ETIOLOGY

- Intrinsic Causes
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ETIOLOGY
Etiology is the study of cause of disease. It gives precise causal diagnosis of any disease. Broadly, the cause of diseases can be divided into two:
   a. Intrinsic causes
   b. Extrinsic causes

INTRINSIC CAUSES
Those causes, which determine the type of disease present within an individual over which he has no control. These causes are further divided into following subgroups:

Genus
Specific diseases occur in a particular genus or species of animals. e.g. Hog cholera in pigs, Canine distemper in dogs

Breed / Race
Diseases do occur in particular breed of animals such as: Dairy cattle are more prone for mastitis. Brain tumors common in Bull dog/ Boxer.

Family
Genetic relationship plays a role in occurrence of diseases in animals. e.g. some chickens have resistance of leucosis; hernia in pigs due to weak abdominal wall.

Age
Age of animal may also influence the occurrence of diseases such as:
   • In young age diarrhoea/pneumonia (Fig. 2.1).
   • Old age- Tumor
   • Canine distemper- Young dogs
   • Strangles- Young horse
   • Prostatic hyperplasia- Old dogs
   • Coccidiosis- Young chickens

Sex
Reproductive disorders are more common in females
   • Milk fever, mastitis and metritis in females.
   • Nephritis is more in male dogs than female, but Bovine nephritis is more common in females.

Colour
Colour may also play role in occurrence of diseases. e.g. Squamous cell carcinoma in white coat colour cattle, melanosarcoma in gray and white horses

Idiosyncrasy
An unusual reaction of body to some substances such as:
   • Drug reaction. Small dose of drug may produce reaction.
   • Individual variations.

EXTRINSIC CAUSES
The etiological factors which are present in the outside environment and may cause/influence the occurrence of disease. These are also known as exciting cause/acquired cause. Majority of cause of diseases falls under this group which are further classified as physical, chemical, biological and nutritional causes.

PHYSICAL CAUSES
TRAUMA
Traumatic injury occurs due to any force or energy applied on body of animal e.g. During control / restraining, shipping or transport of animal.

Contusions/Brui ses
Contusions or bruises arise from rupture of blood vessel with disintegration of extravasated blood (Fig.2.2).

Abrasions
Abrasions are circumscribed areas where epithelium has been removed by injury and it may indicate the direction of force (Fig. 2.3).

Erosions
Partial loss of surface epithelium on skin or mucosal surface is termed as erosion (Fig. 2.4).
Fig. 2.1. Rotaviral diarrhoea in young calf

Fig. 2.2. Diagram showing contusion

Fig. 2.3. Diagram showing abrasion

Fig. 2.4. Diagram showing erosion

Fig. 2.5. Diagram showing incised wound

Fig. 2.6. Diagram showing laceration

Fig. 2.7. Photomicrograph of third degree burn in skin

Fig. 2.8. Electronmicrophotograph of pox virus in CAM
Incised wounds/ cuts
Incised wounds are produced by sharp edged instrument. They are longer than deep (Fig. 2.5).

Stab wound
Stab wounds are deeper than longer produced by sharp edged instrument.

Laceration
Severance of tissue by excessive stretching and is common over bony surfaces or are produced by cut through a dull instrument (Fig. 2.6).

Compression
Compression injury is produced as a result of force applied slowly e.g. During parturition.

Blast injury
Force of compression waves against surfaces followed by a wave of reduced pressure. It can rupture muscles/ viscera.

Bullet wound
Hitting at 90° by firearms to produce uniform margins of abrasion. Exit wounds are irregular and lacerated.

Electrical injury
High voltage currents induce tetric spasms of respiratory muscles and hits the respiratory centre of brain. It also produce flash burns. Lightning causes cyanotic carcass, postmortem bloat, congestion of viscera, tiny haemorrhage and skin damage.

Temperature
Burns
I degree burns
There is only congestion and injury to the superficial layers of epidermis e.g. sun burn on hairless parts or white skinned animal.
II degree burns
Epidermis is destroyed; hair follicles remain intact and provide a nidus for healing of epithelium.

III degree burns
Epidermis and dermis both are destroyed leading to fluid loss, local tissue destruction, laryngeal and pulmonary oedema, renal failure, shock and sepsis. Till 20 hrs of burn, the burn surface remains sterile then bacterial contamination occurs. After 72 hrs millions of bacteria enters in the affected tissue. Bacteria such as staphylococci, streptococci and Pseudomonas aeruginosa invade the deeper layers of skin and cause sepsis. There is a state of immunosuppression in severe burns leading to impaired phagocytosis by neutrophils (Fig. 2.7).

Hyperthermia
Hyperthermia means increased body temperature due to high environmental temperature e.g. Pets in hot environment without water. Hyperthermia leads to increased respiration (hyperpnoea), rapid heart beat (tachycardia), and degeneration in myocardium, renal tubules and brain.

Hypothermia
Hypothermia means decreased body temperature and includes freeze induced necrosis of tissues at extremities

Radiation injury
Radiation as a result of exposure to X-rays, Gamma rays or UV rays leads to cell swelling, vacuolation of endoplasmic reticulum, swelling of mitochondria, nuclear swelling and chromosomal damage resulting in mutation. The impact of radiation is more on dividing cells of ovary, sperm, lymphocytes, bone marrow tissue, and intestinal epithelium. It is characterized by vomiting, leucopenia, bone marrow atrophy, anemia, oedema, lymphoid tissue and epithelial necrosis.

