

I. PHYSIOLOGY

➤ LOCOMOTION

- PM Contraction - Rigor Mortis
- PM Cooling - Algor Mortis
- PM Staining - Livor Mortis
- Creatine phosphate in muscle is referred to as ATP sparer or energy buffer
- Each molecule of glucose produce – 38 ATPs
- About 5-6 hrs after death, all muscles of the body assume a state of contracture – Rigor Mortis
- The efficiency of muscle contraction is – 45%
- Muscle contraction without shortening in length – Isometric Contraction
- Whole cardiac muscle obeys all or none law because of Syncytium
- Refractory period is the brief period during which muscles undergoing contraction for a first stimuli is unable to respond to a second stimuli
- The energy of contraction of muscle is directly proportional to the length of the fibre-Sterling law
- Tetanisation is the fusion of successive twitches when the frequency of stimuli is given at a rapid rate
- Myasthenia gravis is a neuromuscular disorder in which auto antibodies are produced against Ach receptors

➤ BLOOD

- Plasma constitutes about 55-70% of blood
- Viscosity in blood is provided by gamma globulins
- Arterial blood is more Alkaline than venous blood
- Yellow colour of the plasma is due to Bilirubin

- Serum differs from plasma lacking **fibrinogen, prothrombin** and other coagulation factors
- **RBC of species**
 - Biconcave - Dog, Cow, Sheep
 - Shallow/flat - Goat
 - Shallow concave - Horse, Cat
 - Elliptical, sickle shape - Camel, Deer
 - Elliptical & nucleated - Birds, Amphibians
- **Poikilocytosis** – variation in cell shape
- **Anisocytosis** – variation in cell size
- **Larger size RBC** – in dog (7.3 micron)
- **Smaller size RBC** – in goat (4.1 micron)
- Mature RBC derive energy from **Anaerobic EMP pathway** and **HMP shunt** since they have no mitochondria
- **Aplastic** anemia lacks functional bone marrow
- **True PCV** = venous PCV*0.96(Correction factor for trapped plasma)
- Rouleaux formation is seen in **equines and dogs**
- ESR is negatively influenced by **Reticulocyte and Albumin**
- Site of synthesis of Monocytes - **Lymphoid tissue of bone marrow and spleen**
- In ruminants **Haemal lymph nodes** functions as spleen
- **Vit B₁₂ and folic acid** are essential for maturation of RBC
- **Methemoglobin** is formed by oxidation of ferrous iron to ferric iron
- Hb has **200 times** more affinity for CO than O₂
- Each gram of Hb binds with a maximum of **1.34 ml** of O₂
- Average life span of RBC is **120 days (20-30 days in poultry)**

- Destruction of RBC in dog is in **bone marrow**

➤ **RETICULO ENDOTHELIAL SYSTEM**

- In liver and spleen –Stellate Or Kupfer Cells
- In tissues - Histiocytes Or Macrophages
- In blood - Monocytes
- The ratio of WBC to RBC is more in **goats(1:1300)** and **less in cattle(1:800)**
- Shift to left is an increase in number of immature neutrophils characteristic of **bacterial infections**
- T-lymphocytes provide **cellular** immunity
- B-lymphocytes provide **humoral** immunity
- Suppressor or regulatory T cells regulate the activities of **Cytotoxic T cells and helper T cells**
- **Life span**
 - Granulocyte - 4-8 hrs
 - T lymphocytes - 2-3 yrs
 - B lymphocytes - 3-4 days
 - Monocytes - 24 hrs
 - Platelets - 8-11 days
- Platelets are nucleated in **birds and reptiles**
- **Albumin** acts as a primary carrier to fatty acids
- Plasma proteins acts as **blood buffer** and thus maintains pH(7.4)
- **Prostaglandin**
 - PGG₂,PGH₂ - Platelet aggregation

- PGI₂ - Vasodilator
- PGI₂ - Platelet aggregation inhibitor
- **Vitamin K** is necessary for the formation of prothrombin and clotting factors V, VII, IX and X
- **Heller And Paul Mixture** = Ammonium oxalate : potassium oxalate = 3:2
- **Sodium fluoride** is ideal anticoagulant for estimation blood glucose level
- Hemophilia A due to deficiency in **factor VIII**
- Heparin is produced by **mast cells and Basophils**
- **Blood groups**
 - Dogs - 8 groups
 - Horse - 8 groups
 - Cattle - 11 groups
 - Sheep - 7 groups
 - Pigs - 13 groups

➤ **HEART AND CIRCULATION**

- Systemic Circulation - 84% of Blood
- Pulmonary circulation - 8% of Blood
- Coronary circulation - 7% of Blood
- **SA node** controls the rate of heart
- Excitatory stimuli originate outside SA node - **Ectopic foci**
- Conduction velocity is fastest in **Purkinje** fibres
- Cardiac sounds can be recorded by using an instrument called **phonocardiogram**

- **Lub sound (S1)** – closure of AV valve
- **Dub sound (S2)** – closure of pulmonary valve
- **Electriocardiograph** is an instrument to measure electrical changes of heart
- QRS complex shows spreading of electrical potential through A.V node, bundle of his, purkinje fibres, ventricular muscles
- Output of each ventricle is referred as **stroke volume**
- **Cardiac output** is the volume of blood ejected by either the left or right ventricle through the aorta or pulmonary artery per minute
- **Starlings law** = Energy liberated by cardiac muscle is directly proportional to fibre length
- Vagus nerve is **negative chronotropic** and **negative inotropic**
- Two **baroreceptors** one in carotid sinus (**sinus or buffer nerve**) and one in aortic body (**cardio depressor nerve**)
- **Endothelin** is the most potent of all the mammalian vasoconstrictor substances
- True **capillaries** are the place of nutrient exchange
- **Pulse pressure** is the difference between systolic and diastolic pressure
- Blood pressure using **Sphygmomanometer** is measured using femoral artery in dogs and Coccygeal artery in cattle
- Increased blood flow to tissues in response to increased metabolic rate is called as **Active Hyperemia**
- Cerebrospinal fluid produced from **lateral, third and fourth ventricle of brain**

➤ **RESPIRATION**

- Exchange between atmospheric air and pulmonary capillary is **External respiration**
- Gas exchange occurs in **Alveoli**
- Dead space is the respiratory passage from the **External nares to alveoli**

- **Hyperventilation** is increased in alveolar ventilation cause **respiratory alkalosis**
- **Hypoventilation** is decreased in alveolar ventilation cause **respiratory acidosis**
- **Inspiration** is an active process, **Expiration** is passive process
- In **horse** even under rest, expiration is active
- **Hypernea** is state of breathing in which rate, depth or both are increased
- **Polypnea** - rapid, shallow panting type of respiration
- **Tidal volume** – air breathed in during a quite normal respiration
- The entry of air in to pleural cavity is called **Pneumothorax**
- **Residual volume** represents the amount of gas remaining in the lung even after forced expiration
- Respiratory quotient(RQ)= Volume_Of CO₂/ Volume Of O₂
 - RQ of CHO - 1
 - RQ of Lipids - 0.7
 - RQ of protein - 0.8
- Partial pressure of O₂ in alveoli **pO₂=100 mmHg**
- Partial pressure of CO₂ in alveoli **pCO₂=40 mmHg**
- One gram of Hb can transport **1.34 ml of O₂**
- **Arterial blood** **venous blood**
pO₂= 100 mmHg pO₂ =40 mmHg
pCO₂=40 mmHg pCO₂=45 mmHg
- Greater portion of CO₂ is transported in blood in chemical combination as **HCO₃**
- **Chloride shift or hamburger shift** – in venous blood HCO₃ ion comes out of RBC and to replace Cl ion goes in to RBC
- Binding of O₂ to Hb displaces CO₂– a phenomenon referred to as “**Haldane effect**”
- **Asphyxia** is hypoxia combined with hypercapnea

- **Hering Breuer reflex** – inhibits inspiration so that prevents further inflation during over stretch
- Central chemoreceptor area is in **medulla**, peripheral chemoreceptor area is in **carotid and aortic bodies**

➤ **RESPIRATION IN BIRDS**

- Both inspiration and expiration are active
- **Syrinx** - is the vocal organs in birds
- Exchange of gases between lungs and blood occur in **Parabronchi**
- Since Air sacs are Avascular, **no gaseous exchange occurs**
- Diverticula from airsacs are connected to many bones , hence they are **pneumatic**

➤ **NERVOUS SYSTEM**

- Astrocytes closely attached to blood vessels of **CNS**
- Microglia or microcytes formed from **leucocytes**
- **Schwann's cell (neurilemma)** produce myelin sheath, insulating and coating nerve fibre
- **Nodes of ranvier** aid in flow of ions between ECF and ICF
- Velocity of myelinated nerve fibre ranges from **30 -100m/sec**, whereas in unmyelinated **30 m/sec**
- The duration of activity of neurotransmitter in synaptic cleft last only for **1-2 m sec**
- Specific type of neuron synthesis and release only one type of neurotransmitter substance at nerve terminal – **Dale's principle**
- Neurotransmitters susceptible to **anoxia and anesthetic agents**
- **Excitatory neurotransmitters** : Glutamate, Substance P, L-Aspartate

