

Part 1: Amino Acids

A. A repertory of amino acid functions and indications.

Applications for Sport

Condition	Amino Acid	Description of Function
Strength and Performance	Arginine Carnitine Creatine Monohydrate Histidine Inosine Proline	<ul style="list-style-type: none"> - In some trials, a significant increase in strength has been observed with use. ¹ - Improves muscle strength in patients with myopathic deficiency (muscle weakness). ¹ - Improves overall heart function. ² - Increases muscle strength. ² - Precursor of carnosine, which is found in high concentrations in muscles where it acts as a myosin ATPase activator, thus enhancing the ability of ATPase to drive the muscle and produce contractions. ¹ - Used as an ergogenic agent, especially for strength sports such as weightlifting. ¹ - Strengthens heart muscle. ²
Injuries / Wound Healing	Arginine Cysteine Cystine Glutamine Leucine Proline	<ul style="list-style-type: none"> - Enhances wound healing and immune responses. ¹ - Scar tissue has a high arginine content. ³ - Accelerates wound and burn healing. ² - Necessary for the healing of burns and wounds. ³ - Promotes wound healing. ² - Promotes wound healing, especially in tendons, muscles, and connective tissue. ² - Heals cartilage. ³
Lactic Acid Inhibition	Carnitine Creatine Monohydrate Glutamine	<ul style="list-style-type: none"> - Encourages glucose oxidation, and thus reduce lactic-acid build-up. ² - Inhibits production of lactic acid in muscles during exercise up to 41%. ² - Reduces lactic build-up after strenuous exercise. ²

<p>Connective Tissue and Muscle Integrity</p>	<p>Alanine</p> <p>Arginine Aspartic Acid Glycine</p> <p>Histidine Isoleucine Leucine</p> <p>Lysine</p> <p>Methionine Proline</p> <p>Phenylalanine Proline</p>	<ul style="list-style-type: none"> - Connective tissue proteins like collagen and elastin, are rich in alanine. Alanine accounts for 11% of their total amino acid content. This is important for the integrity of connective tissue structures like tendons, ligaments, cartilage and bones. ¹ - Collagen and elastin synthesis. ^{2,3} - Bone calcification. ² - Component of collagen. ² - Constituent of many protein hormones. ² - Involved in the synthesis of collagen. ² - Component of hormones, proteins and peptides. ² - Component of elastin. ² - With proline and threonine, required for formation of bone collagen. ² - Lysine residues are responsible for the cross-linking of the protein chains of elastin, giving it elastic properties. ¹ - Component of collagen. ² - Synthesis of collagen. ² - Proline, and its derivative, hydroxyproline, play an important role in the formation of collagen and elastin. Found in connective tissue in tendons, ligaments and cartilage, collagen is the most abundant protein in the body. ¹ - Contributes to the production of collagen, elastin and melanin. ² - Major amino acid of connective tissue proteins, collagen, and elastin. ² - Strengthens joints, tendons, and heart muscle. ³
<p>Energy Production</p>	<p>Alanine</p> <p>Arginine</p> <p>Aspartic Acid</p>	<ul style="list-style-type: none"> - Transaminated to yield pyruvate, which is converted to glucose and brought back to muscles to be used for energy. This spares muscles from being metabolised. ^{1,2} - Key intermediate in the alanine-glucose cycle, which allows muscles to derive energy from amino acids. ¹ - Involved in glycogenesis, gluconeogenesis, and triggers glucagons release. ^{2,3} - Increases in blood glucose and increased uptake of glucose into the cell → increase in energy. ¹ - Major precursor of creatine → increased muscle creatine concentration → increased energy production. ¹ - Converted to glucose and thus provides an energy source. ^{1,2}

