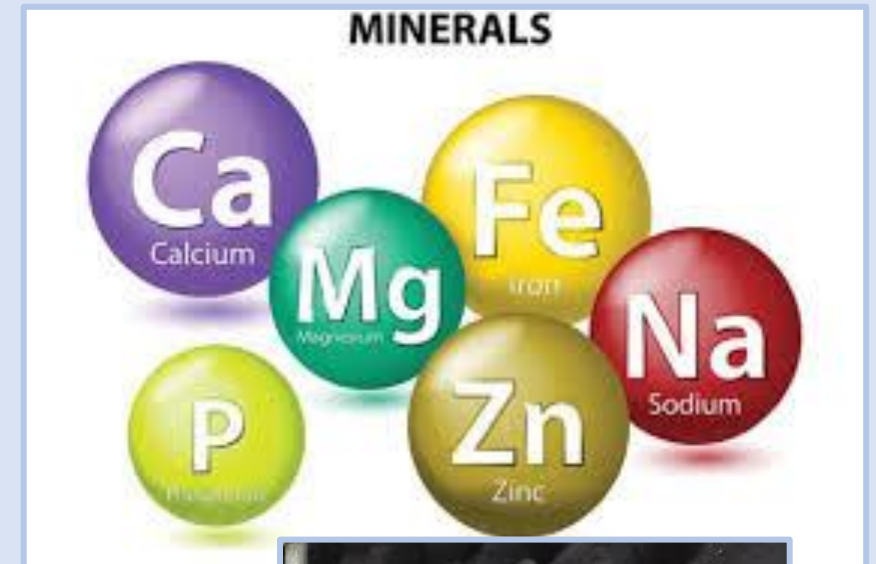


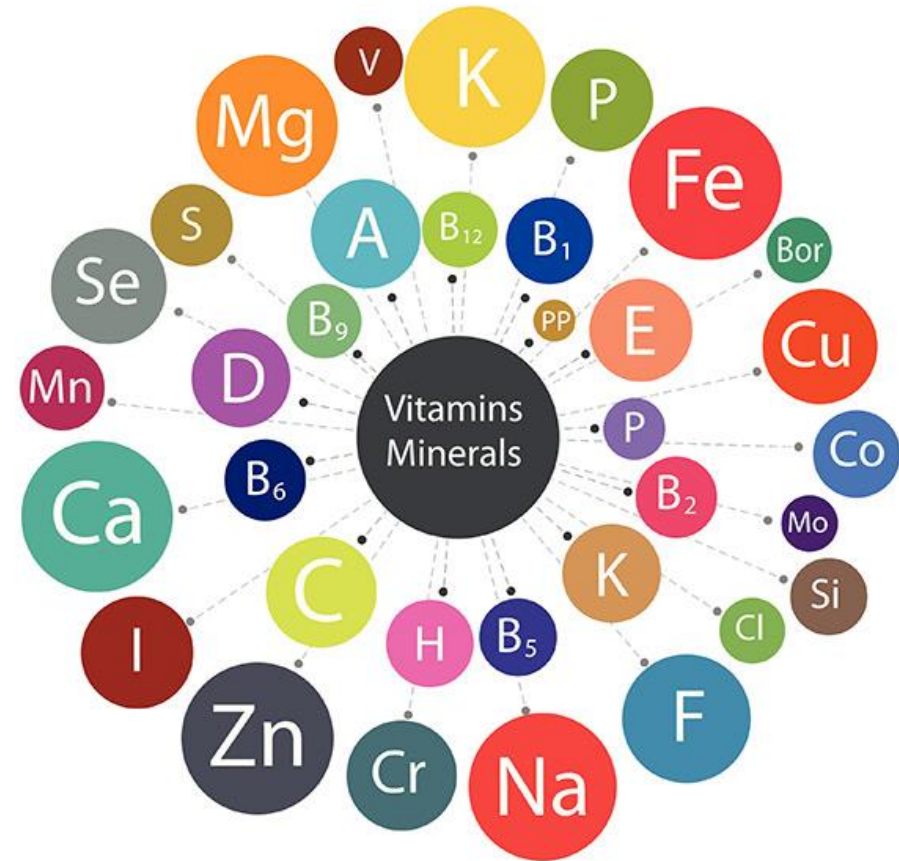
MINERAL AND VITAMIN REQUIREMENT GUIDELINE (Level 2)