Biological causes
Virus
Viruses are smallest organisms, which have only one type of nucleic acid DNA or RNA in their core covered by protein capsid.
Fig. 2.9. Electron microphotograph of reovirus in CAM

Fig. 2.10. Electronmicrophotograph of rotavirus

Fig. 2.11. Diagram of Leptospira.

Fig. 2.12. Diagram of bacteria (a) Staphylococci, (b) Streptococci (c) Bacilli

Fig. 2.13. Photomicrograph of Trichophyton sp. a cause of ringworm

Fig. 2.14. Photomicrograph of Aspergillus flavus

Fig. 2.15. Photomicrograph of Trypanosoma evansi infection

Fig. 2.16. Diagram of Echinococcus and Taenia spp.
**DNA virus**
DNA viruses are grouped in following families (Fig. 2.8).
- Poxviridae
- Papovaviridae
- Adenoviridae
- Iridoviridae
- Herpesviridae
- Parvoviridae
- Hepadnaviridae

**RNA virus**
RNA viruses are classified in following families: (Fig. 2.9 and 2.10).
- Orthomyxoviridae
- Paramyxoviridae
- Rhabdoviridae
- Filoviridae
- Coronaviridae
- Reoviridae
- Arenaviridae
- Togaviridae
- Picornaviridae
- Astroviridae
- Caliciviridae
- Retroviridae
- Bunyaviridae

**Sub viral agents**
- Prion proteins are infectious proteins without any nucleic acid. *e.g.* Bovine spongiform encephalopathy.
- Viroids are having only nucleic acid without proteins. They do not cause any disease in animals. However, they are associated with plant diseases.

**Rickettsia**
*Coxiella burnetti* causes Q-fever

**Mycoplasma**
*Mycoplasma mycoides* is responsible for pneumonia, joint ailments and genital disorders

**Chlamydia**
*Chlamydia trachomatis, C. psittaci* cause abortions, pneumonia, and eye ailments.

**Spirochaete**
*Leptospira sp.* causes abortion, icterus.
*Borrelia ansarina* causes fowl spirochetosis in chickens (Fig. 2.11).

**Bacteria**
Bacteria are classified as Gram positive and Gram negative on the basis of Gram’s staining. Gram positive bacteria include *Staphylococci, Streptococci, Corynebacterium, Listeria, Bacillus Clostridia*. Gram negative bacteria are *E. coli, Salmonella, Proteus, Klebsiella, Pasteurella, Pseudomonas, Brucella, Yersinia, Campylobactor* etc. Besides, there are certain organisms stained with Zeihl Neelson stain and are known as acid fast bacilli *e.g. Mycobacterium tuberculosis* and *M. paratuberculosis* (Fig. 2.12).

**Fungi**
Fungi pathogenic for animals are mostly belongs to fungi imperfecti. *e.g.* Histoplasmosis
Fungi cause three type of disease- *Mycosis e.g. Actinomycosis; Allergic disease e.g. Ringworm; Mycotoxicosis e.g. Aflatoxicosis* (Fig. 2.13, 2.14).

**Parasites**
Parasites are classified mainly in 3 groups:

**Protozoan Parasites**
*Trypanosoma evansi, Theileria annulata, Babesia bigemina, Toxoplasma gondii, Eimeria Spp.* (Fig. 2.15).

**Helminths**
Nematodes- Roundworms *e.g. Ascaris,*
Trematod- Flat worms *e.g. Liverfluke*
Cestodes- Tapeworms *e.g Taenia spp.* (Fig. 2.16).

**Arthropods**
Ticks, Mites, Flies, Lice (Fig. 2.17, 2.18, 2.19, 2.20).

**TRANSMISSION**
Biological agents are transmitted from one animal to another through horizontal or vertical transmission.

**Horizontal Transmission**
Horizontal transmission of biological causes occurs through direct contact or indirectly via animal or inanimate (fomites) objects. It is also known as lateral transmission as it occurs in a population from one to another. Various methods of horizontal transmission are as under:
Ingestion
Food, water, faecal-oral route e.g. Salmonellosis, Johne’s disease, Rotavirus infection.

Inhalation
Air borne infections, droplet infection e.g. R.P., FMD, Tuberculosis.

Contact
Fungal infection, Bacterial dermatitis, Flu, Brucellosis, Rabies through bite.

Inoculation
Introduction of infection in body through puncture either mechanically through needles or by arthropods such as by ticks. Ticks transmit diseases through transovarian (one generation to next generation) or transstadial (through developmental stages) transmission.

Iatrogenic
Transmission of infection during surgical practice or it is created by doctor, through dirty instrument and contaminated preparations.

Coitus
Through sexual contact of animals, biological agents spread from one to another animals. e.g. Campylobacteriosis, Trichomoniasis.