<p>Energy Production (continued)</p>	<p>Carnitine</p> <p>Creatine</p> <p>Cysteine</p> <p>Cystine</p> <p>Glutamic Acid</p> <p>Glutamine</p> <p>Glycine</p> <p>Histidine</p> <p>Inosine</p> <p>Inositol</p> <p>Isoleucine</p> <p>Leucine</p> <p>Lysine</p> <p>Proline</p> <p>Tyrosine</p> <p>Valine</p>	<ul style="list-style-type: none"> - Enables the transport of fatty acids in the form of acyl CoA to sites at which they are converted to energy.¹ - Utilisation of ketone bodies.² - Essential component of creatine phosphate, which enhances the production of ATP.² - Glycogenic, and thus may be metabolised to provide energy.¹ - Promotes the use of adipose tissue as energy.² - Assists in the supply of insulin to the pancreas, needed for assimilation of sugars and starches.³ - Energy can be produced through oxidation of glutamic acid.¹ - Metabolised to form glycogen in the liver.² - Administration after exercise increases glycogen replacement.¹ - Precursor of porphyrins, pigments vital for the structure of haemoglobin and cytochromes, which are enzymes involved in the production of energy.¹ - Precursor for creatine, and together with methionine and arginine, it elevates plasma glucose levels.¹ - Stimulates release of glucose into blood via glucagons to produce energy.² - Required for the normal production of haemoglobin, which is involved in the production of energy.¹ - Production of muscular energy: precursor of adenosine, required to produce ATP.² - Broken down in the kidney to produce glucose for energy.¹ - Actively taken up by muscle where it can provide carbon atoms for synthesis of both glucose and ketones bodies for energy production.^{1,2} - Transaminated to form a keto acid, which is decarboxylated to form succinyl-CoA, which can in turn enter the Krebs cycle to produce energy.¹ - Specifically taken up by muscle as an energy yielding substrate.¹ - It is glucogenic, can be used by the body to produce glucose for energy.¹ - Glucogenic, thus can enter the Krebs cycle to be used as an energy source.^{1,2} - It can be oxidised to fumarate and acetoacetate, both of which can enter the Krebs cycle to produce glucose.¹ - Actively taken up by muscle tissue to yield energy, thus sparing muscle tissue.^{1,2} - Deaminated to α-oxo-isovaleric, which is broken down to succinyl CoA, which in turn enters the Krebs cycle to produce glucose and energy.¹
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<p>Tissue and Muscle Growth</p>	<p>Arginine</p> <p>Creatine Monohydrate</p> <p>Cysteine Glutamine</p> <p>Glycine Leucine Lysine</p> <p>Methionine</p> <p>Ornithine Proline</p>	<ul style="list-style-type: none"> - Oral arginine can increase the secretion of growth hormones, which in turn, contributes to the synthesis of muscle tissue. ^{1,2,3} - Precursor in the synthesis of creatine and creatinine. ² - Enhances protein synthesis. ² - Increases peripheral circulation, thus it can help maximise the beneficial effects of exercise on increasing muscle size. ¹ - Increases muscle size due to an increase in the water content of individual muscle cells. ¹ - Enhances muscle growth. ² - Increases the levels of growth hormones in plasma. ¹ - Increases protein synthesis (anabolic effect). ¹ - Increases human growth hormone release. ² - Increases muscle mass by regulating muscle protein synthesis. ^{1,2} - Amplifies the release of growth hormones, which occurs in response to arginine administration. ¹ - Precursor in the synthesis of creatine. ¹ - Starting amino acid in the synthesis of proteins in humans. ¹ - Increases human growth hormone release. ² - Stimulates growth of muscle tissue. ² - Anti-catabolic, and thus facilitates muscle growth. ²
<p>Endurance</p>	<p>Asparagine</p> <p>Aspartic Acid</p> <p>Carnitine</p> <p>Creatine Monohydrate</p>	<ul style="list-style-type: none"> - Increases the capacity of muscles to use free fatty acids as an energy source, especially important in prolonged exercise, where free fatty acids become relatively more important as energy sources. ¹ - Used in conjunction with asparagine and carnitine, it has been shown to increase time to exhaustion by 40%. This is thought to be due to more efficient use of free fatty acids as an energy source and consequent glycogen sparing. ¹ - Increases stamina, and prevents fatigue. ³ - Decreases ratio of acetyl CoA to CoA → increases the activity of pyruvate dehydrogenase → increases the oxidative utilisation of glucose → increases maximal aerobic power. ¹ - Acting as a buffer to acetyl CoA, it can enhance supramaximal exercise by preventing the flux of citric acid cycle from decreasing due to a lack of CoA. ¹ - Increases the ability to sustain power output on repetitive maximal exercise. ¹ - Delays onset of fatigue during heavy training. ²