Topic	Training & information Content
3.1	Estimating feeding value of fodder & feed on dairy farms
3.2	Sampling feeds & forages/analysis interpretation
3.3	Estimating Dry Matter intake for various breeds/age categories of dairy cattle in the tropics
3.4	Reviewing feed intake, rumen fill, Body Condition Scoring (BCS)
3.5	Life weight estimation of cows
3.6	Rumen fermentation
3.7	Mineral & vitamin requirement, guidelines
3.8	Manure scoring and evaluation
3.9	Guidelines for ration calculations for various breeds, heifers, lactation stage (Rumen8)
3.10	Use of Rumen8 software for ration calculation
3.11	Optimization of ration with Rumen8
3.12	Feeding management guidelines
3.13	Feeding management of dry cows/close-up
3.14	Feeding systems
3.15	Metabolic disorders
3.16	Scoring locomotion and hoof condition
3.17	Mycotoxin in dairy cattle nutrition
3.18	Heat stress in dairy cattle nutrition
3.19	Monitoring feeding management, using KPIs (based on Rumen8)



1. You will learn about (learning objectives):

- Types of minerals and vitamins.
- Functions of minerals and vitamins in a dairy cow.
- Mineral and vitamin requirements by dairy cattle.



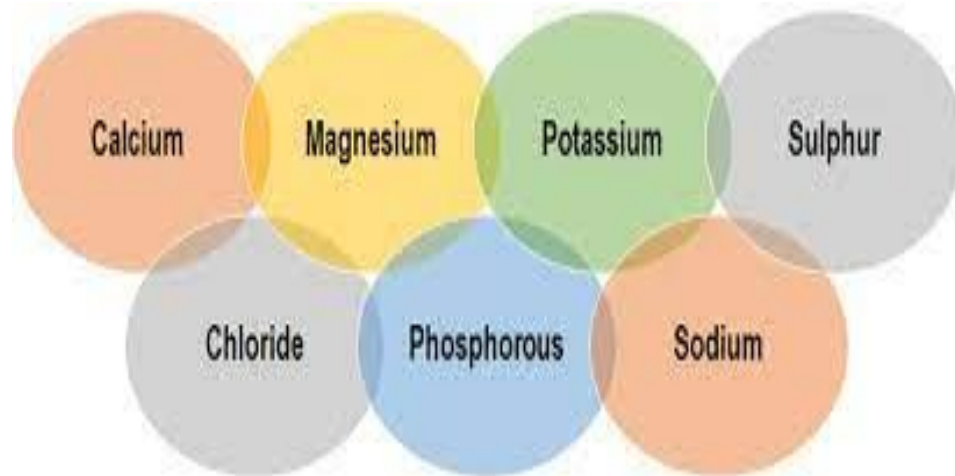
2. Introduction

- **Minerals:** are inorganic elements needed in the cow's body to support some functions.
- **Vitamins:** are organic compounds needed in small quantities to maintain life and body functions.
- Animals get minerals and vitamins through feeding.
- Minerals are divided into two categories;
 - i. Macro minerals,
 - ii. Micro minerals.



3. Macro and Micro minerals

- **Macro minerals:** are minerals that are needed by cows in bigger/larger quantities as compared to microminerals.
- Macro minerals are expressed and measured as a percentage of dry matter intake (DMI).
- Examples of these minerals are;
 - Calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), Sulphur (S), sodium (Na) and chlorine (Cl).