Vertical Transmission
Vertical transmission occurs from one generation to another generation in ovo/in utero or through milk. These include:

Hereditary
Infection/disease carried in the genome of either parent e.g. Retrovirus

Congenital
Diseases acquired either in utero/in ovo
- Infection in ovary/ ovum (Germinative transmission) e.g. ALC in chickens, lymphoid leukemia in mice, Salmonellosis in poultry.
- Infection through placenta. e.g. Feline panleukopenia virus (Transmission to embryo)
- Ascending infection from lower genital canal to amnion / placenta e.g. Staphylococci.
- Infection at Parturition: Infection from lower genital tract during birth. e.g. Herpex simplex virus.

MAINTENANCE OF INFECTION
Biological agents face difficulty of survival at both places in environment or in host. Two types of hazards which create problem to agent.

Internal hazards e.g. Host immune system
External hazards e.g. Desiccation, UV light

Agents try to maintain themselves by adopting following maintenance strategies:

- Avoidance of a stage in the external environment.
- Resistant forms e.g. Anthrax spores.
- Rapidly in-rapidly out strategy e.g. Viruses of respiratory tract.
- Persistence within the host e.g. Mycobacterium tuberculosis, Slow viral diseases.
- Extension of host range.
- Infection in more than one host e.g. Foot and mouth disease.

CHEMICAL CAUSES

Biological Toxins

Snake venom
Snake venom have phospholipase A2 which causes lytic action on membranes of RBC and platelets. The presence of hyaluronidase, phosphodiesterase and peptidase in snake venom are responsible for oedema, erythema, haemolytic anemia, swelling of facial/laryngeal tissues, haemoglobinurea, cardiac irregularities, fall in blood pressure, shock and neurotoxicity.

Microbial toxins
Microbial toxins are those toxins/poisons that are produced by microbial agents particularly by bacteria and fungi.

Bacterial toxins
Bacterial toxins include structural proteins (endotoxins) and soluble peptides/secretary toxins (exotoxins). Endotoxins are present in cell wall of
Gram-negative bacteria and are found to be responsible for septicemia and shock. Exotoxins are secreted by bacteria outside their cell wall and are found responsible for protein lysis and damage of cell membrane. *e.g.* Clostridium toxins suppress metabolism of cell. Most potent clostridial toxins are botulinum and tetanus, which are the cause of hemolysis and are powerful neurotoxin. Besides, *Clostridium chauvei* toxins are responsible for black leg disease in cattle.

**Fungal Toxins (Mycotoxins)**

There are several fungi known for production of toxins. Such toxins are known as mycotoxins and they are mostly found in food/feed items, which causes disease in animals through ingestion.

**Aflatoxins**

Aflatoxins are produced by several species of fungi including mainly *Aspergillus flavus*, *A. parasiticus* and *Penicillium puberulum*. These aflatoxins are classified as B₁, B₂, G₁, G₂, M₁, M₂, B₃a, G₃a and aspertoxin. Aflatoxins are produced in moist environment in grounded animal/poultry feed on optimum temperature and are more common in tropical countries where storage conditions are poor and provide suitable environment for the growth of fungi. These toxins are known to cause immunosuppression, formation of malignant neoplasms and hepatopathy.

**Ergot**

Ergot is produced by *Claviceps purpura* in grains which causes blackish discoloration. It produces gangrene by chronic vasoconstriction, ischemia and capillary endothelium degeneration. It is also associated with summer syndrome in cattle characterized by gangrene of extremities.

**Fusarium toxins**

*Fusarium toxins* are produced by *Fusarium tricinctum* in paddy straw, which are found to cause gangrene in extremities. Zearalenone toxin is the cause of ovarian abnormality in sow.

**Ochratoxins**

*Ochratoxins* are produced by *Aspergillus ochraceous* and *A. viridicatum* fungi in grounded feed on optimum temperature and moisture and are found to cause renal tubular necrosis in chickens and pigs.

**Plant toxins**

Over 700 plants are known to produce toxin. *e.g.* Braken fern which causes haematuria and encephalomalacia. Strychnine from *Strychnos nuxvomica* is highly toxic and causes death in animals with nervous signs. It is used for dog killing in public health operations to control rabies (Fig. 2.21 & 2.22). HCN is found in sorghum which is known to cause clonic convulsions and death in animals characterized by haemorrhage in mucous membranes.

**Drug toxicity**

- **Antibiotics:** Cause direct toxicity by destroying gut microflora. Oxytetracyline, sulfonamides are nephrotoxic. Neomycin and Lincomycin cause Mal-absorption diarrhoea and Immunosuppression.
- **Anti-inflammatory drugs:** like acetaminophen causes hepatic necrosis, icterus and hemolytic anemia.
- **Anticoccidiostate drug:** Monensin is responsible for necrosis of cardiac and skeletal muscles.
- **Trace elements:** There are various trace elements; excess of which may cause poisoning in animals. *e.g.* Selenium poisoning “Blind staggers” or “Alkali Disease” in cattle characterized by chronic debilitating disease. It also causes encephalomalacia in pigs.

