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# Cryobiology and Carbon Dioxide

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The science of life at low temperatures, literally referring to cryobiology, has a number of applicable areas when considering carbon dioxide as a merchant gas. Often, this product would be sought as a USP (United States Pharmacopeia), which is a very small percentage of the merchant fleet of plants available – however, this grade would be strictly used as a respiratory stimulant; and often for many applications considered to have a medical basis behind the use. The refrigeration value available and utilized in a range of applications, when referring to cryobiology, would range from a moderate cooling effect – moderately hypothermic – to cryogenic temperatures.  The application of carbon dioxide can affect biological materials ranging from proteins, cells, tissues, organs, and ultimately organisms.

More specifically, categorically speaking, this application can include the following

> **Cryosurgery – usually minimally invasive approach of unhealthy tissues using CO2.**
> **Cryopreservation of biological materials from cells, tissues, gametes, to embryos of animal and human origin. This preservation can be of a long term nature, and if long term, usually for success to be achieved, specific substances need to be added to the samples – thus protecting the cells during freezing and thawing. With respect to freezing and thawing via CO2 application, the basic nature of cryogenic freezing should be considered, whereby, cryogenic freezing would limit the sharp ice crystals usually formed via slower and warmer temps used in alternate means of freezing, such as mechanical; thus limiting tissue damage, which is essentially**

**results is fewer sharp ice crystals being formed during freezing, which then result in penetration of the cellular walls, and further result in leakage of cellular fluids. Thus cryogenic is the strong advantage in this scenario.**

**Hypothermic conditions, or temps which are less than metabolic readings; thus suitable for transplant of tissues. Along these lines, $CO_2$ as a coolant can be used (dry ice or liquid $CO_2$) in the transport of these (often) life saving tissues, to the surgical theatre.**

**Certain specific applications for lyophilization (freeze drying processes) in production of pharmaceuticals.**

Although much of the application in the field of biologicals, and more specifically cryosurgery and cryobiology often think in terms of physically removing keratosis and skin cancers via freezing, with $LCO_2$,  LIN and other agents; there are a wide variety of applications beyond this old – school technique, many more $CO_2$ – based cryobiological applications are available. Further, cryobiological applications are a world apart from a critical application of USP grade $CO_2$ in respiratory stimulation alone. Respiratory stimulation specifically can bring back the patient from the brink, quite literally. As this small volume market alone, respiratory stimulation would require USP grade (a very small total market within the greater merchant $CO_2$ production plant holdings) $CO_2$ up to about 5% by air volume (v atmospheric $CO_2$ @ .039%).

In addition to the very small respiratory market as mentioned above is the predominant greater market defined as cryobiological – that being application of carbon dioxide as a liquid or solid in temperature reduction and low temperate settings and (cold) storage of various forms of tissue.

Cryosurgery in a fairly common setting includes cryogenic in-situ of carcinoma, such as the removal of abnormal cells which often remain in place for a period of time, thus preventing an otherwise spread to outside healthy tissue, such as the so-called common keratosis or skin cancers. The application is via liquid $CO_2$ from a nozzle to the tissue in question. The same is also achievable via dry ice; however, the use of liquid or ice is a function of availability, and convenience.  When speaking of these procedures, specifically removing abnormal tissue, this is not the cure for skin cancer or melanoma; however it is the removal of non – malignant tissue, moles, and viral – based warts.

Cryobiology at large, generally deals with the chemical and biological aspects of cryopreservation of biological materials. This greater field, from a viable and ethical perspective, in my thinking would generally exclude concepts such as long term storage of whole or partial human or animal bodies; with the long term intentions to 'reanimate'. Reanimation is probably impossible, since cryonics, otherwise deep freezing via cryogenics will generally render some tissue damage; and with technologies today, and for the foreseeable future, the damage to tissue via cryonics, and other factors relating to general feasibility and ethics makes the case for cryonics less than a viable concept. This does not exclude cryogenic storage of tissue as preservation for sampling of DNA and like concepts.

With respect to a growing and successful skin rejuvenation practice via CO2 lasers, dermatologists can turn to carbon dioxide erbium laser resurfacing – which has demonstrated strong success in the removal of sun – damaged skin, eye wrinkles, smoker's lip lines, and other cosmetic challenges. Of course, in addition to removal and rejuvenation of skin lesions, age – related damage, etc, would be the use as a coolant in the many applications whereby carbon dioxide is used (for BTU removal value) in organ and tissue storage, and the additional refrigeration value in cryotransport (often via dry ice) of vital organs, blood, and various tissues and tissue samples to refrigeration, for reuse and application of said tissues. The refrigeration value from LCO2 and dry ice would enhance alcohol bath cooling capabilities, as well as cryogenic freezers supplied by LCO2 all are applicable to the science of cryobiology. In this context, replacing mechanical systems which may not even be applicable, can be well achieved by the portability of dry ice, or the use of LCO2 – thus saving electricity, in theory a green application.

In summary, CO2 usage in the laser – repair of damaged skin, chilling tissue samples and blood for transport, surgical re-attachment, storage, and similar biological applications; plus the use in chilling & freezing mechanisms, from alcohol baths to cryogenic freezers – to the portability and batch sampling accomplished within simple dry ice usage – all of this is an integral part of cryobiology, and carbon dioxide. The advantages of the science of cryogenics is well demonstrated when considering specific applications in the medical field, thus limiting the sharp, pointed ice crystals found when (otherwise) applying slower, warmer methods of freezing (mechanical) – this is essential and consistent when working with life – sustaining biologicals and tissues for human and animal life. The application of CO2 will continue to grow in this field, and the specific demands today and tomorrow are quite fascinating, in my opinion.

## About the author

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