Horse Nutrition

9 basics for successful feeding

1. Good teeth
2. Absence of parasites
3. Good hay or pasture
4. Ample sources of energy
5. Sufficient sources of good protein
6. A clean sand-free feeding area
7. Salt (preferably iodised), free choice
8. Good water, free choice
9. Feed by weight, not by sight.

Minerals

Macro Minerals

- **Calcium [22g]**
  - Dicalcium phosphate and Lime stone (calcium carbonate)
  - Stored in skeleton = 35%. The skeleton in the horse is a calcium reservoir.
  - Efficient absorption by body
  - Excess Phosphorus reduces absorption of C.
  - Oxalate and Phytate in certain plants reduce absorption. Russian thistle high in Oxalate, Bran mash high in Phytate
  - Needed for; Bone formation, Muscular contraction, Blood clotting, Normal release of hormones, Activation of enzymes, and Normal heart rhythm.
  - Grains have low calcium - Alfalfa hay has high calcium, (1.24%)
  - Feed grass hay and grains with Alfalfa to balance Phosphorus
  - Low level can cause "Thumps", hiccups like ailment. Inject calcium solution directly into bloodstream if serious.
- **Phosphorous [14g]**
  - Monosodium Phosphate, (26% phosphorus)
  - Skeleton=14 - 17% P
  - Needed for; Fat and Carb metabolism, Repair and growth of cells, Production of energy (ATP), Calcium and Sugar metabolism, Utilisation of Vitamins, Kidney function, and Muscle activity.
  - Not as easily absorbed as Calcium
  - Most absorption in hind gut, assisted by bacteria.
  - Assist P. uptake with bacteria enhancement i.e. add yeast culture to feed
  - Feed pro biotics; lactobacillus acidophilus. For debilitated or stressed horses only
  - Deficiency symptoms = swollen knees and fetlocks
- **Magnesium [8g]**
  - Magnesium carbonate, magnesium oxide Chelated or proteinated
  - A horse is 0.05% M. - 60% of which in skeleton and teeth
  - Most grain and forage contain enough - it is contained in chlorophyll of green plants
  - Needed for; Synthesis of proteins, and the digestion of starches
  - Activator of over 300 enzyme functions
  - Increase M. intake if going barefoot - strengthens hooves - Kerratin growth
  - M. absorption deficiency can be caused by too much calcium, phosphorus, excess vit. D, diuretics, (eg: Lasix), and lack of dietary protein
  - Uptake of M. and calcium regulated by same hormone
  - Obesity linked to M. deficiency in horses
    - Type II diabetes - insulin resistance
    - Blood sugar goes up after eating, Pancreas releases insulin to carry extra sugar to tissues, Sugar converted to energy by complex enzyme action, Enzyme actions require M. If low M. pancreas gets frustrated - excess blood sugar is turned into fat.
    - Fat deposits at crest of neck and base of tail sure sign
    - High insulin due to low M. blocks small blood vessels - can lead to laminitis
  - M. imbalance easy to cure - supplement M. or cut down on calcium
  - Good calcium to M. ratio to strive for is 1.5 : 1 to 2 : 1
  - Long term effect is mineralisation in arteries and damaged capillaries. Possible laminitis from poor circulation
  - Deficiency symptoms = nervousness, muscle tremors, rough lusterless coat, intolerance to work or excersise, obesity (insulin resistance) - fat deposits at crest of neck and base of tail sure sign.
- **Sulfur**
  - 0.15% of horses mass - average horse contains 1.5 pounds of S.
  - Most S. contained in hooves and hair wich are around 3% S.
  - Two amino acids contain sulfur - methionine and cystine cystine can be metabolised from methionine which is an essential amino acid
  - S. is present in - biotin, thaimin, insulin, heparin, and chondroitin sulphate
  - Needed for; Hoof and hair growth, metabolising of carbohydrates and simple blood sugar,
  - S. is a regulator of blood viscosity. Low S. = low flow rate (lack of heparin in the blood)
  - No known RDA
  - A good quality protein source gives aprox. 0.15% S. which is enough for most horses
  - Elemental S. is not a natural nutrient - do not feed pure sulfur
  - Methionine and biotin are usual means of supplementing for foot and hoof problems
- **Potassium**
  - Potasium Chloride
  - P. and Sodium work together to regulate cell fluid
  - Regulation of osmotic pressure and acid base balance in the body
  - Plays role in nerve impulse transmission - proper muscle function
  - High P. in forage, Low P. in grains
  - 25g P. per day for 1100lb maintenance horse
  - Horses on hay or pasture need no extra P. - 14lbs forage = over 95g P.
  - Very sweaty horses may need extra P. if on high grain diet
  - P. electrolyte formulas can be added to food as top dressing or to water
  - Low level of P. , calcium and/or sodium is a cause of Azoturia
  - Deficiency symptoms = weight loss and generaly poor appearance, loss of appetite - eventualy refusal to eat
- **Salt (Sodium Chloride)**
  - Salt licks should always be offered free choice - always with abundant water nearby
  - Grains and forage are low in sodium and chloride
  - Salt blocks can be straight salt, iodized salt or mineralised salt
  - Sodium and chloride maintain the bodys acid base balance and fluid balance
  - Sodium and potassium act together - P. stops cells drying out / S. stops cells filling with water
  - Horses with salt deficiency will eat slower and drink less water
  - Salt deficiency produces rough haircoat and dry skin - licking things with sweat on them sure sign
  - 102g of salt gives 40g of sodium = lots of licking!

