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Question: describe in details the synthesis of two named neurotransmitters

ANSWER:

DOPAMINE:

Dopamine is synthesized in a restricted set of cell types, mainly neurons and cells in the medulla of the adrenal glands. The primary and minor metabolic pathways respectively are:

Primary: L-Phenylalanine → L-Tyrosine → L-DOPA → Dopamine

Minor: L-Phenylalanine → L-Tyrosine → p-Tyramine → Dopamine

Minor: L-Phenylalanine → m-Tyrosine → m-Tyramine → Dopamine

The direct precursor of dopamine, L-DOPA, can be synthesized indirectly from the essential amino acid phenylalanine or directly from the non-essential amino acid tyrosine. These amino acids are found in nearly every protein and so are readily available in food, with tyrosine being the most common. Although dopamine is also found in many types of food, it is incapable of crossing the blood–brain barrier that surrounds and protects the brain. It must therefore be synthesized inside the brain to perform its neuronal activity.

L-Phenylalanine is converted into L-tyrosine by the enzyme phenylalanine hydroxylase, with molecular oxygen and tetrahydrobiopterin as cofactors. L-Tyrosine is converted into L-DOPA by the enzyme tyrosine hydroxylase, with tetrahydrobiopterin, O2, and iron as cofactors. L-DOPA is converted into dopamine by the enzyme aromatic L-amino acid decarboxylase (also known as DOPA decarboxylase), with pyridoxal phosphate as the cofactor.

Dopamine itself is used as precursor in the synthesis of the neurotransmitters norepinephrine and epinephrine. Dopamine is converted into norepinephrine by the enzyme dopamine β-hydroxylase, with O2 and L-ascorbic acid as cofactors. Norepinephrine is converted into epinephrine by the enzyme phenylethanolamine N-methyltransferase with S-adenosyl-L-methionine as the cofactor.

Some of the cofactors also require their own synthesis. Deficiency in any required amino acid or cofactor can impair the synthesis of dopamine, norepinephrine, and epinephrine.

NOREPINEPHRINE:

Norepinephrine is synthesized from the amino acid tyrosine by a series of enzymatic steps in the adrenal medulla and postganglionic neurons of the sympathetic nervous system. While the conversion of tyrosine to dopamine occurs predominantly in the cytoplasm, the conversion of dopamine to norepinephrine by dopamine β-monooxygenase occurs predominantly inside neurotransmitter vesicles. The metabolic pathway is:

Phenylalanine → Tyrosine → L-DOPA → Dopamine → Norepinephrine.

Thus the direct precursor of norepinephrine is dopamine, which is synthesized indirectly from the essential amino acid phenylalanine or the non-essential amino acid tyrosine. These amino acids are found in nearly every protein and, as such, are provided by ingestion of protein-containing food, with tyrosine being the most common.

Phenylalanine is converted into tyrosine by the enzyme phenylalanine hydroxylase, with molecular oxygen (O2) and tetrahydrobiopterin as cofactors. Tyrosine is converted into L-DOPA by the enzyme tyrosine hydroxylase, with tetrahydrobiopterin, O2, and probably ferrous iron (Fe2+) as cofactors L-DOPA is converted into dopamine by the enzyme aromatic L-amino acid decarboxylase (also known as DOPA decarboxylase), with pyridoxal phosphate as a cofactor. Dopamine is then converted into norepinephrine by the enzyme dopamine β-monooxygenase (formerly known as dopamine β-hydroxylase), with O2 and ascorbic acid as cofactors.

Norepinephrine itself can further be converted into epinephrine by the enzyme phenylethanolamine N-methyltransferase with S-adenosyl-L-methionine as cofactor.