AMINO ACIDS

Proteins Regulation

- Levels of proteins, enzymes, neurotransmitters, hormones
- Regulate gene expression
- Protect from oxidative stress
- Immune responses
- Replacement of cells
- Wound healing

Amino Acid Pool

- Pool of free amino acids in:
  - Organs (eg skeletal muscle, liver, kidneys)
  - Tissues (eg blood, white adipose tissue, skin)
  - Cells (eg hepatocytes, macrophages, lymphocytes)
  - Intracellular organelles (eg cytoplasm, mitochondria)

Gene Expression

- Genetic code inside the gene encodes for a sequence of AA
- AA involved in the making of the purines and pyrimidines which form the basis of the nucleotides, adenine, cytosine, guanine, thymine and uracil

Gene Expression

Arginine	Glutathione
Asparagine	Proline
Glutamine	Glycine
Methionine	Leucine

Gene Expression

Purine & Pyramidine Synthesis

- Aspartate
- Glutamine
- Serine

Gene Expression

- GLUTAMINE increases intestinal expression of genes for cell growth and removal of oxidants
- Reduces the expression of genes that promote oxidative stress and immune activation
- Transcription of a gene to RNA by affecting RNA polymerase, repressors, coactivators or corepressors

Gene Expression

- METHIONINE
- SAM – methylation of proteins and DNA, regulation of gene expression
- GLUTATHIONE – (Cys, Glu, Gly) – regulation of gene expression

Anti-Oxidant Defence

- Alanine – via Beta alanine
- Arginine
- Citrulline
- Taurine
- Glycine
- Histidine
- Methionine

Anti-Oxidant Defence

- Creatine (Methionine, Arginine, Glycine)
- Glutathione (Cysteine, Glutamate, Glycine)
- Carnitine (Lysine & Methionine)

Immunity

- Prevention of the invasion of pathogens depends on specific and non specific immune system
- Glutamic Acid and Aspartic acid can boost the immune system
- Histidine involved in modulation of immune response in the skin and protects against UV radiation

Immunity

- Glutamine modulates the expression of genes that regulate Nitric oxide synthase
- NOS catalyses arginine oxygenation to form Nitric Oxide
- INOS critical for killing of pathogens - parasites, fungi, -ve bacteria, virus

Immune Why 600 Product

- Arginine
- Vitamin C
- Zinc
- Selenium
- Potassium
- calcium

Immunity

- Leucine involved in the regulation of immune responses
- Proline via metabolite H2O2 kills pathogens
- Threonine involved in immune function
- Tryptophan via metabolites

Immunity

- Serotonin, N-Acetylserotonin, melatonin inhibit production of inflammatory cytokines and superoxide
- Anthranilic acid inhibits production of proinflammatory T-helper-1 cytokines, prevents autoimmune neuroinflammation

Immunity

- Tyrosine produces dopamine is involved in immune response
- Tyrosine via melanin, inhibits the production of inflammatory cytokines and superoxide
- Arginine and methionine involved in apoptosis

Immunity

- Arginine, methionine and glycine via creatine has an anti-viral and anti-tumour
- Cysteine, glutathione and glycine involved in apoptosis and immune response
- Gln, aspartate, glycine involved in lymphocyte proliferation

Replacement of cells

- Protein synthesis needed for all cells, particularly rapid turnover
- Epithelial cells of GI tract, mammary glands and skin
- Reticulocytes
- Immune system – lymphocytes
- Gamete cells of reproductive system

Wound healing

- Immune system stimulates the division of cells in wounded tissue and the production of collagen
- Arginine produces nitric oxide
- Lysine, hydroxylysine
- Proline, hydroxyproline, structure of collagen
- Glycine

Nutrient Metabolism

- Alanine - Beta alanine – a component of CoA & pantothenic acid
- Arginine & Phenylalanine - activation of tetrahydrobiopterin (co-factor for INOS)
- Aspartate – synthesis of Inositol

Nutrient Metabolism

- Glutamine – synthesis of NAD (P)
- Tryptophan – synthesis of Niacin, precursor of NAD, NADP