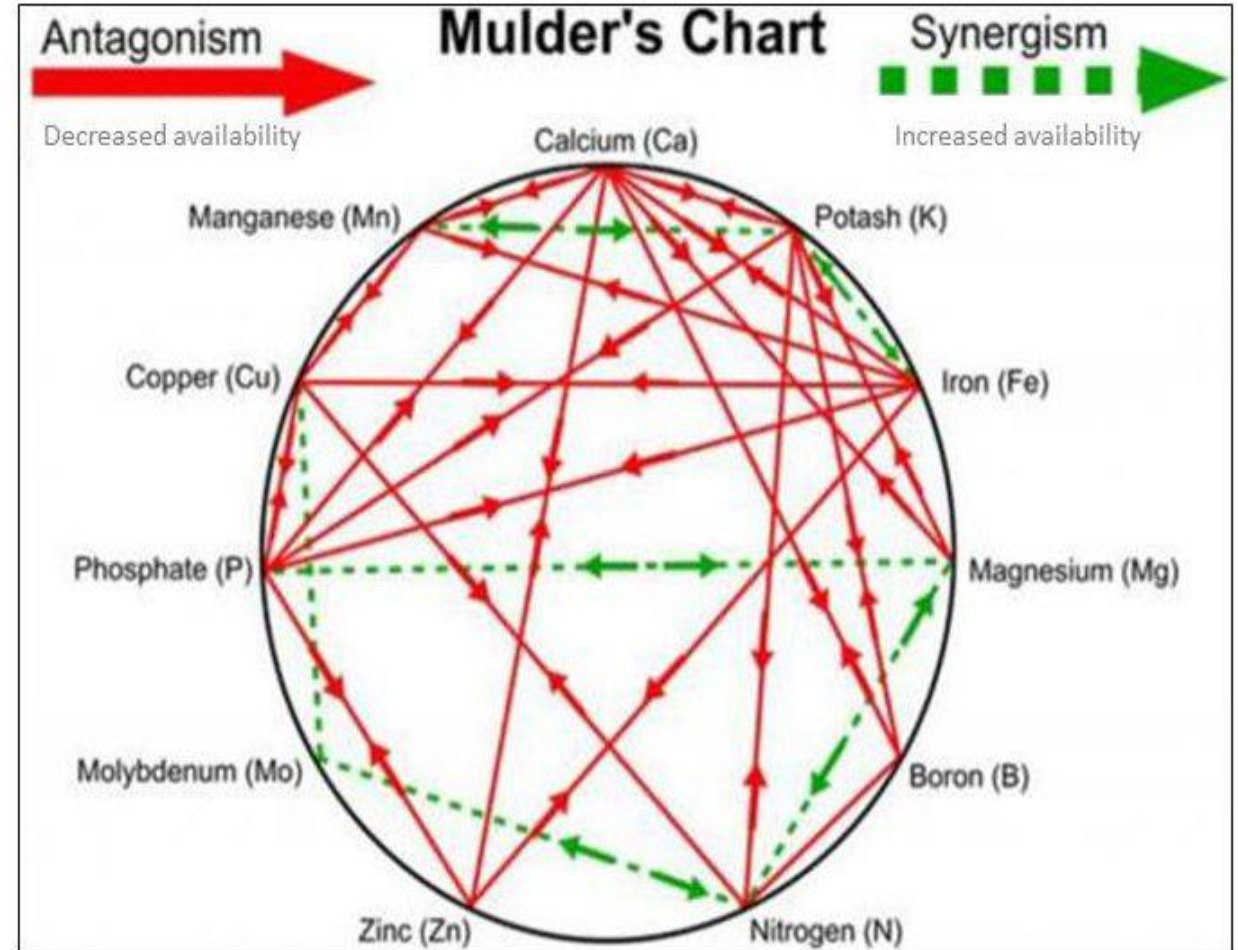


- **Micro minerals:** are minerals needed in smaller quantities.
- They are added to cows ration as premixes.
- Examples of these trace minerals are;
 - Cobalt (Co), copper (Cu), iron (Fe), iodine (I), manganese (Mn), molybdenum (Mo), selenium (Se), zinc (Zn), nickel (Ni) and chromium (Cr).



4. Mineral bioavailability

- This refers to total amount of minerals that can be utilized for normal body function at dietary and tissue level.
- Minerals should be available in ionic form (cations and anions) to make them suitable for transport and uptake.
- Bioavailability of one mineral influences concentration of other minerals in the diet, creating antagonisms or synergisms.



5. Mineral analysis

- Analysis helps correct feeds and forage that are insufficient or excessive amounts of certain minerals.
- Mineral content of forages is influenced by availability of nutrients in the soil (soil fertility).
- This can be done through soil mineral analysis.



6. Macro minerals: Calcium (Ca)

- Majority of calcium in the cow's body is found in animals bones and teeth.
- Forages also contain calcium (legumes contain more Ca than grasses).

Functions of Calcium

- Important for bone & teeth formation, development and maintenance.
- Needed for milk production.
- Important for blood clotting.
- Supports muscle contraction.
- Aids in nerve impulse transmission.

Impact of high Calcium levels

- High calcium levels reduces absorption of zinc and phosphorus.

Supplemental sources of Ca

- Limestone(Calcium carbonate) dicalcium phosphate, calcium sulphate, bone meal and oyster shells.



7. Phosphorus (P)

- Majority of phosphorus can be found in bones and teeth.
- Concentrates are higher in phosphorus than forages. Forage phosphorus levels are lower in mature forages and during dry spells.
- Animals fed on high forage rations should therefore be supplemented with P.

Signs of Phosphorus deficiency

- Decreased appetite (DMI) and growth.
- Reduced milk production.
- Cows eating soil, rocks, wooden post or bones (pica).
- Rickets due to weak and fragile bones (clinical deficiency).