<p>Endurance (continued)</p>	<p>Creatine Monohydrate Isoleucine Leucine Lysine Methionine Valine</p>	<ul style="list-style-type: none"> - Increases exercise tolerance up to 20% in patients with chronic heart failure. ¹ - Administration has been shown to decrease the feeling of tiredness during prolonged exercise. ¹ - Decrease the feeling of tiredness during prolonged exercise. ¹ - The lysine segment in proteins is the first step in the synthesis of carnitine, which increases the work tolerance of muscles. ¹ - Used with glycine and arginine to increase the synthesis of creatine and thus improve performance in endurance sports. ¹ - Decrease the feeling of tiredness during prolonged exercise. ¹
<p>Repair and Recovery</p>	<p>Arginine Carnitine Creatine Monohydrate Glutamine Glycine Histidine Isoleucine Leucine Lysine Ornithine Valine</p>	<ul style="list-style-type: none"> - Arginine can increase the secretion of growth hormones, which in turn, contributes to the synthesis of muscle tissue. ^{1,2} - Promotes muscle regeneration. ² - Accelerates recovery time. ² - Reduces muscle breakdown after strenuous exercise. ² - Retards muscle degeneration by supplying additional creatine. ³ - Enhances the growth and repair of tissues. ^{2,3} - Used with leucine and valine to assist in recovery. ¹ - Decreases protein breakdown and promotes muscle sparing during heavy exercises. ¹ - Rebuilding of tendons and muscle tissue after heavy training. ² - High concentrations in muscle prevents breakdown of tissue proteins. ¹ - Assists in recovery after exercise, directly taken up by muscle cells, thus sparing muscle tissue. ^{1,2} - Taken after exercise to maximise the effects of the exercise on increasing protein synthesis in the muscle. ¹ - Helps to build muscle proteins, and thus important for recovery from sports injuries. ³ - Promotes high levels of growth hormone after exercise, improving recovery. ² - Assists in recovery by rebuilding muscle tissue after heavy training. ^{1,2} - In combination with other branched chain amino acids, it decreases muscle wasting. ²

Immunity	Glutamine	<ul style="list-style-type: none"> - Useful in the prevention or amelioration of overtraining syndrome, the condition of decreased immunity suffered by athletes after vigorous training.¹
Weight Loss	Carnitine Cysteine Cystine Inositol Leucine Methionine Ornithine Tyrosine	<ul style="list-style-type: none"> - Enables the transport of fatty acids in the form of acyl CoA to sites at which they are converted to energy.^{1,3} - Reports from body builders indicate that it is very effective in reducing body fat and achieving a “cut” look. This is probably due to the preferential use of fatty acids as an energy source and the ability to affect lipoproteins responsible for transporting fats in the blood.¹ - Promotes the use of adipose tissue as energy.² - Facilitates the synthesis of insulin and compromises about 12% of insulin, which is important for balancing blood glucose and thus reducing cravings for sugar.² - Common ingredient in weight-loss formulas due to ability to mobilise fats.¹ - Reduces appetite.² - Used with inositol and choline as a lipotropic formulation to aid weight loss.¹ - Assists in the breakdown of fats.³ - Promotes metabolism of body fat.² - Appetite suppressant.^{2,3} - Reduces body fat.³

Brain Biochemistry

Condition	Amino Acid	Description of Function
General Mental Function	Alanine	- Acts as an inhibitory neurotransmitter. ²
	Asparagine	- Maintains balance in the central nervous system, preventing a person from being overly calm or overly nervous. ³
	Aspartic Acid	- Acts as an excitatory neurotransmitter, increases firing of neurons in the nervous system. ^{2,3}
	Glutamic Acid	- Precursor for GABA, the most prevalent inhibitory neurotransmitter in the CNS. ¹
		- Removes excess ammonia from the brain. ²
	Glutamine	- Transports potassium into the cerebrospinal fluid (CSF). ²
		- Useful in the treatment of mental retardation. ¹
		- Dominant amino acid in CSF. ²
	Glycine	- Precursor for GABA. ²
		- As a neurotransmitter, glycine is present in the brain stem, spinal cord and retina. ¹
	Histidine	- Inhibitory neurotransmitter. ²
		- Precursor for the neurotransmitter histamine, which has been implicated in the regulation of arousal, cognition, circadian rhythms and neuroendocrine regulation. ¹
	Inositol	- Involved in the synthesis of myelin sheaths. ²
	Isoleucine	- Acts as a precursor in a secondary messenger system involving serotonin receptors. ¹
		- Influences brain uptake of phenylalanine, tyrosine and tryptophan, leading to improved brain function. ²
Leucine	- Modulates the uptake of neurotransmitter-precursor amino acids like tryptophan, phenylalanine and tyrosine into the CNS. ^{1,2}	
Phenylalanine	- Precursor of tyrosine, which is in turn the precursor of the neurotransmitters adrenaline and noradrenaline, dopamine, thyroxine and melanin. ^{1,2,3}	
Proline	- It may act as a neurotransmitter or an enhancer of synaptic transmission. ¹	
Serine	- Catalyses hydrolytic reactions like inactivating excess acetylcholine (a neurotransmitter) at neuromuscular junctions. ¹	
	- Constituent of phospholipids in the brain and cell membrane. ²	
Taurine	- Thought to act as a neurotransmitter in some areas of the brain and retina. ¹	
Tyrosine	- Precursor of the neurotransmitters dopamine, adrenaline and adrenaline. ^{1,2,3}	
Valine	- Like other branch-chained amino acids, it can influence the uptake into the brain of the neurotransmitter-precursors tryptophan, phenylalanine and tyrosine. ^{1,2}	