AMINO ACIDS

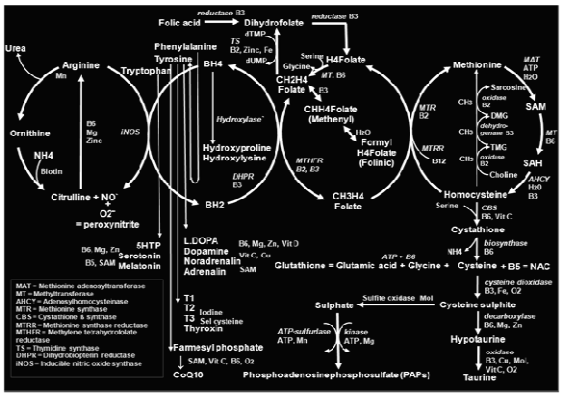
Functions of Individual Amino Acids

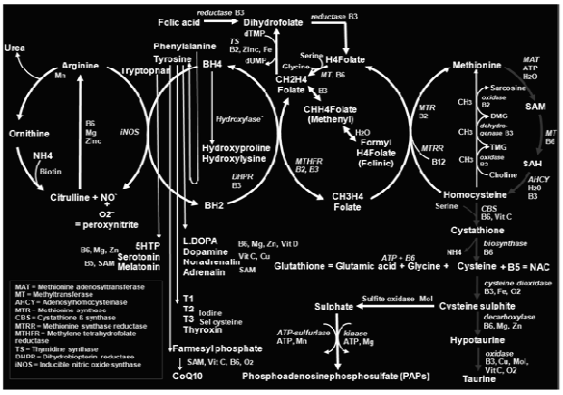
Sulphur containing Amino Acids

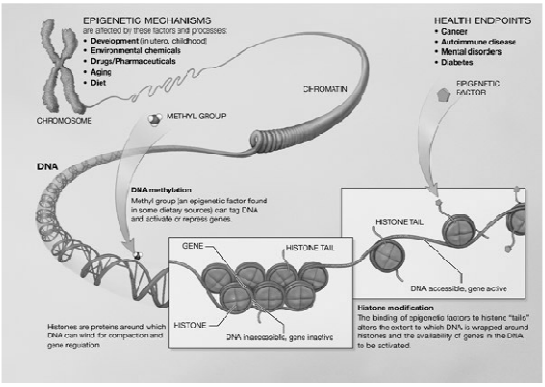
- **Methionine**
- **Cysteine**
- **Taurine**

Sulphur containing Amino Acids

- **Chemically different from other amino acids since they contain a sulphur molecule**
- **Sulphur combines with hydrogen molecules to become powerful anti-oxidants to fight free radicals**
- **Methionine, cysteine, taurine**


Folic acid
Dihydrofolate
reductase B3
Urea
Arginine
Ornithine
NH4
Biotin
Citrulline + NO⁻ + O2⁻ = peroxynitrite
Phenylalanine
Tyrosine
Tryptophan
BH4
BH2
Hydroxylase
Hydroxyproline
Hydroxylysine
DHPR
iNOS
H4Folate
CH2H4 Folate
CHH4Folate (Methenyl)
Formyl H4Folate (Folinic)
CH3H4 Folate
MTHFR
Methionine
SAM
SAH
Homocysteine
Cystathione
Glutathione = Glutamic acid + Glycine + Cysteine + B5 = NAC
Cysteine sulphite
Sulphate
Hypotaurine
Taurine
Phosphoadenosinephosphosulfate (PAPs)
Farnesyl phosphate
CoQ10
LDOPA
Dopamine
Noradrenalin
Adrenalin
5HTP
Serotonin
Melatonin
T1
T2
T3
Iodine
Thyroxin
MAT = Methionine adenosyltransferase
MT = Methyltransferase
AHCY = Adenosylhomocysteinase
MTR = Methionine synthase
CBS = Cystathione β synthase
MTRR = Methionine synthase reductase
MTHFR = Methylene tetrahydrofolate reductase
TS = Thymidine synthase
DHPR = Dihydrobiopterin reductase
iNOS = Inducible nitric oxide synthase


Folic acid
Dihydrofolate
reductase B3
Urea
Arginine
Ornithine
NH4
Biotin
Citrulline + NO⁻ + O2⁻ = peroxynitrite
Phenylalanine
Tyrosine
Tryptophan
BH4
BH2
Hydroxylase
Hydroxyproline
Hydroxylysine
DHPR
iNOS
H4Folate
CH2H4 Folate
CHH4Folate (Methenyl)
Formyl H4Folate (Folinic)
CH3H4 Folate
MTHFR
Methionine
SAM
SAH
Homocysteine
Cystathione
Glutathione = Glutamic acid + Glycine + Cysteine + B5 = NAC
Cysteine sulphite
Sulphate
Hypotaurine
Taurine
Phosphoadenosinephosphosulfate (PAPs)
Farnesyl phosphate
CoQ10
LDOPA
Dopamine
Noradrenalin
Adrenalin
5HTP
Serotonin
Melatonin
T1
T2
T3
Iodine
Thyroxin


EPIGENETIC MECHANISMS
are affected by these factors and processes
• Development (in utero, childhood)
• Environmental chemicals
• Drugs/Pharmaceuticals
• Aging
• Diet
HEALTH ENDPOINTS
• Cancer
• Autoimmune disease
• Mental disorders
• Diabetes
CHROMATIN
EPIGENETIC FACTOR
CHROMOSOME
METHYL GROUP
DNA
DNA methylation
Methyl group (an epigenetic factor found in some dietary sources) can tag DNA and activate or repress genes.
GENE
HISTONE TAIL
HISTONE
DNA inaccessible, gene inactive
HISTONE TAIL
DNA accessible, gene active
Histones are proteins around which DNA can wind for compaction and gene regulation
Histone modification
The binding of epigenetic factors to histone "tails" alters the extent to which DNA is wrapped around histones and the availability of genes in the DNA to be activated.

