

## ANNEXURE - I

### Important functions and deficiency disorders of Vitamins

S.No.	Vitamins	Functions	Deficiency symptoms	Inter relationship with mineral
<b>Fat soluble vitamins</b>				
1	Vitamin A	<ul style="list-style-type: none"> <li>• Vision</li> <li>• Anti-infective vitamin</li> <li>• Provides immunity,</li> <li>• Requires for bone formation and reproduction</li> </ul>	<p><b>Cattle, sheep, goat and pig:</b> Xerophthalmia, Night blindness and infertility in breeding animals.</p> <p><b>Poultry:</b> Nutritional Roup - Retarded growth, weakness, ruffled plumage and a staggering gait. Lesion around eyes, eye lids, nasal and ocular discharge, drowsiness, pale comb and wattles. Ataxia in the young growing chick due to elevation in the cerebrospinal fluid pressure.</p> <p><b>Toxicity:</b> <i>Hypervitaminosis A.</i> Causes nausea, headache, fatigue, loss of appetite, dizziness, and dry skin</p>	Zinc
2	Vitamin D	<ul style="list-style-type: none"> <li>• Antirachitic vitamin</li> <li>• Maintenance of Ca and P level</li> </ul>	<p>Young animal – Rickets Adults -- Osteomalacia.</p> <p><b>In poultry</b> bones and beak become soft and rubbery legs become weak. Egg production is reduced and thin shelled or shell less eggs, In embryos soft beak fail to pip the shell</p> <p><b>Toxicity:</b> Hypervitaminosis D induces abnormally high serum calcium levels (hypercalcemia), which could result in bone loss, kidney stones, and</p>	Calcium and Phosphorus

			calcification of organs like the heart and kidneys if untreated over a long period of time.	
3	Vitamin E	<ul style="list-style-type: none"> <li>• Natural biological antioxidant</li> <li>• Along with the selenium-containing enzyme glutathione peroxidase, it protects cells against oxidative damage</li> <li>• Two main methods of protecting itself against oxidative damage. Firstly, all radicals are scavenged by vitamin E as a first line of defence and secondly, glutathione peroxidase destroys any peroxide formed before they can damage the c</li> <li>• Development and function of the immune system</li> <li>• Reproduction</li> </ul>	<p><b>Cattle: Nutritional myopathy or muscular dystrophy or white muscle disease:</b> Weak leg muscles manifested by difficulty in standing and a trembling and staggering gait. Unable to rise and weakness of the neck muscles prevents them from raising their heads. The heart muscle may also be affected and death may result.</p> <p><b>Sheep:</b> Nutritional myopathy also occurs in lambs, with similar symptoms to those of calves. The condition is frequently referred to as <b>stiff lamb disease</b>.</p> <p><b>Pigs: Mulberry heart disease</b> - The heart muscle is more commonly affected with sudden cardiac failure occurs and on post-mortem examination the lesions of the cardiac muscles are seen as pale patches or white streaks.</p> <p><b>Poultry: Nutritional myopathy, encephalomalacia or crazy chick disease and exudative diathesis.</b></p> <p>In <b>nutritional myopathy</b> the main muscles affected are the pectorals although</p>	<b>Selenium</b>

			<p>the leg muscles also may be involved.</p> <p><b>Nutritional encephalomalacia</b> or <b>crazy chick disease</b> is a condition in which the chick is unable to walk or stand, and is accompanied by hemorrhages and necrosis of brain cells.</p> <p><b>Exudative diathesis</b> is a vascular disease of chicks characterized by a generalized oedema of the subcutaneous fatty tissues, associated with an abnormal permeability of the capillary walls.</p>	
4	Vitamin K	<ul style="list-style-type: none"> <li>• Synthesis of prothrombin</li> <li>• synthesis of factors (stuart factor, plasma thromboplastin and tissue thromboplastin) involved in the conversion of prothrombin to thrombin.</li> <li>• The inactive vitamin k dependent zymogens are converted into calcium binding proteins which activate them</li> </ul>	<p>Low Prothrombin level in blood leads to haemorrhagic conditions. Deficiency is rare in ruminants.</p> <p><b>Cattle: sweet clover disease</b> -Sweet clover that is spoiled contains a compound <b>dicoumarol</b>, which lowers prothrombin content of blood.</p> <p><b>Poultry:</b> anemia and delayed clotting time of blood.</p> <p><b>Toxicity:</b> Menadione (vitamin K<sub>3</sub>) and its derivatives can interfere with the function of glutathione, body's natural antioxidant, resulting in oxidative damage to cell membranes.</p> <p><b>Vitamin K antagonists:</b></p> <p><b>Dicoumarol</b> is similar in structure to vitamin K. When</p>	Calcium

