Tissue-derived cell growth on hybrid sol–gel films

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Hybrid sol–gel films were developed for tissue-derived cell growth. Specifically, Buffalo green monkey kidney cells were grown on hydrophobically modified silica sol–gel thin films and on such films in which poly-l-lysine (PLL) was entrapped in order to affect surface positive charge density. Intermediate hydrophobicity was found optimal for the cell growth. The PLL-modified films enabled drastic reduction of the needed amount of serum. The developed films function better than the commonly used cell-culture polystyrene dishes.

Introduction

Biological applications of sol–gel materials have been extensively studied during the past decade. Many reports have demonstrated that sol–gel materials can serve as host matrices for biological materials, from proteins to whole cells. Examples for the latter include, for instance, immobilization of yeast cells which retained their enzymatic activity; entrapment of microbial cells which retained their metabolic activities; entrapped protozoa which were shown to keep their antigentic properties after entrapment; and encapsulation of Langerhans pancreatic islets, while preserving their insulin secretory capacity. Whereas the majority of these studies have dealt with cell entrapment within sol–gel matrices, less attention was paid to the ability to use these materials for cell growth. A major exception has been bone regeneration using, for instance, a class of materials known as bioactive glasses. And yet, taking into account the many applications of cell-cultures such as their use for production of various biochemicals (including hormones, growth factors and enzymes), for growing and detecting of viruses and for production of antiviral vaccines, the potential of sol–gel materials for the delicate requirement of cell adhesion and cell proliferation. For instance, the most widely used material for this purpose, polystyrene, undergoes glow discharge or exposure to sulfuric acid in order to increase the number of charged groups at the surface, which in turn improves attachment and growth of many cell line types. Additionally, surfaces can be coated with poly-cationic molecules (i.e. poly-l-lysine), which interact with anionic sites on cell outer membrane surfaces. Also of relevance to this report is the application of coatings made of colloidal silica for primary cell cultures growth.

The advent of hybrid sol–gel materials opens new possibilities for tailoring efficient substrates for cell growth. A major advantage of these materials is that the library of methods and chemicals with which one can design almost any desired surface property, is practically endless. In this report, we show how such design indeed produces improved substrates for cell growth. We do so, as mentioned above, by growing Buffalo green monkey kidney (BGM) cells on hydrophobically optimized hybrid silica thin films, and on thin films in which poly-l-lysine (PLL) was entrapped.

Experimental

Chemicals

Medium M199 (with l-glutamine), fetal calf serum, trypsin EDTA solution (0.05% EDTA, 0.25% trypsin), antibiotics (1000 units mL\(^{-1}\) penicillin G, 10 mg mL\(^{-1}\) streptomycin, 25 μg mL\(^{-1}\) amphotericin) were obtained from Biological Industries (Beit Haemek, Israel). Methyl trimethoxysilane (MTMOS, 98%) and tetraethoxysilane (TEOS, 98%) were obtained from Aldrich (Germany). Trypan blue was obtained from BDH (Poole, England). Poly-l-lysine (M.W. 150,000–300,000) (0.1% w/v in water) was obtained from Sigma (USA) (Cat. No. P8920). Water was purified by reverse osmosis and deionized using Destamat Heraeus Quarzgian (Switzerland). All other chemicals and solvents were of analytical grade and were used without further purification.