Methionine - Methylation

- Gene regulation
- Represses or activates genes
- DNA is coiled around proteins called histones
- Each histone has a loose end or tail to which chemicals can attach
- Alters how tightly the DNA is wound around the histone

Methionine - Methylation

- So long as the DNA remains tightly coiled the gene does not activate, to activate the DNA must be partially unwound
- Adding a methyl group switches the gene off and removing a methyl group switches it back on

Methionine - Methylation

- Maintaining the integrity of our DNA over our lifetime is critical to prevent aging, cancer and degenerative diseases
- Methyl groups decide which genes are expressed
- Methyl groups depleted in toxic environment

Some Methylation functions
Phosphatidylethanolamine to phosphatidylcholine
Noradrenalin to adrenalin
Metabolism Dopamine, Noradrenalin, Serotonin
Metabolism of Estrogens and Testosterone
DNA methyltransferase
Methyl Caps DNA /RNA
Synthesis of Creatine, Carnitine
Histone methyltransferases
Synthesis of myelin

Cysteine – the Detoxifier

- **Contains a sulphur molecule and so becomes a powerful antioxidant**
- **Cysteine is highly reactive, rapidly converted to the more stable cystine**
- **Converts to NAC**

Cysteine – the Detoxifier

- **Thiol groups at end of each cystine molecule to prevent oxidation and eliminate toxic chemicals and heavy metals**
- **Produces NAC and glutathione, powerful detoxifying agents in body**

Cysteine – the Detoxifier

- Active part in fatty acid synthase. Uses the thiol groups to fasten carbon atoms, two at a time, onto the lengthening chains that make up each fatty acid
- Horny layers of the skin, hair and nails are high in cystine

Taurine – Good for the Heart

- By-product of sulphurous amino acids cysteine and methionine
- Not contain a carboxyl group and not used in protein strings
- An amino sulphonic acid
- Critical in preterm and newborns – normal growth and development

Taurine

- Increases levels of prolactin
- Concentrated in CNS, heart, and retina
- Facilitates the passage of sodium, potassium, calcium and magnesium ions in and out of cell and electrically stabilises the cell membrane

Taurine

Brain and CNS

- **Most plentiful amino acid in developing brain and second in the adult brain. Mostly in olfactory bulb, hippocampus and pineal**
- **Inhibitory neurotransmitter, anti-anxiety and protects against glutamate excitotoxicity**

Taurine

Heart

- **Most abundant free amino acid**
- **Metabolism of calcium for the transmission of nerve impulses**
- **Depleted in arrhythmia or abnormal heartbeats**
- **Promotes pumping, increases force of heart muscle contraction**

Taurine

Hypertension

- **Antagonist to blood pressure increasing effect of angiotensin**
- **With low levels of taurine, renin is activated and angiotensin is formed and blood pressure rises**
- **Taurine breaks the renin-angiotensin feedback loop**

Taurine

Gall Bladder function

- **Stimulates taurocholic acid, bile salt which breaks down fats in SI**
- **Increases the cholesterol excretion in bile**
- **Improves fat metabolism in the liver and lowers atheroscelerotic plaque in the arteries**

Taurine

Eye

- **Most abundant amino acid in retina**
- **Low levels in retinitis pigmentosa**
- **Protects the eye from toxins**

Antioxidant

- **Particularly effective against hypochlorite**

Taurine

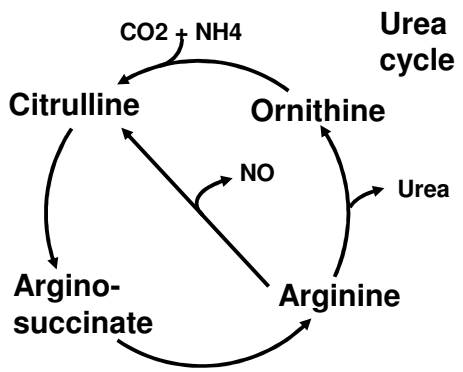
- **Can be used in prevention of epileptic seizures**
- **Acts as an antioxidant and protects against toxicity, such as lead and cadmium**

Arginine – Urea amino acid

- **Can be essential for children, stimulates growth hormone and insulin**
- **Functions in urea cycle to excrete excess nitrogen in urine from the breakdown of proteins**
- **Elimination of ammonia which is produced during deamination,**