Trace Minerals

- **Copper**
  - Supplemental forms; C. sulfate, C. proteinate, C. polysaccharide
  - Needed for enzyme systems involved in manufacture and maintenance of; connective tissue, maintenance of mitochondria within cell nuclei, synthesis of melanin (pigment)
  - Also needed for; bone formation, maintaining elastic strength of blood vessels, manufacture of heamoglobin, healing of wounds
  - Especially important for maintaining an efficient immune system, as an aid in reproduction, and for the synthesis of connective tissue (collagen and elastin)
  - 82mg - 115mg per day, horses can tolerate much higher than min requirement
  - Grass hays generaly have a higher Copper content than alfalfa hays
  - Most feeds low in C. therefore supplement recommended - especially with high carbohydrate diet
  - Prolonged deficiency may cause Osteochondrosis - metabolic bone disease
  - A deficiency may result from feeding too much calcium, iron, molybdenum and zinc. Also caused by low protein levels in the diet
  - Deficiency symtoms = enlarged joints and fragile bones, the haircoat turns grey, slowed growth, may become anemic
- **Cobalt**
  - Cobalt is involved in synthesis of Vit. B12, which is needed for heamaglobin production
  - 0.8 - 1.1mg / day, in forage and grains - 14lb feed usually enough
  - Deficiency symtoms = anemia, reduced appetite, slowed rate of growth
- **Iodine**
  - Regulation of thyroid function - preventing goitre. A diet low in iodine causes thyroid gland to swell due to hormone activity
  - Thyroid Gland
    - Thyroid gland regulates metabolic rate - "metabolic metronome"
    - Produces two amino-acid like hormones both contain iodine
      - thyroxine
      - tri-iodothyronine
      - determines rate at which the body consumes oxygen, burns glucose, and synthesises protein
  - Goitre is common in foals from iodine deficient mares, (large swelling of the neck / throat area)
    - trouble standing to nurse
    - appear very weak
    - mares deficient in iodine may have abnormal oestrus cycles
  - Other deficiency symptoms = rough haircoat, brittle hooves and sparse hair
  - Check for iodine in mineralised salt lick or feed iodised salt lick
- **Iron**
  - Caution - more problems caused by too much iron than lack of it
  - Essential for oxygen transport round body - i.e. most body functions involve iron
  - Basis of the heamoglobin and myoglobin molecules
    - heamoglobin = primary constituent of red blood cells, 60% of bodys 33grams of iron found in blood
    - myoglobin = heamoglobin-like compound, loosely holds oxygen in muscles when abundant, releases it when body needs it
  - Grains and forages generally contain enough iron for most horses
  - May need to supplement for horses under stress, injured with high blood loss, or with heavy parasitic loads also judicious supplement for fast growing horses, late pregnant mares and performance horses
  - High levels of cadmium, cobalt, copper, zinc, and manganese prevent iron absorbtion
  - Alfalfa hay is very high in iron
  - Too much iron can lead to;
    - lowers amount of available zinc and copper leading to other mineral imbalances
    - can make a horse tired and fatigued which cant keep weight on
    - affected metabolism of phosphorus leading to slowed rate of growth accompanied by poorly mineralised bone
    - many pathogenic bacteria have high iron requirement - thus, excess iron may make bacterial infection worse
- **Manganese**
  - M. required by enzymes to metabolise chondroitin sulphate in joint cartilage
  - M. needed for carbohydrate and fat metabolism, and for normal reproductive functions
  - Timothy and orchard grass hay high in M., most other common feeds lacking in M.
  - Supplementation should be considered for growing and performance horses
  - Vitaly important in formation of connective tissues, foals born to mares deficient in M. may have crooked legs and deformed joints with severly limited articulation
  - Min and toxic levels not known. Excess could affect absorbtion and utilisation of other nutrients
  - Performance horses deficient in M. exhibit stiff joints and general soreness. They will not want to work
- **Zinc**
  - Zinc methionine is one form of supplemental Z. found in hoof health supplements.
  - Zinc sulphate - most easily absorbed inorganic source for horses
  - Z. is found in high levels in the eyes, the prostate gland, the skin, the hair, and the hooves
  - Z. is essential for about 340 different enzyme systems
  - Some of the many functions include; Growth and maintenance of hoof walls, skin growth and healing, normal prostate function, phosphourous and protein metabolism
  - Adequate amounts of Z. lacking in almost every common grain and forage
  - Most feed mills include some form of Z. supplement in their grain rations
  - Z. is also available in polysaccharide and amino acid complexes, amino acid chelates, and proteinates
  - High levels can be tolerated but will affect utilisation of other nutrients, especially copper
  - Foals deficient in Z. will have poor appetites, reduced rate of growth, hair loss, and dry scaly skin
- **Selenium**
  - Selinium is serious business - too much can kill!
  - S. is very easily absorbed by the horse, (75% effieciency or above)
  - Sodium selenite, sodium selenate are usual supplemental forms
  - In nature S. forms complexes with the amino acids cystine, cysteine and methionine.
  - S. over dose symptoms = (1.66g for 1100 lbs horse); blind staggers (alkali disease) - horse appears colicky with elevated heart rate and irregular breathing. They may appear to be blind. May be seen to press their head against stationary objects and may sweat profusely
  - Long term signs of overdose = anemia, lameness and joint stifness, rough haircoat with loss of hair in mane and tail, malformed hooves with cracks around coronary band. If symptoms go unchecked for a long time chronic toxicity can cause death
  - Deficiency symptoms = in foals; white muscle disease, (a form of muscular dystrophy), the foal becomes pale in appearance, General weakness and laboured movement, difficulty in nursing and swallowing, irregular and laboured breathing
- Trace minerals are disappearing from the soil due to farming
- Organic forms of copper, cobalt, iodine, iron, maganese and zinc are better absorbed than inorganic forms