General Metabolism	Aspartic Acid Glutamic Acid	<ul style="list-style-type: none"> - Metabolic control in the brain and nervous system. ² - Other than glucose, Glutamic acid is the only energy source for the brain. ^{2,3}
Performance / Alertness	Carnitine Glutamic Acid Lysine Phenylalanine Tyrosine	<ul style="list-style-type: none"> - Increases alertness and arousability in children with neurological handicaps. ¹ - Increases mental and physical alertness in mentally retarded patients. ¹ - Given in bread, it improves the performance of school children whose major protein source is cereal. ¹ - Used in preparations marketed as “smart drugs”, probably due to the elevation of brain neurotransmitters. ^{1,3} - Improves concentration. ²
Memory	Aspartic Acid Glutamic Acid Phenylalanine Tyrosine	<ul style="list-style-type: none"> - Acts as an excitatory neurotransmitter. ² - Stimulatory neurotransmitter → improved memory. ² - Aids in memory and learning. ³ - Improves memory in subjects suffering from stress-induced memory loss. ¹
Depression	Arginine Glutamine Glycine Inositol Phenylalanine Tryptophan Tyrosine	<ul style="list-style-type: none"> - A combination of arginine and aspartic acid are used to treat postpartum depression. ¹ - May have an anti-depressant effect. ¹ - Used in the treatment of bipolar depression. ³ - Doses of 12 g per day shown to successfully treat depression. ¹ - Elevates mood and enables individual to overcome depression. ³ - Potentiates lithium, which may help alleviate depression. ² - Acts as an anti-depressant. ¹ - Effectively treats depression, acting as a mood elevator. ^{1,3}
Insomnia	Tryptophan	<ul style="list-style-type: none"> - Precursor of melatonin and serotonin, which are important for regulating sleep and sensory perception. ^{2,3} - Works as a nocturnal sedative. ¹

Cravings / Addictions	<p>Arginine</p> <p>Aspartic Acid Cystine</p> <p>Glutamic Acid Glutamine</p> <p>Leucine</p> <p>Methionine Phenylalanine</p> <p>Tryptophan Tyrosine</p>	<ul style="list-style-type: none"> - Arginine increases the secretion of insulin, which in turn controls the hypothalamic satiety centre. Insulin also plays a key role in the formation of serotonin, a neurotransmitter that controls sugar and carbohydrate cravings. ¹ - Useful for the treatment of opiate addiction. ¹ - Facilitates the synthesis of insulin and comprises about 12% of insulin, which is important for balancing blood glucose and thus reducing cravings for sugar. ² - Reduces alcohol cravings. ² - Reduces alcohol cravings. ² - Stimulates the production of insulin, and thus reduces carbohydrate cravings. ² - Stimulates insulin release. ² - Appetite suppressant. ² - Reduces alcohol cravings by reducing histamine levels. ² - Phenylalanine causes the release of cholecystokinin, which was found to control appetite and fat intake. ¹ - Reduces carbohydrate and alcohol cravings. ² - Appetite suppressant. ²
Pain	<p>Leucine</p> <p>Methionine Ornithine</p> <p>Phenylalanine</p> <p>Serine Tryptophan</p> <p>Tyrosine</p>	<ul style="list-style-type: none"> - Promotes the release of enkephalins from the brain, which helps to prevent the passage of pain information into the nervous system. ^{1,2} - Promotes endorphin production and is thus analgesic. ² - Shown to have anti-nociceptive (pain killing) effects in rats and mice thought to be due to stimulation of kyotorphin receptors in the brain. ¹ - Constituent of enkaphalins. ² - Decreases the pain associated with migraine, menstruation and arthritis. ³ - Enhances the effects of opiates by increasing opiate binding. ² - Beneficial effects on migraine, and provided pain relief for patients after neurosurgery. This is probably due to its ability to potentiate the analgesic effect at opioid receptors. ¹ - Increases the anti-nociceptive effects of narcotic analgesics. ¹ - Stimulates endorphin production. ²
Narcolepsy	Tyrosine	<ul style="list-style-type: none"> - Used in the treatment of narcolepsy. ¹