Arginine – Urea amino acid

- **Eliminates ammonia from parasites and metabolism of other amino acids and DNA bases**
- **Created from ammonia and carbon dioxide >citrulline > arginine > ornithine**



Arginine – Nitric Oxide

- **Precursor to nitric oxide, helps to dilate and relax the blood vessels**
- **CV prevention. Helps with high BP, clogged arteries, angina, heart failure, coronary heart disease, erectile dysfunction**

Nitric Oxide Formula Product

Citrulline	**ATP**
Hawthorn	**Manganese**
Vitamin C	**Niacin**
Beetroot	**Folic Acid**
Magnesium	**Vitamin B12**
Zinc	
Vitamin B6 (as P5P)	

Arginine – Nitric Oxide

- **Nitric oxide kills gram positive bacteria, viruses and fungi**
- **NO synthesis is stimulated by arginine, citrulline and taurine**
- **BUT inhibited by high levels of lysine, glutamine and homocysteine**

Arginine – the Cholesterol Fighter

Cholesterol Regulation

- **Lowers blood cholesterol and inhibits fat absorption**
- **The higher the Arginine to Lysine ratio, the lower the cholesterol**

Arginine – "Lean and Mean"

- **Helps to reduce body fat and increase lean muscle mass**
- **Used in the treatment of obesity**
- **It forms the building blocks of creatine, needed for making energy in the muscles**

Inhibitors of Arginine

- **High lactate inhibits the synthesis of citrulline from proline by inhibiting proline oxidase acitivity, so limiting the production of arginine from citrulline in the kidneys**
- **Therefore, intensive exercise may contribute to lower levels of ARG**

Inhibitors of Arginine

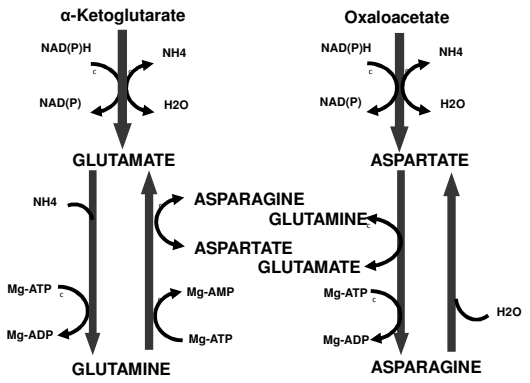
- Lysine competes with ARG for entry into cells and inhibits arginase activity
- Arginine + H_2O → ornithine + urea
- LYS to ARG ratio critical for ARG utilisation in body

Inhibitors of Arginine

- Glucocorticoids upregulate arginine catabolism via the arginase pathway
- Glucocorticoids inhibit NO generation by supressing NOS expression

Glutamate Amino Acids

- Glutamic Acid
- Glutamine
- Proline
- Aspartic Acid
- Asparagine



Glutamic Acid & Glutamine – Brain

- GA made from alpha-ketoglutarate
- Glutamic Acid is an excitatory neurotransmitter
- High concentration in the brain, in cranial nerves and hippocampus
- Mental performance, alertness, attentiveness
- Regulates glycolysis

Glutamic Acid + unpasterised butter

- Role transferring calcium to the bone and decalcifying the arteries
- GA is imported into the walls of the arteries where it binds to calcium and removes it from the blood vessels
- K2 (unpasteurised butter) integrates calcium into the bone

Glutamic Acid & Glutamine – Brain

Glutamine

- **Primary source of brain fuel**
- **Made from Glutamic Acid**
- **Mediator of GA and GABA activity, maintains balance in CNS**
- **Each molecule contains 2 nitrogen atoms, good for transporting nitrogen**

Glutamic Acid & Glutamine – Brain

Glutamine

- **Role in DNA by contributing nitrogen in making of purines and pyrimidines**
- **Denotes nitrogen to form niacin**
- **Participates in metabolism of arginine**

Glutamic Acid & Glutamine – Brain

Glutamine

- **Helps clear ammonia from tissues, specially the brain**
- **Role in metabolism of sugar and fats**
- **Essential for ATP production**

Glutamic Acid & Glutamine – Brain

Glutamine

- **Used to treat intestinal permeability, atrophy or damage**
- **Glutamine increases the expression of anti-oxidative genes and reduces the expression of proinflammatory genes in SI**
- **Intestinal mucosal immunity**

Proline – Collagen synthesis

- **Made from the breakdown of glutamic acid**
- **Improves skin texture by making collagen and reducing the loss through the aging process**

Proline

- **On a per gram basis, the requirement for proline is highest**
- **Growing evidence that it is a key regulator in cell processes**
- **Major role in neonatal SI and placenta, both tissues have high rates of protein synthesis and cell proliferation**

