

# Dopaminergic Reward Pathways and Effects of Stress

MICHELA MARINELLI

The aim of this chapter is to review literature on the dopamine reward system, how it is affected by stress, and its relevance to addiction. The first two sections will provide a brief definition of stress and an introduction on the dopamine system, including methods used to evaluate its activity. The third section will describe the role of the dopamine system in drug addiction. It will also examine the effects of addictive drugs on different aspects of dopaminergic transmission, such as dopamine overflow and action potential output. The fourth section will focus on the effects of stress on dopaminergic transmission. It will highlight how stress has an inverted-U-shaped effect: Mild/moderate stressors increase dopaminergic transmission, whereas intense unpredictable stressors can decrease it. Possible mechanisms underlying the effects of stress on the dopamine system, including the important role of glucocorticoid stress hormones, will also be discussed. The review will conclude by examining how an interaction between stress and dopamine could play an important role in the development of addiction-associated behaviors; it will also provide

different views that try to reconcile findings showing that increased dopamine transmission is seen after both rewarding and stressful stimuli.

## I. DEFINING STRESS

*Stress* is a complex term that requires a brief description at the onset of this chapter. Biologically, stressful events cause a rise in blood levels of glucocorticoids, which are considered as major stress hormones (for review, see Axelrod and Reisine, 1984; Bohus, 1975; Dallman et al., 1989; de Kloet, 2000; Munck and Guyre, 1986). Psychologically, stress generally bears a negative value as it is commonly believed that individuals will avoid stressful stimuli; however, this is not always the case. In humans, some individuals show preference for situations that enhance stress levels (e.g., "sensation-seekers"; Zuckerman, 1990); similar traits exist in animals as well (Dellu et al., 1996). Rats with enhanced hormonal reactivity to stress also choose to spend more time in stressful situations (Kabbaj et al., 2000). In other words, some