Exotic Nutrients

- **Dimethyl Sulfone (Methylsulfonylmethane, MSM)**
  - Manufactured from DMSO (dimethyl sulfoxide), a by-product of paper manufacture. Treat DMSO with hydrogen peroxide and you get MSM compound and water
  - MSM is a methyl donor which means it plays a part in fat and energy metabolism
  - Excellent source of metabolic sulfur - worth feeding for this alone
  - It is abundant in fresh green forages and mares milk. Also in coffee, tea, and beer.
  - MSM has been used to help or cure epiphysitis, navicular disease, arthritis, pulmonary heamorrhage (bleeders syndrome), dull haircoat, and dry / brittle hooves
- **Dimethylglycine, DMG**
  - DMG has been called vit. B15, pangamic acid, an additive and a drug
  - It is a natural compound found in feeds and animal tissue
  - DMG assists the process of aerobic respiration. It aids in the transport of oxygen across the cell to the mitochondria where energy reactions take place.
  - By making oxygen more available for aerobic respiration it delays the build up of lactic acid in the muscles. It is also a factor in breaking down the lactic acid in the muscles and blood - it reduces recovery times
- **Chondroitin Sulfates**
  - C. S. not a natural part of the equine diet. Occuring in some plants, they are bound to other compounds that inhibit digestion. They are synthesised in the connective tissue by specialised cells called chondrocytes.
  - Dietary C. S. supplements are made from bovine trachea, shark catilage, and green lipped mussels. There appear to be no vegetable based formulations available.
  - Connective tissue is comprised of three substances; water, collagen (proteins that are the basic building blocks of connective tissues) and the proteoglycans, which are long chains of glycosaminoglycans (GAG's) in a protein matrix.
  - Very large molecule - most likely that C. S. are completly broken down and re-assimilated by the body. 40% absorbtion but utilised by the body by recombination of constituent compounds within the joints
  - Among the GAG's, the most widely distributed in the body are chondroitin sulphates
- **Glucosamine**
  - Precursor to chondroitin sulphates
  - Smaller molecule than C.S., therefore can pass through digestive system more easily
  - Probably most important building block of the glycosaminoglycans, (GAG's).
  - Found in abundance in synovial fluid in the joints, in chondroitin sulphates and is neccessary for the production of collagen. It is needed for manufacture of nearly every compound involved in joint growth and repair
  - Chondrocytes (cells that make cartilage and chondroitin sulphates) determine how much cartilage they can make by how much glucosamine is available
  - If choosing from the many supplements those that contain glucosamine hydrchloride (purer and more stable) are better than those made with glucosamine sulfate.
  - Supplemental glucosamine may be mixed with zinc, manganese, ascorbic acid, dl-methionine, and bromelain. All are factors in the joint repair process. You may be feeding them in other supplements already.
- **Bromelain**
  - B. is a class of naturally occuring proteolytic enzymes extracted from pineapple stems
  - Easily digested with no known side effects.
