BIODEGRADABLE POLYROTAXANES AIMING AT BIOMEDICAL AND PHARMACEUTICAL APPLICATIONS

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1. INTRODUCTION

Since 1978, to supramolecular chemistry has been given the most attention with regard to the chemistry of molecular assemblies including rotaxanes and polyrotaxanes. A family of polyrotaxanes has been recognized as a molecular assembly in which many cyclic compounds are threaded onto a linear polymeric chain capped with bulky end-groups. The name of rotaxane was given from the Latin words for wheel and axle, and thus it refers to a molecular assembly of cyclic and linear molecules. Polypseudorotaxanes are defined as inclusion complexes in which many cyclic molecules are threaded onto a polymeric chain (Fig. 1a). Further, bulky blocking-groups are introduced at the ends of the pseudo-polyrotaxanes (Fig. 1b) to prevent dethreading of the cyclic molecules. This is known as a polyrotaxane which is a family of newly categorized molecular assemblies. Our recent studies have focused on the design of biodegradable polyrotaxanes aiming at biomedical and/or pharmaceutical applications.
1.1 Studies on Polyrotaxanes using Cyclodextrins

Cyclodextrins (CDs) are frequently used as building blocks for supramolecular structure because they have a hydrophobic cavity that can encapsulate a guest molecule. Also, CDs are of great importance in the pharmaceutical sciences, since CDs and certain drugs form water-soluble and low-toxic complex molecules. Rotaxanes, polypseudorotaxanes and polyrotaxanes have been studied as a new molecular architecture in comparison with homopolymers and/or copolymers. In 1976, Ogata et al. observed a polycondensation reaction of a pseudorotaxane consisting of a β-CD and an α, ω-diaminohydrocarbon with a diacid chloride to form a polypseudorotaxane. This paper was the first one describing the synthesis and characterization of a polypseudorotaxane using CDs. Recent progress in polypseudorotaxane preparation using CDs has been extensively accelerated by Harada et al., who found polypseudorotaxanes consisting of an α- or γ-CD and poly(ethylene glycol) (PEG), a β- or γ-CD and polypropylene glycol) (PPG), a α-CD and polyesters, and a γ-CD and polyisobutylene. Further, they developed a molecular necklace in which many α-CDs are threaded onto an α, ω-diamino PEG chain capped with dinitrophenyl groups. Their findings gave us a great opportunity to design polyrotaxane-based drug carriers.

1.2 Considerable Functions Based on The Polyrotaxane Structure

According to the previous studies on polyrotaxanes, significant characteristics of the polyrotaxanes involve (i) non-covalent bonds between CDs and linear polymeric main chains and (ii) the chemical modification of CDs in the polyrotaxanes. Such the chemical characteristic of non-covalent