperature of -70°C should not be exceeded for their storage if their later use has not yet been determined and a wide variety of analytical options should theoretically be possible. Since the temperature in a ULT is not consistent in every section of the interior [2], it is not recommended to set the units to -70°C. In addition, the interior heats up quickly when the door is opened, for example, to store or remove samples. [3] In this way, the temperature soon reaches a critical range of about -50°C. In the event of a malfunction, the samples can thaw more quickly and become unusable due to the higher storage temperature. Therefore, in order not to endanger the stored samples, a temperature "buffer zone" is required – the freezers should be set to -80°C to be on the safe side. Empty back-up units are an exception to this, which are kept for emergencies only and for which a temperature of -60°C is therefore sufficient.

Follow ULT guideline

To ensure an efficient energy consumption of ULT that are being in use, a guideline for correct handling should be introduced and consistently followed. [4] The most important rules of conduct include:

- Regular de-icing
- Cleaning door seals for tight door closure

- Reduce door opening times – e.g. work on dry ice and store samples collectively
- Consider placing of the samples: Temperature in top shelf rises most when door is opened, temperature on bottom shelf remains most stable
- Use of racks: significantly reduces temperature fluctuations of the samples

Use ULT efficiently – utilise capacities, transfer or discard samples

One way to reduce the energy consumption of ULT is to optimise sample storage or to use the available space more efficiently. Biosamples should be stored as compactly as possible in order to use less equipment overall. In addition, it is worth investigating whether some of the samples stored at -80°C can be stored at higher temperatures. This applies, for example, to DNA samples, which can also be stored at -30°C without significant loss of quality. [5]

In order to save space and thus energy, discarding certain samples may also be an option. This can be done with samples that are unusable for research purposes – for example, samples without additional data, of unknown quality or origin. Researchers who are leaving an institution often leave behind samples that are inadequately labelled. In such cases, so-called exit policies should be applied and researchers should inform the remaining staff about the status of these samples.

ULT alternative: using professional biobanks

Thanks to sample management systems, the efficient use of available storage capacity is routine for professional biobanks. Another advantage of these biobanks is the use of fully automated -80°C storage systems. According to biobanks of the German Biobank Alliance (GBA), these require about one third less energy compared to conventional ULT. Such storage systems are available in numerous GBA biobanks.

Sharing existing biospecimens

Not only in Germany, but also in Europe, there are numerous professional, well-connected biobanks. In the interest of sustainability, the existing sample reservoir should be used as effectively as possible – which in some cases can avoid creating new collections. With the help of the GBN Sample Locator [6], an online search tool for biospecimens, researchers can find and request suitable samples for their projects from GBA biobanks. The Directory of the European organisation BBMRI-ERIC [7] allows them to get an overview of biobanks and sample collections in Europe. Both tools enable biobanks to provide more visibility for their samples. To support biomedical research, GBN recommends to use these tools to all biobanks.

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[6] https://samplelocator.bbmri.de

[7] https://directory.bbmri-eric.eu/