Chapter 7

Nervous Regulation of Islet Functions

7.1 Pathways

Despite a recent surge in interest, the neural regulation of the endocrine pancreas is poorly understood. Possibly, islet innervation is important for the pulsatile release of islet hormones. Pulsatile release of hormones, as opposed to tonic delivery, may have advantages such as increased efficiency at target organs (thus "saving" hormone), or prevention of receptor desensitization (for literature see Weigle et al. 1984; Samols et al. 1986). Another function of islet innervation may be an overriding control in the integration of islet responses. The vast majority of new data on islet innervation, which comes from studies in mammals, already reveals considerable inter- and intraspecific differences (Gerich and Lorenzi 1978; Woods and Porte 1978; R. E. Miller 1981; Smith and Madson 1981; Palmer and Porte 1983; Porte and Woods 1983; Rohn-jeanrenaud et al. 1983; Smith and Davis 1983; Steffens and Strubbe 1983; Luiten et al. 1984; Jeanrenaud 1985). Although comparative studies are in their infancy, the available information shows that it is beforehand impossible to identify phylogenetic or functional patterns of islet innervation (Epple et al. 1980; Buchan 1984). Perhaps the extremes are best illustrated by the cyclostomes which totally lack an islet innervation and the teleosts in which islet cells show particularly intimate contacts with neurons (Epple and Brinn 1975).

It appears possible that the nervous control of the islets involves three efferent pathways: (1) hypothalamic neurosecretions; (2) insular neurosecretions; (3) innervation of islet cells. The question of insulotropic hypothalamic hormones deserves serious attention since hypothalamic extracts with both insulinotropic (Lockhart-Ewert et al. 1976; Hill et al. 1977; Moltz et al. 1979; Knip et al. 1983; Palmer and Porte 1983; Wood et al. 1983; Jeanrenaud 1985) and glucagonotropic (Moltz and Fawcett 1983) effects have been identified in mammals. Furthermore, insulin receptors may well exist in the brain of all vertebrates, from lamprey to mammals (Leibush 1983), and at least in some brain regions of the latter they can be reached by circulating insulin (for literature see Landau et al. 1983; Porte and Woods 1983; Frank et al. 1985; Haskell et al. 1985). This raises the question of a neuroendocrine-feedback system between islet cells and CNS (cf. Melnyk and Martin 1985) which, depending on the species, may involve up to five efferent pathways, and a number of hormonal afferent components (Fig. 7.1). If Van Houten and Posner's (1981) proposed feedback system for blood-borne polypeptide hormones (Fig. 7.2) can be confirmed in its essential features, then the comparative endocrinologists will be faced with new, exciting questions. For example: Is a humoral paraneuron-CNS feedback via circumventricular organs the phylo-
genetically original form of neuroendocrine interactions? Is, perhaps, "efferent" brain secretion the basic route of CNS-islet communication, which is only supplemented by insular neurosecretion and/or direct innervation whenever evolutionary pressures call for it? And if so, is the probably secondary absence of islet innervation (Hahn von Dorsche et al. 1976) in the spiny mouse (*Acomys*...