Proline

- Proline and metabolites now known to regulate gene expression and cellular signalling pathways
- Scavenges free radicals, it increases in response to cellular oxidative stress
- Acts in concert with ARG, GLU, LEU to enhance protein synthesis

Proline

- Prevention of Arteriosclerosis
- Proline enables the walls of arteries to release fat build up into the bloodstream
- So decreasing the pressure built up by fatty blockages

Aspartic acid & Asparagine - Energy

- 2 similar structures involved in generation and transport of energy
- Aspartic acid made from glutamate
- Asparagine made from Aspartic acid and ATP
- Asparagine combines with ammonia to form aspartic acid , reversible reaction

Aspartic acid & Asparagine - Energy

- **Asparagine maintains the balance between too much or too little stimulation in CNS**

Aspartic acid - Energy

- **Regulates glycolysis (glucose to pyruvate)**
- **Krebs cycle, helps to activate the process by transporting energy into the mitochondria**
- **In urea cycle – forms carbamyl phosphate, the key enzyme which starts the urea cycle**

Aspartic acid - Energy

- **Helps to move magnesium and potassium across the intestinal lining, which helps improve energy production in muscles**
- **Deficiency may lead to Chronic Fatigue Syndrome**

Threonine Amino Acids

- **Threonine**
- **Glycine**
- **Serine**
- **Alanine**

Threonine – the Immunity Booster

- **Promotes the growth of the thymus, vital for immune defence**
- **Rats supplemented with threonine showed significant increase in thymus weight and increased immunoglobulin (IgA, IgE, IgG, IgM) response**

Threonine – the Immunity Booster

- **Identified as protecting against mental instability and irritability**
- **Helps with digestion and improves intestinal absorption**
- **Helps to metabolise fats and controls fat build up in the liver**

Threonine

- **Useful in treating CNS, studies shown to help MS**

Glycine – collagen helper

- **Derived from serine and threonine, also dimethylglycine**
- **Collagen contains glycine, proline and lysine**
- **Helps with storing energy, builds up glycogen levels**
- **Major inhibitory neurotransmitter**

Glycine

- **Detoxification**
  - **Stimulates the production of glutathione**
  - **Detoxifies benzoic acid**
  - **Reduces levels of uric acid**
- **Generates HEME**
- **Creates purines (RNA & DNA)**
- **Creates creatine**

Glycine

- Produces serine
- Conjugation of bile acids, key role in the digestion and absorption of lipids and fat soluble vitamins
- Regulates the production of cytokines and superoxide, role in immune function

Collagen Formula Product

Glycine	Vitamin C
Lysine	Magnesium
Proline	Zinc
	Manganese
	Copper
	Niacin

Elastin Formula Product

Glycine
Alanine
Vitamin B6 as P5P
Bilberry Extract
Copper

Serine - Memory

- Derived from threonine and glycine
- Phosphatidylserine – abundant in nerve cells and active throughout the brain, particularly the hippocampus
- Memory problems, learning problems, dementia, Alzheimer's

Alanine – the hypoglycaemia helper

- Good for glycemic control
- It can be converted quickly by the liver to usable glucose
- Regulation of blood sugar levels in hypoglycaemia and diabetes
- Triggers the release of the hormone glucagon, which releases glucose from the cell

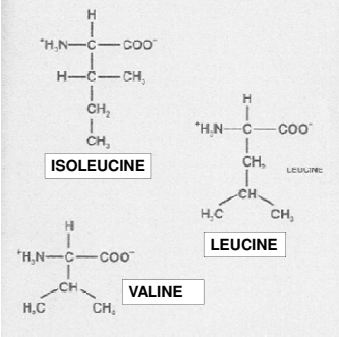
Alanine – the hypoglycaemia helper

- Alanine inhibits pyruvate kinase, enzyme which catalyses the transfer of a phosphate group yielding one molecule of pyruvate and one molecule of ATP
- Thereby regulating gluconeogenesis and glycolysis to ensure optimal glucose production

Alanine – the hypoglycaemia helper

- Largely concentrated in the muscle
- One of most important amino acids released by muscles as a form of circulating energy
- Transports nitrogen from muscles to the liver and guards against the accumulation of toxins in aerobic exercise

Branch Chain Amino Acid - Muscle



Branch Chain Amino Acid - Muscle

- Leucine, isoleucine, valine
- Protect muscle during stress or high energy states
- Act as a fuel for muscle building
- Repair muscle and prevent the breakdown of muscle
- Enhance energy and increase endurance

Branch Chain Amino Acid - Muscle

- When deficient, a "wearing out" syndrome, leading to decreased muscle mass and bone density
- Constituents of neuropeptides capable of producing a calming and pain relieving effect
- Enkephalins contain high amounts of leucine