  - B. known to reduce pain and inflammation due to acute trauma (such as the pounding on a horses joints during competition)
  - B. also known to reduce pre- and post-operative pain and inflammation
  - Given in significant quantities (more than 5 grams a day) a few days before competition, B. could be expected to reduce the severity of joint damage and increase the speed at which the joint recovers
  - Check ingredients list on joint supplements. Is bromelain there? Why is it there? Is there more than 5g per day?
- These exotic nutrients are all either produced in the horses tissues or are in natural feedstuffs

Other nutrients supplied by natural feeds;

- Chromium
- Silicon
- Fluorine
- Nickle
- Etc etc for several thousand chemicals and compounds

Teeth and Gut

Dental Health

- Check at least every 6 - 12 months - preferably every two months
- Impaction colic can be due to worn teeth
- Slobbering and quiding are a sure sign of poor teeth
- No nerves in the horse tooth like humans, rasping doesnt hurt, (herbivor)
- Molars get sharpened by chewing (can take as little as six weeks!)
- If jaws are over or under shot (parrot or pike mouthed) it is very difficult to bite off grass stems. Food can still be ground up by molars.
- Make sure fibres are short if feeding roughage to horses with problem teeth. Possible impaction colic risk.

Gut Health

- Small Stomach - 2 to 3 gallons. Designed for small amounts of grass from grazing.
- Control Parasites - worm regularly. Change wormer seasonally - ask local vet
- "Impaction in the Ileum" = colic
- 8 - 9 % digestion takes place in the stomach
- Bulk of digestion takes place in the Small and Large intestines
- Horses are hind gut fermenters
- Insoluble nutrients are broken down by enzymes produced by bacteria in large intestine (hind gut)
- Soluble nutrients are broken down by enzymes in small intestine
- Impaction materials causing colic can stay in gut for YEARS! eg; plastic, string etc
- Beet pulp is an excellent substitute for all or part roughage needs in older horses. Soak thouroughly before feeding, (24hrs if in cold water).
- Dry fibre re-hydrates in the gut = possible colic. Too much dry feed can kill!
- Digestive upsets, some of which are fatal, are relatively common in the horse.
- Small amounts of food continually, 3/4 full always. Golden Rule = Feed little and often
- Micro Flora and Micro Fauna in the gut need feeding constantly
- Grains are a small part of natural diet in the wild - wild horses eat mostly grass and some leaves
- Grains are only available at one time of year in the wild - a special treat even!
- Round the clock access to roughage is better than grain supplements
- Feed little of all dietary ingredients at each feed for balanced gut organisms
- Large intestine turns 180° (pelvic flexure) = likely impaction site
- A horse cannot produce saliva unless it is chewing. Sponging the mouth between event stages is advantageous.
- Gruel - very tired horses can be given gruel when returning to the stable. Put a double handfull of oatmeal into a bucket and pour on boiling water. Stir well and feed when cool. It should be thin enough to drink easily.
- If a horse does ever regurgitate its food it is very ill indeed.