			<p>consumed by livestock it inhibits vitamin K production.</p> <p><b>Warfarin</b> is a synthetic toxicant derived from coumarol. It is used in rat poisons it also acts as a vitamin K inhibitor to block the blood clotting process and provoke hemorrhaging..</p>	
<b>Water soluble vitamins</b>				
1	<b>Vitamin C (L Ascorbic acid)</b>	<ul style="list-style-type: none"> <li>• Natural antioxidant</li> <li>• Formation of collagen and intercellular cement substance</li> <li>• Metabolism of tyrosine</li> <li>• Hydroxylation of deoxycorticosterone, tryptophan, phenylalanine</li> </ul>	<p><b>Scurvy in adults:</b> Weakness, bleeding, loosens teeth, swollen joints hemorrhages.</p> <p><b>Infantile scurvy:</b> Anorexia, Listlessness, Leg drawn up to abdomen swelling at ends of long bone. Gums swollen, dyspnoea, cyanosis, convulsions and death if not treated. Delay in wound healing. Stress increases the requirement of this vitamin</p>	<ul style="list-style-type: none"> <li>• Iron</li> </ul>
2	<b>Vitamin B Complex</b>			
1	<b>Thiamine (Vitamin B1)</b>	<ul style="list-style-type: none"> <li>• Thiamine diphosphate is a coenzyme involved in oxidative decarboxylation of pyruvate to acetyl coenzyme A.</li> </ul>	<p><b>Chicks: <i>star gazing posture</i></b> -anorexia, emaciation, polyneuritis characterized by head retraction, nerve degeneration and paralysis.</p> <p><b>Polyneuritis</b> in chicks, poult and ducklings</p> <p><b>Ruminant:</b> Deficiency not generally occurs. However certain bacteria are synthesizing thiaminase which destroys the vitamin causing thiamine deficiency. It is characterized by</p>	

			<p>circular movements, head pressing, muscular tremors and blindness. Lactic acidosis caused by the feeding of rapidly soluble carbohydrate may predispose to the production of thiaminases.</p> <p><b>Antivitamin - Thiaminase</b> is also present in bracken fern and thiamine deficiency has been reported in horses feeding it. Raw fish also contains thiaminase, which is destroyed on cooking.</p> <p>Thiamine deficiency in foxes causes <b>Chastek paralysis</b>.</p>	
2	<b>Riboflavin (vitamin B2)</b>	<ul style="list-style-type: none"> <li>• Flavin mononucleotide and Flavin adenine dinucleotide involved in amino acid and carbohydrate metabolism.</li> </ul>	<ul style="list-style-type: none"> <li>• Poor appetite, retarded growth, vomiting, skin eruptions and eye abnormalities.</li> <li>• In sows riboflavin is necessary to maintain normal oestrous activity and prevent premature parturition.</li> <li>• <b>Chicks: <i>curled toe paralysis</i></b> caused due to peripheral nerve degeneration, in which the chicks walk on their hocks with the toes curled inwards.</li> <li>• In breeding hens deficiency causes decreased hatchability.</li> <li>• Embryonic abnormalities occur including the <b><i>clubbed down condition</i></b> in which the down feather continues to grow within</li> </ul>	