Mood Disorders / Psychosis	Glutamic Acid Glycine Inositol Tryptophan	<ul style="list-style-type: none"> - Helps correct personality disorders.³ - Negative symptoms of schizophrenia can be decreased with glycine administration in doses of 0.8 g/kg/day.¹ - Used to treat a variety of psychiatric disorders.¹ - Doses of 12 g per day shown to successfully treat panic disorders.¹ - Doses of 18 g per day linked to beneficial effects in obsessive-compulsive disorders.¹ - Precursor for serotonin, which is important for regulating mood and behaviour.^{1,3}
Epilepsy	Arginine Glutamic Acid Glutamine Glycine Taurine Tryptophan	<ul style="list-style-type: none"> - Precursor for the synthesis of GABA, a neurotransmitter in the brain. GABA decreases epileptic seizures by inhibiting the nerve cells from firing too fast.¹ - Treats petit mal epilepsy.¹ - Effective in the treatment of epilepsy.^{1,3} - Its inhibitory action helps prevent epilepsy.³ - Used to treat some forms of epilepsy.¹ - Use in some forms of epilepsy has produced promising results.¹
Phenylketonuria	Isoleucine	<ul style="list-style-type: none"> - Competes with phenylalanine for uptake into the brain, and thus has been used with some success to treat phenylketonuria.¹

Detoxification

Condition	Amino Acid	Description of Function
General Detoxification	<p>Aspartic Acid</p> <p>Carnitine Cysteine</p> <p>Glutamic Acid Glycine</p> <p>Methionine</p> <p>Taurine</p>	<ul style="list-style-type: none"> - Combines with other amino acids to form molecules that absorb toxins and remove them from the bloodstream.³ - Enhances the effectiveness of antioxidant vitamins C and E.³ - Precursor of glutathione and co-enzyme A, both of which have important biological functions in detoxification and fat metabolism.^{1,3} - Acts as an antioxidant against superoxide and hydrogen peroxide, useful in preventing cataracts.² - Essential component of potent antioxidant glutathione peroxidase.² - Inhibits aflatoxin.² - Essential component of glutathione, important for the formation of glutathione peroxidase.² - One component of glutathione, which forms glutathione peroxidase to reduce toxic peroxides in cells.^{1,2} - Facilitates production of glutathione.² - Acts as an antioxidant.² - Acts as an antioxidant.¹ - Suitable antioxidant in eye drops to treat damage caused by oxidising substances.¹
Drug and Alcohol Metabolism	<p>Alanine</p> <p>Cysteine Cystine</p> <p>Glutamic Acid Glutamine</p> <p>Methionine</p> <p>Taurine Tyrosine</p>	<ul style="list-style-type: none"> - Together with methionine, it reduces the general symptoms of hangover, including headache, stomach discomfort and nausea.¹ - Protects against the toxic effects of alcohol and its metabolites.² - Protects the liver and brain against alcohol.² - Role in modulating opioid receptors.¹ - Used to treat alcoholism.¹ - Protective against the toxic effects of alcohol.² - Lowers the circulating levels of acetaldehyde after ethanol ingestion, and is thus used to treat hangovers.¹ - Used in the treatment of alcohol withdrawal symptoms.¹ - Combined with tryptophan, it may help with cocaine withdrawal.^{1,3}