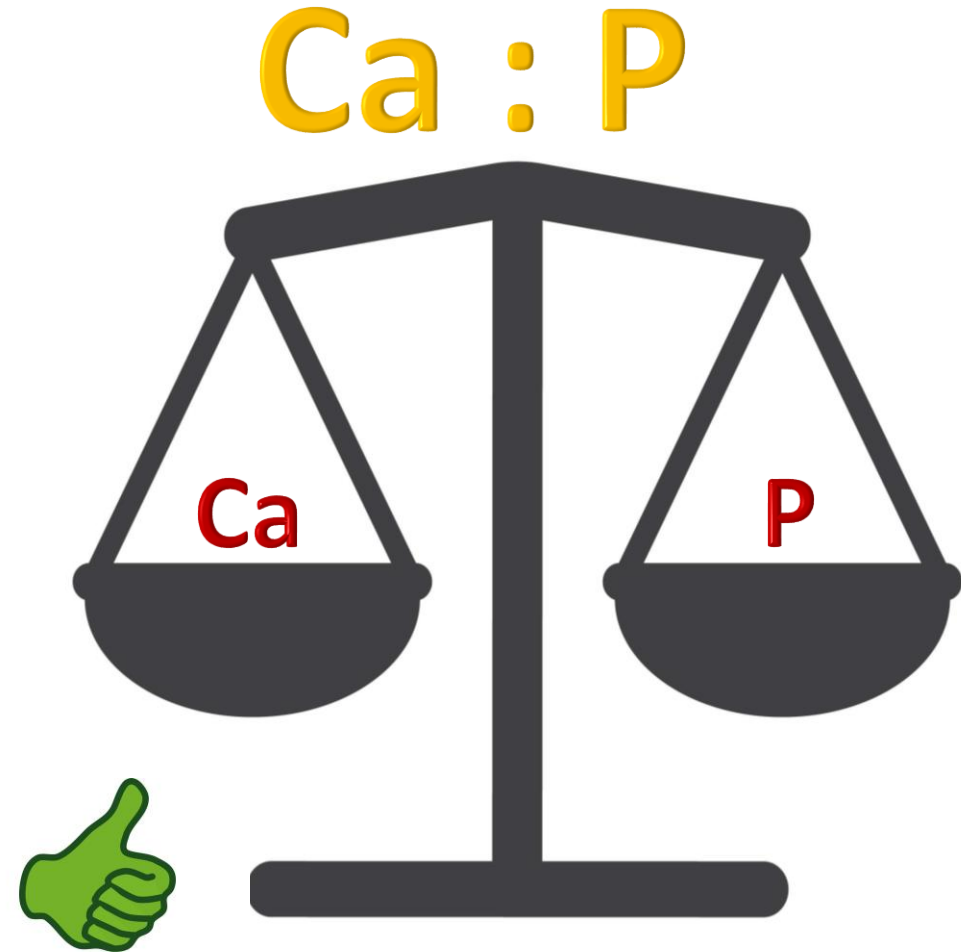


Supplemental sources of P

- Dicalcium phosphate and monocalcium phosphate.

8. Calcium (Ca) and Phosphorus (P) proportion

- Ca and P are one of the major minerals and should be balanced for best utilization by cow.
- Interactions between calcium and phosphorus affects required level of each other in rations.
- One and a half part calcium to one part phosphorus (1.5:1) is recommended.
- An imbalance of the calcium and phosphorus ration can impact fertility.

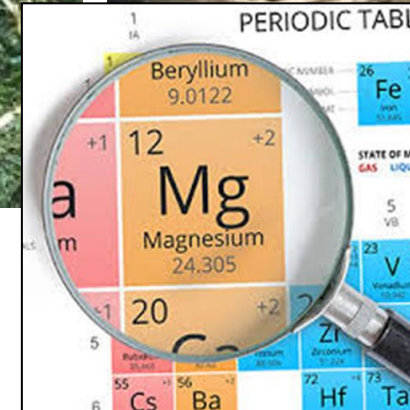


9. Magnesium (Mg)

- Three quarter of magnesium is found in bones of cows.
- Mg is found in feeds, with plant protein sources having higher Mg content.
- Mg levels in diet should not exceed 0.4%.

Signs of Magnesium deficiency

- **Muscle** convulsions.
- Frothing at the mouth.
- Muscle tremors (grass tetany) - See module metabolic disorders.
- Increased blood flow.



Supplemental sources of Mg

- Magnesium oxide and magnesium sulphate.

