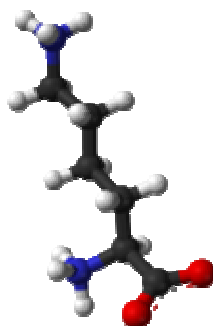
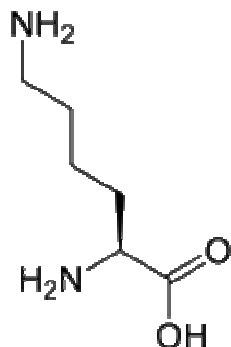


# Lysine

## Lysine



<a href="#">IUPAC name</a>	<a href="#">[show]</a>
Other names	2,6-diaminohexanoic acid
<b>Identifiers</b>	
<a href="#">CAS number</a>	<a href="#">70-54-2</a> , L: [56-87-1] D: [923-27-3]
<a href="#">PubChem</a>	<a href="#">866</a>
<a href="#">SMILES</a>	<a href="#">[show]</a>
<a href="#">ChemSpider ID</a>	<a href="#">843</a>
<b>Properties</b>	
<a href="#">Molecular formula</a>	C <sub>6</sub> H <sub>14</sub> N <sub>2</sub> O <sub>2</sub>
<a href="#">Molar mass</a>	146.19 g mol <sup>-1</sup>
<b>Supplementary data page</b>	
<a href="#">Structure and properties</a>	<a href="#">n</a> , <a href="#">ε<sub>r</sub></a> , etc.
<a href="#">Thermodynamic data</a>	Phase behaviour Solid, liquid, gas
<a href="#">Spectral data</a>	<a href="#">UV</a> , <a href="#">IR</a> , <a href="#">NMR</a> , <a href="#">MS</a>
Except where noted otherwise, data are given for materials in their <a href="#">standard state (at 25 °C, 100 kPa)</a>	

Lysine is an amino acid. Amino acids are fundamental constituents of all proteins. They promote protein production, reduce catabolism, promote wound healing and act as buffers in extra- and intracellular fluids.

*Lysine* (abbreviated as *Lys* or *K*) is an  $\alpha$ -amino acid with the chemical formula HO<sub>2</sub>CCH(NH<sub>2</sub>)(CH<sub>2</sub>)<sub>4</sub>NH<sub>2</sub>. This amino acid is an essential amino acid, which means that humans cannot synthesize it.

Lysine is a base, as are arginine and histidine. The  $\epsilon$ -amino group often participates in hydrogen bonding and as a general base in catalysis. Common posttranslational modifications include methylation of the  $\epsilon$ -amino group, giving methyl-, dimethyl-, and trimethyllysine. The latter occurs in calmodulin. Other posttranslational modifications at lysine residues include acetylation and ubiquitination. Collagen contains hydroxylysine which is derived from lysine by lysyl hydroxylase. O-Glycosylation of lysine residues in the endoplasmic reticulum or Golgi apparatus is used to mark certain proteins for secretion from the cell.

Lysine, organic compound, one of the 20 amino acids commonly found in animal proteins. Only the L-stereoisomer appears in mammalian protein. It is one of several essential amino acids needed in the diet; the human body cannot synthesize it from simpler metabolites. Young adults need about 23 mg of this amino acid per day per kilogram (10 mg per lb) of body weight. Lysine is found in particularly low concentrations in the proteins of cereals; wheat gluten, for example, is relatively poor in lysine. This deficiency in lysine is the reason for the failure of diets in some parts of the world that employ cereal protein as a sole source of essential amino acids to support growth in children and general well-being in adults. Attempts to develop lysine-rich corn have been partly successful. Once lysine is incorporated into protein, its basic side chain often provides a positive electrical charge to the protein, thereby aiding its solubility in water. Its side chain has also been implicated in the binding of several coenzymes (pyridoxal phosphate, lipoic acid, and biotin) to enzymes. It also plays an important role in the functioning of histones.

### *Biosynthesis*

Lysine is an essential amino acid in human nutrition because the body cannot produce it; therefore, it must be taken in either by diet or by supplementation. Lysine was first isolated from casein (a milk phosphoprotein) by Drechsel in 1889.