Radiation	Cysteine Taurine	<ul style="list-style-type: none"> - Protects against the effects of exposure to radiation and chemotherapy. ^{1,2} - Its antioxidant effect has led to successful treatment of radiation injuries. ¹
Poisoning	Cysteine Methionine	<ul style="list-style-type: none"> - Used in the treatment of poisoning, where it possibly acts through production of glutathione. ¹ - Enhances the synthesis of glutathione, and is thus used in the treatment of paracetamol poisoning to prevent liver damage. ¹
Nitrogen / Ammonia	Arginine Aspartic Acid Creatine Monohydrate Glutamic Acid Glutamine Glycine Lysine Ornithine	<ul style="list-style-type: none"> - Converts toxic ammonia to the non-toxic and easily excreted compound urea. ^{1,3} - Effective in the treatment of hyperammonaemia secondary to liver failure. ¹ - Detoxification of ammonia and other muscle waste products. ^{2,3} - Involved in transamination and deamination reactions in the urea cycle. ² - Beneficial in the therapy of hyperammonaemia. ¹ - Decreases ammonia production during exercise. ² - Treats conditions which cause high concentrations of ammonia in the blood. ¹ - Removes excess ammonia from the brain. ² - Carries nitrogen from the brain and muscles to the liver to be converted to non-toxic urea. ¹ - Major transporter of ammonia. ² - Increases clearance of uric acid. ² - Precursor of citrulline, essential component for proper functioning of the urea cycle. ² - Intermediate in the urea cycle, and is used to treat hyperammonaemia. ¹ - Promotes ammonia detoxification in the urea cycle. ^{2,3}
Heavy Metals / Chelation	Cysteine Cystine Glutamic Acid Histidine Methionine Taurine	<ul style="list-style-type: none"> - Chelates Al, As, Cd, Cu, Pb, Hg. ² - Reduces the body's absorption of copper, and thus protects against copper toxicity. ³ - Beneficial effect in mercury poisoning. ¹ - Chelates Cu and Zn. ^{2,3} - Chelates heavy metals. ² - Facilitates the excretion of Al, As. ²

<p>Liver Function</p>	<p>Arginine Aspartic Acid Cysteine Cystine Glutamine Glycine Isoleucine Leucine Methionine Taurine Tryptophan Valine</p>	<ul style="list-style-type: none"> - Aids in liver detoxification.³ - Beneficial in patients with chronic hepatitis.¹ - Hepatoprotective, especially against alcohol.² - Protects the liver and brain against alcohol.² - Used to treat liver disease.¹ - Important for conjugation reactions in the liver, where it helps in the detoxification of foreign compounds.^{1,2} - Used to treat liver failure and hepatic encephalopathy.¹ - Used to treat liver failure and hepatic encephalopathy.¹ - Enhances the synthesis of glutathione, and thus assists the liver in detoxification.¹ - Assists in the breakdown of fats, preventing the build-up of fat in the liver.³ - Useful in treating complications of cirrhosis like muscle cramps and encephalopathy.¹ - Successfully treats fatty liver in children.¹ - Antioxidant effects in the liver, especially protective against metabolites of alcohol.² - Stimulates liver protein synthesis.² - Promotes liver repair.²
<p>Lymphatic System</p>	<p>Alanine Arginine Cysteine</p>	<ul style="list-style-type: none"> - Connective tissue proteins like collagen and elastin, are rich in alanine. This is important for the integrity of connective tissue structures like lymph glands and skin, which are involved in detoxification processes.¹ - Contributes to thymus growth.² - Stimulates T-lymphocytes, enhances thymus gland activity.² - Increases size of thymus gland, and improves T-lymphocyte response.²
<p>Renal Support</p>	<p>Arginine Aspartic Acid Glutamic Acid Glycine</p>	<ul style="list-style-type: none"> - Aids in kidney disorders and trauma.³ - Prevents chronic renal failure and prevents age-related reduction in renal function in rats.¹ - Inhibits the formation of calcium stones.¹ - Reduces formation of calcium oxalate in the urine, and thus reduce the incidence of kidney stones.² - Decreases the nephrotoxicity of cyclosporin.¹

<p style="text-align: center;">Skin Health</p>	<p style="text-align: center;">Alanine</p> <p style="text-align: center;">Arginine Cysteine Cystine Histidine</p> <p style="text-align: center;">Leucine Methionine Tyrosine</p>	<ul style="list-style-type: none"> - Connective tissue proteins like collagen and elastin, are rich in alanine. This is important for the integrity of connective tissue structures like lymph glands and skin, which are involved in detoxification processes.¹ - Enhances wound healing and immune responses.¹ - Major component of keratin, which is found in skin.² - Aids in the formation of skin.³ - Deaminated to form urocanic acid, which tends to build up in the skin. Urocanic acid is the major UV-absorbing compound in the skin, and thus helps to protect the skin against sun exposure.¹ - Histidine deficiency leads to skin lesions like dermatitis.¹ - Promotes the healing of skin.³ - Promotes skin health.² - Essential for melanin production and skin pigmentation.²
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* In the section on Detoxification, I included the lymphatic system, skin and renal system, as these are also vital for detoxification processes.

