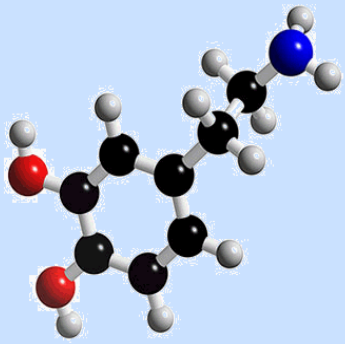
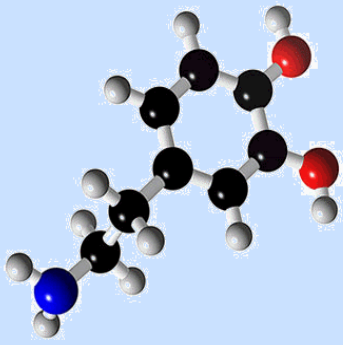


DOPAMINE



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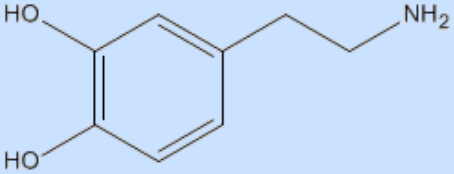
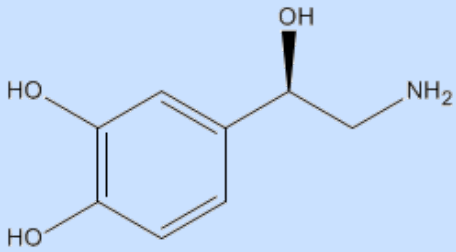
Molecule of the Month - October 2008

Also available: Chime Enhanced, VRML and JMol versions.

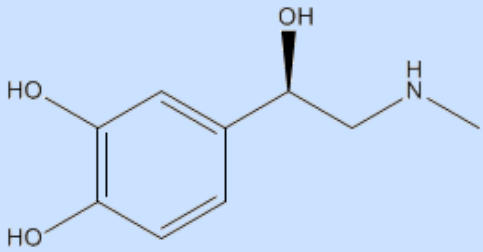
Dopamine is found in the brains of most animals, both vertebrates and invertebrates. It belongs to a family of molecules called catecholamines. This is because it possesses both an amine group and the 1,2-dihydroxy substituted benzene, or catechol, ring. Other catecholamines include norepinephrine, commonly called noradrenaline, and epinephrine, which is more popularly called adrenaline. The IUPAC name for dopamine is 4-(2-aminoethyl)benzene-1,2-diol.



Dopamine



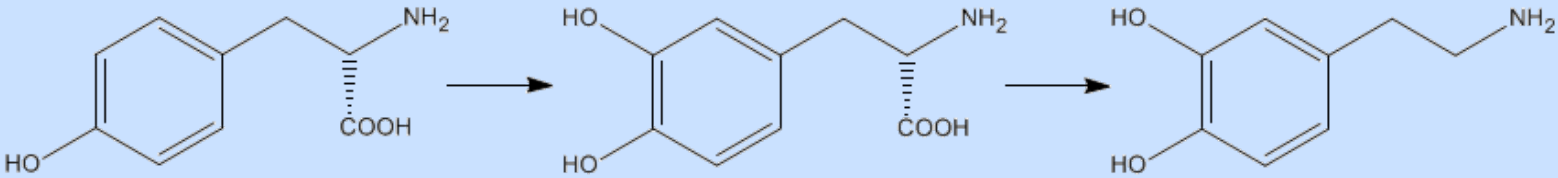
Norepinephrine



Epinephrine

BIOSYNTHESIS

The biosynthesis of dopamine is a two step process starting with the amino acid L-tyrosine. A second phenol group is added to the benzene ring of L-tyrosine forming levodopa, which is more commonly called L-dopa. This process is catalysed by the enzyme tyrosine hydroxylase. Dopamine is formed by the removal of the carboxylic acid group from L-dopa. This is also an enzyme catalysed process and the enzyme involved is referred to, perhaps unsurprisingly, as dopa decarboxylase.