- **Inhibitory neurotransmitters:** Glycine, GABA, Dopamine, Serotonin, Taurine, Morphine, Endorphine
- **Both excitatory and inhibitory :** Ach, Nor Epinephrine, Epinephrine, Histamine, PG
- | <u>Neurotransmitter</u> | <u>Aminoacid Precursor</u> |
|--------------------------------|-----------------------------------|
| ○ Norepinephrine | phenyl alanine |
| ○ Glycine | serine |
| ○ GABA | L-glutamic acid |
- Exteroreceptors and proprioceptors are collectively called **Somatoreceptors**
- **Proprioceptors** – for posture and balance
- **Fore brain** – Proscencephalon
- **Mid brain** - Mesencephalon
- **Hind brain** – Rhombencephalon
- Two cerebral cortices are connected by transverse myelinated fibres known as the **corpus collasum**
- The ability of one hemisphere to control movement, reducing that burden for the other half is called **Cerebral Dominance**
- **Thalamus** functions as sensory relay nuclei
- **Limbic cortex** primarily functions as visceral brain
- **Hypothalamus** acts as a principal motor output pathway of the limbic system and controls the vegetative functions of the body
- Formation and recall of memory require the function of **amygdala and hippocampus**
- Melatonin released from **pineal gland** in response to darkness
- Melatonin inhibits **gonadal activity**
- Tri geminal, Abducent, facial, vestibular originates from **pons**
- Cerebellum is important in the planning and execution of **ballistic movements**

REFLEX

CRANIAL NERVE

- | | |
|-------------------|--------------------------------------|
| ○ Pupillary light | Oculomotor |
| ○ Corneal | |
| ▪ Blink | Ophthalmic division of trigeminal |
| ▪ Lachrmation | -do- |
| ○ Salivary reflex | Trigeminal, facial, glossopharyngeal |
| ○ Emetic | glossopharyngeal, vagus, vestibular |
| ○ Sucking | trigeminal and facial |
| ○ Swallowing | vagus, hypoglossal, glossopharyngeal |
| ○ Mastication | trigeminal, facial, GP |
| ○ Cough reflex | vagus |
| ○ Sneeze | trigeminal |
- **Sleep** is a state of reversible unconsciousness
 - Sleep inducing centre is located in **thalamic reticular** area
 - **Serotonin** is a sleep inducing substance secreted by raphe nuclei
 - The central motor control system include **the motor cortex, basal ganglia and cerebellum**
 - Coordination of slow or ramp movements is associated with **basal ganglia**
 - **Membranous labyrinth** is the functional part of vestibular apparatus
 - The terminal portion of the spinal cord, the meninges and nerves are collectively referred to as **cauda equinae**
 - **Brachial plexus** – C6,C7,C8,T1&T2
 - **Lumbosacral plexus** – L3,L4,L5,S1&S2
 - **Mixed(both motor sensory) cranial nerves:** Trigeminal, Facial, Glossopharyngeal, Vagus
 - **Sensory cranial nerves:** Optic, Olfactory/Vestibulotrochlear

➤ **DIGESTIVE SYSTEM**

- Salivary secretion in cattle – **100 – 200 lit/day**
- Organ of prehension in dog & cat – **fore limb**
- **Fundic glands**
 - Body chief cells/peptic cells – pepsin & rennin
 - Neck chief cells – intrinsic factor & mucin
 - Parietal/oxyntic cells – HCl
- **Acetate : propionate :Butyrate ratio**
 - Forage diet – 70:20:10
 - Grain diet - 60:30:10
- Normal VFA content of rumen – **60 -120 meq/lit**
- Ketone bodies serves as energy source in **CNS & heart**
- **Pancreas**
 - **Secretin** – stimulates secretion of bicarbonates from pancreas
 - **CCK** – stimulates secretion of enzymes from pancreas
- **Sphincter of oddi** guards terminal part of common bile duct
- **Jaundice**
 - Obstructive jaundice – conjugated bilirubin
 - Hepatic jaundice – free bilirubin
 - Hemolytic jaundice – both free & conjugated
- **Duodenum** acts as pace maker of intestine
- CHO in the Small Intestine stimuli for GIP secretion
- Fat & protein in the Small Intestine stimuli for CCK secretion

- Acid in the Small Intestine stimuli for secretin secretion
- **Reverse peristalsis** is a normal feature in colon
- **Absorption**
 - Glucose & amino acid – active transport (Na⁺ Co transport)
 - Short chain fatty acid & glycerol – passive diffusion
 - Intact protein & triglycerides – pinocytosis

➤ **EXCRETORY SYSTEM**

- **Renal function** is the total cardiac out put that passes through the kidneys (21% in man; 20% in dogs)
- Glomerular filtration rate – **180 lit/day**
- Glomerular membrane is completely impermeable to **plasma proteins**
- **Filtration fraction** – percentage of the renal plasma flow that becomes glomerular filtrate(normal plasma flow – 650 ml/min ; normal GFR – 125 ml/min)
- **Glucose & amino acid** are reabsorbed entirely from glomerular filtrate

Part	Amount Of GFR Reabsorbed	Remarks
Proximal tubule (action of PTH)	65%	Decrease Ca excretion
Descending loop of henle	15%	More permeable to water
Ascending loop of henle		Less permeable to urea & sodium
		Less permeable to water More permeable to urea
Distal tubule (action of	10%	Active Na ⁺ transport

aldosterone)		Secretion of K ⁺
Collecting tubule (action of ADH)	9.3%	Permeable to water

- **Plasma load** – total amount of substance in the plasma that passes through the kidneys each minute (plasma load of glucose -600mg/min)
- **Tubular load** – fraction of plasma load that is filtered as glomerular filtrate(tubular load of glucose – 125 mg/min)
- Urine is thick in **horse**
- Tubular fluid contain 2 buffer system namely – **phosphate buffer & Ammonia buffer**
- Presence of fat in urine is **not pathological**
- Glucosuria is a characteristic finding in **enterotoxemia**
- When the pressure in bladder reaches **150 mm H₂O**, contraction of bladder begins
- Avian kidney has 2 types of nephrons – Mammalian type(25% glomerular filtrate) & reptilian type(75% glomerular filtrate)
- Metabolic end product of protein in **mammals – urea** where as in birds & reptiles it is uric acid

GROWTH & BEHAVIOR

- **Only 3%** of the cells with in adult body is capable of dividing
- Shape of Growth curve is **sigmoid or ‘S’ shape**
- GH does not have effect on growth during the **fetal life**
- **Krypton gas** is used to measure body weight indirectly by dilution method
- Thermo neutral zone for most farm animals **60 -90°F**
- **Torpor** is a stage in which animals or birds make their metabolic activities decline

- **Serum magnesium** level is constantly increased during hibernation
- **Brown fat** present in hibernating animals helps them to awake from hibernation
- **Estivation /summer sleep** is observed in – frog, crocodiles & alligators
- Amount of heat loss by evaporation of 1g of water is **580 calories**
- Sweat glands – **Eccrine in man ; Apocrine in animals**
- Among farm animals **sheep & cattle** have lowest critical temperature
- Raise in 1⁰c in body temperature can cause increase of **10 -20% in the basal metabolism**
- Oily secretion of **preen glands** makes the plumage resistant to wetting
- **Ethology** is the study of animal behavior

➤ **ENDOCRINOLOGY**

- **Carbolic acid** is the first disinfectant identified by Joseph Lister
- **Idoxuridine** is the first antiviral drug identified by Kaufman
- **Secretin** is the first hormone identified by Bayliss & Starling
- **Oxytocin & vasopressin** are the peptide hormones
- Precursor of steroid hormones – **cholesterol**
- **RECEPTORS**
 - Protein, peptide hormones
& catecholamines - cell surface
 - Steroid hormones - cytoplasm
 - Thyroid hormones - nucleus
- **First messenger** – hormone
- **Second messenger** – c AMP, Calmodulin, Cytosolic Calcium, Diacyl Glycerol, Inositol Triphosphate

- **Third messenger** – phosphokinase
- Physiologically, the pituitary gland is a **master gland**
- **Arachidonic** acid is a precursor for prostaglandins
- Long day light promote reproduction in **horse – long day breeder**
- Sheep & goat – **short day breeders**
- **α - receptors** control catecholamine release from sympathetic nerve endings

Hormone	No of Amino acid	Type of action	Remarks
Growth hormone	190	Anabolic hormone Protein sparer	<u>Deficiency</u> -Dwarfism <u>Excess</u> – gigantism (young) Agromegaly (adult)
Prolactin		Lactogenic hormone	Crop milk secretion – pigeons Broodiness – birds Maintenance of CL – sheep & goat Metarnal behavior - animals
Vasopressin	8		<u>Deficiency</u> Diabetes insipides
Oxytocin	8		Let down of milk Sperm transport Contraction of uterus
Thyroxine		Potent Galactopoitic hormone Catabolic hormone T4(Thyroxin) – more predominant than T3 T3 is more active than T4	Metamorphosis – amphibians Moulting – birds <u>Deficiency</u> Cretinism(young) Myxedema(adult)