			the follicle leading to curled feather	
3	<b>Niacin (nicotinamide)</b>	<ul style="list-style-type: none"> <li>Nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) involved in the mechanism of hydrogen transfer in living cells.</li> </ul>	<p><b>Pigs:</b> Poor growth, anorexia, enteritis, vomiting and dermatitis.</p> <p><b>Poultry:</b> Bone disorders, feathering abnormalities and inflammation of the mouth and upper part of the oesophagus. Deficiency mainly due to high maize content, since maize contains very little of the vitamin or of tryptophan.</p>	
4	<b>Vitamin B6 (Pyridoxine)</b>	<ul style="list-style-type: none"> <li>Pyridoxal phosphate plays a central role as a coenzyme in the reactions by which a cell transforms nutrient amino acids into mixtures of amino acids and other nitrogenous activities of transaminases and decarboxylases</li> </ul>	<p><b>Pigs:</b> Convulsions reduced appetite and <b>anemia</b>.</p> <p><b>Chicks:</b> Jerky movements, hatchability and egg production are adversely affected</p>	
5	<b>Pantothenic acid</b>	<ul style="list-style-type: none"> <li>A structural component of acyl carrier protein, which is involved, in the cytoplasmic synthesis of fatty acids</li> </ul>	<p><b>Pigs:</b> slow growth, diarrhoea, loss of hair, scaliness of the skin and a characteristic '<b>goose-stepping</b>' gait; in severe cases animals are unable to stand.</p> <p><b>Chick:</b> Growth is retarded and dermatitis, hatchability is reduced.</p>	
6	<b>Folic acid</b>	<ul style="list-style-type: none"> <li>Folic acid is converted into tetrahydrofolic acid which functions as a coenzyme in the mobilization and</li> </ul>	<p><b>Chicks and young turkeys:</b> poor growth, anaemia, poor bone development and poor egg hatchability.</p>	

		utilisation of single-carbon groups (e.g.) formyl, methyl		
7	<b>Biotin</b>	<ul style="list-style-type: none"> <li>• Biotin-dependent enzymes -pyruvate carboxylase, accetyl coenzyme A carboxylase and propionyl coenzyme A carboxylase involved metabolic fuctions of CHO</li> </ul>	<p><b>Pigs:</b> Foot lesions, alopecia (hair loss), a dry scaly skin, growth rate retarded and reproductive efficiency decreased.</p> <p><b>Poultry:</b> Reduced growth, dermatitis, leg bone abnormalities, cracked feet, poor feathering and <b>fatty liver and kidney syndrome (FLKS)</b>.</p> <p><b>FLKS</b> mainly affects two-to five-week-old chicks, is characterized by a lethargic state with death frequently following within a few hours. On autopsy, the liver and kidneys, which are pale and swollen, contain abnormal depositions of lipid.</p> <p><b>Antivitamin: Avidin,</b> a protein present in the raw white of eggs can induce biotin deficiency, which combines with the vitamin and prevents its absorption from the intestine.</p>	
8	<b>Choline</b>	<ul style="list-style-type: none"> <li>• Component of lecithins which play a vital role in cellular structure and activity.</li> <li>• It also plays an important part in lipid metabolism</li> <li>• It serves as a donor of methyl groups in trans methylation reactions and is a</li> </ul>	<p>Deficiency symptoms, including slow growth and fatty infiltration of the liver, have been produced in chicks and pigs. Chorine is also concerned with the prevention of <b>perosis or slipped tendon in chicks</b>. The choline requirement of animals is unusually large for the vitamin, but in spite of this, deficiency symptoms are not common in farm animals because of</p>	

		component of acetylcholine which is responsible for the transmission of nerve impulses.	its wide distribution, its high concentrations in foods and because it can be readily derived from methionine.	
9	<b>Vitamin B12 (Cyanocobalamin)</b>	<ul style="list-style-type: none"> <li>• Co-enzymic forms of vitamin B12 - isomerases, dehydrases and enzymes involved in the biosynthesis of methionine from homocysteine</li> <li>• Metabolism of propionic acid into succinic acid</li> </ul>	<b>Pernicious anemia</b> in human being. <b>Poultry:</b> Poor growth, poor feathering, decreased hatchability, dermatitis and rough coat and reduced appetite, emaciation and anemia	Cobalt

### Important functions and deficiency disorders of Minerals

S.No.	Minerals	Functions	Deficiency symptoms	Inter relationship
<b>Major minerals</b>				
1	Calcium	<ul style="list-style-type: none"> <li>• Structural component of body. 99% of the calcium in the body is present in the bones and teeth</li> <li>• It is essential for the activity of a number of enzyme systems</li> <li>• . It is necessary for the transmission of nerve impulses and for the contractile properties of muscle.</li> <li>• It is also concerned in the coagulation of blood.</li> <li>• <b>Sources:</b> fishmeal, meat and bone meal, ground limestone, steamed bone meal, dicalcium phosphate,</li> </ul>	<b>Young growing animals:</b> <b>Rickets-</b> misshapen bones, enlargement of the joints, lameness and stiffness. <b>Rickety Rosary. Pigeon chested appearance:</b> Enlargement of the osteochondral joints in the ribs due to enlargement of sternum.  <b>Adult animals:</b> <b>Osteomalacia</b> -the calcium in the bone is withdrawn and not replaced,the bones become weak, fragile and are easily broken.  <b>Poultry:</b> soft beak and bones, retarded growth and bowed legs, the eggs have thin shells or there is production of	<b>Vitamin D</b>

