

Oral Drug Delivery: Scientific Challenges and Product Development

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Drug Discovery and Drug Delivery Systems

Modern medicine would not exist without drugs. Since the discovery of penicillin numerous drugs have been discovered and developed. Those drugs have been instrumental in fighting against various diseases and saving human lives. Development of new drugs, however, is a very expensive process, and many drug candidates are abandoned due to their unfavorable properties. Controlled drug delivery systems quite often overcome many deficiencies in new drug candidates and existing drugs to make them more efficacious therapeutic agents.

Of the many routes of drug delivery, oral drug delivery has been regarded as the most convenient route of administration. More than half of the pharmaceutical industry is based on oral formulations. Oral drug delivery, however, has a number of limitations, such as relatively short gastric emptying and intestinal transit time, non-uniform absorption abilities of different segments of the GI tract, presystemic clearance, poor absorption of macromolecular drugs, and poor in vivo-in vitro correlations. Controlled drug delivery systems have been used to overcome various difficulties in oral drug delivery and to maximize the bioavailability of the drugs. There are many scientific challenges to overcome in developing clinically useful formulations.

Factors in Designing Drug Delivery Systems

Development of controlled release systems is much more than simply loading a drug in a polymeric system. There is no flow chart to follow for the development of a particular controlled drug delivery system, but various factors have to be considered simultaneously, as shown in Fig. 1. Oral drug delivery sets a small boundary where drug delivery technologies can be utilized, such as delivery period usually less than 24 hours, size of delivery vehicle, difficulty of targeting, and drug solubility.

Scientific Challenges in Oral Drug Delivery Technologies

Advances in oral controlled drug delivery systems have been slower than those in other formulations partly due to the limitations mentioned above. Selected examples of such challenges are listed in Table 1.

The problem of overcoming poor aqueous solubility of a drug is especially challenging, since poorly soluble drugs are sometimes substrates of efflux pumps present in the GI tract. Drug delivery systems with the ability to increase the aqueous solubility and to inhibit the efflux pumps would allow development of new breed of oral formulations. Various gastric retention devices have been tested, but the devices that can work in humans are yet to be developed. Patient-friendly oral formulations, such as fast-melting tablets, are designed to aid drug administration to children as well as elderly patients. Oral delivery of peptide and protein drugs remains as the holy grail of drug delivery.

Each of the challenges listed in Table 1 can be solved only by enhancing our scientific understanding. Scientific understanding has to be translated into solving practical considerations in product development. This presentation deals with the existing technologies and scientific

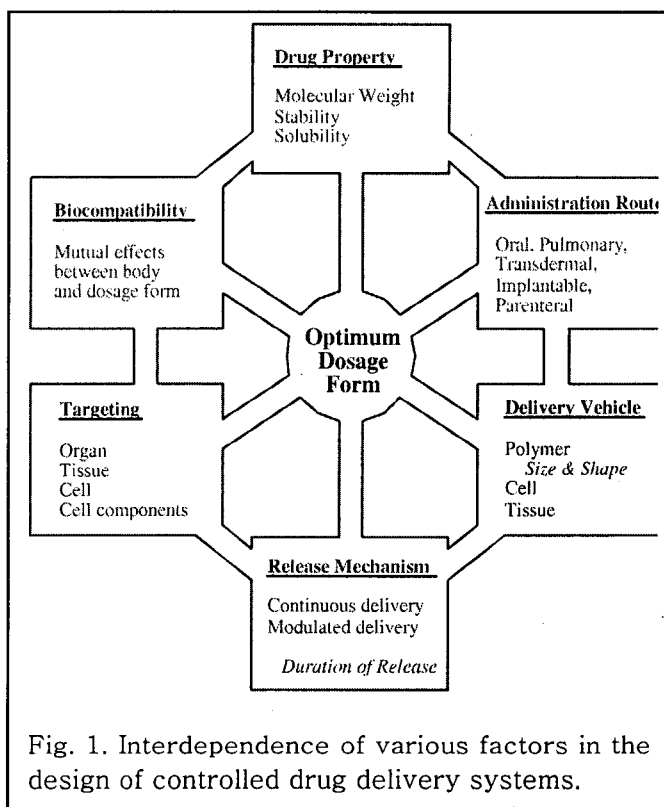


Fig. 1. Interdependence of various factors in the design of controlled drug delivery systems.

understanding required to overcome such challenges.

Table 1. Examples of scientific challenges in oral drug delivery.

1. Increased absorption of poorly water-soluble drugs
2. Development of gastric retention devices
3. Patient-friendly formulations
4. Delivery of peptide and protein drugs
5. Finding in vitro-in vivo correlations

Keywords: oral delivery, aqueous solubility, gastric retention devices, fast-melting tablets.