Para thyroid hormone (Chief cells of parathyroid gland)	84		Increases Ca absorption Minute to minute regulation of blood calcium
Calcitonin (C cells of thyroid gland – animals Ultimobronchial gland –reptiles, amphibians & birds)	32		Rapid but short time regulation of blood calcium Prevent post prandial hypercalcemia
Insulin (β cells of pancreas)	51	Hypoglycemic factor	Fat sparer <u>Deficiency</u> - diabetes mellitus
Glucagon (α cells of pancreas)	29	Hyperglycemic factor Ketogenic hormone	
Mineralocorticoids (zona glomerulosa of adrenal cortex) Eg - aldosterone			Electrolyte balance Blood pressure homeostasis
Glucocorticoids (zona reticularis of adrenal cortex) Eg - Cortisol			Anti inflammatory <u>Deficiency</u> –Addisons disease <u>Excess</u> – cushing syndrome
Catecholamines (adrenal medulla)			Non shivering thermogenesis

II. VETERINARY ETHICS AND JURISPRUDENCE

ACTS	YEAR
Livestock importation act	1898 modified on 1952
The Glanders & Farcy act	1899
The dourine act	1910 modified on 1957
The poisoning act	1919 modified on 1952
Dangerous drugs act	1930
Drugs and cosmetics act	1940
Drugs and cosmetics rules	1945
Prevention cruelty to animal's act	1960
Prevention cruelty to animals to drought & pack animals rules	1965
Prevention cruelty to animals (licensing of Farriers rule)	1965
Prevention cruelty to captured and wild animals	1972
Wild life (protection) act	1972
Project Tiger	1973
Prevention cruelty to animal's registration of cattle premises	1978
Transportation of animals rules	1978
Experimental animals act	1982
Animal welfare board of India	1982
Project Elephant	1992
<i>Note :-</i>	
<ul style="list-style-type: none"> ➤ Livestock importation act 1898 not permitting transport of following diseased animals - <u>Tickpest, Anthrax, Glanders, Farcy, Scabies</u> ➤ Applicable in all states of India except in <u>J&K state</u> 	

- **Cloning in sheep - 1997, DOLLY.**

- **Phook or doomdev** injection air or any materials in to the female genital organ

THE INDIAN PENAL CODE

**THE INDIAN DEALS WITH
PENAL
CODE**

Section 44	Illegal harm to the animals
Section 47	Definition of animals - any living being other than human beings
Section 192	False entry in records
Section 197	False certification of animals
Section 204	Destruction of any documents
Section 269	Done by negligence to spread infectious disease
Section 270	Done by intention to spread infectious disease
Section 271	Not following quarantine rule
Section 272	Adulteration of any food or drink
Section 273	Sale of unfit food or drink -6 months prison with Rs -1000/- fine.
Section 274	Adulterating medicinal items for sale
Section 275	Sale of adulterated medicine
Section 289	Disobey any order, with any animal in his possession
Section 304	Negligently causing death of any person
Section 377	Voluntary carnal inter course/ Bestiality with any animals – 10 yr prison with Rs 10000/ fine
Section 420	Fraudulent cheating of persons altered animals - prison of 7yr
Section 427 & 428	Mischief, maiming, killing by poisoning – prison of 2 yr
Section 430	Causing decrease of water supply for animals

III. IMMUNOLOGY

- **Louis Pasteur** who was credited with the formulation of **germ theory** did extensive work on **fowl cholera, anthrax and rabies** and **developed vaccines**.
- The innate immunity is also called as **natural defense**
- Humoral immunity is mediated by antigen specific blood glycoproteins called **antibodies**.
- There are two populations of T cells – **T helper cells** (T_H cells) and **cytotoxic T cells** (T_C cells).
- **Differences Between Humoral & Cell Mediated Immunity**

	<i>Humoral immunity</i>	Cell mediated immunity
Antigen	Extracellular antigens	Intracellular antigens
Responding lymphocytes	B lymphocytes	T lymphocytes
Effector mechanism	Antibody mediated elimination	Lysis of infected cell
Transferred by	Serum	T lymphocytes

- The portions of antigen that are recognized by the immune system (by individual lymphocytes) are called **epitopes** or **antigenic determinants**
- **Apoptosis** is programmed cell death.
- Memory cells escape apoptosis through expression of a specific gene sequence called **bcl2**
- Immunologic unresponsiveness against individual's own antigen is referred as **tolerance**
- The specific immune response that takes place after an antigen stimulus can be divided into three phases **Recognition Phase, Activation Phase & Effector Phase**.
- There are three classes of lymphocytes – **B-lymphocytes, T-lymphocytes and natural killer cells (NK cells)**

- Mature B cells do not produce antibody but it differentiates into two daughter cells upon antigenic stimulation – **plasma cells and memory cells**
- **Plasma cells** are the only cells in the body to produce antibodies
- The two important CD receptors of T cells are **CD4 and CD8**.
- The **helper T cells** have **CD4 receptors** and **Cytotoxic T cells** have **CD8 receptors**
- The **NK cells** mediate a phenomenon called **Antibody Dependant Cell Mediated Cytotoxicity (ADCC)** that removed the antigen coated with immunoglobulins

Sl.No	Property	B cells	T cells
1.	Site of development	Bone marrow, bursa, Peyer's patches	Thymus
2.	Distribution	Lymph node cortex, splenic follicles	Spleen periarticular sheath
3.	Circulate	No	Yes
4.	Antigen receptors	BCR	TCR
5.	Important surface antigens	Immunoglobulins	CD2, CD3, CD4, CD8
6.	Antigens recognised	Free foreign proteins	Processed foreign proteins on MHC
7.	Tolerance induction	Difficult	Easy
8.	Progeny cells	Plasma cells, memory cells	Helper T cells, cytotoxic cells
9.	Secreted protein	Immunoglobulins	Cytokines
10.	Phenotypic markers	Fc receptor, Class II MHC, CD19, CD21	Helper T cell CD3 ⁺ , CD4 ⁺ , CD ⁻ Cytotoxic cell CD3 ⁺ , CD4 ⁻ , CD ⁺

- The macrophages are considered as powerful phagocytic cells and are referred as **big eaters or garbage collectors**

Different names are given for macrophages found in various organs.

- | | | |
|----------------------|---|--|
| a. Blood stream | - | Monocytes |
| b. Connective tissue | - | histiocytes |
| c. Liver | - | Kupfer cells |
| d. Brain | - | Glial cells |
| e. Lung alveoli | - | Alveolar macrophages |
| f. Lung capillaries | - | Pulmonary intravascular macrophages |
- The most important CD marker of macrophages is CD68, which is otherwise called as **macrosialin**
 - The primary function of macrophage is **phagocytosis**
 - The actual mechanism of macrophage-mediated phagocytosis is by **receptor-mediated endocytosis** followed by lysosomal enzyme degradation.
 - The percentage of neutrophils in blood circulation among animals varies widely. It is **60-70% in carnivores, 20-30% in ruminants and 50% in horses**
 - **Opsonin** make the antigen palatable for phagocytic cells.
 - **Ig E** is one of the isotypes of antibodies that is responsible for **allergic reactions**.
 - Interdigitating dendritic cells are scattered throughout the skin epidermis and called as **Langerhans cells**.

The important roles of generative and peripheral lymphoid organs

1. **Bone marrow** (mammals) and **Bursa of Fabricius** (birds) – **B cell factories**
 2. **Thymus** and **intestinal epithelium** (Peyer's patches) – **T cell factories**
 3. Lymph nodes – Junctional filters in lymphatic system
 4. Spleen – Filter in circulatory system
 5. MALT – localised antibodies at major sites of pathogen entry
- A microorganism is said to be **pathogenic** when it can cause infection and the ability to cause infection is termed as **virulence**.
 - Molecules with a molecular weight of **5000 or greater** are good immunogens
 - **Haptens** are small antigens that cannot elicit antibody response individually. But they become immunogenic when coupled with larger molecules.

- Exotoxins are highly immunogenic and stimulate the production of antibodies. The antibodies against exotoxins are called **antitoxins**.
- When these exotoxins are precipitated by mild protein denaturing agents such as formaldehyde, the exotoxin loses its pathogenicity but retains its immunogenicity called **toxoids**
- Some times rarely immune response is elicited against normal body components. Such substances are called as **autoantigens**
- **Heterophile antigens** are immunologically related groups of antigens that occur in the cells of some bacterial species and also in some species of animals.
- Chemically the antibody molecules are **glycoproteins**.
- The flexibility of an antibody molecule is due to a region called **hinge region** that is rich in **proline** and **cysteine** residues.
- The antigen-combining site of an antibody is called as **paratope**.
- **IgM** is the biggest antibody molecule with a molecular weight of 970kD.
- **IgM** is the first antibody to class to appear in primary immune response
- **IgG** is the only antibody class that can pass through placenta
- **IgE** presence in large amount is an indication of allergic condition.
- Macrophages and dendritic cells are called as antigen presenting cells (APCs)
 1. **Primary binding tests** – In these tests the binding of antigen to an antibody is measured directly. E.g. RIA, ELISA, IFA etc.
 2. **Secondary binding tests** – In these tests, the results of antigen-antibody interaction (agglutination, precipitation, fixation of complement) *in-vitro* are measured. E.g. HI, AGID, CFT etc.
 3. **Tertiary binding tests** – These tests are *in-vivo* tests and require a living system. In these tests, the effects of actual protective effects of antibodies are measured in living system. E.g. Neutralisation assay
- The ability of an assay to detect only the target and not any other is referred as **specificity** of the test.
- The **sensitivity** of an assay refers to ability of the test system to detect very minute amount of the target
- **In Fluorescent immunoassays (IFA)** fluorescent dyes like fluorescent isothiocyanide (FITC) or rhodamine is used

- If the concentration of antibody is in excess it will not produce agglutination. This phenomenon is called as **prozone reaction**.
- **Inactivated vaccines** - Formalin and Beta propiolactone are the common inactivating agents.