As an essential amino acid, lysine is not synthesized in animals; hence it must be ingested as lysine or lysine-containing proteins. In plants and bacteria, it is synthesized from aspartic acid, which is first converted to  $\beta$ -aspartyl-semialdehyde. Cyclization gives dihydropicolinate, which is reduced to  $\Delta^1$ -piperidine-2,6-dicarboxylate. Ring-opening of this heterocycle gives a series of derivatives of pimelic acid, ultimately affording lysine. Enzymes involved in this biosynthesis include:

1. Aspartokinase
2.  $\beta$ -aspartate semialdehyde dehydrogenase
3. Dihydropicolinate synthase
4.  $\Delta^1$ -piperidine-2,6-dicarboxylate dehydrogenase
5. *N*-succinyl-2-amino-6ketopimelate synthase
6. Succinyl diaminopimelate aminotransferase
7. Succinyl diaminopimelate desuccinylase
8. Diaminopimelate epimerase
9. Diaminopimelate decarboxylase

### *Metabolism*

Lysine is metabolised in mammals to give acetyl-CoA, via an initial transamination with  $\alpha$ -ketoglutarate. The bacterial degradation of lysine yields cadaverine by decarboxylation.

Allysine is a derivative of lysine, used in the production of elastin and collagen. It is produced by the actions of the enzyme lysyl oxidase on lysine in the extracellular matrix and is essential in the crosslink formation that stabilizes collagen and elastin.

### *Synthesis*

The amino acid was first isolated from casein (milk protein) in 1889, and its structure was elucidated in 1902.

Synthetic, racemic lysine has long been known. A practical synthesis starts from caprolactam.

### *Properties*

L-Lysine is a necessary building block for all protein in the body. L-Lysine plays a major role in calcium absorption; building muscle protein; recovering from surgery or sports injuries; and the body's production of hormones, enzymes, and antibodies. It is necessary for tissue repair and growth. An essential amino acid, it is needed for proper growth in infants and for maintenance of nitrogen balance in adults

### *Modifications*

Lysine can be modified through acetylation, methylation, ubiquitination, sumoylation, neddylation, biotinylation and carboxylation which tends to modify the function of the protein of which the modified lysine residue(s) are a part.

### *Clinical significance*

It has been suggested that lysine may be beneficial for those with herpes simplex infections. However, more research is needed to fully substantiate this claim

There are Lysine conjugates that show promise in the treatment of cancer, by causing cancerous cells to destroy themselves when the drug is combined with the use of phototherapy, while leaving non-cancerous cells unharmed.

While chemically insignificant to lysine itself, it is worth noting that lysine is attached to dextroamphetamine to form the prodrug lisdexamfetamine (Vyvanse). In the gastrointestinal tract, the lysine molecule is cleaved from the dextroamphetamine, thereby making oral administration necessary.

Lysine, or L-lysine, is an essential amino acid, which means that it is necessary for human health but cannot be made by the body. For this reason, lysine must be obtained from food. Amino acids are the

building blocks of protein. Lysine is important for proper growth, and it plays an essential role in the production of carnitine, a nutrient responsible for converting fatty acids into energy and helping to lower cholesterol. Lysine appears to help the body absorb and conserve calcium, and it plays an important role in the formation of collagen, a substance important for bones and connective tissues including skin, tendon, and cartilage.

If there is too little lysine in the diet, kidney stones and other health related problems may develop including fatigue, nausea, dizziness, loss of appetite, agitation, bloodshot eyes, slow growth, anemia, and reproductive disorders. It is extremely rare, however, to obtain insufficient amounts of lysine through the diet. Generally, only vegetarians who follow a macrobiotic diet and certain athletes involved in frequent vigorous exercise are at risk for lysine deficiency. For vegetarians, legumes (beans, peas, and lentils) are the best sources of lysine.

Lysine is involved in the browning reaction, or caramelization, in foods such as pastries, doughnuts, cookies, and cereals. In this process, lysine and sugar become linked together in a way that makes lysine difficult for the body to absorb. As a result, a diet high in cereals and baked goods, especially those that contain a lot of simple sugars, can result in low lysine intake.

An essential amino acid of special nutritional importance, since it is the limiting amino acid in many cereals. Can be synthesized on a commercial scale, and when added to bread, rice, or cereal-based animal feeds, it improves the nutritional value of the protein.

Not all of the lysine in proteins is biologically available, since some is linked through its side-chain amino group, either to sugars (see Maillard reaction), or to other amino acids. These linkages are not hydrolyzed by digestive enzymes, and so the lysine cannot be absorbed. Available lysine is that proportion of the protein-bound

lysine in which the side-chain amino group is free, so that it can be absorbed after digestion of the protein.

