

LIPOSOMES: FROM THE ORIGIN OF LIFE TO NANOTHERAPY

M. REZA MOZAFARI*

Riddet Centre, Massey University, Private Bag 11 222, Palmerston North,
New Zealand

Liposomes (also known as lipid vesicles) are closed, continuous bilayered structures made mainly from lipid and/or phospholipid molecules. Although it is generally known that liposomes were first emerged around 40 years ago, there are some evidences that these lipid vesicles exist since the origin of life. Lipid vesicles have also been found to be naturally present in human milk. Their resemblance to biological membranes makes them an ideal tool not only for the study of the properties of contemporary biomembranes but also in the investigations of the emergence [Mozafari, M.R. *et al.* **Cell. Mol. Biol. Lett.** 9 (S2) (2004) 97] and functioning [Kahveci, G. *et al.* 12th National Congress of Biochemistry, Istanbul, Turkey, April 1994, C-338] of the initial cell membranes. Liposome-encapsulated simple hereditary material (perhaps self-replicating RNA) is one of the best candidates for being the initial life form in the course of evolution. Complexes of liposomes and DNA molecules, in addition to being a leading gene delivery vehicle, are being used in the elucidation of many biological phenomena including viral infection, bacterial conjugation and nuclear membrane trafficking.

Recently, it was found that a new method (and associated equipment) of liposome manufacture is actually simulating the formation of the early cell membranes under the conditions of the primordial earth [Mozafari, M.R. *et al.* **Cell. Mol. Biol. Lett.** 9 (S2) (2004) 97 and Mozafari, M.R. **UK Patent** No. GB 0404993.8, March 2005]. This technique is capable of producing liposomes (and some other carrier systems) with pharmaceutical qualities for gene and other drug delivery applications. In fact, liposomes are a leading micro- and nano-encapsulation technology as well. This is due to their many favourable characteristics such as biocompatibility, targetability, ability to incorporate molecules and compounds with different solubilities and variation in terms of size, fluidity, surface charge and number of lamellae. Furthermore, unlike other carrier systems, liposomes can be made completely from indigenous material found in our body. Few other areas of research are as diverse as liposomes in terms of properties and applications. Nanoliposomes (vesicles possessing and maintaining nanometric size ranges for prolonged periods of time) have already found an important place in the new fields of nanomedicine and nanotherapy. Peer and Margalit [Peer, D. and Margalit, R. **Neoplasia** 6 (2004) 343] have recently reported successful application of nanoliposomes in active targeting the tumors in mice models.

* E-mail: R.Mozafari@massey.ac.nz

Since the introduction of liposomes to the scientific community, there have been considerable advances in the optimisation of liposomal formulations as well as their manufacturing techniques. These include extension of the liposomal half-life in blood circulation [Allen, T.M. *et al.* **Biochim. Biophys. Acta** 981 (1989) 27], development of ingenious strategies for tissue and cell targeting and elimination of the need for utilisation of harmful agents (e.g. volatile organic solvents and detergents) during their preparation [Mozafari, M.R., *et al.* **Cell. Mol. Biol. Lett.** 7 (2002) 923].

Despite the enormous effort in research and development on liposomes, only a small number of liposomal products have arrived on the market so far. This may be due to various reasons including: toxicity of some liposomal formulations, poor loading of bioactive agents into liposomes, instability of the liposomal formulations and high production costs especially on industrial scales. Once these drawbacks are rectified, liposome technology indeed has great potential to provide many more products approved for human and animal use. This demands research and collaboration of scientists in different disciplines from pharmaceuticals to chemical engineering and from nanomedicine to food nanotechnology.

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