IV. GENERAL MICROBIOLOGY

- **Antoni van Leeuwenhoek** is called as **father of bacteriology**.
- **Robert Hooke** - identified cells using his compound microscope
- Louis Pasteur is called **father of Microbiology**.
- **Flagellum** is the organ of locomotion for bacteria.
- **Monotrichous** - Bacteria having single polar flagellum.
- **Lophotrichous** - Having tufts of flagella at one end
- **Amphitrichous** - Having flagella at both ends
- **Peritrichous** - Having flagella all around surface
- The flagellum is composed of three parts **filament, hook and basal body**
- The major component of cell wall of Gram positive bacteria is **Peptidoglycan (80-90%)**.
- The LPS is also referred as **Endotoxin**
- **Mycoplasma** do not have cell wall.
- The ribosomes of bacteria are **70S** composed of 30S and 50S ribosomes subunits.
- ✓ Four nucleic acid bases form the deoxyribose-nucleotides. They are **Adenine (A), Guanine (G), Cytosine (C) and Thymine (T)** of DNA.
- ✓ The nucleotides of DNA are linked by **3'-5' phosphodiester** bonds.
- ✓ RNA has got purine bases **adenine (A)** and **guanine (G)** and pyrimidine bases **Cytosine (C)** and **Uracil(U)**.
- ✓ DNA is used to code for the synthesis of RNA is called **transcription**.

➤ GROWTH OF BACTERIA

- **Generation** is the interval for the formation of two cells from one cell
- **Lag phase:** The brief period of no activity is called as lag phase.
- **Exponential phase:** During this phase there is rapid increase in the number of bacteria.
- **Stationary phase:** During this phase there is no increase in number of cells.
- **Death phase:** The death phase is also exponential but it is slow. It is due to lack of nutrients.

Bacteria are classified in to five categories.

- ✓ Psychrophile - (13°C)

- ✓ Mesophile - (39°C)
- ✓ Thermophile - (60°C)
- ✓ Hyperthermophile - (88°C)
- ✓ Hyperthermophile - (105°C).
- **Halophile** - Salt loving, prefer NaCl concentration between 1-30%),
- **Osmophile** - grow in high sugar concentration
- **Xerophile** - grow in very dry conditions
- Yield of ATP molecules in respiration : **38 ATP**
- **Mutation**: inheritable change in base sequence of nucleic acid
- **Point mutation**: Mutations involving one or very few base pairs are referred as **point mutation**.
- **Transduction**: process in which DNA is transferred from cell to cell through viruses that infect bacteria called as **Bacteriophages**.
- **Conjugation**: process of transfer of DNA directly from one bacterial cell to another cell by a mechanism that requires cell-to-cell contact
- **Plasmids**: are also referred as extra chromosomal DNA
- **Transposition**: Certain genes in bacteria are capable of shifting from one location to another location in the chromosome
- **Disinfectants** - chemicals that are used to kill microorganisms on **inanimate objects**.
- **Antiseptics** - chemicals that are relatively in toxic and are used to kill or inhibit microorganisms **in living tissues**.
- Generally the chemicals with antimicrobial actions are referred as **germicides**.
- The substances obtained from microorganisms alone are referred as **antibiotics**.
- ✓ **First report of viruses**: by **Dimitrii Ivanowsky** attributed the causative agent of tobacco mosaic disease.

FIRSTS

- **Animal virus** – Foot and mouth disease by **Loeffler and Paul Frosch**
- **Human virus** – Yellow fever by Reeds Commission
- **Plant virus** – Tobacco mosaic disease by **Dimitrii Ivanowsky**
- ✓ The DNA found in the chromosome is attached with a protein called **histones** and this protein is also responsible for staining property (basic staining).
- ✓ The two strands of DNA are joined together by **hydrogen Bonds**.
- ✓ The most commonly used stain for fungal identification is **Lactophenol Cotton Blue**.
- ✓ The media that are commonly used for fungal isolation are the **Sabouraud's dextrose agar**
- The substances that pathogens produce that cause damage to phagocytes are referred to as "**Aggressins**".
- **Endotoxins** are part of the outer cell wall of bacteria.
- **Endotoxins** are associated with cell wall of Gram-negative bacteria - **Lipopolysaccharide**

Extra cellular bacterial proteins that function as invasin

<u>Invasin</u>	<u>Bacteria Involved</u>
✓ Coagulase	<i>Staphylococcus aureus</i>
✓ Leucocidin	<i>Staphylococcus aureus</i>
✓ Lecithinase	<i>Clostridium perfringens</i>
✓ Anthrax Lf	<i>Bacillus anthracis</i>

V. MEAT SCIENCE

- Lateral retro pharyngeal lymph node is used to rule out TB
- Hemal lymph node absent in **horses and pigs**
- Water : protein ratio of young animal > 4:1
- Muscle : Bone ratio for healthy animals - 4:1
- Rigor mortis time of **cattle = 9 hrs, birds = 2 hrs.**
- Chilled meat temperature is 7°C
- Chilled offal temperature is 3°C
- Frozen temperature of meat is -18°C
- Cooked meat temperature is 72°C
- Black cartridge used for slaughtering **medium size of animal**
- In electrical stunning low voltage temperature is 70 volts/250mA, 7-10 sec
- In stunning if current is not sufficient it lead to **Curarisation/Missed Shock**
- Act of slaughter in jewish method is **shechita**
- First slaughter house → **leonar, Mumbai**
- Phosphorous level of meat and blood **55-60% and 80%**
- Mould formation is common in **chilled meat**
- Process of freeze drying called **lyophilisation**
- Sterilization by radiation called **Radapperization**

- Marbling absent in **horse flesh and venison**
- Musky odour seen in **buffalo meat**
- Glycogen content in horse **0.5-1%**
- Refractive index is high in **horse fat**
- Feed efficiency – **poultry(1:1.8)>rabbit(1:2)>pig(1:3)>cattle(1:5)**
- Dressing percentage of pig → **70-75%**
- Ritual method practiced in india is **halal & jhatka method**
- Gut sweat bread → **Pancreas**
- Reducing agent used in curing is **Sodium Ascorbate(0.2-1%)**
- Ultimate pH level of meat is **5.5-5.7**
- Process of conversion of muscle to meat called **rigor mortis**
- Rigor mortis occurs **8-12 hrs** after slaughtering
- Autolytic lysosomal enzymes in meat is called **cathepsin**
- **PSE** occurs mostly in **pig**, **DFD** is common in **beef**
- In cold storage condition, **Z line is disrupted**
- Thawing temperature of meat is **4-6°C**
- Freezing point of meat is **(-1.5°C)**
- Presence of watery or blood stained fluid from frozen meat is called **weep/drip**
- Scalding temperature of pig is **62-64°C for 6 min**
- **One animal unit** =one bovine=2 pigs=3 calves = 5 sheep
- Overhead rails should be placed at the height of **3.3 m for cattle dressing**
- Meat analogues are **Soyabean protein and gluten of wheat**
- Meat of deer is called **venison**
- Dressing % of veal =**63%**

- Art of removing skin/hide is called **flaying**
- Fresh, emulsion type of pork sausage called '**salami**'
- **Vitamin B1 (thiamine)** is higher in pork
- Water level of meat is **65-80%**
- Milk has an excellent source of Ca & P and low in **Fe, cu, I and vitamin C**.
- Self life of vacuum packaging is **8-10 weeks at 0°C**
- Musty/earthy odour due to **Achromobacter** and fishy odour due to **E.coli**
- **Keet** is the name of young guinea fowl
- Cow slaughter is banned in india except in states of **kerala and west Bengal**
- **Maillard reaction** is responsible for development of brown color on the surface of cured meat
- Black rot in eggs is cause by **Proteus and Pseudomonas**
- Red rot caused by **Serratia**
- In sausage making, salts added in the level of **4-4.5%**
- Functional unit of myofibrils called **Sacromere**
- Commonly used humectants are **glycerol/propylene glycol**
- Buffalo meat is white due to absence of **carotene**
- Vitamin A present in beef and mutton **absent in Buffalo, Chevon And Pork**
- Giblet consisting of **heart, liver, gizzard**
- Poultry meat contain high level of **oleic and linoleic acid** and low level of cholesterol
- The onset of rigor mortis is enhanced at ambient temperature **above 20°C**
- In plate type freezer achieved at the temperature of **-10°C** & blast type freezer achieved at **-10° to -30°C**
- Canned meat products have a self life of **2 yrs at ambient temperature**

