



# California Training Institute

Science based solutions to human factor issues

## How Does Caffeine Really Work?

Caffeine and Adenosine <sup>1</sup>

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Why does caffeine wake you up? In short, it's all about two words: brain chemistry. Adenosine is a naturally released neurotransmitter that plays an important role in biochemical processes, such as energy transfer. It plays another role as an inhibitory neurotransmitter in promoting sleep and suppressing arousal. As adenosine is created in the brain, it binds to adenosine receptors. This binding causes drowsiness by slowing down nerve cell activity. Adenosine is an inhibitory neurotransmitter. It also causes blood vessels to dilate to let more oxygen in during sleep. To an adenosine nerve cell receptor, caffeine looks like adenosine.

When caffeine binds to the adenosine receptor two things happen. The receptor is blocked by the caffeine that adenosine would normally bind to and the cell can no longer identify adenosine. Next, caffeine doesn't slow down the cell's activity like adenosine would. Instead of slowing the nerve cell firings speed up. Since caffeine is plugged into the adenosine receptors, adenosine can't do its job, and this causes your central nervous system to run at a faster rate. Thus you experience the classic and often sought-after caffeine jolt.



The central nervous system runs faster because the pituitary gland senses this activity and thinks some sort of emergency must be occurring, so it releases hormones that tell the adrenal glands to produce adrenaline (epinephrine). Adrenaline is the "fight or flight" hormone, and it has a number of effects on your body. This explains why, excess caffeine causes your pupils to dilate, the airway to open up, your heart to beat faster, increased blood pressure, and the liver to release sugar into the bloodstream for extra energy. Caffeine also increases dopamine levels by blocking the re-uptake of adenosine. Heroin and cocaine manipulate dopamine in the same way but to a much lesser degree. This makes us feel better but also explains how it contributes to caffeine addiction and why we can become de-sensitized to caffeine.

Caffeine is a wonderful drug in moderation. Researchers say their experiments explain the chemistry of how the antioxidants in coffee seek out and destroy free radicals associated with Alzheimer's and heart disease. Harvard researchers have determined that men who drink 4 cups of caffeinated coffee a day are half as likely to develop Parkinson's disease as those who skip the coffee. It is presumably that caffeine keeps dopamine molecules active. If we need a boost in arousal or attention, it gives us that also.

Caffeine has a dark side that will be explored in a later newsletter.

<sup>1</sup> Brain, Marshall, Charles W. Bryant and Matt Cunningham. "How Caffeine Works" 01 April 2000. HowStuffWorks.com

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