**Uses:**

Lysine has been studied clinically for the prophylaxis and treatment of herpes infections and cold sores, with mixed results. Lysine improves calcium assimilation and may be helpful in the treatment of Bell's palsy. Lysine acetylsalicylate has been used to treat rheumatoid arthritis and to detoxify heroin. It is useful for treating Cataracts, and to boost the immune system.

L-lysine can be used to treat mouth and genital lesions caused by herpes simplex virus as well as shingles caused by herpes zoster viruses. Taking lysine supplements can speed recovery time and reduce the chance of recurrent breakouts of the herpes infection.

Lysine has been given in pure form to athletes and the elderly at daily doses from 1.5 to 3 g daily.

Definitive clinical studies are needed to understand the medicinal uses of lysine.

*Osteoporosis*

L-lysine helps improve the absorption of calcium from the digestive tract and prevent loss of calcium in the urine. In so doing, some researchers speculate that L-lysine may help prevent bone loss associated with osteoporosis. In addition, laboratory studies suggest that L-lysine in combination with L-arginine (another amino acid) increases the activity of bone-building cells and enhances production of collagen.

*Other*

Certain forms of lysine and lysine bound to anti-inflammatory medications (such as ibuprofen, or Advil) may help alleviate pain following an episiotomy (a procedure performed during labor that

involves cutting the vaginal area to enlarge the vaginal opening and facilitate delivery). These forms of lysine may also relieve migraine headaches and painful periods. Whether L-lysine and other readily available lysine supplements also offer these benefits is not known.

*Dietary Sources:*

*Dietary sources*

The human nutritional requirement is 1–1.5 g daily. It is the limiting amino acid (the essential amino acid found in the smallest quantity in the particular foodstuff) in all cereal grains, but is plentiful in all pulses (legumes). Foods that contain significant amounts of lysine include:

- Hemp Seeds (40,000 ppm)
- Red Meat (14,200–15,000 ppm)
- Eggs
- Buffalo Gourd (10,130–33,000 ppm) in seed
- Berro, Watercress (1,340–26,800 ppm) in herb.
- Soyabean (24,290–26,560 ppm) in seed.
- Carob, Locust Bean, St.John’s-Bread (26,320 ppm) in seed;
- Common Bean (Black Bean, Dwarf Bean, Field Bean, Flageolet Bean, French Bean, Garden Bean, Green Bean, Haricot, Haricot Bean, Haricot Vert, Kidney Bean, Navy Bean, Pop Bean, Popping Bean, Snap Bean, String Bean, Wax Bean) (2,390–25,700 ppm) in sprout seedling;
- Ben Nut, Benzolive Tree, Jacinto (Sp.), Moringa (aka Drumstick Tree, Horseradish Tree, Ben Oil Tree), West Indian Ben (5,370–25,165 ppm) in shoot.
- Lentil (7,120–23,735 ppm) in sprout seedling.
- Asparagus Pea, Winged Bean (aka Goa Bean) (21,360–23,304 ppm) in seed.
- Fat Hen (3,540–22,550 ppm) in seed.
- White Lupin (19,330–21,585 ppm) in seed.

- Black Caraway, Black Cumin, Fennel-Flower, Nutmeg-Flower, Roman Coriander (16,200–20,700 ppm) in seed.
- Spinach (1,740–20,664 ppm).
- Amaranth, Quinoa
- Buckwheat
- Mesquite

Good sources of lysine are foods rich in protein, including meat (specifically red meat, pork, and poultry), cheese (particularly parmesan), certain fish (such as cod and sardines), nuts, eggs, chicken, and turkey.

Soyabean (particularly tofu, isolated soya protein, and defatted soyabean flour), spirulina, and fenugreek seed. Lysine may also be found in foods such as yogurt, brewer's yeast, wheat germ, and other meats. Lysine also may be synthesized in the laboratory.

An essential amino acid found in all proteins. Its concentration is relatively low in certain vegetables, such as cereal crops, so lysine is likely to be deficient in poorly designed vegetarian diets, but mixed vegetable diets are as good as meat. Low levels of lysine can slow down protein synthesis, resulting in poor muscle growth and repair.

Most individuals have an adequate intake of lysine; however lysine levels may be low in vegetarians and low-fat dieters. Without enough lysine or any other of the eight essential amino acids, the body cannot build protein to sustain muscle tissue.

### *Dosage*

### *Pediatric*

For children ages 2 - 12: Recommendations are 23 mg/kg/day or 10 mg per pound of body weight daily.

*Note:* Do not use lysine supplements in children less than 2 years of age unless under the supervision of a health care provider.