**Environmental Pollutants**

Environment is polluted due to presence of unwanted materials in food, water, air and surroundings of animals, particularly by agrochemicals including pesticides and fertilizers. The environmental pollutants exert their direct or indirect effect on the animal health and production. The main pollutants are:
• Heavy metals such as mercury, lead, cadmium are found in industrial waste, automobile and generator smoke, soil, water and also found as contaminants of pesticides and fertilizers, are responsible for damage in kidneys, immune system and neuropathy. They are also associated with immune complex mediated glomerulonephritis.
• Sulphur dioxide is produced by automobiles, industries and generators. It is responsible for loss of cilia in bronchiolar epithelium.
• Hydrogen sulfide is produced by animal’s decay and in various industries. It inhibits mitochondrial cytochrome oxidase leading to death.
• Pesticides are agrochemicals used in various agricultural, animal husbandry and public health operations. They are classified as insecticides, herbicides, weedicides and rodenticides. Chemically, insecticides are grouped mainly as organochlorine organophosphates, carbamates and synthetic pyrethroids. Acute poisoning of pesticides causes death in animals after nervous clinical signs of short duration. Chronic toxicity is characterized by immunosuppression, nephropathy, neuropathy, hypersensitivity and autoimmunity in animals (Fig. 2.23 & 2.24).

NUTRITIONAL CAUSES
Nutrition causes disease in animals either due to deficiency or excess of nutrients. It is very difficult to diagnose the nutritional causes and sometimes it is not possible to find a precise cause as in case of infectious disease because functions of one nutrient can be compensated by another in cell metabolism. Experimental production of nutritional deficiency is not identical to natural disease. When tissue concentration of nutrient falls down to the critical level, it leads to abnormal metabolism and the abnormal metabolites present in tissues can be detected in urine and faeces. First changes of nutritional deficiency are recorded in rapidly metabolizing tissues e.g. skeletal muscle, myocardium and brain. Immature animals are more susceptible to nutritional disease. e.g. calves, chicks, piglets etc.

Types of deficiency
• Acute/chronic e.g. Thiamine deficiency in pigs
• Multiple deficiencies: e.g. Poor quality food.
• Nutritional imbalance: e.g. Imbalance in calcium: phosphorus (2:1) ratio.
• Protein malnutrition: e.g. Malabsorption
• Calorie deficiency: e.g. Loss of fat/ Muscle wasting.

Factors responsible for nutritional deficiency
• Interference with intake e.g. Anorexia, G.I. tract disorders.
• Interference with absorption e.g. Intestinal hypermotility, Insoluble complexes in food (Fat/Calcium)
• Interference with storage e.g. Hepatic disease leads to deficiency of vit. A.
• Increased excretion e.g. Polyuria, Sweating and Lactation
• Increased requirement e.g. Fever, Hyperthyroidism and Pregnancy
• Natural inhibitors e.g. Presence of thiaminases in feed, leads to thiamine deficiency.

Calorie deficiency
Calorie deficiency in animals occurs due to food deprivation or starvation.

Food deprivation
Dietary deficiency of food in terms of quantity/quality leads to emaciation, loss of musculature, atrophy of fat, subcutaneous oedema, cardiac muscle degeneration and atrophy of viscera including liver and pancreas. The volume of hepatocytes reduced by 50% and mitochondrial total volume is also reduced 50%.

Starvation
Starvation is the long continued deprivation of food. It is characterized by fatty degeneration of liver, anemia and skin diseases. Young and very old animals are more susceptible to starvation while in pregnant animals it causes retarded growth.
of foetus. In animals, following changes can be seen due to starvation.

**Intestinal involution**
Absorptive surface is reduced with shrunken cells and pyknotic nuclei. Villi becomes shorter and shows atrophy.

**Atrophy of muscles**
There is decrease in muscle mass.

**Lipolysis**
Increased cortisol leads to increased lipolysis resulting in formation of fatty acids in liver which in turn converts into ketones used by brain.

**Gluconeogenesis**
In early fasting blood glucose level drops down. The insulin level becomes low while glucagon goes high in starvation. Twenty four hours of food deprivation causes reduction in liver glycogen and blood glucose. Fatty acids from adipose tissue forms glucose and in mitochondria after oxidation it forms acetoacetate, hydroxybutyrate and acetone. Which are also known as ketone bodies and are present in blood stream during starvation. It is also known as ketosis e.g. Ketosis/Acetonemia in bovines. Lack of glucose in blood leads to oxidation of fatty acids which forms ketone bodies as an alternate source of energy. They are normal/physiological at certain level but may become pathological when their level is high.

Clinically it is characterized by anorexia, depression, coma, sweet smell in urine, concentration of acetone increases in milk, blood and urine along with hyperlipimia and acidosis. A similar condition also occurs in sheep known as pregnancy toxaemia which is characterized by depression, coma and paralysis. This situation occurs when many children/foetus are there in uterus. There are fatty changes in liver, kidneys, and heart, with subepicardial petechiae or echymosis.

**Protein deficiency**
Generally, protein deficiency does not occur. However, the deficiency of essential amino acids has been reported in animals when certain ingredients are deficient in certain amino acids. e.g. maize is deficient in lysine, and tryptophan that leads to slow growth; peanuts and soybean are deficient in methioine. Protein deficiency is characterized by hypoproteinemia, anemia, poor growth, delayed healing, decreased or cessation of cell proliferation, failure of collagen formation, atrophy of testicles and ovary, atrophy of thymus and lymphoid tissue.