GIT Repair and Support

Condition	Amino Acid	Description of Function
Digestion	Arginine Aspartic Acid Histidine Phenylalanine	<ul style="list-style-type: none"> - Increases the secretion of gastrin, a hormone which causes the secretion of gastric acid and pepsin, which are essential for normal digestion. ¹ - Fundamental part of many digestive enzymes. ² - Stimulates production of gastric secretions via histamine. ^{1,2,3} - Causes secretion of gastrin from the stomach, which in turn, increases the secretions of acid and the digestive enzyme pepsinogen, improves stomach motility and thus facilitates gastric digestion. ¹ - Stimulates the release of cholecystokinin. ²
Absorption	Aspartic Acid Cysteine Glycine Methionine Serine Taurine	<ul style="list-style-type: none"> - Enhances potassium and magnesium uptake. ² - Promotes the absorption of iron from the intestines. ¹ - Increases the absorption of selenium from the intestines. ¹ - Improves iron absorption. ¹ - Enhances calcium and magnesium absorption. ² - Promotes the absorption, transport and bioavailability of selenium. ² - Increases the absorption of iron from the GIT. ¹ - Key component of bile, required for the absorption of fat-soluble vitamins. ³
GIT Integrity	Glutamine Taurine	<ul style="list-style-type: none"> - Improves gut function. ¹ - Supports the intestinal mucosa and generally enhances GIT health. ² - Major fuel source for the intestines. ² - Antioxidant effects protect against NSAIDs-induced gastric mucosal damage. ¹
GIT disturbances	Alanine Glutamine Inositol	<ul style="list-style-type: none"> - Decreases severity of diarrhoea, and addition to oral rehydration solutions have been found to be beneficial. ¹ - Glutamine enrichment has been suggested for treating inflammatory bowel disease. ¹ - Treats mild constipation. ¹

GIT Wound Healing	Arginine Glutamine Histidine	<ul style="list-style-type: none"> - Enhances wound healing and immune responses. ¹ - Promotes wound healing. ² - Enhances the growth and repair of tissues. ²
Electrolyte and Fluid Balance	Glutamine	<ul style="list-style-type: none"> - Stimulates the absorption of water and electrolytes across the intestinal wall. ¹ - Prevents fluid loss from the intestines. ²
Acid / Base Balance	Arginine Glycine Histidine Lysine	<ul style="list-style-type: none"> - Used to treat systemic alkalosis. ¹ - Can be used in conjunction with antacids to treat hyperacidity. ¹ - Used to treat hyperacidity. ³ - Used in the treatment of metabolic alkalosis. ¹
GIT Cancers	Arginine	<ul style="list-style-type: none"> - Enteral supplementation postoperatively for patients with upper GIT cancer significantly reduced hospital stays. ¹ - In experimental models of colorectal cancer in rats, it reduced tumour incidence and size. ¹
Anorexia Nervosa	Carnitine Taurine	<ul style="list-style-type: none"> - A combination of carnitine, pantethine and cyproheptadine is effective in treating this disorder. Changes include body weight gain, improved gastrointestinal function, disappearance of fatigue and improved mental function. ¹ - Facilitates the transfer from parenteral nutrition to enteral feeding for anorexic patients. ¹ - Appetite stimulant. ²
GIT Ulcers	Cysteine Glutamine Methionine	<ul style="list-style-type: none"> - Shown to prevent experimentally induced peptic ulcers. ¹ - Beneficial effects on duodenal ulcers. ¹ - Useful in the treatment of peptic ulcers. ¹ - Given with cimetidine, it improves the healing of duodenal ulcers. ¹
Starvation	Glutamine	<ul style="list-style-type: none"> - Energy source for the intestines and kidney during starvation. ¹