## *Adult*

For adults ages 13 and older: Recommendations are 12 mg/kg/day.

For adults with herpes viral infections: To treat symptoms, take 3,000 – 9,000 mg per day in divided doses. To prevent recurrences, take 500 – 1,500 mg per day in divided dosages.

## *Precautions:*

Because of the potential for side effects and interactions with medications, dietary supplements should be taken only under the supervision of a knowledgeable health care provider.

## *Possible Interactions:*

Arginine and lysine share common pathways in the body. Therefore, excess arginine may lower lysine levels in the body.

Lysine supplementation is contraindicated in patients with kidney or liver disease.

Dosages up to 4,000 mg/day have been proven to be safe and free of side effects.

There are no reports of human toxicities.

## *Other Uses*

Lysine also promotes the body's absorption of calcium, helping to prevent osteoporosis. It slows the damage to the eye caused by diabetes, and it may help cure atherosclerosis. Since it is used to slow the herpes simplex virus, its antiviral properties may help treat chronic fatigue syndrome, hepatitis, and HIV.

L-lysine is best taken as a single supplement and not in combination with other amino acids. Such combinations are touted as nutritional supplements that build more muscle and are often used by athletes

and bodybuilders. However, too much protein strains the functions of the liver and kidneys and can cause other health problems. The single supplement should be taken on an empty stomach because larger amounts of the amino acid can build up in the blood and brain, enhancing its health benefits. Supplements are best used by individuals suffering from a herpes outbreak or by vegetarians and low-fat dieters. Postmenopausal women can take lysine to encourage absorption of calcium by the body.

<b>Foods High in Lysine - Lysine per 100 g</b>		<a href="#">next</a>
<a href="#">Egg, white, dried, powder, glucose reduced</a>	5 g	
<a href="#">Egg, white, dried</a>	5 g	
<a href="#">Fish, cod, Atlantic, dried and salted</a>	5 g	
<a href="#">Soy protein isolate</a>	5 g	
<a href="#">Soy protein isolate, PROTEIN TECHNOLOGIES INTERNATIONAL, SUPRO</a>	5 g	
<a href="#">Soy protein isolate, PROTEIN TECHNOLOGIES INTERNATIONAL, ProPlus</a>	5 g	
<a href="#">Soy protein isolate, potassium type</a>	5 g	
<a href="#">Soy protein isolate, potassium type, crude protein basis</a>	5 g	
<a href="#">Egg, white, dried, flakes, glucose reduced</a>	4 g	
<a href="#">Cheese, parmesan, hard</a>	3 g	
<a href="#">Egg, whole, dried</a>	3 g	
<a href="#">Egg, whole, dried, stabilized, glucose reduced</a>	3 g	
<a href="#">Cheese, parmesan, shredded</a>	3 g	
<a href="#">Pork, cured, bacon, cooked, broiled, pan-fried or roasted</a>	3 g	
<a href="#">Pork, cured, bacon, cooked, microwaved</a>	3 g	
<a href="#">Pork, cured, bacon, cooked, pan-fried</a>	3 g	
<a href="#">Parsley, freeze-dried</a>	3 g	
<a href="#">Seaweed, spirulina, dried</a>	3 g	
<a href="#">Beef, round, top round, separable lean and fat, trimmed to 0" fat, all grades, cooked, braised</a>	3 g	
<a href="#">Beef, round, top round, separable lean only, trimmed to 1/4" fat, all grades, cooked, braised</a>	3 g	
<a href="#">Beef, round, top round, separable lean only, trimmed to 0" fat, all grades, cooked, braised</a>	3 g	

<a href="#"><u>Beef, round, top round, separable lean only, trimmed to 1/4" fat, choice, cooked, braised</u></a>	3 g
<a href="#"><u>Beef, round, top round, separable lean only, trimmed to 0" fat, choice, cooked, braised</u></a>	3 g
<a href="#"><u>Beef, round, top round, separable lean only, trimmed to 1/4" fat, select, cooked, braised</u></a>	3 g
<a href="#"><u>Beef, round, top round, separable lean only, trimmed to 0" fat, select, cooked, braised</u></a>	

- Calcium supplements interacts with LYSINE

Lysine can increase how much calcium the body absorbs. Taking calcium along with lysine can increase the amount of calcium in the body. Avoid taking large amounts of calcium and lysine at the same time.

**Kidney disease:** There is one report of kidney disease linked with taking lysine supplements. If you have a kidney disease, check with your healthcare provider before taking lysine.