**Deficiency of Lipids**
Generally, there is no deficiency of fat in animals. However, essential fatty acids including linolenic acid, linoleic acid and arachdonic acid deficiency may occur which causes dermatoses in animals. Fat has high calorie value and it is required in body because there are certain vitamins soluble in fat only.

**Deficiency of Water**
Deficiency of water may lead to dehydration and slight wrinkling in skin. Deficiency may occur due to fever, vomiting, diarrhoea, haemorrhage and polyuria, which can be corrected through adequate water supply for drinking or through intravenous fluid therapy.

**Deficiency of Vitamins**
Vitamin deficiency may occur due to starvation. There are two types of vitamins viz., fat soluble and water soluble. Fat soluble vitamins are vit. A, D, E and K and water soluble are vit B complex and C.

**Vitamin A**
It is also known as retinol. It is derived from its precursor carotene. It is found in abundant in plants having yellow pigment, animal fat, liver, cod liver oil, shark liver oil. β-carotene is cleaved in gut mucosa into two molecules of retinol (Vit. A aldehyde) which after absorption is stored in liver. Bile salts and pancreatic juice are responsible for
absorption of vit. A from gut. Deficiency of Vit. A occurs due to damage in liver. Vit. A deficiency may lead to following disease conditions:

**Squamous metaplasia** of epithelial surfaces in esophagus, pancreas, bladder and parotid duct, which is considered pathognomonic in calves. Destruction of epithelium/ goblet cell in respiratory mucosa is generally replaced by keratin synthesizing squamous cells in vit. A deficient animals. There are *abnormal teeth* in animals due to hypoplasia of enamel and its poor mineralization. Vitamin A deficiency is also associated with *still birth* and *abortions* in pigs. It causes night blindness (*Nyctalopia*) in animals. Due to deficiency of Vit. A there is recurrent episodes of conjunctivitis/ keratitis. In poultry, there is distention of mucous glands, which opens in pharynx and esophagus because of metaplasia of duct epithelium leading to enlargement of esophageal glands due to accumulation of its secretions. The glands become spherical, 1-2 mm dia. over mucosa. It is considered pathognomonic for hypovitaminosis A. and is known as *Nutritional roup* (Fig. 2.25). Inflammation of upper respiratory tract lead to coryza. Urinary tract of cattle, sheep and goat suffers due to formation of calculi, which may cause obstruction in sigmoid flexure of urethra in males. Such calculi are made up of desquamated epithelial cells and salts and the condition is known as *urolithiasis*. Deficiency of vit. A may also lead to in abnormal bone growth of cranial bones and there is failure of foramen ovale to grow leading to constriction of optic nerves which results in blindness in calves, increased CSF pressure, blindness at birth and fetal malformations. In sows, piglets are born without eyes (*Anophthalmos*) or with smaller eyes- (*Microphthalmos*).

**Vitamin D**

Vitamin D occurs in 3 forms viz. vitamin D₂ or calciferol, Vit. D₃ or cholecalciferol and Vit D₁ impure mixture of sterols. About 80% Vit. D is synthesized in body skin through UV rays on 7-hydrocholesterol. In diet containing egg butter, it is found in abundant quantity in milk, plants, grains etc. Active forms of vit. D are 25-hydroxy vit. D and 1, 25 dihydroxy vit D. (Calcitriol) which is 5 to 10 times more potent than former. Vit D is stored in adipose tissue in body. The main functions of vit D are absorption of Ca and P from intestines and kidneys, mineralization of bones, maintains blood levels of Ca and P and in immune regulation as it activates lymphocytes and macrophages.

- The deficiency of vitamin D is associated with rickets in young animals (Fig. 2.26), osteomalacia in adult animals and hypocalcemic tetany.
- Excess of vitamin D leads to the formation of renal calculi, metastatic calcification and osteoporosis in animals.

**Vitamin E** (*α*-tocopherol)

Source of vitamin E is grains, oils, nuts, vegetables, and in body it is stored in adipose tissue, liver and muscles. It has antioxidant activity and prevents oxidative degradation of cell membrane.

- Deficiency of vit E causes degeneration of neurons in peripheral nerves. There is denervation of muscles leading to muscle dystrophy *e.g.* *White muscle disease* in cattle and *Stiff lamb disease* in sheep and *Myoglobinuria* in horses. Deficiency of vit. E causes degeneration of pigments in retina reduces life span of rbc, leading to anemia and sterility in animals. Crazy chick disease (*Encephalomalacia*) is also caused by vit E deficiency; the chicks become sleepy with twisting of head and neck. There is muscular dystrophy in chickens due to vit. E deficiency (Fig. 2.27).

**Vitamin K**

Vit. K occurs in two forms namely vit. K₁ or Phylloquinone found in green leaf and vegetables and Vit- K₂ or Menadione which is produced by gut microflora. Its main function is coagulation of blood. Deficiency of vit K may leads to hypoprothrombinemia and haemorrhages.
Fig. 2.25. Diagram of Squamous metaplasia in esophageal glands due to vitamin A deficiency

Fig. 2.26. Photograph of a calf showing rickets

Fig. 2.27. Muscular dystrophy due to vitamin E deficiency

Fig. 2.28. Curled toe paralysis in a chick due to Riboflavin deficiency

Fig. 2.29. Slipped tendon or perosis in chicks
**Vitamin B**

Vitamin B is a water soluble vitamin which has at least 9 sub types including B₁ or thiamine, B₂ or riboflavin, B₆ or pyridoxine, B₁₂ or cyanocobalamin, niacin or nicotinic acid, folate or folic acid, choline, biotine and pantothenic acid.