- Hippophagia –consumption of horse meat
- Kynophagia – consumption of dog meat
- Weight taken 24hrs prior to slaughter is considered as Live weight of the animal

- PLUCK in cattle – larynx, trachea, lungs, heart and liver

Sheep – spleen also

Pigs – esophagus also

- Meat inspector in his one day work(8hrs)can examine – 75 cattle/200 pigs/250 calves/400 sheep

- Area size

Small abattoir	Upto 30,000 units/year	1 – 2 acres
Medium abattoir	50,000 + units/year	2 – 4 acres
Large abattoir	1 lakh + units/year	4 – 6 acres

- light intensity

(Taken at the level of 0.9 m from floor)

All inspection points	540 lux units	50 foot candles
Slaughter hall & work room	220 lux units	20 foot candles
Other areas	110 lux units	10 foot candles

- Room temperature

Chilling room	-1 to 5 ⁰ C
Detention room	20 ⁰ C
Edible offal room	3 ⁰ C
Meat cutting room	12 ⁰ C

- PPM level

Chlorine for carcass washing	100 ppm
Chlorine for equipment washing	250 ppm
BOD of domestic sewage	250-300 ppm
BOD of slaughter house	1500-2000 ppm
Sodium nitrite level in cured meat	200ppm
Sodium nitrate level in cured meat	500ppm

- **Dressing percentage**

cattle	50 -54 %
sheep	45 -48 %
Goat	43 -50 %
Pig	70 -75 %
Poultry	65 – 70 %
Rabbit	52 – 58%

- **Bleeding time**

Species	Bleeding time(mts)	Amount of blood (% in body wgt)	Blood yield
Cattle	6	3 - 4%	10 – 12 kg
Calves	6	5 – 6%	1.5 kg
Sheep	5	4 - 4.5%	1 -1.5 kg
Pig	6	3 -4%	2 -3 kg
poultry	1.5 - 2		

Slaughtering of pigs

- Desirable thickness of fat on the back is **1.5 inches** for lean pork production
- Gaseous Stunning – **65-70%CO₂**,
- Electrical stunning - **60-80 volts, 5-10 sec**

- Sticking – **carotid arteries and jugular veins** , 5-6 min
- **Calcium deficient** in meat of pig
- Pig – **highest fat storing ability**
- Pork is **rich in phosphorus, iron,energy**
- **Vitamin A and D not present** in pork
- **Blue pig** - crossing of white and black breed
- **Lard** – pig fat
- **Store pig** – 8 -15 weeks of age for market
- Scalding temperature – **60-63°C for 5 min**

VI. GYNAECOLOGY

Oxytocin

- First hormonal peptide to be synthesized found in the animals
- Oxytocin = rapid birth
- Two sites of origin – ovary, hypothalamus
- Contraction of oviduct, milk letdown
- Ovarian oxytocin - Luteal function – acting on endometrium – induce $PGF_{2\alpha}$ in turn leads to Lysis of CL
- Estrogen enhances responsiveness of smooth muscle to oxytocin

GnRH

- Release of FSH, LH

FSH

- *Growth & maturation of graffian follicle*
- Spermatogenesis – up to secondary spermatocytes
- Acts on receptors of sertoli cells leads to production of ABP

- Spermiation
- Secretion of inhibin from granulosa cells of ovary and sertoli cells of testes

LH or ICSH

- Pre ovulatory LH surge
- Maintains activity of CL
- Stimulates leydig cells

Prolactin

- **Luteotropic** properties in dogs, mice, rats
- Maternal behavior
- Functions as metabolic hormone in lower forms of animals

Placental hormones

- PMSG, hCG, PL, PSPB

PMSG

- Can be isolated from blood, not found in urine
- Endometrial cups of pregnant mare – these are formed by **40th** day of gestation and persist till **85th** day of pregnancy
- Important for maintenance of pregnancy in mare
- Clinical use – super ovulation, anestrus
- More of **FSH** like activity

HCG

- Syncytio trophoblastic cells of placenta of primates
- More of **LH** like activity

- Clinical use – induce ovulation, cystic ovaries

Placental lactogen

- GH like activity
- Imp. Regulator of maternal nutrients to the growing foetus

Estrogen

- Sexual receptivity in female
- Secondary sexual characters
- Ductal development of mammary gland
- Attachment of embryo to uterine wall
- Anabolic effect
- Negative feedback mechanism to the GnRH
- Development of female reproductive tract
- Clinical use : Induction of heat, treatment of misalliance, as Ecboic (Mummification, Pyometra), induces milk production in cow

Progesterone

- Source ; ovary, placenta, adrenal, testes
- Inhibits uterine contractions
- Increases endometrial secretions
- Maternal behavior, nest building
- Induction of lactation

Clinical use

- Treatment of ovarian cysts not responds to GnRH
- Cervico vaginal prolapsed
- Early embryonic mortality

- Habitual abortion
- Cow, Goat, Sow – CL dependant

TESTES

- Mediastinum testes absent in stallion
- Connective tissue capsule – Tunica albuginea
- Medial septum of testes – Dartos
- Blood testes barrier – primary – Peritubular cells -prevent auto immune reactions

Secondary – junctional complexes between sertoli cells

- Testes – 4-6°C lower than body temperature
- Oxytocin, PGF₂α, Ach, tends to alter the Epididymal Transit Time
- Extra gonadal reserve (EGR) – Epididymis, vas deferens, Ampulla
- Time require to complete a cycle of seminiferous epithelium(Spermatogenesis)

Bull – 14 days

Boar – 9 days

Ram – 10 days

Horse – 12 days

- **RUT** – Certain definite period of sexual excitement in some wild animals (Deer, Camel, Elephant) – spermatogenesis occurs in this period
- **Ampullae & Vesicular gland** absent in dog and cat
- **Yellowish** colour of bull semen is due to riboflavin
- **Bulbourethral gland** absent in dog
- Sigmoid flexure – **Pre scrotal** – Boar, **Post scrotal** – Bull, Ram
- Retractor penis muscle controls sigmoid flexure

Glans penis

- Bull – pointed
- Ram – urethral process
- Boar – glans penis absent
- Dog – two parts bulbus glandis(proximal 1/3) , pars longa glandis(distal2/3)
- Cat – short, terminal part having several spines
- Stallion – prominent urethral process, Groove - Fossa glandis

Testicular descent

- Bull – 106 days of gestation
- Horse – Near birth
- Ram, Boar – 70 days of gestation
- Dog – 3 – 4 days post nately
- **High flankers** – Testes reaches the inguinal canal but not descent in to the scrotum
- **Impotentia coeundi** – Reduced to complete lack of sexual desire and ability to copulate
- **Impotentia generandi** – Inability to reduced ability to fertilize
- **Balanitis** – Inflammation of glans penis
- **Posthitis** – Inflammation of prepuce
- **Balanoposthitis** - Inflammation of penis and prepuce
- **Phimosis** – Unable to normally protrude the penis
- **Paraphimosis** – Unable to retract the penis in to the prepuce
- **Diphallus** – Double penis
- **Phallocampsis** – deviation of penis either ventral or lateral or spiral
- **Rainbow penis** – ventral deviation

- **Corkscrew penis** – lateral deviation

Inherited sperm defects

Diadem effect	Sign of disturbance in spermiogenesis, Eversion of galea captis & crater shaped depressions in the nucleus, Nuclear pouch formation defect.	Feulgen stain & phase contrast microscopy helpful in revealing this defect.
Knobbed spermatozoa	Acrosomal defect, Eccentrically placed thickening of the Acrosome.	Eosin-B, Fast green stain & phase contrast microscopy helpful in revealing this defect.

- **Testicular hypoplasia** – Giant cells, medusa cells, high incidence of cytoplasmic droplets
- **Testicular degeneration** – Large no. of primary abnormality

Spermatogenesis

- Bull, Ram, Dog – 60-70 days
- Stallion – 40-45 days
- Boar – 50-60 days
- **Azoospermia** – no sperms
- **Oligospermia** – decrease in sperm concentration

Artificial insemination

- 1780 – Lazzaro spallanzani (ITALIAN) - AI in bitch
- 1900 - Ivanoff (Russian) – used AI as a technique for breeding
- 1939 – in India – Kumaran -Palace dairy farm – Mysore

Semen collection

<u>Species</u>	<u>Artificial vagina Temperature</u>
Bull	39-41°c
Stallion	45-50°c
Boar	45-50°c
Ram & bucks	45-50°c
Dog	40-42°c

- **Sperm cell concentration** – Bull - 10% of the semen volume, Boar – 2-5%

<u>Species</u>	<u>pH</u>
Bull, Ram	6.8
Stallion, Boar	7.4
Dog	6.7

- Fructose – Normal sugar providing energy to spermatozoa in ruminants
- Sorbitol – Sugar alcohol can be oxidized to fructose and provides source of energy
- Inositol – Boar semen
- Ergotheonine – Boar, Stallion
- Glyceryl phosphoryl choline – Epididymal Secretion