Branch Chain Amino Acid - Muscle

- Leucine stimulates insulin release from Beta cells in pancreas. In muscles insulin stimulates protein synthesis and inhibits protein breakdown
- Low Isoleucine - muscle tremors
- Leucine is decreased in liver disease

Branch Chain Amino Acid - Muscle

- Leucine involved in the regulation of gene expression
- Leucine allosterically activates glutamate dehydrogenase (GDH), which converts glutamate to a-ketogluturate and vice versa

Branch Chain Amino Acid - Muscle

- Valine deficiency causes neurological defects in brain
- Valine is involved in the synthesis of glutamine (gene expression)
- Leucine involved in the regulation of gene expression
- Leucine allosterically activates glutamate dehydrogenase (GDH)

BCAA Product

Prevention for Sporting Injuries

Leucine
Isoleucine
Valine

Ratio 2:1:1

Lysine – Immunity, Herpes killer

- Proper growth & development in children
- Well known for fighting cold sores
- Broader immune-enhancing capabilities
- Increase growth of thymus
- Stimulate thymus factors, T & B cells

Lysine – Immunity, Herpes killer

- Lysine & Arginine share a common transport system – antagonistic
- Lysine is sacrificed in stressful situations, psychological and mental stress
- Antiviral effect by blocking the activity of arginine which promotes HSV replication

Lysine v Arginine in HSV prevention

- Increase lysine foods and reduce foods high in arginine
- Foods high in arginine are: beer, peanuts, almonds, walnuts, wheat, soybeans, sunflower seeds, chocolate

Lysine – Collagen builder

- Role in formation of collagen, made from Proline, Glycine, Lysine
- Helpful in osteoporosis
- Studies suggest that lysine along with arginine make bone building cells more active and enhances collagen production

Lysine

- **Lysine helps body absorb calcium and decreases the amount lost in urine**
- **Produces Carnitine, responsible for converting fatty acids into energy and lowers cholesterol**

Histidine – the Arthritis Fighter

- **Low levels found in Rheumatoid Arthritis and arthritic synovial fluid**
- **Has been shown to have anti-inflammatory properties**
- **Regulation of growth and repair mechanisms so can lead to slow regeneration of tissue**

Histidine

- **Deficiency can lead to slow development in children**
- **Conversion to histamine, regulates the immune defence, response to allergic reactions**
- **Methionine counteracts the formation of histamine from histidine**

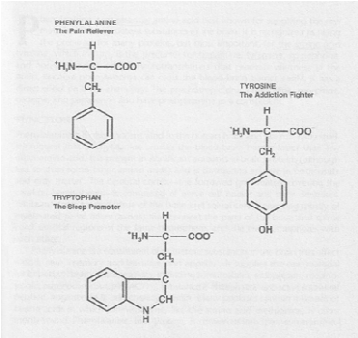
Histidine – the Arthritis Fighter

- Histamine – neurotransmitter, arousal
- Can improve sexual functioning, produces contraction of uterus
- Stimulates the secretion of pepsin and hydrochloric acid
- Helpful in hypertension due to its vasodilatory effects

Histidine – the Arthritis Fighter

- Histamine plays a role in regulating acetylcholine in CNS

Aromatic Amino Acids



Aromatic Amino Acids

- Aromatic ring in their structure
- Similar in structure and function to amphetamines
- Natural stimulants
- Phenylalanine
- Tyrosine
- Tryptophan

Phenylalanine – the Pain Reliever

- Constituent of numerous substances in the brain that affect mood, pain, memory, learning and appetite
- Blocks enzyme enkephalinase which breaks down endorphins and enkephalins

Phenylalanine – the Pain Reliever

- Studies have shown that benficial in cases of osteoarthritis, RA, low back pain, joint pains, menstrual cramps, migraines
- Shown to curb cravings
- Decreased by drinking caffeine

Phenylalanine – the Pain Reliever

- Precursor of tyrosine which produces dopamine, adrenaline and noradrenaline – promote alertness
- Useful for depression as raises noradrenaline
- Converted to phenylethylamine triggers the releases of endorphins

Tyrosine

- Precursor of thyroid hormones
- Precursor of melanin
- Precursor of neurotransmitters dopamine, noradrenaline and adrenaline
- Reducing symptoms of carvings in addiction

Tyrosine

- Research at the University of Texas on using tyrosine to reduce cocaine and alcohol cravings
- As precursor to dopamine it supplies a reward, anti craving effect
- Fights stress because it is a precursor to adrenaline

Iodine & Tyrosine Product

For thyroid dysfunction

Tyrosine	**400 mg**
Iodine	**225 mcg**

Tryptophan – the Feel Good Factor

- **Converted into serotonin so lifts depression and restores emotional equilibrium**
- **Single most studied nutrient in psychiatric community**
- **Converts to melatonin promotes sleep**

