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Review

Controlled Release Technologies: Current Status and Future Prospects

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During the past 25 years, significant advances in controlled drug delivery have been achieved and several products have enjoyed commercial success. At last, the concept of controlled release technology has entered the public's consciousness and reasonable resources have been committed to the field by both the pharmaceutical industry and government agencies. With each successful advance, however, comes a higher and higher level of expectation. Inevitably, the temptation to promise more than what can be delivered (*sic*) is sometimes irresistible, particularly when the financial stakes are high. Needless to say, this is a recipe for disappointment, both for the public and for the investors in innovative technology, and it may even lead to disillusionment and cynicism. Indeed, it was not too long ago that the media was seriously questioning the degree to which the pharmaceutical industry could be trusted at all (1)!

It is the responsibility of the conscientious pharmaceutical scientist, therefore, to provide accurate, informative and critical examinations of the field. This cannot be achieved by a single individual—the pharmaceutical sciences are now so diverse that it is impossible to stay current in all aspects of the research taking place. Equally, it would be complacent for us to rely upon the "sound-bites" of the media for our information. In fact, it can be argued that the pharmaceutical scientist should assume the responsibility of communicating new advances to the public and to his or her colleagues, so that a balanced view is provided and that the hype is minimized.

The goal of this series of four articles is to examine the current status and future possibilities of four areas of controlled release technology. In particular, the idea is to balance the exciting potential perceived with a frank evaluation of the significant challenges that exist. To cover all aspects of the drug delivery field would require an entire issue of *Pharmaceutical Research*, so discussion in the following four articles is limited to oral delivery of peptides and proteins, transdermal technology, implantable devices, and vaccine development. Topics discussed in these articles are listed in Table 1. Each article represents personal views and opinions. Differing views and counter-arguments are encouraged and welcome.

Table I. Topics on Current Status and Future Possibilities of Four Areas of Controlled Release Technology

I. Oral controlled release technology for peptides: Status and future prospects
  A. Current status of oral peptide absorption
    1. Permeability and absorption enhancers
    2. Protection from enzymatic degradation
    3. Rapid clearance
    4. Chemical stability and aggregation
  B. Peptide drugs as candidates for oral controlled release systems
  C. Challenges remaining in the development of oral controlled release peptide systems

II. Current status and future prospects of transdermal drug delivery systems
  A. Current status
  B. Advantages and drawbacks of transdermal delivery
  C. Skin barrier function
  D. New technologies
    1. Chemical enhancers
    2. Novel formulations
    3. Iontophoresis
    4. Electroporation and sonophoresis
    5. Reverse iontophoresis

III. Biocompatibility issues of implantable drug delivery systems
  A. Biomaterials and biocompatibility
    1. Blood compatibility
    2. Tissue compatibility
  B. Implantable drug delivery systems and other devices
    1. Silicone rubber implants
    2. Implantable artificial pancreas
    3. Challenges and opportunities
  C. Implantable biocompatible materials

IV. Drug delivery issues in vaccine development
  A. Single-shot subunit vaccines
  B. Therapeutic vaccines for cancer
  C. Cytokines as vaccine adjuvants
  D. DNA vaccines
  E. Sterilizing immunity vaccines

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