**Thiamine**

In ruminants synthesis of thiamine occurs in rumen. Source of vit. B are pea, beans, pulses, green vegetables, roots, fruits, rice, wheat bran etc. Strong tea, coffee have antithiamine action. It is stored in muscles, liver, heart, kidneys and bones of animals. Thiamine plays active role in carbohydrate metabolism

- Deficiency of thiamine may lead to Beri beri disease characterized by Ataxia and neural/lesions. Chastek paralysis in cats, fox and mink and stargazing attitude of chicks due to thiaminase (thiamine deficiency) in meal may be observed. Bracken fern poisoning in cattle and horses may cause deficiency of thiamine due to presence of thiaminase enzyme in bracken fern. Toxicity of thiamine splitting drugs like amprolium, a coccidiostate, may cause polioencephalomalcia in cattle and sheep. Cardiac dialation in pigs has also been observed due to vit. B₁ deficiency.

**Riboflavin**

Riboflavin is a component of several enzymes and is found in plants, meat, eggs and vegetables.

- Deficiency of riboflavin may cause Curled Toe Paralysis in chicks and swelling of sciatic and brachial nerves (Fig. 2.28).

**Niacin**

Role of niacin (NAD/NADP, nicotinamide adenine dinucleotide) is in electron transport in mitochondria of cells. It is found in grains, cereals, meat, liver, kidneys, vegetables and plants.

- Deficiency of niacin is associated with skin disorders in man Pellegra; anorexia, diarrhoea, anemia in pigs and mucous hyperplasia, haemorrhage in gastrointestinal tract and black tongue in dogs which is also known as Canine pellegra.

**Pyridoxine**

It is found in egg, green vegetables, meat, liver etc.

- Deficiency of pyridoxine causes uremia, convulsions, dermatitis and glossitis

**Pantothenic acid**

- Pantothenic acid deficiency is associated with stunted growth of chicks.

**Folate**

- Folic acid is required in formation of erythrocytes and hence its deficiency leads to anemia.

**Cyanocobalamin**

Deficiency of cyanocobalamin may also lead to anemia, as it is also needed in rbc formation.

**Biotin**

Biotin deficiency causes paralysis of hind legs in calves.

**Choline**

Choline deficiency is associated with fatty changes in liver and perosis.

**Vitamin C (Ascorbic acid)**

It is found in green plants and citrus fruits.

Deficiency of vit. C may cause retardation of fibroplasia, scurvy in G. pigs, haemorrhage, swelling, ulcers and delayed wound healing in animals.

**MINERALS**

Various minerals are also necessary for survival of animals. Deficiency of any one of them or in combination may cause serious disease in animals. Some of the important minerals are:

- Sodium chloride
- Calcium
- Phosphorus
- Magnesium
- Iodine
- Iron
- Copper
- Zinc
**Sodium chloride**
Sodium chloride is an essential salt which maintains osmotic pressure in blood, interstitial tissue and the cells because 65% of osmotic pressure is due to sodium chloride. Chloride ions of hydrochloric acid present in stomach also comes from sodium chloride.
- The excess of sodium chloride causes gastroenteritis in cattle, gastroenteritis and eosinophilic meningoencephalitis in pigs and ascites in poultry.
- Deficiency of sodium chloride is characterized by anorexia, constipation, loss of weight in sows and pica, weight loss, decreased milk production and polyurea in cattle. Deficiency of salt occurs due to diarrhoea, dehydration and vomiting.

**Calcium**
Normal range of calcium is 10-11 mg/100 ml blood in body of animals. If it increases above 12 mg/100 ml blood, metastatic calcification occurs, while its level less than 8 mg/100 ml blood may show signs of deficiency characterized by tetany. Absorption of calcium from gut is facilitated by vit. D. Parathormone stimulates to raise blood Ca level from bones while calcitonin from thyroid stimulates it’s deposition in bones and thus reduces blood Ca levels.
- In pregnant cows, calcium deficiency occurs just after parturition. During gestation calcium goes to foetus from skeleton of cows, resulting in weak skeleton of dam. If calcium is not provided in diet, it may cause disease in dam characterized by locomotor disturbances, abnormal curvature of back, distortion of pelvis, tetany, incoordination, muscle spasms, unconsciousness and death. Such symptoms occur in animals when their blood calcium level falls below 6 mg/100 ml of blood and if it is less than 3 mg/100ml blood, death occurs instantly.
- Milk fever is a disease of cattle occurs due to deficiency of calcium just after parturition. Cow suddenly becomes recumbent and sits on sternum with head bending towards flank and is unable of get up. No gross/ microscopic lesion reported in this disorder. The calcium therapy recovers the animal immediately.
- The excess of calcium may cause metastatic calcification leading to its deposition in soft tissue of kidney, lungs and stomach.