10. Potassium (K)

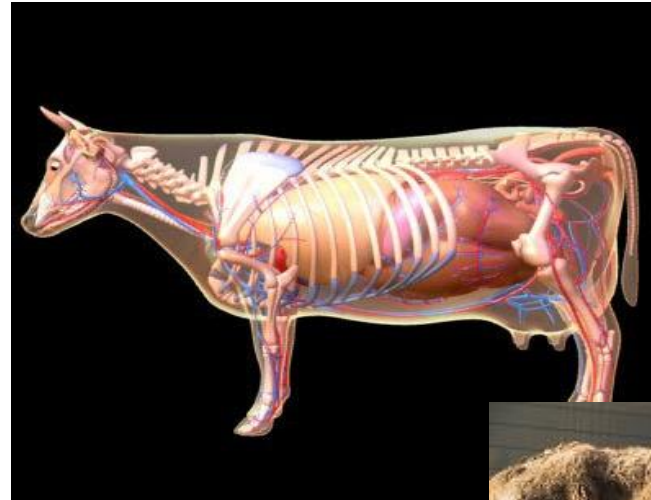
- Forages are a good source of potassium especially well growing green pastures.
- Potassium should not exceed 3% in the diet.

Signs of Potassium deficiency

- Reduced feed and water intake.
- Low milk production.
- Reduced weight gain.
- Rough haircoat.
- Muscle weakness.

Impact of high Potassium levels

- Leads to decline in magnesium utilization.
- Can lead to low calcium level in blood as a result increase risk of milk fever.



Source:

https://www.google.com/search?q=potassium+deficiency+in+cattle&rlz=1C5CHFA_enKE951KE951&sxsrf=APq-WBunNhtxda4Z00MueQwl2mYVtVR9PA:1648058511163&source=Inms&tbm=isch&sa=X&ved=2ahUKEwi1x4Gx6Nz2AhWDhv0HHZk8AqkQ_AUoAXoECAEQAw

Supplemental sources of K

- Potassium bicarbonate, potassium chloride, potassium sulphate and potassium carbonate.

11. Sodium (Na) and Chlorine (Cl)

- Salt concentration should be balanced to avoid excessive or under consumption of salt in animal diets.
- Cows crave sodium and will consume more salt when offered at free choice than is required.
- Sodium deficiency is common and not chlorine. Sodium deficiency may lead to;
 - Decreased appetite.
 - Abnormal eating habits.
 - Low dry matter intake (DMI).
 - Cows licking soil and wood (pica).



Supplemental sources of Na and Cl

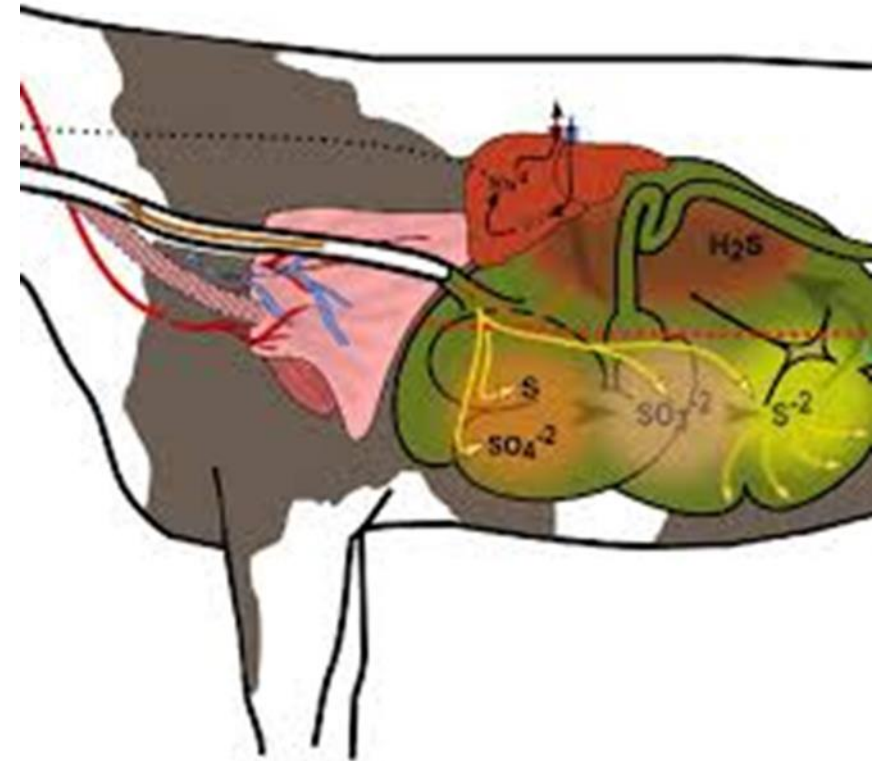
- Sodium chloride (common salt),

12. Sulphur (S)

- Sulphur is a building block for various amino acids and vitamin B (thiamin & biotin) and assists in acid-base balance.
- Sulphur in feedstuff is largely found as a component of protein.
- Low Sulphur levels can reduce copper levels.
- Sulphur in diets should not exceed 0.4%.