Tryptophan – the Feel Good Factor

- **Melatonin serves as an antioxidant protecting nuclear and mitochondrial DNA as well as cell membranes, proteins and lipids from oxidative injury**

Tryptophan – the Feel Good Factor

- Serotonin helps to dampen the craving for carbohydrates that increase body fat
- Tryptophan inhibits insulin release, raises blood sugar and decreases appetite
- More of a calming than stimulatory effect, modified anti-amphetamine

Amino Acid Supplementation

- Take 15 minutes at least before breakfast
- Crystalline AA are directly available for absorption by SI. Therefore they are absorbed into enterocytes and appear in the portal vein more rapidly than peptide bound AA released from protein digestion

Amino Acid Supplementation

- Antagonism or mutually adverse and opposing actions of AA
- AA antagonism commonly occurs amongst chemically or structurally related
  - Lysine-arginine-ornithine
  - Leucine-isoleucine-valine
  - Threonine-tryptophan

Amino Acid Supplementation

- Antagonism may arise from:
- Impairment of intestinal absorption
- Disturbance of AA metabolism
- Reduced generation of signalling molecules eg GABA, NO, CO, H_2S
- Excess production of toxic substances eg ammonia, homocys

Amino Acid Supplementation

- An adult can tolerate a supplemental dose of Arginine of at least 0.21-0.57g/kg body weight/day
- 15-40g per day for a 70 kg person
- According to G Wu Amino Acids Biochemistry and Nutrition 2013

Summary of Amino Acid function

<u>Sulphur Group</u>

Methionine	Methylation Detoxification
Cysteine	Detoxifier
Taurine	Heart, Brain, GB, eye, anxiety

Summary of Amino Acid function

Urea Amino acid

Arginine	**Urea cycle**
	Nitric Oxide
	Cholesterol fighter
	"Lean and Mean"

Summary of Amino Acid function

Glutamate Group

Glutamic Acid & Glutamine	**Brain**
Aspartic Acid & Asparagine	**Energy**
Proline	**Collagen**

Summary of Amino Acid function

Threonine Group

Threonine	**Immunity Booster**
Glycine	**Collagen**
Serine	**Memory**
Alanine	**Hypoglycaemia**

Summary of Amino Acid function

Branch Chain Amino Acids

Leucine, Isoleucine, Valine	Muscle
Lysine	HSV, Immunity Collagen
Histidine	Arthritis fighter Histamine

Summary of Amino Acid function

Aromatic Amino Acids

Phenylalanine	Pain reliever
Tyrosine	Thyroid
Tryptophan	Feel good factor

Essential Amino Acid

Histidine	Tryptophan
Isoleucine	Valine
Leucine	
Lysine	+ Taurine
Methionine	
Phenylalanine	
Threonine	

Non-Essential Amino Acid

Alanine	Glycine
Arginine	Proline
Asparagine	Serine
Aspartic Acid	Tyrosine
Cysteine	
Glutamic Acid	
Glutamine	

VITAMIN K2
MENAQUINONE

Function of K2

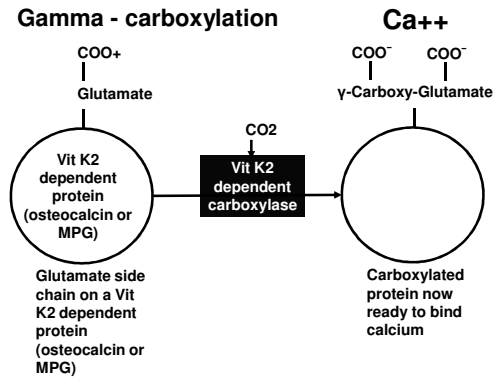
- Regulation of calcium
- Moves calcium into bones
- Removes calcium from arteries
- Fights osteoporosis
- Fights Coronary Heart Disease

K2 dependent enzymes

- K2 activates a protein called Osteocalcin, which attracts calcium into bones and teeth
- K2 activates a protein called matrix gla protein (MGP) which removes calcium from soft tissue like arteries and veins

K2 dependent enzymes

- K2 is the cofactor for an enzyme called vitamin K dependent carboxylase
- This enzyme when activated by K2 alters the structure of osteocalcin and MGP to allow those proteins to bind calcium



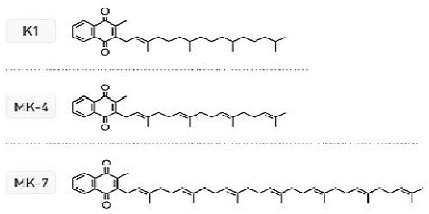
Sources of K2

- Diet and bacterial synthesis
- Dietary sources of pre-made K2 take the form of fat from animals who convert K1 to K2
- Modern diet compromises the amount of K2 in food, grass fed cows, free range eggs

