3 Principles of Endocrinology

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3.1. Introduction

Cells in multicellular organisms must adopt specialized functions. By forming organs, cells can take on specialist functions, which would not be possible in individual cells; functions such as the conversion of food sources to energy (digestion), locomotion (running, jumping, flying), and the processing of more complex information signals (sight, hearing, touch, thought), as well as their storage (learning, memory). The coordination of all of these specialized functions within an organism is essential, as is the exchange of information between all of the different organs and their regulation by the brain. The brain transmits messages by two efferent pathways, through the nervous and the endocrine systems. These
two are closely linked, and some "glands" (the hypothalamus, posterior pituitary, and adrenal medulla) histologically are derived from the nervous system. The transmission of impulses through the nervous system proceeds by way of "neurotransmitters" that are in themselves classical hormones (e.g., noradrenaline). For further reading, see, for example, Bentley (1980), Brown (1994), and Williams (1996).

3.2. General Principles

3.2.1. Hormones

Historical Aspects. Hormones are chemically defined substances that are secreted by endocrine glands or glandlike cells and exert their effect at a distance from their point of origin. A substance is said to have an endocrine effect when removal of a gland or its destruction results in a loss of hormone effect, but which can be restored by replacement with the hormone itself or an extract of the gland.

M. Bayliss and E. H. Starling first employed the term hormone in 1902 for the as yet undefined secretin. The first therapeutic use of gland extracts had occurred some years earlier (Table 1).

The chemical structures of hormones began to be elucidated in this century (Table 2), and required heroic efforts; Butenandt extracted 1500 liters of urine in order to isolate 15 mg of the testosterone metabolite androsterone. R. Guillemin prepared just 1 mg of thyrotropin-releasing hormone from 5 million sheep hypothalami, and E. Rinderknecht and R. E. Humbel extracted plasma proteins from nearly 1 million liters of human blood in order to characterize the structure of insulinlike growth factor (otherwise known as somatomedin C).

Steroid and Thyroid Hormones. Hormones can be divided into several main groups according to their chemical structure. Steroid hormones are synthesized from cholesterol in the ovaries, testes, adrenal glands, and placenta. They are made up of four carbohydrate rings and can be categorized as estrogens, gestagens, androgens, gluco- and mineralocorticoids. Their chemical synthesis requires enzymes located in the endothelial reticulum and the mitochondria, which occur in differing activities according to the individual gland, so directing the synthesis of the various end products. Steroids are not stored after production, but are secreted directly after synthesis (Table 3). The active vitamin

<table>
<thead>
<tr>
<th>Year</th>
<th>Authors</th>
<th>Extract</th>
<th>Hormone</th>
<th>For treatment of</th>
</tr>
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<tbody>
<tr>
<td>1889</td>
<td>C. E. Brown-Sequard</td>
<td>Testis</td>
<td>Testosterone</td>
<td>Sexual activitya</td>
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<tr>
<td>1891</td>
<td>G. R. Murray</td>
<td>Thyroid</td>
<td>Thyroxine</td>
<td>Hypothyroidism</td>
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<td>1909</td>
<td>W. B. Bell</td>
<td>Posterior pituitary</td>
<td>Oxytocin</td>
<td>Postpartum bleeding</td>
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<tr>
<td>1911</td>
<td>J. Hofbauer</td>
<td>Posterior pituitary</td>
<td>Oxytocin</td>
<td>Inadequate labor</td>
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<tr>
<td>1913</td>
<td>R. van der Welden &amp; F. Farini</td>
<td>Posterior pituitary</td>
<td>Adiuretin (vasopressin)</td>
<td>Diabetes insipidus</td>
</tr>
<tr>
<td>1921</td>
<td>F. G. Bantin &amp; C. H. Best</td>
<td>Pancreas</td>
<td>Insulin</td>
<td>Diabetes mellitus</td>
</tr>
</tbody>
</table>

*aThis result could not be confirmed, as almost no testosterone is stored in the testis.