		<p>milk, green leafy crops, especially legumes, are good sources of calcium</p>	<p>leathery eggs.</p> <p><b>Milk fever (parturient paresis)</b> occur in dairy cows shortly after calving and is characterized by a lowering of the serum calcium level, muscular spasms, and in extreme case paralysis and unconsciousness.</p> <p><b>Calcium: Phosphorus ratio:</b> 1:1 to 2:1, The proportion of calcium for laying hens is much larger, since they require great amounts of the element for eggshell production.</p> <p><b>Toxicity: Nutritional secondary hyperparathyroidism (Miller's disease or bran disease or big head disease)</b> - An excess of phosphorus depresses calcium absorption.</p>	
2	Phosphorus	<ul style="list-style-type: none"> <li>• Phosphorus occurs in close association with calcium in bone</li> <li>• Synthesis of Phosphoproteins, nucleic acids and phospholipids.</li> <li>• Formation of adenosine di- and triphosphates.</li> <li>• 80-85 % present in bone and teeth</li> </ul>	<p><b>Rickets or osteomalacia. 'Pica' or depraved appetite</b> has been noted in cattle; the affected animals have abnormal appetites and chew wood, bones, rags and other foreign materials.</p> <p><b>Poor fertility,</b> apparent dysfunction of the ovaries causing inhibition or depression and irregularity of oestrus.</p> <p>Milk production decreased</p> <p>Subnormal growth in young animals and low live weight gains in mature animals</p>	Vitamin D
3	Magnesium	<ul style="list-style-type: none"> <li>• Activates enzymes</li> </ul>	<p><b>Hypomagnesaemic tetany</b></p>	<b>Calcium</b>

		<p>like thiamin pyrophosphate and phosphate transferases, pyruvate carboxylase, pyruvate oxidase which are essential for the metabolism of carbohydrates and lipids.</p> <ul style="list-style-type: none"> <li>• Formation of adenosine tri-di- and mono phosphates</li> <li>• <b>Sources:</b> Wheat bran, dried yeast and most vegetable protein concentrate, especially cottonseed cake and linseed cake and magnesium oxide</li> </ul>	<p><b>or magnesium tetany or lactation tetany or grass staggers:</b> Nervousness, tremors, twitching of the facial muscles, staggering gait and convulsions.</p> <p>Grass staggers is due to heavy dressing of pasture with nitrogenous and potassic fertilizers.</p>	
4	Sodium, Potassium and Chloride	<ul style="list-style-type: none"> <li>• Osmotic regulation of the body fluids and in the acid-base balance in the animal.</li> <li>• Transmission of Nerve and muscle impulses</li> <li>• Carbohydrate metabolism</li> <li>• Present in the soft tissues and body fluids.</li> <li>• The absorption of sugars and amino acids from the digestive tract.</li> <li>• Much of the sodium is ingested in the form of sodium chloride (common salt) and it is also mainly in this</li> </ul>	<p>Poor growth, reduced utilization of digested proteins and energy, lowering of the osmotic pressure and dehydration of the body.</p> <p><b>Poultry:</b> Egg production and growth rate are adversely affected, retarded growth, weakness and tetany, followed by death.</p>	Potassium rich forage produces magnesium deficiency