Signs of high Sulphur levels/Sulphur toxicity

- Diarrhea in cows.
- Restlessness and difficulty in breathing.
- Muscle twitching.



Supplemental sources of S

- Sodium sulphate, calcium sulphate, ammonium sulphate and other elements containing sulphur.

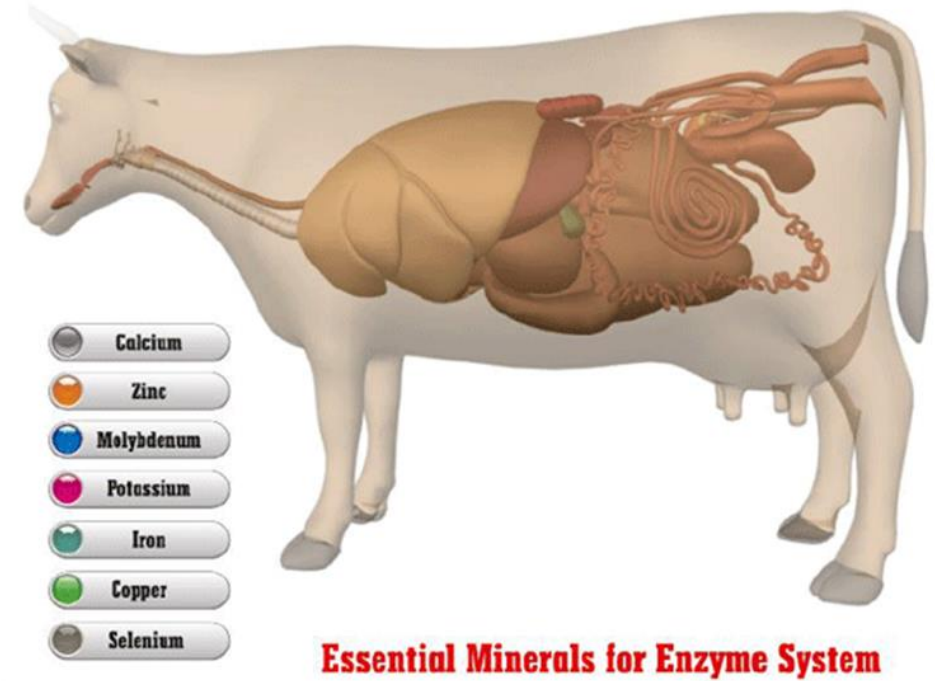
13. Micro minerals: Zinc (Zn) and Iron (Fe)

Zinc (Zn)

- Plant proteins have higher Zn than cereal grains.
- Zn is a component of key enzymes used to activate other enzymes.
- Zinc plays a role in development and functioning of immune system.

Iron (Fe)

- Is a component of hemoglobin and myoglobin (oxygen transfer).
- Fe contributes to copper deficiency.
- Lack of iron causes anemic conditions, pale mucous membrane, reduced feed intake and abnormal raised tissue structure of the tongue.



14. Cobalt (Co) and Manganese (Mn)

Cobalt (Co)

- Is the building block for Vitamin B12 (cobalamin).
- Rumen microbes use vitamin B12 to produce propionate which is a volatile fatty acid used to give energy to cows.
- Young stock are more sensitive to Co deficiency than mature stock.
- Legumes are higher in Co than grass.

Manganese (Mn)

- Important for bone growth and formation.
- Maintains fertility in female cattle.
- Aids metabolism functions.



Cobalt

Manganese

15. Copper (Cu) and Iodine (I)

Copper (Cu)

- Cu is more available in concentrates than in forages.
- Cu aids in iron absorption and metabolism.
- Aids many enzyme systems i.e. hemoglobin formation.
- Important in immune functions.

Iodine (I)

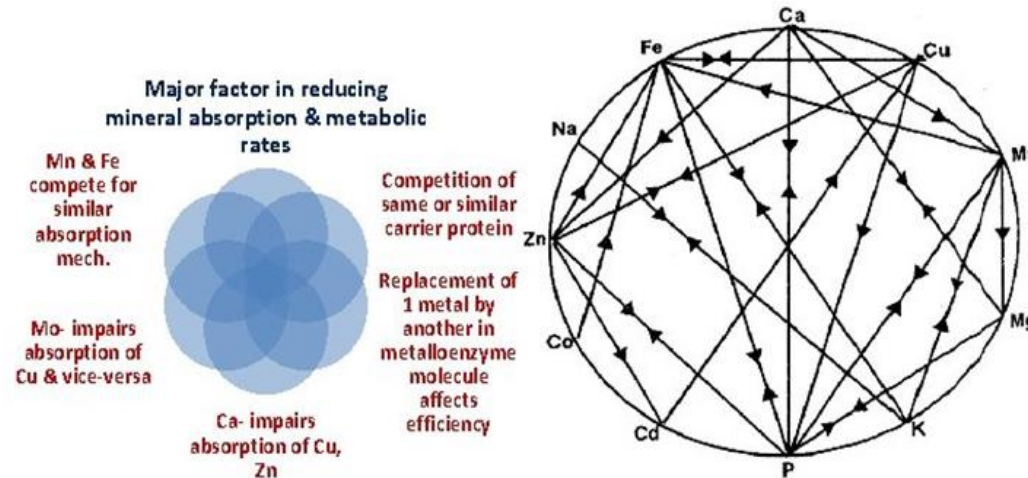
- Important component of the thyroid hormones for energy metabolism regulation in the body.
- Lack of iodine reduces immunity and calves born may be blind. It also causes enlarged thyroid gland (goiter).