- **Age at Puberty**

Species	Female	Male
Cattle	6-18 months	9-12 months
Horses	10-24 months	18 months
Dog	6-12 months	7-10 months
Swine	5-8 months	5-7 months
Cat	5-18 months	5-18 months

- **Monoestrous** – Wild Animals

- **Polyestrous** – Cow, Sow
- **Regular estrous cycle** – Cow, Sheep, Mare, Bitch, Sow
- **Spontaneous ovulators** – ovulation takes place but CL formed will not be functional until mating
- **Induced ovulators** – ovulation & CL formation depends upon the mating has occurred or not (cat, Rabbit, Mink)
- **Uniparous / Monotocous** – one ovum, one fetus(cow, mare, sow)
- **Multiparous / Polytocous** – 3 -15 ova, 3-15 fetus(dog, cat, sow)
- **Nullipara** – female that have never conceived / carried young one
- **Primipara** – conceived for the first time (1st gestation period)
- **Pluripara** – conceived previously 2 or more times earlier

Species	Implantation(Days after Conception)
Cow	22 – 35 days
Mare	36 – 38 days
Ewe	16 -18 days
Sow	13 – 20 days

- FSH & LH required for antrum formation
- Cow – **Metestrual or post Estrual bleeding** – capillary bleeding due to the with drawl of estrogen
- Young animals – slight shorter length of estrous cycle

Sexual differentiation

- Feline, porcine embryo – 30 days of gestation
- Ovine – 35 days
- Bovine – 45 days
- **Ovum ovulated** - All species Metaphase II – 2nd meiotic division

Mare, Dog, Fox – 1st meiotic division

Species	Estrus period	Ovulation time
Cow	14-18 hrs	12-18 hrs after the end of estrus
Mare	4-7 days	Last 2 days of estrus
Sow	2-3 days	Last day of estrus
Ewe	1-2 days	Last day of estrus
Bitch	7-9 days	First 3 days of estrus
Cat	Induced 4 days if copulation occurs or else 9-10 days	One day after mating

- Capacitation initiated in the uterus and completed in isthmus of oviduct
- **Hyaluronidase** – Bull acrosome
- **Arylsulfalase** – Boar acrosome
- **Syngamy** - Fusion of male and female pronuclei
- **Pheromone** – volatile substance secreted or released outside the body and perceived by the olfactory system of other individuals of the same species
- **Boar** – Saliva (sub maxillary gland), Prepuccial pouch – 2 Attractants 3 α androstenol, 5 α androstenone
- **Flehmen response** – Bull, Ram, Stallion
- Delayed ovulation, silent estrus, anovulation may be due to **β -carotene deficiency**
- Early embryonic mortality occurs between **8-19 days** after breeding
- Cow – best time of AI – middle to the end of standing heat (**mid estrus** not metestrus)
- **Card test** – rapid, sensitive accurate test for field screening of **brucellosis**

- Leptospirosis – gargety milk

Disease	organism	Time of abortion
Vibriosis	<i>Vibrio fetus venerealis</i>	Early Embryonic death – common 4 th month to term – occasional (II trimester)
Trichomonosis	<i>Trichomonas foetus</i>	First trimester (2-4 months)
Fungal abortion	<i>Aspergillus fumigatus</i>	5 th -7 th months
Epizootic bovine Abortion	<i>Psittacosis, Chlamydia Group of org</i>	6 th -8 th month
Listeriosis	<i>Listeria monocytogenes</i>	Last trimester (7 th -9 th month)
Brucellosis	<i>Brucella abortus</i>	Last trimester of pregnancy
Leptospirosis	<i>L.pomona, L.hardjo, L.grioppotypphosa</i>	Last half of gestation
IBR –IPV	<i>Herpes virus</i>	All 3 trimesters of the pregnancy

Gonadal sex determination

- XX – **Medulla inhibited** and cortex develops - Female
- XY – **cortical development inhibited** –testes develops - male
- Primary sex cords - Ancestors of spermatozoa
- Secondary sex cords – Ancestors of oocytes

Species	Ovary shape	More functional
Bull , Ewe	Almond	Right
Mare	Bean	Left
Sow	Mulberry	Left
Bitch	Oval	

- Ovarian hormones – **Estrogen, Progesterone, Oxytocin ,Relaxin, Inhibin and Activin**
- Oviduct – opening of infundibulum “*ostium tubae abdominal*”
- Opening of utero tubal junction “*ostium tubae uterinum*”

Uterus	species
Bicornuate	Cow, Ewe, Goat , Sow
Simplex	primates, humans
Deciduate	Bitch, Queen
Non-deciduate	Cow, Doe, Ewe, Mare, Sow
Cotyledonary	Ruminants
Diffuse	Mare, Sow
Zonary	Bitch, Queen
Discoidal	Guinea pig

- Cattle –Caruncle - Arranged in 4 rows (70-120 in number)
- True water(2nd) bag - amnion
- Mare – cruciform or ‘T’ shaped
- Bitch and queen entire uterus lies in the abdominal cavity
- Portion of cervix projects in to the vagina – **Portio vaginalis**
- **Fornix – absent in sow**, prominent in mare
- Remnants of wolffian duct – **gartners duct**
- Pregnancy diagnosis also known as **cyesiognosis**
- **Positive signs of pregnancy** – Amniotic vesicle, Fetal membrane slip, Fetus, cotyledons

Days	Palpable part @ pregnancy
30 days	Amniotic vesicle

35-90 days	Fetal membrane slip
About 90 days	Fetal bump
90-100 days	Placentomes
120 days	Fremitus

- White heifer disease due to **sex linked recessive gene** is commonly seen in white short horn cattle
- Uterine tubal patency test – **phenolsulphonphthalene(PSP) dye test**
- **Follicular cyst** – **nymphonia** (bullers), multiple in both ovaries, relaxation of sacrosciatic ligament- upward displacement of coccyx – “**sterility hump**”
- **Luteal cyst** – often single, **anestrous**, **adrenal virilism**

Mummification of fetus

- In cattle – **hematic type** – 3-8 months , **papyraceous type** occur in other species
- R/E - firmer, dryer leather like tissue with uterine wall without cotyledon

R_x

- PGF2 α -(Lutalyse, vetmate, iliren, dinofertin)
- Cattle – 25mg (total dose)

Maceration of fetus

will occur at any stage – commonly 3rd month

- **Trichomoniasis** and **vibriosis** organisms invade the uterus cause infection and pus formation
- Dropsy of fetal membranes over all incidence 0.3%
- **Hydroallontois** (88%), **most frequently encountered than hydroamnios** (5-10%)

- Hydroallontois - **bloated bull frog like calf**
- Uterine torsion – twisting or revolution of the gravid uterus **on its long axis**
- Signs of approaching parturition in mare – **waxing of teat, patchy sweating**
- ***Fetus decides the day of birth and dam decides the time of birth***
- Normal placental Expulsion time :
 - *cattle - 8 - 12hrs,*
 - *Mare - 0.5 – 3hrs,*
 - *sheep & goat - 3 – 6 hrs*
- Bitch – ***Placentophagy***
- Sow – ***Foetophagy***
- During fetal expulsion – cow, Ewe, Doe – Sternal recumbency, Mare – lateral recumbency
- Post partum period – **puerperium**
- Uterine involution completed by
 - *cattle - 26 – 52 days following parturition*
 - *Mare - 32 days*
 - *Bitch - 4 – 5 week*
- Post partum uterine discharge – **Lochia**
- Onset of estrus after parturition, cattle :- 33 – 90 days, buffaloes :- 4 – 6 months
- ***Foal heat – 5 -12 days post partum***
- Bitch - the post partum **Lochia is green colour** is due to Uteroverdin – break down product of Hemoglobin .
- Uterine incision is closed by – **double row of lembert or cushing sutures**
- Feeding sweet clover to sheep – Hyperestrogenisim can leads to uterine prolapsed.

