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Smart nanotubes : A novel alternative for gene delivery

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Gene delivery, the process of introducing foreign genes into living cells, is an important technique in fields such as metabolic engineering and gene therapy. Including chemical/biological approaches (either using lipids, cationic polymers, or virus as vectors, or using conjugation) and physical approaches (heat shock, electroporation, gene gun, microinjection, and sonoporation), have been applied in bacterial, mammalian, and plant cells. However, these approaches are successful only in a few bacterial species because of the low efficiency of transformation, the complicated operation protocols, the severe damage to cells, and the high cost of complex devices. Carbon nanotubes were used to attain more than 15,000 transformants in the same situation. Therefore, the transformation method could be extended to other nanomaterials. Meanwhile, compared with the mechanism previously reported, we verified quite a different principle for the mechanism responsible for such a transformation. In sum, this unique transformation can be developed to become the third widely-used transformation method in laboratories.

Key words : Gene therapy, Carbon nanotubes

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INTRODUCTION

Gene transfer or DNA uptake refers to the process that moves a specific piece of DNA into cells. The rapid development of genetic engineering technique based on the knowledge of gene structure and function, plant breeding has been dramatically broadened. The directed desirable gene transfer from one organism to another and subsequent stable integration and expression of a foreign gene into the genome is referred as genetic transformation. The technique which are available presently rely on natural plant vector as well as vector less method which include delivery foreign DNA into plant cell.

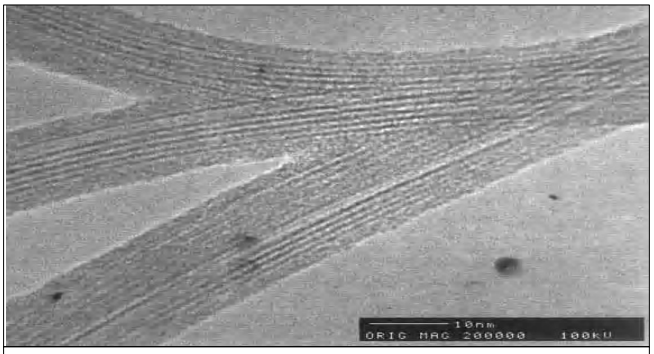

Fig. 1 : Transmission electron micrograph of fullerene carbon nanotubes

Carbon nanotube :

In 1985, Smalley and his co-workers at Rice University discovered a new form of carbon buckminster fullerene or C60 (Kroto *et al.*, 1985), and this work ultimately lead to the awarding of the 1996 Nobel Prize in chemistry. arc discharge method, and in 1991 Iijima discovered nanotubes in the products obtained from such a reactor (Fig. 1) (Iijima, 1991). These tubes are in essence rolled-up, highly ordered grapheme sheets, and they may be single walled or multiwalled. They are typically referred to in the literature as simply carbon nanotubes; however, since there are examples of nanotubes composed of more disordered forms of carbon (Fig. 2) (Miller *et al.*, 2001).

Diameters for these nanotubes range from 1 to tens of nanometers and lengths can be from microns to hundreds of microns (Ajayan, 1997). Since their discovery, there has been a massive international research effort aimed at understanding the properties of fullerene carbon nanotubes and at developing applications for these nanotubes; a number of authoritative reviews have recently appeared (Ajayan, 1997; Dai *et al.*, 1999). There have been a number of recent reports of putting biomolecules onto and into fullerene carbon nanotubes (Chen *et al.*, 2001). For example, Dai *et al.* (1999) used a simple non-