Table 1.2 Microbial survival of extreme conditions

Microorganism	Physicochemical parameter	Time of exposure	Other information	Reference
Deinococcus radiodurans	Ionizing radiation	5–20 h	ca. 20,000 Gy	Ito et al. (1983)
Streptococcus mitis	Surface of the Moon	2.5 years	In a camera	Website[a]
Numerous microorganisms	Minus 20 °C	ca. 10^6 years	Permafrost	Gilichinsky (2002)
Numerous microorganisms[b]	Minus 193 °C	> 10 years	Liquid N_2	Gherna (1994)
Numerous microorganisms[b]	$a_w < 0.75$	> 10 years	Vacuum	Gherna (1994)
Halococcus salifodinae	NaCl >30 %	>10^6 years (?)	In salt crystals	Denner et al. (1994); McGenity et al. (2000)
Endospores (*Bacillus*, *Clostridium*)	Heat; chemicals	>3000 y	Sediments	Madigan et al. (2009)
Endospores (*Bacillus*)	Outer space	6 years	Surface of space probe	Horneck et al. (1994)

[a]http://science.nasa.gov/science-news/science-at-nasa/1998/ast01sep98_1/ (accessed May 2016)
[b]With protective substances (e.g., 25–40 % glycerol)

Denner EBM, McGenity TJ, Busse H-J, Wanner G, Grant WD, Stan-Lotter H (1994) *Halococcus salifodinae* sp.nov., an archaeal isolate from an Austrian salt mine. Int J Syst Bacteriol 44:774–780

Gherna RL (1994) Culture preservation. In: Gerhardt P, Murray RGE, Wood WA, Krieg NR (eds) Manual of methods for general microbiology. American Society for Microbiology, Washington, DC, pp. 278–292

Gilichinsky DA (2002) Permafrost. In: Bitton G (ed) Encyclopedia of environmental microbiology. Wiley, New York, pp. 2367–2385

Horneck G, Bücker H, Reitz G (1994) Long-term survival of bacterial spores in space. Adv Space Res 14:41–45

Ito H, Watanabe H, Takeshia M, Iizuka H (1983) Isolation and identification of radiation-resistant cocci belonging to the genus *Deinococcus* from sewage sludges and animal feeds. Agric Biol Chem 47:1239–1247

Madigan MT, Martinko JM, Dunlap PV, Clark DP (2009) Chapter one: microorganisms and microbiology. In: Brock biology of microorganisms, 12th edn. Pearson Benjamin Cummings, San Francisco, pp. 1–24

McGenity TJ, Gemmell RT, Grant WD, Stan-Lotter H (2000) Origins of halophilic microorganisms in ancient salt deposits. Environ Microbiol 2:243–250