- Downer cow – clinically parturient paresis but unable to rise **after 24 hours and two calcium infusions**
- Creeper cow – cow becomes alert and gains control following calcium injection but **remains recumbent due to inability to use hind quarters**
- Synthetic analogues of **GnRH** – Buserelin(RECEPTAL) , Fertirelin(OVALYSE) , Gonadorelin (FERTAGYL)

Presentation P₁	<i>Relation of the spinal axis of the fetus to that of dam. (eg; longitudinal / transverse and anterior / posterior)</i>
Position P₂	<i>Relation of the dorsum of the fetus in longitudinal presentation or the head in transverse presentation to that of quadrants of maternal pelvis.</i> (eg; dorso – sacral , dorso-pubic etc.,)
Posture P₃	<i>Relation of the extremities or the head, neck and limbs of the fetus to the body of its own.</i> (eg; shoulder flexion, hip flexion nape etc.,)

- Post partum heat in pigs- **3 – 5 days**
- At the time of deep freezing – **30 million** sperms /ml
- At the time of AI (post thaw) - minimum **10 million** sperms / ml
- Buck spermatozoa quite susceptible to cold shock

- Buck semen – Presence of egg coagulating enzyme (Phospholipase A) prevents the storage at 5 °c in yolk containing diluents
- Equilibrium of semen @ **5°c for 6 hrs** to enable **glycerol action**
- Sealing powder – **poly vinyl alcohol**
- **Laboratory seal** has to be cut during AI
- Minimum of **10-15 million** of viable sperms present after freezing and thawing in each doses
- The capacity of French mini straw – **0.25 ml**

VII. LIVESTOCK PRODUCTION AND MANAGEMENT

Four pillars of livestock management (or) LPM

1) Breeding 2) Weeding 3) Feeding 4) Heeding

- ❖ Turkey - *Meleagris gallopavo*
- ❖ J. Quail - *Coturnix coturnix japonica*
- ❖ Guirea fowl - *Numida meleagris*
- ❖ Duck - *Anas platyrhynchos*
- ❖ Goose - *Anser anser*

Common Terms and Definitions

- **Horse**
- Geld (or) gelding - castrated male horse.
- Broken horse - A well trained horse
- Unbroken horse - Untrained horse

- Colt foal - Male young one
- Filly foal - Female young one
- Double rig (both testicles retained in the abdomen) - Cryptorchid
- Foaling - Act of giving birth to young one.
- Mule - **Mare** x **jack ass**
- Jennet/Jenny/hinny/Genet - **stallion** x **she donkey**
- **Cattle**
- Heifer - *Young female over one year, which has just attained maturity.*
- Slink calf - *An aborted calf*
- Bobby calf- *Male calf about 1 week old.*
- Free martin - *Twin calves of different sexes are born*
 - The bull calf - *Sexually normal .*
 - *female calf - Sterile (always)*
- **Sheep**
- Wedder (or)wether - *An adult castrated male sheep.*
- Gimmer - Female sheep which is between 1 and 2 shearing.
- Seggy - an adult male castrated after service
- **Frog** – the central elevated portion behind the foot
- **Chestnut** – the horny growth situated below the hock on both the hind limb
- **Hogging** – clipping the mane
- **Pouring** – pouring small quantity of dip into parts of the fleece along the back,sides and belly

- **Crutching** – removing soiled dung-stained wool of Perineal and inguinal regions
- **Scouring** – removal of impurities in raw wool
- **Mulling** - castration by crude method
- **Ringing** – removal of wool from the region around the penis
- **Eyeing** – clipping of wool around the eye to prevent wool blindness

Species	Number of defined breeds India
Cattle	28
Buffalo	7
Sheep	44
Goat	23
Equines	6

- **Watering of livestock**

Species	water intake /day
Cattle & buffalo	27 – 28 lit
Adult camel	70 – 90 lit
Sheep & goat	18 lit
Pigs	25 – 30 lit
Poultry	250 ml
Dog & cats	14 lit
Horse	36 lit

Species		Water req.for all purposes / day
➤ Cow	-	100 – 110 lit
➤ Horse	-	72 lit
➤ Pigs	-	40 -50 lit

Potable water

Standard physical qualities

Organic matter	3ppm
PH range	7-8.5
Turbidity	5 turbidity scale

Chemical qualities

Chloride, Sulphate	250ppm
Fluoride	1ppm
Ammonia	
Lead	0.1ppm
Arsenic	0.05ppm
Iron	0.3ppm

Hardness of water

- temporary hardness – **bicarbonates of calcium and magnesium**
- Permanent hardness - **Chlorides and sulphates of calcium and magnesium.**
- Chlorine demand for normal water – **0.9-1.8 ppm**
- Brackish taste of water is due to presence of **sodium chloride**
- **Sickle shaped horn – surti**
- **Tallest Indian sheep breed – Nellore**

- **Shortest Indian sheep breed – *Mandya***
 - Pelt breed – *karakul*
 - Largest goat breed – *jamnapari*
 - Dwarf breed of goat – *Barbari*
 - Milk fat percentage highest in *Jakffarabadi* & lowest in *Nili-ravi*
 - *Chegu* and *chanthangi* are pashmina goat
 - Gestation heat is also present in goat
 - Safe sanitary distance is **150-200 feet** away from the sources of contaminations
 - **Glutaraldehyde (2%)** aqueous solution used for sterilization of instruments
 - Trap is a contrivance for preventing **sewar gas** escaping in to house drainage system
 - Presence of iron in water encourages the growth of iron bacteria such as **crenothrix** and **gallionella**
 - Higher concentration of fluoride causes interference with calcification giving rise to dental dystrophy known as **mottled teeth**
 - Cooling power can be measured by **kata thermometer**
 - Air velocity **100ft/min** at **70°C** is found to be comfortable for broilers
 - Percentage of CO₂ present in the atmosphere can be measured by **Haldane's apparatus**
 - Short day breeders – sheep and goat
 - Long day breeders - horse
- ✓ Housing -East- west orientation – temperate regions
- ✓ North – south orientation – tropical regions

Identification of horse

- **Grey** – skin is black with admixture of black and white hairs

- **Bay** – varies from dull red to yellowish color, black mane, tail and the limb
- **Piebald** – irregular patches of white and black
- **Star** – a white mark on the forehead either large or small
- **Stripe** – a narrow white marking running down the face, may be thin or broad
- **Conjoined star and stripe** – stripe in continuation of a star
- **Blaze** – a white marking covering almost the whole of the forehead between the eyes and extending down the front of the face beyond the width of nasal bone and usually involving the muzzle
- **White face** – white covers the whole of forehead
- **Snip** – any isolated white mark in between the nostrils
- **White muzzle** – both lips will be white
- **Whorls** – any irregular setting of hairs
- **Freeze branding** - Dry ice – (- 70°C), Liquid nitrogen – (-196°C)

Teeth

- ✓ **Canine teeth** absent in mare, cattle
- ✓ **Tushes** – canine teeth of pig
- ✓ **Wolf teeth** – 1st pre molar of upper jaw in horse
- ✓ **Dental star** – a mark seen on the table surface of incisors in horse
- ✓ **Infundibulum** – dark depression on the table surface of incisors in horse
- ✓ **Carnassials / sectorial teeth** – in dogs.
 - 4th cheek tooth of upper jaw (4th pre molar)
 - 5th cheek tooth of lower jaw (1st molar)
- ✓ **Galvayne's groove** is a depression on the labial surface of the corner incisors
- ✓ **Bishoping** is an attempt to make the old animals to be mistaken for a young one

Dental formula

species	Temporary (deciduous)		permanent	
	2 (Incisors / canine / premolar)		2 (Incisors/canine/premolar/molar)	
Cattle/sheep/goat	0/4 , 0/0 , 3/3	20	0/4 , 0/0 , 3/3 , 3/3	32
Horse	3/3 , 0/0 , 3/3	24	3/3 , 1/1 , 3-4/3 , 3/3	40 - 42
Pig	3/3 , 1/1 , 3/3	28	3/3 , 1/1 , 4/4 , 3/3	44
Dog	3/3 , 1/1 , 3/3	28	3/3 , 1/1 , 4/4 , 2/3	42
Cat	3/3 , 1/1 , 3/2	26	3/3 , 1/1 , 3/2 , 1/1	30
Camel	1/3 , 1/1 , 3/2	22	1/3 , 1/1 , 3/2 , 3/3	34

- Double dished face is characteristic of **jersey** and **Guernsey**
- **Golden yellow** color milk is seen in Guernsey
- Best milk production of world is **Holstein Friesian**
- Key stone of arch in animal breeding – **selection**
- Mass selection can be powerful for **highly heritable traits**

<u>Species</u>	<u>Sperm count/ml</u>	<u>volume</u>
Bull	600-1200 million	2-10 ml
Buffalo	600-1000 million	2-5 ml
Ram	800-4000 million	0.6-2 ml
Stallion	50-200 million	30-280 ml
Boar	25-1000 million	150-450 ml

- **Calf starter** should be fed at 3 months of age (**TDN -70%, CP -22%**)

- Additional feeding during the pregnancy period – ‘*Steaming up*’
- Cows should be bred after calving within **60-90 days**
- Ear notching is commonly practiced in **pigs**
- Removal of testicles in fowl – **Caponisation**
- Draught power of bullock – **0.75 HP**
- Gestation period of goat is **145-155 days**
- Best known Indian goat milch breed – **jamnapari**
- **Crude Fibre** utilization - **Goat>sheep>buffaloes>cows**
- In sheep **flushing** is practiced **2-3 weeks** before mating
- Age of ram for breeding purpose – **2 yrs**
- Sheep tends to survive best in **drier climates**
- At 20 wks of age, **16 hrs** of lighting is required
- Air movement should not exceed **30 ft (9.2m)/min**
- For production of 1ml of milk **400-500ml** of blood must pass through the udder
- Major elements (Ca, P , K , Cl , and Na) cannot be changed by altering the levels of these elements in the ration of a cow
- **STH,ACTH,TSH and Oxytocin** exert their effect in maintaining the normal lactation curve
- **Galactophore** - a milk duct
- **Galactosidase** - enzyme which catalyses the splitting of lactose into **glucose + Galactose**
- **Galactopoiesis** – maintenance of lactation
- **Lactogenesis** – initiation of milk secretion
- Concentrate feeding – 0.35 kg per lit of milk
- Colostrums also known as **Beesting**