Sources of K2

- Cheese – Gouda and Brie, egg yolks, butter, goose, chicken liver
- Whole milk from grass fed cow – 1 mcg/100ml. Cheese made from milk contains 76 mcg per 100g because of bacterial fermentation
- Good eggs more than double K2 of battery eggs – feed and outdoors

Structure of vitamin K2



Sources of K2

- K2 from dietary animal sources is MK-4
- Molecular structure has a hydrocarbon tail with 4 double bonds
- Short half life. Stays in circulation for only a few hours before blood levels drop

Sources of K2

- Natto – boiled soybeans packed in straw
- Addition of specialised K2 producing microbe – bacillus subtilis natto
- MK-7 form with a structural hydrocarbon tail containing 7 double bonds

Sources of K2

- MK-7 supplements sourced from natto
- Effective protection for heart and bones
- Longer half life so a single dose is sufficient
- Fat soluble vitamin

K2 role in defeating atheroscelerosis

- Deposit of calcium, fatty substances and scar tissue in lining of arteries
- Reduce blood flow
- Arteries become fragile and rupture, leading to clots
- Blocked vessel to heart or brain

K2 role in defeating atheroscelerosis

- K2 prevents tissue calcification via protein MGP
- Other K2 dependent proteins
- Growth arrest specific gene 6 (GAS6) promotes clearance of dead smooth muscle cells which can act as an anchor for circulating fats

K2 role in defeating atheroscelerosis

- K2 dependent protein S encourages the immune system to gently take out the arterial debris rather than launch a full scale inflammatory response which can encourage plaque formation

K2 role in defeating atheroscelerosis

- In 2004 Journal of Nutrition published Rotterdam study
- Evaluated 8000 men and women aged over 55
- High intake of dietary K2 significantly reduced the incidence of arterial calcification and death from CVD

K2 role in defeating osteoporosis

- Loss of bone mineral density and thinning of bone tissue causing bones to become porous and fragile
- Occurs when there is an imbalance between new bone formation (osteoblast) and old bone resorption (osteoclast)

K2 role in defeating osteoporosis

- Osteocalcin is secreted by osteoblasts and osteoclasts. They use the protein to draw minerals especially calcium into the bones
- Osteocalcin is activated by K2
- Without K2 the osteocalcin would be uncarboxylated

Other Conditions

- Diabetes - K2 causes pancreas to secrete more insulin and increases sensitivity to insulin in cells
- Male fertility - the secretion of osteocalcin from bones in males helps regulate testosterone production

Other Conditions

- Varicose veins – smooth tissue cells from varicose veins show increased calcium deposition
- Wrinkles – elastic fibres of skin become calcified
- Dental cavities
- Dental arch development

K2 & Cancer Prevention

- 2010 The European Prospective Investigation into Cancer and Nutrition
- High K2 associated with a reduced risk of developing cancer and overall death from cancer, 30%
- 24,000 aged 35- 64 for 10 years
- Consumption of cheese

K2 & Cancer Prevention

- Prostate cancer – fastest growing body of evidence of K2 benefits
- K2 suppresses growth in all types of lung carcinoma
- In leukemia K2 induces apoptosis, encourages white blood cells to self destruct

K2 & Cancer Prevention

- K2 shown to induce death of liver tumour cells
- Beneficial for cirrhosis

K2 & Cancer Prevention

- Many tumours including breast and prostate have been found to produce MGP
- Suggests that uncarboxylated MGP is bad for cancer prognosis
- Requires K2 & D3 to activate
- Maybe malignant tissue contains the solution

K2 Research

- Professor Traber from Linus Pauling Institute September 2015
- Low K2 is a key factor in prostate cancer as opposed to low vitamin E. Similar structures. More research was required
- "Vitamin K is huge in the brain but nobody is researching it"

Anti Coagulant Treatment

- Studies found association between OAC and reduced bone density
- Increased serum levels of undercarboxylated osteocalcin
- Probably effect of warfarin interference with K recycling
- OAC often linked to high levels of soft tissue calcification

Fat Soluble Vitamins work together

- Vitamin D increases the absorption of calcium from the intestines and stores it in the liver and kidney
- Vitamin D activates osteoblasts
- Vitamin A activates osteoclasts

Fat Soluble Vitamins work together

- Vitamin A and D together regulate the activity of genes that cause cells to produce proteins to which calcium will bind
- Vitamin D increases the production of K2 dependent proteins
- Vitamin A reduces the production of K2 dependent proteins

Fat Soluble Vitamins work together

- Vitamin K2 activates the proteins that transport calcium to appropriate place in body
- Too much Vitamin D may lead to inappropriate calcification without sufficient amounts of K2
- Increasing Vitamin D can increase the need for K2

K2 Products

- B Subtilis
- Vitamin K2 from Natto
- Smart D3 and K2 oil