		form that the element is excreted from the body		
5	Sulphur	<ul style="list-style-type: none"> <li>• Sulphur containing <b>amino acids cystine, cysteine and methionine</b></li> <li>• Vitamins <b>biotin and thiamine</b> Hormone <b>insulin</b> and the important metabolite <b>coenzyme A</b> also contain sulphur</li> <li>• S containing structural compound <b>chondroitin sulphate</b> is a component of cartilage, bone, tendons and the walls of blood vessels</li> <li>• Wool is rich in cystine and contains about 4 per cent of sulphur.</li> <li>• sulphate can be used by ruminal micro organisms more efficiently than elemental sulphur</li> <li>• Tissue protein and milk have a ratio of <b>nitrogen to sulphur of 10 –12 :1 and the ratio in wool is 5:1</b></li> <li>• The nitrogen to sulphur ratio of 10-12:1 should be maintained whenever NPN compounds are used as supplements in ruminant feeds.</li> </ul>	<p><b>Ruminants:</b> Reduced feed intake and reduced cellulose digestion</p> <p><b>Toxicity:</b> reduces rumen motility and causes nervous and respiratory distress</p>	Copper molybdenum sulphur interaction
<b>Minor minerals</b>				

1	<p style="text-align: center;"><b>IRON</b></p>	<ul style="list-style-type: none"> <li>• Iron contained protein <b>haemoglobin</b>.</li> <li>• In blood serum <b>transferrin</b>, which is iron containing concerned with the transport of iron from one part of the body to another.</li> <li>• <b>Ferritin</b>, is a protein containing iron, is present in the spleen, liver, kidney and bone marrow and provides a form of storage for iron.</li> <li>• <b>Haemosiderin</b> is a another storage form of iron.</li> <li>• Activates enzymes of the electron transport chain - <b>cytochromes catalase, peroxidases, phenylalanine hydroxylase</b> and many other including all the tricarboxylic acid cycle enzymes</li> <li>• <b>Sources:</b> green leafy materials, most leguminous plants and seed coats, meat, blood and fish meals</li> </ul>	<p><b>Anaemia:</b> occurs most commonly in rapidly <b>growing suckling animals</b>.</p> <p>This can occur in piglets housed in pens without access to soil.</p> <p>The piglet is born with very limited iron reserves and sow's milk provides only about 1mg per day.</p> <p>The rapidly growing piglet's requirement is 125mg per day, which, in extensive systems, could be obtained by ingestion of soil.</p> <p>Providing the sow with supplementary iron in gestation does not increase the foetal piglets liver iron or the amount in the milk.</p> <p>Therefore, it is routinely supplied by intramuscular injection as a dextran complex by 3 days of age.</p> <p>Usually 200 mg of iron is injected. Alternatively oral iron supplements are available in the form of a paste of the citrate or fumarate or granules of iron dextran but these may not be eaten or the iron may be lost if diarrhoea occurs. Anemia in piglets is characterized by poor appetite and growth. Breathing becomes labored and spasmodic-hence the descriptive term '<b>thumps</b>' for the condition.</p> <p>Although iron deficiency is <b>not common in older animals</b>, increased supplementation is required</p>	<p style="text-align: center;"><b>Vitamin C</b></p>
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			<p>when high levels of copper are used for growth promotion.</p> <p><b>Iron toxicity:</b> Chronic iron toxicity results in alimentary disturbances, reduced growth and phosphorus deficiency</p>	
2	<b>COPPER</b>	<ul style="list-style-type: none"> <li>• <b>Ceruloplasmin (ferroxidase)</b> is a Cu protein which releases the iron from the cells into the plasma i.e. the conversion of iron into transferrin.</li> <li>• <b>Erythrocytorein</b>, is also a Cu protein which occurs in erythrocytes where it plays a role in oxygen metabolism</li> <li>• Activates <b>cytochrome oxidase</b>, which is important in oxidative phosphorylation involved in the synthesis of myelin lipid compounds</li> <li>• Copper containing enzyme <b>lysyl oxidase</b> is needed for the conversion of lysine to desmosine which forms cross links in elastin and collagen fibres</li> <li>• Cu containing pigments, notably <b>turacin, a pigment of feathers</b></li> <li>• Copper is necessary</li> </ul>	<p><b>Anaemia</b>, poor growth, <b>bone disorders</b>, <b>scouring</b>, infertility, <b>depigmentation of hair and wool</b>, gastrointestinal disturbances and lesions in the brain stem and spinal cord.</p> <p>The lesions are associated with muscular incoordination, and occur especially in <b>young lambs - swayback</b> condition also known as <b>'enzootic ataxia'</b> or <b>neonatal ataxia</b>. The signs range from complete paralysis of the newborn lamb to a swaying staggering gait, which affects, in particular, the hind limbs.</p> <p>The wool, which lacks crimp, is referred to as <b>'stringy'</b> or <b>'steely'</b> wool</p> <p><b>Nutritional anaemia</b> in young pigs easily arise in such animals fed solely on milk.</p> <p>In older animals a condition in Australia known locally as <b>'falling disease'</b> was found to be related to a progressive degeneration of the myocardium of animals grazing on copper deficient pastures.</p> <p>Copper deficiency also leads to reproductive problems in</p>	Copper-molybdenum - sulphur interrelationships