L-Tyrosine **L-Dopa** **Dopamine**

BIOLOGICAL FUNCTION

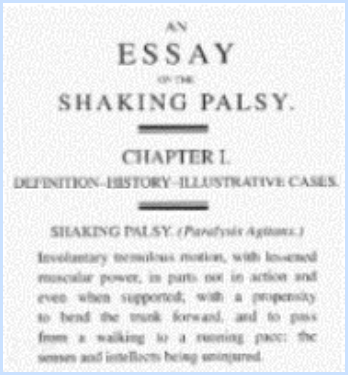
Dopamine has many biological functions. It is a precursor to norepinephrine which in turn is used to synthesise epinephrine in the body. Both of these molecules are hormones. Dopamine also acts as a neurohormone. It reduces the production of prolactin (picture, right), a protein responsible for the production of breast milk. Perhaps the most well know function of dopamine

is as a neurotransmitter. Neurotransmitters are chemicals that can cross a gap between neurons referred to as a synapse. A nerve impulse travels along the neuron and when it reaches the end a neurotransmitter is released. The neurotransmitter crosses the synapse, bridging the gap between the two neurons. This allows the impulse to continue.

There are many dopamine receptors in the brain and it is thought that dopamine is responsible for a general feeling of well-being. For example, dopamine has been linked with feelings of happiness, excitement and positivity as well as the eagerness to go after goals or rewards. Nicotine present in cigarette smoke increases the secretion of dopamine in the brain and hence relieves feelings of anxiety. Other drugs also increase dopamine levels in the brain, such as the amphetamine D-methamphetamine. Dopamine also has an important role in making smooth and controlled muscular movements. Changes in the levels of dopamine in the brain are linked with Parkinson's disease.

DOPAMINE AND PARKINSON'S DISEASE

Parkinson's disease is a degenerative neurological condition that progressively worsens. It is named after James Parkinson, a London doctor who was the first person to profile the disease in his "Essay on the Shaking Palsy". The condition generally affects movements like walking, writing, talking and swallowing. Symptoms may include repetitive shaking, slowness of movement and muscle stiffness. Parkinson's is caused by the loss of nerve cells responsible for synthesising dopamine. Less dopamine is produced and consequently certain parts of the brain cannot function correctly. Symptoms will normally appear when 80% of the dopamine synthesising cells are lost.



AN
ESSAY
ON THE
SHAKING PALSY.

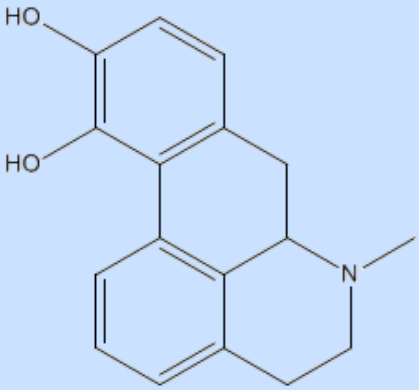
CHAPTER I.

DEFINITION—HISTORY—ILLUSTRATIVE CASES.

SHAKING PALSY. (*Paralysis Agitans.*)

Involuntary tremulous motion, with lessened muscular power, in parts not in action and even when supported, with a propensity to bend the trunk forward, and to pass from a walking to a running pace: the senses and intellects being uninjured.

Although there is no cure for Parkinson's disease, many medications are available to control the symptoms. Some of these drugs will boost the production of dopamine in the brain. Others mimic the effects of dopamine. Interestingly, dopamine itself is not used. This is because the dopamine molecule is too polar to cross the blood-brain barrier, and thus cannot enter the brain. The most common treatment used contains the chemical L-dopa. This molecule is also polar, however because it is an amino acid it is recognised by proteins that carry amino acids across the blood-brain barrier. L-dopa is therefore safely transported across the interface. Once in the brain it is converted to dopamine by decarboxylation. The drug apomorphine is also used to treat the symptoms of Parkinson's. It has structural similarities to dopamine and can therefore mimic the activity of dopamine. This drug is usually administered when sufferers experience periods of greatly reduced mobility.



Apomorphine

BIBLIOGRAPHY

- An Introduction to Medicinal Chemistry, G.L. Patrick (Oxford University Press, Oxford, 2002).
- The Cornell Chronicle, October 24, 1996.
- Molecules at an Exhibition, J. Emsley (Oxford University Press, Oxford, 1999).
- Website of the Parkinson's Disease Society.
- BBC Health Pages.
- Wikipedia.

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