Vitamins

Fat soluble (Only in vertebrates)

- **Vit. A**
  - Vit. A is a class of at least a dozen compounds - all display the same activity in the body
  - Plants do not manufacture Vit. A - only made in the bodies of vertebrates
  - Plants do manufacture pigments called carotenoids which are converted to Vit. A in the body. Most important carotenoid is beta carotene
  - Vit. A is important for vision - cheif component of light sensitive pigment in the rod cells of the eye
  - Essential for cell differentiation, (so bone cells become bone and liver cells become liver), and assist in the continuing process of bone remodeling in growing horses
  - A horse on green pasture will get all the Vit. A it needs
  - Fresh green pasture contains 10 - 120 times more Vit. A-precursors than dried hay due to action of sunlight and moisture on beta carotene
  - Cereal grains, (with the exeption of corn), contain almost no beta carotene. Therefore all your horses Vit. A needs come from forage and supplements
  - Vit A. is stored well in the body, primarily in the liver and beta carotene can be stored in the fat cells where it can be converted to Vit. A when needed Therefore a horse taken off pasture and put on dried feeds is a long way off from Vit A. deficiency and most feed mills add Vit. A to their grain mixes
  - Vit A. overdose symptoms = abnormal thickening of bone and bone fragility, flaky skin, poor muscle tone, rough haircoat and loss of hair, and depression Foals born to mares fed toxic levels of Vit. A throughout their pregnancy can be severely disfigured. Food for thought.
  - Beta carotene is the prefered supplement as it is non-toxic, instead of straight Vit. A Better reproductive performance in breeding stock and anti-oxidant activity in performance horses
  - Deficiency symptoms = poor growth and depressed appetite, progressive weakness, impaired reproductive function, continuously runny / teary eyes, night blindness, hardening of skin and cornea of eyes, respiratory infections, and abcesses of the salivary glands
- **Vit. D**
  - D2
    - Made in plant tissues from compound ergosterol and ultra violet light. Active chlorophyll blocks UV from underlying ergosterol so Vit. D is only produced after the plant is cut
    - Vit. D2 more prevalent in dried forage than green pasture
  - D3
    - Made under the skin as 7-dehydrocholesterol by sunlight
  - Without Vit. D a life threatening mineral imbalance will result
  - Vit D. is part of the proteins that bind calcium and magnesium, facilitating their absorption. Also helps to regulate the excretion of phosphates in the urine.
  - Some plants, such as jasmine (cestrum diurnum), contain a substance that causes hyper absorption of calcium. Horses eating these plants can show symptoms that show Vit. D toxicity
  - Vit. D3 supplementation not neccessary if exposed to sunlight, except young growing horses or mares in final trimester of pregnancy,
  - Over dose symptoms = deposition of calcium in soft tissues primarily in the blood vessels, heart, lungs and kidneys Most likely by over feeding supplements containing Vit. D.
  - Deficiency symptoms = manifests as calcium, magnesium and phosphorus deficiency; rickets -like symptoms, including poor bone density, swollen joints, and a painfull gait / laboured gait
- **Vit E**
  - Vit. E is the term used for the substance, tocopherol, which has at least 8 known variants
  - Vit. E is easily oxidised, i.e. it reacts readily with charged oxygen-containing compounds produced by anaerobic respiration, thus preventing them from reacting with and destroying fats and proteins in the cell membrane, (i.e. it is an anti-oxidant that neutralises free radicals)
  - Selenium works with Vit. E to protect cardiac and skeletal muscle tissues. Selenium is part of an enzyme that protects the cell interior whilst Vit. E protects the outer portion of the cell
  - Some degree of supplementation reccomended for most horses
  - Hay very low in tocopherol if rained on
  - Lactating mares need more to pass on to their foals in their milk
  - Young horses need it for normal muscle development
  - Performance horses need it to combat muscle degredation by anaerobic respiration
  - Recommended for breeding stallions
  - Normal reproductive function in pregnant mares
  - Deficiency symptoms (most evident in young growing horses) = rapid degeneration of cardiac and skeletal muscles, noticable symptoms include exaggerated and uncoordinated movement, especially in the hind limbs and a sprawled stance
- **Vit. K**
  - Required for normal clotting of the blood
  - Usually synthesised by bacteria in the intestine in sufficient quantities for most horses
  - Vit. K3 = menadione - often found in supplements, especially for bleeders although the efficacy of these preparations remains to be seen
  - Oral menadione relatively non toxic
  - Injectable menadione given for heamorrhage can cause acute kidney failure and death