		<p>for the normal pigmentation of hair, fur and wool</p> <ul style="list-style-type: none"> <li>• Copper containing enzyme <b>tyrosinase</b> is needed for the conversion of the amino acid tyrosine to melanin</li> <li>• <b>Sources:</b> Seeds and seed by-products are usually rich in copper. The normal copper content of pasture ranges from about 4 to 8 mg/kg DM.</li> </ul>	<p>cattle.</p> <p><b>Copper-molybdenum - sulphur interrelationship:</b> Sulphide is formed by ruminal microorganisms from dietary sulphate or organic sulphur compounds; the sulphide then reacts with molybdate to form thiomolybdate which in turn combines with copper to form an insoluble copper thio molybdate (CuMoS<sub>4</sub>) thereby limiting the absorption of dietary copper.</p> <p><b>Poultry:</b> Fragile long bones, lameness, shell less and misshapen eggs, reduced egg production and hatchability, depigmentation of feathers</p> <p><b>Copper toxicity:</b> Copper can be regarded as a cumulative poison, so that considerable care is required in administering copper salts to animals. Pigs are highly tolerant and cattle relatively so. Chronic copper poisoning results in necrosis of the liver cells, jaundice, loss of appetite and death from hepatic coma.</p>	
3	<b>COBALT</b>	<ul style="list-style-type: none"> <li>• Cobalt is required by microorganisms in the rumen for the synthesis of vitamin B<sub>12</sub>,</li> </ul>	<p><b>Pining:</b> gradual decrease in appetite with consequent loss of weight followed by muscular wasting, pica, severe anemia and eventually death</p> <p><b>Cobalt toxicity:</b> Excessive cobalt supplementation of ruminant diets can lead to the production of analogues of vitamin B12 and a reduction</p>	<b>Vitamin B12</b>

			in the quantity of the true vitamin.	
4	<b>IODINE</b>	<ul style="list-style-type: none"> <li>• synthesis of the two hormones, triiodothyronine and tetraiodothyronine (thyroxine)</li> <li>• The element also occurs in the gland as monoiodotyrosine and diiodotyrosine, which are intermediates in the biosynthesis of the hormones from the amino acid tyrosine</li> <li>• The thyroid hormones accelerate reactions in most organs and tissues in the body, thus increasing the basal metabolic rate, accelerating growth, and increasing the oxygen consumption of the whole organism.</li> <li>• <b>Sources:</b> Foods of marine origin and values as high as 6g/kg DM has been reported for some seaweed's, fish meal is also a rich source of the element</li> </ul>	<p>Enlargement of the thyroid gland, termed <b>endemic goitre</b>, and is caused by compensatory hypertrophy of the gland. (<b>swelling of the neck, 'big neck'</b>)</p> <p>Reproductive abnormalities;</p> <p><b>Goitrogenic compounds</b> include Brassica genus, especially kale, cabbage and rape, and also soya beans, linseed, peas and groundnuts.</p> <p>A goitrogen present in brassicas has been identified as L-5-vinyl-2-oxazolidine-2-thione (goitrin) which inhibits the iodination of tyrosine and thus interferes with thyroxine the diet.</p> <p>Thiocyanate, which may also be present in members of the Brassica genus, is known to be goitrogenic and may be produced in the tissues from a cyanogenetic glycoside present in some foods.</p> <p><b>Poultry:</b></p> <p><b>Iodine toxicity:</b> depressions in weight gain and feed intake.</p>	
5	<b>MANGANESE</b>	<ul style="list-style-type: none"> <li>• Enzymes activator such as hydrolases and kinases and as a constituent of arginase, pyruvate carboxylase and manganese</li> </ul>	<p><b>Ruminants:</b> Retarded growth, skeletal abnormalities, ataxia of the newborn and reproductive failure, depress or delay oestrus and conception, and</p>	Vitamin K induced blood clotting response

