The adrenal gland is involved in the production of a variety of steroid hormones and catecholamines that influence blood pressure. Thus, it is not surprising that several adrenal disorders may result in hypertension. Many of these disorders are potentially curable or responsive to specific therapies. Therefore, identifying adrenal disorders is an important consideration when elevated blood pressure occurs suddenly or in a young person, is severe or difficult to treat, or is associated with manifestations suggestive of a secondary form of hypertension. Because these occurrences are relatively rare, it is necessary to have a high index of suspicion and understand the pathophysiology on which the diagnosis and treatment of these problems is based.

Three general forms of hypertension that result from excessive production of mineralocorticoids, glucocorticoids, or catecholamines are reviewed in the context of their normal production, metabolism, and feedback systems. The organization of this chapter provides the background for understanding the normal physiology and pathophysiologic changes on which effective screening and diagnosis of adrenal abnormalities are based. Therapeutic options also are briefly considered. Primary aldosteronism, Cushing’s syndrome, and pheochromocytoma are discussed.
### Adrenal Hypertension

#### PHYSIOLOGIC MECHANISMS IN ADRENAL HYPERTENSION

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Cause</th>
<th>Pathophysiology</th>
<th>Pressure mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary aldosteronism</td>
<td>Autonomous hypersecretion of aldosterone (hypermineralocorticoidism)</td>
<td>Increased renal sodium and water reabsorption, increased urinary excretion of potassium and hydrogen ions</td>
<td>Extracellular fluid volume expansion, hypokalemia (?) alkalosis</td>
</tr>
<tr>
<td>Cushing’s syndrome</td>
<td>Hypersecretion of cortisol (hyperglucocorticoidism)</td>
<td>Increased activation of mineralocorticoid receptor (?), increased angiotensinogen (renin substrate) concentration</td>
<td>Extracellular fluid volume expansion (?), increased angiotensin II (vasoconstriction and increased peripheral resistance)</td>
</tr>
<tr>
<td>Pheochromocytoma</td>
<td>Hypersecretion of catecholamines</td>
<td>Vasoconstriction, increased heart rate</td>
<td>Increased peripheral resistance, increased cardiac output</td>
</tr>
</tbody>
</table>

**FIGURE 4-1**
The causes and pathophysologies of the three major forms of adrenal hypertension and the proposed mechanisms by which blood pressure elevation results.

#### Histology of the Adrenal

**FIGURE 4-2**
Histology of the adrenal. A cross section of the normal adrenal before (left) and after (right) stimulation with adrenocorticotropic hormone (ACTH) [1]. The adrenal is organized into the outer adrenal cortex and the inner adrenal medulla. The outer adrenal cortex is composed of the zona glomerulosa, zona fasciculata, and zona reticularis. The zona glomerulosa is responsible for production of aldosterone and other mineralocorticoids and is chiefly under the control of angiotensin II (see Figs. 4-3 and 4-5). The zona fasciculata and zona reticularis are influenced primarily by ACTH and produce glucocorticoids and some androgens (see Figs. 4-3 and 4-19). The adrenal medulla produces catecholamines and is the major source of epinephrine (in addition to the organ of Zuckerkandl located at the aortic bifurcation) (see Fig. 4-25.).
Adrenal Steroid Biosynthesis

**FIGURE 4-3**
Adrenal steroid biosynthesis. The sequence of adrenal steroid biosynthesis beginning with cholesterol is shown as are the enzymes responsible for production of specific steroids [2]. Note that aldosterone production normally occurs only in the zona glomerulosa (see Fig. 4-2). (From DeGroot and coworkers [2]; with permission.)