Water soluble (needed by all animals and available in yeast)

- **Vit. B 1 (Thiamin)**
  - Thiaminase enzymes in bracken, horse tail, and yellow star thistle break down vit B1
  - The need for thiamin is directly related to the calorific needs of the horse. Supplementation beneficial if on a high carbohydrate diet
  - In the body thiamin is converted into thiamin pyrophosphate, a compound required for the metabolism of pyruvic acid, (an essential link in the utilisation of carbohydrates and proteins.)
  - If metabolic thiamin is lacking the horse cannot derive sufficient energy from its diet
  - Some thiamin synthesised in the gut but not enough - supplementation recommended
  - Deficiency can occur from feeding poor quality hay or eating bracken, horse tail, or yellow star thistle
  - Especially helpful to performance horses
  - Thiamin can help restore appetites in horses that have gone off their feed
  - Can help alleviate nervousness in horses that are stall-bound on high energy rations
  - Many vitamin / mineral supplements contain thiamin
  - Safe limit for thiamin is at least 1000 times the minimum requirement - overdose unlikely
  - Deficiency symptoms = nervousness, dull haircoat, loss of appetite, weight loss, lack of coordination in the hind quarters, slowed or irregular heartbeat
- **Vit. B 2 (Riboflavin)**
  - Present in enzyme systems involved in converting feed into energy - essential to every cell in the body
  - Synthesised in large intestine, but not quite enough for daily needs
  - Good quality hay should contain enough - supplementation not a concern for most horses
  - Supplementation may allow performance horses on a high calorie diet to utilise their feed more efficiently
  - No point in feeding large amounts as it is not stored in the body and whatever is not used is quickly excreted
  - May cause retarded growth, hair loss and dermatitis if deficient in diet. Not proven however
- **Niacin**
  - Actually two substances; nicotinic acid and nicotinamide. Both have equal vitamin activity
  - The term "niacin" was adopted to avoid confusion with the addictive alkaloid, nicotine
  - Part of two coenzymes that are critical in the metabolism of carbohydrates, fats, and amino acids
  - Some niacin synthesised by microbes in the gut from the amino acid, tryptophan
  - Ample amounts can be found in forages, protein sources and cereal grains, although most of the niacin in grains is bound in unusable forms
  - Often in large amounts in vitamin supplements for no reason - no record of a naicin deficient horse
  - Deficiency symptoms = pellagra in humans, black tounge disease in dogs. These conditions are characterised by; loss of appetite, muscular weakness, digestive disorders, dermatitis and anemia
- **Pantothenic Acid**
  - Involved in energy metabolism, (a component of coenzyme A)
  - Essential for the synthesis of steroids, including cholesterol, and for the production of adrenal hormones
  - Synthesised in the intestine but a dietary source also needed
  - Brewers yeast is an excellent source
  - No record of deficiency symptoms in the horse
- **Vit. B6 (Pyridoxine)**
  - A component of enzyme systems involved in the metabolism of protein, fats and carbohydrates
  - Required for formation of red blood cells
  - Pyridoxine is the form of Vit. B6 found in plants. Converted in the body into pyridoxal and pyridoxamine
  - Synthesised by microflora in the gut
  - Found in small quantities in forages, grains and protein sources
  - No record of deficiency symptoms in the horse but as it is part of the systems that turn feed into energy, the need increases as the work increases. Often added to supplements for performance horses and pregnant mares
- **Folic Acid**
  - No established dietary requirement
  - Grass is one the richest sources of folic acid
  - Needed for formation of red blood cells, synthesis of methionine, and the formation of nucleic acids
  - Synthesised by intestinal bacteria as well as ingested