- Best time for castration is **8-10 weeks** for cattle
- Deworming – with **piperazone adipate** with in 3rd to 7th day, repeat it once in a month upto 6th month of age
- Calf mortality - **below 8%**
- Adult mortality – **below 3%**
- Chemical used for shearing in sheep – **Cyclophosphamide**
- Limiting amino acid of sheep - **Methionine**
- Dry matter requirement of sheep - **2.5 – 3 kg /head / day**
- The only milk producing sheep breed (goat like sheep) – **Sonadi**
- **Fineness of wool** – expressed in terms of **spinning counts (s)**
- Ratio of secondary to primary follicle in **Fine wool breeds** – **20 : 1**

Carpet wool breeds– 1:1 to 3:1

- Diameter of Wool fiber – **15 – 50 μ**
- Diameter of Kemp fiber – **100 – 200 μ**
- Hair - Medulla is present

Type of wool	Diameter	S unit
Fine wool	<25 μ	64s to 80s
Medium wool	25 – 40 μ	50s to 62s
Coarse wool	>40 μ	<50s

- The fiber from the Angora goat is known as **Mohair**
- Fleece contain Suint and Grease
- **Suint** – water soluble salts present in the wool, which is excretory products from skin

- The waviness of wool is known as **crimp**, fine wool will have more crimps
- Mutton – Pale pinkish
- Chevon – dark red with coarse texture

Type of animal	Floor space per animal (Sq.ft)	
	Covered area	Open area
Cows	20-30(3.5 m ²)	80-100(7 m ²)
Buffaloes	25-35	80-100
Young stock	15-20	50-60
Pregnant cows	100-120	180-200
Bulls	120-140(12 m ²)	200-250(120 m ²)
Ram /Buck	3.4 m ²	
Ewe /Doe	1 m ²	
Boar	9 m ²	9 m ²

VIII POULTRY SCIENCE

- **BREED**: group of individuals with in the species having distinct physical & productive characteristics, which are efficiently transmitted to decedents
- **variety**: subdivision of breed mostly decided by type of comb, colour of plumage
- **Strain**: population of small number of individuals in variety reproducing with well established common characteristics

Breeds

- **Mediterranean class** (Egg type): **M L A** (Minorca ,Leghorn , Ancona)
- **English class**(Meat type): **C O S A**(Cornish, Orphington, Sussex, Australop)
- **American class**(Dual type): **R P N W**(Rhode islandred, Plymouthrock, New Hampshire, Wyandotte) –
- **Asiatic class** – Brhaman, Cochin,Langsharn

Duck**Egg layers**: Khaki Campbell, Indian runner**Meat ducks**: white pekin, Aylsburry, Muscovy, RouvenSex ratio : Male:Female **1:15-16** - Replacement pullets**1:10-12** - broiler breeders**Family selection** is useful in low heritability characteristics

- Low heritability characters **egg production , fertility and viability**
- Pedigree selection is used for **sex limited traits**
- Individual selection adopted for traits of **high heritability**,
- **highly heritable characters** – egg weight, shell quality, sexual maturity, growth rate, confirmation
- Selection of birds for **Layer Line** – 10-14 weeks of age
Meat Type Line – 8 weeks of age
- **NAFED** – National Agricultural Co-Operative Marketing Federation of India
- In marketing of eggs, state level government organizations like MAFCO, TAPCO, POMFCO, NECC and NAFED are making considerable efforts for **marketing and sale promotion of eggs**
- **NECC** – National egg coordination committee – **fixes the prices for the eggs**
- **India – 3rd largest egg producer** next to china & USA
- Fertile egg – nucleus is called as **Germ disc**, infertile egg it is called as **Germ spot**
- **Oviposition** – act of laying, due to the release of **Arginine** and **vasotocin**
- **Brown color of egg** shell is due to the pigment **Porphyrin**
- **Blue shelled eggs** – pigment **Oocyanin**
- The normal depth of air cell is **4 to 8 mm**
- Shell from outside covered by a layer of cuticle which is **Bacteriostatic**
- Shell membranes – **0.001 – 0.02 mm thick**
- Shell – **11 %** of total egg weight
- Albumen – **58 %** of total egg weight

- Yolk – **31 %** of total egg weight
- **Ovomucin** – responsible for firmness of thick albumen

➤ **Oviduct**

- **Infundibulum** - fertilization of ovum, the yolk stays for about **15 min**
- **Magnum** – major qty of thick albumen secreted here , materials stay about **3 hours**
- **Isthmus** – 1.25 hrs, egg white, 2 shell membranes, some salt and water is added to egg
- **Uterus** – major role in egg formation, hard calcareous shell, shell pigment, some minerals & water along with cuticle deposited, egg spends max time 21 hrs at this place
- **Vagina** – egg just passes without spending time
- **24 – 26 hrs** required for formation of an egg
- **Haugh unit(HU)** – Evaluating albumen quality, the HU of good quality egg – **70**
- Temperature Egg holding room **18 – 20°C**
- **Physiological Zero** – to arrest the development of embryo before setting at 75-80 % humidity
- Fumigation – 1x – 40ml of formalin with 20g of $Kmno_4/2.80m^3$
- Incubator - temp-37.5- 37.8°C ,65-70% humidity
- Hatcher – temp- 36.5 – 36.8°C, 75 – 80% humidity
- Incubation period – 20-21 days
- **Brooding management** – up to 4 weeks – broilers, 6-8 wks – layers
- **Brooding space** – 50-66 cm^2 /chick, temperature – 33°C during first week, 2.6°C reduced every week till reaches 21°C
- **Debeaking** - generally done twice in egg type chicken – Day old & Around 9th day or at 3-4 weeks of age
- **Toe-clipping** – breeding males – 6-9 days of age
- **Dubbing** – removal of comb , around 7-8 weeks of age

- **Cropping** - removal of wattles
- **The average stocking density of adult birds**
 - Free range - **250birds/ha**
 - Semi intensive – **750 birds/ha**
 - Intensive system – **10000-25000birds/ha**
- **Foul-patch** – the ground immediately surrounding the houses- more danger of infection
- **Depth of litter** – **5cm** for chicks, **7 -10cm** for growers and layers
- The **relative humidity in the deep litter** system should be **around 40%**
- The **moisture content of litter** should not be less than **18%** and should not exceed **>24%**
- The ammonia level produced by litter should not exceed **25ppm**
- Orientation of poultry houses – **East-West direction**

Floor space requirement

	Layers		Broilers	
	Age (weeks)	Space/bird(cm sq)	Age (weeks)	Space/bird(cm sq)
Deep litter	0-7	650-675	0 - 4	450-470
	8-11	900-925	5 - 7	750-850
	12-19	1800-2000		
Cage system	0-8	200-250		
	9-20	275-300		
	20 & above	337-375		

- **Restricted feeding**- increases the size of initial eggs laid and is an important factor to regulate the size of eggs
- **Egg-borne transmission** (Trans ovarian diseases) - Salmonellosis , Mycoplasmosis, Avianleucosis complex, Ranikhet disease , Infectious Bronchitis, Avian Encephalomyelitis,avian Adeno virus infection, IBH(inclusion body hepatitis), EDS-76, Fowl typhoid
- **Mottled yolk** – Due to coccidiostat, hot weather, gossypol poisoning
- **Blood spot** – Vitamin A deficiency
- **Brooder pneumonia** – Aspergillus fumigates
- **Gape worm** (Forked worms)– Syngamus trachea
- Vaccine - Drinking water administration – For 10 liters of water **1kg of ice** and **60g of skimmed milk powder** is used
- The RH of poultry house should range from **45-75%**
- Hatch weight of broiler chick - **35 – 40 g**
- Chicks must remain in continuous lighting **up to 8 wks** of age

NUTRITION

- Supplemental **nitrogen: sulphur** necessary in the ratio of **10:1**
- Cereal grains are deficient in **lysine** and **tryptophan**
- Fish meal is rich source of **lysine, tryptophan** and **methionine**
- Piglets highly susceptible to **iron** and **cobalt** deficiency
- **Piglet anaemia(thumps)**
 - symptoms - Pale in the region of ears and belly, Listlessness, Rapid breathing, often Diarrhoea .
 - R_x - 100-150 mg of iron in the form of iron dextron – 3 days after birth if necessary a second inj.-3 weeks later

- Weight at weaning age is proof of **efficient growth** and also an indication of the **milking ability** of the gilt
- Creep feeding given from **3rd week** onwards (25-30% CP)
- Yellow maize is rich in **cryptoxanthine**
- **Restricted feeding** produces better quality meat
- Cotton seed meal is known for its efficiency to produce **hard and firm meat**
- Feeds like **ground nut, maize, rice bran, vegetable oils**, etc when fed in liberal will result in **soft pork**
- Maize as a cereal deficient in **calcium**
- **Choline** and **methionine** are needed to supplement to counteract the toxicity resulting from tannin
- Rice polish – rich in **thiamine** and higher in **niacin** and **riboflavin**
- Wheat bran – 12% fiber rich in **phosphorus** and **poor in calcium**
- **Blood meal - >80% protein**
- **Meat meal – 50-55 CP**
- Blood meal is deficient **isoleucine**
- Ground nut cake **40-50% protein**
- Feather meal **5%** inclusion level