		<p>superoxide dismutase and glycosyl transferases which, is required for the formation of the mucopolysaccharide which forms the organic matrix of bone.</p> <ul style="list-style-type: none"> <li>• <b>Sources:</b> Rich sources are rice bran and wheat offals. Most green foods contain adequate amounts</li> </ul>	<p>to increase abortion</p> <p><b>Pigs:</b> lameness is a symptom due thickening and shortening of bones of the legs.</p> <p><b>Poultry: perosis or 'slipped tendon':</b> There is enlargement of the hock joint thickening and shortening of the tibia which causes Achilles tendon to slip from its condyle causing the leg of the bird to be pulled sideward and backward. In breeding birds reduces hatchability and shell thickness, and causes head retraction in chicks, causes a condition called as <b>nutritional chondrodystrophy</b> which is characterized by the shortening of the bones of the wings and legs, shortening of the lower mandible leads to <b>parrot beak condition</b>.</p> <p>.</p> <p>.</p>	
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6	<b>ZINC</b>	<ul style="list-style-type: none"> <li>• Zinc containing enzymes carbonic anhydrase, pancreatic carboxypeptidase, lactate dehydrogenase, alcohol dehydrogenase, alkaline phosphatase and thymidine kinase involved metabolic functions of nutrients</li> <li>• <b>Sources</b> : Yeast, rice bran, germ of cereal grains, meat meal and fishmeal</li> </ul>	<p><b>Pigs: Parakeratosis</b> - reddening of the skin followed by eruptions, which develop, into scabs and subnormal growth, depressed appetite, poor feed conversion.</p> <p>Parakeratosis is aggravated by high calcium levels in the diet and reduced by decreased calcium and increased phosphorus levels.</p> <p>Pigs given diets supplemented with high levels of copper, for growth promotion, have an increased requirement for zinc.</p> <p><b>Calves:</b> inflammation of the nose and mouth, stiffness of the joints, swollen feet and parakeratosis</p> <p><b>Poultry:</b> retarded growth, foot abnormalities, 'frizzled' feathers, parakeratosis and a bone abnormality referred to as the '<b>swollen hock syndrome</b>'.</p> <p>. .</p>	<b>Vitamin A</b>
7	<b>MOLYBDENUM</b>	<ul style="list-style-type: none"> <li>• Being a component of xanthine oxidase, participates in the reaction of the enzyme with cytochrome C and also facilitates the reduction of cytochrome C by aldehyde oxidase.</li> </ul>	<p>Deficiency has not observed under natural conditions in any species.</p> <p><b>Toxicity</b> : 'teart' is described under the element copper.</p>	<b>Copper and sulphur</b>
8	<b>SELENIUM</b>	<ul style="list-style-type: none"> <li>• <b>component of glutathione peroxidase,</b> an enzyme which catalyses the</li> </ul>	<p><b>Deficiency:</b> same as vitamin E</p>	<b>Vitamin E</b>

		<p>removal of hydrogen peroxide, thereby protecting cell membranes from oxidative damage</p> <ul style="list-style-type: none"> <li>• Selenium has a sparing effect on vitamin E by ensuring normal absorption of the vitamin E. Selenium also reduces the amount of vitamin E required to maintain the integrity of lipid membranes and aids the retention of Vitamin E in plasma.</li> <li>• Conversely, vitamin E spares selenium by maintaining the element in its active form and preventing its loss. It reduces the production of hydroperoxides and thus the amount of glutathione peroxidase needed to protect cells.</li> </ul>	<p><b>Toxicity: Alkali disease and blind staggers</b> are localized names for chronic diseases of animals grazing certain seleniferous areas in the USA. Symptoms include dullness, stiffness of the joints, loss of hair from mane or tail and hoof deformities. Acute poisoning, which results in death from respiratory failure, can arise from sudden exposure to high selenium intakes</p>	
9	<b>FLUORINE</b>	<ul style="list-style-type: none"> <li>• Prevention of dental caries</li> </ul>	<p><b>Flurosis:</b> dental pitting and wear, leading to exposed pulp cavities, depression of appetite, lameness and reduced production. Bone and joint abnormalities</p> <p>Fluorine is a very toxic element, with ruminants being more susceptible than non-ruminants .</p>	

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