  - May be of some benefit to pregnant or lactating mares who always need more of everything
  - Folic acid is lost in sweat so supplement for performance horses as they manufacture more blood than other horses
  - Deficiency symptoms in the horse not recorded, symptoms for humans are certain forms of birth defects
- **Choline**
  - Unlike the other B vits, choline has no known catalytic role in the body. i.e. it is not part of any enzyme or coenzyme
  - Further set apart by the fact that it is synthesised in the liver, not the intestine
  - Still vitally important. As a constituent of acetylcholine, it is needed for the transmission of nerve impulses
  - Acts in synergy with methionine as a methyl donor, where it has a role in fat metabolism
  - A structural component of cell membranes
  - Choline chloride added to most supplements
  - Abundant in forages and grains - shortfall in metabolic synthesis unlikely
  - No record of choline deficient horse
- **Vit. B 12 (cobalamin)**
  - Not produced by any plants - synthesised in the horses intestines by microorganisms from cobalt
  - Last vitamin to be discovered
  - Possibly one of the most potent vitamins - very little needed
  - Essential for production of red blood cells
  - Almost always incuded as cyanocobalamin in vitamin supplements formulated for performance horses
  - No signs of toxicity at several hundred times neccessary amount
  - The organs, mainly the liver, can store Vit B12 indefinitely. Horses deprived of cobalt or depleted of intestinal microflora (from parasites or disease) can rely on stores of Vit. B12 for several months if neccessary
  - No evidence of dietary need for Vit. B12 beyond what is synthesised in the gut
- **Biotin**
  - Biotin, like several other B vits, is an integral part of a number of enzymes involved in the synthesis of glucose, fats, proteins, and even RNA and DNA
  - Subject of much controversy as hoof tonic - the reason for hoof improvement remains elusive
  - Horses on a good diet with poor hooves show same biotin levels in the blood as horse on the same diet and good hooves, however, supplementing biotin at 10 - 20 mg per day often shows imrovement. Symtoms re-appear when biotin withdrawn
  - It is unlikely that weak crumbly hooves are a result of simply biotin deficiency
  - It may be that biotin prevents premature decay of the horn cells forming the outer wall of the hoof. This would protect the new horn as it is laid down in an environment more condusive to growth. This still does not explain the same levels of biotin in horses with good and bad feet.
  - A horse will not live long without biotin. Most plants contain small amounts though most is bound to proteins that prevent absorption in the gut. Biotin is, however, synthesised in the gut to such an extent that no deficiency in the horse has been recorded
- **Vit. C (Ascorbic Acid)**
  - Horses manufacture ascorbic acid in their livers from glucose - humans do not therefore it is labled as vit c on human food and ascorbic acid on horse food
  - It is a vitamin for primates but simply a metabolic essential for equines
  - Most important role is as a co-factor in the synthesis of Collagen;
    - primary constituent of connective tissues, including the skin, tendons, bone and cartilage
    - the most prevalent protein in the animal world
    - literally holds us and our horses together
  - Many supplements contain esterified ascorbic acid (Ester- C tm.) for joint and cartilage health but these are from developments in human medicine and tested on rats which have more highly developed absorption
  - If the joint repair supplement you are feeding does contain ascorbic acid it cant hurt
  - No dietary requirement for ascorbic acid in the horse as there appears to be no significant dietary path way for its utilisation. It is very poorly absorbed by horses as it is broken down by gut micrflora before it gets to the bloodstream. If you give a supplement just for its ascorbic acid content you are probably wasting your money

