ELSEVIER

Chemistry and Physics of Lipids
88 (1997) 45–61

CPL
CHEMISTRY AND PHYSICS OF LIPIDS

Mixing behavior of saturated short-chain phosphatidylcholines and fatty acids

Eutectic points, liquid and solid phase immiscibility, non-lamellar phases

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Received 14 April 1997; received in revised form 9 June 1997; accepted 11 June 1997

Abstract

Phase diagrams of the hydrated pseudo-binary mixtures dilauroylphosphatidylcholine (DLPC)/lauric acid (LA) and dimyristoylphosphatidylcholine (DMPC)/myristic acid (MA) have been constructed using high-sensitivity DSC and time-resolved X-ray diffraction. They are of a different type compared to those of the longer chain phosphatidylcholine (PC)/fatty acid (FA) mixtures, the latter being of maximum azeotropic point type. Eutectic points were distinguished in the phase diagrams, at 75 mol% MA and 49°C for the DMPC/MA mixture, and at ca. 67 mol% LA and 29°C for the DLPC/LA mixture. Regions of liquid–liquid and solid–solid phase separation have been located according to the shape of the phase diagrams and observed by X-ray diffraction. Limited regions (2–4°C) of liquid–liquid phase immiscibility exist at compositions with slightly prevailing fatty acid molar content. For instance, at 67 mol% MA, a phase separation between L_α phase enriched in DMPC and H_{II} phase enriched in MA takes place in the temperature range 51–55°C. Solid phase immiscibility is detected between 60 and 90 mol% fatty acid. The studied PC/FA mixtures form compound subgel polymorphic phases (one in the DMPC/MA mixture, with DMPC/MA 1:2 molar stoichiometry, and two in the DLPC/LA mixture, with about 40 and 60 mol% LA, respectively) upon low-temperature equilibration. In the liquid crystalline phase region, non-lamellar phases dominate the phase diagrams, especially in their fatty acid-rich part. With increasing FA content, the nonlamellar phases arrange in the sequence: bicontinuous cubic phases (Ia3d, Pn3m, Im3m) → hexagonal phase (H_{II}) → micellar cubic

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Abbreviations: PC, phosphatidylcholine; DLPC, 1,2-dilauroyl-*sn*-glycero-3-phosphocholine; DMPC, 1,2-dimyristoyl-*sn*-glycero-3-phosphocholine; DPPC, 1,2-dipalmitoyl-*sn*-glycero-3-phospho-choline; DSPC, 1,2-distearoyl-*sn*-glycero-3-phosphocholine; LA, lauric acid; MA, myristic acid; PA, palmitic acid; SA, stearic acid; FA, fatty acid; DSC, differential scanning calorimetry; TRXRD, time-resolved X-ray diffraction.

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PII S0009-3084(97)00043-1