**Magnesium**
It acts as activator of many enzymes e.g. alkaline phosphatase. It requires for activation of membrane transport synthesis of protein, fat and nucleic acid and for generation/ transmission of nerve impulses. The normal blood levels are 2 mg/100 ml of blood.
- Dietary deficiency leads to hypomagnesaemia and a level below 0.7 mg/100 ml cause symptoms in calves characterized by nervous hyperirritability, tonic and clonic convulsions, depression, coma and death.
- The post-mortem lesions of magnesium deficiency includes haemorrhage in heart, intestines, mesentery and congestion of viscera.
- Microscopic lesions include calcification of intimal layer of heart blood vessels (metastatic) muscles and kidneys. *Grass tetany and Grass staggers* occurs due to hypomagnesaemia and characterized by hyperirritability, abnormal gait, coma and death.

**Phosphorus**
Normal level of phosphorus is 4-8 mg/100 ml of blood. In bones, it is in the form of calcium phosphate. Deficiency of phosphorus may lead to hypophosphatemia and characterized by pica, rheumatism and hemoglobinurea.
- Pica is licking/eating of objects other than food. It mainly occurs in cattle, buffaloes and camels, who eats bones, mud and other earthen materials. Such animals have heavy parasitic load in their gut.
- Rheumatism like syndrome is characterized by lameness in hind legs particularly in camels and buffaloes.
- Hemoglobinurea is characterized by the presence of coffee colour urine of animal due to extensive intravascular hemolysis Hemo-
globin urea thus known as postparturient hemoglobin urea.

**Selenium**
Deficiency of selenium causes hemolysis as it protects cell membrane of RBC and thus its deficiency leads to anemia. Blind Staggers occurs due to excess of selenium.

**Iron**
Deficiency of iron leads to anemia, which is hypochromic and microcytic but rarely occurs in animals.

**Copper**
Deficiency of copper results in anemia and steel wool disease in sheep, which is characterized by loss of crimp in wool. Enzootic ataxia with incoordination of posterior limb has been observed in goats.

**Cobalt**
Vit. B₁₂ is synthesized by ruminal bacteria from cobalt in ruminants. Cobalt also stimulates erythropoiesis. Its deficiency may cause wasting disease, cachexia and emaciation in animals. The pathological lesions are comprised of anemia, hemosiderosis in liver, spleen and kidneys.

**Manganese**
Deficiency of manganese causes slipped tendon in chicken or perosis characterized by shortening of long bones in chickens. It occurs as the epiphyseal cartilage fails to ossify at 12 week of age and epiphysis becomes loose and thus gastrocnemious tendon slips medially and condition is known as **Slipped Tendon or Perosis** (Fig. 2.29).

**Zinc**
Deficiency of zinc may cause parakeratosis in pigs at 10-20 weeks age. Calcium in diet with phytate or phosphate forms a complex with zinc making it unavailable for absorption leading to its deficiency, which is characterized by rough skin of abdomen, medial surface of thigh, which becomes horny. It also causes fascial eczema in cattle, thymic hypoplasia in calves and immunodeficiency in animals.

**Iodine**
Deficiency of iodine causes goiter in newborn pigs characterized by absence of hair on their skin. Other signs of iodine deficiency include abnormal spermatozoa, decreased spermatogenesis, loss of libido, reduced fertility, suboestrus, anoestrus, abortions, dystocia and hydrocephalus. Excess of iodine may lead to lacrimation and exfoliation of dandruff like epidermal scales from skin.

**Fluorine**
Excess of fluorine causes mottling in teeth and bones. The teeth become shorter, broader with opaque areas.

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**MODEL QUESTIONS**

**Q. 1. Fill in the blanks with suitable word(s) to answer the followings.**

1. …………… in severe burns leads to impaired phagocytosis by …………..
2. Radiation mainly affects the……………..cells of body in……………….……. and………. 
3. Viruses are classified into two major groups viz. …….…………… and …………. on the basis of presence of ……………
4. Acid fast bacilli causing disease in animals are …………………… and ……………
5. The transmission of infection created by man / doctor is known as ………
6. Snake venom contains ………….., ……………, …………… and ………….. causing lysis of erythrocytes and platelets leading to ……………… and…………

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7. The gangrene on extremities produced by feeding of……….. to the animals and is also known as…………… disease.
8. Fungal toxins like…………… causes immunosuppression and hepatotoxicity while …………… causes renal damage in chickens.
9. Pesticides are classified into four major groups……………, ……………, …………. and, …………… of which a major group is …………
10. Heavy metals such as ……………, …………… and…………… are immunotoxic as well as nephrotoxic in animals.
11. The first changes of nutritional deficiency are recorded in rapidly metabolizing tissues such as ……………, …………… and …………
12. …………… animals are more susceptible to nutritional disorders.
13. Starvation is the …………… of food and is characterized by ……………, …………… and …………
14. Ketone bodies are ……………, …………… and …………
15. Protein deficiency may lead to failure of collagen formation resulting into atrophy of ……………and……………
16. Maize is deficient in…………… are …………… amino acids.
17. Essential fatty acids are ……………, …………… and ……………
18. The deficiency of Vit. A is the cause of recurrent episodes of ……… and ……… in animals.
19. Encephalomalacia is caused by deficiency of vitamin ……………
20. Perosis is caused by……………, …………… and …………… deficiency in birds.

