Editorial

Transfusion Medicine and Hemotherapy

Transfus Med Hemother 2019;46:131–132
DOI: 10.1159/000500553

Received: April 25, 2019
Accepted: April 25, 2019
Published online: May 6, 2019

Science First: Cool Is Beautiful

Andreas Sputtek[a] Barry Fuller[b]

[a]MVZ Medizinisches Labor Bremen, Bremen, Germany; [b]UCL Division of Surgery and Interventional Sciences, Royal Free Hospital, London, UK

Transfusion Medicine and Hemotherapy is the official journal of the DGTI (German Society for Transfusion Medicine and Immunohematology). A couple of years ago, the Society has extended its scope from mainly blood (and blood cells) to cells and tissues, and consequently the scope of the journal has been widened as well. This is the reason why this international issue deals with the preservation of hematopoietic blood stem cells (Hornberger et al. [1]), stem cells for cellular therapies (Hunt [2]), vitrification of oocytes and embryos (Arav and Natan [3]), cryopreservation of ovarian tissue (Rivas Leonel et al. [4]), organ preservation (Petrenko et al. [5]), and remaining challenges of biopreservation (Taylor et al. [6]). The 20 authors of these 6 contributions are affiliated with some 15 institutions, and these institutions are located in 7 countries, i.e. (in alphabetical order), Argentina, Belgium, Brazil, Israel, the UK, Ukraine, and the USA.

But what is the link to transfusion medicine? Well, people operating a blood bank have experience with the preservation of material of human origin, and some are heavily involved in cell, tissue, and organ banking. “Blood bankers” are familiar with organizational requirements (e.g., record keeping and working in accordance with standard operating procedures), acquisition (e.g., ethical and legal rules, anonymity, donor screening, and selection), processing (e.g., identification, inspection, storage, expiration, irradiation, sterilization, freeze-drying, and quality management), labeling, distribution, and transportation [7].

Many biopreservation protocols require the reduction of water activity, and this can be achieved, e.g., by drying, cooling, freezing, vitrification, or lyophilization. The “Boyle-van ’t Hoff relationship” (a plot of cell volume vs. 1/osmolality) determines the osmotically active water content of biological cells. While Robert Boyle (1627–1691, an Anglo-Irish natural philosopher, physicist, and chemist) is well known (at least in the Anglo-Saxon literature), less is known about van ’t Hoff.

Jacobus Henricus van ’t Hoff was born on August 30, 1852, in Rotterdam, the Netherlands. He was the third child in a family of seven children of Jacobus Henricus van ’t Hoff, Sr., a physician, and Alida Jacoba Kolff. In 1869 he entered the Polytechnic School in Delft, and he acquired his technology diploma in 1871. After a year in Leiden, mainly for mathematics, he went to Bonn to work with F.A. Kekulé (founder of the theory of chemical structure) from 1872 to 1873. This period was followed by a stay with C.A. Wurtz (an organic chemist, known for the Wurtz reaction). Van ’t Hoff returned to the Netherlands in 1874 and obtained his doctorate in the same year from E. Mulder (an organic chemist and toxicologist) in Utrecht. In 1876 he became a lecturer at the Veterinary College in Utrecht, but he left this post for a similar position at the University of Amsterdam the following year. In 1878 he was appointed professor of chemistry, mineralogy, and geology at the same university. After having occupied this chair for 18 years, he accepted an invitation to go to Berlin as honorary professor, combined with a membership in the Royal Prussian Academy of Sciences. Van ’t Hoff became the first Nobel Prize Winner in Chemistry in 1901 [8].

