lead to incomplete injection since the forces applied are not high enough to deliver the entire dose volume. The mAb Cimzia® is formulated at 200 mg/mL and is available in a prefilled syringe. A syringe using a 25 g needle with large flanges was developed and apparently can be used by arthritis patients to deliver the full 1-mL dose. The development of this syringe led to several design awards and was recognized by the Arthritis Foundation for ease of use. Needle technology has also been developed to handle highly viscous solutions. Examples include thin wall needles that have larger internal diameters than standard needles, and specially designed needles such as Imprint's DepotOne® that uses a needle that does not have uniform diameter (Maynard, 2003). Essentially, the needle narrows at the tip for easy insertion but is wider at the top to handle viscous solutions. In addition, the aperture for drug delivery is located on the side rather than at the tip used in conventional needles.

The technical challenges for device and formulation development

The development of a delivery device begins with an understanding of the requirements of the device for ease of use for a clinical indication. Ergonomic studies, especially using field studies with models and actual patients, help to define the size, shape, and actuation mechanism for the device (French, 2013; Reynolds, 2012). When the drug is coupled with the device, it is termed a combination product, and even though the device may be designed and manufactured by a separate device company, the pharmaceutical company is responsible for the fully integrated system. Thus, not only must the drug be compatible with the device and remain stable but also the functionality of the device must not deteriorate over the shelf life of the product. Some of the important considerations are the choice of the primary container/closure system in the device, the compatibility of the formulated drug with all surfaces, and the assurance that the correct dose is delivered. Here, we will not discuss further the ergonomic studies that are needed for device development since this is beyond the scope of this book. The choice of container/closure impact on functionality, and compatibility of the formulated drug product with the device will be discussed.

Primary container/closure systems for devices to be used with mAbs

The most common injector systems commercially available are pen injectors that are designed for multiple doses, prefilled syringes, and autoinjectors (Figure 8.1). The pen injectors typically use a cartridge system coupled with a multiuse formulation. The need for large doses of mAbs usually precludes such a device, and a bolus autoinjector is usually the device of choice. The choice of the primary container/closure can still be a cartridge, but a better choice would be a prefilled syringe since if the device cannot be ready at time of entry into the market place, a prefilled syringe can still be used as