16. Molybdenum (Mo)

- Mo is a component of some enzymes.
- Excess Mo causes decreased weight of heifer at puberty.
- Excess Mo affects conception rates.
- Copper & sulphur work against Mo in the body.
- Copper can reduce molybdenum toxicity while molybdenum contributes to copper deficiency. Maintaining Cu and Mo helps reduce this.

Mutual antagonism



17. Selenium (Se)

- Is an antioxidant and component of some enzymes.
- Se is needed for pancreas functions.
- Functions of Vitamin E and selenium are interrelated.
- Lack of selenium affects immune system response of calves.
- It also lead to white muscle disease.



Selenium

18. Nickel (Ni) and Chromium (Cr)

Nickel (Ni)

- Ni is a component of some enzymes (urease enzyme- responsible for urea breakdown).

Chromium (Cr)

- Chromium assists in glucose clearance.
- Chromium supplementation improves immune response of stressed animals.



19. Guidelines for feeding macro minerals

Mineral	Lactating cows	Dry cows	Growing calves	Maximum tolerable level
Calcium, %	0.31	0.18	0.58	-
Magnesium, %	0.10	0.12	0.20	0.40
Phosphorus, %	0.21	0.16	0.26	-
Potassium, %	0.60	0.60	0.70	3.0
Sodium, %	0.07	0.07	0.10	-
Sulphur, %	0.15	0.15	0.15	0.40

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition

20. Factors affecting mineral intake

- Mineral availability and content.
- Palatability and form of the mineral product.
- Mineral feeder location. Place mineral blocks or mineral lick near watering points to increase consumption.
- Deficiency of other nutrients in the diet (protein and energy).
- Forage quality and other feed supplements.
- Concentration of other minerals i.e. phosphorus in high levels can affect ability of using other minerals like Ca, Mg, Fe and Zn.



21. Vitamins

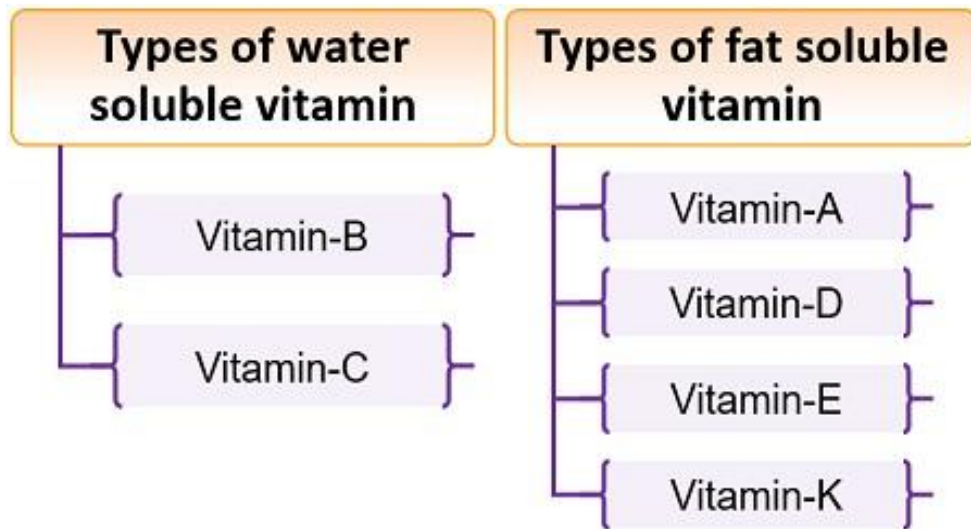
- Vitamins are important for normal functioning of the cow's body.
- Different types of minerals works towards sustaining various operations of the body.
- Colostrum contains vitamins and is a source of vitamins to newborn calves.
- Most vitamins are bound to specific proteins.
- Young calves obtain soluble-vitamins directly added to their diets.