Carbohydrates (digestible energy)

- Carbs are the primary source of energy
- Hay
  - Bromegrass
  - Alfalfa hay
  - Orchard Grass
  - Timothy Hay
  - Most hays have 30% fibre, most insoluble eg; alfalfa and grass
  - Mixed hay best for most horses. From permanent pastures on good upland is best. Cut from specially seeded pastures containing many mixed grasses and clovers.
- Forage
  - High Moisture Content
  - A horse eats 1% to 2% body weight of forage per day
- Grain
  - Oats
    - Feed bruised rather than whole oats.
    - Amount fed should relate to temperament of the horse and the capabilities of the rider. Oats can have an alarmingly exhilarating effect on some horses!
  - Corn
  - Maize
    - Low salt and fibre. High starches, fats and sugars.
    - Good heating fed with other grains or cubes for the winter.
    - Very palatable. Can encourage shy feeders to eat.
- Energy requirement is called "digestible energy", [DE]

Protein [8% - 15%] (building material)

- Amino Acids form proteins in the body - 11 essential must be fed, 25 in total - 14 made by hindgut bacteria
- Primary sources
  - Hay
  - Pasture
- Alfalfa hay [high as 20% when fresh]
- Oats [9% - 14%] — see note under carbohydrates
- Barley [11% - 13%]
- Corn [7.5% - 12%]
- Cottonseed Meal [41%]
- Linseed Meal [35%]
- Soy Bean Meal [45%]
- Peas and beans are very heating. Therefore should be fed in small quantities. Should only be given to horses in hard work or outwintering in severe conditions.
- Feed min. 12% protein, raise for increased work
- Basis of cell protoplasm
- Not stored in the body
- Feed 40 - 50 grams Protein per 1 Mcal of DE
- Variety of sources is best
- Supplement with Lysine (major amino acid) if poor sources
- Deficiency symptoms = dry lusterless coat, loss of appetite, slow hoof growth, loss of body tissue

Fatty acids

- Flaxseed Meal — High omega 3 and 6
- Linseed oil
  - Good for putting a bloom on the haircoat
  - Fed as a jelly, (simmer seeds in water overnight), mixed with bran and cereal. Use the water left from making the jelly in bran mash.
  - Good for a horse that needs fattening. Two weeks to notice results.
- Saturated
  - Solid at room temp
  - Mostly derived from animals
  - Bad fatty acid
- Unsaturated
  - Liquid at room temp
  - Preferred
- Polyunsaturated
  - Liquid at room temp
  - Preferred
- Trans fats very bad — eg hydrogenated
- Omega 6 and 9 can be metabolised from omega 3
- Most important fatty acids
  - Linoleic Acid (Omega 3)
  - Linolenic Acid (Omega 3)
- Deficiency symptoms = dry skin, weak brittle hooves, lusterless coat

Fat (Triglyceride molecules)

- Corn Oil
  - 1 Ounce corn oil = 255 calories
  - Very palatable for Horses
  - Fed as 10% of diet increases D.E. by 15%.
  - When fed long term it encourages the muscles to use free fatty acids, instead of glycogen. This is a stamina advantage.
- 2.25% more energy than Carbs or Protein
- Soluble in ether but not water
- Burned aerobically i.e. useful in slower paced activities
- Too much fat blocks protein absorption, feed more protein with fat - min 12%
- Use fats to replace grain for less bulk but same energy, i.e. for endurance riding
- Easily digested but wont eat it if too much in diet
- "Crude fat" or "Ether Extract" = same thing
- Major deposits of fat are under the skin, around the major organs (suchas the heart), and in the abdominal cavity.
- Fat is a vital energy source. Thirty times as much energy in horses fat (triglyceride) deposits as there are in all the glycogen (starch) stores.
- Too much fat affects heat loss from the body. This can seriously affect the metabolism in general.

Energy

- Stored in body as Glycogen
  - Liver glycogen for general body use. Constant release of glucose into the bloodstream.
  - Muscle glycogen. Supplies glucose and energy for the muscle itself during contraction.
  - Liver fat glycogen. Triglyceride molecules.
  - Glycogen is a Polysaccharide = linked glucose molecules
- Adenosine Triphosphate
  - All living things produce energy from the compound ATP
  - Two types of respiration break down and re-assemble ATP to supply energy to the body:
    - 1) Anaerobic
      - 12 steps, (first ten same as beer!)
      - 1 mol glucose breaks down to give: 2 mol lactic acid - causes cramp
      - 2 ATP produces 4 ATP
      - Sprinting
      - Fast but not very efficient
    - 2) Aerobic
      - 1 mol glucose produces 36 mol ATP
      - Requires oxygen
      - Trekking
      - Slow and very efficient
      - Glucose, Protein and fat used as fuel
  - ATP + H20 ---enzyme---> ADP (adenosine di-phosphate) + P + energy
- Digestible Energy [DE] = energy in food minus energy left in dung
- Average daily requirement = 19600 calories (enough to boil 55 gallons of ice)
- Low energy may result in refusal to work
- Mares come into heat late if not enough energy. i.e. feed more hay and grain
- About 75% lost as heat!
- At rest muscle energy is derived from free fatty acids. As work increases muscle energy is derived more from glucose. Amount of fatty acids still used at speed is good sign of fitness level. Increased enzymes break down more fatty acids in a fit horse. i.e. as it gets fitter it uses less glucose to produce the same energy. Blood suger levels drop less after work in the fit horse. Excess blood sugar is then turned into fat. Hence the need to change the diet as the fittness level of the horse changes.

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