G. Wald, another Nobel Laureate and Professor Emeritus of Biology at Harvard University, wrote down the discovery of the fundamental equation for diluted solutions in 1982. The story is as follows: one day in Amsterdam, van ’t Hoff was walking down the street, when he met his colleague, the botanist Hugo de Vries. They went on together, whereupon de Vries said: “The other day I had a letter from Pfeffer” (W. Pfeffer, 1845–1920, a German botanist and pioneer in the use of semipermeable membranes for the measurement of osmotic pressure). When van ’t Hoff asked for the results, de Vries replied:

KARGER

E-Mail karger@karger.com
www.karger.com/tmh

Dr. Andreas Sputtek
MVZ Medizinisches Labor Bremen
Haferwende 1
DE–28377 Bremen (Germany)
E-Mail andreas.sputtek@mlhb.de

"Well, he writes that for each degree rise in temperature the osmotic pressure goes up by 1/270." Van 't Hoff recognized 270 as an approximation to the absolute temperature, 273 K at 0 °C. That was the start of his theory of ideal solutions (with its equivalent of the ideal gas law, pv ≈ RT), which becomes p/c ≈ RT in dilute solutions, where "p" is the osmotic pressure, "c" is the concentration, "R" is the universal gas constant, and "T" is the absolute temperature [9].

In 1885, van 't Hoff was appointed member of the Royal Netherlands Academy of Sciences, but the first Nobel Prize in Chemistry (1901) was the peak of his career. Among his international distinctions were honorary doctorates from Harvard and Yale (1901), the Victoria University of Manchester (1903), and Heidelberg University (1908). He was awarded the Davy Medal of the Royal Society (1893), as well as the "Helmholtz Medaille der Preussischen Akademie der Wissenschaften" (1911). He became a "Senator der Kaiser-Wilhelm-Gesellschaft" (1911), an honorary member of the British Chemical Society, the Royal Dutch Academy of Sciences (1892), and the American Chemical Society (1898), as well as a member of the "Académie des Sciences" (1905) [8].

Jacobus Henricus van 't Hoff, a man of international experience and broad international reputation, died in Steglitz, near Berlin, on March 1, 1911, of tuberculosis [8].

This glimpse back into scientific history serves not only to mark the pioneers from a previous age, but also to remind us that our modern abilities to preserve living cells has required an understanding of the interface between biology and physics. Progress in a wider application to biopreservation has been hard won since the seminal report from C. Polge and colleagues on successful semen cryopreservation in 1949 [10]. The ability to stop biological time in this way has already facilitated many medical therapies which would otherwise have been difficult to deliver in terms of logistics and governance. Much still remains to be learnt to continue to expand biopreservation technologies into different areas of medicine, and to improve on current protocols, which have been largely developed empirically. However, the efforts will surely be rewarded by improved patient outcomes.

References

1 Hornberger K, Yu G, McKenna D, Hubel A. Cryopreservation of hematopoietic stem cells: emerging assays, cryoprotectant agents, and technology to improve outcomes. Transfus Med Hemother. 2019 May;46(3):1–9.

2 Hunt CJ. Technical considerations in the freezing, low-temperature storage and thawing of stem cells for cellular therapies. Transfus Med Hemother. 2019 May;46(3):1–16.

3 Arav A, Natan Y. The near future of vitrification of oocytes and embryos: looking into past experience and planning into the future. Transfus Med Hemother. 2019 May;46(3):1–5.

4 Rivas Leonel EC, Lucci CM, Amorim CA. Cryopreservation of human ovarian tissue: a review. Transfus Med Hemother. 2019 May;46(3):1–9.

5 Petrenko A, Carnevale M, Somov A, Osorio J, Rodríguez J, Guibert E, et al. Organ preservation into the 2020s: the era of dynamic intervention. Transfus Med Hemother. 2019 doi: 10.1159/000499610.

6 Taylor MJ, Weegman BP, Baicu SC, Giwa SE. New approaches to cryopreservation of cells, tissues, and organs. Transfus Med Hemother. 2019 doi: 10.1159/000499453.

7 Sputtek A, Rowe AW. Looking back from the future to the present: biopreservation will get us there! Transfus Med Hemother. 2011; 38(2):85–7.

8 https://en.wikipedia.org/wiki/Jacobus_Henricus_van_%27t_Hoff [last accessed 2019 Apr 25].

9 Wald G. How the theory of solutions arose. J Chem Educ. 1986;63(8):658.

10 Polge C, Smith AU, Parkes AS. Revival of spermatozoa after vitrification and dehydration at low temperatures. Nature. 1949 Oct; 164(4172):666.