Colostrum is a source of vitamins to newborn calves

22. Types of Vitamins

- There are various classes of vitamins namely;
 - i. Water-soluble vitamins,
 - ii. Fat-soluble vitamins.
- Vitamins are mostly stored in the liver with fat soluble vitamins stored in cow's body fat.



i. Water soluble vitamins

- These vitamins include;
 - Vitamin B complex, vitamin C
- They are provided by rumen microbes. Rumen microbes synthesize water-soluble vitamins to meet her nutritional requirement.
- Most of these vitamins are (co-factors) required for proper enzyme function.
- For mature cows, water-soluble vitamins do not have to be supplemented.
- For young calves these vitamins can be supplements. They are added to rations in milligrams per day.



22.1 Types of Vitamins Cont'd...

ii. Fat soluble vitamins

- High levels of fat can improve absorption of these vitamins.
- They are added to rations in international units (IU) per day.
- These vitamins include;
 - Vitamin A, D, E and K.



Types of fat soluble vitamin

Vitamin-A

Vitamin-D

Vitamin-E

Vitamin-K

23. Vitamin A

- Vitamin A can be obtained from feeds or through injections.
- Vitamin A is stored in the liver.
- It is specially known to maintain tissues (skin, stomach and intestinal cell lining).
- Helps in maintaining normal vision & bone development.
- Supports reproduction functions and growth.

Signs of vitamin A deficiency

- Excessive tears.
- Night blindness, blindness in calves and general blindness.
- Result in still births or abortion.
- Low conception rates and retained placenta.



Vitamin A deficiency can lead to retained placenta

24. Vitamin D

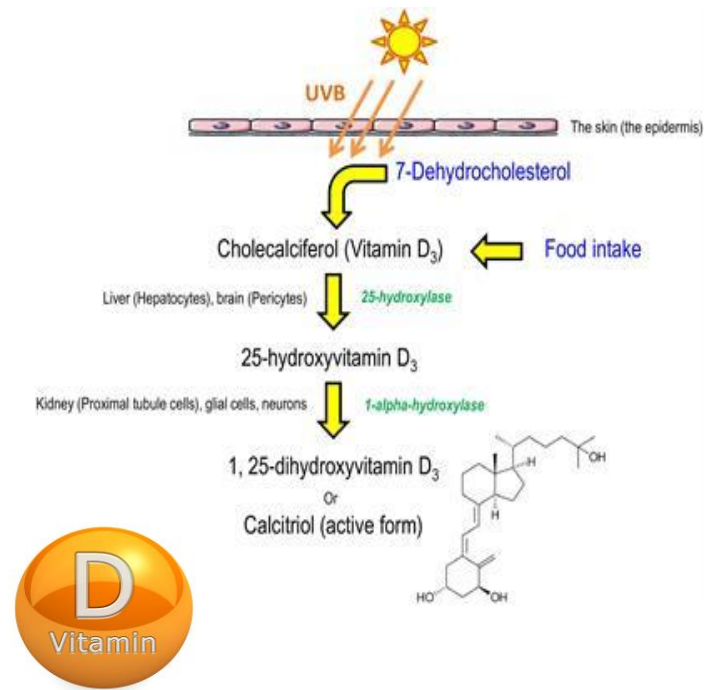
- Vitamin D is found in plants (D2) and animals take in vitamin D when fed sun-cured forages.
- Vitamin D is made when animals are exposed to sunlight.
- It is required for phosphorus and calcium absorption.
- Vitamin D assists in calcium mobilization from bones and aids normal bone mineralization.

Signs of vitamin D deficiency

- Difficulty in breathing.
- Stiff joints.
- Brittle bones.
- Leads to rickets due to poor Ca and P absorption.
- Irritability.

Signs of Vitamin D toxicity

- Decreased appetite.
- Weight loss.
- Bone demineralization.
- Calcification of soft tissues.



25. Vitamin E

- Vitamin E is closely linked with similar deficiency characteristics as selenium.
- Vitamin E acts as an antioxidant in the body.
- Assists in resisting diseases.
- Vitamin E supports membrane formation.
- Supports muscle structure and functioning.

Signs of vitamin E deficiency

- Respiratory difficulties.
- Muscle weakness in calves.
- Difficulties in swallowing.

Note: Similar characteristics to white muscle disease.



26. Vitamin K

- Vitamin K is important for thrombin (blood clotting) production in the liver.
- Vitamin K are produced by rumen bacteria in sufficient quantities to meet the cow's body requirements. For this reason vitamin K is rarely supplemented.
- Moldy feeds should be avoided since it interferes with vitamin K functions.
- Vitamin K can be supplemented through administration to support blood clotting.