Q. 2. **Write true or false against each statement and correct the false statement.**

1. ……………Hog cholera occurs only in pigs.
2. ……………Beef cattle are more prone to mastitis.
3. ……………Nephritis is more common in male in comparison to female bovines.
4. ……………Canine distemper occurs in old dogs.
5. ……………Burns and surgery may lead to immunosuppression.
6. ……………Rabies is caused by lyssavirus belongs to retroviridae family.
7. ……………Pathogenic fungi belong to fungi imperfecti.
8. ……………Trypanosomiasis may be transmitted through inoculation.
9. ……………Ochratoxin causes bile duct hyperplasia and hepatocarcinoma in birds.
10. ……………Most of the antibiotics are having their deleterious effect on gut microflora, which may lead to gastrointestinal tract problems.
11. ……………Newly born piglets are less prone to deficiency diseases.
12. ……………Starvation may cause stunted growth of foetus in pregnant animals.
13. ……………Presence of ketone bodies in blood should always be suspected for ketosis in cows.
14. ……………Soybean is deficient in lysine amino acid.
15. ……………Vitamin B complex and C are water-soluble.
16. ……………Nyctalopia is caused by vitamin E deficiency.
17. ……………Microphthalmos is defined as newborn with smaller eyes.
18. ……………Vitamin D regulates the immune system of animals and activates the lymphocytes and macrophages.
19. ……………Vitamin K2 is produced by gastrointestinal flora and is known as phylloquinone.
20. ……………Slipped tendon is caused by manganese deficiency in birds.
Q. 3. Define the followings.
1. Multiple deficiency
2. Lipolysis
3. Dehydration
4. Urolithiasis
5. Anophthalmos
6. Idiosyncrasy
7. Burns
8. Mode of transmission
9. Maintenance of infection
10. Aflatoxin

Q. 4. Write short notes on.
1. Erosions
2. Laceration
3. Latency
4. Septicemia
5. Blind staggers
6. Osteomalacia
7. Gluconeogenesis
8. Ketosis
9. Pregnancy toxemia
10. Nutritional roup

Q. 5. Select one appropriate word(s) from four options provided with each question.
1. Hog cholera occurs in....................
   (a) Pig  (b) Dog  (c) Horse  (d) Cow
2. Partial loss of epithelium on skin or mucous membrane is known as............
   (a) Abrasion  (b) Erosion  (c) Laceration  (d) Contusion
3. Burn area of skin and tissues remains sterile till...........
   (a) 12 hrs  (b) 16 hrs  (c) 20 hrs  (d) 24 hrs
4. Epidermis and dermis are destroyed leading to shock in ............burn.
   (a) I degree  (b) II degree  (c) III degree  (d) IV degree
5. Radiation affects the dividing cells of........
   (a) Ovary  (b) Testes  (c) Lymphocytes  (d) All of the above
6. Leptospirosa is a....... which causes abortions in cattle.
   (a) Bacteria  (b) Virus  (c) Chlamydia  (d) Spirochaete
7. Coxiella burnetti is a....... which causes Q-fever in animals.
   (a) Mycoplasma  (b) Bacteria  (c) Rickettsia  (d) Chlamydia
8. Ringworm is caused by a....... 
   (a) Bacteria  (b) Virus  (c) Fungi  (d) Parasite
9. Transmission of diseases from one generation to another is known as....... 
   (a) Vertical  (b) Horizontal  (c) Triangular  (d) All of the above
10. Aflatoxins are produced by........
    (a) Aspergillus flavus  (b) Asperillus parasiticus  (c) Penicillium puberulum  (d) All of the above
11. Pesticides includes……
   (a) Insecticide    (b) Rodenticide    (c) Weedicide    (d) All of the above
12. Acetone, \( \beta \)-hydroxybutyrate and acetoacetic acid are known as……
    (a) Ochratoxins   (b) Ketone bodies   (c) Heinze bodies   (d) Pyknotic bodies
13. Prolonged starvation leads to..................... of muscles
    (a) Hypertrophy   (b) Hyperplasia    (c) Atrophy       (d) Metaplasia
14. Deficiency of vitamin A causes...................
    (a) Nutritional roup  (b) Nyctalopia    (c) Calculi in urethra (d) All of the above
15. Vitamin D regulates the activity of...................
    (a) Lymphocytes   (b) Macrophages   (c) All of the above   (d) None of the above
16. Star grazing in chicks in caused by ...... deficiency
    (a) Vitamin B1    (b) Vitamin B2    (c) Vitamin B6      (d) Vitamin B12
17. Curled toe Paralysis is caused by ...... deficiency
    (a) Thiamine      (b) Riboflavin     (c) Choline        (d) Biotin
18. Crazy chick disease is caused by ...... deficiency
    (a) Vitamin A     (b) Vitamin C     (c) Vitamin D      (d) Vitamin E
19. Perosis is caused by ...... deficiency.
    (a) Biotin        (b) Choline        (c) Manganese      (d) All of the above
20. Rheumatism like syndrome is caused by deficiency of ......
    (a) Calcium       (b) Phosphorous  (c) Copper         (d) Zinc